What’s going on with El Niño and climate change?

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Global temperature and carbon dioxide: anomalies through 2015 (projected)

Base period 1900-99; data from NOAA
ENSO is the main source of interannual variability
Global mean T

Global Mean Temperature
NOAA

°C


Base period 1900-99
There is a mini global warming with El Niño: 0.24°C peak in 1998, 0.17°C for year.

*Trenberth et al. 2002*  
The evolution of ENSO and global atmospheric surface temperatures. JGR
Regression of GMST on N3.4

3 month lag:
0.11°C per Nino 3.4 SST change

In 1998 peak N3.4 2.5°C =>
order 0.25°C in GMST or 0.17°C for annual mean 1998.

Also for
2015: ~0.25°C GMST rise

T et al JGR 2002
The biggest source of drought and floods around the world is ENSO.

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Fewer El Niño's in recent years means fewer droughts
Warmer air holds more moisture

7% per °C

Global warming:

More heat → More drying → More evaporation → More moisture

More rain
More drought
Global warming

Heating \(\uparrow\)

Temperature \(\uparrow\) & Evaporation \(\uparrow\)

Water holding capacity \(\uparrow\)

Atmospheric moisture \(\uparrow\)

Greenhouse effect \(\uparrow\) & Rain intensity \(\uparrow\)

Flooding & Droughts
Whether and when a drought occurs is largely natural variability, dominated by ENSO.

But given a drought, global warming makes it more intense and longer lasting.

Extra heat builds up: has nowhere to go.

- Increased drying
- Increased heating and heat waves
- Increased wildfire risk
California drought
Winter 2013-14

Data Source: NCEP CMAP Precipitation

Ridiculously resilient ridge
NH winter EN
We have a strong El Niño.

But the focus should be more on total SST as that controls where low level convergence occurs and thus upper level outflow and Rossby wave forcing.

It is not linear!
Main source term for Rossby waves

Vorticity tendency

includes especially $\beta v_x$

= northward divergent wind component
Last 30 days:
8 Oct-6 Nov
Anomalies

Precipitation

10 inches!

OLR

Divergent wind
El Niños are red, La Niñas are blue.
They follow in sequence every year or two.
Global T and PDO

June 2015
0.88°C above 20th C mean
Energy budget of Earth:

- The OHC data strongly suggest that the ocean loses heat during latter stages of El Niño.
- Largely through evaporative cooling of ocean.
- Moistens atmosphere and invigorates storms and raises risk of floods.
- Leads to mini-global warming.

- Then there is a recharge of heat during La Niña.
- Models do not do this discharge-recharge correctly: they tend to slosh heat around (delayed oscillator).
- In PDO -ve, more heat goes deeper and is less accessible to atmosphere.
Increasing frequency of extreme El Niño events due to increased greenhouse warming

Relies on CMIP models: reduced SST gradients
How ENSO itself changes with climate change is not very clear.

But it is clear that the consequences become greater (in terms of droughts and floods).