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Impact of geological model uncertainty on integrated catchment hydrological modeling

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Various types of uncertainty can influence hydrological model performance. Among them, uncertainty originated from geological model may play an important role in process-based integrated hydrological modeling, if the model is used outside the calibration base. In the present study, we try to assess the hydrological model predictive uncertainty caused by uncertainty of the geology using an ensemble of geological models with equal plausibility. The study is carried out in the 101 km2 Norsminde catchment in western Denmark. Geostatistical software TProGS is used to generate 20 stochastic geological realizations for the west side the of study area. This process is done while incorporating the borehole log data from 108 wells and high resolution airborne transient electromagnetic (AEM) data for conditioning. As a result, 10 geological models are generated based solely on borehole data, and another 10 geological models are based on both borehole and AEM data. Distributed surface water – groundwater models are developed using MIKE SHE code for each of the 20 geological models. The models are then calibrated using field data collected from stream discharge and groundwater head observations. The model simulation results are evaluated based on the same two types of field data. The results show that the differences between simulated discharge flows caused by using different geological models are relatively small. The model calibration is shown to be able to account for the systematic bias in different geological realizations and hence varies the calibrated model parameters. This results in an increase in the variance between the hydrological realizations compared to the uncalibrated models that uses the same parameter values in all 20 models. Furthermore, borehole based hydrological models in general show more variance between simulations than the AEM based models; however, the combined total uncertainty, bias plus variance, is not necessarily higher.