



# Global Water Monitor

## Operational monitoring of lakes, wetlands, and river reaches for Natural Hazards and Regional Security

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Supported by NASA Applied Sciences/Water Resources

- a) Integration of Remotely Sensed Streamflow Data into Alaska Water Resources Management Agency Operations
- b) Remotely Sensed Water Storage for Agriculture and Regional Security



## End User Focus?

Include agriculture (crop production numbers/status) and fisheries (catch potential), but also natural hazards (drought and flood), and “stress indicators” associated with dwindling food, water, and power supply – highlighting the first stages of regional instability that may have national and international implications.

## Data Requirements are variable Stakeholders also look for.....

A Long Heritage with Validated Techniques

Real Time to Archive Data

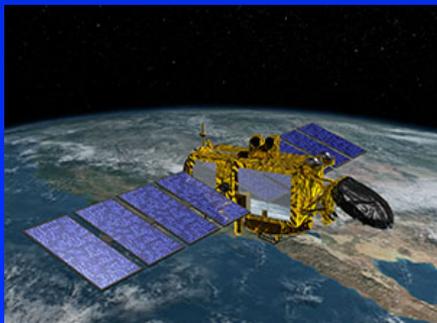
Monthly sampling or better

Continuous Global Monitoring

Fast response to data issues

&

Mission Continuity





# Continuity and Enhanced Technology

## ← Continuity of Short-term Repeat →



Jason-3

2016-2021



Sentinel-3A

2016 (+2023)



Sentinel-3B

2018 (+2025)



Sen-6A/MF

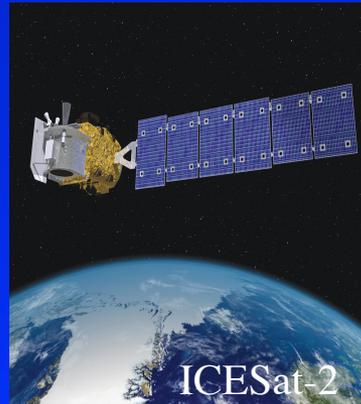
2020 (+2025)

## ← Data Fusion - Mapping & Enhancements →



CryoSat-2

2010



ICESat-2

2018



GEDI

2018



SWOT

2021



## GREALM

[https://ipad.fas.usda.gov/cropexplorer/global\\_reservoir/](https://ipad.fas.usda.gov/cropexplorer/global_reservoir/)

## Global Water Monitor

<https://water-watch.sgt-inc.com/> (Temporary Location)

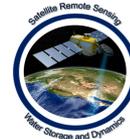


## Welcome to the Global Water Monitor

A prototype online source for satellite data products relevant to lakes, reservoirs, river channels, wetlands and global mean sea level.

(Main Contact: [Charon.M.Birkett@nasa.gov](mailto:Charon.M.Birkett@nasa.gov))

**Important Note**



Water Monitor - Lakes and Reservoirs

Water Monitor - Rivers and Wetlands

Water Monitor - Global Mean Sea Level



# The Satellite Radar Altimetry Processing Chains

## Continental water and mean sea level products in parallel



### Mean Sea Level – mm precision

1-2month Operational Deliveries to PO.DAAC

(Non-gridded) mission/cycle specific mean sea level anomalies.  
Plus global mean sea level rise product

Project management, product queries, ATBD

25yr global mean sea level estimation (reference)

Glacial Isostatic Adjustments

Cross-validations, cf tide gauges for instrument drift, upgrades

25yr co-linear mean sea surface variations

GDR Flags for global ocean mask

Geo-referenced time-tagged altimetric parameter databases for oceans

Sea State Bias

Global Ocean Tide Model (Richard Ray)

Marine Geoid Model (e.g. DTU15)

Radiometer Correction

1Hz GDR

(+Future Coastal retracking via ALES)

← GSFC Precise Satellite Orbits →

Ingestion of Satellite Data Sets and Geophysical Parameters, and parameter database creation

