수문기후연구실

근지표면 온도 예측성이 가뭄 계절적 예보에 미치는 영향: 미국의 사례연구

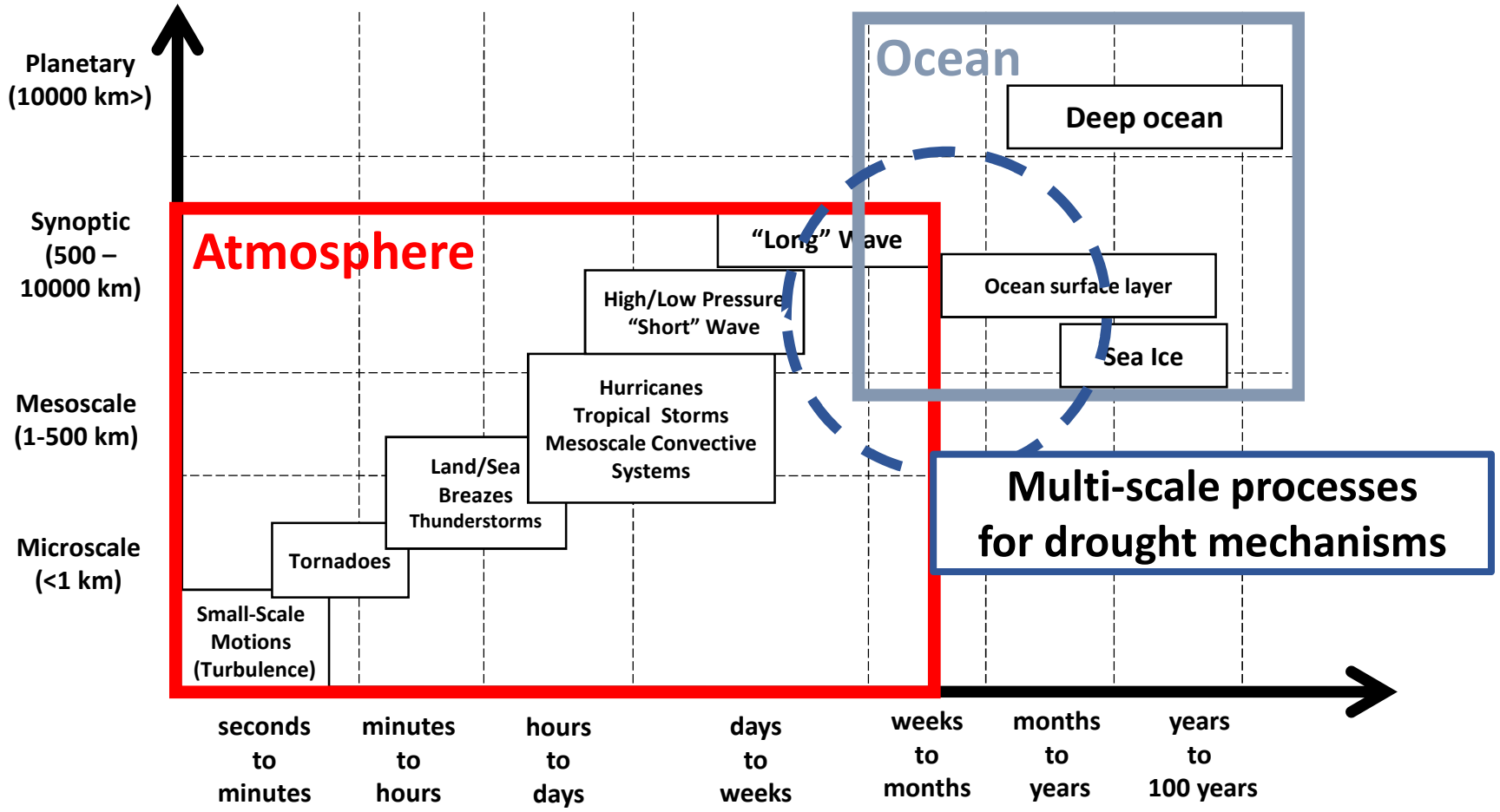
감종훈

포항공과대학교 환경공학부

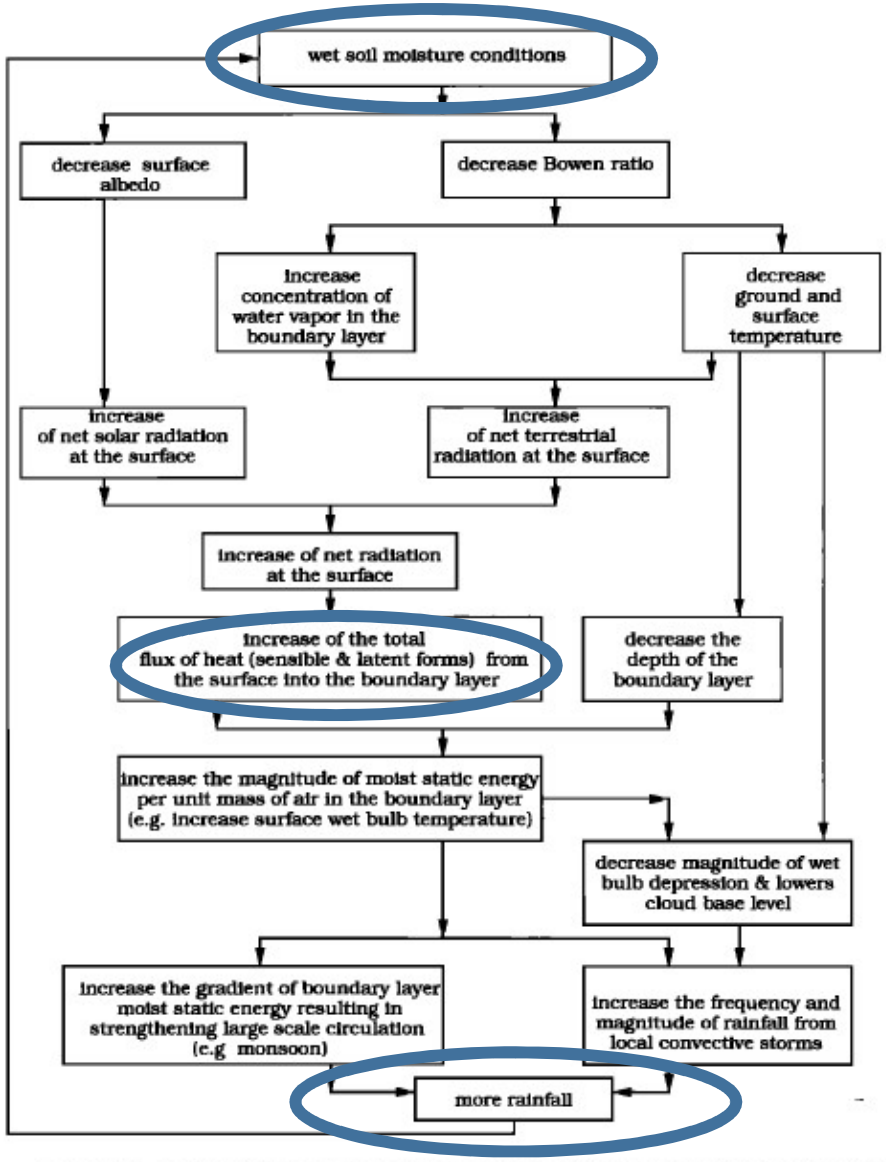
2021년 5월 11일
APCC 기후예측워크숍

Drought mechanisms: multi-scale processes

- Drought is one of **the least understood** natural hazards due to complexity of the generating mechanisms.



