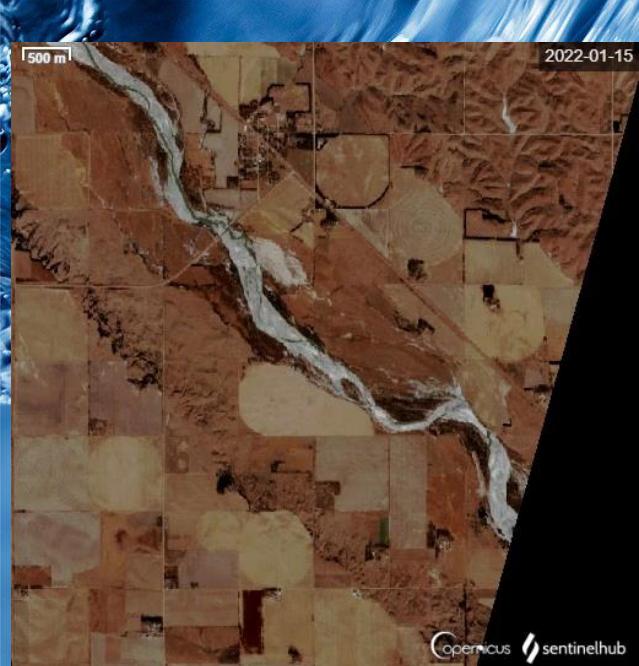




# Synthetic Aperture Radar River Ice Surveillance

*Mapping Ice in the Dark*  
Shawn Carter, NWS/OWP/NWC/WPOD





# River Ice and Consequences

Majority of flooding in Alaska is the result of ice jams

Ice jams are responsible for significant and catastrophic flooding in the northern tier of the continental United States

Difficult to forecast, harder to model





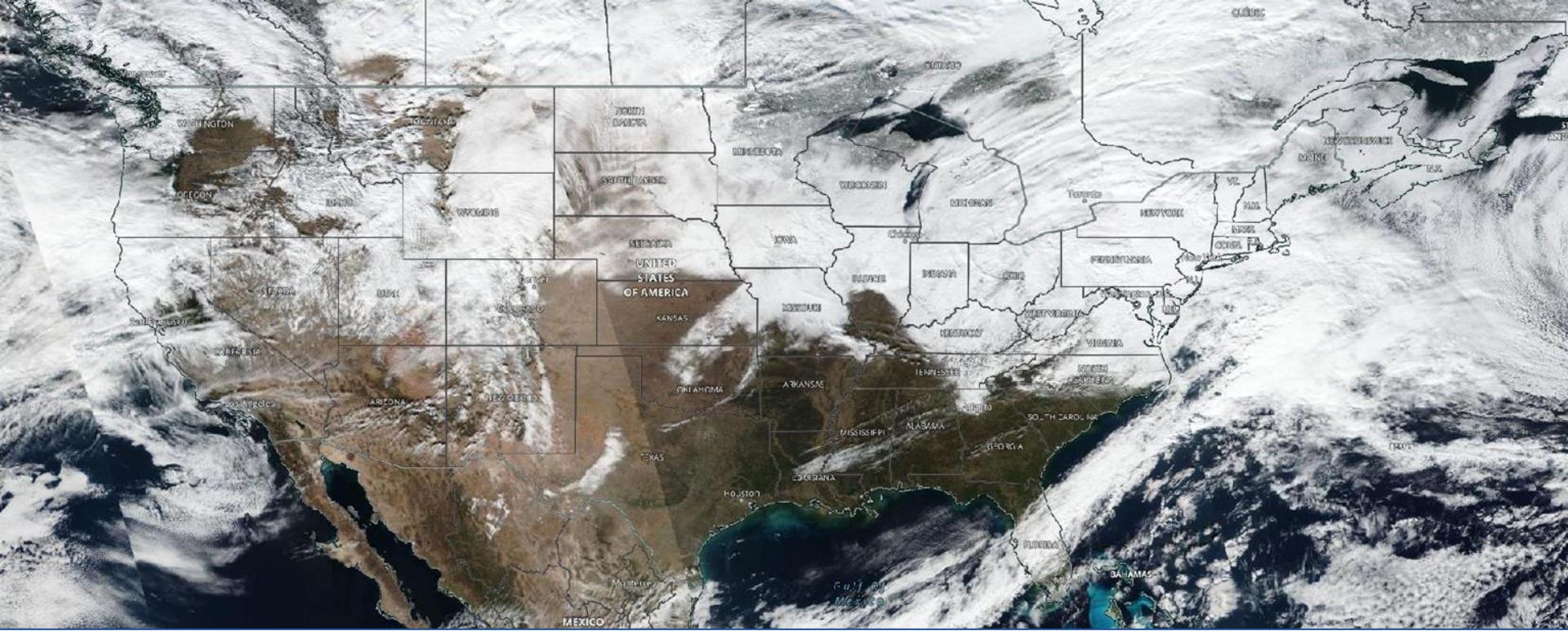
## Objective

Provide an additional tool by which to quantify the extent and qualify the type of ice present in CONUS and Alaskan rivers

Provide forecasters with additional situational awareness, enhancing forecasts, warnings, and preventing loss of life

Incrementally improve the method with close collaboration and coordination with field offices





Average day in winter in North America....

