Suppression of Marine Heatwave Activity by Tropical Cyclone-induced Upper Ocean Cooling

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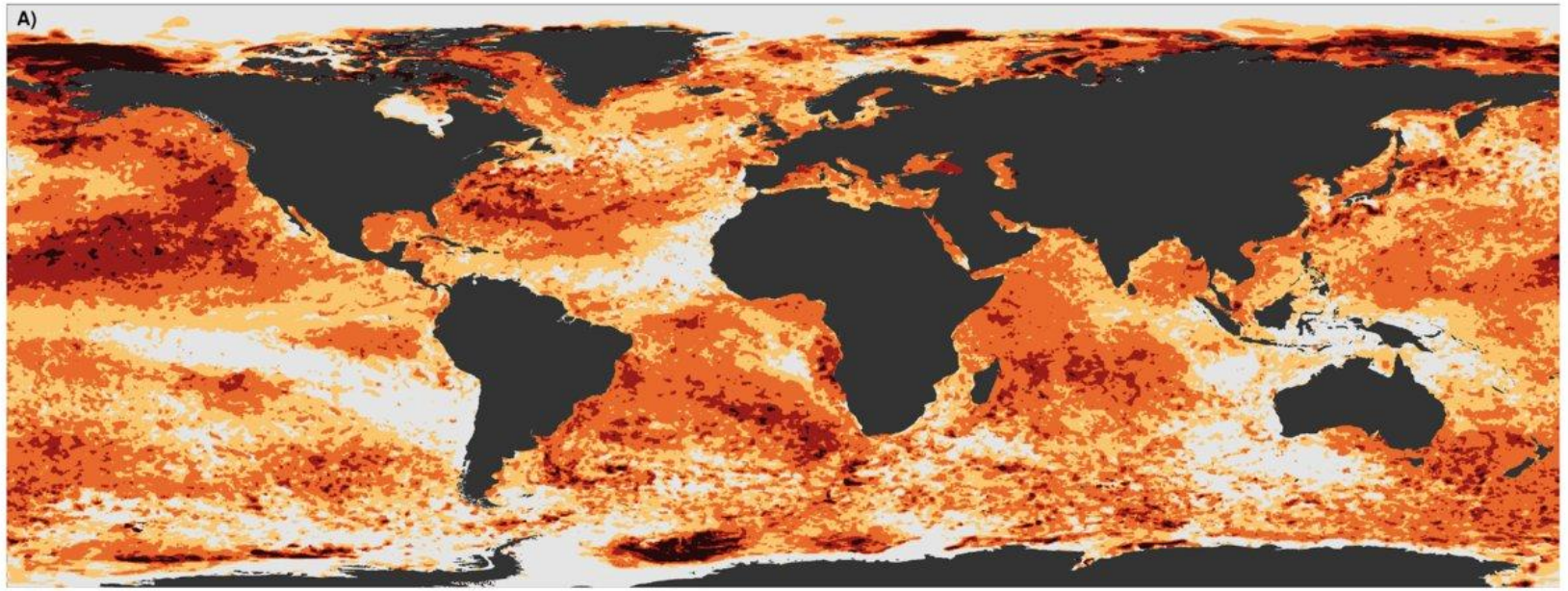
National Taiwan University

Pun et al. Sci. Adv. (2025)

SynObs & Ocean Observing Co-design Workshop 2026

August 24-29, 2026, Mutsu, Japan

Marine Heatwave Map



Category I Moderate II Strong III Severe IV Extreme

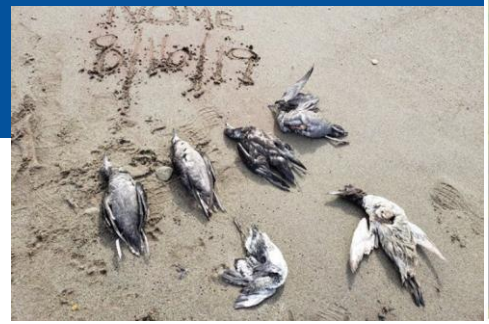
WORLD METEOROLOGICAL ORGANIZATION

The definition of MHW can refer to Hobday et al. (2016, 2018)

