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Development of a soil heat flux and storage model for Global Change Assessment on the regional scale

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The biochemical cycle in the soil under Global Change conditions is an important research topic of integrated assessment and modeling (IAM) on the regional scale. Physical factors influencing the nitrogen cycle in the soil mainly are soil moisture and temperature, which can be modeled in soil-vegetation-atmosphere-transport (SVAT) schemes. While there are numerous models simulating soil moisture in different layers, physically based models of soil heat transfer are scarce. Hence we present the Soil Heat Transfer Module with 4 layers (SHTM-4L) used in the Decision Support System DANUBIA for the Upper Danube catchment (about 77,000 km2) together with a sensitivity analysis of soil physical properties on soil temperature simulation. DANUBIA is developed by the multi-disciplinary, integrative research project GLOWA-Danube (www.glowa-danube.de).
SHTM-4L combines simplified physical algorithms for the computation of the actual temperature in the upper soil layers and an analytical lower boundary condition to represent climate change conditions. Changes in soil moisture and soil freezing are explicitly taken into account. The ground heat flux (GHF) as the driving force of the model is computed explicitly by the models representing radiation balance and surface fluxes in DANUBIA. Soil temperature of the upper layer feeds back into the energy balance simulation, while soil temperature in the root zone is used by biological and agroeconomical models inside DANUBIA.
After presenting the theoretical basis of SHTM-4L and its main equations, we show the validity of the model for the simulation of soil temperature with measured ground heat flux data at two eddy-flux stations in Upper Bavaria, Germany. A short description of the latent heat flux computation inside DANUBIA is followed by the results

of coupled SHTM-4L/DANUBIA runs at the eddy-flux sites. Finally the sensitivity of SHTM-4L parameters on soil temperature simulation is analysed and the need for better spatial parametrization methods at the regional scale is shown.