### Lake Level Anomalies – cm accuracy

Archive and Weekly Operational Delivery to USDA

Specific Lake/Reservoir Products

Project management, product queries, ATBD, most task inputs

Software/Web development

Cross-validations, upgrades

25yr lake level variations

Satellite Pass identification

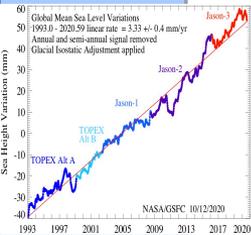
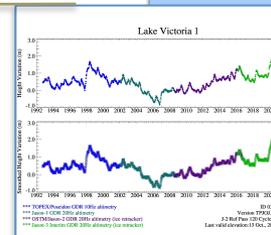
Lake identification

Geo-referenced time-tagged altimetric parameter databases for continents

RADS Atmospheric Corrections  
Static Geoid Model e.g. NGA)

20Hz IGDR/GDR

(+Future Land retracking via SDR)





# Lakes/Reservoirs: Additional Lake Extent Products as a standalone monitoring parameter or combined with altimetric elevation for storage changes

NASA National Aeronautics and Space Administration

## NRT Global Flood Mapping

Data Viewer  
 Africa  
 Asia  
 Australia/NZ  
 Europe  
 North America  
 South America

Product Description  
 Documents  
 Project Summary  
 MODIS Product README  
 Evaluation Report  
 Presentations

Future Enhancements  
 News/Status

Mailing list  
 To subscribe to our mailing list to receive email notification of updates, please, click [here](#).

Global Map

10° Flood Map Tile Production

For more information, please contact floodmap at lists.nasa.gov  
**NOTE: THIS IS AN EXPERIMENTAL PRODUCT AND SYSTEM**

Recent News/Status

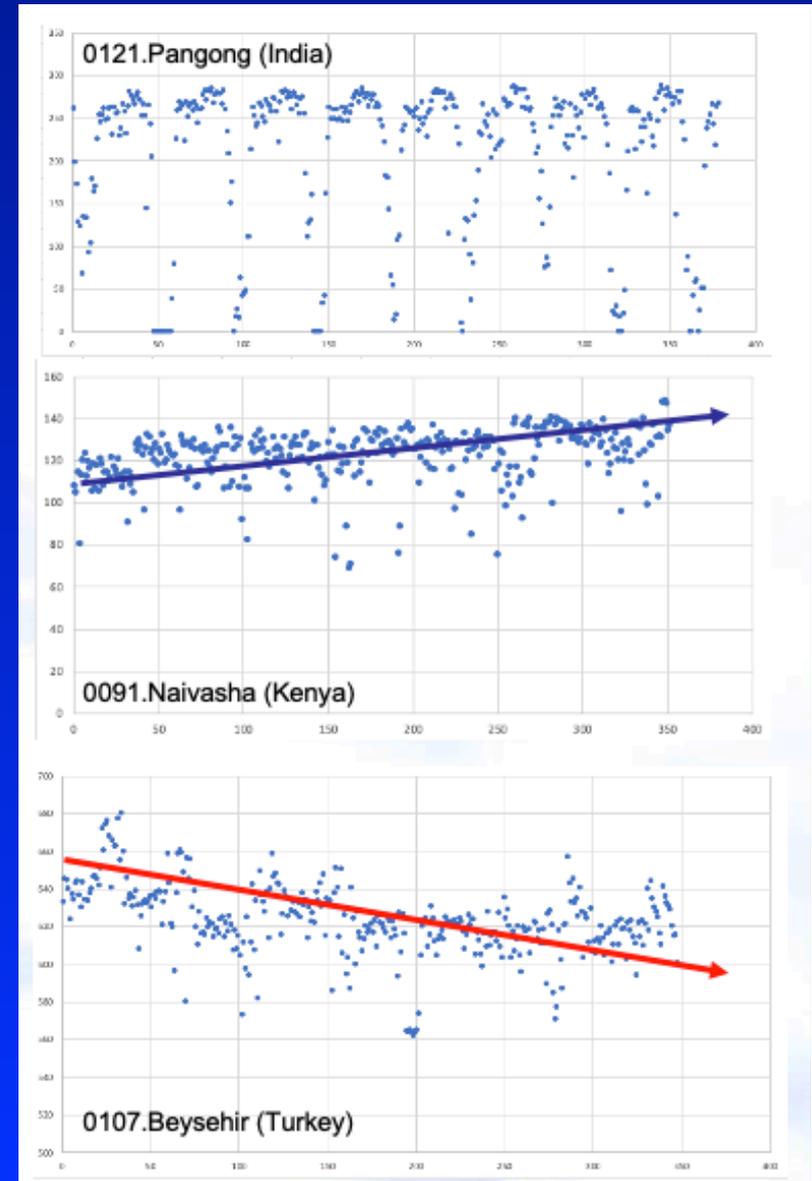
06-Sep-2018: Production interrupted from Sep 3-6th, but now proceeding normally. Missing products will be processed over the next few days (omitting vector products unless requested).  
 12-Feb-2018: Production interrupted from Feb 6-12th, but now proceeding normally. Missing products will be processed over the next few days.  
 28-Sep-2017: Full production has resumed, with some continuing minor problems (randomly skipped tiles/products), which we hope to resolve shortly.

