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Constructing and Validating a Decadal Prediction Model

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For the purpose of identifying potential sources of predictability of Scottish mean air temperature (SMAT), a redundancy analysis (RA) was accomplished to quantitatively assess the predictability of SMAT from North Atlantic SSTs as well as the temporal consistency of this predictability. The RA was performed between the main principal components of North Atlantic SST anomalies and SMAT anomalies for two time periods: 1890-1960 and 1960-2006. The RA models developed using data from the 1890-1960 period were validated using the 1960-2006 period; in a similar way the model developed based on the 1960-2006 period was validated using data from the 1890-1960 period. The results indicate the potential to forecast decadal trends in SMAT for all seasons in 1960-2006 time period and all seasons with the exception of winter for the period 1890-1960 with the best predictability achieved in summer. The statistical models show the best performance when SST anomalies in the European shelf seas (45°N-65°N, 20W-20E) rather than those for the SSTs over the entire North Atlantic (30°N-75°N, 80°W-30°E) were used as a predictor.

The results of the RA demonstrated that similar SSTs modes were responsible for predictions in the first and second half of the 20th century, establishing temporal consistency, though with stronger influence in the more recent half. The SST pattern responsible for explaining the largest amount of variance in SMAT was stronger in the second half of the 20th century and showed increasing influence from the area of the North Sea, possibly due to faster sea-surface warming in that region in comparison with the open North Atlantic.

The Wavelet Transform (WT), Cross Wavelet Transform (XWT) and Wavelet Coherence (WTC) techniques were used to analyse RA-model-based forecasts of SMAT in the time-frequency domain. Wavelet-based techniques applied to the predicted and observed time series revealed a good performance of RA models to predict the frequency variability in the SMAT time series. A better performance was obtained for predicting the SMAT during the period 1960-2006 based on 1890-1960 than vice versa, with the exception of winter 1890-1960. In the same frequency bands and in the same time interval there was high coherence between observed and predicted time series. In particular, winter, spring and summer wavelets at 8 ± 1.5 year band were highly correlated in both time periods, with higher correlation in 1960-2006 and in summer.