

Medicanes and climate change

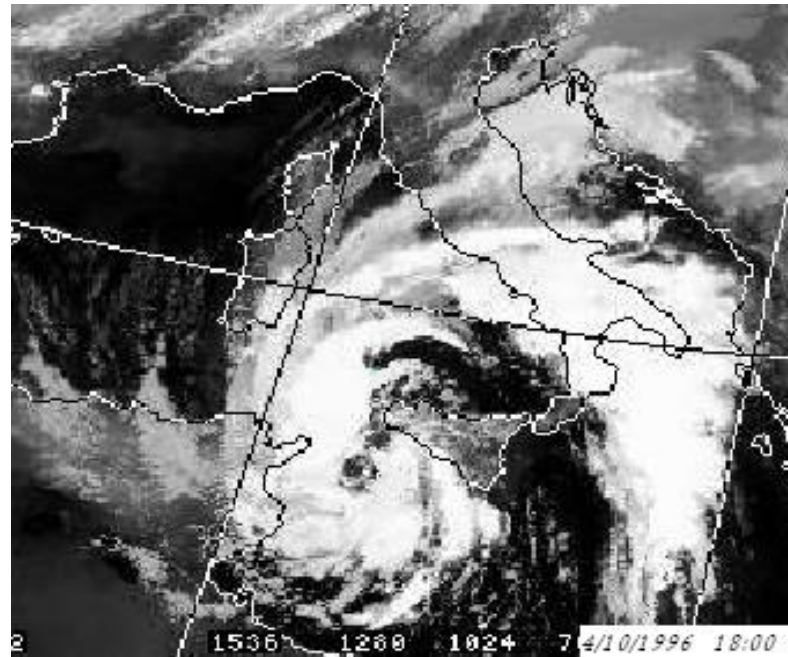
Daive Faranda, M Carmen Alvarez-Castro



Journée « Cyclones et changement climatique » IPSL 2018

0 - OUTLINE

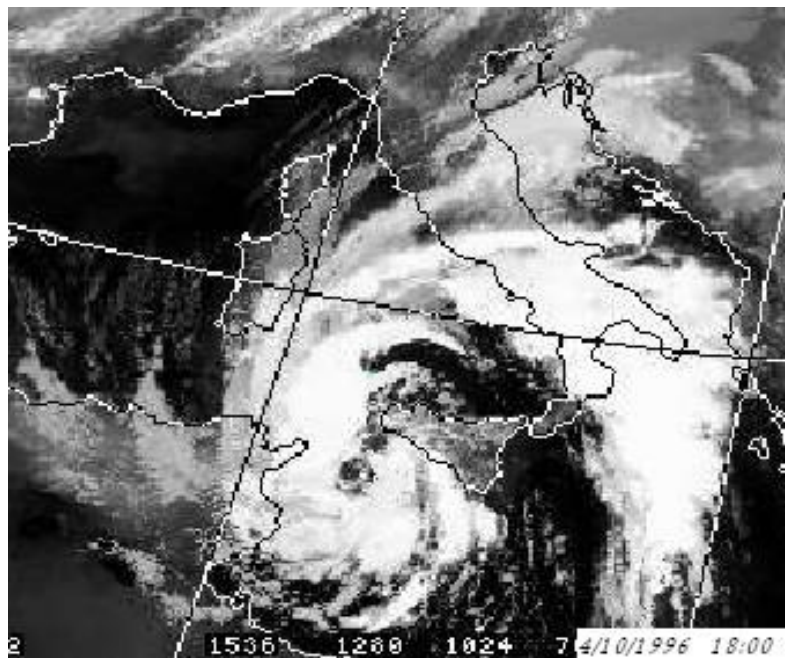
“Cornelia” Meteosat Image



- 1) IMPACTS AND BASIC DYNAMICS OF MEDICANES
- 2) DETECTION OF MEDICANES, TRENDS IN FREQUENCY OF OCCURRENCE
- 3) NUMERICAL SIMULATIONS OF MEDICANES
- 4) OUR APPROACH: ANALOGUES DYNAMICS FOR MEDICANES
- 5) CONCLUSION AND PERSPECTIVES

1 - IMPACTS AND BASIC DYNAMICS

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1 - MEDICANES' IMPACTS EXAMPLES



-In **September 1969**, a North African Mediterranean tropical cyclone produced flooding that **killed nearly 600 individuals**, left 250000 homeless, and crippled local economies.

-A Medicane developed in **September 1996** in the **Balearic Islands** region spawning **six tornadoes**, and inundating parts of the islands.

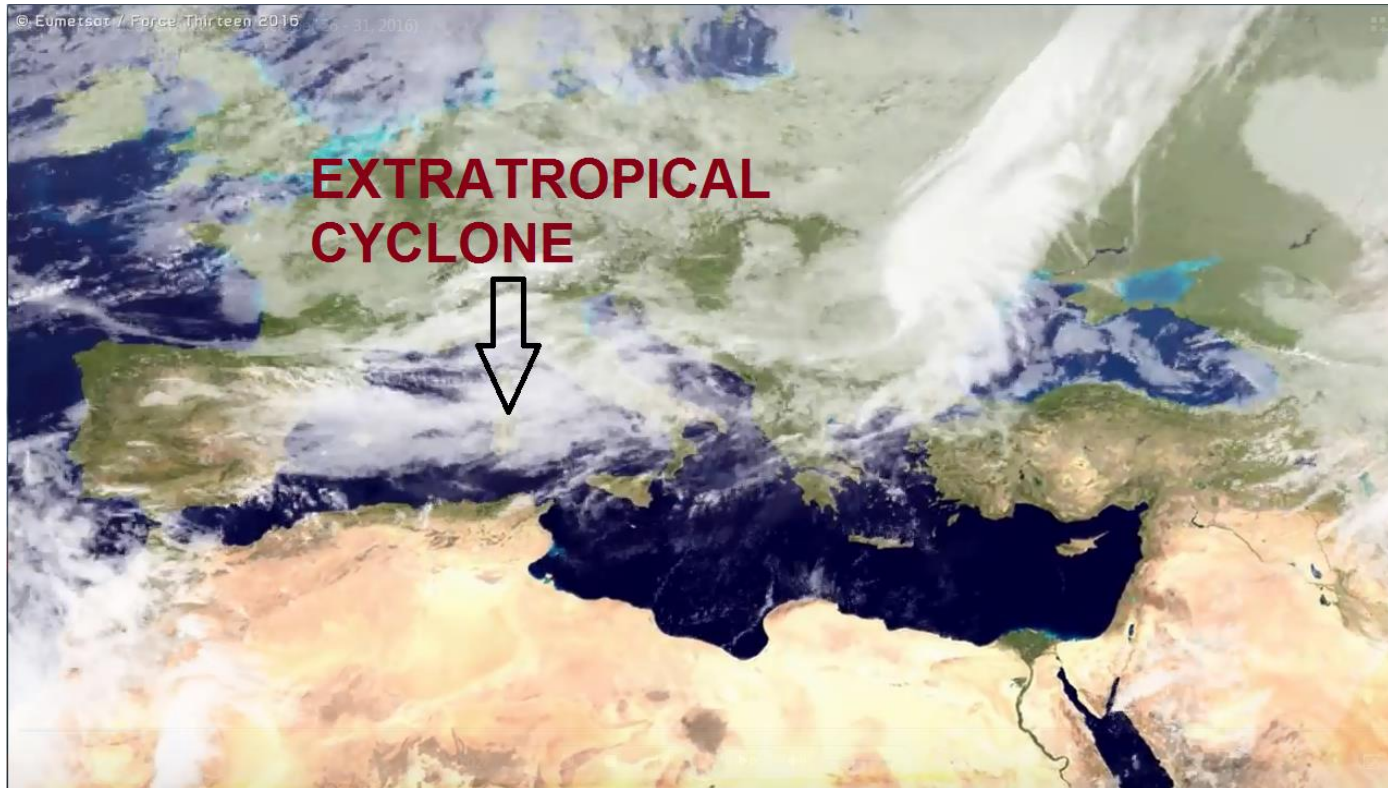
-A similar hybrid low affected Algeria on 9 - 10 November 2001. This storm produced upwards of **270 mm of rain, winds of 140 km/s and killed 737 people near Algiers**, mostly from flooding and mud slides.

-Subtropical storm "**Samir**" **October 8 1996 destroyed sheds, roofs and harbor devices**, and damaged houses and electric lines in the North-west coast of Sicily and the Eolians Islands.