Land-atmospheric coupling: Soil moisture-rainfall Feedback



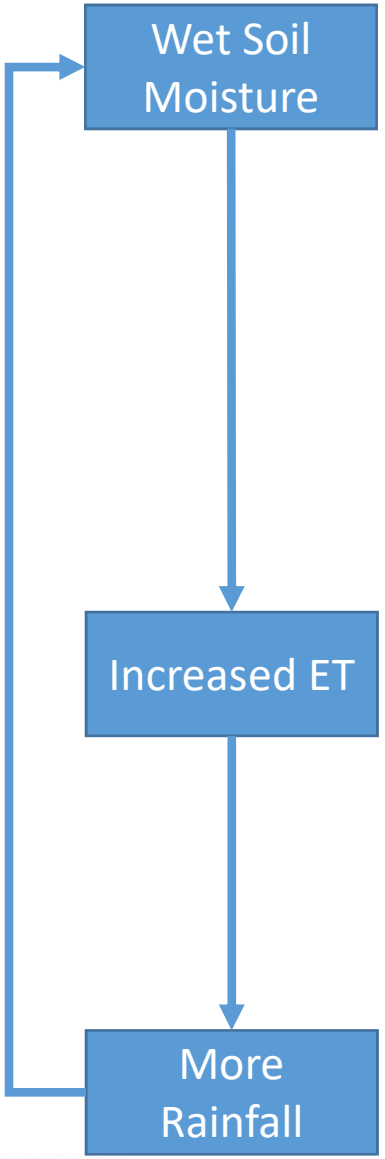


Figure 2. The proposed hypothesis for relating soil moisture conditions and subsequent rainfall processes.

Eltahir et al. 1998, WRR

Temperature-precipitation coupling in summer

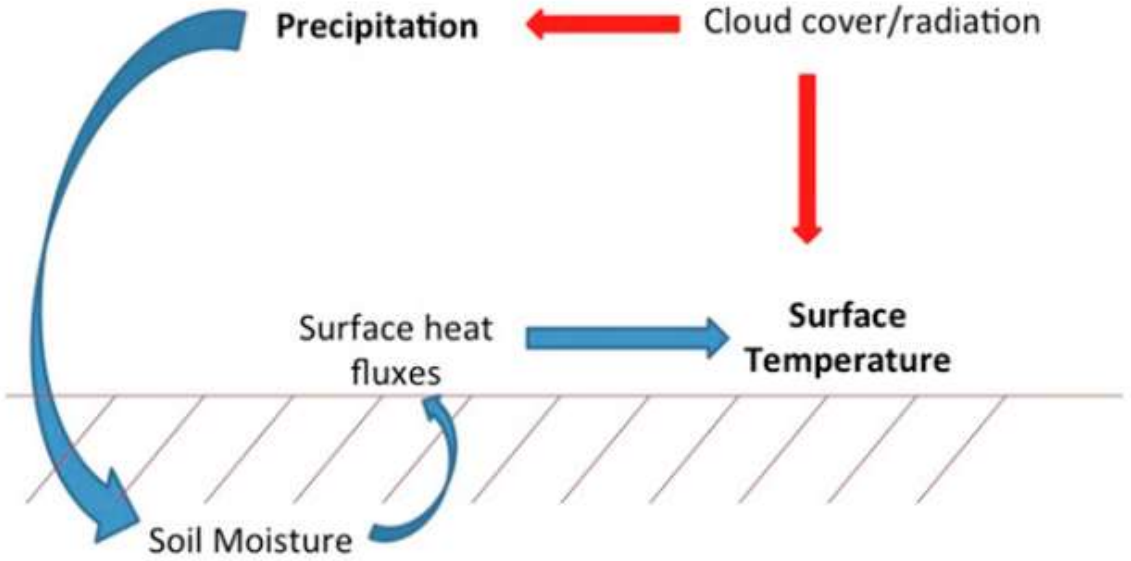
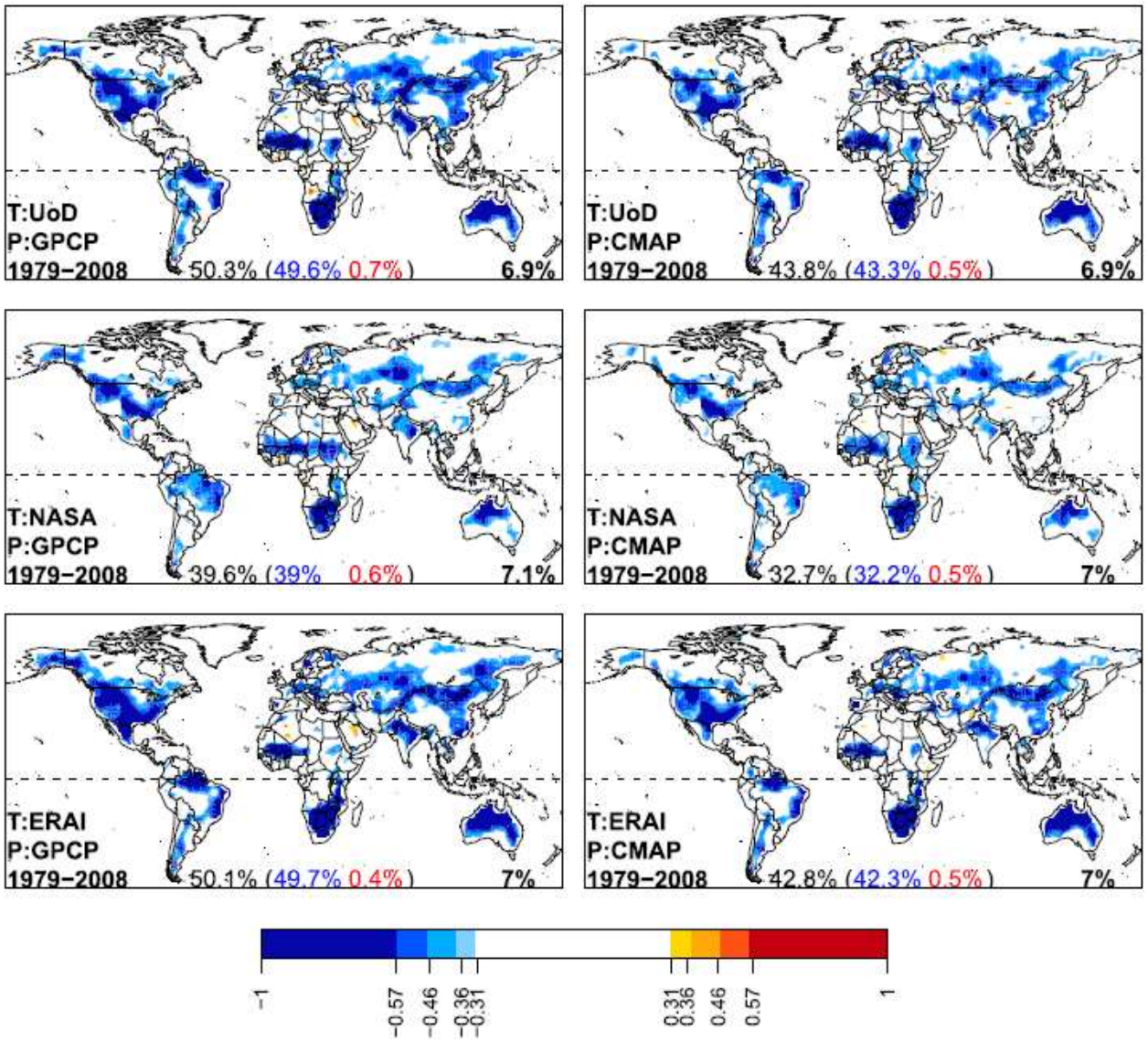


