

Introduction to Data Products for Water Quality and Quantity Monitoring for Agriculture Applications

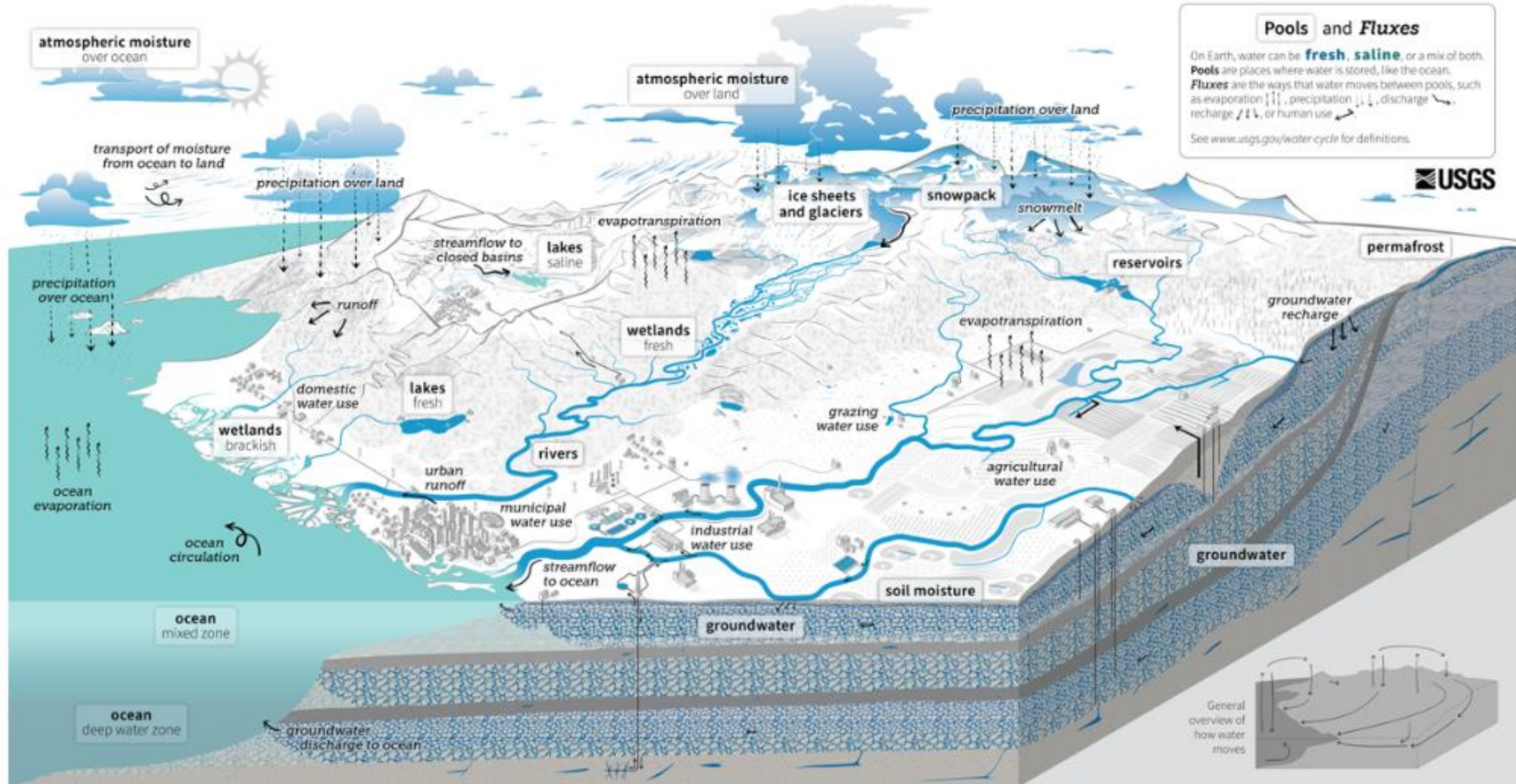


Remote Sensing for Water Management



- Satellite remote sensing can observe inaccessible areas like remote lakes, polar regions, and conflict zones where ground measurements are impossible
- Multiple NASA missions focusing on various water components
- Consistent, timely observations
- Calibrated and validated data
- Reduced field work: Minimizes expensive and time-consuming ground-based monitoring

The Water Cycle

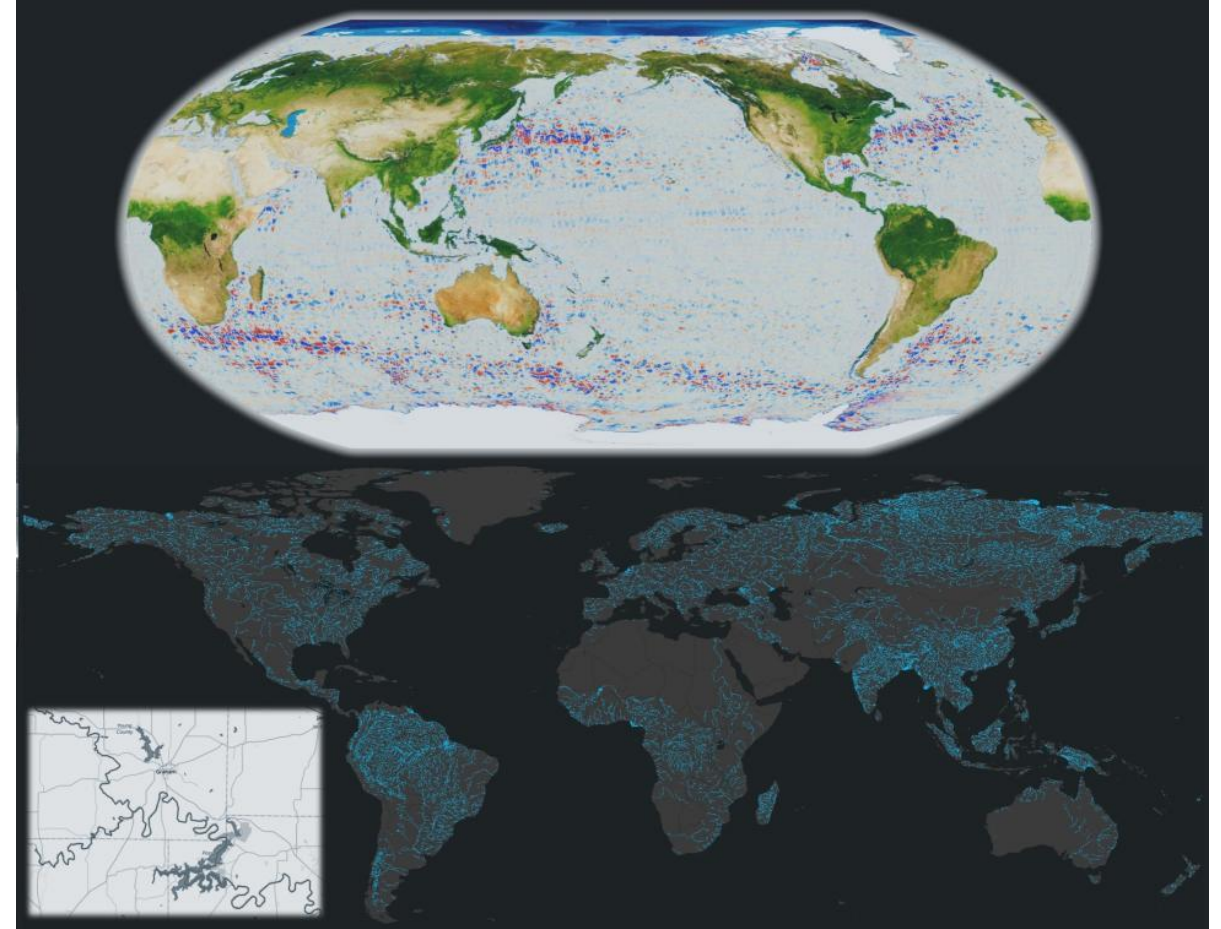


Common Fresh Water Management Variables

- **Evapotranspiration (ET):** The sum of processes by which water moves from the land surface to the atmosphere via evaporation and transpiration
 - **Evaporation:** The process of a liquid (water) changing into gas (water vapor)
 - **Transpiration:** Plant roots uptake water from the soil, water moves through plant tissues, and leaves release water vapor into the air through their stomata
- **Soil moisture:** Expressed as soil water content (mass or volume of water in the soil)
- **Precipitation:** Liquid or solid water molecules that fall from the atmosphere and reach the ground
- **Runoff:** Precipitation that runs off the landscape

