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Greenland Ice Sheet retreat during the Eemian

W. J. van de Berg, M. M. Helsen, R. S. W. van de Wal, M. R. van den Broeke, and J. Oerlemans
University Utrecht, IMAU, Utrecht, Netherlands (w.j.vandeberg@uu.nl)

We present a new estimate of the evolution of the Greenland Ice Sheet through the Eemian (130 till 115 ky BP). This estimate is determined using the 3D 'shallow' ice sheet model ANICE and the regional climate model RACMO2/GR. The two models are time-slice coupled with an interval of 1500 years. 3D interpolated surface mass balance fields from RACMO2/GR force ANICE. Eemian and post-Eemian climate from the GCM ECHO-G drives RACMO2/GR on its lateral boundaries. These boundaries are gradually adjusted from maximum Eemian conditions to post-Eemian inception conditions, following the orbital parameters and Greenhouse gas concentrations derived from ice cores.

The simulation shows a steady mass loss till the insolation conditions decline and the summer climate cools, with a typical rate of mass loss equivalent to 5 cm sea level rise per century for most of the time. Once summer start to cool the Greenland ice sheet recovers fast. The maximum ice loss is about 2 m eustatic sea level compared to present day volume and originates predominantly from southwest Greenland. Our results align with paleo-observations of Eemian ice sheet existence in South Greenland. Strong summer radiation also induces ice retreat in northern Greenland. Moreover, it agrees with preceding studies that the Greenland ice sheet had only a limited contribution to the Eemian sea level high stand.

A finding of this novel approach is the impact of topographic pinpoints on the ice sheet evolution. Subglacial topography, like at 52° W 72° N (near Uummannaq), cause promontories in the ice sheet that enhances snowfall. Locations with high snowfall react less on warming than dry locations, because more melt is needed before all snow is removed, and the more efficient ice melt starts. The reduced ice depth also buttresses inland ice, limiting the ice sheet response to enhanced ablation. As a result, this topographical feature becomes the northern limit of significant ice sheet retreat, and shields the north from the rapid retreat in southwestern Greenland.