FIG. 2. Simplified representation of two pathways through which correlations between seasonal mean temperature and precipitation can occur in summer: red for atmospheric processes and blue for land–atmosphere interactions. Note that in the interest of clarity, not all physical relationships are depicted here (e.g., impacts of temperature on soil moisture and feedbacks of surface fluxes to cloud cover are not represented).

Berg et al. 2014, JClim

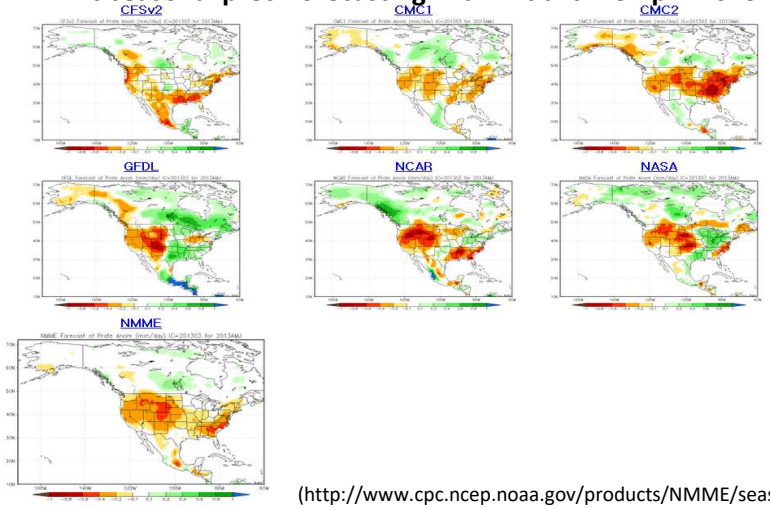
Observed pattern of temperature-precipitation coupling in summer



Berg et al. 2014, JClim

North America Multi-Model Ensemble (NMME) Project

AMJ seasonal prec. forecasting with initial time April 2013



(http://www.cpc.ncep.noaa.gov/products/NMME/seasanom.shtml)

- NMME Project

A multi-institutional collaborative seasonal forecasting system.

- Data:

Summertime (June-August) Forecasts of air temperature at 2 meter (T2m) and precipitation PREC at one month lead (Initial Month: May) over 1982-2020

ID	Model Name	Full Model Name	Description/Organization	Climatiology	Ensemble size
1	CCSM3	COLA-RSMAS-CCSM3	National Center for Atmospheric Research	1982-2010	6
2	CCSM4	COLA-RSMAS-CCSM4		1982-2010	10
3	CFSv2	NCEP-CFSv2	National Center for Environmental Prediction	1982-2010	24
4	CM21	GFDL-CM2p1-aer04	Geophysical Fluid Dynamics Laboratory	1982-2010	10
5	CM25A	GFDL-CM2p5-FLOR-A06		1982-2010	12
6	CM25B	GFDL-CM2p5-FLOR-B01		1982-2010	12
7	CanCM3	CMC1-CanCM3	Canadian Meteorological Centre	1982-2010	10
8	CanCM4	CMC2-CanCM4		1981-2010	10
9	GMAO	NASA-GMAO-062012	NASA Global Modeling and Assimilation Office	1981-2010	11

Using individual ensemble forecasts of nine NMME models

- Anomaly Calculation:

$$F'_n(s,j) = F_n(s,j) - \{F_{EM}(s)\} \quad \text{Eqn. 1}$$

,where s is the index of a grid point (e.g., s =1, 2, …, 1,072 (14,522) for PREC and T2m (SST)), j is the year index (j =1982, 1983, …, 2012), and n is the index of an ensemble member of one model. $F_{EM}(\cdot)$ depicts the ensemble mean of one model and $\{\cdot\}$ is the mean over 1982-2010.

