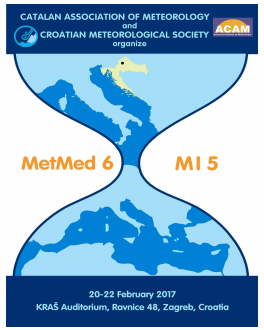
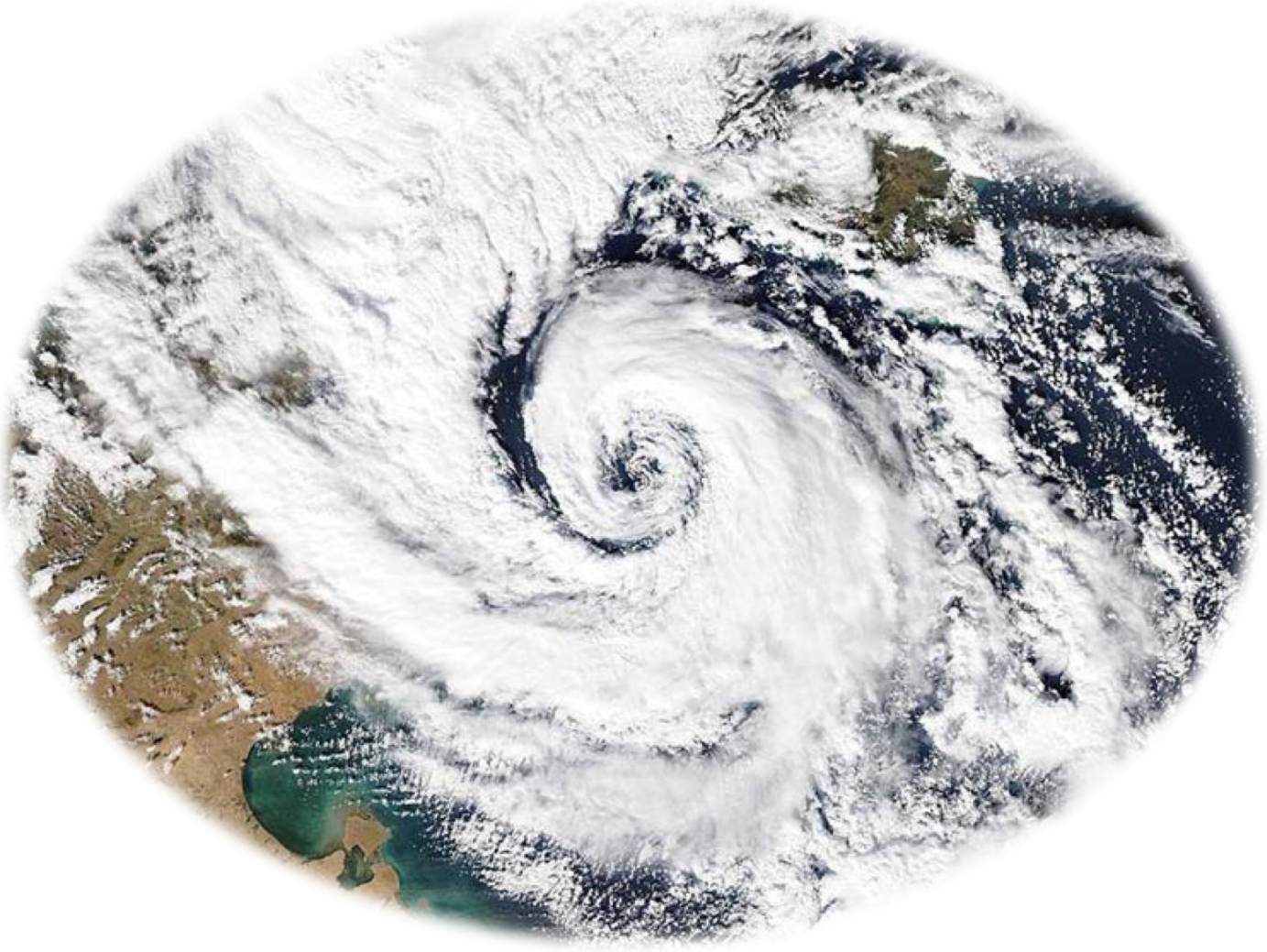


The genesis of the 7 November 2014 tropical-like cyclone: Numerical Sensitivity Study.