> Go to News/Status page

1<sup>st</sup> Phase

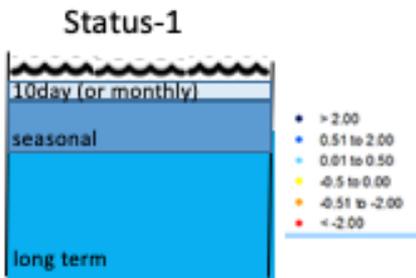
Moving forwards with the NASA Lance System i.e. the MODIS processing chain behind the NASA Near Real Time Global Flood Mapping Tool.

MODIS 250m 8-day composites

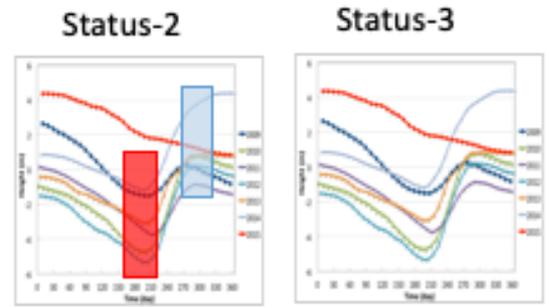




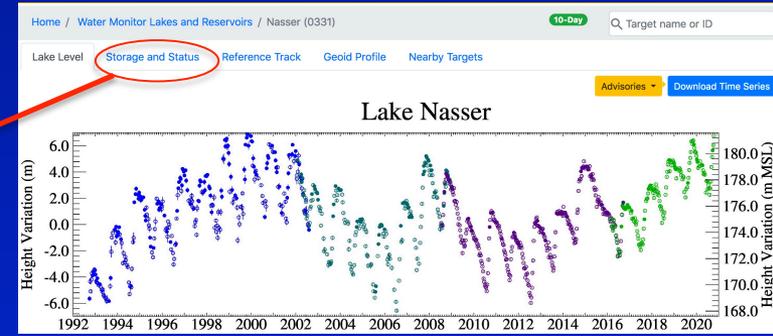
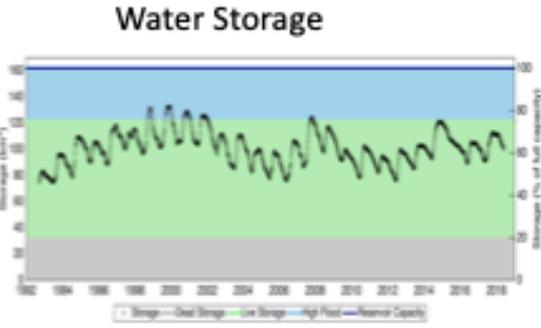
# Example of the Global Water Monitor's new lake and reservoir Storage and Status Products.



Status Source: Water Levels (or Extents)  
Seasonal Baseline: March to May  
Long-term Baseline: 1993-2000



Day-to-day comparison (Levels or Extents)      Season-to-season comparison (Levels or Extents)



