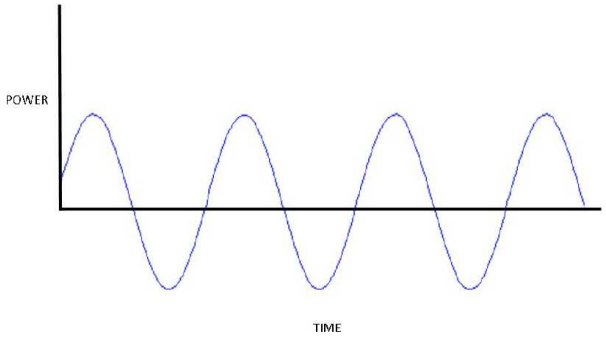
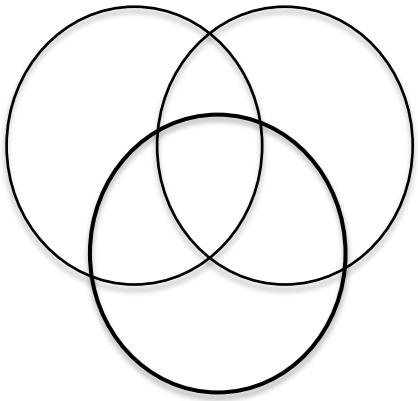
Is there a “BEYOND” on the other side of the ENSO Spring Predictability Barrier?





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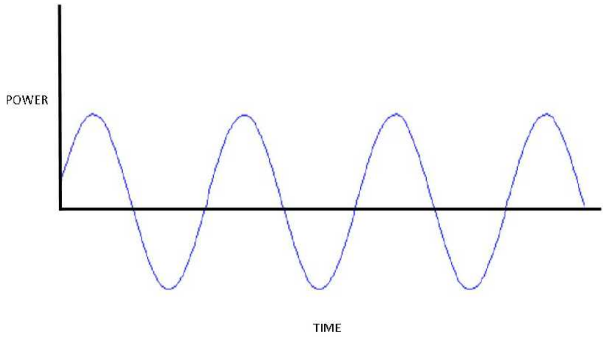

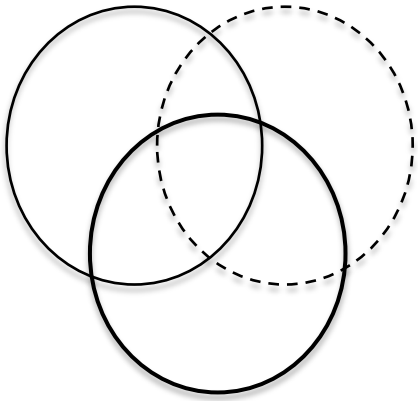

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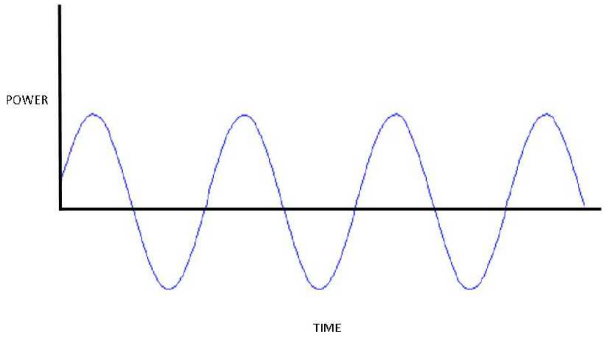

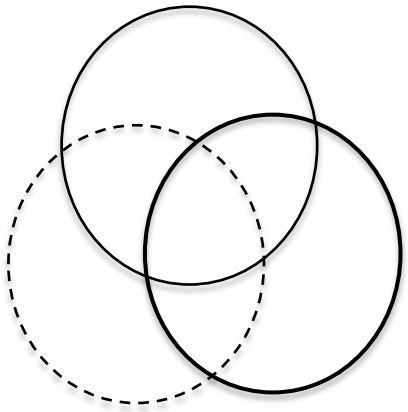

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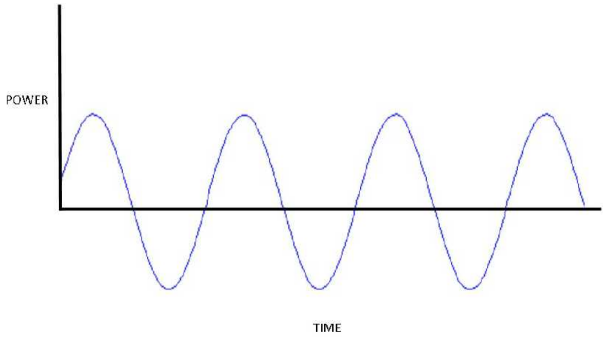

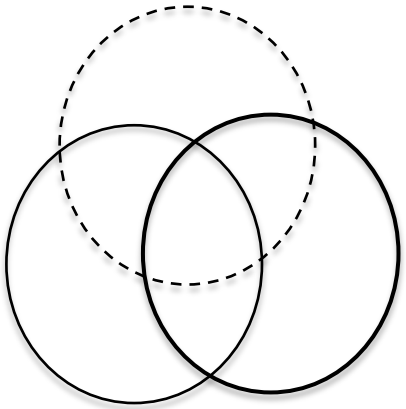

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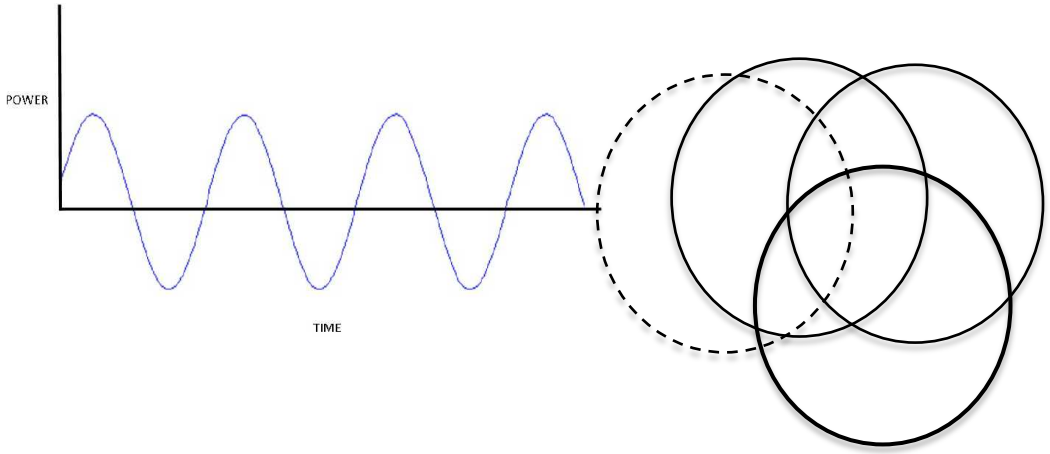

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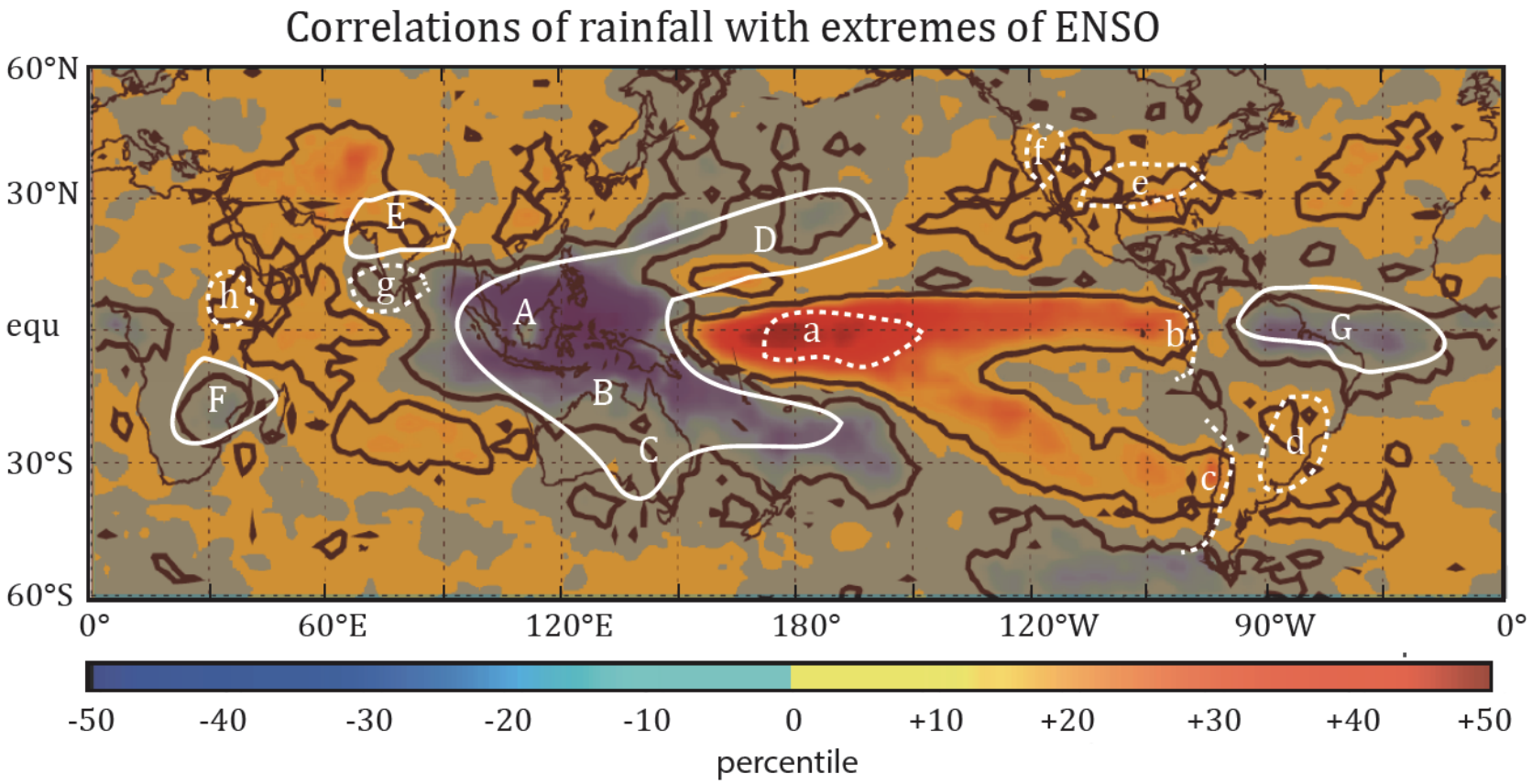
Why do we worry about this?

