

2011 Sea Ice Outlook

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1. Extent Projection

We estimate that the September 2011 minimum sea ice extent is 5.4 million sq km.

2. Methods / Techniques

This prediction is based on sea ice thickness, summer melt, outflow and cloudiness. In summer 2007, a particularly large Arctic sea ice decrease occurred when sea ice extent plunged to its lowest level since satellite observations of sea ice began in the 1970s. In 2007, the contribution of the atmospheric effect to the melt was large. But atmospheric effects don't accelerate the melting of the Arctic sea ice in 2011 that is different from the case of 2007 (Fig.1). We assumed that there is no special atmospheric influence on the sea ice reduction in 2011. We estimated the sea ice thickness using the polarization ratio of the 36GHz observed with the satellite borne passive microwave radiometer AMSR-E. Fig. 2 shows the distribution of the ice thickness on 30 April 2011. We estimated the distributions of the Arctic sea ice thickness on 30 April since 2003 for evaluating the initial ice condition before summer melt starts. We assume in this report that the annual minimum ice extent in September is determined only through the processes of melting and outflow into the Atlantic Ocean during summer. We defined the regional summer melting rates as 171cm in the 65-85N, 74cm in the 88-85N, and 48cm in the 88-90N, respectively, from the Ice Mass Balance buoys data which are opened in the CRREL web site (<http://imb.crrel.usace.army.mil>). We also considered sea ice outflow rate into the Atlantic Ocean through the Fram Strait during summer is 0.4 million sq km by referring Kwok (2009). Fig. 3 shows the predicted sea ice extent and the past minimum sea ice extent reported from IARC-JAXA Information System (IJIS). IJIS has opened Arctic Sea-Ice Monitor by AMSR-E to the public on its web site (<http://www.ijis.iarc.uaf.edu/cgi-bin/seaice-monitor.cgi?lang=e>). The predicted sea ice extents shows good correlation (correlation coefficient is 0.852) with the past minimum sea ice extents as shown in Figure 3. Although there are still constant biases (underestimation approximately 1.0 million sq km) and thus uncertainties in our method, we tuned our prediction model by adding this offset (Fig.4). Correlation coefficient of prediction extent and minimum extent is 0.756. Finally we predicted sea ice extent in September 2011 will be 5.4 million sq km.

3. Rationale

Figure 1 shows mean cloudiness anomaly in June 2007 and 2011. Cloudiness anomaly in 2011 has no remarkable sunny condition and outstanding wind to decrease sea ice different to atmospheric condition in 2007. Therefore, we thought the influence of the atmospheric conditions on sea ice reduction as the average in 2011. We assumed that sea ice minimum extent depends on the initial sea ice thickness on April 30 and melting and outflow during summer season.

4. Executive Summary

Our outlook is primarily based on the estimation of sea ice thickness in spring. We considered sea ice in 2011 has not received special atmosphere effect. Therefore we estimate that the September 2011 mean sea ice extent from sea ice thickness and sea ice export from Fram strait. As a result, we estimate September 2011 mean sea ice is 5.4 million sq km.

5. References

R. KWOK, 2009: Outflow of Arctic Ocean Sea Ice into the Greenland and Barents Seas: 1979–2007, JOURNAL OF CLIMATE, VOLUME 22, pp2438-2457

Figures

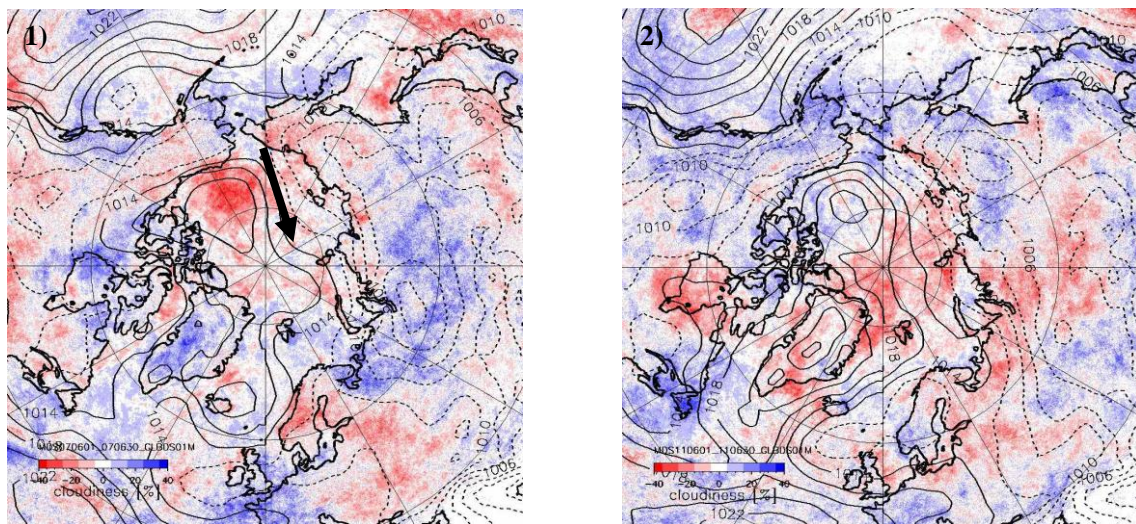


Fig.1 Cloudiness anomaly in June (monthly average), 1) 2007, 2) 2011.

