Impact of global change on the patterns of bloom outbreaks in the coastal waters off Fujian

Weibo Wang, Haifeng Gu
Third Institute of Oceanography,
Ministry of Natural Resources, China

2026.10.28

Contents

Outline

01 Research Background

02 Marine Environmental Anomalies in Spring 2025

03 Hydrodynamic Mechanisms of the Bloom Absence

04 Compound Driving Effects of Extreme Climate Events



Chapter 01

Research Background

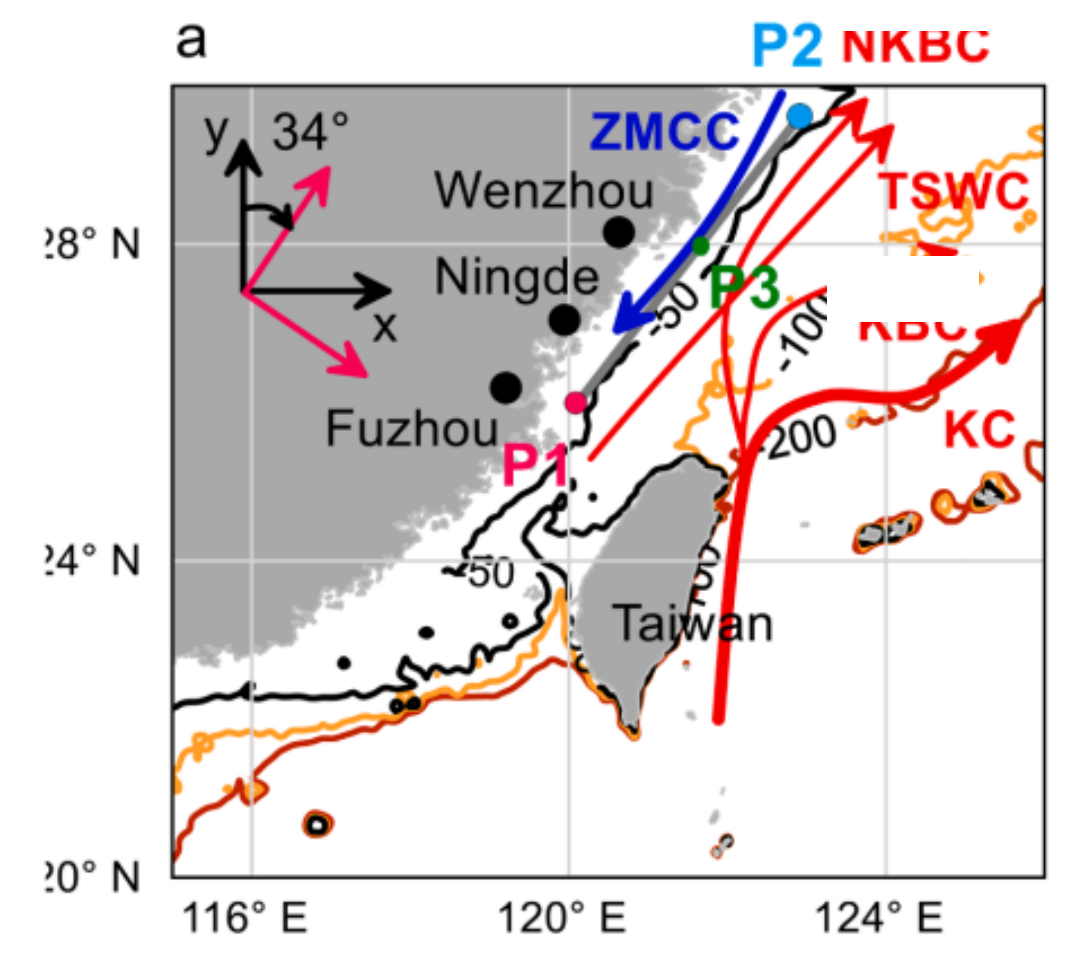
Zhejiang-Fujian Coastal Current (ZMCC): Core Driver of Bloom Outbreaks

- **Nutrient Supply Conduit:**

ZMCC is characterized by low temperature, low salinity, and high nutrients.

