

Tropical-like storms in the Mediterranean Sea: mini-cyclones

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A satellite image of a cyclone over the Mediterranean region. The cyclone is characterized by a dense, swirling cloud structure with a bright white eye in the center. The surrounding clouds are dark and textured, indicating intense weather conditions. The landmasses of the Mediterranean basin are visible in the background, with the sea appearing as a lighter gray area.

Names:

Mini-cyclones

Hurricane-like storms

Tropical-like cyclones

Warm core cyclones

MEDiterranean-hurriCANES: MEDICANES

... in the Mediterranean

A satellite image of a tropical cyclone, showing a well-defined eye and spiral cloud bands over the Indian Ocean. The cyclone is centered in the lower right quadrant of the image. The surrounding ocean surface shows some cloud cover and wave patterns.

Some cases

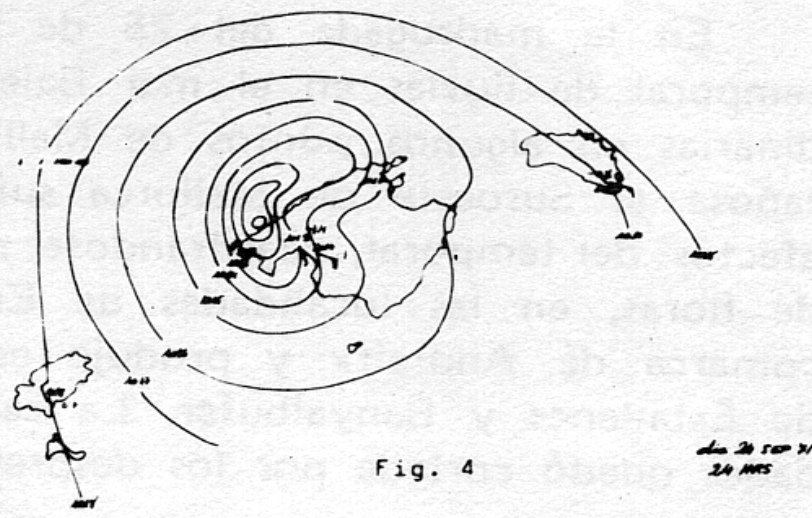
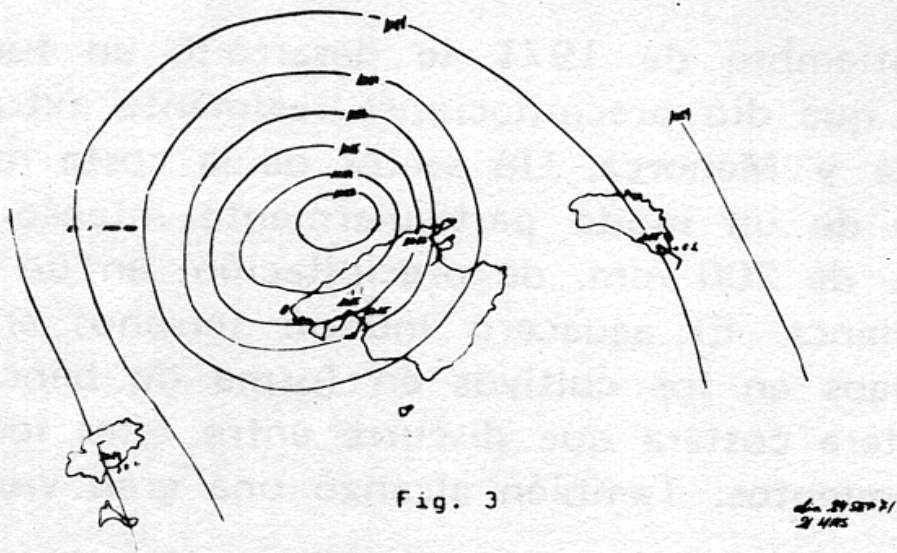
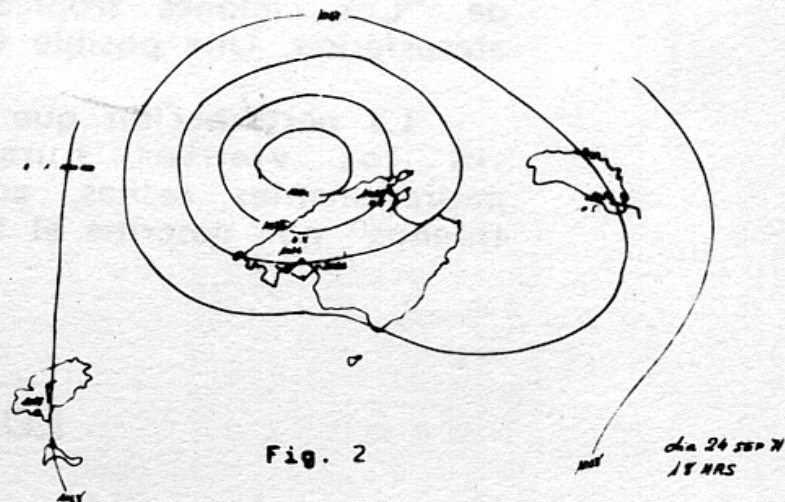
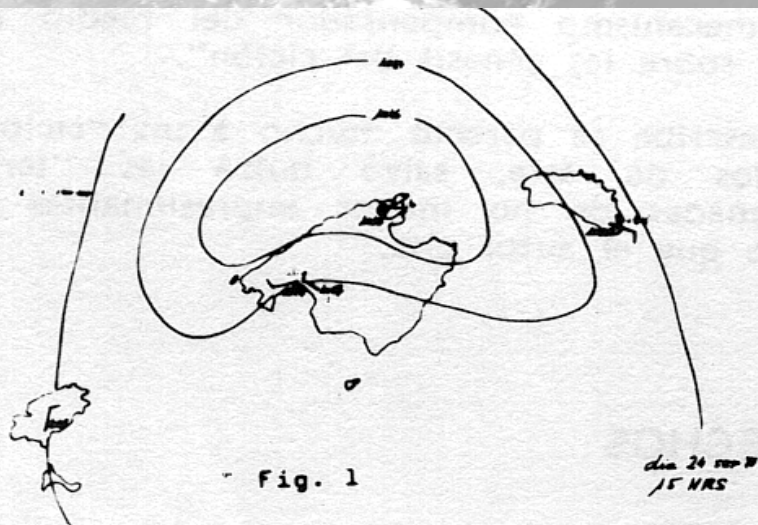
Characterisation

Frequency

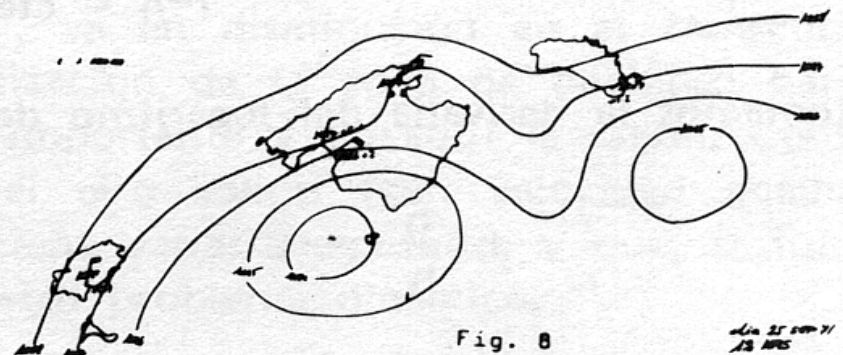
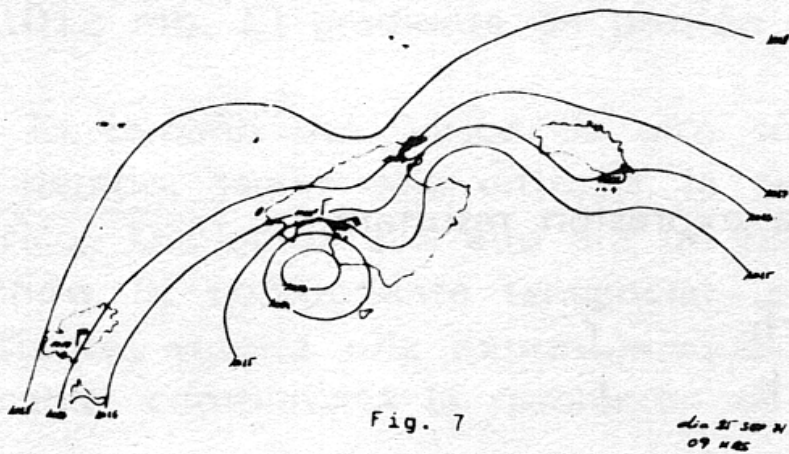
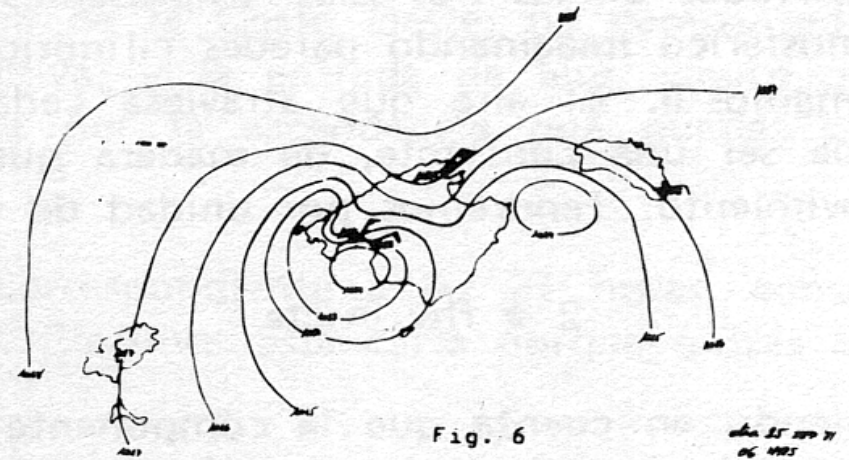
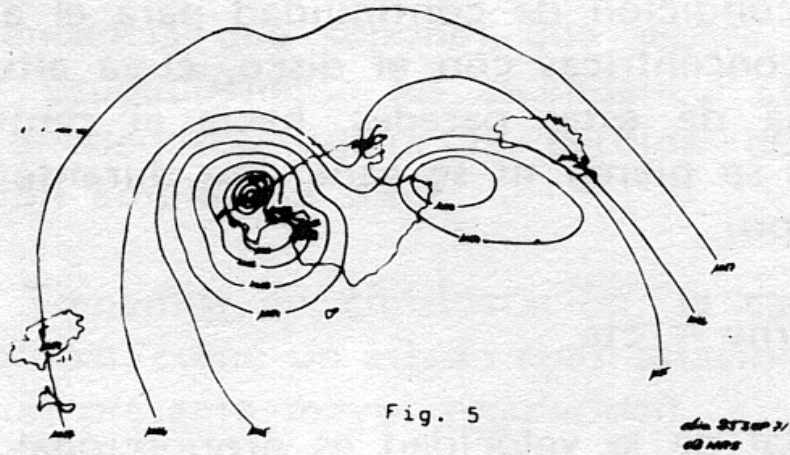
Mechanism

Forecasting

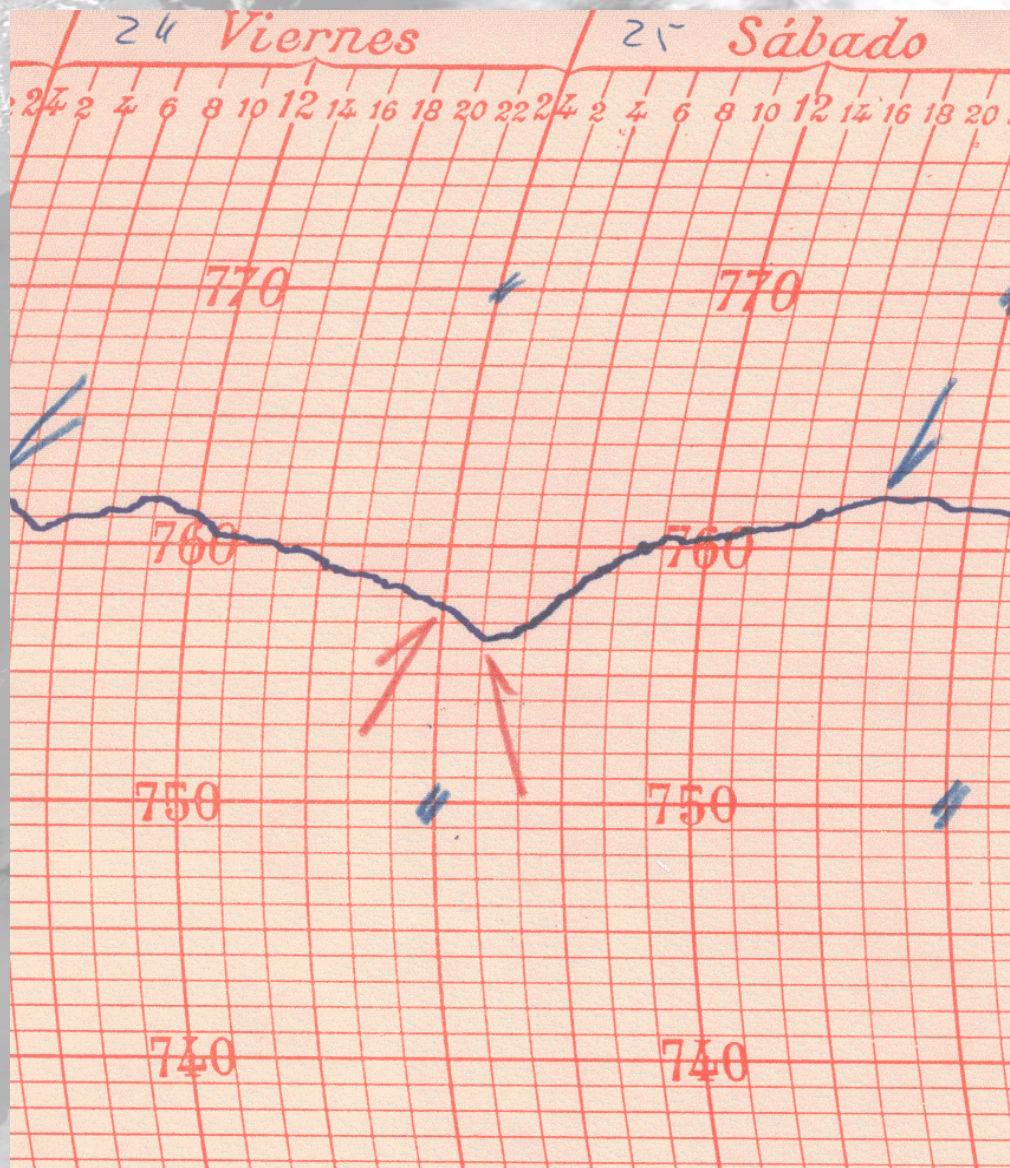
Hypothetic mini-cyclone, 24-25 September 1971



