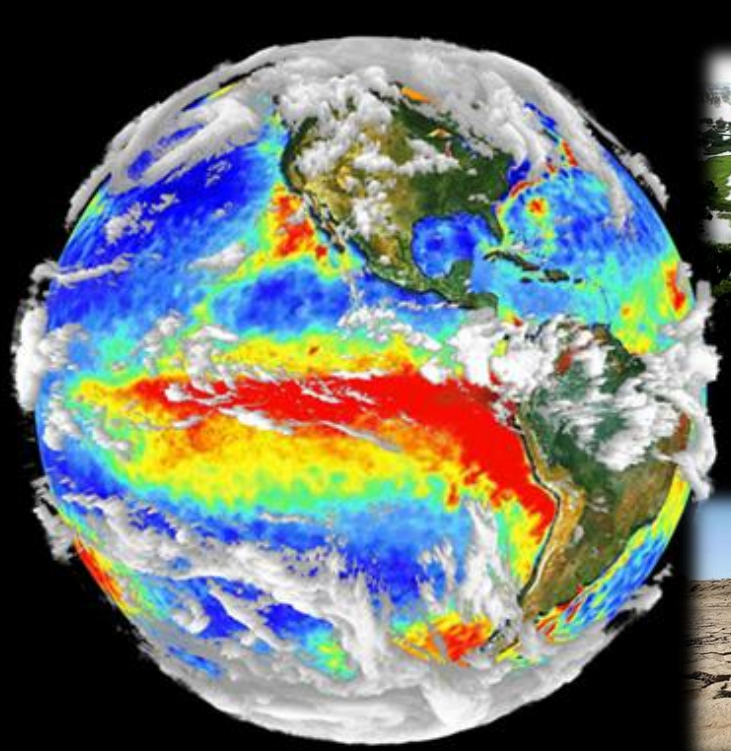
ENSO continuum and its impact on worldwide precipitation: Observation vs CMIP5/6

DIEPPOIS Bastien, EDEN Jonathan, MONERIE Paul-Arthur, POHL Benjamin, CRETAT Julien, CHUN Kwok Pan



