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# $CO_2$ acclimation impacts leaf isoprene emissions: evidence from past to future $CO_2$ levels

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Isoprene is emitted by many plant species as a side-product of photosynthesis. Once in the atmosphere, isoprene exhibits climate forcing through various feedback mechanisms. In order to quantify the climate feedbacks of biogenic isoprene emission it is crucial to establish how isoprene emissions are effected by plant 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. The energetic imbalance is critically related to the photosynthetic electron transport capacity (Jmax) and the maximum carboxylation capacity of Rubisco (Vcmax). Here we compare predictions of the LES-model with observed isoprene emission responses of Quercus robur (pedunculate oak) specimen that acclimated to $CO_2$ growth conditions representative of the last glacial, the present and the end of this century (200, 400 and 800 ppm, respectively) for two growing seasons. These plants were grown in walk-in growth chambers with tight control of light, temperature, humidity and $CO_2$ concentrations. Photosynthetic biochemical parameters Vcmax and Jmax 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. In the short term, an increase in $CO_2$ stimulates photosynthesis through an increase in the leaf interior $CO_2$ concentration and marginally decreases isoprene production owing to an increase in the electron demand for carbon fixation. In the long-term, acclimation to rising $CO_2$ growth conditions leads to down regulation of both Jmax and Vcmax, which modulates the stimulating effect of rising $CO_2$ on photosynthesis. This $CO_2$ effect is most pronounced between sub-ambient to present $CO_2$. Our results highlight that the LES-model provides a suitable theoretical framework to model changes in leaf isoprene emissions related to biochemical acclimation to rising $CO_2$.

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.