Ocean Surface Topography
Chicago, IL
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# The Global Water Monitor
# A new phase of 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

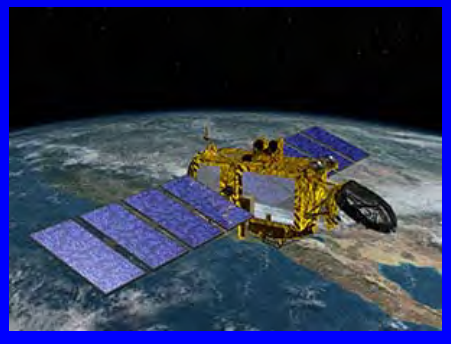
Monthly sampling or better

Continuous Global Monitoring

Fast response to data issues

**&**

**Mission Continuity**



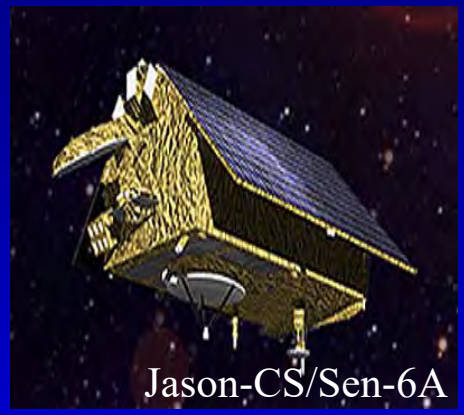
# Continuity and Enhanced Technology

## Continuity of Short-term Repeat


2016


2016 (+2023)


2018 (+2025)




2020 (+2025)

