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Western Pacific Warm Pool Task Force Meeting

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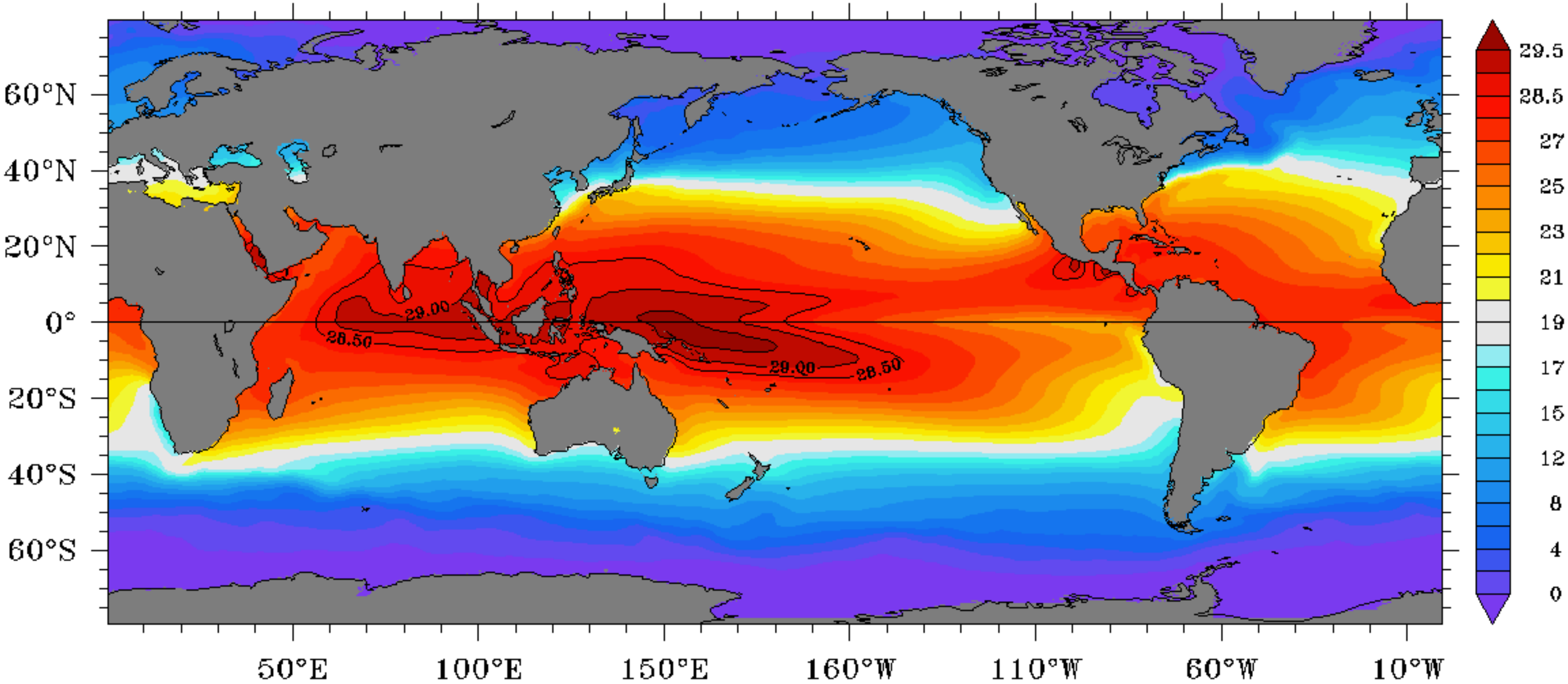
Objectives

- To revisit some of the fundamental mechanisms driving the dynamics of the Western Pacific Warm Pool (WPWP), particularly at its equatorial eastern edge, to determine whether further research was warranted and what form this should take.



Specific Objectives

- What are the characteristics of the edge of the WPWP?
- What are the dynamics that determine the structure of the WPWP?
- How is the WPWP edge important to ENSO dynamics?
- How has the WPWP changed over the last 50 years and how might it change in the future?