Ropelewski and Halpert (1987) and Curtis and Alder (2003) satellite



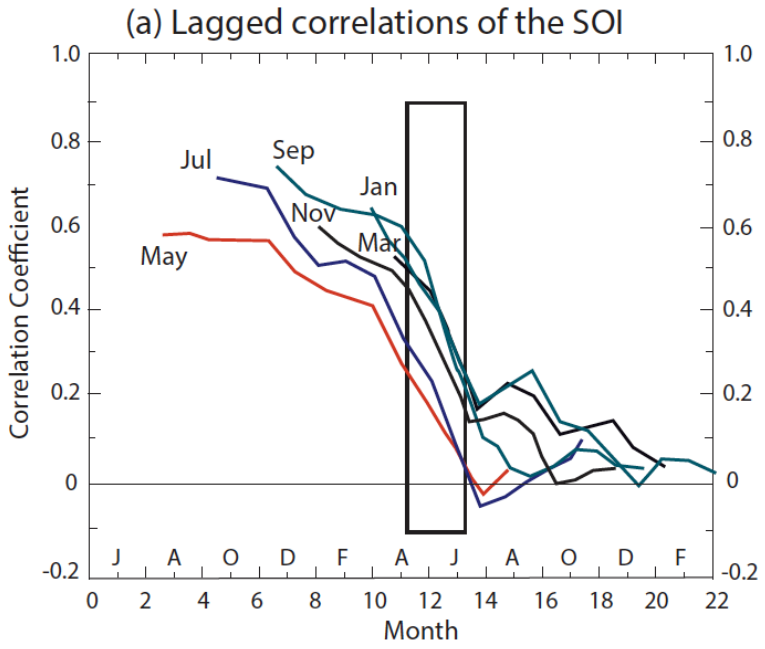
Drier (solid)

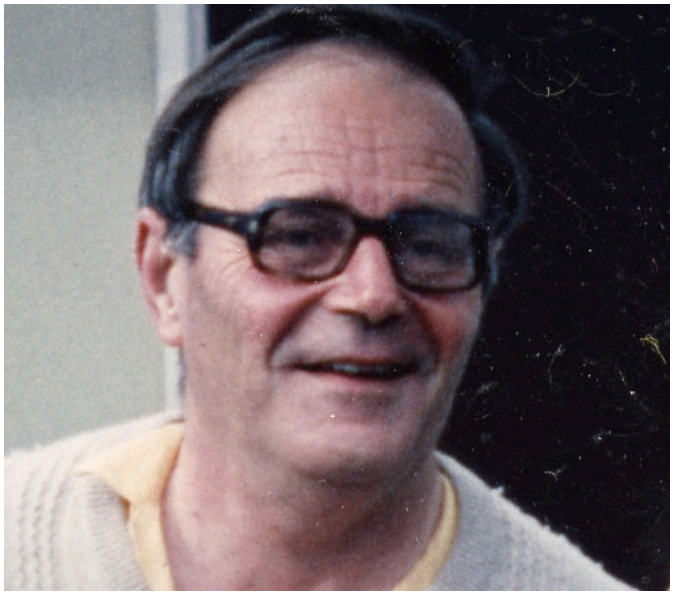
A: Jun(0)-Nov(0)
B: Sep(0)-Mat(+)
C: Mar(0)-Feb(+)
D: Nov(0)-May(+)
E: Jun(0)-Sep(0)
F: Nov(0)-May(+)
G: Jul(0)-Oct(0)

Wetter (dashed)

a: May(0)-Apr(+)
b: Jul(0)....
c: Jul(0)....
d: Nov(0)-Feb(+)
e: Oct(0)-Mar(+)
f: Apr(0)-Oct(0)
g: Oct(0)-Dec(0)
h: Sep(0)-May(+)

Sandy Troup: Annual cycle of predictability and the “barrier”



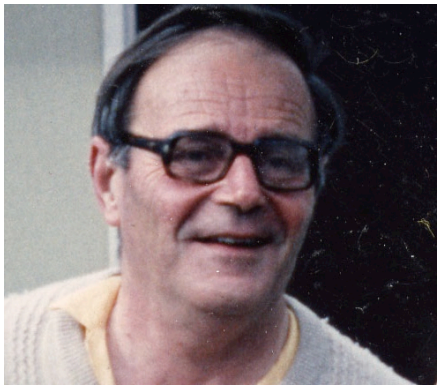


Webster and Yang, (1992)

“…There are important lag correlations between certain elements affected by the Southern Oscillation. These are strongest across southern spring and weakest across southern autumn and the “year” of the oscillation begins in late autumn (boreal spring) *or early winter* (boreal summer)*….”* Troup (1965)

Furthermore:

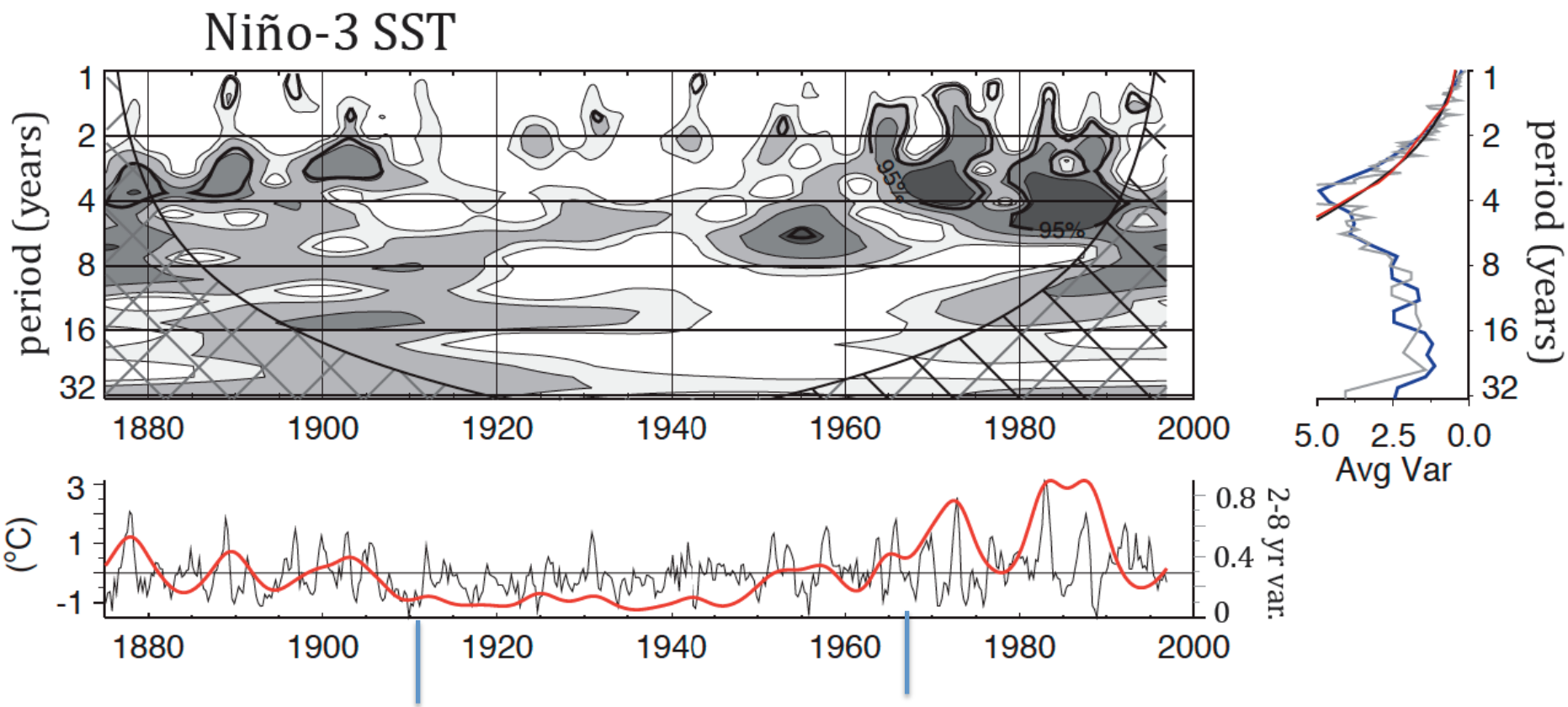
Sandy Troup: SOI (ENSO) as a coupled O/A system



"……variations in the strength of the trade winds would change the degree of upwelling in the central Pacific Ocean as well as along the South American coast…."

