

Developing a cross-institutional open-source cyberinfrastructure to explore, analyze, and communicate greenhouse gas data and information



NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE



Speaker
Siddharth Chaudhary
NASA-IMPACT/UAH
siddharth.chaudhary@nasa.gov

Team: Siddharth Chaudhary, Deborah K. Smith, Jeanné le Roux, Slesa Adhikari, Vishal Gaur, Shanna Combley, Manil Maskey, Argyro Kavvada



What is the U.S. Greenhouse Gas (GHG) Center?

Vision

Inspire and accelerate the use of Earth science data and information for GHG monitoring, measurement, reporting and verification for decision support.

Mission

Extend accessible and integrated GHG data and modeling capabilities from U.S. Government and non-public sources for scalable impact.

Purpose

- Develop and enhance GHG data products that **meet user needs**;
- Foster **collaboration** with networks of interagency, international, intergovernmental and private sector partners to co-develop and increase adoption of **impactful applications**;
- Promote **scientific innovation** and transparency by leveraging **advanced data systems** capabilities and **open source science** principles; and,
- Establish **bidirectional knowledge transfer** and engagement with federal, state, local and tribal governments, researchers, and the general public.

Launch of U.S. Greenhouse Gas (GHG) Center

NASA, Partners Launch US Greenhouse Gas Center to Share Climate Data



NOVEMBER 29, 2023

Interagency Working Group Releases National Strategy to Enhance the Nation's Greenhouse Gas Measurement and Monitoring Capabilities

Climate Change

NASA's new 'Greenhouse Gas Center' tracks humanity's contribution to climate change

News

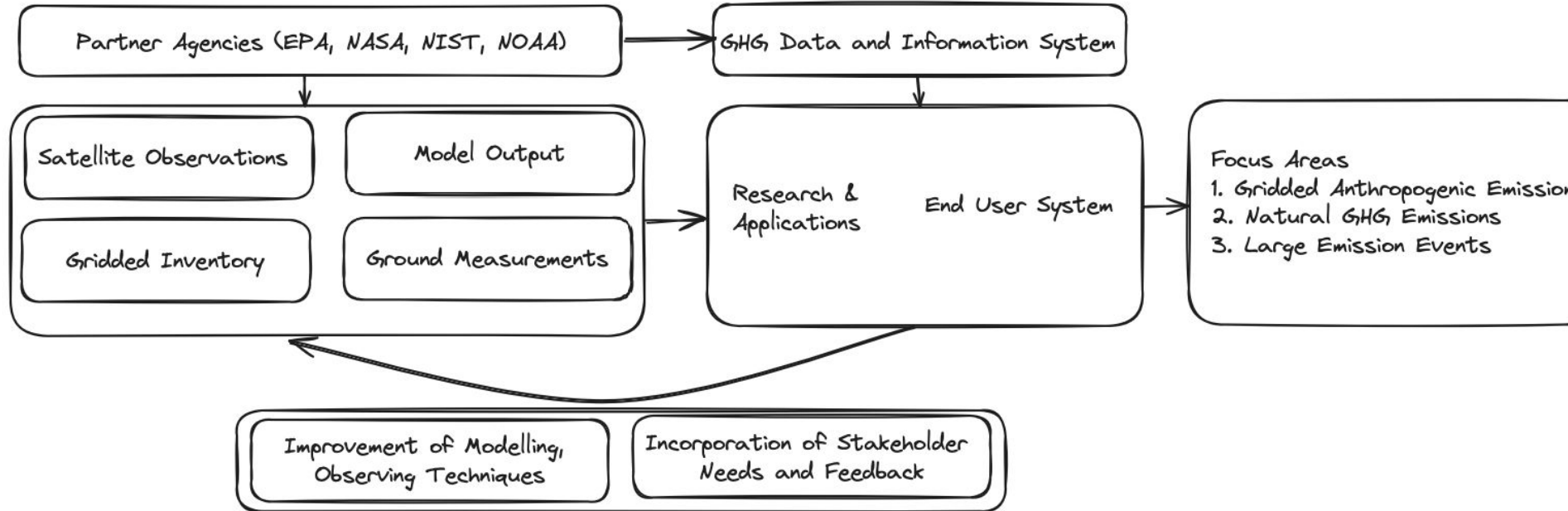
By Meredith Garofalo published December 11, 2023

NASA, EPA share plans for greenhouse gas initiative at COP28



Natalie Harms Dec 7, 2023, 2:24 pm

U.S. Greenhouse Gas (GHG) Center



U.S. Greenhouse Gas (GHG) Center

It's providing **new scientific capabilities and insight**

- Science teams are working to provide the latest GHG data; collaborating with partners to bring together GHG data from diverse sources & programs