Topics discussed

- Defining the eastern edge of the WPWP
- Variability and Trends in the WPWP
- Barrier Layers
- Primary Productivity
- Simulating the WPWP in CMIP5
- Need to understand the WPWP now and in the future:
  - Coral bleaching
  - Tropical Tuna
- Atmospheric interactions
- Schematic of the WPWP mean state and changes for El Nino conditions

Defining the eastern edge

- It is apparent that there is no one 'best' metric for defining the edge, rather a variety of metrics are necessary depending on application and where changes in the background state are occurring (see Table in next slide). While these metrics are all strongly correlated, they diverge at certain times (Picaut et al. 2001). The reason for this divergence is still not fully understood.

Why are we interested in the WPWP?

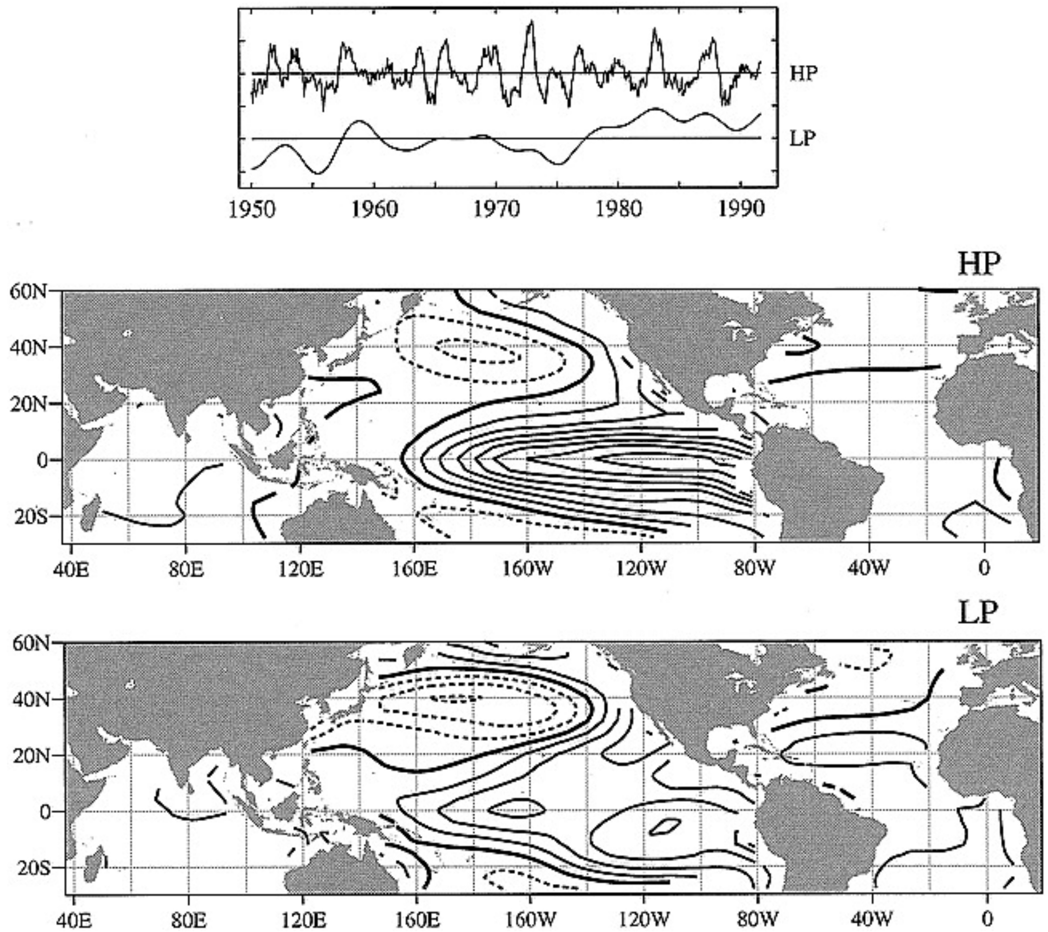
- From a thermodynamical point of view: SST (for the ocean/atmosphere coupling)
  - Which isotherm?
- From a dynamical point of view: convergence zone at the equator (for ENSO dynamics)
  - Position of the convergence zone
  - Proxies for the convergence zone
- From a biological point of view: bio. front
  - Are these positions collocated?

