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Spatial allocation of low resolution runoff model outputs to a high resolution stream network

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Global analyses of water scarcity and water resource management in developing countries would benefit from fine scale estimates of water availability at global extent. The standard procedure for hydrological predictions in ungauged basins includes 1) generation of a river network and watershed from a DEM, 2) derivation of meteorological forcing, either by interpolation of observations or downscaling from climate models, 3) estimation of parameters based on physical properties of the catchment. The procedure can produce detailed and relatively reliable information about water resources in catchments, but is non-trivial at global scale. On the other hand, predictions from global or continental scale models are widely available but have too low spatial resolution to describe precise conditions in the field. In this paper, we test an approach to extract sub-grid resolution information from a global 30-minute, a global 6-minute and basin scale 5km resolution runoff data. The gridded model output is overlaid with the high resolution HydroSheds river network, and runoff is allocated to the river segments present in each cell. This is equivalent to using identical forcing and parameter values for all sub-catchments within a grid cell, but it is more computationally efficient and can be implemented entirely by post-processing existing model outputs. To address cases where a river network may be known, but not watershed boundaries, we test four spatial allocation methods to distribute the output value to river segments: equal, stream order, segment length, and network Voronoi polygon based distribution. HydroSheds-derived watersheds are taken as the ground truth to which the performance of the spatial allocation methods is compared. An open source library is developed in R language, and a case study of the 3S River Basin (consisting of Sekong, Sesan and Srepok tributaries of the Mekong River) is conducted. Analysis of uncertainty is essential when using this method for prediction. Other potential uses of the method could be to partition grid cell runoff to explicit stream network for validation purposes, and for a more relatable visualisation of gridded model results.