Hypothetic mini-cyclone, 24-25 September 1971



Hypothetic mini-cyclone, 24-25 September 1971

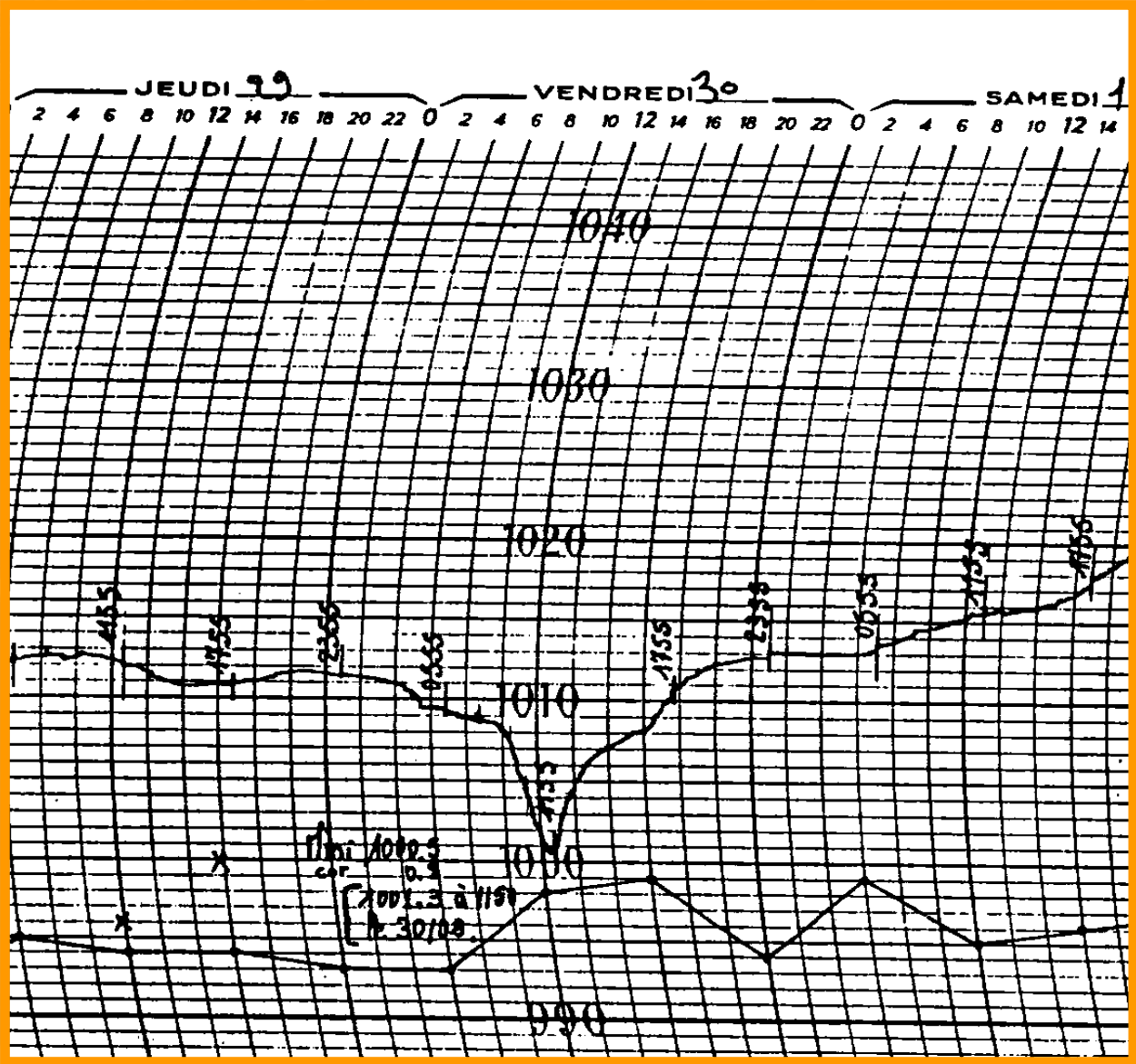


Mini-cyclone at Ajaccio: 30 September 1983

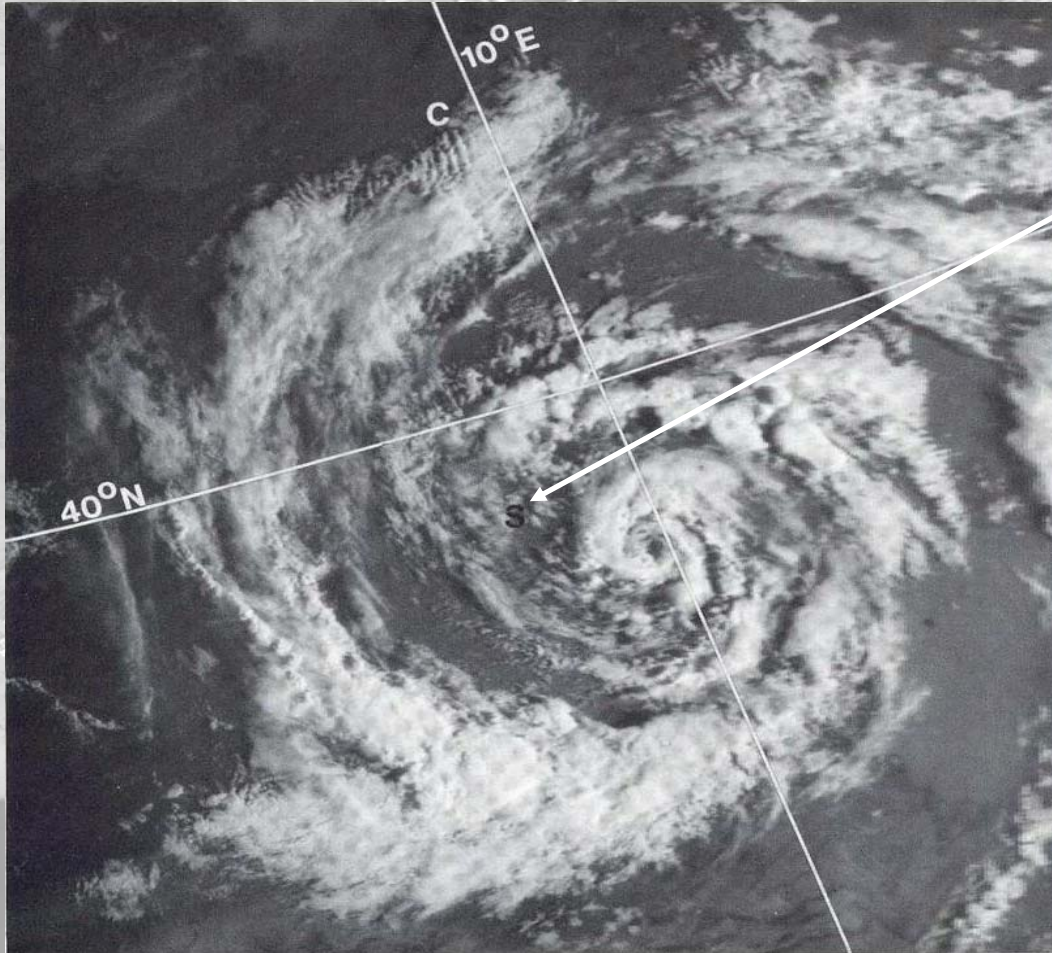


From Palma, we have denied the Navy warning about the approaching of a "tropical" cyclone

Mini-cyclone at Ajaccio: 30 September 1983



Mini-cyclone at Ajaccio: 30 September 1983



NOAA-7

28 Sept 83, 08:07

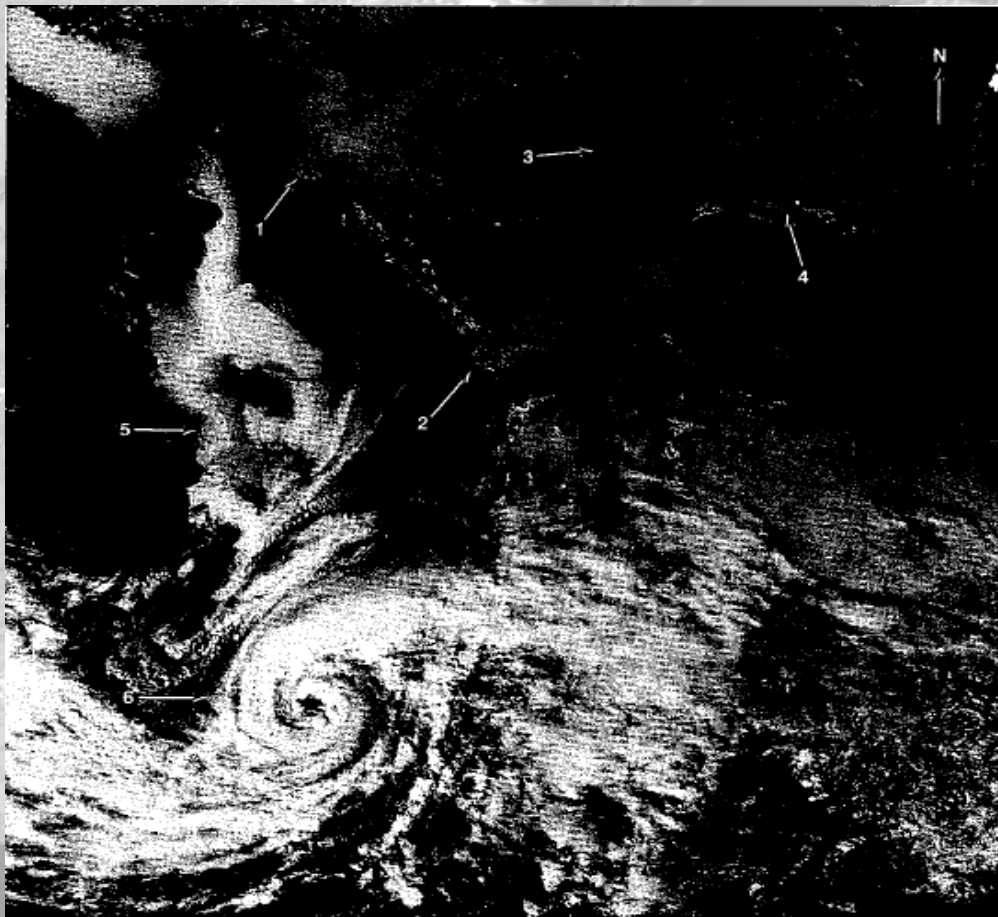
Near South Sardinia ("S")

(from Rasmussen&Zick, 1987)

Second case under study:

Mayençon, 1983

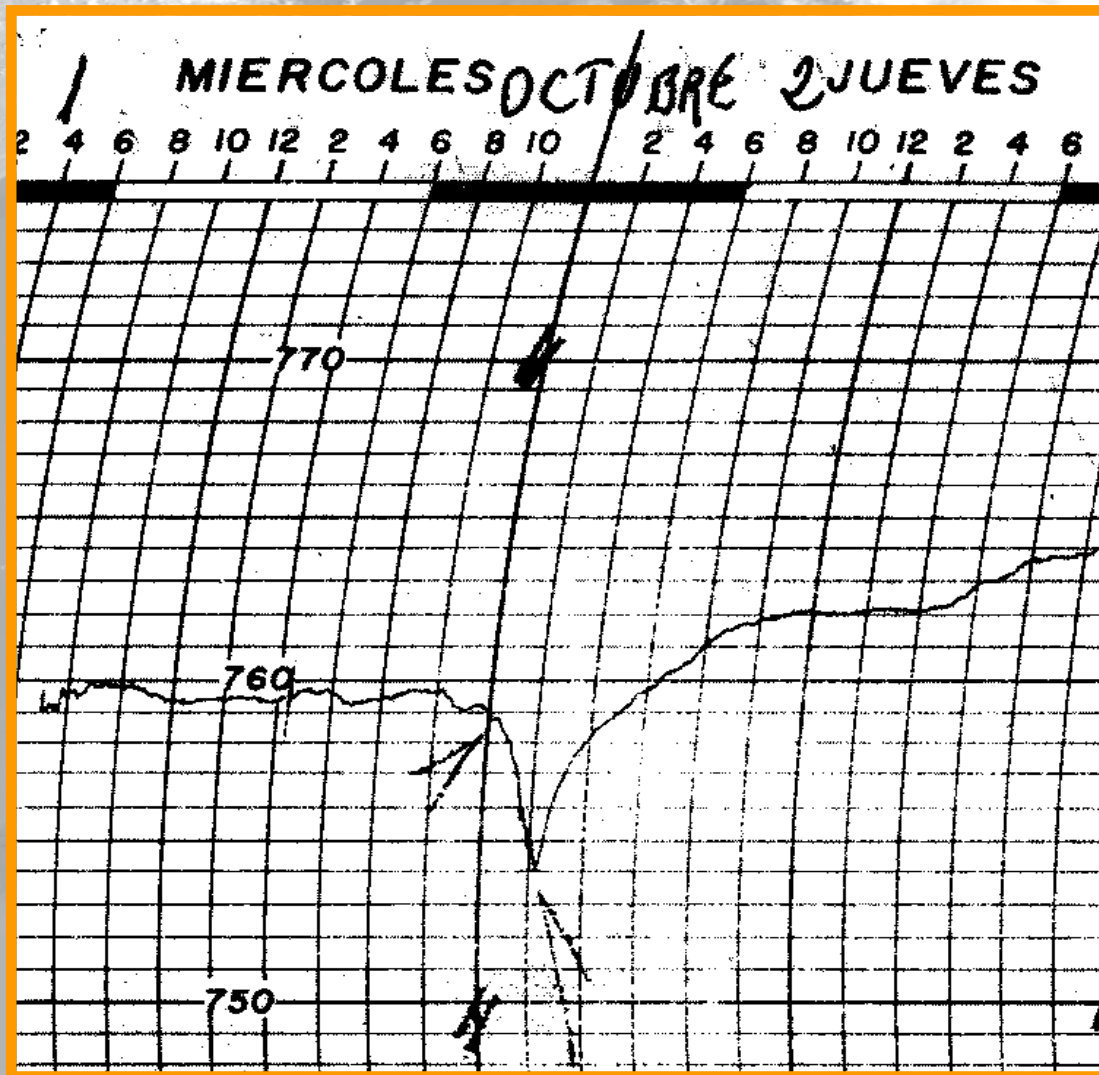
Rasmussen&Zick, 1987



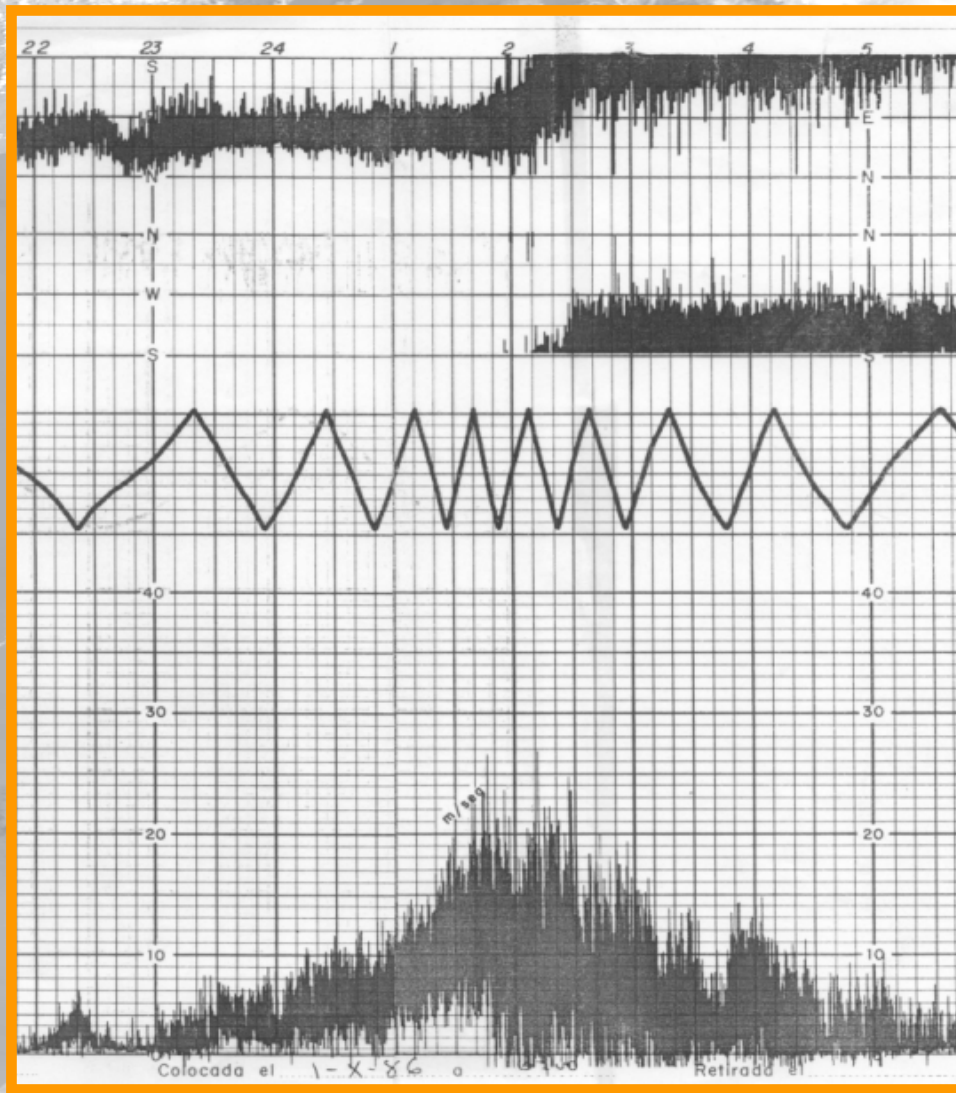
Apart from the hypothetical case of Sep 71, the first case under study was in the Eastern Mediterranean, on 26 Jan 1982

**Ernst & Matson, 1983
(*Weather*)**

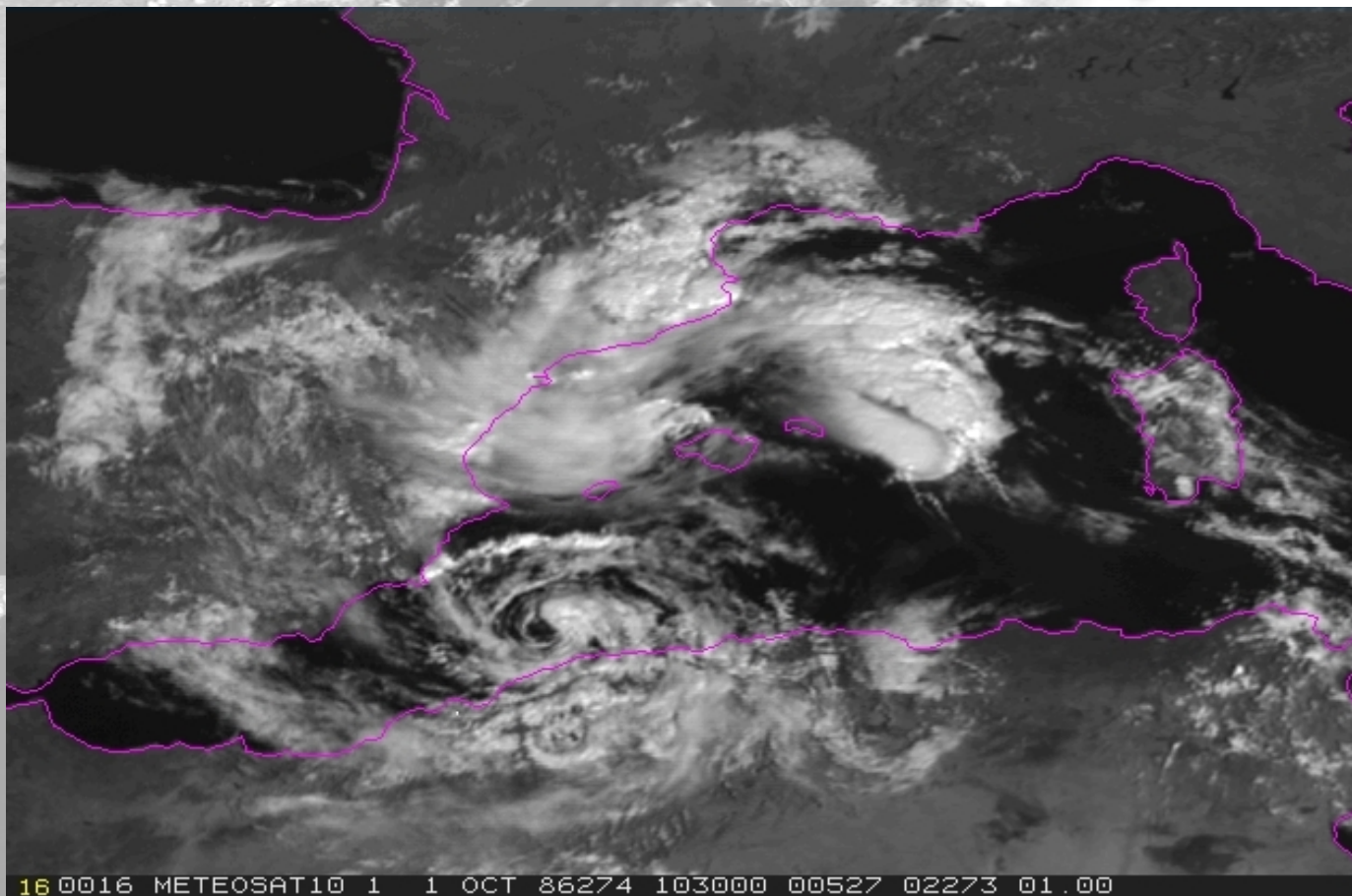
Mini-cyclone at Palma: 2 Oct 1986



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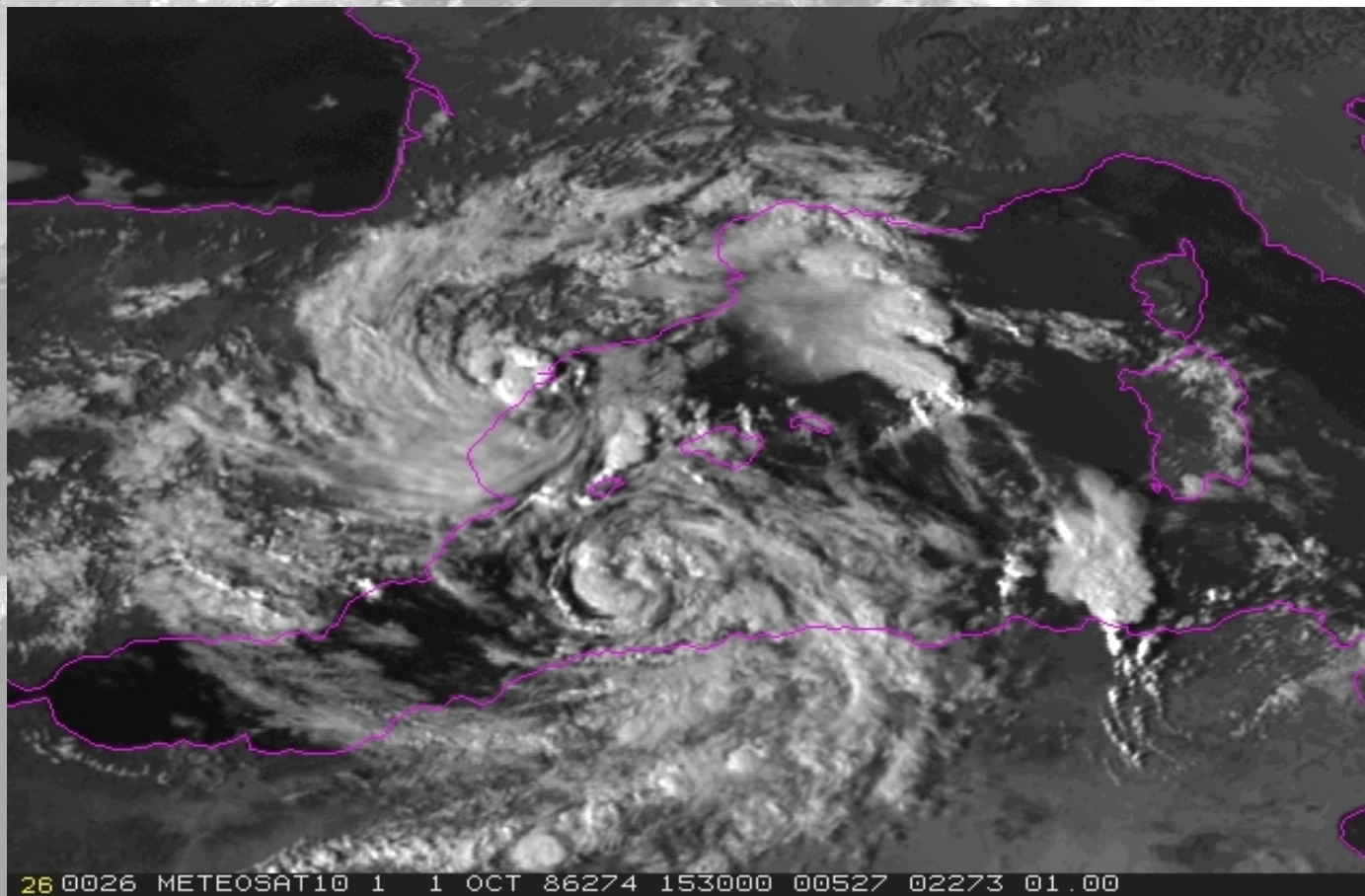


Mini-cyclone at Palma: 2 Oct 1986



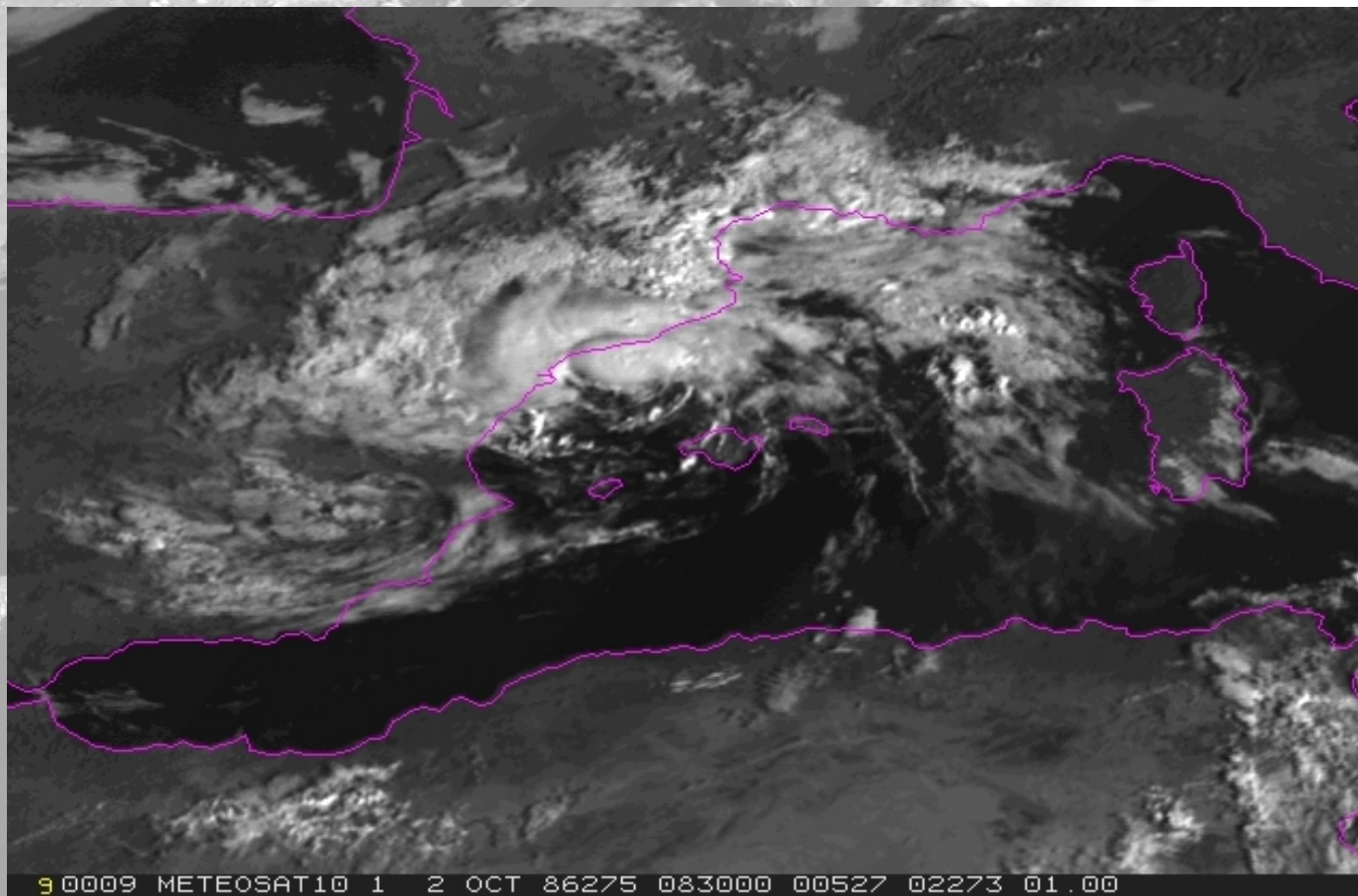
images from the UIB "medicanes" web

Mini-cyclone at Palma: 2 Oct 1986



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Mini-cyclone at Palma: 2 Oct 1986



