Seasonal Prediction of Asian Monsoon by the NCEP CFSv2

Xingwen Jiang

Institute of Plateau Meteorology, CMA, Chengdu, Sichuan, China

Song Yang, Arun Kumar, Wanqiu Wang, Bhaskar Jha

Climate Prediction Center, NCEP/NOAA, Maryland, U.S.A.

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Thank CPC for hosting my visit

Model, experiments, and data

Model data

- Hindcast: 9-month hindcast, every 5th day and 4 times per day, 1983-2010, ensemble mean of 24 members
- AMIP: forced by observed SST from 1951-2010, ensemble mean of 11 members
- CMIP: initialized in 1988, 48-years run, last 28 years for analysis

Validation data

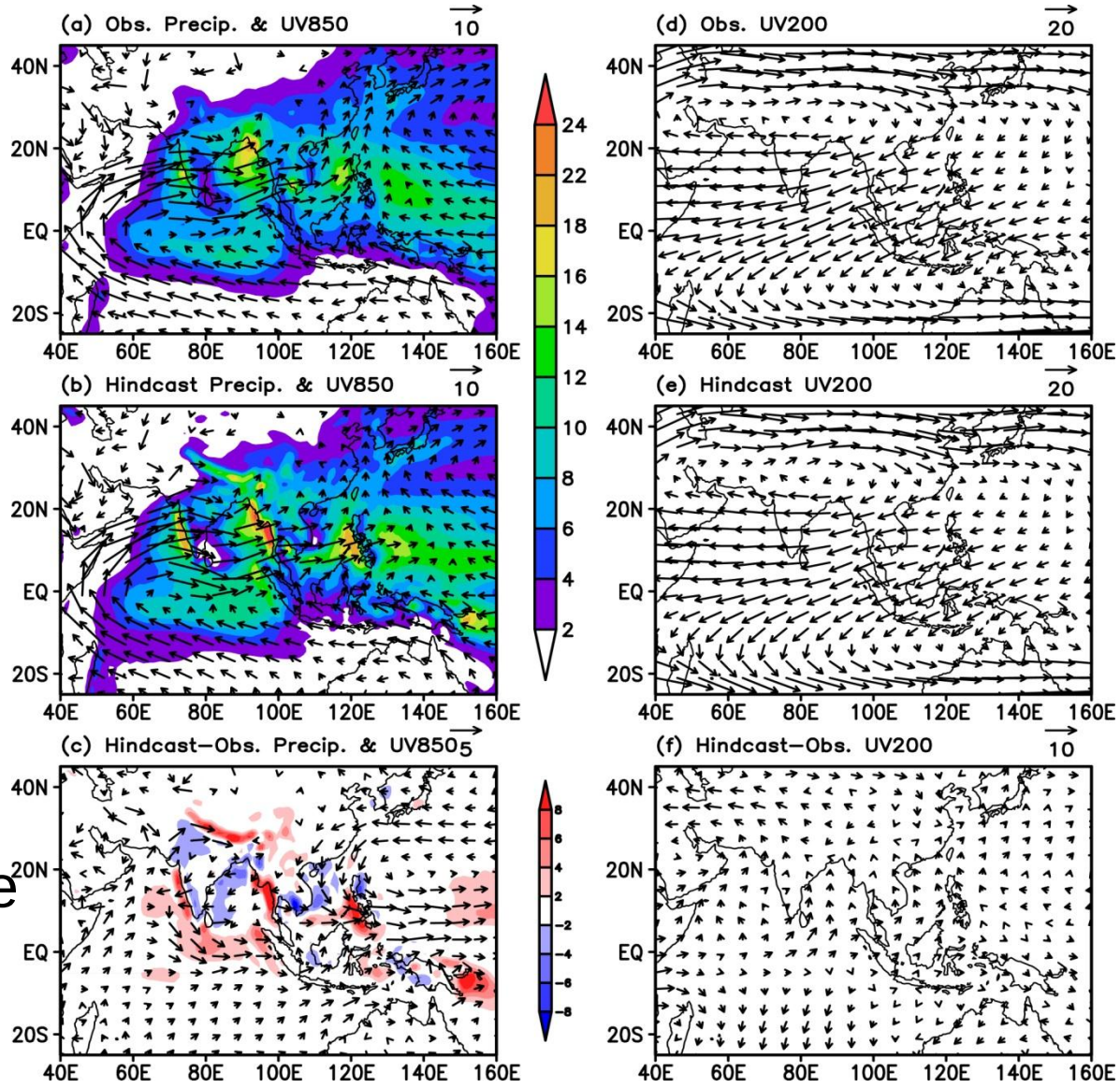
- OI SST (v2)
- CMAP precipitation
- CFSR T2m, SLP, winds and geopotential height

JJA Precipitation and Winds

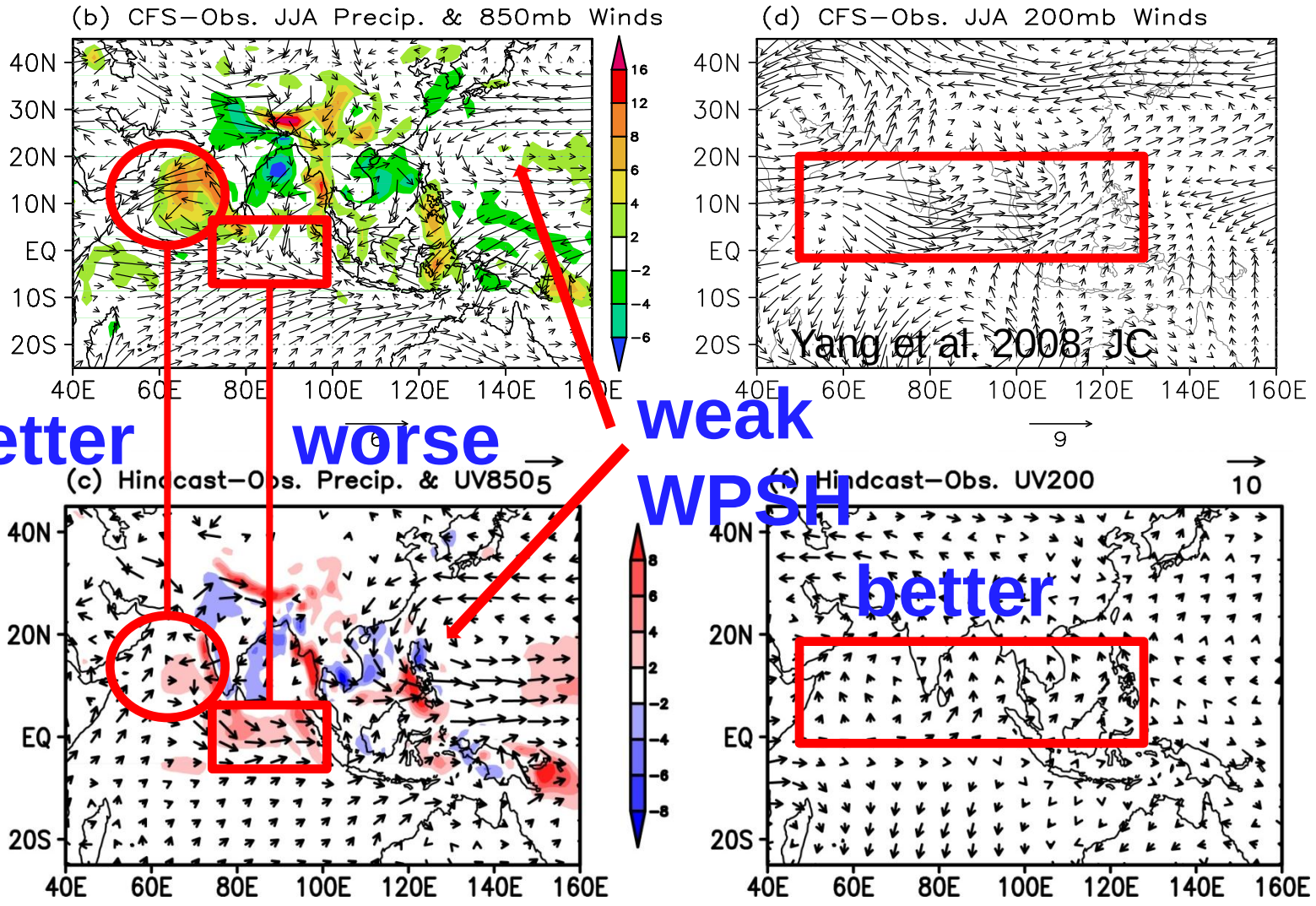
Obs.

LM0 hindcast

Difference



Diff. in JJA Clim. (Hindcast-Obs.)



