

Air-Sea Transition Zone Processes Driving Mean State and Climate Variability Model Biases in Tropical Pacific

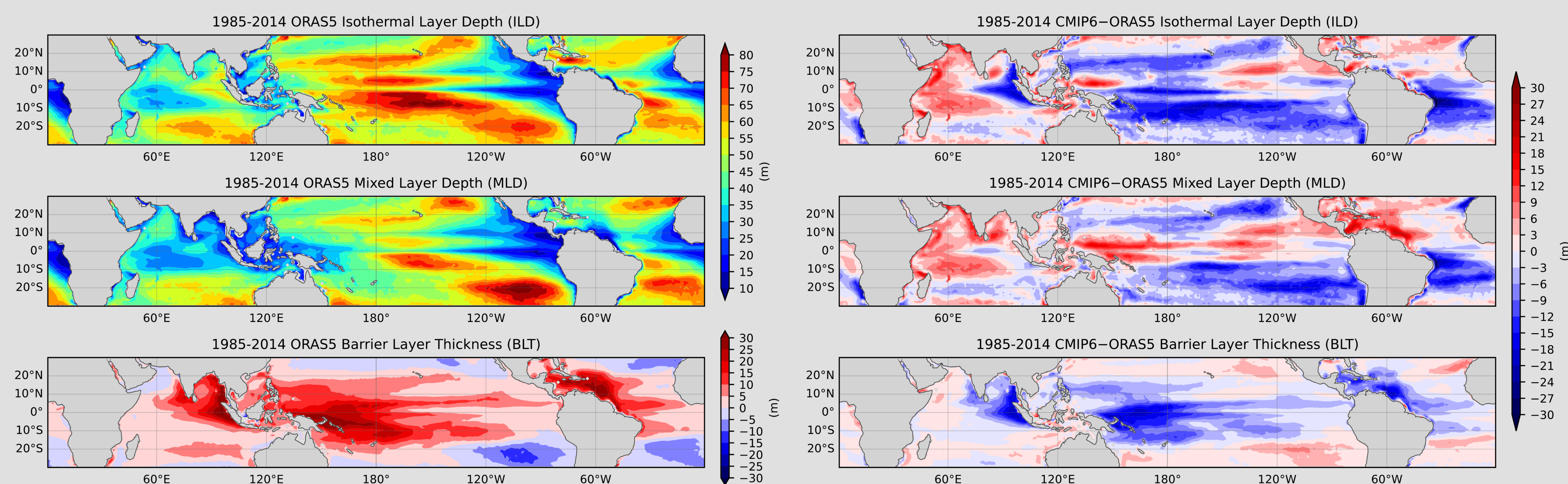
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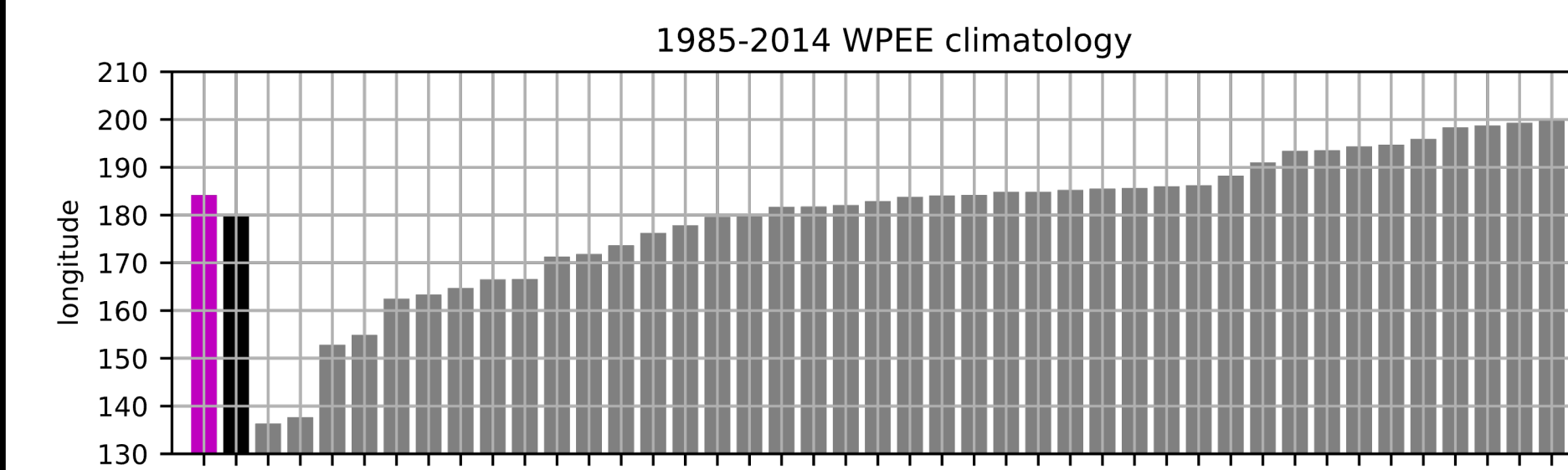
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1. Barrier Layer Thickness 1985-2014 Climatology and Model Biases

