Drought Information Supported by Citizen Scientists (DISCS)

Citizen Science for Earth Systems Program (CSESP)

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Motivation

- The ROSES 2016 Citizen Sciences for Earth Systems Program solicitation sought new and innovative activities to engage citizen scientists, participating in the collection and analysis of NASA mission data to support new discoveries and applications
- Our emphasis: supporting observations of drought
  - NASA is uniquely well-suited to contribute observations of vegetation, precipitation, soil moisture, and drought impacts.
  - We need observations to help with validation of soil moisture, crop stress indicators, and other factors.
  - Creating a platform to solicit citizen science observations of drought impacts benefits the broader drought analysis and response community.

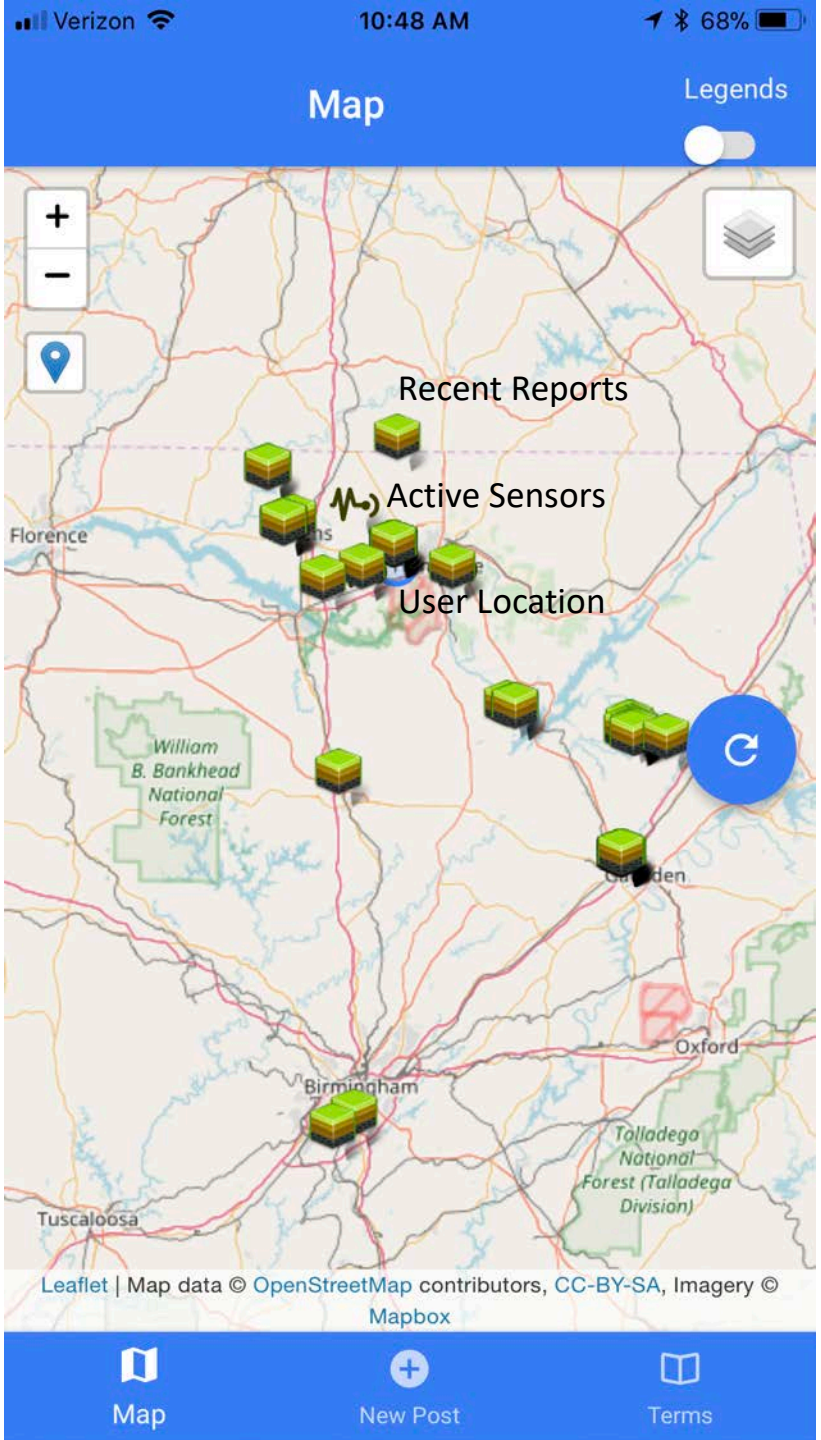
Citizen Science Goals

- Engage weather-minded folks and those in agriculture
  - Regional focus first, leveraging agricultural extension officers and NOAA/NWS partnerships (via SPoRT) to their Cooperative Observer network – *over 100+ years of citizen scientist partnerships*
  - Working to beta test with NWS Co-Ops, Auburn U. agricultural extension, Alabama A&M Research Farm and other observers in N. Alabama and Middle Tennessee
- Develop a smartphone app that allows them to contribute observations about crop type, health, soil moisture, irrigation status, other comments, and digital photography
- Supplement their observations with innovative, low-cost soil moisture sensors via DIY activities or off-the-shelf solutions
- Educate them on NASA remote sensing and modeling products that they can use to monitor their local conditions.
- We use their observations to address science questions:
  - How well do our products represent the state of the drought?
- They use their observations to meet their needs:
  - How do my conditions compare to those around me, and NASA data sets?
  - How can national drought analysts (Drought Monitor, USDA) incorporate observations to understand the current drought situation and impacts?

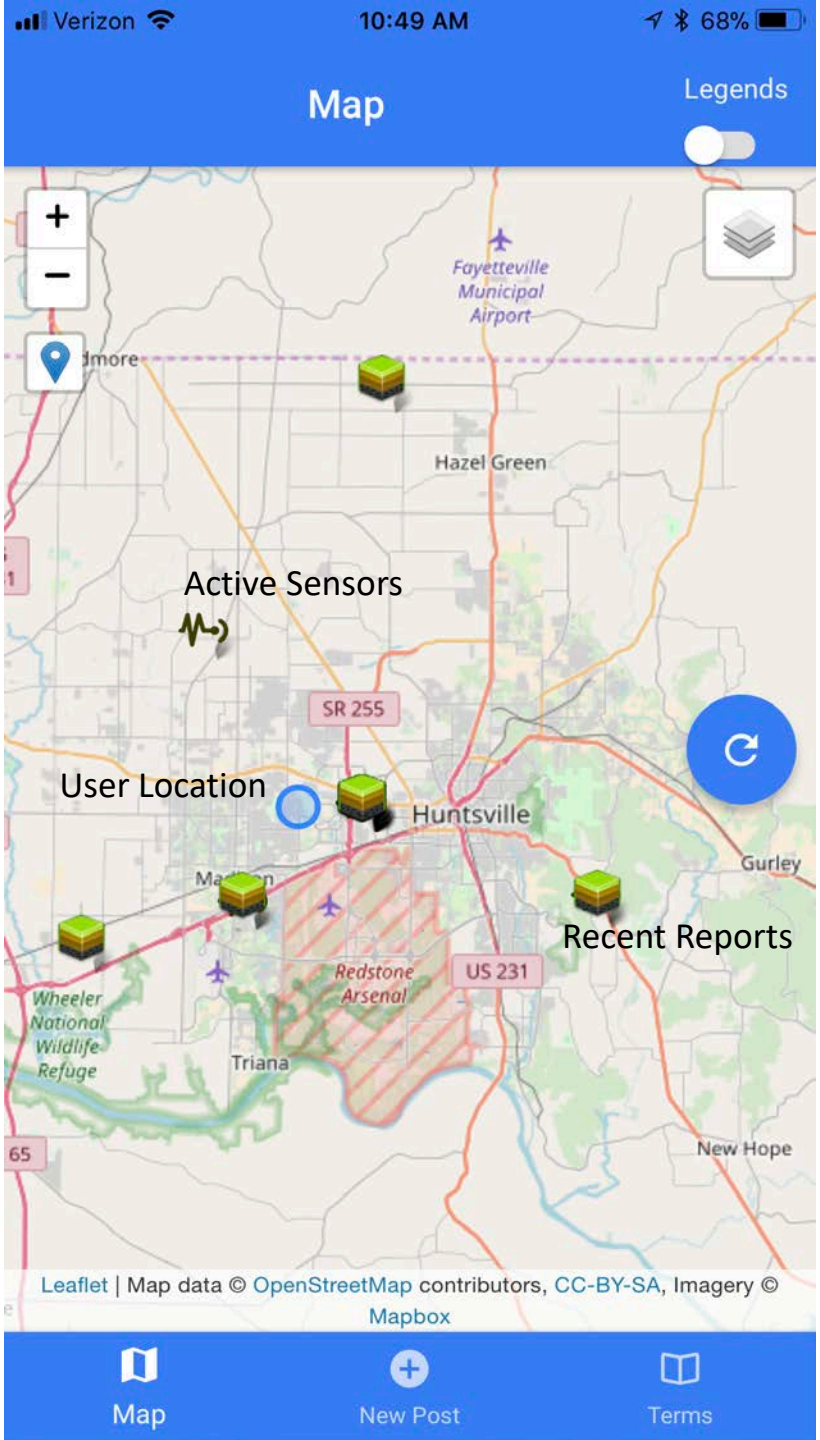
Smartphone Application

- The team collaborated to develop a smartphone application that allows for:
  - Sharing of NASA products (hosted by MSFC/SPoRT) and supplemental weather information from NOAA
  - Display of the latest U.S. Drought Monitor information to update on the official drought status
  - Observations collected by citizen science participants