CFSv1

CFSv2

better

worse

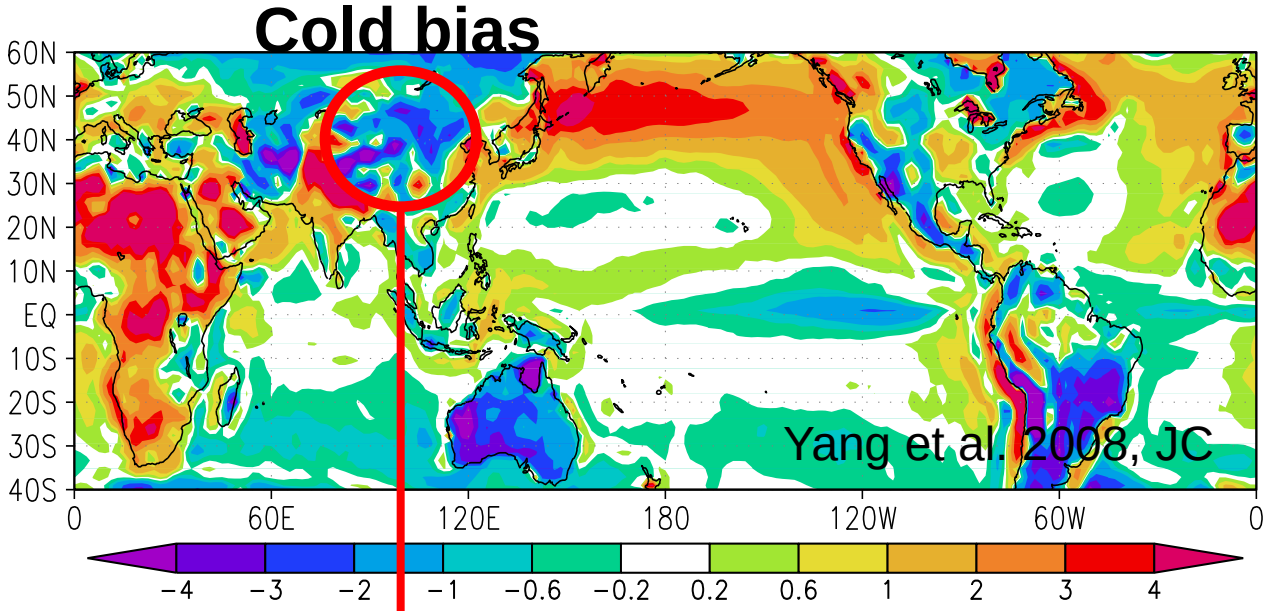
weak

WPSH

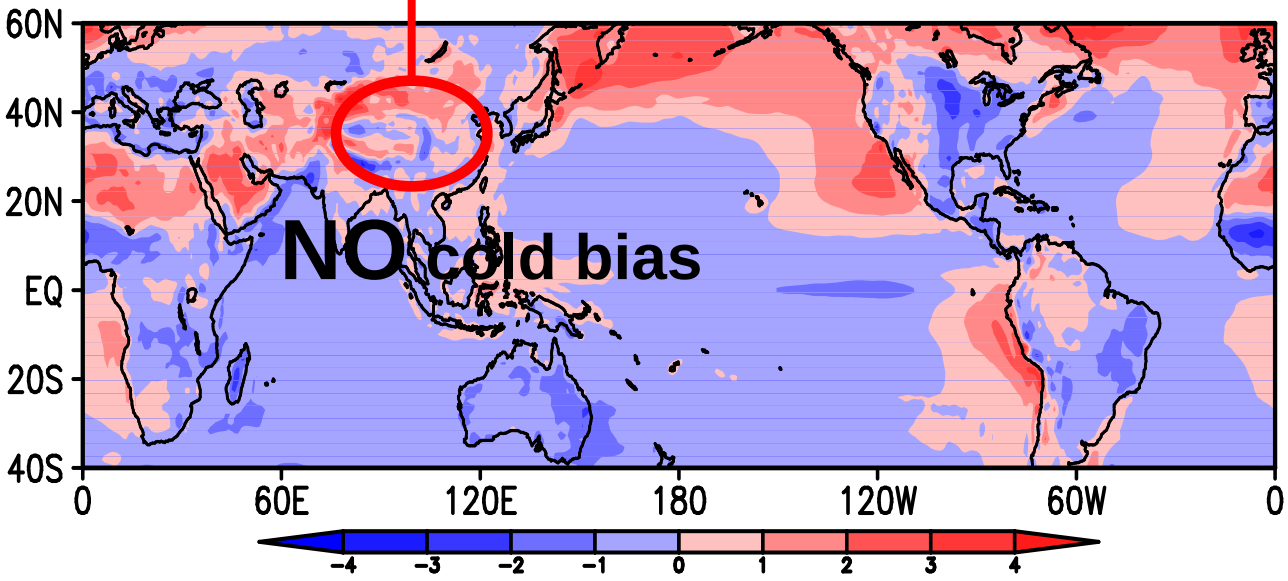
better

Diff. in JJA T2m (CFS – Obs.)

CFSv1



CFSv2



Dynamical monsoon indices

Index	Definition
WY	Vertical zonal wind shear between 850 and 200 hPa, U_{850}-U_{200}, averaged over south Asia region (5˚-20˚N/40˚-110˚E) from June to August
SA	Vertical meridional wind shear between 850 and 200 hPa, V_{850}-V_{200}, averaged over South Asia monsoon region (10˚-30˚N/70˚-110˚E) from June to August
SEA	Horizontal 850-hPa zonal wind shear over the Southeast Asia monsoon region U_{850}(5˚-15˚N/90˚-130˚E)- U_{850} (22.5˚-32.5˚N/110˚-140˚E), from June to August

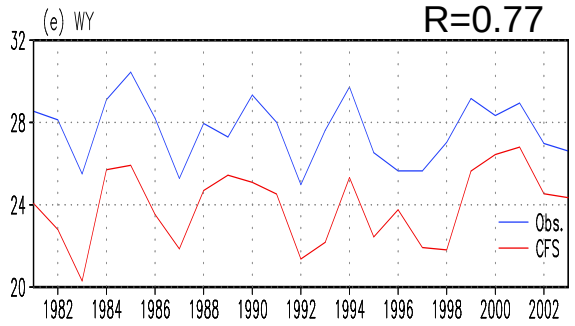
WY: Webster-Yang (1992) index for large-scale Asian monsoon circulation

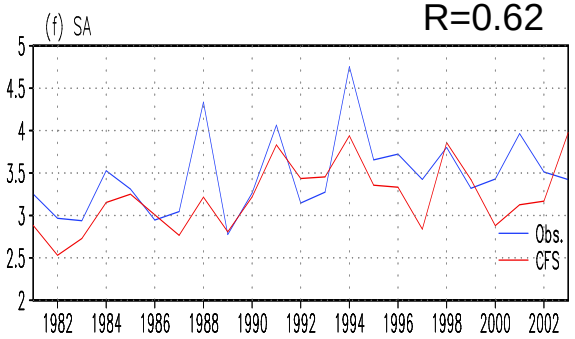
SA: South Asian monsoon (Goswami et al. 1999)

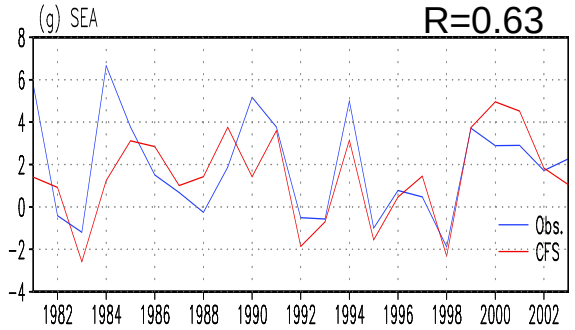
SEA: Southeast Asian monsoon (Wang and Fan 1999)