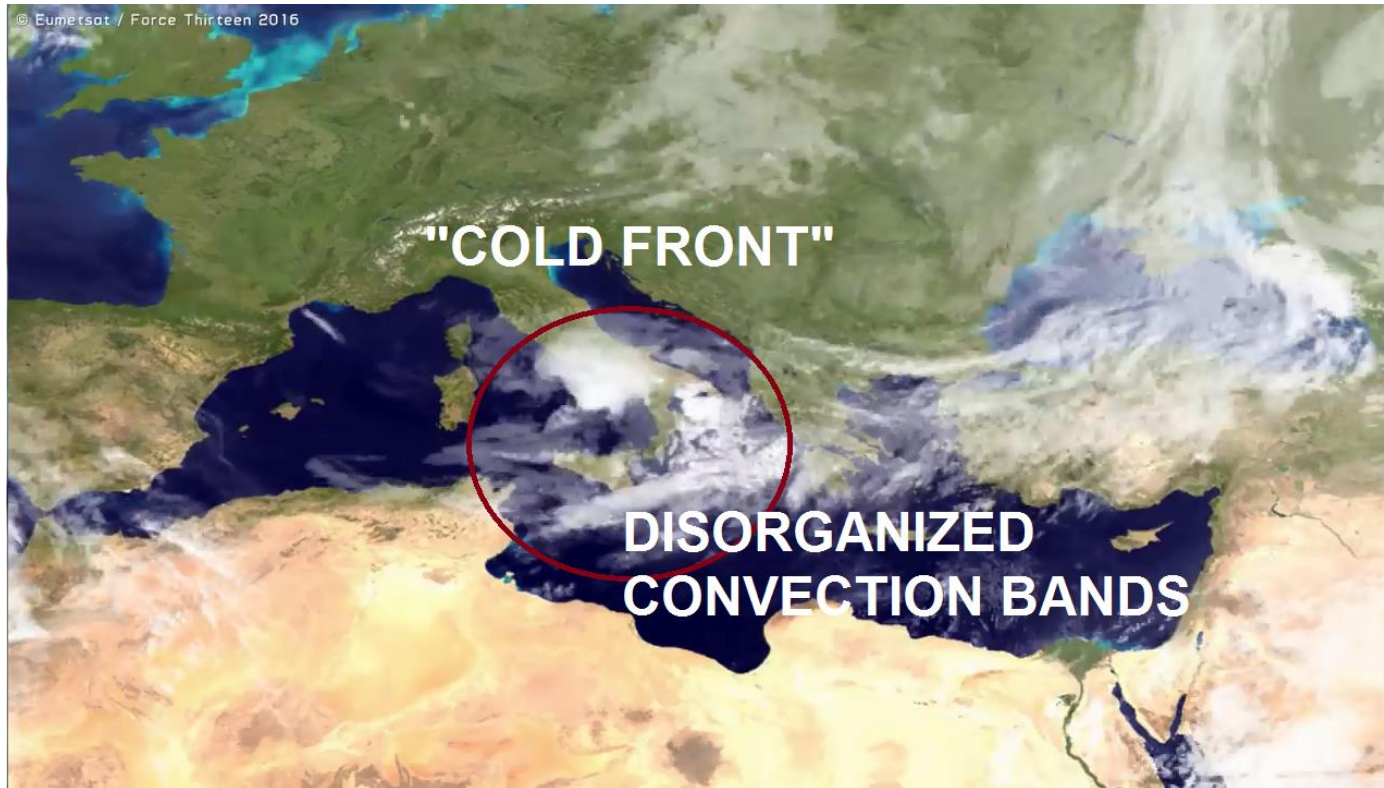
"Samir" Meteosat Image

1 - LIFECYCLE OF A MEDICANE



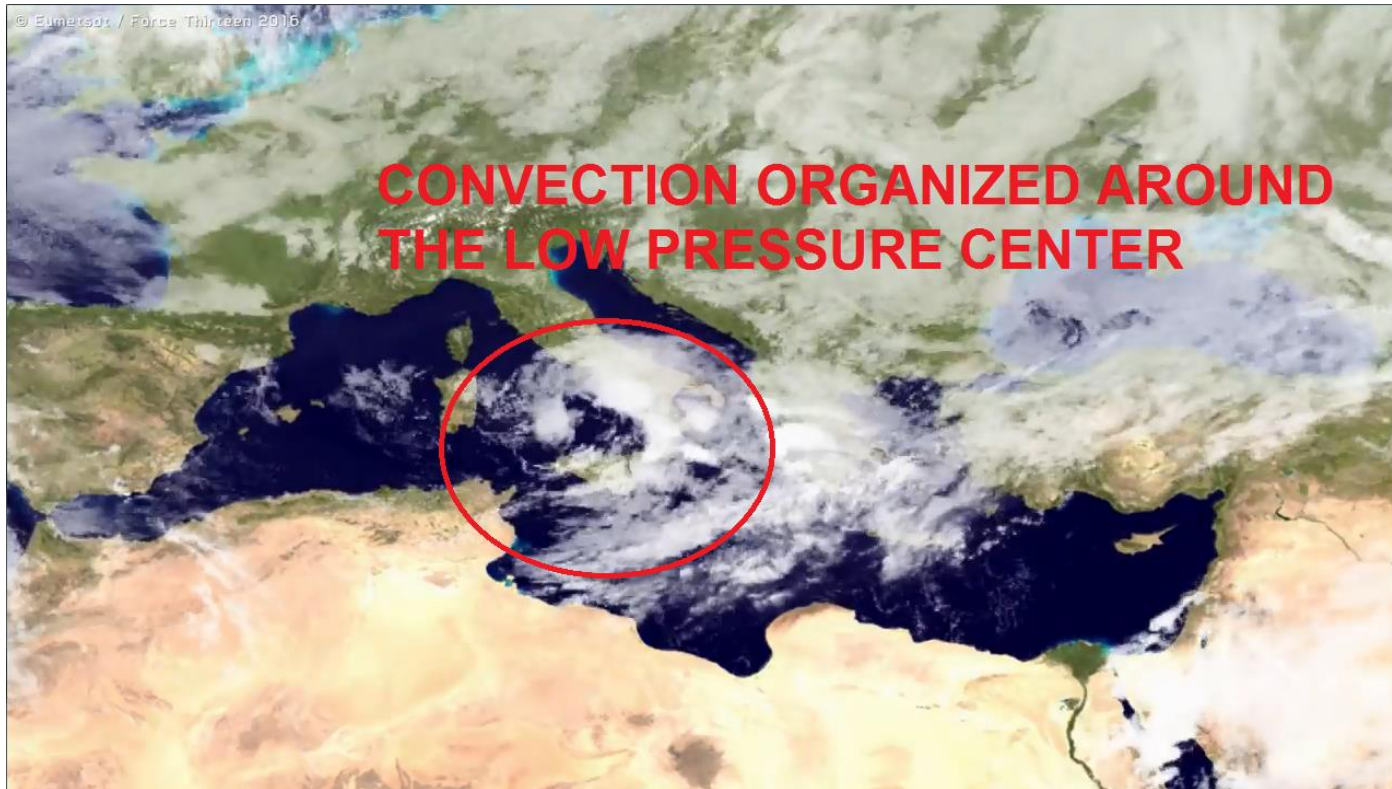
Visible/Infrared satellite animation from October 26 0000Z to October 31 2345Z 2016 shows a storm system forming in the Mediterranean Sea. The system was operationally referred to as 90M by NOAA.

