Geophysical Research Abstracts
Vol. 18, EGU2016-10578-1, 2016
EGU General Assembly 2016

Plant acclimation impacts carbon allocation to isoprene emissions: evidence from past to future CO_2 levels

Hugo J. de Boer (1), Annick van der Laan (1), Stefan C. Dekker (1), and Rupert Holzinger (2)

(1) Environmental Sciences, Utrecht University, Utrecht, the Netherlands, (2) Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, the Netherlands

Isoprene (C_5H_8) is produced in plant leaves as a side product of photosynthesis, whereby approximately 0.1-2.0% of the photosynthetic carbon uptake is released back into the atmosphere via isoprene emissions. Isoprene biosynthesis is thought to alleviate oxidative stress, specifically in warm, dry and high-light environments. Moreover, isoprene biosynthesis is influenced by atmospheric CO_2 concentrations in the short term (<days) via responses in the leaf interior CO_2 concentration (C_i), and in the long term (>weeks) via acclimation in photosynthetic biochemistry. In order to understand the effects of CO_2-induced climate change on carbon allocation in plants it is therefore important to quantify how isoprene biosynthesis and emissions are effected by both short-term responses and long-term acclimation to rising atmospheric CO_2 levels.

A promising development for modelling CO_2-induced changes in isoprene emissions is the Leaf-Energetic-Status model (referred to as LES-model hereafter, see Harrison et al., 2013 and Morfopoulos et al., 2014). This model simulates isoprene emissions based on the hypothesis that isoprene biosynthesis depends on the imbalance between the photosynthetic electron supply of reducing power and the electron demands of carbon fixation. In addition to environmental conditions, this imbalance is determined by the photosynthetic electron transport capacity (J_{max}) and the maximum carboxylation capacity of Rubisco (V_{cmax}).

Here we compare predictions of the LES-model with observed isoprene emission responses of *Quercus robur* (pedunculate oak) specimen that acclimated to CO_2 levels representative of the last glacial, the present and the end of this century (200, 400 and 800 ppm, respectively) for two growing seasons. Plants were grown in walk-in growth chambers with tight control of light, temperature, humidity and CO_2 concentrations. Photosynthetic biochemical parameters V_{cmax} and J_{max} were determined with a Licor LI-6400XT photosynthesis system. The relationship between photosynthesis and isoprene emissions was measured by coupling the photosynthesis system with a Proton-Transfer Reaction Time-of-Flight Mass Spectrometer.

Our empirical results support the LES-model and show that the fractional allocation of carbon to isoprene biosynthesis is reduced in response to both short-term and long-term CO_2 increases. This CO_2 effect is most pronounced going from glacial to present CO_2. In the short term, an increase in CO_2 stimulates photosynthesis through an increase in C_i and marginally decreases isoprene production owing to an increase in the electron demand for carbon fixation. In the long-term, acclimation to rising CO_2 leads to down regulation of both J_{max} and V_{cmax}, which modulates the stimulating effect of rising CO_2 on photosynthesis. Specifically the down-regulation of J_{max} reduces isoprene emissions at this time scale, whereas the down-regulation of V_{cmax} has a marginal effect according to the LES-model. Our results highlight that biochemical acclimation to rising CO_2 influences the allocation of carbon to isoprene biosynthesis.

References

Harrison, S. P. *et al*: Volatile isoprenoid emissions from plastid to planet, New Phytol., 197(1), 49–57, 2013.

Morfopoulos, C. *et al*: A model of plant isoprene emission based on available reducing power captures responses to atmospheric CO_2, New Phytol., 203(1), 125–139, 2014.