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Numerical analysis of a Mediterranean Hurricane coupling the SWAN, WRF and WRF-Chem models: investigation of feedbacks among sea spray, drag coefficients, and latent heat flux

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Occasionally, cyclones with tropical-like characteristics, sometimes called as Medicanes, are observed in the Mediterranean. Due to the intense wind forcing and the consequent development of high wind waves, a large number of sea spray droplets are likely to be produced at the sea surface. On the other side, it is known that Medicane intensity is sensitive to fluxes of momentum and enthalpy between the ocean and atmosphere in the high wind core of the storm. It has been recognized that much of this exchange between ocean and atmosphere is likely mediated by sea spray. In particular, the enhancement of sea-air enthalpy flux under severe wind speed is supplied by sea spray that produces the large amount of heat necessary to generate and maintain the hurricane core. Laboratory studies, numerical spray droplets models and observations have proved that sea spray can redistribute enthalpy between the temperature and humidity fields in the marine boundary layer. In particular, the role of re-entrant spray particles, the portion of spray that fall back into the sea, have the important effect of cooling the ocean thus representing a net enthalpy flux to the atmosphere.
This work represents an integrated numerical study utilising the third-generation wave model (SWAN) two-way coupled with the Weather Research and Forecasting Model, running in both stand-alone configuration (WRF) and integrated with the chemistry package (WRF-Chem). The latter is configured using GOCART aerosol module, which explicitly consider the emission and transport of sea spray aerosol. An additional sea spray source function for severe wind conditions has been implemented in the WRF-Chem model under the GOCART aerosol module. The operative sequence is performed considering the offline coupling sequence: first SWAN with WRF, and then SWAN with WRF-Chem. With this sequence, there is a full consistency between the wind field and wave geometry.
A test is performed considering the Medicane occurred in South-Eastern Italy on September 26, 2006. This Medicane is one of the most deeply analyzed in literature, so that an intensive investigation of the feedbacks between sea-spray, drag coefficients and latent heat flux may be made considering our integrated approach in comparison with its known features.