Interannul variability of Monsoon indices

CFSv1





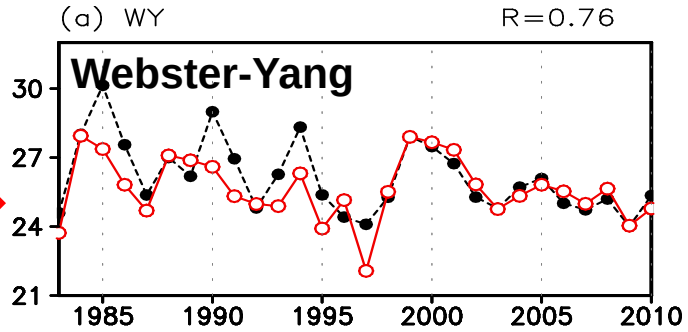


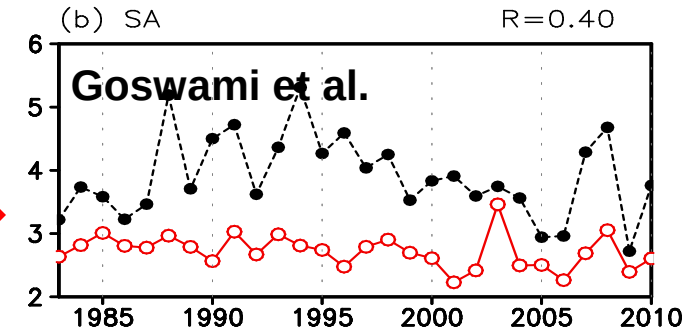
Yang et al. 2008, JCLI

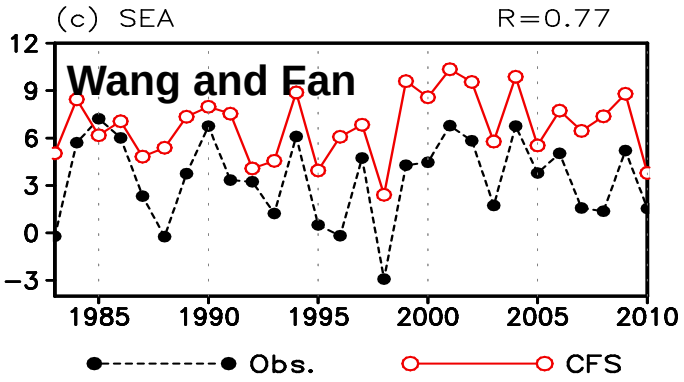
better

worse

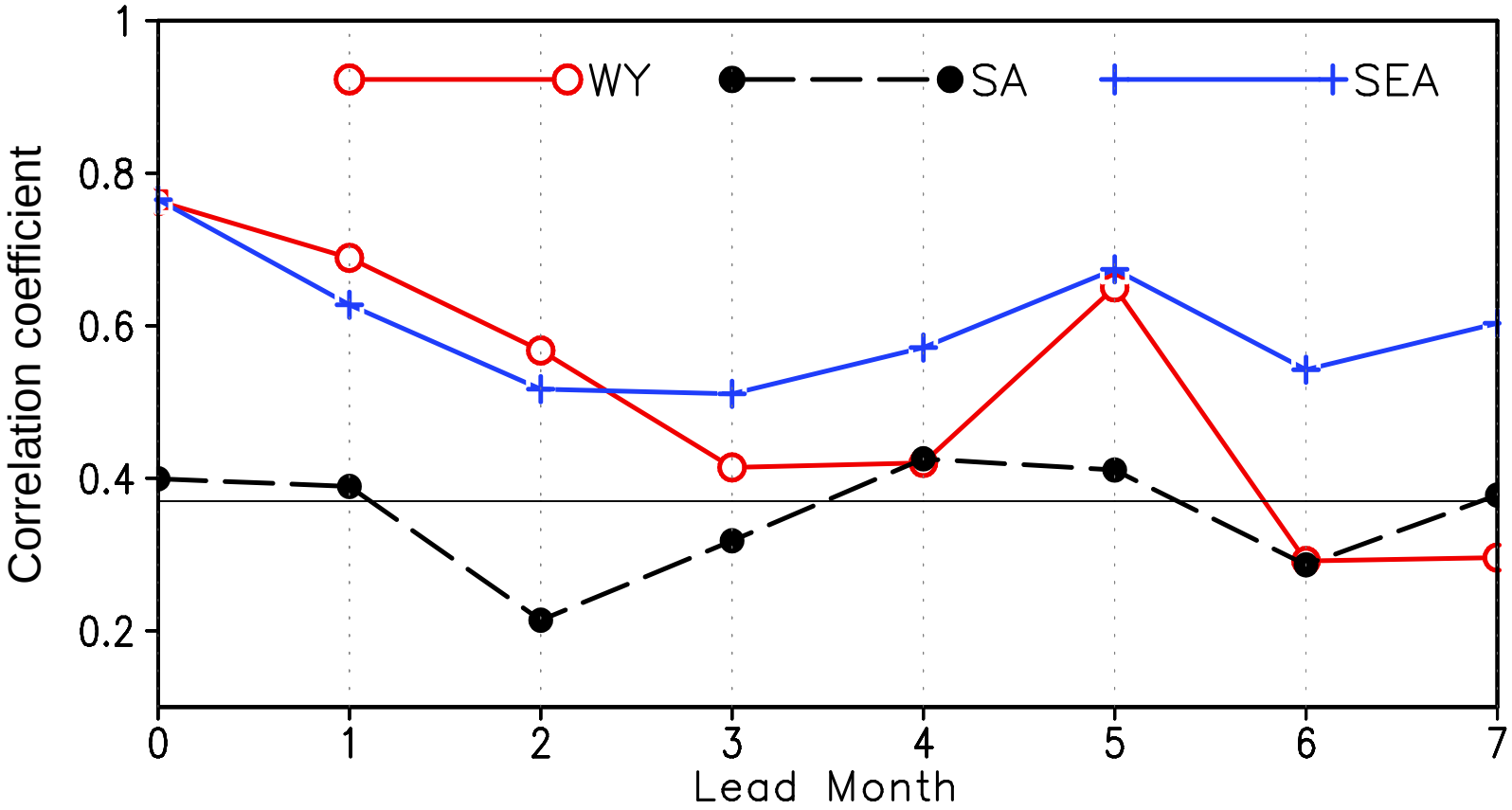
CFSv2



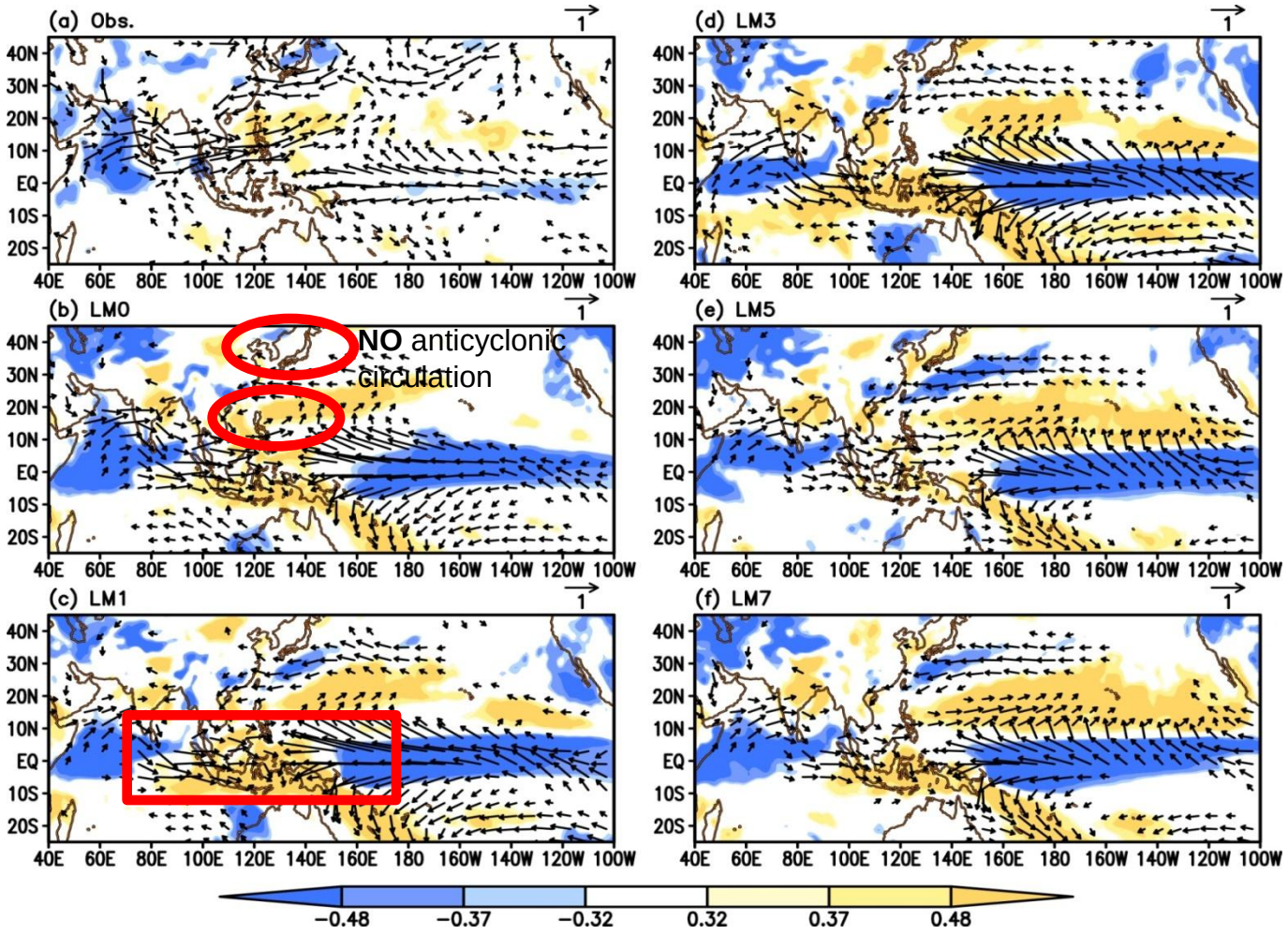




Predictions of Monsoon Indices

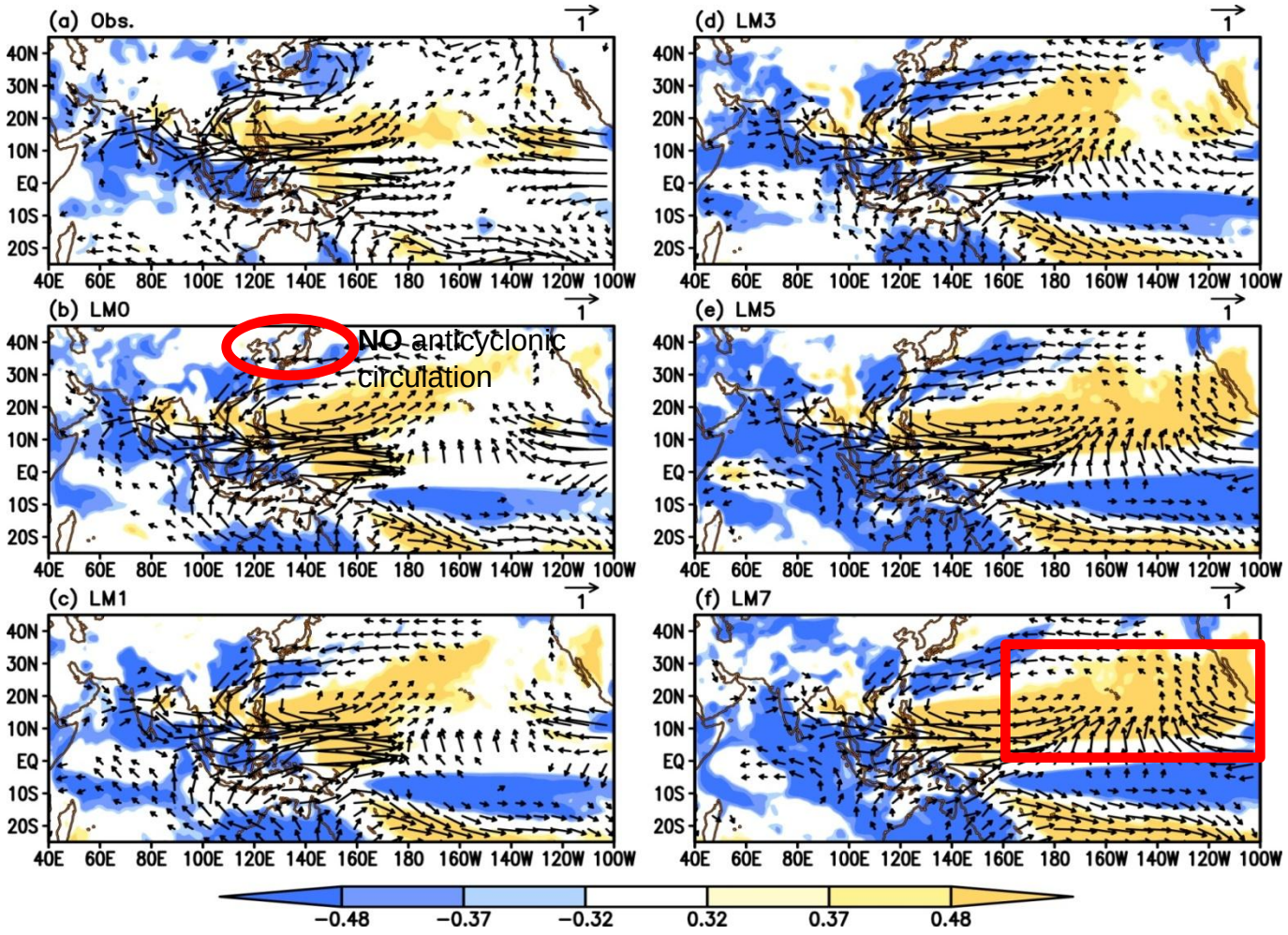


Relationships of WY with Rainfall and 850-hPa Winds



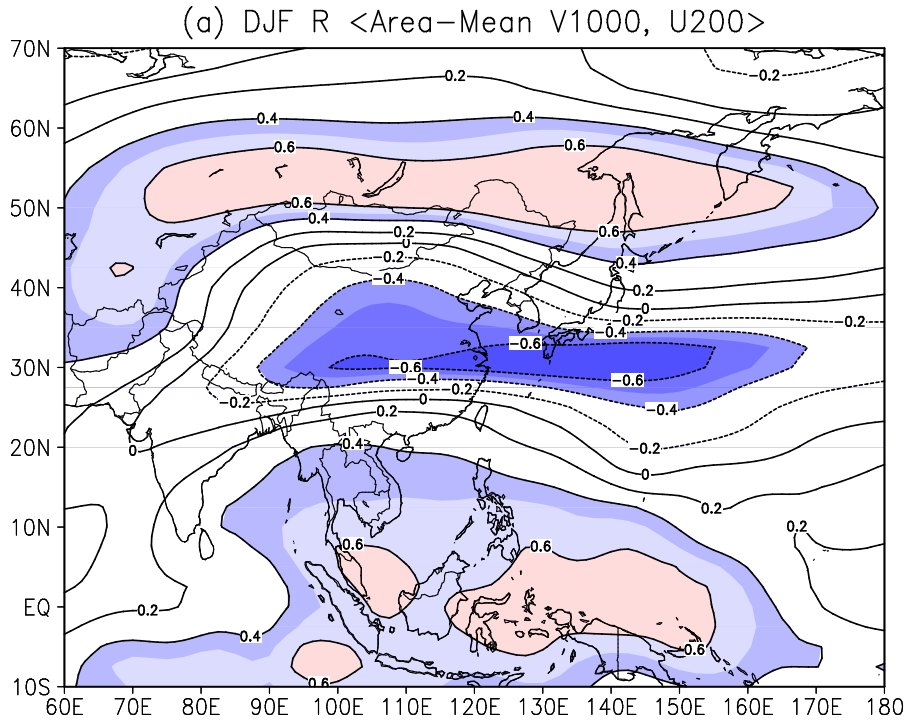
CFSv2 predicts weaker cyclonic circulation over Southeast Asia and stronger response of WY to ENSO, and fails to predict climate anomalies over Northeast Asia

