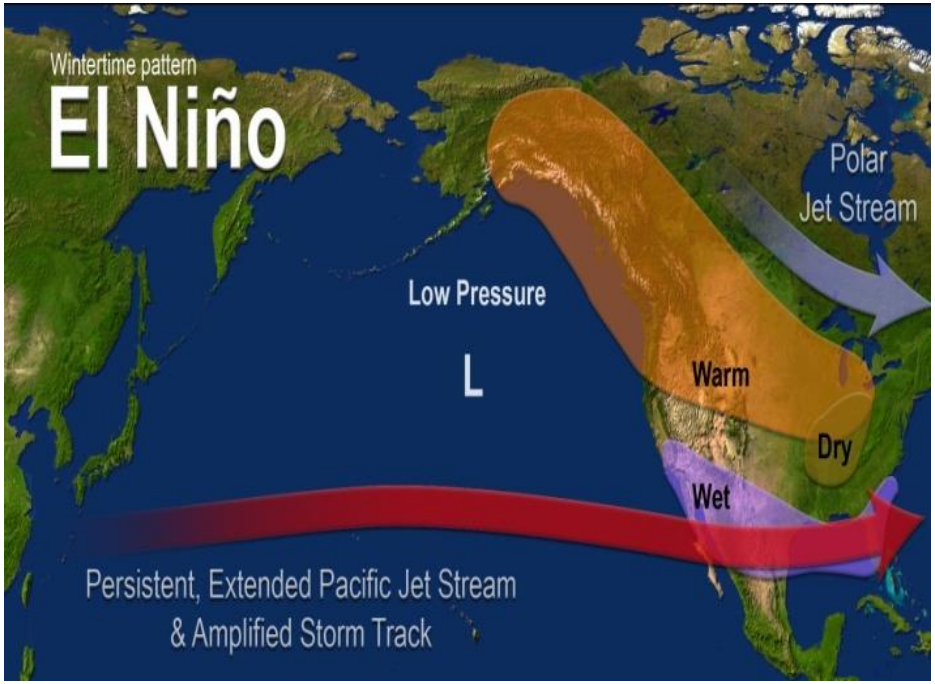
Changes in Weather and Climate Patterns during El Niño and La Niña



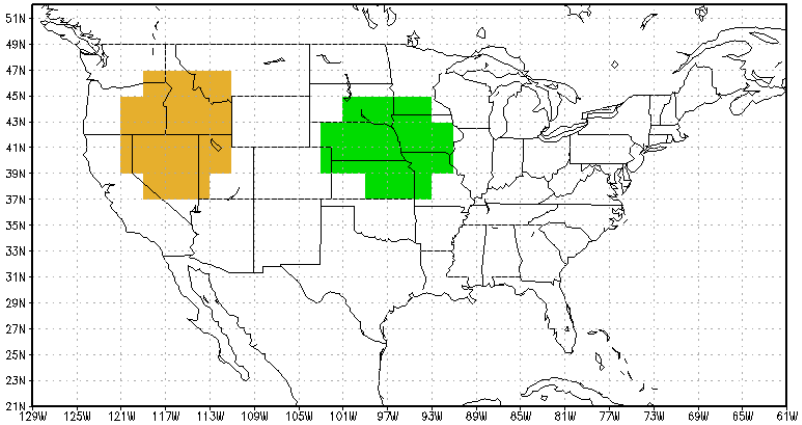
The Pacific jet stream responds by strengthening & extending eastward during El Niño (weakening & retracting westward during La Niña).

Changes in the jet lead to changes in temperature and precipitation patterns, hence changes in the number & intensity of weather events, including extremes.

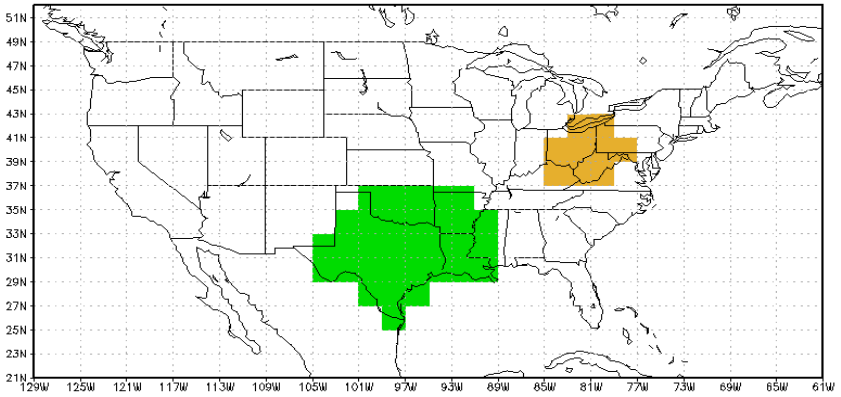
➢ Why were US T&P predictions unsuccessful in some ENSO years?

	Aug 2004	Sep 2004	Oct 2004	Nov 2004	Dec 2004
3-Mon ONI	0.6°C	0.7°C	0.7°C	0.7°C	0.7°C
Non-EC HD score (US Mon Precip)	-35	7	-10	-2	-46

