Sea surface temperature anomalies associated with Mediterranean tropical-like cyclones

***Francisco Pastor**, Daniel Pardo-García, and Samira Khodayar*

Mediterranean Center for Environmental Studies (CEAM)

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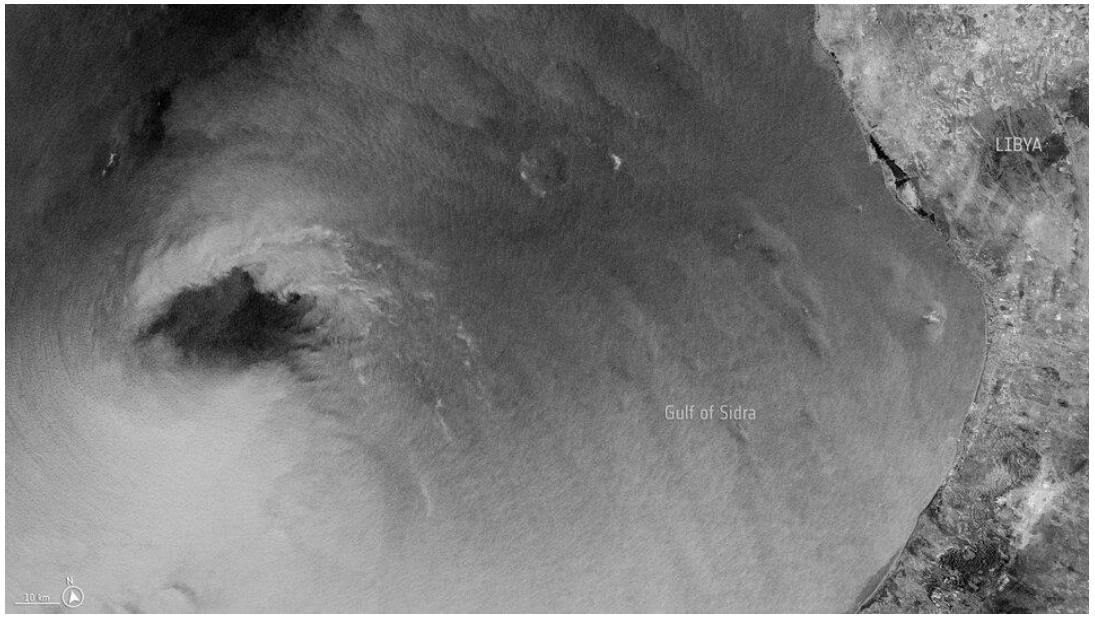
Medicanes

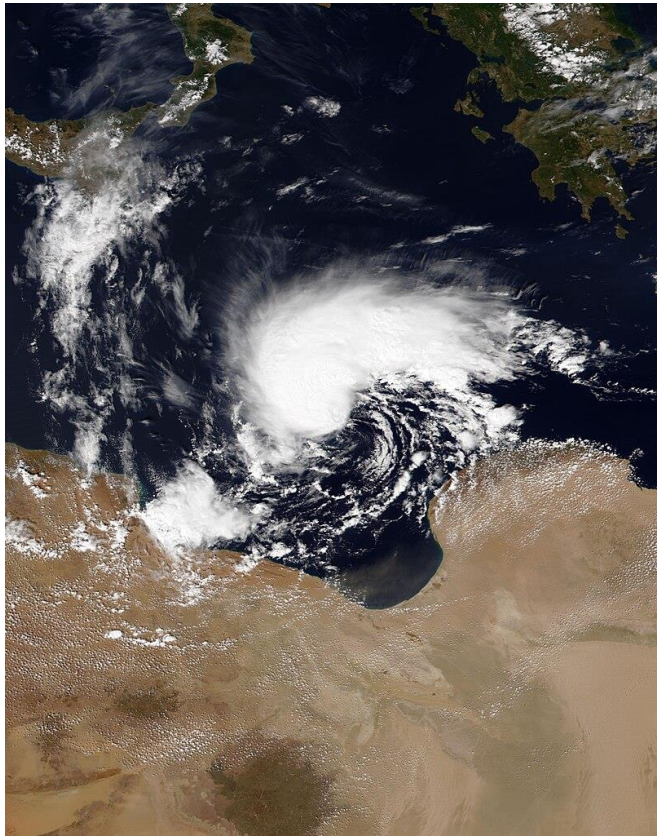
A medicane is a mesoscale cyclone that develops over the Mediterranean Sea and displays tropical-like cyclone characteristics: a warm core extending into the upper troposphere, an eye-like feature in its center with spiral cloud bands around, an almost windless center surrounded by nearly-symmetric sea-surface wind circulation with maximum wind speed within a few tens of km from the center.

