Predictability of a drastic reduction in the Arctic sea ice with climate model MIROC

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We focus on the predictability and mechanism of a drastic reduction in the Arctic summer sea ice, using a control simulation (CTRL) that was run as part of the Arctic Predictability and Prediction On Seasonal to Inter-annual Timescales (APPOSITE) project with climate model MIROC5.2. CTRL does not include a global warming trend because of radiative forcings fixed at the year 2000. Nevertheless, the time series in sea ice extent and volume suggest that a drastic decline of September Arctic sea ice could occur about once or twice a century. The spatial distribution of sea ice is characterized as extreme negative anomalies from the Russian coast to near the North Pole, which are similar to the spatial patterns observed in September 2007. Considering that a sea level pressure (SLP) dipole pattern with positive anomaly over the Beaufort Sea and negative anomaly over the Kara Sea is formed in summer, it is inferred that sea ice drifts offshore with winds associated with the SLP dipole anomaly, leading to the large retreat of ice edge throughout July to August. To examine the predictability of extreme sea ice loss, we conducted a series of perfect model ensemble prediction experiments (PRED) started in 1 October, 1 January, 1 April, and 1 July chosen from CTRL. PRED started in July successfully predicted the sea ice distribution in the year when sea ice drastically decreased in CTRL. This is because the SLP anomaly pattern is well predicted. Meanwhile, although PRED started in April cannot predict the sea ice extent, the spatial pattern of sea ice in the Russian side of the Arctic Ocean is well predicted.

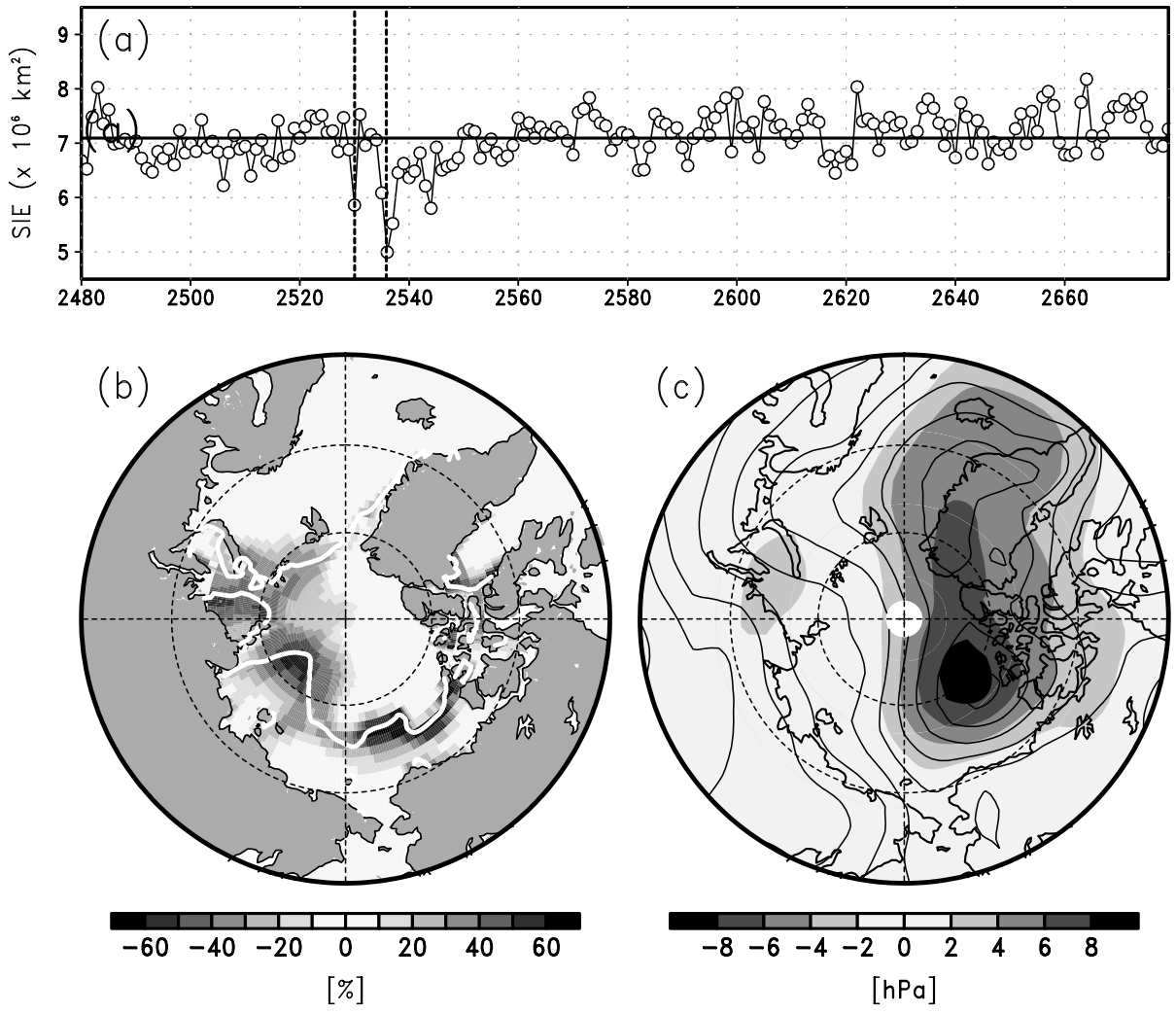

Figure 1. (a) Time series of September Sea ice extent (x10^6 km^2) from 2480 to 2679 for CTRL. Two vertical dashed lines denote the year 2530 and 2536. (b) Sea ice concentration anomaly (%) in September 2536. White line indicates the 15% concentration contour. (c) Sea level pressure anomaly (hPa) averaged on July to August 2536.