Realistic land initialization impacts in JMA operational seasonal prediction system (+ implications of pre-ILSTSS2S experiment)

Yuhei Takaya

Meteorological Research Institute
Japan Meteorological Agency

Acknowledgement: Prof. Yongkang Xue, Dr. Ismaila Diallo

Outline

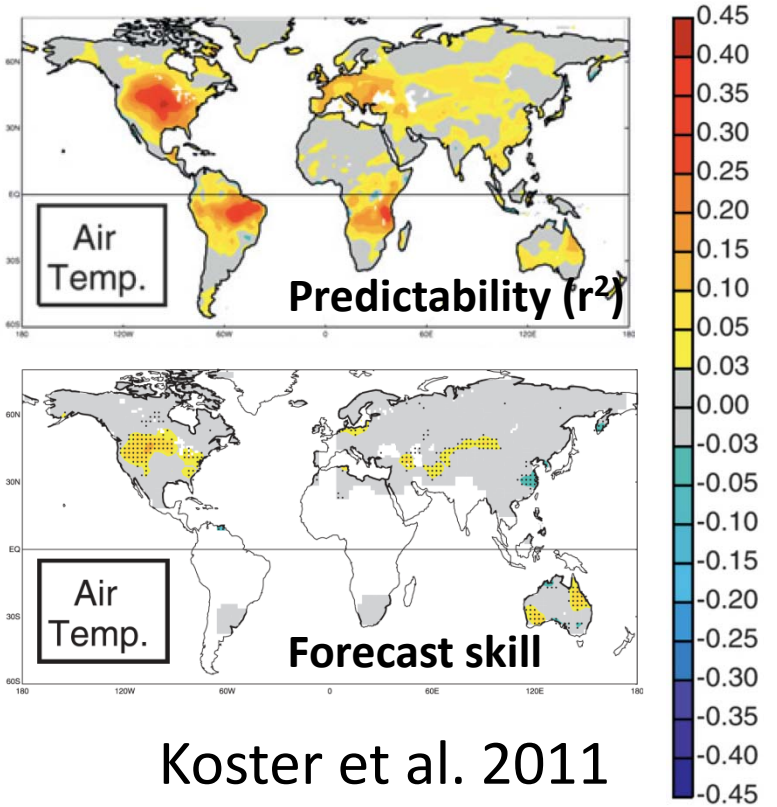
- Backgrounds
- Assessments of the land-related potential predictability and predictive skill gains
- Model errors of Asian summer monsoon and Himalayas-Tibetan Plateau topography: implications of the ILSTSS2S experiment
- Summary

Backgrounds

Numerous previous studies found that the land has a significant contribution to the (potential) predictability in subseasonal to seasonal time scales.

BUT…

Actual skill gains by realistic land initialization are rather limited than expected.



Koster et al. 2011

Scientific questions and challenges

- How well do state-of-the-art S2S prediction systems initialize/represent the land processes?
- What do impede prediction systems to gain benefits from the land initialization?

Assessments of the land-related potential predictability and predictive skill gains

GPC Tokyo (since 2007)

Source: LC-LRFMME

Consistent land initialization in JMA/MRI-CPS2

Inconsistency of land parameters in the land initialization often causes model drifts and biases.

In the JMA system, the land component in the seasonal prediction system is same as in-house reanalysis products used to initialize the land component.

* The model still presents some drifts due to climatological difference between the reanalysis and forecast model.

Takaya et al. (2018) Clim. Dyn.

Land initialization sensitivity experiment

Experiment	Land A	Land C
Land Initial Condition	JRA-55 Land Analysis	Climatology (1981-2010) of JRA-55 Land Analysis

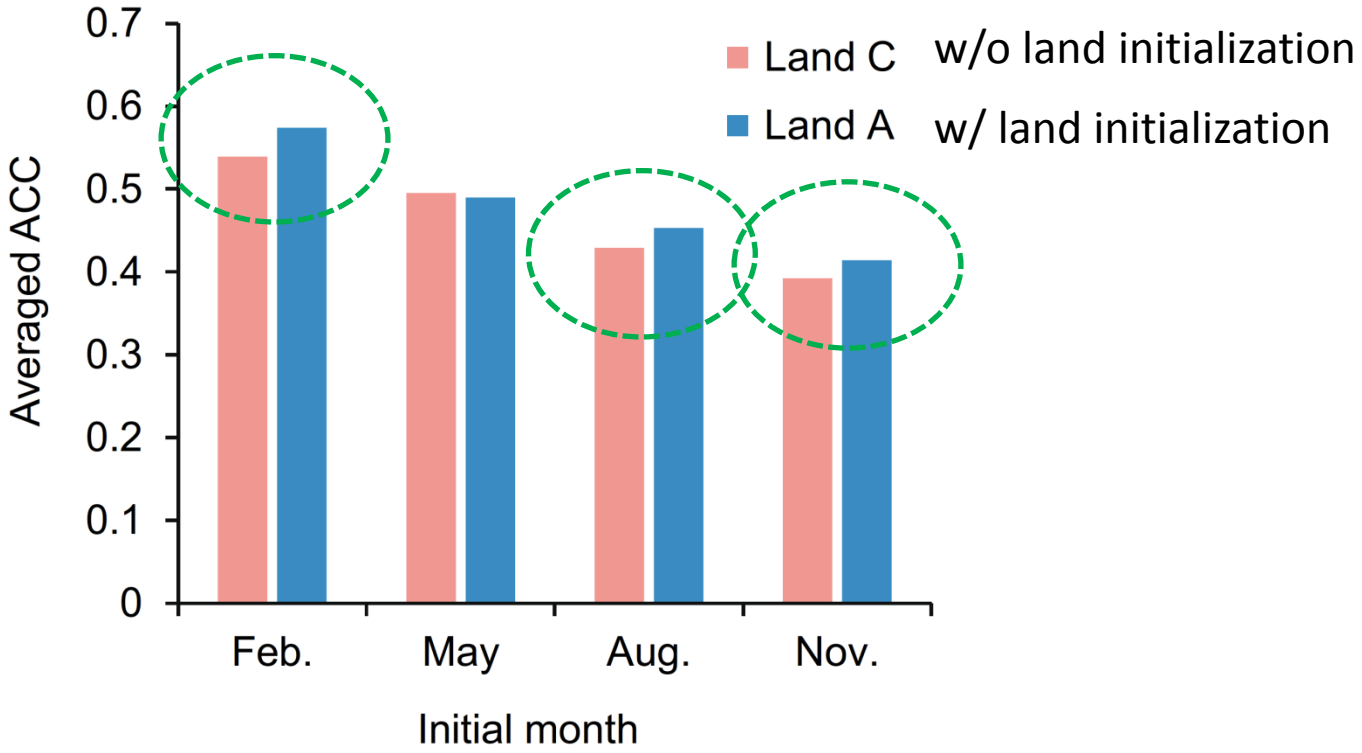
Experimental period: 1981-2010
Ensemble size: 10

Question:
How do the potential predictability and actual skills change with the realistic land initialization?

Takaya et al. (2018, Clim. Dyn.)