Thus, Troup had reached an important conclusion that the modification of air-sea interaction, produced by the oscillating winds of the SO, is a critical component in producing the phenomenon itself!" Troup (1965)

Interdecadal variability of interannual variability

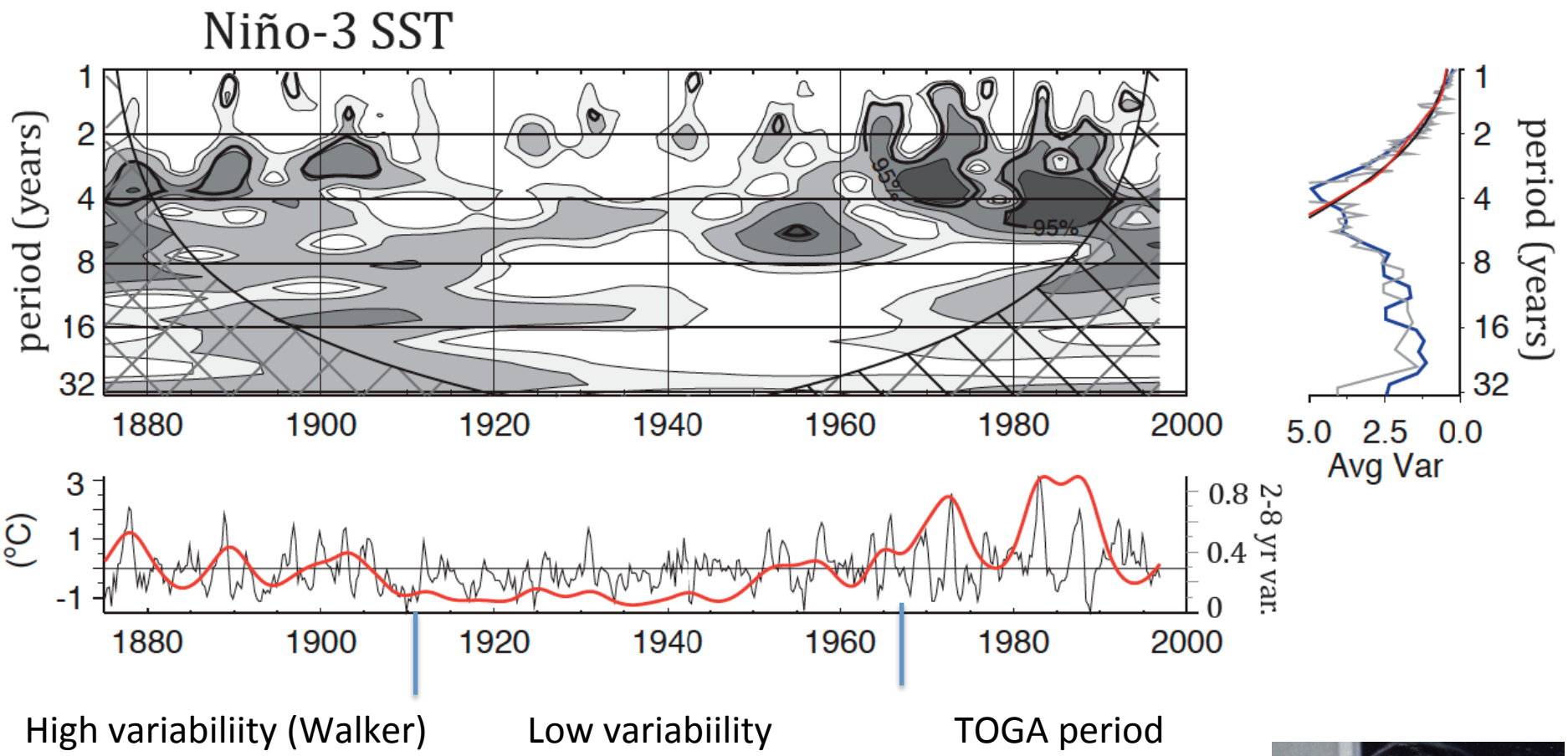


High variabiliity (Walker)

Low variabiility

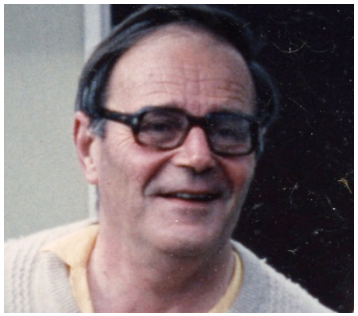
TOGA period

Interdecadal variability of interannual variability

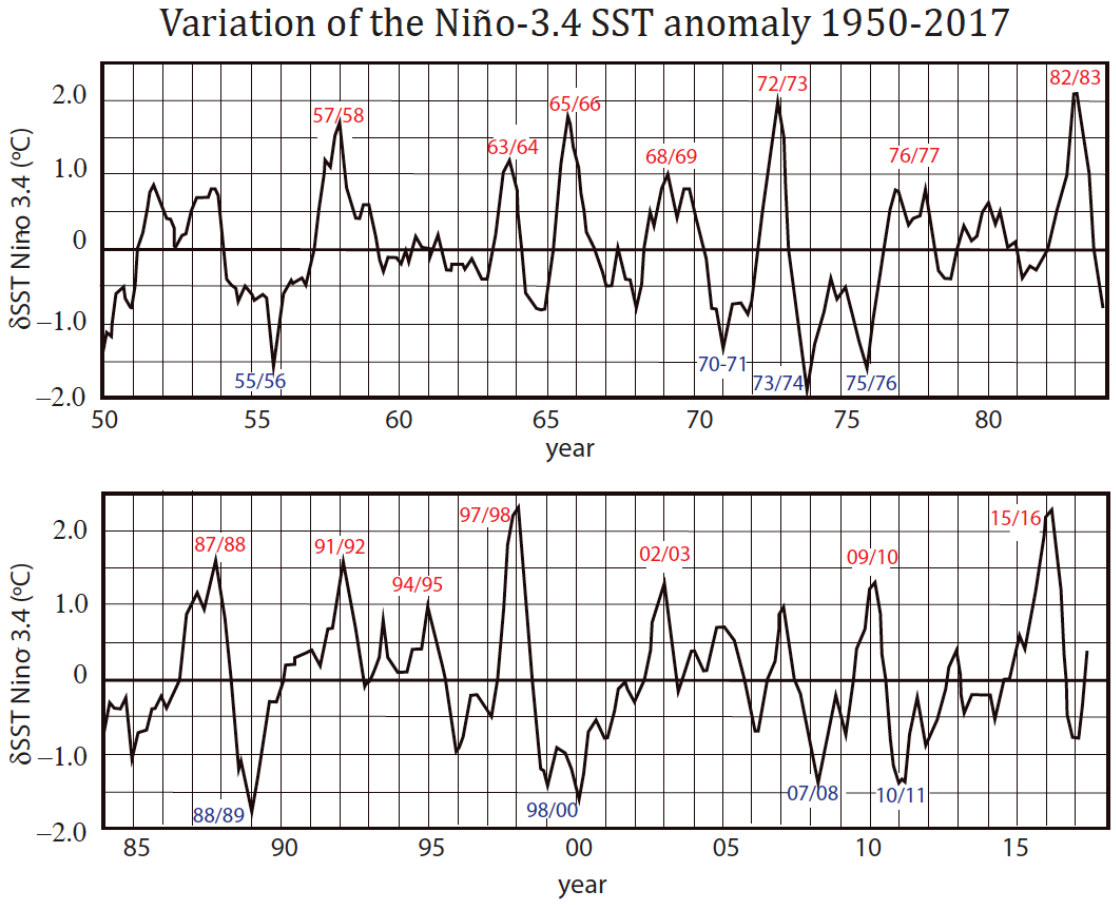


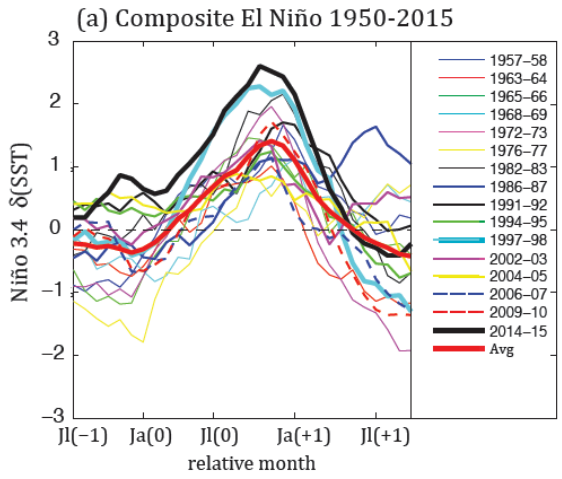
High variabiliity (Walker) Low variabiility TOGA period

