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Elevation change of the Greenland Ice Sheet from the merged ERS-1, ERS-2 and Envisat satellite radar altimetry

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The Greenland Ice Sheet is an important earth-system component whose potential melting is critical for sea-level change and freshwater impact on ocean circulation. In order to estimate the spatial and temporal variability of the ice-sheet surface elevation, we derive long time series through combining measurements from different satellite altimeters (e.g., European Space Agency satellites ERS-1, ERS-2 and Envisat), including estimation of inter-satellite biases.

ERS-1/ERS-2 and ERS-2/Envisat biases of elevation and received backscatter power measurements were calculated by the method giving higher reliability resulted from using larger number of crossover points between orbits of the different satellites, then only crossovers available during the periods of simultaneous operation. In addition ascending - descending bias, which significantly affects inter-satellite bias, was taken into account. ERS-1/Envisat bias was estimated as a sum of two other defined biases. Elevation biases were used to correct inter-satellite elevation crossover differences, while both biases - for elevation and backscatter power measurements - were needed to determine correction, which accounts correlation between these two parameters. Determination of the biases for each grid cell (1 degree longitude $\times$ 0.5 degrees latitude) has shown that biases are not spatially invariant. For both biases (ERS-1/ERS-2 and ERS-2/Envisat), the largest and smallest values are observed over margins and in the central areas, respectively. Backscatter-power bias patterns are more complicated,

but also indicate similar features for both cases.

Elevation-change estimation shows that increases in surface elevation which were observed over the high-elevation central regions of Greenland from 1995, have decelerated over the period from 2003 to 2005. In contrast, surface-elevation decreases in the low-elevation areas of ice sheet - decreases that started in 2001 - have continued due to enhanced summer melting. Indicated relationship between elevation changes with Northern Hemisphere atmospheric circulation in winter, such as Arctic, North Atlantic and North Pacific Oscillations, reveals important role of atmospheric circulation for Greenland ice sheet.