Metrics used to describe the edge of the Western Pacific Warm Pool and their advantages and disadvantages

Warm Pool Edge metric	Advantages	Disadvantages
SST threshold (28 - 30°C)	• Important for atmospheric response, e.g. convection, tropical cyclones, intraseasonal variability including WWBs. • Satellite and in-situ data products readily available.	• Strongly affected by background warming • Inconsistent thresholds between models • Higher SST isotherms not always present • Decouples from other definitions in extreme events and at high-frequency time scales (such as diurnal cycle).
SSS threshold (34.2 to 35.2)	• More closely representative of dynamical edge.	• Same as above • Limited data availability, though new satellite products (SMOS & Aquarius) now available
Maximum SSS gradient	• Insensitive to background state • Representative of dynamical edge	• Limited data availability • Noisy and may be contaminated by high frequency variability
Isotherm fit to SSS gradient	• As above. • Useful for model intercomparison	• Isotherm needs to be revised with background warming
Density threshold (not common)	• Combines temperature and salinity changes	• Incorporates disadvantages of both temperature and salinity.
Convergence using hypothetical drifters	• Representative of 'dynamical edge' • Can use dynamic height, or satellite mean sea level as proxy	• Need to compute hypothetical drifters • May not converge in models due to the high sensitivity to background mean state • Limited observations and reliance on combined satellite estimates.
Chl-a (e.g. 0.1mg/m^3)	• Sharp front	• Limited to satellite record • May decouple from physical parameters.
Nitrate/pCO2	• Usually tracks the frontal zone	• Limited observations • May decouple from physical parameters.

Variability of the WPWP

- <u>The WPWP has decadal variability </u>(related to ENSO and the Pacific Decadal Oscillation) that needs to be accounted for when exploring long term trends (Zhang and Church 2012). <u>The decadal variability may also alter the dynamics of the WPWP and hence the ENSO mechanisms.</u> (Matthieu Lengaigne's talk yesterday)