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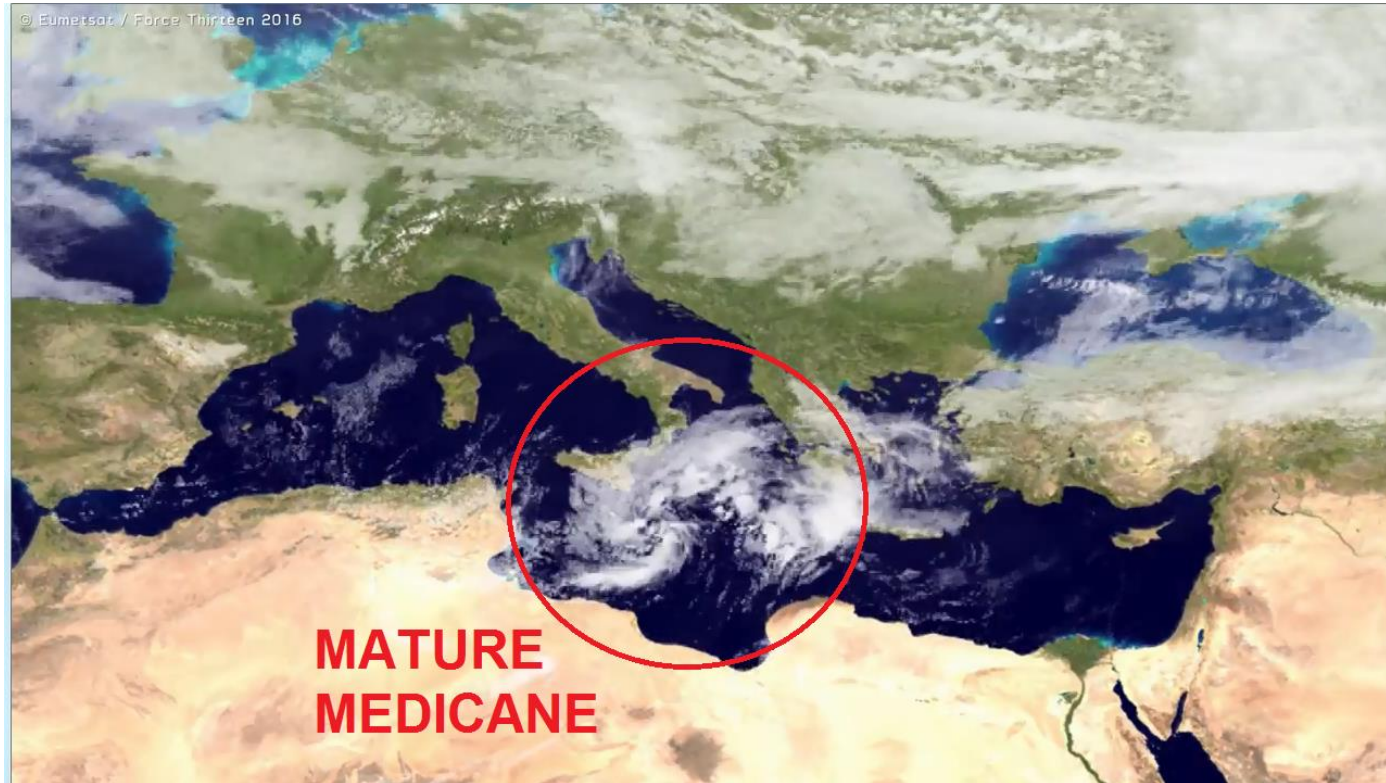
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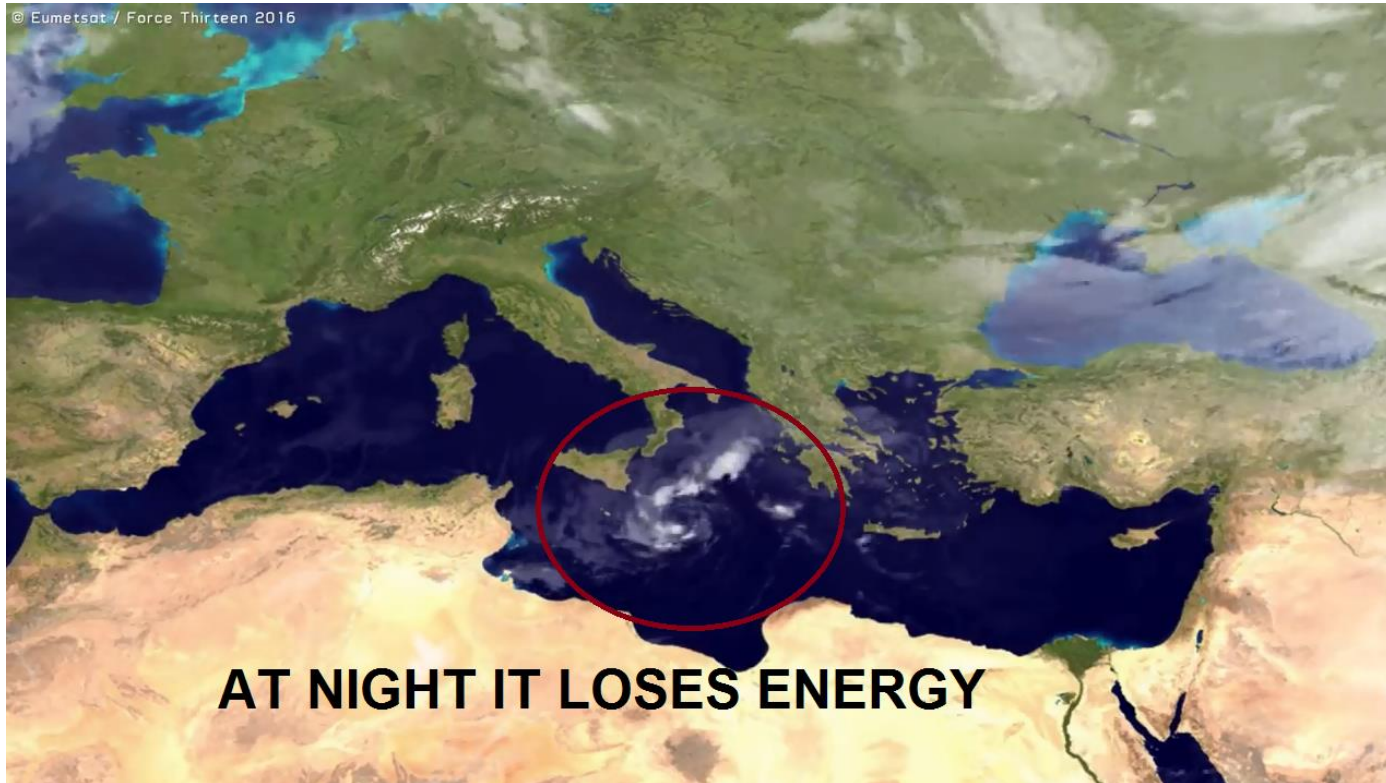
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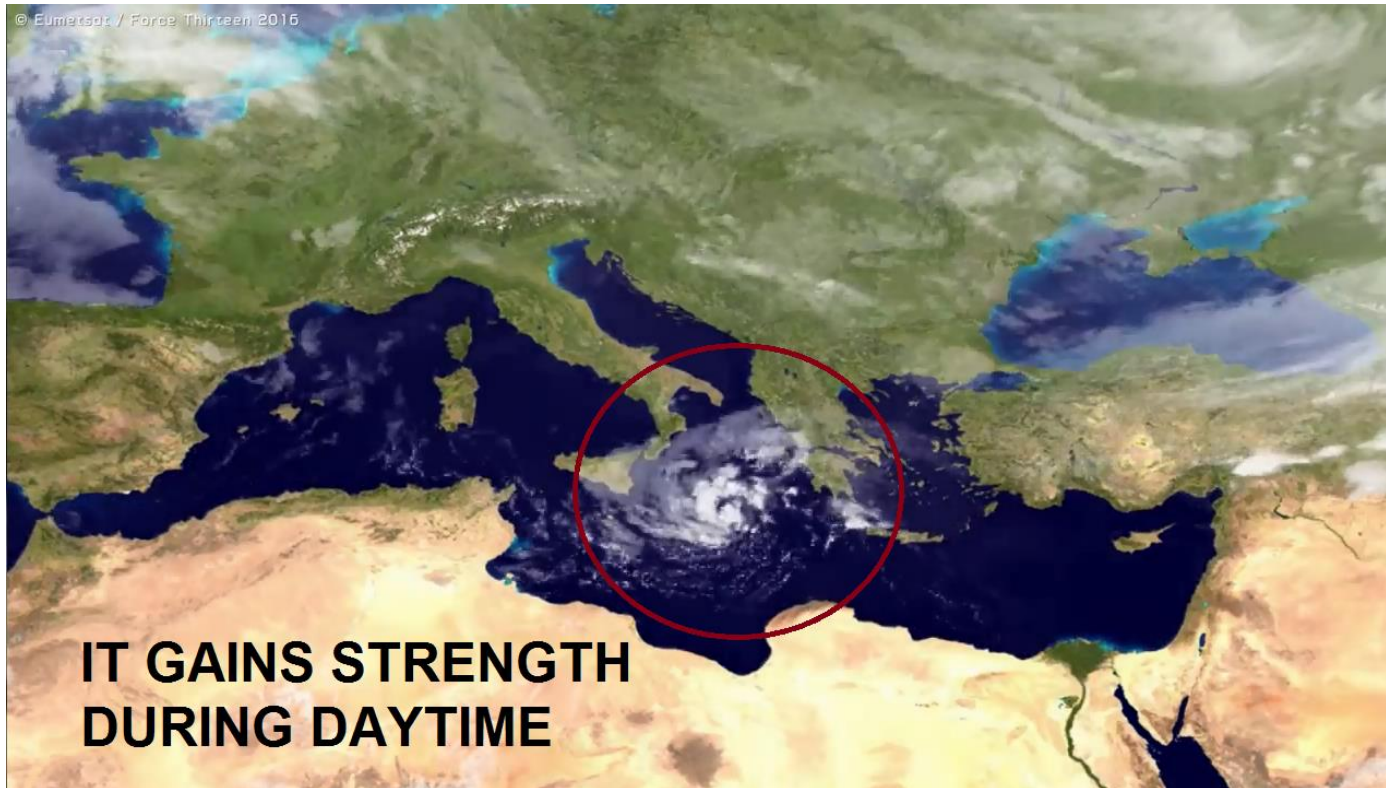
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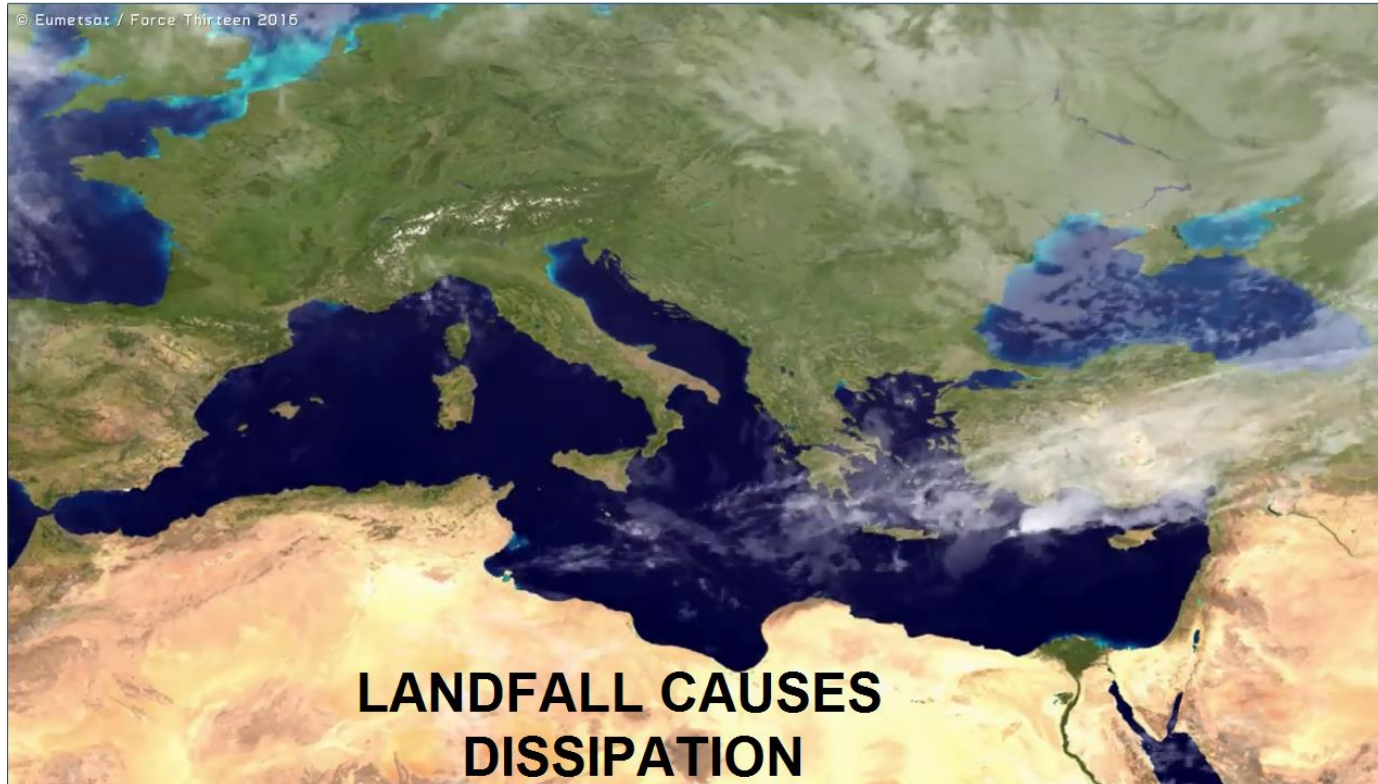
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1 - MEDICANES VS TROPICAL CYCLONES

MEDICANES



Medicanes can occur in every season.

Extratropical Cyclone enters the Mediterranean Sea

Strong vertical temperature gradients favor **convection**

Convection is sustained and concentrate around a **warm core**

Complete dissipation

HURRICANES



Hurricanes mostly occur from June to November

Strong Organized **convection** reach mesoscale size

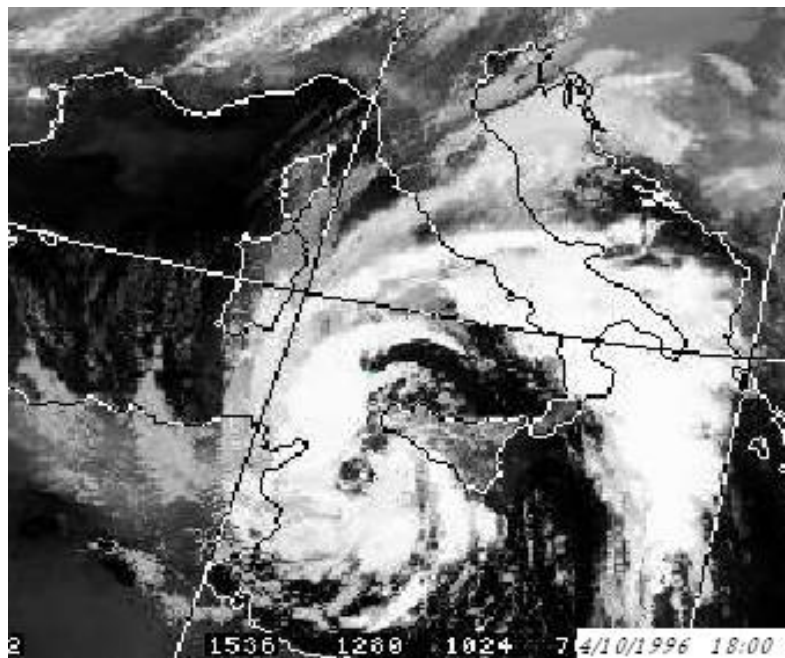
Rotation starts to affect convective cells, a **warm core** creates.

Convective cells organize in bands

In most case, it does not dissipate but it transforms in **extratropical cyclones**

2 – DETECCION & TRENDS

“Cornelia” Meteosat Image



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2 - STATE OF THE ART ON MEDICANES

Historical data



- 1) **The detection of medicanes in the pre-satellite era based on impacts is problematic** (similar effects can be related to extratropical storms or to isolated convective systems).
- 2) They mostly **affect areas with historically poor meteorological coverage.**
- 3) Most of the time, they move on the sea where no meteorological stations were available

2 - STATE OF THE ART ON MEDICANES

Detection with automatic techniques



PRESSURE AND TRAJECTORY

- Pressure gradient greater than $\Delta P > 20 \text{ Pa}/100 \text{ km}$ for consecutive times (at least 12 h) 2.
- no more than half of the positions of a given track can correspond to land points

SYMMETRY AND WARM CORE

- A cyclone is classified as a medicane if it shows vertical symmetry and a warm core for more than 10 % of the track or more than 6 h.

