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# Surface Mass Balance of the Greenland Ice Sheet in the Energy Exascale Earth System Model

**Adam Schneider**[1], Stephen Price[2], Jonathan Wolfe[2], and Charles Zender[1]
[1]University of California, Irvine, Irvine, United States of America (amschnei@uci.edu)
[2]Los Alamos National Laboratory, Los Alamos, United States of America (sprice@lanl.gov)

Since 1993, nearly 10 percent of the observed rise in global mean sea level can be attributed to the coincident increase in surface mass loss from the Greenland Ice Sheet (GrIS) (Meredith et al., 2019; WCRP, 2018). To determine the GrIS surface mass balance (SMB), defined as the ice sheet's annual net (surface) mass increase due to snow accumulation minus ablation, a climate model can be coupled to a snowpack model, which enables simulating relevant hydrologic processes including precipitation, phase changes, and runoff. Recent developments within the Energy Exascale Earth System Model (E3SM) include an active ice sheet component. To explore GrIS snowpack conditions relevant to present-day climate, we conduct simulations demonstrating the evolution of SMB and accumulation of snowpack depth, first in E3SM's land component (ELM). After forcing ELM's surface condition using 20th century atmospheric reanalysis, we couple ELM to E3SM's atmosphere component (EAM) and simulate both atmospheric and snowpack conditions over a fixed GrIS geometry. Finally, we activate the MPAS-Albany Land Ice model (MALI), which enables prognostic SMB calculations including elevation-change feedbacks. We find broad agreement in the spatial patterns of GrIS SMB compared to regional climate model (RACMO) and Community Earth System Model (CESM) simulations. We provide insights regarding the use of a statistical downscaling method, which involves using multiple elevation classes with time-varying areal coverages within ELM grid-cells. Within this dynamic system, we can begin investigating elevation feedbacks, where the atmospheric temperature lapse rate allows the SMB to accelerate both positively and negatively in a rapidly changing climate.

References

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