It's a **data and information system**

- Building a system that supports the GHG Center mission (web presence, data catalog, visualizations, data interactions, access, analysis capabilities, disclaimers)

It's building **new connections**

- The Stakeholder Engagement team is working to foster relationships & promote the GHG Center

Use Cases/Demonstration Areas



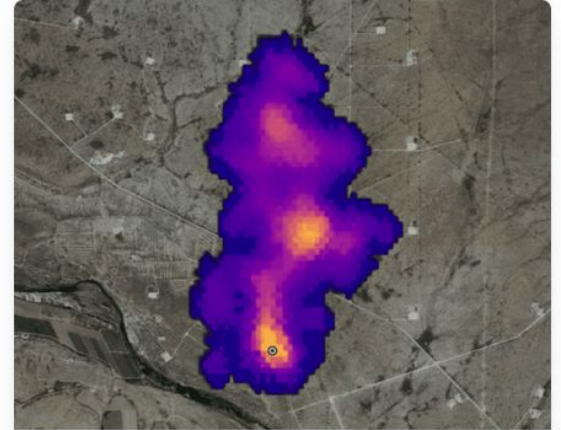
Gridded Anthropogenic Greenhouse Gas Emissions

Emission estimates from human activities including the energy, agriculture, waste, and industry sectors



Natural Greenhouse Gas Sources and Sinks

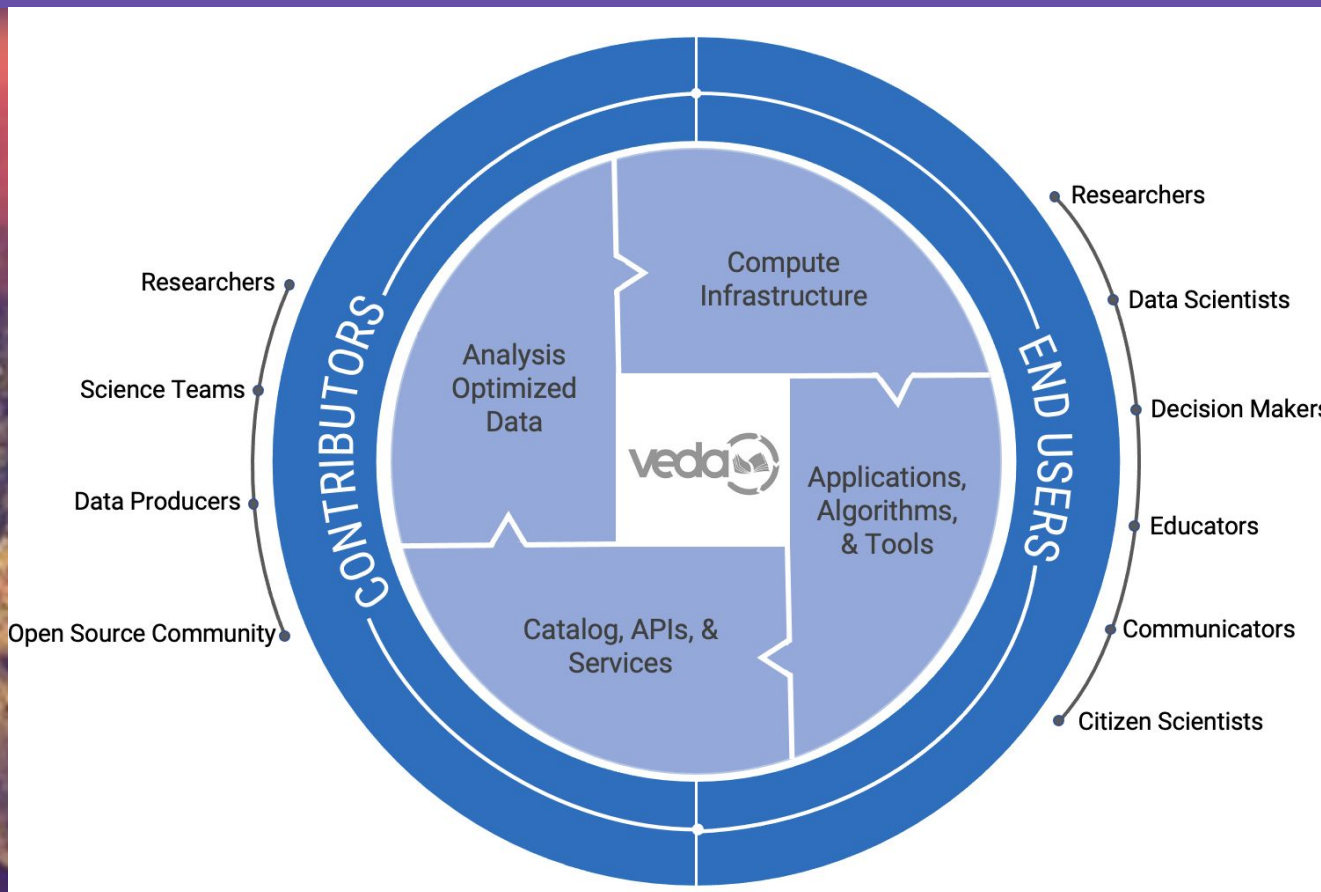
Naturally-occurring greenhouse gas fluxes from land, ocean, and atmosphere



