Medicanes impact on the physical and biogeochemical properties of the upper Mediterranean Sea

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Introduction

A Mediterranean cyclone is classified as a medicane present tropical-like characteristics, such as a cloud-free calm "eye," spiraling cloud bands, and strong winds near the vortex center. These features may be associated with the absence of fronts, weak vertical wind shear, and a warm core (WC) with an axisymmetric structure. (Miglietta et al., 2019; Flaounas et al., 2022; Panegrossi et al., 2023)

Collapse of hospitals, buildings and trees

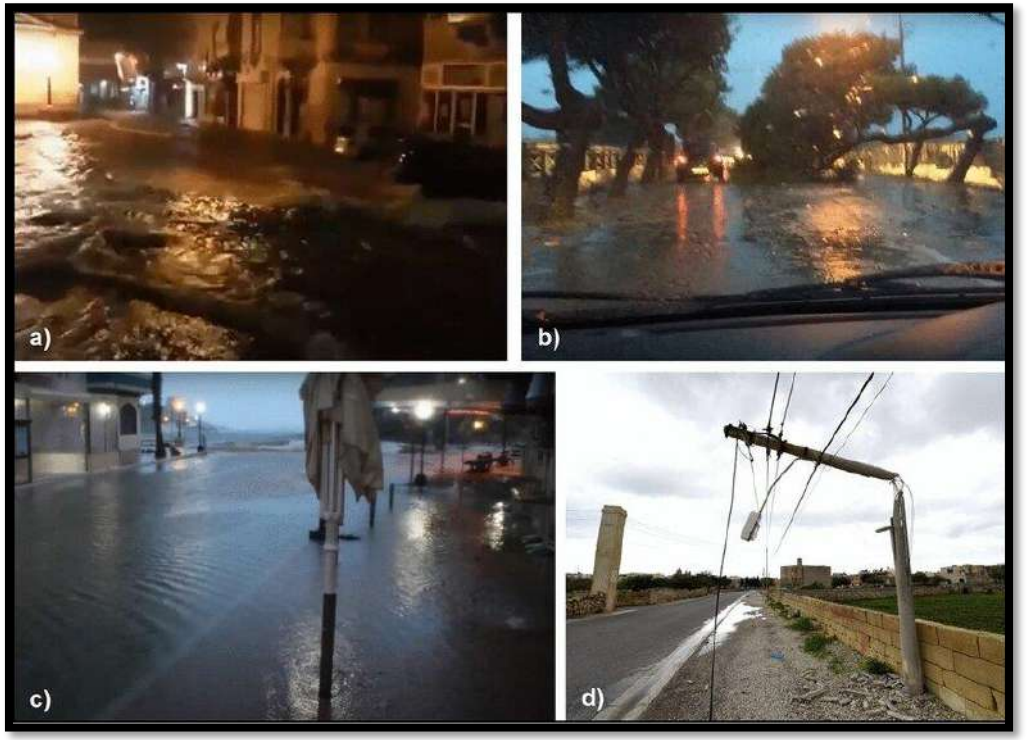
Residents become homeless and traumatized

Rise in sea level

Damage of roads and electric poles

Migration of people

Damage due to Quendresa



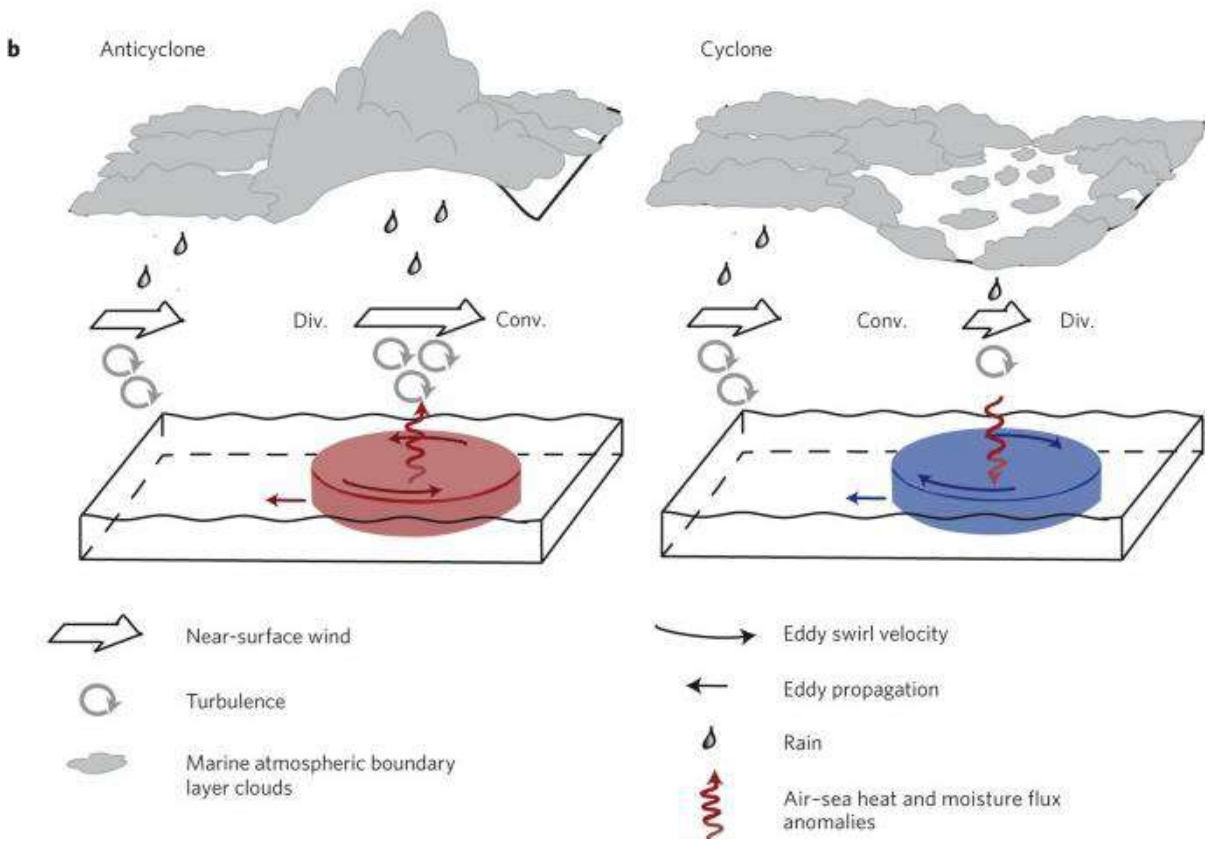
Due to medicane Daniel Flooded hospitals and nearly 4000 people died in Libya

Damage occurred due to Cyclone Ianos

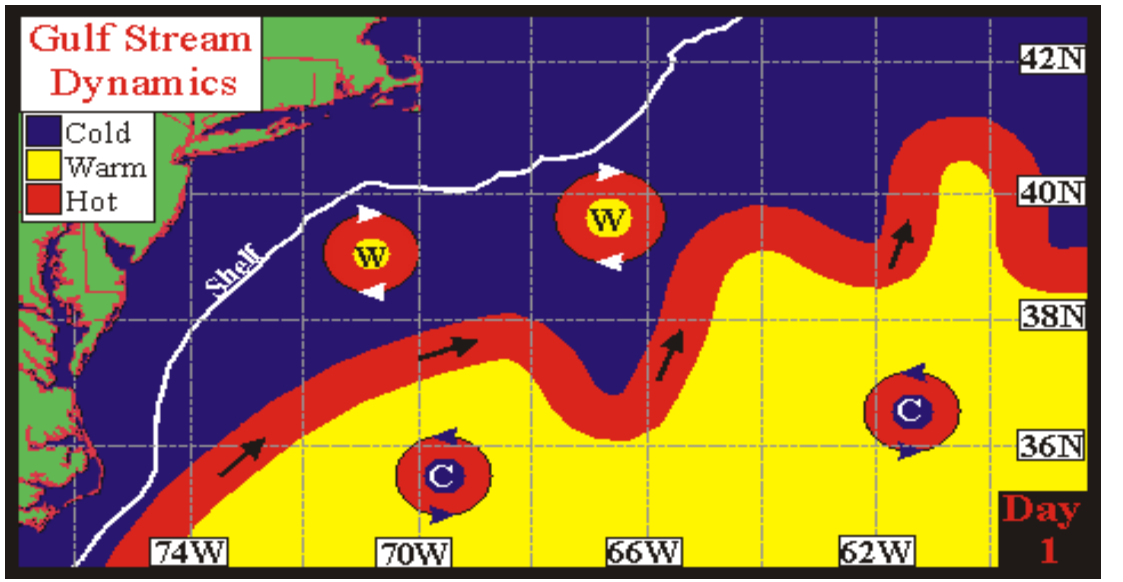
More than 5,000 homes were damaged. Near Ionian Island

Important factor affecting cyclone intensity?

