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September Arctic sea ice predicted to disappear for 2°C global warming above present

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The decline of the Arctic sea ice extent as a consequence of human-induced warming is one of the most visible impacts of climate change. Arctic sea ice extent shows large interannual variability due to the numerous factors, but on longer time scales the total sea ice extent is approximately linearly related to Arctic surface air temperature in both models and observations. However, models overall underestimate the past sea ice decline. Here we show that this can be attributed to two interlinked biases. Most climate models simulate a smaller sea ice area reduction per degree local surface warming. Polar amplification, the ratio between Arctic and global temperature, is also underestimated. In order to assess the uncertainty associated with polar amplification and the reduction per degree surface warming, the interannual variability of both is analyzed. In contrast to a number of studies which come to the conclusion that climate models are not reliable in representing polar amplification we find that at least some models are consistent with observations within the estimated climate variability. A recalibration of the CMIP3 ensemble of global climate models using observations over 50 years provides a scenario independent relationship and yields 3°C above present as the most likely global temperature threshold for September sea ice to disappear. Observations of the last 30 years suggest an even lower threshold at 2oC above present but with larger uncertainties caused by a larger variability. In a high emission scenario the Arctic is therefore projected to be seasonally ice free. If on the other hand global temperature increase could be stabilized at 2°C above preindustrial, the Arctic could likely be prevented of becoming ice-free during summer.