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Can we improve streamflow simulation by using higher resolution rainfall information?

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The catchment response to rainfall is the interplay between space-time variability of precipitation, catchment characteristics and antecedent hydrological conditions. Precipitation dominates the high frequency hydrological response, and its simulation is thus dependent on the way rainfall is represented.

One of the characteristics which distinguishes distributed from lumped models is their ability to represent explicitly the spatial variability of precipitation and catchment characteristics. The sensitivity of runoff hydrographs to the spatial variability of forcing data has been a major concern of researchers over the last three decades. However, although the literature on the relationship between spatial rainfall and runoff response is abundant, results are contrasted and sometimes contradictory. Several studies concluded that including information on rainfall spatial distribution improves discharge simulation (e.g. Ajami *et al.*, 2004, among others) whereas other studies showed the lack of significant improvement in simulations with better information on rainfall spatial pattern (e.g. Andréassian *et al.*, 2004, among others). The difficulties to reach a clear consensus is mainly due to the fact that each modeling study is implemented only on a few catchments whereas the impact of the spatial distribution of rainfall on runoff is known to be catchment and event characteristics-dependent. Many studies are virtual experiments and only compare flow simulations, which makes it difficult to reach conclusions transposable to real-life case studies. Moreover, the hydrological rainfall-runoff models differ between the studies and the parameterization strategies sometimes tend to advantage the distributed approach (or the lumped one).

Recently, Météo-France developed a rainfall reanalysis over the whole French territory at the 1-kilometer resolution and the hourly time step over a 10-year period combining radar data and raingauge measurements: weather radar data were corrected and adjusted with both hourly and daily raingauge data. Based on this new high resolution product, we propose a framework to evaluate the improvements in streamflow simulation by using higher resolution rainfall information. Semi-distributed modelling is performed for different spatial resolution of precipitation forcing: from lumped to semi-distributed simulations. Here we do not work on synthetic (simulated) streamflow, but with actual measurements, on a large set of 181 French catchments representing a variety of size and climate. The rainfall-runoff model is re-calibrated for each resolution of rainfall spatial distribution over a 5-year sub-period and evaluated on the complementary sub-period in validation mode. The results are analysed by catchment classes based on catchment area and for various types of rainfall events based on the spatial variability of precipitation.

References

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