Are there really different types of ENSO?

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Number of ICOADS SST obs in the Niño 3.4 region 1800-present
There have been 11 El Niño events since 1970 (according to the CPC website).

How many events needed to identify a change in the frequency of El Niño (currently about every 4 years)?

Assuming a normal distribution with variance that does not change, to detect a change in frequency of 6 months takes more than 30 events (Ray and Giese, 2012).
ENSO is becoming more frequent!
Time since last El Niño (months)
Data from Ray and Giese (2012)
Time since last El Niño (months)
Ray and Giese (2012)
In response to the need for longer time series of SST reconstructions were developed: eg. Kaplan, HadISST, ERSST

These reconstructions rely on patterns of ENSO in data rich periods to reconstruct SST in data poor periods.
Simple Ocean Data Assimilation (SODA 2.2.6)

SODA 2.2.6 is constructed from the average of 8 ensemble ocean reanalyses.

- **Eight Ensemble Ocean Members**
  - Forced by eight ensemble members of 20CR daily stress 1861 – 2008
- **Heat and Salt fluxes**
  - Bulk formulae using 20CR daily variables
- **SODA Data Assimilation**
  - ICOADS 2.5 SST data
Shading: SSH  Contours: Zonal wind stress

Strong ENSO

Weak ENSO
CHI – Center of Heat Index

First moment of SST anomaly – Like the center of mass

SST anomaly must be $\geq 0.5^\circ$C and Area $\geq$ Niño 3.4 area

CHI Longitude = (center of El Niño warming)

CHI Amplitude = (strength of El Niño warming)
## ENSO Location

<table>
<thead>
<tr>
<th>Warming in East</th>
<th>Warming in West</th>
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<tbody>
<tr>
<td>Traditional ENSO</td>
<td>Dateline ENSO / Modoki</td>
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<tr>
<td>Cold Tongue ENSO</td>
<td>Warm pool ENSO</td>
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<td>East Pacific ENSO</td>
<td>West Pacific ENSO</td>
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Note: Our notion of what is traditional is largely based on the 82/83 and 97/98 events….which were both strong and far to the east.

It is also possible that SST reconstructions imprint the structure of these events into periods of few observations.
Distribution of all CHI Longitudes
The Gaussian (in red) has the same variance and mean

mean=137.18W
standard deviation=13.53
Distribution of all CHI Longitudes for SODA, ERSST, and HadISST

- SODA
  - 1871–1949
  - Mean: 136.4°W
  - Std: 11.5°
  - 1950–2008
  - Mean: 137.5°W
  - Std: 15.7°

- ERSST
  - Mean: 129.6°W
  - Std: 10.1°

- HadISST
  - Mean: 126.7°W
  - Std: 9.3°
Averaged El Niño

SODA 2.2.6
CanESM2
CSIRO-MK3-6-0
HadCM3
MIROC-ESM
NorESM-M

BCC-CSM1-1
CNRM-CM5
GISS-E2-R
IPSL-CM5A-LR
MPI-ESM1-M

Number of Occurrence

Longitude
Observations

• Lack of observations limits the population of ENSO

• El Niño in SODA has considerable variability, but relatively little long term trend in strength, location, or frequency.

• There is no evidence from the reanalysis, reconstructed SST, or the CMIP5 historical runs that there are distinctly different types of ENSO.

• At the very least, central Pacific warming is not “new”. East Pacific warming may be anomalous, not the other way around.
CMIP5 Historical Runs

- SODA 2.2.6
- CanESM2
- CSIRO-MK3-6-0
- HadCM3
- MIROC-ESM
- NorESM-M
- BCC-CSM1-1
- CNRM-CM5
- GISS-E2-R
- IPSL-CM5A-LR
- MPI-ESM1-M
Trends (in deg/Century) of El Niño Location

East

West

-10
-8
-6
-4
-2
0
2
4
6

SODA
BCC-CSM1-1
CanESM2
CNR-M-CM5
CSIRO-MK3-6-0
GISS-E2-R
HadCM3
IPSL-CM5A-LR
MIROC-ESM
MPI-ESM1-M
NorESM1-M
GFDL-CM3
MRI-CGCM3

Longitude/Century