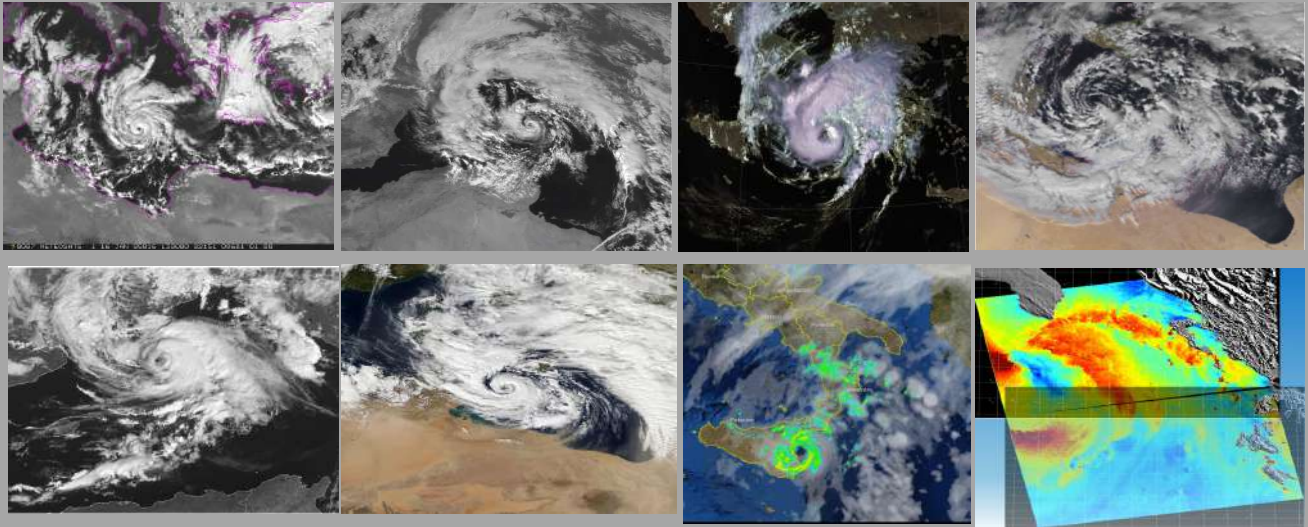


TOWARD A DEFINITION OF «MEDICANE»



Mario Marcello Miglietta¹ and the COST Action on Mediterranean cyclones - initiative on the definition of «Medicanes»

¹Miglietta M. M., D. S. Carrió Carrió, L. Cavicchia, L. P. D'Adderio, S. Dafis, S. Davolio, L. Fita Borrell, H. Flocas, M. A. Gaertner, J. J. Gonzalez Aleman, J. Gutierrez Fernandez, M. Hatzaki, V. Homar Santaner, A. Jansa, G. Panegrossi, F. Pantillon, C. Pasquero, P. Patlakas, M. A. Picornell, I. Pytharoulis, F. Ragone, S. Raveh-Rubin, A. Ricchi, R. Husson, D. Schultz, E. Scoccimarro, E. Flaounas

¹ISAC-CNR, Italy



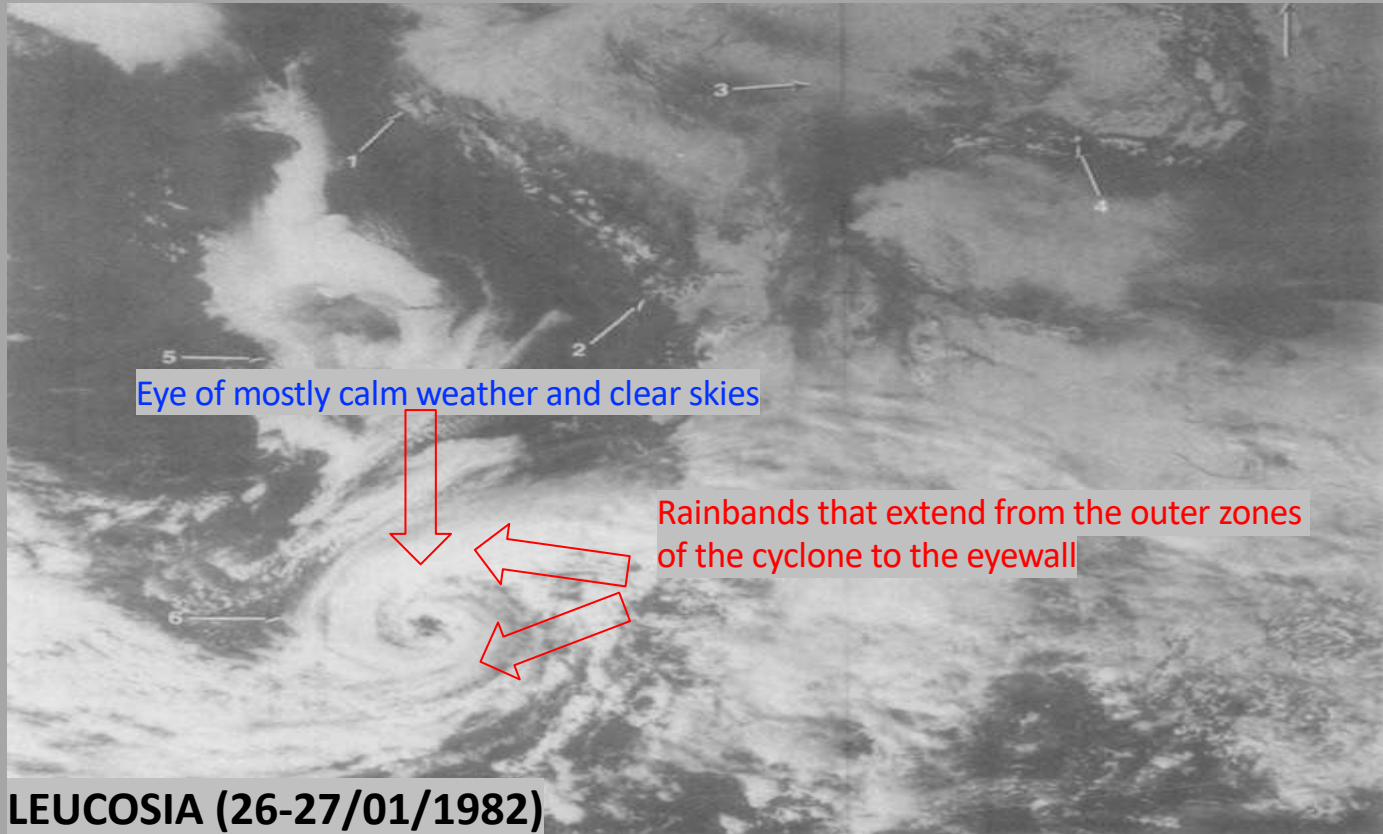
MOTIVATION

In the context of the COST Action MEDCYCLONES context, an initiative has been proposed to provide a definition of Medicanes.

