3rd MedCyclones Training School

15–19 July 2024

Material and slides prepared by

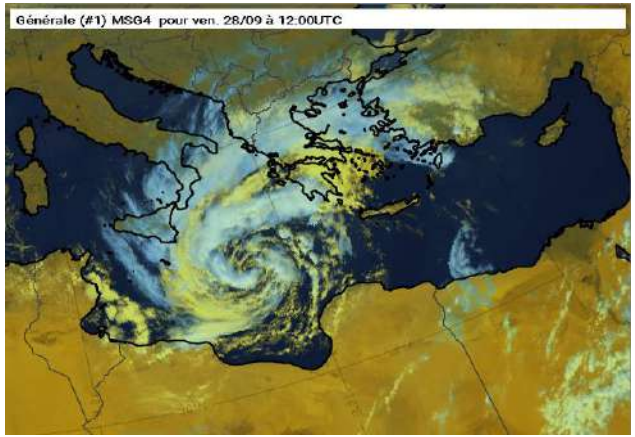
Michaël Kreitz & Frédéric Ferry, Météo-France – Ecole Nationale de la Météorologie (ENM)

Overview of the week

	MedCyclones Workshop			MedCyclones Summer school	
	Monday 15 July	**Tuesday 16 July**	**Wednesday 17 July**	**Thursday 18 July**	**Friday 19 July**
09:30-10:30	Introduction (F. Pantillon and P. Patlakas) Magellan room	Oral session S3 (3 talks) Magellan room	Oral session S6 (3 talks) Magellan room	Practical session 1 Cook and Science Hub	Practical session 4 Cook and Science Hub
10:30-11:00	coffee break	coffee break	coffee break	coffee break	coffee break
11:00-11:45	Introduction (F. Pantillon and P. Patlakas) Magellan room	Oral session S4 (2 talks) Magellan room	Oral session S7 (7 talks) Magellan room	Practical session 2 Cook and Science Hub	Preparing presentations Cook and Science Hub
11:45-13:30	Lecture 1 Mesoscale dynamics (S. Gray) Magellan room	Visit ESA 1st group 11:45-12:15 / Poster session Magellan room			
13:30-14:30	lunch break	lunch break	lunch break	lunch break	lunch break
14:30-16:15	Oral session S1 (5 talks) Magellan room	Oral session S5 (5 talks) Magellan room	Lecture 2 Medicanes (M. Miglietta) Magellan room	Practical session 3 Cook and Science Hub	Student presentations Magellan
16:15-16:45	coffee break	coffee break	coffee break	coffee break	
16:45-18:30	Oral session S2 (5 talks) Magellan room	Visit ESA 2nd group 16:45-17:15 / Poster session Magellan room	Lecture 3 Climate change (D. Faranda) Magellan room	Lecture 4 D. Schultz (remote) Cook and Science Hub	

Outlook of the practical sessions

Case study :
Medicane Zorbas
(september 2018)



Session 1 : Monday 15 July morning

1. Dynamical study of the medicane

Session 2 : Thursday 18 July

1. Storm tracking in ERA5 reanalysis
2. Cyclone Phase Space (CPS) diagrams
3. Analysis and deterministic forecast
4. Ensemble forecast

Session 3 : Friday 19 July morning

1. Preparation of the student presentations

Friday 19 July afternoon: student presentations

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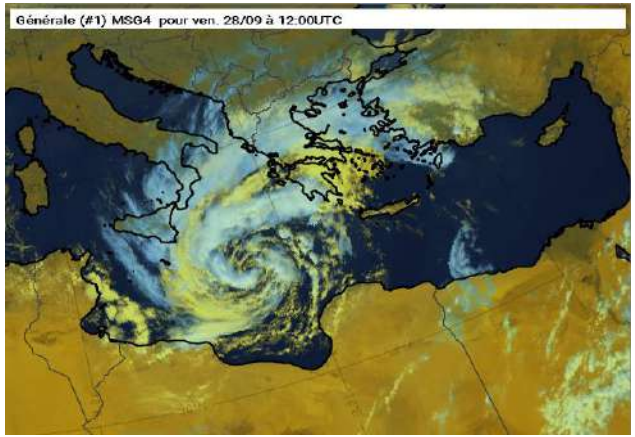

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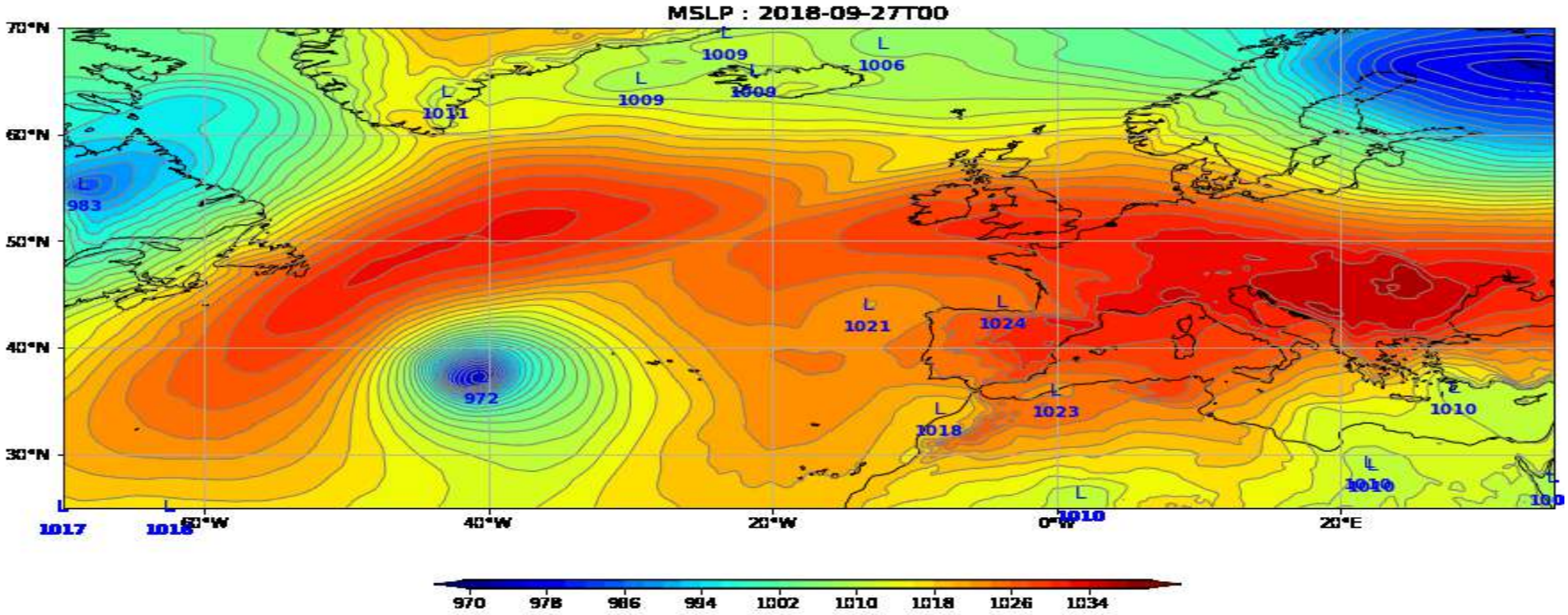
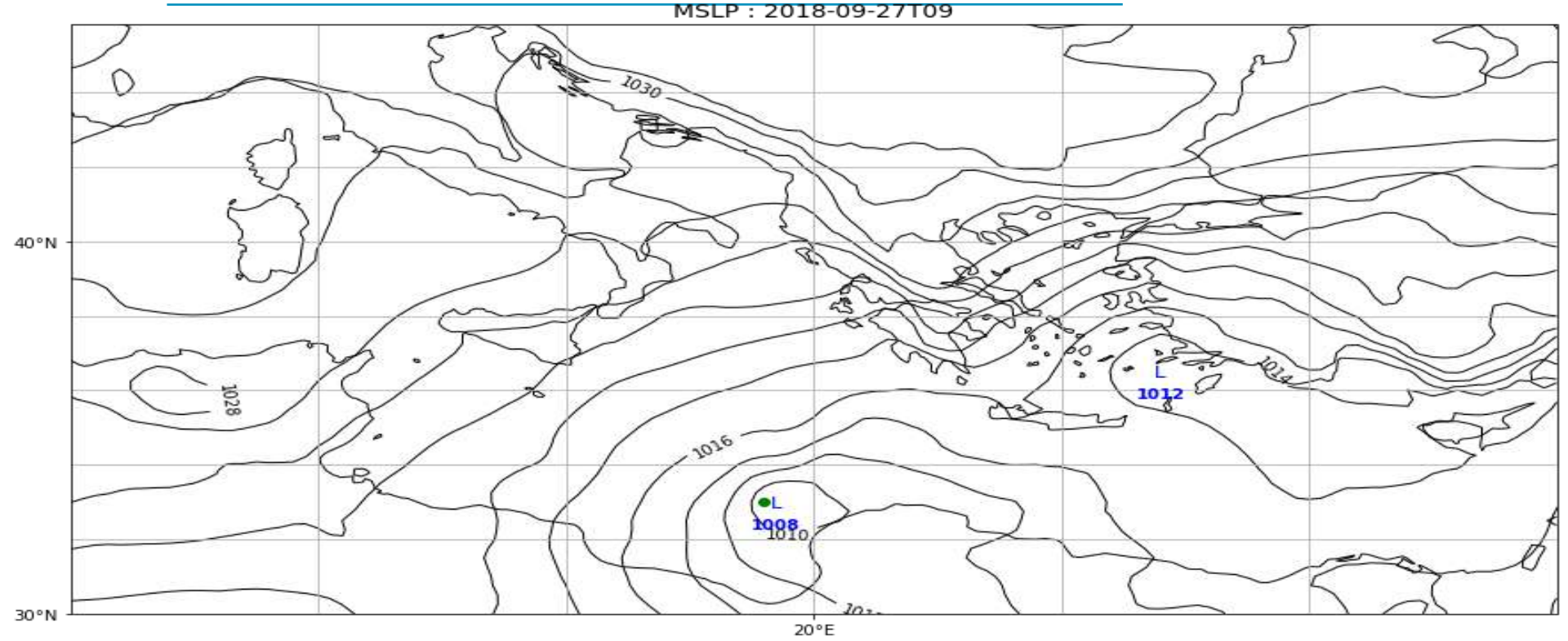
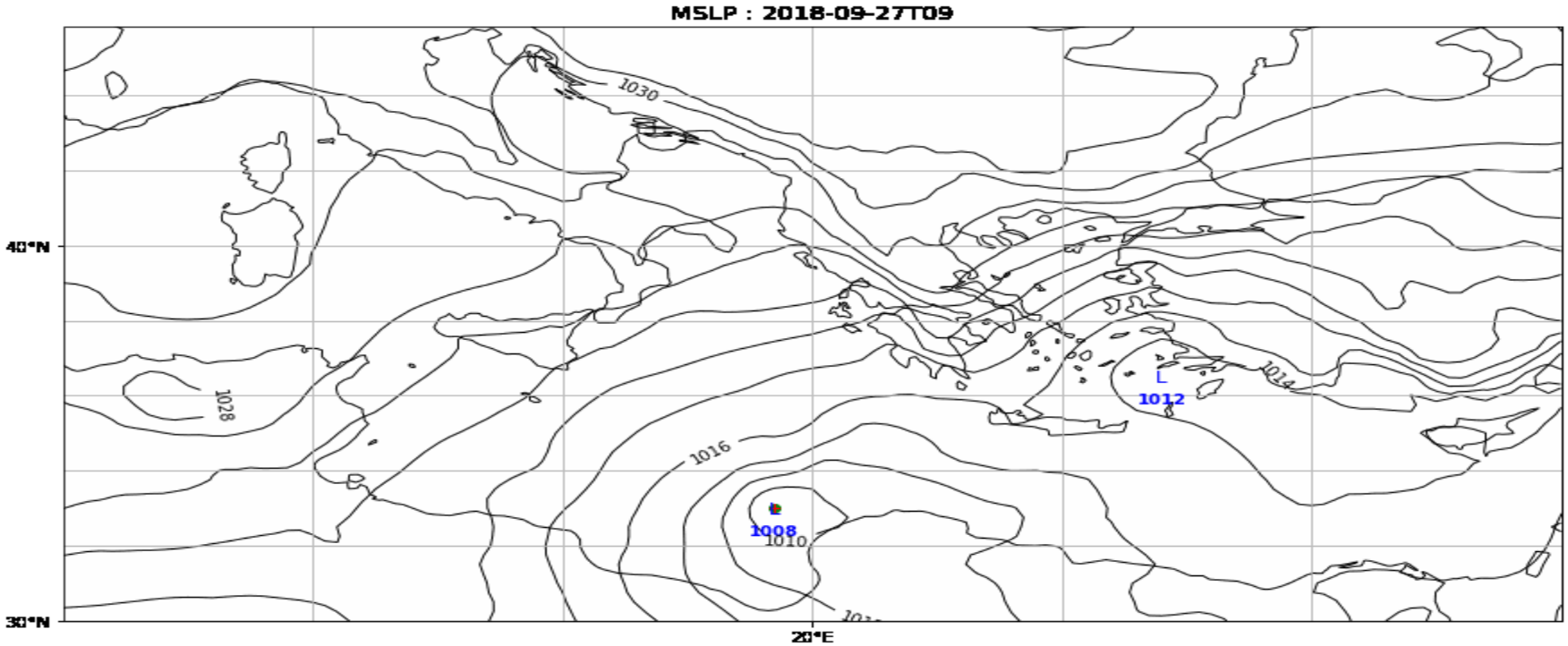
MSLP : large domain



