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# Treelines in a changing world

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**Abstract**

The world's alpine treelines represent one of the most obvious and well-known vegetation boundaries. At a global scale, the climatic tree limit parallels the snow line (the line at which all precipitation falls as snow, and where snow cover can persist year round). Both lines are most likely controlled by temperature. Low temperature really is the only common denominator of the mountain climate at altitudes where natural treelines occur. All other climatic drivers such as snow pack, wind, solar radiation and atmospheric pressure vary with latitude and from region to region, while the world's treelines follow a common growing season isotherm of between 5.5 and 7 °C. The century long treeline discussion suffered from a confusion between general mechanisms of global significance and local or regional modulating forces. These modulating forces may induce a local deviation from the thermal tree limit by perhaps 50-150 m of elevation, but quite often the significance of these modulators seems to be overestimated. For instance, some exposed temperate zone treelines in continental areas may be influenced by strong wind or "winter drought", phenomena inexistent in most other parts of the world.

It is not yet fully understood what the decisive mechnisms are through which low temperature prevents tree growth above a certain elevation. Given the many species which thrive in the alpine zone above the treeline, it is unlikely to be a phyllogenetic physiological shortcoming which limits trees but not other species. It rather is the growth form of trees which exposes them to the unbuffered, harsh climate once they emerge from the protective low stature grass and shrub layer and causes trees to experience a much more hostile world than these smaller plants do. In fact, both shoot and root temperatures of trees at the treeline are commonly substantially cooler than temperatures of low stature alpine vegetation. In other words, trees experience a colder climate than low stature alpine vegetation does.
The rather abrupt elevational limit of upright trees seems to be associated with a thermal threshold phenomenon. Evidence is accumulating which suggests a direct limitation of formative processes (the construction of new cells and tissues) rather than a limitation of carbon acquisition by photosynthesis. Trees at their upper cold limit contain more starch, lipids and sugars as trees at only 100 meters below the treeline (Hoch et al. 2002, Hoch and Körner 2003). The obvious implications for global change are that it is unlikely that atmospheric CO2 enrichment can induce a sustained stimulation of tree growth at the climatic treeline. In contrast, a warmer

growing season should stimulate growth (as was shown by Paulsen et al. 2000) and induce upward migration. The length of the growing season seems to be less significant, given that treelines occur at similar growing season isothermes in regions with season length varying from 2-3 to 12 months (Körner 1998, 1999).