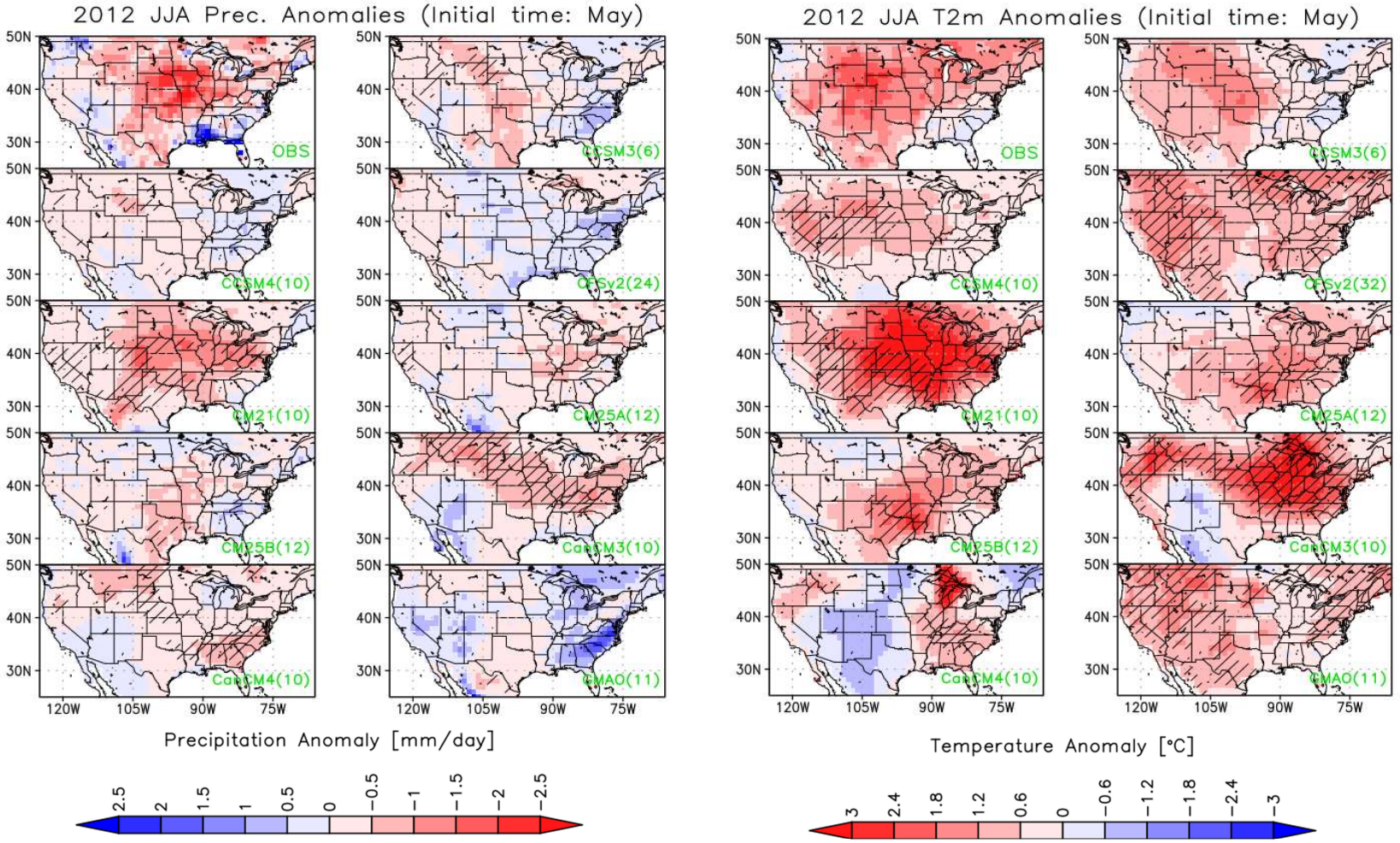
- Anomaly Correlation Coefficient (ACC) for 1982-2012:

$$ACC_n = \frac{\sum_s \sum_j \frac{w_S X'(s,j) Y'(s,j)}{W}}{\left[\sum_s \sum_j \frac{w_S X'(s,j)}{W}\right]^2 \left[\sum_s \sum_j \frac{w_S Y'(s,j)}{W}\right]^2} \quad \text{Eqn. 2}$$

- Spatial Anomaly Correlation Coefficient (SACC) for a specific year(J):

$$SACC_n(J) = \frac{\sum_s \frac{w_S X'(s,J) Y'(s,J)}{W}}{\left[\sum_s \frac{w_S X'(s,J)}{W}\right]^2 \left[\left[\sum_s \frac{w_S Y'(s,J)}{W}\right]\right]^2} \quad \text{Eqn. 3}$$

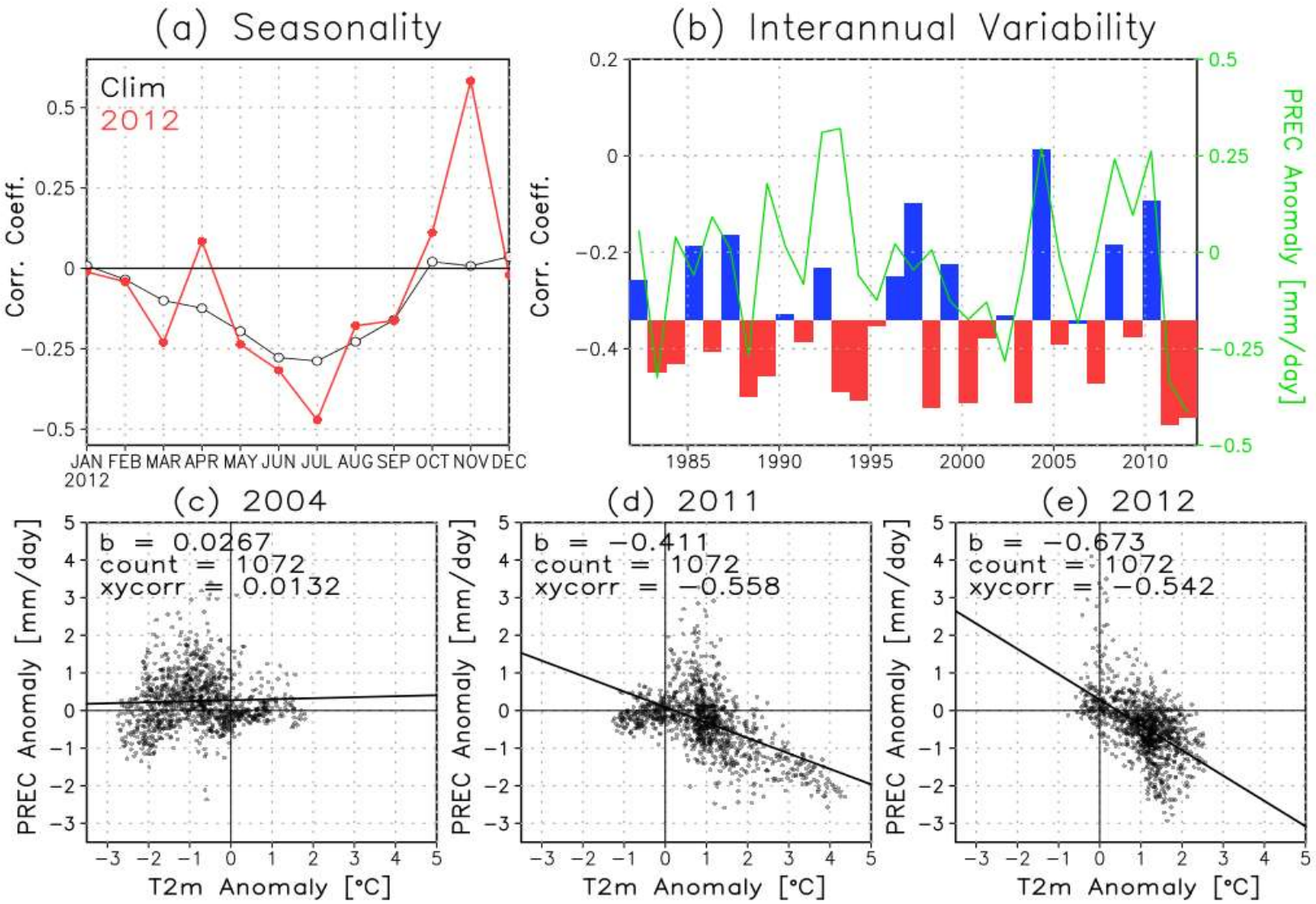
Does the skillful prediction of T2m help the prediction of PREC?