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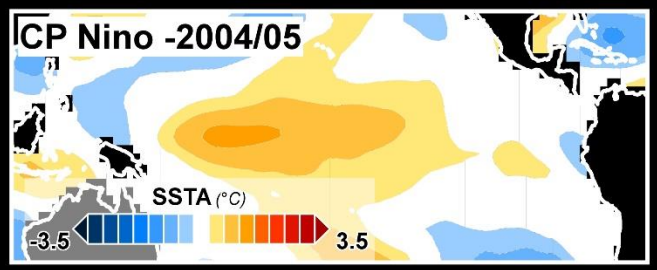
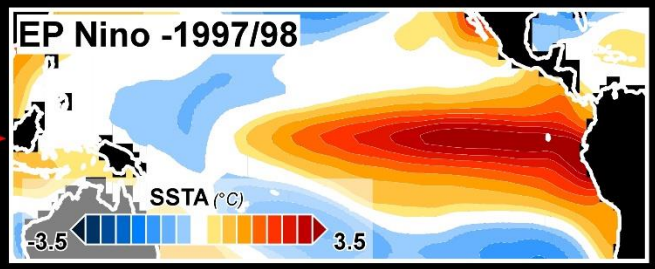
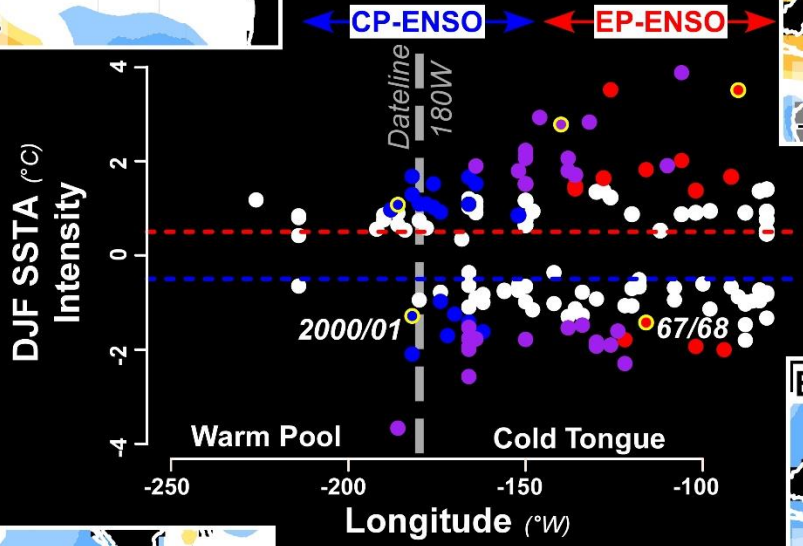
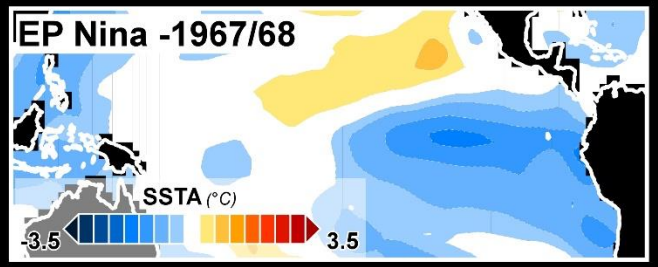
