The crucial representation of deep convection for the cyclogenesis of medicane Ianos

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EMS 2024 Barcelona

COST Action MedCyclones (2020–2024)

Mediterranean cyclones play a crucial role
- in the regional climate and water cycle
- in high-impact weather

Some outcomes of the COST Action
- **Review paper** Flaounas et al. (2022) https://doi.org/10.5194/wcd-3-173-2022
- **Best-track dataset** Flaounas et al. (2023) https://doi.org/10.5194/wcd-4-639-2023
- **Workshops and training schools** Hatzaki et al. (2023) https://doi.org/10.1175/BAMS-D-22-0280.1

COST is supported by the Horizon 2020 Framework Programme of the European Union
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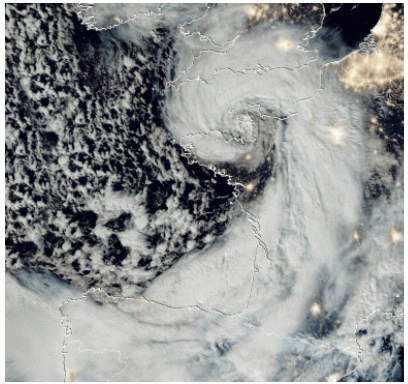
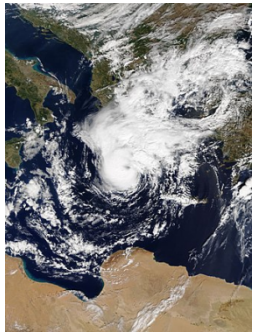
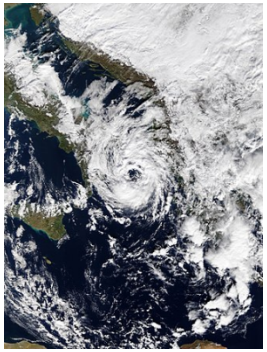
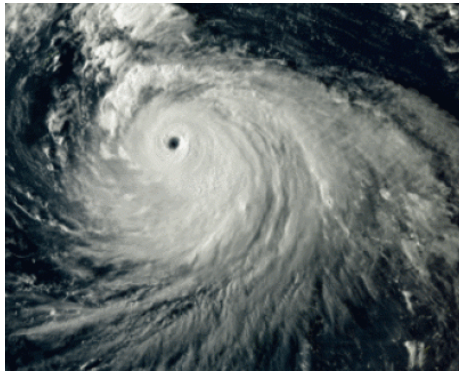
What is a medicane? ("Mediterranean hurricane")



Extratropical cyclone

?

Tropical cyclone

Medicane (~1/year) ≠ Mediterranean cyclone (~100/year)

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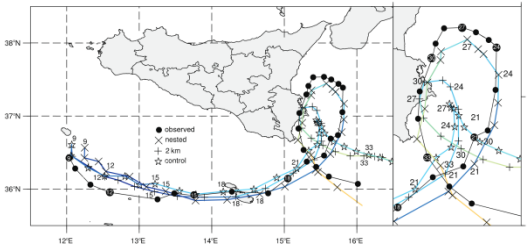
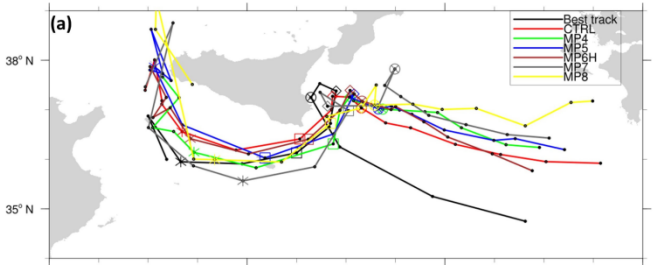
How to best predict a medicane?

*Investigating the predictability of a Mediterranean tropical-like cyclone using a **storm-resolving** model*



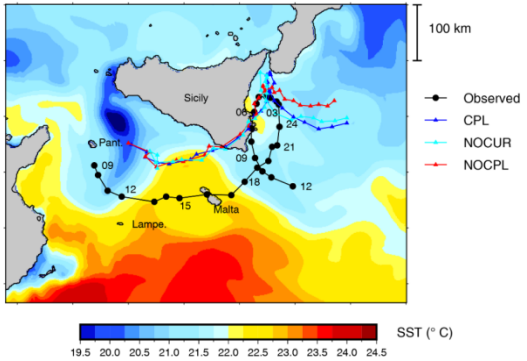
Cioni et al. (2018)
ICON model

*Sensitivity of a Mediterranean Tropical-Like Cyclone to **Physical Parameterizations***



Pytharoulis et al. (2018)
WRF model

*Surface processes in the 7 November 2014 medicane from **air–sea coupled** high-resolution numerical modelling*



