International Workshop of First Phase of GEWEX/GASS ILSTSS2S Initiative and TPEMIP (Washington D.C., USA, 8–9 December 2018)

KIAPS
KOREA INSTITUTE OF ATMOSPHERIC PREDICTION SYSTEMS

Impact of Land Surface Temperature Anomaly in KIAPS developing model

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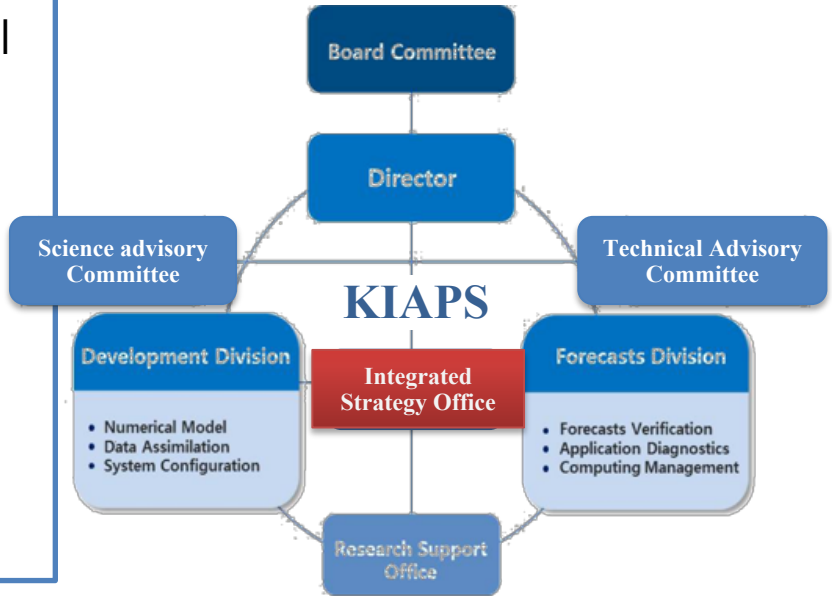
Acknowledgement:
Yongkang Xue and Ismaila Diallo (UCLA)
Hyun-Joo Choi, Kyung-Hee Seol, and Song-You Hong (KIAPS)

www.kiaps.org

Organization of KIAPS

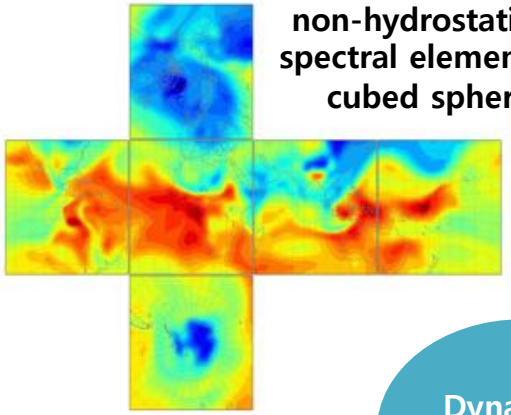
- Purpose : Developing a next generation global operational model for KMA
- Project period : 2011~2019 (total 9 years)
- Total Budget: $95 million
  2018 budget -$10 million
- Public institution sponsored by government
  - organization: 2 divisions, 6 teams, 2 office
  - Man power: 58/58 + 11 + 1



Total	Director	Research Staff				Administrative staff			
		Principal Researcher	Senior Researcher	Researcher	Assistant	Principal Staff	Senior staff	Staff	Assistant
58+12	1	13 +1	25	11	5	1	2	3	6

