

An LSC-based framework for geoid-consistent geometric height reference surface determination in the Baltic Sea using SWOT altimetry

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Despite significant theoretical advances in high-resolution gravimetric geoid modelling, establishing a consistent offshore geoid-based height reference surface remains challenging in regions where marine gravity observations are sparse or difficult to obtain. High-resolution Ka-band Radar Interferometer (KaRIn) sea surface height (SSH) observations from the Surface Water and Ocean Topography (SWOT) altimetry mission offer an alternative geometric approach to marine geoid determination. Combined with hydrodynamic modelling, instantaneous geoidal heights are derived by removing modelled dynamic ocean topography from SWOT SSH observations. A remove-compute-restore and least-squares collocation (LSC) framework is then employed to determine a geoid-consistent geometric height reference surface from an ensemble of instantaneous geoidal heights. The resulting surface in the Baltic Sea agrees well with the gravimetric BSCD2000 quasigeoid model, with most differences within ± 3 cm and a standard deviation of 2.2 cm. Moreover, validation using coastal GNSS-levelling control points yields a standard deviation of 2.3 cm within an extrapolation distance of 5 km, indicating good consistency with the BSCD2000 model in the coastal zone. The results demonstrate that SWOT altimetry observations provide a viable geometric alternative to conventional gravimetric marine geoid determination. The determined geometric model can also support offshore data quality control and geoid modelling diagnostics.