## Data Fusion Enhancements


2010

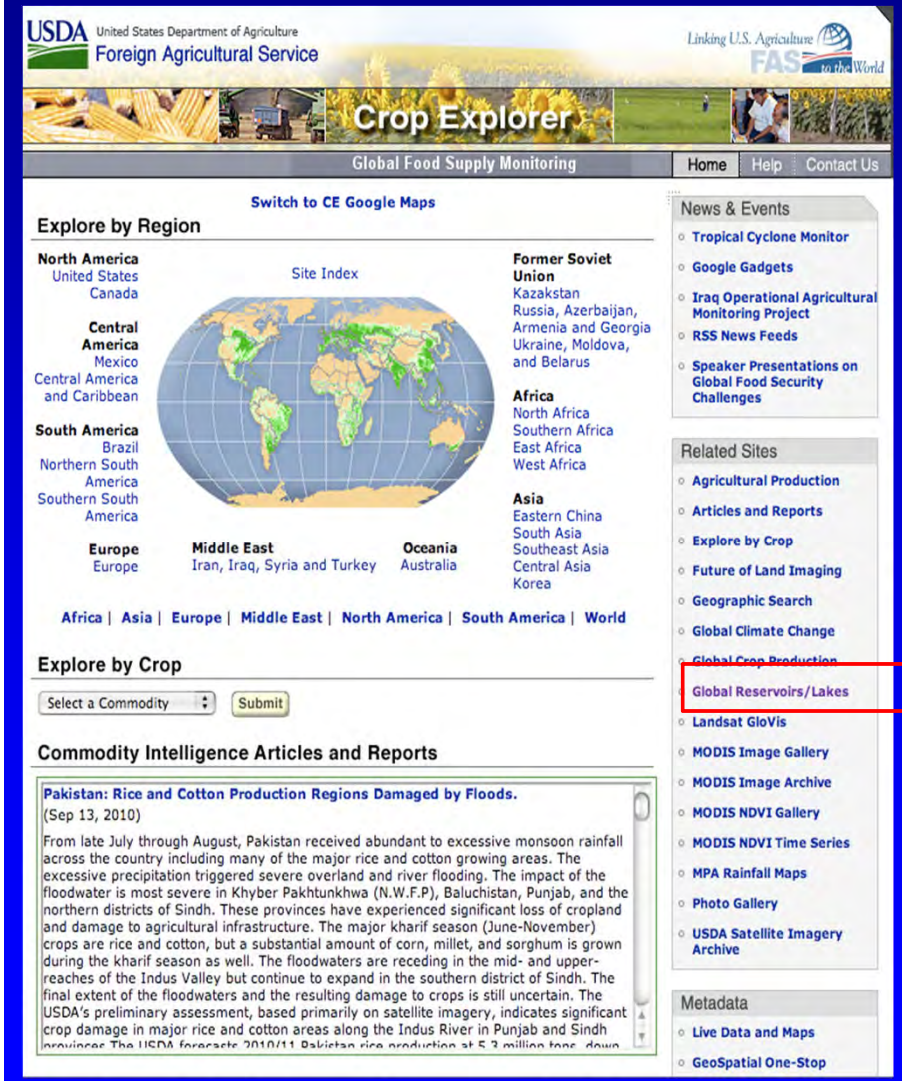

2018


2018


2021

# Operational Product Services (1-3day data delay, weekly updates)

## G-REALM
https://ipad.fas.usda.gov/cropexplorer/global_reservoir/




## 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)

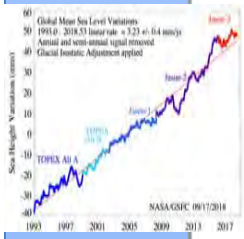
Important Note

Water Monitor - Lakes and Reservoirs

Water Monitor - Rivers and Wetlands

Water Monitor - Global Mean Sea Level

# The Satellite Radar Altimetry Processing Chains




## 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)*

## 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

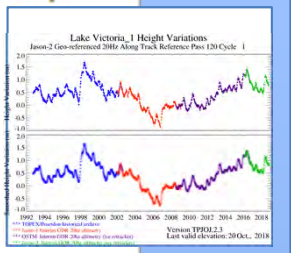
Satellite Pass identification

Lake identification

Geo-referenced time-tagged altimetric parameter databases for continents

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

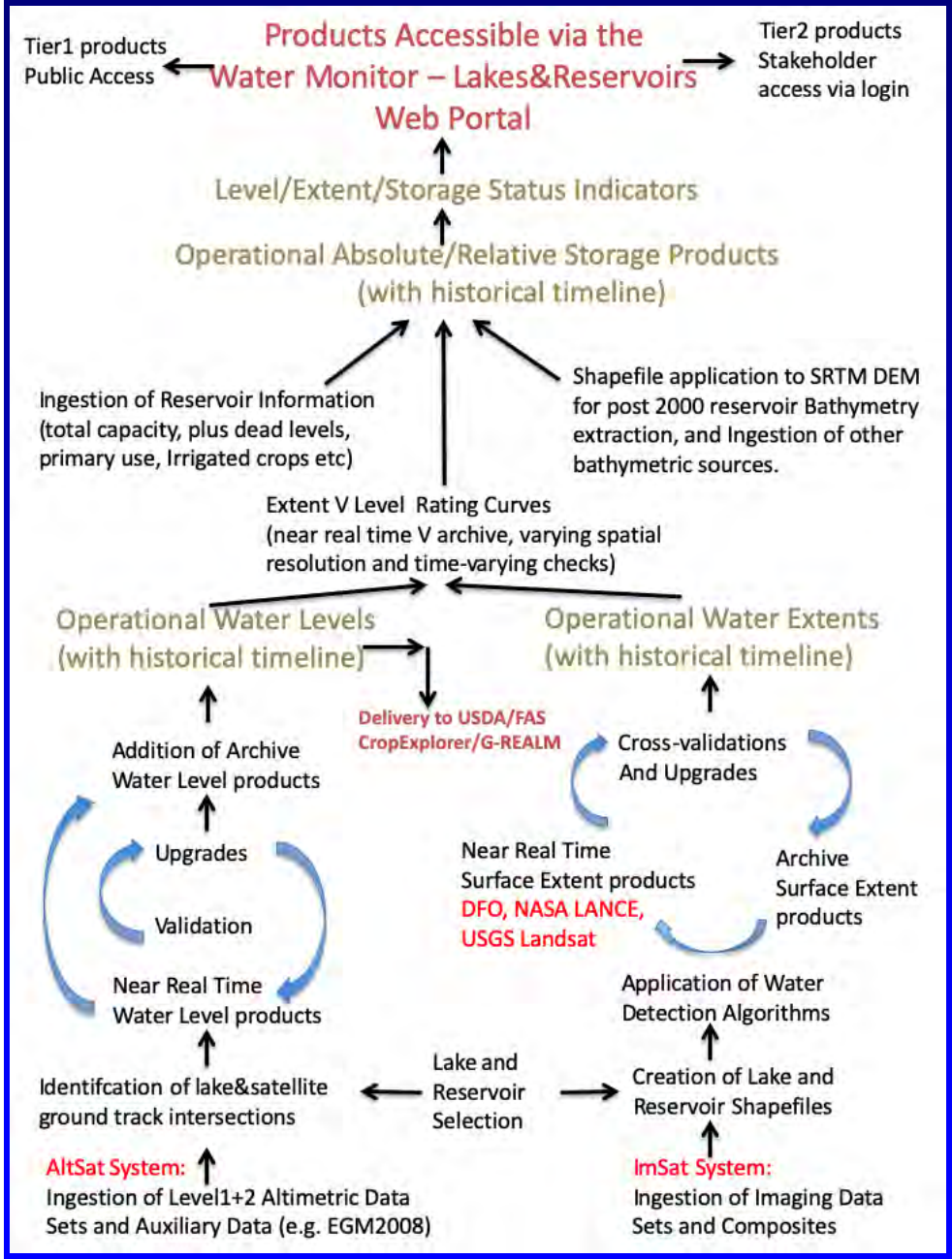
20Hz IGDR/GDR
*(+Future Land retracking via SDR*

