AWI contribution to the June 2016 Sea Ice Outlook – two different methods but similar results

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Sea ice in both Polar Regions is an important indicator for the expression of global climate change and its polar amplification. Consequently, a broad information interest exists on sea ice, its coverage, variability and long term change. Knowledge on sea ice requires high quality data on ice extent, thickness and its dynamics. As an institute on polar research we collect data on Arctic and Antarctic sea ice, investigate its physics and role in the climate system and provide model simulations on different time scales. All this data is of interest for science and society. In order to project the potential development of the seasonal signal, AWI is contributing this year to the Arctic sea ice outlook (SIO) with two prediction methods: a dynamical one and a statistical one.

Although both methods are totally different in their methodology, the predicted mean September sea ice extent in 2016 based on observations available until end of May 2016 is very consistent (4.73 ± 0.41 mill. km^2 for the dynamical and 4.68 ± 1.00 million km^2 for the statistical approach).

Since the start of the international SIO activity in 2008, AWI is applying a **dynamical method** to predict the September sea ice extent from the beginning of the melting season on. The method builds on the sea ice ocean model NAOSIM by which ensemble runs are performed. For the present outlook NAOSIM has been forced with atmospheric surface data (a combination of NCEP, NCEP-CFSR, and NCEP-CFSv2) January 1948 to May 29th 2016. All ensemble model experiments have been started from the same initial conditions on May 29th 2016. The model setup has not changed with respect to the last year's outlook. We use summer atmospheric forcing data from each of the years 2006 to 2015 (here from May 29th until September 30th) for the ensemble prediction and thus obtain ten different realizations of potential sea ice evolution for the summer of 2016. The use of an ensemble allows the estimation of probabilities of sea ice extent predictions for September 2016. As for the 2015 SIO a variational assimilation system around NAOSIM is used to combine the model with March and April sea ice observations, using the Alfred Wegener Institute's CryoSat-2 ice thickness product, the University of Bremen's snow depth product, and the OSI SAF ice concentration and sea-surface temperature products. A bias correction scheme for the CryoSat-2 ice thickness employing a spatially variable scaling factor could enhance the skill considerably (Kauker et al, 2015a). The ensembles mean of the September sea-ice extent of the outlook 2016 amounts to 4.73 million km². The ensemble standard deviation is 0.41 million km^2 which serves as uncertainty estimate of the prediction. The main effect of the assimilation of March and April sea ice observations is a reduction of the ice thickness in the Beaufort Sea and an increase of the ice thickness in the eastern Eurasian Basin in March (Kauker et al, 2015a,b).

The dynamical method also allows the estimation of regional probabilities. Figure 1 depicts the probability of a grid cell to have an ice concentration above 15 % for both outlooks (with and without initialization with sea ice and ocean observations) and the probability for a grid cell to exhibit average ice thickness (mean thickness of ice covered grid cell) above 0.5 m, respectively. The latter is a common critical threshold used for Arctic shipping. According to these metrics both outlooks predict an ice free North West Passage for the section along the Alaskan coastline (the coarse model resolution does not allow reliable estimates within the Canadian Archipelago) while the probability of an ice free North East Passage is about 50 %.

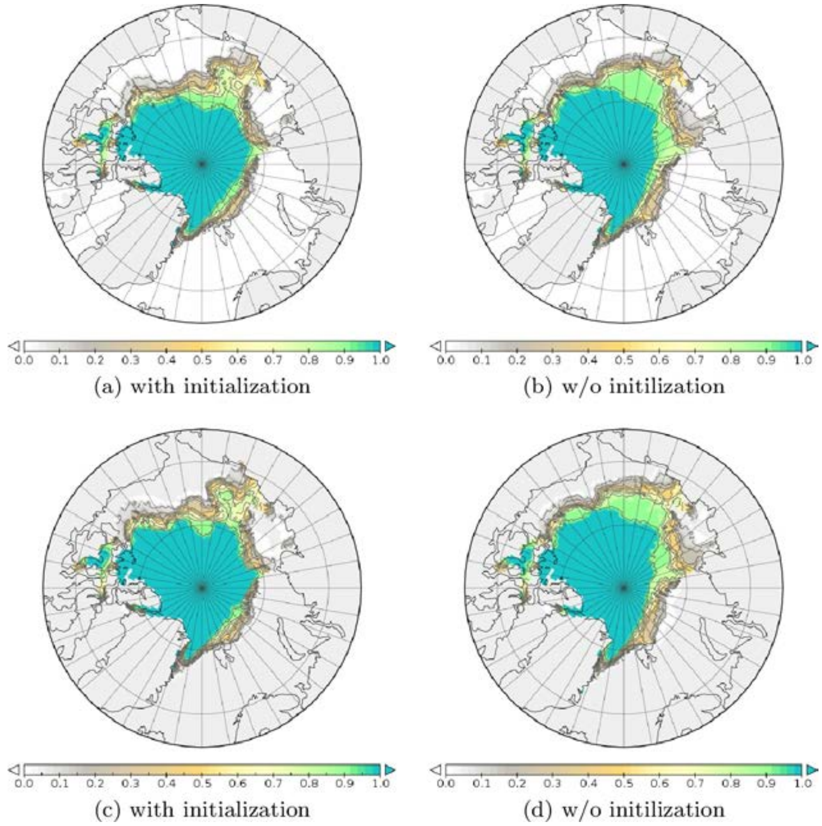

Figure 1: The probability of an ice concentration above 15% (a and b) or an averaged ice thickness above 0.5 m (c and d) in September 2016. Two different results are shown based on (a and c) a re-initialization of the ensembles with assimilation of sea ice observations and ocean quantities in March and April and (b and d) without a re-initialization of the ensemble runs.

