Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04369, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04369
EGU General Assembly 2008

Quantifying epistemic and parameter uncertainties in predictions of evaporation and net infiltration, using maximum likelihood Bayesian model averaging

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We discuss the quantification of epistemic and parameter uncertainties involved in assessing key components (potential evapotranspiration, evapotranspiration, and net infiltration) of the hydrologic balance equation by means of alternative conceptual-mathematical models. Calculations are based on historical monthly-averaged climatic data from analogue meteorological stations representing diverse climatic conditions. We use two classes of semi-empirical formulae describing (1) reference-surface potential evapotranspiration (including the temperature-based Blair-Robertson, Blaney-Criddle, Caprio, Hargreaves-Samani, Hamon, Jensen-Haise, Linacre, Makkink, Thornthwaite, and Turc models, and the radiation-based Priestly-Taylor and Penman models) and (2) surface-dependent potential evaporation using the radiation-based Penman-Monteith method. Each of these models has its own input parameters. We use Monte-Carlo simulations to assess the frequency distribution and statistics of potential evapotranspiration calculated using each formula. These statistics are then used as input into Monte Carlo simulations of evaporation and net infiltration, based on the Budyko (1974) and Zhang et al. (2001) water-balance models. Finally, we assess conceptual-model and parameter uncertainties using maximum likelihood Bayesian model averaging (Neuman, 2003). To quantify prediction uncertainties in evapotranspiration and net infiltration generated by different conceptual-mathematical models, as well as a joint predictive performance of all models (for particular climatic condi-

tions), we first assign prior probabilities to different models and their specific input parameters. We then estimate posterior parameters for each model by inversion (i.e., model calibration) against field measurements from Class A pan evaporometers, and by independent estimates of groundwater recharge and percolation rate through the unsaturated zone at selected test sites. We also provide ranking of the models based on their relative information content and posterior probabilities. This work was partially supported by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.