Kam et al. ERL (2021)

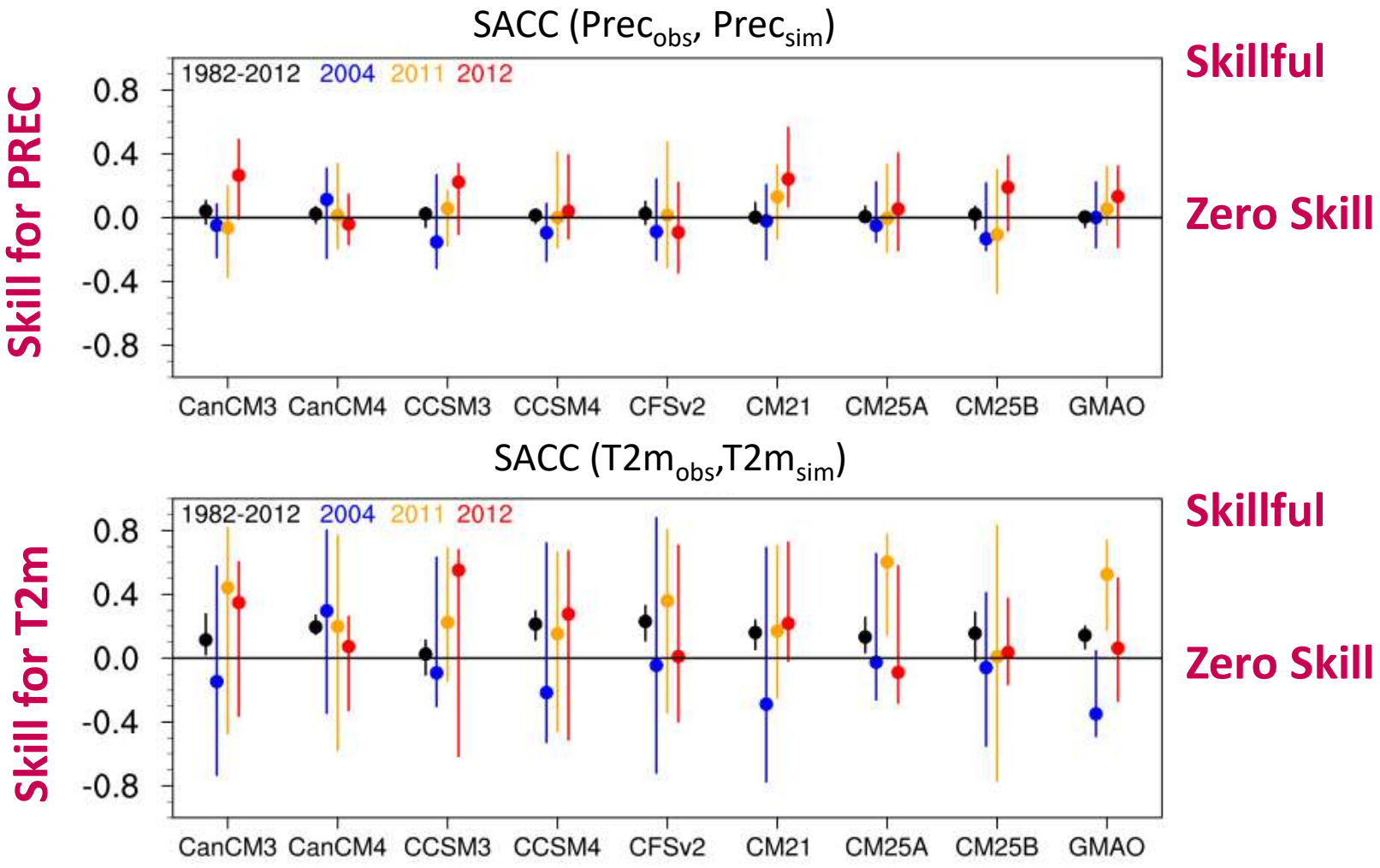
- CM21 CanCM3 show strong extensive high anomalies of T2m and PREC.
- The model update doesn't guarantee the improved prediction skill (CSMs and CanCMs)

Seasonality and interannual variability of land-atmospheric coupling



Kam et al. ERL (2021)

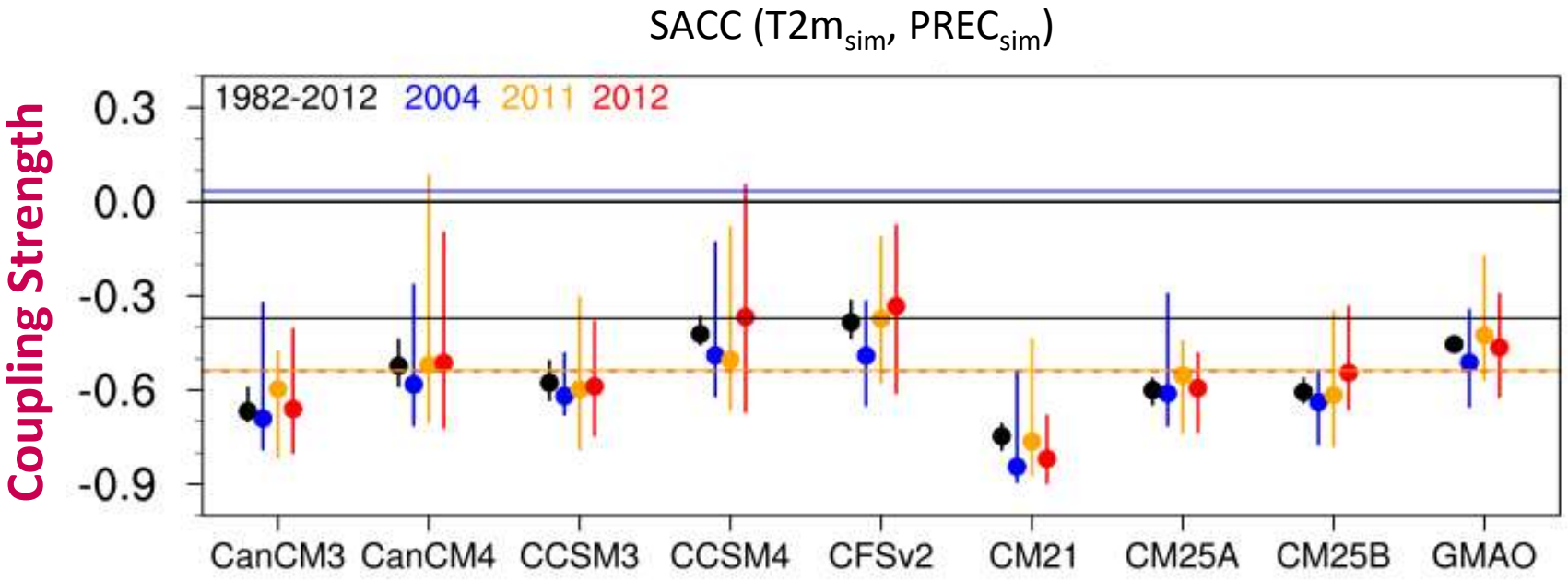
NMME prediction skills are not for T2m and PREC



- NMME prediction skills are year-dependent and model-dependent.
- The prediction skill for T2m show a stronger influence of initial conditions than the prediction skill for PREC.

