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Initial soil saturation, lead time and river flow predictability with a distributed hydrologic model assimilating discharge data

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Initial condition of soil moisture and lead time are two crucial factors affecting river flow predictability. However, their impact on forecasts accuracy is not straightforward to quantify. In this work, we assess the dependence of forecasting errors from both factors in a distributed hydrologic model assimilating river flow data at multiple locations. The hydrologic model employed, MOBIDIC, is part of the operational forecasting chain for the Arno river in central Italy. The assimilation system adopts a mixed variational-Monte Carlo approach to update efficiently initial river flow, initial soil moisture, and a parameter related to infiltration processes on a distributed basis. Forecasting errors are evaluated in several hindcast experiments that include both high flow events and false alarms (relevant rainfall accumulation but relatively low river flows). The area of study is Arno river basin, which is the main catchment of Tuscany region, Italy. Forecasting accuracy is evaluated as a function of lead time at the various assimilation locations for each event. Overall, accuracy increases as lead time reduces, but with error reduction in respect to open loop significantly dependent on the specific characteristics of the single event. However, the reduction becomes increasingly event-independent as the forecast horizon shortens. Furthermore, results show that the improvement obtainable in respect to open loop is significantly affected by soil saturation level at the initial instant of assimilation. In particular, an initially completely dry or fully saturated soil could be critical in case of, respectively, overestimated or underestimated forecasts. Under such conditions, accuracy may not increase as lead time reduces.