New Observations for Tracking Large Emission Events

Identify and quantify large methane leak events leveraging aircraft and space-based data

Leveraging Visualization, Exploration, and Data Analysis Platform



VEDA - Reusable in part or in whole



VEDA Services

tipg

titiler-pgstac

stac-fastapi

APIs

pgSTAC

s3

Data

VEDA Applications

s3

veda-ui

veda-config

Dashboard

MAAP ADE

2i2c JupyterHubs

Development Environments

Browse

Q This field is required. SEARCH BY NAME

SHOW ALL SHOW ALL SHOW ALL SHOW ALL

Air-Sea CO₂ Flux, ECCO-Darwin Model v5

Global, monthly, average air-sea CO₂ flux of 1979-2007. Reproduced from 2007 by ECCO.

View this page online

Atmospheric Carbon Dioxide Concentrations from NOAA Global Monitoring Laboratory

Atmospheric concentration of carbon dioxide (CO₂) measured at various sites worldwide. This data is available for all sites. The data is available for all sites.

View this page online

Atmospheric Methane Concentrations from the NOAA Global Monitoring Laboratory

Atmospheric concentration of methane (CH₄) measured at various sites worldwide. This data is available for all sites. The data is available for all sites.

View this page online

EXPLORE

- Map
- Exploration
- Data Access

PUBLISH

- Data Catalog

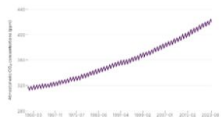
Open VEDA Platform

RESEARCH

- Analysis on the fly
- Analysis Hub
- Notebooks
- QGIS

The Role of Carbon in the Earth System

The movement of carbon between land, ocean, and atmosphere is one of the foundations that governs how Earth functions. Carbon dioxide (CO₂) and methane (CH₄) play a crucial role in governing global temperatures through absorption of infrared radiation. On land, carbon is the currency shared between plants, microbes, and the atmosphere. Through photosynthesis, plants remove CO₂ from the air to support their growth. When plants die or leaves fall to the ground, soil microbes return much of this CO₂ back to the atmosphere through respiration. In flooded wetland soils, where no oxygen is available, microbes known as methanogens produce and release methane gas (CH₄) rather than CO₂. These processes are similar in the ocean, except that atmospheric CO₂ first dissolves into the ocean surface before it is used in photosynthesis by tiny plants called phytoplankton. The rate and balance of carbon cycling between land, ocean, and atmosphere is modulated by the Earth's climate, which includes environmental variability and changes driven by global warming.



NOAA's observations at the Mauna Loa Observatory in Hawaii have allowed scientists to track the build-up of atmospheric concentrations of CO₂ in our atmosphere from all sources. Recent analyses revealed it encompasses the region of the seasonal cycle of vegetation in the northern hemisphere. The Mauna Loa CO₂ data is the longest record and was reported by U.S. State Agency for the Strategic Information and Reports, 2018 as a NOAA fact sheet. NOAA Credit: NOAA Data.

COMMUNICATE

- Data Insights
- Data Driven Storytelling

U.S. GHG Center Data and Information Management - Beta

- 
1. Data Governance Framework
 2. GHG Center System Data Flow
 3. Gathering Dataset Information
 4. Verifying Data Ingestion
 5. Data Incorporation

