Jason-2/OSTM, SARAL, and ICESat-1 Altimetry over Continental Waters with relevance to Research and Operational Programs

Charon Birkett (1), Dave Bjerklie (2), Claudia Carabajal (3), Brian Beckley and Xu Yang (4), and Curt Reynolds (5)

CONTACT: cmb@essic.umd.edu (Tel: 301-405-9296)

(1) ESSIC, University of Maryland at College Park, (2) USGS/Connecticut, (3) Sigma Space Corp. and (4) SGT at NASA/GSFC, (5) USDA/FAS Washington DC

Supported by NASA Grants NNX13AH15G (OSTST) and NNX12AJ85G (Applied Sciences).

Jason-2/OSTM PI Meeting, Constance, Germany, October 28th-31st, 2014

1. Introduction

Standard radar altimetry is applying itself to a number of research and operational-based programs that focus on lakes, reservoirs, river channels and wetland zones. With several decades of surface water level estimates, seasonal and inter-annual variations are being exploited for agriculture and climate analysis. The changes in water heights detected by radar are also used directly as an indicator of hydrologic flux, and are used as input to various algorithms that provide secondary data products including river flow and changes in water storage. Enhanced radar altimetry and laser altimetry (such as SARAL, Cryosat-2, ICESat-1) offers improvements in spatial resolution and accuracy, and multiple data sets allow for cross-validations. Here, we re-examine the performance of the Jason-3 and GLAS altimeters, and compare it to the performance of the AltiKa altimeter with relevance to on-going research and operational programs. Focus is on target acquisition times and elevation accuracy, and the merits of combining data sets. Regions of study include the Yukon River, the Usangu wetlands, and various small lakes, reservoirs and irrigation enclosures around the globe. Applications are both national and international with basin hydrology, conservation of ecosystems, and water resources interests and objectives.

2. Data Sets

TOPEX/Poseidon MGDR

Jason-1

Jason-2/OSTM
GDR Version D

NRL/GFO GDR

ESA/ERS-1. ERS-2 WAP

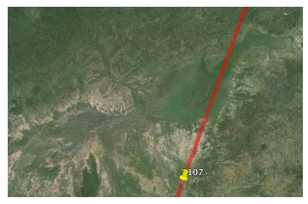
ESA/ENVISAT V2.1
RA/MWR GDR

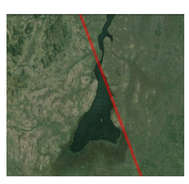
ICESat-1 Version 633
products 14 and 6.

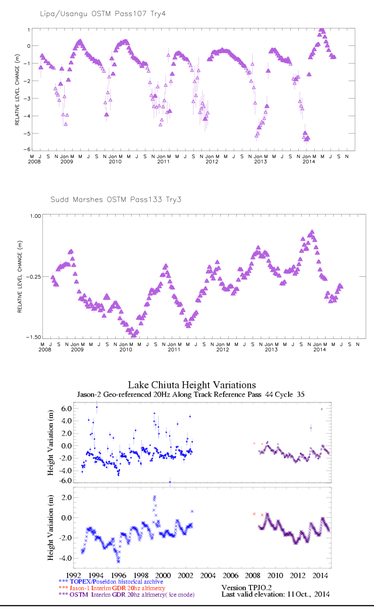
ISRO/SARAL GDR

3. Water Accounting, Habitat and Fisheries

Altimetric monitoring of lakes and wetlands for i) Fisheries (Lake Chilwa) in terms of catch potential, water levels, and variations due to climate change, ii) Conservation (Usangu) in terms of ecology concerns versus irrigation and grazing practices, iii) Dam controls (Sudd) and conservation.



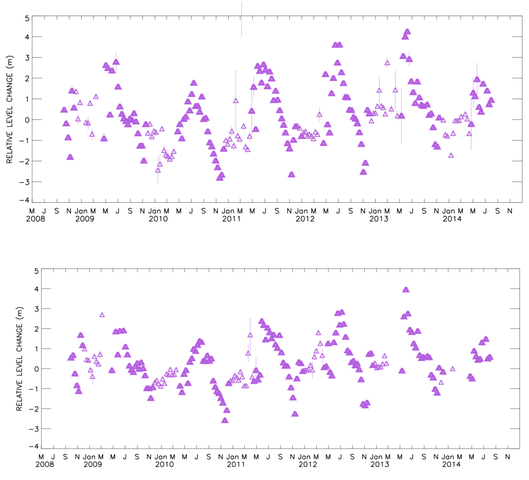


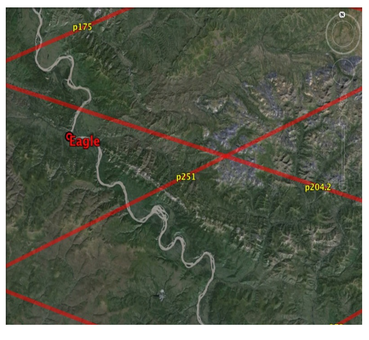


Jason-2/OSTM time series of water-level variations (GDR) for various satellite overpassesacross the Usangu marshes, the Sudd wetland and Lake Chilwa