In the scientific literature, the term “Medicane” has been adopted in different ways, depending on the purpose of the study and on the tools employed for the analysis.

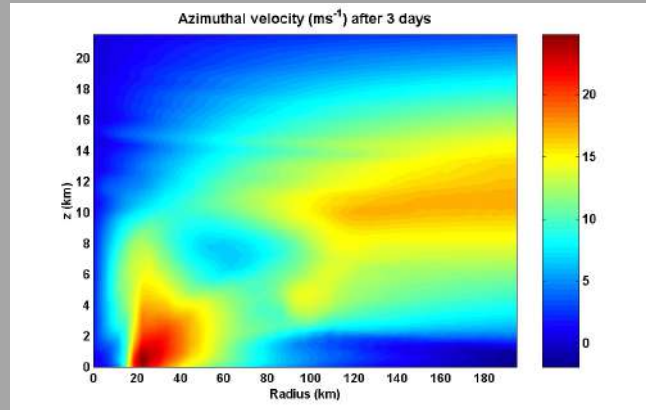
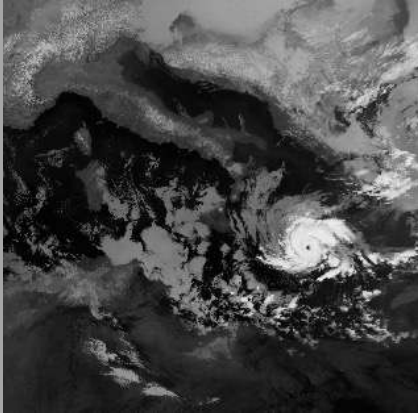
Also, social media sources may classify newly formed or forecasted cyclones as medicanes.

Visual characteristics similar to TC

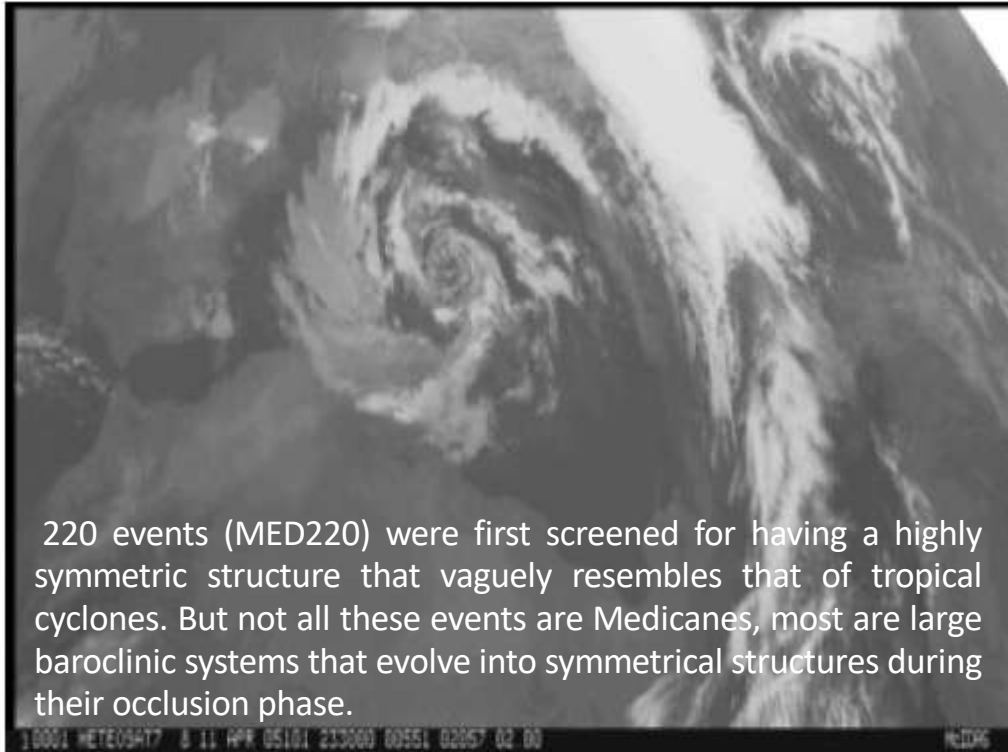


NOAA-7 visible band image of January 1982 storm. Arrow number 5 indicates southeastern Italy, arrow number 2 corresponds to the coast of Albania (Ernst and Matson, 1983).

Genesis and maintenance of “Mediterranean hurricanes” (Emanuel, 2005)



An **axisymmetric, cloud-resolving model** -in which any development may occur only due to the **feedback between surface enthalpy fluxes and wind** – was applied to show that an **upper-level cold low** can produce high potential intensity in an Ionian cyclone



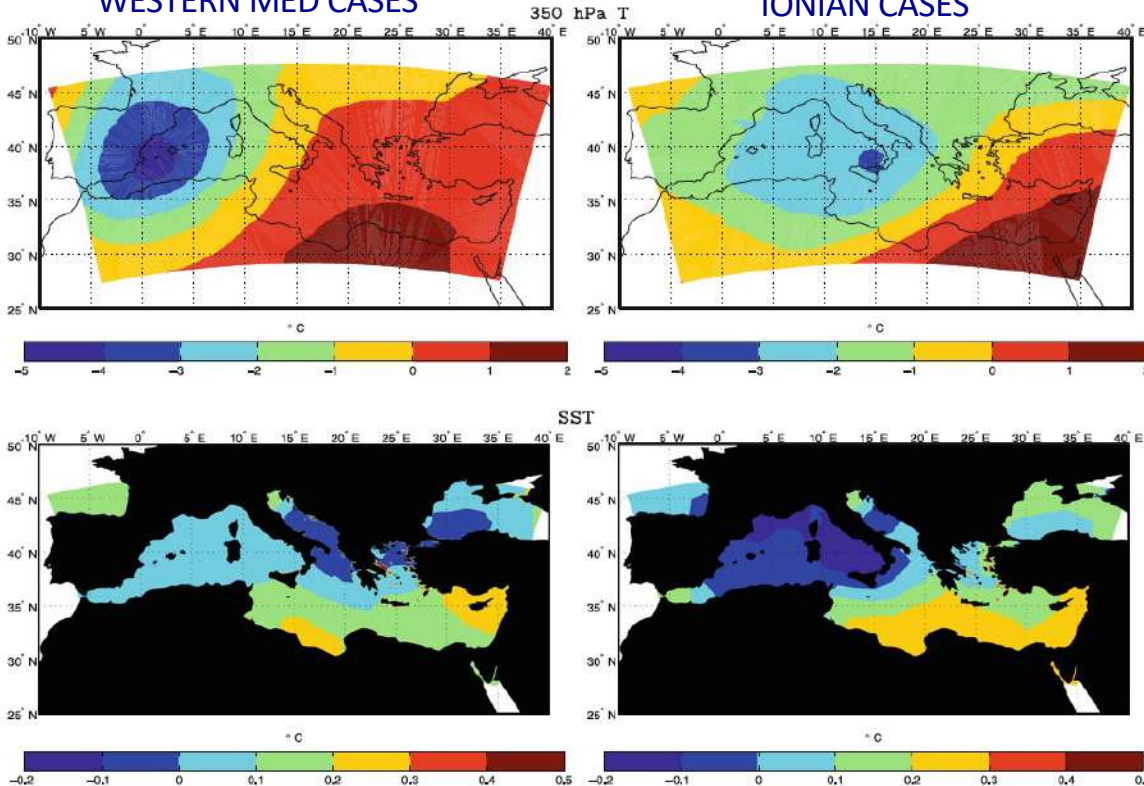
220 events (MED220) were first screened for having a highly symmetric structure that vaguely resembles that of tropical cyclones. But not all these events are Medicanes, most are large baroclinic systems that evolve into symmetrical structures during their occlusion phase.