D. S. Carrió, V. Homar, A. Jansa, R. Romero and M. A. Picornell

Universitat de les Illes Balears

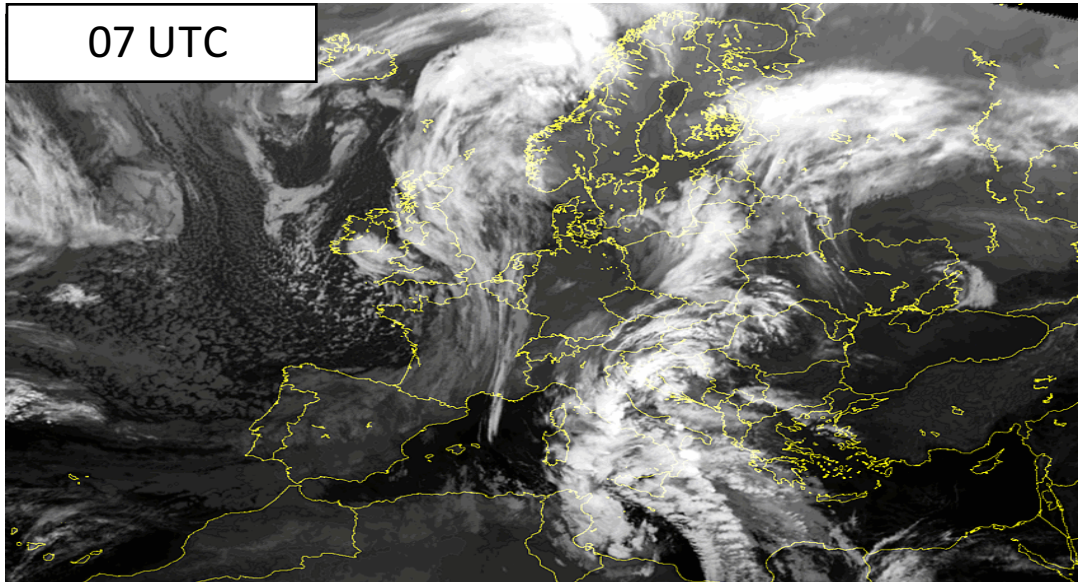


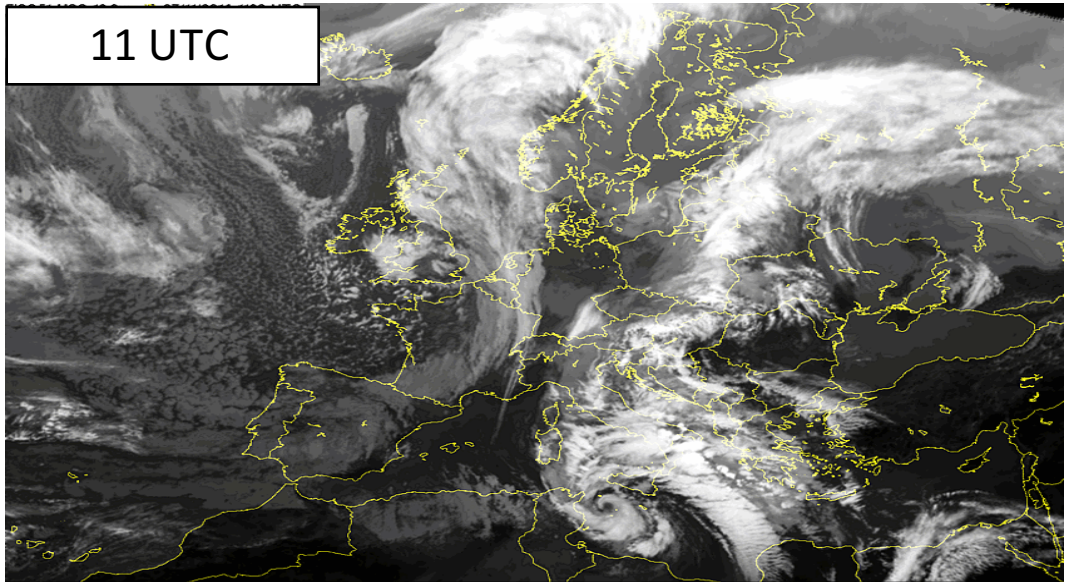
diego.carrio@uib.es

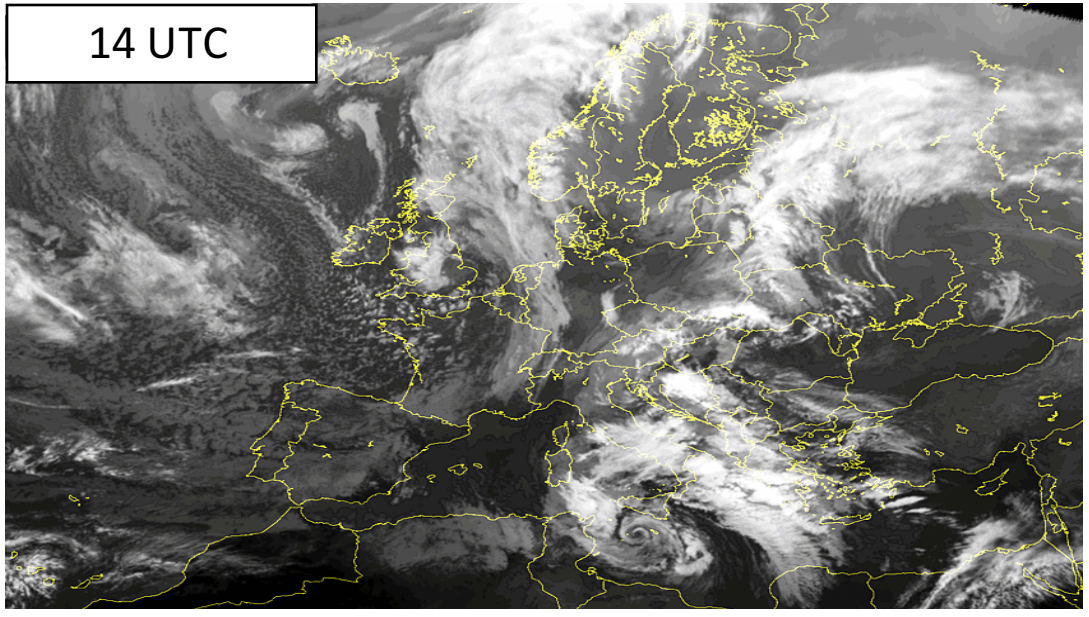
21th February 2017

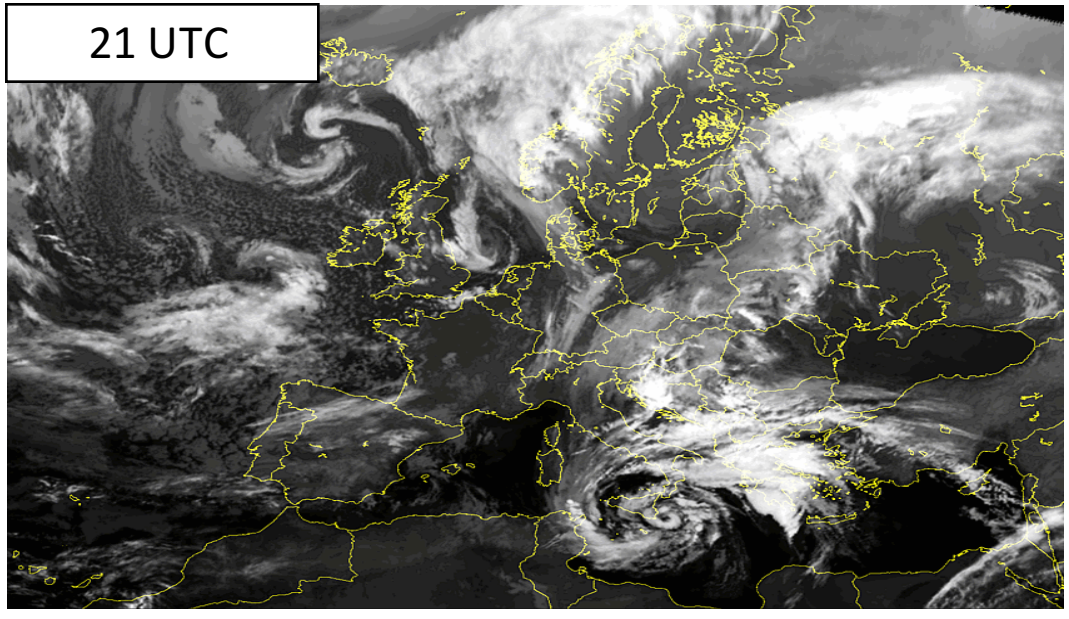
SYNOPTIC SITUATION OF THE EVENT

- Infrared Meteosat Second Generation imagery on 7 November 2014





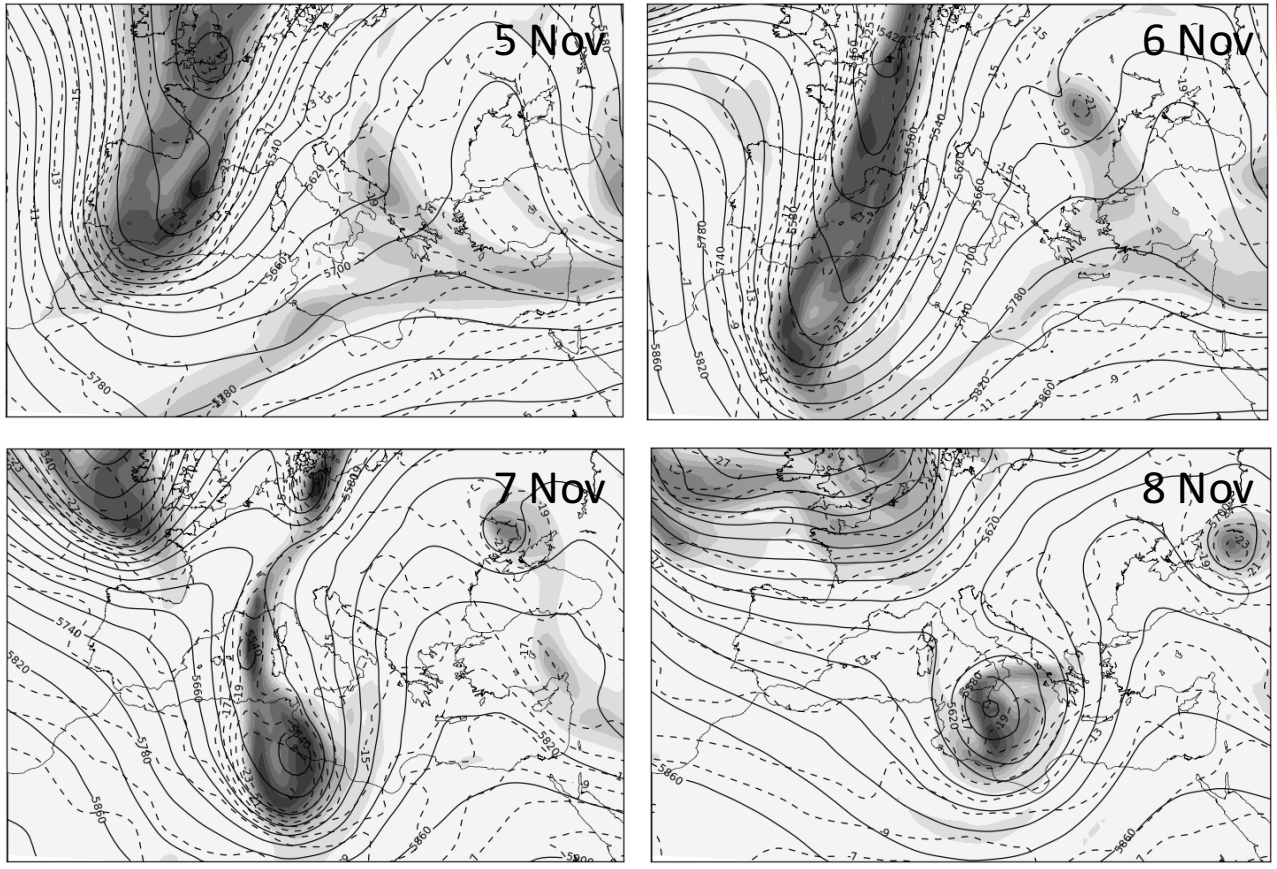


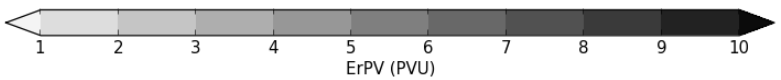


SYNOPTIC SITUATION OF THE EVENT

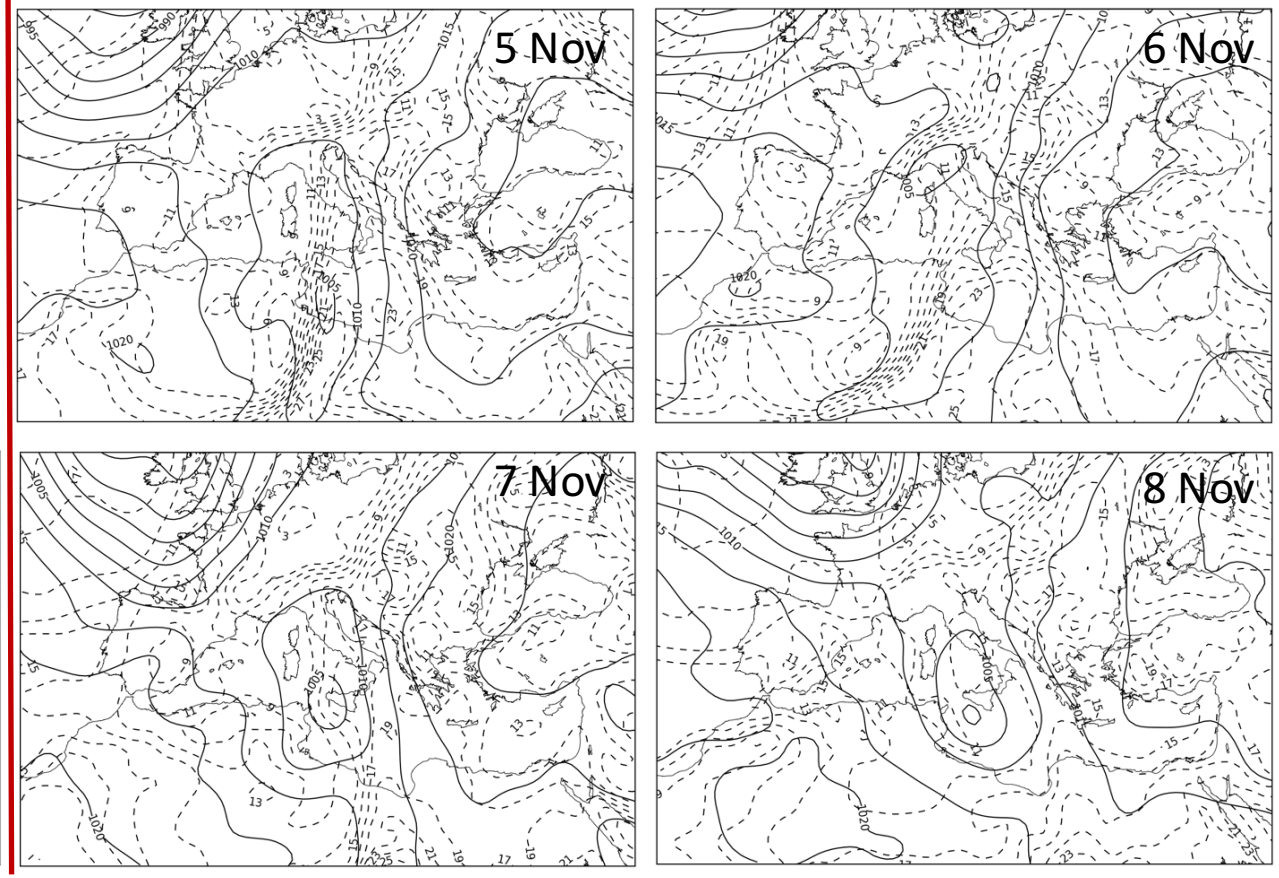
- GFS analyses from NCEP used to diagnose synoptic event **from 5 to 8 November 2014 at 00 UTC**

Potential Vorticity (300 hPa; shaded), **geopotential** (solid lines) and **temperature** (dashed lines) at **500 hPa**



