気候モデル MIROC を用いた北極域における海氷の予測可能性

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Predictability of sea ice in the Arctic regions with the MIROC climate model

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The Arctic environment has markedly changed due to the rapid decline of sea ice in summer Arctic Ocean. The retreat of sea-ice cover could be associated with the Arctic amplification and an increase in the frequency of severe cold winters in the Northern Hemisphere mid-latitudes. Accurate predictions of sea-ice variability on seasonal to inter-annual time-scales and its mechanisms would be useful for further progress in science as well as socio-economic activity. It has been well known that the potential predictabilities are 1-2 and 2-4 years for sea-ice extent and volume (Blanchard-Wrigglesworth et al., 2011). However the predictability of sea ice based on the real conditions is limited to be 7 month (Masdec et al., 2014). We have developed the prediction system for the Arctic regions with the climate model MIROC5 (Watanabe et al., 2010) that has an improved sea ice module (Komuro et al., 2012). We performed assimilation experiments from 1975 to 2011 using the MIROC5 whose the atmosphere component has a resolution of T42 and L40 and the ocean component has a resolution of 1.4^{o} x 0.5^{o}-1.4^{o} degrees and 50 levels. The method used for the assimilation is a simplified version of an incremental analysis update (Tatebe et al., 2012). The data used for the assimilation are ocean temperature, salinity, and sea-ice concentration (Ishii and Kimoto, 2009), and air-temperature and wind from the ERA and ERA-Interim. Further, we carried out ensemble prediction experiments with 8 members, which were initialized by the assimilation experiments. These experiments were started from initial state of January, April, July, and October. We compared the reproducibility of sea ice in September and investigated the predictability. Initializations for atmosphere and sea-ice fields in the Arctic regions have been successfully done. Assimilation and prediction at 3-month lead-time follow well the observed seasonal and inter-annual variability in the detrended SIE anomaly (Fig. 1a). The anomaly correlation coefficient (ACC) scores suggest that a dynamical prediction for summer SIE is possible with a climate model (Fig. 1b).

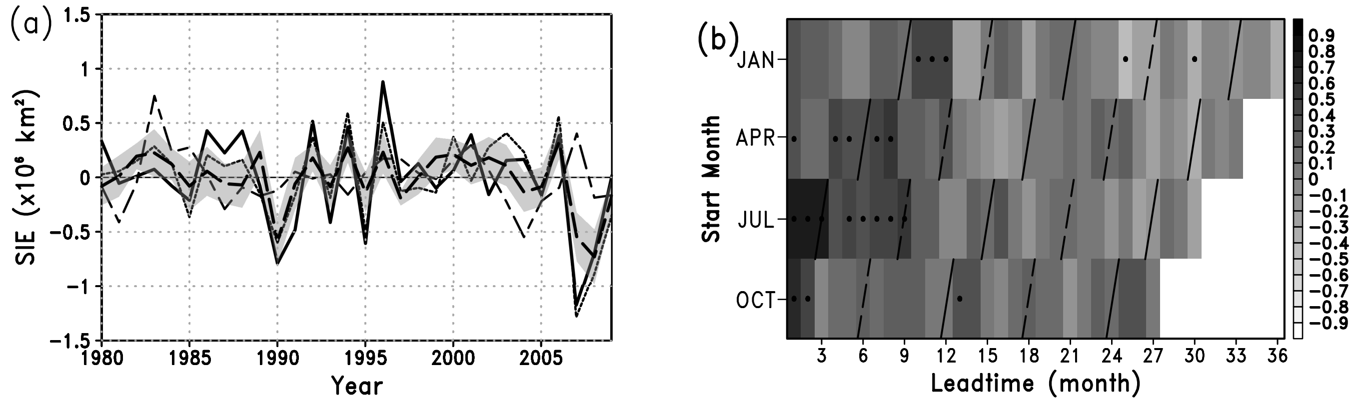

Fig. 1 (a) Time series of the detrended September SIE anomaly in the Northern Hemisphere from 1980 to 2009 for observation (solid line), assimilation (short-dashed line), historical (short-long-dashed line), and prediction (long-dashed line) at three months lead-time. Gray shading indicates the ensemble spread. (b) Lead-time dependence of SIE anomaly correlation coefficient for January, April, July, and October start prediction experiments. Solid and dashed lines denote values for September and March, respectively. Dots indicate months where the ACC is larger than that of the statistical forecast.

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