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Sensitivity and predictive uncertainty of the ACASA model at a spruce forest site

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The Advanced Canopy-Atmosphere-Soil Algorithm (ACASA), developed at the University of California, Davis, was used to model the turbulent fluxes of heat, water vapor and momentum as well as the CO2 exchange within and above a spruce canopy at the FLUXNET-station Waldstein-Weidenbrunnen in the Fichtelgebirge mountains in northern Bavaria, Germany. This multilayer canopy-surface-layer model incorporates a diabatic, third-order closure method to calculate turbulent transfer within and above the canopy.

The present work focusses on the evaluation of the sensitivity and uncertainty of the ACASA model by employing the Generalized Likelihood Uncertainty Estimation (GLUE) method. Flux data above the canopy for five days from each of the intensive observation periods carried out within the EGER (ExchanGE processes in mountainous Regions) project in autumn 2007 and summer 2008 were considered. For a number of model parameters, parameter ranges were defined that cover a realistic range of values for the Waldstein site based on measurements and literature values. All parameter ranges were assigned a uniform distribution and random sets of parameters were produced for a large number of model runs. From the model outputs and the measured data, likelihood measures were calculated to assess the performance of each model run. Based on these likelihood measures, the sensitivity of the model to the parameters can be evaluated and uncertainty bounds for each time step derived.

This sensitivity analysis allowed the identification of the most influential parameters of the ACASA model. Among these are some internal plant physiological parameters, which are not made user-defined in the ACASA model, indicating the need to adapt these parameters for various plant species. However, the sensitivity analysis also revealed the equifinality of many parameters in the ACASA model, similarly to other complex process-based models. The analysis of two time periods, each representing different meteorological conditions (relatively wet and cool in autumn 2007, hot and dry in summer 2008), provides an insight into the seasonal variation of parameter sensitivity. Furthermore, weaknesses of the representation of some processes within the model were detected which require improvement.