Update on LANCE Flood Product (MCDWD)

LANCE UWG 23 June 2023
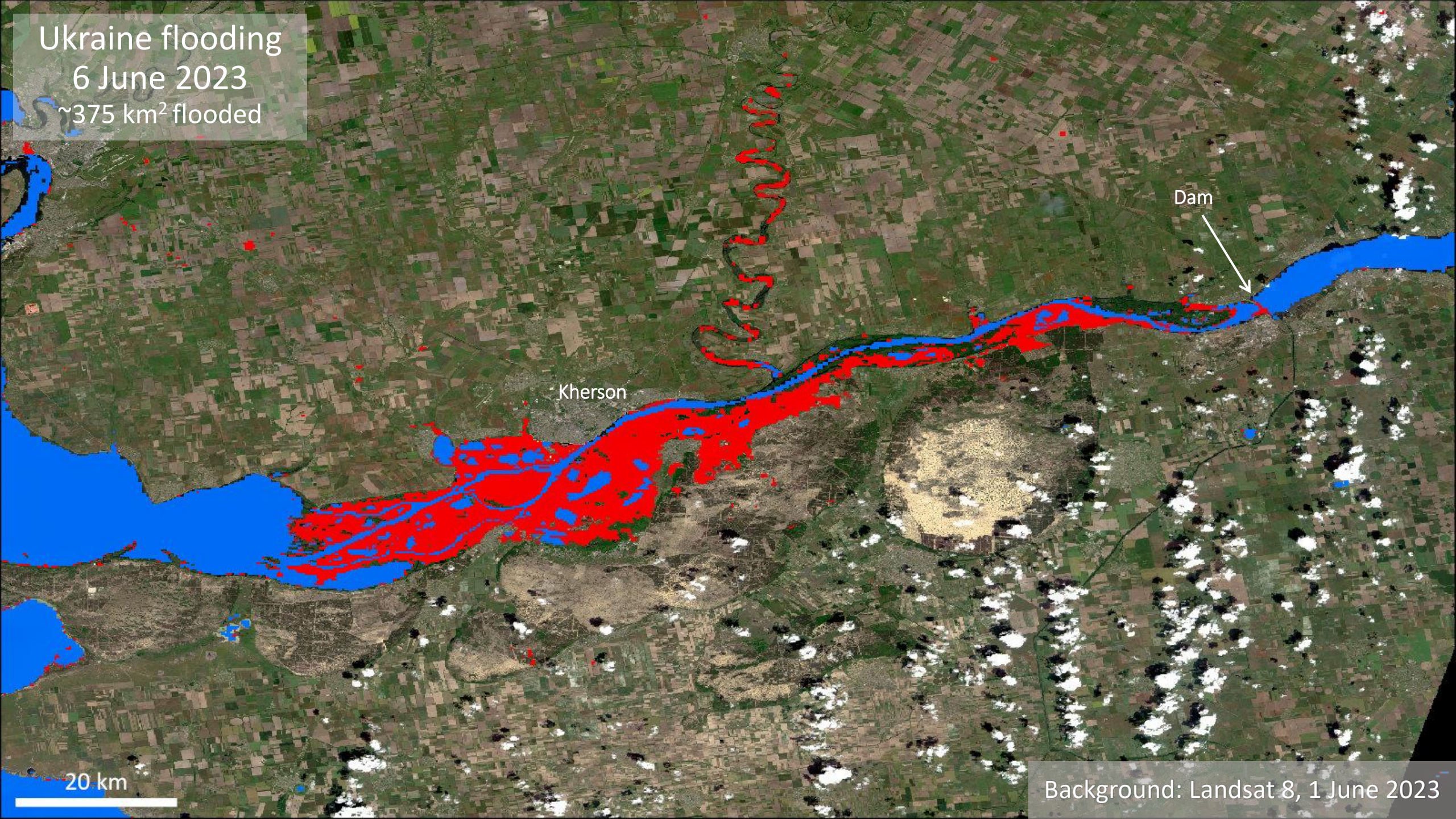
Dan Slayback[1,2]
(dan.slayback@nasa.gov)

Diane Davies[1,2], Sadashiva Devadiga[1],
David Landis[1,3], Ranjay Shrestha[1,2]
[1]NASA GSFC, [2]SSAI, [3]GST

20 km

Ukraine flooding
6 June 2023
~375 km² flooded

Dam

Kherson

20 km

Background: Landsat 8, 1 June 2023

NASA Flood Product: A brief history

- Bob Brakenridge (Dartmouth Flood Observatory): manual generation of flood maps using MODIS rapid response imagery as source, from mid 2000s (?)

- Circa 2010, NASA GSFC Office of Applied Science (via Fritz Policelli) initiated a project to automate
  - LANCE component: daily composited Terra and Aqua Surface Reflectance (MOD09).
  - OAS component: processing code, browse/distribution website.
  - Automated global production began end of 2011
  - Production system: PI-owned / maintained server (not redundant).

- Circa 2017, LANCE UWG agreed to transition production to LANCE.
  - Improved latency, redundancy, long-term operations.
  - Required a complete rewrite of the processing system to conform to MODAPS requirements.
  - Jan 2021: beta release.
  - Jan 2023: added topographic mask.
 - June 2023: OPS code in testing.

Flood process summary

- PGE 152: Water detection, from MOD09 swath granules.

- PGE 155: Map swath granules to output grid (lat/lon, 10x10° tiles, "heavy").

- PGE 170: Select and retain best within-swath pixel ("lite": contains one layer for every swath overpass, for a given pixel).

- PGE 159: (Level-3) Composites (over time), applies thresholding, masks, and compares to reference water to identify flood.

Recent Product Updates: HAND mask

- Problem: Terrain shadows often detected as water.
- Solution: Mask out areas with significant relief.
  - Unlikely to retain water, if there are nearby drainages.
  - Mountain flooding is typically in narrow valleys, and often not laterally extensive enough to be captured by 250 m MODIS pixels.
  - Usually transient and rapid; water may not be present during the twice-daily MODIS observations.
  - Sun/topography geometry-specific terrain shadow masks are difficult and not entirely effective.
- HAND mask = Height Above Nearest Drainage.
  - Generated from Copernicus DEM (90m).
  - Threshold at 30 m height (empirically determined).

