Geophysical Research Abstracts
Vol. 15, EGU2013-4351, 2013
EGU General Assembly 2013

A unifying conceptual model for the environmental responses of isoprene emissions by plants

Catherine Morfopoulos (1), Colin Prentice (1,2), Trevor Keenan (3), Pierre Friedlingstein (4), Belinda Medlyn (2), and Malcolm Possell (5)

(1) Imperial College of London (c.morfopoulos@imperial.ac.uk), (2) Macquarie University, (3) Harvard University, (4) University of Exeter, (5) University of Sydney

Isoprene (2-methyl-1,3-butadiene, C5H8) is the most important biogenic volatile organic compound (BVOC) emitted by terrestrial vegetation, both in terms of abundance and impacts on atmospheric chemistry. Factors influencing isoprene emission rate, such as temperature, CO_2 concentration and water supply, are certain to change in the future. Therefore it is essential to understand and model the processes governing isoprene production at the leaf level in order to assess future isoprene emissions and their impacts. These impacts include effects on tropospheric ozone concentration, methane lifetime, secondary organic aerosol production, and heat-stress damage to vegetation.

Several isoprene models have been developed over the last two decades. Despite attaining reasonably good agreement with observations, these models are not, or only partly, process-based. They typically include separate parameterizations of the responses of isoprene emission to different factors, and thus do not allow for possible mechanistic interactions between them.

Here, we introduce a simple conceptual model based on the hypothesis that isoprene production rates are primarily controlled by the excess or deficit of electrons generated by Photosystem II, relative to the needs of carbon fixation. We show that this hypothesis alone is sufficient to reproduce widely observed responses of isoprene emission to changes in light, temperature, CO_2 concentration and drought. We revisit a body of published data, paying particular attention to how the isoprene/carbon assimilation ratio (Iso/A) varies in response to light. The systematic increase of Iso/A with light, at both leaf and canopy levels, confirms the importance of electron availability in determining isoprene emission rates, consistent with recent findings in plant physiology.