Bouin & Lebeaupin Brossier (2020)
Meso-NH model

→ *same case (Qendresa) but different models & configurations…*

Model intercomparison project

15 meteorologists from **5** European countries

COST Action MedCyclones

5 meteorological models with **10** standard configurations

BOLAM, Méso-NH, MetUM, MOLOCH, WRF

1 common framework

Same domain, horizontal resolution, initial and lateral boundary conditions

Control simulations
Initialization: IFS analysis
Resolution: Δx=10 km

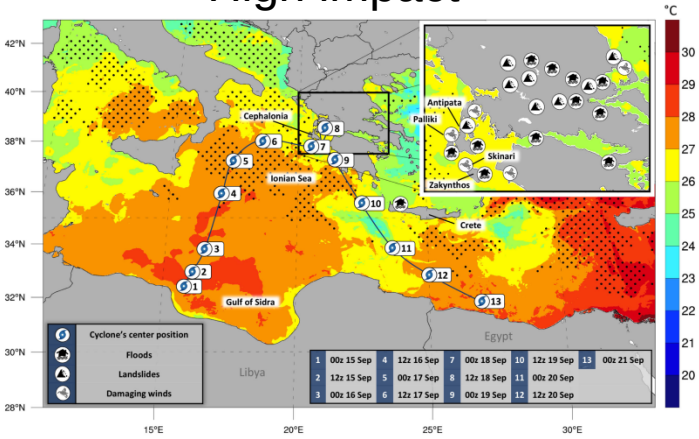
Sensitivity test 1
initialization: ERA5 reanalysis
Resolution: Δx=10 km

Sensitivity test 2
Initialization: IFS analysis
Resolution: Δx=2 km

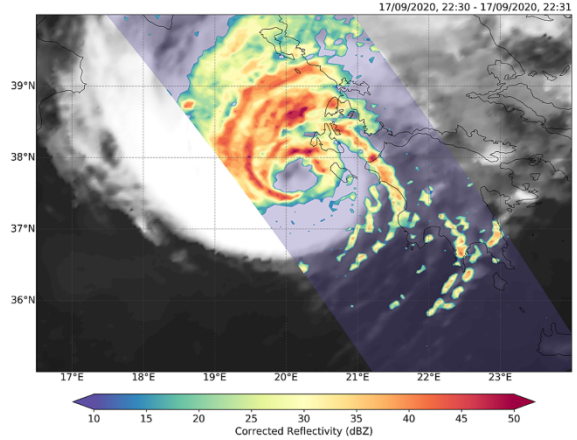
look for robust response!

Case study: medicane Ianos (mid September 2020)

High impact

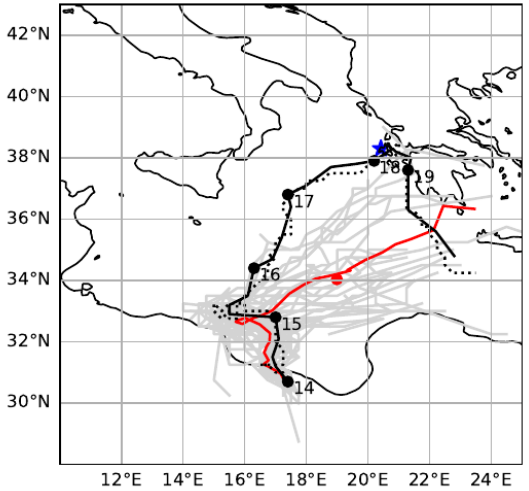


Tropical characteristics



Lagouvardos et al. (2022)

Low predictability



& occurred at the starting of COST Action MedCyclones!

