Mediterranean Storms
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A SPRING CASE OF HEAVY RAINFALL IN THE BALEARICS: A PRELIMINARY STUDY

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ABSTRACT

From the 6th to the 8th of May 2002, an episode of heavy rainfall occurred in the West Mediterranean area, strongly affecting the east coast of the Iberian Peninsula and the Balearic Islands (especially Ibiza). Extremely high precipitations for this month were registered. Both a synoptic and a mesoscale study of the situation are presented and the role of an intense Mediterranean cyclone on the generation of large maxima of moisture convergence is explored. In this case, deep convection is not present as it usually is in autumn heavy rainfall Mediterranean episodes.

1 INTRODUCTION

It is a well known fact that most of the heavy rainfall episodes in the Mediterranean occur in autumn. At that time of the year, the water content of the warm Mediterranean air mass is usually very large and it is concentrated in the lowest layer, which favours convective instability (*Jansà*, 1997). However, on some occasions important amounts of precipitation are registered during the rest of the year. In this episode, up to 130 mm were recorded in Ibiza island, where the average rainfall for the month of May is of approximately 25 mm. With the help of radar images, observations and operational HIRLAM_INM 0.5º analysis we have tried to find the most important factors which were responsible for these precipitations.

2 OBSERVATIONS

In Ibiza, the precipitation event began in the morning of May 6, lasting until the evening of the 7th. Rainfall intensity was not too strong, however the rain fell in a continuous and persistent way, especially between 18 UTC of May 6 and the 7th in the morning (see figure 1). In fact, 24-hour accumulated rainfall was greater than historical maximum for May at seven of the nine rain gauges in Ibiza island. Return periods of precipitations registered in rain gauges with more than 32 years, calculated until May 2001, are greater than 30 years (even up to 70 years for Ibiza airport), indicating the extraordinariness of this event.

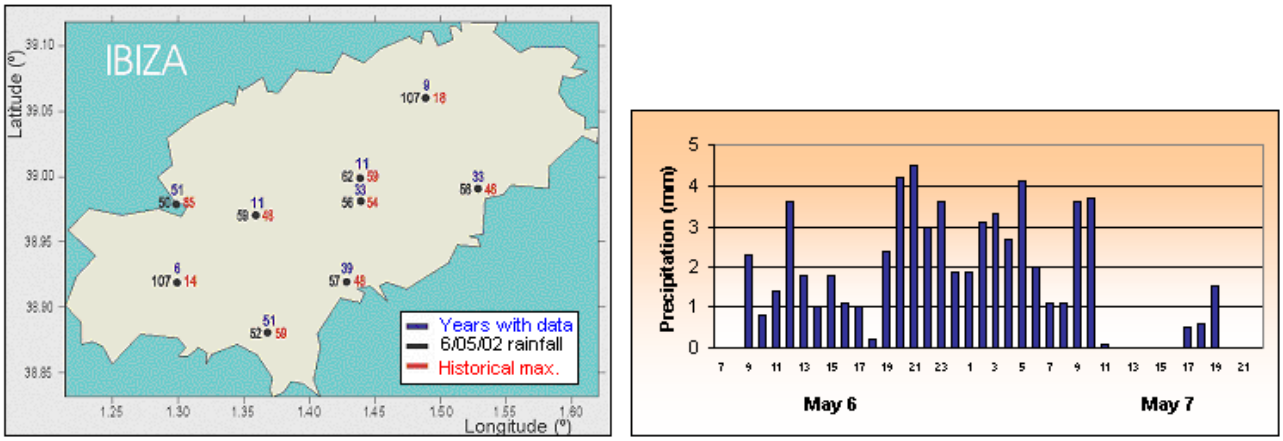

Figure 1. On the left, 24-hour accumulated rainfall for the 6th versus historical maximum for May (both in mm) at the nine rain gauges in Ibiza island. On the right, hourly accumulated rainfall at Ibiza airport during the 6th and the 7th of May; the vertical axis represents the precipitation registered during the previous hour of the time that appears in the horizontal axis.

Observations proved that atmospheric instability was not too significant: less than 5 mm/hour of rainfall intensity, radar echotops of only 5-6 km, no electric discharges registered near Ibiza and 500 hPa temperatures very similar to climatological medium values, according to atmospheric soundings at Palma de Mallorca.

During the whole episode, the wind blew with a constant ENE direction in Ibiza. In the evening of the 7th, the wind direction suddenly changed from 70º to 270º, bringing along the end of the rainfall event.

