Short Project Summary

Water level time series from satellite altimetry

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Monitoring water level variation is of unarguable importance in water management. The information has been traditionally provided by *in situ* gauging stations, the number of which has significantly decreased during the last few decades. Satellite altimetry has proved effective in filling this gap (Calmant et al., 2008) and more than that offering a much denser network of virtual gauging stations at a global scale. As part of the research project SaWaM, our group has focused on deriving water level time series by conducting inland altimetry.

Methods and Data

In order to derive water level time series, the altimeter's range measurements are corrected for path delays caused by the atmospheric (wet tropospheric, dry tropospheric, ionospheric, and inverse barometric) and geophysical effects (solid earth tide, ocean tide, pole tide and sea state bias). The water level is then calculated by subtracting the corrected range from the satellite altitude (Figure 1).

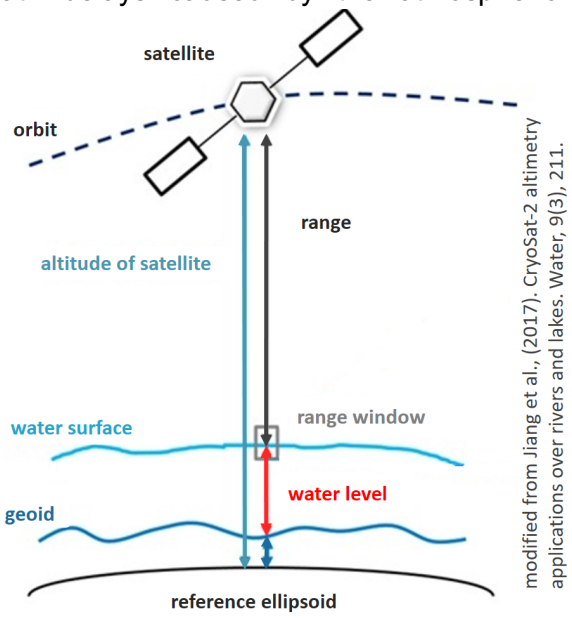

Figure 1. The basic principle of satellite altimetry

Each water level time series is calculated for a single virtual station. A virtual station (Figure 2) is the average position of intersection between an altimetry ground track and the inland water body of interest.

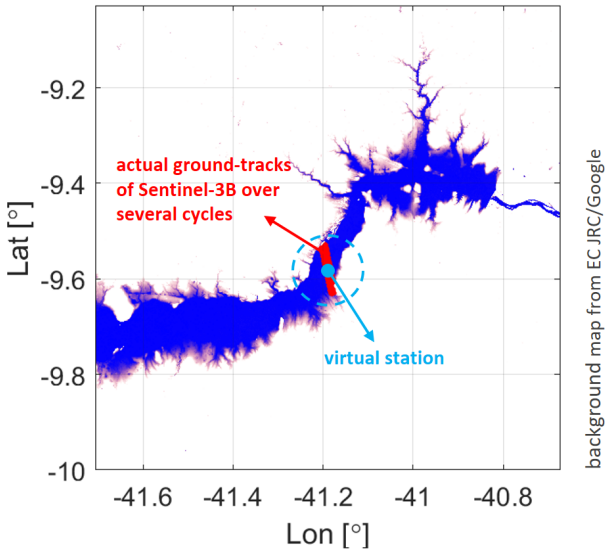

Figure 2. An altimetry virtual station from Sentinel-3A (pass number 33) over the São Francisco river

Table 1 details the most important specifications of the satellite altimetry data which are used in determining the water level time series. The geoid model XGM2019e is used as the reference height.

Table 1. Specifications of the altimetry datasets used for deriving the water level time series

MISSION	VERSION	RETRACKER	SOURCE
ENVISAT	GDR-V3	ICE-1	ESA
ENVISAT-XT[1]	GDR-V3	ICE-1	ESA
SARAL/ALTIKA	GDR-t	ICE-1	AVISO
JASON-1	GDR-e	ICE	AVISO
JASON-2	GDR-d	ICE	AVISO
JASON-3	GDR-d	ICE	AVISO
SENTINEL-3A	O_NT_003	OCOG	COPERNICUS
SENTINEL-3B	O_NT_003	OCOG	COPERNICUS

Results and Conclusions

We have generated water level time series for tens of altimetry gauging stations in São Francisco (Brazil), Karun (Iran), Blue Nile (Sudan), and Upper Atbara (Sudan) basins. The products will be publically available through the SaWaM Decision Support Server (DSS).

Our research confirms that local water authorities can benefit from satellite altimetry data in order to establish virtual gauging stations over lakes, reservoirs, and rivers. This will enrich the water monitoring databases, and provide valuable information during hazards – e.g. the mid-March to April 2019 flooding in Iran which destroyed several water gauging stations. Moreover, the altimetry-derived water heights are shown to be effective in hydrologic and hydrodynamic modeling and discharge estimation (Schneider et al., 2018; Tourian et al., 2013). Another less emphasized application is the potential in resolving transboundary water disputes – e.g. the conflict between Sudan, Egypt, and Ethiopia over filling of the Grand Ethiopian Renaissance Dam (GERD) (Biancamaria et al., 2011).

References

Biancamaria, S., Hossain, F. and Lettenmaier, D. P.: Forecasting transboundary river water elevations from space, Geophys. Res. Lett., 38(11), 2011.
Calmant, S., Seyler, F. and Cretaux, J. F.: Monitoring continental surface waters by satellite altimetry, Surv. Geophys., 29(4–5), 247–269, 2008.
Schneider, R., Tarpanelli, A., Nielsen, K., Madsen, H. and Bauer-Gottwein, P.: Evaluation of multi-mode CryoSat-2 altimetry data over the Po River against in situ data and a hydrodynamic model, Adv. Water Resour., 112, 17–26, 2018.
Tourian, M. J., Sneeuw, N. and Bárdossy, A.: A quantile function approach to discharge estimation from satellite altimetry (ENVISAT), Water Resour. Res., 49(7), 4174–4186, 2013.

[1] Envisat-XT stands for the Envisat mission while on the interleaved orbit.