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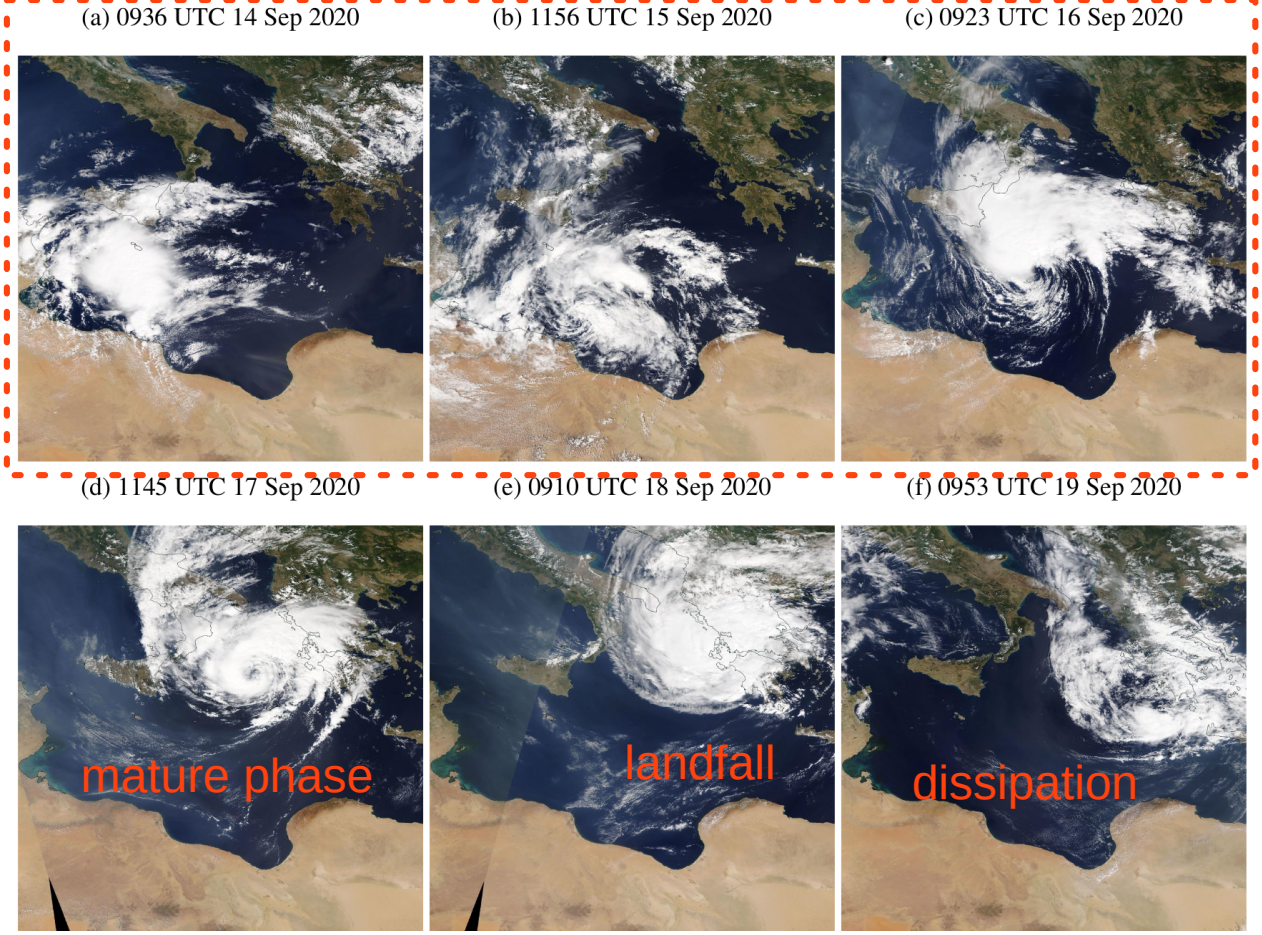
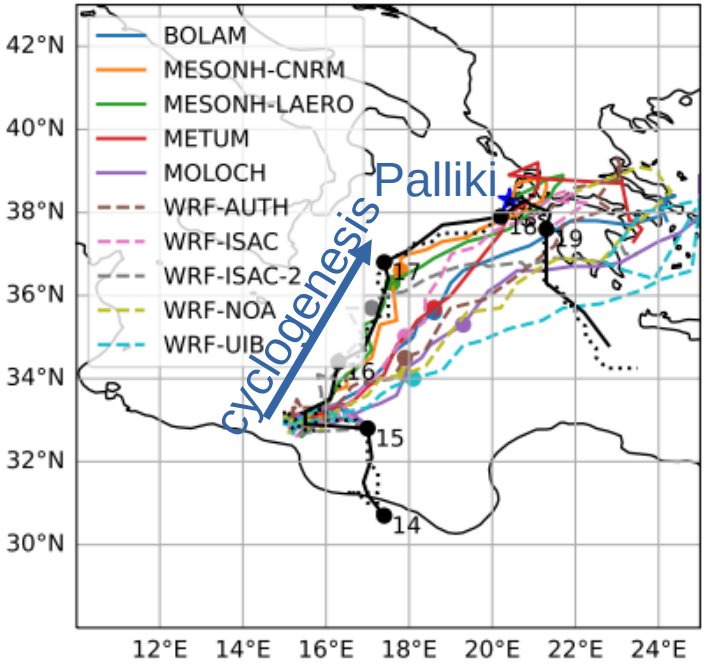
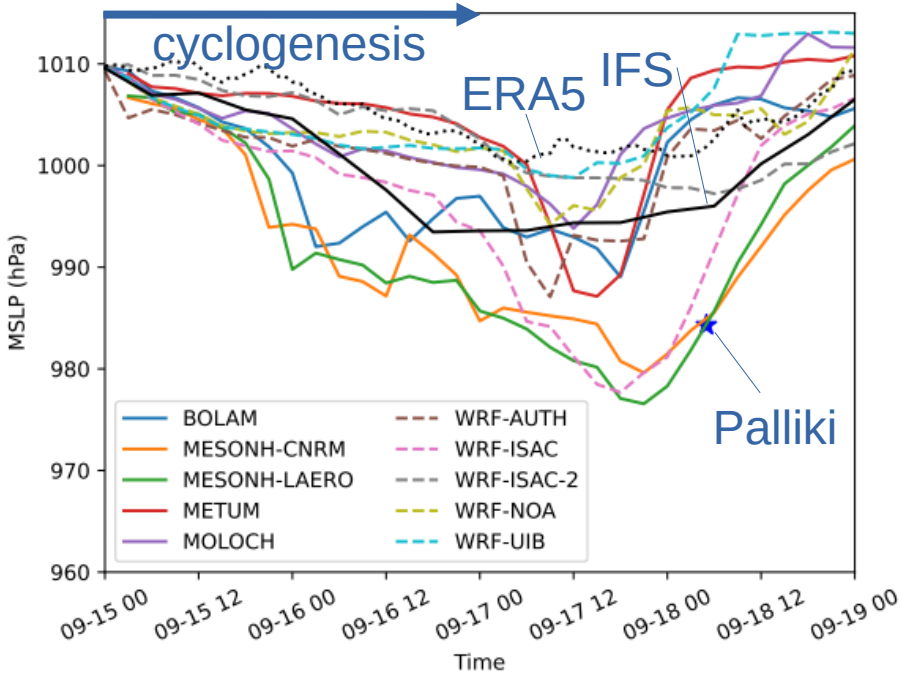
Chronology

