Geophysical Research Abstracts,
Vol. 11, EGU2009-6742, 2009
EGU General Assembly 2009

The response of stomatal conductance to changing humidity and CO2 in a warming climate

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The physiological function of stomata regulates the exchange of water and carbon fluxes between vegetated and atmospheres. Atmospheric humidity and CO2 are key environmental variables in controlling the stomatal conductance (g), and both of them are projected to increase under future warming climate. Recently, several climate model experiments have investigated the impacts of climate changes on terrestrial ecosystem water vapor and CO2 fluxes through stomatal regulation. Among the land surface parameterizations in these climate models, the Ball-type's g model is most widely used to describe the characteristics of humidity- and CO2-induced stomatal closure.

Although the g in Ball's model was not directly controlled by photosynthetic rate (A), it adopted a linear relationship between g and A according to a phenomenological argument. The Ball's model can predict g realistically over the controlled ambient conditions; however, it is not clear whether this linear relation can be applied to changing climate since they were not derived by causal relationship. On the other hand, a recently reported experiment by Bunce [1998, Plant Cell Environ. 21, pp. 115-120] revealed that the sensitivity of g to humidity (i.e., water vapour deficit) is not constant but a function of the ambient CO2 concentration. In this study, we show that the performance of the Ball-type models under a warming climate is not consistent with the experimental finding by Bunce [1998]. Here, we proposed a revised model and demonstrate its application in a land surface parameterization scheme.