3 SYNOPTIC ENVIRONMENT

In the evening of the 5th of May 2002 a high level perturbation coming from the Atlantic Ocean reached the African coast and set over a surface low previously established in Algeria, at the lee side of the Great Atlas. During the 6th the system evolved into a well developed cyclone, remaining almost stationary for the first 6 hours of the day and beginning a slow northeastern movement towards the Algerian coast at 12 UTC (see figure 2). The deepening of the surface low continued until 18 UTC. At this time the surface pressure at the low center fell to the minimum value of the episode, below 992 hPa (shown in figure 3). The whole cyclone began then a slow decay that continued during the following days, affecting the Eastern Communities of the Iberian Peninsula. In the evening of the 7th the system moved into the West Mediterranean, rapidly crossing over the Balearic Islands and heading towards Cataluña. This produced a sudden westerly flow over Ibiza which brought along the end of the rainfall event in the island.

During the precipitation episode, the synoptic environment at 850 hPa in the area of interest was characterized by a constant warm advection (see top right corner in figure 2), with an easterly flow which was gradually increasing its speed up to 40 kt. At 500 hPa (bottom left), both a geopotential and a thermal trough were present, with quite an important vorticity advection at high levels (bottom right).

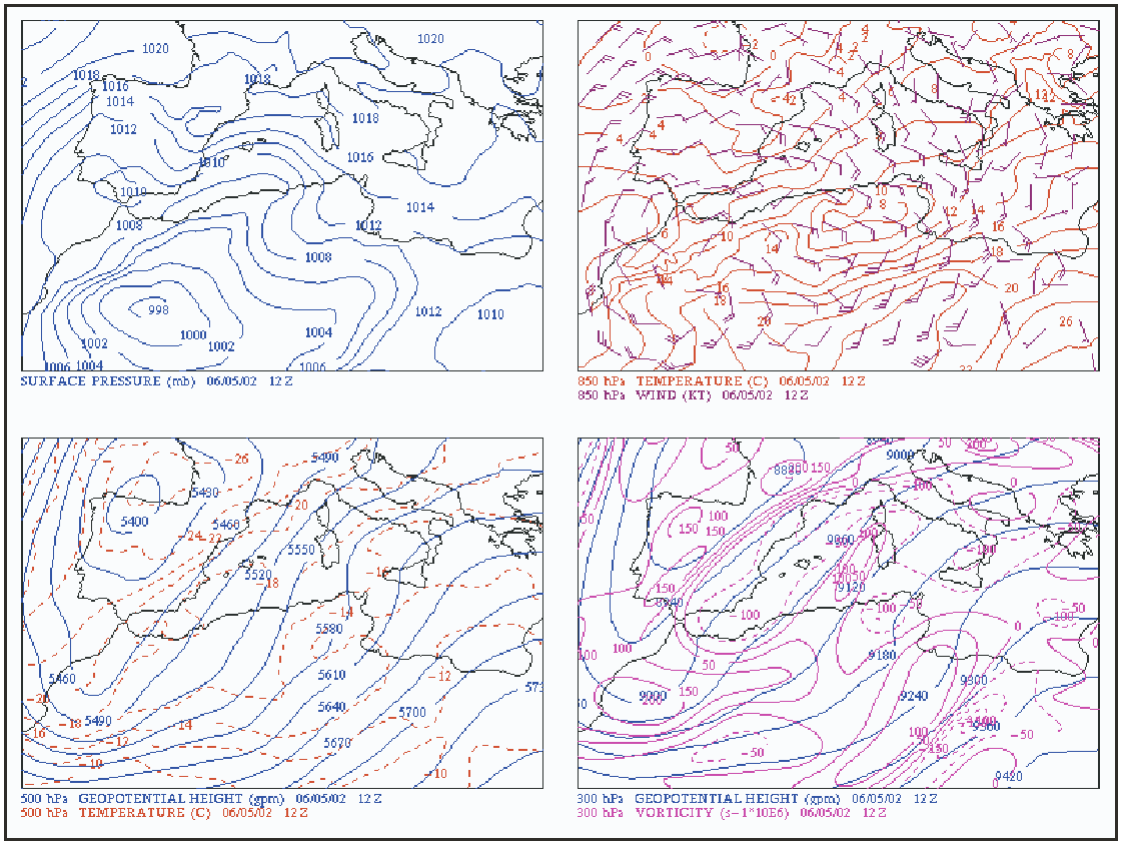

Figure 2. Operational HIRLAM_INM 0.5º analysis at 12 UTC, 6th of May 2002.