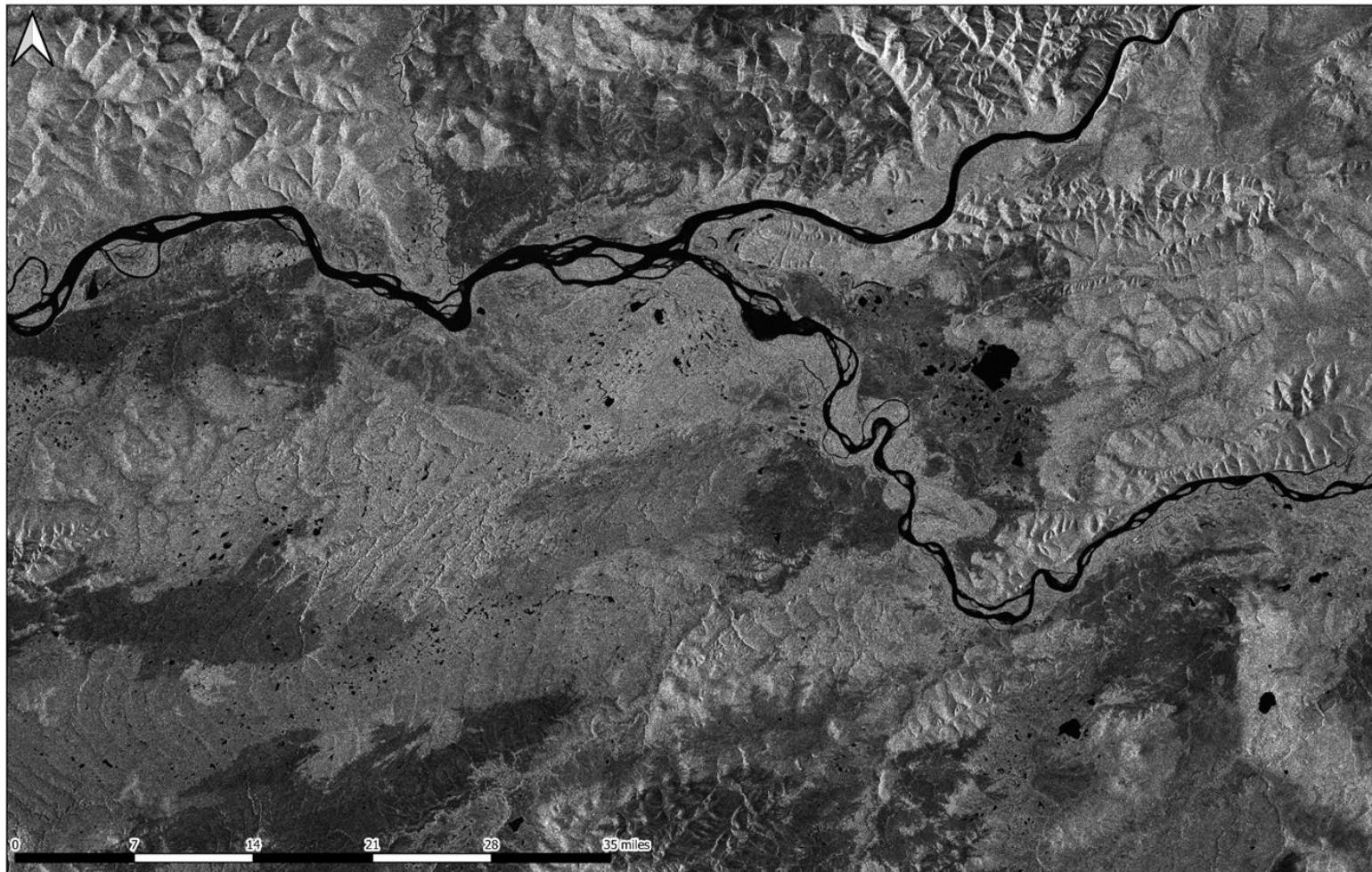




Sentinel-1 Co-Pol

Sentinel-1 Image Time: 2021-07-23 03:37:25 UTC  
Confluence of the Yukon and Tanana Rivers, Alaska

NWC | National Water Center



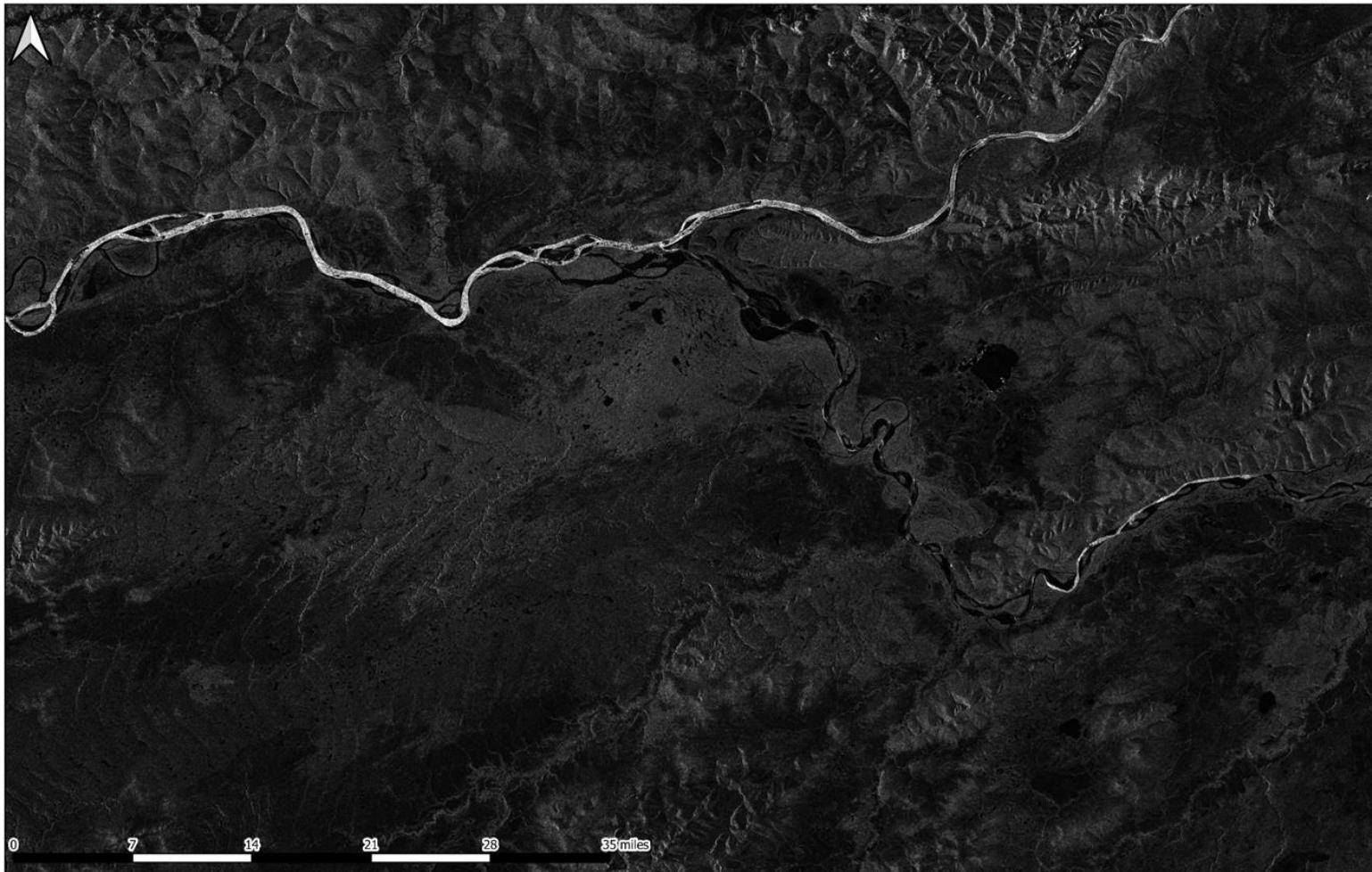
Copernicus Sentinel data 2021. Retrieved from ASF DAAC 08 July 2021, processed by ESA.