The **statistical model** takes into account different climatological parameters, the ocean heat content, sea surface temperature and atmospheric variables in order to calculate an estimate of the September minimum sea ice extent for every year. The forecast scheme for the September sea ice extent is based on a methodology similar to that used for the monthly and seasonal prediction of Elbe river streamflow (Ionita et al., 2009, 2014). The basic idea of the statistical method is to identify regions with stable teleconnections between the predictors (climatological parameters) and the predictand (here sea ice extent). The September sea ice extent has been correlated with the potential predictors from previous months, up to eight months lag, in a moving window of 21 years. The results remain qualitatively the same if the length of the moving window varies between 15 to 31 years. The correlation is considered to be stable for those grid-points where September sea ice extent index and global sea surface temperature, the ocean heat content integrated over the first 700 m, air temperature, sea level pressure and surface winds are significantly correlated at 95 %, 90 %, 85 % and 80 % level for more than 80 % of the 21-year windows, covering the period 1979-2015. This methodology was applied for sea ice extent prediction for the first time for the year 2016 and we will provide updated results every month for the sea ice outlook report. The statistical model, based on the data available at the end of May 2016, estimates a monthly mean September 2016 sea-ice extent of 4.68 million km^2 (± 1 million km^2) (Figure 2).

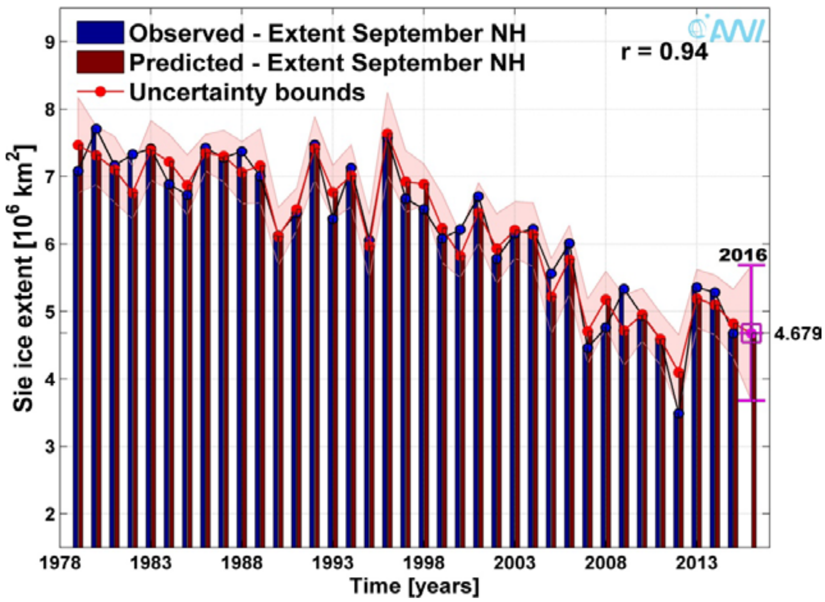

Figure 2: Observed (blue) and predicted (red) September sea ice extent values considering climate data until the month May over the period 1979-2016 based on predictors from the stable regions. The pink shaded area represents the 95% uncertainty bounds.

Both methods will be applied successively for the next three month in order to provide respective summer minimum sea ice extent forecasts for the Arctic. While the uncertainty of the predictions is large for May, we expect a more exact forecast during the upcoming months. Surprisingly, the correspondence of the two completely different approaches is very good so far, giving high reliability of the AWI SIO contribution to the September sea ice minimum extent 2016. The next forecast will be available from 5th July 2016.

References:

Kauker et. al. (2015a), Seasonal sea ice predictions for the Arctic based on assimilation of remotely sensed observations. The Cryosphere Discussion, doi:10.5194/tcd-9-5521-2015.

Kauker et. al. (2015b), Bewertung des AWI-Konsortium Sea Ice-Outlook Beitrags für Sommer 2015 (in German)

Ionita, M., M. Dima, G. Lohmann, P. Scholz and N. Rimbu, 2014: Predicting the June 2013 European Flooding based on Precipitation, Soil Moisture and Sea Level Pressure. J. Hydrometeorology, 16, 598–614., doi: http://dx.doi.org/10.1175/JHM-D-14-0156.1

Ionita, M., G. Lohmann and N. Rimbu, 2008: Prediction of Elbe discharge based on stable teleconnections with winter global temperature and precipitation, Journal of Climate, 21, 6215–6226, doi:10.1175/2008JCLI2248.1