- Limitations: DEM accuracy, dams/water engineering.
- Implemented Jan 2023.
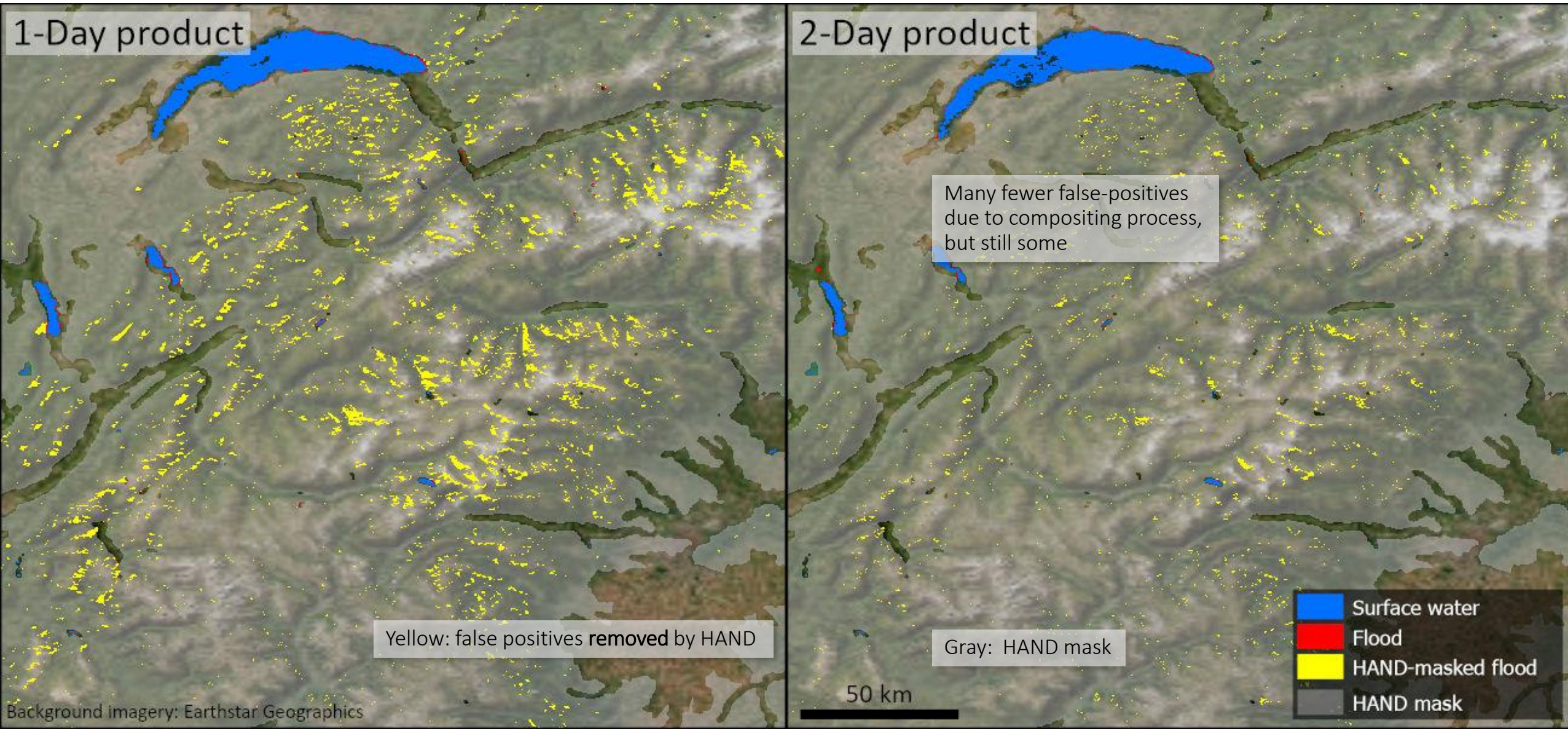
Product Updates: Thresholding

- Problem: Cloud shadow false-positives contaminating higher latitude products with additional swath observations.

- Solution: Update thresholding from fixed to dynamic, depending on number of observations.

- Fixed thresholding (initial release and legacy product):
  - 50% of nominal observations must be water to label a pixel as water
    - 2-Day product: 2 required (over potential 4 Terra/Aqua obs over 2 days).
    - 3-Day product: 3 required (over potential 6).
    - 1-Day product: only 1 required (over potential 2 Terra/Aqua obs / 1 day).
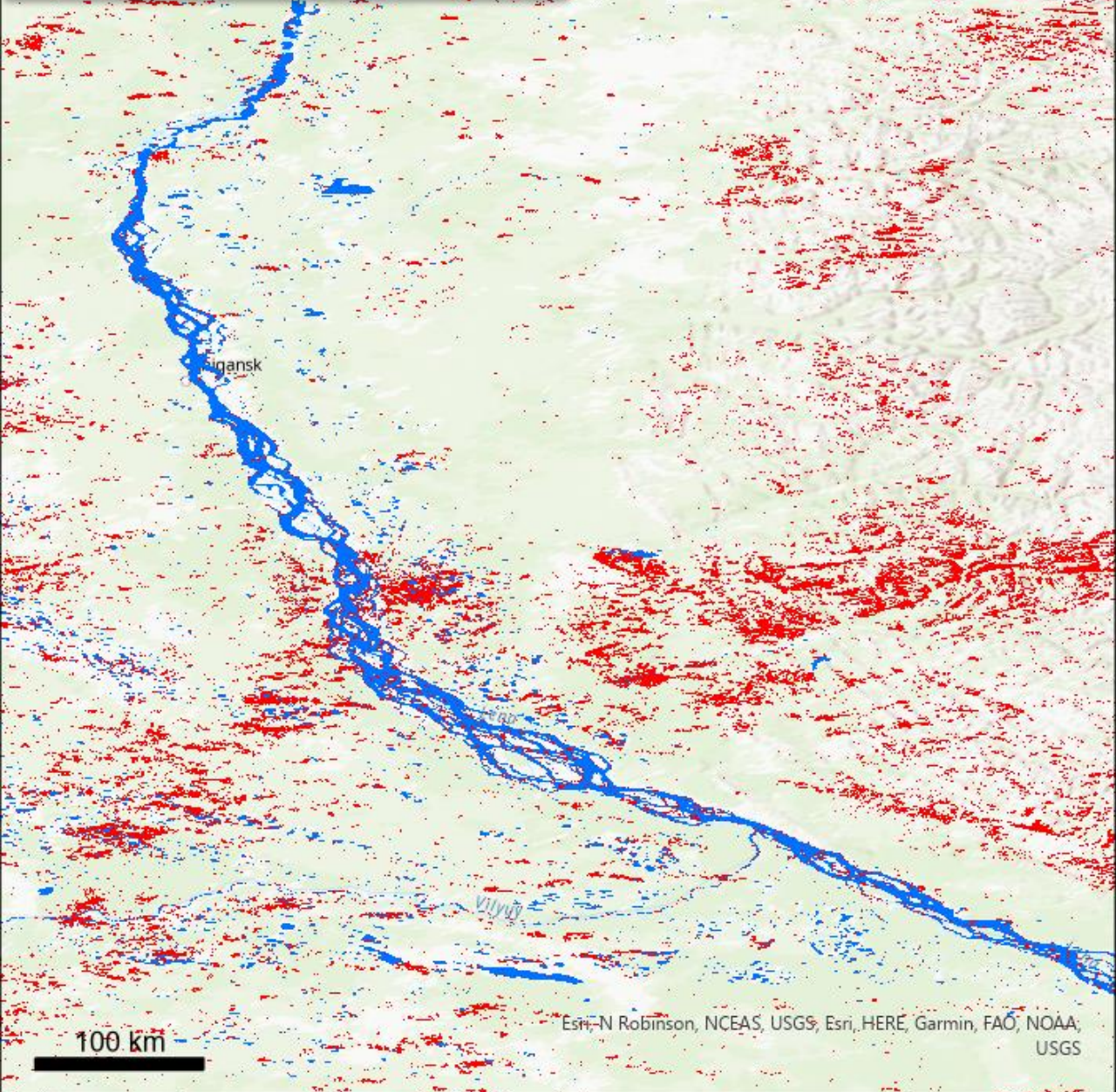
Product Updates: Thresholding

