

GLOBE Observer: App of the GLOBE Program Project Documentation 2015 to 2025

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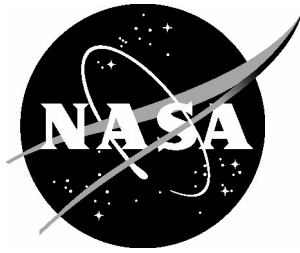
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Project Documentation 2015 to 2025

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Produced by the NASA Earth Science Education Collaborative (NESEC),
funded under NASA's Science Activation Program, Award No. NNX16AE28A.

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1.Introduction

This publication documents the development and implementation of GLOBE Observer between 2016 and 2025 under the NASA Earth Science Education Collaborative (NESEC)*. During this period, NESEC was funded by NASA's Science Activation Program under IGES award No. NNX16AE28A.

This publication provides history and programmatic documentation for the development and implementation of GLOBE Observer to support ongoing implementation and provide context for future decisions.

1.1. Overview: GLOBE Observer and the GLOBE Program

GLOBE Observer began in 2016 as a means to engage a broader community of volunteers in the Global Learning and Observations to Benefit the Environment (GLOBE) Program. An international science and education program, participation in GLOBE had been largely restricted to educators and students in GLOBE countries after application and training. As the field of citizen science gained traction, GLOBE Program management recognized that GLOBE protocols, database and structure had the potential to support a wider audience in contributing environmental observations to support Earth system science and education. Congress passed the [Crowdsourcing and Citizen Science Act of 2016 \(15 USC 3724\)](#) authorizing the use of citizen science within the U.S. Federal Government and provided additional impetus to create GLOBE Observer.

GLOBE Observer was designed to allow volunteers of all ages to participate in GLOBE by removing barriers to participation while still maintaining high quality data collection. No prior training, application, or specialized equipment beyond a smart phone is required to join GLOBE as a citizen scientist. Volunteers collect and submit data through a smart phone application called GLOBE Observer. Here and throughout *GLOBE Observer* refers to the implementation of GLOBE with volunteers beyond the traditional education context. The app will be referred to as the *GLOBE Observer app*.

Though it was incubated outside of GLOBE management under the NASA Science Activation Program, GLOBE Observer is part of the GLOBE Program.

1.2. Scope

1.2.1. Scope of documentation

This publication focuses on the management and implementation structure for GLOBE Observer. It does not include technical documentation for the GLOBE Observer app, which is managed by GLOBE's [Data and Information System](#) (DIS) team. Limited technical documentation for the GLOBE Observer website is included, but complete technical documentation is managed by DIS.

1.2.2. Scope of GLOBE Observer

For the purpose of this document, GLOBE Observer refers to the implementation of GLOBE with volunteers who are not GLOBE-trained educators or students. (GLOBE-trained educators are those who have completed formal protocol training.) We acknowledge that trained educators and students benefit from the resources created to support all volunteers. Volunteers who are not fully trained in GLOBE may include both formal and informal educators, students, and individuals of all ages. During the period covered by this document, GLOBE-trained educators and students were supported by the GLOBE Implementation Office (GIO). Starting in 2026, all volunteers will be supported by the GIO.

It should be noted that at the end of 2025, GLOBE transitioned to a single account type, giving citizen scientists the same access to GLOBE protocols as educators. All users must complete online training to contribute data to GLOBE using protocols beyond the core GLOBE Observer protocols. This documentation describes the environment prior to the account change.

* All acronyms are defined in [Appendix A](#).

2.GLOBE Observer Implementation

2.1. Science Activation and NESEC Structure

The NASA Science Mission Directorate (SMD)* Science Activation (SciAct) program is the umbrella under which GLOBE Observer was developed. SciAct is a competitively selected network of collaborative projects that seek to connect NASA Science with learners of all ages and backgrounds in ways that activate minds and promote a deeper understanding of our world and beyond, with the ultimate vision: to increase learners' active participation in the advancement of human knowledge.

GLOBE Observer development and implementation is a component of the NASA Earth Science Education Collaborative (NESEC), a SciAct cooperative agreement, award number NNX16AE28A. Theresa Schwerin, Institute for Global Environmental Strategies (IGES), is the Principal Investigator, and partner organizations include NASA's Langley Research Center (LaRC, Co-I Jessica Taylor), NASA's Goddard Space Flight Center (GSFC, Co-I Dr. Trena Ferrell), Jet Propulsion Laboratory (JPL, Susan Callery was the original Co-I, current NESEC institutional lead is Anya Bifurno), and Oregon State University (OSU, Dr. Martin Storksdieck and Dr. Heather Fischer, evaluation team leads)

Holli Kohl, a contractor (Science Systems and Applications, Inc. (SSAI)) at GSFC, leads the GLOBE Observer team. Staff from all NESEC institutions participate in GLOBE Observer, with development and implementation priorities set collaboratively. A full description of the NESEC team, including roles and responsibilities, is in [Appendix B](#).

2.2. GLOBE Program Coordination

2.2.1. GLOBE Implementation Office and GLOBE Program Office

GLOBE Observer is part of the GLOBE Program, which means that its development and implementation is done in close coordination with both the GLOBE Implementation Office and the GLOBE Program Office. Coordination with the GIO and GPO occurs primarily through weekly implementation coordination meetings. In the weekly meeting, the GO team, GIO, DIS, and GPO discuss current tasks and priorities related to the implementation of GLOBE Observer; activities, challenges or problems that require coordination to implement or resolve; key decisions.

2.2.2. GLOBE Data and Information System

GLOBE's Data and Information System (DIS) team receives funding from NESEC to develop and support the development and sustainment of the GLOBE Observer app, GLOBE Observer website, and (until June 2024) lead communication efforts in coordination with the GLOBE communications director under GIO.

2.3. Decision Authority

The implementation of GLOBE Observer has been collaborative. Broad priorities and direction are set in annual meetings of the NESEC GLOBE Observer team, including DIS, GPO, GIO, and Science Activation leadership are informed and may provide input on high level decisions. GPO can overrule decisions that impact GLOBE's broader objectives.

Within the GLOBE Observer team, each protocol has a science lead who interfaces with other scientists and sets the science priorities for each protocol. These influence the types of engagements (e.g., data challenges and partnerships) planned for GLOBE Observer. NESEC leadership also provides input and direction for decision making. Day-to-day decisions occur within the scope of individuals' responsibilities and are coordinated across the team as needed. A full description of the NESEC team, including roles and responsibilities, is in [Appendix B](#).

2.4. Reporting

GLOBE Observer decisions and activities, including future plans, are reported in the NESEC annual reports submitted to Science Activation. Informal, interim reports are sent to stakeholders (the NESEC team, GPO, GIO, DIS) quarterly. Additionally, activities are reported to Science Activation during its monthly group meeting and to GIO, GPO, and DIS during the weekly coordination meeting and its minutes. Significant developments and outcomes are reported to the volunteer community through news announcements on the GLOBE Observer website and in the GLOBE newsletter.

* All acronyms are defined in [Appendix A](#).

3. Foundations of GLOBE Observer

3.1. Guiding Principles

GLOBE Observer is meant to provide a low-barrier path to participation in GLOBE. To ensure wide access, we adopted the following guiding principles:

- Anyone in a GLOBE country can participate. No application process is required. Participants only need an active email address to register. NOTE: GLOBE countries can opt out of allowing non-educators to participate as citizen scientists. As of March 2025, only Saudi Arabia has opted out of GLOBE Observer for untrained volunteers.
- No prior training should be required to participate in GLOBE through GLOBE Observer. App-based data collection allows for in-app training and just-in-time guidance during data collection.
- Number of protocols offered to everyone in the GLOBE Observer app should be limited (not all GLOBE protocols) to minimize chances of overwhelming a participant.
- No equipment is required to collect basic data. Protocols may ask for data collection with easy-to-obtain, inexpensive tools as long as that step is optional.
- To be included in GLOBE Observer, a protocol must first be based on a GLOBE protocol.
- GLOBE Observer can be a pathway to deeper participation in GLOBE. Ideally, anyone who wants to participate in GLOBE should be able to take eTraining and submit data. NOTE: Implementation of this guideline is currently limited internationally by the language in the bilateral agreements. A country coordinator may choose to allow non-educators to become trained, but it is not a requirement of the GLOBE Program.

It should be noted that future decisions may result in revisions to these guiding principles. GLOBE may choose to make more protocols available to all citizen scientists in the GLOBE Observer app, including protocols that require equipment.

3.2. Objectives

In addition to the guiding principles, the NESEC team identified the following objectives to guide development:

- Increase GLOBE data density both spatially and temporally
- Expand scientific research with distributed volunteer observations
- Enable student and citizen science research
- Expand the GLOBE community by welcoming volunteers beyond the education community and helping them feel like they are part of the community
- Increase scientific literacy among participants

3.3. Capabilities of GLOBE Observers within GLOBE

A GLOBE Observer is registered as a citizen scientist in the GLOBE system. They can submit data for the open protocols in the GLOBE Observer app (not the protocols under data entry which require GLOBE training), submit research reports, create and/or join a GLOBE team, see their observations on a My Observations page, and earn badges and recognition. However, since no vetting occurs to allow a citizen scientist to join GLOBE, their access to the GLOBE system is limited. They cannot edit their data once submitted. A GLOBE Observer does not have their own My Page, cannot set up student accounts, and is part of a general citizen science organization by country on the GLOBE website (i.e. “United States of America Citizen Science”). In some countries, GLOBE Observers may apply for full membership, be vetted, and if accepted as a trusted person, may take eTraining to be permitted to enter data for all GLOBE protocols.

Note: As of December 2025, all accounts have similar capabilities, although new users can still indicate on the [Create a GLOBE Account](#) page if they are a teacher/formal educator or informal educator. All users are now able to set up guest accounts (formerly student accounts) and take training to enter all protocols. My Pages have been replaced for all users with My Observations+ pages.

3.4. Legal Considerations

Decisions regarding the development and implementation of GLOBE Observer have been guided by the following legal considerations.

3.4.1. Data Privacy Regulations

Two regulations have influenced decisions related to data privacy in GLOBE Observer: the [Children’s Online Privacy Protection Rule \(COPPA\)](#) (United States) and [General Data Protection Regulation \(GDPR-K\)](#) (European Union).

COPPA restricts the collection of personal information from children under the age of 13 in digital environments. Restricted personal information includes an email address and physical address. Since GLOBE Observer requires an email address for registration and a physical location for data collection, the decision was made to restrict access to individuals over the age of 13. We could decide to extend the app’s use to younger individuals if we develop a way to collect and track parental or teacher consent. Younger individuals may use the app with an anonymous student account, which does not violate COPPA. As a U.S. program, GLOBE is obligated to comply with COPPA.

GDPR-K is a similar restriction throughout Europe that restricts access for children under the age of 16 (or younger, depending on the European Union country). The decision to limit access to age 13 complies with U.S. regulations, but it should be noted that some European countries may choose to recommend student accounts for app use with teens to align with the more conservative GDPR-K restrictions.

3.4.2. Paperwork Reduction Act

The [Paperwork Reduction Act \(PRA\)](#) limits the amount of information a federal entity may request from the public. No government organization can request the same information from more than nine individuals in a calendar year without a PRA exemption, even if the information is voluntary. NASA has obtained a general PRA exemption for citizen science under which GLOBE's "Information Collection" is covered. However, the GLOBE Program is required to routinely provide data to NASA to ensure the program is covered under the agency PRA. This task is currently managed by DIS Task Monitor, Lisa Dallas. The data call requests the following for each protocol:

- Number of participants (low estimate to high estimate)
- Length of time to register/get account (estimated as 5 minutes)
- Length of time to complete the training
- Length of time to do an observation
- Number of observations

Note: Other agencies comply with PRA regulations in different ways, and this may limit partnerships. For example, early in the development of GLOBE Observer, the National Park Service required a PRA exemption for every park that might want to use GLOBE Observer or any other citizen science project.

3.4.3. Section 508 and Accessibility

[Section 508 of the Rehabilitation Act of 1973](#) requires federal agencies to make electronic resources accessible to people with disabilities. Under this law, individuals with disabilities should have access to the same information as everyone else. As a federally funded project, the GLOBE Observer app, communication products, and website are required to comply with all requirements. The GLOBE Observer style guide was developed to guide the creation of compliant products.

3.4.4. Crowdsourcing and Citizen Science

The [Crowdsourcing and Citizen Science Act](#) is a 2017 law that authorizes the use of citizen science within the federal government and recognizes its value to advancing agency missions as well as stimulating and facilitating connecting members of the public directly to the NASA mission and to each other.

3.4.5. NASA Citizen Science Policy

NASA policy document [Science Mission Directorate Policy on Citizen Science \(SPD-33\)](#) and [NASA Policy Directive 1090.2: Citizen Science \(NPD 1090.2\)](#) define citizen science within NASA and set expectations for the implementation of citizen science. Those expectations include a requirement to meet NASA's rigorous science standards. GLOBE is a citizen science program that includes support to engage volunteers in a variety of settings. Each GLOBE Observer tool has a science lead or science liaison. The NESEC team developed the [GLOBE Data User Guide](#) for scientists and invested significant effort in discussing and encouraging collaboration with scientists at NASA centers and beyond. These efforts are covered fully in [Chapter 5: Protocols](#) and [Chapter 6: Science](#).

3.5. Timeline of Development

The GLOBE Observer app developed on the following timeline:

2015	GLOBE and Citizen Science Workshop On January 13-14, 2015, GLOBE Program Manager Dr. Ming Ying Wei sponsored a workshop to discuss if and how GLOBE could welcome individual volunteers of any age participating outside of school. The core concept of GLOBE Observer came from the workshop.
2016	NASA Earth Science Education Collaborative NASA selects the NASA Earth Science Education collaborative to create and implement GLOBE Observer under the Science Activation Program. Early planning meetings create the core structure and guiding principles of the GLOBE Observer team.
2016	GLOBE Clouds The GLOBE Observer app launched formally on August 30, 2016, after a few months of launch in beta and updates. At launch, the app contains the GLOBE Clouds tool, which is a direct translation of the GLOBE Clouds protocol.
2017	GLOBE Mosquito Habitat Mapper The development and timing of Mosquito Habitat Mapper in March 2017 was driven by the global emergence of the Zika virus and the rise of other mosquito-borne illnesses. Department of State funding and support drove development with field tests and training for implementation in select South American, Caribbean, and African countries. This is the only GO tool not based on a previously existing GLOBE protocol, though it was adapted from a prior protocol.
2017	GLOBE Eclipse GLOBE Eclipse is designed and released for the August 2017 total solar eclipse in the United States.
2017	S'COOL Integration and Satellite Match GLOBE Clouds is updated to fully integrate with S'COOL, adding cloud height, sky color and visibility, and transparency. S'COOL integration also included the creation of satellite collation tables for all data collected during a satellite overpass and the in-app overpass predictor. S'COOL, Students' Cloud Observations Online, was previously funded at NASA's Langley Research Center to involve students and citizen scientists in collecting cloud data to support CERES instrument science. See Section 5.3.2: Basis in GLOBE Protocols
2018	GLOBE Land Cover GLOBE Land Cover is released in September 2018. The tool is based on GLOBE's site definition protocol.
2019	GLOBE Trees GLOBE Trees is released in March 2019 based on the GLOBE Biometry protocol.

2019	GLOBE Eclipse	GLOBE Eclipse is opened for a South American total solar eclipse in July 2019.
2019	GLOBE Teams	The GLOBE Teams function is released.
2020	Cloud Wizard Update	The Clouds tool is updated with a guided cloud identification system, the cloud wizard, that leads users through a series of questions to assign cloud type. Additional modifications adjust the contrails field to improve data quality.
2020	GLOBE Eclipse	The Eclipse tool is released for the December 2020 total solar eclipse in South America.
2021	GLOBE Mosquito Habitat Mapper Update	Mosquito Habitat Mapper received a redesign in 2021 with a more visual key.
2021	SciStarter	The ability to connect GLOBE Observer data with SciStarter occurred in 2021.
2021	Data Entry Integration: Atmosphere	Data entry for all atmosphere protocols is added to GLOBE Observer as the app becomes the app of the GLOBE Program.
2021	Geofencing Tool Released	In November 2021, a function to request data in a specific location is released. It remains in testing while the process for requesting and approving requests is developed and tested.
2022	Photo AI and QA Checks	In March, cloud photos begin to be screened through an artificial intelligence (AI) tool to filter text, people and inappropriate content. Manual photo review continues for any photo flagged by the AI. The app update also adds quality checks to ask users to verify unusual locations (0,0 or 90,90) and times (00:00). The update also improves accessibility and adds the ability to send out location-based in-app announcements.
2022	Data Entry Integration: Hydrosphere	A July 2022 update adds data entry for all Hydrosphere protocols.
2022	Screen Names	GLOBE Observer allows volunteers to choose a screen name to help them identify themselves within the GLOBE Program.
2022	Photo AI Expansion	In July, all photos submitted to GLOBE begin to be screened through the AI, expanding from cloud photos.

2023	Data Entry Integration: Biosphere	Biosphere data entry is added to GLOBE Observer.
2023	GLOBE Eclipse	The GLOBE Eclipse tool is available for the October 2023 annular eclipse in North, Central, and South America.
2023	Land Cover Special Feature Photo	In December, a new function is added to GLOBE Land Cover to allow users to add up to four photos of things that wouldn't fall in the normal North-East-South-West photos. This function supports the use of the land cover tool for new purposes such as monitoring river ice.
2024	My Achievements	Users are able to earn and track rewards in GLOBE Observer, including streaks and milestones.
2024	GLOBE Eclipse	The Eclipse tool is opened for the April 2024 total solar eclipse.
2024	GLOBE Trees Update	In November 2024, GLOBE Trees is updated to allow users to add genus and species to their observation.
2025	Data Entry Integration: Pedosphere	Pedosphere protocols are added to GLOBE Observer, completing the migration of data entry into the Observer app.
2025	Practice Mode	Users are able to practice data collection or try the app without creating an account or submitting real data.
2025	Land Cover Satellite Match	Users start receiving emails with land cover and Landsat and Sentinel images to align with their land cover observations.
2025	Clouds Special Feature Photos	Users are able to submit photographs of things that don't show up in standard clouds photos, such as dust storms or contrails.

4. GLOBE Observer Application

The GLOBE Observer app was originally developed to provide data entry access to GLOBE for volunteers who are not trained educators or students. Many approaches could have been taken to allow such individuals to participate in GLOBE, such as offering access to online training (GLOBE eTraining) and web-based data entry. However, app-based citizen science such as iNaturalist was gaining popularity in 2015-16 and culturally, there seemed to be some expectation that wide-reaching citizen science be facilitated through an app. Unlike web forms, an app has the potential to function offline. In the case of GLOBE Observer, it was designed to allow a user to collect data offline and then submit data once the app is online again. As we hoped that engaging non-school based volunteers would expand geographic data collection in more remote locations, being able to function offline was important.

Additionally, a phone-based app can utilize a GPS, camera and various on-device sensors that facilitate accurate data collection, which simplifies the data entry process and requires minimal investment in additional equipment. The app removes barriers while allaying concerns about allowing participation in GLOBE without vetting or training. An app provides guided data collection to ensure data quality from untrained users. Simple, in-app training provides the basic information needed to get started. Account management, data submission, and simple communication can also be done through the app so that a volunteer is not required to interact with GLOBE through its website, social media, in-person meetings, or newsletters (though volunteers are encouraged to engage in those ways). By gathering the essence of GLOBE into a single, simple location — the GLOBE Observer app — we hoped to create an easy-to-access capability that would make it possible to build a new community of individual volunteers.

This section defines the function of the GLOBE Observer app and how it is used to support citizen scientists. The technical specifications, including the app architecture and code, is documented by GLOBE DIS. DIS also maintains a record of change requests for each app development. The details below reflect the app as it stood at the end of 2025, before programmatic changes related to training and access to Data Entry were made.

4.1. Definition of Terms

- **GLOBE Observer App:** The term *GLOBE Observer app* refers to the app platform overall. The app contains multiple components that enable data submission to GLOBE including citizen science protocols and GLOBE data entry forms. The app also includes various additional features such as communications to users, recognition for participation, notifications etc., detailed below.
- **Tool:** The “appified” protocols (Clouds, Mosquito Habitat Mapper, Land Cover, Trees, and Eclipse) that are visible to citizen scientists and guide data collection and submission. Referred to as tools, i.e., the GLOBE Clouds tool in the GLOBE Observer app, to differentiate from the underlying protocol and the broader app platform.
- **Protocol:** The underlying scientific procedure for collecting data regardless of how it is recorded and submitted to GLOBE. For example, clouds data may be collected and submitted through GLOBE Observer or collected on paper data sheets then submitted via GLOBE’s web-based data entry forms all following the same scientific protocol. It should be noted that the GLOBE Clouds protocol is uniform across all data entry methods (i.e., Observer, Data Entry, and web or paper data sheets), while the other three tools deviate to various extents from the traditional GLOBE protocol as part of the “appification” process.

4.2. In-App Training

Participating in GLOBE as a citizen scientist through GLOBE Observer does not require prior training. However, each tool includes a brief, in-app training that must be completed before the tool is “opened” to collect and submit data. Including training in the app instead of separate online training or in-person training was meant to make it easier for anyone to join GLOBE and use the app.

We tried various approaches to training in each of the protocols, and as a result, the training for each protocol is very different.

- Clouds has a short, three-screen introduction that provides an overview of the science ask, steps involved in collecting data and links to more information. It also includes a link to [extended training](#) available on the GLOBE and GLOBE Observer websites. Additionally, the Clouds tool provides in-protocol guidance in the form of the Cloud Wizard.
- Mosquito Habitat Mapper is a more complex protocol. It fully integrates training into the protocol screens. The user gets the information when they need it to collect data instead of learning about it ahead of time. Like Clouds, Mosquito Habitat Mapper has a short, four-screen introduction that provides an overview of the science ask, steps involved in collecting data and links to more information.
- [Land Cover training](#) is interactive and done in three parts. Users cannot click through the training. They are required to demonstrate their comprehension by matching classification types with photos, classifying land cover in additional photos and answering questions. Once the user completes each phase of the training, they earn a badge. Tapping on the badge from the Land Cover landing screen opens the training again. While the interactive nature of the training was thought to encourage learning, some feedback from trainers and users suggest that it might be a barrier to collecting land cover data. It is recommended that this training be simplified to be more like Clouds or Mosquito Habitat Mapper in the future and that the more complex tasks of classification be simplified or provide guidance during data collection. Both the Cloud Wizard and the updated Mosquito Habitat Mapper classification have taken this approach with integrated just-in-time guidance rather than extensive upfront training.
- [Trees training](#) is done through a series of screens containing concise text and illustrations or simple animations showing each step. It is more visual and less dense than other trainings, but users have to click through more screens.

Future development might consider making the training approach consistent across all tools in the GLOBE Observer app.

Once users have completed the training, the tool is unlocked for data collection. For all protocols, training can be accessed by tapping on the small question mark (help) in the lower right corner of any tool screen. Tapping the *Help* icon terminates an observation in progress. The GLOBE Observer website also provides training resources under *Do GLOBE Observer > [Protocol Name] > Taking Observations*.

4.3. Location

All protocols require location data. Traditional GLOBE protocols require a school to set up a data site, which can be used for multiple protocols. GLOBE Observer deviates from the approach by automatically creating a new site (if one doesn't already exist) when the user makes the measurement. The sites created for GLOBE Observer use the Military Grid Reference System (see [GLOBE Data User Guide](#) for details) to create sites at a resolution of 100 x 100 meters. Any GLOBE Observer measurement that occurs within a given MGRS grid is associated with the site that is named after that grid. Additionally, the user's actual latitude and longitude are stored with the measurement as additional metadata.

For all protocols, the GLOBE Observer app pulls the data location from the device's location services, which rely on GPS satellites and triangulation from cell towers to identify the phone's location. The location accuracy for all observations is dependent on the device, the user's location, the availability and visibility of GPS satellites and other factors. In some circumstances, such as dense urban environments, the line of sight to both satellites and cell towers is limited, and we receive user's location data that includes a high level of uncertainty. As covered in [section 7.1](#), location is the largest source of error in GLOBE Observer data.

To help improve accuracy, the app pings user location on the initial load of the main home page, followed by pings within each protocol. An initial ping on home page load can help accuracy as on some devices the initial ping activates the location services and location accuracy starts improving as the user continues into the given protocol.

For Clouds, Mosquitoes and traditional Data Entry protocols, the app pings five additional times and the last value is used for location. For Trees and Land Cover the app pings up to ten times, however there is a check which stops the pinging once the accuracy is within 50 meters.

The location accuracy is provided to the user in the app (i.e. estimated accuracy: 10 meters). The app includes a mechanism for the user to refresh their location, along with text that says, "Please press reset button (above) to improve estimated accuracy if needed (most useful is 12 meters or less)." By pressing the refresh button, the user gives their phone the opportunity to acquire refined location data and potentially improve reported accuracy. Alternatively, a user may manually adjust the location using an embedded map. This approach is especially encouraged for Trees, where a highly precise location is essential to compare GLOBE tree heights to satellite data ([Lu et al., 2025](#)). If the app is unable to acquire a location, the location accuracy is reported as 999999. In these instances, the location should not be trusted.

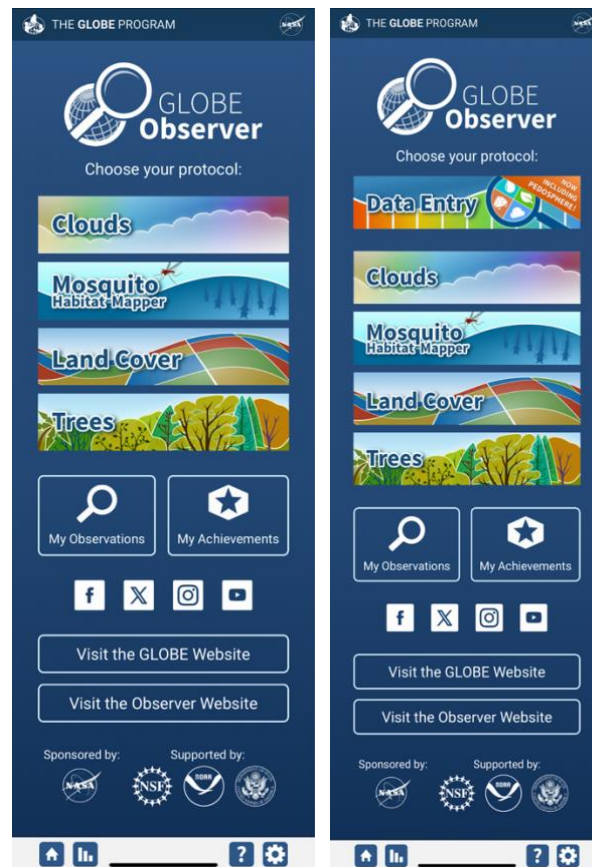
The GLOBE Observer app does not track users' locations when the app is not active. For citizen science accounts, location is never associated with personally identifiable information in public distribution of the data.

4.4. App Sections

The GLOBE Observer app is made up of the following top-level sections:

4.4.1. Home

The home screen provides access to the GLOBE Observer tools, My Observations, My Achievements, GLOBE social media channels (Facebook, X, Instagram, and YouTube), the GLOBE website, and the GLOBE Observer website. Trained users will also see GLOBE Data Entry (right image).



The lower bar navigation includes buttons to the home screen, data review and submission screen, help, and settings. The home (house icon) and data review (bar graph icon) buttons remain on the lower navigation bar for every screen in the app. The icons on the right, help (question mark) and settings (gear icon) become section-specific items elsewhere in the app, such as tool help or tool home.

4.4.2. My Observations

Tapping on *My Observations* opens the user's My Observations page on the GLOBE website. This screen shows data submitted by an individual during the time period specified in the "start" and "end" date fields. The time defaults to the current date but may be adjusted to show data from a range of dates. The end user can select the type of data (clouds, mosquito habitats, etc.) they wish to see. For clouds and land cover, each observation also includes a link to collocated satellite data for that observation. This page can also be accessed directly on the GLOBE Observer website. When a user is logged in with their account, a *View My Observations* button appears at the upper right.

Clouds

Measured Date: 2025-03-29

Organization Name: United States of America Citizen Science

Site ID: 381892

Site Name: 18SUJ234066

Latitude: 38.890536

Longitude: -77.03623

Elevation: 5.2m

Measured At: 2025-03-29T20:08:00

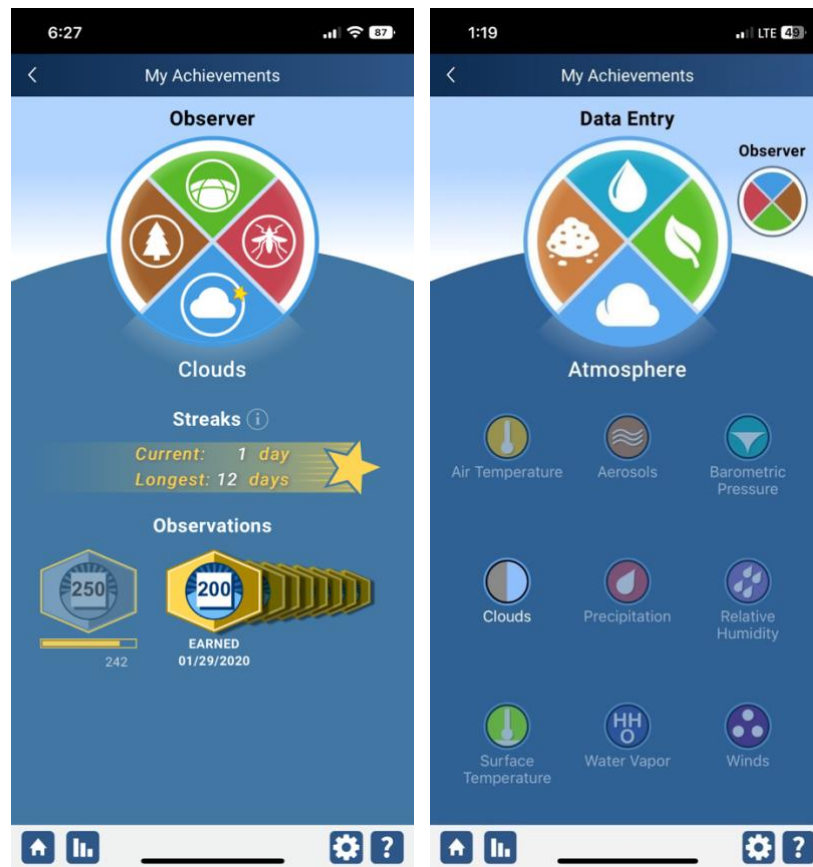
Solar Measured At: 2025-03-29T20:08:00

Cloud Cover High:	broken
Cloud Cover Mid:	scattered
Cloud Cover Low:	broken
Opacity High:	transparent
Opacity Mid:	translucent
Opacity Low:	opaque
Spreading Contrails:	4
Dry Ground:	true
GLOBE Teams:	AccentureTest2,ACC General,Axient Team,GLOBE Annual Meeting Detroit 2019,New Mexico Observers,New Mexico Trees
Data Source:	GLOBE Observer App
Satellite Match:	GOES-16

Show on Map

4.4.3. My Achievements

Tapping *My Achievements* goes to an in-app landing page showing all of a user's streaks and milestone achievements. A trained user will see achievements for both Observer and Data Entry. A user can navigate to see achievements for each protocol by tapping on the protocol icon in the navigation wheel.



Some level of in-app rewards have been part of the GLOBE Observer app from the beginning. Every tool had an observation count on the tool home screen. Land Cover also offered badges earned by taking each phase of land cover training.

To make rewards and recognition consistent, we released an expanded rewards and recognition system in March 2024 that applied consistently to every tool and all GLOBE protocols for the entire GLOBE community. This system tracks the total number of observations per protocol as well as streaks—the number of consecutive days an observation was taken and submitted—and rewards users who achieve significant milestones, such as “first observation submitted”, etc.

The update created a landing screen for My Achievements in addition to showing protocol-based achievements on the tool home screen. This creates space for two types of badges or recognition: automated badges assigned by the system based on submitted data (badges for number of observations and streaks) and ad hoc badges that could be assigned manually.

We scoped this work by surveying the GLOBE community to find out what types of badges and recognition they would find most motivating. We surveyed U.S. Partners, the GLOBE Implementation Office, the NESEC team, and GLOBE working groups and identified the

types of behavior that should be encouraged through rewards. The top priority was consistency (recognized by streaks) followed by completeness (submitting optional data, taking all requested photos), data density (repeat measurements at a site or mapping to fill a grid), and experience (milestone badges). In the initial phase of development, it was decided to move forward with the top priority category—consistency—to develop recognition for streaks and the lower priority experience category (milestones) because milestones already existed in the app and would need to be integrated regardless.

In discussion, it became clear that recognizing completeness might be more effective if there were functions integrated into the tools to indicate the completeness or quality of the observation as the person collects data rather than later. As this involved a deeper level of development, it was tabled for future work.

Data density was prioritized lower by the community, so it was not developed initially. It could be implemented at a future date or folded into specific science requests.

Other community badge requests were for things that would not be easy to automate based on what a volunteer submitted to the database. These included providing badges for high quality data, meeting specific science needs (such as providing data during a challenge, intense observation period or data request), reviewing or taking training, or getting a certain number of satellite matches. The community also requested the ability to define a badge themselves, as not all categories of recognition can be predicted. For these types of badges, DIS is building the capability to award ad hoc badges. To award these badges, GIO, the partner, or whoever is authorized provides a list of user IDs to DIS along with the appropriate badge. DIS would then distribute the badge to the users identified. DIS records of development are tracked in separate documentation, available from that team.

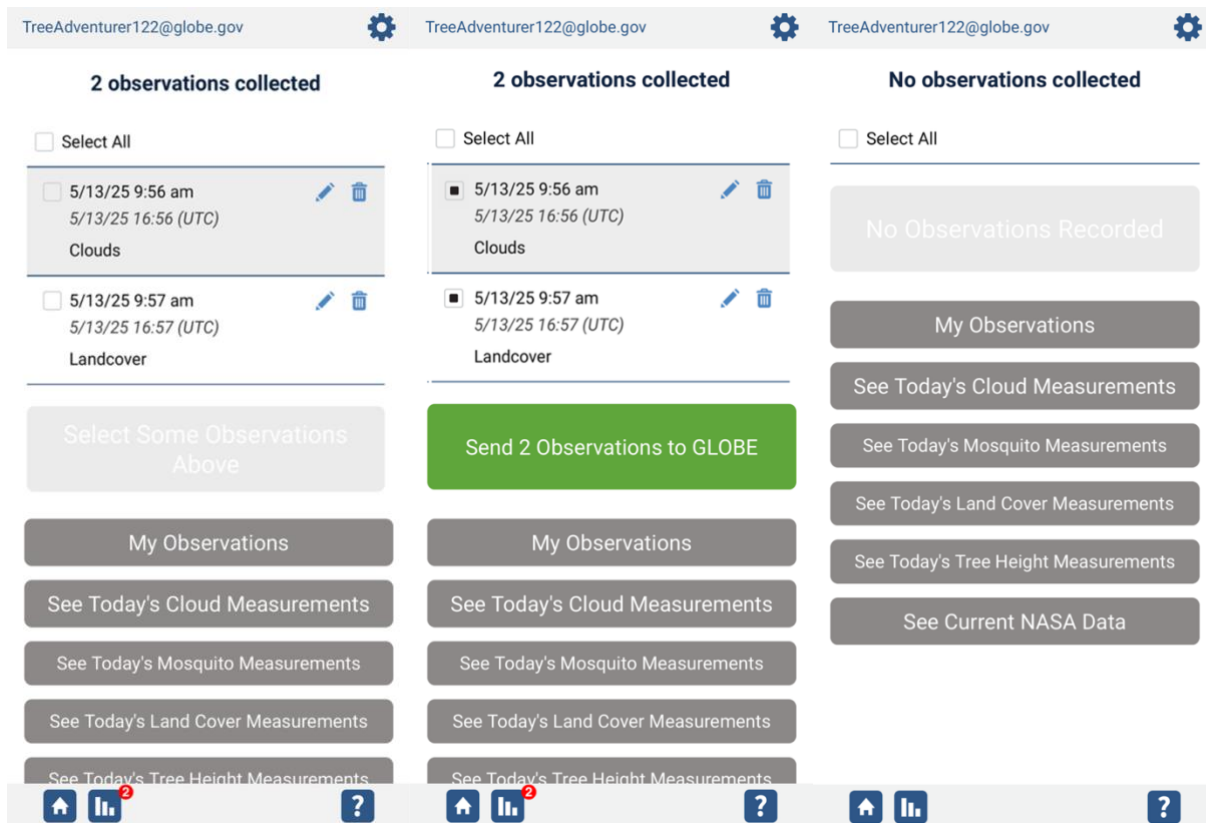
4.4.4. GLOBE Observer Protocol Tools and Data Entry

At the heart of the GLOBE Observer app are the GLOBE Observer tools for data collection and data submission functionality. GLOBE Observer tools are all designed to guide data collection with little prior knowledge. These are detailed in [Chapter 5: Protocols](#). Data entry mirrors GLOBE's [web-based data entry](#) for all other GLOBE protocols.

4.4.5. Data Review and Submission

The bar graph icon on the lower left corner of every screen leads to a data review and submission screen. The screen shows all the observations a person has on their device that are ready to submit to GLOBE. When a user has data waiting to be submitted, a small number will appear over the graph icon indicating the number of observations which are stored on the device.

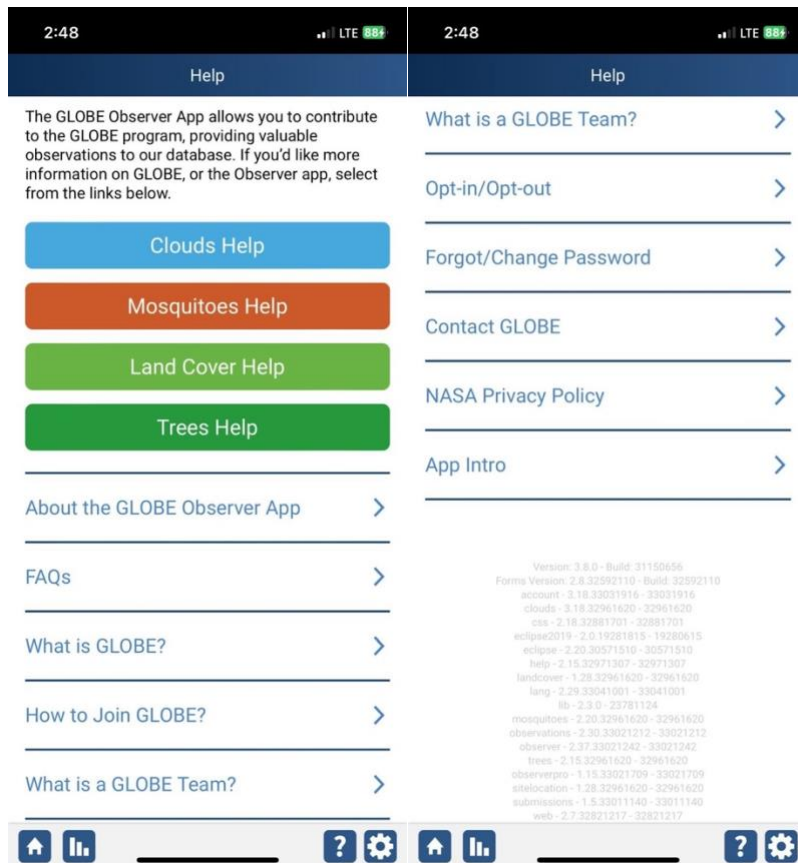
Once on the data review and submission screen, a user can review and edit their saved observations by tapping on the pencil icon. The user can delete the data by tapping the trash can. The user submits data by selecting the box next to the data entry, then tapping *Submit [#] Observation(s) to GLOBE*, which will become active once at least one observation is selected. The data submission process is shown in a short video, [How to Submit Your Data to GLOBE](#).



If no data is stored to be submitted, a user can view their submitted observations (*My Observations*). The buttons to *See Today's Cloud, Mosquito, Land Cover, or Tree Height Measurements* lead to the GLOBE Visualization System. *See Current NASA Data* leads to the [NASA Worldview](#) satellite data visualization browser.

4.4.6. Help

The question mark icon from the home screen leads to the overall help section for the app. Each app tool has its own help section with frequent questions and guidance. The tool help sections are linked from the main help section. Additional topics include: about the GLOBE Observer app, FAQs, what is GLOBE, how to join GLOBE, what is a GLOBE team, opt-in/opt-out, forgot/change password, contact GLOBE, NASA privacy policy, and app introduction. Each option leads to a screen with information on the topic or to a form associated with the action (opt-in/opt-out or contact GLOBE). When a user selects *Contact GLOBE*, the app launches an email to the GLOBE Community Support Team (CST) or GLOBE Help Desk. The CST coordinates response/support related to citizen science and GLOBE Observer with the GLOBE Observer team.



Pale gray text at the bottom of the help screen indicates the app version and data associated with the user's installation of the app. This information can be critical in troubleshooting issues and therefore may be requested when an issue is reported to the DIS team.

4.4.7. Settings

The Settings page, accessed via the gear icon in the lower right, helps users manage their account and various user preferences. On top are account settings or information about the user who is currently logged in to the app. This information includes the userID, a value that allows the user to be found in the GLOBE system. When troubleshooting issues related to a person's data or account, the GLOBE Help Desk may request the userID from this screen. It is also the number used to generate a person's My Observations screen, which has a URL of the format:

www.globe.gov/myobservations/?userid=12345678

Citizen scientists will also see their screen name below the userID. They can tap *Edit* next to the screen name to change their screen name. The screen name is the user's public identity that appears on the GLOBE website, e.g. in a GLOBE Teams page leaderboard. The user can also logout or switch to a different account from the Settings screen and enter or exit Practice Mode.

The screenshot shows the 'Settings' page of the GLOBE app. The page has a dark blue header with a back arrow and the title 'Settings'. The main content is organized into two columns. The left column is titled 'Account Settings' and displays the user's 'UserID: 125223295' and 'ScreenName: WindAstronaut08' with an '[Edit]' link. Below this is an orange 'Logout' button showing the email 'Globeobserver2016@gm...'. A dropdown menu labeled 'Select a user from the list below:' shows 'Select User'. Below that is a green 'Select a User Above' button. Further down is an orange 'Use Practice Mode' button, followed by a link 'What is Practice Mode?' with an info icon. At the bottom left is a 'Login with a Different Account' button. The right column contains buttons for 'Create a New Account', 'Forgot/Change Password', and 'Request Account Deletion'. Below these is the 'App Settings' section with buttons for 'Opt-In/Opt-Out Settings', 'Connect GLOBE observations to SciStarter', 'Learn More About SciStarter', and 'Change Language'. The 'GLOBE Teams' section at the bottom right has buttons for 'Join a GLOBE Team', 'Create a GLOBE Team', and 'Find a GLOBE Team'. A bottom navigation bar includes icons for home, list, help, and settings.

The settings screen provides links to create a new account, change the password, or delete an account. These open the appropriate functions on the GLOBE website within the app. *Request Account Deletion* leads to the "Contact Us" form on the GLOBE website.

The app settings page gives the users the ability to change their communication or language preferences or connect to SciStarter. Opt-in/opt-out settings give GLOBE permission to contact a user for specific reasons. When a person registers for an account, they are opted in to receive email notifications including NASA satellite co-location data, citizen science updates (rarely used), science requests, and recognition awards. A user may opt out of any of these communications on this screen. More information about the email communications themselves can be found in [section 8.8.4](#).

SciStarter is a citizen science clearinghouse that recruits and supports volunteers for a variety of projects. GLOBE is a SciStarter affiliate, which means that users can connect their GLOBE account with their SciStarter account. A video is available to show the process to [link a SciStarter account in the GLOBE Observer app](#). Once the accounts are linked, SciStarter is able to pull that user's data from GLOBE, and volunteers can see their GLOBE activity on their SciStarter dashboard.

The final section of settings allows a person to join, create, or find a GLOBE Team. GLOBE Teams are described in detail in [section 8.3.4.1](#). *Join a GLOBE Team* opens a screen for a person to enter a referral code to join a private team. *Create a GLOBE Team* opens a form that includes the team's name, country, and optional location fields. People are referred to *Find a GLOBE Team* to identify public teams. Find a team includes a list of all teams with a search function that narrows the list by name, country, or team type. Users may tap "join" from the list to join a team. If the team is private, a pop-up box requesting the referral code will appear.

4.5. Languages and Translation Process

An important feature of the GLOBE Observer app, given the international nature of the GLOBE Program, is the ability for users to change the language. The app will automatically sense the user's chosen locale, or language preference, and if available, will switch to that language on the fly for the user when the app is opened. In addition, a user logged in to the app can tap on the gear icon in the lower right corner of the home screen to get to the Settings page, scroll down and tap on the Change Language button. That brings up a drop-down to select a different language, a preference that will be saved when the user next opens the app. The languages available in the app as of April 2025 are Arabic, Chinese (Taiwan), Croatian, Dutch, English, French, German, Hindi, Latvian, Polish, Portuguese, Russian, Spanish, Swahili, Thai, and Vietnamese.

The original translation of the text in the app was done as each tool was added, including the Data Entry portions available to trained users only. Additional languages have been added upon request, as long as suitable expertise is available to provide the translated content. The primary challenge is maintaining the translations, both when new features are added or text is otherwise updated, and when the community brings to our attention a concern with an aspect of the current translation. In general, the process for translation involves the DIS team generating a list of the text in the app in a spreadsheet form, with columns for the English original, any translation already present in the app, and a Google Translate version for any new text. Volunteer translators, often but not exclusively the Country Coordinator for a country where the given language is spoken, then review the automated translation and confirm or make any needed corrections. Ideally, at least two native speakers would sign off on the translation before it is sent back to the DIS team for incorporation into the app.

4.6. In-App Alerts and Messages

The GLOBE Observer app includes the capability for the GLOBE Program to communicate with users through in-app messages and notifications. User communication outside of the app is covered in [Section 8.4: Supporting Existing Volunteers](#).

4.6.1. In-App Messages

The GLOBE Observer app has a mechanism to pop up short messages sent from the GLOBE Program to users on the app home screen upon opening. The messages are only visible in the app, and the user will not receive them if they do not open the app while the message is active. The messages can go to a particular user type, such as trained users only, or to a particular region and for a specific period of time. The geographic area can be defined to a very small area, such as a single school or library, or could be global.

Messages are drafted, then reviewed by GLOBE Communications within the GLOBE Implementation Office before going out. Once approved, the messages will go out during the scheduled period. An end user can ask that a particular message not be shown again or they can temporarily dismiss the message. If temporarily dismissed, it would be shown again the next time the user opens the app.

These messages have been used to announce new features, request an update, alert to a science data request, or to announce an event. There is no constraint on the message content apart from length. No length limit is coded, but in practice, messages should fit on the screen without scrolling. Messages may include a single URL, which will be activated if the user taps the *More Information* option at the end of the message. Detailed instructions about how to create an in-app message are in [Appendix E2: In-App Messages](#).

4.6.2. Satellite Overpass Alerts

GLOBE provides users with the option of receiving collocated data from satellites that correspond to their submitted ground-based clouds observations. At this writing, GLOBE clouds observations are matched to NOAA-20 and various geostationary satellite data. A user may choose to set up an alert when NOAA-20 is over their location. This alert tells the user to collect cloud data up to 15 minutes before and after the overpass time. The alert is sent to the phone and received as a notification even if the GLOBE Observer app is not open. As of July 2025, alerts are available for NOAA-20 only. In the past, alerts went out and collocated comparisons were made for Aqua, Terra, and CALIPSO. Over time as those satellites aged out, these were removed from the GLOBE alert and collocation systems. Geostationary satellite data is also collocated based on time and location, but no overpass alert is necessary as these instruments are always overhead by the nature of their orbit.

Users must opt in to satellite overpass notifications. They can do this by opening the Clouds tool, tapping on the satellite icon, then tapping “set notifications.” They can choose to be notified at solar noon or when a satellite is overhead. Notifications can be set for today only or on a schedule. Schedule options allow users to select both the days of the week and the times they wish to receive notifications. In the past, when multiple polar-orbiting satellites were included in the collocation system, users could also choose which satellites they wanted to be notified about.

The satellite overpass notifications go out as long as the app has been opened within the last two weeks. If the app has not been used for more than two weeks, the notifications will stop until the user opens the app again. This occurs because GLOBE Observer gets two weeks of satellite overpass information for a user’s location when they open the app. Beyond that time frame, the user would need to open the app again to generate a new overpass schedule.

Notifications are created based on the user’s last location. If the user travels to a different location, the notifications will not update until the app is opened at the new location. GLOBE Observer does not get or use location data while the app is closed.

Full documentation for the satellite collocation system is available in [Rizzi et al. \(2024\)](#).

4.7. Common App Issues

The GLOBE Observer team has collected [frequently asked questions](#) on a dedicated page on the website, as well as tool-specific questions on each of the Taking Observations pages for [Clouds](#), [Land Cover](#), [Trees](#), [Mosquito Habitats](#), and [Eclipse](#). Described below are some of the most common general queries we have received over the years, particularly related to the functioning of the app. One of the major challenges is that there are many different devices running many different operating system versions, including many older and out of date systems, which we are trying to support. There have also been several instances where new operating system updates pushed out by the major platforms without notice broke key capabilities in the app. While detailed technical descriptions are beyond the scope of this document, the examples below are illustrative if not comprehensive of the user-reported issues over the years. Other common questions more related to programmatic and structural issues are addressed in [Section 8.4.2: Help Desk](#). In addition, brief summaries of app updates since September 2019, including some of the issues that were addressed with each, can be found on the [App Status](#) page.

- A common error for both Clouds and Land Cover can occur if the device has orientation lock set, not allowing the screen to rotate into landscape mode and enter the automatic photo mode. The solution is simply to ensure orientation lock is not activated.
- A magnetometer built into the device is necessary both to determine the direction of photos and to measure the angle from the bottom to the top of a tree to calculate tree height. Some phones don't have such a sensor included, and so users will not be able to successfully use the Trees tool. Those users will need to manually determine cardinal directions for the photos in Clouds or Land Cover.
- While the app is designed to be able to collect data while offline, it is necessary to have an Internet connection (through Wi-Fi or cellular data) to create an account and make the initial connection to the database, as well as to send in data. Many reported app errors are likely attributable to poor connectivity, for example challenges with downloading updates, which users report with some regularity. The basic suggestion is to make sure the user is on a strong connection before trying to open the app again, but because of these user reports, the DIS team has also made some changes in how the app handles updates, checking the connection speed and delaying update installation until the signal is strong enough.
- Connectivity issues while sending in data can result in the database receiving the values, but the device not receiving the return confirmation that the data has been stored, and therefore not removing it from the pending queue in the app. The user then tries to send the data in again, but the database perceives it as a duplicate and gives an error message. The original solution was to advise the user to check My Observations, and if the data was there already, it was safe to delete from the phone. However, the DIS team has since been able to revise the process such that if a duplicate observation is detected, the database simply tells the app that the data is already received and automatically deletes the duplicate data, so the user no longer sees this problem.
- Especially in the middle years of the program, we would also regularly get questions about whether the app was available on Kindle (no, because it runs a different version of the Android operating system) or on Chromebooks (the app can't be used, but the online Data Entry forms would be available to trained users). Questions about those specific platforms have come less frequently in recent years, although as of May 2025, there is still an issue with the app not working on iOS 14 and 15.

4.8. App of the GLOBE Program

In 2021, GLOBE Observer began to transition from the citizen science app supporting the GLOBE Program to become the only app of the GLOBE Program. The decision was made to integrate GLOBE's Data Entry app with GLOBE Observer so that the program only had to support and promote one app. The Atmosphere data entry forms were integrated into GLOBE Observer in 2021. Hydrosphere was added in 2022, followed by Biosphere in 2023. Pedosphere protocols followed in 2024 and 2025. Since 2021, GLOBE Observer has been branded as the app of the GLOBE Program.

4.9. Planned Developments

The NESEC team had planned three new developments to the GLOBE Observer app in 2025: practice mode, land cover satellite match, and clouds special features photos. We also scoped development for badges.

Practice mode would allow a user to open the GLOBE Observer app and explore data collection without logging in or creating an account. The person would need to be logged in to an active account to submit data to the database. Data submitted while in practice mode does not get stored, though a person can go through all GLOBE Observer screens, including data submission, while in practice mode. This development was requested by many within the GLOBE community to facilitate training and to support new members who want to explore the app. It will also improve data quality, since people can learn without submitting data to the “real” GLOBE database. Currently, people learning to use the app submit data indoors or submit data that is not real. In one case, people at a training workshop submitted photos of a mosquito larva not natively found in that country. The larva was a test sample used for training, but it appeared to be a real observation in the database. This triggered an alert from a partner, who believed the observation meant the invasive mosquito had spread to a new location. The practice or training mode would eliminate these false data submissions.

The land cover satellite comparison function expands the ability to collocate Landsat and Sentinel-2 data acquired with GLOBE Land Cover data. This function has existed for GLOBE Clouds since 2017. The development expands the function to GLOBE Land Cover.

The special feature function in GLOBE Clouds would allow volunteers to submit photos of the sky focused on something not in the north, east, south, or west directions, or that is at a different elevation above the horizon than the standard 14 degrees called for in the clouds protocol. This feature will enable easier observations of things like dust storms or contrails in support of specific research.

Finally, the NESEC GLOBE Observer team is leading discussions to scope “ad-hoc” badges which could be awarded to volunteers as recognition for a variety of achievements, such as participation in a challenge or data request. The badges would be available on the rewards and recognition page in the GLOBE Observer app.

5. Protocols

5.1. Criteria for Selecting Protocols

Protocols were selected for inclusion in GLOBE Observer based on their potential scientific value and their accessibility to a wide range of volunteers. As stated in [Section 3.2: Objectives](#), one of GLOBE Observer's objectives was to fill in temporal and spatial data gaps by enabling people to collect data anywhere at any time. The protocols selected become increasingly valuable with greater data density. Clouds are highly variable on both spatial and temporal scales. Mosquito distribution can be difficult to map as finding and identifying breeding sites is labor intensive. Further, their population density can be correlated with human disease. Land cover can change in rapid events or because of human activity. Tree height can be measured from space, but ground-based measurements are helpful in verifying those measurements as well as assessing individual trees as opposed to a group.

We also required that protocols included in GLOBE Observer have a potential science user community who had expressed interest in using data from the protocol. These communities are described individually in the following protocol sections.

In addition to the science requirement, protocols that entered the GLOBE Observer app had to be easy to do with just the app and no external equipment for required observation elements. We wanted a volunteer to be able to collect data at any time, and requiring outside equipment could limit a volunteer's participation. Most people don't carry thermometers or sampling tools routinely. We also considered if app-based data collection was simple enough that non-expert volunteers felt confident collecting data, but robust enough that the data collected had scientific value.

5.2. Common Data Collected Across Protocols

All protocols collect the location of the observation site, date, and time. The GPS receiver simultaneously populates a map interface on the app, enabling the user to verify the location. GPS-enabled smartphones in an open sky environment typically display accuracy of ± 5 m with accuracy decreasing with obscured sky conditions (buildings, bridges, trees, etc.). Depending on the device and conditions, locations with error estimates between 7 to 13 m can be expected in urban settings. As documented in multiple publications, including [Lu et al \(2025\)](#), [Enterkine et al. \(2022\)](#), [Low, Nelson, et al. \(2021\)](#), and [Amos et al. \(2020\)](#), errors in location accuracy pose a significant challenge to scientific use of GLOBE data, particularly for use as reference data for comparison with satellite data products. Trees data, in particular, require high location accuracy to map to remote sensing data ([Lu et al., 2025](#)).

To help improve accuracy, we ping the user location on the initial load of the main home page, followed by pings within each data collection tool. We found that an initial ping on home page load can help as on some devices it appeared that it would activate the location services and location accuracy would start improving from that initial ping.

For Clouds, MHM and Data Entry, GLOBE Observer pings the user location five times and then uses the last value. DIS found that reported accuracy can initially be poor, so waiting for the last one usually provides the highest accuracy. Averaging the five location results would reduce location accuracy, as the first one or two location pings can report errors of hundreds of meters.

Because location accuracy is more critical for Trees and Land Cover, GLOBE Observer pings up to 10 times within these tools. However, there is a check which stops the pinging once the accuracy is within 50m. When Land Cover was initially built, we often saw reported accuracies greater than hundreds of meters.

Each tool shows the location on a map. We also include the “reset” button on each map which allows the user to refresh their position as often as they like with the text that says, “Please press reset button (above) to improve your estimated accuracy if needed (most useful is 12 meters or less.” Users can also move the map to manually adjust their position. Anecdotally, it is not always possible to reach five-meter accuracy while under a tree in the GO Trees tool, even with Wi-Fi. The GPS view is too obstructed.

Note that we are also relying on the phone’s self-reporting of accuracy which has its own issues. Some phones seem to underestimate location accuracy while others overestimate it. The high accuracy potential assumes higher quality phones and clear skies with good GPS.

Users may move the location pin on the map to manually set their location in cases in which the phone GPS is inaccurate. Latitude and longitude data can also be entered manually, either using data from an external GPS receiver, or by identifying the location on an auto-generated map interface ([Low et al., 2022](#)).

Beyond location, all but Mosquito Habitat Mapper include surface conditions — conditions that are variable that could influence the interpretation of satellite data at the site. Surface conditions include the presence of snow or ice, standing water, mud, dry ground, leaves on trees, and raining or snowing.

Following a 2025 update to GLOBE Clouds, all protocols include a field notes section where a volunteer may enter additional information about the observation.

5.3. Clouds

5.3.1. Science Purpose and Achievements – Clouds

Clouds can change rapidly, and different types of clouds have different effects on local climates. While lower cumulus clouds tend to have a cooling effect on the Earth, cirrus clouds higher in the atmosphere warm the planet by reflecting more outgoing radiation back towards the ground.

It is tricky to capture the extent of these interactions with satellites alone. That is why it is so crucial for researchers to have data gathered from the Earth’s surface. That makes GLOBE members’ observations very important because they provide scientists with a fuller perspective on how cloud cover affects our climate. Additionally, when members submit frequent measurements over time, their data provides NASA with greater detail on how the climate is changing.

After app users submit their cloud observations, the NASA GLOBE Clouds team at NASA’s Langley Research Center collocates their measurements with satellite data to provide an augmented data set, which is published on the GLOBE Observer website. The co-located satellite data and images are then sent to volunteers by NASA in a personalized email. This direct feedback allows more people to contribute to authentic scientific research, engaging them with more steps in the process of science, and connects them with active NASA missions.

In 2020, the [Community science project Leveraging Online and User Data through GLOBE And Zooniverse Engagement \(CLOUD GAZE\)](#) was funded under the auspices of NASA's [Citizen Science for Earth Science Program](#) to bring GLOBE Clouds data into the Zooniverse platform for volunteers to classify cloud types based on photos submitted through GLOBE Clouds. The project ran through 2022.

The GLOBE Clouds tool and data are discussed in the following publications presented in reverse chronological order. A full list of references and table of publications with topic notations can be found in [Appendix C](#).

[Autore et al. \(2025\)](#), **GLOBE Eclipse 2024: A case study of the effects of the April 2024 total solar eclipse on cirrus clouds and contrails in the United States of America** - As recommended by the National Academies of Sciences, Engineering, and Medicine, ground-cloud observations of contrails are important to track the life cycle of these types of clouds.

[Dodson et al. \(2022\)](#), **Do citizen science Intense Observation Periods increase data usability? A deep dive of the NASA GLOBE Clouds data set with satellite comparisons** - Shows the minimum number of ground-cloud observations by citizen scientists necessary to obtain a signal over the noise for understanding total cloud cover. When compared to multiple satellite instruments, overall values agreed within 10%, with variability in cloud base altitude reports. As expected, satellites report most high and mid-level clouds while volunteers report most low-level clouds.

[Colón Robles et al., \(2020\)](#), **Clouds around the world: How a simple data challenge became a worldwide success** - An analysis of the Spring Cloud Challenge from 15 March to 15 April 2018 including how the challenge was crafted, outreach to volunteer scientists around the world, details of the data collected, and impact of the data. The event showed how a period of intense observations can increase the number and locations of ground observations collocated with cloud-observing satellites and raise the baseline of year-round observations received by citizen scientists.

[Amos et al. \(2020\)](#), **GLOBE Observer Data: 2016–2019** - Data description and quality flags for observations of all four GLOBE Observer data types (clouds, land cover, mosquito habitats, and trees) around the world. Show that most data is over Europe and the U.S.

[Dodson et al. \(2019\)](#), **Eclipse across America: Citizen science observations of the 21 August 2017 total solar eclipse** - Shows correlation between total cloud cover and air temperature changes in the path of totality during the 2017 total solar eclipse. Only possible with volunteers who can move to the path of totality to collect observations.

[Hayden et al. \(2019\)](#), **GLOBE: Connecting a community of observers directly to NASA satellites** – Describes the bridge between satellite observations and ground-cloud observations made by volunteers and how to engage the public with satellite data.

5.3.2. Basis in GLOBE Protocols – Clouds

The Clouds tool mimics the revised GLOBE Clouds protocol with the addition of submitting multiple sky photographs. In the GLOBE Observer app, users locate, photograph, and classify the cloud cover of the overhead sky. Each GLOBE Observer cloud observation contains information about the percentage of sky covered by clouds, the presence of obscuration, and surface conditions (e.g., snow or ice on the ground). An obscuration occurs when more than 25% of the sky is blocked by either sand, smoke, haze, heavy snow, fog/stratus, spray, dust, blowing snow, heavy rain, or volcanic ash. Optional fields for cloud observations are: sky color; sky visibility; presence of low-, mid-, and high-level clouds and contrails; types of clouds and contrails; and visual opacity. Users are encouraged to conduct their observations in an outdoor area with a relatively unobstructed view of the sky. Users have the option to take photographs of the sky (north, south, east, west, up) and surface conditions (down). The app guides users to align their smartphone cameras in the correct direction and tilted to a 14-degree angle, then automatically takes the photographs. Photos are taken at the 14-degree angle to align with the original GLOBE Clouds protocol, which instructs: Anything above an angle of ~14 degrees is to be included in the observation. Below that, along the horizon, clouds are too far away to correctly identify, and also don't correspond to the satellite view of your area ([GLOBE Clouds Protocol Guide](#), p. 6) All photos captured automatically will be taken at 14 degrees. Manually uploaded photos may not follow the 14-degree requirement, however manual and automatic photos are not differentiated in GLOBE data.

A special feature photo option for clouds, allowing users to capture sky features that may fall outside the directional photos (such as contrails or unusual clouds in between the cardinal directions, or dust or other conditions at the horizon) was released in August 2025. GLOBE Observer Clouds requires no additional equipment beyond a smartphone. See more details in the [GLOBE Data User Guide](#).

5.3.3. Scientists Consulted –Clouds

Dr. Lin Chambers and Sarah McCrea oversaw the revisions during the merger of the S'COOL (Students' Cloud Observations On-Line) aligned cloud protocol with the GLOBE Program. The primary scientific advisors for the Clouds tool were the GLOBE Clouds team at NASA's Langley Research Center, especially Marilé Colón Robles and Jessica Taylor. The GLOBE Clouds team also works collaboratively with the CERES (Clouds and the Earth's Radiation Energy System) science teams, in particular the SatCORPS (Satellite CLOUD and Radiation Property retrieval System) and FlashFLUX (Fast Longwave And SHortwave Radiative Fluxes) science teams, as well as with the ASDC (Atmospheric Science Data Center) for storing the data. Details on how the ground cloud reports are compared to multiple cloud properties retrieved by the CERES instrument can be found in the Satellite Data Collocation Documentation ([Colón Robles et al., 2025](#)).

Additional scientists were involved in the original development of the GLOBE Clouds protocol, including Drs. Susan Postawko and Paul Ruscher. Additional scientists from the CERES science team were also involved in the original development of the S'COOL protocol which merged into GLOBE.