Water Quantity

- Water is measured in terms of mass per volume or in terms of depth or height per unit area.
- Water amount measured is referred to as water budget and includes:
 - Precipitation
 - Soil moisture
 - Evapotranspiration ET
 - Ground water
 - Water runoff
 - atmospheric humidity and clouds
 - Reservoirs and lakes



Credit: [Accessing Data for the World's Water with SWOT](#)

Surface Water Quantity – SWOT

- Surface Water and Ocean Topography ([SWOT](#))
- 2022 – present
- Spatial Resolution:
 - Swaths: 120 km
 - Oceans: 14-15 km
 - Coastal Zones: 10 km
 - Land ~100 m
- Temporal Resolution: 21-day revisit
- Microwave Radar Interferometer & Radar Altimeter Microwave
- Access: ([PO.DAAC](#))



Credit: [SWOT](#) Visualization

Water Quality

Usability of water for various applications depends on water quality

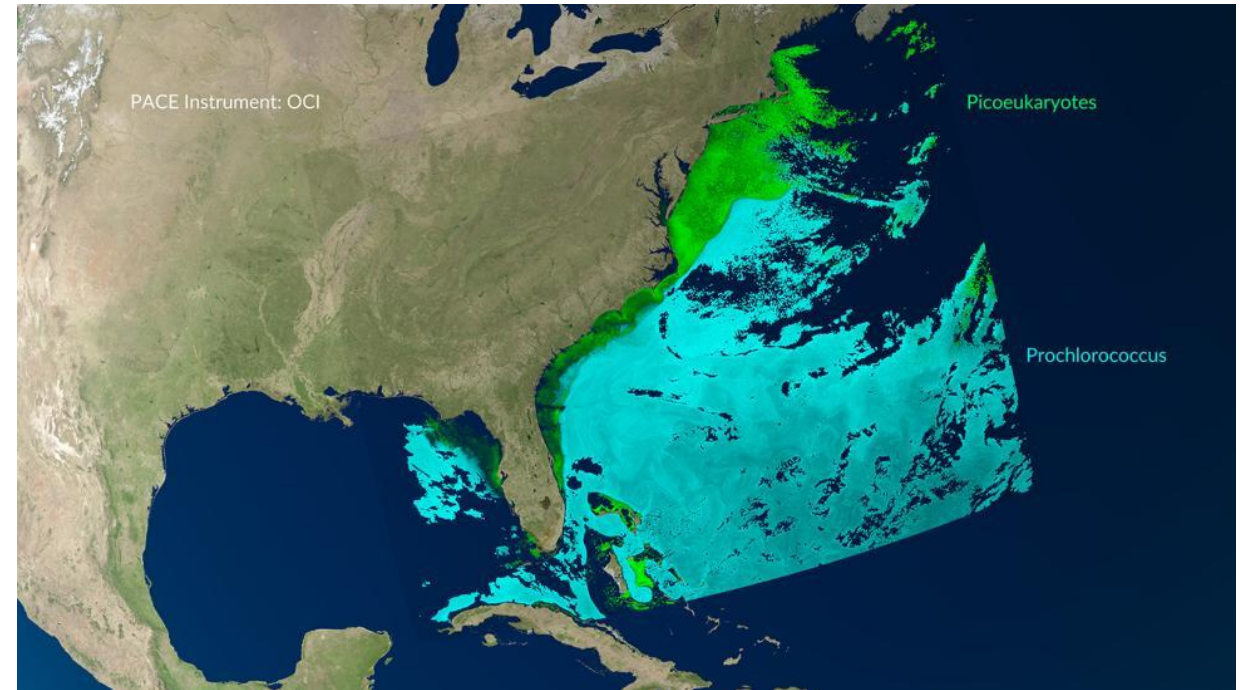
- Is the physical, chemical, biological, and microbiological constituents of water that determines its suitability for particular uses.
- Water quality in lakes, rivers, coastal oceans is affected by nutrients and pollution from surrounding watershed areas resulting from natural (rainfall and runoff) and human activities (e.g. agricultural, industrial, land use change), temperature and ecosystem changes.



[Credit: Lake Erie Blooms - NASA Science](#)

Surface Water Quality – PACE

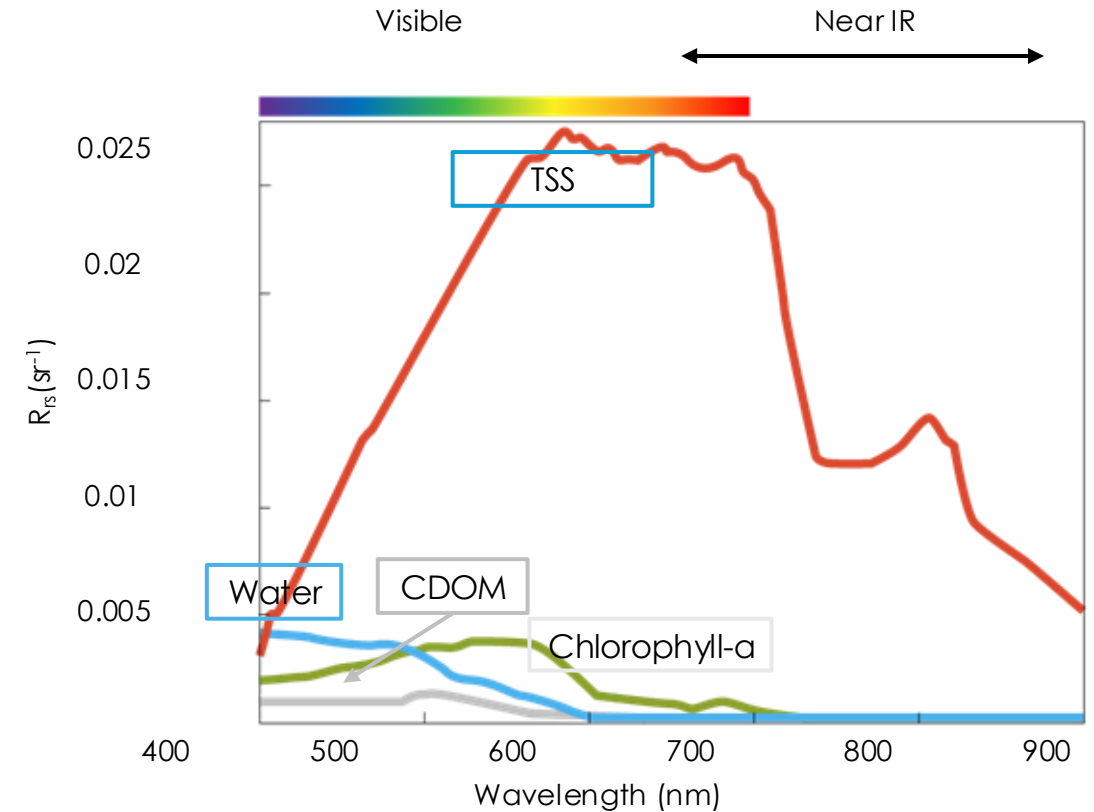
- NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)
- 2024 – present
- Spatial Resolution: 1km – 3km
- Temporal Resolution: 1-2 days
- Hyperspectral global coverage
- Sensors measure ocean ecology including phytoplankton distribution, analyzes aerosols and clouds, and informs research on ocean - atmospheric exchange
- Access: [Earthdata Search](#) & [Worldview](#)