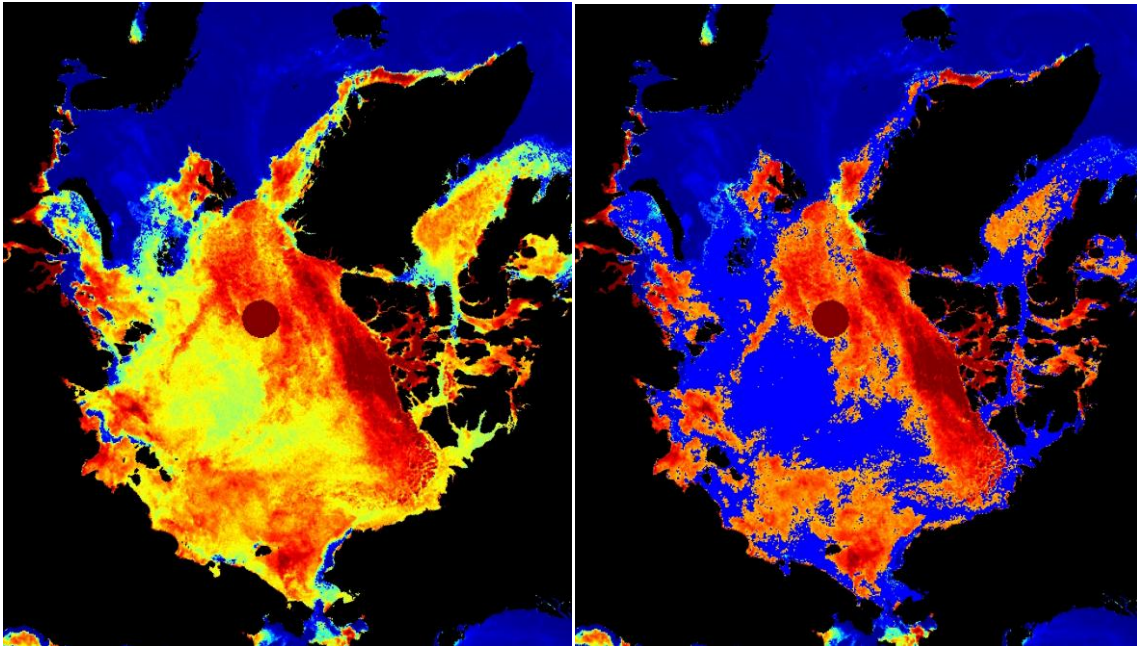


Fig.2 Sea ice thickness in Arctic Ocean on 30 April 2010.

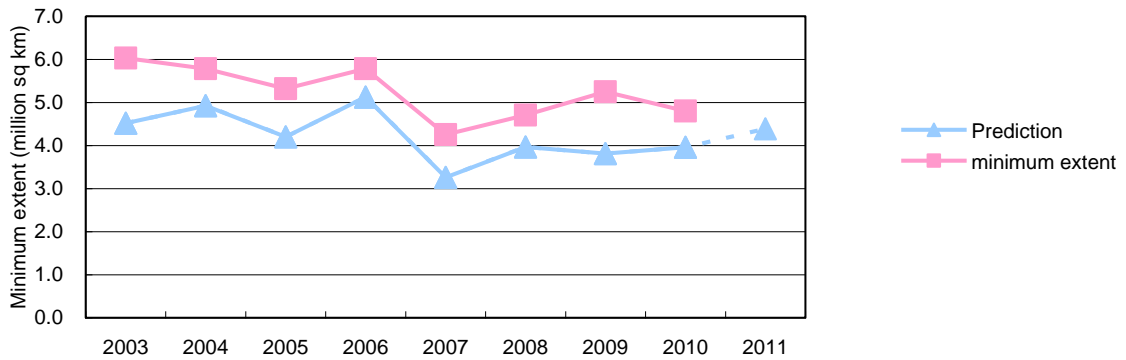


Fig.3 Prediction of sea ice in Arctic Ocean, minimum extent shows actual minimum sea ice extent data from IJIS web site during 2003-2010.

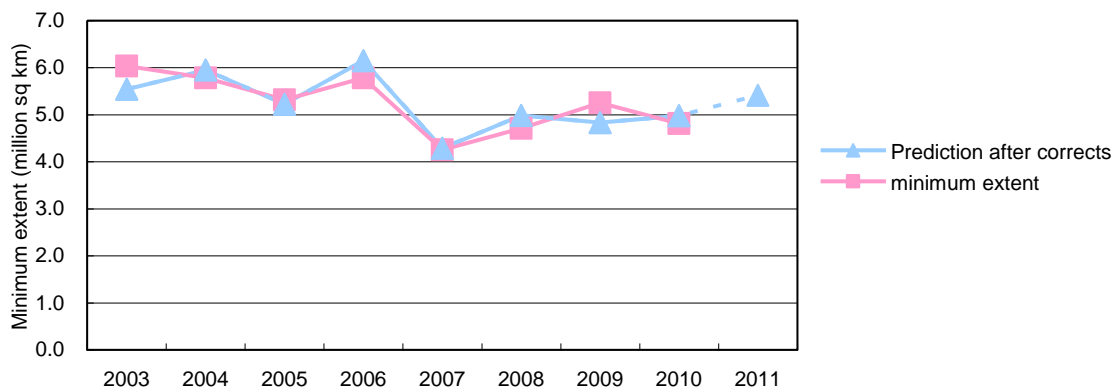


Fig.4 Prediction of sea ice extent in Arctic Ocean after the corrections