5.3.4. Overview of Clouds App Tool

The Clouds tool mirrors the original pen-and-paper version of cloud reports designed for classroom teachers. It also contains tutorials and photo examples for each step. An interactive dichotomous key was developed, called the Cloud Wizard, to help first-time observers classify different cloud types based on how their skies look at that moment. The tool also allows users to track polar orbiting satellites to time their observations. A full description of the tool can be found in [Colón Robles, et al. \(2020\)](#).

5.3.5. History of Development and Use - Clouds

In 2016, GLOBE Observer launched with a single tool: GLOBE Observer Clouds. GLOBE Clouds is based on the revised cloud protocol which combined the GLOBE Program and Students' Cloud Observations Online (S'COOL) ([Chambers et al., 2017](#)). S'COOL was developed at NASA's Langley Research Center starting in 1996 to involve students and citizen scientists in collecting cloud data to support CERES science. Prior to and under NESEC, NASA Earth Science Division directed the integration of S'COOL with GLOBE, which also had a cloud protocol. Because the S'COOL protocol collected more information than GLOBE Clouds, the integration required the addition of cloud height, sky color and visibility, and transparency to GLOBE Clouds. S'COOL integration was completed in 2017. The GLOBE Observer Clouds tool mirrors the updated GLOBE Clouds protocol after the S'COOL integration.

S'COOL integration also included the creation of satellite collocation tables for all data collected during a satellite overpass and the in-app overpass predictor, which launched in 2017. This function is described in [section 5.3.1](#).

5.3.6. Data Collected - Clouds

Each data element collected is described in [section 5.3.2](#) above. Every data option (cloud cover, sky color, etc.) receives a column in the data file as detailed in the GLOBE Data User Guide.

The GLOBE Clouds data and satellite comparison data are provided as CSV files for the current year (updated biweekly) and summary files for notable events, and made on a yearly basis (some files are compressed into ZIP format if they are too large). These data files include all clouds data received by GLOBE and matched to satellite data by the GLOBE Clouds team at NASA's Langley Research Center as of the date in the file name (example: 2017_GLOBE-AnnualCloudData_2022-03-18_v3-0.csv).

Data documentation is available on the [GLOBE Clouds data page](#), with detailed descriptions of GLOBE cloud reports, satellite comparisons, and variable definitions.

Between January 1, 2017, and August 1, 2025, 1,708,64 clouds observations were ingested by the GLOBE Clouds team and collocated to satellite data when possible. A total of 922,968 cloud observations were submitted through GLOBE Observer globally; the rest came through other GLOBE data entry options. Observations have come from every continent, including Antarctica, and every ocean basin as a result of partnerships with cruise companies.



Image from the [GLOBE Visualization System](#) showing all the data collection locations for Clouds since 2017. While some dots over the ocean represent data collected on board ships, some (and some other scattered dots) may also represent mistakenly reported locations.

5.3.7. Change Documentation – Clouds

GLOBE Clouds launched in GLOBE Observer in 2016 with cloud cover, surface conditions, cloud type and directional photos. Integration with S'COOL in 2017 added cloud height, sky color and visibility. The Cloud Wizard was added in 2020. While this did not change the data collected, it implemented a dichotomous key to better guide decision making and improve data quality. In 2025, special feature photos were added to Clouds so that additional photos beyond North-East-South-West-Up-Down, and associated field notes may be submitted. The GLOBE Data User Guide tracks all changes made to GLOBE data.

5.4. Mosquito Habitat Mapper

5.4.1. Science Purpose and Achievements – Mosquito Habitat Mapper

Released in 2017, the Mosquito Habitat Mapper tool enables citizen scientists to report in situ ground-based observations of mosquito breeding sites.

Mosquito breeding sites are places with standing water where mosquitoes lay their eggs, and where eggs, larvae, and pupae develop into adult mosquitoes. Citizen scientists using the Mosquito Habitat Mapper tool contribute ground-based observations that could support community-scale mosquito larval surveillance and mitigation actions recommended by international health agencies to reduce local mosquito-borne disease risk. For low-resource communities where mosquito control services are inadequate, Mosquito Habitat Mapper can serve as a cost-effective tool that residents can use to protect their communities from mosquito borne disease. The tangible benefits to human health supported by the Mosquito Habitat Mapper tool have encouraged its wide adoption, with more than 45,000 observations submitted from over 80 countries.

Beyond the immediate public health benefits to communities who participate in Mosquito Habitat Mapper citizen science, mosquito breeding site surveillance data can improve the accuracy and resolution of mosquito habitat models and disease risk maps. National Science Foundation-funded research (Carney, Chellappan, and Low, SCH INT: NSF #2014547) was made possible through the provision of field-based mosquito observations by citizen scientists, supporting the surveillance and control of mosquito borne disease through automated species identification and spatiotemporal modeling, resulting in several publications ([Carney et al., 2025](#); [Carney et al., 2023](#); [Uelman et al., 2023](#); [Carney et al., 2022](#), [Low et al., 2022](#)).

A funded NASA research project is now applying GLOBE Observer Mosquito Habitat Mapper and Land Cover tools to document fine-grained, localized data on mosquito habitats and environmental conditions (EMERGE, Dr. Di Yang, 24-CSESP24-0011). These data are being integrated with NASA Earth observation data to enhance the spatial and temporal resolution of mosquito habitat models and disease risk maps. The project's focus is on predicting future changes in mosquito-borne disease risk under different climate scenarios and directly addresses NASA's goal of improving the prediction of future changes in the Earth system and their impacts on human societies and ecosystems through the application of NASA data. Yang's AI-driven modeling approach, which incorporates techniques such as deep learning, spatially aware ensemble models, and Bayesian inference can account for spatial and temporal heterogeneity in mosquito habitats, enabling more precise predictions of disease risk at local and regional scales. Moreover, coupling the integrated mosquito habitat models with climate models and disease transmission models can provide valuable insights into future disease risks under different climate change scenarios.

The GLOBE Observer Mosquito Habitat Mapper has been influential for the broader international citizen science community. As part of work conducted as a Fulbright Scholar in Brazil (2022-2023) Low worked with scientists at the Federal University of Paraná, Brazil, in the creation of a school based-citizen science program modeled after GLOBE, Programa Interinstitucional de Ciência Cidadã na Escola (Interinstitutional Citizen Science Program in Schools, PICCE). This program adopted the GLOBE Observer protocol as part of Monitoramentodo Habitat de *Aedes aegypti* (Monitoring the Habitat of *Aedes aegypti*, [Eleuterio et al., 2023](#)), releasing it in a Portuguese language format appropriate to the cultural context of local schools. This work also led to the launch of the Zika Bus in 2022, a Federal University of Paraná mobile mosquito laboratory equipped with equipment and materials to support the implementation of Mosquito Habitat Mapper investigations in remote, disenfranchised schools and communities.

In response to the most severe dengue pandemic in the Americas on record (2023-2024), the U.S. State Department sponsored a series of virtual workshops serving educators in Central America through the GLOBE Plus Post Program: *Empoderamiento para guardianes ambientales: Capacitación virtual del Programa GLOBE para la vigilancia de mosquitos y la prevención de enfermedades en América Central y el Caribe* in August-September, 2023. Through the U.S. Department of State Speaker Program, Low was sponsored to travel to Central America and share the citizen science approach to community surveillance and mitigation with government officials, public health departments and educators in Costa Rica and Jamaica (August-September 2024) and Dominican Republic (October 2024 and August 2025).

Awareness of GLOBE Observer's Mosquito Habitat Mapper was broadened through a white paper created by the Wilson Center ([Sinha-Chaudhuri & Parker, 2024](#)), which identifies the critical role that GLOBE Observer Mosquito Habitat Mapper is playing in the effort to control the invasions of *Anopheles stephensi*, a danger invasive mosquito that has been naturalizing in Africa since 2012. Since 2022, Mosquito Habitat Mapper virtual workshops have been hosted in Ghana, South Africa, Ethiopia, Seychelles, Cameroon, and Nigeria.

The GLOBE Observer Mosquito Habitat Mapper tool and data are discussed in the following publications presented in reverse chronological order. A full list of references and table of publications with topic notations can be found in [Appendix C](#).

[Carney et al. \(2025\)](#), **Artificial intelligence and citizen science as a tool for global mosquito: Madagascar case study** - Documents a case study in which an artificial intelligence model identified an invasive *Anopheles stephensi* mosquito larvae in a photo submitted to GLOBE Mosquito Habitat Mapper.

[Nelson et al. \(2024\)](#), **GLOBE Observer: A case study in advancing Earth system knowledge with AI-powered citizen science** - Describes how artificial intelligence tools are used with GLOBE data, including as part of the data ingest and process for privacy and safety screening and for classification of mosquito larvae and land cover photos.

[Carney et al. \(2023\)](#), **Citizen Science as an Approach for Responding to the Threat of *Anopheles stephensi* in Africa** - Describes how connections between local citizen science networks with global databases can be leveraged for early detection of and rapid response to vector-borne public health threats.

[Uelmen et al. \(2023\)](#), **Global mosquito observations dashboard (GMOD): creating a user-friendly web interface fueled by citizen science to monitor invasive and vector mosquitoes** - Describes how GMOD combines data streams from multiple citizen science projects into an interface for visualization of mosquito population trends and ranges, and serves as an educational resource, encouraging collaboration and data sharing.

[Carney et al. \(2022\)](#), **Integrating Global Citizen Science Platforms to Enable Next-Generation Surveillance of Invasive and Vector Mosquitoes** - Describes how data from multiple international citizen science apps are combined into one database to aid researchers, mosquito control personnel, and policymakers, and the citizen science imagery used to develop artificial intelligence software to automatically identify the mosquito species.

[Low et al. \(2022\)](#), **Building International Capacity for Citizen Scientist Engagement in Mosquito Surveillance and Mitigation: The GLOBE Program's GLOBE Observer Mosquito Habitat Mapper** - Overview of the Mosquito Habitat Mapper tool, including data collection processes, potential sources of error, and example projects using the tool.

[Cho et al. \(2021\)](#), **The STEM Enhancement in Earth Science "Mosquito Mappers" Virtual Internship: Outcomes of Place-Based Engagement with Citizen Science** - A description of the virtual internship program, including evaluation of the success of the program as measured by knowledge of pertinent science concepts and processes, changes in future career orientation of the participants, and an exploration of the role of place-based citizen science in interns' experience of their research projects.

Low, Boger, et al. (2021), GLOBE Mosquito Habitat Mapper citizen science data 2017–2020 - A technical report describing the data submitted by citizen scientists during the first three years of GLOBE Mosquito Habitat Mapper in Africa, Asia and the Pacific Islands, and Latin America and the Caribbean, as well as a closer examination of data in three cities in Senegal, West Africa.

Amos et al. (2020), GLOBE Observer Data: 2016–2019 - Data description and quality flags for observations of all four GLOBE Observer data types (clouds, land cover, mosquito habitats, and trees) around the world. Show that most data is over Europe and the U.S.

Aikpon, Dramane, et al. (2019), Larval breeding characteristics and distribution of Aedes mosquito species in the economic capital of Benin: A public health concern - An assessment of the breeding habitats and presence of *Aedes* mosquitoes through a house-to-house entomology survey in the study area in Benin.

Funded scientific research developed in conjunction with the GLOBE Observer Mosquito Habitat Mapper:

2025: Forecasting Mosquito-Borne Disease Risk in a Changing Climate: Integrating GLOBE Citizen Science and NASA Earth System Modeling (ROSES-24 A.50 Citizen Science for Earth Systems Programs, NNH24ZDA001N-CSESP); Principal Investigator (PI): Di Yang, University of Florida; Dates: 01/01/2025 - 12/31/2027.

2020: Surveillance and control of mosquito borne diseases through automated species identification and spatiotemporal modeling (SCH INT: NSF #2014547); PI: Ryan Carney, University of South Florida; Dates: 10/01/2020 - 09/30/2024.

2017: Mosquito Mappers (ROSES-16 A.47 Citizen Science for Earth Systems Programs, NNH16ZDA001N-CSESP). PI: Russanne Low, Institute for Global Environmental Strategies (IGES). Dates: 04/1/2017 - 3/31/2018.

2016: Mosquito Challenge Community Campaign (USAID Combating Zika and Future Threats Grand Challenge, AID-OAA-F-16-00099); PI: Russanne Low, IGES; Co-PI: Theresa Schwering, IGES; Dates: 10/15/2016 - 07/16/2018

2016: Collaborative Research: Mosquito Watch USA-Let's GO! Citizen Science Software Development for Geographical Distribution of Mosquito-borne Disease (EARly-concept Grants for Exploratory Research, NSF 16-1); PI: Rebecca Boger, City University of New York; Co-PI: Russanne Low, IGES; Dates: 09/15/2016 - 08/31/2017

5.4.2. Basis in GLOBE Protocols – Mosquito Habitat Mapper

The GLOBE Observer Mosquito Habitat Mapper tool is based on the GLOBE Mosquito Protocol developed by GLOBE scientists (Russanne Low, Rebecca Boger). The GLOBE Mosquito protocol was developed at the request of the GLOBE Implementation Office (GIO) to merge regional protocols developed by GLOBE Thailand and GLOBE Africa. Compared to the Mosquito Protocol, the Mosquito Habitat Mapper tool simplified data collection to improve the citizen science experience without compromising the usefulness of the mosquito surveillance data. The GLOBE Mosquito Protocol has since been discontinued with data collection and entry being done exclusively through GLOBE Observer Mosquito Habitat Mapper.

5.4.3. Scientists Consulted – Mosquito Habitat Mapper

Scientists and subject matter experts consulted included members of the GLOBE community and external science advisors. GLOBE community members included Dr. Mullica Jaroensutasinee, Dr. Kris Jaroensutasinee, Dr. Elena Sparrow, Dr. Lin Chambers, Dr. Dixon Butler, David Overoye, Holli Kohl, Travis Andersen, and Dr. Tony Murphy.

Scientific advisors consulted during development of the tool included:

- Dr. Yvonne-Marie Linton, Research Director, Walter Reed Biosystematics Unit (WRBU), Suitland, Maryland
- David Pecor, WRBU, Suitland, Maryland
- Dr. Michael “Doc” Weissmann, Vector Disease Control International (VDCI), Broomfield, Colorado
- Dr. Lawrence Reeves, Florida Medical Entomology Laboratory, Vero Beach, Florida
- Ms. Anita Schiller, ACIS Natura, Houston, Texas
- Dr. Lee Coenstadt, United States Department of Agriculture (USDA), Lawrence, Kansas
- Dr. Assaf Anyamba, NASA’s Goddard Space Flight Center, Greenbelt, Maryland
- Dr. Michael Wimberley, University of Oklahoma, Norman, Oklahoma
- Dr. Caio Franca, Southern Nazarene University, Bethany, Oklahoma

Expert review of tool after South American Pilot: Dr. Dustin Swanson, USDA, Lawrence, Kansas

5.4.4. Overview of Mosquito Habitat Mapper App Tool

Added to the GLOBE Observer app in May 2017, the Mosquito Habitat Mapper tool prompts volunteers to conduct a series of guided data collection tasks, including answering yes/no questions, uploading photos, sampling standing water and counting larvae, and identifying mosquito specimens, aided by a built-in pictorial taxonomic key. Data collection proceeds stepwise through user interaction with a graphic interface. There are four steps that users can take when using Mosquito Habitat Mapper, each increasing in complexity, and it is important to note that users do not have to do all the steps to make observations. The user is asked at each step if they are done with their observation, or if they wish to continue. The steps prompt volunteers to document larval habitats, sample and count larvae, identify larvae, and, if possible, eliminate the breeding site by dumping the water or other means ([Low et al., 2022](#)).

To document larval habitats, volunteers select from images of 32 different categories representing natural standing water environments, natural containers (such as tree holes), artificial containers (such as tires or cisterns), or experimental habitats (such as larvae traps or ovitraps). “Other” is also an option. Users select the habitat type they observe and are instructed to photo-document the habitat and its immediate surroundings. Up to nine digital images can be captured at this step. At the end of this step, the user is prompted to indicate whether they can see mosquito larvae in the water (yes/no) and if they want to continue making observations.

Users are asked if they want to count and photo document larvae found in the water sample. At this point users can select to exit the tool or continue with data collection. To conduct this step, the user will need to use a 300 mL cup, dipper, or bulb syringe to extract a water sample. Larvae and pupae are tallied separately, and the presence/absence of eggs or nearby adults are recorded.

If larvae are observed in this step, users are prompted to photo-document one or more representative specimens, using the camera's zoom feature on their mobile device. Interested citizen scientists are encouraged to obtain an inexpensive (less than USD 10) 60–100× clip-on macro lens, to obtain digital images of a sufficient resolution to enable taxon identification. Users are prompted to take several photos of their specimen(s), including one that captures the whole body, as well as close-up images of the diagnostic features located on the anterior and posterior ends of the specimen. Up to nine mosquito images can be saved during a single observation. Voucher photos of the larvae are uploaded at their original resolution to the GLOBE database.

Users are asked if they want to proceed with taxonomic identification of their larval specimen. The citizen scientist's own mosquito larvae photos are displayed in the user interface at each identification step for convenient comparison with diagnostic images in the key. After determining that the specimen is a mosquito larva, the citizen scientist uses the in-app pictorial dichotomous key to determine if their specimen belongs to one of three medically important genera found worldwide: *Aedes*, *Culex*, and *Anopheles*. The key also distinguishes whether an *Aedes* specimen can be assigned to the species *Ae. aegypti* or *Ae. albopictus*, two widespread invasive mosquitoes that are also competent vectors for arboviruses that cause disease in humans. A text box is provided for users who wish to report taxa not included in the in-app taxonomic key.

Users respond to the prompt: "Were you able to eliminate the breeding site from use?" If the citizen scientist can dump out or cover a container, remove trash, or otherwise mitigate the breeding site, they can select "yes." This step reinforces the practice of source reduction, an important mitigation practice known to have a measurable impact on the transmission of mosquito-borne diseases within a community.

When the citizen scientist has completed all the observations they wish to make in that session, the last frame presents several options. The choice, "Make a Land Cover Observation," connects the user to the GLOBE Land Cover tool on the same platform and enables the collection of land cover photos surrounding the mosquito larval habitat.

5.4.5. History of Development and Use – Mosquito Habitat Mapper

The concept for a mosquito app was developed in January 2015, when Dr. Rebecca Boger, Brooklyn College and City University of New York (CUNY), and Dr. Russanne Low, University of Nebraska Lincoln and Institute for Global Environmental Strategies (IGES), were creating a new GLOBE Mosquito Larvae Protocol based on regionally specific mosquito protocols developed by GLOBE Thailand and GLOBE Africa. They scheduled fieldwork in the Caribbean country of Antigua and Barbuda, through grant support from Youth Learning As Citizen Environmental Scientists (YLACES) to Dr. Rebecca Boger. This country was selected because both scientists had previously worked there and there was logistical support through the Barbuda Research Center, which at the time was affiliated with CUNY.

Following are questions identified for this fieldwork:

- What is the shared understanding of Barbudans about mosquitoes and mosquito borne disease?
- Are students and teachers familiar with mosquito larvae and where they are found?
- Can larvae be distinguished by species by younger students (6th graders)?
- Do students and teachers find working with mosquitoes interesting?
- Can participants work with a dichotomous key?

The Barbuda Research Center had received a donation of 12 new electronic tablets for use in science outreach programs. Boger and Low decided to build a beta mosquito app for this test using an off the shelf Esri tool, ArcGIS Collector, so that the field pilot could take advantage of and introduce the teachers and students to this new technology. The app was installed in each of the tablets and provided to students for the study. Using the app, the geolocation and time of collection was automatically recorded.

Boger and Low conducted a field excursion around the village of Codrington and recorded all the places where mosquitoes were found and took samples. They also discussed the wide variety of potential mosquito habitats that were available. All habitats were sampled where they encountered larvae. Samples were put into plastic bags and labeled for future counting and identification.

Following the original protocol, Boger and Low returned to the lab the next day and provided students with a magnifying glass to examine their specimens. They provided two afternoon workshops with the students, and two workshops with teachers to investigate our questions. Note the test app did not have a built-in key that the Mosquito Habitat Mapper has currently: they provided the key using an overhead projector and worked with the students and teachers as they examined their specimens.

They determined that the teachers and students found using the test app to record locations of mosquito breeding sites fun and interesting. There was value to the learning experience because many were not aware of the range of places where mosquitoes might breed. Students knew about and observed “wigglers,” but very few knew that wigglers were immature mosquitoes (mosquito larvae). In the lab, Boger and Low developed a procedure for identification and counting that would later become part of the protocol. The use of a magnifying glass was insufficient to determine species, but some genera were identifiable at 15x resolution. Higher power magnification (60x-100x) would be necessary for use in the protocol.

5.4.5.1. Concept Development: GLOBE Observer

The work by Low and Boger served as an existing proof of concept for a mosquito tool in the GLOBE Observer app. The decision was made to develop the Mosquito Habitat Mapper in the fall of 2016 in part to help address the emerging Zika epidemic in Brazil. The epidemic raised awareness of a serious new health threat and the mosquito species responsible for the transmission of Zika were invasive in the U.S. In conjunction with changing weather and climate, the range and distribution of *Aedes aegypti*, one of the two mosquitoes identified as vectors for Zika, is expanding northward, posing an ever-increasing health threat in the continental U.S. ([Kraemer et al., 2015](#)).

Low worked with entomologists to develop a simplified in-app dichotomous key that could be used by non-specialists to determine possible vector taxa. The need for mosquito images at higher resolutions than cameras on mobile devices provided at that time was met using an inexpensive clip-on microlens (60x) that fitted over the lens.

5.4.5.2. Mosquito Habitat Mapper Field Testing

Low and Boger provided scientific content for Mosquito Habitat Mapper and provided feedback as the tool was developed. The Mosquito Habitat Mapper was released May 31, 2017.

The Mosquito Habitat Mapper was piloted as part of an IGES project funded through USAID's *Combating Zika and Future Threats Grand Challenge Initiative: Mosquito Challenge Community Campaign* (MCCC), USAID Award No. AID-OAA-F-16-00099 to IGES, Low PI, Schwerin Co-PI, October 2016 through July 2018.

The USAID project took place in Brazil and Peru, in six communities at high risk for Zika and dengue transmission. This project tested the hypothesis that school age students can be effective agents of change and their actions could contribute to reduction of vector-borne disease in their communities. The MCCC project provided an intervention where classroom students (primarily middle and high school students) were connected in a citizen science project observing, recording, and mitigating mosquito breeding sites in and around their schools and communities. The project was disseminated through teacher workshops, where educators were provided with educational materials, training in the use of GLOBE Observer Mosquito Habitat Mapper mobile app, and classroom equipment.

This demonstration project had the following key elements:

- Through training and support, catalyze citizen scientists in Brazil and Peru to collect mosquito larvae and identify and mitigate breeding sites of disease vectors
- Connect this citizen science initiative to public health and mosquito control officials
- Task citizen scientists (primarily students) to develop an action plan tailored to both the need and the resources available• Provide a web-based forum for innovating and sharing ideas; reporting findings, research and action plans; and potentially stimulating replication in other communities

The app was tested with 7 groups of teachers at hands-on workshops in Peru and Brazil. This was the first usability analysis conducted using the Mosquito Habitat Mapper tool.

The IGES field team (Low and Renee Codsí, IGES) identified some technical issues during the pilot, which were addressed responsively by the DIS team. The version app posed issues in some of our test sites in Peru and Brazil in the first pilot. In communities where participants tended to have older phones, many of the teachers at the workshops could not download the app because it was optimized for newer phones (5.x Android). Older models did not have the computational capacity to run the app, so this was an additional challenge encountered during the 2017 pilot. A new version of the app was released in March 2018, in time for a second pilot. The new version loaded 2x faster and was able to work on older Android 4.x phones.

Over the course of the project 20 face to face workshops trained 387 teachers in use of the Mosquito Habitat Mapper. Participants received professional development about mosquito vectors and reducing risk of disease through surveillance and mitigation. GO MHM data was collected at 489 sites in Brazil and Peru, with a total of 1,318 observations submitted and 829 breeding habitats mitigated from May 28, 2017-July 15, 2018. Evaluators conducted a survey at the end of the project and demonstrated that post intervention, 98% of the participating households were actively mitigating mosquito habitats in and around their homes (a 22% increase from baseline).

IGES contracted with the National Opinion Research Center (NORC) at the University of Chicago to evaluate the USAID MCCC pilot implemented in Peru and Brazil. As part of this evaluation, NORC designed a survey for Public Health Officials (PHOs) and other potential users of the data to ask them about their perceptions of the usefulness of the data collected with the MHM mobile application and suggestions on how it could be improved to help their work.

The survey of the MCCC pilot included responses from 34 PHOs – 14 in Peru and 20 in Brazil. These 34 PHOs represent a diverse range of intended end-users of the MHM database including government health officials, hospital and clinic workers, students and researchers from academic institutions, and nongovernmental organization representatives. Key points reported by PHOs to NORC follow.

1. High enthusiasm among PHOs about the MHM database: PHOs are very positive about the prospect of using the MHM database in the future and about the efficacy of a tool like the MHM database to support their work.
 - a. 93% of all PHOs surveyed in both Peru and Brazil responded they are either somewhat or highly likely to use the MHM database in the future.
 - b. In Peru, PHOs were very enthusiastic: 92% of PHOs report they are highly likely to use the MHM database in the future.
 - c. 96% of all PHOs reported the database could be very effective in supporting their mosquito surveillance work.
2. PHOs in both countries report that many features of the MHM database are useful and accessible.
 - a. PHOs responded that the number of observations and their location on the map are very useful (94%) and very accessible (70%).
 - b. PHOs found the zoom in and out function from the global to street level very useful (91%) and very accessible (76%).
 - c. PHOs found the observations for a specific day on the map very useful (84%) and very accessible (72%).

- d. PHOs found the observations, such as photos of larva, for a specific site on a map very useful (85%) and very accessible (59%), though this was the least accessible according to PHOs in both countries.
3. PHOs report there are potential barriers to using the MHM database (60%), though this was much more common in Peru.
 - a. 43% of PHOs in Brazil reported barriers that may inhibit regular use of the database; the most commonly cited barrier among this group was “I have trouble using or navigating the database” (33%).
 - b. 91% of PHOs in Peru reported barriers; the mostly commonly cited was “I have no or limited access to Wi-Fi or other network coverage” (50%).
4. PHOs believe GLOBE citizen science offers benefits to their work.
 - a. 83% of PHOs reported that GLOBE citizen science “provides data for regions where we do not already sample” and that “users will be motivated to eliminate breeding sites around their homes.”
 - b. 79% of PHOs believe that GLOBE citizen science provides “useful information to the public.”

Source: Bullet summary of outcomes, MCCC Project, as reported by Public Health Officials to NORC. Source: Internal NORC evaluation report for IGES.

5.4.5.3. Durable Outcomes of the GLOBE Observer Mosquito Habitat Mapper Partnerships

Featured in PBS Documentary, [The Crowd and the Cloud](#)

The GLOBE Observer Mosquito Habitat Mapper, while still in development, was featured in [The Crowd & The Cloud](#), a 4-part public television series which first premiered in April 2017. Hosted by former NASA Chief Scientist Waleed Abdalati, each episode featured projects and people on the front lines of citizen science (Boger, PI, Low, Co-PI).

Collaboration with Smithsonian on an International, Multilingual Zika Curriculum

An exciting synergy emerging from our project is our collaboration in the development of a Zika curriculum with the Smithsonian Science Education Center. IGES collaborated with Mr. Andre Radoff, curriculum development specialist at the Smithsonian Science Education Center. Radoff led the development of Mosquito! an international education module for middle and high school students. Mosquito! is funded by the Gordon and Betty Moore Foundation and Johnson & Johnson. Mosquito Habitat Mapper was selected by the Smithsonian curriculum developers as a tool for middle school students to collect place-based data about the risk of disease in their home communities as a core component of the curriculum (see unit 4.5) Thus, the Smithsonian Mosquito! Curriculum provides a new avenue to introduce citizen science mosquito observations and the GO MHM app to youth worldwide- potentially multiplying the impact of the MCCC project many times over, once the curriculum is in broad use. The curriculum was released in English and Spanish in June 2018.

The Zika Bus

Another significant outcome of the MCCC project was the creation of the Zika Bus, a mobile laboratory bringing GLOBE Observer Mosquito Habitat Mapper citizen science experiences and vector health education to underserved communities in southern Brazil. Funded by the Brazilian Ministry of Science and Technology in 2018, this initiative was created by one of the workshop participants, a professor at the Federal University of Parana (Dr. Rodrigo Arantes Reis). As of 2025, Zika Bus outreach and programming is still in operation.

In 2018, the GLOBE Implementation Office, UCAR, was awarded a grant sponsored by the Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State (award number SLMAQM17CA2074) to expand the IGES USAID-funded pilot. GLOBE Engaging Citizens in the Forecasting and Observation of Mosquito Threats leveraged scaled up intervention to support work across 22 countries in three GLOBE regions: the Asia-Pacific, Latin America and Caribbean, and Africa.

The project had three main objectives:

1. to provide Zika education and mosquito breeding site elimination;
2. to develop and strengthen networks of public health officials, GLOBE countries, scientists, teachers, and other community members; and
3. provide public health officials with on-the-ground citizen science-collected data to track mosquitoes and fight mosquito-borne diseases.

In May and June 2018 more than 100 representatives from 49 GLOBE countries attended one of three GLOBE Zika Education and Prevention regional workshops:

- Hanoi, Vietnam: 15 GLOBE Countries from the Asia-Pacific Region, 10-11 May (India, Marshall Islands, Micronesia, Palau, Philippines, Thailand, Vietnam)
- Lima, Peru: participants from 17 GLOBE countries in the Latin American and Caribbean Region, 22-23 May (Argentina, Colombia, Costa Rica, Dominican Republic, Guatemala, Paraguay, Peru, Suriname)
- Lomé, Togo, participants from 17 GLOBE Countries from the Africa Region (Benin, Burkina Faso, Cameroon, Nigeria, Senegal, Togo, Uganda)

Over a three-year period (winter 2018 through fall 2020), the project supported 135 Country Mosquito Trainings and engaged more than 4,300 individuals including 8 public health workers - in training workshops hosted in 80 countries, to foster use of the Mosquito Habitat Mapper by local citizen scientists to support monitoring of disease-carrying mosquitos in their communities. This work greatly increased the visibility and use of the app in GLOBE countries.

By the end of the third year of the project (September 2020), all project implementation countries and cooperative countries submitted a total of 154,283 mosquito larvae data points to the GLOBE database, with other GLOBE countries submitting 37,747 mosquito larvae data points, for a grand total of 192,030 total mosquito larvae data points, or observations. This involved more than 800 schools and organizations, with more than 75,000 community members engaged.

The first research paper published using GLOBE mosquito larvae data was from Benin in the International Journal of Mosquito Research, titled “Assessment of population dynamics and biting trends of *Aedes aegypti* in northern Benin: Public health implications” ([Aikpon, Dramane, et al., 2019](#)). The Africa Francophone RPHO received a grant from GLOBE to conduct this research and consequently published his work in this article. He continued his research on the *Aedes* mosquito in Benin and published a second paper entitled “Larval breeding characteristics and distribution of *Aedes* mosquito species in the economic capital of Benin: A public health concern” in the International Journal of Entomology Research in May 2019 ([Aikpon, Klotoe, et al., 2019](#)). At the University of Walailak in Southern Thailand, professors and active GLOBE community members, Krisanadej Jaroensutasinee and Mullica Jaroensutasinee, published their paper, “Spatial and temporal variations on the coexistence of *Aedes* and *Culex* larvae in Southern Thailand” in the Journal for Animal Behaviour and Biometeorology ([Chumsri et al., 2020](#)).

5.4.6. Data Collected – Mosquito Habitat Mapper

Each data element collected is described in [section 5.4.2](#) above. Every data option (habitat type, larvae count, etc.) receives a column in the data file as detailed in the GLOBE Data User Guide. Volunteers may upload up to 9 habitat photos and 9 larva photos. Data associated with publications are archived on the GLOBE Observer website under [GLOBE Mosquito Habitat Mapper Data](#).



As of August 2025, more than 45,000 mosquito habitat observations have been submitted globally. Map from the [GLOBE Visualization System](#).

5.4.7. Documentation of Changes – Mosquito Habitat Mapper

Based on feedback from early implementation of Mosquito Habitat Mapper and an assessment of common data submission errors (Amos et al., 2020), we updated the user interface in 2021. We moved from a photo-based interface to line drawings both to reduce the size of the tool and to improve larvae identification. The dichotomous key was refined, and larvae count fields were restricted to a reasonable range. The [GLOBE Data User Guide](#) tracks all changes made to GLOBE data.

5.5. Land Cover

5.5.1. Science Purpose and Achievements – Land Cover

GLOBE Observer Land Cover was developed to create a database of geotagged, labeled land cover photos to provide ground-based reference data for land cover classification products derived from satellite data. The protocol, science need and justification are documented in [Kohl et al. \(2021\)](#), which states:

Volunteer-collected geotagged photographs have been shown to provide useful reference data if a protocol is followed ([Foody et al., 2017](#)). At minimum, photos should include date, location, and standardized tags; ideally, a photograph should be taken in each cardinal direction to fairly sample the land cover at that location ([Antoniou et al., 2016](#)). The GLOBE Observer Land Cover protocol meets these requirements. The protocol contains two components: definition of the observation site and definition of the attributes of the site.

While working with student interns participating in the STEM Enhancement in Earth Science (SEES) Program, Dr. Rusty Low (IGES) and Peder Nelson (Oregon State University) developed a method of collecting land cover data to maximize its alignment with satellite data ([Low, Nelson, et al., 2021](#)).

In 2021, NASA EPSCoR (Established Program to Stimulate Competitive Research) funded four universities to examine applications of artificial intelligence and machine learning to label GLOBE Observer land cover photos. Funded research teams were at the University of Vermont, University of Wyoming, New Mexico State University and the University of Puerto Rico. Two teams published their approaches to AI-assisted analysis of GLOBE Observer land cover photos: [Huang et al. \(2023\)](#) and [Manzanarez et al. \(2022\)](#).

The GLOBE Observer Mosquito Habitat Mapper has been influential for the broader international citizen science community. As part of work conducted as a Fulbright Scholar in Brazil (2022-2023), Low worked with scientists at the Federal University of Paraná, Brazil, in the creation of a school based-citizen science program modeled after GLOBE, Programa Interinstitucional de Ciência Cidadã na Escola (Interinstitutional Citizen Science Program in Schools, PICCE). This program adopted the GLOBE Observer protocol and has incorporated the GLOBE Observer Land Cover Protocol as part of each of the 15 citizen science investigations, contextualizing each of the citizen science projects on the landscape. These data are now being collected by PICCE and can eventually be incorporated into the GLOBE database when an API-in function is developed.

Amazonian students at the Federal University of Para, Obidos, Brazil participated in a week-long land cover change research project sponsored by the Brazilian Space Agency. The project engaged students in documenting current land cover using the Adopt a Pixel 3 km method ([Low, Nelson, et al., 2021](#)) and examining historic Landsat landcover data since 1984.

Because of its flexibility, GLOBE Observer Land Cover has also been used to support science initiatives beyond land cover science. The [Fresh Eyes on Ice](#) project uses GLOBE Observer Land Cover to document river ice conditions during transitional seasons. The project received funding from the NASA Citizen Science for Earth Systems Program in 2020 and 2022 in addition to other funding sources. Land cover data confirmed ice conditions as verification for models and interpretation of satellite data. The project produced multiple [publications](#), including one about GLOBE Observer data, [Abdelkader et al. \(2024\)](#).

In 2020 and 2024, Dixie National Forest obtained USDA Forest Service funding to recreate historic photos of the forest using GLOBE Observer Land Cover to document change. See news story, "[Tracking Change in Dixie National Forest.](#)"

In 2025, Dr. Yoseline Angel, NASA GSFC, requested GLOBE Observer Land Cover observations of wildflower blooms in California, Nevada, and Arizona to verify the presence and color of flowers in remote sensing data. See news story, "[Looking for Wildflower Blooms and Flowering Trees with GLOBE.](#)"

The GLOBE Observer Land Cover tool and data are discussed in the following publications presented in reverse chronological order. A full list of references and table of publications with topic notations can be found in [Appendix C](#).

[Nelson et al. \(2024\)](#), GLOBE Observer: A case study in advancing Earth system knowledge with AI-powered citizen science - Describes how artificial intelligence tools are used with GLOBE data, including as part of the data ingest and process for privacy and safety screening and for classification of mosquito larvae and land cover photos.

[Abdelkader et al. \(2024\)](#), A Google Earth Engine platform to integrate multi-satellite and citizen science data for the monitoring of river ice dynamics - Describes an automated system blending multi-satellite information and citizen science data for reliable and timely observations of lake and river ice in under-observed northern regions. The integration of citizen science data added value in the validation of remote sensing products and filled gaps whenever satellite observations cannot be collected due to cloud obstruction. Citizen science data could also be converted to valuable quantitative information such as ice thickness, which is very useful when combined with ice extent derived from remote sensing.

[Huang et al. \(2023\)](#), Land cover mapping via crowdsourced multi-directional views: The more directional views, the better - An investigation assessing the efficacy of the GLOBE Land Cover multi-directional data-collecting protocol using four selected deep learning architectures, showing that multi-directional views benefit land cover classification.

[Manzanarez et al. \(2022\)](#), Land use land cover labeling of GLOBE images using a deep learning fusion model - Describes a process for using a deep learning fusion model to label land cover images and integrating the labels from multiple directional images to assign a unique label to the image sets. The validation step showed that the architecture of labeling the images resulted in 90.97% label accuracy.

[Low, Nelson et al. \(2021\)](#), Adopt a Pixel 3 km: A multiscale data set linking remotely sensed land cover imagery with field based citizen science observation - Describes the pilot of the Adopt a Pixel project with high school research interns, in which they examined satellite imagery coupled with their *in-situ* land cover land use observations and classified the images using Collect Earth Online (CEO).

[Kohl et al. \(2021\)](#), GLOBE Observer and the GO on a Trail data challenge: A citizen science approach to generating a global land cover land use reference dataset - Describes the data collection process for the GO on a Trail challenge, as well as examining data quality and potential applications of the dataset.

[Amos et al. \(2020\)](#), **GLOBE Observer Data: 2016–2019** - Data description and quality flags for observations of all four GLOBE Observer data types (clouds, land cover, mosquito habitats, and trees) around the world. Show that most data is over Europe and the U.S.

[Boger et al. \(2020\)](#), **Identifying hurricane impacts on Barbuda using citizen science ground observations, drone photography and satellite imagery** - Describes the process of documenting and analyzing the landscape scale changes that took place on the island as a result of the hurricane using ground level observations, aerial photographs and satellite images.

5.5.2. Basis in GLOBE Protocols – Land Cover

GLOBE Observer Land Cover was based on the [GLOBE Land Cover Sample Site Protocol](#), which required the location and photos of the site along with an assessment of the land cover at the location.

The full [GLOBE Land Cover](#) protocol requires equipment—a long measuring tape—that we couldn't expect a volunteer to have. For that reason, GLOBE Observer Land Cover does not duplicate the GLOBE Land Cover protocol. Developments since the original implementation of GLOBE Observer Land Cover have made it possible to estimate distances without the measuring tape.

If funding allows in the future, it is recommended that GLOBE Observer Land Cover be updated to align with GLOBE Land Cover, while keeping the photos. In particular, the method of determining the land cover classification should be aligned. In addition to aligning the two protocols, this change is recommended to improve data quality. GLOBE Observer Land Cover asks participants to visually estimate percent cover for each potential land cover type in each photo. Visual estimation is subjective at best and may provide a false sense of accuracy by offering a numeric value in the percent cover field (clouds data by contrast provides a broad range, i.e. 25-50%). Additionally, the ask is challenging and very few volunteers provide the classification. Informal conversations with multiple scientists indicate that photo labels (trees, grass, urban) would be highly useful. An update would ask the user to select land cover types present from a checklist, as GO Land Cover currently does, then drop the percent coverage estimates. Instead, it is recommended that users be referred to the GLOBE biometry protocol to quantify land cover.

GLOBE Observer Land Cover was also informed by Adopt a Pixel, a project led initially by Holli Kohl and developed under Landsat education and communication initiatives in 2013 in consultation with the Landsat Science Team. This project served as a sort of pilot for GLOBE Observer Land Cover, though it continued in its own right maintained by the United States Geological Survey's Earth Resources Observation and Science (EROS) Center (see [Adopt a Pixel](#)). Once GLOBE Observer Land Cover launched, USGS redirected volunteers to GLOBE.

5.5.3. Scientists Consulted – Land Cover

Scientists involved in the 2017 development of the Land Cover tools include:

- Dr. Dixon Butler, GLOBE Senior Advisor
- Dr. Eric Brown de Colstoun, NASA Goddard, Greenbelt, Maryland
- Mr. Peder Nelson, Oregon State University, Corvallis, Oregon
- Dr. Robert Kennedy, Landsat Science Team/Oregon State University, Corvallis, Oregon
- Dr. Russ Congalton, University of New Hampshire, Durham, New Hampshire (though it should be noted that he disagreed with the direction of development)

The GLOBE Program:

- Mr. Travis Anderson
- Dr. Tony Murphy

5.5.4. Overview of Land Cover App Tool

The protocol contains two components: definition of the observation site and definition of the attributes of the site. Data collection begins with the definition of the observation site, a 100-square meter area centered on the observer. The date, time, and location derived from carrier and phone settings are auto filled and verified by the user.

Site attributes identified in the second phase of the data-collection protocol include ephemeral surface conditions (snow/ice on the ground, standing water, muddy or dry ground, leaves on trees, raining/snowing), site photos, and optionally, land cover classification labels. Up to six photographs are taken at each location: horizontal landscape views focused on the nearest 50 meters and centered on each cardinal direction, up to show canopy and cloud conditions, and down to show ground cover at the center of the site. Volunteers may also submit photos of a special feature not included in the N-E-S-W photos. A field notes section allows volunteers to enter information about the observation site, including a description of the special feature photo.

Next, volunteers may label each N-E-S-W photo with the primary land cover types visible in the image and estimate the percentage of the 50-meter area that includes that land cover type. The classification step is optional, and an observation may be submitted without classifications.

To collect high quality data, users are trained before data collection and are required to review data before submission. Before data collection begins, users complete an interactive in-app tutorial to unlock the protocol tools. Training includes definitions of land cover, animations demonstrating how to photograph the landscape, and an interactive labeling exercise. The tutorial and a simple land cover classification guide with photo examples are accessible from any screen during data collection and classification. After collecting data, the volunteer sees a summary of the observation and has the opportunity to correct errors before final submission. GLOBE Observer Land Cover is documented in [Kohl et al., 2021](#).

5.5.5. History of Development and Use – Land Cover

Development on the GLOBE Observer Land Cover tool formally started in early 2017. It was tested with the GLOBE community at the 2018 GLOBE Learning Expedition in Killarney, Ireland. The tool was formally released in September 2018.

The idea for GLOBE Observer Land Cover was incubated, in part, by the Landsat mission's Adopt a Pixel project. Adopt a Pixel was a citizen science project that engaged volunteers in collecting photos of land cover and tagging them with the location. The idea was formulated in a 2009 workshop at NASA's Goddard Space Flight Center that included experts in both land cover and citizen science. With titles and affiliation from the time of the workshop, expert participants included:

- Janis Dickinson, Director of Citizen Science, Cornell Lab of Ornithology
- Jes Koepfler, Institute for Learning Innovation
- Ed Geary, GLOBE
- Walter Staveloz, Director of International Relations Association of Science and Technology Centers (ASTC)
- Sandra Henderson, Director, Project Budburst
- Theresa Crimmons, National Phenology Network
- Wayne Esaias, researcher, NASA Goddard
- Rebecca Jordan, Assistant Professor of Environmental Education and Citizen Science, Rutgers University
- Peter Griffith, researcher, NASA Goddard
- Joanne Nightingale, researcher, MODIS Land Products, NASA Goddard
- Robert Wolfe, researcher, MODIS Land Products, NASA Goddard
- Louis Steyaert, researcher, NASA Goddard
- Eric Brown de Colstoun, researcher, NASA Goddard
- Enrique Montaña, researcher, Land Processes Distributed Active Archive Center (DAAC), NASA Goddard,
- Tammy Beaty, researcher, Oak Ridge National Lab Distributed Active Archive Center (DAAC)
- Jennifer Brennan, communication lead, NASA's Earth Observing System Data and Information System (EOSDIS), NASA Goddard
- Holli Riebeek (Kohl), education lead, NASA Goddard (workshop organizer)

The workshop explored the intersection between data needs and citizen science capabilities, including both existing citizen science and the potential for new citizen science to support NASA land missions, particularly MODIS and Landsat. The Adopt a Pixel photography project was the outcome. GLOBE was considered at the time, but its restriction to students and educators limited its utility in collecting widespread data. (The 2015 decision to open GLOBE to citizen scientists made GLOBE a better option for data collection and data management.)

Adopt a Pixel was developed and presented to the [2012-2017 Landsat Science Team](#) at the [2013 Landsat Science Team Meeting](#), where the approach was received positively as a potential source of georeferenced ground reference data for land cover classification products. In 2014-15, shifts in NASA Education and Outreach funding limited the full implementation of Adopt a Pixel. The Landsat communication team handed it to USGS EROS Data Center, which hosted the project going forward to improve integration with Landsat data. The NASA Earth Science Education Collaborative also folded the concept into their proposal for GLOBE Observer, where it informed the development of GLOBE Observer Land Cover.

5.5.6. Data Collected – Land Cover

As of June 2025, 57,132 GLOBE Observer Land Cover observations have been submitted to GLOBE. These include geotagged photos and surface conditions. Since land cover classification is optional, only a fraction of observations include a classification label (Modified UNESCO Classification or MUC Code). During a 2019 land cover data collection challenge, 24 percent of observations included labels. ([Kohl et al, 2021](#))

Data are distributed globally. The most common error in the data is a location error where data are reported to be collected over oceans. While some data have been collected onboard ships, this data is primarily clouds. Data points in the ocean are likely errors.



Map showing all the data collection locations for land cover through 2025. Map from the [GLOBE Visualization System](#).

5.5.7. Change Documentation – Land Cover

Updates to GLOBE Observer Land Cover have been limited. In 2023, the training was slightly simplified to align better with other protocols. In December 2023, a new function was added to GLOBE Land Cover to allow users to add up to four photos of special features that wouldn't fall in the normal North-East-South-West photos. This function supports the use of the land cover tool for new purposes such as monitoring river ice. All updates that impact data collection are described in the [GLOBE Data User Guide](#).

5.6. Trees

5.6.1. Science Purpose and Achievements - Trees

Biometry is the measurement of living things, such as the height of trees or shrubs. Tree height is the most widely used indicator of an ecosystem's ability to grow trees, so tracking tree height over time can help us to assess the ecological health of a given area. Along with tree height, scientists, researchers, and foresters often need more information, like tree circumference and the tree genus, species, and/or common name. Tree circumference can be used by foresters and managers to calculate the approximate age of the tree, and the measurements are also used to estimate the amount of standing timber in a forest. Both tree height and trunk circumference can also help to measure biomass, the total mass of living material above ground measured across a particular area. Identifying the type of tree is important because it helps us understand a tree's specific characteristics, potential ecological roles, and the type of care a tree will need to thrive in different environments.

NASA uses field campaigns and sensors on satellites and the International Space Station (ISS) to improve our understanding of how much carbon is being stored in terrestrial ecosystems and how this could change as patterns of drought, fire, and forest ecosystems shift in a changing climate. For example, NASA has launched satellites such as the Ice, Cloud, and land Elevation Satellite-2 (ICESat-2) as well as instruments such as the Global Ecosystem Dynamics Investigation (GEDI) on the ISS, which use lasers to measure the height of Earth's surface below them as they orbit our planet. These measurements of the third dimension of forest structure help improve estimates of how much carbon is stored above ground in large forests.

Ground sources of data are also needed to verify the measurements from satellites, and observations from citizen scientists can help fill in gaps in that data. For example, tree height measurements will help scientists working on NASA missions like ICESat-2, which is measuring the heights of forest canopies worldwide. Those satellite observations can be complemented by citizen scientists using the GLOBE Observer app, who will be able to gather tree heights from many more places than the ICESat-2 scientists alone could measure ([Malambo & Popescu, 2024](#)).

ICESat-2 scientists have looked, and continue to look, for places where clusters of citizen scientist measurements overlap with ICESat-2's measurements and compare the two datasets. Having this overlap provides ICESat-2 scientists a second layer of tree height data that could be used in potential research. Also of interest are locations across the globe where ICESat-2 has not measured trees. Even though the ICESat-2 satellite has been able to measure the height of hundreds of billions of trees globally (there are approximately 3.03 trillion trees on the planet), it is, and will not be able to, measure every single tree, due to things like thick canopy, undergrowth, smaller trees, thick cloud cover, and more. This is where GLOBE Observer tree height observations can fill in gaps.

Two projects funded under NASA's [Citizen Science for Earth Science Program](#) in 2024 use GLOBE Observer Trees for data collection. Dr. Maria Vernet, oceanographer at Scripps Institution of Oceanography, experimented with GLOBE Observer Trees to measure iceberg height in the North Atlantic Ocean as part of her project, *Coupling Citizen Science and Remote Sensing Observations to Assess the Impacts of Icebergs on Coastal Arctic Ecosystems*. Dr. Duan Biggs, Northern Arizona University, planned data collection with GLOBE Observer Trees for his project, *Engaging Citizen Scientists for Inclusive Earth Systems Monitoring* to improve models of vegetation structure and biomass built on data from NASA's Global Ecosystem Dynamics Investigation (GEDI). In 2025, Dr. Yoseline Angel

at NASA Goddard also requested the use of GLOBE Observer Trees to document blooming tree phenology in the tropics.

The GLOBE Observer Trees tool and data are discussed in the following publications presented in reverse chronological order. A full list of references and a table of publications with topic notations can be found in [Appendix C](#).

[Lu et al. \(2025\)](#), Use of GLOBE Observer Citizen Science Data to Validate Continental-Scale Canopy Height Maps Derived from ICESat-2 and GEDI - Study using ground-based observations from GLOBE Trees to evaluate and validate three canopy height models from satellites as well as airborne lidar data from selected sites. The results showed low general agreement between citizen science data and airborne lidar reference heights or spaceborne lidar-derived canopy height maps, including geolocation inaccuracies and measurement inconsistencies.

[Patil et al. \(2024\)](#), Review of earth observation techniques and citizen science approach for biodiversity hotspot study - The review study explores contemporary Earth observation (EO) methods and the influential role of citizen science in environmental research.

[Enterkine et al. \(2022\)](#), The potential of citizen science data to complement satellite and airborne lidar tree height measurements: lessons from The GLOBE Program - This paper describes tree height data collected through GLOBE Observer and identifies sources of error in data collection, as well as illustrating how the ground-based citizen science data can be used in conjunction with ICESat-2 tree height observations.

[Campbell, B. \(2021\)](#), ICESat-2 and the Trees Around the GLOBE student research campaign: Looking at Earth's tree height, one tree at a time - Describes how students, as part of the Trees Around the GLOBE Student Research Campaign, have been collecting tree height data and comparing it to ICESat-2 tree height data.

[Amos et al. \(2020\)](#), GLOBE Observer Data: 2016–2019 - Data description and quality flags for observations of all four GLOBE Observer data types (clouds, land cover, mosquito habitats, and trees) around the world. Show that most data are over Europe and the U.S.

5.6.2. Basis in GLOBE Protocols - Trees

GLOBE Observer Trees uses portions of the GLOBE Program's [Biometry Protocol](#), including tree height and tree circumference measurements, along with tree identification (including genus, species, and common name).

While the data collected through GLOBE Observer Trees does not differ from the GLOBE Biometry protocol, the method of data collection does. Since the beginning of the GLOBE Program in 1995, students could take tree height observations using a hand-held clinometer, an instrument used for measuring angles to determine the heights of objects without directly measuring them. Through this method, the students would implement calculations by applying principles based on the properties of right triangles. The GLOBE Observer app uses the same principle of a clinometer, except that the app has the built-in trigonometry, and uses a cellphone's built-in gyroscope to measure the angles to estimate the height of a tree.

5.6.3. Scientists Consulted – Trees

Several scientists were consulted prior to the release of the GLOBE Observer Trees tool and continue to serve in an as-needed advisory role. These scientists are internal and external to NASA, but all have some type of role with biosphere research using NASA satellites, instruments, and campaigns. These scientists include:

- Dr. Thomas Neumann, Project Scientist, ICESat-2 Mission, NASA's Goddard Space Flight Center in Greenbelt, Maryland
- Dr. Kelly Brunt, Scientist, National Science Foundation (formerly with ICESat-2 at NASA Goddard)
- Dr. Paul Montesano, Research Scientist, Global Ecosystems Dynamics Investigation (GEDI) Mission, ADNET Systems, Inc. at NASA Goddard
- Dr. Laura Duncanson, Remote Sensing Scientist, GEDI Mission, University of Maryland, College Park, Maryland
- Dr. Amy Neuenschwander, Senior Research Scientist, University of Texas, Austin, Texas
- Dr. Sorin Popescu, Senior Research Scientist, Texas A&M University, College Station, Texas

5.6.4. Overview of Trees App Tool

The GLOBE Observer Trees tool uses the phone's built-in gyroscope and camera to convert the phone into a clinometer. Prior to using the tool, the observer must review the "Introduction" and "Tutorial" sections in order to understand how to correctly use the tool to take observations of tree height, tree circumference (optional) and tree genus, species, and/or common name (optional). Then, the user enters their height into the Trees tool, a requirement to calculate tree height and distance. The user locates a tree for which they can see both base and crown and can walk to its base in a straight line. They then tilt the phone to see the base of the tree, then the crown of the tree in the camera. This action measures the angle between the bottom and the top of the tree (required). The user photographs the tree, then walks to the base of the tree counting the number of steps. The step count and user's height are used together to estimate distance to the tree. Then, the Trees tool records the location at the tree's base (required). At that point, the user can take the optional tree circumference and record tree genus, species, common name identification.

The Trees tool converts measurement of distance and sight angles into tree height using trigonometry. The process of these calculations and potential sources of error are documented in [Enterkine et al. \(2022\)](#).

5.6.5. History of Development and Use – Trees

Trees was selected to become a GLOBE Observer tool at the request of scientists and educators on NASA's ICESat-2 mission, which launched September 18, 2018. The mission was designed to measure ice thickness and vegetation height, and the ICESat-2 community hoped that GLOBE Observer could provide complementary, ground-based observation of vegetation height.

Supported by ICESat-2 funding, the development of the GLOBE Observer Trees tool began in late 2017 and continued to its official release on 26 March 2019. Development consisted of a combination of planning, testing, and implementation meetings between developers on the Data Information System (DIS) team in Pasadena, California, scientists internal and external to NASA (see [section 5.6.3](#)), and the GLOBE Observer team at NASA's Goddard Space Flight Center. Because the Trees tool required new capabilities of the app - the ability to measure both angle and distance - development took significantly longer than prior tools. Extensive testing and iteration occurred between the DIS team and the GLOBE Observer Team at NASA's Goddard Space Flight Center. Outcomes of the testing, particularly error assessments, are included in [Enterkine et al. \(2022\)](#).

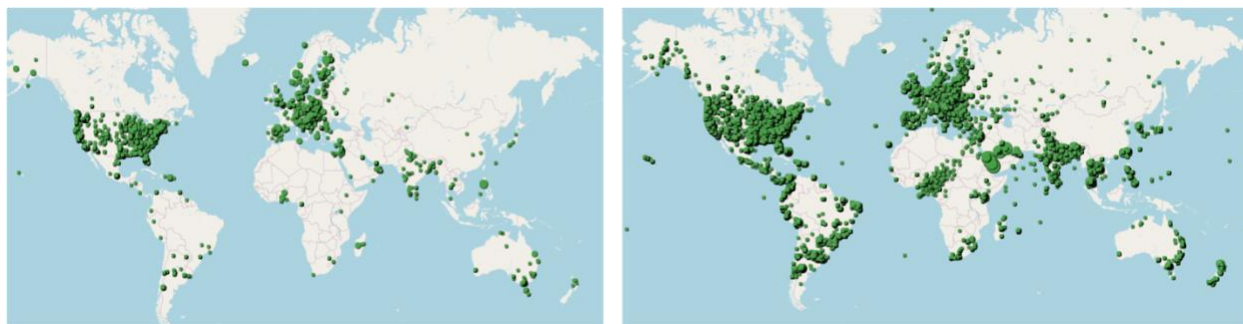
Once the GLOBE Observer Trees tool was released, testing and discussion continued, including with a small group of Trees Around the GLOBE Student Research Campaign members inside and outside the United States. During this time, Brian Campbell, at NASA's Wallops Flight Facility, was named the GLOBE Observer Trees Science Lead/Liaison.

5.6.6. Data Collected – Trees

Trees data includes estimates of tree height, location, date and time, and (if included) circumference and genus/species/name. Every data field receives a column in the data file as detailed in the GLOBE Data User Guide.

Since the official release of the GLOBE Observer Trees tool on 26 March 2019, observers have collected over 100,000 tree height observations from more than 35,000 sites across the GLOBE community in 127 GLOBE countries. Prior to the GLOBE Observer Trees tool being released, the GLOBE Biometry protocol's tree height measurement using a hand-held clinometer resulted in just over 14,000 tree height observations from 1,300 sites across the GLOBE community from 23 April 1995 - 25 March 2019.

In addition to the steady collection of tree height observations entering the database regularly, there have been concentrated tree height observations from past Intensive Observation Periods (IOPs) that have been part of the Trees Around the GLOBE Student Research Campaign and from GLOBE Observer challenges including the 2021 Community Trees Challenge, NASA GLOBE Trees Challenge 2022, and the NASA Moon Trees Quest 2023. These IOPs, challenges, and quests are specifically designed to have GLOBE observers collect a large amount of tree height data in a short period of time, usually from one to three months. These IOPs and challenges have allowed GLOBE to build more robust datasets for use by students to professional researchers and allow comparisons between ground-based GLOBE tree height observations and the space-based tree height observations from missions like ICESat-2 and GEDI.



The map on the left shows the number and distribution of GLOBE tree height observations collected between April 1, 1995 and March 1, 2019. The map on the right shows the number and distribution of observations collected between March 1, 2019 and September 1, 2025. The GLOBE Observer Trees tool was released on March 26, 2019. Maps from the [GLOBE Visualization System](#).

5.6.7. Change Documentation – Trees

GLOBE Observer Trees was updated in late 2024 to include the ability to enter a tree's genus and species or common name. No additional significant update has been made to the tool. Documentation for the GLOBE Observer Trees tool is included as part of the [GLOBE Data User Guide](#).

5.7. Eclipse

5.7.1. Science Purpose & Achievements – Eclipse

[GLOBE Eclipse](#) was designed to help individuals appreciate the Sun-Earth connection by observing changes in temperature and clouds during a solar eclipse. We specifically sought to answer questions about what happens when the Sun is blocked by the Moon during an eclipse, and how the eclipse will affect solar-powered processes in the atmosphere, especially temperature changes and clouds. While the data were analyzed for science, the design purpose was education and outreach.

GLOBE Eclipse tool and data are discussed in the following publications presented in reverse chronological order. A full list of references and a table of publications with topic notations can be found in [Appendix C](#).

[Autore et al. \(2025\)](#), GLOBE Eclipse 2024: A case study of the effects of the April 2024 total solar eclipse on cirrus clouds and contrails in the United States of America - This research couples model data and satellite imagery with ground observations submitted by volunteers to examine how cloud coverage and the type of clouds changed during the eclipse. Volunteers found cirrus and contrails typically increased near the local eclipse maximum (LEM), demonstrating that even temporally short events, like a solar eclipse, may affect atmospheric conditions enough to alter the likelihood of formation of these high-level clouds.

[Giarratano et al. \(2024\)](#), GLOBE Eclipse Workshop engages educators in Earth science research - Describes a 5-week workshop with over 60 educators from across the United States to train them to collect various environmental and atmosphere data during the eclipse.

[Tarosky \(2024\)](#), Annular solar eclipse - This article reports on cloud observations and air temperature data recorded over a 3-hour window during the October 14, 2023, annular eclipse event from Tacoma, Washington, USA using the GLOBE Observer app.

[Amos et al. \(2020\)](#), **GLOBE Observer Data: 2016–2019** - Data description and quality flags for observations of all four GLOBE Observer data types (clouds, land cover, mosquito habitats, and trees) around the world. Show that most data are over Europe and the U.S.

[Dodson et al. \(2019\)](#), **Eclipse across America: Citizen science observations of the 21 August 2017 total solar eclipse** - Examines the relationship between cloud cover and the eclipse-induced temperature depression. Also compares the GLOBE results with Mesonet data to test the robustness of the citizen science results. The results also show the great benefit that research using citizen science data receives from increased numbers of participants and observations.

[Rahman et al. \(2019\)](#), **Validation of GLOBE citizen science air temperature observations using data from the Great American Solar Eclipse**. - In this study, GLOBE air temperature observations were compared with data from National Weather Service weather stations. The results show that there was good correlation between the datasets.

[Weaver, Kohl et al. \(2019\)](#), **How cool was the eclipse? Collecting Earth science data with citizen scientists and GLOBE Observer** - Describes the data collection process developed for the 2017 total solar eclipse, as well as outreach efforts for the event, and an overview of the data collected.

5.7.2. Basis in GLOBE Protocols – Eclipse

GLOBE Eclipse builds on GLOBE’s air temperature and clouds protocols. It enables the collection of air temperature data by all app users. GLOBE users who are trained can always enter air temperature data, either through Atmosphere Data Entry within the GLOBE app or via online data entry forms. The Eclipse tool opens up the ability to report air temperature without the standard GLOBE training, though in-app training is still required.

In addition to temperature, the Eclipse tool prompts users to switch to the Clouds tool and periodically take observations of sky conditions. Starting with the 2023 annular eclipse, an observation of land cover was also incorporated into the process, to set the scene for data collection and give context for the air temperature and clouds data.

5.7.3. Scientists Consulted – Eclipse

The scientific advisors for the Eclipse tool were the GLOBE Clouds team at NASA’s Langley Research Center, especially Marilé Colón Robles and Jessica Taylor. Since all of the protocols used were pre-existing GLOBE protocols, the development needed was primarily how to make the air temperature and clouds measurements fit within the context of an eclipse (for example timing of observations) as well as creating a user-friendly interface that would encourage and facilitate untrained observers to participate in data collection.

5.7.4. Overview of Eclipse App Tool

For the special Eclipse tool, standard GLOBE training was not required to submit air temperature data. The in-app instructions emphasized that a separate thermometer was needed, and to not use a weather app on the phone. As part of the initial settings when first opening the tool, users were asked to confirm the type of thermometer and given the options of liquid filled, digital, weather station and other (although the responses were not stored with the data.) Participants were given reminders (including a countdown in the tool and a pop-up message) to collect air temperature data every ten minutes until 30 minutes before maximum eclipse, at which point the reminders increased to every five minutes until 30 minutes after maximum eclipse, when the frequency returned to every ten minutes. Instructions also included a suggestion to pause and enjoy the eclipse during totality before resuming data collection.

During the eclipse, users were directed to use the Clouds tool and the regular process of taking a cloud observation. In the Eclipse tool, reminders were given to take cloud observations every 30 minutes except for the period a half hour before and after maximum eclipse, during which the reminders were every 15 minutes.

New for the eclipses in 2023 and 2024 compared to previous eclipse events, users were asked to take a single observation with the Land Cover tool at their data collection site, to set the scene for the other types of data collected. A reminder of this occurred during initial set up of the app, and once afterward via a pop-up message.

5.7.5. History of Development and Use - Eclipse

The Eclipse tool was originally developed for the total solar eclipse on 21 August 2017 across the United States. At that point, it was open to anyone using GLOBE Observer, even areas not experiencing any portion of the eclipse. For eclipses after the initial 2017 event, the appearance of the GLOBE Eclipse tool has been constrained geographically to roughly the area experiencing the eclipse.

