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Salinity-Driven Barrier Layer Dynamics in the Equatorial Pacific

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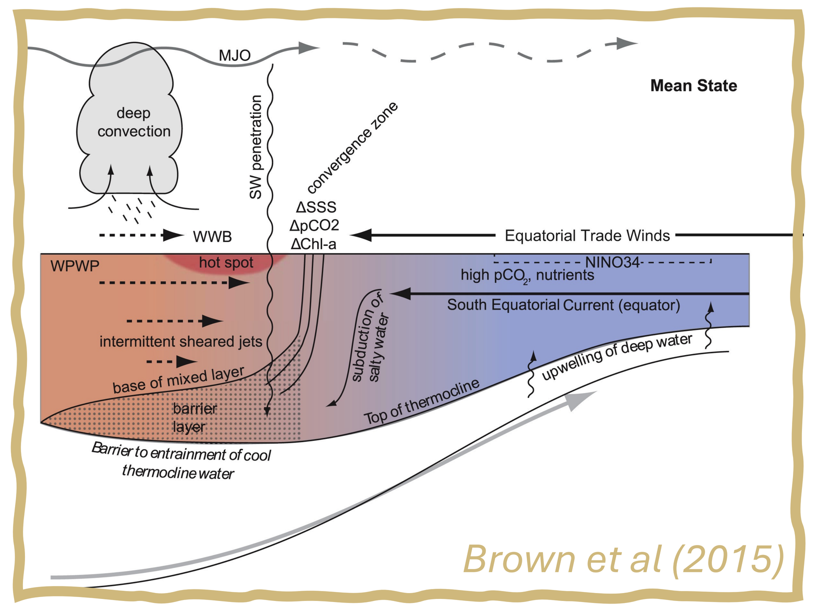
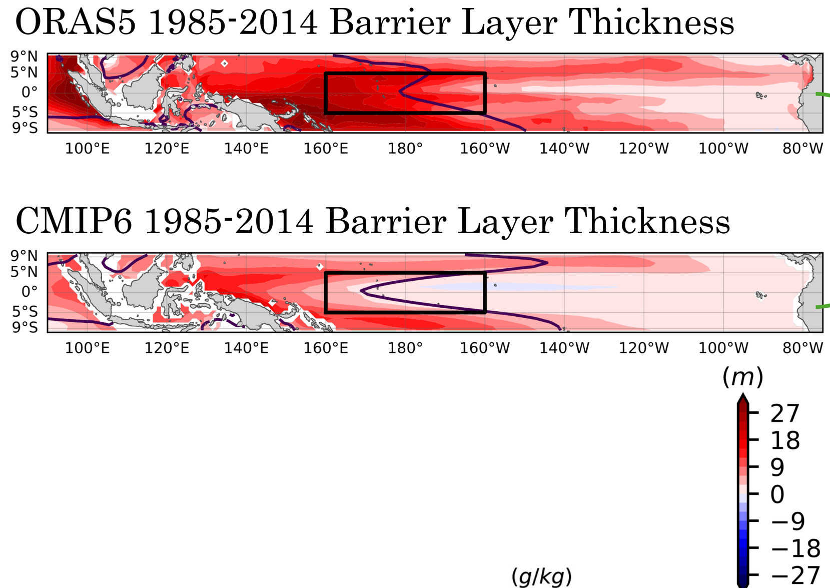
** This work is under review for Journal of Climate*

