Hidden potential in predicting wintertime temperature anomalies in the Northern Hemisphere

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Key Points:

- Temperature anomalies can be skilfully predicted for the upcoming winter through increased variability and skill of predicted NAO
- Skilful prediction of temperature anomalies in the Northern Hemisphere for upcoming winter

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Supplementary information

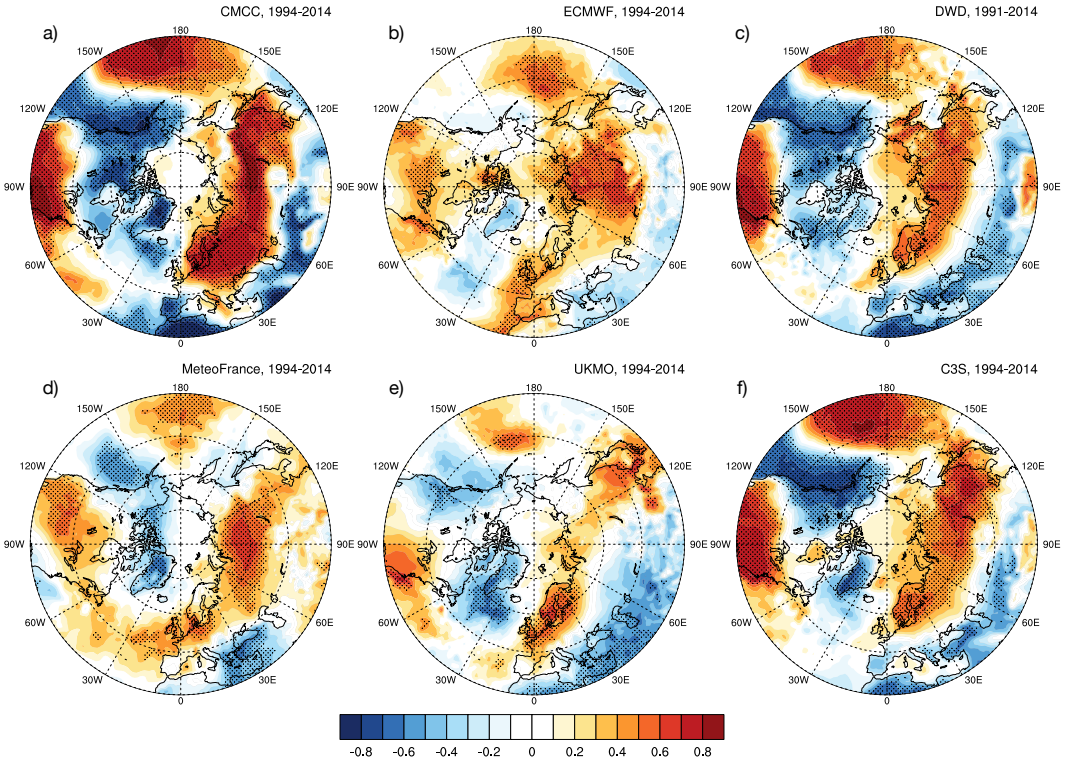
Figure S1 Response of wintertime (DJF) 2-meter temperature on the NAO variability.

Figure S5 Normalised winter (DJF) NAO index.

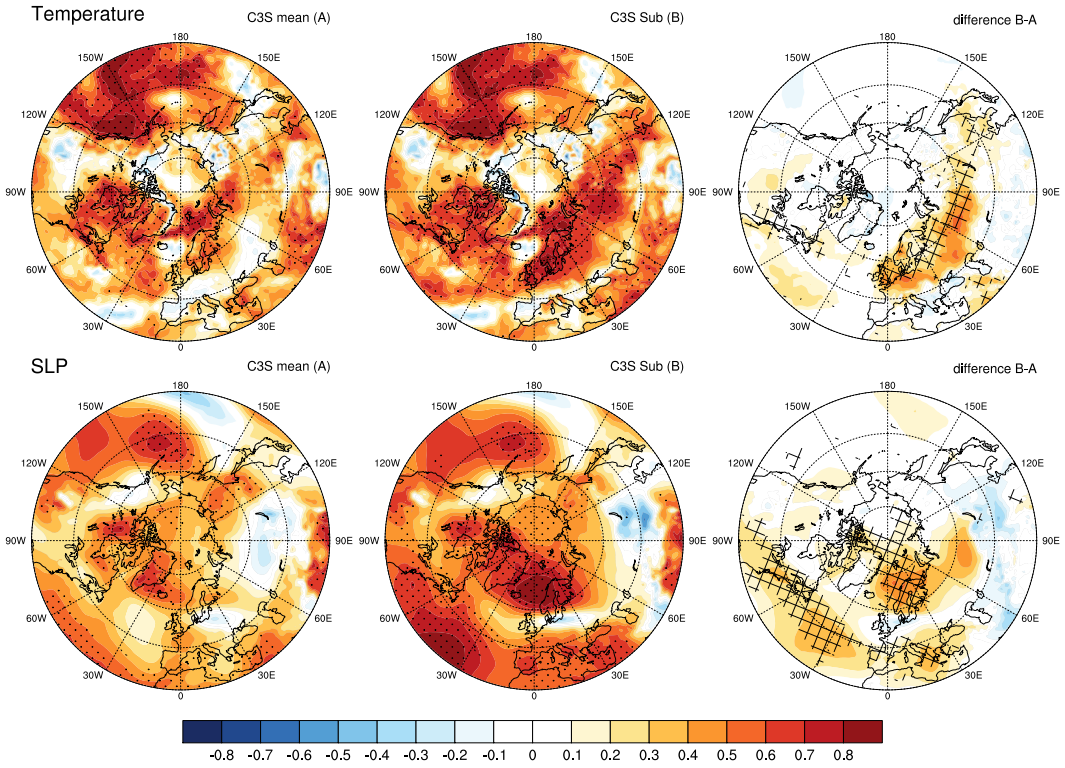
Figure S3 ERA-Interim first-guess of the winter NAO index.

