El Niño and Climate Change

January 27, 2016
Bernadette Woods Placky
Meteorologist
bplacky@climatecentral.org

Sean Sublette
Meteorologist
ssublette@climatecentral.org

January 27, 2016
http://www.climatecentral.org/workshops-and-webinars
El Niño and Climate Change

Tom Di Liberto
Meteorologist
Climate Prediction Center
Washington, DC

January 27, 2016
El Niño-Southern Oscillation

What the heck is that?

Tom Di Liberto – @TDLiberto
Innovim/Climate Prediction Center
OUTLINE

• What are El Niño, La Niña and the Southern Oscillation?
• What are they NOT?
• What is going on this year?
• Climate Change and ENSO – what is going to happen?
ENSO – a history

Sir Gilbert Walker
Southern Oscillation – 1924

Also NAO, NPO ... smart guy
ENSO – a history

Jacob Bjerknes

Linked Pacific Ocean to Atmosphere – 1960s

Also another very smart guy
Um.. The 1960s?

Obs not widespread until second half of 20th century.

Deser et al. 2010
Monthly Mean Global SST (°C): January
Climatology: 1982–1995
SST Climatology

Monthly Mean Global SST (°C): October
Climatology: 1982–1995
El Niño Evolution
Global Impacts

20-30% of land impacted by ENSO

High Resolution Images can be found at:
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/ENSO-Global-Impacts/
US Impacts

Wintertime
El Niño pattern

low pressure

warmer

drier

extended
Pacific Jet Stream,
amplified storm track
ENSOSO Myths

When is El Niño going to hit?

Strongest El Nino Storm So Far This Winter Hits California

By CHRISTOPHER WEBER, ASSOCIATED PRESS
LOS ANGELES — Jan 6, 2016, 10:08 PM ET

El Nino storms arriving on the West Coast

JANUARY 5, 2016, 6:41 PM | Communities that were dealing with wildfires and drought are now being covered under mudslides as storms brought on by El Nino pummel the West Coast. As Ben Tracy reports, more storms are coming throughout the week.
Wintertime
El Niño pattern

- Warmer
- Wetter
- Drier

Extended Pacific Jet Stream, amplified storm track

DETOUR
ENSO Myths

When is El Niño going to hit?

El Niño is NOT a storm.
It changes the background state.
El Niño causes EVERYTHING.
### ENSO Myths

