EGU21-12958
https://doi.org/10.5194/egusphere-egu21-12958
EGU General Assembly 2021

Multi-millennial response of the Greenland Ice Sheet to anthropogenic warming

Michele Petrini[1], Miren Vizcaino[1], Raymond Sellevold[1], Laura Muntjewerf[1], Sotiria Georgiou[1], Meike D.W. Scherrenberg[2], William Lipscomb[3], and Gunter Leguy[3]

[1]Delft University of Technology TUDelft, Geoscience and Remote Sensing, Delft, Netherlands (m.petrini@tudelft.nl)
[2]Institute for Marine and Atmospheric research Utrecht, Utrecht University, Utrecht, the Netherlands
[3]Climate and Global Dynamics Laboratory, National Center for Atmospheric Research, Boulder, CO, USA

Previous coupled climate-ice sheet modeling studies indicate that the warming threshold leading to multi-millennial, large-scale deglaciation of the Greenland Ice Sheet (GrIS) is in the range of 1.6-3.0 K above the pre-industrial climate. These studies either used an intermediate complexity RCM (Robinson et al. 2012) or a low resolution GCM (Gregory et al., 2020) coupled to a zero-order ISM. Here, we investigate the warming threshold and long-term response time of the GrIS using the higher-order Community Ice Sheet Model version 2 (CISM2, Lipscomb et al. 2019), forced with surface mass balance (SMB) calculated with the Community Earth System Model version 2 (CESM2, Danabasoglu et al. 2020). We use different forcing climatologies from a coupled CESM2/CISM2 simulation under high greenhouse gas forcing (Muntjewerf et al. 2020), where each climatology corresponds to a different global warming level in the range of 1-8.5 K above the pre-industrial climate. The SMB, which is calculated in CESM2 using an advanced energy balance scheme at multiple elevation classes (Muntjewerf et al. 2020), is downscaled during runtime to CISM2, thus allowing to account for the surface elevation feedback. In all the simulations the forcing is cycled until the ice sheet is fully deglaciated or has reached a new equilibrium. In a first set of simulations, we find that for a warming level higher than 5.2 K above pre-industrial the ice sheet will disappear, with the timing ranging between 2000 (+8.5 K) and 6000 years (+5.2 K). At a warming level of 2.8 K above pre-industrial, the ice loss does not exceed 2 m SLE, and most of the retreat occurs in the first 10,000 years in the south-west and central-west basins. In contrast, with a higher warming level of 3.6 K above pre-industrial as much as 7 m SLE of ice are loss in 20,000 years, with primary contributions from the western, northern and north-eastern basins. We will conclude by showing preliminary results from a second set of simulations focusing on the 2.8-3.6 K warming above pre-industrial interval.