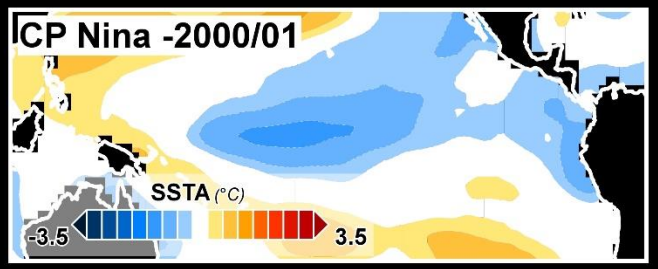
Eastern vs. Central Pacific ENSO











Each year between 1860 - 2018

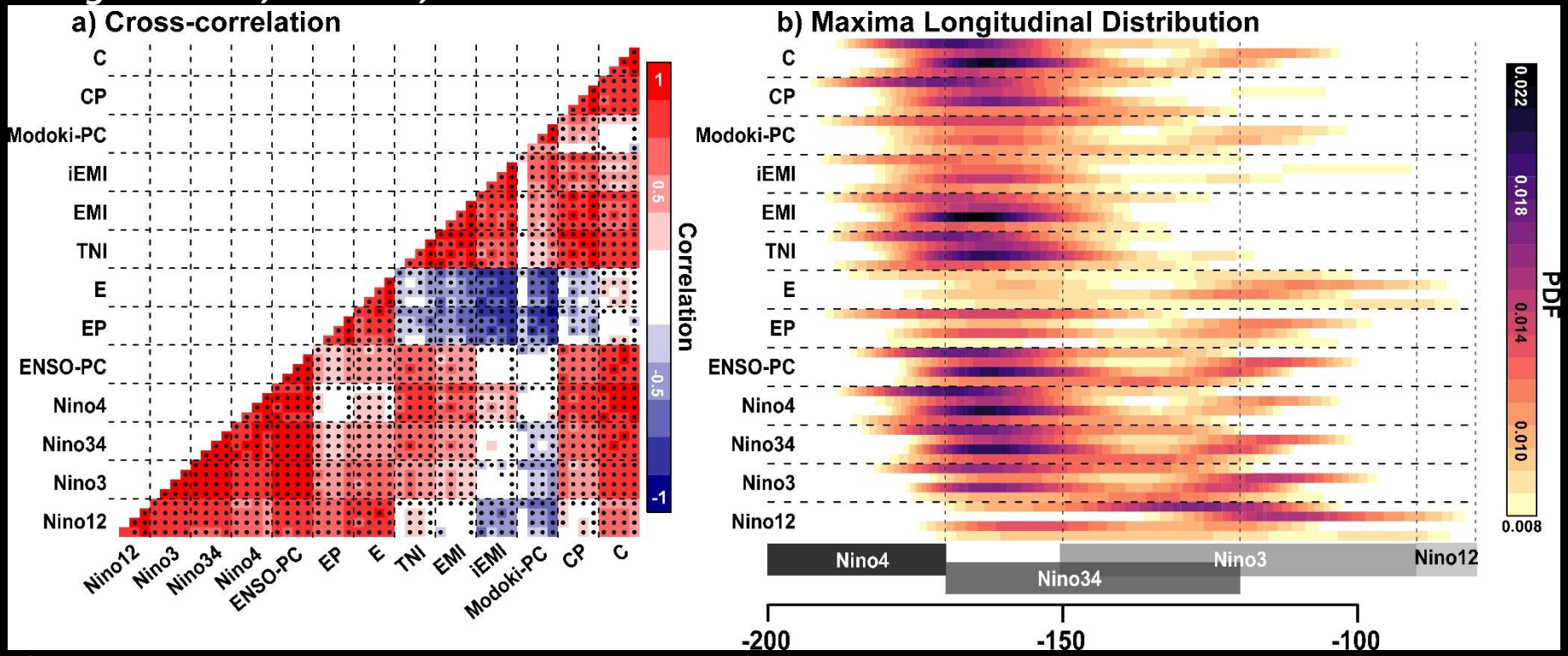
Event captured by CP index *(Kao & Yu 2009)*

