Plinius Conference Abstracts
Vol. 12, Plinius12-108
12th Plinius Conference on Mediterranean Storms
Corfu Island Greece, September 2010

Application of factor separation to heavy rainfall and cyclogenesis events: Mediterranean examples

R. Romero
University of the Balearic Islands, Spain (Romu.Romero@uib.es)

The Mediterranean basin is an ideal atmospheric research "laboratory" recognized as one of the main cyclogenetic areas in the world. Much of the high impact weather affecting its coastal countries (notably strong winds and heavy precipitations) has been statistically associated with the near presence of a distinct cyclonic signature. The numerical modelling of these atmospheric circulations is the most powerful tool available to scientists to develop a better physical understanding of the responsible mechanisms. In particular, many studies have used this potential to isolate the role played by different physical factors by means of the factor separation technique. Boundary factors (e.g. orography and latent heat flux from the Mediterranean) and model physics factors (e.g. latent heat release in cloud systems) have been typically considered. Different results about the role of both types of factors in Mediterranean flash flood events will be shown and discussed.

Comparatively less attention, however, has been paid to the effects due to internal features of the flow dynamics (jet streaks, troughs, fronts, etc) probably because, unlike the boundary of model physics factors, modifying or switching off these elements in the simulations is not straightforward. The three-dimensional nature and mutual dependence of pressure, temperature and wind fields pose serious constraints on the ways these fields can be altered without compromising the delicate dynamical balances that govern both the model equations and actual data. It will be presented a relatively clean approach to deal with these dynamical factors, based on the concept of potential vorticity (PV) and its invertibility principle. The role of upper-level precursor disturbances on heavy rain producing western Mediterranean cyclones will be studied by this PV inversion method.

Finally, the applicability of the factor separation method to the study of extratropical cyclones in a framework which does not involve numerical model simulations will be highlighted. Specifically, an experimental design which implements quantitatively the PV thinking concepts will be presented. It is based on a prognostic system of balance equations that are consistent with the PV inversion method. By switching on and off the PV anomalies of interest, different flow configurations are generated and the corresponding solutions to the prognostic equations can be algebraically combined to isolate the magnitude of both the individual and synergistic effects of the PV anomalies on the spatial pattern of geopotential height tendency –and vertical motion– around the cyclone, with the additional advantage of its low computational cost. The potentialities of this novel approach to elucidate the impacts and interactions of the undulating tropopause, the low-level baroclinicity and the latent heat release on a deep Mediterranean cyclone will be discussed in this talk.