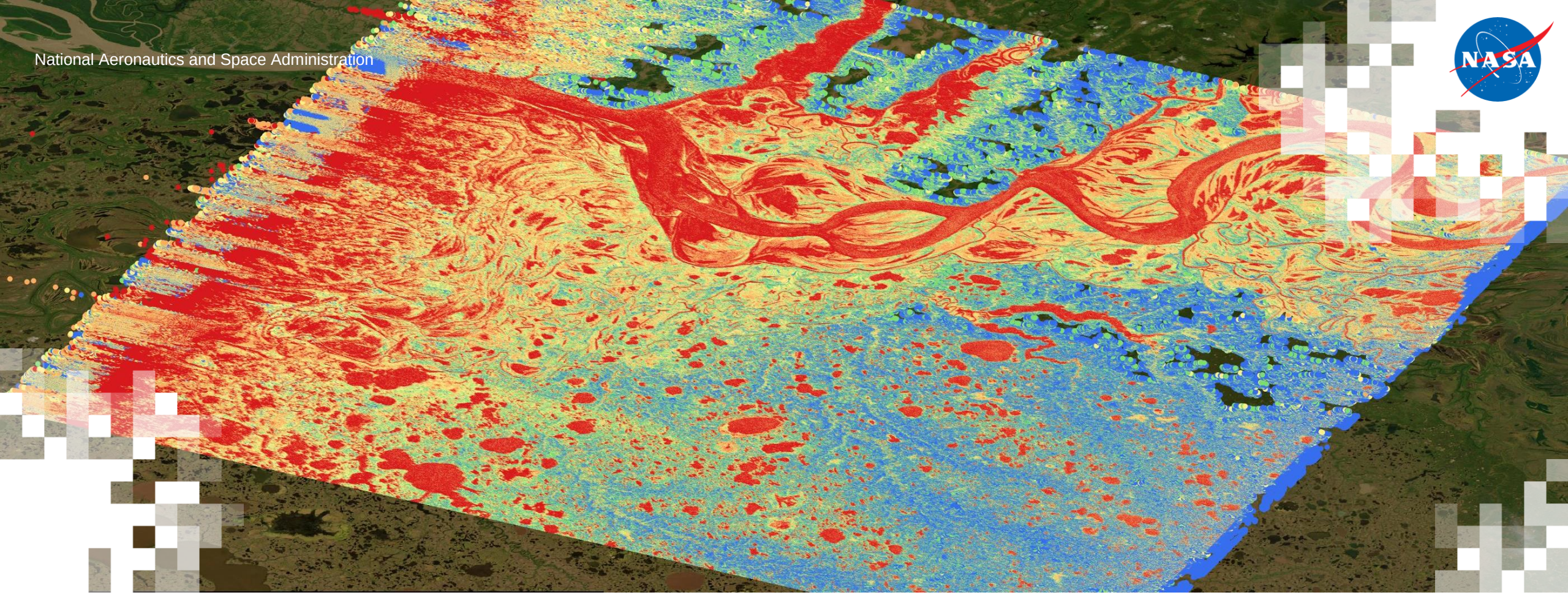


Monitoring Global Terrestrial Surface Water using Remote Sensing

Part 2: SWOT Mission Applications and Access for Retrieving, Visualizing, and Manipulating Data

ARSET Instructors: Amita Mehta (612, GESTAR II), Sean McCartney (610, SSAI), Erika Podest (NASA JPL, Caltech)
Guest Speakers: Merrit Harlan (USGS), Michael Durand (Ohio State University)

May 15, 2025

Part 1 Review

- Review of Altimeter-based lake level height data from historical and current missions.
  - Data Access: Global Water Measurements
- Overview of SWOT Mission and Data Products:
  - Hydrology Relevant Level-2 Data
- Data Access:
  - NASA Earthdata Search
  - Hydrocron API
- SWOT Applications and Early Adopters Program

Missions

Topex/Poseidon
Jason-1
Jason-2/OSTM
Jason-3
Sentinel-6A Michael Freilich
ERS-1 and ERS-2
ENVISAT
SARAL
Sentinel-3
SWOT
ICESat-2

Prerequisites

- Fundamentals of Remote Sensing
- Mapping and Monitoring Lakes and Reservoirs with Satellite Observations

Training Outline

Part 1

Overview of Remote Sensing Observations for Monitoring Global Terrestrial Surface Water in Large Rivers and Lakes

May 13, 2025

11:00–12:30 EDT (UTC-4)

Part 2

SWOT Mission Applications and Access for Retrieving, Visualizing, and Manipulating Data

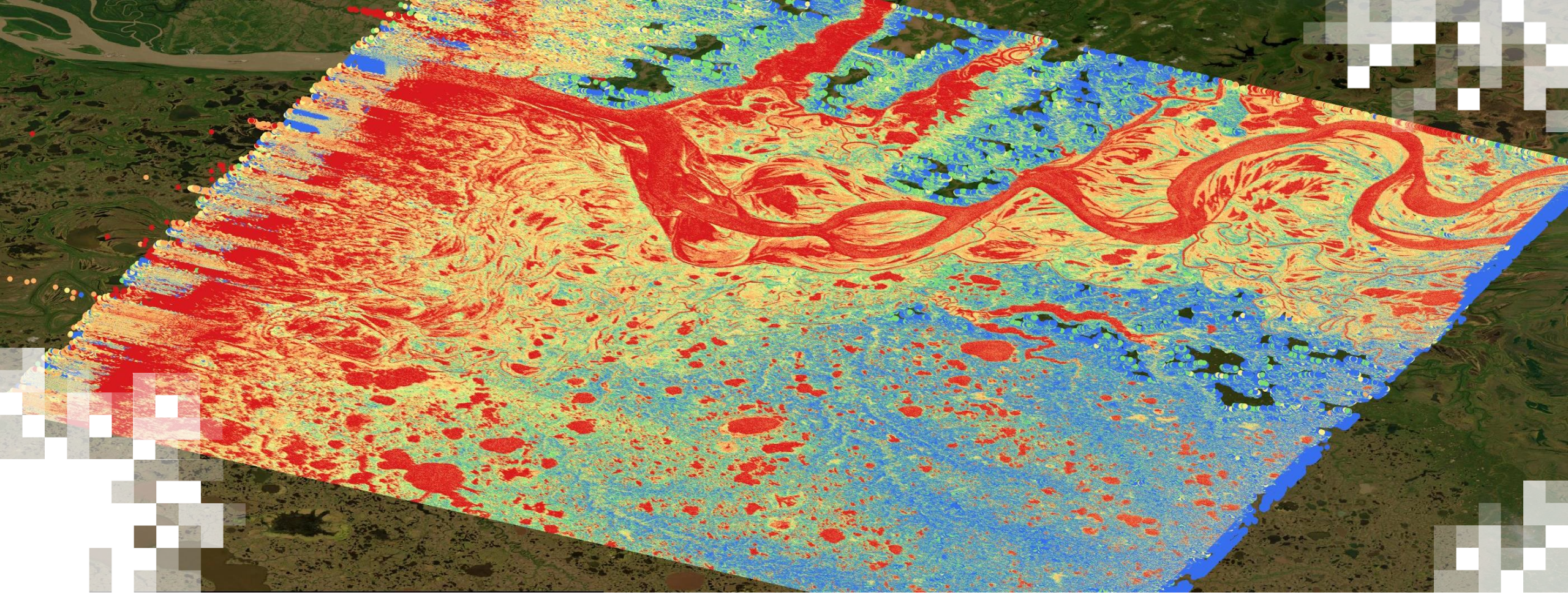
May 15, 2025

11:00–12:30 EDT (UTC-4)

Homework

Opens May 15 – **Due May 31** – Posted on Training Webpage

A certificate of completion will be awarded to those who attend all live sessions and complete the homework assignment(s) before the given due date.



Monitoring Global Terrestrial Surface Water using Remote Sensing

Part 2: SWOT Mission Applications and Access for Retrieving, Visualizing, and Manipulating Data

Part 2 – Trainers

Merritt Harlan, PhD

Research Hydrologist

USGS

Michael Durand, PhD

Professor

Ohio State University

Part 2 Objectives

By the end of Part 2, participants will be able to:

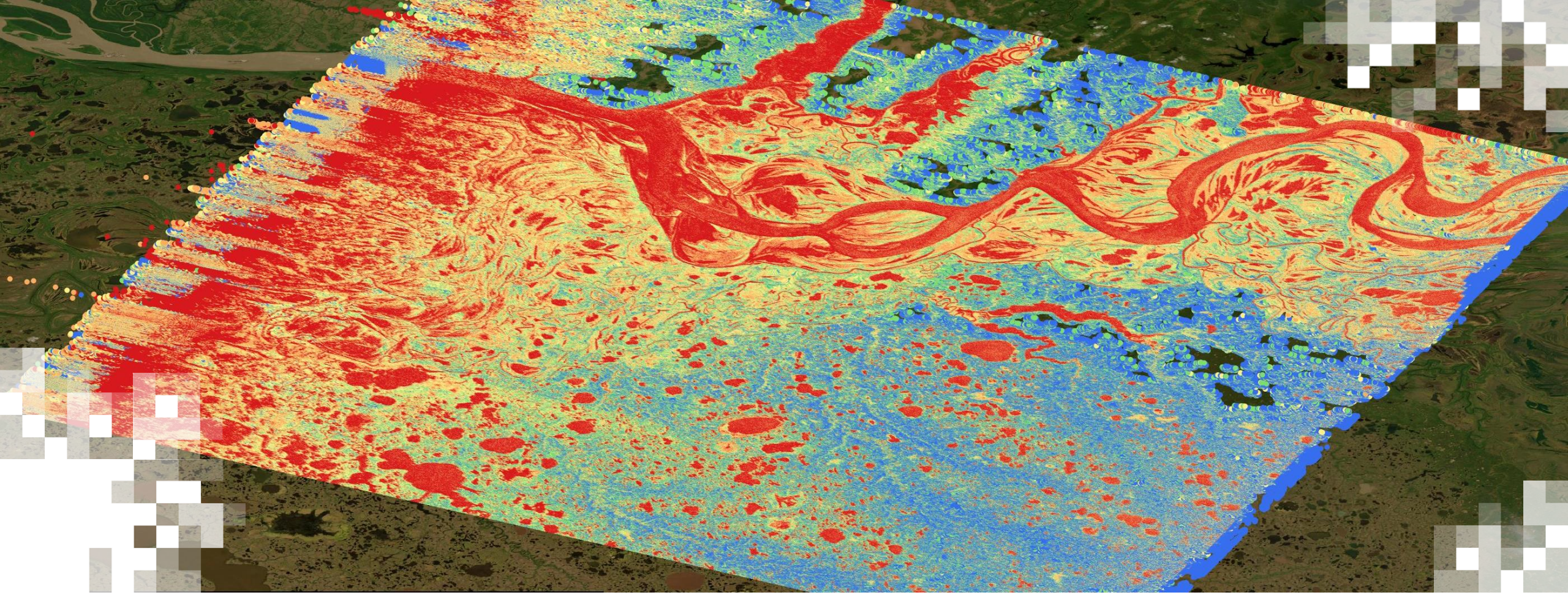
- Identify ways to apply SWOT data for water resources and disaster management applications.
- Recognize how to utilize the SWOT rivers data visualization tools such as SWOT Viz and WISP to monitor water availability and flooding potential.

