



Analysis of the Greenland ice sheet elevation time series from satellite altimetry

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Change in surface elevation is an important characteristic of the ice sheet behavior, which is used in mass balance studies. Greenland ice sheet elevation changes were analysed using 20-years (1992-2012) time series derived from ERS-1, ERS-2 and Envisat satellite radar altimeter measurements by crossover method.

The methods that allowed improving estimation of the ice sheet elevation changes from satellite radar altimeters were developed and applied. Altimeter measurements from different satellites were merged through determining of spatially variable inter-satellite biases in order to create continuous and consistent time series. Inter-satellite biases of elevation and altimeter waveform parameters have shown to be significantly affected by the bias between measurements in ascending and descending orbits. Distribution of the biases reveals remarkable spatial variability, so their detailed determination is required. Analysis of elevation and backscatter parameter time series indicated significant temporal changes in their sensitivity gradient, which is used for estimation of backscatter correction and correcting of the measured elevation changes to account for penetration of radar altimeter signal in snow. Taking these gradient changes into account results in better correction of seasonal and inter-annual elevation variations.

Over whole time period considered elevation increases in the interior of the Greenland ice sheet and significantly decreases over low-elevation areas. At the same time spatio-temporal analysis shows large inter-annual elevation variability over western and south-eastern regions of the ice sheet. In particular, increases in surface elevation from 1995 were followed by an elevation decrease from 2006 caused primarily by the changes over western flank of the ice sheet. Over low-elevation areas below 1500 considerable elevation decrease started from 2000 has continued.

Comparison of elevation time series derived using temporally consistent altimeter measurements from Envisat and ICESat satellites provided an assessment of uncertainty of elevation change estimation. Although elevation changes derived from these two satellites are in a reasonable agreement over most part of the Greenland ice sheet, there are large discrepancies in some areas indicating existence of the bias between the results. Both – positive and negative – biases are observed in different areas, and may be resulted either from Envisat measurements due to inaccurate estimation of backscatter correction and slope-induced errors caused by large footprint or from ICESat measurements due to low spatio-temporal data coverage.