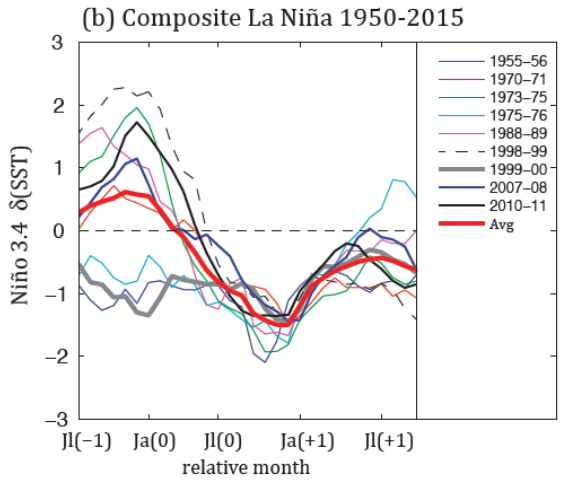
Interdecadal variability pointed out by Troup (1961, 1965) *!!!!*



Time-series of the Niño 3.4 SST 1950-2017



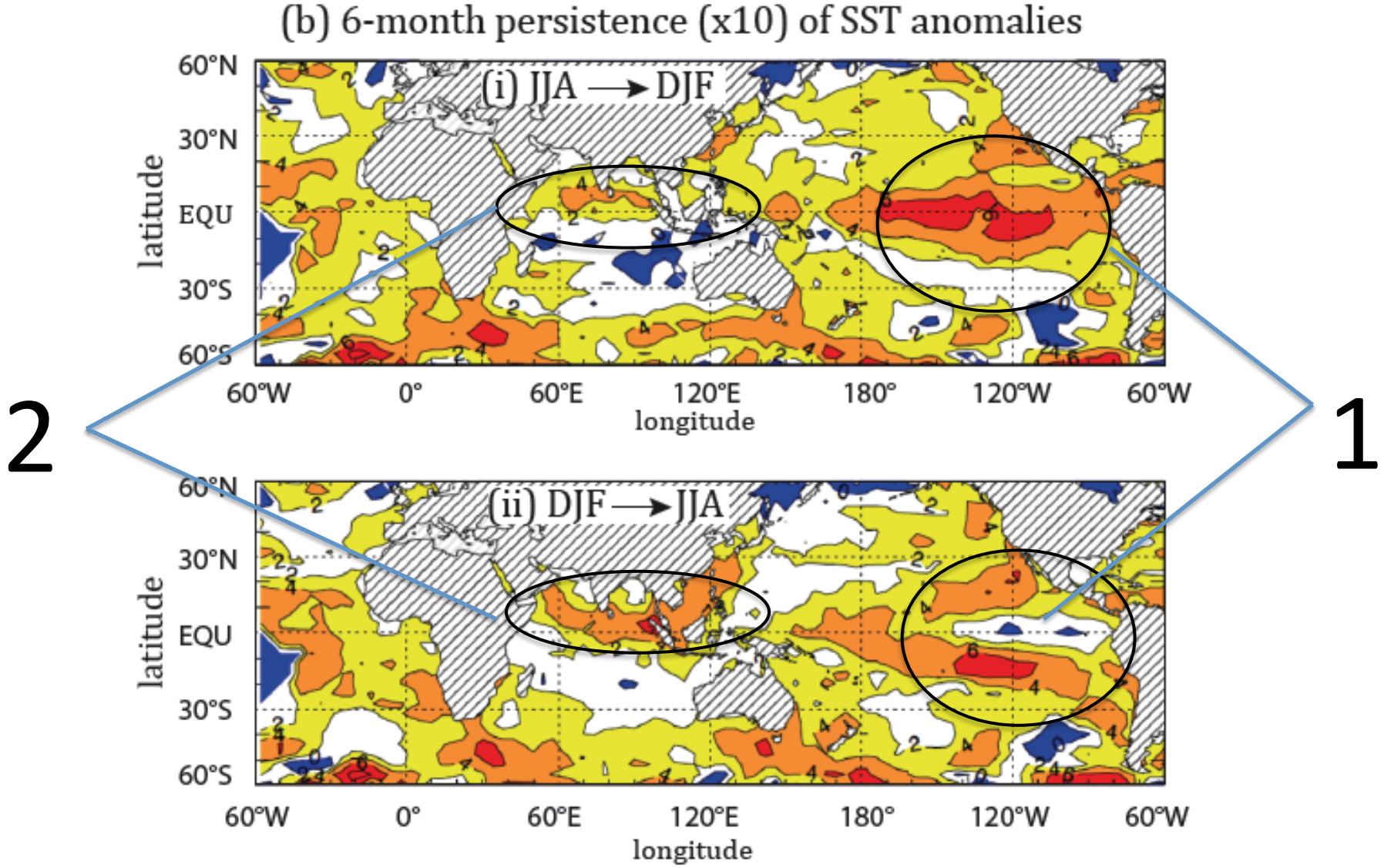




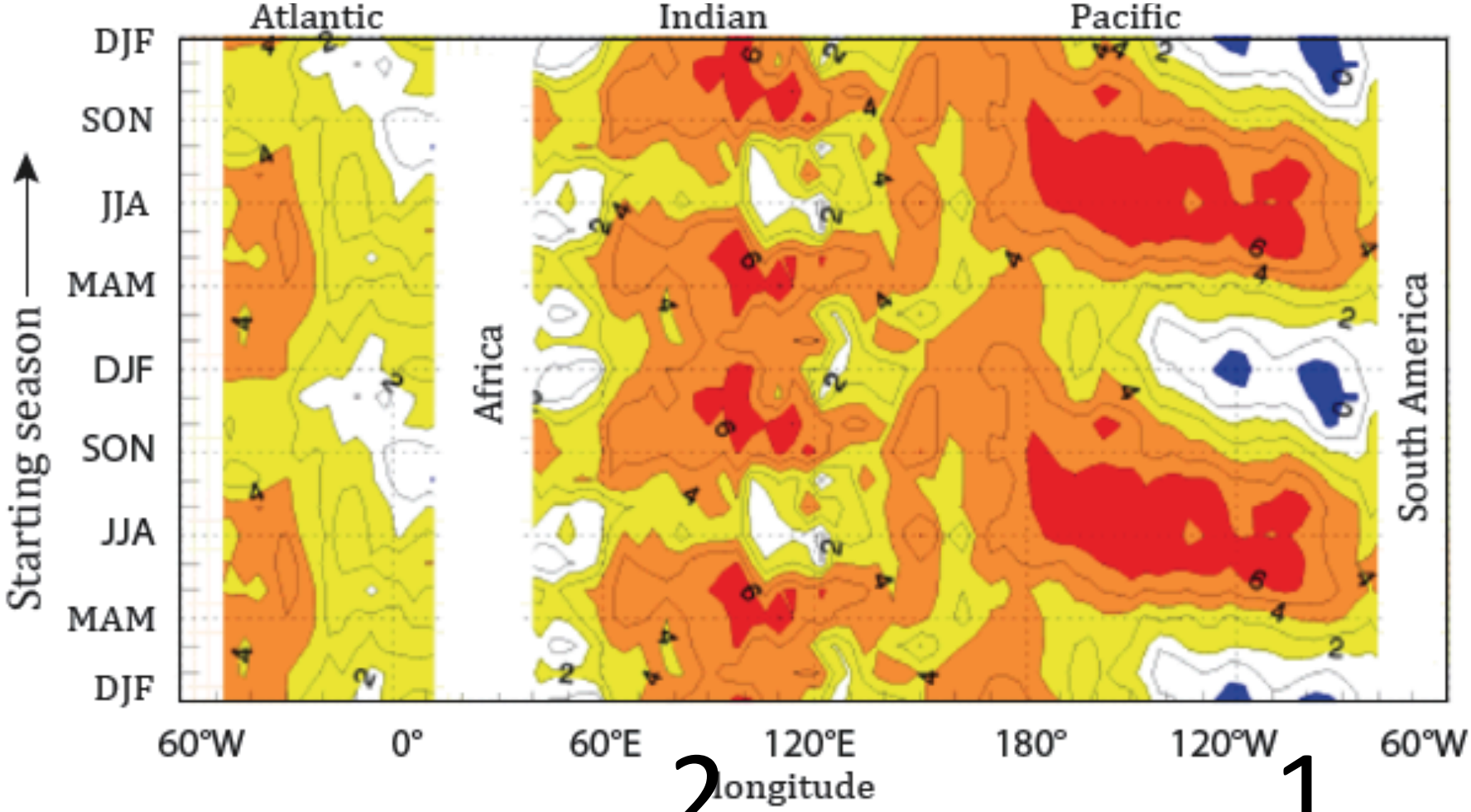
ENSO extrema appear to commence boreal spring/early summer, decay mi-winter