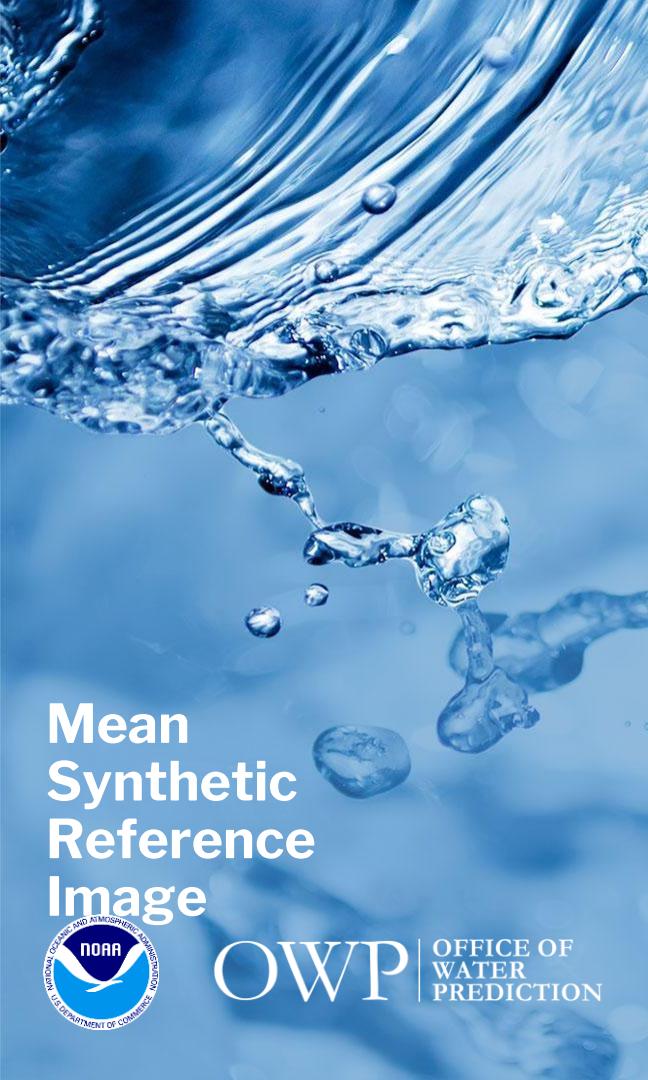
Sentinel-1 Co-Pol

Sentinel-1 Image Time: 2021-12-14 03:37:27 UTC  
Confluence of the Yukon and Tanana Rivers, Alaska

NWC | National Water Center



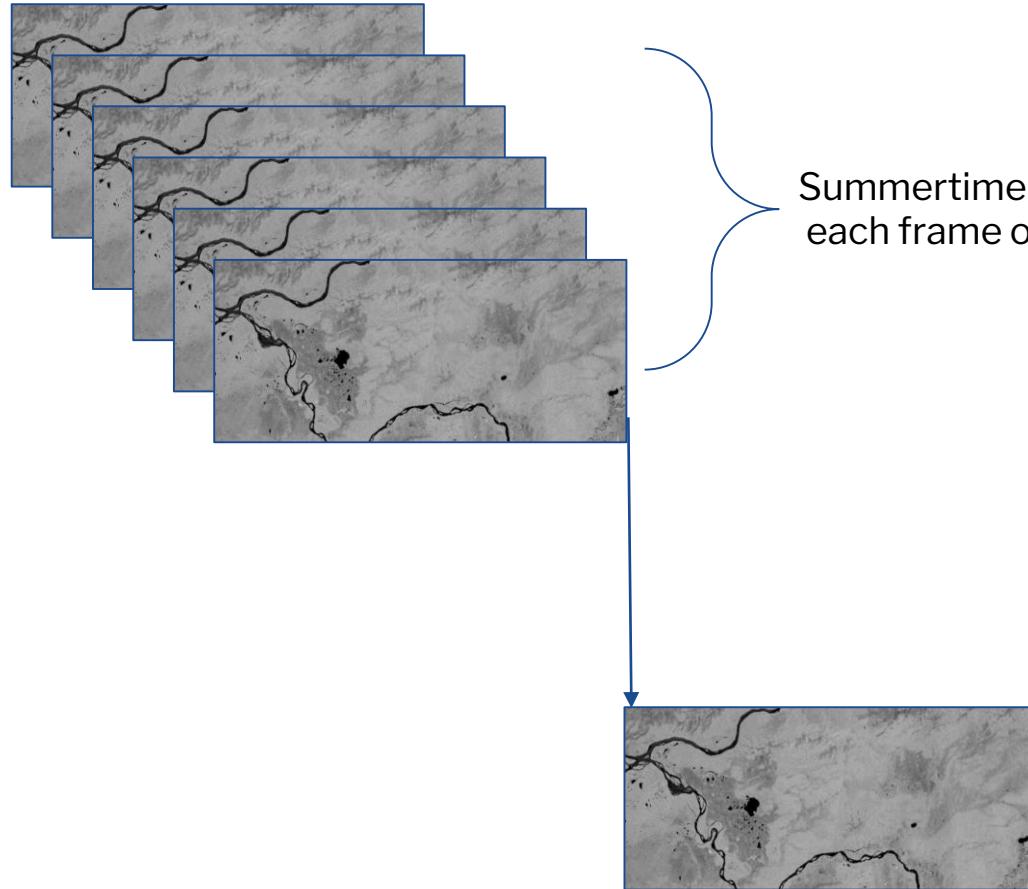
Copernicus Sentinel data 2021. Retrieved from ASF DAAC 15 December 2021, processed by ESA.



# Mean Synthetic Reference Image



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WATER PREDICTION



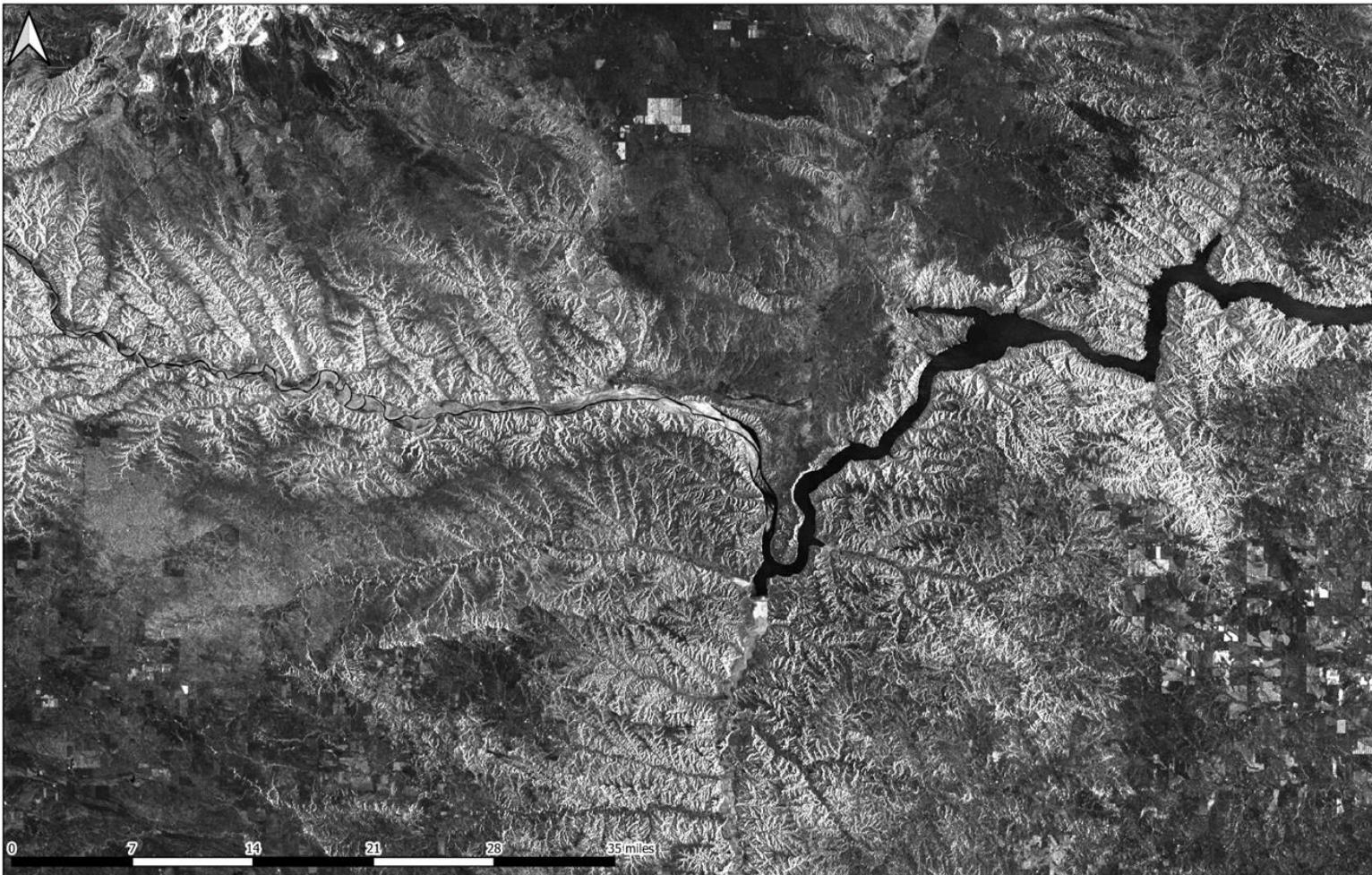
Summertime images of  
each frame of each orbit