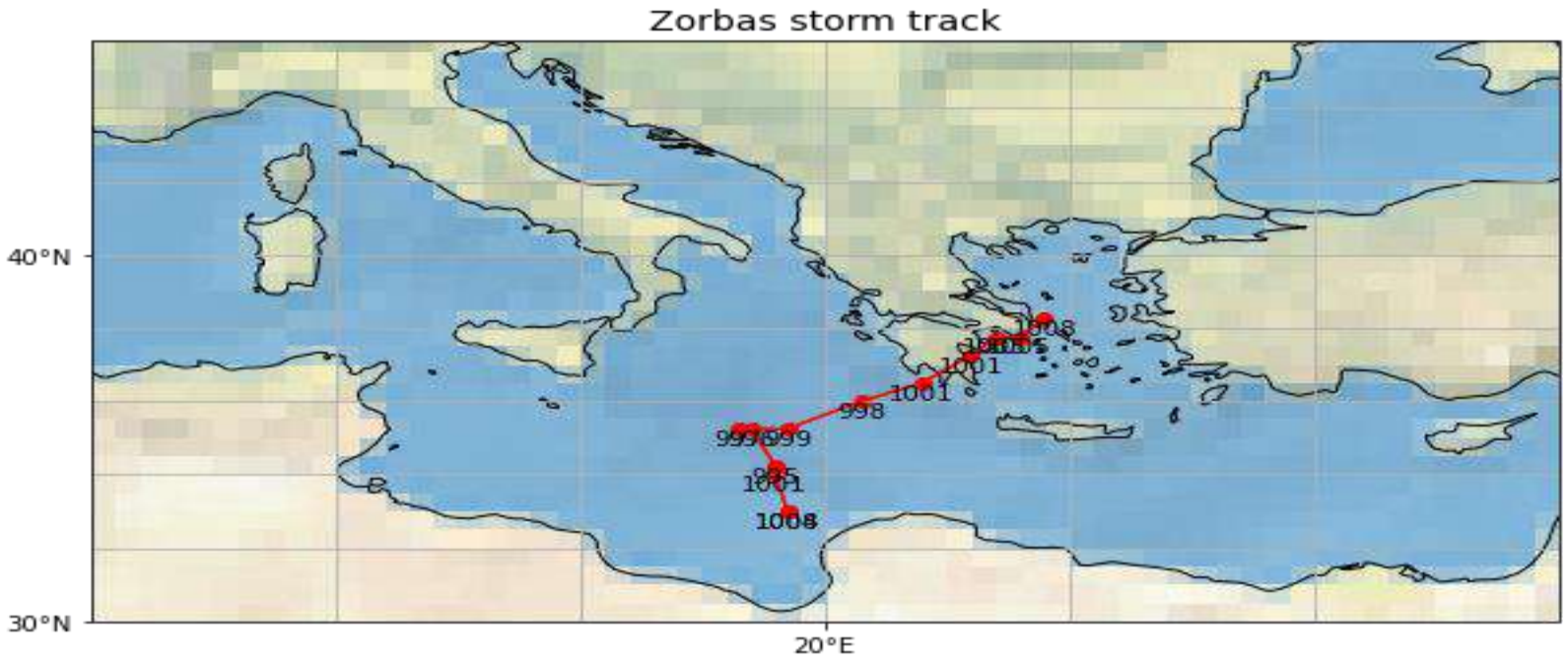
Medicane Zorbas : tracking



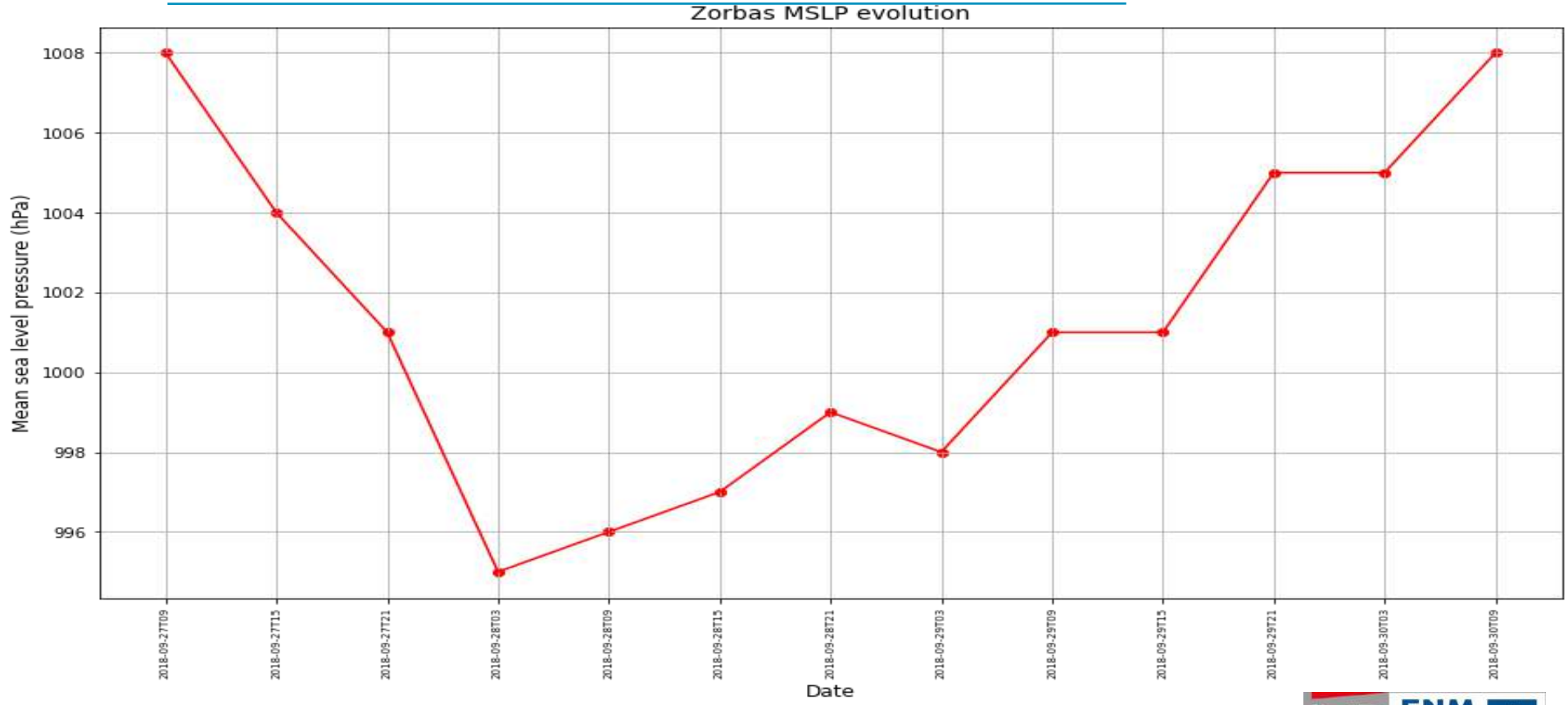
Medicane Zorbas : tracking



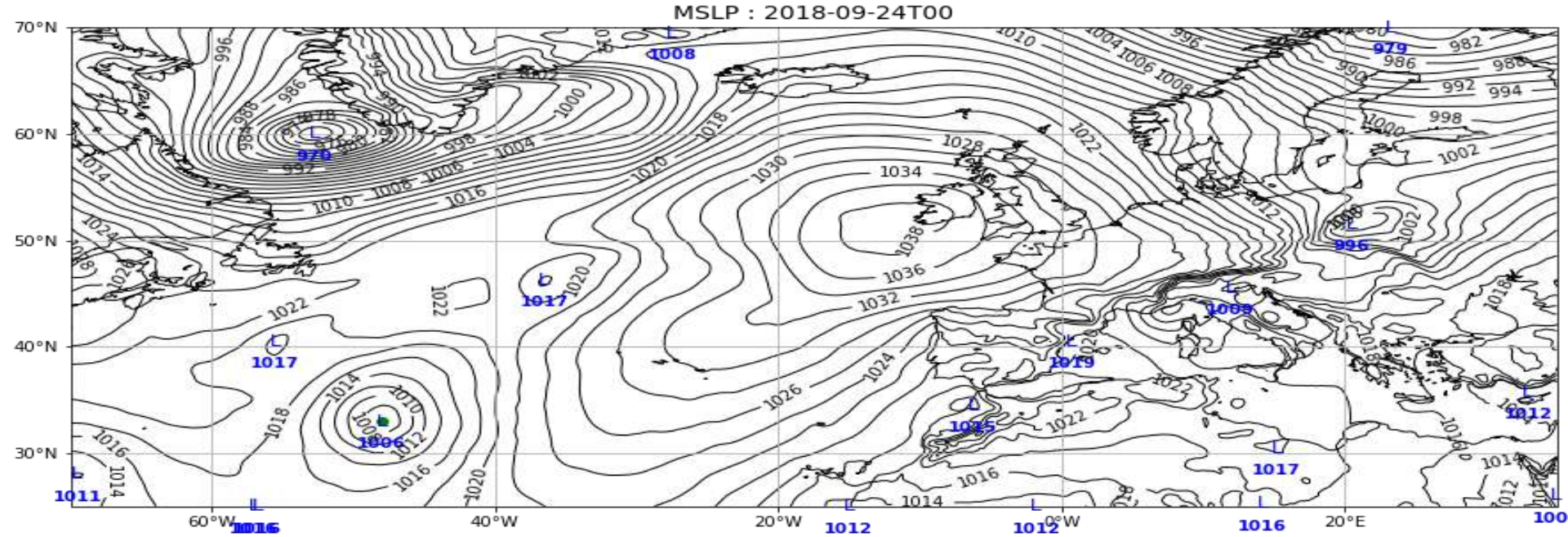
Medicane Zorbas : tracking



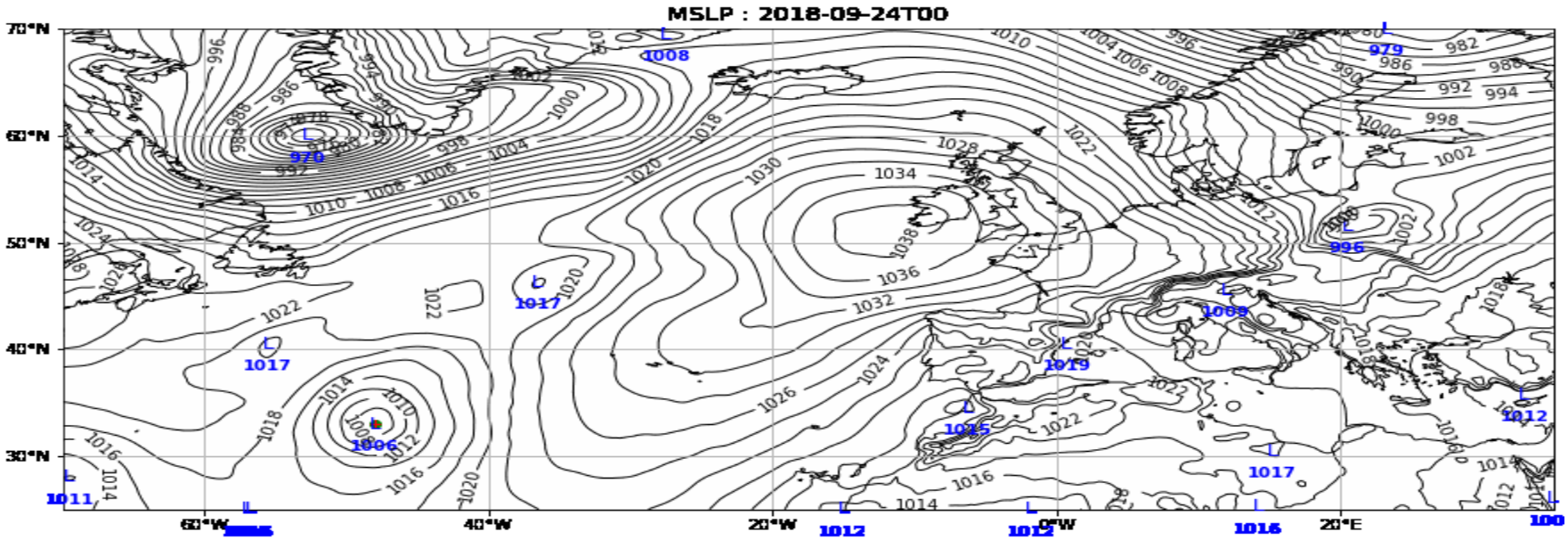
Medicane Zorbas : MSLP evolution



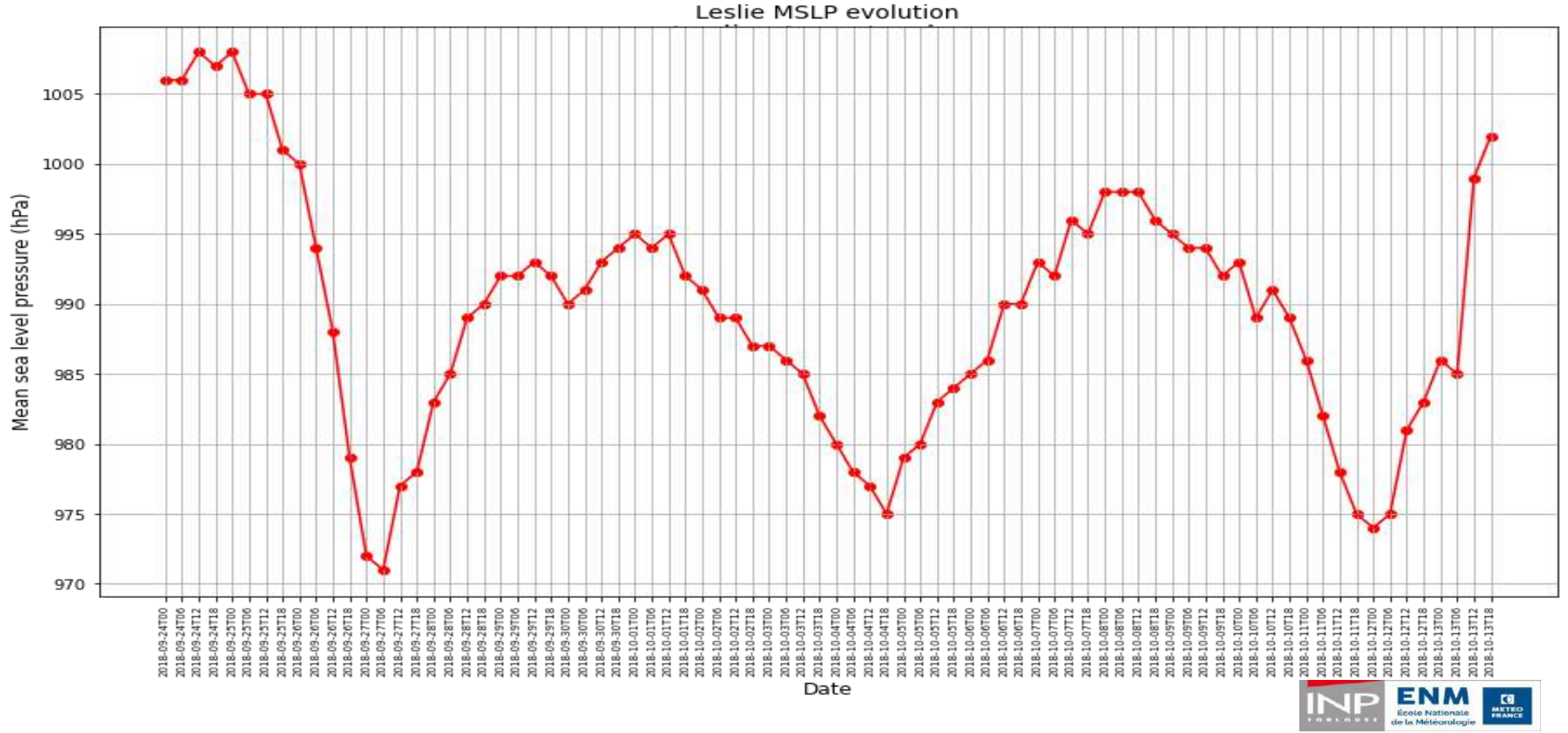
Tracking Hurricane Leslie



Tracking Hurricane Leslie



Tracking Hurricane Leslie



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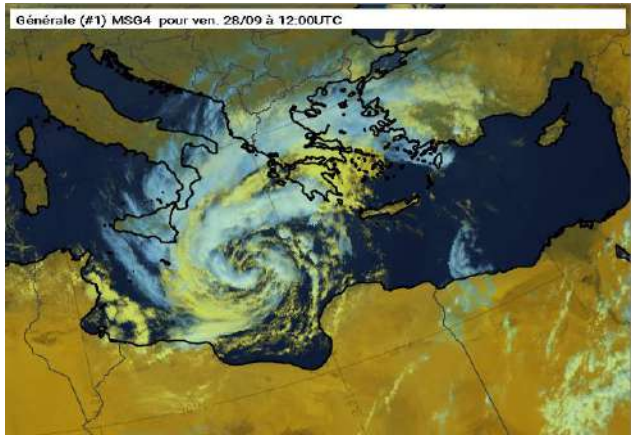

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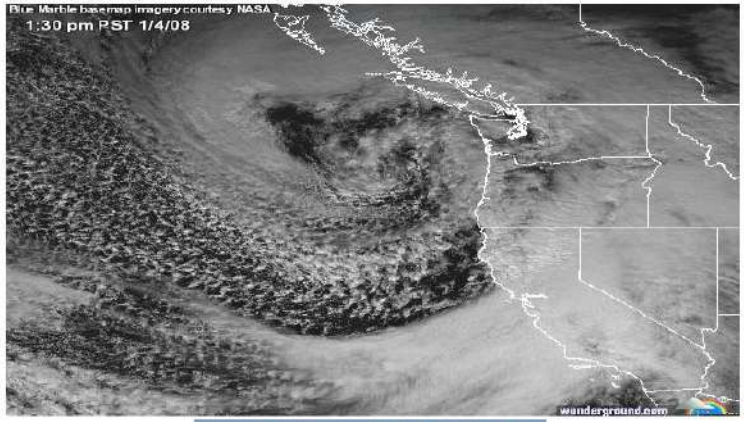
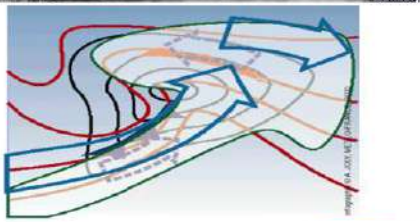
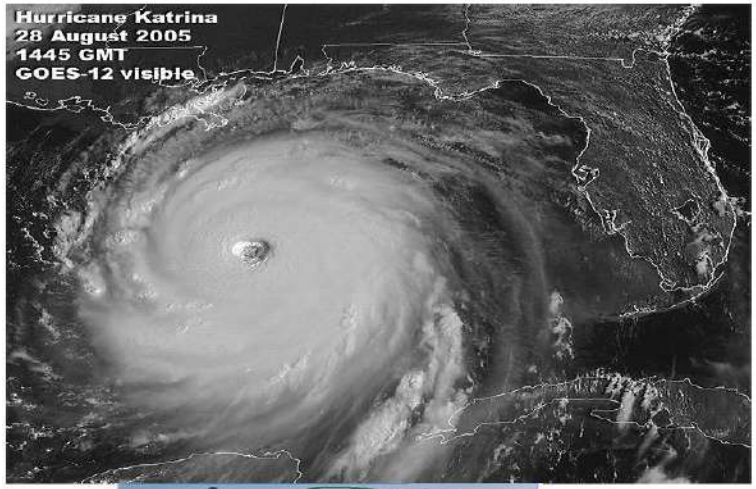
Extratropical cyclone

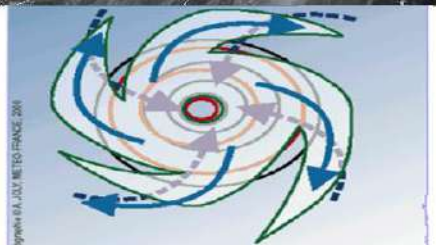




- Evolves at **mid latitudes**.
- Forms by the **interaction of and uper level disturbances and a surface disturbance**.
- Intensify via **baroclinic instability.**
- **Converts the available potential (APE) of the baroclinic zone into kinetic energy of the perturbarionen**.
- **Diabatic effects are of secondary importance**.

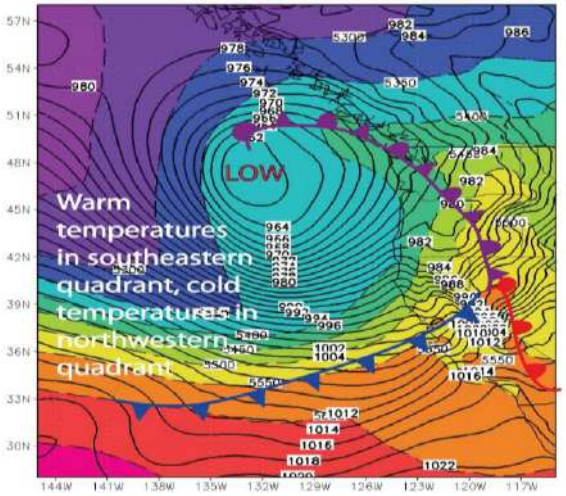
Tropical cyclone





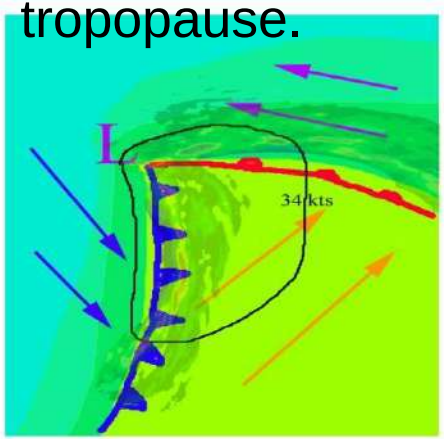
- Evolves at **tropical and subtropical latitudes**.
- Forms via several mecanisms of **convective organization**.
- Intensifies via **convective instability** (**C**onditionnal **I**nstability of the **S**econd **K**ind) or **feedback between circulation and surface heat fluxes** (**W**ind **I**nduced **S**urface **H**eat **E**xchange).
- **Converts diabatic heating into potential the kinetic energy**.

Extratropical cyclone



MSLP and 1000-500hPa mean temperature. West USA depression 04/01/2008 18UTC

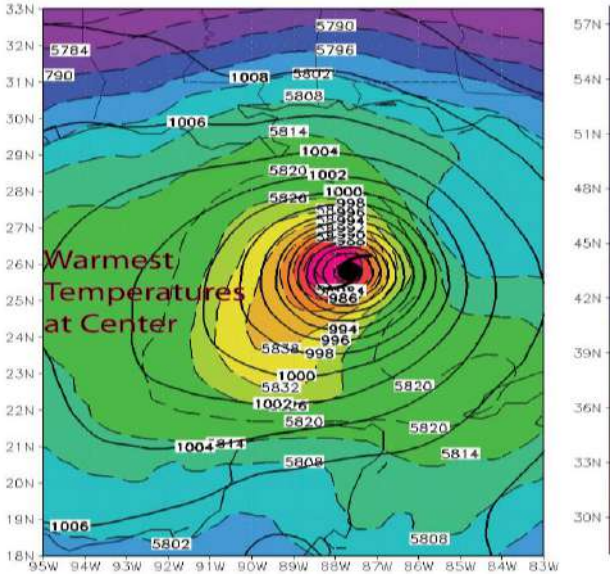
- **Frontal system** : warm, cold, occluded fronts (**thermal asymmetry**)
- **Tropospheric cold core system** (**cyclonic thermal wind**) → stronger winds are at the tropopause.



Extratropical Cyclone

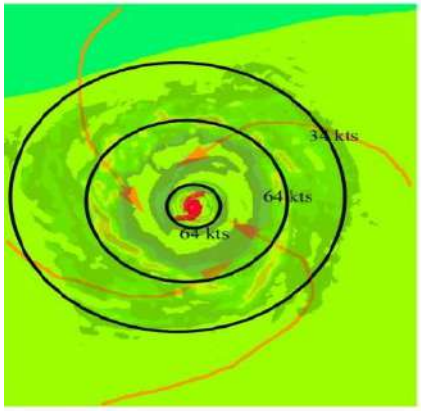
Merrill 1993

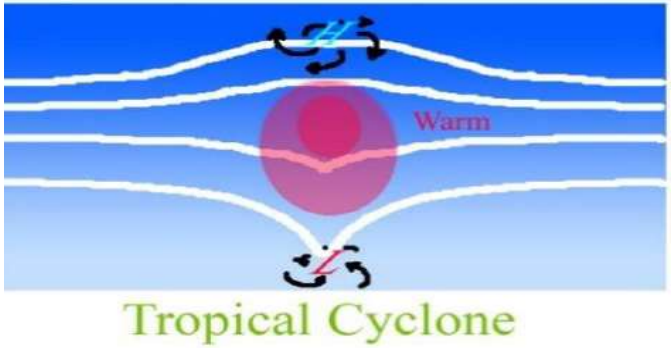
Tropical cyclone



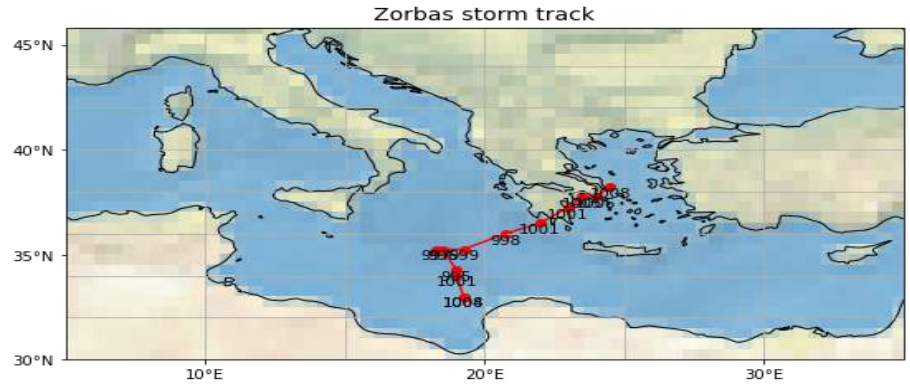
MSLP and 1000-500hPa mean temperature. Huricane Katrina 28/08/2005, 12UTC

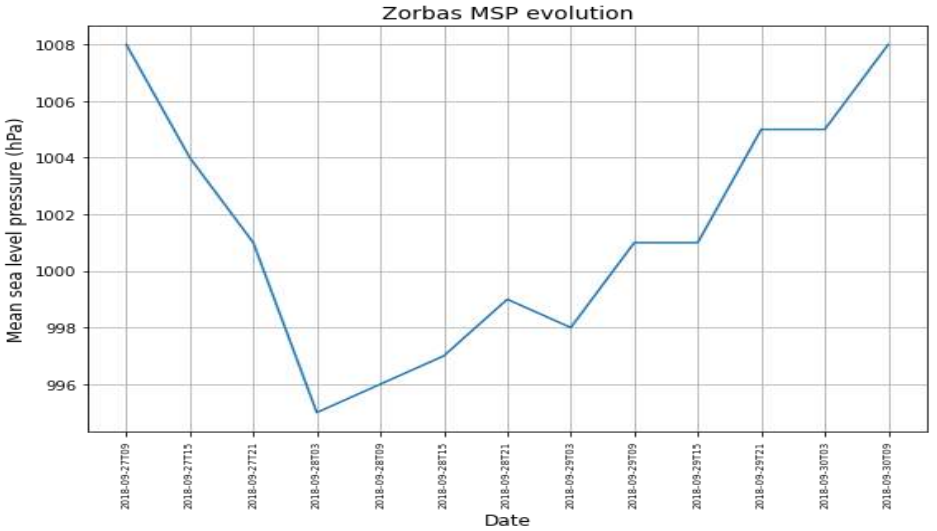
- **Non frontal system** : no horizontal surface gradient (**thermal symmetry**)
- **Tropospheric warm core system** (**anticyclonic thermal wind**) → stronger winds (>33m/s) are near the surface.



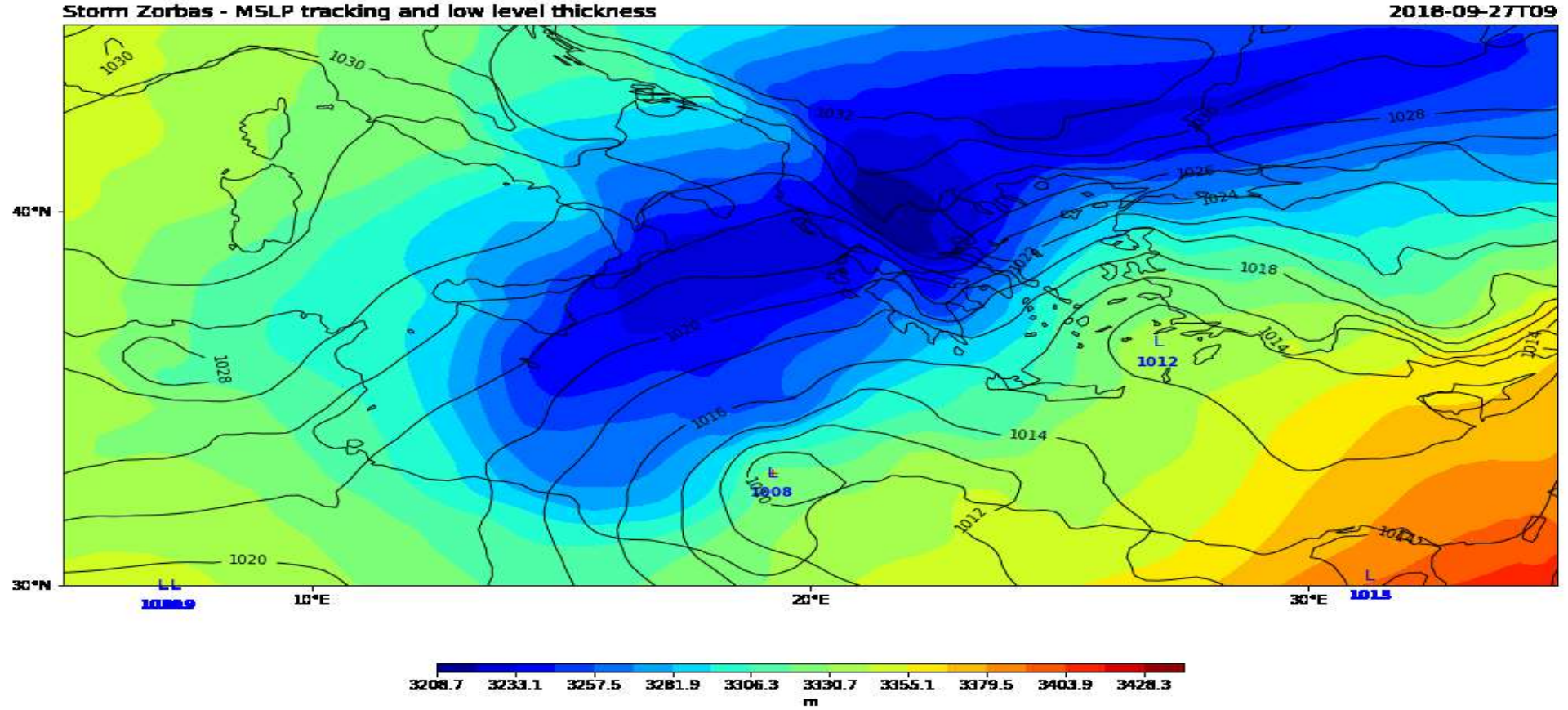


Medicane Zorbas : tracking

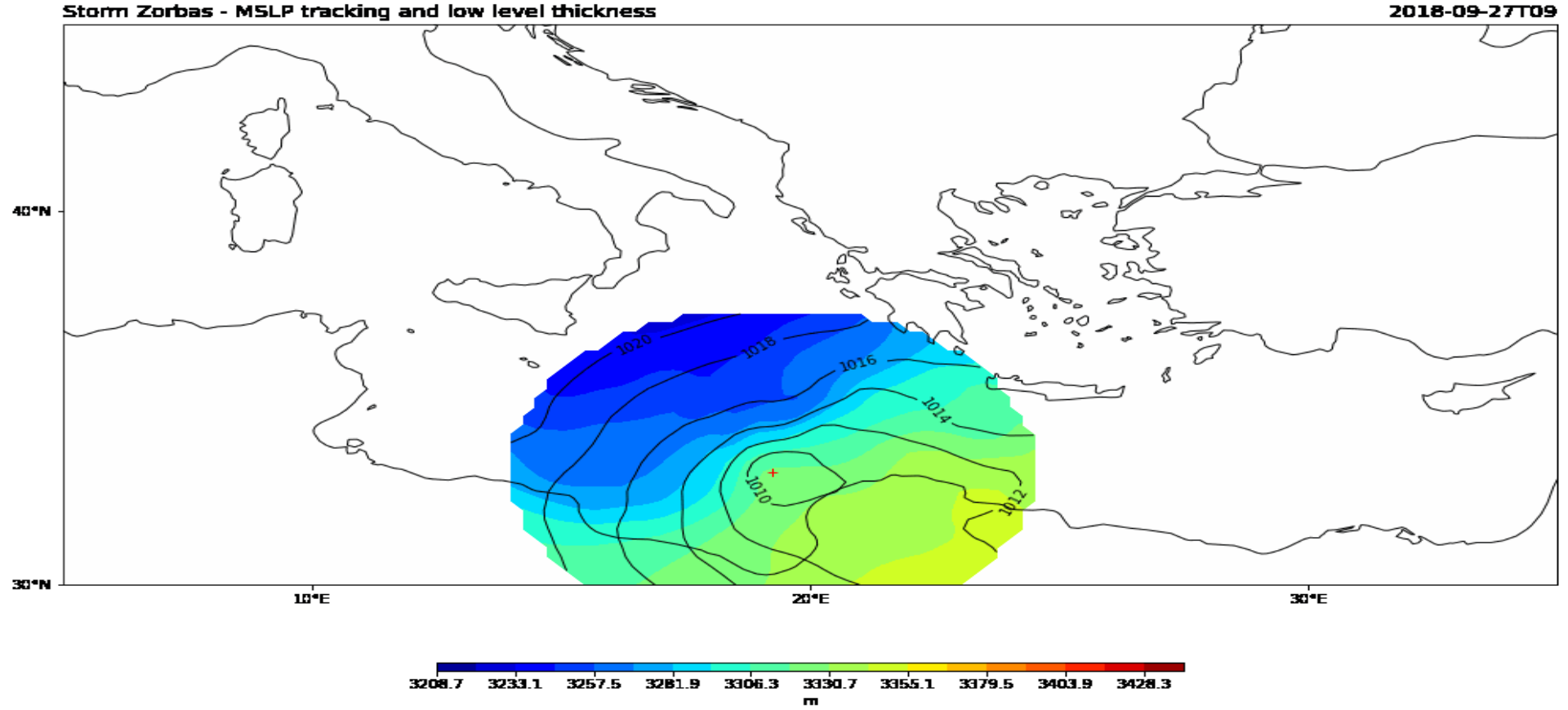




Medicane Zorbas : low-level thickness

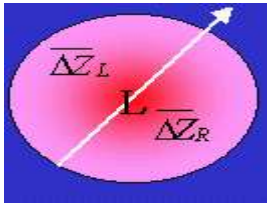


Medicane Zorbas : choosing a radius

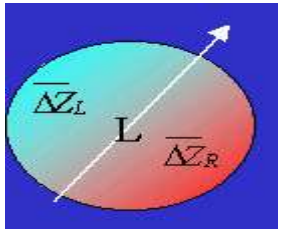


CPS diagram : thermal asymmetry parameter

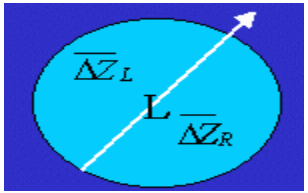
$$B = h\left(\overline{Z_{600} - Z_{900}}\,|_R - \overline{Z_{600} - Z_{900}}\,|_L\right)$$



