Geophysical Research Abstracts
Vol. 13, EGU2011-6572-1, 2011
EGU General Assembly 2011

Intrinsic water-use efficiency in conifer species in a global change scenario. Can the increasing atmospheric CO2 prevent drought-induced trees' growth decline?

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The projected rise of temperature and atmospheric CO_2 concentration at a global scale with a simultaneous rainfall decrease and rainfall concentration in extreme events can dramatically affect survival of tree populations, especially those located at the limits of their geographical and altitudinal distribution. Drought-induced mortality has been noted in forests subjected to severe water deficit, as most of those located in the Mediterranean Basin. Moreover, there is a lack of knowledge about vulnerability of Mediterranean forests to global change and the future of community species composition in these forest ecosystems, where water availability is the major limiting factor for tree growth and survival.

It has been proposed that global atmospheric CO_2 rise could compensate for stomatal closure driven by drought events, in water-limited forest ecosystems, giving no noticeable changes in tree primary production and growth. However, several authors have also shown the lack of correlation between assimilation and growth rates indicating that the increasing CO_2 availability is not necessarily stimulating growth mainly due to both, alternative pathways for C such as increasing respiration rates, and the modulating effect of local climate conditions, stand structure, tree age or intra-specific competition for limiting resources, particularly water and light.

In this work we show different trends of intrinsic water use efficiency (iWUE), estimated from δ^{13}C in tree rings, and basal area increment (BAI) as an estimator of stand growth, measured in several conifer species from different geographical locations and structural characteristics. Responses to increasing atmospheric CO_2 concentration were modeled under different physiological theoretical scenarios. We have compared stands in the following locations: i, healthy *vs* decline *Abies alba* stands in the Pyreneans. ii, healthy *Abies pinsapo* stand from the upper altitudinal distribution range (1700 m a.s.l.); declining *A. pinsapo* stand from the lower altitudinal distribution range (1200 m a.s.l); *Pinus halepensis* stands from the same lower elevation site; all of then are located in Sierra de las Nieves Natural Park (Southern Spain). iii, healthy *A. pinsapo* stands in Grazalema Natural Park (Southern Spain). iv, healthy *A. pinsapo* subsp. *maroccana* in Talassemtanne Natural Park (Northern Morocco). v, *Pinus ponderosa* stands along a strong precipitation gradient in the Chilean Patagonia. We obtained a general 20^{th} century iWUE increase, but lower increasing rate was yielded in water-limited stands from the mid 1980s. Declining *A. alba* and *A. pinsapo* stands, showed higher mean iWUE but lower rate of increase after recurrent drought events. Healthy stands of both species showed a stronger response to atmospheric CO_2. A simultaneous decrease in tree BAI was also found in declining stands. These results suggest that the CO_2 increase cannot compensate for the stomata closure under drought conditions. On the other hand, *P. halepensis*, although in the same locality as declining *A. pinsapo* stands, under the same climatic conditions (1200 m a.s.l.) did not show a BAI decrease and yielded higher rate of iWUE increase, suggesting higher ability to cope with low water availability by means of increasing C assimilation under increased CO_2 availability. Finally, no differences were found in BAI measured in *P. ponderosa* stands along the geographical and precipitation gradient while first results of iWUE estimated from ^{13}C discrimination suggest different acclimation mechanisms related to C sink along this gradient.