visible imagery from MODIS instrument aboard AQUA and TERRA satellites



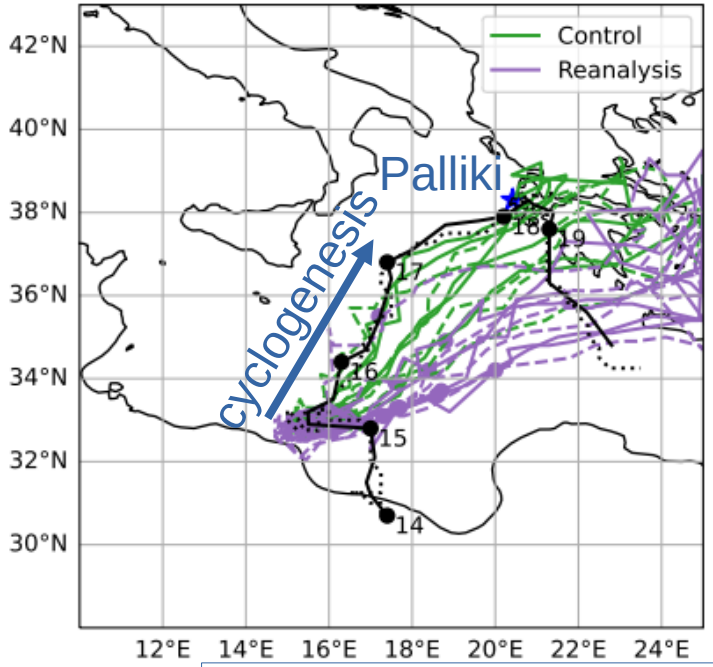
Results from control simulations

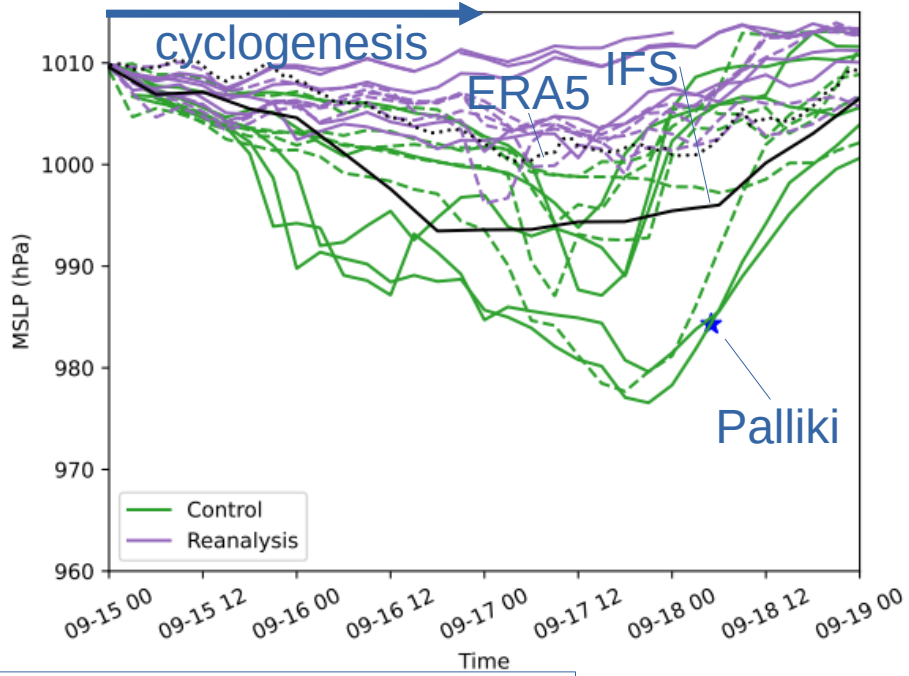




→ ***large spread in track (southeastward shift) and intensity (too weak)***

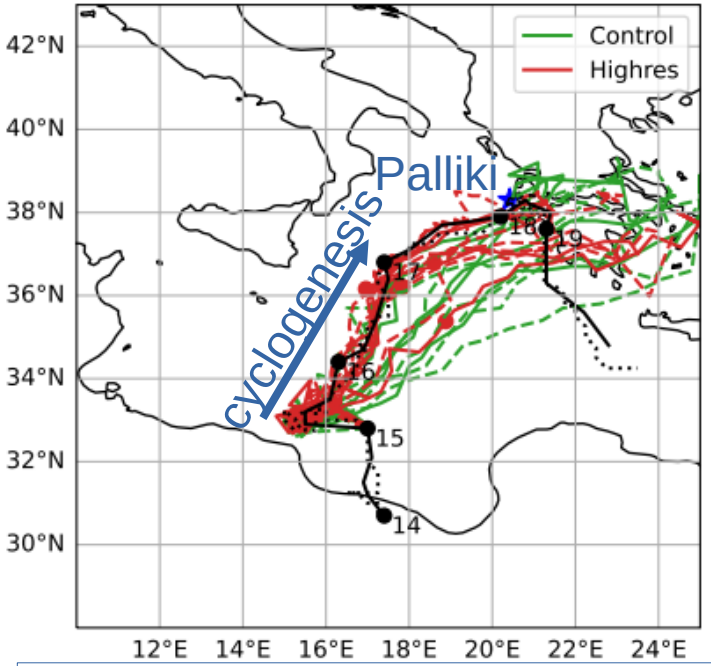
Sensitivity to initial conditions

