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Greenland ice sheet surface mass balance response to high CO2 forcing: threshold and mechanisms for accelerated surface mass loss

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We use the Community Earth System model 2.1 to investigate the response of the Greenland Ice sheet (GrIS) surface mass balance (SMB) to an idealized high CO_2 forcing scenario (1% per year increase to four-times-preindustrial). The SMB calculation is coupled with the atmospheric model, using a physically-based surface energy balance scheme for melt, explicit calculation of snow albedo, and a realistic treatment of polar snow and firn compaction. The SMB becomes negative for a global mean temperature increase of 2.7 K compared to pre-industrial temperature, and the surface mass loss accelerates. Longwave radiation is the primary contributor to melt energy before acceleration. A decrease of the albedo due to ablation area expansion together with turbulent heat flux increase due to the surface of the ice sheet nearing melting point, are the main contributors at/after acceleration. Further, trends towards more positive North Atlantic Oscillation and more negative Greenland Blocking Index partially reduces future melt increase.