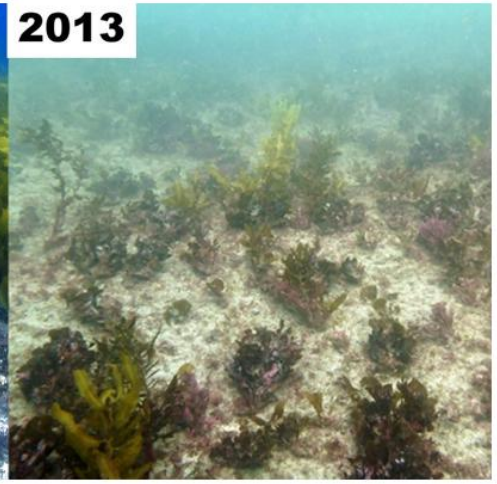
Become an important climatic issue

Strong impact on ecosystems

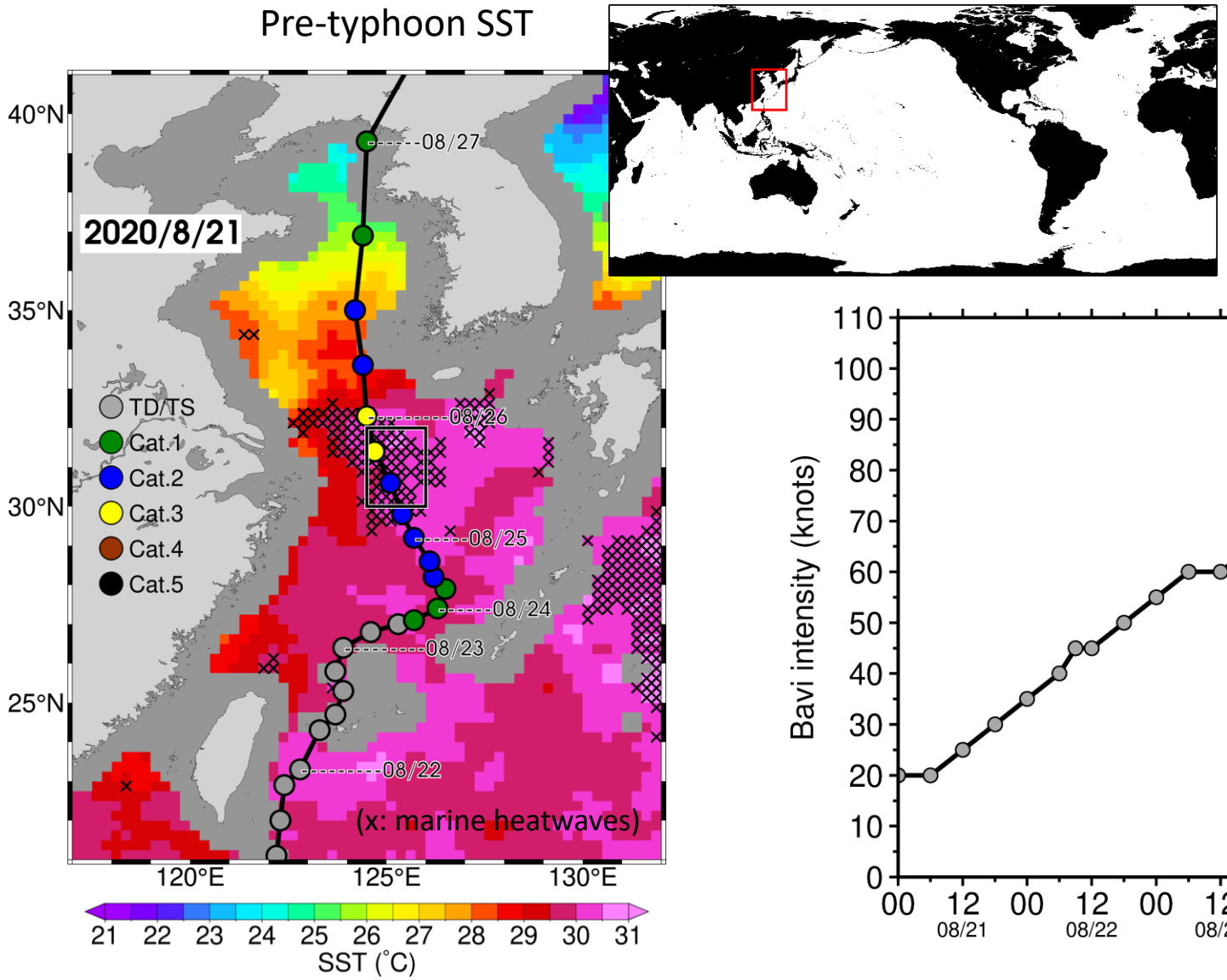




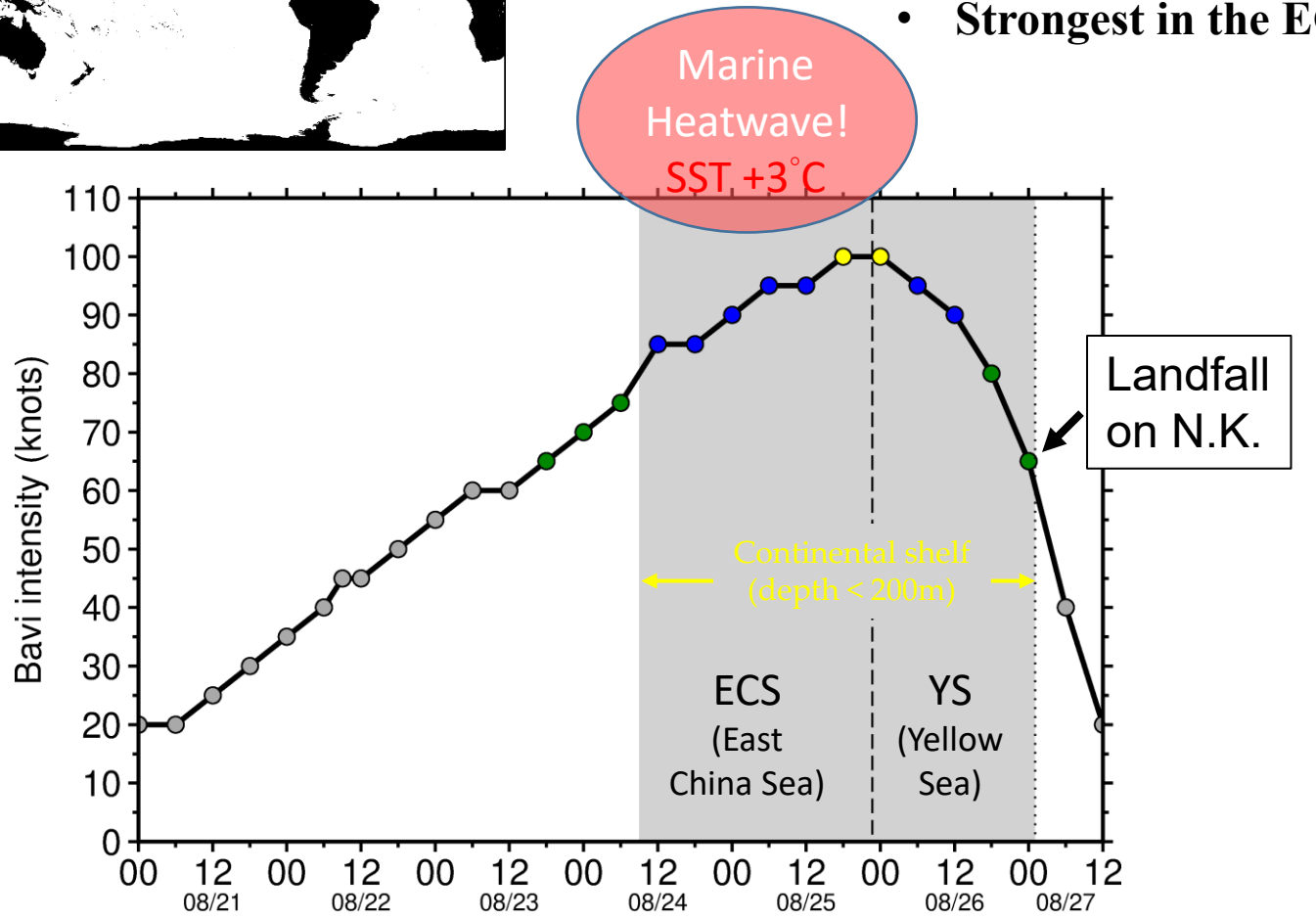




MHW intensifies Typhoon Bavi (2020) in the East China Sea



- **Intensity increased by 25kt (75 → 100 kt) over the ECS**
- **Strongest in the ECS**

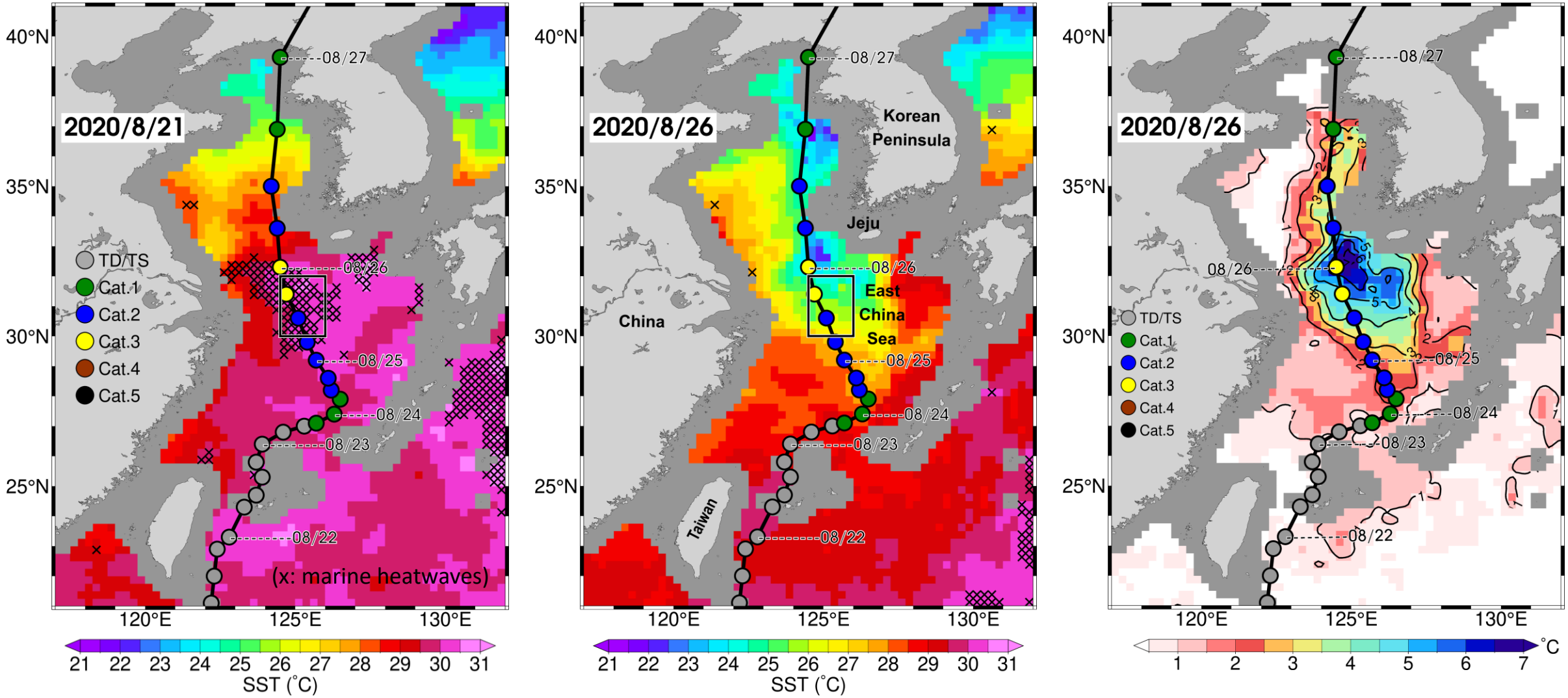


(Pun et al. 2023, npj Clim. & Atm. Sci.)

Pre-typhoon SST

After-typhoon SST

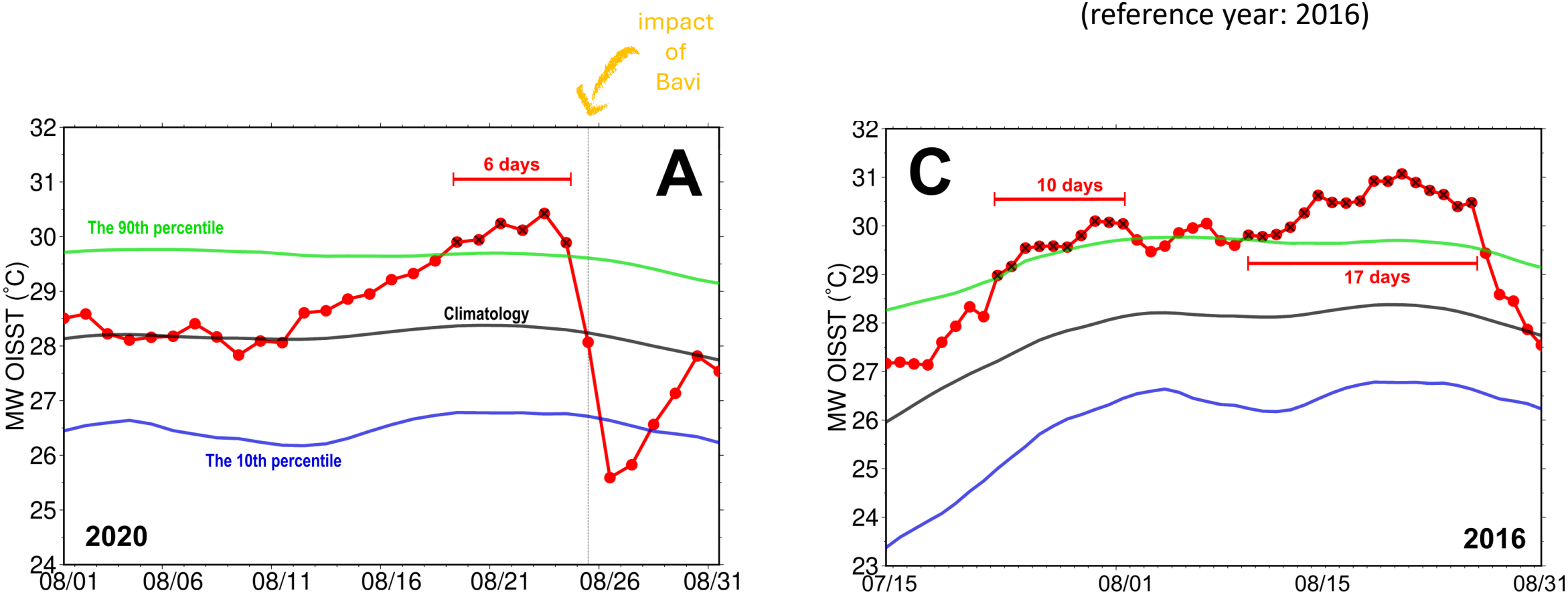
SST cooling



Bavi immediately terminated a mature MHW by inducing strong SST cooling (>7℃)

