Regional Sea Ice Outlook for Greenland Sea and Barents Sea
- based on data until the end of May 2013

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In this report, we give a brief overview on the sea ice situation for Greenland and Barents Seas for April and May 2013, along with information from field observations near Svalbard, and a regional prediction.

Sea Ice Extent Maps

The monthly mean sea ice extent for April and May 2013, based on Norwegian ice charts (http://met.no/Hav_og_is/) produced primarily from SAR since 2007 and supplemented with cloud-free optical, where available, with passive microwave being used where no higher resolution data is available, is compared with the corresponding monthly means for April and May for the years 2009-13 (Fig. 1a and 2a), and with 30, 20, and 10 year averages of monthly April and May means for the periods 79-08, 80-99 and 99-08 (Fig. 1b and 2b, respectively).

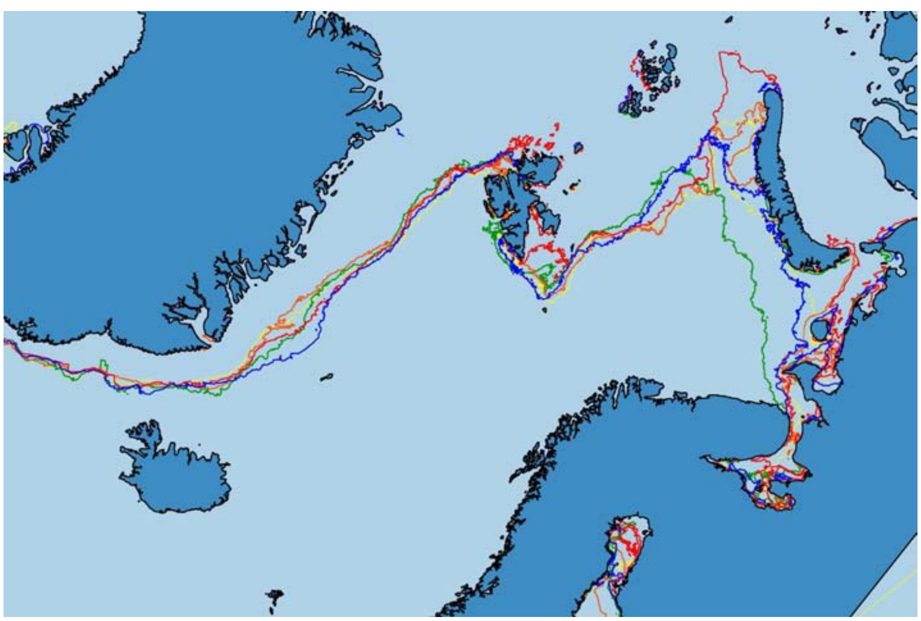

Fig. 1a: Sea ice extent (monthly means, April), border of 30% ice concentration, in the Greenland Sea/Fram Strait and Barents Sea, based on met.no ice charts (April in 2013 (blue), 2012 (red), 2011 (orange), 2010 (green) and 2009 (yellow).

The sea ice regimes in the Greenland Sea and in the Barents Sea are substantially different. Sea ice in the Greenland Sea is dominated by ice drifting with the Transpolar Drift and the East Greenland current out of the Arctic Basin southwards (see e.g. Vinje et al. 1998; Spreen et al. 2009), whereas sea ice in the

Barents Sea consists to a high degree of seasonal ice formed in the same area during the past winter (see e.g. Vinje and Kvambekk 1991). However, years with high inflow from the Arctic Basin exist (e.g. Kwok et al., 2005) and can cause positive ice area anomalies in the Barents Sea (Kern et al., 2010).

