Sea ice outlook in 2012: Springtime atmospheric and sea ice dynamical contributions to fall sea ice extent

June Report based on May Data

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Estimate for sea ice extent for September, 2012; comparable to or less than the 2011 minimum in sea ice extent, or 4.33 million square kilometers.

Executive Summary

It is hypothesized that the 2012 fall sea ice extent will achieve values comparable to those of 2011 based on a heuristic assessment of sea ice and stratospheric dynamics, with regional losses governed by local ice conditions determined by sea ice deformation characteristics.

Rationale

Similarity in stratospheric dynamical conditions and their anomalies in February, 2012 to those encountered during years associated with a record low in fall sea ice extent (2007 and 2011) manifested in the tripolar configuration pattern in wind extrema at high latitudes (Figures 1 and 2) and dissimilarity during years that exhibited a partial recovery in ice extent (2009) suggests a continued decline in sea ice extent during summer from atmospheric dynamical contributions as springtime stratospheric anomalies propagate to the surface. Furthermore, dissimilarity and a continued loss in coherence in sea ice drift patterns in March, 2012 relative to March, 2007 and 2011 suggests that spatiotemporal variability in fall ice extent will be governed by local ice conditions and ice-ice interactions as monitored by small-scale properties associated with sea ice deformation. Investigation of sea ice concentrations support this hypothesis with the emergence of lower ice concentration bands in the southern Beaufort Sea in May, 2012 within an increasingly heterogeneous sea ice cover in the Arctic.

Methods

Connections between atmospheric dynamics and summertime sea ice extent in the Arctic are examined in the context of stratospheric and sea ice dynamics. Explored in particular were the stratospheric (10 mb) relative vorticity fields in February (the last available month for 2012). Monthly means of ECMWF ERA-Interim relative vorticity used in this study as in previous analyses were obtained from the ECMWF data server.

Stratospheric wind composites and anomalies for April are also presented for 2012, and compared with the 2007 and 2011 conditions associated with the record minimum in sea ice extent, in addition to the 2009 conditions associated with a partial recovery of the fall sea ice extent. Stratospheric winds were obtained from the NCEP reanalysis dataset provided by the NOAA/ESRL Physical Sciences Division. Investigated also is AMSR-E sea ice motion in March, 2007, 2009, 2011 and 2012 obtained from the Institut Francais de recherche pour l'exploitation de la mer, in addition to sea ice concentrations for March and May, 2007, 2009, 2011, and 2012 and obtained from the University of Bremen.

Discussion

Stratospheric relative vorticity fields for February illustrate a dipolar configuration for 2012 similar to that observed in 2007 and 2011 that differs significantly from circulation observed in 2009 (Figure 1). The dipolar configuration in 2012 is displaced relative to 2011 and 2007, with maximum anticyclonic activity located over the Beaufort Sea and cyclonic activity over the North Atlantic. Stratospheric winds in March highlight a tripolar configuration in 2007, 2011, and 2012 not evident in 2009 (Figure 2). Noteworthy are higher winds at lower latitudes in 2009 relative to 2007/2011 and 2012 (top row). Also of interest is the regional similarity in stratospheric wind anomalies at high latitudes during years associated with record lows in minimum sea ice extent in fall, with extrema at high latitudes and over the Laptev and Chukchi Seas. Differences between the 2102 and both the 2007 and 2011 stratospheric winds similarly indicate anomalous behaviour over the Laptev and Chukchi Seas, with implications for sea ice deformation and ridging and ice-ice interactions in this region.

Sea ice concentration maps for March indicate lower ice concentrations at higher latitudes in 2012 relative to 2011, and 2007 (Figure 3, top row). Noteworthy also is a reduction in coherent features in ice drift in March, 2012 relative to March, 2007 and 2011 (Figure 3), in a manner consistent with recent observations illustrating a decrease in dispersion in a more heterogeneous ice cover, and the emergence of lower ice-concentration bands in the southern Beaufort Sea in May, 2012 (Figure 4). The loss of coherence and differences in ice drift patterns between 2007, 2011, and 2012, in addition to the emergence of lower-concentration filaments in the Beaufort Sea region suggests dominant contributions from local ice-ice interactions within a heterogeneous ice regime, and increased input from sea ice deformation to reducation in sea ice extent and cover.

