

EGU24-1855, updated on 20 May 2024

<https://doi.org/10.5194/egusphere-egu24-1855>

EGU General Assembly 2024

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The impact of sea ice thickness biases on the projected summer sea ice-free Arctic in CMIP6 ensemble experiments

Tian Tian and Shuting Yang

Danish Meteorological Institute, Denmark (tian@dmi.dk)

The IPCC's 2021 assessment suggested that substantial emissions reduction and limiting global temperature rise to well below 2.0°C could prevent the complete loss of Arctic sea ice in this century. However, these assessments come with large uncertainties. Recent research projects a summer ice-free Arctic by the 2050s even under a low emission scenario by constraining future sea ice area with satellite-derived sea ice concentration (SIC) since 1979. Notably, the climate models in these assessments commonly underestimate the accelerated Arctic warming and the pace of sea ice melting, particularly over the last two decades. Moreover, recent studies indicate that in a warming climate, the thinning of sea ice and snow over sea ice may intensify surface warming, thereby accelerating the melting.

In this study, we leverage the increasing availability of observations and recent reanalysis data for Arctic-wide sea ice to investigate the link between changes in sea ice thickness (SIT), sea ice concentration (SIC), and Arctic warming. We employ these datasets to evaluate biases in historical periods and uncertainties in future scenarios within the CMIP6 multi-model ensemble for SIT and SIC. We further investigate the relationship between the thinning of sea ice and the snow layer on sea ice and surface temperature changes on a basin or regional scale. The findings are then used to constrain projected Arctic changes. Our study aims to gain some insights into the impact of model biases in the Arctic on projected climate projections, crucial for decision-making in a changing climate.