

Ocean Surface Topography
Chicago, IL
October 21-25th 2019



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

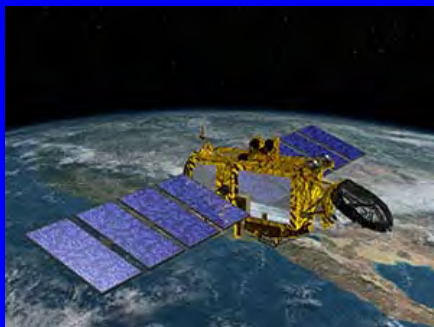
Monthly sampling or better

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/cropeexplorer/global_reservoir/

USDA United States Department of Agriculture
Foreign Agricultural Service

Linking U.S. Agriculture to the World

Crop Explorer

Global Food Supply Monitoring

Home Help Contact Us

Switch to CE Google Maps

Explore by Region

North America
United States
Canada

Central America
Mexico
Central America and Caribbean

South America
Brazil
Northern South America
Southern South America

Europe
Europe

Middle East
Iran, Iraq, Syria and Turkey

Oceania
Australia

Former Soviet Union
Kazakhstan
Russia, Azerbaijan, Armenia and Georgia, Ukraine, Moldova, and Belarus

Africa
North Africa
Southern Africa
East Africa
West Africa

Asia
Eastern China
South Asia
Southeast Asia
Central Asia
Korea

Africa | Asia | Europe | Middle East | North America | South America | World

Explore by Crop

Select a Commodity Submit

Commodity Intelligence Articles and Reports

Pakistan: Rice and Cotton Production Regions Damaged by Floods.
(Sep 13, 2010)

From late July through August, Pakistan received abundant to excessive monsoon rainfall across the country including many of the major rice and cotton growing areas. The excessive precipitation triggered severe overland and river flooding. The impact of the floodwater is most severe in Khyber Pakhtunkhwa (N.W.F.P.), Baluchistan, Punjab, and the northern districts of Sindh. These provinces have experienced significant loss of cropland and damage to agricultural infrastructure. The major kharif season (June-November) crops are rice and cotton, but a substantial amount of corn, millet, and sorghum is grown during the kharif season as well. The floodwaters are receding in the mid- and upper reaches of the Indus Valley but continue to expand in the southern district of Sindh. The final extent of the floodwaters and the resulting damage to crops is still uncertain. The USDA's preliminary assessment, based primarily on satellite imagery, indicates significant crop damage in major rice and cotton areas along the Indus River in Punjab and Sindh provinces. The USDA forecasts 2010/11 Pakistan rice production at 5.3 million tons, down from 5.8 million tons in 2009/10.

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



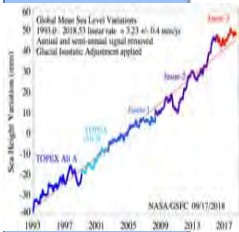
Water Monitor - Lakes and Reservoirs

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)

