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Large scale modelling of catastrophic floods in Italy

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The RMS European Flood HD model® is a suite of country scale flood catastrophe models covering 13 countries throughout continental Europe and the UK. The models are developed with the goal of supporting risk assessment analyses for the insurance industry. Within this framework RMS is developing a hydrologic and inundation model for Italy. The model aims at reproducing the hydrologic and hydraulic properties across the domain through a modeling chain. A semi-distributed hydrologic model that allows capturing the spatial variability of the runoff formation processes is coupled with a one-dimensional river routing algorithm and a two-dimensional (depth averaged) inundation model. This model setup allows capturing the flood risk from both pluvial (overland flow) and fluvial flooding.

Here we describe the calibration and validation methodologies for this modelling suite applied to the Italian river basins. The variability that characterizes the domain (in terms of meteorology, topography and hydrologic regimes) requires a modeling approach able to represent a broad range of meteo-hydrologic regimes. The calibration of the rainfall-runoff and river routing models is performed by means of a genetic algorithm that identifies the set of best performing parameters within the search space over the last 50 years.

We first establish the quality of the calibration parameters on the full hydrologic balance and on individual discharge peaks by comparing extreme statistics to observations over the calibration period on several stations. The model is then used to analyze the major floods in the country; we discuss the different meteorological setup leading to the historical events and the physical mechanisms that induced these floods. We can thus assess the performance of RMS' hydrological model in view of the physical mechanisms leading to flood and highlight the main controls on flood risk modelling throughout the country. The model's ability to accurately simulate antecedent conditions and discharge hydrographs over the affected area is also assessed, showing that spatio-temporal correlation is retained through the modelling chain.

Results show that our modelling approach can capture a wide range of conditions leading to major floods in the Italian peninsula. Under the umbrella of the RMS European Flood HD models this constitutes, to our knowledge, the only operational flood risk model to be applied at continental scale with a coherent model methodology and a domain wide MonteCarlo stochastic set.