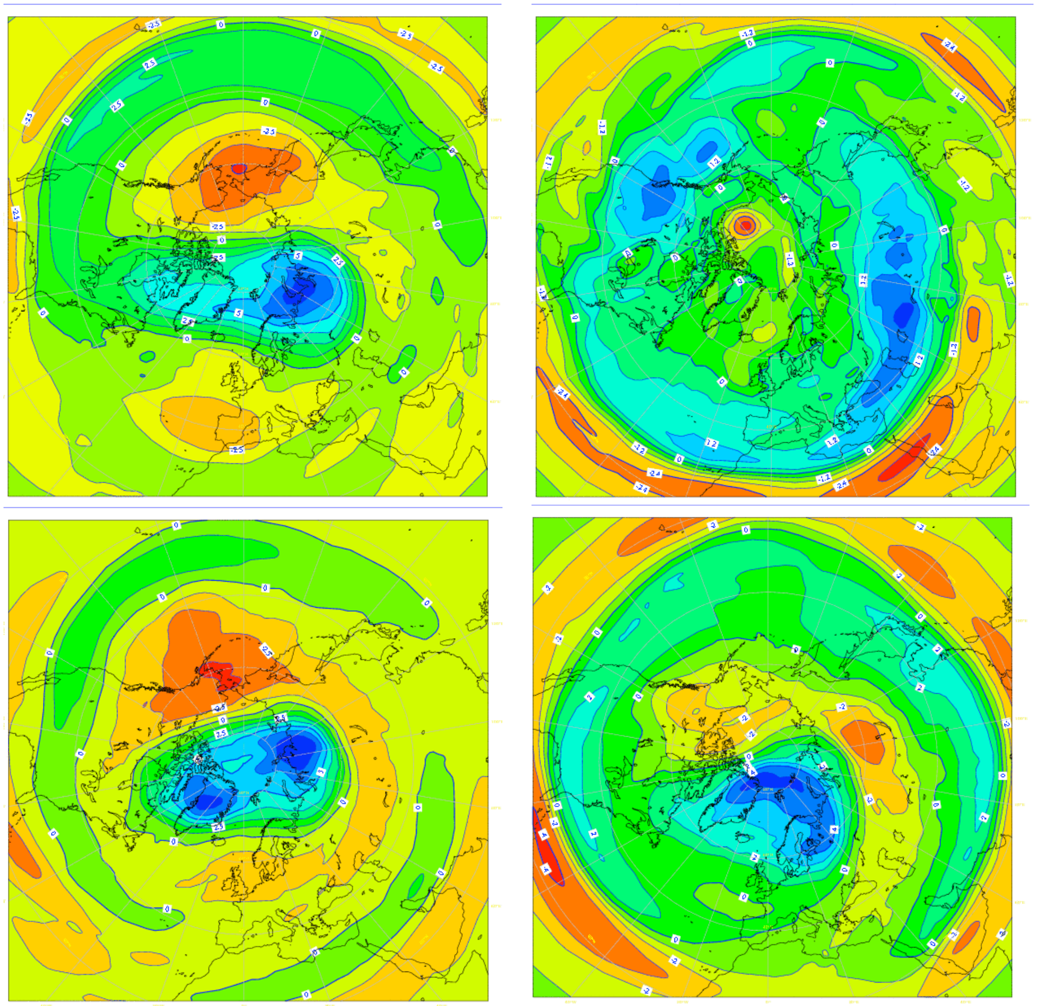

Figure 1. Stratospheric (10 mb) relative vorticity fields for (clockwise from upper left corner) February, 2007, 2009, 2011 and 2012. Anticyclonic activity (negative relative vorticity) is depicted by red shading. Image provided by the ECMWF ERA-Interim data portal at http://data-portal.ecmwf.int/data/d/interim_moda/levtype=pl/.