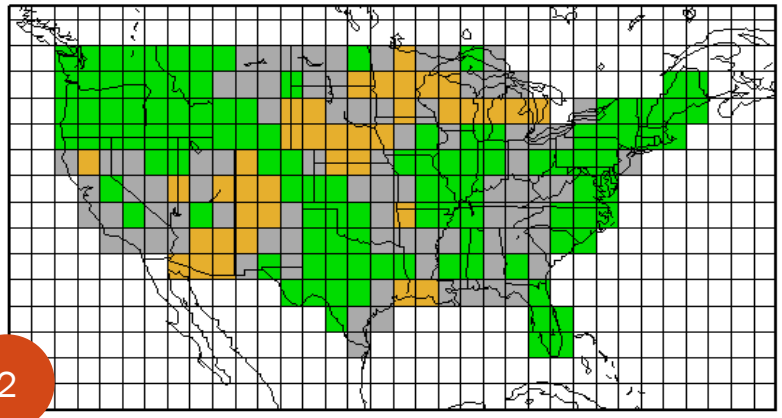
August 2004 Prec Official_Forecast



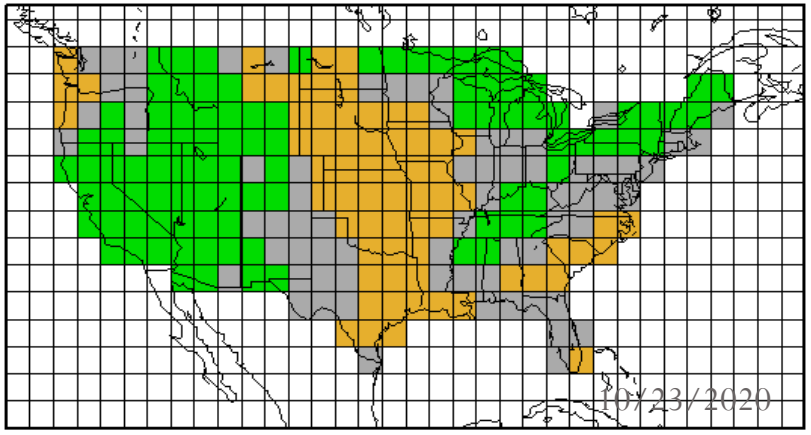
December 2004 Prec Official_Forecast



August 2004 Prec Obs_Categories



December 2004 Prec Obs_Categories



Uncoupled El Niño Warming

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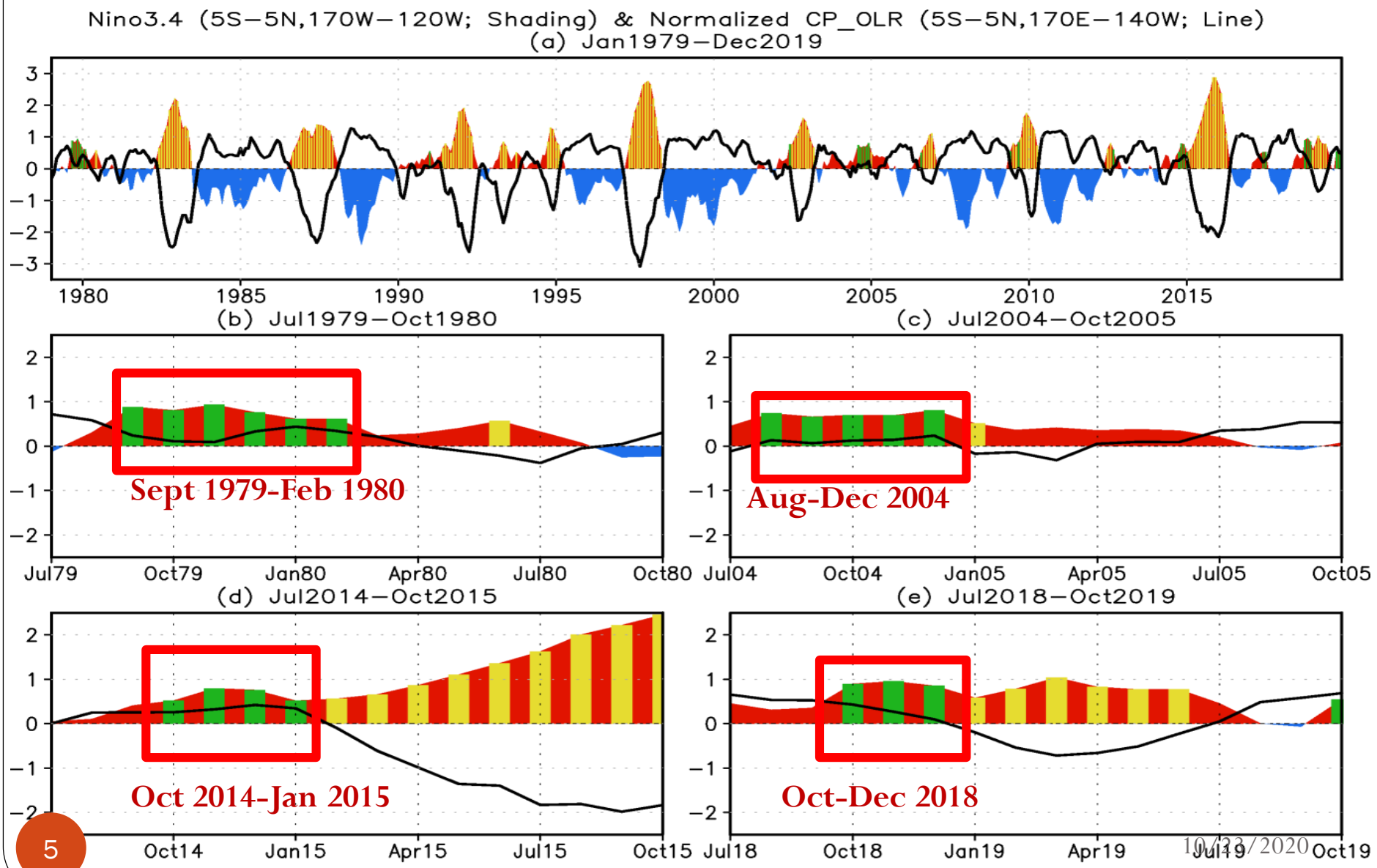
What is the uncoupled El Nino warming?