Part 2 Outline

- Overview and demonstration of Water Information from SPace (WISP)
- Overview and demonstration of SWOT Data Viewer Application (SWOT Viz)

How to Ask Questions

- Please put your questions in the Questions box and we will address them at the end of the webinar.
- Feel free to enter your questions as we go. We will try to get to all the questions during the Q&A session after the webinar.
- The remainder of the questions will be answered in the Q&A document, which will be posted to the training website about a week after the training.

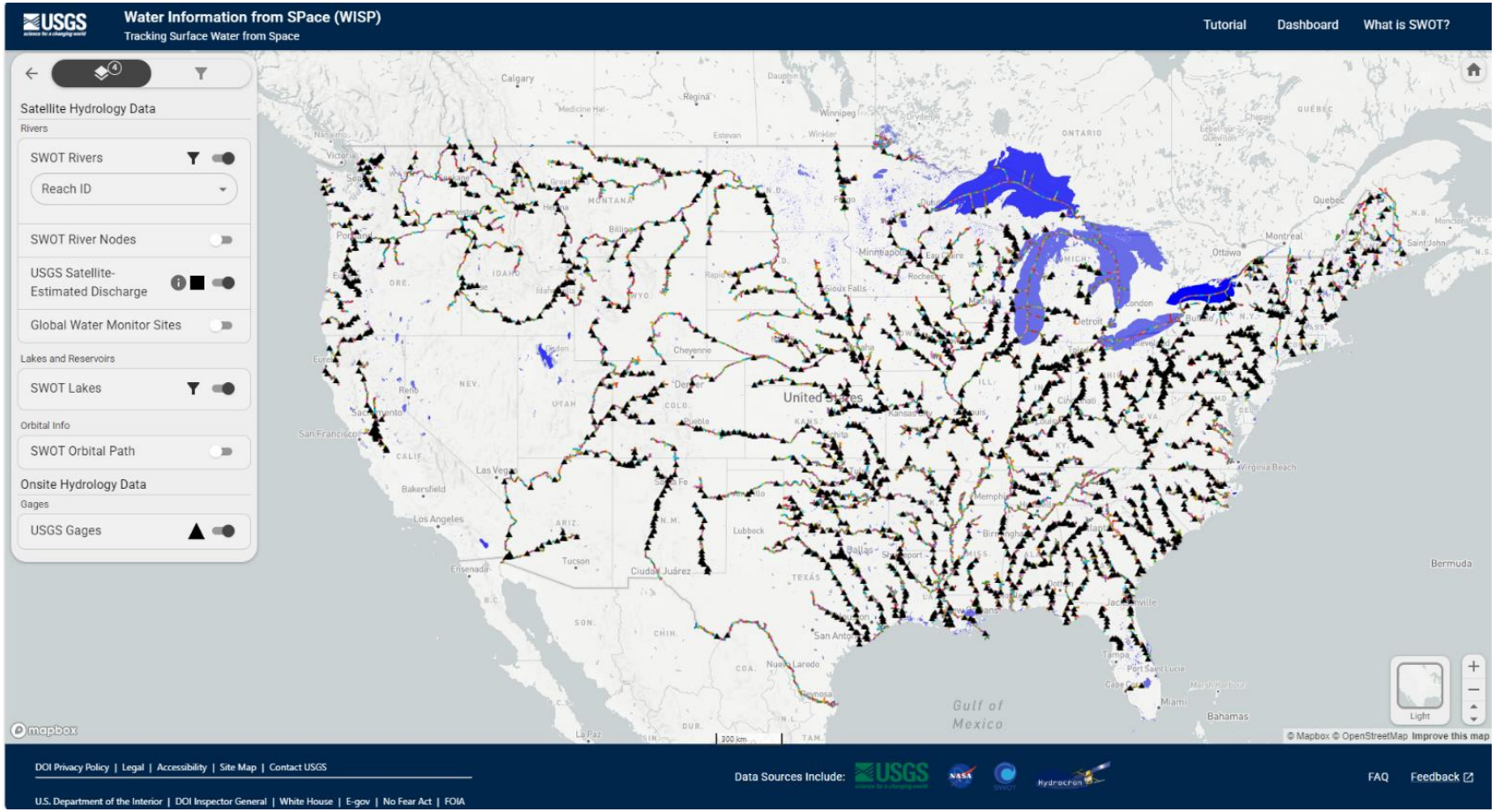


Water Information from SPace (WISP)

Water Information from Space

Dr. Merritt Harlan

U.S. Geological Survey
Hydrologic Remote Sensing Branch

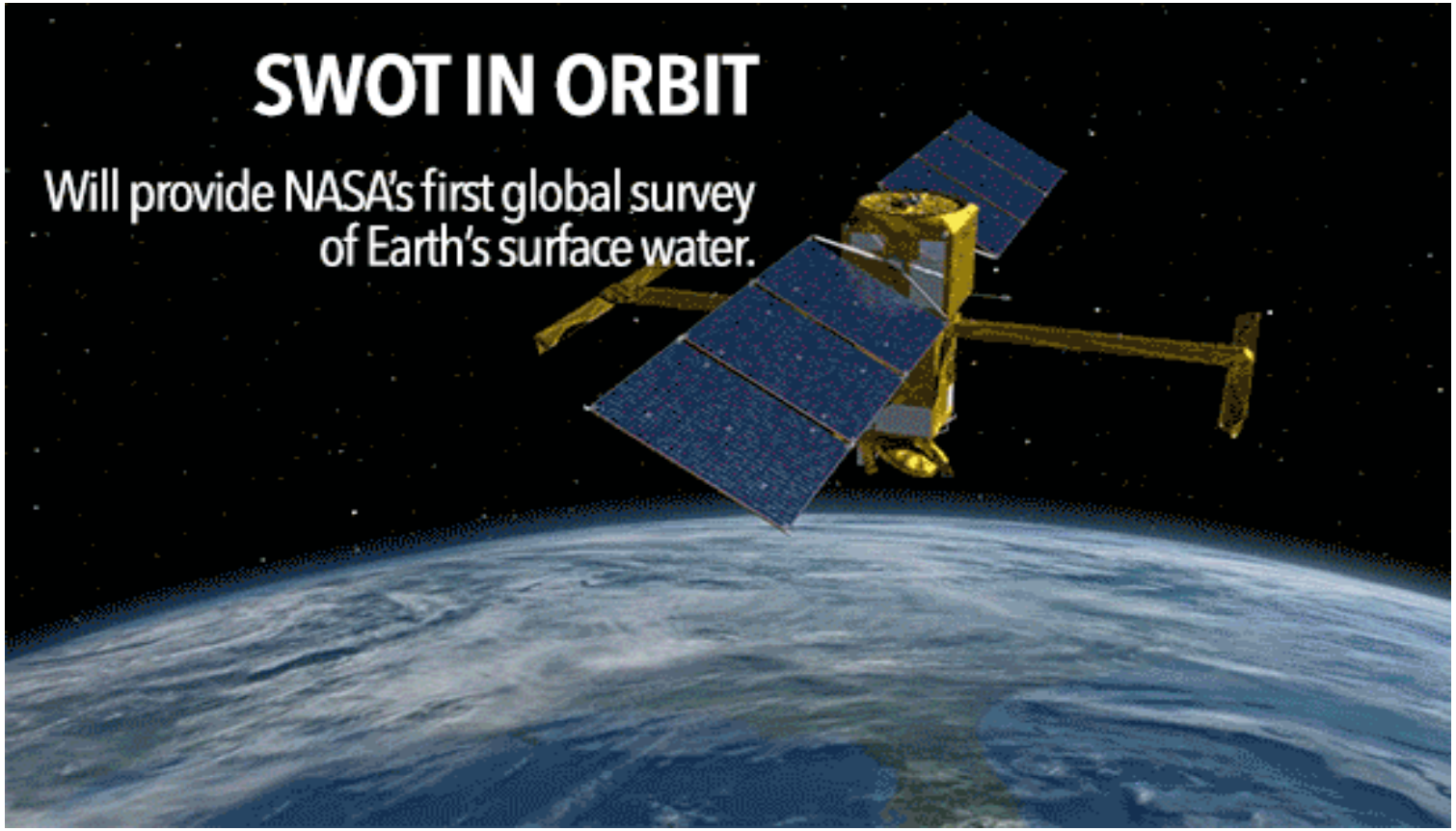


Overview

Surface Water Ocean Topography (SWOT) Background

Public Data Portal: Water Information from Space (WISP)

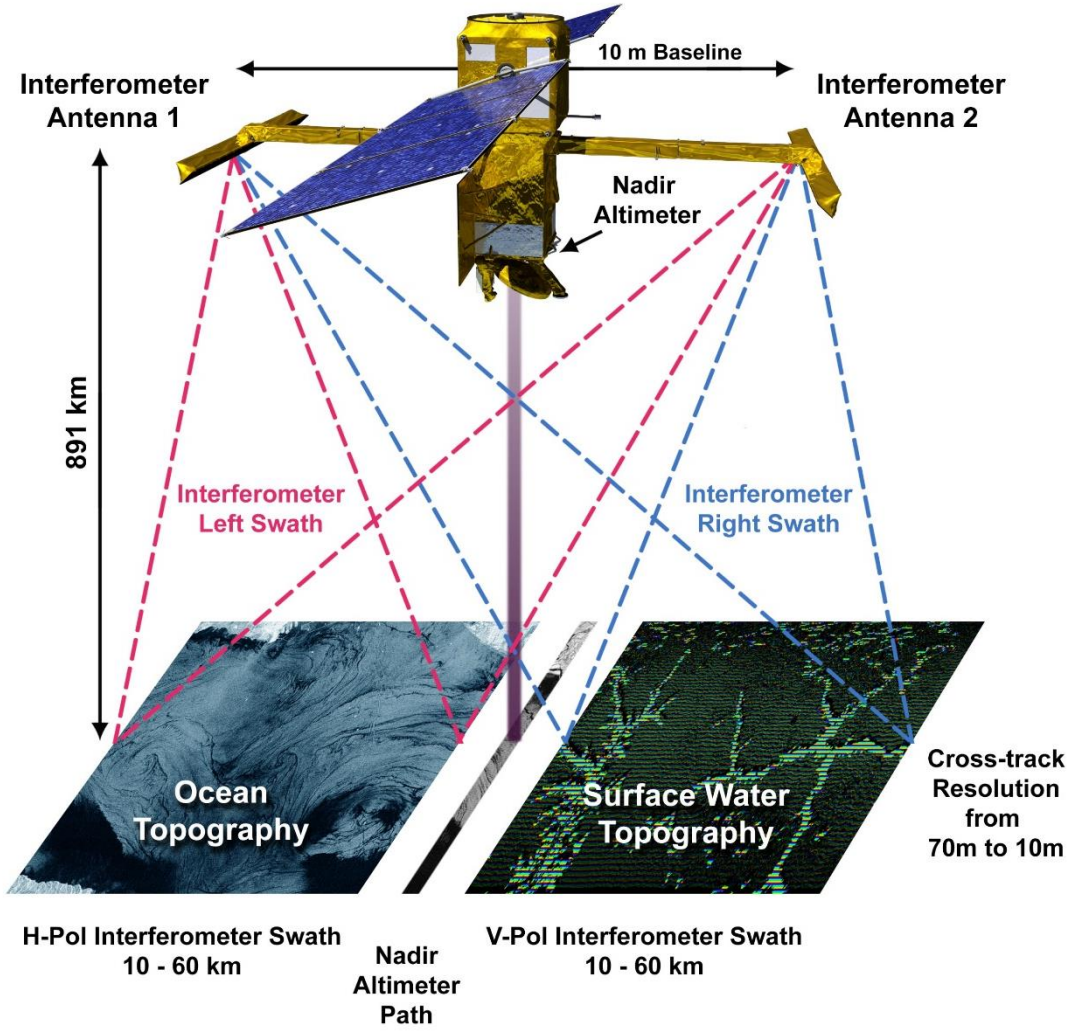
Water Management Applications with SWOT Data



