A process-based anatomy of the dynamical structure of Mediterranean cyclones

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Abstract
According to the invertibility property of potential vorticity (PV), a surface cyclone can be regarded as the outcome of a set of PV anomalies. Therefore, quantifying the contribution of different atmospheric processes to PV is equivalent to delineating the contribution of these processes to a cyclone’s dynamical structure. In this study we analyse the dynamical structure of Mediterranean cyclones, defined by the horizontal and vertical distribution of PV near the cyclones’ centres. Using a modelling technique, PV structure is decomposed into a non-adiabatic component and several diabatic ones, generated by heating/cooling due to radiation, turbulent fluxes of temperature, frictional forces and convection.

An ensemble of 100 intense Mediterranean cyclone cases have been selected from a dataset composed by all tracked Mediterranean cyclones in a 10-year period, from 2008 to 2017. These cyclones have been simulated using the WRF model (v4.0) and their process-based PV budget has been analysed in detail. We show that Mediterranean cyclones present a high variability of dynamical structures, where several processes are capable of both positive and negative feedbacks on the intensification of cyclones. In particular, we discuss the role of latent heat to intensify Mediterranean cyclones, as well as its potential use for distinguishing tropical-like cyclones (medicane) from other intense systems.