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Parameterizations of daily temperature standard deviation for modeling ice sheet mass balances using a temperature-index method under paleoclimate conditions

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A number of recent studies have suggested time-dependent parameterizations of daily temperature standard deviation for modelling surface mass balances of ice sheets and glaciers using a temperature-index method. These have been inferred from in-situ measurements and climate reanalysis data, which are only available on yearly to decadal time scales. To date, the existing literature has not explored their applicability to climate conditions that are different from those of today. This study presents an ensemble of simulations of the Greenland Ice Sheet's history since the Last Glacial Maximum to assess the performance of existing parameterizations of daily temperature standard deviation on millennial time scales. To limit the influence of the uncertainties arising from poorly constrained external and internal factors we adopt climate strategies of different complexities and a sensitivity analysis of ice sheet model parameters. Our study reveals that previously proposed parameterizations of daily temperature standard deviation have a limited performance during the deglaciation stage, failing to simulate the retreat of ice masses as suggested by geological reconstructions. In contrast multiple studies that use constant values of daily temperature standard deviation within the range of 4 to 5˚C receive support from our analysis, implying that either the ice sheet model used is missing the fundamental physics necessary to capture complex processes associated with rapid deglaciation or the values of daily temperature standard deviation suggested by parameterizations based on present-day observations are too low to ensure the consistent Wisconsin-to-Holocene ice sheet retreat.