4. The Yukon River Basin

The altimetric monitoring of a sparsely gauged river basin for i) an improved understanding of basin hydraulics and dynamics, and ii) towards the potential determination of river discharge via combining radar/laser/optical data sets and channel geometry theory.

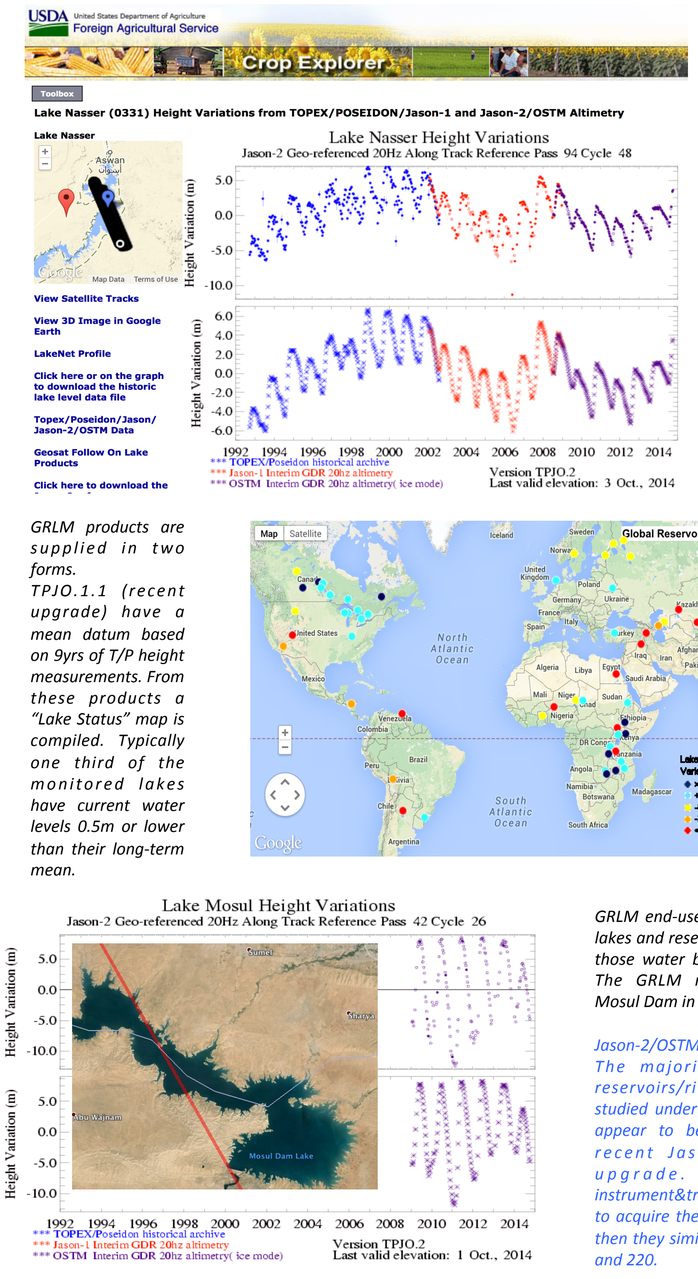




Jason-2/OSTM Time series of river channel water-level variations (GDR) for satellite overpasses up- and down- stream of the Eagle gauge station.

5. The USDA/NASA Global Reservoir and Lake Monitor

Altimetric monitoring of lakes and reservoirs for the USDA/NASA Global Reservoir and Lake Monitor.



Delivering 10-day resolution products based on the NASA/CNES T/P, and Jason series. Near real time products allow assessment of agricultural drought. Longer-term archive allows an assessment of hydrological drought.
A recent upgrade of products to TPJO.3 incorporates more accurate satelite orbit and atmospheric corrections.

GRLM products are supplied in two forms. TPJO.1.1 (recent upgrade) have a mean datum based on 9yrs of T/P height measurements. From these products a "Lake Status" map is compiled. Typically one third of the monitored lakes have current water levels 0.5m or lower than their long-term mean.