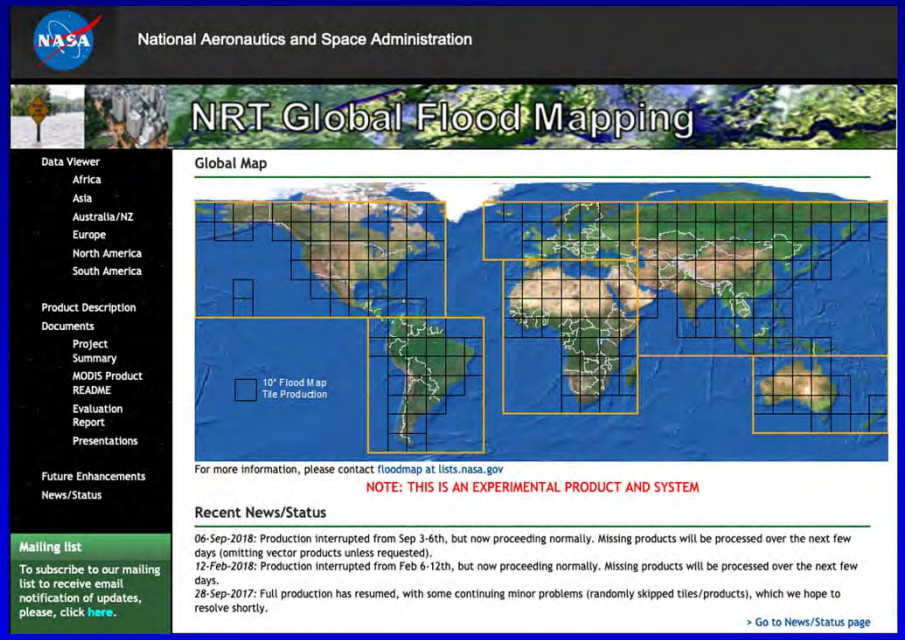



GSFC Precise Satellite Orbits

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

# Lakes/Reservoirs: Merging Altimetry and Imagery Chains



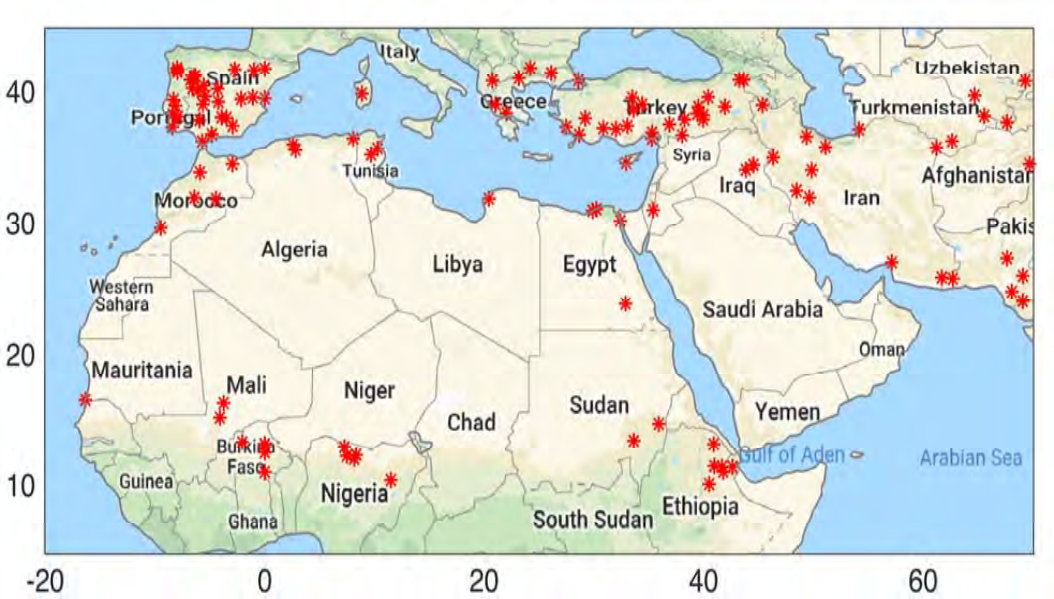




1st Phase

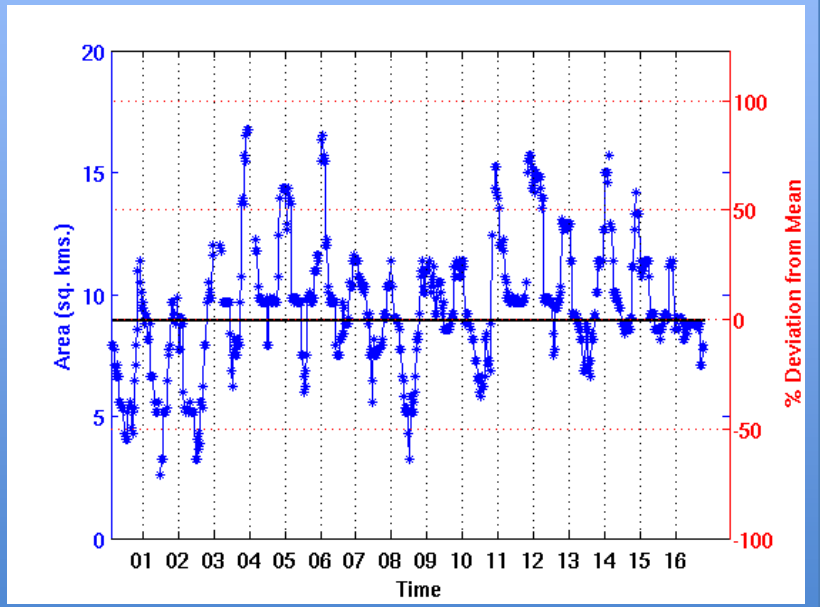
Moving forwards with the NASA Lance System i.e. utilizing the NASA Near Real Time Global Flood Mapping Tool.

MODIS 250m 8-day composites

10% (≥100km$^2$) and 30% (10-99km$^2$) of lakes do not have a 10day or 27day overpass. Majority are small and those in arid lands will be shallow with large extent variations. Changes in surface area will be the dominant monitoring parameter.