Korean Integrated Model (KIM) system

non-hydrostatic
spectral element
cubed sphere

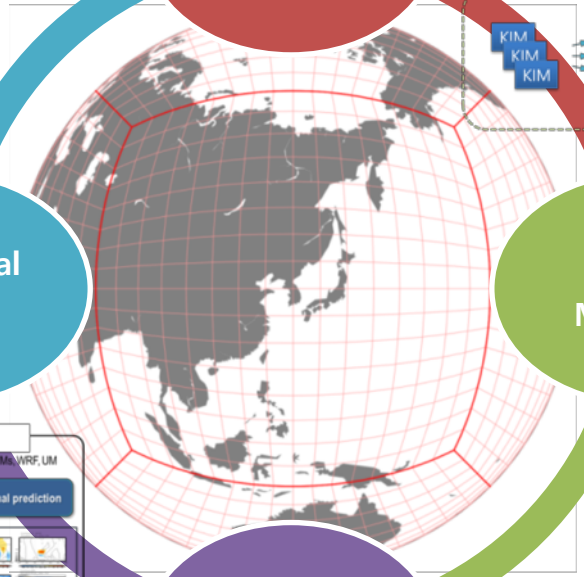


Data Assimilation

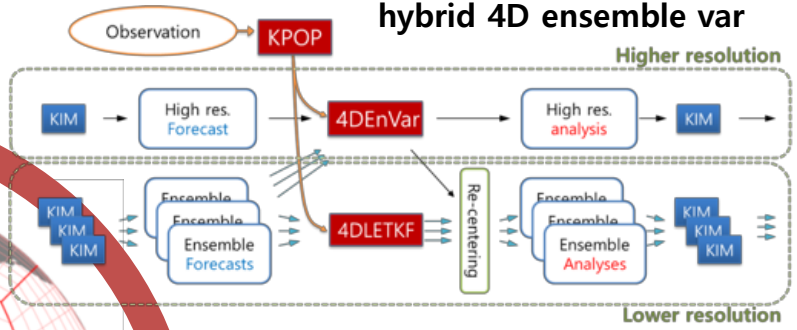
Dynamical Core

Physics Modules

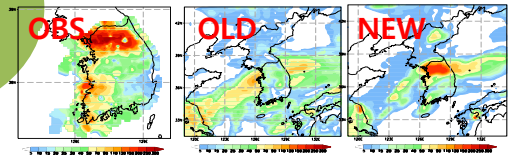
Evaluation Analysis



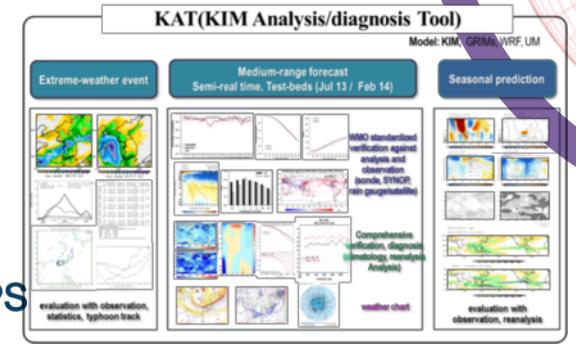
hybrid 4D ensemble var



advanced physics package



Physics schemes	KIM 3.1	Remarks
Cumulus parameterization (CPS)	Han et al. (2016) Kwon and Hong (2017)	Routed in GFS CPS of GRIMs, but with the improved cloud microphysics and the inclusion of scale-aware function, names KSAS (gray-zone SAS)
Shallow convection (SCV)	Hong and Jang (2018)	Routed in Tiedtke SCV (Tiedtke 1989) of GRIMs, but with improved diffusivity, and triggering function
Cloud microphysics (MPS)	Hong et al. (2004) Bae et al. (2018)	Routed in WSM5 (Hong et al. 2004) of WRF, but with the inclusion of cloud properties in radiation package (Bae et al. 2016)
Radiation (RAD)	Baek (2017)	Routed in RRTMG (Iacono et al. 2008) of WRF, but with a newly developed unified RAD package
Cloudiness (CLD)	Park et al. (2016)	A newly developed prognostic cloudiness package based on the Tiedtke prognostic cloudiness (Tiedtke 1993)
Vertical diffusion (PBL)	Shin and Hong (2015) Lee et al. (2018)	Routed in YSU PBL (Hong et al. 2006, Hong 2010) of WRF, but with the inclusion of scale-aware function and stratocumulus mixing
Aerosol chemistry (AER)	Choi et al. (2018)	A newly generated 3D aerosol data, based on IFS MACC 2D aerosol climatology
Orographic gravity wave drag (GWDo)	Choi and Hong (2015)	Routed in GWDo (Kim and Arakawa 1995, Hong et al. 2008) of GRIMs, but with the inclusion of orography blocking and anisotropy of mountains
No-mountain gravity wave drag (noGWDo)	Choi et al. (2018)	A newly developed source-based spectral non-orographic GWD, based on Choi and Chun (2011) and Richter et al. (2010).
Land surface layer (LSM)	Koo et al. (2017, 2018)	Routed in Noah 3.0 of GRIMs (Ek et al., 2002, Chen and Dudhia, 2000), but a revised snow physics and the inclusion of form drag
Ocean surface layer (OSM)	Kim and Hong (2010), Lee and Hong (2018)	Routed in GRIMs, but with the inclusion of salinity effect in latent heat flux computation



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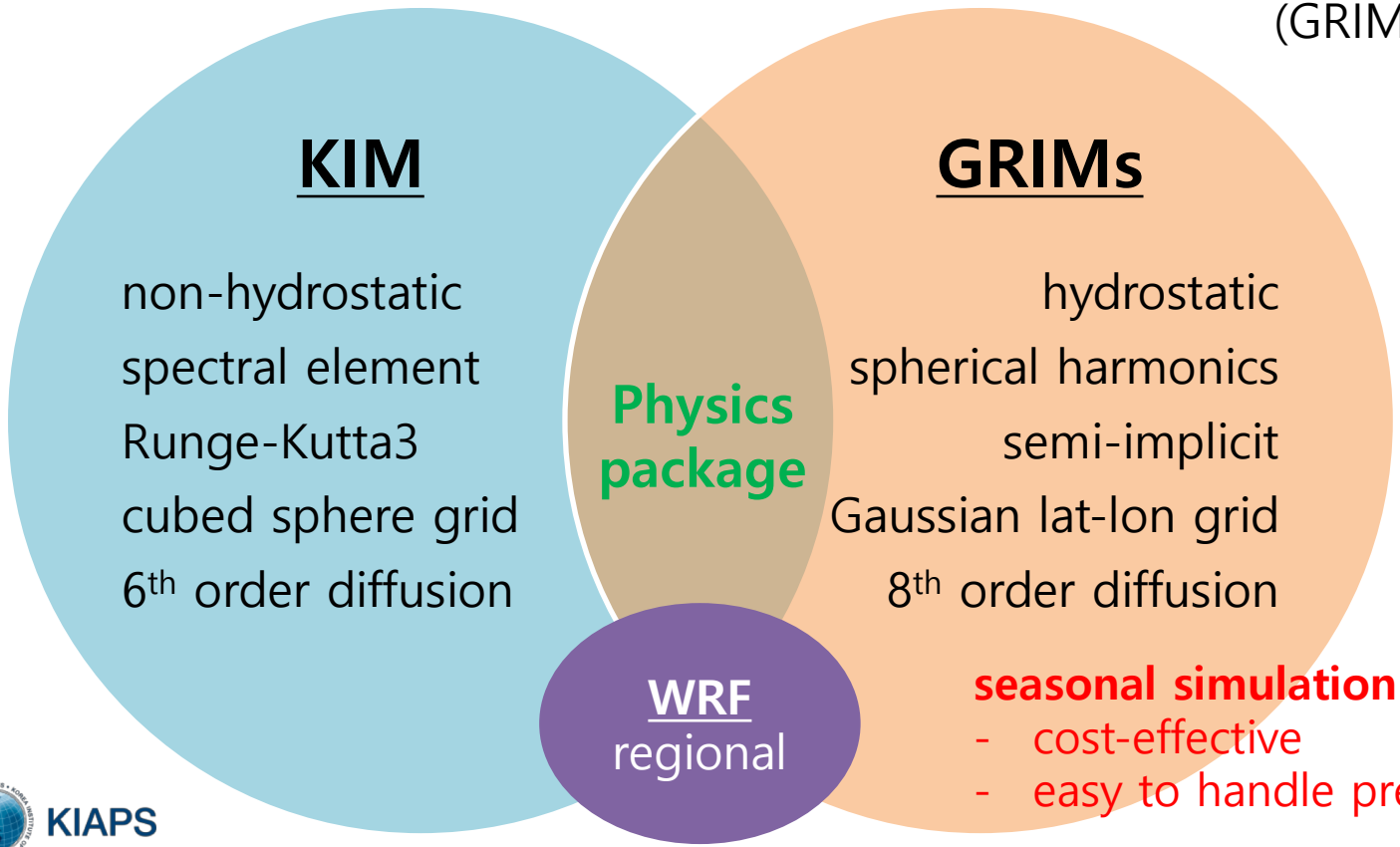
Development strategy: reference model

