Assessment of dynamical downscale ability to simulate intra-seasonal variation in China and Mongolia

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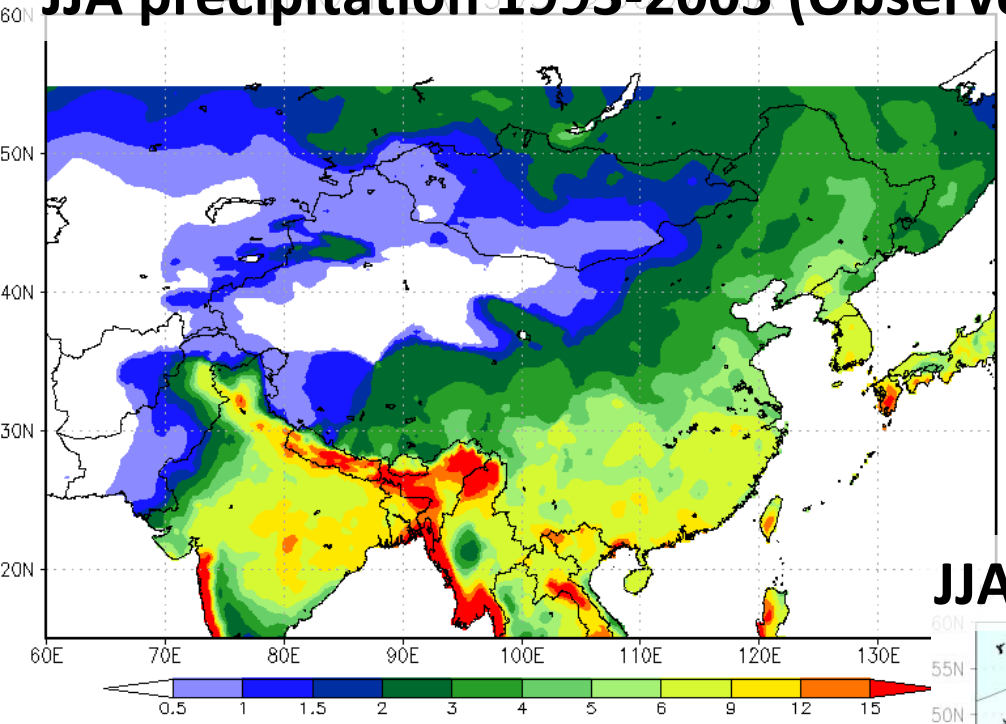
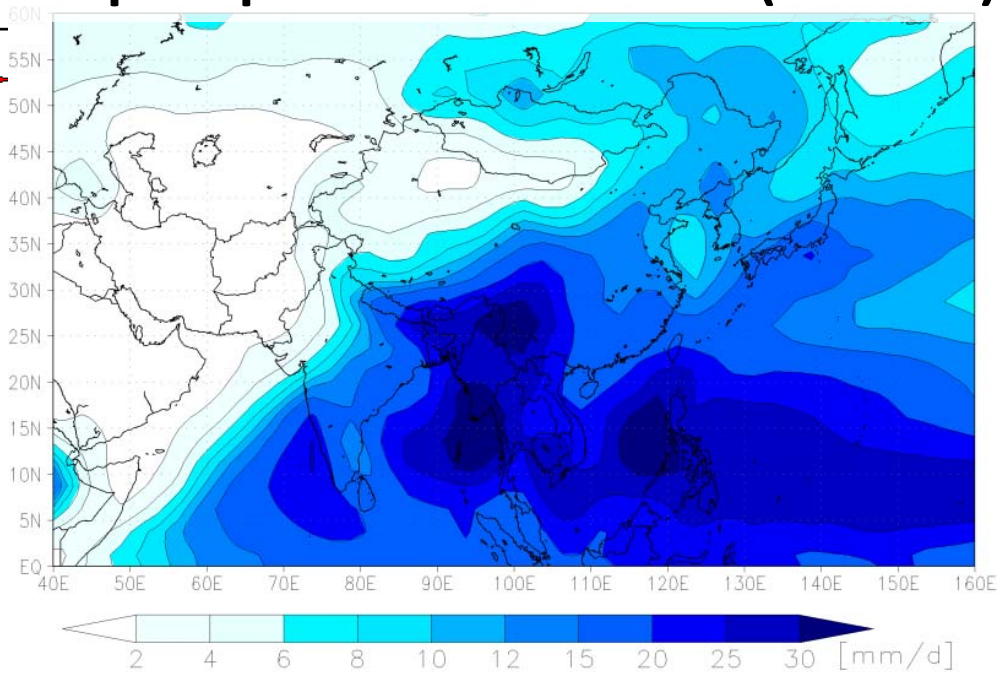
Precipitation patterns in East Asia

