The role of off-equatorial surface temperature anomalies in the 2014 El Niño prediction

Jieshun Zhu

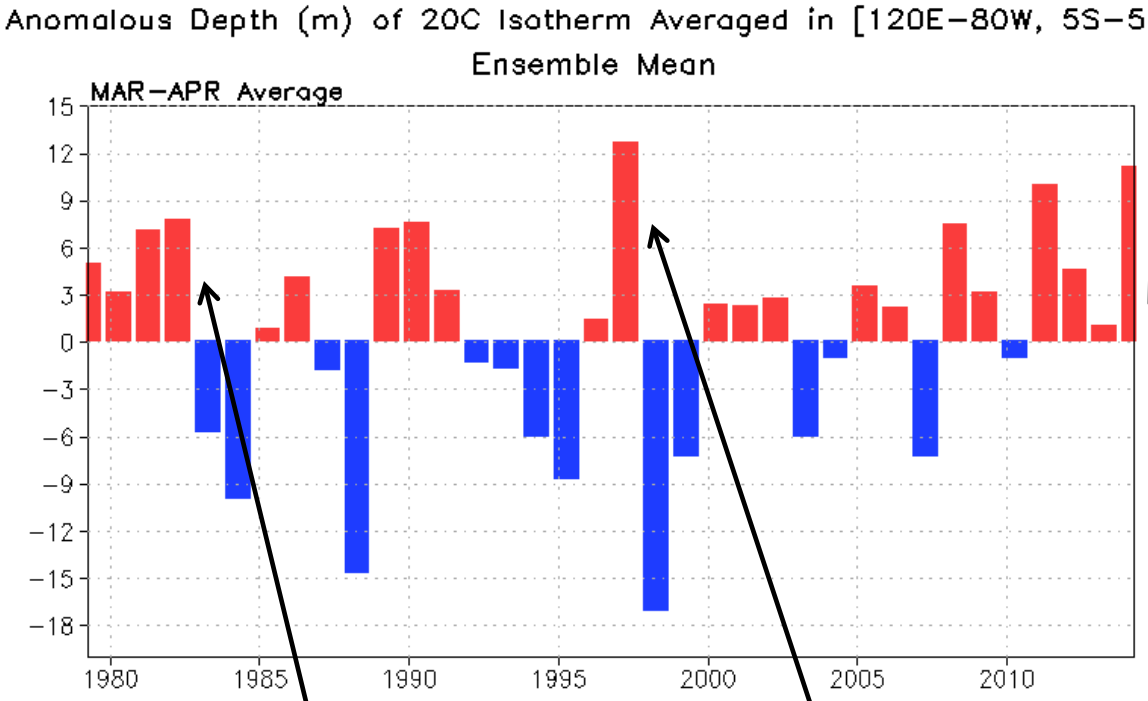
CICS-MD/ESSIC and Climate Prediction Center/NCEP/NOAA

In collaborations with *A. Kumar*[1], *B. Huang*[2], *M. A. Balmaseda*[3], *Z.-Z. Hu*[1], *L. Marx*[2] *and J. L. Kinter*[2]

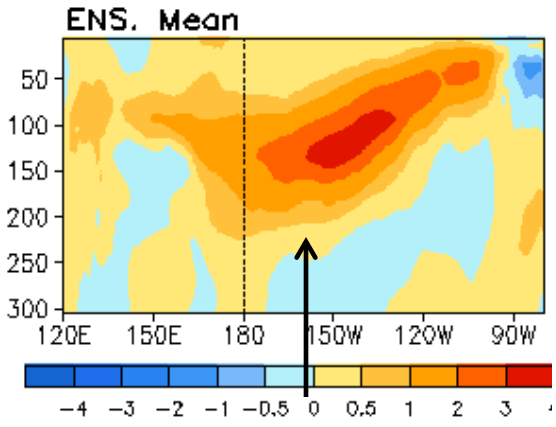
[1]*CPC*, [2]*COLA/GMU, and* [3]*ECMWF*

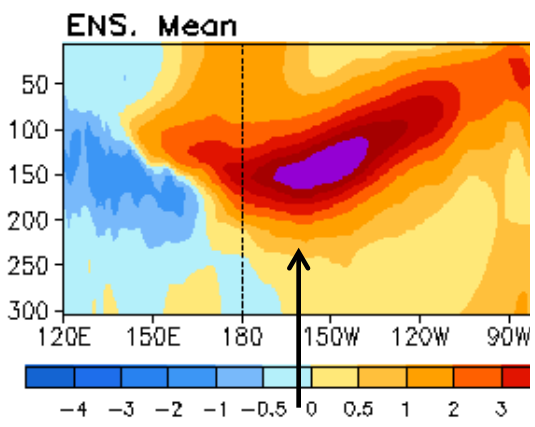
Zhu, J., A. Kumar, B. Huang, M. A. Balmaseda, Z.-Z. Hu, L. Marx and J. L.Kinter III, 2016: The role of off-equatorial surface temperature anomalies in the 2014 El Niño prediction. *Sci. Rep.*, **6:** 19677. DOI:10.1038/srep19677.