Based on McPhaden 2015)

Persistence of Niño 3.4 SST before/after boreal spring



Annual cycle of 6-month persistence of SST anomalies



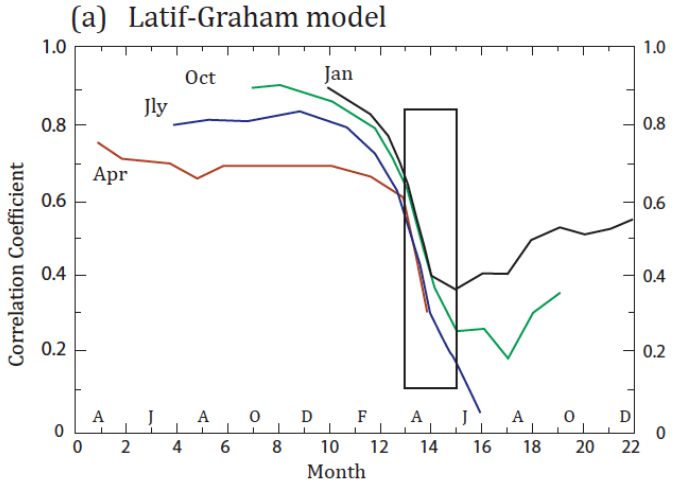
2

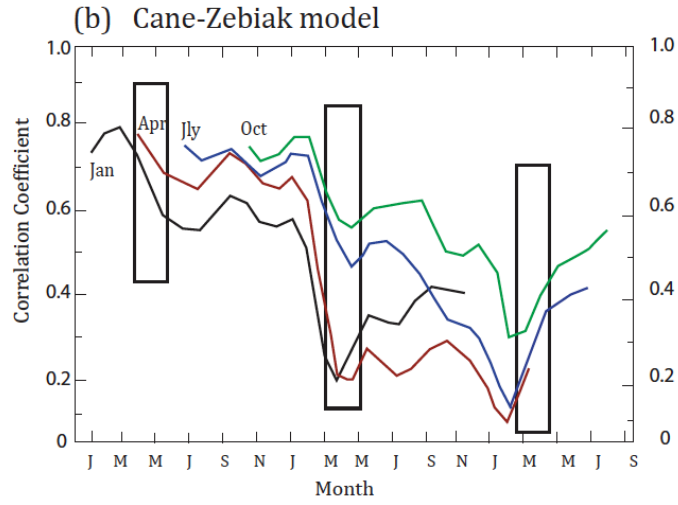
Monsoon bienniality

1

PO springtime persistence decrease

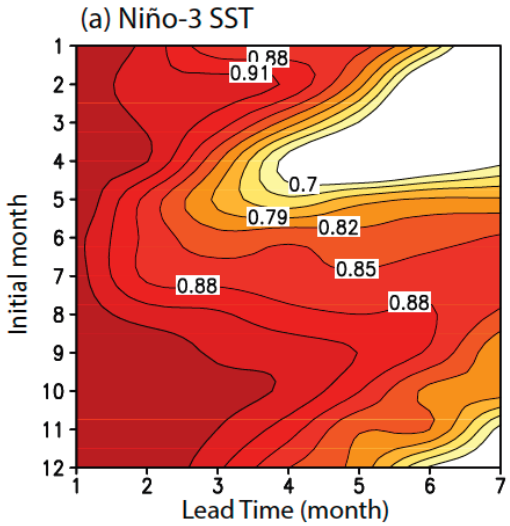
All models: consistent with observations, simple and complex possess a “boreal spring time predictability barrier”

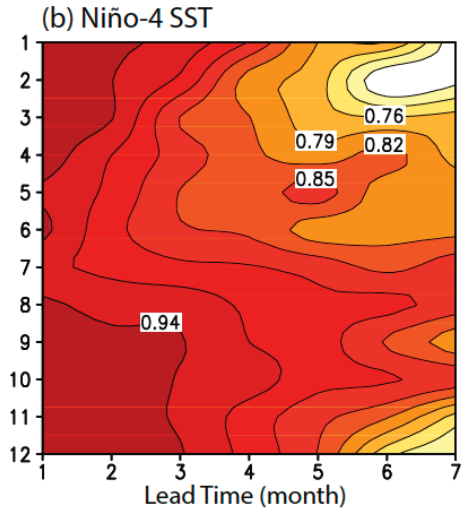




Persistence barrier is also a predictability barrier!

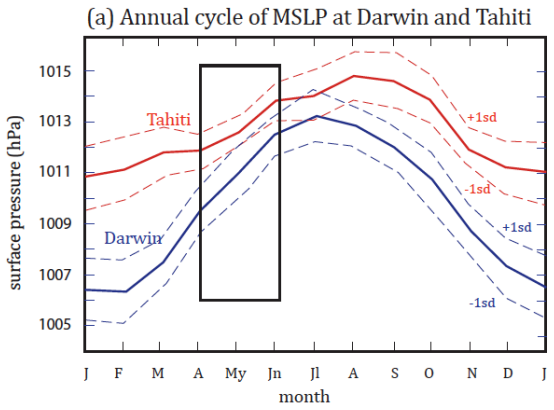
(c) ECMWF

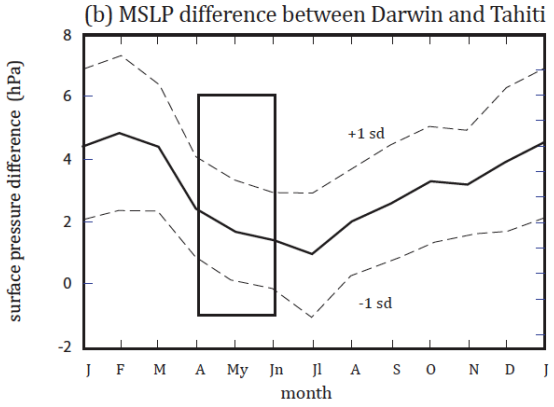


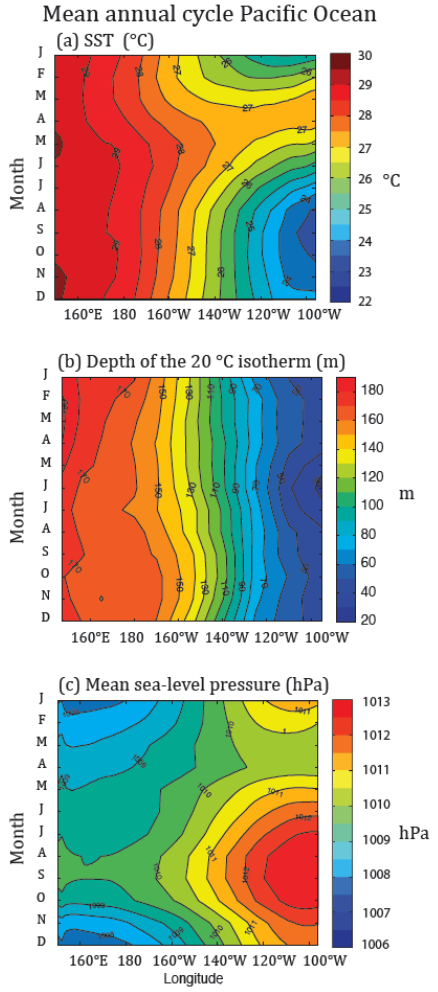


So, what causes the “spring persistence/ predictability barrier”?