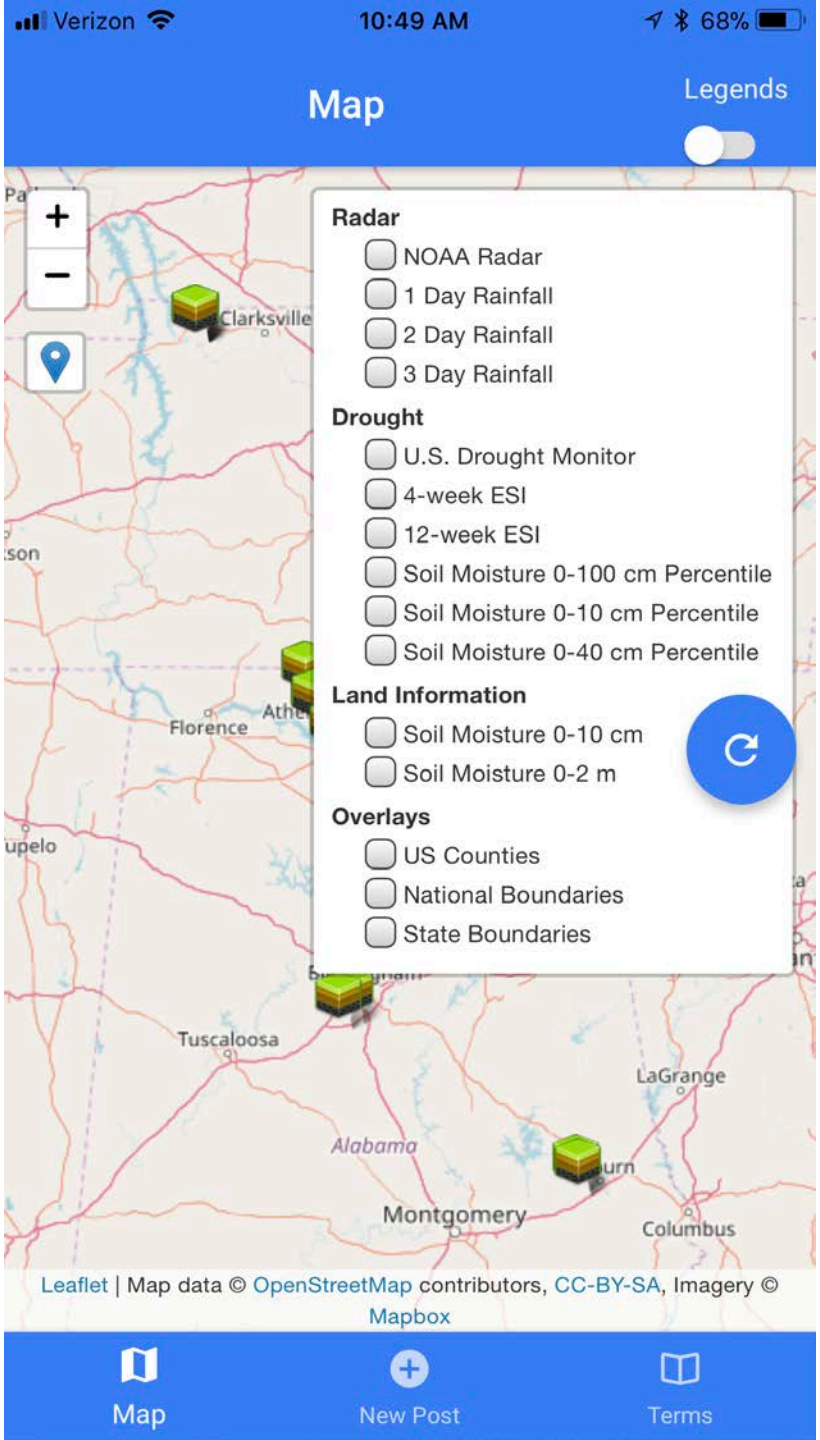
Default Map Display



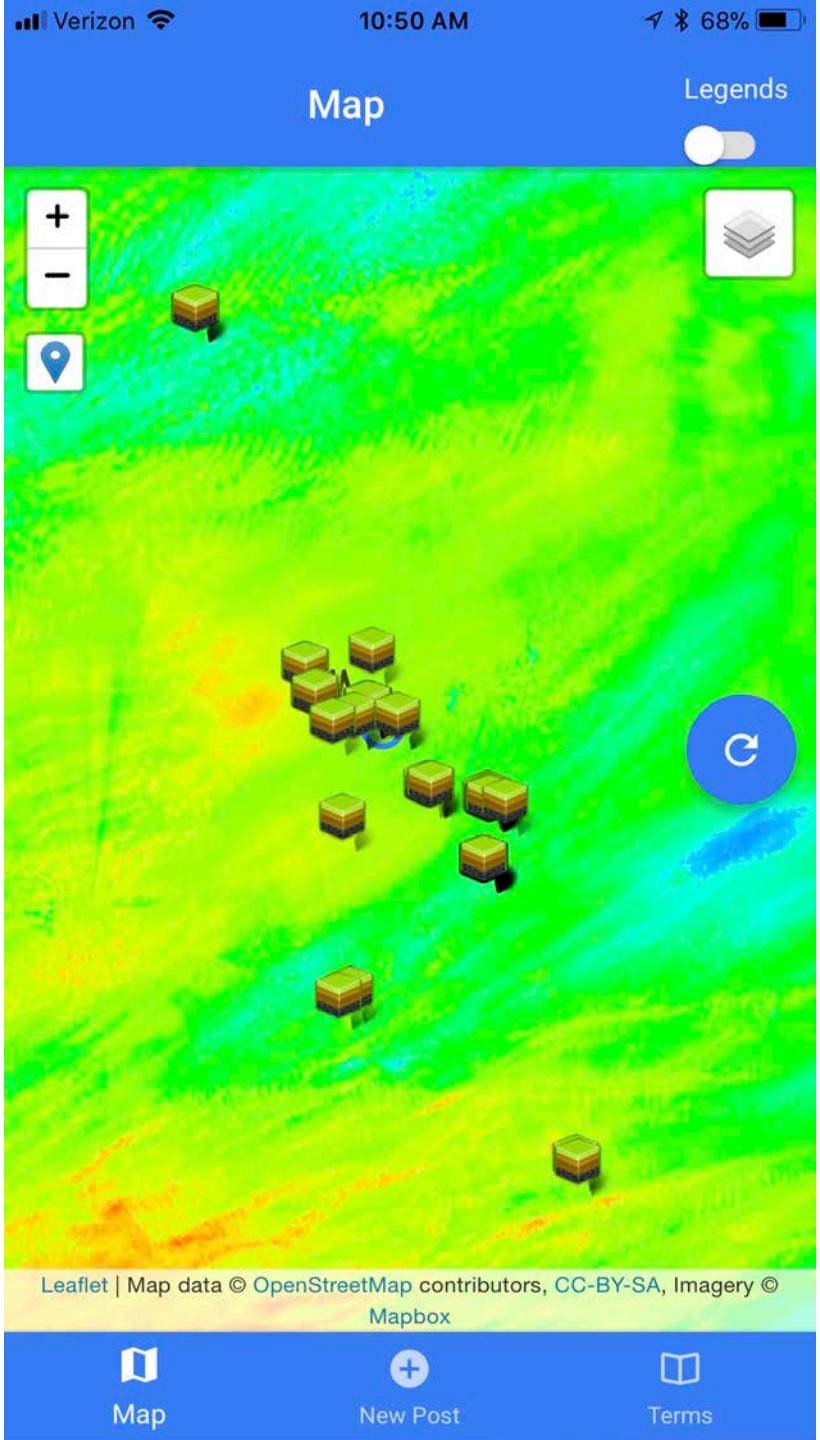
Pinch / Zoom Display



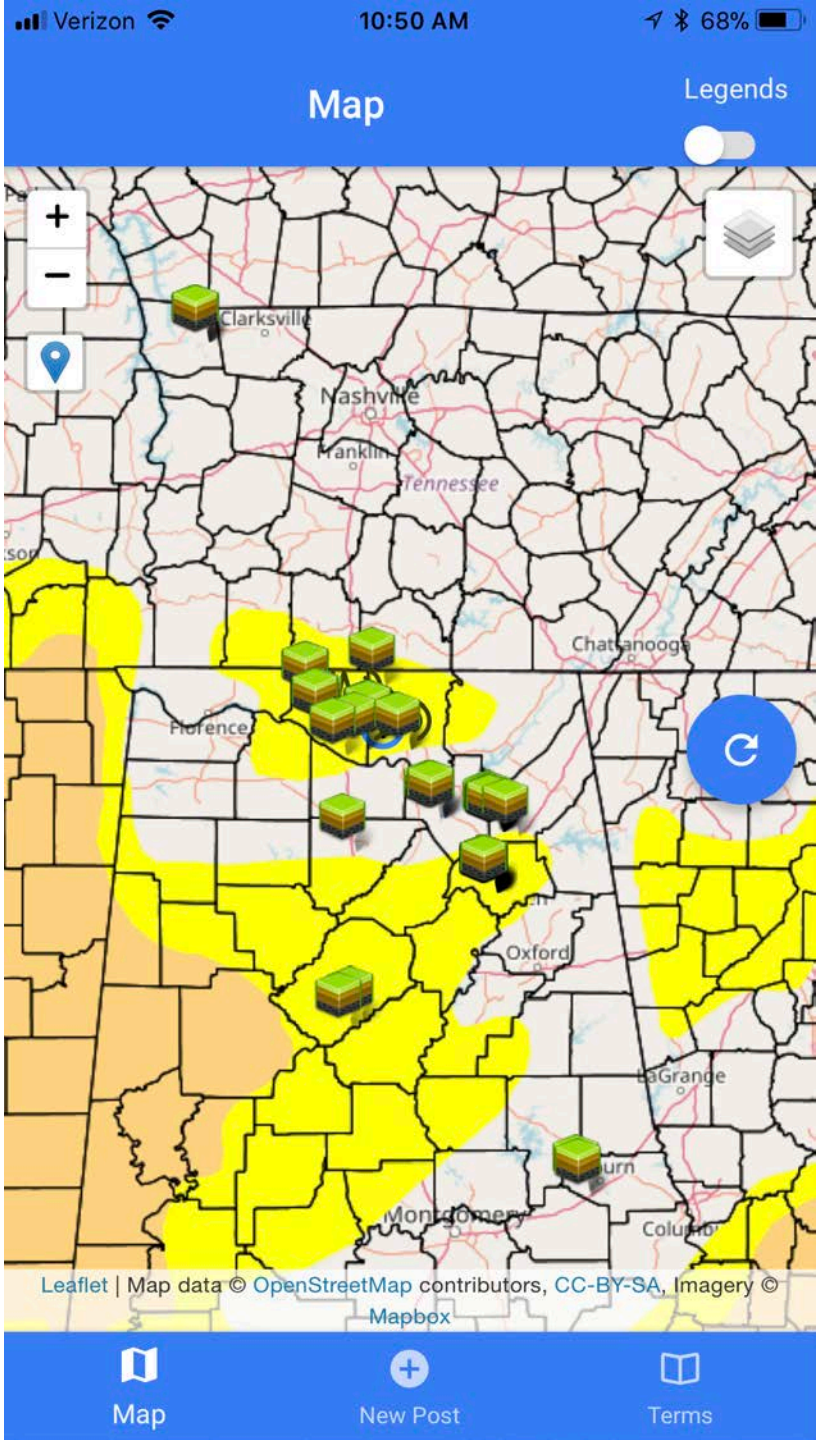
Data Layers


Verizon
10:49 AM
68%
Map
Legends
Radar
NOAA Radar
1 Day Rainfall
2 Day Rainfall
3 Day Rainfall
Drought
U.S. Drought Monitor
4-week ESI
12-week ESI
Soil Moisture 0-100 cm Percentile
Soil Moisture 0-10 cm Percentile
Soil Moisture 0-40 cm Percentile
Land Information
Soil Moisture 0-10 cm
Soil Moisture 0-2 m
Overlays
US Counties
National Boundaries
State Boundaries
Clarksville
Florence
Tuscaloosa
LaGrange
Alabama
Montgomery
Columbus
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox
Map
New Post
Terms

