Geophysical Research Abstracts
Vol. 21, EGU2019-15784, 2019
EGU General Assembly 2019

Greenland ice sheet evolution and associated Earth deformation

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Although largely investigated over the past decades, providing accurate ice sheets mass balance remains a challenge due to the difficulty of combining multiple geodetic technics to resolve the ice spatio-temporal evolution. Focusing on the Greenland, we use elevation changes of the ice sheet derived from satellite altimetry (ERS-2, Envisat and CryoSat-2) from 2002 to 2017, regional GPS time series and time-variable gravity measurements from GRACE to improve the spatial and temporal resolution of the ice sheet.
The GRACE mission provides estimates of the mass variations averaged over a few hundred kilometers. The GPS data record crustal displacements caused by ice mass loss with an important contribution from ice losses of small wavelength located a few kilometers away from the stations. The altimetry provides with a spatial resolution of a few tens of kilometers the surface elevation change associated with the increase or decrease of the ice volume. The GRACE and altimetry results are combined and used to predict crustal displacements, assuming elastic Earth properties and the predicted vertical and horizontal motions are compared with the GPS data. We use decompositions of the mass variation into spherical harmonics up to the degree 2700 to resolve local effects affecting GPS measurements.
Ultimately, the combination of these different methods will aim at separating the different sources of deformation in the region (GIA, deformation induced by recent ice melting, tectonics) and to put constraints on the short-term (decadal) rheology of the mantle and on the ice mass budget over Greenland.