WINDS

- A cyclone is classified as a medicane if the wind speed (averaged in a circle of radius 50 km around the pressure minimum) at 850 hPa is higher than the wind speed at 300 hPa.2

(Cavicchia et al 2014)

2 - STATE OF THE ART ON MEDICANES

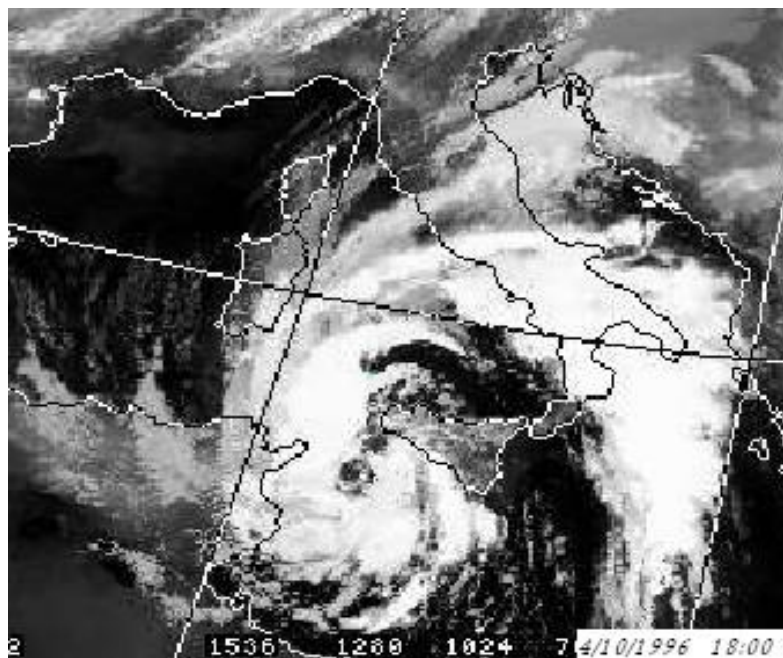
Frequency of medicanes and climatic trends



- **Occurrences of Medicanes:** an average of **1.57** forming **annually**
- **Up to 99 recorded occurrences** of tropical-like storms discovered between 1948 and 2011 (Cavicchia et al 2014)
- **No definitive trend in activity in this historical period** (Cavicchia et al. 2014)
- Gaertner et al. (2007): an **increase in ocean temperatures of 3° C in the Mediterranean by the end of the century could lead to hurricanes.**
(Experiment: 9 models, resolutions ~ 50 km : some models simulated hurricanes in the Mediterranean in September by the end of the century, when sea temperatures ~ 30° C)

3 – NUMERICAL SIMULATIONS

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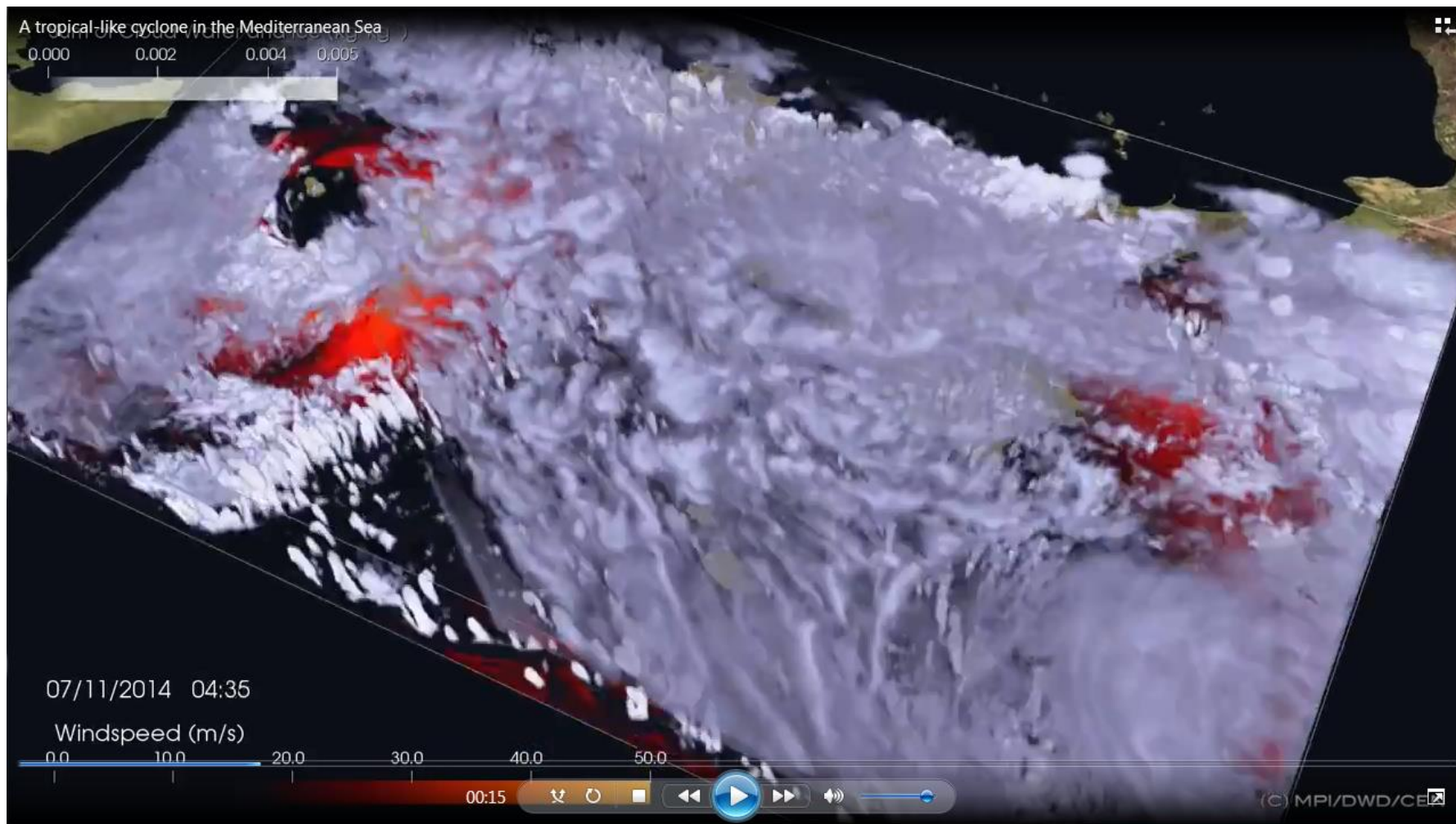
300M RESOLUTION ICON LEM MODEL SIMULATION
A TROPICAL-LIKE CYCLONE IN THE MEDITERRANEAN SEA

SIMULATION PERFORMED BY GUIDO CIONI (MPIMET) AND DANIEL KLOCKE (DWD)
ON THE SUPERCOMPUTER MISTRAL (DKRZ)

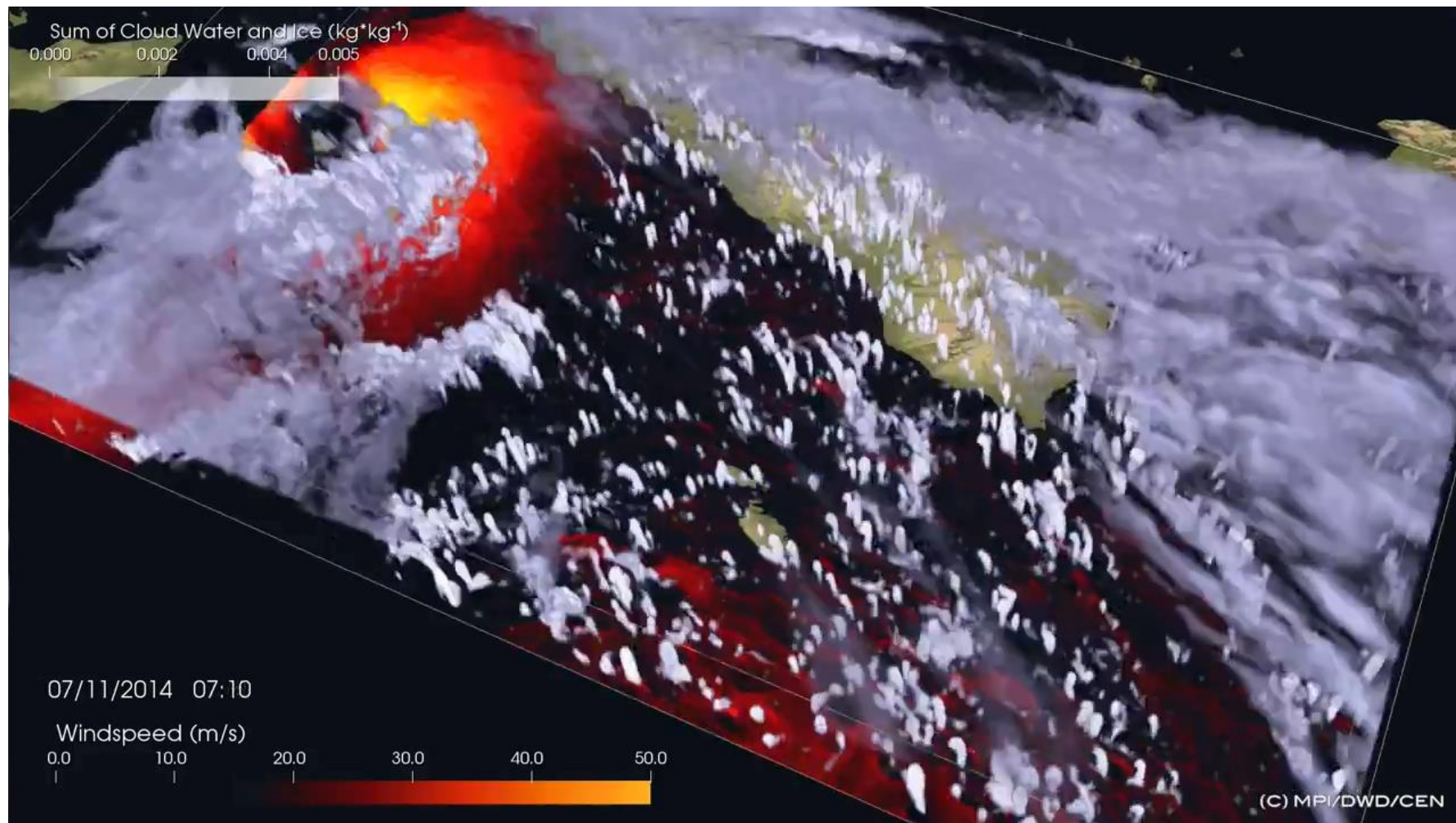
VISUALIZATION BY FELICIA BRISC (CEN/UNIVERSITY OF HAMBURG)