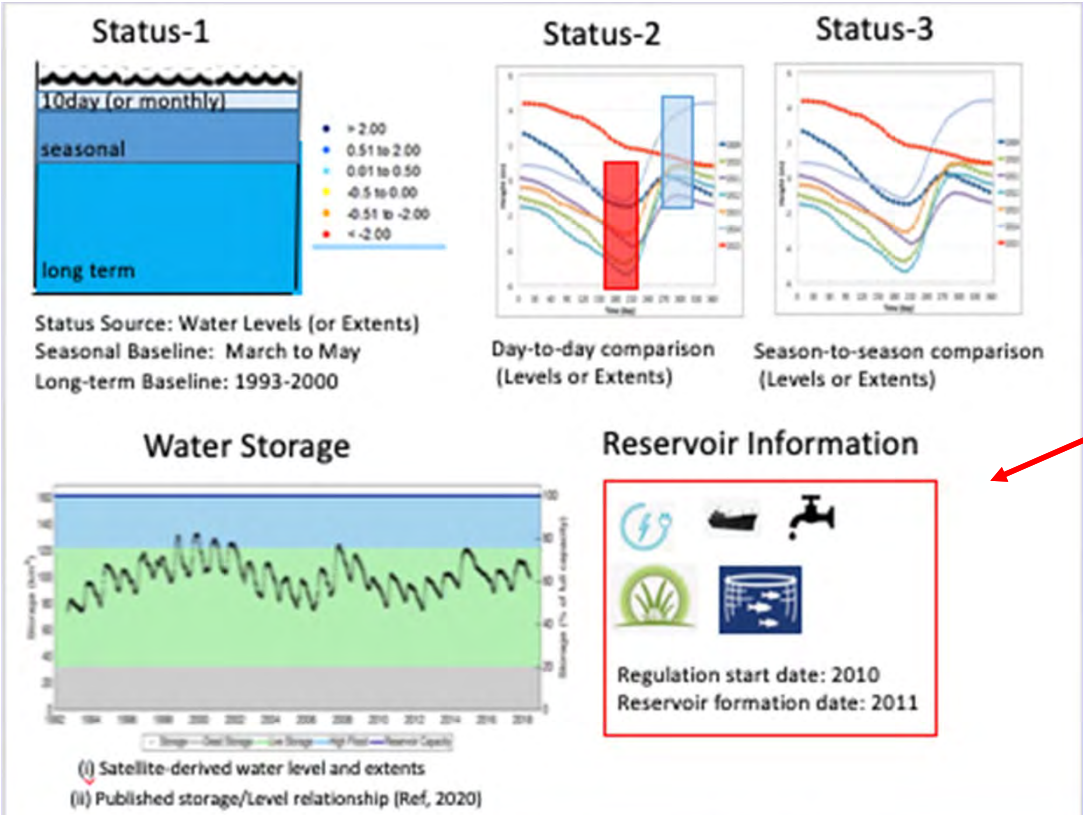


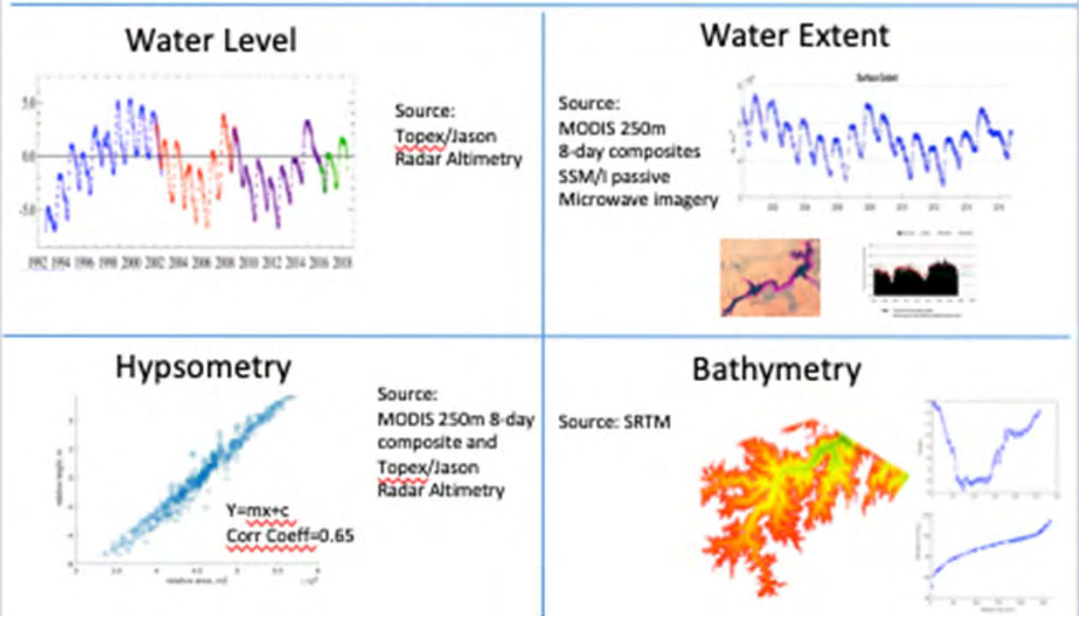

*(Above) Location of lakes/reservoirs where no altimetric-derived water levels are available, example for the arid lands stretching from West Africa to Afghanistan where water bodies are often shallow and undergo large extent variations. These water bodies will have no operational altimetric overpass to exploit for the derivation of operational water levels and hence storage determination. However, extent variability alone still has merit in highlighting seasonality and short/long-term status.*

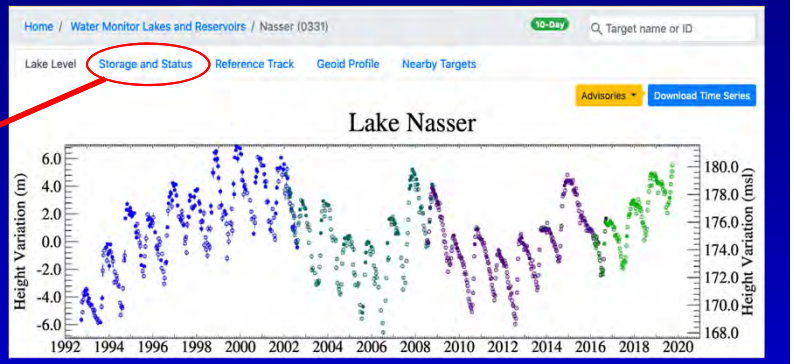



*(Above) MODIS 500m resolution lake extent variations, example for the ~100km$^2$ Sidi Saad reservoir in Tunisia.*