Figure 2. Large and highly symmetric baroclinic cyclone on 11 April 2005 at 2330 UTC (IR image of Meteosat).

ANOMALIES OF METEOROLOGICAL PARAMETERS

WESTERN MED CASES

IONIAN CASES



350 hPa
Temperature

SST

Fig. 9 Composite plots of the daily means, on the day corresponding to the first point in the track, for medicanes in the western Mediterranean (left panels) and Ionian Sea (right panels) of the

anomalies with respect to the climatological monthly means. 350 hPa temperature (top, 1 °C contours), sea surface temperature (bottom, 0.1 °C contours)

NCEP/NCAR reanalysis downscaled by CCLM

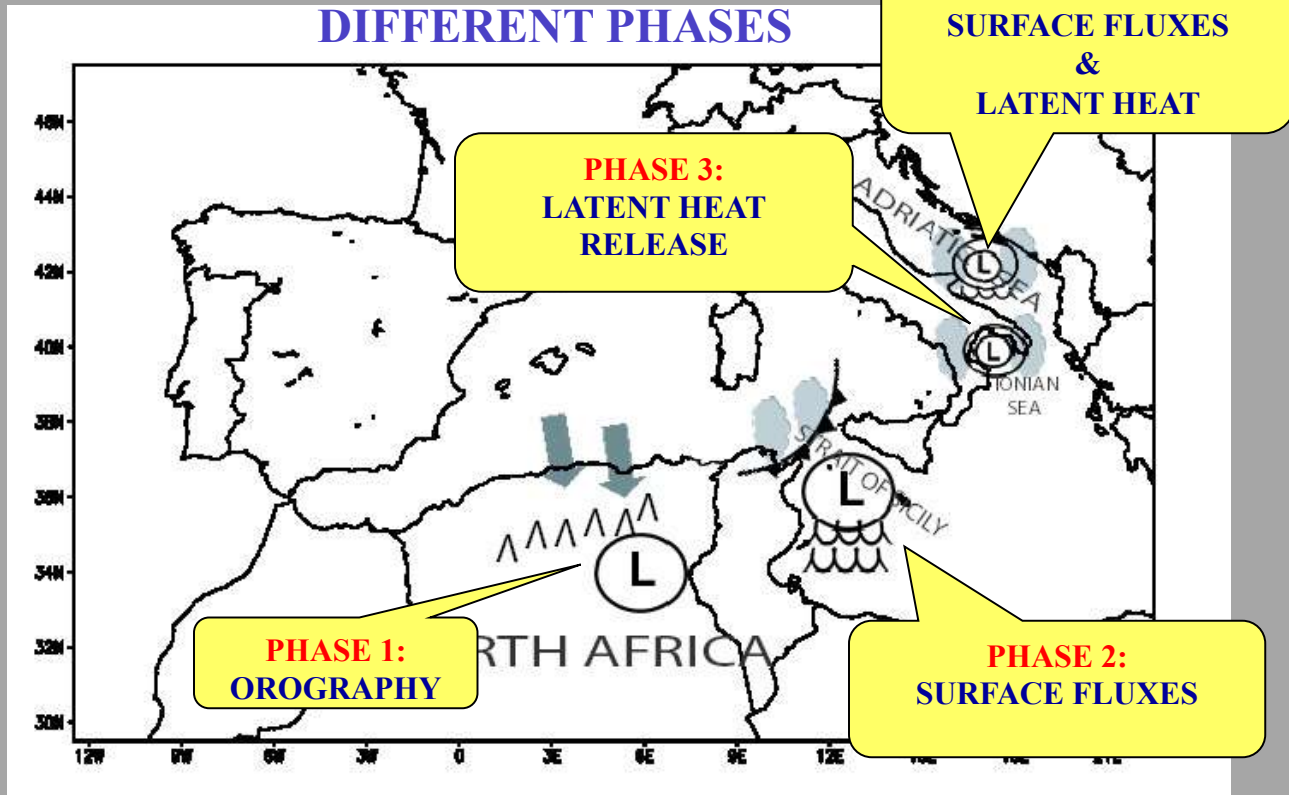
10 km resolution

Period: 1948-2011

Cavicchia et al. (2013)