- **Mature tropical cyclone : B=0 (symmetric non frontal)**



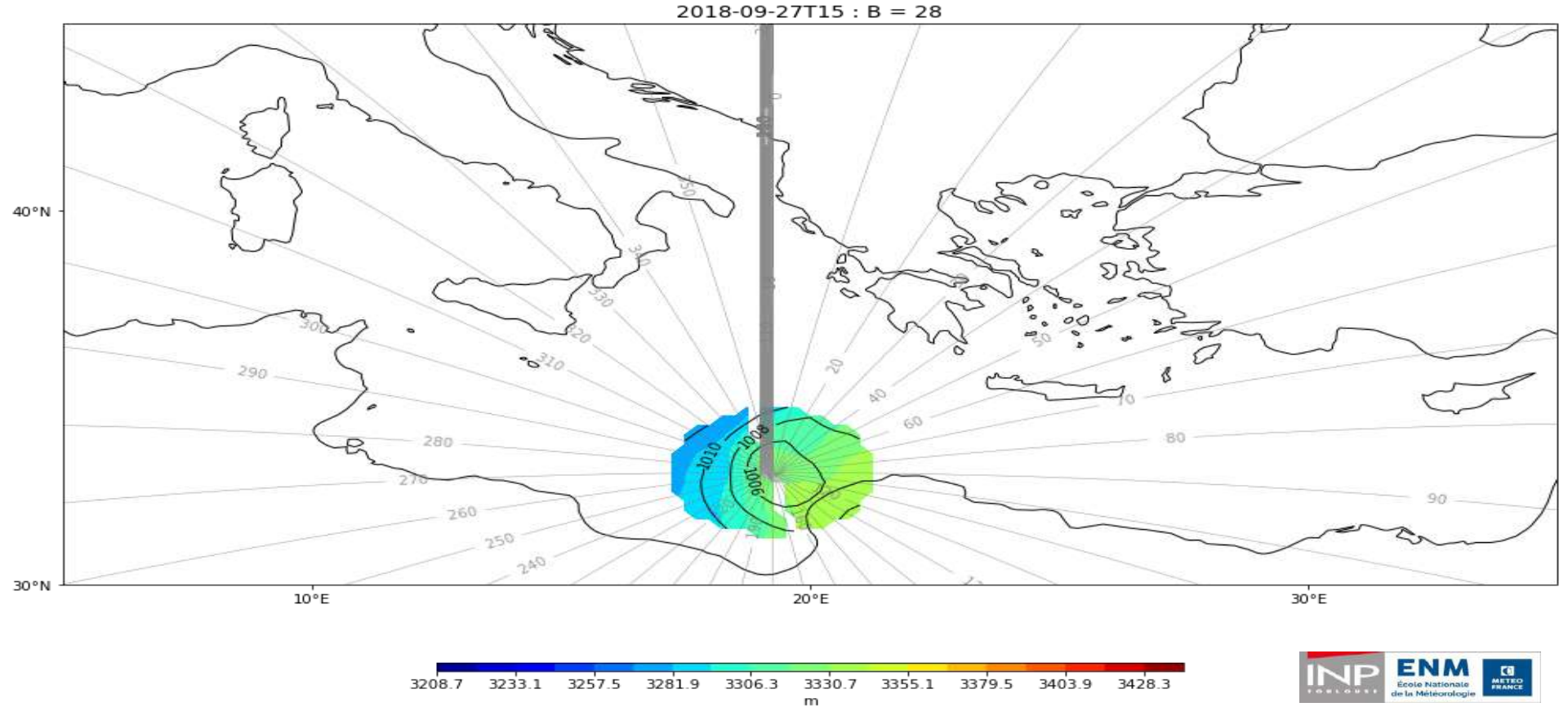
- **Intensifying extratropical cyclone : B>>0 (asymmetric frontal)**



- **Occluded extratropical cyclone : B=0**

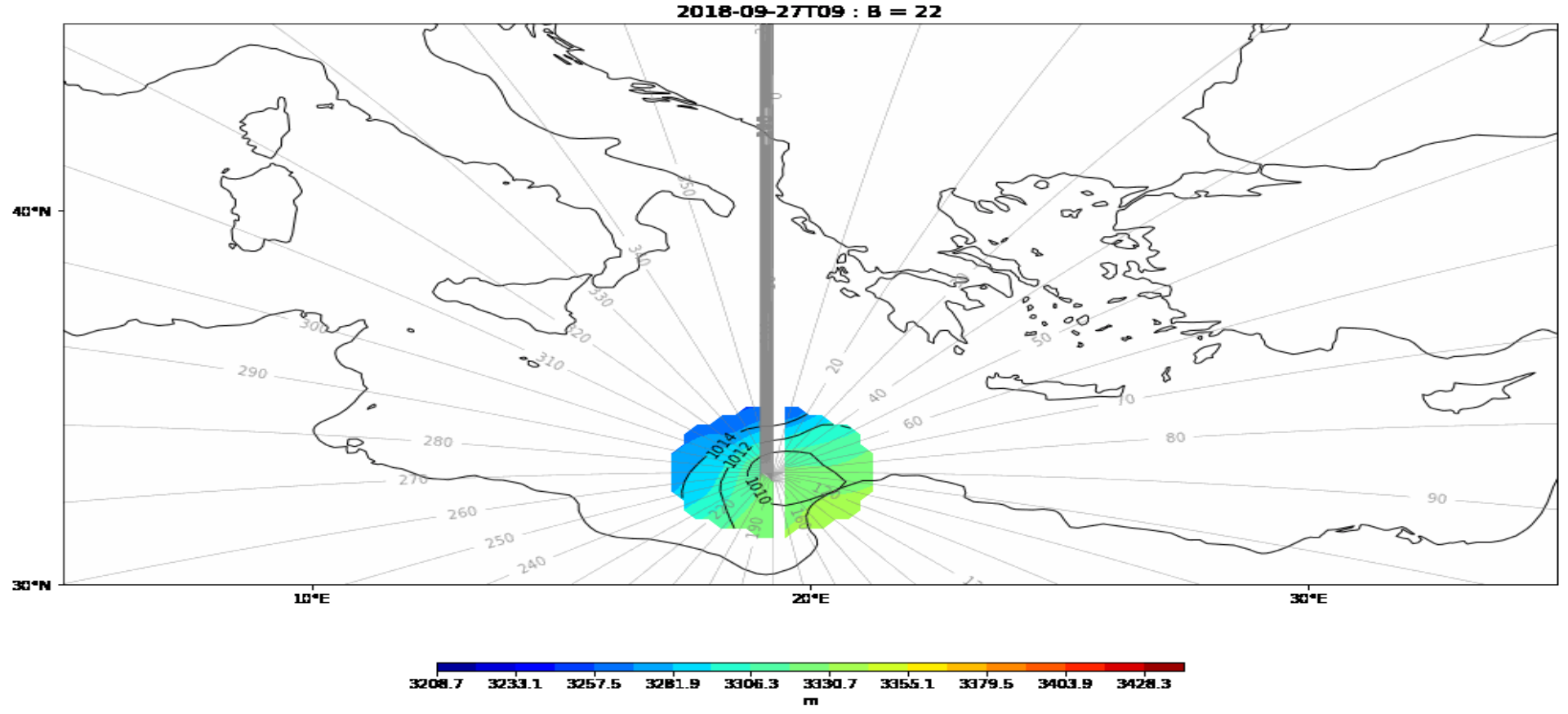
http://moe.met.fsu.edu/cyclonephase/help.html

Medicane Zorbas : thermal asymmetry

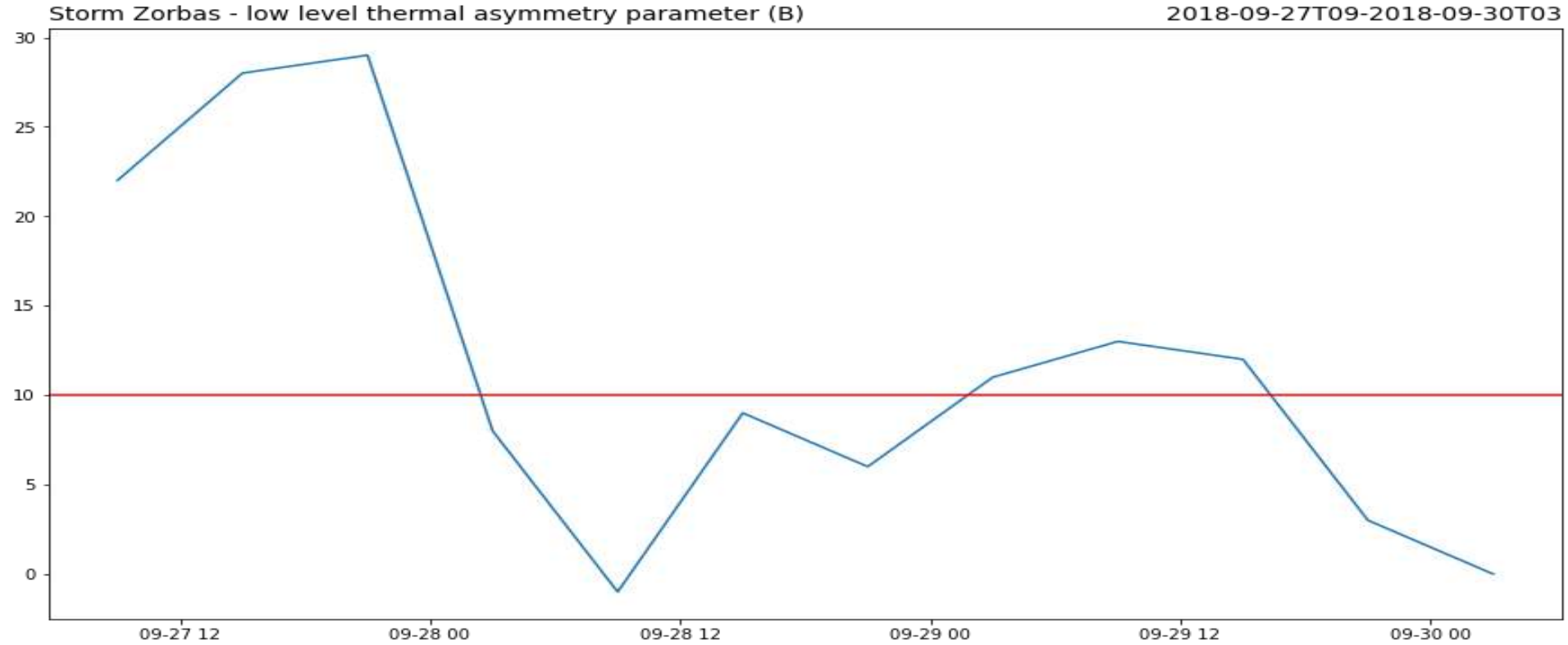


Storm Zorbas - MSLP, low level thickness and right/left quadrants

Medicane Zorbas : thermal asymmetry



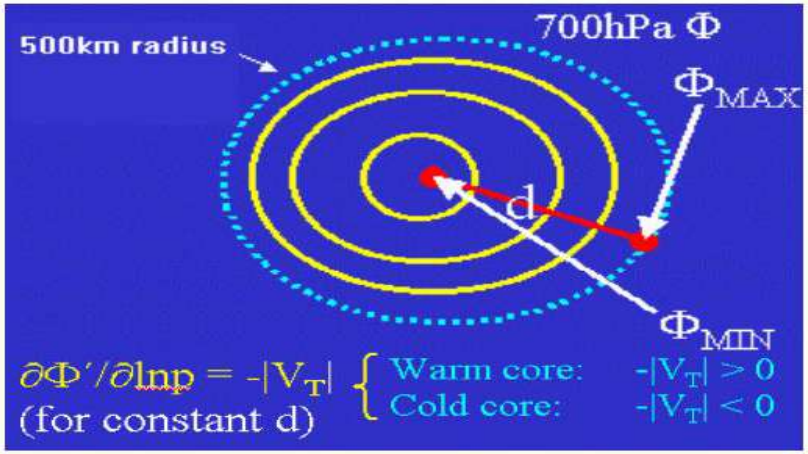
Medicane Zorbas : thermal asymmetry



CPS diagram : -VT parameter

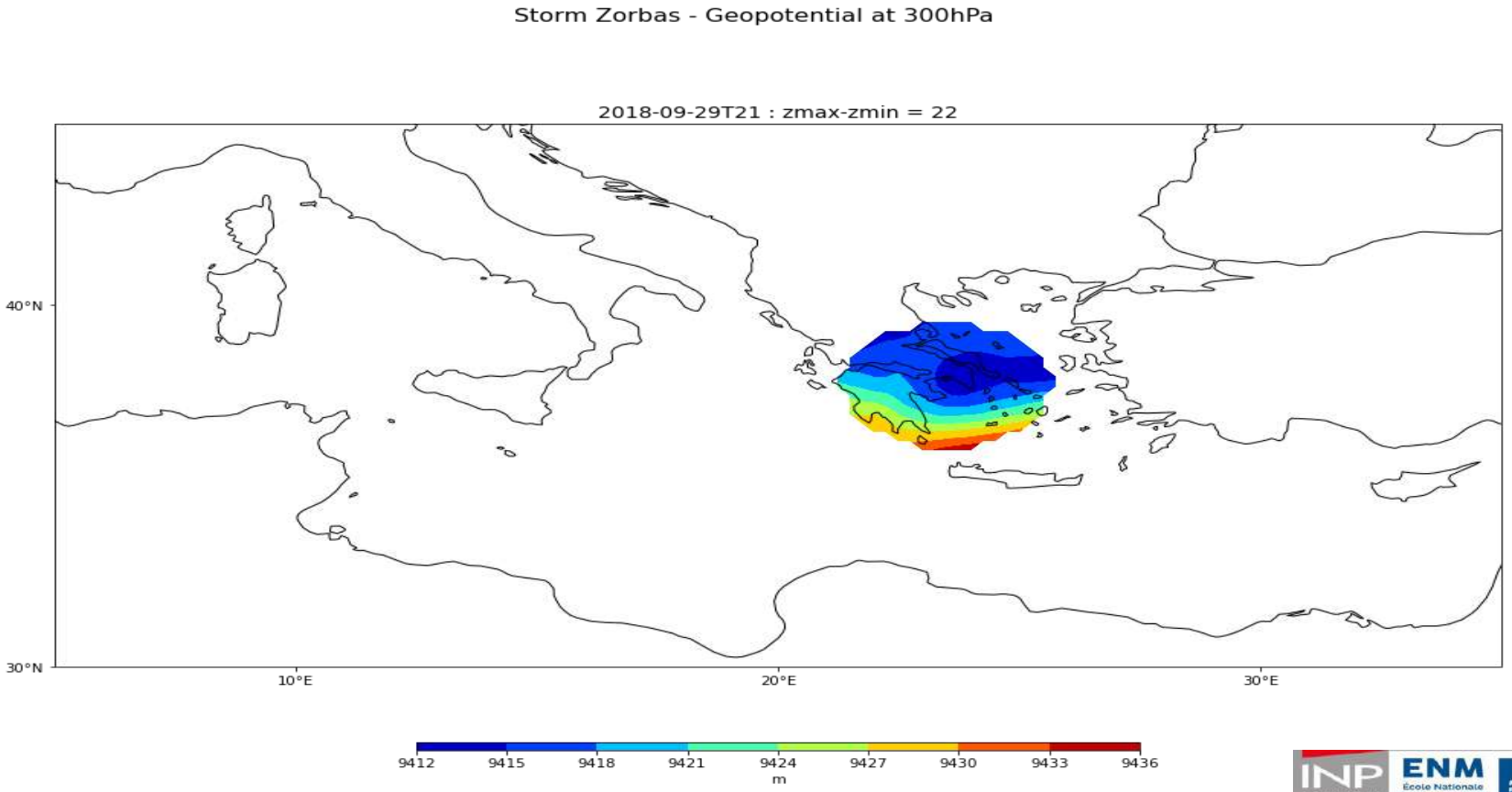
$$\Delta Z = Z_{\max} - Z_{\min}$$

$$\left.\frac{\partial(\Delta Z)}{\partial \ln p}\right|_{900}^{600} = -\left|V_T^L\right| \quad ; \quad \left.\frac{\partial(\Delta Z)}{\partial \ln p}\right|_{600}^{300} = -\left|V_T^U\right|$$

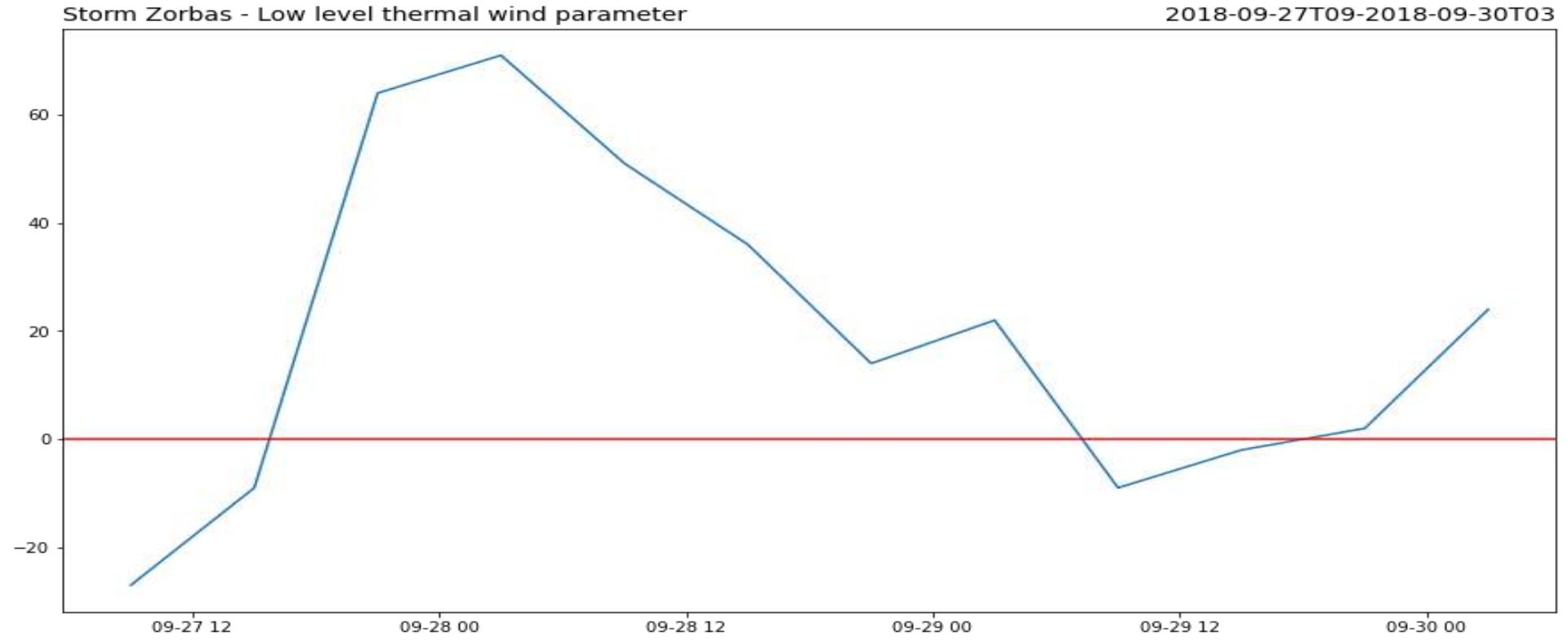


- **Tropical cyclone = tropospheric warm core : the isobaric geopotential gradient decreases above the cyclone center : -VT>0**
- **Extratropical cyclone = tropospheric cold core : the isobaric geopotential gradient creases above the cyclone center : -VT<0**
- **Hybrid, system : -VTU ≠ -VTL**

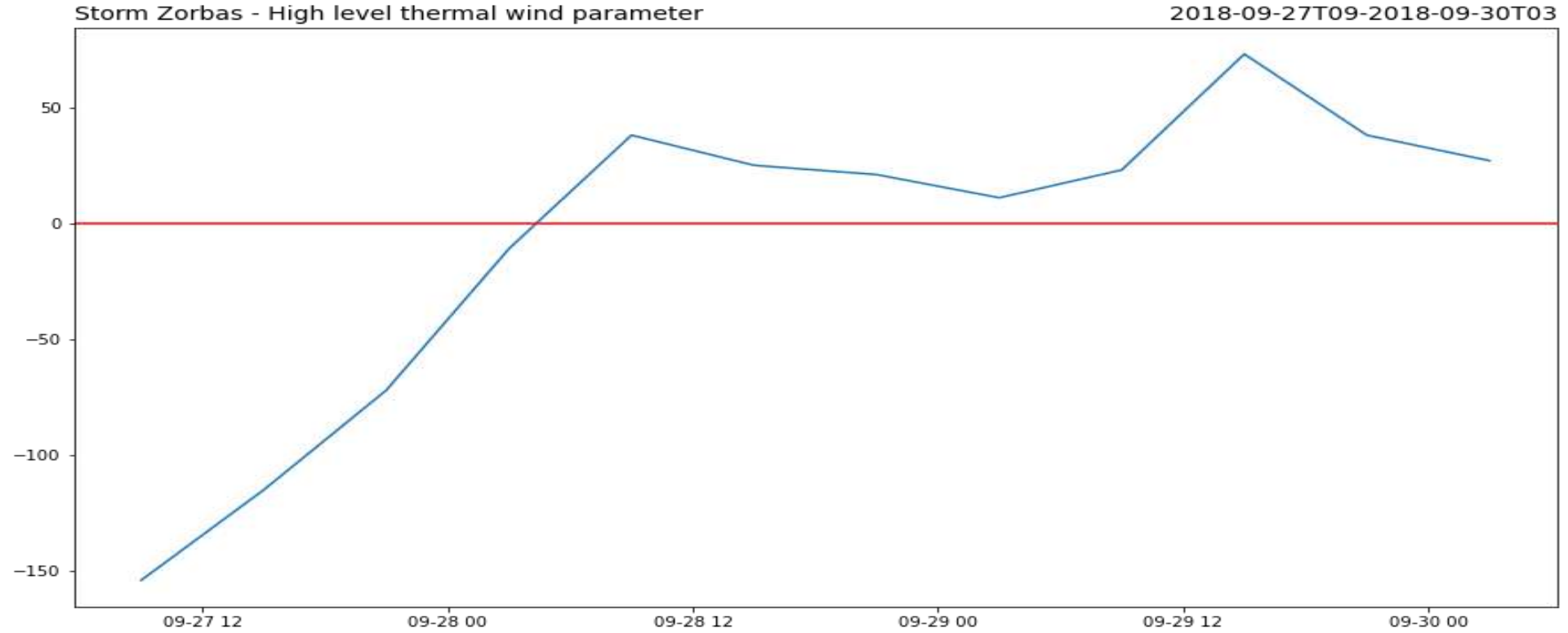
Medicane Zorbas : ΔZ



Medicane Zorbas : low level cold core / warm core



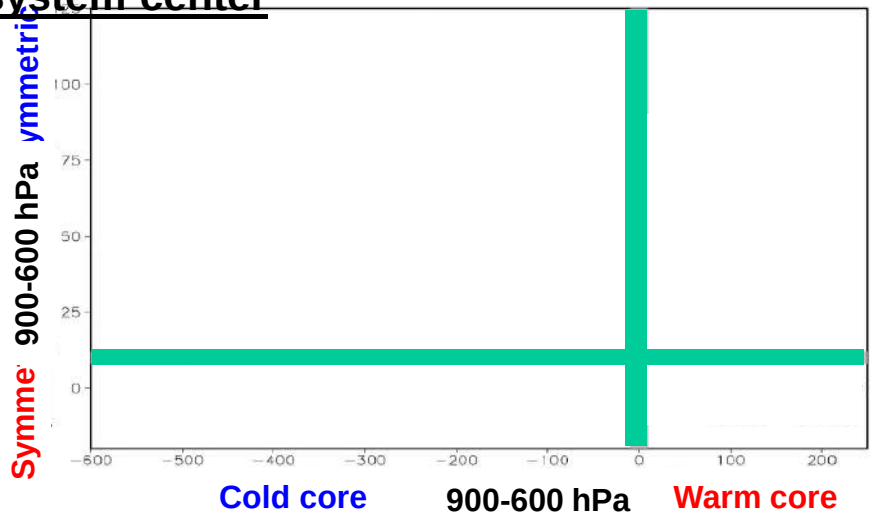
Medicane Zorbas : high level cold core / warm core

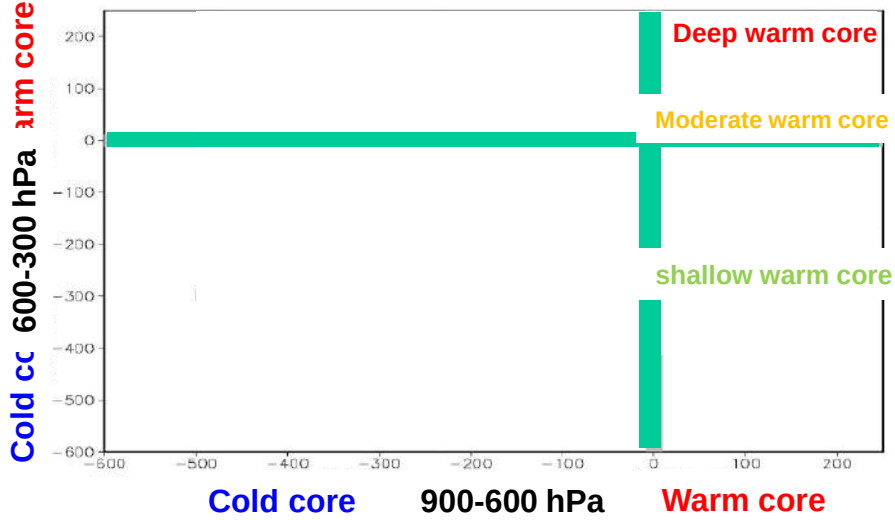


Cyclone Phase Space (CPS)

Analysis of the **thermal asymmetry**(symmetric /non frontal VS asymmetric/frontal) and the **vertical variation of the slope of the isobaric surfaces** (warm core VS cold core).

