Timescales of Tropical Pacific Wind Variability and their Relationship with ENSO

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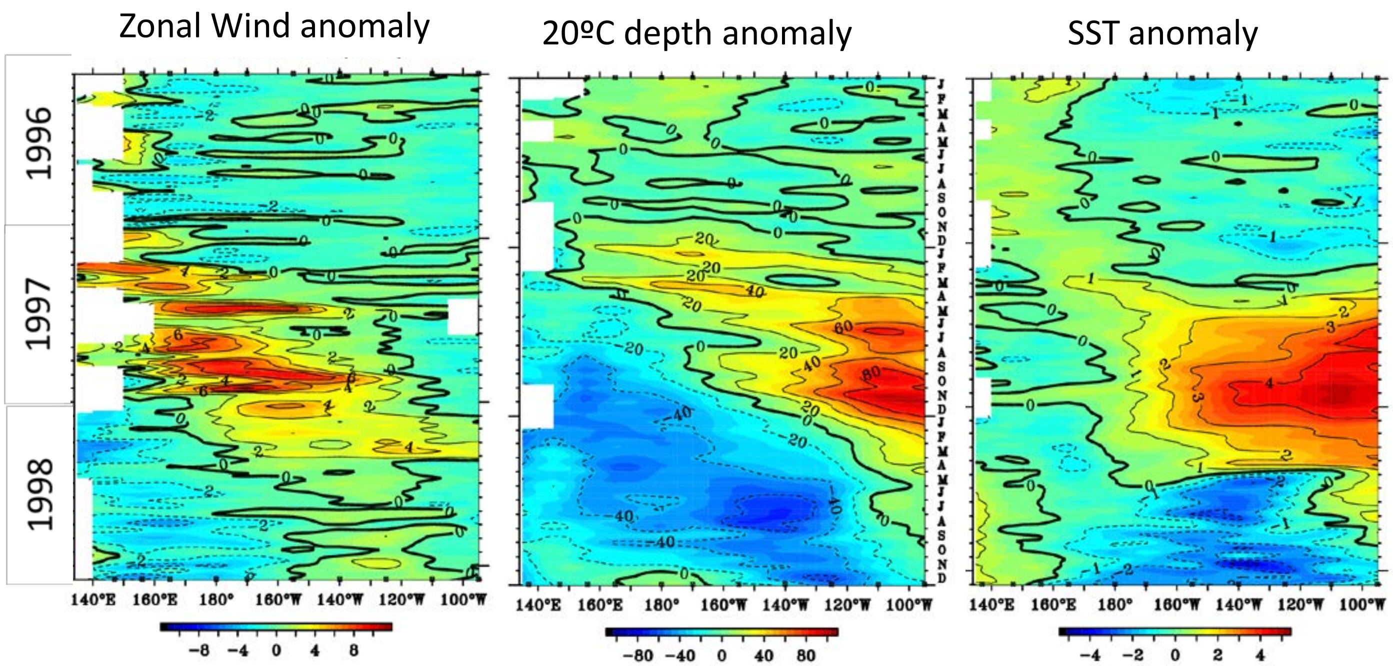
Tropical Atmosphere Ocean (TAO) data suggest important role played by high-frequencies wind anomalies (WWEs)



WWEs → downwelling oceanic Kelvin waves → deeper eastern eq. Pacific thermocline → positive SST’ in eastern Pacific → Bjerknes feedback

WWEs intensify and move eastward as SSTs warm (McPhaden 1998; Yu et al. 2003) → WWEs are state-dependent, multiplicative noise.

Some studies have stressed the importance of individual WWEs, while others have emphasized the low-frequency component of the atmospheric noise.

Questions

1. Is there a state-dependency of intra-seasonal variability on the ENSO state?

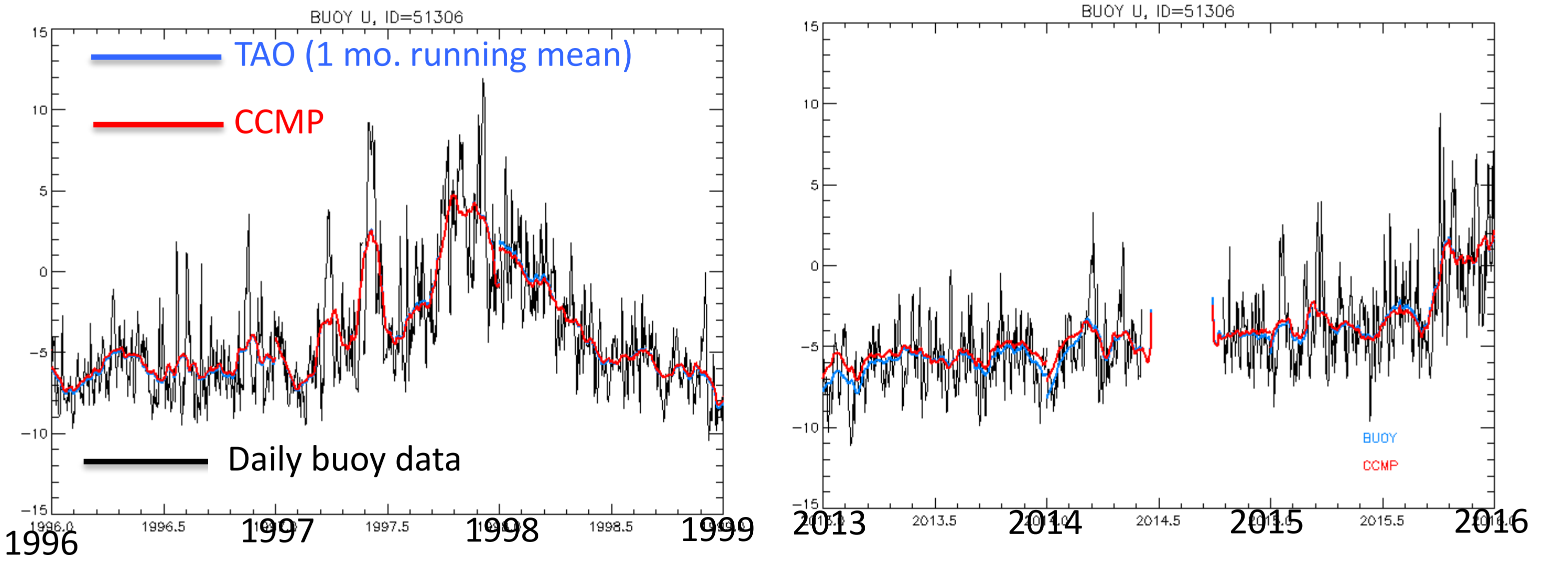
2. Which timescales are most effective in triggering ENSO events? Are individual WWEs important or is their "low frequency component" that matters for ENSO?