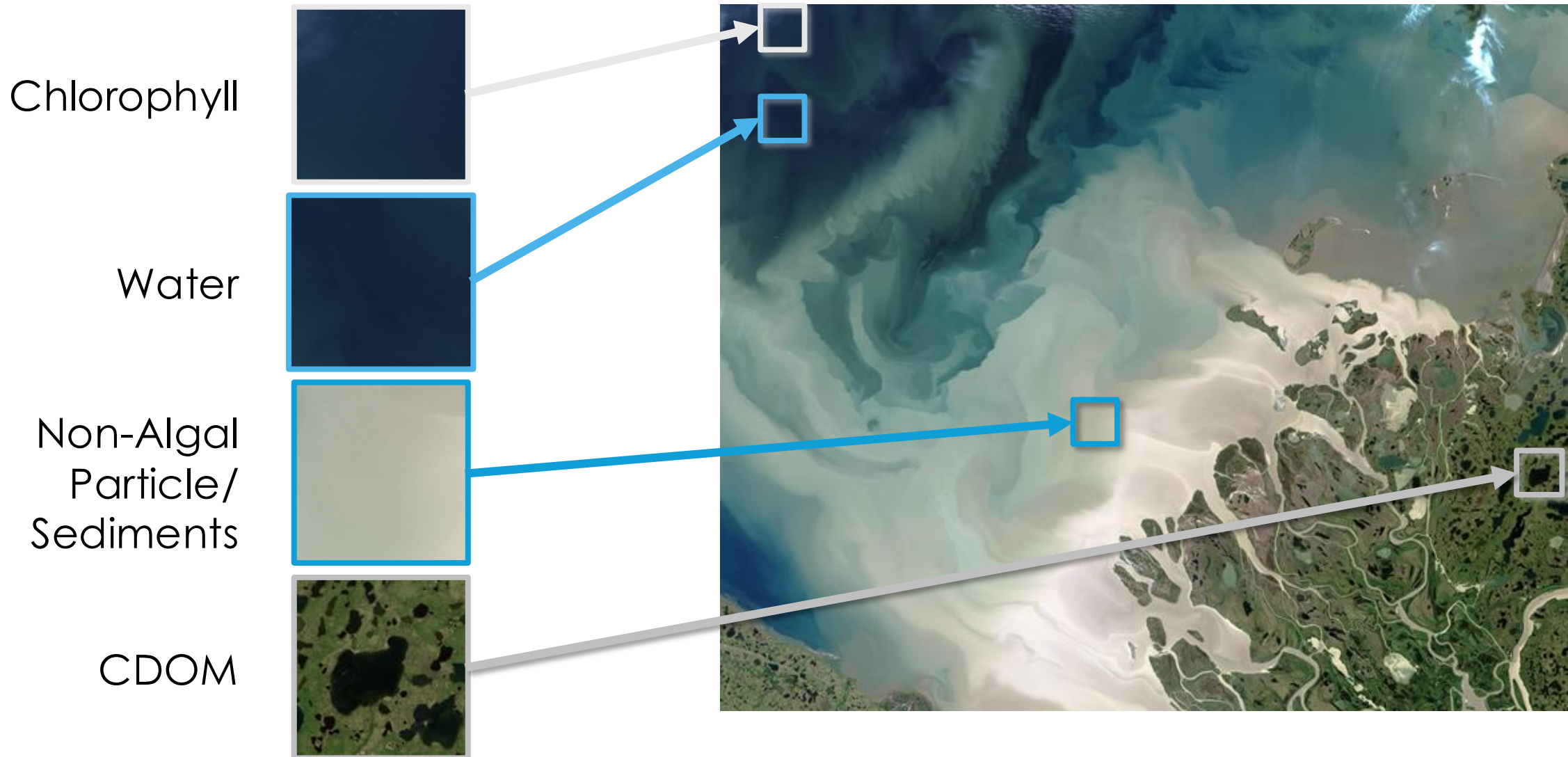
Credit: [PACE Data Tutorials](#)

Common Earth Observation Water Quality Parameters

- **Chlorophyll-a (Phytoplankton):** Primary green pigment in algae (harmful & non harmful)
- **Colored Dissolved Organic Matter (CDOM):** Impact light penetration, nutrient cycles, aquatic ecosystem health and carbon cycle
- **Total Suspended Solids (TSS):** Include pollutants, heavy metals, and nutrients. Affect light penetration and aquatic ecosystem. Sediment loads are critical for protecting the integrity of sediment-maintained geomorphic features such as river deltas and marsh and mangrove wetland platforms



Inherent Optical Properties (IOPs) decide the 'Color' of Water



Water Quality Ranges for Lakes

- **Total Suspended Solids (TSS):** Range (mg/L or g/ m³)
 - Less than 20 mg/L, is recommended for cold-water aquatic life
 - Levels below 30 mg/L are considered reasonable for warm water aquatic habitat
 - Values over 40–80 mg/L indicating cloudy, potentially impaired conditions

- **Chlorophyll-a (Phytoplankton):** Range (µ g/L or mg/m³)

Credit: [EPA](#)

