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# Functional paleoclimate networks of North Atlantic terrestrial proxies: A new tool for studying spatio-temporal climate variability within the Arctic 2k framework

Jasper G. Franke (1,2) and Reik V. Donner (1)

(1) Potsdam Institute for Climate Impact Research, RD 4, Potsdam, Germany (jasper.franke@pik-potsdam.de), (2) Humboldt University, Berlin, Germany

The increasing availability of high-resolution paleoclimate proxies allows to not only study climate variations in time, but also temporal changes in spatial variability patterns. In this study we use the method of functional paleoclimate network analysis [1] to investigate changes in the statistical similarity patterns among ensembles of high-resolution terrestrial paleoclimate records from Northern Europe. The study region ranging from Southern Finland over Northern Fennoscandia to Iceland is of paramount importance for reconstructions of the climate of the last two millennia within the Arctic 2k framework, and understanding the associated spatial variability of regional paleoclimate is a key question for further regional reconstructions.

The analysis reported here is based on an ensemble of 16 paleoclimate proxy records comprising tree ring data from the Scandinavian Peninsula, different lacustrine archives from Southern Finland and one lake sediment record cored on Iceland, having a common interpretation as proxies of (mainly summer) temperatures.

Based on the mentioned selection of existing data sets, we construct complex networks capturing the mutual statistical similarity of the variability recorded by different archives furing different episodes in time. These ”functional” networks are not restricted to capturing linear Pearson correlations, but can also be obtained based on nonlinear characteristics like mutual information. This allows for comparing non-normally distributed time series or data of different origin like tree ring and lake sediment records as considered in this study. Furthermore, the obtained functional paleoclimate networks are used to test if regional (gridded) proxy-based temperature reconstructions preserve the essential spatial correlation patterns of the underlying archives.

Temporal changes in the network structure indicate changing dynamics in the regional climate system and enable us to distinguish different episodes with distinct dominating variability patterns associated with, for example, different phases of the North Atlantic Oscillation or a varying influence of the Sibirian High.

Our analysis reveals a highly variable spatial structure throughout the last two millennia. This is especially the case for the interconnectivity between the two groups of records from the Scandinavian Peninsula and Southern Finland, where phases of strong statistical similarity among all records alternate with episodes of more independent and, thus, more localized climate dynamics.

[1] K. Rehfeld, N. Marwan, S.F.M. Breitenbach, J. Kurths: Late Holocene Asian summer monsoon dynamics from small but complex networks of paleoclimate data. Climate Dynamics 41, 3-19, 2013