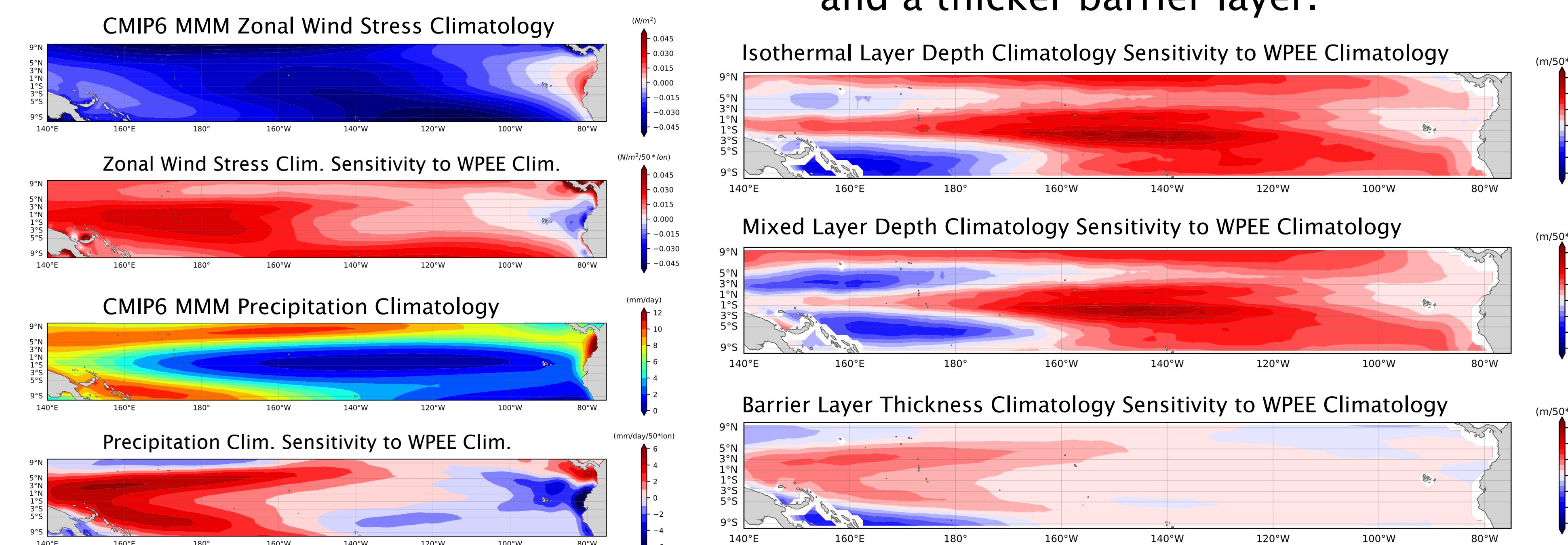
- CMIP6 models exhibit strong climatological biases in barrier layer thickness within the west-to-central equatorial Pacific, due to a shallower isothermal layer depth (defined by temperature) and deeper mixed layer depth (defined by density).
- This research investigates the air-sea transition zone processes that drive: (a) barrier layer thickness mean-state model biases and inter-model spread, and (b) internal variations of barrier layer thickness across multiple timescales.



3. CMIP6 Inter-model Spread of Barrier Layer Thickness



- Models with a more eastward Warm Pool Eastern Edge (WPEE) climatology tend to project weaker easterlies in the west-to-central equatorial Pacific.
- This is accompanied by enhanced surface warming and increased precipitation, leading to a shallower mixed layer depth and a thicker barrier layer.



