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The Influence of the Sensible Heat of Rain and Subsurface Heat Transport on the Energy Balance at the Land Surface

S. Kollet (1), I. Cvijanovic (2), D. Schüttemeyer (3), R.M. Maxwell (4), A.F. Moene (5), and P. Bayer (6)

(1) Meteorological Institute, Bonn University, Bonn, Germany (stefan.kollet@uni-bonn.de), (2) Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark (ivanacv@gfy.ku.dk), (3) Meteorological Institute, Bonn University, Bonn, Germany (dirk.schuettemeyer@uni-bonn.de), (4) Department of Geology and Geologic Engineering, Colorado School of Mines, Golden, USA, (rmaxwell@mines.edu), (5) Meteorology and Air Quality Group, Wageningen University and Research Centre, Wageningen, The Netherlands (Arnold.Moene@wur.nl), (6) Institute of Environmental Engineering, Ecological Systems Design, ETH Zürich, Zürich, Switzerland (bayer@ifu.baug.ethz.ch)

In land many surface models, which account for the energy balance at the land surface, subsurface heat transport is an important component that reciprocally influences ground, sensible and latent heat fluxes, and net radiation. The applied subsurface heat transport parameterizations are commonly simplified for computational efficiency. A major simplification is the disregard of the sensible heat of rain and convective subsurface heat flow, i.e. the transport of heat through moisture redistribution, which basically decouples heat transport from moisture transport at the land surface and in the subsurface.

In the presented analysis, the influence of sensible heat of rain and convection on the energy balance is studied using a coupled model that integrates a subsurface moisture and energy transport model with a land surface model. It is shown that all components of the land surface energy balance depend on the sensible heat of rain. The strength of the dependence is related to the rain rate, and the temperature difference between the rain water and the soil surface. The rain water temperature is a parameter rarely measured in the field that introduces uncertainty in the calculations and is approximated using the either the air or wet bulb temperatures in different simulations. In addition it is shown that the lower boundary condition for closing the problem of subsurface heat transport has strong implications on the energy balance under dynamic equilibrium conditions. Comparison with measured data from the Meteostation Haarweg, Wageningen, The Netherlands, shows good agreement and suggests the usefulness of the proposed approach.