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A hydro-meteorological ensemble prediction system for real-time flood forecasting purposes in the Milano area

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Analysis of forecasting strategies that can provide a tangible basis for flood early warning procedures and mitigation measures over the Western Mediterranean region is one of the fundamental motivations of the European HyMeX programme. Here, we examine a set of hydro-meteorological episodes that affected the Milano urban area for which the complex flood protection system of the city did not completely succeed before the occurred flash-floods. Indeed, flood damages have exponentially increased in the area during the last 60 years, due to industrial and urban developments. Thus, the improvement of the Milano flood control system needs a synergism between structural and non-structural approaches. The flood forecasting system tested in this work comprises the Flash–flood Event–based Spatially distributed rainfall–runoff Transformation, including Water Balance (FEST-WB) and the Weather Research and Forecasting (WRF) models, in order to provide a hydrological ensemble prediction system (HEPS). Deterministic and probabilistic quantitative precipitation forecasts (QPFs) have been provided by WRF model in a set of 48-hours experiments. HEPS has been generated by combining different physical parameterizations (i.e. cloud microphysics, moist convection and boundary-layer schemes) of the WRF model in order to better encompass the atmospheric processes leading to high precipitation amounts. We have been able to test the value of a probabilistic versus a deterministic framework when driving Quantitative Discharge Forecasts (QDFs). Results highlight (i) the benefits of using a high-resolution HEPS in conveying uncertainties for this complex orographic area and (ii) a better simulation of the most of extreme precipitation events, potentially enabling valuable probabilistic QDFs. Hence, the HEPS copes with the significant deficiencies found in the deterministic QPFs. These shortcomings would prevent to correctly forecast the location and timing of high precipitation rates and total amounts at the catchment scale, thus impacting heavily the deterministic QDFs. In contrast, early warnings would have been possible within a HEPS context for the Milano area, proving the suitability of such system for civil protection purposes.