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On the use of high resolution atmosphere-ocean-wave coupled model to describe a flash-flood event over the North-East Italy

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Many studies have focused on the SST role and effect in convective and highly-localized intense events that originate nearby coastal areas. This specific case study deals with a “flash-flood” event that took place in the Venice lagoon region on September 26, 2007. As described by Davolio et al. (2009), the whole event was due to the convergence between dry and cold air coming from the Alps with warmer and more humid air traveling from the south Adriatic. The clash of these two different air masses happened to be near the coast line, and activated an intense thunderstorm. The storm activity persisted in the generation area for about 6 hours and caused accumulated precipitation around 340 mm over localized area. The purpose of this work is the detailed study of this event with the aid of the modeling suite COAWST (Couple Ocean Atmospheric Wave Sediment Transport system), in order to identify the importance of the various oceanic components: Sea Surface Temperature (SST), mixed layers depth and waves. COAWST provides the coupling of WRF (Weather Research ad Forecasting) atmospheric model, ROMS (Regional Oceanographic Model) ocean model and SWAN (Simulating Wave in Nearshore) wave model. The configuration of the WRF grid is composed by 3 domains at 9 km-3 km-1km of horizontal resolution. ROMS and SWAN models were run at a 1 km resolution with computational grid that cover all the Adriatic Sea. Using a standard configuration, the first phase of the study used WRF in "standalone model", using the SST obtained from the spectrum-radiometer RTG_SST at 8.3 km resolution. As a second step, the same WRF numerical configuration used WRF received the SST derived from “uncoupled” ROMS simulation (produced by a long “spin-up” over the same grid used for the coupling at 1 km of horizontal resolution). In the third stage of the work, coupled numerical runs WRF-ROMS (run AO) and WRF-ROMS-SWAN (run AOW) were performed. The results suggests that the use of high-resolution SST is a good approach to increase the performance of the models but only coupled numerical runs can reproduce vertically both the deep convection process that characterize the event (showing high vertical velocities even in the higher atmosphere) and the reflectivity high values, structured in a single cell in the area of the event. Humidity in higher levels suggests that uncoupled runs maintain a moisture distribution above the PBL characterized by a dry-air tongue, that limits the convection. Differently, in the coupled runs not only the humidity distribution above the PBL is evident, but values within the PBL as well are well marked. We can therefore conclude that coupled numerical models can represent a valid support for the accurate forecast of such extreme events, at least in proximity of coastal regions. They can indeed provide a more energetically consistent system, capable of transferring more heat and moisture in the lower and medium atmosphere. However, further analysis are required to confirm the findings here discussed. Numerical runs were performed thanks to the CINECA grant ISCRA C “COMARE”.