Geophysical Research Abstracts
Vol. 13, EGU2011-10649, 2011
EGU General Assembly 2011

Long-term effect of elevated CO2 concentration on temperature optimum of photosynthetic CO2 assimilation in two tree species

Petra Holisova (1), Ladislav Sigut (2), Otmar Urban (1), Karel Klem (1), and Vladimir Spunda (2)

(1) Institute of Systems Biology and Ecology; CzechGlobe - Center for Global Climate Change Impacts Studies, Academy of Sciences of the Czech Republic, Poříčí 3b, CZ-603 00 Brno, Czech RepublicCzech Republic (holisova.p@czechglobe.cz), (2) Department of Physics, Faculty of Science, Ostrava University, 30. dubna 22, CZ-701 03 Ostrava 1, Czech Republic

In this study, we have tested the hypothesis that elevated CO2 concentration leads to a shift of the temperature optimum of photosynthetic rate in long-aged tree species. Since the elevated CO2 treatment usually leads to the significant decreases in stomatal conductance and consequently to decreases in transpiration (decline in output of latent heat) followed by increases in leaf temperature, we hypothesized that elevated CO2 thus results in the acclimation of plants to higher temperature. We studied two most common economic species in Czech Republic – European beech (Fagus sylvatica) and Norway spruce (Picea abies). The eight-year-old trees were grown in glass domes at the experimental research site Bílý Kříž in the Beskydy Mts. and they were exposed for three growing season to ambient (AC; 380 μmol(CO2) mol-1) and elevated CO2 concentrations (EC; 700 μmol(CO2) mol-1). Using the gas-exchange system Li-6400 (Li-Cor, USA) we measured the temperature response of basic photosynthetic characteristics at six different leaf temperatures ranging from 15 to 40°C. In situ measurements were carried out in mid-season (July) on sun exposed and fully developed leaves and shoots. The changes in temperature acclimation of tree species studied were evaluated on the base of the shift of temperature optima and/or on the base of Q10 parameter (the factor by which the rate constant increases for a 10°C temperature increment).
Although the stomatal conductance is usually suppressed by elevated CO2 concentration by 40–47 and 32–50 % in F. sylvatica and P. abies, respectively (see long-time trends in Košvancová et al. 2009); the significant decrease in light-saturated stomatal conductance, caused by EC conditions, was observed only in beech trees (by 28 % at the reference leaf temperature 20°C) during the course of our measuring campaign. Stomatal conductance was not changed in spruce and transpiration decreased only slightly (non-significant).
Light-saturated CO2 assimilation rate (Amax) was stimulated by EC treatment. However, the stimulation was negligible at low sub-optimal leaf temperatures below 18°C in beech and 15°C in spruce. The highest stimulation of Amax by EC was observed at 30°C in beech (by 52 %) and at 27°C in spruce (by 60 %). Temperature optima of Amax were achieved at 26–28 and 29–31°C in beech trees grown under AC and EC, respectively and at 19–23 and 26,5–27,5°C in spruce trees grown under AC and EC, respectively. The shifts of the temperature optimum of photosynthetic rate were at average 3°C in beech and 6°C in spruce. Similarly, the positive acclimation to higher temperatures, caused by the long-term EC treatment, was observed also in other physiological parameters like Rubisco carboxylation rate (VCmax) or water use efficiency (WUE).
Our data thus support the initial hypothesis that long-term growth of plants under elevated CO2 concentration leads to the acclimation of photosynthesis and other related processes to higher temperature.

Reference: Košvancová, M., O. Urban, M. Šprtová, M. Hrstka, J. Kalina, I. Tomášková, V. Špunda, and M.V. Marek. 2009. Photosynthetic induction in broadleaved Fagus sylvatica and coniferous Picea abies cultivated under ambient and elevated CO2 concentrations. Plant Sci. 177:123–130.

Acknowledgements: This work was supported by grant no. IAA6008707001 (GA AV)
and no. Governmental Research Intention no. AV0Z60870520.