2 layers : **900-600hPa**, **600-300hPa** . Parameters are computed within a **500km radius around the system center**

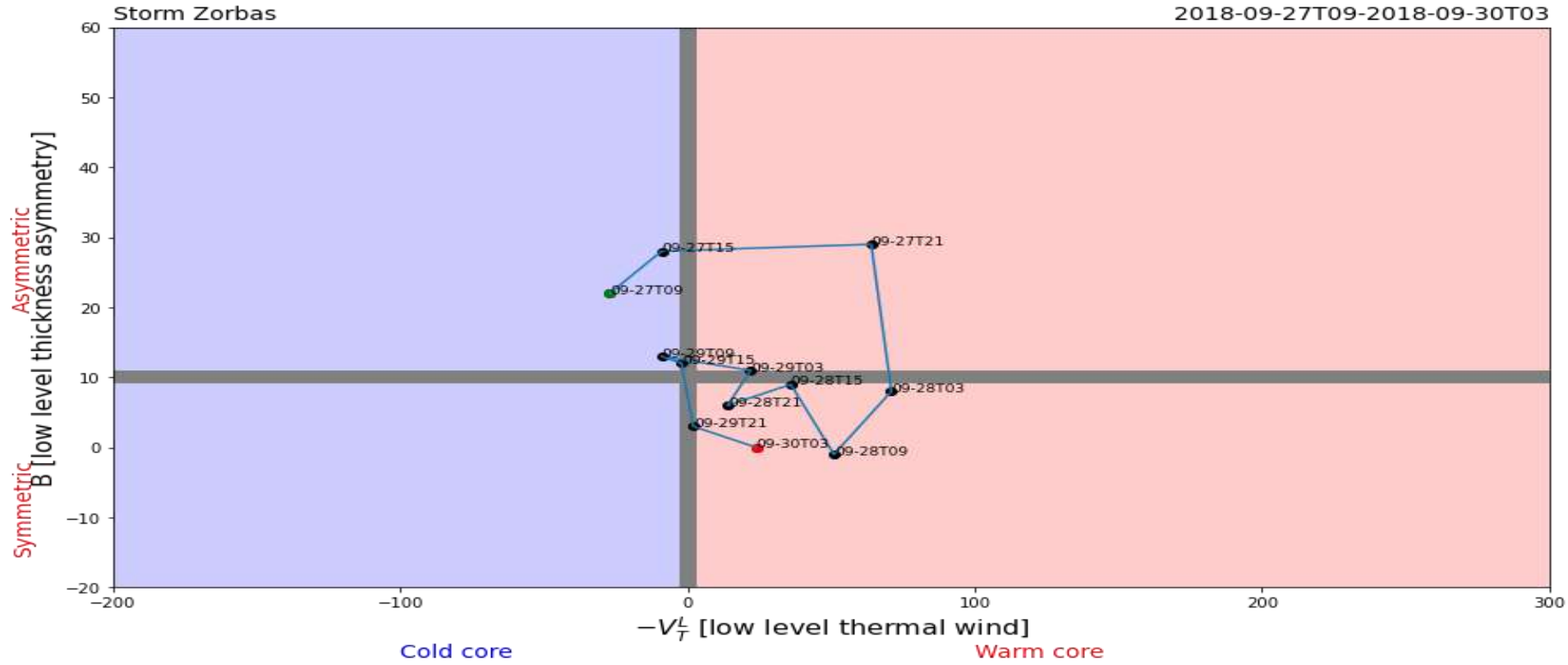




Hart, 2003 : a cyclone phase space derived from thermal wind and thermal asymmetry

http://moe.met.fsu.edu/cyclonephase/

Medicane Zorbas : CPS diagram



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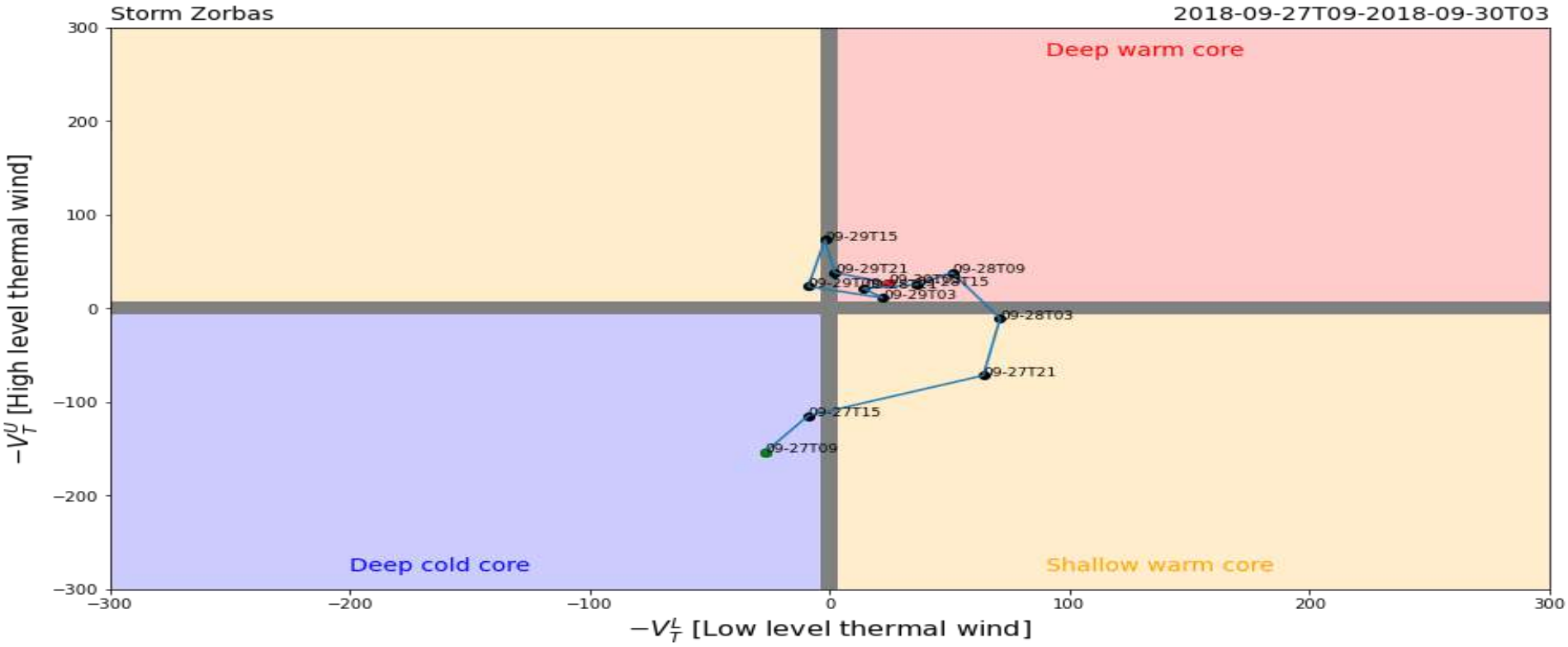

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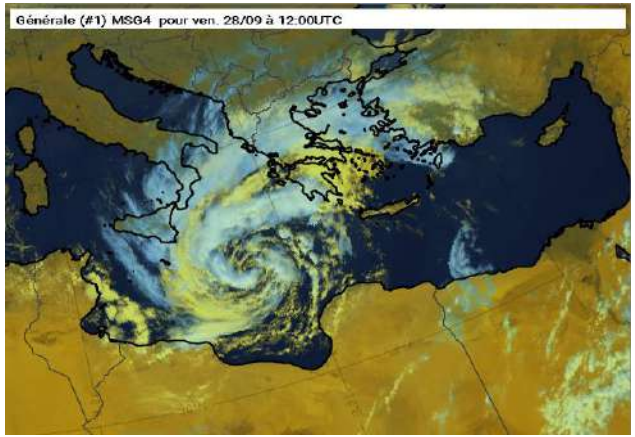

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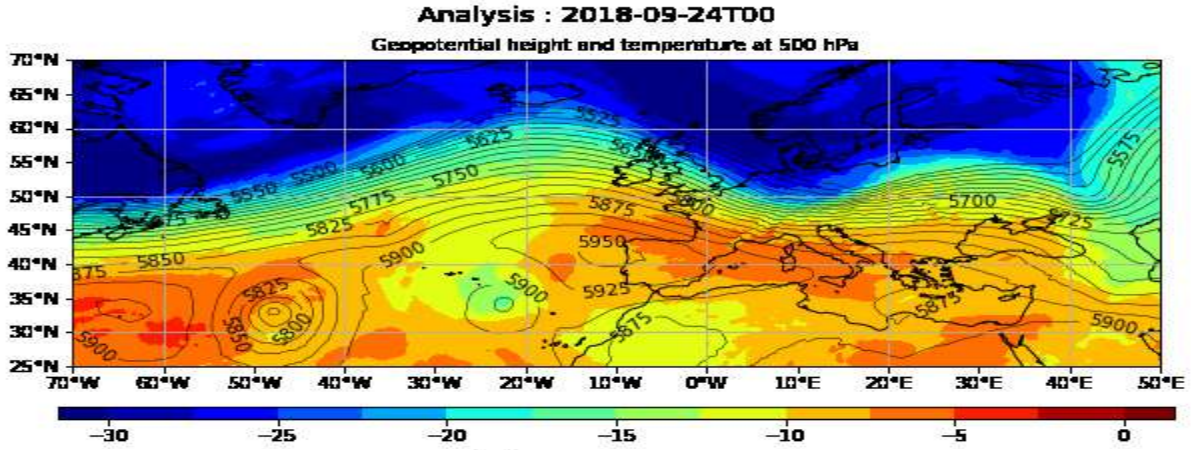

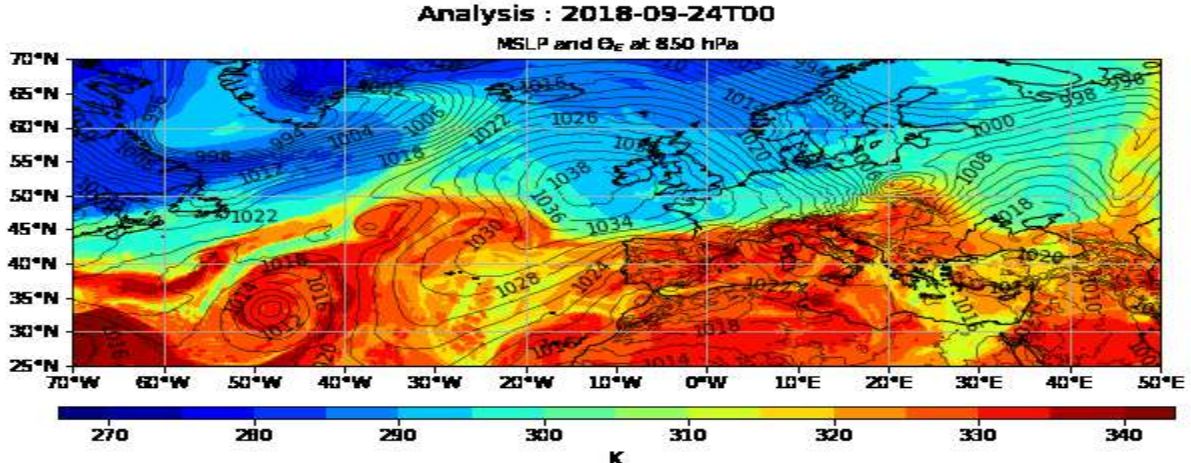

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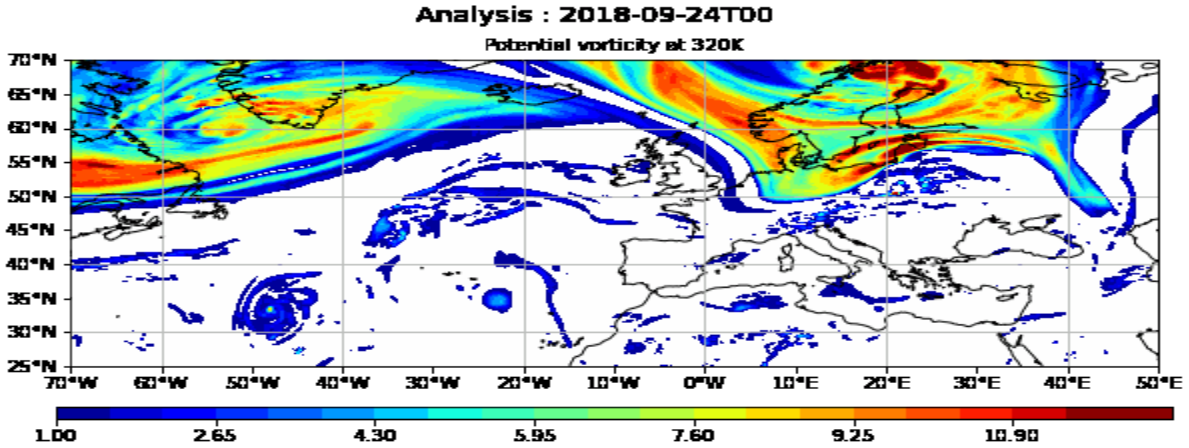

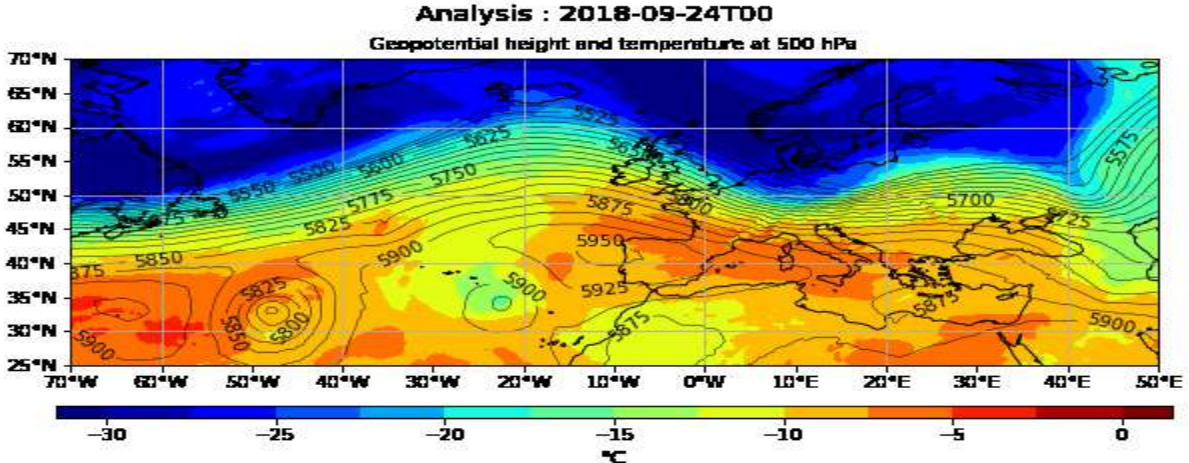

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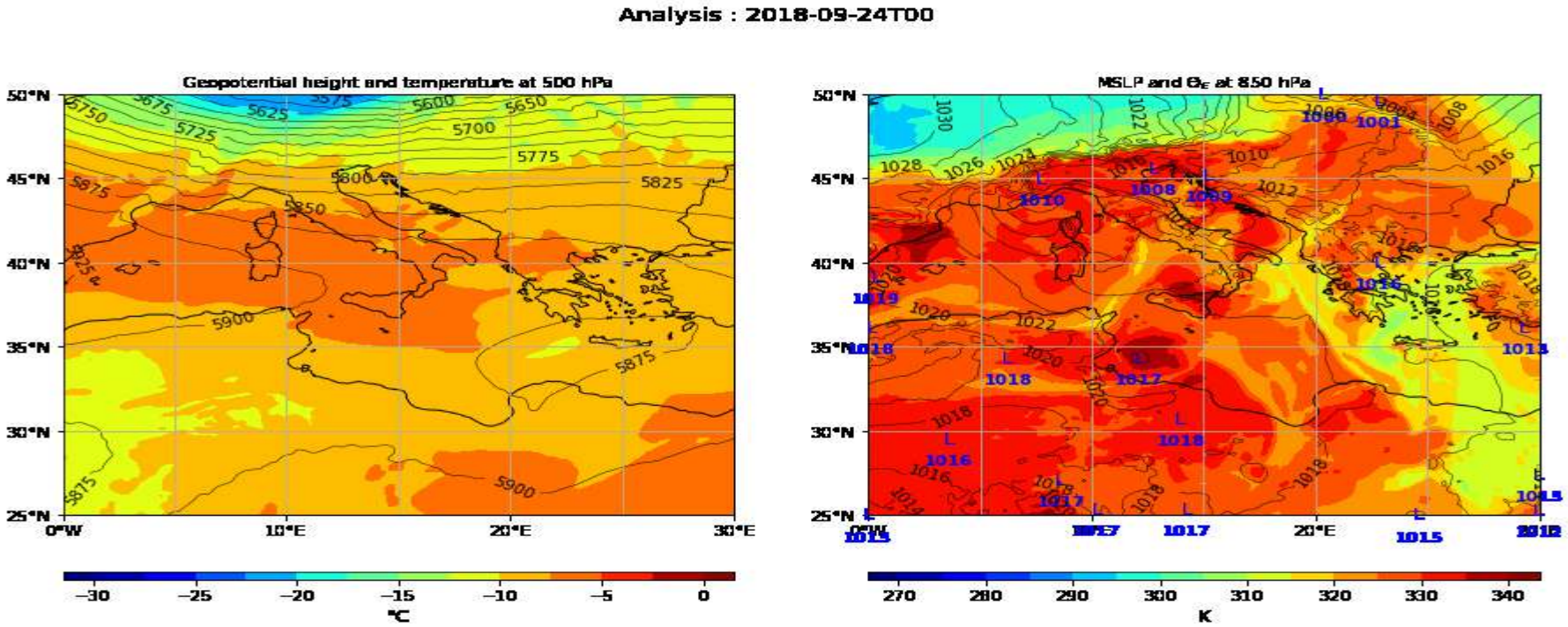
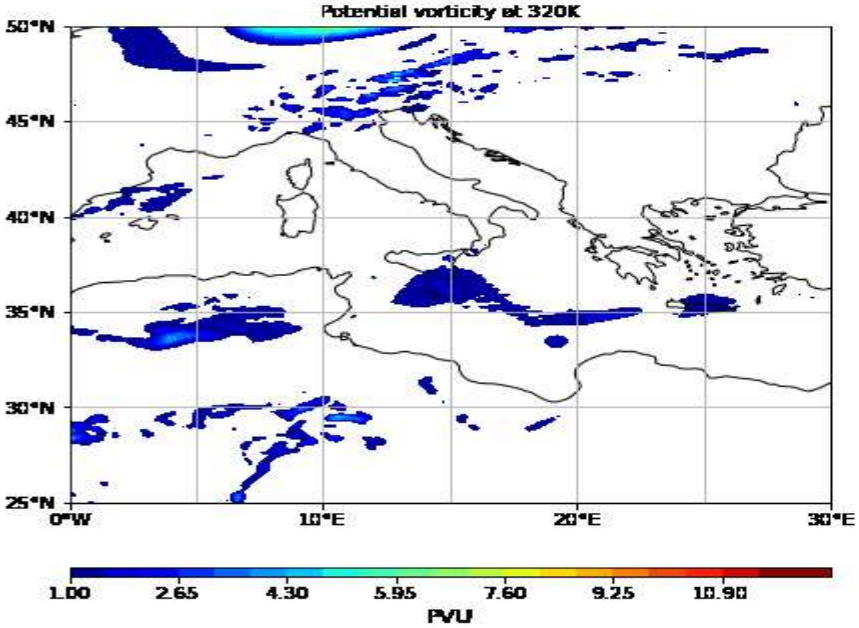
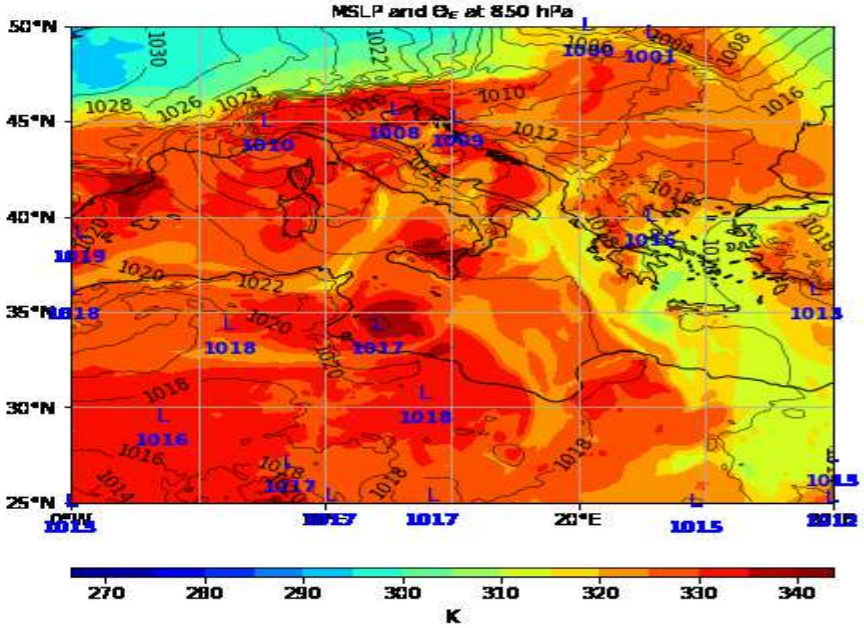


