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Response of the ice sheets to fluctuating temperatures

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Forecasting the future sea level relies on accurate modeling of the response of the Greenland and Antarctic ice sheets to changing tempera- tures. Using coupled climate and ice sheet models long time forecasting is often made computationally feasible by running the ice sheet model in off-line mode, such that the temperature and precipitation fields govern- ing the mass balance of the ice sheets are taken to be constant over time. As the temperature and precipitation fluctuates, the asymmetry in the typical time scales for accumulation and ablation would result in a bias in the resulting mass balance of the ice sheet.

We show that the steady state of the ice sheet is biased toward larger size of the ice sheet, if the short time scale fluctuations in temperature are not taken into account. This could potentially imply that the critical global temperature increase for ice sheet collapse is overestimated, thus the risk of collapse in a given climate change scenario underestimated.

Our results highlight the need to consider the variability and not only the mean of the forcing of the mass balance of the ice sheet. We estimate that the effect of temperature variability on surface mass balance of the Greenland Ice Sheet in recent ensemble forecasting should be adjusted downward by as much as 10 percent of the present day observed value, if assuming a 2 degree warming. We are thus closer to a potential tipping point, than previously anticipated. Many predicted scenarios of the future climate show an increased variability in temperature over much of the Earth. In light of the findings presented here, it is important to gauge the extent to which this increased variability will further influence climate change.