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

Master Thesis

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Introduction

Motivation:

Seasonal climate forecast ensemble member subsampling based on (statistical) linear prediction of winter NAO index using autumn predictors

Dobrynin et al., 2018: Improved teleconnection-based dynamical seasonal predictions of boreal winter

Thesis approach:

Nonlinear winter NAO index prediction based on (ERA5 data, 1981-2020):

- Sea surface temperature
- Sea ice concentration
- Snow depth
- Stratospheric temperature 100 hPa

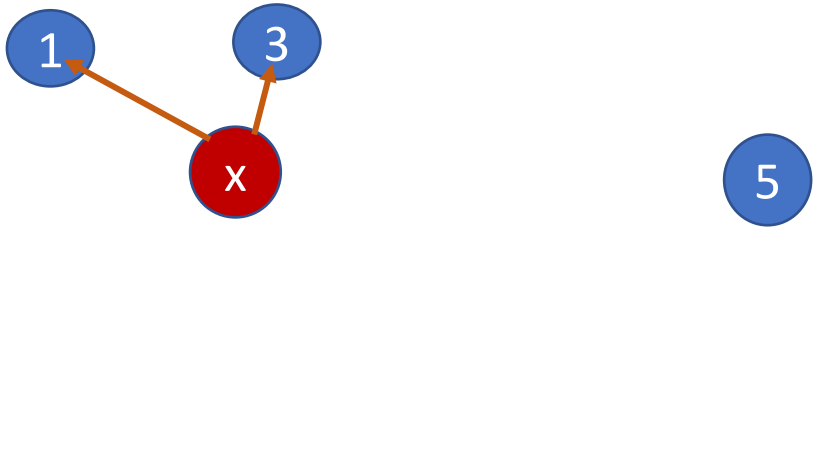
Creation of machine learning model (1)

- Dimension reduction: Grid point selection based on p-value threshold of correlation between predictor and NAO index (**p-value**: model parameter)
- Cross-validation
- Underlying method: k-nearest neighbors (**k**: model parameter)

Unknown: x
k: number of „neighbors“

k = 1 => x = 3
k = 2 => x = (3+1)/2 = 2
…

k = 2:



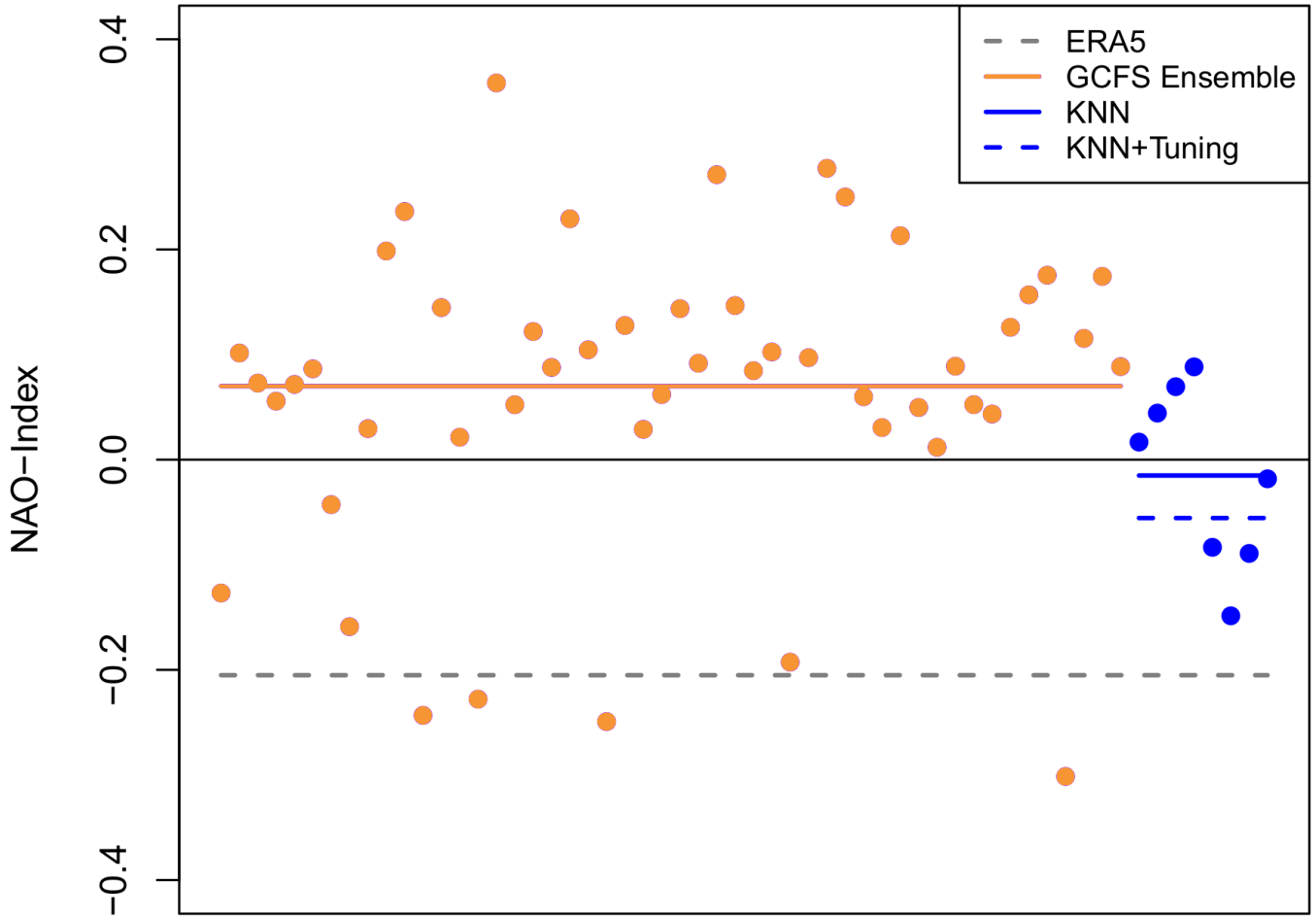
Creation of machine learning model (2)

