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Improving rainfall representation for large-scale hydrological modelling of tropical mountain basins

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Errors in the forcing data are sometimes overlooked in hydrological studies even when they could be the most important source of uncertainty. The latter particularly holds true in tropical countries with short historical records of rainfall monitoring and remote areas with sparse rain gauge network. In such instances, alternative data such as the remotely sensed precipitation from the TRMM (Tropical Rainfall Measuring Mission) satellite have been used. These provide a good spatial representation of rainfall processes but have been established in the literature to contain volumetric biases that may impair the results of hydrological modelling or worse, are compensated during model calibration. In this study, we analysed precipitation time series from the TMPA (TRMM Multiple Precipitation Algorithm, version 6) against measurements from over 300 gauges in the Andes and Amazon regions of Peru and Ecuador. We found moderately good monthly correlation between the pixel and gauge pairs but a severe underestimation of rainfall amounts and wet days. The discrepancy between the time series pairs is particularly visible over the east side of the Andes and may be attributed to localized and orographic-driven high intensity rainfall, which the satellite product may have limited skills at capturing due to technical and scale issues. This consequently results in a low bias in the simulated streamflow volumes further downstream. In comparison, with the recently released TMPA, version 7, the biases reduce. This work further explores several approaches to merge the two sources of rainfall measurements, each of a different spatial and temporal support, with the objective of improving the representation of rainfall in hydrological simulations. The methods used are (1) mean bias correction (2) data assimilation using Kalman filter Bayesian updating. The results are evaluated by means of (1) a comparison of runoff ratios (the ratio of the total runoff and the total precipitation over an extended period) in multiple basins, and (2) a comparison of the outcome of hydrological modelling using the distributed JULES (Joint-UK Land Environment Simulator) land surface model. First results indicate an improvement in the water balance that directly translates into an increased hydrological performance. The more interesting aspect of the study, however, will be the insights into the nature of satellite precipitation errors in this extreme environment and the optimal means of improving the data to generate increased confidence in hydrological predictions.