Medicane Zorbas : analysis

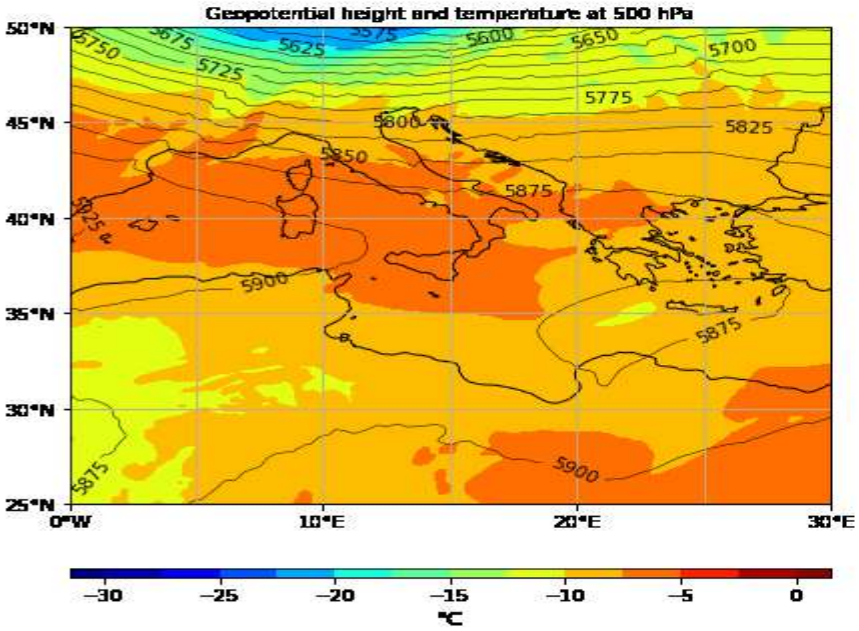
Analysis : 2018-09-24T00

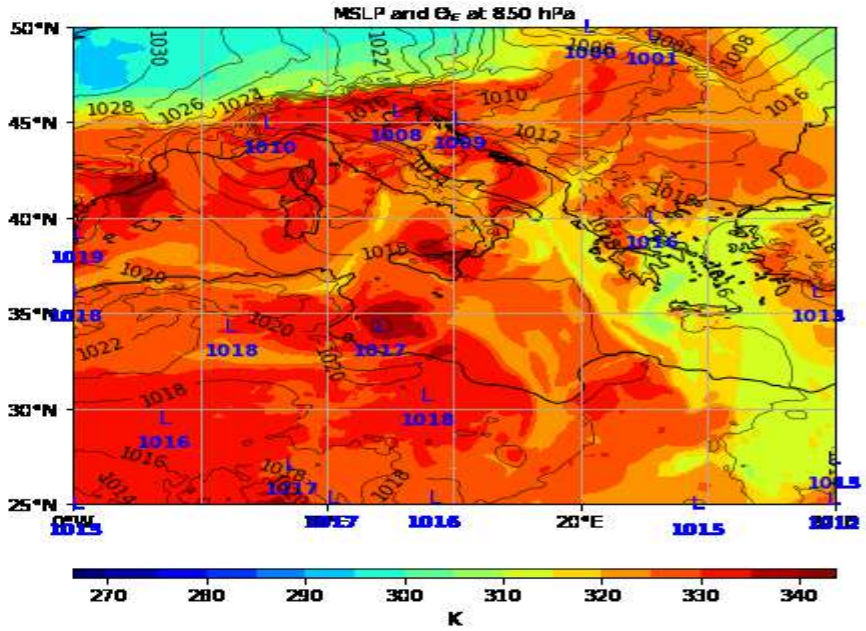




Medicane Zorbas : deterministic forecast

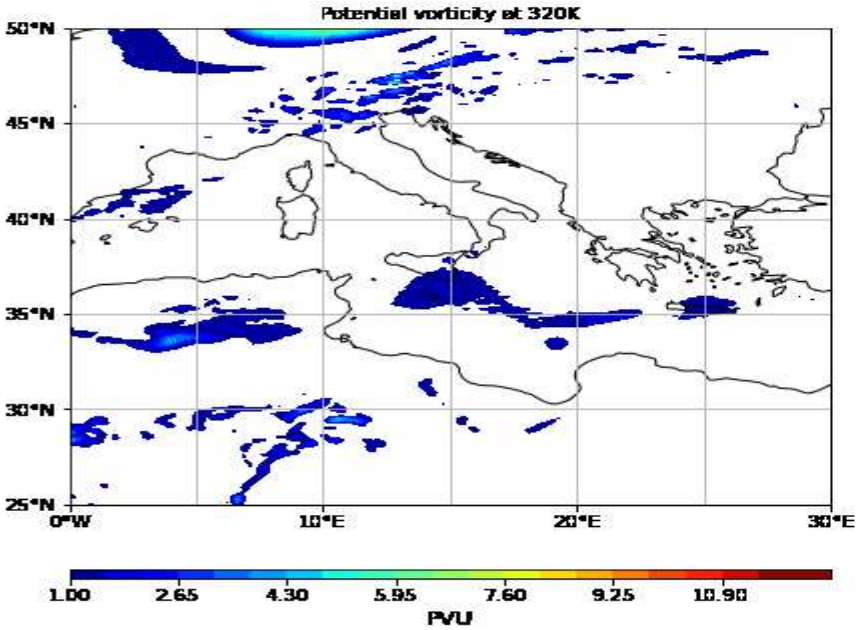
Analysis : 2018-09-24T00 - Forecast : 2018-09-24T00

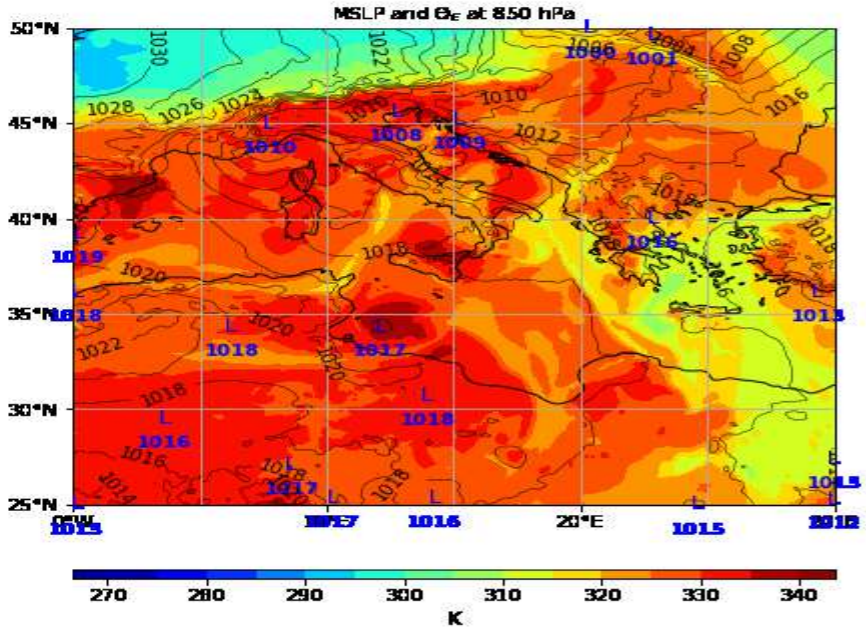




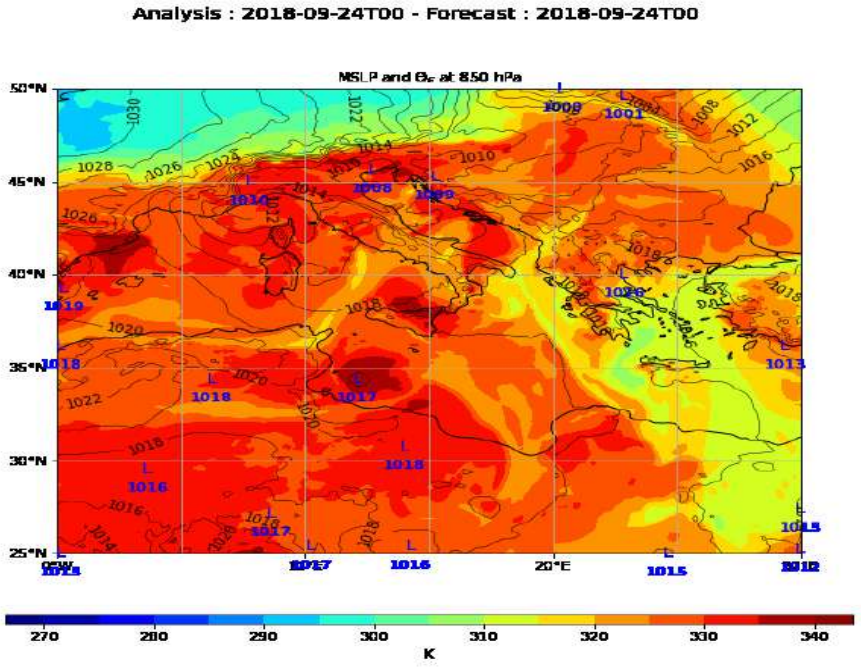
Medicane Zorbas : deterministic forecast

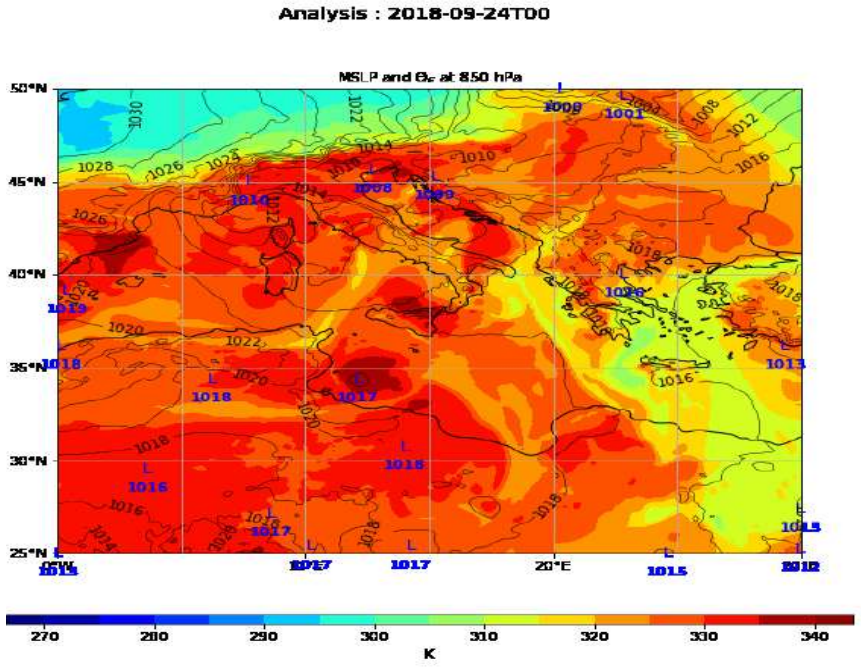
Analysis : 2018-09-24T00 - Forecast : 2018-09-24T00