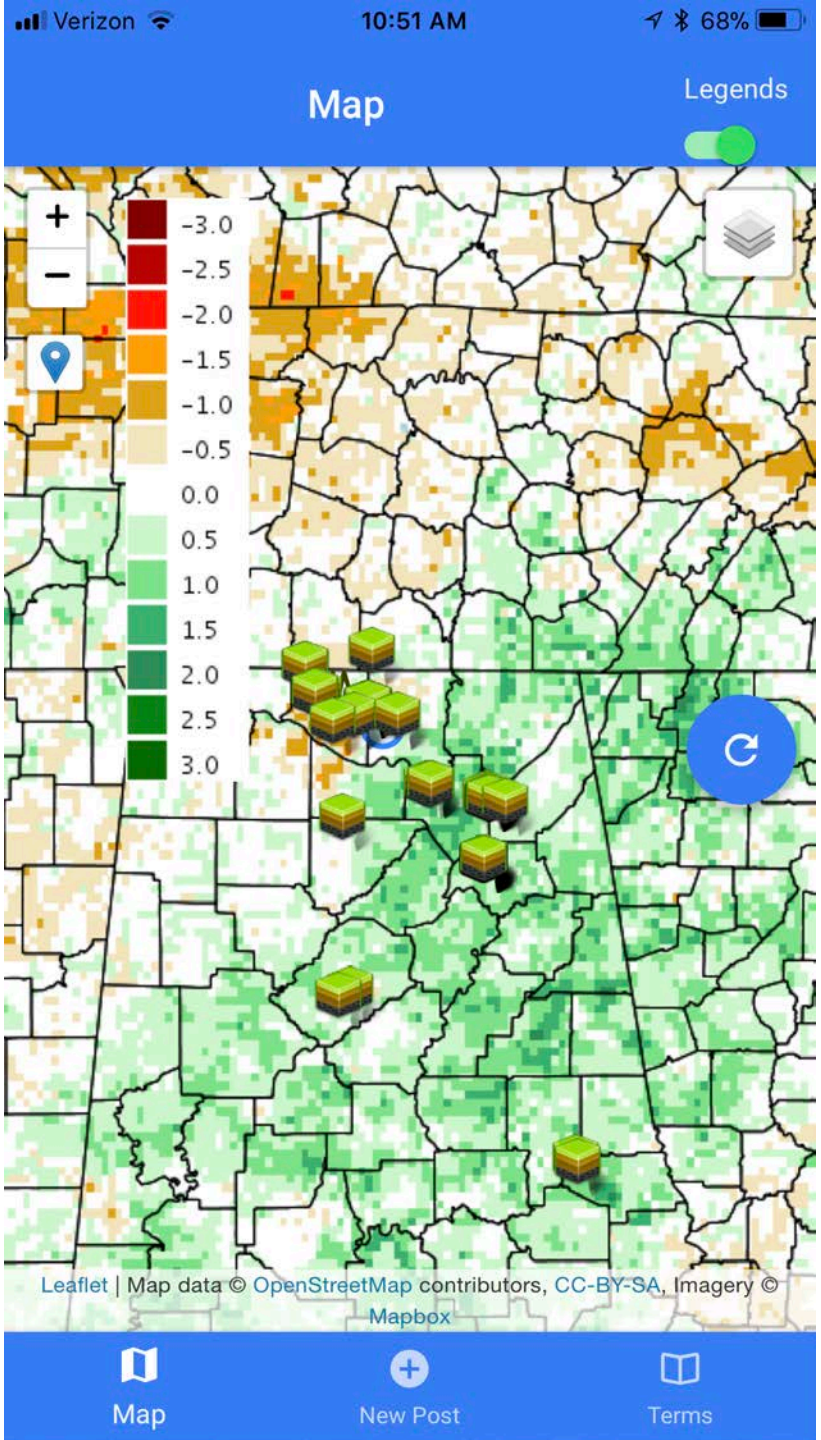
NOAA 3-Day Rainfall
Ending 12/6



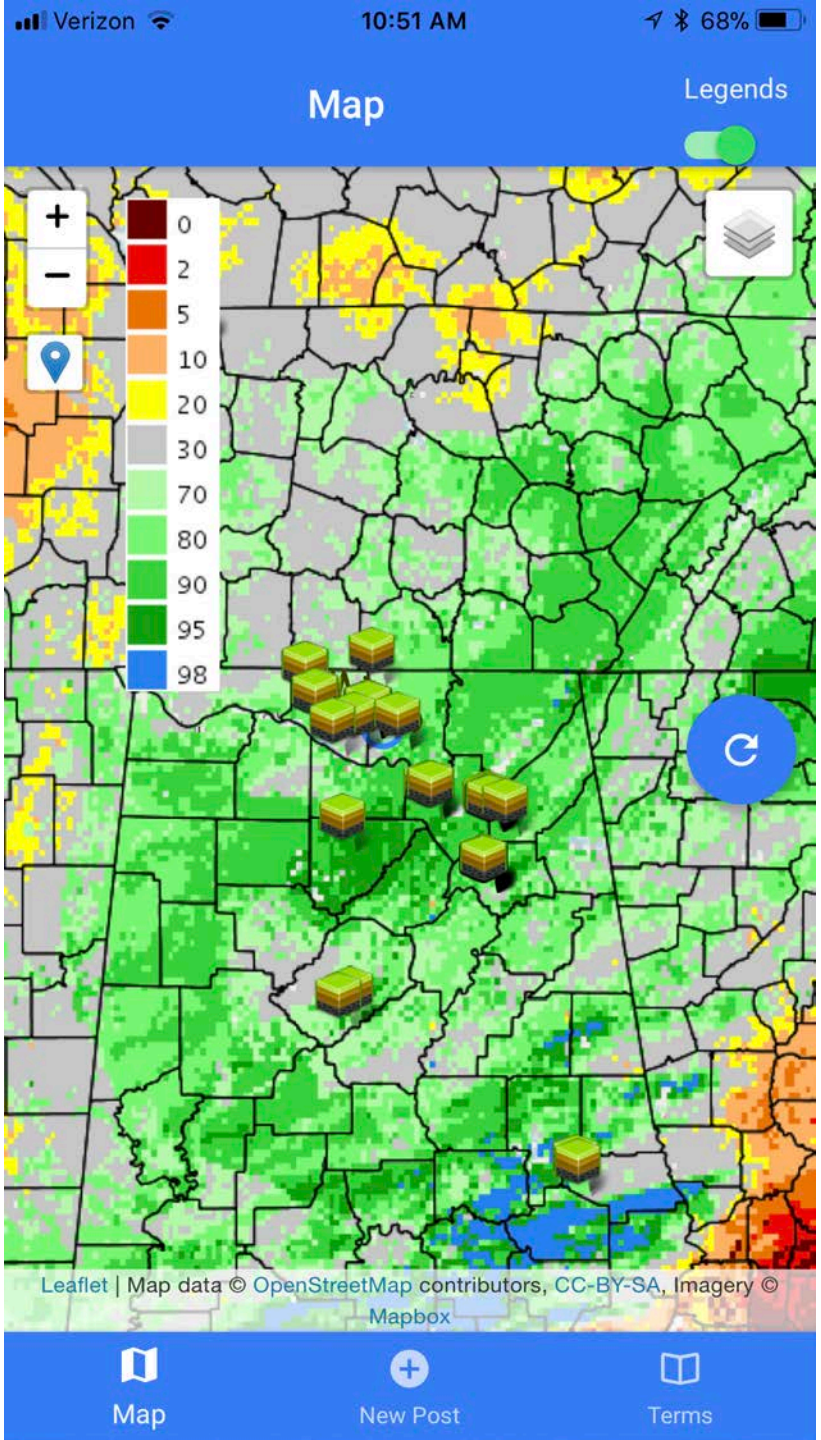
U.S. Drought Monitor



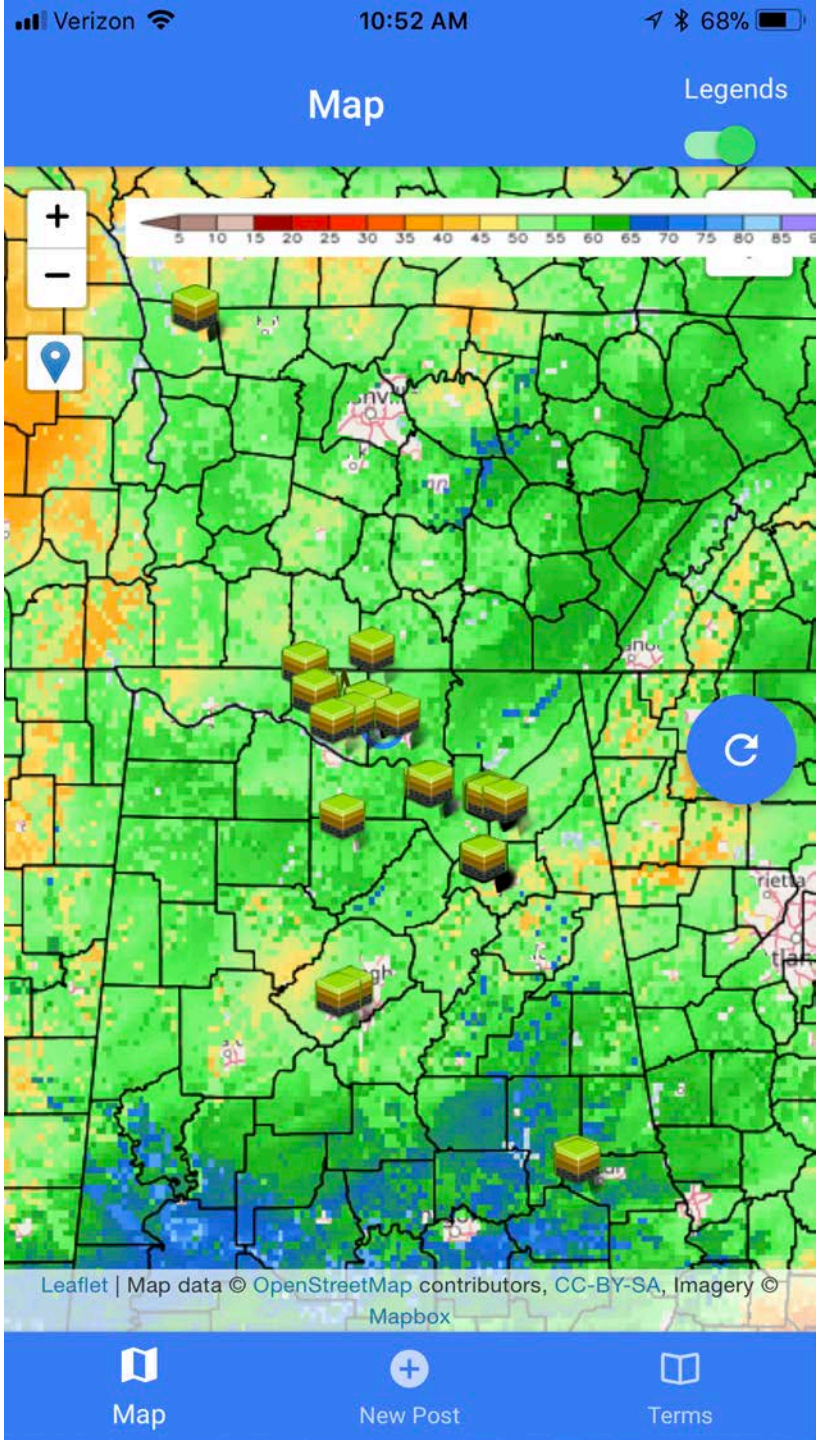