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

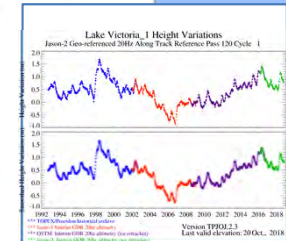
Lake identification

Geo-referenced time-tagged
altimetric parameter databases for
continents

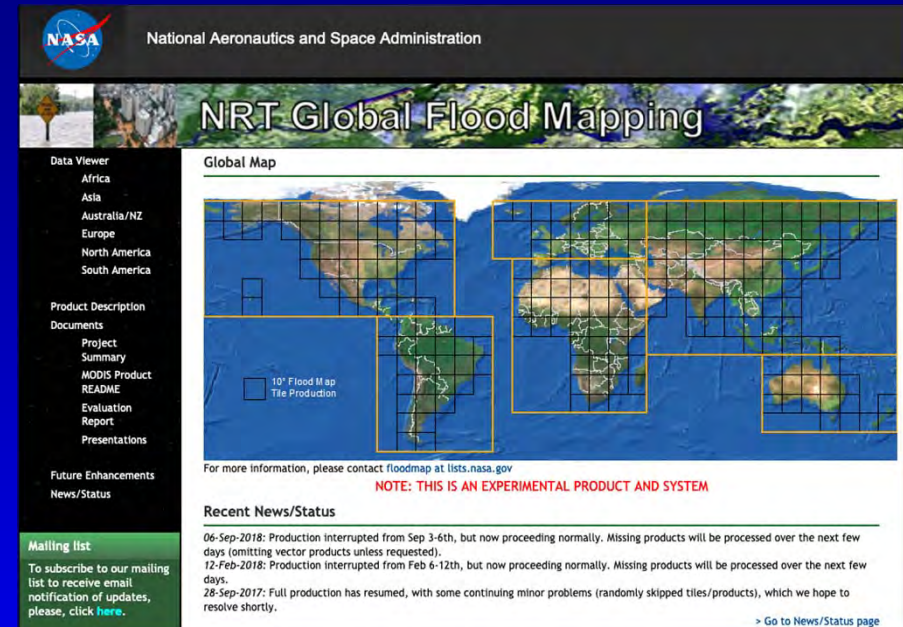
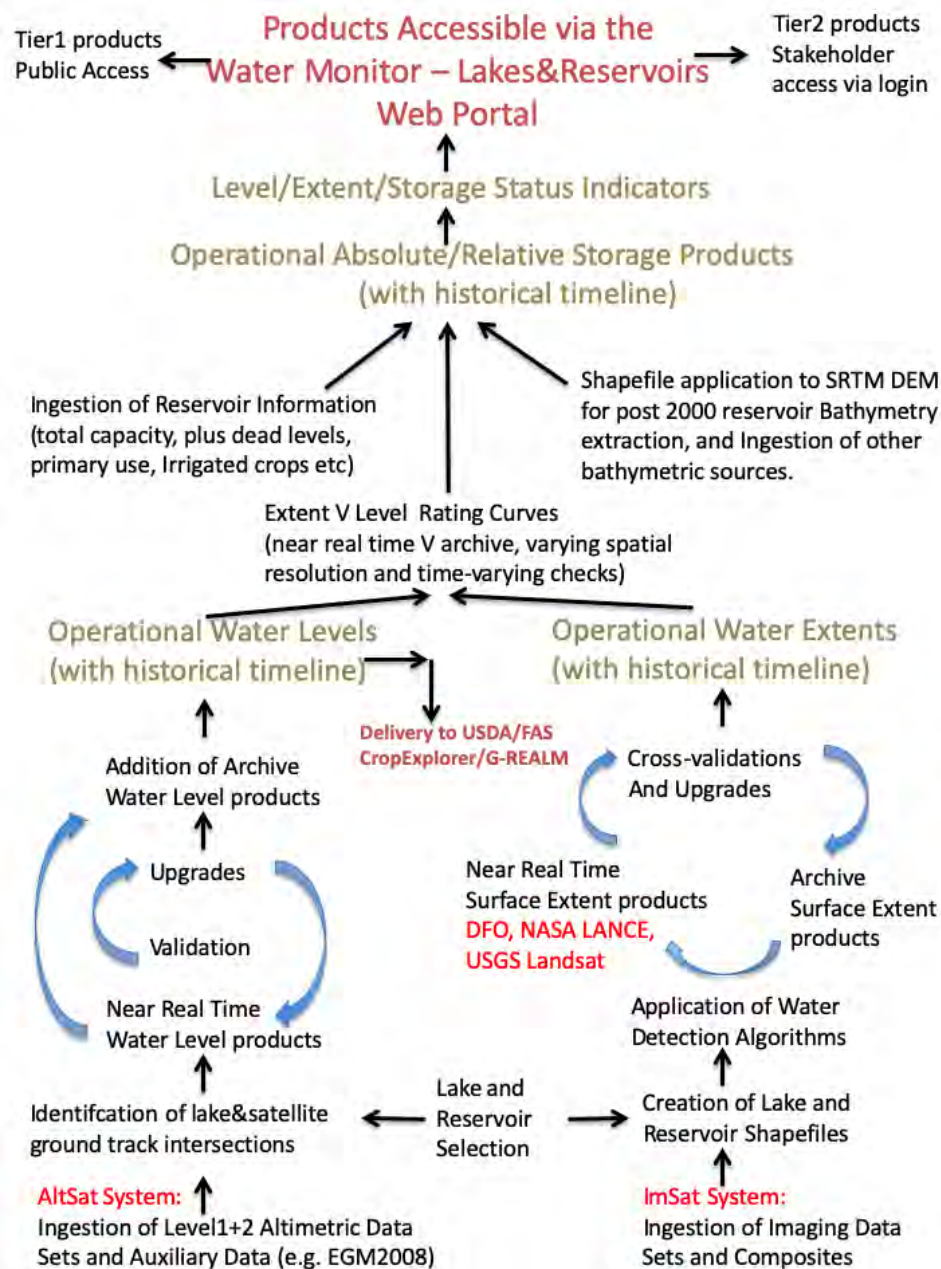
RADS Atmospheric Corrections
Static Geoid Model e.g. NGA)

20Hz IGDR/GDR

(+Future Land retracking via SDR



Lakes/Reservoirs: Merging Altimetry and Imagery Chains

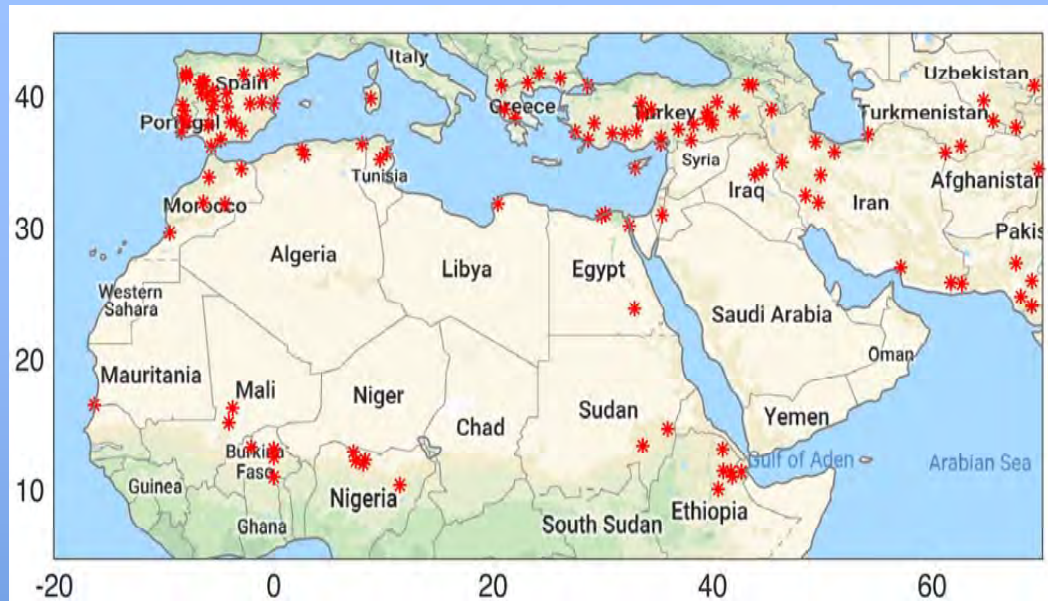


1st Phase
Moving forwards with the NASA Lance System
i.e. utilizing the NASA Near Real Time
Global Flood Mapping Tool.