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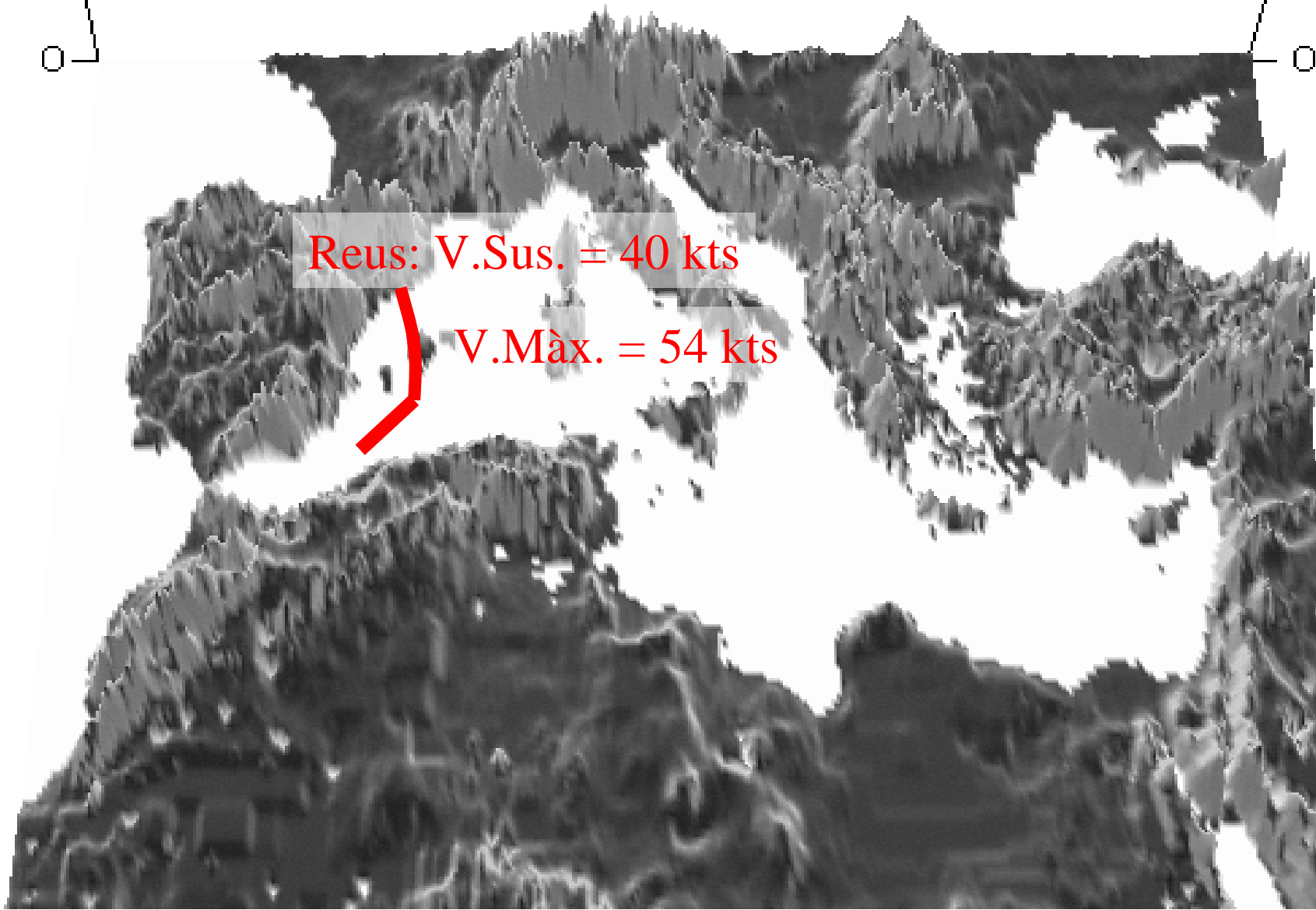
Reus: V.Sus. = 40 kts

V.Màx. = 54 kts



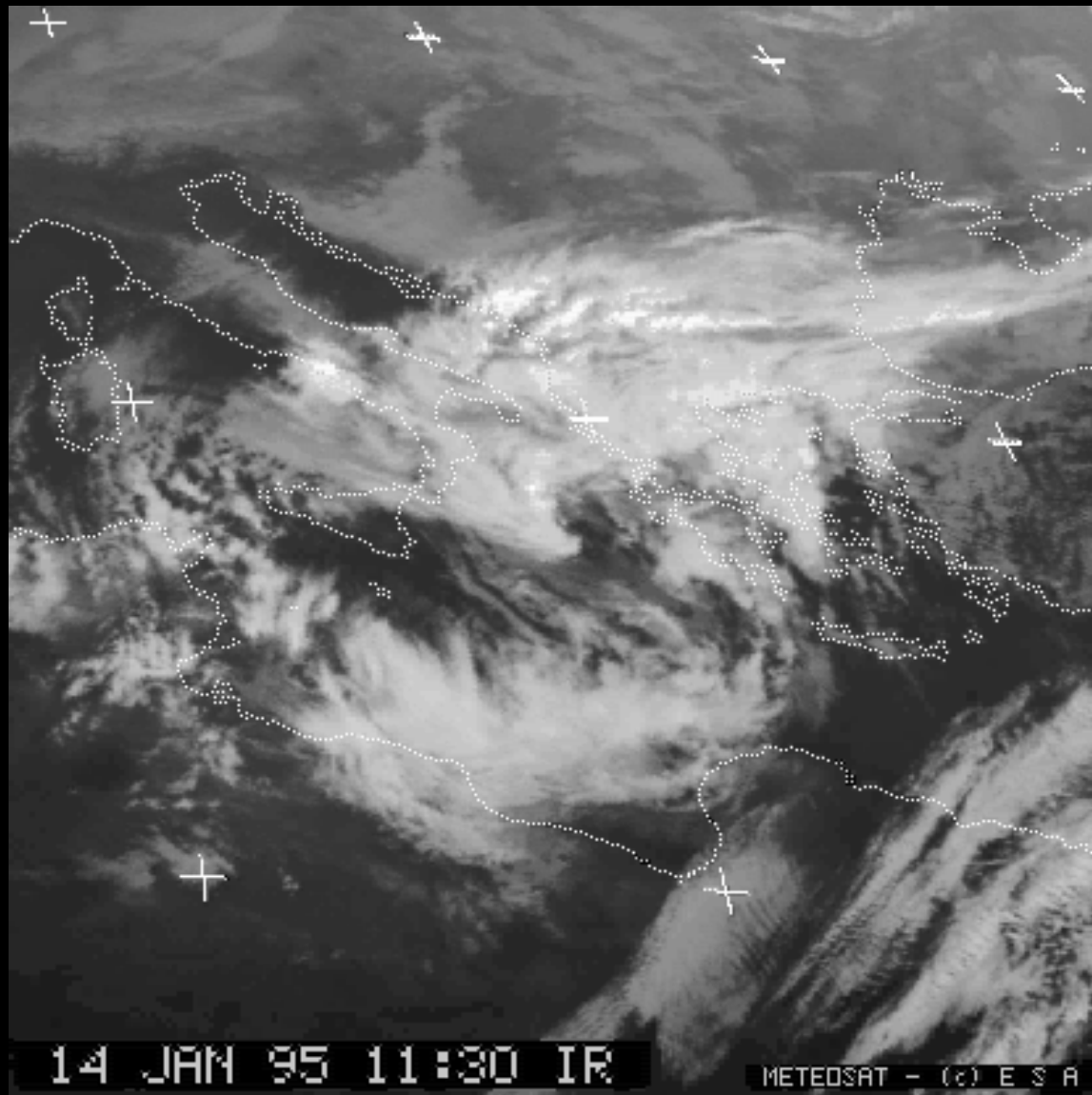
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Other cases: Characterisation

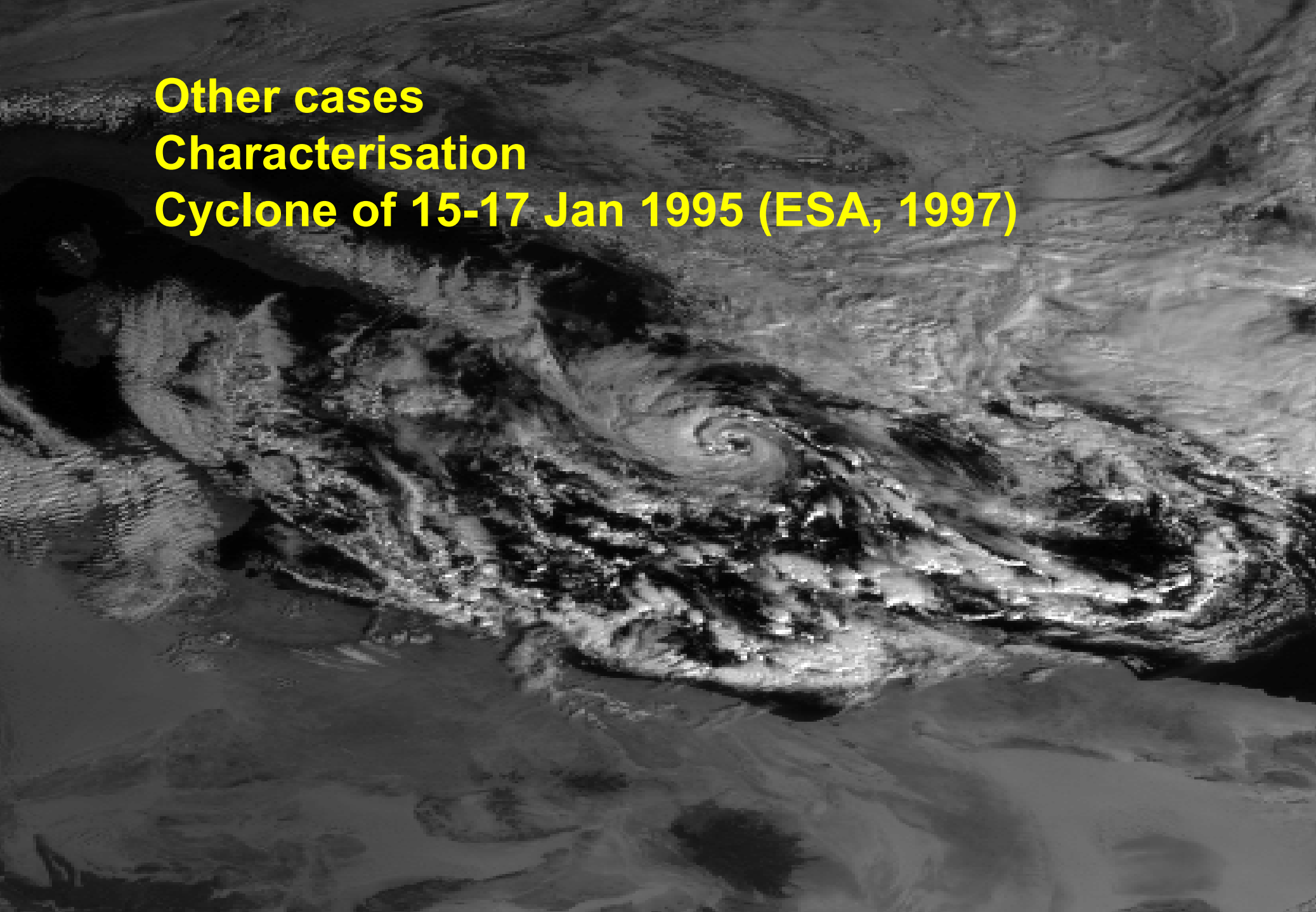
Cyclone of 15-17 Jan 1995 (ESA, 1997)



