1st TERRABITES Symposium
Hamburg, Germany, 9-11 February 2010
TERRABITES-2

Stomatal adapation to atmospheric CO2 and their influence on water use efficiency

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Terrestrial plants adapt themselves to changes in atmospheric CO¬2 concentration by altering stomatal conductance. This will directly influence physiological responses and Water Use Efficiency (WUE). Currently it is unclear if this will lead to decreased transpiration or increased biomass production and how this will feedback to climate if CO2 concentrations continue to increase. Data of stomatal properties from LGM, pre-industrial to present day are now becoming available. From statistical fits to stomatal densities, it is hypothesized that plasticity in stomatal conductance is constraint. Yet little is known how such response-limits mechanistically work and at what CO2 level they occur. In our approach, we hypothesize that species can adapt the length and the number of stomata within the constraints set by a species independent lower limit of leaf area allocated to stomata. We have quantified adaptation of stomatal conductance to altered CO2 concentrations by using a novel coupling between a mechanistic model of long-term structural optimization with a model of short term (dynamic) adaptation of stomatal conductance. With this coupled model, we are able to model the effect of the structural adaptation with or without structural limits at different levels of CO2. We have tested this plant physiological model for Florida, by using a large database of the majority of canopy species of stomatal properties from pre-industrial to present day conditions. In the (sub)tropical forests in Florida species are light or nutrient limited and therefore we assume constant biomass with elevated CO2 First results show that at 800 ppm CO2, transpiration fluxes decrease 140 W/m2 and 30 W/m2 by respectively with and without structural adaptation. If this structural adaptation will affect the climate need to be tested in a coupled climate-vegetation model, to account for numerous vegetation-climate feedback mechanisms.