Per pixel mean of all images



**Sentinel-1 Synthetic Reference Image**  
Mean Pixel Value: 2021-06-01 through 2021-07-31  
Missouri River at the Fort Peck Lake Headwater

**NWC** | National Water Center



ASF DAAC 2015,  
contains modified  
Copernicus Sentinel  
data 2021, processed  
by ESA.

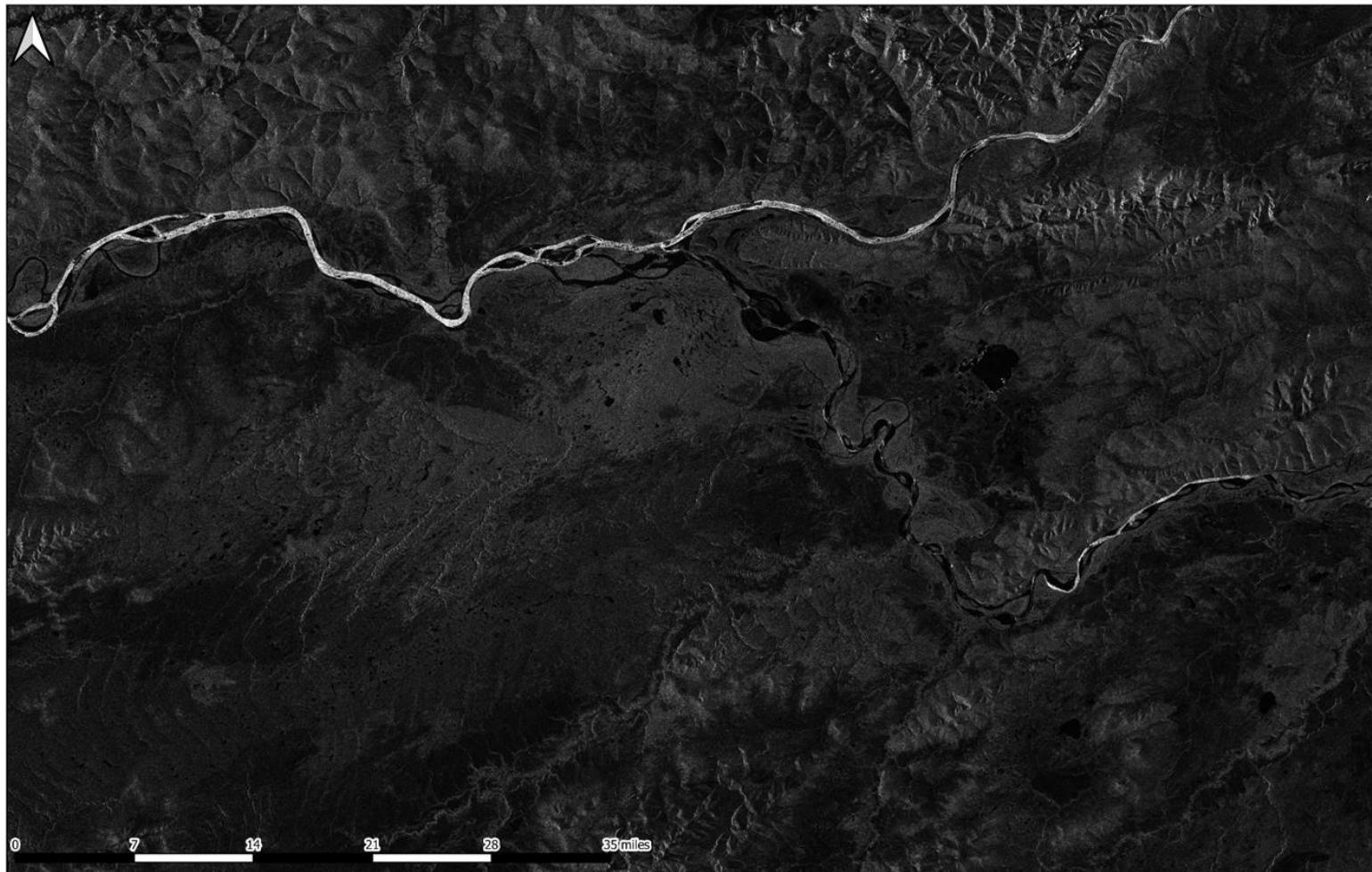




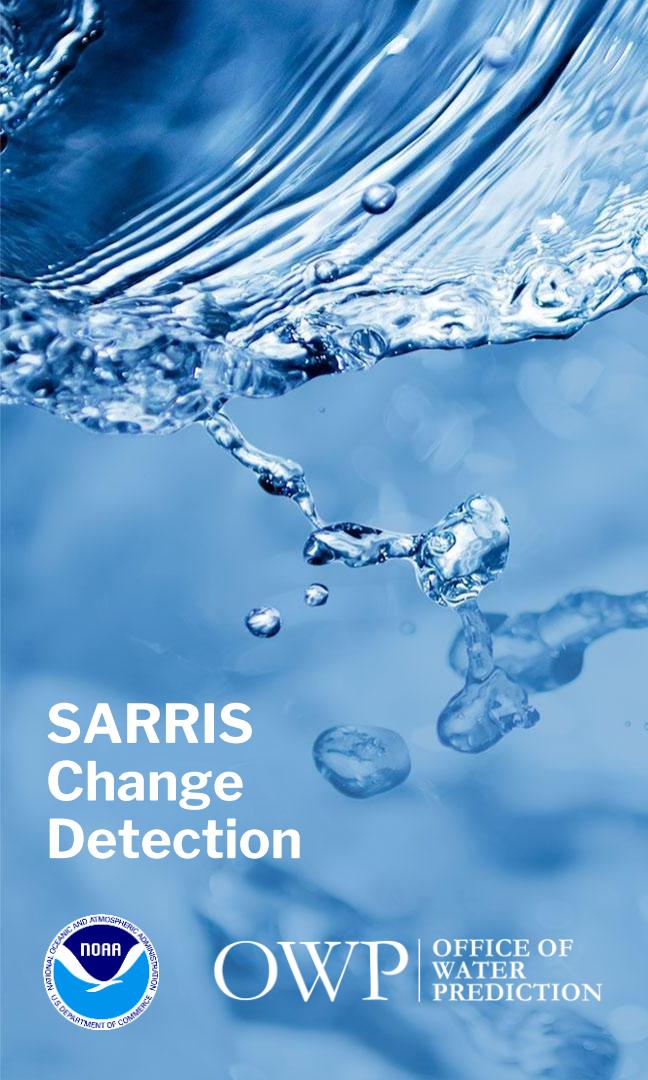
Sentinel-1 Co-Pol

Sentinel-1 Image Time: 2021-12-14 03:37:27 UTC  
Confluence of the Yukon and Tanana Rivers, Alaska

NWC | National Water Center



Copernicus Sentinel data 2021. Retrieved from ASF DAAC 15 December 2021, processed by ESA.