(C) MPI/DWD/CEN

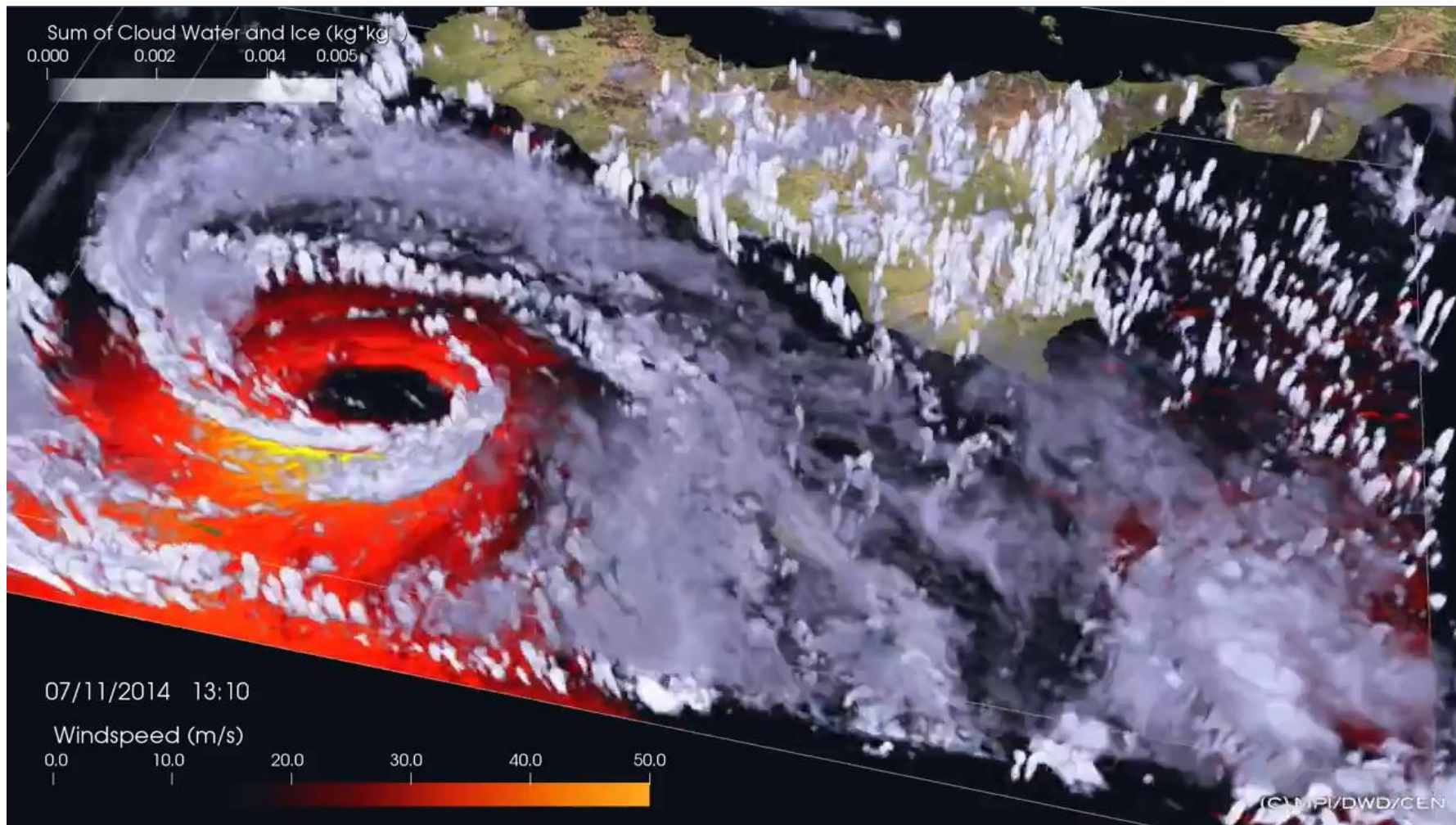
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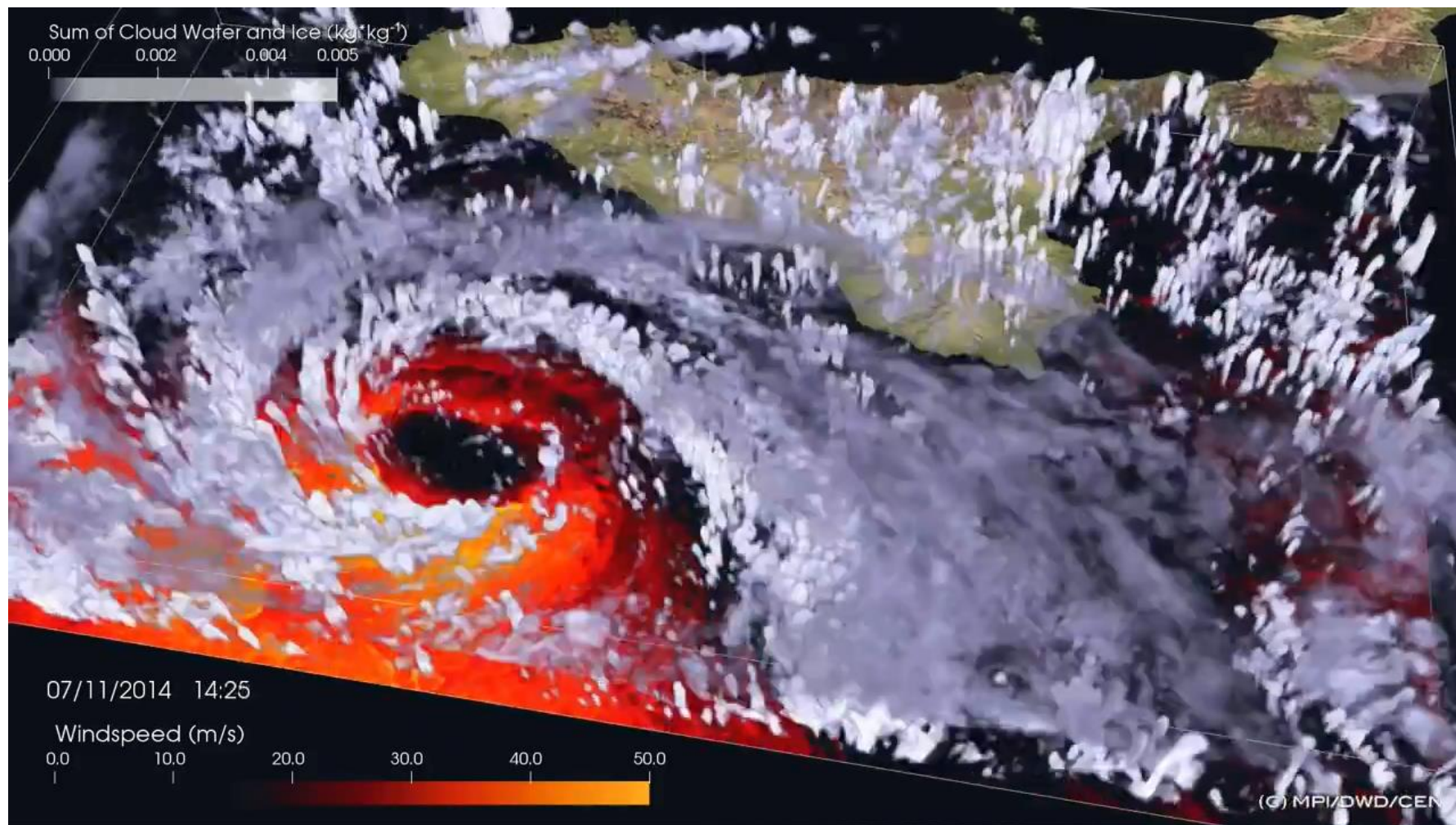
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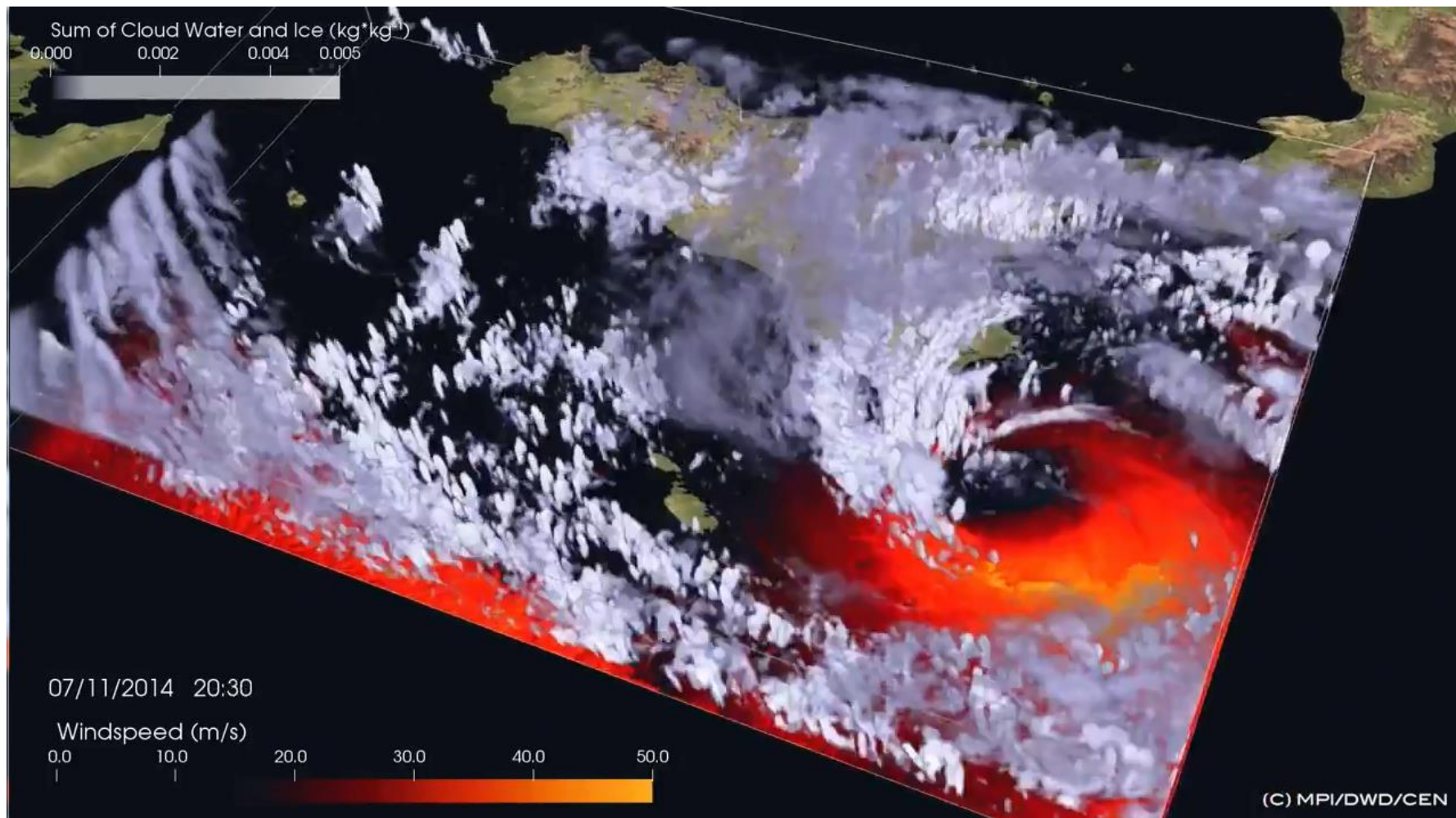
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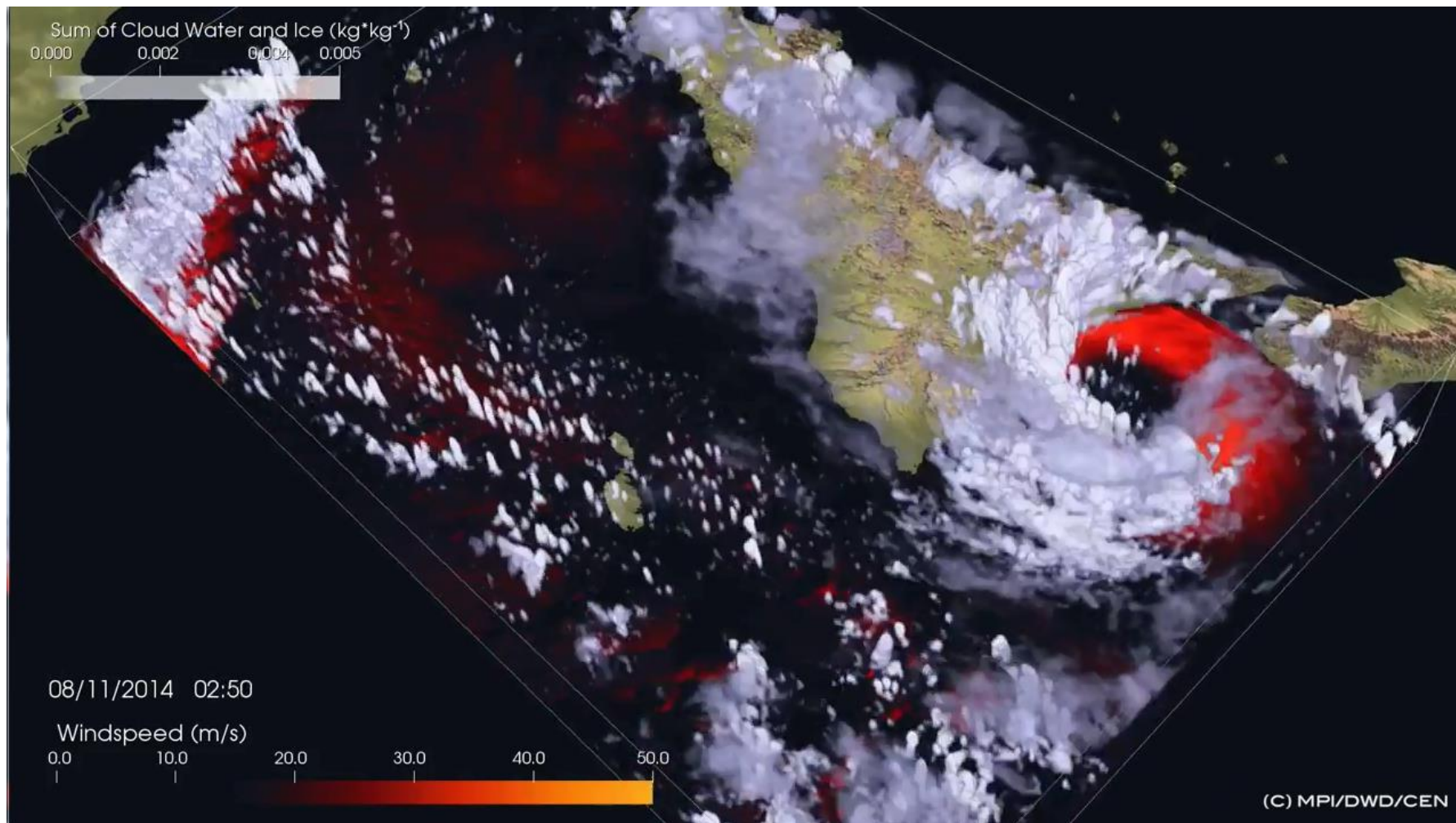
