Overview of the 2010-2011 La Niña Episode

Michelle L'Heureux and CPC ENSO Forecast Team*

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Additional acknowledgements for this talk: Dan Collins, Wei Shi, Peitao Peng, Ping-ping Xie, Emily Becker, and Huug van den Dool for discussions and pointing me to helpful datasets.

OUTLINE

(1) Review the ENSO team predictions

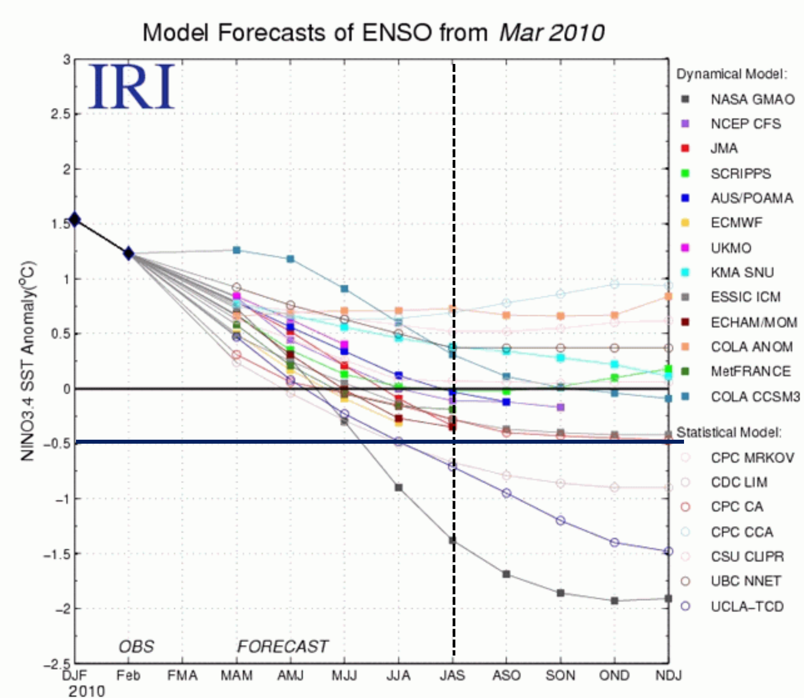
(2) Comparison of sea surface temperatures (SSTs) and rainfall anomalies to past recent La Niña episodes

(3) Examine atmospheric indices

(4) Reconstruction of 500-hPa heights and precipitation anomalies based on atmospheric ENSO indices and AO for NDJ 2010/11 and FMA 2011.

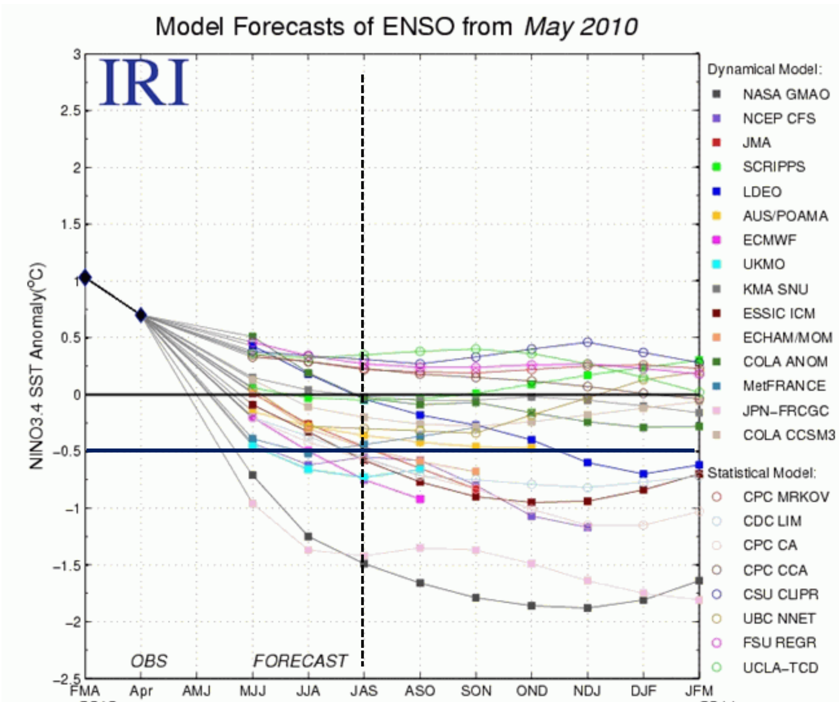
(5) Summary of Primary Findings

La Niña began during July-September (JAS) 2010.



On April 8th 2010, "increasing number of models, including CFS, are predicting below-average temperatures in the Niño-3.4 region by N. Hemisphere fall, with some reaching the threshold of La Niña."

On May 6th, a "growing possibility of La Niña developing during the second half of 2010."



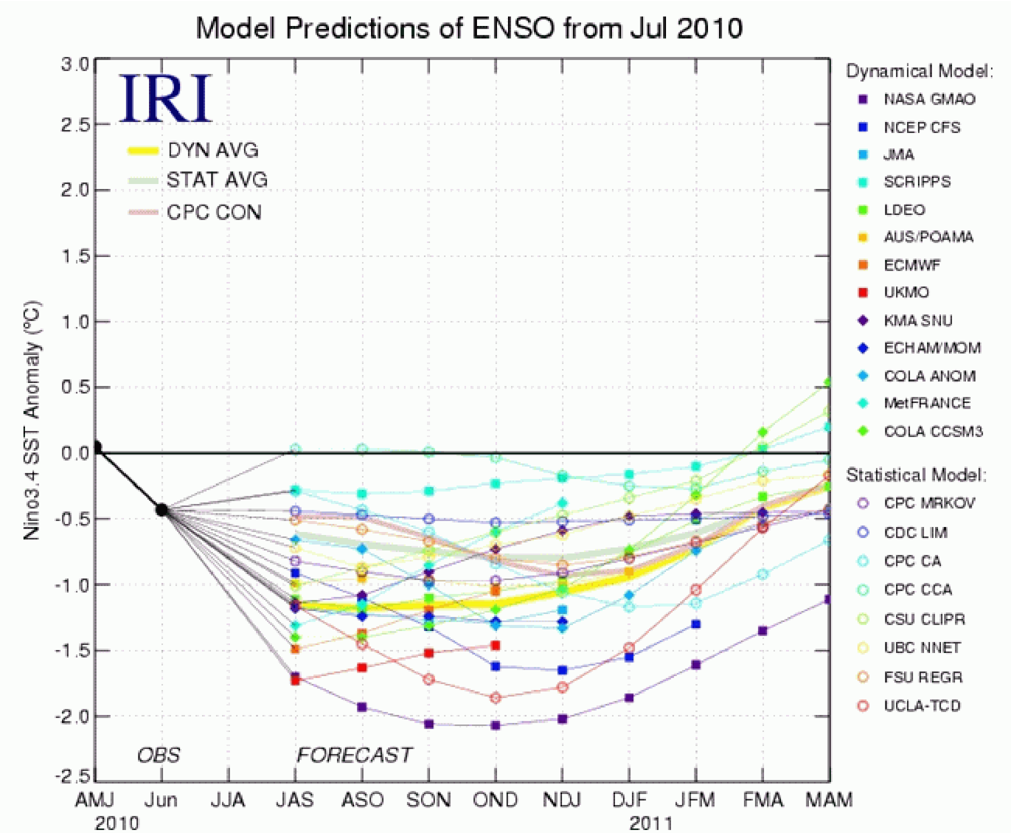
June 3rd, 2010 Final El Niño Advisory issued along with a La Niña Watch

August 5th, 2010 La Niña Advisory Issued

CFS.v1: predicting strong La Niña (NDJ ~ -1.7°C) at this time.

Leading up to the Advisory issuance:
- notable disparity between statistical (weaker) and dynamical models (stronger), which dissipated by September. The dynamical models caught on sooner!

We wrote "the dynamical model outcome of a moderate-to-strong episode is favored at this time" in part due to strong oceanic cooling and robust atmospheric circulation.



September 2010-on

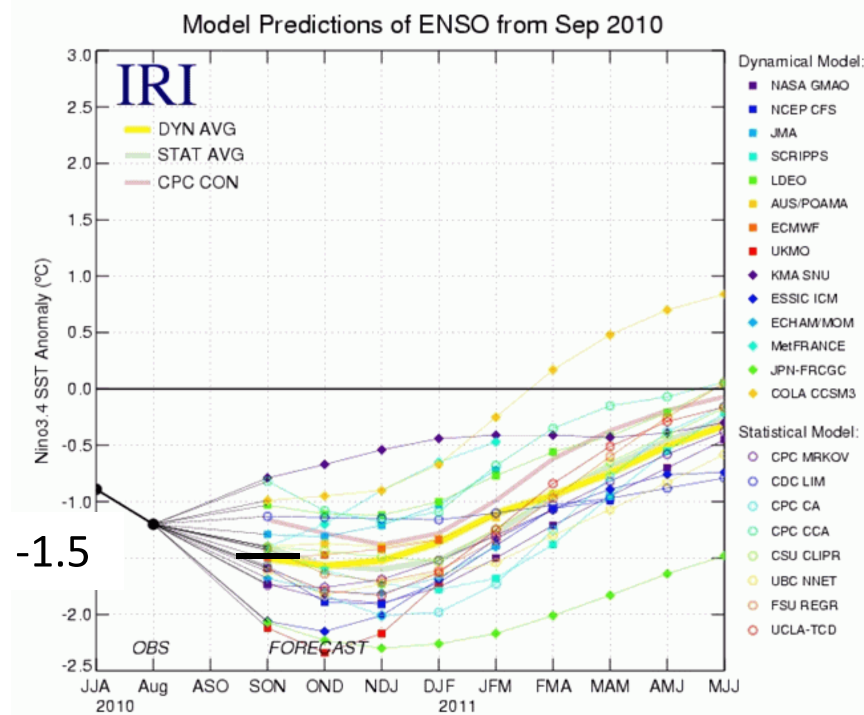
Majority of models : predicted strong episode during NDJ/ DJF (ONI < -1.5°C) even at short lead times.

