Ocean Surface Topography
Science Team Meeting
Oct 31 – Nov 4, 2022

Global Water Monitor: Operational monitoring of lakes, wetlands, and river reaches for Natural Hazards and Regional Security

Martina Ricko, KBR at NASA/GSFC
Charon Birkett, NASA/GSFC
Hunter Yang, KBR at NASA/GSFC
Curt Reynolds, USDA, Washington DC
Elias Deeb, USACE, New Hampshire

Contact: Martina.Ricko@us.kbr.com

Supported by NASA OST and NASA Applied Sciences/Water Resources (Integration of Remotely Sensed Streamflow Data into Alaska Water Resources Management Agency Operations, 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

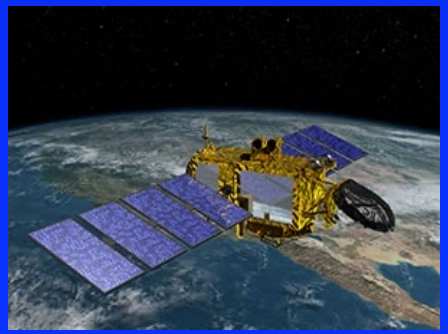
Monthly sampling or better

Continuous Global Monitoring

Fast response to data issues

&

Mission Continuity



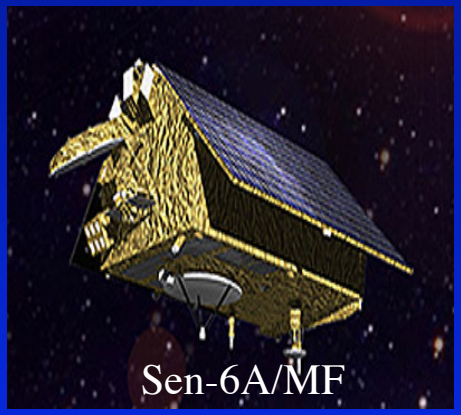
Continuity and Enhanced Technology

Continuity of Short-term Repeat

2016-2021

2016 (+2023)

2018 (+2025)



2020 (+2025)