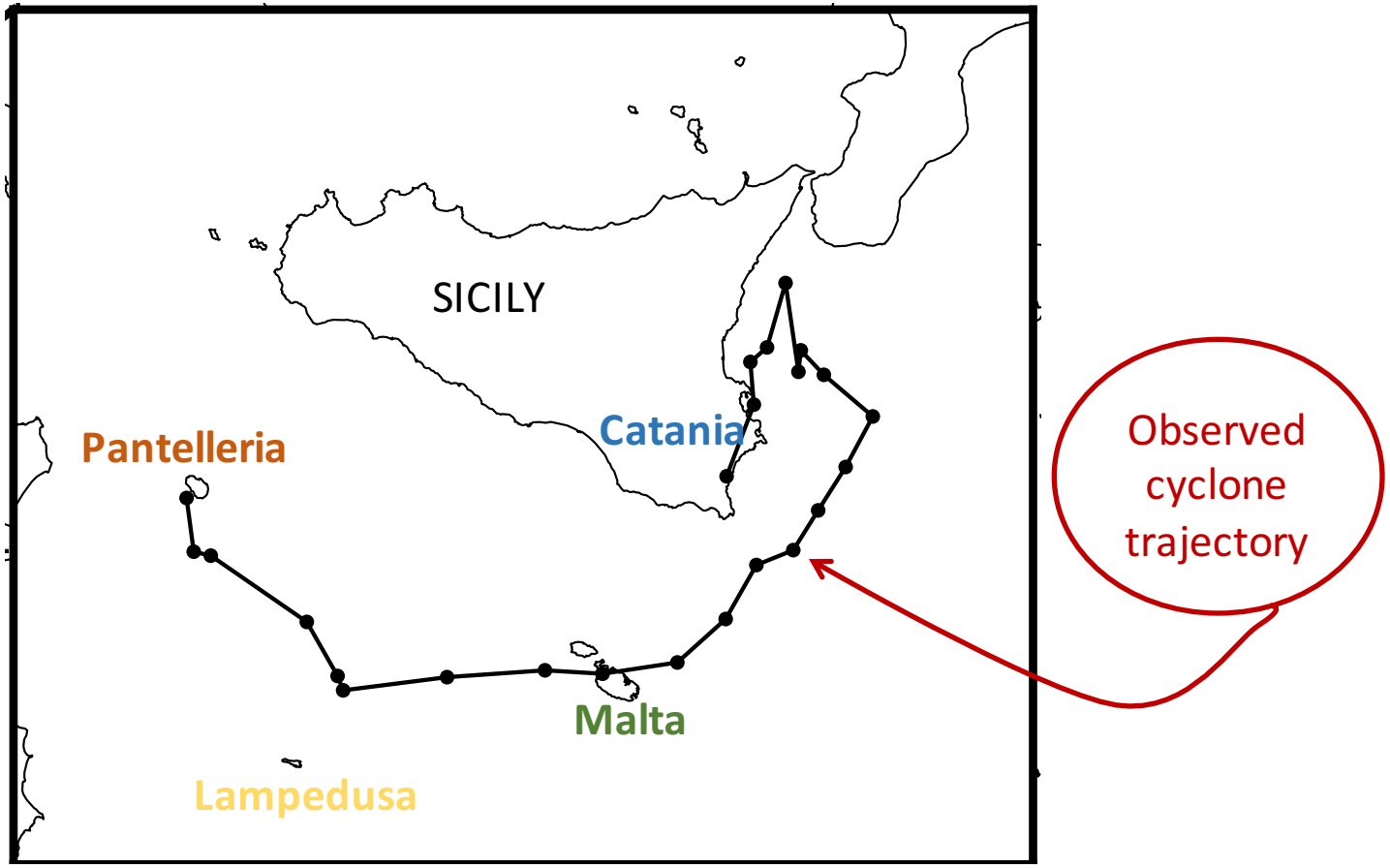


Temperature (**925 hPa;** dashed **lines**) and **MSLP** (solid lines)



AVAILABLE OBSERVATIONS

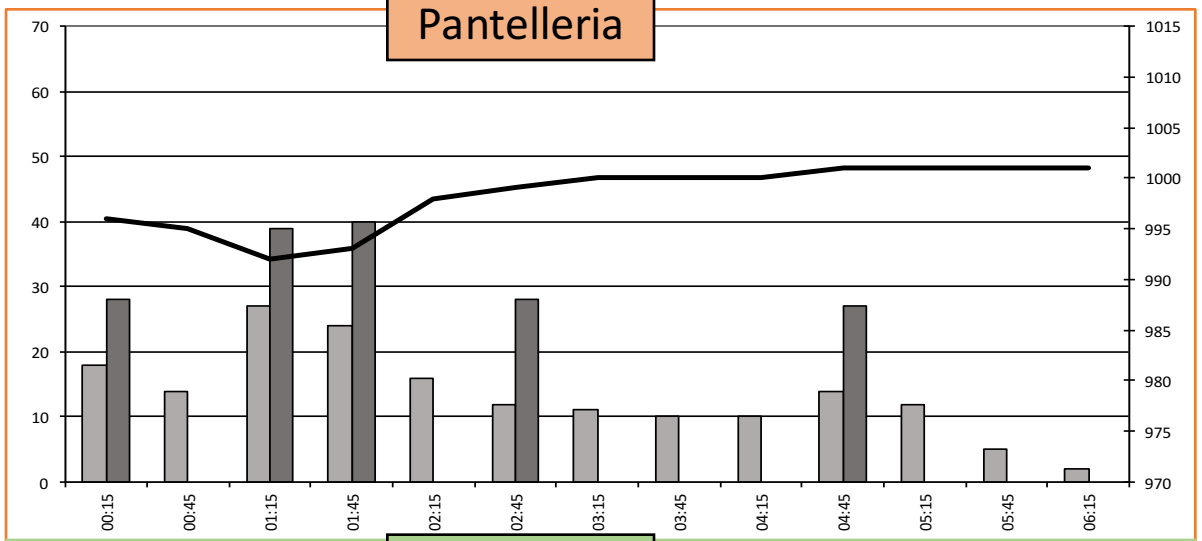
- Limited number of in-situ observations available
- We use METARs observations from:



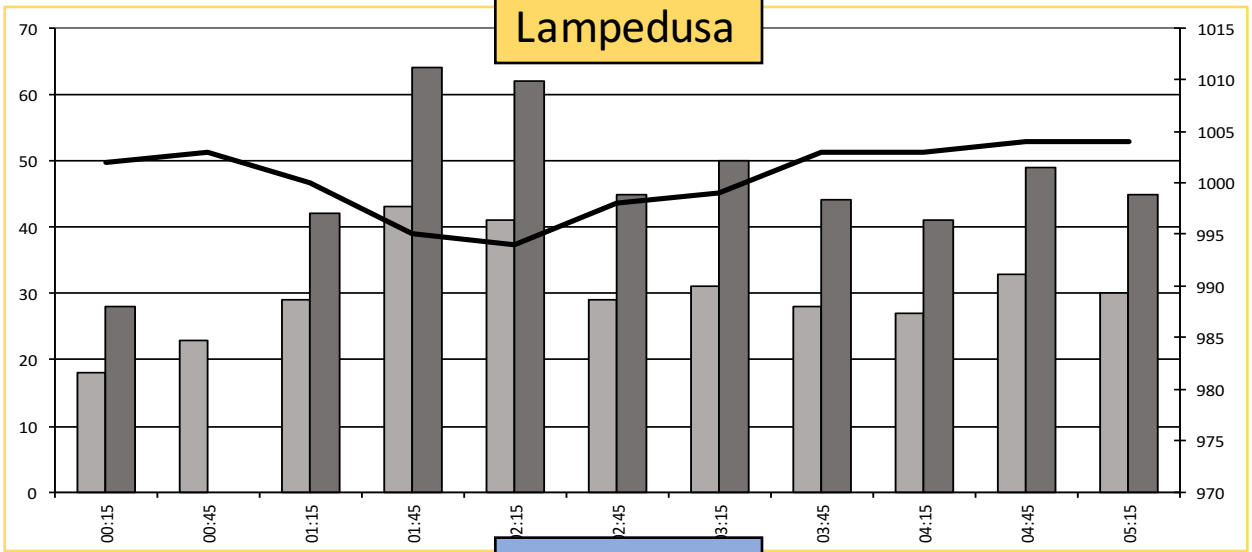
AVAILABLE OBSERVATIONS

- METAR observations: **surface pressure** (hPa, solid line), **sustained and gust winds** (m s-1, light and dark grey bars resp.)
- Indicated times in UTC of 7 November 2014