- During boreal spring, PO equatorial mslp gradient minimum.
- Annual cycle of surface temperature “detached” from thermocline variability.
- During the boreal spring, system is most susceptible to forcing
- Signal/noise ratio a minimum







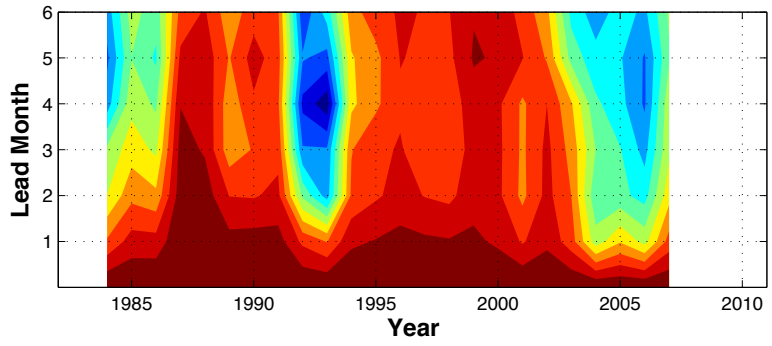
Wesbter & Yang) 1992) Webster (1995),

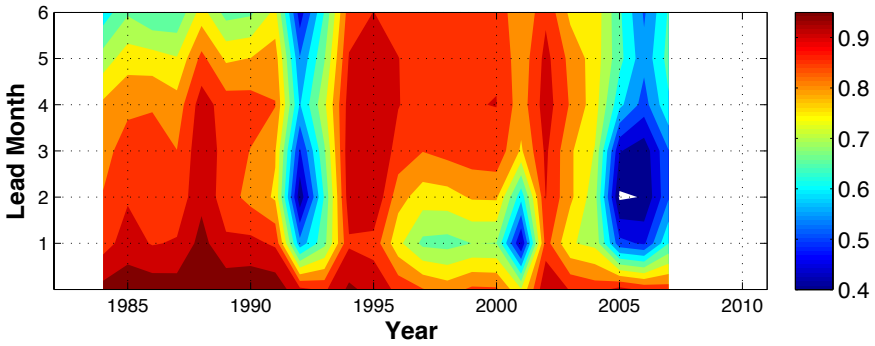
Clue: There exists a strong interannual variability of persistence/correlation in PO

persistence

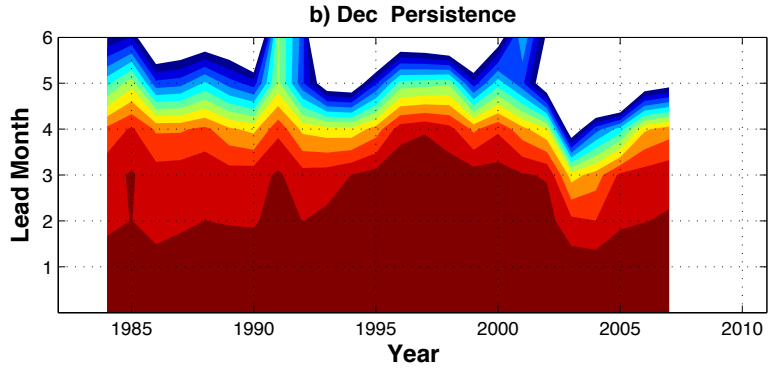
correlation

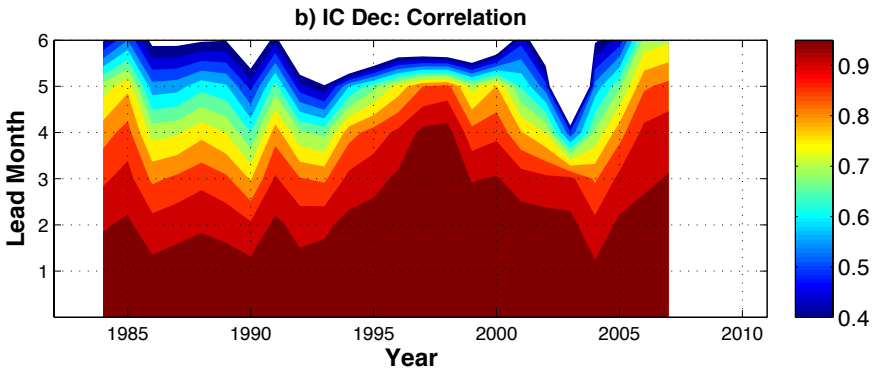
June





Dec

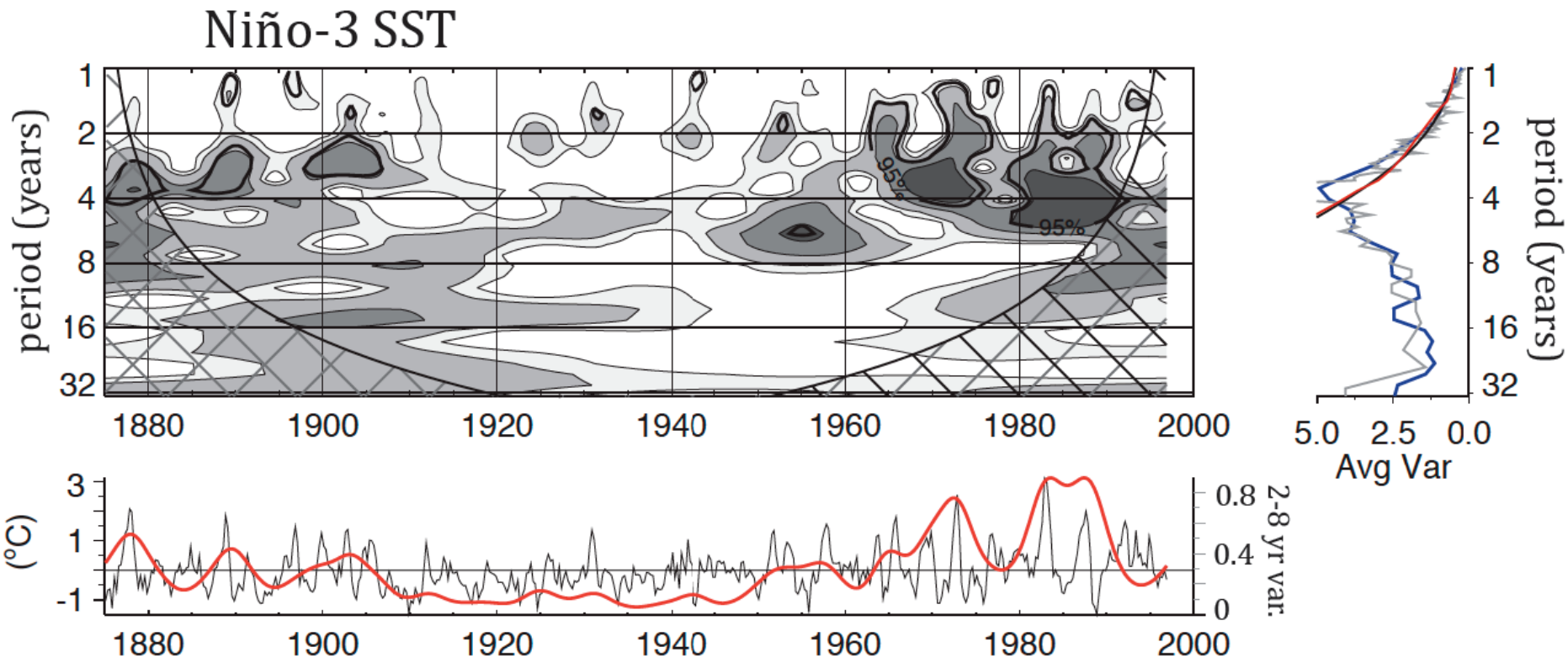




Can the differential external influences on ENSO system be identified?

Analysis of ECMWF retrospective forecast
Courtesy. Dr. V.E. Toma

Amplitude variability 1870-2000 of Niño 3.4 SST: Wavelet analysis



- Time series appears non-stationary.
- Is it possible to attribute the variance variability to definable influences?

