

Detailed open water and partial inundation maps of the Yukon-Kuskokwim Delta, Alaska

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Motivation

The rapid warming of the Arctic and sub-Arctic regions induces profound changes in the hydrological dynamics of these ecosystems, with cascading impacts on local communities, wildlife, and greenhouse gas (GHG) feedbacks. Remote sensing has been instrumental in mapping surface water and monitoring changes over multi-year timescales. However, the analysis of hydrological change is often limited by spatial resolutions that are too coarse to capture small ponds (<0.01 km²), which are considerable sources of methane emissions and crucial habitats for vertebrates. Moreover, the temporal revisit rates of many satellite platforms, coupled with persistent cloud cover, result in a limited number of usable observations in any given year.

We used **PlanetScope** imagery to map **open water and partial inundation** in the Yukon-Kuskokwim Delta, AK at a 3m spatial resolution and sub-weekly frequency.

Planned Products

	climatological composite masks	monthly composite masks	vector database
open water	✓	✓	✓
partial inundation	✓	✓	

Applications

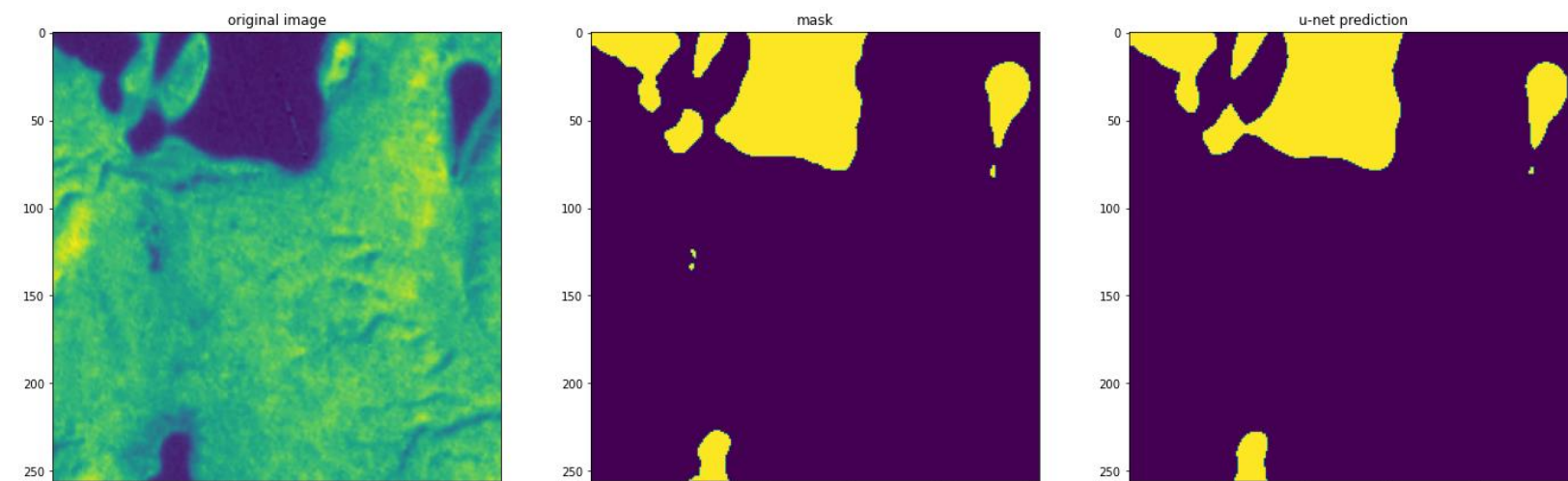
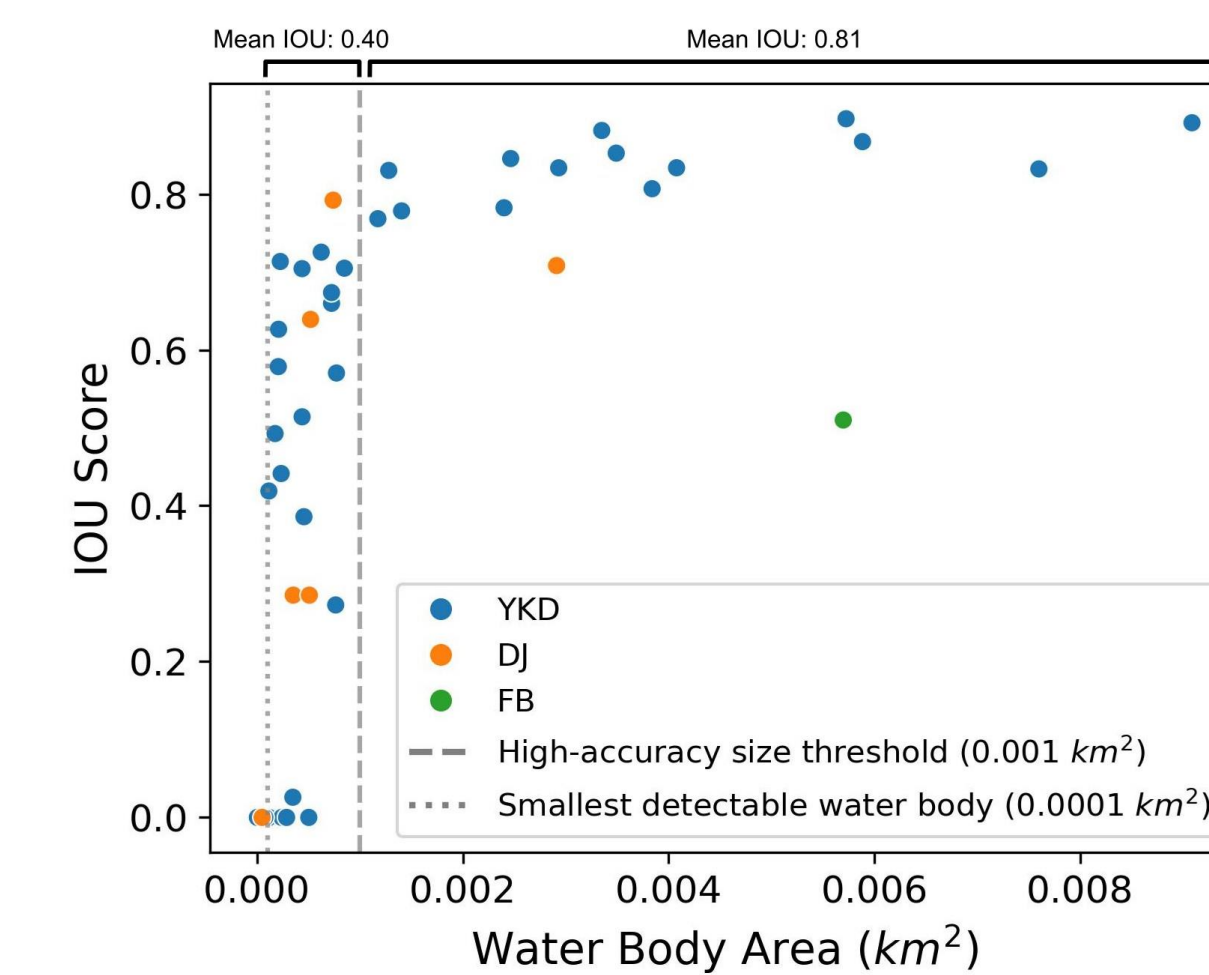
- Greenhouse gas emissions upscaling and process-based modeling
- Community risk assessment
- Waterfowl modeling