Skill gains

Improvements of correlation skills (averages over land)
with the land initialization.
(1-month averaged 2-m temperature with a 0-month lead)

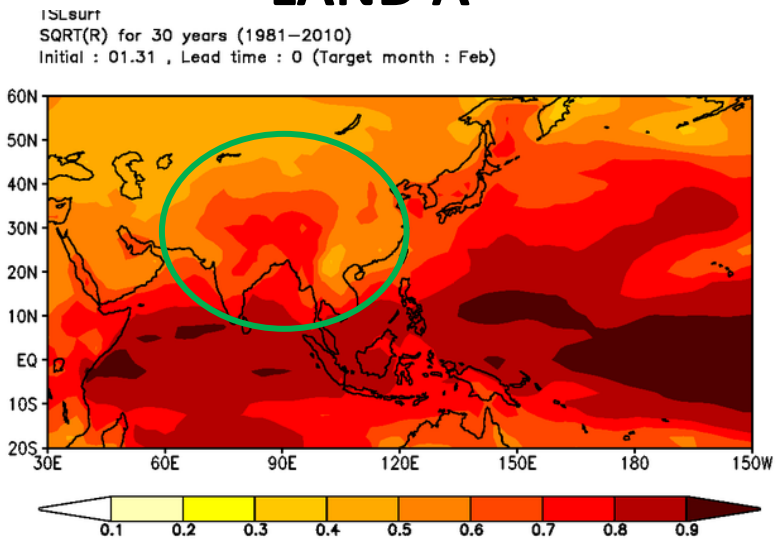


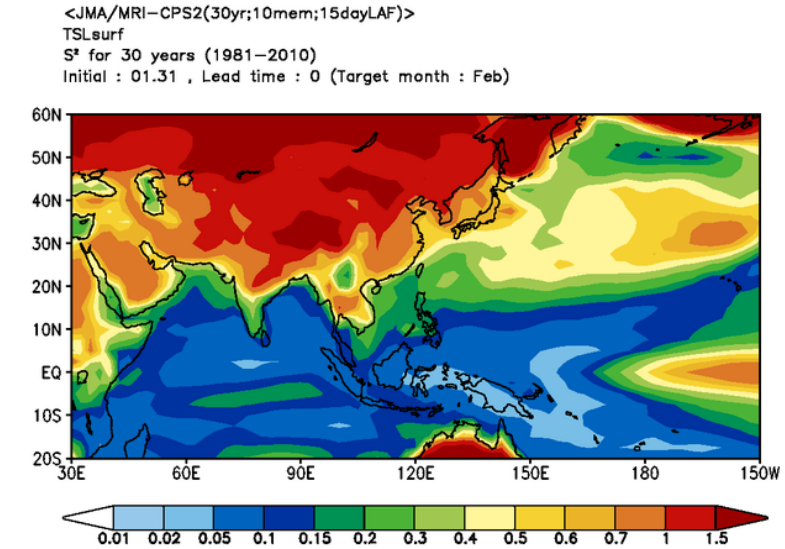
The latest operational system gains some skills from the realistic land initialization.

Takaya et al. (2018) Clim. Dyn.

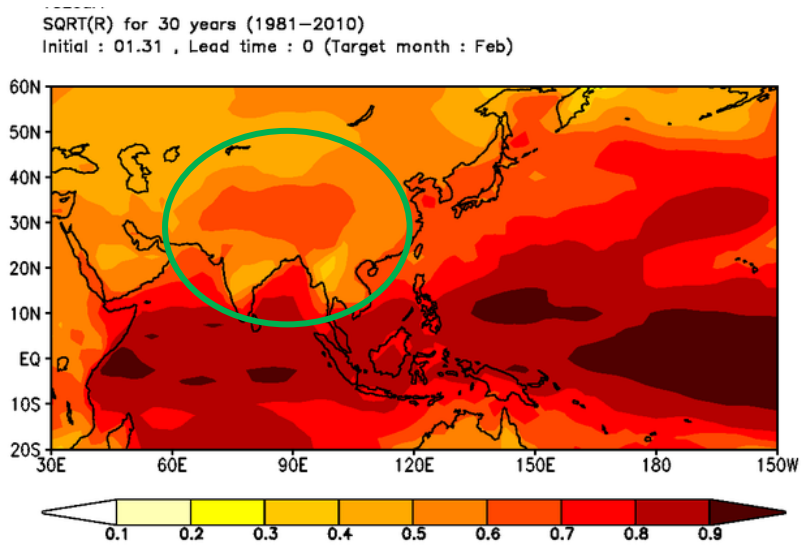
Impacts on T2m potential predictability (1st month)