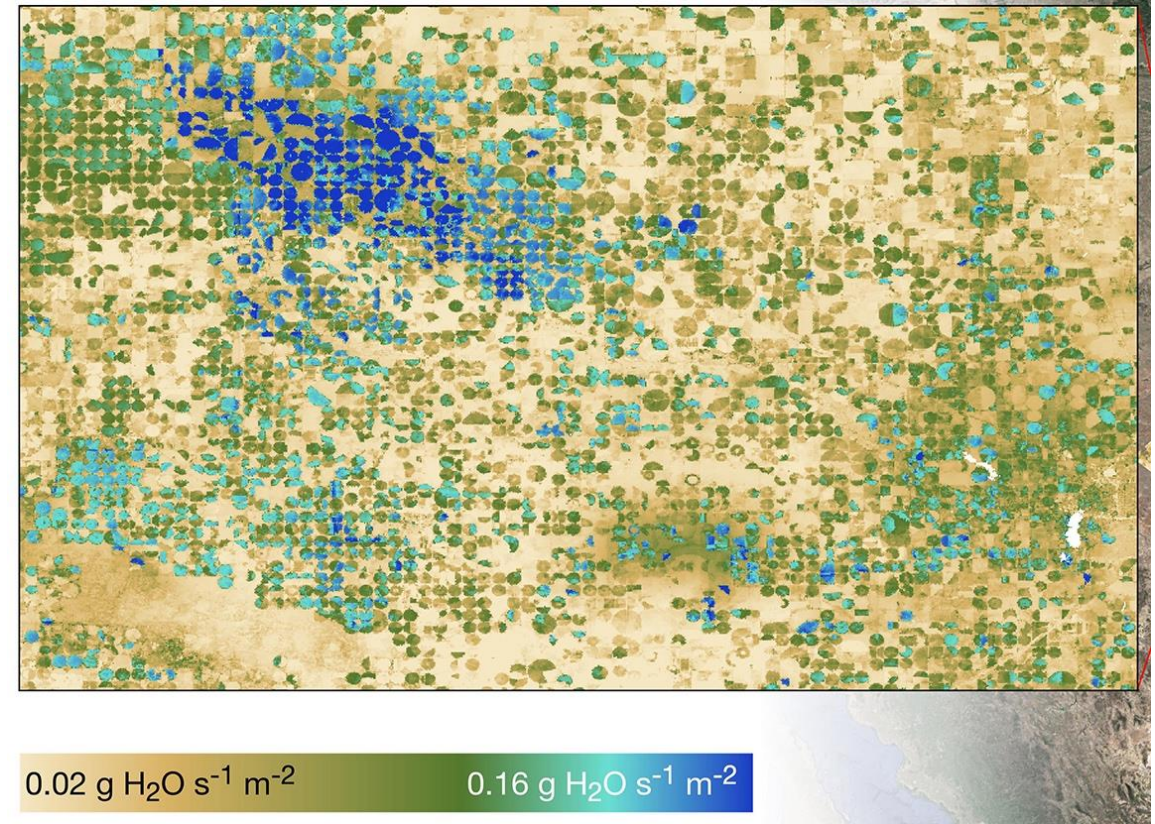
Chlorophyll-a Range	Trophic State	Water Quality Condition
< 5	Oligotrophic	Clear water, high oxygen, excellent drinking water quality
5 - 10	Mesotrophic	Intermediate productivity, moderate plant/algae growth
10 - 20	Eutrophic	High biological productivity, prone to occasional algal blooms
> 20	Hypereutrophic	Highly productive, dense algal mats, poor water clarity, potential for toxic blooms



SWOT

Evapotranspiration – ECOSTRESS

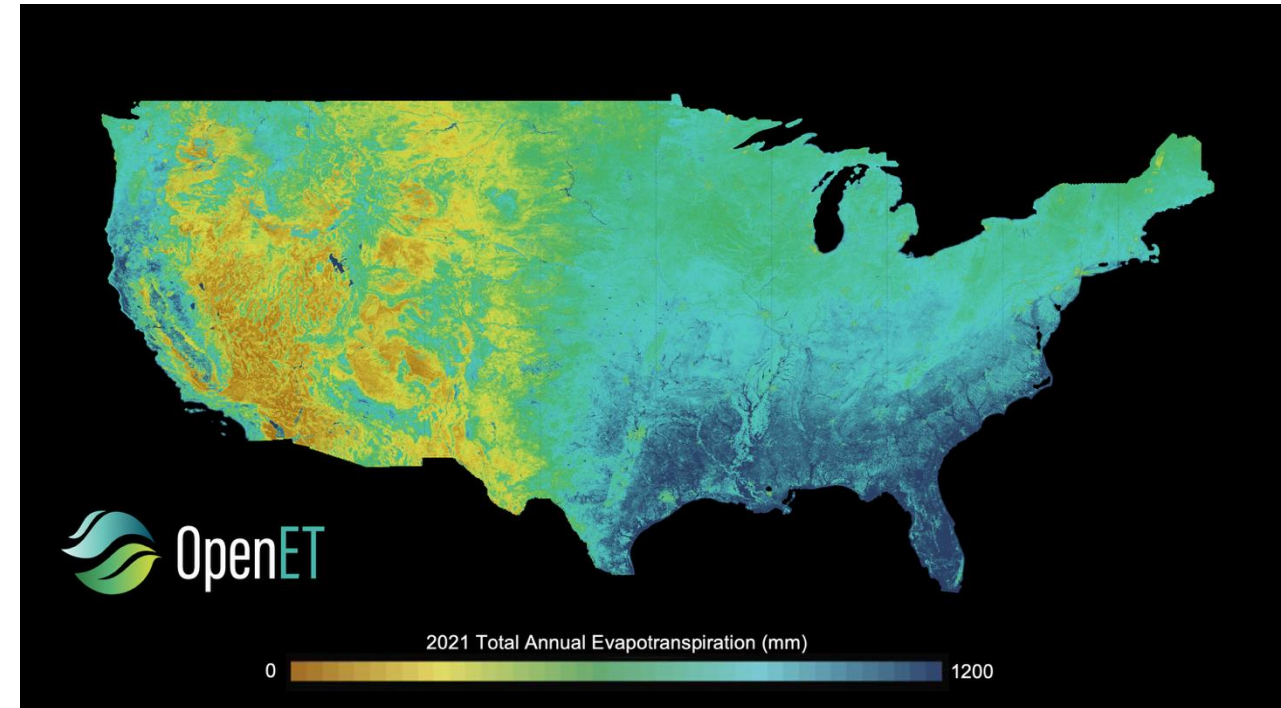
- ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS)
- July 2018 – present
- Spatial Resolution: 70 m
- Temporal resolution: Variable revisit (ISS orbit-dependent)
- International Space Station (ISS) mounted thermal radiometer
- Measures agricultural water use
- Access: AppEEARS (free registration)



ECOSTRESS evapotranspiration data from Hart, Texas (July 29, 2018) displays inter-field and intra-field crop health variations in pivot-irrigated agriculture.
Image Credit: [NASA/JPL](#)

Evapotranspiration – OpenET

- 2016 – Present
- Spatial Resolution: 30 m
- Latency: Variable
- OpenET
- Evapotranspiration data from OpenET do not represent direct measurements of ET; rather they are estimates based on satellite, meteorological, soil, and vegetation datasets that are used within state-of-the-art ET models.
- Access: OpenET



[Getting Started](#) ▾[Data Access](#) ▾[About OpenET](#) ▾[OpenET Science](#) ▾[Impact Stories](#) ▾

Filling the Biggest Data Gap in Water Management

OpenET **empowers** water management from local to global scales by delivering transparent, scientifically rigorous satellite-based evapotranspiration (ET) data through accessible tools.

[Data Explorer](#)[OpenET API](#)[FARMS Tool](#)

What's the difference? [Compare tools](#) →

Compare OpenET Tools



Data Explorer

A user-friendly, visual tool for quickly exploring ET data. You can select areas of interest, view historical patterns, and download results.

[More About Data Explorer](#) →



API

Provides automated access to ET data for large-scale or repeated use. Ideal for integrating ET into irrigation scheduling tools, hydrologic models, water accounting systems, or other applications.

[More About the API](#) →



FARMS Tool

Designed for growers, this tool compares ET with water use at the field level. Reports from FARMS can help users to optimize irrigation efficiency, and support farm-level decision-making.

[More About FARMS](#) →

▶▶▶ Draw Custom Area ◀◀◀



Cities

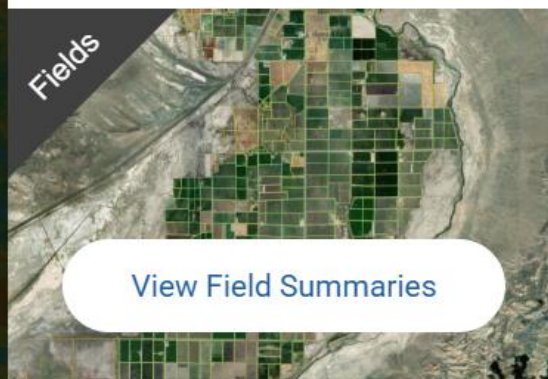
Crops

mm in



Choose to view data by **fields** or by **grids**.