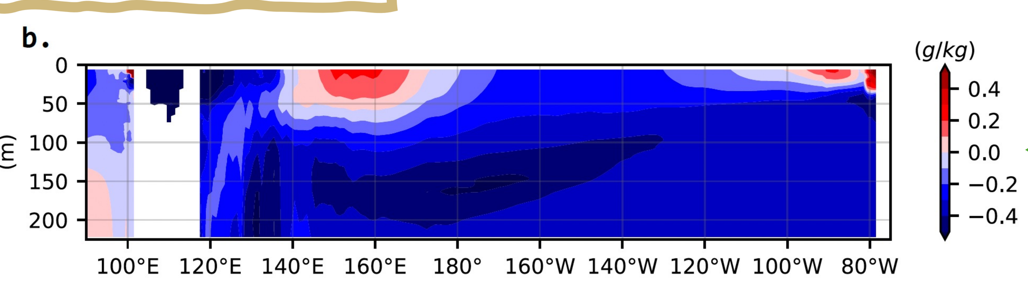


ORAS5 1985-2014 Barrier Layer Thickness

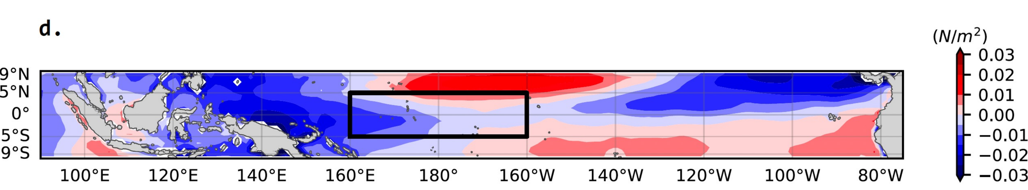
CMIP6 1985-2014 Barrier Layer Thickness



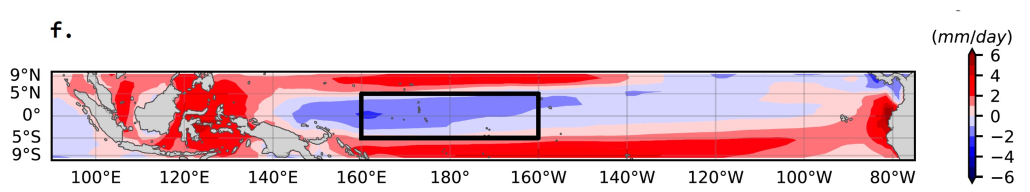
(CMIP6 – ORAS5) Salinity Bias



(CMIP6 – ORAS5) Zonal Wind Bias



(CMIP6 – ORAS5) Precipitation Bias



1985–2014 CMIP6 Climatological Biases

- Too-shallow mixed-layer depth (MLD) and too-thin barrier layer (BL)

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- Westward WPEE bias along the equator
- Positive upper-ocean salinity bias in the W. Pacific

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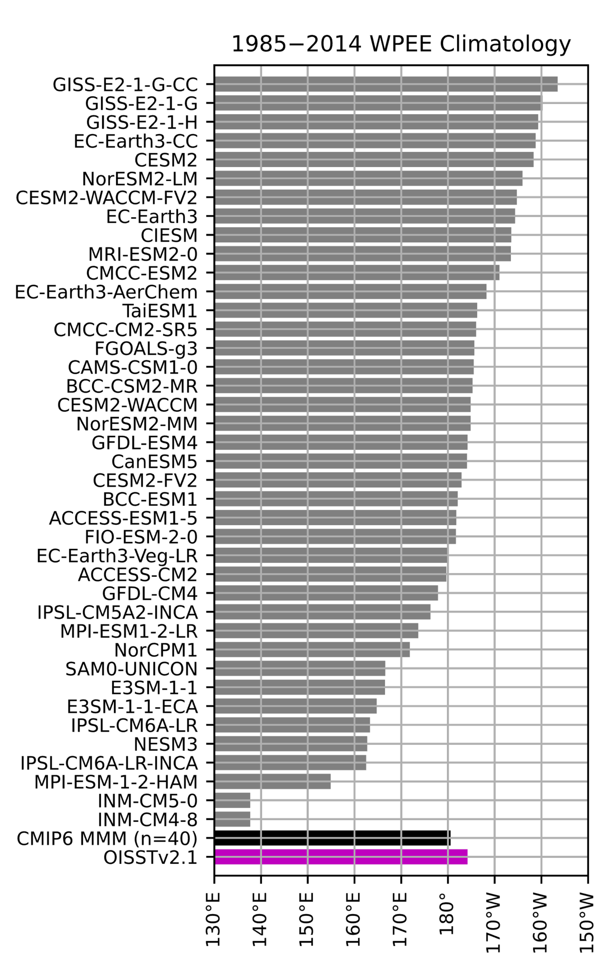
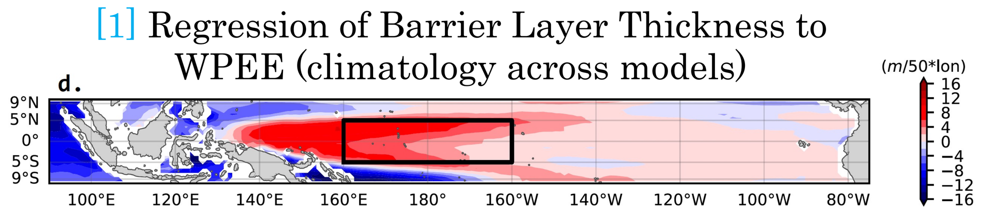
- Cold tongue bias
- Too-strong easterly winds in the W. Pacific
- Double-ITCZ bias



