Regional Coupled Modelling of the eastern equatorial Pacific with CROCO-WRF: Mesoscale air-sea coupling and mixing

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Australian Government
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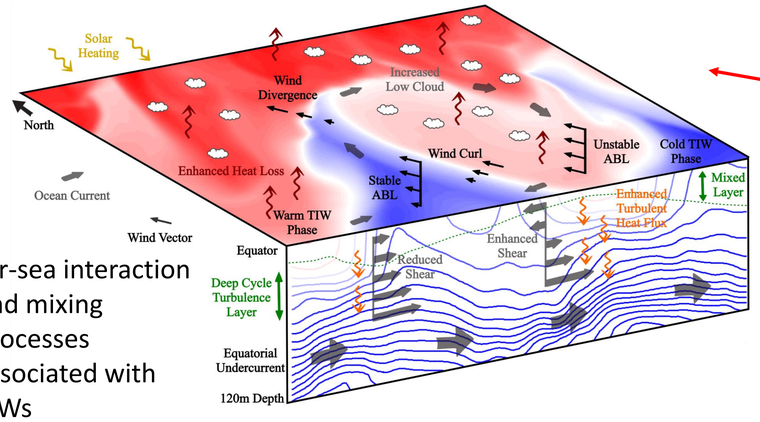
Motivation

GCMs suffer from biases in the tropical Pacific that affect projections/predictions. This project aims to study key small-scale processes that are thought to impact equatorial circulation/climate, but are missing from GCMs:

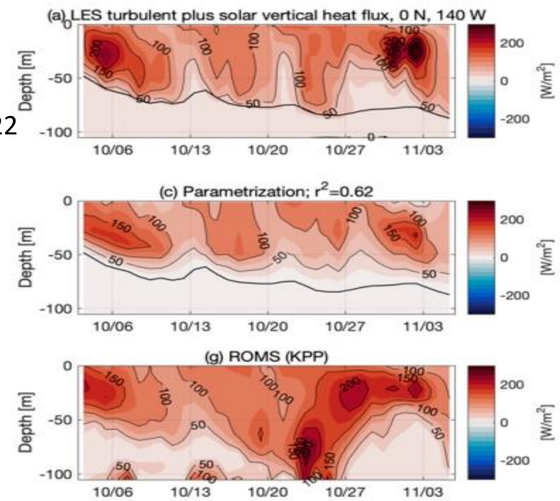
Air-sea coupling: Mesoscale features (e.g. TIWs) impact the atmosphere through a host of mechanisms. **How do these impacts feedback onto the ocean, atmosphere and ENSO?**



Air-sea interaction and mixing processes associated with TIWs

Turbulent mixing: Shear-driven mixing in the EUC plays a key role in SST/momentum budgets. Mixing is strongly shaped by the mesoscale. Yet existing parameterizations have known issues. Recent work highlights potential ways forward, but has so far been disconnected from GCM work (e.g. KPP is dominant and largely unchanged since 1990s!).

Whitt, Cherian, Holmes et al. (2022 JPO): LES simulations embedded in regional model suggest new scaling for EUC shear mixing



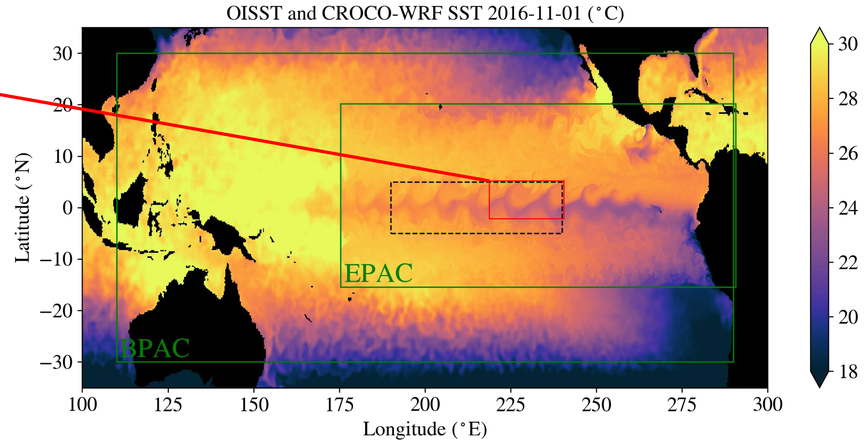
Due to the strong local air-sea coupling, parameterizations should be tested in coupled mode (Richards et al. 2009)

The Model and Approach

We need a

1) **coupled,**
2) **ocean mesoscale/front resolving,**
3) **boundary constrained (regional eastern equatorial Pacific)**