The temporary tool has so far been opened for the total solar eclipses in 2017 (United States), 2019 and 2020 (South America), and 2024 (North, Central and South America), and the annular solar eclipse in 2023 (North and Central America). More details about the dates of data collection and the regions of Eclipse tool visibility for each event can be found on the [GLOBE Eclipse Data](#) page.

In addition to including Land Cover as noted above, collection of wind data was also contemplated for the 2023 and 2024 eclipse. While there is a wind protocol as part of the GLOBE Program, it is not as fully developed as most other protocols and is primarily used for automated weather station data reported to the database. Options explored for the Eclipse tool were the use of qualitative observations such as the Beaufort scale and adapting the wind flags protocol developed by the AREN Project (NASA Science Activation) and including photos that could be used to estimate wind speed and direction (where the ribbon was pointing for direction and the angle from vertical to give a sense of speed).

However, there were concerns about the ultimate scientific utility of the data, and they were not implemented into the app. Wind data included as part of the eclipse curated data sets therefore comes from automated weather stations and a few trained users with handheld anemometers who entered measurements through Data Entry, either in GLOBE Observer or on the website, or through email data entry.

The Eclipse tool was available in English only for the 2017 eclipse, and English and Spanish for subsequent eclipses. Because of the path across Brazil in 2023, Portuguese was added for the 2023 eclipse, and because of Quebec, French for 2024. The Clouds tool is always available in all four of those languages. Many of the training resources for 2023 and 2024 were also available in Spanish (see the [Eclipse Resource Library](#)), and a few were also translated into French.

For future possible deployments of the Eclipse tool, there are a few steps required. To begin, the text needs to be updated to represent the path of the given eclipse, and a GeoJSON shape of the desired area of visibility provided to the DIS team, steps previously taken by the GLOBE Observer team. While the DIS team can provide more details about the technical steps needed for the release, at a minimum, graphics would need to be updated to show the correct dates on the app screens and on the graphs, changes made to the back-end coding used to provide new eclipse timings by location, and testing done to ensure the tool works with any operating system or other app code updates since the last release.

The DIS team also does load testing on the servers to make sure the system is ready for the increased traffic, including test runs for the app switching between modes for before, during and after the eclipse event. The recently introduced “plan B” backup database will also need to be taken into account, as that didn’t exist during any of the previous eclipses and may need special handling. Ideally, DIS would need four to six weeks to prep the tool for deployment. This assumes no new features added to the tool, simply opening up the tool as it existed after the 2024 eclipse, and a full complement of team members available for the work. Changes to either of those conditions would require more lead time.

In addition to the app, the DIS team created a custom visualization page for the air temperature data for each eclipse, since the usual layer for temperature in the GLOBE Visualization System is a daily average, not suited to displaying the short-term changes during an eclipse. Examples are linked in the [GLOBE Eclipse section](#) of the Observer website.

5.7.6. Data Collected – Eclipse

Eclipse data includes air temperature, all clouds data fields, and land cover data fields. Eclipse data are not “findable” in GLOBE’s data distribution systems as a separate protocol, since the tool is a combination of existing protocols. It may be pulled from the GLOBE Advanced Data Access Tool or GLOBE API by selecting air temperature, clouds (sky conditions), and land cover for eclipse dates and locations. Graphs of eclipse data that were presented to users of the app on the day of the eclipse are accessible through the GLOBE API using the “eclipses” variable. Eclipse data are archived on the GLOBE Observer website.

During the 2017 eclipse, more than 10,000 observers collected 20,000+ cloud observations with 60,000 photos and 80,000 air temperature measurements. Eclipses in South America in 2019 and 2020 resulted in just over 2,500 temperature measurements and 300 cloud observations. The annular eclipse in October 2023 resulted in over 17,000 air temperature, 2,200 clouds, and 130 land cover data points. During the total solar eclipse in 2024, more than 32,000 air temperature, 7,000 clouds, and 630 land cover observations were reported. These, plus the wind data points primarily collected from weather stations, are available in the GLOBE database and as curated data sets on the [GLOBE Eclipse Data](#) page. The Civil Air Patrol also collected additional data constituting thousands of data points that are not currently available in the GLOBE database.

Two peer-reviewed papers have been published associated with GLOBE Eclipse data, [Dodson et al. \(2019\)](#) and [Autore et al. \(2025\)](#). GLOBE Eclipse was included in the summary paper about NASA outreach during the 2023 and 2024 eclipses, “Uniting Under the Eclipse: A Mega-Collaboration to Activate Science Learning Across the Penumbra and Beyond.” ([Chambers et al., 2025](#))

In addition, GLOBE Eclipse was described in two chapters in the book *Celebrating the 2017 Great American Eclipse: Lessons Learned from the Path of Totality*, one focusing on air temperature data ([Rahman et al., 2019](#)) and the other on describing outreach efforts ([Weaver, Kohl, et al., 2019](#)).

5.7.7. Documentation of Change - Eclipse

Every time the Eclipse tool is released, it requires an update to match the path of the eclipse being observed. The tool correlates eclipse timing and subsequent reminders for data collection on the user’s location within the eclipse path. Additionally, the tool is only visible in areas experiencing an eclipse. It is not available outside of the eclipse path, based on a shape file provided to the DIS team using a GeoJSON file. Finally, the DIS team has needed to scale data servers to manage significant additional traffic during eclipse events. As a result, any decision to make the Eclipse tool available for data collection has an associated development cost and timeline.

Limited documentation of GLOBE Eclipse data is available in the [GLOBE Data User Guide](#). More specific details are on the [GLOBE Eclipse Data](#) page, along with the available curated data sets and links to related Clouds data. In addition, a detailed report of GLOBE Eclipse efforts in 2023 and 2024 was created by the GLOBE Observer team, which is available in [Appendix D](#).

5.8. Protocols Considered but not Developed

Initial early discussions about GLOBE and citizen science explored existing GLOBE campaigns and science partnerships that could benefit from citizen science data collection. GLOBE campaigns were initiatives that engaged GLOBE schools in focused data collection. Other science initiatives provided information or context to GLOBE educators were not part of campaigns.

In 2015, four GLOBE campaigns were flagged as being most accessible to volunteers: surface temperature and albedo, soil moisture, precipitation, and clouds.

Additionally, the following protocols were aligned with science partnerships in late 2014 and early 2015:

- Aerosols: European Aerosol Campaign and CALIPSO
- Soil moisture: SMAP and CoCoRaHS
- Precipitation: GPM and CoCoRaHS
- Clouds: Cloudsat, CALIPSO, and CERES, S’COOL
- Ozone: EOS Aura
- Land cover: Landsat and Adopt a Pixel

At that point, we thought that citizen science participation in GLOBE would consist of creating a new membership category for citizen scientists that would enable anyone to take GLOBE training online then collect and submit data through existing data entry forms. The structure of the international agreements later limited citizen science access to the GLOBE Observer app for

select protocols. Later work narrowed the protocols to those that could be done without equipment and in the GLOBE Observer app.

Dr. Dixon Butler assessed GLOBE protocols to recommend which might work best for broadly accessible citizen science based on required instrumentation:

Environmental measurements differ in their instrument, commitment, and time requirements. Some observations require nothing more than sight and a cell phone, some require instruments but may be taken once at any given location, others require installation of instruments to collect measurements over time.

Cell phone only observations:

- Clouds and contrails (and sky color)
- Land cover (and surface cover and snow cover and frozen water body)
- Ground cover
- Mosquitoes
- Phenology (phenophases only)
- Species location

Cell phone plus one instrument:

- Surface temperature (IR thermometer)
- Soil temperature (soil thermometer)
- Water temperature (calibrated thermometer)
- Current air temperature (calibrated thermometer)
- HydroColor (gray scale card)
- Relative humidity (hygrometer)
- Barometric pressure (barometer)
- Tree height (clinometer & known pace length)
- Tree circumference at “breast” height (tape measure)
- Canopy cover (densiometer)
- Aerosol optical thickness (Sun photometer)
- Phenology (color chart or ruler)

Permanent installation:

- Max/min daily air temperature (max/min thermometer in instrument shelter)
- Max/min daily soil temperature (max/min thermometer in instrument shelter)
- Liquid precipitation (mounted rain gauge)
- Automated weather station
- Automated soil temperature and moisture station
- Frost tube

More involved measurements not requiring permanent instrument installation:

- Soil moisture
- Water sampling (turbidity, pH, DO, nitrates, conductivity, salinity, alkalinity)
- Freshwater macroinvertebrates
- Soil characterization (structure, color, consistence, texture, presence of rocks, roots, and carbonates, particle density, bulk density, particle size distribution, pH, fertility, horizon depths)
- Snow

Note that full biometry for a land cover site requires a combination of measurements listed above.

Protocols more deeply considered for inclusion in GLOBE Observer follow along with a discussion of why we decided not to include them.

5.8.1. HydroColor (Water Color and Turbidity)

In 2015, the GLOBE Program Manager, Dr. Ming Ying Wei, asked the GLOBE Observer team to explore the feasibility of integrating the HydroColor app ([Leeuw and Boss, 2018](#)) into GLOBE Observer to measure water color and turbidity. HydroColor mimics ocean color satellites by measuring the intensity of light reflected from the water surface to calculate turbidity. However, the app requires that end users have a calibration card. If we wanted GLOBE Observer to function without external equipment, or with only minimal equipment that is easily accessible, HydroColor wasn't compatible with Observer. As we couldn't find a way around the calibration card requirement, water color was ruled out as a protocol at that time.

5.8.2. Fire Fuel

Fire Fuel is one of the most complex GLOBE protocols, but it is also a measurement with tremendous societal impact. The increase in devastating wildfires has prompted significant interest in measuring fire fuel. Additionally, federal land managers have an increasing need for fire fuel data, but data collection is time consuming. For these reasons, we recognized that fire fuel could be a valuable and popular protocol for GLOBE Observer.

In 2017, then GLOBE Program Manager, Dr. Lin Chambers, funded Jennifer Taylor (UCAR) to explore the feasibility of translating GLOBE Fire Fuel into an Observer protocol. Taylor identified an established fire fuel assessment technique, published in the scientific literature and in use by land managers, that assessed fire fuel based on photos. Called the photoload sampling technique ([Keane & Dickinson, 2007](#)), volunteers are asked to photograph a square meter plot, then using reference photos, visually estimate the density of different fuel types (woody fuel less than 1 cm in diameter, woody fuel 1-2.5 cm in diameter, woody fuel 2.5-7 cm in diameter, logs greater than 7 cm in diameter, shrubs, and herbaceous fuels).

An evaluation of the photoload technique found that people trained in assessing fire fuel underestimated the amount of fuel present using photoload as compared to traditional measurement methods. Volunteers are not trained, and we weren't sure they would be successful at making the visual estimates, particularly since fuel types are mixed in the real world. The reference photos show a single fuel type, making it challenging to translate to real world conditions for an untrained observer.

We created a set of wireframes to assess how well the technique might translate into Observer. We found that, ultimately, the approach seemed too complex for a citizen scientist.

An additional factor was that photoload was developed for Rocky Mountain forests. The approach has not been tested in other ecosystems. We didn't know if and how it could be applied in other types of landscapes globally. Because of its complexity and lack of global application, we decided that Fire Fuel was not a good candidate for GLOBE Observer in 2020.

In 2023, a help desk email from a land manager within the USDA Forest Service looking for fire fuel data caused us to revisit the possibility of developing an Observer fire fuel protocol. We held several conversations with fire fuel scientists at NASA and within the Forest Service. Holli Kohl met with several scientists (Duncan Lutes, Tobin Smail, and Mark Finney) from [Landfire](#), which uses satellite data to assess fire fuel, among other things. Finney noted that among fire fuels, fine fuels are extremely difficult to measure in satellite data, and they would welcome more measurements of fine fuel. [Keane and Lutes \(2004\)](#) developed the original GLOBE Fire Fuel protocol based on the Brown's transect method. Lutes (duncan.lutes@usda.gov) would be interested in ongoing conversations if a decision is made to move forward with fire fuel in some way.

Kohl also spoke to Dr. Doug Morton, a fire researcher at NASA Goddard Space Flight Center. He saw potential for citizen science measurements on private land near the wildland interface. These locations are most at risk for wildfire and are places scientists are not able to access to measure.

Nearly every person Kohl spoke to named Dr. Andy Hudak, a scientist at the USDA Forest Service who leads a NASA-Forest Service collaboration on wildfire, as the primary expert on satellite-based assessments of fire fuel). Hudak noted that scientists and modelers are desperate for ground-based fuel data, but measuring fire fuel is extremely difficult. He said:

Fuels are not easy to measure. The photoload method is the simplest method I know. That said, it has potential for subjectivity. You have to calibrate your observers for consistency. That seems impossible for citizen science. Fuels are so variable. You can measure something at one place then get a wildly different estimate a couple of meters away. Hard to get an estimate that can overcome all of that variability. Complexity does not lend itself well to citizen science.

Hudak noted that a transect approach, like the existing GLOBE Fire Fuel protocol, might be more viable, but it's extremely difficult to do. Given the complexity of the measurement and the sense from expert scientists that citizen scientists would struggle with the measurement, we decided, once again, to table Fire Fuel. At some point in the future, AI integration alongside ground measurements of vegetation depth may make fire fuel a viable protocol.

5.8.3. Macroinvertebrates

The GLOBE community was interested in a GLOBE Observer macroinvertebrates tool to be used as an indicator of water quality. A simplified version of the macroinvertebrates protocol can be done with iNaturalist now, so it is accessible for app-based citizen science. However, it still requires sampling equipment and training. Additionally, the sampling technique for the GLOBE protocol is too complex to translate well to Observer. If the protocol is updated in the future and if GLOBE decides that simple sampling equipment is acceptable for Observer protocols, this may be a good candidate for Observer in the future.

5.8.4. Soil Characterization

Originally, we hoped to include something from every sphere in the GLOBE Observer app. For pedosphere, [Soil Characterization](#) aligned well with GLOBE Observer. It does not require equipment. Moreover, we were working with SMAP scientist Dr. Erika Podest at NASA's Jet Propulsion Laboratory, who felt that soil characterization was valuable data to support satellite-based soil moisture assessments.

This protocol would work well in Observer except for soil color. The protocol asks for soil color compared to a standard chart. Importing the chart into an app doesn't work because different phones may display the colors differently. An external reference is necessary to get the right color. We didn't know how to provide the color reference to all end users. If this problem can be solved, solid characterization would be an excellent Observer protocol.

In 2018, GIO held a meeting with representatives of the Land-Potential Knowledge System ([LandPKS](#)) project initiated by USDA and partners. While there was interest and potential applicability, resources were not available to pursue a partnership.

6. Science

6.1. Science Scope for GLOBE Observer

GLOBE Observer was funded to engage learners of all ages in NASA science through citizen science. Science itself was not part of the scope, but we realized that we needed deep, real science connections to be successful.

When we started GLOBE Observer, we examined best practices in citizen science particularly to understand the needs of the volunteer community we hoped to build. Published literature indicated that volunteers participate in citizen science for a variety of reasons, including contributing to science or making science discoveries, monitoring environmental hazards or issues in their community, or learning new things ([Shirk et al., 2012](#)). Prior to GLOBE Observer, people participated in GLOBE under the supervision of an educator, largely as part of a classroom experience.

While we knew that GLOBE Observer *could* be used by educators, we acknowledged that the volunteer community we hoped to build may not be motivated solely by learning. Participatory science, by its nature, requires action and time from those who engage in it. Why should someone give up limited free time to collect environmental data with GLOBE Observer? The fundamental premise of citizen science is that volunteers make real contributions to science. If GLOBE Observer did not make real science contributions, we felt we would be breaking an unspoken contract with volunteers who believe their observations are contributing to science.

We recognized that we needed to lean into the science component of the GLOBE Program to provide genuine connections to science if we hoped to recruit and retain an active, engaged volunteer base. The GLOBE Observer team includes a scientist or science liaison for every protocol. Every GLOBE Observer tool was developed in consultation with scientists. At times, the team also included a science lead who focused on engaging scientists in GLOBE, particularly in using GLOBE data.

The GLOBE Observer website includes a section called “why observe” under each protocol in which we lay out the science connections. This emphasis on science was essential. A 2019 survey of the GLOBE Observer community showed that the most common reason for participating in GLOBE with GLOBE Observer was to contribute to science, particularly to NASA science. Further, people stopped engaging when they felt their contribution didn’t matter ([Fischer et al., 2021](#)). Thus, science is the backbone of GLOBE Observer.

6.2. Science Engagement

Science engagement was built into the structure of the NASA Earth Science Education Collaborative. The early NESEC budget for each NASA center included small amounts of funding or some other structure to engage scientists in project work broadly. All three centers funded consultant scientists and made additional efforts to engage the science community.

In 2018, we realized that GLOBE Observer would benefit from a more coordinated approach to science engagement. We hired a science lead, Dr. Helen Amos, to assess GLOBE Observer and make recommendations to better engage scientists. The goal was to promote scientific research conducted using GLOBE Observer data and to make stronger connections to NASA scientists for the volunteer community. In her assessment, Amos interviewed scientists and reviewed existing resources within the GLOBE Program. She recommended that we improve data access for scientists, hold regular meetings for scientists engaged with GLOBE Observer, and extend outreach to science communities aligned with GLOBE Observer protocols.

6.2.1. Regular Science Engagement

To create a forum for regular communication, we created the GLOBE Observer Science Forum. Participants included scientists at each of the NASA centers who contributed to NESEC and GLOBE Observer, scientists and science liaisons for each GLOBE Observer tool, and other scientists interested in GLOBE Observer. Beginning in November 2018, this group met once a month to provide guidance on the development of GLOBE Observer and the scientific use of GLOBE Observer data. Broader GLOBE data use was out of scope, as that was the purview of the GLOBE Science Working Group.

Under Amos, the GO Science Forum helped define recommendations for improved data access and data quality. The forum also provided opportunities for participants to update others in the group about their work and to collaborate across protocols. Amos left the GLOBE Observer team in early 2020, although the forum continued meeting (convened by Kristen Weaver and Agnes Conaty) until September 2023, eventually being phased out to make room for eclipse work. After the new cooperative agreement for the GLOBE Implementation Office was awarded in early 2024, it became clear that the role of the GO Science Forum would be filled by the STEPE portion of GIO, and meetings were not resumed.

6.2.2. Improving Science Data Use

To improve data access and use, Amos wrote the initial [GLOBE Data User Guide](#). Scientists need to trust data before accepting it for scientific use. The most trusted data sources provide clear documentation since trust is built through transparency around data provenance and potential for error. The need for data documentation is even greater for citizen science projects because scientists tend to distrust citizen science data. Within GLOBE, the [teacher's guide](#) documents methods of data collection. GLOBE Observer had no equivalent documentation apart from the app itself.

Amos filled the gap by writing the GLOBE Data User Guide. The purpose of the GLOBE Data User Guide is to help scientists and researchers understand, access, and use available GLOBE data. Initially focused on GLOBE Observer data, the scope now includes data collected by GLOBE-trained teachers and students, automated weather stations, as well as data collected by citizen scientists using the tools in the GLOBE Observer mobile application.

The second action taken by the GLOBE Observer team to improve science data use was to request an application programming interface (API) so that science data users can automate data pulls from the GLOBE database. An API for the GLOBE database previously existed for the GLOBE Clouds team at NASA Langley to pull observations and make satellite comparisons for sending match emails, but it was only used for that internal purpose and not publicly available. The GLOBE Observer science lead consulted scientists in the GO Science Forum and elsewhere to gather requirements for an API-out tool. NESEC funding to the DIS team supported the development of the [GLOBE API-out tool](#), and we provided input and testing throughout its development. The GLOBE API-out tool was released in 2019.

Third, the GO Science Forum recommended that GLOBE Observer photos receive a unique name in the database. Images are stored under the observation as “original.jpg.” All photos have the same name, making it more complex to search for and download the photos for research. The GO Science Forum proposed updating the file names to be:

protocol_latlon_yyyymmddTHHMMZ_direction_photoid.jpg

Latlon refers to the latitude and longitude in three-digit integers as follows: N090, S090, W180, E180. The date string includes the four-digit year, two-digit month, two-digit day, two-digit hour and two-digit minutes. Times are defined in UTC. Direction indicates the direction the photo was taken (north, etc.). For Mosquito Habitat Mapper, direction would indicate the type of photo: ws for water source, fb for full body mosquito larva, or ab for abdomen mosquito larva with an addition of a number for duplicate photos (FB, FB2). Photo id is a unique number assigned to each photo. A south-facing cloud photo from Maryland would then be: Clouds_N038W076_20190110T1132Z_SOUTH_834887.jpg

This work was not completed because of the cost of updating file names for previously existing photos and because it would have impacted the Clouds satellite comparison API. Additionally, the inclusion of special feature photos would require an adjustment to the recommended naming convention.

The Science Forum also recommended that GLOBE Observer develop the ability to direct data collection to meet specific science needs. The Forum provided case studies and requirements for this capability, which was developed as the geofenced data request, detailed in [section 6.6](#).

Finally, the Science Forum recommended that GLOBE Observer provide data quality flags to help science data users assess the validity of the data. The group identified key parameters that could be assessed, which are described in greater detail in [section 7.1](#). The initial steps in assessing data quality were included in the foundational peer-reviewed paper about GLOBE Observer, [Amos et al. \(2020\)](#).

6.2.3. Outreach to Scientists

To expand the community of scientists who are aware of GLOBE data and who might be interested in collaboration or using data, the NESEC team has participated in science team meetings, presented at lab or division meetings at GSFC, LaRC, and JPL, and participated in scientific conferences. Many GLOBE Observer team members are located at these NASA centers and work to build individual relationships with scientists.

Individual conversations have led to collaborations such as [dust observations](#) for Dr. Daniel Tong, funded under the NASA Health and Air Quality Applied Science Team. He wanted ground-based confirmation of dust storms to verify the presence of dust in satellite data. Another collaboration that came out of a NASA networking conversation was the [wildflower blooms data request](#), a project submitted by Dr. Yoselin Angel, a scientist at NASA's Goddard Space Flight Center.

The NESEC GLOBE Observer team also participates in science conferences, including the Fall Meeting of the American Geophysical Union and the American Meteorological Society Annual Meeting, to build awareness and potential science collaborations. The team often supports the NASA conference booth and gives presentations.

In both conversations, presentations, and conferences, we offered opportunities for scientists to join a GLOBE Observer science email list. The concept was to provide a place to build a community of science data users and collaborators. However, there wasn't a lot of uptake. While the list still exists at go-sci-join@lists.nasa.gov, it hasn't been used since 2020 when Dr. Amos left for another position.

Finally, we offered a training on GLOBE data called [GLOBE Data Fundamentals](#). The tutorial was developed for a science audience and included information about how to access, visualize, and analyze GLOBE data. The recording and slides are provided on the GLOBE Observer Get Data page.

6.3. Scientific Publications

With the understanding that peer-reviewed publications are essential for scientific credibility, the GLOBE Observer team published an initial paper defining GLOBE Observer data:

Amos, H. M., Starke, M. J., Rogerson, T. M., Colón Robles, M., Andersen, T., Boger, R., Campbell, B.A., Low, R.D., Nelson, P., Overoye, D., Taylor, J. E., Weaver, K. L., Ferrell, T., Kohl, H., & Schwerin, T. G. (2020). GLOBE Observer Data: 2016–2019. *Earth and Space Science*, 7(8). doi.org/10.1029/2020EA001175

The GO team also ensured that every protocol was defined within the scientific literature with a publication.

Clouds:

Colón Robles, M., Amos, H. M., Dodson, J. B., Bouwman, J., Rogerson, T. M., Bombosch, A., Farmer, L., Burdick, A., Taylor, J. E., & Chambers, L.H. (2020). Clouds around the world: How a simple citizen science data challenge became a worldwide success. *Bulletin of the American Meteorological Society*, 101(7), E1201-E1213. doi.org/10.1175/BAMS-D-19-0295.1

Mosquito Habitat Mapper:

Low, R., Boger, R., Nelson, P., & Kimura, M. (2021). GLOBE Mosquito Habitat Mapper citizen science data 2017–2020. *GeoHealth*, 5(10). doi.org/10.1029/2021GH000436

Land Cover:

Kohl, H.A., Nelson, P.V., Pring, J., Weaver, K.L., Wiley, D.M., Danielson, A.B., Cooper, R.M., Mortimer, H., Overoye, D., Burdick, A., Taylor, S., Haley, M., Haley, S., Lange, J., & Lindblad, M.E. (2021). GLOBE Observer and the GO on a Trail data challenge: A citizen science approach to generating a global land cover land use reference dataset. *Frontiers in Climate*, 3. doi.org/10.3389/fclim.2021.620497

Trees:

Enterkine, J., Campbell, B. A., Kohl, H., Glenn, N. F., Weaver, K., Overoye, D., and Danke, D. (2022). The potential of citizen science data to complement satellite and airborne lidar tree height measurements: lessons from the GLOBE Program. *Environmental Research Letters*, 13(7). doi.org/10.1088/1748-9326/ac77a2

Eclipse:

Dodson, J.B., Colón Robles, M., Taylor J.E., DeFontes, C.C., & Weaver K.L. (2019). Eclipse across America: Citizen science observations of the 21 August 2017 total solar eclipse. *Journal of Applied Meteorology & Climatology*, 58(11), 2363-2385. doi.org/10.1175/JAMC-D-18-0297.1

Known science publications that use GLOBE Observer data are listed on the GLOBE Observer [publications page](#). To keep the volunteer community informed about how their data are used, some publications were summarized in GLOBE news articles, and all were reported out on GLOBE's social media channels.

Publications through 2025 are included in [Appendix C](#). [Appendix C1](#) lists publications and other references from this document in alphabetical order. A table with notations of topic (protocol, data quality, data quantity, data distribution, data processing/modeling, science results, societal applications, connecting to remote sensing, education, and outreach/impact) can be found in [Appendix C2](#).

6.4. Student Research

One of the objectives of GLOBE Observer was to increase student research. Originally, the NESEC team believed the increase in student research would result from the increase in data. Additionally, we thought that adult volunteers would collect data to support students. However, much of the increase in student research came from students using the GLOBE Observer app as part of their data collection and subsequent analysis.

It is difficult to fully quantify the increase in student research because we do not collect data about a person's age when they set up a GLOBE Observer account. However, GLOBE Observer has been a component of multiple student experiences, including the NASA STEM Enhancement in Earth and Space Science (SEES) internship, GLOBE campaigns, GLOBE Mission Earth, GLOBE student research symposia, and more.

An analysis of student research reports submitted between 2017 and 2025 shows that students are using GLOBE Observer for their own research. The analysis was done by reviewing every abstract and (if needed for clarification) report submitted between 2017 and 2025. Only those that directly name GLOBE Observer were counted as using the app or data collected through it in the research. Student use of GLOBE Observer increased significantly in 2020 and 2021. This coincides with the full implementation of GLOBE Observer with all four tools and with the global pandemic that may have limited school-based, in-field data collection otherwise.

Student Reports	2017	2018	2019	2020	2021	2022	2023	2024	2025 (through Aug)	Total 2017-2025
Number of GLOBE IVSS, SRS with GO in the U.S.	0	5	10	9	40	37	30	21	12	164
Number of GLOBE IVSS, SRS with GO, International	4	5	16	45	38	18	29	31	47	233
Total projects using GO	4	10	26	54	78	55	59	52	59	397
TOTAL Projects (inclusive)	176	209	280	317	288	323	323	318	394	2628
Percent of total projects that used GO	2.27	4.78	9.29	17.03	27.08	17.03	18.27	16.35	14.97	15.11

Student research reports that indicate using GLOBE Observer. Additional students may have used GLOBE Observer for research reports. This table does not include projects that used Clouds, Land Cover, or Trees but did not indicate whether Observer was used for data collection. In these cases, students may have done the traditional GLOBE protocols and reported data through data entry. Some of the early mosquitoes projects (2017) may also fall in this category and were not counted.

6.5. Data Challenges

6.5.1. Definition

Challenges are invitations to volunteers to collect specific GLOBE Observer data in a designated time period similar to a [GLOBE Intensive Observation Period](#). The term challenge built on the popularity of challenges on social media. Early challenges were designed to recruit and engage volunteers. Over time, we realized that people weren't motivated to participate unless there was a clear scientific need for the data. Many later challenges were designed around a science data request or question, though some remained focused on public engagement.

Initially, a scientific paper was an expected outcome of a challenge, however, only three papers were published for 17 challenges. One paper addressed multiple challenges. Some challenges, like the first land challenge or the mosquito blitz in 2019, were too short to collect enough data for analysis. Later, starting in 2020, challenges became a tool for user engagement more than a tool for science with more challenge decision making being driven by communication needs than science needs. This happened in part because we did not have a scientist ready to analyze the data even though all challenge questions were formulated in consultation with scientists. To ensure that publications come out of future challenges, it is recommended that there be a plan for data analysis and publication in collaboration with a funded scientist committed to using the data. This means fewer challenges, but more meaningful challenges. This contributed to GLOBE Observer shifting toward supporting science data requests (see [Section 6.6: Geofenced Data Requests](#)).

All challenges increased data collection largely as a result of focused communication and community engagement demonstrating the power of the GLOBE network in collecting a large volume of ground-based data ([Colón Robles et al., 2020](#)). Challenges were also a significant driver in bringing new volunteers to GLOBE and in engaging the existing community. Engagement outcomes for challenges are described in greater detail in [Chapter 8: Volunteer Management](#).

6.5.2. Challenges Held

6.5.2.1. Spring Cloud Observation Data Challenge

Participants were invited to enter up to 10 cloud observations per day between March 15, 2018 to April 15, 2018, using the [GLOBE Program's data entry options](#) or using the [GLOBE Observer app](#) to collect a high volume of data for comparison with satellite data. GLOBE and GLOBE Observer participants with the most observations were congratulated by NASA scientists with a video posted on the NASA GLOBE Clouds website. The challenge resulted in 55,639 observations from more than 15,000 locations in 99 countries and every continent, including Antarctica. Curated [2018 Spring Cloud Challenge data](#) is published on the GLOBE Observer website.

The challenge resulted in one peer-reviewed publication, which analyzed the data (along with data from the later 2019 Fall Cloud Challenge) and compared volunteer cloud classification with satellite data ([Colón Robles et al., 2020](#)).

6.5.2.2. Land Challenge

To encourage volunteers to try the newly released Land Cover tool, GLOBE Observer held a [Land Challenge](#), encouraging people to map as much land as possible between September 22, 2018, Public Lands Day, and October 1, 2018, NASA's 60th Anniversary. Nearly 4,000 photos were submitted from 25 countries. The data from this challenge were not archived on the GLOBE Observer website, but we did publish a news announcement about the [Land Cover Challenge Winners](#). As this challenge was focused on communication more than science, no paper was published from the data.

6.5.2.3. Mosquito Blitz

The first mosquito challenge, called a [Mosquito Blitz](#), was held at the beginning of the Northern Hemisphere mosquito season between April 7-13, 2019. Since this challenge ran for just a week, it didn't generate significant data or attention.

6.5.2.4. GO on a Trail

Held June 1 - September 2, 2019, [GO on a Trail](#) was a significant event planned in collaboration with [Lewis and Clark National Historic Trail](#). We experimented with targeted data collection along the Lewis and Clark trail and at specific sites of historic or ecological significance along the trail. The science ask was to document land cover on the trail in each of the ecological regions found along the trail. The challenge was equally an outreach or communication initiative in collaboration with the National Park Service (the Trail, in this case) and a science partnership between GLOBE and park scientists. To broaden participation to the full GLOBE community beyond the Trail, we set up rewards for top data collectors in each GLOBE region. Top participants along the trail and beyond received recognition and GO on a Trail commemorative material. Among the top participants were Scouts in Australia, who collected data in Australia's interior where data were sparse.

We received 2,800 land cover observations globally, and 900 along the trail. Land cover [data from GO on a Trail](#) are archived on the GLOBE Observer web site. This challenge generated a peer-reviewed science article, [Kohl et al. \(2021\)](#).

6.5.2.5. GO Oklahoma

While called a challenge, [GO Oklahoma](#) was different from others. It was regional, focused solely on the greater Norman-Oklahoma City, Oklahoma area, and asked volunteers to register to commit to regular mosquito habitat observations between June 15 and October 31, 2019. GO Oklahoma was designed to support scientists Dr. Michael Wimberly, University of OK, Norman, and Dr. Caio França, Southern Nazarene University, Oklahoma City, who were conducting mosquito research to help fight vector-borne disease. The project provided opportunities to participate in webinars, social media, and online chats with the project team and scientists.

Initial workshops for citizen scientists and informal educators were hosted by local organizations in June 2019. These included the Oklahoma City County Health Department, the Science Museum of Oklahoma, the Oklahoma City Library, and the National Weather Center. Other groups engaged included 4-H. Training was conducted by Dr. Rusty Low, IGES, and science lead for the Mosquito Habitat Mapper, and Cassie Soeffing, IGES, an informal education lead for GLOBE Mission Mosquito, with Dr. Wimberly and Dr. França. Dr. Wimberly provided mosquito traps (ovitrap), and IGES provided a limited supply of print resources. There were initially 39 interested community members who registered, and the team connected with many via training sessions with 4H, the Science Museum of Oklahoma, Pioneer Library System, Southern Nazarene University, and Southwest Oklahoma City Library.

Data collection was too limited to achieve the science goal, and the data for this challenge were not archived. However, Dr. Caio França made connections to NASA science through this project and was later able to obtain NASA early career funding. Connections were also fostered with informal educators who presented at GLOBE Mission Mosquito Webinars (e.g., this [library-focused webinar in August 2019](#)) and continued to do local events with Dr. França and Dr. Wimberly.

6.5.2.6. Fall Cloud Observations Data Challenge

The [Fall Cloud Observations Data Challenge](#) echoed the Spring 2018 Clouds Data Challenge. As before, participants were invited to enter up to ten cloud observations per day between October 15, 2019 and November 15, 2019, using either option of the [GLOBE Program's data entry tools](#) or the [GLOBE Observer app](#) to collect a high volume of data for comparison with satellite data. GLOBE and GLOBE Observer participants with the most observations were [congratulated by NASA scientists](#) with a video posted on the GLOBE Observer website. The challenge resulted in more than 45,300 observations from more than 15,000 locations in 93 countries and every continent, including Antarctica. The [2019 Fall Cloud Challenge data](#) is published on the GLOBE Observer website.

The challenge resulted in one peer-reviewed publication that analyzed the data for both Spring 2018 and Fall 2019 and compared volunteer cloud classification with satellite data, [Colón Robles et al. \(2020\)](#).

6.5.2.7. Community Clouds Challenge: Science is Better Together

The [Community Clouds Challenge: Science is Better Together](#) was held July 15 - August 15, 2020. It was originally meant to duplicate the prior spring and fall clouds challenges, but COVID restrictions meant we had to adjust. We could not ask people to go outside to collect data because some communities were asking residents to remain in their homes. Asking for up to 10 daily observations could have put people at risk, so we had to find other ways for people to participate.

We transitioned instead to inviting people to do an at-home activity such as Cloud in a Jar, starting a nature journal, or taking a GLOBE Clouds observation. We created a [Community Cloud Challenge activity tracker](#) for the challenge, which included participation options around learning about clouds, creating cloud art, engaging with GLOBE or friends, or observing clouds. To earn a participation badge, participants just had to do one activity from the tracker.

We also focused on a Clouds challenge social media campaign with weekly videos showing how to do clouds activities at home. In all, we produced six activity videos, which went out every Thursday on the NASA Earth Facebook page. The videos were shared on GLOBE and archived on GLOBE YouTube.

The challenge brought in more than 26,000 observations from 80+ countries, which doubled the amount of clouds data collected during the same period in 2019. Details are in the [2020 Cloud Challenge summary news story](#). Data for this challenge are published on the [Clouds data page](#).

6.5.2.8. Community Trees Challenge: Science is Better Together

The [Community Trees Challenge: Science is Better Together](#) was held April 15 - May 15, 2021. Because COVID-19 restrictions were still in place, the GLOBE Program Manager required that we provide multiple ways to participate in the challenge. We decided to duplicate the approach from the 2020 Clouds Challenge. This challenge featured an activity tracker with a variety of ways for people to be part of the challenge, including by observing tree heights with GLOBE Observer. This challenge also included a social media campaign, but it did not produce weekly videos. Partners at the USDA Forest Service helped promote the challenge. Communication efforts for this challenge reached over 2.8 million people through a combination of Facebook, Instagram, Twitter, Snapchat, and Reddit.

The challenge resulted in 2,441 tree height observations from 1,733 global locations. This is a significant increase in the rate of data collection for trees, and at the time, represented 7 percent of tree height data in the GLOBE system. For details, see the [2021 Community Trees Challenge summary news story](#). Data from this challenge were not posted and there were no specific science outcomes.

6.5.2.9. Mosquito Habitat Photo Challenge

The [Mosquito Habitat Photo Challenge](#) ran July 25 through August 25, 2021. We were collaborating with Dr. Ryan Carney at the University of South Florida, who was working on an image recognition system to classify mosquito larvae in GLOBE photos. He needed a variety of photos with different lighting conditions, backgrounds, etc. to provide rigor to the training model. This challenge was meant to increase data collection to offer more photos for the project.

We produced a photo guide and a photo tips handout to get usable photos. Participants were also asked to photograph mosquito larvae with Mosquito Habitat Mapper and to document their habitat with a land cover observation. We were trying to reinforce the importance of including land cover with mosquito observations.

Since we were still operating under some COVID-19 restrictions with the requirement that challenges offer multiple ways to participate, we also provided the option of a [Mosquito Habitat Photo Challenge activity tracker](#) developed in collaboration with Los Angeles Public Library. The library provided Spanish, Armenian, Chinese, Japanese, Korean, Persian, and Russian translations, making this the only activity guide available in multiple languages. This challenge included a social media campaign and a kick-off webinar co-hosted by the Los Angeles Public Library.

This challenge also featured a [mosquito habitat and land cover data dashboard](#) to track data collected in real time and to provide the data to science partners quickly. Just under 1,000 mosquito observations were submitted - a substantial increase from the baseline. We also received 690 land cover observations. Data were archived through this dashboard rather than the GLOBE Observer website. The science work associated with the challenge was initially published in [Carney et al. \(2022\)](#).

6.5.2.10. Cloud Challenge 2022: Clouds in a Changing Climate

The [Cloud Challenge 2022: Clouds in a Changing Climate](#) was held from January 15 to February 15, 2022, followed the previous spring, fall, and summer challenges to collect winter data. Cloud Challenge 2022 offered two ways to participate: collect Clouds data during a satellite overpass or classify clouds in photos in the GLOBE CLOUD GAZE Zooniverse project. The goal was to make 20,000 satellite comparisons during the challenge. We connected this challenge to the launch of GOES-T, which eventually became one of the satellites used in the Clouds satellite comparisons.

Communication around this challenge included five Instagram reels focused on satellites and cloud science and YouTube videos from GLOBE student vloggers in addition to routine social media posts and web stories. This challenge also included a kick-off webinar with the Los Angeles Public Library.

We also created a [clouds data dashboard](#) for this challenge. The challenge resulted in more than 41,000 observations and 49,455 satellite comparisons (as a single observation may be compared to data from more than one satellite). As before, [Cloud Challenge 2022 data](#) are archived on the GLOBE Observer website.

6.5.2.11. Land Cover Challenge 2022: Land Cover in a Changing Climate

The [Land Cover Challenge 2022: Land Cover in a Changing Climate](#) ran July 26 through August 26, 2022. It maintained the “changing climate” theme from the Clouds challenge earlier in the year. This challenge was connected to the 50th anniversary of the Landsat satellites and focused on tracking change over time. We asked volunteers to submit 25+ observations. Those who submitted 25 observations received Landsat material in the mail. Those who submitted 50 observations received additional material.

The communication campaign included 8 short social media videos about land science released on NASA Earth or NASA Climate. Participants were also invited to participate in Camp Landsat, a series of online activities offered throughout the summer.

As shared in the [Land Cover Challenge 2022 summary news story](#), the challenge resulted in just over 1,600 land cover observations. 22 volunteer observers collected more than 25 land cover observations, and 12 of those volunteer observers collected more than 50 observations. The data are not archived outside of the GLOBE database.

6.5.2.12. Trees Challenge 2022: Trees in a Changing Climate

The [Trees Challenge 2022: Trees in a Changing Climate](#) wrapped up the *changing climate* series of challenges in 2022. Held October 11 through November 11, 2022, the challenge simply asked for tree observations.

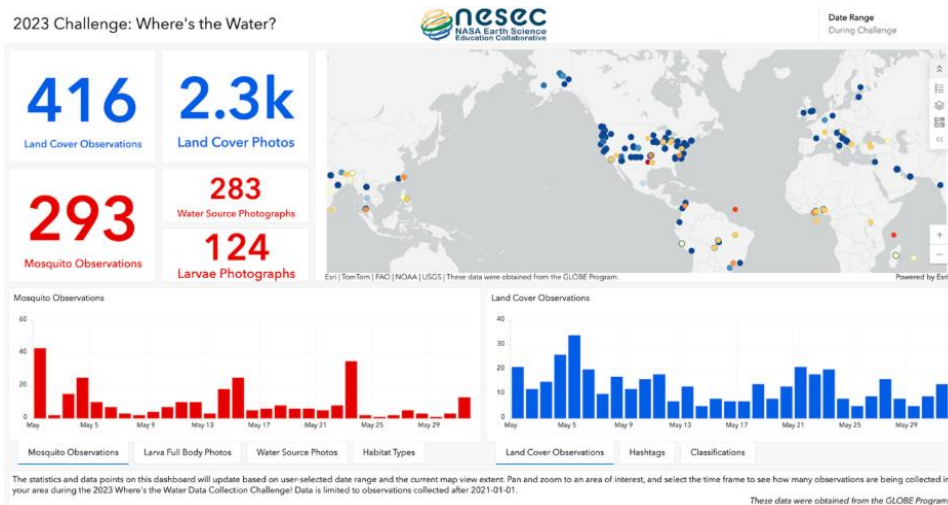
We held a kick-off webinar with the Los Angeles Public Library on October 11. Through SciStarter, who featured GLOBE Trees in a SciStarter Live event, we invited Girl Scouts to participate in the challenge as part of the Girl Scout Tree Promise, the Girl Scout Climate Challenge, or the Think Like a Citizen Scientist Journey. As with other challenges, we produced a series of six short social media videos about trees and tree science. Unique to this challenge, we supported two podcasts. Trees science lead Brian Campbell was a guest on [SciStarter’s Citizen Science podcast](#) and the [Solve It! For Kids podcast](#). In addition, Solve It! For Kids published an accompanying blog post, [Be a Citizen Scientist and help NASA GLOBE Measure Trees](#).

The challenge resulted in 4753 observations from 754 unique participants (see the [Trees Challenge 2022 news summary](#)). Data were not archived outside of the GLOBE database.

6.5.2.13. Where is the Water? A GLOBE Observer Data Challenge

Where is the Water? A GLOBE Observer Data Challenge was held May 1 through May 31, 2023, and it had a science data focus. We asked people to collect land cover observations of water edges, particularly in places where surface water is tough to identify in satellite data, such as under vegetation. We also asked that people do a mosquito habitat observation at that site to document whether mosquito larvae were present in the water.

We produced six short social media videos as part of this challenge. We also held a GLOBE Observer Connect event, the first associated with a challenge. This was the most complicated challenge data request, and that shows in the results as [summarized here](#). We received 616 land cover observations and 299 mosquito observations, as shown in the challenge [data dashboard](#).



Andrew Clark, IGES, created a data dashboard to track data submitted to the *Where is the Water?* Challenge.

6.5.2.14. GLOBE Eclipse Challenge: Clouds and Our Solar-Powered Earth

The [GLOBE Eclipse Challenge: Clouds and Our Solar-Powered Earth](#), held March 15 through April 15, 2024, was designed to collect cloud data complementary to data collected during the April 8 total solar eclipse in North America. Participants were asked to collect observations at varying times of the day to mimic changes in light that would occur during the eclipse. The dates also aligned with the first clouds challenge, so there was potential to compare data between years. The challenge included a GLOBE Observer Connect conversation along with a social media campaign. Much of the emphasis was on the eclipse. This challenge resulted in 23,693 cloud observations, archived on the [GLOBE Observer Clouds data page](#).

6.5.3. Lessons Learned

Challenges were an extremely effective tool for recruiting new users and engaging the Observer community. Spikes in app downloads and account creation were often correlated with challenges. Data came in at increased rates during challenges, often double or more the usual rate.

Providing competition, as we did early on, seemed to drive up the participation rate. However, it also resulted in bad data, as some people sent in batches of duplicate data separated by a minute. Removing the competition aspect was necessary during COVID, as we wanted to provide ways for people to participate no matter what restrictions were in place. This removed the pressure to submit large volumes of data, but it also seemed to reduce participation.

We found that month-long challenges seemed to be the most effective, lasting long enough to pick up steam as people learned about them, but not so long that people started to tune out. Participation in some of the longer challenges slowed after a month.

The challenges eventually developed into a social media campaign associated with an action. Creating and supporting social media products (videos/reels, activity tracker, etc.) was significant work for the whole team. Over time, the challenges began to lose their effectiveness, bringing in less and less data. The final clouds challenge resulted in half the data collected during the initial clouds challenge. This may have been in part a shift in the surrounding culture as social media challenges were less and less popular.

As the return on investment decreased, we stopped hosting challenges and focused instead on more focused data collection associated with geofence data requests and partnerships. Focused data collection led by a scientist or community partner has great potential for real engagement and meaningful data collection. While global challenges could still be useful, local data collection may have a longer-lasting impact.

6.6. Geofenced Data Requests

6.6.1. Definition of data request

The GLOBE Observer app includes a mechanism (a geofence) that alerts volunteers when they open the app that data are needed at or near their location. Each data request provides specific instructions for data collection as well as information about the research or community project the data will support. This function was developed after conversations with scientists who said they would be more likely to use GLOBE data if it were collected where and when they needed it. Geofence data requests give scientists the ability to direct data collection.

As of July 2025, the data request function only applies to Observer tools. Data requests for broader GLOBE data collection falls under the GLOBE Implementation Office, typically as an Intensive Observation Period or Campaign.

6.6.2. Application form

Anyone who has a GLOBE account may submit a data request. The application is only visible when a user is logged in to the GLOBE Observer website. The application requests information that will be visible in the app as well as information needed to review the proposed project.

The form fields include:

- Contact information: name, phone number, email address, and organization
- Required project information for volunteers (information that is visible in the GLOBE Observer app)
- Project name
- Project Description
- Project Impact (why a scientist or community leader is asking for the data)
- Instructions
- Protocols used
- Date range during which data are requested
- Optional information for volunteers
- A contact email volunteers can use to reach the requestor
- A link to a website, usually a GLOBE Observer landing page, for more information
- A link to a GLOBE team
- Tags for field notes, used to make it easier to sort data
- Required review information

- Requestor credentials
- Project proposal - longer and potentially more technical than the in-app project description. This is meant to give reviewers enough information to assess the validity of the request.
- Policy checklist - this section asks the proposer to agree to GLOBE policies around data requests
- I will be available to answer questions
- I will report results
- I will cite GLOBE in any publication
- I agree to GLOBE's and NASA's terms of use and privacy policies
- I understand that GLOBE data are free and publicly accessible
- I have GLOBE training for the protocol I'm requesting to use
- Indicate if data are requested in private, sensitive or protected areas. If so, what is the plan to coordinate with owners or managers to ensure appropriate access?
- Does this data collection put participants at risk? If so, what will you do to mitigate the risk?
- Geofenced area of interest, including the name of the region and the name of the country.

When an application is submitted, those designated (currently Holli Kohl, Kristen Weaver, and members of the DIS team), receive an email notification that a project has been submitted. The proposed project is accessible to those individuals under *Manage* (grid icon in the upper right) then *Geofence Projects* when logged in to the GLOBE website. Projects pending approval appear in a table. Clicking on the three dots in the far-right column provides the option to view the request (non-editable), edit the request, approve the request, or delete the request. Once approved, projects are moved into either “active” or “approved” status. Approved, but not active projects are waiting to go into the app pending the project start date. Active projects are those currently visible in the GLOBE Observer app. Geofence projects run over a designated period. Once an approved project ends, it will move into expired status.

6.6.3. Review process

Because in-app data requests use a NASA-funded resource (the GLOBE Observer app) to collect data, their presence in the app implies that NASA approves of the research. This necessitates a review process for requests.

All data requests are first reviewed by the GLOBE Observer team to ensure that they are complete and clear. If necessary, the team iterates with the proposer to edit information that will be in the app. The Observer team follows a review checklist to track the approval process, which can be found in [Appendix E4: Checklist for Geofencing Project Evaluation](#).

All science data requests go to a panel of external scientists in clouds, mosquito habitats, land cover, or trees. These scientists provide a high-level review of the proposal to ensure the science is valid. The reviewing scientists were recruited and trained. To simplify the review, we provide a review checklist they may follow. The checklist for science reviewers is found in [Appendix E5: Science Checklist for Data Request Evaluation](#).

If a project is approved by both the Observer team and scientists, it goes to the GLOBE Implementation Office for final sign off. Community-based data requests skip science review but must still complete Observer and GIO review. GIO approves or declines the request using the review checklist. International requests additionally must be approved by the country coordinator or regional office where the data are requested.

6.6.4. In-app implementation

Once a request is approved, the GLOBE Observer team logs in to the GLOBE Observer website, goes to *Manage, Geofence Projects*, and selects “approve” for the project from the “pending approval” category. Approved requests are then pushed out into the GLOBE Observer app during the designated time period. All volunteers in the geofenced area who open the GLOBE Observer app during that period will see a small alarm bell in the upper right corner of the screen indicating that a request is present. If they click on the bell, they will see the data request with instructions.

In-app messages may also go out in association with the data request, though this does not happen automatically. These are documented in Volunteer Management, [section 8.4.5](#).

6.6.5. Website Implementation

The GLOBE Observer team creates a landing page for all data requests. This serves as a place for additional training or more information, since screen space in the app is limited. Data requests are found on the Observer website under *Do GLOBE Observer > Do More -> [Data Requests](#)*.

6.6.6. Development and Pilot

The development of the data request/geofence function included technical development followed by two pilot phases. The function was presented to the GLOBE community at several annual meetings throughout its development to get feedback.

During the first pilot phase, we developed, tested, and refined the approval process. This phase was lengthy, in part because of transitions within the GLOBE Implementation Office. It culminated with the [NASA Moon Trees Quest](#). The Moon Trees Quest is a good example of using the geofence request for a complex, community/education-focused project. It included five geofenced data requests, each covering different regions of the United States. We also used the in-app message system to send pop-up notifications to people within about 25 miles of a known Apollo Moon Tree. This project worked smoothly, demonstrating that the function was viable and the approval process worked.

From the phase 1 pilot, we moved to phase 2, which was full implementation within the United States and an international pilot. The transition to full implementation in the United States consisted of linking the data request pages to navigation on the GLOBE Observer website so people can find them.

The international approval process is more complex, as it needs to involve the country coordinator or regional office. As of July 2025, we have conducted one international pilot in Ireland, [National Tree Week - How Tall is my Local Tree?](#) This project seemed to run smoothly. It was proposed and implemented by the Ireland country coordinator, so the full approval process was not tested, however, the process is approved to move forward for future projects.

6.6.7. Example Projects

In addition to the projects described above, these early projects provide a good example of the type of work that might be accommodated by the data request functions.

6.6.7.1. Snow and Snowdrift photos in Delta Junction

The University of Alaska Fairbanks, in collaboration with the NASA Snow Program, the NASA Terrestrial Hydrology Program (THP) and the Delta Junction Trails Association, submitted a request for a participatory science photo collection project from February 1 to February 28, 2025, [Snow and Snowdrift Photos in Delta Junction](#). They asked volunteers to use the GLOBE Observer app to take land cover photos of snow along the Bluff Cabin Trail in Alaska with a focus on snowdrifts.

Snowdrifts store water and melt slower than the surrounding snowpack. Knowing where snowdrifts are can help scientists develop remote sensing techniques to find, map and estimate snowdrift water content from space.

6.6.7.2. Wildflower Blooms

The [Wildflower Blooms](#) project asked volunteers to photograph the emergence of seasonal wildflowers in large areas and note the predominant bloom color. A NASA scientist planned to use these photos to identify blooms in satellite data. By analyzing how the blooms look in the data, scientists can then identify blooms at other places and times. The collected data was meant to help scientists look back in time through the satellite record to identify the timing and extent of blooming events and understand change.

6.6.7.3. NASA Response Mappers

The NASA Disasters Response Coordination System provides a variety of data products to emergency managers to help in disaster response efforts and decision making. The goal of the [NASA Response Mappers](#) data request was to determine the utility of GLOBE Land Cover observations in disaster response and recovery. To accomplish this, they requested regular land cover observations during the peak hurricane season when hurricane awareness is higher. For the GLOBE data to be impactful, regular (weekly or monthly) observations of a particular location were requested over a wide geographic area.

According to the project proposers, GLOBE observations can provide localized, timely, and geolocated photos which may help emergency managers. These photos can fill gaps in time and space that exist in satellite data and traditional information from official field reporting. First responders may use the observations to understand the extent of area impacted or support damage assessments of homes, businesses, roads, utilities, etc. Observations could help recovery personnel understand the extent of debris, or government agencies gain insight into cropland damage or document high water marks. GLOBE photos can also help verify satellite data.

6.6.7.4. National Tree Week

The [National Tree Week - How Tall is my Local Tree?](#) project was the first international project. It was meant to engage GLOBE students and volunteers in measuring tree height as part of Ireland's National Tree Week. This data request was submitted to help scientists better understand the distribution and height of Irish Trees. Ireland has approximately 12 percent tree cover, this is due to centuries of clearance for intensive farming and overexploitation for timber which have reduced Ireland's once extensive woodlands to the remnants we see today.

6.6.7.5. NASA Moon Trees Quest

From Apollo 14 in 1971 to Artemis I in 2022, the NASA Moon Trees Program has served as inspiration in STEM engagement, education, and environmental stewardship. With the Moon Trees Initiative, GLOBE Observer embarked on a collaboration with the NASA Next Gen STEM Program, USDA Forest Service, and the Artemis Mission (more in [Section 8.3.3.5: Partnerships](#)), with a purpose of having volunteers collect tree height observations of Apollo 14 Moon Trees and related tree species and to inspire the Artemis generation through a fun STEM engagement initiative.

Through the three-month [NASA Moon Trees Quest](#) (June 21, 2023 - September 21, 2023), GLOBE Observer Volunteers across the United States searched for Apollo 14 Moon Trees and related tree species, with the help of some guidance from the GLOBE Observer App. The Quest included five different geofence data requests corresponding to the natural range of five tree species in the United States.

When a person was close to an actual Apollo 14 Moon Tree, the app alerted you with the tree location and coordinates and suggested taking a tree height observation if safe to do so. During the three-month quest, there were 6,859 tree height observations submitted with the GLOBE Observer.

7.Data Management

Data management is essential to the success of science, including citizen science. GLOBE data are stored in a free and open database aligned with [NASA's open science](#) philosophy. Data fields and metadata are defined by the requirements of the protocols. Most GLOBE data management, including maintenance of the GLOBE database and distribution systems, is the responsibility of the DIS and GIO teams. This documentation covers contributions of the GLOBE Observer team to data quality, documentation, and distribution.

A survey of GLOBE Observers indicated that many or most are motivated to participate in GLOBE because they want to contribute to science, particularly NASA Science. Additionally, volunteers report that they stop participating if they feel their contribution isn't contributing to science ([Fischer et al., 2021](#)). This means that the success of GLOBE Observer hinges on genuine science outcomes based on GLOBE data.

Scientists, on the other hand, frequently express skepticism about the rigor of citizen science data. The GLOBE Observer team has taken measures to provide scientists with information to assess data rigor and to analyze GLOBE Observer data in light of their science questions. To make GLOBE Observer data "usable" for scientists, GLOBE Observer conducted data quality assessments, implemented data quality measures, created data documentation, and enhanced data access.

7.1. Data Quality Assessments and Measures

[Dodson et al. \(2019\)](#) published the first assessment of the robustness of GLOBE clouds data after the release of the GLOBE Observer app. Volunteer reports of cloud cover aligned with satellite data within one standard deviation from the mean, with the greatest disagreement in clear vs. isolated cloud cover. In these conditions, volunteers report clouds when satellite assessment reports clear (0-10% cloud cover). In many cases this is due to the satellite missing small or thin clouds that are easily seen from the ground.

[Amos et al. \(2020\)](#) offers an analysis of GLOBE Observer data from all four protocols. The publication establishes a system of quality flags based on logical consistency, temporal quality, and geospatial quality. The assessment found that 7.8 percent of observations coming into the GLOBE database through GLOBE Observer were flagged for potential quality concerns compared to 13 percent of GLOBE observations submitted through other channels, indicating that use of the app improves data quality.

The most common errors identified in Amos et al. were location errors, particularly observations reported over water, though some observations are made from vessels and ships. Other frequent errors include inconsistencies around reports of obscurations in cloud observations and unbelievably large contrail or mosquito larvae counts.

The assessment examined the following quality flags (from Table 2 in [Amos et al., 2020](#)):

CI :	Cloud cover is invalid
CM :	Cloud cover is coded as missing
CT :	8 out of 10 cloud types or more are reported as present
CX :	Cloud cover attribute is missing
DF :	Date or time of measurement is in the future
DI :	Date or time of measurement is invalid
DO :	Date or time of measurement is before 1995
DZ :	Date or time of measurement is at midnight UTC
DX :	Date or time of measurement attribute is missing
EI :	Elevation is invalid (not a number)
EM :	Elevation is coded as missing
ER :	Elevation is outside of expected range (-300m to 6000m)
EX :	Elevation attribute is missing
LI :	Location is not a valid latitude/longitude pair
LM :	Latitude and longitude exactly match
LW :	Location may be over ocean
LZ :	Latitude and/or longitude are integers
MI :	Mosquito larvae count is invalid
MR :	Mosquito larvae count is outside of expected range (0 - 199)
NR :	Contrail count is outside of expected range (0 - 19)
OC :	Obscuration reported but cloud types also reported
OP :	Spray reported possibly over land
OR :	More than two obscurations reported
OX :	Obscured cover reported but obscuration type missing
PD :	Duplicate photo within the same observation
TI :	Tree height is invalid (not a number)
TM :	Tree height is coded as missing
TR :	Tree height is outside of expected range (0m - 199m)
TX :	Tree height attribute is missing

Amos et al. offered the following recommendations to improve data quality:

- Optimize the role of photos in the data, since most users collect photos over reporting classification data. Use AI or secondary labeling for classification. [Nelson et al. \(2024\)](#) provides a summary of AI classification work completed after this recommendation.
- Expand satellite match to all protocols to provide co-located, independent data that can be leveraged in research. [Dodson et al. \(2022\)](#) documents how GLOBE cloud observations complement satellite data, providing a potential case for such an expansion to other protocols. Ground-based observers are able to document atmospheric phenomena that satellites may not detect and vice versa. [Lu et al. \(2025\)](#) and [Enterkine et al. \(2022\)](#) describe challenges associated with aligning GLOBE Trees data with ICESat-2 and GEDI data. In particular, location accuracy of cell phone location data makes alignment with individual trees in satellite data challenging.

7.1.1. Database and App QA Measures

GLOBE places QA boundaries around submitted data such that out-of-range data are not accepted for many fields. These limits are defined in the [GLOBE Data User Guide](#).

QA assessments have led to changes in the GLOBE Observer app. All changes after July 5, 2019, are documented in the GLOBE Data User Guide.

To reduce errors caused by reports of zero contrails vs skipped reporting, users now choose between entering a count for the number of contrails seen, report that no contrails are visible or skip contrails. This change reduces the error in which people were reporting no contrails when they skipped the field.

To fix location and time/date errors, users now receive an error message, which they can override, when they enter a latitude and longitude at unlikely coordinates such as 0,0 or 90,90 or unlikely times. Note: these errors are more common when location, date and time are entered manually. Using the GLOBE Observer app to get location, date, and time significantly reduces this error.

Additionally, a location accuracy estimate was added to Land Cover, Mosquito Habitat Mapper, and Trees to tell users the potential error in measuring their location. Users are encouraged to refresh the location to give the app more time to improve location measurements.

7.1.2. Post-processing for Quality Assessment

Since data quality flags are important to identify potential issues, inconsistencies, or anomalies in the data collected using the GLOBE Observer app, the NESEC team worked to translate the codes reported in [Amos et al. \(2020\)](#) to assess GLOBE Observer data quality annually. The idea was to tag individual observations that triggered a quality flag. The flags ensure the reliability and integrity of citizen science data and provide users guidance in determining which data is most useful for scientific analysis. Flagging doesn't mean the data will be removed from the collection, it means that the data user may need to further investigate the observation and gives information about whether the data may or may not be suited for a particular research purpose. For example, many cloud observations could be flagged as having potential location errors because the observation location is over an ocean. However, tour ships have been integrating GLOBE Clouds into their programming, so there are many valid cloud data points over oceans.

Ideally, quality flags would be applied as data is submitted and would be associated with individual observations in the GLOBE database. However, in practice, this approach was

beyond the budget and scope of the NESEC GLOBE Observer team. Instead, we decided to run quality checks after data submission and provide the flagged data as a secondary data file on the GLOBE Observer website.

This approach aligns with NASA's approach to data processing for satellite data. The raw data collected by the observer goes into the database without addition. Secondary processing results in a secondary data file, leaving the raw data as submitted in the database.

7.1.3. Development of Operational QA Code

To move the QA code developed for the assessment reported in Amos et al. to a routine, operational format, we needed to develop a way to assign flags to individual observations vs a large-scale statistical analysis of the data as a batch. Initial efforts toward this approach were started by summer intern Jessica Mo in 2023. She assessed and expanded the QA code and began work to align with individual observations.

Dr. Agnes Conaty was hired to operationalize the QA code and publish the data at least annually on the Observer website. After supervising Ms. Mo's internship, Dr. Conaty continued operationalization. We had wanted to create a process by which we could automate a data pull through the GLOBE API, convert the data from a GeoJSON format to CSV, then run the QA code to apply the flags to each line as applicable and publish the end result as a CSV file. She additionally moved the code to a Jupyter Notebook to make it more accessible.

Dr. Conaty started with land cover as it had the simplest output. The land cover QA code provides checks on date and time, elevation, and location attributes to assure reliability and data integrity.

The work faced several challenges, and decisions were made as follows:

First, there was a need to set up a uniform data ID across protocols. GLOBE Observer data lacked a unique ID across protocols, which posed a challenge for mapping the QA code to individual observations. Dr. Conaty developed code to assign a unique ID to each observation by combining the protocol name, site ID, user ID, and date and time. This identifier is essential for tracking observations and logging issues systematically.

Second, she reformatted the time stamp to make the code run smoothly. The old timestamp format introduced some problems in keeping the data format unchanged from JSON to CSV. Additionally, timestamps across the datasets have different formats. Some include time zones while others do not. To resolve this issue, we used `pandas.to_datetime()` with robust parsing and standardized formatting (YYYYMMDDhhmm).

Next, long column names were streamlined and made shorter by removing the protocol name to avoid redundancy. We also re-arranged the columns to improve ease of use and logic.

Of all the data quality flags, the checks for location over ocean (LW) and location over lake (LL) proved to be the most challenging. Determining whether a point lies in the ocean or lake requires geographic shapefiles. The shapefiles were downloaded from the website of [Natural Earth Data](#). These shapefiles needed to be transformed into shapes that Shapely could interpret. For this, we used `pyshp` and `Shapely` to load and convert shapefile geometries. This process generated errors that were never fully resolved. An observation being located over a lake or ocean does not automatically mean it is invalid, as we do have volunteers taking observations on board boats, but it is potentially a useful piece of information to have, depending on the data end user's research needs.

In order to verify that the Jupyter Notebook works as it should, we generated data that triggers most of these data quality checks to see if the quality flags are indeed flagged and their two-letter symbols are written in the quality-flags column. Except for the location over lake or over ocean (LL and LW) quality flags, all the other quality flags described above have been verified for land cover datasets.