- Dynamic thresholding:
  - Threshold is dependent on number of actual swaths.
  - Tradeoff between detecting real water and avoiding false-positives
  - Empirical analysis found an approximately linear relationship: 50% of available observations at the low end, but becoming logarithmic for higher numbers of observations (higher latitudes).
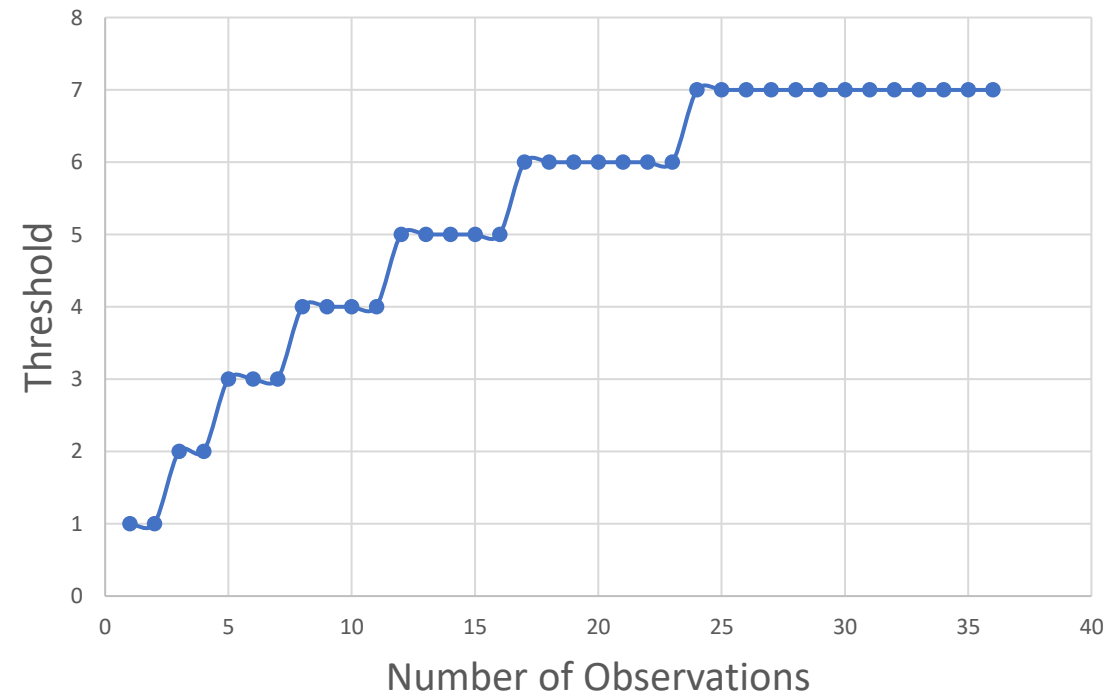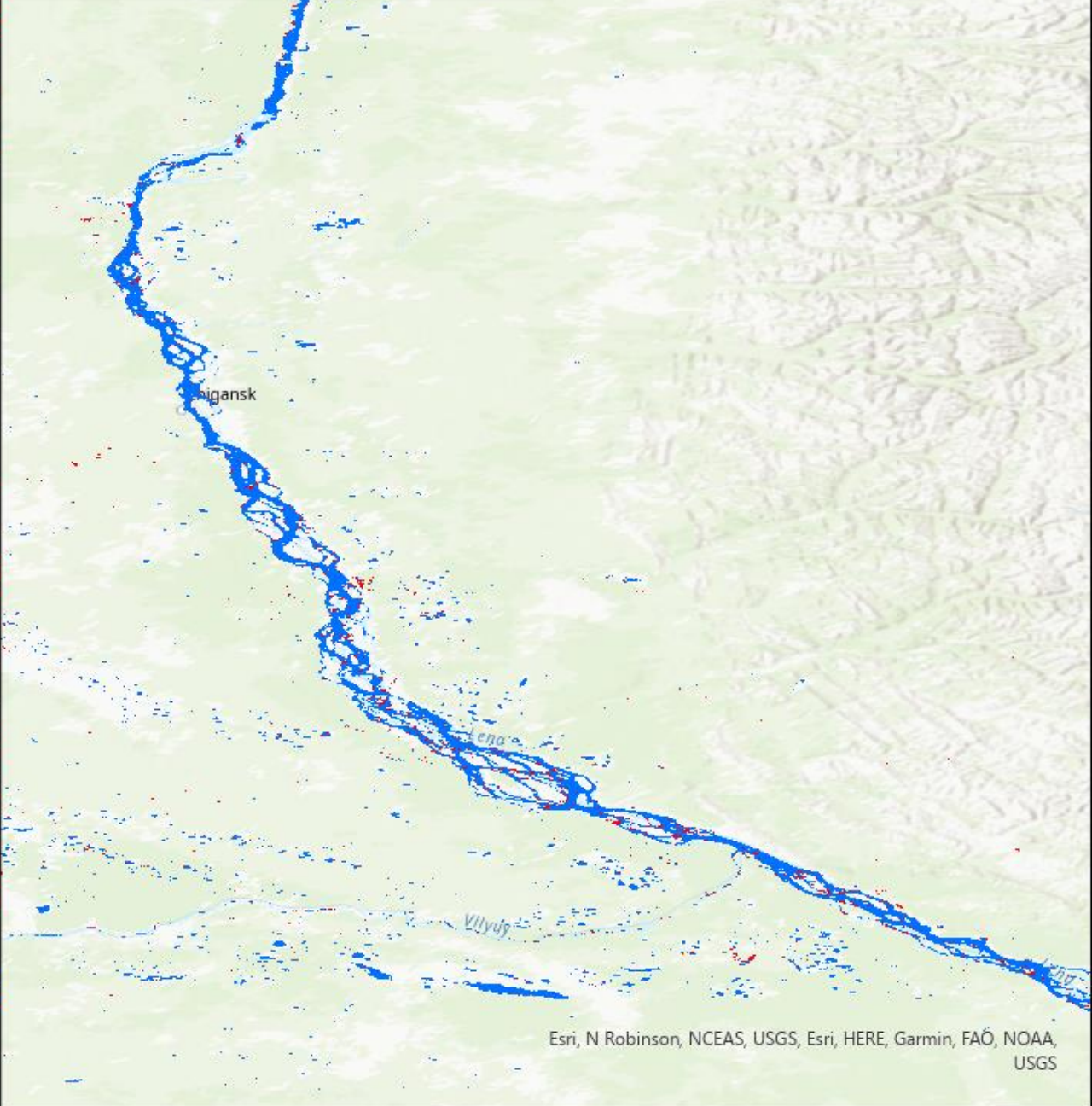
Current fixed Thresholding
2-Day product, 7/1/2022
Siberia – Lena river (~60-70° N)

Dynamic Thresholding (update)
2-Day product, 7/1/2022

100 km

Product Updates: OPS Code Development

- OPS ("operational", or "science" code) (vs NRT) nearing completion.
  - Allows backprocessing of historical data, and archiving of product.
- Updated thresholding was needed to proceed; now complete.
- Operational testing underway.

Future Updates: Updated Reference Water

- Current Reference Water: original MOD44W version (10+ years old)
  - In many places out of date (new reservoirs, river course changes, etc).
- Update Reference Water and add "recurring flood" class.
  - Process ~10+ years of historical archive with OPS code.
  - Analyze output to update Reference Water layer
    - Using MCDWD product to define reference water will minimize differences due to algorithms (vs MOD44W algorithm).
  - Add "recurring flood", based on product history.
    - Allows discrimination between expected seasonal flooding and truly unusual floods.