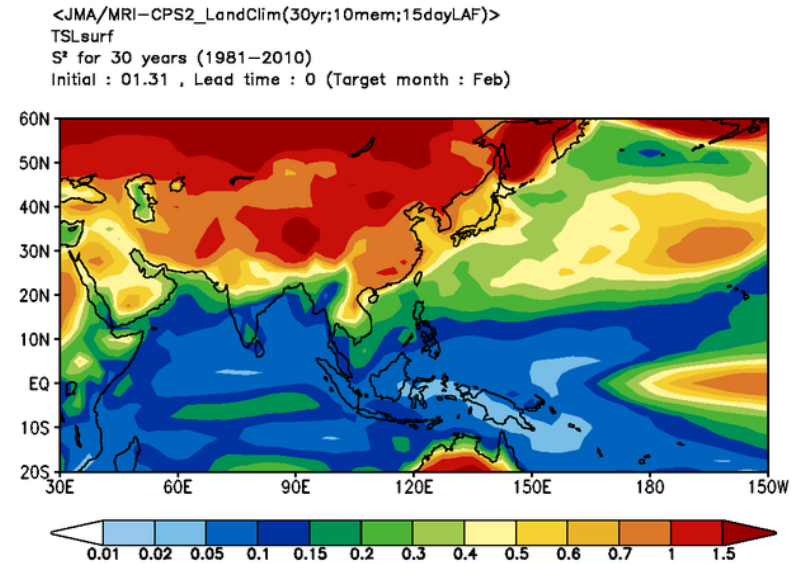
LAND A





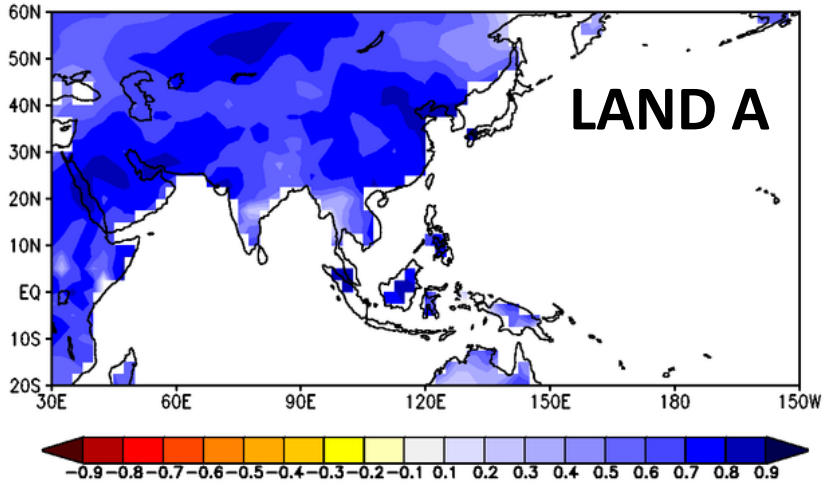
LAND C

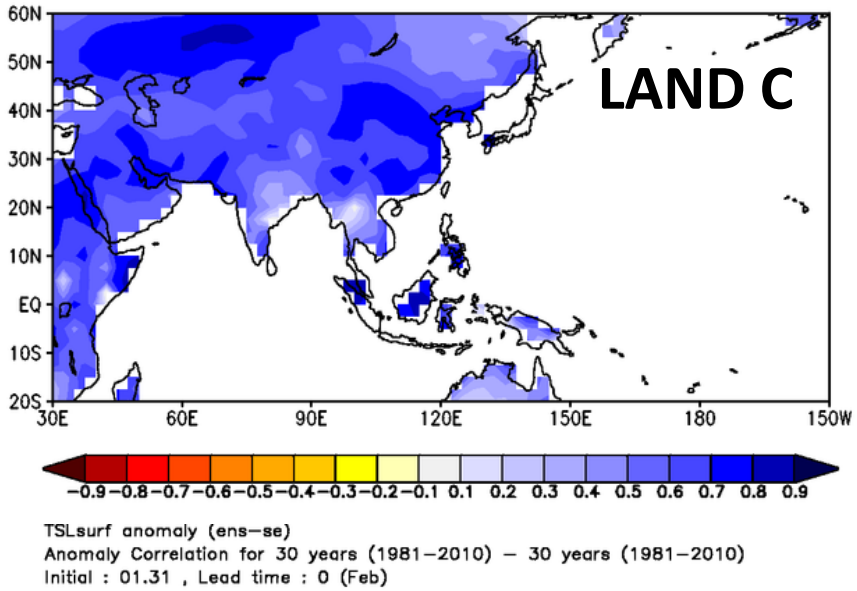




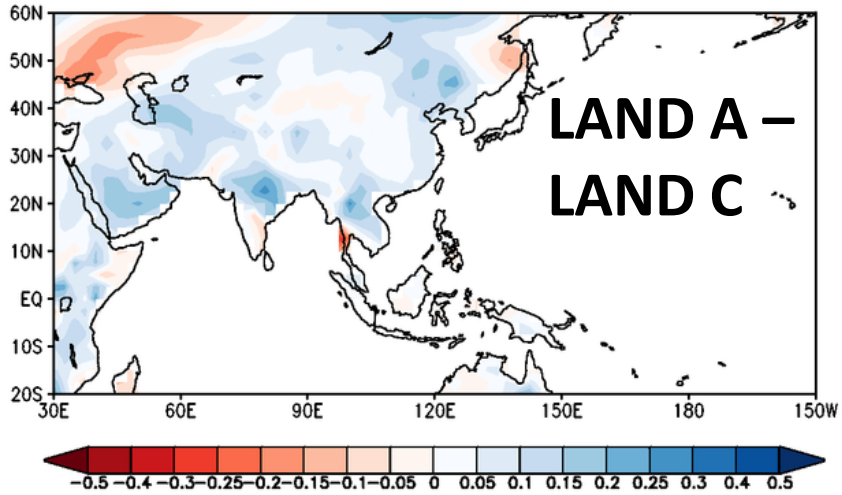
Impacts on T2m predictive skill (1st month)

Correlation skills of February-mean T2m with 0-month lead



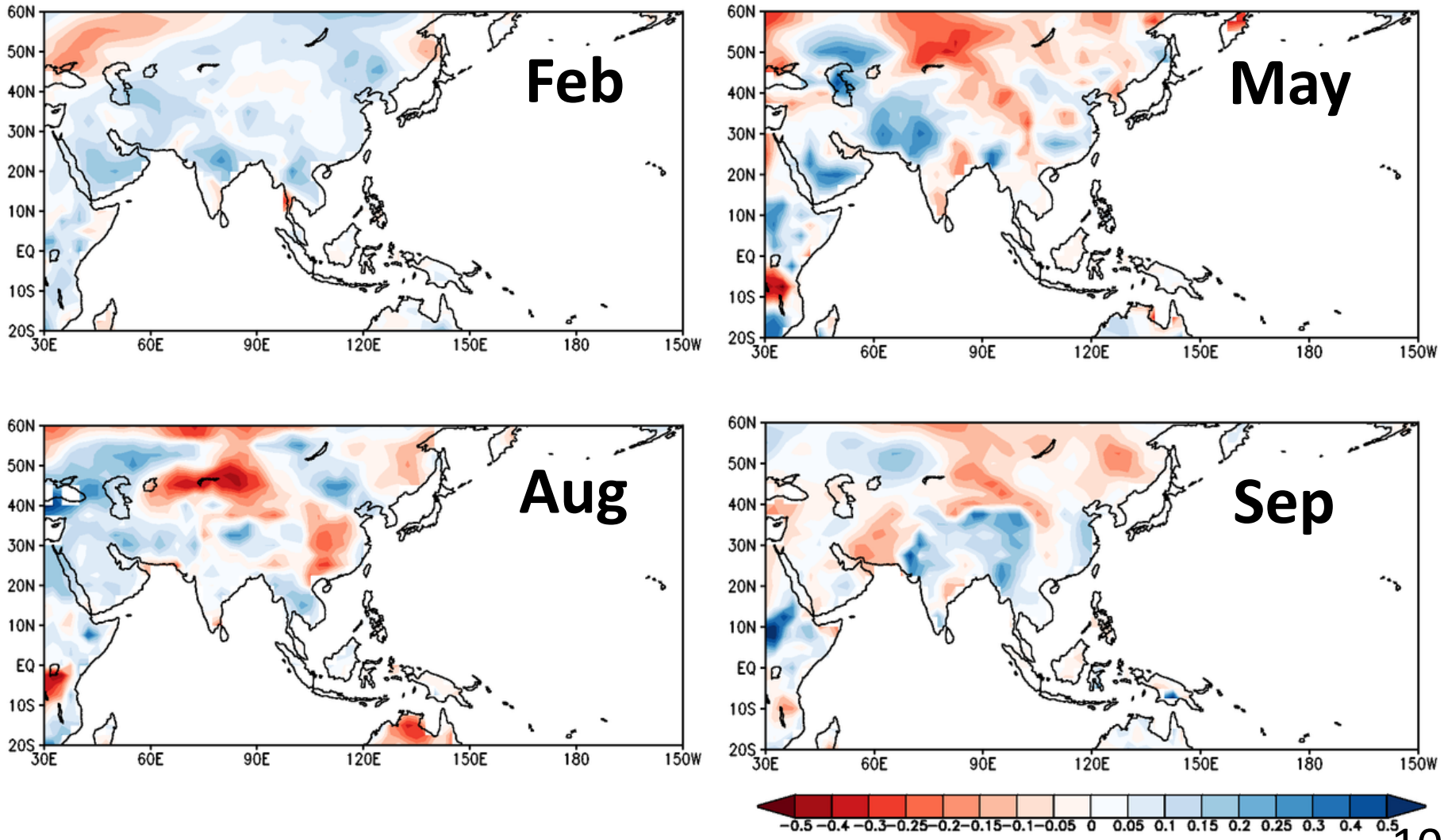


This kind of research is only possible with high consistency between a land model and analysis. Our system provide research opportunity.



