Estimation of ECHAM5 climate model closure parameters with adaptive MCMC

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Climate models contain closure parameters to which the model climate is sensitive. These parameters appear in physical parameterization schemes where some unresolved variables are expressed by predefined parameters rather than being explicitly modeled. Currently, best expert knowledge is used to define the optimal closure parameter values, based on observations, process studies, large eddy simulations, etc. Here, parameter estimation, based on the adaptive Markov chain Monte Carlo (MCMC) method, is applied for estimation of joint posterior probability density of a small number (n=4) of closure parameters appearing in the ECHAM5 climate model. The parameters considered are related to clouds and precipitation and they are sampled by an adaptive random walk process of the MCMC. The parameter probability densities are estimated simultaneously for all parameters, subject to an objective function. Five alternative formulations of the objective function are tested, all related to the net radiative flux at the top of the atmosphere. Conclusions of the closure parameter estimation tests with a low-resolution ECHAM5 climate model indicate that (i) adaptive MCMC is a viable option for parameter estimation in large-scale computational models, and (ii) choice of the objective function is crucial for the identifiability of the parameter distributions.

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