Future Updates: incorporate VIIRS

- Code development well underway.
  - First 3 PGEs (water detection from granule inputs; remapping) complete.
  - Final L3 PGE code testing now in progress.

- When test data are available, will evaluate how to integrate into product.
  - Replace Aqua?
  - Use in addition to Aqua?
  - Use J1 along with SNPP?
  - New thresholding allows flexibility.

Future Updates: Sentinel-3/OLCI potential

- Flood product quality significantly degrades with loss of less-cloudy Terra/AM observations.

- Tested loss of Terra on Pakistan flood event: →
  - Reduction in flood area observed.
  - Poorer continuity through cloudy periods.

- S3/OLCI provides a daily morning overpass that will help fill this critical gap.


Pakistan flooding 2022
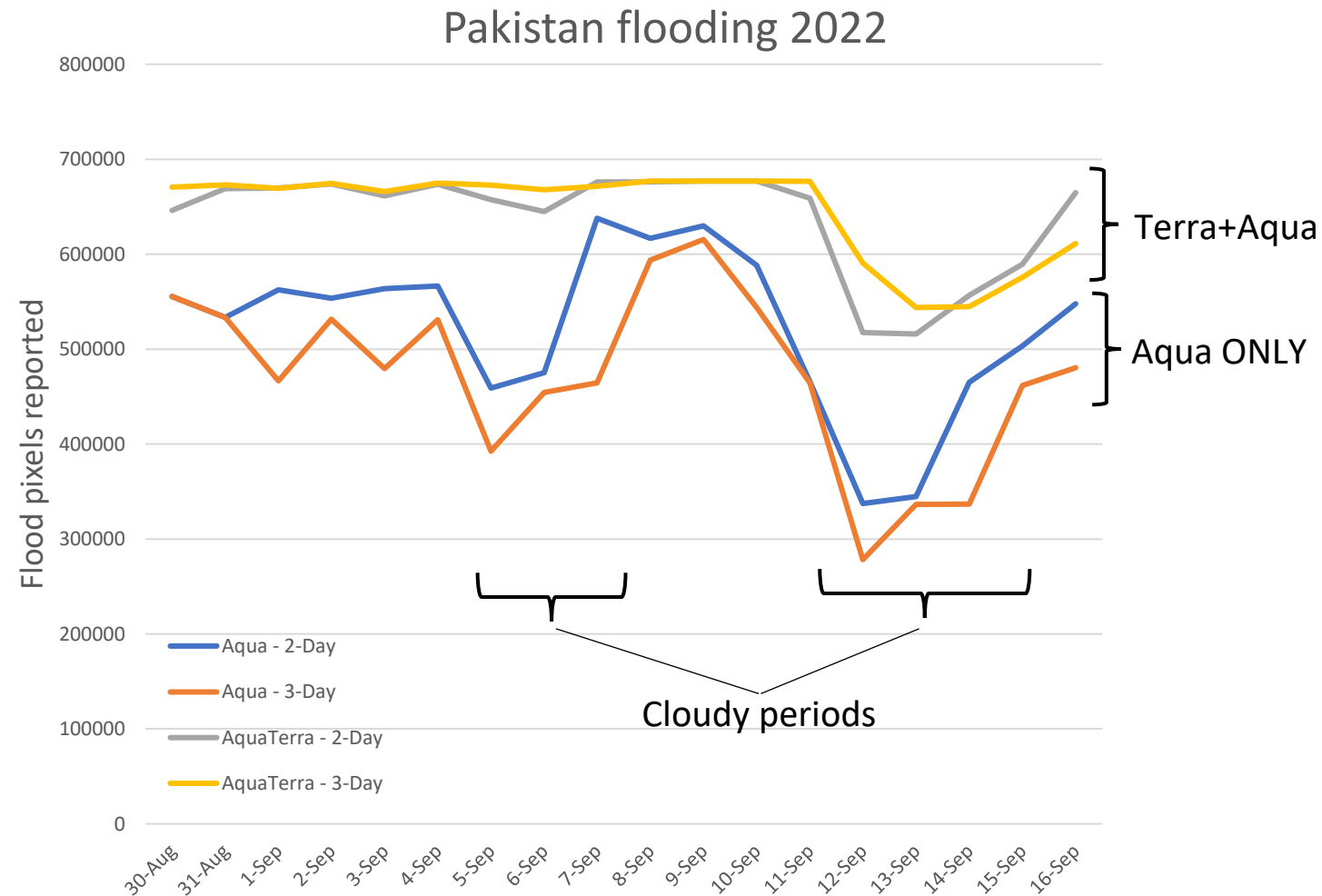
Product Use & Users

- Semi-frequent requests for historical/archive data
  - Currently none available directly: legacy website retired in early 2023; no MCDWD OPS production (yet).
    - Providing archive data on-request, time-permitting, via NASA Box.
  - Most requests come from PhD students.
  - Some from companies looking at climate risk.
    - Aquantix (Morningstar) requested entire legacy archive!
- Recent events:
  - California, Jan-present 2023
  - Northern Territory/Queensland, March 2023
  - Upper Mississippi, April 2023
  - Ukraine, June 2023
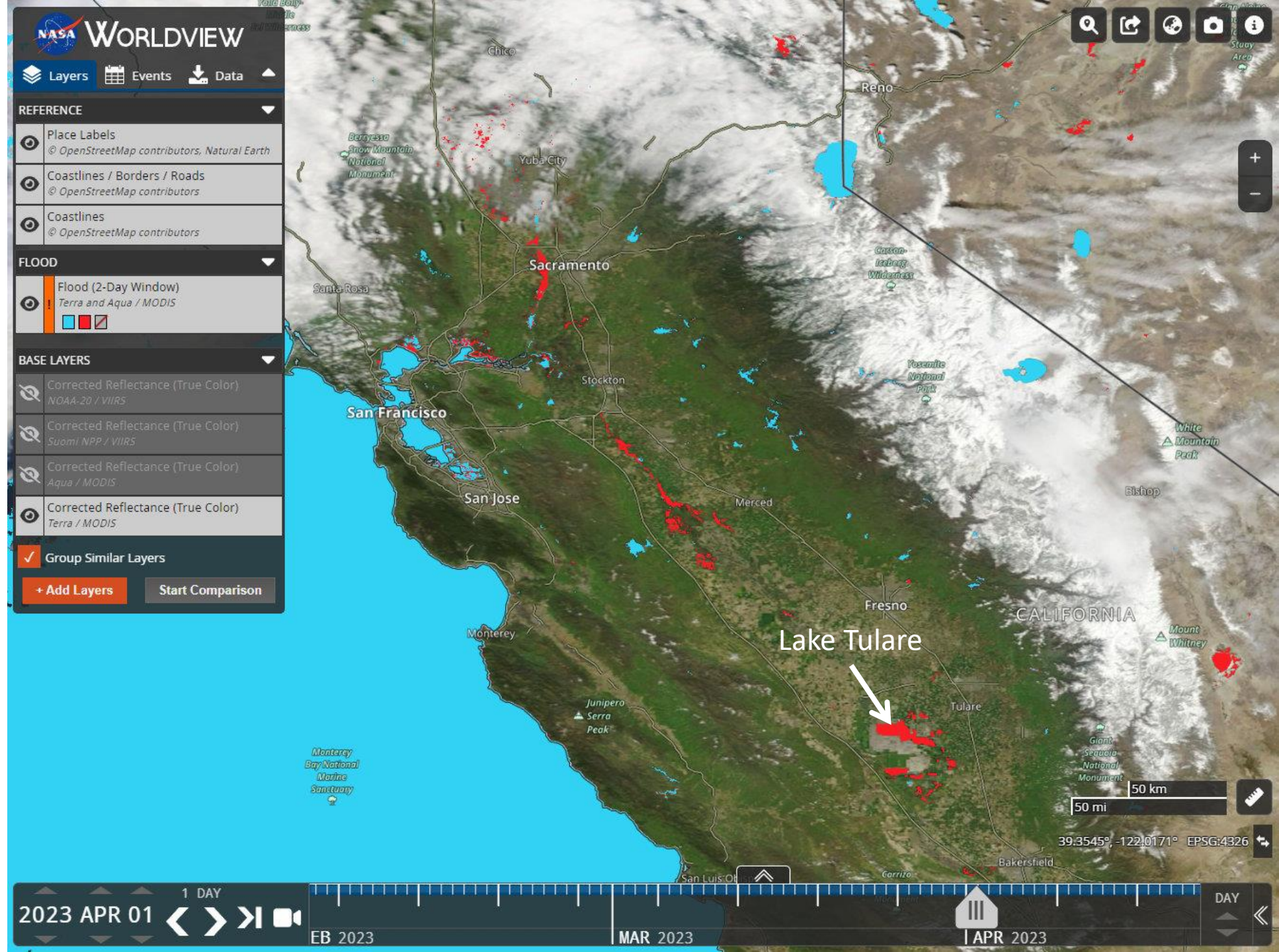
California