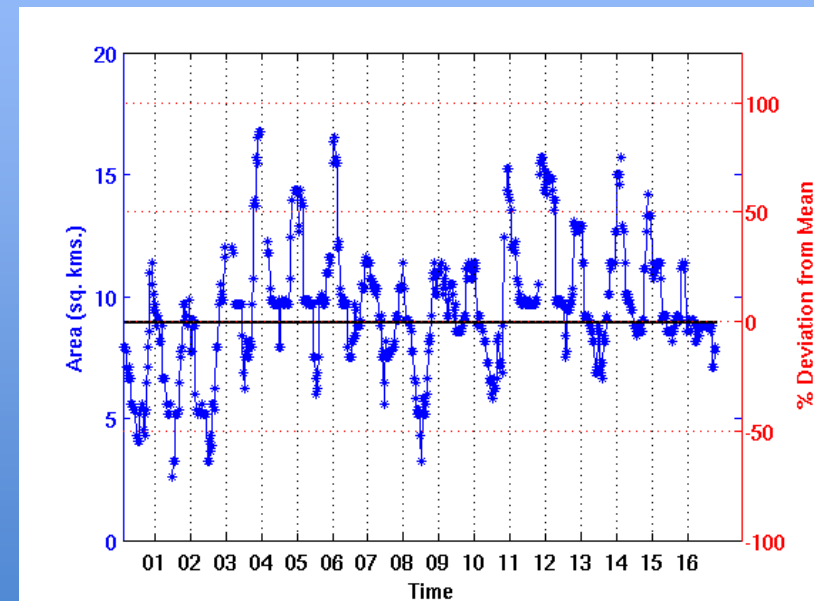
MODIS 250m 8-day composites



10% ($\geq 100\text{km}^2$) and 30% ($10\text{-}99\text{km}^2$) 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.



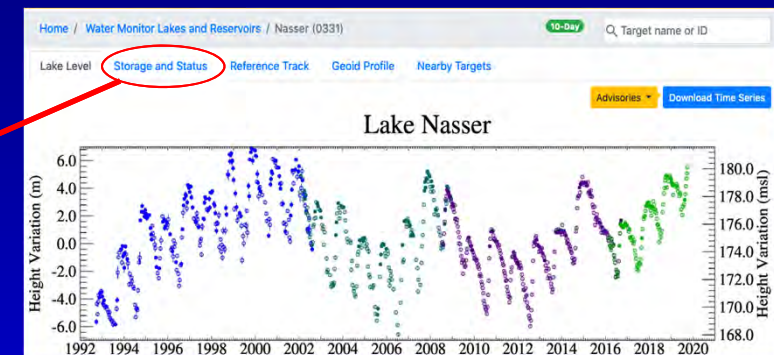
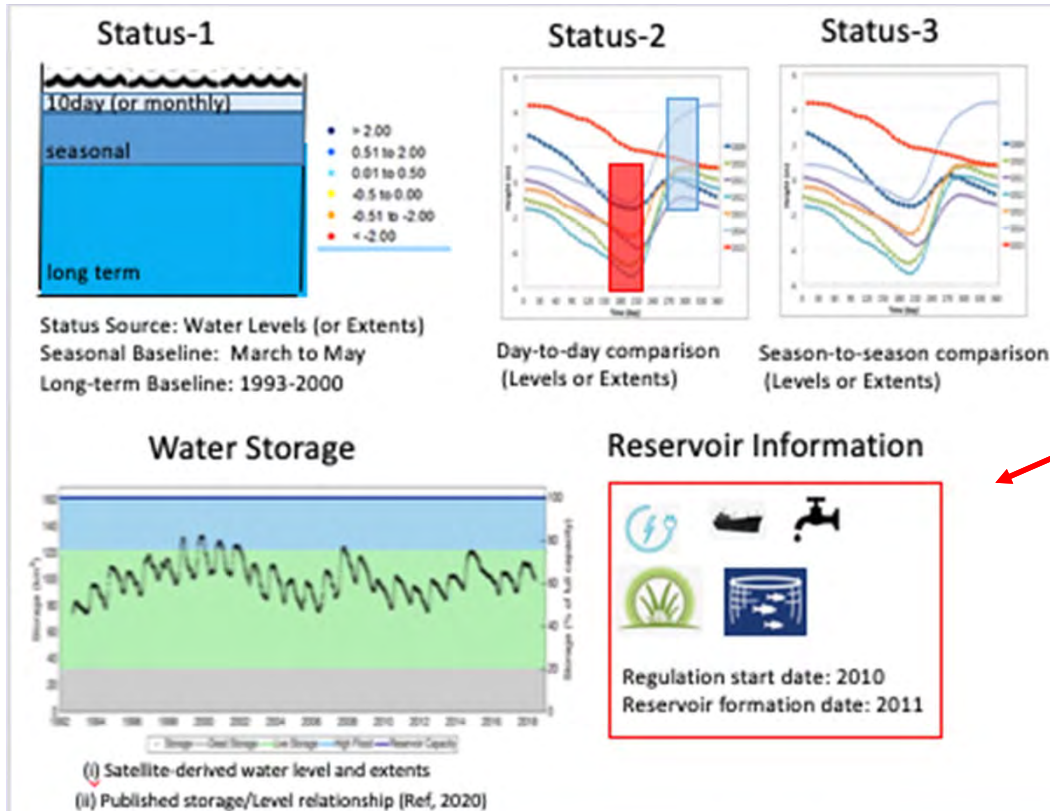
(Above) Location of lakes/reservoirs where no altimetric-derived water levels are available, example for the arid lands stretching from West Africa to Afghanistan where water bodies are often shallow and undergo large extent variations. These water bodies will have no operational altimetric overpass 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 $\sim 100\text{km}^2$ Sidi Saad reservoir in Tunisia.