Credit: NASA Scientific Visualization Studio

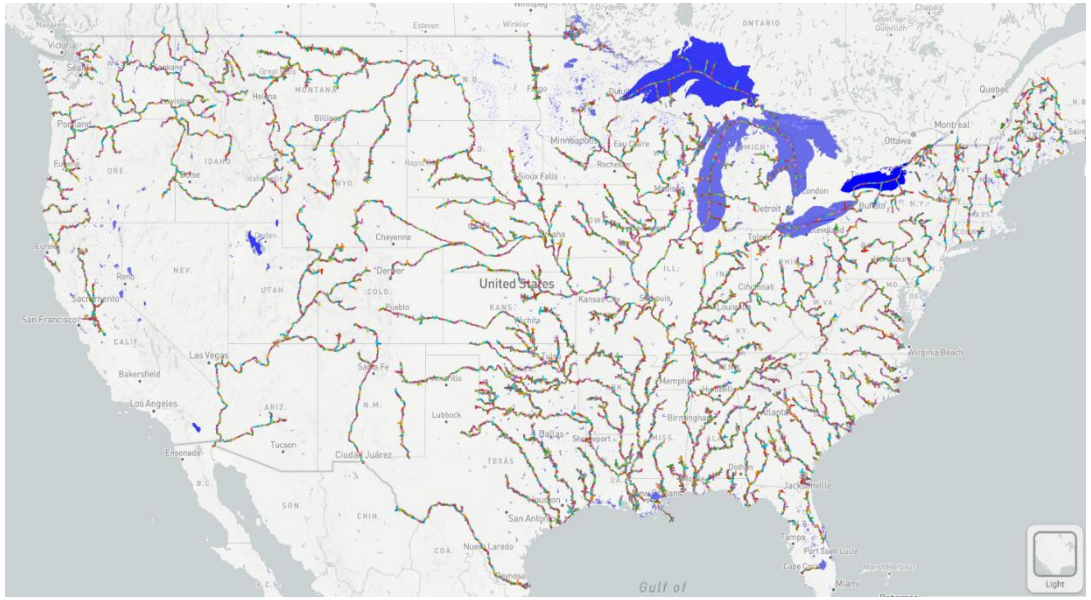
Surface Water Ocean Topography (SWOT) – Background

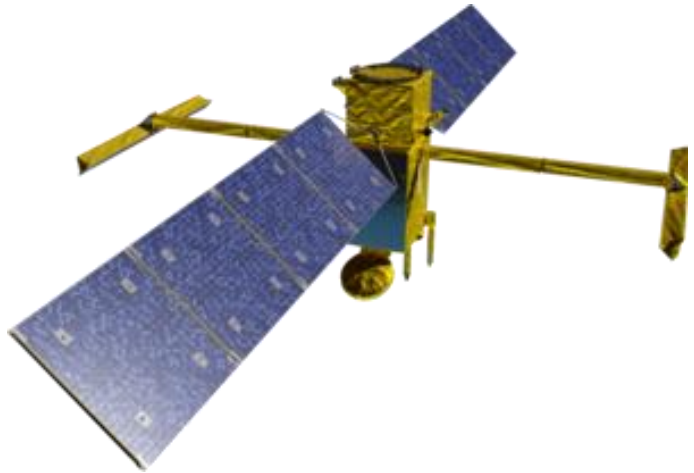
- NASA Mission Joint with CNES (France), UKSA (United Kingdom and CSA (Canada)
- Satellite Monitors:
  - Ocean Waters – Heights, Waves
  - Inland Waters – Rivers, Lakes, Reservoirs, and Wetlands
- Inland Water Measurements:
  - Water Elevations, Widths and Areas, Slope, Volume Changes and Discharge



Surface Water Ocean Topography Measurements

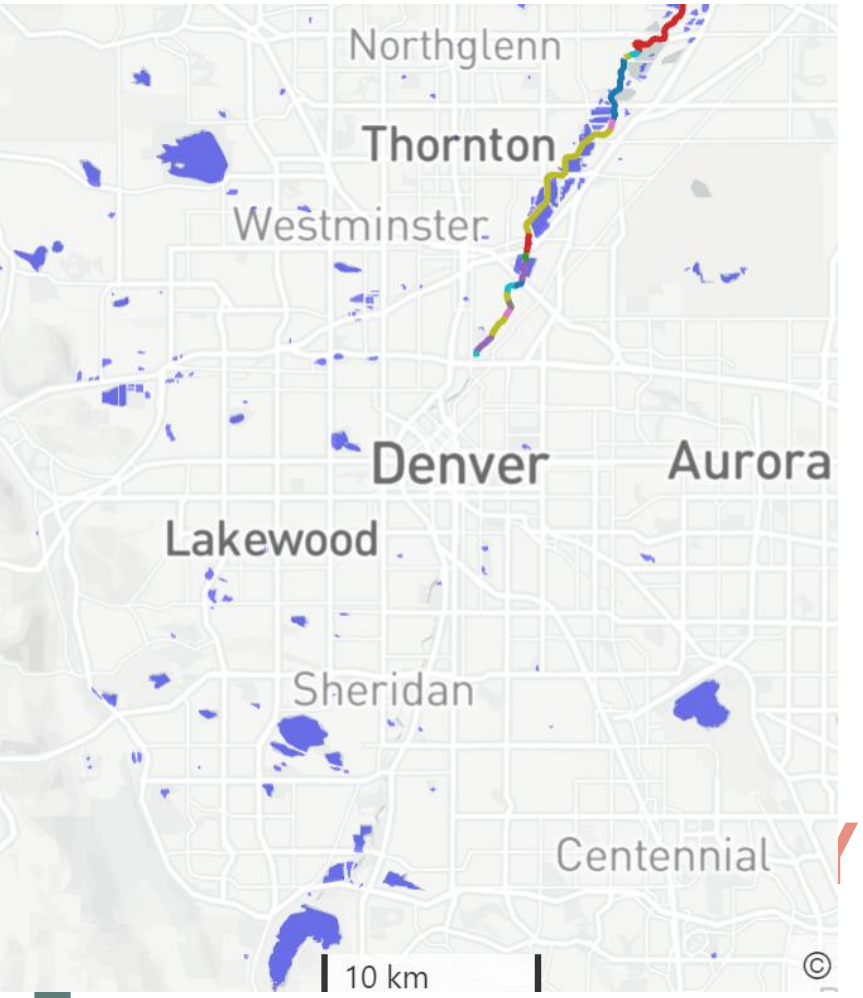
- Data starting March 2023
- Global surveying of surface water
- Repeat coverage every ~10 days in U.S.
- More frequent coverage in Alaska, ~3–6 days
- In the US, SWOT Measures:
  - ~467,000 Lakes
  - ~93,000 River Miles



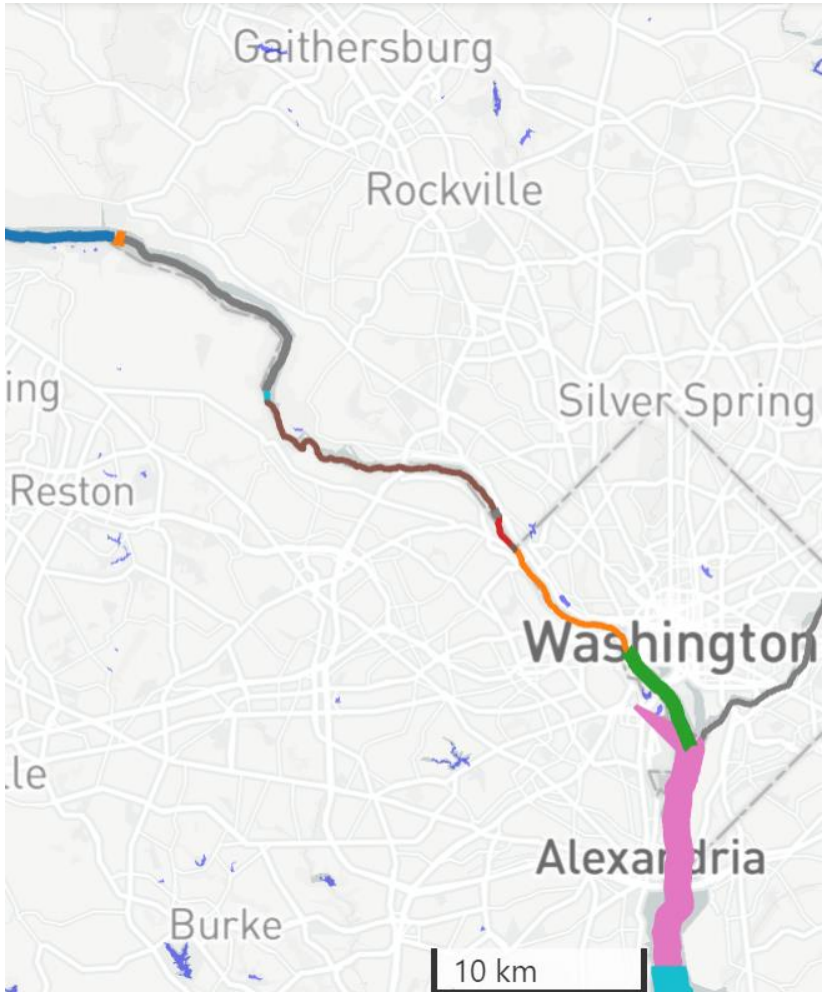


SWOT is Measuring:

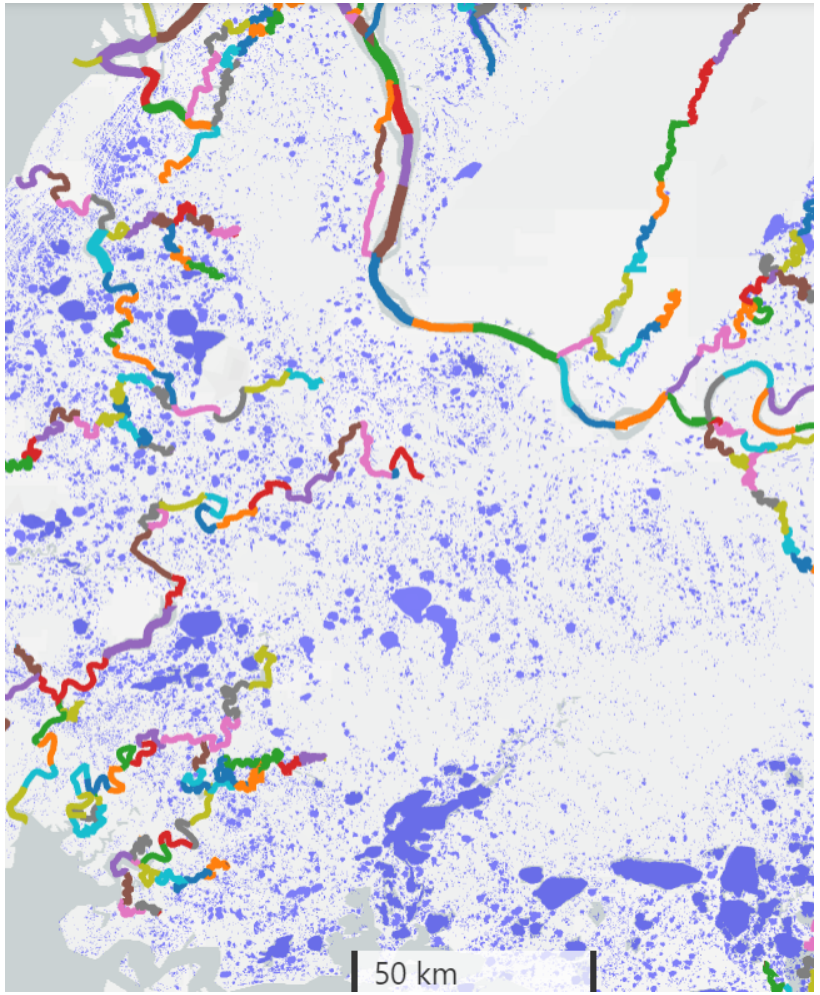
Denver, CO



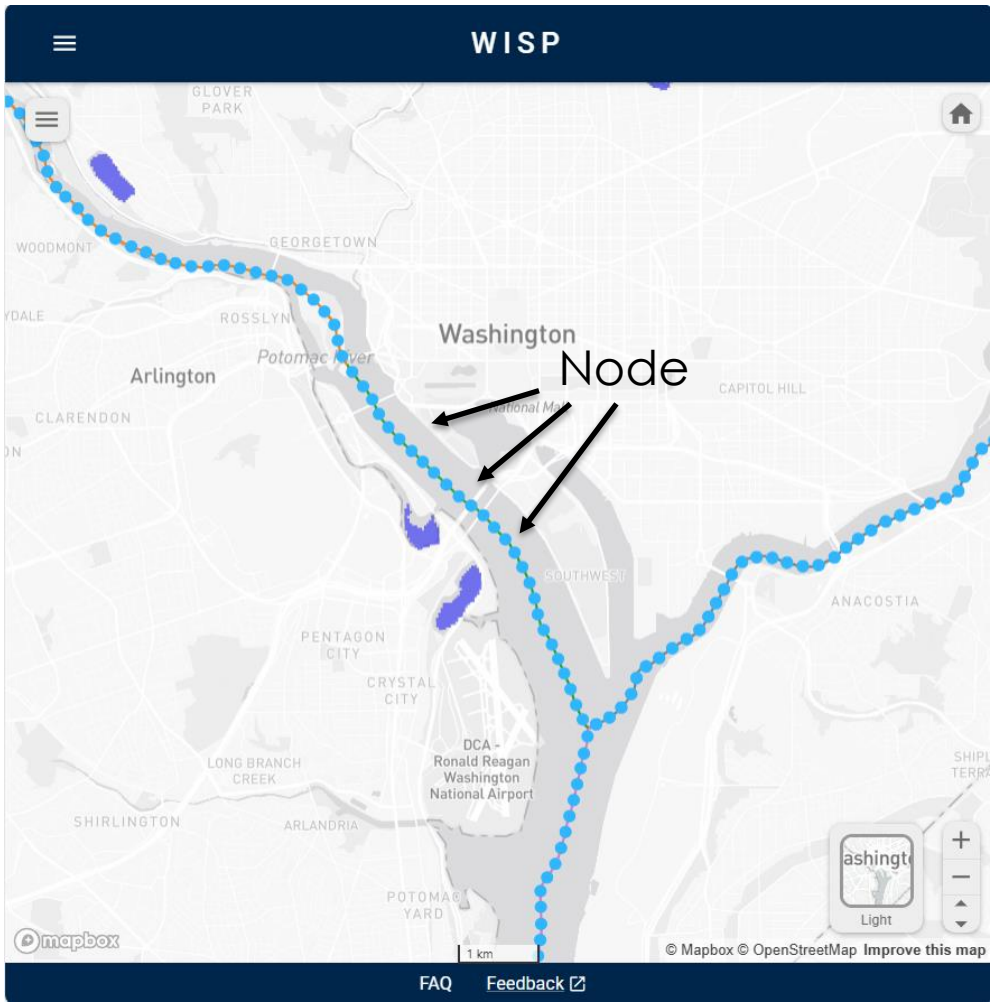
Washington, DC



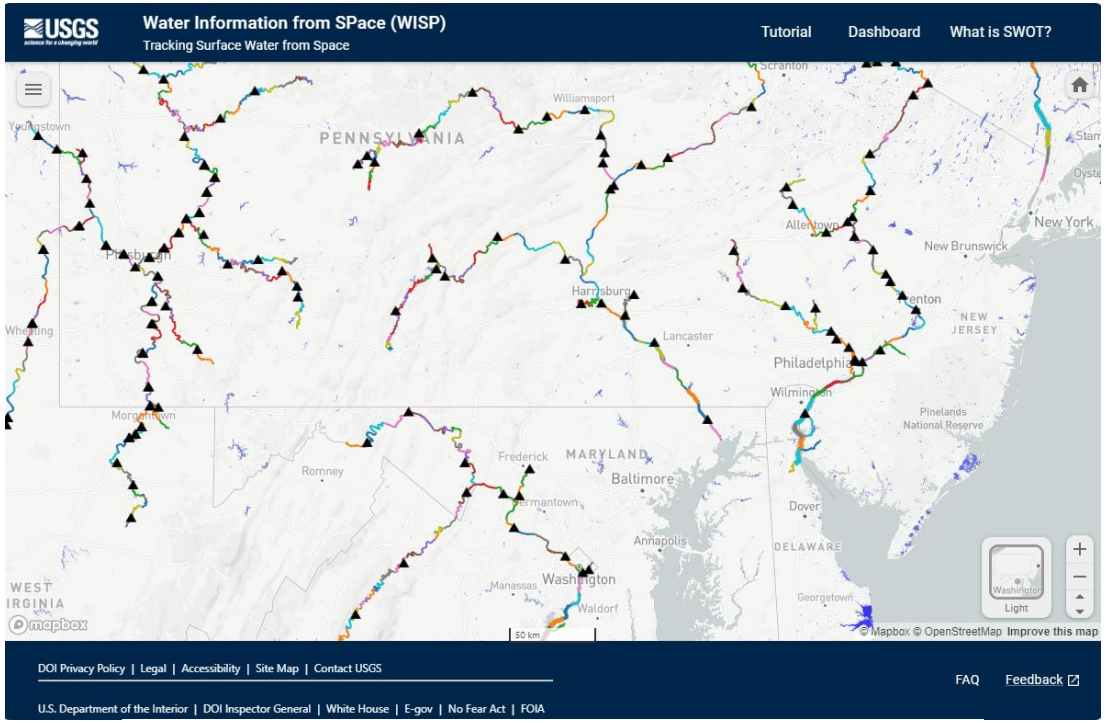
Yukon Delta, AK

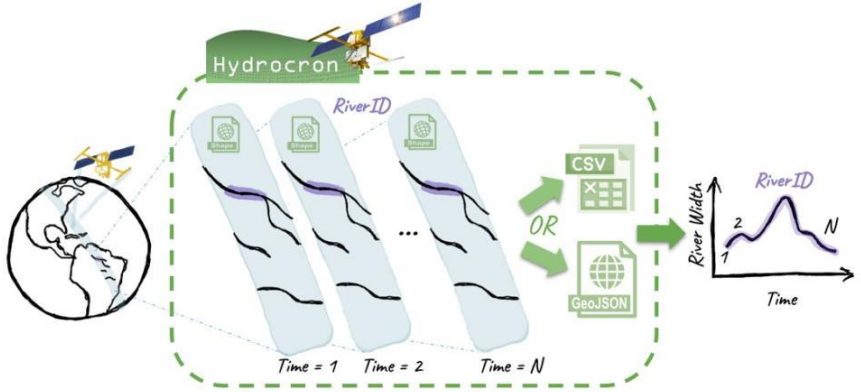


SWOT-Measured Water Features



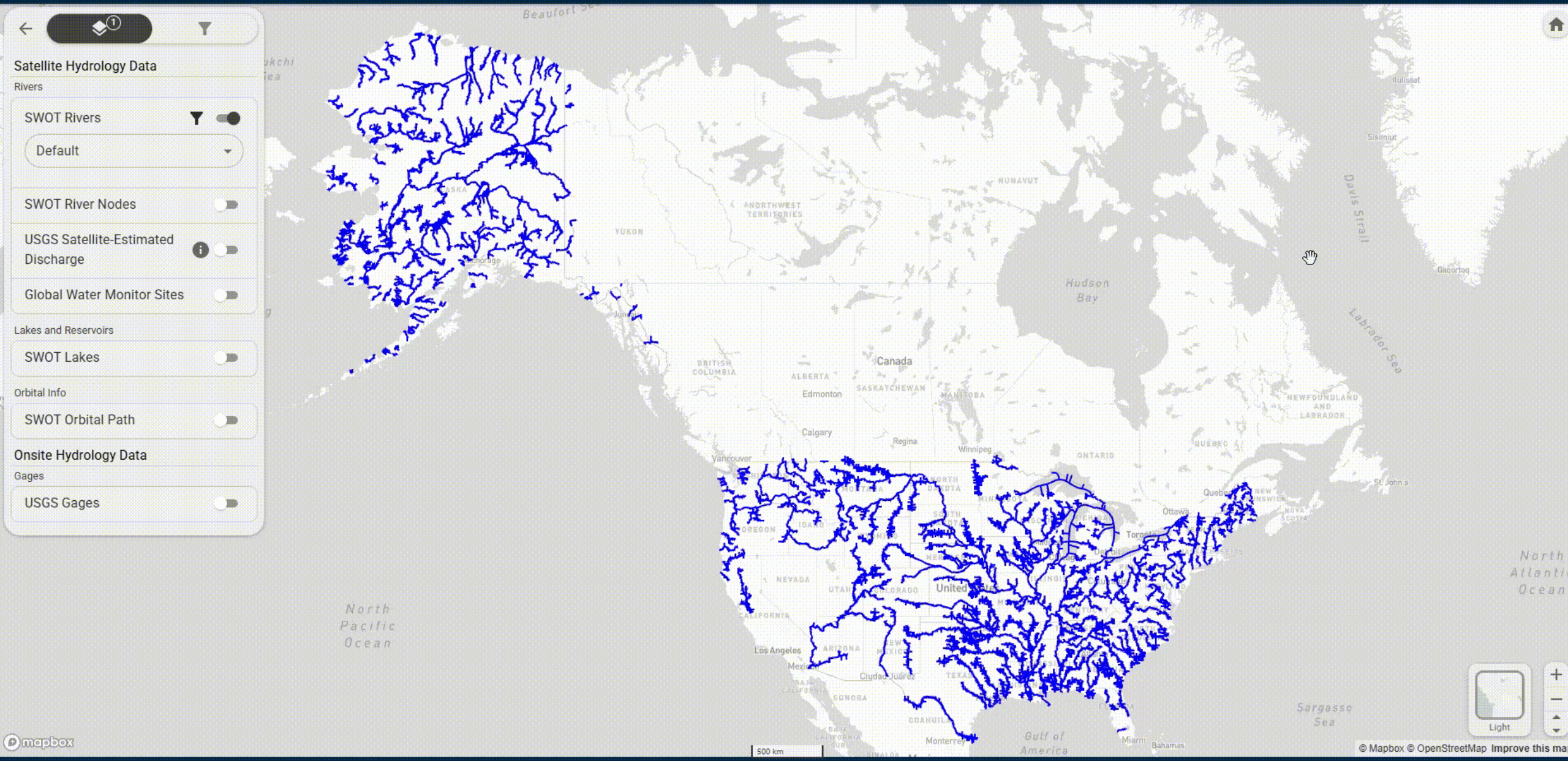
Public Data Portal: Water Information from Space (WISP)