RELEVANT ATMOSPHERIC PROCESSES

DIFFERENT PHASES



UPPER LEVEL DYNAMICS AND PREDICTABILITY ISSUES

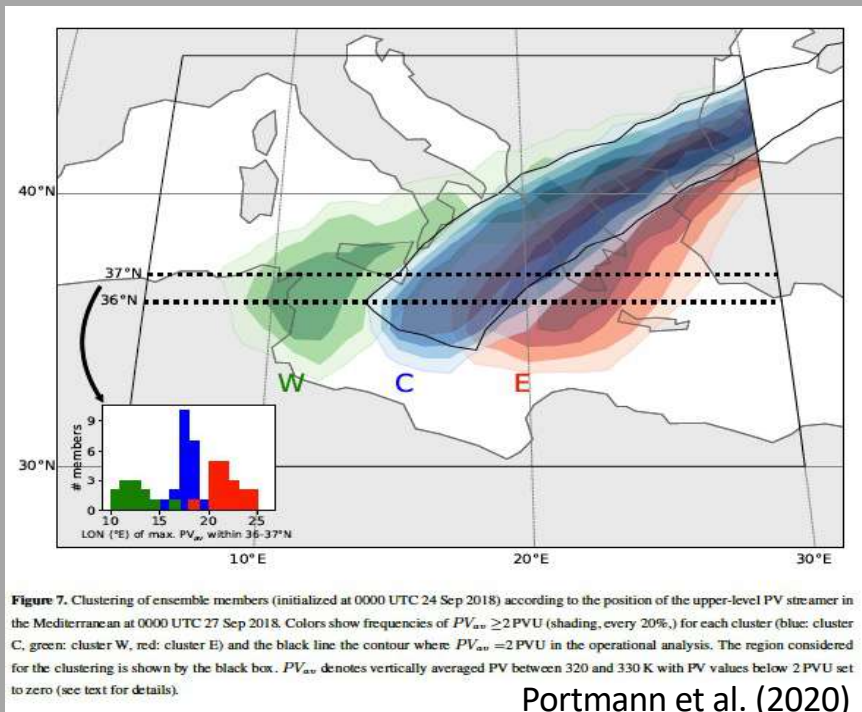
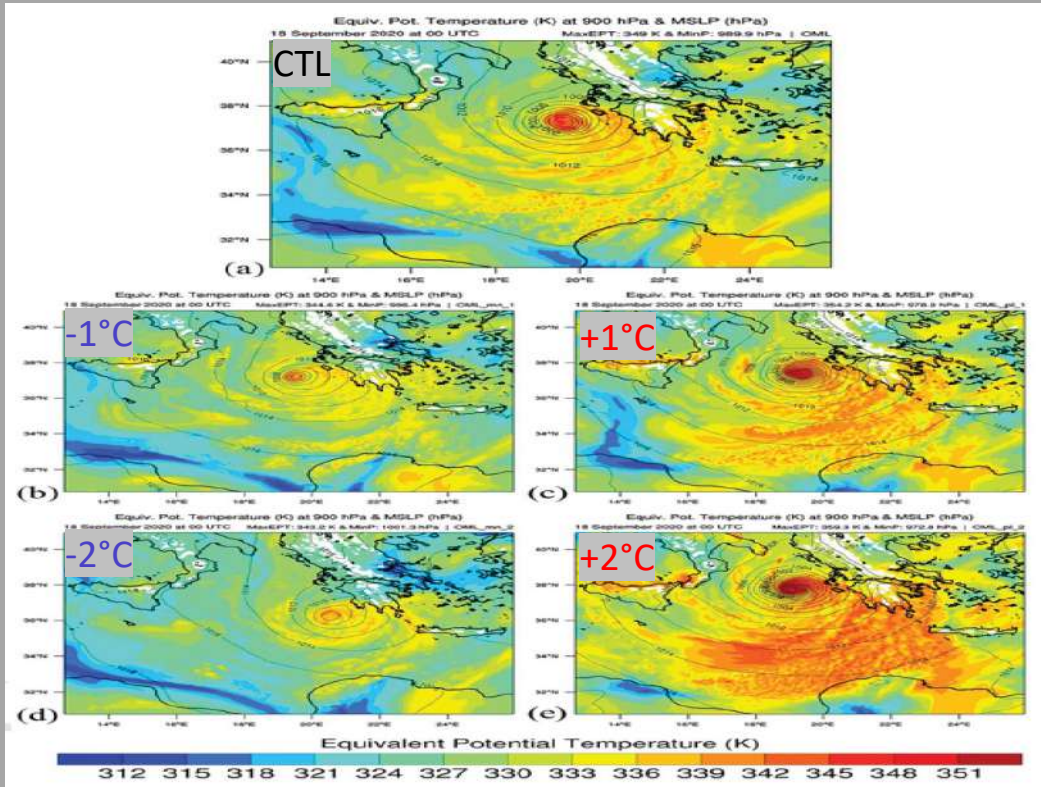


Figure 7. Clustering of ensemble members (initialized at 0000 UTC 24 Sep 2018) according to the position of the upper-level PV streamer in the Mediterranean at 0000 UTC 27 Sep 2018. Colors show frequencies of $PV_{av} \geq 2$ PVU (shading, every 20%) for each cluster (blue: cluster C, green: cluster W, red: cluster E) and the black line the contour where $PV_{av} = 2$ PVU in the operational analysis. The region considered for the clustering is shown by the black box. PV_{av} denotes vertically averaged PV between 320 and 330 K with PV values below 2 PVU set to zero (see text for details).

PV streamers control the coupling with the low-levels and determine its location and intensity. Portmann et al. (2020) found that short-wave perturbations on the North Atlantic waveguide a few days before the development of an intense medecane dramatically affected its subsequent evolution.

ZORBAS (27-30/09/2018)

ROLE OF SST ANOMALY



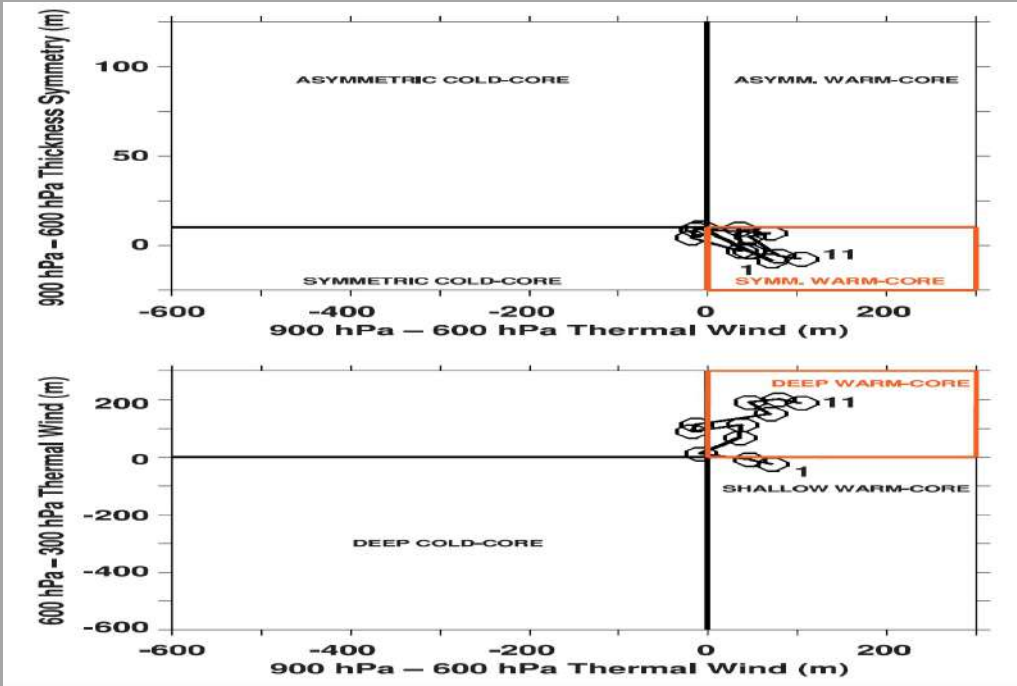
No SST significant anomalies prior to cyclone development, but higher SST anomalies intensify the cyclone warm core and the pressure minimum (e.g., Varlas et al., 2023)

IANOS (15-20/09/2020)

How can we discriminate Medicanes from a dynamic perspective?

