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Simulated Eemian Greenland Surface Mass Balance shows strong sensitivity to SMB model choice

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Understanding how the Greenland Ice Sheet (GrIS) behaves in a warmer climate is of utmost importance in respect to improve future sea level rise projections. Many authors in the past did so by simulating the GrIS during the Eemian Interglacial, the most recent warmer-than-present period in Earth's history, approximately 125,000 years ago. The idea behind it is that future Arctic temperature may become similar to the past Eemian Arctic temperature. Furthermore, there is proxy data to constrain models results, in contrary to solely rely on future model projections. Although the Eemian warming was caused by orbital conditions rather than higher Greenhouse Gas concentration as today, much can be learned from the simulated response of the GrIS.

The various Eemian GrIS studies result in very different ice sheets and sea level rise contributions from Greenland. The key to simulate the GrIS extend correctly in an ice sheet model is to get the Surface Mass Balance (SMB) during this period right. In this study we use three different types of SMB models forced with a Global and a Regional Climate Model to calculate the SMB on Greenland during the Eemian Interglacial. A simple, empirical Positive Degree Day (PDD) model, as a legacy baseline, a full Surface Energy Balance (SEB) model, as a best-guess approach, and an intermediate model. We discuss how a single global climate simulation (and its dynamically downscaled realization) can result in very different SMBs. We evaluate the influence of the climate forcing resolution and the SMB model choice and review the approaches of earlier studies with a focus on their SMB calculation. We find that the differences in previous Eemian GrIS simulations is dominated by different SMB forcings.