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Application of the Bayesian calibration methodology for the parameter estimation in CoupModel

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Abstract. This study provides results for the optimization strategy of highly parameterized models, especially with a high number of unknown input parameters and joint problems in terms of sufficient parameter space. Consequently, the uncertainty in model parameterization and measurements must be considered when highly variable nitrogen losses, e.g. N leaching, are to be predicted. The Bayesian calibration methodology was used to investigate the parameter uncertainty of the process-based CoupModel. Bayesian methods link prior probability distributions of input parameters to likelihood estimates of the simulation results by comparison with measured values. The uncertainty in the updated posterior parameters can be used to conduct an uncertainty analysis of the model output. A number of 24 model variables were optimized during 20 000 simulations to find the "optimum" value for each parameter. The likelihood was computed by comparing simulation results with observed values of 23 output variables including soil water contents, soil temperatures, groundwater level, soil mineral nitrogen, nitrate concentrations below the root zone, denitrification and harvested carbon from grassland plots in Northern Germany for the period 1997–2002. The posterior parameter space was sampled with the Markov Chain Monte Carlo approach to obtain plot-specific posterior parameter distributions for each system. Posterior distributions of the parameters narrowed down in the accepted runs, thus uncertainty decreased. Results from the single-plot optimization showed a plausible reproduction of soil temperatures, soil water contents and water tensions in different soil depths for both systems. The model performed better for these abiotic system properties compared to the results for harvested carbon and soil mineral nitrogen dynamics. The high variability in modeled nitrogen leaching showed that the soil nitrogen conditions are highly uncertain associated with low modeling efficiencies. Simulated nitrate leaching was compared to more general, site-specific estimations, indicating a higher leaching during the seepage periods for both simulated grassland systems.

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