- Jan 2023
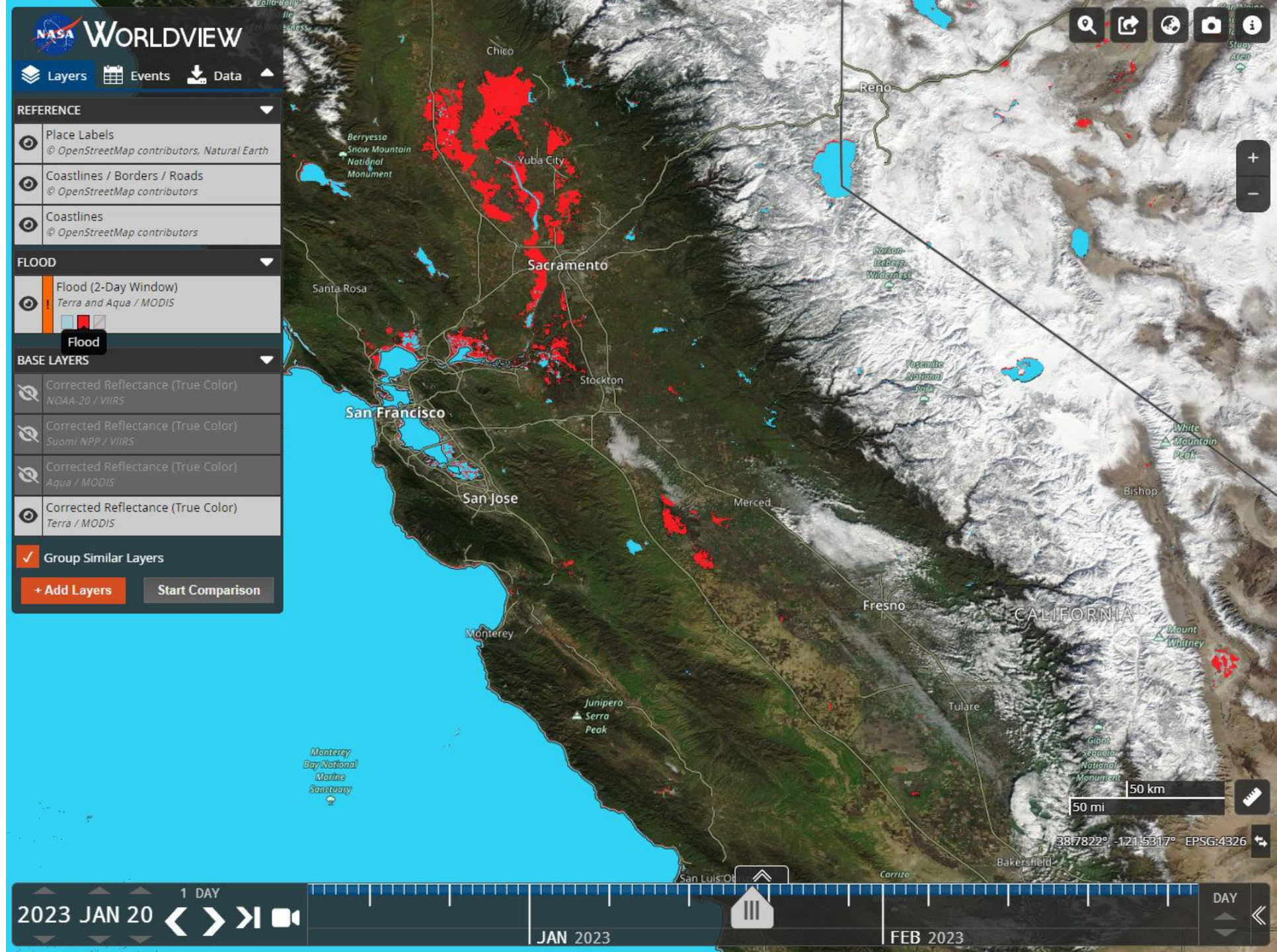
California

- March 2023
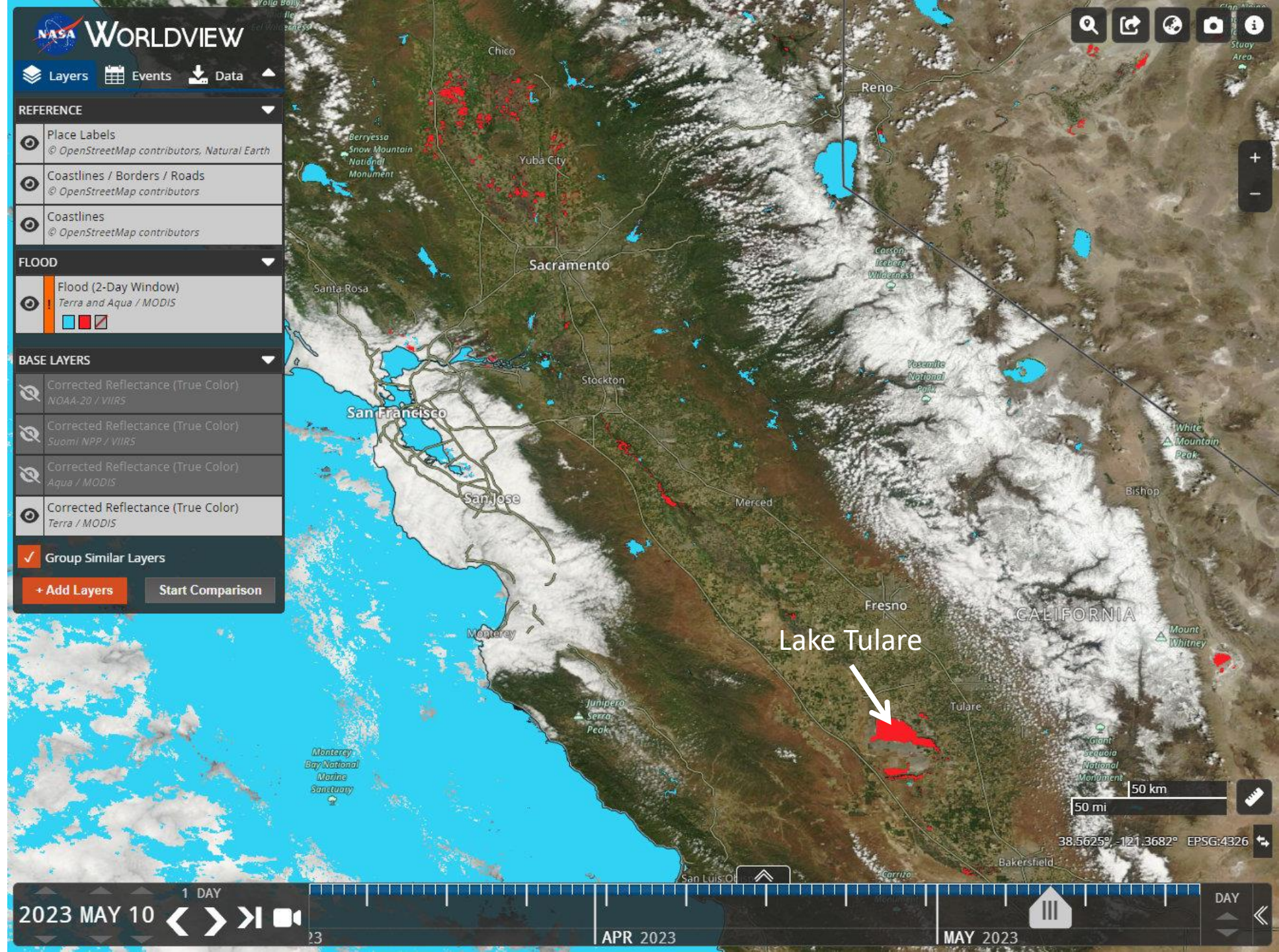