Fields

[View Field Summaries](#)

Grids

[View Gridded Data](#)

OpenET provides data at different scales. You can view the data summarized for millions of individual fields or in the original raster format, or you can create a custom report to define your own boundaries, time frames, and data summaries.

[▶▶▶ Draw Custom Area ◀◀◀](#)

Grand Valley, CO, USA



Select Year
2020

Variable
ET

Raster View

☒ Field View

? New Here? Take a Tour!



Units

mm in

47 in

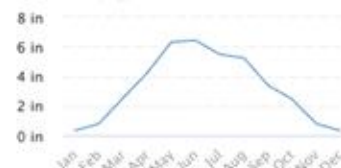
Cumulative Ensemble Evapotranspiration (in)

0 in

2020 ET: 38 in

Area: 100 Acres

USDA/CNWR Crop Type: Alfalfa



? About Crop Type
and Field Boundaries

Opacity



Powered by

Google Earth Engine

>>> Draw Custom Area <<<

Grand Valley, CO, USA

Select Year
2020Variable
ET

Raster View

☒ Field View

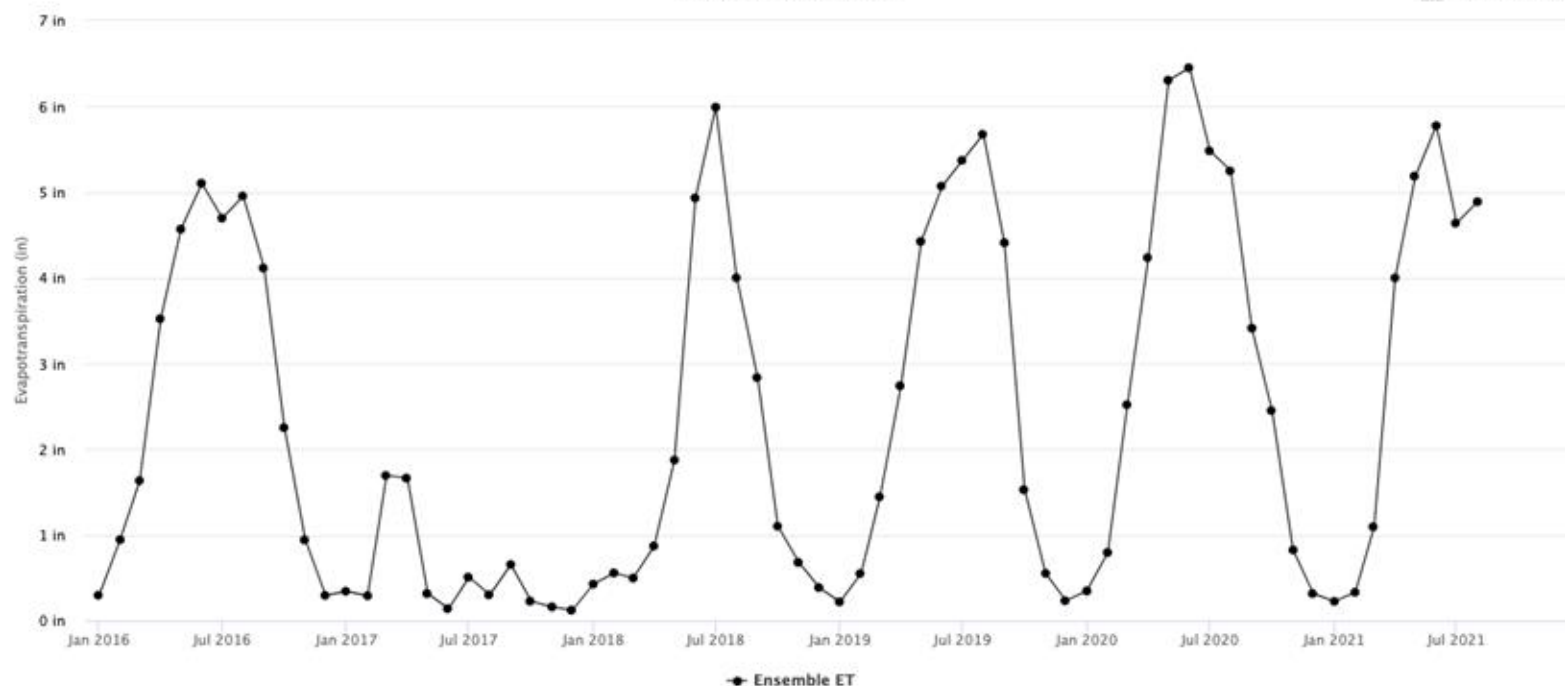
USDA/CNWR Crop Type: Alfalfa | Area: 100 Acres | Field ID: 084171