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

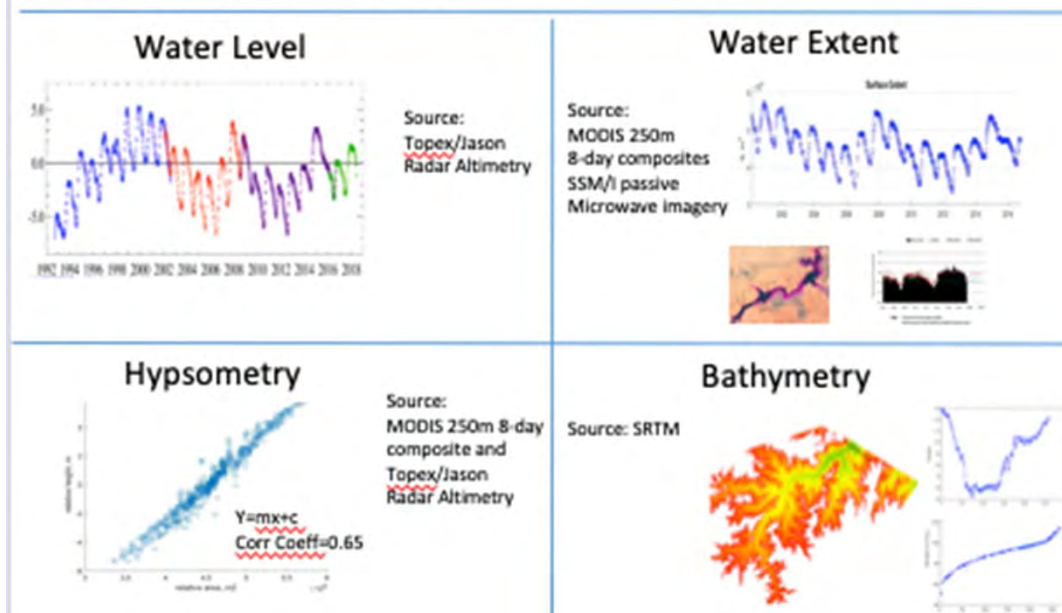


Responding to stakeholder requirements.

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

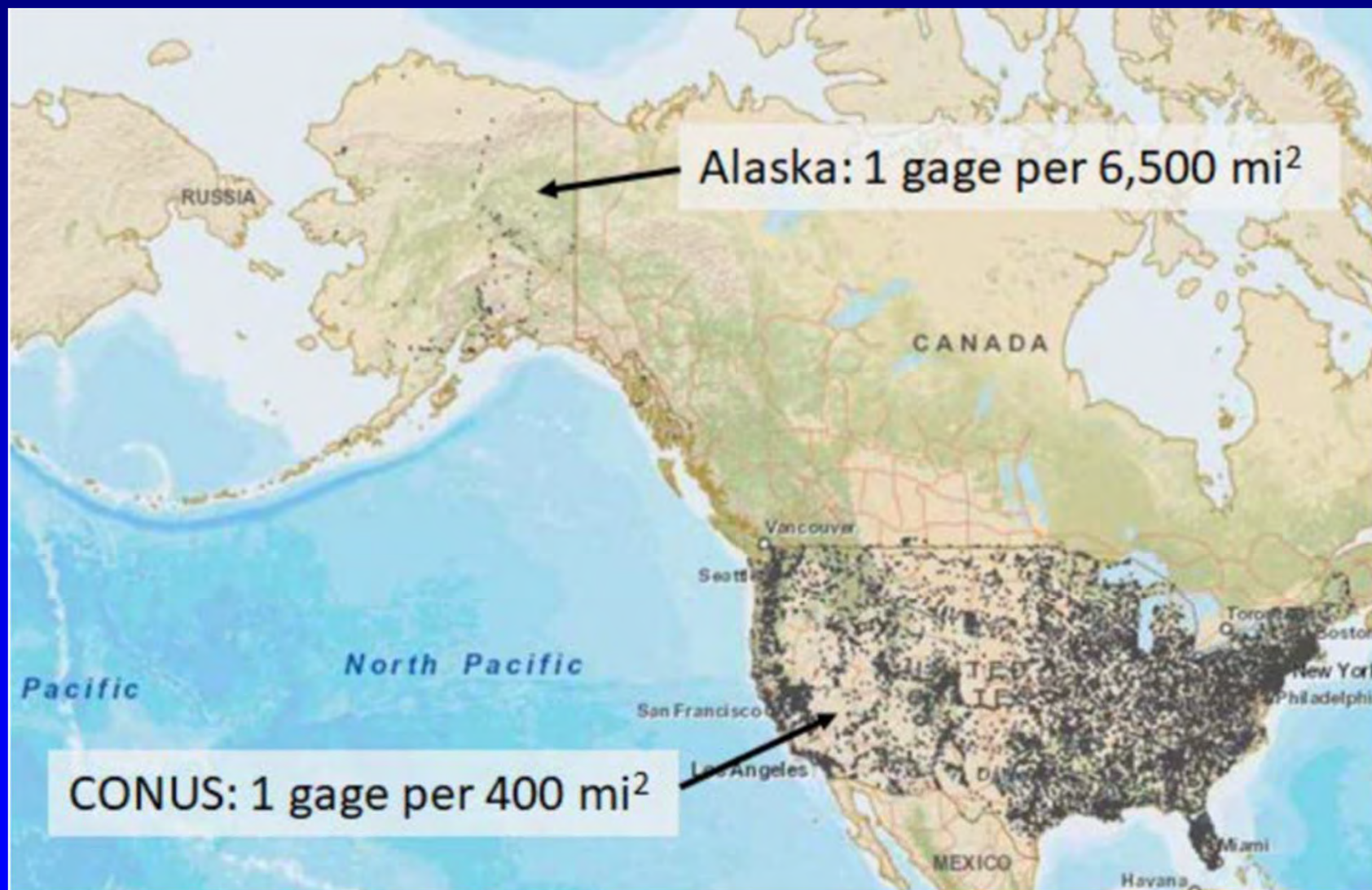
Storage or storage variations based on known or derived bathymetry.