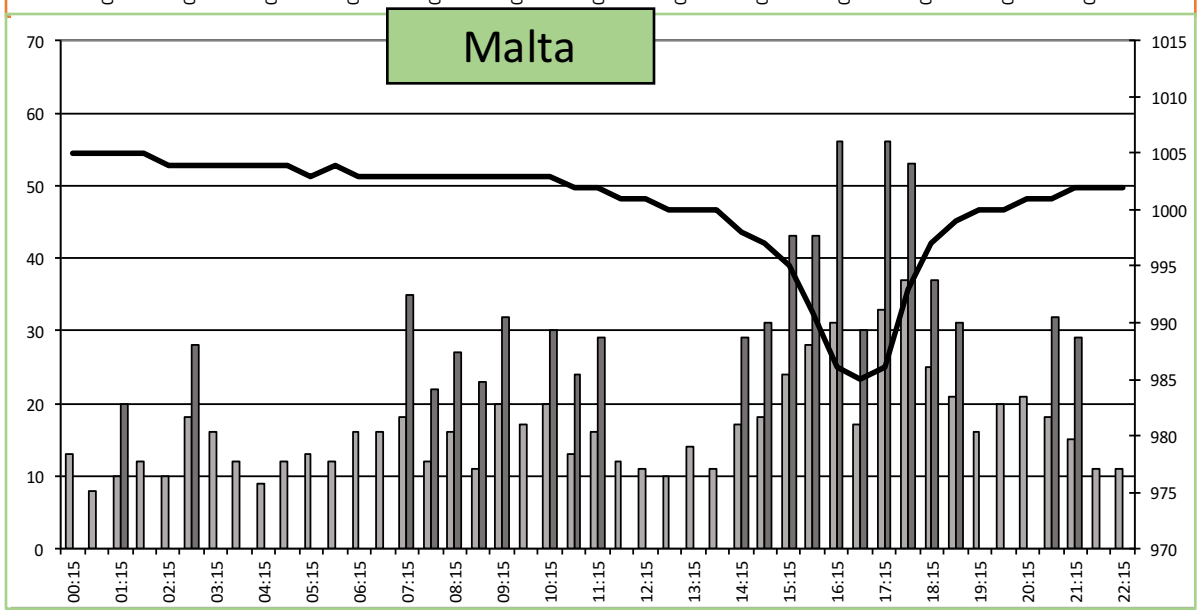
Pantelleria



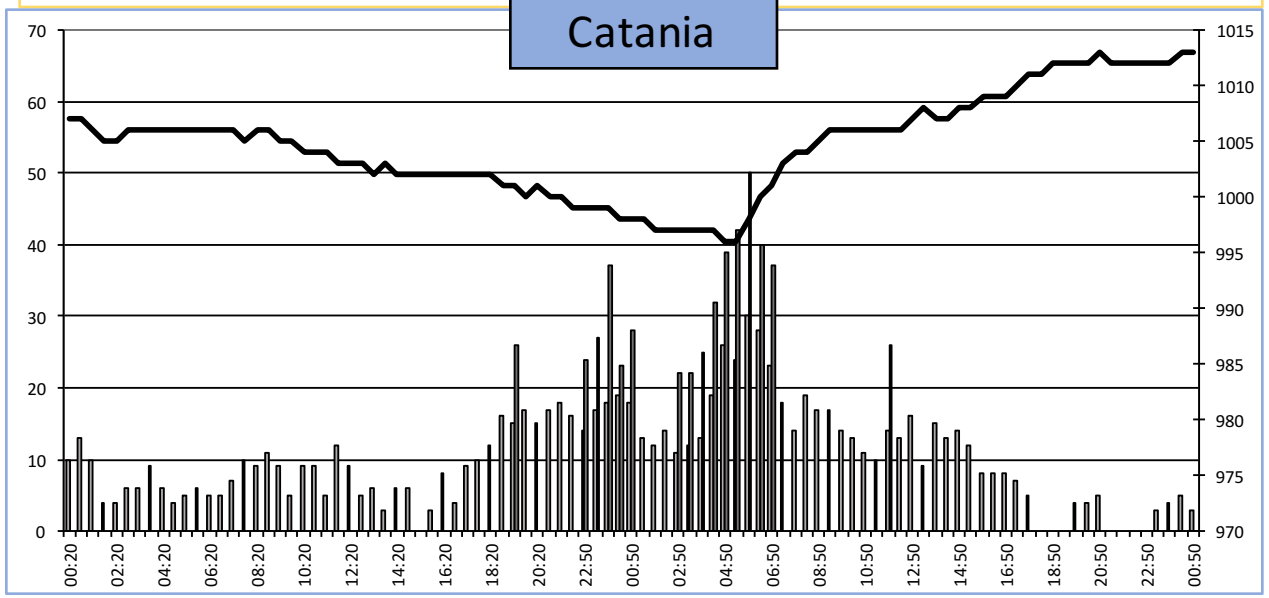
Lampedusa



Malta



Catania

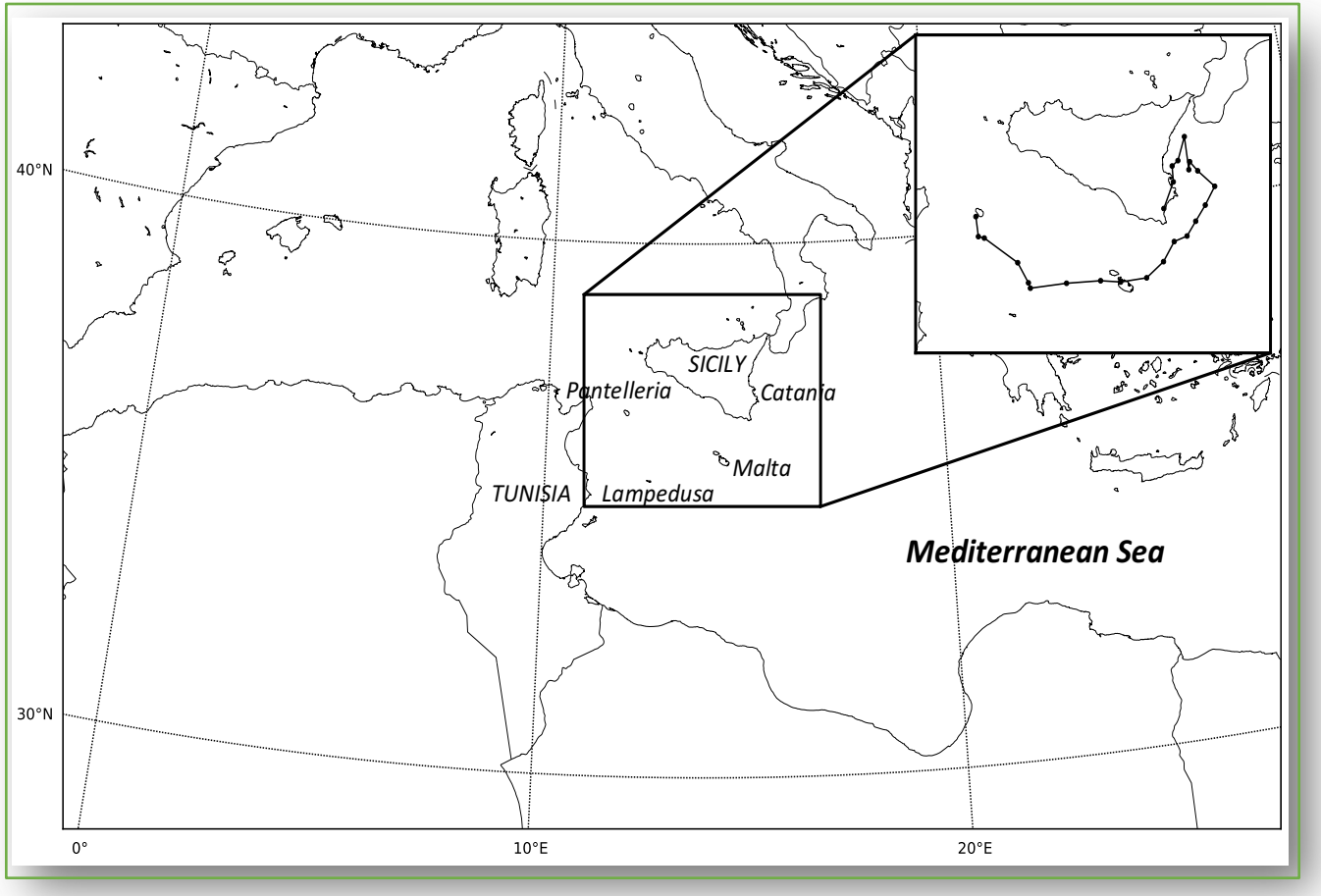


HIGH-RESOLUTION CONTROL RUN: Model Configuration

Model Configuration:

- **WRF-ARW** model V3.4: Fully compressible, non-hydrostatic model
- Initial and Boundary Conditions from **GFS** (0.5º horizontal grid resolution)
- $\Delta x = \Delta y = \mathbf{2.5}\ \boldsymbol{km}$
- Grid size: 1040x640
- 30 terrain-following etha levels up to 50 hPa

- Start simulation time: 00 UTC 7 November 2014
- End simulation time: 18 UTC 8 November 2014



Physic Parameterizations:

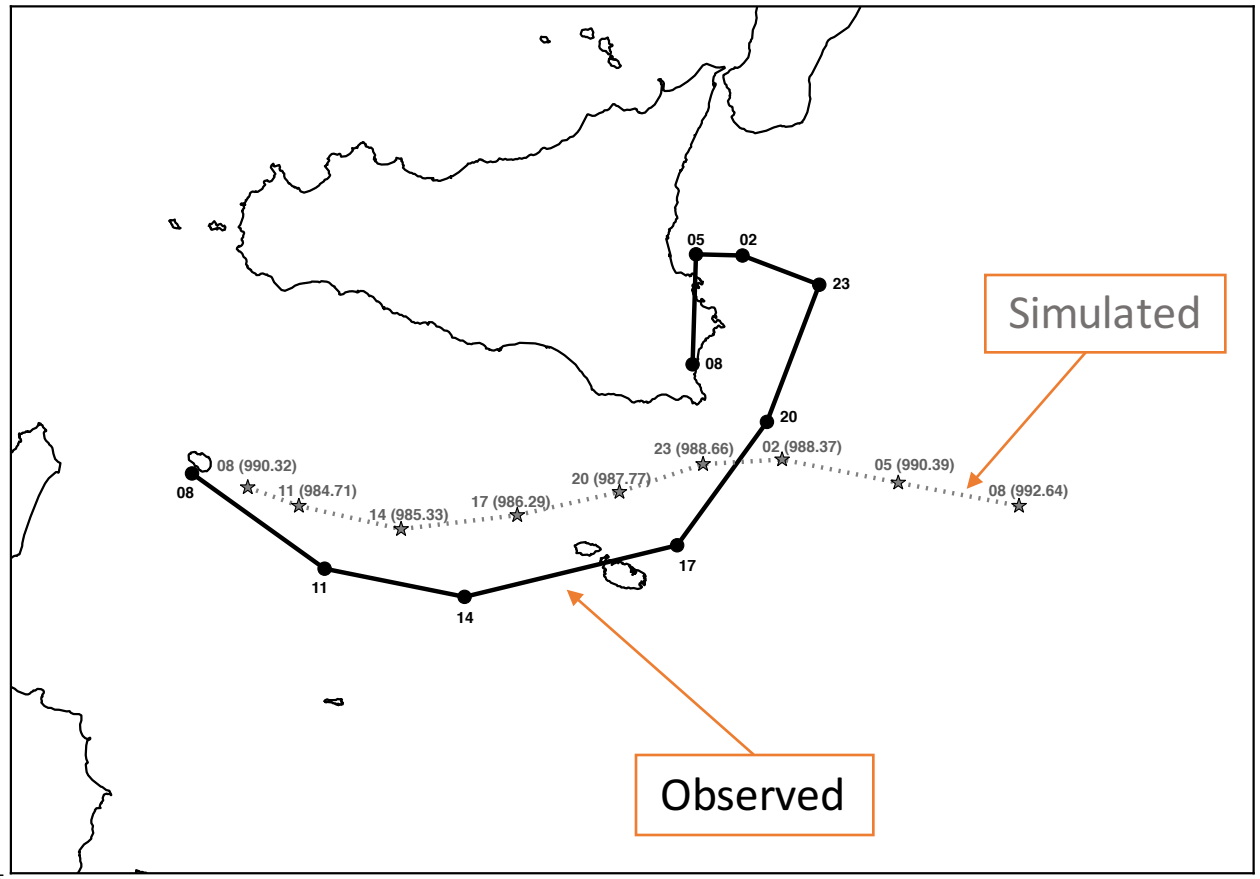
- Microphysics: **Single-Moment Thompson**
- SW/LW: **RRTMG** radiation scheme
- PBL: Second-Order scheme Mellor-Yamada Nakanishi and NIINO LEVEL 2.5 (**MYNN2**)

HIGH-RESOLUTION CONTROL RUN: Diagnosis and Verification

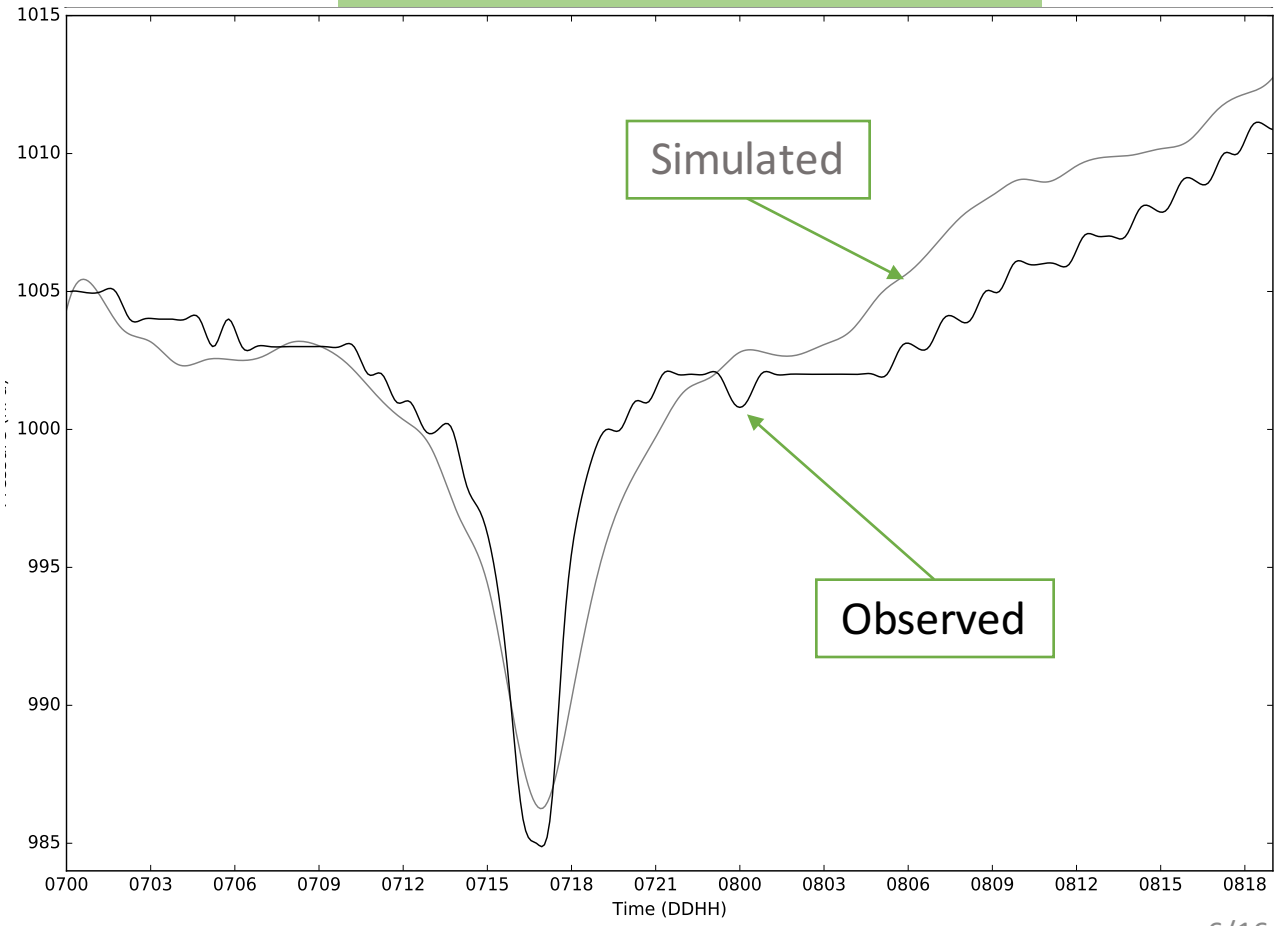
Control run VS Observations:

- Comparison from 7 Nov 08 UTC to 8 Nov 09 UTC

Minimum surface pressure trajectory



Cyclone-Centre pressure in Malta



HIGH-RESOLUTION CONTROL RUN: Diagnosis and Verification

Air-Sea Fluxes Role:

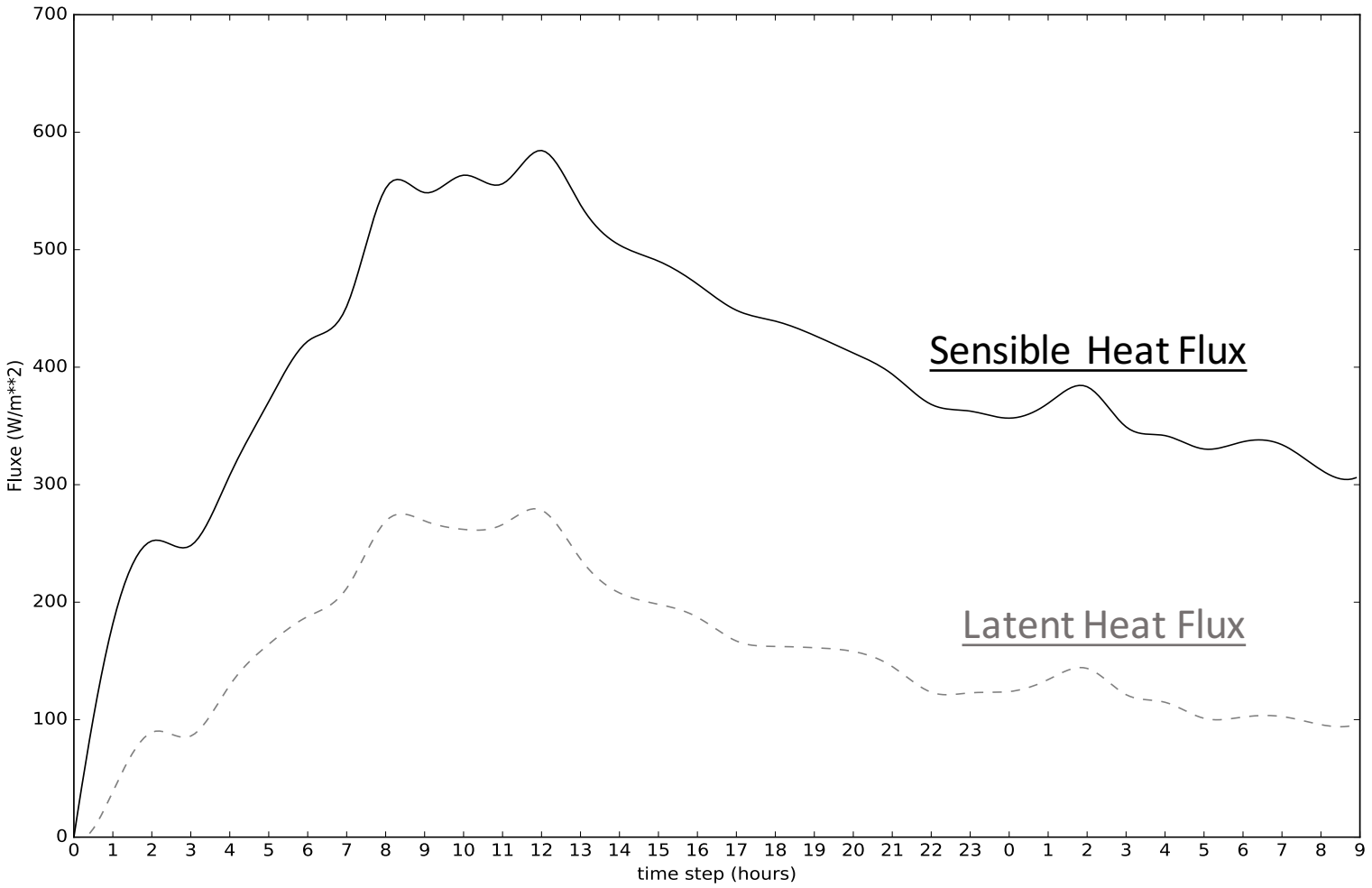
Crucial during lifecycle of quasi-tropical cyclones

Fluxes calculated over a **100 km x 100 km** arround simulated cyclone center

- Maximum values of **latent heat fluxes** ~300 W m^{-2}

- Maximum values of **sensible heat fluxes** ~600 W m^{-2}

Temporal evolution heat fluxes from 00 UTC 7 to 09 UTC 8 November



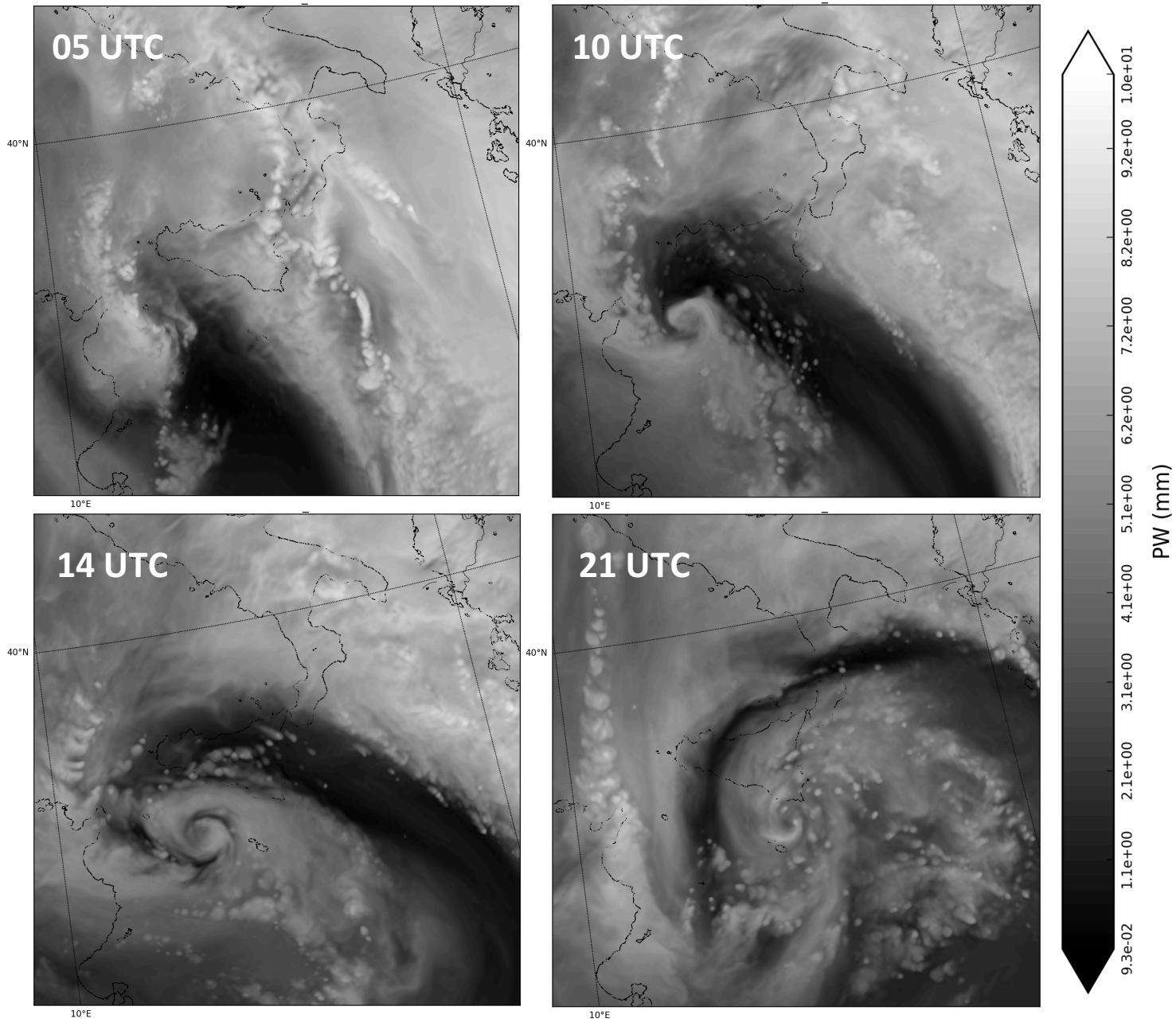
HIGH-RESOLUTION CONTROL RUN: Diagnosis and Verification

Precipitable Water (pseudo product satellite imagery):

Integrated over **650-200 hPa** on **7 November 2014**

$$PW = g^{-1} \int_{p_{650}}^{p_{200}} q \, dp$$

- Match **the shape, location and time** of those observed over satellite images!
- **Upper-air dry intrusion** curling around low-pressure center
- Clear transition to an **axisymmetric cloud-free eye**

