

MESI and MUNSTER can be used in concert as a first look indicator of a mesoscale eddy's potential impact on nutrient cycling and upper ocean processes

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Multiparameter Mesoscale Eddy Tracking Products for Operational Use

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INTRODUCTION

- Mesoscale eddies play a major role in the global ocean circulation and have a significant impact on biophysical and biogeochemical processes.
- Here we present updates on the Multiparameter NRT System for Tracking Eddies Retroactively (**MUNSTER**) and the Multiparameter Eddy Significance Index (**MESI**), products in development in NOAA's Lab for Satellite Altimetry with NOAA CoastWatch

DATA SOURCES

- Sea level anomaly: NOAA RADS daily 0.25° grid
- SST: NOAA Geo-polar daily night 5 km grid
- Ocean color: NOAA MSL12 daily VIIRS multi-sensor DINEOF gap-filled analysis Chl-a 9 km grid
- SSS: JPL SMAP V5.0 CAP 8-day mean daily 0.25° grid

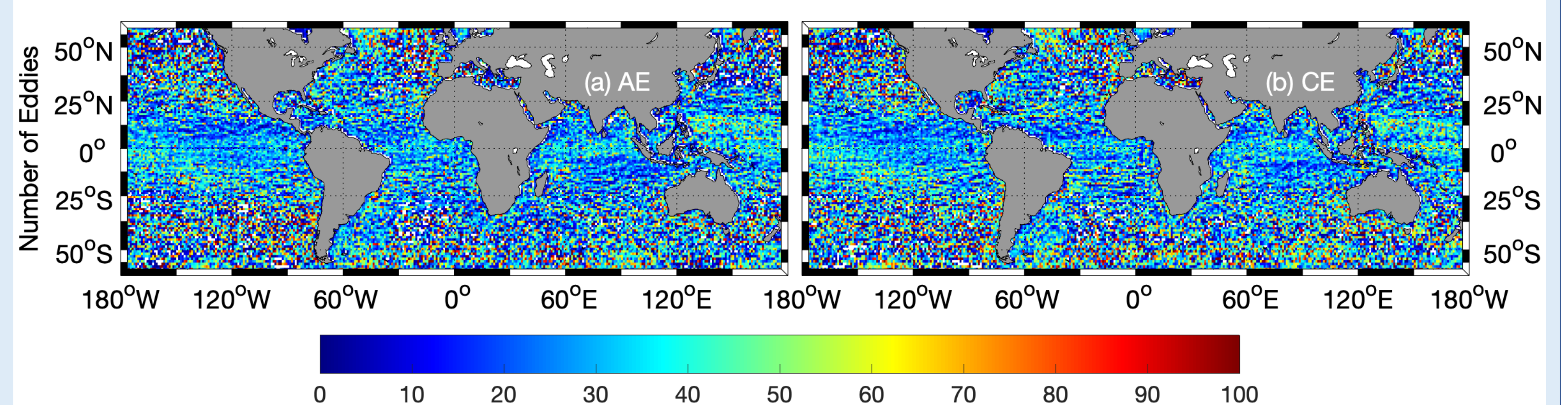
METHODS

- Multiparameter eddy tracking is adapted from algorithms originally developed by Chaigneau *et al.*, (2008, 2009) and Pegliasco *et al.*, (2015)
- Threshold free (amplitude and time)
- Eddy contours are created using altimetry, but the system tracks SST, SSS, Chl-a, and calculated variables from altimetry
- MESI is calculated from normalized values of SLA, EKE, SST, SSS, Chl-a while maintaining SLA circulation type (Roman-Stork *et al.*, 2023)
- Data available from 2019-2023, near global (-180-180°E, 60°N-60°S)