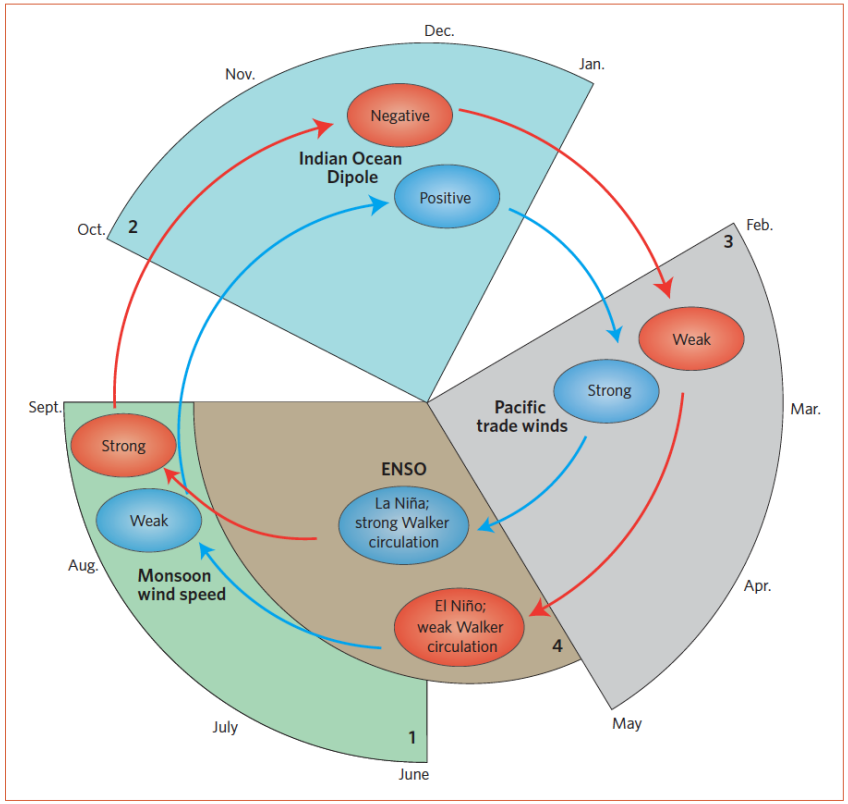
Candidates/culprits

ENSO itself possess its own chaotic variability

Influences of other nonlinear systems

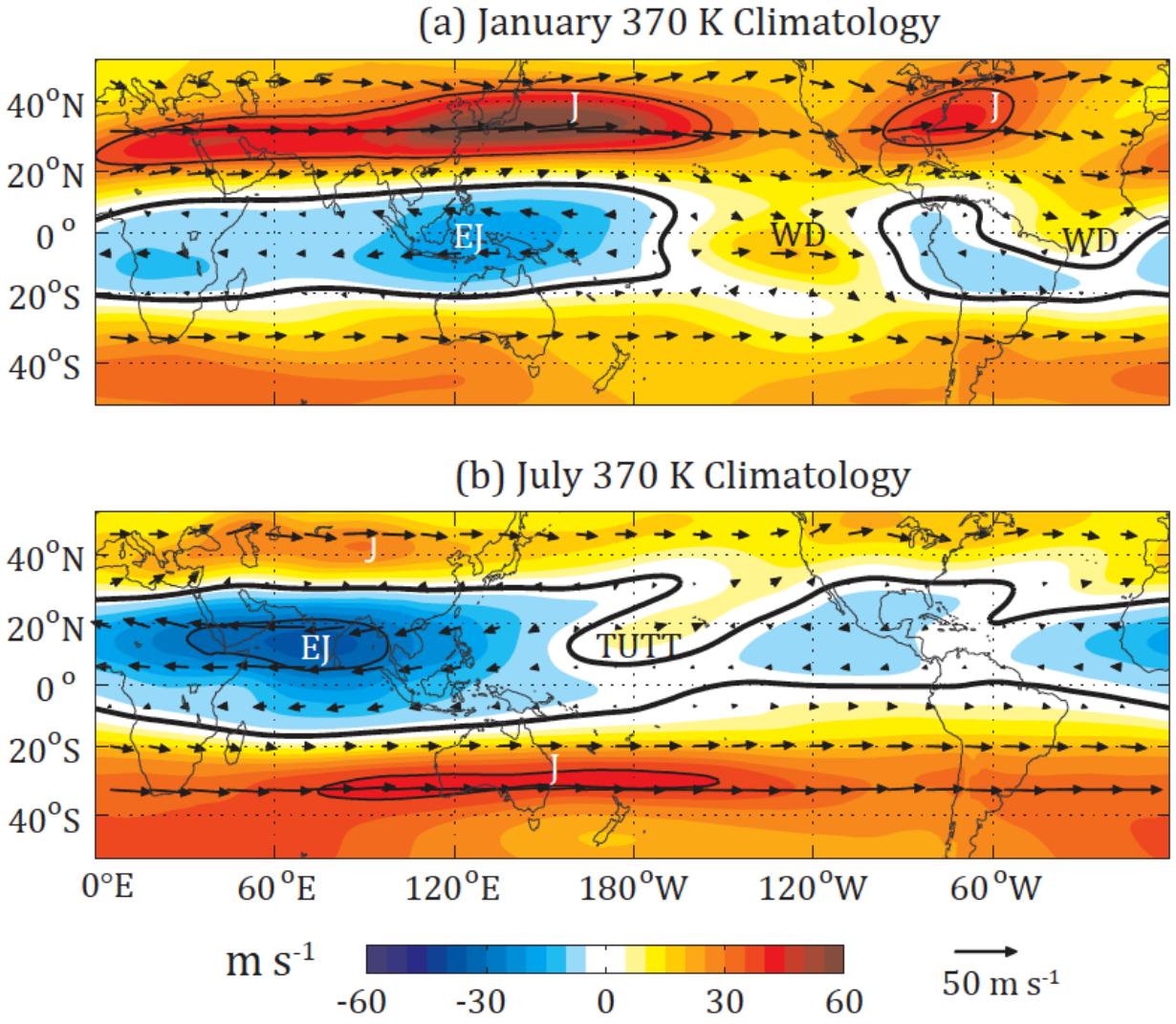
- Monsoons system interactions
- Extratropical processes
- Stratospheric events, Rossby wave breaking….
- NAO, ……
- Man behind the curtain?

We noted earlier that the monsoon had a biennial component of variability:

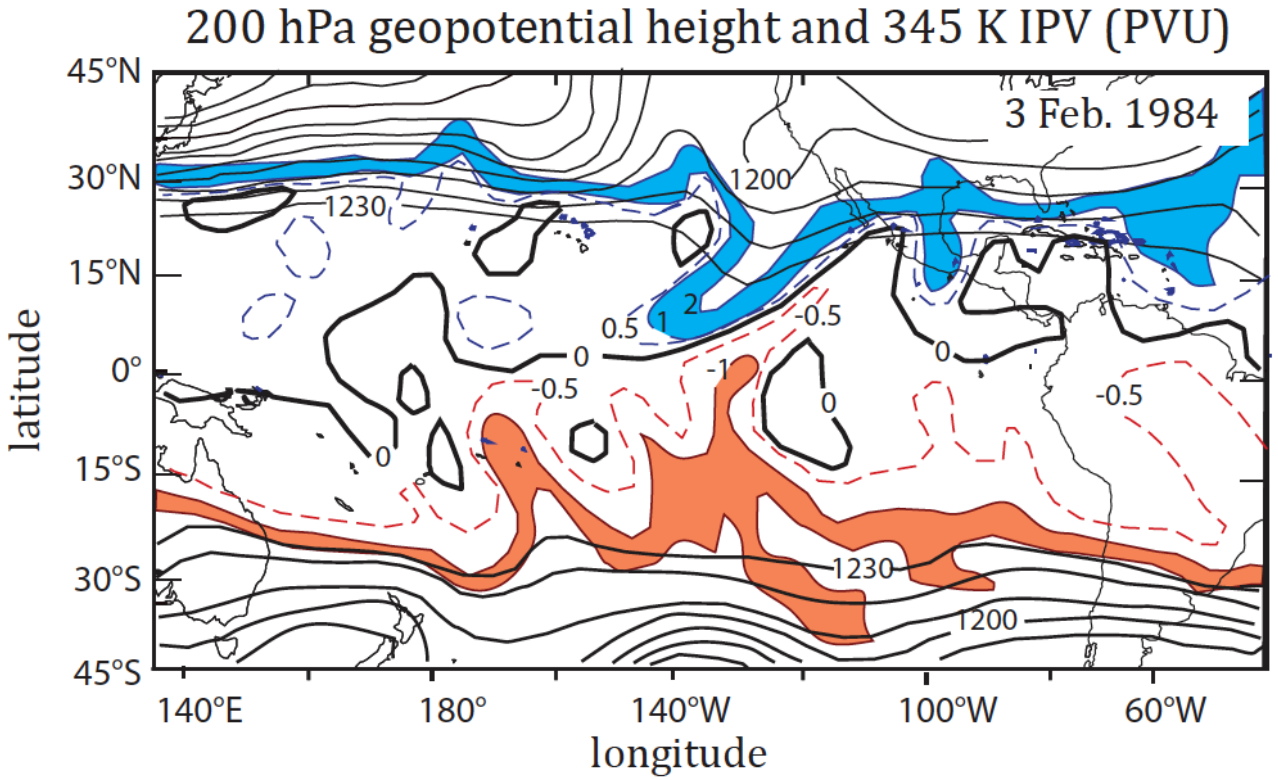


- Quasi-biennial IO dipole
- Izuma et al. (2010) and Webster and Hoyos (2010) speculated this introduced biennial "noise" into the ENSO system (and vv) during the boreal spring.