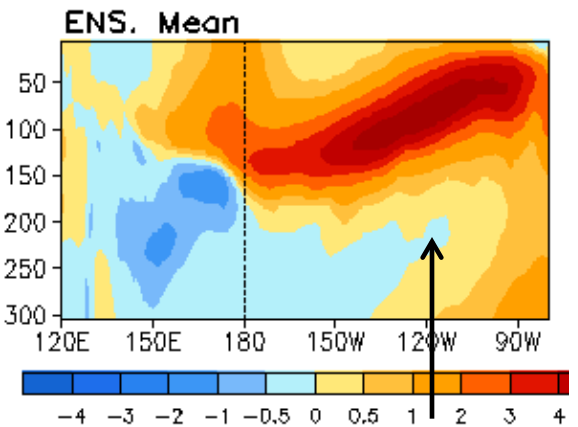
Warm Water Volume Index



Mar~Apr 1982 **Mar~Apr 1997** **Mar~Apr 2014**







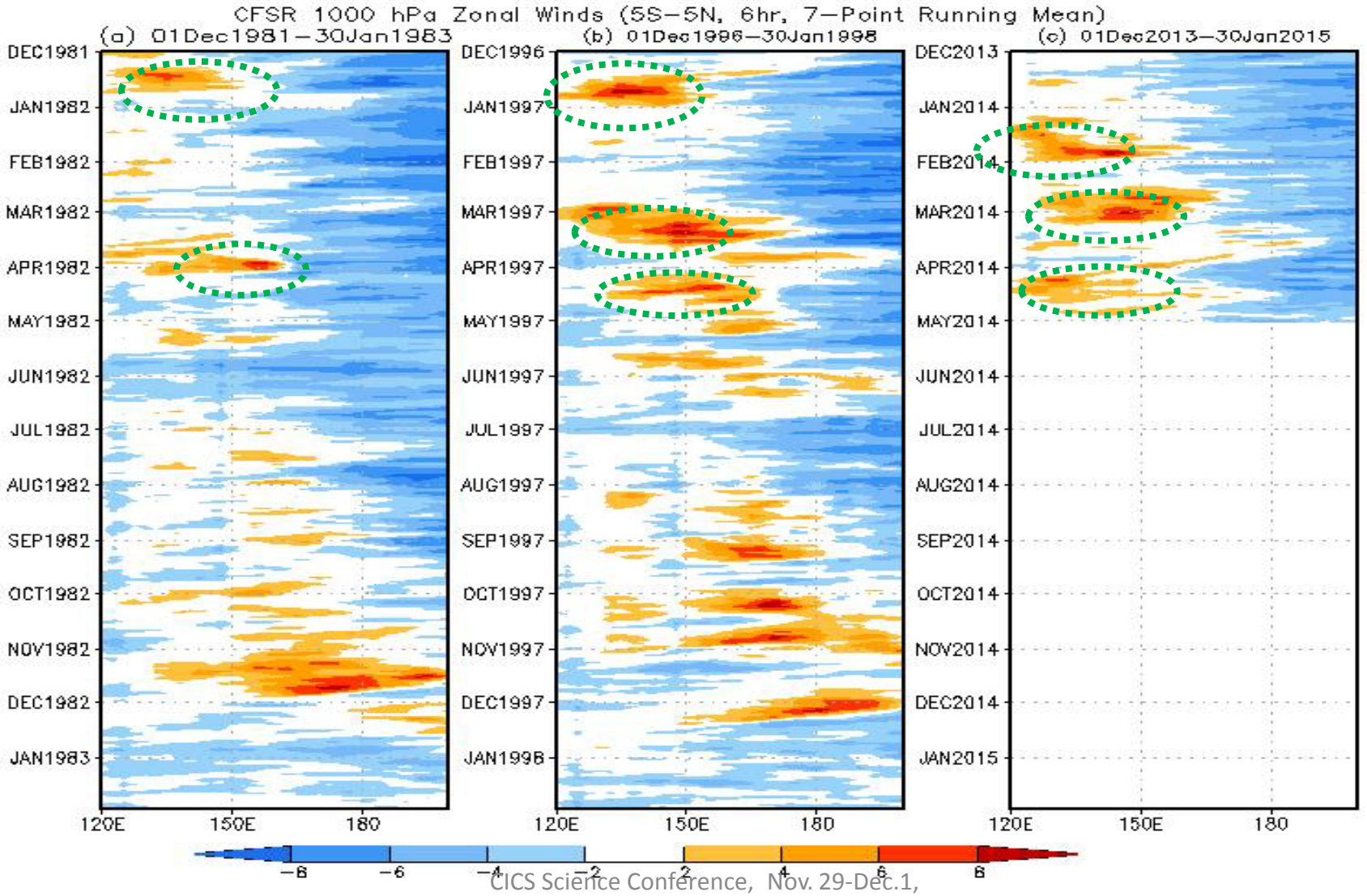
Anomalous Temperature Average in 1S-1N

By courtesy of Dr. Z.-Z. Hu

CFSR: Westerly wind burst (WWB) events

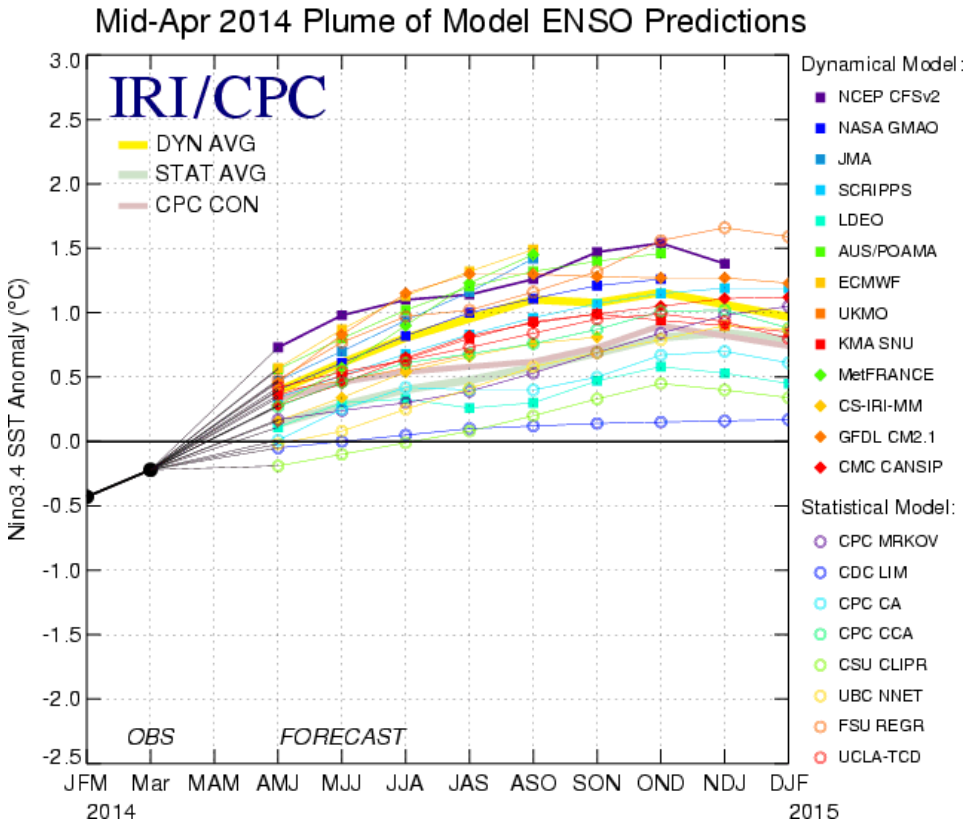
a) stronger in 1997-98 than in 1982-83

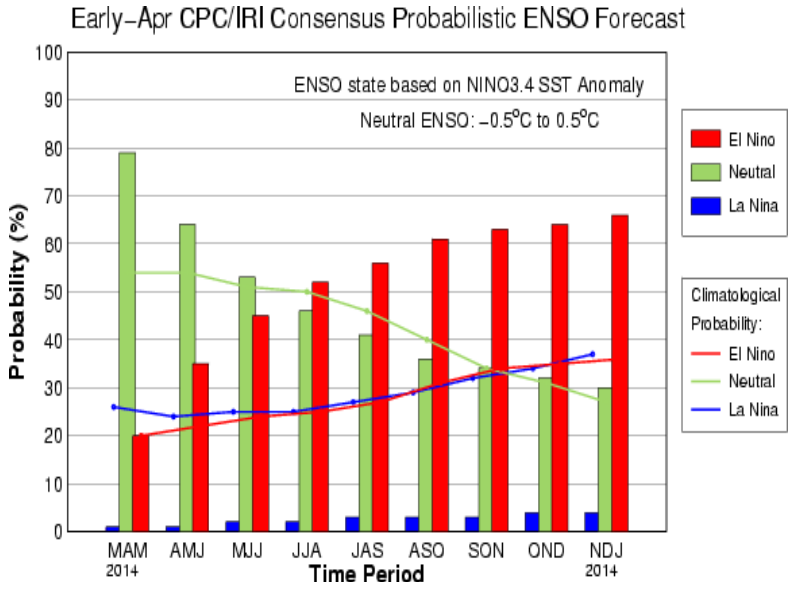
b) strong multi-WWB events in 1997-98

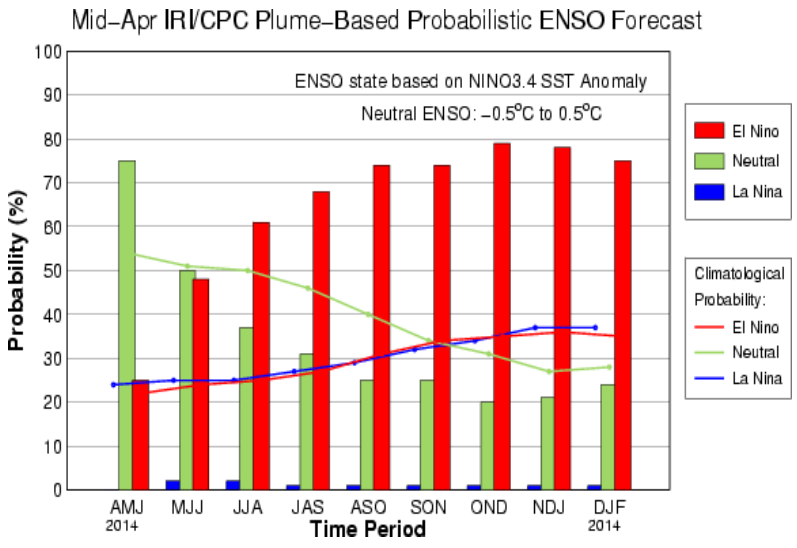


