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Calibration of a Hydrological Model using Ensemble Satellite Rainfall Inputs

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A combination of satellite rainfall estimates (SRFE) and hydrological models can provide useful information for many remote areas of the planet. However, each component contains its own uncertainties and these uncertainties will interact when SRFE are used as inputs for hydrological models. For any assessment of a coupled system such as this there is a requirement for a comprehensive analysis of all sources of uncertainty, with full consideration of both facets.

SRFE have been shown to be useful in many areas that lack the infrastructure to make timely and accurate estimations of rainfall from the ground. Sub-Saharan Africa is typical of this, where a paucity of rain recording radar and sparse gauging networks combine with a highly variable climate and a reliance on rain-fed agriculture. When operating at higher spatial and temporal resolutions, SRFE contain large uncertainties which will propagate through a hydrological model if used as a driving input. This study used a sequential method to produce ensemble SRFE based around the full conditional distribution of recorded rainfall from a sparse, historic raingauge network. The TAMSIM method (introduced by Teo, 2006) was used to produce 200 unique yet equiprobable SRFE, each used as a driver to a downstream hydrological model.

Traditional hydrological modelling uses the adjustment of variable parameters within the model to reduce the error between a recorded record of discharge and the modelled one, and many automatic procedures have been produced to refine this calibration process. When SRFE have been used as a driver, little consideration has been paid to this process and often a calibration using the raingauge data has been used, without any consideration to the resulting uncertainty within the hydrological model and its calibration. A similar issue arises when ensemble inputs are used to a hydrological model that has been calibrated using a deterministic estimate of rainfall. This study has shown that such approaches are not suitable for use with ensemble SRFE inputs, and that a calibration approach that incorporates each ensemble input individually and as a whole is required.

Finally, the study showed that temporal biases within the SRFE, due to interannual variations of the seasonal rainfall, were directly transferred to the biases in the modelled discharges, yet spatial biases, due to climatic variations across the catchment, where compensated for by the automatic calibration of the hydrological model.