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Global Sensitivity Analysis of an integrated parallel hydrologic model: ParFlow-CLM

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An integrated parallel hydrologic model (ParFlow-CLM) was constructed to predict water and energy transport between subsurface, land surface, and atmosphere for a synthetic study using basic physical properties of the Stettbach headwater catchment, Germany. Based on this model, a global sensitivity analysis was performed using the Latin-Hypercube (LH) sampling strategy followed by the One-factor-At-a-Time (OAT) method to identify the most influential and interactive parameters affecting the main hydrologic processes. In addition, the sensitivity analysis was also carried out for assumptions of different slopes and meteorological conditions to show the transferability of the results to regions with other topographies and climates. Our results show that the simulated energy fluxes, i.e. latent heat flux, sensible heat flux and soil heat flux, are more sensitive to the parameters of wilting point, leaf area index, and stem area index, especially for steep slope and subarctic climate conditions. The simulated water fluxes, i.e. evaporation, transpiration, infiltration, and runoff, are most sensitive to soil porosity, van-Genuchen parameter n, wilting point, and leaf area index. The subsurface water storage and groundwater storage were most sensitive to soil porosity, while the surface water storage is most sensitive to the Manning's n parameter. For the different slope and climate conditions, the rank order of in input parameter sensitivity was consistent, but the magnitude of parameter sensitivity was very different. The strongest deviation in parameter sensitivity occurred for sensible heat flux under different slope conditions and for transpiration under different climate conditions. This study provides an efficient method of the identification of the most important input parameters of the model and how the variation in the output of a numerical model can be attributed to variations of its input factors. The results help to better understand process representation of the model and reduce the computational cost of running high numbers of simulations.