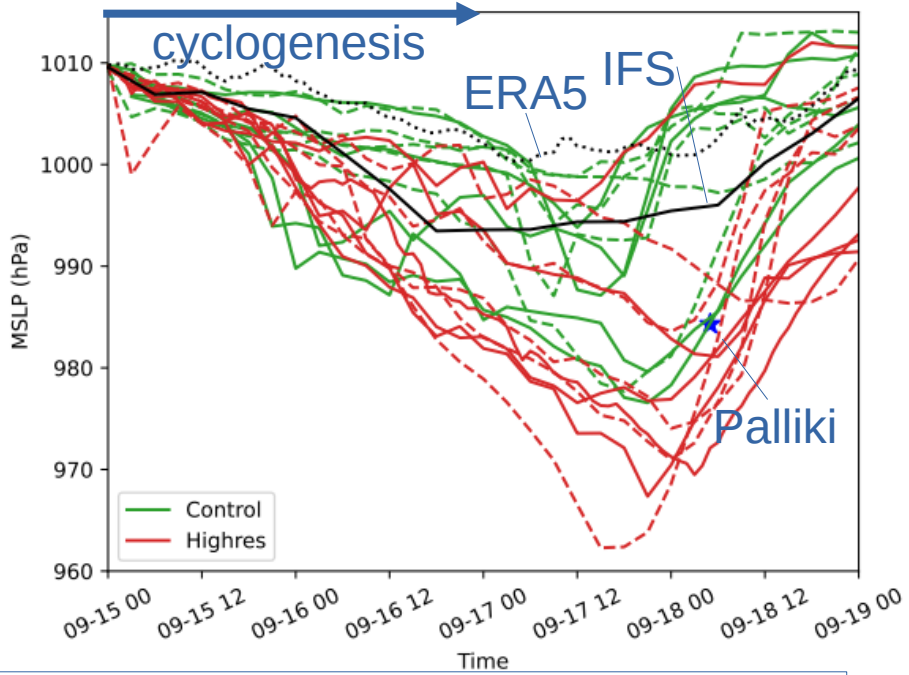




→ ***cyclogenesis hardly predicted using ERA5***

Sensitivity to horizontal resolution

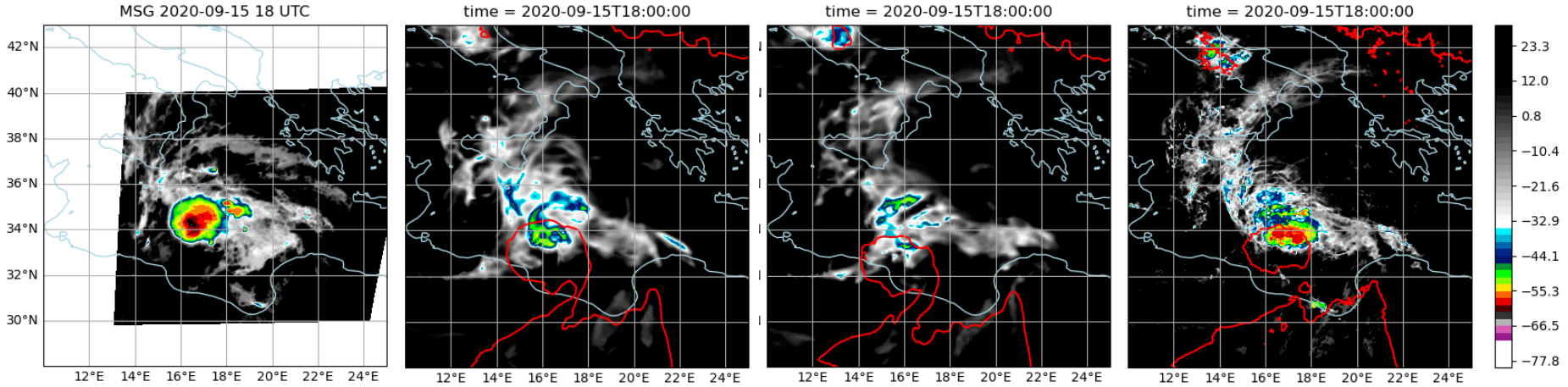




→ ***improved track with explicit representation of deep convection***

Representation of convection during cyclogenesis (t+18h)

MSG observation | **Control run** | **ERA5 initialization** | **High resolution**

