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A European flash flood indicator based on a distributed runoff coefficient

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Europe and more particularly the Mediterranean region are particularly exposed to flash flood hazard. They are usually triggered by a combination of intense precipitation and high runoff production. Recently, a purely rainfall based indicator that provides an early warning for flash floods several days in advance using probabilistic numerical weather prediction has been developed. This indicator, called the European Precipitation Index based on Climatology (EPIC) provides probabilistic forecasts and covers the European part of the Mediterranean 5 days in advance and with a good detection rate up to 3 days as part of the operational European Flood Awareness System (EFAS) [Alfieri 2011, Alfieri 2012]. It consists in summing up at each cell of a 1 x 1 km river network the forecasted rainfall data falling on the whole upstream area for durations of 6, 12 and 24 h and converting these values in return periods originating from a 20 years climatology of the indicator. Computations are performed for catchments with areas up to 5000 km^2 to focus on flash flood prone basins. The main weakness of EPIC is that it is only rainfall based and does not take into account any hydrological features such as slope, land use or initial soil moisture conditions which can have a significant impact on flash flood triggering.
This study proposes an improvement of the EPIC indicator by introducing hydrologically relevant parameters. Making use of the hydrological model set up of EFAS, a soil moisture-runoff relationship is generated for each 5 x 5 km cell of the domain using an automated fitting procedure and the 22 years climatology of the hydrological model LISFLOOD. This relationship is then used to calculated the spatially distributed daily runoff coefficient from the initial soil moisture conditions which are provided on a daily basis by the flood forecasts of EFAS. Downscaling the daily runoff coefficient to the 1 x 1 km river network the different rainfall contributions within a sub catchment can be weighted accordingly. The evaluation of the modified indicator, called ERIC (European Runoff Index based on Climatology), based on several case studies having different hydro-meteorological characteristics indicates that the number of detections has been increased and that the system is more accurate on event locations. ERIC is also able to successfully forecast flash floods due to smaller rain amounts but with saturated soils. The false alarm rate does not show any change. Finally, the signal is more focused on the areas where flash floods were actually reported especially for dry initial moisture conditions.