- Algorithm combining different regions by different predictor variables iteratively, finding the best combination
- Optimization based on Wang-Bovik index q (error measure combining correlation, bias and variance)

  Mo et al., 2014: Application Potential of Four Nontraditional Similarity Metrics in Hydrometeorology
- Tuning: expand predicted NAO index to 100% of variance of NAO time series
- Sensitivity studies with different model set-ups and parameters

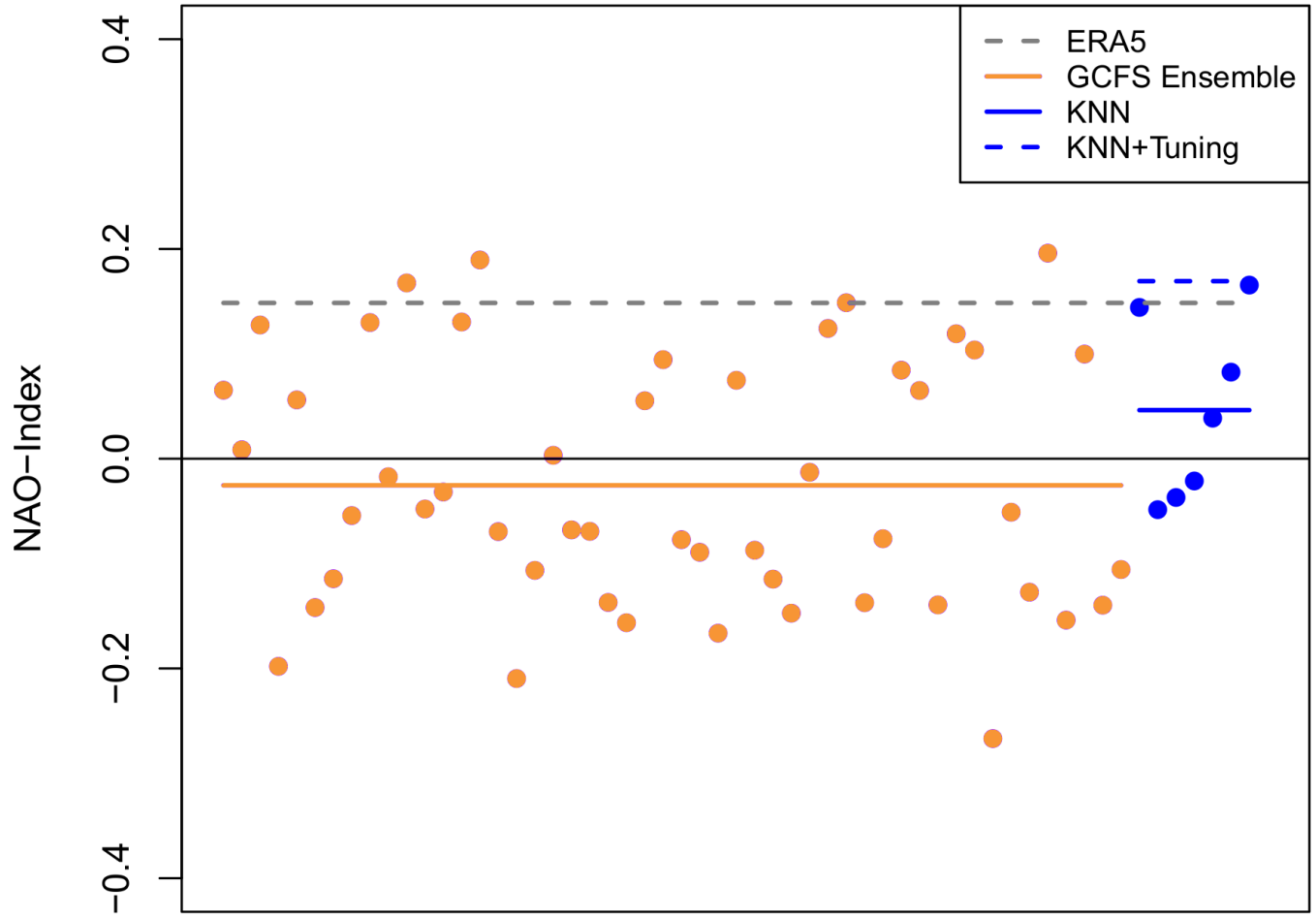
Results for test prediction winter 2020/21