Acknowledgements

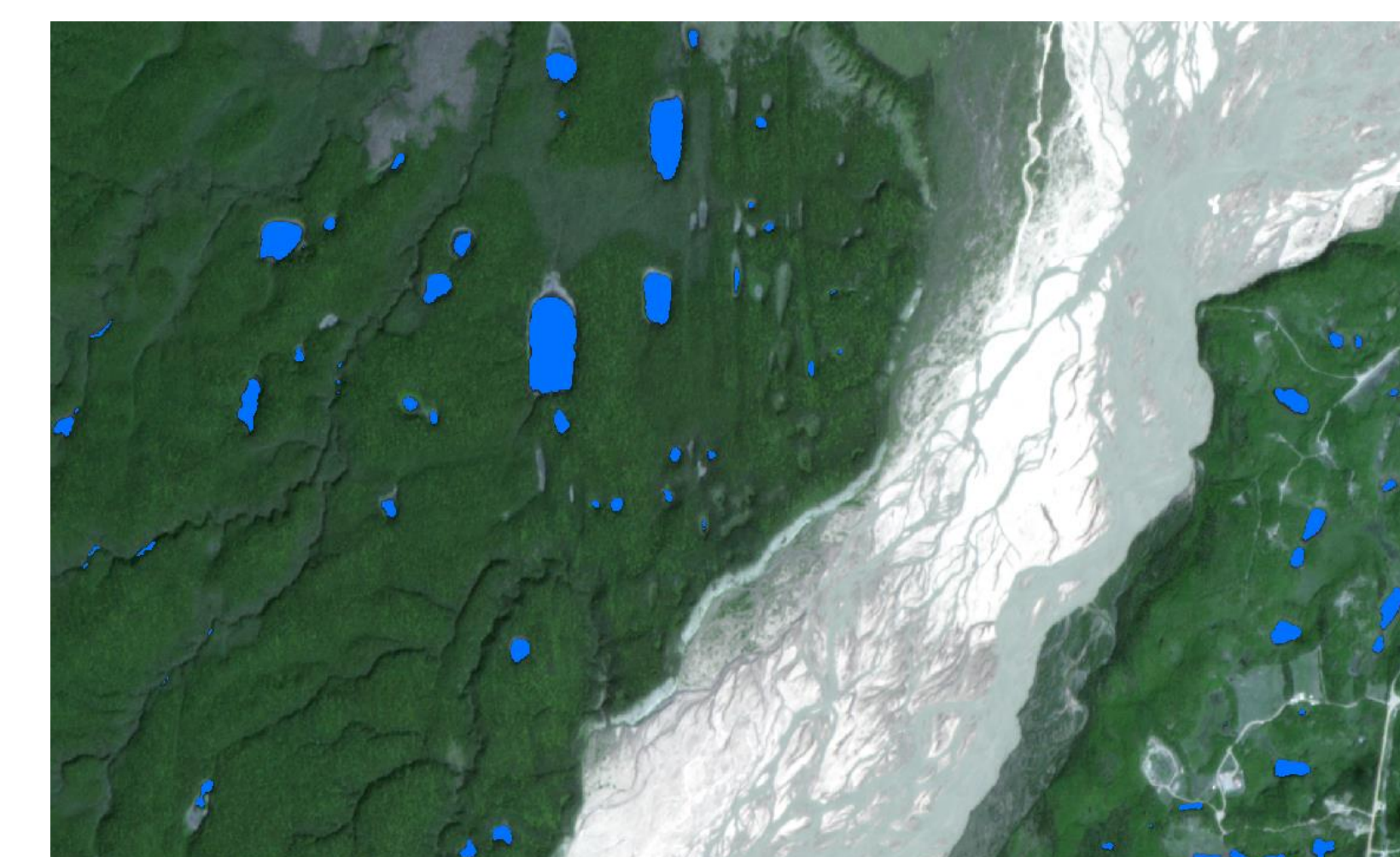
The Yukon-Kuskokwim Delta is located in the traditional lands of the Yup'ik people. Funding for this work was provided by a NASA CSDA grant (80NSSC23K1455). Planet Labs imagery was provided through the CSDA program.

Open water lakes and ponds

A convolutional neural network (U-Net) was trained to detect lakes and ponds in **3m PlanetScope imagery**. The model was trained on > 14,000 delineated water bodies across the AK boreal forest and tundra. The U-Net was validated and determined to **detect lakes and ponds > 100 m²**. The model was trained to detect only lakes and ponds, **ignoring rivers**.