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



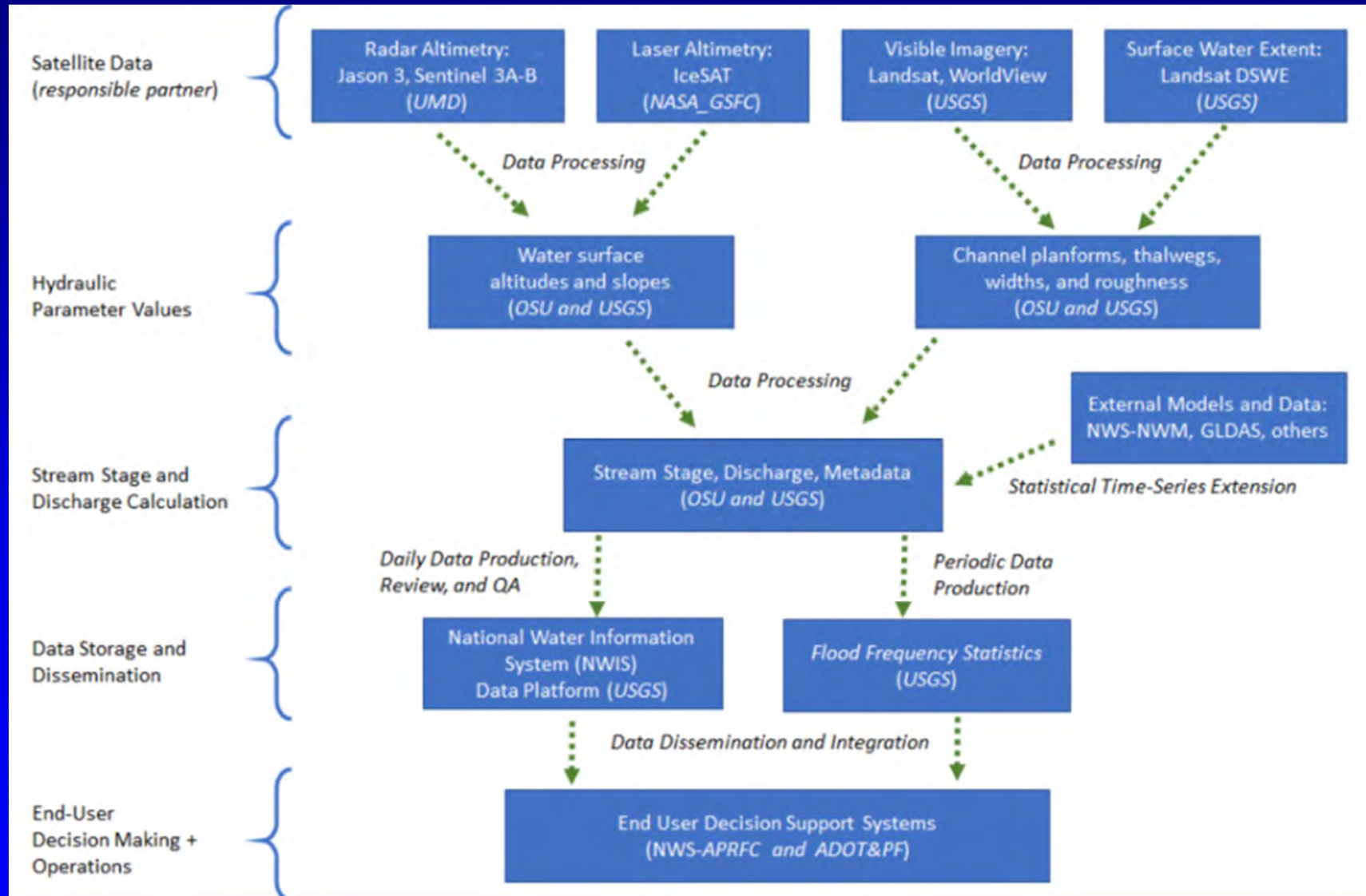


Water Monitor – Portal for Wetland and River Surface Water Levels
e.g., USGS Alaska Discharge Determination Project