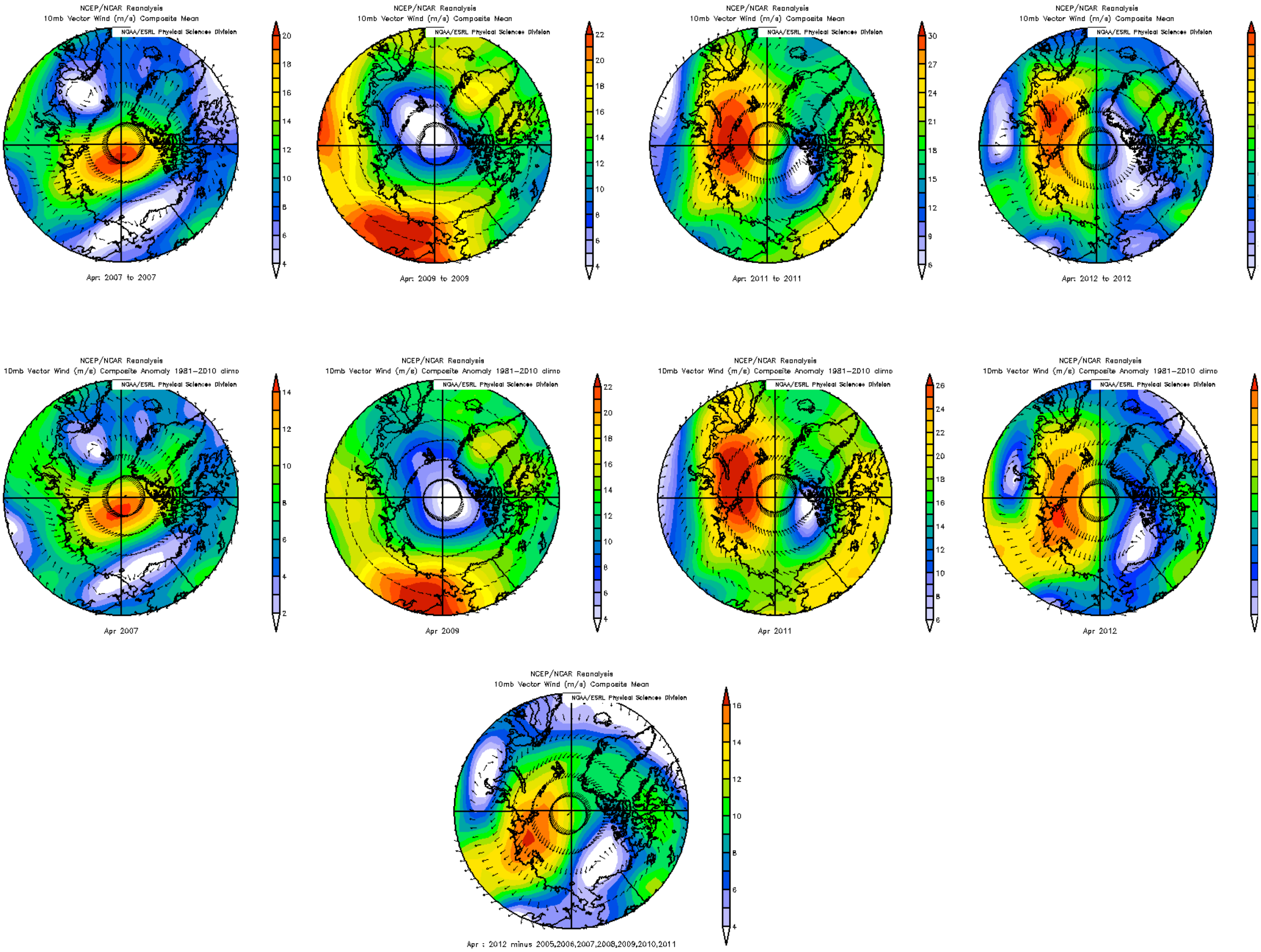

Figure 2. Stratospheric (10 mb) winds for April, 2007, 2009, 2011, and 2012 (top row), anomalies for respective years (second row) and the difference between 2012 and years (2005 – 2010) with record minima in sea ice extent (lowermost panel). Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado from their Web site at http://www.esrl.noaa.gov/psd/.