Impacts on T2m predictive skill (1st month)

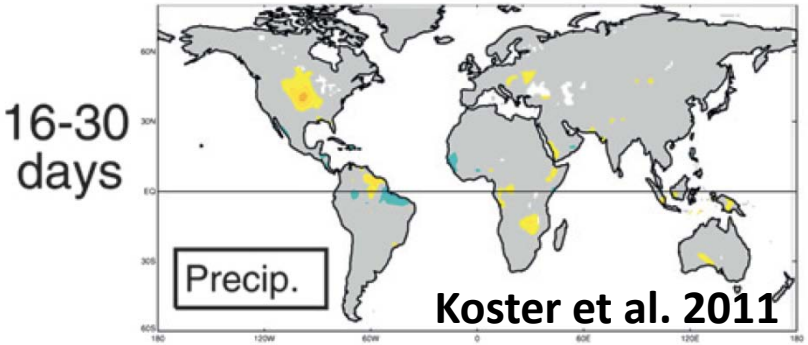
CC of T2m (LAND A –LAND C)

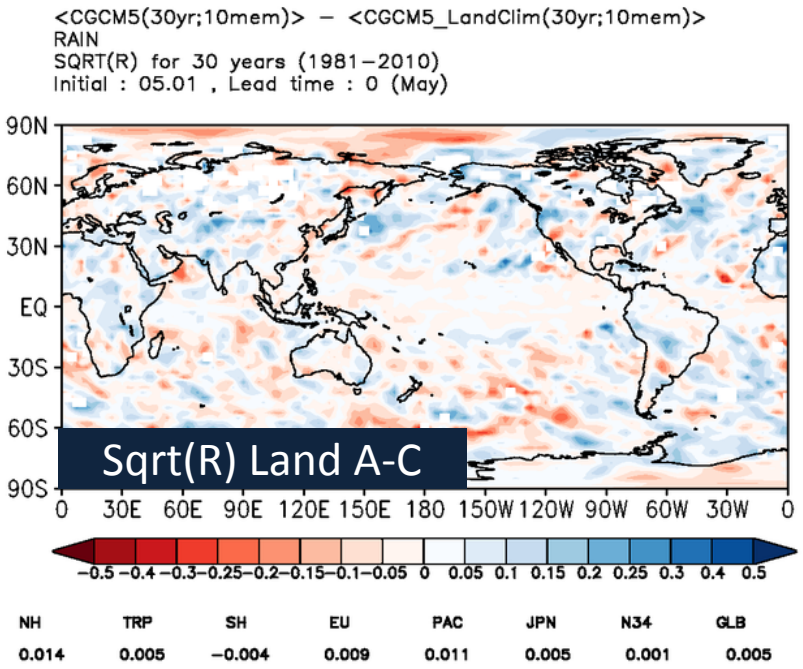


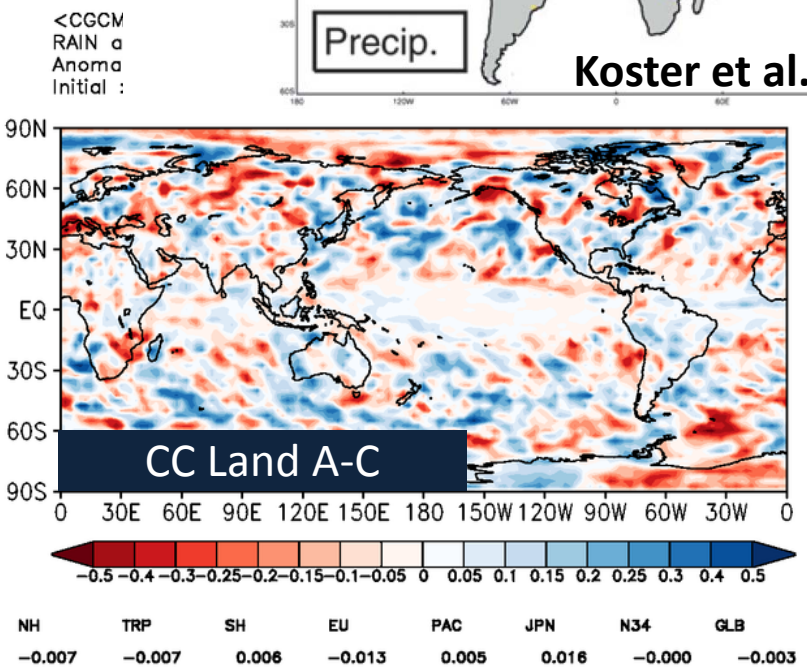
Needs of multi-model coordinated experiments

To evaluate the land impacts, coordinated multi-model studies are required. In particular, precipitation impacts are hard to identify with single model results.

Precipitation (May initial, Land A-C)



