Geophysical Research Abstracts
Vol. 12, EGU2010-13039-1, 2010
EGU General Assembly 2010

Idealized numerical study of Mediterranean heavy precipitating events : identification of favoring ingredients

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During the fall, in the western Mediterranean region, Heavy Precipitating Events (HPEs) frequently occur and can cause torrential rain and flash-floods. They are often generated by Meso-scale Convective Systems (MCSs) which are back-building phenomena with a continuous convective cell renewal. The meteorological ingredients favouring these MCSs are quite well-known : a slow-evolving synoptic environment associated with conditional convective instability, low-level moist flows from the sea and an orographic barrier. Moreover previous studies have identified the three main mechanisms of deep convection triggering and maintaining of such event as low-level convergence, orographic forcing and Low-Level Cold Pool (LLCP). Understanding how these ingredients impact the mechanisms combination and interaction to produce more or less precipitation with different locations of MCSs (over the mountain, upstream over the plains or the Sea) is still an open question. This study focuses over Southeastern France, which is the most affected area of this country. It contributes to address this question, based on high-resolution idealized simulations of MCSs over this region, for which the intensity of the flow, the environmental humidity and the orography alternatively vary. To identify the prominent mechanisms, Lagrangian backward trajectories and Eulerian passive tracers are used and budgets are also performed to highlight the water vapour role in the intensification of MCS precipitation.

The location and intensity of the Mediterranean quasi-stationary MCSs do not depend on an unique combination of deep convection triggering mechanisms. Thus the environmental characteristics impact on the deep convection mechanisms and consequently on the behaviour of the MCS. Slower flow speeds or dryer environments generate a quasi-stationary MCS over the sea. In these cases, deflection around the relief is larger and in turn increases the low-level convergence over the sea. Due to under-saturated lower-levels, precipitation can more easily evaporate and form a LLCP which acts in lifting the low-level moist and instable air masses at its leading edge. Orographic forcing becomes predominant for faster or moister flows, thus the system settles over the mountain range and its precipitation intensity is strongly related to the low-level water vapour supply.

This study helps to identify the impact of environmental ingredients on the behaviour of MCSs and define regions and mechanisms that are important to better document during the HyMeX Special Observation Period.