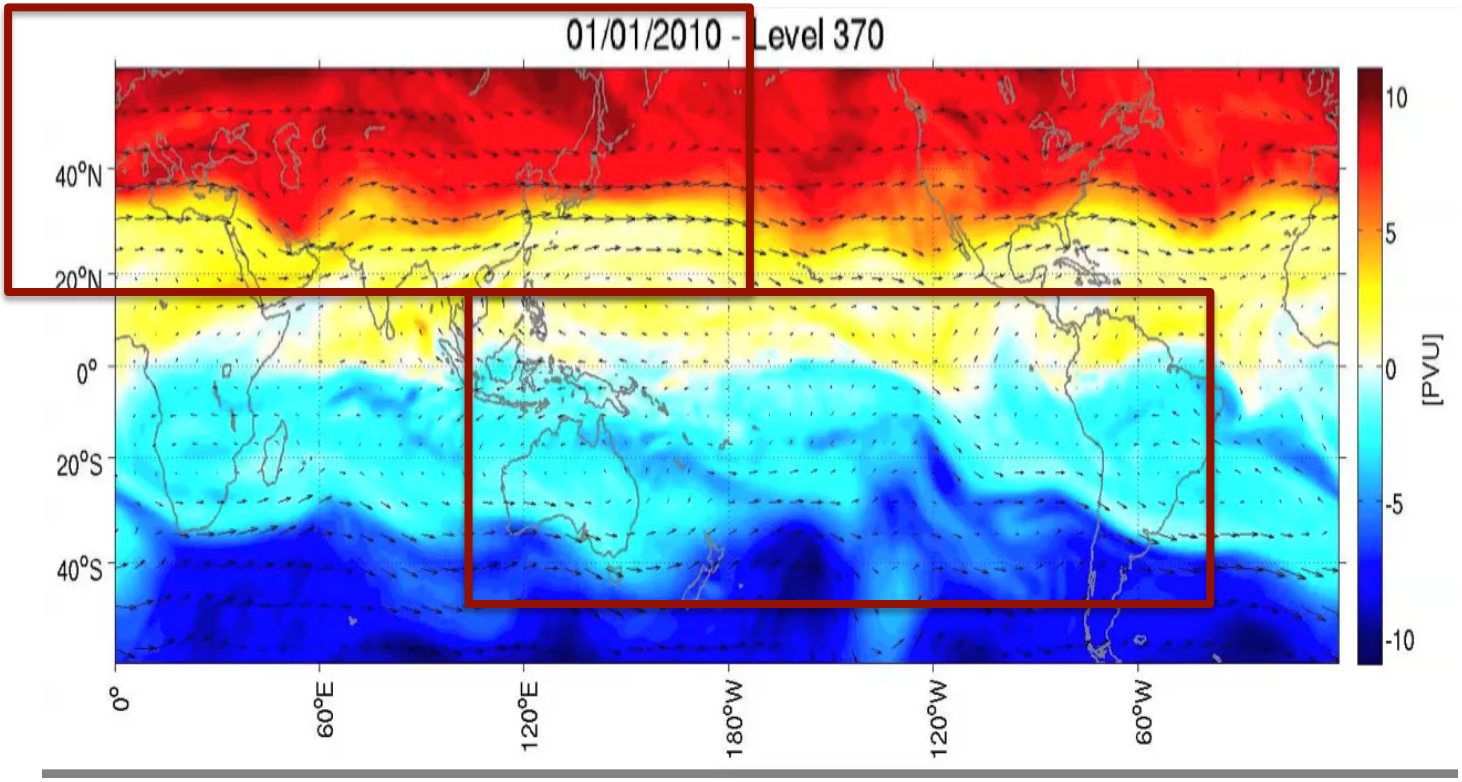
Recursive influence of extratropical breaking Rossby waves (strong noise) through westerly duct



Recursive PV intrusions extratropics to tropics through westerly ducts
Importance of short term intrusions can't be ignored

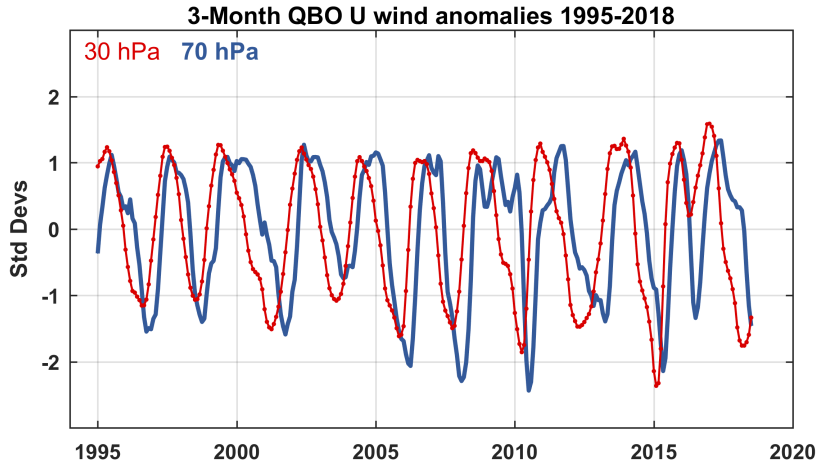


In fact: Ortega et al (2018) show that basic PV constraints tie tropics <-> extratropics together. Expand on this AGU DC December.

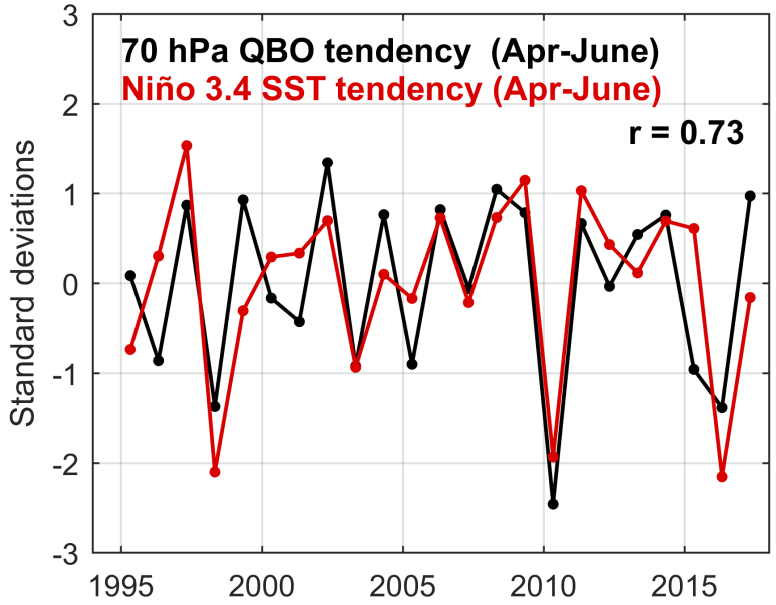


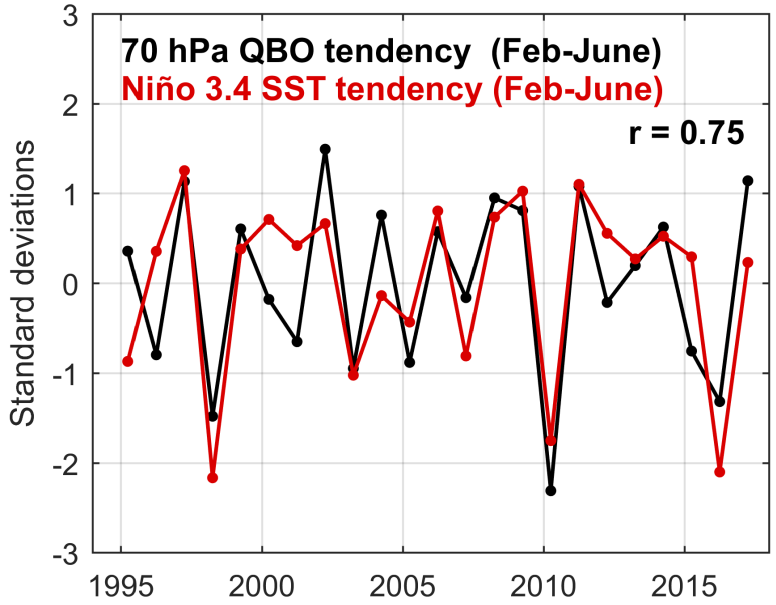
ERA interim data – Isentrope 370K

Transition of phases of the tropical QBO occurs in the boreal spring

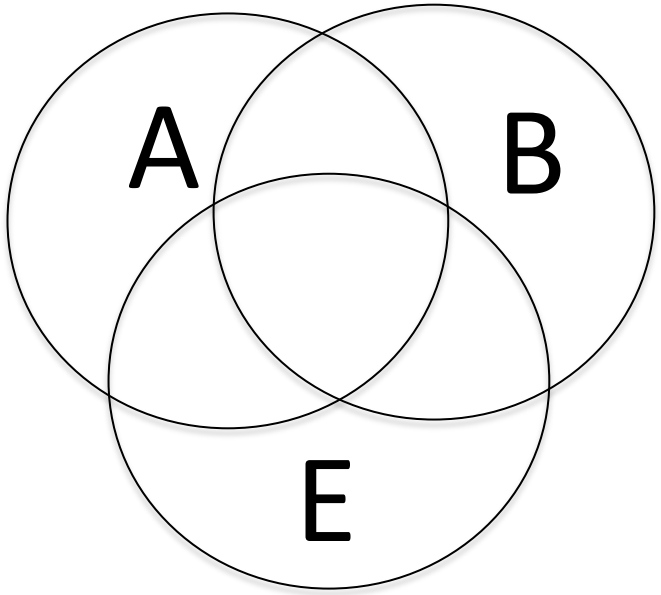


QBO (70hPa) Niño 3.4 appear to correlate across the spring barrier





Courtesy Dr. J. Johnstone



- There is substantial interannual variability in the predictability of ENSO (E)
- Strong variability in those systems (e.g., A, B) => E
- Persistence after the boreal spring varies interdecadally as well.

- Perhaps the existence of a spring barrier is a property of the coupled O/A system in the Pacific Ocean.
- But, perhaps an important step is to seek the A's and B's and etc. that accompany the variability of the variance of E.