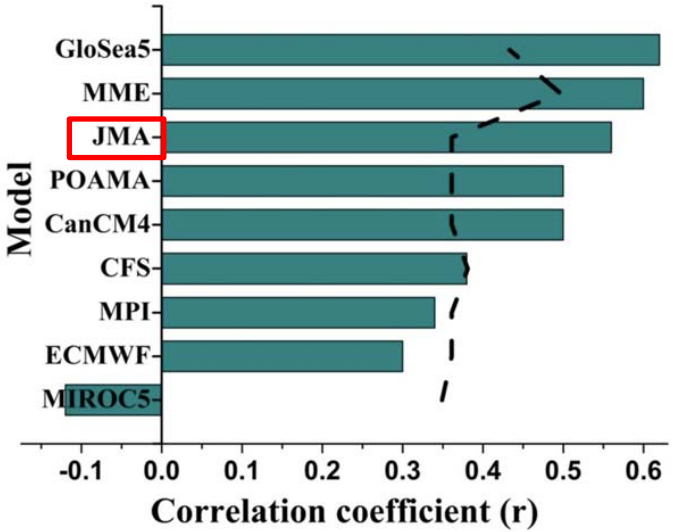


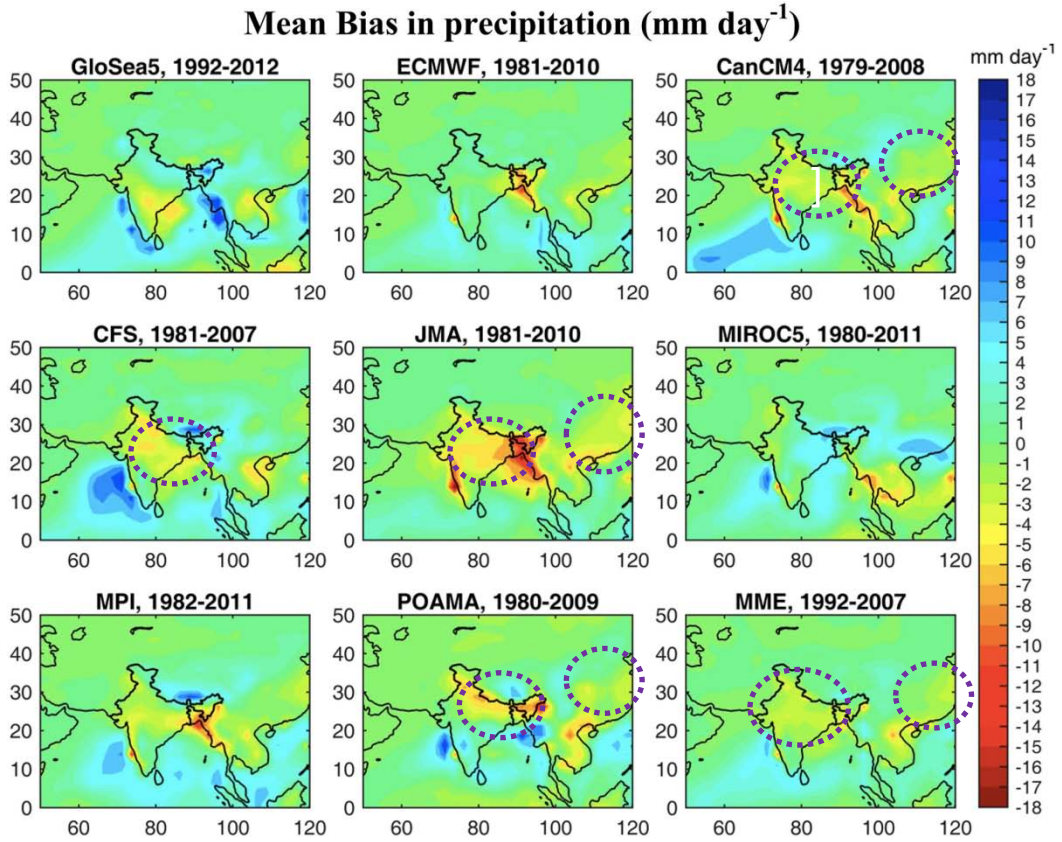


Model errors of Asian summer monsoon and Himalayas-Tibetan Plateau topography: implications from pre-ILSTSS2S experiment

Precipitation predictive performance of JMA/MRI-CPS2

Indian ranfall temporal correlation score



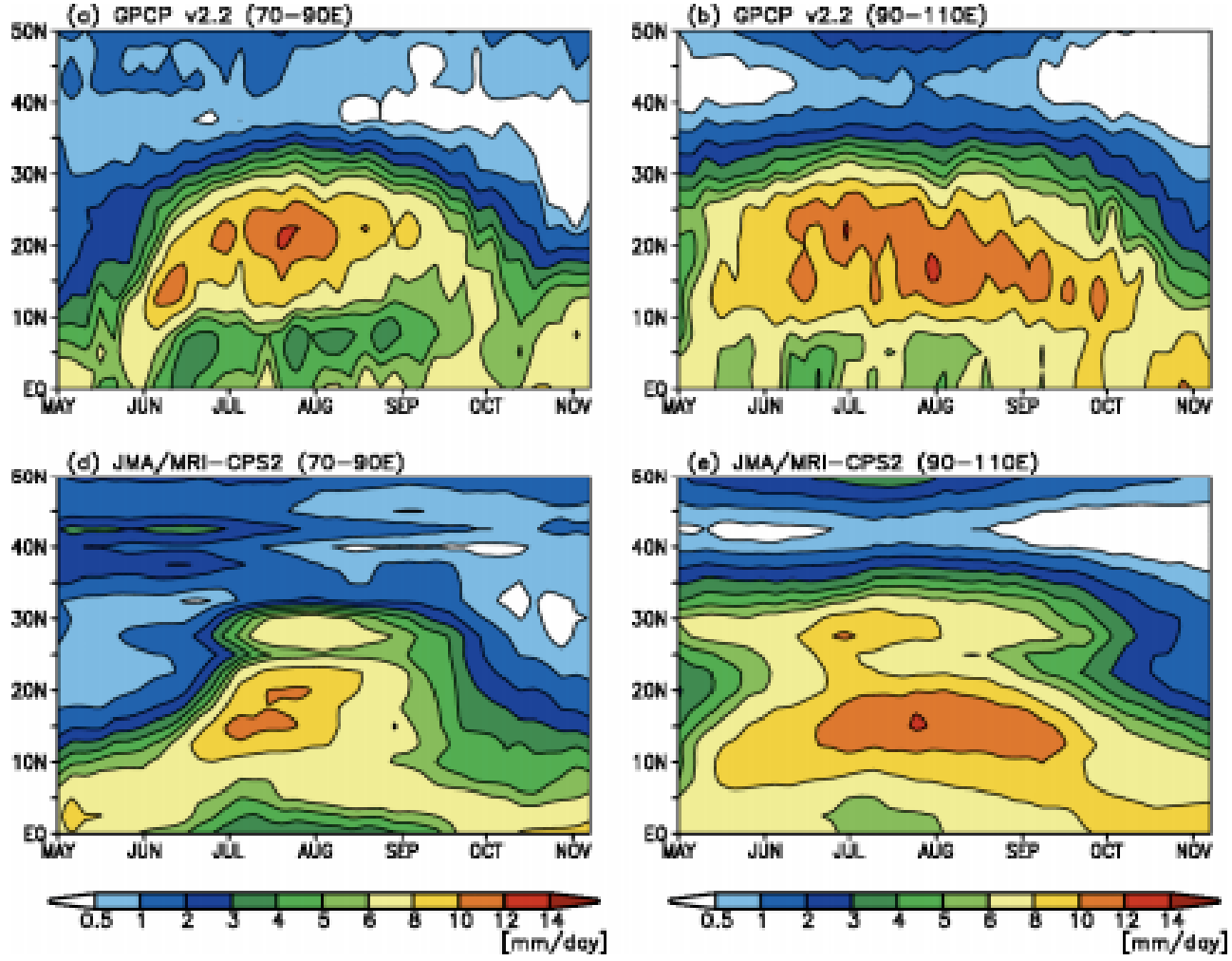


Jain et al. 2018 Clim Dyn

The correlation skill of CPS2 is relatively good, but the bias is not. Many models exhibit dry biases over the Indian subcontinent and South China. Why?

Monsoon onset in JMA/MRI-CPS2

Latitude-time sections of precipitation climatology



Low res. Models tend to delay the Indina monsoon onset.

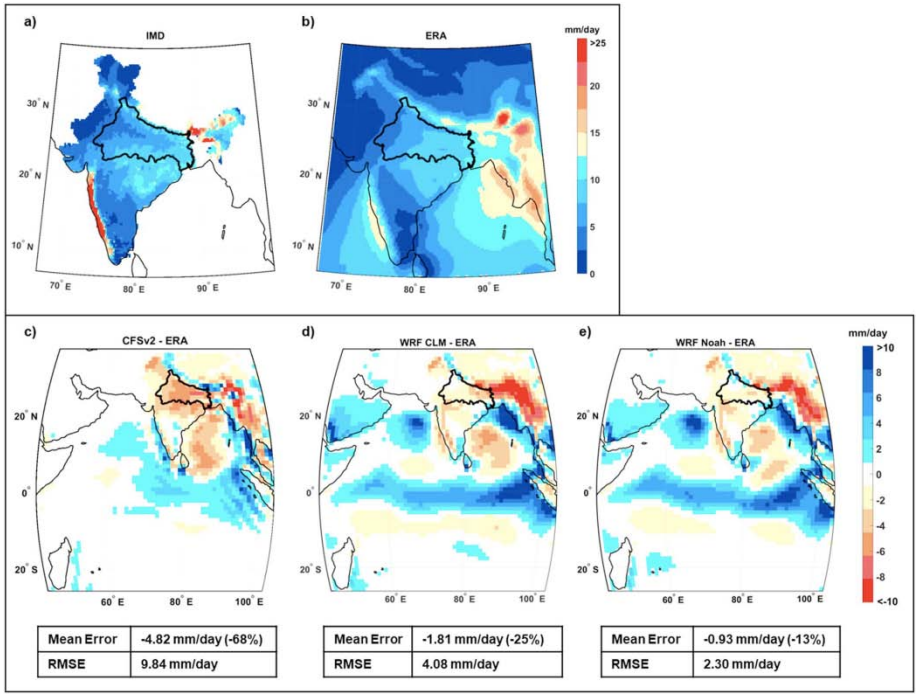
Ashfaq et al. (2017)

Takaya (2015)
JMA internal report
(in Japanese)

The monsoon onset of JMA/MRI-CPS2 is too late.