Data Fusion - Mapping & Enhancements

2010

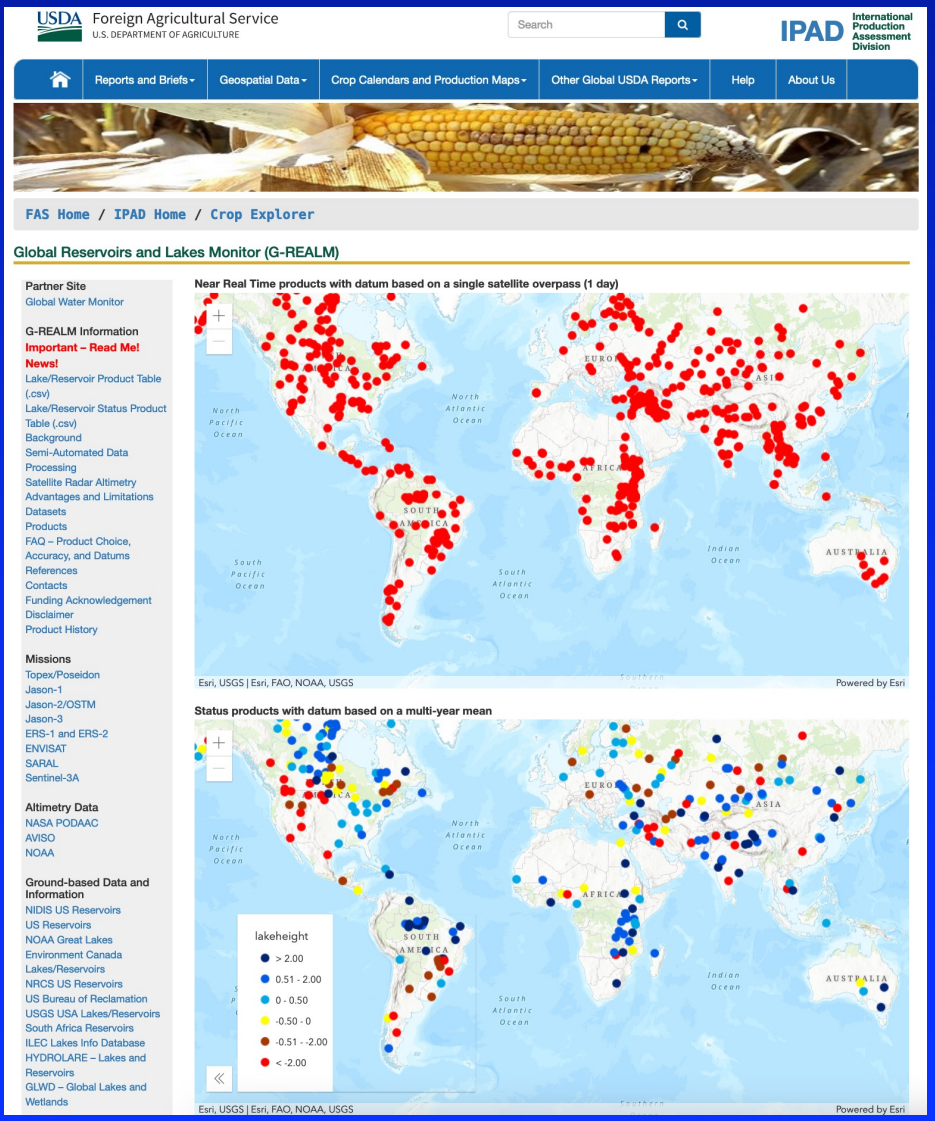
2018

2018

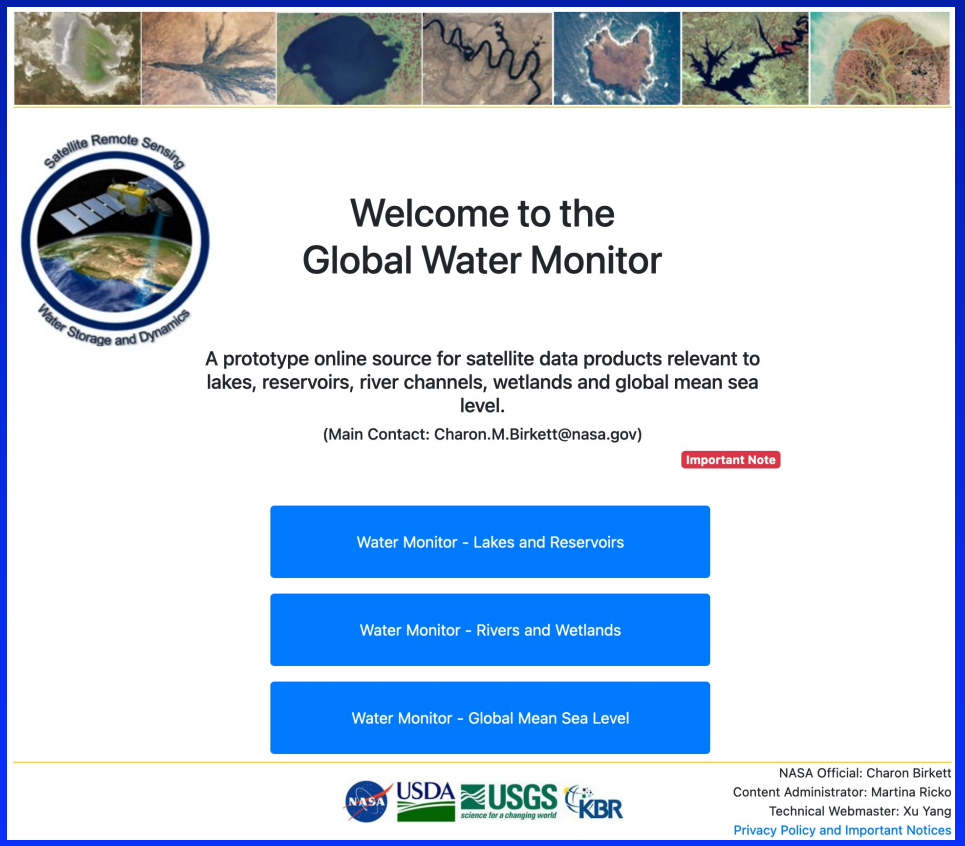
2022

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

Global Reservoirs and Lakes Monitor (G-REALM)
https://ipad.fas.usda.gov/cropexplorer/global_reservoir/

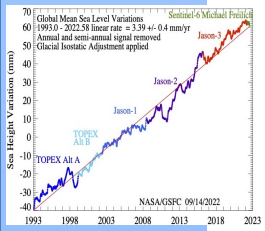


Global Water Monitor (GWM)
https://blueice.gsfc.nasa.gov/gwm



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

30yr global mean sea level estimation (reference)

Glacial Isostatic Adjustments

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

30yr co-linear mean sea surface variations

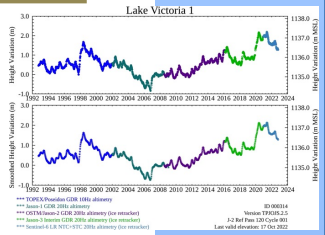
GDR Flags for global ocean mask

Geo-referenced time-tagged altimetric parameter databases for oceans

Sea State Bias
Global Ocean Tide Model
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

30yr 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)