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



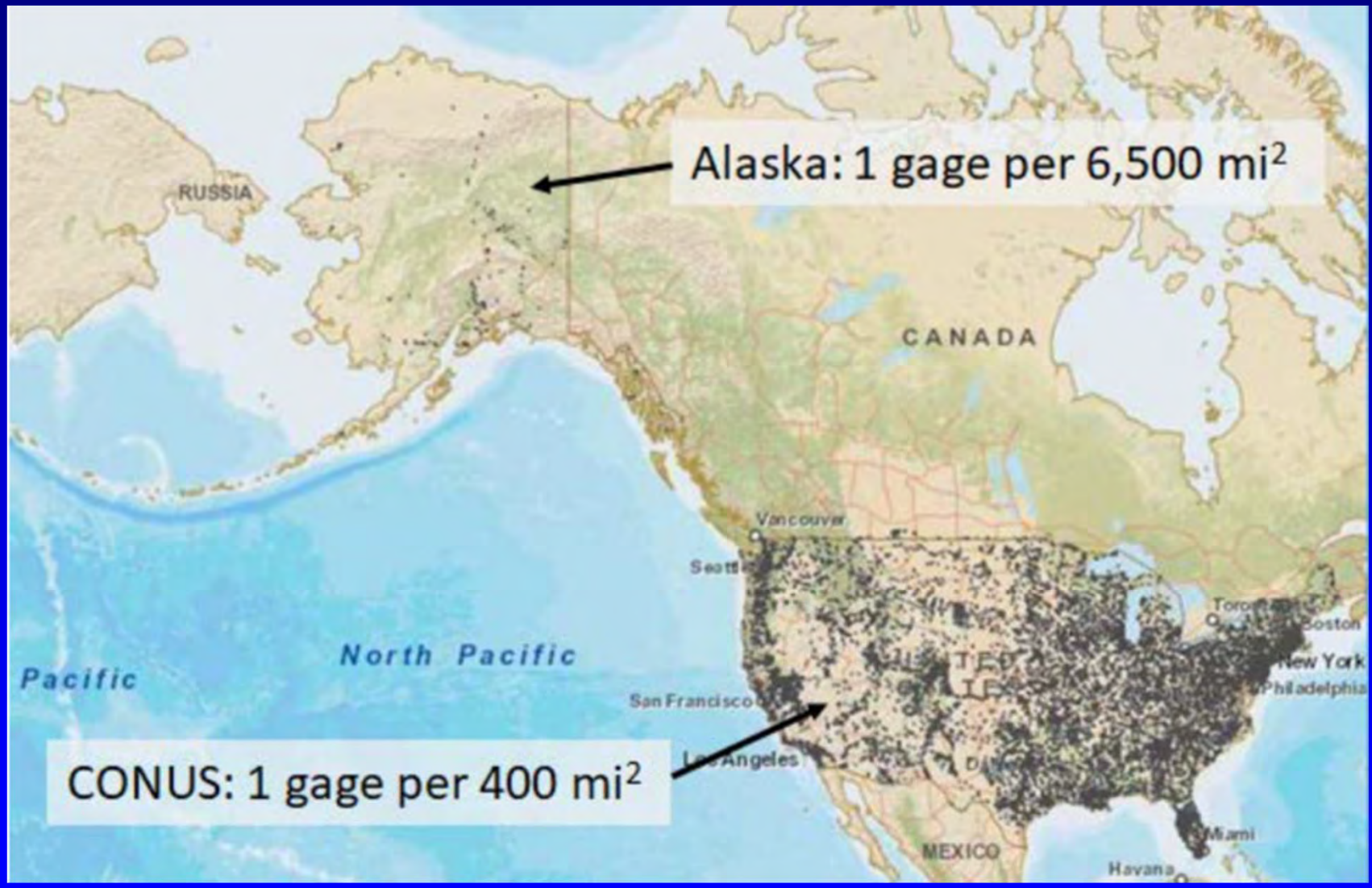

<u>Responding to stakeholder requirements.</u>

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.

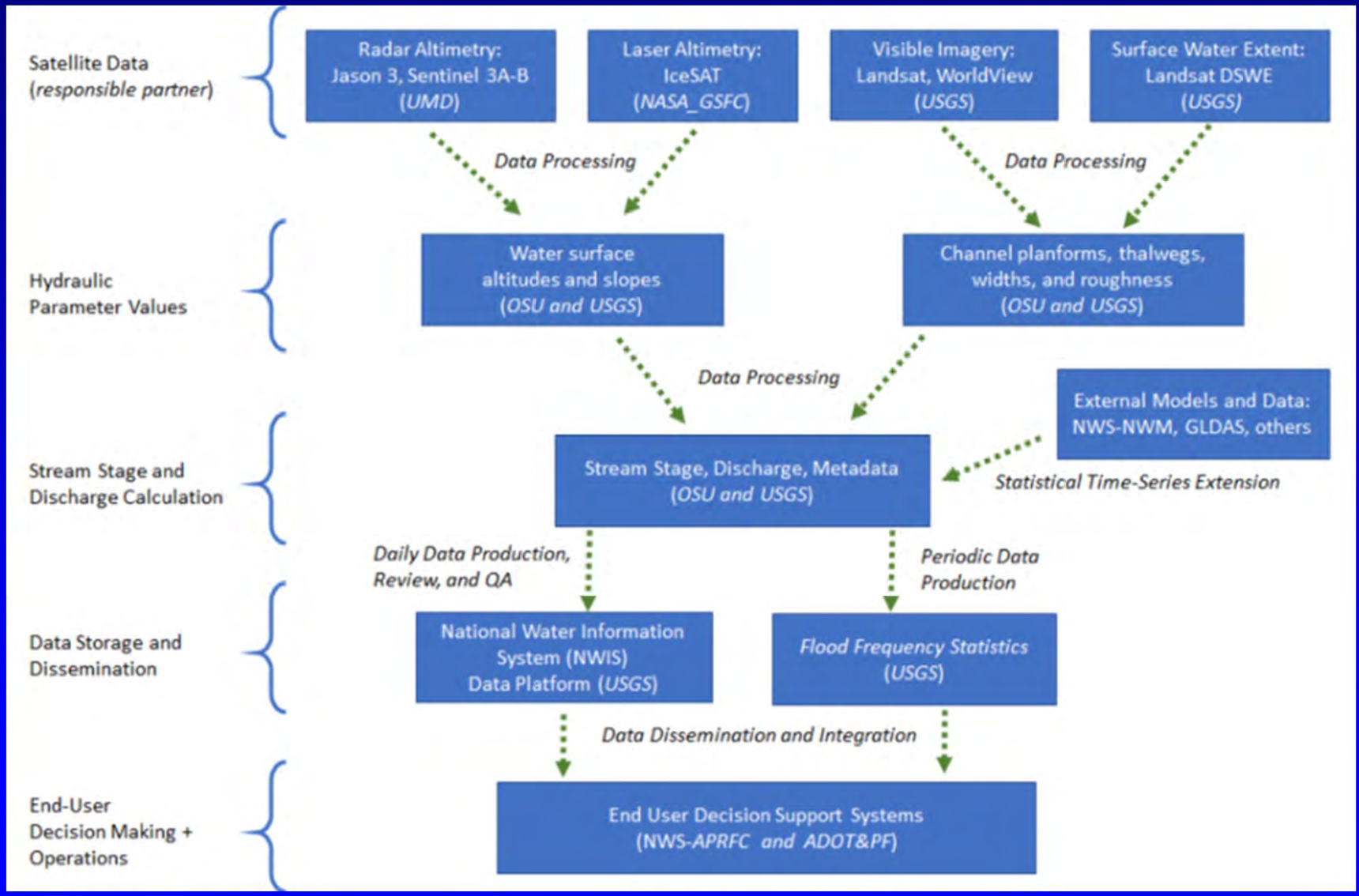
For reservoirs, storage to be given in relation to known dead, live, at capacity, and flood storage values.