HART (2003) DIAGRAM

Symmetry
Upper-troposphere
Temperature

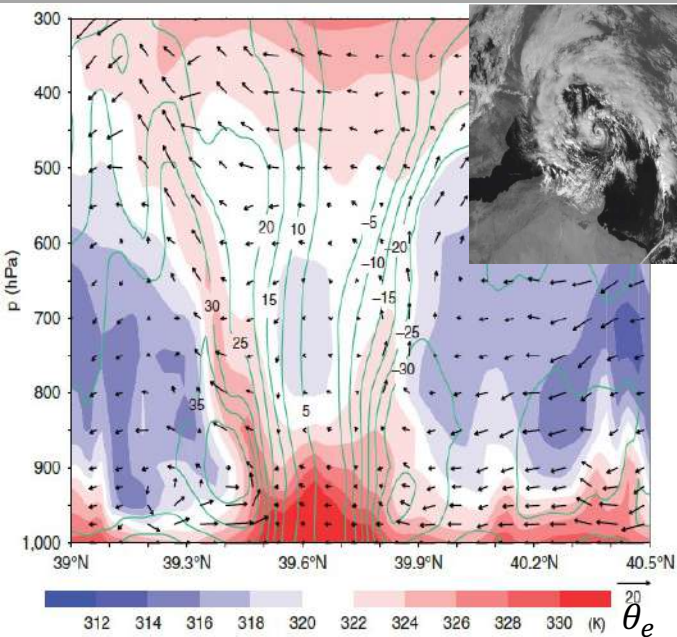


Lower-troposphere Temperature

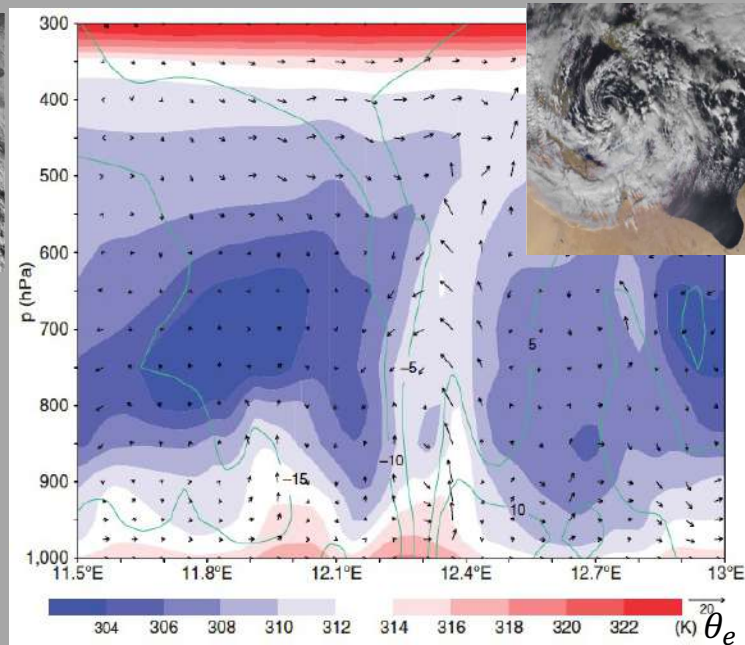
BUT the presence of a warm central core may be due to a warm seclusion (Mazza et al., 2017; Fita and Flaounas, 2018).

CROSS SECTION ALONG THE CYCLONE CENTER

In both cases symmetric, deep warm core structures but only the first one shows the upward transport of warm/moist air typical of TC
Different contribution of baroclinic versus diabatic processes



CORNELIA (OCTOBER 1996)

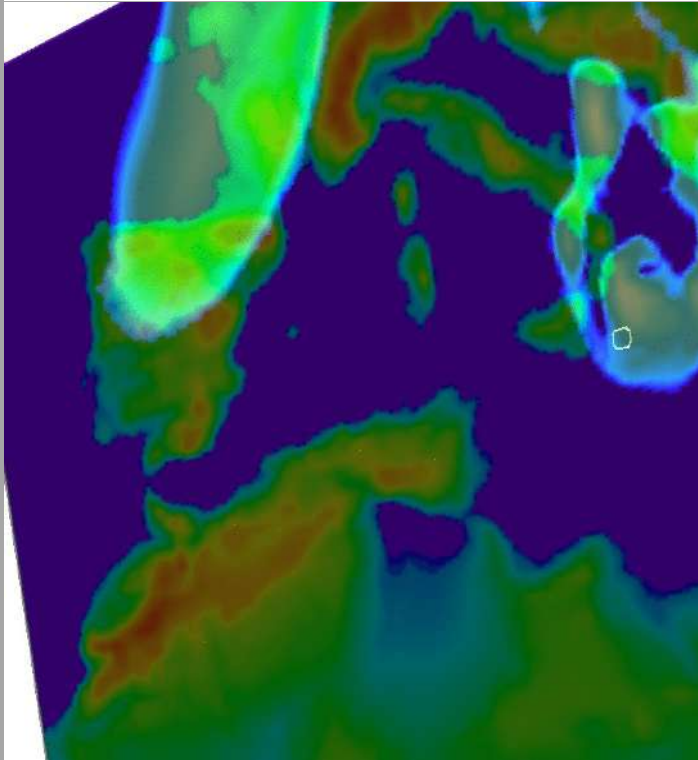


ZEO (DECEMBER 2005)