Figure S2 Subsampling of the multi-model ensemble C3S.

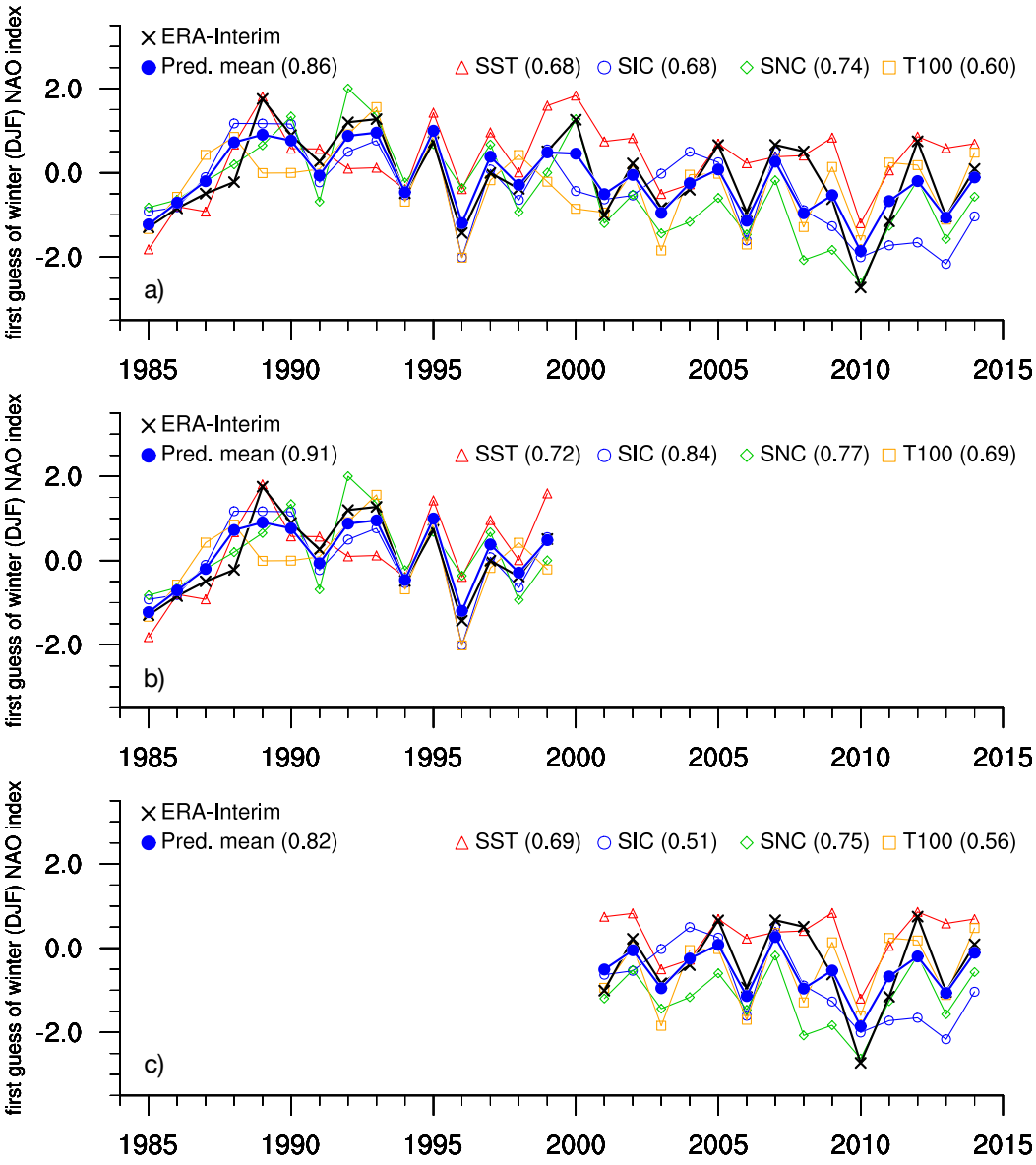
Figure S4 Subsampling of individual models from C3S.