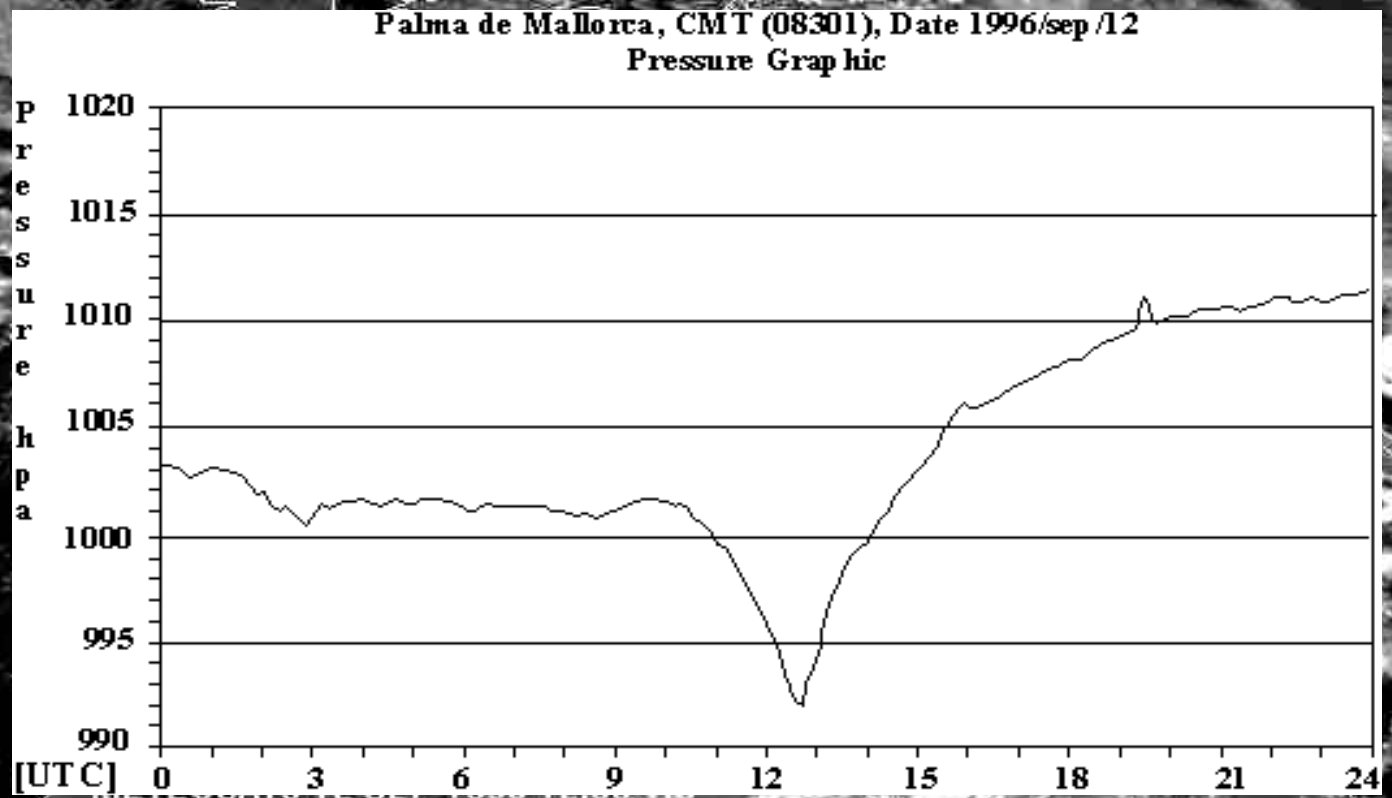
Other cases

Characterisation

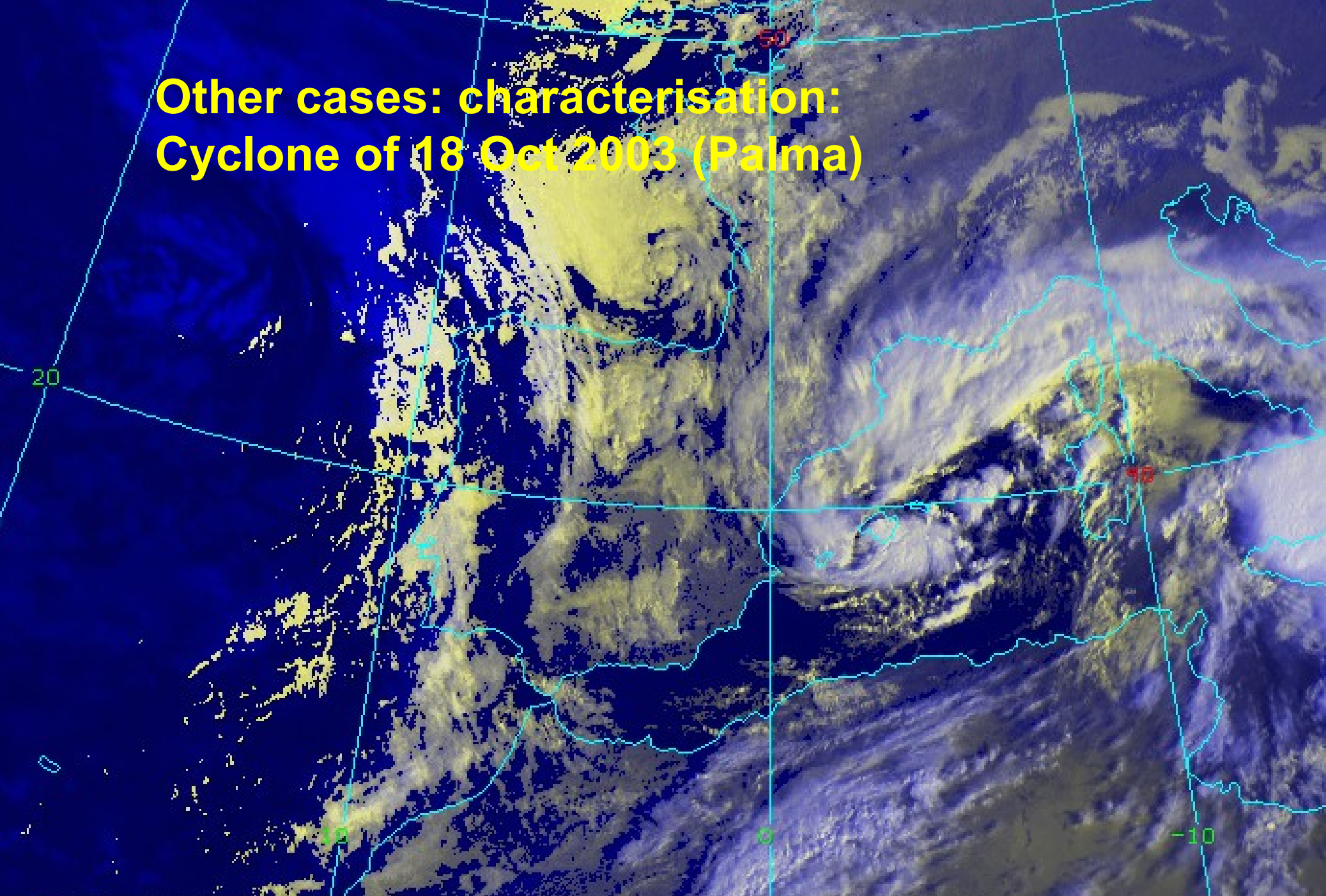
Cyclone of 15-17 Jan 1995 (ESA, 1997)



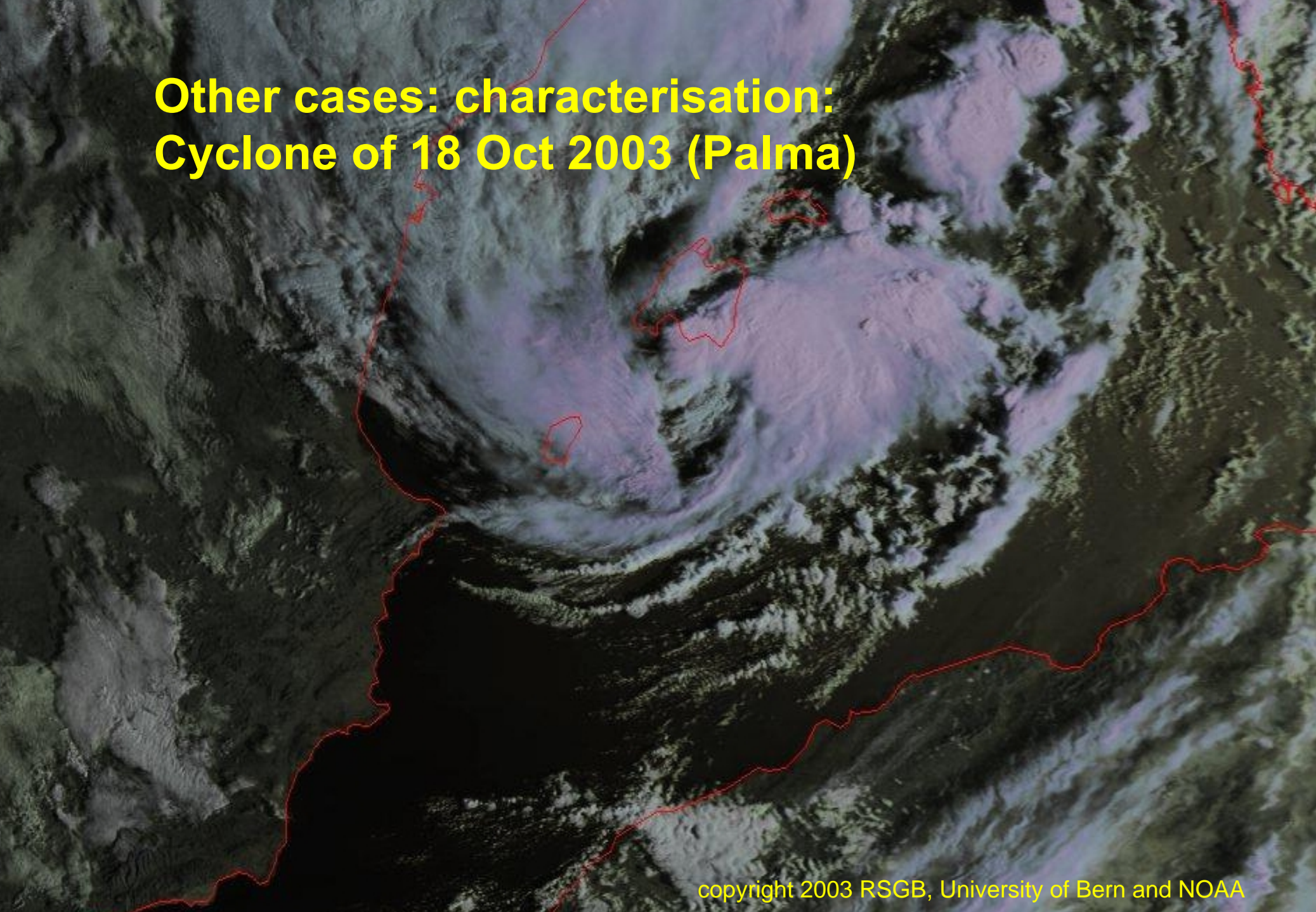
Other cases: Characterisation Cyclone of 12 Sep 1996 at Palma



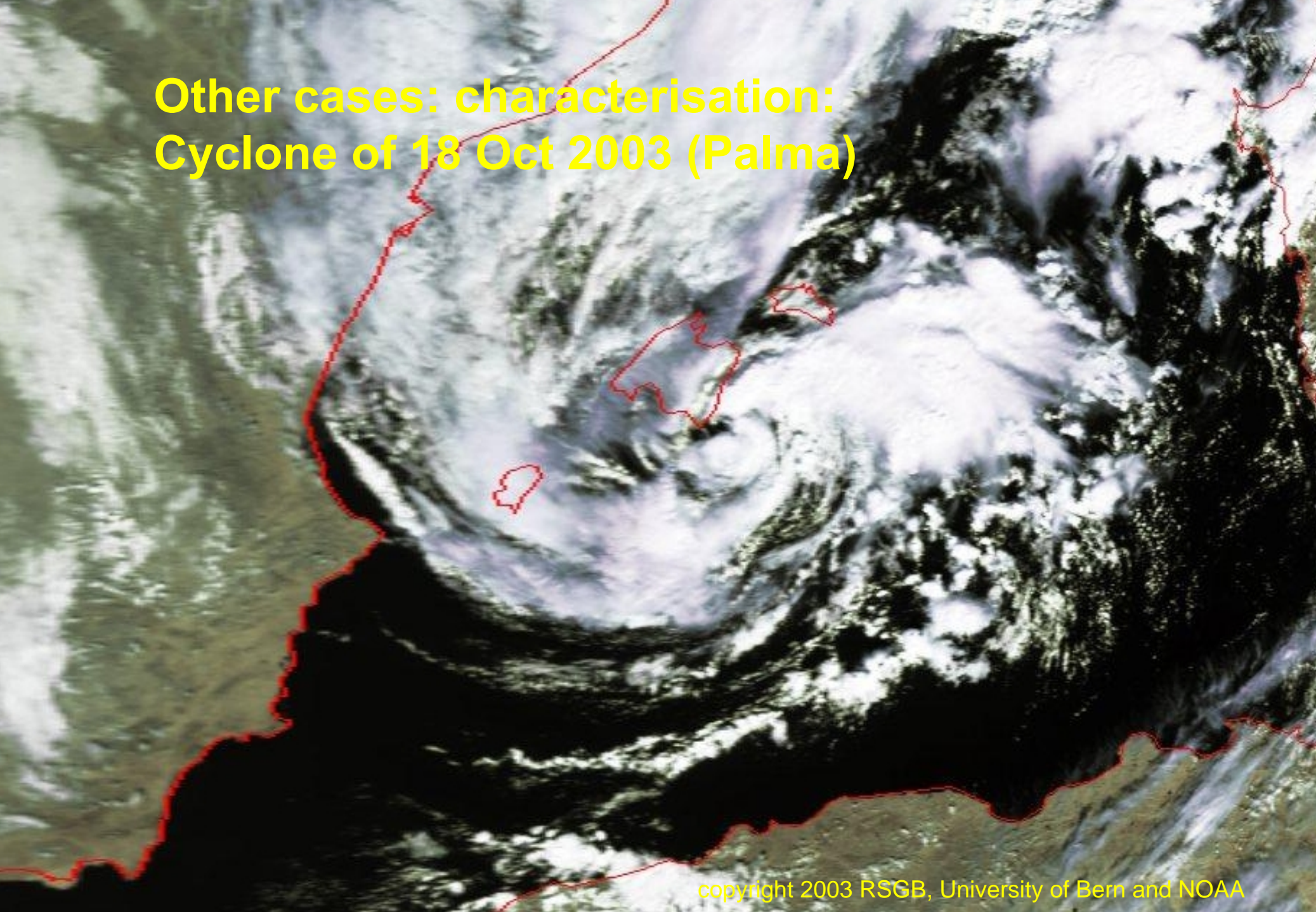
**Other cases: characterisation:
Cyclone of 18 Oct 2003 (Palma)**



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Cyclone of 18 Oct 2003 (Palma)**



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Cyclone of 18 Oct 2003 (Palma)**



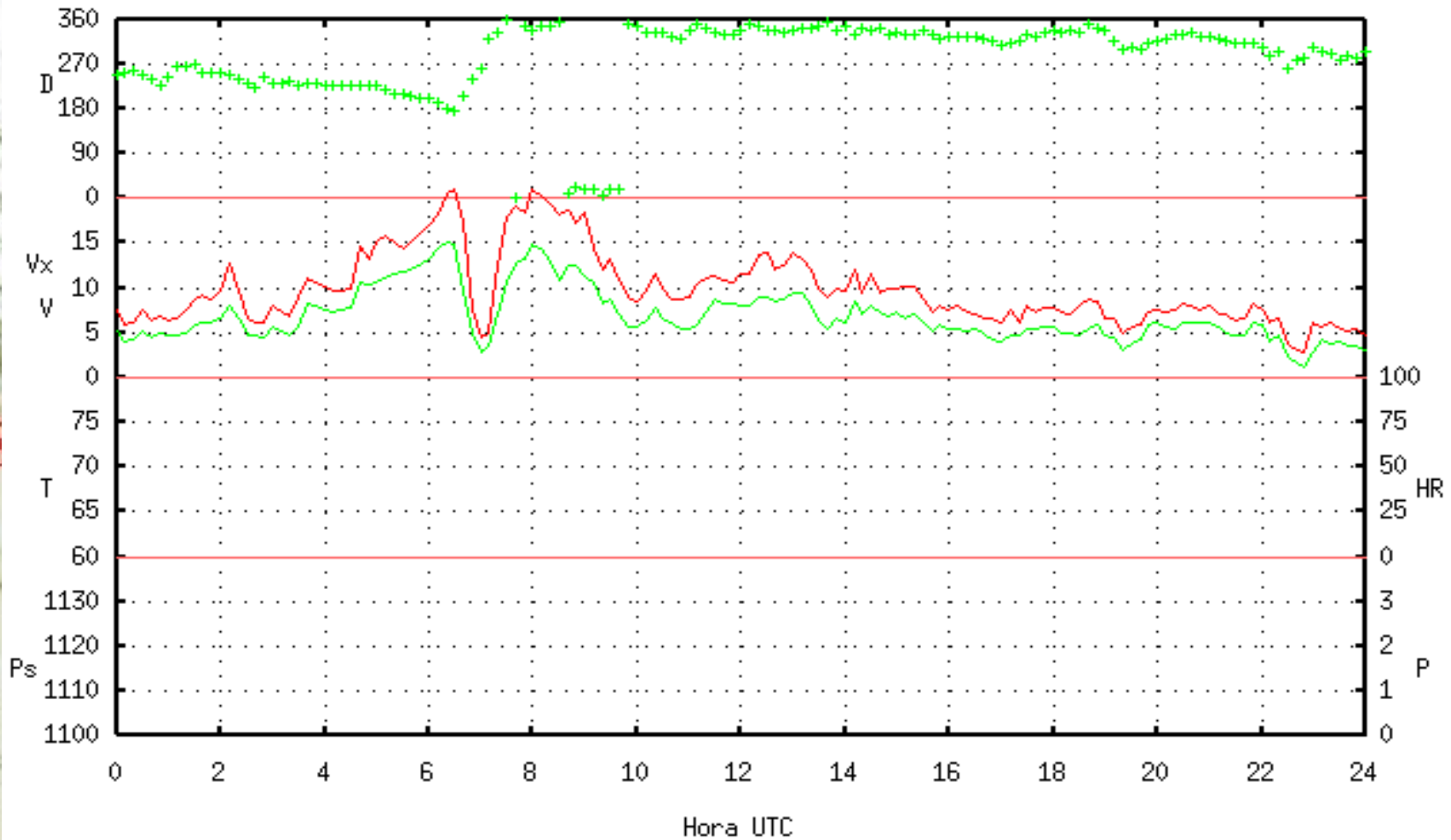
17 VIERNES

18 SABADO

Other cases: characterisation.

