# The severe thunderstorm of 4$^{th}$ October 2007 in Mallorca

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Climatologically, October is the rainiest month in the Balearic Islands, and the period from September to November exhibits the annual maximum in thunderstorm occurrence. Very occasionally these thunderstorms attain severe characteristics, mainly in the form of convective downbursts, hail falls and tornadoes. In spite of its high potential impact, these extreme phenomena have been of weak magnitude, or quite localized in space and time or have not affected densely populated areas. A statistical assessment of tornadoes for the 1989-1999 period shows, for instance, that out of the 27 recorded events only one reached the F3 intensity in the Fujita scale (most lie in the F0-F1 category), their paths rarely exceeded 8 km and no injuries or fatalities can be attributed to them. A notable exception to this phenomenology is the squall line that affected the island of Mallorca in the afternoon of 4$^{th}$ October 2007: severe straight-line winds hit extensive areas as the storm entered the island from the south and progressed northward at a speed of 80 km/h, and post-storm surveys of ground effects indicate the coexistence of one or several tornadoes of F2-F3 intensity embedded within the parent system. Since this thunderstorm crossed Palma city (400.000 inhabitants), the associated violent winds led to unprecedented traffic and social disruptions, huge economical losses and even one fatality. An observational description and some preliminary numerical simulations of this severe convective storm are presented.

Remote sensing products display the long-lasting nature and high degree of organization of the storm, which initiated offshore Murcia (mainland Spain) 300 km away from Mallorca, almost 5 hours before affecting the island. The most clearly defined linear structure of the system, of about 20-30 km length, and the coldest cloud tops, associated with impressive overshooting tops, are observed at the time when the thunderstorm was approaching the bay of Palma from the south. The episode occurred under a synoptic scenario dominated by an upper-level trough over mainland Spain and warm and moist advection at low-levels driven by a weak low pressure area located to the southwest of the islands. This scenario is known to be conducive to deep convection and sometimes flash-floods in Mediterranean Spain, especially in the early autumn when SST values are very high. The simultaneous presence on 4$^{th}$ October 2007 of a southwesterly upper-level jet and warm African air surge over the western Mediterranean Sea is also related with the genesis of gravity waves which were able to trigger convection. Indeed, satellite images show that the severe episode was preceded by a train of convective systems evolving over the region from southwest to northeast. High frequency pressure oscillations registered at several automatic weather stations and the occurrence of atmospherically forced seiches at Ciutadella harbor (Menorca) -locally known as “rissagues”- confirm the occurrence of high-amplitude gravity waves. Of particular relevance among the information extracted from the weather stations is the signature of a pre-squall mesolow shortly preceding the onset of heavy rain and strong winds as well as a post-squall mesohigh, as it has been documented in previous case studies. On the other hand, the analysis of the few available neighbor soundings shows some particular features of convective environments such as an “onion-shape” temperature/dewpoint vertical profile in the lower troposphere; the bulk of calculated instability indices does not suggest, however, the likelihood of severe convection.

Finally, numerical simulations of the event attempted with MM5 and WRF models illustrate the complexity of the problem, arising from the small-scale of the convective system and its fast genesis and evolution over the data-void Mediterranean area. Standard simulations with both models fail to capture the event and only a specifically designed WRF simulation operating at very high resolution is able to provide indication of a significant convective storm over Mallorca, albeit with appreciable temporal shift. New simulations involving assimilation of plausible triggering factors (e.g. outflow boundaries from previous convection, thermal and moisture mesoscale fronts, etc) in the model initial conditions, are planned for the future.