Combination of different sea surface height measurement techniques

Name: Ole Roggenbuck
E-Mail: ole.roggenbuck@jade-hs.de
Supervisor: Prof. Dr.-Ing. Florian Seitz
German Geodetic Research Institute and Chair of Geodetic Geodynamics (DGFI-TUM)

Started: 08/2016
☒ ongoing ☐ finished

Motivation
Reliable and precise information about the sea surface height (SSH) and its temporal behaviour are important for scientists and the global community. Such data plays a key role in e.g. coastal defence, ocean- and climate modelling. Currently, most SSH measurements are performed by tide gauges and altimeter satellites. Different studies demonstrate how GNSS aboard ships can be used to gather additional SSH observations. As many ships are constantly sailing the oceans, carrying out measurements using at least a few of them would lead to a valuable independent SSH dataset. Beside of using this dataset for calibration and validation of altimeter missions, a combination of all techniques is feasible. Each technique has its individual strengths and weaknesses in case of e.g. spatial and temporal resolution. To benefit from all technique specific strengths, a combined analysis is meaningful. The project goals are the realization of continuous ship-based SSH measurements and the development of an empirical combination approach.

Survey area and measurements
The area under investigation is the German Bight (Fig. 1). In this area a dense tide gauge network is operated and satellite altimeters provide SSH data as well. Two ferries, heading to the island Helgoland once a day, are used for the ship-based approach. For this purpose both ships were equipped with three dual-frequency GNSS antennas and receivers. The GNSS observations are used to calculate the ships attitude and its position with respect to a global reference frame (Fig. 2). Corrections for systematic effects like height variations caused by waves or the hydrodynamic squat effect are applied resolution of the ships method and a fine grid may be unsolvable due to an insufficient number of observations. The combination approach developed in this project uses a fine grid and is based on the assumption that all estimated parameters are continuous in the survey area. This behaviour is expressed with the Laplace equation. This differential equation can be solved with e.g. the finite element method (FEM) with boundary conditions.
The system of equations given by the FEM acts as pseudo-observations during the estimation process. Due to strong tidal variations in the survey area harmonic parameters have to be set up in addition to the SSH. During the second half of the project the effect of different boundary conditions and weightings will be studied and a stochastic model will be developed. Finally a combined model of all datasets will be calculated using the new approach.

References

Roggenbuck, O., Reinking, J. (2017): GNSS-based SSH Observations from Ships combined with Satellite Altimetry and Tide Gauge Readings, Poster presented at EGU General Assembly 2017, Vienna,

Stand: 23.01.2018