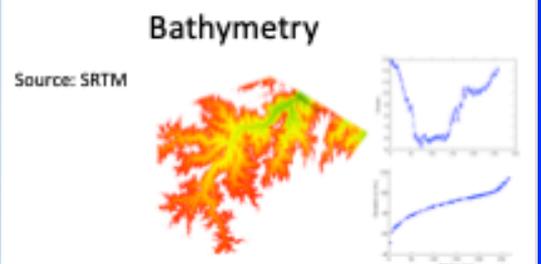
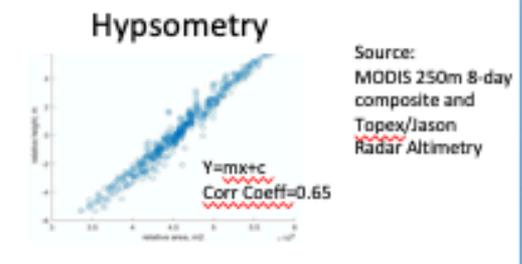
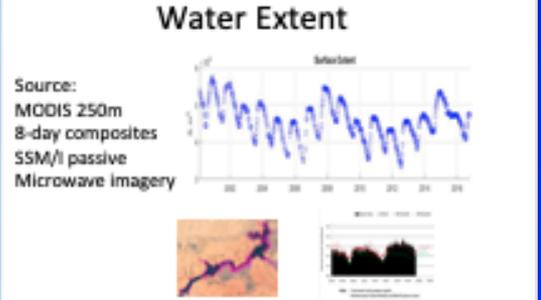
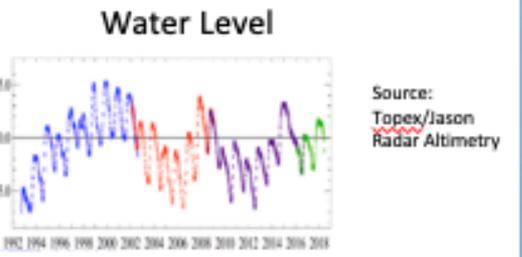
(i) Satellite-derived water level and extents  
(ii) Published storage/Level relationship (Ref, 2020)

## Responding to stakeholder requirements.

Status indicators reveal current conditions in relation to previous time periods. Can be given with respect to water levels, extents, or storage.

Storage or storage variations based on known or derived bathymetry.

For reservoirs, storage to be given in relation to known dead, live, at capacity, and flood storage values.





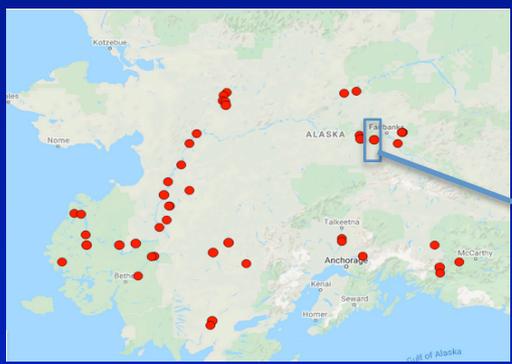
# Global Water Monitor – Portal for River Surface Water Levels

Despite it's size Alaska has few permanent gauge sites. Near real time monitoring is required for flood hazard monitoring, and for wildlife and transport considerations.