- **Frontal Convergence Zone:**

The convergence of the southward ZMCC and the northward Taiwan Warm Current (TSWC) forms an active frontal zone.



Northeast Moonsoon

Spatiotemporal Distribution of Blooms along the Zhejiang-Fujian Coast

Bloom in the Aquaculture Areas





Temporal Pattern: High-incidence window from April to June

A total of 263 bloom events from 2001 to 2022.

April to June accounts for pproximately 88%.

Spatial Pattern: From Putian to Ningde Waters

Concentrated in the coastal areas of northeastern Fujian, the most vital aquaculture base in Fujian.

CHAPTER 02

Marine Environmental Anomalies in Spring 2025

Comprehensive anomaly records: from phytoplankton density to current structure

Historic Anomaly: Absence of Spring Blooms in 2025

First Complete Absence on Record:

No blooms in Fuzhou and Ningde aquaculture areas recorded from April to June 2025.

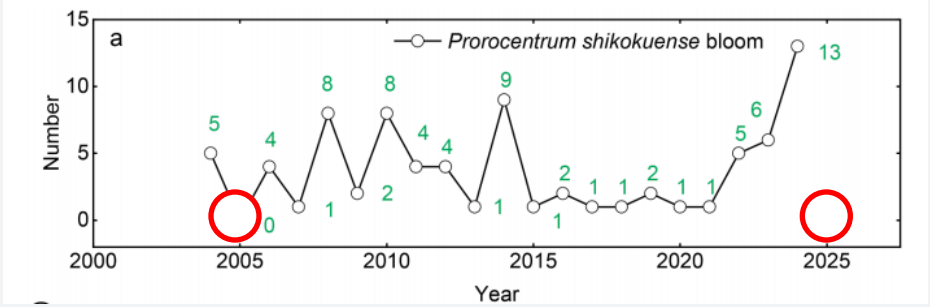
Basin-Wide Phenomenon:

No blooms occurred along the Wenzhou coast

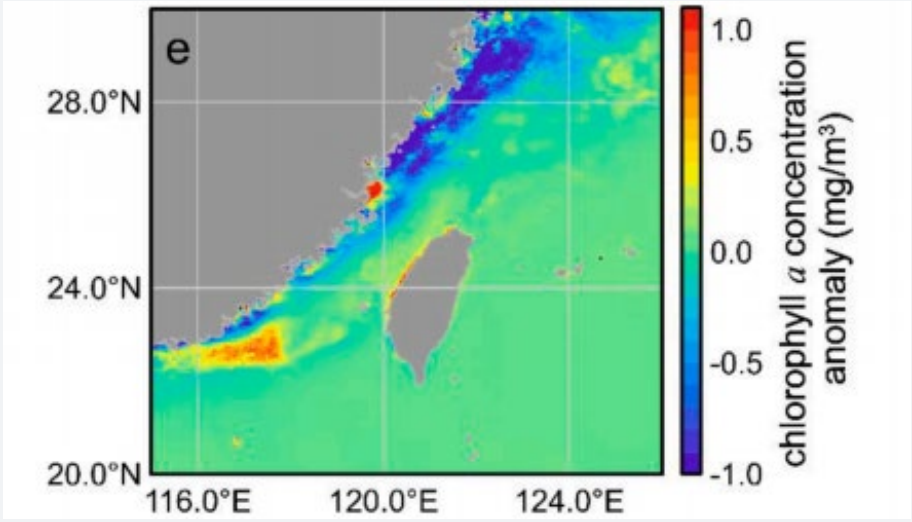
Satellite Remote Sensing Validation:

GlobColour data revealed significant negative anomalies in Chlorophyll-a concentrations along the Zhejiang-Fujian coast

Annual frequency of blooms



Anomalies in Chlorophyll-*a* (April- June, 2025)



Spatial Anomaly Patterns of Sea Surface Temperature (SST)