An uncoupled warming event is defined as an event with

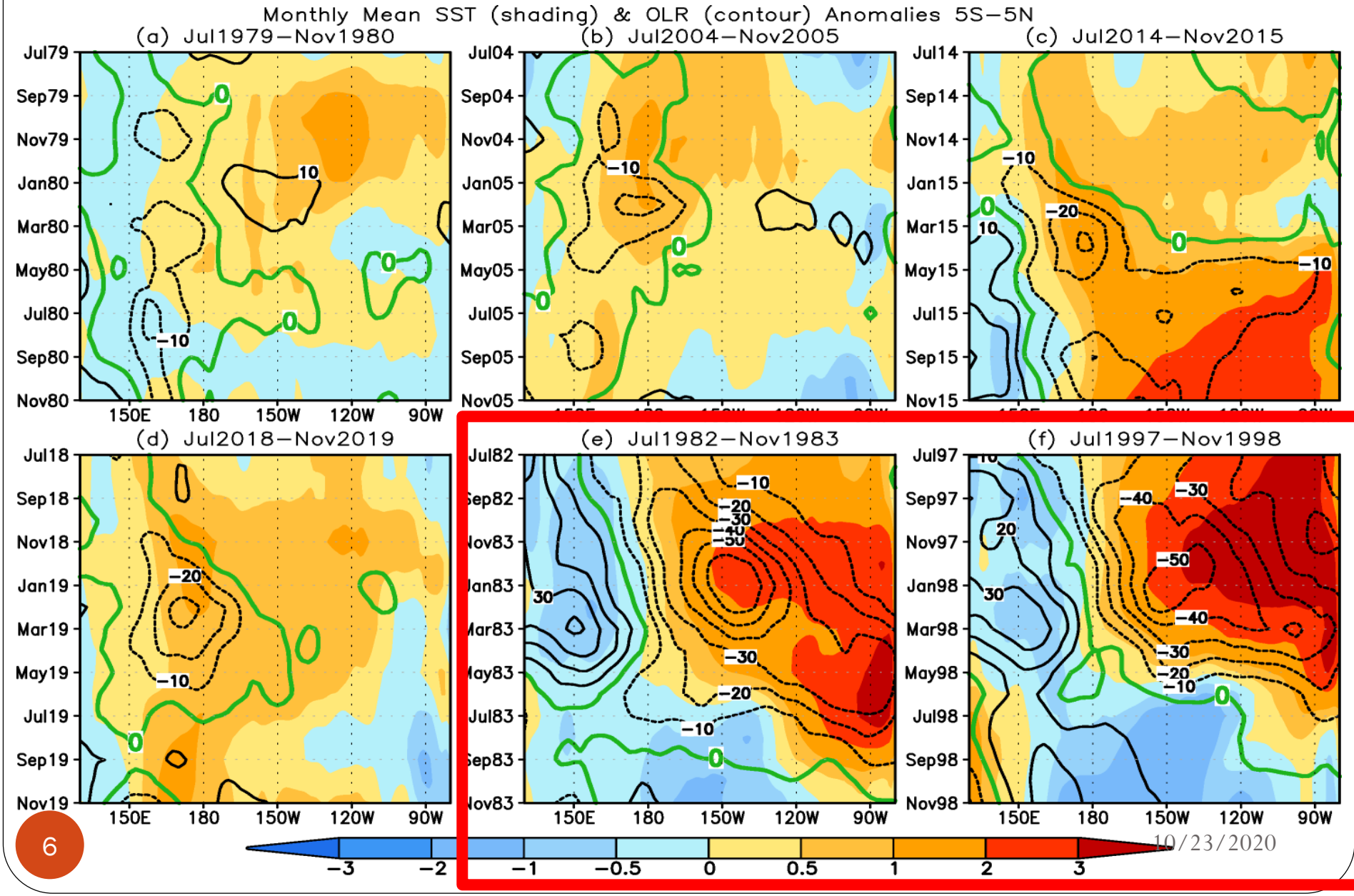
- **(a) Monthly mean Niño3.4 index ≥ 0.5°C;**
- **(b) Central Pacific OLR (CP_OLR) index >0.0;**
- **(c) (a) & (b) persist for at least 3 consecutive months.**

4 uncoupled warming events since 1979

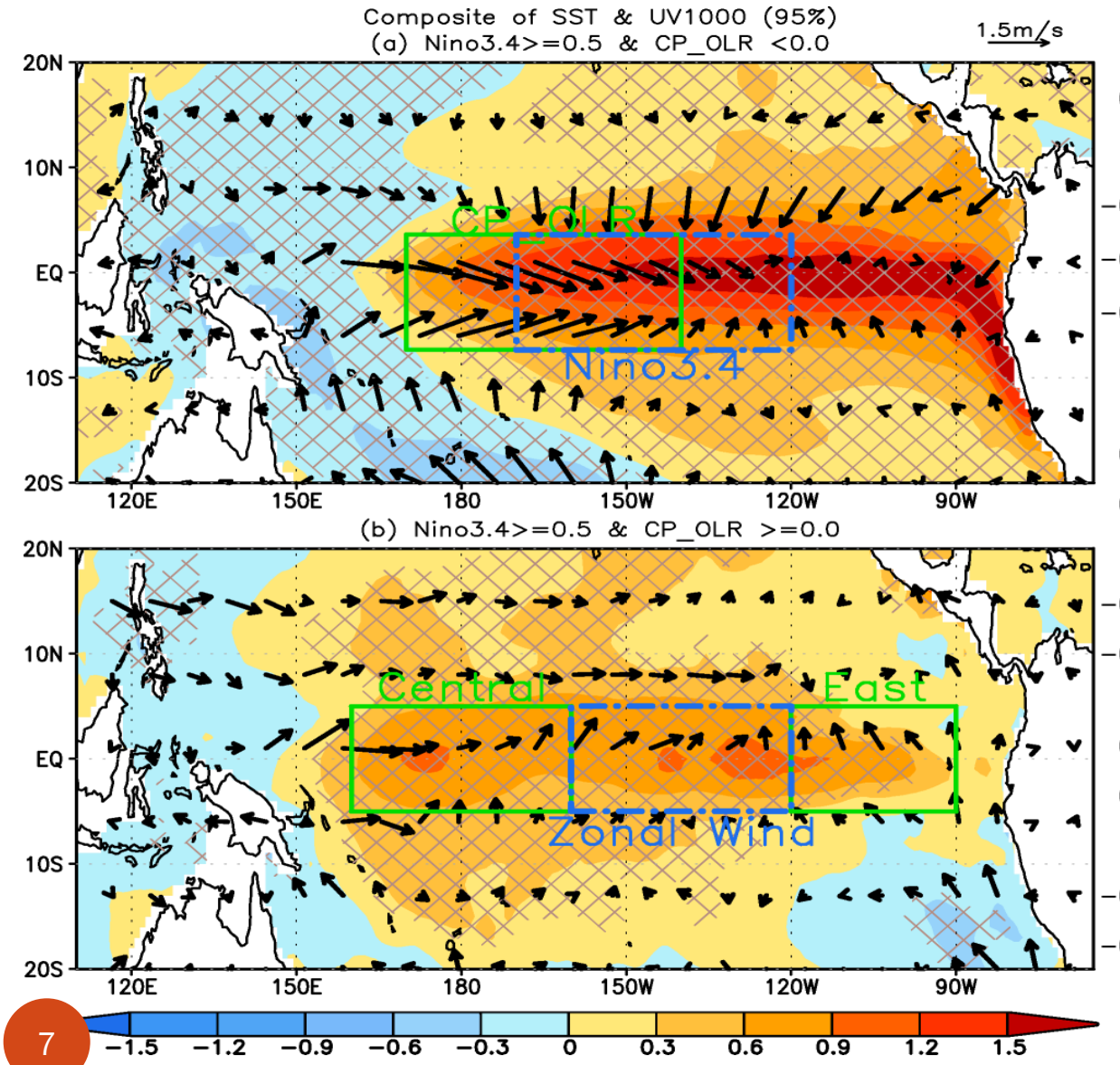
(Sep 1979-Feb 1980, Aug-Dec 2004, Oct 2014-Jan 2015, & Oct-Dec 2018)