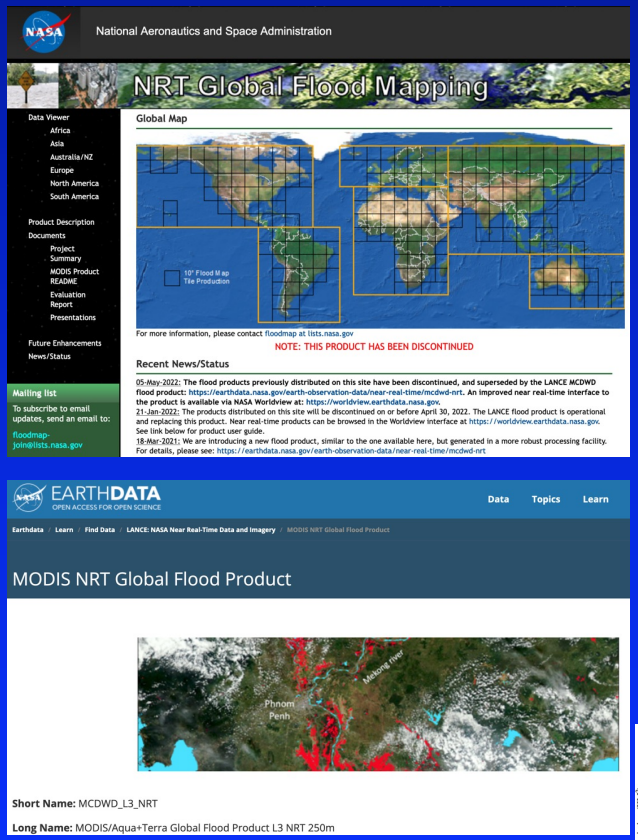
20Hz IGDR/GDR
(+Future Land retracking via SDR)

GSFC Precise Satellite Orbits

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

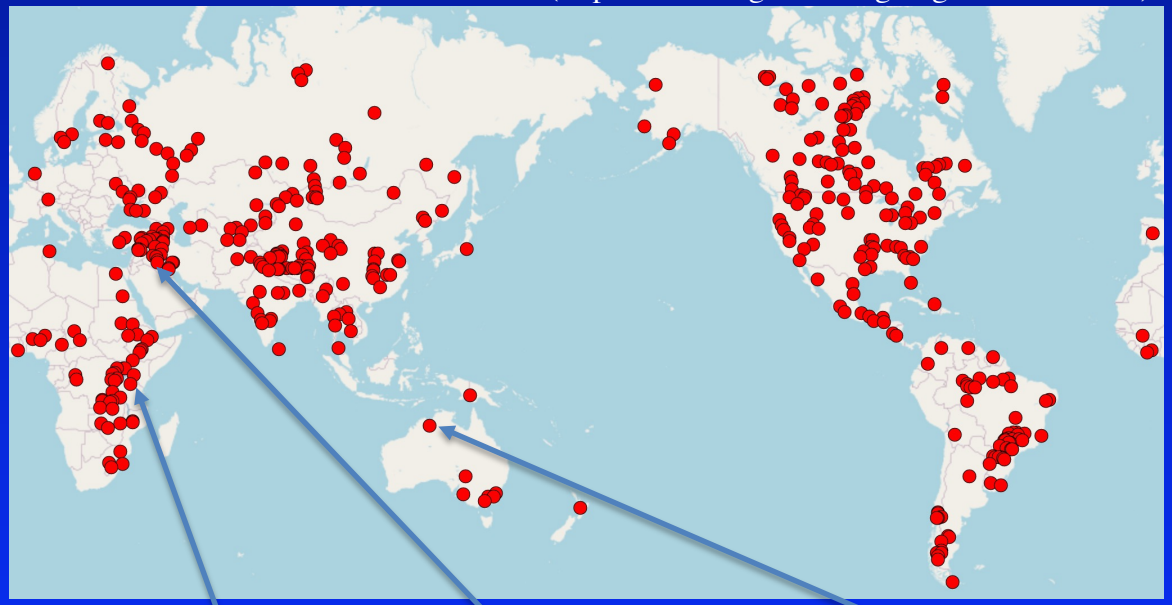
Lakes/Reservoirs: Surface Extent Products

as a standalone monitoring parameter or combined with altimetric elevation for storage changes

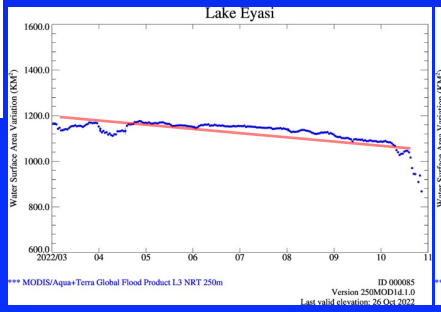


Based on the NASA Near Real Time Global Flood Mapping Tool.
MODIS 250m 8-day composites.