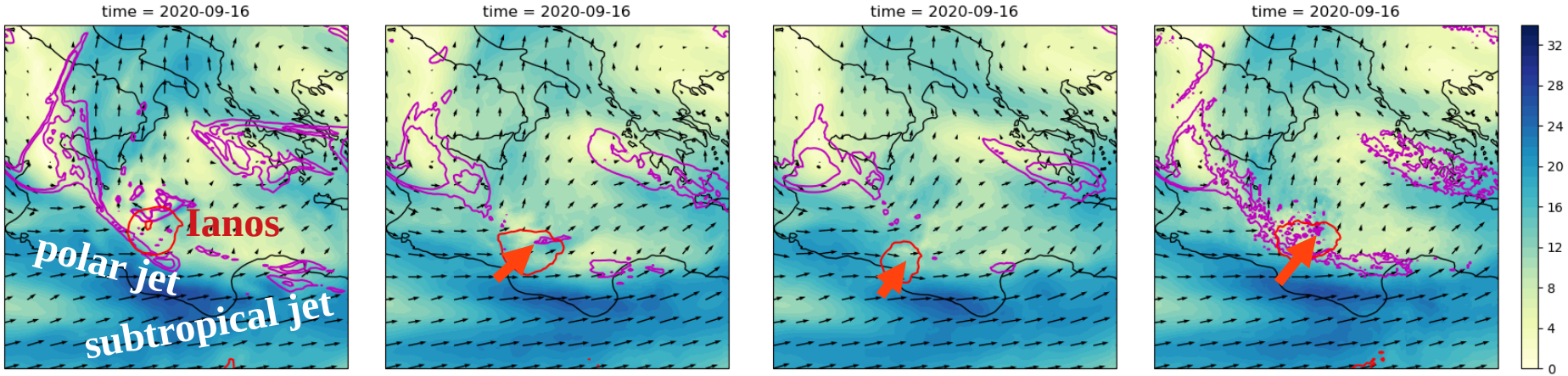


Infrared brightness temperature (in K) observed and simulated by the Meso-NH model

→ ***Convective activity enhanced at high resolution***

Interaction between scales I (t+24h)

IFS analysis | **Control runs** | **ERA5 initialization** | **High resolution**

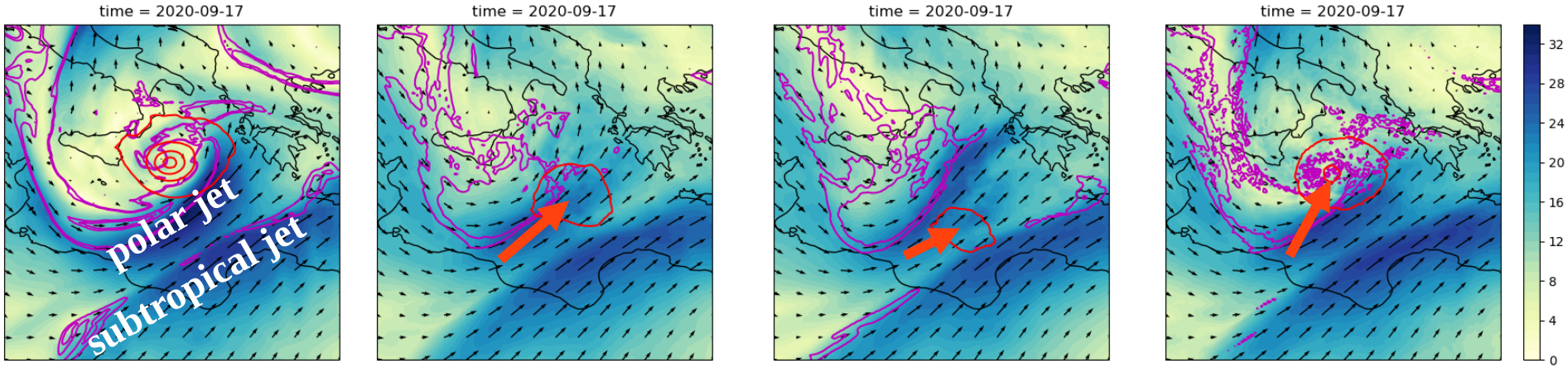


Composites of 300 hPa wind (vectors and shading), 300 hPa potential vorticity (contours), MSLP (contours)

→ ***slight difference in phasing between simulations***

Interaction between scales II (t+48h)

