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# Temporal Stability and Dendroclimatology in Silver Fir and Red Spruce

By

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Key words: Dendrochronology, climate change.

#### Summary

SMITH K.T., UFAR K. & LEVANI T. 1999. Temporal stability and dendroclimatology in silver fir and red spruce. - Phyton (Horn, Austria) 39 (3): (xxx) - (xxx).

Dendroclimatology uses precisely dated tree-ring series and climate measurements to reconstruct climate for periods prior to instrumented records. Dendroclimatology requires a predictable, relationship between growth and climate. Tree-ring series from silver fir in Slovenia and red spruce in the northeastern US were calibrated to monthly climate variables for two periods, corresponding approximately to the first and second halves of the 20th Century. Bootstrapped response function analysis indicated that growth during the two periods was associated with markedly different variables of monthly mean temperature and monthly total precipitation. These findings suggest caution in dendroclimatic reconstruction and are interpretable as indications that the relationship of tree growth to climate may have changed during the 20th Century.

#### Introduction

Dendroclimatology reconstructs past climate patterns through mathematical models that relate precisely dated tree-ring records to climate measurements (FRITTS 1976). The mathematical relationship is then extrapolated to tree-ring series formed prior to climate measurement. Such dendroclimatological reconstructions depend on a predictable linkage of growth to climate. Recent research questioned the stability of the dendroclimatic relationship for trees at high elevations and far-northern latitudes across the northern hemisphere (BRIFFA & al. 1998). In this research we examine the temporal stability of the dendroclimatic

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(2)

relationship at lower elevations and lower latitudes for silver fir (*Abies alba* Mill.) in Slovenia and red spruce (*Picea rubens* Sarg.) in the northeastern United States.

#### Material and Methods

Locations representative of silver fir in Slovenia (forests in Bistra (550 m elevation), Javornik (950 m), and Ravnik (600 m) at ca. 46° N lat.v-h14]TJ/TT7 1 Tf24.73650 TD0 Tc0 Tw<0071≸j/TT4 1 Tf0.40 temporal stability in the statistical relationship occurred for silver fir in Slovenia and red spruce in the northeastern United States.

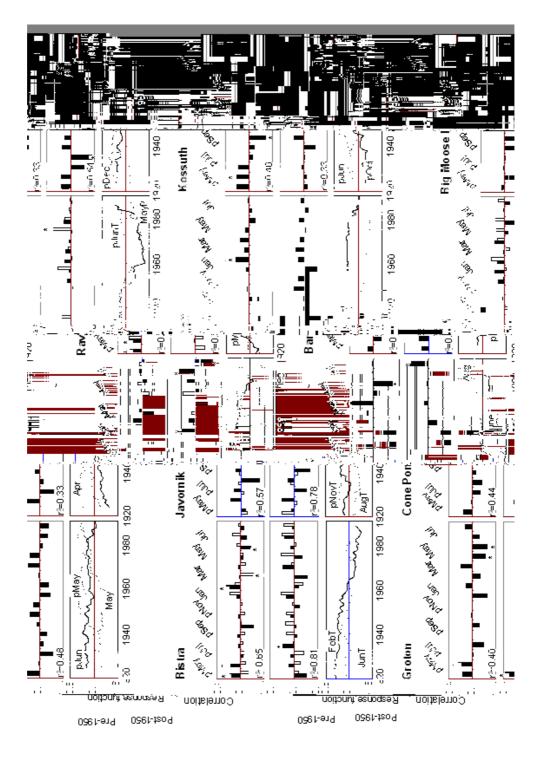


Fig. 1. Response function and correlation analysis of tree-ring chronologies with monthly mean temperature (filled bars) and monthly total precipitation (open bars).

Differences in the statistical relationship to climate were dramatic and not due to slight differences. For example, for fir in Ravnik, growth from 1897-1946 was significantly associated with warm May and June temperatures in the year prior to ring formation (response function coefficients (rfc) for pMay and pJun of 0.20 and 0.21, respectively). No significant relationship was evident in the 1947-1988 period, rfc=0.01 and <0.01, respectively). However, June precipitation was significantly related to growth for the later period (rfc=0.38) yet not related to growth in the earlier period (rfc=0.13). Similar lack of consistency of the statistical relationship of growth to climate was evident at all eight forest locations reported here (Fig. 1).

The correlation of tree-ring chronologies with significant climate variables (as identified by the bootstrapped response functions) over 25-year moving intervals also suggest that a statistically significant relationship was temporally dependent (critical correlation coefficient = 0.40 for P=0.05, 23 degrees of freedom).

### Discussion

Tree growth is affected by climate through the processes of energy capture and storage, cell division and maturation, and defense. The statistical relationship of fir and spruce growth to climate changed through the 20<sup>th</sup> Century. This change could be due to statistical artifact, changes in temperature or precipitation patterns, or changes in tree sensitivity to climate.

The consistency of these results and earlier observations of the dendroclimatic response of red spruce (JOHNSON & al. 1988) argue against statistical error as an explanation. Although changes in temperature and precipitation patterns do occur within some span of time, there is no visibly Bend earl1 was e62 TU

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