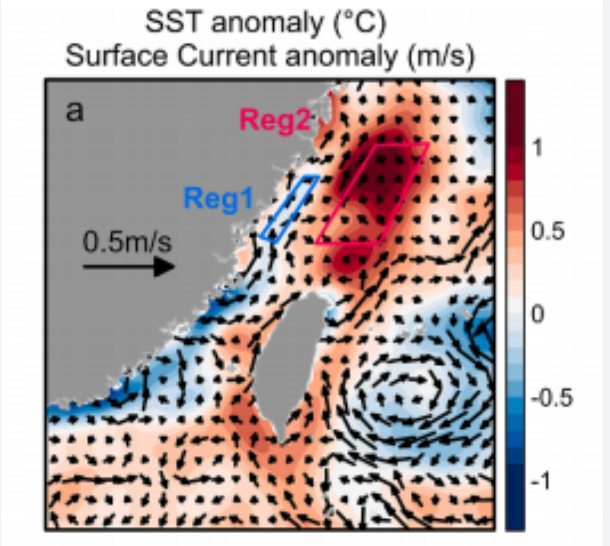
SST Anomalies

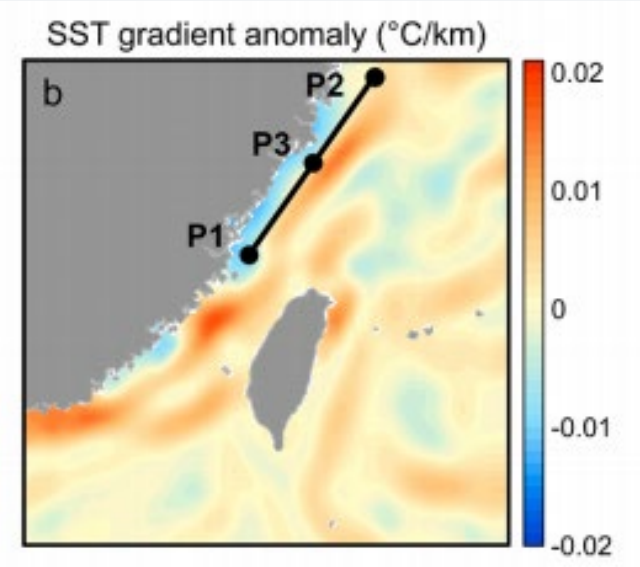
North of Wenzhou:

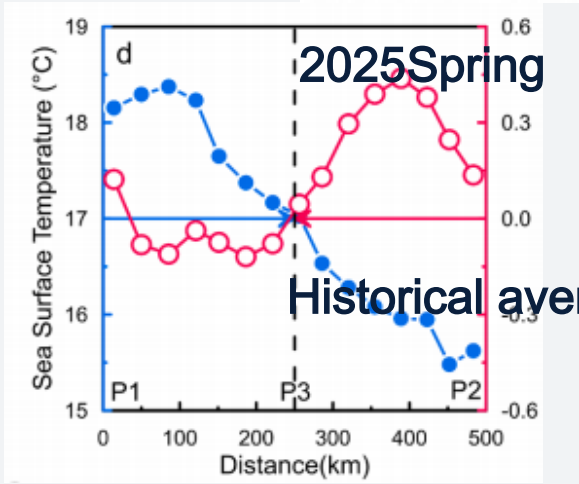
1. SST positive anomalies exceeded +0.45°C;
2. Significant negative anomalies occurred in inshore waters.

Altered Frontal Structure:

The coastal front was significantly disrupted, inhibiting algal accumulation and proliferation.



