EGU2020-12045
https://doi.org/10.5194/egusphere-egu2020-12045
EGU General Assembly 2020

High resolution data for semi-distributed hydrological modeling: where should we draw the line?

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High-resolution data are readily available and used more than ever in hydrological modeling, despite few investigations demonstrating the added value. Nonetheless, a few studies have looked into the benefits of using increased spatial resolution data with the widely-used, semi-distributed, SWAT model. Meanwhile, far too little attention has been paid to the physically-based, semi-distributed, hydrological model HYDROTEL which is widely used for hydrological forecasting and hydroclimatic studies in Quebec, Canada. In a preliminary study, we demonstrated that increasing the spatial resolution of the digital elevation model (DEM) had a significant impact on the discretization of a watershed into hillslopes (i.e., computational units of HYDROTEL), and on their topographic attributes (slope, elevation and area). Accordingly, values of the calibration parameters were also substantially affected; whereas model performance was slightly improved for high- and low-flows only. This is why, we hereby propose the systematic assessment of HYDROTEL with respect to the resolution of the spatiotemporal computational domain for a specific physiographic scale. This investigation was conducted for the 350-km^2 St. Charles River watershed, Quebec, Canada. The DEM used was derived from LiDAR data and aggregated at 20 m. Due to a lack of accurate precipitation information at time scales less than 24 hr, data from the high resolution deterministic precipitation analysis system, CaPA-HRDPA, were used to generate various time steps (6, 8, 12, and 24 hr) and to control results obtained from observed data. This approach, recently applied to three watersheds in Yukon, proved to be an excellent alternative to calibrate a hydrological model in a region known as a hydometeorological desert (see EGU 2020 presentation of Abbasnezhadi and Rousseau). The number of computational units ranged between 5 to 684 hillslopes, with mean areas ranging from 75 km^2 to 0.5 km^2. HYDROTEL was automatically calibrated over the 2013-2018 period using PADDS. We combined the Kling Gupta Efficiency and the log-transformed Nash Sutcliffe Efficiency to ensure good seasonal and annual representations of the hydrographs. The 12 most sensitive calibration parameters were adjusted using 150 optimisation trials with 150 repetitions each. Behavioral parameters were used to assess uncertainty and ensuing equifinality. All scenarios were evaluated using flow duration curves, performance indicators (RMSE, % Bias) and hydrograph analyses. In addition, quantitative analyses were done with respect to physiographic features such as: length of river segments, hillslopes, and sub-watershed boundaries for each resolution. We believe this study provides the needed systematic framework to assess trade-offs between spatiotemporal resolutions and modeling performances that can be achieved with HYDROTEL. Moreover, the use of various

numbers of CaPA-HRDPA stations for model calibration has allowed us to determine the number of precipitation stations needed to achieve a given performance threshold.