Relationships of SEA with Rainfall and 850-hPa Winds



CFSv2 predicts a more close relationship of SEA with winds and rainfall over the tropical Pacific as lead time increases

A Dynamical EAWM Index



Li and Yang, 2010, JCLI

$$EAWM = (U1 - U2 + U1 - U3)/2$$

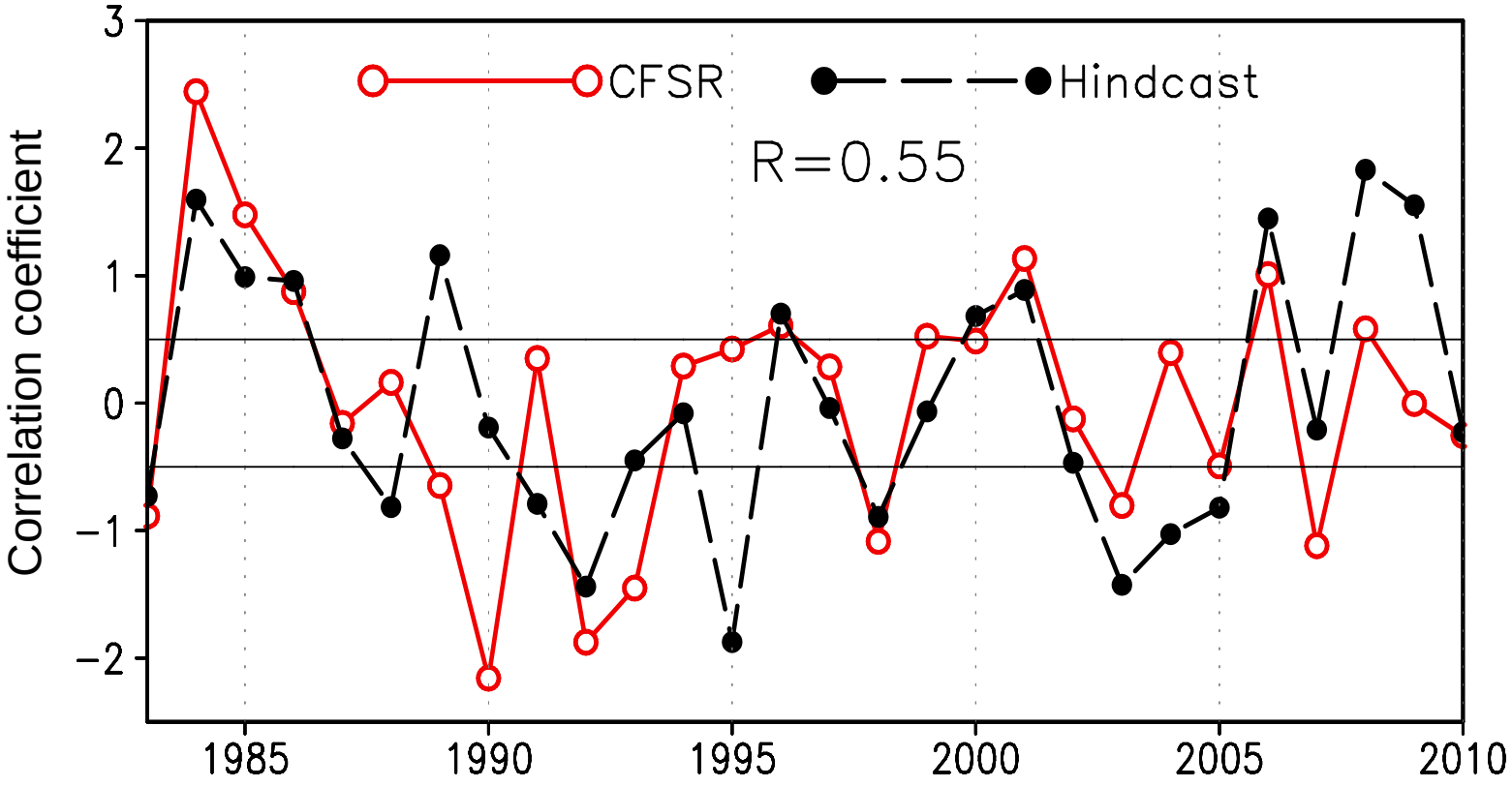
$$U1=U_{200}(30^{\circ}\text{-}35^{\circ}N/90^{\circ}\text{-}160^{\circ}E)$$

$$U2=U_{200}(50^{\circ}\text{-}60^{\circ}N/70^{\circ}\text{-}170^{\circ}E)$$

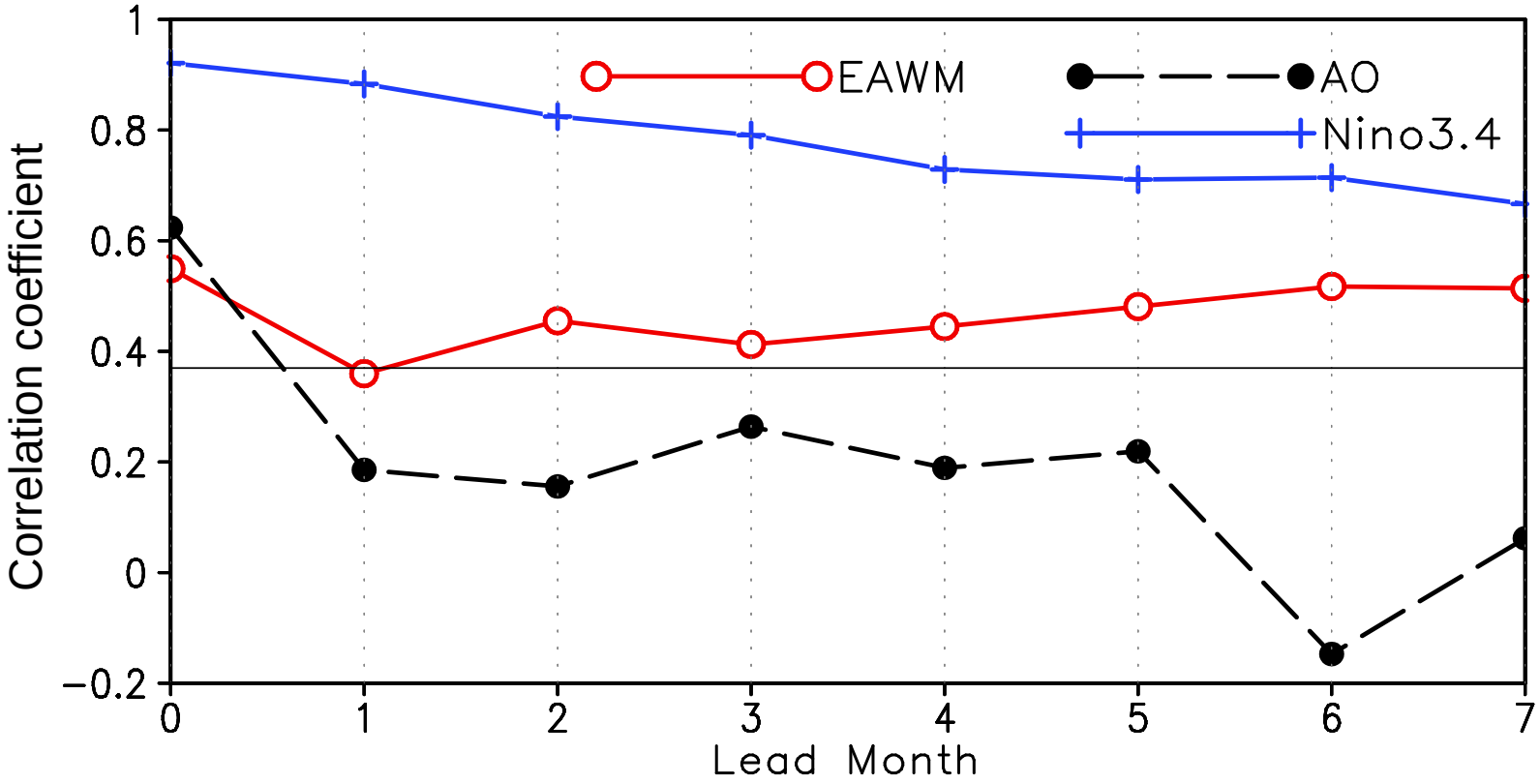
$$U3=U_{200}(5^{\circ}S\text{-}10^{\circ}N/90^{\circ}\text{-}160^{\circ}E)$$

Compared to other monsoon indices, this index is highly correlated with ENSO and AO, which have significant impact on the interannual variation of the EAWM

