Implications of changing scattering properties on Greenland ice sheet volume change from Cryosat-2 altimetry - DTU Orbit (22/12/2018)

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Long-term observations of surface elevation change of the Greenland ice sheet (GrIS) is of utmost importance when assessing the state of the ice sheet. Satellite radar altimetry offers a long time series of data over the GrIS, starting with ERS-1 in 1991. ESA's Cryosat-2 mission, launched in 2010, provides an invaluable radar altimetry dataset for monitoring the current changes of the ice sheets due to its dense spatial and temporal coverage of these areas. Here, we investigate the effects of including different parameters which describe the shape of the return radar waveform (waveform parameters) in the elevation change algorithm, to correct for temporal changes in the ratio between surface- and volume-scatter in Cryosat-2 observations. We present elevation and volume changes for the Greenland ice sheet in the period from 2010 until 2014. The waveform parameters considered here are the backscatter coefficient, and the leading edge width, which are both available in the ESA Cryosat-2 Level-2i data product. Investigations into relocation of radar reflection points are also included. Inter-comparison of the Cryosat-2 derived elevation changes with those derived from Operation IceBridge laser data suggests waveform parameters to be applicable for correcting for changes in volume scattering. The best results in the Synthetic Aperture Radar Interferometric mode area of the GrIS are found when applying only the backscatter correction, whereas the best result in the Low Resolution Mode area is obtained by only applying a leading edge width correction. Using this approach to correct for the scattering properties, a volume loss of $-292\pm38 \text{ km}^3 \text{ yr}^{-1}$ is found for the GrIS for the time span November 2010 until November 2014. The inclusion of waveform parameter corrections and improved relocation for the GrIS, helps to reconcile the satellite-derived elevation changes with those observed by Operation IceBridge. However, the bias of temporal changes in the scattering horizons of Cryosat-2 is not entirely removed and suggests that future improvements could be made by including climate data and/or additional waveform parameters to make additional corrections in the Cryosat-2 radar altimetry.

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