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A topography-driven hydrological model in the Heihe River, China

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A new topography-driven hydrological model was developed and tested in the upper Heihe River Basin and validated in two nested sub-basins using independent remote sensing sources. Topography is closely related to geomorphology, land use, ecosystems, and, as a result, it reflects the dominant hydrological processes. However, existing models use topography in a rather basic way. In this study, we classified the river basin into four landscapes by using two topographic indicators: the elevation above sea level, and the Height Above the Nearest Drainage (HAND). On the basis of this classification each landscape class was described by a different conceptual model. During this translation process, we used soft data and expert knowledge to constrain the model structure and parameter ranges. After calibration, additional data was used for validation, including hydrograph data in different periods and in nested gauge stations. In addition we compared modeled evaporation with evaporation maps obtained from remote sensing. The novelty of this study is threefold: (1) we used a new method for topography-driven landscape classification and successfully translated this classification into model structures describing the dominant hydrological processes in the different landscapes; (2) the two nested catchments have quite distinct landscapes which made the nested validation process more stringent; (3) independent evaporation data was used to further validate the model. Several interesting conclusions are drawn: (1) the classification method which combined HAND and elevation is powerful to separate different landscapes; (2) the wetland and the summit area covered by bare soil/rock are the main peak flow producing region in the Heihe River Basin. The hillslopes with grassland and the summit area are mostly responsible for deep percolation and generate the largest proportion of the base flow ; (3) almost all the rainfall in the forested area of the upper Heihe River Basin is evaporated, both by interception and transpiration, and very little runoff is produced in the forests.