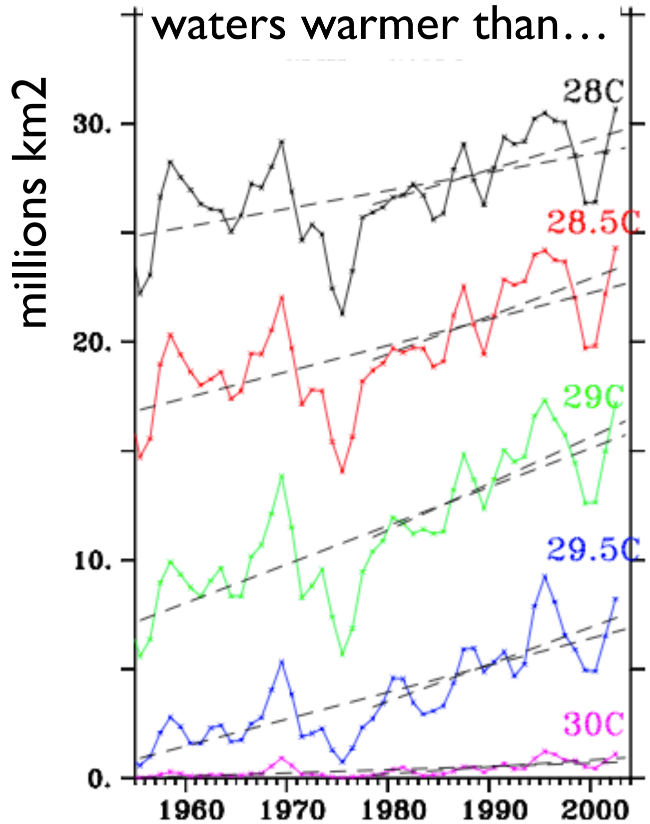


Xuebin Zhang

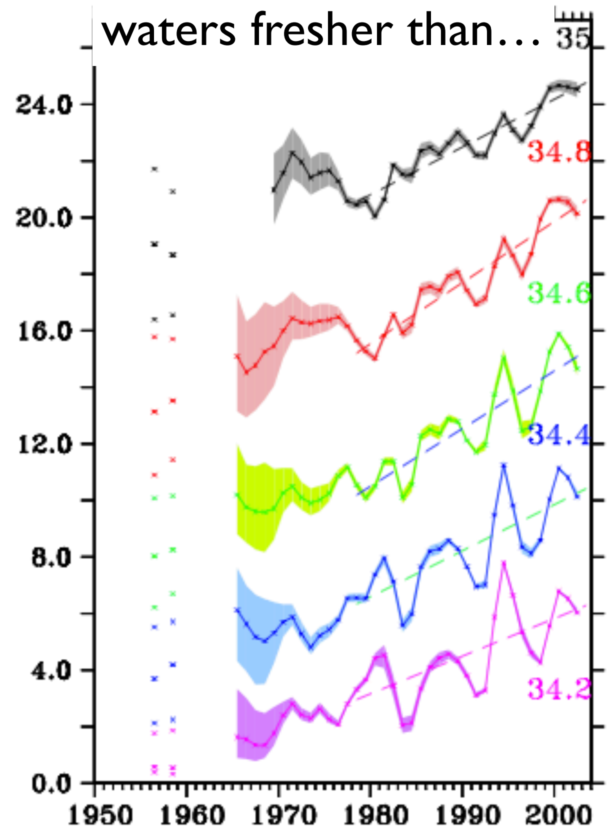
Trends in the WPWP

- Since 1955, different observations consistently show that the WPWP has significantly warmed and freshened.

