Geophysical Research Abstracts
Vol. 17, EGU2015-12672, 2015
EGU General Assembly 2015
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Mass Loss and Surface Displacement Estimates in Greenland from GRACE

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The estimation of ice sheet mass changes from GRACE is basically an inverse problem, the solution is non-unique and several procedures for determining the mass distribution exists. We present Greenland mass loss results from two such procedures, namely a direct spherical harmonic inversion procedure possible through a thin layer assumption, and a generalized inverse masscon procedure. These results are updated to the end of 2014, including the unusual 2013 mass gain anomaly, and show a good agreement when taking into account leakage from the Canadian Icecaps.

The GRACE mass changes are further compared to GPS uplift data on the bedrock along the edge of the ice sheet. The solid Earth deformation is assumed to consist of an elastic deformation of the crust and an anelastic deformation of the underlying mantle (GIA). The crustal deformation is due to current surface loading effects and therefore contains a strong seasonal component of variation, superimposed on a secular trend. The majority of the anelastic GIA deformation of the mantle is believed to be approximately constant. An accelerating secular trend and seasonal changes, as seen in Greenland, is therefore assumed to be due to elastic deformation from changes in surface mass loading from the ice sheet. The GRACE and GPS comparison is only valid by assuring that the signal content of the two observables are consistent. The GPS receivers are measuring movement at a single point on the bedrock surface, and therefore sensitive to a limited loading footprint, while the GRACE satellites on the other hand measures a filtered, attenuated gravitational field, at an altitude of approximately 500 km, making it sensitive to a much larger area. Despite this, the seasonal loading signal in the two observables show a reasonably good agreement.