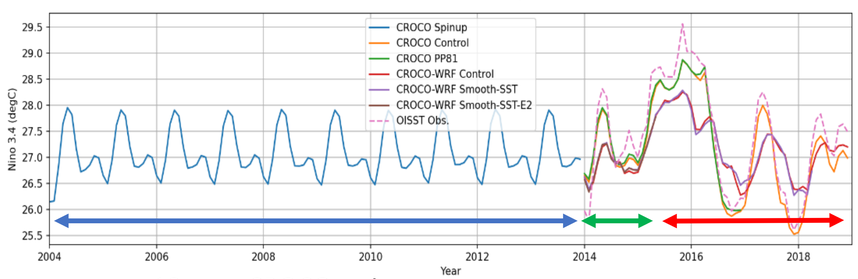
model to study the dynamics and test mixing sensitivities. The chosen solution: ***1/14-degree, 75 vertical levels CROCO + ¼-degree WRF*** with SODA3.4.2 ocean BCs and ERA-5 atmospheric BCs/forcing over EPAC domain. Plans for a future BPAC basin-wide domain.



Experiments

- Control CROCO and CROCO-WRF simulations covering 2014-2019
- CROCO-WRF "Smooth SST": Filter applied through OASIS to pass smoothed no-TIW SST to atmosphere. **No thermal feedback**
- No **current feedback** (CFB): no ocean currents passed to atmosphere
- No Mesoscale CFB: Smoothed ocean currents passed to atmosphere
- Planned mixing sensitivity experiments: KPP vs. PP81 vs. Whitt et al. vs. Neural Network trained (Moum et al.)

Nino 3.4 SST time series from initial EPAC CROCO-only and CROCO-WRF experiments

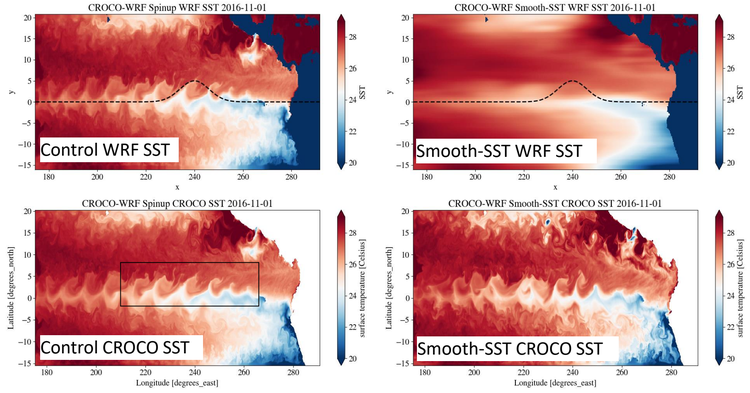


10-year CROCO-only spinup (2014 repeats)

1-year CROCO-WRF spinup

Analysis period

Preliminary air-sea coupling results



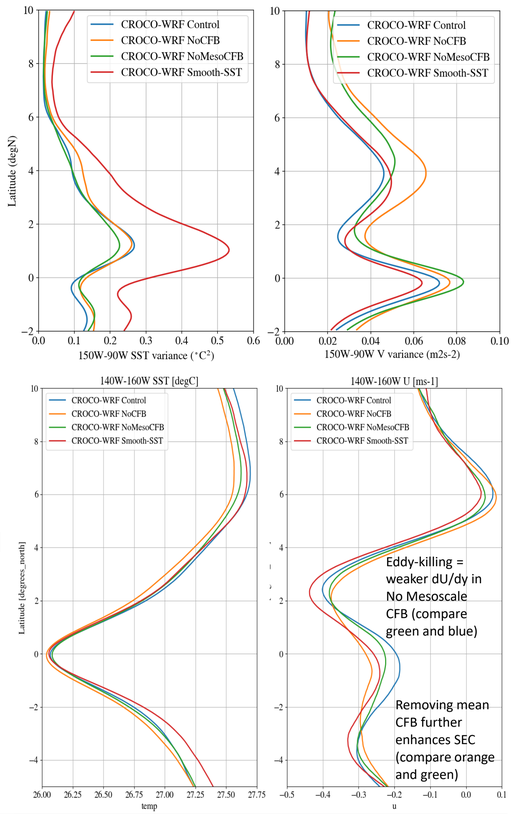
- SST variability enhanced by factor of 2 in Smooth-SST

- U/V variability enhanced in no-CFB experiments.

- Mean CFB important: No CFB differs from No-Mesoscale CFB

- Noticeable impacts on SEC and SEC-EUC shear

- Impacts on mean SST weak.



Next steps/questions

- Conduct mixing sensitivity exps. (CROCO and CROCO-WRF)
- Can OASIS smoothing be used more generally? E.g. smoothing kappa, currents etc. to evaluate eddy effects
- Impacts on ENSO: BPAC domain. How constrained will the solution be?
- Feed new knowledge back to ACCESS