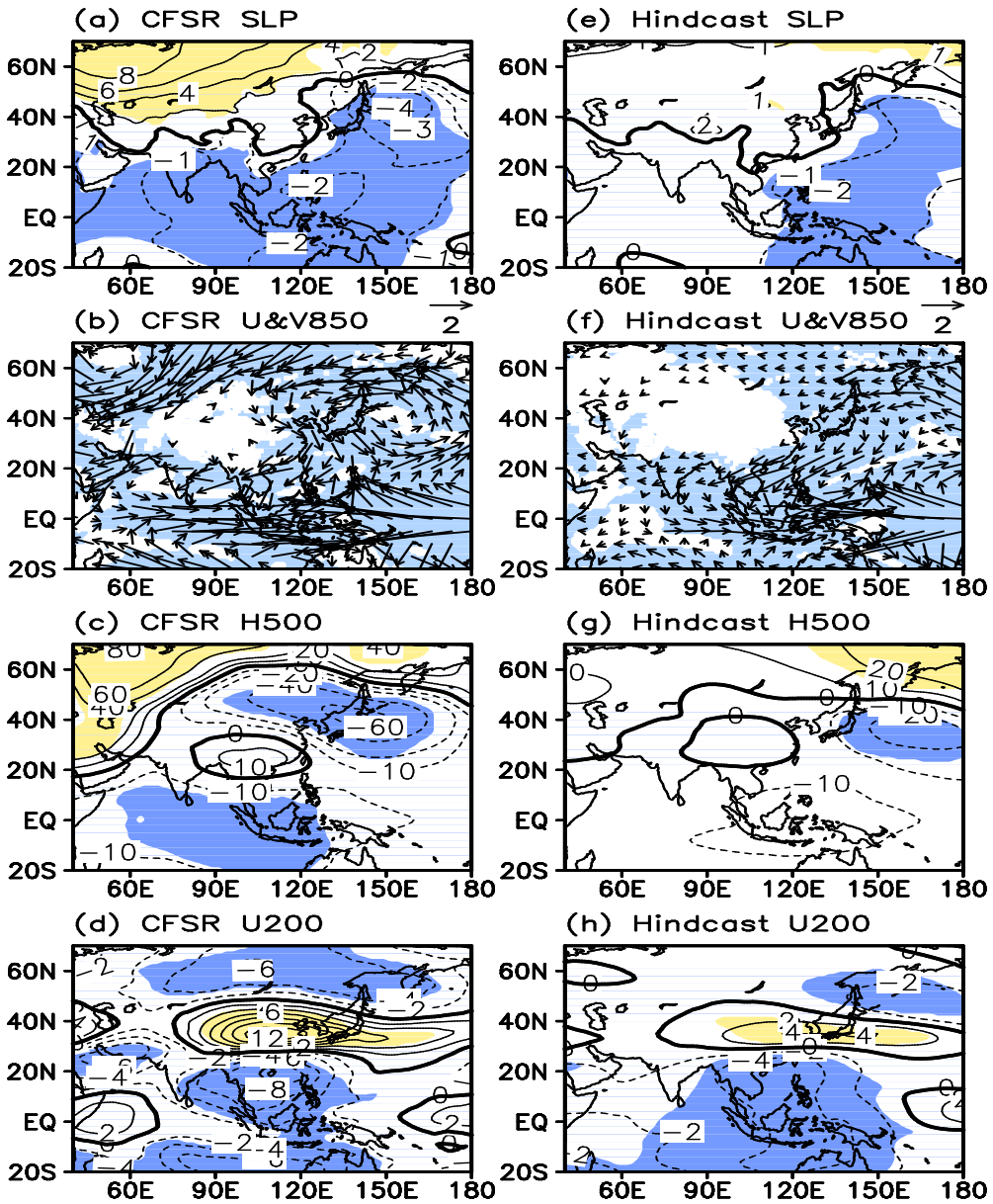
Interannual Variability of EAWM

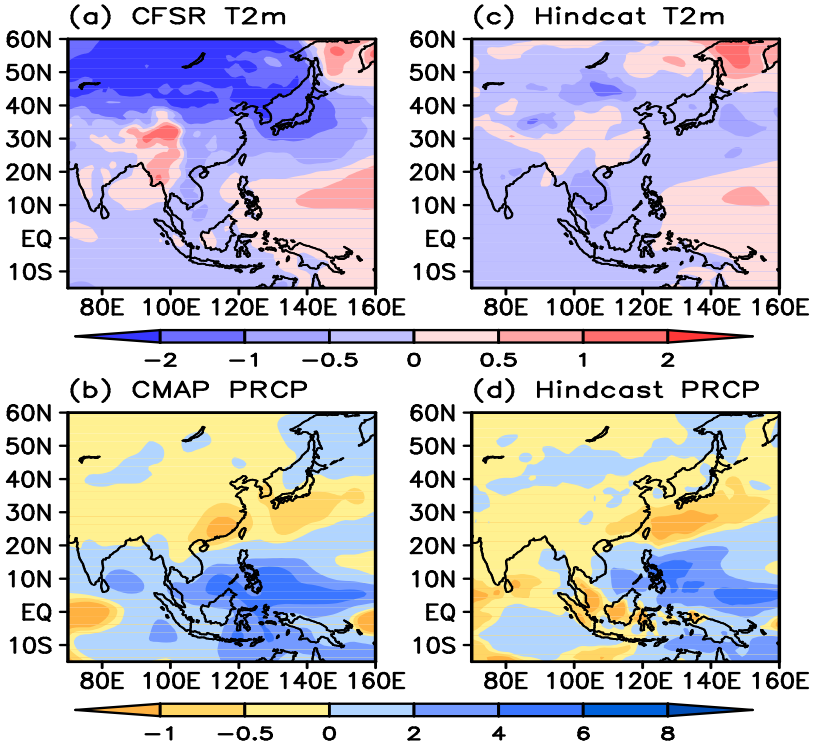


Predictions of EAWM, AO and ENSO



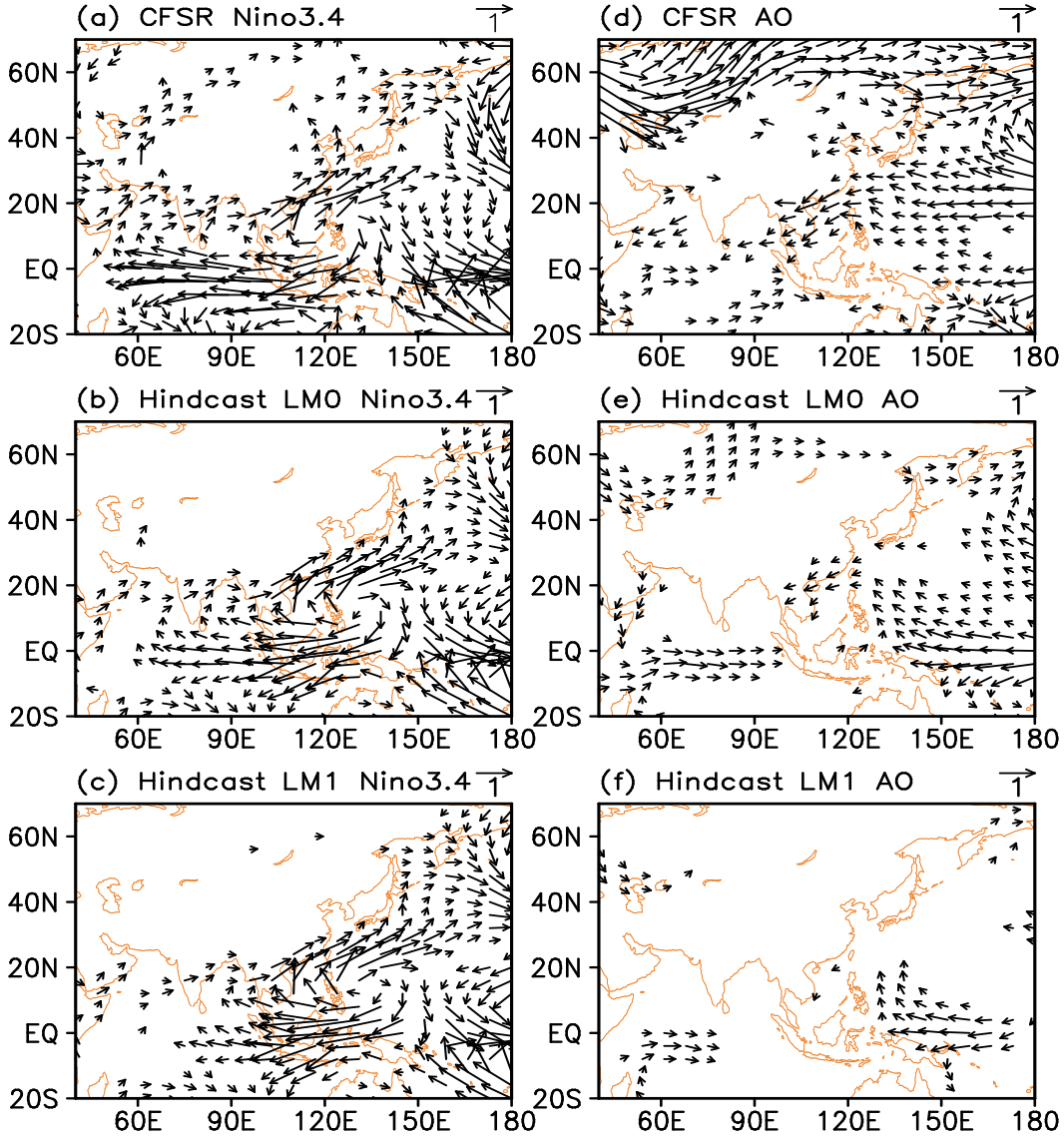
Difference (strong-weak EAWM)