Miglietta, M. M. et al. Defining Medicanes: Bridging the Knowledge Gap between Tropical and Extratropical Cyclones in the Mediterranean. Bull. Am. Meteorol Soc 106, E1955–E1971 (2025).

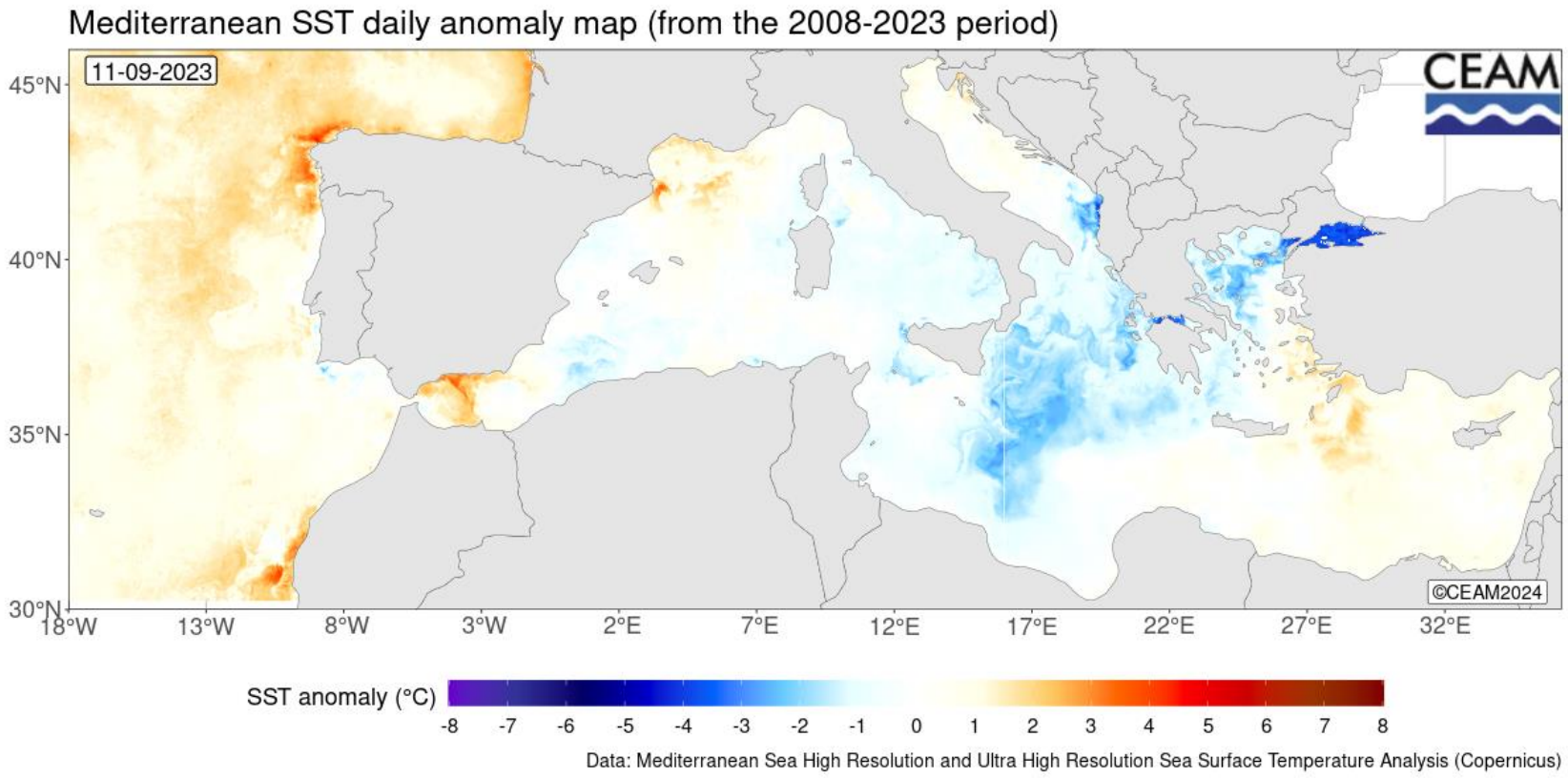


Medicane Jolina (credit ESA)
https://www.esa.int/Applications/Observing_the_Earth/FutureEO/Getting_to_the_core_of_a_medicane