- Smaller spread than seasonal climate forecast GCFS ensemble predictions
- closer to reference (ERA5) than mean of GCFS ensemble
- shows *negative* phase of NAO index



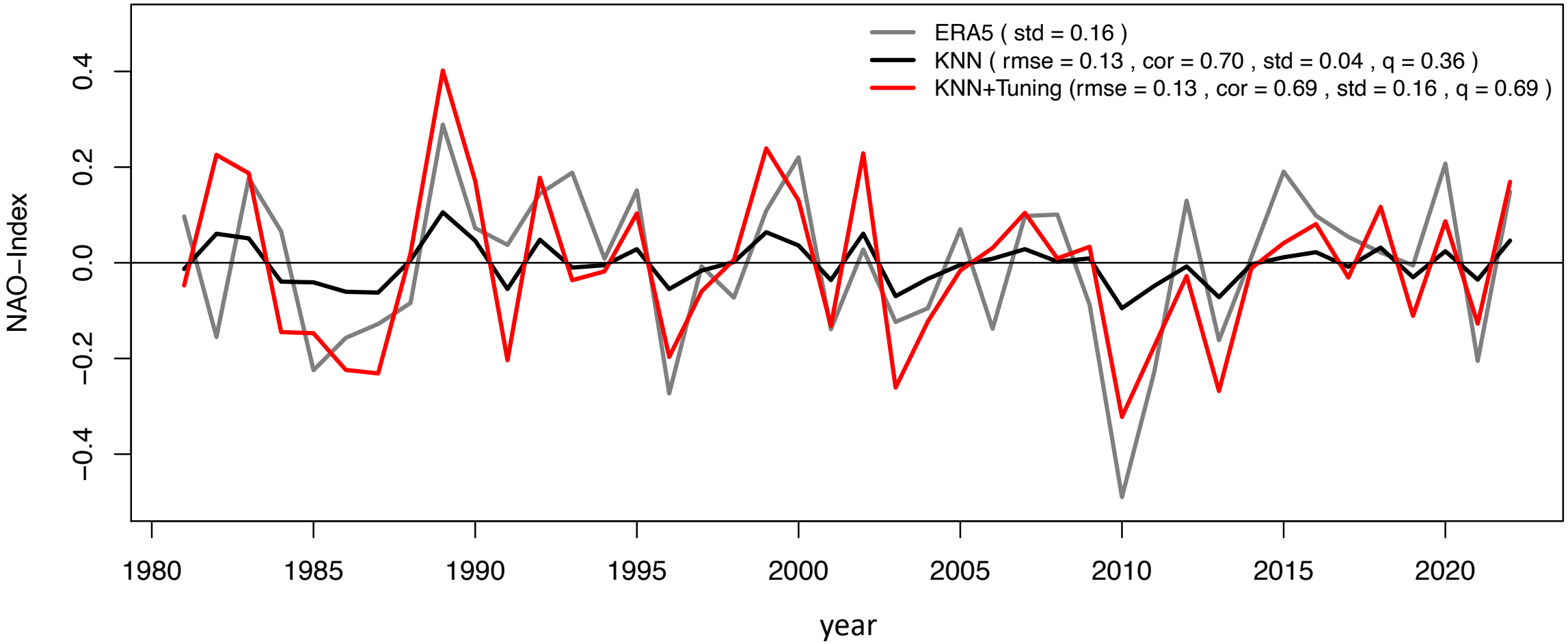
Results for test prediction winter 2021/22

