Skilful seasonal predictions of Baltic Sea ice cover

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1. Abstract

The interannual variability in the Baltic Sea ice cover is strongly influenced by large scale atmospheric circulation. Recent progress in forecasting of the winter North Atlantic Oscillation (NAO) provides the possibility of skilful seasonal predictions of Baltic Sea ice conditions. In this paper we use UKMO GloSea5 forecast system to assess the predictability of the Baltic Sea annual maximum ice extent (MIE).We find a useful level of skill in retrospective forecasts initialized as early as the beginning of November. The forecast system can explain as much as 30% of the observed variability in MIE over the period 1993–2012. This skill is derived from the predictability of the NAO by using statistical relationships between the NAO and MIE in observations, while explicit simulations of sea ice have a less predictive skill. This result supports the idea that the NAO represents the main source of seasonal predictability for Northern Europe.

2. Baltic Sea ice and NAO

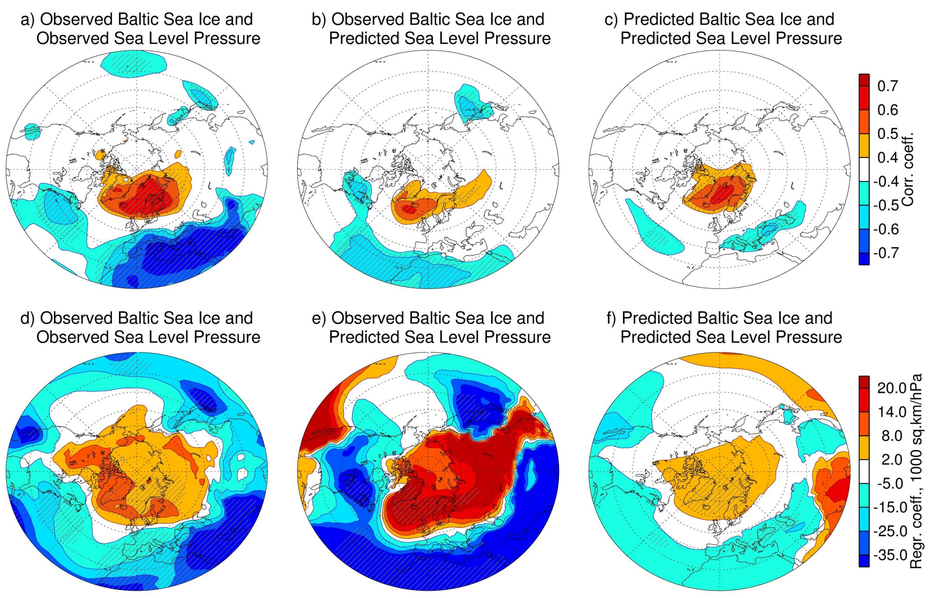

Fig.1: *(**Top**) correlation and (**bottom**) regression coefficients between Baltic Sea MIE and DJF SLP for the period 1993–2012: (**a**), (**d**) observed MIE and observed SLP, (**b**), (**e**) observed MIE and GloSea5 predicted ensemble mean SLP; (**c**), (**e**) GloSea5 predicted MIE and SLP calculated across all individual members. Areas where absolute values of the correlation coefficient exceeds 0.44, which is statistically significant for 20 independent data pairs at p =0.05, are hatched. Note irregular scale for the regression coefficients which is used to account for large variability of the polar SLP compared to the mid-latitude SLP.*

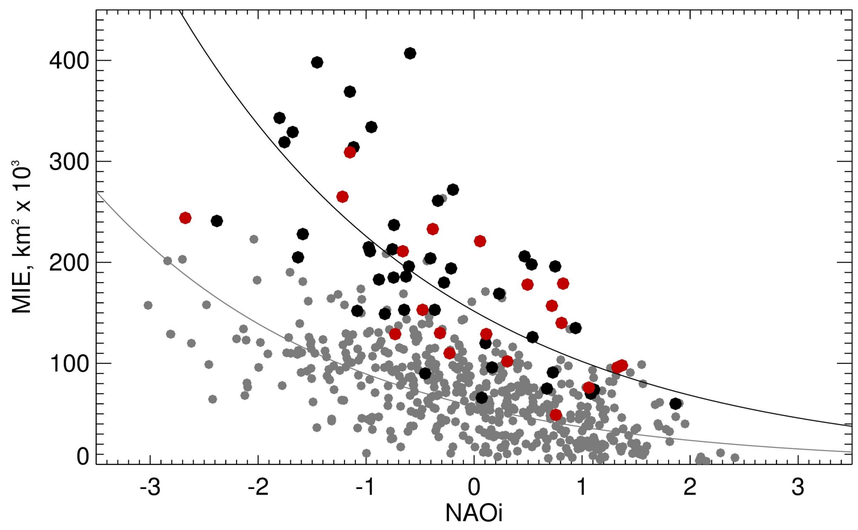

Fig.2: *Scatterplot of MIE against NAOi in observations for the period 1950–1992 (black circles) and 1993–2012 (red circles) and GloSea5 ensemble members for the period 1993–2012 (grey circles). Solid lines are the regression model fits for observations (MIE = 152 × 103 × $e^{-0.40 \times NAOi}$) and GloSea5 (MIE=58×103 × $e^{-0.44 \times NAOi}$).*

