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Regional ice-mass variability in Greenland from GRACE, InSAR and surface-mass balance modelling

Zdenek Martinec (3), Jonathan Bamber (2), Ingo Sasgen (1), and Michiel van den Broeke (4)

(1) Helmholtz Centre Potsdam GFZ, Geodesy and Remote Sensing, Potsdam, Germany (sasgen@gfz-potsdam.de), (2) School of Geographical Sciences, University of Bristol, University Road, Bristol BS8 1SS, United Kingdom (j.bamber@bristol.ac.uk), (3) School of Theoretical Physics, Dublin Institute for Advanced Studies, 10 Burlington Road, Dublin 4, Ireland (zdenek@cp.dias.ie), (4) Institute for Marine and Atmospheric Research, Utrecht University, PO Box 80 005, 3508 TA, Utrecht, The Netherlands (m.r.vandenbroeke@uu.nl)

The Gravity Recovery and Climate Experiment (GRACE) satellite mission has allowed the resolution of temporal variations in the Earth's gravity field to serve as a new observable for monitoring mass changes in cryosphere. Here, we analyse the GRACE time series from August 2002 to August 2008 with regards to regional ice-mass variability in Greenland. We smooth the monthly GRACE gravity fields using the Wiener optimal filtering method and invert the resulting temporal anomalies to variations of ice mass using a constrained gravity-field modelling approach. We correct the temporal linear trends in the GRACE gravity fields for glacial-isostatic adjustment with a viscoelastic Earth model subjected to a global glacial history covering the last glacial-interglacial transition, in particular the Laurentide and Greenland ice sheets. We find that the mass change of the Greenland Ice Sheet amounts to ~ 0.5 mm/a equivalent sea-level change and significantly accelerated during the observation period. The comparison with Interferometric Synthetic Aperture Radar (InSAR) data and output from surface-mass balance modelling indicates that mass-loss acceleration is mainly caused by increasing discharge in the Northwest starting in the year 2005. In the year 2007, mass loss additionally accelerates in the Southwest caused by a reduced surface-mass balance. We conclude that GRACE allows for the detection of regional scale mass variations, including accelerations, and may further contribute to the understanding the processes governing the current changes of Greenland Ice Sheet.