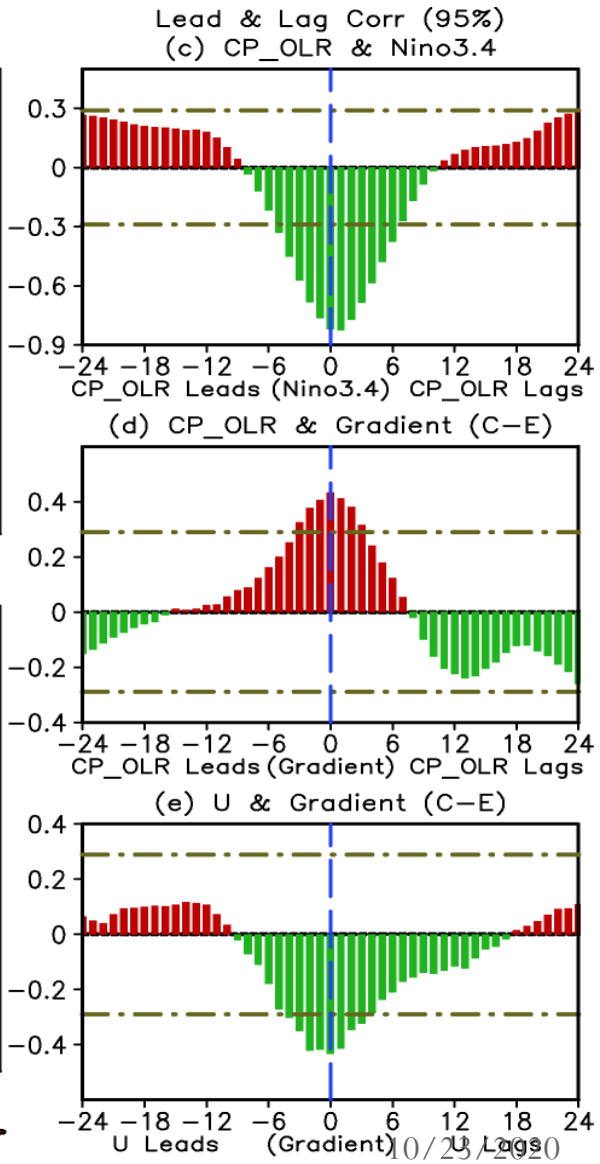


Uncoupled El Nino: small SSTA zonal gradient & positive OLR

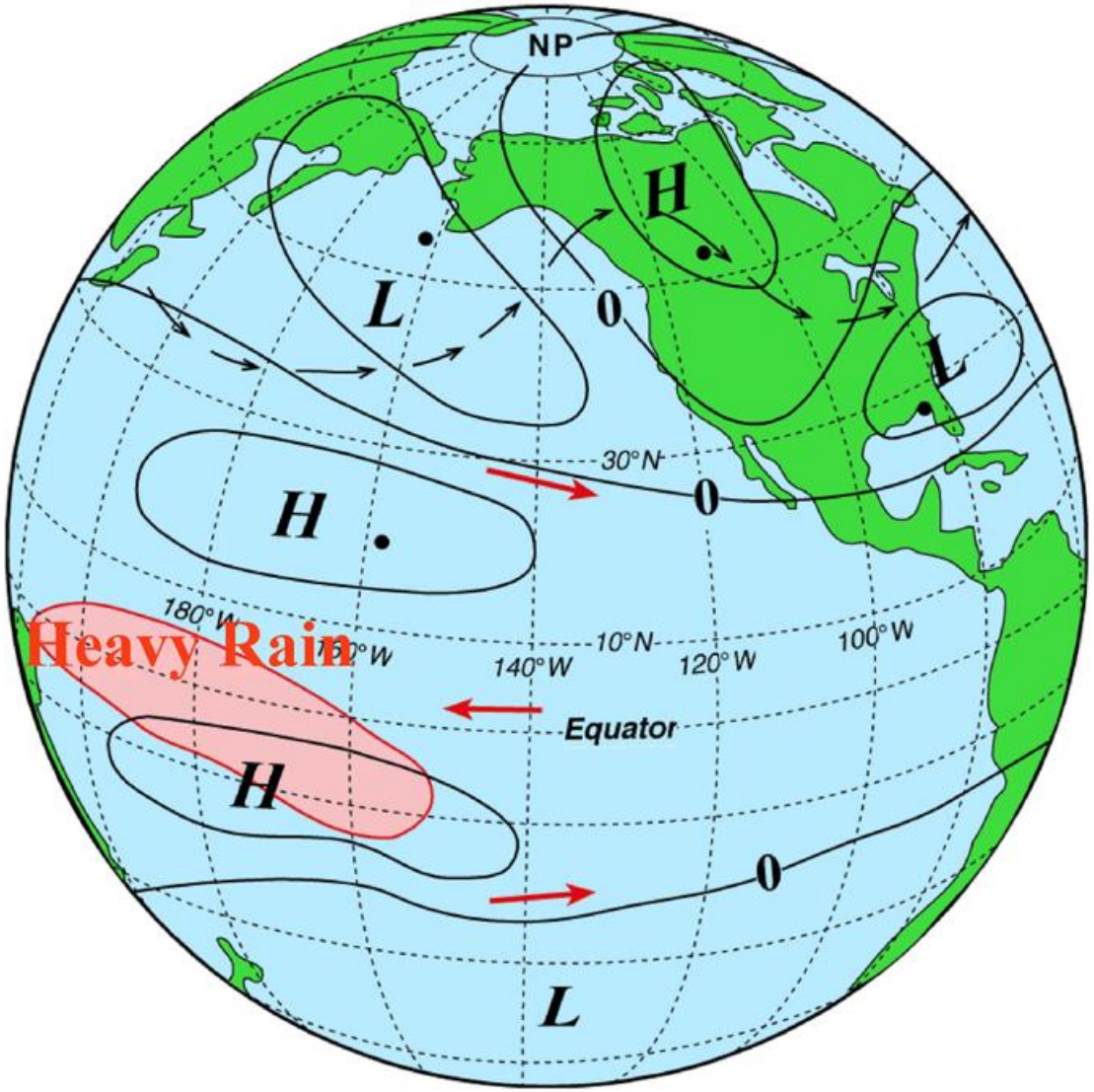


- Zonal SSTA gradient ↔ Zonal Wind anomaly ↔ Convection/OLR ↔ ENSO
- NO Zonal SSTA gradient ↔ NO Zonal Wind anomaly ↔ NO Convection/OLR ↔ NO Coupling