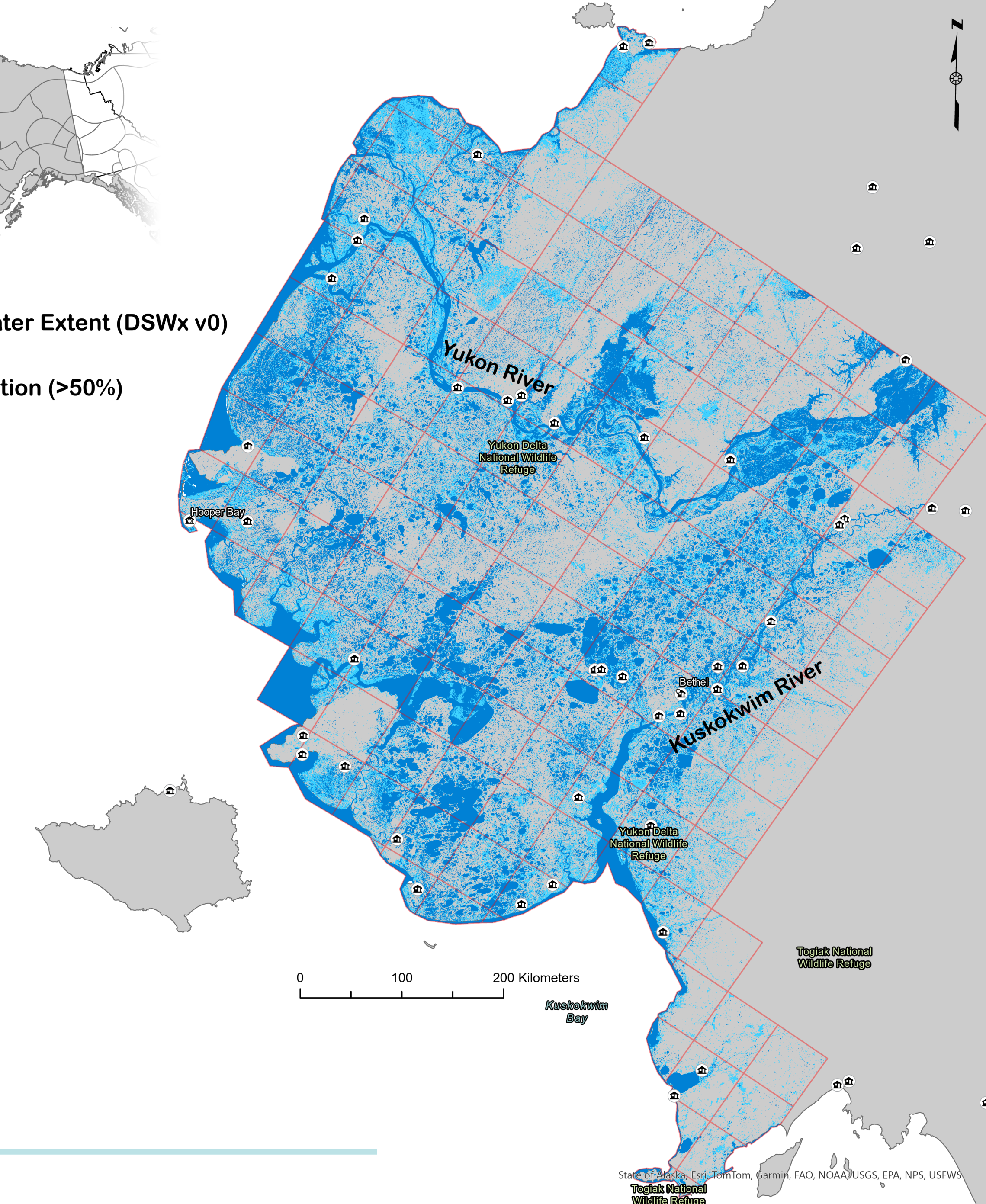


Example of PlanetScope image (left), hand-delineated open water mask (center), and U-Net open water prediction (right).