MHW interfered by Bavi

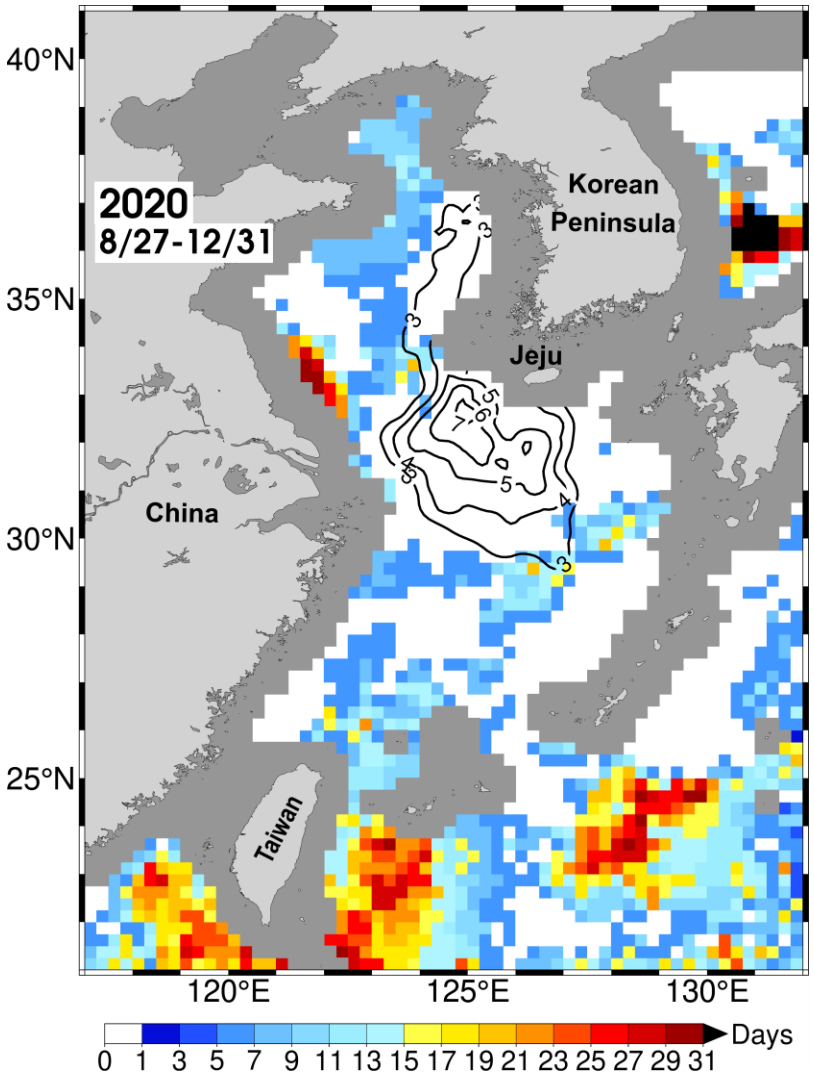
No typhoon interference
(reference year: 2016)



(x: marine heatwaves)

The duration of MHW was reduced by 65%

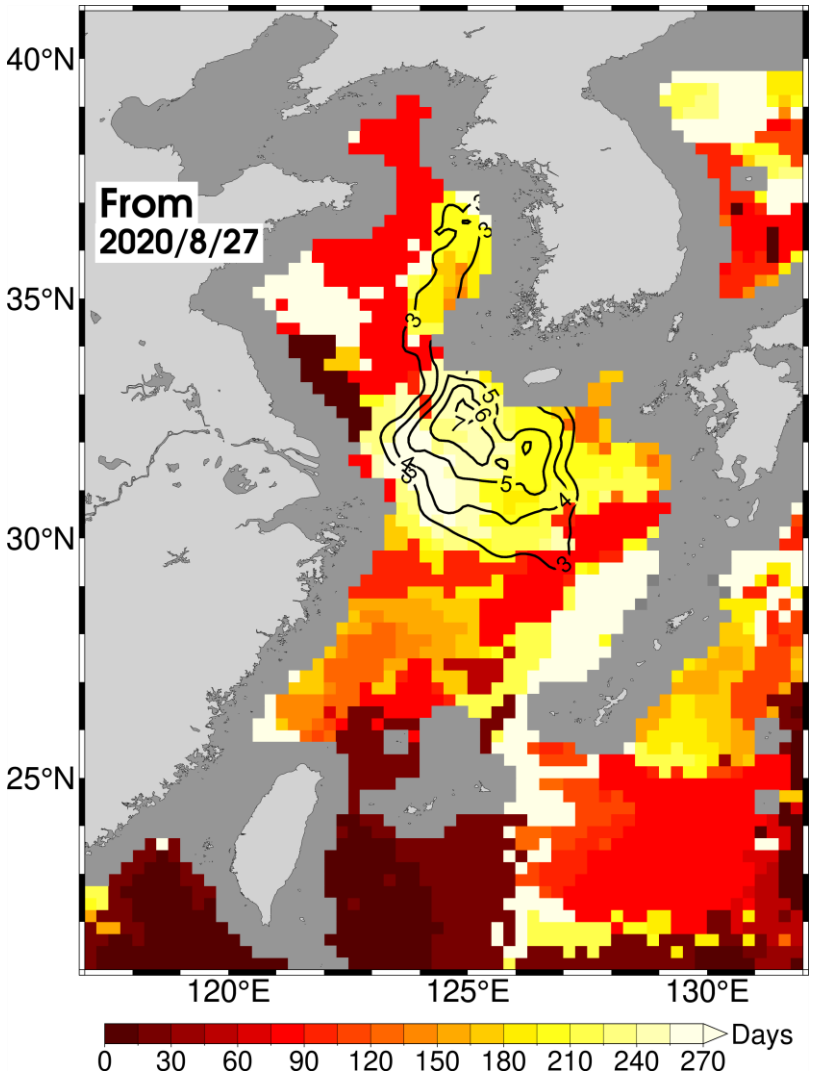
Pun et al. (2025)



MHW day count
(until the end of the year following Bavi)

Inside the cold wake: **0 day**

Outside the cold wake: 10 ~ 30 days

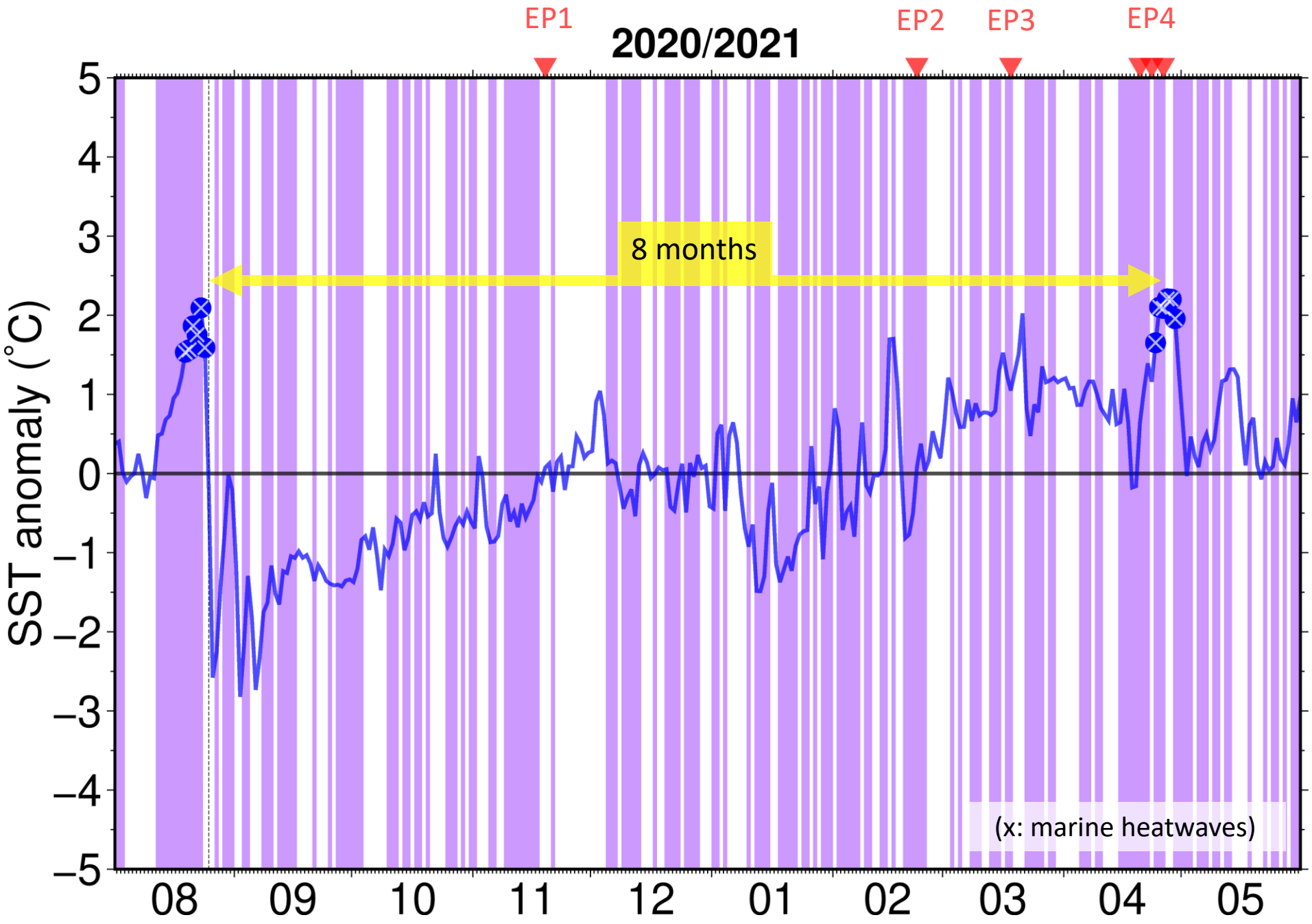


Next MHW event in the cold wake region:

240 days (~8 months!)