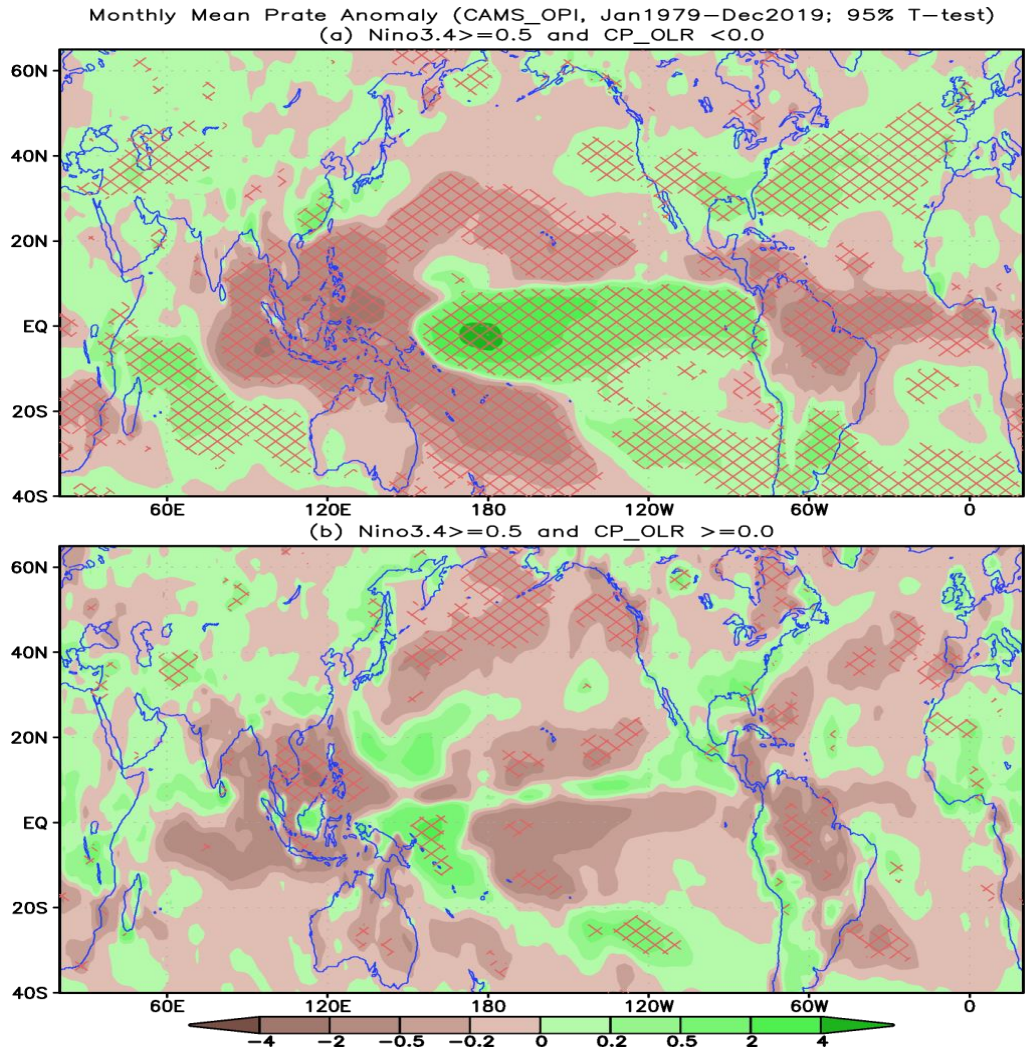
Pacific-North American (PNA) Pattern



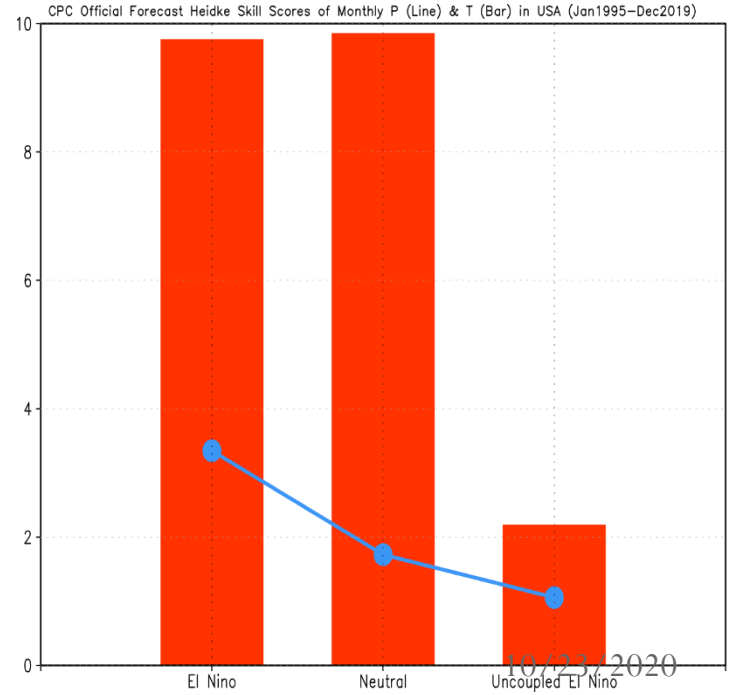
Without tropical convection, there will be NO extratropical response.

Wang, C. Three-ocean interactions and climate variability: a review and perspective. Clim Dyn 53, 9–5136 (2019). https://doi.org/10.1007/s00382-019-04930-x

Coupled El Nino

