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Height Estimation and Error Assessment of Inland Water Level Time Series calculated by a Kalman Filter Approach using Multi-Mission Satellite Altimetry

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Originally designed for open ocean applications, satellite radar altimetry can also contribute promising results over inland waters. Its measurements help to understand the water cycle of the system earth and makes altimetry to a very useful instrument for hydrology.
In this paper, we present our methodology for estimating water level time series over lakes, rivers, reservoirs, and wetlands. Furthermore, the error estimation of the resulting water level time series is demonstrated. For computing the water level time series multi-mission satellite altimetry data is used. The estimation is based on altimeter data from Topex, Jason-1, Jason-2, Geosat, IceSAT, GFO, ERS-2, Envisat, Cryosat, HY-2A, and Saral/Altika – depending on the location of the water body. According to the extent of the investigated water body 1Hz, high-frequent or retracked altimeter measurements can be used. Classification methods such as Support Vector Machine (SVM) and Support Vector Regression (SVR) are applied for the classification of altimeter waveforms and for rejecting outliers. For estimating the water levels we use a Kalman filter approach applied to the grid nodes of a hexagonal grid covering the water body of interest. After applying an error limit on the resulting water level heights of each grid node, a weighted average water level per point of time is derived referring to one reference location.
For the estimation of water level height accuracies, at first, the formal errors are computed applying a full error propagation within Kalman filtering. Hereby, the precision of the input measurements are introduced by using the standard deviation of the water level height along the altimeter track. In addition to the resulting formal errors of water level heights, uncertainties of the applied geophysical correction (e.g. wet troposphere, ionosphere, etc.) and systematic error effects are taken into account to achieve more realistic error estimates.
For validation of the time series, we compare our results with gauges and external inland altimeter databases (e.g. Hydroweb). We yield very high correlations between absolute water level height time series from altimetry and gauges. Moreover, the comparisons of water level heights are also used for the validation of the error assessment.
More than 200 water level time series were already computed and made public available via the "Database for Hydrological Time Series of Inland Waters" (DAHITI) which is available via http://dahiti.dgfi.tum.de .