Impact/feedback between Medicanes and Mediterranean Sea Surface temperature



Satellite imagery of Daniel (September 2023) over the Mediterranean.
(VIIRS imagery from NASA Worldview)



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Data and methodology

Medicanes tracks from the ESA funded MEDICANES Project
(Contract No. 4000144111/23/I-KE)

Source: Flaounas, E., et al https://doi.org/10.5194/wcd-4-639-2023

Mediterranean Sea - High Resolution L4 Sea Surface Temperature Reprocessed

Source: Copernicus Marine Service (https://doi.org/10.48670/moi-00173)

Temporal resolution: Daily
Spatial resolution: 5,5 km

Surface heat fluxes from Copernicus European Regional ReAnalysis (CERRA)

Source: Copernicus programme https://climate.copernicus.eu/copernicus-regional-reanalysis-europe-cerra

Temporal resolution: Hourly
Spatial resolution: 5,5 km

Previous analysis on Medicanes-SST relationship

- SST drop in previous days
- SST decrease during medicane passage
- Time window from 2 to 10 days before and after medicane

New indicator proposal: ***SST daily variation (SST_{dvar})***

- Not seasonally dependent: unrelated to absolute SST values (warm autumn vs cool winter SST)
- Locally constrained (pixel by pixel analysis)
- SST_{dvar} anomaly as indicator of *"stronger than usual"* energy transfer from the sea to the atmosphere

Through medicane passage

- Less intense warming or cooling from late winter/spring to summer
- Stronger cooling from late summer to winter

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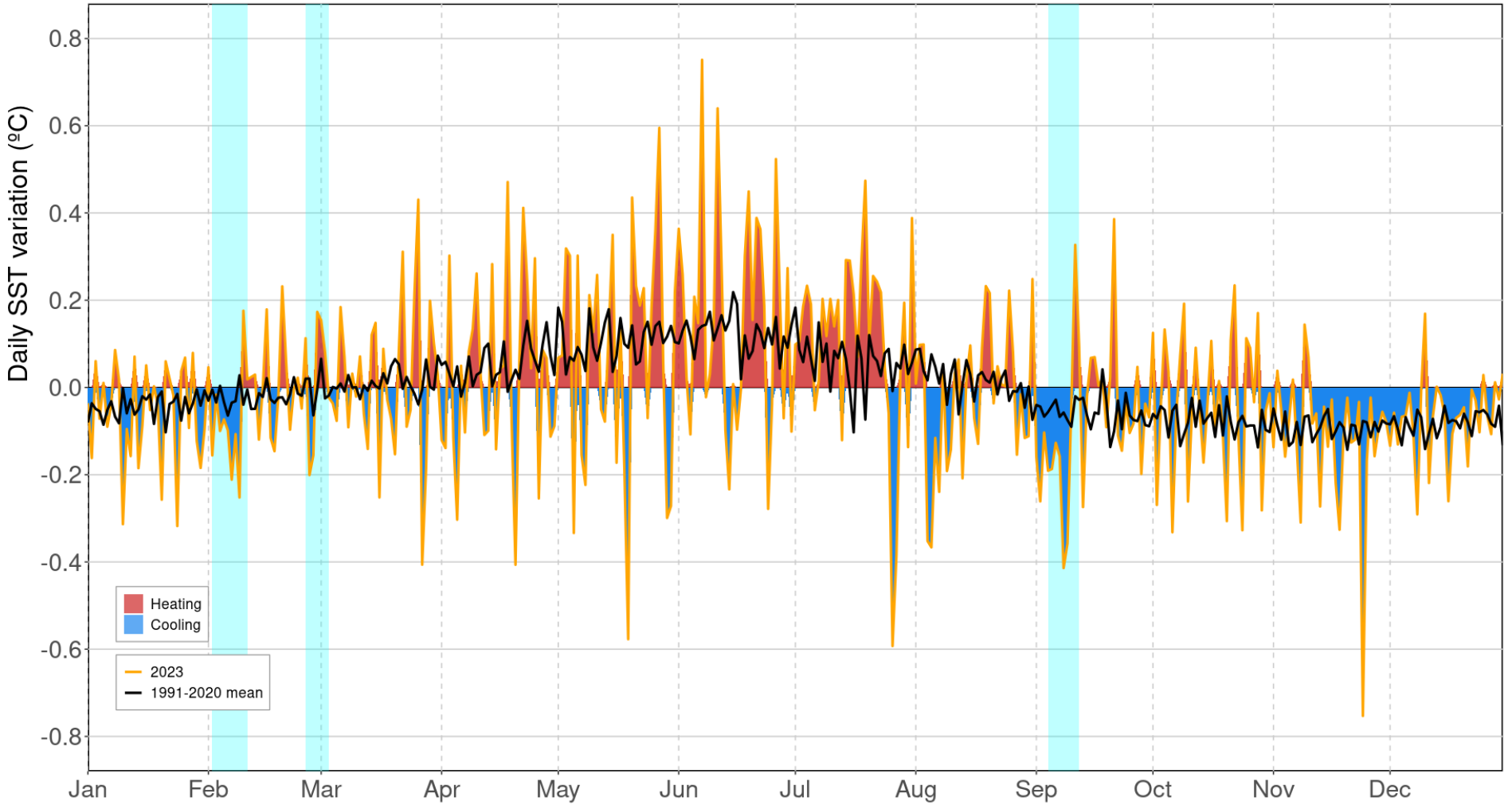
SST daily variation climatology (by basin)