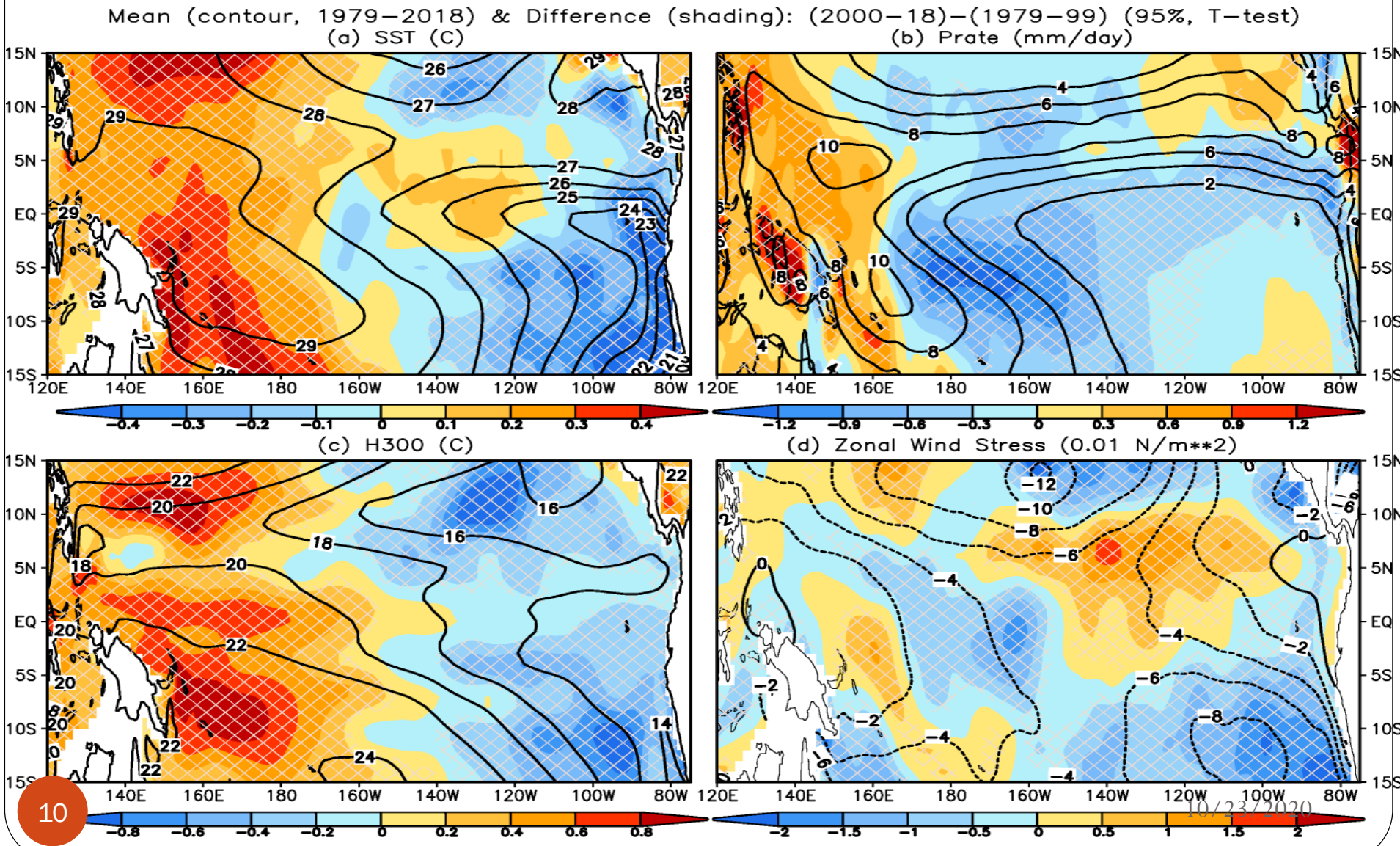


- Coupled composite is more significant than uncoupled one;
- CPC official forecast skill of T/P in El Nino is higher than uncoupled one;
- **So we must distinguish uncoupled El Nino from coupled one.**



Uncoupled El Nino

Consistently, the zonal gradients overall increased implying potential of increase of uncoupled El Nino warming