Monthly

Cumulative

Evapotranspiration

Download Data



Data Options

ET

☒ Ensemble☐ Range☐ eeMETRIC☐ SSEBop☐ SIMS☐ PT-JPL☐ DisALEXI☐ geeSEBAL

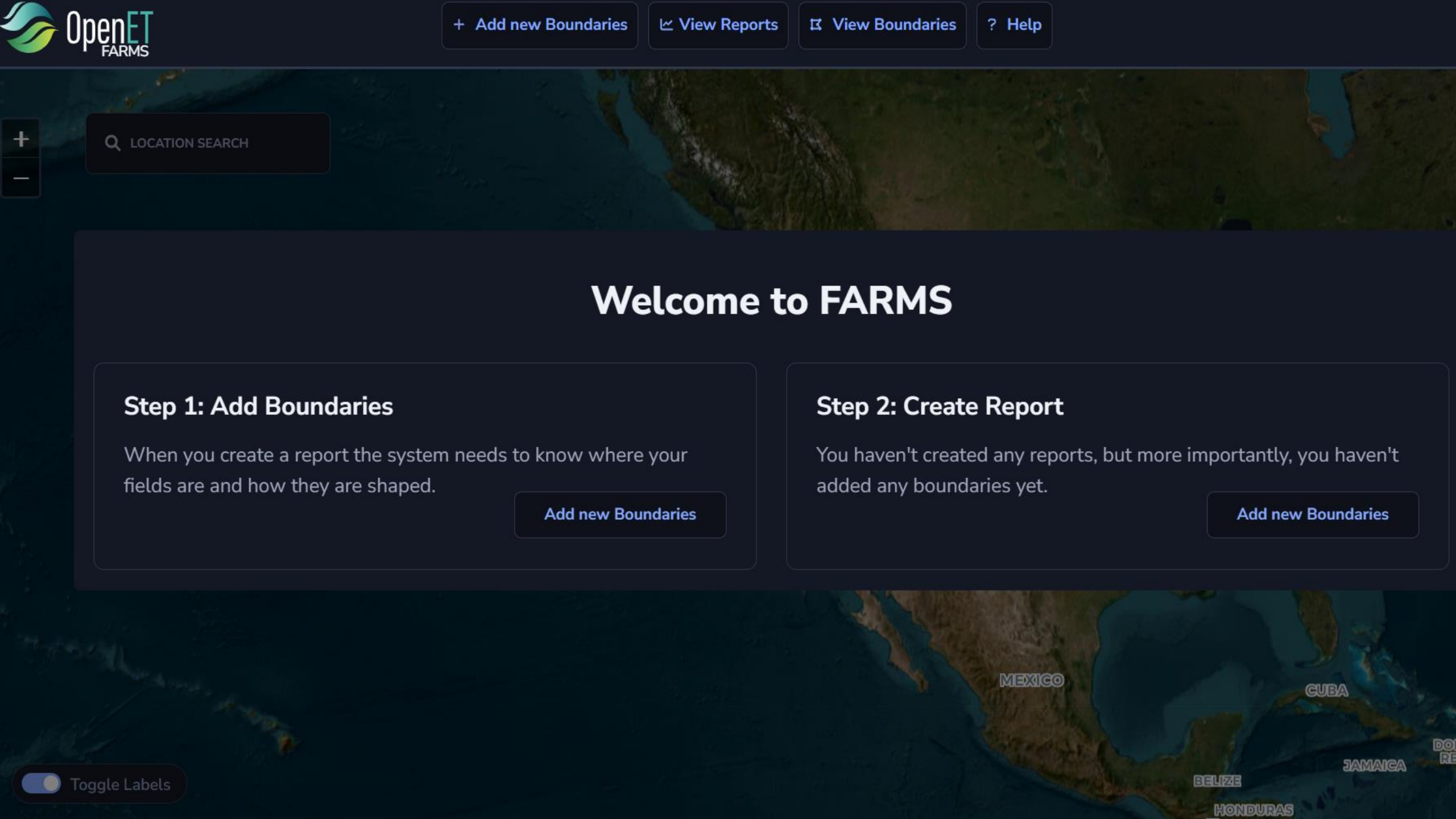
ET Fraction

Additional Variables

[? About Crop Type
and Field Boundaries](#)

Capacity

[Draw Custom Area](#)



LOCATION SEARCH

Welcome to FARMS

Step 1: Add Boundaries

When you create a report the system needs to know where your fields are and how they are shaped.

[Add new Boundaries](#)

Step 2: Create Report

You haven't created any reports, but more importantly, you haven't added any boundaries yet.

[Add new Boundaries](#)

 LOCATION SEARCH

Upload Shapes

Click here to upload a zipped shapefile or a geojson file.

Draw your Own

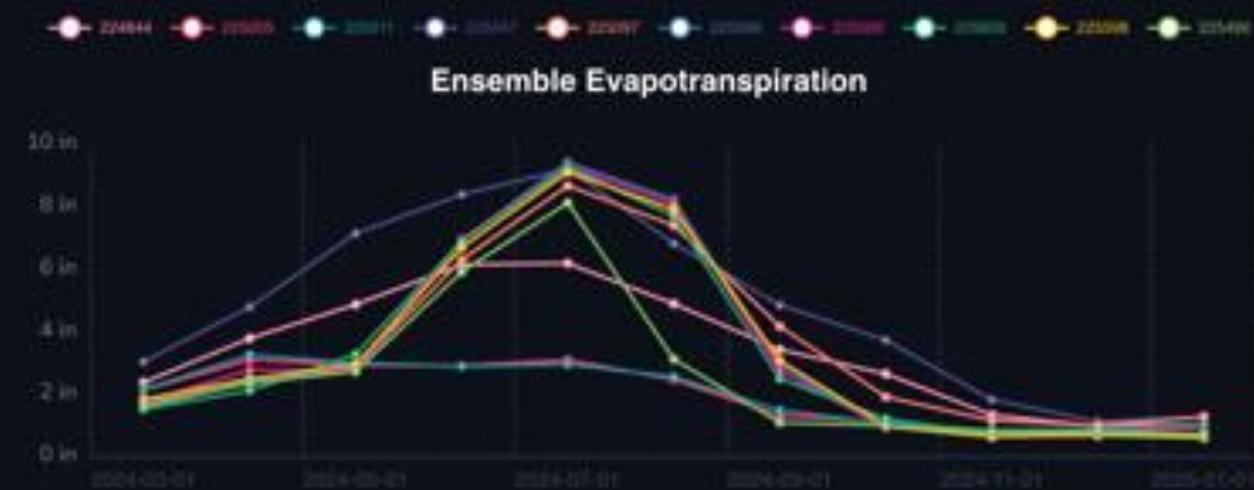
Draw your own field boundaries using our drawing tools.

Select Existing

Choose your fields from the existing OpenET boundaries.

Example Report

Ensemble Evapotranspiration



Report Data

Field ID: 224844

Acres: 24.79



MODEL

ensemble

VARIABLE

et

Field ID: 224844

Date	Value (inches)	Acre-Feet
2024-12-01	0.724	1.496
2024-11-01	1.119	2.312
2024-10-01	2.016	4.165
2024-09-01	3.197	6.605
2024-08-01	4.52	9.338
2024-07-01	6.294	13.003



Demo – OpenET



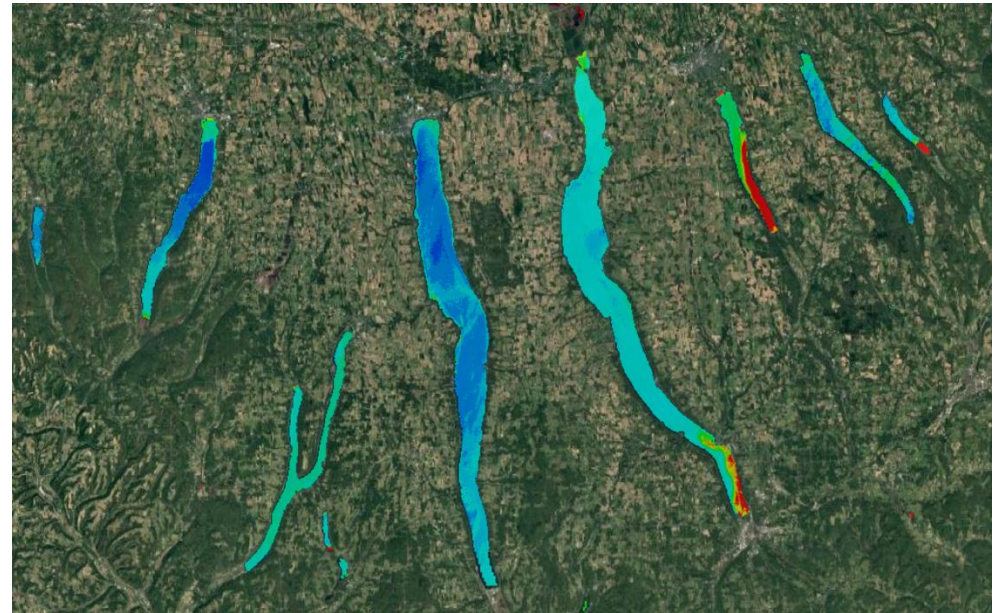
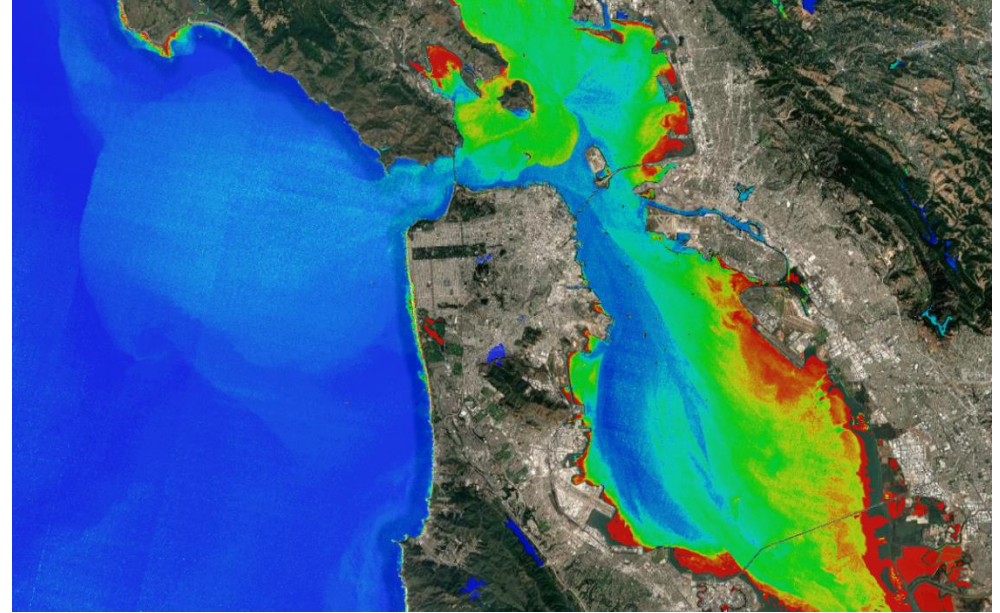
OpenET Case Study – Lubbock Texas Agriculture