It took much longer time than the outside

Pun et al. (2025)



During this 8 months, the ECS experienced 3 episodes,

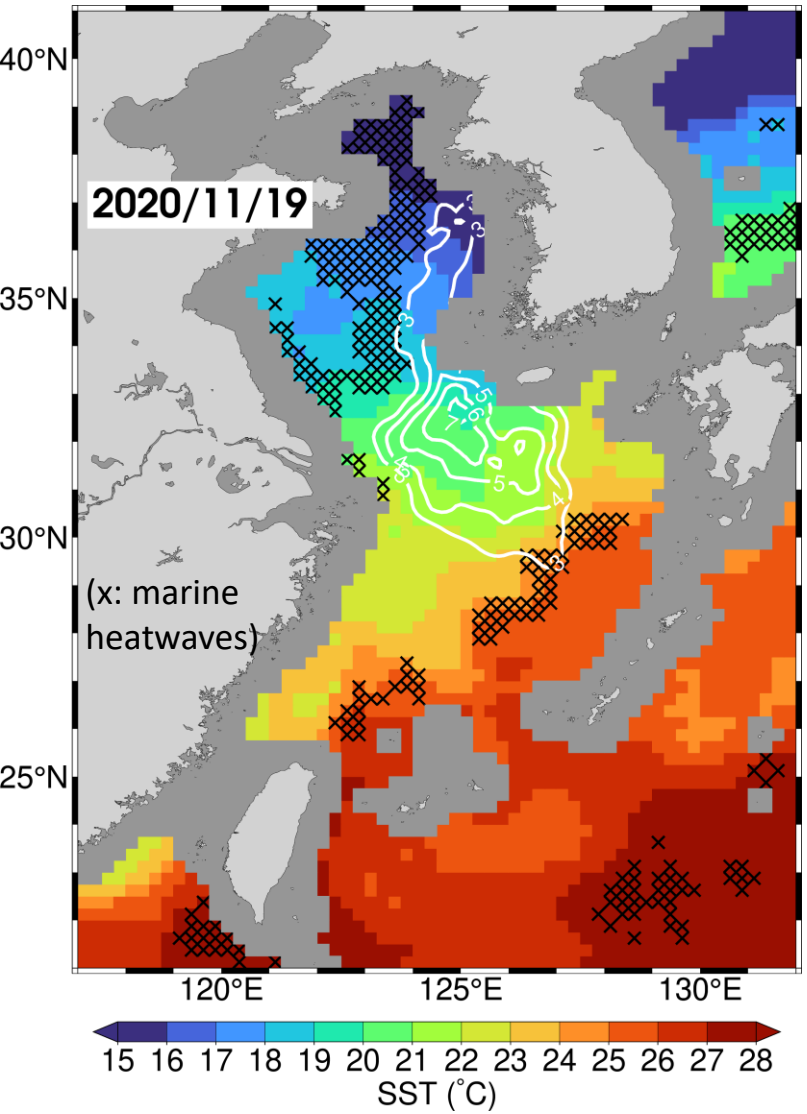
But the cooling area was still MHW-free

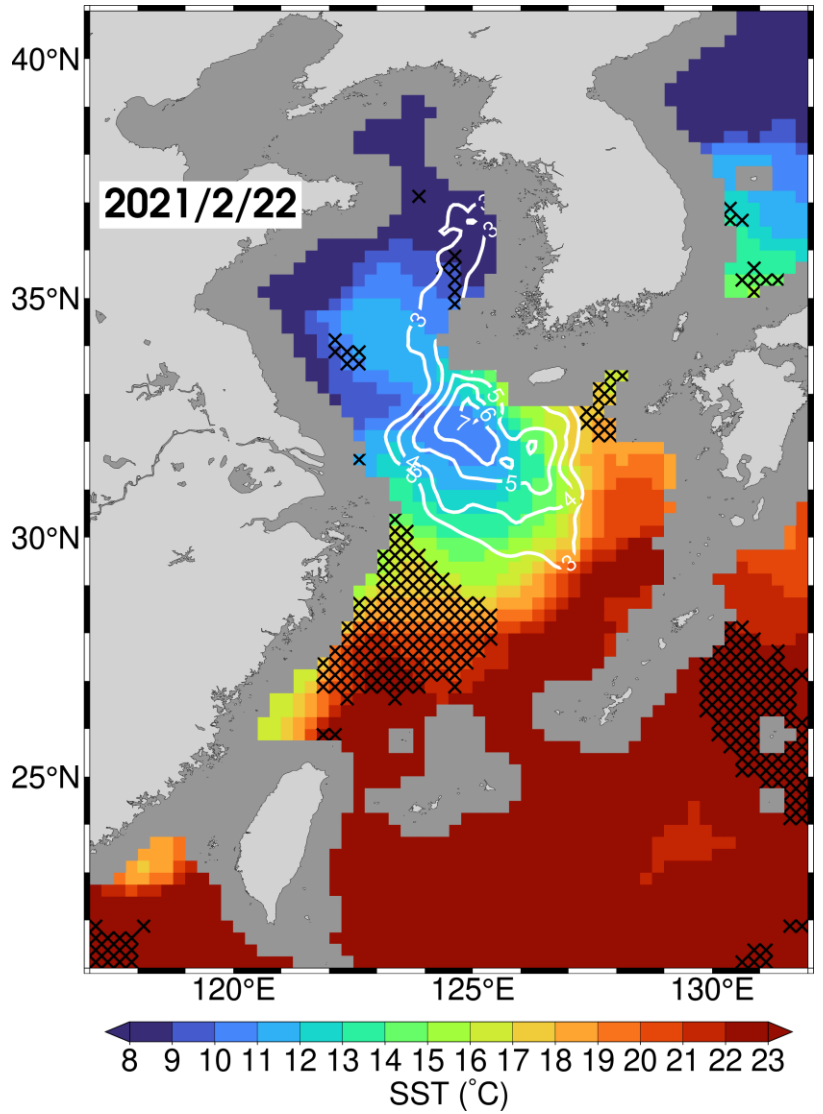
favorable atm. conditions

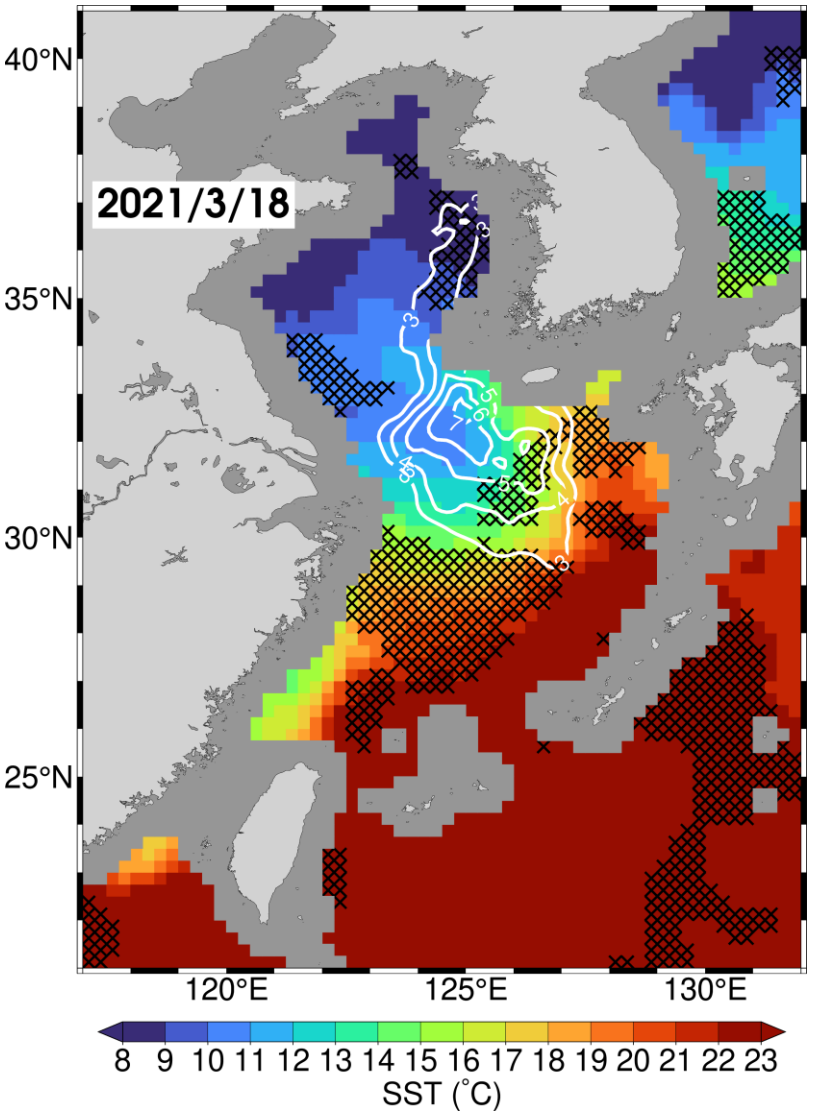
MHW episode 1

MHW episode 2

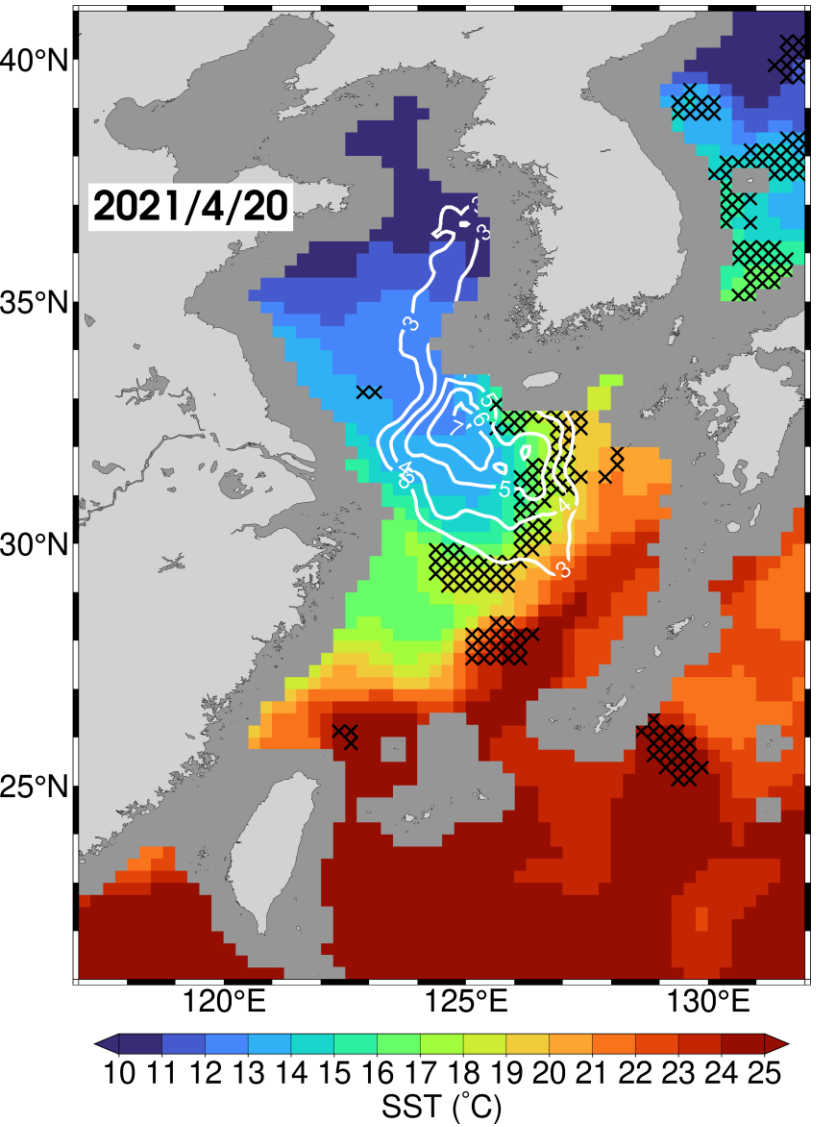
MHW episode 3

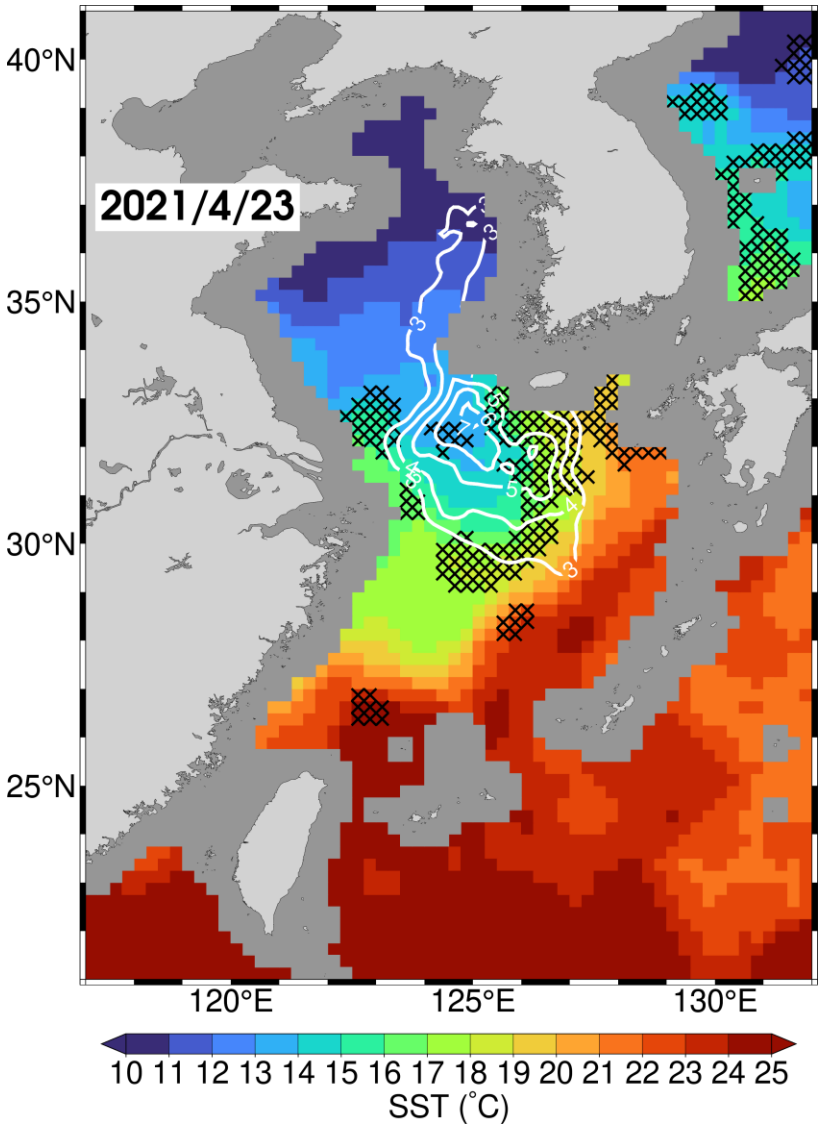


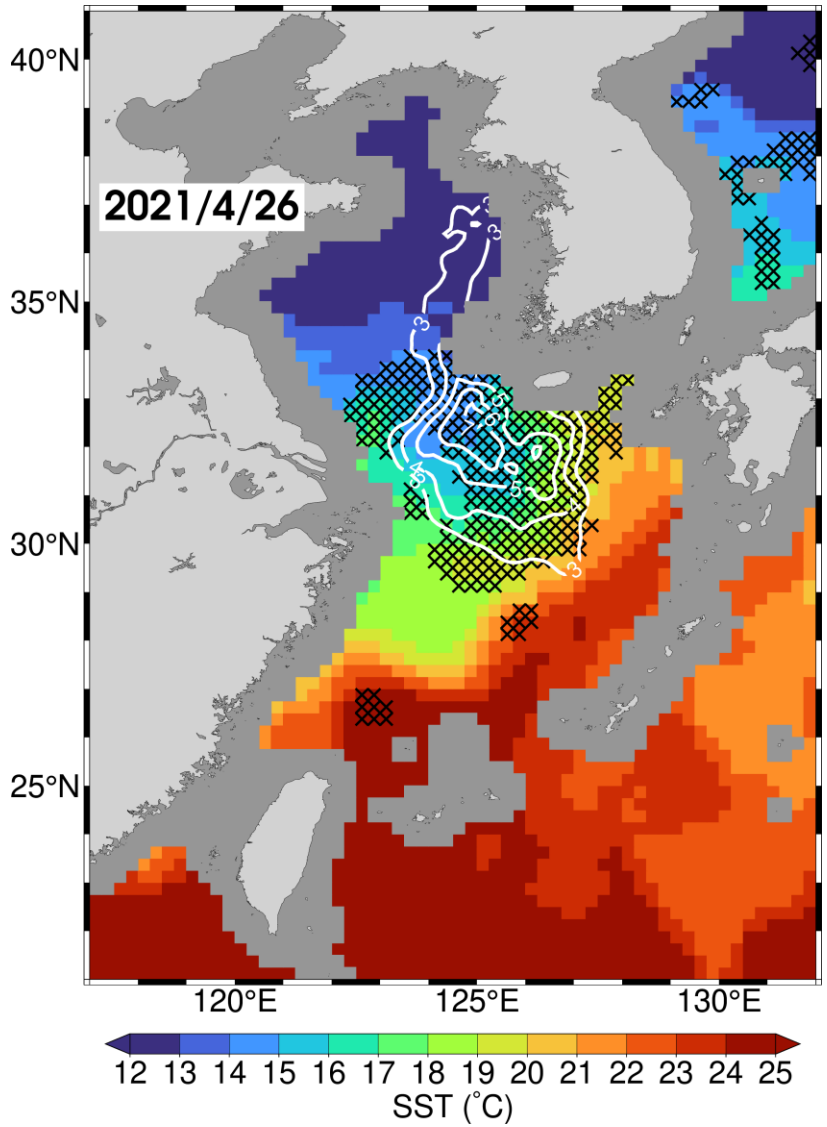


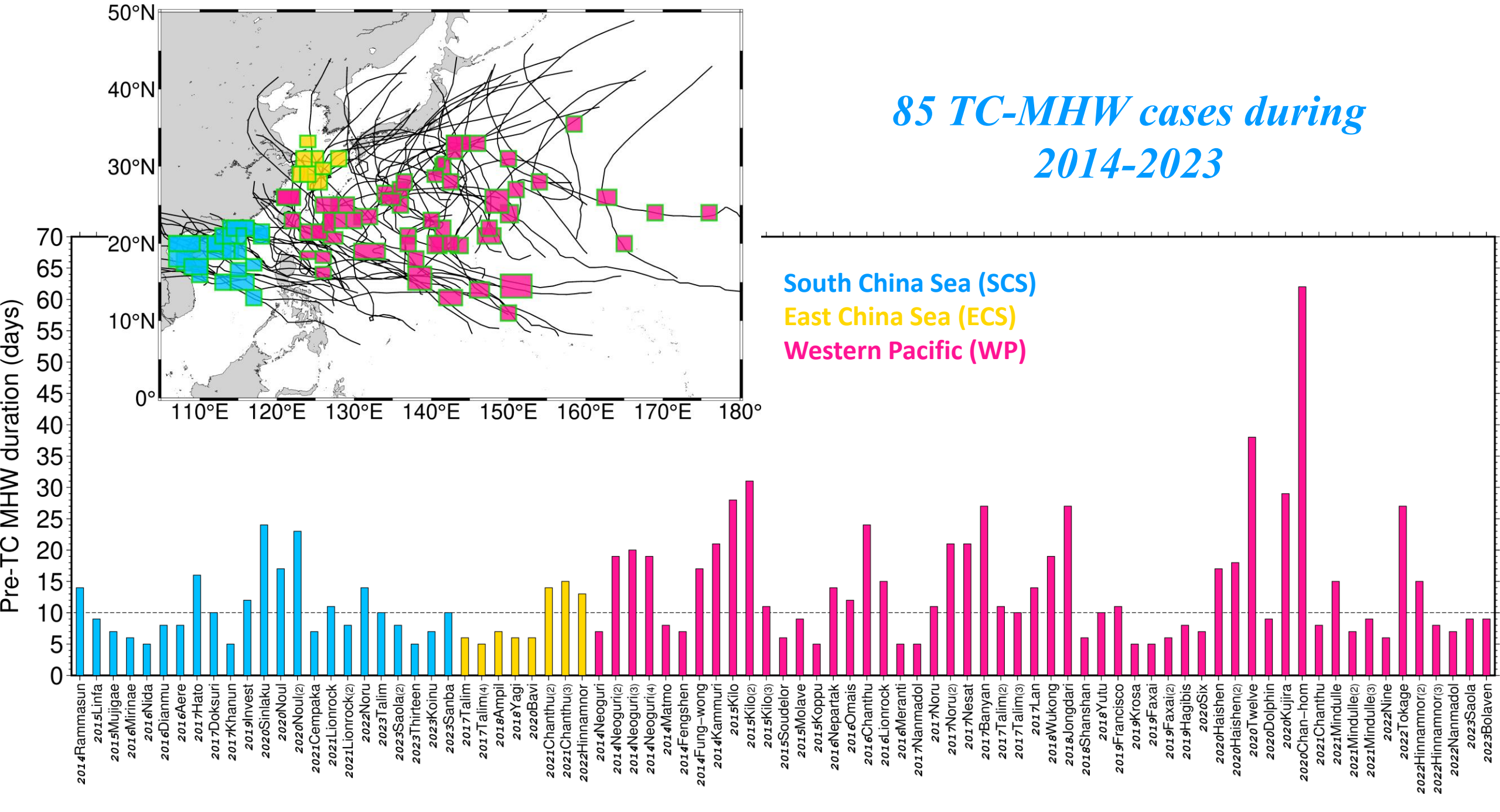


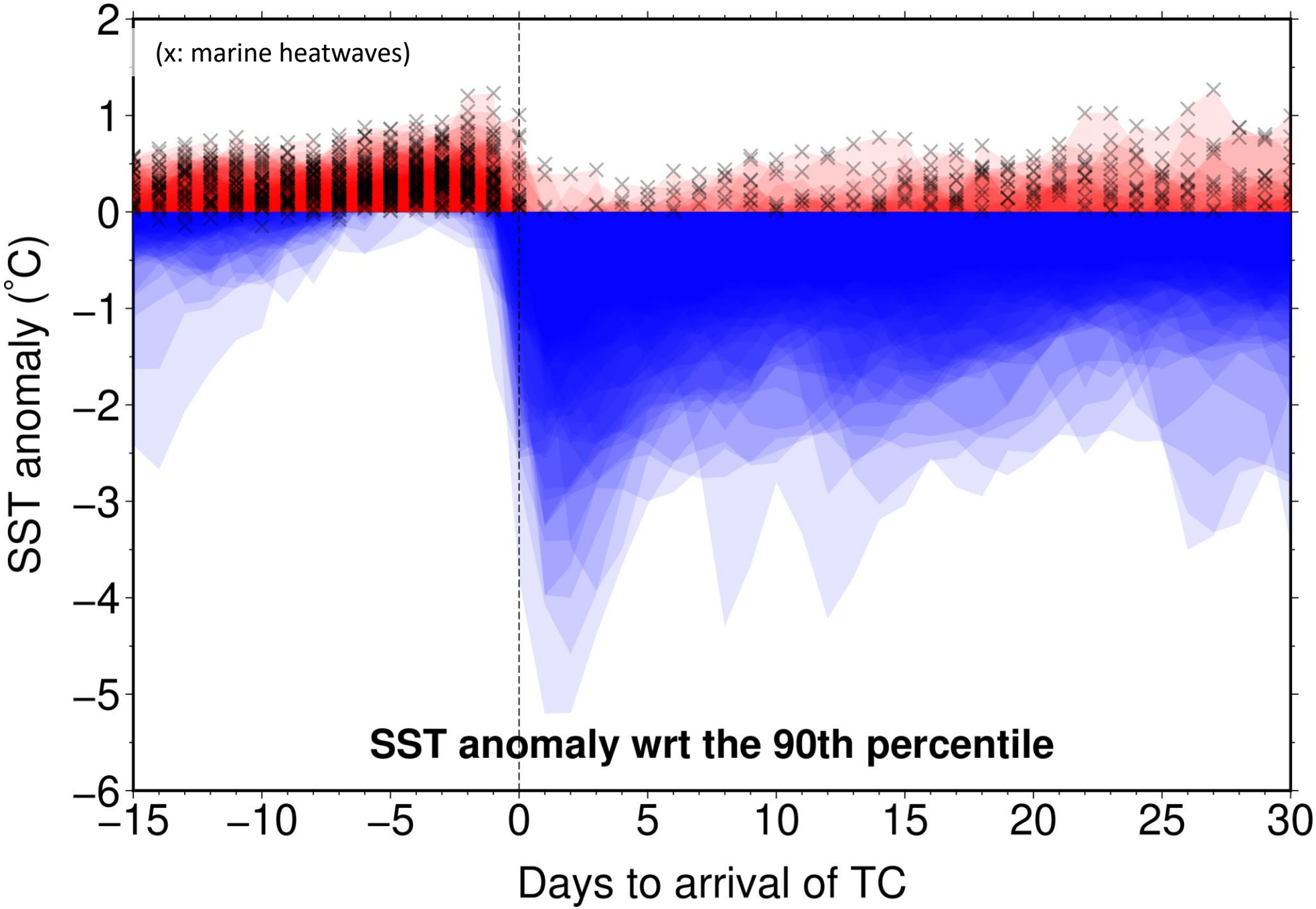
MHW finally developed in the cold wake area!