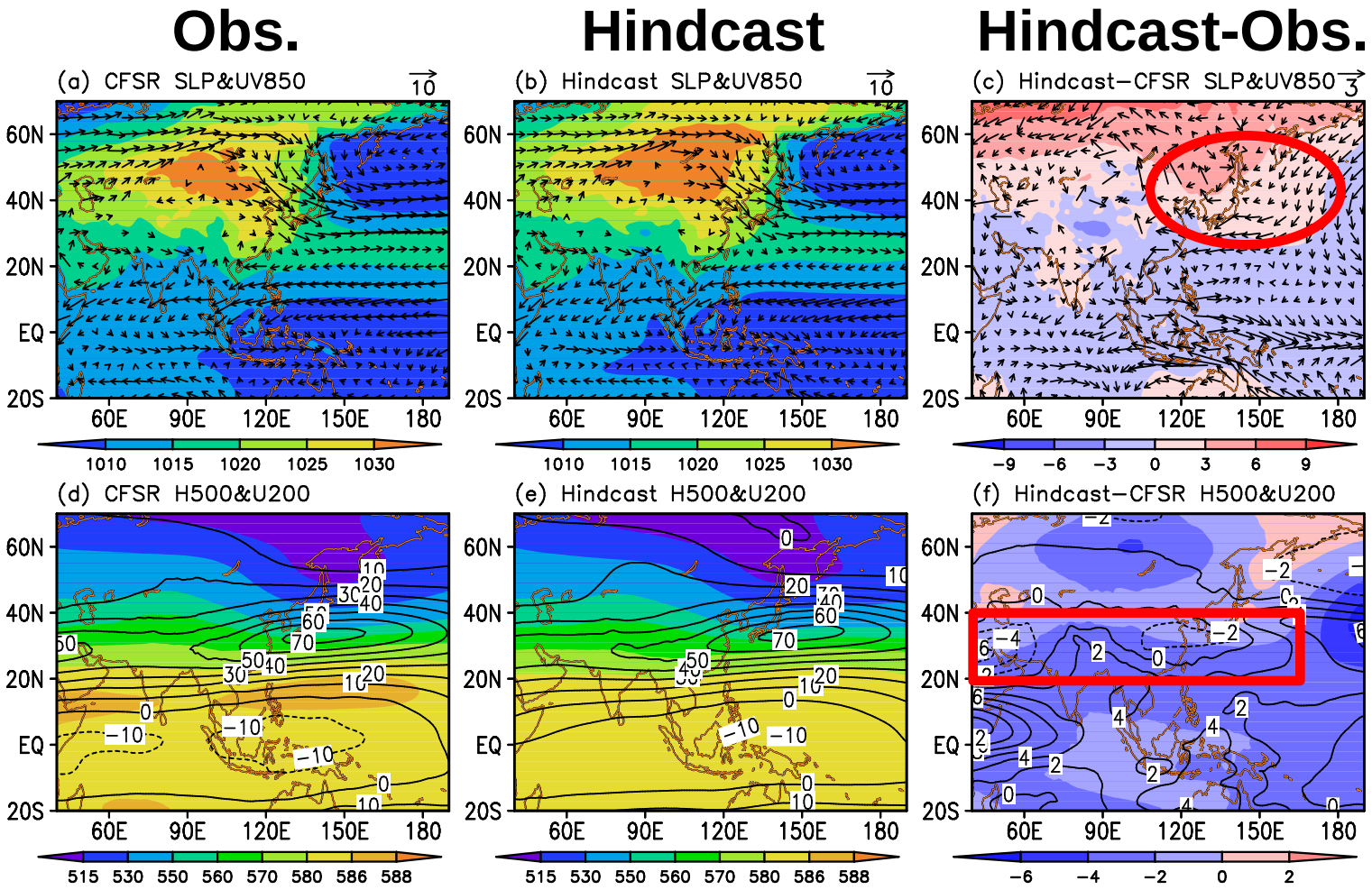
CFSv2 fails to predict the EAWM related features over the northern Asian Continent

Regression of 850-hPa winds on ENSO and AO



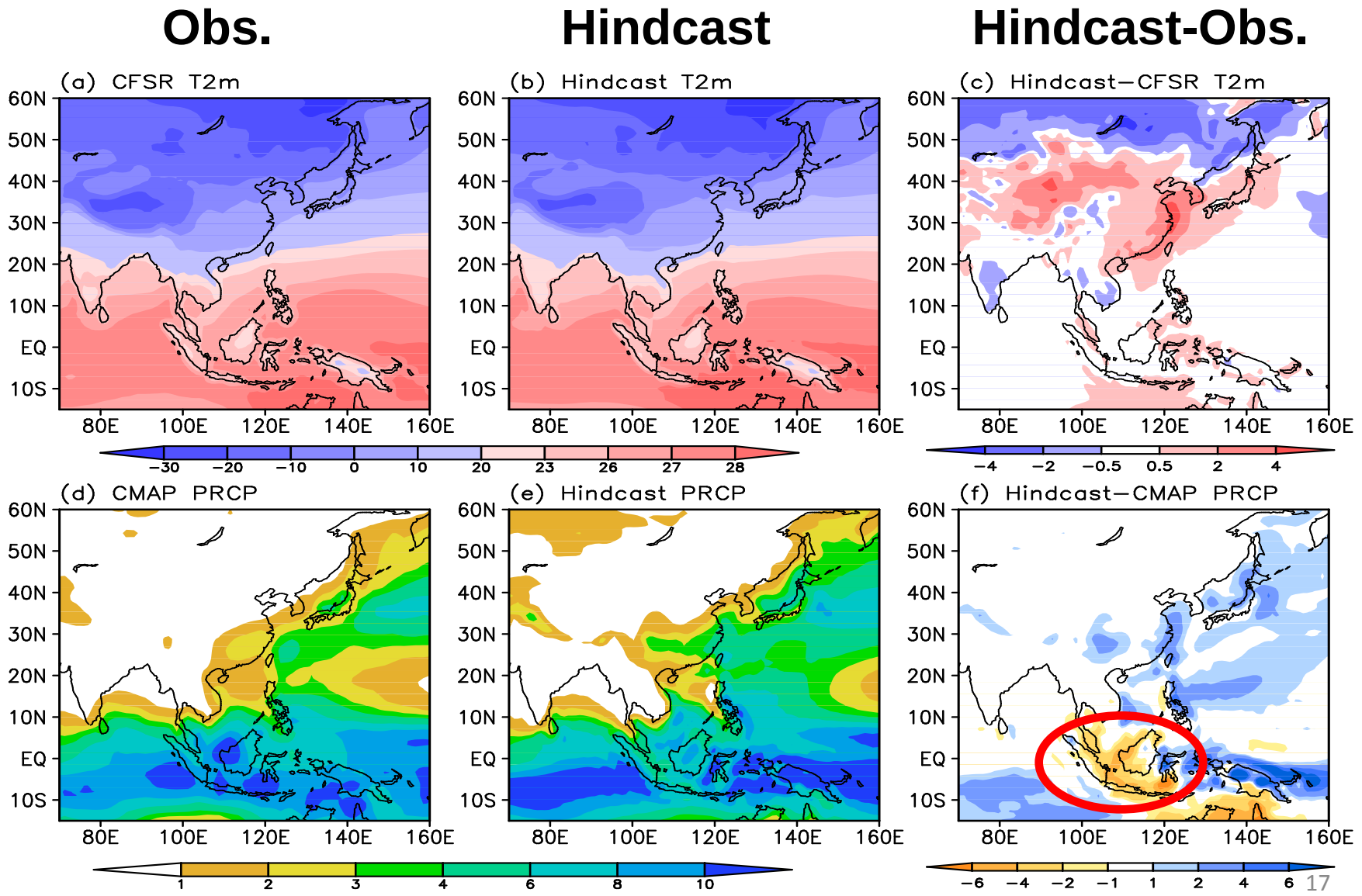
CFSv2 captures most features related to ENSO, but fails to predict the circulations associated with the AO.

DJF SLP, H500, UV850 and U200



CFSv2 predicts weak EAWM, including weak EA jet stream and 850-hPa northwesterlies and a shallow EA trough