JJA precipitation 1993-2003 (Observed)



JJA precipitation 1980-1999 (9 GCMs)

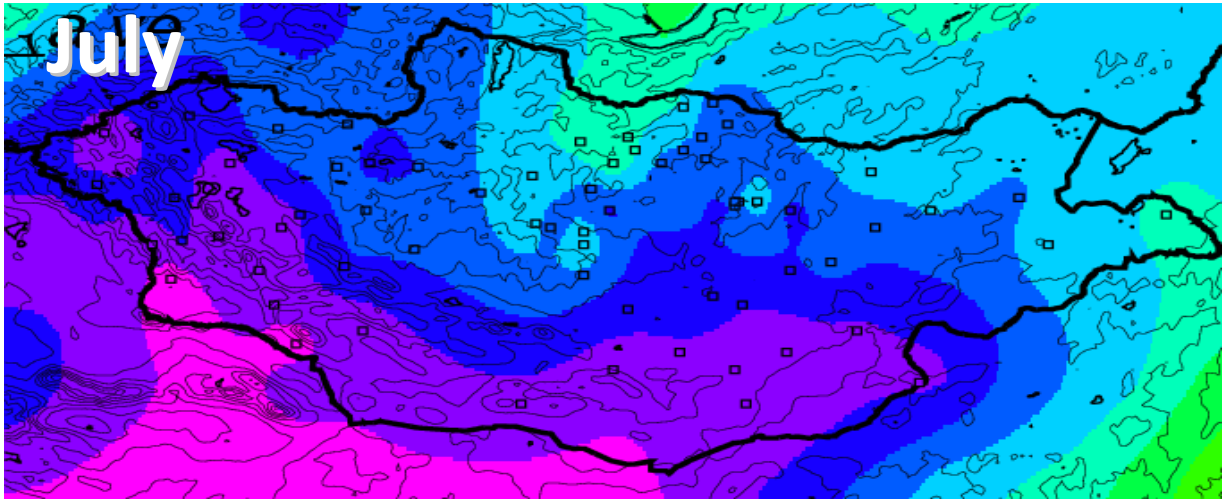


If looking at country scale…

Observation

Station (+ CMAP)