By courtesy of Dr. Z.-Z. Hu

IRI NINO3.4 Forecast Plum







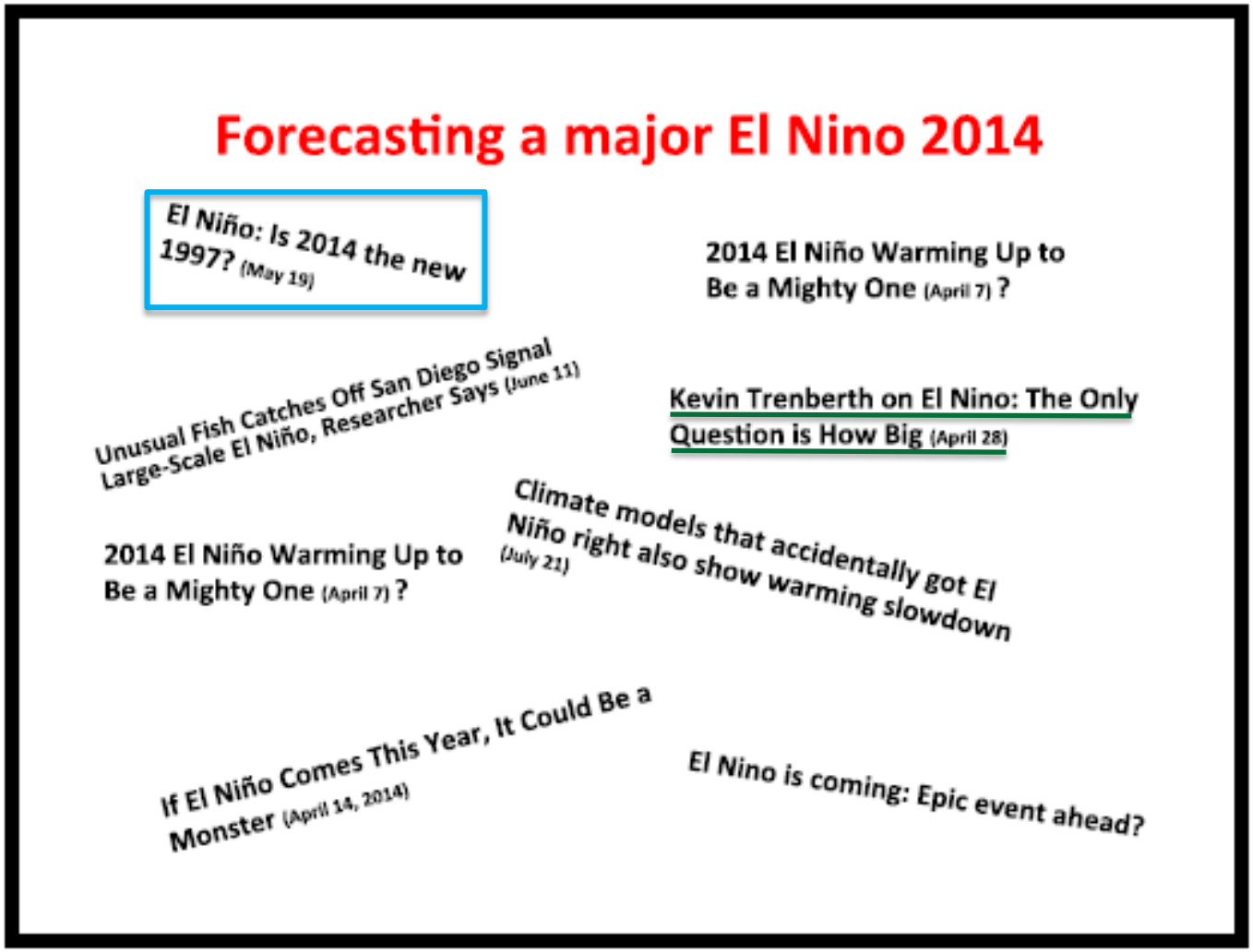
- All models predicted a warming tendency and a majority of them predicted an El Nino in second half of 2014.

- Consensus probabilistic forecasts favor a warm phase of ENSO since JJA 2014.

- NOAA "ENSO Diagnostic Discussion" on 8 May 2014 issued "El Nino Watch" and suggests that *"Chance of El Niño increases during the remainder of the year, exceeding 65% during summer"*

