Geophysical Research Abstracts
Vol. 16, EGU2014-2806, 2014
EGU General Assembly 2014

Time-evolving mass loss of the Greenland ice sheet from satellite altimetry

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Mass changes of the Greenland ice sheet may be estimated by the Input Output Method (IOM), satellite gravimetry, or via surface elevation change rates. Whereas the first two have been shown to agree well in reconstructing mass changes over the last decade, there are few decadal estimates from satellite altimetry and none that provide a time evolving trend that can be readily compared with the other methods. Here, we interpolate radar and laser altimetry data between 1995 and 2009 in both space and time to reconstruct the evolving volume changes. A firn densification model forced by the output of a regional climate model is used to convert volume to mass. We consider and investigate the potential sources of error in our reconstruction of mass trends, including geophysical biases in the altimetry, and the resulting mass change rates are compared to other published estimates. We find that mass changes are dominated by SMB until about 2001, when mass loss rapidly accelerates. The onset of this acceleration is somewhat later, and less gradual, compared to the IOM. Our time averaged mass changes agree well with recently published estimates based on gravimetry, IOM, laser altimetry, and with radar altimetry when merged with airborne data over outlet glaciers. We demonstrate, that with appropriate treatment, satellite radar altimetry can provide reliable estimates of mass trends for the Greenland ice sheet. With the inclusion of data from CryoSat II, this provides the possibility of producing a continuous time series of regional mass trends from 1992 onward.