Model topography and rainfall bias (1)

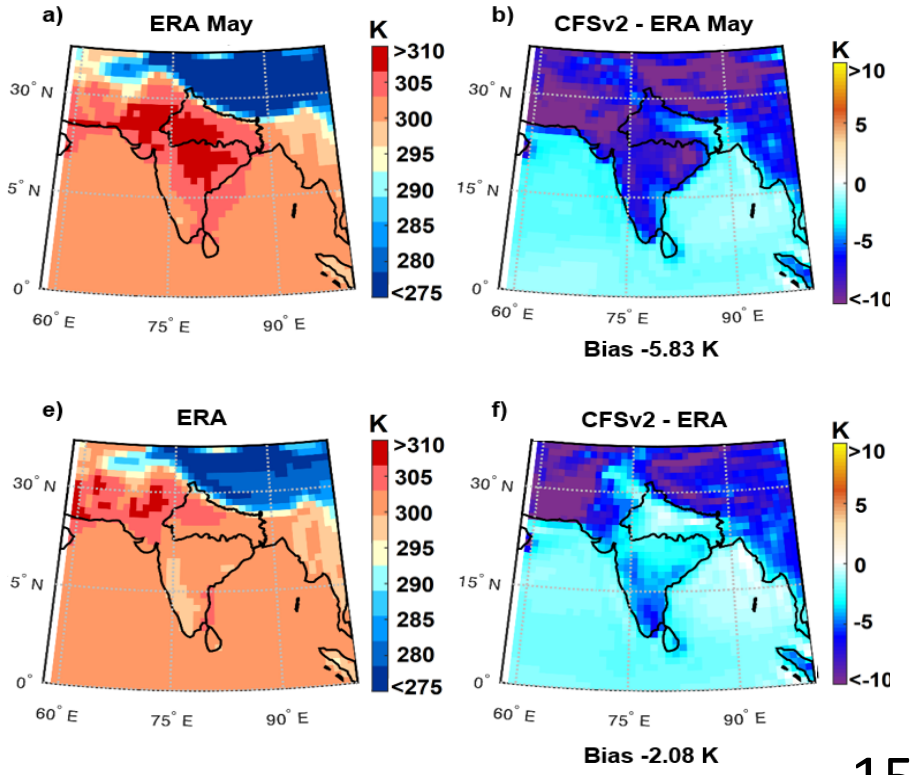
Devanand et al. (2018) attributed dry biases of CFSv2 and WRF models to too smooth topography due to insufficient resolution, and resultant effects of (a) moisture transport from Western and Upper Indian Ocean to Ganga Basin and (b) improved precipitation recycling over the Ganga basin.



Mean Error	-4.82 mm/day (-68%)
RMSE	9.84 mm/day

Mean Error	-1.81 mm/day (-25%)
RMSE	4.08 mm/day

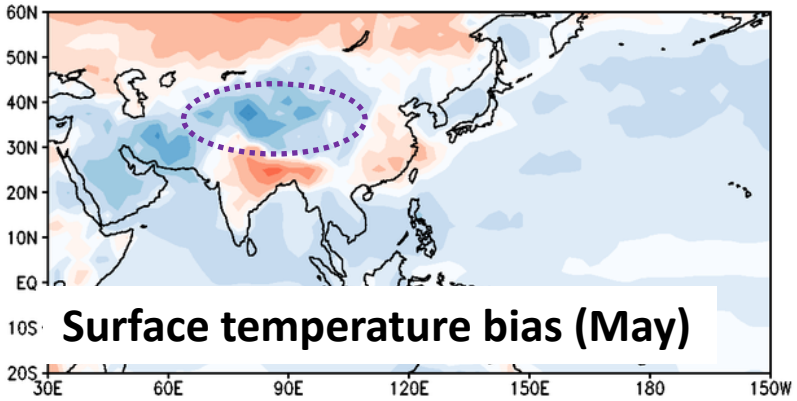
Mean Error	-0.93 mm/day (-13%)
RMSE	2.30 mm/day



Devanand et al. 2018 GRL

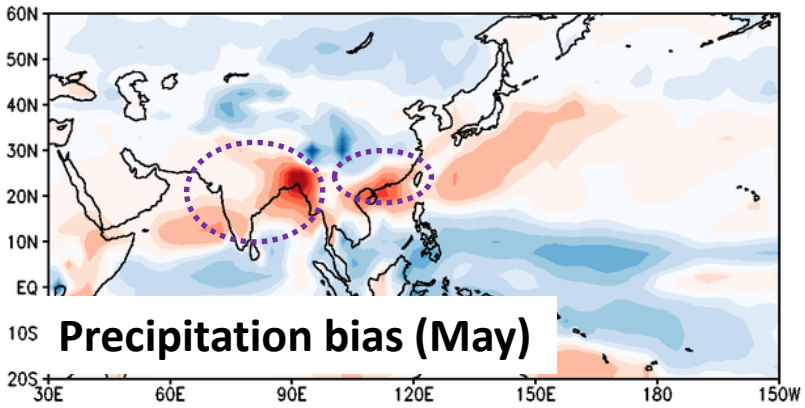
Model topography and rainfall bias (2)

<JMA/MRI-CPS2(30yr;10mem;15dayLAF) : JRA55>
TSsurf [K]
BIAS for 30 years (1981–2010)
Initial : 04.26 , Lead time : 0 (Target month : May)



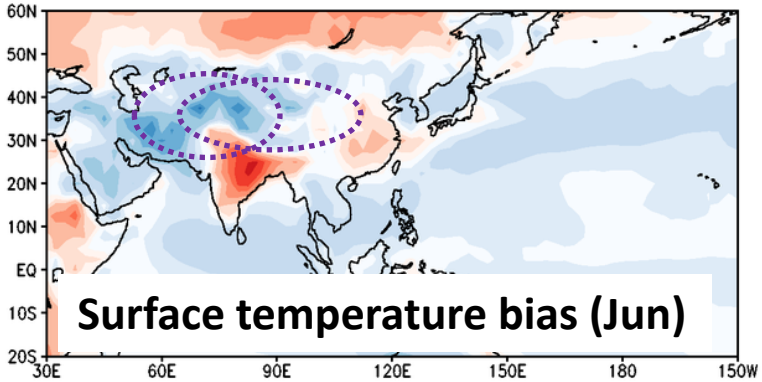
Surface temperature bias (May)

<JMA/MRI-CPS2(30yr;10mem;15dayLAF) : GPCP_v2.2>
RAIN [mm/day]
BIAS for 30 years (1981–2010)
Initial : 04.26 , Lead time : 0 (Target month : May)

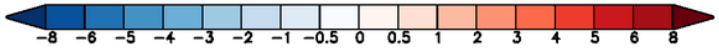


Precipitation bias (May)

<JMA/MRI-CPS2(30yr;10mem;15dayLAF) : JRA55>
TSsurf [K]
BIAS for 30 years (1981–2010)
Initial : 04.26 , Lead time : 1 (Target month : Jun)



Surface temperature bias (Jun)