Sea Ice Extent in April 2013

Sea ice in the Greenland Sea in general exhibits little interannual variability for April 2013 (Fig. 1a), as also observed in earlier years of the Arctic Sea Ice Outlook for this region. The only subregions that have some difference in the position of the ice edge between recent years are the area NW of the island Jan Mayen (more ice in 2013 relative to earlier), and the area NW of Svalbard (2013 similar to 2012, but both Aprils with less ice than Aprils 2009-2011). April 2013 was the closest sea ice has been to Jan Mayen since 2004, getting to within 60 nautical miles of the island. In the Barents Sea, interannual variability is also low in the western part, but higher in the east. There, west of Novaya Zemlya, the position of the ice edge can be found in-between maxima and minima of recent years, but with significantly more ice than in 2012. The ice maps indicate some ice west of the northern half of Novaya Zemlya.
Looking at decadal means (Fig. 1b), April 2013 appears as a month with pretty much representative sea ice extent for Fram Strait and Greenland Sea, but as a month with little sea ice, when comparing this year's April extent with earlier decadal means close to NW Svalbard in the Barents Sea. Among the decadal means of sea ice extent, the one covering 1999-2008 (orange in Fig. 1b) is closest to the April 2013 extent, but still substantially larger than last April.

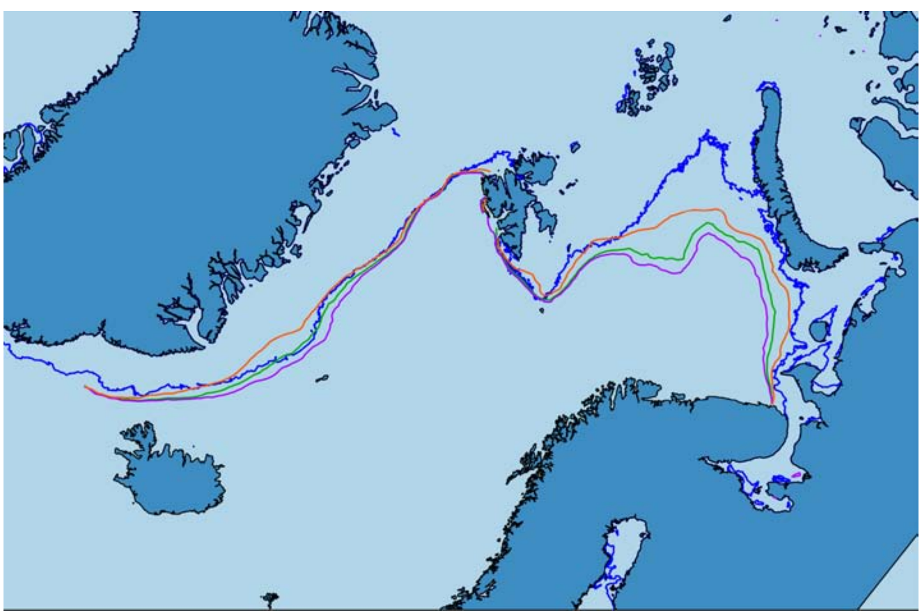

Fig. 1b: Ice extent (monthly means, April) border of 30% ice concentration, in the Greenland Sea / Fram Strait and Barents Sea, based on met.no ice charts (blue = monthly mean April 2013, orange = mean April 1999-2008, purple = mean April 1980-1999, green = mean April 1979-2008).

Sea Ice Extent in May 2013

For Fram Strait and Greenland Sea, sea ice extent in May shows very little variability between the recent years, including 2013 (blue in Fig. 2a). In the central northern Barents Sea, May 2013 stands out with an ice edge relatively close to Franz Josef Land, compared with earlier years. Beyond that, ice extent in May 2013 was not very different from ice extent May 2010 (green in Fig. 2a). The western coast of Novaya Zemlya appears now ice-free in the sea ice map for May 2013.

