AN ADAPTATION OF THE OBJECTIVE CYCLONE DETECTION ALGORITHM TO A MEDICANE EVENT

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Although tropical-like cyclones rarely affect the Mediterranean region, they can produce extremely strong winds. These warm-core cyclones, called MEDICANES (MEDIterranean hurriCANES) are small size, tend to develop over the sea and are infrequent. For these reasons, the detection and forecast of medicanes is a difficult task and much efforts have been devoted to identify them. In this sense five criteria had been established by some authors to define a medicane from the satellite images and a first data base of twelve medicanes had been derived from the IR image data (1982-2005) of Meteosat satellite: cyclone eye clarity, symmetric shape, continuous cloud cover, diameter less than 300-km and lifetime greater than 6 hours.

The goal of this work is to establish a first step to assess the capability of the numerical models to simulate a medicane event and to develop some criteria to identify medicanes from numerical model outputs. To do that, a method for detection and tracking of the Mediterranean cyclones has been adapted to small-scale intense cyclonic perturbations. The procedure has been applied to a numerical simulation output of the tropical-like cyclone that affected the Balearic Sea on September 12th 1996, a medicane selected from satellite-derived data base. This simulation has been done with the ECMWF operational model (T1279L91Cy36r1, grid length 15km). The suitability of the presented objective detection of medicanes from numerical model outputs is evaluated.

MEDICANE EVENT

On 12th of Setember 1996 a small quasi-tropical cyclone formed in the gulf of Valencia and later affected Balearic Islands. This cyclone crossed the island of Mallorca with an intense fall of pressure, observed in the pressure recording of Palma, and strong winds recorded on the island. From the radar images an eye of clear air sourrounded by a circular wall of cumulonimbus. The cyclone moved to East - North-East, from Valencia to Sardinia.

This event has been simulated with the ECMWF operational model T1279L91Cy36r1, grid length 15km. A method for detection and tracking of the Mediterranean cyclones has been adapted to small-scale intense cyclonic perturbations. First, the algorithm has been modified to properly describe these small cyclones. Next, some parameters have been tuned to discriminate between medicanes and other small cyclones.

The procedure has been applied to the numerical simulation output of this tropical-like cyclone,a medicane selected from satellite-derived database. The predicted cyclone and its evolution has been compared against some available observational data:

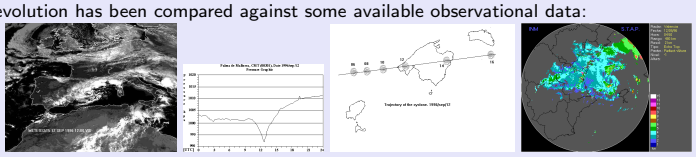


Fig.1 VIS Meteosat image 12UTC, pressure recording in Palma, observed medicane track, radar image, echotop 0450UTC (from Gili et al.1997)

MEDICANE DETECTION

The minima of the mean sea level pressure (MSLP) fields are selected as possible medicanes if their pressure gradient overcomes a threshold value, $\nabla p \geq 1{,}5hpa/100km$.

The cyclone domain is limited by zero-vorticity line. The vorticity field is particularly sensitive to the presence of very small structures in the pressure field, because they are amplified to obtain the vorticity field and can mask the features of the cyclone. The Cressman filter smoothing technique performs a distance-weighted average of mslp with all neighbors points within a radius rcr and is used to eliminate these disturbances. A smoothing of 50 km radius (blue line in Fig.2) has been applied, in an attempt to correctly describe small vortices. With a more intense smoothing (red, green and turquoise lines), whith a larger radius, the pressure away from the value of the original field and the domain assigned to the cyclone is larger.

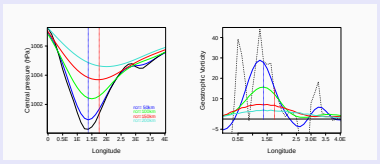
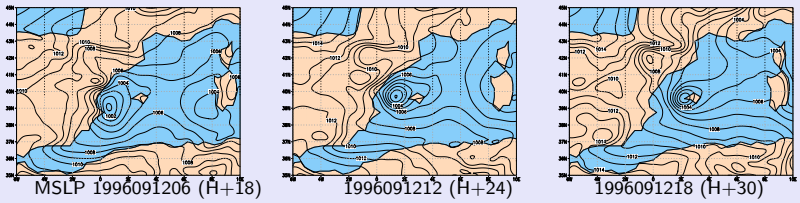


Fig2. Longitudinal section of pressure and geostrophic vorticity with different filters



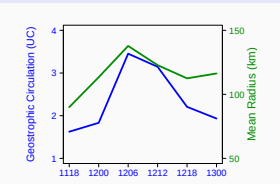
MSLP 1996091206 (H+18) 1996091212 (H+24) 1996091218 (H+30)

The model is able to simulate an intense cyclone but never reached the pressure drop recorded in Palma.

SUMMARY

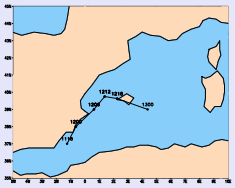
- The model is able to simulate the medicane, but not with strength enough and with a time lag regarding to the observacions.
- Some criteria have been established to detect and characterize this medicane. However these thresholds must be validate with other medicane events. Probably,with a more realistic simulation of the medicane event the criteria may be more exigent and discriminant of other small cyclones.
- Once the procedure is set to describe the medicanes features, it may contribute to obtaining a medicane databasefrom event simulations or from high resolution operational numerical models.

FEATURES AND TRACKING



The cyclone is small, with a mean radius between 90 - 140 km. The maximum strength is arreached at 06UTC.

From the comparison of the cyclone track against the track from observations (fig1) it can be established that the medicane evolution is delayed 6 hours. At 12UTC the medicane reaches Mallorca but in the MSLP chart is located at West of island.



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IDENTIFICATION OF WARM CORE

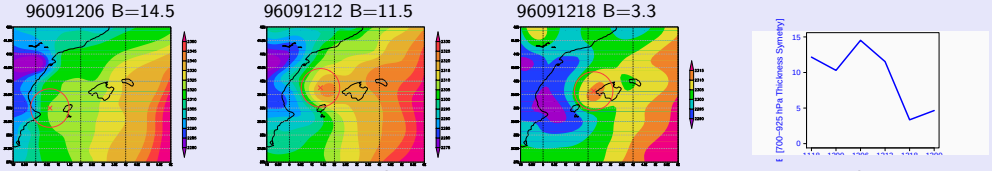
The frontal nature of the cyclone (or lack thereof) and its sign are fundamental indictors of the type of cyclone and the stage of evolution. This frontal nature is defined by Hart as the storm-motion-relative 900-600 hPa thickness asymmetry across the cyclone within 500-km radius, measured by the parameter B:

$B = |(Z_{600} - Z_{900})_L - (Z_{600} - Z_{900})_R|$ L: left, R: right

Thermal sym → non frontal cyclone → $B < 10$
Thermal asym → frontal cyclone → $B > 10$

In this work, a first step to identify a possible warm core structure within the small quasi-tropical cyclone has been to analyse its 700-925 thickness structure (equivalent to its thermal structure). A radius of 100-km is used in this case.

96091206 B=14.5 96091212 B=11.5 96091218 B=3.3



In this simulation a warm core is observed at 12UTC, although the value of B is still more than 10. At 18UTC parameter value is 3.3, low value according with the mature stage of the medicane.

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