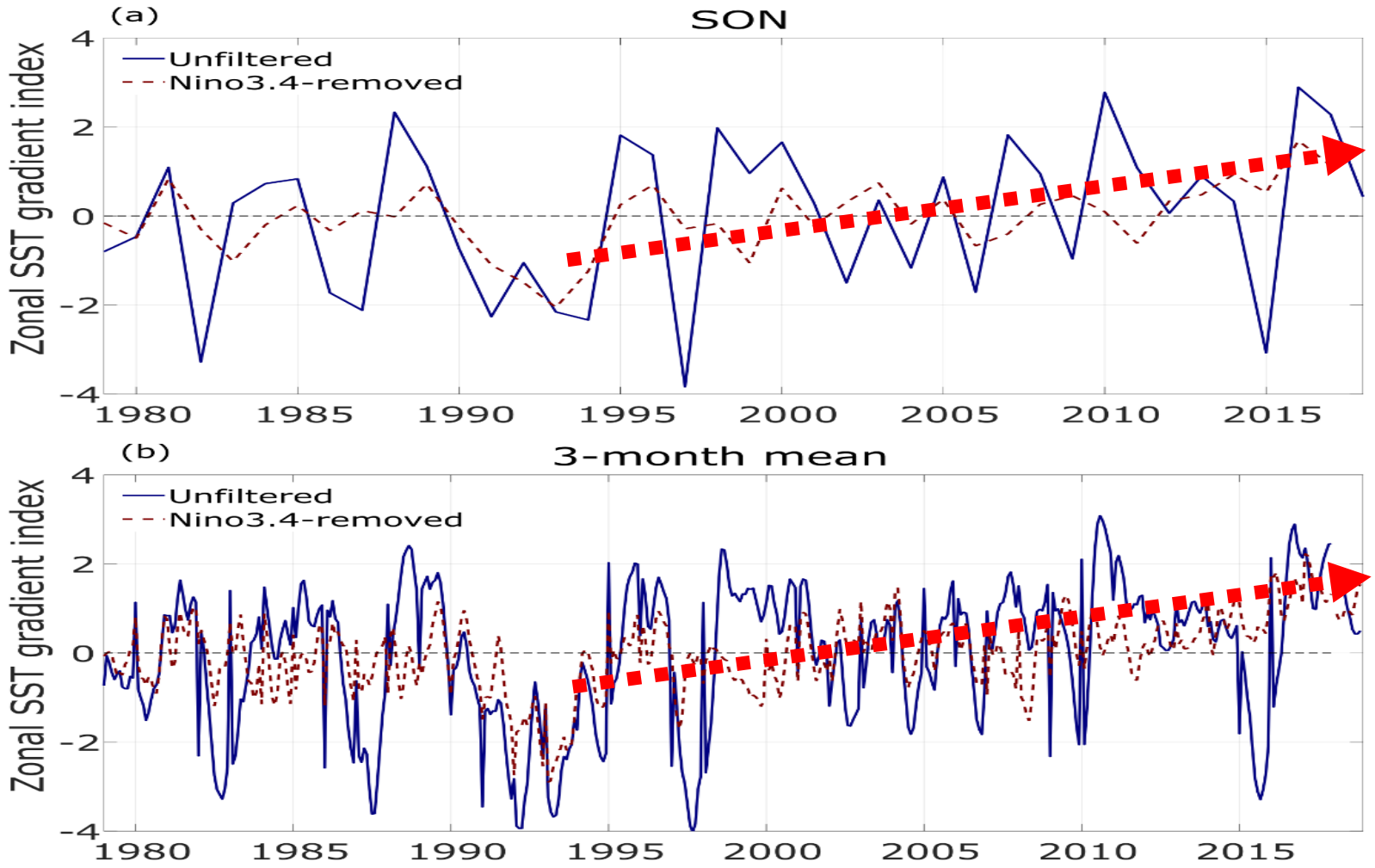
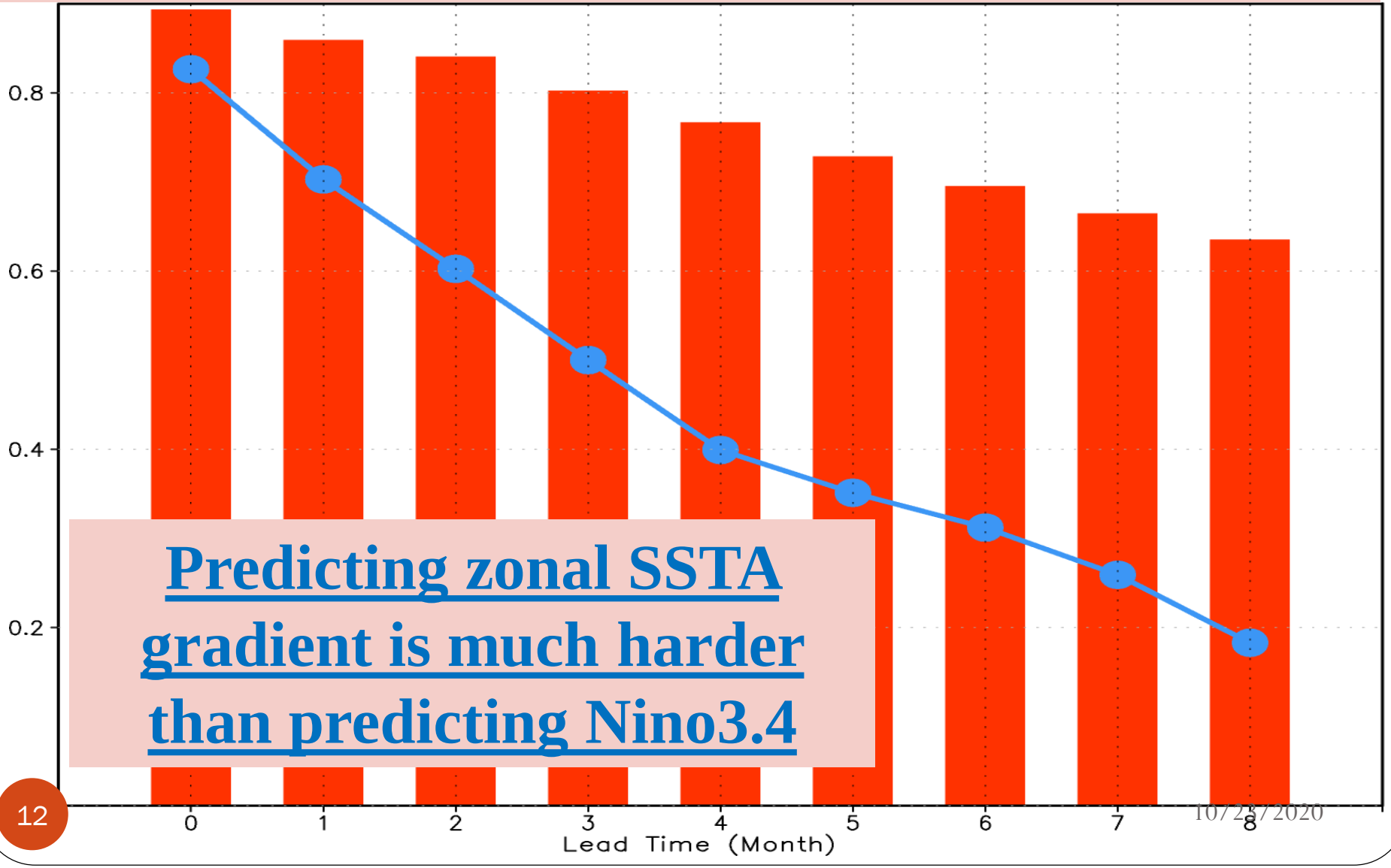