Event captured by Nino3 index *(Rasmusson & Carpenter 1982)*

Event captured by both indices

How do the different indices compare and perform in capturing ENSO continuum

Using HadSST1, ERSSTv5, COBESSTv2 between 1860-2018



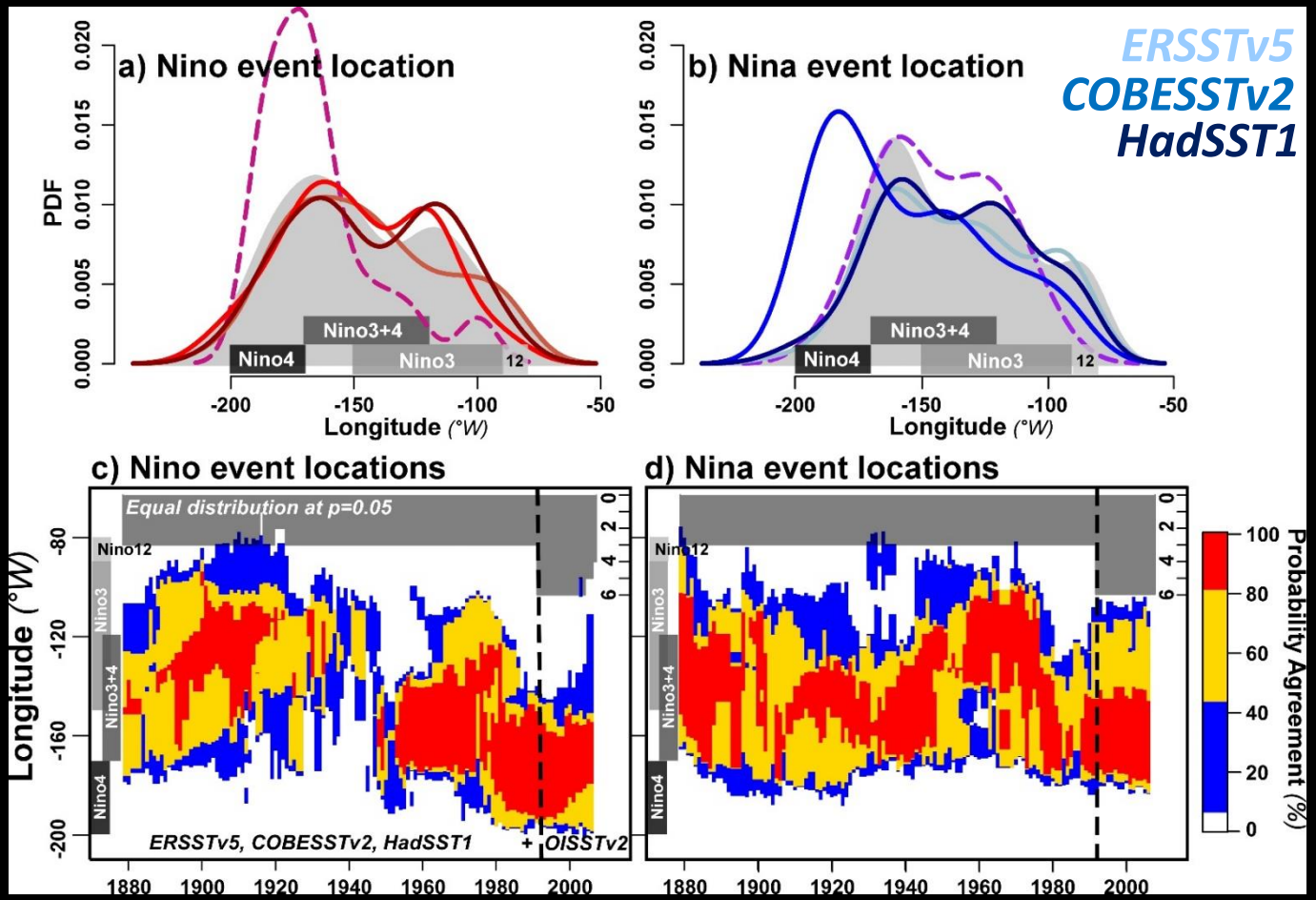
- *Significant correlations at p<0.05 using 1000 phase-randomizations (Ebisuzaki, 1996)*