- Lubbock Texas
- Explore OpenET's FARMS tool
- Identify fields within Texas to generate ET/NDVI report
- Assess ET, NDVI, and Precipitation
 - Explore daily and monthly ET trends
 - Compare different fields in the report viewer
 - Export table to excel



NASA STREAM

- 2018 – Present
- Spatial Resolution: 20-30m
- Uses Sentinel-2 and Landsat 8/9
- Generate water quality maps for chlorophyll-a (Chla), Total Suspended Solids (TSS), and Secchi Disk Depth (Zsd)
- In partnership with the United Nations Environment Program, STREAM plays a pivotal role in consistent monitoring and reporting of Sustainable Development Goal 6 ([indicator 6.3.2](#)) under the United Nations 2030 Agenda
- Access: [STREAM](#)





STREAM

Satellite-based Tool for Rapid Evaluation of Aquatic environments

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STREAM

Monitor water quality with high-resolution satellite imagery to support timely decision-making

[Explore Map](#)[Download Data](#)[API Documentation](#)



STREAM

Satellite-based Tool for Rapid Evaluation of Aquatic environments

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[Map](#)

[Time Series](#)

[Archive](#)



☐ Sentinel-2 Grid (Tile ID)

☐ Landsat Grid (WRS2 PathRow)

Search for a location...



Active Layers (Drag to Reorder)

Coordinates: 28.122°, -113.1179°

Add Layer Directly



Satellite(s):

Sentinel 2



Product Type:

Chlorophyll-a



Date:

08 / 09 / 2024



STREAM Tile View



STREAM

Satellite-based Tool for Rapid Evaluation of Aquatic environments

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43.8561, -84.0048

[View Timeseries](#)

[Search Landsat Coverage](#)

[Search Sentinel Coverage](#)

200 km

Click on a tile ID to view available data

MAP CONTROLS

Satellite Tile Grids

☒ Sentinel-2 Grid (Tile ID)

☐ Landsat Grid (WRS2 PathRow)

Active Layers (Drag to Reorder)

aqv_chla_20240809_sentinel

Pixel: --

Remove

Hide

Expand

aqv_chla_20240804_sentinel

Pixel: --

STREAM Data Download Options



STREAM

Satellite-based Tool for Rapid Evaluation of Aquatic environMents

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Tile Search

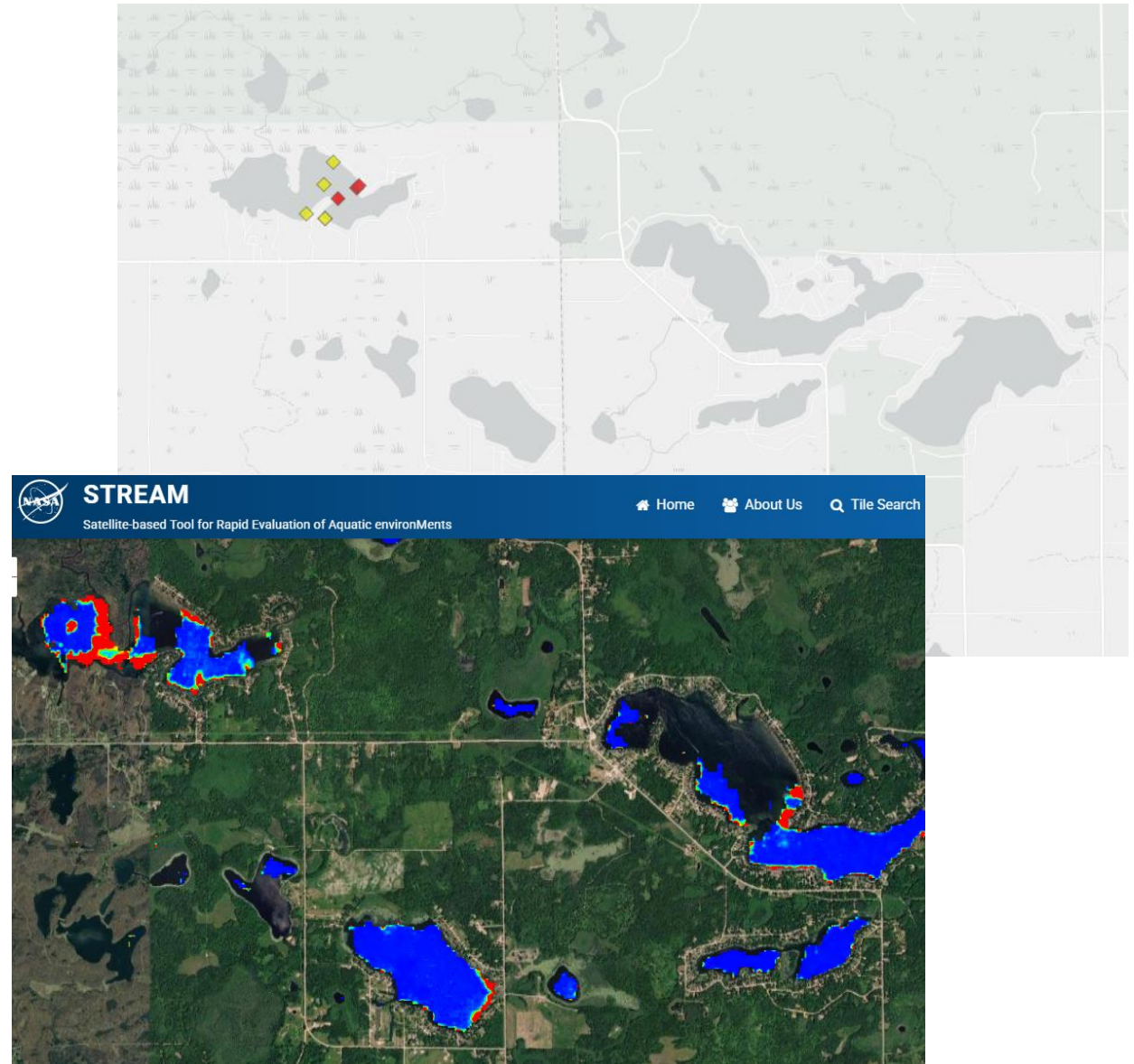
Date - DoY	Available In	Products Available
2026-06-20 - 171	Archive Only	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-06-19 - 170	Archive Only	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-06-17 - 168	Archive Only	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-06-15 - 166	Archive Only	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-06-12 - 163	Archive Only	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-06-10 - 161	Archive Only	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-06-07 - 158	Archive Only	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-06-05 - 156	Archive Only	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-06-02 - 153	Map Viewer & Archive	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)
2026-05-31 - 151	Map Viewer & Archive	Chlorophyll-a, Total Suspended Solids (TSS), Secchi Depth (Transparency), True Color Composite (RGB)

Demo – STREAM



STREAM Case Study – Michigan water quality

- Au Sable Lake, Ogemaw County Michigan
- Michigan Harmful Algal Blooms [MI HABs](#) August, 2025
- Explore Sentinel-2 grid layers for:
 - Changes in chlorophyll-a levels from two different dates
 - Explore surrounding lakes
- Community concerns:
 - Potential nutrient runoff
 - Invasive species such as European Frog-bit (*Hydrocharis morsus-ranae*)



Hands on Exercise Time

Ask a trainer for assistance!

