Geophysical Research Abstracts
Vol. 17, EGU2015-12638, 2015
EGU General Assembly 2015

Can rising CO_2 concentrations in the atmosphere mitigate the impact of drought years on tree growth?

Alexis Achim (1), Heather Plumpton (2), David Auty (1,3), Jerome Ogee (2), Heather MacCarthy (4), Didier Bert (5), Jean-Christophe Domec (6), Ram Oren (7), and Lisa Wingate (2)

(1) Renewable Materials Research Centre, Laval University, 2425 rue de la Terrasse, Québec, Qc, G1V 0A6, Canada (Alexis.Achim@sbf.ulaval.ca), (2) INRA UMR1391 ISPA, Villenave D'Ornon, 33140, France, (3) Northern Arizona University, School of Forestry, Arizona, USA, (4) University of Oklohoma, Dept. of Microbiology and Plant Biology, Oklohoma, USA, (5) INRA UMR 1202 BIOGECO, Cestas, 33612, France, (6) Bordeaux Science Agro UMR 1391 ISPA, Villenave D'Ornon, 33140, France, (7) Nicholas School of the Environment, DUKE University, Durham, North Carolina, USA

Atmospheric CO_2 concentrations and nitrogen deposition rates have increased substantially over the last century and are expected to continue unabated. As a result, terrestrial ecosystems will experience warmer temperatures and some may even experience droughts of a more intense and frequent nature that could lead to widespread forest mortality. Thus there is mounting pressure to understand and predict how forest growth will be affected by such environmental interactions in the future. In this study we used annual tree growth data from the Duke Free Air CO_2 Enrichment (FACE) experiment to determine the effects of elevated atmospheric CO_2 concentration (+200 ppm) and Nitrogen fertilisation (11.2 g of N m-2 yr-1) on the stem biomass increments of mature loblolly pine (Pinus taeda L.) trees from 1996 to 2010. A non-linear mixed-effects model was developed to provide estimates of annual ring specific gravity in all trees using cambial age and annual ring width as explanatory variables. Elevated CO_2 did not have a significant effect on annual ring specific gravity, but N fertilisation caused a slight decrease of approximately 2% compared to the non-fertilised in both the ambient and CO_2-elevated plots. When basal area increments were multiplied by wood specific gravity predictions to provide estimates of stem biomass, there was a 40% increase in the CO_2-elevated plots compared to those in ambient conditions. This difference remained relatively stable until the application of the fertilisation treatment, which caused a further increase in biomass increments that peaked after three years. Unexpectedly the magnitude of this second response was similar in the CO_2-elevated and ambient plots (about 25% in each after 3 years), suggesting that there was no interaction between the concentration of CO_2 and the availability of soil N on biomass increments. Importantly, during drier years when annual precipitation was less than 1000 mm we observed a significant decrease in annual increments across all treatments. However, the relative difference in growth between CO_2-elevated and ambient plots was greater during drought years, providing evidence that tree growth in the future might become less sensitive to water shortages under elevated CO_2 conditions.