Ocean Surface Topography Science Team Meeting, June 2026 Wiesbaden

High-Latitude Lake and River Dynamics: Altimeter products from the Global Water Measurements System

Charon Birkett[1], Martina Ricko[2], Hunter Yang [2]
With collaborators Dave Bjerklie[3], Curt Reynolds[4], Dan Shugar[5]
[1] NASA/GSFC Greenbelt MD, [2] KBR at NASA/GSFC
[3] US Geological Survey, [4] USDA/FAS, [5] University of Calgary

National Aeronautics and Space Administration

Background

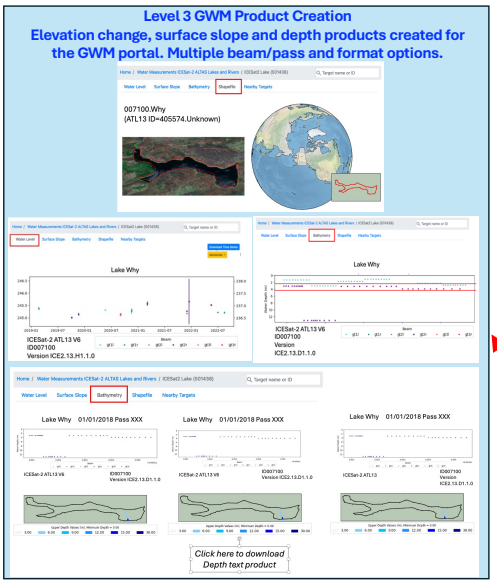
High-latitude surface water dynamics are complex, fast, and driven by snow, ice, and permafrost. Modeling efforts that look to understanding the mechanisms, and to predicting the variability due to natural processes and climate change, often lack the basic hydraulic measurements, and the frequency of current observations are spatially and temporally poor. Satellite altimetry missions serve both the science and applied science sectors, and each mission contributes to the archive of global measurements. The ICESat-2 ATLAS laser altimeter system is recording surface elevations to ±88˚ latitude, monitoring surface water levels across all seasons, and with an unprecedented along-track spatial resolution. The ground-track density, particularly at high latitudes, and the simultaneous operation of 6 lasers, also offers an increase in spatial coverage compared to other profiling altimeters. While elevation is the primary parameter, the river-reach bank-to-bank super-elevation (surface gradient) and the flow direction river channel gradient can be derived. For water of a particular clarity, the water depth can also be retrieved. The SWOT mission contributes a nadir-altimeter to the current operational suite, plus the swath-based KaRIn instrument. With a spatial resolution that is finer than the profiling radar altimeters, and an ability to record simultaneous elevation and extent (or width) measurements, KaRIn also has advantages. Both ICESat-2 and SWOT-KaRIn therefore are helping to supplement, enhance and cross-validate, the measurements from the suite of profiling radar altimeters. Here, we look to high-latitude lakes and river reaches. Most are within the State of Alaska or the Yukon and British Columbia Provinces where gauge deployment is sparse. While water dynamics (e.g., investigating the changes in channel morphology or assessing the complexities within large, braided, river reaches) are of scientific interest, the monitoring of water elevation and status (ice to water transitions) are important for analyzing flood risks. Such flood events have the potential to effect downstream communities, damage infrastructure, and delay the transport of goods. Observation of superelevation (bank-to-bank surface gradient) and depth are useful parameters for post-flood analysis and for assessing general changes to water resources and ecological conditions. The monitoring of lake extents and river widths also serves in the reconstruction of lake hypsometry and contributes to the determination of river discharge. Both ICESat-2 and SWOT supplement the profiling continuity radar instruments by providing measurements at high latitudes and on a more global coverage. The quantity and quality of the ICESat-2 and SWOT-KaRIn parameters though needs to be fully explored with careful consideration given to mission time spans, mission continuity, and speed of dataset availability. These must be assessed before local and government stakeholders adopt the new satellite observations and integrate these high-latitude parameters into their current decision support systems that often have operational capability. Here, emphasis is on a wide range of lake types including glacial lakes prone to ice dams, a series of small shallow lakes within an Arctic National Wildlife Refuge, and the large lakes along the Aleutian Peninsula. Where available, measurements from Sentinel-3, Sentinel-6 and the SWOT-NA, together with ground sources, serve as cross-validation sources. All Level 3 profiling and swath-altimeter products are being posted at the NASA Global Water Measurements portal (https://earth.gsfc.nasa.gov/gwm).