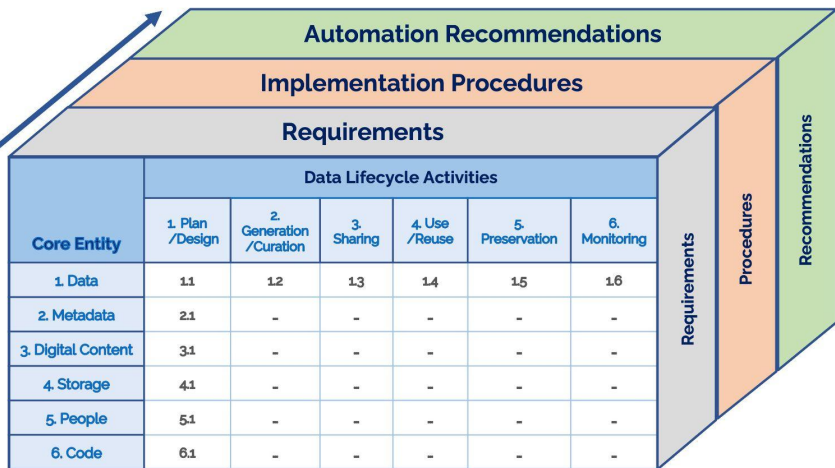
U.S. GHG Center Modern Data Governance Framework (mDGF)

Developed a new modern Data Governance Framework (mDGF), designed to organize and simplify data stewardship for projects

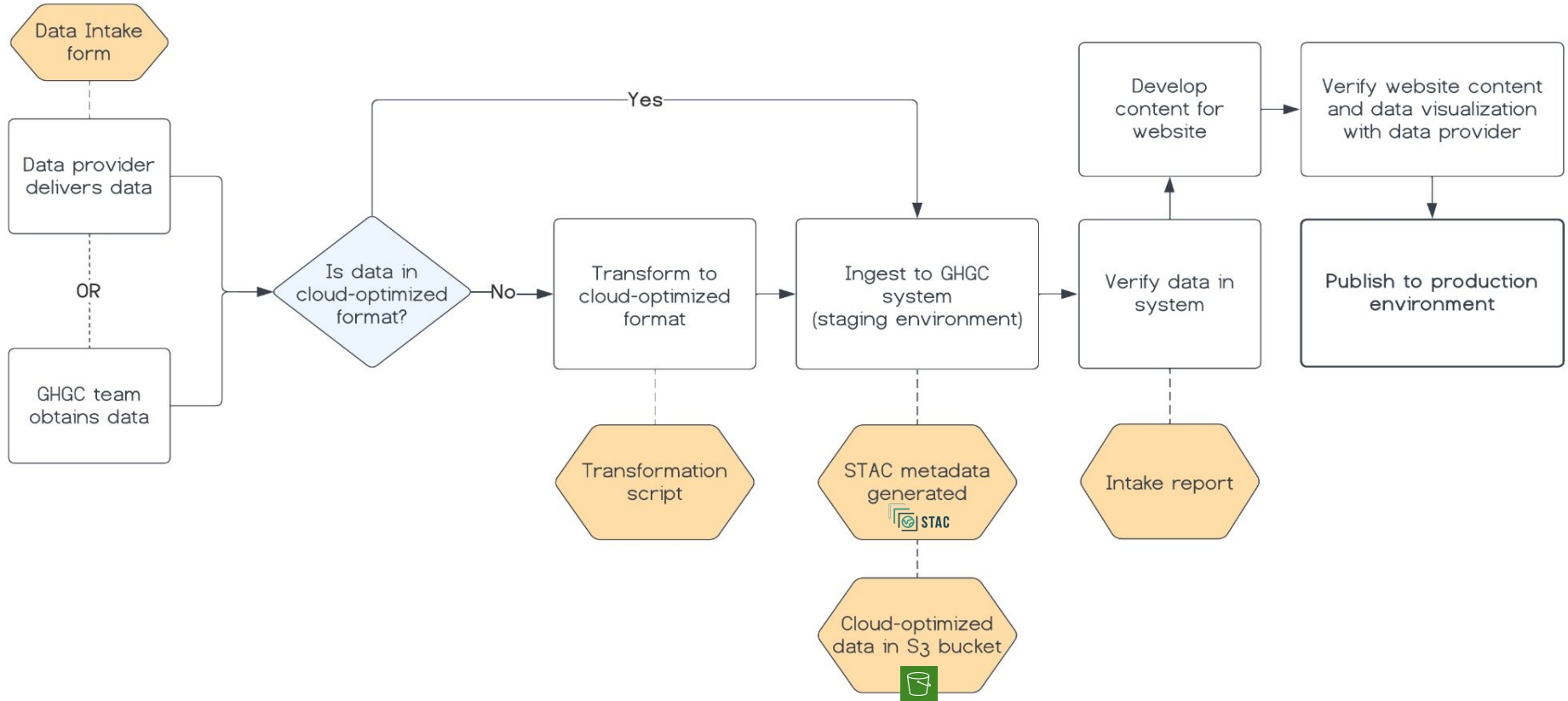
All aspects of data handling have been planned and are in the process of being implemented

The mDGF is a data management plan, a resource management plan, a software management plan all in one

Entities and Lifecycle Activities relevant to a given project can be selected to customize the framework



Data Flow Diagram



Data Intake Form

Greenhouse Gas Center (GHG Center) Data Intake Information Form

The purpose of this document is to collect important information about datasets to be incorporated into the GHG Center from the data provider. The *gray italicized text* provides instructions for how to fill out each item.