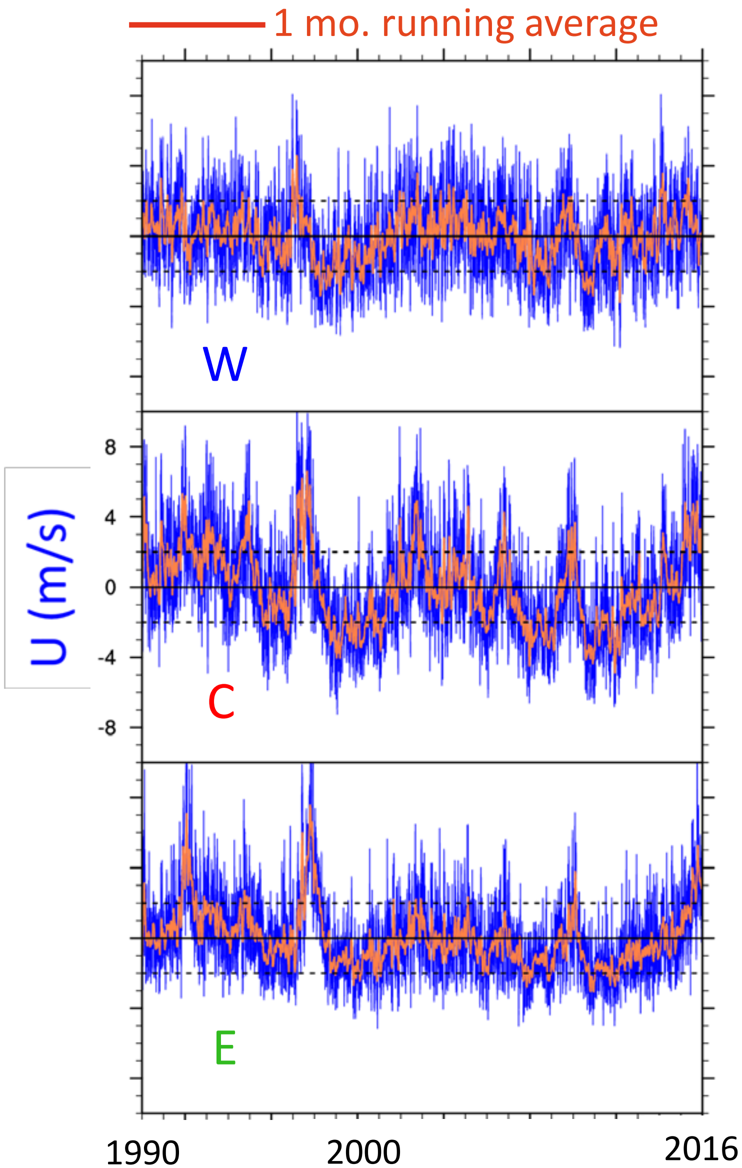
Wind Data

Cross-Calibrated Multi-Platform surface wind vector data Version 2.0 (CCMP V2.0, Remote Sensing Systems), over the period 1988-2015, 6 hourly, 1/4° spatial resolution.

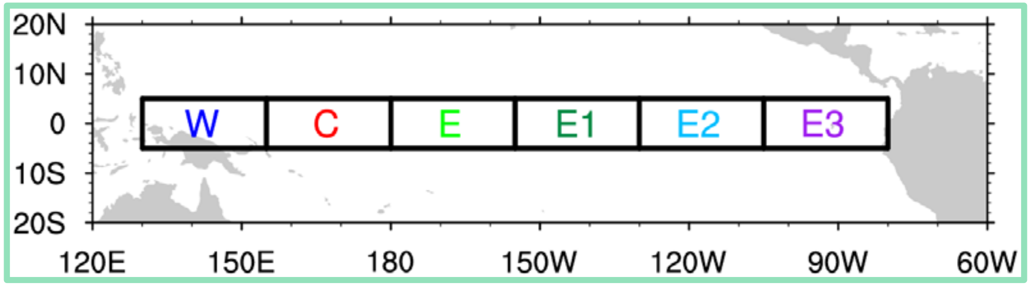
Uses a Variational Analysis Method to combine intercalibrated satellite wind products, ship and buoys data using the ERA-Interim reanalysis as first guess winds.

TAO Buoy 2°S, 190°E



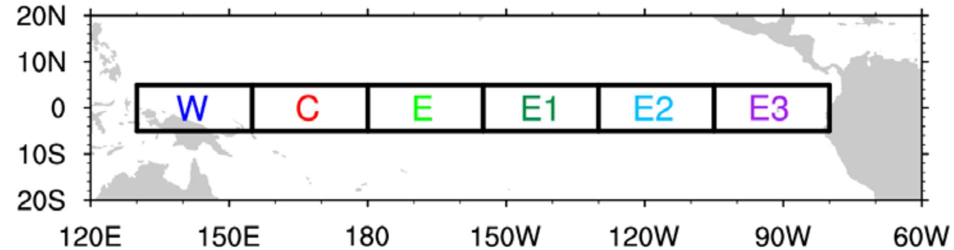


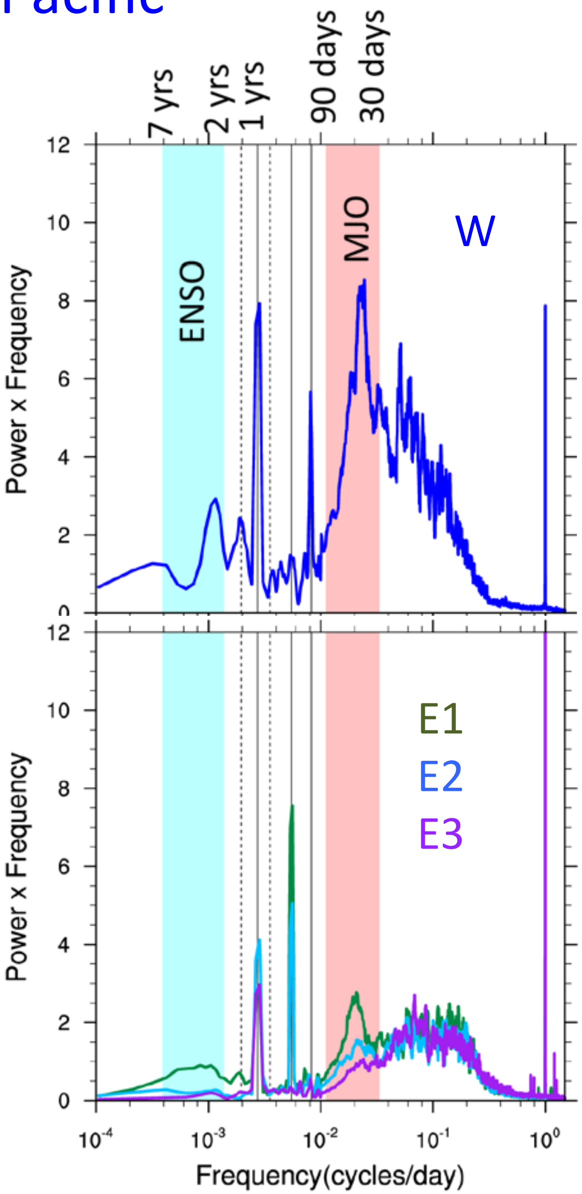
Zonal wind anomalies (U) show variations over a broad range of timescales