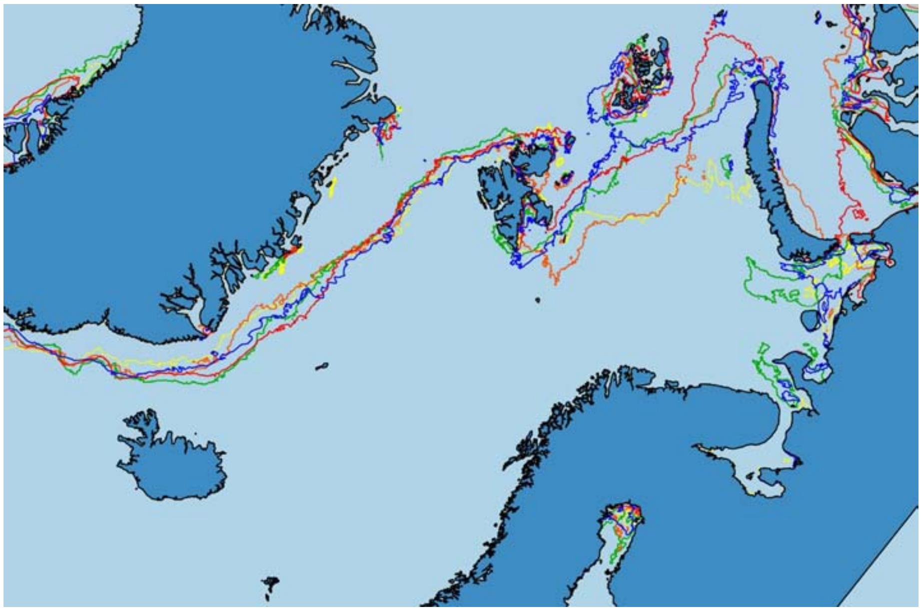

Fig. 2a: Sea ice extent (monthly means, May), border of 30% ice concentration, in the Greenland Sea/Fram Strait and Barents Sea, based on met.no ice charts (May in 2013 (blue), 2012 (red), 2011 (orange), 2010 (green) and 2009 (yellow).

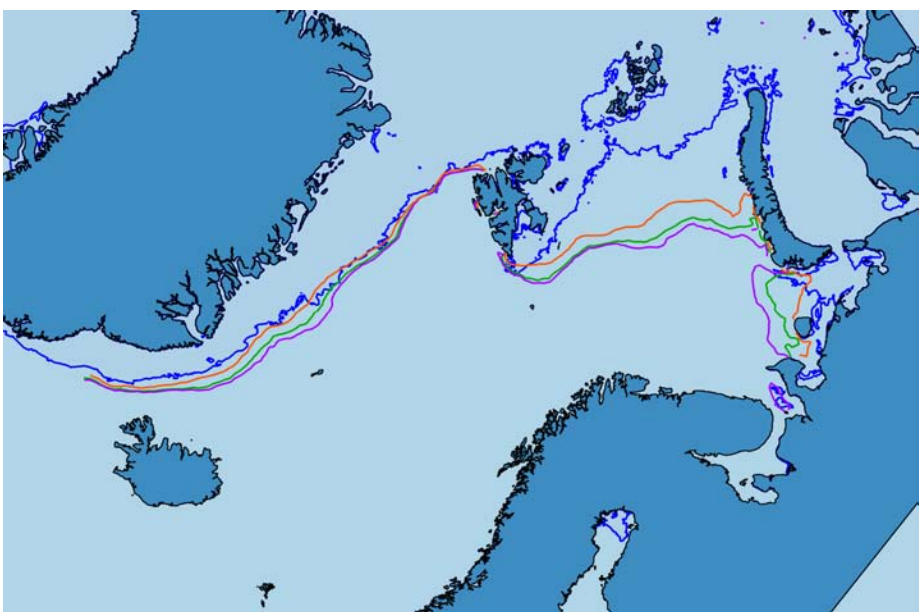

Fig. 2b: Ice extent (monthly means, May) border of 30% ice concentration, in the Greenland Sea/Fram Strait and Barents Sea, based on met.no ice charts (blue = monthly mean May 2013, orange = mean May 1999-2008, purple = mean May 1980-1999, green = mean May 1979-2008).

The sea ice extent for May 2013 relative to decadal means (Fig. 2b) shows little to no difference between the different means in the northern Greenland Sea and Fram Strait. However, near NW Svalbard and in the Barents Sea, May 2013 show substantially less ice than any of the decadal means. Differences are largest in the NE Barents Sea.

Brief Comments on Sea ice observations near Svalbard in spring 2013

Fieldwork of the Norwegian Polar Institute took place off Svalbard in Kongsfjorden (West Spitsbergen) and in Storfjorden. The work is part of the longterm monitoring of Svalbard sea ice of the Norwegian Polar Institute (see e.g. Gerland and Renner, 2007), and two process study-based projects.