By courtesy of Dr. Z.-Z. Hu

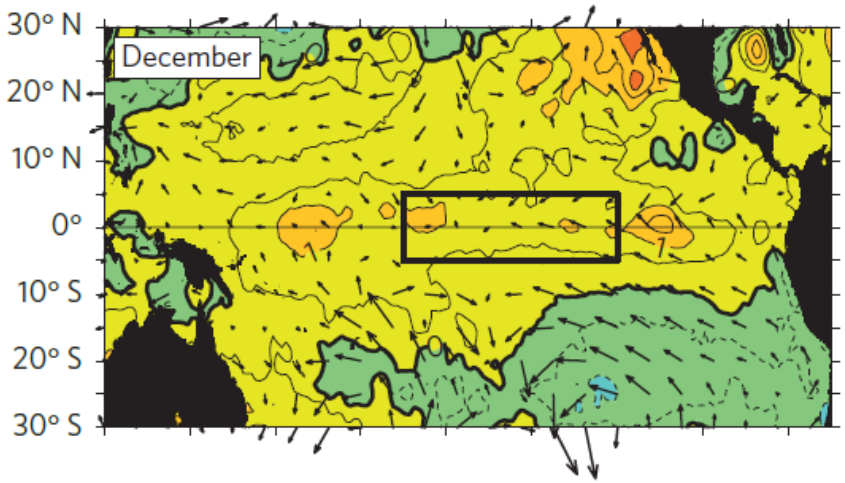
Weblines from news sources that appeared on the Internet before mid-June 2014



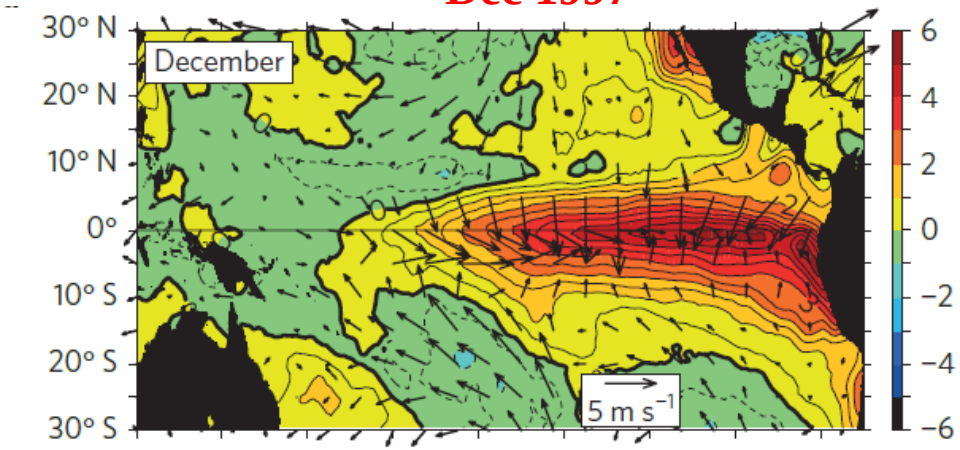
(Glantz 2015)

SST (color) & Surface wind anomalies (vector)

Dec 2014



Dec 1997



(McPhaden 2015)

Question:

- ***Why our models failed in predicting the 2014 El Nino development?***

Forecast Experiment (CTL)