4-Week
Evaporative Stress Index



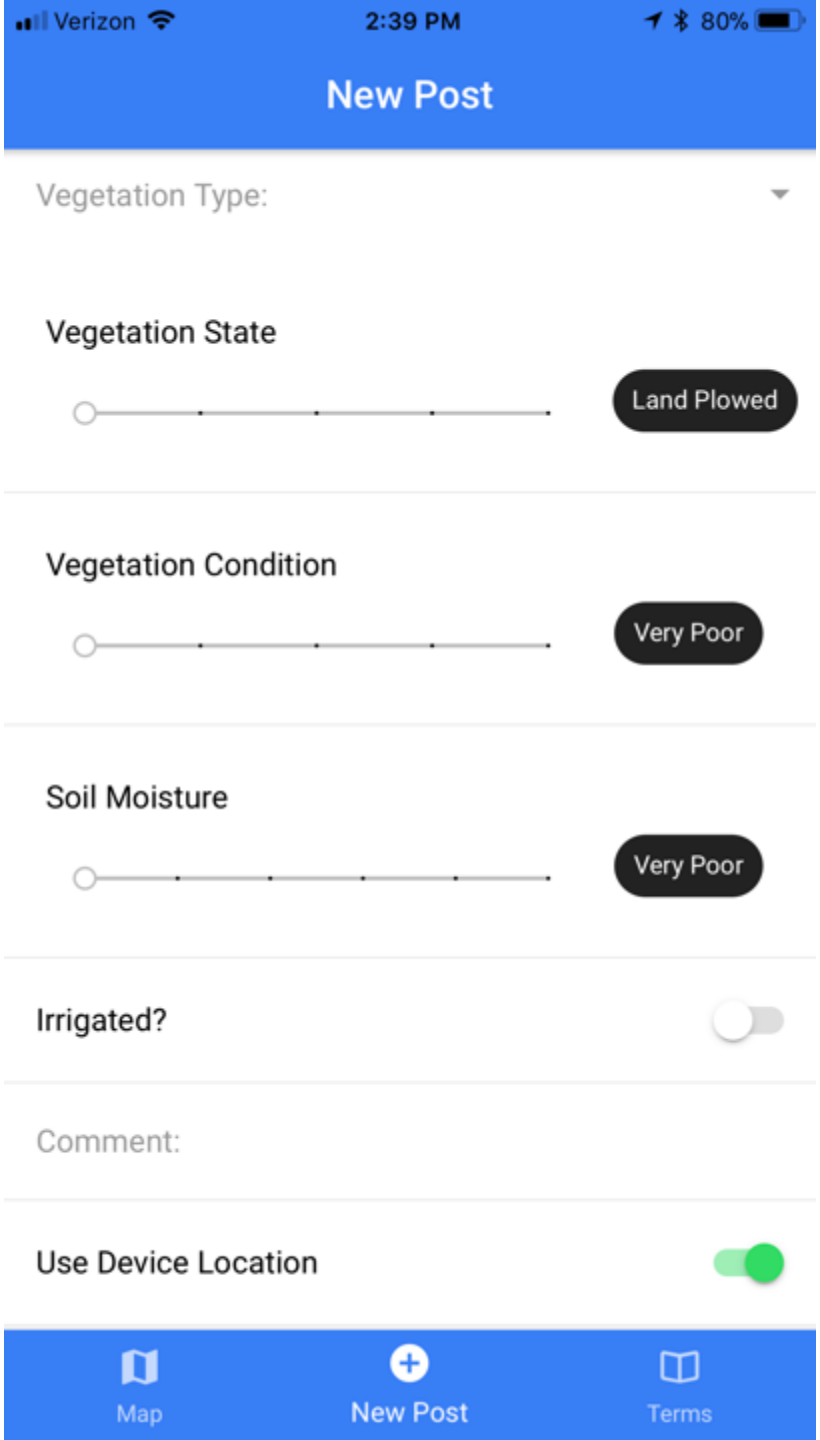
NASA SPoRT LIS
Soil Moisture Percentile



NASA SPoRT LIS
Current Soil Moisture



Submitting New Post