The code documentation including detailed QA flag definitions is provided in [Appendix D5](#).

As of 2024, assessing and publishing information about data quality is a function of the GLOBE Implementation Office. In 2025, the NESEC team met with the GLOBE Implementation Office to discuss continuity and hand off. It became clear that the approach to be taken at GIO differed from the NESEC GLOBE Observer approach significantly enough that it no longer made sense for the NESEC team to continue this work.

7.1.4. Photo Approval

Photos are a significant component of GLOBE Observer data. Since GLOBE Observer data includes photos that are made accessible to anyone, including GLOBE students, screening photos is an important part of data management and data quality. To prevent the risk of exposing children to inappropriate images that may include violence, nudity, and offensive or harmful language, GLOBE decided to screen every photo submitted through the GLOBE Observer app starting with the app's launch in 2016. Screening also reduces privacy concerns in that photos that show a recognizable person or identifying text at the observation location can be prevented from entering the database. A detailed step-by-step description of the photo approval process is included in [Appendix E3](#).

7.1.4.1. Manual Photo Approval

From 2016 through 2022, a member of the GLOBE Observer team looked at every photo submitted by untrained users through GLOBE Observer and approved or rejected each one. Photos were screened for text, faces, and inappropriate content. Photos were primarily rejected due to text or people. Very few photos were rejected for inappropriate content. Photos submitted through GLOBE Data Entry or by trained GLOBE Educators through GLOBE Observer were not screened between 2016 and 2022 under the assumption that trained, known volunteers would not submit inappropriate photos. Rejected photos are kept but are not accessible through GLOBE data retrieval.

It is important to note that photos are not rejected for irrelevance. If a photo shows the inside of a classroom, for example, the photos are approved as an indicator that the rest of the data associated with the observation is questionable. Irrelevant photos are stored as a quality flag, currently a manual process by the data end user browsing the photos, but which could be incorporated as an automated quality flag at some point in the future. The majority of irrelevant photos seem to come from training sessions. The new practice mode released in August 2025 should reduce the amount of bad data submitted as people learn to use the app or do the protocols.

Manual photo approval happens through a photo approval tool, which is visible on the GLOBE website under “manage” for authorized users. The tool displays 10-30 photos per screen and provides checkboxes to approve or reject each photo. In fiscal year 2019, 646,370 photos were submitted to GLOBE. Assuming a person approves about 10 photos per minute, approving photos in 2019 required 1,077 hours, just over 0.5 FTE. Rates of photo submission were increasing annually, meaning that photo approval would become increasingly time consuming and expensive.

Manual photo approval also delays the entry of photos into the database. Volunteers may not see their observations in the database for up to several days. While text data was immediately visible, photos were not, leading people to believe they had done something wrong or feeling that they were not contributing. A survey of GLOBE volunteers found that significant reasons people stop participating in the project include technical issues (such as with the app) and the perception that their contribution was not meaningful ([Fischer et al., 2021](#)). The necessary manual photo review process contributes to both issues.

For these reasons, GLOBE decided to implement image recognition software to screen photos starting in 2022. After an assessment of available image recognition software, Amazon Rekognition was selected to screen photos. GLOBE data was already hosted in the Amazon cloud, making implementation simpler than using another product or developing our own system. The software selection process is documented in a white paper, *Exploring AWS Rekognition to Decrease Manual Photo Approval*, available in [Appendix D2](#).

7.1.4.2. Artificial Intelligence (AI) Photo Screening

GLOBE's use of AWS Rekognition is documented in [Nelson et al. \(2024\)](#).

All GLOBE images, both GLOBE Observer and data entry images, are sent to the Rekognition tool, and tags are returned which provide a list of items and types of items which are potentially identified in the provided photo. Each tag includes a percent likelihood that the item is in the photo. For example, Rekognition may report there is a 95% likelihood of there being a tree in the photo, or a 35% probability of there being a bicycle.

GLOBE has developed a machine learning based algorithm which interprets the Rekognition tags and based on the tagging the algorithm will decide if the photo is potentially irrelevant or inappropriate. For example, if the Rekognition tags list a high probability for bookcases, walls and a desk in the photo, the algorithm will likely flag the photo as having irrelevant data, but if the tags are largely sky, clouds and trees, the algorithm may automatically approve the photo.

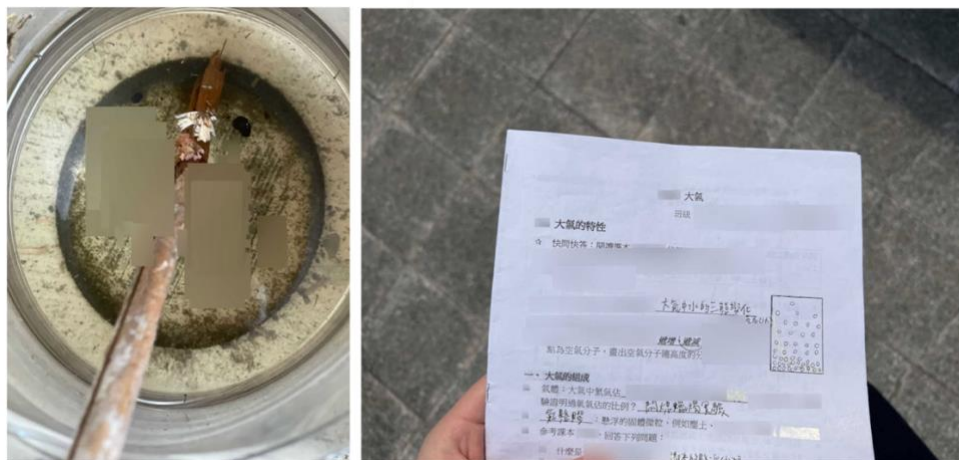
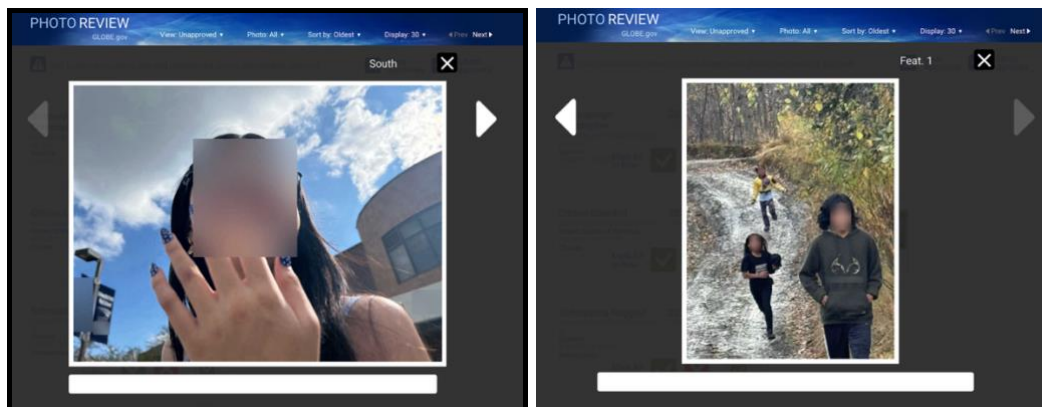
The algorithm which analyzes Rekognition tags was intentionally designed to require human review even if there was a relatively low probability of inappropriate or irrelevant content in a given photo. The desire was to maintain a very high standard for automated approvals and therefore have a very high level of confidence that the algorithm would not approve something problematic. To further improve confidence in the results, and to reduce the possibility of a smaller piece of inappropriate content passing through the tools, all images are subdivided into smaller quadrants and are scanned in pieces. The sum of the tags from the overall photo in addition to the individual subdivided pieces are fed into the algorithm to determine success or failure.

In addition to providing tags and probabilities of likely photo content, Rekognition also does an excellent job identifying the location and extent of any faces and/or text which appear in the photo. Face and text information presence is another factor used by the GLOBE algorithm to determine the acceptance or rejection of a given photo. In addition, facial and textual location and extent information is used by a secondary GLOBE photo processing capability that blurs out facial and textual features for all photos, helping to ensure the privacy for all users who are seen in the photo, as well as render any text unreadable.

Amazon Rekognition and the GLOBE machine learning algorithm was integrated into the GLOBE system in April of 2022. As of September 2025, more than 1.8 million photos had been screened by the system. Just over a million images were automatically approved (~65% of images), leaving 710,000 images for human review. To date there have been zero reported instances of an automatically approved photo containing either inappropriate or irrelevant content. Updated statistics on automated photo review can be found at this [private GLOBE API call](#).

During an early assessment of the accuracy of the AI tool, we looked at statistics for 260,000 photos screened by humans. Of these, 161 were rejected as inappropriate. As noted above, irrelevant photos are approved as a secondary QA check on the associated data.

Since the system now blurs face and text information, photos which had previously been manually rejected no longer require rejection, so if there is still relevant scientific data in the photos, they can now be approved, increasing the volume of citizen science data that the project can accept. All original (pre-blurred) images are kept with the system, so if required, they can be retrieved and used for scientific analysis in situations where blurring obscures desired data, but the retrieval of the images is not currently part of the automated or manual approval process. A future iteration of the tool may allow administrators to replace the blurred image with the original in these special cases.



Examples of AI-blurred photos submitted to GLOBE. Top, the AI appropriately blurs faces. Bottom, examples of AI blurring data that might be desired. Left, mosquito larvae are blurred as being suspected text and right, a data sheet is blurred.

All photos flagged by the AI are reviewed by members of the GLOBE Observer team. As these are a smaller subset of the total photos submitted, the AI review process reduces the amount of time staff spends screening photos to two to three hours per week even though the volume of photos continues to increase.

As manual photo review is a process that will need to continue, instructions are included in [Appendix E3](#).

As part of its photo screening, Rekognition generates a set of tags labeling the image content. These tags are saved but not surfaced in any readily accessible location. Amos, et al. suggested that these tags may be provided as a secondary quality check on volunteer classifications as a potential future development, though this should be done with care. AI image interpretation can be faulty, as shown in the image above in which Rekognition flagged mosquito larvae as text. External researchers have been developing more robust models to extract information from GLOBE land cover and mosquito photos ([Nelson et al. 2024](#)).

7.1.5. Satellite Collocation

The GLOBE Clouds team collocates GLOBE Clouds and GLOBE Land Cover observations with satellite data. The collocated satellite data is sent to observers through an email and made available via the GLOBE Visualization System and My Observations. End users report that receiving these emails increases their confidence and motivation to collect quality data ([Fischer et al., 2021](#)).

This process of collocating or comparing GLOBE Clouds observations is a legacy of the Students' Cloud Observations On-Line (S'COOL) project which started in 1997 at NASA Langley ([Chambers et al., 2003](#); [Chambers et al., 2017](#)). In 2016, the S'COOL project and the GLOBE Program merged, adapting the Clouds protocol and introducing the satellite comparisons to the GLOBE community. The process was expanded to all types of citizen scientists through the introduction of the GLOBE Program's GLOBE Observer app in 2017.

The collocation process for GLOBE ground cloud observations with satellite data involves collaboration with various teams from NASA Langley, in particular NASA's Atmospheric Science Data Center, Clouds and the Earth's Radiant Energy System (CERES), and the Satellite Cloud and Radiation Property retrieval System (SatCORPS) teams. Comparisons included data from Terra, Aqua, and CALIPSO satellites. Current comparisons are done with NOAA-20 and geostationary satellites (GOES, Meteosat, and Himawari) around the world. Collocation details, including past satellite data, can be found in Colón Robles et al., 2025.

In 2025, satellite collocations expanded to GLOBE Land Cover observations. Land Cover classifications are collocated with the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument flying on NASA's Terra satellite. Recent images of the location from the Landsat 8 or 9 satellites and a selection of Sentinel 2 satellites are also included in the satellite comparison table.

Details of the systems used to pull data, create, and send satellite collocations is found in [Rizzi et al., 2024](#).

7.2. Data User Guide

The [GLOBE Data User Guide](#) was developed to provide data users with definitions of GLOBE data and metadata, information about how to access and interpret GLOBE data, variables available for download, primers, and sample Python scripts to access data by calling the GLOBE API.

The NESEC GLOBE Observer team developed the initial GLOBE Data User Guide in 2019 with an emphasis on GLOBE Observer data to support expanded science use of GLOBE data. DIS manager Lisa Dallas maintained subsequent versions of the Data User Guide until it was passed to the GLOBE Implementation Office in 2024.

The Data User Guide covers:

- Definition of GLOBE data (background), including citation, data characteristics, and data variables and metadata
- Methods and materials for collecting GLOBE data - GLOBE training, GLOBE protocols, and GLOBE Observer app
- Quality assurance
- Applications and terms of use
- Data visualization
- Data and photo access

Starting in July 2019, app or protocol changes that impact data are tracked in the Data User Guide Change History Log.

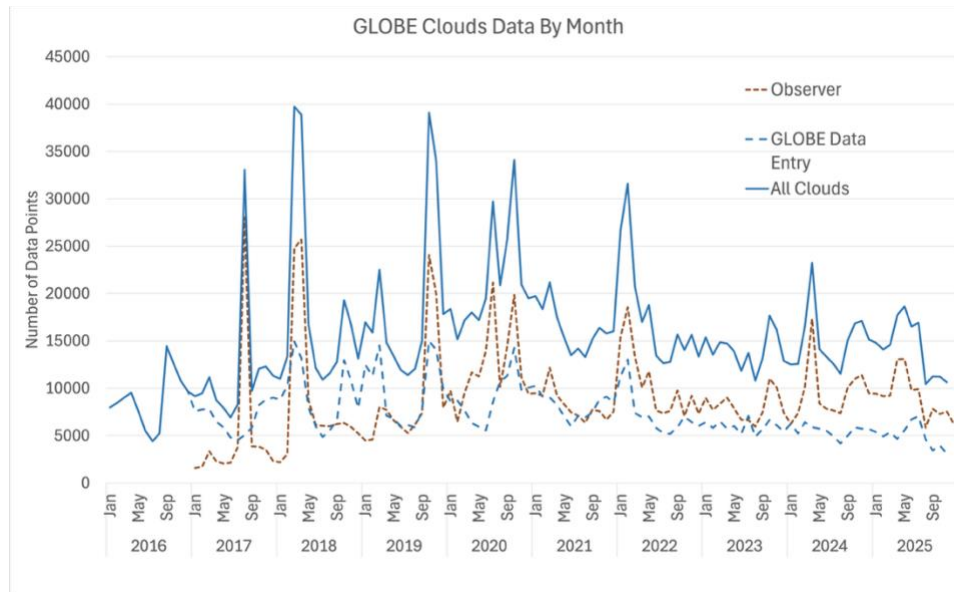
7.3. Data Growth

As described in [Chapter 3: Foundations of GLOBE Observer](#) in this documentation, one of the objectives of GLOBE Observer was to increase data density. GLOBE Observer added nearly 1.2 million data points to the GLOBE database between January 2017 and December 2025. The table below shows annual data submission through GLOBE Observer for each protocol. Data entered into the GLOBE database through data entry are not included. A detailed view of data submitted per protocol follows.

Date	GO Clouds	Mosquito Habitats	GO Land Cover	GO Trees
2017	58439	1377	0	0
2018	106926	4921	1532	0
2019	108501	13420	7108	10390
2020	149046	6052	7244	12960
2021	102075	9838	5960	15458
2022	135115	2029	7439	17211
2023	105236	5043	6330	18514
2024	123836	2043	8361	14800
2025	119123	3798	10234	17155

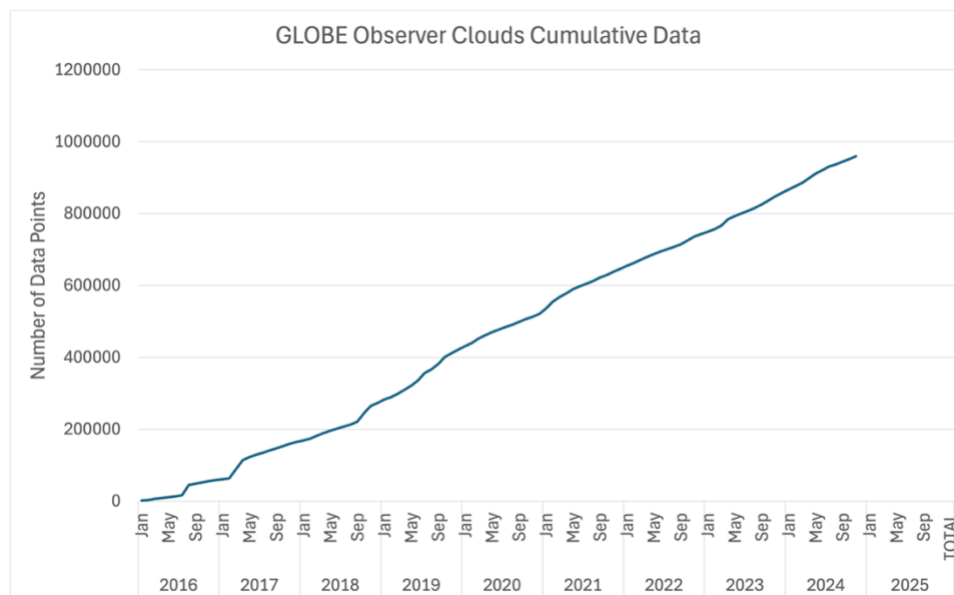
7.3.1 Clouds Data

GLOBE Clouds data submitted through GLOBE Observer are flagged in the database, so it is possible to separate Observer Clouds data from data collected and submitted through GLOBE Data Entry. Between January 2017 and December 2025, 1,008,297 Clouds observations have been submitted through GLOBE Observer.



Monthly data counts for GLOBE Observer Clouds, GLOBE Data Entry Clouds, and all Clouds data. Observer consistently overtakes Data Entry as the most popular form of data submission in 2020, but both methods remain very active.

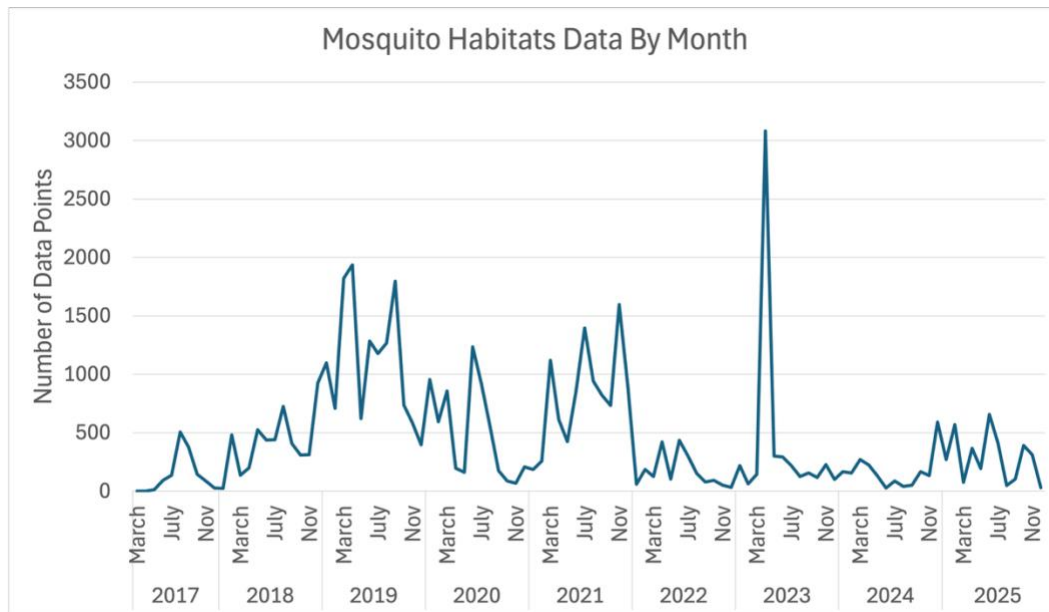
The rate of growth for clouds data has been largely steady, as shown below. The small instances of rapid growth correspond to data challenges and eclipses.



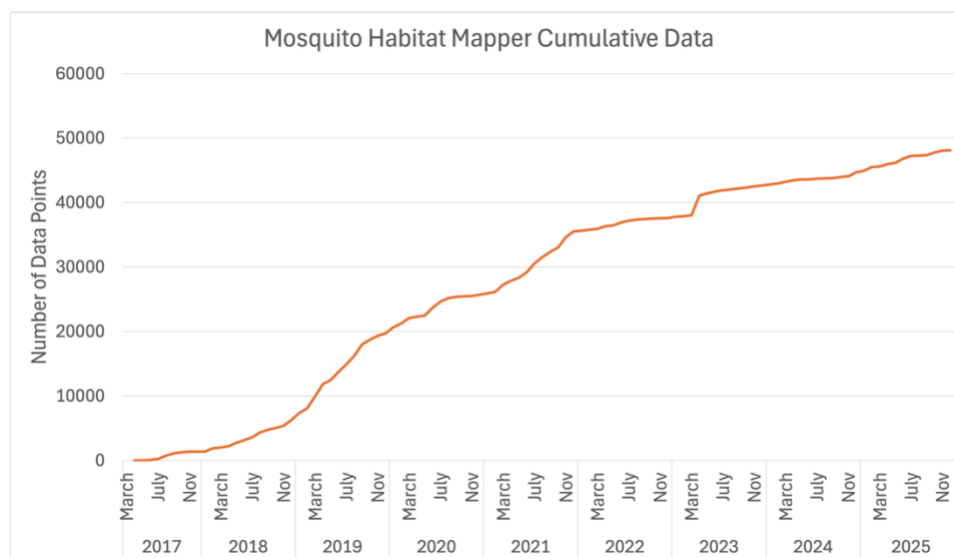
GLOBE Observer Clouds data has grown at a relatively even rate with a few step jumps corresponding to data collection challenges and the eclipses.

7.3.2. Mosquito Habitat Mapper Data

Between March 2017 and December 2025, users submitted 48,521 Mosquito Habitat Mapper observations. Mosquito Habitat Mapper does not have an equivalent under GLOBE Data Entry, so all of these are from the GLOBE Observer data collection tool. Data submission is largely seasonal with spikes that align with data collection challenges and other initiatives such as intensive observation periods. Some of the spikes in Mosquito Habitat data correspond to regional training workshops. Data submission shows steady growth throughout the life of the project.

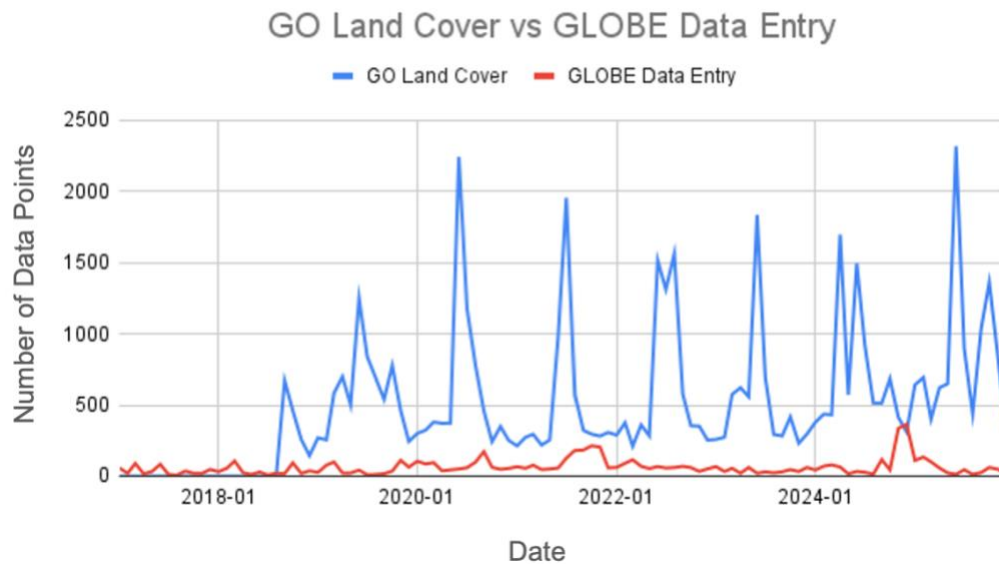


The rate at which mosquito habitat data entered the database is not as steady as clouds. Rapid early growth is related to extensive workshops and promotion associated with the 2018-2021 GLOBE Zika Education and Prevention project funded by the U.S. State Department (see [section 5.4.5](#)). Data growth leveled off after the end of the project with one large step in 2023 that may be associated with the May *Where is the Water* data challenge.

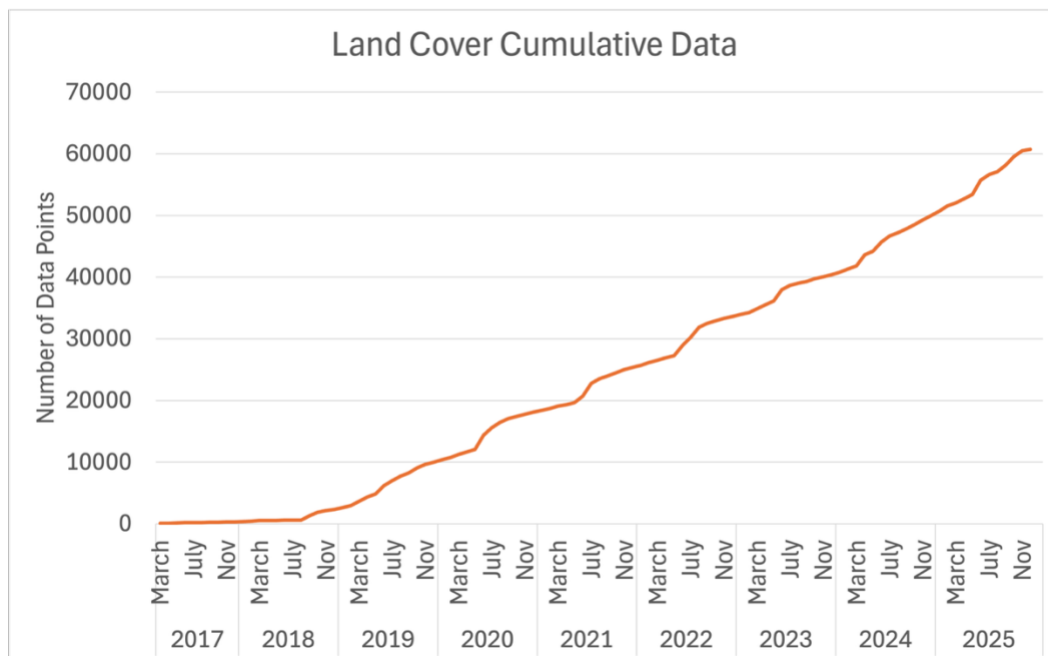


7.3.3. Land Cover Data

GLOBE Observer Land Cover launched in September 2018. From that time through December 2025, users have submitted 54,208 observations through GLOBE Observer vs 6,046 via data entry. Like Clouds, data submission spikes seasonally and with data collection events. The data submission rate for land cover overall also jumped significantly after GLOBE Observer Land Cover was released.

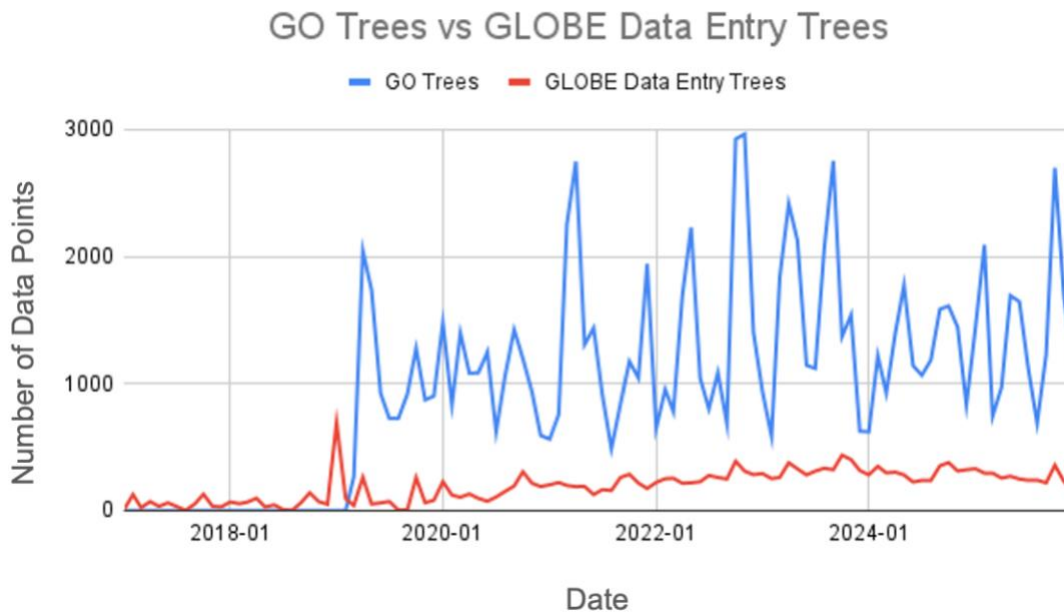


As shown below, the rate of data submission for land cover has grown steadily since GLOBE Observer Land Cover launched in 2018.

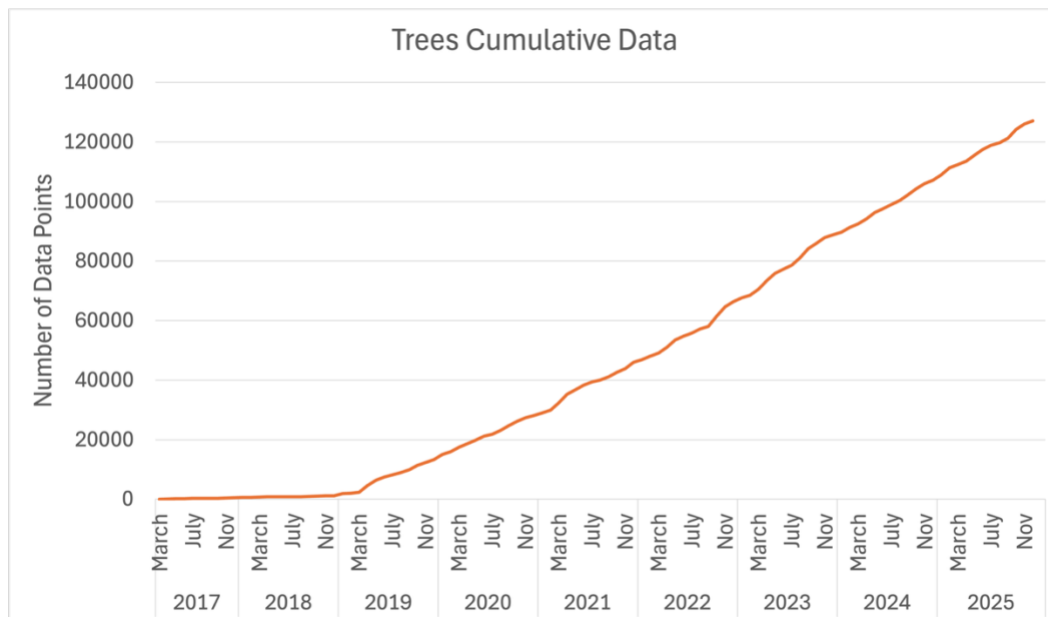


7.3.4. Trees Data

GLOBE Observer Trees launched in March 2019. Between March 2019 and December 2025, users submitted 125,077 Trees observations, of which 106,488 came through GLOBE Observer. Data submission is largely seasonal with spikes that align with data collection challenges and other initiatives such as intensive observation periods. The data submission rate increased significantly after GLOBE Observer Trees was released.

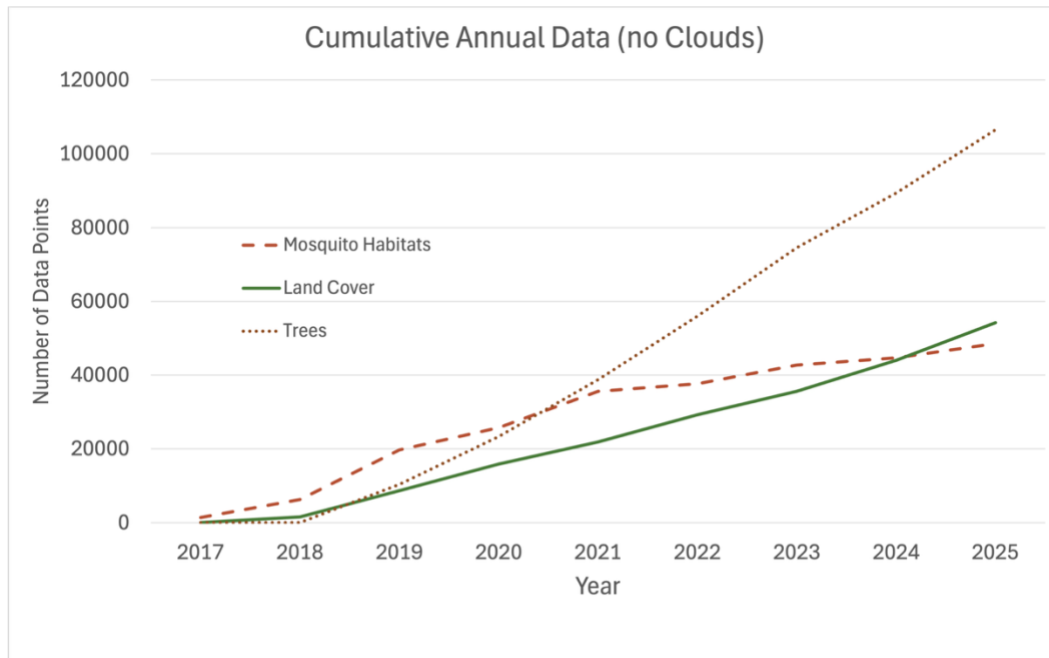


As shown below, data growth for Trees has been strong since the launch of GLOBE Observer Trees in 2019.

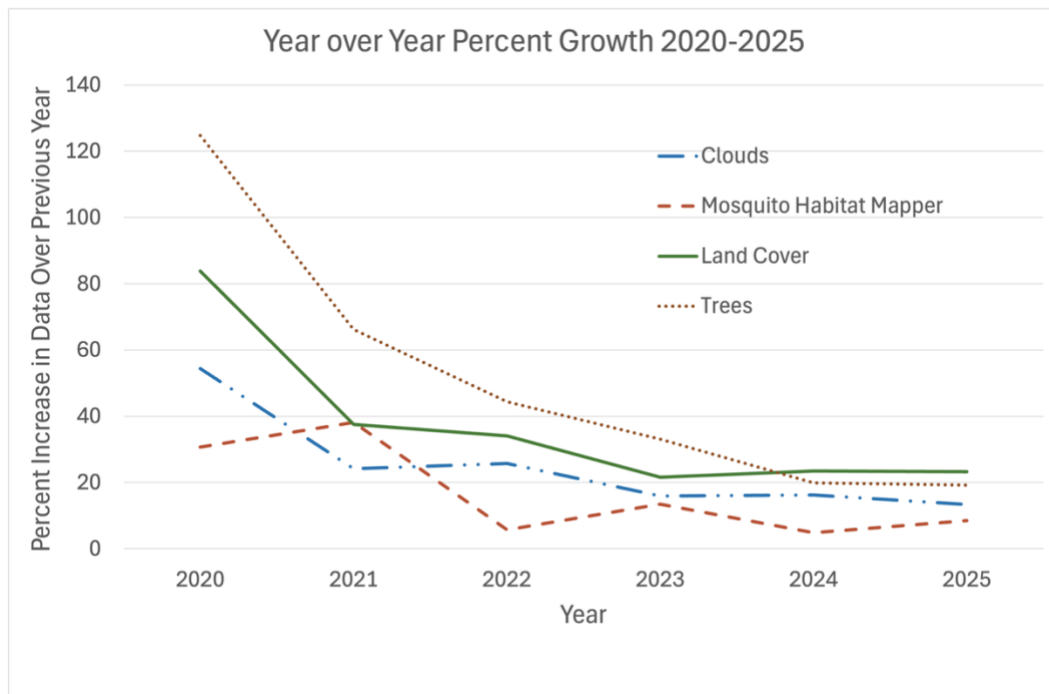


7.3.5. Growth Across all Tools

Comparing the rate of growth over time for Mosquito Habitat Mapper, Land Cover and Trees shows that Trees grew more quickly than others. Clouds data is not included because of the extreme difference in scale. (See cumulative data growth for clouds alone in the graph in [section 7.3.1.](#))



Comparing the percent growth year over year shows a steep growth for every protocol on release followed by a relatively steady growth rate that is comparable across protocols.



7.4. Data Access

Following NASA's Open Data guidelines, all GLOBE data are available for download without restriction. Data are distributed through the GLOBE webpage and can be accessed through the GLOBE Visualization System, Advanced Data Access Tool, or GLOBE API.

7.4.1. GLOBE Observer Archived Data

The GLOBE Observer website provides archived CSV files of GLOBE Observer data collected during data challenges or with added information, such as satellite match data or analysis data from publications. The following data are available on GLOBE Observer with associated documentation:

Clouds

- Clouds Matched Satellite Data annual data 2017-2025
- 2017 Eclipse data
- 2018 Cloud Challenge data
- 2019 Cloud Challenge data
- 2020 Cloud Challenge data
- 2021 Terminator problem (challenge) data
- 2022 Clouds in a changing climate (challenge) data
- 2023 Eclipse data
- 2024 Eclipse data
- 2024 Eclipse challenge data (month-long period, global)
- Cloud GAZE data

Dust

- 2012-2019 GLOBE dust data
- 2020 GLOBE dust data

Eclipse

- 21 August 2017 eclipse path data (clouds and air temperature)
- 02 July 2019 eclipse path data (clouds and air temperature)
- 14 October 2023 eclipse path (clouds, air temp, land cover, wind)
- 08 April 2024 eclipse path (clouds, air temp, land cover, wind)

Land Cover

- Adopt a Pixel 3 km data 2020
- GO on a Trail challenge 2019

Mosquito Habitats

- Adopt a Pixel 3 km data 2020
- Mosquito Habitat Mapper data 2017-2020

Each dataset was created for a different purpose and with different parameters, and available documentation about how each was created is on the linked landing pages above. For data sets associated with a specific published paper, those links are also on the data landing pages. In addition, there is a [Zenodo Community for GLOBE](#) with available datasets and associated documentation. As of March 2026, the community was closed to new additions at least temporarily.

7.4.2. Publications Page

All known science publications that use GLOBE Observer data are listed on the GLOBE Observer website under [Publications](#). This section is maintained to communicate to volunteers how their data are used. Publications are uploaded manually as we become aware of them as described in [section 9.4.9](#). More efficient publication tracking in the future could be done through Google Scholar or a similar service.

7.4.3. Application Programming Interface (API)

The GLOBE DIS team developed the [GLOBE API](#) at NESEC's request and with NESEC funding to expand data access in support of GLOBE Observer's priority to expand science research with GLOBE data (see [Section 6.2.2: Improving Science Data Use](#)). The API allows data users to develop code to call the GLOBE database and pull data into research systems. It facilitates the download of large batches of data as well as routine data pulls for operational systems.

Additionally, the GLOBE Clouds team manages an API in partnership with GLOBE DIS that pulls GLOBE data to generate satellite co-location tables and data. The GLOBE Clouds team and DIS are in conversation to move toward using the primary GLOBE API so that only one API needs to be maintained in the future.

8. Volunteer Management

The primary purpose of the GLOBE Observer initiative was to bring a new community of volunteers into the GLOBE Program. As a result, recruiting and supporting volunteers is a significant component of the implementation of GLOBE Observer.

8.1. Becoming a GLOBE Observer

As of 2024, all GLOBE accounts start out as GLOBE Observer citizen science accounts. Both formal and informal educators may apply for educator accounts and take additional training to unlock additional membership privileges, including full data entry access, a My Page, and student accounts.

Creating a GLOBE Observer account may be done on the GLOBE website or through the GLOBE Observer app. People must be in a GLOBE country and have an active email address to become an Observer. No additional application or review process is required. As GLOBE Observer accounts are not vetted, their access to GLOBE systems has been limited, as detailed in [section 3.3](#).

Note: GLOBE account types were flattened in December 2025, so that all accounts behave as U.S. citizen science accounts. All accounts will be able to access data entry with training, but no approval or application will be required.

8.2. GLOBE Observer Volunteer Metrics

Metrics used to track the progress of the GLOBE Observer initiative include the number of Observer accounts and the estimated amount of time donated in supporting science through GLOBE Observer.

The GLOBE website provides a running tally of the number of GLOBE Observer accounts on its home page. As of December 1, 2025, there are 303,551 individuals who have GLOBE Observer accounts.

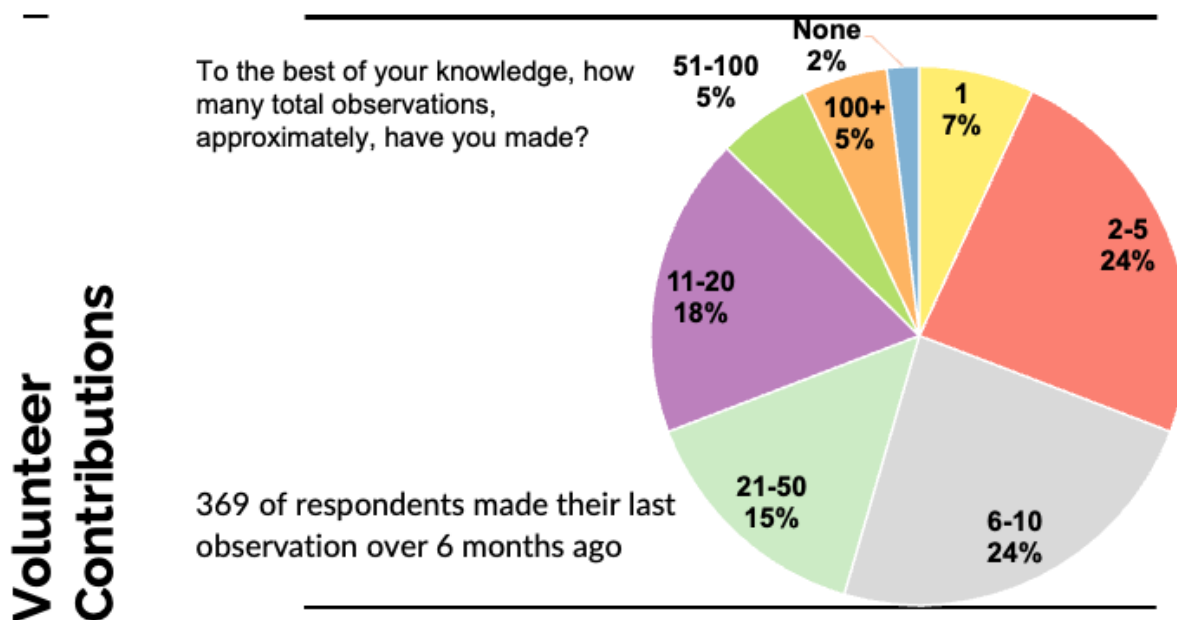
Volunteer hours are calculated based on the number of observations submitted for Clouds, Mosquito Habitat Mapper, Land Cover, and Trees. It is estimated that a complete observation takes five minutes, though some individuals may take more time and others less. We multiply the total number of observations by 5 to get the number of volunteer minutes, then divide by 60 to calculate volunteer hours.

By this metric, volunteers submitted 1.22 million observations through GLOBE Observer between 2017 and 2025. If each observation took five minutes, volunteers gave 101,460 hours to GLOBE total during those nine years.

Calculations of volunteer hours offer an estimate for the amount of time volunteers spent collecting data, but they do not indicate how much time people engaged with GLOBE overall. Additional time may be spent reading or viewing content on the website or social media channels, doing training, interacting with activities, engaging with satellite match emails, and more.

It is possible to assess how much time an individual has contributed in data collection by downloading or sorting data based on the user ID and counting the number of observations the user ID has submitted. Similarly, sorting the data by user ID offers insight into how much time volunteers generally give to GLOBE.

In general, a few super users contribute significant amounts of time (many observations), while a larger percentage of people volunteer smaller chunks of time collecting only a few observations ([Fischer et al., 2021](#)). A 2019 survey of GLOBE Observers found that only five percent of volunteers had submitted more than 100 observations since the launch of the app. An additional five percent submitted between 51 and 100 observations. Half of volunteers reported submitting 10 observations or less.



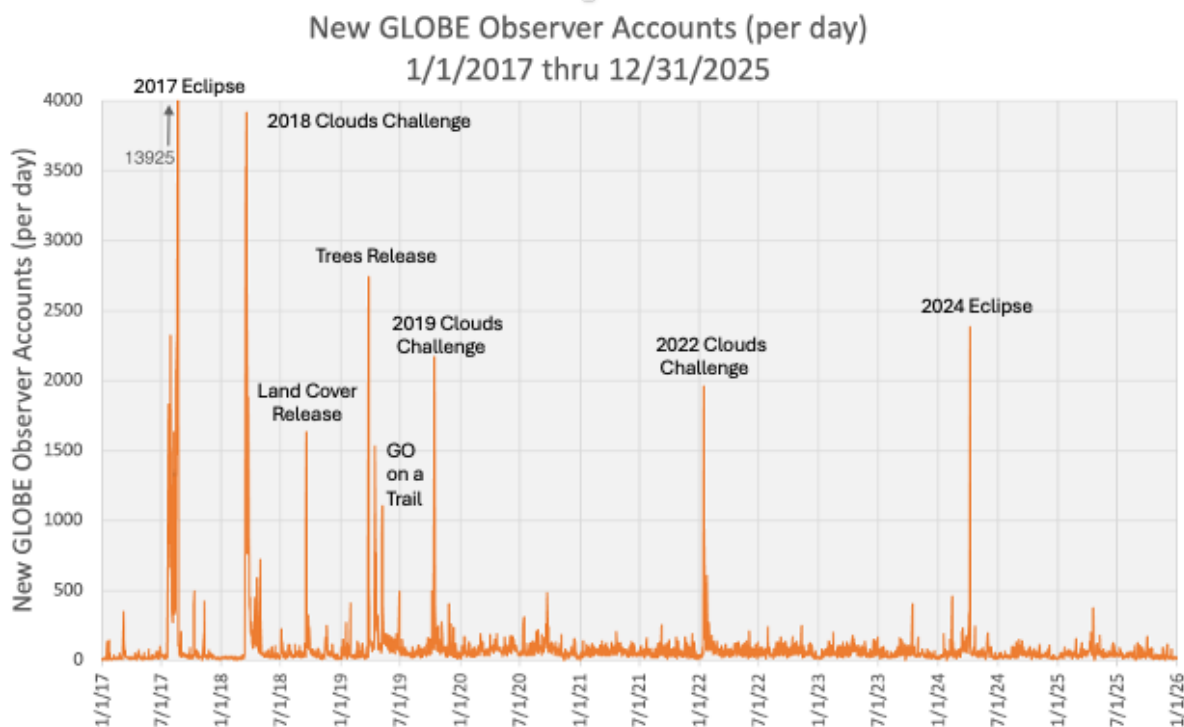
An analysis of a 2019 survey of 800 volunteers taken in 2019 as reported to the GLOBE community at the 2019 GLOBE Annual Meeting. (Full presentation available in [Appendix D3](#).) Of approximately 75,000 Observer volunteers in North America in early 2019, 4,000 received the survey - 2,000 above average users and 2,000 below average users. This analysis shows a subsample of 800 responses. Courtesy Heather Fischer and Martins Storksdieck, Oregon State University. Full results from the survey are reported in [Fischer et al. \(2021\)](#).

8.3. Recruiting Volunteers

As GLOBE Observer was meant to bring new communities to GLOBE, NESEC spent significant effort on recruiting new volunteers and supporting existing volunteers. We followed two strategies for recruiting volunteers: direct recruitment through communication initiatives and recruiting through partnerships.

Early surveys of GLOBE Observer volunteers indicated that people joined because they were interested in contributing to science, and they were particularly interested in contributing to NASA science. The next most common reason people joined was to volunteer for a worthy cause. ([Fisher, et al., 2021](#)). Understanding the motivations of volunteers influenced our approach to recruitment. In particular, we made significant efforts to connect to NASA science in all communications.

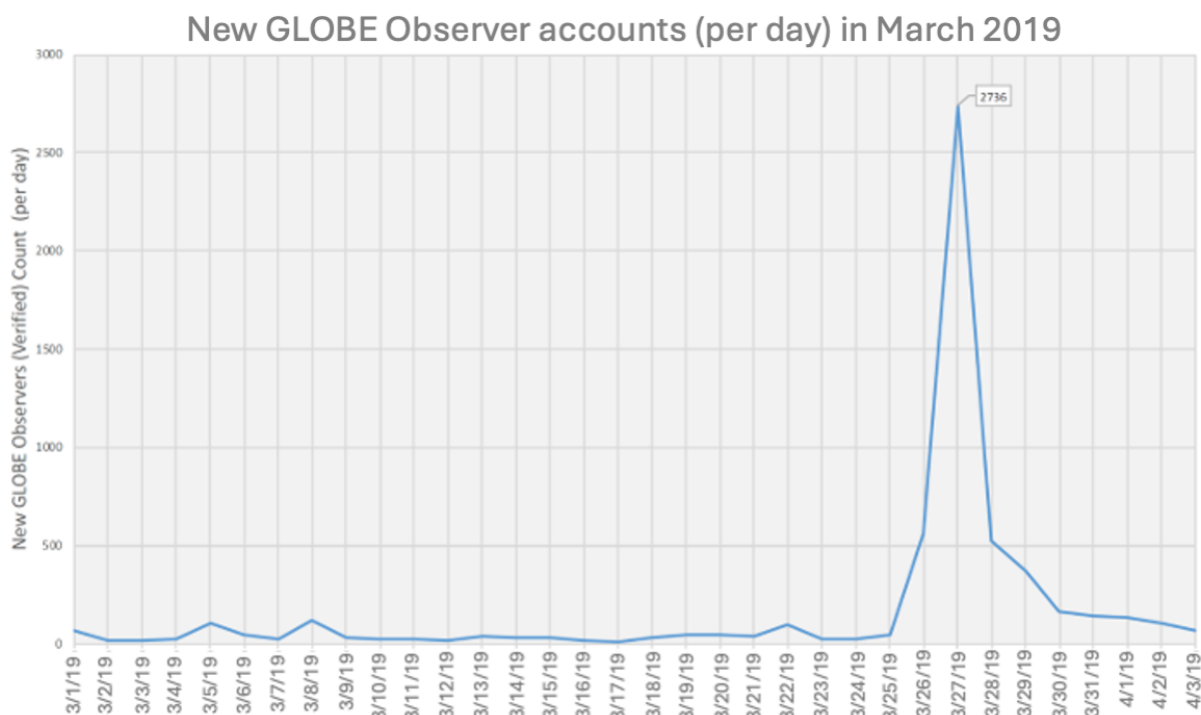
Tracking new account creation throughout the life of GLOBE Observer shows that the largest spikes in new volunteers occurred during communication events, particularly data challenges. The single largest event driving account creation was the 2017 total solar eclipse in North America.



8.3.1. Recruiting Volunteers Through Direct Communication

8.3.1.1. NASA Communication Collaboration

NASA communications have been a significant driver bringing new volunteers to GLOBE Observer. In particular, large spikes in account creation and downloads align with social media stories shared on the NASA flagship accounts. These stories typically include a call to action such as downloading the app or participating in a challenge or event. The platforms that generate the largest spikes in account creation have varied over time. Most recently, stories and reels, which go out on Instagram, Facebook and Snapchat, have generated the largest impact.



NASA flagship Instagram, Facebook, and Snapchat accounts ran a story announcing the release of GLOBE Observer Trees on March 26, 2019, reaching more than 2.1 million people. We saw a significant spike in new volunteers on that day. Graph courtesy GLOBE Data and Information System Team.

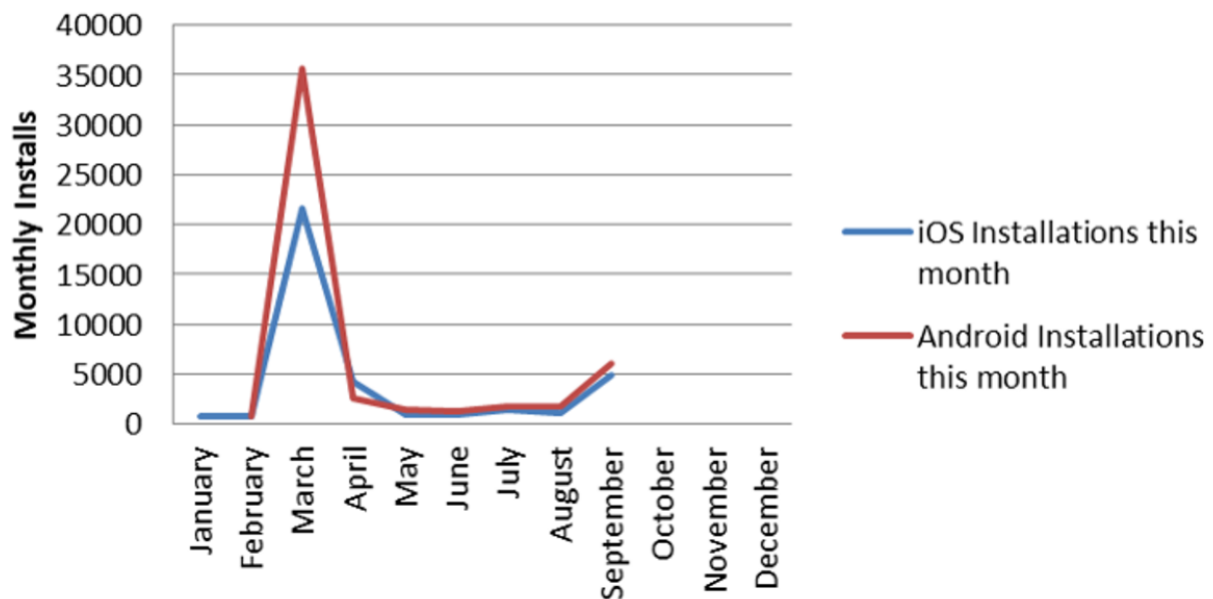
Initially, in 2016 and 2017, GLOBE Observer generated the most interest through NASA web stories and more traditional media. However, we quickly learned that we received more engagement through social media posts, particularly if they were posted or shared on NASA's flagship platforms, which have a large number of followers. NASA Earth has been more willing to share GLOBE content frequently. While their influence is slightly smaller, more frequent exposure and collaboration has helped drive awareness and volunteer recruitment. A more complete description of GLOBE Observer social media engagement is in the [Chapter 9: Communication](#) of this document.

8.3.2. Challenges and volunteer recruitment

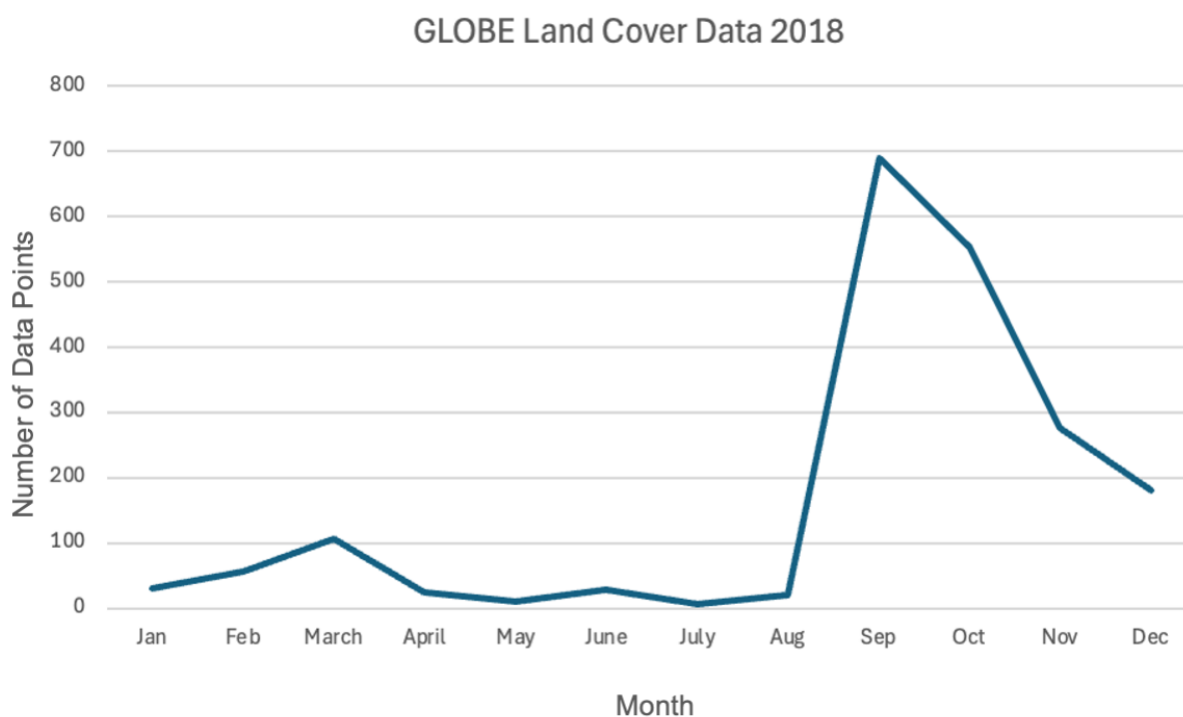
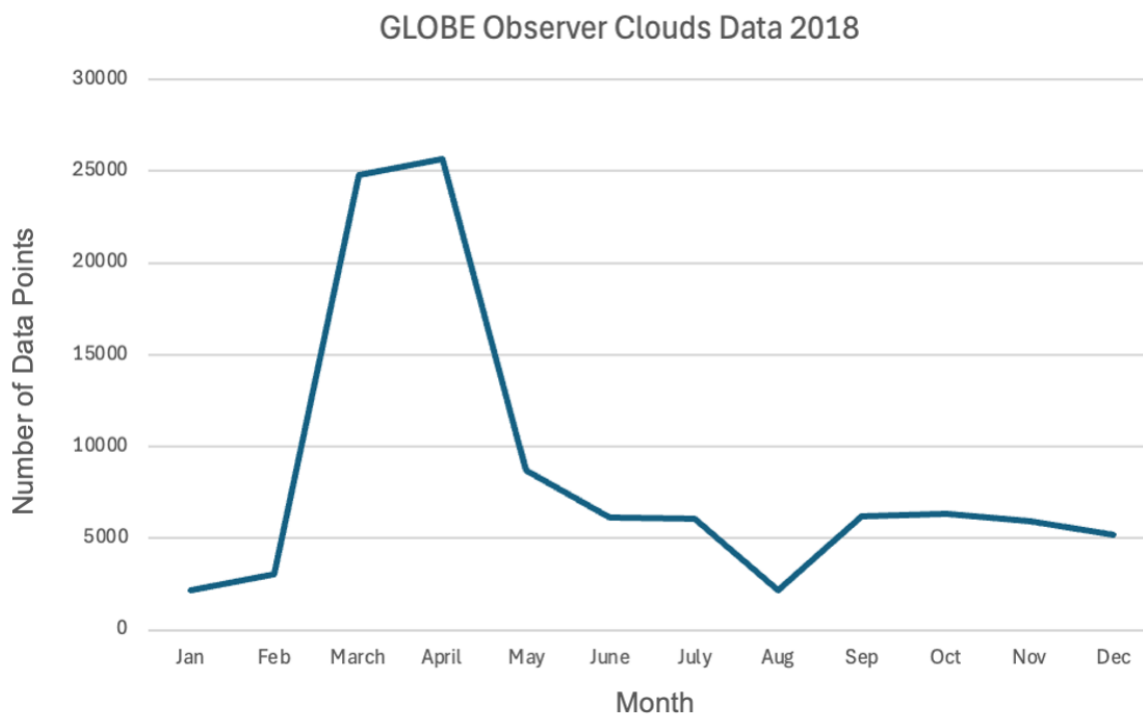
As described in [section 6.5](#), challenges were initially designed to engage volunteers in data collection with a focused science-based data request. The first challenge in March 2018, the Spring Cloud Observation Data Challenge, created the largest growth, but all challenges and associated communications brought in new users.

Challenges attracted new users and engaged existing users because most involved a concentrated communication campaign associated with a simple, direct action: download the app and take a certain type of observation in a defined period of time.

GLOBE Observer App Downloads - 2018



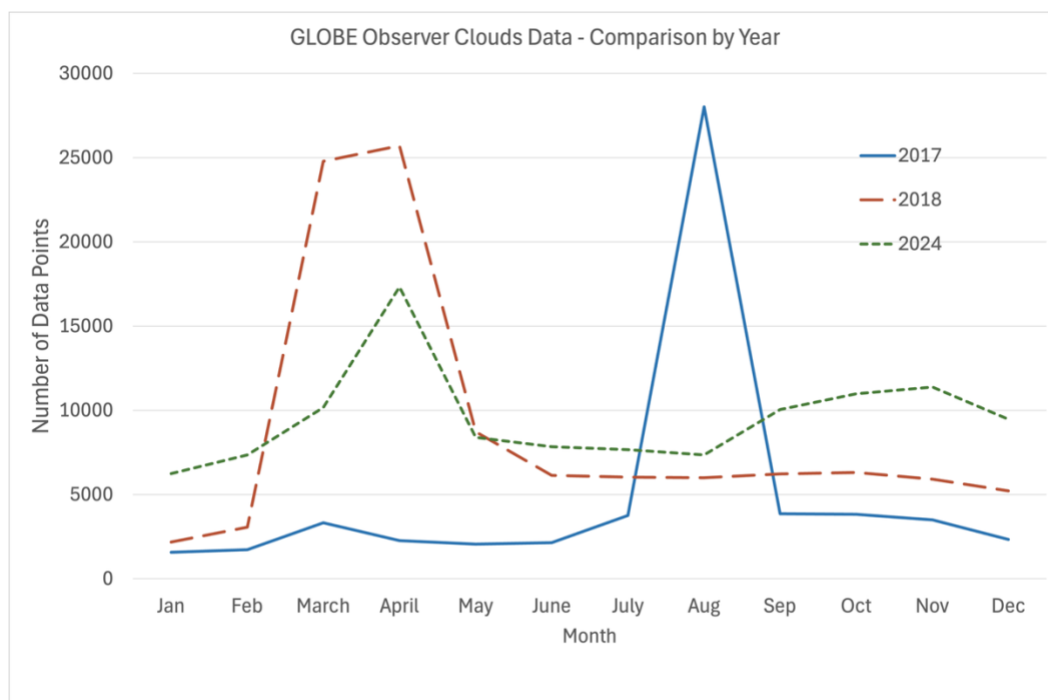
The GLOBE Data and Information System Team reported app downloads for 2018 showing the impact of two challenges: the Spring Cloud Observation Data Challenge March 15 - April 15, 2018, and the Land Challenge, September 22 - October 1, 2018. Both created an increase in downloads from new volunteers.



Both challenges of 2018, Clouds (top) and Land Cover (bottom) show a marked increase in engagement in the form of data submission. In both cases, participation drops after the end of the challenge, but participation rates remain higher than before the challenge. Note: The Land Challenge was held to promote the release of the land cover tool. Data prior to September was submitted through GLOBE Data Entry.

While valuable in bringing in volunteers, the challenges had limitations. First, volunteers thought they were joining a short-term initiative and didn't realize that they could continue to participate in GLOBE after the challenge ended ([Fischer et al., 2021](#)). Data submission rates after a challenge drop, but they do not drop to pre-challenge levels. This indicates that some new or existing volunteers continue routine observations at an increased rate.

Second, over time, challenges became less effective in bringing in new volunteers. The 2024 Eclipse Challenge, March 18 - April 18, 2024, saw a small spike in new users aligned with NASA communications events and the eclipse itself, but the rate of account creation remained near average levels on other days during the challenge. Engagement as measured in data submitted was also lower during the 2024 Eclipse Challenge than earlier Clouds challenges. Global data challenges may still be effective, but we got the sense that the volunteer community was growing fatigued. After the eclipse, we pivoted our attention to more focused science data requests with recruitment through local partnerships rather than mass communication.



