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Impacts of regional grid refinement on climate extremes over the Arctic in storyline-based earth system model simulations.

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Over the last few decades, the Arctic region has warmed up at a greater rate than elsewhere at the globe, partly resulting from the on-going loss of sea ice and snow over land. It is projected that the amplified warming of the surface will continue in the future, most likely altering the magnitude and frequency of temperature extremes, such as heat waves and cold spells. In addition, the intensity and frequency of extreme precipitation and droughts are projected to change, which may pose serious threats for the human infrastructure and livelihoods. To assess (future) climate extremes, Earth System Models (ESMs) with (regionally) refined resolution could be helpful, particularly in mountainous regions.

In this study, we use the variable-resolution Community Earth System Model version 2.2 (VR-CESM) to evaluate and assess present-day and future climate extremes, such as heat waves and heavy precipitation, over the Arctic. Applying a globally uniform 1-degree grid and a VR grid with regional grid refinements to 28 km over the Arctic and Antarctica, we run present-day (2005–2014) and future (2090–2099) simulations with interactive atmosphere and land surface models, and prescribed sea ice and surface temperatures. The simulations follow two storylines of Arctic climate change that represent a combination of strong/weak polar Arctic amplification and strong/weak SST warming in the Barents-Kara seas. We evaluate the ability of the VR grid to simulate climatic extremes by comparison with gridded outputs of the globally uniform 1-degree grid and the ERA5 reanalysis and assess future climate extremes by focussing on temperature and precipitation extremes. The initial outcomes generally show that for some temperature/precipitation extremes indices the VR grid performs better than the globally uniform 1-degree grid, while for other indices the globally uniform 1-degree grid performs better. Future projections suggest that warm temperature extremes will generally increase both in magnitude and frequency, whereas cold temperature extremes will decrease in magnitude, especially over regions dominated by large sea ice loss. Further, precipitation is projected to increase in intensity and volume. The outcomes of this study may contribute to an improved understanding on future climate extremes and its implications.