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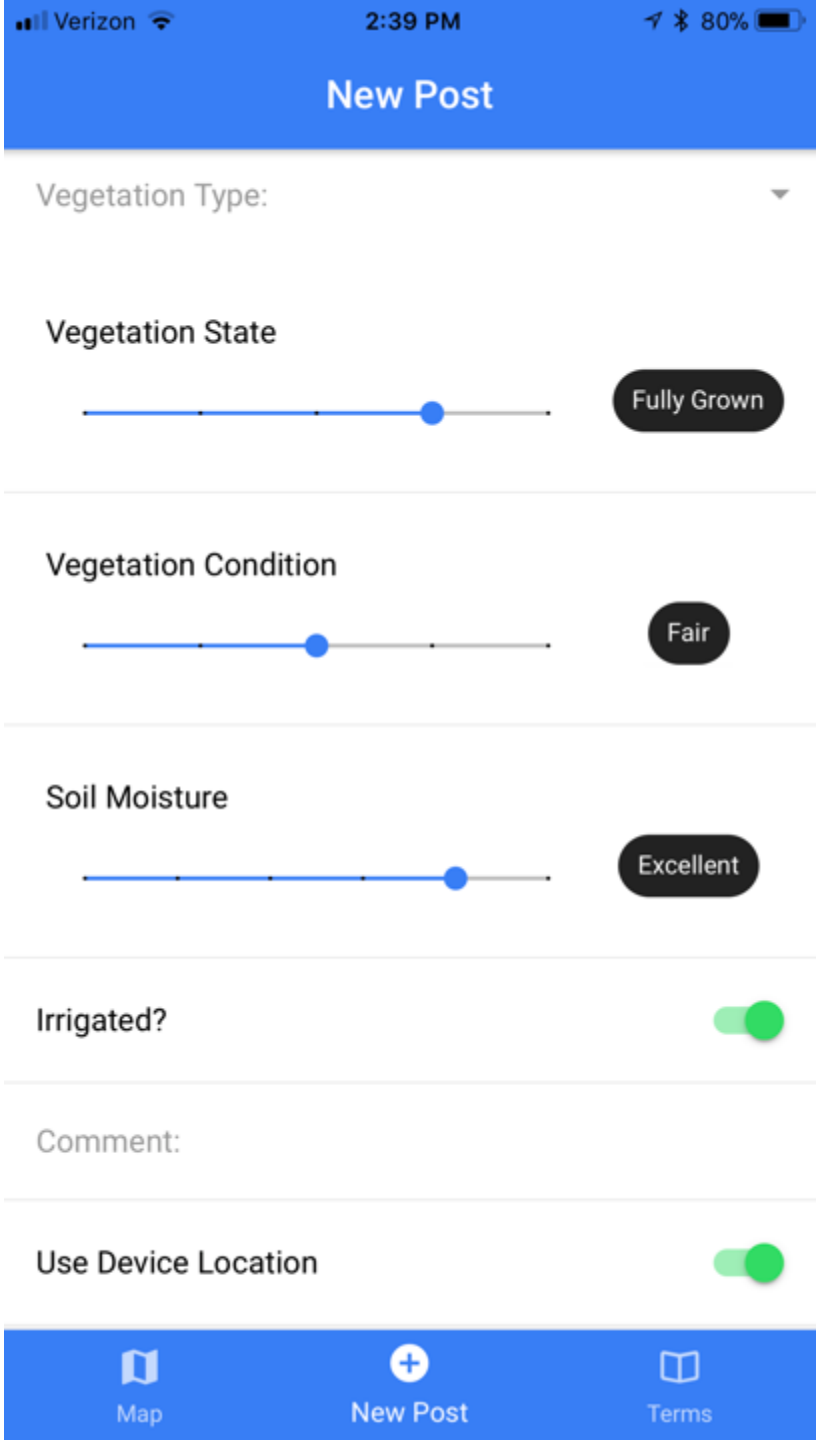

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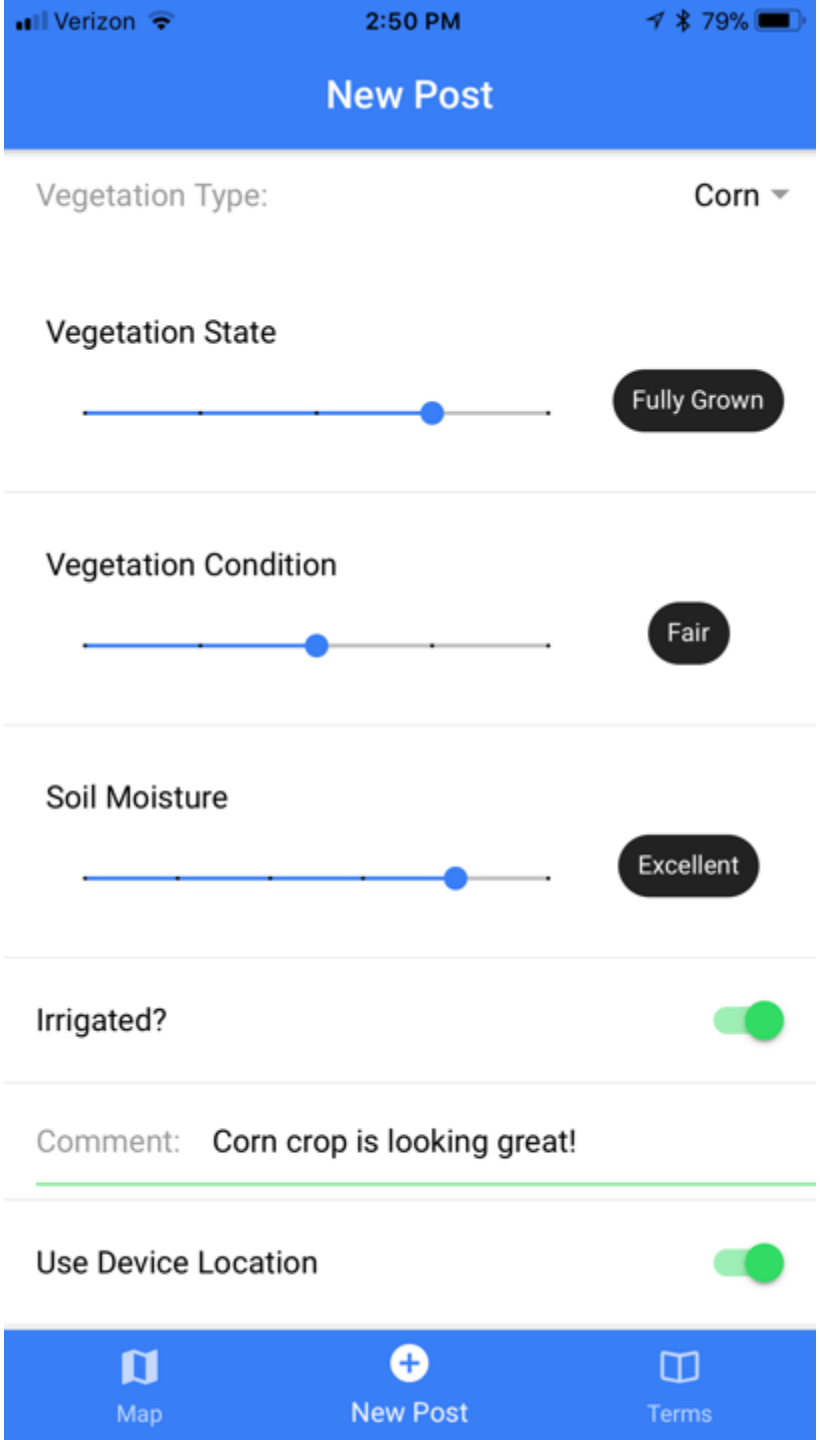

