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A complete meteo-hydrological chain to support early warning systems from weather scenarios to flooded areas: the Apollo medicane use case

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An intense Mediterranean hurricane (medicane Apollo) hit many countries during the last week of October 2021. Up to 7 people died because of the floods caused by the cyclone in Tunisia, Algeria, Malta and Italy. Apollo persisted over the same Mediterranean area from 24 October to 1 November 2021 producing flash-flood and flood episodes with very intense rainfall events, especially over eastern Sicily and Calabria on 25-26 October 2021. CIMA Foundation operated in real-time with a complete forecasting chain to predict both the Apollo medicane weather evolution and its hydrological and hydraulic impacts. The work provides support to the Italian Civil Protection Department early warning activities and in the framework of the H2020 LEXIS and E-SHAPE projects. The complete meteo-hydrological forecasting chain is composed by the cloud-resolving WRF model assimilating radar data and in situ weather stations (WRF-3DVAR), the fully distributed hydrological model Continuum, the automatic system for water detection (AUTOWADE), and the hydraulic model TELEMAC-2D. This work presents the forecasting performances of each model involved in the CIMA meteo-hydrological chain, with focus on both very short-range temporal scales (up to 6 hours ahead) and short-range forecasts (up to 48 hours ahead). The WRF-3DVAR model results showed very good predictive capability of the most intense rainfall events in terms of timing and location over Catania and Siracusa provinces in Sicily. Thus, enabling also very accurate discharge peaks and timing predictions for the creeks hydrological network peculiar of eastern Sicily. Starting from the WRF-3DVAR model predictions, the daily AUTOWADE tool run using Sentinel-1 (S1) data, was anticipated with respect to the scheduled timing to quickly produce a flood map (S1 acquisition performed on 25 October 2021 at 05UTC, flood map produced on the same day at 13UTC). Furthermore, an ad hoc tasking of the COSMO-SkyMed satellite constellation was performed, again based on the on the WRF-3DVAR predictions, to overcome the S1 data latency on eastern Sicily during the period 26-30 October 2021. Finally, the resulting automated operational mapping of floods and inland waters was integrated with the subsequent execution of the hydraulic model TELEMAC. Due to the probable frequency increase of such extreme events (in light of the ongoing climate change), the application of a complete meteo-hydrological chain presented in this work can pave the way for future applications in early

warning activities in the Mediterranean areas.