Clouds data collected in 2024 compared to 2018 illustrates the declining return in challenge data. The 2018 Spring Clouds Challenge and the 2024 Eclipse Challenge both ran March 15-April 15 in their respective years. Both resulted in an increase in engagement as seen in data collection, but the jump from background was much greater in 2018. Participants may have viewed the 2024 eclipse challenge as a single event (eclipse observation) rather than a sustained data ask. Participation and data submission patterns echo those seen during the August 2017 total solar eclipse when eclipse data collection was limited to a single day. As shown in [section 8.3.1.1](#), the 2024 Eclipse Challenge did bring in new volunteers corresponding to social media posts.

8.3.3. Recruiting through partners

NESEC also recruited and supported volunteers through informal education partners. While we do not see the large-scale spikes in downloads that we see associated with direct communication, we have seen more sustained, meaningful involvement. In fact, much of the data received during the 2024 total solar eclipse came through people affiliated with partner organizations.

Partners offer local, on-the-ground support and community for volunteers. Some of the Observers surveyed in 2019 reported that they stopped participating in GLOBE Observer in part because they felt their contributions were not meaningful ([Fischer et al., 2021](#)). Local community partners can provide meaning to participation by connecting data collection to things that matter in the community. They also provide training and technical support.

To better understand how to implement citizen science through partnerships, Oregon State University's evaluation team conducted a needs assessment in late 2017. The assessment included a literature review, one-on-one conversations with citizen science experts, and a workshop with informal educators from a variety of organizations. The assessment identified the following as essential for recruiting and supporting volunteers:

Recruitment:

- High-quality materials - sufficient resources are available to begin (and continue) the project
- Minimal effort (easy to do)
- Trust/Credibility
- Program is straightforward, easy to follow, well-organized – clearly defined goals
- Sense of valuable contribution
- Connection to others involved

Retention:

- Staff responsive to needs and questions
- Well-designed protocols, materials and reporting website (no frustrations; not too complex)
- Flexibility (various effort levels)
- Validation (of data usefulness and of volunteer effectiveness)
- Communication (relevant emails or newsletter or reports that talk about people and statistics)
- Access to published work, teaching and learning supports built into data sheets, guidebooks
- Interactive systems to support volunteers

Source: Nancee Hunter, Oregon State University, January 2018.

While GLOBE Observer provides all of these things independently, NESEC recognized that community-based partners would add great value in providing connection to others and interaction beyond social media, the only other mechanism available for connection and interaction between volunteers.

The assessment also recommended the development of toolkits that provide a framework for doing GLOBE Observer in an informal educational setting. The framework should include a compilation of resources and ideas, guidelines to help an educator get started, step-by-step instructions, and be adaptable to meet community needs as partnerships develop and grow.

The needs assessment identified common elements of successful toolkits. These include:

- An overview page that demonstrates the value of citizen science to science and to the community and the importance of collecting reliable and consistent data.
- Case studies serve as models, spotlight successes, identify potential challenges, and show how data can be collected, analyzed and used in a community setting, such as a library or afterschool program.
- A discussion forum where informal educators can share lessons learned and best practices for designing, implementing, and evaluating citizen science initiatives in a community.
- A searchable project catalog to find resources.
- A resource library that includes a list of internal and external resources.
- How-to sections that detail how to collect and analyze data, how to conduct an evaluation, and to help informal educators understand the resources needed to collect data.
- A feedback form to gather insight into why people participate and stay involved. This could be a form that partners use to evaluate their programs and/or a way for NESEC to collect feedback to improve partner support.

Based on the assessment, NESEC decided to develop the Toolkit for Informal Educators (described below in [section 8.3.3.1](#)) which evolved to include audience guides. We also produced resources to support programming, including family science guides and observation stations.

8.3.3.1. Toolkit

The [Toolkit for Informal Educators](#) landing page offers general suggestions for how GLOBE Observer might be used in an informal learning environment. Suggestions range from simple data collection to becoming a GLOBE Partner. It includes information about accessing, using, and storing GLOBE data.

The toolkit also includes audience-specific guides that provide a framework and case studies for using the resources to implement GLOBE Observer with specific audiences such as libraries. These are covered in [section 8.3.3.2](#).

Since partners, particularly libraries, expressed a need for resources in a range of languages, the toolkit includes a [Spanish-language resource page](#) that collates all GLOBE Observer materials available in Spanish. Some resources are also available in other languages, and these are linked to from the resource libraries of each protocol.

For each protocol, the toolkit includes a resource library, quick facts to help educators prepare programming and answer science-based questions, and tips and troubleshooting for doing the protocol with a group or in a program.

The resource library is the largest component of each protocol's toolkit. It contains hands-on activities related to the protocol; books, videos and presentations; and printables and promotional materials.

Resource Library: Activities

Many of the activities were developed by the GLOBE Observer team to be used in an informal education context, and other activities are resources useful in teaching the science related to the protocol. Some activities were adapted from GLOBE Learning Activities to work in an informal environment. All activities were tested with informal education partners or at tabling events before being posted in the toolkit. Descriptions of various archives and locations to find GLOBE Observer activities is provided in [Appendix F](#).

Resource Library: Books, Videos, and Presentations

For each protocol, NESEC curated a list of books in WorldCat. [WorldCat](#) is a free online catalog of thousands of library collections. Books listed in WorldCat include a summary as well as links to libraries where the book can be found and to vendors. The booklist was particularly important for supporting library partners, who were interested in recommending books related to the protocols to their patrons. Each protocol includes a booklist for kids and one for teens and adults.

The video list includes short videos relevant to the protocol that might be helpful in programming. Videos include those produced by NESEC, many as social media resources, NASA videos, and a few videos produced by partners like [NASA eClips](#).

The presentations section provides slides that a partner may use or adapt for programming.

Resource Library: Printables and Promotional Materials

Printables are graphic resources designed to be printed and used in programming. They include resources like the Cloud Identification Chart, GLOBE Observer rack card, NUBE card game, coloring sheets, and observation stations.

Promotional materials include table-top signs, photo release forms, and basic graphic resources that can be used to create signs or programming promotional materials.

Quick Facts

The *Quick Facts* section of the toolkit provides printable background facts about each protocol in a question-and-answer form.

- [Clouds Quick Facts](#)
- [Mosquito Habitat Mapper Quick Facts](#)
- [Land Cover Quick Facts](#)
- [Trees Quick Facts](#)

Tips and Troubleshooting

The *Tips and Troubleshooting* section provides information about common issues informal educators might encounter. It includes information about planning safe data collection sites, compatible devices, and presentation tips.

Of the elements recommended by the needs assessment, the toolkits do not include a discussion forum or feedback forms. We were unable to create a discussion forum because of constraints of the GLOBE Program. We were able to encourage partner organizations to get formal GLOBE training to become GLOBE partners, which unlocked the ability to post discussions to the GLOBE website (a function scheduled

to end in late 2025). NESEC also used Basecamp as a community forum for some collaborations, including a library network and Texas Master Naturalists. Basecamp may have offered a more effective collaboration space since all participants “owned” the space equally. Basecamp collaboration space is also private, so educators may have felt more comfortable sharing challenges or questions.

The needs assessment also recommended a detailed how-to section covering how to do the protocols. GLOBE Observer does include such a section on its website, but it is not specifically part of the Toolkit for Informal Educators.

8.3.3.2. Audience guides

Broader NESEC work has supported the implementation of GLOBE Observer with specific informal educator audiences. This work taught us that while the generic toolkit resources are helpful, most organizations need support in planning how to use the resources in their setting. A camp educator has a different set of challenges and needs than a librarian. To meet this need, the NESEC team compiled case studies and how-to information to support specific partner audiences. To date, audience guides are available for [Girl Scouts](#), [4-H](#), [Camps](#), and [Libraries](#). If time permits, NESEC may also create a guide for Lifelong Learners.

Each guide is different because each audience has different needs. However, all include detailed information about how to implement GLOBE Observer in those particular settings. (See also [Section 9.4.6: Lead a Program](#))

8.3.3.3. Family Science Guides

Many informal educators serve a range of ages, and often programming includes family groups that include toddlers to seniors. To help partner educators use GLOBE Observer with family groups and to support families interested in doing science at home, the GLOBE Clouds team created the [Clouds Family Guide](#). It includes information about how to observe clouds with GLOBE and satellite matches, hands-on activities, videos to learn from scientists, and career information.

In late 2019, NESEC developed a [Trees Family Guide](#) with activities and learning resources for young children, older children, and teens and adults.

When the COVID-19 pandemic closed institutions and schools in 2020, education partners became even more interested in materials that could support families at home. NESEC was able to offer the family guides to meet the need immediately. In addition to the Clouds and Trees family guides, NESEC GLOBE Mission Mosquito Team developed the [Mission Mosquito Science Notebook](#) to support science from home, including a [Companion Guide for Parents and Caregivers](#). Over time, NESEC adapted existing hands-on activities to be done at home and produced short videos demonstrating each. These are available on the [GLOBE Observer Family Science page](#).

8.3.3.4. Observation Stations

In 2019, the NESEC team partnered with Lewis and Clark National Historic Trail to host [GO on a Trail](#), a challenge to collect land cover observations both along the trail and worldwide. The National Park Service educator who collaborated with us recommended pavement stickers to encourage visitor center guests to take a GLOBE observation at specific sites. These locations would be considered training sites and would offer repeat data - something science partners were interested in as they assessed land cover data quality, particularly location accuracy.

We designed observation station stickers for GO on a Trail. Based on their success, we created observation station graphics for each protocol as well as a generic station with space that an institution could use to integrate their own branding. Each station graphic includes compass points to help volunteers orient themselves during the observation. This also provides secondary confirmation of the compass direction for data quality.

The NESEC team created a facilitator guide for the observation stations with instructions about how to customize, print and install the stations.

The [Observation Station page](#) on the GLOBE Observer website provides information for volunteers who find an observation station in a location that is not facilitated. It also includes all observation station files and the facilitator guide.

It should be noted that the implementation of the AI photo approval system made Observation Stations less effective. The AI blurs all text in images submitted to GLOBE, including Observation Station text. Future developments or refinements of AI implementation might consider either limited text blurring or making it possible to access and approve an image without blurring implemented. As the original image is stored in the GLOBE system, the second option is feasible.

8.3.3.5. Partnerships

The NESEC team implemented GLOBE Observer with partner organizations in a variety of ways. Some are detailed in the audience guides. Key partnerships are highlighted here, including unique types of engagement with GLOBE Observer, though this list is not exhaustive.

Accenture

[Accenture](#) selected GLOBE as one of the options for employees participating in a company-wide volunteer initiative. The company wanted an impactful project that employees in more than 120 countries could do equally. Accenture's global distribution aligned well with GLOBE. They selected GLOBE Clouds and worked with the GLOBE Clouds team and NESEC to create internal training materials and a training event featuring Marilé Colón Robles, Holli Kohl, and Kristen Weaver.

Accenture wanted to gauge the effectiveness of their volunteer initiative, reward participants, and create competition across countries using an internal dashboard. They requested the ability to form country-based teams that allowed them to see who was on the team and how much data each individual submitted and when. They also wanted to filter team data by date so they could set a challenge or competition period. These requirements fed into requirements for GLOBE Teams (more details can be found in [section 8.3.4.1](#)).

Using 44 GLOBE Teams, Accenture made GLOBE Observer part of their annual volunteer initiative annually between 2020 and 2024, adding Land Cover in 2023. The partnership added a significant number of new volunteers. We did see data spikes during the Accenture annual engagements. Accenture teams have contributed 46,623 observations to GLOBE, the majority of which are Clouds observations.

Camps

Working with [Camp Discovery](#) in Blythewood, South Carolina, Tina Ballinger created a series of pacing guides to support the implementation of GLOBE Observer in a camp setting. She expanded to a small group of additional camps in a pilot, refined, and then continued to grow reaching over 70 camps and outdoor education centers across the United States through a project called [GLOBE Goes to Camp](#). GLOBE Goes to Camp was promoted through a partnership with the American Camp Association through sessions during the national conference, webinars, and periodic blog posts. The four pacing guides can be found on the GLOBE Observer website as the [Camp Guide](#).

Civil Air Patrol

Captain Shannon Babb, then the Rocky Mountain Region Aerospace Education Officer for the Civil Air Patrol, contacted GLOBE Observer in 2023 to ask if Civil Air Patrol units could participate in data collection for the 2023 annular solar eclipse. The Civil Air Patrol is the civilian auxiliary of the U.S. Air Force and includes aviation-connected volunteer professionals, character and leadership programs for youth (cadets) and aerospace education programs for K-12. She organized the Civil Air Patrol Eclipse Mission to engage cadets (youth ages 12-20) in collecting GLOBE Eclipse data alongside observations of changes in animal behavior and VHF radio operations. On October 14, 2023, 191 teams of cadets (about 1,650 individuals) in 35 states and Puerto Rico collected air temperature, clouds, and wind speed and direction data during the eclipse and submitted it through the GLOBE Observer app and paper data sheets.

Based on the success of the 2023 Eclipse Mission, Captain Babb and Civil Air Patrol expanded the Eclipse Mission for the total solar eclipse of 2024 to include a new classroom component. The Civil Air Patrol Solar Eclipse Classroom was designed for K-12 students and included classroom visits by Civil Air Patrol cadets. The classroom initiative engaged 41,500 students (600 educators) in collecting eclipse data on paper data sheets during the total solar eclipse. Additionally, approximately 4,000 Civil Air Patrol members from all 50 states, Washington, DC, Puerto Rico, and two Canadian provinces collected GLOBE Observer data during the April 8, 2024, total solar eclipse. This marked the largest one-day mission in Civil Air Patrol history. (See more information in [Appendix D4: GLOBE Observer Eclipse Report 2023-2024](#), as well as the publication [Autore et al., 2025](#).)

Civil Air Patrol expressed interest in an ongoing partnership after the eclipse, which led Marilé Colón Robles and Captain Babb to design the Aviation Weather Mission. Taking place between April and July of 2025, the Aviation Weather Mission engaged Civil Air Patrol squadrons in using GLOBE Clouds to collect observations of contrails alongside using flight tracker apps to track airplane type and altitude. A few cadets were also selected for micro-internships with the GLOBE Clouds team to analyze the data.

The positive experiences for both Civil Air Patrol and NESEC led to discussions to form a formal partnership between NASA and Civil Air Patrol. A formal Space Act Agreement is working its way through the approval process in early 2026.

Eclipse Soundscapes

[Eclipse Soundscapes](#) is a NASA Science Activation funded citizen science project that recruited volunteers to record changes in animal behavior and sound during the eclipse. A collaboration between Eclipse Soundscapes and GLOBE Eclipse made sense because temperature data is highly relevant to changes in animal behavior. The projects co-produced and co-led training events for partners, particularly for Texas Master Naturalists and libraries, including a conversation in a virtual session as a [GO Connect event](#), which was recorded and published as a resource for partners on the Observer website. GLOBE Observer posted a summary of their project on the Eclipse page and encouraged volunteers to do both projects. Eclipse Soundscapes reciprocated and encouraged their volunteers to also do GLOBE Eclipse.

In particular, GLOBE Eclipse and Eclipse Soundscapes coordinated on programming for libraries. Through a competitive application process, NASA@ My Library (NAML), another Science Activation collaborator, selected 49 libraries nationwide in geographic areas with large Spanish-speaking populations to receive bilingual (Spanish/English) solar science kits in September 2023 that included the GLOBE Eclipse kits (resources and air temperature thermometers) and Eclipse Soundscapes AudioMoths recording devices. NAML, Eclipse Soundscapes, and NESEC collaborated on two webinars with libraries that received the bilingual solar science kits: 1) September 7, 2024 “unboxing” webinar and 2) September 27, 2024 deeper dive into Eclipse Soundscapes and GLOBE Eclipse kit resources.

4-H

[4-H](#) is an out of school program funded under the Cooperative Extension System and the U.S. Department of Agriculture. Since 4-H emphasizes hands-on learning and outdoor activities, the organization was identified very early as being a strong potential partner. In April 2016, a group of 17 youth delegates participating in the 4-H National Conference in Washington, D.C., were given the challenge to provide recommendations on the topic: How can NASA best engage youth in becoming Earth citizen scientists? The teens, ages 15-19, had a day to research and develop recommendations, which they presented at NASA Goddard Space Flight Center on April 12, 2016. They suggested that GLOBE be integrated into existing 4-H activities like [Spark clubs](#) or camps, that youth be given leadership opportunities, and that we leverage social media to reach youth. All 17 youth were invited to participate in a youth advisory council for one year. Many accepted but follow through from them was limited.

In October 2016, Jeannie Allen, Holli Kohl and Martin Storksdieck (OSU evaluator) co-hosted a workshop at NASA Goddard Space Flight Center with 4-H National Coordinator, Jim Kahler. Participants included eight 4-H educators from across the United States, Jennifer Shirk, who had done work with citizen science and 4-H for Cornell Lab of Ornithology, and Dixon Butler representing the GLOBE Implementation Office. The two-day workshop explored ways that GLOBE might be integrated with 4-H and resulted in a formal evaluation report: NASA GLOBE Observer for Afterschool Science (see [Appendix D1](#)).

Recommendations that emerged:

- GLOBE should create and nurture a separate 4-H or extension community around GLOBE. 4-H is implemented locally without top-down hierarchy. Educators within the extension community create and recommend materials for 4-H organizations within their state, so nurturing a larger community of extension educators would enable potential national reach.
- Materials for 4-H should be co-developed with GLOBE and 4-H educators
- GLOBE should focus on science learning to fill existing gaps in 4-H curriculum
- GLOBE can support 4-H in its digital future. In 2016, 4-H had limited opportunities for digital resources, and GLOBE could be a nice tool to help 4-H educators bridge digital and environmental discovery.

Following the workshop, Jeannette Rea-Keywood, a 4H extension agent and associate professor at Rutgers, and Jeannie Allen (NESEC GLOBE Observer) co-developed a 4-H unit on GLOBE Clouds. The GLOBE Clouds team reviewed the unit and provided input. We published the unit as an activity guide: [4-H Activity Guide GLOBE Observer Citizen Science Exploring Clouds](#).

Additional follow through did not occur because of other priorities. Partnership with 4-H has high potential but would require more capacity than the GLOBE Observer team had.

Fresh Eyes on Ice

[Fresh Eyes on Ice](#) is a citizen science project managed at the University of Alaska Fairbanks to document ice conditions on Arctic rivers through photography and satellite data. The project's funders included NASA's Citizen Science for Earth Systems Program.

Fresh Eyes used GLOBE Observer Land Cover as a data collection tool. The NESEC GLOBE Observer team attended the project's monthly implementation coordination meetings to support their use of the app.

Fresh Eyes secured funding to add a function to GLOBE Observer Land Cover to submit photos that aren't facing north, south, east or west. The Fresh Eyes team helped define requirements for the special feature photos, including the number of photos submitted, caption and field note options to share information about the special photos, and metadata collected associated with the photos.

Girl Scouts

Girl Scouts can participate in GLOBE Observer through any of three initiatives created through SciStarter (see [SciStarter](#) below).

- [Girl Scout Climate Challenge](#): Available for grades K-12, girls complete ten activities, including data collection in a participating citizen science project, to learn about climate science in their community and earn a badge. GLOBE Observer Clouds is one of the citizen science options.
- [Think Like a Citizen Scientist Girl Scout Journey](#): Available for grades K-12, this Girl Scout Journey guides Scouts through activities that explore how scientists solve problems over the course of six meetings. The Journey culminates in a Take Action project in which Scouts use citizen science to create a project that makes a difference in their community. GLOBE Observer Mosquito Habitat Mapper, Land Cover, and Trees are included in the Journey. The GLOBE Observer [Girl Scout Audience Guide](#) is focused on participating in the Journey.
- [Girl Scout Tree Promise](#): Girls learn about the importance of trees and do one activity associated with trees, then make the Girl Scout Tree Promise. They then plant a tree or participate in a citizen science project associated with trees, including GLOBE Observer Trees.

The NESEC GLOBE Observer team presented to Girl Scouts multiple times at both regional and national levels. Regional presentations rose out of one team member's (Tassia Owens) personal participation in Girl Scouts with her daughter. National presentations were coordinated through SciStarter.

Lewis and Clark National Historic Trail

Ashley Danielson, an educator at [Lewis and Clark National Historic Trail](#), learned about GLOBE Observer by participating in [Earth to Sky](#), a partnership between NASA, National Park Service, and U.S. Fish and Wildlife Service that supports a broad community of interpreters to bring NASA science to place-based learning. Ashley had done a prior project with another NASA group and was eager to find more NASA connections for her work.

Together, we planned a GLOBE Observer data collection challenge, [GO on a Trail](#), to collect land cover observations along the Lewis and Clark National Historic Trail during the summer of 2019. The GLOBE Observer Land Cover tool had just launched in the fall of 2018, and the NESEC GLOBE Observer team was eager to recruit more volunteers in collecting land cover data. We also wanted data to help us assess the quality and value of data coming in. Since Lewis and Clark National Historic Trail crosses nearly every major ecosystem in the United States, a data collection on the trail would result in a good sample of land cover data.

As discussed in [section 8.3.3.4](#), we developed Observation Stations to be deployed at Trail visitor sites. We held training webinars for visitor center staff to support the implementation of GO on a Trail, including the Observation Stations.

The challenge gave “points” to every land cover observation submitted. Those collected at a visitor center or Observation Station earned 4 points. Observations collected near one of the designated historic sites along the Lewis and Clark National Historic Trail earned 2 points, and land cover data collected within a 10 km buffer

along the trail earned 1 point. The volunteers who earned the most points received a package of materials that included Lewis and Clark National Historic Trail material, a poster, GLOBE Observer and NASA stickers, and Landsat material. We also awarded prizes to top participants in each GLOBE region based on observations collected at unique sites by an individual observer.

The challenge brought in 2,800 land cover observations worldwide, with 900 observations within the Lewis and Clark trail swath. Among the winners in the Asia and Pacific region was a troop of Australian Scouts who provided significant observations across interior Australia (see [Scouts Australia](#) below).

The challenge was another case study that guided the development of the geofence data request function. Sending people to observe along the trail was challenging, since we had to link out to a secondary map to direct data collection.

The partnership with Lewis and Clark National Historic Trail culminated in a paper: GLOBE Observer and the GO on a Trail Data Challenge: A Citizen Science Approach to Generating a Global Land Cover Land Use Reference Data Set. ([Kohl et al. 2021](#)) The partnership is also documented in the [Lewis and Clark National Historic Trail 2019 Annual Report](#).

While there was interest in working together again, the COVID pandemic stopped plans. We didn't resume the partnership once normal operations began again. This partnership was highly impactful for GLOBE Observer, and it would be valuable to revive it in the future.

Libraries

Library partnerships have been an important part of GLOBE Observer implementation from the beginning. With their deep community roots, trusted status, and commitment to lifelong learning, libraries are uniquely positioned to engage learners of all ages in participatory science. From 2017 to 2025, NESEC has collaborated with over 400 libraries to implement GLOBE Observer programming in a variety of programs for audiences of all ages.

Many of our partnerships with libraries have been strengthened and facilitated through collaborations with the Space Science Institute's [NASA@ My Library](#) (NAML) Science Activation project and SSI's broader library network, [STAR Net](#). The NESEC team also supported libraries through collaborations with SciStarter's [Citizen and Community Science Library Network](#) including their library kit initiative ([Mapping Mosquito Habitats](#)) and co-presenting numerous webinars and workshops targeted for library staff.

NESEC has benefitted from deeper collaborations with individual library systems and librarians: Vivienne Byrd, Los Angeles Public Library (LAPL), and Donna Blomquist (retired) from LaSalle Public Library in LaSalle, Illinois have served as library advisors to NESEC since 2019. Los Angeles Public Library is a GLOBE Partner and has developed [Neighborhood Science DIY Kits](#) that can be checked out from 35 branch libraries, including three GLOBE kits (Clouds, Mosquito Habitat Mapper, and Urban Heat Island, which includes Trees). The Pioneer Library System and Southwest Oklahoma City Library hosted in-person trainings with the Mosquito Habitat Mapper team and co-presented on GLOBE Mission Mosquito webinars (See Chapter 6: Science, [6.5.2.5 GO Oklahoma](#)).

Los Angeles Public Library has also engaged in multiple data collection challenges, hosted webinars, and co-presented conference workshops with NESEC. During the [2021 Community Trees Challenge](#), LAPL supported the translation of GLOBE Observer materials into Armenian, Chinese, Japanese, Korean, Persian, Russian, and Spanish to support at-home activities.

Following are major NESEC collaborations from 2017 to 2025 to partner with libraries

- **2017 Earth Day Pilot:** Included 100 libraries in 27 states, which received packets of resources (cloud ID chart, cloud teller game, and Elementary GLOBE Clouds book) for Earth Day programs using GLOBE Observer Clouds.
- **2019 Pilot testing the GLOBE Observer Toolkit for Informal Educators.** NESEC PI, Theresa Schwerin, worked with seven libraries representing urban, rural, and suburban populations located in California, Florida, Illinois, Kentucky, New Jersey, North Carolina, and Texas. Librarians field tested activities and supplementary resources from the GLOBE Observer Toolkit for Informal Educators and completed evaluation surveys on the ease of preparation and setup, examples of what worked well, challenges, and suggestions for implementing or refining for different library audiences.
- During the **2023 and 2024 Eclipse**, NESEC PI Theresa Schwerin, NASA@My Library, and GLOBE Mission Earth built a network of 100 libraries to support data collection during the eclipses. Libraries were provided with an eclipse kit consisting of equipment, safety supplies, education and outreach materials, and training. Bilingual English/Spanish kits (including Eclipse Soundscapes resources as well) went to an additional 49 libraries, and more libraries joined the network without receiving the eclipse kits. (See [Appendix D4: GLOBE Observer Eclipse Report 2023-2024.](#))
- **2025 NUBE GLOBE Clouds Game:** Rosalba Giarratano, LaRC GLOBE Clouds team, worked with the Queens Public Library to co-develop and field test the [NUBE GLOBE Clouds Game](#). Through a collaboration with NAML, over 300 U.S. libraries in 47 states were selected by application to receive 2 or 4 card decks for use in their programs beginning summer 2025. Participating libraries have completed evaluation surveys on how they are using or plan to use the game and analysis of survey results is underway in late 2025.

The [GLOBE Observer Library Guide](#) provides additional case studies and incorporates examples of library implementation of GLOBE.

Lifelong Learners

Lifelong learners, particularly retired individuals, were an audience the NESEC team focused on recruiting from the beginning. Lifelong learners tend to have more time and interest in giving back through volunteerism including citizen science. While lifelong learners themselves are not partners, many partnerships in this list were initially intended to recruit and support lifelong learners. Initially, we sought out partnerships with libraries to recruit and support lifelong learners. Libraries were also very interested in family programming, and many use GLOBE Observer or its resources for children or youth. Partnerships with Master Naturalists and SciStarter also emphasized working with retired individuals.

Dorian Janney developed an annotated bibliography of key references, conducted interviews within a small, ongoing group and conducted a few small pilots to assess how best to serve lifelong learners (See [Appendix D6: Engaging and Sustaining our Lifelong Learners](#)). Her work shows that this audience is motivated to participate in citizen science because they want to expand their knowledge, build more social connections, and give back through environmentally related activities to support their values. She recommended the following best practices for engaging lifelong learners:

- Partner with organizations that already support lifelong learners: support lifelong learners where they already are. These organizations include senior and community centers, Road Scholars, Osher Lifelong Learning Institutes, and those that support a broader audience, but include lifelong learners such as libraries or SciStarter.
- Have varied options for engagement.
- Provide opportunities for lifelong learners to share their stories and experiences
- Lifelong learners stop participating because of a lack of time, waning interest, or trouble reading/using the app.
- Provide feedback about how their contribution is supporting NASA science.

NESEC participated as instructors in the Osher Lifelong Learning Institutes in South Dakota (Cassie Soeffing, IGES), Maryland (Janney) and Hawaii (Soeffing and Low) and conducted courses for lifelong learners at a community college in Maryland (Janney).

Janney coordinated a small interest group on GLOBE/NASA Science and lifelong learning. Participants led a few projects worth documenting as case studies to guide future work with lifelong learners.

- Todd Toth (GSFC) and Brenda Sieglitz (Chesapeake Bay Foundation) conducted a program at Millersville University in which they engaged both lifelong learners and university students studying education in collecting GLOBE data as part of a short lifelong learning program. The cross-generational aspect of the project was very successful.
- Longtime GLOBE trainer Lynne Hehr worked with Northwest Arkansas Master Naturalists to engage them in collecting regional weather data. They set up five weather stations against which they could validate atmospheric data submitted by citizen scientists.
- Staci Tiedeken (GSFC) started a speaker series to bring NASA science talks to senior living communities.
- Materials from the literature review and case studies may become an audience guide on the GLOBE Observer website, though it would not have the same type of content as other guides. It would focus on best practices and case studies rather than detailed “how to” information.

Master Naturalists

The Master Naturalist program is part of the university extension system funded by the U.S. Department of Agriculture. Most state-based Master Naturalist programs also receive state and other local funding. Master Naturalists are volunteers who provide education and service around the natural environment. Volunteers receive training and certification to be a Master Naturalist. With existing commitment to volunteerism and the environment, Master Naturalist organizations are a natural partner for the implementation of GLOBE citizen science.

The NESEC team provided training and engagement with [Virginia Master Naturalists](#). Virginia Master Naturalists created a GLOBE team in January 2019. As of October 2025, the team has 158 members, and observations continue to come in regularly from team members.

NESEC partnered with [Texas Master Naturalists](#) for the 2023 and 2024 solar eclipses, since Texas was in the path of both eclipses. We felt that the Master Naturalist community was well positioned to include GLOBE Observer Eclipse in community events. NESEC attended their state-wide volunteer fair in May 2023 to recruit interested ambassadors. We presented in a virtual training hosted by Texas Master Naturalists in June 2023 and provided additional webinars as follow up for those who were interested. Dorian Janney attended the October 2023 Texas Master Naturalist conference, which was held in the path of annularity during the annular eclipse. 600 people attended the conference and learned how to participate in the April eclipse.

Janney formed a Texas Master Naturalist Eclipse Educators group of about 90 volunteers. She provided ongoing training and support through the group. Volunteers hosted local events during the April 2024 total solar eclipse, reaching an estimated 3,400 people. (See [Appendix D4: GLOBE Observer Eclipse Report 2023-2024](#).)

Other Master Naturalist organizations seem to have adopted GLOBE through other GLOBE partners or on their own. There are four Master Naturalist teams in the GLOBE system in addition to the Virginia Master Naturalist team, though only two of the four appear to be active.

Museums

The NESEC team partnered with the Association of Science and Technology Centers to host an international global experiment as part of International Science Center and Science Museum Day. Between October 1 and October 22, 2016, museums were encouraged to collect cloud observations as a way to come together. Results were presented in the form of a [NASA-produced video](#) at the Science Center World Summit 2017.

We encouraged each participating museum to create a referral code, which they sent to the GLOBE Observer team. DIS set up informal education “schools” for these museums and added a field to the GLOBE Observer app for new users to add the referral code to join the museum group. This provided the foundation for the later development of GLOBE Teams and informal education organizations.

Thirty museums registered to participate, and they collected 921 observations during the experiment. ASTC hosted a session about the experiment at their 2018 annual conference. Holli Kohl co-presented with multiple museums who shared how they integrated GLOBE into their programming. GLOBE was integrated into additional museum programming through SciStarter, the National Informal STEM Education Network (NISE Net), the NASA Informal Education Alliance.

NASA Museum and Informal Education Alliance

The [NASA Museum and Informal Education Alliance](#) provides NASA content and materials to informal educators through professional development and community building. NESEC has presented in webinars routinely throughout the implementation of GLOBE Observer.

National Informal STEM Education Network

The [National Informal STEM Education Network](#) (NISE Net) provides educational materials designed for informal spaces like museums along with professional development and a community network. NISE Net received Science Activation funding to create kits with hands-on activities and learning materials to be distributed to museums. The kits included GLOBE Observer content and supplies. Additionally, NESEC has participated in professional development with NISE Net and has distributed information about challenges and updates through the NISE Net newsletter.

NASA Next Generation STEM

NASA Next Generation STEM is NASA's K-12 STEM initiative. Next Gen STEM partnered with the Artemis program and the USDA Forest Service to support a new Moon Trees initiative in which tree seeds were sent on the Artemis test flight around the Moon, returned to Earth, sprouted and distributed to schools across the U.S.

From Apollo 14 in 1971 to Artemis I in 2022, the NASA Moon Trees Program has served as inspiration in STEM engagement, education, and environmental stewardship. With the Moon Trees Initiative, GLOBE Observer embarked on a collaboration with the Moon Tree initiative partners to have volunteers collect tree height observations of Apollo 14 Moon Trees and related tree species and to inspire the Artemis generation through a fun STEM engagement initiative.

Through the three-month NASA Moon Trees Quest (June 21, 2023 - September 21, 2023), GLOBE Observer volunteers across the United States searched for Apollo 14 Moon Trees and related tree species, with guidance through the GLOBE Observer app. Five regions were set up as geofence projects directing app users to measure trees of the same type as the seeds carried on Apollo 14. Additionally, the app alerted volunteers when they were near a known Apollo 14 Moon Tree with the tree location and suggested taking a tree height observation. During the three-month quest, there were 6,859 tree height observations submitted to GLOBE.

This collaboration was a highly successful nod to the legacy of the NASA Moon Trees Program while serving as an inspirational example of a collaboration across multiple programs. This success included several million impressions across NASA flagship, GLOBE, and partner social media and communication outlets. Additionally, a few educators engaged through GLOBE applied for and received Artemis Moon Trees.

Polar Citizen Science Collective

The [Polar Citizen Science Collective](#) engages tourists traveling to polar regions in collecting citizen science data that would otherwise be cost-prohibitive to obtain. The group provides training to other expedition ship leaders on how to make cloud observations in the polar regions, with a focus on horizon photographs. The group also connected the team to the [International Association of Antarctic Tour Operators](#) who promotes cloud observations in their newsletters.

The Polar Citizen Science Collaborative started collecting GLOBE Clouds data in 2016 shortly after GLOBE Observer launched. Guides engage guests on polar cruises in collecting clouds data while at sea when few other citizen science activities are possible. Observations collected near the poles are valuable because such regions have gaps in satellite coverage.

In 2024, Dr. Maria Vernet received NASA citizen science funding for [Fjord Phyto](#), a citizen science program that uses volunteers on cruises to sample polar waters for phytoplankton. She is exploring ways to use GLOBE Observer Trees to measure iceberg height. If successful, the measurement would be added to Fjord Phyto and tourists on polar cruises would be able to collect iceberg height data. See the news article, "[GLOBE Goes to Sea](#)."

SciStarter

[SciStarter](#) is a citizen science clearinghouse based at Arizona State University. NESEC provided funding to SciStarter annually during Science Activation 1.0 (2015-2020) implementation to help GLOBE Observer recruit and support volunteers, and the organization has played a significant role in reaching new communities. SciStarter integrated GLOBE into programming for libraries, museums, lifelong learners (limited), and Girl Scouts. At times, SciStarter has been among the largest referring sites to the GLOBE Observer website meaning that SciStarter has directed many people to GLOBE Observer.

Each GLOBE Observer tool has a project page in SciStarter:

- [GLOBE Clouds](#)
- [GLOBE Mosquito Habitat Mapper](#)
- [GLOBE Land Cover](#)
- [GLOBE Trees](#)
- [GLOBE Eclipse](#)

GLOBE is a SciStarter affiliate. People can link their GLOBE accounts to SciStarter so that they can track their participation in GLOBE on their SciStarter Dashboard. This is helpful because citizen scientists often participate in more than one citizen science project. If a volunteer enjoys participating in a project that collects data adjacent to GLOBE, SciStarter can recommend that they also collect GLOBE data.

Being a SciStarter affiliate means that we are able to track the number of people engaged in each GLOBE tool through SciStarter. GLOBE Clouds has 5,676 participants. Mosquito Habitat Mapper has 468 participants. Land Cover has 699 participants. Trees has 1,508 participants. Eclipse has 122 participants.

The NESEC team has frequently presented during SciStarter events. Conversely, GLOBE Observer events, such as GLOBE Observer Connect sessions and challenges, are posted and promoted on SciStarter's calendar.

Scouts Australia

Dr. John Pring, a scientist with Geoscience Australia and an active member of the Australian Citizen Science Association, contacted GLOBE Observer in 2019 to find out more about the [GO on a Trail](#) challenge. In particular, he wanted to know if he could use the challenge to set up a data collection competition for [Scouts Australia](#), a youth organization for children ages 5 to 25. He wanted troops to collect land cover data as part of GO on a Trail and in competition with each other. The troops traveled 20,000 kilometers collectively to collect 183 new land cover observations and 1,028 photos, many in locations that had not been well-documented such as interior Australia. The winning troop was invited to a ceremony, where they were recognized. They were also among the top participants for the challenge overall and received award materials from NESEC. Pring documented this partnership as a co-author on the paper, “GLOBE Observer and the GO on a Trail data challenge: A citizen science approach to generating a global land cover land use reference data set” ([Kohl et al., 2021](#)).

Solar System Ambassadors

[Solar System Ambassadors](#) is a program that engages volunteers in planning and implementing events about NASA science across the United States. NESEC has provided training and materials about GLOBE to Solar System Ambassadors to integrate into their programming on a regular basis throughout the implementation of GLOBE Observer.

During the 2023 and 2024 solar eclipses, NESEC provided training and materials to the NASA Eclipse Ambassadors, an initiative modeled on Solar System Ambassadors.

United States Department of Agriculture Forest Service

Partnerships with the USDA Forest Service have occurred across multiple projects. The two most prominent are an ongoing project with Dixie National Forest and the Moon Trees initiative. As [NASA Next Generation STEM](#) coordinated the Forest Service partnership for the Moon Trees initiative, that is described in greater detail under that partnership summary.

The partnership with Dixie National Forest arose from a presentation Kristen Weaver gave about GLOBE Observer and the [GO on a Trail](#) challenge at the National Association for Interpretation annual conference in 2019. Nancy Brunswick, a regional landscape architect from the U.S. Department of Agriculture Forest Service saw the presentation and recognized the potential for using GLOBE Observer for a project in Dixie National Forest in southern Utah.

In the late 1990s, the Forest Service had taken a series of landscape photos in Dixie National Forest. Brunswick wanted to recreate the photos to document change. Since the 1990s, the forest has experienced significant change from wildfire, bark beetle outbreaks, and development. The project launched in the summer of 2020 when a summer intern was tasked with recreating the photos. However, since the photo locations were not well documented, the project was challenging. Also in 2020, visitor staff had free time, since they had few public interactions during the COVID pandemic. They used this time to digitize the original photo project, including notes and location information.

The challenge with recreating historic photos in this partnership informed the development of the geofence function in the GLOBE Observer app. The project highlighted the need for directed data collection and helped us think through requirements. (See [Section 6.6: Geofence Data Requests](#).)

In 2024, Brunswick was able to secure Forest Service funding to try to recreate the photos again. This time, she hired intern Callie Davis, the daughter of the original photographers. Armed with both photo locations and her parents' insight, she was able to recreate many of the original photos. The 2024 project is described in the news article "[Tracking Change in Dixie National Forest](#)."

Brunswick was interested in potentially creating a geofence project to engage the public in documenting change at some locations throughout the forest. However, she retired in 2025. Graydon Bascom was named her successor for the project.

In 2021 and 2022, Brian Campbell and Peder Nelson were part of the NASA-USDA Forest Service "Pitch Fest" and USDA Forest Service "Applied Earth Observation Innovation Partnership Spring Workshop," respectively. Through these two events, Campbell and Nelson presented and discussed the value of bringing the GLOBE Observer Trees and Land Cover protocols into the Forest Service's volunteer training structure. We discussed how GLOBE land cover and tree height might be valuable either as data or engagement tools in many forests. The events led to establishing contacts with several personnel in the Forest Service: Everett Hinkley, Kevin Megown and Stacie Bender. These contacts helped promote the GLOBE Observer 2021 Community Trees Challenge, which ran from April 15 - May 15, 2021, and yielded 2,441 GLOBE Observer tree height observations from 1,733 global locations in 41 countries (see [section 6.5.2.8](#)). Communication efforts for this challenge also reached over 2.8 million people through a combination of Facebook, Instagram, Twitter, Snapchat, and Reddit.

8.3.4. Infrastructure to support partner use of GLOBE Observer

In addition to the toolkit and audience guides, GLOBE implemented changes to the infrastructure to support informal educators who are not formal GLOBE educators or partners: GLOBE Teams and the Informal Educator membership category.

8.3.4.1. GLOBE Teams

During the implementation of GLOBE Observer in informal education settings, informal educators wanted to be able to see the data collected by the people in their organization, much as school data is grouped in GLOBE. The initial request for a team came from Accenture (see [section 8.3.3.5](#)) which used GLOBE Observer as part of their employee volunteer program. They needed a way to track participation to give employees credit for making observations through GLOBE Observer. Based on our experience working with them, we created [GLOBE Teams](#) for all users.

A GLOBE Team is simply a group of people working together under the team umbrella. Teams may be open, meaning anyone can join, private and joined by invitation only, or closed, which means the membership is static. The team manager may change a team's type at any time. Once a person joins a team, all the data they submit from that point forward is associated with that team. There is no limitation on the number of teams an individual can join.

Every GLOBE Team has a landing page that shows the team name, referral code used to invite new members (for private teams, visible only to members when they are logged in), a map showing the distribution of the team's data, current members and their observations, a list of observations by site, and a list of the most recent observations. The data shown on the Team page can be restricted to a designated period of time, making it possible to track team activity during particular events. Data collected by the team can be downloaded in GLOBE's Advanced Data Access Tool by selecting the "School/Teacher/Partner/Team" option.

Anyone can set up a GLOBE Team. A manager can remove people from the team, update the team name, change a team's type, deactivate a team, or pass control of the team to another person.

Individuals can join a team through the GLOBE Observer app or the GLOBE website during account creation or later on. However, to join an organization, such as a school or informal education organization, an individual must enter the referral code for the organization on the website. A person can't join an organization beyond a team through the app.

In addition to Accenture, many organizations have found GLOBE Teams helpful in implementing GLOBE. GLOBE Teams have been used to coordinate participation in the Civil Air Patrol Eclipse (2023-2024) Missions and Aviation Weather Mission (2025). In this case, groups from across the United States joined the Team and worked together to collect data. In 2019, GLOBE Teams were used to conduct a competition between Scout troops in Australia. Each group set up their own team and collected data. The team with the most data received a national award. Libraries organized under teams for data collection during the 2024 eclipse and have used teams for programming at other times. Educators may use a team to connect students or community members who participate in school data collection using their own GLOBE Observer accounts.

More information about teams:

- [GLOBE Observer GLOBE Teams page](#)
- [GLOBE Teams landing page](#)
- [GLOBE Teams tutorials](#)

8.3.4.2. Informal Educator Membership Category

GLOBE created an informal educator membership category in its new membership structure in 2024. When a person selects "Create an Account" from the *About/Join* menu on the GLOBE website, they get a list of possibilities that include teacher/formal educator, informal educator/volunteer coordinator, citizen scientist, scientist/STEM professional, student, and I am interested in becoming a GLOBE Partner. When a person selects *informal educator*, they are taken to the educator page, where they have the option to set up a citizen science account or a trained educator account. A trained educator account gives them an organization page for their institution and the ability to create student accounts. NOTE: a pending update in December 2025 will eliminate all educator accounts, including the informal education category, although the option to identify as such when creating a GLOBE account remains.

8.4. Supporting Existing Volunteers

8.4.1. Motivation for Engagement

The 2018 evaluation survey of 800+ GLOBE Observer volunteers has shaped our decisions about how to provide support to volunteers. ([Fischer et al., 2021](#); [Appendix D3: Nibble and Drop Presentation to 2019 GLOBE Annual Meeting](#)). The responses to three questions are particularly informative:

What initially motivated you to participate?

- I wanted to contribute to NASA research (29.1%)
- I wanted to contribute to science (27.5%)
- I feel it is important to volunteer for a worthy cause (13.4%)
- I wanted to learn more about clouds (10%)

Why do you continue to contribute?

- I feel my contributions are helpful (21.8%)
- It is easy to participate (19.7%)
- I feel that it is meaningful (16.9%)
- It is easy to do (12%)
- I like spending time outside (11.6%)

Why did you stop participating?

- I signed up to participate in a one-time event (37.2%)
- I don't have enough time (18.9%)
- I encountered technical problems (12.8%)
- I felt like I wasn't making a meaningful contribution (10.37%)

Contribution is a significant thread in these responses. The desire to contribute motivated nearly three-quarters of volunteers to join GLOBE, and more than a third cite a feeling that their contributions matter or are helpful as their reason to continue to participate. A feeling that their contributions didn't matter drove just over 10 percent of volunteers to stop participating.

This led us to conclude that we need to ensure that volunteer data is truly useful to scientists or partners. We reached out to science communities to collaborate on meaningful data collection and publication (see [Chapter 6: Science](#)). We hosted challenges and data requests focused on data collection to support specific science or community needs.

To help volunteers feel their contributions matter, the evaluation recommended providing feedback. Starting in 2017, we co-located cloud observations with satellite data and shared the co-located data with volunteers as feedback on each cloud observation. Anecdotally, this email from NASA is highly motivating to volunteers and helps them feel their contribution is meaningful (see [Section 8.4.4: Emails](#)). We expanded satellite co-location to land cover in 2025 and explored expanding to the other protocols to provide additional feedback.

We also recognized that it was imperative to be accountable to our volunteers in reporting back to them how their data is used. At least once a month, we publish a blog showing the connection between science and GLOBE observations, focusing on impacts and results when possible (see [Chapter 9: Communication](#)). We host monthly informal conversations with scientists or other partners to allow volunteers the opportunity to interact with those who use their data (see [Section 8.4.3: GLOBE Observer Connect](#)).

For those who joined GLOBE to learn, we provide background information for each protocol on the GLOBE Observer website, including why the observation matters to science. To accommodate a range of learning styles, we provide hands-on activities, videos, and reading lists in addition to the web content.

Finally, to support those who encounter technical problems, we support a help desk. We provide feedback to DIS to improve usability and resolve technical issues. This feedback has led to improvements in the app.

The survey also indicated that many people found out about GLOBE Observer through social media, which means that many of our volunteer community are active on social media. We choose to spend significant time on social media campaigns along with routine social media posts relating to science.

8.4.2. Help Desk

The GLOBE Observer help desk operates independently from but in coordination with the GLOBE community support system. It enables the GLOBE Observer team to be aware of issues immediately and to respond quickly. The Help Desk is the most significant mechanism for two-way conversation with volunteers. We have developed relationships with some very active volunteers who communicate routinely.

8.4.2.1. Process

The GLOBE Observer Help Desk email was set up as a separate system from the GIO main GLOBE Help Desk to address app-specific issues and not add to the burden of the main help desk team when the app launched in 2016. It was created as a NASA mailing list with the address globeobserverhelp@lists.nasa.gov. While various GLOBE Observer team members have been on the list at times, most queries were responded to by the GLOBE Observer coordinator, Holli Kohl, and deputy coordinator, Kristen Weaver. Certain issues, especially related to account problems and passwords, were referred to the main GLOBE Help Desk or created as tickets for the DIS team as needed. A link to the help email was originally provided in the app as the primary contact means. In November 2020, a [Contact Us form on the Observer website](#) was also created to allow visitors to the website to contact the GLOBE Observer team. As more of the Data Entry tools for trained observers were transitioned into being included in the app, the in-app contact information was switched to point to the main GLOBE Help Desk email.

8.4.2.2. Common Questions

As noted previously in [Section 4.7: Common App Issues](#), the GLOBE Observer team has collected [frequently asked questions](#) on a dedicated page on the website, and on the Taking Observations page for each tool. Described below are some of the most common general questions related to supporting volunteers and not related to the function of the app itself.

- One common general issue, especially early on, was people needing help with password resets, or who were not getting the needed verification email. Some of these issues have been solved by improved processes implemented by DIS for users to be able to reset a password themselves, although there still can be a challenge of verification or other GLOBE emails getting stuck in spam filters, or other user-end errors.
- We find that any time satellite matching (or satellite overpass information and notifications) is disrupted for any reason, some of our most dedicated observers are quick to point out that they are not getting their match emails or overpass alerts. The LaRC GLOBE Clouds team always works to get those issues resolved as quickly as possible, but it does point out the value of those communications back to users.
- Especially after the GLOBE Program received unusual press coverage in 2019 in Indonesia and Malaysia, neither a GLOBE country, we received a flood of inquiries about why a user's country was not in the dropdown list during account creation. The heaviest level of inquiries was from April to May 2019, although occasional inquiries on the topic still come in. With the help of GIO and the International Coordinator, we crafted a standard response explaining the structure of GLOBE and the required international agreements for the program to be active in a country, to be able to send back to users. A pop-up information item was also added to the account creation form at that point of the form explaining the process, which did a lot to reduce the quantity of inquiries coming in. The text of the standard response is:

“Internationally, the GLOBE Program is implemented through bilateral agreements between the U.S. government and governments of partner nations (see a list of GLOBE countries). The National Aeronautics and Space Administration (NASA) is the lead agency and signs the GLOBE agreements on behalf of the U.S government. In other countries, typically the Ministry of Education, Environment or Science are the signatories of GLOBE agreements. Individuals, schools, and organizations in non-GLOBE countries are encouraged to engage someone from the appropriate Ministry in their countries regarding their interest in participating in the GLOBE Program. The ministry can then engage in discussion about the program with NASA and the GLOBE Implementation Office (GIO). Inquiries can be sent to Rebecca Lewis, Director of Community Engagement & Support, GIO, at rlewis@edc.org.”

A main point to emphasize is that user feedback received through the help desk email has often led to improvements in the app interface. We may not be able to take every suggestion, but especially when multiple users are asking about the same issue, it can point to an area of confusion in the app or other processes such as account creation.

8.4.2.3. Help Desk Problems

While the GLOBE Observer help email has always gotten a certain quantity of spam messages, either directly or through the contact form, the volume picked up notably around early 2024 and dropped off again in 2025. While we are not sure exactly what changed at that point, it has generally been more of a nuisance than anything more serious.

As the two help desks, GIO Community Support and the GLOBE Observer team, were separate systems with separate processes, there have been some challenges with coordination, and making sure that each group was aware of current issues and the best solutions to suggest to users. Although the goal was to not add to the workload of the existing GLOBE Help Desk, in retrospect, a more integrated approach at the launch of the app might have been preferable. With the absorption of many GLOBE Observer team functions into GIO after the end of the NESEC SciAct 2.0 funding in December 2025, the GIO Community Support Team will become the sole help desk provider for the GLOBE Observer app. *Note: NESEC will be able to operate under a no-cost extension into the spring of 2026 to support the GO help desk as needed.*

8.4.3. GLOBE Observer Connect

GLOBE Observer Connect is a short, informal conversation with volunteers held monthly. It is meant to provide a space for the volunteer community to ask questions directly and to connect with one another. Each GO Connect session has a discussion topic and a guest speaker, though participants are allowed to ask questions about any topic. Each event is recorded, and the recordings are posted to the GO Connect event page.

8.4.3.1. Origins of GO Connect

Our first initiative to bring our volunteer community together was on July 26, 2022. As part of the GLOBE Annual Meeting that year, we hosted a two-hour event called [GLOBE Observer Connection-Conversation-Celebration](#) (GO C3). GO C3 was structured like a conference session with three components: presentations and a panel discussion featuring volunteers, science updates, a breakout session about the future of GLOBE Observer, and a highlight of submitted observations. 115 people logged on to the event from 41 countries. 285 people registered. The event was recorded and made available on the GLOBE Observer website.

We invited volunteers to submit a short video describing why they joined GLOBE and how they participated with GLOBE Observer. We selected six panelists: Suzanne Keyser (Hawaii, USA), Yashraj Patil (Maharashtra, India), Om Prakash Gupta (Uttar Pradesh, India), Allison Swann (Maryland, USA), Nojeem Olanrewaju Sanni (Lagos, Nigeria), and Josiah Diosanta (Quezon City, Philippines). GLOBE Observer summer intern Allison Swann (SSAI/GSFC) edited the video responses into a polished presentation and participated as a panelist sharing her unique experience with citizen science. The majority of participants who responded to a post-event survey reported that the volunteer panel was their favorite part of the event.

The volunteer panel was followed by small group discussions that gave participants a chance to talk to each other. We suggested that they discuss priorities for future GLOBE Observer developments in addition to sharing their own experiences with GLOBE Observer. The breakout discussion time went quickly and most groups didn't get to the priorities discussion.

The next portion of GO C3 was a report-out highlighting how GLOBE Observer data has been used in science. Each science lead presented results from peer-reviewed publications. Participants responded positively to this session. After the science session, we had an open question and answer session in which participants could ask about anything. All questions were focused on the science supported by GLOBE Observer.

In a post-event survey, participants reported most enjoying the volunteer panel and the science highlights. People wanted breakout discussions to be longer and to be in multiple languages. Participants also expressed a desire for more frequent events of this nature, particularly to learn about how their data are used and meet GLOBE and GLOBE Observer leadership.

GO C3 was very successful, but it took a tremendous amount of effort. It was the sole focus of several GLOBE Observer team members for months. Holding this type of event regularly wasn't sustainable, but we wanted to offer the essence of the event routinely. We decided to try short, conversational events focused on science. Shortening the name from *GLOBE Observer Connection-Conversation-Celebration*, we called the shorter conversational events GLOBE Observer Connect.

The first GLOBE Observer Connect conversation was in April 2023. Initially, each monthly topic featured the prior month's science blog topic rotating among each of the GLOBE Observer tools. Some events brought in guest speakers, but the GLOBE Observer science leads led the initial conversations. Over time, we expanded the topics to include topics related to implementation, partnerships, and technology.

The earliest GO Connect events were held at two times to accommodate global time zones: 12 pm ET and 8 pm ET and lasted 30 minutes. We found that one time would be well attended, while the other was not, though the best time varied. Eventually, we moved to one event per month, alternating times. Occasionally, we have hosted more than one GLOBE Observer Connect during a month. Most GO Connect sessions were recorded for those who were unable to attend.

8.4.3.2. Templates & Branding

As a monthly event, GLOBE Observer Connect has its own visual branding not used for any other purpose. GLOBE Observer graphic designer, Heather Mortimer, created templates for web and social media images. The templates are Google Slides, making them easy for other team members to use.

Templates feature a circle or square in a GLOBE Observer brand color. The solid color element is a background for information about the event and sits over a photo related to the topic. Photos featuring people work best in the template, but other types of images have been used.



This image was created to promote the first GLOBE Observer Connect. Every GO Connect has informational graphics following this template.

8.4.3.3. Topics and archive

Topic: Link goes to the description and event page	Recording	Date (mo/day/yr)
Mosquito Distribution	Not available	4/6/23
Where does land become water?	YouTube link	5/4/23
Moon Trees	YouTube link	6/8/23
Fire in the Sky	YouTube link	7/13/23
Latest updates to GLOBE Observer	Not available	8/10/23
Satellite match: intern report	Not available	9/14/23
Eclipse Soundscape	YouTube link	10/5/23
Eclipse experiences	Not available	11/9/23
Multi-views for land cover mapper	Not available	12/14/23
GLOBE at AGU	Not available	1/18/24
NASA Moon Tree Quest Results	Not available	2/8/24
Eclipse and Cloud Formation	YouTube link	3/21/24
Eclipse preparation	YouTube link	4/2/24
Eclipse experiences	Not available	4/25/24
Abandoned pools pose mosquito risk	YouTube link	5/21/24
New technology to study trees	YouTube link	6/25/24

Topic: Link goes to the description and event page	Recording	Date (mo/day/yr)
River ice	YouTube link	8/15/24
GLOBE goes to sea	YouTube link	8/29/24
Phenology and trees	YouTube link	9/19/24
Meet Monique, a GO volunteer	YouTube link	10/24/24
GLOBE Observer app development	YouTube link	11/21/24
Tracking change in Dixie National Forest	YouTube link	12/12/24
GLOBE goes to camp	YouTube link	1/30/25
Eclipse results	YouTube link	2/13/25
Trees update	YouTube link	3/20/25
Citizen science month and mosquitoes	Not available	4/10/25
Impacts of GLOBE Observer	YouTube link	5/22/25
NUBE card game	YouTube link	6/26/25
AI and GLOBE	YouTube link	7/17/25
Civil Air Patrol Aviation Weather	YouTube link	8/14/25
Land cover satellite comparisons	YouTube link	9/18/25
No event - government shutdown	n/a	10/25
No event - government shutdown	n/a	11/25
Practice Mode	YouTube link	12/11/25
Impacts of NASA Response Mappers	YouTube link	1/22/26
Exploring Data Entry – Water Quality	YouTube link	2/26/26
Bringing Your Observations to Meteorologists	YouTube link	3/19/26
Using Your Blowing Snow Ground Photos to Verify a Satellite Product	YouTube link	3/26/26

8.4.3.4. Attendance

Attendance at GLOBE Observer Connect events has varied from a handful of people to just over 100. Eclipse events, technology sessions and the event that featured Civil Air Patrol have been the best attended.

8.4.4. Emails

Email is a personal way to provide feedback and support to volunteers. The GLOBE Observer help desk is managed exclusively through email. We had long wanted to send more regular updates to volunteers but faced some challenges, including managing permissions so volunteers can opt out of emails and finding a way to send mass emails.

8.4.4.1. Permissions

A volunteer is automatically opted in to all email types when they create an account. Volunteers can opt out of receiving emails from GLOBE under “Settings” in the GLOBE Observer app or “Account Settings” when logged in to the GLOBE or GLOBE Observer websites by selecting “Opt-In Settings or GLOBE Opt-In.”

Volunteers can opt in or out of the following types of email:

- NASA satellite images - the satellite comparison email
- Updates for citizen scientists
- Scientist requests for additional information
- Notifications of awards

This enables them to choose to receive some form of communication while opting out of others.

8.4.4.2. Satellite Comparison Emails

Volunteers who collect cloud data during a satellite overpass or who collect land cover data receive an email that includes their observation and the satellite data showing conditions at their location. This provides a form of feedback, helping volunteers see how their classification stacks up against classifications of the same parameters from space. Volunteers report appreciation for the satellite emails and the feedback they provide.

Collocated satellite data for clouds is taken at the same location within 15 minutes of the GLOBE Observer clouds observation. Collocated satellite data for land cover is the closest in time overpass of the location. This means that all land cover observations generate a satellite email, while only certain cloud observations do. Cloud observations are matched to geostationary satellite data, which is “always on” for most locations, in addition to data from polar orbiting satellites, which have more limited overpasses at a location.

Emails include information about how to understand the satellite comparison with a link to a web-based table showing the collocated data. They also provide a link to updates from the GLOBE Clouds team.

Sample cloud collocation email:

Dear Citizen Scientist,

The September/October/November 2025 [NASA GLOBE Clouds Quarterly Update](#) is now available!

Thank you for your NASA GLOBE cloud observation! The NASA GLOBE Clouds Team matched your cloud observation with corresponding satellite data. The satellite match is based on the time and location of your cloud report. You can learn more about how to understand your satellite match at [GLOBE Clouds Satellite Comparison](#).

The link(s) below show your data. The satellite names shown correspond to the satellites that matched the time and place of your report.

[Measurement 2025-10-06 16:42:00 GOES-19](#)

**Please note: Data retrieved from different satellites is processed at different speeds. You may receive multiple satellite match emails for one cloud observation. An email is sent each day a new satellite match is found.*

The GLOBE Observer mobile app has a Satellite Flyover tab. Check the tab to find when a satellite will fly over your location and to set reminder notifications.

You received this email because you participated in NASA GLOBE Clouds. Did you know you can receive emails in addition to satellite matches? To verify your NASA cloud email settings visit the GLOBE Observer app. Click on the wheel icon at the bottom of the page. Click on the blue button 'Opt-In/Opt-Out Settings' and select 'Yes' for each desired option. To stop receiving NASA satellite match emails Select 'No' under 'Receive NASA Satellite Images'.

Thank you for your cloud report! We look forward to your continued observations. Your observations help NASA scientists better understand what is happening in the atmosphere from your unique point of view.

The NASA GLOBE Cloud Team

LaRC-GLOBE-Clouds@mail.nasa.gov

Sample land cover collocation email:

Dear Citizen Scientist,

Thank you for your GLOBE Land Cover observation! The NASA GLOBE Observer Team matched your observation with corresponding satellite data from the Landsat and Sentinel satellites, as well as a land cover classification based on the Moderate Imaging Spectroradiometer (MODIS) instrument. The satellite comparison is based on the time and location of your land cover report. You can learn more about how to understand your satellite comparison at GLOBE Land Cover Satellite Comparison. The link(s) below show your data.

[Measurement 2025-10-11 18:14:00](#)

You received this email because you participated in GLOBE Land Cover. Did you know you can receive emails in addition to satellite matches? To verify your email settings, visit the GLOBE Observer app. Click on the wheel icon at the bottom of the page. Click on the blue button 'Opt-In/Opt-Out Settings' and select 'Yes' for each desired option. To stop receiving NASA satellite match emails Select 'No' under 'Receive NASA Satellite Images'.

Thank you for your land cover report! We look forward to your continued observations. Your observations help NASA scientists better understand the details on the ground from your unique point of view.

The GLOBE Observer Team

LaRC-GLOBE-Observer.nasa.gov

The GLOBE Clouds team at NASA Langley Research Center manages the satellite comparison system as documented in the internal report "NASA Langley Research Center GLOBE Cloud Processes," NASA-TP-20240013399 ([Rizzi et al., 2024](#)).

8.4.4.3. Updates and Scientist Request Emails

We set up the opt-in/opt-out categories for updates and scientist requests thinking that it would be useful to have permissions in place to send out a newsletter or other types of routine updates. We also wanted to be able to allow scientists to communicate with volunteers to request data or clarification on an observation.

We didn't have a good system for managing update emails. The GLOBE Implementation Office uses Constant Contact, a service that the GLOBE Observer team did not have the budget to manage. The NASA listserv system was another potential solution, but we were led to believe that it was being phased out. Additionally, the listserv would have been very complicated to manage.

Instead, we occasionally include information in the satellite collocation emails. The GLOBE Clouds team provides a quarterly update that goes out in the satellite emails. We also provide information to the GLOBE News Brief. However, the GLOBE News Brief serves the broader GLOBE community with content that is not entirely relevant to citizen science volunteers. We don't know how many citizen scientists subscribe to the GLOBE newsletter. We have occasionally used the permission to contact individuals for scientist requests on a very limited, individual basis.

8.4.4.4. Award Notifications

When a volunteer receives a milestone badge in the GLOBE Observer app, they also receive an email notification from GLOBE.

Sample Milestone Email:

Congratulations Citizen!

You have been awarded your



50 Observations Milestone

*for submitting **50 Air Temperature** observations!*

Your new milestone will be added to your My Achievements page in the GLOBE Observer App!

Thank you for your continued contributions to Earth system science research and the GLOBE Program!

Sincerely,

The GLOBE Helpdesk

Note: We had requested that the salutation be changed to simply say Congratulations removing the term citizen as it reads poorly with strong negative connotations. ("Citizen Scientist" is the name given to untrained users in the system, so "Citizen" pulled as if it were the first name.)

8.4.5. In-app Communication

As described in [section 4.6](#), the app has the capability of supporting volunteers with a short in-app message that may include one URL leading to more information. Messages can be global for all users, focused on a particular audience type, and/or sent to a designated geographic region. The message pops up on the home screen when the GLOBE Observer app is opened. Users may dismiss the message with one of the following options: do not show again, remind tomorrow, more information (which leads to whatever URL is associated with the message).

If there is more than one message in the system for a user type and location, the messages will be stacked and the user will have to dismiss each one. We take care to not overuse the message system so that this scenario is rare.

8.4.5.1. Geofenced Messages

The in-app message capability was built on the data request or geofence project system. This means that we can send messages to individuals based on their location. For instance, if a particular GLOBE country wanted to invite all educators to collect tree data during a phenology campaign, we can create a message that only goes to educators (not citizen scientists) in that country.

