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Coastal Vertical Land motion in the German Bight

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In the framework of the ESA Sea Level Climate Change Initiative (CCI) we analyse a set of GNSS equipped tide gauges at the German Bight. Main goals are the determination of tropospheric zenith delay corrections for altimetric observations, precise coordinates in ITRF2008 and vertical land motion (VLM) rates of the tide gauge stations. These are to be used for georeferencing the tide gauges and the correction of tide gauge observations for VLM.

The set of stations includes 38 GNSS stations. 19 stations are in the German Bight, where 15 of them belong to the Bundesanstalt für Gewässerkunde, 3 to EUREF and 1 to GREF. These stations are collocated with tide gauges (TGs). The other 19 GNSS stations in the network belong to EUREF, IGS and GREF. We analyse data in the time span from 2008 till the end of 2016 with the Bernese PPP processing approach. Data are partly rather noisy and disturbed by offsets and data gaps at the coastal TG sites. Special effort is therefore put into a proper estimation of the VLM. We use FODITS (Ostini2012), HECTOR (Bos et al, 2013), CATS (Williams, 2003) and the MIDAS approach of Blewitt (2016) to robustly derive rates and realistic error estimates.

The results are compared to those published by the European Permanent Network (EPN), ITRF and the Système d'Observation du Niveau des Eaux Littorales (SONEL) for common stations. Vertical motion is small in general, at the -1 to -2 mm/yr level for most coastal stations. A comparison of the standard deviations of the velocity differences to EPN with the mean values of the estimated velocity standard deviations for our solution shows a very good agreement of the estimated velocities and their standard deviations with the reference solution from EPN. In the comparison with results by SONEL the standard deviation of the differences is slightly higher. The discrepancies may arise from differences in the time span analyzed and gaps, offsets and data preprocessing. The combined estimation of functional and stochastic parameters is rather sensitive to the characteristics of the time series and thus the estimated velocity also depends on the applied stochastic model and on the selected parameters.

The GPS vertical land motion rates are finally compared to the difference between sea level rates measured by co-located altimetry and by tide gauge station data, which gives another estimation of VLM.