RESULTS & DISCUSSION

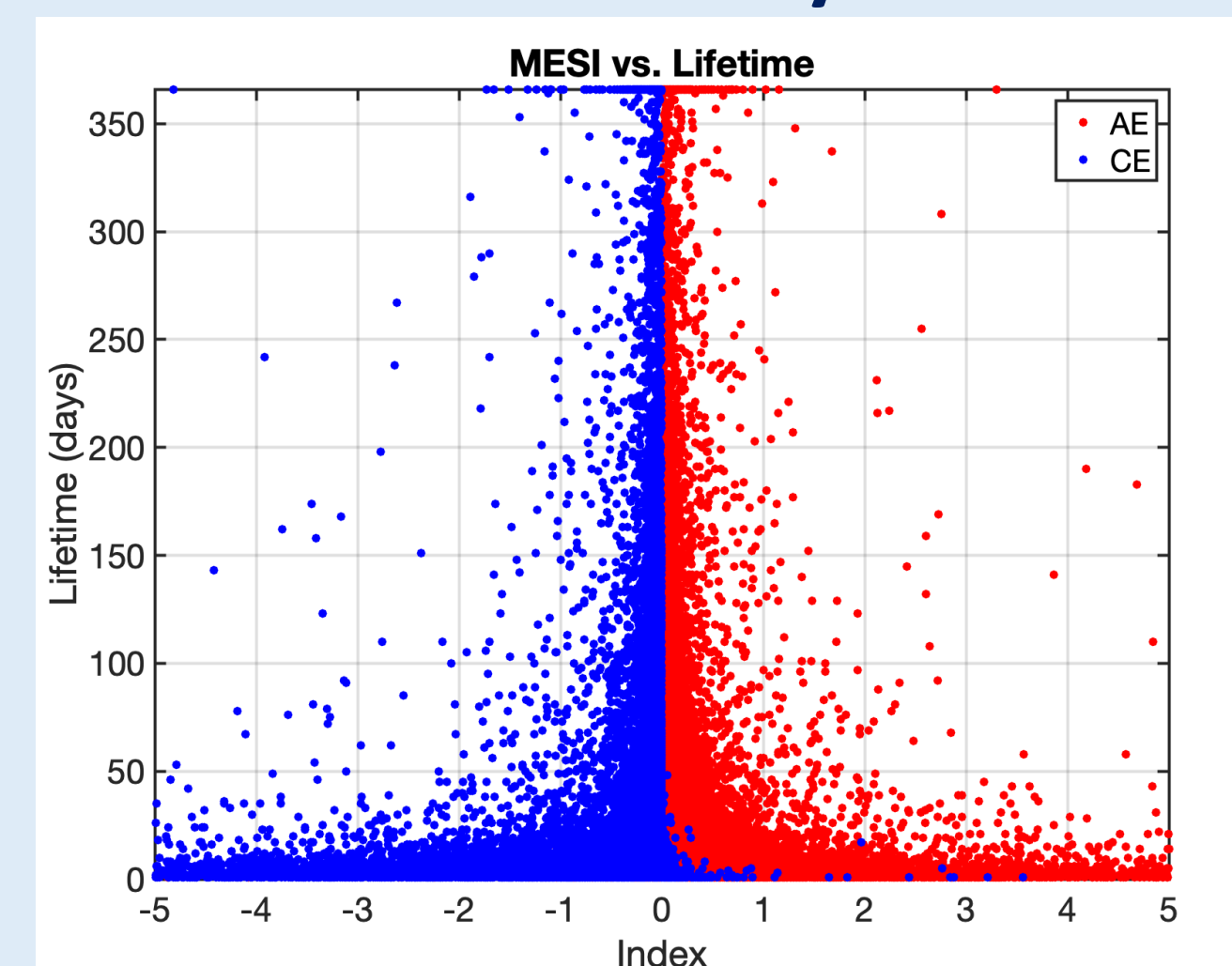
- Global distribution of eddies is consistent with literature and similar products (**Figure 1**)
- Threshold free eddy tracking allows for the study of transient features that still have a significant impact on air-sea interactions, nutrient cycling, and upper ocean processes (**Figure 2**)
- MESI is highly correlated with biogeochemical variables (Fe, NO₃, PO₄, and pH) in both eddy circulation types (**Figure 3**; Roman-Stork *et al.*, 2023)
- MESI highlights eddies with strong surface responses, such as in the California Current System, that can impact nutrient pumping, marine ecosystems, ocean acidification, and other upper ocean processes (**Figure 4**)
- MUNSTER can be used to monitor coral reef conditions and has been used to determine the impact eddies have on bleaching events in the Flower Garden Banks National Marine Sanctuary (Gulf of Mexico, 190 km from Galveston, Texas) (**Figure 5**; McWhorter *et al.*, *In Review*)