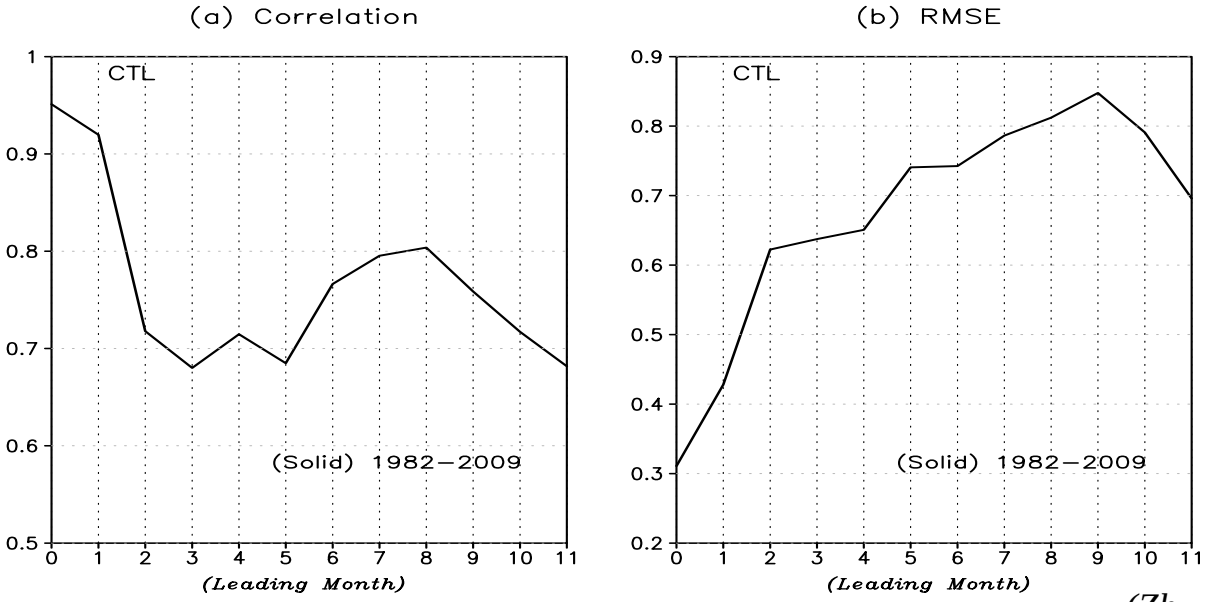
- Forecast model: **NCEP CFS version 2**

  Ocean initial state (OIC): **ECMWF ORA-S4**

  Perturbed atmosphere-land ICs (4-member with each OIC, Apr. 1-4, **CFSR**)

Prediction skill of the Nino3.4

12-month hindcasts initialized in April 1982-2009

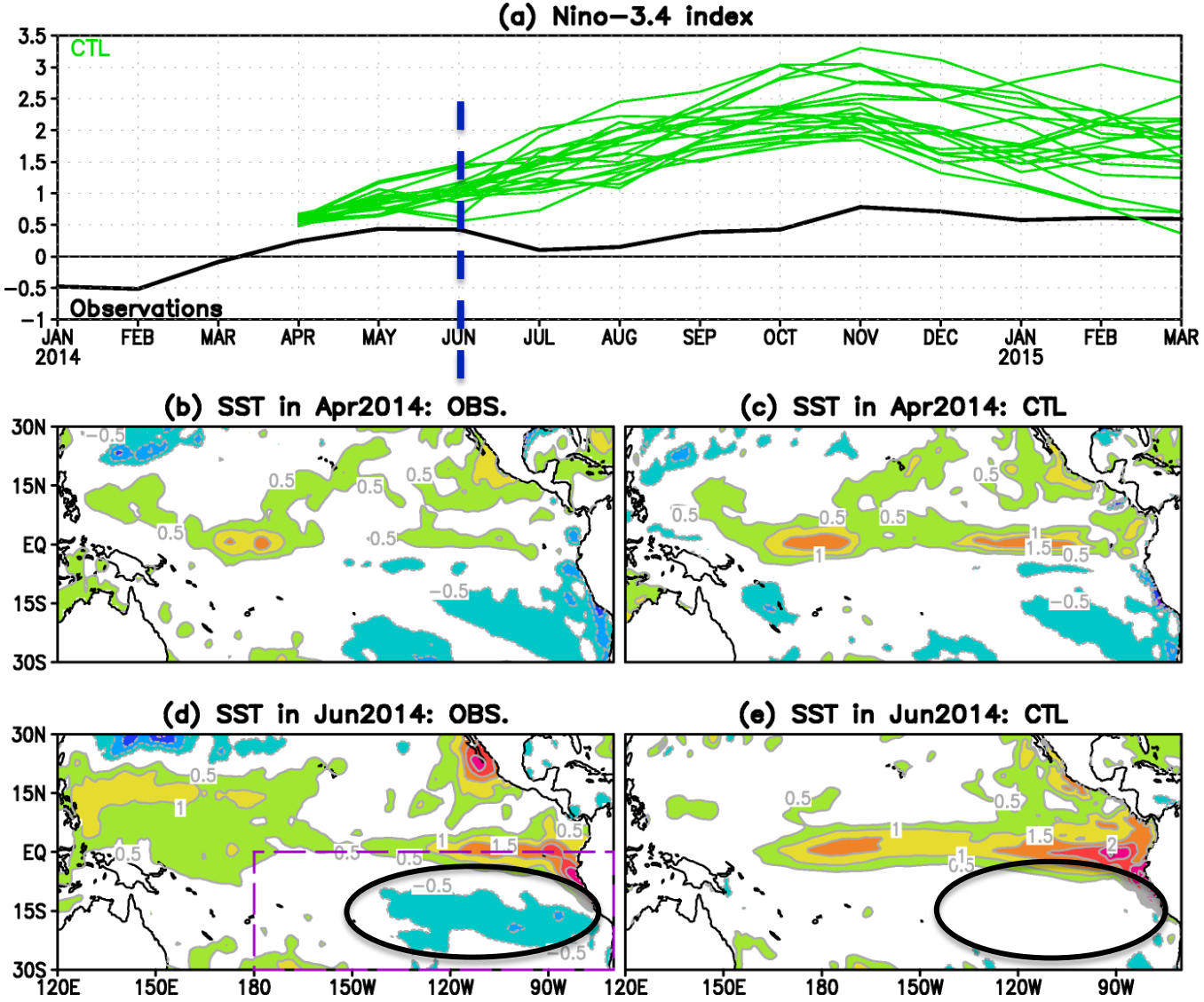


(Zhu et al. 2012)