B228d - Palma Dic de l'oest

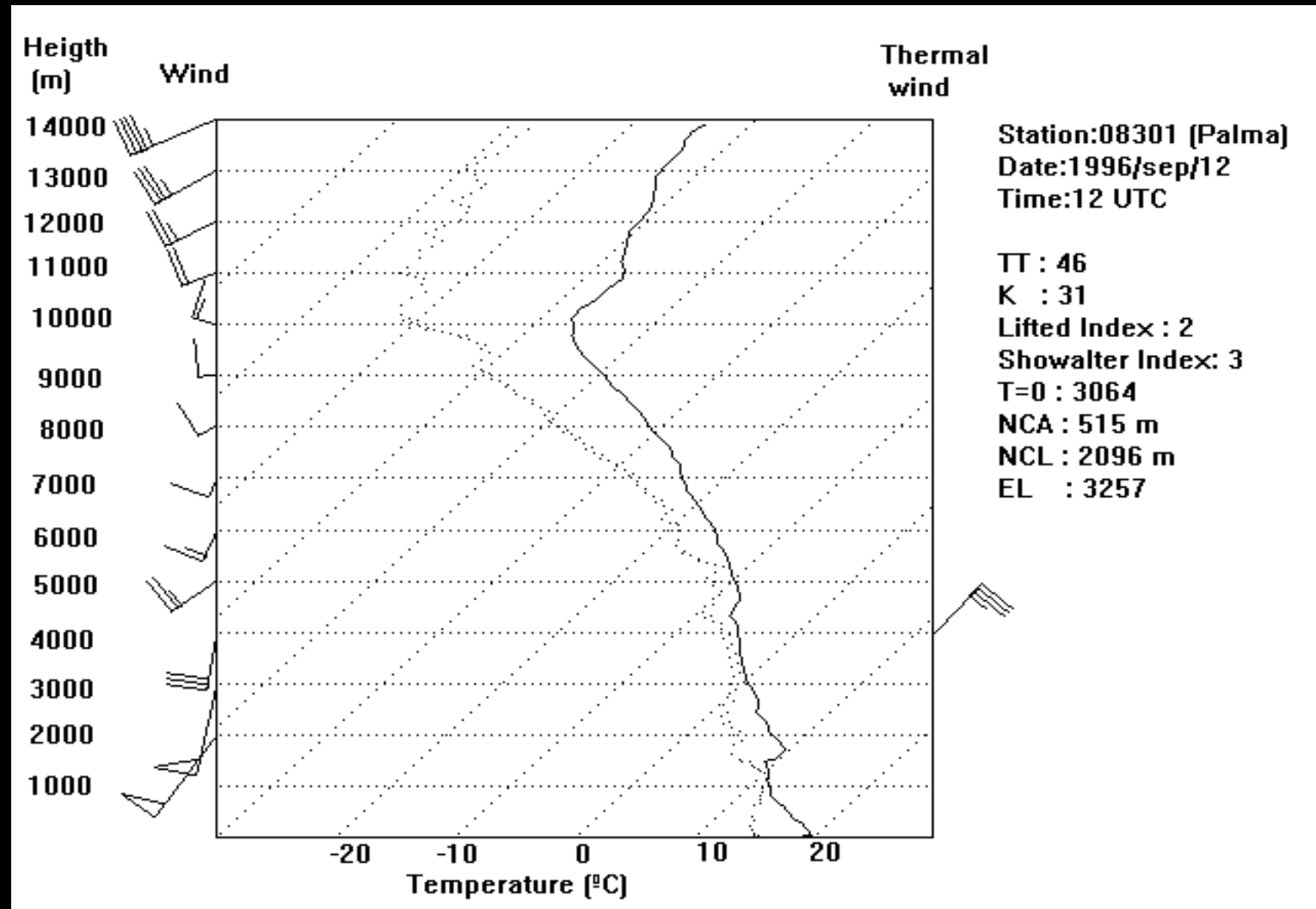
Dia 18-10-2003



Characterisation:

- **Spiral / comma, formed by convective cloudiness moderate or deep**
- **Frequently visible eye (Ex., ≈ 28 km – case of 28 Jan 1982 -)**
- **Diameter 100-300 km (≈ 150 km)**
- **Pressure fall ≈ 10 hPa (7-12 hPa ?)**
- **Sustained winds ≈ 15 -30 m/s**
- **Warm core**

Evidence of a warm core – case of 12 Sep 1996 – radiosounding of Palma just before the arrival of the cyclone:



Computed wind

Simplified method:

Gradient wind: $F_{\text{pressure}} = F_{\text{Coriolis}} + F_{\text{centrifugal}}$,

with $R=75 \text{ km}$, $\Delta p=10 \text{ hPa} \rightarrow V=30 \text{ m/s}$ (average)

(The influence of R is almost negligible per small cyclones)

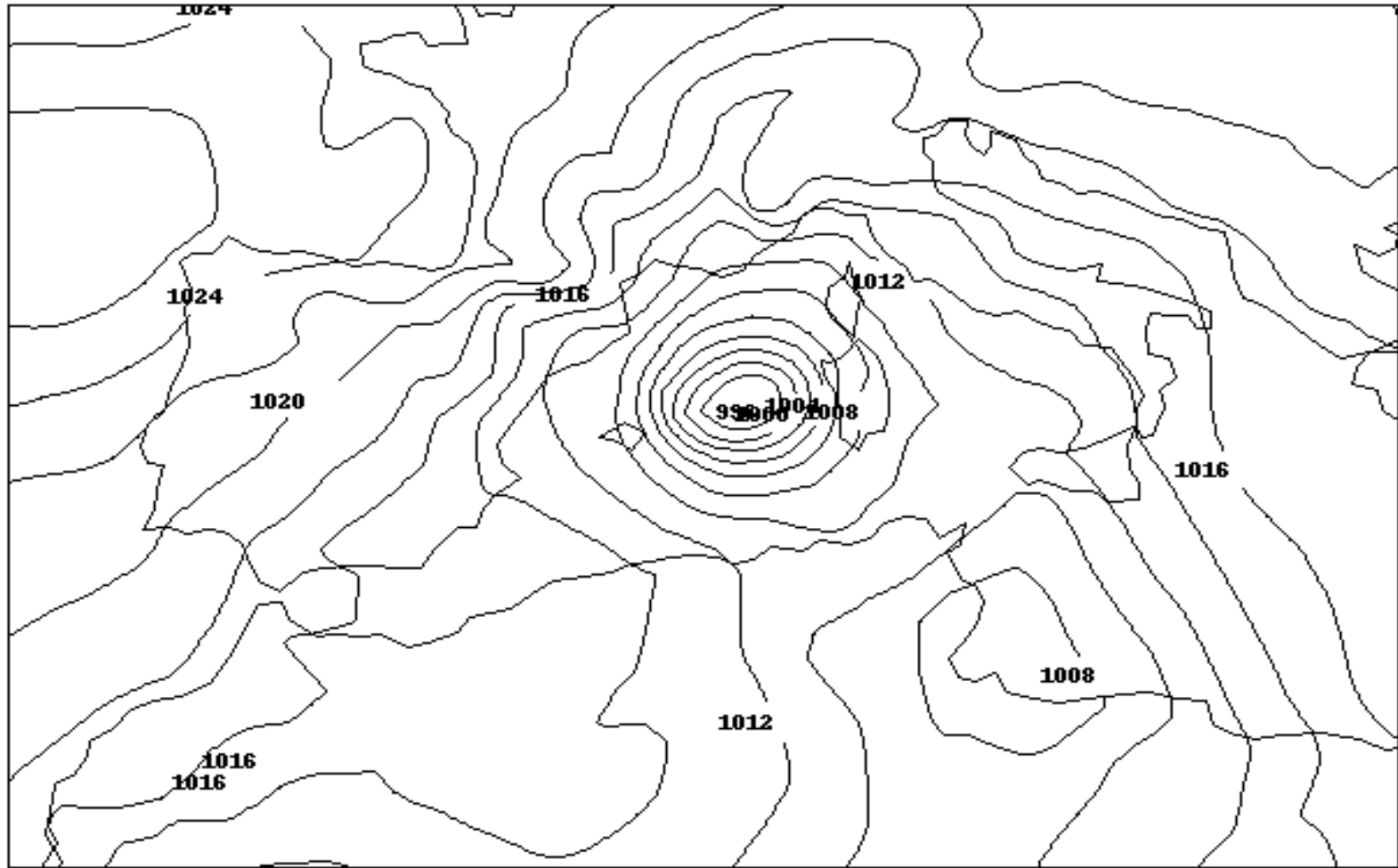
With friction, $V=15-20 \text{ m/s}$ (average)

Holland's method (tropical cyclones):

$$V_{\text{max}} = (B.R.T/(P_0 + 1/3(P_w - P_0).e))^{1/2}(P_w - P_0)^{1/2} + V_{\text{transl}}$$

$P_w - P_0 = 10 \text{ hPa} \rightarrow V_{\text{max}} = 31,5 \text{ m/s}$ (maximum sustained wind)

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Frequency:

from the UIB “medicanes” web:

<http://www.uib.es/depart/dfs/meteorologia/METEOROLOGIA/MEDICANES>

The screenshot shows the MEDICANES website interface. The top navigation bar includes 'Introduction', 'Medicanes & Hurricanes', 'Dynamical evolutions', 'Schemes', 'Evolution', 'Air-sea mechanism', and 'Cases'. The main content area features a table of storm cases and a grid of satellite images.

ID	Initial Date	Final Date	Initial Date	Final Date	Zone
961210	08/12 00 ⁰⁰	11/12 20 ⁰⁰			W
970926	24/09 01 ³⁰	28/09 01 ⁰⁰			C-E
000909	07/09 20 ⁰⁰	11/09 20 ⁰⁰			E
001009	07/10 18 ³⁰	10/10 08 ³⁰			C
030527	25/03 12 ⁰⁰	28/05 04 ³⁰	27/05 08 ³⁰	27/05 15 ³⁰	W
030917	15/09 11 ³⁰	19/09 23 ³⁰			C
030928	27/09 18 ⁰⁰	29/09 13 ⁰⁰			C
031018	17/10 00 ⁰⁰	19/10 04 ⁰⁰	18/10 12 ³⁰	18/10 13 ³⁰	W
040920	04/09 08 ⁴²	21/09 16 ⁴²			C
041103	02/11 22 ¹²	05/11 23 ⁵⁷			C
050915	14/09 17 ⁴²	16/09 07 ⁴²			C
051027	26/10 20 ³⁰	29/10 14 ³⁰	28/10 10 ⁰⁰	28/10 12 ⁰⁰	C
051215	13/12 05 ⁰⁰	16/12 12 ¹⁵	14/12 08 ⁰⁰	14/12 15 ¹⁵	C-E
			15/12 06 ⁰⁰	15/12 14 ¹⁵	
060201	31/01 11 ⁴²	03/02 00 ¹²			C
060926	25/09 12 ⁴²	28/09 18 ¹²			C
061016	15/10 10 ⁵⁷	17/10 15 ¹²			C
070322	19/03 14 ²⁷	23/03 17 ⁵⁷			C
071018	16/10 18 ⁴²	18/10 22 ¹²			W
071019	18/10 19 ⁵⁷	20/10 05 ¹²			W
071026	25/10 09 ¹²	27/10 15 ¹²			W

Storm initial and final date, Eye formation and dissipation for each case ([DD]/[MM] [HH]^[M]) and Mediterranean Zone of evolution (W, Western; C, Central; E, Eastern)

At least **37 cases** in **24 years**

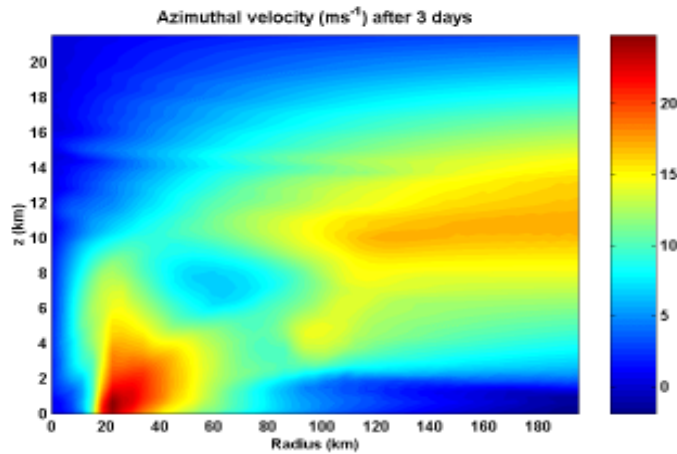
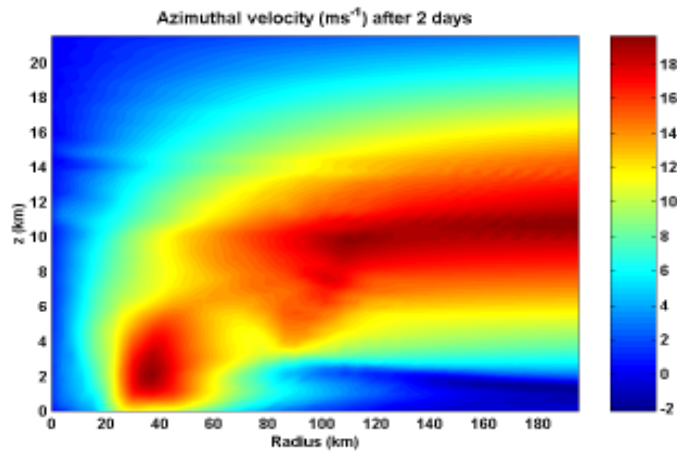
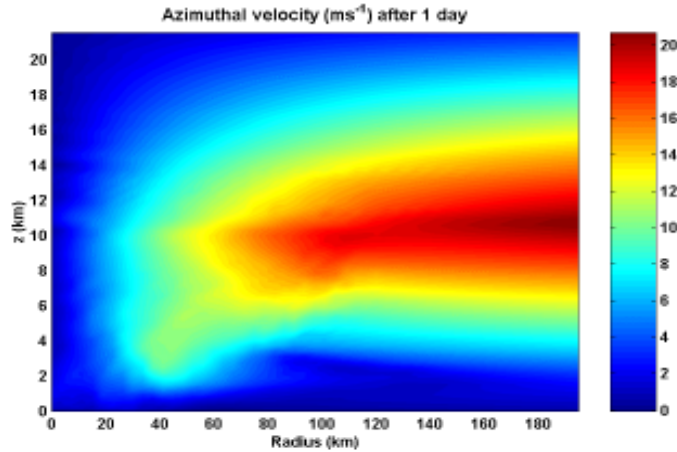
At least **1.5 cases/year**

Genesis

The cause of the Mediterranean tropical-like mini-cyclones - in common with the origin of the tropical cyclones and the polar lows- is, in brief, the release of latent heat, with local warming and local pressure fall.

Following Rotunno & Emanuel (1987), when the sea water is warm compared to the air temperature, a pre-existing cyclonic circulation forces a wind induced sensible and latent heat flow from the sea to the air, favouring the triggering or intensification of convection, with final latent heat release and warming.