NH	TRP	SH	EU	PAC	JPN	N34	GLB
−0.113	−0.389	0.183	0.030	−0.098	−0.357	−0.642	−0.110

<JMA/MRI-CPS2(30yr;10mem;15dayLAF) : GPCP_v2.2>
RAIN [mm/day]
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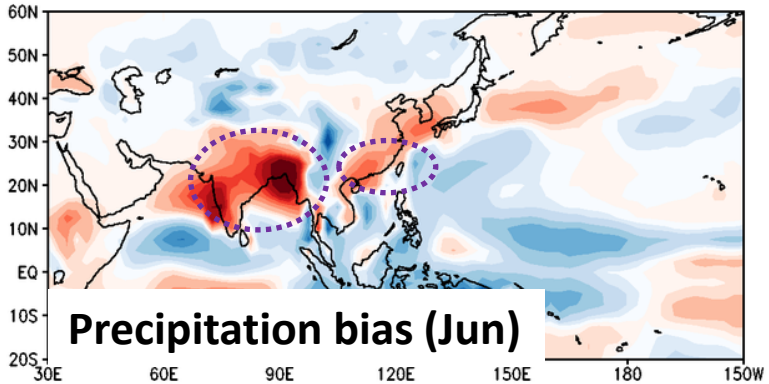
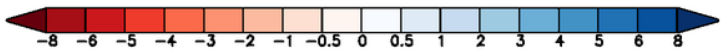
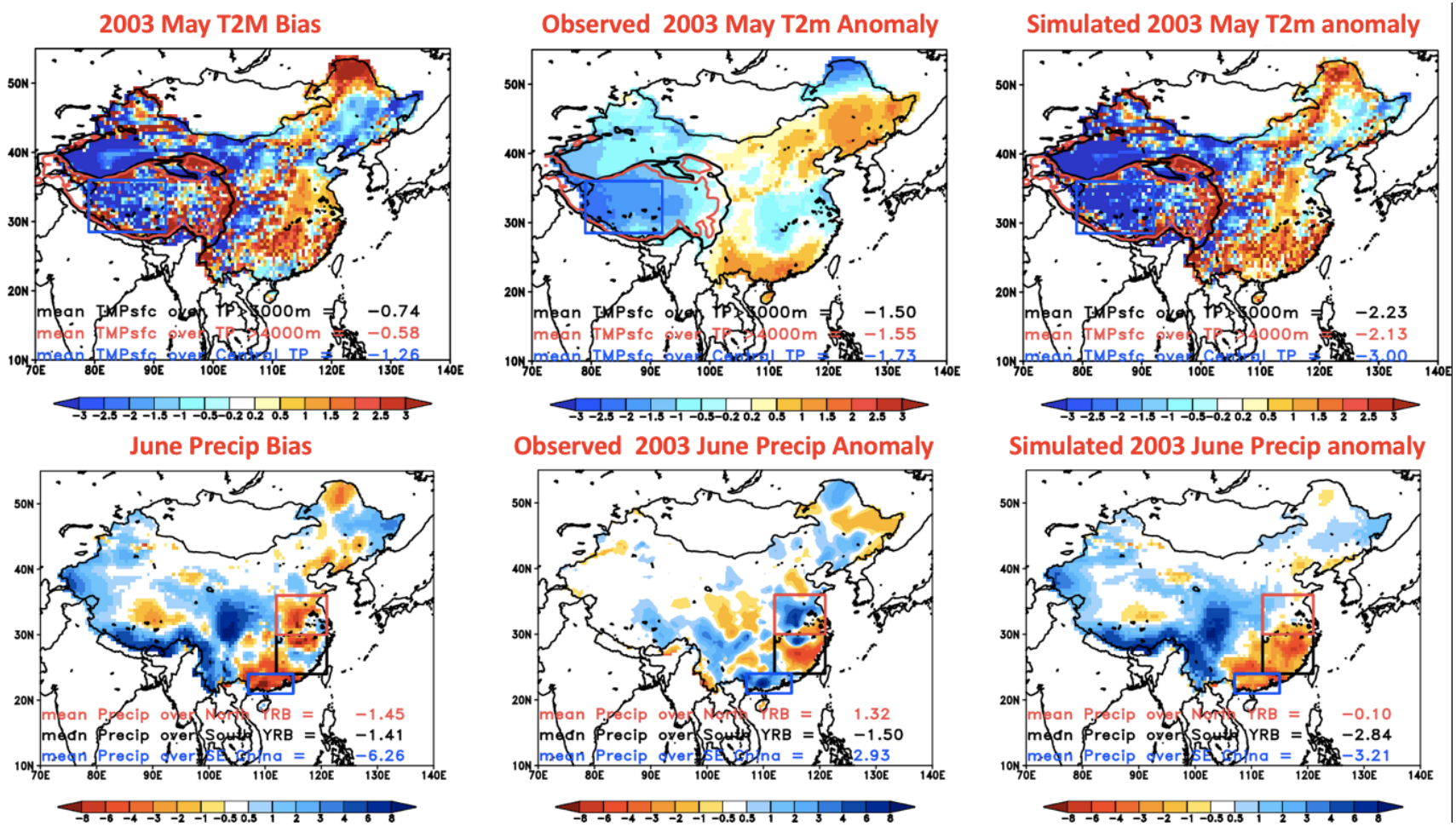


Precipitation bias (Jun)



ILSTSS2S experiments (2003 case, CTRL)

Biases and simulated anomalies of T2m and precip wrt observed CMA climatology



Courtesy: Dr. Ismaila Diallo, Prof. Yongkang Xue

Pre-ILSTSS2S experiment

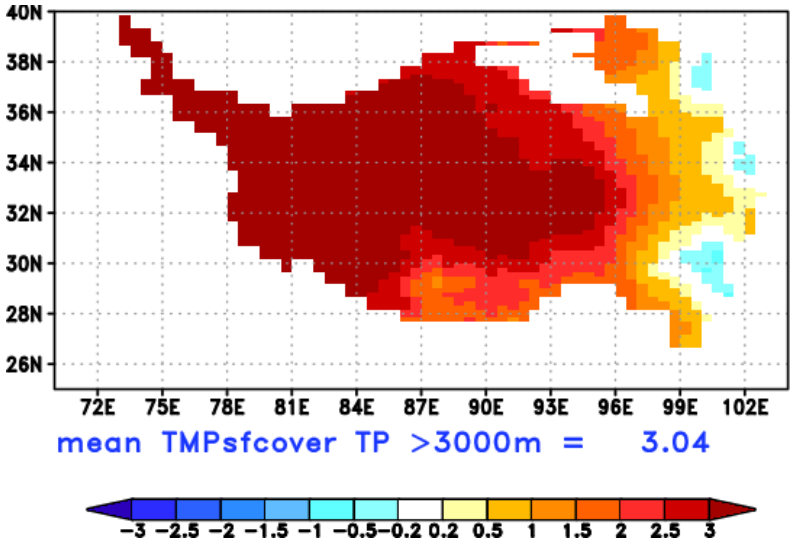
Two sensitivity experiments were conducted.

