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Greenland 2012 melt event effects on CryoSat radar altimetry

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Measurements of ice sheet surface topography by radar altimetry are repeated in time to monitor changes. In the interior parts of the ice sheets dry snow is slowly being transformed into ice, and in this transformational stage the dielectric properties differs from solid ice. The radar signal penetrates down into the snow/firn layers and becomes reflected against sub-surface structures, with the penetration depth being dependent on the dielectric properties. Thus radar altimeters do not measure the actual physical surface of the ice sheets and adds to the uncertainty of radar altimetry elevation change detection.

In July 2012, the Greenland Ice Sheet experienced the most extensive melt events in recent time, and 98.6% of the surface experienced melting on July 12, 2012. The abnormal surface temperatures were observed for less than two weeks at which the temperatures returned to normal. This event would lead to an abrupt change in surface scattering properties, as the surface of the ice sheet later refroze. The interior part of the Greenland Ice Sheet would have undergone a rapid change from volume to surface scattering conditions from a microwave frequency point of view, affecting the inferred surface height of the ice sheet, with the potential to be interpreted as an actual elevation change, the magnitude of which would be dependent on the retracking correction used.

The aim of this study is to demonstrate that the 2012 melt event introduced an elevation bias in the observed elevations and also changes surface scattering properties. To observe these effects surface elevations and scattering parameters were estimated from CryoSat-2 data, near the North Greenland Eemian Ice Drilling site (NEEM) at 77.45 deg N and 51.06 deg W, in NW Greenland. CryoSat data was collected before and after the event for the analysis and in-situ data from NEEM was used to validate the results. Results from this study show a dramatic change in surface scattering properties, measured from the radar waveforms, where a clear transition from volume to surface scattering was observed. The change in scattering properties introduced a significant bias in the mean surface elevation of the study area.