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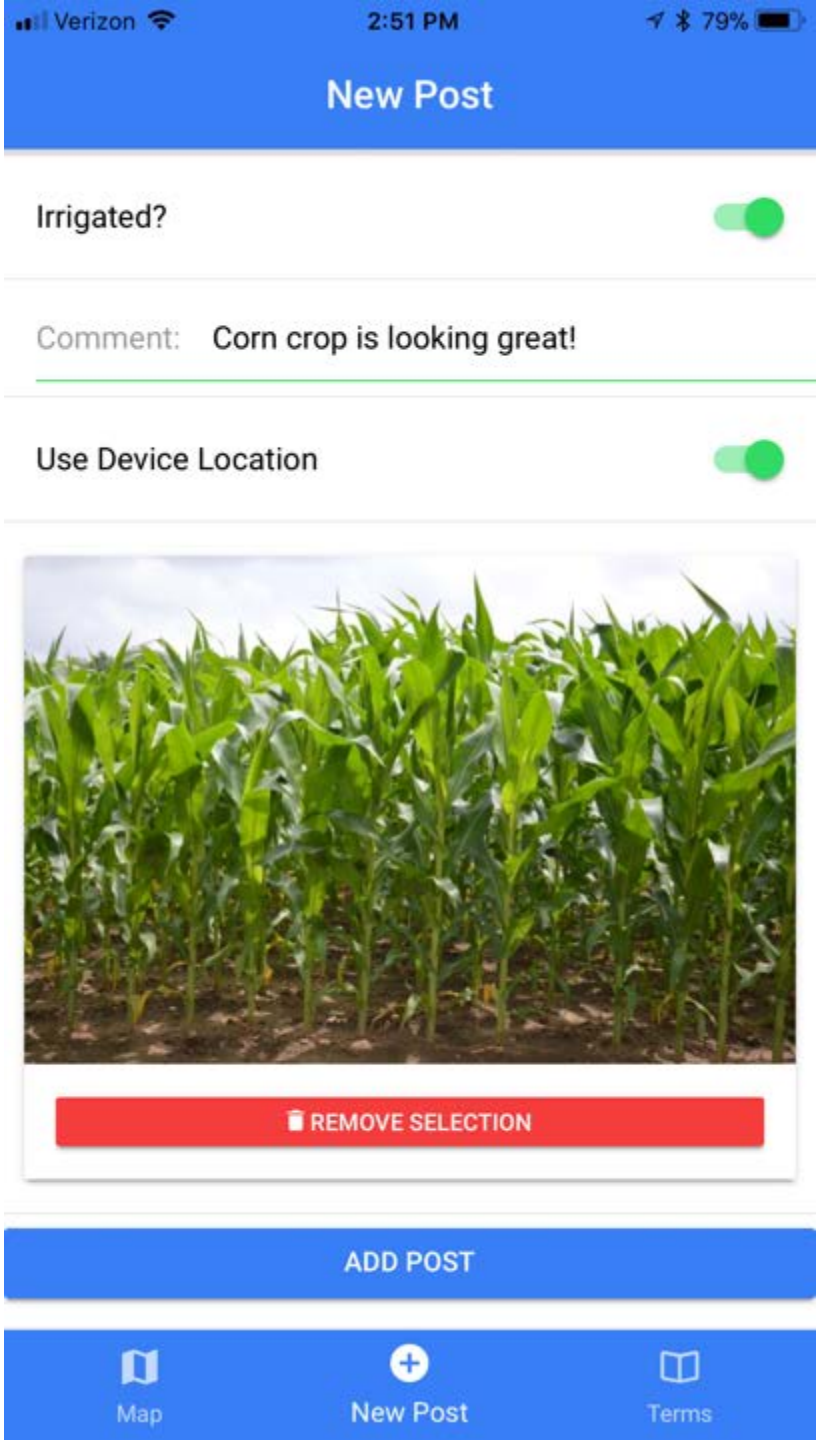
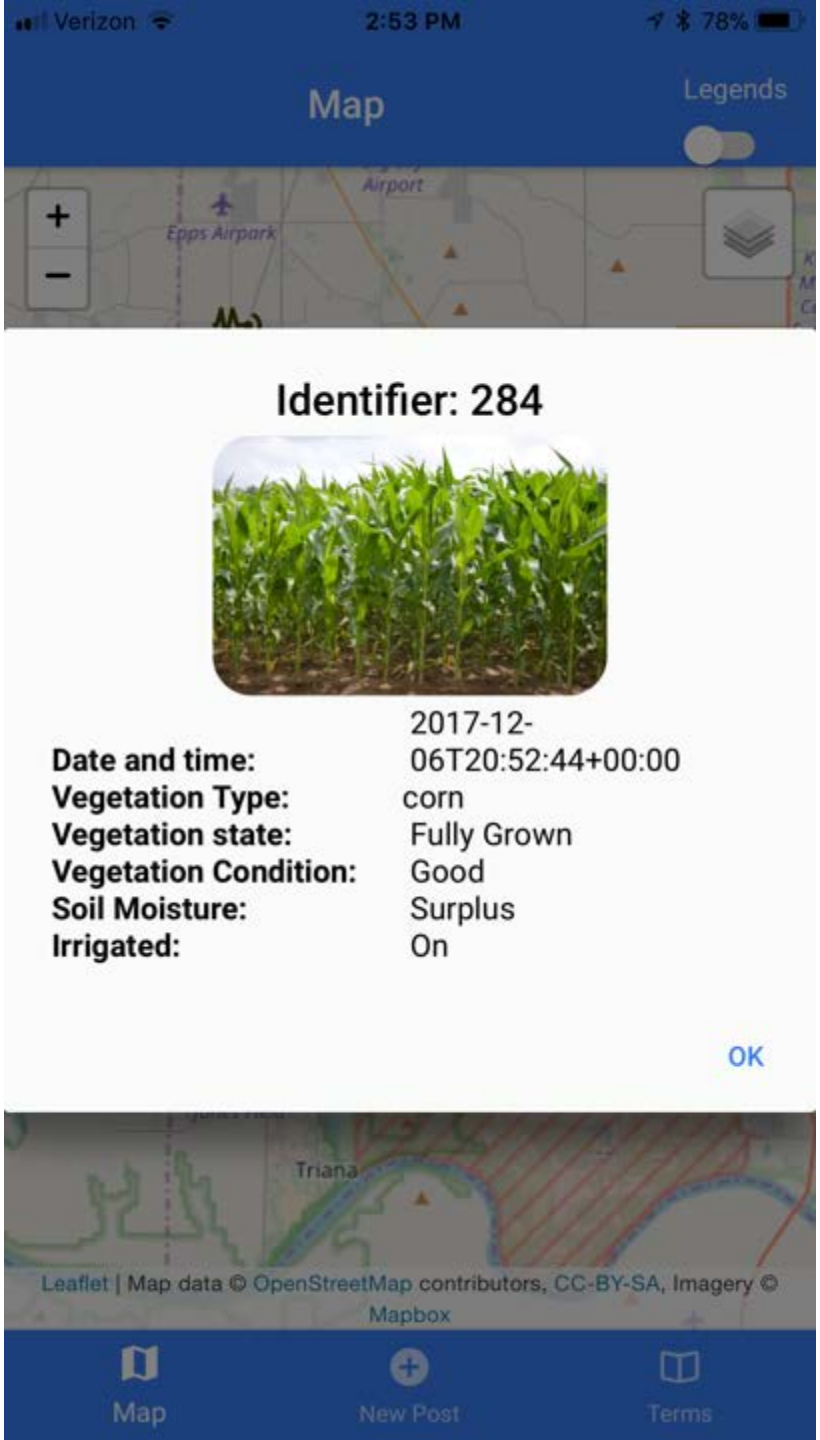
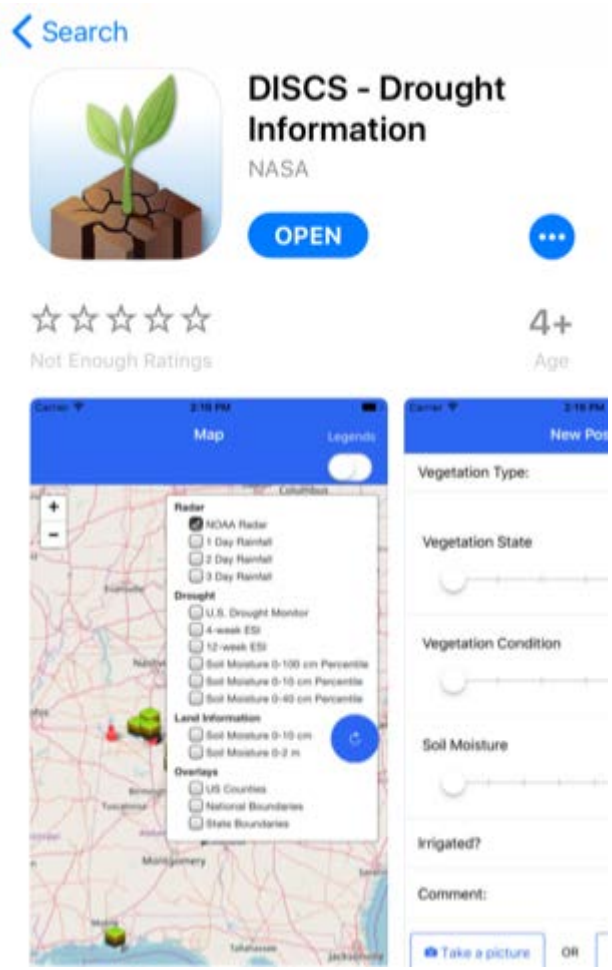


