From streamflow back to rainfall: hydrological model inversion using the Monte Carlo method. Test and crash-test over 202 French catchments.

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Precipitation is known to exhibit a high spatial variability. For this reason, raingage measurements, which only provide a local information about rainfall, may not be appropriate to estimate areal rainfall. On the other hand, catchments have the ability to aggregate rainfall over their area and route it to a unique point - the outlet - where it can be easily measured. A catchment can thus be viewed as a large raingage, with the difference that what is measured at the outlet is a complex transformation of the rainfall. In this communication, we propose to use a model of this transformation (a so-called rainfall-runoff model) and to infer rainfall from an observed streamflow using a Monte Carlo method. We apply the method to 202 catchments in France and compare the inferred rainfall with the areal raingage-based rainfall measurements. We show that the inferred rainfall accuracy directly depends on the accuracy of the rainfall-runoff model. Potential applications of this method include rainfall estimation in poorly gaged areas, correction of uncertain rainfall estimates (e.g. satellite-based rainfall estimates), as well as historical reconstitution of rainfall based on streamflow measurements.