3. Forecast model

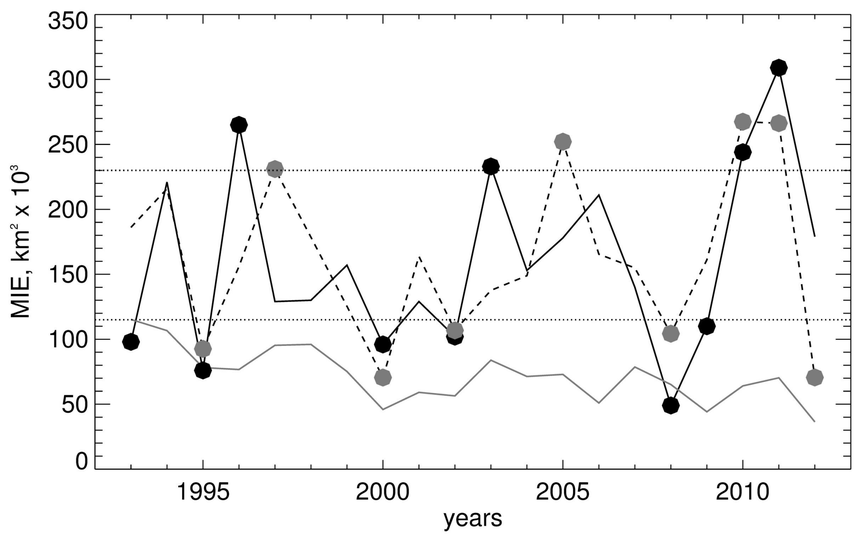

Fig.3: *Timeseries of observed (solid black line) and GloSea5 simulated (grey line) Baltic Sea MIE. Dashed line shows MIE calculated from GloSea5 NAOi. Dotted lines indicate conventionally defined thresholds for mild (MIE<115000 km²) and severe (MIE>230000 km²) ice winters. Years with observed mild and severe ice conditions are indicated by black circles, and those predicted by GloSea5 are indicated by grey circles.*

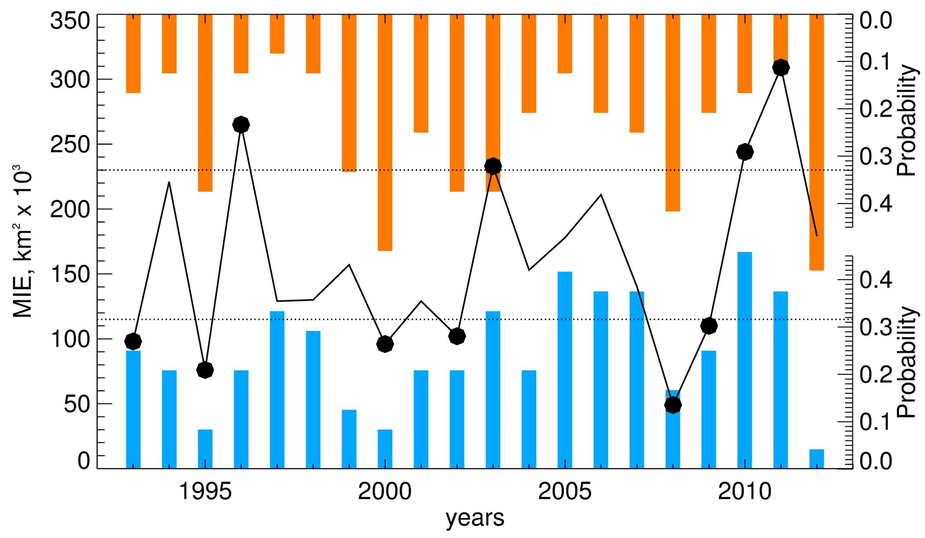

Fig.4: *Timeseries of observed (solid black line) Baltic Sea MIE. Dotted lines indicate conventionally defined thresholds for mild and severe ice winters. Years with observed mild and severe ice conditions are indicated by black circles. Bar chart indicates probabilities of mild (orange) and severe (blue) ice conditions calculated from GloSea5 ensemble members (note the reversed axis for the mild winter probabilities).*

Forecast	Observed			Forecast distribution
	Mild	Near normal	Severe	
Mild	4 (4)	1 (1)	0 (0)	5 (5)
Near normal	2 (2)	7 (5)	2 (3)	11 (10)
Severe	0 (0)	2 (2)	2 (3)	4 (5)
Observed distribution	6 (6)	10 (8)	4 (6)	20

Table 1: *Contingency table for Baltic Sea MIE forecasts (1993–2012). The numbers indicate the distribution of forecasts and observations obtained using operational definition of mild (MIE<115000 km²) and severe (MIE>230000 km²) winters based on the observations from the period 1961–2010. The numbers in parentheses indicate the distribution obtained when mild and severe winters are defined in cross-validation mode using the data from the period 1993–2012. Note that the ROC area for the forecasts of mild and severe ice conditions is 0.79 and 0.76, respectively.*

Reference: Karpechko, A. Yu., K. A. Peterson, A. A Scaife, J. Vainio, and H. Gregow (2015), Skilful seasonal predictions of Baltic Sea ice cover, *Environ. Res. Lett.*, **10,** 044007, doi:10.1088/1748-9326/10/4/044007

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