Air-sea interactions and Small-Scale ocean features (Eddies, Marine heat waves, and Ocean Heat Content)

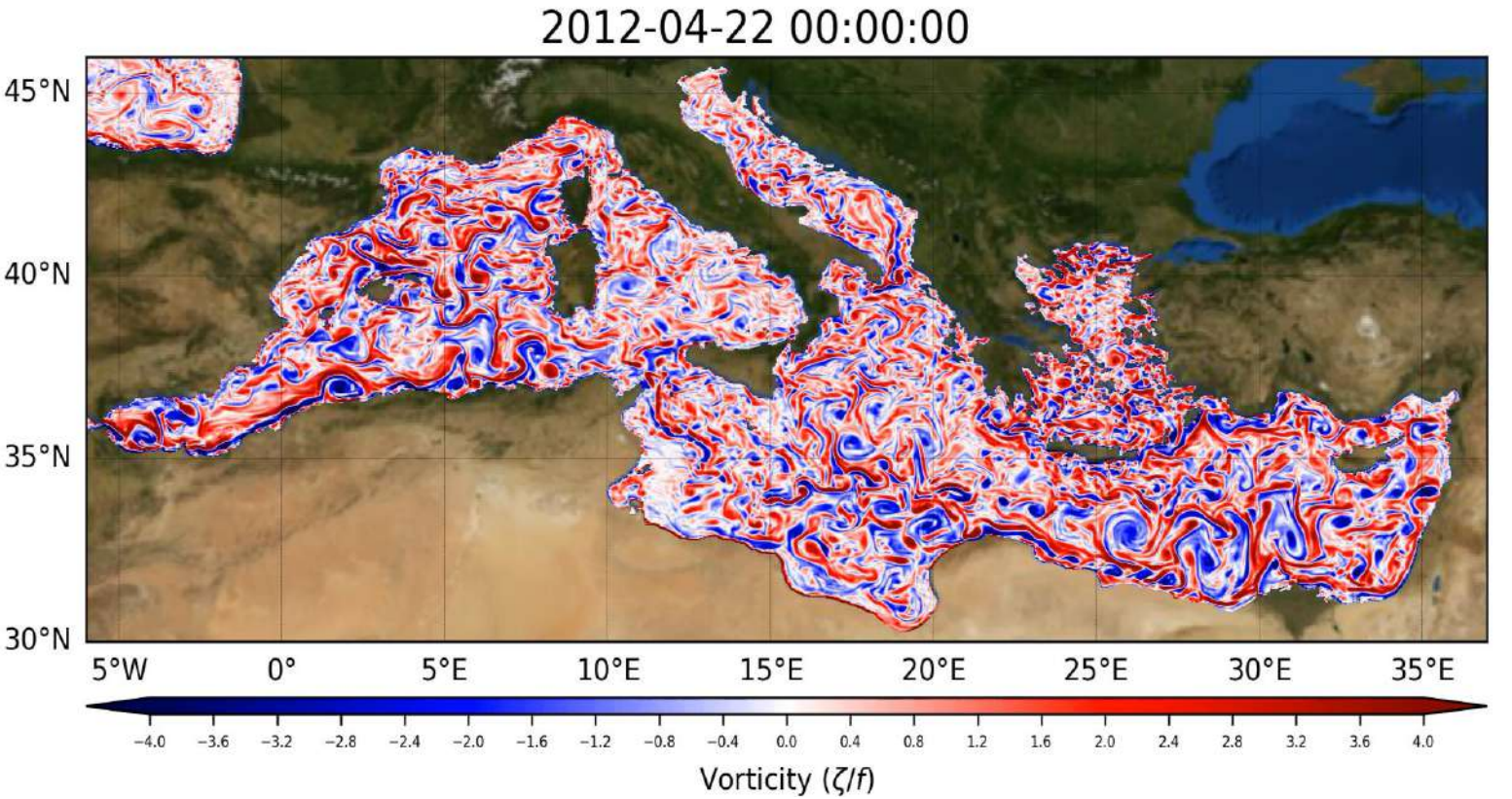


Frenger et al., 2013



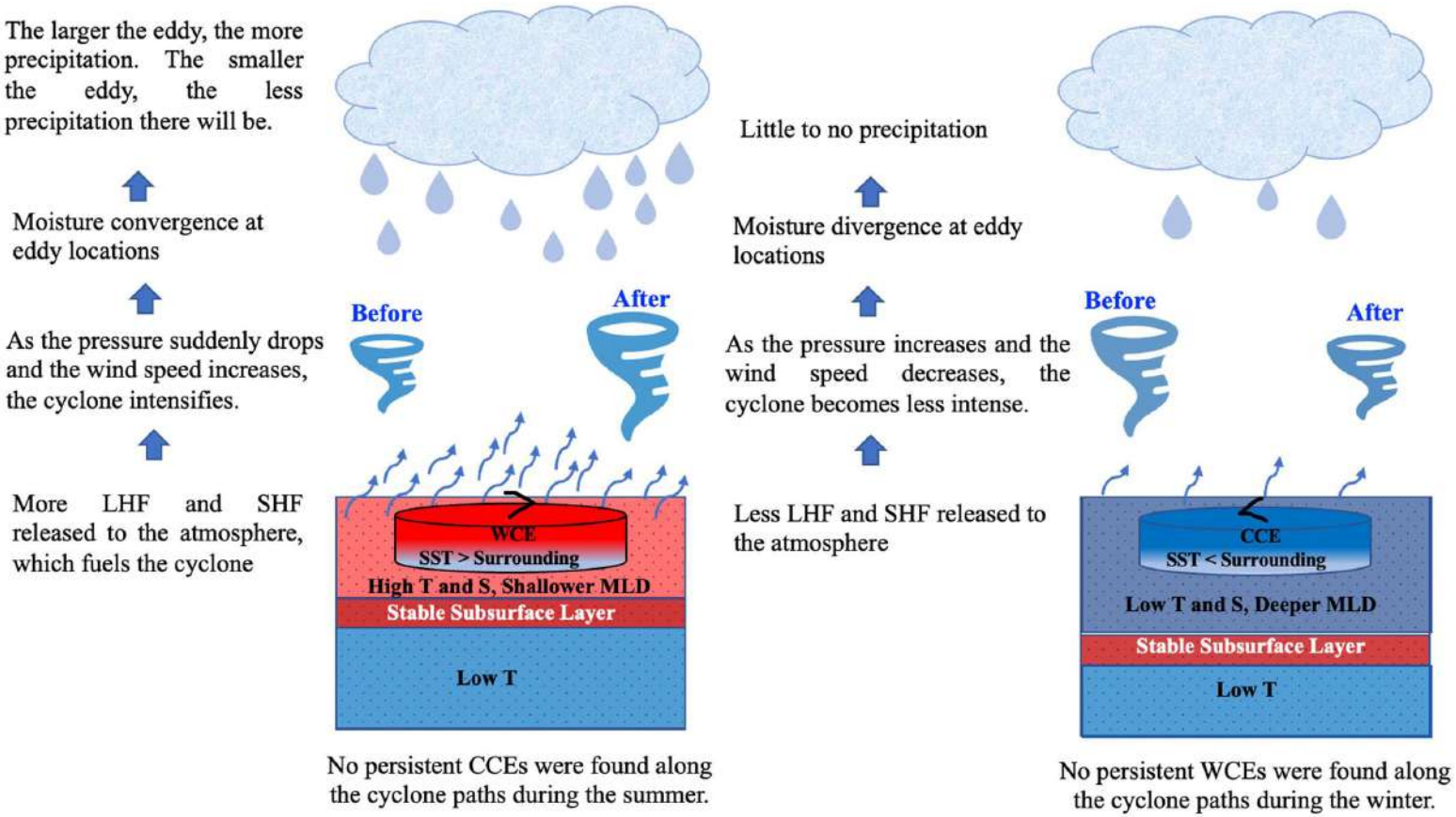
Source: NASA

Why this study is important to MS?