Global/Regional Integrated Model system
(GRIMs; Hong et al. 2013)



seasonal simulation by GRIMs

- cost-effective
- easy to handle pre- and post-process

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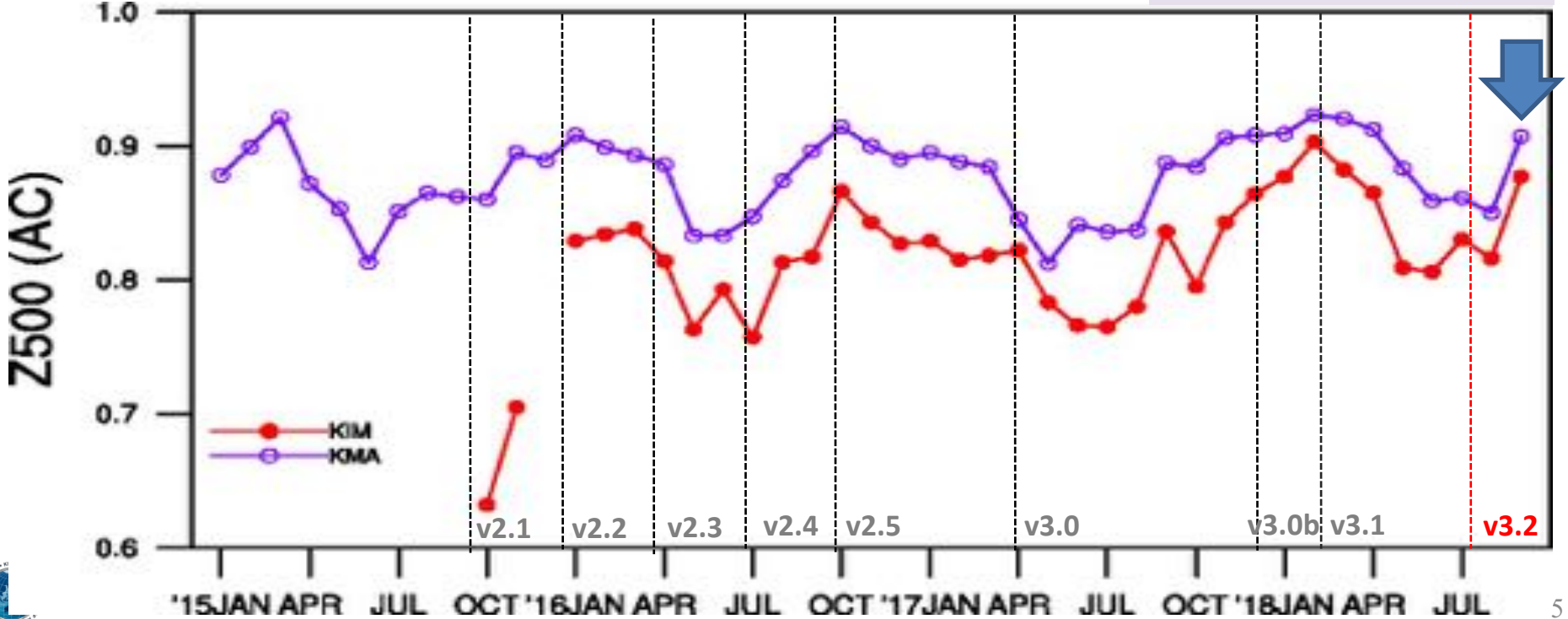
KIM predictability

NH 500hPa Geopotential height Anomaly Correlation at 120-hr fcst

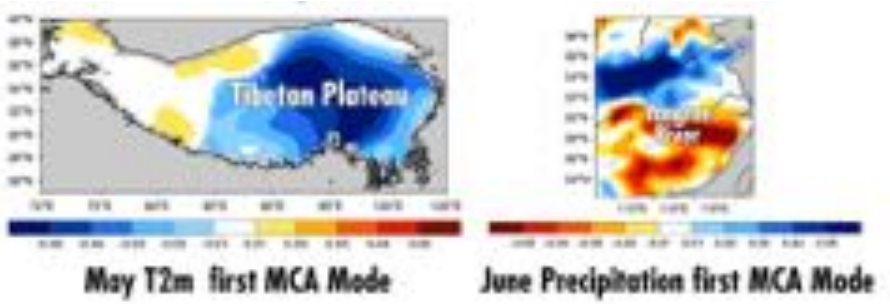
KIM vs. KMA-UM

September 2018
96.7%(=0.877/0.907)



Purpose of this study

In KIAPS developing model,
an early experiment has been done to test
the sensitivity of June precipitation
to May 2-m temperature (T2m)



https://ilstss2s.geog.ucla.edu/

- Impact of T2m anomaly over the Tibetan Plateau (TP) region
  → main focus of ILSTSS2S project
- Impact of T2m bias correction over the Low plain (LO) of East China
  → local temperature bias
- Impact of the updated radiation scheme reducing systematic T2m bias
  → systematic inland temperature bias

Model configuration for ILSTSS2S project

	Description
Model version	KIM V3.2a (+ minor revision)
Land surface model	Revised Noah LSM (Koo et al. 2017; 2018)
Resolution	T126L42 (~1°)
Initial data	NCEP Reanalysis II (RA2; T62L28)
Start time	00Z 01–05 Apr 2003 (5 members with lagged starting time) • 1-month spin up
Surface cycling	every 24 hour
Analysis metric - SIM: KIAPS simulation - OBS: CMA surface data	SIM Bias : SIM(2003) – OBS (2003) OBS anomaly : OBS (2003) – OBS climatology (1981–2010) SIM anomaly : SIM (2003) – OBS climatology (1981–2010)