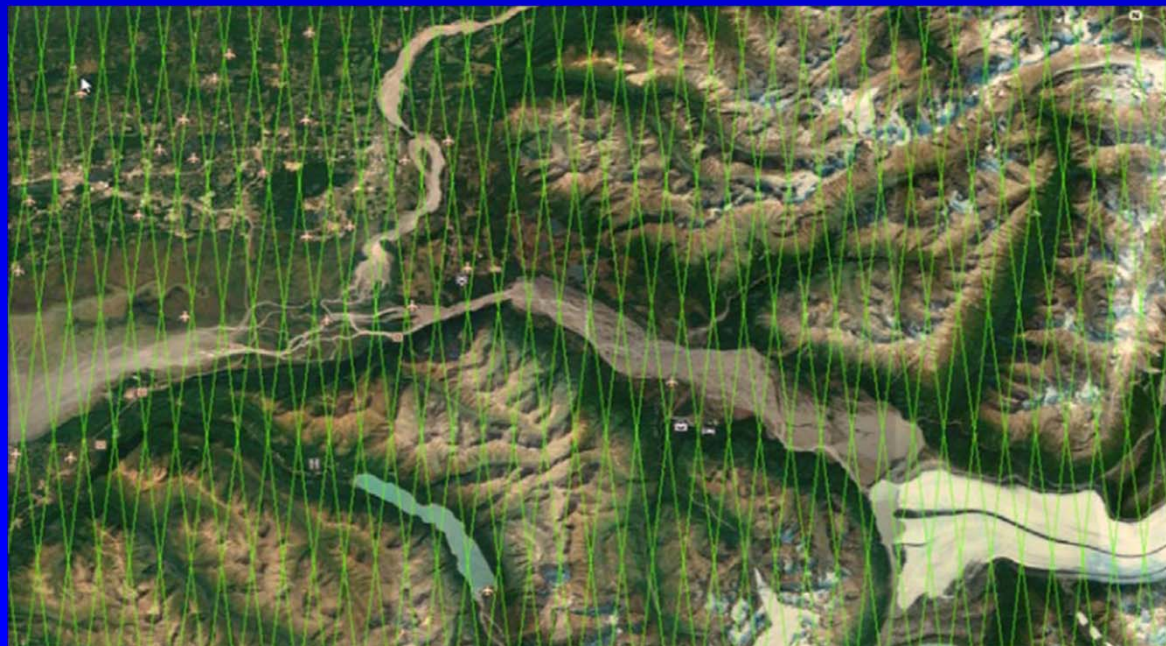
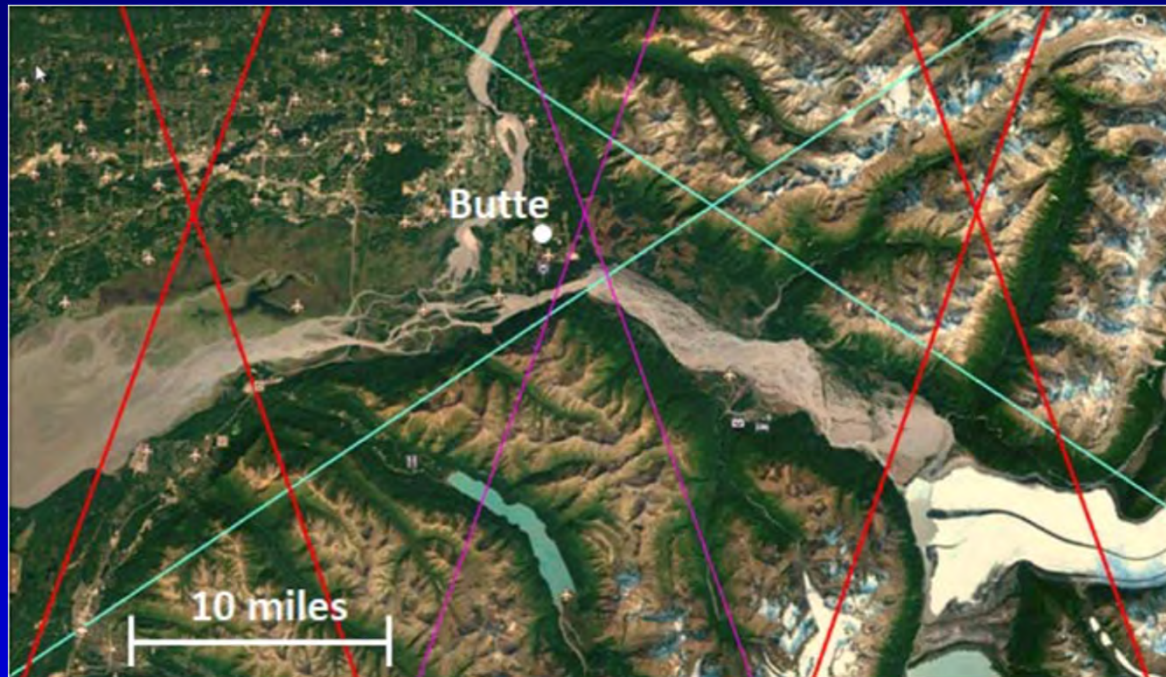


Discharge Determination – A Complex Data Processing Chain

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

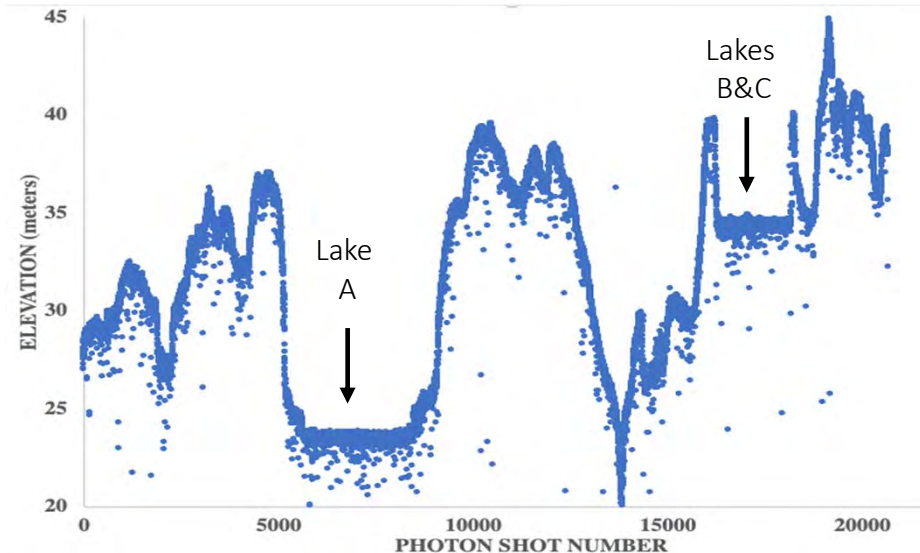
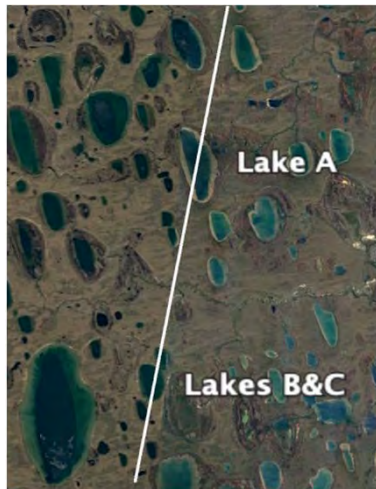
Mapping mode over continents