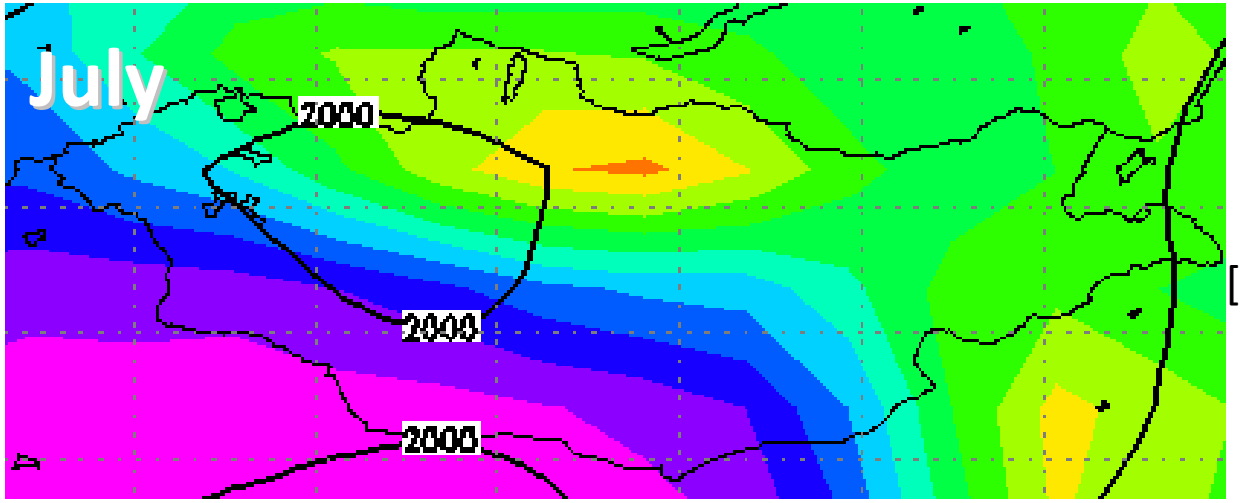
11-yr mean

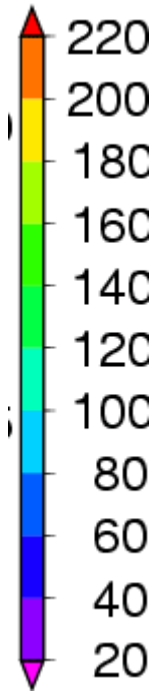


MRICGCM

(10yr-1991-2000)

2.8degree interval





Dynamical downscaling; is it effective?

Difficulties

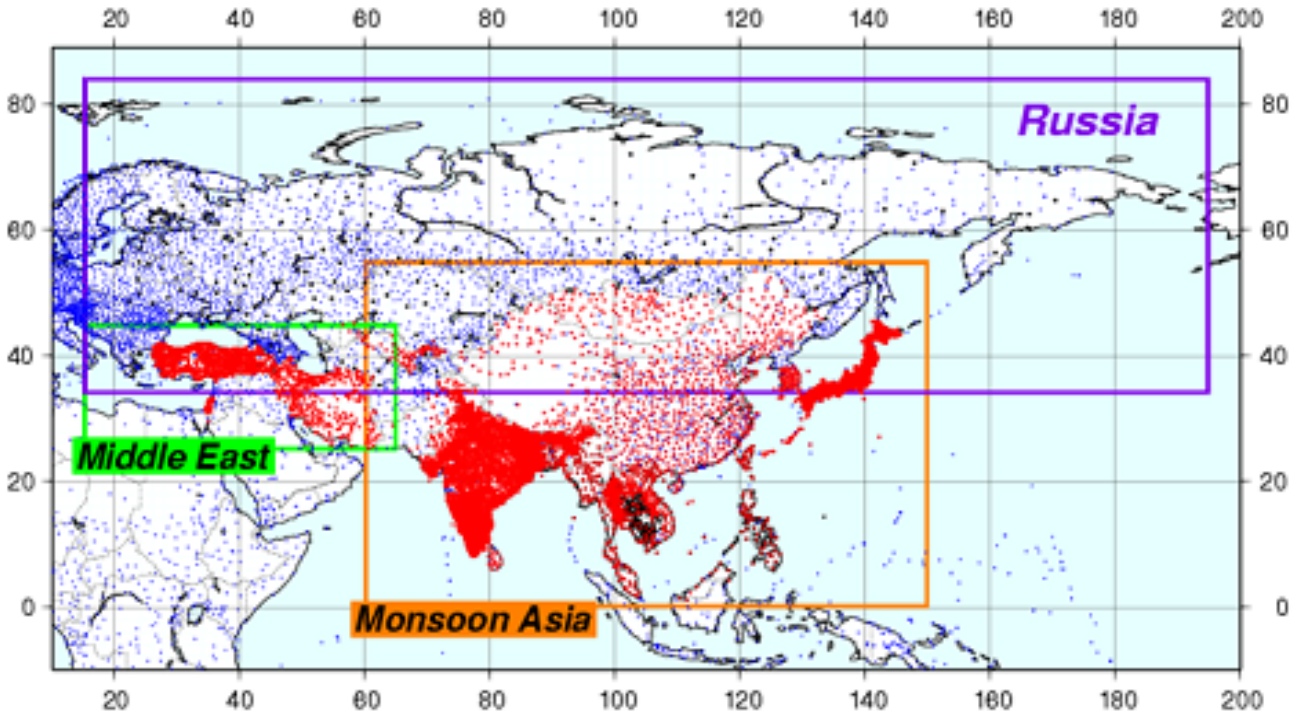
- Geographical complexities
  - Topography (NW; mountain, SE; flat, Remote effect of Tibet)
  - Land cover (N; grassland and forest, S; desert)
  - External forcing (NW; mid-latitude storm, SE; Asian Monsoon, land-ocean contrast)
- Limitation in available data and GCM resolution
- Large intra-seasonal and interannual variability

Investigating ability of regional climate model for this region to improve a performance for predicting flood/drought risks.

