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Global scale prediction of river flow-duration curves with remote sensing: an assessment for the SWOT mission

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The Surface Water and Ocean Topography (SWOT) satellite mission will provide high-resolution images of riverine water surface characteristics (i.e. elevation, width and slope), which may be used for the estimation of river discharges. However, only rivers wider than 100 m will be observed, with a time interval between two satellite observations that varies from 3 to 10 days approximately, in relation to the latitude, and with errors on river discharge estimate highly dependent on flow regimes and geomorphic conditions. We aim to compare remotely sensed and empirical period-of-record flow-duration curves (FDCs) in order to deliver an assessment of SWOT reliability for the estimation of these hydrological signatures at global scale. Empirical FDCs describe the percentage of time (duration) in which a given streamflow is equalled or exceeded over an historical period of time. FDCs are fundamental for a variety of different engineering applications and have always attracted great interests for their ability to provide a simple graphical view of the overall historical variability of streamflows in river basins, from floods to low-flow conditions. In this analysis, we used the Global Runoff Data Centre (GRDC) dataset, which is the world largest and freely available source of streamflow data. From the whole dataset, we selected those gauging stations that matched different criteria: river width must be larger than 100 m and streamflow series must have no gap in a time frame of at least 10 years. With this configuration, 1140 gauging stations are used for the assessment. To simulate the SWOT mission, each series have been sensed with a time interval of 10 days and for a period of 3 years (i.e. mission duration), corrupting the gauged data with a random error retrieved by means of a normal distribution function having zero mean and 20% root-mean-squared-error. For each gauged station, we obtained a set of SWOT simulated FDCs to be compared to their empirical counterparts. The study also takes into account different climatic regions at global scale, founding that for humid and temperate climate good estimates might be delivered, while, for mostly arid and intermittent flow regimes, higher errors must be expected. Also, lower errors are likely to occur for high- and medium-flows, whereas the low-flows show spreader curves and higher prediction uncertainty.