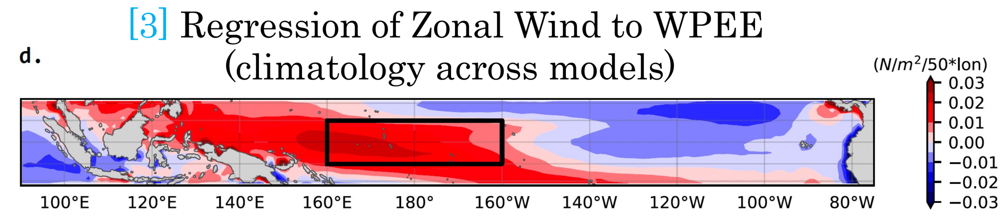
CMIP6 Intermodel Spread

- Models with a more eastward-extending WPEE climatology generally exhibit larger BLT [1] and reduced upper-ocean salinity climatology [2] in the equatorial W. Pacific.
- This low-salinity mean states can be explained by strong westerly winds [3] and high precipitation climatology [4] for models with a more eastward-extending WPEE.

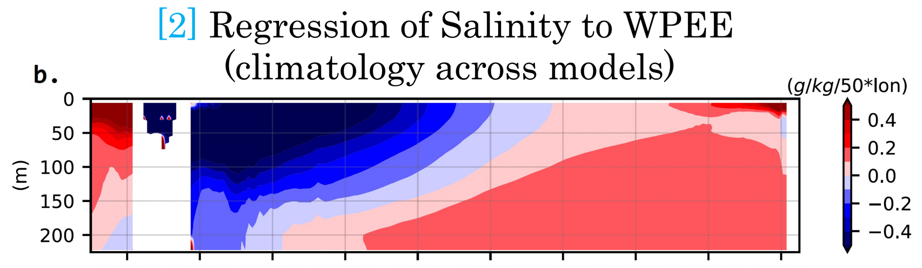
[1] Regression of Barrier Layer Thickness to WPEE (climatology across models)



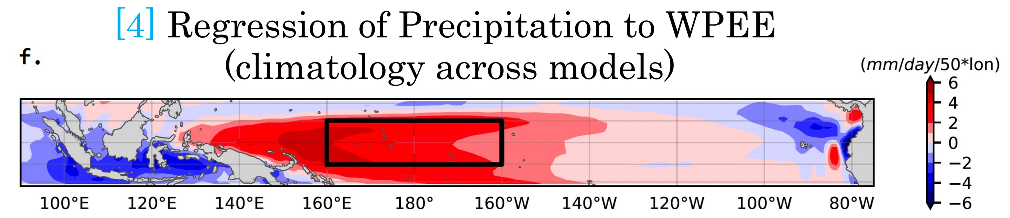
[3] Regression of Zonal Wind to WPEE (climatology across models)