FIGURE 1. Global eddy statistics



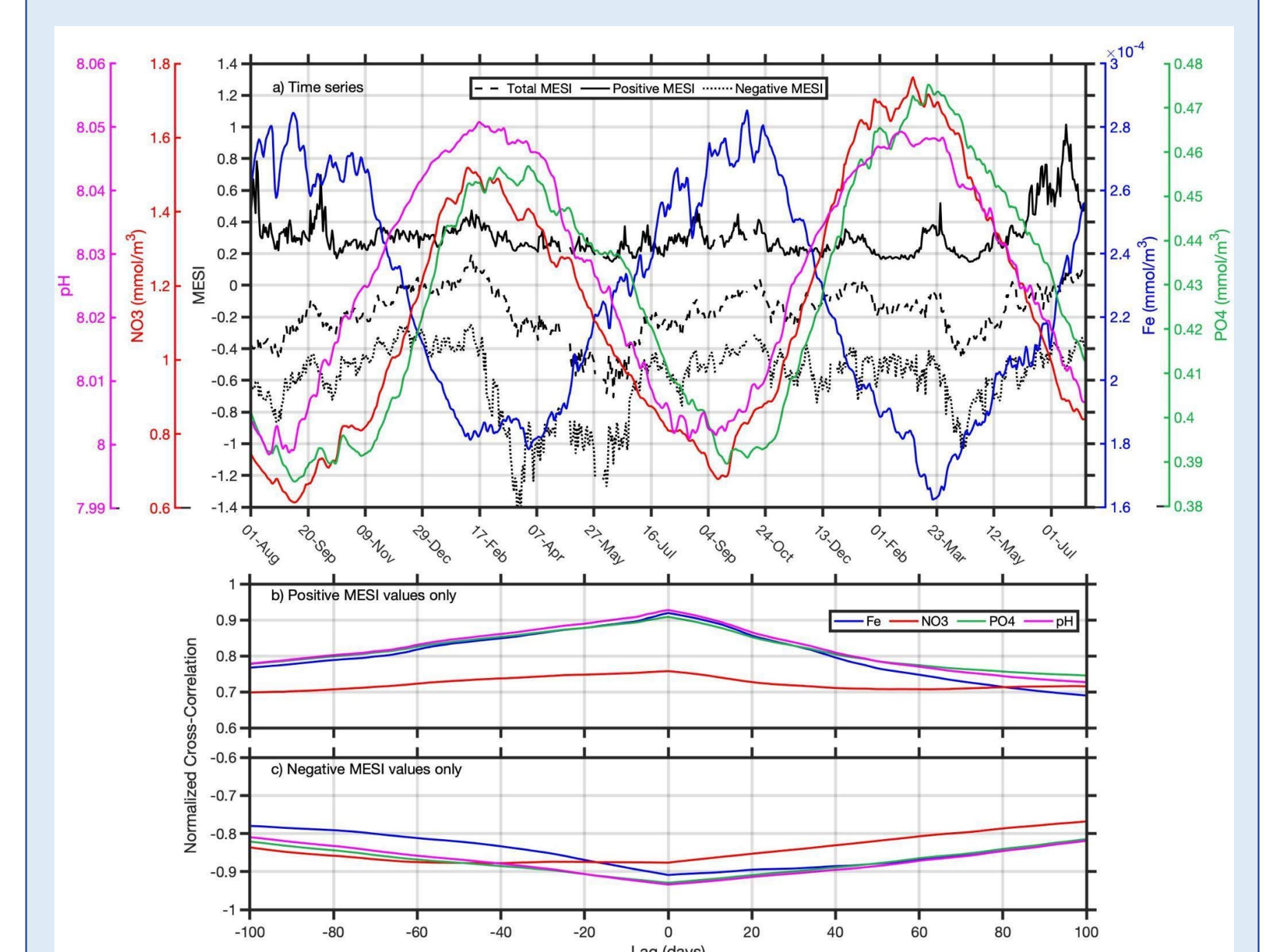
Global accumulated distribution of eddies from MUNSTER when run daily for 2020, averaged over one degree bins for anticyclonic eddies (AE; left) and cyclonic eddies (CE; right).