- Smaller spread than seasonal climate forecast GCFS ensemble predictions
- closer to reference (ERA5) than mean of GCFS ensemble
- **shows *positive* phase of NAO index**

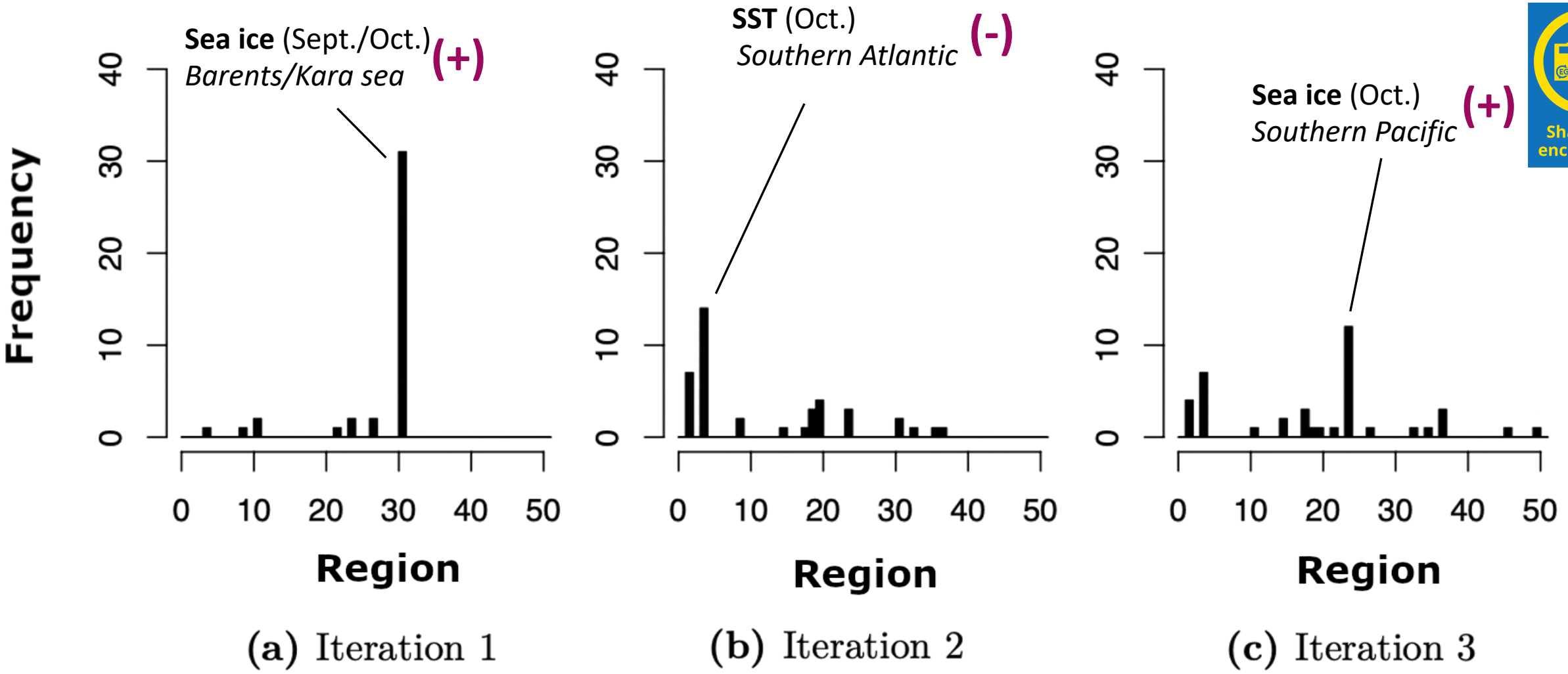


Sharing is encouraged

NAO prediction time series



Best predictors/regions



Summary

- *KNN method* with combined regions
  performs better (q=0.7…0.8) than linear regression (q=0.33)
  and seasonal forecast GCFS ensemble (q=0.32)

- Best predictors for winter NAO: **Sea ice** and **SST**