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Using airborne laser scanning profiles to validate marine geoid models

Kalev Julge (1), Anti Gruno (1,2), Artu Ellmann (1), Aive Liibusk (3), and Tõnis Oja (2)

(1) Tallinn University of Technology, Tallinn, Estonia (kalev.julge@ttu.ee), (2) Estonian Land Board, Tallinn, Estonia, (3) Estonian University of Life Sciences, Tartu, Estonia

Airborne laser scanning (ALS) is a remote sensing method which utilizes LiDAR (Light Detection And Ranging) technology. The datasets collected are important sources for large range of scientific and engineering applications. Mostly the ALS is used to measure terrain surfaces for compilation of Digital Elevation Models but it can also be used in other applications. This contribution focuses on usage of ALS system for measuring sea surface heights and validating gravimetric geoid models over marine areas. This is based on the ALS ability to register echoes of LiDAR pulse from the water surface.

A case study was carried out to analyse the possibilities for validating marine geoid models by using ALS profiles. A test area at the southern shores of the Gulf of Finland was selected for regional geoid validation. ALS measurements were carried out by the Estonian Land Board in spring 2013 at different altitudes and using different scan rates. The one wavelength Leica ALS50-II laser scanner on board of a small aircraft was used to determine the sea level (with respect to the GRS80 reference ellipsoid), which follows roughly the equipotential surface of the Earth's gravity field.

For the validation a high-resolution (1'x2') regional gravimetric GRAV-GEOID2011 model was used. This geoid model covers the entire area of Estonia and surrounding waters of the Baltic Sea. The fit between the geoid model and GNSS/levelling data within the Estonian dry land revealed RMS of residuals $\pm 1 \ldots \pm 2$ cm. Note that such fitting validation cannot proceed over marine areas. Therefore, an ALS observation-based methodology was developed to evaluate the GRAV-GEOID2011 quality over marine areas.

The accuracy of acquired ALS dataset were analyzed, also an optimal width of nadir-corridor containing good quality ALS data was determined. Impact of ALS scan angle range and flight altitude to obtainable vertical accuracy were investigated as well. The quality of point cloud is analysed by cross validation between overlapped flight lines and the comparison with tide gauge stations readings. The comparisons revealed that the ALS based profiles of sea level heights agree reasonably with the regional geoid model (within accuracy of the ALS data and after applying corrections due to sea level variations). Thus ALS measurements are suitable for measuring sea surface heights and validating marine geoid models.