* elevation correction in 2-m temperature by –6.5 K km^{-1}

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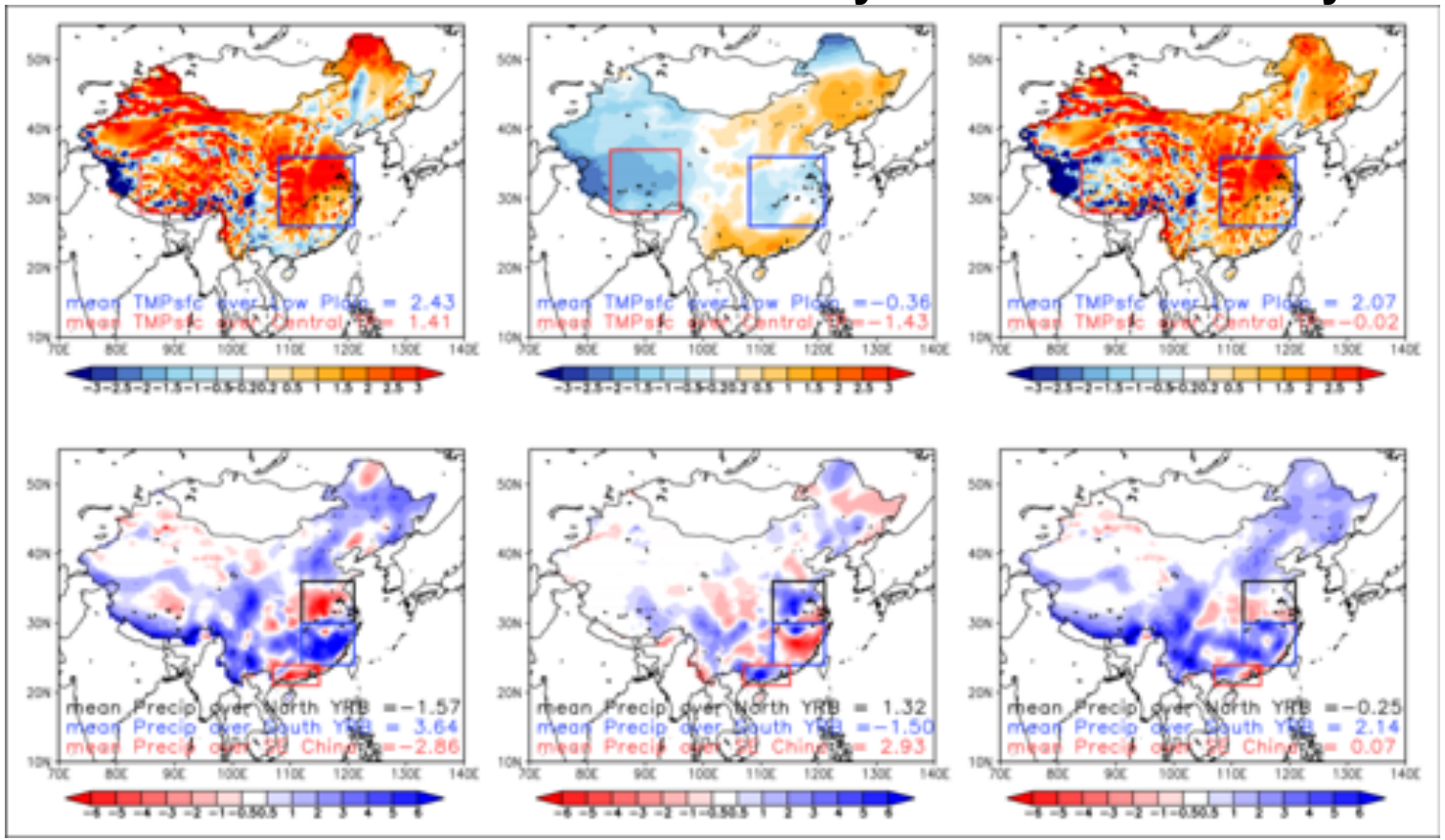
T2m (May) and precipitation (June) in 2003



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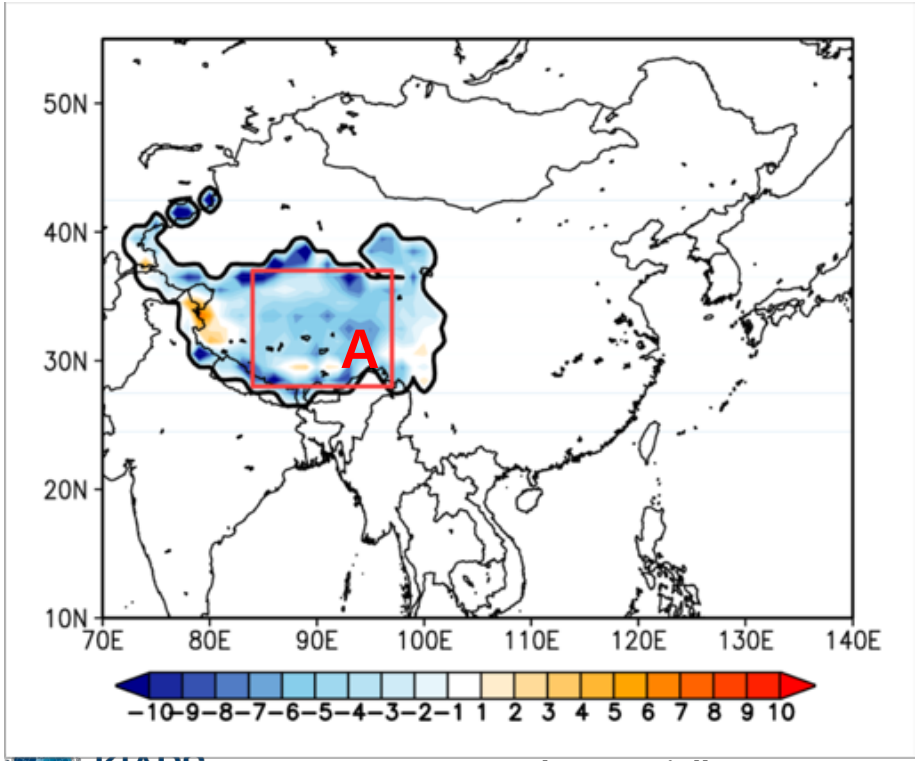
Experimental setup for TP anomaly

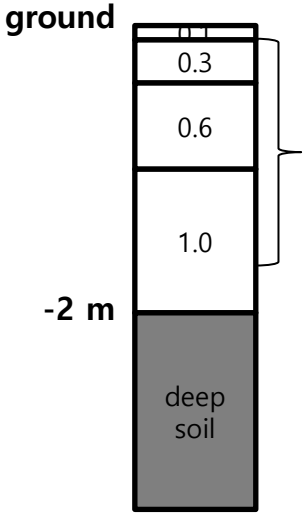
Anomaly difference in May T2m
(OBS anomaly – SIM anomaly)



by Dr. Diallo (UCLA)

EXP	Perturbed magnitude
TP1	Anomaly difference
TP2	Anomaly difference * 2
TP3	Anomaly difference * 3

