Geophysical Research Abstracts
Vol. 16, EGU2014-5577, 2014
EGU General Assembly 2014

Multi-constraint calibration of a surface-subsurface-atmosphere model at the catchment scale

Simon Stisen (1), Torben Obel Sonnenborg (1), Jens Christian Refsgaard (1), Julian Koch (1), Simone Bircher (2), and Karsten Høgh Jensen (3)

(1) Geological Survey of Denmark and Greenland, Copenhagen, Denmark (sst@geus.dk), (2) Centre d'Etudes Spatiales de la Biosphère (CESBIO), Toulouse, France, (3) Department of Geosciences and Natural Resource Management, University of Copenhagen, Denmark

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 from the HOBE hydrological observatory in Western Denmark, enables a comprehensive application of multiple independent constraints to the model parameter optimization at the catchment scale (1050 km2). Five independent observational data sets consisting of stream discharge (8 stations), groundwater head (361 stations), latent heat flux (2 stations), soil moisture (28 stations) and remotely sensed land surface temperature (full spatial coverage on 28 days) are the basis for formulating 11 objective functions focussing on bias and RMSE of time series from multiple stations. In contrast to many multiple objective studies, where objective functions essentially originate from the same observational dataset (typically discharge time series), the dataset used in this study enables a truly multi-constraint evaluation of the states and fluxes simulated by the model. A preliminary sensitivity analysis of 35 model parameters reveals that even surface fluxes and states such as soil moisture, heat fluxes and land surface temperatures are highly sensitive to parameters that are typically associated with the groundwater components of the model. This indicates the importance of using fully coupled modelling approaches also in detailed studies of the near surface-atmosphere exchanges. The model parameter optimization, conducted using the gradient based search algorithm in PEST, has been carried out for three separate assumptions of available evaluation data. The first calibration uses only traditional observations of stream discharge and groundwater head, the second uses observations associated mainly with the land surface component, specifically latent heat flux, soil moisture and remotely sensed surface temperature. As a third scenario the model is calibrated using all available observational data sets, and finally each of the calibrated models are evaluated against the observations that were not used during calibration and for all observations for a validation period. The results illustrate the importance of multiple constraints to complex coupled models and the potential consequences of using model predictions of output that the model has not been constrained against. The study also highlights the need to develop spatial model calibration through new spatial performance metrics and new parameterisation and optimization frameworks that explicitly allow the models to improve their spatial pattern predictions while maintaining a reasonable number of free calibration parameters.