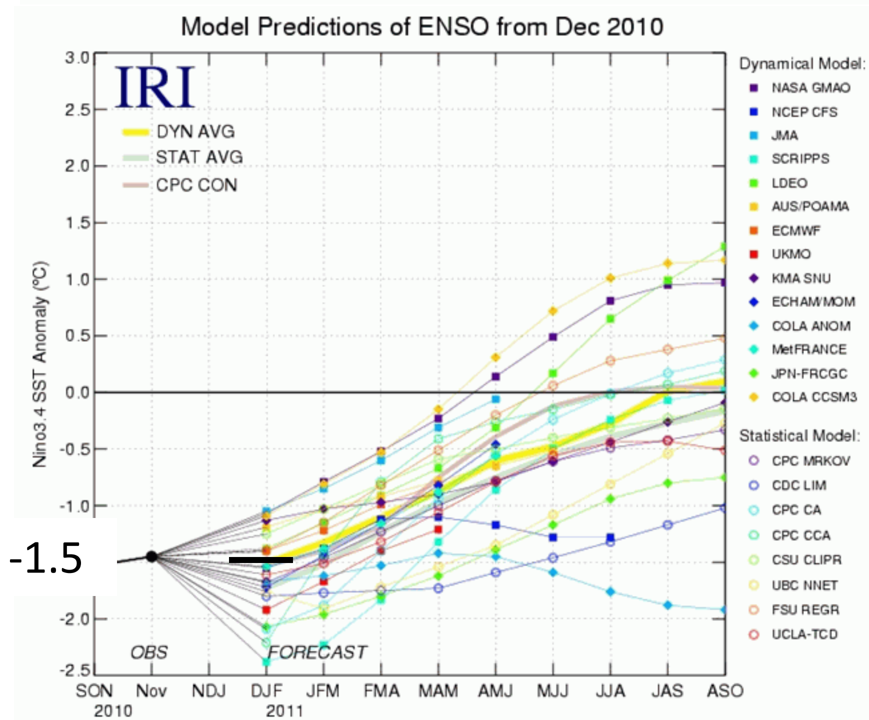
So how did we do?

<u>Bottom Line:</u>

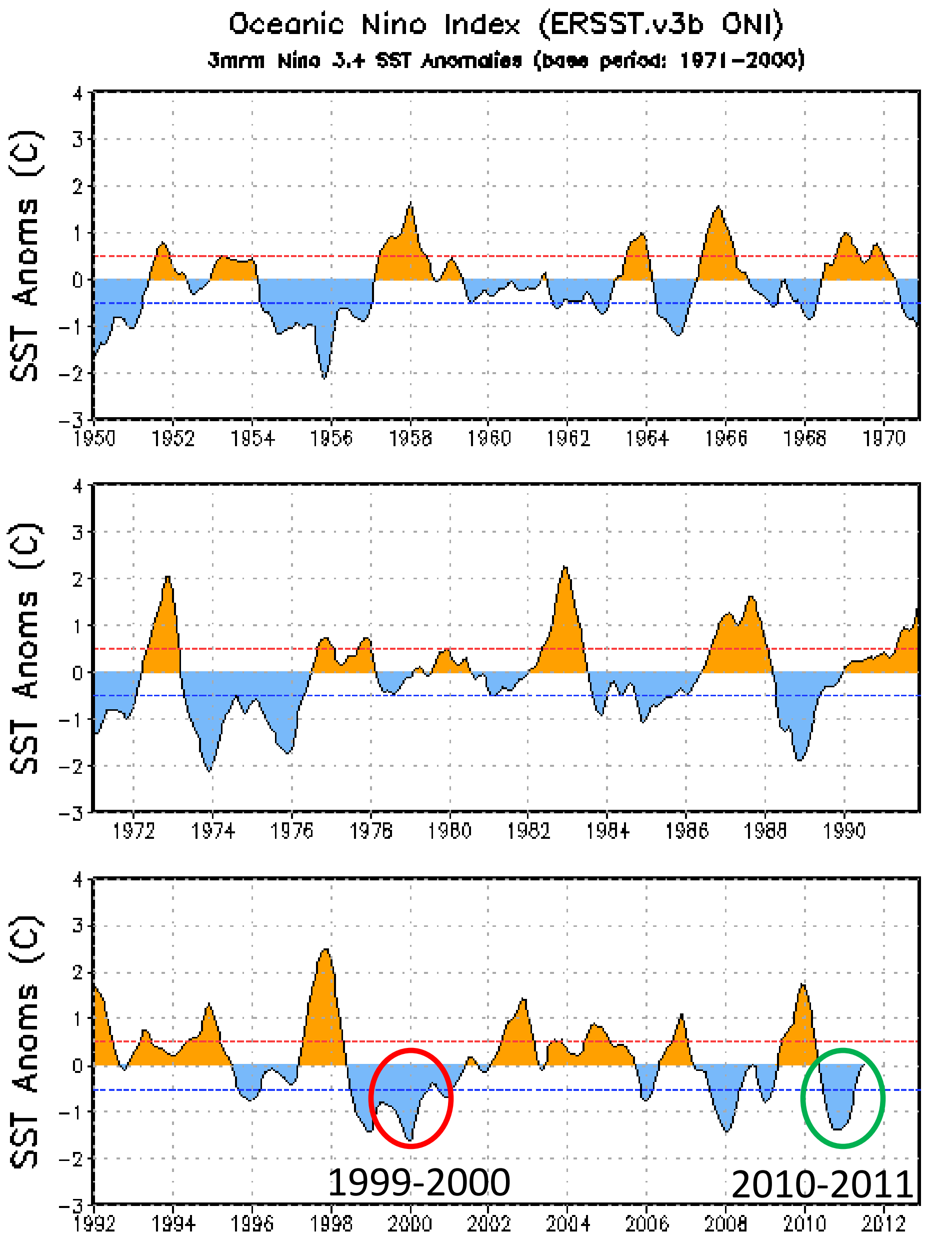
- Most of the models (and CPC) over-predicted the peak strength of La Niña (based on Nino-3.4 SSTs).

- did a good job with onset timing by issuing a La Niña Watch in early June 2010, with some hints at La Niña conditions as early as April 2010.



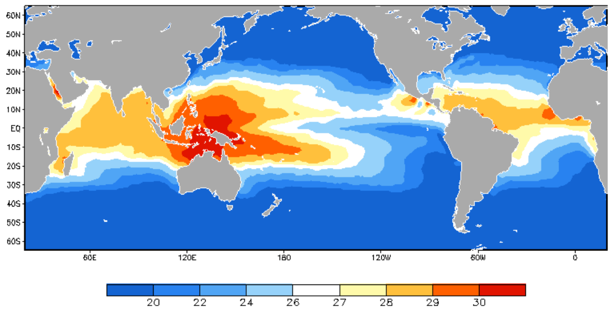


Comparison of the 2010-2011 La Niña with the 1999-2000 La Niña

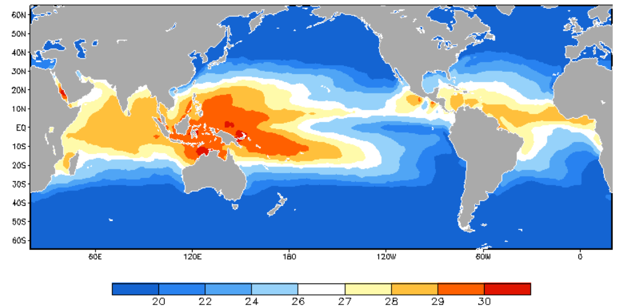


Sea Surface Temperatures during November-January (top half) and February- April (bottom half)

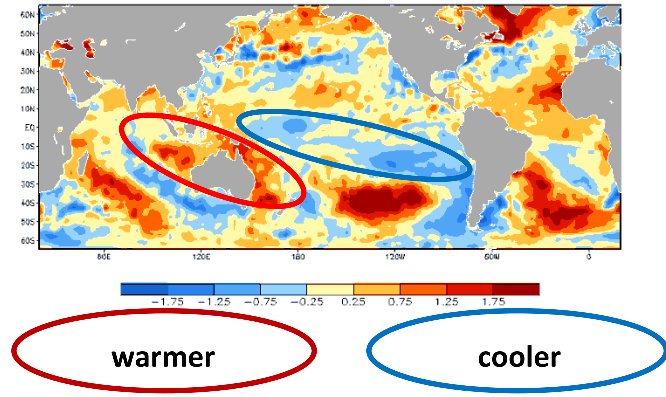
NDJ 2010/11 (recent)



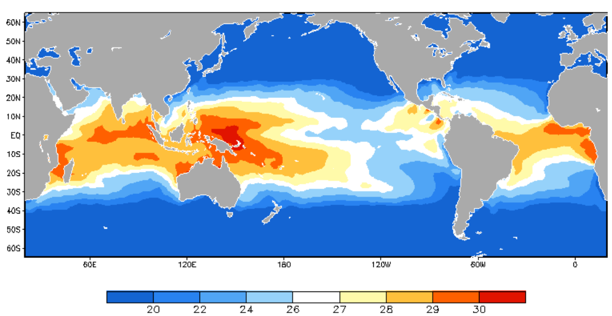
NDJ 1999/2000



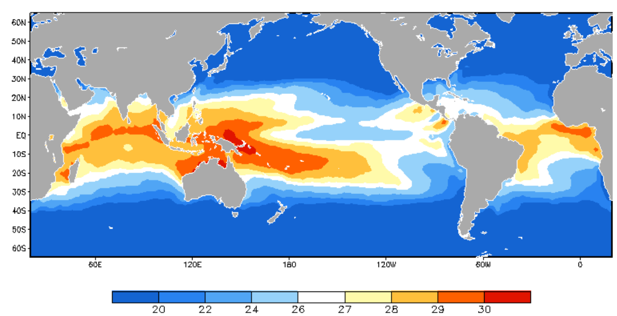
Left panel minus middle panel (NDJ 2010/11 minus 1999/00)