- Re-emergence of Lake Tulare & Owens lake
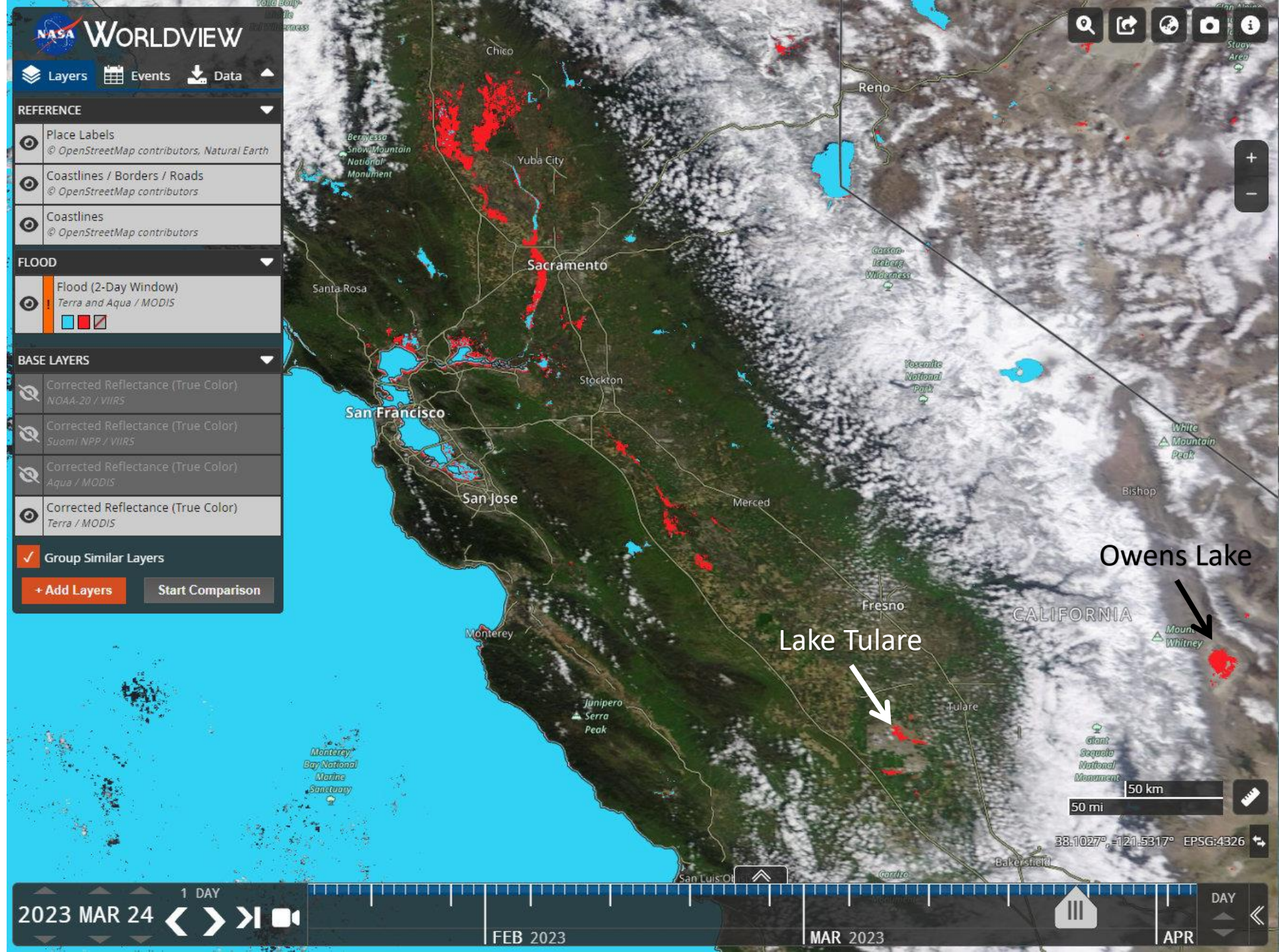
California