Area covered by waters warmer than…



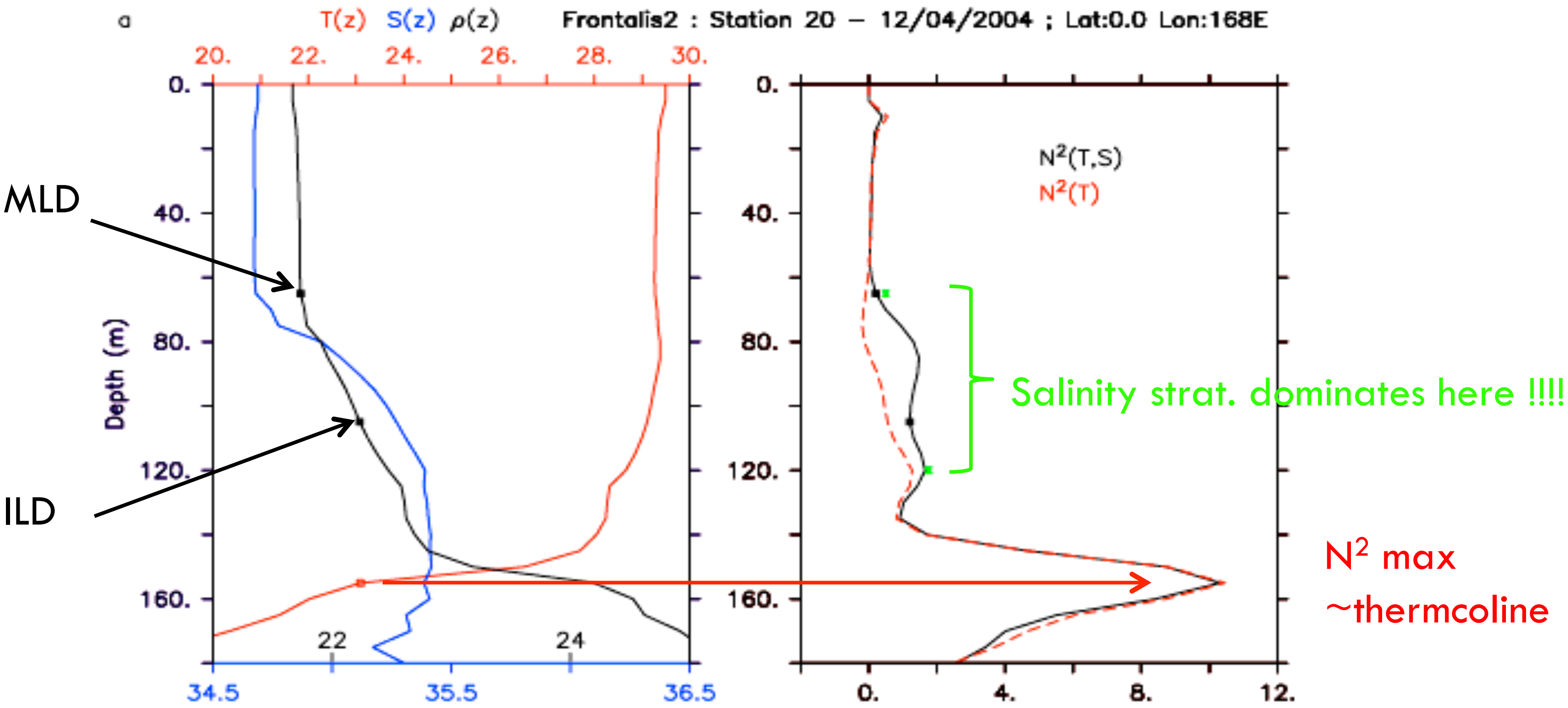
Area covered by waters fresher than…



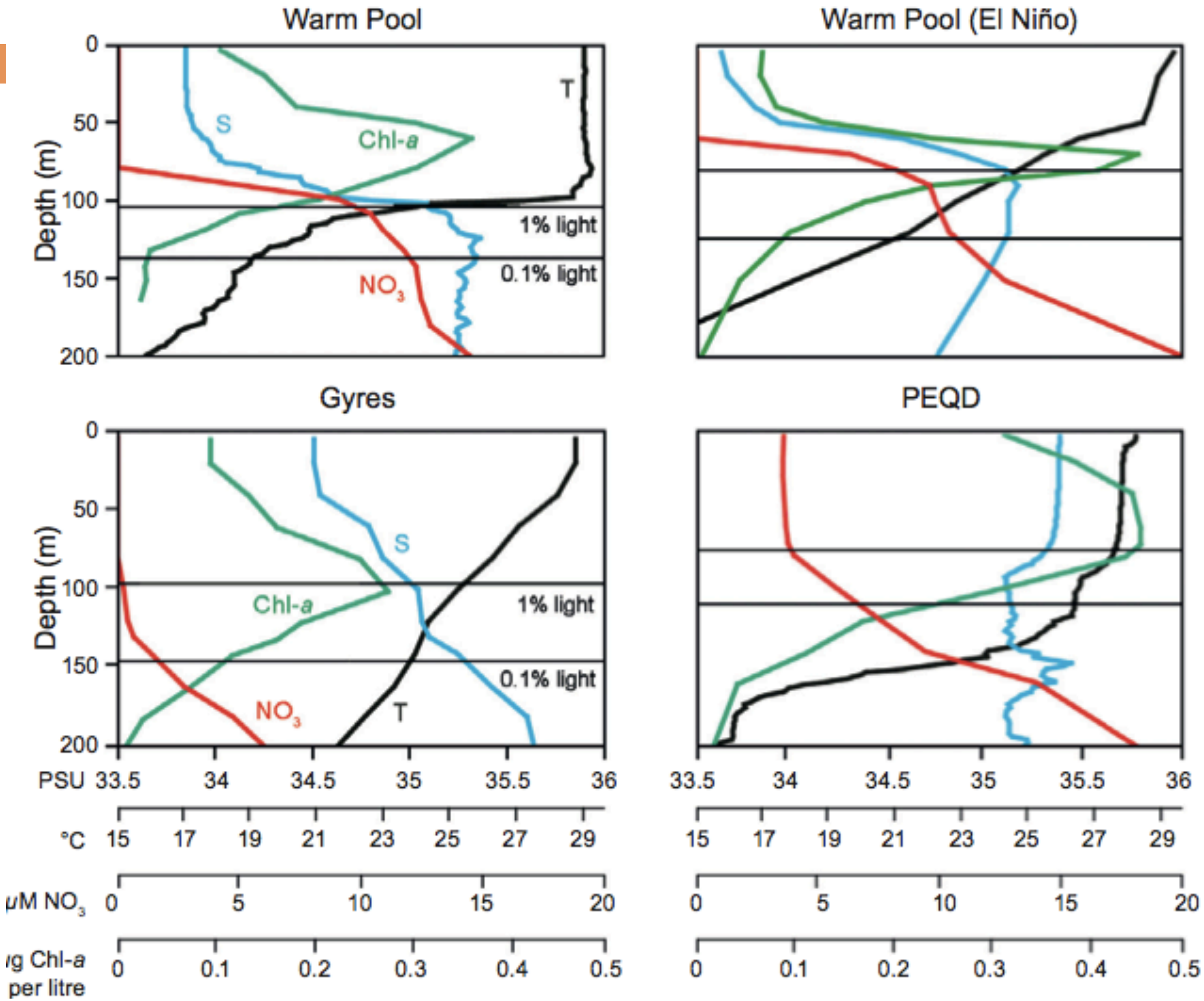
Sophie Cravatte

Barrier Layers