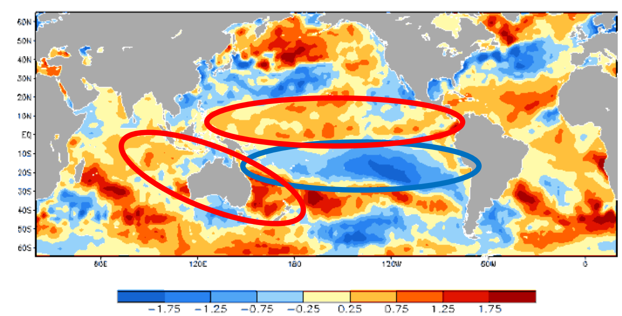
FMA 2011 (recent)



FMA 2000

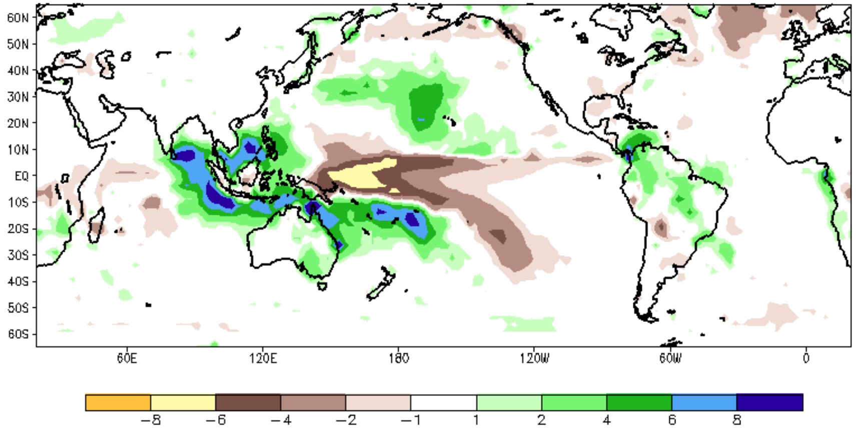


Left panel minus middle panel (FMA 2011 minus 2000)

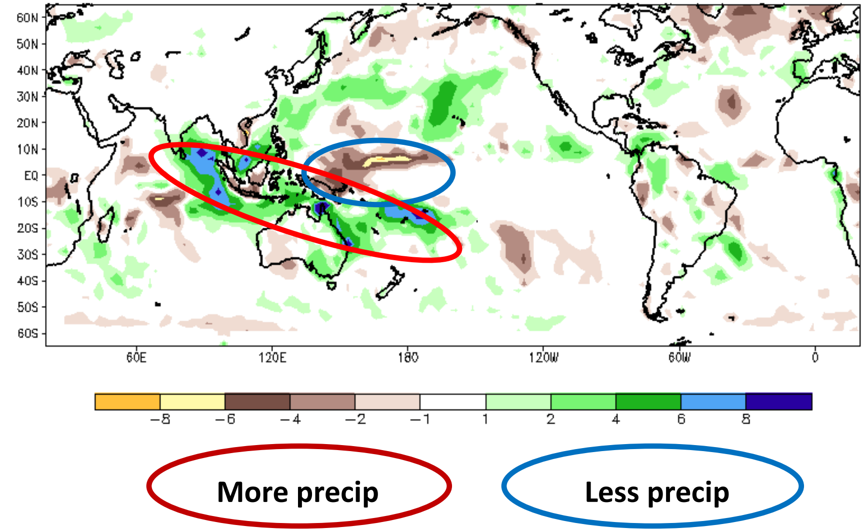


Precipitation during November-January (top half) and February- April (bottom half)

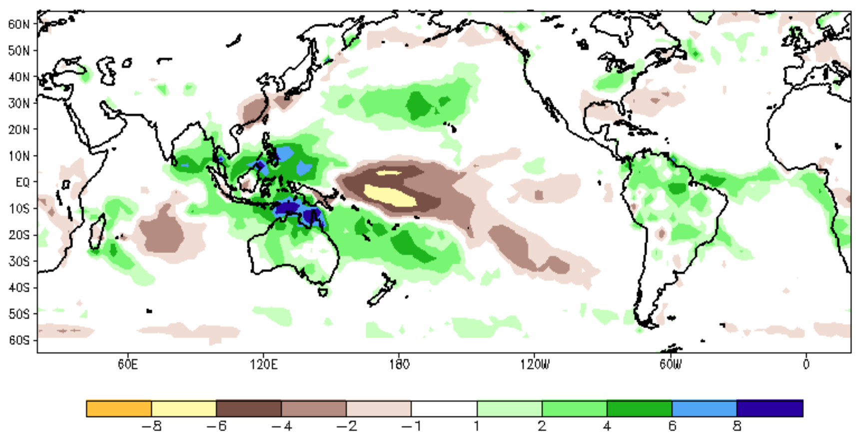
NDJ 2010/11 anomalies (recent)



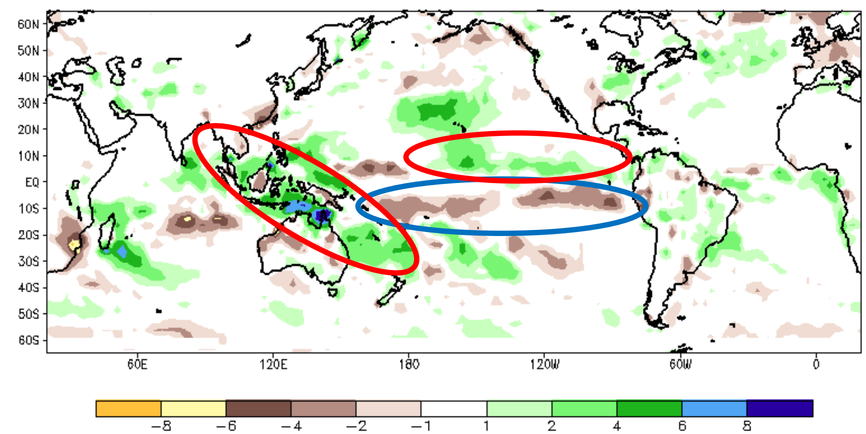
NDJ 2010/11 minus 1999/00



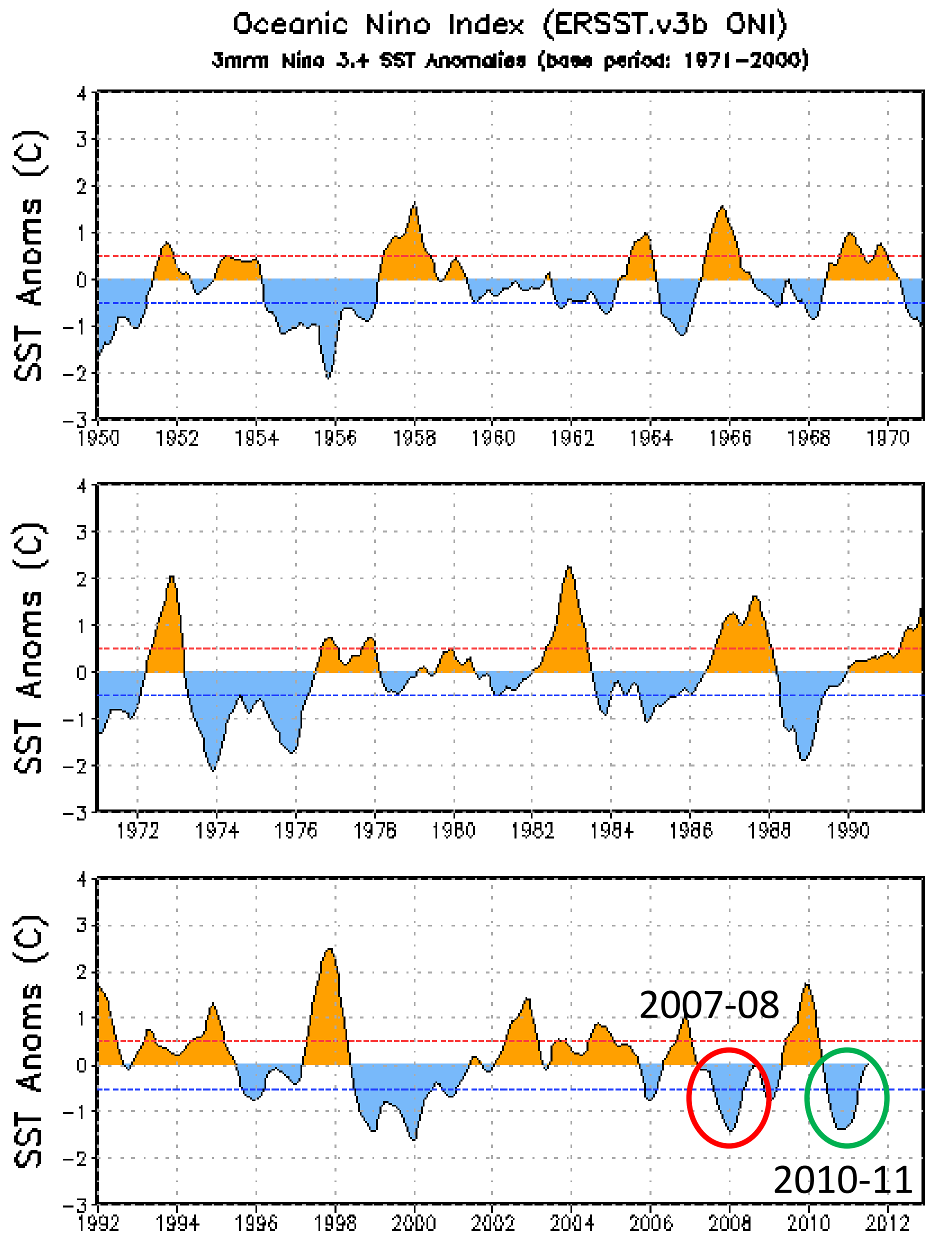
FMA 2011 anomalies (recent)



