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ARCTIC SEA ICE PREDICTION WITH A GLOBAL COUPLED ATMOSPHERE-OCEAN MODEL

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We developed a coupled atmosphere-ocean general circulation model (CGCM), Model for Interdisciplinary Research on Climate 5 (MIROC5)[1], including an initialization system and an improved sea ice module,[2] and performed ensemble prediction in decadal time-scale contributing to the Coupled Model Intercomparison Project Phase 5. The effectivity of the initialized CGCM prediction was demonstrated for the prediction of the Pacific decadal oscillation, for example. At present we are constructing a seasonal prediction system for the Arctic sea ice and the climate over subpolar regions with MIROC5.

We had several data assimilation (DA) experiments for producing initial values by changing the observations used in DA: only with the oceanographic temperature and salinity (oTS), with oTS and atmospheric temperature and wind (aUVToTS), and with aUVToTS plus sea ice concentration (SIC) (aUVToTSI), with MIROC5 in 1975–2011. The experiments were carried following Tatebe et al.[3] The observed data used in DA are the global objective analysis of ocean temperature and salinity[4] at tens of depths above 3000 m and the reanalysis data of ERA-40 (before 1978) and ERA-Interim (after 1979) approximately in the atmospheric boundary layer. We also conducted a prediction experiment with six sets of initial values obtained from the aUVToTSI experiment.

We compare the reproducibility of the Northern Hemisphere sea ice in September among the experiments. The comparison between the experiments of oTS and aUVToTS shows the effectiveness of the DA with atmospheric values to reproduce interannual variations in the Arctic sea ice. In the mean time, a problem in these experiments is a large bias in sea ice extent (SIE), defined as a total area of grids with SIC over 0.15. Compared to the observations, SIE is larger by 2 million km^2 in September and the surface air temperature is lower by 1–2 ˚C in the annual mean over the Arctic Ocean in the aUVToTS experiment. There is no large bias of SIE in the aUVToTSI experiment directly assimilated with SIC observation. The prediction with the initial values obtained from the aUVToTSI experiment show a skill to predict seasonal variation of SIE and El-Nino Southern Oscillation (Fig. 1) in certain of cases.

We are carrying out a new model initializa- tion experiment by DA with observed anomalies of atmospheric and o- ceanic variables from the climate to avoid the large bias problem. This ap- proach has an advantage in climate prediction be- cause model climate drifts due to the model biases are minimized.

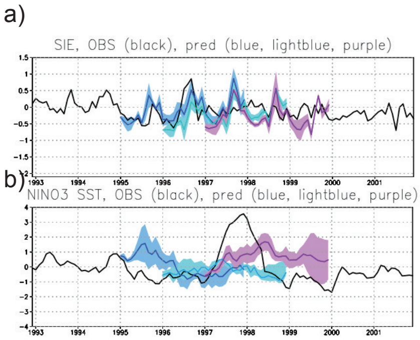

Fig. 1. The predicted (a) SIE and (b) sea surface temperature (SST) in the NINO3 region from the initial values on Jan 1st in 1995, 1996, and 1997 (blue, lightblue, and purple lines, respectively) initialized with the aUVToTSI experiment. SIE and SST are modified with prediction drifts by model. The observed and the aUVToTSI experiment SIE and SST are also shown with black line.

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