We will reconvene at 3:35pm



Hands on Practice

Step 1. In small groups or individually, select either [STREAM](#) or [OpenET](#)

Step 2. Explore features:

STREAM features to explore:

- Explore data availability for Sentinel-2 vs. Landsat grids for:
- Harmful Algal Blooms (HABS) with Chlorophyll-a: Lake Erie in Late June 2024; Oneida Lake, NY in mid August 2025
- Total Suspended Solids (TSS): Mississippi Delta; Missouri River, Coosa River
- Apply the true color layer for cloud pixel contamination
- Run time series analysis tool for preferred location

OpenET features to explore:

- Explore differences in evapotranspiration trends between different crop types using the field view explorer: Denver, CO; Lubbock, TX; Walla Walla, WA
- Explore the relationship between ET and additional variables such as precipitation and NDVI for both field and raster view
- Run time series analysis with customized polygons in raster view; explore data download
- Add fields to the FARMS tool, generate a report

Hands on Exercise Discussion

- Q & A
- Reflection questions:
 - What tool did you choose to explore?
 - Which products or layers did you select?
 - Did you find any difficulties with the tools or data?
 - Did you see anything interesting or notable?
 - How might this apply to your work/how might you use these resources in the future?

OpenET Summary

- Web-based platform that maps and monitors evapotranspiration from 2021-present
- Requires registration, or access via google account
- Available at 30-meter spatial resolution
- Provides both field view (western US) and gridded raster view (CONUS)
- Allows for monthly and cumulative ensemble model outputs
- Allows for daily and monthly time series of evapotranspiration, NDVI, and precipitation through the FARMS tool
- FARMS tool generates report that can be exported into a CSV file for multiple fields

Want to learn more? Check out ARSET's [Applications of Remote Sensing-Based Evapotranspiration Data Products for Agricultural and Water Resource Management!](#)

STREAM Summary

- STREAM water quality data are derived from Landsat 8 & 9 / OLI & OLI-2 and Sentinel-2/MSI
- STREAM water quality data are available at 20-30 meters spatial resolution
- STREAM offers four product types:
 - Total Suspended Solids
 - Chlorophyll-a
 - Secchi Disc Depth
 - True Color Composite
- Offers time series analysis
- Biggest limitation is weather resulting in heavy clouded pixels

Want to learn more? Check out ARSET's [Monitoring Water Quality in Lakes and Coastal Regions using STREAM](#) training!

NASA Applied Remote Sensing Training (ARSET) Program

Q&A



NASA Applied Remote Sensing Training (ARSET)

The ARSET Program delivers cost-free training to increase the knowledge, awareness, and use of Earth observations for decision making

Visit our homepage:



[www.earthdata.nasa.gov/
data/projects/arset](http://www.earthdata.nasa.gov/data/projects/arset)

ARSET Training Themes



AGRICULTURE



DISASTERS



ECOLOGICAL CONSERVATION



HEALTH & AIR QUALITY



WATER RESOURCES



WILDLAND FIRES

ARSET Trainings Are Designed to Meet Audience Knowledge Levels



Fundamentals

Assumes no prior knowledge of remote sensing

Fundamentals of Remote Sensing

Introductory

Requires fundamentals training or equivalent knowledge

Covers specific applications

Introduction to Remote Sensing of Harmful Algal Blooms

Intermediate

Requires introductory training or equivalent knowledge

Covers specific applications

Monitoring Coastal and Estuarine Water Quality: Transitioning from MODIS to VIIRS

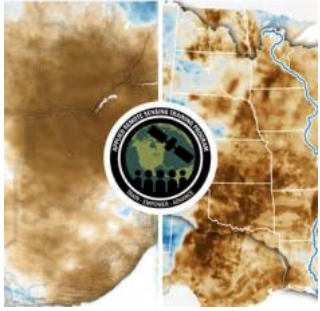
Advanced

Requires introductory or intermediate training or equivalent knowledge

In-depth and highly focused topics

Integrating Remote Sensing into a Water Quality Monitoring Program

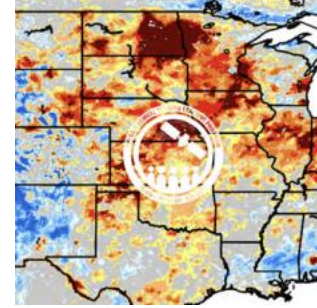
ARSET Trainings – Agriculture



Drought Monitoring, Prediction, and Projection using NASA Earth System Data



Large Scale Applications of Machine Learning using Remote Sensing for Building Agriculture Solutions



Application of NASA SPoRT-Land Information System (SPoRT-LIS) Soil Moisture Data for Drought



Crop Mapping using Synthetic Aperture Radar (SAR) and Optical Remote Sensing



Applications of Remote Sensing-Based Evapotranspiration Data Products for Agricultural and Water Resource Management



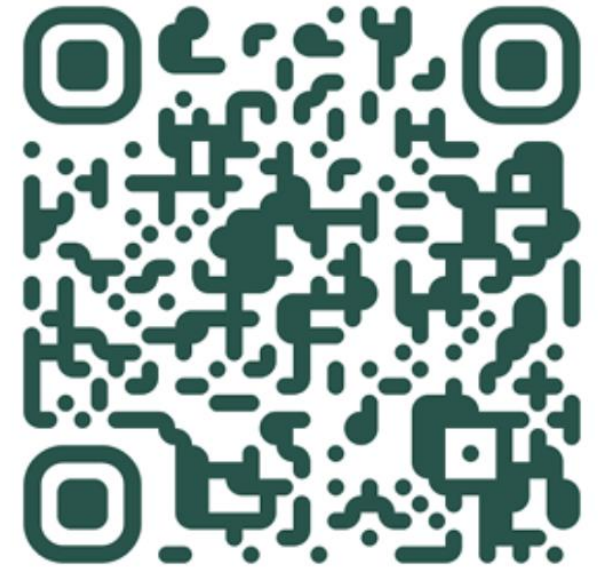
Satellite Remote Sensing for Agricultural Applications

Connect with ARSET

<https://www.earthdata.nasa.gov/data/projects/arset>

- **View all recordings and materials** from previous trainings
- **Register** for an upcoming training
- We use training survey responses to assess the effectiveness of each component of the training and get **ideas for future trainings**.
- Browse all our previous trainings since 2015 in our **Online Resource Guide**
- Take our **new self-paced training** on Fundamentals of Remote Sensing
- **Sign up for our listserv** to find out about our newest trainings

Visit our homepage:



[www.earthdata.nasa.gov/
data/projects/arset](https://www.earthdata.nasa.gov/data/projects/arset)

Please Take Our Survey

- This survey will only take a few minutes and will help us better understand how to meet your needs.



Contact:

Kaitlyn.I.lemon@nasa.gov

NASA Resources

Visualize and Analyze Data – **The Visualization, Exploration, and Data Analysis Project (VEDA)**

<https://www.earthdata.nasa.gov/data/tools/veda>

Find Data, Tutorials, and Use Cases – **Earth Science Data Systems (ESDS)**

<https://www.earthdata.nasa.gov/>

Access data by theme – **Earth Information Center (EIC)**

<https://earth.gov/themes/agriculture>