8.4.5.2. Time

Messages are set to appear over designated dates. The message should be distributed for long enough that people who only open the app occasionally can see it. However, time sensitive messages may be constrained to a single day.

8.4.5.3. Approval Process

The approval process for in-app messages is quick and informal. In-app messages are drafted with a title and short message then emailed to the GLOBE Communication lead and the GLOBE Observer team to coordinate both the messaging and the number of messages in the app at one time. If all agree, the message can be put into the system to go out in the app immediately.

8.4.5.4. Message Creation

In-app messages are uploaded to the app through an interface on the GLOBE website. Each announcement requires a title, content, audience (citizen scientists, educators, or both), date, and optionally a URL in the additional information field. The announcement can be geographically targeted by entering a GeoJSON file or it can be sent out globally. Detailed instructions to create in-app messages are in [Appendix E2](#).

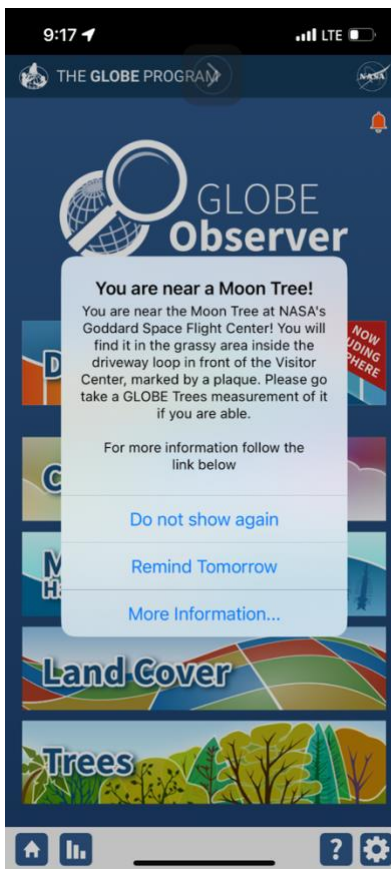
8.4.5.5. Example Uses

In app messages have been used to support a variety of communication needs.

- Technical issues: we message volunteers to inform them of significant updates or server down time.
- Events: messages may be sent to invite volunteers to a GLOBE Observer Connect or webinar.
- Data collection challenges or requests: We have sent messages requesting a particular data collection in support of a challenge or science data request.

The Moon Trees Quest was the most unique application of in-app messages, and one that could be a model for future science data requests. As described in [Section 6.6: Geofenced Data Requests](#), the Moon Tree Quest requested GLOBE Tree observations in five separate geofenced data request regions that correspond to the natural range of five tree species. The data request asked volunteers to find and measure the height of trees of the target species (Douglas-fir, Loblolly Pine, Sweetgum, Sycamore, or Coast Redwood).

We also wanted people to find the known Apollo 14 Moon Trees and measure their height. We created a series of geofenced in-app messages that alerted app users to the location of Moon Trees within five degrees latitude/longitude of their location. Each message described the tree and what was known about its location beyond latitude and longitude. A full description of how these messages were set up and managed is provided in [Appendix E2](#).



Pop-up message that appeared to users who were near the Moon Tree at the Visitor Center for NASA's Goddard Space Flight Center.

8.4.6. Badges and Recognition

The initial design of the GLOBE Observer app included an observation counter for each tool that shows people how many cloud, mosquito habitat, land cover, or tree height observations they have submitted to GLOBE. These counters were extremely popular. If the counters stop working, volunteers notice and reach out very quickly.

Given their popularity, we realized that expanding badges and recognition would be a good way to further motivate volunteers. The NESEC team, DIS, and GIO separately brainstormed to identify behaviors that we might want to incentivize and then ranked those ideas from most important to reward to least. We collated the responses and created a survey, which we sent to the GLOBE community. The survey asked GLOBE partners and educators to rank the behaviors or actions they would most like to reward. The survey also included an open field for additional ideas.

Survey results indicated that the community most wanted to motivate collecting quality data, consistency, and experience (trusted observer). Proposed badges related to data quality included a badge based on a QA assessment, completeness (did they provide data in all fields), consistency in collecting data, repeat measurements, or measurements to meet a scientist's data request. The most requested badge suggested for consistency was a recognition of streaks.

Other categories wanted for badges were completeness, data density, and experience. Completeness was highly ranked and also recommended as a data quality badge. The other categories were not as highly ranked.

Discussions between the GO team, DIS, and GIO to agree on requirements and implementation of badges led us to realize that the badges fell into two types: badges that could be assigned automatically based on a person's record in the GLOBE database (number of observations, streaks) and those that would require some additional assessment and would need to be awarded manually. Internal discussions referenced this second type of badge as ad hoc badges.

Automated badges recognized experience or milestones and consistency or streaks. Milestones were already part of the app and would be missed if removed. DIS had already laid the groundwork to recognize streaks, making this a logical badge to develop early on.

Though data quality was the behavior the community most wanted to encourage through badging, the badges in this category could only be assigned on an ad hoc basis. Completeness, also a highly desired thing to motivate, would best be encouraged during data collection through the app design rather than a badge after the fact.

We decided to develop automated badges first and then add ad hoc badges in later phases of development if possible.

8.4.6.1. Streaks and milestones

We recognize streaks, or the number of consecutive days a person has submitted data for a particular protocol. We allow a two-day gap before a streak is broken to account for schools breaking over a weekend. Volunteers see their current streak and their longest streak for each GLOBE Observer tool.

Volunteers receive badges for milestone achievements. Milestone badges are awarded when volunteers reach the following observation counts: 1-5-10-25-50-75-100-150-200-250-300-400. Badges are awarded on the 100 level after 400 until 1000, at which point it switches to intervals of 500.

The observation count and streaks are shown on each tool home screen.



The GLOBE Observer app has an awards center called “My Achievements.” For each GLOBE Observer tool or GLOBE sphere (for trained GLOBE members), a volunteer sees both streaks and milestone badges. My Achievements is accessible from the home page. A future development goal would be to have the My Achievements page also accessible on the website, not just via the app.



8.4.6.2. Ad hoc badges

Ad hoc badges would be a good potential future development, but we are not implementing ad hoc badges at this time. DIS built a mechanism in the back end to accept a list of user IDs and a badge image and then send out badges to those users. In theory, ad hoc badges could be added to a person's achievements page.

In 2025, the GLOBE Observer team, DIS, and GIO agreed on the following process for identifying and awarding ad hoc badges in a future implementation.

- All GLOBE members who are U.S. partners and higher (country coordinators and assistant country coordinators internationally) can request badges under the “manage” function. We could also include trainers.
- GIO (science and education) will manage badge approvals.
- Badge review will largely check for completeness because applicants are trusted. This will minimize time and impact to GIO.
- Badge form will include the following fields:
 - Badge title
 - Date awarded
 - Type of badge (category)
 - Description for recipients
 - Description for reviewers
 - Graphic (select from designed options in some way; option to upload another badge available to GIO approvers in special circumstances)
 - Alt text for image (could be pre-defined based on pre-existing badge designs)
 - Who awarded the badge
 - People receiving badge

We agreed that badges would all be based on a set of graphics with guidelines so that there is visual consistency across the app. Those awarding the badge could choose visual elements and/or words to distinguish their badge.

If ad hoc badges are developed in the future, this process will likely need to be revised to match whatever management structure exists in GLOBE.

9.Communication

9.1. Branding

9.1.1. Visual Identity

9.1.1.1. Why have a Visual Identity?

Recognition

GLOBE Observer materials, such as flyers, presentations, and activity guides, are produced by various members of the GLOBE Observer team. A unified visual identity and consistent branding help participants recognize these materials as GLOBE Observer resources.

Trust

GLOBE has been a trusted program for over 30 years. Consistent branding helps participants know that a resource was produced by the GLOBE Observer team, and that they can trust the information contained within the resource.

Accessibility

As a federally funded program, the GLOBE Observer app and supporting resources are required to comply with Section 508 of the Rehabilitation Act, which ensures that government ICT, or information and communication technology, is accessible to people with disabilities.

9.1.1.2. GLOBE Observer Logo

The logo of the GLOBE Program features three children around a globe. Because GLOBE Observer was intended to expand the reach of GLOBE beyond students and teachers to anyone with a smartphone, a new, more-inclusive logo was created for the app. Designed by Harman Smith, of the DIS team, the GLOBE Observer logo features a magnifying glass partially overlapping a globe, cleverly forming the project's acronym, "GO."



GLOBE Observer logo

Logo Color

The logo may be black, white, or navy blue. The latitude and longitude lines on the globe and the glare on the magnifying glass are set to 70% opacity.

Logo Lockups

A logo lockup is the arrangement of a brand's visual elements, such as name, logo, and tagline. The preferred lockup consists of the wordmark on two lines, to the right of the icon. This is how the logo appears on the app home screen. The tagline, "the app of the GLOBE Program," may be used when space allows. This lockup was developed to bridge the gap between GLOBE branding and GLOBE Observer branding, rather than using both logos.

When space is limited, or the logo appears multiple times (for example, a set of resources or a deck of slides), the icon alone or the single line wordmark may be used.



the app of **THE GLOBE PROGRAM**

Preferred Lockup with optional tagline

The app icon consists of the magnifying glass and globe icon above the word "GLOBE" in white on a navy-blue background. Due to space considerations, the app name displayed under the app icon is "Observer," rather than "GLOBE Observer." To make up for this, "GLOBE" was added to the app icon. However, this lockup (the icon over "GLOBE") should not be used anywhere else.



GLOBE Observer App Icon

9.1.1.3. Other Logos

The logo is GLOBE Observer's most powerful visual identifier. It's what people will be looking for when they search for the app. Using multiple logos is confusing and makes it harder for people to recognize the GLOBE Observer brand. However, there are situations in which including other logos is necessary or beneficial.

NASA Insignia

NASA is one of the most powerful brands in the world. As a NASA project, GLOBE Observer resources are allowed to use the NASA insignia ("meatball"). However, there are strict guidelines for using the insignia, which can be found in the NASA Graphic Standards Manual. GLOBE Observer materials that include the NASA insignia should comply with all requirements outlined in the manual.

Attributions

There are instances in which resources include other logos as attribution (for example, the sponsor ribbon, which includes the NASA, NOAA, NSF, and State Department logos, and sometimes the CUNY and EDC logos). When used as attribution, logos should appear in a similar location to text attributions (for example, the end of the document).

GO Connect Wordmark

The GO Connect Wordmark is used to promote GLOBE Observer's interactive webinar series of the same name. It consists of the text "GLOBE Observer Connect" with the GO icon replacing the "O" in "Connect." The wordmark should only be used for webinars in the Connect series, which follow a specific, highly interactive format. More on GO Connect branding in [section 8.4.3.2](#).



The GO Connect wordmark typically appears in white on a colored background.

9.1.1.4. Colors

GLOBE Observer's primary color is navy blue. There are four secondary colors – one for each protocol in the app – as well as a yellow accent color. A darker navy blue and light and dark versions of the protocol colors are also provided to increase flexibility and allow for the creation of gradients.

Name	Hex Code
Observer Dark	#213D5E
Observer Primary and Clouds Dark	#2F5687
Clouds Blue	#2D7ABE
Clouds Light	#2B9CDA
Mosquitoes Dark	#A13D12
Mosquitoes Orange	#CA4C16
Mosquitoes Light	#EA723E
Land Cover Dark	#3A692B
Land Cover Green	#4B8235
Land Cover Light	#5EA343
Trees Dark	#855200
Trees Brown	#A86800
Trees Light	#D18000
Yellow Accent	#FCD553

Color Usage

Protocol-specific resources are not restricted to the colors named for that protocol (for example, a presentation on Trees is not limited to using the three Trees colors). However, when all four protocols are mentioned in one resource, the appropriate protocol color should be used (the rack card uses protocol-specific background colors, for example). If the protocol colors are used for color-coding, an additional method, such as text labels, should be used to distinguish between objects. Using color alone to convey information is inaccessible to people who are colorblind.

Color Contrast

The Web Content Accessibility Guidelines, which are incorporated into Section 508 by reference, require a contrast ratio of 4.5:1 for regular text and 3:1 for large text. For simplicity, GLOBE Observer resources typically meet or exceed a 4.5:1 contrast ratio for all text, regardless of text size. The dark protocol colors contrast with white and yellow, the medium protocol colors contrast with black and white, and the light colors contrast with black. A gradient from a dark protocol color to a medium protocol color contrasts with white, while a gradient from a medium protocol color to a light protocol color contrasts with black. See contrast ratios for all color combinations in the online [Contrast Grid](#).

9.1.1.5. Typography

Because everyone on the GLOBE Observer team uses different operating systems and has access to different software, there are several options for fonts. Acceptable fonts for headings include: DIN 2014 (Adobe Fonts), Grandview (Microsoft Office), and Oswald (Google Workspace). Body text should be Helvetica or Arial.

9.1.1.6. Images

The GLOBE Observer team prioritizes the use of high-quality images of people actively engaging in citizen science. The images must have appropriate permissions (for example, photo releases, attribution, etc.).

For landscape and macro images, using images from the GLOBE database rather than stock imagery shows participants that their observations are valued.

Circular photo frames mirror the circles in the GLOBE Observer logo.

9.1.1.7. Design Elements

Phone Frames

Many GLOBE Observer outreach materials include screenshots of the app. With new phone models being released every year, photos of actual phones become dated very fast. For this reason, GLOBE Observer materials use either a graphic representation of a phone (the “phone frame”) or a heavy outline with rounded corners in a brand color around screenshots of the app.

Wave

The “wave” is a vector shape based on the in-app protocol artwork. The simplified design allows text and other elements to be placed on top, while still maintaining a visual connection to the app.

Protocol Wordmarks (Retired)

The protocol wordmarks, stylized text on a transparent background, were developed as a more flexible, low-ink alternative to the in-app selector buttons. The names of the protocols were stylized to match the original selector button artwork, with the wave shape superimposed over the text.

The protocol wordmarks are being phased out for several reasons. 1. Images of text are inherently less accessible than actual text. Images require alternative text, and text embedded in images cannot be resized or recolored using assistive technologies. 2. The wordmarks were confusing to new users, who did not realize that all protocols are available in one app rather than separate apps for each protocol. 3. When the selector buttons were updated to the new, smaller versions, the text was no longer stylized the same way.

The protocol wordmarks are being replaced with the protocol icons.



Protocol Icons

The protocol icons were introduced with in-app achievements. They offer a much more flexible visual to represent the protocols. The icons work best when paired with the protocol name in actual text in a similar font and color as it appears on the home screen of the app. The protocol icons should be used with the GLOBE Observer logo, not instead of it.



9.1.1.8. Templates

Templates are useful for ensuring that GLOBE Observer materials are branded consistently and comply with Section 508. The GLOBE Observer team has used many templates over the years, but the following are the most current. Example are available in [Appendix G](#) and in the NASA-internal [SharePoint archive](#).

- Activity Guide Templates: Word templates for writing up GLOBE Observer activities. There are templates for each protocol, as well as instructions for using the templates (including suggested headings and accessibility features) and guidelines for writing attributions for the activity.
- PowerPoint and Google Slides Templates: Slide templates for presenting on GLOBE Observer. Both include generic introduction slides.
- GO Connect Templates: Customizable Google Slides templates for promoting GO Connect sessions, including website rotator, square social media post (1080 x 1080) and rectangular social media post (1600 x 900) templates.
- Website Banner Templates: Customizable Google Slides templates for the rotating website banner (1440 x 640).

9.1.2. Language and Style Guide

GLOBE Observer communications materials follow the [NASA Stylebook and Communications Manual](#) first, then the Associated Press (AP) Stylebook, Merriam-Webster, and the [GLOBE Editorial Style Guide](#).

9.1.2.1. Key Message

NASA has a unique view of Earth from space. Your view is unique, too. Contribute to NASA's incredible library of Earth science data with the GLOBE Observer app.

This message was developed in response to common questions. It answers why NASA is collecting this data (to provide a different perspective than the one from space), how participants can contribute (by using the app), and what happens with the data (it goes into a publicly accessible database).

This message replaces “Want to do Earth science with NASA? There’s an app for that.” which references an early iPhone marketing campaign that is now considered a cliché.

9.1.2.2. Tagline

GLOBE Observer's tagline is "the app of the GLOBE Program." This helps participants know that the GLOBE Program and GLOBE Observer are affiliated despite using different logos. See [section 9.1.1.2](#).

9.1.2.3. Describing the Protocols

The different methods of data collection enabled by the GLOBE Program are called "protocols." The five citizen science protocols in the app can also be referred to as "tools" (see [section 4.1](#).) The protocols should never be referred to as "apps."

Correct: The GLOBE Observer app includes four built-in tools for collecting scientific observations.

Incorrect: Use the GLOBE Trees app to estimate the height of trees.

The names of the protocols are capitalized (Clouds, Mosquito Habitat Mapper), when referring to the tool, but not when referring to the type of data being collected.

GLOBE Observer contains four tools for collecting observations of clouds, mosquitoes, land cover, and trees. Participants can share their observations of the sky with the Clouds tool.

Referring to a tool preceded by "GLOBE" is acceptable (GLOBE Clouds, GLOBE Mosquito Habitat Mapper) but tends to refer to the broader protocol rather than the in-app tool in most usages. When referencing the tool, it is encouraged to include "Observer" (GLOBE Observer Clouds). It should be clear to readers that the app is called GLOBE Observer. Do not include a colon between "GLOBE Observer" and the protocol name.

9.1.2.4. Citizen Science and Related Terms

Citizen science, participatory science, community science and crowdsourcing are all terms that have been used to describe GLOBE Observer and similar projects. The most appropriate term to use depends on the context and audience. Our team has found that avoiding jargon by simply describing the project works best for general audiences (instead of "do citizen science with GLOBE Observer," say "collect scientific observations with GLOBE Observer").

Citizen science is the term that NASA uses to describe public participation in scientific data collection and analysis. For people who are already interested or involved in citizen science, the term is useful for describing what GLOBE Observer is. However, it can be confusing for people who are unfamiliar with the concept. Additionally, there has been increased sensitivity around the word "citizen" in recent years, especially in the U.S. The term may also imply that people who are not legal citizens are not eligible to participate.

The term "participatory science" is being adopted by many organizations to address some of the issues with "citizen science." In early 2024, the leading US professional organization for public participation in science changed its name from the Citizen Science Association to the Association for Advancing Participatory Sciences. The term is less confusing for people new to the concept but lacks the recognition that "citizen science" has.

Community science is a type of citizen science, but the term should not be used interchangeably with citizen science. "Community science" refers to citizen science that is community-led. GLOBE Observer itself is not a community science project, as the

science is led by scientists and other subject matter experts. However, communities may use the GLOBE Observer app as part of a community science project.

Crowdsourcing is another term that can be used to describe GLOBE Observer. It is a broader term, because it includes efforts that are not scientific in nature (for example, crowdsourced transcription of historic documents).

9.1.2.5. Describing Participants

While the GLOBE Program frequently uses terms like students and learners, GLOBE Observer avoids these phrases, as anyone with a smartphone (regardless of whether or not they're in a school setting) can participate. Participant, volunteer, citizen scientist, observer, and user are all acceptable terms depending on the context.

The terms “participant” and “volunteer” work best in more general settings. “Observer” is okay for people who are familiar with the app but may be confusing to someone who doesn't understand the reference to the app's name. “User” works best in more technical contexts or when talking specifically about the app (user experience, new users). See [section 9.1.2.4](#) for more information on the term “citizen science.”

In some cases, it is okay to reference specific audiences, like campers or park visitors, but using more generic terms allows resources to be used by different audiences.

9.1.2.6. Common Style Issues

date and time: Because of GLOBE's international audience, we use the international format for dates and times and spell out the month. (GLOBE) For example: 6 November 2019.

diseases: Disease names should be lowercase, except for proper nouns that are part of the name. (AP)

Examples: chikungunya, West Nile virus, dengue, Zika, malaria

Earth: Capitalize Earth when referring to the planet. Do not use “the” before Earth. (NASA Stylebook)

GLOBE: GLOBE is an acronym for Global Learning and Observations to Benefit the Environment. When referring to the GLOBE Program or the GLOBE Observer app, “GLOBE” should be capitalized. (GLOBE)

land cover: Land cover is two words. (Merriam-Webster)

man-made: Avoid. Use human-made instead (NASA Stylebook).

Note: When referencing mosquito habitats, GLOBE Observer prefers “artificial.”

mosquitoes: While “mosquitos” is also correct, we use the spelling recommended by the AP Stylebook: Mosquitoes. (AP)

Oxford comma: NASA prefers to use the Oxford comma. (NASA Stylebook)

place names: NASA follows the [U.S. Board on Geographic Names](#) for place names. For the correct spelling of foreign country names, see the State Department's [Countries and Areas list](#). (NASA Stylebook)

scientific names: Scientific names of plants and animals should be italicized. The genus should be capitalized, and the species should be lowercase (*Aedes albopictus*). On second reference, the genus can be abbreviated (*A. albopictus*). (AP)

Sun: Capitalize when referring to Earth's star. (NASA Stylebook)

9.2. Social Media

GLOBE Observer set up Facebook and Twitter accounts in August 2016 to support the launch of GLOBE Observer. Initially, social media was intended to build community and offer user support. Despite efforts to engage volunteers in conversation via social media, it never really became highly interactive. Instead, social media became a critical vector for recruiting volunteers and sharing information (see [Section 8.3: Recruiting Volunteers](#)).

The GLOBE Observer accounts were very active with daily posts. Members of the team were assigned days and created content for both platforms on their assigned day. The GLOBE Program hosted separate channels focused on the implementation of GLOBE with educators. Since GLOBE Observer had a different and new audience, we didn't want to confuse either citizen scientists or educators with content meant for the other group.

In 2020, NASA instituted a social media consolidation initiative. GLOBE Observer Facebook and Twitter (X) accounts were merged with GLOBE accounts in February 2020. The GLOBE Observer accounts still exist with a pinned post directing people to GLOBE social media accounts. They have not otherwise been updated since February 2020.

After February 2020, the GLOBE Observer team contributed posts to GLOBE Facebook and Twitter platforms at least twice weekly. Social media posts are drafted in a shared Google document where they are peer reviewed and reviewed by the GLOBE communications lead before being posted. This process allows coordination between GIO and the GLOBE Observer team and ensures the implementation of strategic communication across the full GLOBE organization.

The GLOBE social media team posts five to seven days a week, including multiple posts a day when there are upcoming or current webinars, IOPs, campaigns, challenges, quests, and events to share.

The GLOBE Program has been creating social media content for Twitter/X for over seventeen years. The GLOBE Program's Twitter page was created in 2009 and has over 11.5K posts that have reached millions of people. During the August 2016 - February 2020 time period, the GLOBE Observer Twitter account published nearly 3K posts. A major part of the Twitter social media component was the sharing of pertinent posts from NASA flagship accounts such as NASA, NASA Earth, NASA center Twitter pages, and other government agency Twitter pages such as NOAA, NSF, USGS, and the U.S. State Department. The GLOBE Program also shared posts from some of its major partners like SciStarter, L.A. Public Library, GEDI, Zooniverse, and others. These partners have served as major collaborators with the GLOBE program through cooperative social media messaging.

As of November 2025, GLOBE Facebook had just over 106,000 followers. GLOBE Observer's Facebook page has 21,500 followers, though it hasn't been updated since February 29, 2020. Similar to X, GLOBE interacts with collaborators when there is an appropriate opportunity and shares and comments on pertinent NASA Facebook posts.

GLOBE also posts to Instagram and YouTube. GLOBE Observer posts have supported both channels, particularly during challenges or focused communication initiatives.

A significant component to our social media strategy has been to pitch posts and messaging to NASA and other partner platforms. This allowed us to reach new audiences and build our volunteer base (see [Section 8.3: Recruiting Volunteers](#)).

9.3. Core Communications Materials

GLOBE Observer has several core communications products for promoting the app at conferences and events. We have found that people tend to prioritize smaller (stickers) or more useful handouts (Cloud Identification Chart) over larger postcards or flyers. Increasingly, many people ask to scan a QR code rather than take a handout. Previews of these files can be found in [Appendix H](#); design and print files can be found in the NASA-internal [SharePoint archive](#).

- **Rack Card:** The rack card includes descriptions of the app and protocols in both English and Spanish.
- **Table Signs:** There are two 8.5"x11" table signs. One contains the same content as the rack card. The other has two large QR codes for downloading the app from the Apple App Store or Google Play.
- **Stickers:** The sticker design is based on the GLOBE Observer logo, and features the text "I do NASA science with GLOBE Observer." The back of the sticker has additional information about the app and a QR code for the website.
- **Cloud Identification Chart:** While not specific to the GLOBE Observer app, the Cloud Identification Chart is a popular handout. It includes a URL for the GLOBE website, from which the GLOBE Observer website can be accessed.
- **Intro Slides:** These generic slides about the app can be added to any presentation.
- **Digital Ads:** NASA exhibits at conferences and other event often feature a vertical screen with rotating "ads." We have digital ads for GLOBE Observer and the cloud card game NUBE.

9.4. Website

9.4.1. Why a Separate Observer Website

While the observer.globe.gov website is a subdomain of the main GLOBE website, it was considered important to have a distinct site for the non-teacher audience that was the initial target audience for the app. The site is separated both in the page and document structure in the Liferay website hosting system, although the same login is used for both. The rich content on the main GLOBE website could be overwhelming to an individual user, who would have to wade through protocol guides and other materials related to features they didn't have access to without going through training. Having a separate GLOBE Observer site allowed us to focus on materials related to the four main tools in the app (plus eclipse), while referring back to the main GLOBE website as appropriate. It also allowed for cleaner branding on materials such as handouts which were specifically targeted to individual citizen scientists or informal educators. In the sections below, we will describe the various pages of the Observer site, and the structures used to meet our audiences' needs.

9.4.2. Sections and Purpose of the Observer Website

The main goal of the landing page overall is to have fresh, interesting content when new users visit. The GLOBE Observer home page has four main sections:

- A feature banner rotator, similar to the GLOBE homepage, which provides a short description to go along with a visually appealing banner, and a link to more information. This is populated by the “Observer Features” Liferay content type (more in [section 9.4.10](#)). In general, this carousel is limited to five current activities or featured resources and is updated as often as relevant.
- A flexible web content area with a quick overview description of what GLOBE Observer is, and some featured content. What is listed here has varied, and at various times has included a call out for special events such as the eclipse, an embedded video such as an overview of the GLOBE Annual Meeting, or what is currently on that page, an embedded playlist of GLOBE Observer Connect sessions, which automatically updates to the most recent recording available. The hope with this section was to be able to give a very brief intro to the app but also have something enticing and interesting right up at the top.
- A Liferay widget called “Latest Data” which automatically populates the last seven days of recent measurements for cloud cover, land cover classification, mosquito habitats and tree height, in a simplified version of the GLOBE Visualization System. Again, the automated updating of this widget means that new information is always displayed, and it can potentially help connect users to the part they are playing in the broader data collection goal, especially if they see their recent data points on the map.
- The “GLOBE Observer Now” section, which has a widget with content structures showing the latest news, events and featured people (more in [section 9.4.8](#)). As new items of the “Observer News,” “Observer Events” and “Observer Scientist” Liferay content types are added, they automatically appear here. Note that while the people section uses the “Observer Scientist” content structure type, the people featured represent a wide variety of users of the GLOBE Observer app and data, including citizen scientists, professional researchers, GLOBE Observer team members, and informal educators.

The primary navigation structure for the GLOBE Observer website was created to separate resources focused on different audiences, especially as distinct from formal educators using the main GLOBE website: individual observers, facilitators or informal educators running programs, and scientists and researchers looking for data. While those three sections are not static, the *News, Events and People* is where much of the latest and most updated content is found. Also in the navigation menu is general information in the *About* section and a *Publications* page. More detail on the website areas is in the sections below.

The remaining entries in the main navigation bar are *Get the App* and *Search*. Get the App goes to a single page with overview information, and can be reached through a short link useful for print products or social media, observer.globe.gov/get-the-app. The Get the App page is in the structure under About but is also prominently linked from the main navigation menu to make it easier for users to find the key information about how to participate in the program as soon as they go to the Observer home page. The Search page is simply a form for doing a Google-powered search of the GLOBE Observer website.

The Observer website currently uses drop-down menus with expanding sub-menus, requiring hovering over and maneuvering the mouse to select the sub-page desired. The main GLOBE page uses a “megamenu” structure, which keeps the menu open when clicked, and would be ideal for a future enhancement of the Observer website, as it would solve some current accessibility issues related to the use of screen readers with the navigation menu.

9.4.3. Website Management

While content for the GLOBE Observer website came from many sources (see especially [Section 9.4.8: News, Events, and People](#)), the primary management and maintenance of the site was driven by the coordinator and deputy coordinator for the GLOBE Observer team, as well as the team’s graphic designer and members of the IGES portion of NESEC. In particular, Andrew Clark, a team member from IGES, developed several additional back-end structures in Liferay to facilitate our content needs, specifically “GLOBE Publications and Presentations,” “GLOBE Observer Web Content Resources” and “GLOBE Observer Web Content Resources - 5 URLs,” to supplement the structures created by the DIS team as part of the original Observer website. (See [section 9.4.10](#) for more details.)

Coordination for needed website updates occurred in an every-other-week website meeting, as well as a spreadsheet that tracked upcoming news/blog posts, feature banners, people profiles, activities, and publications, with notes about planned dates and assignment to team members to post. In addition, the GLOBE Observer coordinator and deputy coordinator had access to the Jira ticketing system used by the DIS team to track bugs and enhancements for both the GLOBE Observer app and website.

9.4.4. About (including Get the App)

The About section is a general information area related to the app, with various sub-menu items:

- *About GLOBE Observer*, a general page about GLOBE Observer and the tools available, and how they support science and fit into the wider GLOBE Program.
- *Citizen Science*, an even briefer summary of GLOBE Observer and the original intro video for the app. (Note: this page is rather out of date and ideally would be updated with more general information about what citizen science is, how GLOBE Observer fits in that ecosystem, and with a newer video.)
- *FAQ*, a page for frequently asked questions, separated into General, Seeing My Data, and Questions from Teachers/Educators categories. There are also tool-specific questions on the Taking Observations pages.
- *App Status*, starting from September 2019, this page lists information about updates to the app, as well as any current known errors or operational issues. It was created as a place for users to check on the status of the app and perhaps prevent some help desk queries but has also served as public documentation of the new features and other changes to the app since that time.
- *Our Team*, listing of GLOBE Observer team members using the “Observer Team Members” content structure type. This is divided into categories of personnel focused on Project Management, Communications, Science and Community Liaisons, protocol sections for Clouds, Mosquito Habitat Mapper, Land Cover, and Trees, and Technology Development and Evaluation. There is also a link back to the main GLOBE webpage for GLOBE Implementation Office staff.

- *Contact Us*, A web form that goes to the GLOBE Observer help email, globeobserverhelp@lists.nasa.gov. For more, see [section 8.4.2](#).
- *Get the App*, overview information for GLOBE Observer, a summary of each of the four regularly available tools, and a listing of the languages currently available in the app (with information about how to change language). This page is also linked as the first item on the main navigation bar, because of its importance for new users, and can be accessed by the shortened link observer.globe.gov/get-the-app.
- *Explore the App*, a page with a series of brief tutorial videos about features in the app, such as how to turn on satellite flyover notifications, change the display language, opt-in to GLOBE Observer news, submit data, see past observations, and how to connect to SciStarter in the app. Further videos were planned in this series, including any time a major new feature was released, but didn't come to fruition due to time constraints and other team priorities. The videos are formatted to be very short, and suitable for use on social media as well as on the website.

9.4.5. Do GLOBE Observer

The *Do GLOBE Observer* area is aimed for individual volunteers, to inform them about the science behind each tool, and with additional help and tips beyond the basic information available through the in-app training. The first sub-page is the *Getting Started* page with basic information and a link to the form for creating an account on the main GLOBE website. In addition, there are sections for each of the tools in the app (Clouds, Mosquito Habitats, Land Cover, Trees and Eclipse), with resources related to those tools.

9.4.5.1. Common Do GO Sections Across Tools

The tools each have the same sections, with some slight variations for Eclipse:

Overview

Gives a summary of the tool and the basic components of data collection, as well as why the observations are important, and a list of student research papers in the GLOBE database. The Clouds section also has a very brief mention of satellite matching. All overview pages have the "GLOBE Observer Now" widget at the bottom.

Taking Observations

Focuses on the mechanics of using each of the tools, including an introductory video, tips about how, where and when to observe, and screens showing the milestone badges and streaks available in the app. Additional support for observations include a Tips and Tricks gallery (using the Liferay Media Gallery Structure), with a series of social media shareables for each tool, as well as a tool-specific frequently asked questions area, and links to additional tutorial and training resources available, customized for the tool. There are minor differences in how the Tips and Tricks galleries are set up, primarily because the Clouds shareables were not all exactly the same size, so they appear in a different layout on the page. There is also variability in how many different tutorial and training resources are available for each tool. (Clouds has by far the most.)

Science

This section goes into more background detail related to each protocol area. Each page starts with a science background video. For Clouds, it is a video produced by the GLOBE Clouds team at NASA Langley. The Land Cover and Trees videos are from the Why Observe? series produced by the Scientific Visualization Studio. The Mosquito Habitat Mapper video was produced by the GLOBE Observer team at Goddard. After the video, each page describes why it's important to study the particular aspect of the environment related to the tool, and then goes into why NASA specifically is interested in the data, and a specific NASA example and video. Finally, there is a section with quick facts about the science area, and a listing of the GLOBE Observer publications specifically related to this tool (filtered from the listing on the main Publications page.) In addition to these sections, the Clouds and Land Cover Science pages also have details about comparisons to satellite data, including which satellites are matched to GLOBE observations and more information about the satellite comparison emails.

Resource Library

Each *Resource Library* page is sorted into categories based on resource type and uses Liferay website content structures described more in [section 9.4.10](#). The main categories are Activities, About (science and informational resources), Videos, Books, and Tutorials. Most consist of individual resources with a description, although the Books section contains links lists separated for kids, and teens and adults in WorldCat, a system that allows users to search local libraries for the referenced books.

9.4.5.2. Family Guides

In addition to the above, Clouds and Trees have links to family guides with specifically curated resources for an audience of parents or caregivers looking for activities with children or youth. This is similar to the guides in the Toolkit for Informal Educators but housed here because that audience may not think of their activities as “leading a program,” and the resources are framed more from the starting point of individual observers.

The Clouds Family guide started in 2020 as part of the *2020 Community Cloud Challenge: Science is Better Together* as a way for families to engage in the intense observation period in safe ways due to health situations around the world. The GLOBE Clouds Family Guide describes how to make observations with the app, as well as how to do other activities like creating a science journal with examples and starter sentences, as well as reading the Elementary GLOBE book on cloud types.

The Trees Family Guide was released in 2021 as part of the *2021 Trees Community Challenge*. It has three sections with activities and resources for young children (up to early elementary), older children (upper elementary and middle school), and teens and adults. The content in each section includes questions, activities, demonstrations, and creative projects.

9.4.5.3. Eclipse Tool Section Variations

The Eclipse tool area under *Do GLOBE Observer* is slightly different than the other tool sections. It does have an overview, taking observations and resource library subpages, but they are structured slightly differently. The *Overview* page includes the science background and why observations matter, plus information about past data collection, but there is no separate Eclipse Science page. Since the eclipse observations are based on other GLOBE tools and protocols, the *Taking Observations* page describes the options, but relies on links to other areas of the site rather than spelling out the details. The *Resource Library* is a single listing, not divided by resource type, although there is a separate area for Spanish and French resources, since those were an emphasis area especially for the 2023 and 2024 eclipses.

Eclipse has two unique sections, *Data Analysis* and *Media Kit*. The data analysis page was created after the 2017 eclipse to encourage the use of the GLOBE data in between eclipse data collection opportunities. While there is some information about how to access the data, and examples of graphs, the curated datasets have now been moved under *Get Data*, described more in [section 9.4.7](#). The Eclipse Media Kit was developed for the 2023 and 2024 eclipse with information, videos, graphics and sample social media text specifically for broadcasters or other members of media. It was previously linked under *About* as a more prominent location and to be easier to find, and can still be accessed via the short link observer.globe.gov/eclipse-media-kit. A future area of development could use this as a model for a more general media kit related to promotion of the app.

9.4.5.4. Challenges and Do More

Also under the *Do GLOBE Observer* menu can be found a list of data collection challenges with the most current highlighted (more in [Section 6.5: Data Challenges](#)), a *Do More* section, and a page with resources in Spanish (described in [section 9.4.11](#)). The *Do More* section was created as a bit of a miscellaneous area, for resources useful to individual observers but not related to a specific data collection tool in the app.

Stations

The original idea for the Observation Stations came out of the [GO on a Trail](#) data collection challenge, run in partnership with the Lewis and Clark National History Trail from 01 June to 02 September, 2019. The LCNHT had used heavy-duty concrete stickers successfully for a previous activity, and so we originally designed a GO on a Trail sticker for them to distribute to the visitor centers along the trail to advertise the data collection over the summer. As an offshoot of that, we created a generic, non-challenge sticker, as well as tool-specific stickers. In addition to being a way to promote the app in a fixed location, the idea was that a station would encourage repeat observations by different observers in the same place. As examples, that would provide change over time photographs for a site (using Land Cover), as well as the ability to compare measurements of the same tree from different users and assess accuracy and monitor growth (using Trees). The sticker for the Trees tool could also be placed at a pre-measured distance from the tree of interest, providing a more accurate distance measurement to be entered into the app than available through pacing (see [Section 8.3.3.4: Observation Stations](#)).

The use of the stations, which were intended to be included in the down photos, was complicated by the later AI photo review process which blurs text. And while LCNHT was able to print the large concrete stickers for the GO on a Trail challenge, that format was not necessarily as useful for other venues. That said, we do see at least occasional use of the stickers in observations in the database, for example [Udhagamandalam, India, 2025-06-11](#) , or [Jincheng Township, Taiwan, 2023-09-28](#) (visible in Sky Conditions down photos for both locations on those dates.) An area of future development would be to work on a format and size for the stickers that could make the observation stations more widely useful.

Teams

GLOBE Teams are a way to group data by an organization or interest group, for a competition, community citizen science effort, or other initiative. While the landing page for GLOBE Teams is in this Do More subsection, more detail is [section 8.3.4.1](#).

At Home

The GLOBE Observer at Home resource page was spurred by the COVID-19 pandemic beginning in 2020, assembled quickly as a place to collect resources to add to the overall NASA at Home initiative. As the pandemic began, GLOBE was one the few NASA programs that had ready activities suitable for families pivoting to being in lockdown. The page is a curated collection of resources that are especially suitable to be used by families at home, and included selected hands-on activities, ideas for exploring the data, opportunities for taking eTraining, and a listing of the Elementary GLOBE storybooks, among other things. During this time, we also created how-to videos for some of the most popular activities, recorded by team members while in lock-down during the early pandemic, and included on a GLOBE @ Home playlist. Some of the videos were also shared by larger NASA social media accounts.

Data Requests

The *Data Requests* page is a landing page within the larger website structure for the individual geographically limited (“geofenced”) data requests as described in more detail in [section 6.6](#). While some people may navigate to these pages directly, it is much more likely that they will find them from the project pages in the GLOBE Observer app. The page to [submit a data request](#) is found under Get Data.

Connection, Conversation, Celebration

The Connection-Conversation-Celebration (C3) event was held in July 2022 as an attempt to involve citizen scientists more in the GLOBE Annual Meeting without requiring them to travel or pay for a registration. As part of the virtual session, we heard stories from volunteer observers and science updates from the science leads for each tool. The idea of C3 evolved into the monthly GLOBE Observer Connect sessions, which were envisioned as a conversation between volunteer observers and scientists on a particular topic. More on GO Connect is in [section 8.4.3](#).

Family Science

The collection of resources titled “Our Favorite GLOBE Observer Activities for Families” was created as a response to educators (particularly out-of-school), parents, and caregivers looking for science-at-home opportunities for families and other multi-generational audiences. The collection includes one selected activity for each tool (Clouds in a Jar, Build a Mosquito Larvae Trap, Making a Map, and Build a Clinometer), with additional information for each: a video demonstration, safety information, adaptations and suggestions for younger or older children, questions to prompt discussion, a brief explanation of why the topic is of interest to NASA, and links to suggested activities and resources for going further.

During summer 2020, 14 families field-tested the activities and responded to questions related to availability of the materials at home, enjoyability, questions that were sparked, if the activity worked as expected, if there were any difficulties, modifications or substitutions that were needed, usefulness of the supplemental resources, and suggestions for improvement. Feedback from field testing reinforced the overall approach and informed strategies for family engagement.

An article about the collection and strategies identified for successfully engaging families in GLOBE Observer was published in Connected Science Learning (CSL), a publication of the National Science Teaching Association ([Schwerin et al., 2020](#)). The primary audience for CSL is “STEM learning professionals, especially practitioners with responsibility for program development, in both in-school and out-of-school science learning environments (ranging from schools to museums, afterschool programs, media and technology experiences, and home and family learning).

9.4.6. Lead a Program

Lead a Program is for those facilitating events or programs using GLOBE Observer, especially informal educators. This section is also referred to as the Toolkit for Informal Educators, an overview of which is on an initial *Getting Started* page.

9.4.6.1. Common Lead a Program Sections Across Tools

The sub-sections for each of the main tools (Clouds, Mosquito Habitats, Land Cover and Trees), each have the following pages:

Overview

A general landing page with featured activities and links to the further resource library sections as described below. The featured activities were intended to be rotated periodically but ended up being more static due to other priorities rising to the top. This page also includes general facilitation tips, including specific tips for the particular tool referenced. A future planned development was to add case studies on these pages with real-world examples of implementation by informal educators of each of the Observer tools.

Activities

There is some duplication between this section and the Do GLOBE Observer Resource Library, but the focus is on materials that are more specifically aimed at program facilitators, such as pacing guides and observation stations. Ideally, there would be two different versions of relevant activities, one aimed for individual observers and framed that way, and one with a facilitator’s guide for groups, but that’s not available in all cases.

Books, Videos and Presentations

This section contains curated books lists from WorldCat, as well as other books and guides as available. There is overlap with some videos from the Resource Library sections for the tools, but this page also includes training webinars more specifically for educators, as well as sets of training slides for use by them.

Printables and Promotional Materials

In this section are resources like the printable rack card and table signs promoting GLOBE Observer, logos and a sample photo release that informal educators might find useful. Some of these materials (plus more graphic resources) would be good to include in a more general media and promotion kit, which was an item for future development. (See the Eclipse Media Kit description in [section 9.4.5.3](#) as an example.) The team has on multiple occasions gotten requests for things like posters to print and even exhibit materials, which we have shared directly, but are not always on the website, another area of future development.

9.4.6.2. Eclipse Tool Section Variations

The Eclipse toolkit section is simpler than for the standard tools. It contains links to information about accessing data and a single list of resources, alphabetical by name rather than being separated by category. Again, the emphasis was on materials that would be helpful to those leading a program rather than individual observers. For the eclipses, we also focused on translating materials, primarily into Spanish but also a few into French, and those are listed separately on this page.

9.4.6.3. Audience Specific Guides

Under *Guides* can be found audience-specific guides for Girl Scouts, 4H, camps and libraries. Each is set up slightly differently, tailored for leaders of groups in those audiences. A lifelong learners guide is the next planned in the series of guides.

Girl Scouts

The [Girl Scouts Guide](#) includes detailed instructions, including videos and presentation slides, for guiding scouts through the Think Like a Citizen Scientist Journey using any of the four tools, including links to SciStarter.

4-H Activity Guide

The 4-H Activity Guide ([Keywood & Allen, 2018](#)) is a PDF document developed as a joint project between GLOBE Observer and a 4H extension agent and associate professor at Rutgers, focusing on cloud content. (See 4-H under [section 8.3.3.5.](#))

Libraries

Includes examples of programs created and suggested by librarians and partners of programs using GLOBE Observer. The examples mix and match resources from the GLOBE Observer Toolkit for Informal Educators. Examples have been added periodically, including suggestions for incorporating GLOBE Observer programs to support annual summer library program themes (e.g., iREAD and the Collaborative Summer Library Program). The guide was developed by the Institute for Global Environmental Strategies. Informing the guide and its development has been pilot field testing and initiatives such as the GLOBE Eclipse Libraries for the 2023 and 2024 eclipses, with librarians particularly requesting examples of library programs that have been created and implemented by librarians.

The pilot field test (2019-2020) included libraries that were selected by application and represented urban, rural, and suburban populations in 7 states (California, Florida, Illinois, Kentucky, New Jersey, North Carolina, and Texas). Libraries field tested GLOBE Observer activities and resources in at least two programs with a target of 15 or more people per group. Libraries could choose how to combine activities and resources (i.e., one program could include multiple activities) and completed evaluation surveys. The surveys were aimed at providing feedback on their implementation efforts with the toolkit activities. Responses included information on the number of participants and audience for the activities, the ease of preparation and setup, examples of what worked well, challenges, and suggestions for implementing or refining for different library audiences.

Camp Guide

These guides were designed, tested, and revised with the input from camp partners in the GLOBE camp project, led by the GLOBE Goes to Camp Team at NASA Langley. Pilot camps implemented the activities, provided feedback, and met together monthly to provide peer support. After that feedback process, the Learning Menu of activities, including timing details, materials, and relevant journal prompts, was added to the website. A Camp to School Connections section highlights the academic learning standards, which can help camps in promoting their offerings to schools.

9.4.7. Get Data

Get Data is the section for researchers and scientists, which includes an overview about how to use GLOBE data in research, including links to download directly from the database, tutorials, and information about the GLOBE Data User Guide. Previously, there was a mailing list for scientists interested in learning more about GLOBE data, but that is no longer actively used. The most significant portion of this section is the pages for curated data by categories: clouds, dust, eclipse, land cover, and mosquito habitats. More details about the curated data sets can be found in [Section 7.4: Data Access](#).

9.4.8. News, Events, and People

The *News, Events and People* landing page has the same “GLOBE Observer Now” widget as appears on the bottom of the home page, and each of those sections goes to a page listing the content structure types of each category, in general ordered by date with the most recent at the top. News and events can be filtered by year and related app tool category: Clouds, Eclipse, Land Cover, Mosquitoes, and Trees. News also has a no longer used category of Weekly Roundup, which was originally used to tag a weekly summary of GLOBE Observer news items. People can only be sorted by the tool category, not by year.

From October 2016 to December 2018, the *News* section was used only for weekly round-up summary articles, which had links to related articles and videos. After that point, the GLOBE Observer team started writing more direct articles, including updates about new features in the app, highlights of data collection challenges and results from those, blogs related to the science of each tool, and other newsworthy items. Originally, the science blogs were on a monthly rotation written by the science leads for each GLOBE Observer tool, but later on that expanded to include a variety of outside voices as well.

In July 2022, in conjunction with the GLOBE Annual Meeting, the GLOBE Observer team held an event called [Connection-Conversation-Celebration](#), which showcased volunteer observers and updates from the science leads. The popularity of that event led to the idea of a more regular opportunity for conversations with citizen scientists, and eventually to the creation of GLOBE Observer Connect sessions starting in April 2023. (See [section 8.4.3.](#)) The original premise was that the short presentation followed by conversation (kept to a total of about half an hour) for each month would be related to the science blog from the previous month, which provided background material for attendees prior to the session. That became a less strict connection later on, to include not just science and research topics but also new outreach products such as the GLOBE Goes to Camp guide or the NUBE clouds card game.

For *Events*, the goal was to curate items to include webinars or other activities hosted by GLOBE, NASA or other related organizations that would specifically be of interest to a general observer or informal educators. GLOBE Observer Connect events are posted and archived in the events section.

In the *People* section (which uses the Observer Scientist Liferay structure), we aimed to highlight a variety of those involved with GLOBE Observer, including science leads and other researchers using GLOBE data, as well as volunteer observers and informal and formal educators. We also aimed to have geographic and other diversity represented among those featured, and to post a new profile approximately once a month. Some profiles included video interviews with the subjects, others were more a Q&A format. In addition to content written by the core GLOBE Observer team, interns working under the GLOBE Social Media Lead generated many of the profiles, and some were pulled from the GLOBE Clouds team's quarterly updates. More about the mechanics of posting in the News, Events and People portion of the website can be found in [section 9.4.10.](#)

9.4.9. Publications

[Publications](#) includes both publications and presentations on a single page, in a listing using the "GLOBE Observer Publications and Presentations" content structure type. The top has publications, sorted with the most recent at the top. The presentations and posters section at the bottom is sorted by year in expandable sections, although additions to this section have not been kept as up to date as the publications area, with the latest added in 2021. The publications listing includes both peer-reviewed scientific articles, as well as more education and outreach focused articles, the primary consideration being the use of data from the four main GLOBE Observer tools plus Eclipse. Details about the GLOBE Observer Publications and Presentations web structure is in [Section 9.4.10.1.](#)

9.4.10. Liferay Structures

The GLOBE Observer website uses a combination of the page types offered by Liferay, initially Widget pages with two basic formats: a single page (GLB OBS 1) or a page with main section and a sidebar (GLB OBS 2). Those pages are populated by Basic Web Content boxes and Asset Publishers. The team also created some custom structures using HTML to allow formatting in ways the main Web Content boxes didn't allow. Later version updates of Liferay allowed Content pages that had some additional layout flexibility and would be able to potentially replace some of the custom structures, but we do not plan to replace the pages with the new type by the end of the Science Activation 2.0 funding period at the end of December 2025.

9.4.10.1. Original Content Types

The use of Asset Publishers calling on content templates of different types allows a flexible way to pull resources onto different pages, while storing the descriptions and links in a centralized way that allows edits only in one place. The main content types originally created by the DIS team are listed below with a brief description of each.

Observer Events

A basic event framework, requiring title, start/end date and optionally a start/end time and location. A short description appears wherever the Events widget is found, and a longer full description on the landing page for each event (which can include images and embedded videos.) Also required is a thumbnail image with alternate text, and an optional external URL for the event to link to. Using the Protocol Type tag under properties, events can be filtered on the landing page by protocol type and year. After some issues with getting events to appear in the right order, the “priority” property was used to ensure the appropriate sequence, described in more detail in [Appendix E1: GLOBE Observer Content Types and Liferay How-To](#).

Observer Features

The *Observer Features* structure populates the rotating banner on the Observer homepage, consisting of a title, date, short description, banner image with alt text and a URL. While there would be ways to automatically select which banners are currently featured, they change infrequently enough that it has proven easier to manually add the chosen features, and also to rearrange the order as needed. In addition to the title linking to an outside page, the team has also used HTML code in the blurb field to display a “Learn More >” link as part of the description, to make it more obvious to visitors that more information is provided elsewhere.

Observer News

The various content sources for News items, also referred to as blogs, was previously described in [section 9.4.8](#). From a structural standpoint, News items include a title, date, short description, full text and thumbnail image with alt text, very similar to the Events structure. While there is the option for an external URL, that was used much less with News items compared to Events. News items can be filtered by the related protocol type and year as with Events, and the priority property was used in a similar way as noted above. News also has a category for Weekly Roundup, although that tag for posts hasn’t been used since the end of 2018.

Observer Scientist

Despite being called a Scientist structure, this structure type was used more broadly for professional scientists, citizen scientists, educators and students who contributed to GLOBE in a notable way. The basic fields are first name, last name, title, thumbnail image with alt text (usually a picture of the person), a short blurb for the People page and a full text description that goes on its own landing page. Additional details about how people were selected to be profiled is included in [section 9.4.8](#).

Observer Team Members

The final DIS structure is for GLOBE Observer team members, populating the *Our Team* section under *About*, described more in [section 9.4.4](#). This structure requires a photo with image description, name, affiliation, short bio, team role, and webpage URL, which was directed back to the corresponding My Page landing page on the main GLOBE website. *Note: As of December 2025, these go to My Observations+.*

9.4.10.2. Custom Content Types

In addition to the structures created by DIS, Andrew Clark, a NESEC team member from IGES, created three custom structures as the team's needs evolved

GLOBE Observer Web Content Resources

The Web Content Resource type is the key structure used for resources on the Observer website, used for all types of materials from activities to videos to handouts. Each resource has a title, a thumbnail with image description) and a description. Then, there are options to upload a local file, or list an external URL or file, each with the option to specify anchor text. One of those three is designated the preferred resource link, which will be linked from the resource title in the entry. Tags, as described below, are very important to include in the properties sidebar, as that's how the resources are pulled to the correct page(s) on the website.

GLOBE Observer Web Content Resources - 5 URLs

Very similar to the basic content resource type above, this structure was created when the team realized that there were some resources that needed the ability to have more links as part of the entry, for example when there are multiple translations of the same resource, or components in separate files that all need to be included. The basic fields are the same, including an upload local file option, but there are a total of five external resource URL options. The preferred resource link can only be the local file or URL #1.

GLOBE Observer Publications and Presentations

This structure, originally used for both presentations and publications, in later years was primarily updated with publications, especially as more of those became available. Fields needed were a title, publication or conference logo (including alt text), a citation and a URL to an abstract (or full text if available.) Presentations have expandable content areas by year, although as noted, the latest year where those were actively kept up was 2022. Sorting for publications is in reverse chronological order, with the most recent on top. Using the tagging system described below, the relevant publications for each GLOBE Observer tool are also pulled onto the Science pages in those sections, helping keep content current while only requiring descriptions to be added in one place.

9.4.10.3. Sorting Content with Tags

In order to pull the content structure items of various types onto the correct pages, a series of tags was developed. Then, the settings of a given asset publisher can be adjusted to only pull the correct content types onto the page. The tags are added in the properties pane of each relevant structure type. A top-level tag of "GO" is given to all resources, to indicate it was intended for the GLOBE Observer site. The next general tag is for audience category: "observer," relevant for individual users of the app; "facilitator," for those doing group activities or leading events using the app; and, "scientist," for items relevant to researchers, which was primarily applied to scientific publications, but could also be used for data guides and similar. If a resource applies to more than one audience, multiple tags are applied.

The DIS-created structures of Events, Scientist, News, etc. have a place to select Protocol Type, but for the custom structure types (Web Content Resources, Web Content Resources 5-URLs, and Publications and Presentations), we use specific tags for each of the tools: clouds, land cover, trees, mosquitoes, and eclipse. Most resources will only have one tool label, although a cross-cutting resource could have multiple.

The next level is the product type tags, as below:

- printable (something designed to be a handout)
- video
- activity (hands-on activity instructions, for example)
- promotional material (things like sample press releases, photo releases, logos and graphics, etc.)
- case study (planned, but not extensively used up to this point)
- references (informative articles and similar)
- presentation (PowerPoint slide decks and similar, for use in presenting a program, and distinct from scientific presentation below)
- scientific publication
- scientific presentation (distinguished from just presentation above – usually a link to an abstract or other reference to a conference presentation, and includes references to scientific posters)

One advantage of this system is the simplicity of maintaining content as updates made in one place propagate across the site. Another advantage is the ability to add tags for new resource types or other categories as needed, giving us flexibility to adapt to new ideas. As an example of that, we also created a few specifically targeted to help sort resources onto the proper pages

- taking observations (tutorial-type materials and how-tos, which could be videos or other types of materials, but intended to be pulled onto the “Taking Observations” pages for a tool.)
- girl scouts (for things to specifically add to that audience page)
- español (for Spanish resources, especially used for eclipses initially)
- French (only used for the limited resources in French created for the 2024 eclipse)
- 2017, 2018, 2019, 2020, etc. (primarily for scientific presentations, to divide them into subgroups since the listing was so long)
- eclipse2017, eclipse2019, eclipse2020, eclipse2023, eclipse2024 (to tag resources with details related to just one of the eclipses, not more generally eclipse-related - these resources would also be given the general “eclipse” tag along with the specific one)

9.4.10.4. Expandable Content Sections

Another useful structure for many pages, to allow for robust content but make the pages shorter for browsing, is using expandable content sections. We used some built-in structures in Liferay, for example in the “Why study...?” sections on the Science page for each tool. That allows people to see the topic title and expand to read more but also skip more quickly to the later sections of the page if they wish to. That structure was especially helpful for FAQ pages, both the main FAQ page under About and the tool-specific FAQs on the Taking Observations pages.

9.4.10.5. Custom HTML on Pages

In other circumstances, the team wished to have a different format for revealing content, and so Andrew Clark (the same NESEC team member who created the custom web content structures) created custom HTML on a few pages, which allowed, for example, switching between similar content in the same space by clicking on the app icon for each of the four tools. There may be capabilities in the newest version of Liferay that could replace some of these custom structures. Pages with custom HTML are:

- *Do GLOBE Observer > Do More > [Family Science](#)*: Thumbnails of selected activities related to the four main tools which toggle between more details for each.
- *Lead a Program > Guides > [Girl Scouts](#)*: App button icons toggle between the resource list of presentations and videos for each of the four main tools.
- *Lead a Program > Guides > [Camp Guide](#)*: App button icons toggle between the detailed learning menu options for each of the four main tools. Note that the text on this page needs to be edited in the HTML code, not the GUI interface, because of the way it needed to be set up on the new Liferay Content Page (versus the previously used Widget Page). More details in [Appendix E1](#).
- *Lead a Program > Guides > [Library Guide](#)*: App button icons toggle between the detailed library recommendations for each of the four main tools plus Eclipse.
- *About > [Explore the App](#)*: Structure created to allow an array of videos to be displayed on the page.

9.4.10.6. File Structure

The back-end file structure of the website has folders for materials related to the various resources/activities, as well as for images related to features, events, blogs/news posts, etc., and curated data sets. The exact structure is described in more detail in [Appendix E1: GLOBE Observer Content Types and Liferay How-To](#).

9.4.10.7. Shortened URLs

Especially as the team was developing print resources, we realized the need for shorter URLs than the long links that come with the Liferay structure, so we used the capability of the system to redirect to a specified page of the site or an outside URL and created a number of shortlinks. For example, [observer.globe.gov/eclipse](#), which was used on print products, is pointed to the longer URL [observer.globe.gov/do-globe-observer/eclipse](#).

Another advantage of using this structure is that the same short URL could be redirected to updated items, as in the link observer.globe.gov/go-connect always pointing to the next GLOBE Observer Connect event page, even though the specific URL changes monthly. Although these URLs are found in the top level of the website structure-wise, they are hidden from navigation so as to not appear in the menu bar. As one further note, short URLs are also created for each geofenced project request (see [section 6.6](#)), as URLs for those landing pages are too long to fit in the form field for adding those projects to the app.

9.4.11. Spanish-language Pages and Translation Process

As noted in [section 4.5](#), the GLOBE Observer app itself is available in a number of languages. However, the GLOBE Observer team didn't have the capacity to create and maintain the entirety of the content on the GLOBE Observer website in other languages, so we focused on selected activities and resources, especially related to Eclipse and Clouds and in Spanish, relying especially on two native Spanish speakers on the GLOBE Clouds team at NASA Langley, and the non-native but conversational skills of several of the NASA Goddard GLOBE Observer team members. The general process was to use Google Translate for an initial pass, but then have the text reviewed by one of the native speakers before posting. While Liferay does have the ability to detect preferred language when set by a user logged in to the GLOBE website and display an alternate version, since so few pages on Observer were translated, we instead use a direct link in the text to indicate a translation is available, or have the translation(s) linked as part of an activity entry in the asset publisher displays.

One key page that was translated into Spanish is the Get the App page, which also indicates the other languages in which the app is available. Other Spanish resources (activities, videos, printables) are collected in a "Recursos en español" page which is linked under both Do GLOBE Observer and Lead a Program. Materials there are sorted by tool name or materials for facilitators. In addition, the Eclipse Resource Library pages for both of those sections has a separate area for Spanish materials, and the few items that were also translated into French due to the 2024 eclipse path crossing over Quebec, Canada. In addition, a very few news articles were translated into Spanish, indicated as a separate asset publisher item on the News page, and with a link at the top of the article to toggle between languages. More details about how tags were used to be able to automatically put resources on the correct page by language and resource type is in [section 9.4.10.3](#). One of the exciting potential capabilities of the Liferay update in July/August 2025 is the capability for improved automated translation of pages, which would make many of the resources more accessible to the international GLOBE audience.

9.4.12. Capabilities for Registered Users

By design, most of the GLOBE Observer website is available to anyone, without them being logged in to their GLOBE account. While untrained GLOBE Observers can also log in to the main GLOBE website using the same credentials, their capabilities in the system are intentionally limited. For example, while untrained users can select a username from a pre-determined list (otherwise receiving an alphanumeric identifier), they are not able to change their name from "Citizen Scientist" until they have gone through at least the eTraining process. Basic GLOBE Observer accounts also don't get a *My Page* as GLOBE Educators do. If a user is not logged in to their account, they will see the option to sign in in the upper right corner of the GLOBE Observer website, as well as a link to a forgot/change password page.

Note: In December 2025, all GLOBE accounts transitioned to have the same capabilities as citizen science accounts. Blog capabilities will be removed as part of account simplification, and the My Page will become a link to My Observations+. All users have the ability to create up to 10 guest accounts, formerly called student accounts.

The two main capabilities on the GLOBE Observer website that are available to GLOBE Observer volunteers who are logged in are the *My Observations* page and the *Request Observations* feature. *My Observations* is reached via the “View My Observations” button in the upper right of the website, and takes a user to the same *My Observations* page accessible via the button in the app and described in [section 4.4.2](#).

The URL for a user’s *My Observations* page is standardized using their numeric userID, so it is possible to navigate to that page for any user by changing the ending digits:

<https://observer.globe.gov/myobservations/?userid=xxxxxxx>

The top of the page will display the name for those who are trained GLOBE Educators and either the pre-assigned alphanumeric identifier or the selected username if untrained. That username is what is displayed, for example, on the landing page for a GLOBE Team or school of which a user is a member.

A user must also be logged in to make a request for localized data collection in the GLOBE Observer app, also known as a geofence project. This is found under *Get Data* and *Request Observations*. The landing page there displays basic information about the process, but the “Apply for a Data Request” button at the bottom will prompt the user to log in with their GLOBE account to submit an application for a project. At this time, anyone with a GLOBE account, whether a simple Observer account or a full Educator account, can submit a proposal for a geofence project, although all projects are subject to review before becoming active in the app. More details about geofenced data requests can be found in [section 6.6](#). As noted above, untrained GLOBE Observers can use the same credentials to log in to the main GLOBE website, although they don’t have access to posting blogs, writing comments, etc. One capability that is open to them is to create a GLOBE Team, described more fully in [section 8.3.4.1](#).

10. Ideas for Future Development

This documentation describes GLOBE Observer as it existed through the end of 2025. Given more time and funding, the GLOBE Observer team recommends implementing the following developments: complete the badge system with ad hoc badges, update the Land Cover tool to improve usability and data quality, fully implement data quality flags, and adjust photo review. Each development has been detailed in the section of documentation where the related function is described. For ease of reference, these development recommendations are gathered here. Other recommendations for development are also described throughout this documentation, but these four are the highest priority items that likely require developer time.

10.1. Badges

As described in [section 8.4.6](#), the GLOBE Observer app has an integrated badges and recognition system. As of the end of 2025, volunteers received badges for milestones (overall number of observations collected per protocol) and for streaks (number of consecutive days they collect data). Awarding the badges is an automated process.

Much of the structure is in place on the back end to reward users on an ad hoc basis to recognize activities such as support for a particular science initiative or participation in a science symposium. As described in [section 8.4.6.2](#), DIS built a mechanism in the back end to accept a list of user IDs and a badge image and then send out badges to those users. From the technical side, the data repository to support ad hoc badges and the mechanism of delivery of those badges and information to the app is ready. Pieces that are still missing in terms of implementation are a graphical user interface for adding badges (to avoid a manual database import) and decisions about where and how the ad hoc badges would appear in the app (what they look like, how they are organized, etc.) In theory, ad hoc badges could be added to a person's achievements page, but the details still need to be determined.

In 2025, the GLOBE Observer team, DIS, and GIO agreed on the following process for identifying and awarding ad hoc badges in a future implementation.