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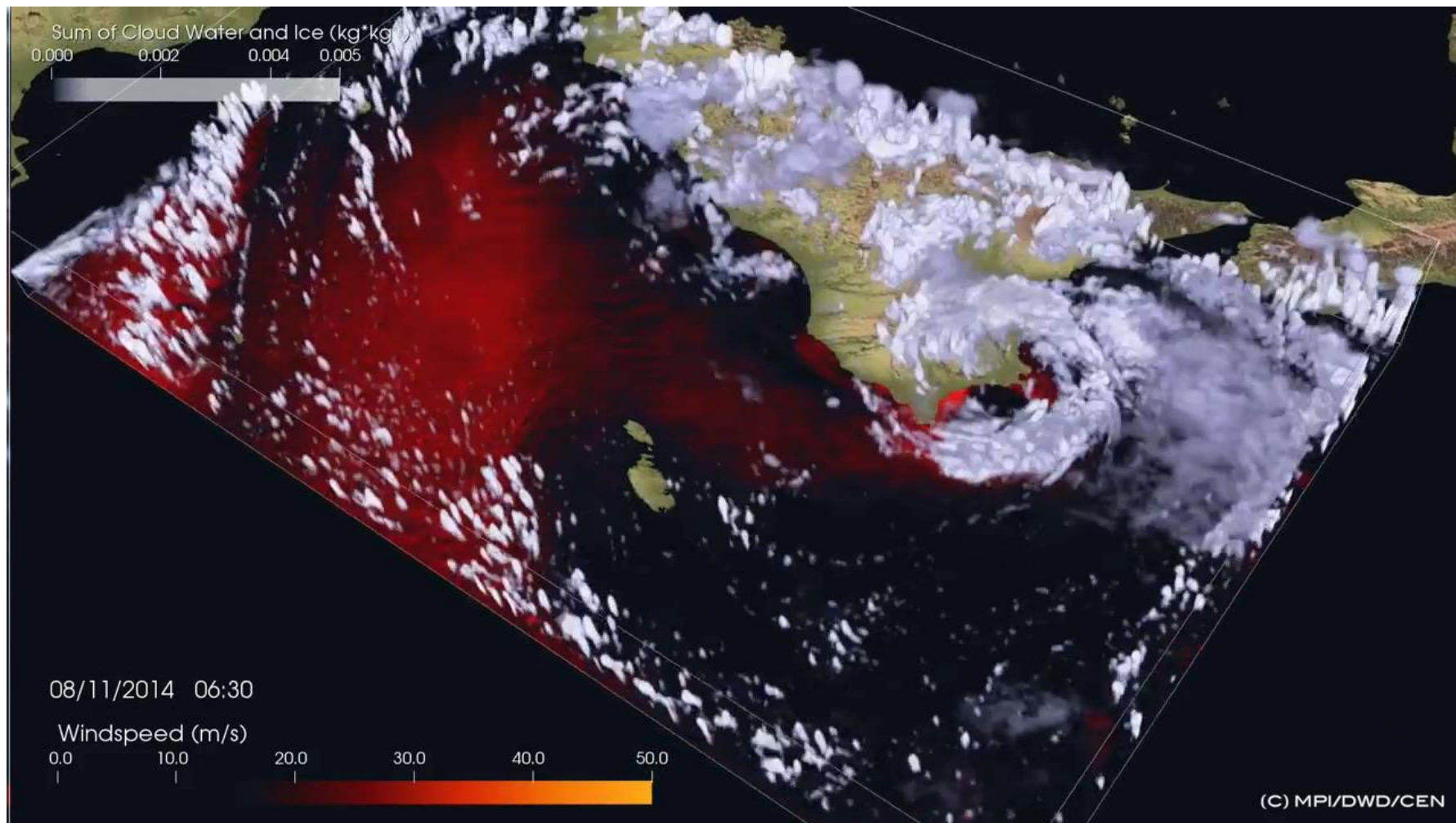
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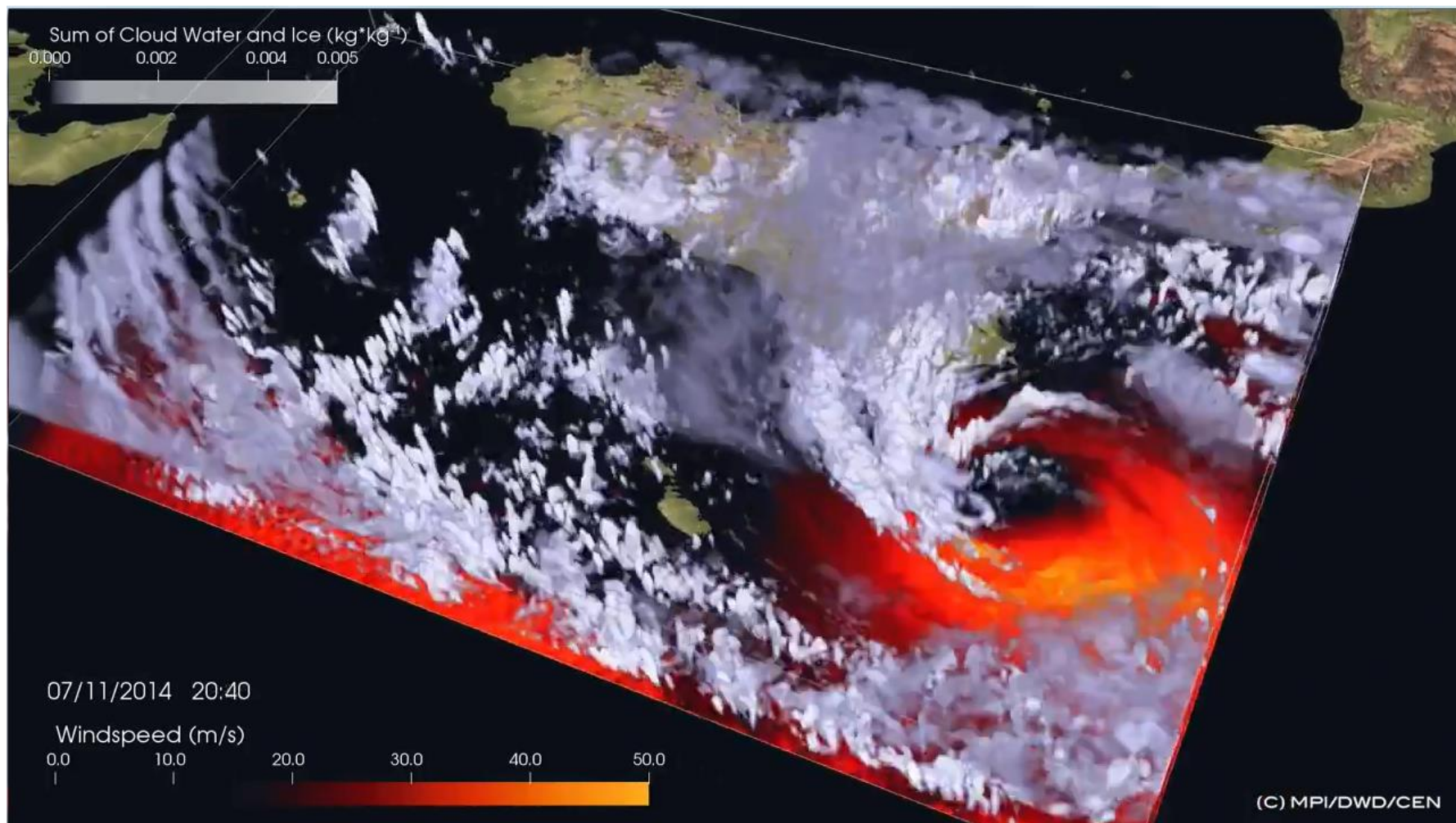
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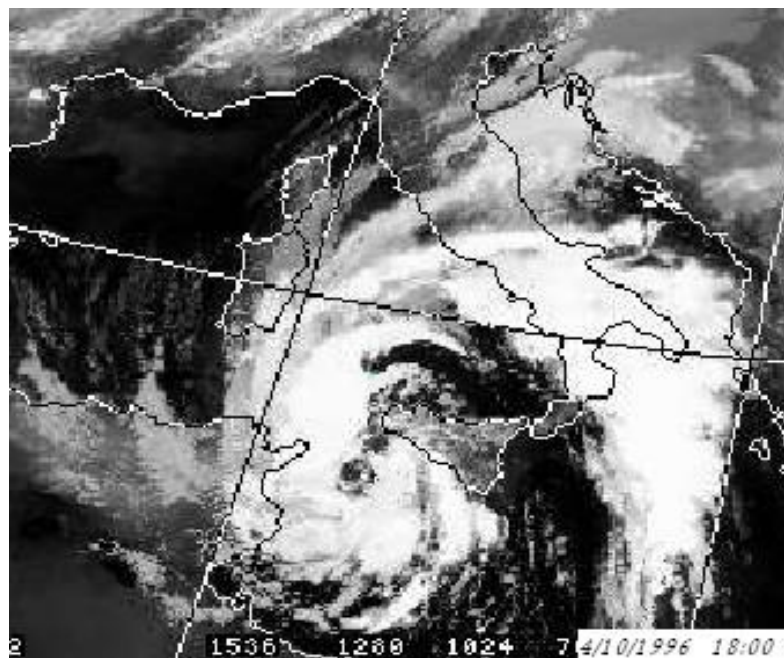


