Climate and Land Surface Changes in Hydrology
Proceedings of H01, IAHS-IAPSO-IASPEI Assembly, Gothenburg, Sweden, July 2013 (IAHS Publ. 359, 2013 146-151

Investigating the importance of groundwater for near surface flux and state simulation through a multi-constraint analysis of a complex surface–subsurface–atmosphere model

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Abstract A complex distributed numerical modelling framework including both groundwater–surface-water flow and heat flux exchange with the atmosphere, combined with a unique observational data set, enables a comprehensive application of multiple independent constraints to the model parameter optimization at the catchment scale (1050 km^2). Five independent observational data sets consisting of stream discharge, groundwater head, latent heat flux, soil moisture and remotely-sensed land surface temperature are the basis for formulating 11 objective functions focusing on the bias and RMSE of time series from multiple stations. A sensitivity analysis of 35 model parameters reveals that even surface fluxes and states, such as soil moisture, heat fluxes and land surface temperature, are highly sensitive to parameters that are typically associated with the groundwater components of the model. This indicates the importance of also using fully coupled modelling approaches in detailed studies of the near surface–atmosphere exchanges.

Key words surface–subsurface–atmosphere model; sensitivity analysis; multi-constraint; groundwater; surface flux