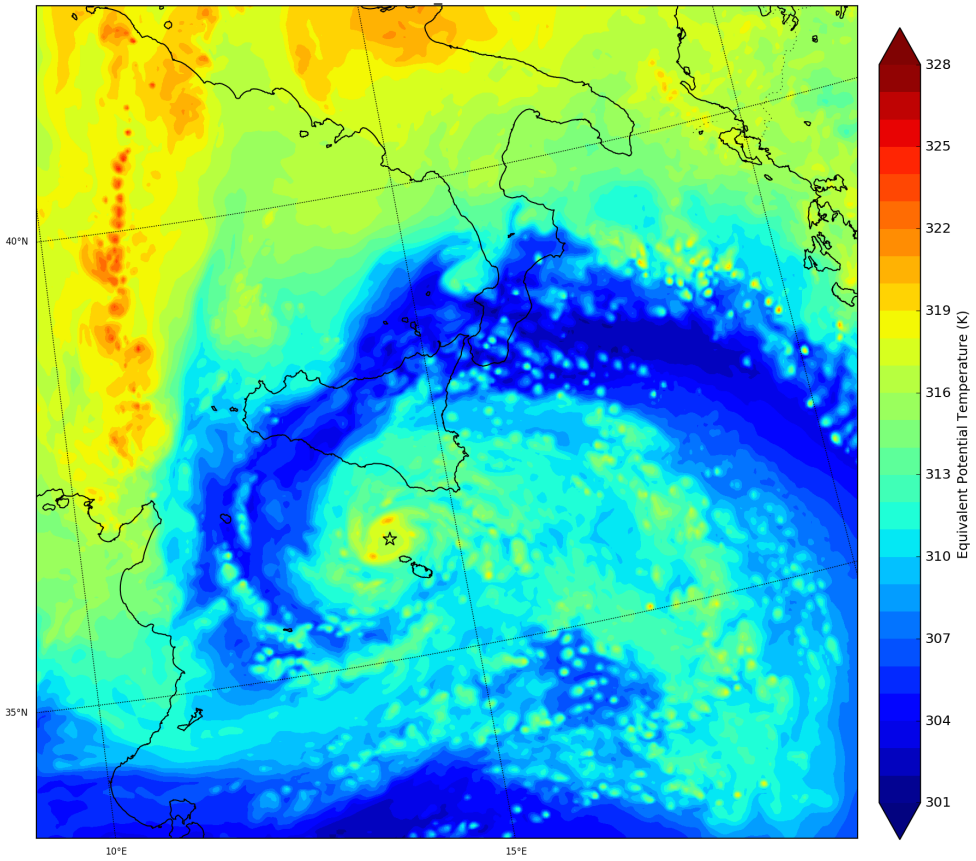


HIGH-RESOLUTION CONTROL RUN: Diagnosis and Verification

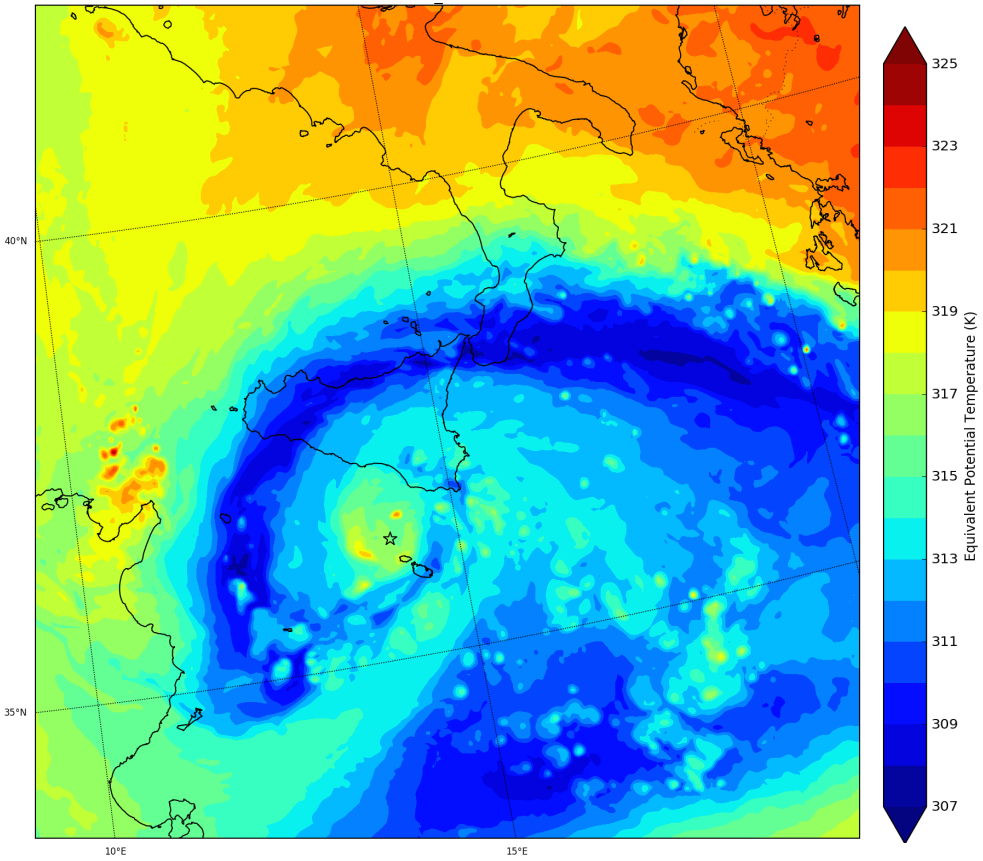
Equivalent Potential Temperature

Clear **warm-core anomaly** (characteristic quasi-tropical Mediterranean cyclones) on **7 November at 18 UTC**

CONTROL EXP
(700 hPa)



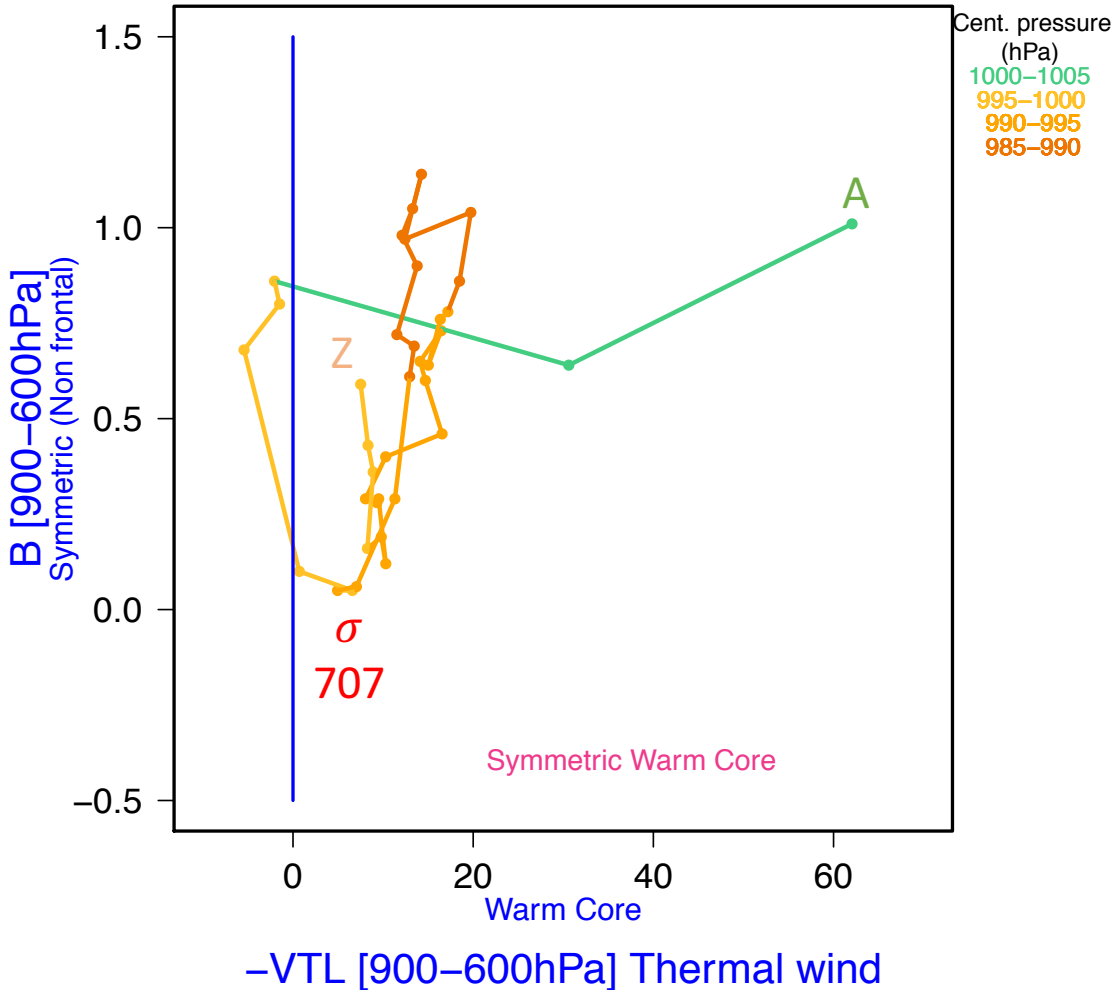
CONTROL EXP
(500 hPa)

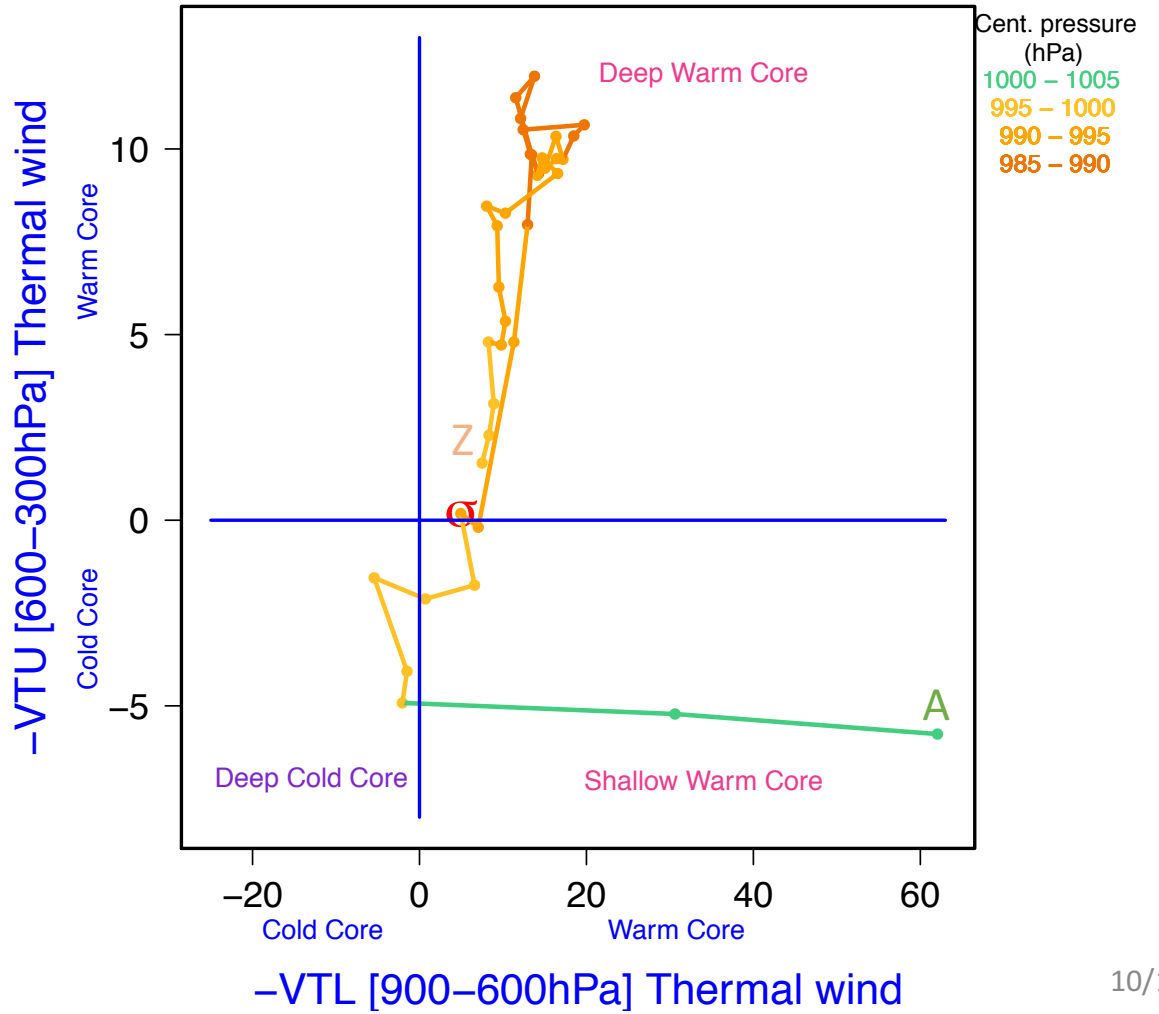


HIGH-RESOLUTION CONTROL RUN: Diagnosis and Verification

HART's Phase Diagram

- HART's mesoscale-adapted version (Picornell et al., 2014)





