



Monitoring Water Quality for Aquaculture using NASA Remote Sensing Observations

Amita Mehta (GESRAT II, NASA Goddard Space Flight Center (GSFC)), William Wainwright (SSAI, NASA GSFC), Kelly Luis (NASA Jet Propulsion Laboratory (JPL)), & Rachel Jiang (JPL)

Coordinators: Erin Urquhart (NASA), Kelly Luis (JPL), Melanie Follette-Cook (NASA GSFC)

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Overview of SRTEAM

[Satellite-based Tool for Rapid Evaluation of Aquatic EnvironMents]

William Wainwright (SSAI, NASA GSFC)

Workshop Agenda

Part 1: Presentations [9:30 to 11:00 AM]

- Introduction to NASA Water Resources Program
- Introduction to Earth Observations for Monitoring Water Quality
 - Fundamentals of Remote Sensing
 - Satellite missions
 - Data products
- **Demonstration:** data access, analysis, and visualization web tools: [Worldview](#)
- **Overview of Satellite-based Tool for Rapid Evaluation of Aquatic Environments (STREAM)**
- **Demonstration:** data access, analysis, and visualization web tools: [STREAM](#)

Break [11:00 to 11:15 AM]

Part 2: Hands-on Exercises [11:15 AM to 12:15 PM]

- Monitoring coastal and inland WQ parameters for facilitating aquaculture applications using Worldview and STREAM

Summary and Survey [12:15 to 12:30 PM]





STREAM

Satellite-based Tool for Rapid Evaluation of Aquatic enviro



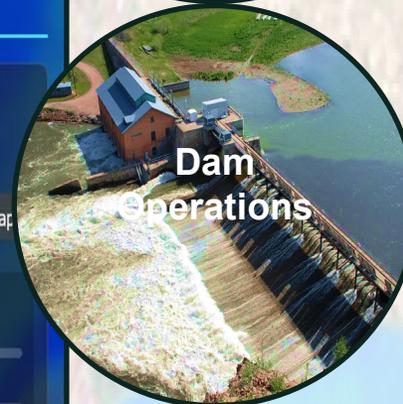
HABs Ecosystem



WARNING
HARMFUL ALGAE PRESENT
PEOPLE AND ANIMALS SHOULD AVOID SWIMMING AND WADING UNTIL FURTHER NOTICE
HABs Health
EXPOSURE TO ALGAL TOXINS MAY CAUSE ILLNESS
Call your doctor or veterinarian if you or your animals have sudden or unexplained sickness or signs of poisoning.
While fish consumption is not affected by toxic algae, thoroughly cleaning the fish, discarding the carcass & guts, & washing hands & surfaces afterward with soapy water is advised.



Restoration



Dam Operations



Aquaculture



HABs Hypoxia



HABs Drinking Water

Home Q Tile Search Map NASA

Active Layers (Drag to Reorder)

aqv_chla_20250621_sentinel

Pixel: 0.72 mg/m³

Remove Hide Collapse

Min/Max: 0 - 30

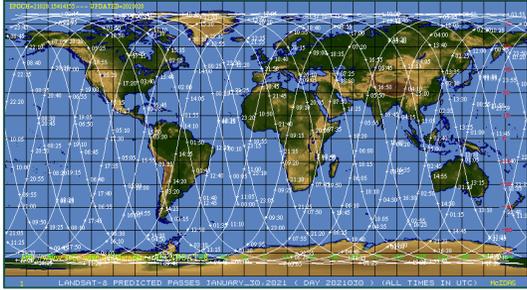
Opacity:

William Wainwright | NASA Official: Sadashiva Devadiga | Communications Policy | Freedom of Information Act

Photo credit: PA Dept. of Environmental Protection; LA Times. San Francisco salt pond A12; Fish kill in March in Cocoa Beach. NY Times; NY Times. Flip bags containing oysters in Cape Cod Bay; Ohio EPA; American Whitewater/Hydropower; Virginia Department of Health; USDA Natural Resources Conservation Services.