Kam et al. ERL (2021)

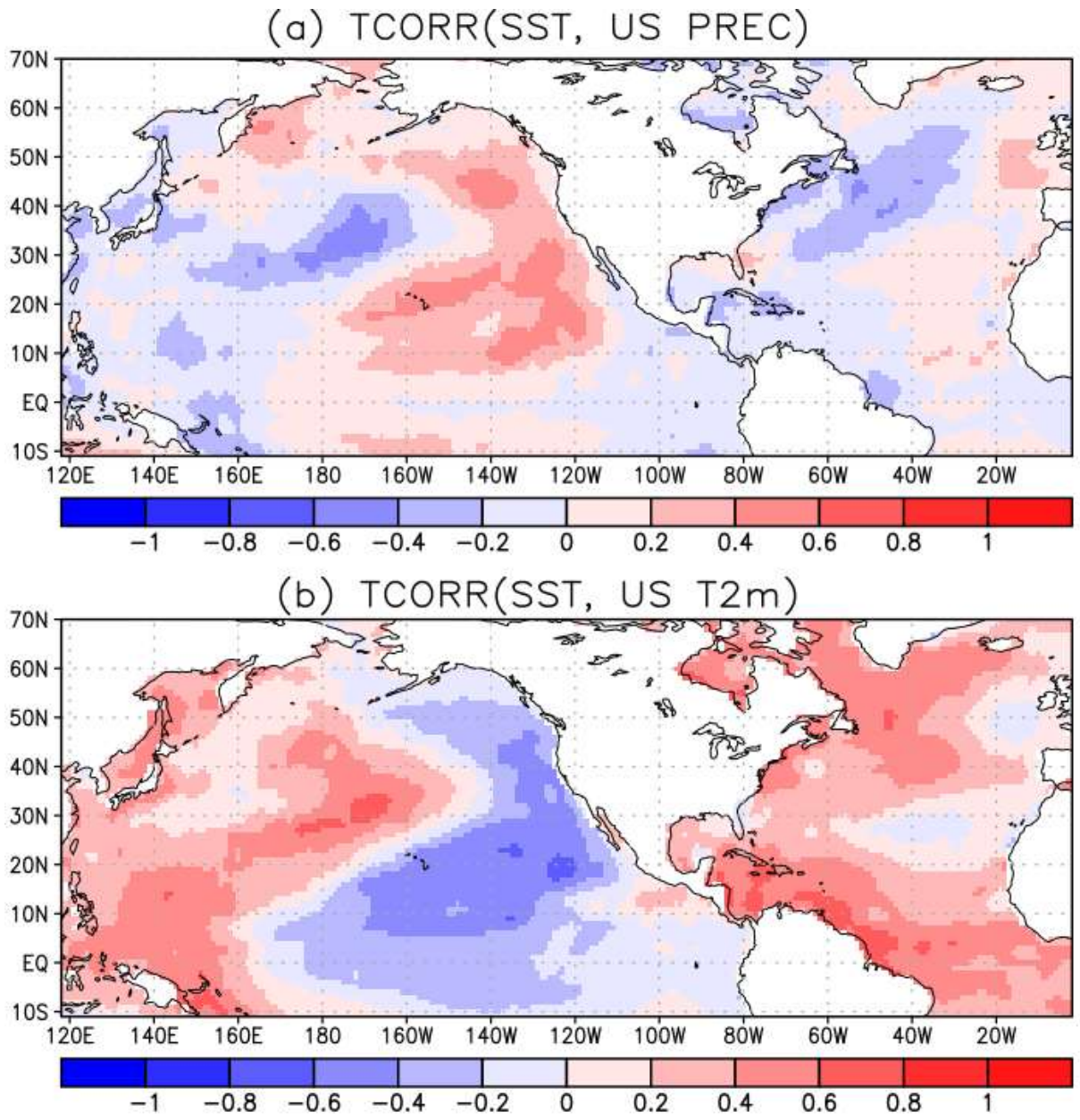
Strong Land-Atmospheric coupling in NMME models.



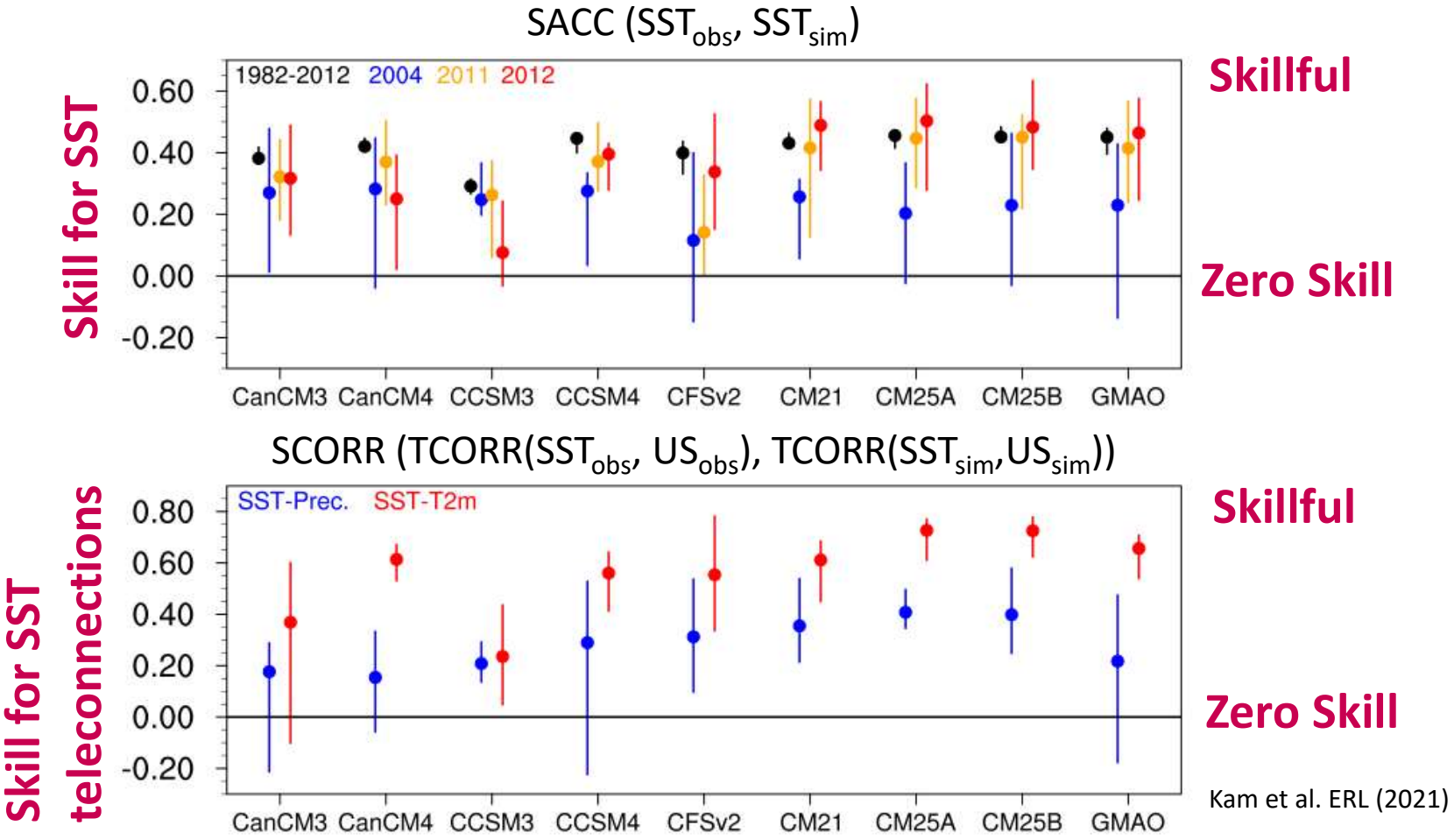
- Over 1982-2012, the observational data show strong T2m-PREC coupling (black solid line).
- In dry years, the T2m-PREC coupling was stronger (orange line (2011) and red line (2012)) while it was weaker in a wet year (2004).
- Over 1982-2012, the NMME models show a weak influence of initial conditions on the coupling strength.
- Most of the NMME models show a weak interannual variability of the T2m-PREC coupling.