SENSITIVITY EXPERIMENTS

We are interested in investigate the role of:

- **Baroclinicity (**intense upper-level trough with associated vorticity advection)
- **Diabatic Proceses (**symmetric eye and the cloud structure surrounded with convective activity)

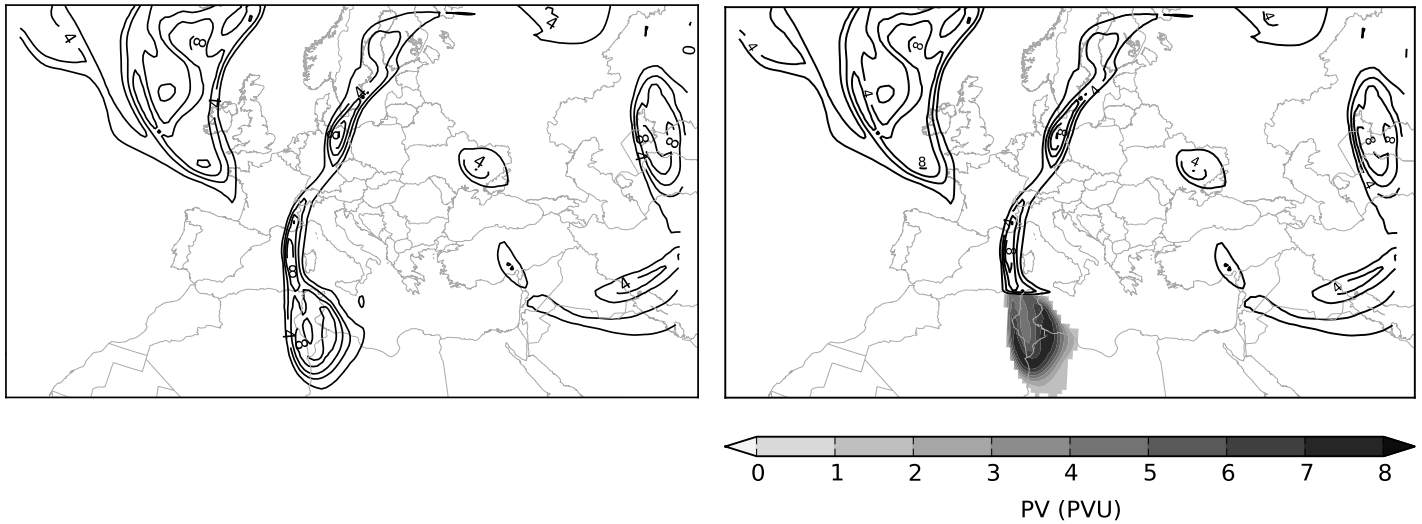
Configuration of the sensitivity experiments

Experiment	Latent-heat release	Sfc.-heat fluxes	PV anomaly
EXP_CNTR	1	1	1
EXP_NLH	**0**	1	1
EXP_NSFL	1	**0**	1
EXP_PV	1	1	**0**

SENSITIVITY EXPERIMENTS: Reduced upper-level PV experiment (EXP_PV)

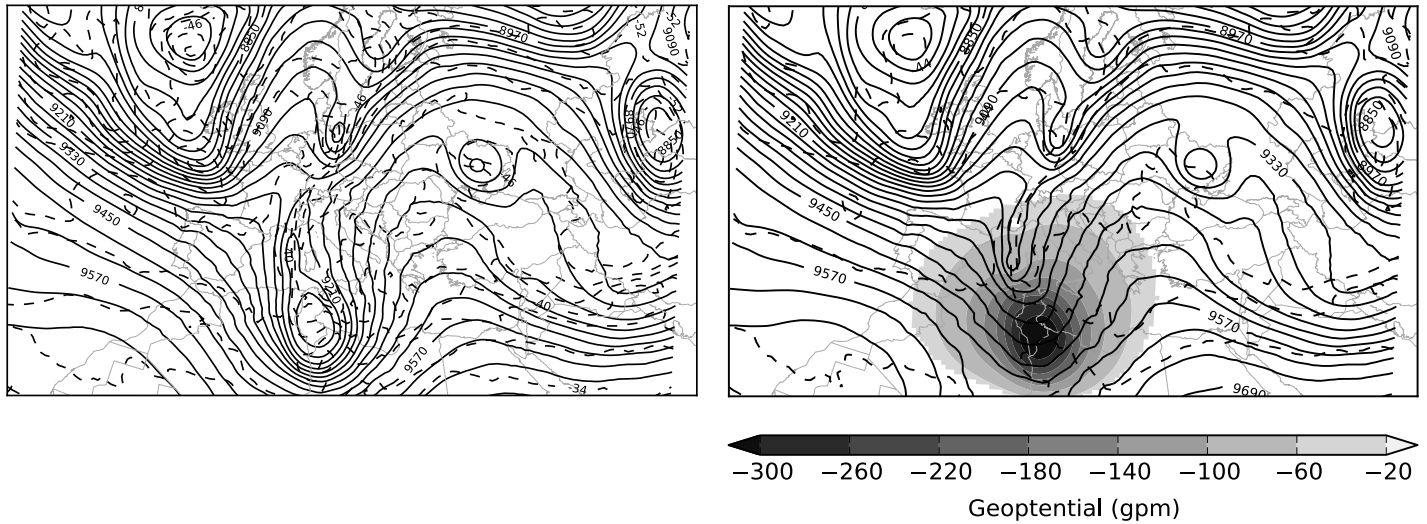
- Reduce upper-level dynamic forcing
- PV-Inversion technique of Davis and Emanuel (1991) -> Generate new initial conditions at 00 UTC on 7 November 2014
- PV anomaly defined with respect to the zonal mean

EXP_CONTROL:
Potential Vorticity
at 300 hPa



EXP_PV:
Potential Vorticity
at 300 hPa

EXP_CONTROL:
Geopotential height and
temperature
at 300 hPa

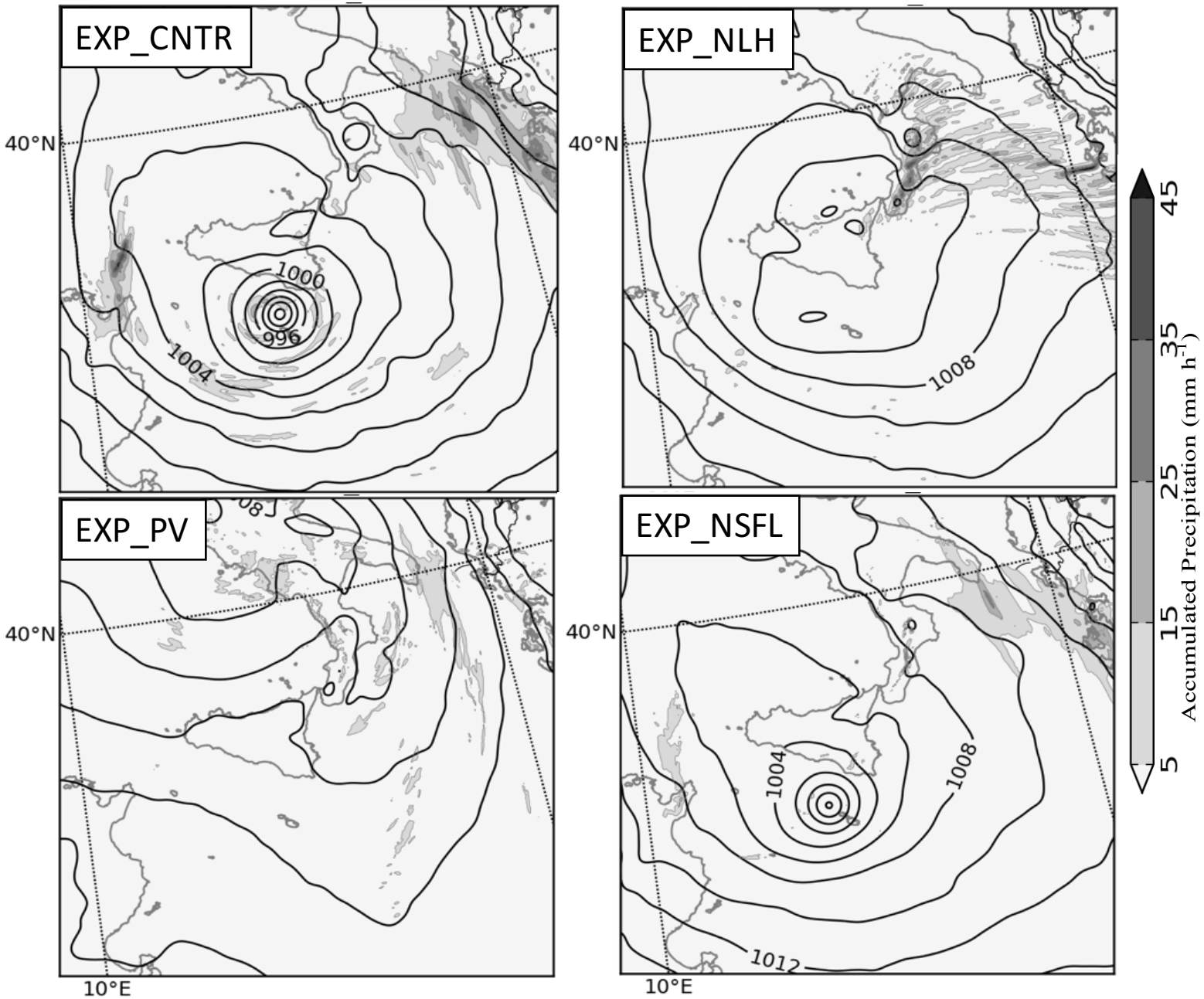


EXP_PV:
Geopotential height and
temperature
at 300 hPa

SENSITIVITY EXPERIMENTS: Results

- Results showed at **18 UTC 7 November:**
- Comparison **MSLP** among experiments
- **EXP_NSFL:** No significant differences.
- **EXP_NLH:** Supression intense cyclonic structure.
- **EXP_PV**: Notably differences.