→ **at the initial time only**



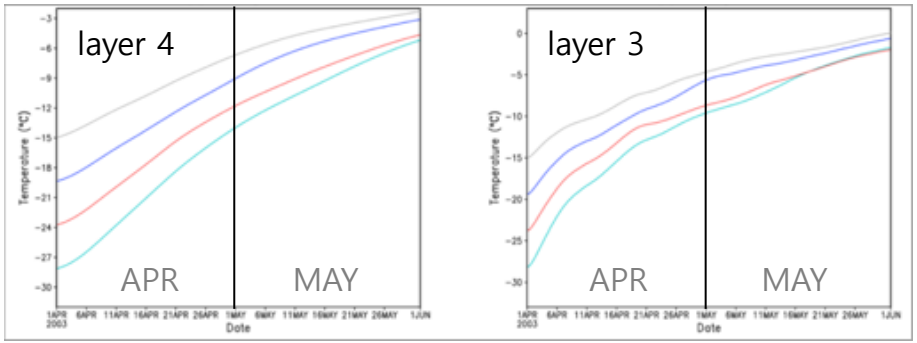
4 layers in Noah LSM

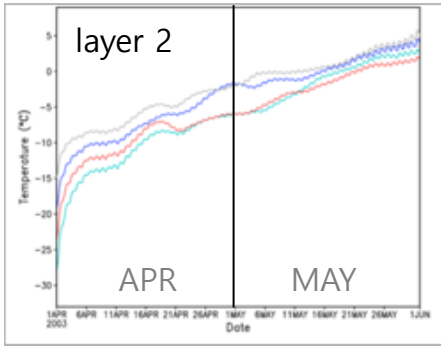
➔ **which layers should be perturbed?**

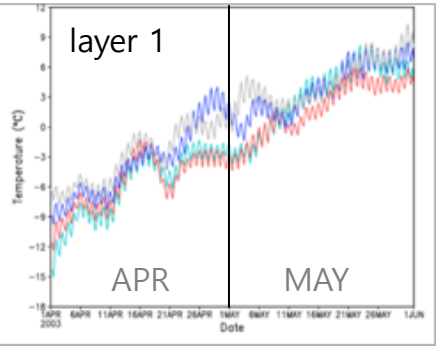
Time series of soil temperature (A region)

Perturbing all layers

CNTL TP1 TP2 TP3

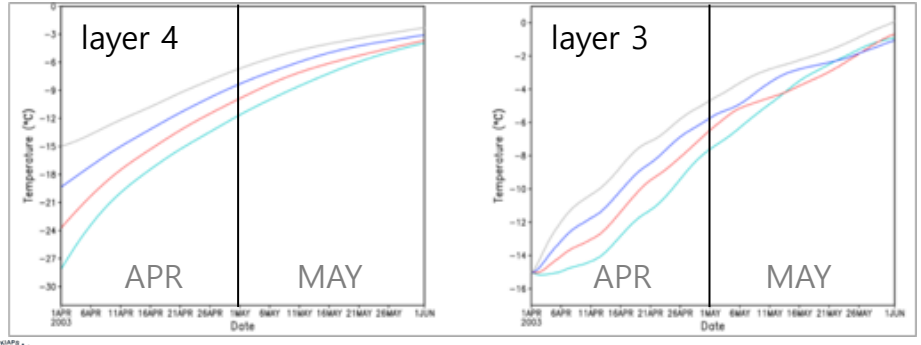


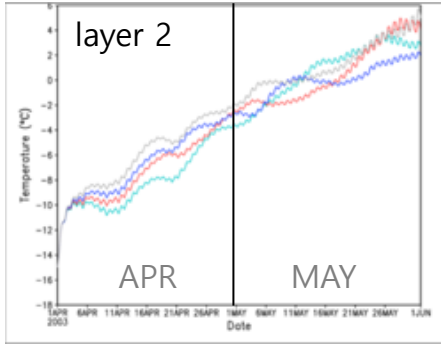


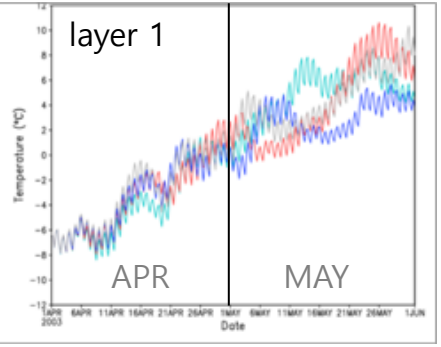


Perturbing 4th layer only

CNTL TP1 TP2 TP3

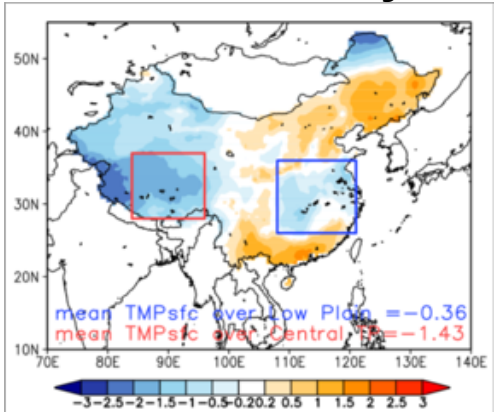
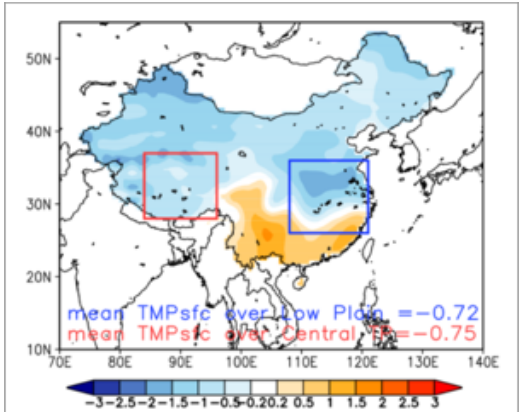
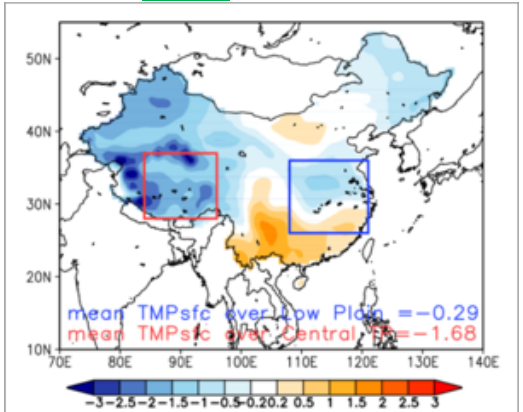
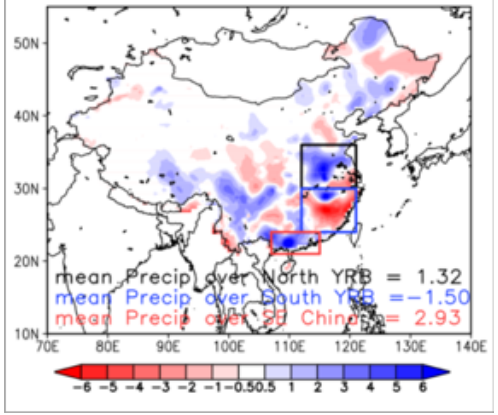
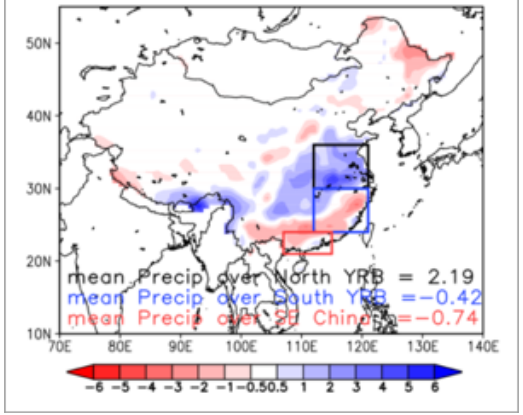
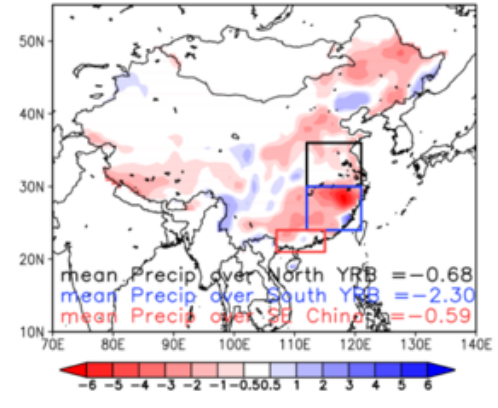






