



Determining influencing factors of climate-growth relationships of European beech across its ecological amplitude

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The prospect for European beech forests (*Fagus sylvatica* L.) over the course of the 21st century is uncertain due to climate change. In context, climate sensitivity of growth is a valuable indicator of physiological integrity, but its natural variability is poorly understood in productive, closed canopy forests. Climate sensitivity may not only depend on temporal and spatial differences in climatic conditions, but also on trees' rank progression in the course of forest maturation.

Here, we determine how the drought sensitivity of secondary growth in beech varies in space and time according to growth trends, growth variability and climatic conditions. The temporal variability of these variables is determined via a moving window approach using a network of tree-ring sites across the species' geographical and climatological distribution. The moving window derived variables are applied to a linear mixed-effects model allowing for the estimation of linear, non-linear and interactive effects. Furthermore, dry and wet subsets of the data are supplied individually to determine differences between dry and wet site conditions.

Our results indicate considerable variability in climate sensitivity due to complex non-linear and interactive effects of all variables. Generally, drought sensitivity is strongly and positively coupled with growth variability and climatic aridity. The strong non-linear and interactive effects between all variables result in drought sensitivity changing considerably with changes in growth variability and growth trends when climatic conditions are average or wetter than average. However, during dry time-periods, drought sensitivity is consistently high and decoupled from changes in growth trends and growth variability. While these patterns remain relatively similar between dry and wet sites, dry sites show significantly higher drought sensitivity compared to wet sites overall.

In conclusion, we found beech's drought sensitivity to be significantly affected by growth variability, growth trends and climatic conditions. Furthermore, the influence of each variable on drought sensitivity changes drastically as they interact, indicating all these factors need to be considered when interpreting beech's climate sensitivity.

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