- All GLOBE members who are U.S. partners and higher (country coordinators and assistant country coordinators internationally) can request badges under the “manage” function. We could also include trainers.
- GIO (science and education) will manage badge approvals.
- Badge review will largely check for completeness because applicants are trusted. This will minimize time and impact to GIO.
- Badge form will include the following fields:
 - Badge title
 - Date awarded
 - Type of badge (category)
 - Description for recipients
 - Description for reviewers
 - Graphic (select from designed options in some way; option to upload another badge available to GIO approvers in special circumstances)
 - Alt text for image (could be pre-defined based on pre-existing badge designs)
 - Who awarded the badge
 - People receiving badge

We agreed that badges would all be based on a set of graphics with guidelines so that there is visual consistency across the app. Those awarding the badge could choose visual elements and/or words to distinguish their badge.

If ad hoc badges are developed in the future, this process will likely need to be revised to match whatever management structure exists in GLOBE.

10.2. Land Cover

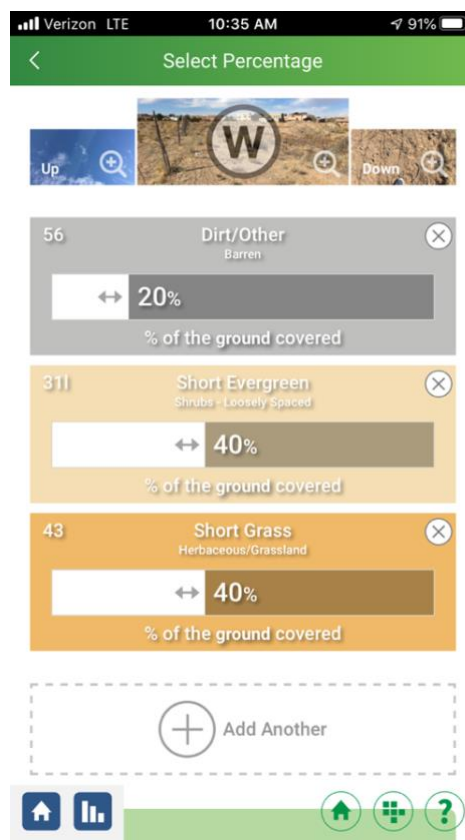
We recommend updates to the Land Cover tool to improve usability and data quality and to improve alignment with GLOBE biometry protocols.

As described in [section 5.5.2](#), the Land Cover tool is based on the GLOBE Land Cover Sample Site protocol. In an attempt to simplify assigning a land cover type, we asked volunteers to select broad land cover categories (trees, grasses, urban, etc.) and then estimate what percent of the area contained that land cover class. The idea was that scientists could use the percent estimates to assign a land cover class using whatever land cover classification system they desired. This was done because GLOBE's MUC system is not widely used and there are a variety of land cover classification systems in use. The [MODIS Land Cover product](#) is provided in six different classification systems, for example. We felt that if we gave scientists the tools to map to whatever system they choose, the GLOBE Land Cover data would be more widely useful.

The problem is that end users assign percent coverage for each land cover type using a slider. The slider is not precise, but reports a specific numeric value to the database, giving the impression that the percent coverage is a far more exact value than it is. Additionally, people struggle to provide a visual estimate of percent cover.

People simply don't know what 25 percent trees looks like, particularly in a non-homogenous pixel. We manage this in Clouds by asking people to select a broad range (25-50 percent), which provides flexibility and does not imply precision. The slider itself poses problems for accessibility as it is difficult to use for those with mobility issues and does not offer an alternative form of input for visually impaired users. Additionally, the text labels on the sliders don't meet minimum contrast ratios for visibility, though that is a simpler thing to resolve.

Users must assign percent coverage for each directional photo (see image at right), something that turned out to be time consuming and mentally challenging. As a result, most people skip this step. The result is that most GLOBE Observer land cover observations lack classification information. The 2021 analysis of GO on a Trail challenge data showed that only 25 percent of observations included classification ([Kohl et al., 2021](#)). As a result, it is not easy to find GLOBE Observer Land Cover data or photos based on classification. Potential science data users have reported that even having labels for land cover photos would be useful as it would make the photos more discoverable.



We would recommend the following modifications:

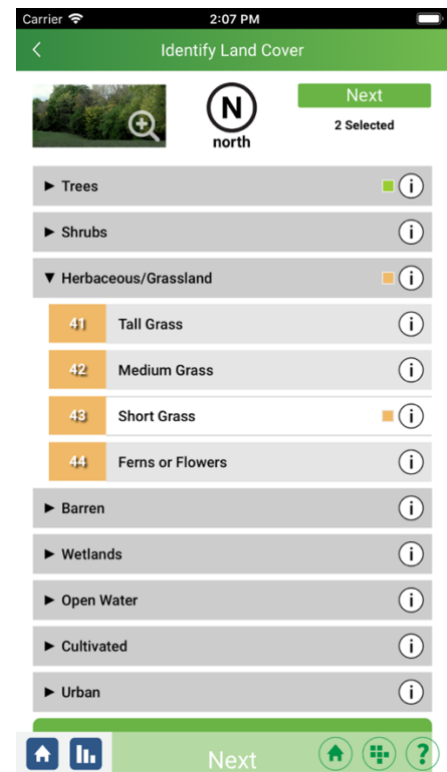
1. Eliminate the slider screen from GLOBE Observer Land Cover (previous image).

2. Ask volunteers to simply select land cover from the existing land cover identification screen (see image at right). This step is currently optional, and we would make it mandatory. Additionally, we would ask that this selection happen for the entire observation site so the user only has to do it once. Currently people classify each photo to account for nonhomogeneous sites.

3. Add a checkbox to indicate if the area being mapped is homogenous or all one type of land cover. Dr. Russell Congalton felt this was a critical distinction to make for science data users.

4. Direct users to the [GLOBE Biometry Protocol](#) to fully classify land cover (optional). As all users now have access to data entry, this is the simplest way to align the protocols.

5. In the future GLOBE Biometry could be a good candidate to become a GLOBE Observer tool. Required equipment includes a measuring tape, clinometer, densiometer, and GLOBE Modified UNESCO Classification (MUC) System guide, all of which could be or already is part of GLOBE Observer. For trees, we have people pace to estimate distance, something we could do for biometry. Alternatively, Dr. Eric Brown de Colstoun informally tested random sampling for densiometer measurements and found that such an approach may be more accurate than measuring a pixel. The Trees tool is equivalent to a clinometer, and it would be straightforward to turn the camera viewing screen into a densiometer following the approach used elsewhere in the app. The MUC guide has already been turned into an app for iPhone and could be integrated into Observer as a decision tree. Such changes would need to be explored to determine the best approach to generate science data.



These changes will result in labeled photos that are discoverable and true measurements of land cover to determine classification, which will result in better data quality. Additionally, GLOBE land cover data will be consistent regardless of whether it came from Observer or Data Entry.

One additional potential development might be to provide AI labeling for land cover photos as a data field when someone pulls GLOBE data. Amazon Rekognition currently labels all photos as part of the screening process, and these labels are being saved. The data isn't being surfaced anywhere accessible to an end data user. Ideally, we would provide this information to potential data users to assess its value. If it turns out to be a useful enhancement of GLOBE data, making the existing AI labels visible in some way could be another way to improve data quality and value. Dr. Di Yang, University of Florida, and others have assessed AI labeling of GLOBE Land Cover photos and will likely have good recommendations should GLOBE decide to move this direction. See [Huang et al. \(2023\)](#) and [Manzanarez et al. \(2022\)](#).

10.3. Data Quality Flags

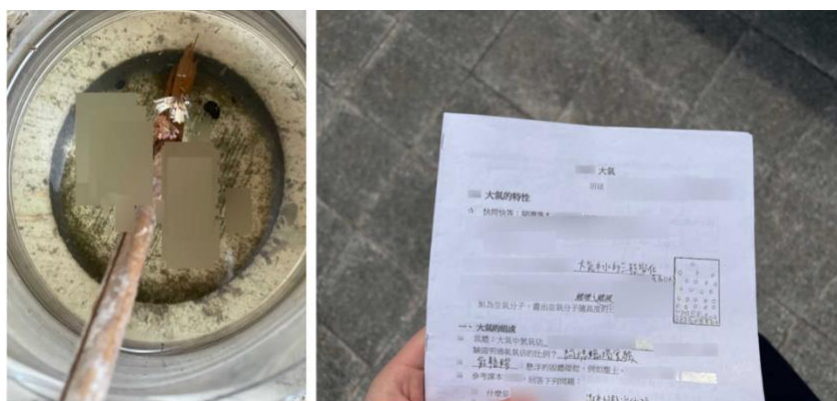
As described in [section 7.1](#), GLOBE Observer developed a set of data quality flags. We wanted to run quality checks on GLOBE Observer data and flag potentially problematic observations. The flag would not eliminate the data, but it would identify it as being potentially problematic for potential data users. Ideally, these flags would be integrated with the GLOBE database. Recognizing the challenges of integration, the GLOBE Observer team decided to run the quality checks after the fact and publish the processed data as annual *.csv files on the GLOBE Observer website.

Unfortunately, we never fully operationalized the QA code. Given more time, we would recommend completing the work to operationalize the code. Ideally, the code would be used to generate annual QA-checked data sets. However, we could also simply publish the Jupyter Notebook with the code and documentation to enable end-users to run a QA check. Once operational, the code should be published regardless.

This work stopped with the understanding that the GLOBE Implementation Office was tasked with implementing an overarching QA system for all GLOBE data. The GLOBE Observer QA work could still be folded into such an effort or move forward in a different way.

10.4. Adjusting Photo Review

As described in [section 7.1.4.2](#), the current settings for AI photo review blur all text that appears in photographs submitted to GLOBE. This includes text that might be desired, such as Observation Stations or data sheets. Additionally, the code has mis-identified mosquito larvae as text and blurred the larvae, destroying the value of that observation.



DIS keeps the unblurred photos, but there is currently no way to tell the system to revert to the original photos. We recommend a checkbox be added to the existing manual photo review system to tell the database to revert to the original photo. Another option might be to modify the AI so that it only blurs car license plates. However, this leaves open the possibility that someone could enter offensive language into the database via a photo.

We also recommend a checkbox be added to manual photo review to flag the entire observation as being suspicious. Currently, if someone submits photos taken indoors or cartoons or non-data photos, we leave the photos in the system as an indicator that the data associated with the photo should not be trusted. If we could check a box that would flag those observations as being bad, we would not have to allow the irrelevant photos into the database. Note: We hope that Practice Mode will reduce instances of indoor photos taken during training workshops or in a classroom.

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Appendix A: Acronyms

AI – Artificial Intelligence

API – Application Programming Interface

AREN – AEROKATS and ROVER Education Network

ASTC – Association of Science and Technology Centers

AWS – Amazon Web Services

CAP – Civil Air Patrol

CES – Community Engagement and Support (portion of GIO run by EDC)

COPPA – Children’s Online Privacy Protection Act (Rule)

CST – Community Support Team within the GLOBE Implementation Office

CUNY – City University of New York (awardee for 2/3 of the GIO cooperative agreement)

DAAC – Distributed Active Archive Center

DIS – Data and Information System

EDC – Education Development Center (awardee for 1/3 of the GIO cooperative agreement)

EODIS – Earth Observing System Data and Information System

EROS – Earth Resources Observation and Science

FAQs – Frequently Asked Questions

GDPR-K – General Data Protection Regulation

GEDI – Global Ecosystem Dynamics Investigation

GIO – GLOBE Implementation Office

GLOBE – Global Learning and Observations to Benefit the Environment

GME – GLOBE Mission Earth

GMRI – Gulf of Maine Research Institute

GO – GLOBE Observer

GPO – GLOBE Program Office at NASA Headquarters

GPS – Global Positioning System

GSFC – Goddard Space Flight Center

HBCU – Historically Black Colleges and Universities

HEAT – Heliophysics Education Action Team

ICESat-2 – Ice, Cloud, and land Elevation Satellite-2

IGES – Institute for Global Environmental Strategies

ISS – International Space Station

IOP – Intensive Observation Period

JPL – Jet Propulsion Laboratory
JSON/GeoJSON – JavaScript Object Notation / Geographic JavaScript Object Notation
LaRC – Langley Research Center
LAPL – Los Angeles Public Library
LLL – Lifelong Learners
MCCC – Mosquito Challenge Community Campaign
MGRS – Military Grid Reference System
MHM – Mosquito Habitat Mapper
MODIS – Moderate Resolution Imaging Spectroradiometer
MUC – Modified UNESCO Classification
NAML – NASA@ My Library
NASA – National Aeronautics and Space Administration
NOAA – National Oceanic and Atmospheric Administration
NORC – National Opinion Research Center
NPD – NASA Policy Directive
NESEC – NASA Earth Science Education Collaborative
NSF – National Science Foundation
OLLI – Osher Lifelong Learning Institute
OSU – Oregon State University
PHO – public health official
PI – principal investigator
PICCE – Programa Interinstitucional de Ciência Cidadã na Escola (Interinstitutional Citizen Science Program in Schools)
PRA – Paperwork Reduction Act
QA – Quality Assurance
QR – quick-response (as in QR code)
ROSES – Research Opportunities in Space and Earth Science
SciAct – Science Activation
S’COOL – Students’ Cloud Observations Online
SEES – STEM Enhancement in Earth Science
SMD – Science Mission Directorate
SSAI – Science Systems and Applications, Inc.
SSI – Space Science Institute
STAR Net – Science-Technology Activities and Resources (STAR) Library Network
STEM – Science, technology, engineering and mathematics

STEPE – Science, Training, Education, and Public Engagement (portion of GIO run by CUNY)

TMN – Texas Master Naturalists

UNESCO – United Nations Education, Scientific and Cultural Organization

URL – Uniform Resource Locator

USAID – United States Agency for International Development

USGS – United States Geological Survey

UTC – Coordinated Universal Time

YLACES – Youth Learning as Citizen Environmental Scientists

Appendix B: GLOBE Observer Team 2016-2025

GLOBE Observer has been implemented by individuals from multiple larger teams, particularly NESEC and DIS. All named here received some level of funding from NESEC, though only those who contributed directly to work documented here are included. Those who focused primarily on other NESEC work and most interns are not included.

Eight individuals worked full time on GLOBE Observer under NESEC funding between 2016 and 2025 and these are starred. The GLOBE Clouds team did work beyond GLOBE Observer, but most of that work aligned with GLOBE Observer significantly, which is why they are designated as full time.

All other team members listed supported Observer in some way with partial funding. Members of the DIS team worked collectively on Observer and other projects, which meant that individuals may have popped on to Observer work for a few weeks, then moved to other work. They are named here, but dates may not be included.

Team Member	Roles and documentation sections that describe GO work	Time on Observer
*Holli Kohl	Project Lead, 1-9	2016-2026
*Kristen Weaver	Deputy Lead, 1-9	2016-2026
*Heather Mortimer	Graphic Design; Informal educator toolkits, 8-9	2018-2026
Andrew Clark	GLOBE Observer website; data support, 7,9	2016-2026
*Helen Amos	GO Science lead, 4, 6-7	2016-2020
Agnes Conaty	GO Science lead, 7	2022-2025
Lin Chambers	GLOBE Clouds; LaRC lead, 2-6, 8	2016-2017
Jessica Taylor	GLOBE Clouds; LaRC lead, 2-9	2017-2026
*Sarah McCrea	GLOBE Clouds lead, 5	2016-2017
*Marilé Colón Robles	GLOBE Clouds lead, 5-6, 8-9	2016-2026
*Tina Rogerson	Satellite Match, 5-8	2016-2026
Russanne Low	Mosquito Habitat Mapper science liaison, 5-8	2016-2026
Peder Nelson	Land Cover science liaison, 5-8	2017-2026
Brian Campbell	Trees science liaison, 5-9	2016-2026
Autumn Burdick	Communications, 9	2017-2024
Tassia Owen	Communications and volunteer support, 8-9	2016-2022

Team Member	Roles and documentation sections that describe GO work	Time on Observer
Tessa Clougherty	Communications, 9	2021-2024
Angelina Tsai	Communications, 9	2021-2024
Theresa Schwerin	NESEC PI, GO library lead, 8	2016-2026
Cassie Soeffing	Mission Mosquito, 8	2016-2026
Liz Burck	Developed toolkit materials, 8	2016-2023
Trena Ferrell	NESEC Co-PI at GSFC	2016-2026
Dorian Janney	Volunteer support, toolkits, 8, 9	2016-2025
Jeannie Allen	Volunteer support, land cover protocol, 5, 8	2016-2020
Eric Brown de Colstoun	Science, land cover protocol, toolkit activity, 5-6, 8	2018-2020
Siddharth Jasti	Intern, land cover satellite match, 8	2023
Jessica Mo	Intern, data quality, 7	2023
Allison Swann	Intern, GO C3, 8	2022
Matthew Starke	Intern, data quality analysis, 7	2019
Ashlee Autore	Science (clouds/eclipse), Eclipse protocol, 5-6	2024-2025
Rosalba Giarratano	Volunteer engagement, Spanish Comm, 8-9	2024-2026
Tina Ballinger	Camps, Volunteer engagement, 8	2016-2026
Brant Dodson	Science (clouds/eclipse), 6	intermittent
Jason Welsh	Science (clouds), 6	2021-2022
Logan Butler	Intern, land cover satellite match, 8	2025
Peter Falcon	Volunteer management, 8	2016-2025
Heather Fischer	Evaluator, 3-4, 8	2019-2026
Martin Storksdieck	Evaluator, 3-4, 8	2016-2026
Matthew Nyman	Evaluator, 3-4, 8	2020-2026
Nancee Hunter	Evaluator, 8	2018-2019
Lisa Dallas	GSFC DIS manager, 2-7	2017-2025

Team Member	Roles and documentation sections that describe GO work	Time on Observer
David Overoye	DIS manager, 2-10	2016-2025
Cornell Lewis	DIS, website, 9	2016-2025
Dixon Butler	Sr Advisor, 2-10	2016-2025
*Joseph Wieclawek	DIS lead app developer, 4-5	2016-2026
Harman Smith	DIS graphic designer, 4, 8-9	2016-2025
John Schimmels	DIS GLOBE Database, 4-6	2016-2026
Adarsh Ravindran	DIS, 4	intermittent
Ashwin Ravindran	DIS, 4	intermittent
Andrew Clifford	DIS	intermittent
Bryan Littlefield	DIS system administrator, 7, 9	intermittent
Elizabeth Johnson	DIS, tester, 4	intermittent
Sean Graham	DIS, interface design, 4, 9	intermittent
Daniel Balandran	DIS	intermittent
Benny Chan	DIS, 4	intermittent
Donovan Theseira	DIS	intermittent
Jessica Beelie	DIS	intermittent
Eve Terrill	DIS	intermittent
Kyle Liu	DIS	intermittent
Ben Luker	DIS	intermittent
Stella Xsin	DIS	intermittent

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Appendix C2: Publications Table with Topic Notations (Chronological)

A [spreadsheet version of this publications table](#) that can be sorted or filtered by topic is available (internal NASA document).

Publication	Year Published	Clouds	Mosquito Habitat Mapper	Land Cover	Trees	Eclipse	App General	Data Quality	Data Quantity	Data Distribution / Geog. Coverage	Data Processing / Modeling	Science results	Applications	Remote Sensing	Education	Evaluation / Outreach Impact
Chambers et al. (2003) , The CERES S'COOL Project.	2003	x						x	x					x	x	x
Ault et al. (2006) , Validation of the MODIS snow product and cloud mask using student and NWS cooperative station observations in the Lower Great Lakes Region.	2006	x										x		x		
Chambers et al. (2017) , CERES S'COOL Project update: The evolution and value of a long-running education project with a foundation in NASA Earth science missions.	2017	x						x	x			x		x	x	x
Spellman et al. (2018) , Connected climate change learning through citizen science: an assessment of priorities and needs of formal and informal educators and community members in Alaska.	2018														x	x
Aikpon, Dramane et al. (2019) , Larval breeding characteristics and distribution of Aedes mosquito species in the economic capital of Benin: A public health concern.	2019		x										x			

Publication	Year Published	Clouds	Mosquito Habitat Mapper	Land Cover	Trees	Eclipse	App General	Data Quality	Data Quantity	Data Distribution / Geog. Coverage	Data Processing / Modeling	Science results	Applications	Remote Sensing	Education	Evaluation / Outreach Impact
Colón Robles et al. (2019) , Integrating tech: making science come alive with clouds.	2019	x													x	
Dodson et al. (2019) , Eclipse across America: Citizen science observations of the 21 August 2017 total solar eclipse.	2019	x				x		x	x	x	x	x		x		
Hayden et al. (2019) , GLOBE: Connecting a community of observers directly to NASA satellites.	2019	x												x	x	x
Muñoz et al. (2019) , Mosquitoes and public health: Improving data validation of citizen science contributions using computer vision.	2019		x								x		x			
Rahman et al. (2019) , Validation of GLOBE citizen science air temperature observations using data from the Great American Solar Eclipse.	2019					x		x	x	x		x				
Weaver, Davis, & Giddens (2019) , Can an app change how you see the world? GLOBE Observer for interpreters.	2019			x			x									x
Weaver, Kohl, et al. (2019) , How cool was the eclipse? Collecting Earth science data with citizen scientists and GLOBE Observer.	2019	x				x			x	x					x	x

Publication	Year Published	Clouds	Mosquito Habitat Mapper	Land Cover	Trees	Eclipse	App General	Data Quality	Data Quantity	Data Distribution / Geog. Coverage	Data Processing / Modeling	Science results	Applications	Remote Sensing	Education	Evaluation / Outreach Impact
Amos et al. (2020) , GLOBE Observer Data: 2016–2019.	2020	x	x	x	x	x	x	x	x	x	x					
Boger et al. (2020) , Identifying hurricane impacts on Barbuda using citizen science ground observations, drone photography and satellite imagery.	2020			x						x			x	x		
Colón Robles et al. (2020) , Clouds around the world: How a simple citizen science data challenge became a worldwide success.	2020	x							x	x		x		x		x
Campbell (2021) , ICESat-2 and the Trees Around the GLOBE student research campaign: Looking at Earth's tree height, one tree at a time.	2021				x									x	x	
Cho et al. (2021) , The STEM Enhancement in Earth Science "Mosquito Mappers" virtual internship: Outcomes of place-based engagement with citizen science.	2021		x	x											x	
Fischer et al. (2021) , Going beyond hooked participants: The Nibble-and-Drop Framework for classifying citizen science participation.	2021					x										x

Publication	Year Published	Clouds	Mosquito Habitat Mapper	Land Cover	Trees	Eclipse	App General	Data Quality	Data Quantity	Data Distribution / Geog. Coverage	Data Processing / Modeling	Science results	Applications	Remote Sensing	Education	Evaluation / Outreach Impact
Kohl et al. (2021) , GLOBE Observer and the GO on a Trail data challenge: A citizen science approach to generating a global land cover land use reference dataset.	2021			x				x	x	x		x		x		x
Low, Nelson, et al. (2021) , Adopt a Pixel 3 km: A multiscale data set linking remotely sensed land cover imagery with field based citizen science observation.	2021		x	x				x	x	x	x			x		
Low, Boger, et al. (2021) , GLOBE Mosquito Habitat Mapper citizen science data 2017–2020.	2021		x					x	x	x			x			
Carney et al. (2022) , Integrating global citizen science platforms to enable next-generation surveillance of invasive and vector mosquitoes.	2022		x								x		x			
Dodson et al. (2022) , Do citizen science Intense Observation Periods increase data usability? A deep dive of the NASA GLOBE Clouds data set with satellite comparisons.	2022	x						x	x	x	x	x		x		

Publication	Year Published	Clouds	Mosquito Habitat Mapper	Land Cover	Trees	Eclipse	App General	Data Quality	Data Quantity	Data Distribution / Geog. Coverage	Data Processing / Modeling	Science results	Applications	Remote Sensing	Education	Evaluation / Outreach Impact
Enterkine et al. (2022) , The potential of citizen science data to complement satellite and airborne lidar tree height measurements: lessons from The GLOBE Program.	2022				x			x	x	x		x		x		
Freeman et al. (2022) , Utilizing citizen science to model the distribution of Aedes aegypti in West Africa.	2022		x								x		x			
Low et al. (2022) , Building international capacity for citizen scientist engagement in mosquito surveillance and mitigation: The GLOBE Program's GLOBE Observer Mosquito Habitat Mapper.	2022		x	x				x	x	x		x	x		x	x
Manzanarez et al. (2022) , Land use land cover labeling of GLOBE images using a deep learning fusion model.	2022		x								x					
Polineni et al. (2022) , MOSQUITO EDGE: An edge-intelligent real-time mosquito threat prediction using an IoT-enabled hardware system.	2022		x								x	x	x			
Sun et al. (2022) , Predicting future mosquito larval habitats using time series climate forecasting and deep learning.	2022		x								x	x				

Publication	Year Published	Clouds	Mosquito Habitat Mapper	Land Cover	Trees	Eclipse	App General	Data Quality	Data Quantity	Data Distribution / Geog. Coverage	Data Processing / Modeling	Science results	Applications	Remote Sensing	Education	Evaluation / Outreach Impact
Surasiang et al. (2022) , Mosquito larva distribution and natural Wolbachia infection in campus areas of Nakhon Ratchasima, Thailand.	2022		x							x			x			
Carney et al. (2023) , Citizen Science as an approach for responding to the threat of Anopheles stephensi in Africa.	2023		x							x	x		x			
Huang et al. (2023) , Land cover mapping via crowdsourced multi-directional views: The more directional views, the better.	2023			x							x	x				
Uelmen Jr. et al. (2023) , Global mosquito observations dashboard (GMOD): creating a user-friendly web interface fueled by citizen science to monitor invasive and vector mosquitoes.	2023		x	x							x		x			
Abdelkader et al. (2024) , A Google Earth Engine platform to integrate multi-satellite and citizen science data for the monitoring of river ice dynamics	2024			x							x	x	x	x		
Edson et al. (2024) , Practical applications of a participatory science project evaluation tool: Perspectives from across Earth and space science.	2024															x

Publication	Year Published	Clouds	Mosquito Habitat Mapper	Land Cover	Trees	Eclipse	App General	Data Quality	Data Quantity	Data Distribution / Geog. Coverage	Data Processing / Modeling	Science results	Applications	Remote Sensing	Education	Evaluation / Outreach Impact
Giarratano et al. (2024) , GLOBE Eclipse workshop engages educators in Earth science research.	2024	x				x									x	
Nelson et al. (2024) , GLOBE Observer: A case study in advancing Earth system knowledge with AI-powered citizen science.	2024		x	x			x				x		x	x		
Patil et al. (2024) , Review of earth observation techniques and citizen science approach for biodiversity hotspot study.	2024						x						x	x		x
Tarosky (2024) , Annular solar eclipse.	2024	x				x										x
Autore et al. (2025) , GLOBE Eclipse 2024: A case study of the effects of the April 2024 total solar eclipse on cirrus clouds and contrails in the United States of America.	2025	x				x					x	x		x		
Carney et al. (2025) , Artificial Intelligence and Citizen Science as a Tool for Global Mosquito Surveillance: Madagascar Case Study.	2025		x								x	x	x			

Publication	Year Published	Clouds	Mosquito Habitat Mapper	Land Cover	Trees	Eclipse	App General	Data Quality	Data Quantity	Data Distribution / Geog. Coverage	Data Processing / Modeling	Science results	Applications	Remote Sensing	Education	Evaluation / Outreach Impact
Chambers et al. (2025) , Uniting Under the Eclipse: A Mega-Collaboration to Activate Science Learning Across the Penumbra and Beyond.	2025	x				x			x	x					x	x
Dooder et al. (2025) , Mangrove biomass productivity and sediment carbon storage assessment at selected sites in Mauritius: the effect of tidal inundation, forest age and mineral availability	2025				x							x		x		
Lu et al. (2025) , Use of GLOBE Observer Citizen Science Data to Validate Continental-Scale Canopy Height Maps Derived from ICESat-2 and GEDI.	2025				x			x	x	x	x	x		x		

Appendix D: White Papers/Detailed Reports/Other References

Appendix D1: NASA GLOBE Observer for Afterschool Science – Year 1 Needs Assessment Report

The [NASA GLOBE Observer for Afterschool Science - Year 1 Needs Assessment Report](#) was written by Martin Storksdieck from the Oregon State University evaluation team for GLOBE Observer, describing the discuss at the 4-H/NASA GLOBE Observer Citizen Science Workshop, held November 9-10, 2026 at NASA's Goddard Space Flight Center, Greenbelt, MD 20771.

Appendix D2. Exploring AWS Rekognition to Decrease Manual Photo Approval

The [Exploring AWS Rekognition to Decrease Manual Photo Approval white paper](#) was written by Matthew Bandel from the Data and Information System team in October 2020 to describe the process for using artificial intelligence photo analysis for the process of approving photo sent to the database from GLOBE Observer.

Appendix D3: Nibble and Drop: Why do Volunteers Drop Out of Volunteer Science Programs?

The [Nibble and Drop: Why do Volunteers Drop Out of Volunteer Science Program?](#) slides were presented by Heather Fischer from the Oregon State University evaluation team for GLOBE Observer at the Citizen Science 2019 conference held in Raleigh, NC from March 12-17, 2019. The presentation contains preliminary results for a paper later published in Citizen Science: Theory and Practice ([Fischer et al., 2021](#)).

Appendix D4: GLOBE Observer Eclipse Report 2023-2024

The [GLOBE Observer Eclipse Report 2023-2024](#) was prepared by the GLOBE Observer team (lead by Holli Kohl, project coordinator), to gather information about eclipse-related activities into a single document and sum up the extensive efforts of the NASA Earth Science Education Collaborative during the October 2023 and April 2024 eclipses.

Appendix D5: Quality Assurance Code Documentation

Definition of Quality Flags

The quality flags developed for GLOBE Observer Land Cover, as the first protocol to be assessed in detail, are defined as follows:

Datetime Quality Flags:

Date or time of Measurement is in the Future (DF)

This flag indicates errors in time stamps or potential data entry errors since it's impossible that an observation is recorded in the future.

Date or time of Measurement is Invalid (DI)

A date or time invalid flag may be due to incorrect formatting, non-existent dates, or other errors that make datetime measurement unusable.

Date or time of Measurement is before 1995 (DO)

The GLOBE Program started in 1995 so measurements before 1995 do not exist.

Date or time of Measurement is at Midnight UTC (DZ)

Measurements at exactly midnight UTC resulting from default values or logging data errors might be suspect.

Date or time of Measurement Attribute is Missing (DX)

When date or time values are missing in datasets, temporal trends may be difficult to analyze due to incomplete data.

Elevation Quality Flags

Elevation is Invalid (Not a Number) (EI)

Non-numeric values in elevation may lead to datasets being unusable.

Elevation is Coded as Missing (EM)

Missing elevation data could result in incomplete data, which makes elevation-related trends difficult to analyze.

Elevation is Outside of Expected Range (-300 m to 6000 m) (ER)

Typical range of elevation values is from -300 m to 6000 m. Outside of this range, such as values below -300 m or above 6000 m, indicate errors or values that need verification or consideration.

Elevation Attribute is Missing (EX)

Missing elevation attributes may result from errors in data entry or incomplete dataset.

Location Quality Flags

Location is Not a Valid Latitude/Longitude Pair (LI)

Latitude values should be between -90 and 90 degrees. Longitude values range from -180 to 180 degrees. Values outside of these ranges are invalid.

Location May be Over a Lake (LL)

Especially for land cover data, observations over water bodies, such as lakes, may need consideration or verification.

Latitude & Longitude Exactly Match (LM)

When observations show matching latitude and longitude values, this may indicate an error in data entry.

Location May be Over Ocean (LW)

For the same reason as location may be over a lake, observations that indicate location over ocean need further verification or consideration.

Latitude and/or Longitude are Integers (LZ)

Latitude and/or longitude values are normally written in decimals; rarely are they in integer form (e.g. 60.0000 degrees). Thus, locations that show latitude and/or longitude in integers may indicate rounding errors or default values.

Other Flags

Photo Duplicate Flag (PD)

Duplicate photo detected within the same observation.

Step-by-Step Explanation of the Code

The Jupyter Notebook code starts by importing necessary libraries such as geopandas for handling geospatial data and pandas for managing and manipulating tabular data; shapely for geometric operations; datetime for handling date and time formats; hashlib for generating image hashes to detect duplicate photos; and requests for downloading and verifying photos.

This is followed by loading GeoJSON data for the protocol and time period to assess and filtering to include only observations taken through the GLOBE Observer app. Then the GeoJSON data is converted into pandas DataFrame for a row-by-row analysis.

The next step is to reformat timestamps from YYYY-MM-DDThh:mm:ss to a standard YYYYMMDDhhmm format. For the code to work properly, we create a new column with the converted timestamp and call it "landcoversMeasuredAt_new."

Then we create a unique dataID for each observation by joining protocol, sitelid, landcoversUserId, and landcoversMeasuredAt_new. The other columns in the DataFrame remain the same. Next we position dataID as the first column in the DataFrame.

The next step for the assessment of land cover data is to define the quality flags we use to check land cover data by creating a List of Data Quality Flag dictionaries with two-letter symbols as a key and meaning as value for datetime, elevation, location, and photo duplication.

The quality flag check starts with photo duplication. First, we initialize a dictionary for hashes for each image URL in a global cache. By providing a global cache to store hashes in a dictionary, we can speed up the process by using comparison with later hashes. Next, we create a function to check duplicate photos within the same observation. The process involves downloading the image from the provided URL and returning its SHA-256 hash, which is cached. For each observation, we download each available photo, calculate its hash, and check whether the same hash appears more than once. The code returns "PD" if a duplicate is found, otherwise it returns "None". While the initial photo duplication checks are only within an observation, a further useful development direction would be to compare photos between observations, especially those in close geographic and temporal proximity, to detect someone submitting multiple copies of the exact same photos repeatedly.

After the code checks for photo duplicates, it now goes through the rest of data quality checks for date and time, elevation and location quality checks, starting first with loading shapefiles for both lakes and oceans. First it loads ocean and lake shapefiles from the local directory. Then it converts shapefile geometries to Shapely objects and extracts ocean and lake shapes using `get_shapes`. Then the function checks if an observation latitude and longitude is within any of the provided shapes in the shapefiles. It loads and processes shapefiles to determine if points fall within lakes or oceans.

We then create a function to check quality flags (date and time, elevation and location) for each observation as defined in [section 7.1](#). Using `gdf.apply`, we check quality flags for each row of observations. We display the DataFrame with quality flags for a quick check.

For efficiency and clarity, we rename the columns to shorter column names. Then, we reorder the columns to facilitate better logic and usage of data.

We save the updated DataFrame to a new CSV file. This step exports the cleaned and processed data to a CSV file in the local directory. An optional step is to provide a quick check of output in `dataId` and `qualityFlags` columns prior to seeing the entire new CSV file.

The complete Jupyter Notebook code and documentation is found in [Zenodo](#).

Appendix D6: Engaging and Sustaining our Lifelong Learners

Perspectives

The global population is getting older, and projections indicate that over 21% of people worldwide will be over the age of 60 by the year 2050. This large and voting portion of society is often left out of science outreach and should be invited to participate as we face the mounting and complicated issues across the globe. Being engaged in citizen science efforts also serves to improve both mental and physical health for this audience. Retirement can lead to social isolation, which has been linked to health problems including heart disease and early death. Motivations are more related to personal benefits, such as increasing their own background knowledge and holding values which lead them to being involved in environmentally related activities. Once motivations and needs for this audience are better understood in the context of GO, then recruitment strategies and retention methods can be tailored accordingly.

Best Practices

- Find ways to engage with this audience within the network of organizations who already serve and recruit them. These range from efforts focused on this audience, such as local senior and community centers, Road Scholars, and Lifelong Learning Institutes; to larger organizations that include lifelong learners (LLL) as well as other age groups, such as public libraries, Sci Starter, and others.
- Having varied options for engagement is important. These can include shorter 2-week “campaigns”, engagement with SME’s who provide context and show value for their observations, as well as monthly emails highlighting the work being done by these citizen scientists as well as showcasing specific people to keep them engaged and their efforts noted. This audience is not as motivated by being involved in scientific papers as much as by knowing they are involved and engaged in efforts to serve a larger good or to be useful. Providing updates on NASA science is very valuable to this audience, as well as other resources they can access to learn more about topics of interest.
- Providing multiple ways of being engaged is essential. Considering a continuum that includes stand-alone efforts, multigenerational activities, working with formal/informal education as a volunteer, as an aspect of work they are doing with a larger project (Master Gardener, Audubon, etc.). Providing “case studies” of how the different ways that GO LLL are getting involved and sustaining their engagement would be useful.
- LLL are interested in sharing their stories and their work with others. This aspect of LLL could be considered by sharing case studies, having a monthly email showcasing people and their efforts, having a dedicated webpage with GLOBE to share these (similar to [GLOBE Stars](#)).
- Lack of available time, waning interest in the topic, overly complicated protocols, and web/app design that is hard to read or understand become the main reasons for not starting or dropping out. Being able to monitor the needs and interest as well as the goals is important in maintaining their involvement.
- Evaluation results from NESEC’s “*Nibble and Drop*” research ([Fischer et al. 2021](#)) suggested that this audience were statistically more likely to cite contributing to NASA research and science as their primary motivations for joining the program. They also found that this audience ceased participation in GO was that they felt they were not making a meaningful contribution or when if they didn’t receive feedback and felt they were not doing a good job.

Lifelong Learners Literature Review

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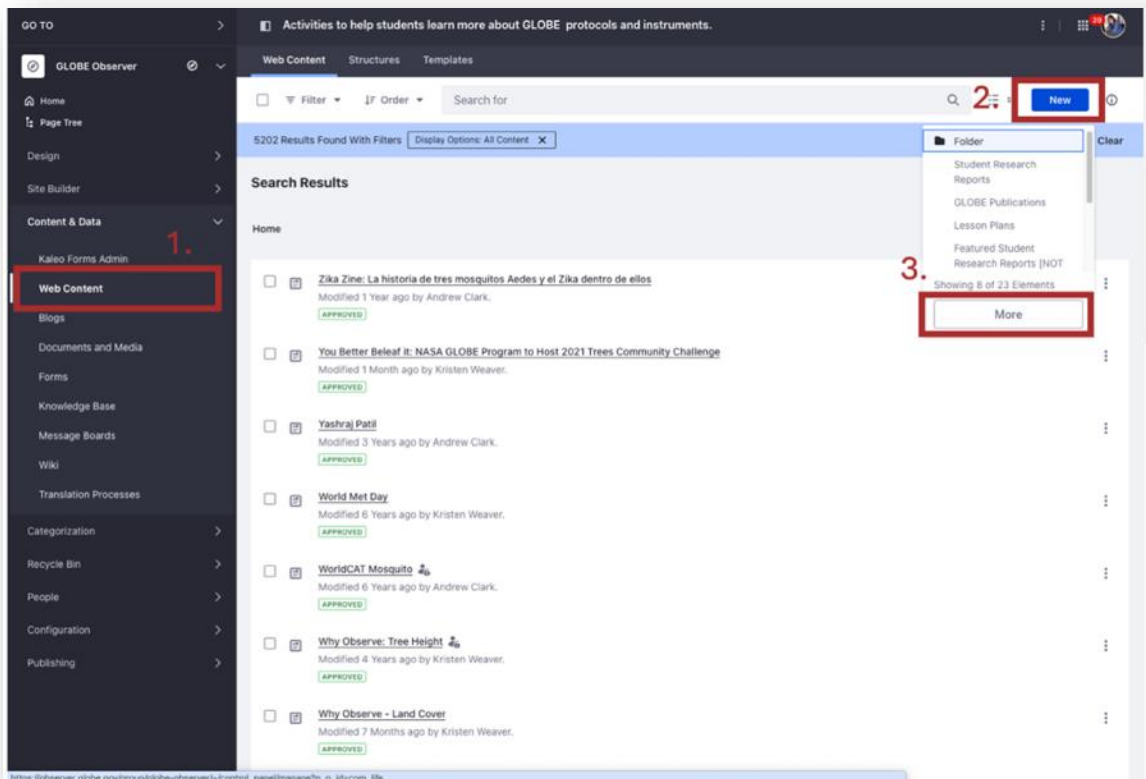
Appendix E: How-to Documents

Appendix E1: GLOBE Observer Content Types & Liferay How-To

Overview

A broad descriptive view of the GLOBE Observer website can be found in documentation [Section 9.4: Website](#), especially in subsections [9.4.8: News, Events, and People](#), [9.4.9: Publications](#), and [9.4.10: Liferay Structures](#). This appendix is intended to serve as a more detailed how-to manual about how content of various types is added to the GLOBE Observer website. For more general website management, the Data and Information Services Team documented [Managing Content on the GLOBE Website – Liferay 7.4](#) in a separate document.

Many of the pages on the GLOBE Observer website use Liferay Asset Publishers in combination with protocol type labels and tags to automatically pull Web Content Articles of various template types to the right location(s). To add any new content type, whether originally created by the DIS team or created by the Observer team later, you first need to be logged into a GLOBE account with the proper privileges. Then, from the left-hand menu, under GLOBE Observer, select *Content & Data* and *Web Content*. If the left-hand menu pictured below isn't visible, use the icon to expand it. From the upper right corner, select the button that says *New*. As of the Liferay 7.4 update, you will need to then select the *More* button and select the type of content you wish to create. (There may be a way to adjust the favorites list to avoid this step.)



To find an existing Web Content item to edit, you can search by name, using the bar at the top, although it may be easier to first filter by structure type (Observer News, Observer Events, etc.) to limit the options that come up, especially with common terms. You can also filter to show only items you've added to the system.

As of the Liferay 7.4 update, the selection of content items for an Asset Publisher using either the dynamic or manual options is deprecated, so at some point the third option of creating a collection may be necessary for all of the instances described below.

Observer News

This content type is also referred to informally as blogs, especially the regular (approximately monthly) science blogs provided by the science leads or guest scientists. It is distinct from the News content type used on the main GLOBE website.

Main components:

- *News Title*
- *News Date* (items appear on the News list page with those with the latest date on top, unless the priority is used differently as described below)
- *News Short Description* (500 characters, appears on the News list page)
- *News Full Text* (appears on the News item detail page)
- *News Thumbnail Image* (215 x 120 pixels)
 - Must be uploaded directly through the form - can't be pre-loaded into the file structure. Images are stored in the "GLOBE Observer News Images" folder, which automatically creates subfolders by year (ex: "News 2025") and month (ex: "August 2025") when images are added.
- *News External URL* (not required, as there is always a landing page for the News item created, but could link to the original source of an article, for example - it creates a text link on "More >>" at the bottom of the News item landing page)

Properties used:

- *Categorization > Protocol Types* - select from Clouds, Eclipse, Land Cover, Mosquitoes, and Trees (Weekly Roundup is no longer used)
- *Categorization > Priority* - in the format YYYYMM.DD, duplicating the news date in most cases
 - We started using this when some news items weren't showing up in the right order in the listing based solely on the date
 - Could also be used to adjust the order of news items posted with the same date, although that is less frequent

Asset Publisher/Display Settings:

The News page uses dynamic asset selection (*Configuration > Setup* tab), choosing all Web Content Articles of the Observer News structure type from within the scope of the GLOBE Observer site (no tags used), and ordering by Priority, then Publish Date. The Display Template (*Configuration > Display Settings* tab) is Observer News Template, which adds the ability to filter items by year and protocol. Other key settings are that ten items are displayed on the page at a time, and when you click on an item title, it opens the news item into a new page (Asset Link Behavior).

Observer Events

This item type is distinct from the Events content type used on the main GLOBE website. Events chosen for posting are those of general interest and availability to a wide group of citizen scientists and/or informal educators, so most events are virtual or cover a large in-person area more than just a specific single location. Events specifically for formal educators/classroom teachers or students are generally left to the main GLOBE site to promote.

Main components:

- *Event Title*
- *Event Start Date* (items appear on the Events list page with those with the latest date on top, unless the priority is used differently as described below)
- *Event End Date*
- *Event Start Time* (not required, but if a start time is given, and end time must also be given)
- *Event Location* (not required)
- *Event Short Description* (500 characters, appears on the Events list page)
- *Event Full Text* (appears on the event landing page)
- *Event Thumbnail Image* (280 x 160 pixels)
 - Must be uploaded directly through the form - can't be pre-loaded into the file structure. Images are stored in the "GLOBE Observer Events Images" folder.
 - Most images seem to have loaded in the main folder noted above, although some have been filed in sub-folders for 2024 and 2025.
- *Event External URL* (not required, but often used to direct to an external registration page)

Properties used:

- *Categorization > Protocol Types* - select from Clouds, Eclipse, Land Cover, Mosquitoes, and Trees
- *Categorization > Priority* - in the format YYYYMM.DD, duplicating the event date in most cases
 - We started using this when some events items weren't showing up in the right order in the listing based solely on the date
 - Can be used to adjust the order of visibility of events with a wide time range, for example the NASA Response Mappers Data Collection spanning from August 1st to October 31st - a priority of 202510.31 was used to keep it near the top of the list throughout that period

Asset Publisher/Display Settings:

The Events page uses dynamic asset selection (*Configuration > Setup* tab), choosing all Web Content Articles of the Observer Events structure type from within the scope of the GLOBE Observer site (no tags used), and ordering by Priority, then Publish Date. The Display Template (*Configuration > Display Settings* tab) is Observer Events Template, which adds the ability to filter items by year and protocol. Other key settings are that ten items are displayed on the page at a time, and when you click on an item title, it opens the content in a new page (Asset Link Behavior).

Observer Features

This item type is distinct from the Feature Stories content type used on the main GLOBE website. While there is not a functional limitation on how many items can be in the rotator at any one time, we try to limit it to no more than five or six simultaneously. While most banners are created by creating a new Observer Features item, the GLOBE Observer Connect item is updated each month with new text and a new image (the URL stays the same, observer.globe.gov/go-connect, but is redirected to the new event page - see more details in the [section about shortened links](#) below).

Main components:

- *Feature Story Title*
- *Feature Story Date* (not generally used, as banners are selected manually for the front-page rotator)
- *Feature Story Blurb* (maximum length 200 characters)
 - Text is added over the banner image on the right hand side. Although the maximum length is 200 characters, only using about 140 characters allows for adding a link at the end of the text description with a cue like “Learn more >” or “Get the game >” or “Watch the videos >”, which is more obvious as a place for users to click than the title, which also will go to the URL in that form field.
 - To add a link as part of the blurb, HTML can be entered in the form field, for example: *See this new cool thing we added to the app!

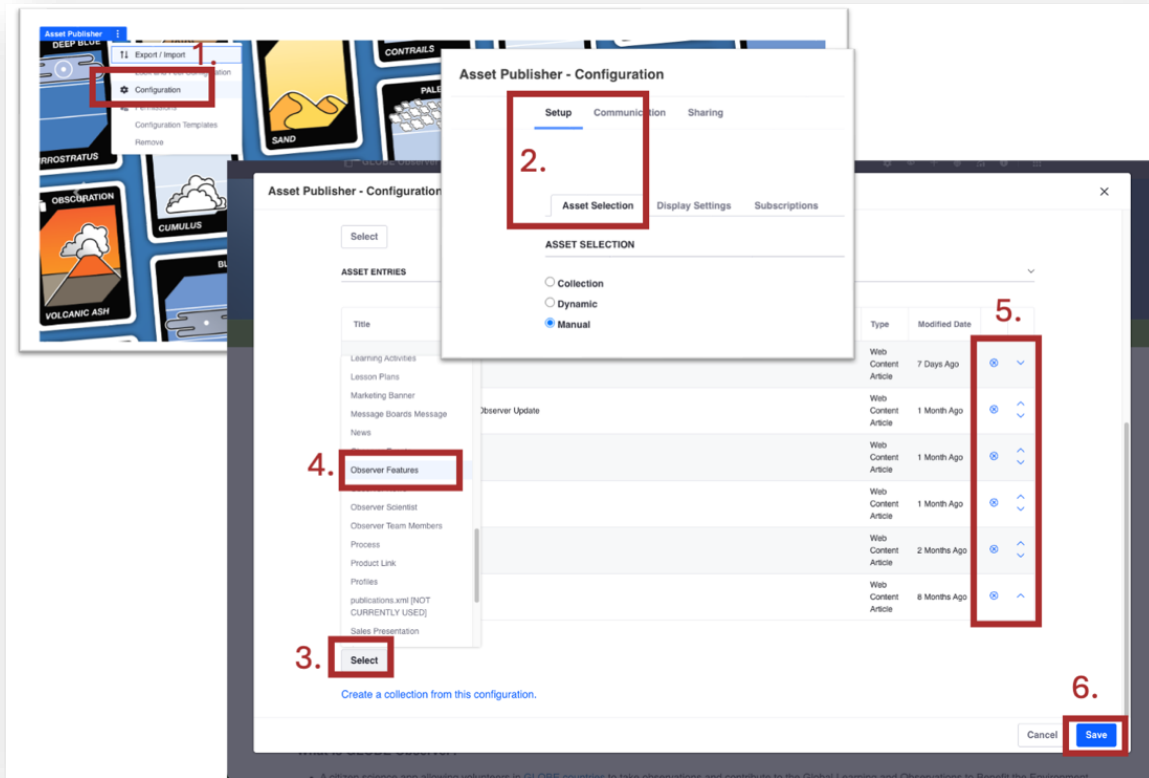
 Learn More >> * (the breaks give a nicer space after the descriptive text itself, and the > or >> after is another visual cue the user will be taken somewhere else)
- *Feature Story Image* (1440 x 640 pixels)
 - The blurb entered above is added as white text with a darkened but transparent background on the right-hand side of the banner image, so key graphical elements are best situated on the left-hand side of the banner image.
 - Although a size for a banner image is given, portions of the top and bottom are cut off depending on the size of the browser window, so it's best to leave a buffer without essential visual elements in those areas.
 - Heather Mortimer, graphic designer for GLOBE Observer, created templates for banners of various types, described more in [section 9.1.1.8](#).
 - The banner images must be uploaded directly through the form - can't be pre-loaded into the file structure. Images are stored in the “GLOBE Observer Features Images” folder
- *Feature Story Image Alt Tag* (alt text for the image)
- *Feature Story URL* (link to a location with more information, often a News or Event item)

Properties used:

No tags or other properties are used for GLOBE Observer Features, as they are added manually to the homepage, as described below.

Adding or removing banner rotator items:

While new banner items are created via the back-end menus as described under the overview above, they are added to (or removed from) the rotator manually through the configuration settings of the Observer Features Asset Publisher on the Observer homepage, under the *Setup* and *Asset Selection* tabs. Scroll down to *Asset Entries*, click the *Select* button, choose *Observer Features*, and select the new banner item to add from the options available. (Recently created items should appear at the top to make it easier.) Features items can be removed or reordered via the x's and arrows on the right. Be sure to save changes with the blue button before proceeding.



Note that the current maximum number of items to display is set at seven, so if more Observer Features are added to the Asset Entries list, they will not all appear. That number can be changed via the *Display Settings* tab. Also in that tab is noted that there is a Display Template for the rotator: *Observer Home - Home Features*.

Observer Scientist

While the content type is labeled as Observer Scientist, the section is called People, and includes scientists and other researchers, informal educators, citizen scientists, etc.

Main components:

- *Prefix* (select from a dropdown list that includes Dr., Mr., Mrs. or Ms. - it is possible to leave this unselected and enter a different title as part of the person's first name if needed). As of December 2025, not selecting a title will result in a stray "." listed before the name on the page (a ticket is in the system to correct this error).
- *First Name*
- *Middle Initial* (not required)
- *Last Name*
- *Title*
 - For purposes of the People profiles, this is the role of the person, such as "Research Scientist," "Children's Librarian," or "Citizen Scientist" as just a few examples.
- *Email* (field not used)
- *Organization* (field not used)
- *Website* (field not used)
- *Thumbnail Image* (224 x 280 pixels)
 - Main profile image must be uploaded directly through the form - can't be pre-loaded into the file structure. Images are stored in the "GLOBE Observer Scientists Images" folder.
 - In some cases, sub-folders were created to hold other images used in the profiles.
- *Short Blurb* (appears on the People list page along with name, title and thumbnail image, and at the top of the profile landing page)
- *Full Text*
 - The general format has varied from a series of questions and answers to video interviews to prose. The profile image will appear at the top of the profile landing page, but additional images can be added with the text if desired.

Properties used:

- Categorization > Protocol Types - select from Clouds, Eclipse, Land Cover, Mosquitoes, and Trees if the person being profiled is associated strongly with a particular tool. Selecting a protocol type will allow the profile to be listed on the tool landing page under "GLOBE Observer Now."

Asset Publisher/Display Settings:

The People page uses dynamic asset selection (*Configuration > Setup* tab), choosing all Web Content Articles of the Observer Scientist structure type from within the scope of the GLOBE Observer site (no tags used), and ordering by *Publish Date* then *Title*. The Display Template (*Configuration > Display Settings* tab) is Observer People Template, which adds the ability to filter items by protocol. Other key settings are that ten items are displayed on the page at a time, and when you click on an item title, it opens the news item into a new page (Asset Link Behavior).

Note: The Liferay 7.4 update introduced an extra {} that appears between the title and the short blurb at the top of the profile landing page. As of October 2025, a ticket has been submitted to correct the issue.

Observer Team Members

Main Components:

- *Content* (field not used - artifact from how the structure type was created)
- *Team Member Photo* (cropped to a square)
- Team Member Name
- *Team Member Affiliation* (for example NASA Goddard, NASA Langley, IGES, etc.)
- *Short bio* (one or two sentences describing what the person does for the GLOBE Observer team and where they are based)
- Team Role
 - Categories are: Project Management, Communications, Science and Community Liaisons, Clouds, Mosquito Habitat Mapper, Land Cover, Trees, Technology Development, Evaluation and The GLOBE Program
- *Personal Webpage* (linked to GLOBE MyPage for individuals, and the GLOBE Implementation Office page for the GLOBE Program entry)

Properties used:

No tags or other properties are used for Observer Team Members, as the content is added manually to the appropriate section. When added to a page, the individual web content display for each should use the "GLOBE-OBSERVER-TEAM-TEMPLATE" display template. That should occur by default, but if not, it can be selected from the *Web Content Display > Configuration > Template*.

Adding or removing team members:

Unlike many of the other pages using Liferay structures, the GLOBE Observer Team page doesn't use an Asset Publisher but instead uses a series of Web Content Displays with the appropriate Observer Team Member content item manually selected. Removing team members can be used by simply removing the appropriate Web Content Display box using the menu from clicking the three dots that appear when you hover over the item in question. To add a new team member, first create the appropriate Web Content Article, then add to a new Web Content Display in the appropriate section of the page.

GLOBE Observer Publications and Presentations

This item type is distinct from the GLOBE Publications content type, which populates to the main GLOBE website. While initially both publications and presentations were entered, as more publications were produced, we focused on them. The last section of presentations and posters is from 2021. If bringing that section up to date, or adding date ranges to the publications to make the list more navigable, the presentations and posters section uses an “Observer Presentations - Collapsible Display” template, found in the *Asset Publisher > Configuration > Setup* tab.

Main Components:

- *Content* (field not used - artifact from how the structure type was created)
- Publication or Presentation Title
- *Publication or Conference Logo* (can be uploaded through the form, or pre-loaded and selected)
- *Citation* (publication or presentation citation in APA format)
- *Abstract URL* (full URL for the presentation or publication abstract)

Properties used:

- The Default Template should be changed to GLOBE-OBSERVER-PUBLICATION-TEMPLATE (as opposed to the PublicationTitlesURLs option when is the default when a new publication is added)
- *Categorization > Tags* - more details are given in [section 9.4.10.3](#), but all items on this page receive the tags “go,” “scientist” and either “scientific publication” or “scientific presentation.” A tag for the year (2024, 2025, etc.) is required for sorting presentations and could be used for future sorting of publications. Tag(s) for the tools referenced are also needed (clouds, land cover, trees, mosquitoes, eclipse)
- *Categorization > Priority* - in the format YYYY.MM, to allow ordering based on publication date rather than when publications are added (given the frequency of publications is comparatively less than News or Events, only the year and month are used)

Asset Publisher/Display Settings:

The top of the Publications page uses dynamic asset selection (*Configuration > Setup* tab), choosing all Web Content Articles of the Observer Publications and Presentations structure type from within the scope of the GLOBE Observer site with the tag “scientific publication” and ordering by *Priority* then *Modified Date*. The Display Template (*Configuration > Display Settings* tab) displays the full content without using a template of any sort.

For the Presentations and Posters section of the page, which is set up for years 2017 to 2021, there are separate Asset Publishers for each year. The selection of resources is with the tags “scientific presentations” and whatever year is appropriate for each Asset Publisher (2021, 2020, etc.), ordered by *Priority* then *Modified Date* as above. Each year is separately collapsible, using the Display Template Observer Presentations - Collapsible (*Configuration > Display Settings* tab).

GLOBE Observer Web Content Resources (and 5-URL variation)

The GLOBE Observer Web Content Resources structure was created as a way to have one entry for different materials that could then be pulled onto various pages of the GLOBE Observer website as appropriate using tags. This way, any changes (updated file versions, descriptive text changes, etc.) only need to be made in one place to be reflected everywhere that resource appears. These structures are especially used on the Resource Library pages for each of the GLOBE Observer tools but have also been used to pull resources onto challenge landing pages or other collections such as the At Home or Spanish resources pages.

The GLOBE Observer Web Content Resources - 5 URLS resource type was created as a complement to the original Web Content Resources type when we realized that some resources, especially those with translations or other multiple versions, couldn't fit all in one entry. The main components are overall the same, with the differences outlined below. Note that Liferay sees these as two different structures, so you have to search within the type you are looking for and add them both as types in the configuration settings to make all resources of the original or 5 URL variations appear in the same list.

Main Components:

- *Resource Title* (descriptive title to be displayed to the user)
- *Resource Thumbnail* (can be uploaded through the form, or pre-loaded and selected from the file structure)
 - Note: There was a field for an Image Description for the Resource Thumbnail to include alt text for the image, but that is gone after the Liferay 7.4 update
- *Description of Resource* (displayed everywhere the resources appears, so keep short)
- Options for linking a resource (only one is needed, but multiple can be used)
 - *Upload Local Resource File* (4a) and corresponding Anchor Text (4b)
 - ◆ For files that will live on the GLOBE Observer website
 - ◆ Navigate to the appropriate subfolder of GLOBE Observer Resources before uploading files, or upload ahead of time through the Documents and Media menu and navigate to the correct location
 - *External Resource Page URL* (5a) and corresponding Anchor Text (5b)
 - ◆ Primarily for external resources that have a landing page with a URL, but can also be used for an internal GLOBE Observer page or resource by copying and pasting the URL
 - ◆ For the 5 URLS variation, these are labeled External Resource URL #1, External Resource URL #2, etc., but operate the same way otherwise
 - *External File URL* (6a) and corresponding Anchor Text (6b)
 - ◆ While labeled specifically to link to a file stored elsewhere, this can just point to a second URL in a regular GLOBE Observer Web Content Resources structure, whether a file or a webpage.
 - ◆ For the 5 URLS variation, all external options are simply labeled External Resource URL #1 (5a/5b), External Resource URL #2 (6a/6b), etc.

- *Additional External URL* and *Anchor Text* fields (not used - artifact from how the structure type was created)
- Preferred Resource Link
 - Choose between one of the three options above which will be linked from the *Resource Title* and *Resource Thumbnail*
 - If only one of the three link options is included and no anchor text is provided, this will be the only link in the resource entry
 - For the 5 URLs variation, the preferred link can only be the local resource file or URL #1, so keep that in mind when entering the URLs in the appropriate form fields.

Best Practices for Anchor Text:

- The anchor text should be the title of the document or another useful (short) description.
- If more than one of the resource link options above is chosen, anchor text should be provided, which will appear below the description in the entry.
- While not universally applied when creating resources, it's helpful to users to specify what the link will take them to, especially if it's to download a document, and if there are multiple file types (ex: PDF or XLSX for eclipse paper data sheets, PPT versus PDF for presentation slides, etc.) or if the link will go to an external location (ex: YouTube for a video)
- For resources that have multiple versions (ex: different languages, vertical/versus horizontal formats of the video, one-pager versus a brochure with the same content, etc.) that is also ideally specified in the anchor text.
- For videos, the length of the video should be specified either at the beginning of the description or as part of the anchor text.
- Especially for large downloads (ex: PPT files with lots of visuals, MP4 versions of videos, etc.), it can also be helpful to specify the size in MB so users know before they click.

Properties used:

- *Categorization > Tags* - more details are given in [Section 9.4.10.3](#). All items receive the "go" tag to mark it as a GLOBE Observer resource. Additional tags are for audience ("observer" for individual volunteers or "facilitator" for those leading programs) and then for resource type (video, activity, reference, etc.). Tag(s) for the tools referenced are also needed (clouds, land cover, trees, mosquitoes, eclipse), and any specific tags for languages or other specialty tags.

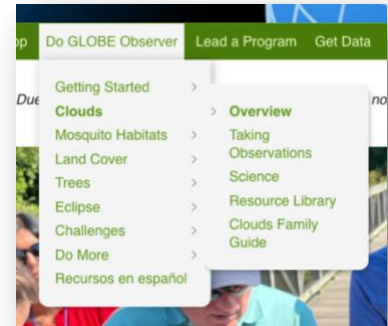
Asset Publisher/Display Settings:

The exact settings needed are going to depend on which page (and section of the page) the resources are being displayed. In general, most resource lists use dynamic asset selection (Configuration - Setup tab), choosing all of the Web Content Articles of the GLOBE Observer Web Content Resources and/or GLOBE Observer Web Content Resources 5 URLs structures from within the scope of the GLOBE Observer site, and then with whatever tags are appropriate. For most instances, ordering is by Title for alphabetical order. The tool-specific resource libraries have multiple Asset Publishers each for one type of resource, for

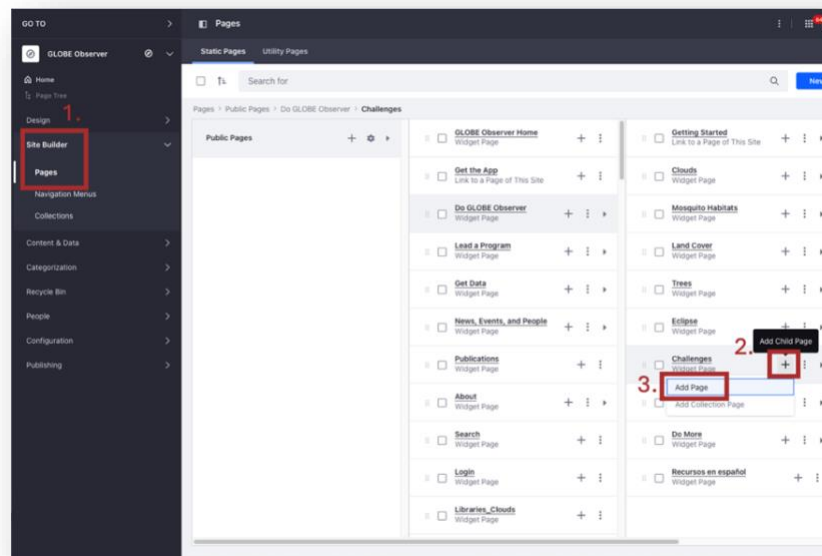
example Activities or Videos. The Display Template (Configuration - Display Settings tab) displays the full content without using a template of any sort. In some cases, manual selection may be more appropriate, especially if only a few resources are being pulled for a specific purpose. As one example, the highlighted resource at the top of the [GLOBE Observer At Home page](#) is manually selected, and can be updated to feature a new resource when desired.

Creating a New Page

New pages are added via the left-hand menu under *Site Builder* and *Pages*. All pages are under the *Public Pages* section. In the top level, you will see the main pages that appear in the navigation menu. Below that are pages created at the top level for navigation purposes, or “pages” that are really links to other locations (see more in the sections about shortened links below), both of which are hidden from navigation. You don’t want to add anything at this top level without hiding it from navigation. Within the main sections, you will see subsections. In general, items will appear in the navigation menus to the third subsection, so for example, the main Do GLOBE Observer menu branches to Clouds and then subpages like Overview, Taking Observations, etc.