- **All indices strongly are inter-correlated**
- **They do not fully disentangle both event types**
- **Nino34 is good index to study the impact of both events**

Longitudinal locations of ENSO events

ENSO event locations = location of max/min of Pacific SSTa between 5S and 5N

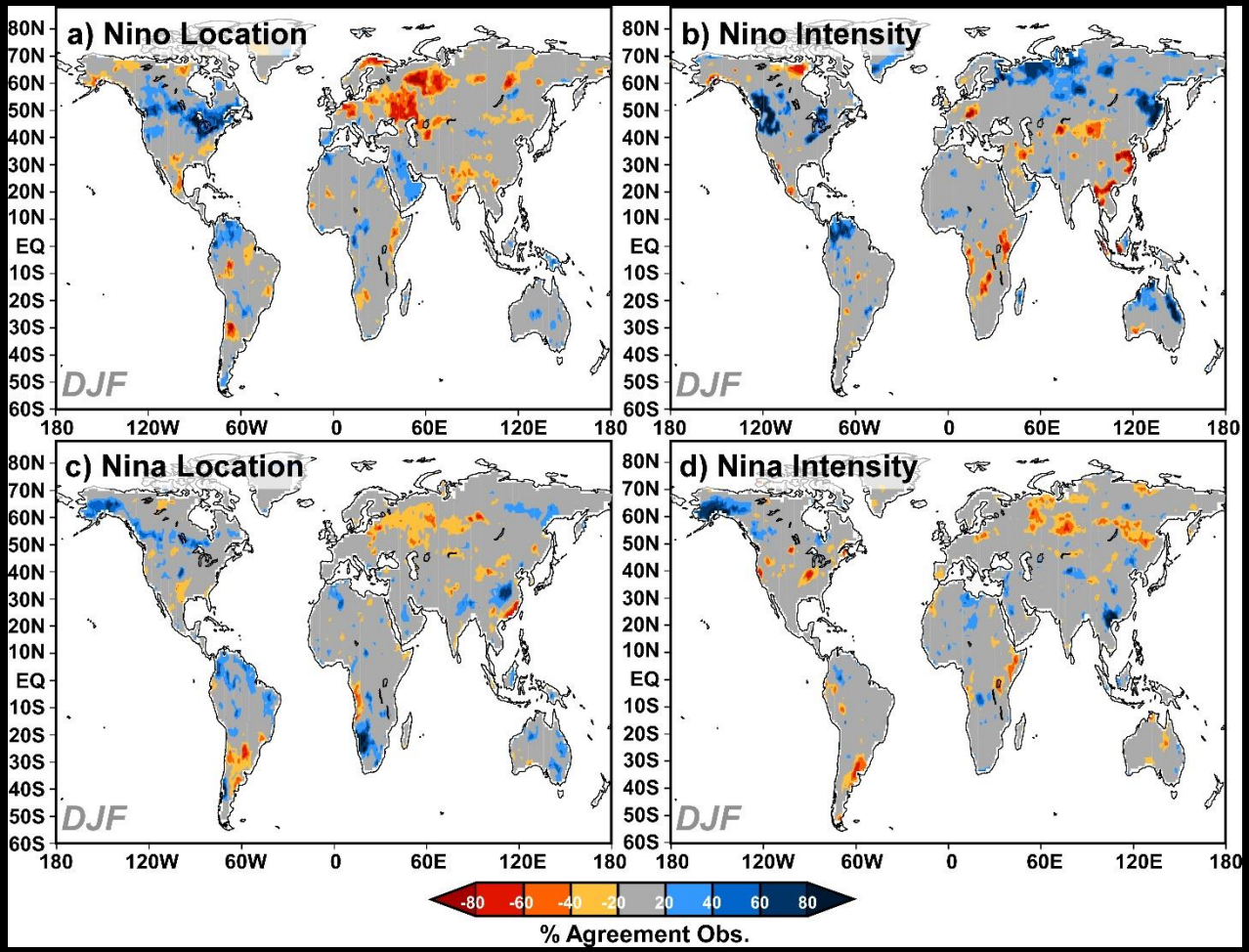
ERSSTv5
COBESSTv2
HadSST1
OISST
All Obs.



- *Slight differences between data sets*
- *Temporal variations in agreement between data sets*
- *Similar variations are found in the intensity of ENSO events (not shown)*

Impact on winter rainfall

Agreement in significant positive and negative regression



3 precipitation data sets
(CRU, GPCC, UDEL)
+
3 SST data sets
(ERSST, COBESST, HadSST1)
+
Significance tested with
1000 permutations at p < 0.05