- A remaining question is whether realistic BL variability in models is essential for improving ENSO forecasts and future climate projections.



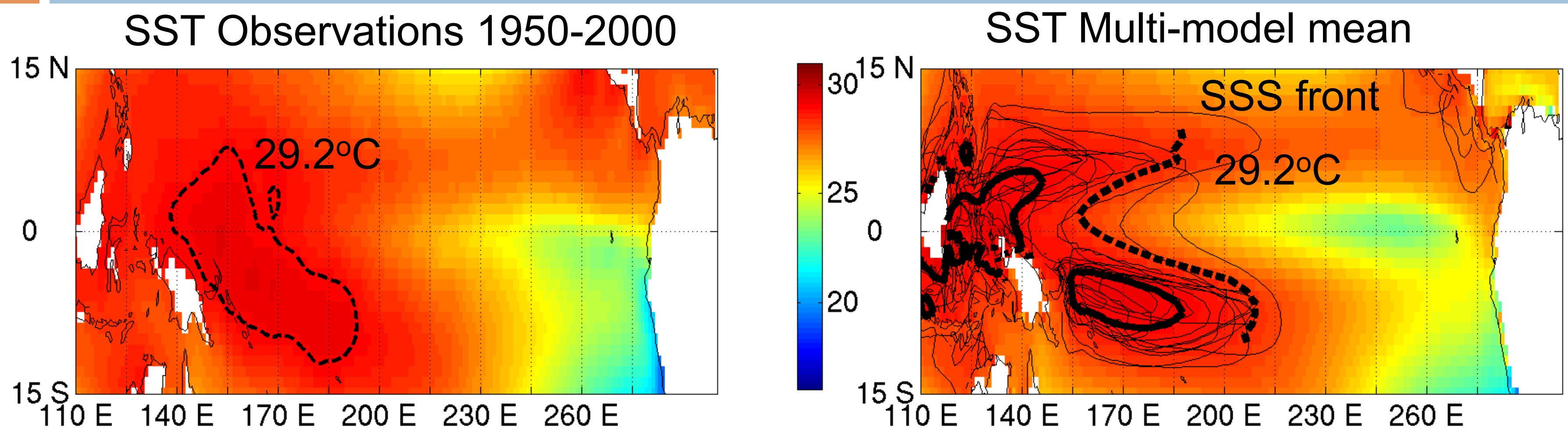
Primary Productivity: Vertical Structure