- April 2023
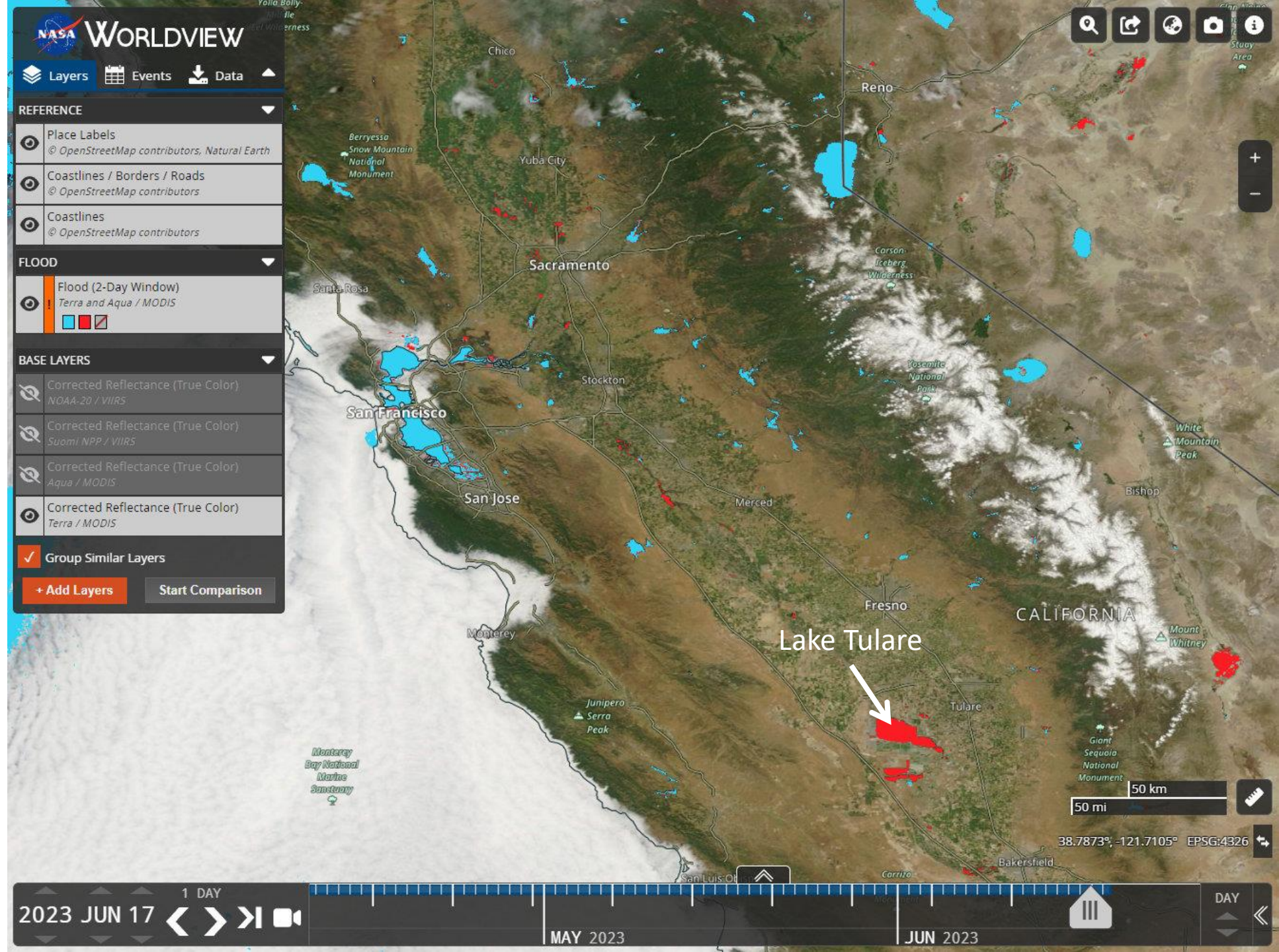- Growth of Lake Tulare

California

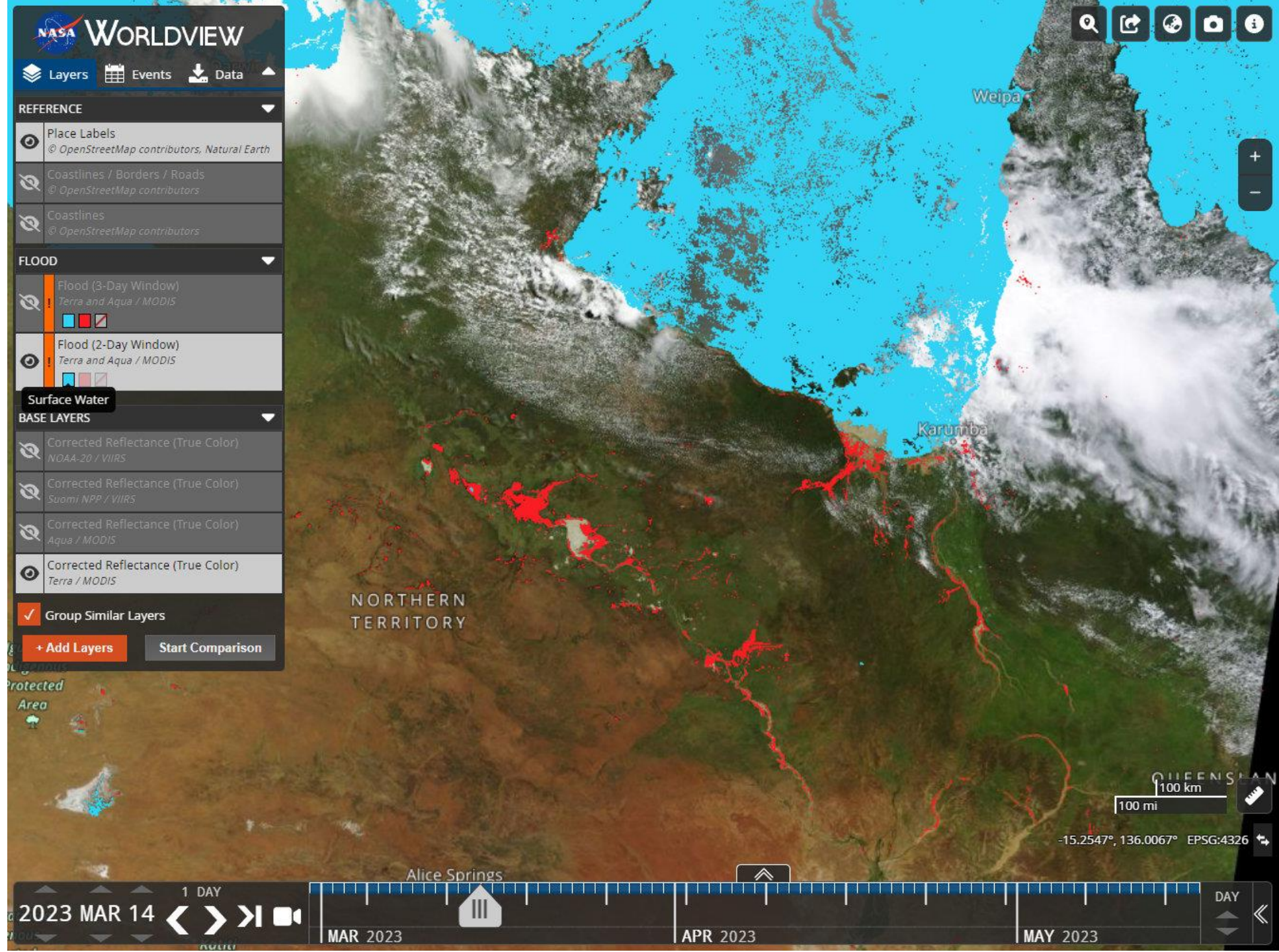- May 2023
- Growth of Lake Tulare

California

- June 2023
- Growth of Lake Tulare
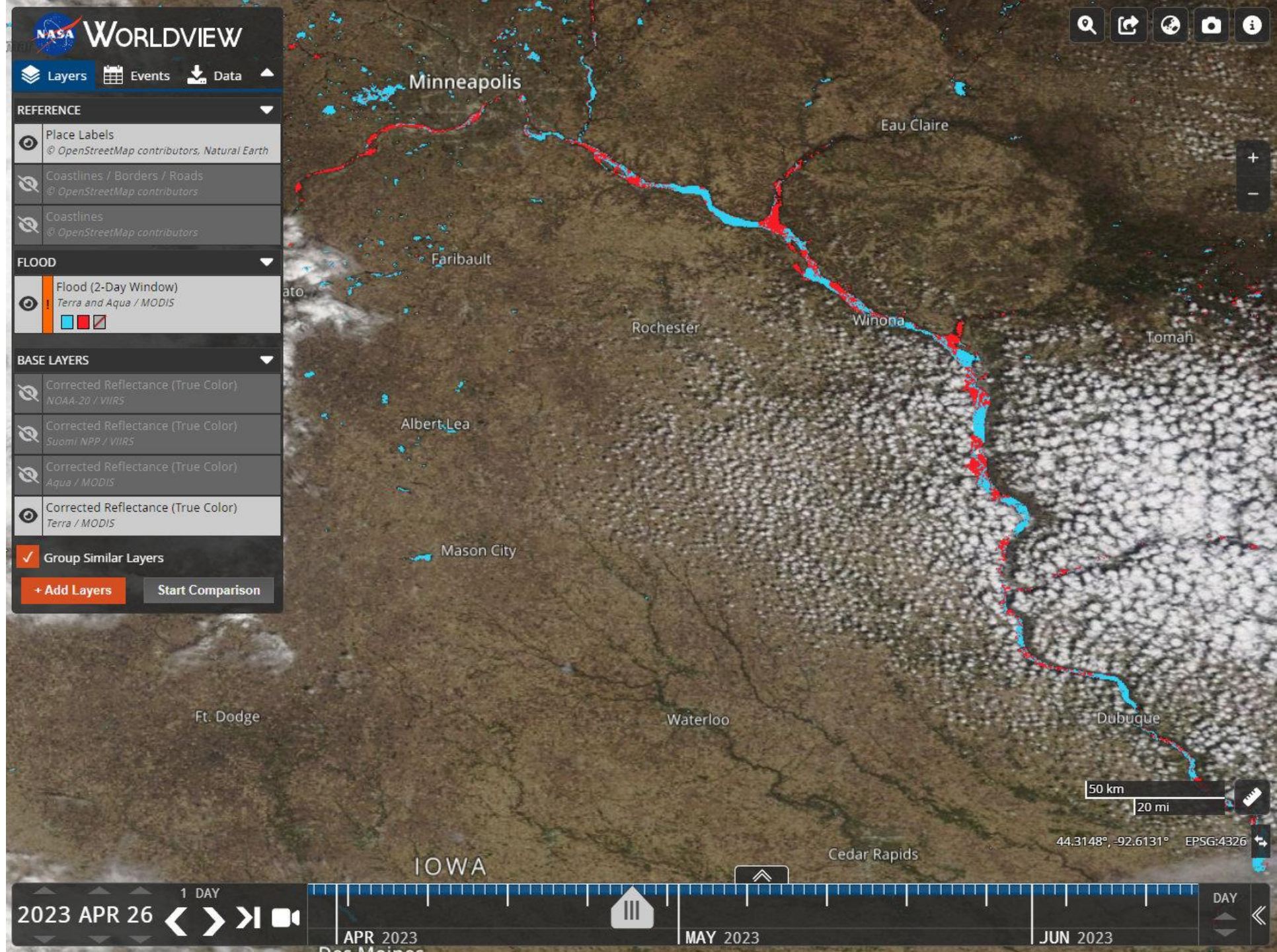
Northern Territory / Queensland

• March 2023

