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Cryosat-2 and Sentinel-3 tropospheric corrections: their evaluation over rivers and lakes

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In the scope of the Sentinel-3 Hydrologic Altimetry PrototypE (SHAPE) project, errors that presently affect the tropospheric corrections i.e. dry and wet tropospheric corrections (DTC and WTC, respectively) given in satellite altimetry products are evaluated over inland water regions. These errors arise because both corrections, function of altitude, are usually computed with respect to an incorrect altitude reference. Several regions of interest (ROI) where CryoSat-2 (CS-2) is operating in SAR/SAR-In modes were selected for this evaluation. In this study, results for Danube River, Amazon Basin, Vanern and Titicaca lakes, and Caspian Sea, using Level 1B CS-2 data, are shown.

DTC and WTC have been compared to those derived from ECMWF Operational model and computed at different altitude references: i) ECMWF orography; ii) ACE2 (Altimeter Corrected Elevations 2) and GWD-LR (Global Width Database for Large Rivers) global digital elevation models; iii) mean lake level, derived from Envisat mission data, or river profile derived in the scope of SHAPE project by AlongTrack (ATK) using Jason-2 data. Whenever GNSS data are available in the ROI, a GNSS-derived WTC was also generated and used for comparison.

Overall, results show that the tropospheric corrections present in CS-2 L1B products are provided at the level of ECMWF orography, which can depart from the mean lake level or river profile by hundreds of metres. Therefore, the use of the model orography originates errors in the corrections. To mitigate these errors, both DTC and WTC should be provided at the mean river profile/lake level. For example, for the Caspian Sea with a mean level of -27 m, the tropospheric corrections provided in CS-2 products were computed at mean sea level (zero level), leading therefore to a systematic error in the corrections. In case a mean lake level is not available, it can be easily determined from satellite altimetry. In the absence of a mean river profile, both mentioned DEM, considered better altimetric surfaces when compared to the ECMWF orography, can be used.

When using the model orography, systematic errors up to 3-5 cm are found in the DTC for most of the selected regions, which can induce significant errors in e.g. the determination of mean river profiles or lake level time series. For the Danube River, larger DTC errors up to 10 cm, due to terrain characteristics, can appear. For the WTC, with higher spatial variability, model errors of magnitude 1-3 cm are expected over inland waters. In the Danube region, the comparison of GNSS- and ECMWF-derived WTC has shown that the error in the WTC computed at orography level can be up to $\sim$3 cm. WTC errors with this magnitude have been found for all ROI. Although globally small, these errors are systematic and must be corrected prior to the generation of CS-2 Level 2 products. Once computed at the mean profile and mean lake level, the results show that tropospheric corrections have accuracy better than 1 cm.

This analysis is currently being extended to S3 data and the first results are shown.