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Global scale river network extraction based on high-resolution topography, constrained by lithology, climate, and observed drainage density

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To improve the representation of surface and groundwater flows, global land surface models started to rely on high-resolution parameters, being able to provide a more realistic description of the hydrological cycle. To fulfill this demand, several studies focused on algorithms to produce hydrologically conditioned digital elevation models, and corrected flow directions. River pixels are routinely defined as the pixels with sufficient flow accumulation, usually with a unique value of flow accumulation threshold over the globe. This takes into consideration the first-order control of topography onto the river network, its length and the resulting drainage density, but it overlooks the effects lithology and local climate. This work proposes a calibration of the flow accumulation threshold, based on global lithology and precipitation. We use the high-resolution hydrologically corrected flow directions and flow accumulations from HydroSHEDS, where threshold values are calibrated to match good quality observed river networks (from national databases in France and USA), by distinguishing several precipitation and lithological classes. The calibrated thresholds are then used for river network extraction over the globe. All threshold values remain under 5 km2, with higher thresholds, corresponding to smaller drainage density, in areas with carbonate and unconsolidated sediments and/or low precipitation. The results are presented at 15 arc-seconds resolution ($\sim$ 500 m), with global river network and drainage density information. All drainage density results remain in the same order of magnitude as the observations, with an error under 1%. Independent validation will be presented against observed river networks from Brazil. The resulting thresholds provide a tool to extract more realistic river network from any digital elevation model, and the global river network here presented can be incorporated to land surface and climate models.