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Impact of sea surface temperature representation uncertainty on operational hydrometeorological forecasts over coastal Mediterranean catchments

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When intense air-sea exchanges combine to deep interaction with complex orography, quantitative precipitation forecast becomes even more challenging. The complexity of such kind of scenario, rather common in the Mediterranean area, is often not fully interpreted by regional models, leading to relevant errors also in the forecast of the hydrological response, especially in areas characterized by complex morphology with several small-to-medium sized catchments. The issue is addressed from different perspectives, from theoretical models enhancements to strategies for fully exploiting available observations in various data assimilation techniques.

This study focuses on the impact of different accuracy levels of SST representation on operational meteorological-hydrological forecasting chains over coastal Mediterranean catchments. Specifically, two severe hydro-meteorological events affecting Calabria Region (Southern Italy) on 2015, the former characterized by convective, very localized in time (August 11-12) and space precipitation and the latter by more persistent (October 30-November 2) and widespread stratiform precipitation, are analyzed.

For the analysis of both events, the atmosphere-hydrology modeling system WRF-Hydro is used in its uncoupled version with a 2 km-resolution for the innermost domain and a 200 m-resolution for the hydrological model. Four reference forecasts are achieved with initial and lateral atmospheric boundary conditions given by both the 0.5° and the 0.25° output resolution GFS grid dataset, the 16 km resolution ECMWF's Integrated Forecasting System (IFS) and, for comparison, the 0.75° ERA-INTERIM reanalysis. Then, in different steps, both initial and lower boundary SST data are replaced with the Medspiration L4 Ultra-High Resolution SSTfnd from the Medspiration Project by IFREMER/CERSAT (with 24 hour time resolution and 2.2 km spatial resolution) and the European Ocean-Sea Surface Temperature MultiSensor L4 Three-Hourly Observations (averaged every 6 hours and with a 2 km spatial resolution) provided by CMEMS. Precipitation estimates are compared with both ground-based data and a product merging ground observations to estimates from a National Civil Protection Department single-polarization Doppler radar. Impacts on discharges of several rivers and creeks affected by the extreme precipitation events are also assessed.

Results highlight in both cases that IFS boundary conditions outperform GFS boundary conditions and related forecasts are comparable or even better than ERA-INTERIM-driven results. Concerning the convective event, deterministic 48 hours ahead forecasts show that a more accurate representation of SST fields in both space and time leads to precipitation patterns more consistent with observations, but not necessarily improves hydrological forecasts, since such patterns are not yet as accurate as needed for the several small-sized coastal catchments in the analyzed area. In the stratiform event, 96 hours ahead meteo-hydrological forecasts perform rather well, especially in the most rainy areas, not depending too much on the accuracy of SST representation, highlighting that in such case, beyond the role that high-resolution SST can assume in improving short-range weather and hydrological forecasts, current level of accuracy is already acceptable for Civil Protection purposes.