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Consistency of internal fluxes in a hydrological model running at multiple time steps

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Improving hydrological models remains a difficult task and many ways can be explored, among which one can find the improvement of spatial representation, the search for more robust parametrization, the better formulation of some processes or the modification of model structures by trial-and-error procedure. Several past works indicate that model parameters and structure can be dependent on the modelling time step, and there is thus some rationale in investigating how a model behaves across various modelling time steps, to find solutions for improvements.
Here we analyse the impact of data time step on the consistency of the internal fluxes of a rainfall-runoff model run at various time steps, by using a large data set of 240 catchments. To this end, fine time step hydro-climatic information at sub-hourly resolution is used as input of a parsimonious rainfall-runoff model (GR) that is run at eight different model time steps (from 6 minutes to one day). The initial structure of the tested model (i.e. the baseline) corresponds to the daily model GR4J (Perrin et al., 2003), adapted to be run at variable sub-daily time steps.
The modelled fluxes considered are interception, actual evapotranspiration and intercatchment groundwater flows. Observations of these fluxes are not available, but the comparison of modelled fluxes at multiple time steps gives additional information for model identification.
The joint analysis of flow simulation performance and consistency of internal fluxes at different time steps provides guidance to the identification of the model components that should be improved. Our analysis indicates that the baseline model structure is to be modified at sub-daily time steps to warrant the consistency and realism of the modelled fluxes. For the baseline model improvement, particular attention is devoted to the interception model component, whose output flux showed the strongest sensitivity to modelling time step. The dependency of the optimal model complexity on time step is also analysed.

References:
Perrin, C., Michel, C., Andréassian, V., 2003. Improvement of a parsimonious model for streamflow simulation. Journal of Hydrology, 279(1-4): 275-289. DOI:10.1016/S0022-1694(03)00225-7