Start month: May 2003 (11, 26 Apr.)
Ensemble size: 10

Exp T1: Temperature anomaly (delta T) added to land Temp

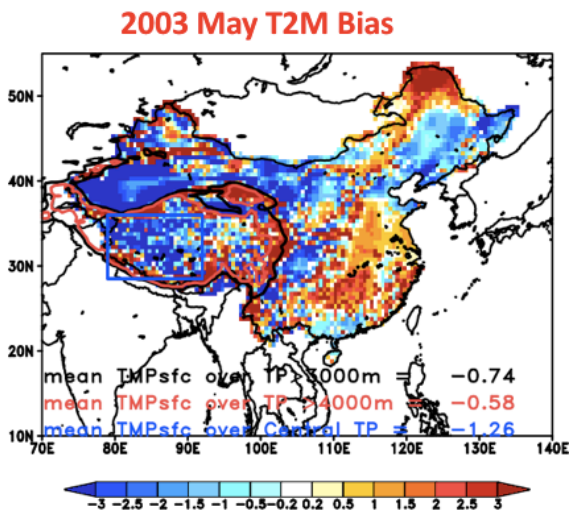
Exp T2: Same as Exp T1, but 2 x delta T

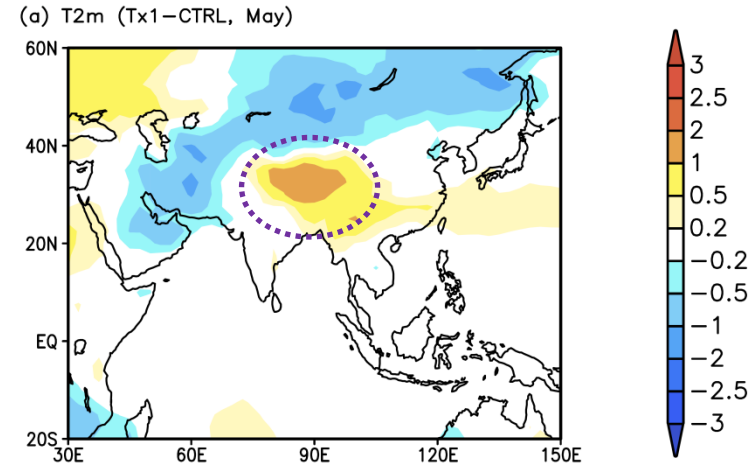
Anomaly added over the Tibetan Plateau

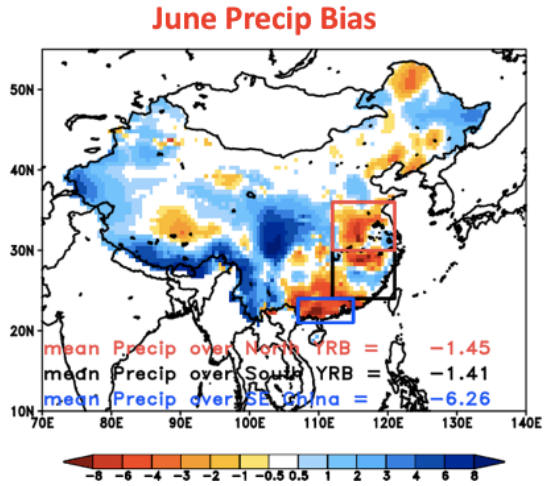


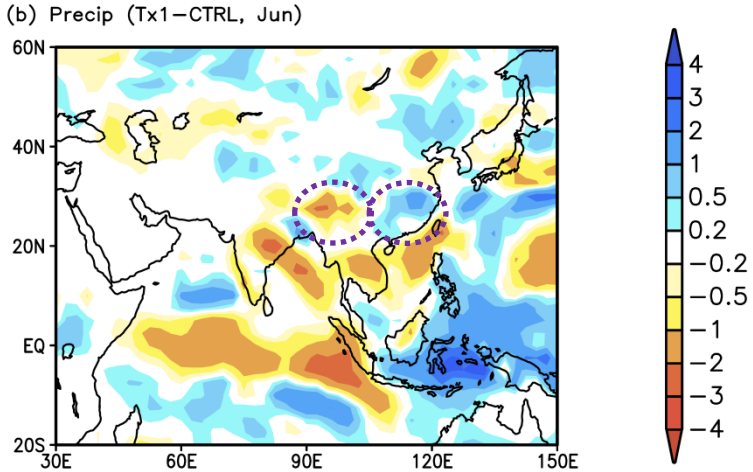
Courtesy: Dr. Ismaila Diallo, Prof. Yongkang Xue

Impacts of imposed temperature anomaly









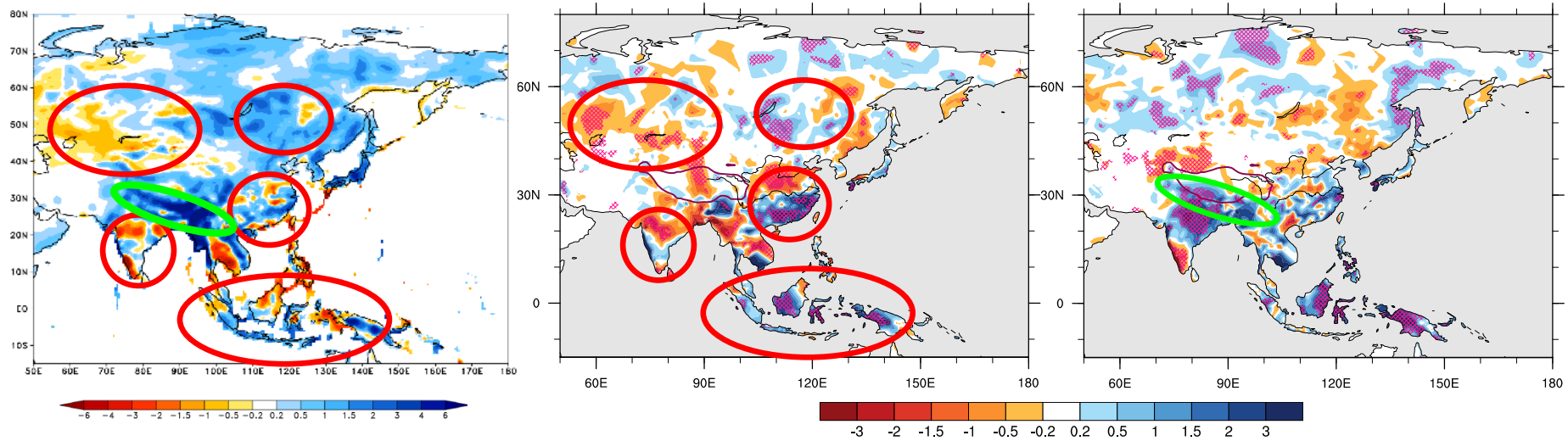
Precipitation is increased in the South China. This is consistent with ILSTSS2S analysis. But not increased over the Indian subcontinent, Tibetan heating is not enough? Maybe central TP and Iranian Plateau...

Observed June Precip. Differences between Warmest and Coldest Years

June Precip. ensemble mean Bias

Central and Eastern TP

Western TP



June ensemble mean precipitation biases in some areas are in general agreement with the June precipitation anomalies between eastern-central TP/western TP warm years minus cold years

From Prof. Yongkang Xue

Summary

- Land initialization improved subseasonal predictive skills of JMA/MRI-CPS2.
- The predictability is resulted from the realistic interannual variability and its influence to atmospheric fields.
- The Himalayas-Tibetan Plateau topography seems to have significant impacts on model's representation of Asian summer monsoon.
- ILSTSS2S experiment alludes to significant impacts of land temperature for precipitation in East Asian.
- The eastern Tibetan heating can not explain the dry bias over the Indian subcontinent in the pre-ILSTSS2S experiment. Indian rainfall processes are complex… Central TP and Iranian Plateau reconcile the results?

Thank you for your kind attention.

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