Viewing Post In-App

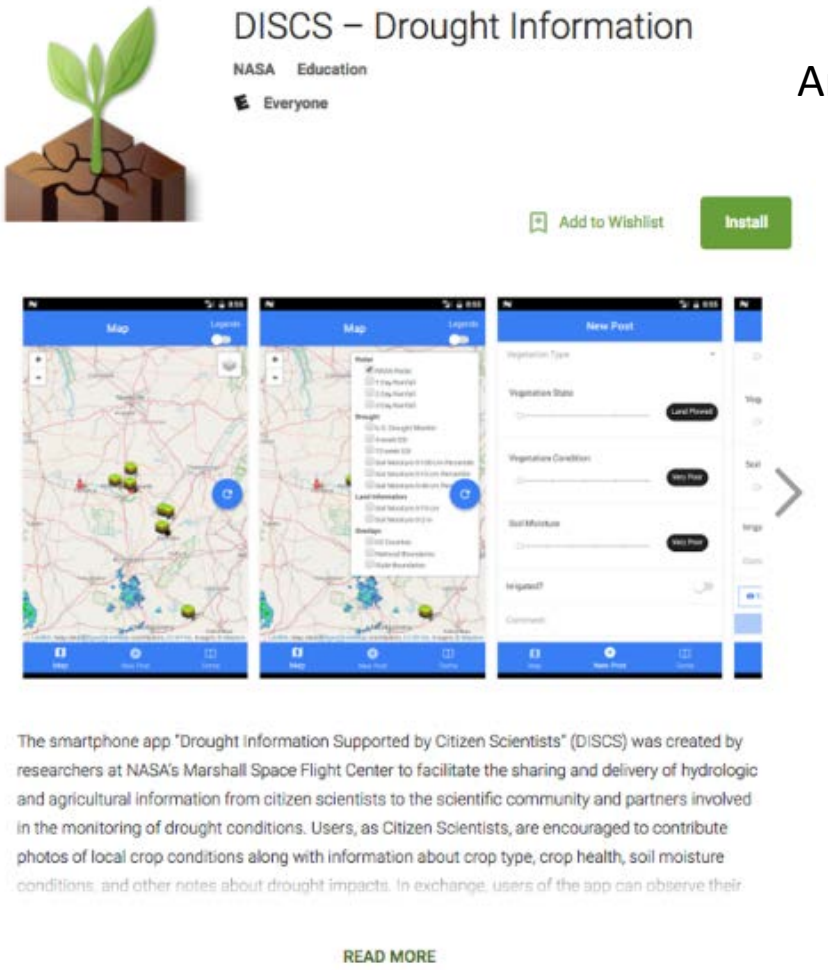


Software Release Process

iOS



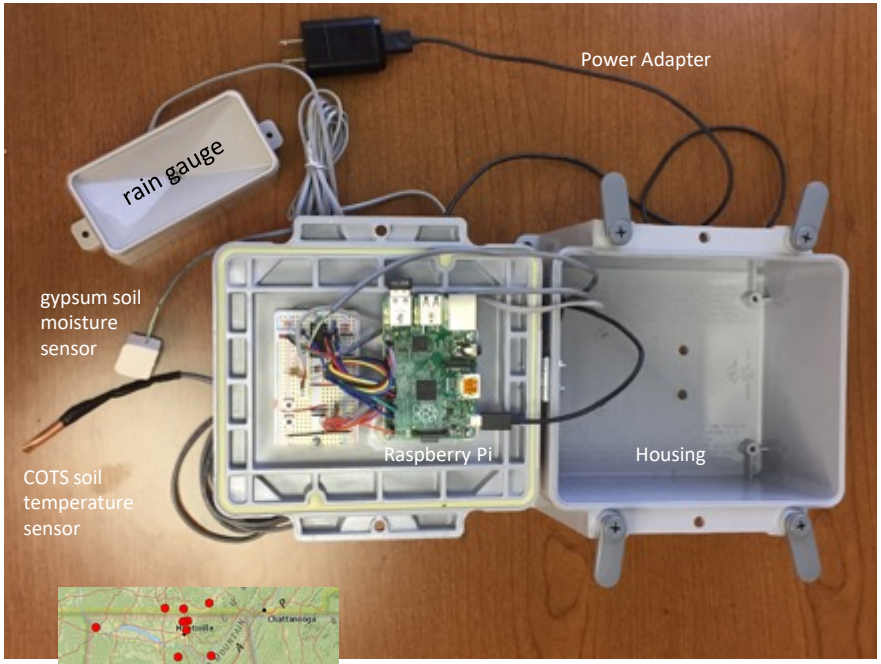
Android



Partnership with Marshall Space Flight Center's Technology Transfer Office allows for open-source release of underlying application code and also the release of app versions and updates via iOS and Android. Android in collaboration with team at NASA Ames.

Sensor Approaches

- Small low-cost sensors are being developed by UAH partners to permit in situ soil moisture measurements, using Raspberry Pi equipment and:
  - Commercially available soil temperature sensors and tipping rain gauge
  - Commercially available, low cost soil moisture sensors – tested, but found to be inaccurate / biased
  - Homemade, gypsum-based soil moisture sensors that can be made at low cost with methods for calibration – go-forward plan, including student involvement
- Goals of the sensor network:
  - Incorporate into local STEM education as opportunity to monitor local conditions, build sensors.
  - Supplement limited 16 SCAN soil moisture sites across the entire state with low-cost sensor packages to improve soil monitoring.
    - 30 of our sensors run around $4K.

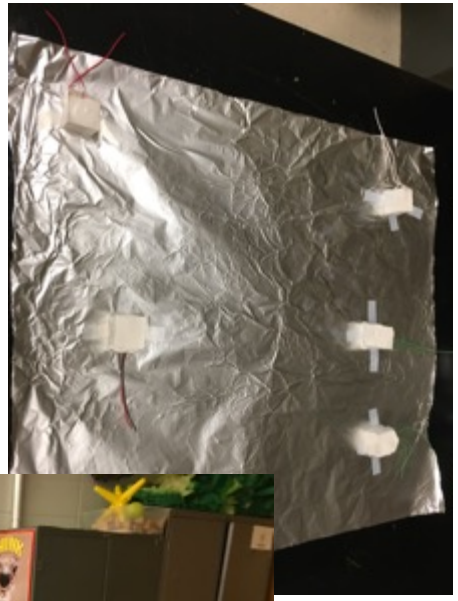


Top: Sensor package including Raspberry Pi with wireless internet, soil conditions, and rainfall.