Advisories - Download Time Series

Winter ice

Braided reach



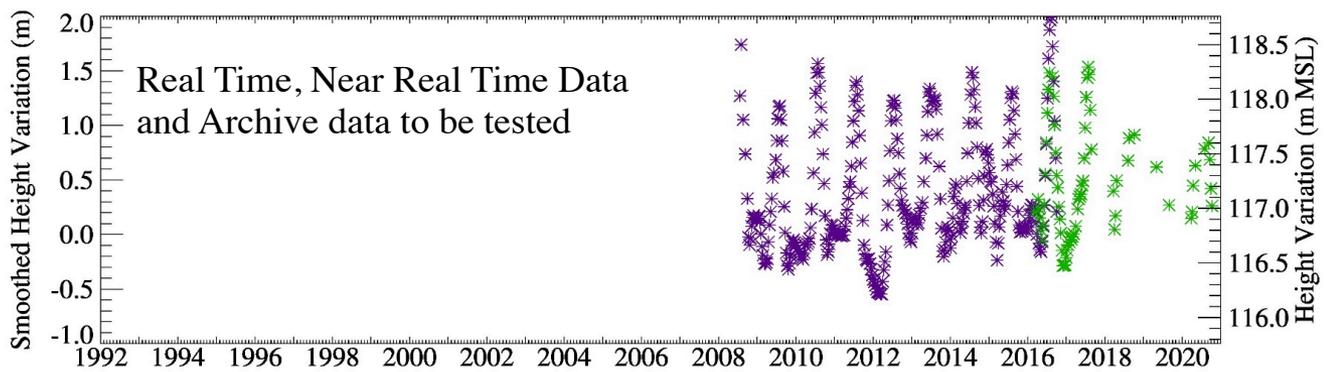
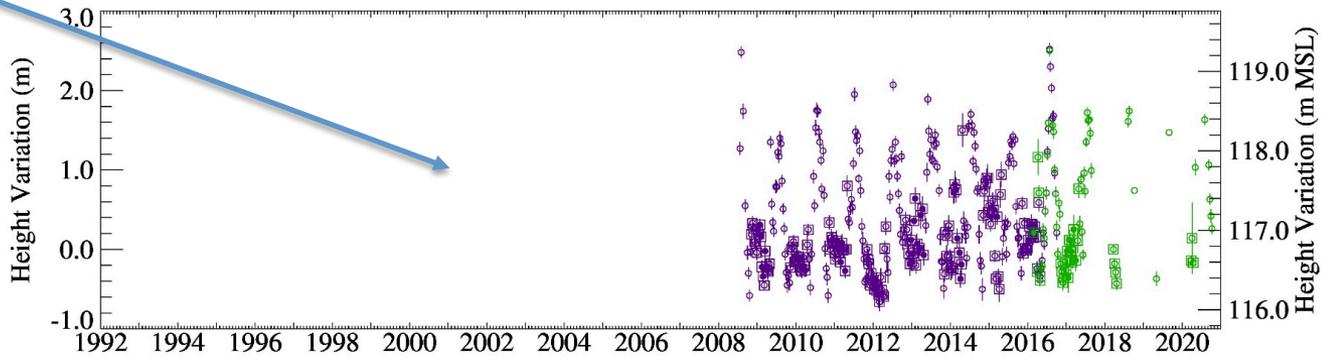
Home / Water Monitor Rivers and Wetlands / Tanana (8051)

Water Level Reference Track Geoid Profile Nearby Targets

10-Day Target name or ID

Advisories - Download Time Series

## Tanana River



Real Time, Near Real Time Data and Archive data to be tested

Name	USGS Site ID	Latitude	Longitude	Width (m)	Drainage Area mi <sup>2</sup>
<i>Sites Collocated with Existing USGS Gaging Station</i>					
Snow R. nr Seward	15243900	60.287	-149.337	50	150
Susitna R. at Gold Creek	15292000	62.774	-149.688	300	6,130
Tanana R. at Fairbanks	15485500	64.789	-147.837	900	21,000
Knik R. near Palmer	15281000	61.503	-149.030	400	1,220
Yukon R. near Stevens Village	15453500	65.872	-149.717	600	194,000
Chena R. at Fairbanks	15514000	64.840	-147.701	50	1,990
<i>Ungeaged but with Project Field Data</i>					
Copper R. at Chitna-Copper	NA	61.520	-144.410	200	NA
Yukon R. downstream of Koyukuk R.	NA	64.861	-157.856	1400	NA
Nushagak R. downstream of Ekwok	NA	59.288	-157.628	350	NA
<i>Ungeaged, no ground/field data</i>					
Koyukuk R. near Huslia	NA	65.773	-156.458	300	NA
Colville R. upstream of Umiat	NA	69.055	-153.785	1000	NA
Porcupine R. upstream of Fort Yukon	NA	66.989	-142.999	450	NA

- \*\*\* TOPEX/Poseidon GDR 10Hz altimetry
- \*\*\* Jason-1 GDR 20Hz altimetry
- \*\*\* OSTM/Jason-2 GDR 20Hz altimetry (ice retracker)
- \*\*\* Jason-3 Interim GDR 20Hz altimetry (ice retracker)

ID 8051  
Version TPJOJ.2.5.1  
J-2 Ref Pass 230 Cycle 102  
Last valid elevation: 8 Oct., 2020

## Selection of Target Reaches

Shown above are relative lake height variations computed from TOPEX/POSEIDON (T/P), Jason-1 and Jason-2/OSTM altimetry with respect to a datum that is based on a single fly-over date of the Jason-2/OSTM mission. The equivalent water elevation with respect to mean sea level (msl based on WGS84/EGM2008) is also provided. Near real time observations are being provided by Jason-3. The top graph are the processed results available for download. The bottom graph is a smoothed/filtered representation for general observation only. Open circle symbols in the top graph are potentially indicative of calm or frozen surface water. An additional square box highlights the typical freeze period based on general reports.