- Mediterranean cyclones are less intense, smaller in size, and have shorter duration, but they still have devastating impacts due to the high population density in this region.

- **D**espite knowing it is an eddy-rich region, till now, it has not been explored in the Mediterranean Sea.



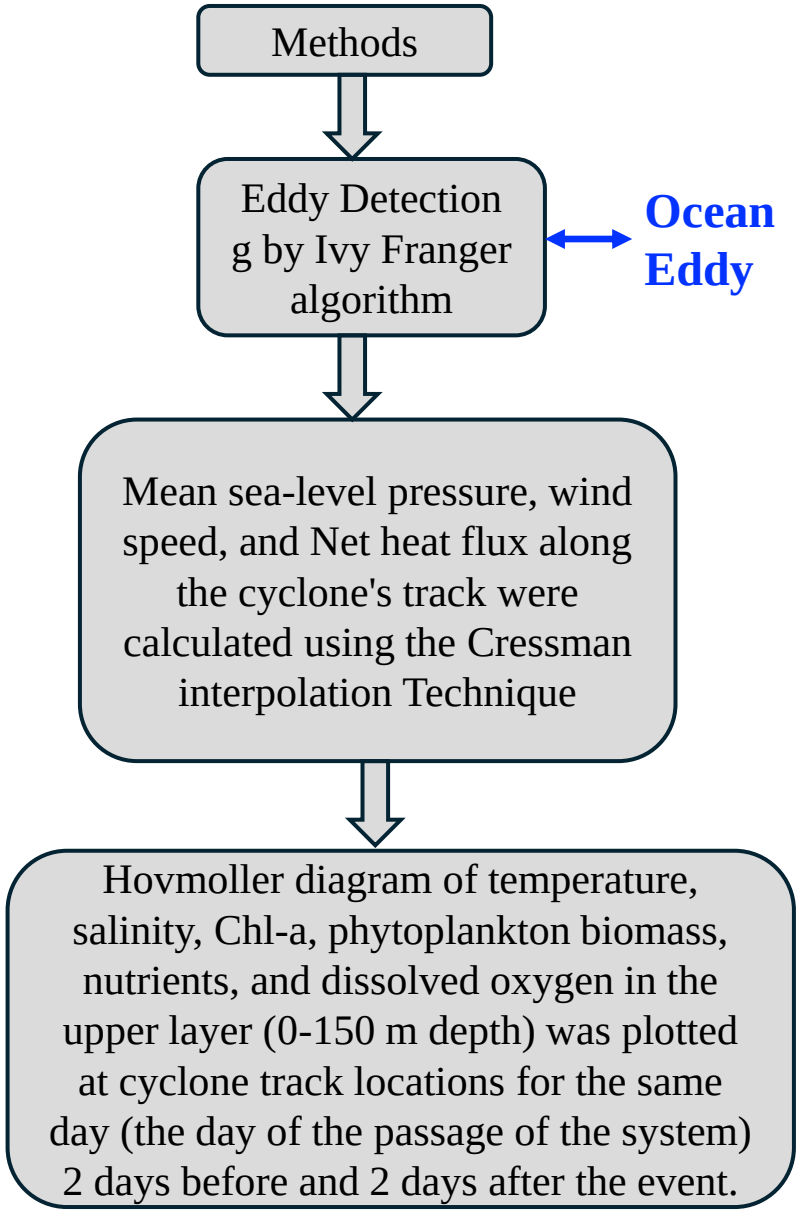
Jangir et al., 2023, JGR-Atmosphere

- This is the first study in the Mediterranean region in the context of shedding light on cyclone's impact on biogeochemical properties in the function of the pre-existing ocean conditions, including the presence/absence of eddies, gyres, and marine heatwaves.

- Additionally, for the first time globally, we are showing the alterations in biogeochemical parameters (i.e., Chl-a, nutrients, oxygen concentration) along the water column using vertical profiles.

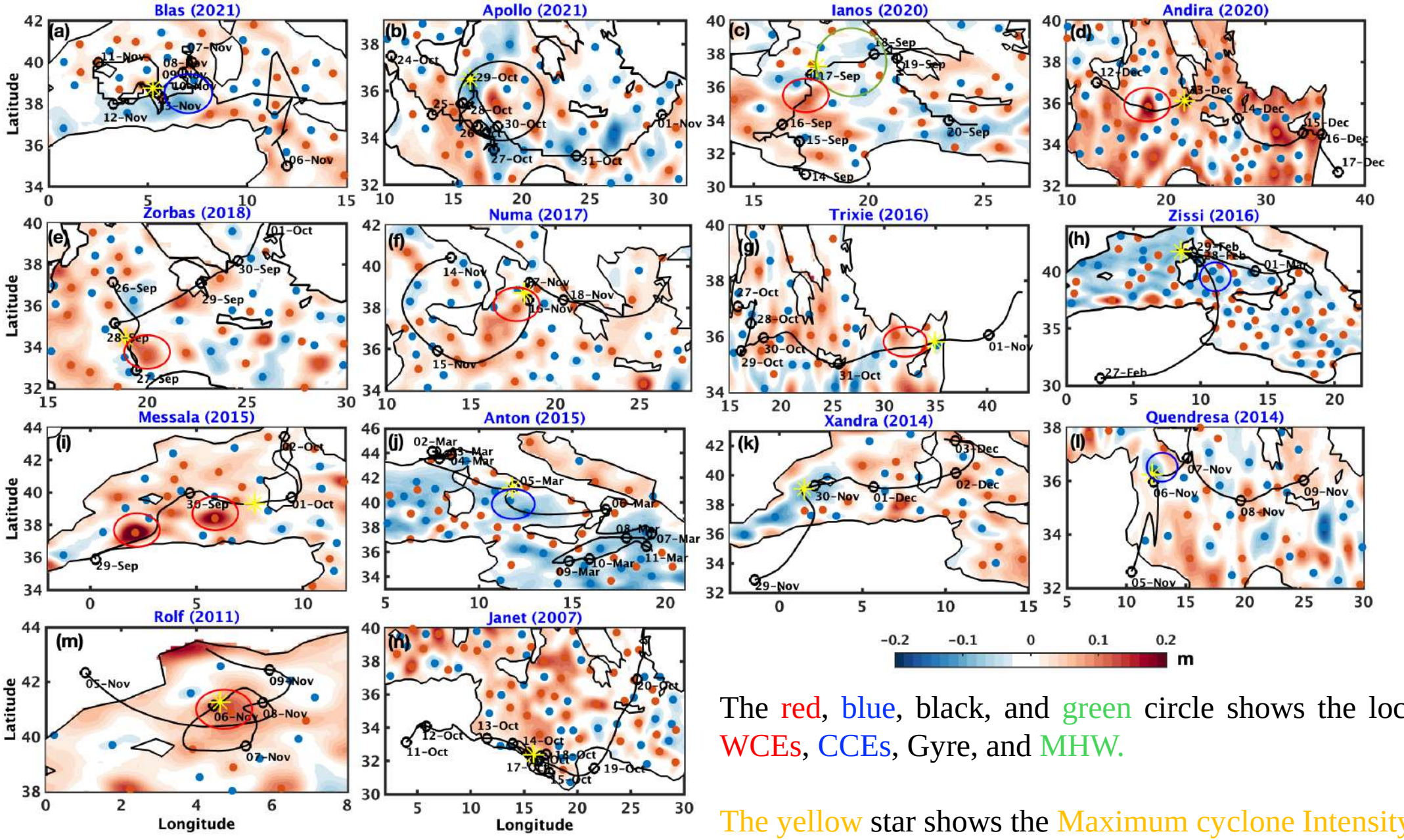
Data and Methods

Parameter	Temporal and Spatial Resolution	Source	Links
Medicane Track Data	Hourly	Flaounas et al. (2023)	https://doi.org/10.5194/wcd-4-639-2023-supplement
Sea Level Anomaly	Daily 0.125º	Copernicus Marine Services	https://data.marine.copernicus.eu/product/SEALEVEL_EUR_PHY_L4_MY_008_068/download
Temperature and Salinity profiles and Mixed Layer Depth (MLD)	daily and 4-5 km spatial resolution	Copernicus Marine Services	https://data.marine.copernicus.eu/product/MEDSEA_MULTIYEAR_PHY_006_004/download
Biogeochemical parameters	daily and 4-5 km spatial resolution	Copernicus Marine Services	https://data.marine.copernicus.eu/product/MEDSEA_MULTIYEAR_BGC_006_008/download
The atmospheric parameters (MSLP, wind speed), radiative fluxes (shortwave and longwave radiations, and turbulent heat fluxes	1-hr temporal and 0.25° × 0.25 spatial resolution	Era 5 Reanalysis products	Hersbach et al., 2020