https://apps.usgs.gov/wisp

Jet Propulsion Laboratory
California Institute of Technology


Satellite Hydrology Data
Rivers
SWOT Rivers
Default
SWOT River Nodes
USGS Satellite-Estimated Discharge
Global Water Monitor Sites
Lakes and Reservoirs
SWOT Lakes
Orbital Info
SWOT Orbital Path
Onsite Hydrology Data
Gages
USGS Gages
Canada
Edmonton
Calgary
Vancouver
Winnipeg
Ottawa
Toronto
Quebec
Hudson Bay
Davis Strait
Labrador Sea
North Pacific Ocean
North Atlantic Ocean
Gulf of America
Sargasso Sea
Los Angeles
Ciudad Juárez
Monterrey
Miami
Bahamas
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500 km
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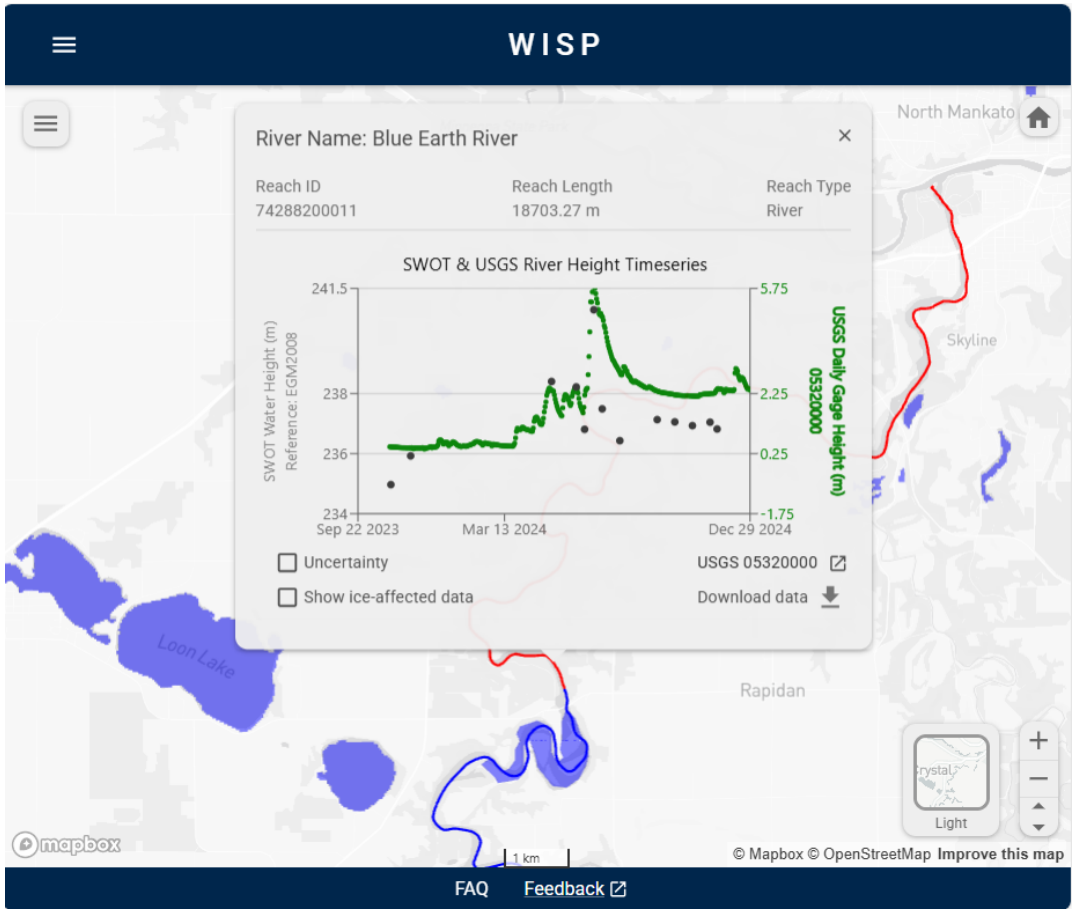
SWOT is capturing flood events.



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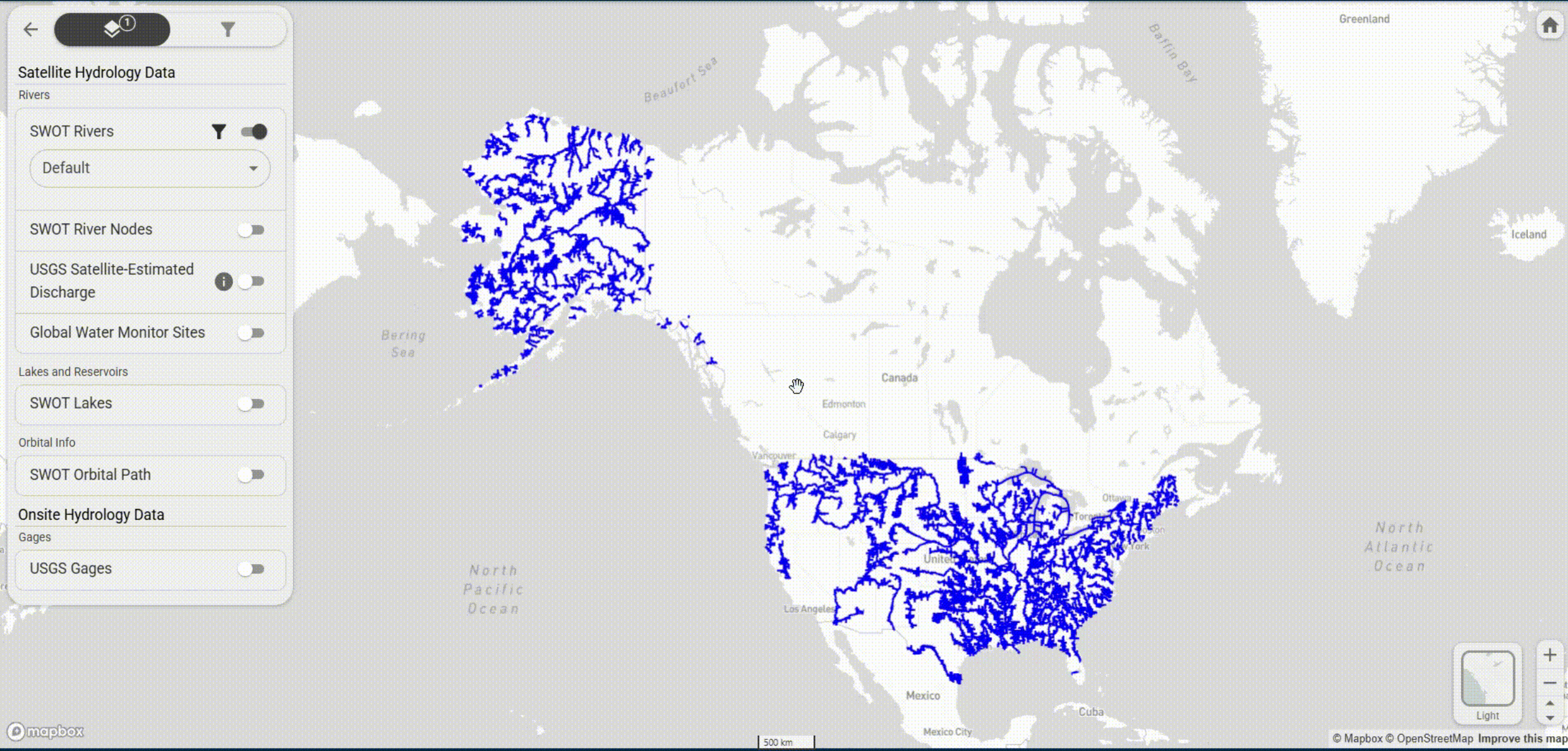
June 25, 2024, Flooding Event in Blue Earth River at the Rapidan Dam in Minnesota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Vancouver
Ottawa
Toronto
United States
Los Angeles
Mexico
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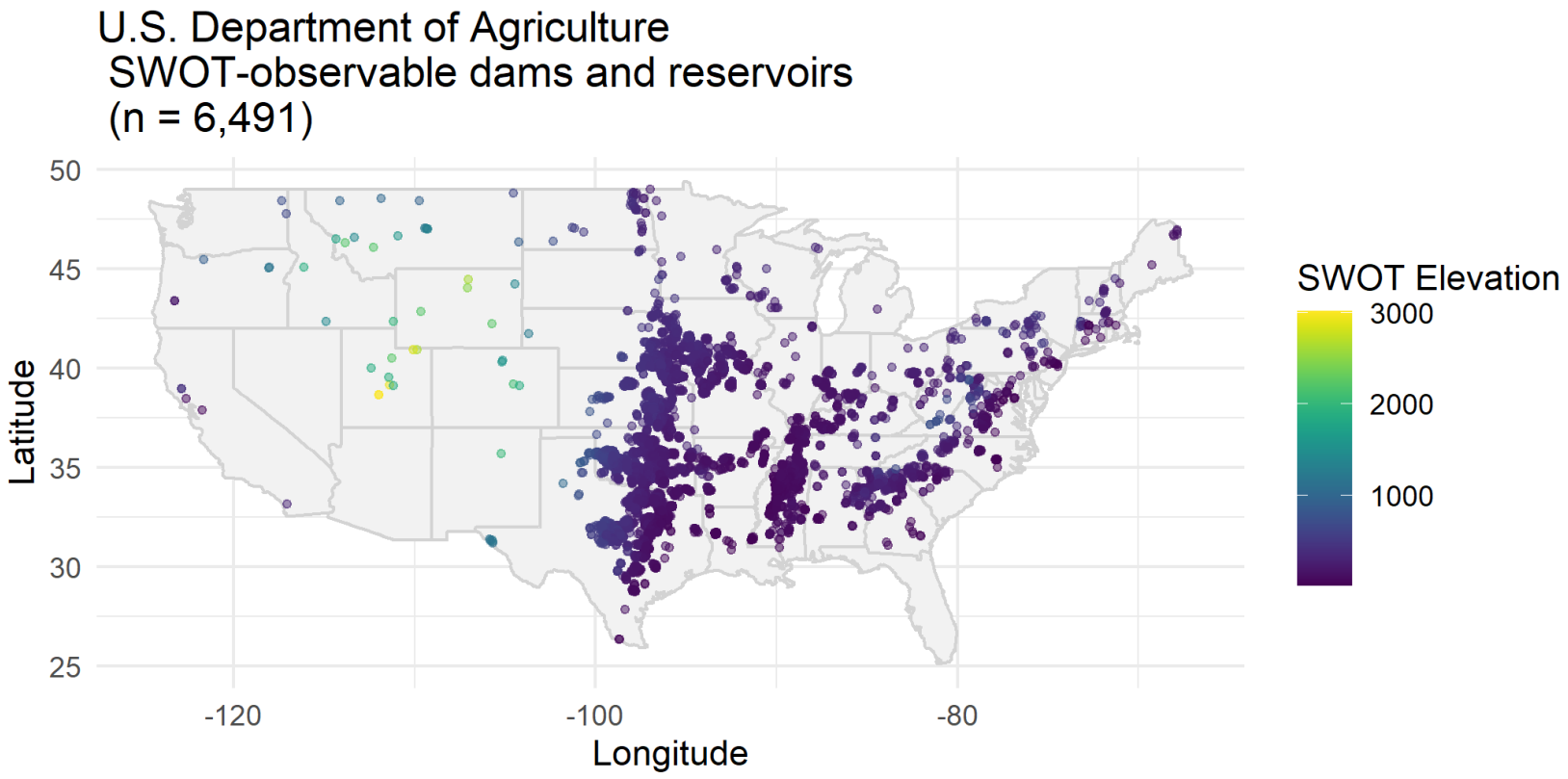
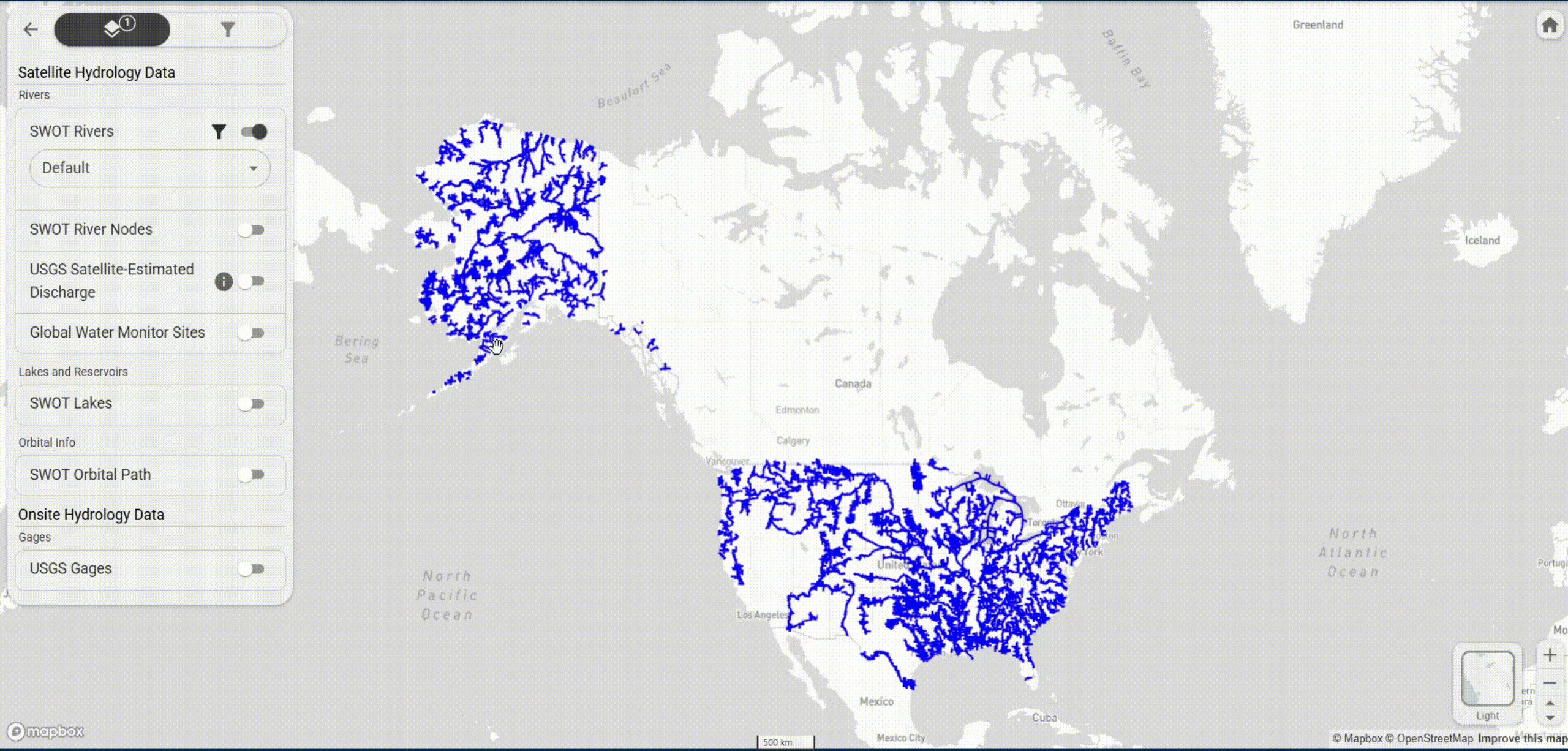
SWOT is measuring USDA flood control and irrigation dams.