Genesis

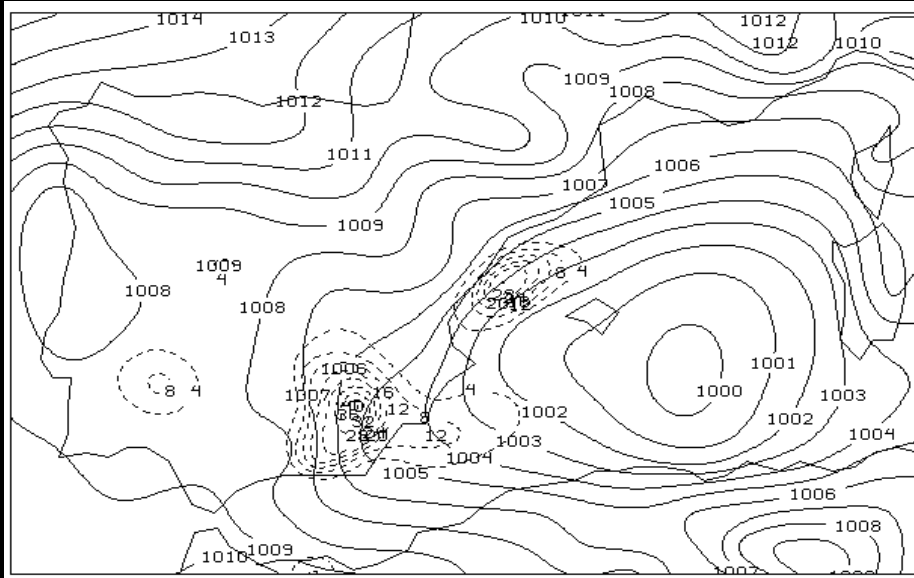


By means of an axisymmetric non-hydrostatic cloud-resolving numerical model, Emanuel (2005) has demonstrated that in some Mediterranean environments a cold upper level disturbance can evolve to form a tropical-like surface mini-cyclone.

The existence of a warm-core is the first indication that the origin of the mini-cyclones or medicanes is the warming by latent heat release.

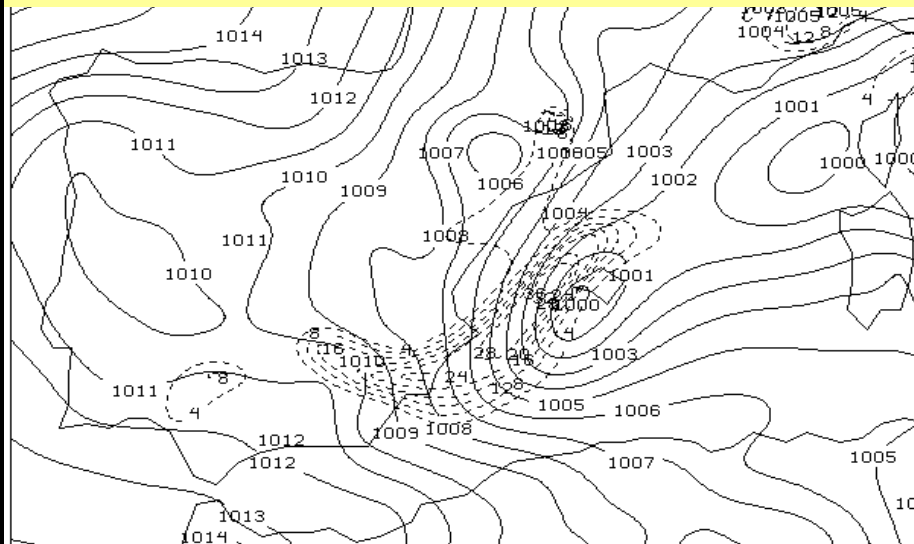
The numerical experimentation permits to prove it.

Gili et al, 1997: Experiment about the 12 Sep 1996 cyclone

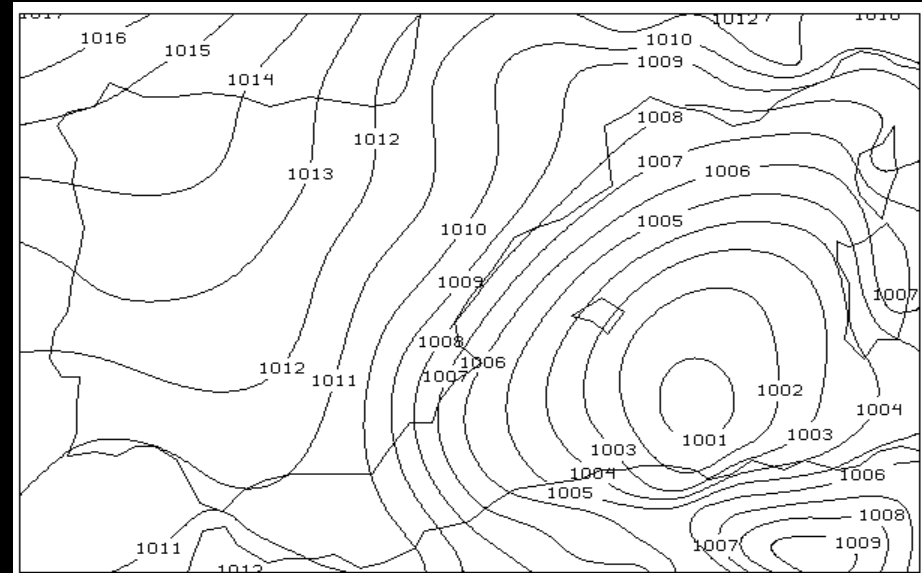


PSL (MB) TIME 12 DAY 96255 SFC VALID 96256/00Z
PCP (MM) TIME 12 DAY 96255 SFC VALID 96256/00Z

Control simulation

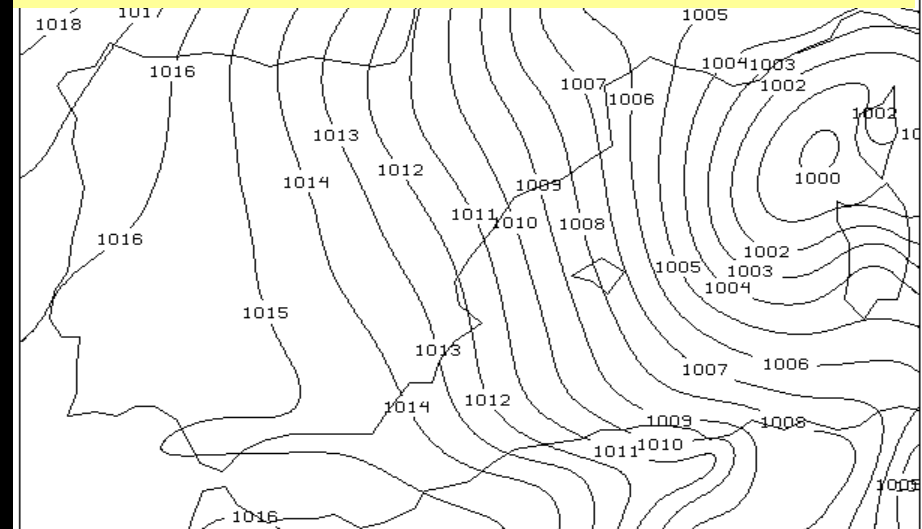


PSL (MB) TIME 12 DAY 96255 SFC VALID 96256/12Z
PCP (MM) TIME 12 DAY 96255 SFC VALID 96256/12Z



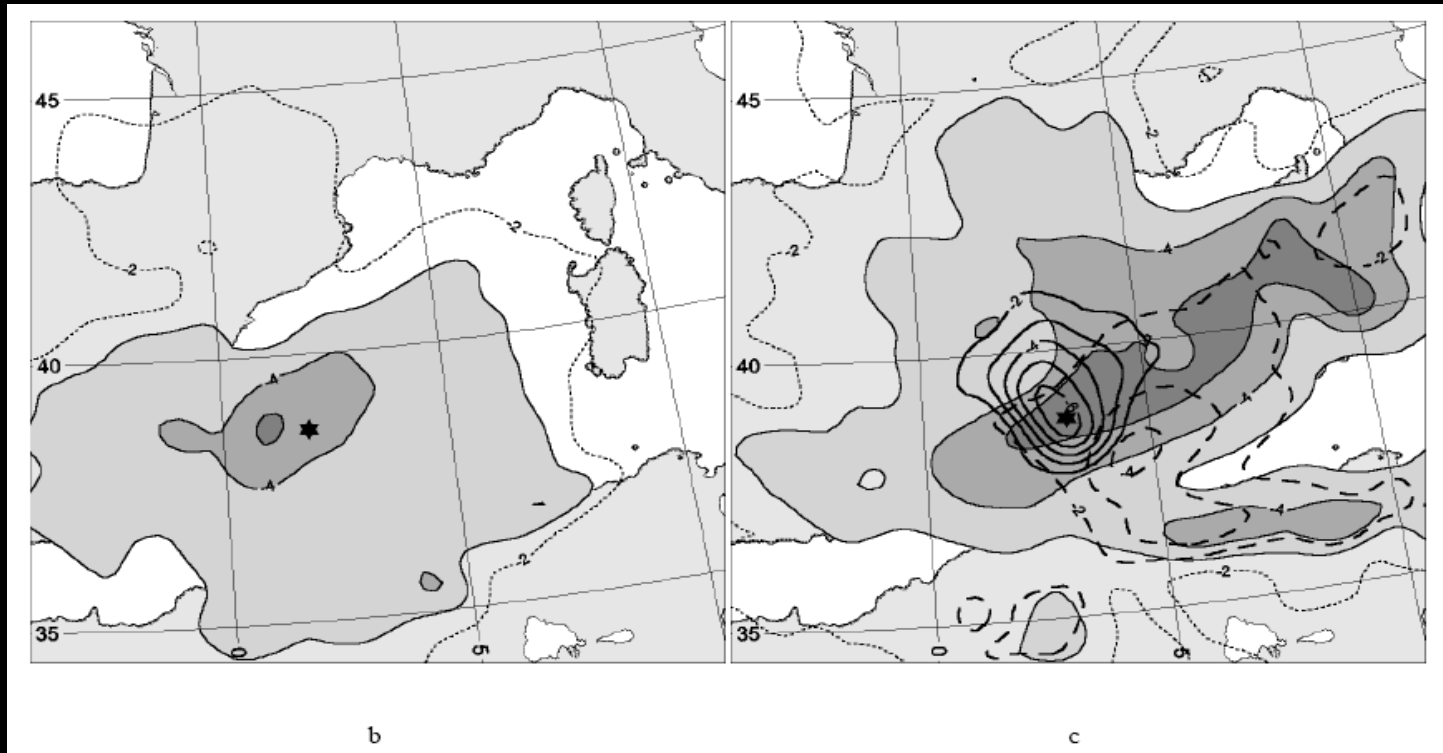
PSL (MB) TIME 12 DAY 96255 SFC VALID 96256/00Z

"Dry" simulation



PSL (MB) TIME 12 DAY 96255 SFC VALID 96256/12Z

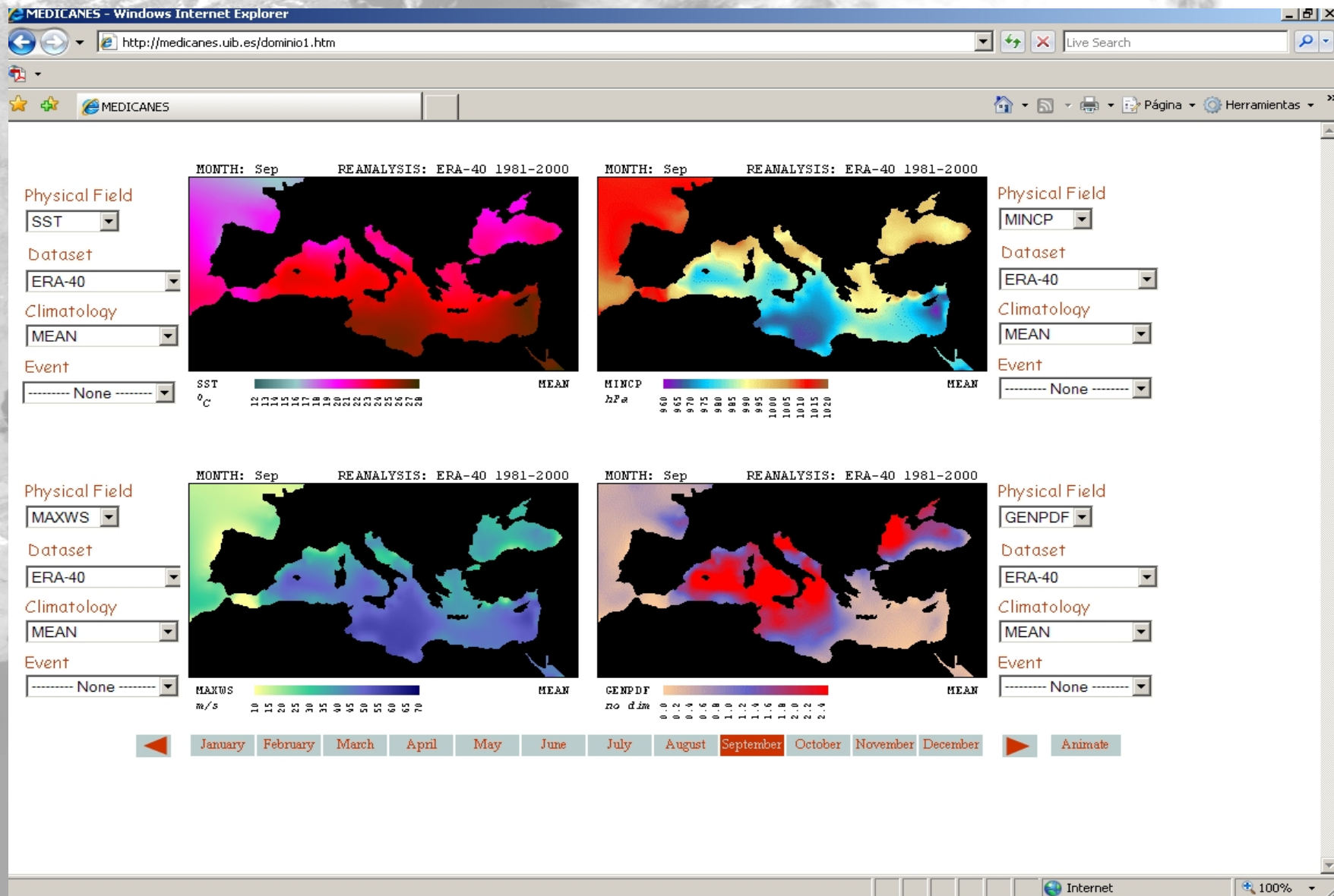
Homar et al, 2003, Numerical diagnosis of a small ..., QJRMS (Experiments about the quasi-tropical cyclone of 12 Sep 1996)



Spatial distribution of the effects of the PV anomaly (shaded, dotted line represents -2 hPa), the latent heat flux (dashed) and the interaction (solid) at b) 0000 UTC and c) 1200 UTC 12 September 1996. Stars represents the cyclone center location in the control simulation.