KIAPS ➔ could affect 1st soil layers in May with 1-month spin up.

Sensitivity to TP anomaly

	OBS anomaly	TP2 – CNTL	TP4 – CNTL
T2m			
Precip.			

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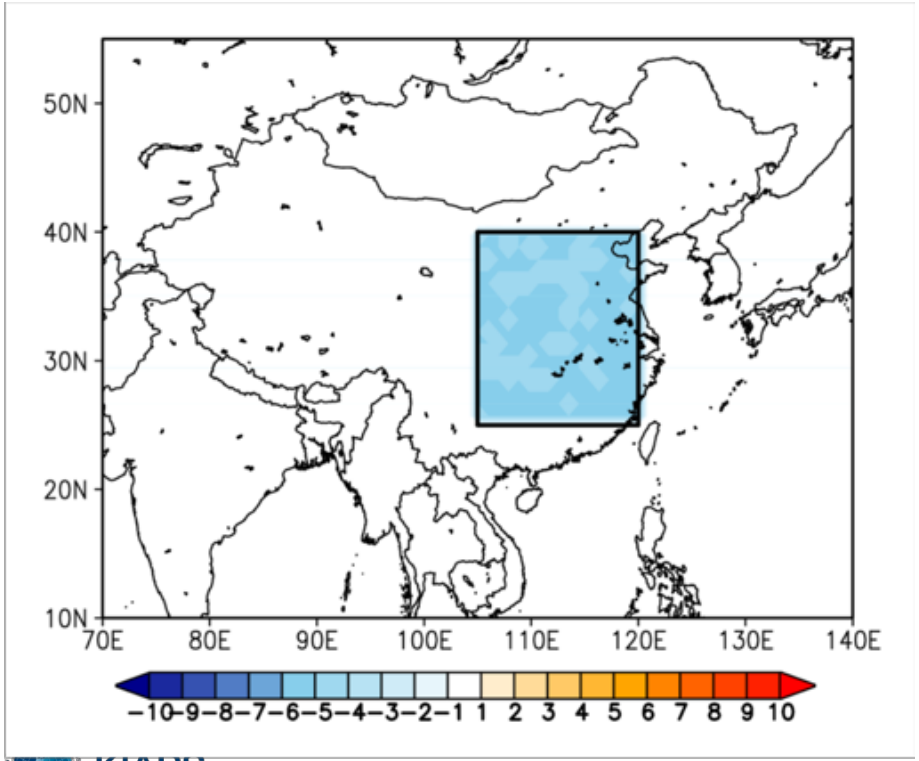
Experimental setup for LO anomaly

Temperature difference
(LO-5 – CNTL)