United States Department of Agriculture

Natural Resources Conservation Service

Oklahoma Flood Control Dam
Managed by NRCS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Ottawa
Toronto
North Pacific Ocean
North Atlantic Ocean
Los Angeles
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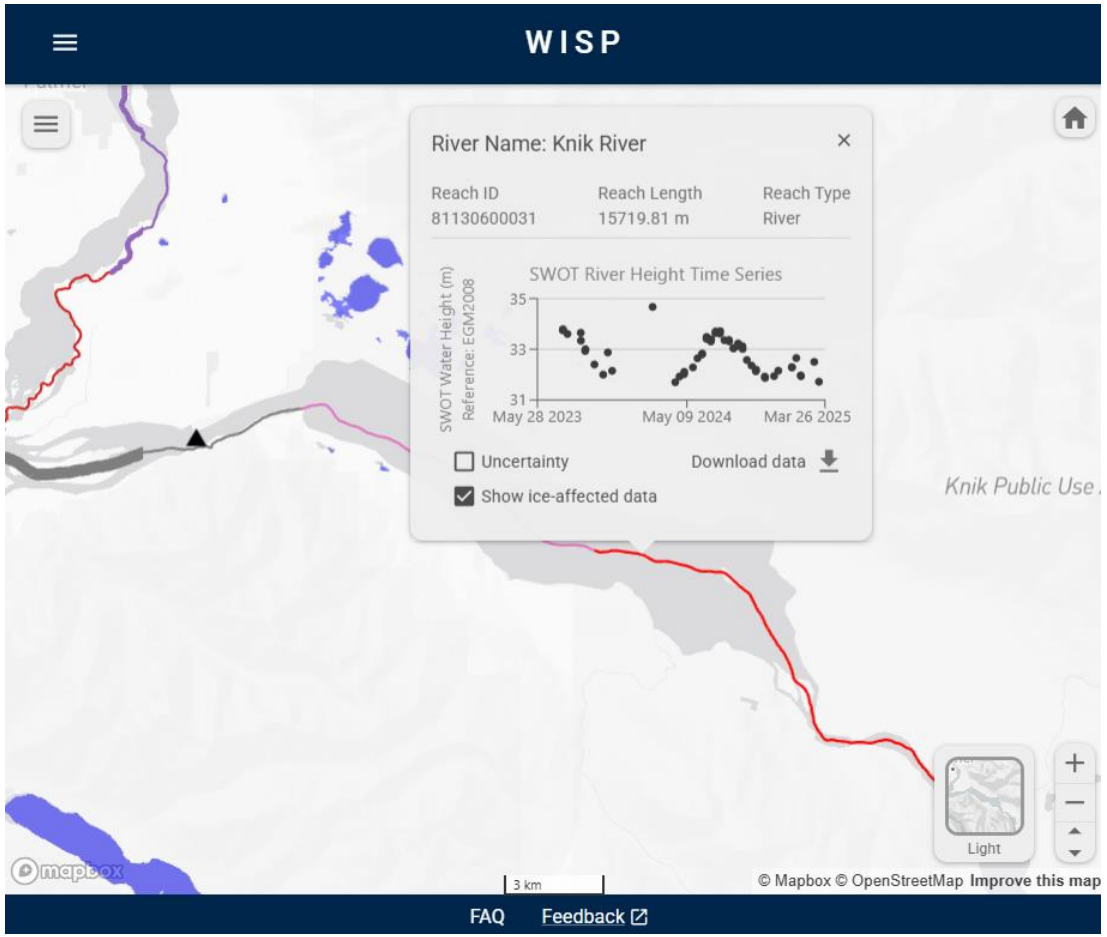
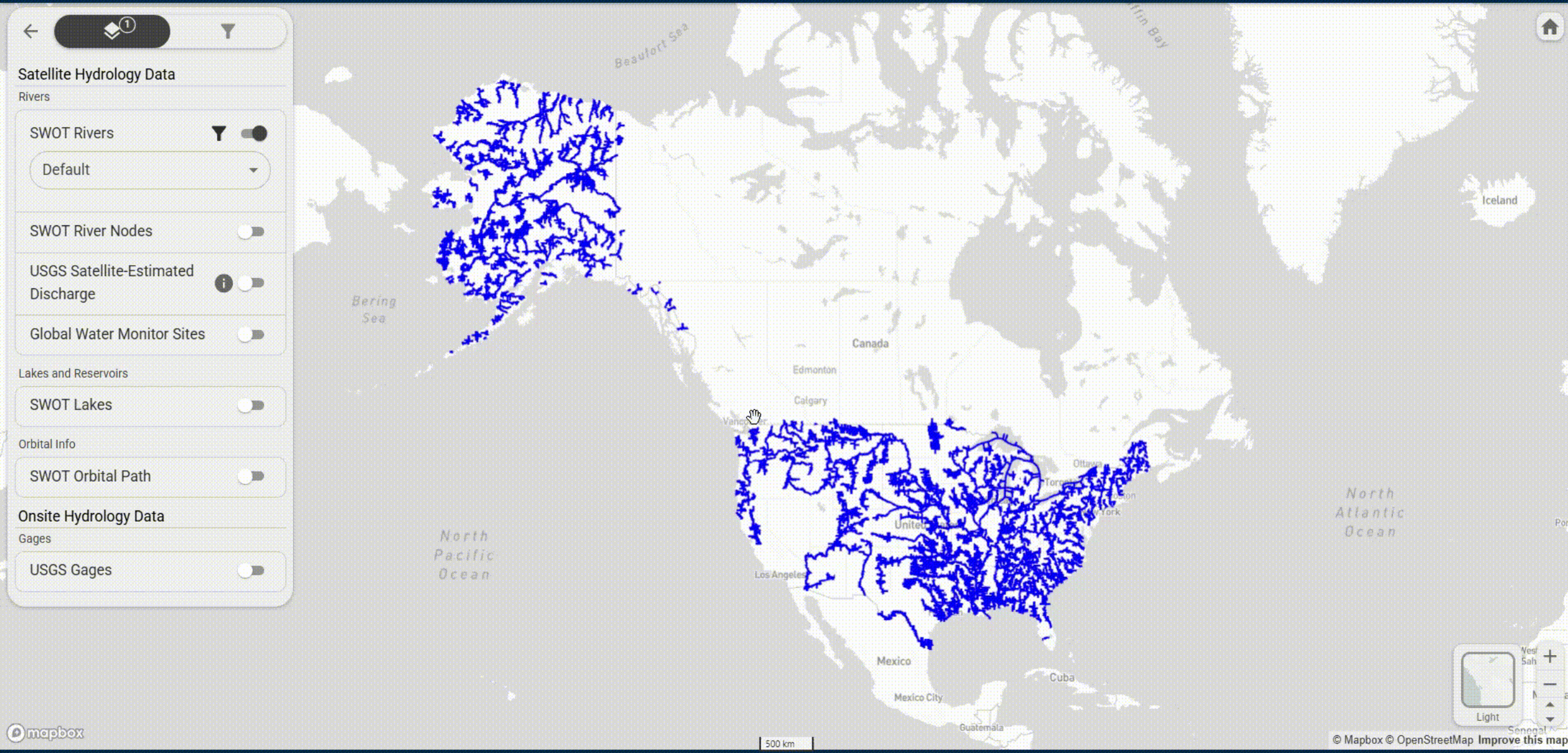
SWOT data in Alaska helps design safer bridges.