FMA 2011 minus 2000

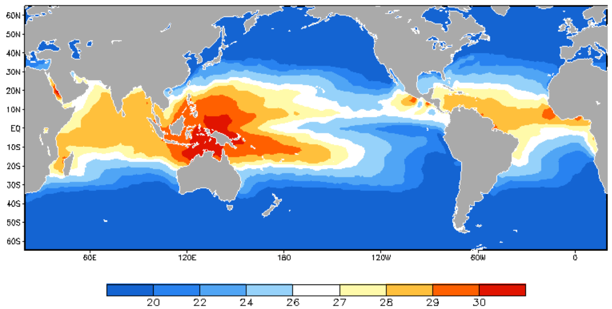


Comparison of the 2010-2011 La Niña with the 2007-2008 La Niña

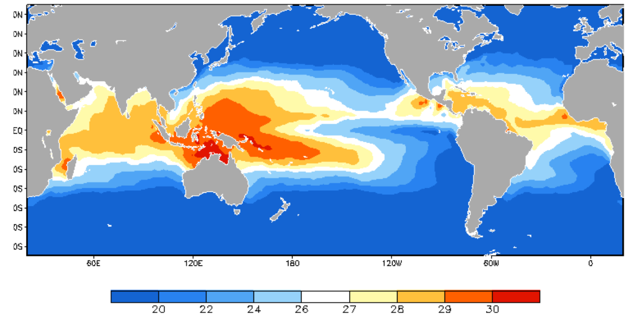


Sea Surface Temperatures during November-January (top half) and February- April (bottom half)

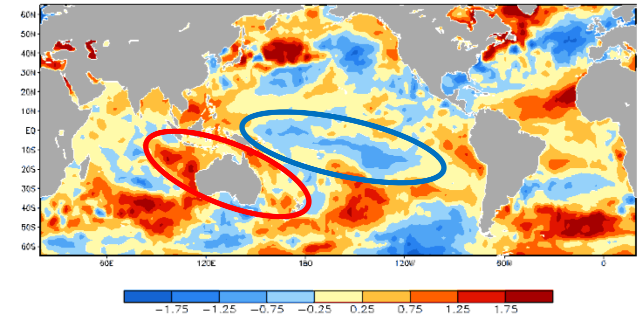
NDJ 2010/11 (recent)



NDJ 2007/08



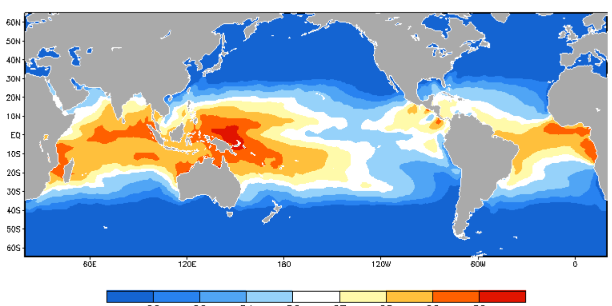
Left panel minus middle panel (NDJ 2010/11 minus 2007/08)



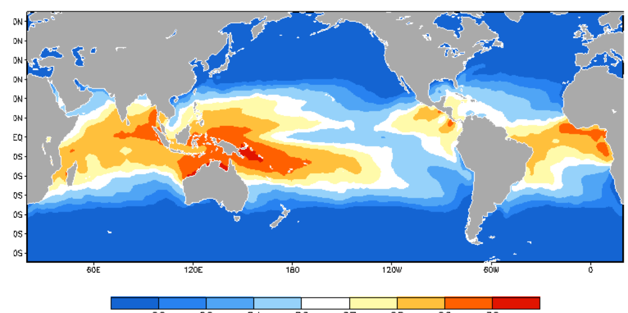
warmer

cooler

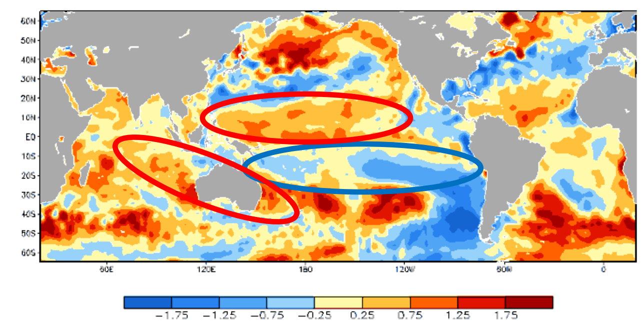
FMA 2011 (recent)



FMA 2008



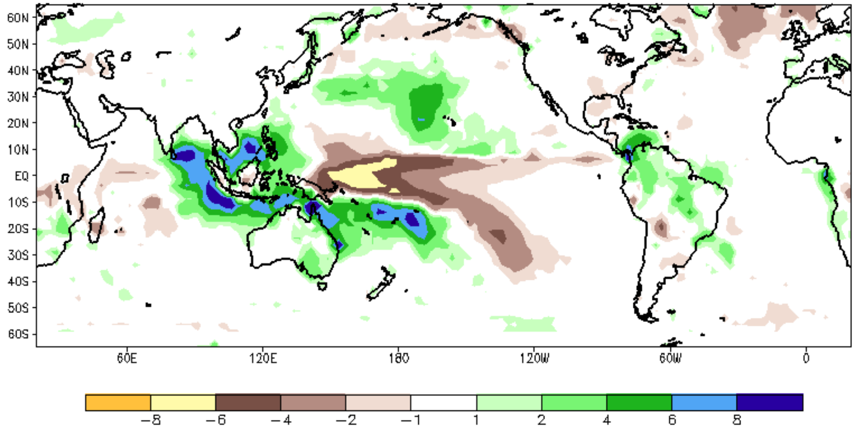
Left panel minus middle panel (FMA 2011 minus 2008)



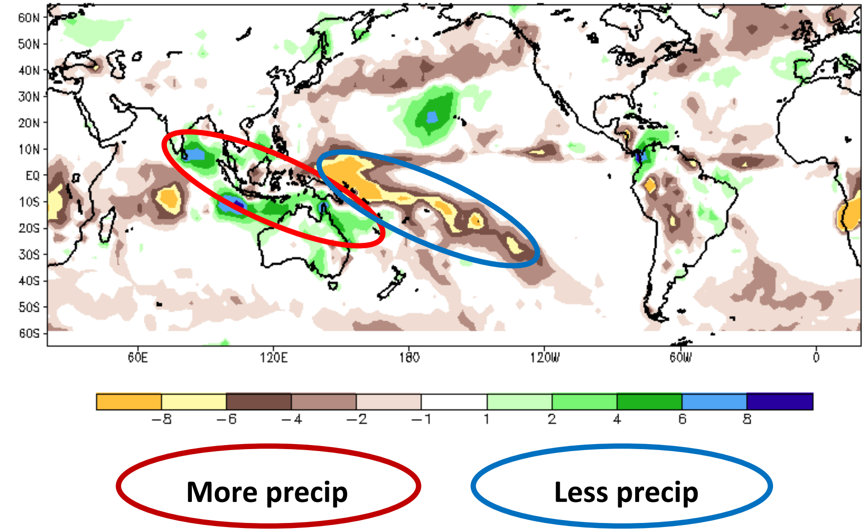
Location and sign of the SST differences qualitatively similar to comparison with 1999-2000 La Niña

Precipitation during November-January (top half) and February- April (bottom half)

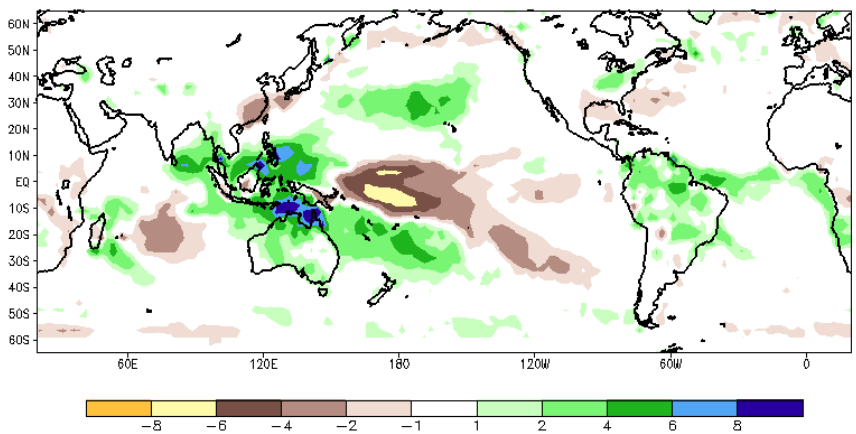
NDJ 2010/11 anomalies (recent)



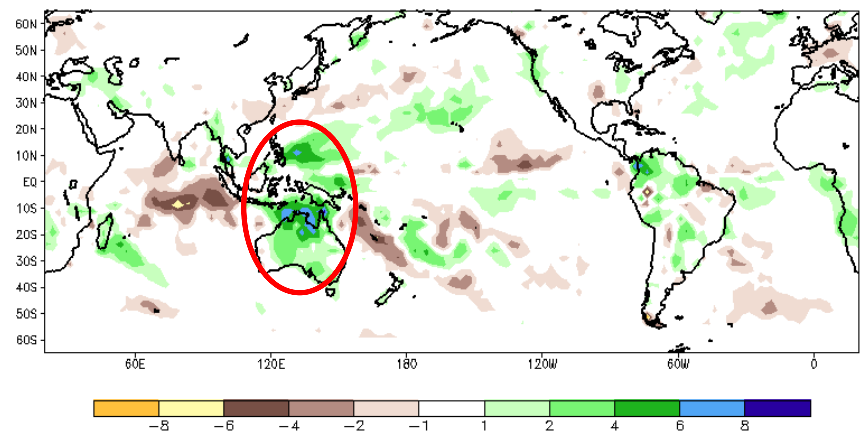
NDJ 2010/11 minus 2007/08



FMA 2011 anomalies (recent)



FMA 2011 minus 2008



Two Winters in One due to flip in AO

La Niña was present throughout with some (typical) weakening from NDJ (ONI was -1.4°C) to FMA (ONI was -0.9°C).

