Geophysical Research Abstracts
Vol. 19, EGU2017-19150, 2017
EGU General Assembly 2017

The effect of signal leakage and glacial isostatic rebound on GRACE-derived ice mass changes in Iceland

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Iceland is losing ice mass at sustained rapid rate that should be well visible in the time-variable gravity field observed by the GRACE satellite mission. However the small size of the Icelandic ice caps and its location close to the rapidly changing southeast Greenland makes an accurate estimate especially challenging to retrieve. Moreover the ice loss signal is partially covered by the mass redistribution within the low viscosity Earth mantle due to Glacial Isostatic Adjustment (GIA) since the Little Ice Age (about 1890 AD). Previous GRACE-derived estimates do not take into account the above challenges. Here, we investigate in detail the ice mass changes of the Icelandic ice caps as derived from GRACE data. The mass balance of the ice caps is well constrained by field mass balance measurements, making this area ideal for such investigations. To minimize the signal that leaks towards Iceland from Greenland, we employ an independent mass change estimate of the Greenland Ice Sheet derived from satellite laser altimetry. We also estimate the effect of post Little Ice Age GIA, from knowledge of the ice history and GPS network constrained crustal deformation data. We show how much both the leakage from Greenland and the post Little Ice Age GIA are important to take into account, in order to correctly determine Iceland ice mass changes from GRACE. When applying these corrections we find an average mass balance of the Icelandic ice caps of -11.4 +/- 2.2 Gt/yr for the period 2003–2010. This number corresponds well with the available independent field mass balance measurements.