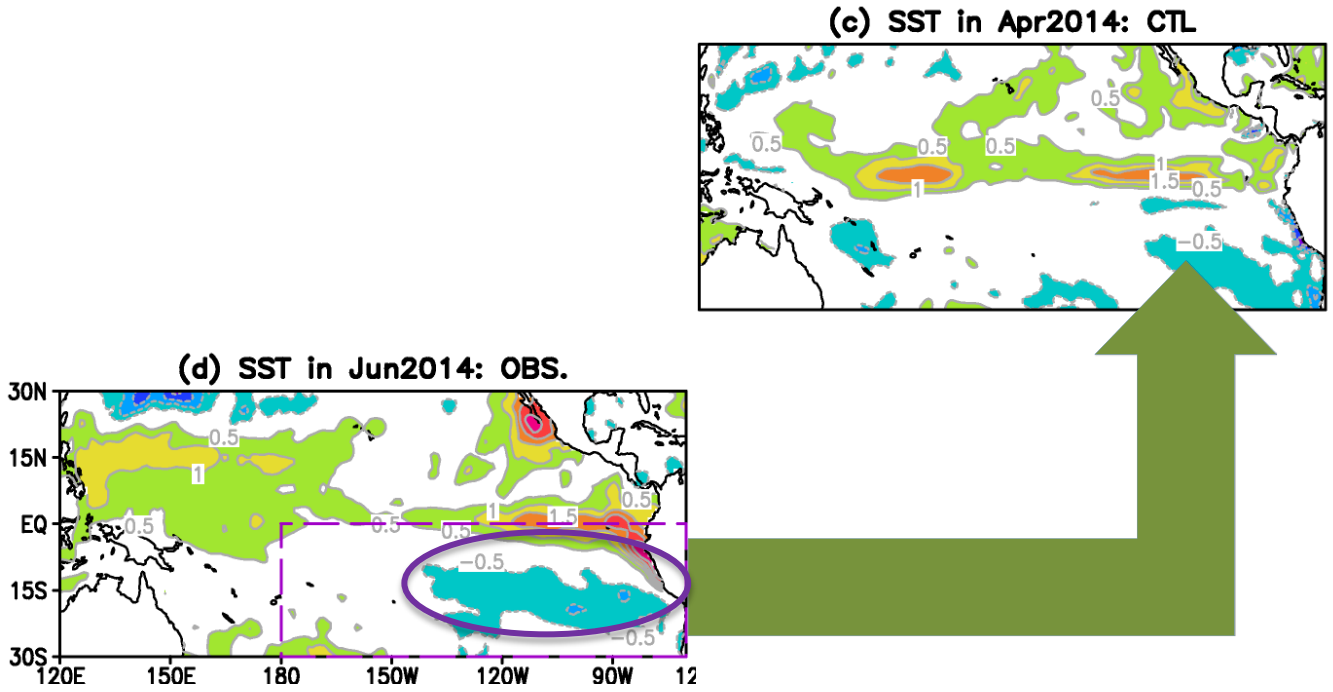
Validation SST: ***OISSTv2***

Predictions of 2014 El Nino

(20 ensemble members)