Weaker easterly climatology in west-to-central equatorial Pacific

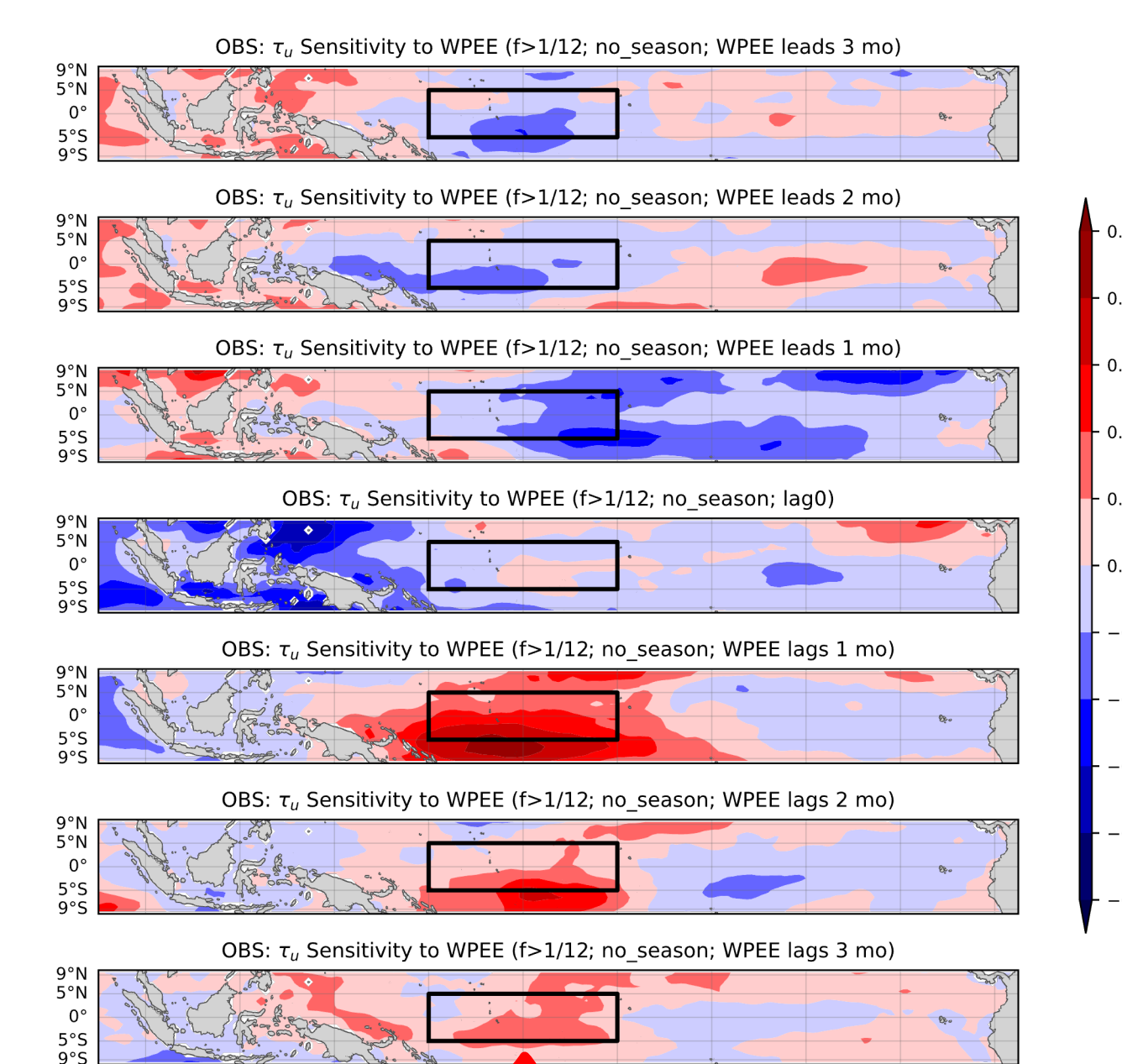
More eastward WPEE climatology

Enhanced SST and precipitation climatology

Shallower mixed layer depth and thicker barrier layer climatology in west-to-central equatorial Pacific

Monthly variations in CEP

Westerly surface wind stress anomalies
1-3 months
Eastward shift of Warm Pool Eastern Edge
1-3 months
Easterly surface wind stress anomalies



2. Observational Variations in Warm Pool Eastern Edge and Barrier Layer Thickness across Multiple Timescales

- Using observations, we find that an eastward shift of the Warm Pool Eastern Edge (WPEE) corresponds to a westerly surface wind stress anomaly, an enhanced precipitation, and a decrease in upper-ocean salinity. The reduction in upper-ocean salinity shoals the mixed layer, thereby increasing the barrier layer thickness.
- These processes are evident across multiple timescales, including monthly variations (with the seasonal cycle removed), as well as interannual and decadal variations.
- For monthly variations, we also find that westerly surface wind stress anomalies *leads* the eastward shift of the WPEE by 1–3 months, whereas easterly anomalies follow the WPEE eastward shift by 1–3 months.