4 MESOSCALE FORCING INGREDIENTS

The large scale system established a persistent southerly flow against the mountains in northern Algeria, which induced a dipolar perturbation in the sea-level pressure field, its negative part being a well defined small low at the lee side (*Bessemoulin et al.*, 1993), over the sea (visible in figure 3, top left corner). This low pressure center was strong enough to canalize the flow in the proximities of the Balearic Islands, resulting in a persistent easterly wind that blew intensely. Between the islands and the Iberian Peninsula, the flow turned to NNE and it suffered the blocking of the orography over mainland (the blocking ridge is well defined in SLP analysis of 18 UTC, May 6, taking in the eastern edge of the peninsula, as shown in figure 3). All of this resulted in a strong low level frontal convergence (similar to

that explained in *Ramis et al.*, 1994) close to Ibiza and over the sea, of an almost saturated warm easterly flow and a cold northeasterly low level jet (see figures 4 and 5).

The concurrence of these focusing elements was constant during the night while the macroscale environment slowly changed. The flow distribution and the moisture feeding at low levels were maintained; the convergence line remained therefore almost stationary (see moisture convergence and radar image in figure 3). This explains the fact that most of the rain fell over Ibiza during the night in a continuous and efficient way.

At 06 UTC of May 7 the situation started to change in Ibiza and the major forcing ingredients occurred over the coast of the peninsula (see right graphic in figure 5). At 10 UTC in the morning the rain stopped at Ibiza Airport and in most of the island, while it kept raining in Mallorca during the day.

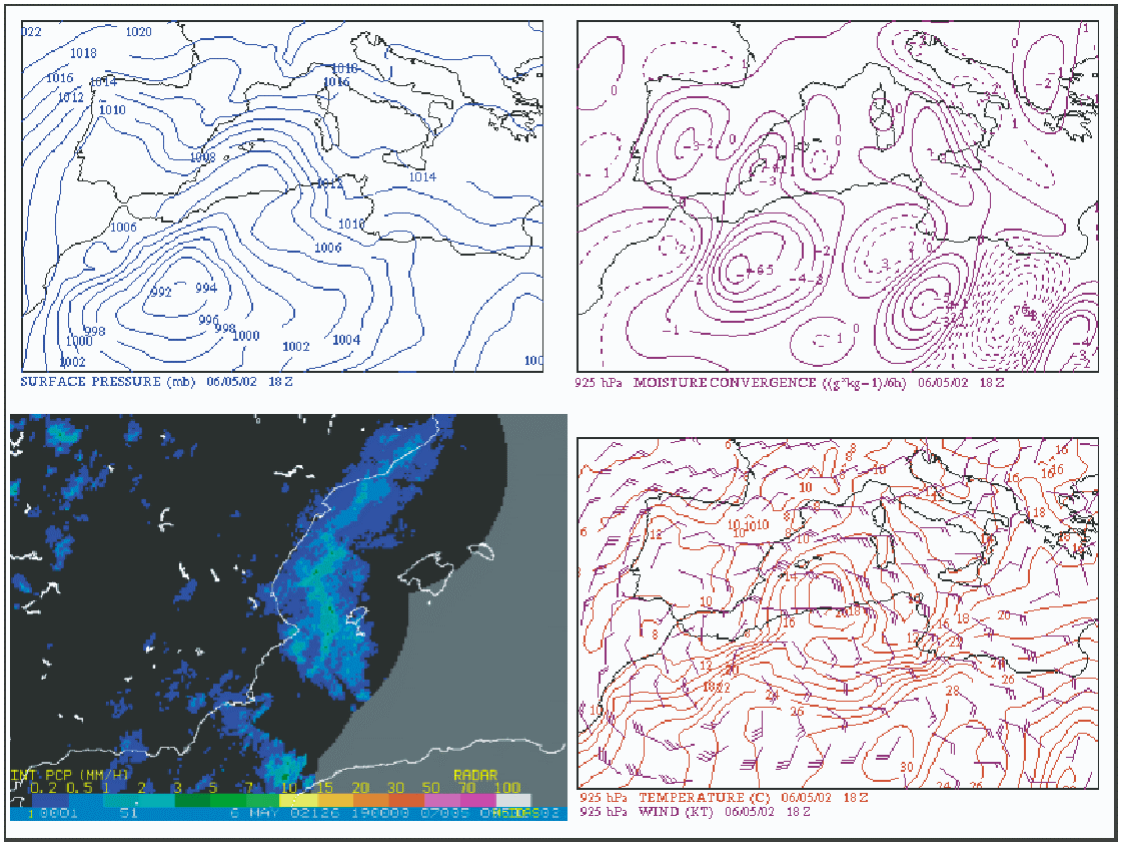

Figure 3. Hirlam analysis at 18 UTC and radar image at 19 UTC, 6th of May 2002.