November-January (NDJ):

Negative AO (strength mostly confined to December but NDJ average was 1.3sigma or top ~10% of negative NDJ seasons)

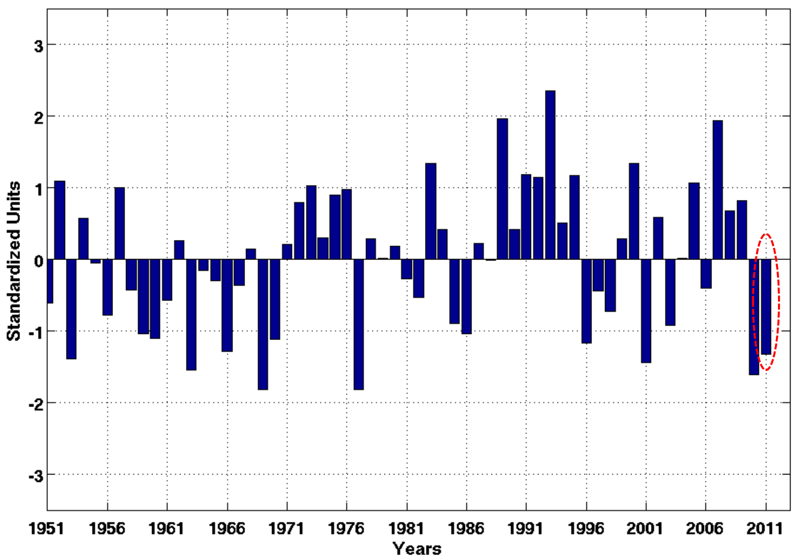
Strong positive Equatorial SOI (2.4sigma) and exceptionally negative Indonesia SLP (2.5sigma)

February-April (FMA):

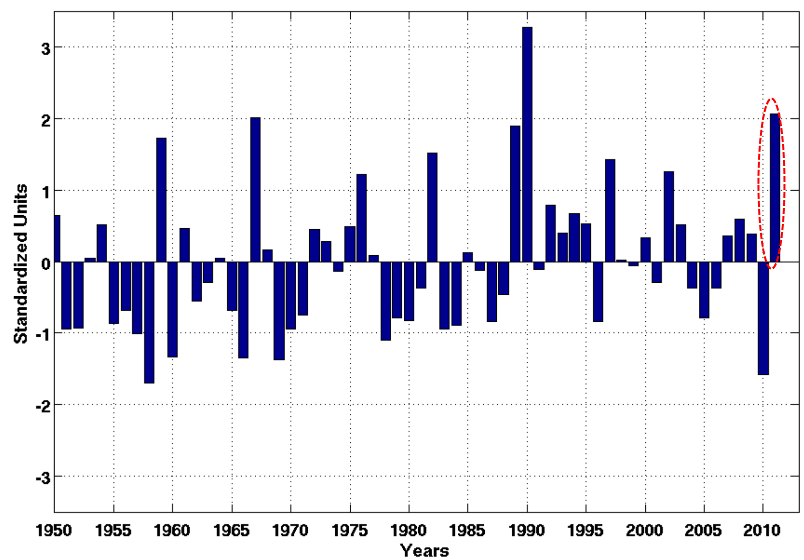
Positive AO (2nd highest FMA value in the 61-year record; 2 sigma)

Strongly positive Equatorial SOI (2.1 sigma) with weaker, but still negative Indonesia SLP (1.4sigma)