Bottom: Current distribution of 16 SCAN sites in Alabama

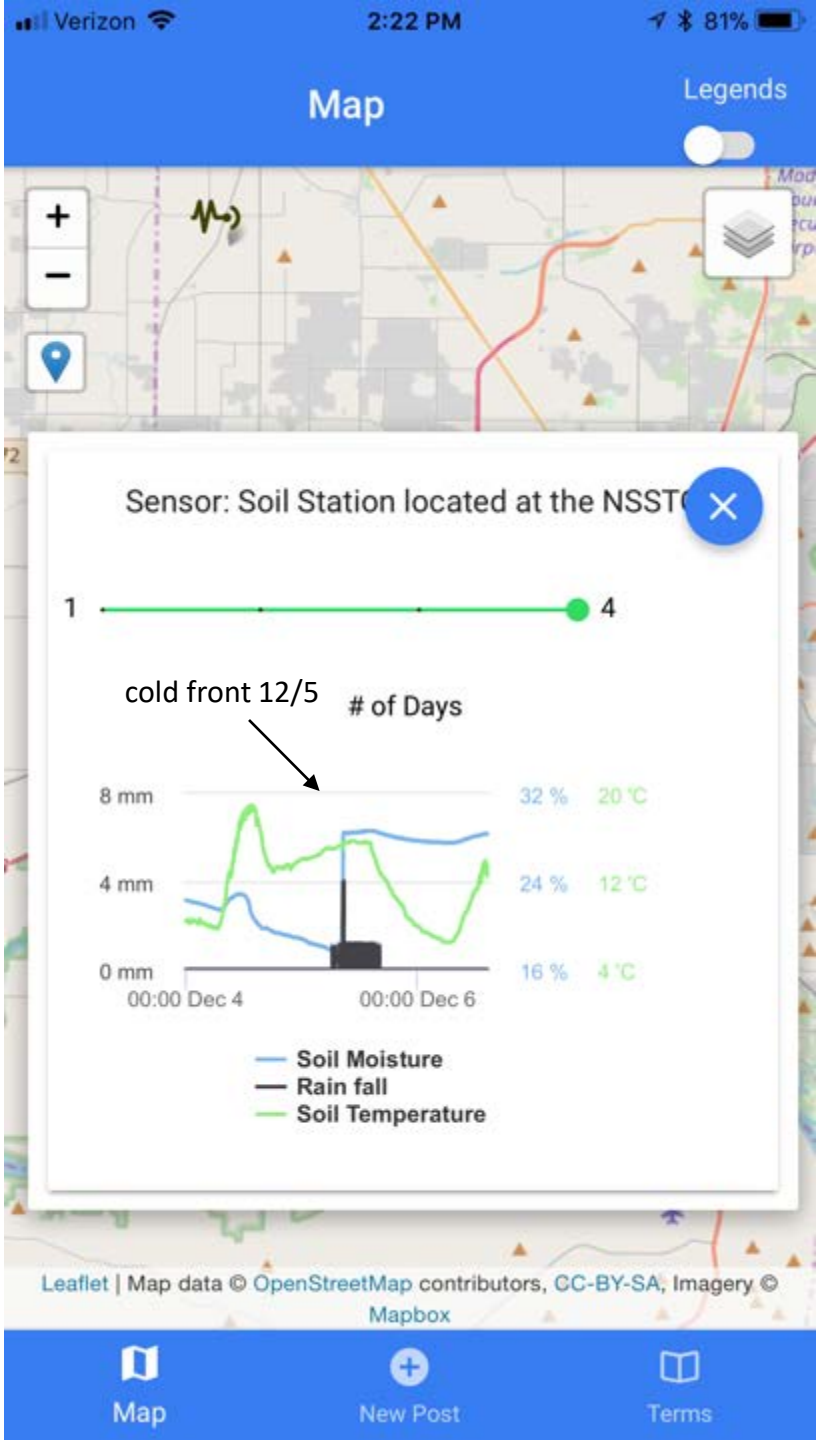
Calibration Procedures

- Create moist clay samples with known water content by mixing dry clay with water in different proportions
- Insert the sensors into such moist clay samples with known gravimetric soil moisture content (*W*) and measure the resistance of the sensor (*R*)
- Use this information to determine calibration (*a, b*) coefficients that relate *W* to *R*
  - $W = aR^{-b}$



Sensor Views In-App

Multi-day time series of parameters capture diurnal cycle and rainfall events.



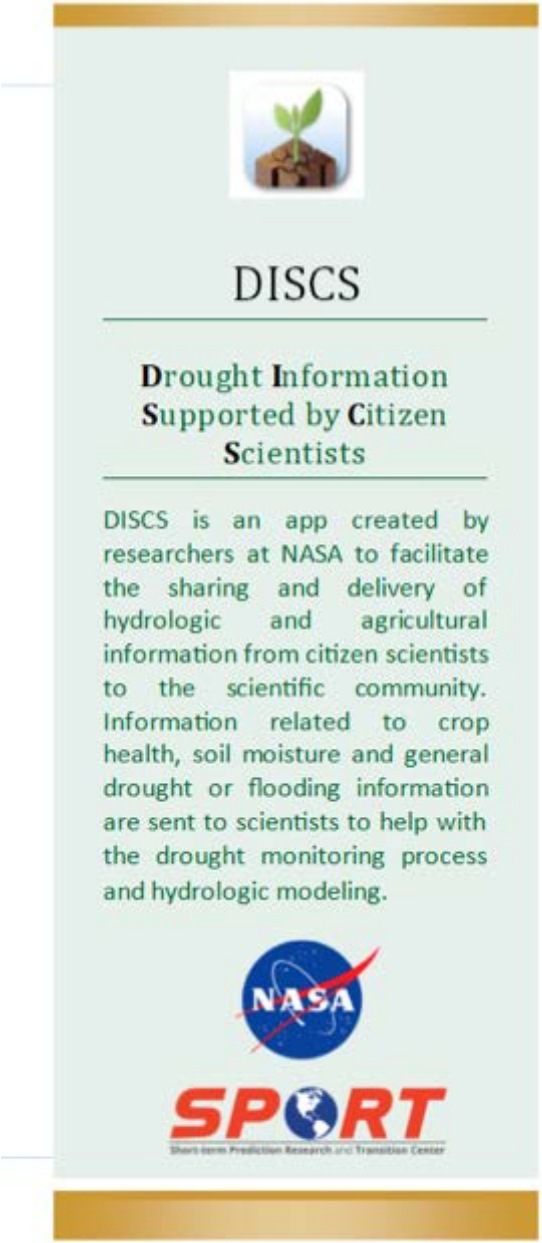
User Outreach / Engagement

Current:

- Development of DISCS brochure was completed in spring 2016 and disseminated to testers for the app

Future:

- Development of .pdf document that provides further instruction about app utility (link available)
- Development of YouTube video
  - Details uses of the app (e.g., data overlays, crop inputs, etc.)
  - Contains video showing how the data may be utilized by NASA researchers and potentially personnel from the USDM
  - Use Screenflow or other software to record audio/video directly from the mobile device



Progress

- Some early success stories of the project:
  - Rapid prototyping of the smartphone application
  - Integration of NASA/MSFC Earth Science data sets available through local web mapping system resources
  - First MSFC release of an app targeting the general public and use of our local science outputs
  - Outreach via NOAA/NWS partners to local co-op observers who are contributing observations and feedback
  - Demonstration and testing of wireless soil moisture sensor data in collaboration with UAH partners
  - Preliminary work to collaborate with K-12 educators on data collection and sensor linkage to STEM education

Future Work

- Our team will continue building a community of observers in our region through the short remainder of our prototype period
  - Coordinated engagement with end users via iOS/Android app, encouraging continued use outside of the growing season:
    - App installation, loading, and use
    - Best practices for collecting data
    - Descriptions of various NASA data sets and their utility
    - Data usage by NASA researchers and the drought community
- Broader partnerships:
  - With availability in the App Stores, we have begun reaching out to select U.S. Drought Monitor authors, USDA staff, and others to get a broader reach of input beyond local Alabama collaborators.
    - App feedback from these valuable end-users will be used for app modification
    - Broader engagement of Ag Extension Services (Auburn, Alabama A&M)
  - We'll demonstrate the value of the observations for drought monitoring, understanding the validity of other remote sensing approaches, and helping to validate other products