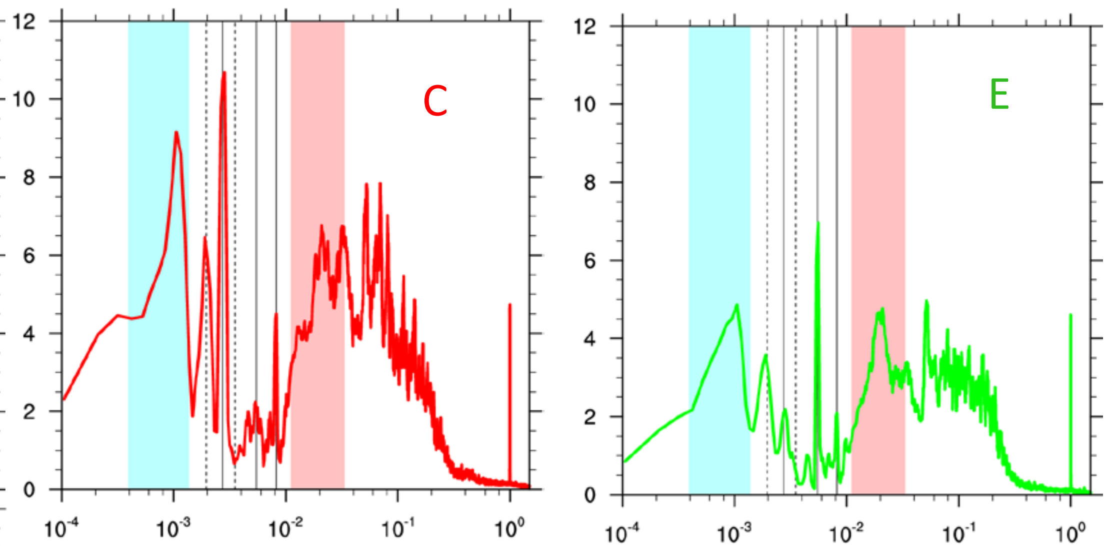


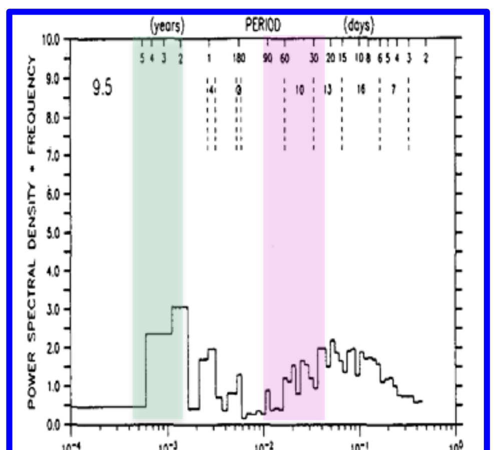
Harrison and Vecchi 1997

Spectral characteristics of zonal winds across the equatorial Pacific



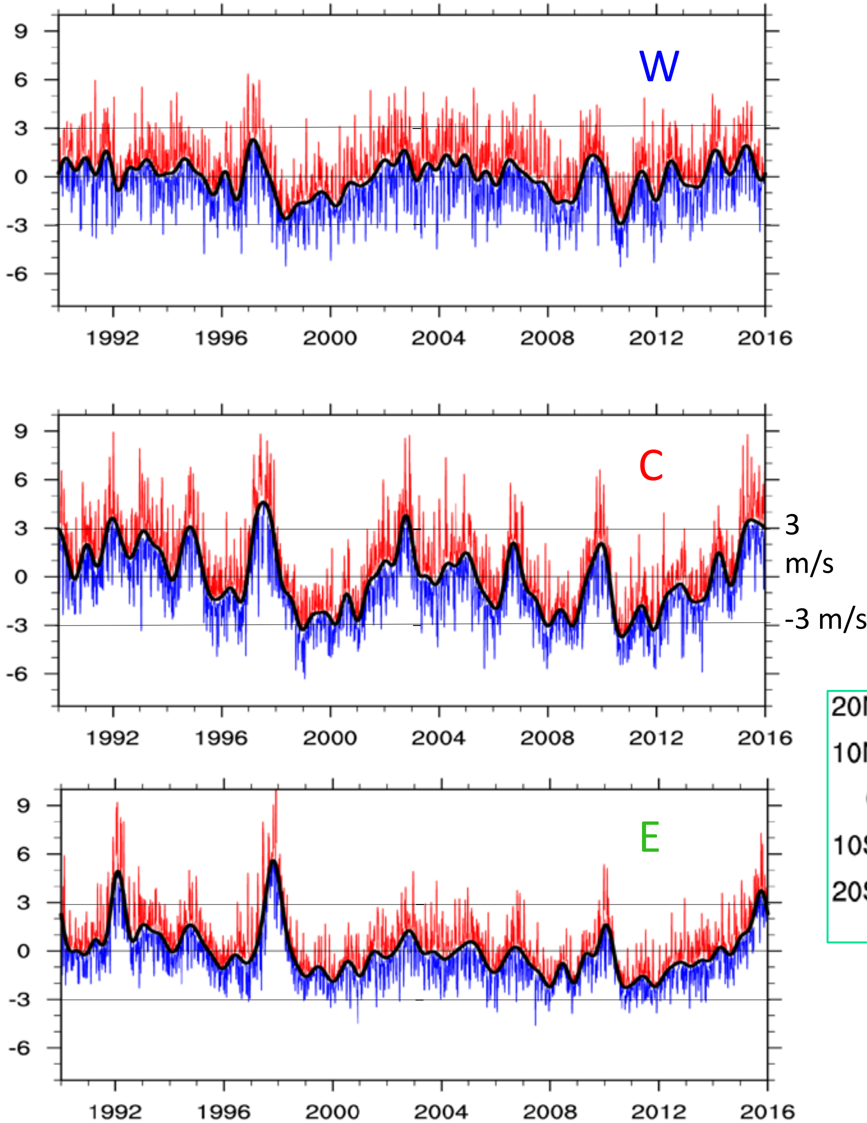






Tarawa (1°N, 173°E)
1949-1980

<u>Harrison and Luther (1990)</u>