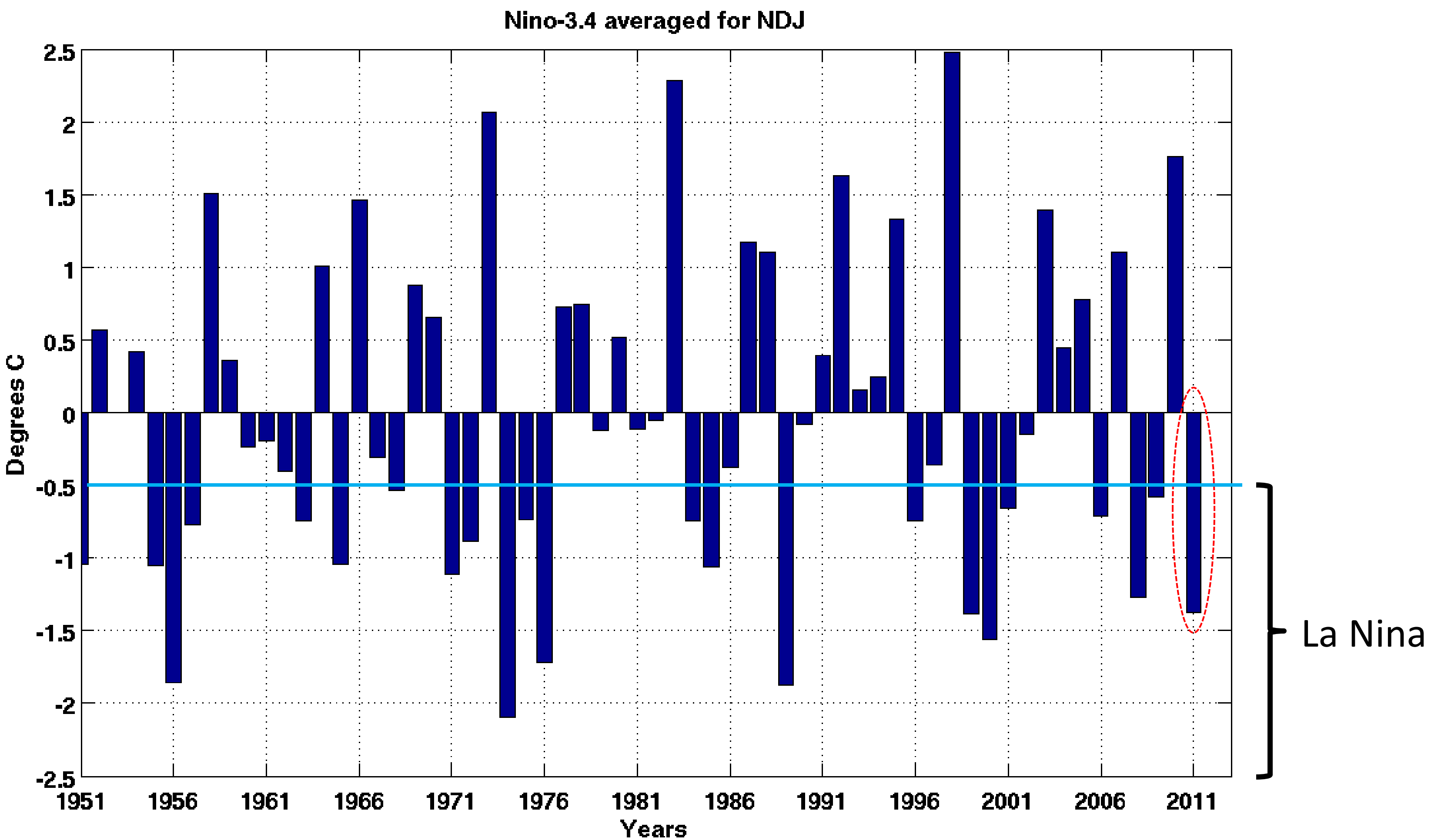
AO for NDJ average



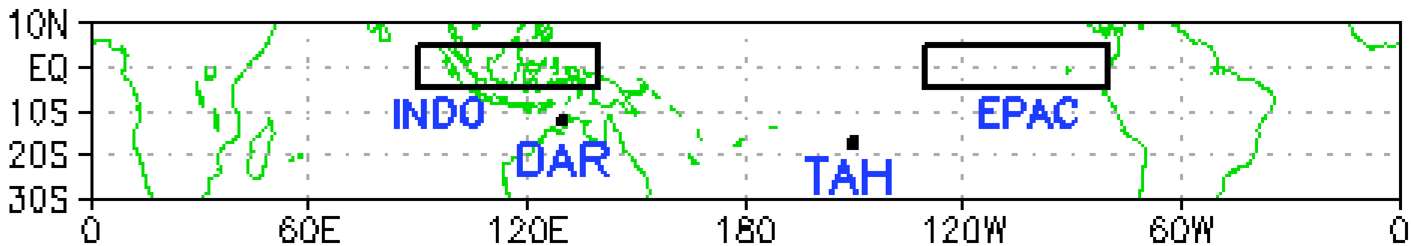
AO for FMA average



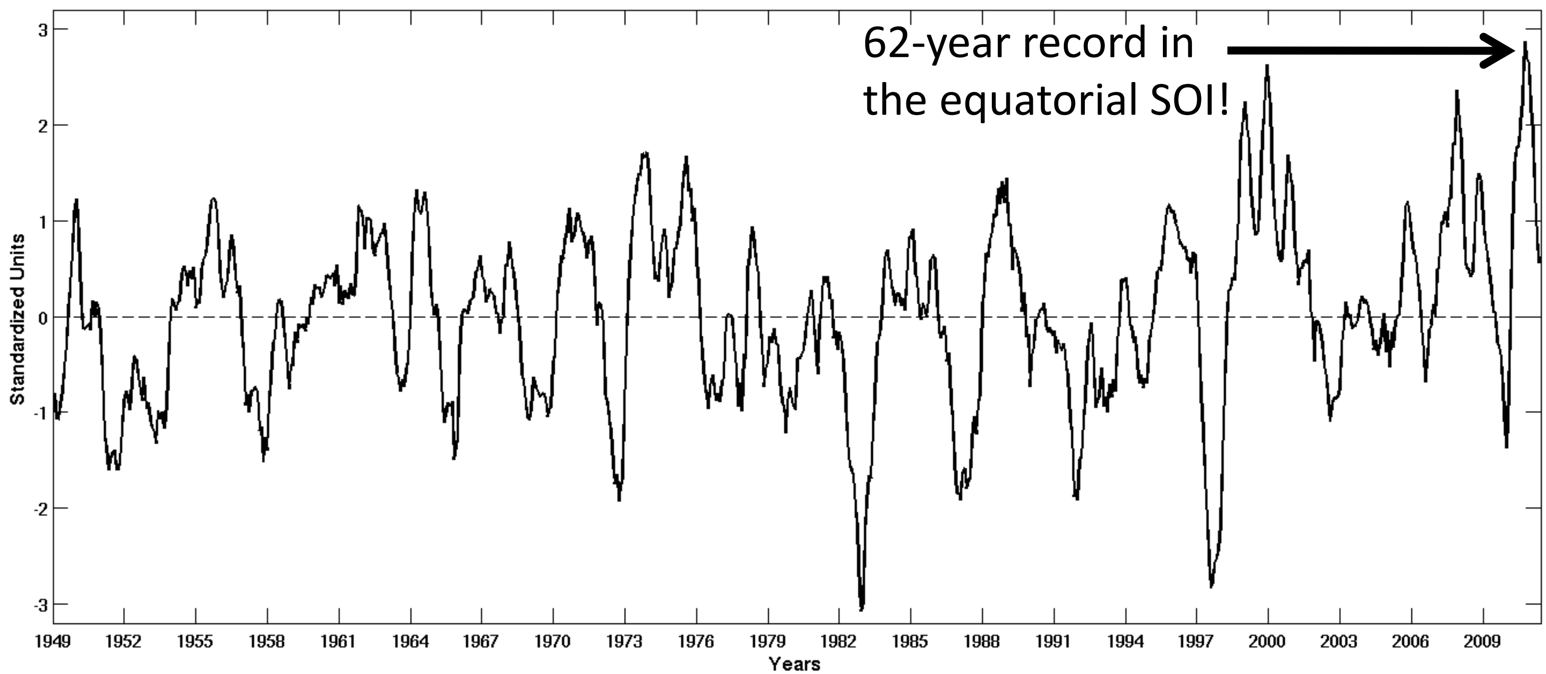
- Peak value in the ONI/Niño-3.4 index came in NDJ (-1.4°C).
- Based on Niño-3.4 region sea surface temperatures, a “borderline strong” ranking at best.
- Just barely made it into the top third of La Niña events since 1950.



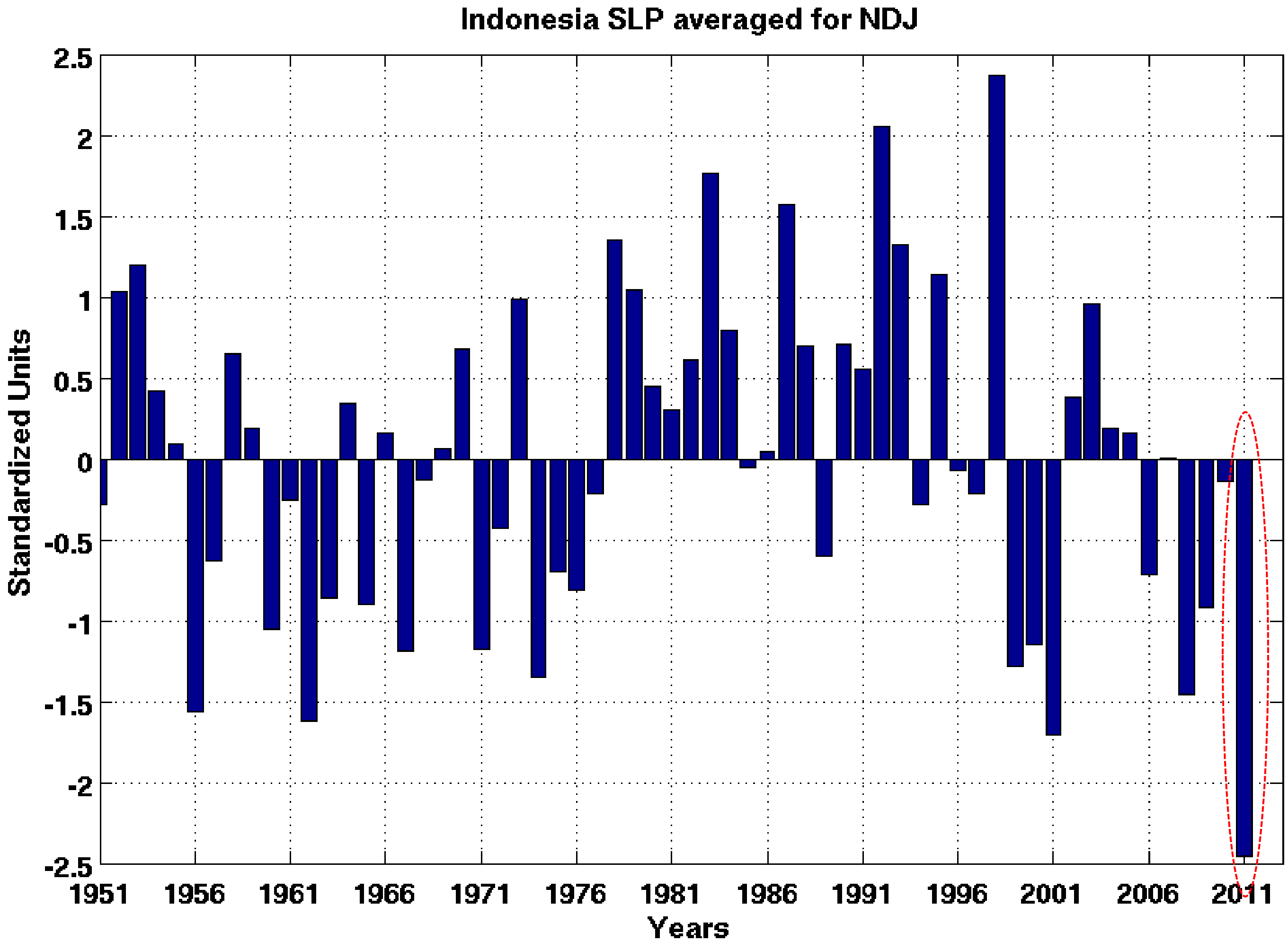
Equatorial Southern Oscillation Index is calculated as
EPAC sea level pressure anomaly (SLPA) minus INDO SLPA
Using NCEP/NCAR Reanalysis (CDAS-1)



Standardized Monthly Equatorial Southern Oscillation Index



- Much of the Equatorial SOI strength comes from the strongly negative Indonesian SLP during NDJ (a value of 2.5sigma or ~1 in 140 year chance of occurrence).
- Most of the record rainfall in eastern Australia came in November-December 2010.
- The NDJ EQSOI and Indonesia SLP are correlated to -0.87.

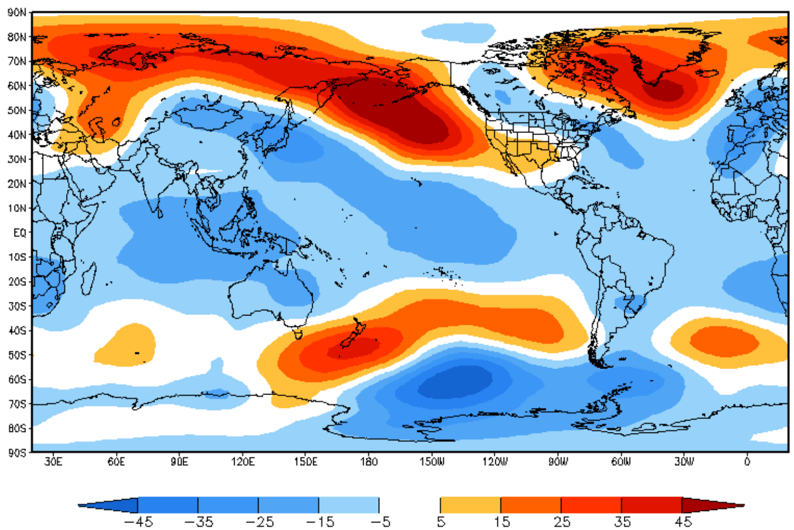


- Indonesia SLP is correlated to Niño-3.4 SST at 0.75, which means that roughly half of the variance is described by the other.