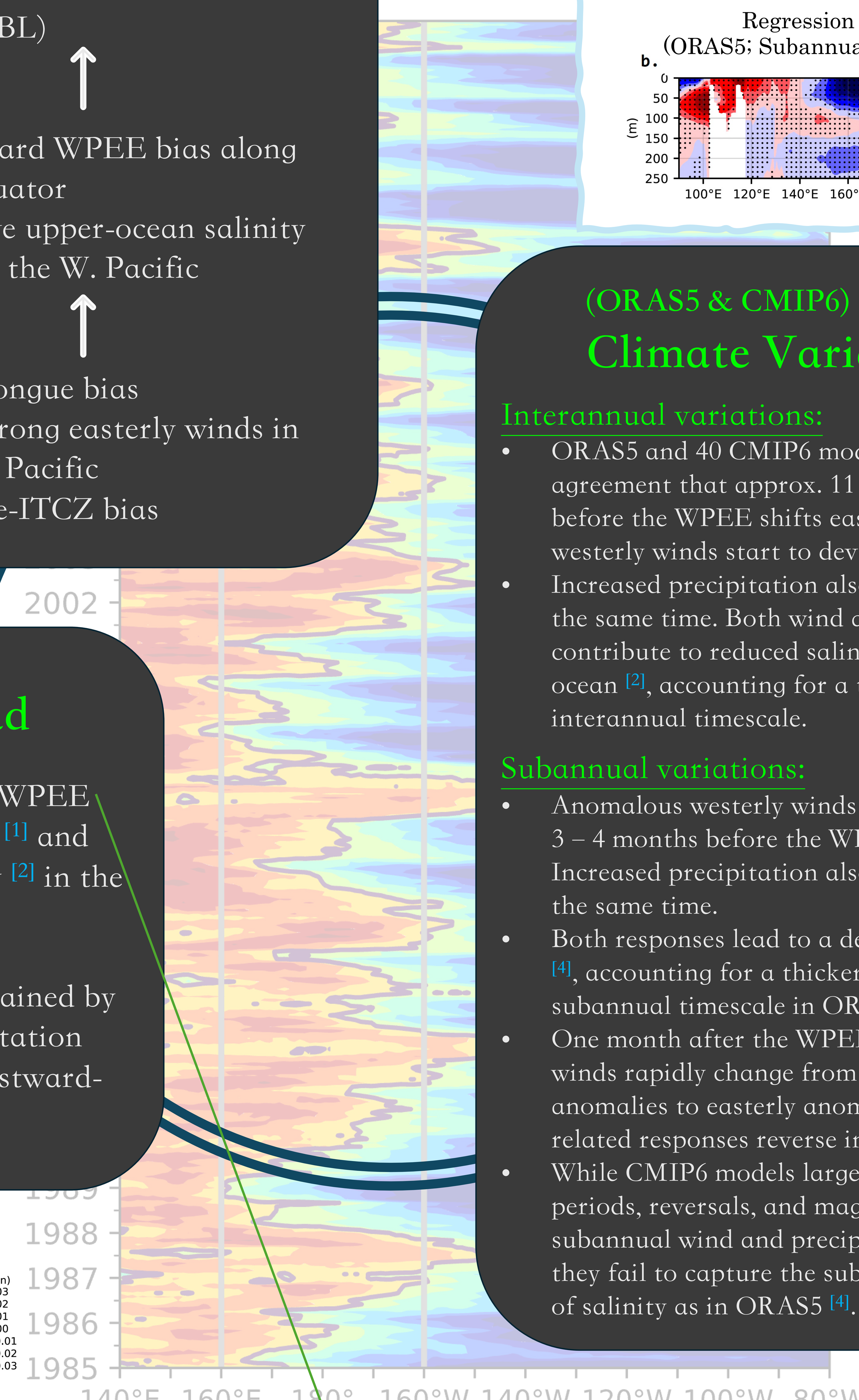


[2] Regression of Salinity to WPEE (climatology across models)



[4] Regression of Precipitation to WPEE (climatology across models)