# Multi-Decadal Timelines important for Historical Reconstruction

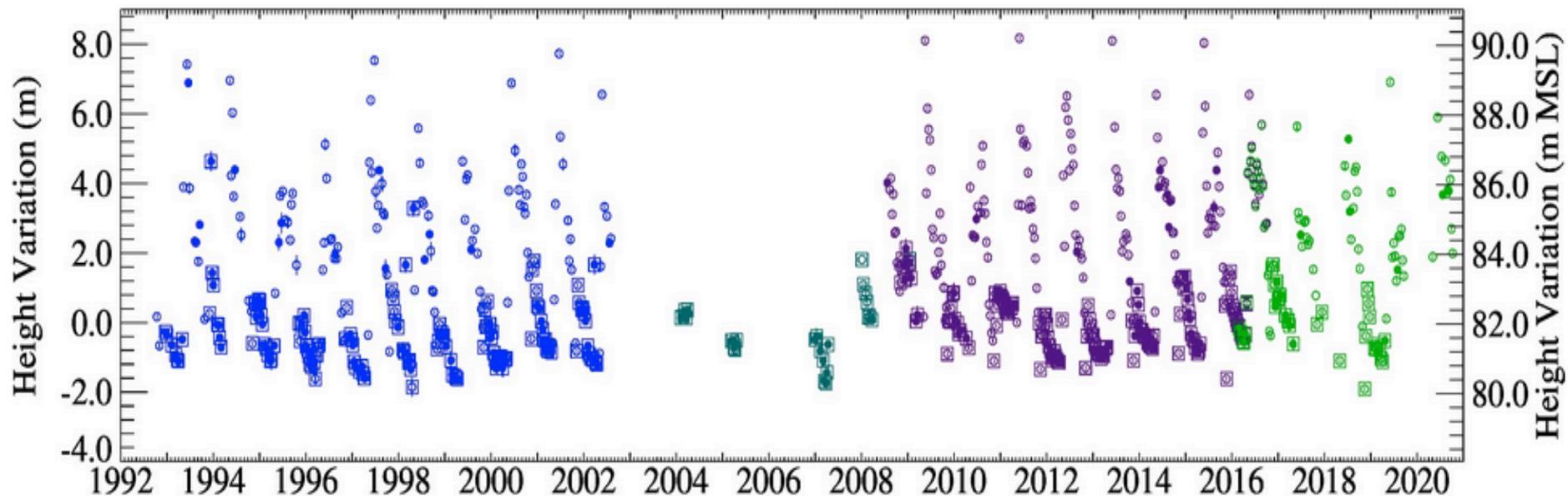


Current altimeters can be better than historical.

Some historical instruments had data collection issues (e.g. Jason-1)

Merging results from multiple platforms can be tricky especially during ice-on periods

## Yukon River



\*\*\* TOPEX/Poseidon GDR 10Hz altimetry

\*\*\* Jason-1 GDR 20Hz altimetry

\*\*\* OSTM/Jason-2 GDR 20Hz altimetry (ice retracker)

\*\*\* Jason-3 Interim GDR 20Hz altimetry (ice retracker)