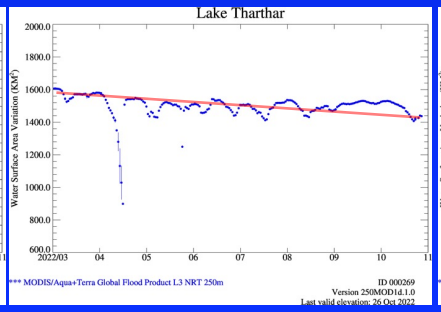
GWM Lake Extent Products (https://blueice.gsfc.nasa.gov/gwm/lake/Index)



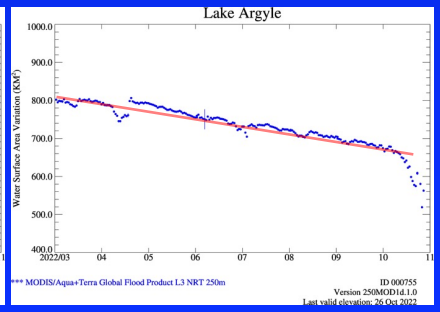
Lake Eyasi (Tanzania)



Lake Tharthar (Iraq)

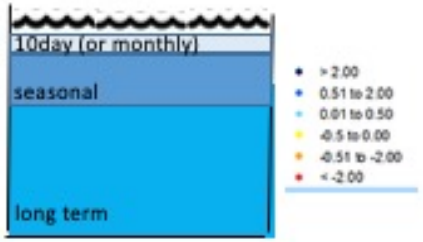


Lake Argyle (Australia)



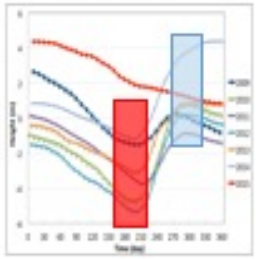
Examples of declining water surface area => drought events!

Status-1



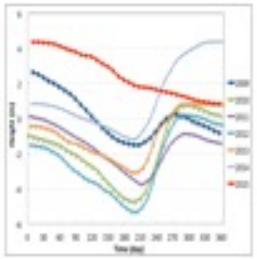
Status Source: Water Levels
Seasonal Baseline: March to May
Long-term Baseline: 1993-2000

Status-2



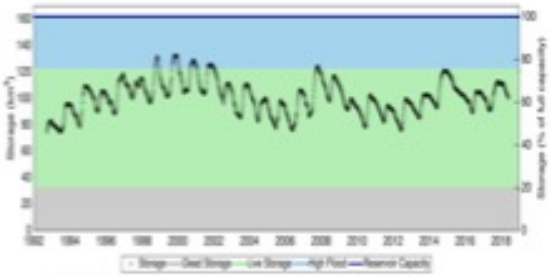
Day-to-day comparison
(Levels)

Status-3



Season-to-season comparison
(Levels)

Water Storage

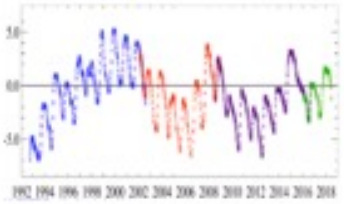


(i) Satellite-derived water level and extents
(ii) Published storage/Level relationship (Ref, 2020)

Reservoir Information

Regulation start date: 2010
Reservoir formation date: 2011

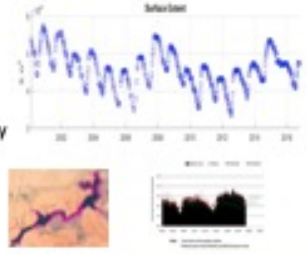
Water Level



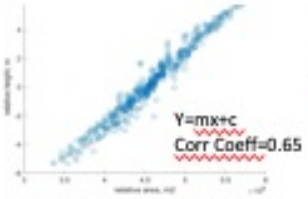
Source:
Topex/Jason
Radar Altimetry

Water Extent

Source:
MODIS 250m
8-day composites
SSM/I passive
Microwave imagery



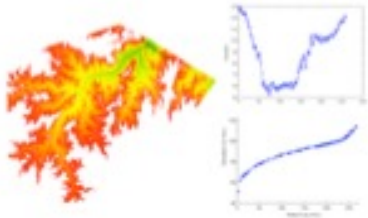
Hypsometry



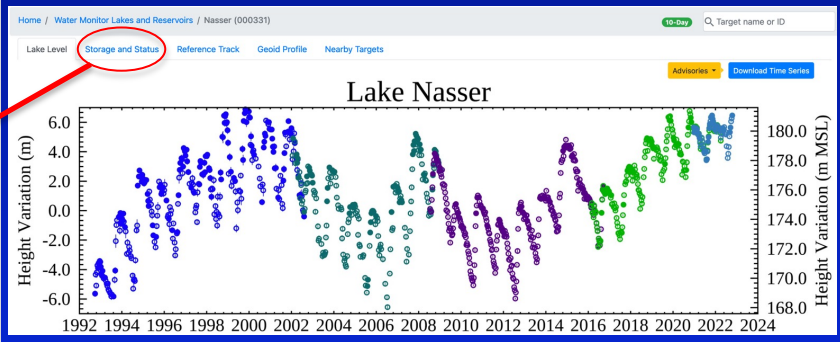
Source:
MODIS 250m 8-day
composite and
Topex/Jason
Radar Altimetry

Bathymetry

Source: SRTM



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.