→ Preliminary results on dynamical downscale ability for warm season precipitation in Northeast/East Asia

Dataset for evaluation

- APHRODITE's water resources V0902 (Yatagai et al., 2009)
  - 0.25deg-mesh
  - Daily interval



- NCEP/DOE AMIP-II Reanalysis (Kanamitsu et al., 2002)
  - 1.875 deg-mesh
  - 6-hour interval

Setting in Control run

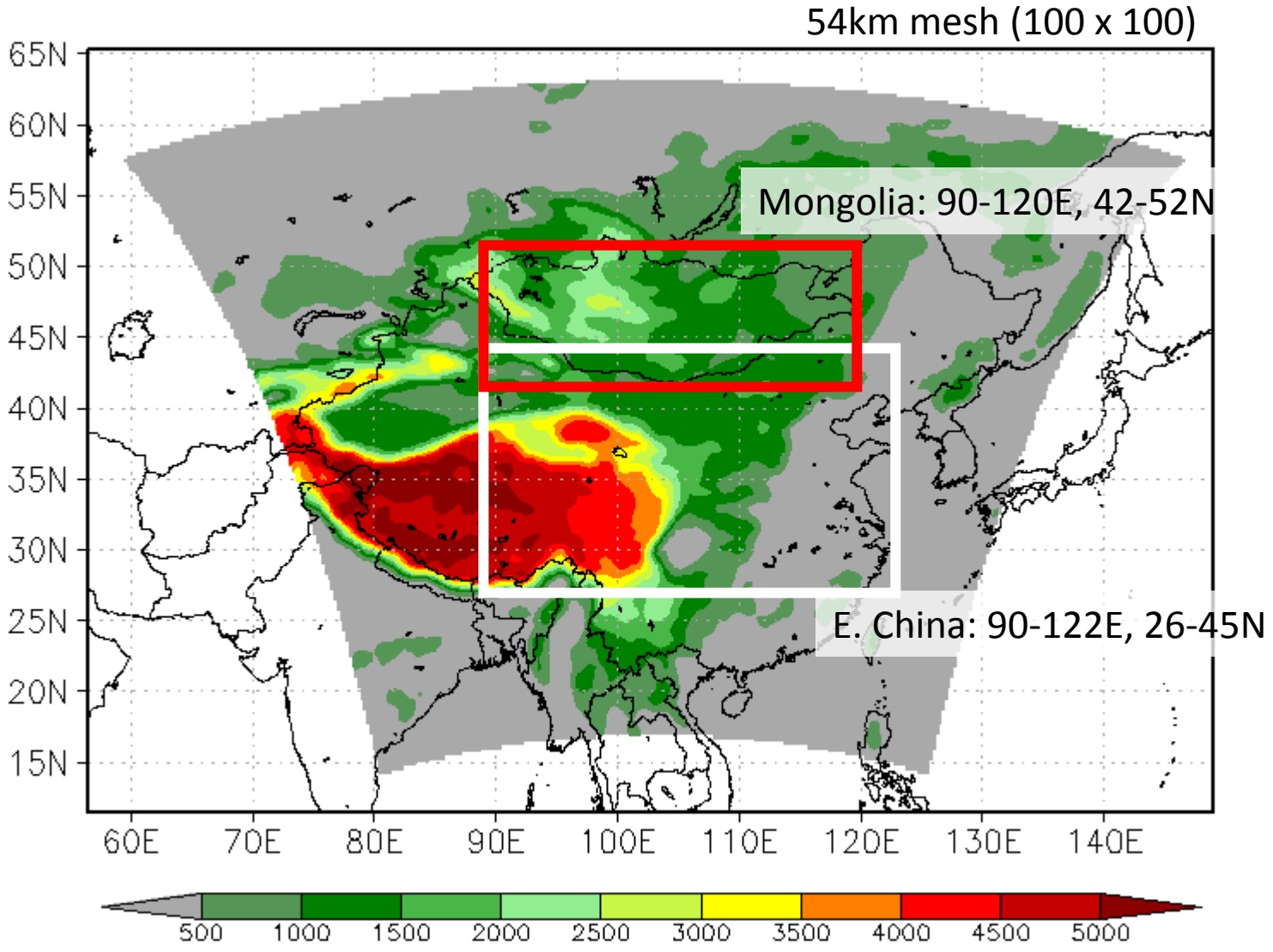
- WRF/ARW version 3.0.1 with SSiB version 3.
- Grid size is 54 km, and 100 x 100 grids
- Simulation starts 25 May 2001 through 1 September 2001.
- Initial and boundary forcing is provided by NCEP reanalysis 2.