85 TC-MHW cases during 2014-2023
South China Sea (SCS)
East China Sea (ECS)
Western Pacific (WP)
Pre-TC MHW duration (days)
50°N
40°N
30°N
20°N
10°N
0°
110°E
120°E
130°E
140°E
150°E
160°E
170°E
180°
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2014Rammasun
2015Linfa
2015Mujigae
2016Mirinae
2016Nida
2016Dianmu
2016Aere
2017Hato
2017Doksuri
2017Khanun
2019Invest
2020Sinlaku
2020Noul
2020Noul(2)
2021Cempaka
2021Lionrock
2021Lionrock(2)
2022Noru
2023Talim
2023Saola(2)
2023Thirteen
2023Koinu
2023Sanba
2017Talim
2017Talim(4)
2018Ampil
2018Yagi
2020Bavi
2021Chanthu(2)
2021Chanthu(3)
2022Hinnamnor
2014Neoguri
2014Neoguri(2)
2014Neoguri(3)
2014Neoguri(4)
2014Matmo
2014Fengshen
2014Fung-wong
2014Kammuri
2015Kilo
2015Kilo(2)
2015Kilo(3)
2015Soudelor
2015Molave
2015Koppu
2016Nepartak
2016Omais
2016Chanthu
2016Lionrock
2016Meranti
2017Nanmadol
2017Noru
2017Noru(2)
2017Nesat
2017Banyan
2017Talim(2)
2017Talim(3)
2017Lan
2018Wukong
2018Jongdari
2018Shanshan
2018Yutu
2019Francisco
2019Krosa
2019Faxai
2019Faxai(2)
2019Hagibis
2020Six
2020Haishen
2020Haishen(2)
2020Twelve
2020Dolphin
2020Kujira
2020Chan-hom
2021Chanthu
2021Mindulle
2021Mindulle(2)
2021Mindulle(3)
2022Nine
2022Tokage
2022Hinnamnor(2)
2022Hinnamnor(3)
2022Nanmadol
2023Saola
2023Bolaven



