A Quasi-Tropical Cyclone over the Western Mediterranean: Dynamical vs Boundary Factors

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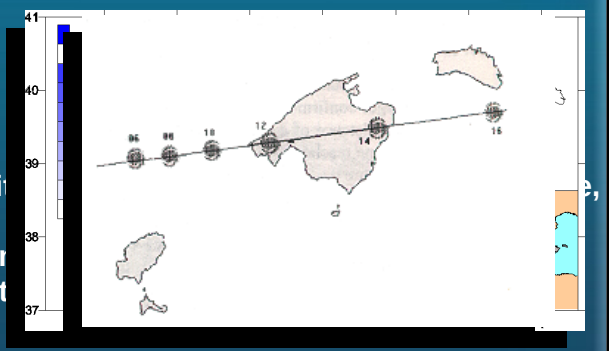
The Event. Description

Event description and social impacts:

- Very active episode on 11 and 12 September 1996:
  - 6 tornadoes at the Balearic Islands
  - Heavy precipitation in Valencia
  - A small and deep cyclone crossed Mallorca
- Extensive damages in harbours and the countryside

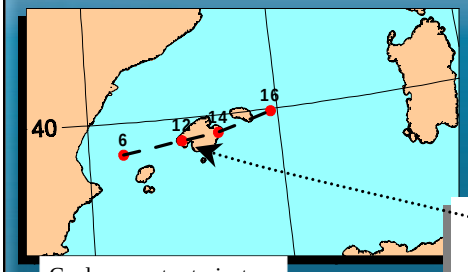


Objectives:

- Numerical sensitivi… focusing on:
  - Upper levels dynar…
  - Evaporation from t…
  - Topography