3 – NUMERICAL SIMULATIONS



4 – ANALOGUES OF MEDICANES

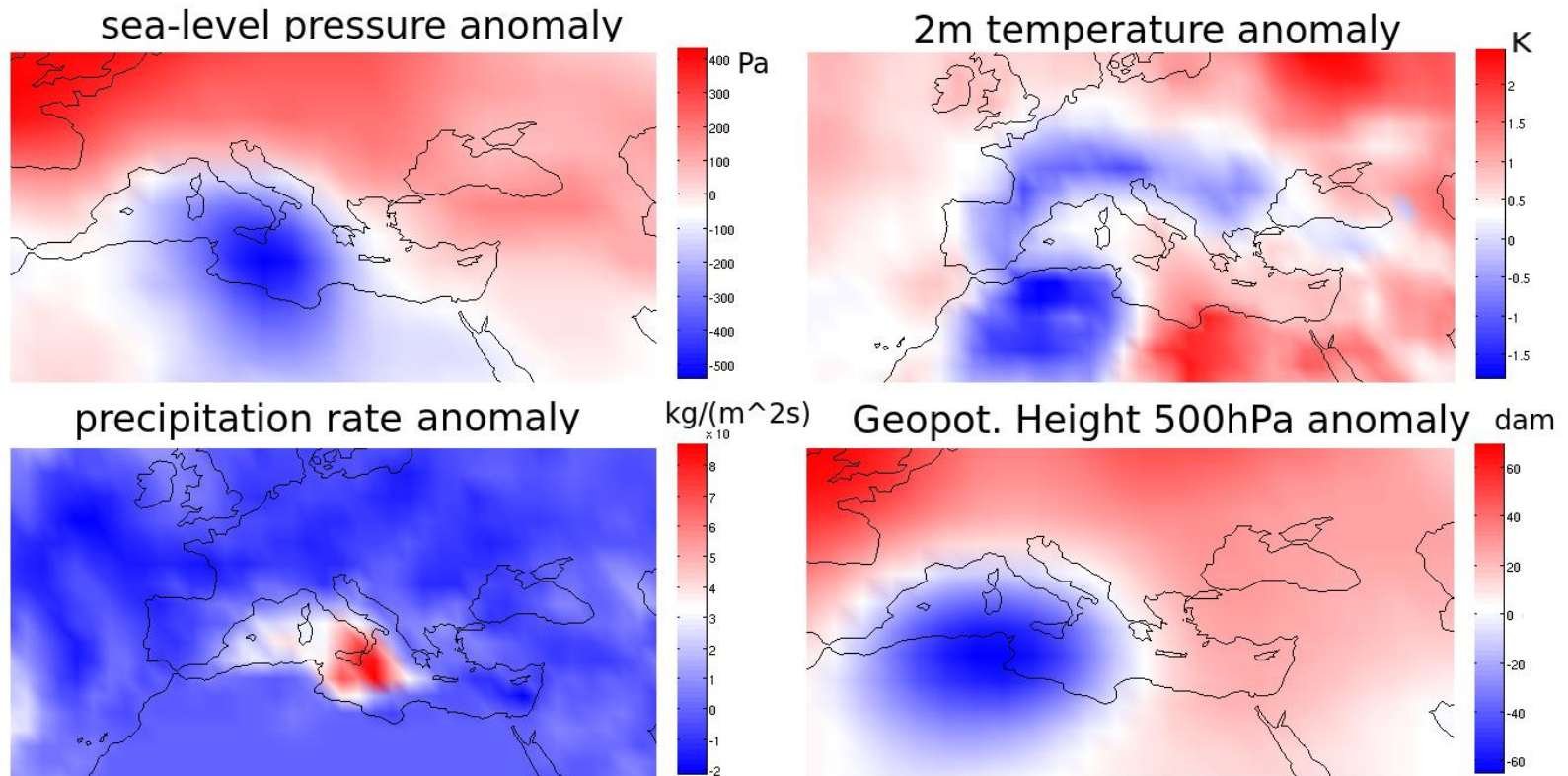
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4 - OUR APPROACH: ANALOGUES

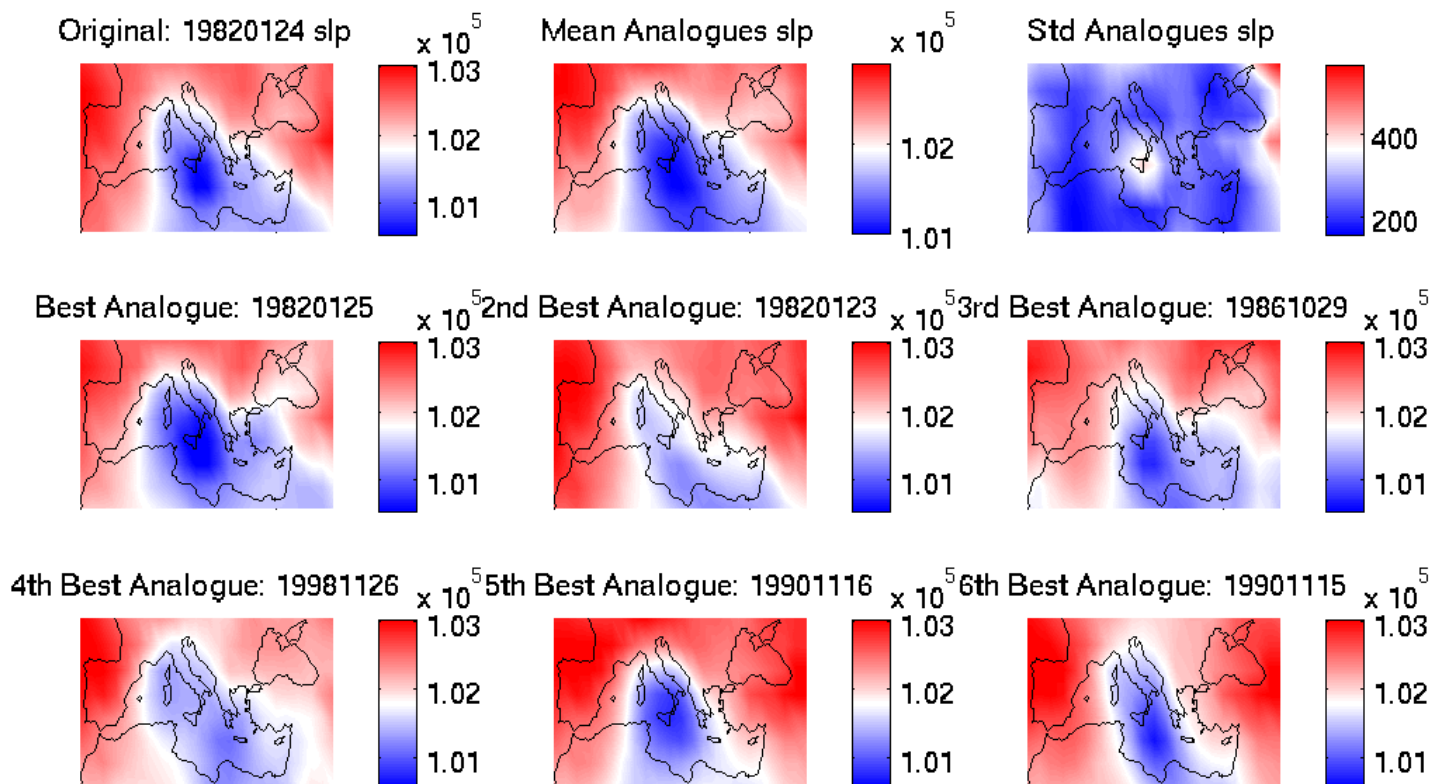
Reconstruction of a database based on documented occurrences of Medicanes
Composed by ~40 events lasting from 2 to 5 days. Average anomalies in NCEP data



4 - OUR APPROACH: ANALOGUES

We define the **typical medicane** as the one with the most analogues in the dataset

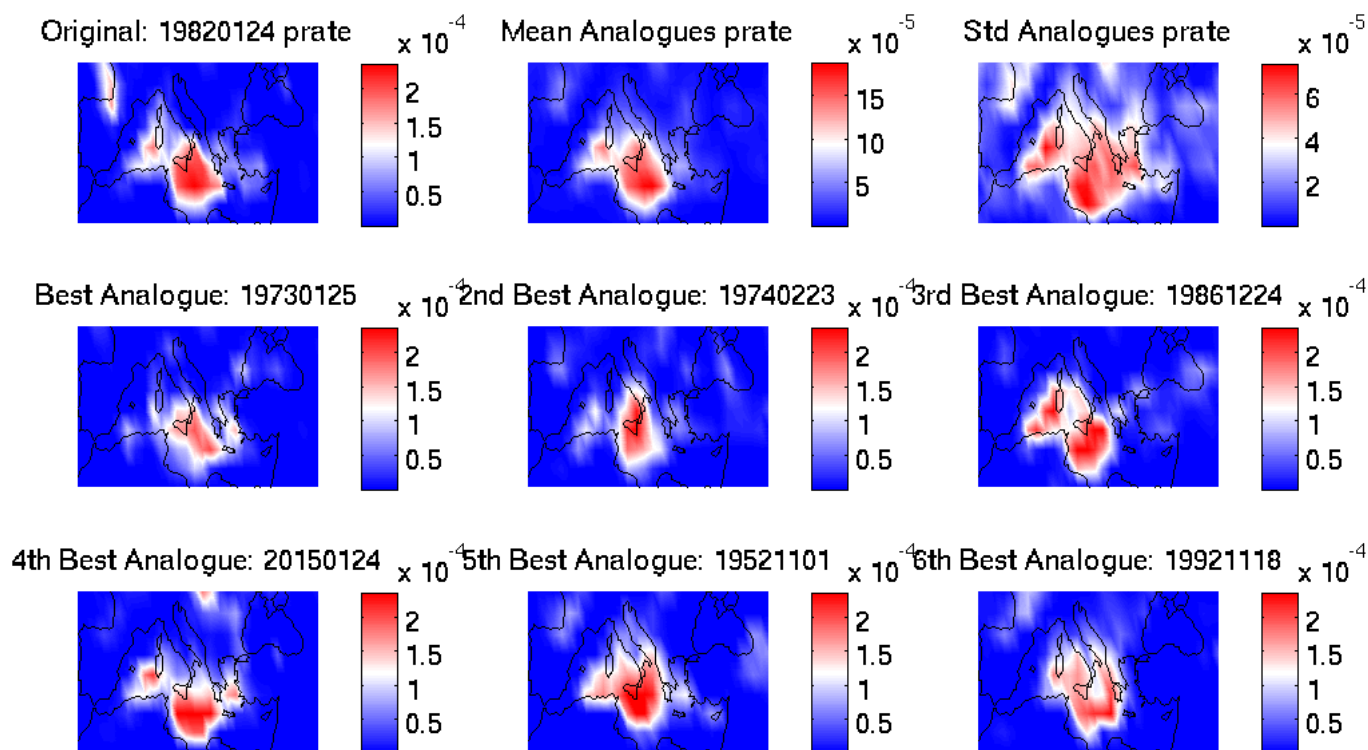
1) With respect to the **sea-level pressure fields (about 6 cross-analogues)**