Example of PlanetScope-based water mask (blue).

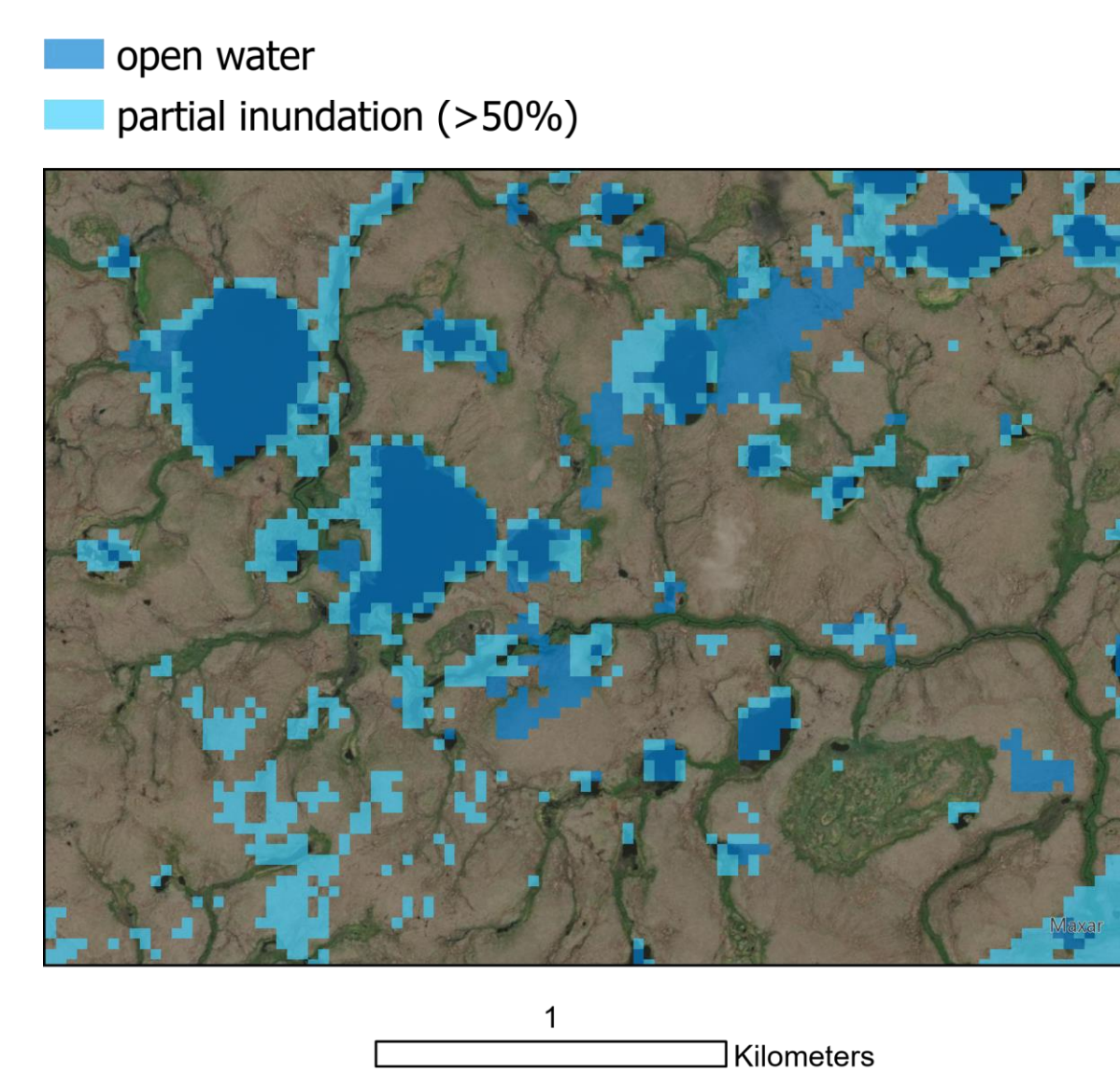
Dynamic Surface Water Extent (DSWx v0)
■ open water
■ partial inundation (>50%)
 * Native Village
 □ ABoVE Tiles