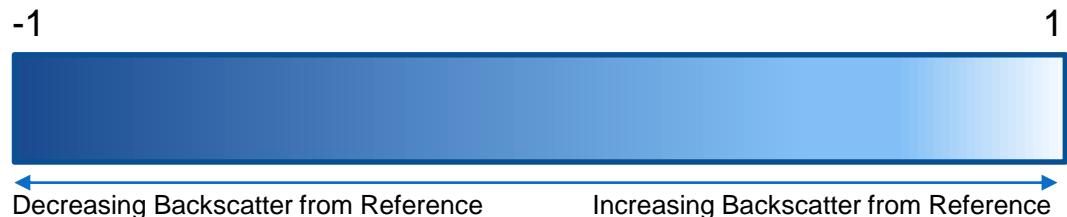


# SARRIS Change Detection



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$$\frac{(\Sigma_0_{Current} - \Sigma_0_{Reference})}{(\Sigma_0_{Current} + \Sigma_0_{Reference})} = [-1, 1]$$

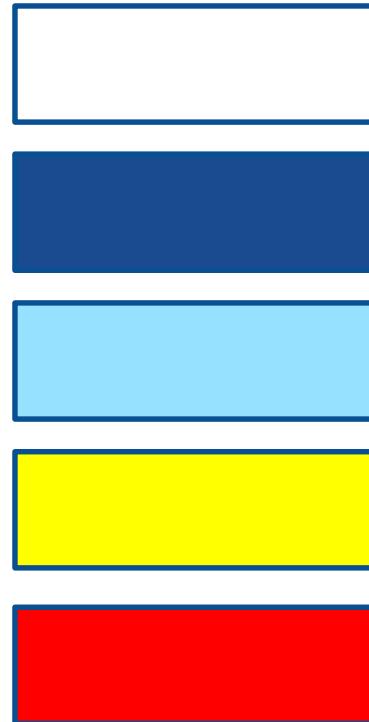




# SARRIS Classifications



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-1.0 to 0.05 (No Data)

0.05 to 0.50 (Open Water / Thin Ice)

0.5 to 0.75 (Wet Ice)

0.75 to 0.95 (Frazil / Fractured / Pan Ice)

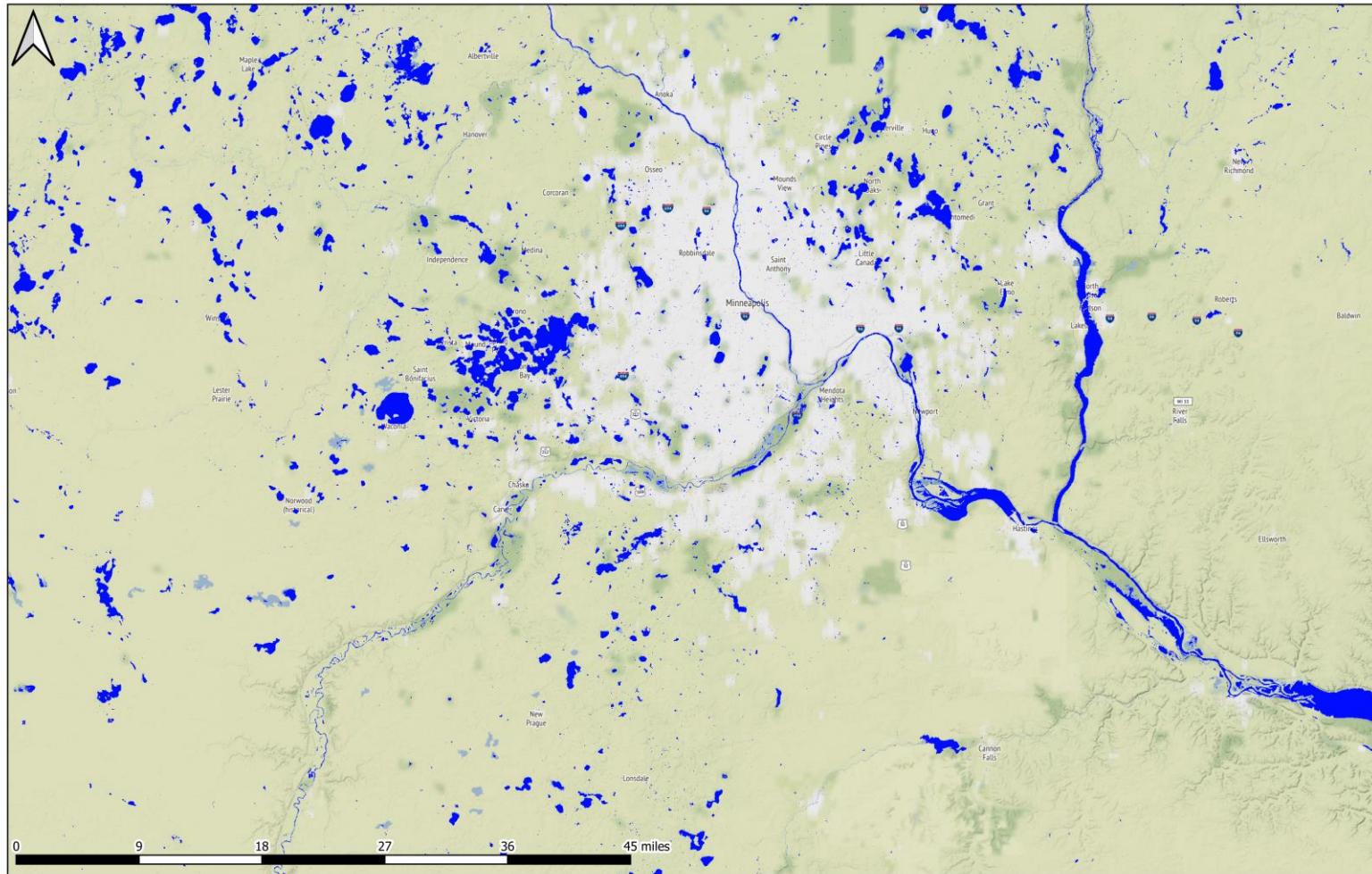
0.95 to 1.0 (Jumbled Ice)

