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Effect of precipitation spatial distribution uncertainty on the uncertainty bounds of a snowmelt runoff model output

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This study analyses the effect of precipitation spatial distribution uncertainty on the uncertainty bounds of a snowmelt runoff model's discharge estimates. Prediction uncertainty bounds are derived using the Generalized Likelihood Uncertainty Estimation (GLUE) methodology.

The model analysed is a conceptual watershed model operating at a monthly time step. The model divides the catchment into five elevation zones, where the fifth zone corresponds to the catchment glaciers. Precipitation amounts at each elevation zone i are estimated as the product between observed precipitation (at a single station within the catchment) and a precipitation factor FPi. Thus, these factors provide a simplified representation of the spatial variation of precipitation, specifically the shape of the functional relationship between precipitation and height. In the absence of information about appropriate values of the precipitation factors FPi, these are estimated through standard calibration procedures. The catchment case study is Aconcagua River at Chacabuquito, located in the Andean region of Central Chile.

Monte Carlo samples of the model output are obtained by randomly varying the model parameters within their feasible ranges. In the first experiment, the precipitation factors FPi are considered unknown and thus included in the sampling process. The total number of unknown parameters in this case is 16. In the second experiment, precipitation factors FPi are estimated a priori, by means of a long term water balance between observed discharge at the catchment outlet, evapotranspiration estimates and observed precipitation. In this case, the number of unknown parameters reduces to 11. The feasible ranges assigned to the precipitation factors in the first experiment are slightly wider than the range of fixed precipitation factors used in the second experiment. The mean squared error of the Box-Cox transformed discharge during the calibration period is used for the evaluation of the goodness of fit of the model realizations. GLUE-type uncertainty bounds during the verification period are derived at the probability levels p=85%, 90% and 95%.

Results indicate that, as expected, prediction uncertainty bounds indeed change if precipitation factors FPi are estimated a priori rather than being allowed to vary, but that this change is not dramatic. Firstly, the width of the uncertainty bounds at the same probability level only slightly reduces compared to the case where precipitation factors are allowed to vary. Secondly, the ability to enclose the observations improves, but the decrease in the fraction of outliers is not significant. These results are probably due to the narrow range of variability allowed to the precipitation factors FPi in the first experiment, which implies that although they indicate the shape of the functional relationship between precipitation and height, the magnitude of precipitation estimates were mainly determined by the magnitude of the observations at the available raingauge. It is probable that the situation where no prior information is available on the realistic ranges of variation of the precipitation factors, and the inclusion of precipitation data uncertainty, would have led to a different conclusion.

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