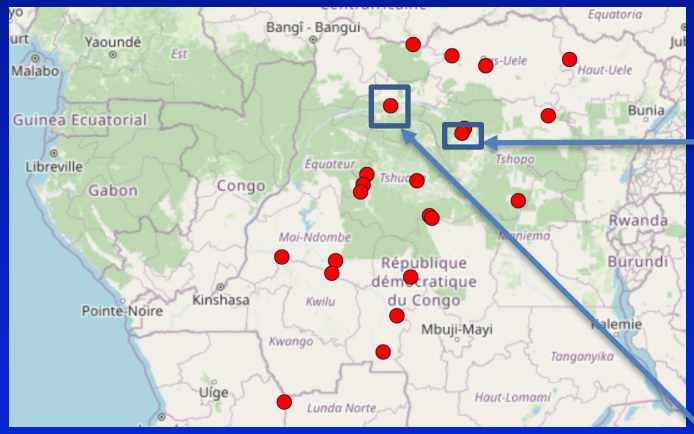
Monitoring drought (ongoing and recovery)

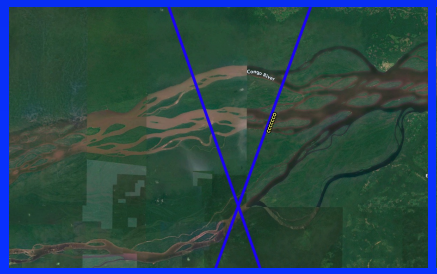
Watching pre-flood status and new reservoir in-fills and variability

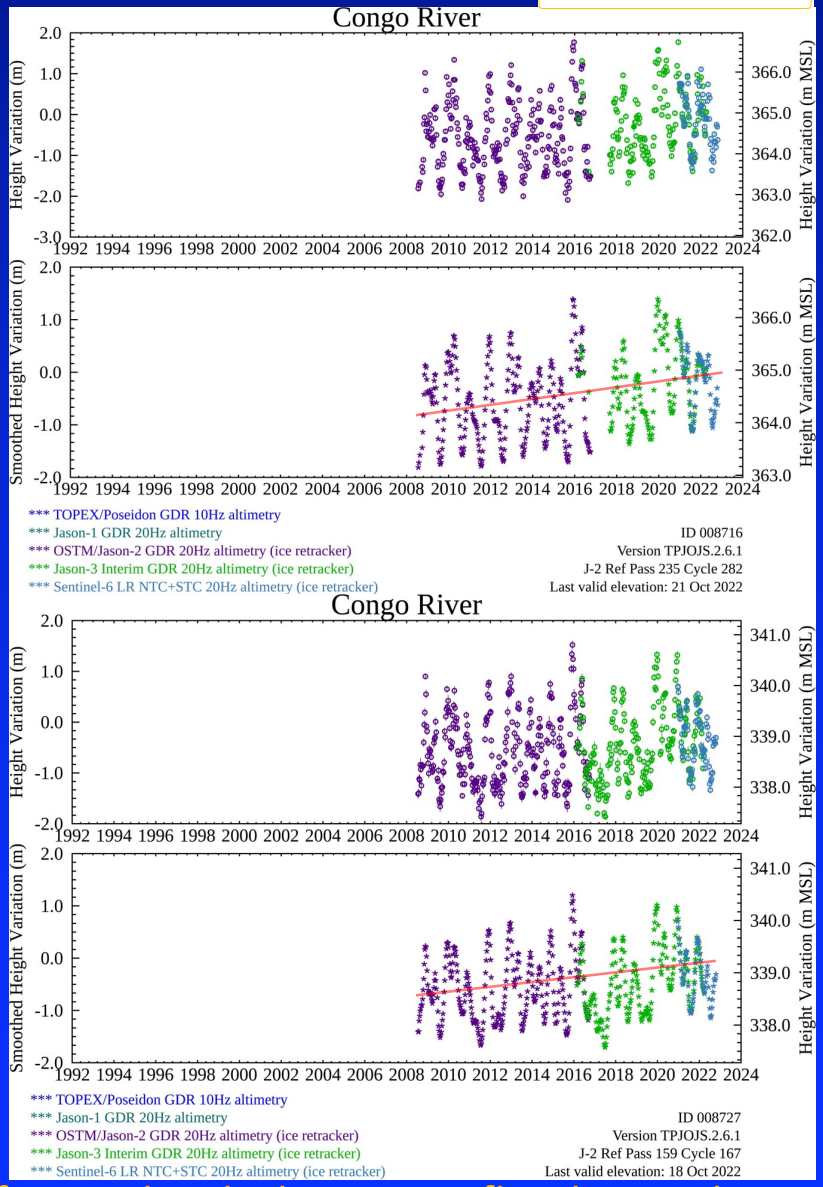
Global Water Monitor – Portal for River Surface Water Levels

Near real time monitoring is required for flood hazard monitoring.