Impact estimated in term of robustness of the signal

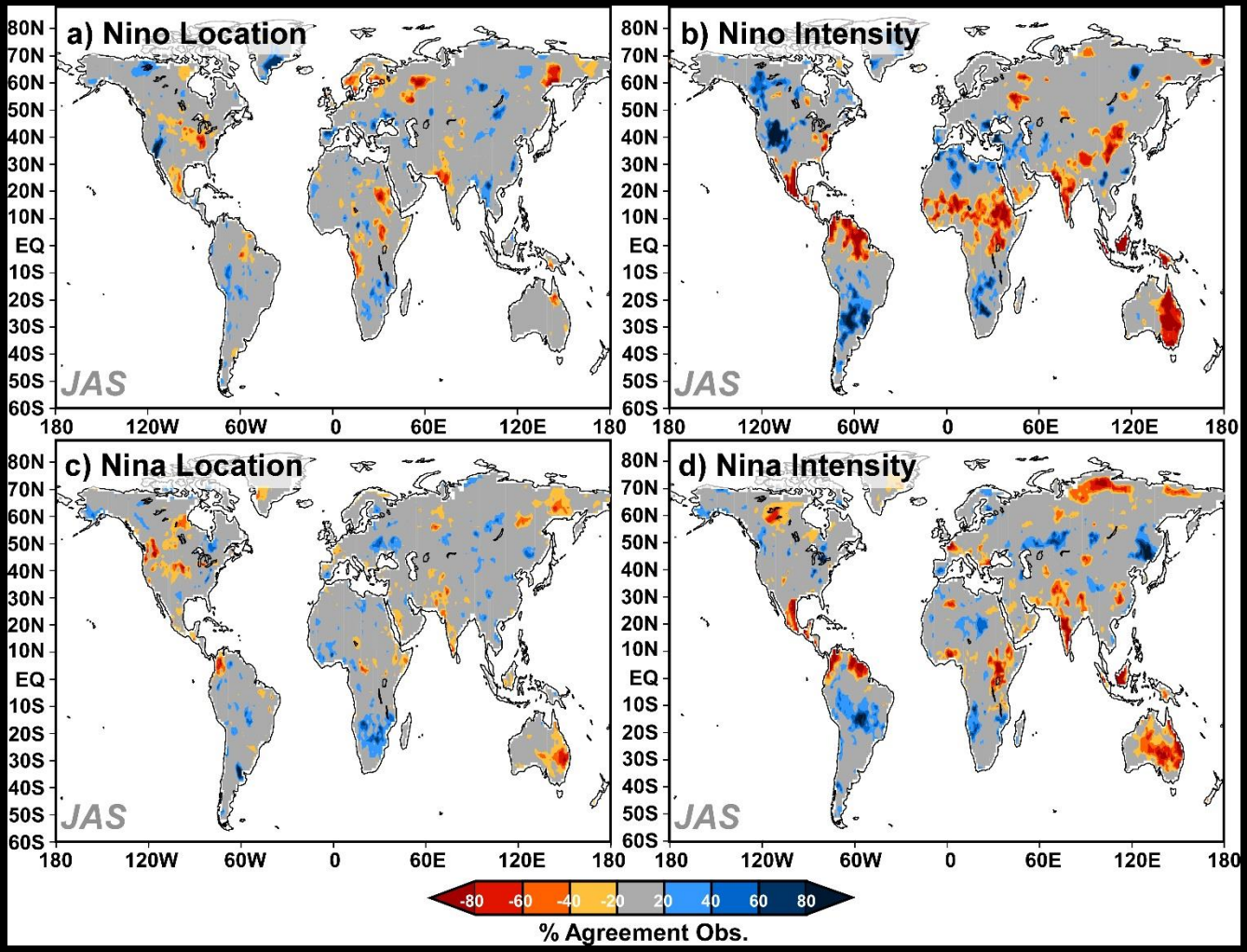
+ Greater Impact
- Weaker Impact

- ***Non-linearity between Nino and Nina, their locations and intensity***

Ex.: Southern Africa = + Nina, - Nino, + Location, - Intensity

North America = + Nino, - Nina, + Location → W, + Intensity → E

Impact on Summer rainfall



+ Greater Impact
- Weaker Impact

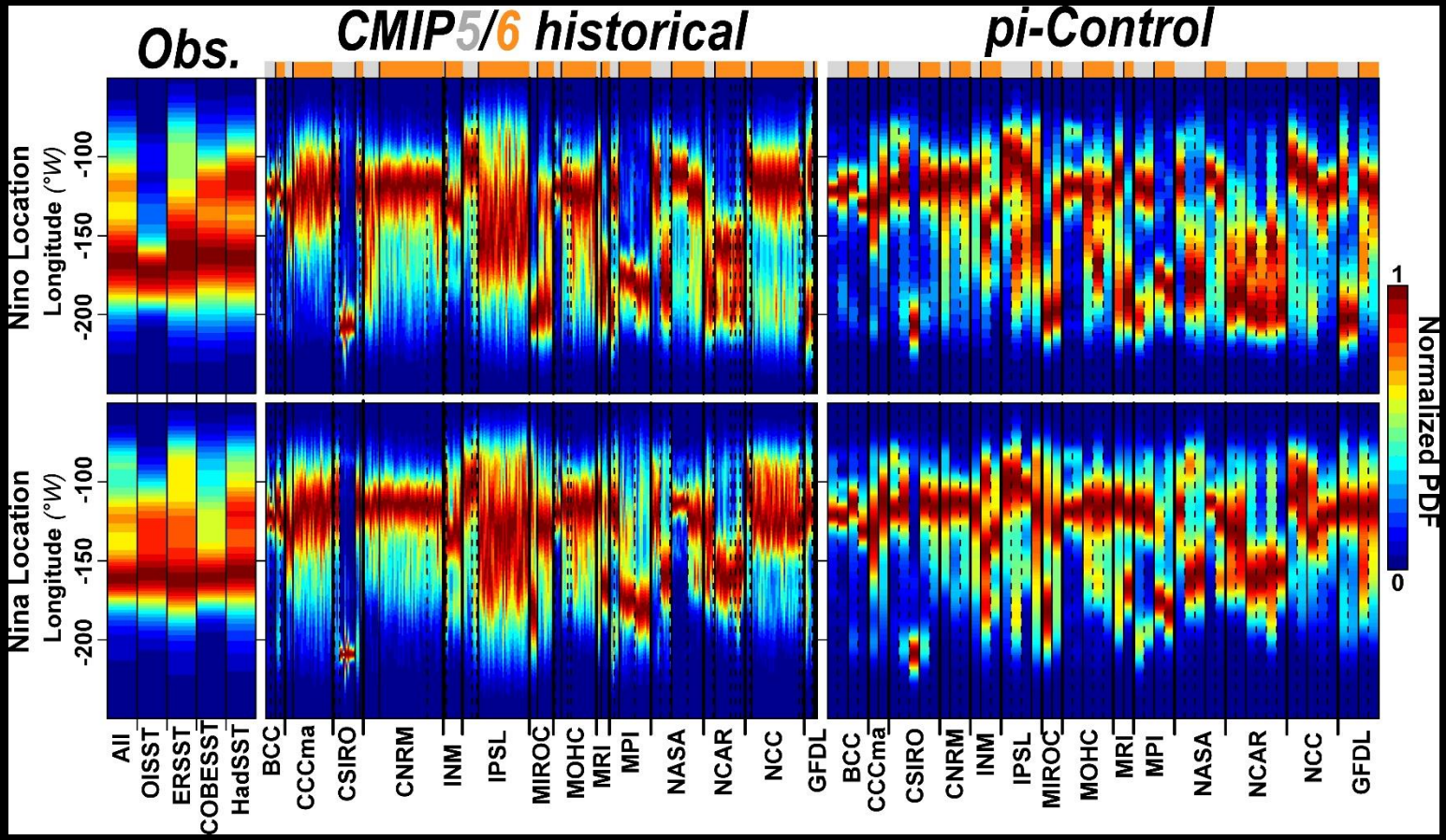
- ***Similarly in summer…***

Ex.: West Africa = + Nina, - Nino, + Intensity, - Location

- ***ENSO impacts differ according to the season***