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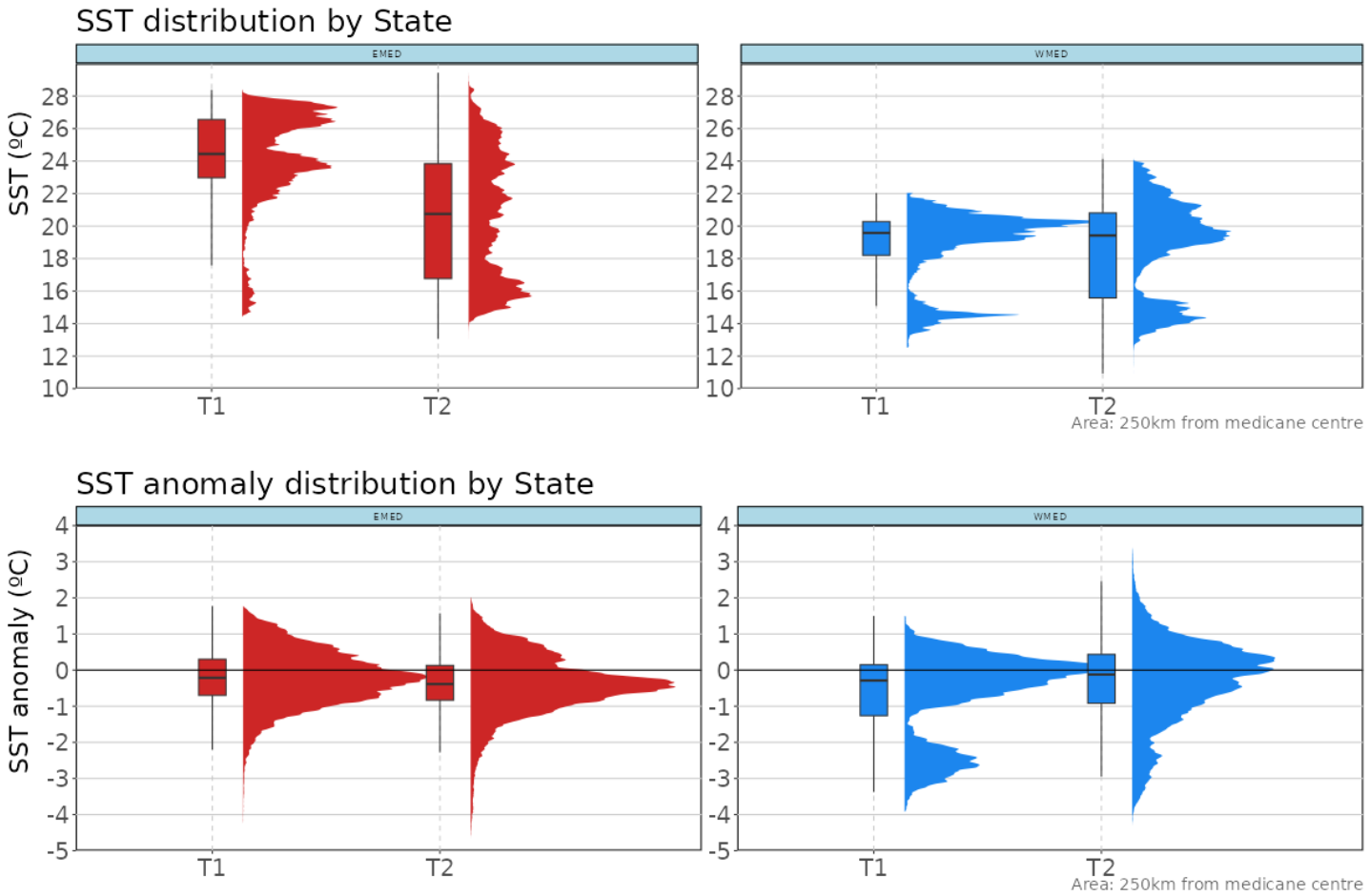
Local scale analysis



