Geophysical Research Abstracts
Vol. 20, EGU2018-12813-2, 2018
EGU General Assembly 2018

Evaluation of the Sentinel-3 tropospheric corrections over continental waters

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In the scope of the Sentinel-3 Hydrologic Altimetry PrototypE (SHAPE) project, the tropospheric corrections provided in satellite altimetry products over continental waters (rivers, lakes and enclosed seas) have been analysed, aiming at inspecting the errors that presently affect the tropospheric corrections – dry and wet tropospheric corrections (DTC and WTC, respectively). These errors arise because both corrections, being dependent on altitude, are usually computed with respect to an incorrect altitude reference. This study is conducted on selected regions of interest (ROI), such as the Amazon and Danube rivers, Titicaca and Vanern lakes and the Caspian Sea.
DTC and WTC provided in Sentinel-3 (S3) products, at 1 Hz, have been compared to those derived from European Centre for Medium-Range Weather Forecasts (ECMWF) Operational model, at 20 Hz, and computed at different altitude references: i) ECMWF orography; ii) ACE2 (Altimeter Corrected Elevations 2) global digital elevation model (DEM); iii) mean lake level, derived from Envisat data, or river profile derived in the scope of SHAPE project by Along-Track (ATK). Whenever Global Navigation Satellite Systems (GNSS) data are available in the ROI, a GNSS-derived WTC was also generated and used for comparison. On the other hand, in-situ measurements of atmospheric pressure were also used to derive DTC values, allowing an independent evaluation.
Tropospheric corrections present in S3 products are provided at two different levels: measurement and zero level. Over inland water regions, tropospheric corrections computed at zero altitude are not recommended, being suitable only for open-ocean. Concerning the tropospheric corrections provided in S3 products at measurement level, globally they are very close to those computed at DEM and mean level, with non-significant differences over e.g. central parts of lakes, however large differences are found close to the sea/lake borders and mainly in the rivers. It can be observed that these errors are mainly related with the poor sampling of the corrections (1 Hz). To mitigate these errors, with direct impact in the determination of mean river profiles or lake level time series, both DTC and WTC should be computed at 20 Hz. In summary, the main issues related to the DTC and WTC provided in S3 products are due to the fact that they are provided at 1 Hz instead of 20 Hz, with significant impact on regions with large height gradients, such as narrow rivers.
Independent comparisons show that, once computed at the correct surface elevation, the errors in model-derived tropospheric corrections are expected to be less than 1 cm for the DTC and less than 2 cm for the WTC.