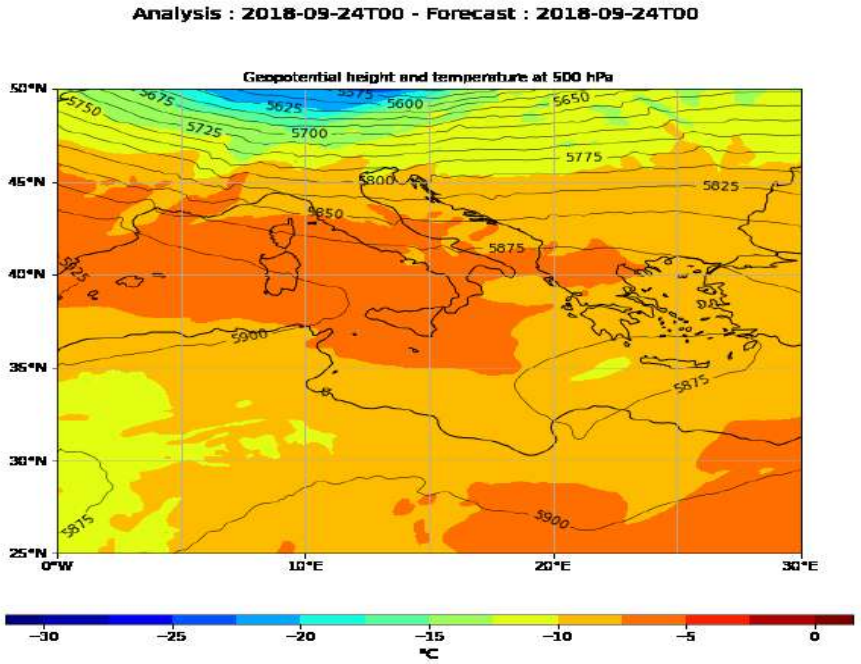


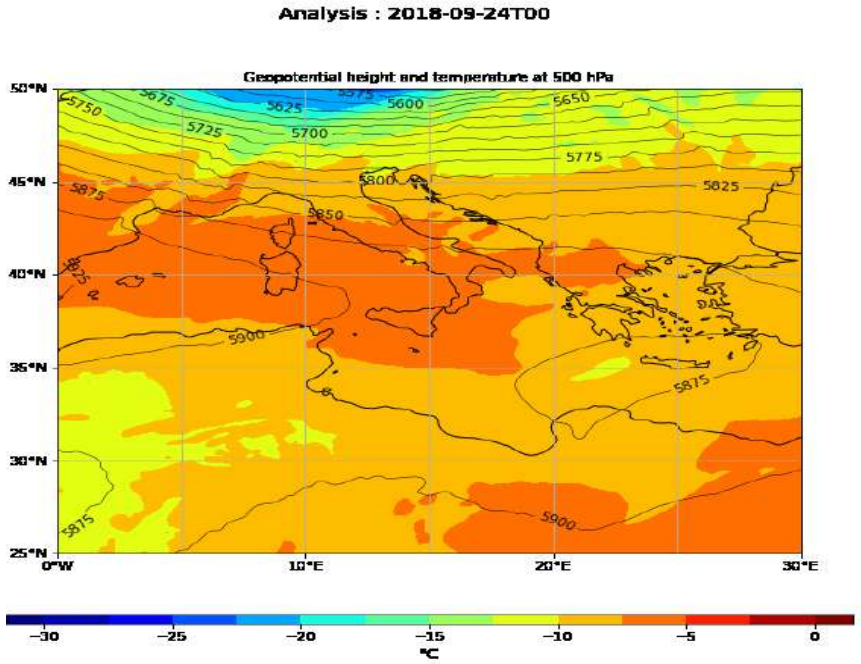
Medicane Zorbas : analysis VS forecast



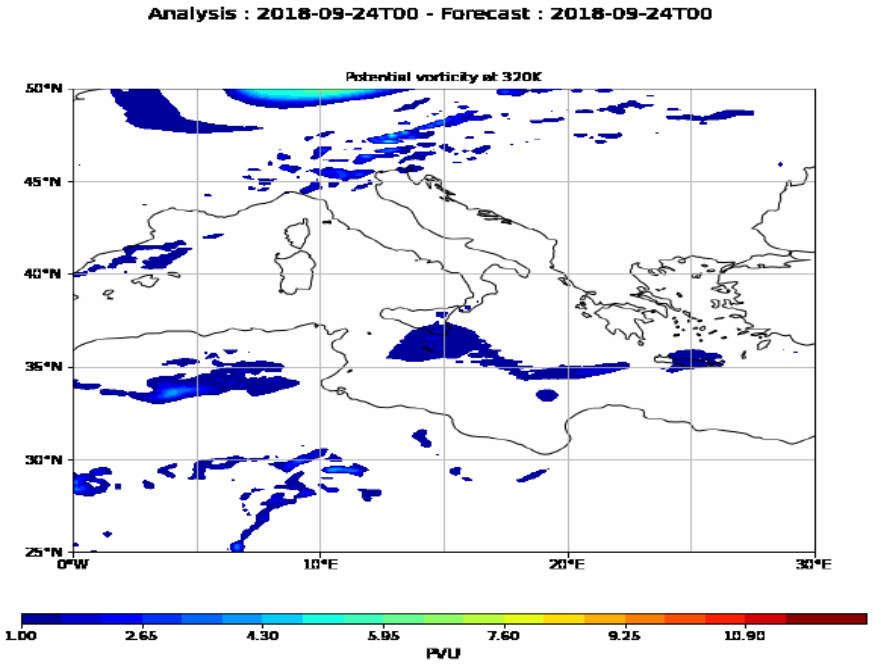


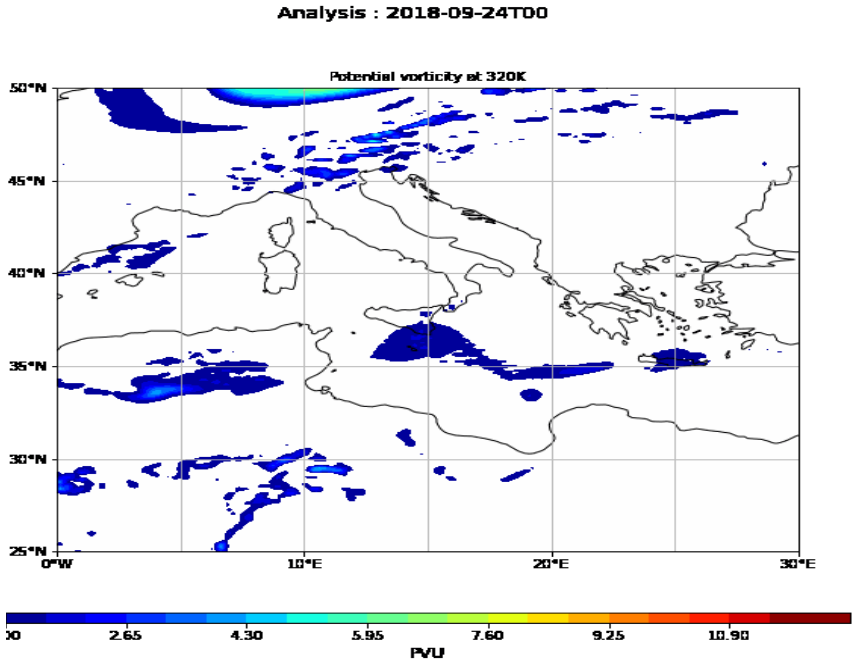
Medicane Zorbas : analysis VS forecast



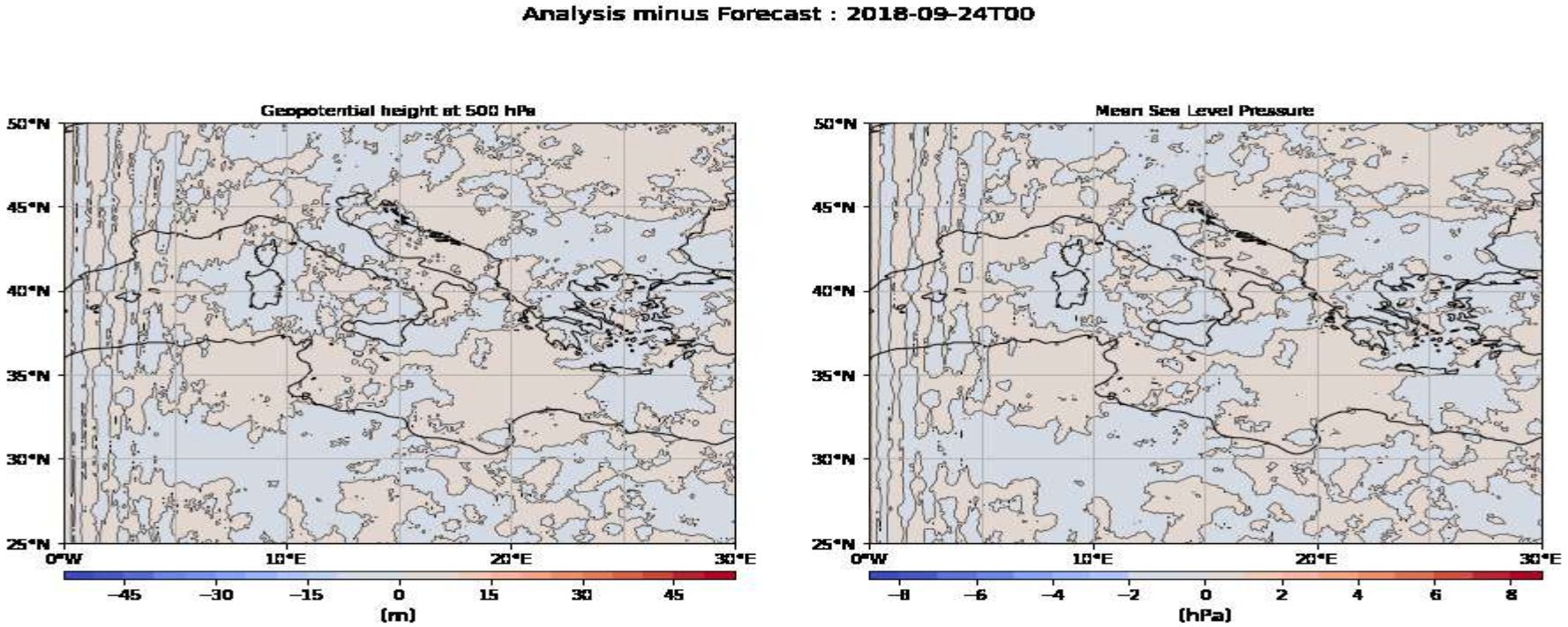


Medicane Zorbas : analysis VS forecast

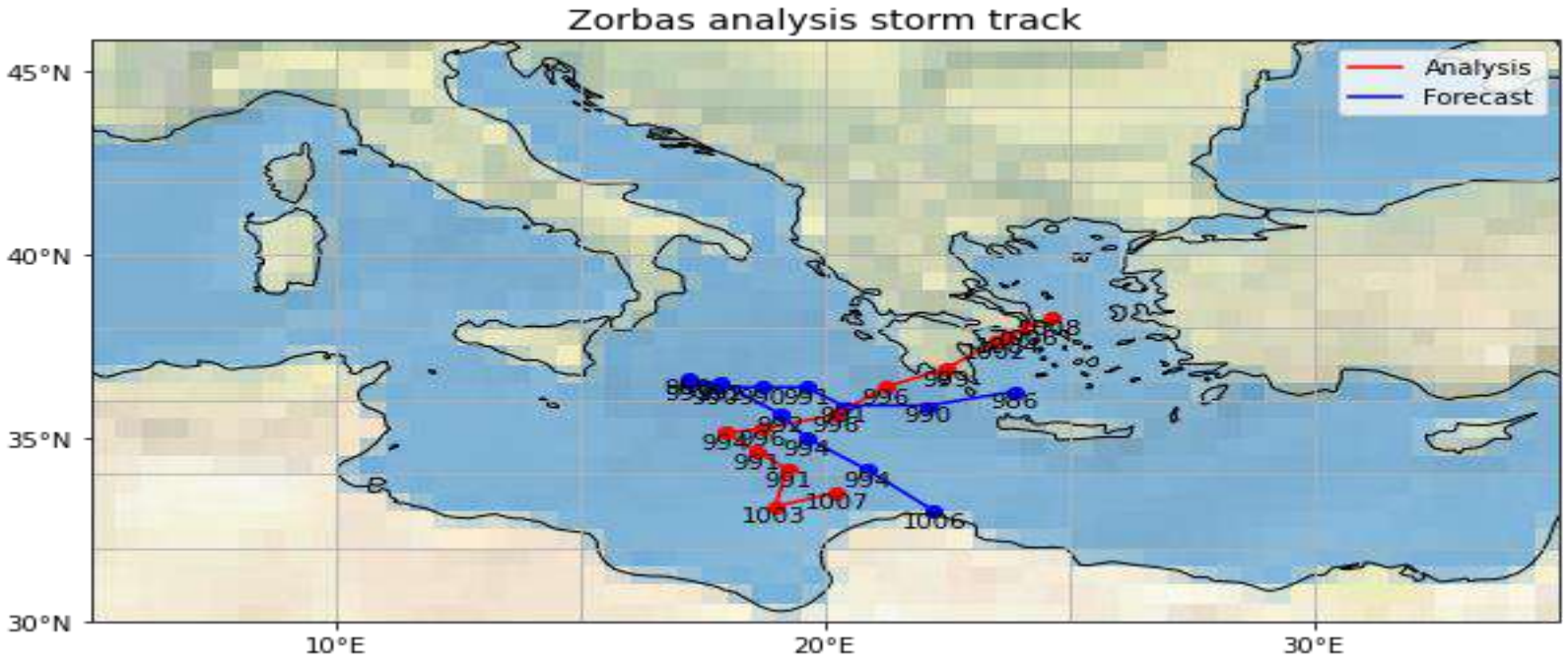




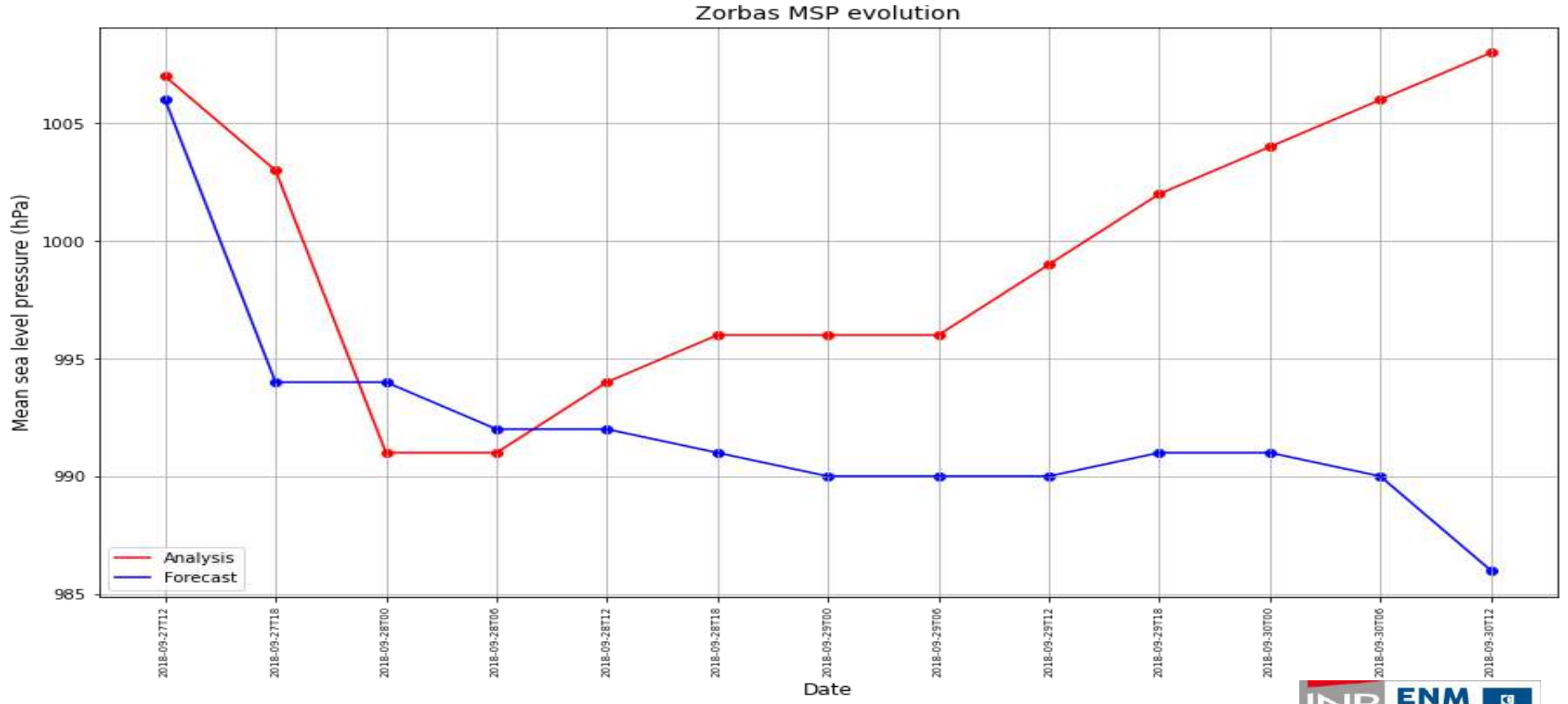
Medicane Zorbas : analysis VS forecast



Medicane Zorbas : analysis VS forecast

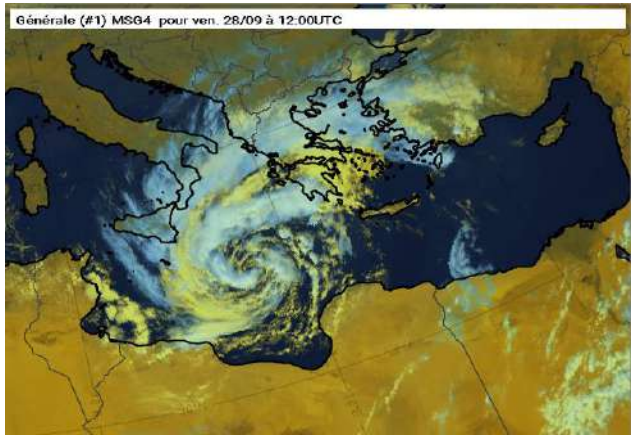


Medicane Zorbas : analysis VS forecast



Outlook of the practical sessions

Case study :
Medicane Zorbas
(september 2018)



Session 1 : Monday 15 July morning

1. Dynamical study of the medicane

Session 2 : Thursday 18 July

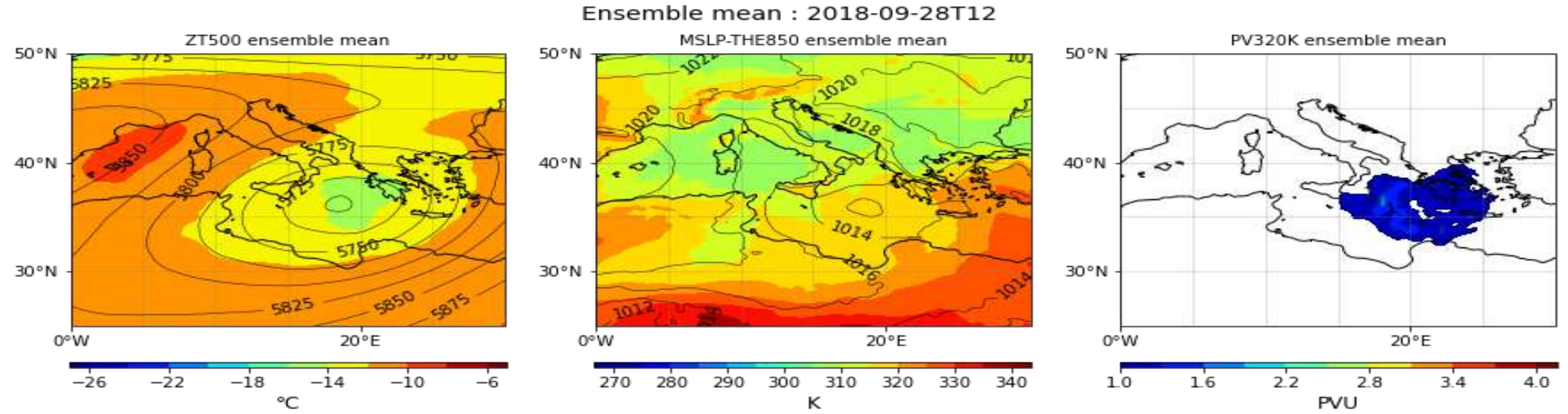
1. Storm tracking in ERA5 reanalysis
2. Cyclone Phase Space (CPS) diagrams
3. Analysis and deterministic forecast
4. **Ensemble forecast**

Session 3 : Friday 19 July morning

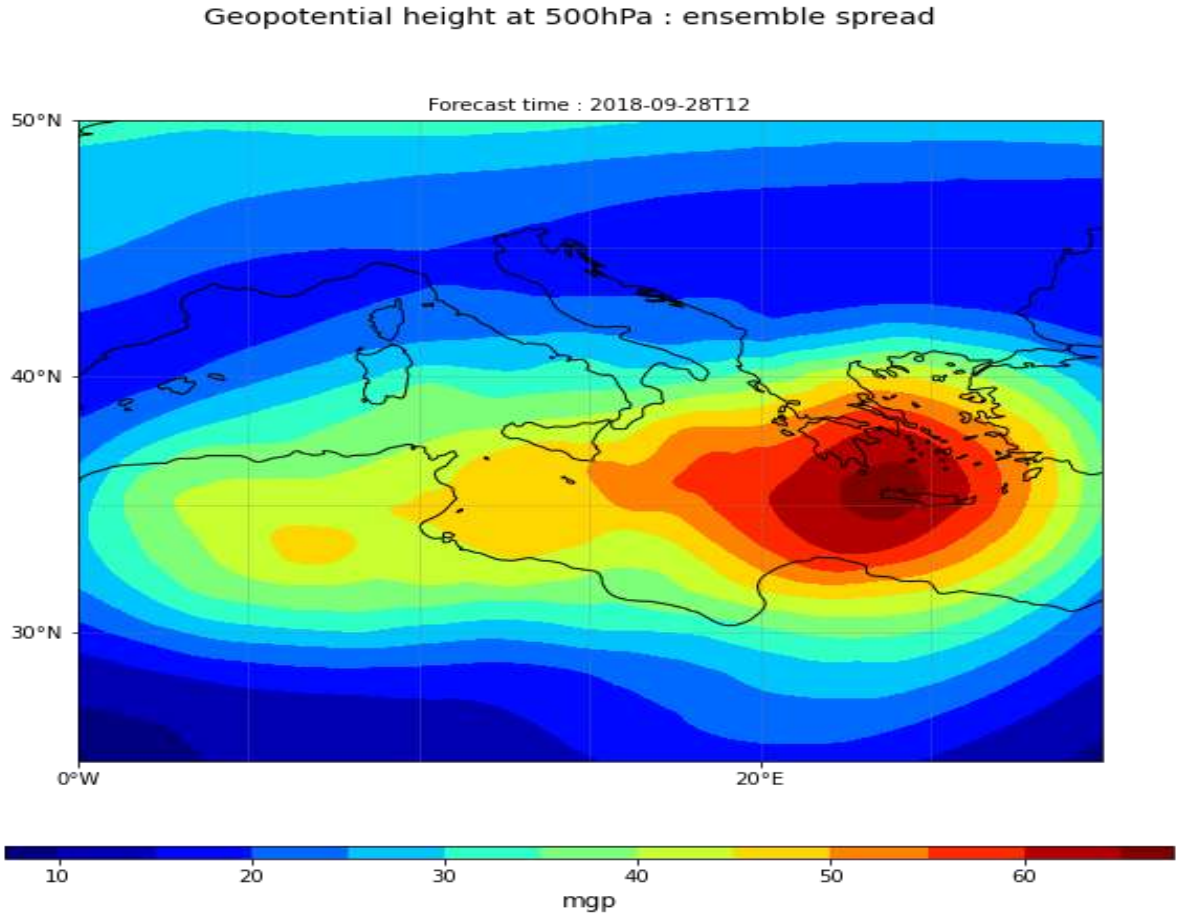
1. Preparation of the student presentations

Friday 19 July afternoon: student presentations

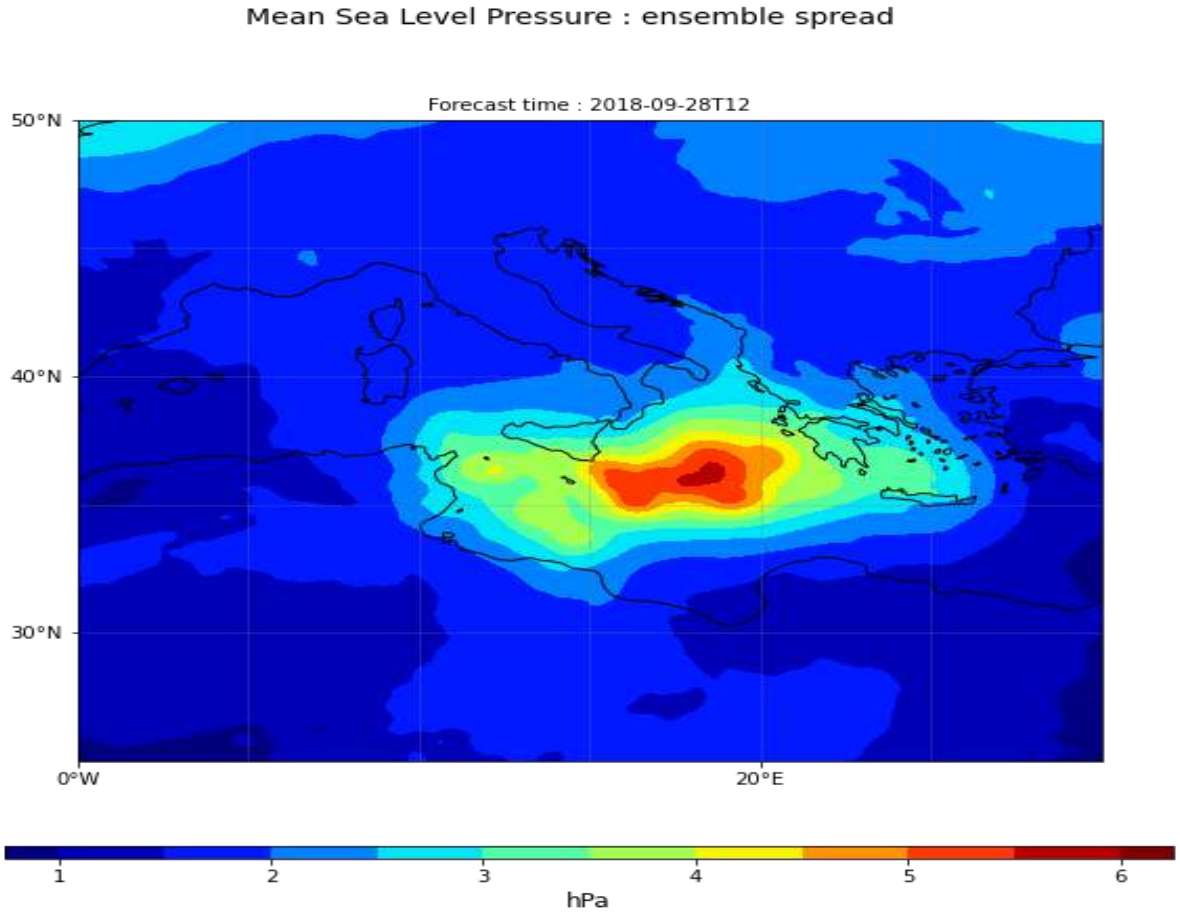
Medicane Zorbas : ensemble mean



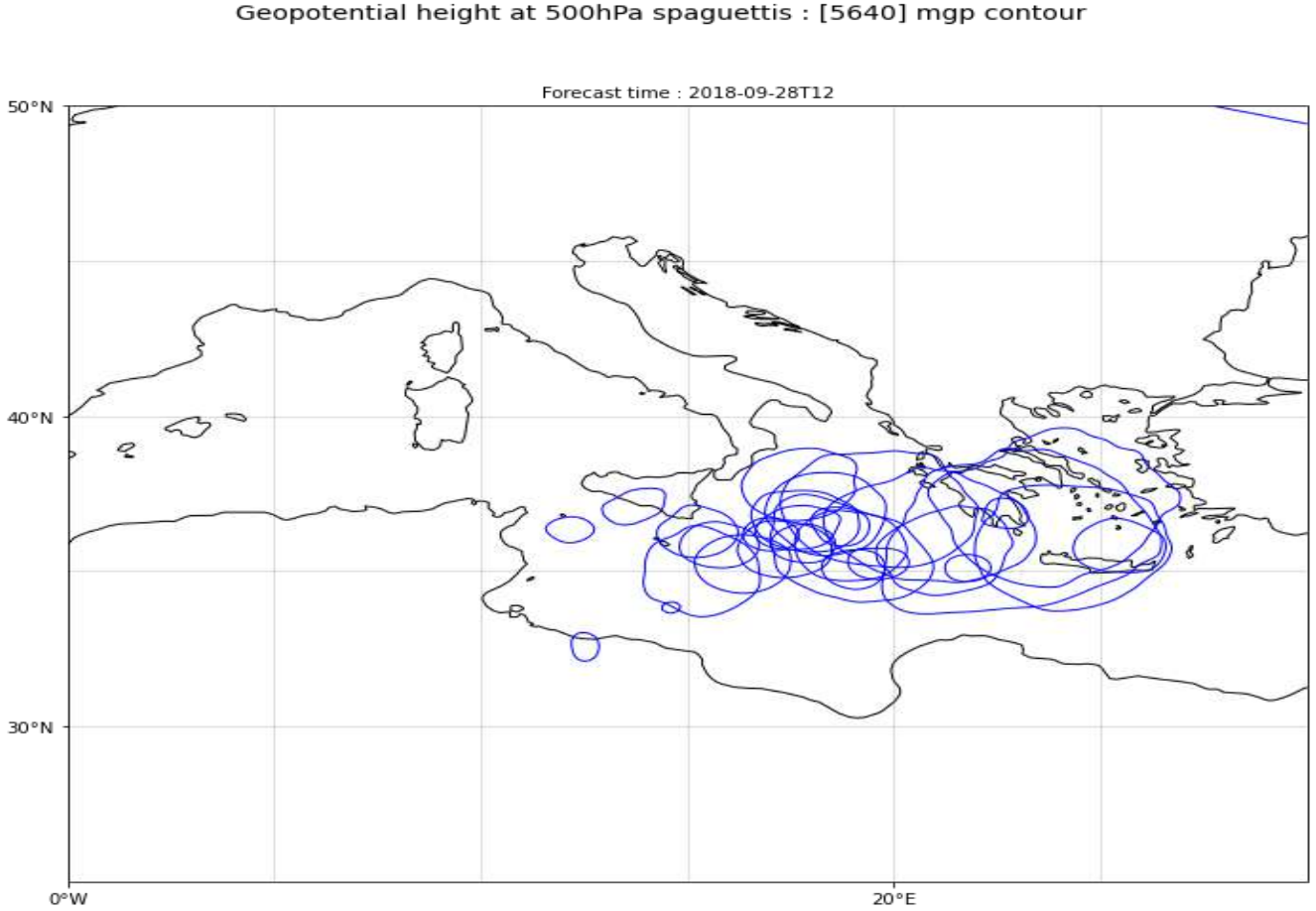
Medicane Zorbas : ensemble spread (Z500)



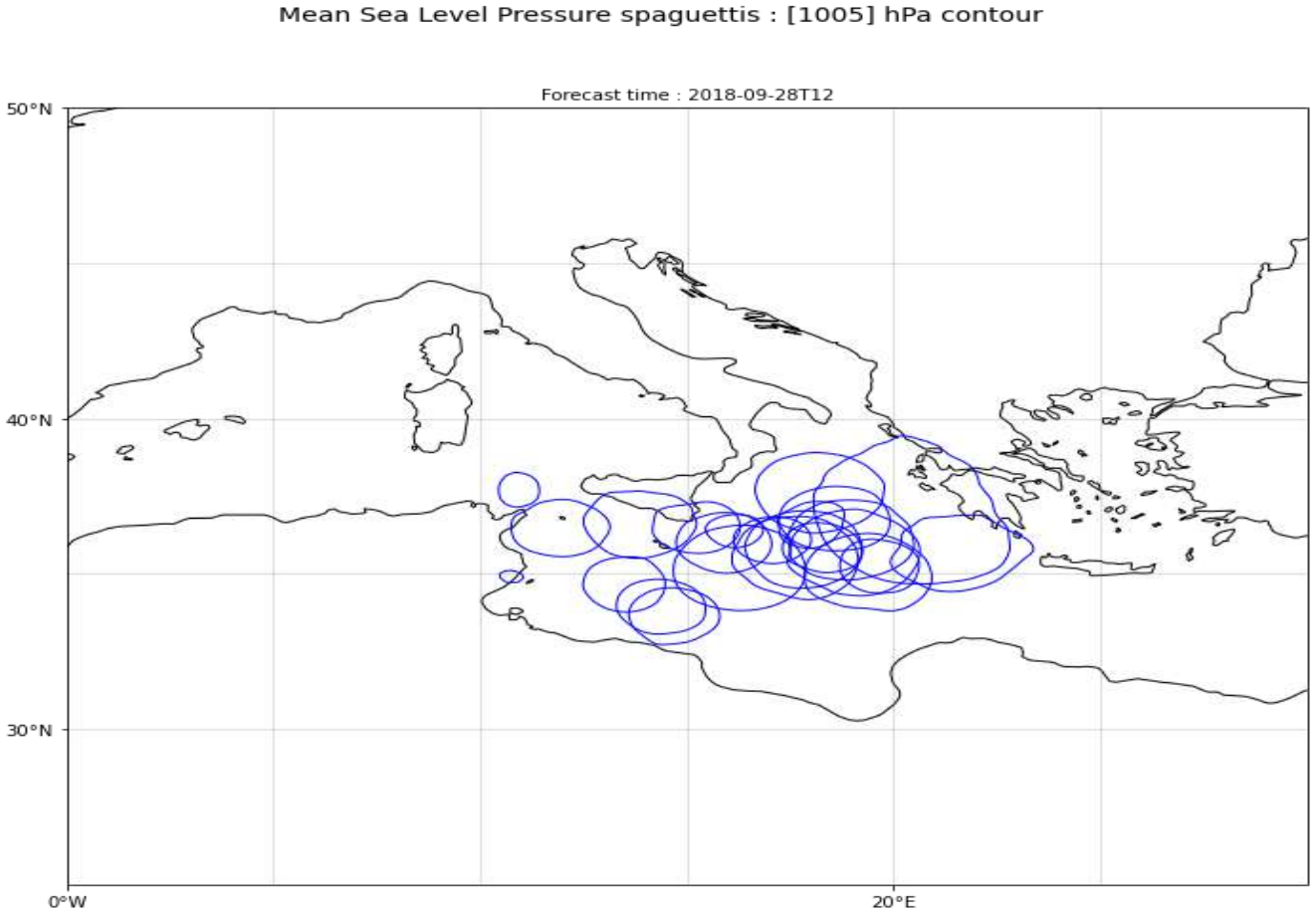
Medicane Zorbas : ensemble spread (MSLP)



