Snow Surface Height Change Induced by 2 Decades Surface Air Temperature Variations over Antarctic Ice Sheet

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In most regions of polar ice sheets, fluctuations of surface air temperature drive the firn temperature change hence the densification rate causing the snow surface elevation change. These changes are mainly in seasonal to decadal time scale and superimposed on the long-term changes due to the past and present mass imbalance of the ice sheets. Study of the firn compaction and the resulted elevation change is of great importance in the interpretation of satellite altimetry data and improves our knowledge not only in understanding the temporal variations but also in detecting long term changes in snow surface height. In this study, two decades (1982-2000) monthly mean surface air temperatures inferred from satellite infrared data (AVHRR) over the Antarctic ice sheet are applied to the time-dependent densification model to derive the corresponding surface height changes. The model is driven by surface climate forces (accumulation rate, temperature and temperature gradient) and characterized by the higher temperature sensitivity. Results show that the seasonality of surface air temperature causes clear seasonal variations in surface height with maximum and minimum occurring in late austral spring and fall respectively. The seasonal amplitudes of the surface height increase from millimeters to centimeters with increasing accumulation rate and surface temperature over the ice sheet. Interannual variations show that the surface height significantly decreases with mean rate of –1.9 cm yr^{-1} (92-2000) over the West Antarctica. Surface snow melting around ice shelf region enhances this decrease in surface height. Over East Antarctica, the surface increases with typical rate of several mm yr^{-1}.

The results will be applied to satellite observed surface elevation change (dH/dt) as a correction part to allow more accurate estimations of the ice sheet mass balance and the contributions to the sea level change.