Satellites and Sensors Applied within STREAM



Landsat 8 & Landsat 9



Sentinel-2 A, B, & C

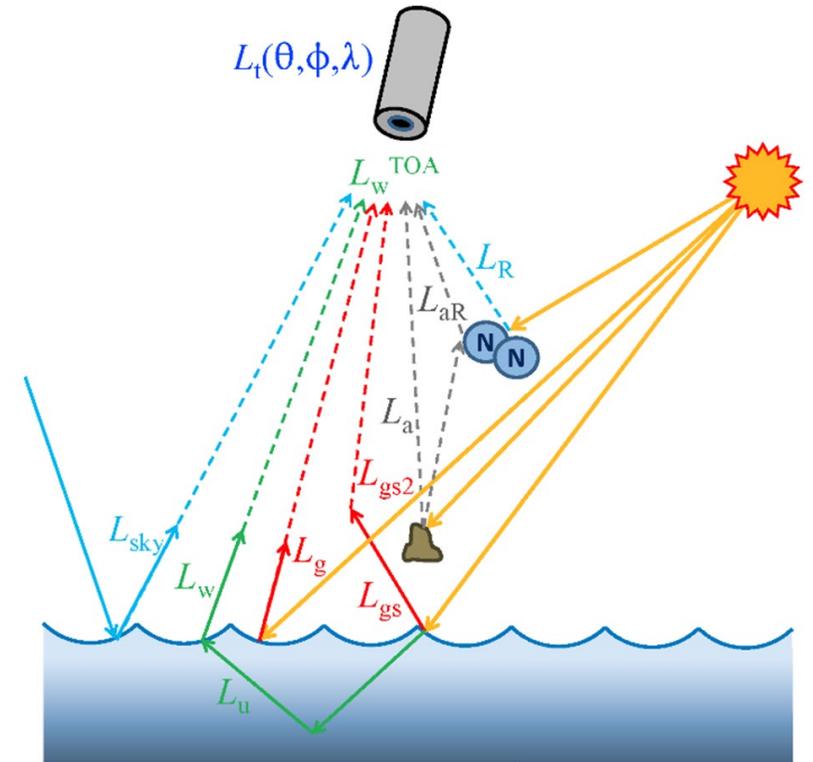
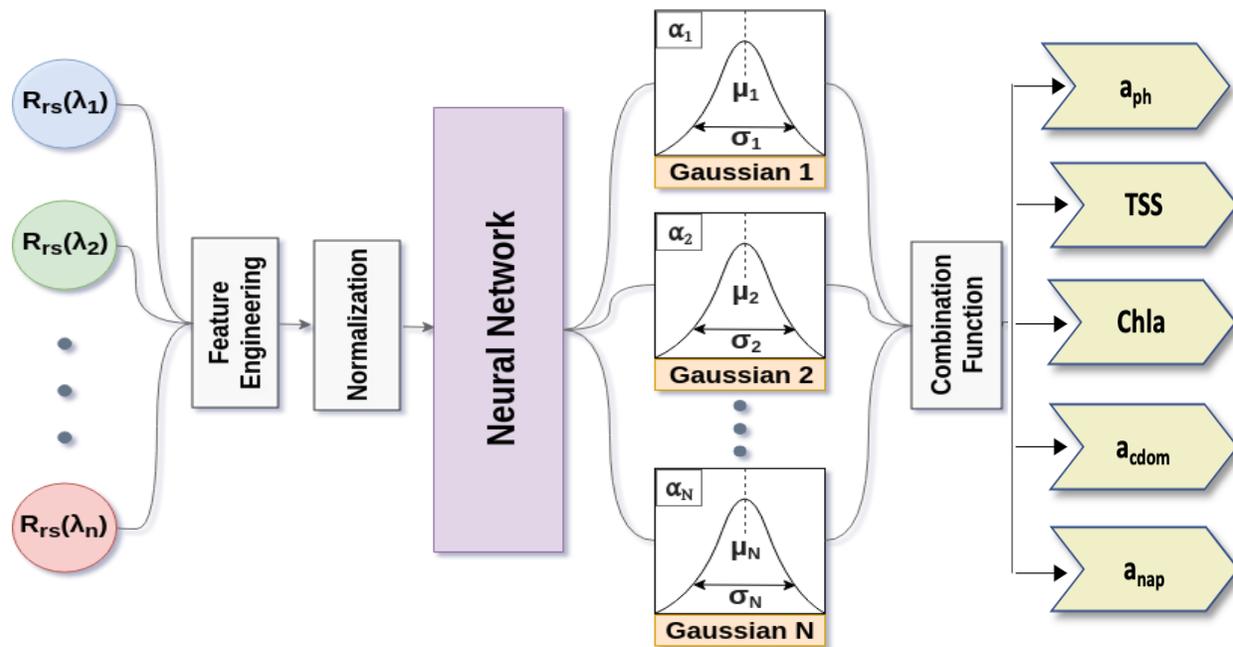
- All are polar orbiting satellites with different swath widths and revisit times.
- Landsat 9 (9/27/2021 – Present)
- Landsat 8 (2/1/2013 – Present)
- Sentinel-2A (6/23/2015 – Present)
- Sentinel-2B (3/7/2017 – Present)
- Sentinel-2C (9/5/2024 - Present)

