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Radar-driven High-resolution Hydrometeorological Forecasts of the 26 September 2007 Venice flash flood

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Space and time scales of flash floods are such that flash flood forecasting and warning systems depend upon the accurate real-time provision of rainfall information, high-resolution numerical weather prediction (NWP) forecasts and the use of hydrological models. Currently available high-resolution NWP model models can potentially provide warning forecasters information on the future evolution of storms and their internal structure, thereby increasing convective-scale warning lead times. However, it is essential that the model be started with a very accurate representation of on-going convection, which calls for assimilation of high-resolution rainfall data. This study aims to assess the feasibility of using carefully checked radar-derived quantitative precipitation estimates (QPE) for assimilation into NWP and hydrological models. The hydrometeorological modeling chain includes the convection-permitting NWP model COSMO-2 and a hydrologic-hydraulic models built upon the concept of geomorphological transport. Radar rainfall observations are assimilated into the NWP model via the latent heat nudging method. The study is focused on 26 September 2007 extreme flash flood event which impacted the coastal area of north-eastern Italy around Venice. The hydro-meteorological modeling system is implemented over the Dese river, a 90 km2 catchment flowing to the Venice lagoon. The radar rainfall observations are carefully checked for artifacts, including beam attenuation, by means of physics-based correction procedures and comparison with a dense network of raingauges. The impact of the radar QPE in the assimilation cycle of the NWP model is very significant, in that the main individual organized convective systems were successfully introduced into the model state, both in terms of timing and localization. Also, incorrectly localized precipitation in the model reference run without rainfall assimilation was correctly reduced to about the observed levels. On the other hand, the highest rainfall intensities were underestimated by 20% at a scale of 1000 km2, and the local peaks by 50%. The positive impact of the assimilated radar rainfall was carried over into the free forecast for about 2-5 hours, depending on when this forecast was started, and was larger, when the main mesoscale convective system was present in the initial conditions. The improvements of the meteorological model simulations were directly propagated to the river flow simulations, with an extension of the warning lead time up to three hours.