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The CAP Optimisation Hypothesis Provides Improved Formulations for Stomatal Conductance and Photosynthesis in JSBACH

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Stomatal conductance formulations are of great importance to how land surface models predict carbon assimilation and transpiration in vegetation. In this study, novel stomatal conductance formulations based on the CAP optimisation hypothesis (Dewar et al. 2018) are implemented in the land surface model JSBACH. Besides new stomatal conductance functions, the CAP framework enables a computational streamlining of the resolution of photosynthesis rate and leaf internal CO_2 concentration.

The formulations are based on the CAP optimisation hypothesis coupled to different photosynthesis models. Models constructed this way incorporate non-stomatal limitations to photosynthesis through the coupling of carbon assimilation to the soil-to-leaf hydraulic pathway. This entails a direct link from soil water status to stomatal conductance, photosynthesis rate and leaf internal CO_2 concentration. While this construction does away with the need for some previous fitted or empirical parameters, new parameters are required to represent xylem hydraulic conductance and downregulation of photosynthesis during drought stress.

These new models are compared to the widely used USO stomatal conductance model (Medlyn et al. 2011). A standalone version of JSBACH is run for single grid cells representing two boreal Scots pine (*Pinus sylvestris*) dominated sites in Finland (Hyytiälä and Sodankylä). Climate forcing is done with FLUXNET data from 2001 through 2012 and observations are from eddy covariance measurements from the two sites.

Preliminary results indicate that some of the new formulations give reasonable results. This is very promising, since they are more detailed and theoretically robust than their semi-empirical predecessors, yet streamline the computational process.

References:
Dewar et al. 2018, *New Phytol.* 217: 571–581
Medlyn et al. 2011, *Glob. Change Biol.* 17: 2134–2144