Elevation, width, slope,
bathymetry, (depth)

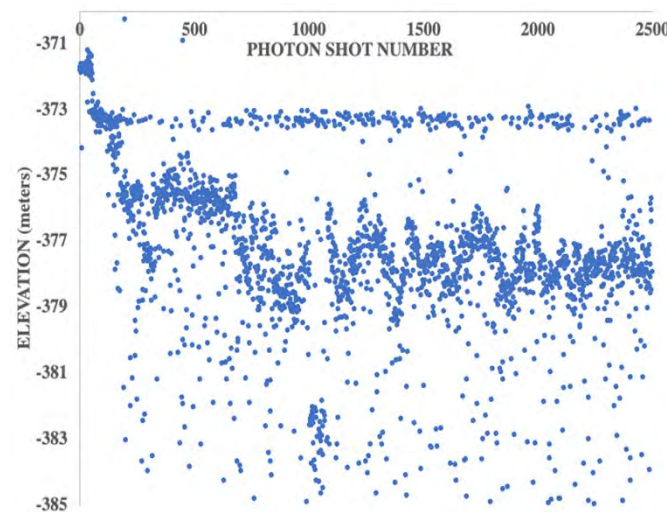
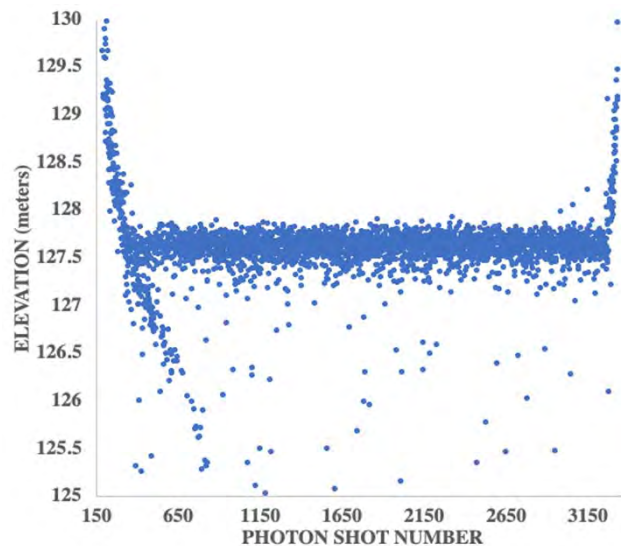
Level 2 (ATL03) and Level3
(ATL14) datasets available via
<https://earthdata.nasa.gov/>
HDF-5 readers freely available

Not waveforms but statistics !

ICESat-2 examples



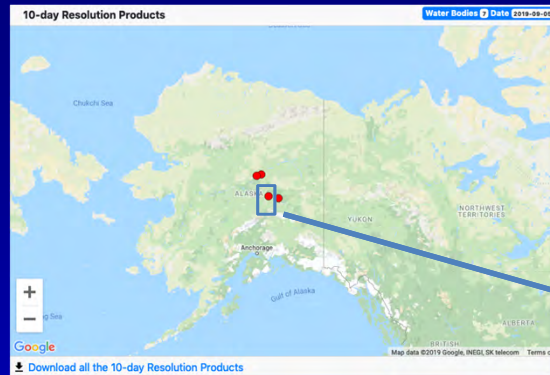
Capturing the frozen surfaces of three small lakes on the Alaskan North Slope (0.5 to 1.5km overpass widths). The region is an important fish habitat .



(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 mi ² |
|---|--------------|----------|-----------|-----------|-------------------------------|
| <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>Un-gaged 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>Un-gaged, 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 |

Home / Water-Watch Rivers and Wetlands / Tanana (8051)