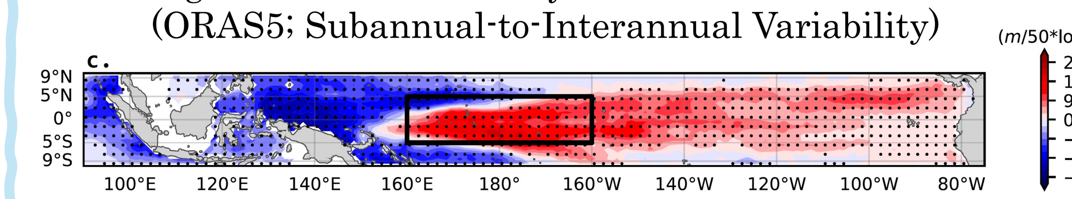




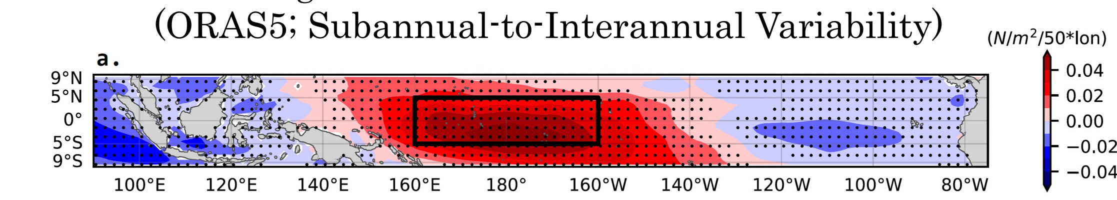
Warm Pool Eastern Edge (WPEE)

WPEE is defined as the longitude where the 5°S–5°N averaged SST equals 28.5 °C within the bounds of the western Pacific warm pool region, 130°E–120°W. This longitude range is selected based on observational warm pool extent variations.

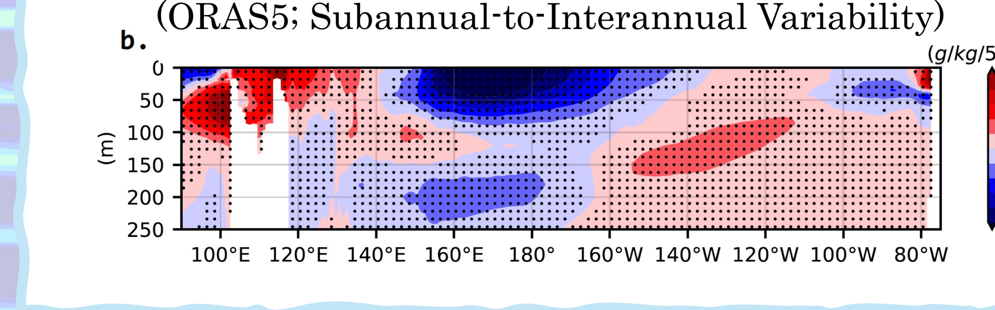
Regression of Barrier Layer Thickness to WPEE (ORAS5; Subannual-to-Interannual Variability)



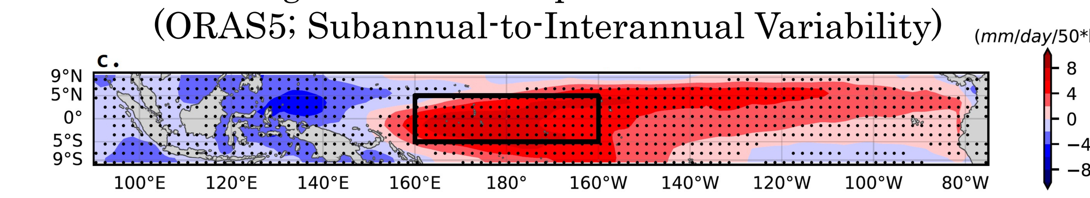
Regression of Zonal Wind to WPEE (ORAS5; Subannual-to-Interannual Variability)



Regression of Salinity to WPEE (ORAS5; Subannual-to-Interannual Variability)



Regression of Precipitation to WPEE (ORAS5; Subannual-to-Interannual Variability)