Medicane Zorbas : Z500 spaguettis

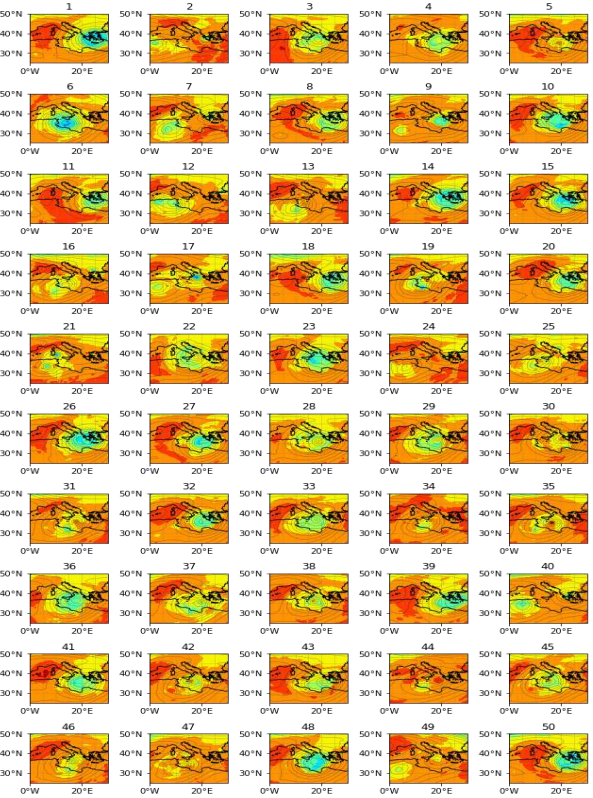


Medicane Zorbas : MSLP spaguettis

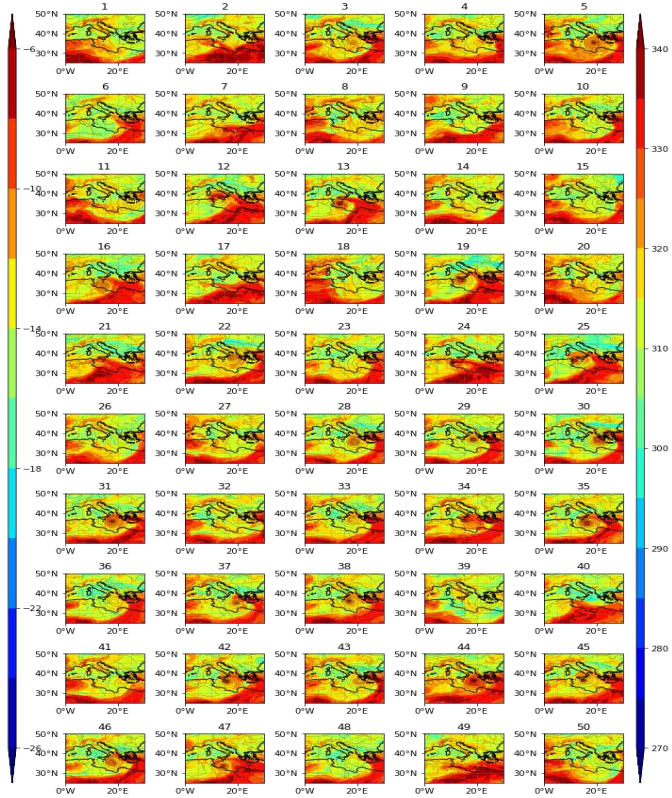


Medicane Zorbas : stamps

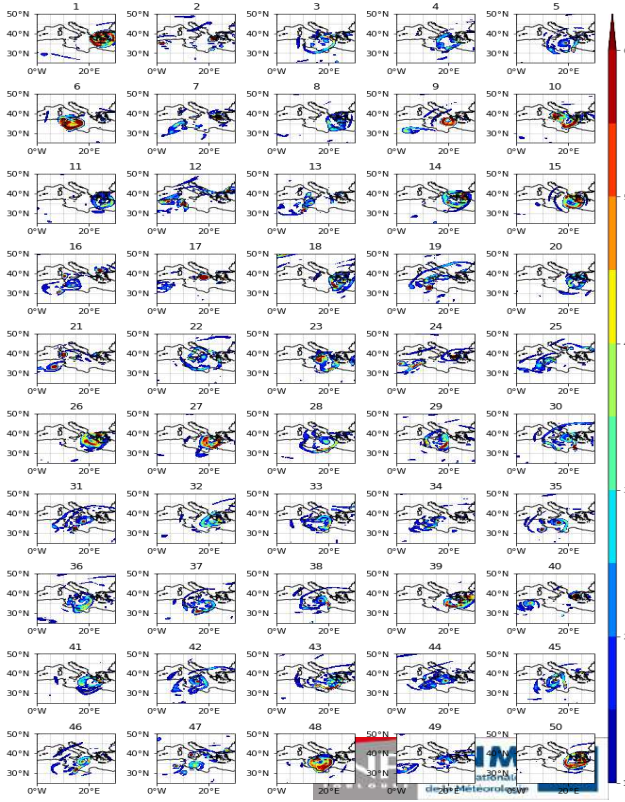
ECMWF ensemble members - ZT500. Forecast time : 2018-09-28T12



ECMWF ensemble members - MSLP and Θ_E at 850 hPa. Forecast time : 2018-09-28T12

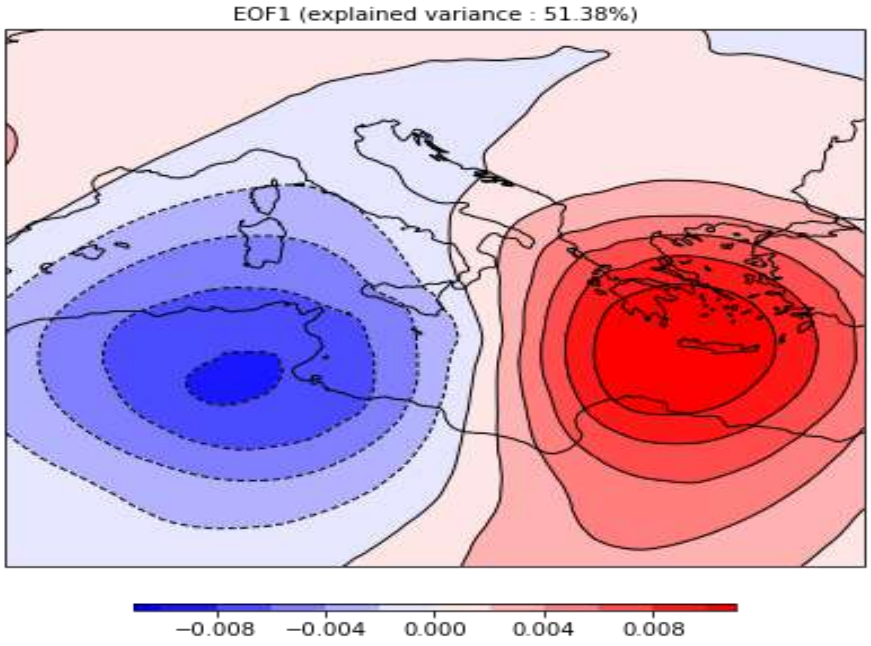


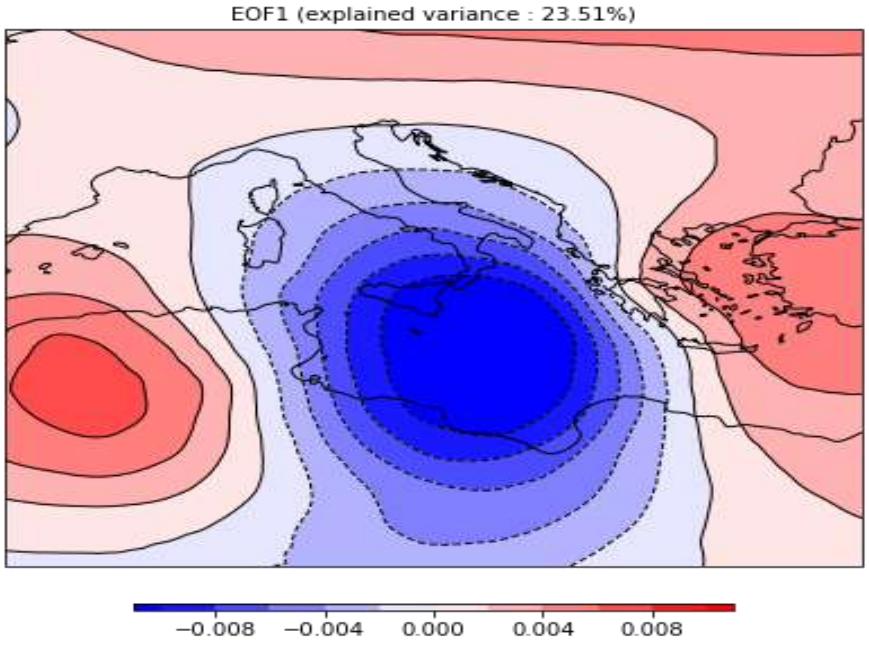
ECMWF ensemble members - PV320K. Forecast time : 2018-09-28T12



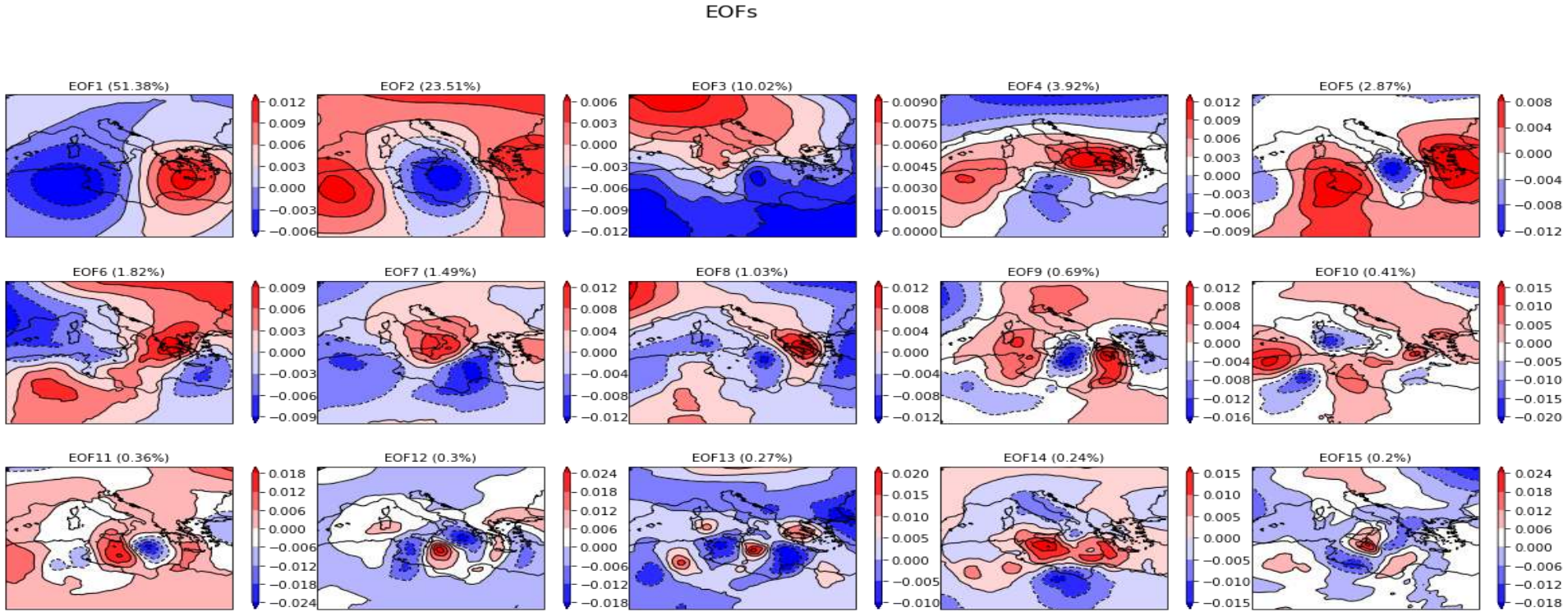
Medicane Zorbas : EOF analysis

ECMWF ensemble members - EOF analysis : Z500 - 2018-09-28T12

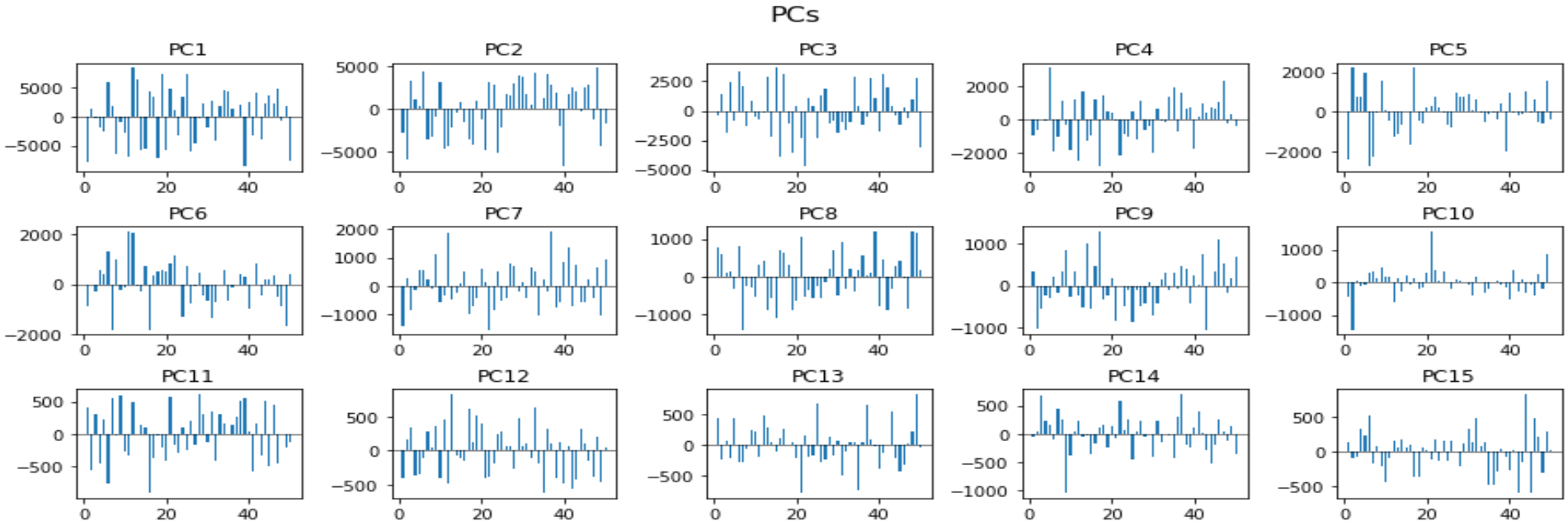




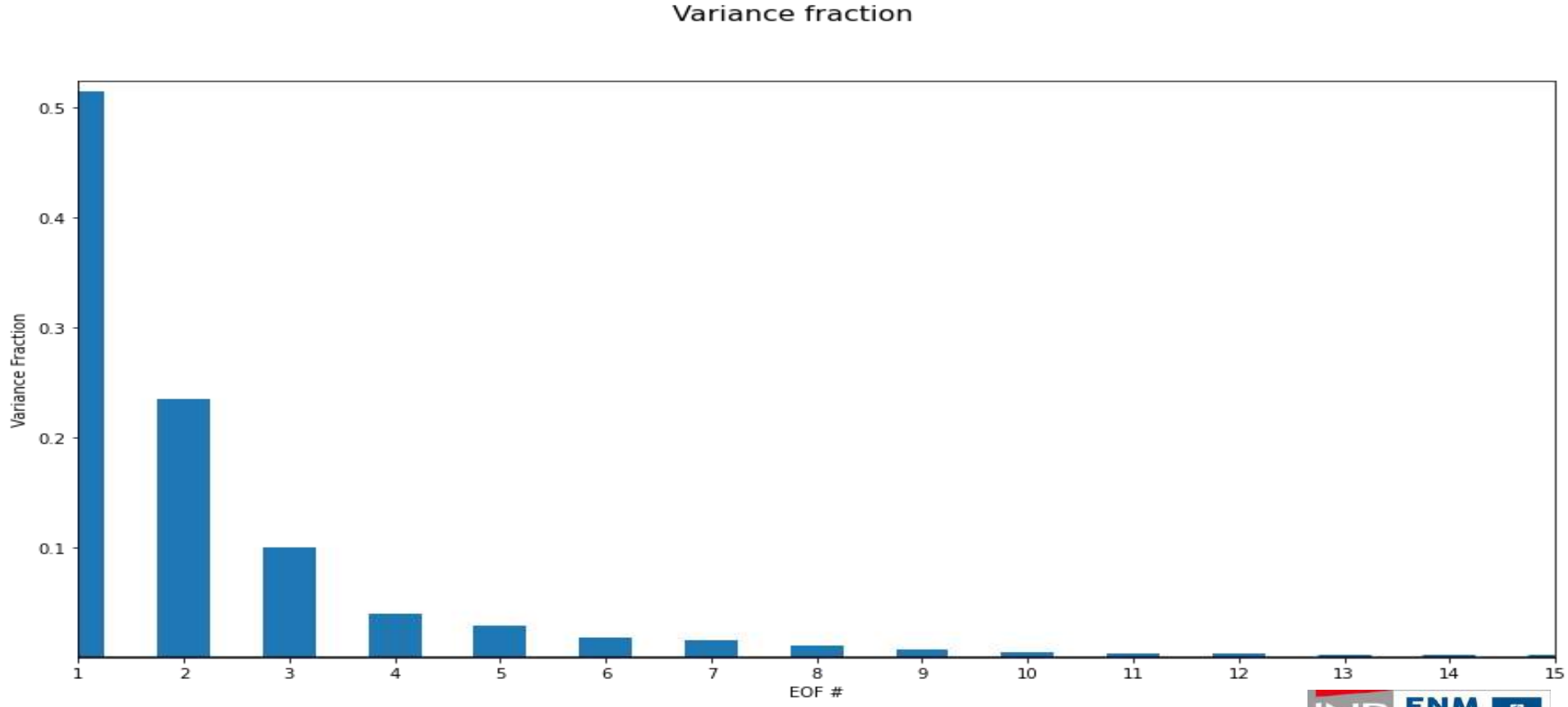
Medicane Zorbas : EOF analysis



Medicane Zorbas : EOF analysis

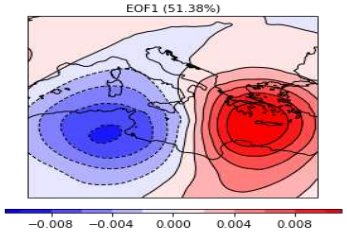


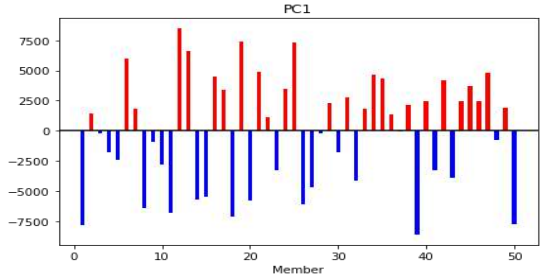
Medicane Zorbas : EOF analysis

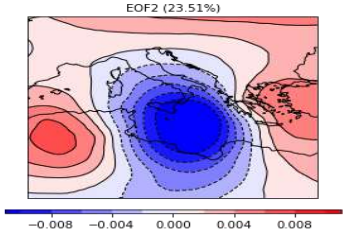


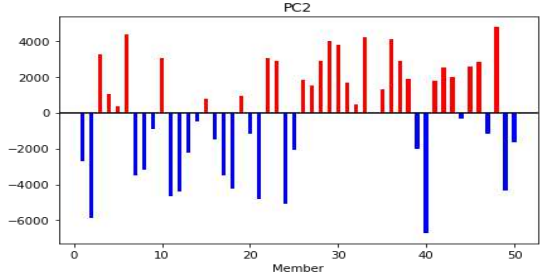
Medicane Zorbas : EOF analysis

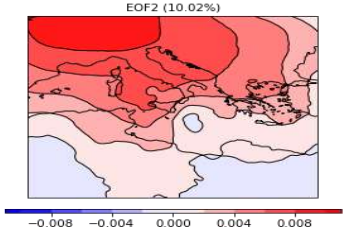
ECMWF ensemble members - EOF analysis (Z500) : 2018-09-28T12