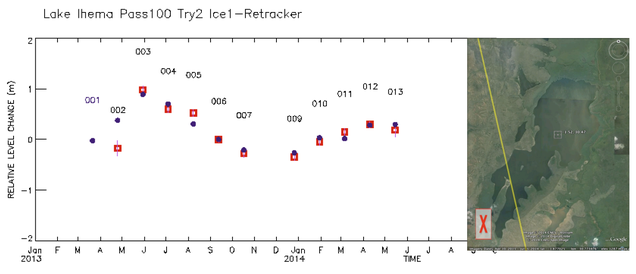
GRLM end-users request additional lakes and reservoirs, particularly for those water bodies "in the news". The GRLM recently added the Mosul Dam in Iraq.

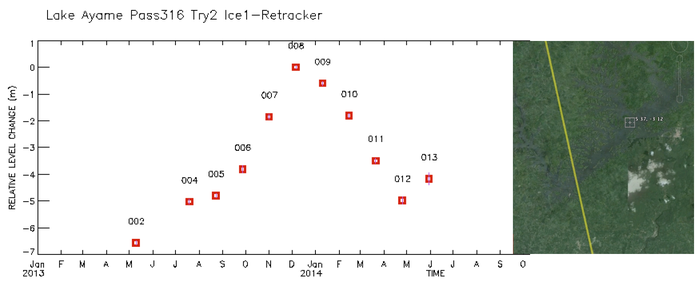
Jason-2/OSTM DEM Upgrade:
The majority of the lakes/ reservoirs/river/wetland zones studied under this program do not appear to be influenced by the recent Jason-2/OSTM DEM upgrade. If the Jason-3 instrument&trackig logic logic fail to acquire the surface in cycle 034, then they similarly fail in cycles 209 and 220.

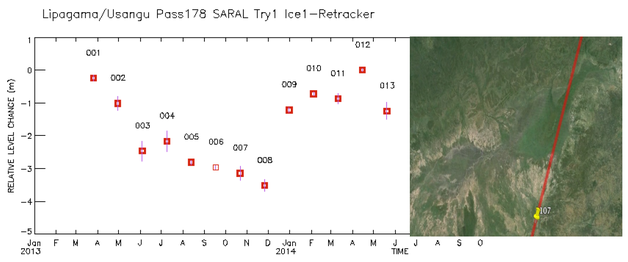
6. Exploration of SARAL

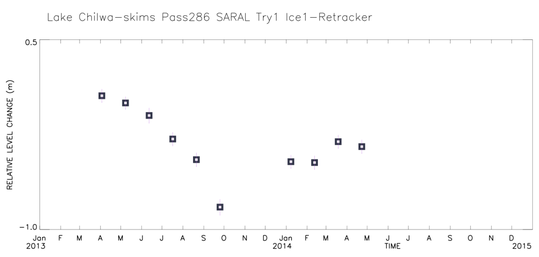
The exploration of a new altimetric data set for contributions to science and applied programs. (See Oral presentation for details)
- Majority of water body elevations appear ok
- Ice retrackers better than ocean over calmer waters
- Acquisition times/distances) variable (e.g. 3-4km Lake Van, Turkey)
- Deviations from reference track can be several km.
- Target acquisition and maintaining lock appears problematic in some regions with the need for echo retracking investigations.
- Height bias and "striping" - requesting instrument teams to further investigate and notify SWT if rectification is possible.

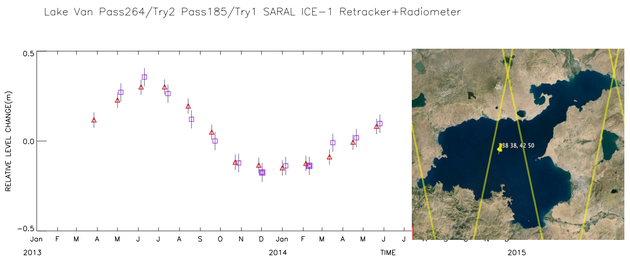
Examples of good acquisition and surface tracking

