Geophysical Research Abstracts
Vol. 20, EGU2018-13454, 2018
EGU General Assembly 2018

Climate and drought responses in a continent-wide tree-ring network of European beech (*Fagus sylvatica* L.)

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Dendrochronologists often focus on remote and climatically stressed sites, where trees are particularly useful for climatic reconstruction. Typically, these sites do not represent closed-canopy forest conditions. As a consequence, attempts to characterise the regional variability of forest growth from tree-ring data, and compare it to mean ecosystem responses at landscape scale, e.g. from vegetation model output, can be impeded by tree-ring data stemming from climatically stressed sites.

Here, we present a large new tree-ring width network of European beech (*Fagus sylvatica* L.), compiled exclusively from closed-canopy stands, and representing locally typical beech forests. The network covers the entire geographical (5.8°W-28.4°E, 38.8°N-58.5°N) and climatological (490-1830 mm annual precipitation sum, 1.9-12.8°C annual mean temperature) distributional range of this deciduous broadleaved late successional tree species. Currently, the data set comprises 418 chronologies from more than 7,700 trees and 900,000 site-tree years of data. The sites represent a dense continuum, in climate and growth space, rendering a data-driven clustering unfeasible.

Climate-growth response patterns differ across the species distribution. Preconditioning of growth by high temperatures in the previous late summer is particularly pronounced in the north-east, and relatively weak in the Alpine areas. Growth limitation by high current summer temperatures is strongest in the south-east, whereas in the Alpine areas, high summer temperatures have a positive effect on growth. High early summer precipitation generally is connected to wider tree-rings, except in the north-east.

Drought years are associated with immediate growth reductions across the species distribution, but most prominently in the west, north-east, and south-east. A strong preconditioning effect on growth is found for previous year drought in the north-west. Typically, it takes two years for growth increments to recover from drought events, similar to growth deflections not connected to drought conditions. On cold and wet high altitudinal sites in the Alpine areas, however, it takes up to four years to recover from drought. On these sites, extreme drought events exhibit relatively long median return times of approx. 60 years. The longer recovery time could therefore be a consequence of a weaker selection for drought resistance.

In conclusion, despite the strictly ecological sampling focus of the network, regionally coherent climate signals and drought response patterns can be identified. Therefore, we propose that monospecific, distribution-wide networks from closed canopy sites can provide valuable contributions to research questions dealing with past and future responses of forests to environmental conditions.