Water Monitor – Portal for Wetland and River Surface Water Levels
e.g., USGS Alaska Discharge Determination Project

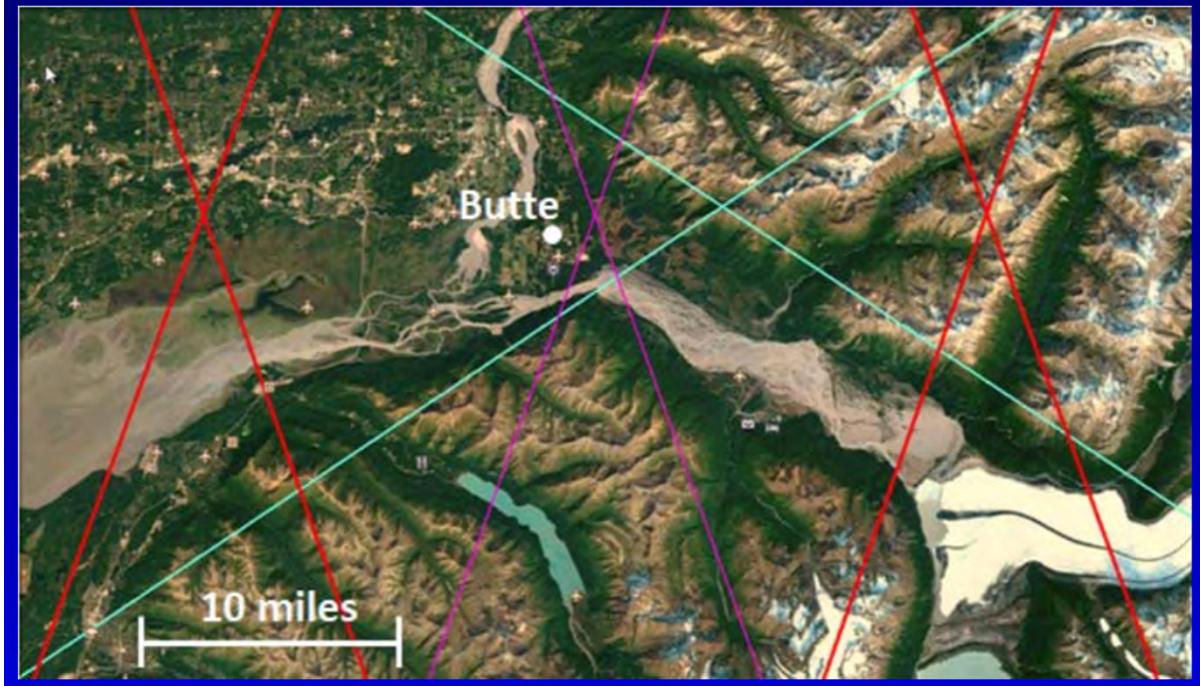


# Discharge Determination – A Complex Data Processing Chain

## Stakeholders: AK NOAA/NWS, Dept. Transport, Dept. Fish and Game, Fisheries/Wildlife Service



# Not just Radar Altimetry – Exploration of laser altimetry




ICESat-2

532nm green wavelength
6 beams (3 pairs)
90m and 3.3km spacing between beams

Nominal 12m footprint
0.7m along-track spacing

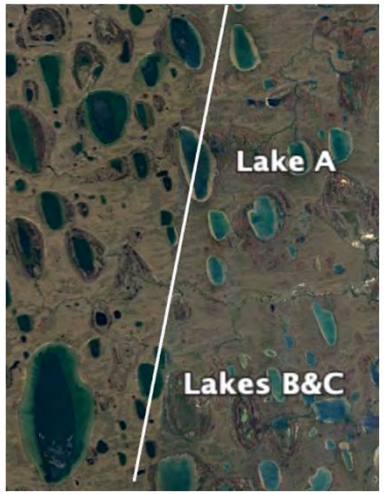
Mapping mode over continents

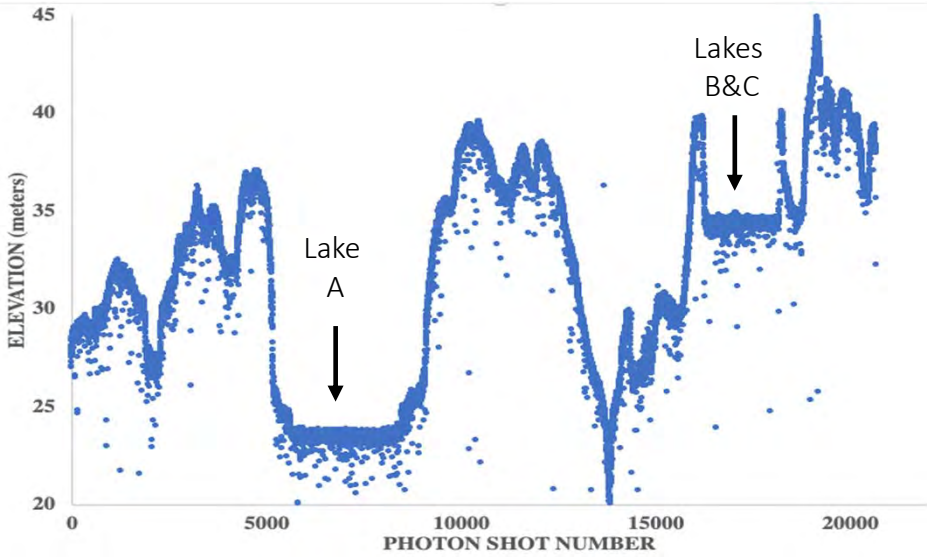
Elevation, width, slope, bathymetry, (depth)

Level 2 (ATL03) and Level3 (ATL14) datasets available via https://earthdata.nasa.gov/
HDF-5 readers freely available

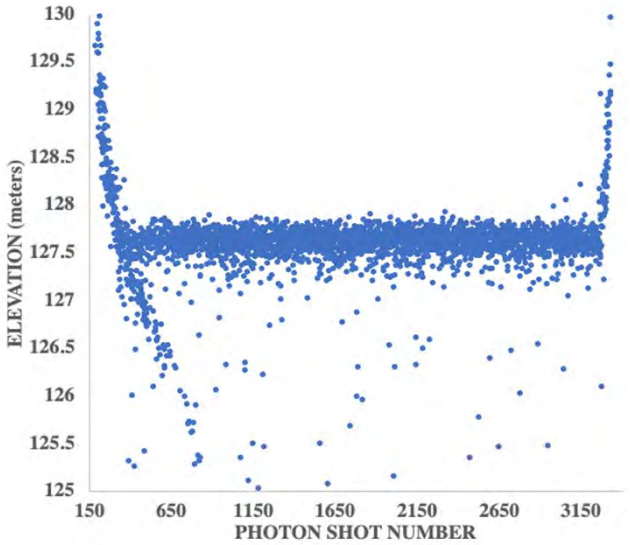
Not waveforms but statistics !