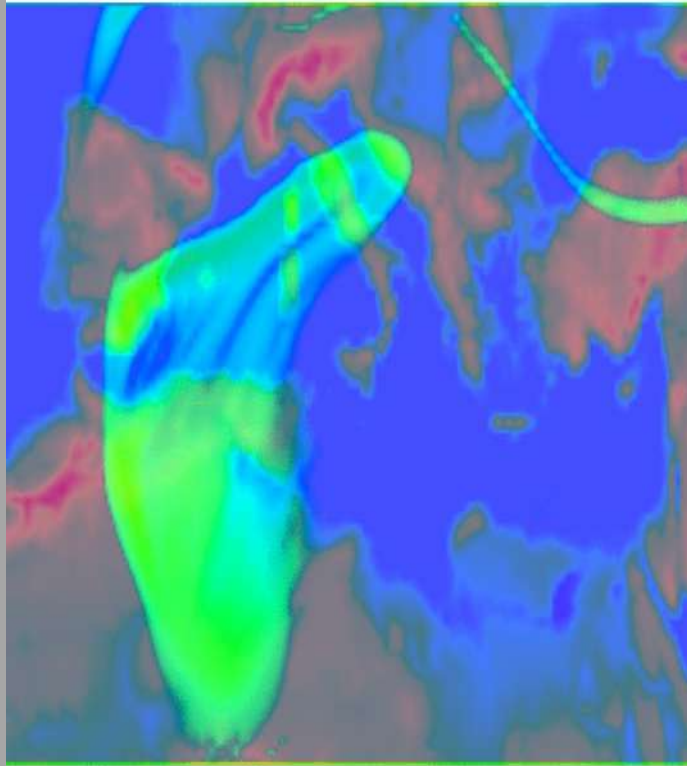
Vertical cross-section of θ_e (colours), storm-relative winds (vectors), absolute momentum (lines, contour interval=5m/s; zero not shown) near the cyclone centre
Miglietta and Rotunno (2019)

PV @ 9000 m; mslp

OCTOBER 1996

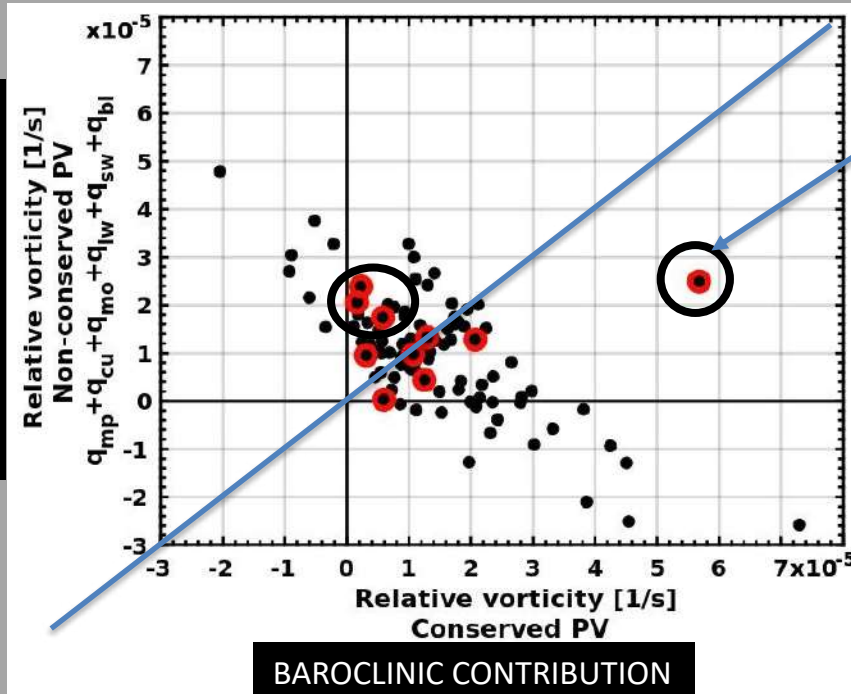


DECEMBER 2005



Contribution of baroclinic versus diabatic processes to 850 hPa relative vorticity

DIABATIC CONTRIBUTION



Some Medicanes are not exclusively sustained by air-sea interaction

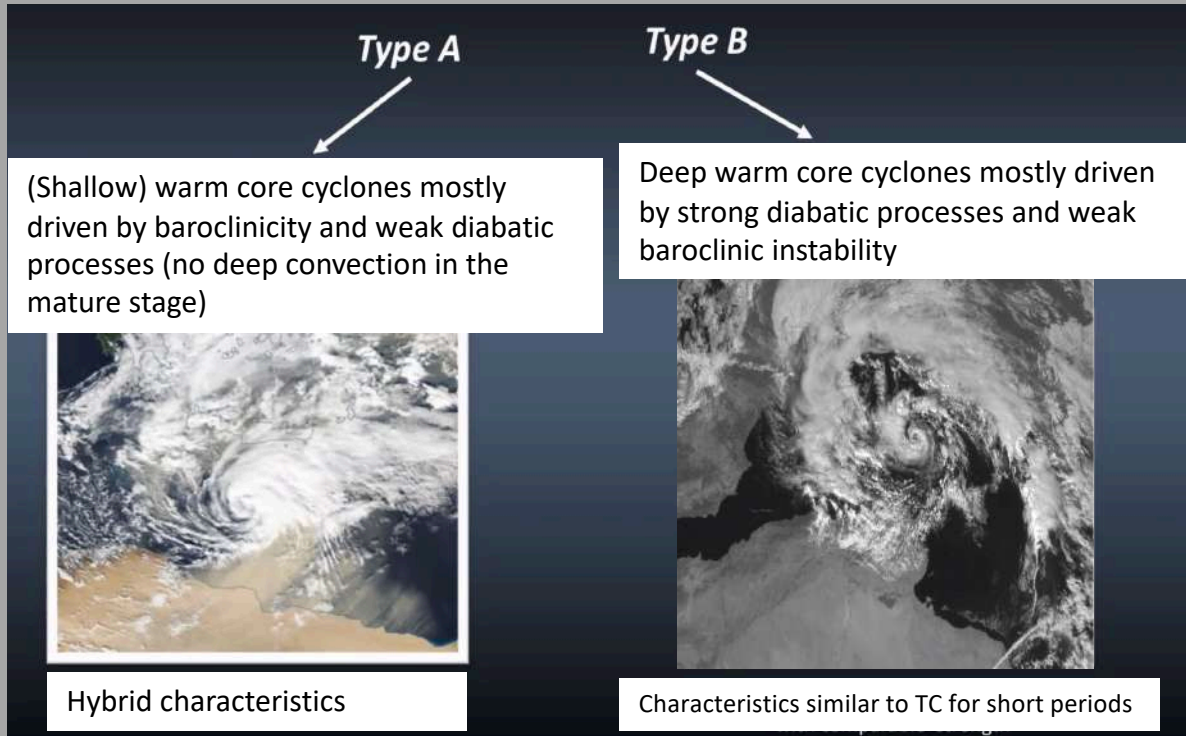
Mature stage

Contribution of different PV sources to 850 hPa relative vorticity, in the centre of 100 cyclones: conserved, adiabatically transported PV (x-axis) and non-conserved, diabatically-produced PV (y-axis).

Medicanes (red) do not concentrate in a region of the parameter space.