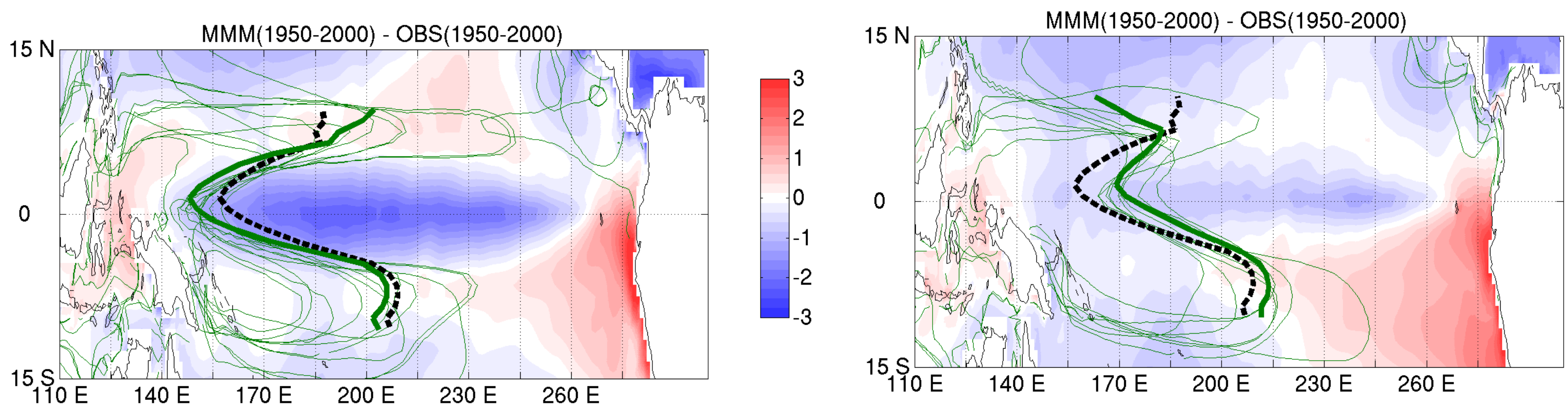
Simulating the WPWP in CMIP5

- Surprisingly, even models with a very poor representation of the WPWP still often simulate a realistic Nino3.4 variability. This implies that their ENSO dynamics must be quite different to what is observed. Regardless of the simulation of the WPWP edge, models show a zonal structure to the warming pattern. There appears to be a lower rate of warming inside the warm pool than in the cold tongue to the east, in the 2050-2100 period under the RCP8.5 scenario (Brown and Langlais, submitted).

Dynamic Warm Pool Edge using SSS front



New metric – the warm pool edge is better simulated in CMIP5 than if assessed only on temperature.



Need to understand the WPWP now and in the future

Coral bleaching

- The coral within the WPWP have been projected to be one of the first to suffer from an increased frequency of bleaching events under various climate change scenarios (Meissner et al. 2012).
- Due to a low temperature variability (no seasonality and low interannual variability), the coral reefs within the WPWP are projected to have the latest onset of severe bleaching risk in the Western Pacific, but the fastest rate of risk increase (Langlais et al., submitted).
- These reefs are projected to be one of the first to suffer from an increased frequency of bleaching events. The fastest rate also implies that they would require a fastest adaptation.
- Accurate temperature and acidification projections will aid management strategies.