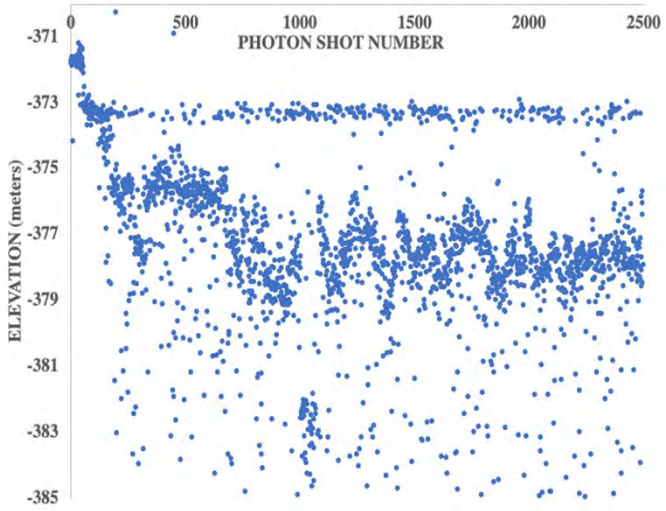
# ICESat-2 examples



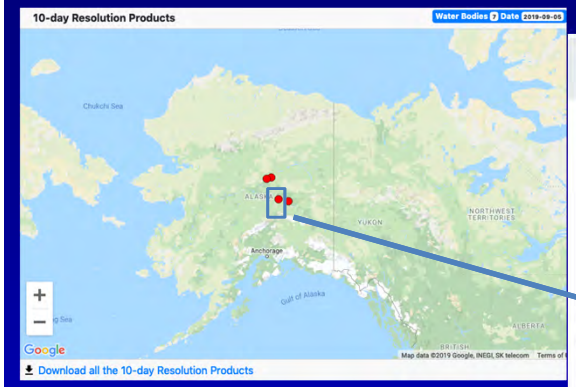

*Capturing the frozen surfaces of three small lakes on the Alaskan North Slope (0.5 to 1.5km overpass widths). The region is an important fish habitat .*

