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Quantification of the impact of precipitation spatial distribution uncertainty on predictive uncertainty of a snowmelt runoff model

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This study is intended to quantify the impact of uncertainty about precipitation spatial distribution on predictive uncertainty of a snowmelt runoff model. This problem is especially relevant in mountain catchments with a sparse precipitation observation network and relative short precipitation records.

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's glaciers. Precipitation amounts at each elevation zone i are estimated as the product between observed precipitation at a station and a precipitation factor FPi. If other precipitation data are not available, these precipitation factors must be adjusted during the calibration process and are thus seen as parameters of the model. In the case of the fifth zone, glaciers are seen as an inexhaustible source of water that melts when the snow cover is depleted.The catchment case study is Aconcagua River at Chacabuquito, located in the Andean region of Central Chile.

The model's predictive uncertainty is measured in terms of the output variance of the mean squared error of the Box-Cox transformed discharge, the relative volumetric error, and the weighted average of snow water equivalent in the elevation zones at the end of the simulation period. Sobol's variance decomposition (SVD) method is used for assessing the impact of precipitation spatial distribution, represented by the precipitation factors FPi, on the models' predictive uncertainty. In the SVD method, the first order effect of a parameter (or group of parameters) indicates the fraction of predictive uncertainty that could be reduced if the true value of this parameter (or group) was known. Similarly, the total effect of a parameter (or group) measures the fraction of predictive uncertainty that would remain if the true value of this parameter (or group) was unknown, but all the remaining model parameters could be fixed. In this study, first order and total effects of the group of precipitation factors FP1- FP4, and the precipitation factor FP5, are calculated separately.

First order and total effects of the group FP1- FP4 are much higher than first order and total effects of the factor FP5, which are negligible This situation is due to the fact that the actual value taken by FP5 does not have much influence in the contribution of the glacier zone to the catchment's output discharge, mainly limited by incident solar radiation. In addition to this, first order effects indicate that, in average, nearly 25% of predictive uncertainty could be reduced if the true values of the precipitation factors FPi could be known, but no information was available on the appropriate values for the remaining model parameters. Finally, the total effects of the precipitation factors FP1- FP4 are close to 41% in average, implying that even if the appropriate values for the remaining model parameters could be fixed, predictive uncertainty would be still quite high if the spatial distribution of precipitation remains unknown.

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