Kam et al. ERL (2021)

Observed SST teleconnections with US climate



Prediction Skills for SSTs are Promising!

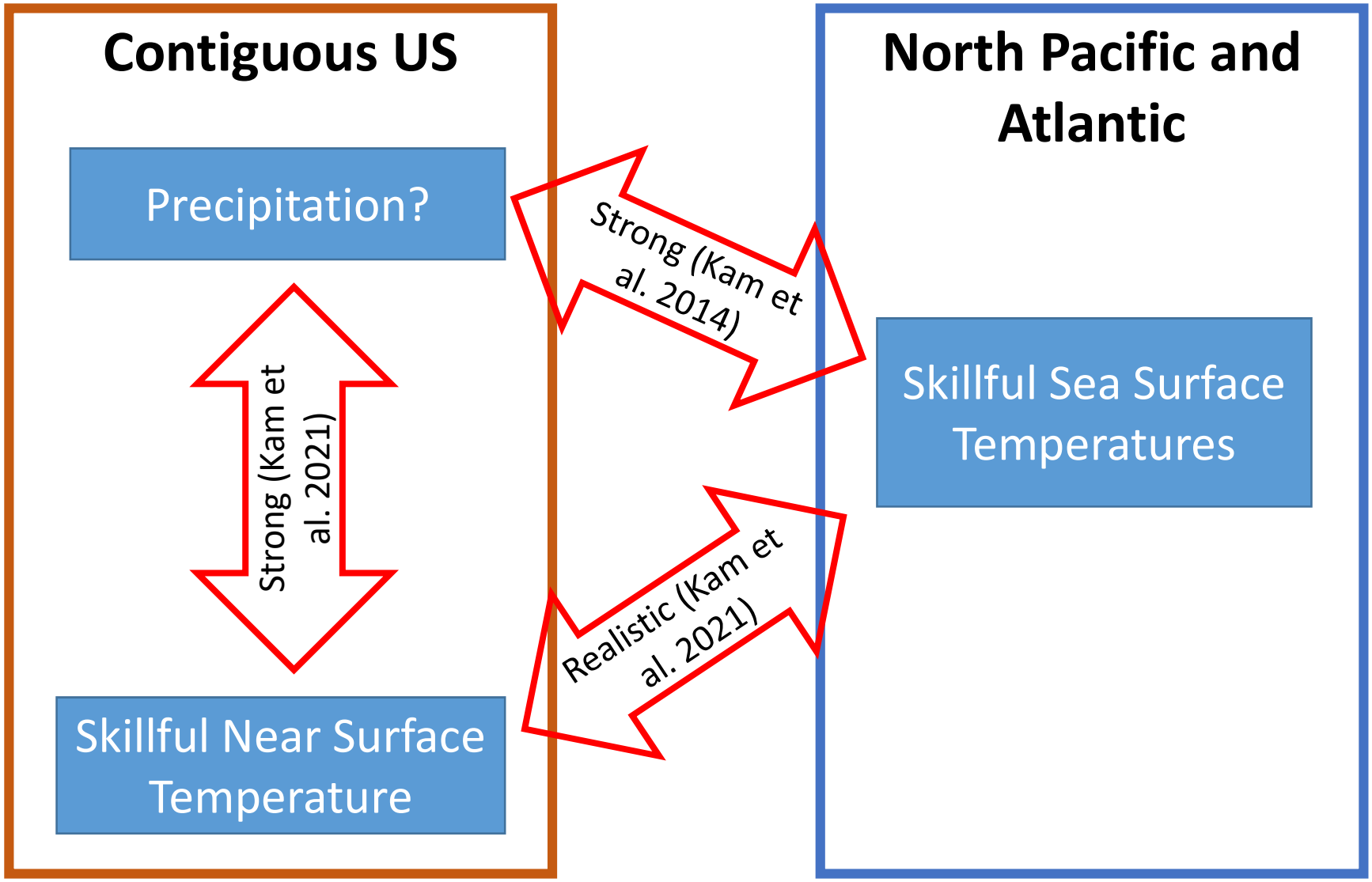


Kam et al. ERL (2021)

- Over 1982-2012, the NMME prediction skills are skillful.
- Some NMME models show a realistic spatiotemporal patterns of SST teleconnections with T2m and PREC while their patterns with T2m are more realistic.

