Geophysical Research Abstracts, Vol. 8, 00301, 2006
SRef-ID: 1607-7962/gra/EGU06-A-00301

Effects of the biosphere on the atmospheric boundary layer: An investigation into the feedbacks between plant physiology and the atmosphere

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There has been a recent proliferation in the use of General Circulation Models (GCMs) for predicting future climate scenarios and the impact of land-atmosphere feedbacks. This has resulted in an increased requirement for measurements of the land-surface at multiple scales, to parameterise and corroborate GCMs and the land-surface interactions represented in them. In order to provide these land-surface measurements, and investigate critical land-atmosphere interactions, we need to develop effective methods for the scaling-up of measurements: From stand-based measurements of eddy covariance and tree physiological measurements, to regional scale atmospheric measurements utilising measurement platforms such as tall towers, aircraft and radiosondes. In order to perform this scaling, and investigate the land-surface feedbacks, a 3 source coupled model of the land-surface and the atmosphere was developed. The atmospheric component of the coupled model was a 1 dimensional 1st order closure planetary boundary layer model run in a prognostic mode. The land surface component comprised of a high resolution process based biosphere model. The biosphere model couples carbon, water and energy fluxes: Allowing loosely defined parameters to be better constrained. This gives greater confidence in the modelled land-surface responses when run outside the range of corroborating measurements. The model was corroborated using measurements from the 1994 Boreal Ecosystem-Atmosphere Study (BOREAS), based in Saskatchewan, Canada. Soil and plant respiration were both dealt with in a dedicated respiration sub-model. An offline version of the biosphere model, including the respiration sub-model, was compared to 120 days of eddy flux measurements from a Black Spruce site in Saskatchewan. Once the biosphere

component was verified a fully coupled model was compared to radiosonde releases from Candle Lake covering the full span of the 120 day measurement period. We will show that the biosphere model captures the energy, water and carbon fluxes for the whole 120 day test period, including the transition from late May's deeply frozen soils. Corroboration of the fully coupled 3 source model shows that the model adequately predicts the diurnal evolution of temperature and moisture profiles throughout the atmospheric boundary layer. We show that the 3 source model can be considered a viable tool for the investigation of land-surface interactions and the scaling up of measurements. We also present the critical sensitivities of the coupled model to changes in ecological parameters at the land-surface and at a reference height within the boundary layer.