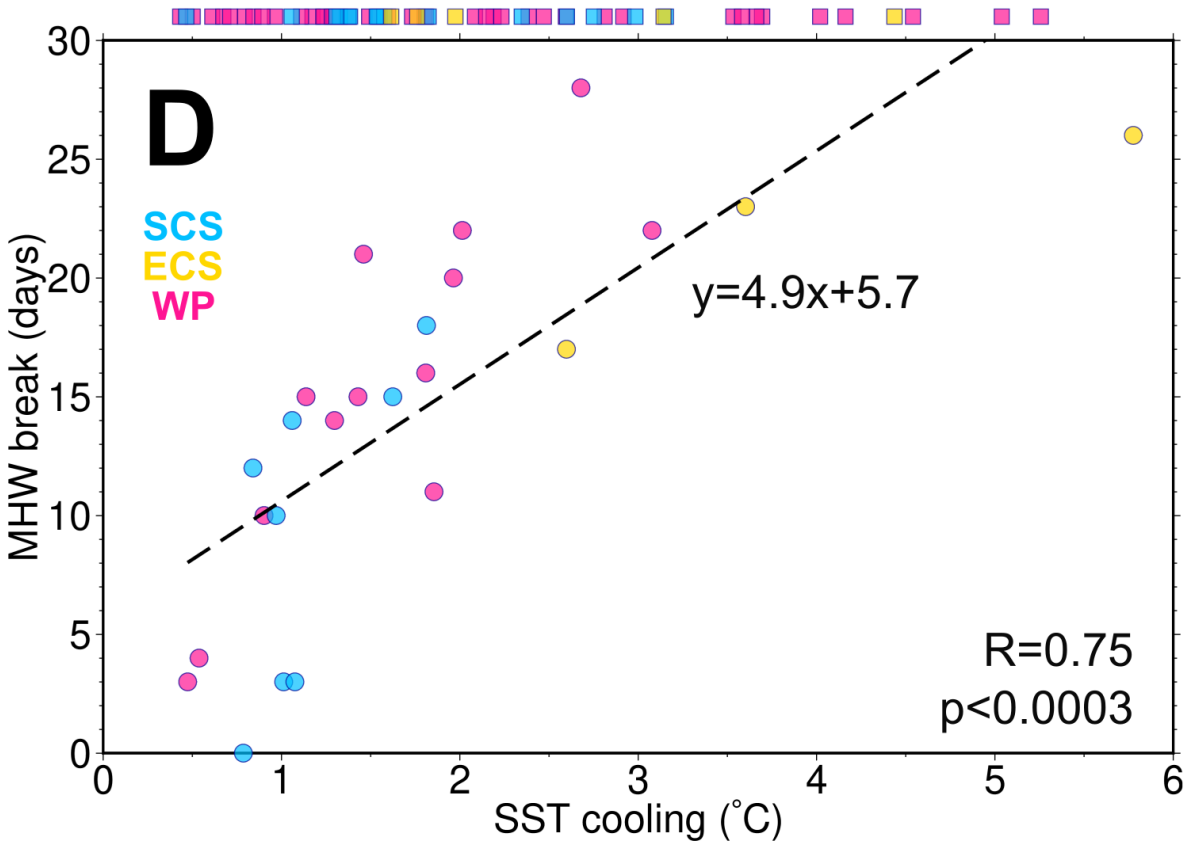
Dissipation cases:
84

Total cases:
85

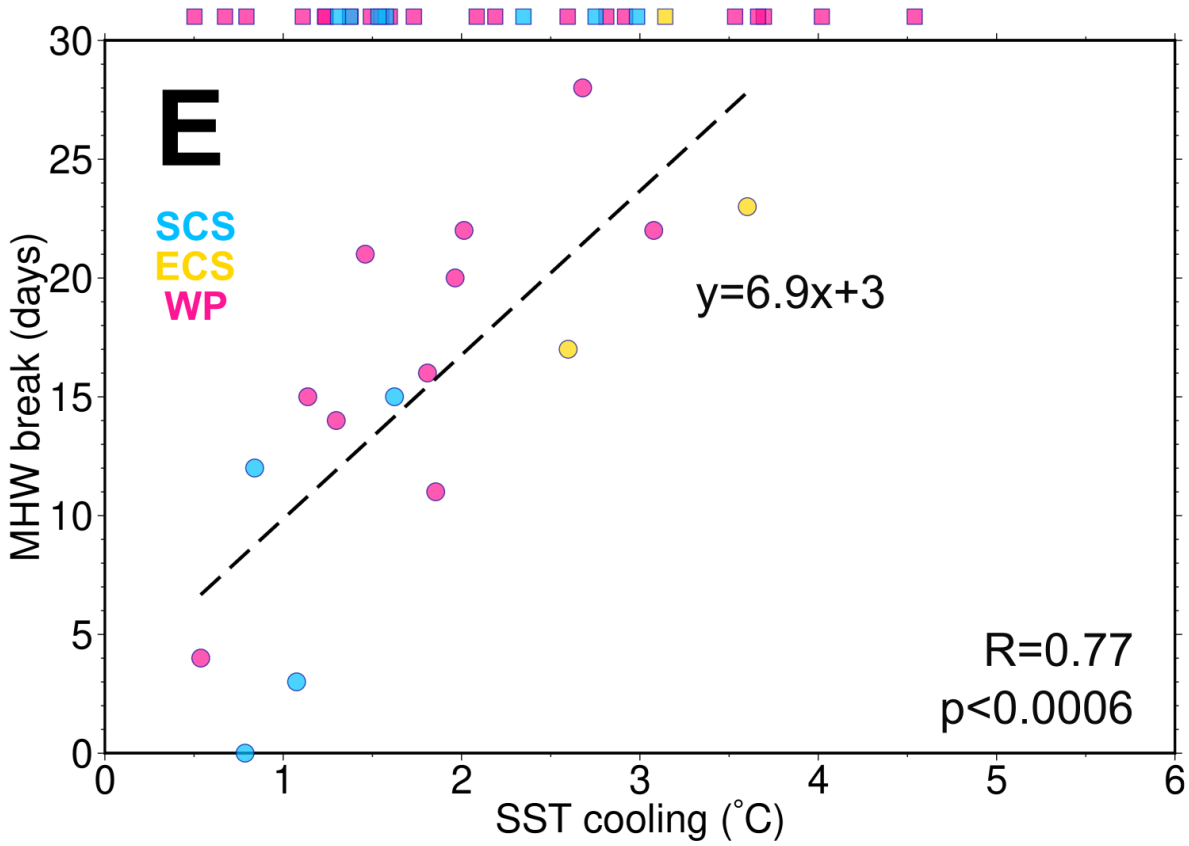
Dissipation percentage:
~99%

Fast recovery cases: MHW reoccurring within 30 days after TCs

Short pre-existing MHW cases



Long pre-existing MHW cases

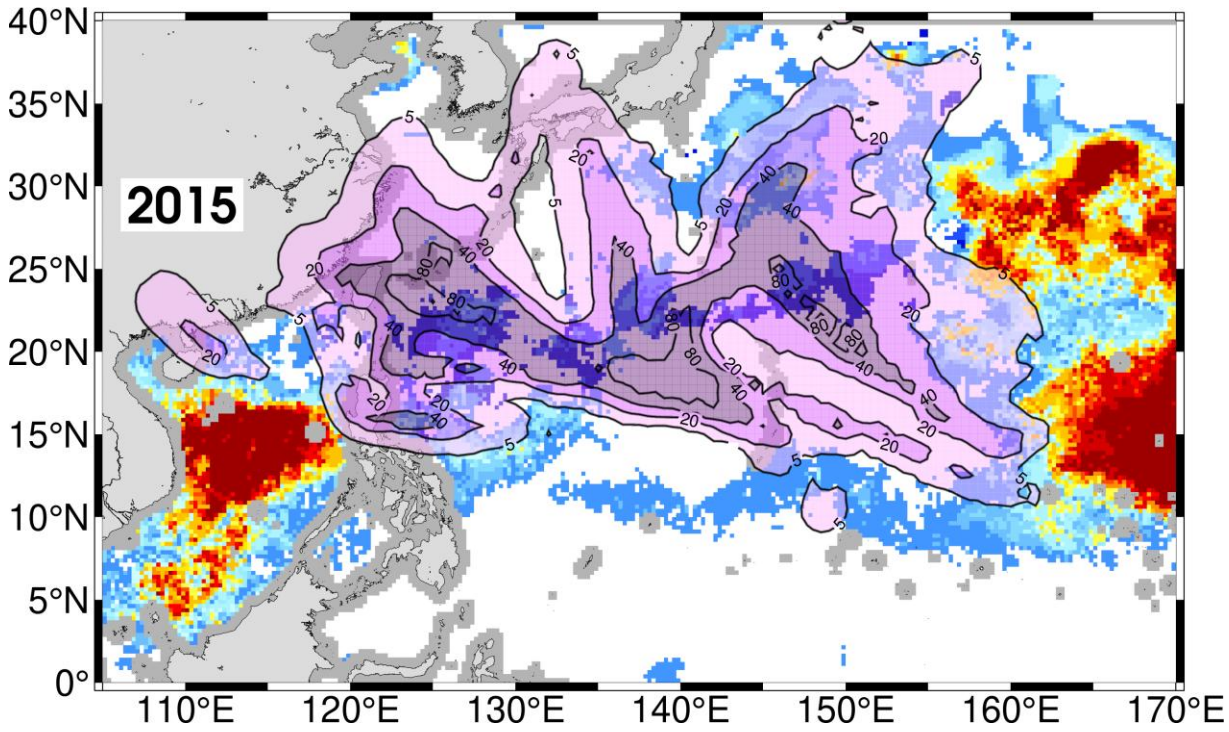


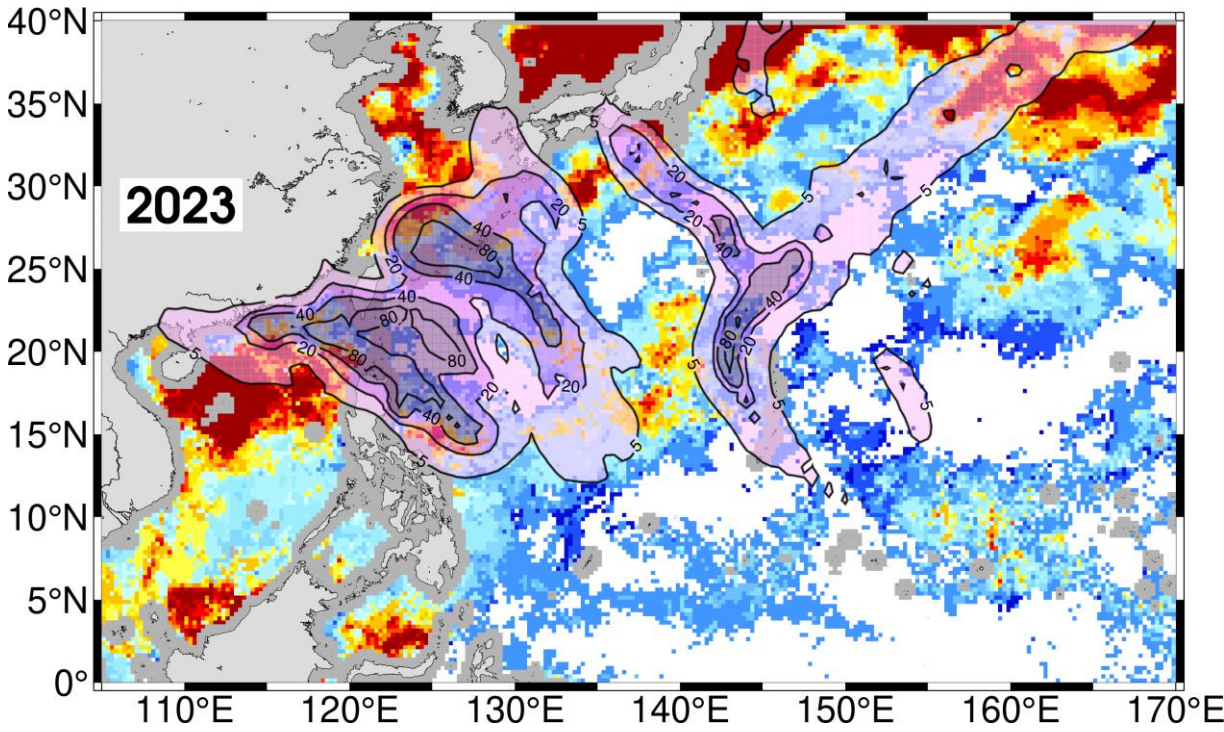
1℃ of SST cooling → MHW reformation delay: 5-7 days