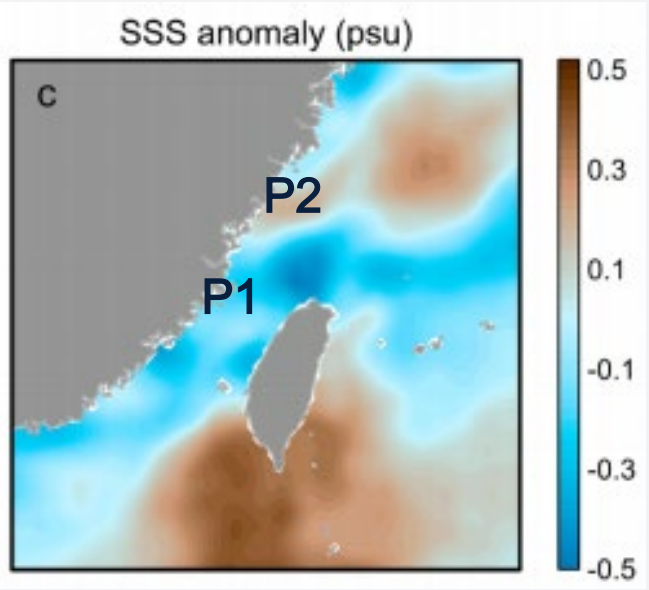


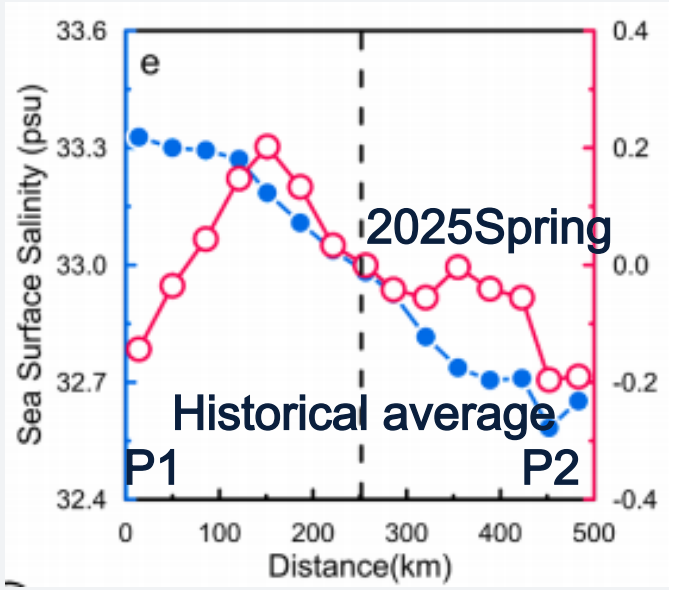


Spatial Anomaly Patterns of Sea Surface Salinity (SSS)

High-Salinity Water Intrusion:
A positive salinity anomaly belt (+0.2 psu) extended from P2 section to the Wenzhou coast.

Suppressed Southward Advection:
Negative salinity anomalies were recorded along the Fuzhou coast.





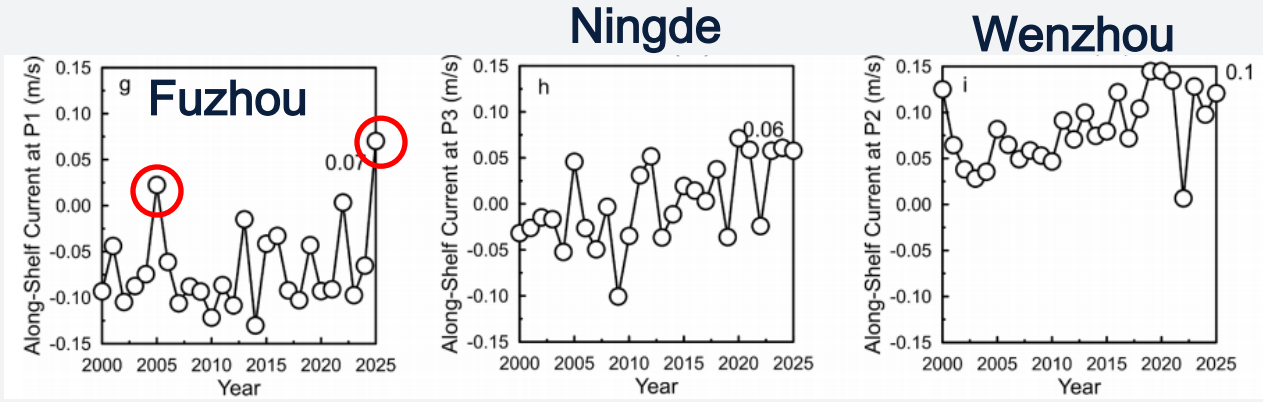
Record-Breaking Coastal Current Reversal

Flow Reversal:

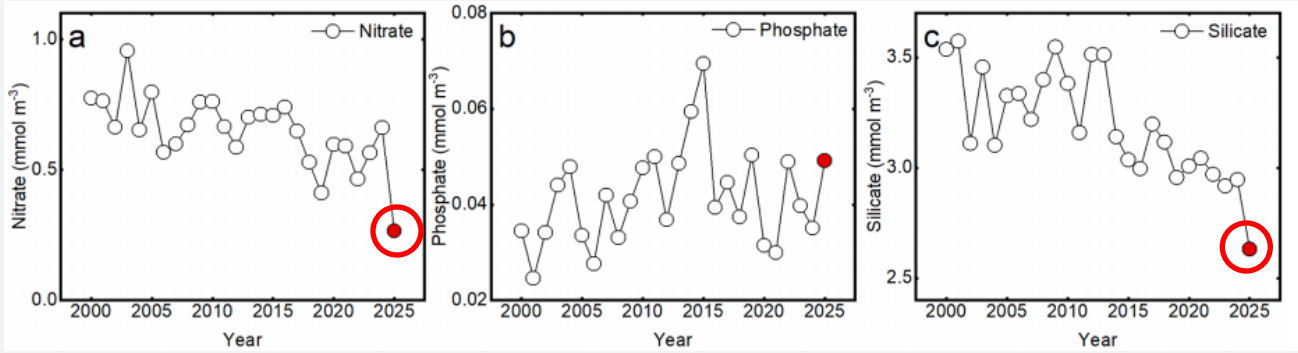
A prominent northeastward current anomaly reversed the climatological southward ZMCC flow.

Nutrient Blockage:

GOBH dataset showed nitrate and silicate concentrations plunged to historic lows.



Changes in flow velocity over the past 25 years



Changes in nutrients over the past 25 years

CHAPTER 03

Hydrodynamic Mechanisms of the Bloom Absence

From dynamic decomposition to regional differentiated driving mechanisms

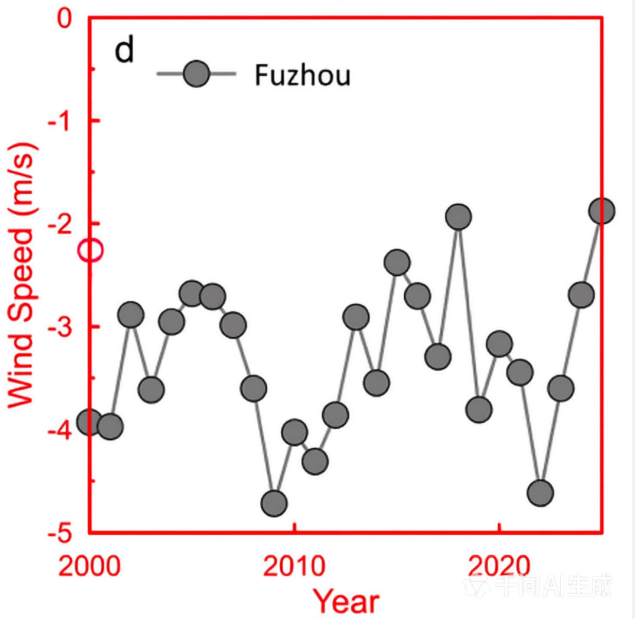
Fuzhou Waters: Barotropic Mechanism Driven by Weakened Monsoon

Abnormally Weakened NE Monsoon:

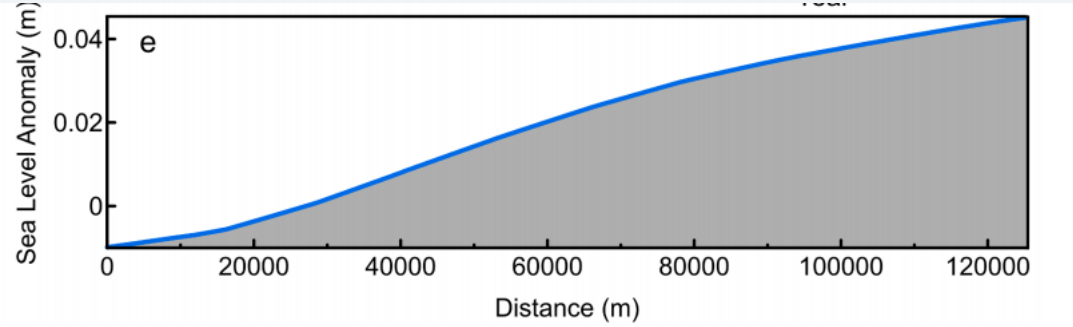
Wind speed dropped from the climatological mean of 3.3 m/s to 1.9 m/s in spring 2025.

