El Niño typology and trends

Insight from three decades of weekly SST (and wind stress)

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This Ensō symbol is from http://zenbuddhismforthought.blogspot.com/2012/05/enso-and-ending.html (not sure of the original source).
Three views on tropical Pacific SST variability

Papers about “Modoki”

Questioning 2
Identifying 5
Contrasting 12
Diagnosing 3
Impacts 18

Antarctica 1
Biology 2
Coastal 1
Monsoons 10
Stratosphere 1
Trop. Cyclones 3

Predictability 2
Trends 12
Total 54

All but 3 from 2009–
What is the “simplest” hypothesis?

Various types of global, gridded SST data

<table>
<thead>
<tr>
<th>Type</th>
<th>Example(s)</th>
<th>Time Res.</th>
<th>Time coverage</th>
<th>Spatial Res.</th>
<th>Spatially complete?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure instrumental</td>
<td>ICOADS</td>
<td>Monthly</td>
<td>1800–present</td>
<td>2°</td>
<td>No</td>
</tr>
<tr>
<td>Instrumental analyses</td>
<td>HadISST, ERSST</td>
<td>Monthly</td>
<td>~1880–present</td>
<td>1–5°</td>
<td>Yes, via OI or EOF</td>
</tr>
<tr>
<td>Pure satellite</td>
<td>AVHRR, MODIS</td>
<td>Daily+</td>
<td>1982/2000s–present</td>
<td>~4 km</td>
<td>~Yes for weekly+</td>
</tr>
<tr>
<td>Satellite–era blends</td>
<td>NCEP OI v.2</td>
<td>Daily+</td>
<td>1982–present (30 yr)</td>
<td>¼–1°</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Niño∞**

Traditional ENSO indices

\[
\text{Niño}_\infty(t) = T'_{\varphi=0}(\lambda, t) \text{ for } T' > 0
\]

\[
\text{Niña}_\infty(t) = T'_{\varphi=0}(\lambda, t) \text{ for } T' < 0
\]

30 years of unclassified warm events

30 years of unclassified **cold** events

Example of the 2002–03 El Niño

<table>
<thead>
<tr>
<th>#</th>
<th>Year(s)</th>
<th>Type(s)</th>
<th>Max. SSTA (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1982–83</td>
<td>CP, EP+</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td>1986–88</td>
<td>CP, EP, CP</td>
<td>1.3</td>
</tr>
<tr>
<td>--</td>
<td>1991</td>
<td>EP</td>
<td>0.7</td>
</tr>
<tr>
<td>3</td>
<td>1991–92</td>
<td>CP, EP</td>
<td>1.7</td>
</tr>
<tr>
<td>4</td>
<td>1993</td>
<td>EP</td>
<td>0.9</td>
</tr>
<tr>
<td>5</td>
<td>1994–95</td>
<td>CP, EP</td>
<td>1.2</td>
</tr>
<tr>
<td>6</td>
<td>1997–98</td>
<td>CP, EP+</td>
<td>2.9</td>
</tr>
<tr>
<td>7</td>
<td>2002–03</td>
<td>CP, EP</td>
<td>1.5</td>
</tr>
<tr>
<td>--</td>
<td>2003–04</td>
<td>EP</td>
<td>0.7</td>
</tr>
<tr>
<td>8</td>
<td>2004–05</td>
<td>CP, EP</td>
<td>0.9</td>
</tr>
<tr>
<td>9</td>
<td>2006–07</td>
<td>CP, EP</td>
<td>1.4</td>
</tr>
<tr>
<td>10</td>
<td>2008</td>
<td>EP2</td>
<td>0.9</td>
</tr>
<tr>
<td>--</td>
<td>2011</td>
<td>EP2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**Table 1: Three decades of El Nino typology (1982–2011).**

Identifying number (#), year(s), type(s) of El Niños involved, and peak 3–month running mean SSTA (°C) of each event indicated on Figs. 2 and 3. Events without a number (--) did not pass the threshold on Fig. 2 but are marked with dashed lines on Fig. 3 and discussed in the main text. CP stands for Central Pacific, EP for East Pacific, and EP+ refers to the sequence of EP El Nino followed by a very strong warm anomaly in the far eastern Pacific between the Galapagos and mainland South America. See main text for discussion of EP2.

Trends in CP and EP El Niño events


(No trend in amplitude)
Summary, conclusions, and a haiku

• Presented a straightforward interpretation of 30 years of reliable weekly SST and wind stress observations across the equatorial Pacific Ocean in time–longitude space.

• Are there two distinct types of El Niños?

Westerly wind stress anomaly (synoptic “burst” or large-scale)

Gill

\[ u \frac{\partial u}{\partial x} \text{ (and } w \frac{\partial u}{\partial z} \text{) } \]

Bjerknes

Downwelling Kelvin wave

Eastward translation of warm pool edge
( = CP El Niño )

Depress eastern thermocline / warm SST
( = EP El Niño )

“Local” response El Niño

“Remote” response El Niño

Summary, conclusions, and a haiku

• Presented a straightforward interpretation of 30 years of reliable weekly SST and wind stress observations across the equatorial Pacific Ocean in time–longitude space.

• Are there two distinct types of El Niños?

• Any appearance of a trend over this period of time, particularly for Modoki, is heavily in favor of random chance.

• Cannot evaluate trends in amplitude for different types separately.

Many want to know,  
Modoki, or come and go?  
Decades, I can’t show.