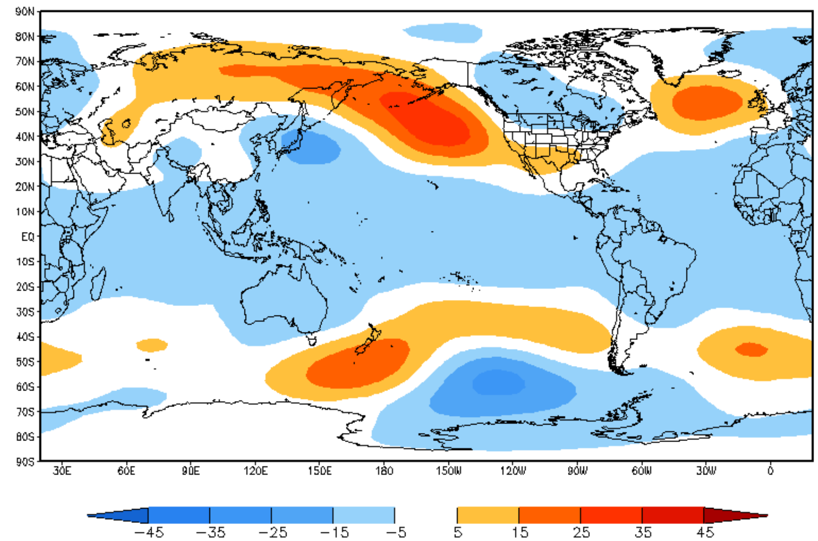
Red shading: Above-average 500-hPa heights

Blue shading: Below-average 500-hPa heights

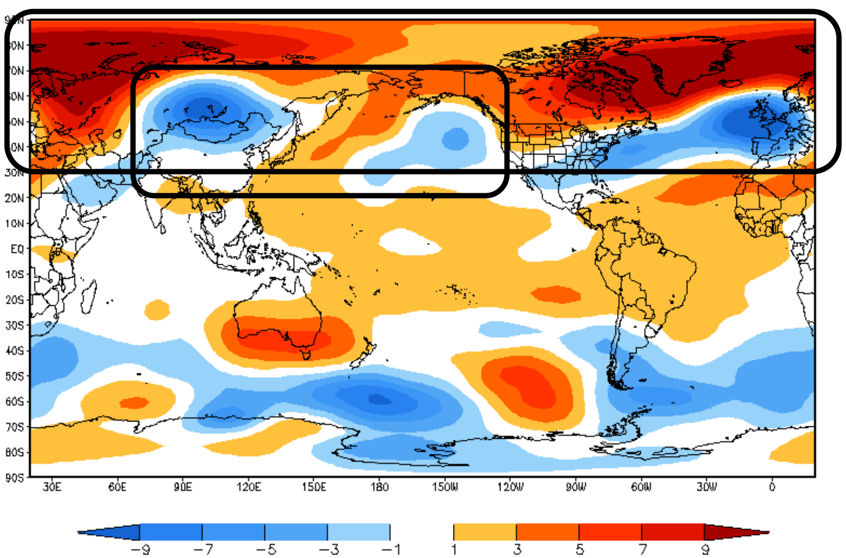
Indonesia SLP reconstruction for NDJ 2010-11



Nino-3.4 reconstruction for NDJ 2010-11



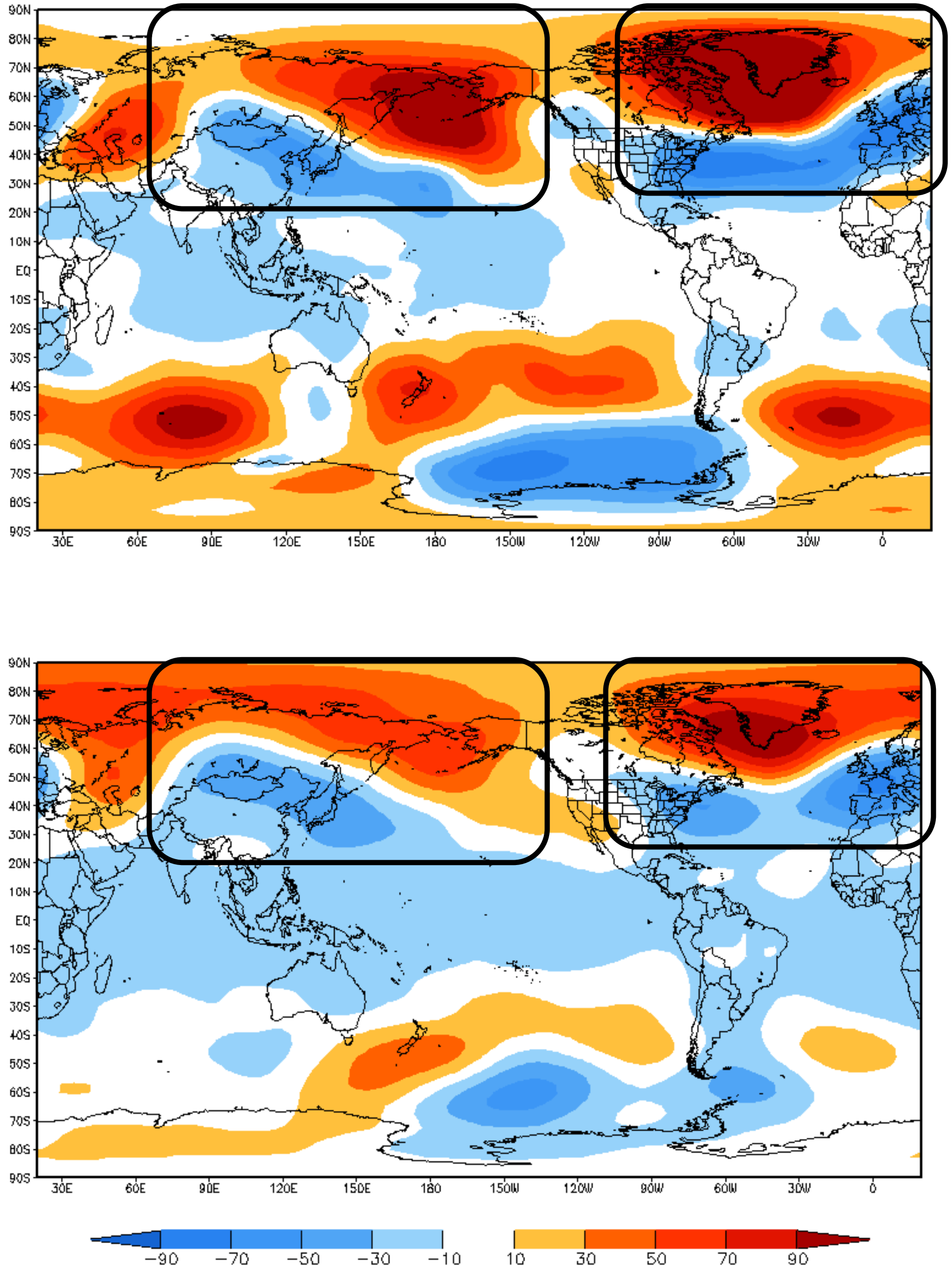
Q: What are the primary differences in the **regression pattern** of Indonesian SLP and Nino-3.4 SSTs?



- Indonesian SLP is associated with an Asian-Pacific wave train pattern that is generally extended further westward
- Interestingly, the difference is also associated with a feature that looks a lot like the negative AO, which was also observed in NDJ.

Prior to calculation, correlations between AO and INDO have been linearly removed

Global 500-hPa Anomalies during NDJ 2010-11

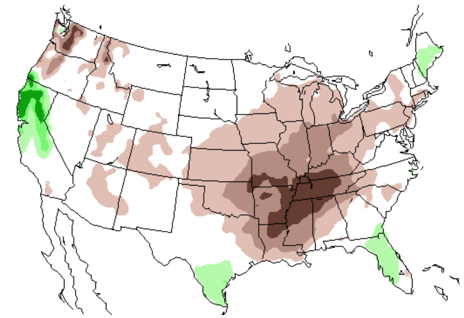


Observed Pattern

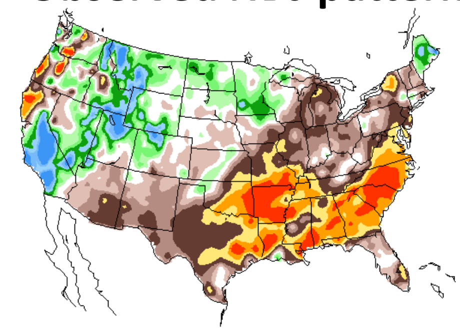
Summed Reconstructions for the AO and INDO SLP

U.S. Precipitation Anomalies during NDJ 2010-11

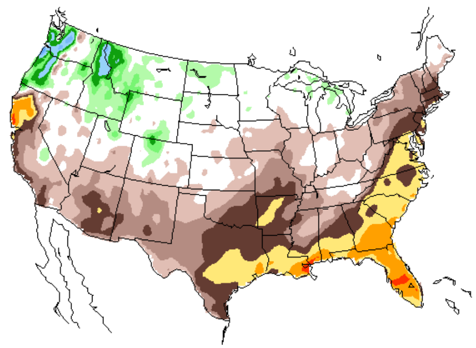
AO Reconstruction (x -1.3)



Observed NDJ pattern

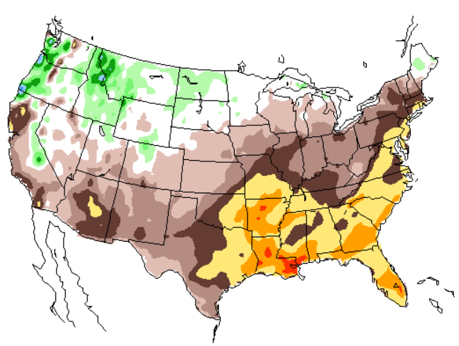


INDO SLP Reconstruction (x -2.5)