Satellites	Sensors	Resolution
Landsat 8 & 9	Operational Land Imager (OLI & OLI2)	185 km Swath; 30 m 16-Day Revisit
Sentinel-2A, -2B, and -2C	Multi Spectral Imager (MSI)	290 km Swath; 10 m, 20 m, 60 m; 5-Day Revisit



How STREAM Works

- Mixture density network (MDN)
 - Rayleigh scattering & gaseous absorption
 - Compensate for aerosol with first MDN
 - Retrieve Chla, TSS, and Zsd with second MDN



Validation – GLORIA & AERONET-OC

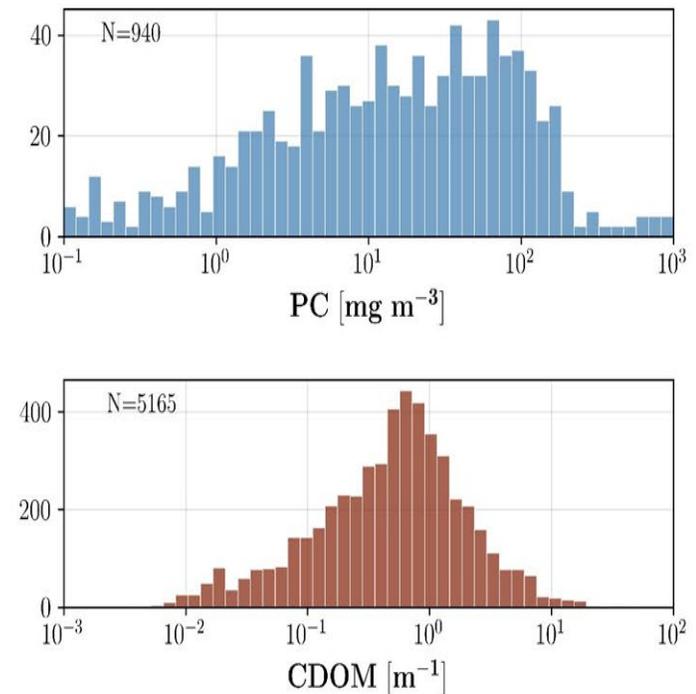
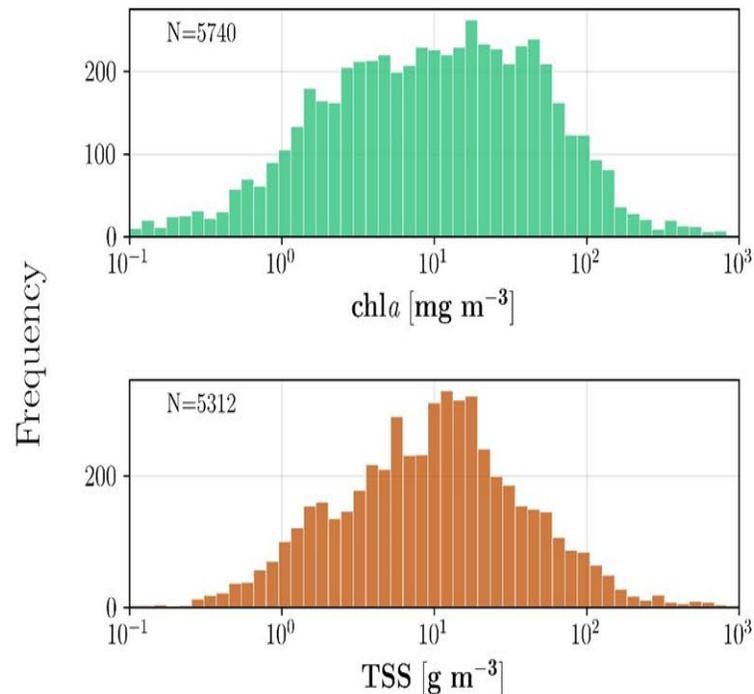
- Over 7500 hyperspectral RRS
 - 1nm intervals from 350-900nm
- Coastal and inland water bodies
- Co-located in-situ water quality indicators
- Over 25 years of temporal coverage