Example: The Congo River in DR Congo, Africa.



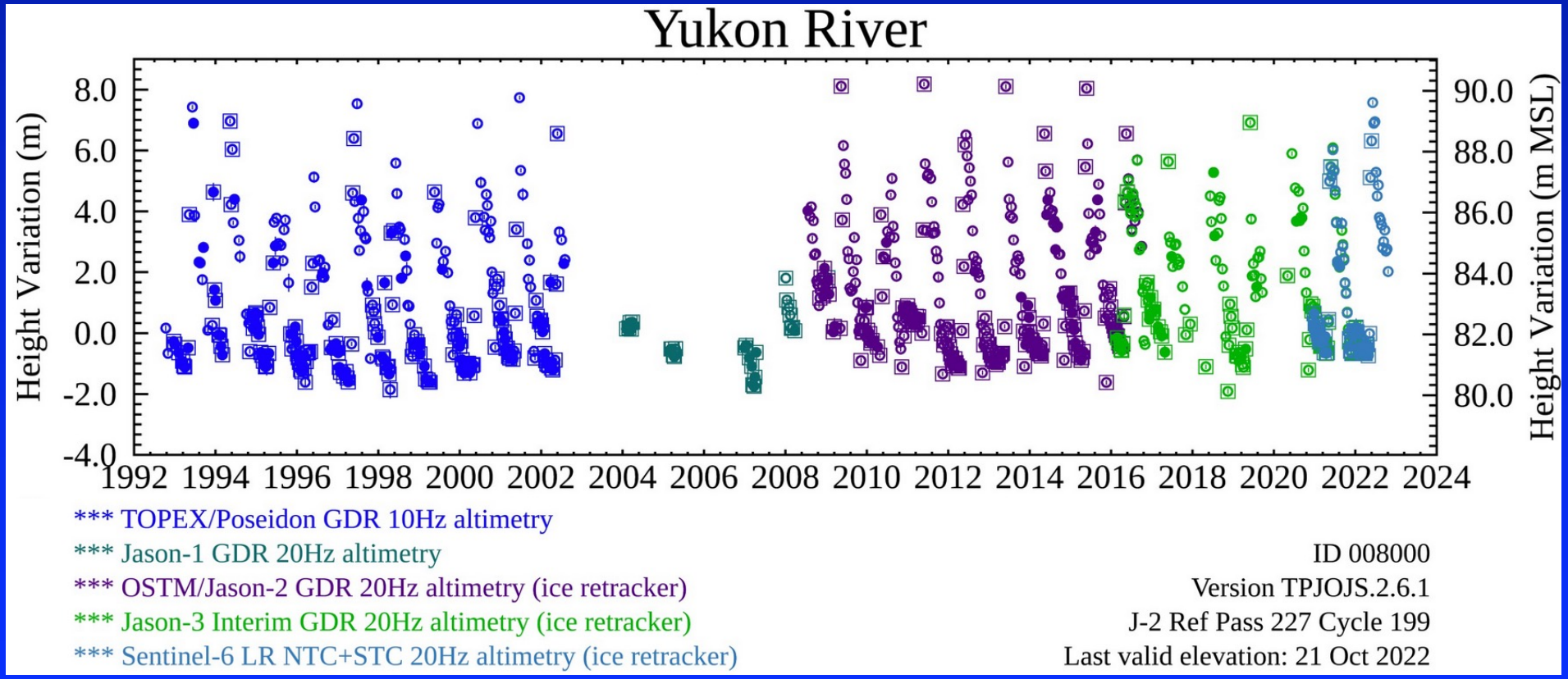




Examples of rising water level => monitoring of water levels during pre-flood status!

Multi-Decadal Timelines important for Historical Reconstruction => 30-yrs!

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



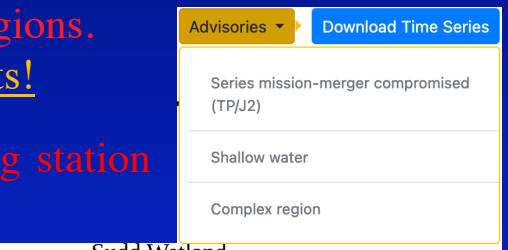
Yukon River example shows how successful Sentinel-6A is appended to Jason-3 data with a full 12-months overlap during 2020/2021 period, in high latitude region of Alaska, and during ice period (ice-jam breaks)!