Partial inundation

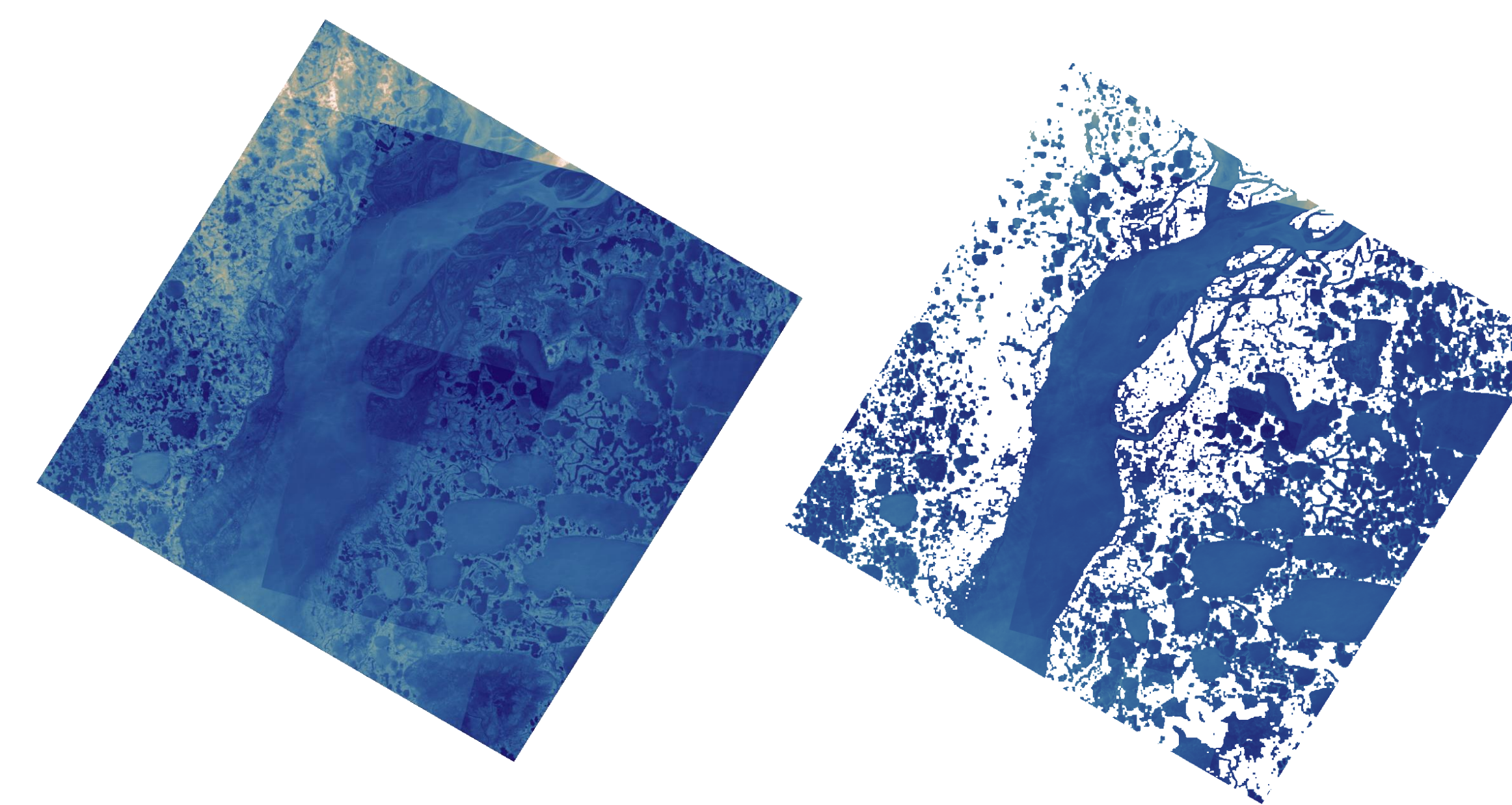
Step 1: DSWx

- Dynamic Surface Water Extent (DSWx v0) from OPERA
- Based on Harmonized Landsat-Sentinel (HLS; 30 m)
 - Created mosaic for YKD using union of all images (2023 - Present)