GLORIA:

- Lehmann, M.K., Gurlin, D., Pahlevan, N. et al. GLORIA - A globally representative hyperspectral in situ dataset for optical sensing of water quality. *Sci Data* 10, 100 (2023). <https://doi.org/10.1038/s41597-023-01973-y>.
- [ARSET Training: Monitoring Water Quality of Inland Lakes using Remote Sensing](#)

AERONET-OC:

- [Aerosol Robotic Network-Ocean Color](#)

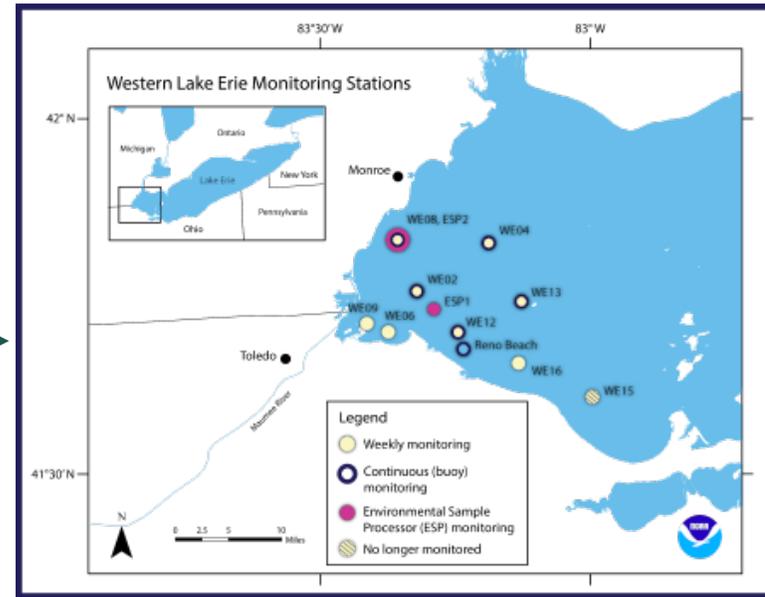


O'Shea et al. 2023 (Remote Sensing of Environment)



Why Monitor Water Quality Using Remote Sensing?

