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Validation of recent altimeter missions at non-dedicated tide gauge stations in the Southeastern North Sea

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The absolute and relative accuracy of sea surface heights derived from six altimeter missions (Jason-1/2/3, Envisat, Saral, Sentinel-3A) is evaluated at five GNSS-controlled tide gauge stations in the German Bight (SE North Sea). The precision of the total water level envelope (TWLE) is assessed for the period 2000 to 2019 based on RMS errors and explained variances. The comparison is based on TWLE instead of dealiased sea level data since the tidal and barotropic dynamic is not known with sufficient accuracy in this area. The tide gauges are partly located at the open sea, partly at the coast close to mudflats. The tide gauge data is available every minute, the 20 Hz level 2 altimetry data is interpolated to virtual stations at distances between 2 and 15 km to the tide gauges. The altimeter data is based on standard retracers, the correction models are adjusted to coastal applications and exclude the corrections for ocean tides and dynamic atmosphere to allow a direct comparison to the tide gauge data. To account for slight differences of the tidal dynamics between gauge and altimetry an optimal time shift and scale between each pair of locations is estimated and applied. This tidal correction improves the RMS errors by 15-75%. The explained variances are excellent at all stations (> 96%). The resultant RMS errors are mainly between 2-5 cm depending on location and mission. The RMS errors rise up to 10 cm where coastal dynamics play a dominant role or the altimeter approaches the land very closely (<7 km). The accuracy of the absolute biases is strongly dependent on the knowledge of the mean sea surface heights in the region.