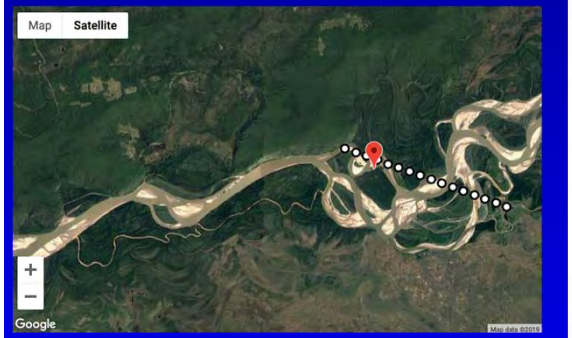


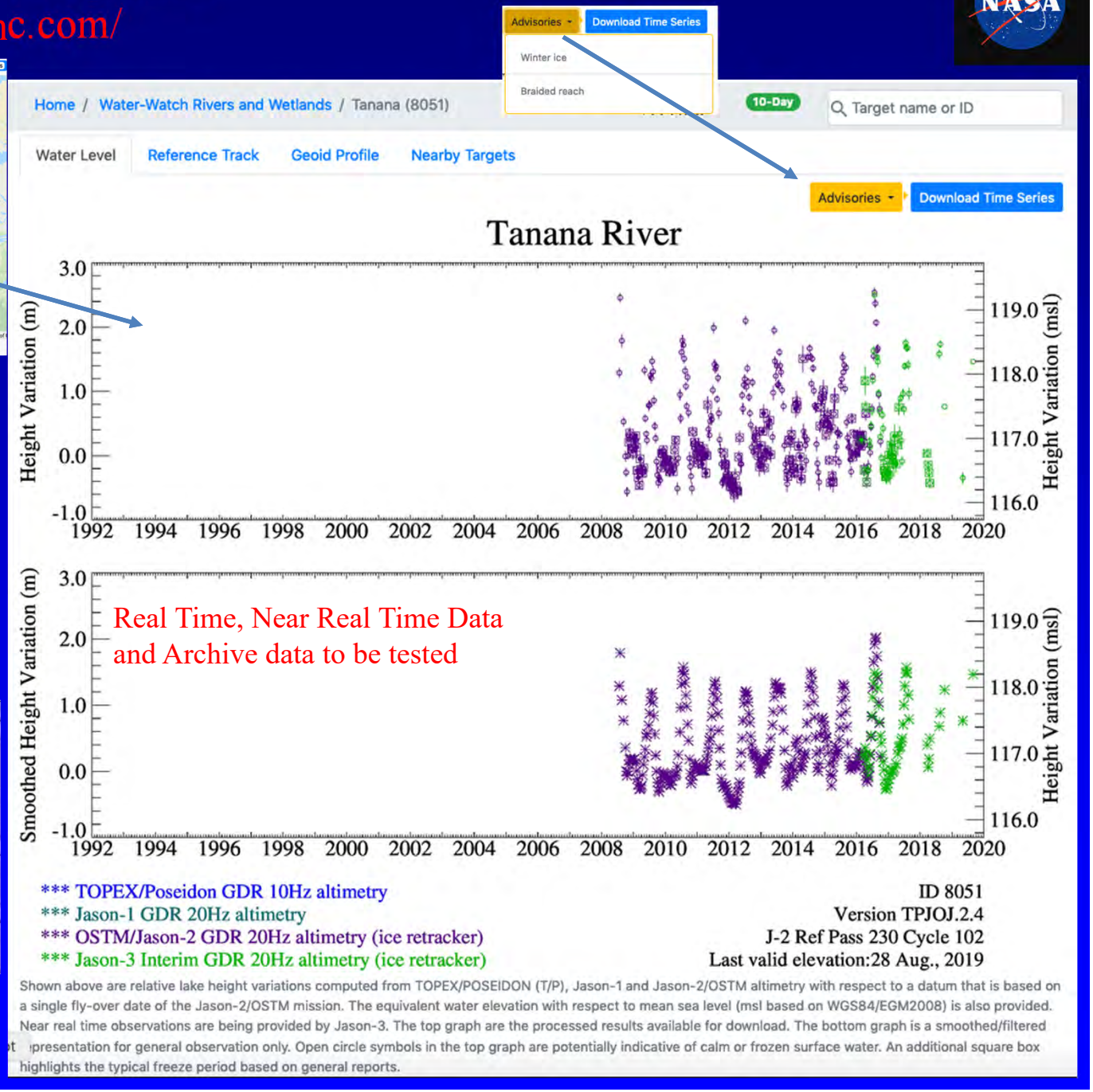

*(left) Lake McKenzie, Australia and (right) one of the Dead Sea evaporation (salt industry) ponds in Israel. For Lake McKenzie, the majority of ATLAS photons are reflected off the surface but some penetrate 2m and appear to follow the shape of the lake basin. For the pond, many photons penetrate 5m possibly revealing natural or salt-crust undulations below.*

# Water Monitor e.g. river level product
# https://water-watch.sgt-inc.com/



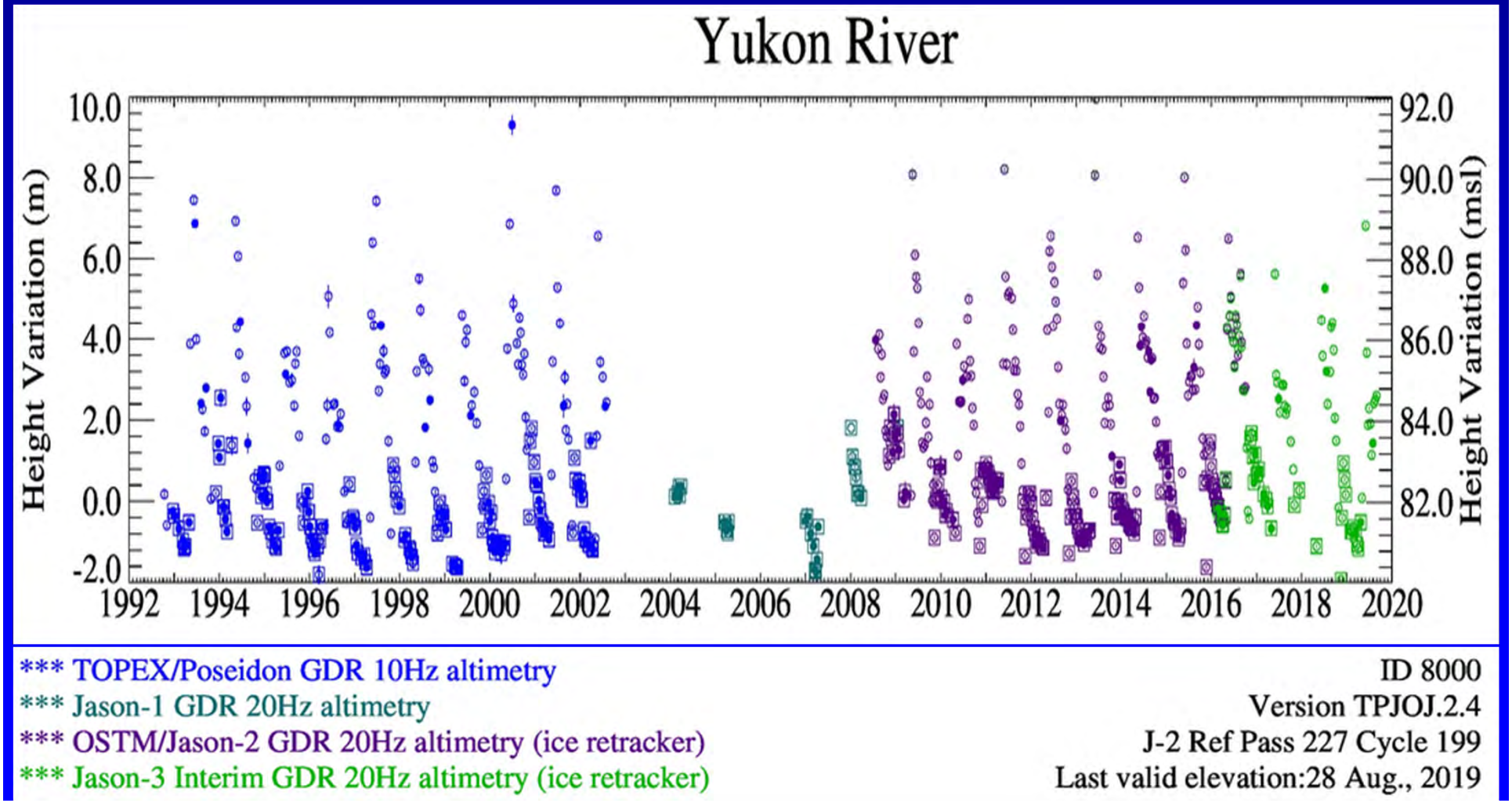




| Name | USGS Site ID | Latitude | Longitude | Width (m) | Drainage Area mi² |
|---|---|---|---|---|---|
| *Sites Collocated with Existing USGS Gaging Station* | | | | | |
| Snow R. nr Seward | 15243900 | 60.287 | -149.337 | 50 | 150 |
| Susitna R. at Gold Creek | 15292000 | 62.774 | -149.688 | 300 | 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 |
| *Ungaged but with Project Field Data* | | | | | |
| 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 |
| *Ungaged, no ground/field data* | | | | | |
| 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 |



# 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



# MAIN CHALLENGES

Appending multi-platform results

Historical 35-day ground tracks (1994-2016) are different than 27-day tracks (≥2016) and there are time gaps across the 27/35-day time series.
(use of ICESat, Cryosat-2, and for rivers - tests of variability along the reach)

Jason-3 and Sentinel-3 DEM failure to capture surface
Continuous new water bodies being added
Request working with the ST to achieve a faster turn around times for upgrades

# FUTURE

Looking to **CONTINUTY** from Jason/Sentinel series
and enhanced mapping from ICESat-2, GEDI, SWOT
and also to Landsat, Sentinel-2 imagery