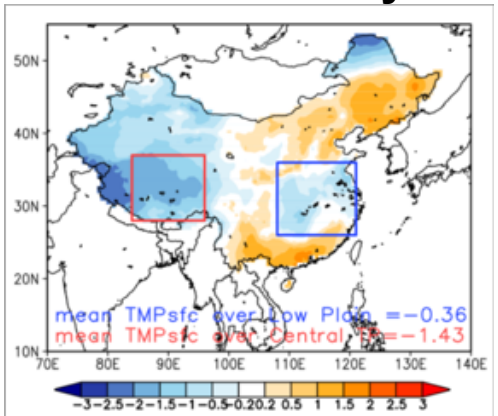
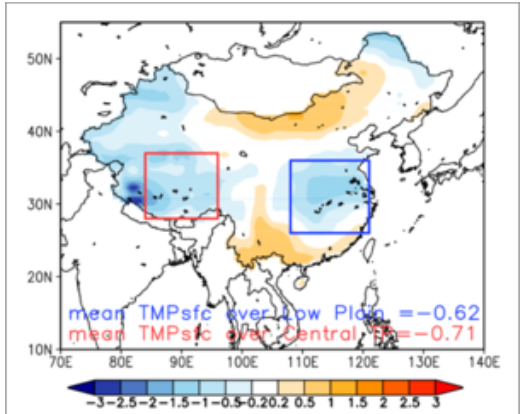
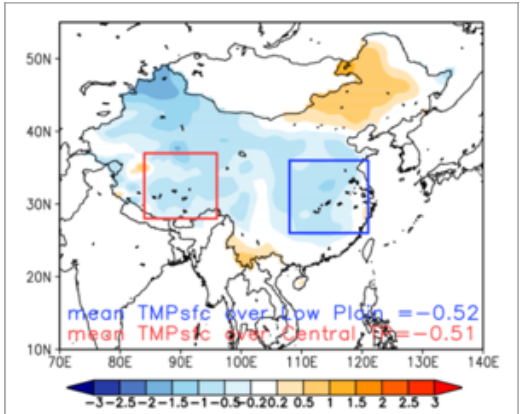
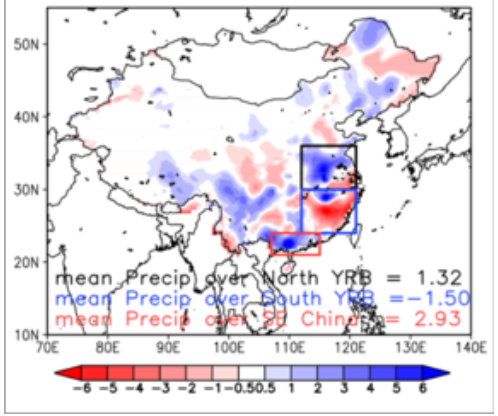
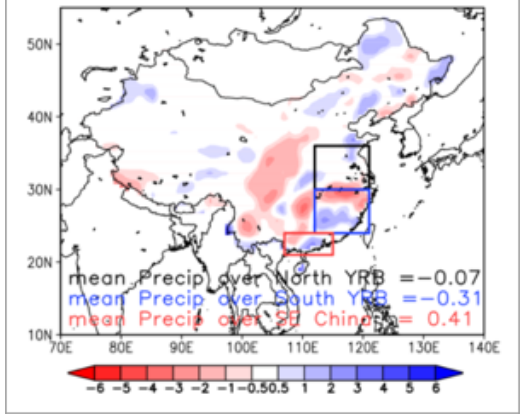
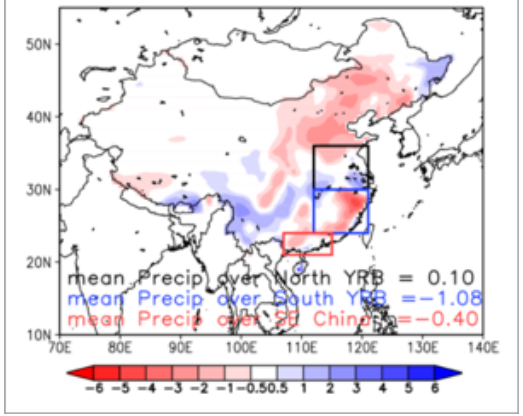


EXP	Perturbed magnitude
LO-5	decrease by -5 K
LO-10	decrease by -10 K
LO-20	decrease by -20 K

→ **at the initial time only**

- To remove the local warm bias in which precipitation is of interest to us.

Sensitivity to LO anomaly

	OBS anomaly	LO-10 – CNTL	LO-20 – CNTL
T2m			
Precip.			

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Summarized table of sensitivity test

2003	May T2m		June Precipitation		
	TP	LO	N. YRB	S. YRB	SE China
OBS anomaly	-1.43	-0.36	1.32	-1.50	2.93
TP2 – CNTL	-0.75	-0.72	2.19	-0.42	-0.74
TP4 – CNTL	-1.68	-0.29	-0.68	-2.30	-0.59
LO-10 – CNTL	-0.71	-0.62	-0.07	-0.31	0.41
LO-20 – CNTL	-0.51	-0.52	0.10	-1.08	-0.40

- Model can reproduce the observed relationship between May T2m and June precipitation in 2003.

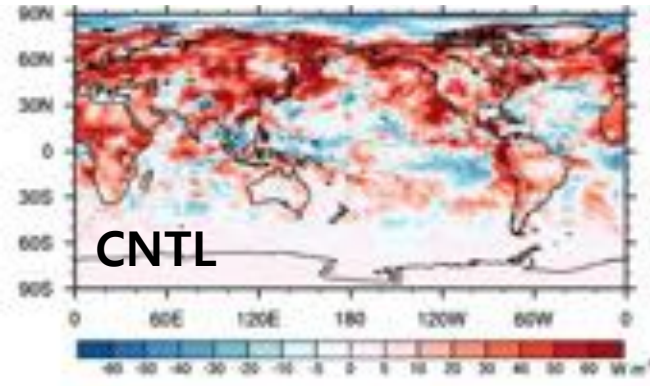
Summarized table of sensitivity test

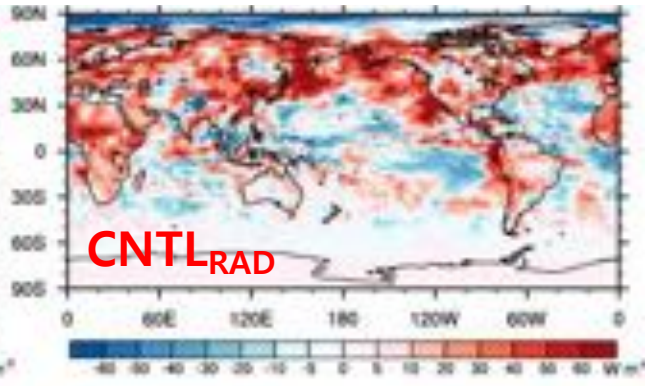
2003	May T2m		June Precipitation		
	TP	LO	N. YRB	S. YRB	SE China
OBS anomaly	-1.43	-0.36	1.32	-1.50	2.93
TP2 – CNTL	-0.75	-0.72	2.19	-0.42	-0.74
TP4 – CNTL	-1.68	-0.29	-0.68	-2.30	-0.59
LO-10 – CNTL	-0.71	-0.62	-0.07	-0.31	0.41
LO-20 – CNTL	-0.51	-0.52	0.10	-1.08	-0.40

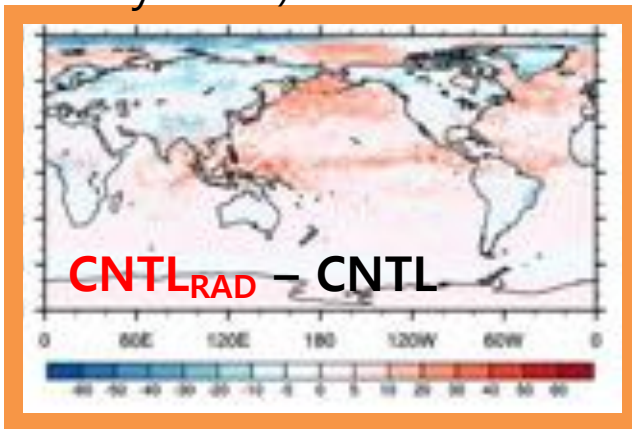
- TP and LO regions seem to closely interact with each other in terms of T2m.