 - Open water and partial water (> 50%)



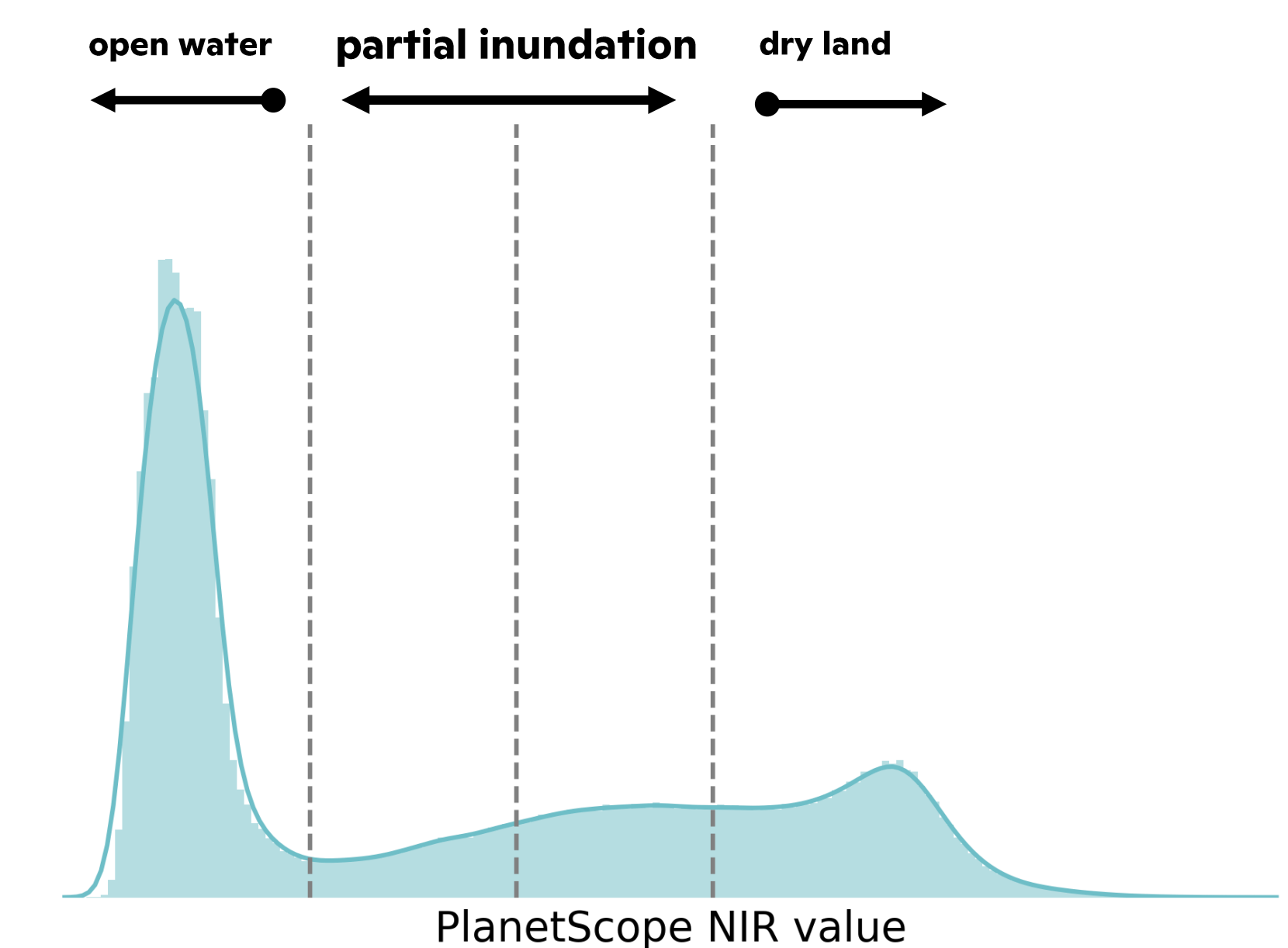
Step 2: Mask Planet Image

- Dilated DSWx map to buffer open water and partial inundation by 60 m
- Masked Planet images with buffered DSWx map