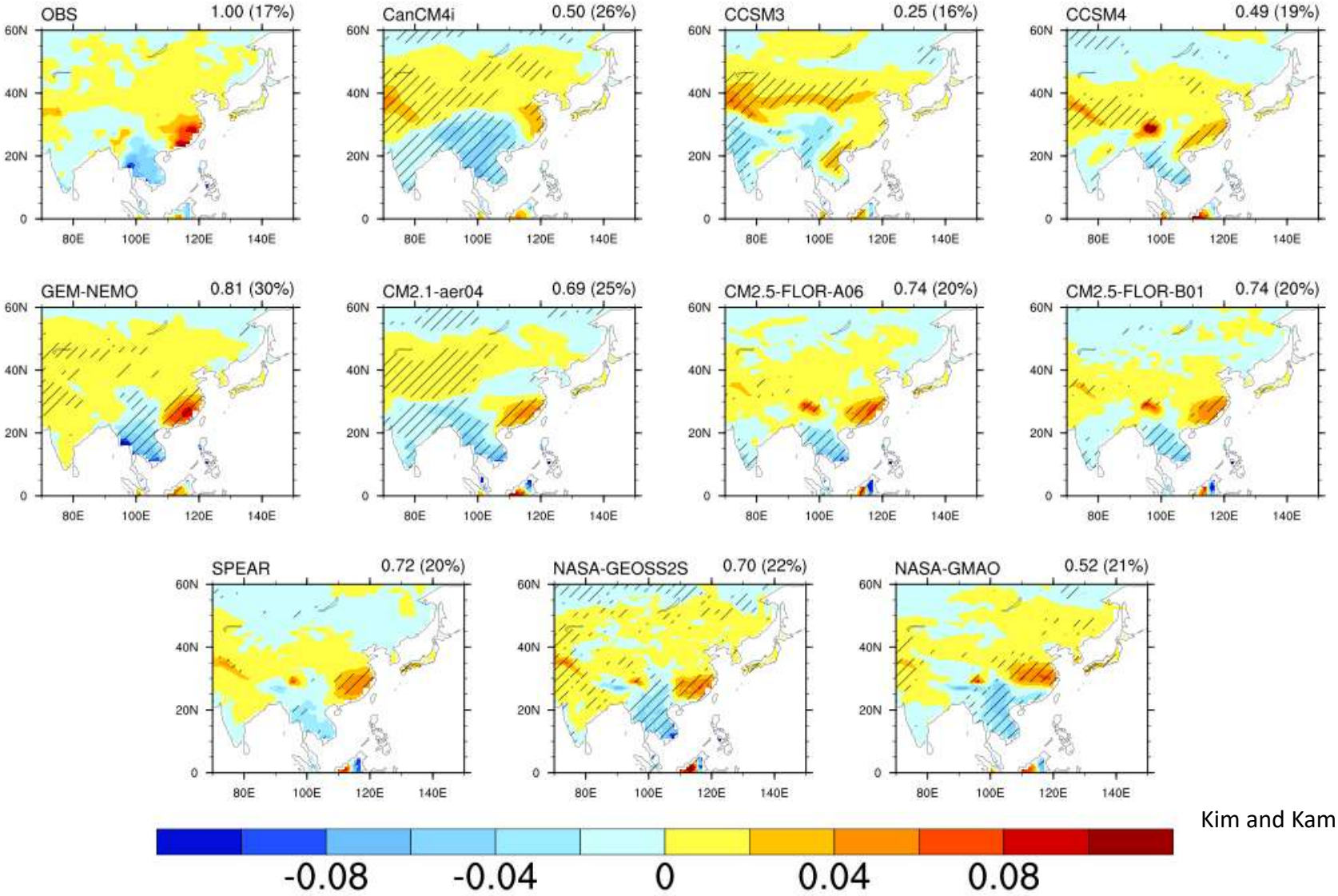
Representation of Sea-Land-Atmosphere Interactions

Focusing on the successful prediction of CM21 for the 2012 US drought,



Discussion: Potential Application of NMME to East Asia Droughts

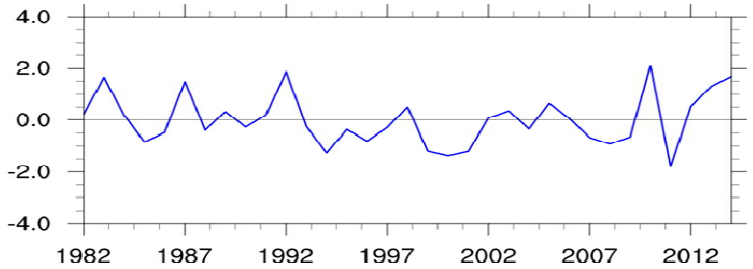
EOF 1 mode of MAM precipitation (1982-2014)



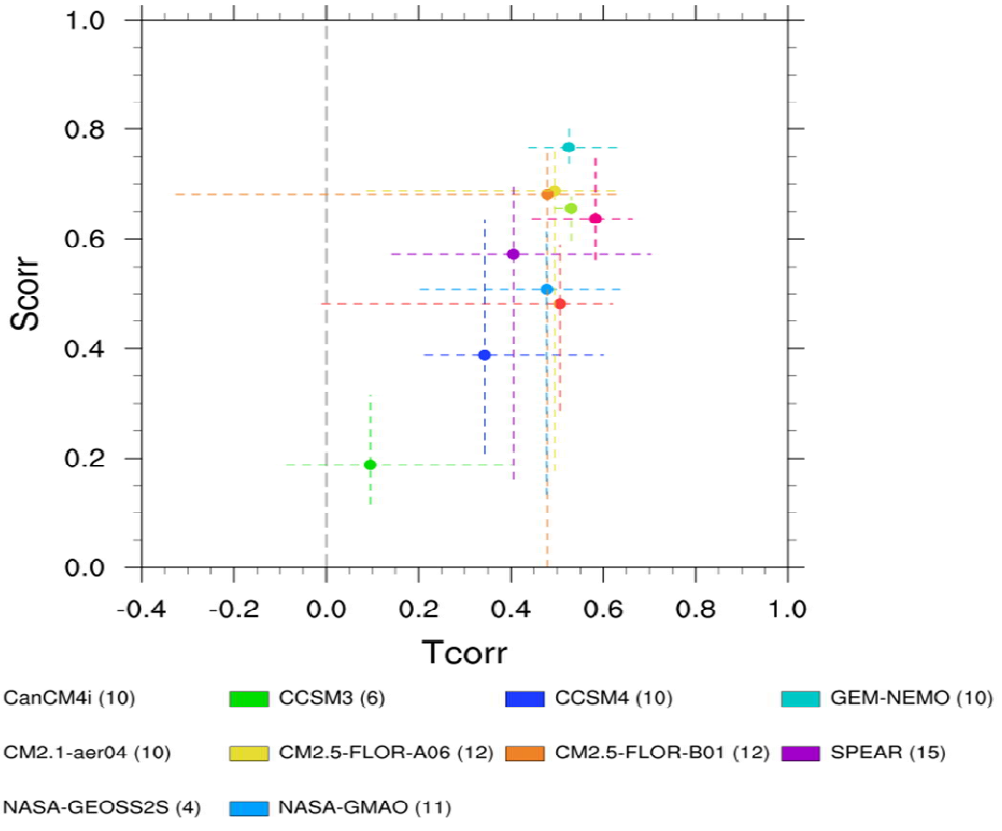
Kim and Kam (*in prep.*)

NMME: SST is a potential source for MAM precipitation over East Asia

(a) PC1 of OBS



(b) Performance of NMME



Kim and Kam (*in prep.*)

Conclusion

Prediction skill of near-surface temperature is still year-dependent and model-dependent.

NMME models show a strong bias in summertime LA coupling (T2m-PREC).

SST is still reliable source for the improvement of the prediction skill of US summertime climate at the sub-seasonal time scale (one lead month).

Questions?

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