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Analysis of tropical-like cyclones over the Mediterranean Sea through a combined modeling and satellite approach

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Vortices with characteristics similar to tropical cyclones, such as spiral-like cloud bands and the presence of an "eye", are occasionally observed in satellite images over the Mediterranean. Among these cyclones, twenty-eight cases occurred after 1999 are selected as candidates having tropical dynamical features, i.e. an upper-level warm, symmetric core, and are analyzed by means of numerical simulations and satellite products.
Numerical simulations have been performed with the Weather Research and Forecasting (WRF) model. The analysis in terms of Hart (2003) parameters shows that only 14 of these cyclones show tropical features. Also, simulations reveal that the analyzed cases have very different properties, ranging from very small and weak vortices to larger and stronger cyclones. The analysis of the tracks identifies two preferred areas of occurrence, the Ionian Sea and the Balearic Islands. Tropical features are generally present for a limited number of hours. A specific case, the cyclone that affected the western part of the Mediterranean in November 2011, displays a much longer persistence of tropical features than the other events (about 60 hours).
Anyway, the method adopted for the analysis of these cases suffers from the limitation that just one simulation is performed for each case. In particular, the set of parameterization schemes selected for the experiments, and the initial conditions used to force the model may significantly affect the results. For these reasons, for the very well documented case of September 2006, a set of sensitivity experiments to different parameterization schemes and to different starting times is additionally performed. Results show that, at least for this case study, the presence of tropical features is only weakly affected, with microphysics schemes having a stronger impact.
The microwave precipitation retrieval method 183-WSL (Laviola and Levizzani, 2011) is then used to describe the characteristics of these storms by analyzing evolutionary stage in terms of cloud development, precipitation regime and type (convective/stratiform). In particular, the satellite analysis of cloud top height and retrieved rainfall indicates that the stage characterized by the most intense convective activity and rainfall anticipates the mature phase, when the cyclone is more intense and characterized by tropical features, during which convection is shallower and rainfall weaker. This result is also confirmed by a preliminary analysis of the lightning activity.

Bibliography:
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