(ORAS5 & CMIP6) Climate Variability

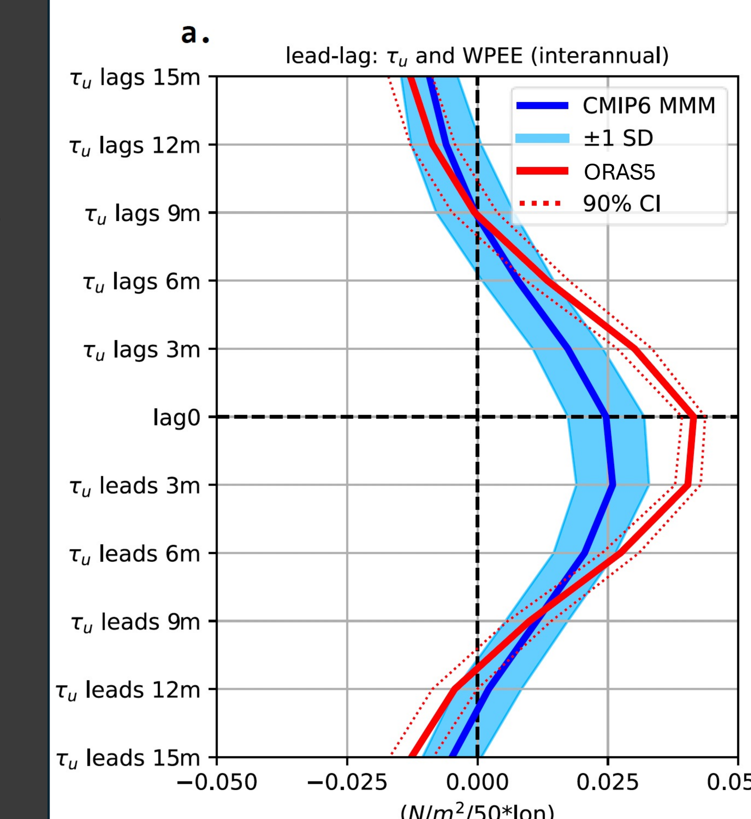
Interannual variations:

- ORAS5 and 40 CMIP6 models show strong agreement that approx. 11 – 13 months before the WPEE shifts eastward, anomalous westerly winds start to develop [1].
- Increased precipitation also begins around the same time. Both wind and precipitation contribute to reduced salinity in the upper ocean [2], accounting for a thicker BL on an interannual timescale.

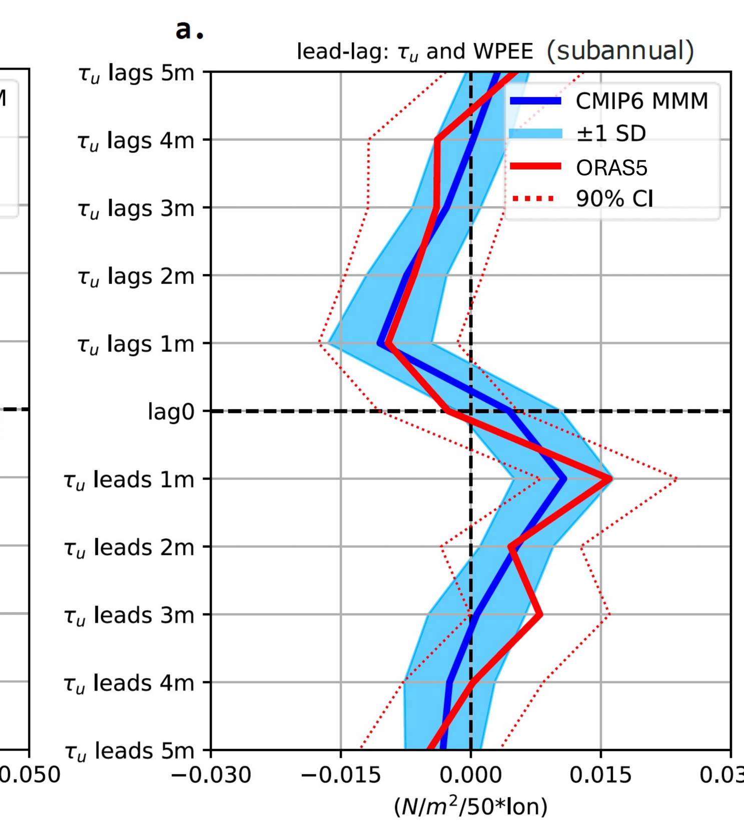
Subannual variations:

- Anomalous westerly winds start to develop 3 – 4 months before the WPEE in ORAS5 [3]. Increased precipitation also emerges around the same time.
- Both responses lead to a decrease in salinity [4], accounting for a thicker BL on a subannual timescale in ORAS5.
- One month after the WPEE shift in ORAS5, winds rapidly change from westerly anomalies to easterly anomalies [3], and all related responses reverse in sign.
- While CMIP6 models largely capture the periods, reversals, and magnitudes of subannual wind and precipitation variability, they fail to capture the subannual variations of salinity as in ORAS5 [4].