FIGURE 2. MESI vs. Eddy Lifetime



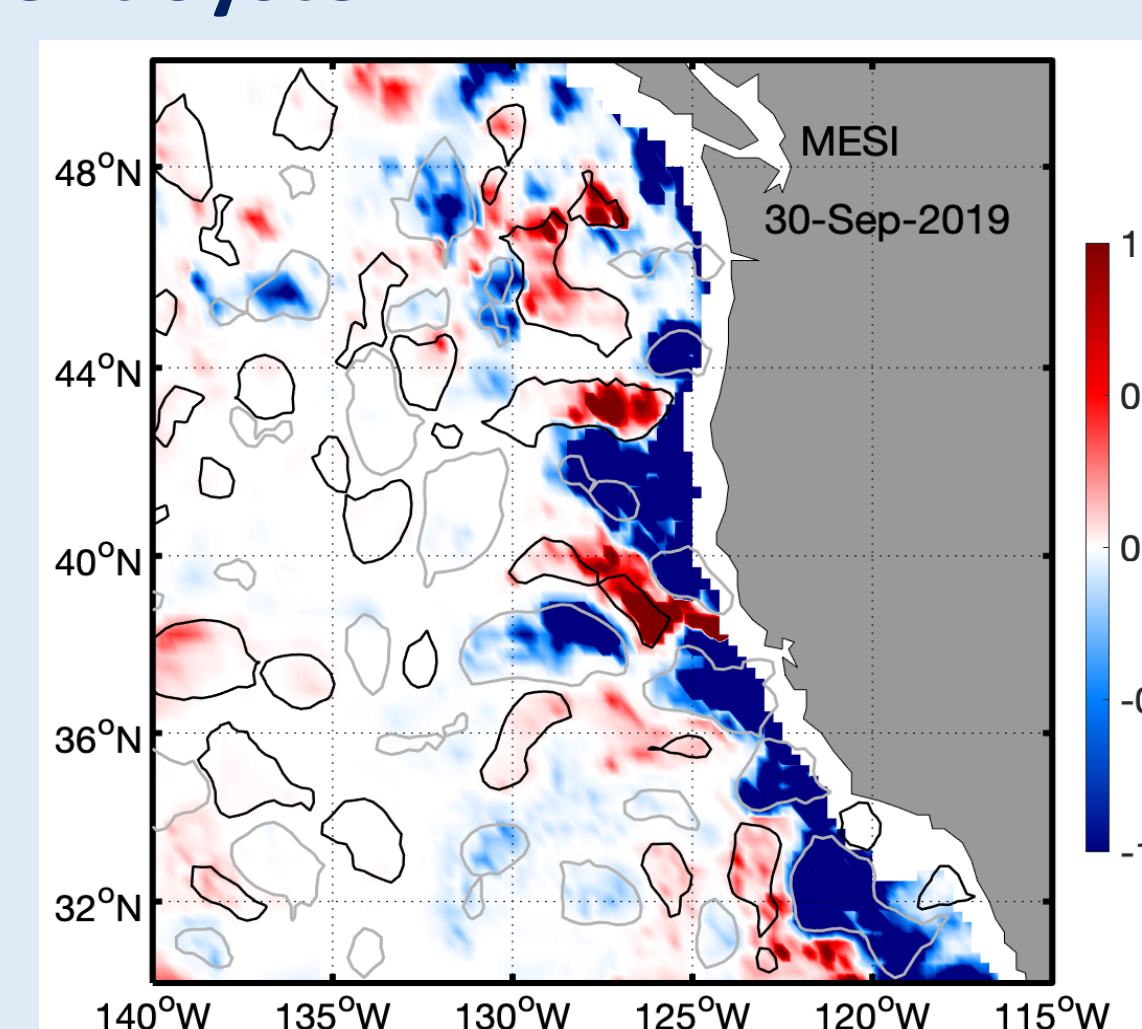
Distribution of MESI vs. eddy lifetime for near-global (-180-180°E, 60°N-60°S) MUNSTER in 2020; error = 4%.

