Decadal Global Monsoon in CCSM3

[1]Hua Chen (chen@cola.iges.org), [1,2]Edwin K Schneider

1.George Mason University, VA; 2.Center for Ocean-Land-Atmosphere Studies, MD

1. Introduction

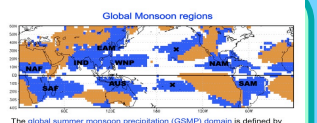
Motivation

- The observed global summer monsoon precipitation (GSMP) is dominated by the SST warming trend on decadal time scale: Wang et al. (2011) found GSMP had a predominant increasing trend on decadal time scale and was related to the warming SSTs in the global ocean except in the eastern Pacific.
- What is the intrinsic variability of global monsoon precipitation?

Model and Data

- Observation
  - Precip: 1979 to 2010 monthly CMAP
  - SST: 1979 to 2010 monthly ERSST
- Model
  - NCAR's coupled GCM: CCSM3, with constant external forcing, integrated for 300 model years
- A 7-year running mean is applied to all datasets before analyses.

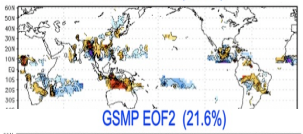
2. Observational Results



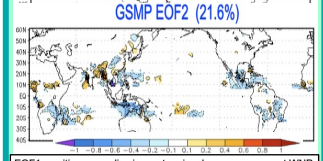
The global summer monsoon precipitation (GSMP) domain is defined by the local summer-minus-winter precipitation rate exceeding 2 mm/day and the local summer precipitation exceeding 55% of the annual total. The dry region is defined by the local summer precipitation less than 1 mm/day. (definition by Wang et al. 2011)

The local summer denotes May through September (MJJAS) for NH and November through March (NDJFM) for SH.

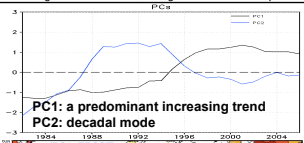
GSMP EOF1 (44.4%)



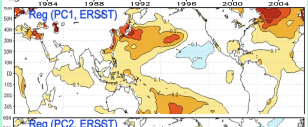
GSMP EOF2 (21.6%)

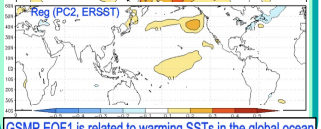


EOF1: positive anomalies in most regional monsoons except WNP, eastern part of SAF and southern part of NAM.
EOF2: negative anomalies in most regional monsoons except IND.



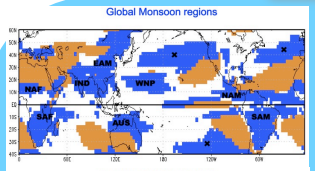
PC1: a predominant increasing trend
PC2: decadal mode



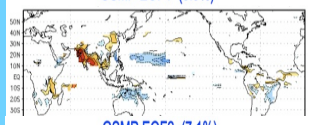


GSMP EOF1 is related to warming SSTs in the global ocean except in the eastern Pacific.

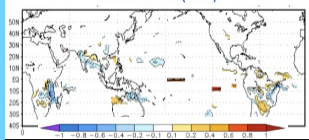
3. Model Results



GSMP EOF1 (8.9%)

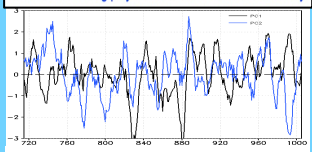


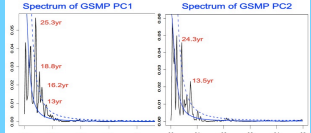
GSMP EOF2 (7.1%)



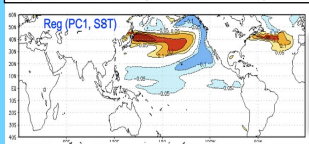
Different from obs., the magnitudes of both EOFs are reduced, the anomalies are uneven among regional monsoons. EOF1 has larger anomalies in IND.

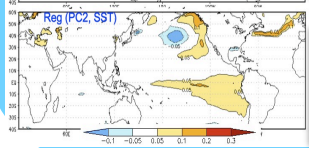
The external forcing play a role in GSMP decadal variability.





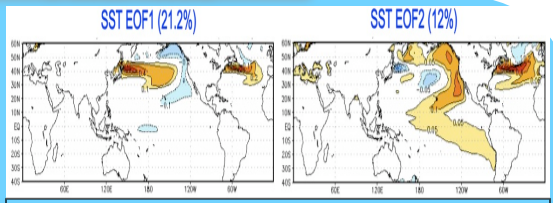
The period of GSMP leading modes is within 13-25yr band.



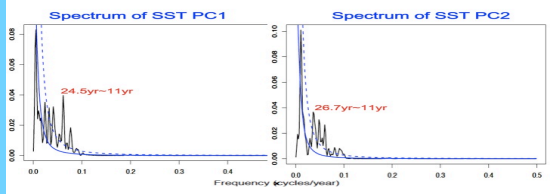


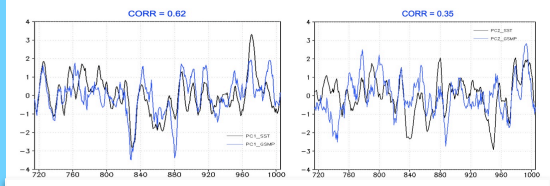
GSMP EOF1 is related to the decadal mode of SST in North Pacific and North Atlantic.

GSMP EOF2 is related to the tropical eastern Pacific, western coast of North America, and North Atlantic.



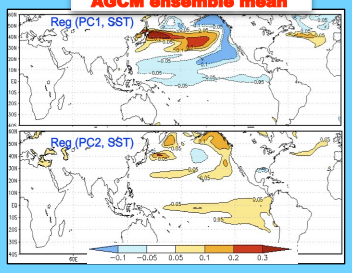
SST EOF1: strong positive anomalies in North Pacific and North Atlantic, negative anomalies near western coast of North America.
SST EOF2: positive anomalies in North Atlantic and western coast of North America.





SST PC1 and GSMP PC1 are highly correlated simultaneously.
SST PC2 and GSMP PC2 are positively correlated simultaneously.
→ SST forces the GSMP decadal variability.

AGCM ensemble mean



The ensemble mean of AGCMs forced by the same SST produces the SST forced response. The similarity with CGCM results suggests the GSMP decadal modes are primarily forced by SST.

4. Conclusions

1. In observation, GSMP EOF1 shows a predominant increasing trend, related to the warming SSTs in global ocean except the eastern Pacific.
2. The reduced magnitudes of GSMP EOFs and the uneven anomalies among regional monsoons in CCSM3 indicate that external forcing plays a role in the GSMP decadal variability. GSMP mode may not exist in the internal variability.
3. In CCSM3, GSMP EOF1 is highly related to SST EOF1 in North Pacific and North Atlantic. GSMP EOF2 is related to SST EOF2 in the North Atlantic and western coast of North America.
4. Without external forcing, the GSMP decadal variability in CCSM3 is primarily forced by the SST leading modes.