Fig. S3. Time series of unfiltered (red) and residual (blue) zonal SST gradient index for (a) SON and (b) all three-month seasonal means.

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).

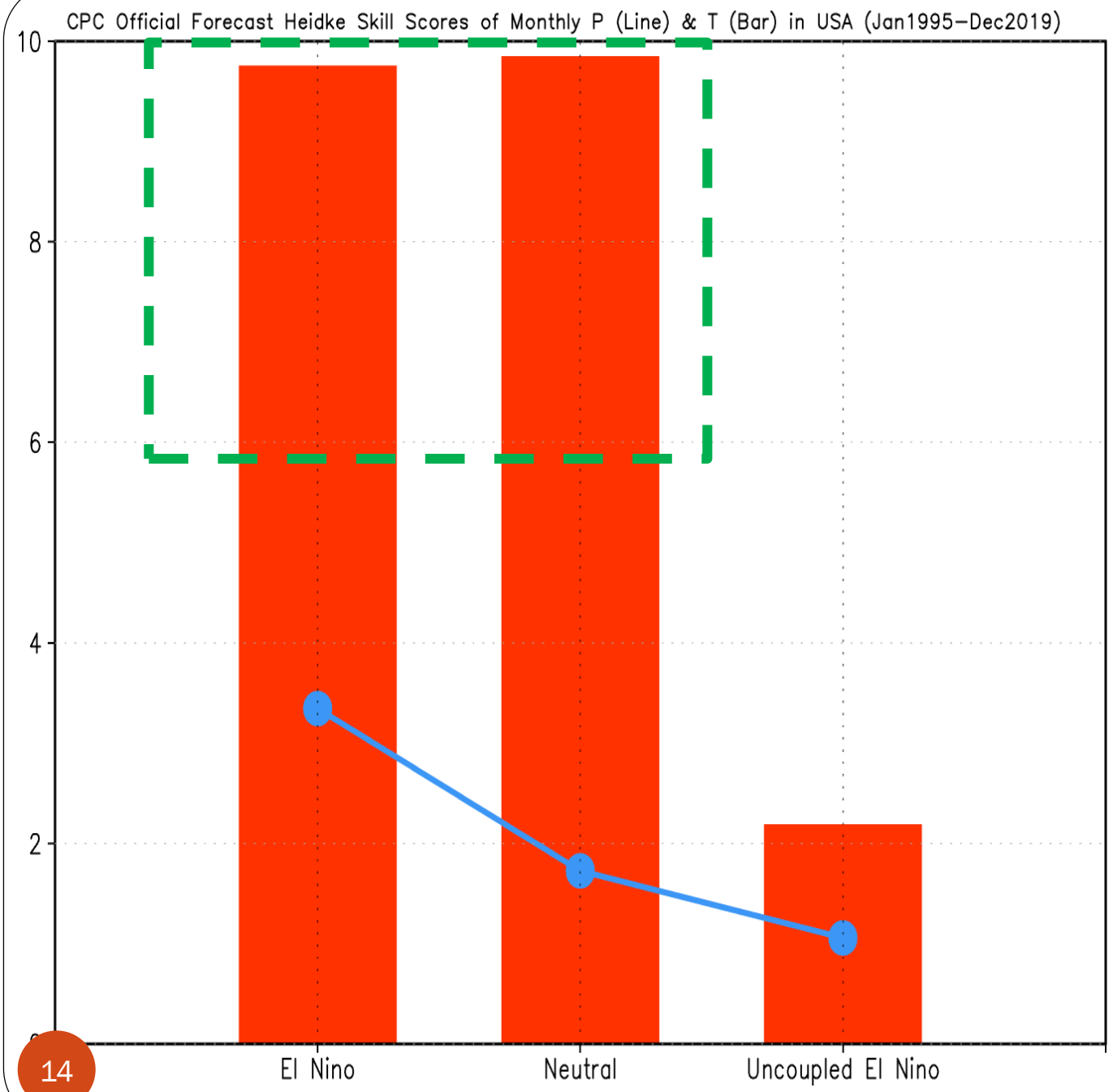
Lead-time dependent prediction skill of CFSv2 predicted Niño3.4 (bar) and zonal gradient of SSTA (the central (5°S-5°N, 160°E-160°W) minus the eastern (5°S-5°N, 120°W-90°W) tropical Pacific; line) indices. The skill is defined as the linear correlation between the ensemble mean of 20 forecast members and observations in Jan 1982-Dec 2018



Predicting zonal SSTA gradient is much harder than predicting Nino3.4

Summary and Conclusions

- 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.
- Such uncoupled warm events happened in 1979, 2004, 2014, and 2018. A weaker zonal gradient of SSTA across the tropical Pacific compared with that in a conventional El Niño may partially account for the decoupling.
- 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.



El Nino seems no contribution to temperature forecast skill during 1995-2019.

Why?