Changes in Weather and Climate Patterns during El Niño and La Niña

The Pacific jet stream responds by strengthening & extending eastward during El Niño (weakening & retracting westward during La Niña).

Changes in the jet lead to changes in temperature and precipitation patterns, hence changes in the number & intensity of weather events, including extremes.
Why were US T&P predictions unsuccessful in some ENSO years?

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<tr>
<td>3-Mon ONI</td>
<td>0.6°C</td>
<td>0.7°C</td>
<td>0.7°C</td>
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<td>Non-EC HD score (US Mon Precip)</td>
<td>-35</td>
<td>7</td>
<td>-10</td>
<td>-2</td>
<td>-46</td>
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August 2004 Prec Official_Forecast

December 2004 Prec Official_Forecast

August 2004 Prec Obs_Categories

December 2004 Prec Obs_Categories
Uncoupled El Niño Warming

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What is the uncoupled El Nino warming?

An uncoupled warming event is defined as an event with

- (a) Monthly mean Niño3.4 index \( \geq 0.5^\circ C \);
- (b) Central Pacific OLR (CP_OLR) index \( > 0.0 \);
- (c) (a) & (b) persist for at least 3 consecutive months.
4 uncoupled warming events since 1979
Uncoupled El Nino: small SSTA zonal gradient & positive OLR
- Zonal SSTA gradient ↔ Zonal Wind anomaly ↔ Convection/OLR ↔ ENSO
- NO Zonal SSTA gradient ↔ NO Zonal Wind anomaly ↔ NO Convection/OLR ↔ NO Coupling
Without tropical convection, there will be NO extratropical response.
Coupled composite is more significant than uncoupled one;

- CPC official forecast skill of T/P in El Nino is higher than uncoupled one;
- So we must distinguish uncoupled El Nino from coupled one.
Consistently, the zonal gradients overall increased implying potential of increase of uncoupled El Nino warming.
Fig. S3. Time series of unfiltered (red) and residual (blue) zonal SST gradient index for (a) SON and (b) all three-month seasonal means.

Johnson et al. GRL 2019: zonal SST gradient index is defined as the difference between the standardized SSTA averaged over a box near Papua New Guinea (10°S–10°N, 130°E–170°E) and the standardized SSTA averaged over a box in the central Pacific (10°S–10°N, 180°–140°W).
Lead-time dependent prediction skill of CFSv2 predicted Niño3.4 (bar) and zonal gradient of SSTA (the central (5°S-5°N, 160°E-160°W) minus the eastern (5°S-5°N, 120°W-90°W) tropical Pacific; line) indices. The skill is defined as the linear correlation between the ensemble mean of 20 forecast members and observations in Jan 1982-Dec 2018.

Predicting zonal SSTA gradient is much harder than predicting Nino3.4.
In addition to various flavors of ENSO, oceanic warming in the central and eastern tropical Pacific sometimes is not accompanied by corresponding atmospheric anomalies, i.e., atmosphere and ocean remain uncoupled.


Without coupling, the impact of the El Nino warming on extratropical climate may also be different from that of its coupled counterpart, implying an additional challenge for seasonal climate prediction.

The enlarged zonal contrast trend across the tropical Pacific may be associated with more frequent uncoupled El Nino warming since 1999/2000.

Why?