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Tree-ring growth trends in the Austrian Alps during the 20th century

**Dendroclimatological approach to the study of the influence
of recent climatic changes on tree growth**

Dissertation for obtaining a doctorate degree at the University of Natural Resources
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Abstract

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An extensive new network of ring-width chronologies was established, comprising data from a total of 1206 trees from 100 sites within the Austrian Eastern Alps, made up of five conifer species (*Abies alba* Mill., *Picea abies* (L.) Karst., *Larix decidua* Mill., *Pinus cembra* L., and *Pinus nigra* Arn.). Five separate high-frequency tree-growth signals were identified from these data. Tree growth at low altitudes (<730 m) is controlled mainly by spring-summer (April-July) water availability. At high altitudes (>1400 m) precipitation is no longer a limiting factor and growth is mostly determined by summer (June-July) temperature. In the intermediate altitudinal range, direct relationships with specific climatic variables were not found.

At intermediate and high altitudes three common periods of growth stand out: (1) a pronounced growth reduction during the mid-70s, already reported by several authors and associated with the unusual drought conditions felt during this decade in Central Europe; (2) a strong growth recovery during the 1980s, also pointed out in several other parts of the world, in response to a marked increase in temperature; (3) an apparent return to 'normal' growth rates at the end of the century despite the continued temperature rise. The reasons for this recent slowing down in growth are not clear but this feature raises the questions of whether the present forecasts are overestimating the amount of carbon that forests will be able to sequester in the future.

At low altitudes, analysis of the temporal stability of the relationship between tree growth show that, during the late 20th century, tree rings grew wider than expected given the predicted relationship between rainfall and growth rate observed in the early 20th century. This change in sensitivity suggests that tree growth was no longer primarily dependent on water availability. It is proposed that there was an improvement in water-use-efficiency arising from a stimulation of photosynthesis and declining stomatal conductance as a consequence of the increasing CO₂ concentration in the atmosphere and that this effect was enhanced by a relatively high input of N due to the proximity of N emission sources.

The divergence between the main growth-driving climatic factors and tree growth, found at the lowest and highest altitudes during the late 20th century, has important implications. The climate models based on tree growth tend to misestimate the climatic parameters over the last half of the 20th century and can compromise reconstructions of past climates.