Results

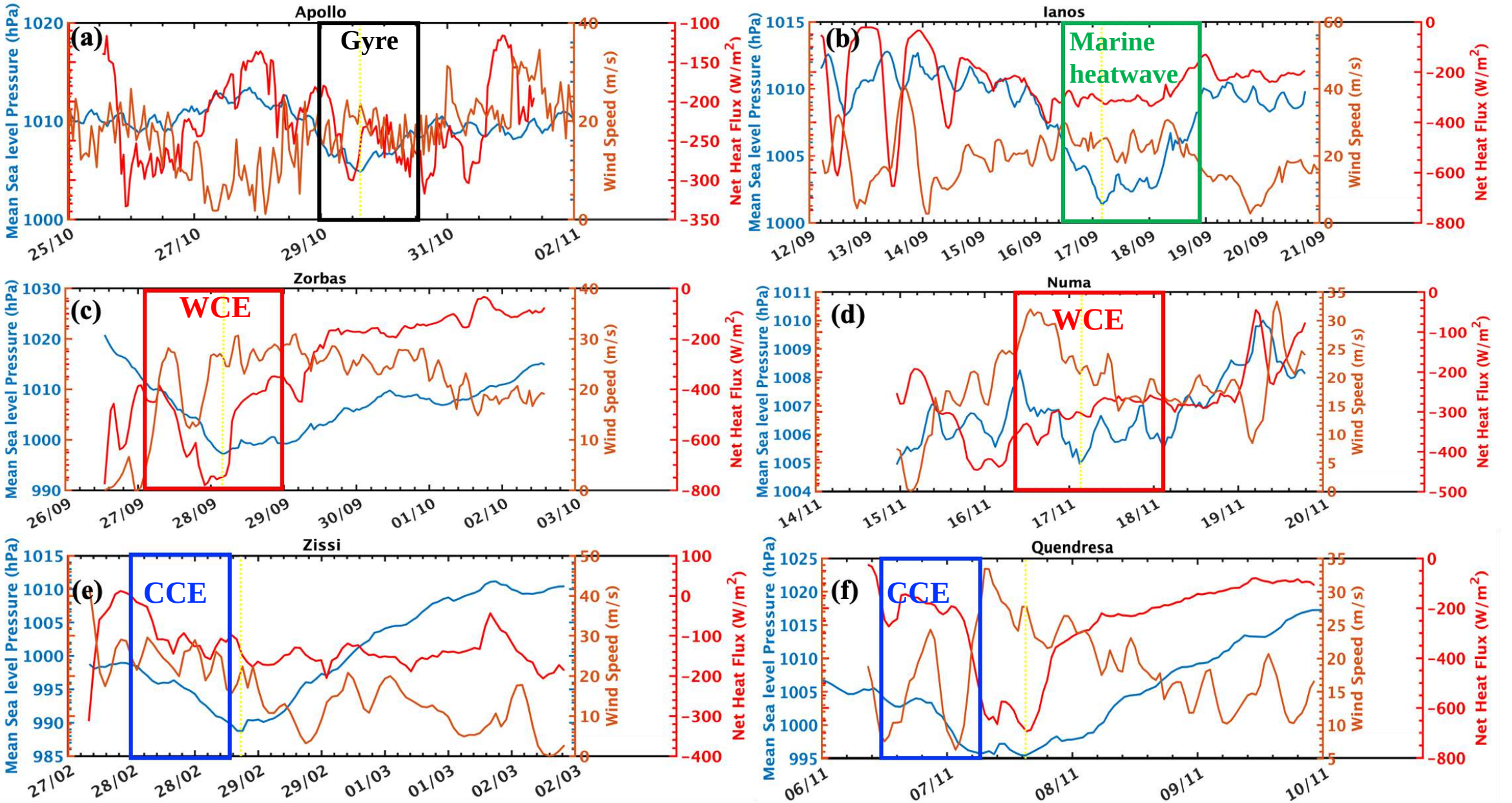
14 cyclones from 2007 to 2021 in the presence and absence of an eddy



The red, blue, black, and green circle shows the location of WCEs, CCEs, Gyre, and MHW.

The yellow star shows the Maximum cyclone Intensity

How do cyclones intensify due to the presence of eddies, marine heat waves, and gyres?