Medicane phase

- T1: cyclogenesis phase
- T2: mature stage

Avolio et al. (2024)

EMED

- Mean SST strong decrease
- Change in the shape of SST distribution
- Weaker change in SST anomaly

WMED

- No relevant change in mean SST
- Quite similar SST distribution
- Weak increase of SST anomaly (less negative)

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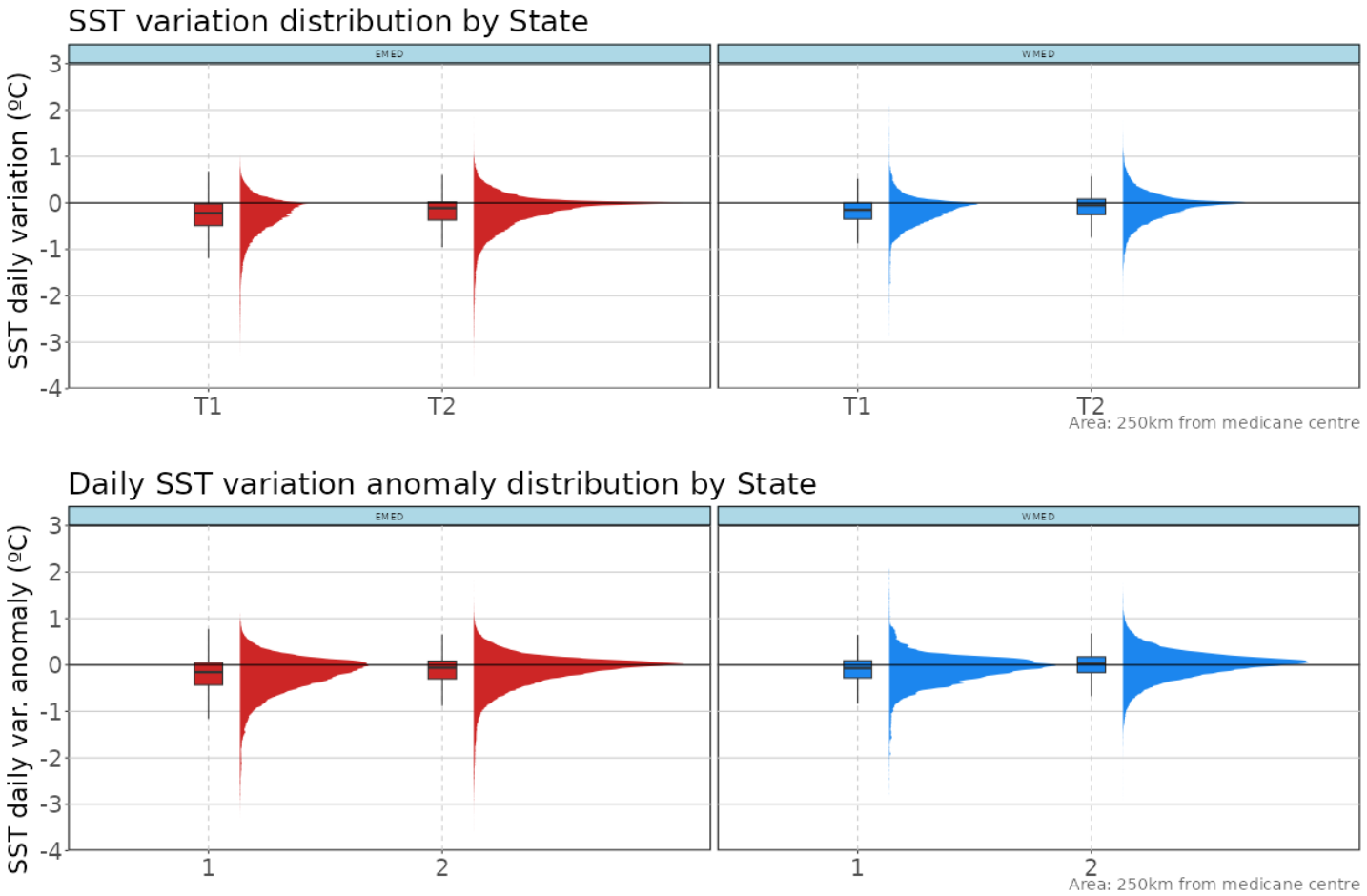
Local scale analysis