- **Monitoring water quality is vital for:**
 - Managing drinking water treatment
 - Public health and ecosystem advisories
 - Assessing health and productivity of freshwater and saltwater fisheries
- Conventional in situ measurements of water quality parameters are expensive and have limited spatial and temporal coverage.
- Remote sensing provides a cost-effective way to assess water quality in thousands of lakes and in coastal waters with improved coverage.



[NOAA Great Lakes Environmental Research Laboratory](#)

For monitoring harmful algal blooms (HABs), water samples are collected weekly at eight sampling sites and continuously at a few buoys in western Lake Erie.



[NASA Earth Observatory](#)

Algal bloom observed by Landsat-9 (OLI 2) on August 13, 2024.



Training Learning Objectives

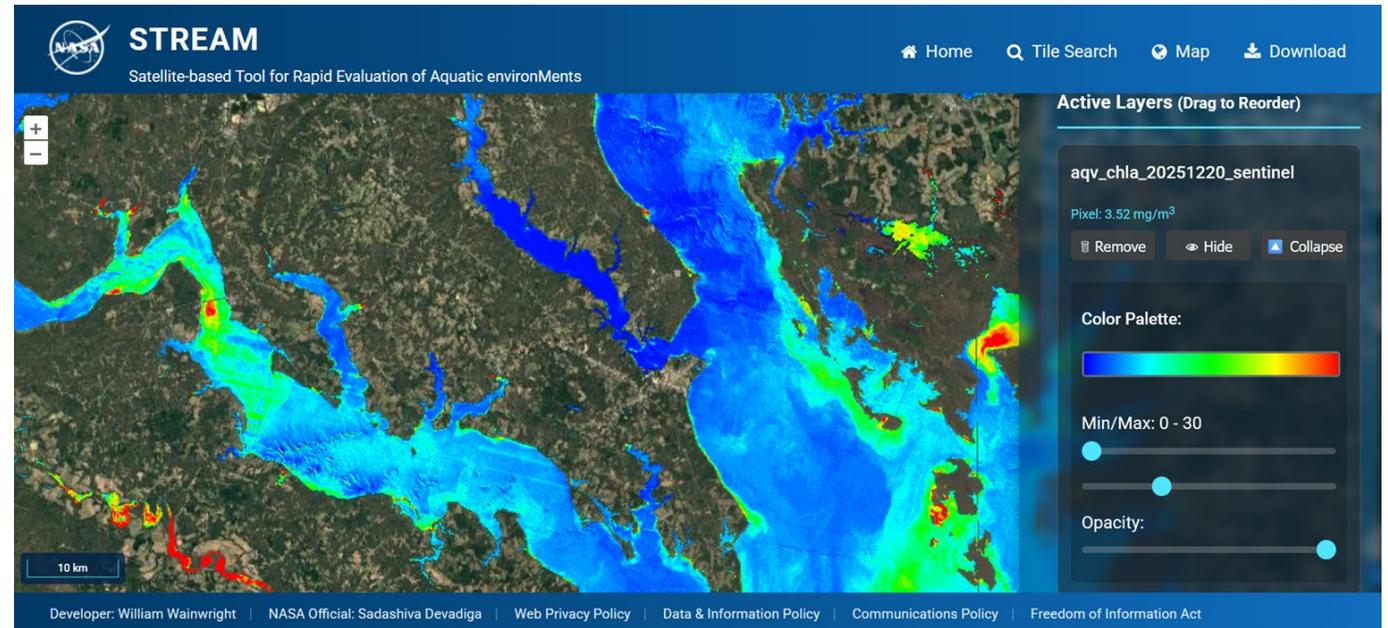
By the end of this training, participants will be able to:

- Identify the purpose, capabilities, and benefits of the STREAM tool for analyzing inland and coastal water bodies.
- Identify the process to use STREAM to monitor chlorophyll-a concentration, Secchi disk depth, and total suspended solids in lakes and coastal waters.
- Identify the steps to use STREAM API to search and download chlorophyll-a concentration, Secchi disk depth, and total suspended solids data for a specific time period.
- Examine time series of chlorophyll-a concentration, Secchi disk depth, and total suspended solids using QGIS.
- Identify how an open-source machine-learning model based on Mixture Density Network (MDN) enables users to estimate water quality parameters for any inland/coastal water body (greater than 100m x 100m) worldwide.