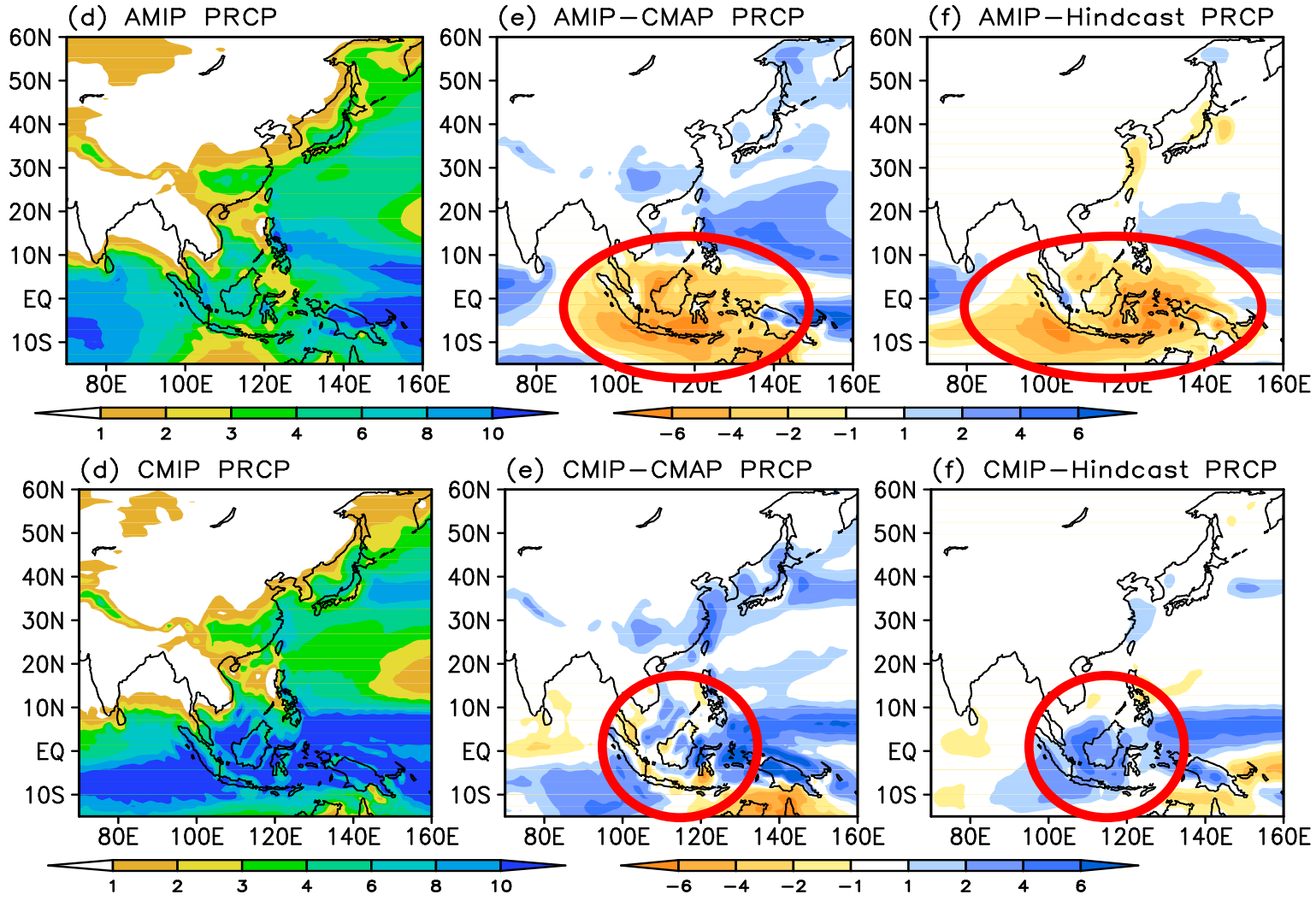
DJF T2m and Precipitation



DJF Precipitation in AMIP and CMIP

AMIP

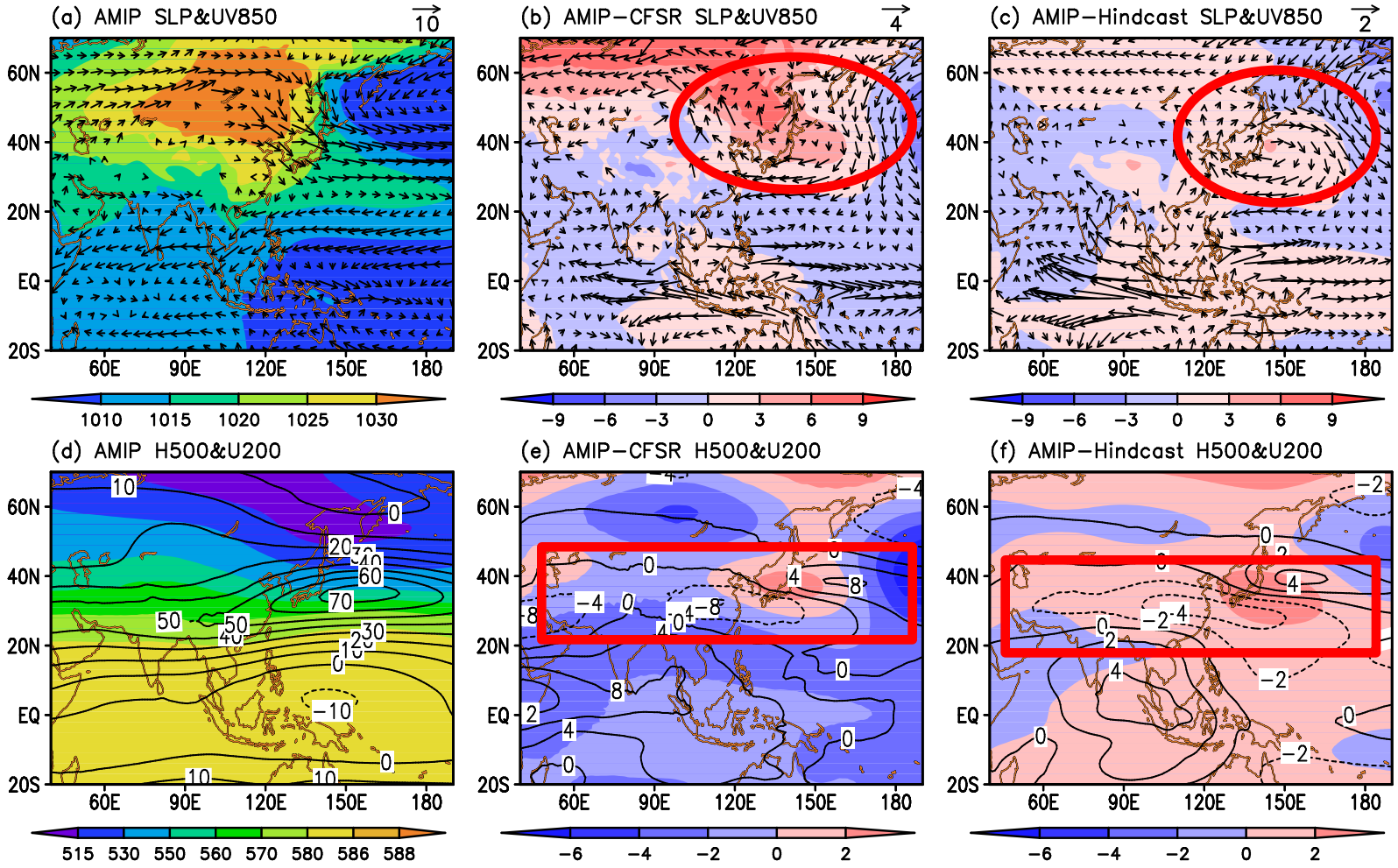
CMIP



AMIP significantly underestimates the precipitation over the Maritime Continent

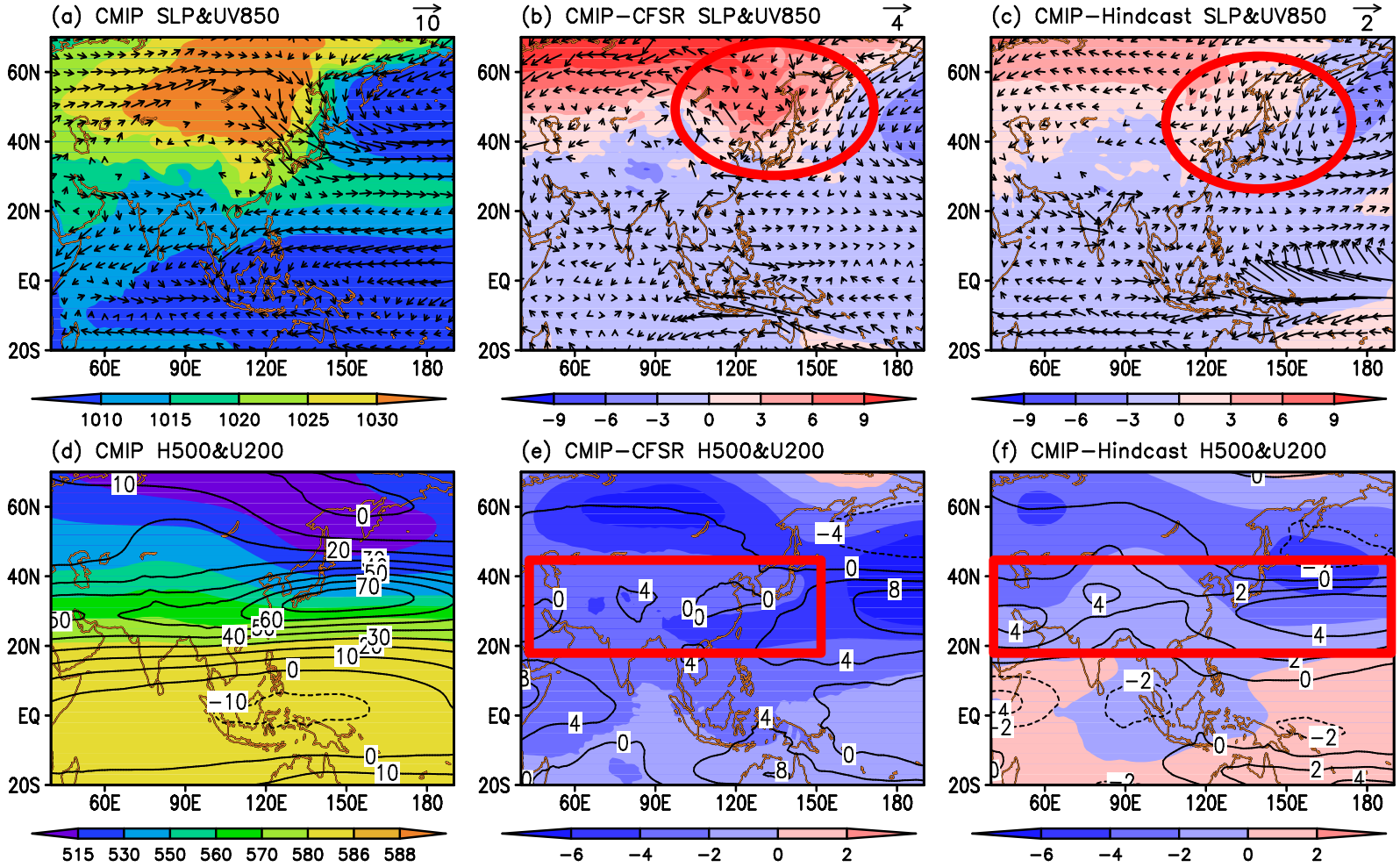
CMIP captures precipitation over the Maritime Continent

DJF SLP, H500, UV850, and U200 in AMIP



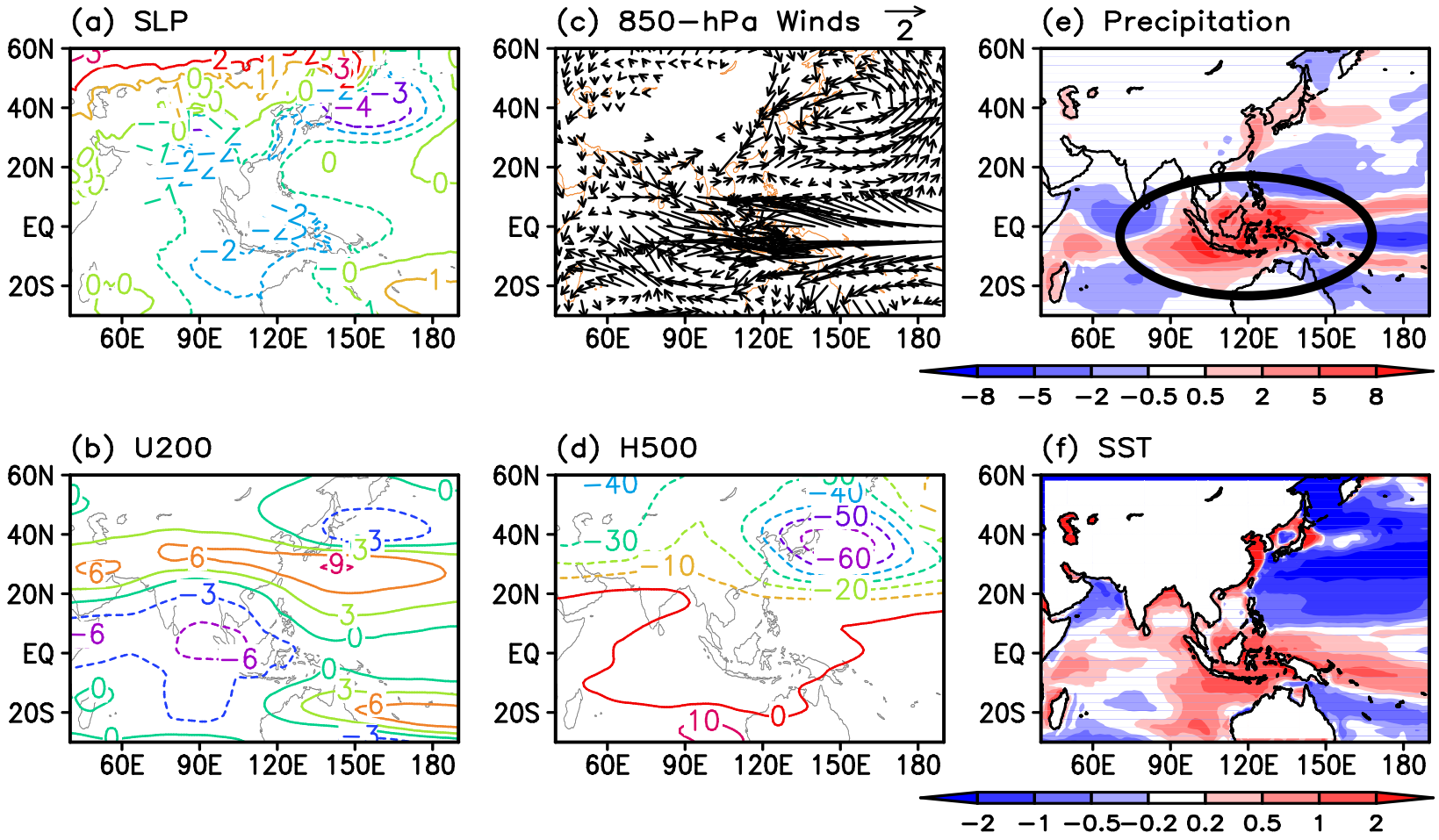
AMIP predicts weaker EAWM compared to either observation or hindcast