IFS analysis | **Control runs** | **ERA5 initialization** | **High resolution**



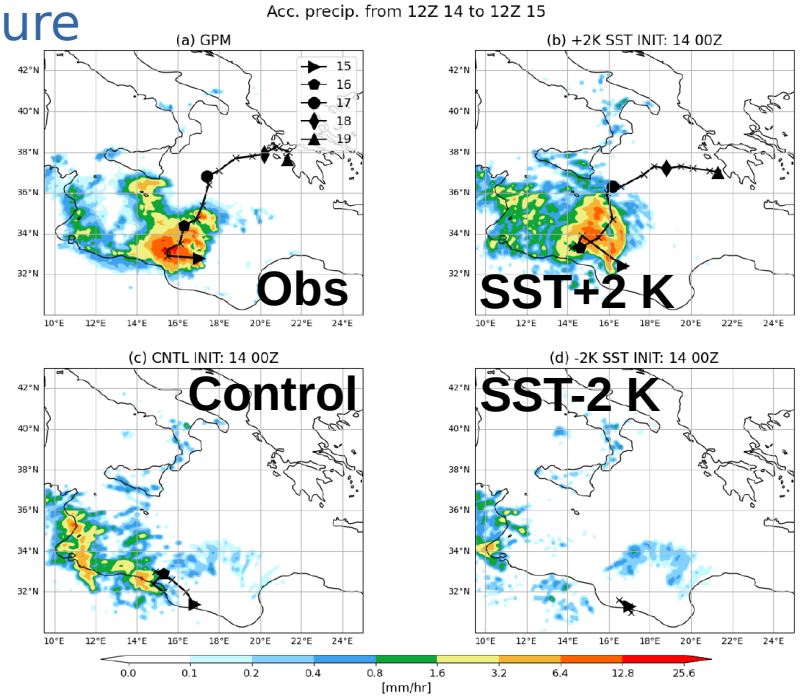
Composites of 300 hPa wind (vectors and shading), 300 hPa potential vorticity (contours), MSLP (contours)

→ ***upscale impact of convection on phasing with upper-level jets***

Sensitivity to sea surface temperature

MetUM runs only
Init IFS analysis 14 Sep
2.2 km grid spacing
SST control ± 2 K

→ modulates **surface fluxes**
→ controls **convective activity**



Sanchez, C., Gray, S., Volonte, A., Pantillon, F., Berthou, S., and Davolio, S.: *The impact of preceding convection on the development of Medicane Ianos and the sensitivity to sea surface temperature*, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2023-2431, 2023.

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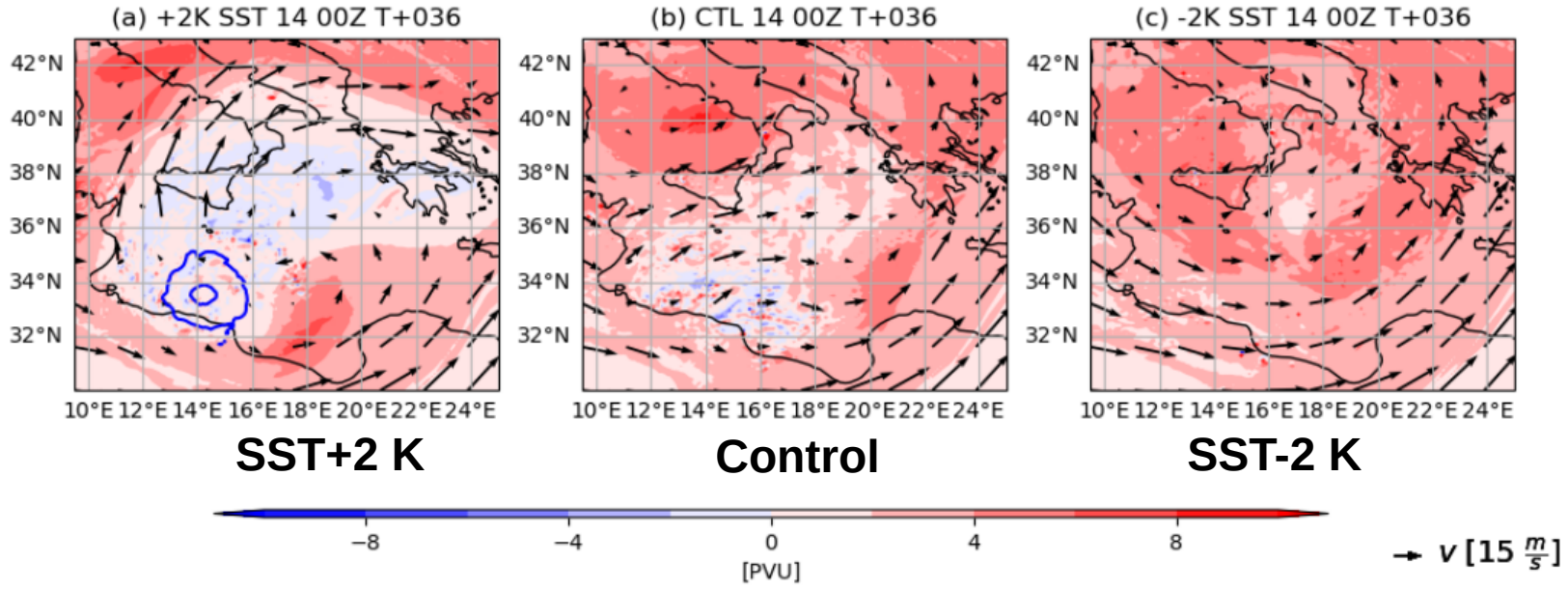
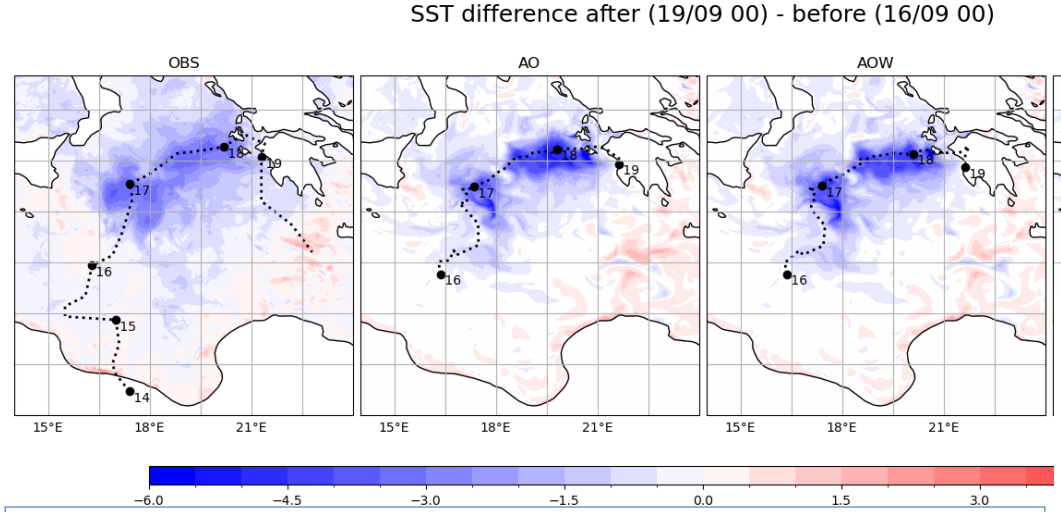
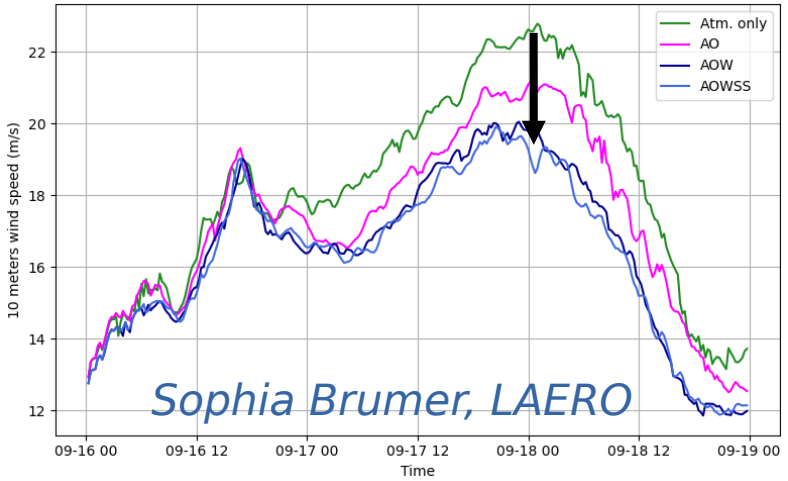
Formation of a bubble of low potential vorticity at upper levels



