Evaluation of the simulation of Arctic sea ice in the CMIP5 climate models

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Sea ice is a significant component in the Earth's climate system. Coupled climate system models are important tools for the study of sea ice, its internal processes, interaction with other components, and projection of future changes. This paper evaluates the model's simulation capability in Arctic sea ice for the fifth phase of the Coupled Model Inter-comparison Project (CMIP5) models that were run with historical forcing compared with satellite-derived observations for 1979–2005.

The results show as following: Arctic sea ice spatial distribution is well captured by most of the models. The majority of models is simulating annual cycles that are phased at least approximately correctly, but the magnitude of sea ice extent differs from that observed in over the last 30 years. Many of the models have a negative bias compared to the satellite data in late summer. From 1979 to 2005, the largest sea ice extent decreases are observed during July–September, with the greatest monthly decrease in September ($-0.59 \times 10^6 \mathrm{km}^2 \mathrm{dec}^{-1}$). The Arctic sea ice simulated by the models shows a trend of decrease, but has very large differences in magnitude. The Arctic sea ice extent simulated by the models shows a decrease in each month, with the smallest multi-model mean monthly decline of $-0.22 \times 10^6 \mathrm{km}^2 \mathrm{dec}^{-1}$ in June and the greatest of $-0.53 \times 10^6 \mathrm{km}^2 \mathrm{dec}^{-1}$ in September.

The Arctic sea ice extent reduces $1.02 \times 10^6 \mathrm{km}^2$ in response to 1.0˚ C increase of surface air temperature, as the uncertainties of the climate models, the Arctic sea ice extent of models have a decrease of ice range from 0.62×10^6 to $1.68 \times 10^6 \mathrm{km}^2$. Meanwhile, the trends and sensitivities vary largely across ensemble members in the same model, indicating impacts of initial condition on evolution of feedback strength with model integrations.