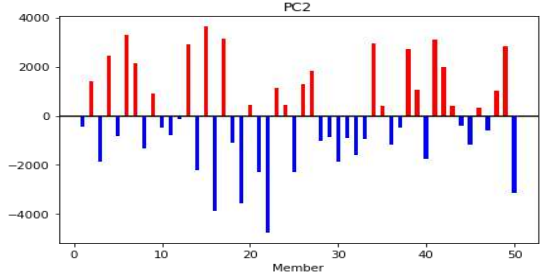




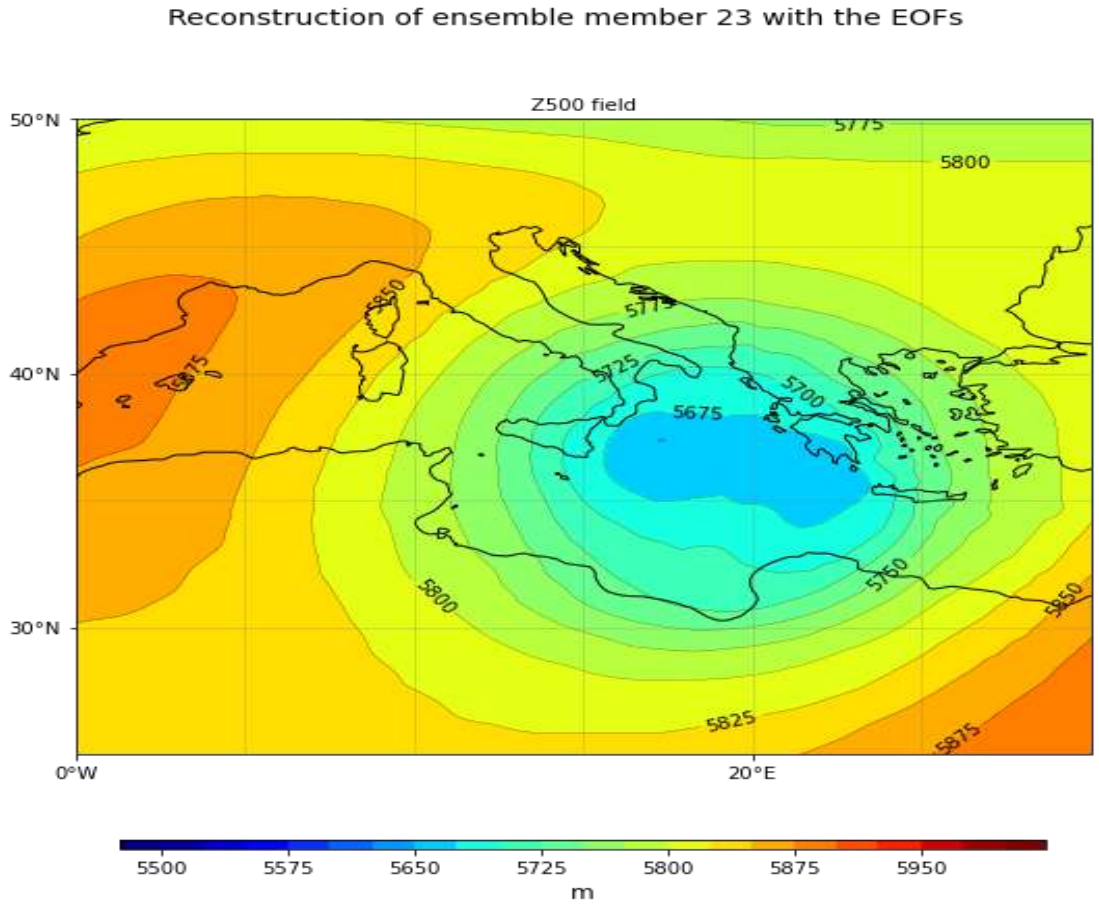




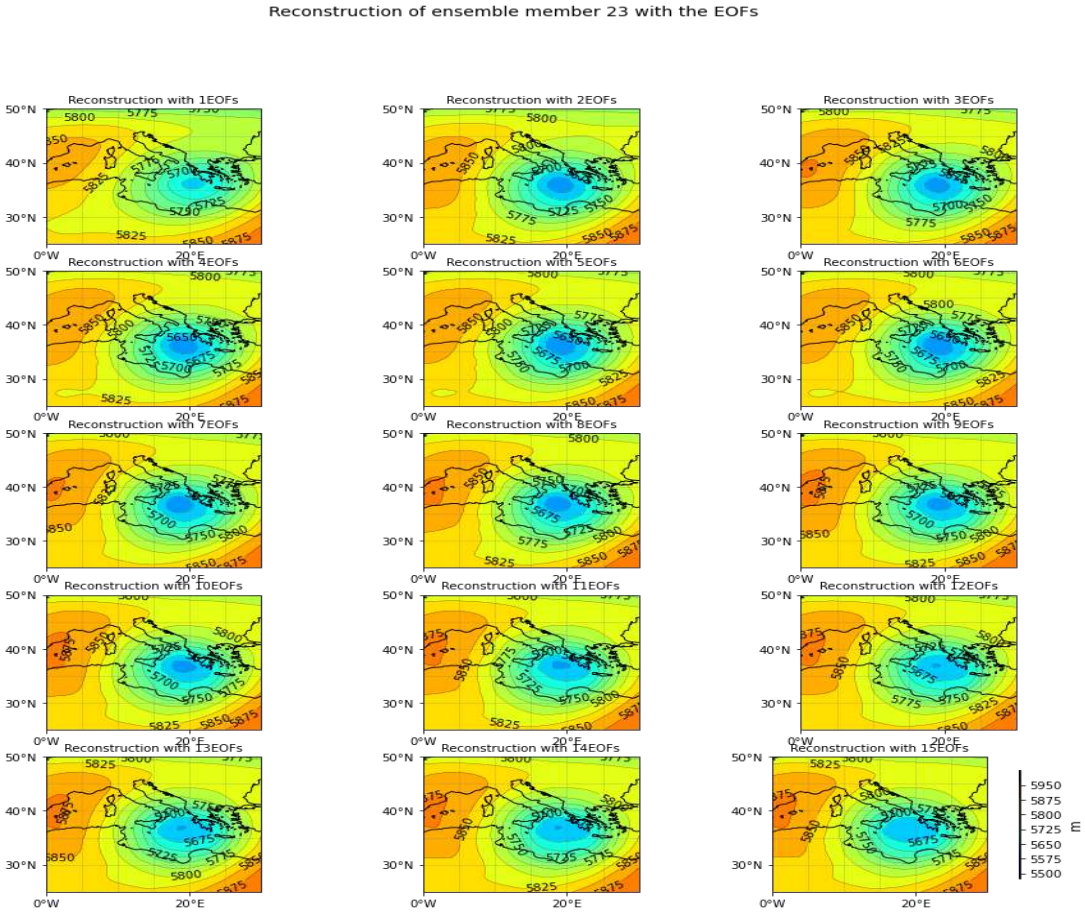




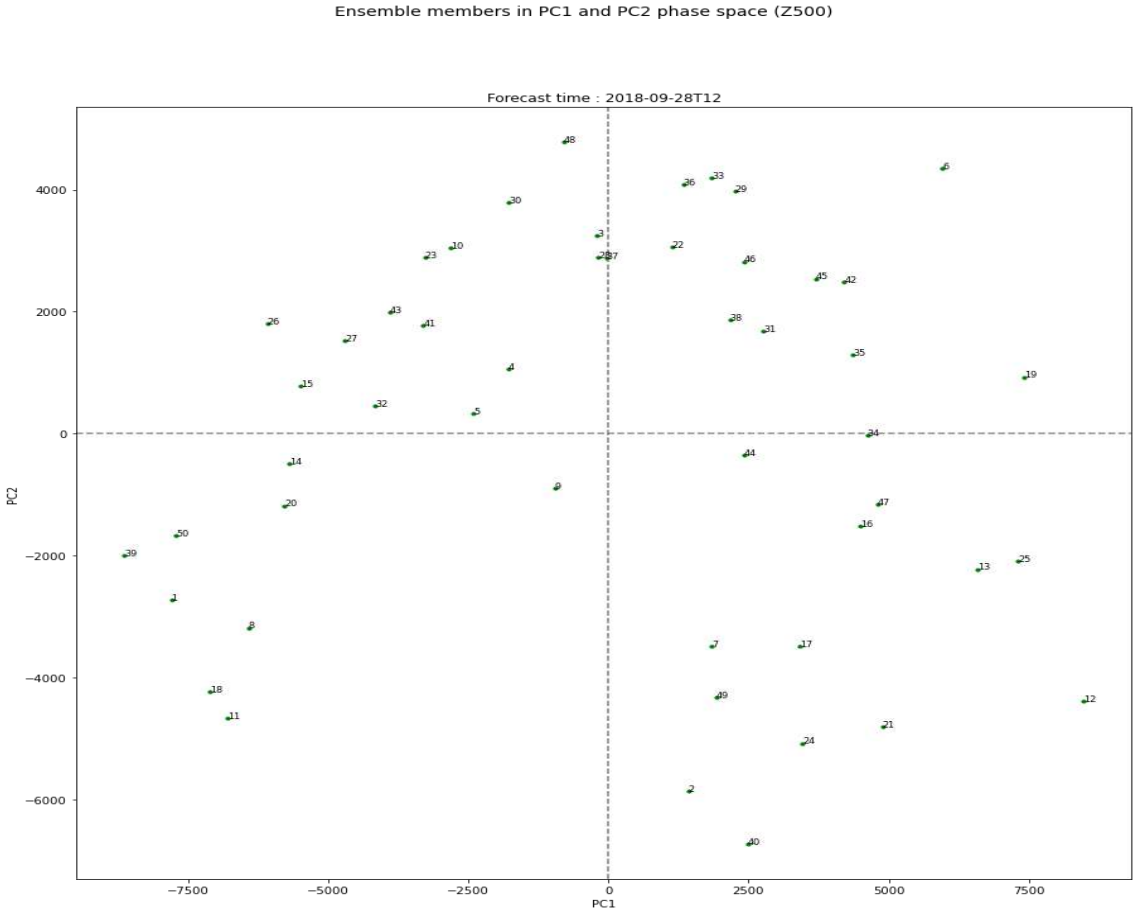
Medicane Zorbas : EOF analysis



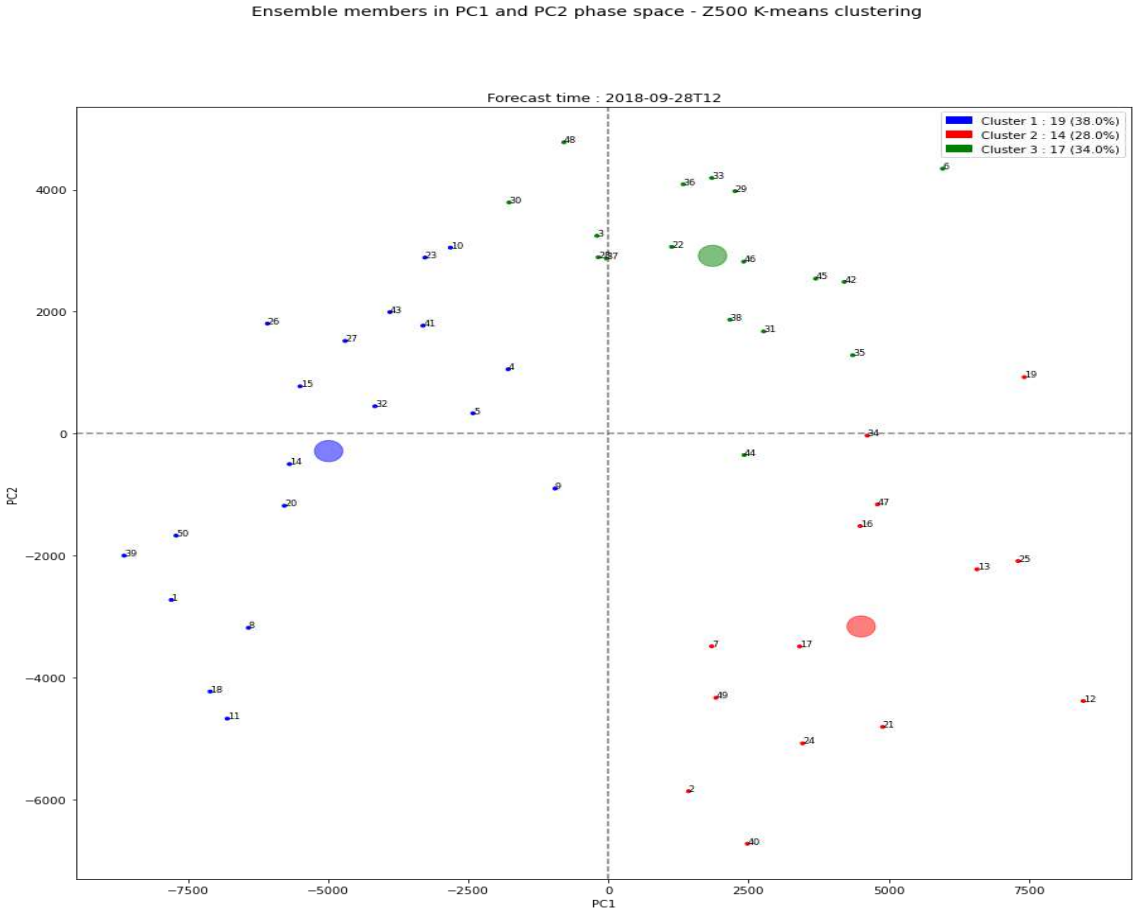
Medicane Zorbas : EOF analysis



Medicane Zorbas : EOF analysis

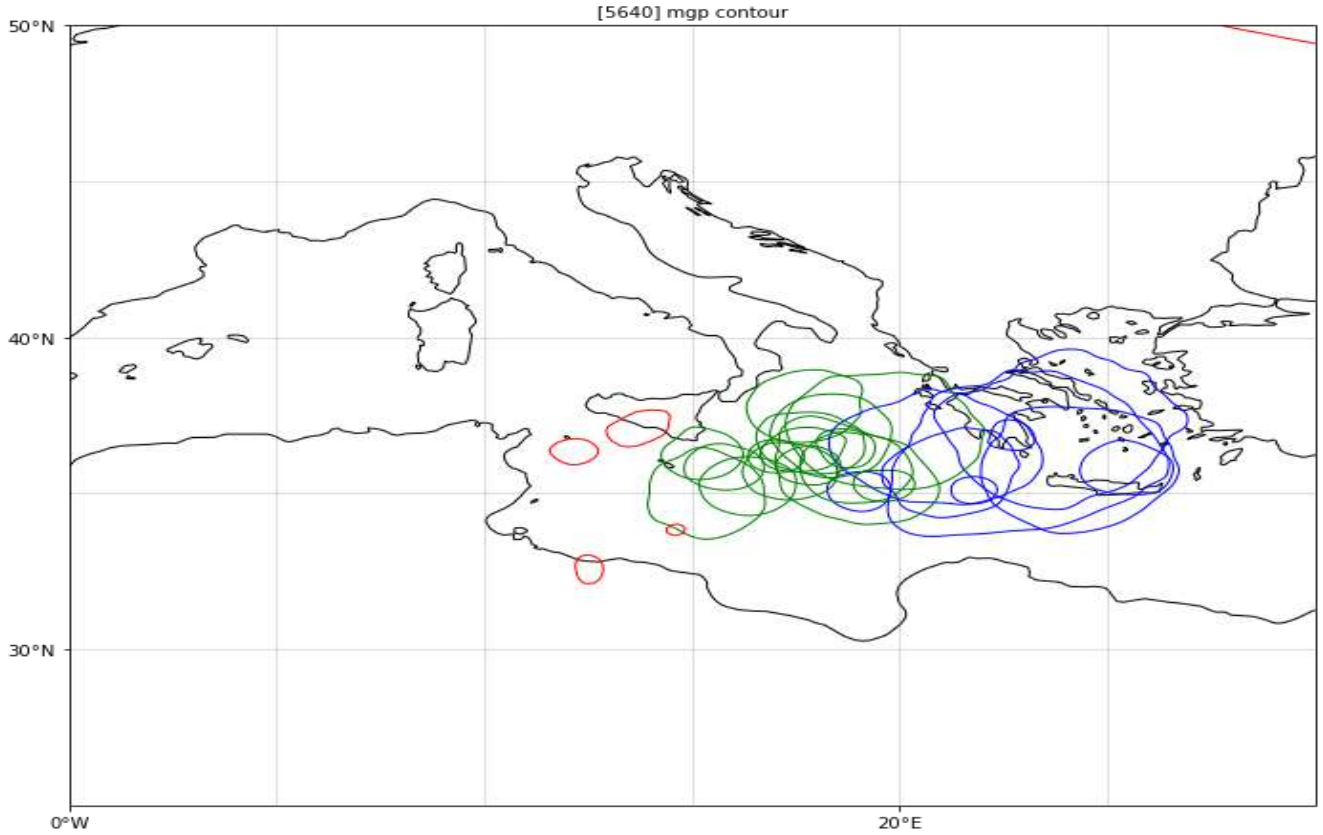


Medicane Zorbas : kmeans clustering

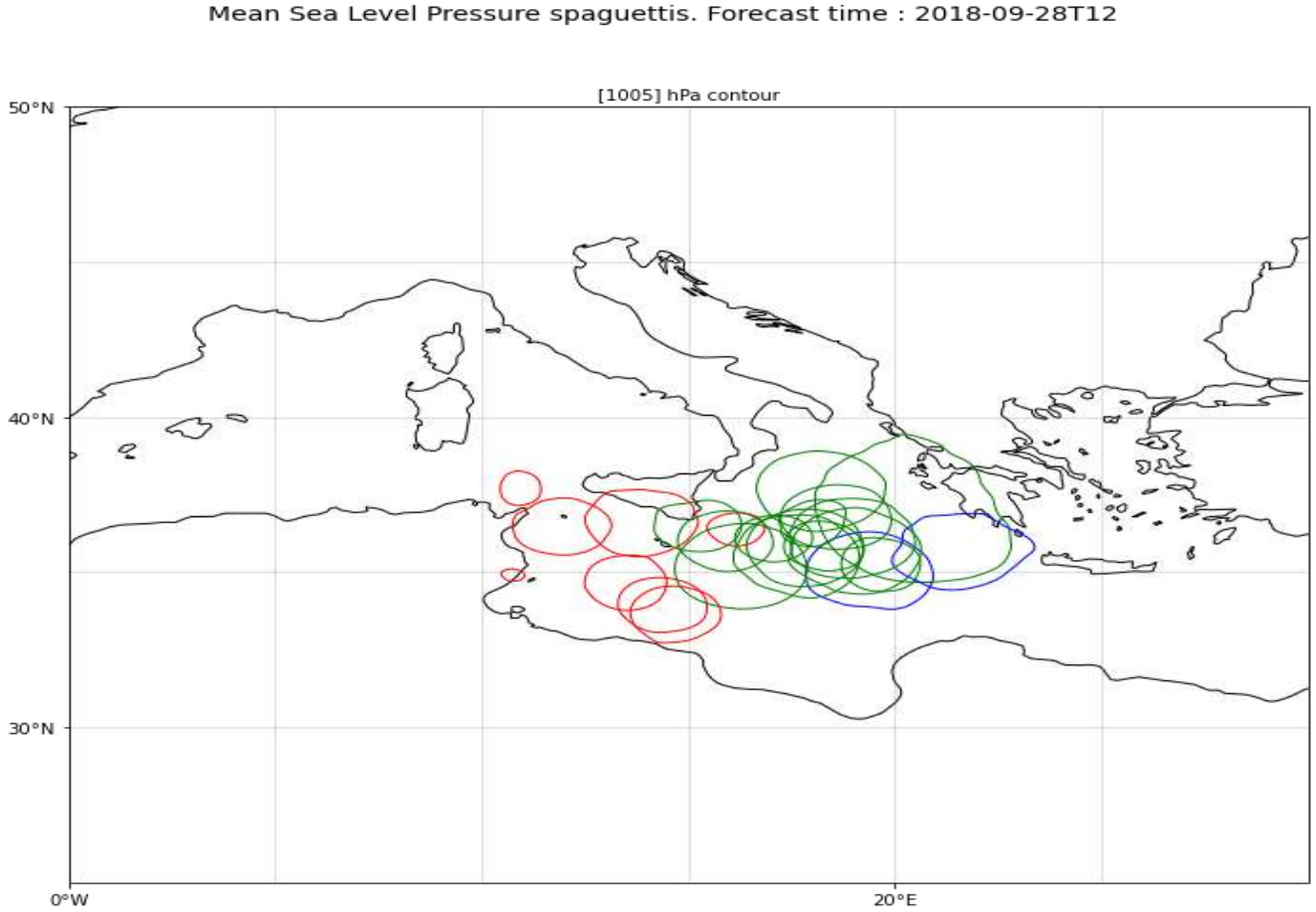


Medicane Zorbas : kmeans clustering

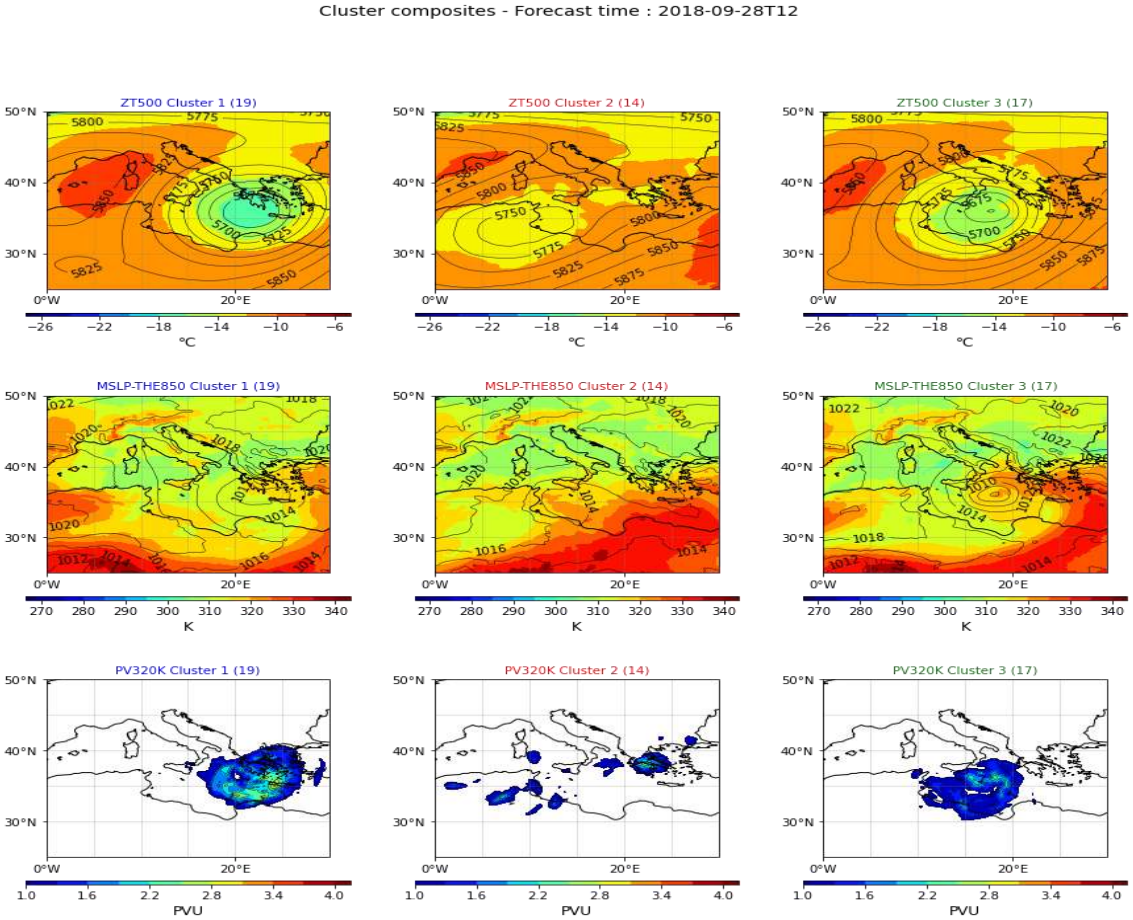
Geopotential height at 500hPa spaguettis with clustering. Forecast time : 2018-09-28T12



Medicane Zorbas : kmeans clustering

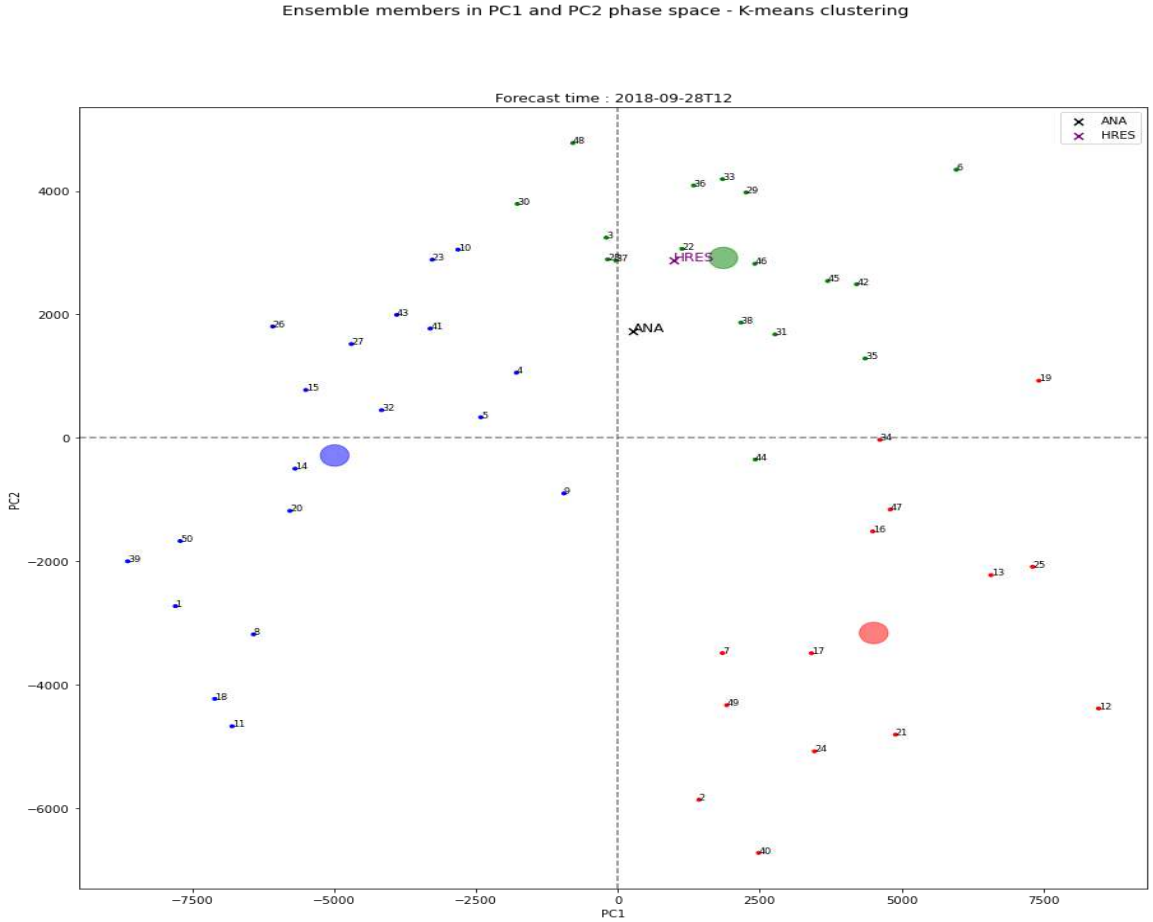


Medicane Zorbas : kmeans clustering



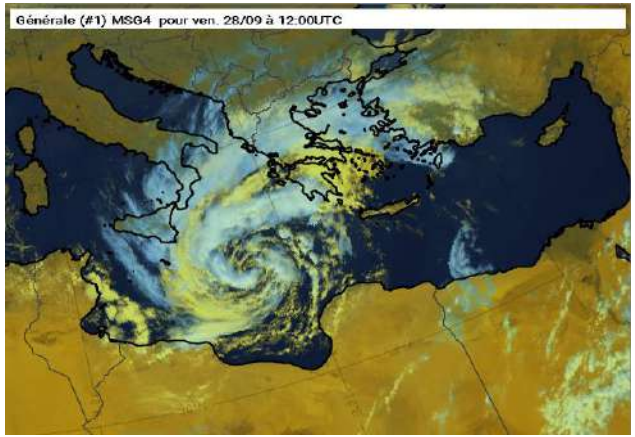
Medicane Zorbas : kmeans clustering

Medicane Zorbas : kmeans clustering



Outlook of the practical sessions

Case study :
Medicane Zorbas
(september 2018)



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4. Ensemble forecast

Session 3 : Friday 19 July morning

1. **Preparation of the student presentations**

Friday 19 July afternoon: student presentations

Notebook extra tasks

1. Track hurricane Leslie over the Atlantic
2. Compute the CPS diagrams for hurricane Leslie
3. Compare tracks and MSLP evolutions (analysis VS deterministic forecast)
4. Classification of the ensemble (EOF and Kmeans clustering)
5. Projection of the analysis and deterministic forecast in the PC phase space

- *To achieve extra task 2 you will need the tracking file from extra task 1*
- *Extra task 4 is in fact an advanced task that may have been done in class*

Bibliography

- Portmann, R., González-Alemán, J. J., Sprenger, M., and Wernli, H.: How an uncertain short-wave perturbation on the North Atlantic wave guide affects the forecast of an intense Mediterranean cyclone (Medicane Zorbas), Weather Clim. Dynam., 1, 597–615, https://doi.org/10.5194/wcd-1-597-2020, 2020.

- Kouroutzoglou, J.; Samos, I.; Flocas, H.A.; Hatzaki, M.; Lamaris, C.; Mamara, A.; Emmannouil, A. Analysis of the Transition of an Explosive Cyclone to a Mediterranean Tropical-like Cyclone. Atmosphere 2021, 12, 1438. https://doi.org/10.3390/atmos12111438