→ ***The convective ouflow preconditions the large-scale flow***

Onging work: sensitivity to air-sea interactions





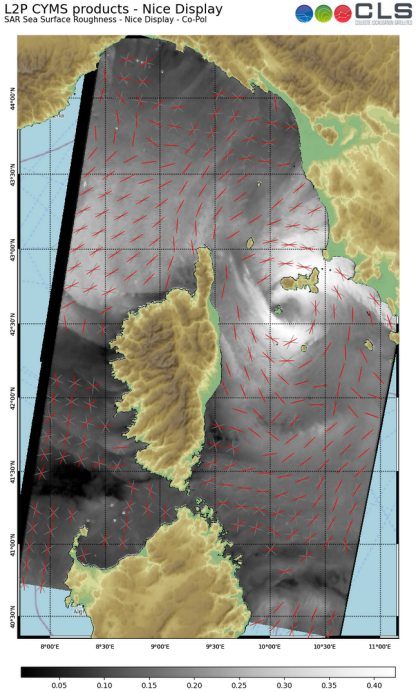
Coupled ocean-wave-atmosphere runs

→ Cold wake along cyclone track

→ Weakening of near-surface winds

Reminiscent of tropical cyclone dynamics

COST Action MedCyclones is over… What's next?



ESA MEDICANES (2024–2026)

Earth observations as a cornerstone to the understanding and prediction of tropical-like cyclone risk in the Mediterranean

https://medicanes.isac.cnr.it/

MEDICANES

COST Action FutureMed (2023–2027)

A transdisciplinary network to bridge climate science and impacts on society

https://www.cost.eu/actions/CA22162/

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Conclusions

Model Intercomparison Project to improve predictions of Mediterranean cyclones

Collective effort with 10 mesoscale models & setups to look for **robust response**

Focus on poorly predicted **cyclogenesis of Medicane Ianos** (mid Sep 2020)

Strong sensitivity to initial conditions: **cyclogenesis hardly captured using ERA5**

→ *Important for weather and climate studies as ERA5 is widely used*

Strong sensitivity to horizontal resolution: **clearly improved with explicit convection**

→ *Important for the next generation of weather and climate models*

Cyclone evolution controled by **convection and phasing with upper-level jets**

→ *Interplay of convective and baroclinic processes during cyclogenesis*

Pantillon et al., accepted in WCD https://doi.org/10.5194/egusphere-2024-1105
Sanchez et al., accepted in WCD https://doi.org/10.5194/egusphere-2023-2431

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