Medicane phase

- T1: cyclogenesis phase
- T2: mature stage

Avolio et al. (2024)

BOTH BASINS

- More negative SSTdvar values in the T1 stage
- More negative SSTdvar anomaly in the T1 stage

- Coherent behaviour in the whole Med basin

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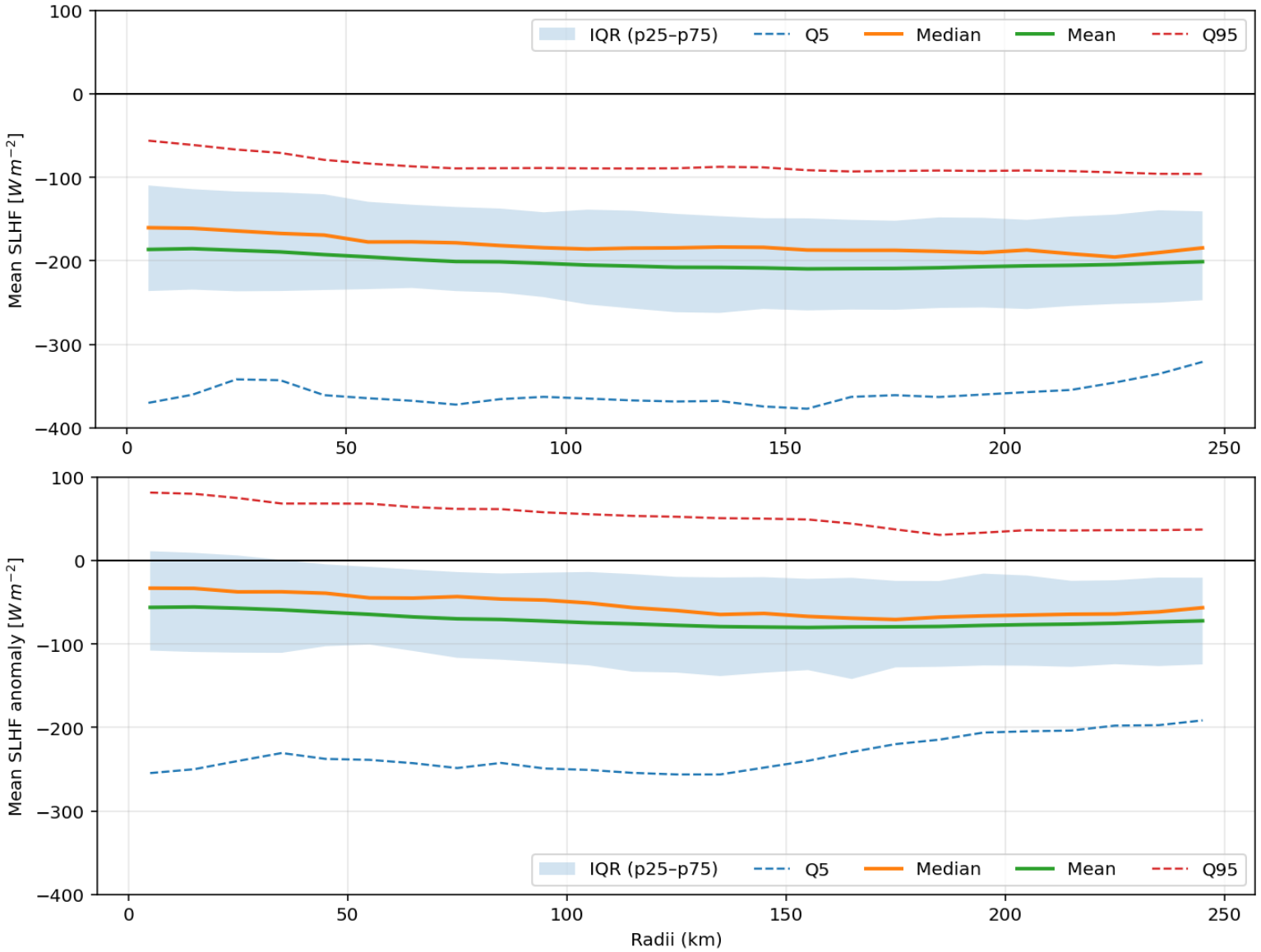
Local scale analysis – Surface heat fluxes