Power Dissipation Index (Emanuel. 2005):

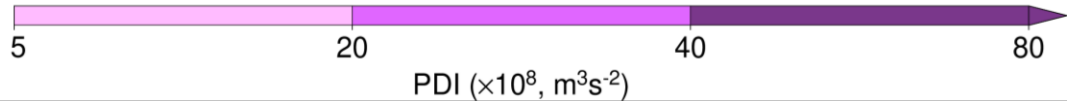
$$\mathrm{PDI} \equiv \int_{t_0}^{t_1} V^3 dt$$

TC activity (PDI) vs. MHW activity (day count)

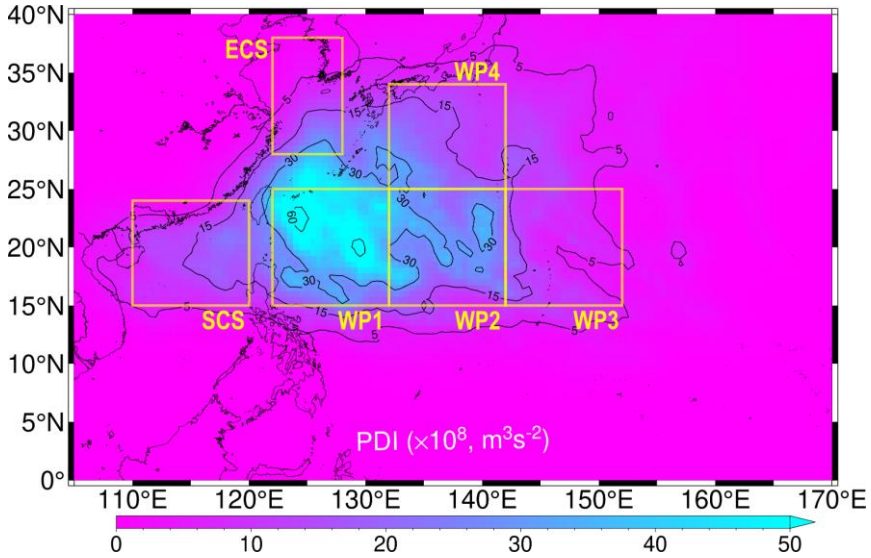




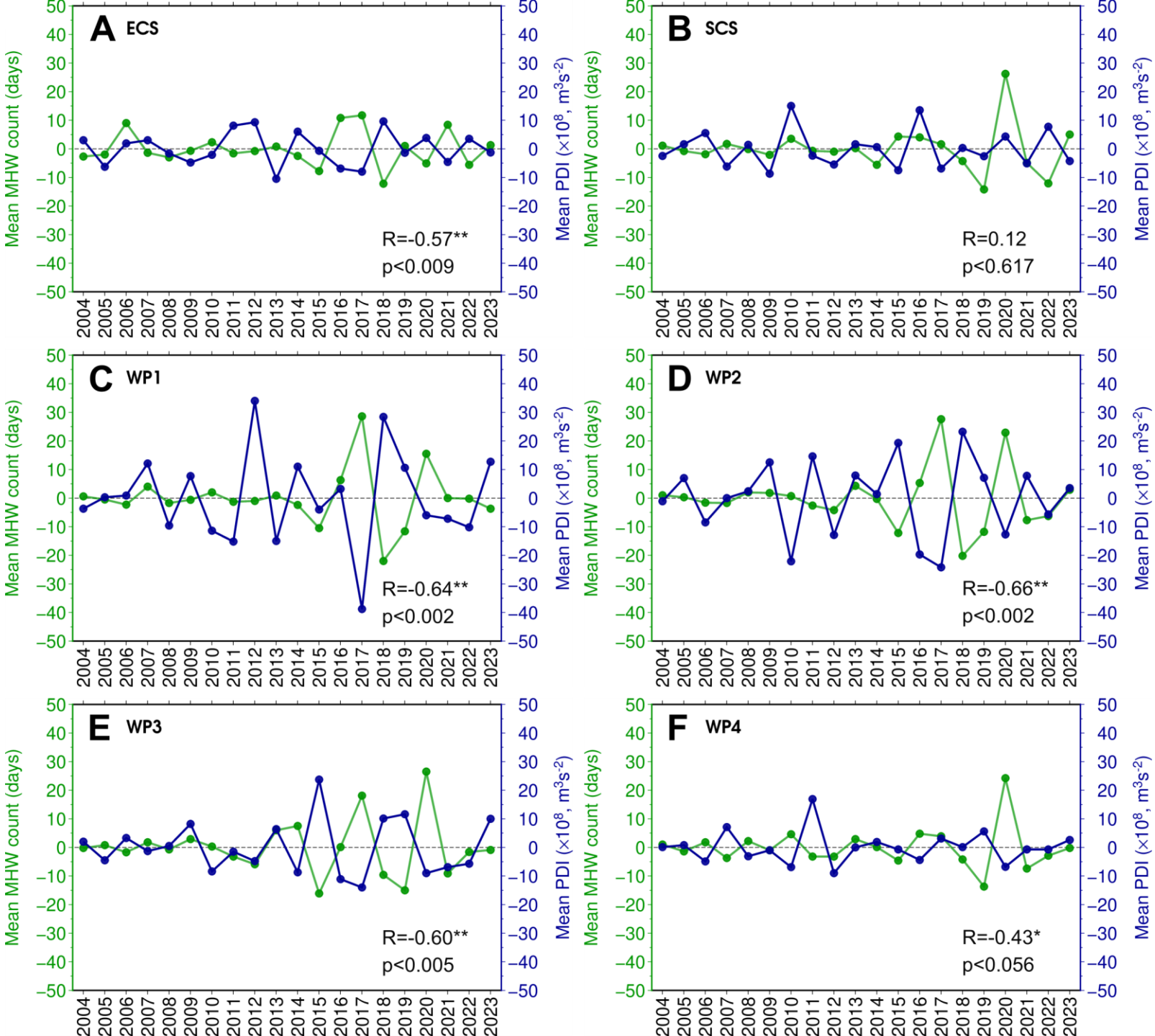




20-year correlation analysis (2004-2023)



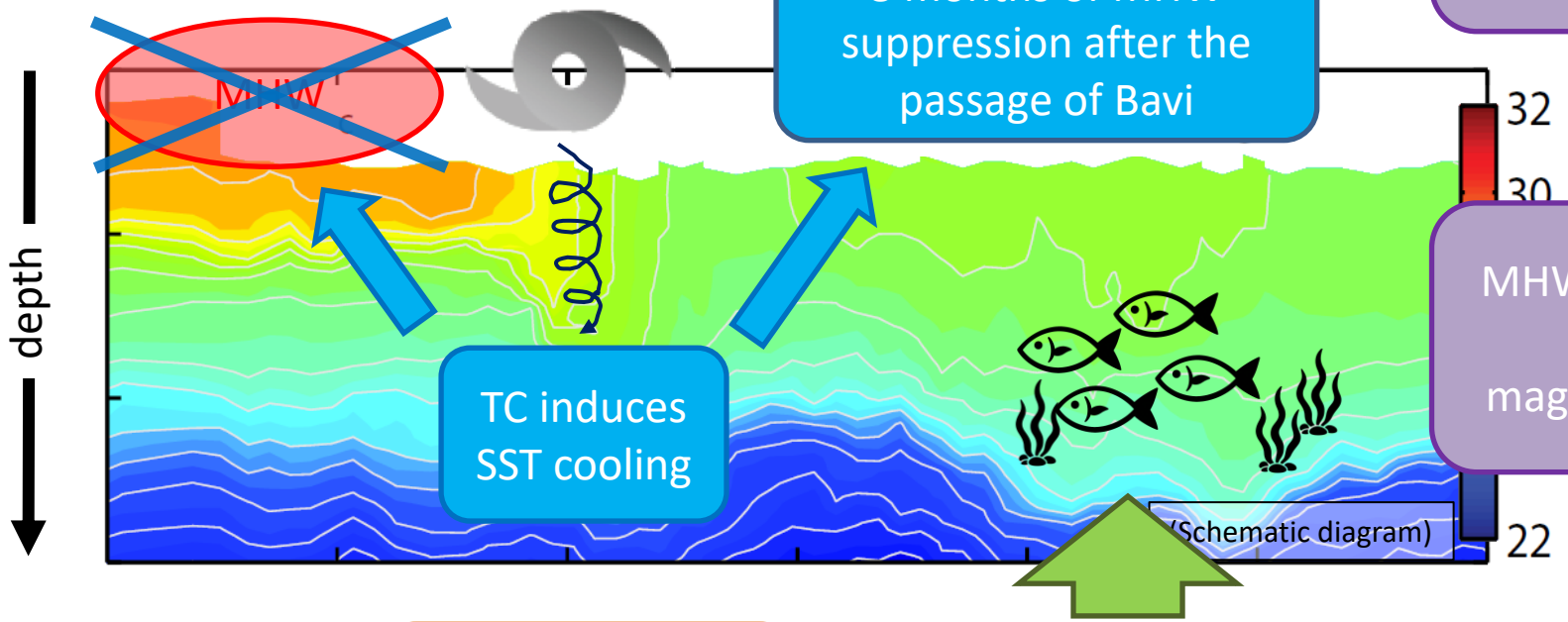
Strong inverse relationship between MHWs and TC activity! ($p < 0.01$)



Conclusion

in 85 TC-MHW cases (2014-2023), 99% were terminated following TC passage

8 months of MHW suppression after the passage of Bavi



MHW disruption duration
∝
magnitude of SST cooling

~5-7 days/°C (under favorable atmospheric conditions)

potential lifeline for marine ecosystems

TCs can act as natural regulators for MHWs

a 2004-2023 analysis:
MHW development
∝
$(\text{TC activity})^{-1}$

Pun et al. (2025)

Thank you for your attention!