Dataset Name

The full/formal title of the dataset.

Short Name/Unique Dataset ID

Shortened or abbreviated dataset title or other dataset id. Note: the original short name may be updated to reflect processing applied for GHG Center (e.g. MOD4A > MOD4A-cog). If the dataset is cataloged in the Common Metadata Repository (CMR) and discoverable in Earthdata Search, also provide the unique collection identifier for the dataset. E.g. C1214470488-ASF

Dataset POC

Name of the primary point of contact for the dataset. The GHG Center may reach out to this POC for questions or additional dataset information.

POC Email

Dataset POC email address.

POC Affiliation

Dataset POC organization/affiliation.

Access URL

The link(s) for accessing the dataset (e.g. https or s3).

Access Instructions/Credentials

Provide any additional instructions needed to access and read the data (e.g. directory structure, access credentials, read routines).

Version

Dataset version number.

Processing Level

The data processing level or processing level description. If possible, map to the equivalent EOSDIS data processing level:

<https://www.earthdata.nasa.gov/engage/open-data-services-and-software/data-information-policy/data-levels>

Data Maturity Level

Indicate the data maturity level (Beta, Provisional, Validated Stage 1-4) based on the [ESDS data maturity level criteria](#).

Production Status (Static/Active)

Indicate whether the dataset is complete/static or active (e.g. new data routinely added to the dataset from an operational satellite or sensor).

Planned Version Update

Describe any plans for data reprocessing or version updates. Include a timeline, if known (approximate)

Gather important information about a data product needed to appropriately portray it in the GHG Center

Data Processing and Confirmation Report (Intake Report)

Processing and Confirmation Report

Background Information

- Original Dataset Name: ODIAC Fossil Fuel Emission Dataset
- GHGC Dataset Title: ODIAC Fossil Fuel CO₂ Emissions
- Dataset Provider: NASA/NIES
- Date Obtained: 06/01/2023
- Location Obtained from: https://db.cger.nies.go.jp/dataset/ODIAC/DL_odiac2022.html
- Data location in GHGC: odiac-fossil-fuel-co2-emissions-2022
- Data POC(s): Dr. Tomohiro Oda, Dr. Lesley Ott
- Dataset File Type(s): GeoTIFF
- Projection (if different from WGS84): NA

Data Transfer Confirmation

An SHA-256 checksum is used to detect high-level errors within data transmissions

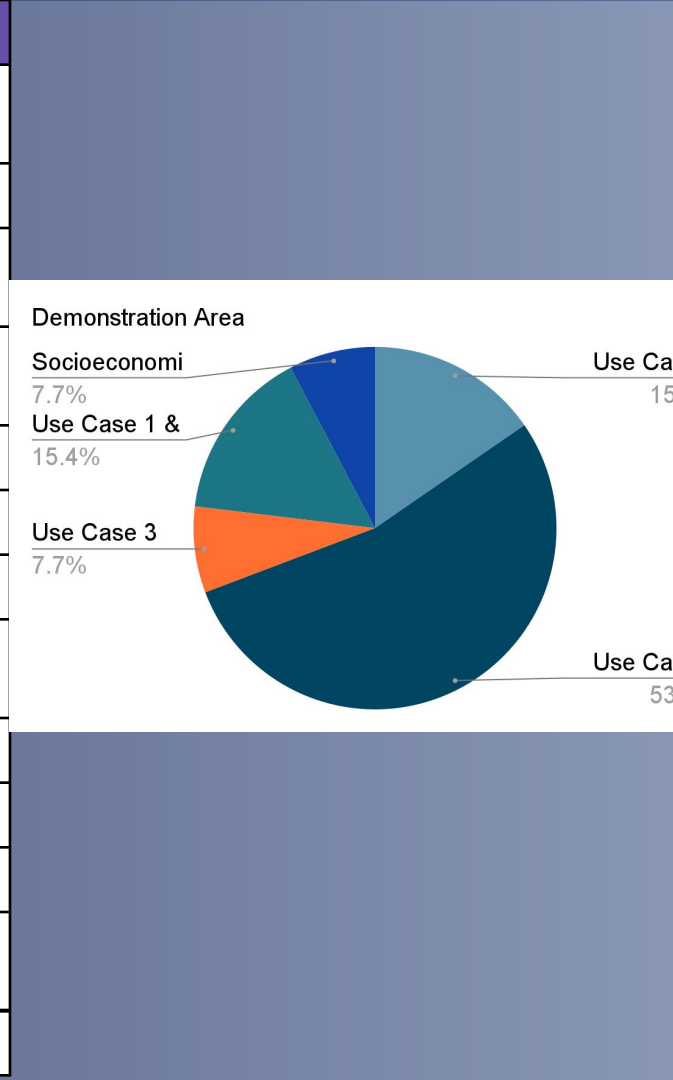
- Results from individual checksum file comparisons of pre-transfer and post-transfer
 - All files were transferred successfully