Knik River Bridge Near Anchorage, AK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Canada
Edmonton
Calgary
Iceland
North Atlantic Ocean
Los Angeles
Mexico
Mexico City
Cuba
Guatemala
Light
500 km
mapbox
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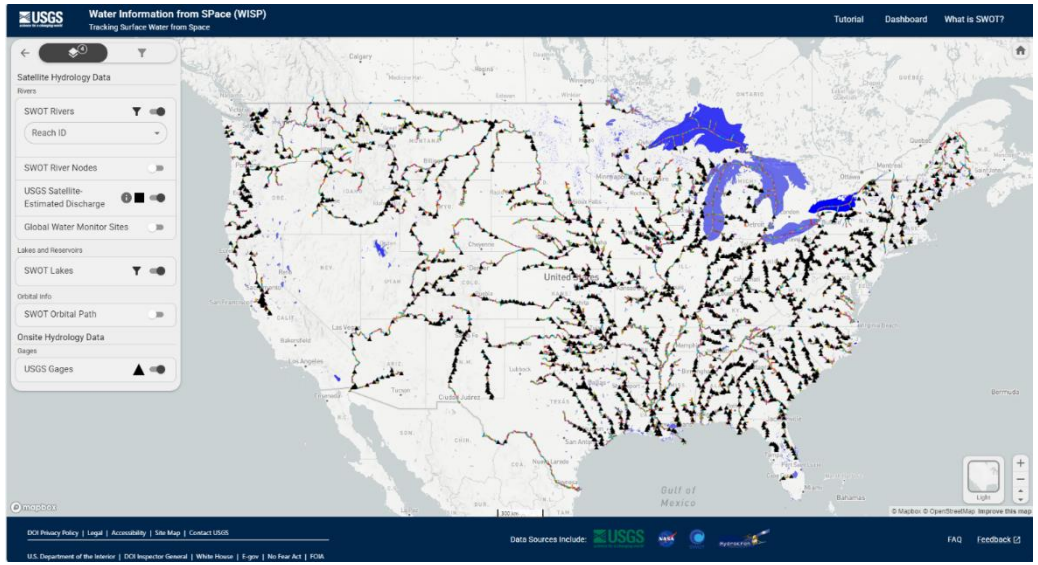
Conclusions

Contact me with any questions, feedback, or ideas!

Dr. Merritt Harlan, mharlan@usgs.gov

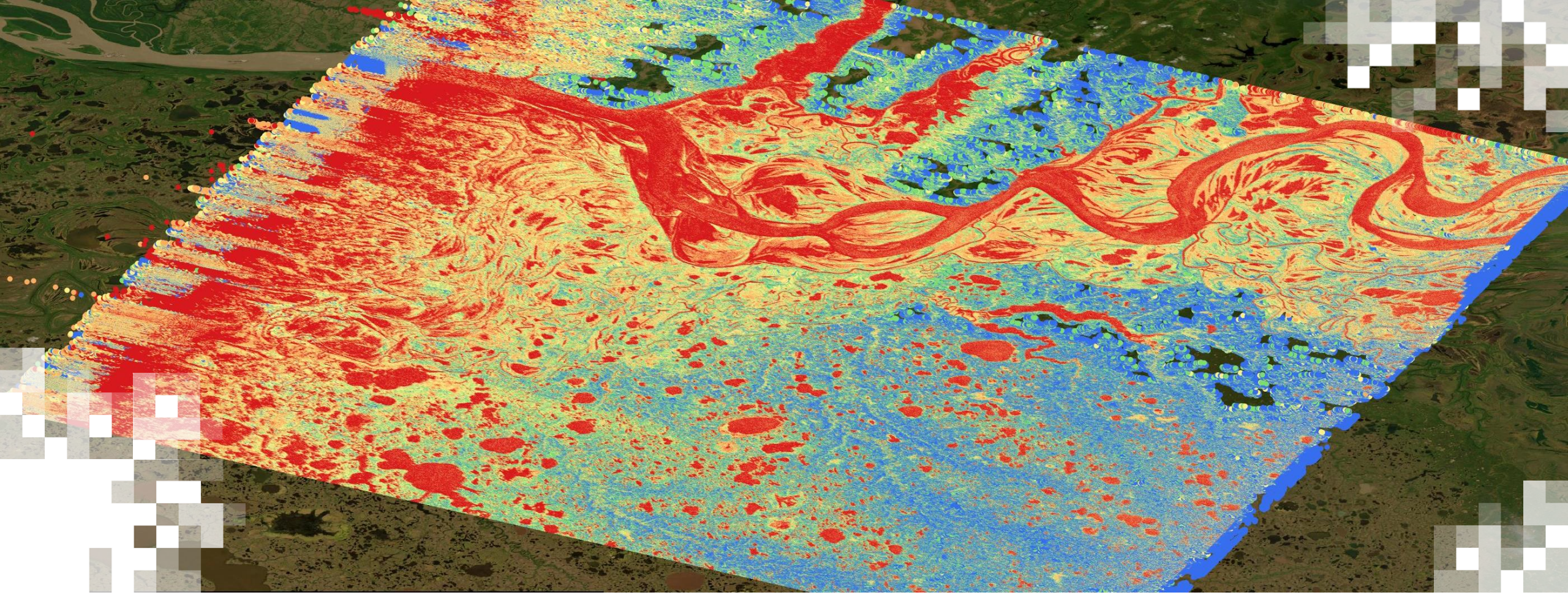
https://apps.usgs.gov/wisp



SWOT measures vast numbers of lakes, reservoirs, and rivers globally.

U.S. SWOT data are publicly accessible through WISP.

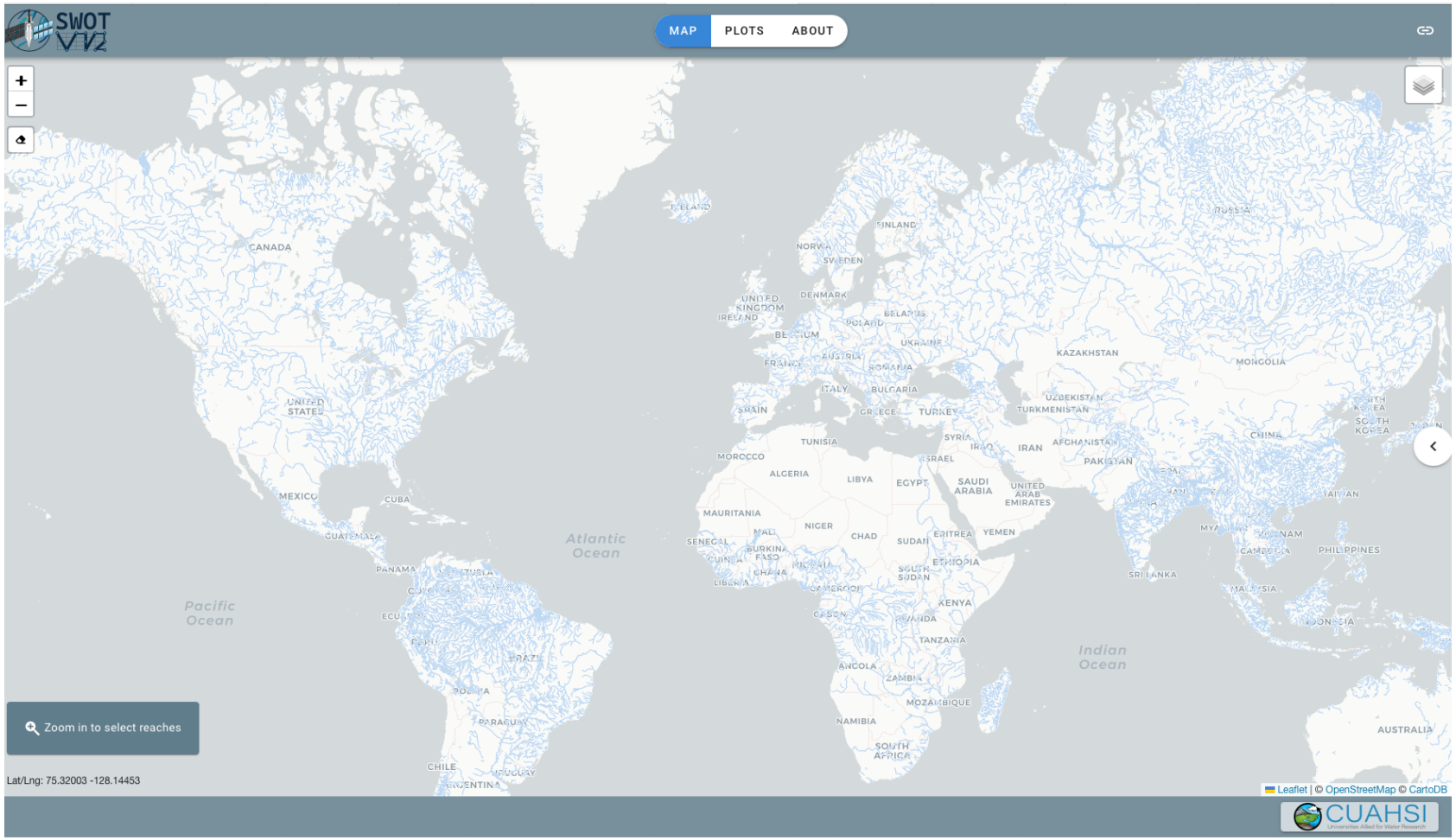
Discover your own use for SWOT data on WISP!



SWOT Viz: Web Application to Explore and Visualize SWOT Data

Presentation by Mike Durand, Ohio State

SWOT Viz: https://swotviz.cuahsi.io



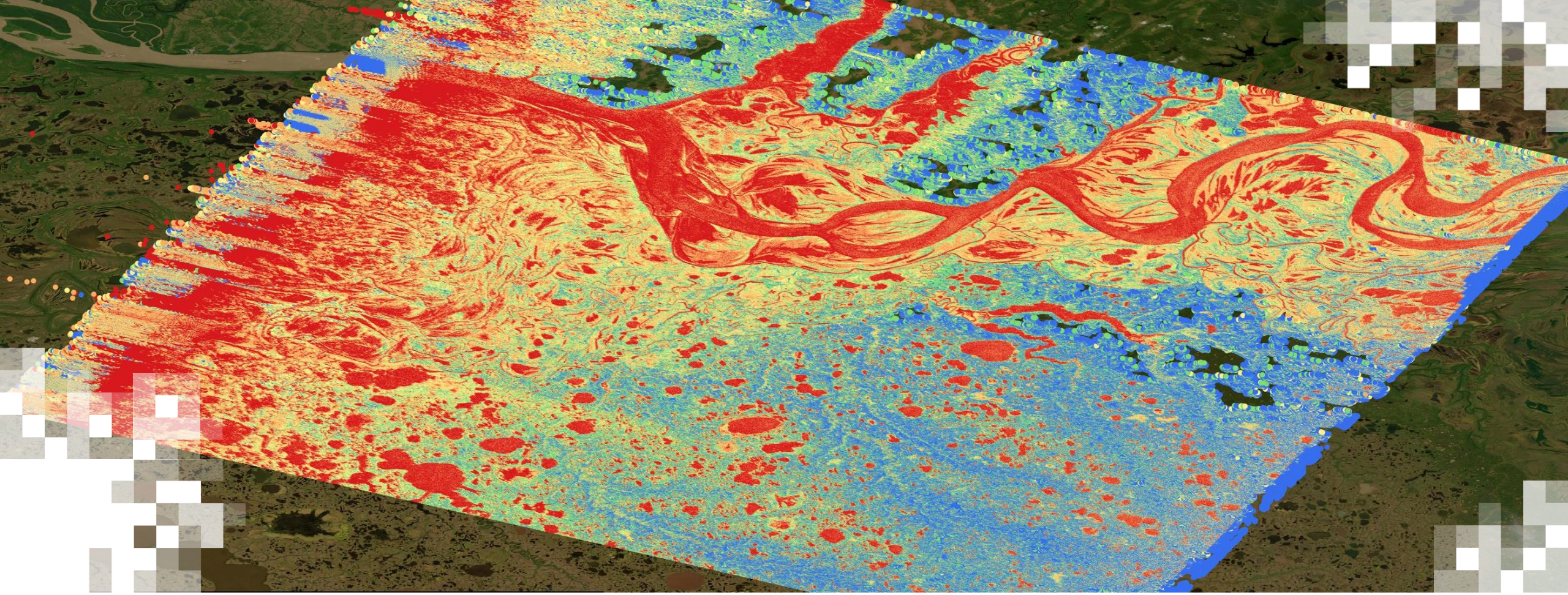
SWOT Viz enables global SWOT data access.