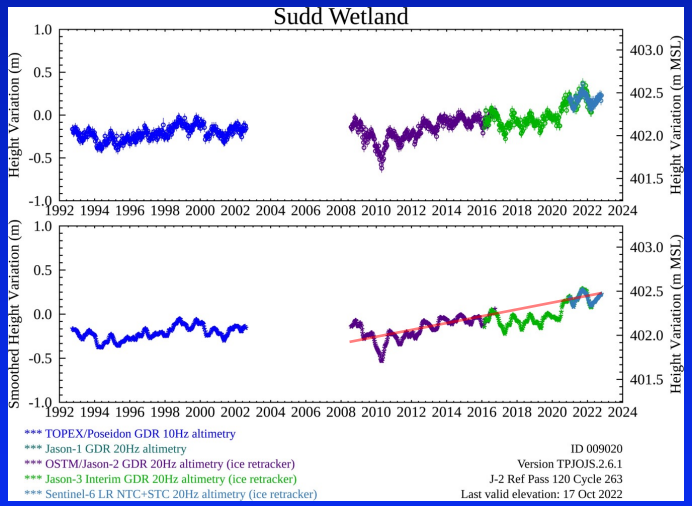
Global Water Monitor – Portal for Wetland Surface Water Levels

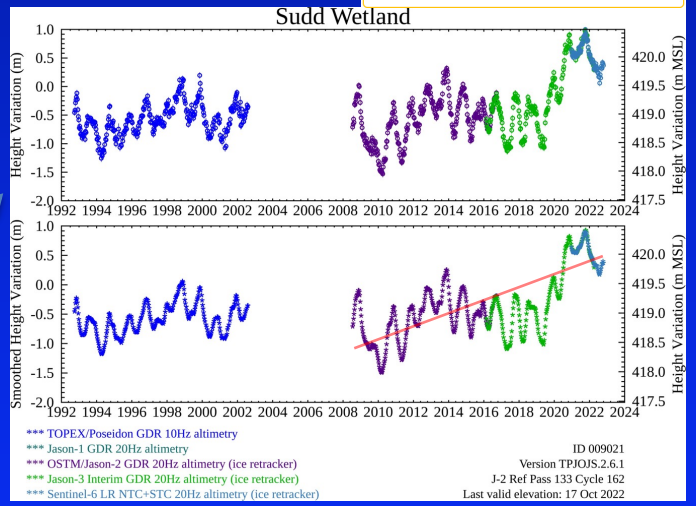
Monitoring of water variability in complex regions. In many places water resources for municipal and irrigation needs, and power supply generation, must all be addressed while maintaining conservation of these ecologically important regions.

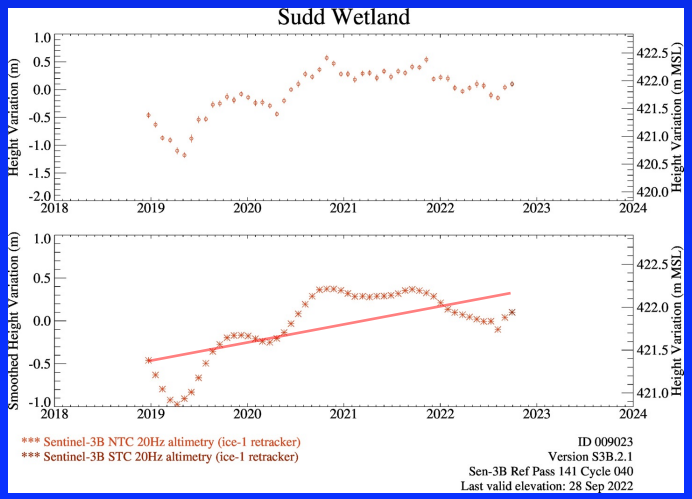
Sudd Wetlands in South Sudan: examples of rising water level => flood events!

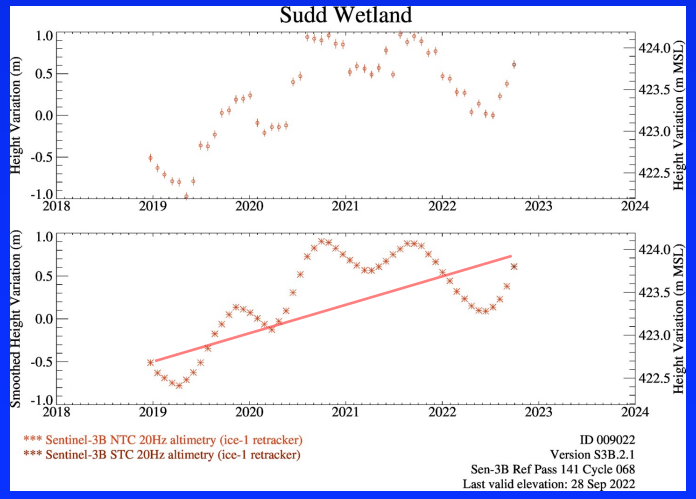
Sentinel-3A virtual stations added to supplement a ground-based monitoring station that aims to assist with early flood detection.