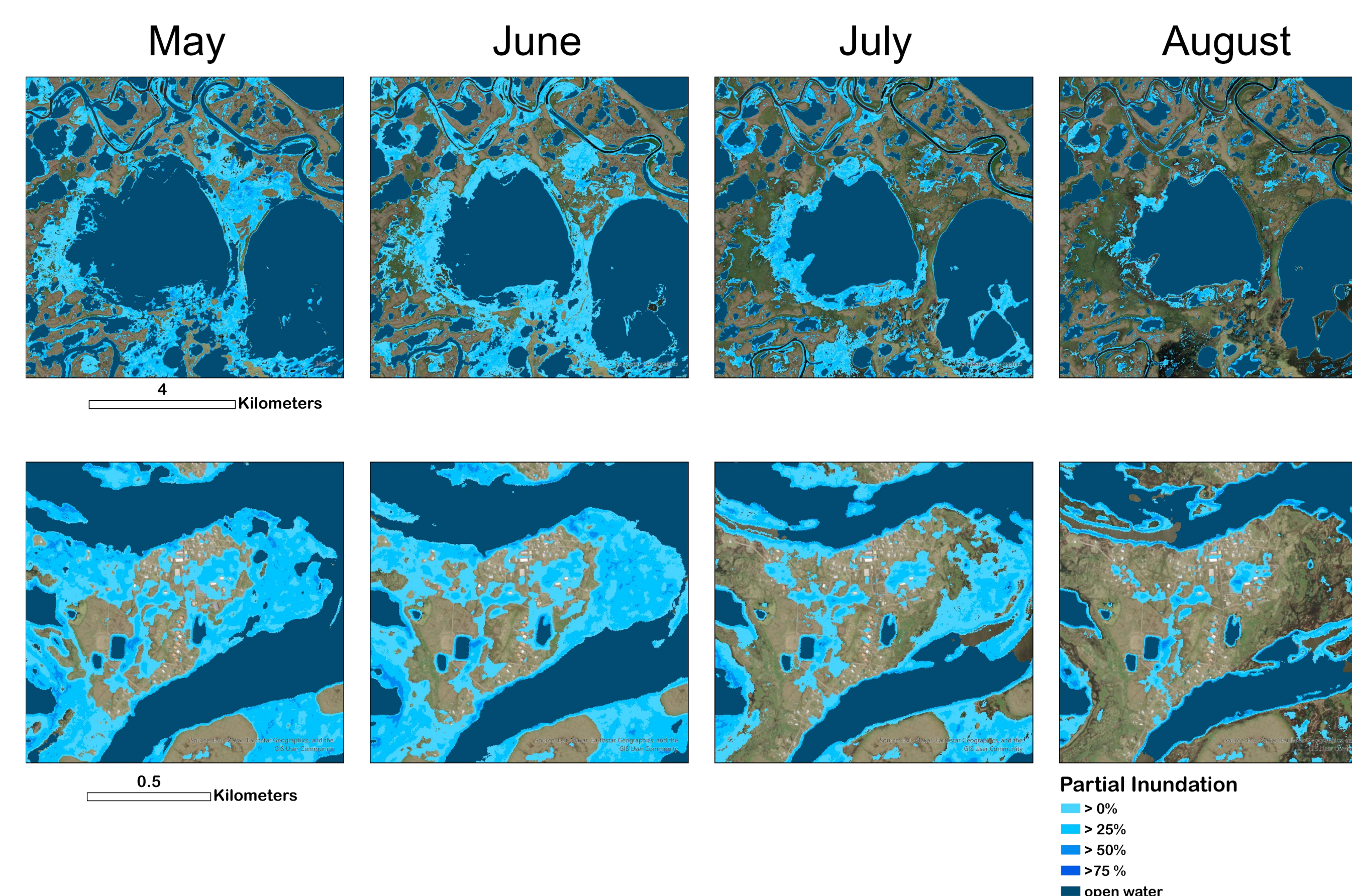


Step 3: Unsupervised classification

- Uses Otsu thresholding to detect boundaries for fractional water in histogram of Planet NIR band
- Experimented with NDWI, but NIR yields best results



