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Trends in total heat content in a very long climate change simulation

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The equivalent potential temperature Θ_e is a useful measure of the total heat content in the atmosphere, as it is conserved during both dry adiabatic and wet adiabatic processes. It is defined as letting an air parcel expand pseudo-adiabatically until all the water vapour has condensed, release and precipitate all its latent heat and compress it dry-adiabatically to the standard pressure of 1000 hPa.

Changes in surface or air temperature can thus be related to changes in humidity. For example, the relative contributions of temperature and humidity changes in tropical cyclones can be addressed, Arctic amplification due to the fact that saturation mixing ratio follows an exponential curve with temperature can be investigated, and by considering Θ_e in different vertical levels, an assessment of changes in convective stability can be made.

We have conducted a very long climate simulation with a global model interactively coupled to a Greenland ice sheet component. An extended RCP8.5 scenario is applied, where emissions of greenhouse gases continue to increase and then eventually level out around 2250. The model is then run for another 1000 years. With such an extreme forcing, all Arctic sea ice has completely disappeared, and a large part of the Greenland Ice Sheet has melted at the end of the simulation.

We examine changes in the total heat content based on observations and model data for past and present as well as for future climate. Daily data, allowing the identification of individual weather systems will be discussed for time slices with a seasonally and later a totally ice-free Arctic.