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Catchment modelling at the global scale using the World-Wide HYPE (WWH)

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Traditionally, catchment modelling mainly focused on simulating the lumped hydrological cycle at local to regional scales with high precision in a specific point of a river. However, recent advancement in understanding hydrological processes, accessing new data sources, and refining methods for parameter constraints, should make it possible to apply catchment models also for ungauged basins over large scales. In this presentation we explore how far integrated catchment modelling can reach in predicting storage and dynamics of the Earth's freshwater, only using open and readily available data sources.

When setting up the HYPE model globally, we made use of more than 20 databases of landscape characterization and physiography (e.g. topography, land cover, soil, waterbodies, karst, alterations). A database with time-series from 20 000 river-flow gauges was compiled and of these some 11 000 stations were used for model evaluation and parameter estimation. Catchment delineation and routing was based on the dataset GWD-LR (3 arcsec grid), which provides flow accumulation, flow direction and river width (Yamazaki et al., 2014). The landmass of Earth (except from Antarctica) was divided into 131 283 catchments with an average size of some 1000 km2, varying from larger in flatlands and smaller in mountainous areas. Catchment outlets were also directed by gauging sites, large waterbodies or dense/sensitive building infrastructure. The model was forced with a new dataset from SMHI (Hydrological Global Forcing Data; Berg et al., 2017), based on bias adjusted ERA products and forecasts from ECMWF.

The HYPE model is integrated, process-oriented and semi-distributed with open-source code (http://hypecode.smhi.se/) . For model set up, groups of parameters that are linked to specific hydrological processes are estimated simultaneously using selected representative basins from the large-sample dataset of observations. Estimated parameters are then transferred to the whole model domain. Major waterbodies may also be calibrated individually. In each catchment, HYPE calculates the water balance for a given time-step separately for various terrestrial water storages, such as glaciers, soil, groundwater, river channels, wetlands, floodplains, and lakes. Its finest calculation unit within the catchment is land classes (including soil and groundwater), defined by a combination of land use, soil and elevation. Model parameters are estimated at the global scale in a step-wise manner (following the water path-ways) using various data sources, including in-situ observations, Earth Observation products, soft information and expert judgements (e.g. Pechlivanidis and Arheimer 2015). This presentation will especially focus on challenges and current approaches in WWH regarding: (i) catchment delineation and routing; (ii) water balance of various land cover (e.g. vegetation and soil), (iii) storage in water bodies (glaciers, lakes, floodplains, reservoirs), (iv) influence of water management (regulation and irrigation).

References

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