The blue, red, and brown line represents MSLP, NHF, and WS

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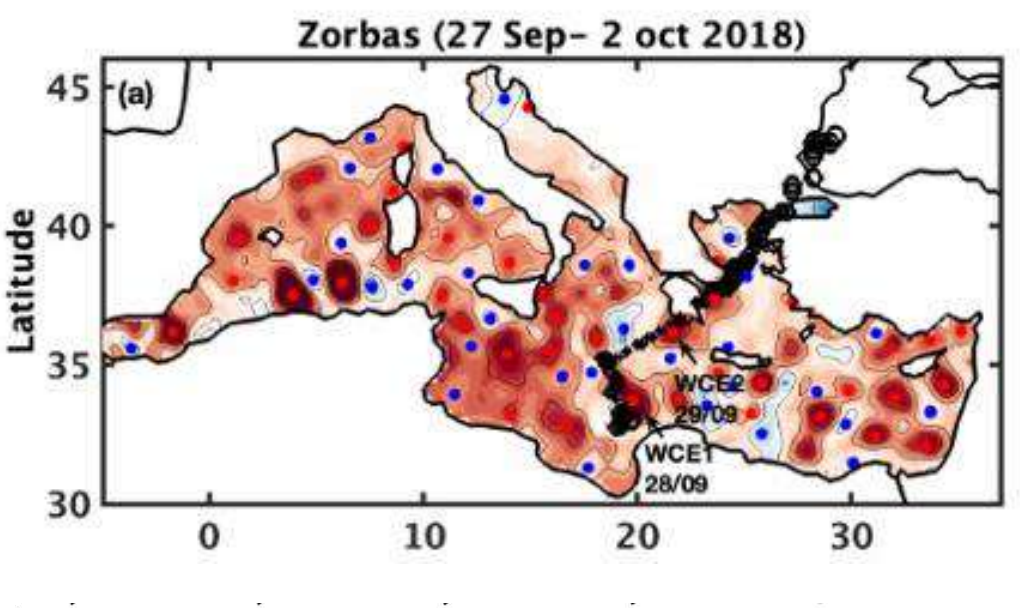
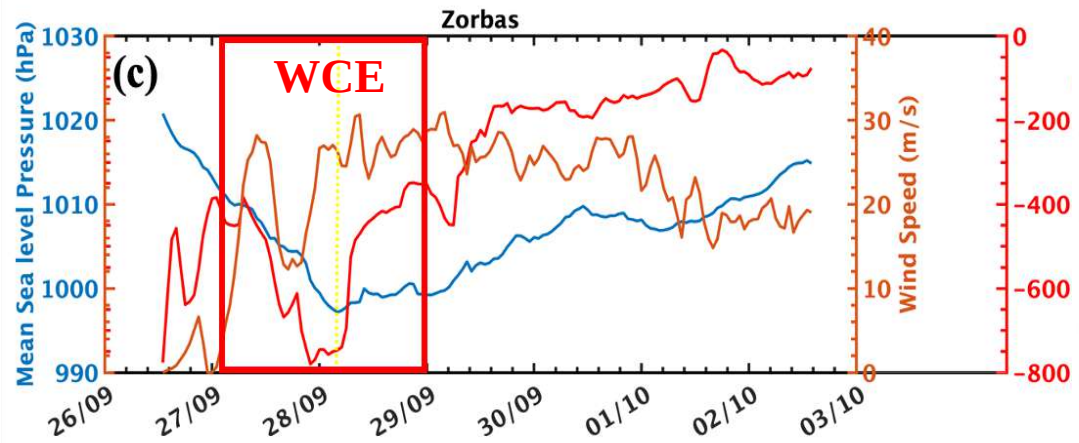
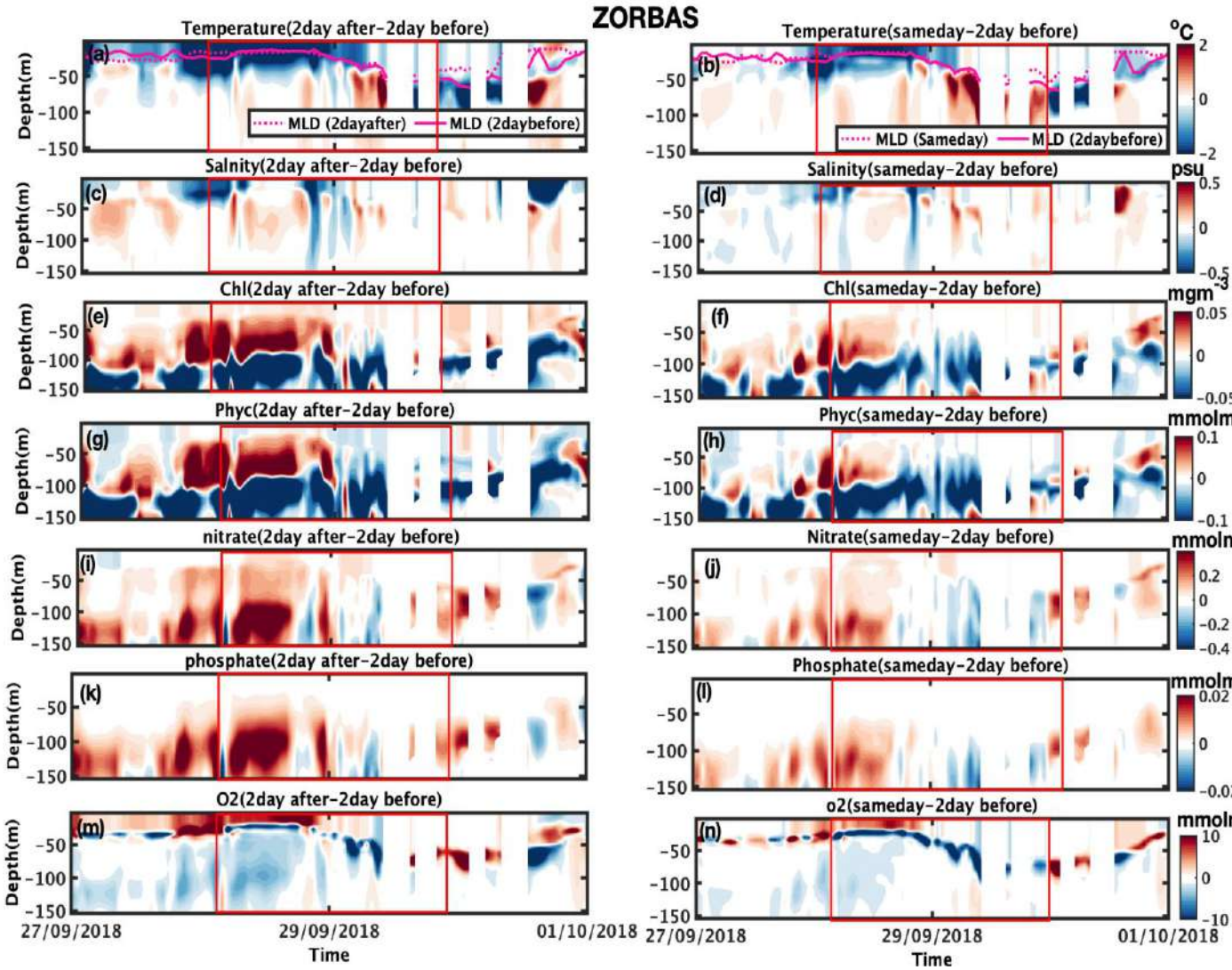
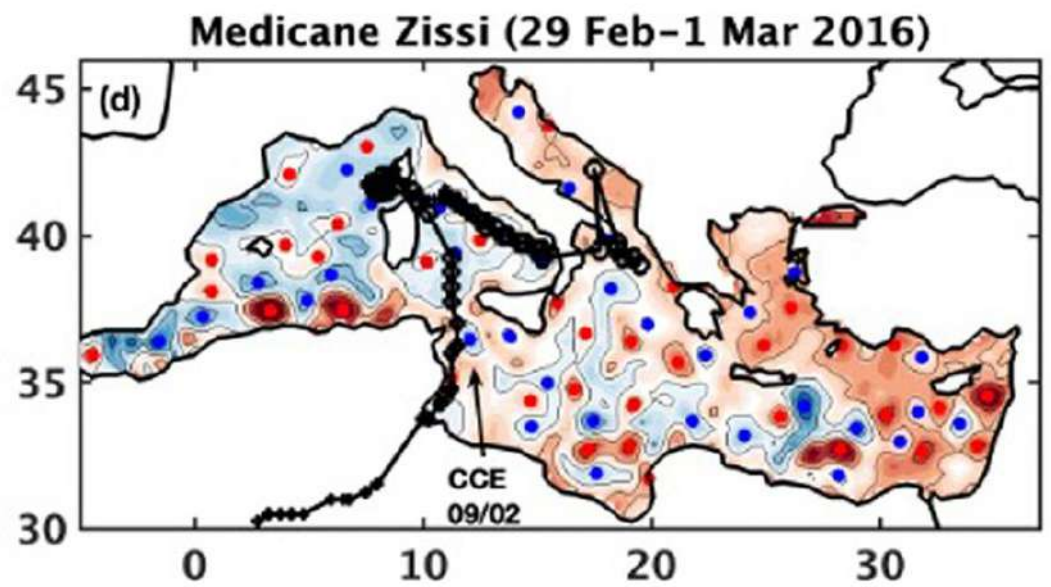
Cyclones along Warm Core Eddy in their path:

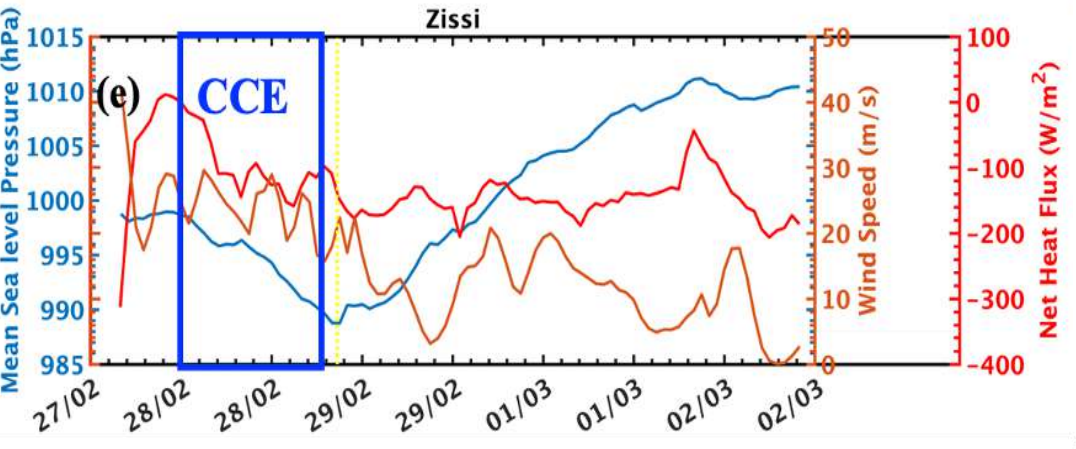


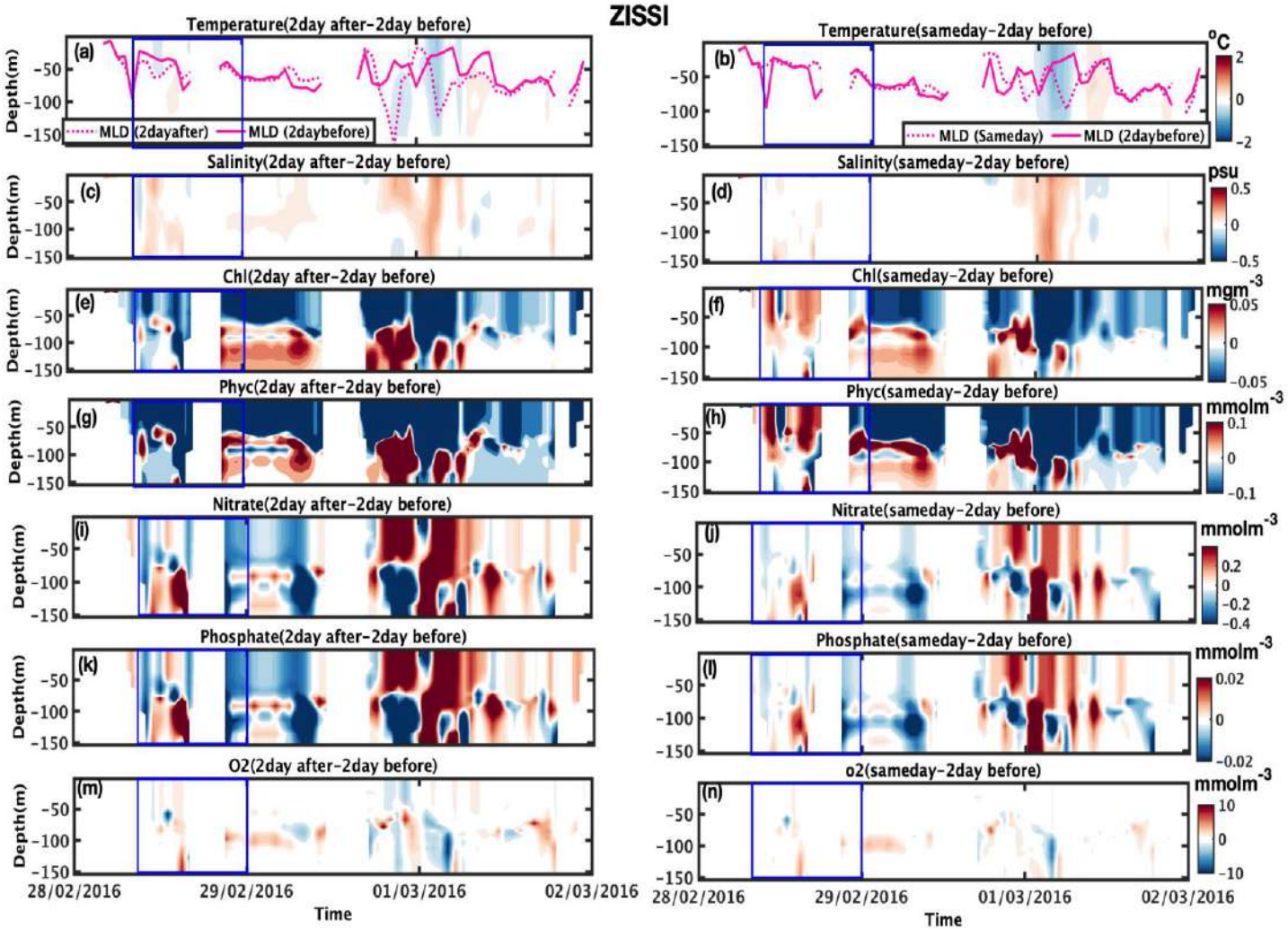




Cyclones along Cold Core Eddy in their path:







In the case of CCE, eddy-induced upwelling dominated rather than wind-driven upwelling. For cyclones like Quendresa and Blas, the surface concentrations of Chl-a, phytoplankton, and oxygen increased, whereas the opposite happened in the case of Zissi and Anton.

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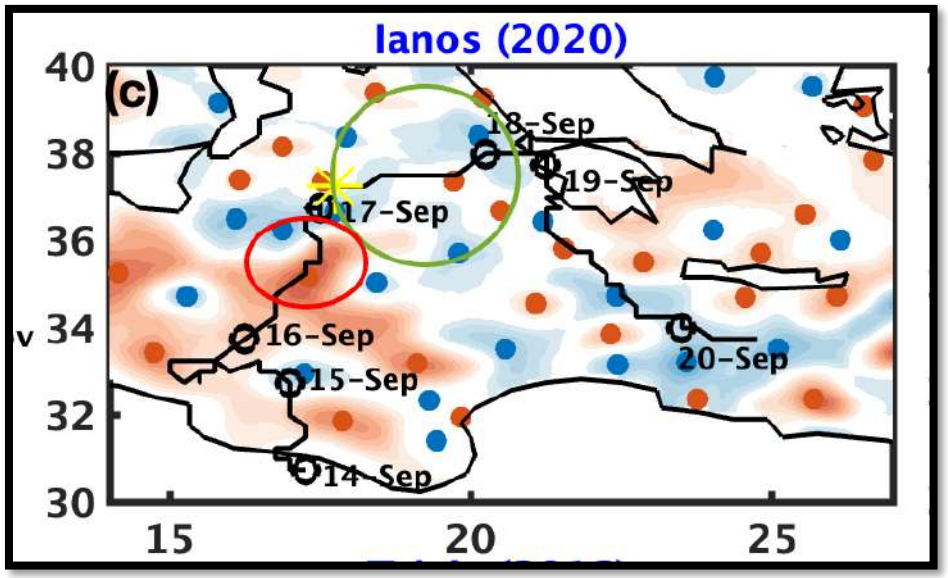
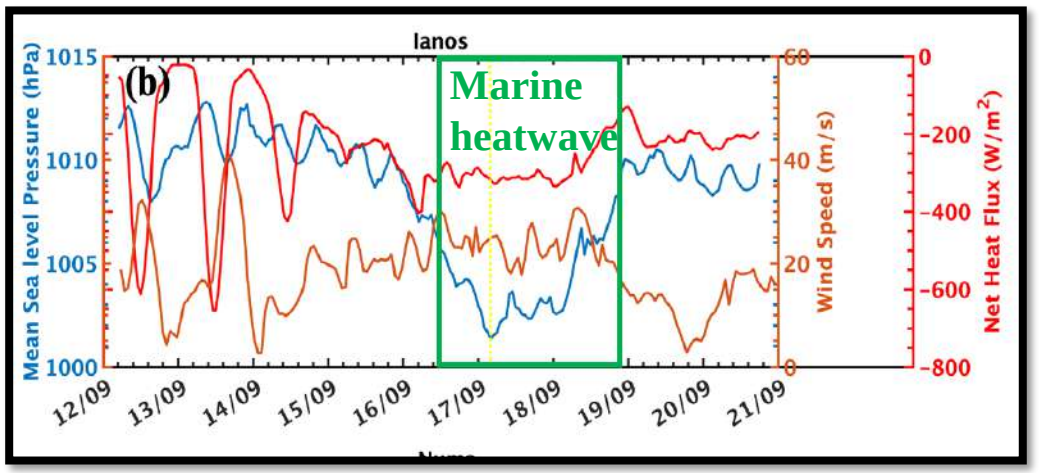
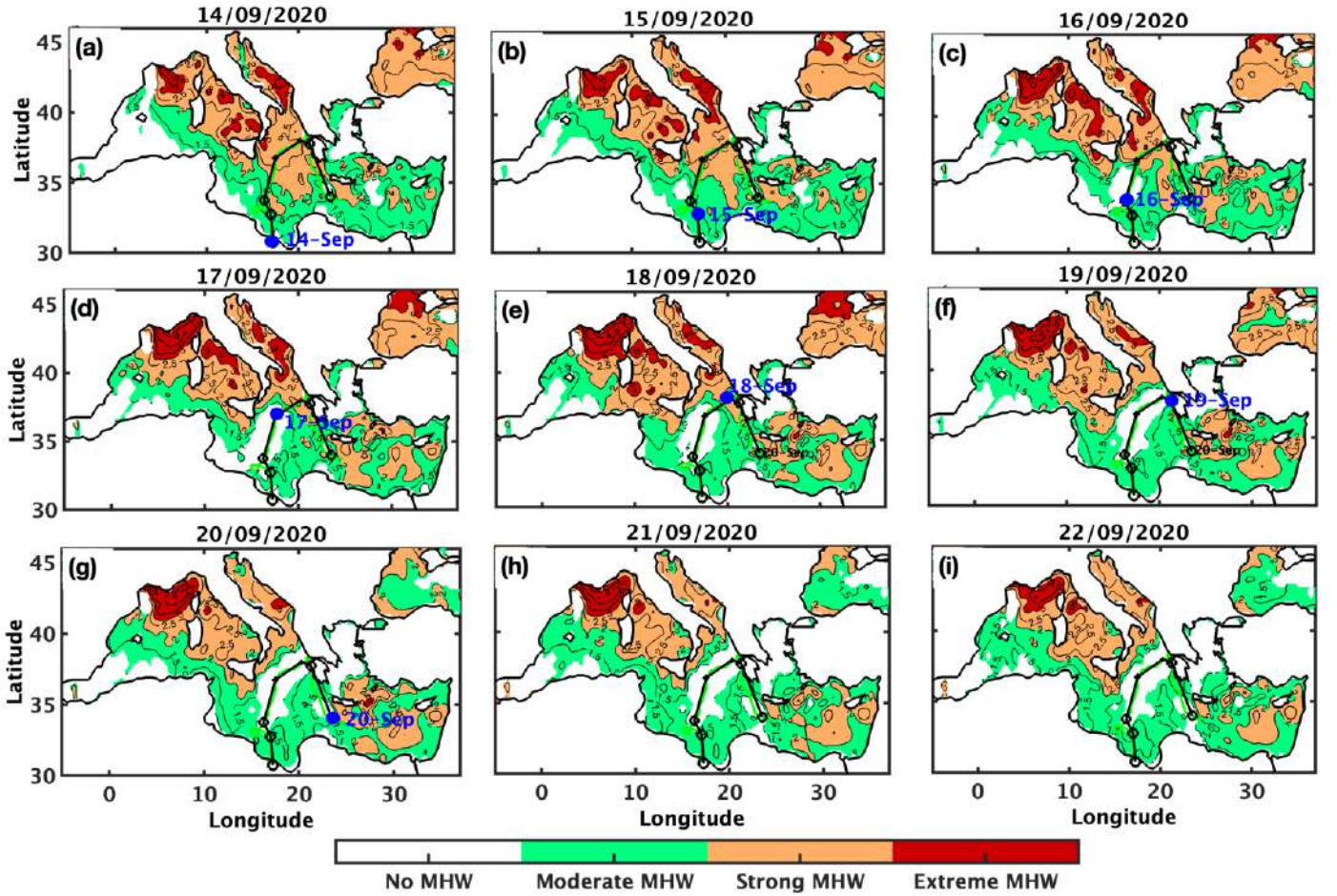
Role of Marine Heatwave in Intensification of Cyclone IANOS