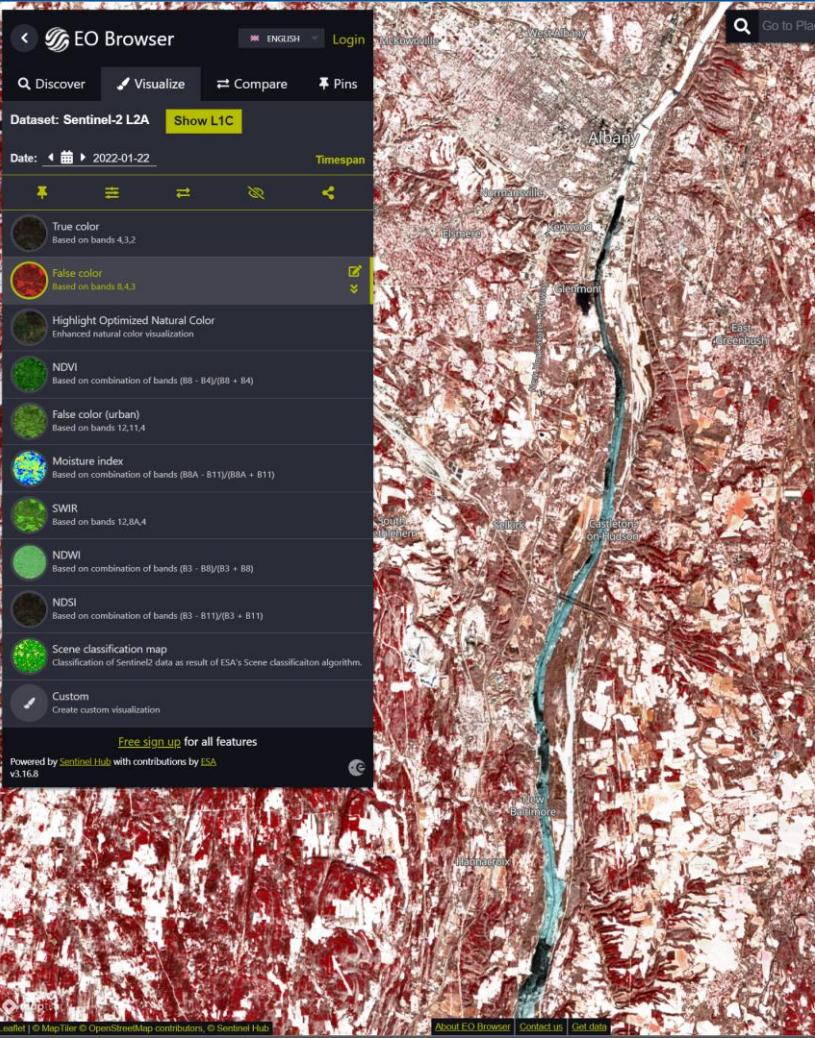
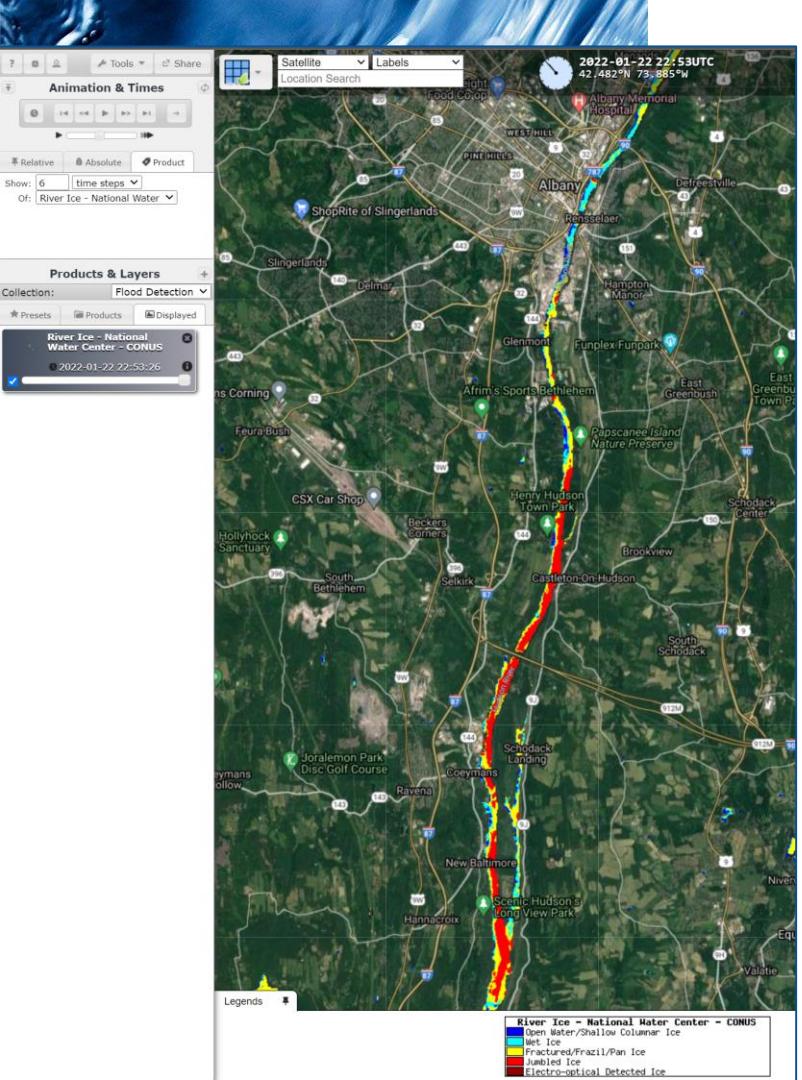