To add a new page, navigate to the correct sub-section (for example *Challenges* in the image below), and then click on the plus sign, and select *Add Page*. You will see a few options, but for an actual new page (rather than the shortened links as described below), the Content Page Template for either “Article Page” or “Article Page - Right Rail” will create a new page of the Content Page type with the appropriate formatting, including the breadcrumb navigation at the top of the page. As of this writing in October 2025, most of the pages are still the old Widget Page type, although eventually the goal is to convert many of them to the new type. For any Widget Pages that are converted to Content Pages, the “Master Observer” template should be selected from the Basic Templates options, to ensure that all the Liferay fragments not used by the GLOBE website are hidden.



A box will pop up to enter the name of the page. When there are spaces between words, they will be replaced with a dash, for example, “Do GLOBE Observer” becomes “/do-globe-observer.” The most important option in the configuration menu, after the name, is the “Hidden from Menu Display” selector box, which allows work on a page as a draft before it’s ready to be added to the menus, or placing a page in the logical location in the website structure, without the intention of adding it to the menu. As an example, while there have been nearly 20 different data collection challenges that appeared in the menu structure under *Do GLOBE Observer > Challenges* when they were active, only the most recent three are kept visible in that menu, with an entry for “Past Challenges” as a “Link to a Page of This Site” option that goes to the landing page for challenges with all of them listed.

Creating a Geofence Project Page

In addition to challenge pages, the most frequently created new pages are likely to be landing pages for geofenced projects. While the request form for new projects is under *Get Data*, the landing pages for the projects themselves are under *Do GLOBE Observer > Do More > Data Requests*. Project landing pages are hidden from navigation, and projects can be found on the main landing page, divided between Currently Active or Upcoming Data Requests and Past Data Requests, which should be updated as needed as projects cycle. The general sections for a geofenced project page, text for which is pulled from the application, are: Project Description, Project Impact, Protocols Used, Active Dates, Special User Instructions and Tags, Regions of Interest (including a map and a link to download the GeoJSON for the project area), and For More Information. These sections can be varied as needed for an individual project. For example, the NASA Response Mappers page contains embedded videos of the webinars held for the project. Because of the location in the structure of the Observer website, the URL for a data request page is too long to fit in the form, so a shortlink should be created and added to what will appear in the app. See the section below about [creating shortened links](#).

Creating a new Asset Publisher on a page

A new Asset Publisher can be added to either a Widget Page or a Content Page. The main settings used for some of the specific content types are described above, and there are some custom templates for a few uses, but for a generic Asset Publisher, here are a few things to keep in mind.

Display Settings:

- You will probably want the display template to be Full Content (unless you are using one of the custom templates), since most items to be included are activities with short descriptions.
- You will want to deselect “Show Asset Title,” “Show New Page Link” and “Show Extra Info”
- The Asset Link Behavior may be set to either “View on New Page” or “Show Full Content” - the links will open either the document or an external page in the current tab whichever you select.
- Confirm that the *Number of Items to Display* is set to a large enough number to show all the resources you will be selecting (or that you choose a pagination option below).
- Pagination type will vary depending on your purpose - for the Resource Libraries, we have not used pages, but simply have everything included on one long page. There could be reasons, as for News and Events, to choose pagination.
- You will want to deselect all the options under Set and Enable, as they aren’t needed.

Asset Selection:

- If you will be adding more resources over time, dynamic asset selection will be helpful, as it uses the tags to automatically populate the list when new resources are added.
- The scope can be left as the default “Current Site (GLOBE Observer)”
- Under Source, you are most likely to be creating a new collection of Web Content Articles of the type “GLOBE Observer Web Content Resources” and “GLOBE Observer Web Content Resources - 5 URLs.” The website considers these two distinct structures, so unless you are sure that all of the resources you eventually add will be one or the other, make sure you select “Select More Than One” and choose both from the list.
- The Filter section is where you choose which tags you want to use to select resources (see [section 9.4.10.3](#) of the main documentation for a list of tags used)
- The default is to first order by *Modified Date*, and then by *Title*, but in many cases, you will want to order by *Title* first. Then you could choose modified data as a second sorting or just select *Title* for both options to have items in alphabetical order. This is also a place where the *Priority* field can be used if you want to determine the order of sorting yourself.
- For fixed sets of resources that will not be added over time, manual asset selection allows you to not set up the filtering by tags but just choose the items for the Asset Publisher. This is best suited for small, static sets of resources.

HTML Custom Code Used for Formatting

Because of limitations in the formatting allowed by Web Content boxes in the original version of Liferay for the site, the team (primarily Andrew Clark) created custom structures using HTML on some pages. Broadly speaking, the custom structures allowed a page to have a visual selection of options (for example the GLOBE Observer tool buttons) that toggled between displaying content in a main space. This created a more compact and appealing look on the page. Later version updates of Liferay allowed Content pages that had some additional layout flexibility and would be able to potentially replace some of the custom structures, but it is not expected that the team will have broadly replaced the pages with the new type by the end of the Science Activation 2.0 funding period at the end of December 2025. This custom code is located on the [Camp](#), [Girl Scouts](#) and [Library](#) Guide pages, the [Family Science](#) page, and the sub-pages of Trees Family Guide with separated activities for age levels of [Sprouts](#), [Seedlings](#) and [Saplings](#).

Some of these pages have been converted to Content Pages (Camp Guide, Library Guide, and Family Science Page), with an HTML module for the custom code (required since Content Page fragments of the paragraph type don't allow access to the back-end HTML). For those pages, all editing to the text must be done as part of the HTML code itself, not through the graphical interface. For the pages that are still Widget Pages (Girl Scouts and Trees Family Guide subpages), there is a portion of the code that breaks if you try to edit and save the page. The correct code is stored in a comment in the HTML. So, after any changes made to the text on the page, you need to go into the HTML editor and copy and paste the correct code into the labeled area, then save and publish the page directly without going back into the graphical interface.

Shortened Links to Specific Pages and Menu Redirects

URLs that link to individual pages on the GLOBE Observer website can be lengthy and complex, which is not well suited for posting to social media or print resources where clean, short links are desirable. Although Liferay shows an option on the *General* tab of the configuration options for each page of Observer that says "Friendly URL" and has what appears to be text for a shortened link, the GLOBE Observer web team found that those links didn't actually work. So, for important pages that were referenced often, or for events like challenges that would get a lot of promotion, shortened URLs were created manually when necessary. While separate link shorteners such as bit.ly or even NASA shortened URLs were also used at times, especially for one-off short link needs, these manually created links were used when the observer.globe.gov branding was felt to be important, and when the link would be used multiple times. Additionally, because of the location in the website structure, landing pages for geofenced data request projects were too long for the form field (and would appear very messy in the app), so shortened links are created for each of those projects.

How to Create a Shortened Link

The short links are all found under the main *Public Pages* section of the website, so that they would have the observer.globe.gov/short-link format. They are created from the *Site Builder > Pages* menu, making sure that *Public Pages* is selected. A new page is created as if it were going to be a content page, but instead of choosing a template, select either "Link to a Page of This Site" (for internal locations) or "Link to URL" (for external locations, although can also be used to link to an internal URL). With either selection, a box will pop up prompting you to create a new page name. Words separated by spaces will end up as dashes in the final URL.

After the page is created, a configuration page appears, which allows you to either navigate to the internal page you wish to point to or enter a URL. It's important to select the checkbox near the top that says "Hidden from Menu Display" so that the new page isn't added to the top menu bar. While most of these shortened links always point to the same place, one exception is observer.globe.gov/go-connect, which is redirected to the most current GLOBE Observer Connect event page for each successive event.

Existing Short Links and Where They Point

Shortened link (after observer.globe.gov):	Points to:	Notes
/at-home	observer.globe.gov/do-globe-observer/do-more/at-home	Audience-specific page
/blazewatch	observer.globe.gov/do-globe-observer/do-more/data-requests/blaze-watch	Data request landing page
/c3	observer.globe.gov/do-globe-observer/do-more/connection-conversation-celebration	Specific event or activity (non-challenge)
/camp-guide	observer.globe.gov/toolkit/guides/camp-guide	Audience-specific page
/cloud-challenge-2020	observer.globe.gov/do-globe-observer/challenges/community-cloud-challenge-2020	Challenge page
/cloud-challenge-2022	observer.globe.gov/do-globe-observer/challenges/cloudchallenge-2022	Challenge page
/clouds	observer.globe.gov/do-globe-observer/clouds	General short link for a commonly used page
/clouds-family-guide	www.globe.gov/web/s-cool/home/family-cloud-resources	Audience-specific page
/dust	observer.globe.gov/news-events-and-people/news/-/obsnewsdetail/19589576/how-to-observe-dust	Specific event or activity (non-challenge)
/eclipse	observer.globe.gov/do-globe-observer/eclipse	General short link for a commonly used page
/eclipse-challenge	observer.globe.gov/do-globe-observer/challenges/eclipse-challenge	Challenge page
/eclipse-data-analysis	observer.globe.gov/hidden/science-connections/eclipse2017/data-analysis	Specific event or activity (non-challenge)
/eclipse-media-kit	observer.globe.gov/do-globe-observer/eclipse/media-kit	Audience-specific page
/eclipse2017	observer.globe.gov/hidden/science-connections/eclipse2017	Specific event or activity (non-challenge)
/eclipselibraryresources	observer.globe.gov/toolkit/guides/libraries-guide/eclipse-library-resources	Audience-specific page

Shortened link (after observer.globe.gov):	Points to:	Notes
/eyes-on-the-landscape	observer.globe.gov/do-globe-observer/do-more/data-requests/eyes-on-the-landscape	Data request landing page
/fall-cloud-challenge	observer.globe.gov/do-globe-observer/challenges/fall-cloud-challenge	Challenge page
/family-science	observer.globe.gov/do-globe-observer/do-more/family-science	Audience-specific page
/get-the-app	observer.globe.gov/about/get-the-app	General short link for a commonly used page
/ghi	observer.globe.gov/do-globe-observer/do-more/data-requests/mosquito-observers-of-greenbelt	Data request landing page
/girl-scouts	observer.globe.gov/toolkit/guides/girl-scouts	Audience-specific page
/globe1m	observer.globe.gov/do-globe-observer/challenges/globe1m	Specific event or activity (non-challenge)
/go-connect	varies - adjusted to point to next GO Connect event page	Specific event or activity (non-challenge)
/go-oklahoma	observer.globe.gov/do-globe-observer/challenges/go-oklahoma	Challenge page
/go-on-a-trail	observer.globe.gov/do-globe-observer/challenges/go-on-a-trail	Challenge page
/juegonube	www.globe.gov/es/web/s-cool/home/nube	Specific event or activity (non-challenge)
/land-cover	observer.globe.gov/do-globe-observer/land-cover	General short link for a commonly used page
/land-cover-2022	observer.globe.gov/do-globe-observer/challenges/land-cover-challenge-2022	Challenge page
/libraries	observer.globe.gov/toolkit/guides/libraries-guide	Audience-specific page
/mhm-observations	observer.globe.gov/do-globe-observer/mosquito-habitats/taking-observations	May have been used by Mission Mosquito
/mosquito-challenge	observer.globe.gov/do-globe-observer/challenges/mosquito-habitat-photo-challenge	Challenge page
/mosquitoes	observer.globe.gov/do-globe-observer/mosquito-habitats	General short link for a commonly used page
/nasa-moon-trees-coast-redwood	observer.globe.gov/do-globe-observer/do-more/data-requests/nasa-moon-trees-coast-redwood	Data request landing page

Shortened link (after observer.globe.gov):	Points to:	Notes
/nasa-moon-trees-douglas-fir	observer.globe.gov/do-globe-observer/do-more/data-requests/nasa-moon-trees-douglas-fir	Data request landing page
/nasa-moon-trees-loblolly-pine	observer.globe.gov/do-globe-observer/do-more/data-requests/nasa-moon-trees-loblolly-pine	Data request landing page
/nasa-moon-trees-quest	observer.globe.gov/do-globe-observer/challenges/nasa-moon-trees-quest	Challenge page
/nasa-moon-trees-sweetgum	observer.globe.gov/do-globe-observer/do-more/data-requests/nasa-moon-trees-sweetgum	Data request landing page
/nasa-moon-trees-sycamore	observer.globe.gov/do-globe-observer/do-more/data-requests/nasa-moon-trees-sycamore	Data request landing page
/nasa-response-mappers	observer.globe.gov/do-globe-observer/do-more/data-requests/nasa-response-mappers	Data request landing page
/national-tree-week	observer.globe.gov/do-globe-observer/do-more/data-requests/national-tree-week	Data request landing page
/nubegame	www.globe.gov/en/web/s-cool/home/nube	Specific event or activity (non-challenge)
/polvo	www.globe.gov/es/web/s-cool/home/new-dust-observations/how-to-report-your-dust-observations	Specific event or activity (non-challenge)
/resources	observer.globe.gov/toolkit	General short link for a commonly used page, created when we changed the terminology and created the toolkit
/smart-fires	observer.globe.gov/do-globe-observer/do-more/data-requests/smart-fires	Data request landing page
/snow-photos-delta-junction	observer.globe.gov/do-globe-observer/do-more/data-requests/snow-photos-delta-junction	Data request landing page
/spare-tire-blitz	observer.globe.gov/news-events-and-people/news/-/obsnewsdetail/19589576/are-old-tires-new-mosquito-condos	Specific event or activity (non-challenge)
/stations	observer.globe.gov/do-globe-observer/do-more/stations	General short link for a commonly used page
/support	observer.globe.gov/home	Likely created by DIS, has a sub page of "page not found"
/trees	observer.globe.gov/do-globe-observer/trees	General short link for a commonly used page

Shortened link (after observer.globe.gov):	Points to:	Notes
/trees-2020	observer.globe.gov/do-globe-observer/challenges/trees-challenge-2020	Challenge page
/trees-2021	observer.globe.gov/do-globe-observer/challenges/community-trees-challenge-2021	Challenge page
/trees-2022	observer.globe.gov/do-globe-observer/challenges/trees-challenge-2022	Challenge page
/trees-family-guide	observer.globe.gov/do-globe-observer/trees/family-guide	Audience-specific page
/water-challenge-2023	observer.globe.gov/do-globe-observer/challenges/where-is-the-water-challenge	Challenge page
/wildflower-blooms	observer.globe.gov/do-globe-observer/do-more/data-requests/wildflower-blooms	Data request landing page

Navigation Menu Redirects

As related note to shortened links, the tool-specific subsections under Do GLOBE Observer and Lead a Program each have a menu item called “Overview” which just links back to the main page of that section. Using a page set up as a redirect as described for shortened links means something appears to users in the sub-menu when it pops out. As an example, *Lead a Program > Land Cover > Overview* goes the same place as just selecting *Lead a Program > Land Cover* (observer.globe.gov/toolkit/land-cover-toolkit), but having it in the menu makes for easier navigation for users, to know all the sections that are available.

Contact Us Form

The Contact Us form was created using a capability in Liferay. To edit the form fields, you need to go to the *Content & Data > Forms* section of the left-hand menu, rather than *Site Builder* or *Web Content* where most other changes are made. The basic fields are Name, Email Address, and Your Message. There is placeholder text in the message field to prompt those contacting the team with app technical issues to specify the platform (iOS or Android) and give the operating system version they are running. This prompt was added after the form was created to try to get more of the details needed to successfully troubleshoot issues up front. The form generates an email to globeobserverhelp@lists.nasa.gov, a list which includes members of the GLOBE Observer team who can respond. There is also a setting requiring CAPTCHA, although we still get spam messages through the form regularly.

File Structure

Files (including images and documents) used on the GLOBE Observer website are generally stored in the *Documents and Media* area under *Content & Data* on the left-hand menu. While we made some attempts at organizing things, not all items are where they truly belong in the structure. While a bit of clean-up was done in October 2025, it was deemed not entirely worth the effort to completely rearrange files for true consistency, given that links to resources and such would need to be checked. A few main notes, including where future clean-up could be prioritized:

- The folder App-Support is utilized for accessing additional resources for the app, especially videos for Mosquito Habitat Mapper. The folder should not be removed or renamed, since the app refers to it.
- GLOBE Observer Blog Images contains subfolders for 2016, 2023, 2024, 2025 and Intern Blogs, and a few stray images in the main folder, but as Blogs are also News items, many of the accompanying images for that structure type ended up in that folder instead.
- GLOBE Observer Events Images main folder is automatic location for events thumbnail images, and subfolders were created for 2024 and 2025, although not extensively used. The folder should not be removed or renamed, since the process of creation of Events structure types refers to it.
- GLOBE Observer Features Images main folder is the automatic location for feature banner images and doesn't contain any subfolders.
- GLOBE Observer News Images main folder is the automatic location for news thumbnail images. There are subfolders for News 2019 through News 2025, but some images used in specific News items are also contained in the main folder.
- GLOBE Observer Resources is one of the main content folders. It contains sub-folders for Challenges, individual folders for each tool (Clouds, Eclipse, Land Cover, Trees, and Mosquito Habitats), as well as folders for Guides, Family Science, Observation Stations, Tips and Tricks, Logos, and Posters, Presentations and Publications. Some items are also just in the main folder.
- GLOBE Observer Scientist Images is where the main headshot for People profiles automatically goes. There are also subfolders for some profiles that have additional images.
- Standard Pages Documents doesn't have any subfolders and may be where files go automatically when through the Web Content Resources/5 URLs structures. Ideally, these would be rearranged into the GLOBE Observer Resources folder, split up by tool type.
- The Team Bios Photos contains older bio photos, some of which are no longer in use, plus selected clouds photos from an earlier iteration of the Team page. This could be consolidated. It is also not clear where in the structure the current team bio photos are located.
- Training & Documents has curated datasets, but also folders for challenges and other overlapping folder topics that would ideally be consolidated into the GLOBE Observer Resources folder.

- Website Images contains folders for blogs, challenges, main Do GLOBE pages, images used for geofencing pages, navigation icons for the resource libraries and Trees Family Guide, and so on. Some folders that overlap content-wise (the subfolder Blog Images could be consolidated with GLOBE Observer Blogs images for example), but as these images are referenced in various places on the website, it would require careful checking that the URLs don't break.

Miscellaneous Notes:

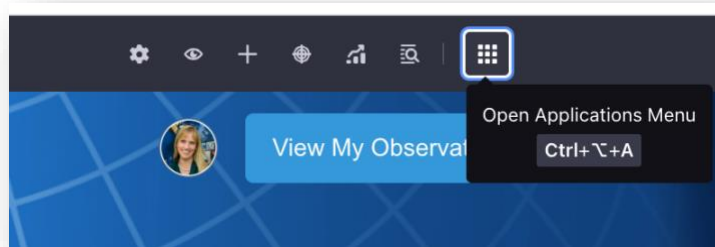
- While in general the default for our content items is that they don't expire, we have had a couple of People profiles accidentally go away when an expiration date was set, so that's something to check.
- Make sure the structure you create are set to Anyone (Guest Role) in Viewable By (it is the default, but once or twice things were hidden unless a user was logged in)
- As of October 2025, there is an issue with proper indentation of lists in both paragraph fragments and generic Web Content boxes. For Web Content boxes, it can be fixed by adding code to the list in the HTML: `<ul class="pl-5" style="list-style-position: outside;">` (also works for ordered lists.)
- Copying text from either Microsoft Word or Google Docs into a form for creating an Asset Publisher item (such as News or Events) can result in formatting tags carrying over. These could be manually deleted from the HTML, but other options are to move the text to a simple text editor first, or paste without formatting (especially easy with keyboard shortcuts like Option + Shift + Command +V on Mac or Ctrl + Shift + V in most browsers on PC.)

Appendix E2: In-App Messages

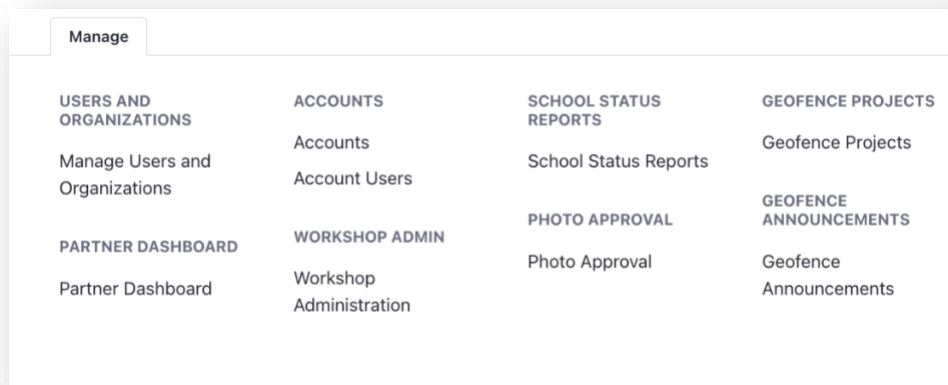
How to Create Geofenced Announcements

To set up or edit an in-app alert, follow these steps:

- Log in to the GLOBE website
- Click on the waffle grid in the upper right corner



- Select the *Manage* tab
- Click *Geofence Announcements*. Only those who have been granted access to the form will see the option to select geofence announcements.



- Click Create News Announcement.

- If editing an existing message, click on the dots in the far-right column of the table row containing the message. Select *Edit*.

Announcements

Create News Announcement

News Title	Audience	Start Date	End Date	News Content	
Database Downtime	All Users	2025-11-06	2025-11-08	You will not be able to submit data from 01:00 UTC Friday, 7 Nove...	⋮
GLOBE Data Submission Now...	All Users	2025-10-06	2025-10-07	GLOBE's data servers are now available. If you experienced errors...	⋮
GLOBE servers offline 25-...	All Users	2025-08-18	2025-08-27	GLOBE servers will be offline 25-28 August for an updated. GLOBE ...	⋮
NASA Data Request Near Yo...	All Users	2025-07-16	2025-07-21	NASA scientists are asking for GLOBE land cover data from your ar...	⋮

- Fill in the form to include title, content, audience, date, and a URL in the additional information field.

News Title *

News Content *

Audience *

☐ All Users
☐ Citizen Scientists
☐ Non Citizen Scientists (i.e. GLOBE Educators)

From: Dec 01, 2025 📅 To: Dec 01, 2025 📅

Additional Information

- Draw on the map or enter a GeoJSON file to define the geographic region that will receive the message. You may click worldwide to send the message to everyone.
- Click **Save**

Bulk creation of geofenced announcements around a set of points

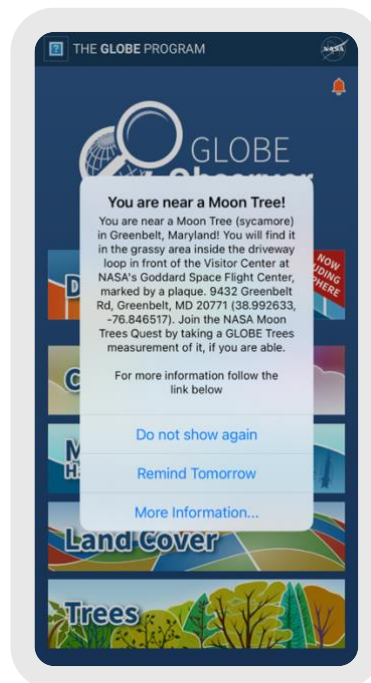
Introduction:

The fields needed for geofenced announcements are:

- News Title
- News Content
- Audience – choose between All Users, Citizen Scientists, and Non Citizen Scientists (i.e. GLOBE Educators)
- Date range for display
- Additional information – URL where the “More Information ...” button will go (optional)
- GeoJSON shape to define the area of display for the announcement

While many announcements will be single, one-off notices, the announcement feature can also be used to help direct people to data collection opportunities at a particular point or area, either in connection with one or more geofenced projects or as stand-alone notifications. This process was first used with the Moon Trees Quest, where geofenced project areas were set up for tree height data collection of trees of the same type as the Apollo 14 Moon Trees, but announcements were also created to direct people to the actual Moon Trees themselves. While at this time the geofenced announcements must be created individually, there is a way to bulk-create the text and GeoJSON shape based on the points, which can then be copied into the form more efficiently to create the individual announcements. It's recommended to have the columns in the same order as the fields listed above (see the sample spreadsheet available), as it makes the process of transferring to the geofenced announcements form flow better.

A spreadsheet is an easy way to bulk-create the fields for the announcement, with a column for each of the needed fields, and one for the final combined text. As an example, for the Moon Trees Quest (see image of a pop-up in the app at right), the title for all the announcements was the same, “You are near a Moon Tree!” The text for the announcement was customized using the CONCATENATE or CONCAT formula (depending on the spreadsheet software you are using). Any text details that would vary between announcements were given their own column, with universal text in between, which could then be copied down the rows to generate the variable final News Content for each announcement. For example (with content pulled from other columns in <>): “You are near a Moon Tree (<tree type>) in <location name>. You will find it <manually written text description for each tree>. <address> (<latitude>, <longitude>). Join the NASA Moon Trees Quest by taking a GLOBE Trees measurement, if you are able. For more information, follow the link below.” Titles could be customized using the same process if desired, although that wasn't done in the Moon Trees case.



Audience and date range will need to be manually selected by whoever is creating the announcement but are likely to be the same for the complete set of announcements. The Additional Information URL may be the same for all announcements or varied. For Moon Trees, the URL went to the geofenced project landing page for the type of Apollo 14 Moon Tree referenced in the announcement, sycamore, loblolly pine, coastal redwood, etc. The URLs could also be customized using CONCATENATE and other columns, or entered manually, depending on how much variation there is between URLs. Even if all the URLs are the same, it can be helpful to have a dedicated column with the repeated text each row, as it makes the flow easier for the copy and paste.

Creating the GeoJSON shape format:

The most complicated piece to create for bulk geofenced announcements is the GeoJSON. However, this can still be generated via simple arithmetic and the CONCATENATE formula based on the given point associated with the announcement. The keys are to calculate the offset for each corner based on the original point, to get the order of the arguments for the polygon coordinates set up correctly and then combine that with the needed formatting for the GeoJSON. An [example template for bulk-creating](#) announcements is provided, although especially the custom text fields may need to be added or removed based on your purpose.

To calculate the corners, use the original latitude/longitude pair, and add or subtract an offset for the edges in each direction, contained in a separate column for ease of adjustment if you want to experiment with the size of the geofenced area. (One you have shapes to test, [geojson.io](#) is one easy place to visualize the polygon and decide if a different offset is needed before you finalize the announcements). The same offset could be used for all announcements, or it could be varied based on other characteristics. The size of the offset could also be different for the latitude versus longitude, although the provided template assumes the same for both (0.5 decimal degrees). The template also assumes a simple rectangle for the geofenced announcement area. More complicated shapes can be used for geofenced announcements, but for the bulk-created ones, simpler is likely better. For the north and east edges, you will be adding the offset. For the south and west edges, you will be subtracting the offset (regardless of hemisphere).

Once the individual corner latitude/longitudes are calculated in their columns, the polygon can be concatenated using those columns and the required internal formatting between the coordinates. The format of the GeoJSON coordinates consists of pairs within square brackets, and with longitude and latitude separated by commas, as well as each bracketed pair separated by commas. Note the reversed order (longitude, latitude) compared to the way we usually present location coordinates. Also, the first and last coordinate pair must be repeated to close the polygon. Spaces are not needed, nor are line breaks, although you may see that with GeoJSON on occasion for ease of visual parsing.

Given the order of corners NW, SW, SE, NE, NW, here is the format for the polygon coordinates:

[W_Lon, N_Lat], [W_Lon, S_Lat], [E_Lon, S_Lat], [E_Lon, N_Lat], [W_Lon, N_Lat]

And an example with real values (which matches the example row in the template spreadsheet):

	D	E	F	G	H	I	J
1	Center Point Latitude	Center Point Longitude	N Edge Latitude	W Edge Longitude	S Edge Latitude	E Edge Longitude	Offset
2	38.9927	-76.8394	39.4927	-77.3394	38.4927	-76.3394	0.5

The formula for the polygon is:

=CONCAT("[" , G3 , "," , F3 , "], [" , G3 , "," , H3 , "], [" , I3 , "," , H3 , "], [" , I3 , "," , F3 , "], [" , G3 , "," , F3 , "])

And the result is:

[-77.3394,39.4927], [-77.3394,38.4927], [-76.3394,38.4927], [-76.3394,39.4927], [-77.3394,39.4927]

The formula can then be copied down all the rows to automatically create the needed polygon format for each individual location. The final piece to prepare this segment for copying into the geofence announcement form is to add the surrounding formatting for the GeoJSON, as below (coordinates created previously highlighted in gray). Again, line breaks are often used for visual parsing but they aren't necessary.

```
{
  "type": "FeatureCollection",
  "features": [
    {
      "type": "Feature",
      "properties": {},
      "geometry": {
        "coordinates": [
          [
            [-77.3394,39.4927], [-77.3394,38.4927], [-76.3394,38.4927], [-76.3394,39.4927], [-77.3394,39.4927]
          ]
        ],
        "type": "Polygon"
      }
    }
  ]
}
```

Because of the use of the "" in the CONCATENATE formula itself, you will need to put the necessary text in its own column (or on a separate sheet as in the template spreadsheet) before combining the text. As an example, with the polygon coordinates in cell K2, and the beginning and ending text in Text for Formatting!A2 and Text for Formatting!B2, the formula

=CONCAT('Text for Formatting!\$A\$2,K3,'Text for Formatting!\$B\$2)

results in the final GeoJSON format above. (Note the use of the \$ to prevent changing of the row or column designators when copying down the rest of the column to create all the formatted GeoJSON text for copying.) Also, be very careful of commas and periods, as getting the wrong one in the wrong place will cause an error.

Creating the News Content text:

The News Content text can be created by using CONCATENATE as well, using variable text from cells interspersed with standard text. For example:

	A	B	C	D	E
1	Location Name or Description	Custom Text 1	Custom Text 2	Center Point Latitude	Center Point Longitude
2	Anyplace, USA	Cool Thing To Observe 1	123 Main Street	38.9927	-76.8394
3	Another Place, USA	Cool Thing To Observe 2	47 Walnut Street	40.4371	-104.7031

Using the formula:

=CONCAT("You are near ", B2, " in ", A2, "! You will find it at ", C2, " (", D2, ",", E2, "). Please take an observation! Learn more at the link below.")

Will result in the announcement text:

You are near Cool Thing To Observe 1 in Anyplace, USA! You will find it at 123 Main Street (38.9927,-76.8394). Please take an observation! Learn more at the link below.

That can be copied to the next row to get the next announcement (and so on):

You are near Cool Thing To Observe 2 in Another Place, USA! You will find it at 47 Walnut Street (40.4371,-104.7031). Please take an observation! Learn more at the link below.

You can add extra columns for custom text to the sample spreadsheet as needed.

Final process steps:

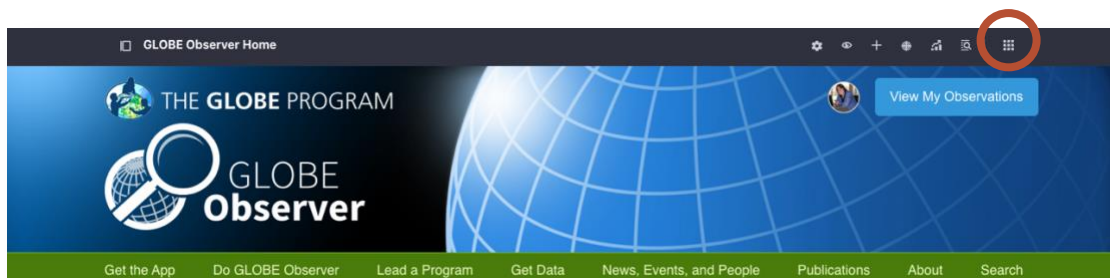
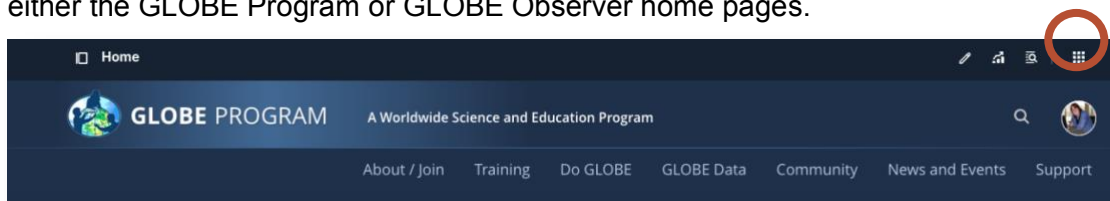
While not described in detail here because they are simpler, you should make sure you have all of your News Title and Additional Information URL rows ready to go in your spreadsheet (likely a simple copy down the column of the same text). After everything is ready (all the Final Announcement Fields in the sample spreadsheet), it's a simple (if slightly tedious) task to create a new announcement in the Geofence Announcements module of the GLOBE website and copy over the appropriate text from the cells in the spreadsheet, as well as selecting the radio button for audience and the time frame for the announcements to appear, then save and repeat.

Appendix E3: Photo Review and Approval Process

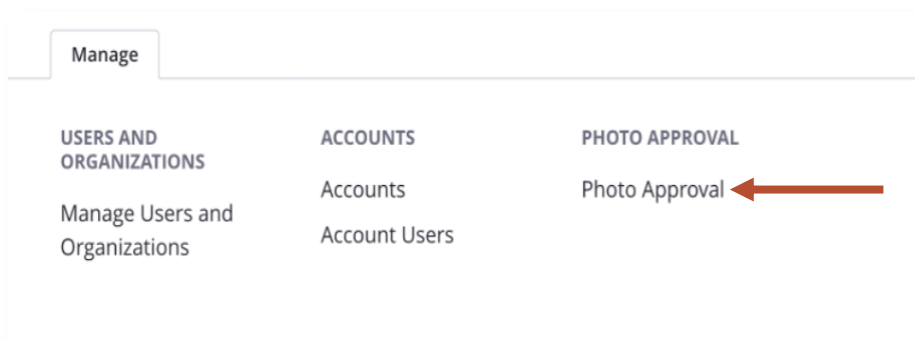


This section describes how to review and approve/reject GLOBE Observer photos before they become part of the GLOBE Program database. A full description of why photo review is necessary is covered in [section 7.1.4](#).

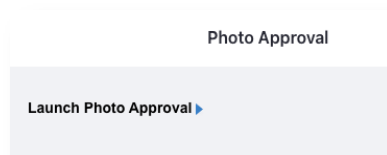
1. Log into your GLOBE account and click on the  at the top right section of either the GLOBE Program or GLOBE Observer home pages.



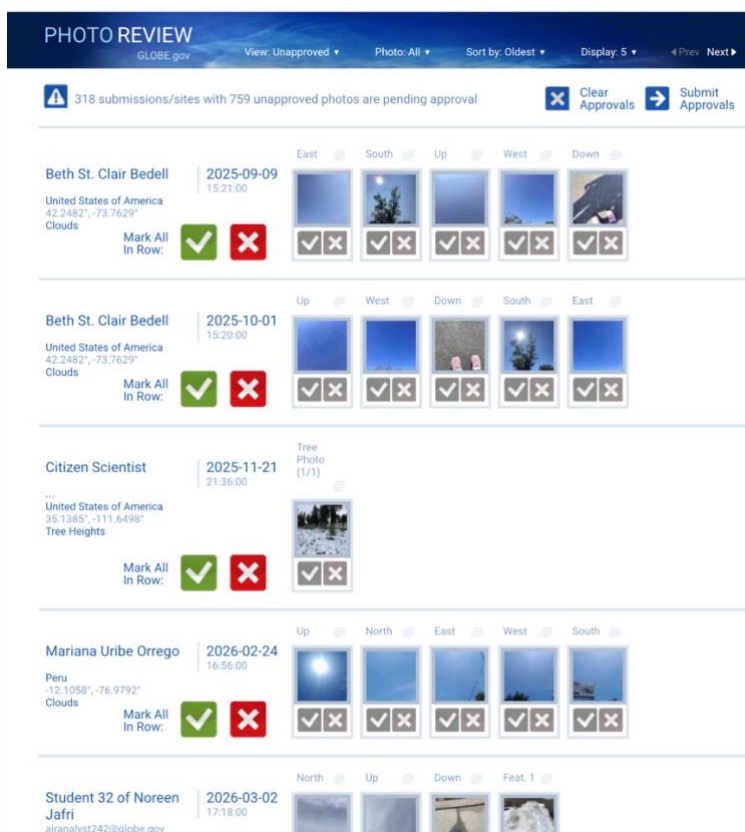
2. From the *Manage* menu select “Photo Approval.”



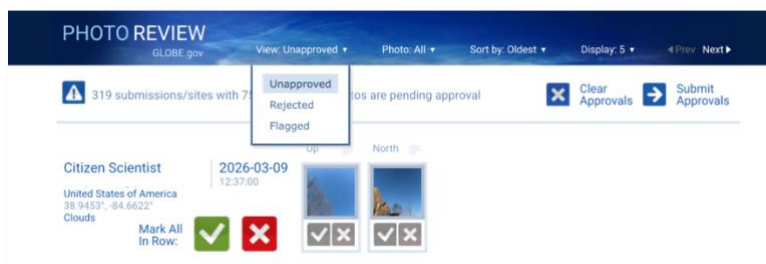
3. The click “Launch Photo Approval”



4. The GLOBE Observer photo approval landing page will look like the image below. The number will vary, based on the number of “submissions/sites” and “unapproved photos” that are pending approval from a manual approver.

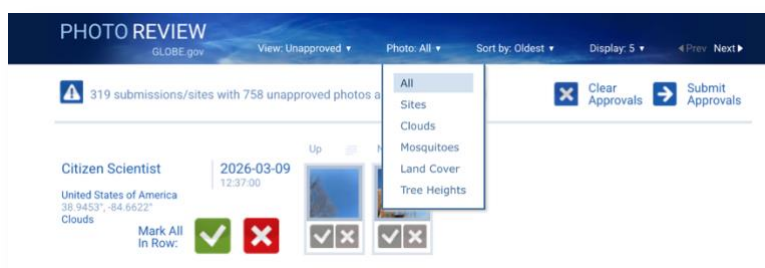


5. You will see a series of four drop down headers.
 - a. View: Unapproved/Rejected/Flagged



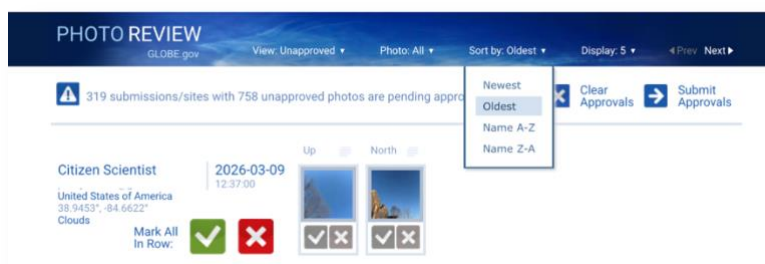
- i) Unapproved: Photos to be manually reviewed
- ii) Rejected: Photos that have been rejected and will not continue to the GLOBE database
- iii) Flagged: Photos “set aside” for further review

b. Photos: All, Sites, Clouds, Mosquitos, Land Cover, Tree Heights



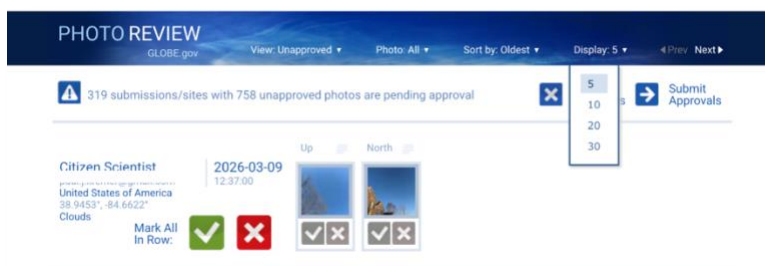
- i) You can review the photos by individual protocol or all together. Many reviewers find it best to review by each protocol.
- ii) Note: When you click on “Sites,” you may see that some observers have created sites that align to their locations/schools, etc. Please note that AI DOES NOT currently review these photos, meaning that there is no pre-screening for faces or identifying information. These pictures need to be closely scrutinized before being approved/rejected!

c. Sort by: Newest, Oldest, Name A-Z, Name Z-A



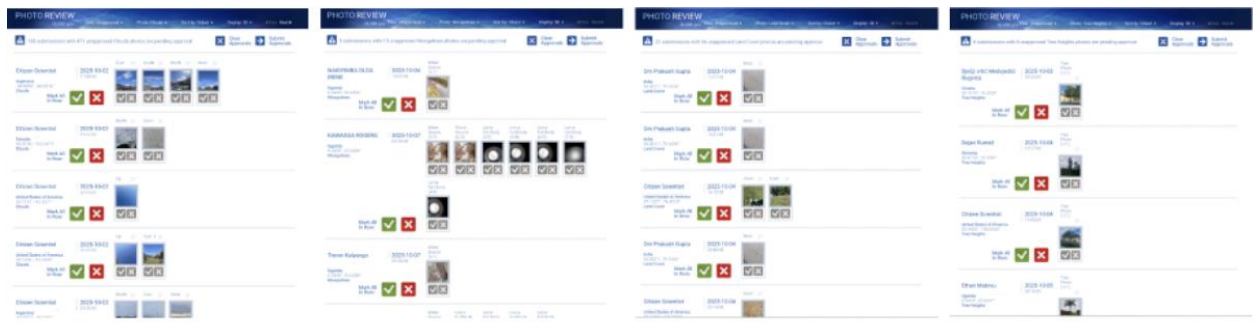
- i) You can sort by newest photos, oldest photos, or alphabetically. There is no right or wrong way to do this and is the choice of the photo reviewer.

d. Display: 5, 10, 15, 30



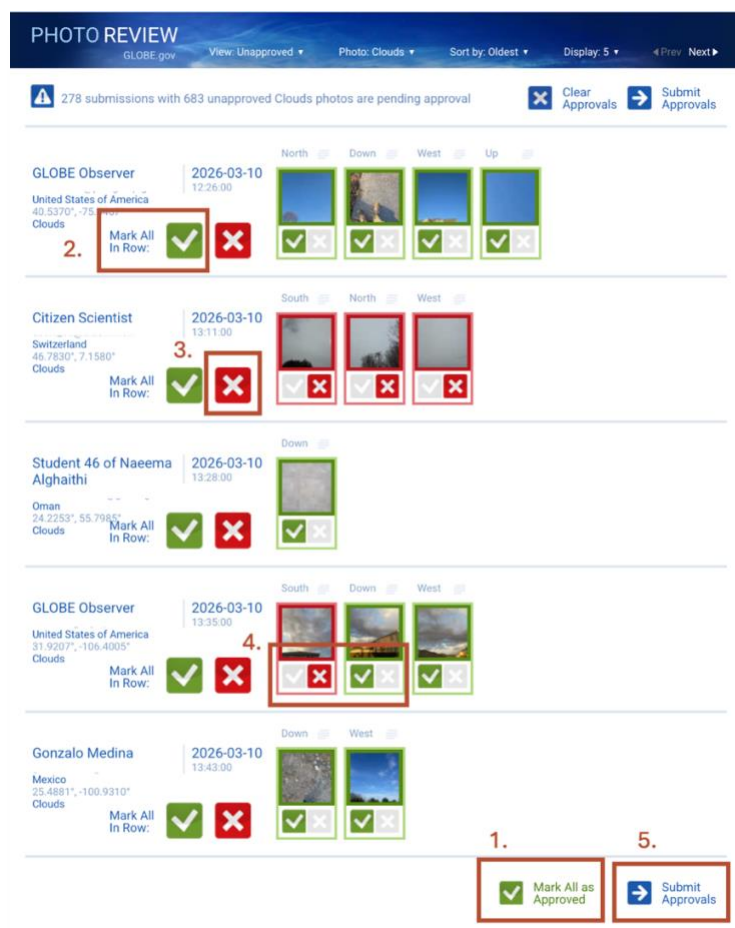
- i) You can view 5, 10, 15, or 30 images at a time on your screen. If you are new to reviewing GLOBE Observer photos, it is best to start with the default number of 5, then as you become more experienced, the display number can be increased as needed.

6. Reviewing Sites, Clouds, Mosquitoes, Land Cover, and Trees



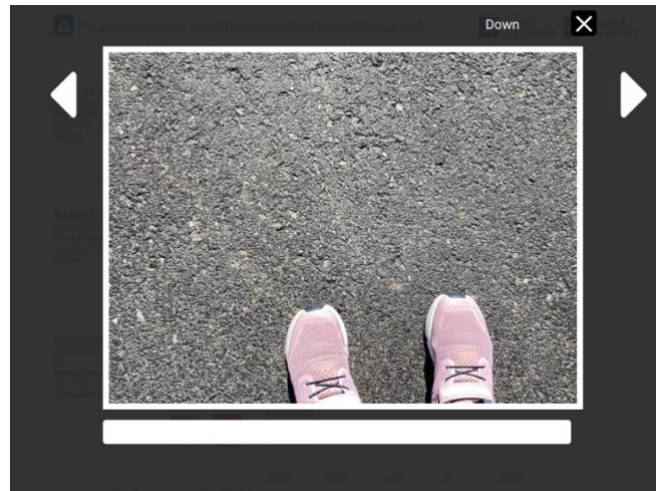
Examples of GLOBE Observer photos for review (left to right) Clouds, Mosquitoes, Land Cover, Trees

7. You can mark all photos as approved at once (1), select a full row for approval (2) or disapproval (3), or mark photos individually (4). When all photos have been marked, click “Submit Approvals” (5). Note that in the image below, the photos marked for disapproval are not problematic and could be approved – they are marked as they are simply to demonstrate the functionality



What to look for during review of the GLOBE Observer photos:

- Look for inappropriate content such as violence, nudity, or offensive or harmful language. Also, look for identifying information that may have been missed by the AI blurring, process, such as a recognizable face or identifying text such as a car license plate. If you see any photo showing any of these, click the red . When you click “Submit Approvals,” this photo will be rejected and not sent to the GLOBE database.
- Click on a thumbnail image to open a larger photo for closer review and inspection. This may not always be necessary, as depending on your screen and/or monitor size, the thumbnails may be sufficient.



- If you notice something suspicious in the thumbnail image, it is best to click on it and make it larger. Often, the thumbnail crops part of the image. Once enlarged, you will be able to see the entire submitted image.

It is recommended that GLOBE Observer photo approval be divided up among multiple people and be done multiple times a week as several thousand GLOBE Observer cloud, mosquito habitat, land cover, tree, and site photos must be manually reviewed each week. Also, when there are special GO events and/or GLOBE Intensive Observation Periods (IOPs) that utilize GLOBE Observer, there may be over 10,000 photos a week waiting for manual review.

Appendix E4: Checklist for Geofencing Project Evaluation

Project Name:

Date Received:

Basic completeness checks:

- ☐ Enough detail is provided for the project description and impact fields to give a full sense of the project
- ☐ Manually check that if the box for data collection in a sensitive area is marked yes, information is provided in the text box
- ☐ Manually check that if the box for enhanced risk or danger to participants is marked yes, information is provided in the text box

→ If any of the above are not checked, follow up with the proposer for more information

Consistency/clarity checks:

- ☐ Project name is descriptive enough to be useful for observers
- ☐ Identified protocols match the project description
- ☐ An appropriate time frame is identified (especially looking for projects requesting longer than three months)
- ☐ The time frame identified is far enough in the future to allow the project to go through the review process (especially for international projects)
- ☐ The bio/credentials of the principal investigator generally match the project area
- ☐ The project proposer has indicated they will be available to answer questions and communicate with users
- If marked no, follow up with the proposer to find out why
- ☐ The project proposer has indicated they will share findings and research
- If marked no, follow up with the proposer to find out why
- ☐ The project proposer has completed training for the protocols they have indicated for the project
- ☐ (If applicable) Explanation of steps taken related to data collection in sensitive areas is reasonable and sufficient
- ☐ (If applicable) Explanation of safety risks and mitigation is reasonable and sufficient
- ☐ Name of region is descriptive enough to be useful for observers
- ☐ Countries where data collection will take place are accurately identified
- ☐ Region defined is reasonable for the project and for intent of geofencing (especially looking for projects requesting overly large regions)

Other checks:

Does the project's proposed area overlap any native lands?

(Using the [USGS Protected Areas Database of the United States \(PAD-US\) 2.1](#), provided through an [ArcGIS map layer](#).)

- ☐ No
- ☐ Yes → Further discussion/review is needed

Notes:

For proposals by a commercial entity, would they make a profit on the project, and/or would it appear that NASA/GLOBE is endorsing them?

- ☐ N/A (not a commercial entity)
- ☐ No → For commercial entities that wouldn't be making a profit, further discussion may be needed
- ☐ Yes → Grounds for denying the project

Notes:

GLOBE capacity questions:

Does this project duplicate or overlap geographically with other proposed or existing projects?

- ☐ No
- ☐ Yes → Consider connecting the proposers of related projects

Is the GLOBE Observer team currently at capacity in terms of geofencing projects we can support?

- ☐ No
- ☐ Yes → Revisit with broader team, or consider if the timing of the project is flexible

Overall process progress:

- | | |
|--|-------|
| ☐ GLOBE Observer initial review complete | Date: |
| ☐ Educational resources added | Date: |
| ☐ Science review complete
(n/a for community-based projects) | Date: |
| ☐ GIO review complete | Date: |
| ☐ (If applicable) Country coordinator review complete | Date: |
| ☐ Landing page created on the GO website | Date: |
| ☐ Project approved for launch | Date: |

Notes:

Appendix E5: Science Checklist for Data Request Evaluation

Are the data being requested able to address the questions being posed?

- ☐ GLOBE observations (clouds, mosquito habitats, land cover or trees) can address the question
- ☐ Directions are specific enough that a volunteer can collect the data needed

Comments:

Would this research question pass peer review in a proposal process? (i.e., the proposer is not asking for data to support unreasonable questions that NASA/NOAA/NSF would not support)

- ☐ Enough detail is provided for the project description and impact fields to give a full sense of the project. (Note, proposers are only required to provide 2-3 paragraphs, so we aren't looking for the equivalent of a full scientific proposal.)
- ☐ The project addresses meaningful science or applications that NASA (or other federal science agencies) would accept (i.e., it's not a hunt for sasquatch or proof that the Earth is flat, etc.)
- ☐ Does the work have the potential to be published in a peer-reviewed scientific journal?

Comments:

Is the proposing scientist credible?

- ☐ Does the requesting scientist have the training and/or experience to analyze the resulting data?

Comments:

Appendix F: GLOBE Observer Activity Archives

The primary archive for GLOBE Observer activities and resources is the Observer website, especially the *Resource Library* page available under each tool in both *Do GLOBE Observer* and *Lead a Program*. Given recent uncertainties related to the future of the GLOBE Program, attempts have been made to archive resources elsewhere as well.

A Zenodo community called [NASA SciAct Eclipse 2023-24](#) was created by Science Activation to archive resources created by their funded projects during those eclipses. NESEC and GLOBE Observer resources in that archive are divided into [Eclipse Learning Resources](#), [Eclipse Data](#), and [Eclipse Graphics and Display Materials](#), each with its own landing page containing multiple individual materials. There is also a page collating [GLOBE Eclipse Journal Articles](#), each of which are included in the references of this document: [Autore et al. \(2025\)](#), [Giarratano et al. \(2024\)](#) and [Tarovsky \(2024\)](#).

Many GLOBE Observer (and broader GLOBE Program) resources are also linked from the [Learning and Educational Activities and Resources from NASA Science catalog](#). As per the description on that page, this catalog of learning resources draws from NASA science content. You can search this collection using key words and/or the drop-down filters to pinpoint resources to use with your audience of learners. However, those listings point to locations on the GLOBE and GLOBE Observer website, so while useful for helping users find materials, the catalog does not serve as a true archive.

A selection of key materials created or adapted by the GLOBE Observer team can be found in the [GLOBE Observer NASA SharePoint archive folder](#).

Appendix G: Templates

The below templates are available in a [GLOBE Observer NASA SharePoint archive folder](#), accessible to those with NASA IT access.

Activity Templates

Word templates for writing up GLOBE Observer activities. There are templates for each protocol, as well as instructions for using the templates (including suggested headings and accessibility features) and guidelines for writing attributions for the activity. The archive folder contains:

- Word Templates for each protocol (example for GLOBE Clouds at right)
- Instructions for using the templates
- Guidelines for writing attributions

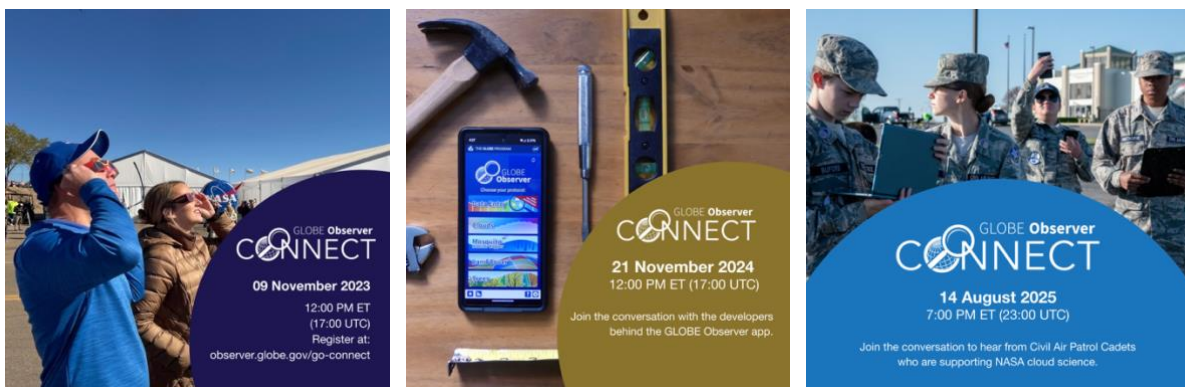
The image shows a template for a GLOBE Observer activity. It has a header with the GLOBE Observer logo and the word 'Clouds'. Below the header is a section for 'Heading 1: Activity Name' with a subtitle '(optional)'. There is a placeholder text: 'Write a short description of the activity. This description should help facilitators quickly decide whether or not they would like to continue reading the instructions for the activity.' Below this are sections for 'Heading 2', 'Heading 3', 'Heading 4', 'Heading 5', and a 'Regular Paragraph'.

Presentation Templates

Slide templates for presenting on GLOBE Observer in PowerPoint and Google Slides formats. Both include generic introduction slides (also available in [Appendix H](#)).

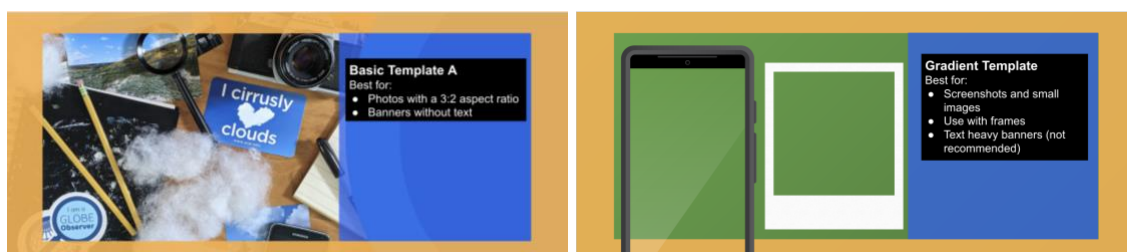
GLOBE Observer Connect Templates

Customizable Google Slides templates for promoting GO Connect sessions, including website rotator, square social media post (1080 x 1080) and rectangular social media post (1600 x 900) templates.



Website Banner Templates

Customizable Google Slides templates for the rotating website banner (1440 x 640).



Appendix H: Core Communications Documents

Graphics Assets

The below graphics assets (described in more detail in [Section 9.1.1: Visual Identity](#)) are available in a [GLOBE Observer NASA SharePoint archive folder](#), accessible to those with NASA IT access.

Brand Assets Design File: An Adobe Illustrator file that contains all brand graphics in an editable format, including the logo, protocol icons, wave, phone frames, and app store buttons.

GLOBE Observer Logos: A folder including PNGs and SVGs of the different GLOBE Observer logo variations.

- Preferred (Two-Line) Lock-up
- Preferred Lock-up with Tagline
- One-Line Lock-up
- Icon Only
- GO Connect Logo

Core Communications Materials

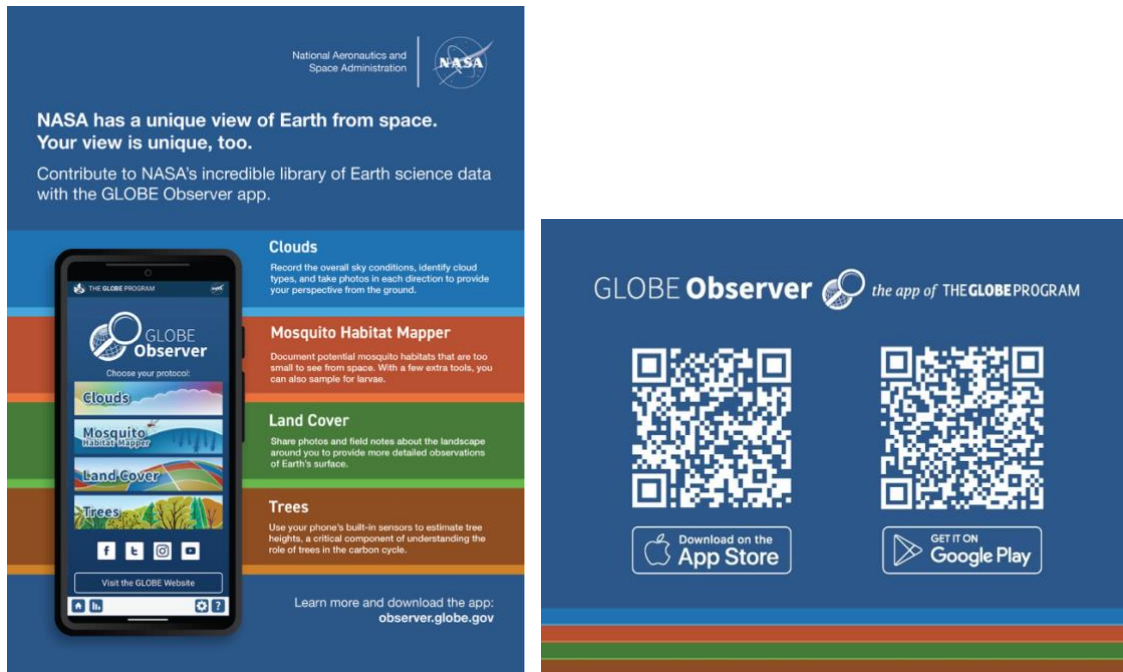
Rack Card

The rack card includes descriptions of the app and protocols in both English and Spanish. The archive folder contains a web file, print file (with bleeds) and design files.



Table Signs

There are two 8.5"x11" table signs. One contains the same content as the rack card. The other has two large QR codes for downloading the app from the Apple App Store or Google Play. The archive folder contains PDF versions of each.



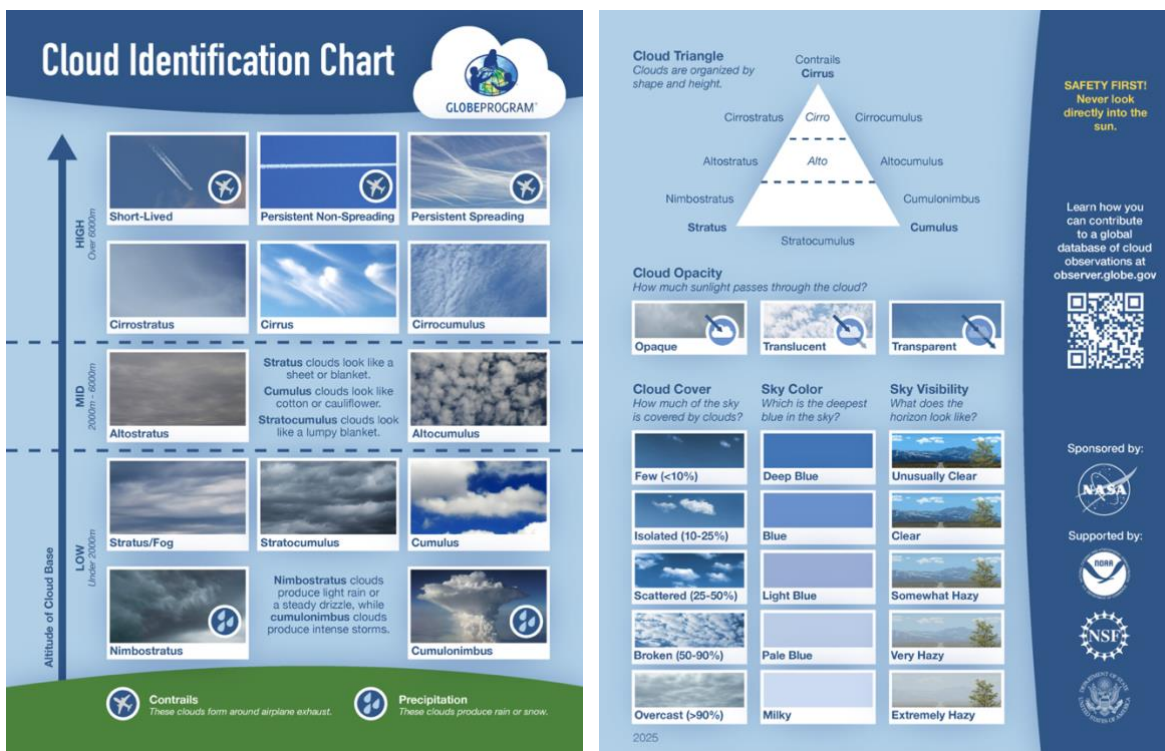
Stickers

The sticker design is based on the GLOBE Observer logo and features the text "I do NASA science with GLOBE Observer." The back of the sticker has additional information about the app and a QR code for the website. The archive folder contains a web file, print file (with bleeds) and design files.



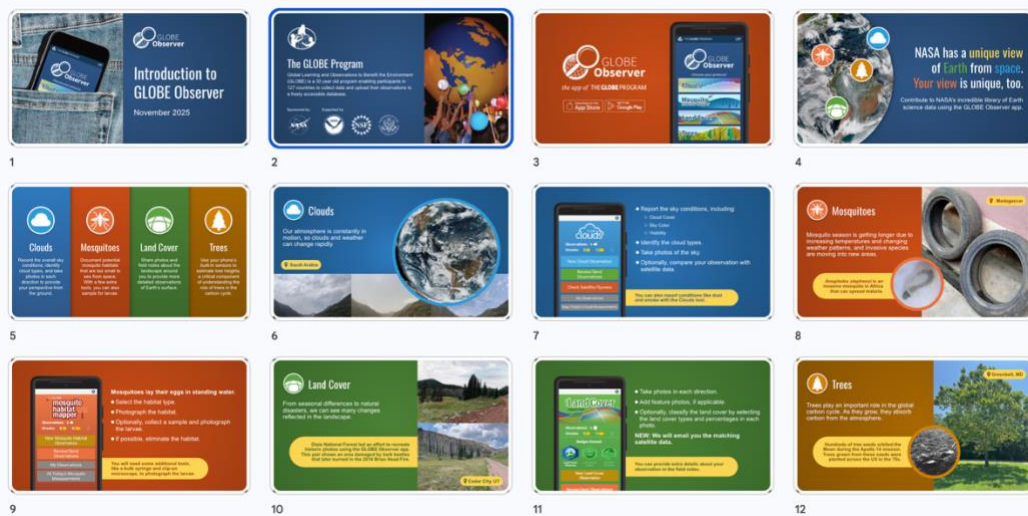
Cloud Identification Chart

While not specific to the GLOBE Observer app, the Cloud Identification Chart is a popular handout. It includes a URL for the GLOBE website, from which the GLOBE Observer website can be accessed. The archive folder contains a web file, print file (with bleeds) and design files, as well as a document with suggested alternate text for the images in the cloud chart.



Intro Slides

These generic slides about the app can be added to any presentation. The archive folder contains PPTX and PDF versions.



Digital Ads

NASA exhibits at conferences and other events often feature a vertical screen with rotating “ads.” We have digital ads for GLOBE Observer and the cloud card game NUBE. The archive folder contains files for both.