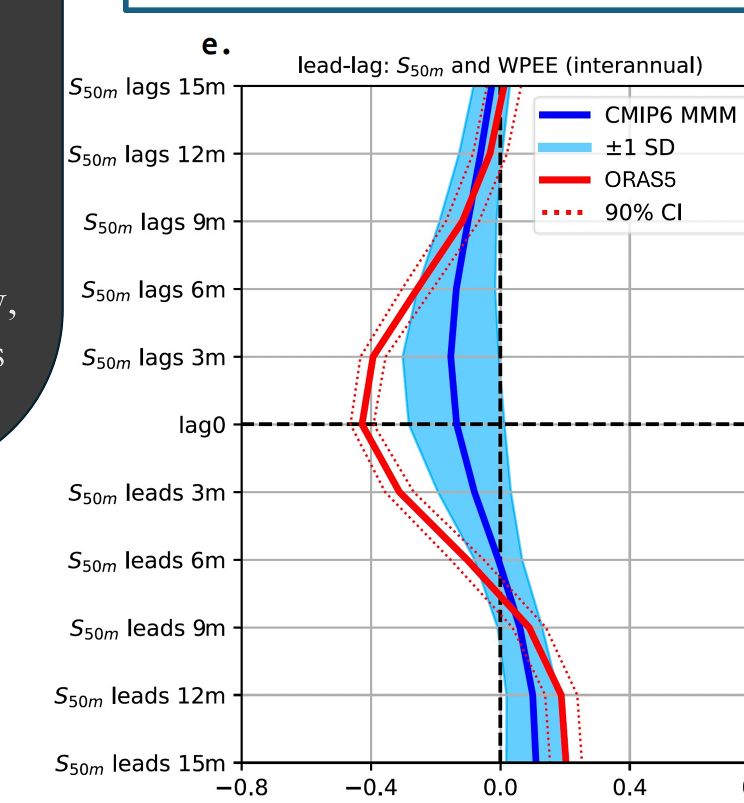
[1] Lead-lag regression of zonal wind against WPEE (**interannual** timescale)



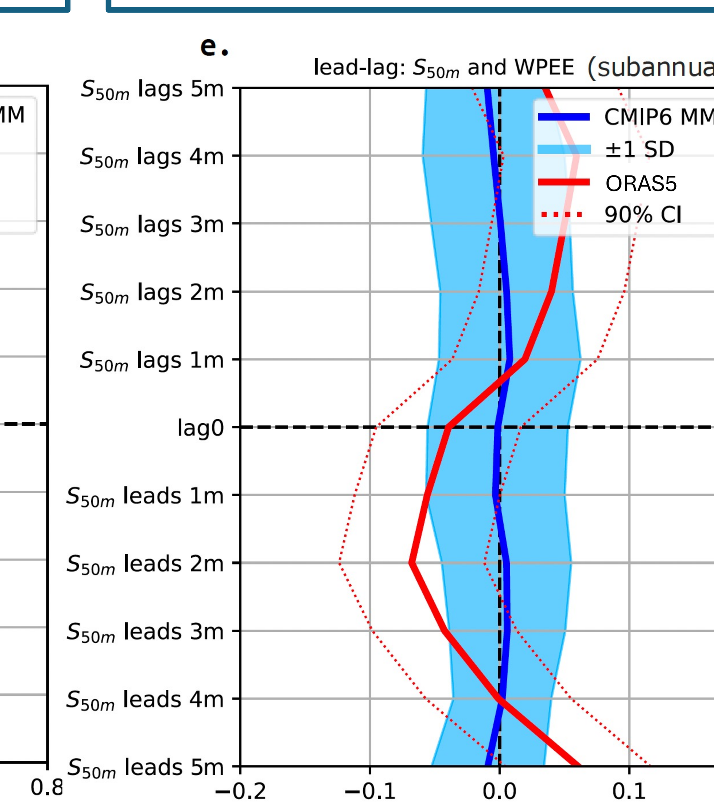
[3] Lead-lag regression of zonal wind against WPEE (**subannual** timescale)



[2] Lead-lag regression of 50m salinity against WPEE (**interannual** timescale)



[4] Lead-lag regression of 50m salinity against WPEE (**subannual** timescale)



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