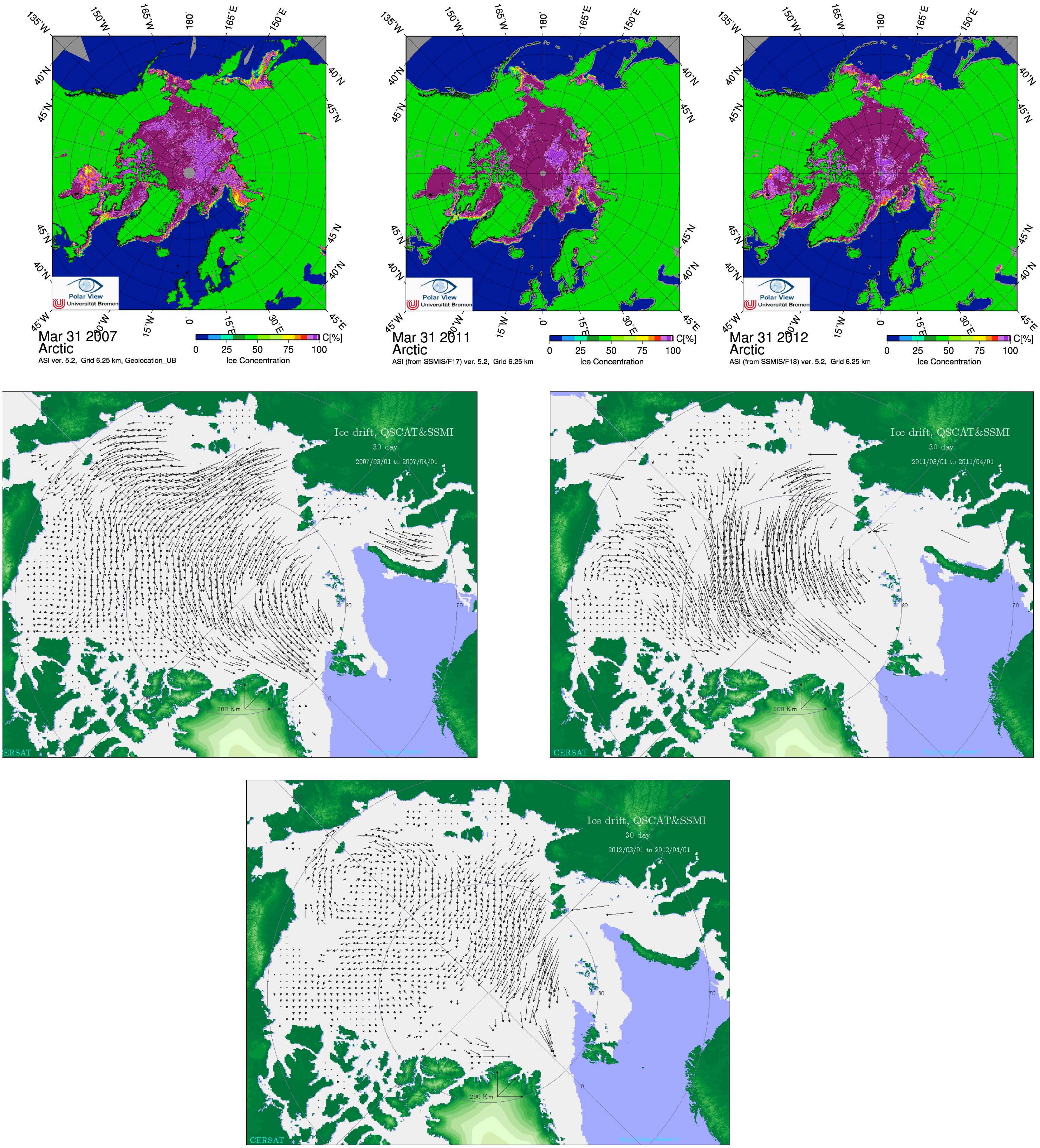

Figure 3. AMSR-E maps of sea ice concentration in the Arctic for March 31st in 2007, 2011, and 2012 in addition to monthly sea ice drift for March 2007, 2011, and 2012. Sea ice concentration image provided by the University of Bremen at http://www.iup.uni-bremen.de:8084/amsr/, and sea ice drift image provided by Institut Francais de recherche pour l'exploitation de la mer at ftp://ftp.ifremer.fr/ifremer/cersat/products/gridded/psi-drift/quicklooks/arctic/.

