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Effect of firn depth and density variations on ice sheet elevation changes in Antarctica

M. M. Helsen (1), M. R. van den Broeke (1), R. S. W. van de Wal (1), W. J. van de Berg (1), E. van Meijgaard (2)

(1) Utrecht University, (2) Royal Netherlands Meteorological Institute

Satellite altimetry (radar on ERS-1and ERS-2, laser on IceSAT) is a valuable tool to monitor ice sheet elevation change (dh/dt). Before dh/dt observations can be translated into long-term volume changes, corrections must be made for postglacial rebound (usually $<$ 1 cm per year) and short-term variability in firn densification rate and accumulation. Because dh/dt observations cover a period of about 15 years, annual to decadal anomalies in the firn depth and density can have a significant contribution to ice sheet elevation changes. We calculated this contribution, using 6-hourly output of a regional atmospheric climate model (1980-2004) to drive a time-dependent firn densification model. The results show that a significant part of the observed elevation changes in Antarctica in the period 1992-2003 can be explained by changes in firn depth and density caused by temperature and accumulation variability. An exception is the Amundsen coast of West Antarctica, where glacier thinning clearly exceeds or is even opposed to changes expected from firn modeling. These results are therefore useful to separate long-term (ice dynamical) effects from the short term climatic 'noise' in satellite dh/dt data.