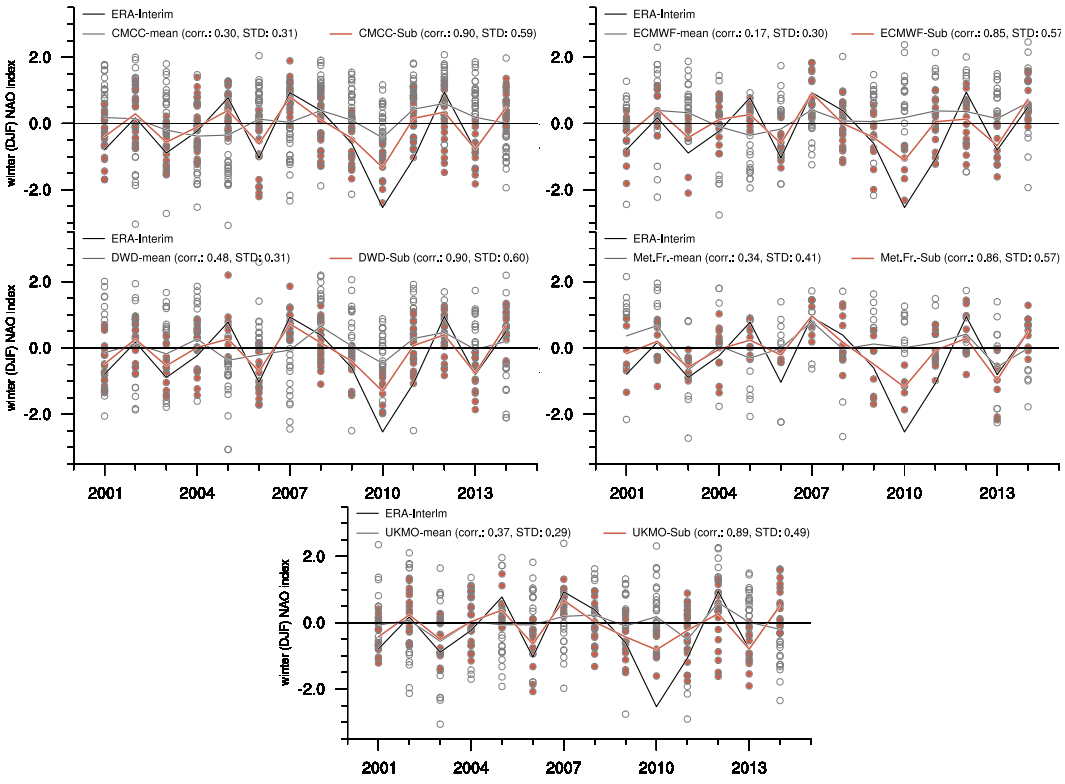
Supplementary Figure S1. Response of wintertime (DJF) 2-meter temperature on the NAO variability. Correlation between 2-meter DJF temperature and NAO index for individual models (a–e), and for multi-model ensemble C3S (f).



