Sea-ice Outlook for Summer 2009

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1 Retrospective Summary

The motivation for participating in the Sea-ice Outlook (our first time this year) is to start experimenting with the utilization of ICESat-derived sea-ice thickness as initial conditions for prediction of the summer sea-ice minimum in the Arctic Ocean. With the exception of initial sea-ice thickness, our approach is conventional: it is based on a coupled ocean and sea-ice model in combination with past years' surface atmospheric boundary conditions (BCs). Our predicted 2009 sea-ice minimum based on August data was $4.4 \pm 0.5 \times 10^6$ km^2, which was below this year's value of 5.36×10^6 km^2. Initial sensitivity experiments showed that near-surface air temperature and specific humidity fields already contain significant amount of information about the sea-ice coverage (Fig. 1). As a consequence, any sea-ice coverage ensemble forecast that uses the 2007 temperature and specific humidity fields as part of the input surface BCs will approximately have the 2007 sea-ice minimum as the lower-end estimate of the ensemble. In addition, a combination of thinner sea-ice initial conditions [Kwok and Rothrock,2009] and high surface temperature would significantly reduce Arctic sea-ice coverage. This is the main reason for our lower than observed sea-ice extent prediction. We used the 2007 and 2008 atmospheric BCs from the Japanese 25-year Re-Analysis (JRA25) and ICESat-derived sea-ice thickness for March 2009 to arrive at the low predicted 2009 sea-ice extent value of $4.4 \pm 0.5 \times 10^6 km^2$. In order to have more reliable predictions of sea-ice coverage, we need to improve the quality of our predicted atmospheric BCs.

Compared to the last two years, both 2009 surface air temperature and specific humidity are lower in August and September (Fig. 1, only temperature fields are shown here). In addition, summer 2009 did not have the 2007 pattern of high pressure over the Beaufort Gyre and low pressure over the Siberian coast, which drove the thick multi-year ice out of the Arctic Ocean (Fig. 2, only Sept. shown here). These factors could contribute to the higher sea-ice extent in the Arctic Ocean in late August to September this year compared to the two previous years. As mentioned above, however, as well as in last year's Outlook Summary Report, the Central Arctic sea ice is mostly thin, first-year ice. Therefore, anomalous summer atmospheric conditions such as those that occurred during the summer of 2007 can potentially reduce summer sea-ice coverage to another record low in the near future.

2 Reference

Kwok, R., and D. A. Rothrock. 2009. Decline in Arctic sea ice thickness from submarine and ICESat records: 19582008, Geophys. Res. Lett., 36, L15501, doi:10.1029/2009GL039035.