ID 8000

Version TPJOJ.2.5.1

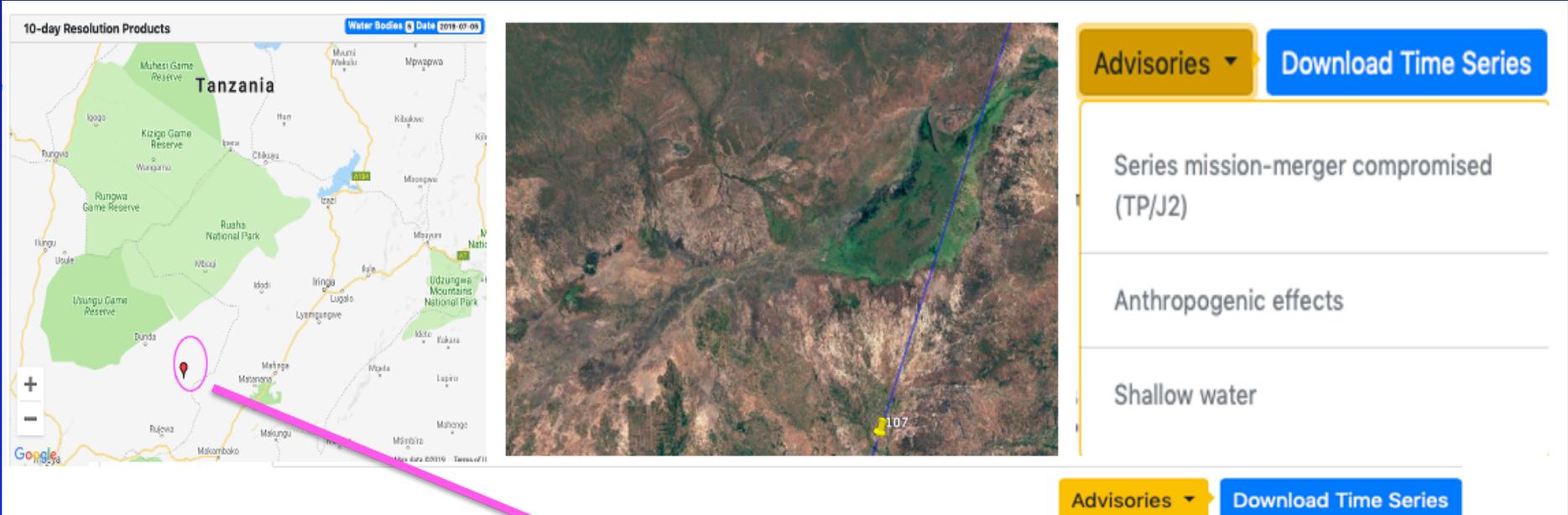
J-2 Ref Pass 227 Cycle 199

Last valid elevation: 7 Oct., 2020

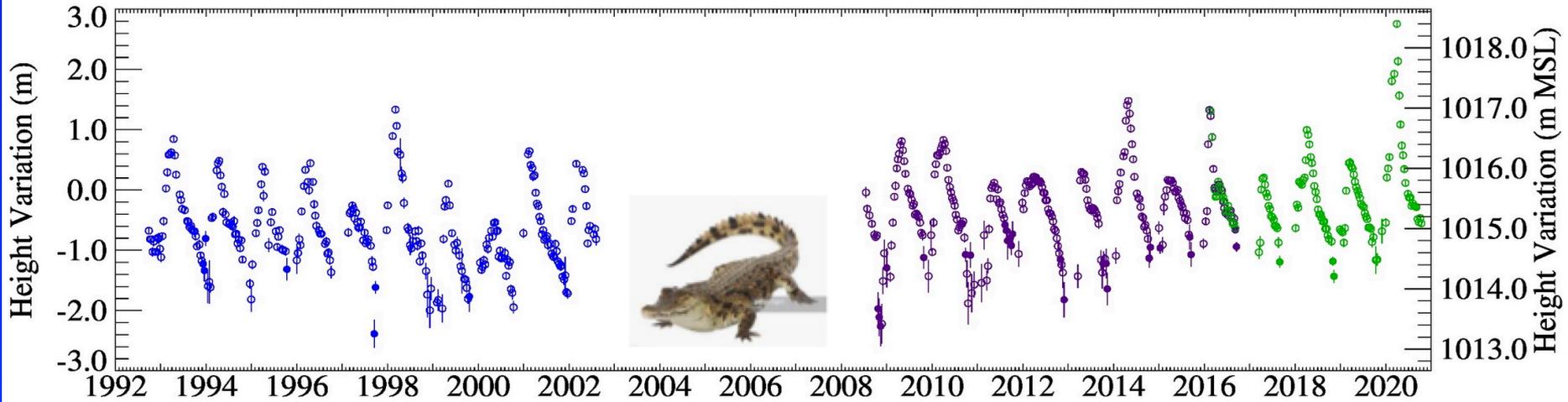


# Global Water Monitor – Portal for Wetland Surface Water Levels

Monitoring of water variability in complex regions. In many places water resources for municipal and irrigation needs, and power supply generation, must all be addressed while maintaining conservation of these ecologically important regions. Example, Usangu Wetlands in Tanzania.