DJF SLP, H500, UV850, and U200 in CMIP



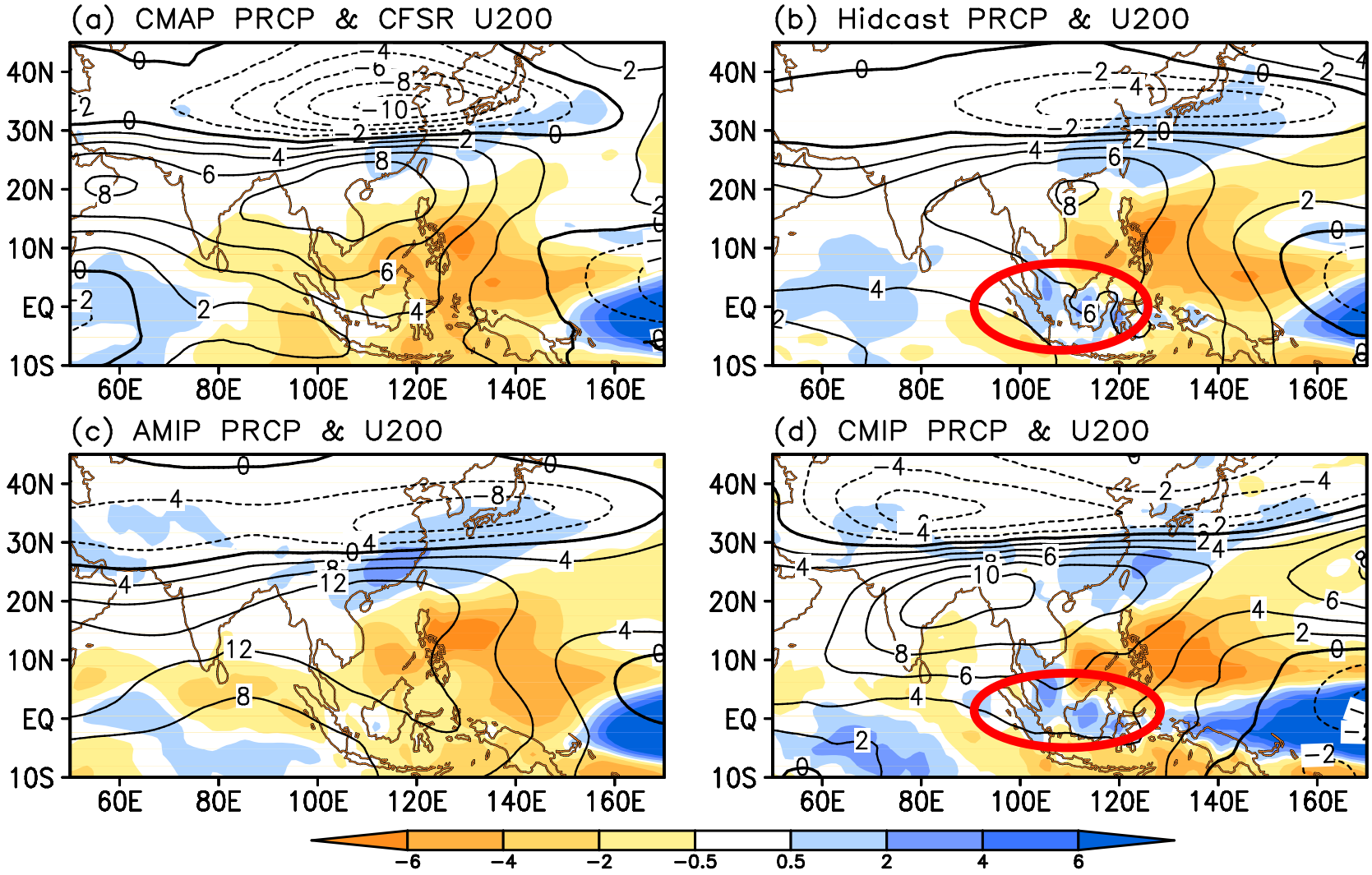
The weak EAWM in AMIP and hindcast are improved by CMIP

Diff. in the EAWM between CMIP and AMIP



Convection over the Maritime Continent is important for the prediction of EAWM

U200 and Precipitation (El Niño - La Niña)



More realistic convection over the Maritime Continent potentially enhance the prediction of EAWM

Summary

- Many ASM features are well predicted by the CFSv2. Several commonly-used dynamical monsoon indices and their associated precipitation and circulation patterns can be predicted several months in advance. The CFSv2 has better skill in predicting the Southeast Asian monsoon than predicting the South Asian monsoon.

- Compared to CFSv1, the CFSv2 has increased skill in predicting large-scale monsoon circulation and precipitation features but decreased skill for the South Asian monsoon, although some biases in the CFSv1 still exist in the CFSv2, especially the weaker-than-observed western Pacific subtropical high.

Summary

- Several major features of the EAWM are well predicted by the model. The EAWM related atmospheric circulation and surface climate over oceans is predicted well several months in advance, and are better than the prediction of the counterparts over land. The model has low skill in predicting the Arctic Oscillation. However, El Niño-Southern Oscillation (ENSO) and its impact on the EAWM can be predicted, which contributes to the decent prediction of the monsoon-related atmospheric components over oceans. Improving the simulation of the convection over the Maritime Continent potentially enhances the prediction of the EAWM in CFSv2.

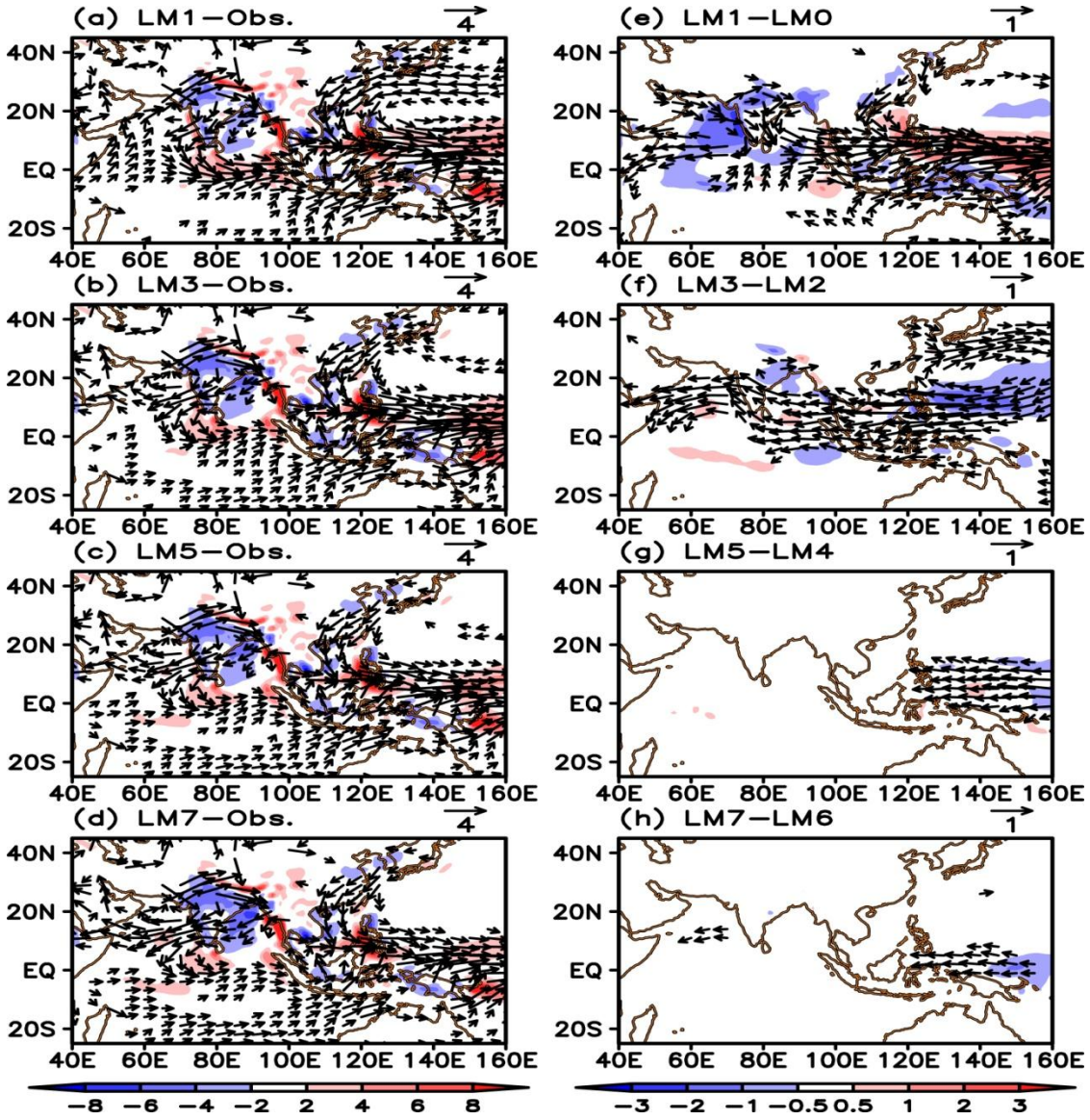
References

- Jiang, X., S. Yang, Y. Li, A. Kumar, X. Liu, Z. Zuo, and B. Jha, 2012a: Seasonal-to-interannual prediction of the Asian summer monsoon in the NCEP Climate Forecast System Version 2. *J. Climate*, conditionally accepted.
- Jiang, X., S. Yang, Y. Li, A. Kumar, W. Wang, and Z. Gao, 2012b: Dynamical prediction of the East Asian winter monsoon by the NCEP climate forecast system. *J. Geophys. Res.*, conditionally accepted.


Observation tower in the Tibetan Plateau

Welcome to Sichuan, China

Prediction Errors of 850-hPa Winds and Rainfall



Initial condition is important for the short time lead predictions

Rainfall and 850-hPa winds related to SA