Ianos was the only medicane that reached up to category 2 cyclone (Saffir-Simpson scale)

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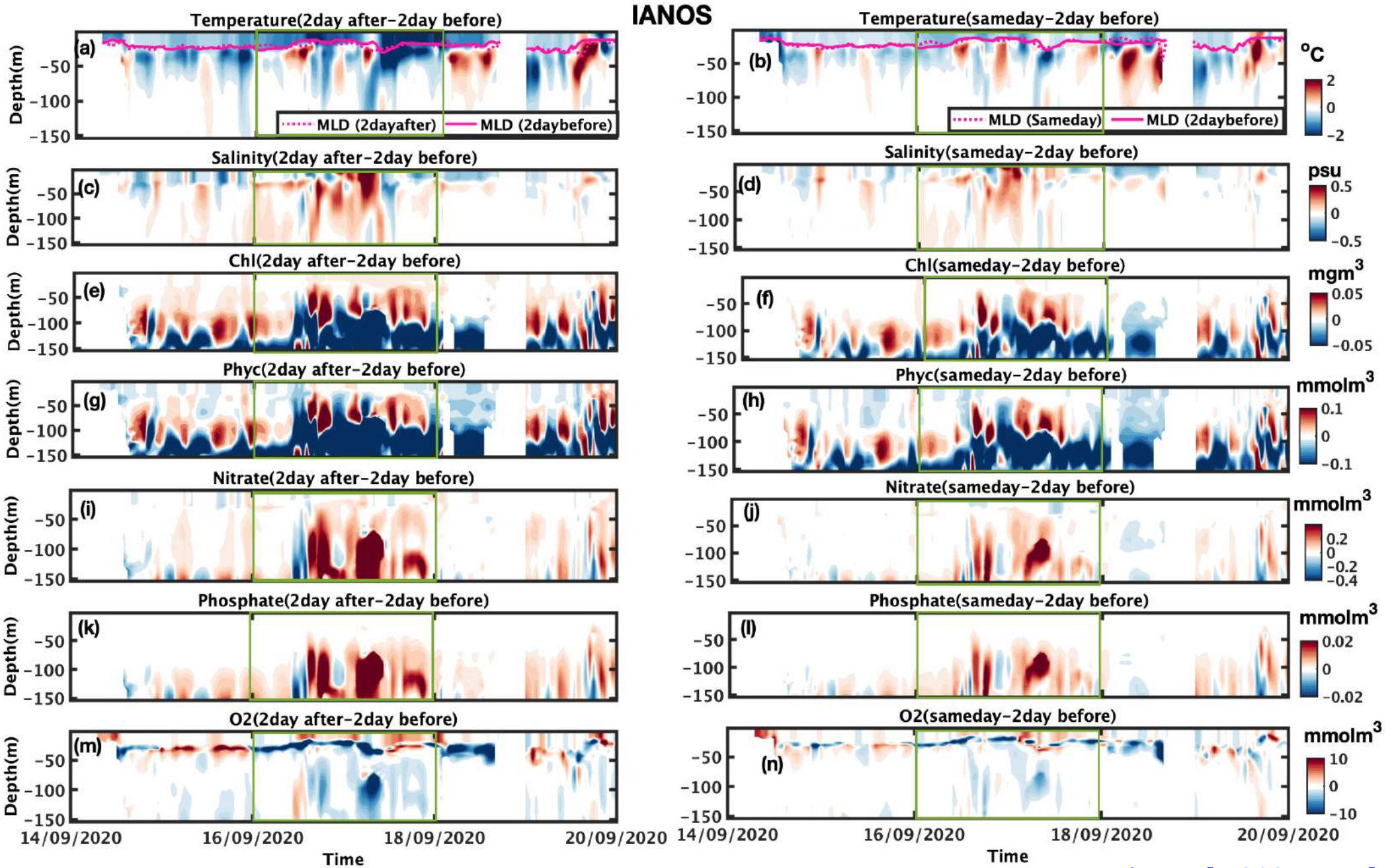
Intensification of cyclones due to the Marine Heat wave



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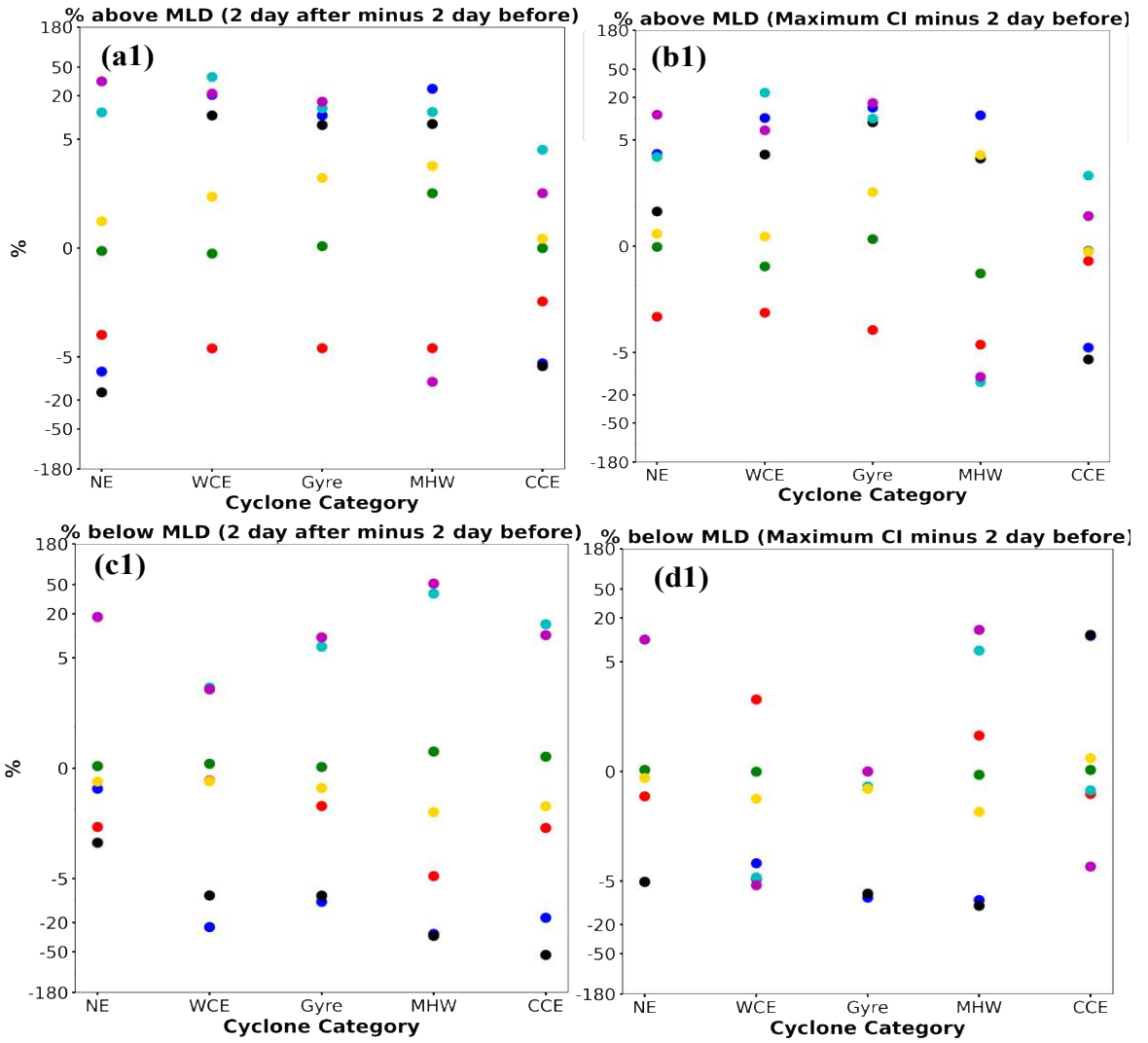
Comprehensive analysis of all the medicanes:



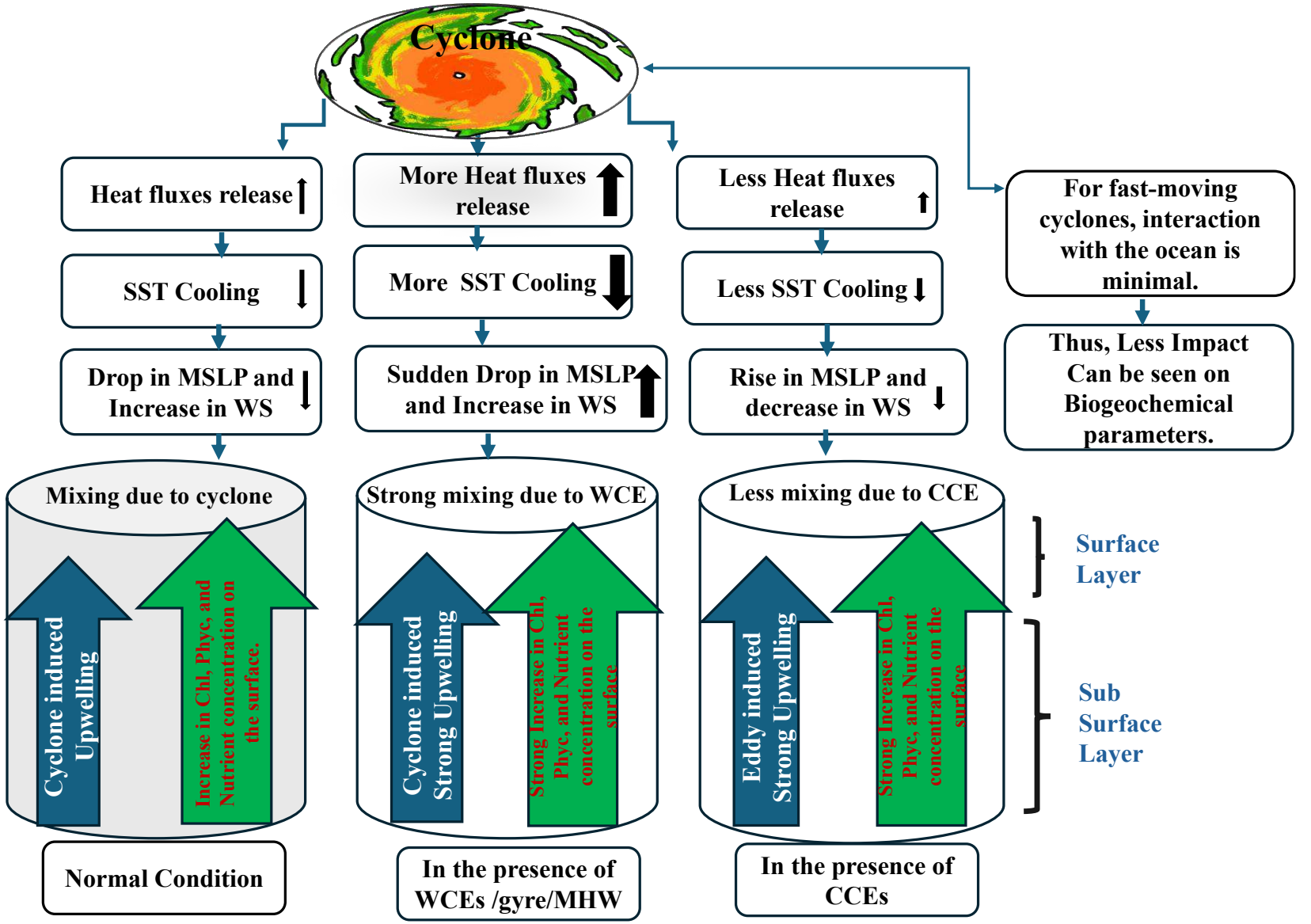
CYCLONE NAME	AV_TS	Max CI to 2 days before	Type	Features @ Max-CI Location	Date of Max-CI	MSLP/GPH at 1000 hpa	Season
BLAS	3.617	6.618	Slow	No Eddy @ Max-CI	10/11/2021	48.95 (gph)	Autumn
APOLLO	3.538	0.092	Slow	Cyclonic gyre @Max-CI	31/10/2021	33.25 (gph)	Autumn
IANOS	3.308	4.83	Slow	No Eddy (MHW) @ Max-CI	17/09/2020	1000.44(mslp)	Summer`
ANDIRA	**4.893**	**11.01**	**Slow**	WCE @ Max-CI	13/12/2020	996.32(mslp)	Autumn
ZORBAS	3.597	2.99	Slow	WCE@ Max-CI	28/09/2018	996.52(mslp)	Autumn
NUMA	4.480	9.517	Slow	WCE@ Max-CI	17/11/2017	1004.38(mslp)	Autumn
TRIXIE	**5.365**	**13.77**	**Slow**	WCE @ Max-CI	01/11/2016	1002.94(mslp)	Autumn
ZISSI	**7.730**	**20.13**	**Fast/ Mod**	Mostly CCE/or no eddy @ Max-CI	29/02/2016	990.42(mslp)	Winter
MESSALA	4.425	5.66	Slow	WCE @ Max-CI	01/10/2015	1007.16(mslp)	Autumn
ANTON	**3.489**	**14.645**	**Fast/ Mod**	CCE @ Max-CI	05/03/2015	998.43(mslp)	Winter
XANDRA	4.353	**12.01**	Slow	No Eddy @ Max-CI	30/11/2014	990.21(mslp)	Autumn
QUENDRESA	4.454	9.93	Slow	No Eddy @ Max-CI	07/11/2014	992.36(mslp)	Autumn
ROLF	3.360	10.126	Slow	WCE @ Max-CI	06/11/2011	996.45(mslp)	Autumn
JANET	3.934	7.009	Slow	WCE @ Max-CI	15/10/2007	1007.49(mslp)	Autumn

•TS<14kmph- slow-moving, TS~15 to 25 kmph- moderate moving, TS>25 kmph- Fastmoving
•Autumn (Sep 23 to Dec 22) and Winter (Dec 23 to Mar 22)

Zissi exhibited an exceptionally high translational speed. The fast evolution of Zissi resulted in limited interaction with the underlying ocean, which is responsible for its unique characteristics during the event.

Conclusions

14 cyclones analyzed from 2007-2021



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Thank you for your Attention

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