

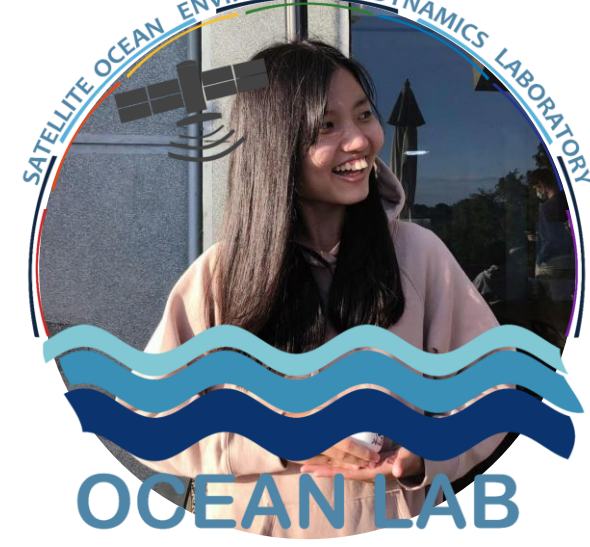
Spatiotemporal Changes of the Coastal Environment in Northwestern Taiwan

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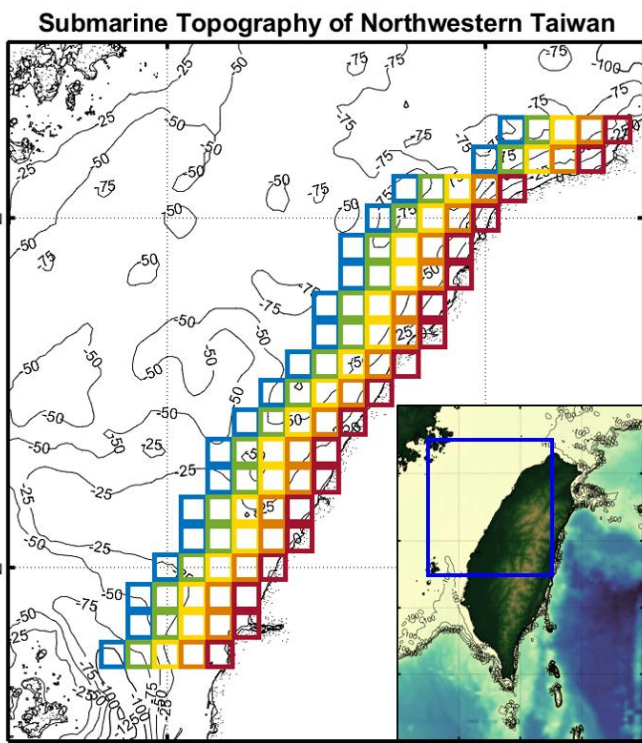
1. BACKGROUND AND MOTIVATION



Since the Sustainable Development Goals (SDGs) are guide policies in many countries today, this research aligns with two key SDGs.

- **Goal 13: Climate Action** is addressed by improving the understanding of climate variability to inform adaptation strategies.
- **Goal 14: Life Below Water** is supported through analysis of oceanographic changes that aid marine conservation and ecosystem protection.

Marine environmental research in Taiwan has primarily focused on the eastern and southwestern coasts, with relatively limited studies in the northwest. However, the northwestern coast is a critically important area for rapid urban development, dense infrastructure, and river outflows rich in nutrients, supporting high biodiversity and aquaculture. Several marine protected areas (MPAs), such as the Guanyin Algal Reef, Xinfeng Mangroves, Xiangshan Wetland, and Gaomei Wetland, have been established. Yet, long-term anthropogenic pressures have affected coastal ecosystems, making the balance between development and conservation a growing concern.

