Geophysical Research Abstracts
Vol. 15, EGU2013-11579-1, 2013
EGU General Assembly 2013

Evaluating the species- and site-specific differences in the physiological response of Picea abies, Fagus sylvatica and Larix decidua to drought

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Sensitive regions like the Alps are very vulnerable to climate change. Especially warmer temperatures and a higher frequency of drought periods may imply strong effects on mountain ecosystems. In the Northern Limestone Alps, temperatures were already 1 °C higher (compared to the reference period 1941-1970) in the last two decades.

Within a Bavarian-Austrian EU-project (INTERREG program) we investigated long-term growth patterns of mountain tree species and a possible growth effect caused by climate change using a dendroecological approach. In total we measured the ring widths of ∼1300 living, on average 180 year old trees. The samples were taken along altitudinal gradients, ranging from 500 up to 1700 m a.s.l., in five different regions in the Northern Austrian and Bavarian Limestone Alps, covering the most prevalent coniferous (Picea abies, Abies alba, Larix decidua, Pinus sylvestris) and broad-leafed (Fagus sylvatica, Acer pseudoplatanus) mountain forest species.

To get more detailed information about the physiological response to climate and especially drought events of different tree species, an additional study was conducted in the Kalkalpen Nationalpark, Austria. Stable isotopes (δ13C and δ18O) of Picea abies, Fagus sylvatica and Larix decidua tree-rings (8 trees per species and site) were analysed at three different sites. The sites are located at the montane elevation level (900 m a.s.l.) on a south-facing and a north-facing slope as well on a plateau situation with deeper soils.

Our main focus deals with the following questions:

i) Is it possible to identify “drought events” in a region like the Alps with generally humid precipitation conditions (1400 mm/a), by analysing stable isotopes in tree rings?

ii) Are there species- and/or site-specific differences in the isotopic signatures – also with respect to the trees’ climate response?

We will present (i) the isotopic signatures for the common period 1970-2010, (ii) their response to climate conditions, and (iii) compare them with our findings of the comprehensive tree-ring width measurements.