Inter-annual

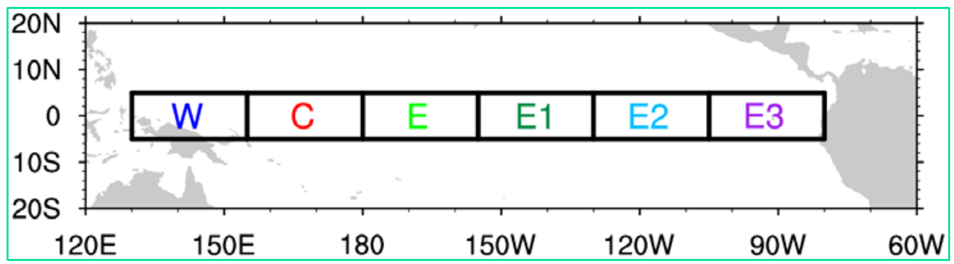
+

Intra-seasonal winds

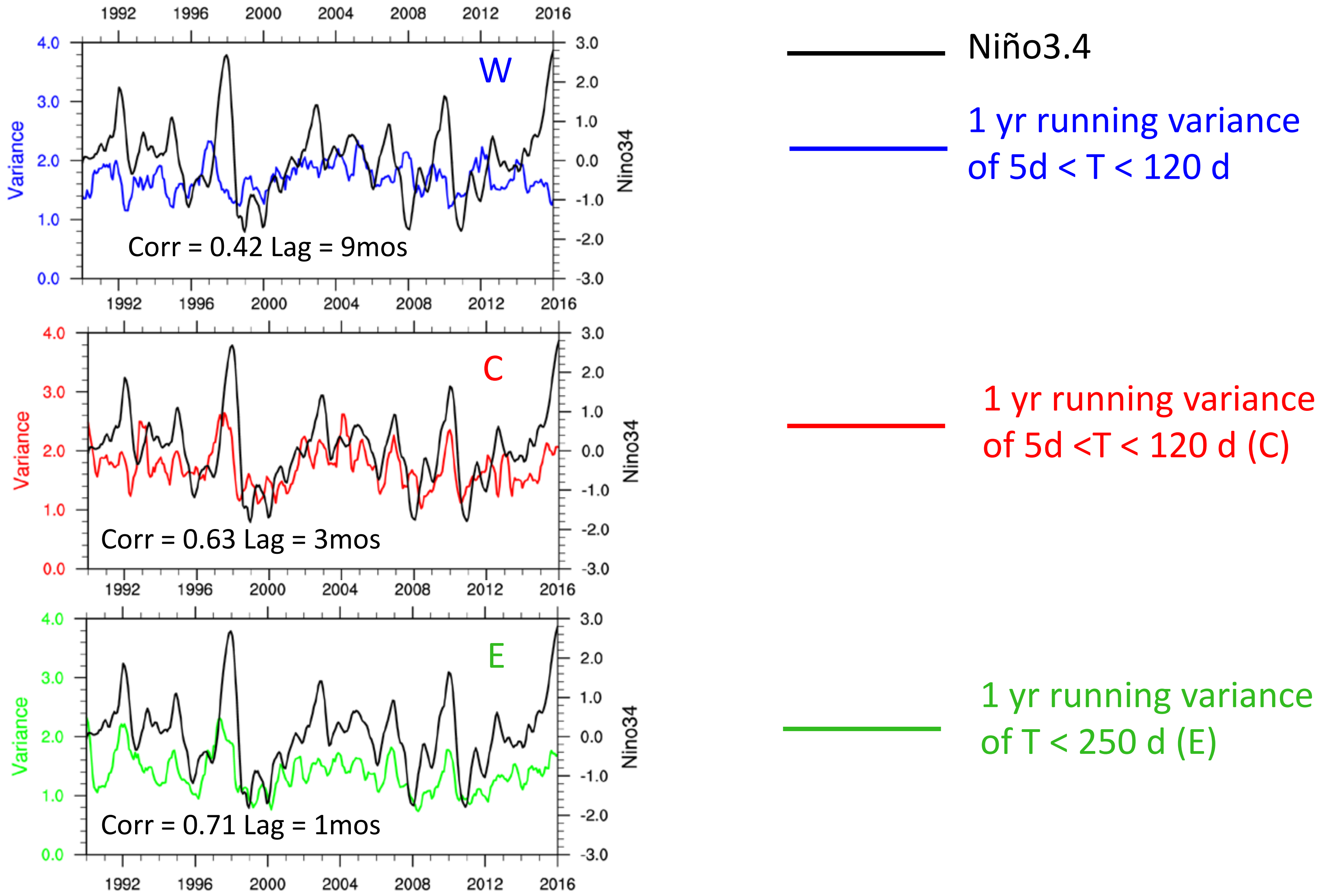
T > 250 days

T < 250 days, positive

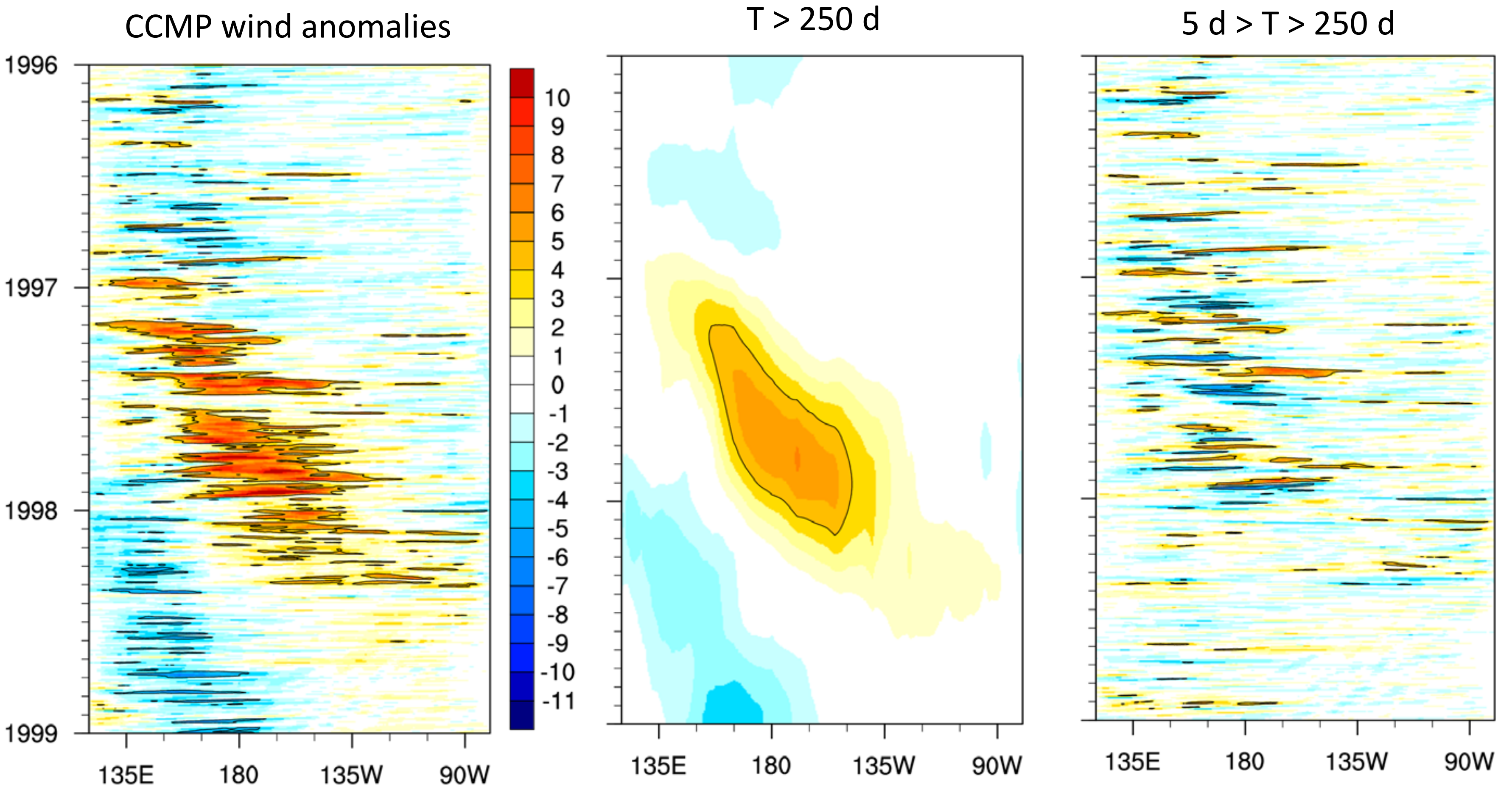
T < 250 days, negative



Is Intra-Seasonal (5 – 120 days) wind activity correlated with ENSO?