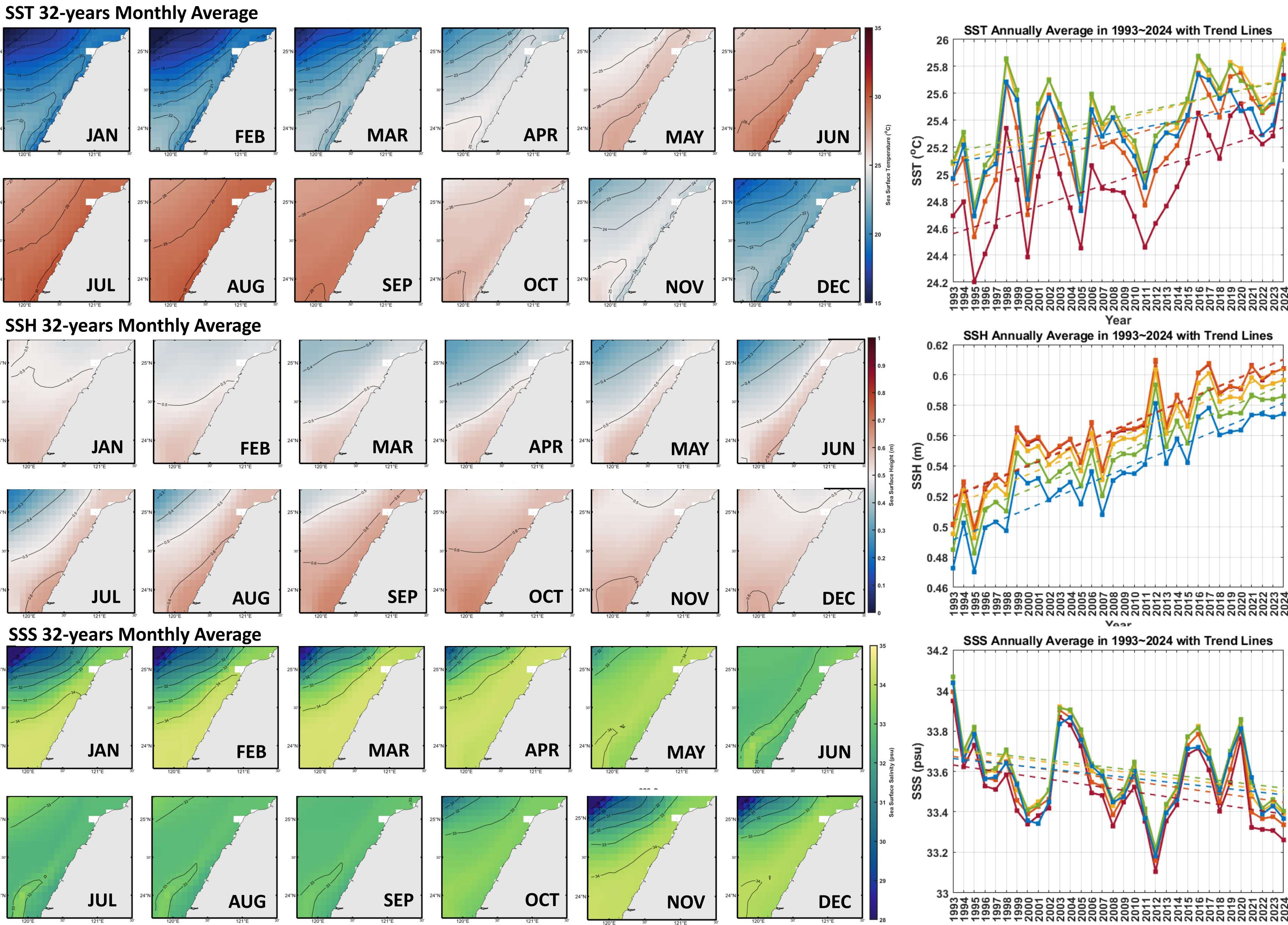


2. METHODS AND PARAMETERS

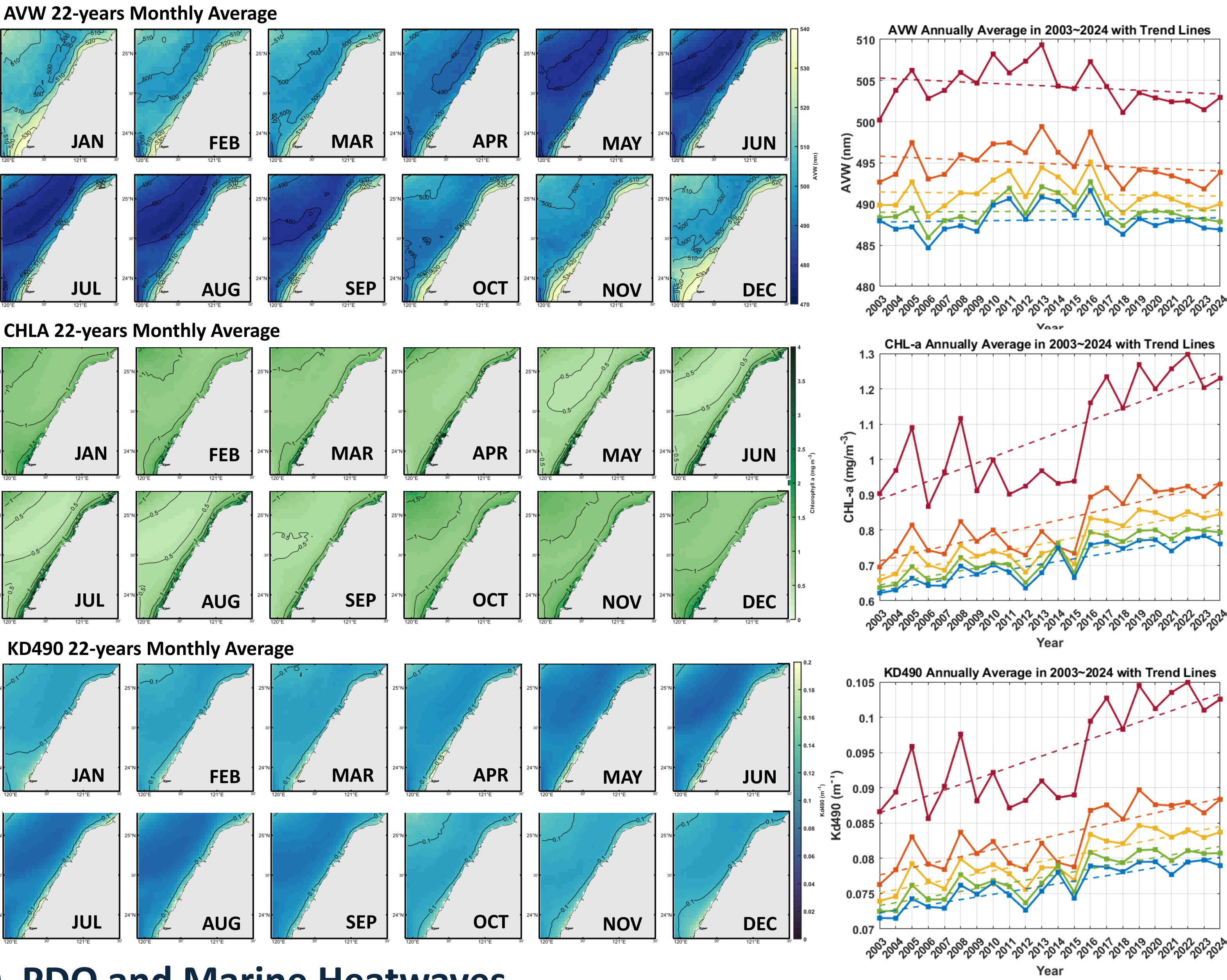
Variables	Sea Surface Height (SSH; m)	Sea Surface Temperature (SST; °C)	Sea Surface Salinity (SSS; psu)	Chlorophyll a (chlor_a; mg m ⁻³)	Diffuse attenuation coefficient for downwelling irradiance at 490 nm (Kd; m ⁻¹)	Apparent Visible Wavelength (AVW; nm)	Sea water pH reported on total scale (pH)	Surface partial pressure of carbon dioxide in sea water (spCO ₂ ; micro atm)	Surface downward mass flux of carbon dioxide expressed as carbon (fpCO ₂ ; molC m ⁻² yr ⁻¹)	Total alkalinity in sea water (TA; micro mol kg ⁻¹)
Product ID/ Satellite	GLOBAL_MULTI_YEAR_PHY_001_030			OCEANCOLOUR_GLO_BGC_L4_MY_009_104/ OCEANCOLOUR_GLO_BGC_L4_NRT_009_102		MODIS-Aqua/Terra VIIRS-SNPP/IPSS1 PACE-OCL		MULTIOBS_GLO_BIO_CARBON_SURFACE_MYNRT_015_008		
Spatial resolution	0.083° × 0.083°			4 km		4 km		0.25° × 0.25°		
Temporal resolution	Monthly			Monthly		Monthly		Monthly		
Temporal extent	1993-01-01 to 2024-12-31			2003-01-01 to 2024-12-31		2003-01-01 to 2024-12-31		1993-01-01 to 2023-12-31		
ENSO, PDO, Global Warming										
<div><div>Ocean Physics Reanalysis</div><div>NOAA Coral Reef Watch (CRW)</div><div>Ocean Colour</div><div>Ocean Bio-Geo-Chemical</div><div>Spatial Distribution</div><div>Time Series</div><div>Correlation Coefficient</div></div>										