Offshore Ekman Transport:

Southwesterly wind anomalies drove offshore Ekman transport, lowering coastal sea level and establishing an offshore-high/inshore-low cross-shelf.

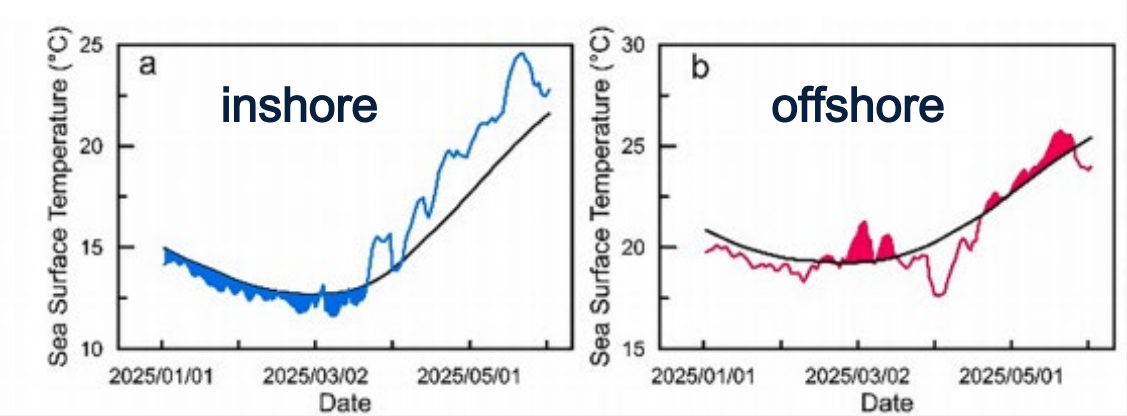


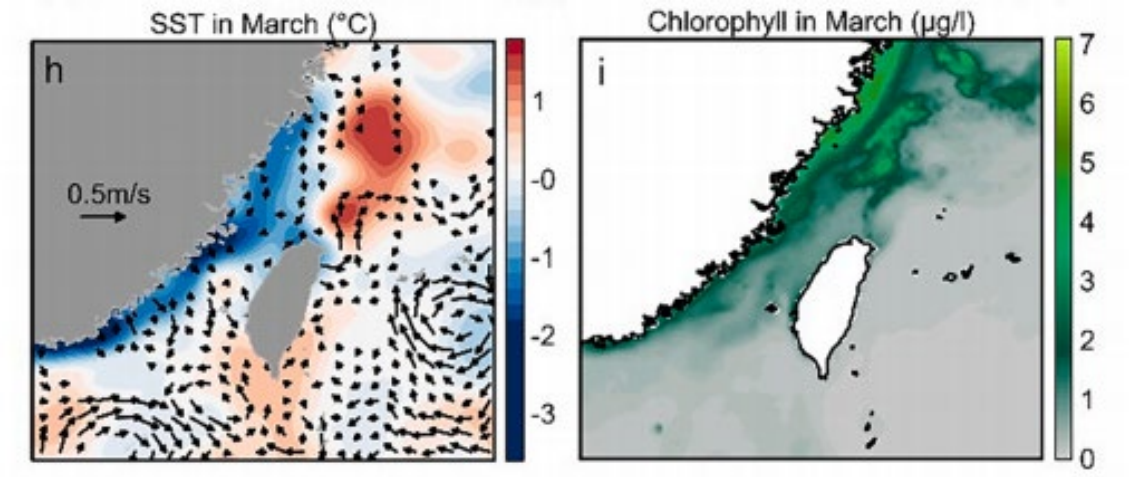
Changes in wind speed over the past 25 years



The sea level anomaly

Wenzhou Waters: Baroclinic Mechanism Driven by Thermal Wind





Temperature Gradient & Baroclinic Flow Generation

Coexistence of offshore MHW and inshore MCS established a strong cross-shelf SST gradient. Thermal wind effect drove a strong northward baroclinic current.