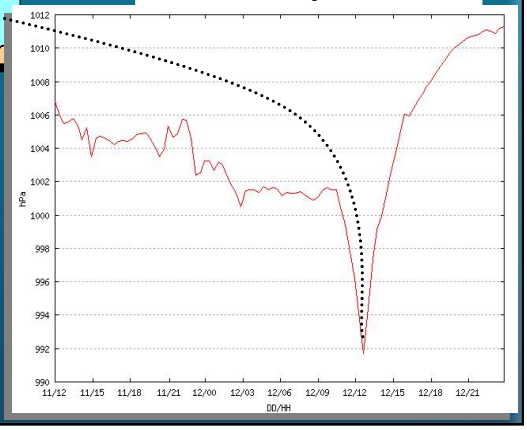
The Event. Observations

- **A sudden Surface Pressure decrease: 9 hPa in 2 h**



Cyclone center trajectory

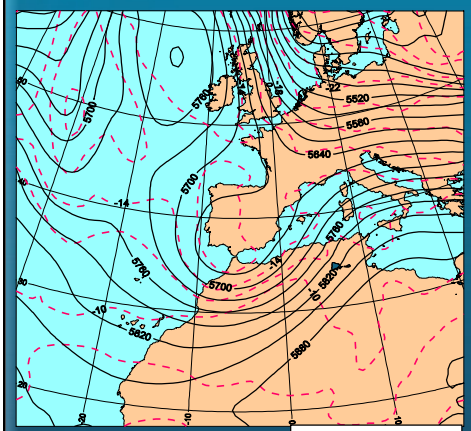
Observed Surface pressure in Palma



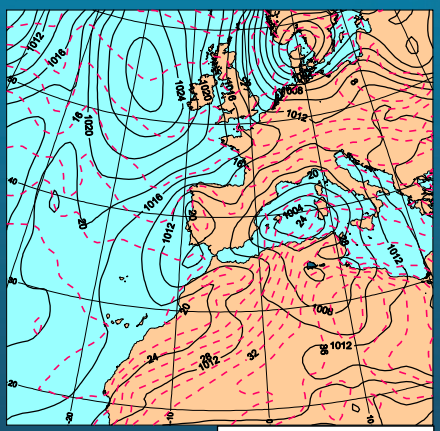
Synoptic Overview

- **NCEP analysis 6h before the cyclone formation:**

12 September at 00 UTC



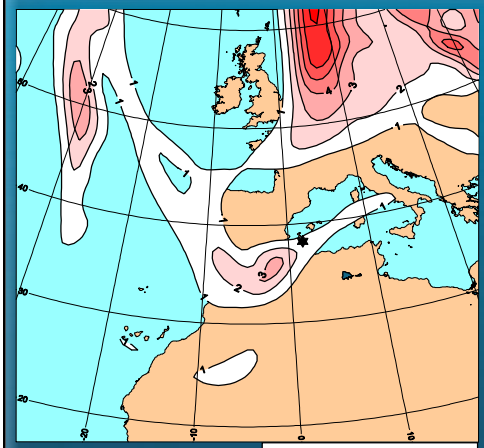
Geo-Tem 500 hPa



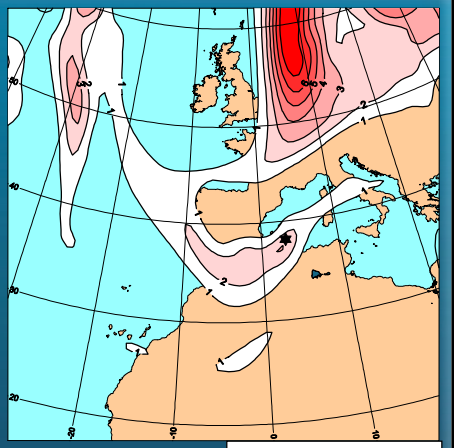
Srf Pres-Tem 1000 hPa

Synoptic Overview

- Upper levels



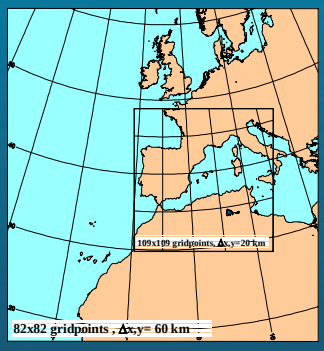
PV 300 hPa. 0600 UTC



PV 300 hPa. 1200 UTC

Numerical Experiments configuration

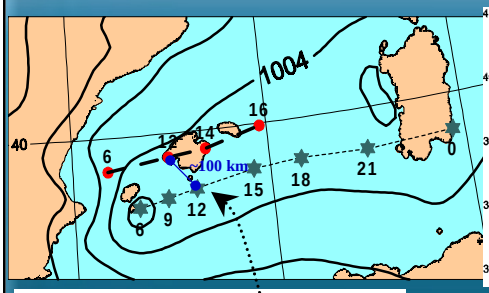
- The MM5 model was used to perform numerical simulations
- Kain-Fritsch convective parameterization is used
- Two domains are defined to obtain high resolution over the area of interest while retaining in the simulation the main synoptic features of the event

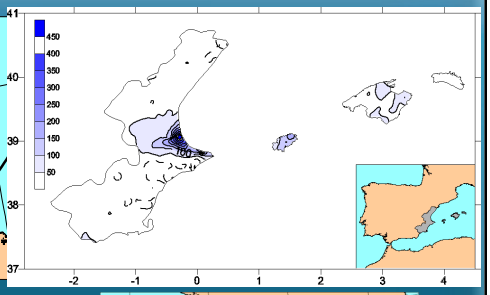


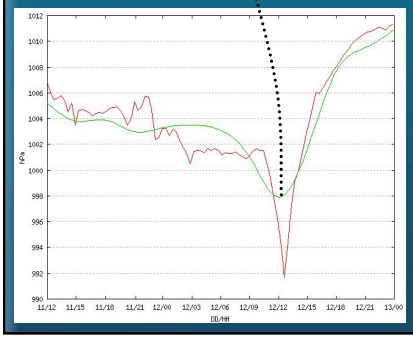
- Simulations start at 1200 UTC 11 September (18 h previous to the cyclone formation) and extend out to 36 h
- Corrected NCEP global analyses are used as initial and boundary conditions, available at 0000 and 1200 UTC

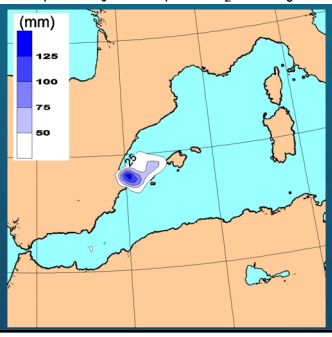
Control Run Validation

- Cyclone center Trajectory, Surface pressure and precipitation:



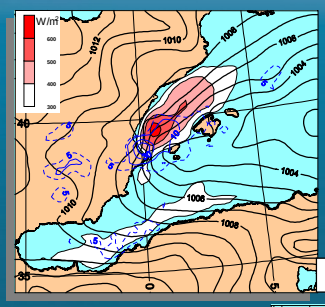


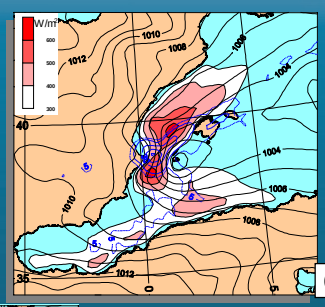


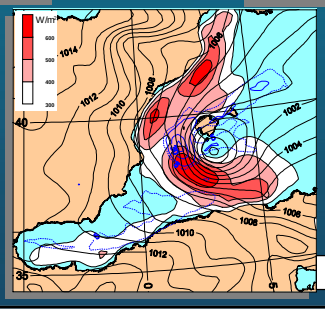


Control Run. Analysis

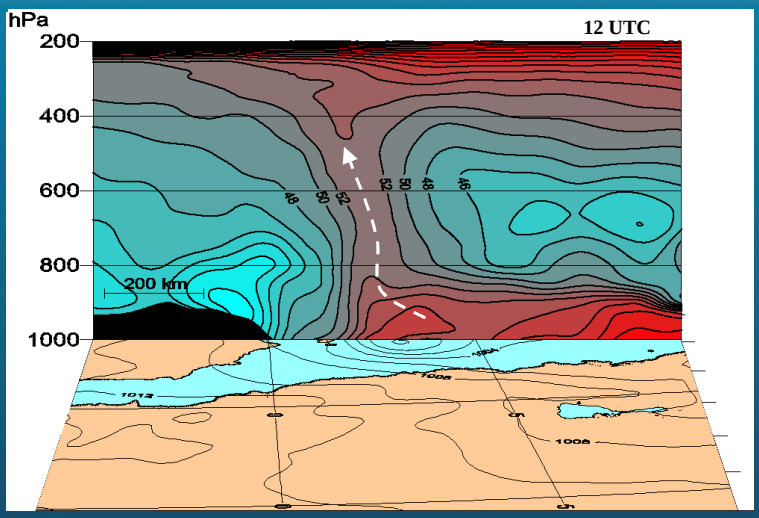
- Surface pressure, rainfall and sea surface evaporation:







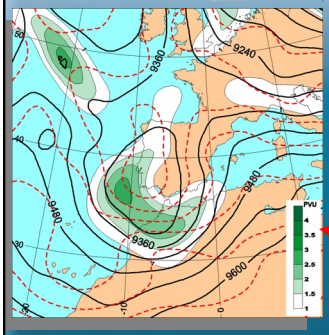
Control run. Analysis

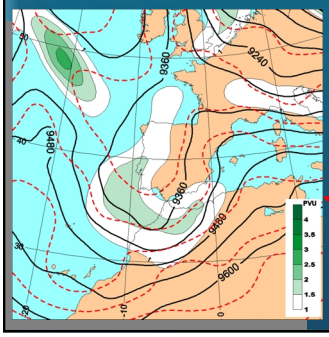


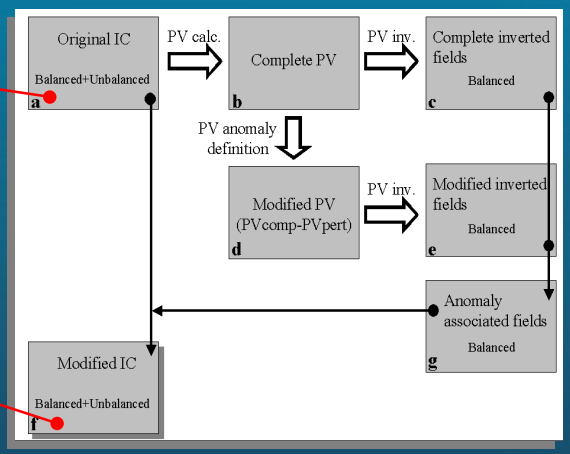
Sensitivity analysis

- **Considered agents:**
  - **Orography**
  - **Latent Heat Release**
  - **Evaporation from the sea (LHF)**
  - **Upper levels cutoff intensity**

PV inversion methodology

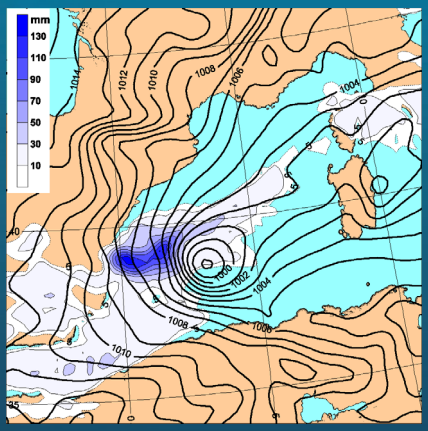


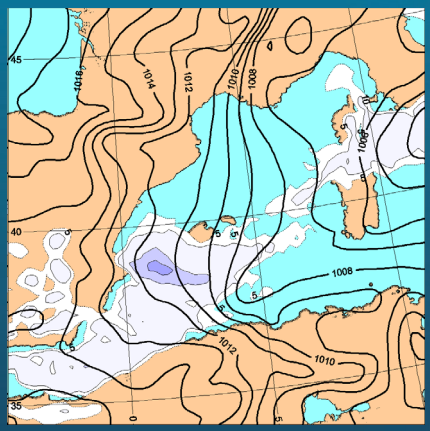




Sensitivity Experiments

Experiment	Description
NORO	No topography
NOLHR	No latent heat release from condensation
NOLHF	No latent heat flux. Evaporation.
NOPVP	Weakened upper levels PV perturbation