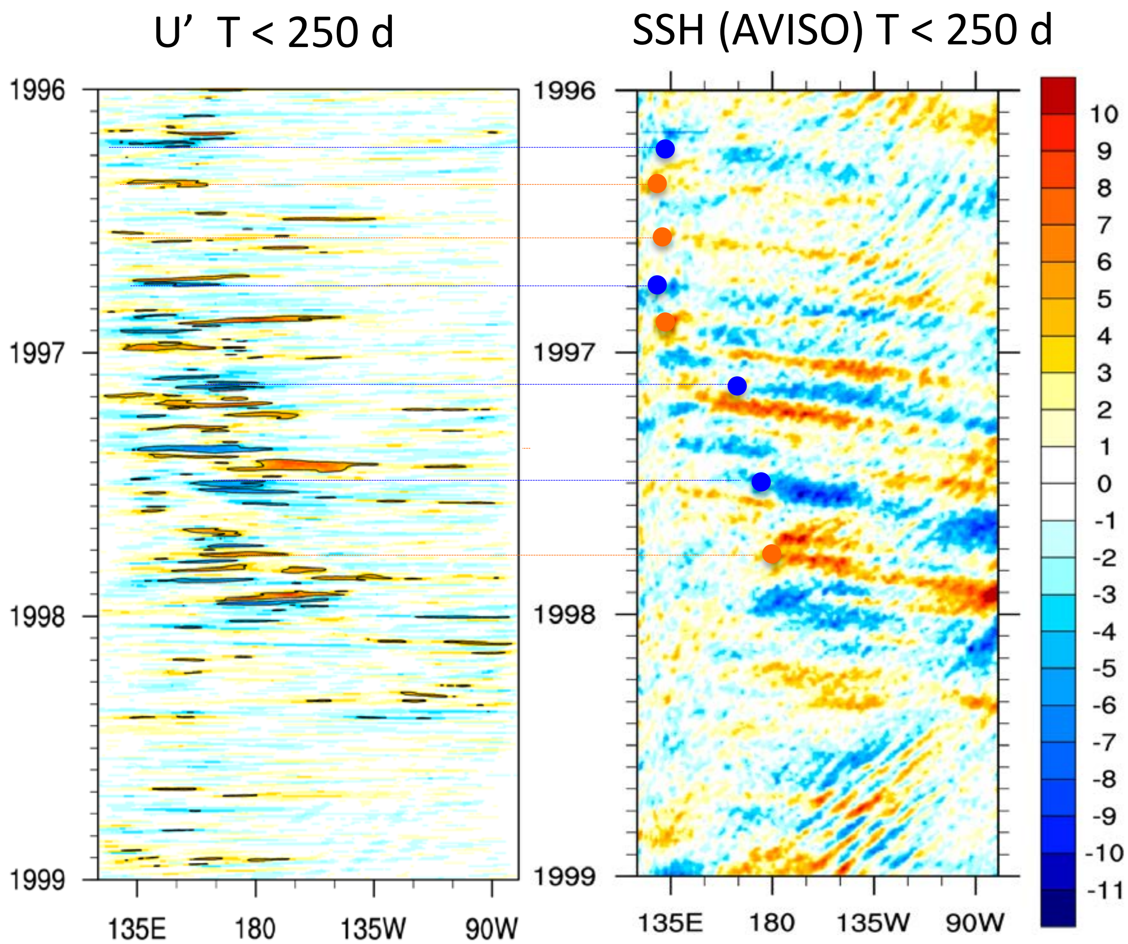


What is the role of different timescales in ENSO evolution?
Do WWEs intensify as they propagate eastward?



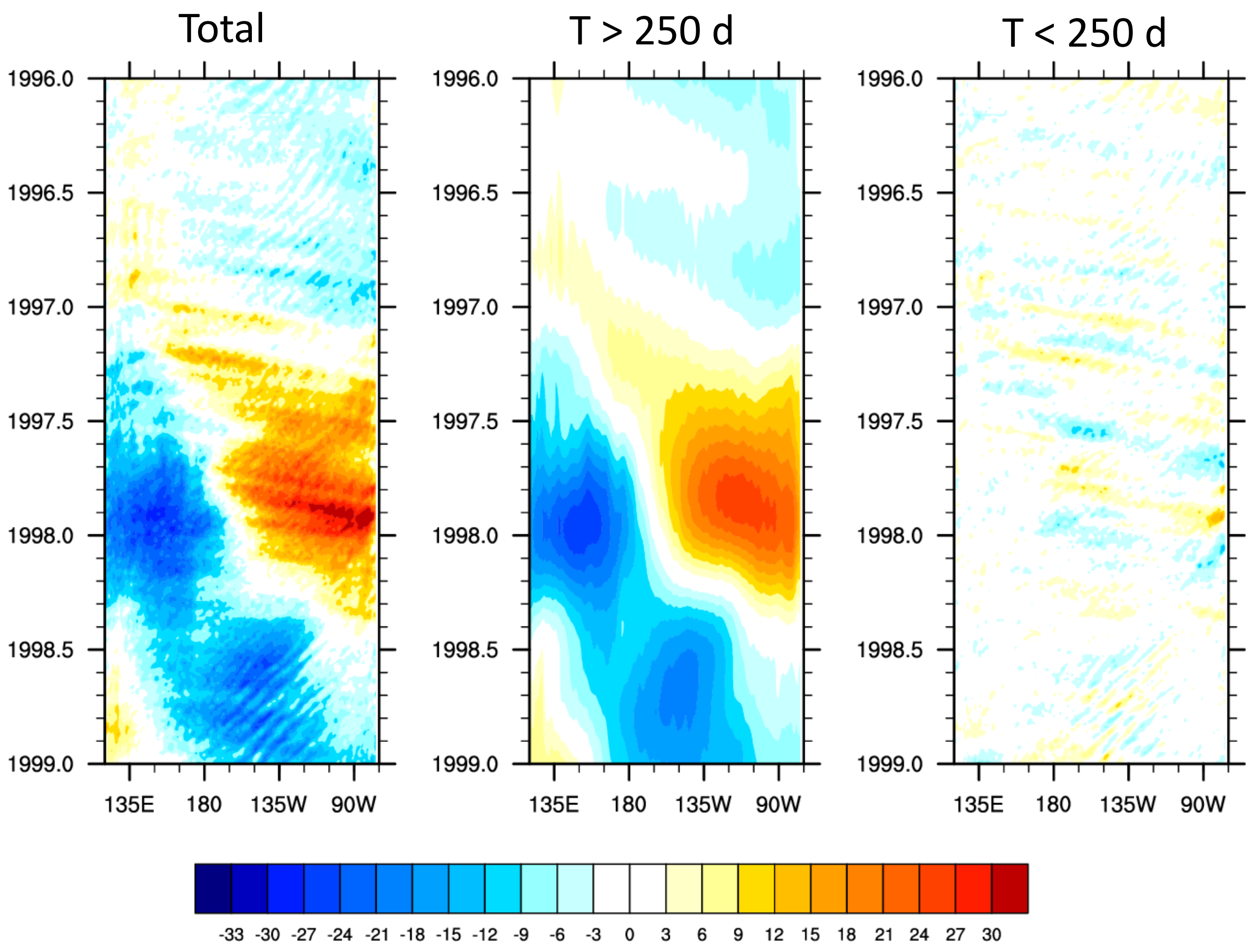
The intensification and eastward propagation of wind anomalies is mainly seen in the interannual wind component

How effective are WWEs in exciting oceanic Kelvin waves and changing the thermocline depth in the eastern Pacific?