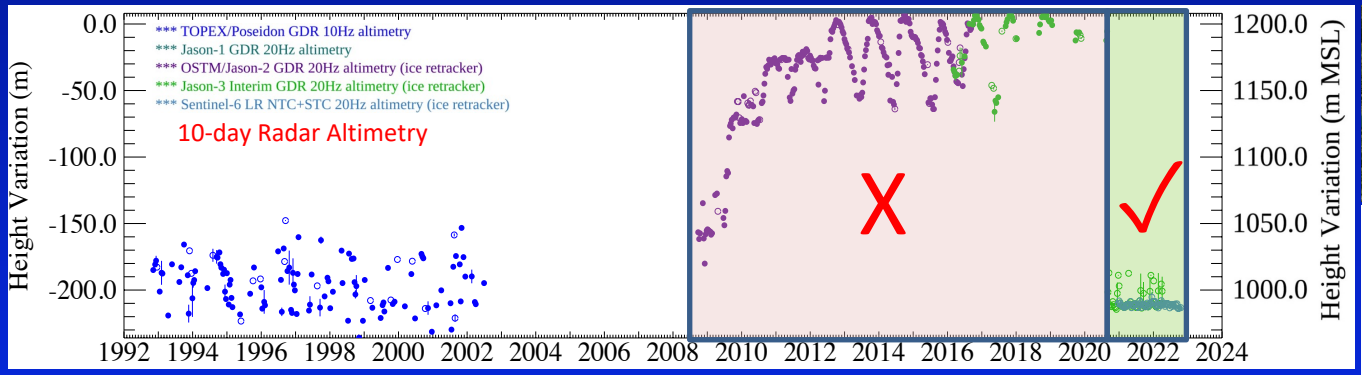


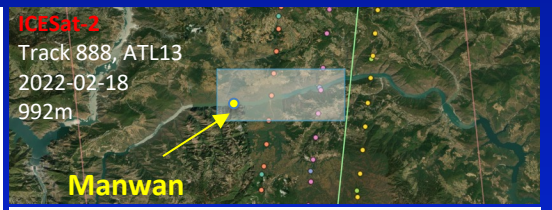
Jason-3/Sentinel-6A and Sentinel-3A DEM correction examples

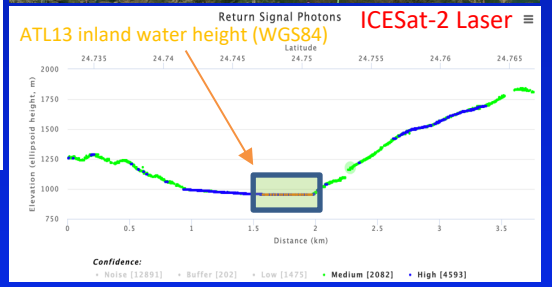
Improved surface acquisition (on-board DIODE/DEM mode)

Enhanced high-resolution information from ICESat-2 (https://openaltimetry.org/data/icesat2)

Manwan reservoir formed in 1994. Corrected Jason-3/Sentinel-6A DEM to a lower height during Sep 2020 update.

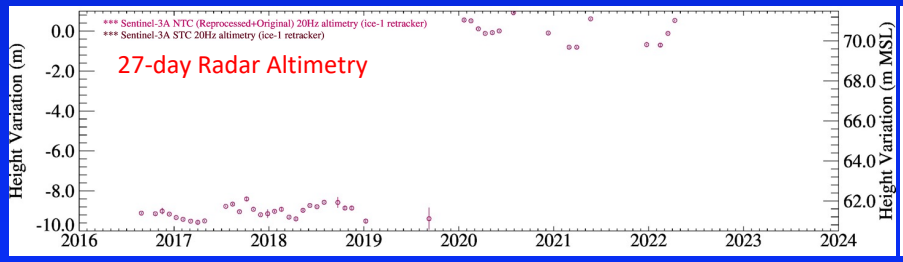


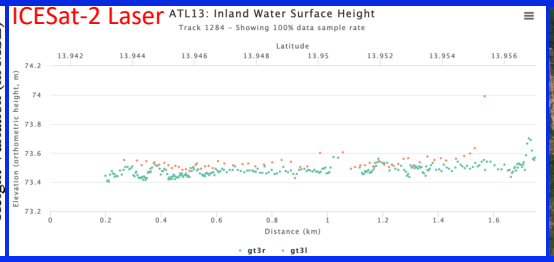




Don Sahong reservoir pool formed in 2017, but greatly expanded in 2019.

Virtual station added to the OLTC table in Aug 2020. Sentinel-3A DEM to be corrected.





Current and future building of dams will increase pressure on water resources and there is little governance with respect to water sharing and controls. Routine monitoring will aid regional security assessments.

Success/failures of the DEM from reported GWM products:

70 reported in 2021-2022, ~20 fixed, ~20 still waiting to be rectified (Sen-6A in 2022!)

Reporting the DEM failures to CNES: 3-4 times per year.

The DEM can be changed/corrected only once per year affecting the GWM Operations with delays of repair/validation of released products and creation of new products, and extra verification tasks.