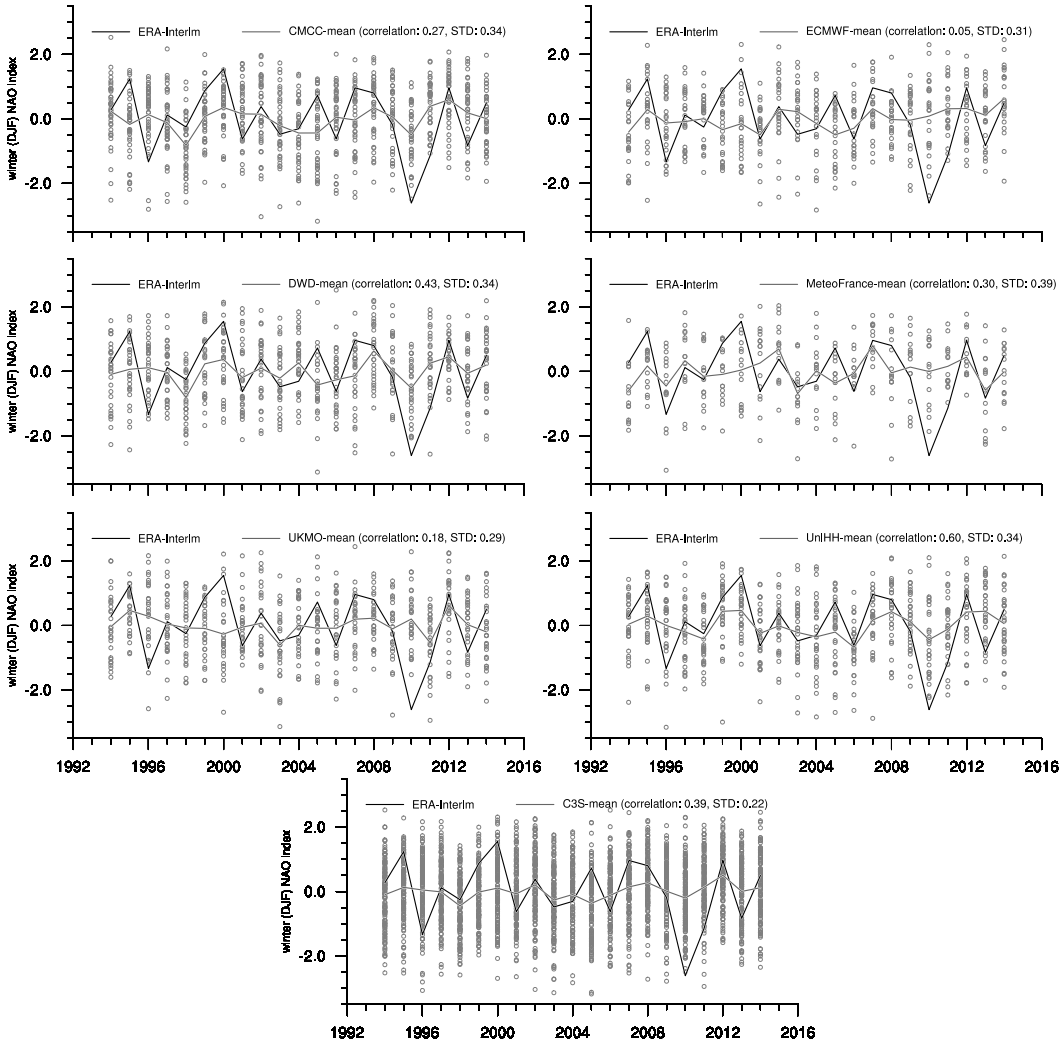
Supplementary Figure S2. Subsampling of the multi-model ensemble C3S. Anomalies correlation coefficient between C3S ensemble mean (left column) and C3S subsampled mean (middle column) and the ERA-Interim calculated for 2-meter temperature (upper panel) and sea level pressure (lower panel) in a real forecast test from 2001 to 2014. Regions that are significant at the 95% confidence level are indicated by dots on the maps in the left and middle column. Hashing on the differences plots (right column) indicates regions that became significant after subsampling.



Supplementary Figure S3. ERA-Interim first-guess of the winter NAO index. Statistically predicted from the ERA-Interim predictors winter NAO index for three periods: a) from 1985 to 2014, b) 14 years similar to real test period starting from 1985 to 1999, and c) real forecast test from 2001 to 2014. The training period from 1979 until the year previous to forecast year was used for all plots. Values of significant at the 95% confidence level correlation between the NAO index and each autumn predictor sea surface temperature in the North Atlantic (SST), Arctic sea ice concentration (SIC), snow cover in Eurasia (SNC) and 100 hPa level air temperature (T100), and for mean predictor (Pred. mean) are given in parentheses.



Supplementary Figure S4. Subsampling of individual models from C3S. NAO prediction skill of individual C3S models for the NAO index in a real forecast test from 2001 to 2014 as calculated from subsampled ensemble (orange line) and from ensemble mean (gray line) compared to the EAR-Interim (black line). Open circles denote each C3S ensemble member, filled circles indicate subsampled due to NAO teleconnection-based approach ensemble members. 13, 8, 10, 5, and 9 members for each predictor were selected for CMCC, ECMWF, DWD, Meteo France, and UKMO system respectevelly.



Supplementary Figure S5. Normalised winter (DJF) NAO index. Prediction skill of the winter NAO index is calculated as a correlation between the ERA-Interim NAO and the ensemble mean for each prediction system, and for the C3S ensemble mean. Correlations and standard deviation of ensemble means (STD) are given in parentheses. The range of the NAO prediction skill varies from 0.05 to 0.43 when all systems are individually considered. In general, all models individually and as a multi-model ensemble underestimate the variability of the NAO index calculated as a standard deviation (hereafter STD) of the ensemble mean. The NAO STD varies from 0.29 to 0.39 for individual models comparing to 1.00 for ERA-Interim NAO. The Universität Hamburg (UniHH-30) seasonal prediction system is not a part of the multi-model C3S ensemble and shown here for information only.