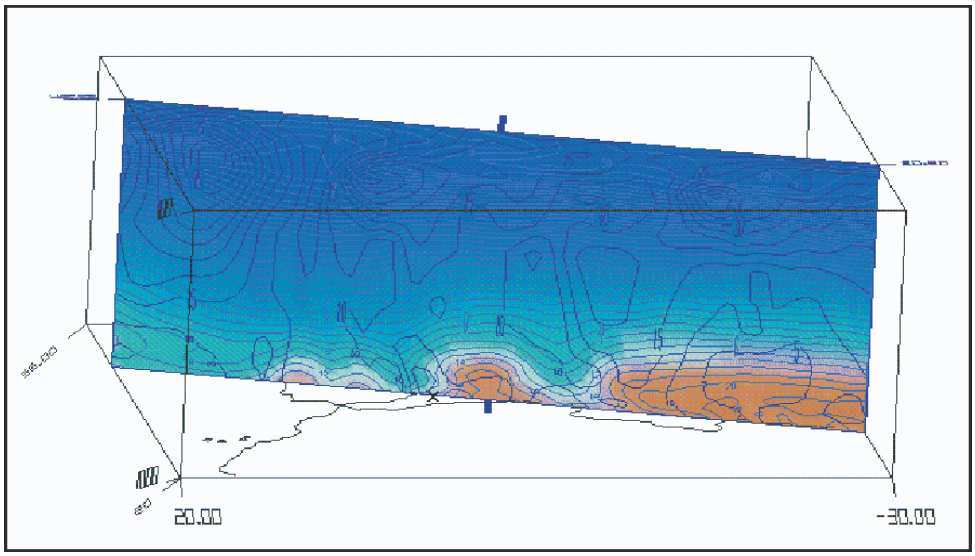

Figure 4. Vertical cross-section of temperature (light blue) and wind isothacs (dark blue) along a line that crosses Ibiza, 06/05/2002 at 18 UTC. Contour intervals, 2ºC and 5 m/s, respectively. Lower temperatures in dark blue and higher temperatures in red.

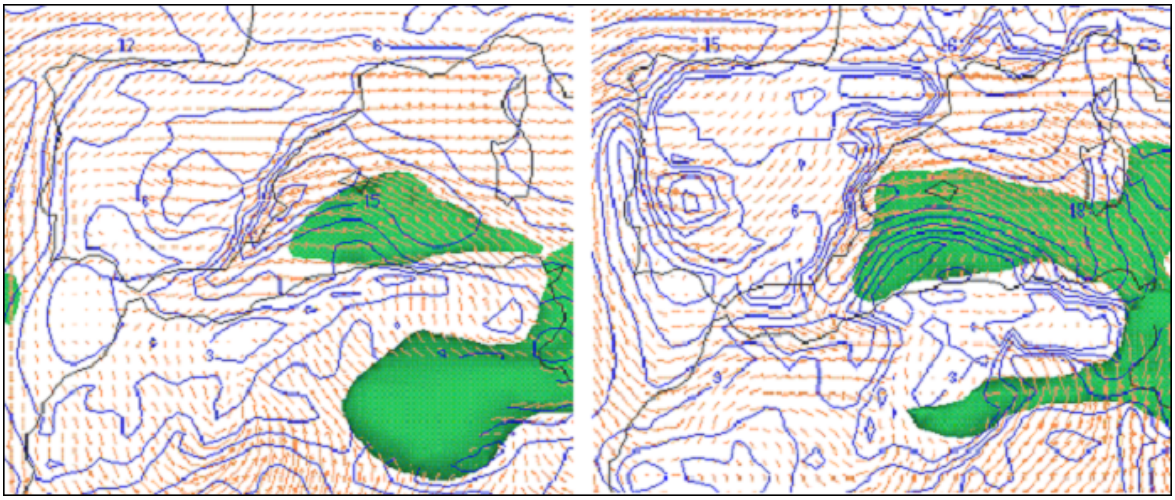

Figure 5. On the left, May 6 at 18 UTC; on the right, six hours later, May 7 at 06 UTC. Wind vectors in orange and wind isothacs in dark blue, both at 925 hPa. In green, 13 ºC dew point isosurface.

5 SUMMARY AND CONCLUSIONS

A description of an episode of heavy rainfall with historical maximum values for 24-hour accumulated precipitation in Ibiza has been presented. Although weak in intensity, the rainfall pattern was distinguished by its persistence. Observations and operational HIRLAM_INM 0.5º analysis proved that atmospheric instability was not too significant.

The synoptic environment was characterized by a well developed cyclone at all levels, thus creating a favourable high scale setting for rainfall and moderate winds. A persistent convergence of an almost saturated warm easterly flow with a cooler and less humid northeasterly low level jet generated a frontal zone between Ibiza and the Iberian Peninsula, which triggered and sustained the upward flow for over 12 hours.

Therefore, in a favourable synoptic environment, the mesoscale structures generated due to the interaction of a high scale flow with local orography are able to focus the convergence in a specific area. Furthermore, if the adequate moisture and temperature conditions at low levels are present, these structures can determine the precipitation area.

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