## Usangu Wetland

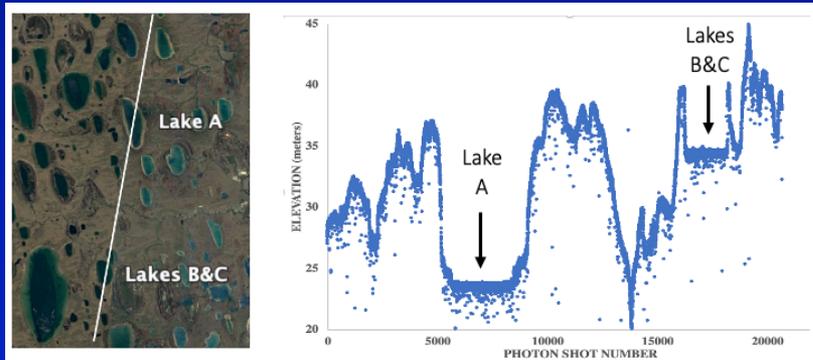


# The Sentinel-6A Michael Freilich Mission

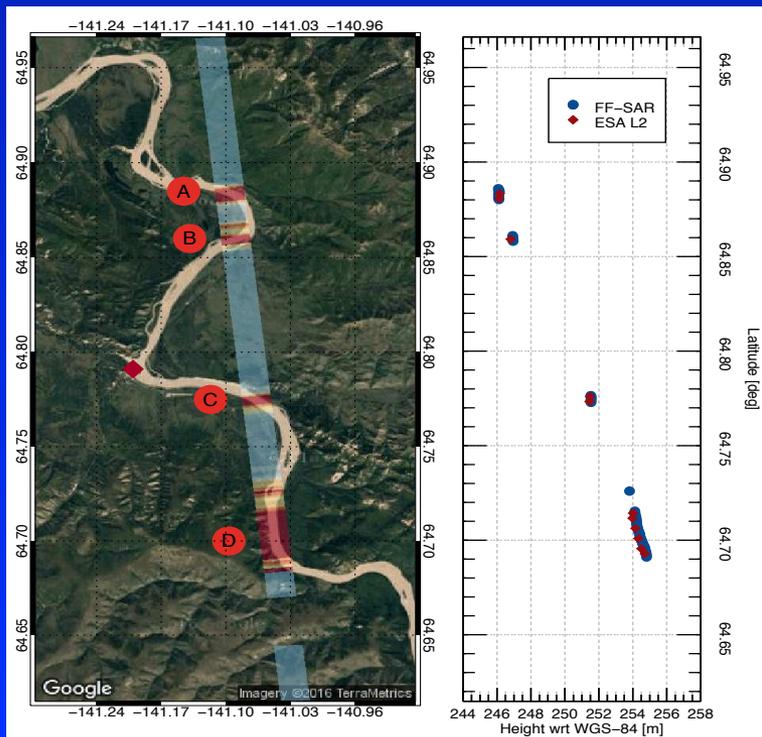


Looking to:

Enhanced **high-resolution information from ICESat-2** and GEDI to aid on-board DEM accuracy  
And D-D SAR, FF-SAR, enhanced wet tropospheric Range Correction, enhanced retracker



**On-board DEM enhancement.** Laser altimeters are capable of acquiring very small water bodies. Such data will be utilized to enhance the Sen-6A/MF onboard DEM. Example shown is from ICESat-2 (11/17/2018, white ground track location). With an along-track spacing of 0.7m the surfaces of three small lakes on the Alaskan North Slope (0.5 to 1.5km overpass width) are captured. This region is an important fish habitat and the ability to acquire elevation measurements is of particular interest to USGS and NOAA.



**Enhanced Spatial Resolution.** Example from CryoSat-2 SAR data and the Yukon River Alaska near the USGS Eagle station, where reach widths at the satellite overpass crossing sites are 400-630m. (Top) The CryoSat-2 overpass (May 2015) samples two up- and two down-stream locations (Sites A to D). The color scale represents the normalized power for the improved (~84m along track) FF-SAR resolution cell after multi-looking. (Bottom) The FF-SAR application is successful with mean elevations (blue) similar to SAR (red) and provides a reach slope of 0.000293 comparable to USGS and Jason-2 estimates of 0.0003. However, FF-SAR provides ~4x the number of data points than SAR, does not have to be noise filtered, and provides an additional measurement location at the narrower north end of Site D. Similar improvements in along-track spatial resolution are expected for FF-SAR application to Sen6A/MF SAR data. FF-SAR processing courtesy of Alejandro Egido.