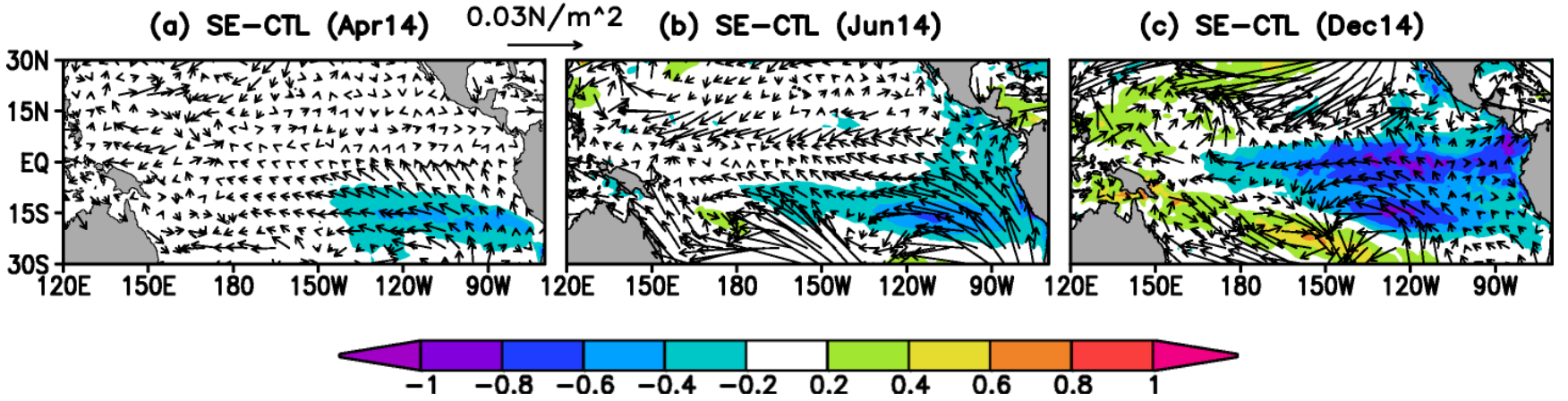


Sensitivity Experiment: SE

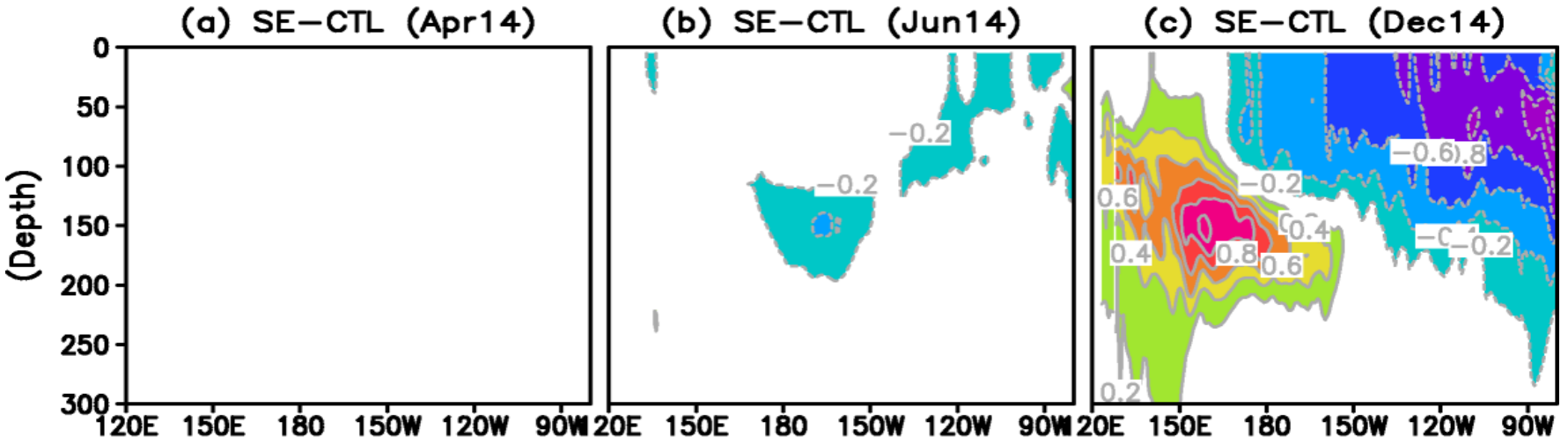


- ***Artificially add the June SSTA in SE to the April OIC***

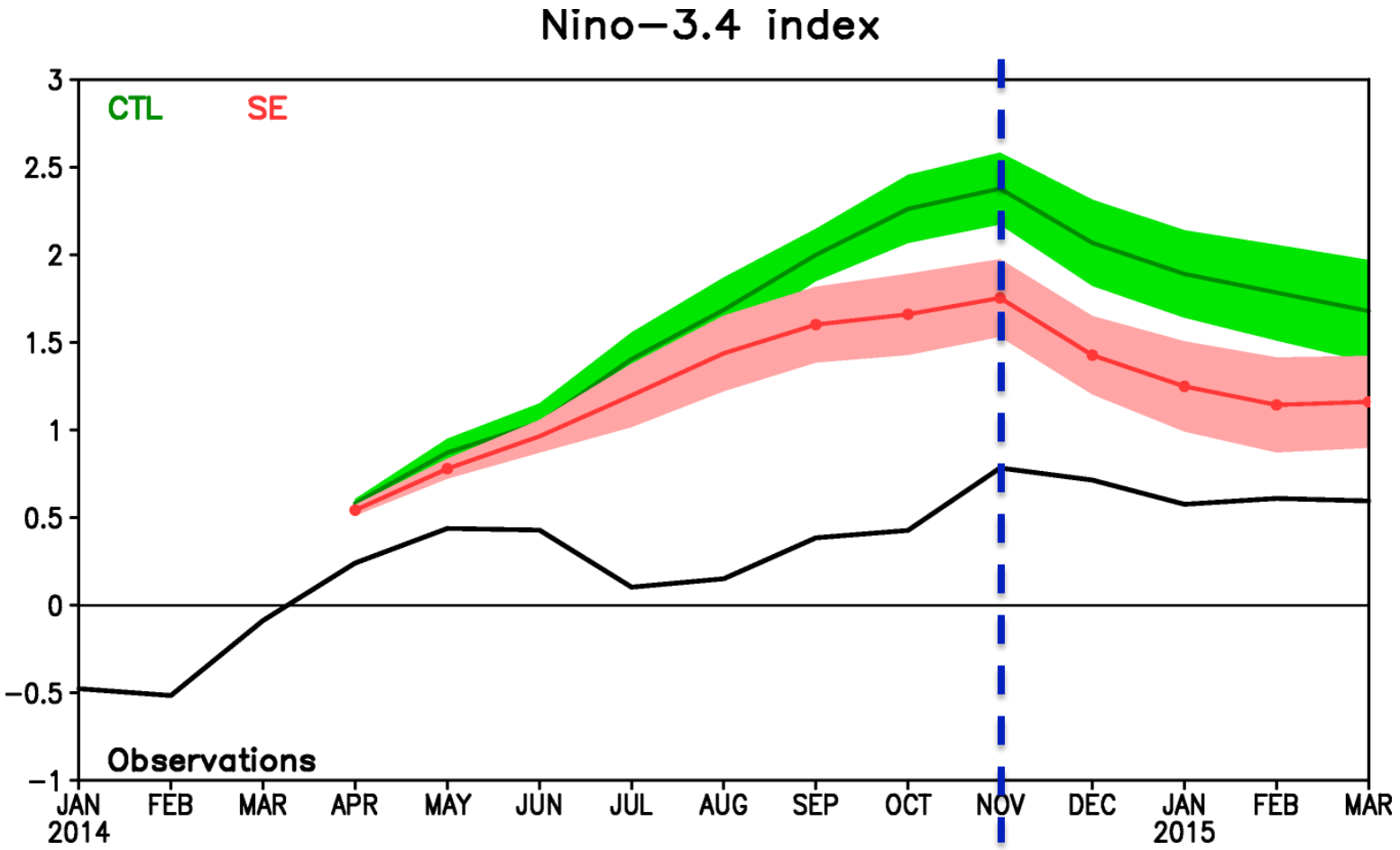
SST (color) & Surface wind (vector) Diff. *relative to CTL*



