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Stability of climate reconstructions

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Reconstruction of climate mode indices using proxy data as predictors is limited due to non-stationarity in atmospheric teleconnections. In this paper a method is presented to identify stable predictors for the reconstruction of the Arctic Oscillation (AO) index. Using the 20th Century reanalysis data, the AO index is calculated for the last 140 years and correlated with global two meter temperature, precipitation, and sea surface temperature anomalies in various moving windows. The stability of the correlation was checked in every point of the global grids. Anomalies from the regions where the correlation of the AO index is stable are used as stable predictors for the AO index. It is shown that the predictors identified through our analysis lead to proper AO reconstructions. Statistical analysis of a global climate simulation covering the last millennium reveals that the stability correlation map of model AO and temperature are very similar to the corresponding observed correlation stability map. It is shown that the stability correlation maps of the AO, as derived from the model, are insensitive to different climate forcing and can be used to systematically select stable predictors for the AO reconstruction during the last millennium and most likely for the late Holocene. Finally, several high resolution proxy data from the stable regions are selected and used for a reconstruction of the AO index during the last three centuries. We argue that selection of proxy data from the stable regions of AO teleconnections leads to a suitable AO reconstruction.

Furthermore, the hypothesis of stable teleconnections is tested using atmospheric circulation model experiments. For climate conditions with other ice sheet distributions on the Northern Hemisphere, such as the last glacial maximum climate, considerable changes are detected in the atmospheric variability pattern compared to the present day. Correlation maps of pseudo proxy records over Europe, the Red Sea area, and Greenland indicate that the associated wind pattern can change drastically. During glacial times, Greenland ice cores indicate cold and warm phases in the northern North Atlantic. When looking in detail for the interannual variability for these phases, model simulations indicate that Greenland temperature variations are linked to distinct large-scale Northern Hemisphere circulation patterns and associated local wind directions. It is argued that such analysis provides a dynamical interpretation of past climate variability. With the combined use of models and data, one can examine the representativeness of sites where the reconstructions are available.