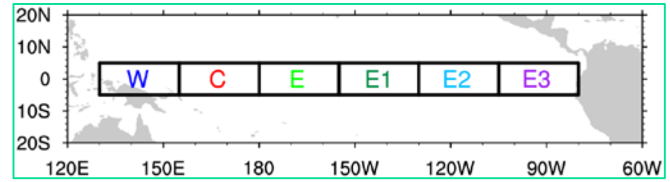


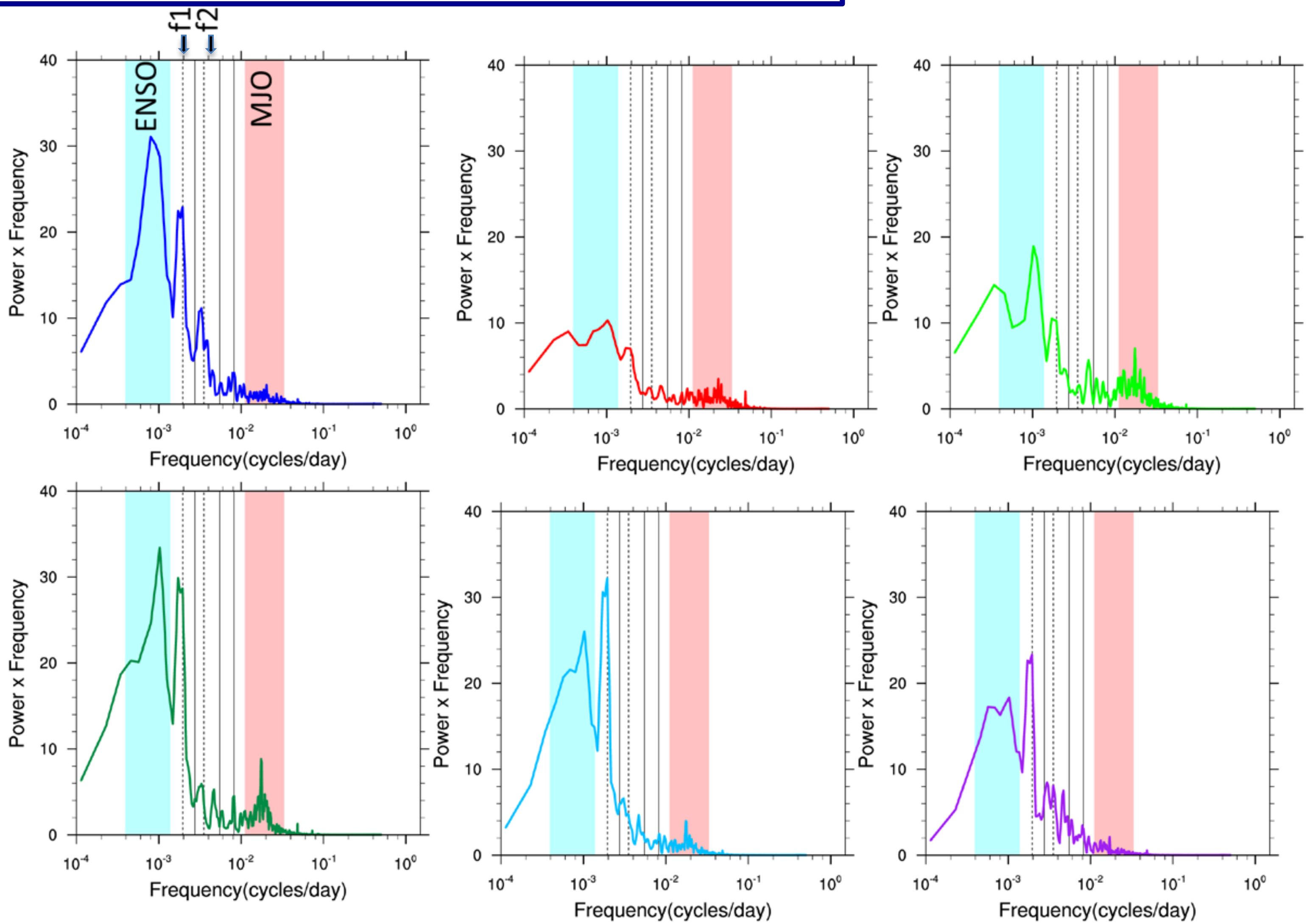
WWEs can force Kelvin waves that propagate all the way to the eastern Pacific, but the SSH signal in the eastern Pacific is small.

Intra-seasonal variations in **SSH** (and thermocline depth) anomalies are a small perturbation of the inter-annual signal



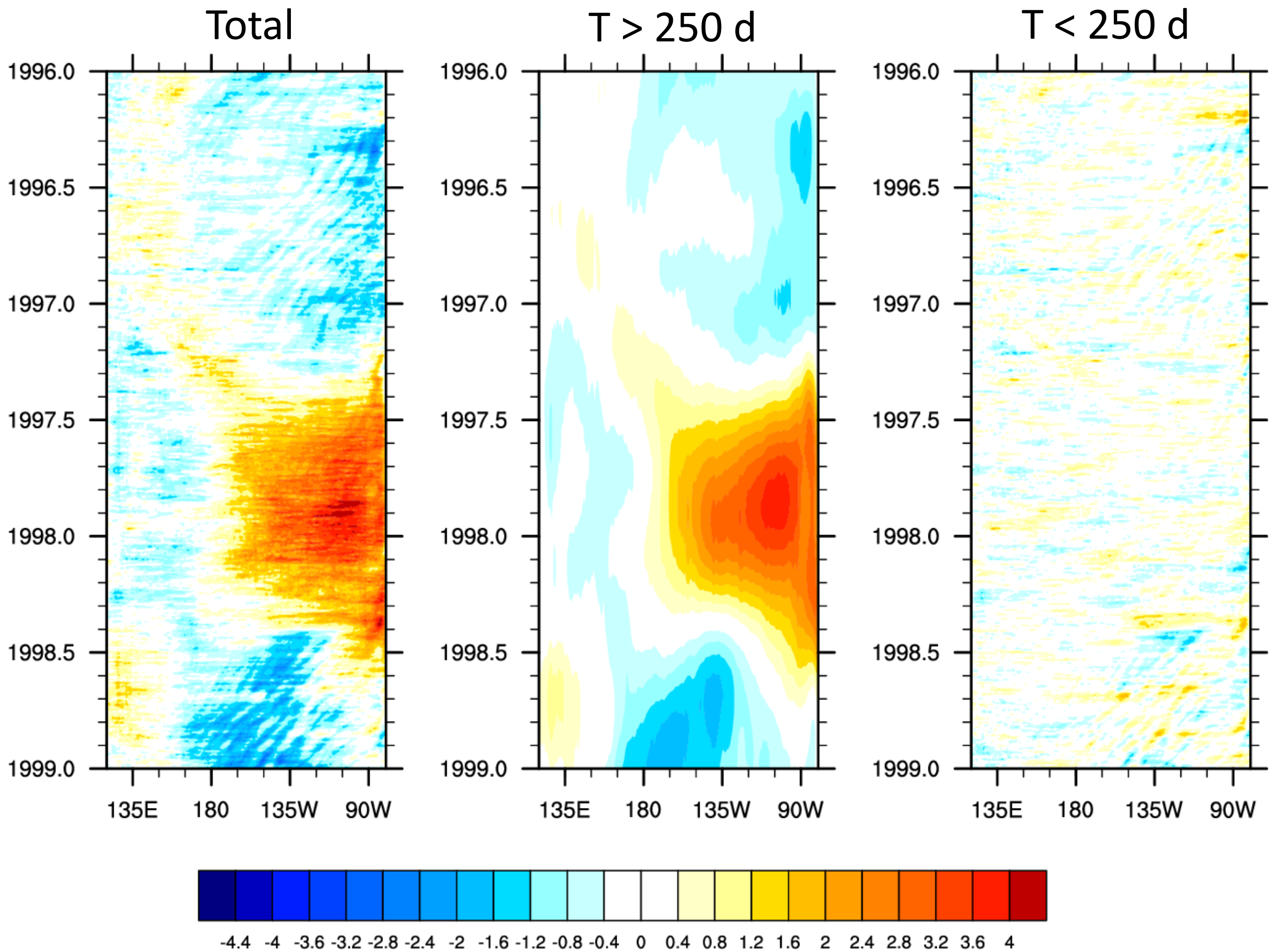
What are the dominant timescales of SSH variability?