4 - OUR APPROACH: ANALOGUES

2) With respect to the precipitation rate fields (8 analogues)

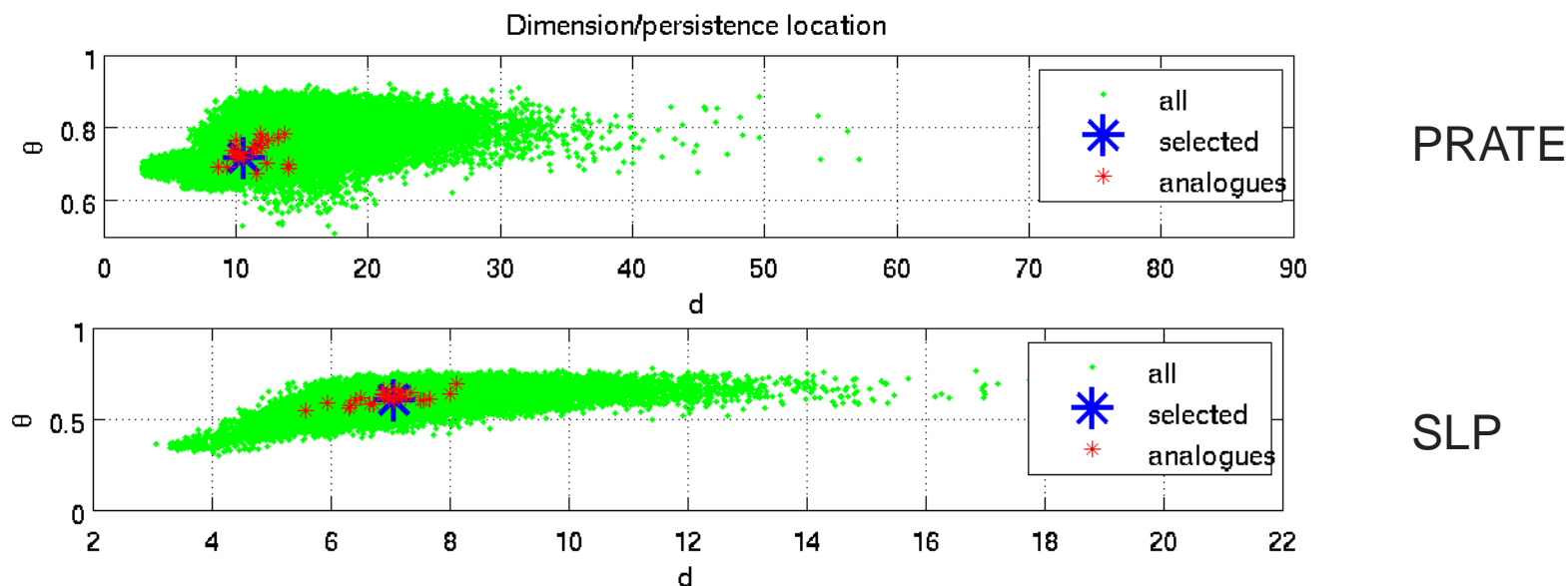
The analogues are different but the typical medicane turn out to be an **Object forming near the southern coasts of Sicily and propagating towards NE**



4 – MEDICANES' DYNAMICAL PROPERTIES



Dynamical properties of Medicanes in Phase Space to determine their origins

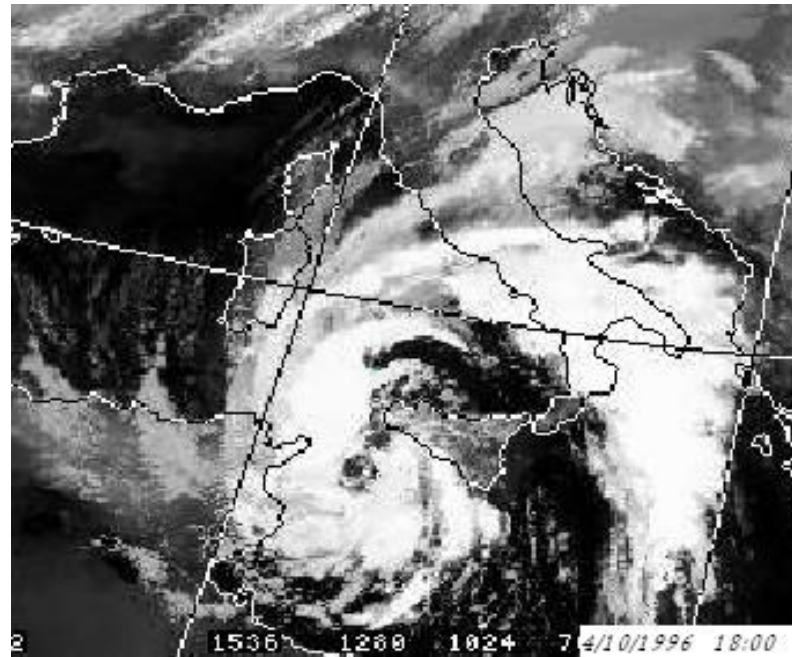


The medicanes **occupy specific regions of the dimension persistence diagram**
(Faranda et al 2017 Scientific Reports)

- ⇒ Information on their averages dynamical properties
- ⇒ Use higher resolution datasets, study climate change

5 - CONCLUSIONS - PERSPECTIVES

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- 1) Despite their damage potential and their frequency of occurrence they **have received little attention from the meteorological/climatology community**
- 2) Our preliminary analysis shows that the dynamical signature of medicanes is in the precipitation rate, rather than on the pressure
- 3) Although they mostly affect southern Italy or Greece, « **black swans** » **have struck Corse & Southern France.**
- 4) Few numerical simulations, **few studies on the climate change, few studies on the potential trajectories.**

=> the room is open and plenty of space for improvements

REFERENCES



-Cavicchia, L.; von Storch, H.; Gualdi, S. (2014). "A long-term climatology of medicanes". *Climate Dynamics*. **43** (5–6): 1183–1195.

-Cioni, G., Cerrai D. and Klocke D.: "Investigating the predictability of a Mediterranean Tropical-like Cyclone using a non-hydrostatic high-resolution model", *J. Adv. Earth System Model* [submitted, in review]

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-Faranda, D.F; Messori, G., Yiou, P. (2017) "Dynamical proxies of North Atlantic Predictability and Extremes" *Scientific Reports*.

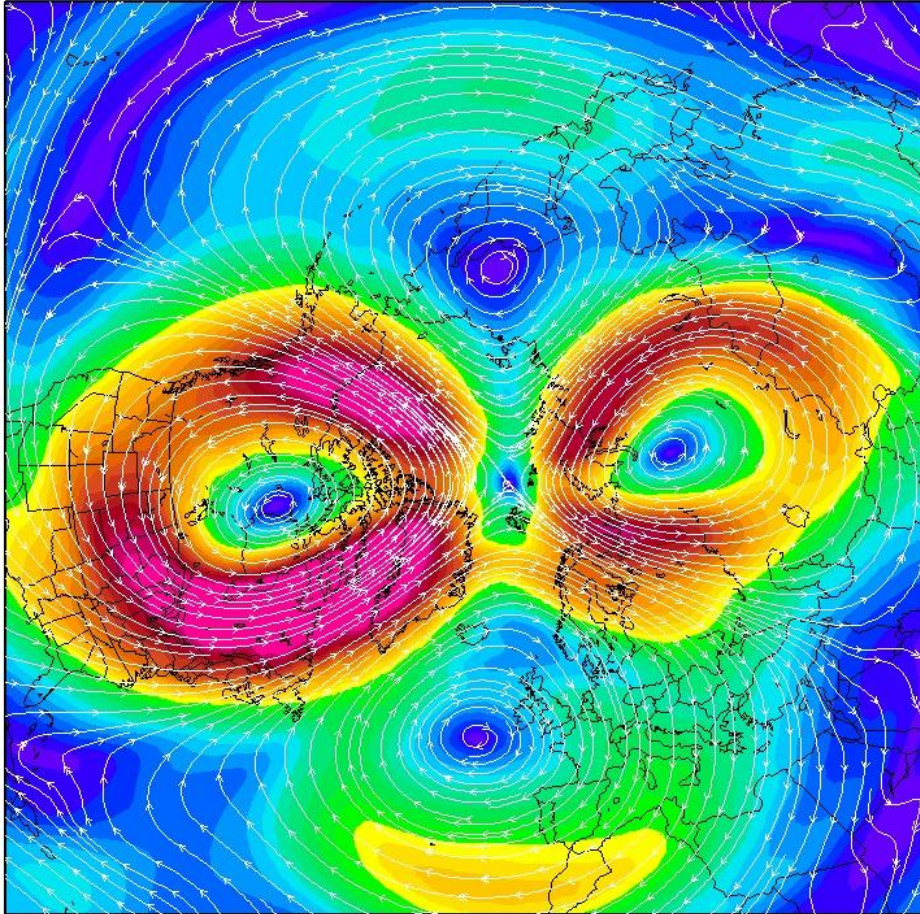
-Gaertner, M.A.; Jacob, D.; Gil, V.; Domínguez, M.; Padorno, E.; Sánchez, E.; Castro, M. (2007). "Tropical cyclones over the Mediterranean Sea in climate change simulations". *Geophysical Research Letters* **34** (14): L14711

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MERCI POUR VOTRE ATTENTION!

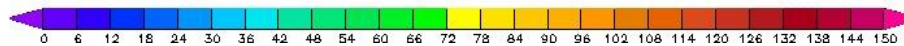


Init: Wed,31JAN2018 06Z 10 hPa Stromlinien und Windgeschwindigkeit (kt) Valid: Mon,12FEB2018 18Z



Nawak Illustrations

Data: GFS OPERATIONAL 1.000°
(C) Wetterzentrale
www.wetterzentrale.de



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