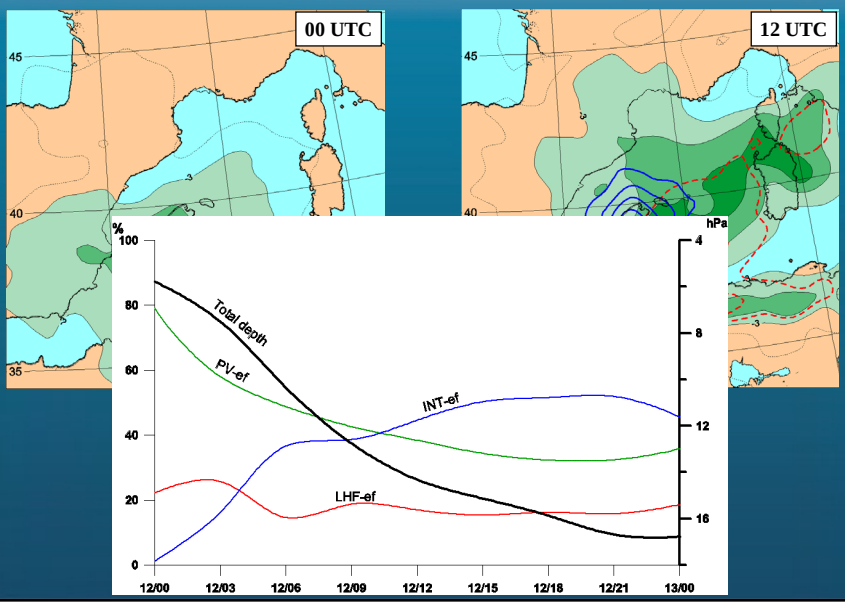




Sea surface pressure and accumulated precipitation 12 UTC

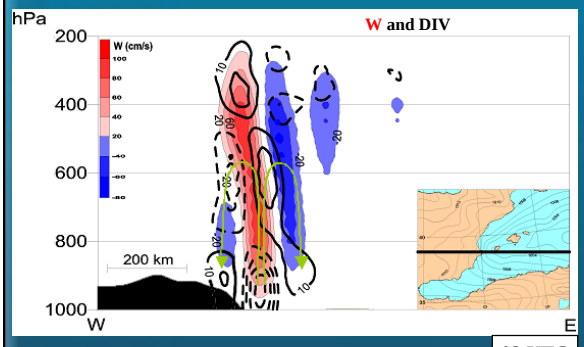
LHF and PV effect

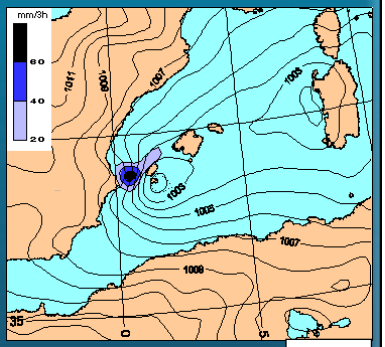
- Factors separation: **LHF**, **PV perturbation** and **their synergism:**



LHF and PV effect

- Effect of the **synergism**



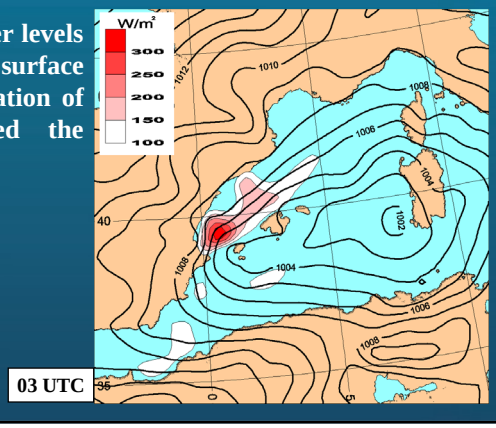


Air-Sea Interaction

- Air-sea interaction instability (Emanuel, 1986 JAS)?

- Circulation attributed to the PV anomaly aloft is revealed as the triggering agent of the instability by enhancing values of evaporation from the warm sea surface.

- The principal effect of the upper levels PV anomaly was not a direct surface pressure decrease but the generation of surface flow which intensified the evaporation.



03 UTC

Conclusions

- Synoptic settings: cold cutoff over the Iberian Peninsula and a surface low over the Western Mediterranean.

- Numerical experiments: intense and deep convective activity

- Sensitivity experiments show:
  - the primary role of the latent heat release on the cyclogenesis, and the negligible role of the orography in this event.
  - the crucial effect of the upper levels cutoff and the enhanced evaporation from the sea.
  - the synergism of the circulation at low levels and the derived evaporation from the sea was the responsible of the small scale deep cyclogenesis.

- Air-sea interaction instability was able to sustain the observed cyclone intensity.