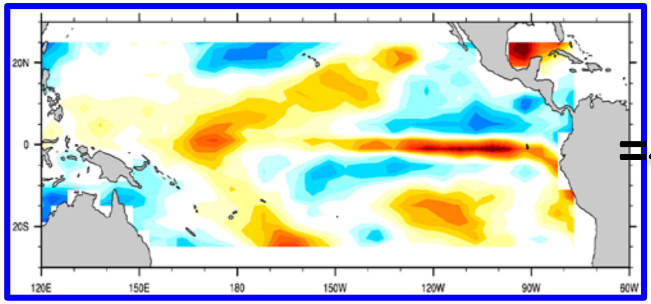
Most of the power is at timescales longer than 1 year

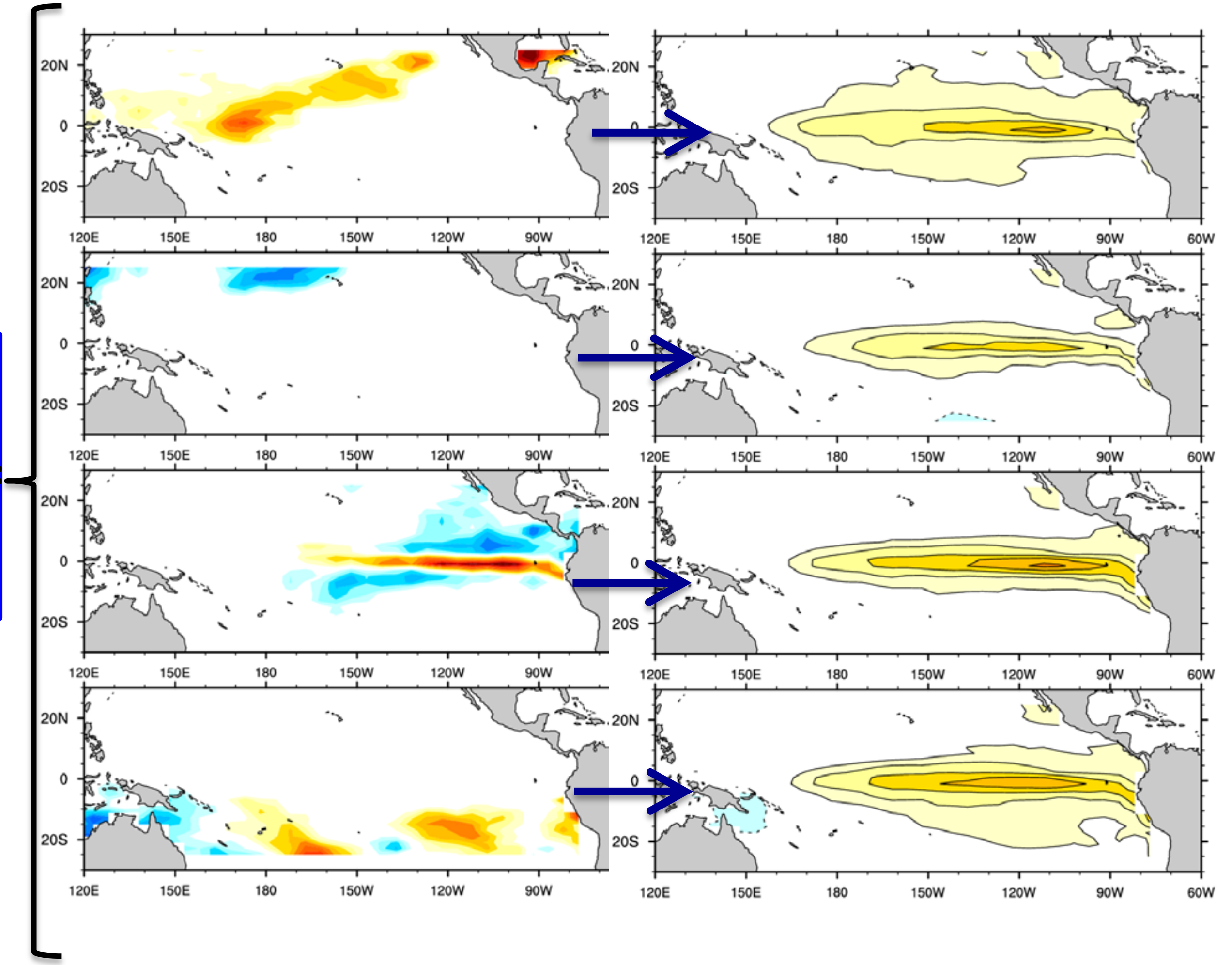
Intra-seasonal variations in **SST** (OISST) anomalies are a small perturbation of the inter-annual signal



