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From baroclinic to barotropic: the evolution of Medicane Cornelia

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The Mediterranean Basin is a very cyclogenetic area with more than 100 cyclones developing on average every year, most of which evolve as baroclinic, mid-latitude disturbances. There is, however, a restricted group of cyclones that acquire barotropic characteristics during their development. Given their similarities with hurricanes they are generally referred to as “medicanes”. They can be associated with severe wind gusts and intense rainfall and represent a serious threat to coastal areas.

Medicane Cornelia (6-10 October 1996) formed in the western Mediterranean Sea, under the influence of a large, cut-off low in the upper levels located over the Iberian Peninsula. It is the longest-lived among the recorded medicanes. In this work, a domain shifting method is used to initialize full-physics ensemble simulations of Cornelia using COSMO-CLM. Different atmospheric states are obtained by integrating the model over domains that are shifted with respect to each other. This enables us to stress the relevance of dynamical and thermodynamical mechanisms involved in the tropical transition of Cornelia. Cyclones in the ensemble exhibit significant differences both in their structures and in their temporal evolutions. A comparison of the ensemble members shows that medicanes develop from a baroclinic, frontal system, located to the east of the cut-off low, that undergoes warm seclusion. A first intensification stage occurs during the seclusion process, a second one takes place after the cyclones crossed Sardinia.

Convection is known to be a crucial mechanism in the tropical transition process, both in terms of shear reduction and contribution to sea-level pressure fall via latent heat release. During warm seclusion, a bent-back occluded front develops and a pocket of warm air is secluded from the warm sector. Remarkable differences in the vertical motions are found along the developing bent-back front in each member. Cyclones that feature stronger bent-back fronts show more intense convection and larger diabatic heating, resulting in a faster sea-level pressure minimum deepening. The interaction of cyclones with the complex topography of Sardinia appears to be responsible for the differences in the second intensification stage.