Filename	SHA 256 Original file	

- Report any individual file issues: NA

Report for data providers that documents the data ingestion process and data verification outcomes

Dataset Name	Source	Demonstration Area
Gridded Anthropogenic Methane Emissions Inventory	EPA	1
ODIAC Fossil Fuel CO ₂ Emissions	NASA/NIES	1
Atmospheric Carbon Dioxide Concentrations from the NOAA Global Monitoring Laboratory	NOAA	1 & 2
Atmospheric Methane Concentrations from the NOAA Global Monitoring Laboratory	NOAA	1 & 2
Wetland Methane Emissions, LPJ-wsl Model	NASA	2
CASA-GFED3 Land Carbon Flux	NASA	2
OCO-2 MIP Top-down CO ₂ Budget	NASA/NOAA	2
GOSAT-based Top-down Total and Natural Methane Emissions	NASA	2
OCO-2 GEOS Column CO ₂ Concentrations	NASA	2
Air-Sea CO ₂ Flux, ECCO-Darwin Model v5	NASA	2
TM5-4DVar Isotopic CH ₄ Inverse Fluxes	NASA/NOAA	2
EMIT Methane Point Source Plume Complexes	NASA	3
SEDAC Gridded World Population Density	NASA	Socioeconomic

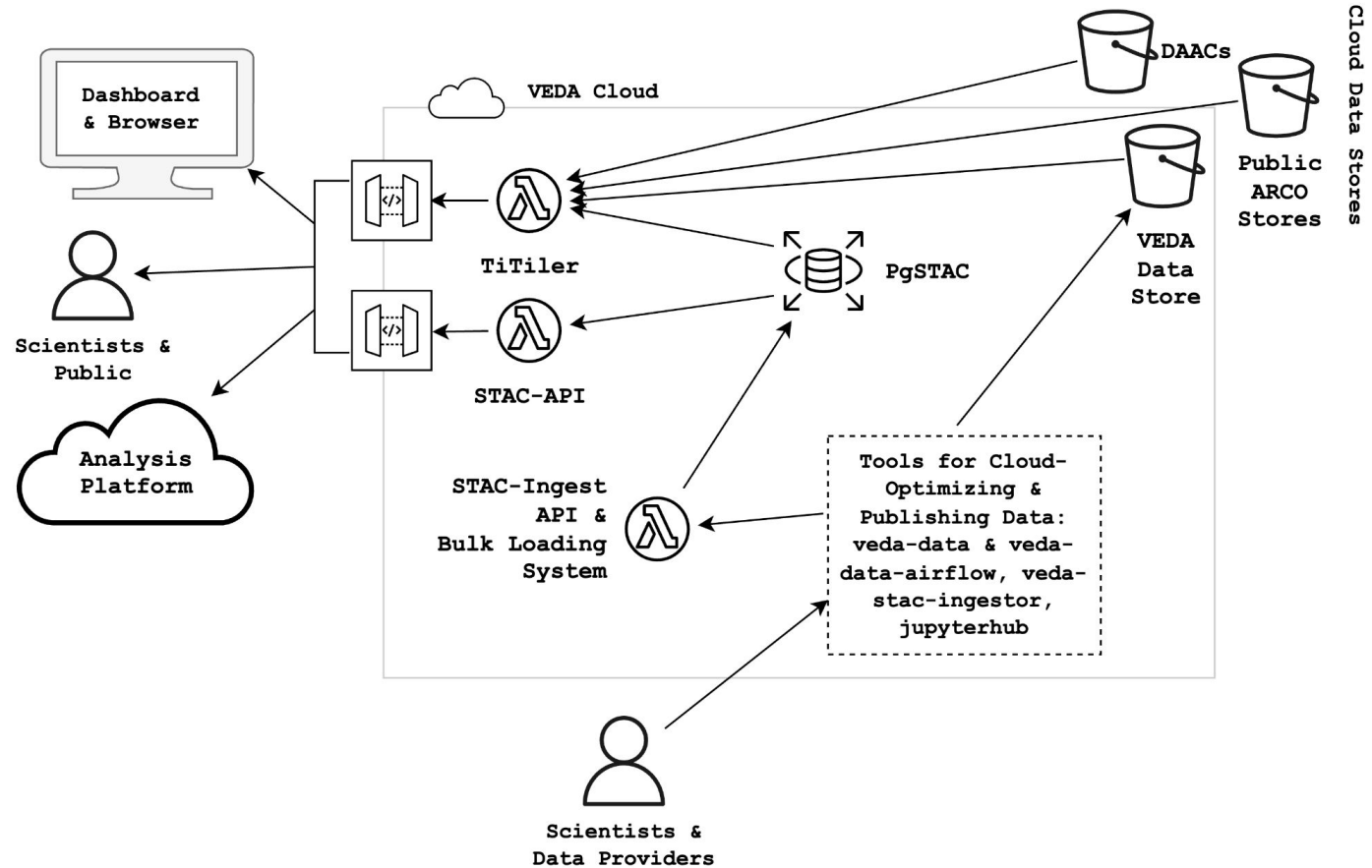


System Demonstration

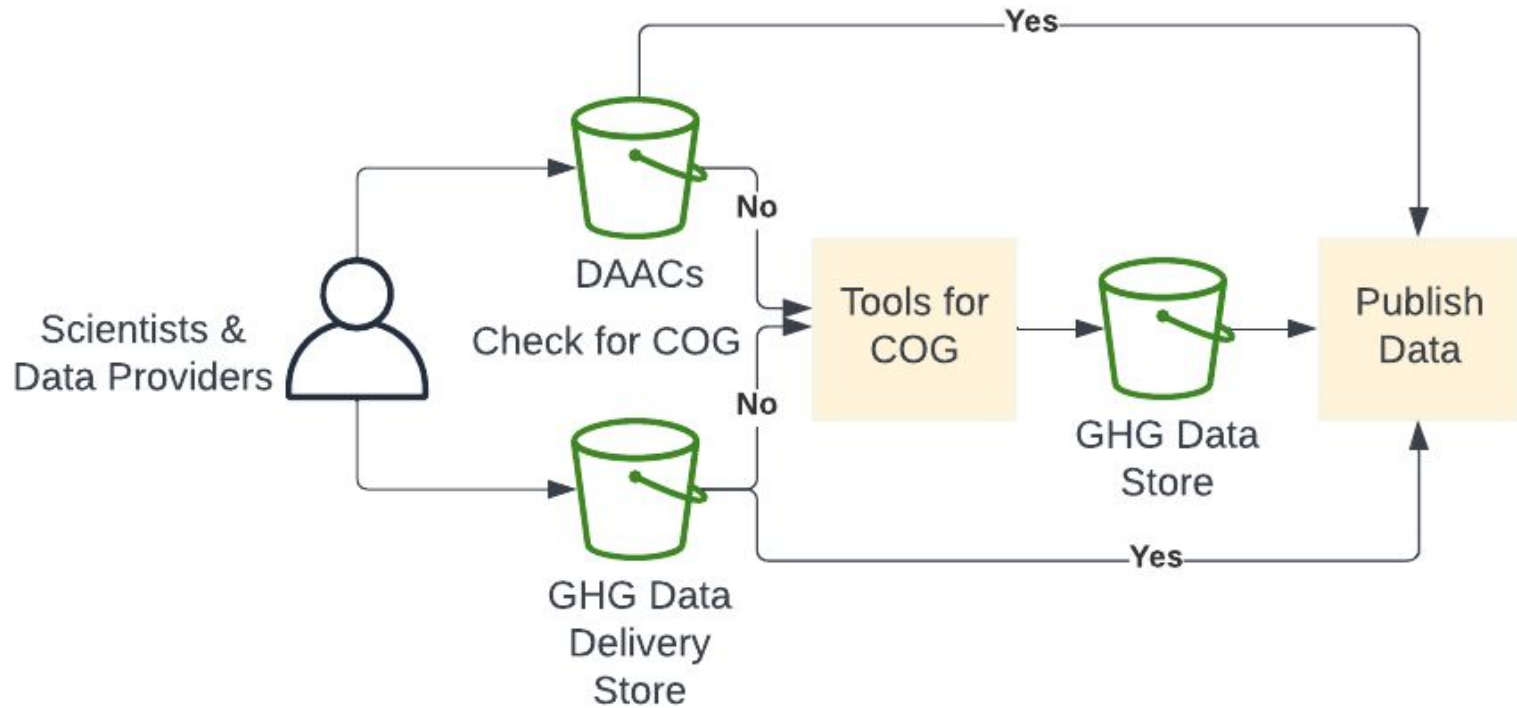
1. Home Page
2. Browse Data Catalog (Filters, Use case, Tags)
3. Curated Data (Intro about data)
4. Access Data
5. Explore Data (Comparison, legend, Integration with QGIS)
6. Data Insights (1 story)
7. Analysis
8. Hub
9. Contact Us