Ecological Effect:

Nutrients was transported offshore.

A high Chlorophyll-a belt formed in the offshore frontal zone.



CHAPTER 04

Compound Driving Effects of Extreme Climate Events

Multi-factor synergy: from ENSO transition to the northward shift of the WPSH

ENSO Transition & Extreme Northward Shift of the Western Pacific Subtropical High (WPSH)

ENSO Phase Transition:

Transition from the 2024 El Niño to La Niña.

The El Niño decaying phase induced anticyclonic anomalies over the western Pacific.

Extremely Intensified WPSH:

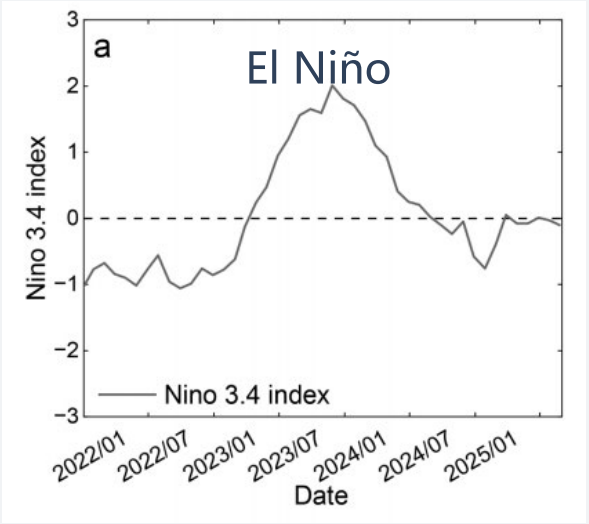
The WPSH ridge reached its northernmost position since 2000.

Enhanced Solar Radiation:

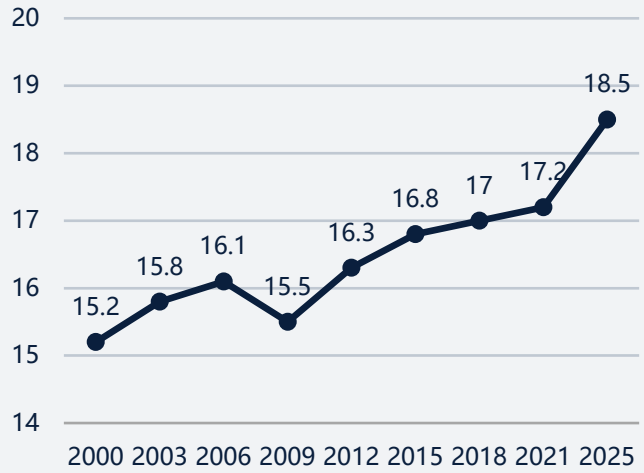
The key atmospheric driver for frequent offshore MHWs near Wenzhou.

Weakened Northeastern Monsoon:

The northward displacement of the WPSH simultaneously weakened coastal northeasterly winds.



Transition from El Niño to La Niña.



Changes in WPSH over the past 25 years

Comprehensive View: Climate-Ocean-Ecosystem Compound Disaster Chain

This case reveals how compound extreme climate events can counterintuitively suppress ecological disasters.

Climate Forcing Layer

El Niño-to-La Niña transition induced western Pacific anticyclonic anomalies; WPSH ridge shifted to the northernmost position since 2000.

Induced dual effects: weakened coastal northeasterly winds and enhanced solar radiation driving frequent MHWs.

Ocean Dynamic Response Layer:

Fuzhou: Weak monsoon → SW wind anomaly → Ekman transport → SSH gradient → Barotropic anomaly (95.5%).

Wenzhou: Inshore MCS + Offshore MHW → Strong SST gradient → Thermal wind effect → Baroclinic anomaly (178.2%).