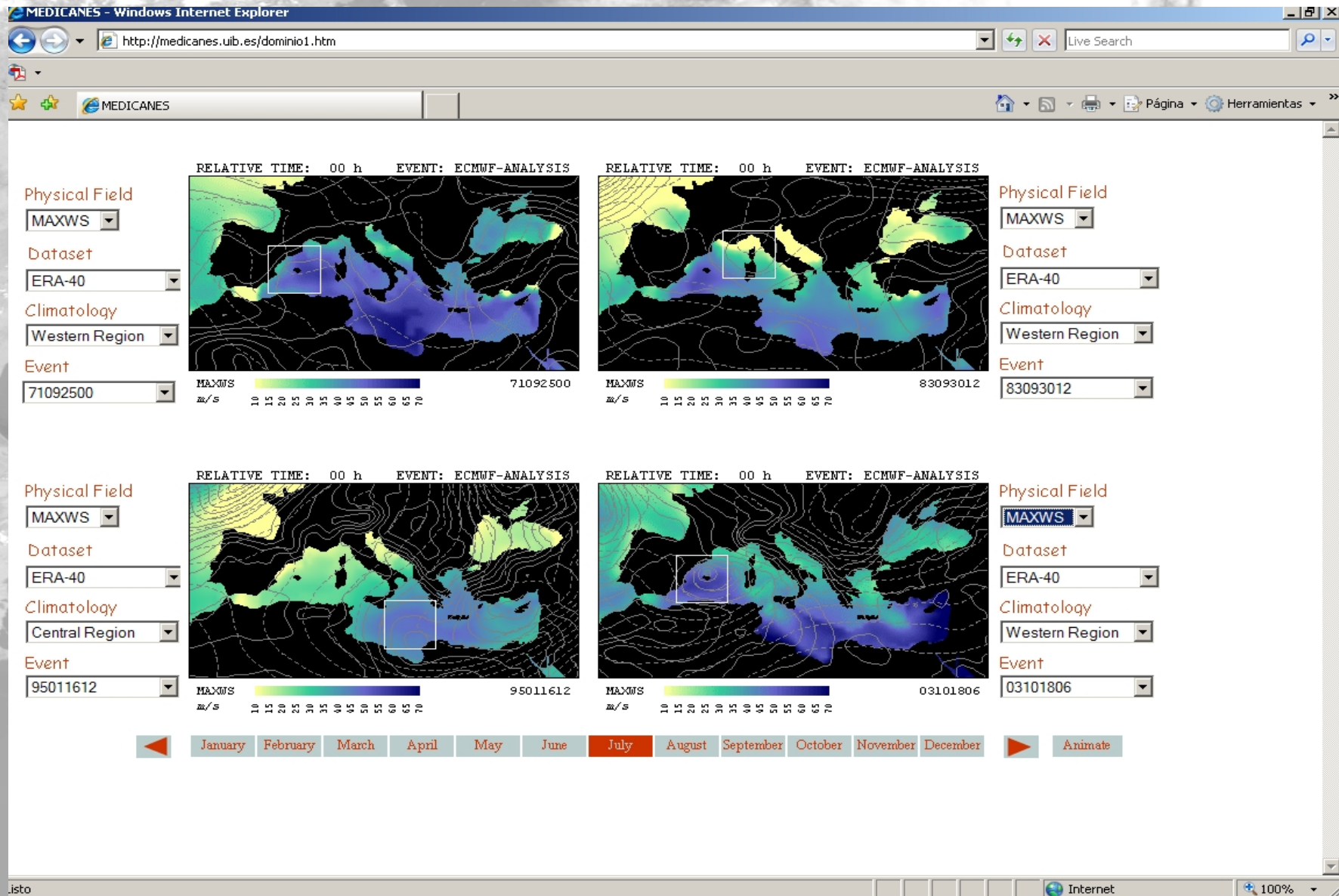
The interaction between the upper air PV anomaly and the surface latent heat flux is the most effective factor of cyclogenesis

Climatological potentiality of medicane generation (according the Rotunno & Emanuel theory and model): some theoretical magnitudes, September (From the UIB medicanes web site)

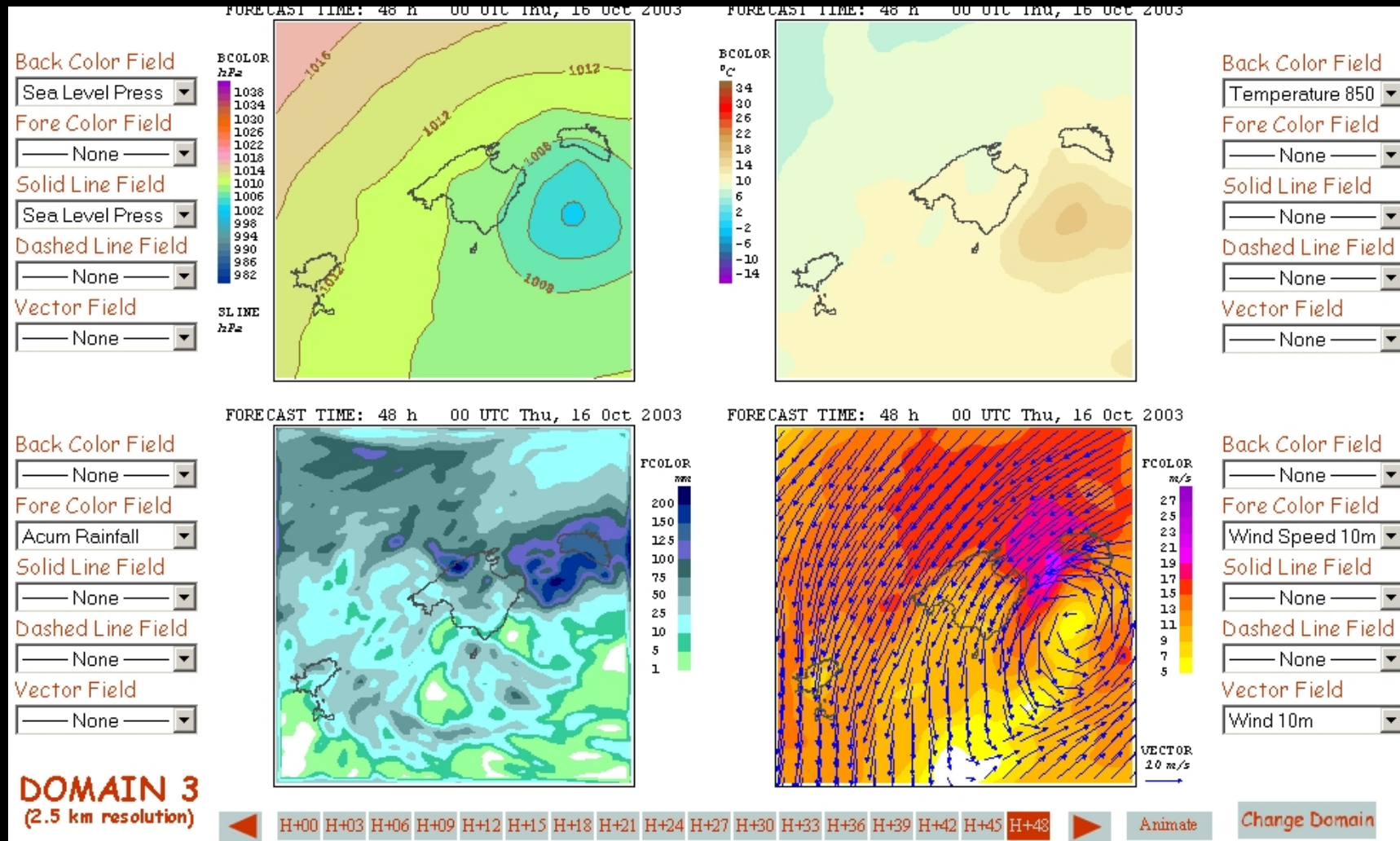


Theoretical max sustained wind, selected cases

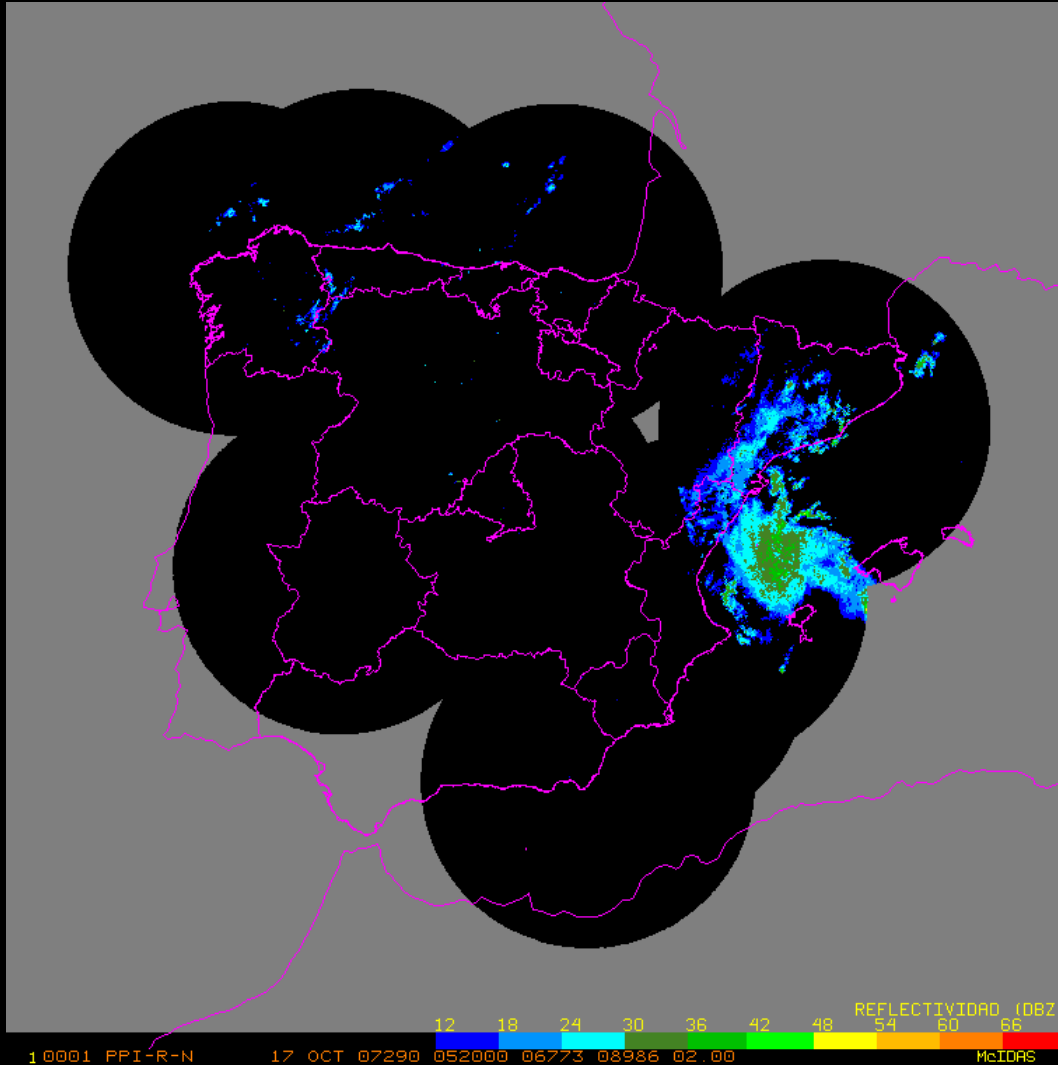
(From the UIB medicanes web site)



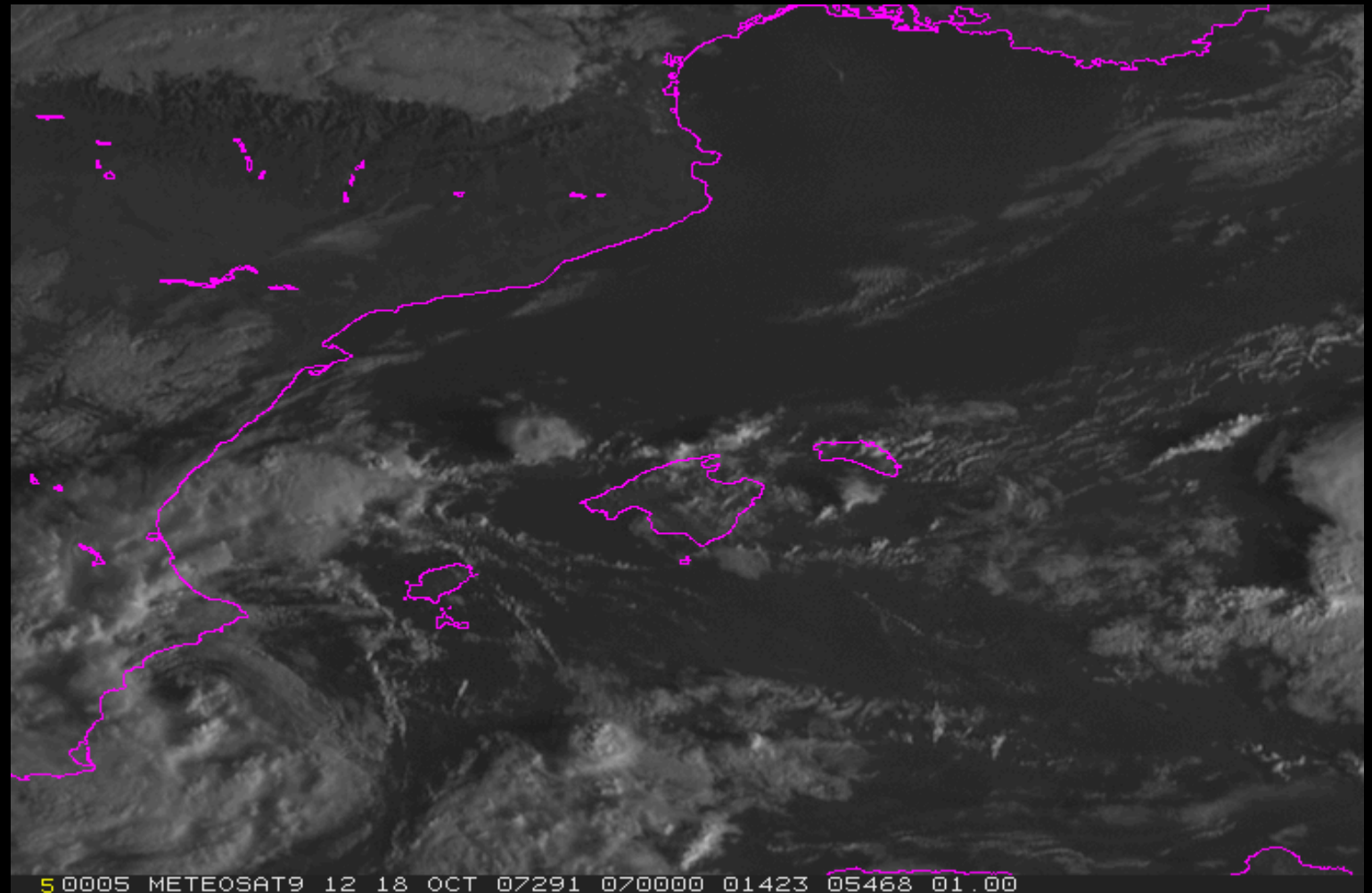
Models with resolution enough can generate tropical-like mini-cyclones in the Mediterranean, but sometimes these are spurious storms



We cannot totally rely on tropical-like mini-cyclones as forecasted by the models: to check their existence against conventional or remote sensing observations is necessary, but even this is sometimes not enough to well identify what we are observing



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