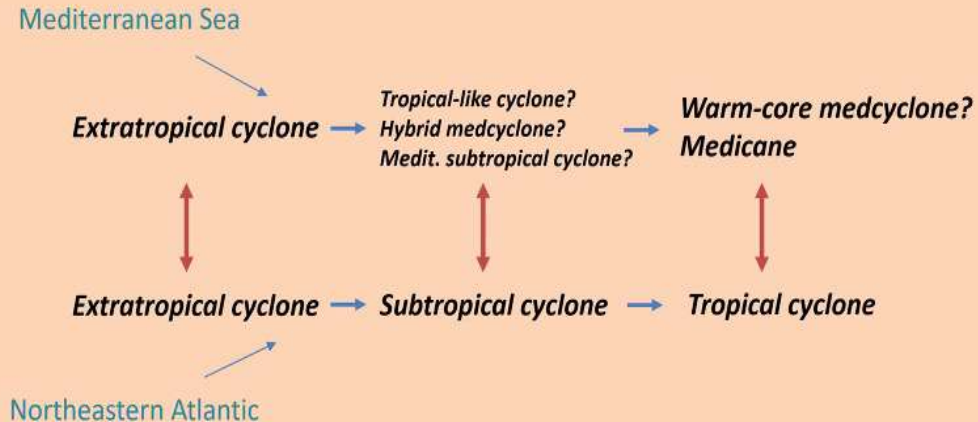
The term “medicane” has been used to cover a wide range of the continuum existing between ECs and TCs.

A classification in **categories** was proposed, depending on the dominant process in the mature stage.



Toward a definition of medicane

- The main idea/hypothesis:



STRATEGY FOR REAL-TIME IDENTIFICATION

Is it a medicane?

Four conditions to be satisfied for the identification of a medicane

1

Convective Activity - Satellite Observations

- a) Meteosat: Presence convection (IR channels) and a spiral cloud coverage with an "eye" (VIS channels)
- b) Microwave sensors ATMS – AMSU-A: Detection of a warm core (although problematic considering the short duration of their mature stage and their small horizontal extent)
- c) Lightning Activity: Indications of the onset of the mature stage (based on the decrease in the number of lightning flashes).



4

Numerical Diagnostics:

- a) Surface pressure tendency equation
- b) Potential vorticity methods
- c) Changes in the distance of maximum wind speed
- d) Environmental characteristics: baroclinicity, coupling index, CAPE, etc...



2

Wind Field

- a) Analysis/Reanalysis: Although their resolution is too coarse for a good estimation of small-scale wind structures.
- b) Scatterometers: Although rough information at high wind speed and their resolution is too coarse for a good estimation of small-scale wind structures
- c) SAR: can provide very fine, accurate data, but they provide non-continuous, limited-area coverage, thus they are able to scan cyclones only occasionally.
- d) Adaptation of the NHC Dvorak intensity estimation technique

3

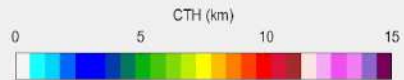
Adapted Cyclone Phase Space:

Identification of the presence of a symmetric deep warm core.

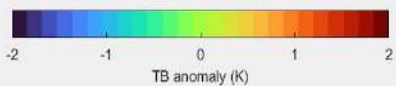
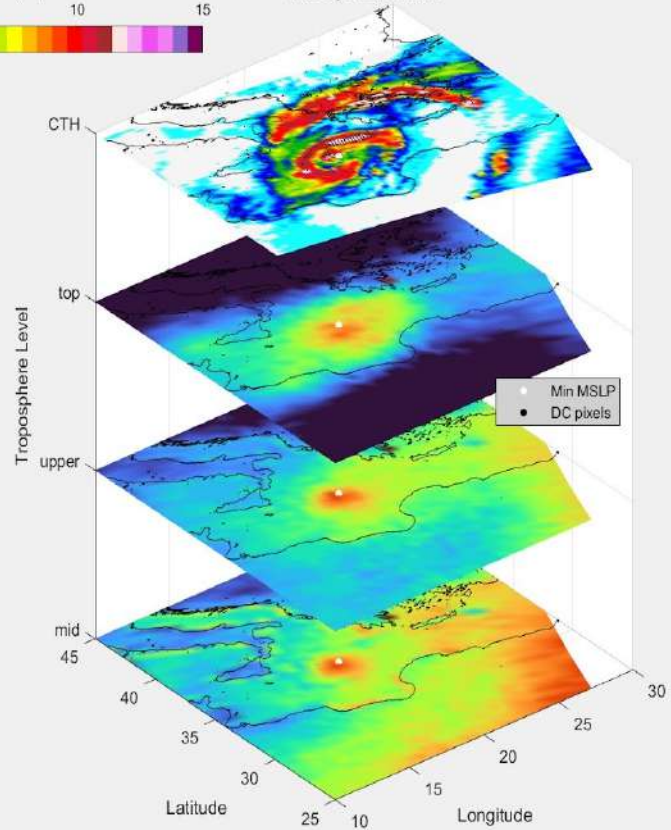
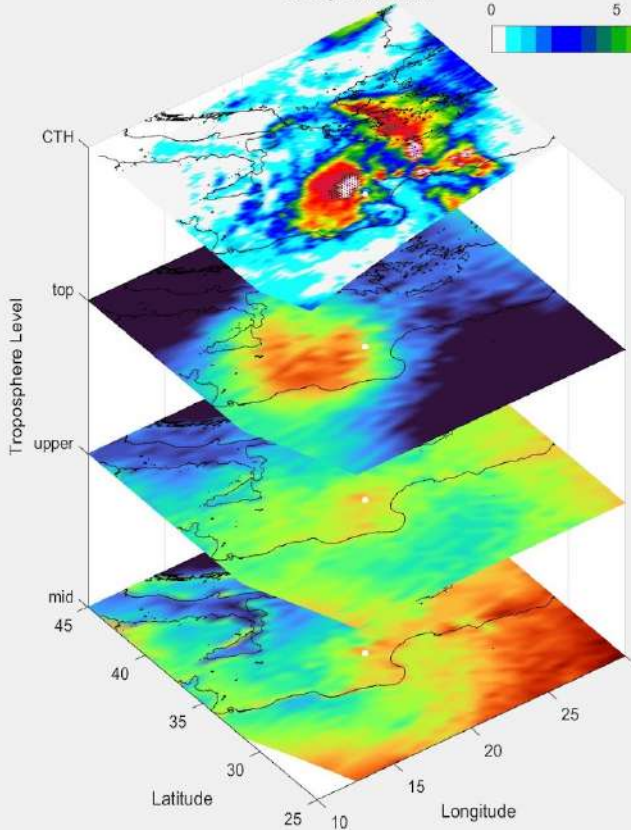


ZORBAS THERMAL STRUCTURE (PMW)

27-Sep-2018 18:18



28-Sep-2018 08:33



Panegrossi et al. (2023)