Surface sensible heat flux

- No relevant change with distance

Surface latent heat flux (SLHF)

- Maximum SLHF mean value around 150 km from medicane centre
- Maximum SLHF mean anomaly value beyond 150 km from medicane centre
- Results consistent with literature locating deep convection in medicanes

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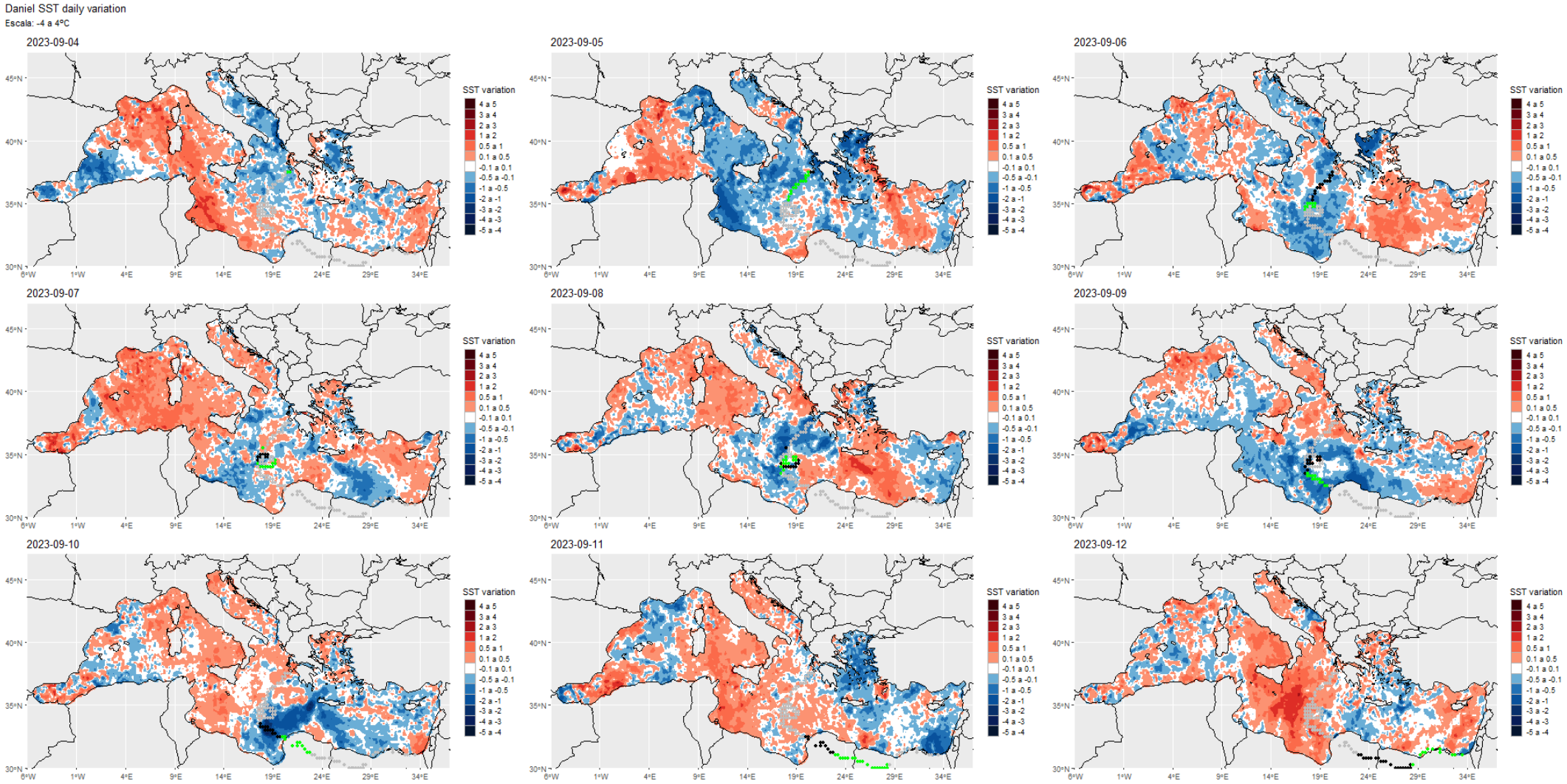
Heat fluxes and SST daily variation