FIGURE 3. Times series and cross-correlations of MESI and biogeochemical variables in the California Current System



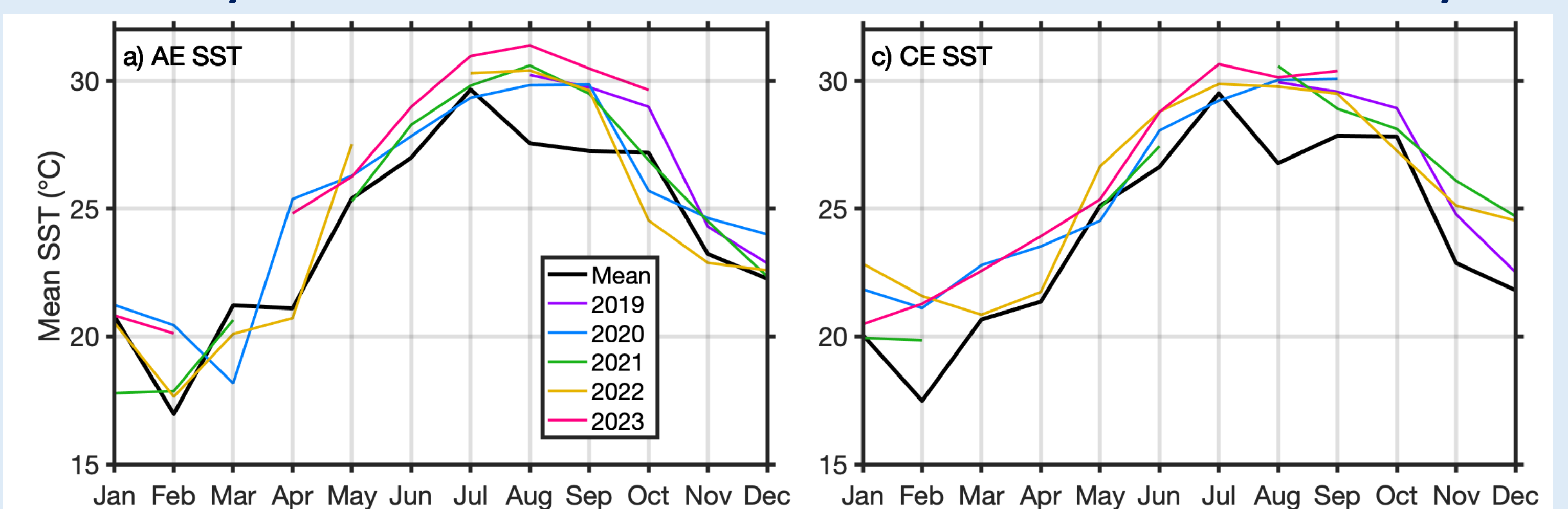
For the California Current System domain (150-100°W, 10-55°N) during August 1, 2019-July 31, 2021, a) time series of total MESI (solid black line), positive MESI values only (anticyclonic eddies; dashed black line), negative MESI values only (cyclonic eddies; dotted black line), NO₃ (red; mmol/m³), pH (magenta), Fe (blue; mmol/m³), and PO₄ (green; mmol/m³) and b) normalized cross-correlations of NO₃ (red), pH (magenta), Fe (blue), and PO₄ (green) with MESI. From Roman-Stork *et al.*, (2023)

FIGURE 4. MESI in the California Current System



MESI overlaid with cyclonic (gray) and anticyclonic (black) eddy contours indicating regions of nutrient cycling and productivity

FIGURE 5. Eddy SST in the Flower Garden Banks National Marine Sanctuary



Monthly mean eddy SST (°C) in anticyclonic eddies (a; AEs) and cyclonic eddies (b; CEs) in the Flower Garden Banks National Marine Sanctuary coral reefs in the Gulf of Mexico (91-95°W, 27-30°N) for 2019-2023 compared to the 20-year mean (2002-2022). Persistent high SSTs compared to the mean in bleaching years around the reefs contribute to bleaching conditions.