

External drivers on the Arctic warming and associated sea ice reduction in the early 20th century in a new climate model MRI-ESM2.0

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In the first half of the 20th century, some observational records show that there was significant warming called the early twentieth century warming (ETCW) comparable to that presently occurred. The characteristic of that warming is to appear only in the Arctic. Furthermore, a recent reconstructed sea ice dataset and some observational studies indicate a reduction on Arctic sea ice extent associated with the higher temperatures in the ETCW period. But large uncertainties remain in both the observation and the previous model simulations.

We investigated the external drivers of the temperature changes in the Arctic and the associated sea ice changes especially in the first half of the 20th century by DAMIP experiments using a new climate model MRI-ESM2.0. We conducted a pre-industrial control experiment (CNTL), the historical experiments and the DAMIP experiment to evaluate the cause of historical climate change. The DAMIP experiments consist of historical simulations with well-mixed greenhouse gasses (hist-GHG) only, anthropogenic aerosols only (hist-aer), solar irradiance and volcanic aerosol only (hist-nat), and solar irradiance only (hist-sol). The historical experiments of this study consist of five ensemble members with initial conditions taken at 50-yr intervals from January 1st of years 1 of the CNTL. Each of the DAMIP experiments has three ensemble members with the same initial conditions as those of the original historical experiments.

Climate simulations by MRI-ESM2.0 showed the historical temperature changes including the ETCW more realistically. The DAMIP experiments imply that the natural forcing of long-term low volcanic activity in the ETCW is attributed one of the major factors on the temperature rise and associated the sea ice reduction. Some kinds of feedback mechanisms, such as ice-albedo feedback or ice-ocean-albedo feedback could be acting on amplifying the temperature increase in the ETCW period.

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