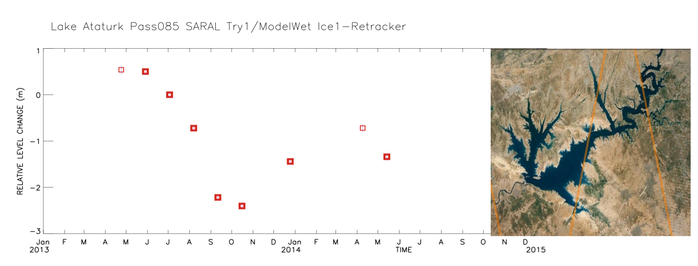


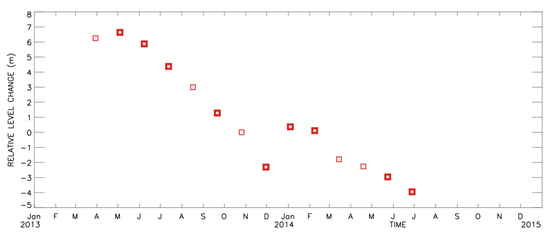


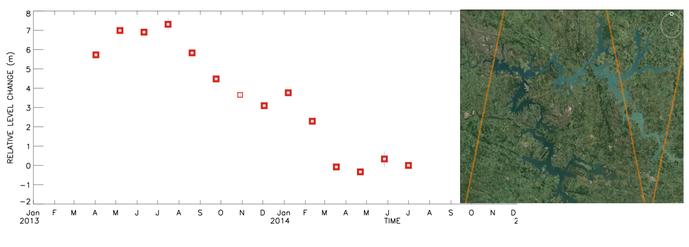




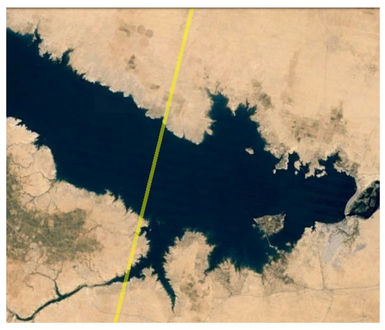




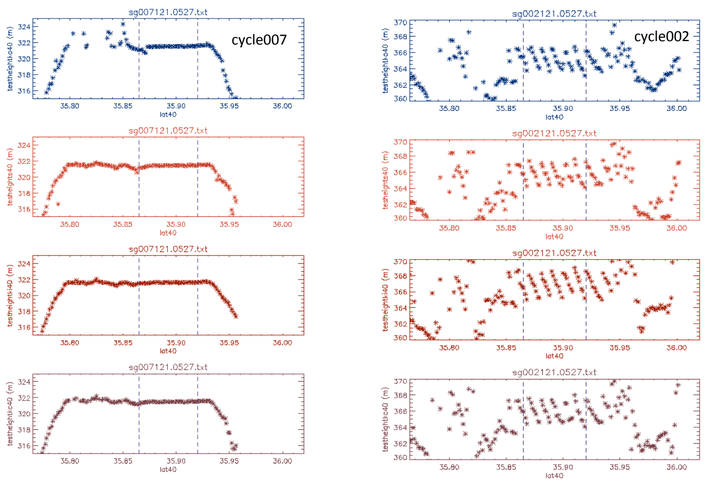


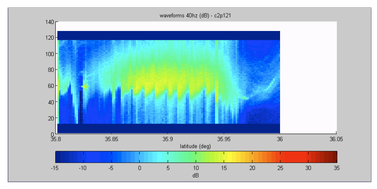


Examples of problematic acquisition and surface tracking

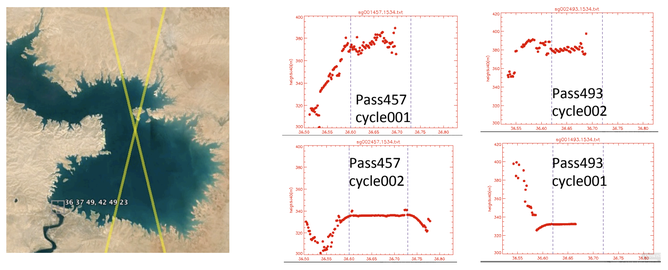


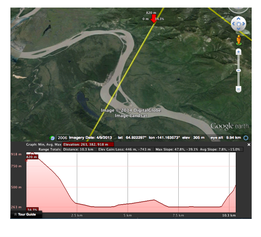
Lake 600km²
Narrowest extent 9km
Max cross-track separations 2.8km
Data loss 40%
Pass121 – 40m height jumps and striping in 5 cycles

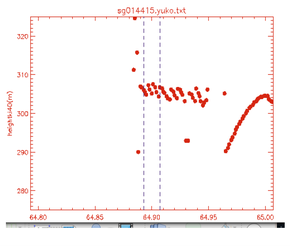




Lake 300km²
Narrowest extent 10km
Data loss 25-66%
Max cross-track separations 0.9-2.4km
Pass457 – 30m height jumps in 3 cycles Pass493 – 25m height jumps in 6 cycles
with "striping" observed in 4 (cycles 002, 004, 005, 011)







SARAL Pass830
Narrowest extent 0.9km+islands
Data loss 100%
~25m height jumps and striping in 3 cycles
SARAL Pass286
Narrowest extent 2km+islands
Data loss 75%