Water Level Reference Track Geoid Profile Nearby Targets

Advisories - Download Time Series

Winter ice

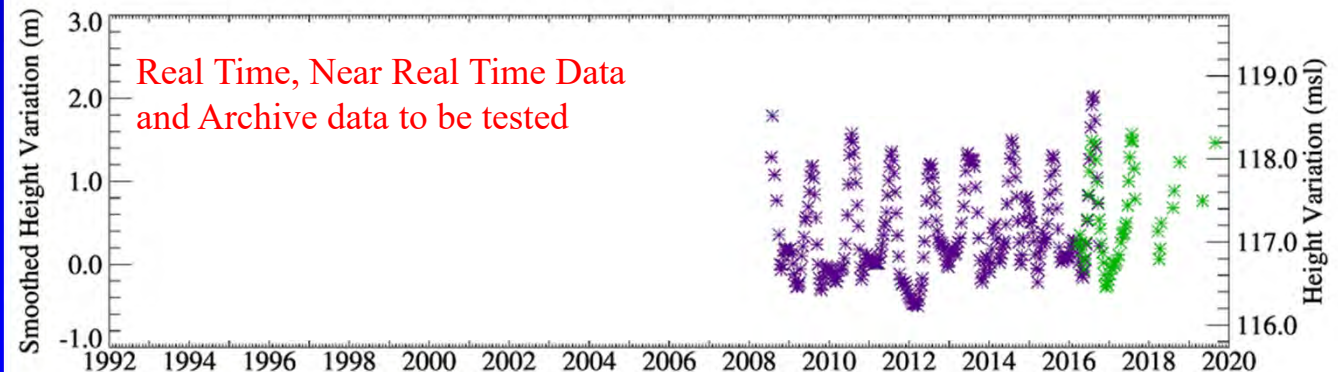
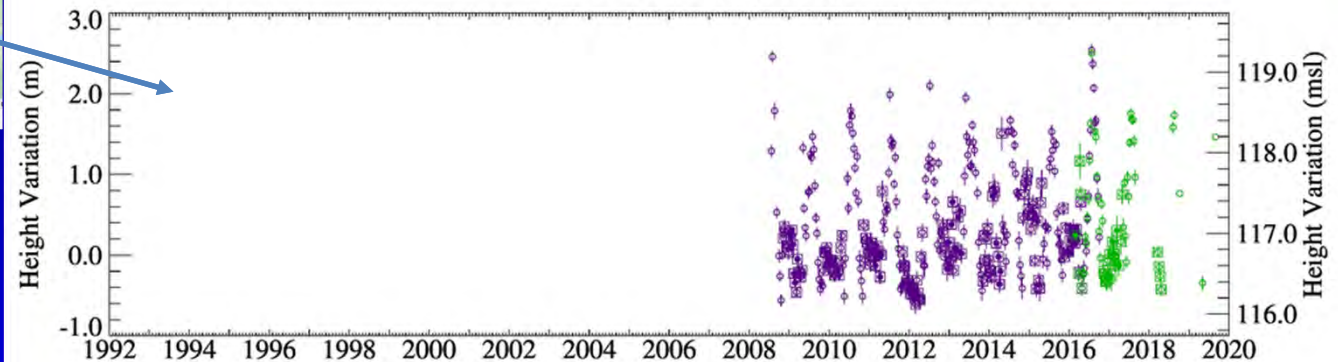
Braided reach

10-Day

Target name or ID

Advisories - Download Time Series

Tanana River



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

*** 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.2.4

J-2 Ref Pass 230 Cycle 102

Last valid elevation: 28 Aug., 2019

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 presentation 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.

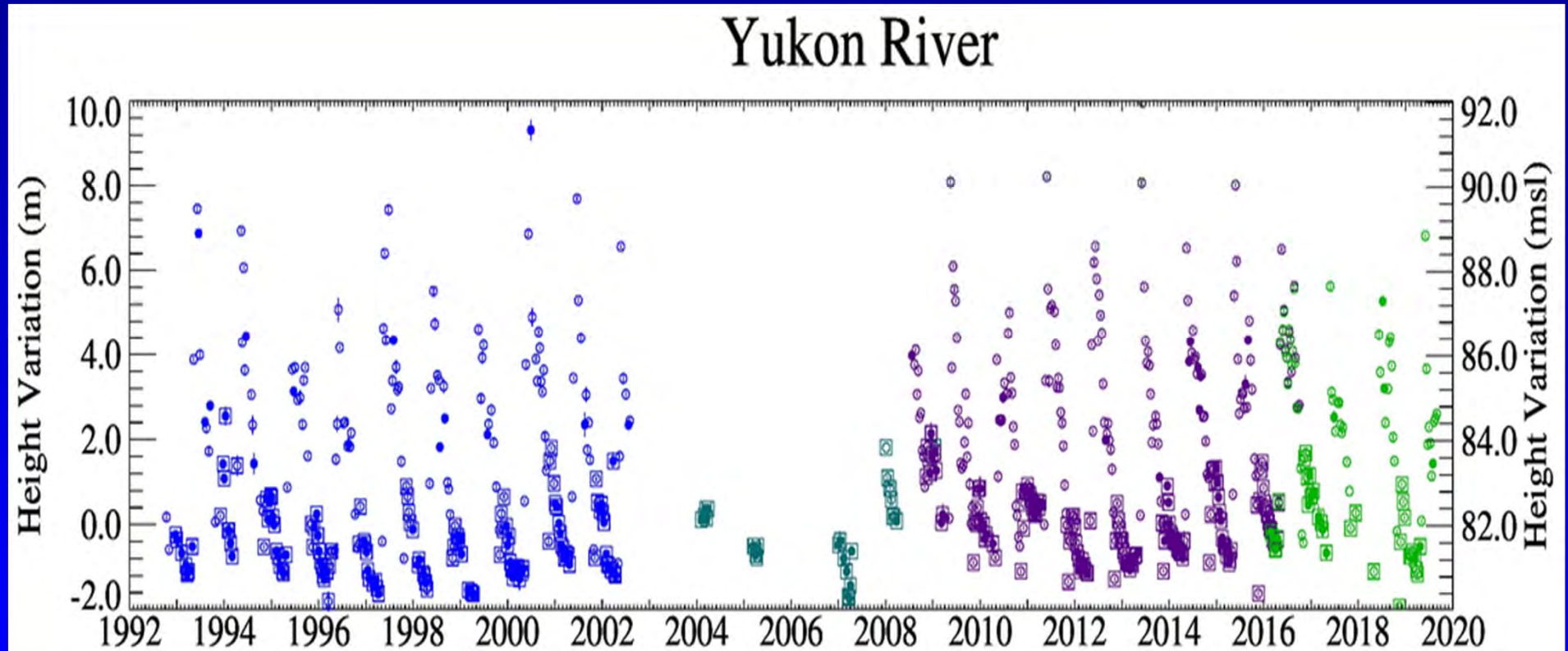
Multi-Decadal Timelines important for Historical Reconstruction



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



*** 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.2.4
J-2 Ref Pass 227 Cycle 199
Last valid elevation: 28 Aug., 2019



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