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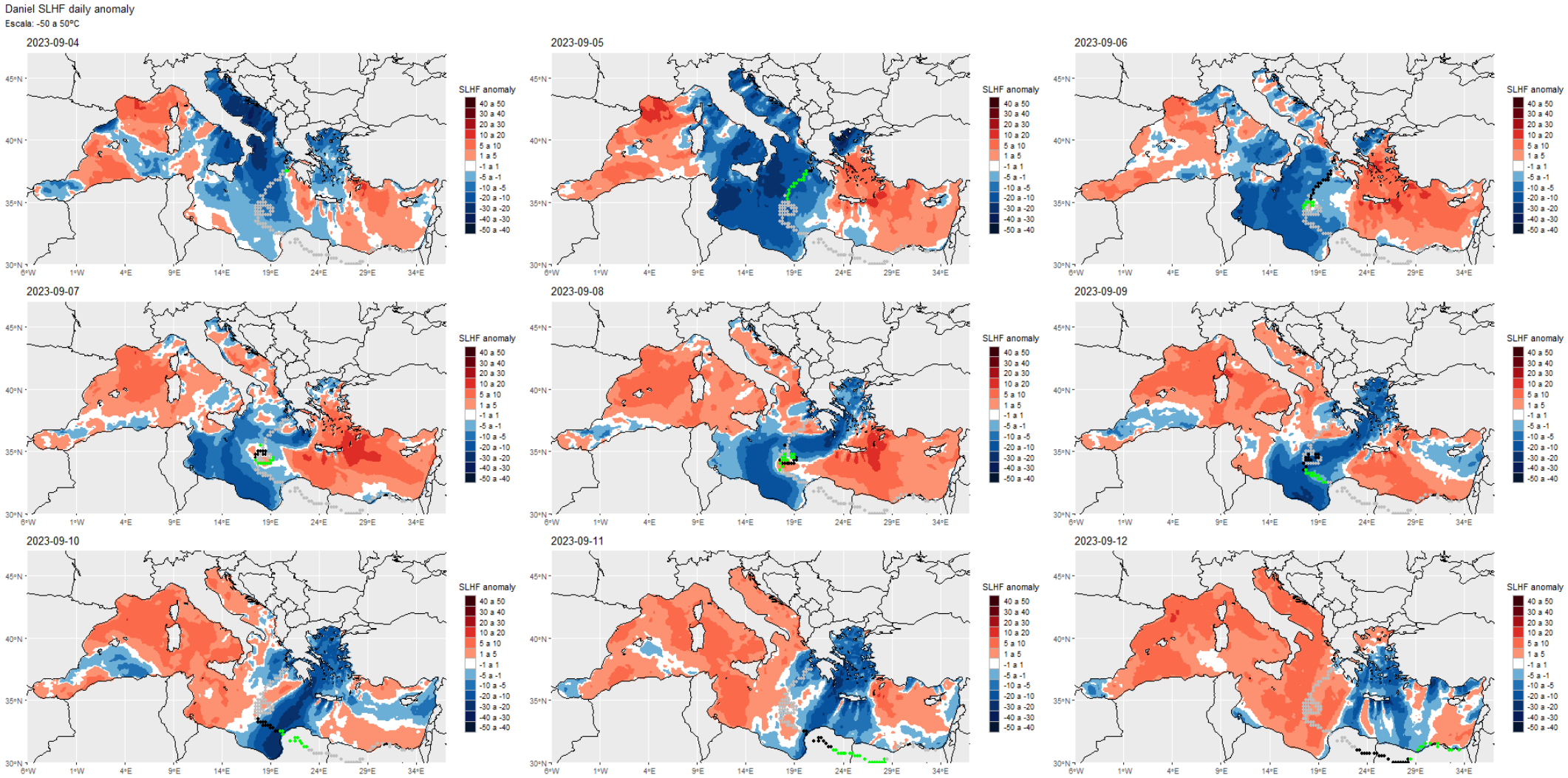
Heat fluxes and SST daily variation



Conclusions

- Strong impact/feedback between medicanes and SST field
    - Noticeable fingerprint of medicane passage from whole basin to regional scale
    - More intense impact observed at local scale (250 km)
- More relevant in the cyclogenesis stage
    - SST, SST anomaly and SSTdvar at the cyclogenesis pase
- Heat fluxes dominated by most negative latent heat fluxes
- ***SST daily variation***
    - More coherent behaviour across the whole Mediterranean basin than SST or SST anomaly
    - ***Good indicator of SST-medicanes correlation***

Acknowledgement

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MEDICANES

European Space Agency *through Earth Observations as a cornerstone to the understanding and prediction of tropical like cyclone risk in the Mediterranean*

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

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COST through the Action CA22162 ***FutureMed***

https://www.futuremedaction.eu

Thanks for your attention!

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