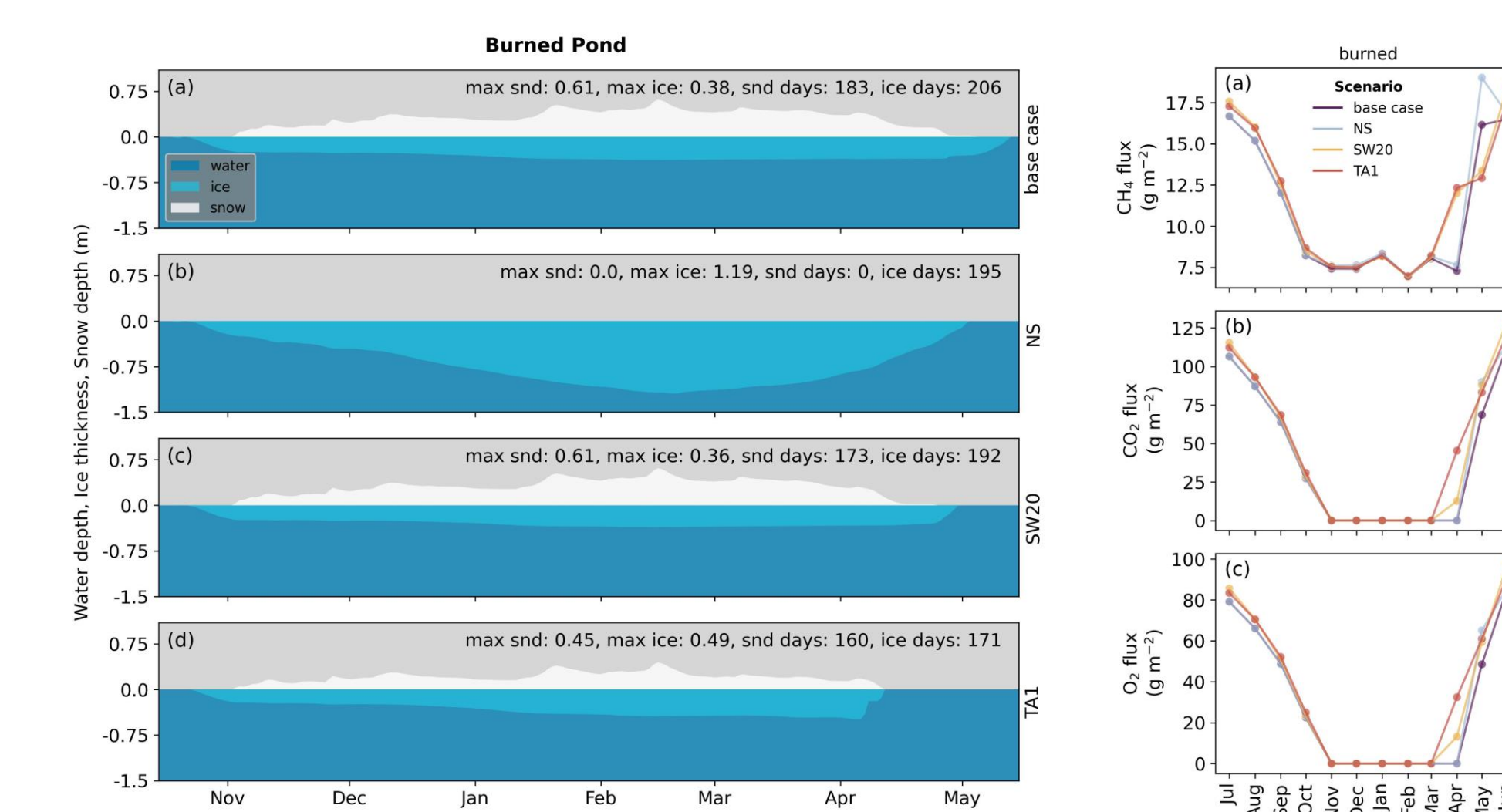
Water maps



Pitfalls and Improvements

- Rivers confuse U-Net detection of open lakes and ponds
- Very bright areas (development, unmasked snow, ice and clouds) and dark areas (shadows from buildings, terrain, trees) often falsely detected as partially inundated
- SAR (Sentinel-1) based wetland product could improve Planet masking, thresholding, and resulting fractional water maps

Modeling integration



A fully-coupled, thermal-biogeochemical model (LAKE) has been calibrated for two ponds in the Yukon-Kuskokwim Delta. Future work will leverage process-based model simulations and new high-resolution surface water products to scale modeling efforts and improve aquatic carbon budgets.