SWOT Viz – Facilitating Global Access to Hydrology-Related SWOT Observations

A web user interface for retrieving, visualizing, and manipulating SWOT measurements

- Developed in collaboration with CUAHSI scientists
- Lightweight web app that enables quick access and visualization of SWOT river data
- Leveraged open-source software and the PO. DAAC HydroCron API for data retrieval
- Funded by NASA Water Resources Program (80NSSC22K0965)

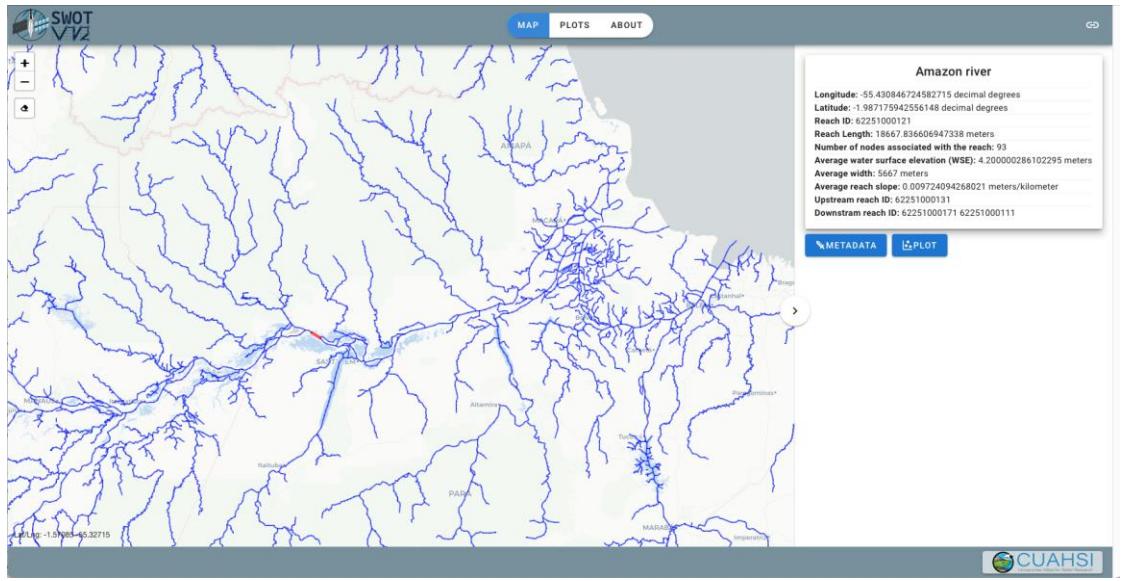
https://swotviz.cuahsi.io

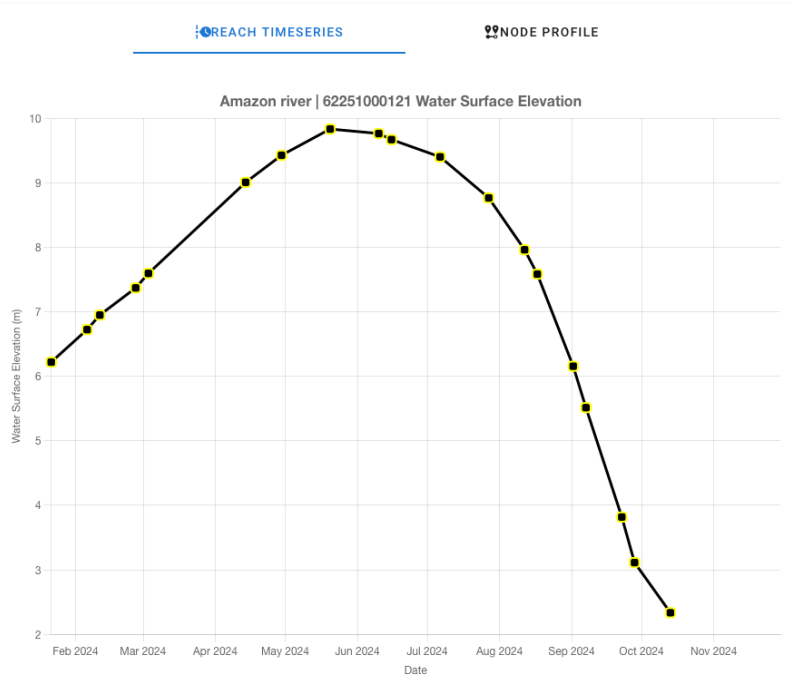


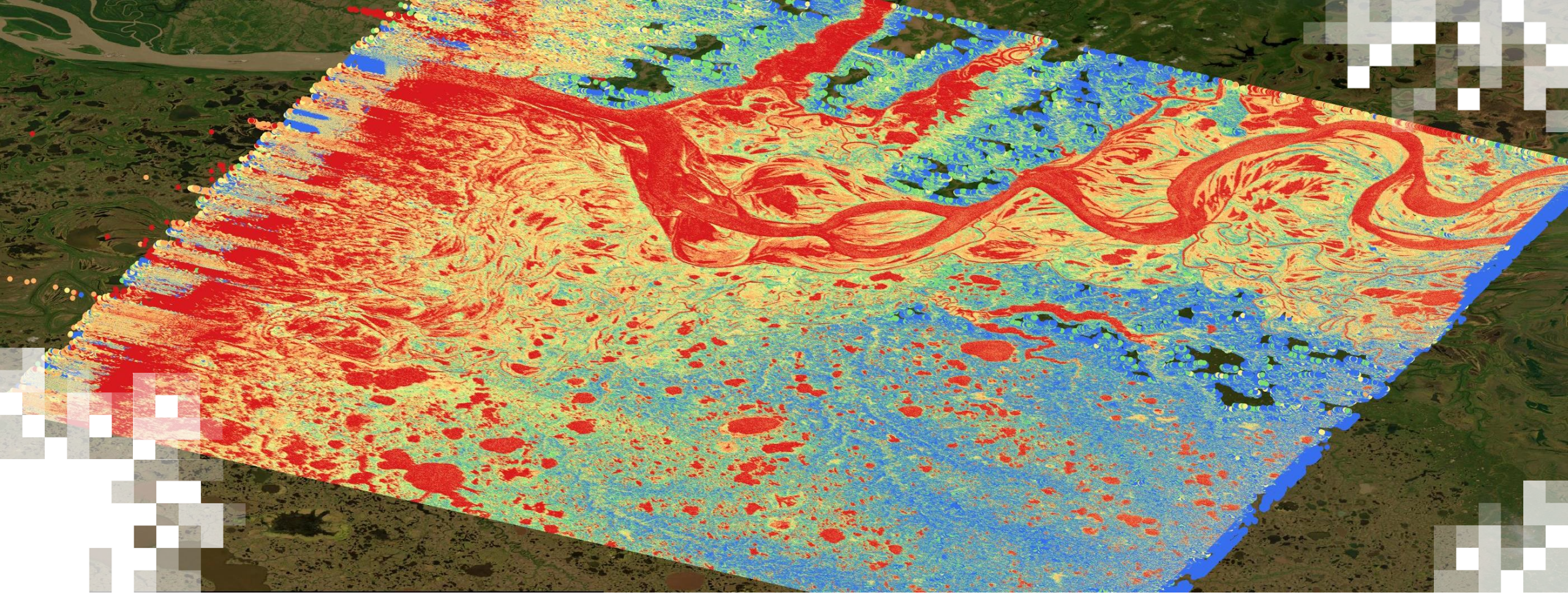
SWOT Viz: Demonstration

SWOT Viz: Summary

- SWOT Viz is a helpful tool for exploring SWOT data anywhere in the world.
- Compared with the USGS WISP tool, SWOT Viz allows global SWOT data exploration, but does not include built-in ability to compare to USGS gauges.
- SWOT Viz will be expanded in the future to include lakes and notebooks that enable deeper data exploration.







Monitoring Global Terrestrial Surface Water using Remote Sensing

Summary

Training Summary

- Monitoring surface water extent and amount are crucial for sustainable water and disaster management.
- The latest NASA mission, **Surface Water and Ocean Topography (SWOT)**, measures global ocean surface topography and land surface water extents & elevation with great accuracy.
- Level-2 Products Available from SWOT:
  - Point cloud of water mask pixels (NetCDF)
  - Surface water elevation and inundation extent (NetCDF)
  - Vectors of river reaches and nodes (Shapefile)
  - Vectors of lakes in prior database and detected features not in the prior databases (Shapefile)
- Data Access:
  - NASA Earthdata Search
  - Hydrocron API
- WISP is a web tool for water management applications in the USA.
- SWOT Viz is a lightweight web app that allows quick visualization of SWOT river data globally.

Homework and Certificates

- **Homework:**
  - One homework assignment
  - Opens on May 15, 2025
  - Access from the training webpage
  - Answers must be submitted via Google Forms
  - **Due by May 31, 2025**

- **Certificate of Completion:**
  - Attend all live webinars (attendance is recorded automatically).
  - Complete the homework assignment by the deadline.
  - You will receive a certificate via email approximately two months after completion of the course.

Acknowledgement

Merritt Harlan, PhD

Research Hydrologist

USGS

Michael Durand, PhD

Professor

The Ohio State University

Perry Oddo

Program Coordinator,
Water Resources Program

NASA Earth Science Division

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  - sean.mccartney@nasa.gov
- Erika Podest
  - erika.podest@jpl.nasa.gov

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Resources

- Greguska, F., Tebaldi, N., McDonald, V. V., & Nickles, C. (2024). *Podaac/hydrocron: 1.4.0rc5*. Zenodo. https://doi.org/10.5281/zenodo.13774808
- Hydrocron link: https://podaac.github.io/hydrocron/intro.html
- SWOT. (2024). *SWOT Level 2 River Single-Pass Vector Data Product*. NASA Physical Oceanography Distributed Active Archive Center. https://doi.org/10.5067/SWOT-RIVERSP-2.0
- WISP link: https://apps.usgs.gov/wisp
- WISP developers: Chuck Hansen, Colin Keating, Tom Bergamaschi, James Merges, Kyle O'Connor (USGS California Water Science Center)


APPLIED REMOTE SENSING TRAINING PROGRAM
TRAIN - EMPOWER - ADVANCE

Thank You!