Title

Examination of Drivers of Large Surface Melt on the Greenland Ice Sheet

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Abstract

The Greenland Ice Sheet (GrIS) is an ice sheet situated on the island of Greenland. It has a surface area of about 1.74 million km^2 and contains a volume of ice equivalent to 7.4 m of global mean sea level rise. The GrIS is vulnerable to climate disruptions such as anthropogenic climate change. As a result of increased greenhouse gas emissions, the mass of the GrIS is observed to be decreasing starting in the 1990.

Our research uses output from a climate model called Community Earth System Model version 2.1 (CESM2.1). CESM is an earth system model, meaning that it tries to model the whole earth for its major physical, chemical and biological functions. Importantly for our research, it models the GrIS such that its shape can change, so that it can model changes in atmospheric flow. This is known as an “interactive ice sheet”.

This research three scenarios run on an interactive ice sheet to find its results. It uses a historical run to evaluate the model. Then it also uses two hypothetical scenarios called 3xCO2 and 4xCO2. Each starts at the pre-industrial concentration of 285 ppm CO2, and then increases the concentration by 1\% per year until reaching 3 and 4 times pre-industrial concentrations respectively, after which the concentration is maintained constant.

This thesis focuses on the mass balance (MB) of the GrIS, as these differ strongly between 3xCO2 and 4xCO2. In the scenarios we researched, this mass balance is dominated by the surface mass balance (SMB). SMB is in turn primarily driven by the ice melt. Negative SMB is called Ablation Area SMB

The thesis makes two important observations. Firstly, area distribution can be split up into a total surface area component, which depends on time, and a relative elevation distribution component, which depends on elevation. Secondly, the area normalised AASMB is linear with elevation, but the gradient varies with time.

Typically, increased melt is explained as a result of ablation area expansion. However, this does not capture the elevation distribution of the AASMB. Using the two results drawn from above, we create a new mental model which results in a more detailed explanation of the GrIS mass loss.