Fieldwork at Kongsfjorden was conducted in mid April 2013. Kongsfjorden had a relatively short fast ice season, and thicknesses observed by drillings did not exceed 35 cm. This is little compared to most other years with observations (e.g. Gerland and Renner 2007, Pavlova et al. in press). Snow depth was small with just a few cm. Also the maximum extent of fast ice in Kongsfjorden was low, reaching not further west than the Lovén islands in the inner part of the fjord. In the south, Kongsfjorden was open all the way to Kongsvegen glacier.

At Storfjorden, both in situ and helicopter-borne fieldwork could be performed. Monitoring of sea ice in Storfjorden, Svalbard, started on 1 March 2013 when a SAMS ice mass balance buoy (IMB) was installed in the fast ice in Inglefieldbukta (N 77° 54’, E 18° 17’). The initial ice thickness was 55 cm with 7 cm snow cover. Ice thickness increased continuously until about mid May when first surface melting events occurred. Ice thickness on 7 May was about 95 cm and snow depth 45 cm. By 10 June, ice thickness was about 88 cm and snow depth 20 cm. The south-western part of the Storfjorden fast ice broke up by now but the northern and western fast ice areas are still intact and the seasonal ice thickness development measured by the IMB should be representative for these areas. In addition to in situ observations in Inglefieldbukta, NPI conducted several helicopter-borne EM-bird campaigns over fast ice in Storfjorden. In early March, prolonged northerly winds advected thick drift ice out of the fjord and large parts of the fjord were subsequently covered by nilas and young grey ice. During flights on 3 and 6 April, the fast ice in the north and north-western part of the fjord was covered, and the modal total snow and ice thickness was 0.7 m. In early May, the inner fjord was ice free and only fast ice remained around the edges in the north and the west of the fjord. On 11 May, modal ice thickness of the western fast ice was 1.2 m.

Regional Prediction

Ice concentration data from the Norwegian Ice Service ice charts were analysed to produce monthly ice area values for the Svalbard region, 0 to 40° E longitude, 72 to 82° N latitude. These were compared against climatic variables, including sea surface temperature (SST) for the West Spitsbergen Current, and Arctic Oscillation (AO) index values, to develop a linear regression model for future ice area from which the prediction for September ice area for the area is derived. The prediction last year for September 2012 was 164,313 km^2. The actual minimum ice extent was 120,839 km^2 and therefore there will be further investigation to determine if the model can be improved in any way.

Monthly SST data was acquired from the NOAA Extended Reconstructed SST V3b (http://www.esrl.noaa.gov/psd/data/gridded/data.noaa.ersst.html) dataset, and AO index values from the NOAA National Weather Service (NWS) Climate Prediction Center (CPC)

(http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao.shtml).
Data was input into the Weka data mining software (http://www.cs.waikato.ac.nz/ml/weka/) to experiment with different methods for predicting future ice area values. The time series extension to this software provides a linear regression model to determine the best fit to the data by predictor variables at large number of time lags. Sea ice area for the Svalbard area evaluates as:

```
ist_svalbard =
   0.1896 * Month=oct,jul,nov,dec,jun,jan,may,feb,apr,mar +
  -0.1207 * Month=jul,nov,dec,jun,jan,may,feb,apr,mar +
   0.2579 * Month=nov,dec,jun,jan,may,feb,apr,mar +
  -0.1048 * Month=jun,jan,may,feb,apr,mar +
   0.1181 * Month=jan,may,feb,apr,mar +
  -0.0675 * Month=may,feb,apr,mar +
   0.0569 * Month=feb,apr,mar +
  -0.0002 * date-remapped +
   0.7603 * Lag_ist_svalbard-1 +
  -0.1092 * Lag_ist_svalbard-2 +
   0.078  * Lag_ist_svalbard-4 +
   0.0659 * Lag_ist_svalbard-8 +
  -0.0677 * Lag_ist_svalbard-9 +
   0.0995 * Lag_ist_svalbard-10 +
   0.0676 * Lag_ist_svalbard-11 +
  -0.1029 * Lag_ist_svalbard-12 +
   2.4393
```

For September 2013 this produces a preliminary prediction of 160,643 km^2. As was mentioned above, there will be further work taking in place in June to improve the model and hopefully provide a more accurate prediction.

Acknowledgements
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