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Can climate variability information constrain a hydrological model for an ungauged Costa Rican catchment?

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Long–term hydrological data are key to understanding catchment behaviour and for decision making within water management and planning. Given the lack of observed data in many regions worldwide, hydrological models are an alternative for reproducing historical streamflow series. Additional types of information – to locally observed discharge – can be used to constrain model parameter uncertainty for ungauged catchments. Climate variability exerts a strong influence on streamflow variability on long and short time scales, in particular in the Central-American region. We therefore explored the use of climate variability knowledge to constrain the simulated discharge uncertainty of a conceptual hydrological model applied to a Costa Rican catchment, assumed to be ungauged. To reduce model uncertainty we first rejected parameter relationships that disagreed with our understanding of the system. We then assessed how well climate-based constraints applied at long-term, inter-annual and intra-annual time scales could constrain model uncertainty. Finally, we compared the climate-based constraints to a constraint on low-flow statistics based on information obtained from global maps. We evaluated our method in terms of the ability of the model to reproduce the observed hydrograph and the active catchment processes in terms of two efficiency measures, a statistical consistency measure, a spread measure and 17 hydrological signatures. We found that climate variability knowledge was useful for reducing model uncertainty, in particular, unrealistic representation of deep groundwater processes. The constraints based on global maps of low-flow statistics provided more constraining information than those based on climate variability, but the latter rejected slow rainfall-runoff representations that the low flow statistics did not reject. The use of such knowledge, together with information on low-flow statistics and constraints on parameter relationships showed to be useful to constrain model uncertainty for an – assumed to be – ungauged basin. This shows that our method is promising for reconstructing long-term flow data for ungauged catchments on the Pacific side of Central America, and that similar methods can be developed for ungauged basins in other regions where climate variability exerts a strong control on streamflow variability.