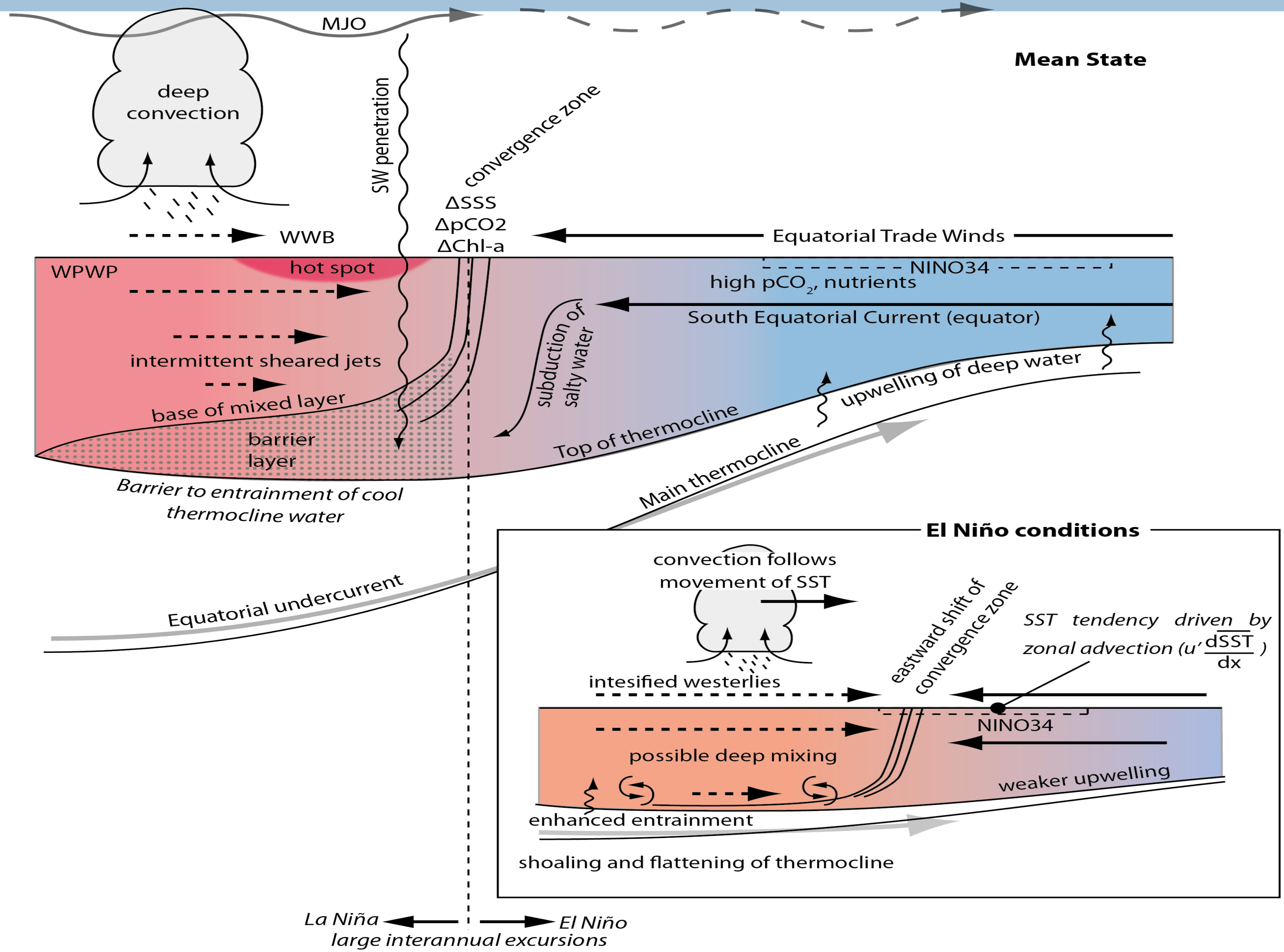
Tropical Tuna

- Tuna fisheries provide a substantial proportion of Gross Domestic Product to Pacific Island nations as well as food security (Bell et al., 2013).
- A strong link was found between the catch per unit effort (CPUE) of skipjack tuna and the edge of the WPWP (Lehodey et al., 2011).
- The causal links between ocean state, biogeochemistry, plankton and tuna behaviour are still being established.

Atmospheric interactions

- We noted at the workshop a lack of understanding of the atmospheric links to the WPWP, particular through atmospheric fluxes, the MJO and WWBs.

Schematic of the WPWP mean state and changes for El Nino conditions (inset)




Thank you!
The Pacific Adventures of the Climate Crab
http://www.pacificclimatechangescience.org/animations/climatecrab/