95.5% • 178.2%

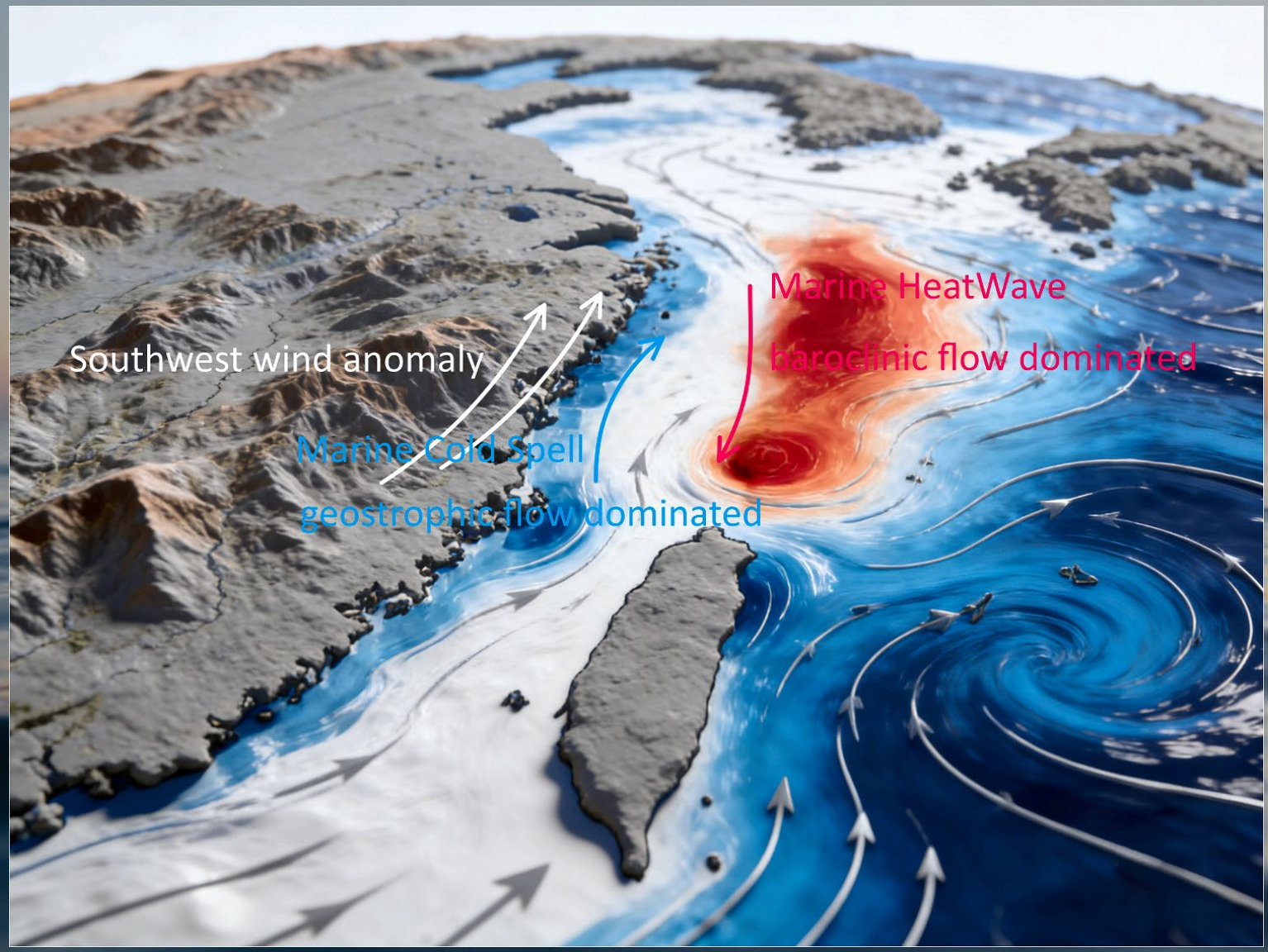
Ecological Impact Layer:

ZMCC southward transport was severed; nitrate and silicate dropped to historic lows, cutting off bloom "fuel".

Nutrients were exported cross-shelf to the offshore front, resulting in coastal bloom absence but elevated offshore Chlorophyll-a.

ZMCC cutoff

Conclusion & Outlook



Conclusion & Outlook

- Summary:

Compound effects of extreme climate events can fundamentally restructure coastal marine ecosystems.

- Outlook:

Future research must focus on multi-factor coupling dynamics and the enhancemen of coastal harmful algal bloom (HAB) predictive models under global change scenarios.

ssifié

Thank You!

