

Large-scale summer circulations from a European tree ring stable isotope network over the past 400 years

Daniel Balting (1), Martin Wegmann (1), Norel Rimbu (1), Monica Ionita (1), Gerhard Helle (2), Mandy Freund (3,4), Ingo Heinrich (2,5), Gerhard Schleser (6), and Gerrit Lohmann (1)

(1) Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Germany, (2) Helmholtz Centre Potsdam German Research Centre for Geosciences GFZ, Germany, (3) University of Melbourne, Australia, (4) ARC Centre of Excellence for Climate System Science, Australia, (5) Humboldt-University Berlin, Berlin, Germany, (6) Forschungszentrum Jülich, Germany

A number of emerging studies use stable oxygen and carbon isotopes from tree rings to reconstruct climate variables such as temperature and precipitation. In the mid latitudes, these key variables are essentially determined by the prevailing large scale atmospheric circulation which can be expressed via indices such as the North Atlantic Oscillation (NAO). However, only a few studies have investigated the relation between stable isotopes from trees and large-scale atmospheric circulation.

Here we present ongoing research on the link between large scale atmospheric circulation and stable isotopes based on the European tree ring isotope network ISONET. This network contains stable oxygen and carbon isotope from 26 different sites in Europe over the last 400 years. In this study, empirical orthogonal functions (EOFs) were used to extract the key patterns and the climate information in this dataset. We focus on the first two EOFs of carbon and oxygen stable isotopes. Finally we use correlation and composite analysis in combination with gridded climate datasets, such as climate reanalysis and reconstructions, to assess the large scale summer climate conditions during the last 400 years.

Strong links are identified between the investigated stable isotopes and the leading EOF of North Atlantic-European summer mean sea level pressure with its corresponding climate extremes. The frequency of extremes shows an increase from the 17th to the 20th century which may be attributed to the footprint of the Maunder Minimum and the Little Ice Age. In addition to the identified summer signal, a significant relation between oxygen isotopes and winter NAO is found. We propose that this mechanism works via precipitation in winter which subsequently modulates the soil moisture and water storage at the beginning of the growth season. Overall, the results highlight the potential of stable isotopes as an indicator for large-scale atmospheric conditions over Europe.