How does CMIP5/6 simulate ENSO continuum

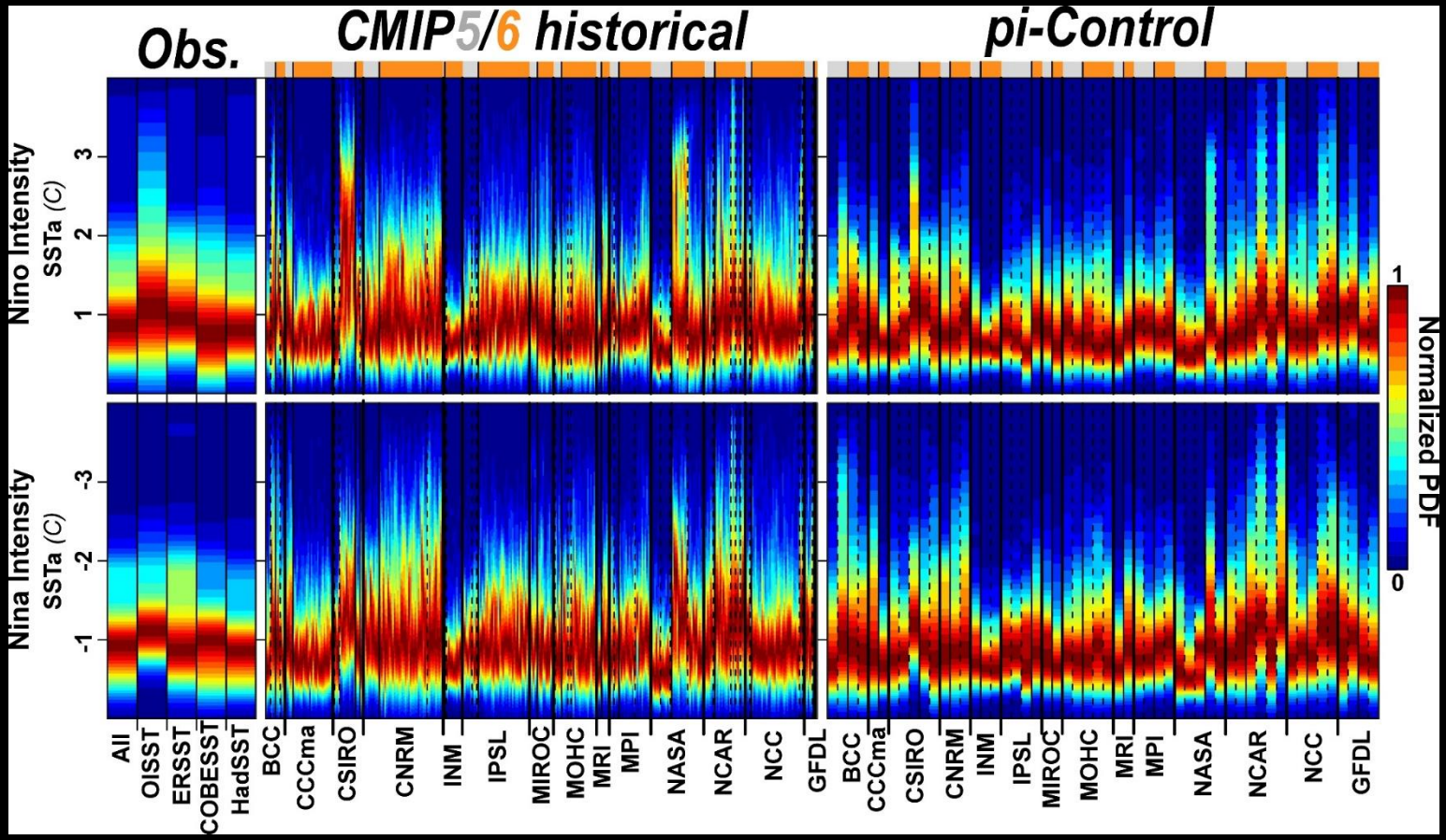
ENSO event locations in 345 historical simulations + 53 piControl runs



- *Most CMIP models tend to favor one type of event*
- *Few models perform quite well, especially in CMIP6 (e.g. IPSL, NCAR, GFDL)*

How does CMIP5/6 simulate ENSO continuum

ENSO event intensity in 345 historical simulations + 53 piControl runs



- *CMIP model are much better in simulating the intensity of events*
- *But some models tend to overestimate the intensity*

Summary

Commonly used ENSO indices do not fully-capture the ENSO continuum

We can physically disentangle both event, their locations and intensity

Differences between Obs. data sets (event characteristic + impact on rainfall)

Consequences for climate model evaluations

in all SST data sets…

Temporal var. in Location & Intensity of ENSO events

Non-linearity in the impacts on precipitation of ENSO events, their locations and intensity

Potential for seamless seasonal/decadal prediction systems

Most CMIP5/6 models favor only one type of event, and their intensity is often overestimated

Potential consequences for future projections