Pr-recorded video

U.S. GHG Center Infrastructure



Cloud Data Store



eoAPI: an open-source framework for working with Earth Observation data

This is eoAPI

- tipg 4 Make it accessible (features API) ★
- titiler-pgstac 3 Make query-driven dynamic visualizations
- stac-fastapi 2b Make it discoverable
- pgSTAC 2a Catalog it
- s3 1 Put data on the cloud

Data Analysis Hub - Computational Capabilities



NIST NATIONAL INSTITUTE OF
STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE



Welcome to the **U.S. Greenhouse Gas Center** JupyterHub.

New user? Please see our documentation about [how to request access](#).

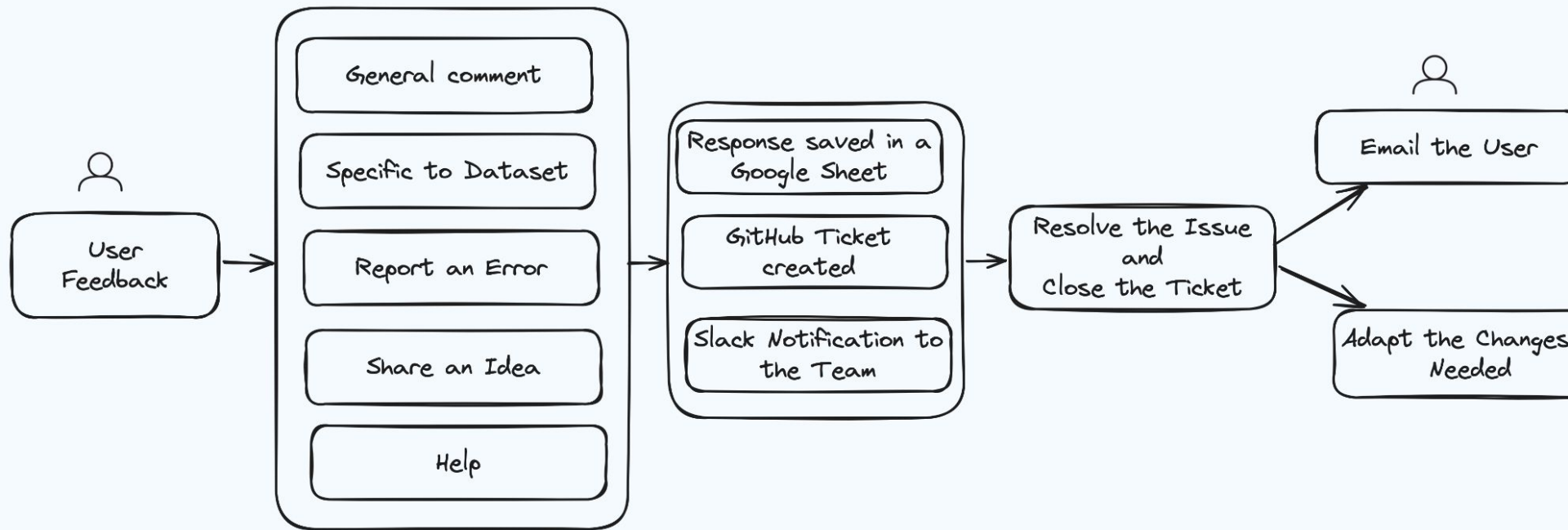
Log in to continue

GIF

US GHG Center supports Open Science

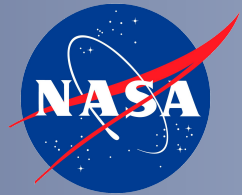
- Data is open
Data, it's visualization and analysis, - everything is open!
- Methods are open
Data transformation code
Data validation reports
Data analysis code
- Infrastructure is open
The computing infrastructure to do scientific analysis is open -
via JupyterHub!
- Software is open
Via public GitHub repositories!
- Educational resources are open
Via the web portal, via notebooks, via workshops like
these!

User Feedback



Upcoming Features

1. Update in Explore and Analysis Feature
2. Datasets for different use cases in release 2



Thank You

siddharth.chaudhary@nasa.gov

This research is supported by NASA Grant
NNM11AA01A as part of the IMPACT project.