Update in radiation scheme ($CNTL_{RAD}$)

Bias in downward shortwave flux (against the CERES in July 2017)

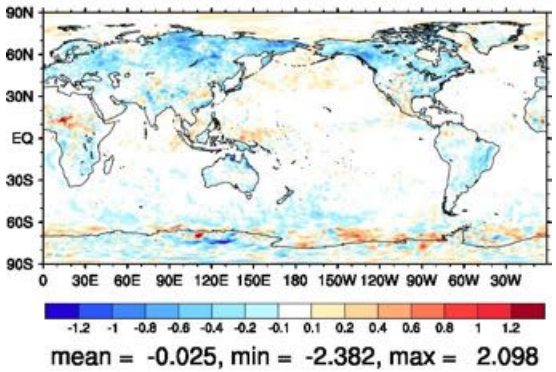




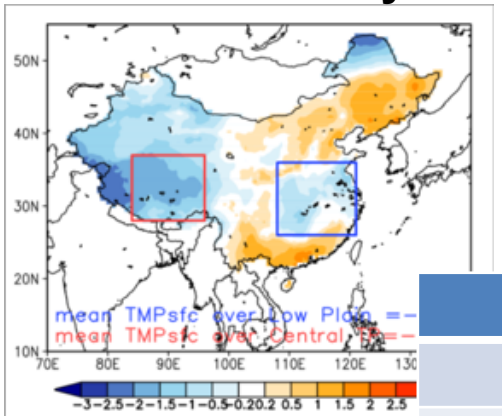
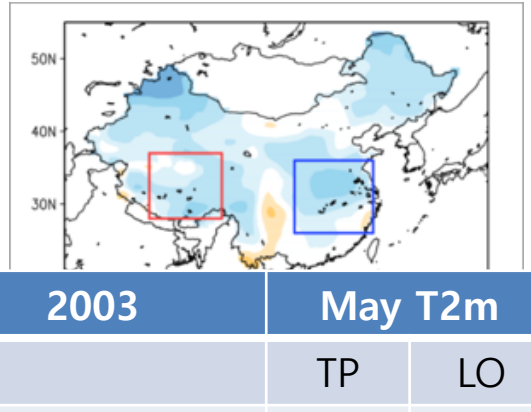
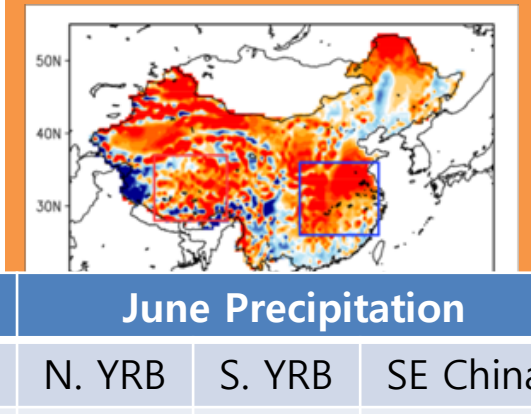
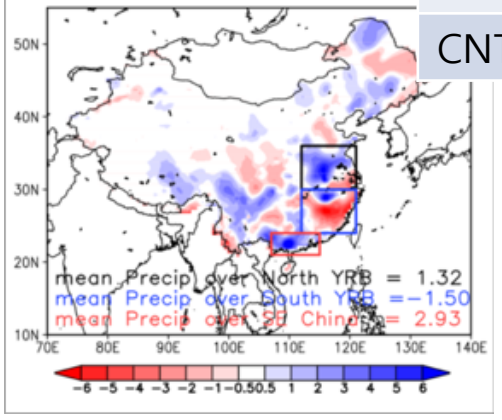
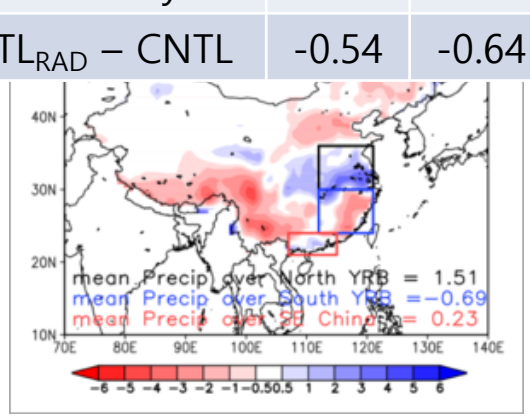
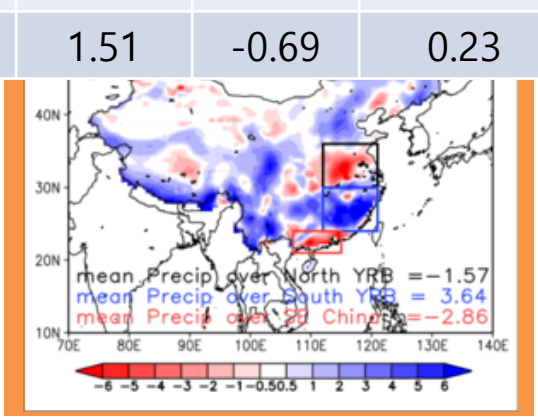


- Inland warm bias was attributed to the overestimation in downward shortwave flux.
- $CNTL_{RAD}$ can reduce the warm bias biases by the reduction in downward shortwave flux.

T2m diff.



Sensitivity to model update

	OBS anomaly	$CNTL_{RAD}$ – CNTL	CNTL bias
T2m			
Precip.			

2003	May T2m		June Precipitation		
	TP	LO	N. YRB	S. YRB	SE China
OBS anomaly	-1.43	-0.36	1.32	-1.50	2.93
$CNTL_{RAD}$ – CNTL	-0.54	-0.64	1.51	-0.69	0.23

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Summary and concluding remark

- It was found that KIAPS developing model could reproduce the observed relationship between May T2m over TP and June precipitation in East Asia.
- TP region seems to be closely interacting with LO region, which needs to be further investigated.
- Correction of systematic (radiation) temperature bias could improve the bias and anomaly of simulated precipitation, which is in line with OBS anomaly.
- Not shown here but little spin-up did not generate better sensitivity (why?)

Q) How to effectively impose temperature anomaly ?

- magnitude : T2m did not linearly respond to LST/SUBT anomaly magnitude.
- spin-up : 1-month spin-up was generally better than little spin-up.
- ensemble : simulated results were different from member to member.

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Thank you
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