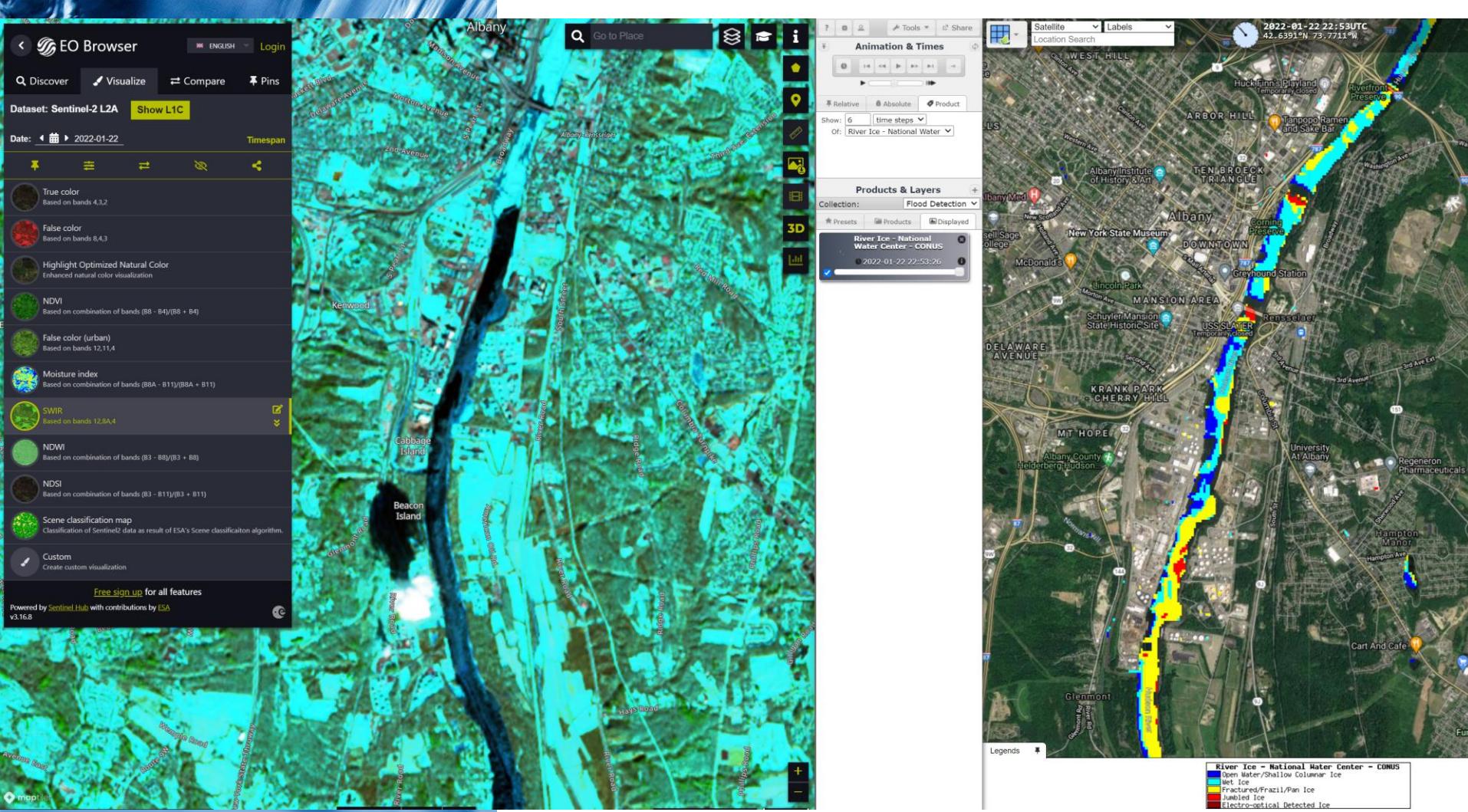
## NWC Sentinel-2 Derived Water Mask

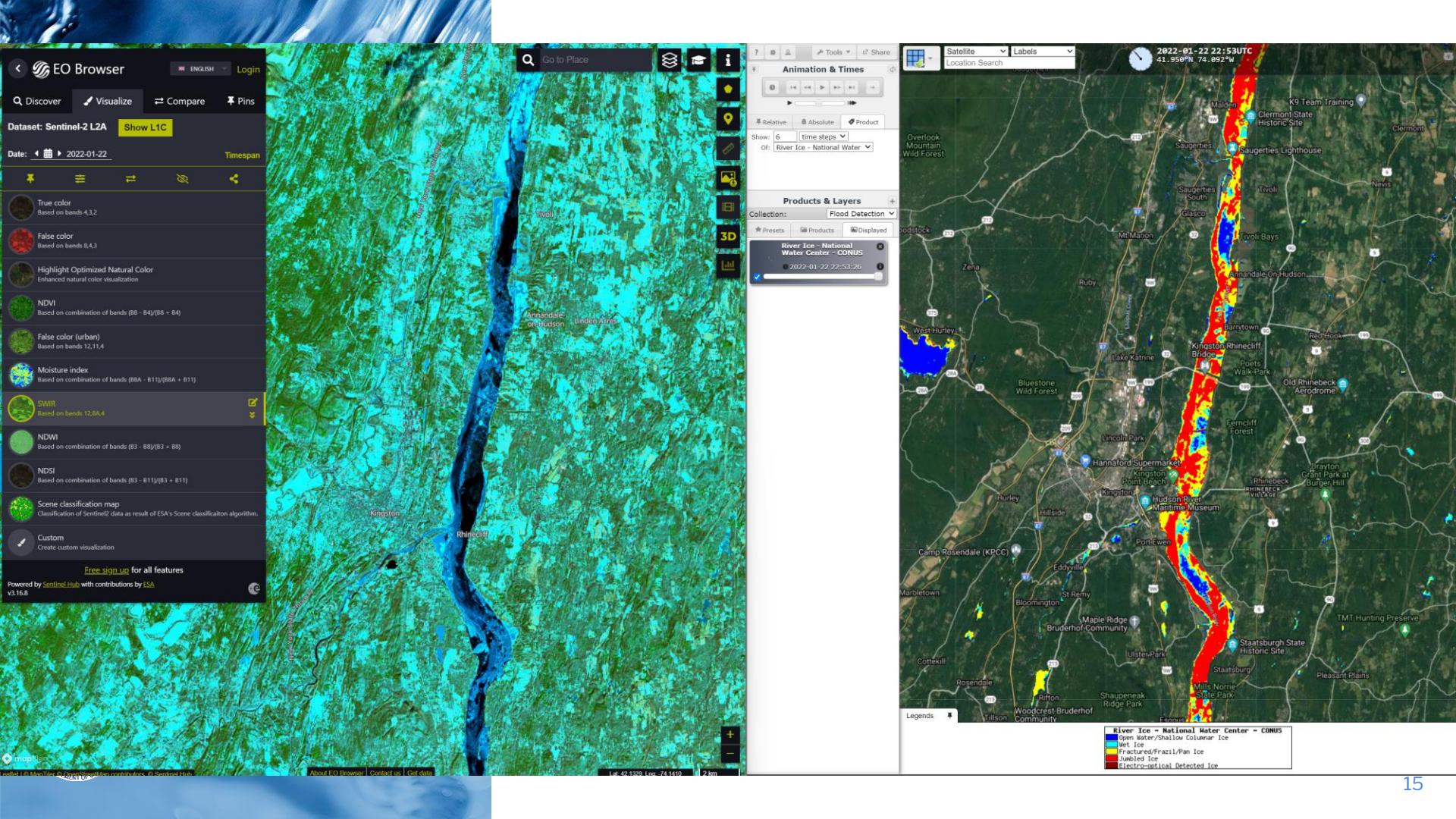
Minneapolis, MN

NWC | National Water Center





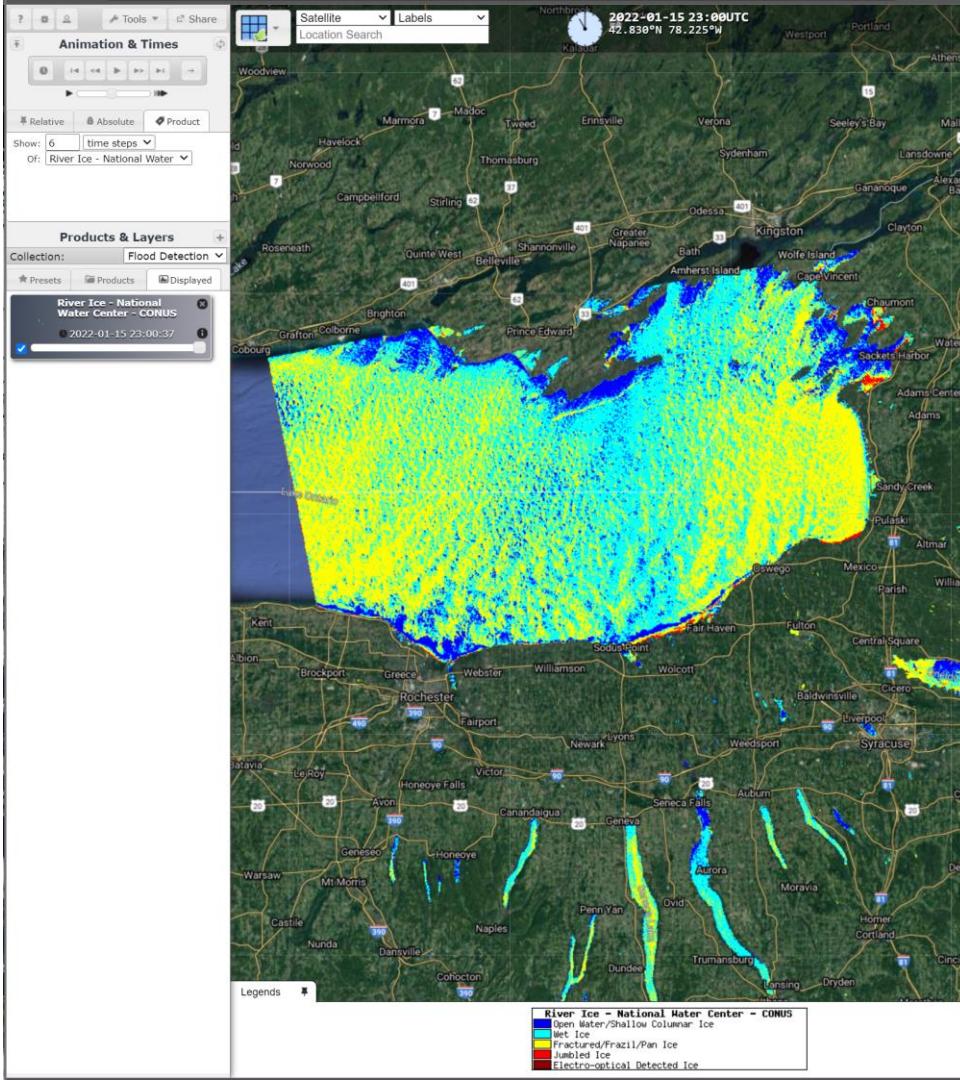


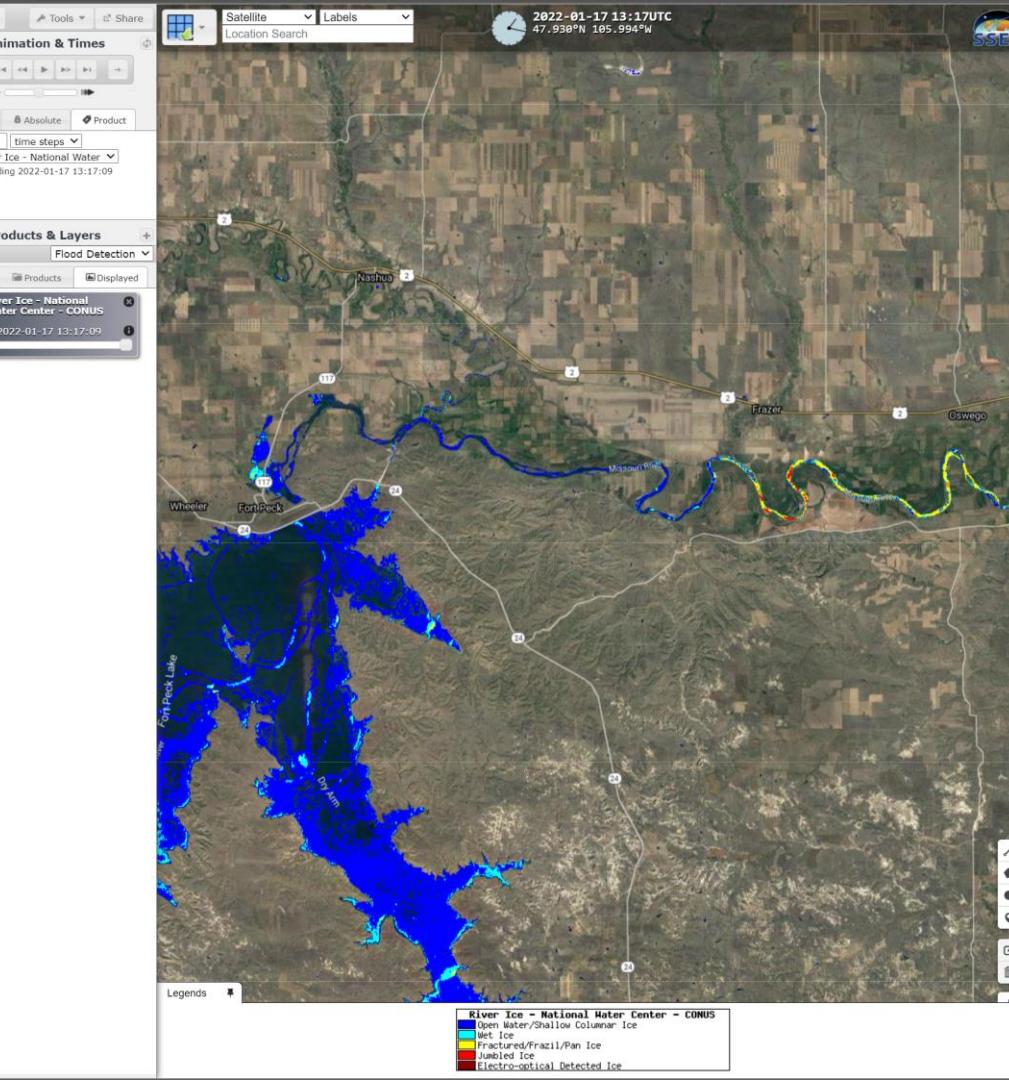




Wind and limited intelligence of radar

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## January 18, 2022 Analyst Discussion

River Ice - National Water Center	
Open Water/Shallow Columnar Ice	
Wet Ice	
Fractured/Frazil/Pan Ice	
Jumbled Ice	
Electro-optical Detected Ice	

\*\*THIS IS AN EXPERIMENTAL PRODUCT. NOT FOR OFFICIAL USE.\*\*  
Using the method shown above, please select 2022-01-17 13:17:09 UTC.



The Winter Hydrology and Remote Sensing Desk here at the National Water Center processed a Sentinel-1 swath over portions of Montana and Wyoming with the main rivers of interest being the Missouri, Yellowstone, and Bighorn rivers. Sentinel-2 imagery was either unavailable or cloud covered for the Missouri and Yellowstone and thus was not used to assist in the analysis. The analyst discussion is based solely off of the SARRIS classifications for those locations.

**Missouri:** SARRIS classifies the [Missouri from Fort Peck Lake to Culbertson, MT](#). The first 25 miles of the river downstream of Fort Peck Lake are classified to be ice free and this is confirmed by Sentinel-2 imagery. Further downstream, ice classifications begin to pick up and are mostly in the [wet ice and fracture/frazil/pan classification slots](#), though there are some jumbled ice signatures. No AHPS gauges along this stretch are demonstrating ice effects.

**Yellowstone:** SARRIS classifies the Yellowstone from near [Billings, MT to just upstream of Marsh, MT](#). Overall the river appears to be either [open or smooth ice](#) near Billings, MT and then stronger classifications begin to appear as you move further downstream with several areas of [fractured/frazil/pan and jumbled ice](#) classifications. The only AHPS gauge that I see with ice effects was the Miles Cities gauge a few days ago.



# *Thank You!*

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<https://water.noaa.gov>

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