**Billion-Dollar Weather Disasters**

World-wide Tally (January - December 2023)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Disaster</th>
<th>Date</th>
<th>Cost</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wildfires, Indonesia</td>
<td>1/1 - 12/31</td>
<td>$16.1 billion</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>Flooding, Southeast U.S.</td>
<td>10/1 - 10/11</td>
<td>$5.0 billion</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>Drought, Western U.S.</td>
<td>1/1 - 9/30</td>
<td>$4.5 billion</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Typhoon Mujigae, China, Philippines</td>
<td>10/2 - 10/4</td>
<td>$4.2 billion</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>Flooding, South India and Sri Lanka</td>
<td>11/9 - 12/8</td>
<td>$4.0 billion</td>
<td>386</td>
</tr>
<tr>
<td>6</td>
<td>Severe Weather, U.S. Plains, Midwest, Rockies, Southeast</td>
<td>5/23 - 5/28</td>
<td>$3.75 billion</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>Winter Weather, Eastern U.S.</td>
<td>2/16 - 2/22</td>
<td>$3.25 billion</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>Typhoon Soudelor, China, Taiwan, Saipan</td>
<td>8/2 - 8/8</td>
<td>$3.2 billion</td>
<td>41</td>
</tr>
<tr>
<td>9</td>
<td>Severe Weather, U.S. Plains, Midwest, Southeast</td>
<td>12/26 - 12/30</td>
<td>$3 billion</td>
<td>46</td>
</tr>
<tr>
<td>10</td>
<td>Drought, Romania, Poland, Czech Republic</td>
<td>6/1 - 10/31</td>
<td>$2.7 billion</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>Flooding, UK</td>
<td>12/22 - 12/31</td>
<td>$2.5 billion</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6/7 - 6/11</td>
<td>$2.0 billion</td>
<td>16</td>
</tr>
<tr>
<td>13</td>
<td>Drought, South Africa</td>
<td>7/1 - 1/30</td>
<td>$2.0 billion</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>Wildfires, California</td>
<td>9/9 - 10/30</td>
<td>$2.0 billion</td>
<td>7</td>
</tr>
<tr>
<td>15</td>
<td>Drought, China</td>
<td>1/1 - 12/31</td>
<td>$1.8 billion</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>Severe Weather, U.S. Plains, Midwest, Mississippi Valley</td>
<td>4/7 - 4/10</td>
<td>$1.65 billion</td>
<td>3</td>
</tr>
<tr>
<td>17</td>
<td>Typhoon Chan-hom, China</td>
<td>7/4 - 7/13</td>
<td>$1.6 billion</td>
<td>16</td>
</tr>
<tr>
<td>18</td>
<td>Flooding, Chile</td>
<td>3/25 - 4/8</td>
<td>$1.5 billion</td>
<td>25</td>
</tr>
<tr>
<td>19</td>
<td>Drought, Ethiopia</td>
<td>10/1 - 12/31</td>
<td>$1.4 billion</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>Severe Weather, U.S. Rockies to Mid-Atlantic</td>
<td>6/19 - 6/26</td>
<td>$1.3 billion</td>
<td>4</td>
</tr>
<tr>
<td>22</td>
<td>Flooding, China</td>
<td>7/20 - 7/24</td>
<td>$1.2 billion</td>
<td>28</td>
</tr>
<tr>
<td>23</td>
<td>Flooding, China</td>
<td>5/18 - 5/22</td>
<td>$1.15 billion</td>
<td>48</td>
</tr>
<tr>
<td>24</td>
<td>Winter Storm Ted, UK, Ireland, Norway</td>
<td>12/22 - 12/30</td>
<td>$1.1 billion</td>
<td>3</td>
</tr>
<tr>
<td>25</td>
<td>Severe Weather, U.S. Plains, Midwest, Southeast</td>
<td>12/22 - 12/26</td>
<td>$1.0 billion</td>
<td>18</td>
</tr>
<tr>
<td>26</td>
<td>Severe Weather, U.S. Plains, Midwest, Rockies</td>
<td>5/6 - 5/13</td>
<td>$1.0 billion</td>
<td>6</td>
</tr>
<tr>
<td>27</td>
<td>Drought, Western Canada</td>
<td>1/1 - 12/31</td>
<td>$1.0 billion</td>
<td>0</td>
</tr>
<tr>
<td>28</td>
<td>Winter Storms Mike and Niklas, Western &amp; Central Europe</td>
<td>3/29 - 4/1</td>
<td>$1.0 billion</td>
<td>9</td>
</tr>
<tr>
<td>29</td>
<td>Flooding, France</td>
<td>10/3 - 10/4</td>
<td>$1.0 billion</td>
<td>19</td>
</tr>
</tbody>
</table>

Source: Aon Benfield
ENSO Myths

El Niño causes EVERYTHING.

Not Quite.

20-30% of land areas show repeatable ENSO patterns (Mason and Goddard 2001).

ENSO explains only 15-20% of extreme precipitation (Dai et al 1997).
El Niño and La Niña means more extreme weather globally
ENSO Myths

(b) Relative Disaster Occurrences

<table>
<thead>
<tr>
<th>Events</th>
<th>Neutral</th>
<th>El Nino</th>
<th>La Nina</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

La Nina Yrs | El Nino Yrs

(c) Relative Disaster Occurrences

<table>
<thead>
<tr>
<th>Events</th>
<th>Onset Yrs</th>
<th>Demise Yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Onset Yrs | Demise Yrs

Goddard and Dilley, 2005
El Niño and La Niña means more extreme weather globally

NOPE. We just know where the events may happen.
El Niño and La Niña means DESTRUCTION...
GODZILLA... ROARRRRRRR
More Winners Than Losers
El Nino Effect on Growth

Cumulative Percentage Point Change in GDP After Four Quarters

Source: IMF Report
ENSO Myths

El Niño and La Niña means DESTRUCTION...
GODZILLA... ROARRRRRRRR

It does in some places but net positive elsewhere.
ENSO Myths

El Niño and La Niña means weather and climate are unpredictable.
ENSO Myths
US Seasonal Forecasts 1997-2008

Livezey and Timofeyeva, 2008
ENSO Myths

El Niño and La Niña means weather and climate are unpredictable.