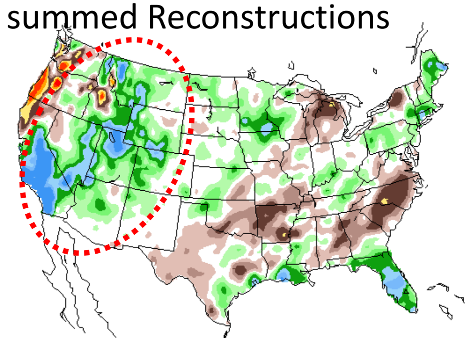


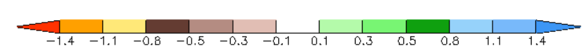
- **Combined AO+INDO pattern describes precip fairly well over the eastern 2/3rd of the U.S.**
- **AO+INDO does not account for wetter conditions across much of the western 1/3rd. This wet pattern is also unaccounted for in AMIP/CFS runs.**

Summed AO + INDO SLP Reconstructions



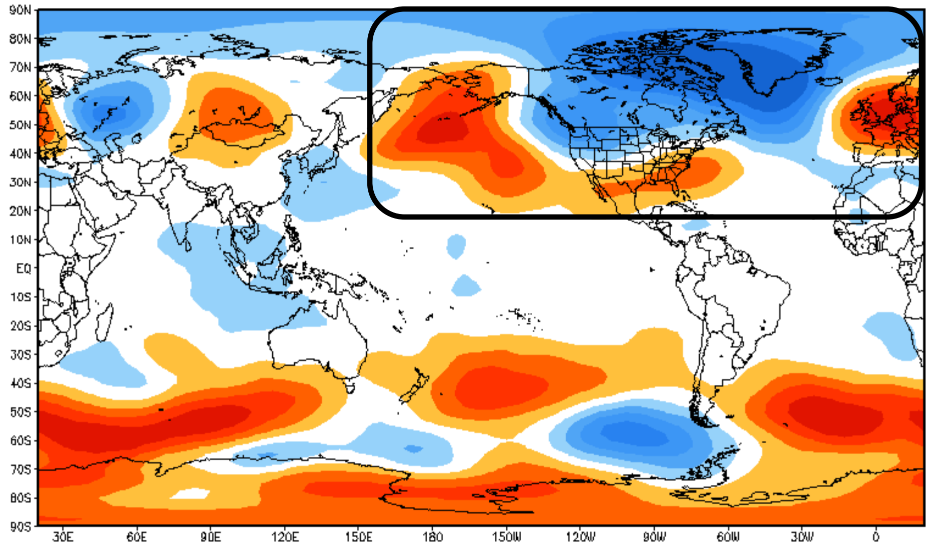
“Residual” (Observations minus summed Reconstructions



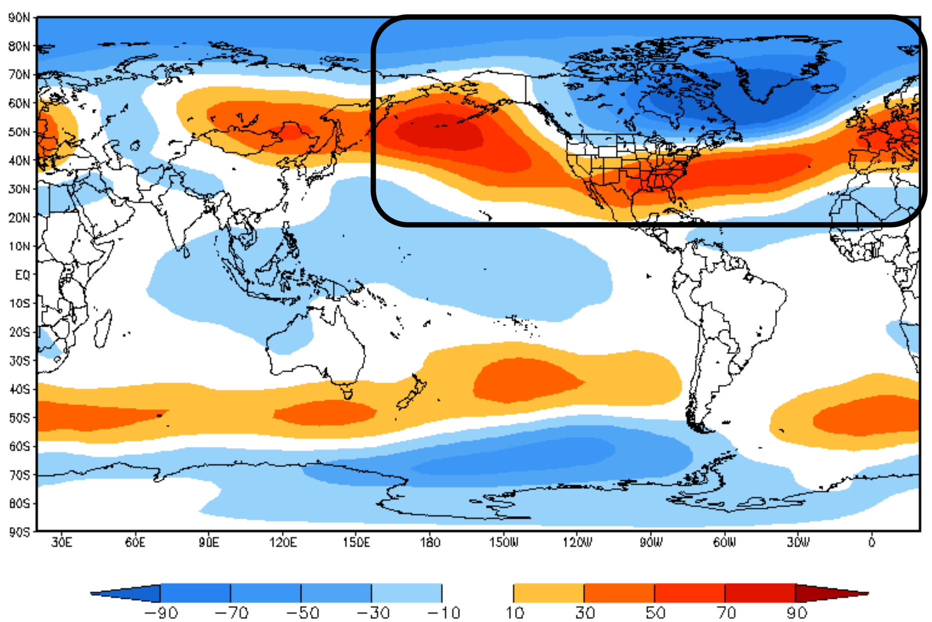


Global 500-hPa Anomalies during FMA 2011

Prior to calculation, correlations between AO and EQSOI have been linearly removed



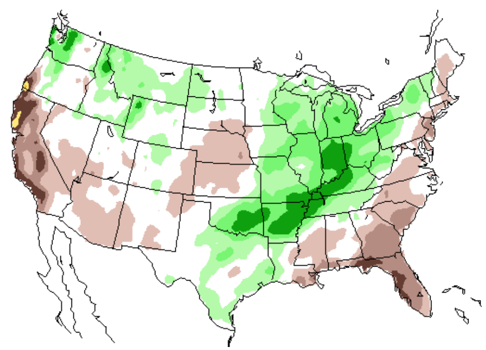
Observed Pattern



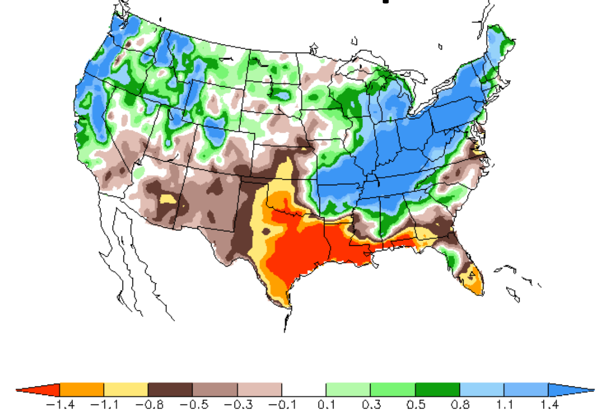
Summed Reconstructions for the AO and Equatorial SOI

U.S. Precipitation Anomalies during FMA 2011

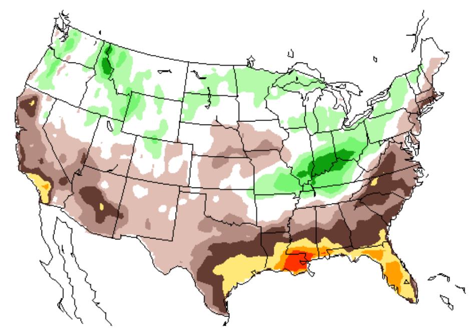
AO
Reconstruction
(x +2.1)



Observed FMA pattern

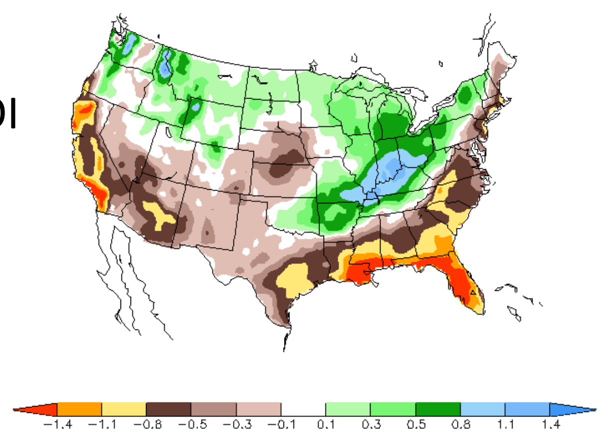


EQSOI
Reconstruction
(x +2.1)

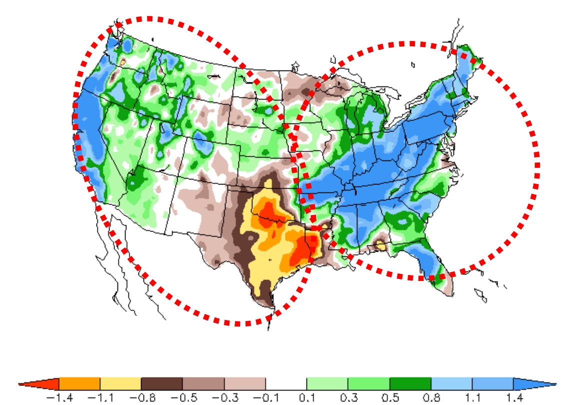


- **Intensity of the wet signal over the eastern U.S. unaccounted for in the reconstruction and AMIP/CFS runs.**
- **Reconstruction also does not capture large amplitude of dry conditions over Oklahoma/Texas and wetter conditions over the West Coast. The AMIP/CFS runs capture these anomalies better.**

Summed AO + EQSOI
SLP Reconstructions



"Residual" (Observations minus summed Reconstructions



SUMMARY

(1) The outlooks for La Niña generally over-predicted the peak magnitude of the episode. CPC forecasts were decent for the timing of La Niña onset.

(2) Compared to two previous recent La Niñas, the 2010-11 La Niña was generally characterized by:
-- higher SSTs/rainfall stretching in a NW-SE alignment from the Indian Ocean to the South Pacific Convergence Zone (SPCZ) region near eastern Australia.
-- lower SSTs/rainfall in the western equatorial Pacific and across the Pacific in a zonal band located south of the equator (~0° to ~20°S).

(3) The 2010-11 La Niña was accompanied by unusually strong index values in the tropical atmospheric circulation (i.e. Equatorial SOI and Indonesian SLP). An SST-based index, as reflected by the Niño-3.4 region was marginally strong.

(4) Along with the flip in the Arctic Oscillation (AO) from NDJ (negative) to FMA (positive), the observed circulation + precipitation patterns over the Pacific-North American domain and U.S. largely reflect a combination of La Niña + AO (except over the West Coast).

New Regressions/Correlations between ENSO and *global* temperature/precipitation anomalies on CPC webpage (courtesy of Peitao Peng)

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/regressions/