Geophysical Research Abstracts
Vol. 12, EGU2010-12372, 2010
EGU General Assembly 2010

Assessing stomatal conductance changes on short and long time scales and its possible impact on climate

Emmy Lammertsma, Friederike Wagner-Cremer, and Wolfram M. Kuerschner

Palaeoecology, Institute of Environmental Biology, Faculty of Science, Utrecht University, Utrecht, the Netherlands (e.i.lammertsma@uu.nl)

Two fundamental responses of vegetation to increasing atmospheric CO2 concentrations ([CO2]) are increased photosynthesis and decreased stomatal conductance. The latter is determined by both stomatal aperture adjustment on the short term, and by stomatal frequency and size adjustment on the long term. The resulting increased WUE of vegetation leads to changes in the hydrological cycle. Integrating this physiological forcing in Global Circulation Models (GCMs) results in increased surface warming and is thought to enhance terrestrial runoff significantly. Stomatal conductance is therefore considered a critical parameter in modelling past and future climate and environmental changes. However, quantification of the rate of change under [CO2] variability has proven to be not so straightforward. Values obtained from growth experiments under elevated [CO2] generally reflect the short term adaptation only, and seem to have too short a runtime for structural adaptation of the vegetation.

Here we present the stomatal conductance changes deduced from Florida subfossil leaves over a 100ppmv [CO2] increment since the industrial revolution. Temporally high-resolution measurements of stomatal frequency and size on the epidermis for 8 common Florida tree species (Taxodium distichum, Pinus elliottii, P. taeda, Quercus nigra, Q. laurifolia, Acer rubrum, Myrica cerifera and Ilex cassine) are used to calculate the maximal stomatal conductance to water vapour Gwmax. Resulting conductance decreases over a 100ppmv [CO2] interval range between -19% to -59% for the different species, with an average of -40%.

The current warm-temperate to subtropical Florida climate and vegetation composition serve as a modern analogue for Late Tertiary Europe, when [CO2] is thought to be comparable to today's levels. If it is assumed that past vegetation has responded similarly to [CO2] fluctuations, the stomatal conductance change reconstructed for Florida and related WUE changes can be used to better understand hydrological and climatological changes further back in the geological history. As a corollary we present for the first time stomatal conductance Gwmax from Miocene and Pliocene oak leaves. Mainly the stomatal density changes on these leaves result in significant fluctuations in Gwmax, as a consequence of variation in palaeoatmospheric CO2.