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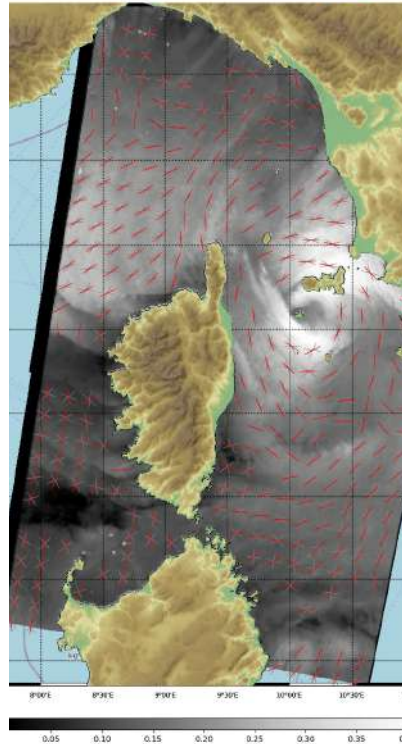
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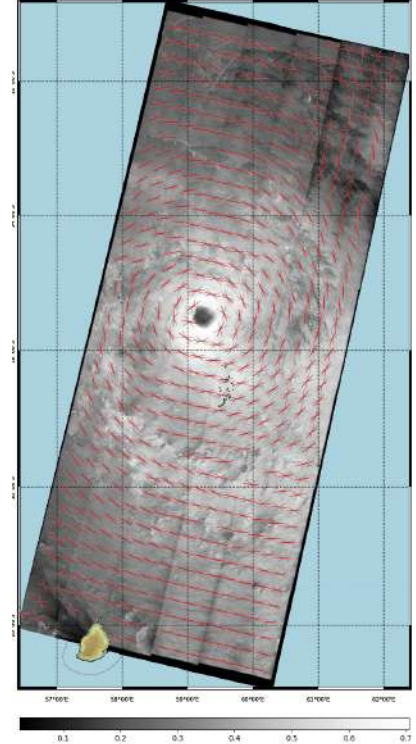


SAR images: Medicane BLAS vs TC Emnati

P CYMS products - Nice Display
Sea Surface Roughness - Nice Display - Co-Pol

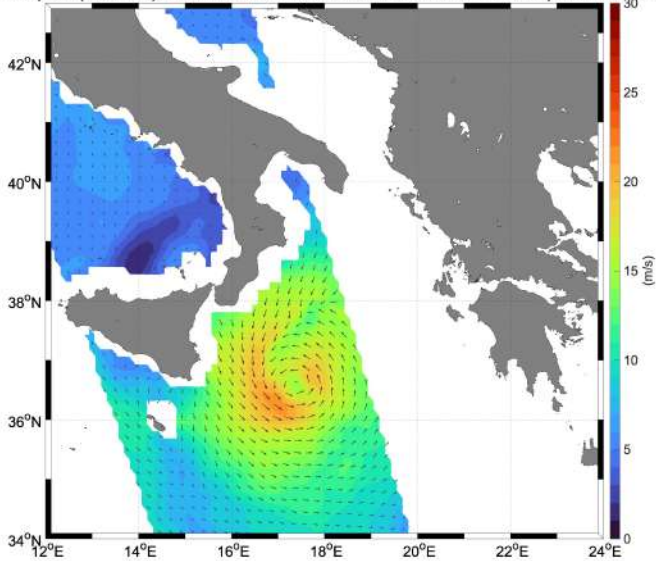


2P CYMS products - Nice Display
Cross-Pol

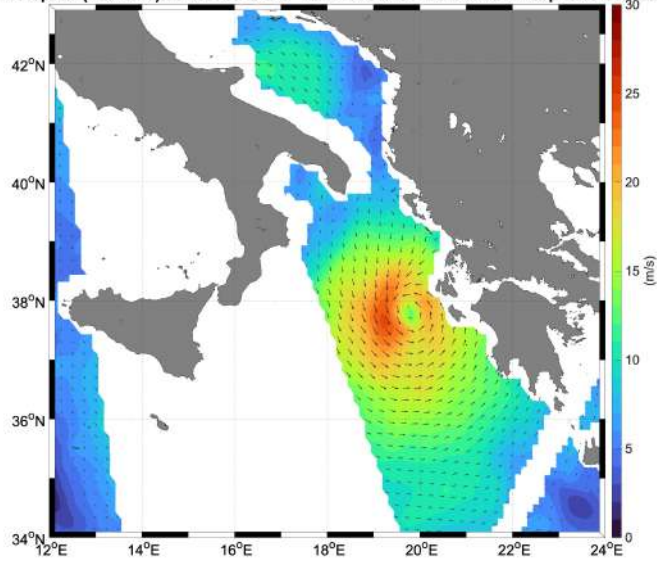


METOP-C ASCAT images: Medicane Ianos

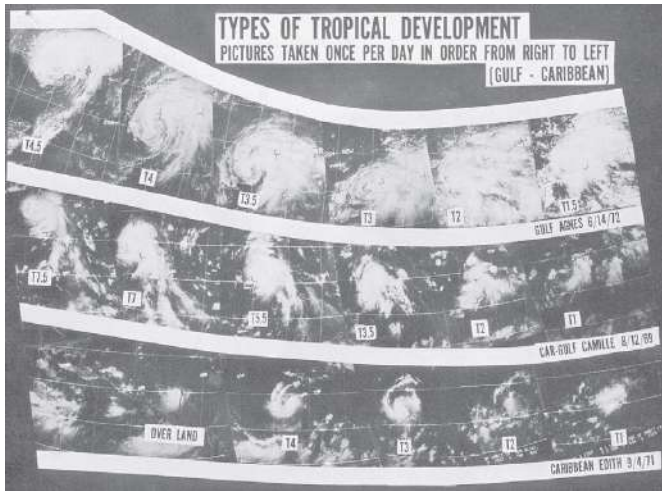
Wind Speed (max 21.8) METOP-C ASCAT 12km ASCEND TLC IANOS 16-Sep-2020 21:16:48



Wind Speed (max 24.3) METOP-C ASCAT 12km ASCEND TLC IANOS 17-Sep-2020 20:57:36



Dvorak technique



DEVELOPMENTAL PATTERN TYPES	PRE STORM	TROPICAL STORM		HURRICANE PATTERN TYPES		
		(Minimal)	(Strong)	(Minimal)	(Strong)	(Super)
CURVED BAND PRIMARY PATTERN TYPE	T1.5 - 2.5	T2.5	T3.5	T4.5	T5.5	T6.5 - T8
CURVED BAND EIR ONLY						
CDO PATTERN TYPE VIS ONLY						
SHEAR PATTERN TYPE						

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