Subsurface Temperature Diff. *relative to CTL*

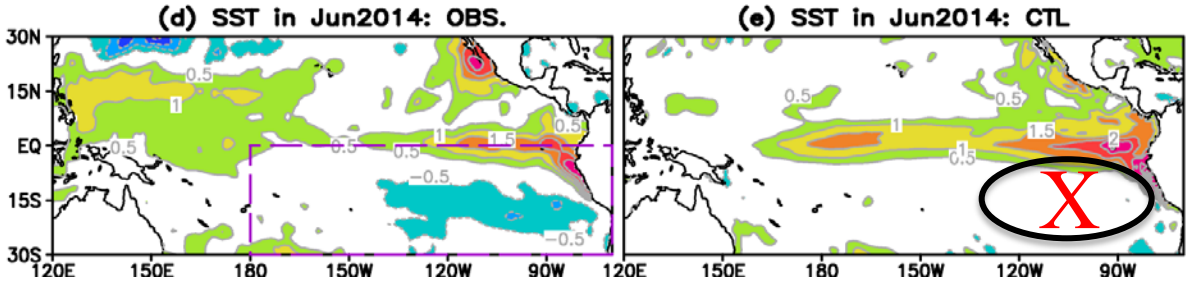


Prediction of the Nino3.4 index



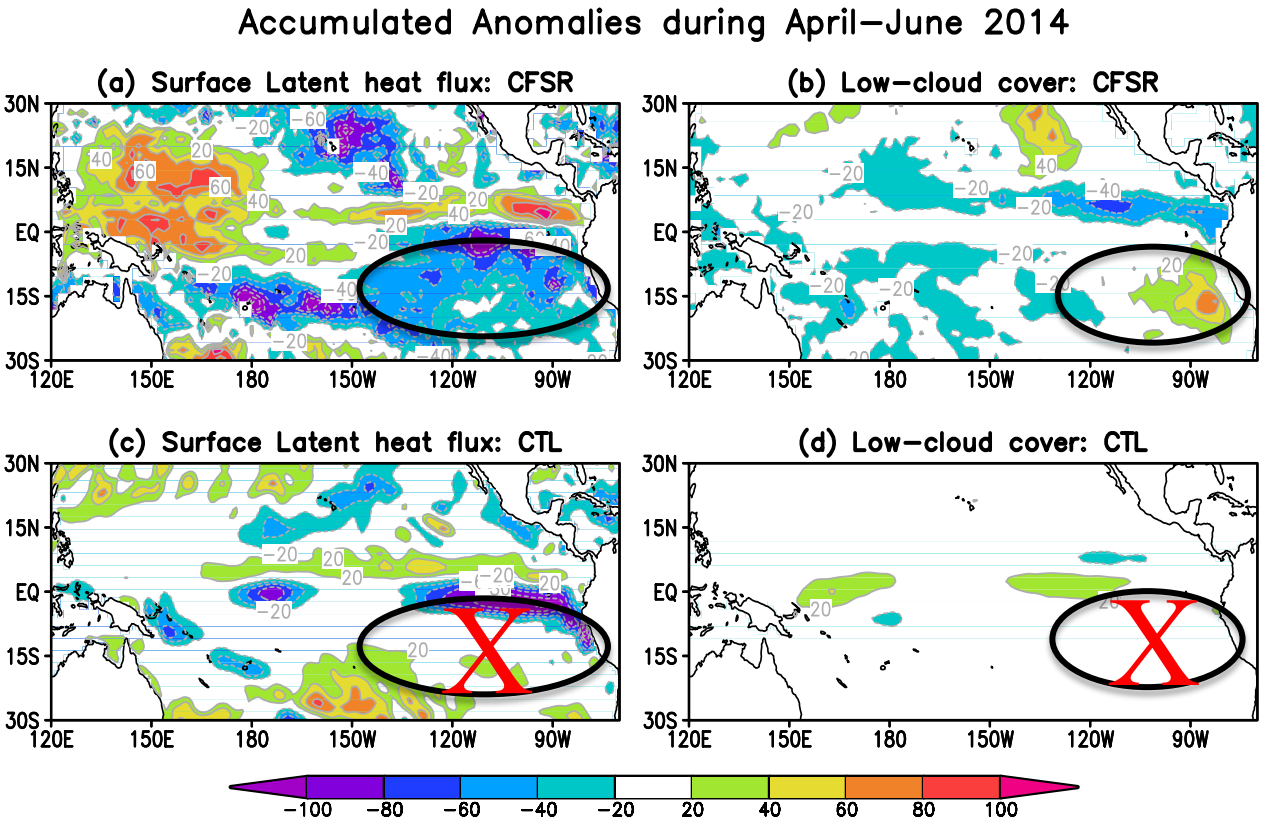
0.78 (OBS) vs. 2.38 (CTL) vs. 1.75 (SE)

Why the negative southeastern Pacific SSTA is missing?



Answer:

Model deficits in representing the **thermodynamic WES** and **stratus-SST** feedbacks**!**



Summary

- The **cold SST anomalies in SE** is one of error sources for the 2014 El Nino prediction: *explaining 40% amplitude error at the peak phase*;
  - Another source*: the lack of WWBs from May-June (Menkes et al. 2014) and an EWB during June (Hu and Fedorov 2016), both beyond the seasonal climate predictability.*

- Climate model error analysis is essential to improve model performance and future predictions: *model deficiency in representing thermodynamic WES and stratus-SST feedbacks.*

Another Sensitivity Experiment: SE3

The added cold SSTA in SE was tripled