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
Eastern vs. Central Pacific ENSO

Event captured by both indices

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

- 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

○ Significant correlations at p<0.05 using 1000 phase-randomizations (Ebisuzaki, 1996)
Longitudinal locations of ENSO events

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

- 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

- 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

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
Similarly in summer...

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

- ENSO impacts differ according to the season
How does CMIP5/6 simulate ENSO continuum

- 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
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) 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 consequences for climate model evaluations

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

Potential consequences for future projections

Potential for seamless seasonal/decadal prediction systems