3. RESULTS AND DISCUSSION

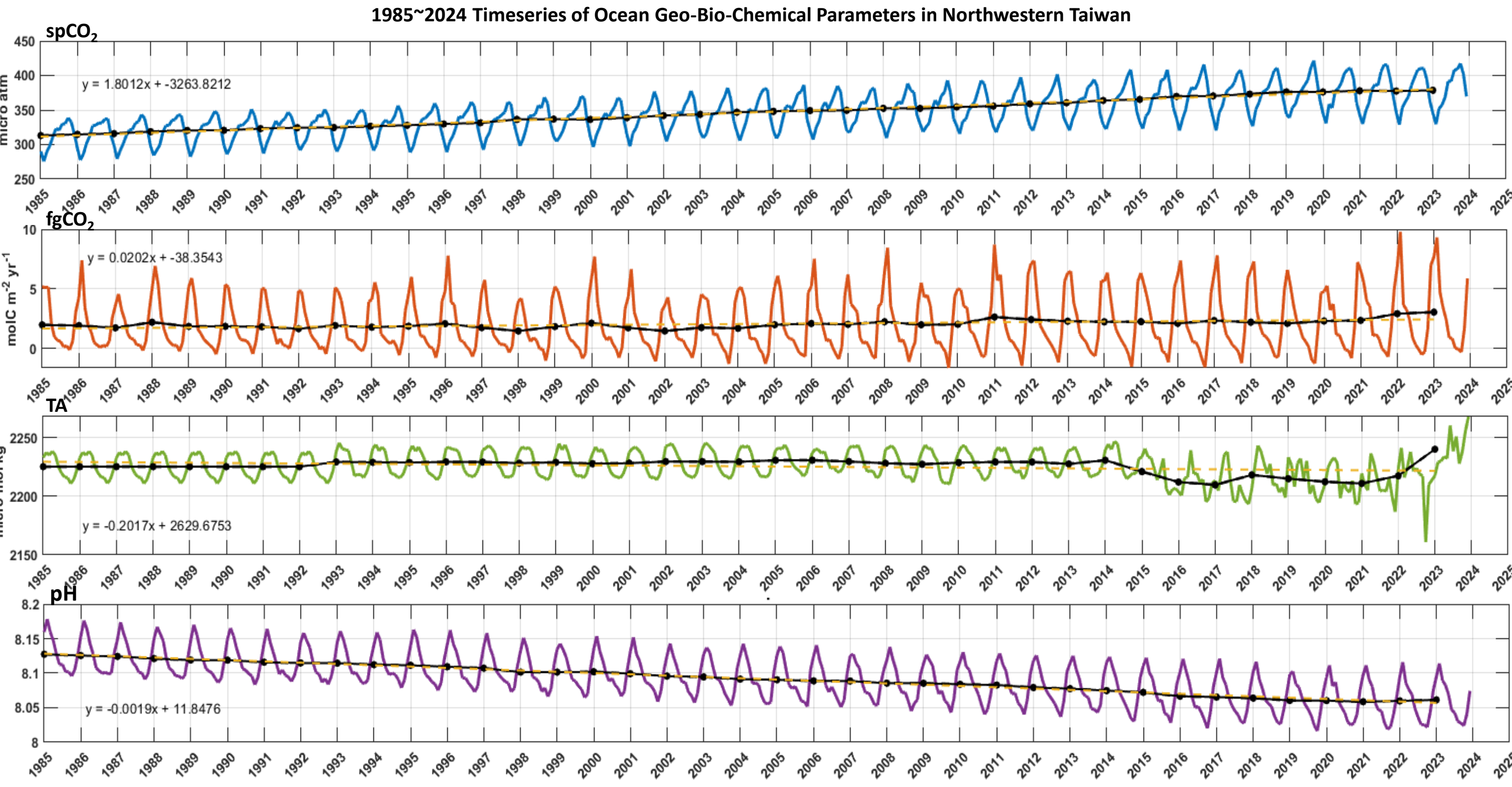
3-1 Ocean Physical Reanalysis



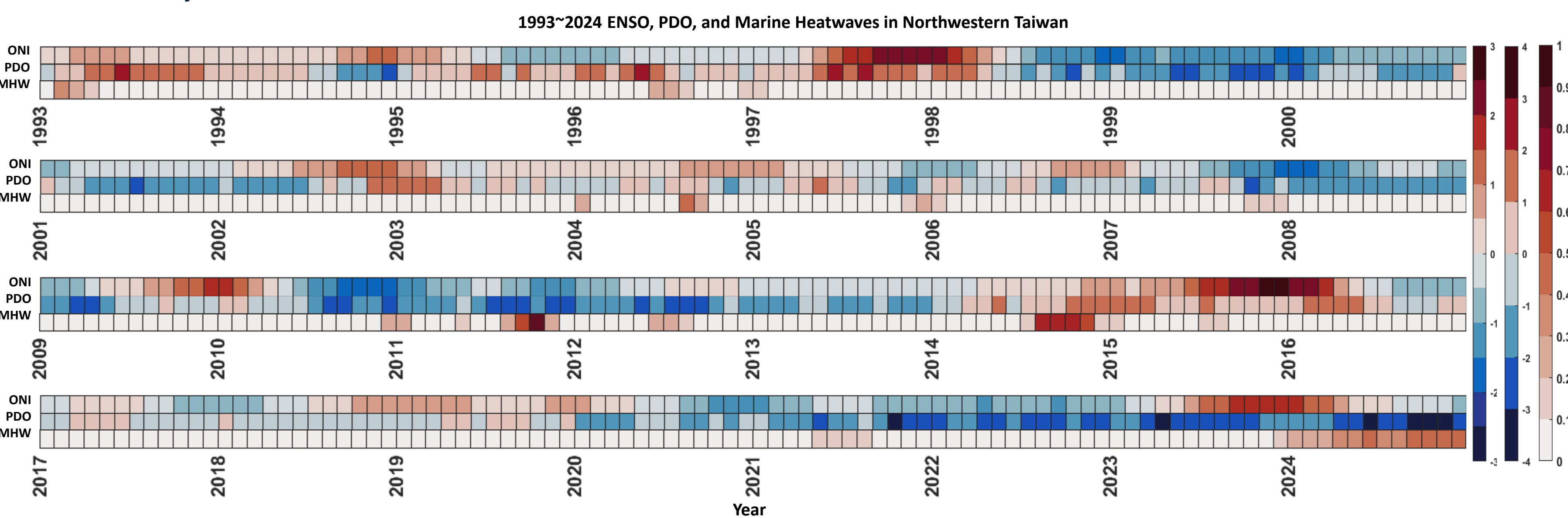
3-2 Ocean Colour



3-3 Ocean Geo-Bio-Chemical



3-4 ENSO, PDO and Marine Heatwaves



MHWs of northwestern Taiwan typically occur during La Niña years and when the PDO is negative. These include 1993 (EN+), 1996 (LN+), 2011 (LN-), 2012 (LN-), 2014 (N+), 2021 (LN-), and 2024 (N-).

4. CONCLUSION

1. SST and SSH have shown an **increasing trend** from 1993 to 2024, indicating the impact of **climate change** in this region.
2. AVW, Kd490, and Chla exhibit **similar seasonal characteristics**. The comparative analysis reveals that the relatively high AVW values in coastal areas are due to **the water is turbid and having more phytoplankton and nutrients**.
3. The rising pCO₂ concentration, with decreasing TA concentration and an overall decline in pH, indicates **the oceans in northwestern Taiwan are gradually acidifying**, aligning with the decreasing trend of SSS.
4. MHWs in northwestern Taiwan typically occur during La Niña years and negative PDO phases. These events have become more frequent since 2011, peaking in October 2011 (1993-2024). Notably, MHWs occurred every month in the active year of 2024.
5. Correlation coefficients show a significant negative relationship between Chla and SST (-0.78), and Chla and MHW (-0.66), suggesting **decreased phytoplankton productivity with rising seawater temperatures or frequent marine heatwaves**.

5. REFERENCES

1. Hsu, P. C., Centurioni, L., Shao, H. J., Zheng, Q., Lu, C. Y., Hsu, T. W., & Tseng, R. S. (2021). Surface current variations and oceanic fronts in the southern East China Sea: Drifter experiments, coastal radar applications, and satellite observations. *Journal of Geophysical Research: Oceans*, 126(10), e2021JC017373.

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