STREAM Website & API

- Interactive map
 - All scenes mosaicked
 - Multiple layers
 - Live readout at cursor
- Archive of daily processing
 - Full resolution GeoTIFs
 - Per-tile basis
- RESTful API
 - Documentation included
 - Query and download
 - Example python script available



API SUMMARY

API METHODS - DEFAULT

- coverageGet
- datesGet
- downloadGet
- layersGet
- productsGet
- rootGet
- satellitesGet
- sceneIdGet
- sitesGet
- tilesGet
- wmtsGet

downloadGet

Returns a product image or tar.gz containing multiple product images

GET

/download

Usage and SDK Samples

Curl Java Android Obj-C JavaScript C# PHP Perl Python

```
curl -X GET \
-H "Accept: image/gif,text/plain; charset=utf-8" \
"https://adsweb.modaps.eosdis.nasa.gov/stream/api/(version)/download?sceneID=&product="
```

Parameters

Query parameters

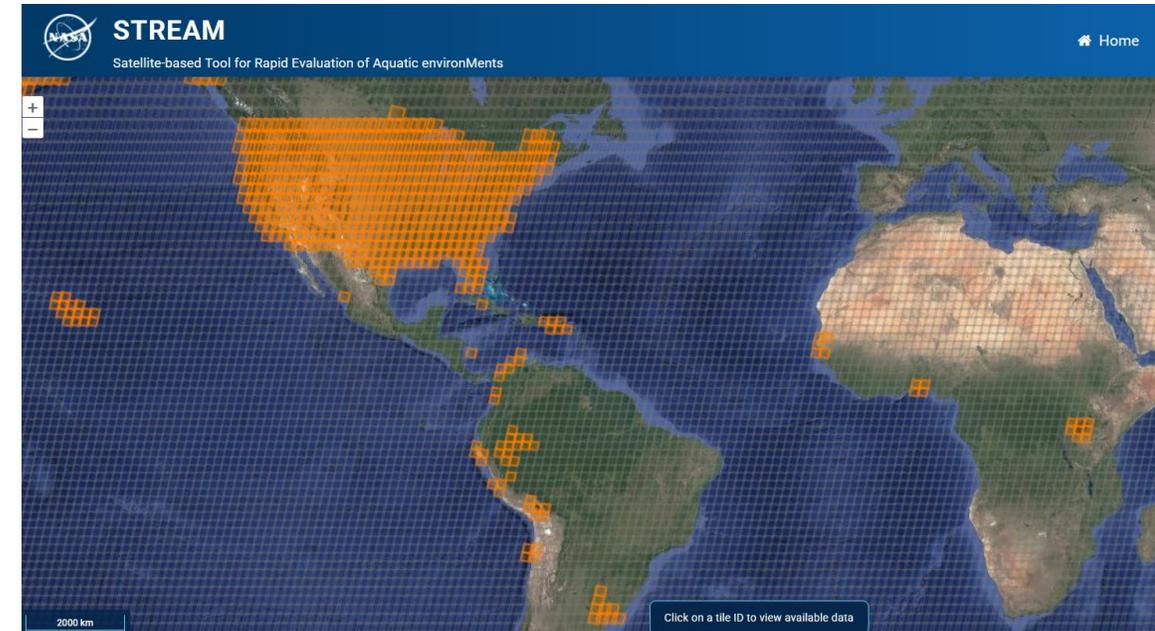
Name	Description
sceneID	String Scene ID
product	String Allowed to be chla, secchi, tss, or tar