ICESat-2 elevation, surface gradient, depth products

GWM products on-line by September 2026

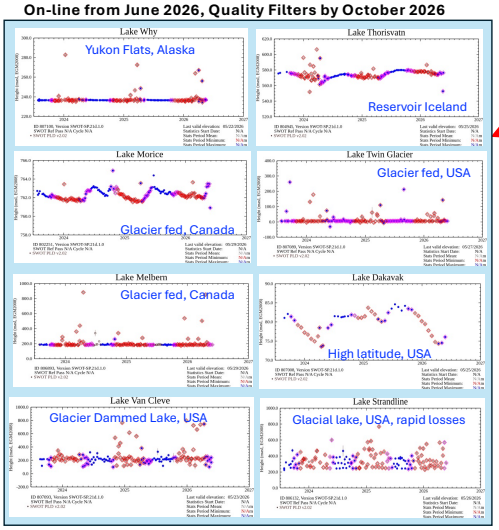
Level 3 GWM Product Creation

Elevation change, surface slope and depth products created for the GWM portal. Multiple beam/pass and format options.



SWOT-KaRIn elevation products

On-line from June 2026, Quality Filters by October 2026

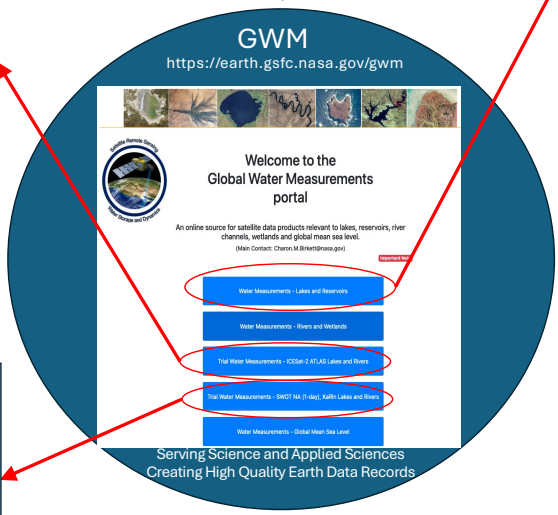


Target Identification – Science and Applied Science Application

Studying Glacial Lake Outburst Floods and River Dynamics
River Dynamics after ice or glacial melt flood events
Tourism, Wetland Ecology, Wildlife and Fish Habitat, Transport

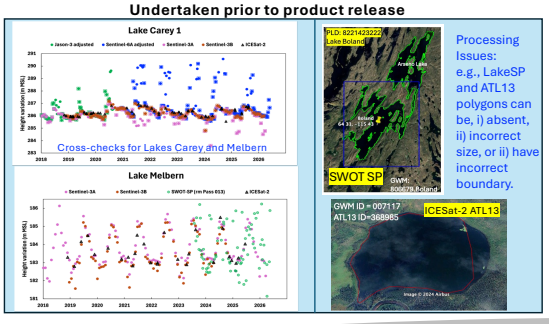
Target Specific Pass or Polygon Identification

Singe beam radar altimeters – the selection of 1 overpass
Multi-beam ICESat-2 – selection of pass and polygon within ATL13
SWOT-KaRIn - selection of polygon within LakesSP



All-sources Cross-validation Efforts

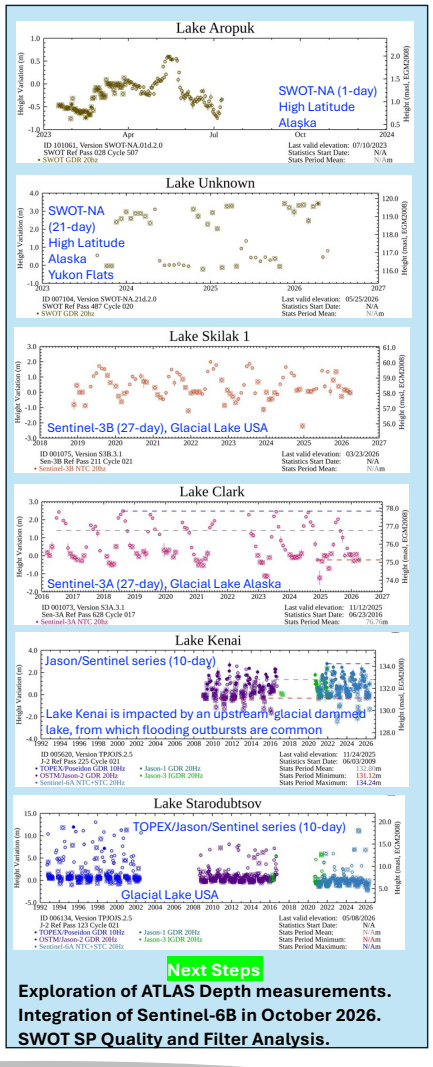
Undertaken prior to product release



Processing Issues: e.g., LakeSP and ATL13 polygons can be, i) absent, ii) incorrect size, or ii) have incorrect boundary.

Nadir Altimeter elevation products

Operations using Sentinel-3A, Sentinel-3B, Sentinel-6A, and SWOT-NA
Historical archive from TOPEX/Poseidon and the Jason series



Next Steps

Exploration of ATLAS Depth measurements.
Integration of Sentinel-6B in October 2026.
SWOT SP Quality and Filter Analysis.

Contact

Dr. Charon Birkett
Charon.M.Birkett@nasa.gov

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