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Modelling a Tropical Like Cyclone in the western Mediterranean sea: a sensitivity study using a coupled atmosphere-ocean-wave approach

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Between the 4th and 10th of November 2011 a cut-off low developed in the western Mediterranean, parted from the Atlantic flow and evolved into a Tropical-Like Cyclone (TLC) around the Balearic Islands, where it persisted for three days. Between 12:00 UTC on 06 Nov and 12:00 UTC on 09 Nov, the TLC generated intense winds, heavy rainfall and waves up to 8 meters. To investigate the drivers of this event we ran a set of numerical simulations over the entire Mediterranean basin and extending to the "European" Atlantic ocean in order to account for the effects of the Atlantic circulation on the Mediterranean region. Different initial conditions, nesting and model coupling strategies have been tested with the COAWST system, which includes an atmospheric (WRF), an ocean circulation (ROMS), and a wave (SWAN) model, and pushing the horizontal grid spacing down to 5x5 km. Since the cyclone developed southern of the Iberian Peninsula and the Pyrenees, the sensitivity to topography was also explored. The results of the numerical experiments demonstrate how this event is strongly influenced by the initialization strategy and the balance of the initial fields with respect to the marine conditions and topography. In particular, two-way coupling the atmospheric model with ocean and wave models showed that the interaction with waves in the presence of a detailed SST fields can modify the distribution of heat fluxes, rainfall and horizontal pressure gradient. Also the 10 meters wind is conditioned by the coupling and by the wave-induced roughness patterns, especially in the southern part of the basin where the larger fetch produces more developed sea for the study of the case. The effect of atmosphere-ocean-waves interactions associated to the TLC is also pronounced in the marine variables, resulting in a decrease of SST and Mixed Layer thickness along the trajectory of the cyclone.