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Investigation of sea level variations and trends in the Baltic Sea from geometric and gravimetric observations

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Geometric and gravimetric measurements both have proven to be robust approaches to analyzing sea level changes. The relationship between them is also worth exploring. In this research, the geometric signal and gravimetric signal as well as volume variations in Baltic Sea are compared during the period from 2002.4 to 2016.12. Ideally, the geometric signal should be the sum of gravimetric signal and volume variations, which is so-called sea-level budget. Here, the geometric signal is selected as altimetric data from multi missions combined with in-situ observations from tide gauges. The Mascon solutions are used as gravimetric signals while the volume variations are represented by steric height derived from Baltic Sea Physics Reanalysis model. The Baltic Sea is divided into four regions and the sea level budget equation is applied in each region. The results reveal the gravimetric and volume components exhibit satisfying correlations with geometric signals, which are larger than 0.85 in all four regions. The north region has the least correlation due to the sea ice problem. Furthermore, the comparison underscores the dominance of the gravimetric signal, contributing to approximately 90% of the total sea level change. On the other hand, the sea level trend is estimated by both geometric signal and the sum of gravimetric and volume components. The difference between the two trends in each region is mainly caused by ocean bottom deformation, primarily influenced by glacier isostatic adjustment (GIA). In the processing of mason, the GIA effect is already removed but the geometric signal contains ocean bottom deformation. Therefore, it is necessary to consider the land deformation during the trend comparison. However, because of the sea level equation, the sea level does not change as much as ocean bottom changes, but much smaller. Here we employ the geoid change from NKG2016LU as a trend correction in ocean bottom deformation. The findings contribute valuable insights for predicting sea level changes in the Baltic Sea, emphasizing the significance of accounting for gravitational and volumetric factors along with ocean bottom deformation in sea-level research.