Not entirely. Higher winter seasonal forecast skill thanks to ENSO!
What is El Niño

Historical Definition

• 5 consecutive 3-month overlapping seasons >= +0.5°C in Niño-3.4 region (aka. Oceanic Niño Index or ONI)
• Currently using a 1981-2010 climatology.
• Switched from the use of ERSSTv3b to ERSSTv4 data in July 2015
What is El Niño

When is it here?

Start here

Is the monthly Niño-3.4 SST ≥ 0.5 °C?

YES

Think the Niño-3.4 SST will stay ≥ 0.5 °C for the next several seasons?

YES

What does the atmosphere look like?

Indications of a weaker Walker circulation (such as more rain over the central Pacific, less rain over Indonesia)

NOPE!

NO

Insufficient indications of a weaker Walker circulation

Is it El Niño conditions?
2015/2016 El Niño... pretty big right?
Yup.
ERSSTv4 - Niño Regions

Monthly ERSSTv4 Niño 3.4 Index Values

Monthly ERSSTv4 Niño 4 Index Values (no trend)

Monthly ERSSTv4 Niño 3 Index Values (no trend)

Monthly ERSSTv4 Niño 1+2 Index Values (no trend)

Record!

Lagging

#3
Latest CPC Update

Monthly ENSO outlook - 2nd Thursday of month

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.html

Current: El Niño Advisory

El Niño to remain strong through winter, transition to neutral late spring/early summer
So Climate Change - ENSO...

What’s the deal?

A Scientific

-\_-(ツ)\_/-
Global Land and Ocean Temperature Anomalies, January-December

Anomaly (°C)

El Niño/La Niña Global Surface Temperature Influence

Warming is clear.
Correcting GISTEMP for ENSO

2015 is still a record in ENSO-Corrected data

But not all El Niño’s fault

Correction uses 3-month ENSO averages leading temperature data by 12 months

Via Gavin Schmidt – NASA GISS
How will ENSO change?

One Thought.

Change in average state.

Weakened Walker Circulation

Adapted from Collins et al. (2010) and IPCC AR5 (2013)
How will ENSO change?

BUT

Other studies have shown a strengthening Walker Circulation.
How will ENSO change?
How will ENSO change?
How will ENSO change?

Climate model uncertainty

Vecchi and Wittenberg, 2010
How will ENSO change?

Climate model uncertainty

Error compensation

Processes affecting ENSO

Upwelling/thermocline
Low cloud physics
Large-scale atmospheric circulation
Equatorial ocean dynamics
Shift of convection/high cloud physics
Ocean advection

Resulting ENSO amplitude

Model A
Model B
Model C
How will ENSO change?

Could we even tell?

Natural variability is quite...... variable.
How will ENSO change?

NINO3 SST (°C):
running annual mean
& 20yr low-pass

(a) Observational reconstruction (ERSST.v3)

(b) CM2.1 PI control simulation

Wittenberg, 2009
How will ENSO change?

Two questions.

How long does it take before we know what regime we are in right now?

How long before we could detect a Climate Change signal amid that variability?
How will ENSO change?

The IPCC has LOW confidence in exactly what will happen to ENSO in the future even while they have HIGH confidence that ENSO itself will continue (IPCC, 2013).
Climate change affects ENSO impacts

El Niño and Rainfall

El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.

This occurs in climate change-affected background state.

References

• CPC/Climate.gov ENSO Blog –
  • https://www.climate.gov/news-features/blogs/enso/


• Or just ask me a question on twitter @TDiLiberto

• Or email – tom.diliberto@noaa.gov
Workshops and Webinars

Below you will find a collection of materials associated with our climate-related workshops and webinars. Please contact Bernadette Woods Fluty (bfluty@climatecentral.org, 409-286-1991) with any questions or comments.

Workshops
- Climate Smart
- AMS Broadcast Meteorology Short Course

Webinars
- 2013
  - El Estudio del Clima del 2013
  - A Brief History of Climate Change Science
  - A Deep Dive into the Southern Ocean
  - A Retrospective Look at the Kepler Curves
  - A Deep Dive into The California Drought
- 2014
  - Understanding the Southern Ocean
  - 2014: Review of Significant Weather Events
  - Winter Outlook 2014-2015
  - Climate Change at the Poles
  - Western Wildfires
  - Hurricane
  - Severe Weather & Climate Change
- 2015
  - Winter Outlook 2014-2015
  - Climate 101

http://www.climatecentral.org/workshops-and-webinars

January 27, 2016
El Niño and Climate Change

January 27, 2016