ENSO can also be triggered by extra-tropical precursors

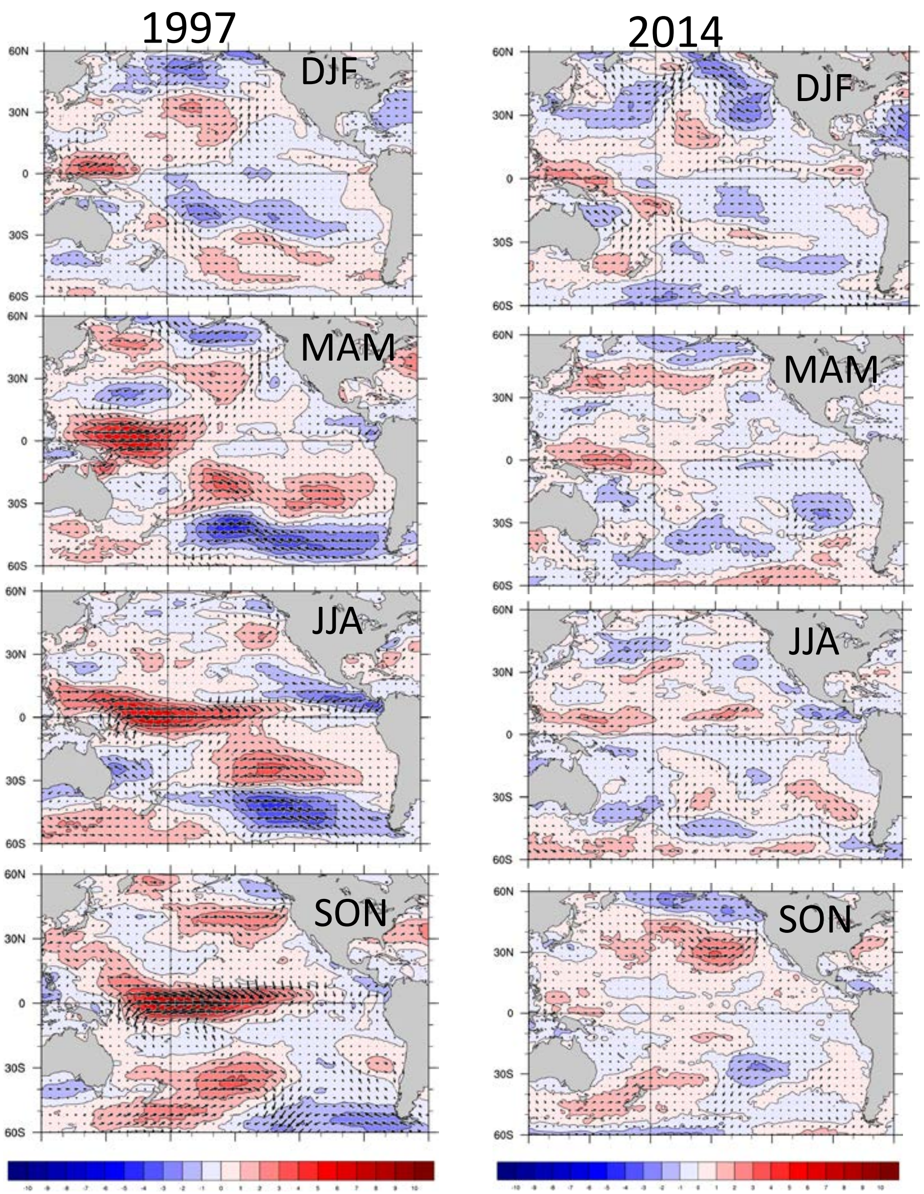
Optimal 6 months SST precursor pattern





Penland and Sardeshmukh 1995, Newman et al. 2011, Capotondi and Sardeshmukh 2015

Seasonal wind anomalies.
Shading: U-component



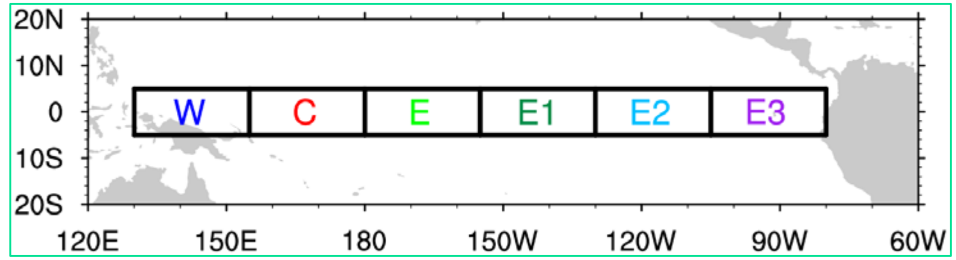
Failed 2014 El Nino has been attributed to EWEs during the Summer of 2014.

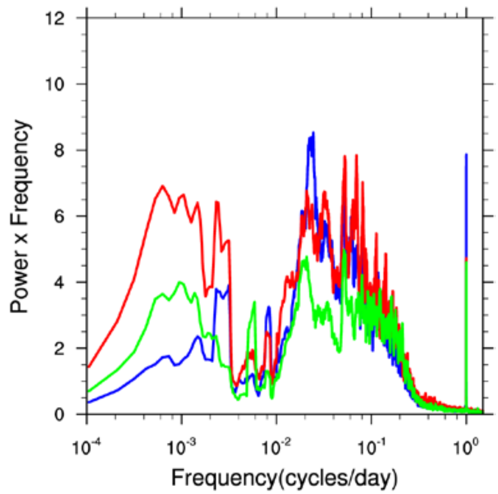
Large-scale wind conditions were different during the two cases.

Conclusions

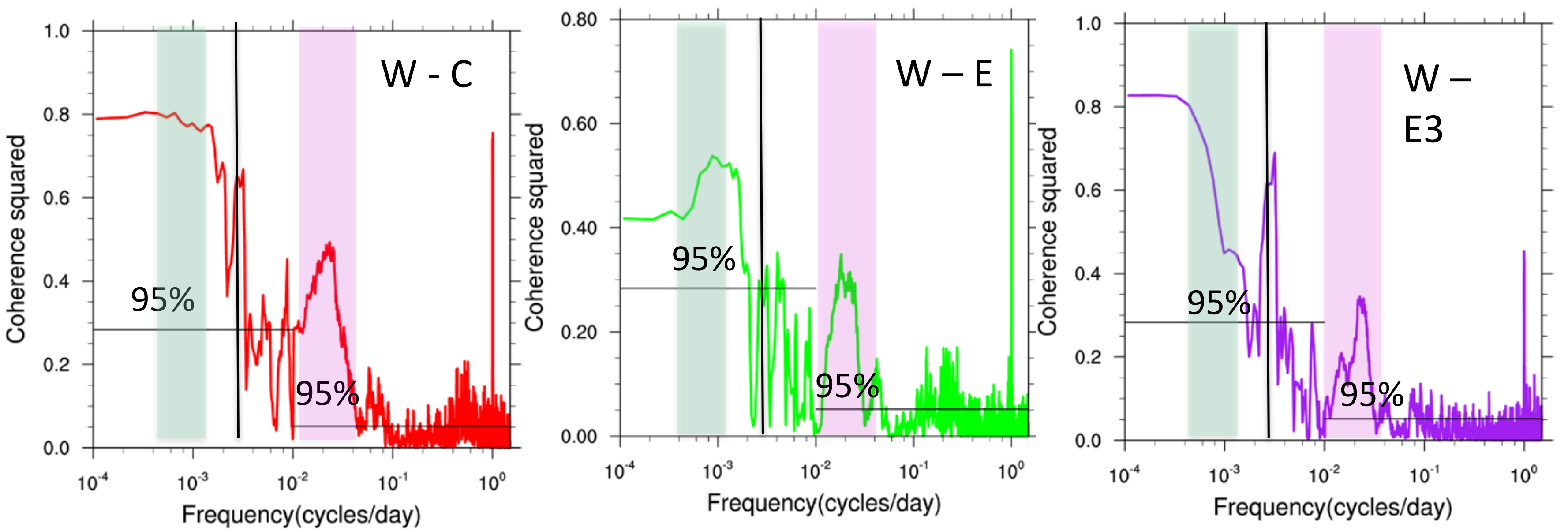
- Intra-seasonal wind activity is generally enhanced during El Niño events, sometimes leading the events, and reduced during La Niña events → There is state dependency of the "noise"
- Kelvin waves are triggered by intra-seasonal winds, but their signature does not seem to be important compared to the inter-annual signal. Similarly, intra-seasonal SST anomalies are small. Thus, inter-annual variations are the most effective in triggering ENSO.
- It is important to consider extra-tropical precursors of ENSO events to achieve a more complete understanding of ENSO development.

How coherent are the wind variations across the basin?





Coherence squared



Observational Needs

- ENSO events occur on interannual timescales with large event-to-event differences. To understand ENSO and its diversity we need **<u>sustained</u>** observations.
- We need accurate wind measurements. Satellites provide large-scale and high resolution observations, but ***in situ*** data are fundamental for their validation, inter-calibration as well as for creating products like CCMP.
- Important to retain as many TAO moorings as possible.