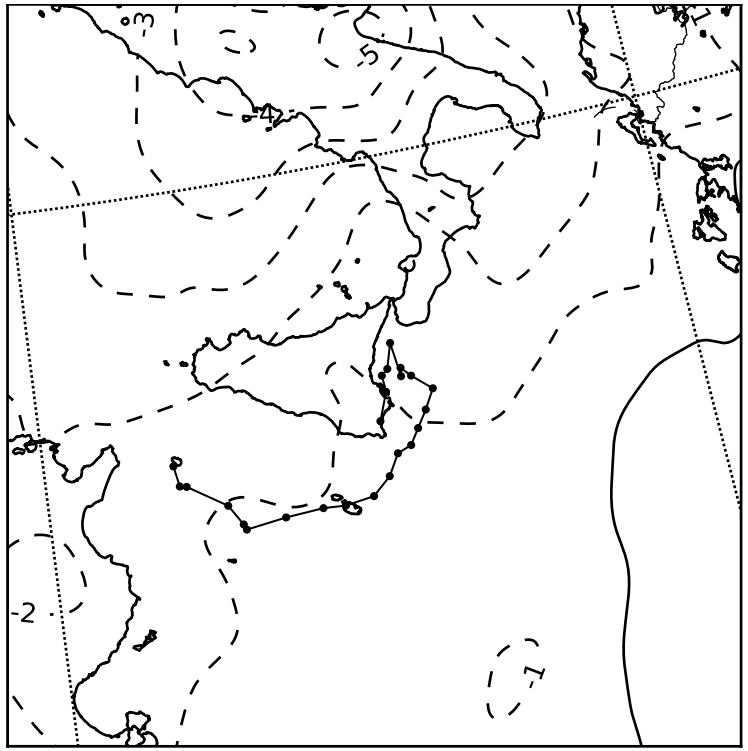
Latent heat release and **dynamic forcing from upper levels** identified as leading factors.



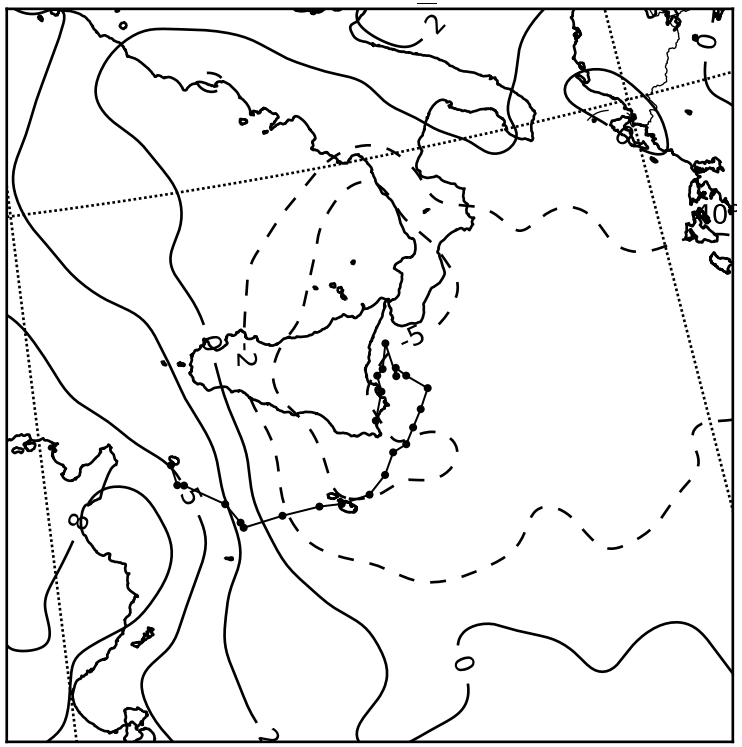
SENSITIVITY EXPERIMENTS: Factor Separation

- We apply **Factor Separation technique** (Stein and Alpert, 1993). Results showed at the time observed cyclone is more intense (**~1800 UTC** on 7 November)

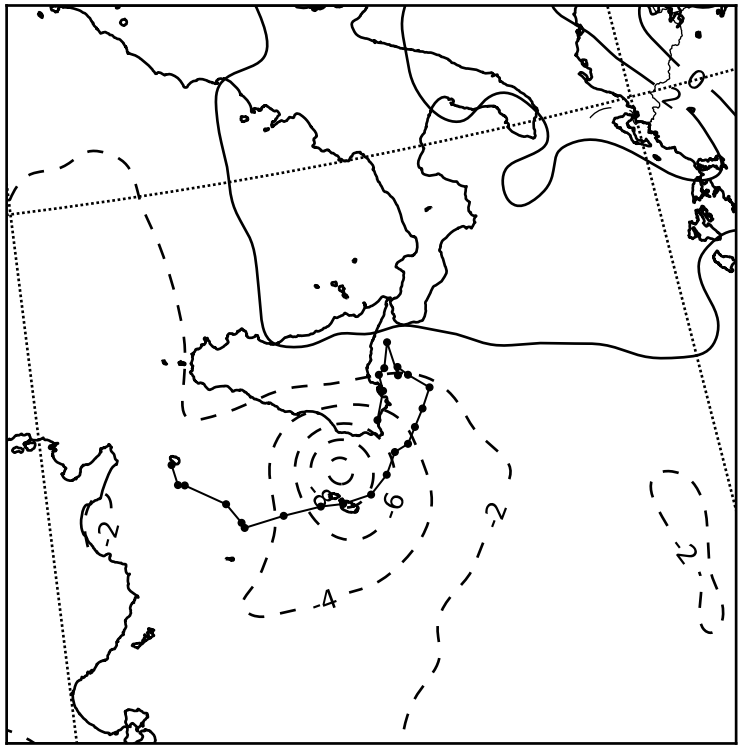
LHR Effect



PV_anomaly Effect



Synergism Effect



SENSITIVITY EXPERIMENTS: Factor Separation

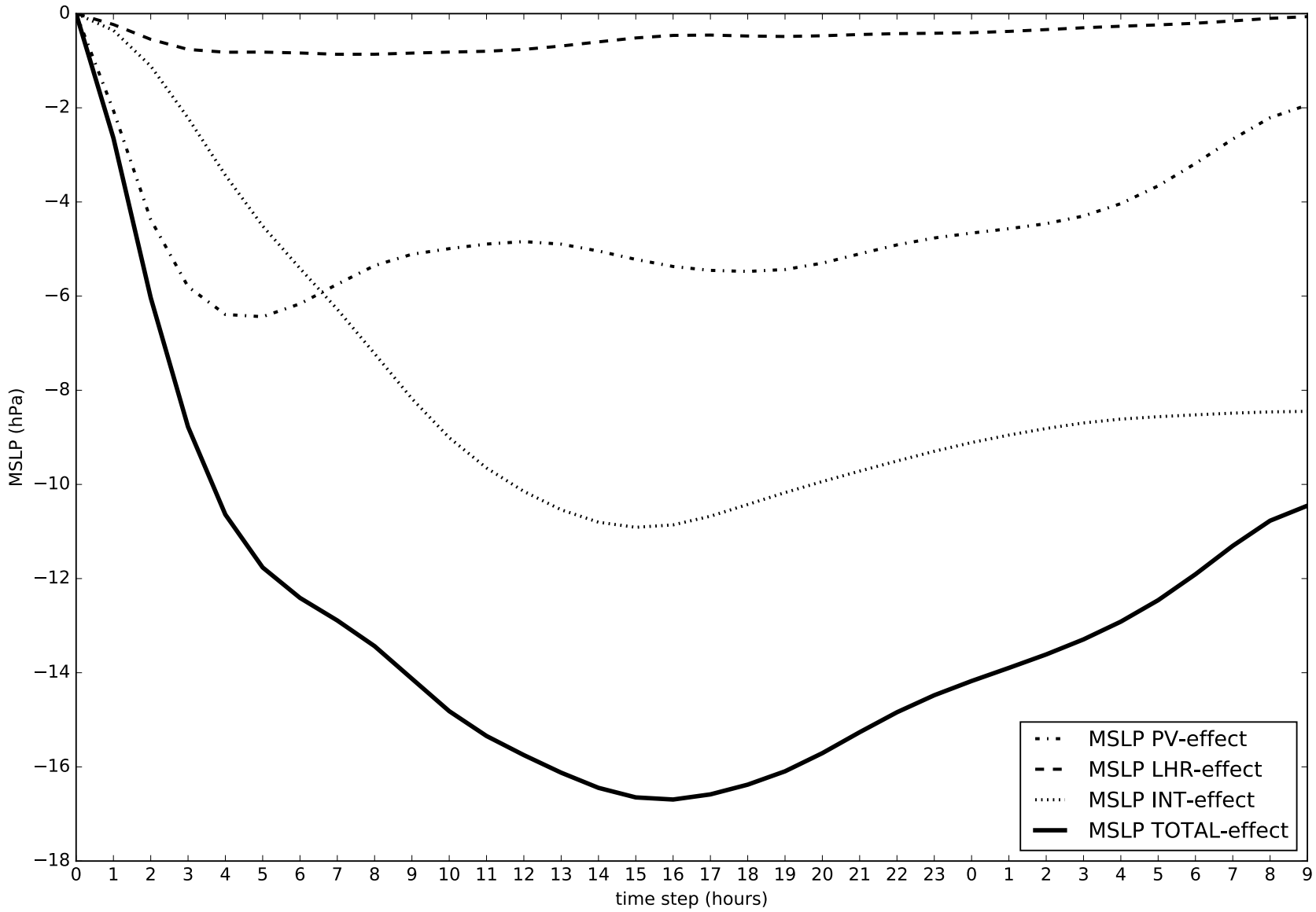
- Time evolution of the **cyclogenetic effects** of the three factors over the EXP_CNTR low pressure system

- PV anomaly effect dominates during first 5 hours.

- LHR effect does not contribute significantly

- Synergy effect becomes progressively the leading factor for the cyclogenesis

- Development 'Meteorological Bomb' (> 16.7 hPa/24h) for latitude of 37º.



CONCLUSIONS

- Available observations (METARs and IR satellite imagery) reveal the formation of a tropical-like Mediterranean cyclone (medicane).

- Control Run reproduces properly the timing and location of the observed cyclone, performing accurately the observed trajectory and its deepening.

- Hart's diagram shows the transition from a shallow-warm to a deep-warm symmetric core (medicane).

- Numerical sensitivity experiments using factor separation and PV-inversion reveal the **key role of the PV effect on the cyclogenesis during early stages**, helping to set up a deep convection prone environment requiered for the medicane development.

- Neither latent heat release nor the surface heat fluxes contribute significantly to the genesis or evolution of the quasi-tropical like cyclone.

- The most crucial phase of the **deepening** and circular-shape of the cyclone **is attributable to the synergism between PV and LHR factors.**

- **These results highlight that small and intense cyclonic systems that resemble tropical cyclones must be physically analysed in more detail before they can be classified as medicanes.**

Thanks for your attention!!

AKNOWLEDGEMENTS:

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