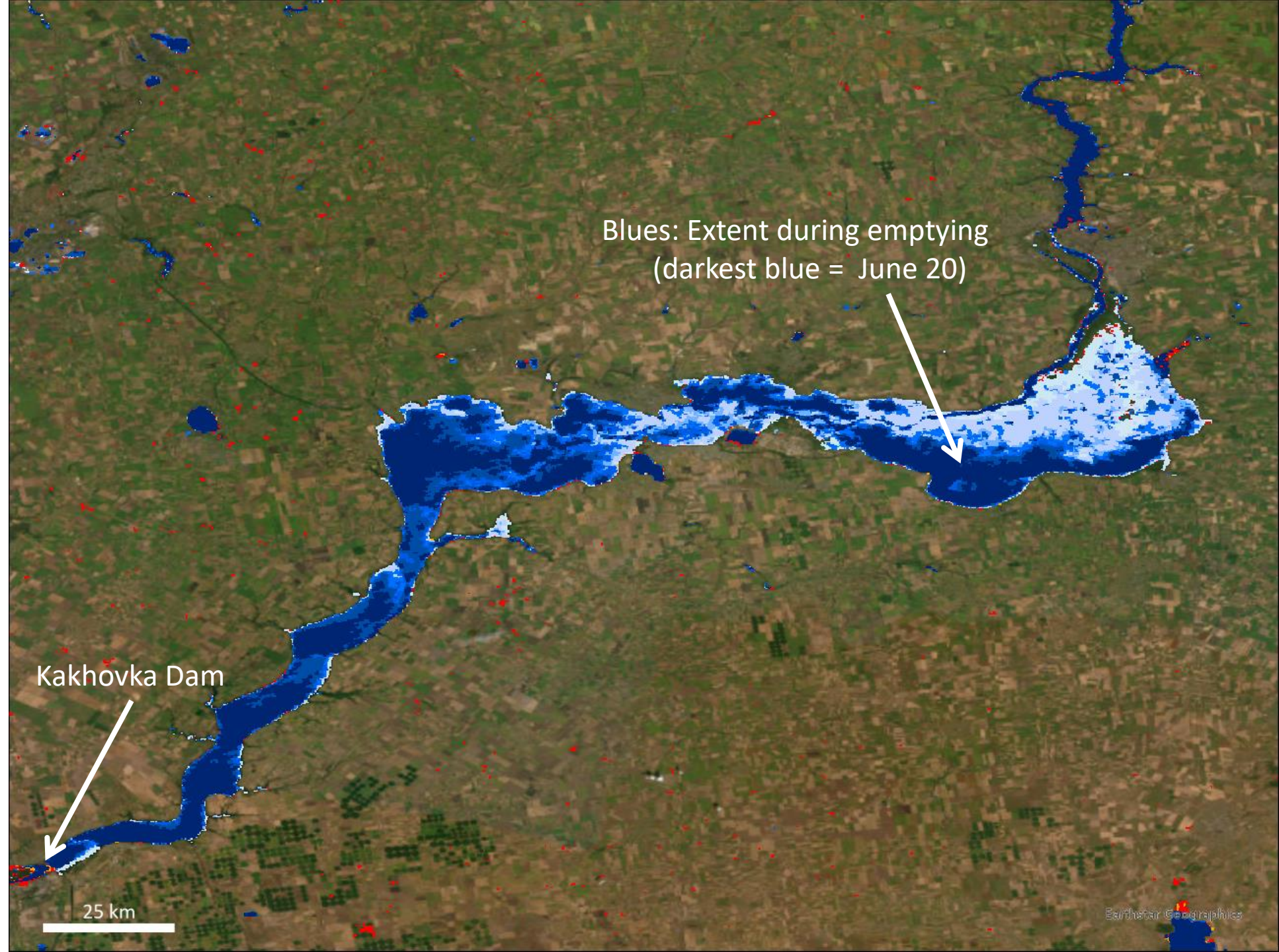# Mississippi River, Upper Midwest

- April 2023

Ukraine:
Emptying of Kakhovka reservoir
- June 6 – 20

Blues: Extent during emptying
(darkest blue = June 20)

Kakhovka Dam

25 km

Earthstar Geographics

Thank you

Questions?

Blues: Extent during emptying
(darkest blue = June 20)

Kakhovka Dam

25 km

Earthstar Geographics