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Towards scale independent lake-hydrology modeling in semi-arid regions: mHM lake module (mLM) development

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With large fluctuations in annual precipitation, one of the key anthropogenic features of semi-arid regions is seasonal storage and its intensive use of water. A reliable hydrological forecast system at such regions requires accurate representation of the existing lakes and/or hydraulic regulation infrastructures. The meso-scale hydrological model (mHM), a well established scale-independent hydrological model, was augmented with a new lake module for tacking this task.

The mHM lake module (mLM) delineates natural or man-made lakes (reservoirs) based on the fine morphology input (ℓ_0, 0.2 – 1 km). Lake precipitation and evaporation are calculated using the coarse meteorology input (ℓ_2, 10 – 50 km) while lake inflow is collected from adjoining mHM cells (hydrology level, ℓ_1, 1 – 10 km). Apart from these lake processes, seepage, spill and reservoir regulation are calculated and the balanced outflow is passed on to the routing module further downstream. Most of the lake process parameters are regionalized (as other mHM parameters) while others are optimized based on a user-given input range. The user also has the option to optimize the mLM parameters using reservoir levels, spill history and/or discharge gauges. As a part of the Seasonal Water Management (SaWaM) project (Funded by the BMBF), the headwater catchment of São Francisco basin (Brazil) is selected as test case for development phase. Lake levels based on satellite altimetry are used during model calibration. The results highlights the significant model improvement achieved by accounting process based storage effect in lake-hydrology systems.

Apart from the successful integration of mLM into the routing system of mHM, this study discusses future plans such as evolving mLM to cater cascade lake-hydrology systems and dynamic reservoir storage conditions due to sedimentation and sluicing. Furthermore, it aims to explore concepts for scale free modeling of lake-hydrology systems, upholding the multi-scale paradigm of mHM.