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Land Surface Modeling Parameter Sensitivity Analysis and Estimation in the Amazon Basin

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A comprehensive parameter sensitivity analysis and estimation of the Simple Biosphere land surface model (SiB3) was conducted using data collected during the Large-scale Biosphere-atmosphere experiment in Amazonia (LBA: 1999-2006), in the context of the LBA Data-Model Intercomparison Project (LBA-DMIP). The eight study sites include four evergreen broadleaf forests, a deciduous broadleaf forest, a savanna biome, and two cropland/pastureland biomes. A novel multi-criteria implementation of the variance-based Sobol sensitivity analysis approach was used to determine the influence of each parameter based on their percentage contributions to model output variances. Model evaluation was conducted against hourly sensible and latent heat fluxes and net ecosystem exchange of CO2. The new approach gives emphasis to multiple-criteria aspects and provides a more objective basis than current methods. Sensitivity analysis was performed to identify the most influential SiB3 parameters common to all sites. Estimation of these most influential SiB3 parameters was conducted using the AMALGAM multi-operator genetic optimization algorithm. Calibration results in a substantial reduction in Root Mean Squared Error (RMSE) compared with default parameter sets. The amount of improvement is found to vary with seasonality (wet and dry seasons). Increase in daytime net carbon assimilation in the dry season at forest sites is well captured using the calibrated parameter estimates and compare more closely with observations. A decomposition of the total prediction uncertainty into mean, variability, and shape/timing components shows that adjustments to the parameters reduce the first two uncertainty components significantly at all sites, but do not bring about significant improvements in timing and shape (dynamical properties) of the flux time series. The decomposition provides a meaningful way to better evaluate model performance against observations, and suggests that an interactive implementation can help achieve deeper insight into shortcomings in model structure and behavior.