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Prediction of the North Atlantic Oscillation index for the winter months December-January-February via nonlinear methods

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Recently, an increase in forecast skill of the seasonal climate forecast for winter in Europe has been achieved through an ensemble subsampling approach by way of predicting the mean winter North Atlantic Oscillation (NAO) index through linear regression (based on the autumn state of the four predictors sea surface temperature, Arctic sea ice volume, Eurasian snow depth and stratospheric temperature) and the sampling of the ensemble members which are able to reproduce this NAO state. This thesis shows that the statistical prediction of the NAO index can be further improved via nonlinear methods using the same predictor variables as in the linear approach. This likely also leads to an increase in seasonal climate forecast skill. The data used for the calculations stems from the global reanalysis by the European Centre for Medium-Range Weather Forecasts (ECMWF) ERA5. The available time span for use in this thesis covered only 40 years from 1980 till 2020, hence it was important to use a method that still yields statistically significant and meaningful results under those circumstances. The nonlinear method chosen was k-nearest neighbor, which is a simple, yet powerful algorithm when there is not a lot of data available. Compared to other methods like neural networks it is easy to interpret. The resulting method has been developed and tested in a double cross-validation setting. While sea ice in the Barents-Kara sea in September-October shows the most predictive capability for the NAO index in the subsequent winter as a single predictor, the highest forecast skill is achieved through a combination of different predictor variables.