Responses



STREAM's Coverage

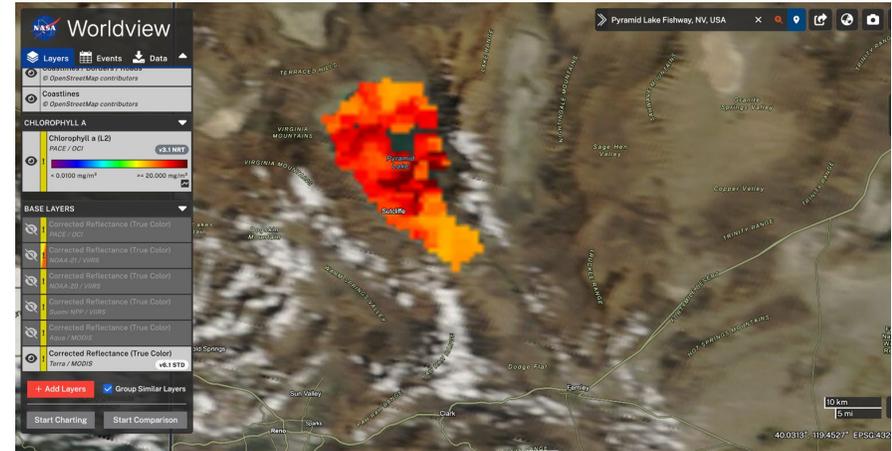
- Daily processing since June 2024
 - Processed overnight/as available
 - Chlorophyll-a, total suspended solids (TSS), Secchi depth, RGB True color composite
- Landsat 8/9 and Sentinel-2
 - Landsat at 30m resolution
 - Sentinel-2 resampled to 20m
- Full coverage of U.S. and additional water bodies in
 - India, South Korea, South Africa, Benin, Ghana, Chile, Uruguay, Peru, Colombia, Mexico, Cuba
- Coming Soon!
 - Sea-surface temperature
 - Time series tools



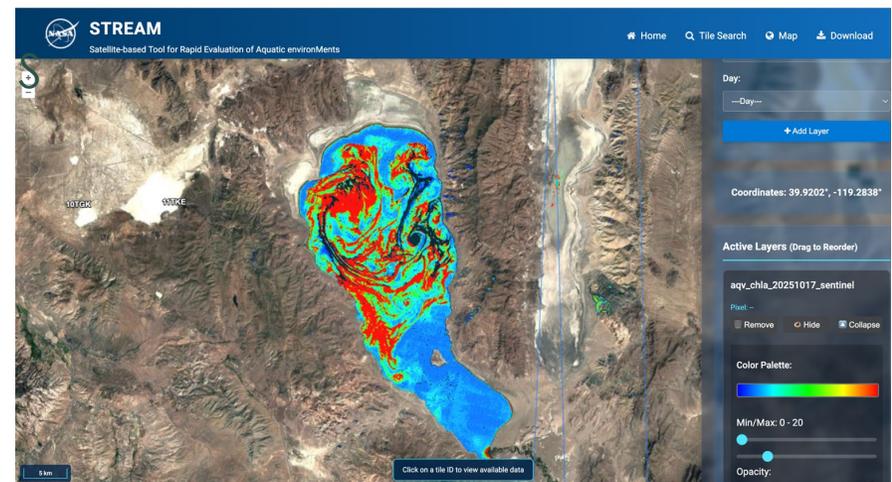
Summary

- STREAM web tool and API:
 - Uses Landsat 8 & 9, and Sentinel 2 a,b, and c to obtain water quality parameters, including chlorophyll a concentration, Total Suspended Solids, and Secchi Disk Depth in coastal estuaries and inland lakes in the US
 - Provides the water quality parameters at 20 m to 30 m spatial resolution
 - API allows search and download of multiple images of an area of interest

PACE/OCI



Sentinel 2/MSI



Chlorophyll-a concentration in Pyramid Lake from PACE/OCI and Sentinel 2/MSI





Data Access, Analysis, and Visualization Web Tool

Demonstration: STREAM