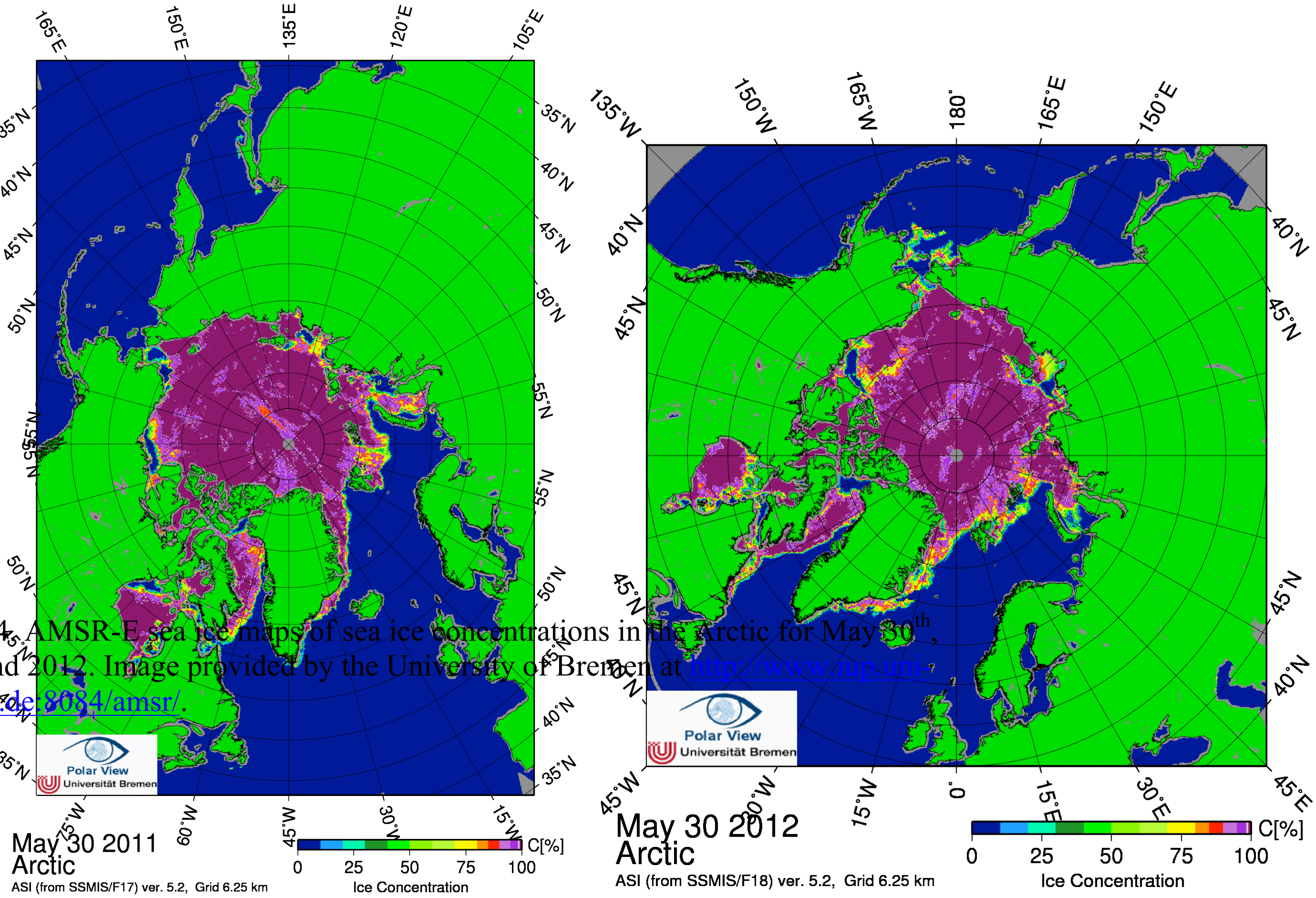

Figure 4. AMSR-E sea ice maps of sea ice concentrations in the Arctic for May 30th, 2011 and 2012. Image provided by the University of Bremen at http://www.iup.uni-bremen.de:8084/amsr/.