SWOT cal/val Lake Issyk Kul (Kyrgyzstan) two ships – two buoys

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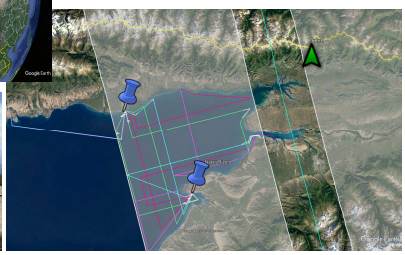
Radar altimetry is widely used for monitoring global and regional sea level changes as well as monitoring inland water resources such as in lakes, reservoirs and rivers. One of the major uncertainties is a possible drift of (one of the components of) the radar sensors resulting in an apparent drift of the derived water level time series.

A permanent monitoring facility is established at Lake Issyk Kul in Kyrgyzstan. The lake is a large high-altitude inland lake but ice-free the year around. Due to its E-W extension of ~170km all active radar altimetry missions cross this lake. LEGOS (France), CAIAG (Kyrgyzstan) and GFZ Potsdam (Germany) operate several GNSS-controlled tide gauges (N, NE, S, E, W) and two **r**emotely **o**perated **m**ulti-**p**arameter **s**tations (ROMPS), which deliver meteorological information at the western and southern Lake Issyk Kul shore. The lake has very favorite monitoring conditions. The surface is neither influenced by tides nor by inverse barometric effects. Seiches, which occur occasionally during strong winds are identifiable by data of the wind sensor at the east coast and the distinct variations (120') of the lake level. Surge effects are also small.

For the SWOT cal/val a comprehensive plan was developed taking advantage of the tide gauges at the northern and southern coast within the SWOT beam and the two ships and two buoys/GNSS-carpet. In addition, three continuous GNSS stations where operated additionally to all other sensors for a better characterization of the ionospheric and tropospheric disturbances. With two vessels (Multur and Fortuna) lake level profiles where mapped during the days, which are either along- or cross-track to the SWOT beam. This (will) allow(s) to asses the random and roll errors across the swath, and to determine the precision of the instrument in Low Resolution (LR) and High Resolution (HR) mode.

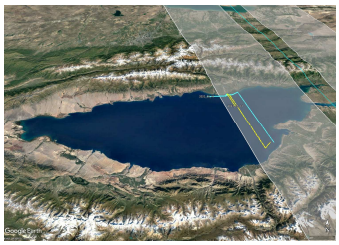
Issyk Kul – SWOT Tier 1 site

During the 1-day cal/val phase, the lake was passed on a descending arc with the right swath. The nadir beam was in shallow water.
Both tide gauges (pin) had a continuous GNSS. ROMPS are not shown.

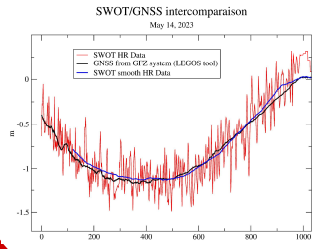


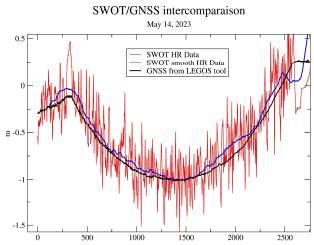
Equipment

First results & To Do's



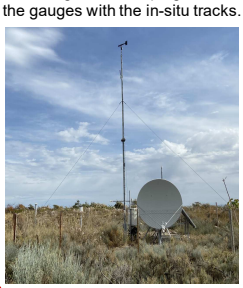
For the characterization of the SWOT along-track stability both vessels followed a S-N track (after the passage 4:50LT). The more tracks on other days are not detailed here, they are under processing.
First results show still differences between the SWOT-HR results and the ship tracks. More detailed analyses of both, SWOT and GNSS@vessels is needed to fully understand the individual errors and the potential of SWOT over inland water bodies.



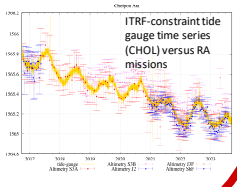


Issyk Kul Radar Altimetry Monitoring

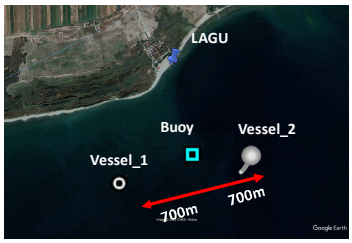
Since 2008 the Issyk Kul is quipped with digital tide gauges (OTT RLS), GNSS and meteorological station by LEGOS. Additional gauges (VEGA WL61) have been added at different locations by GFZ/CAIAG to support the monitoring of radar altimetry but also study effects of climate change in water availability in Central Asia. Tide gauge data (radar and pressure) is sampled every minute (WL61) and 5 minutes (RLS). All gauges are connected to either continuous or campaign GNSS-sites by leveling. Various ground campaigns with vessels connect the gauges with the in-situ tracks.



The setup of the observatory is complemented by two ROMPS climate stations delivering environmental data, such as wind and air pressure, every five minutes. Additionally GNSS is operated continuously allowing to estimate TZD. Both stations are part of GFZ's Global Change Observatory Central Asia and the regional Green Central Asia network, funded by the German MFA. Climate data are freely available at https://sdss.caiag.kg.



Special Experiments



During the cal/val period we took advantage of the project design. While SWOT was passing the three systems where drifting 1.5km off the LAGU tide gauge spanning a along- and cross-track net. Despite possible tilts of the lake surface and missing cross-test between the sensors, the results agree quite well.

Vessel_1 = 1563,824 ± 0,1154 m
Buoy = 1563,813 ± 0,0661 m
Vessel_2 = 1563,826 ± 0,0680 m
LAGU = 1564,116 ± 0,0053 m

The water level of the GNSS-controlled LAGU tide was controlled by the buoy, the height difference to the offshore instrumentation is due to the surface tilt (either current or geoid) between the locations. This opens also the possibility to control every SWOT passage during the cal/val and the nominal orbit.

A similar experiment was performed at the southern shore, 3.5km off NATI tide gauge and 800m offset between the vessels and the buoy. Processing of the data is under way.

The first day of the mission, both vessels followed (almost) the same track to allow the inter-comparison between all 4 sensor systems.

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We appreciate the support of the crews of the Multur and Fortuna for their very early morning wakeup and fully day work.
We also appreciate the support of many colleagues, which helped us with the installation and operation.