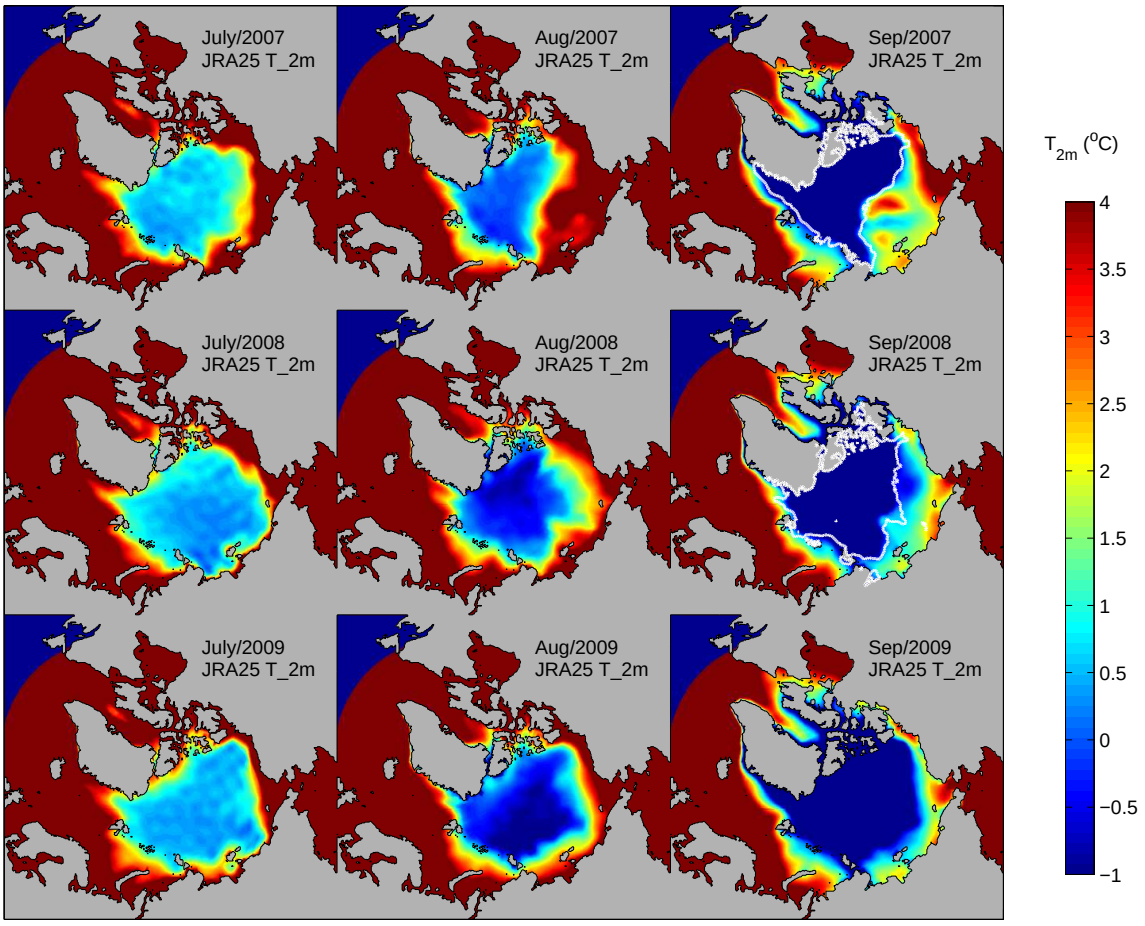

Figure 1: JRA25 monthly mean surface air temperature in degree Celsius (color scale) for summer 2007 to summer 2009. White contours are SSMI 15% sea-ice concentration for Sept 15 of the corresponding years. The surface temperature field contains information about the sea-ice coverage as seen by the SSMI contours outlining the low surface temperature in September 2007 and 2008. As a result, if initial conditions are similar, using atmospheric boundary conditions from any particular year to drive a coupled ocean and sea-ice model will yield approximately the sea-ice coverage for that year.

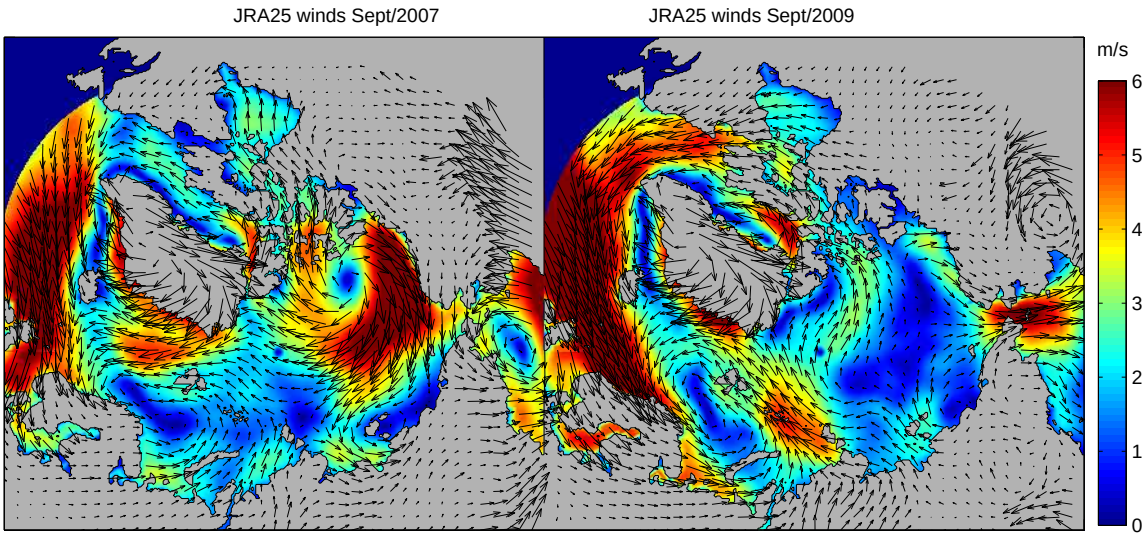

Figure 2: JRA25 September monthly mean surface winds for 2007 and 2009, with wind speed in m/s shown in color. In 2007, a high pressure system over the Beaufort Gyre and low pressure over the Siberian coast drove the thick multi-year ice along the Canadian Archipelago to the central Arctic for accelerated melting and export at Fram Strait. In summer 2009, surface temperature is lower than 2007 and 2008 (Fig. 1), and the 2007 anomalous high/low pressure system is absent. These factors could contribute to the higher sea-ice extent for this year in the Arctic Ocean compared to the two previous years.