List of sensitivity experiments

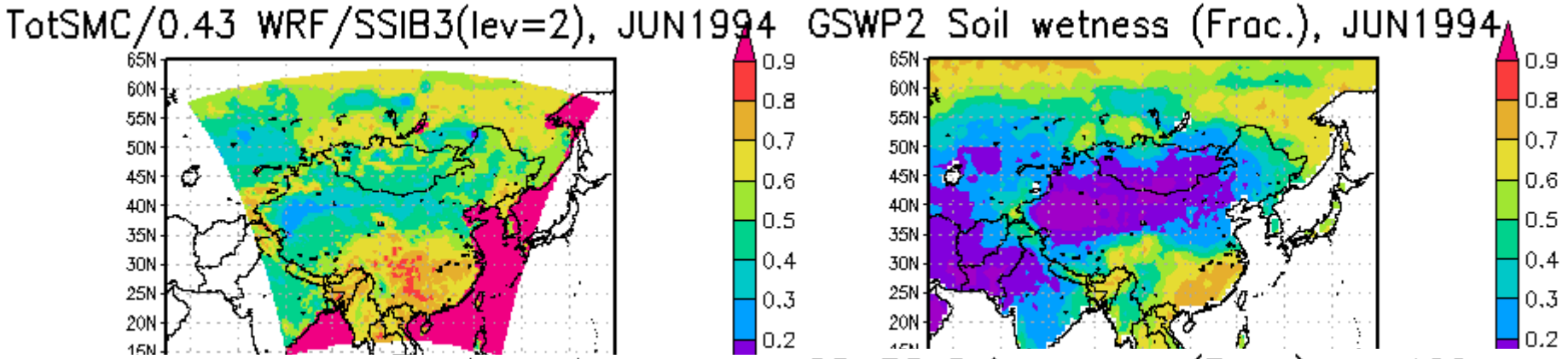
Run name	Land Surface scheme	Initial soil moisture
Control	**SSiB**	**NCEP2**
Noah	**Noah LSM**	NCEP2
GSWP	SSiB	**GSWP2 climatology for 3 layers**

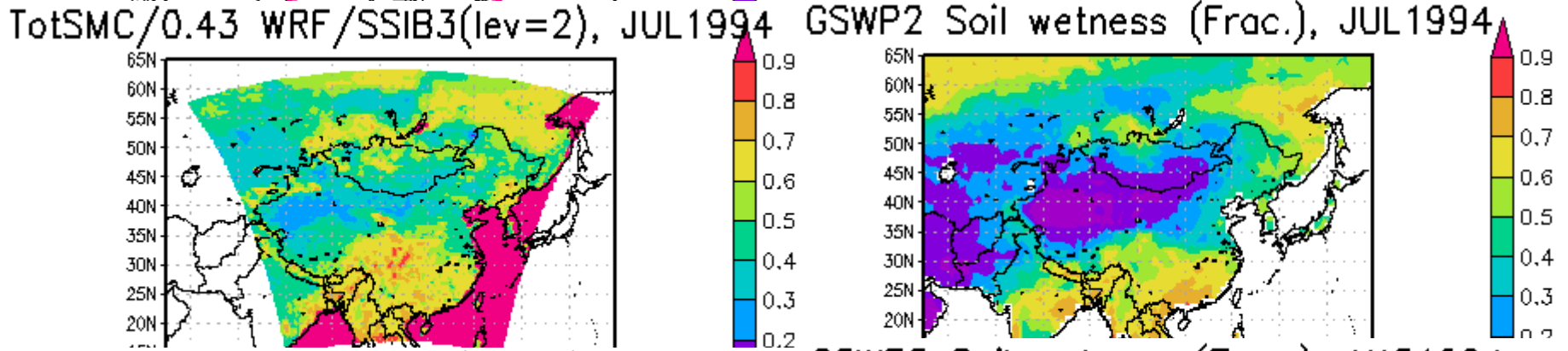
- Land surface: Simplified Simple Biosphere (SSiB)
- Cloud microphysics: WRF Single-Moment (WSM) 3-class simple ice scheme
- Cumulus: Kain-Fritsch
- Radiation: RRTM scheme (Longwave/Shortwave)
- Surface Layer: Monin-Obukhov Similarity scheme
- PBL: YSU boundary layer scheme

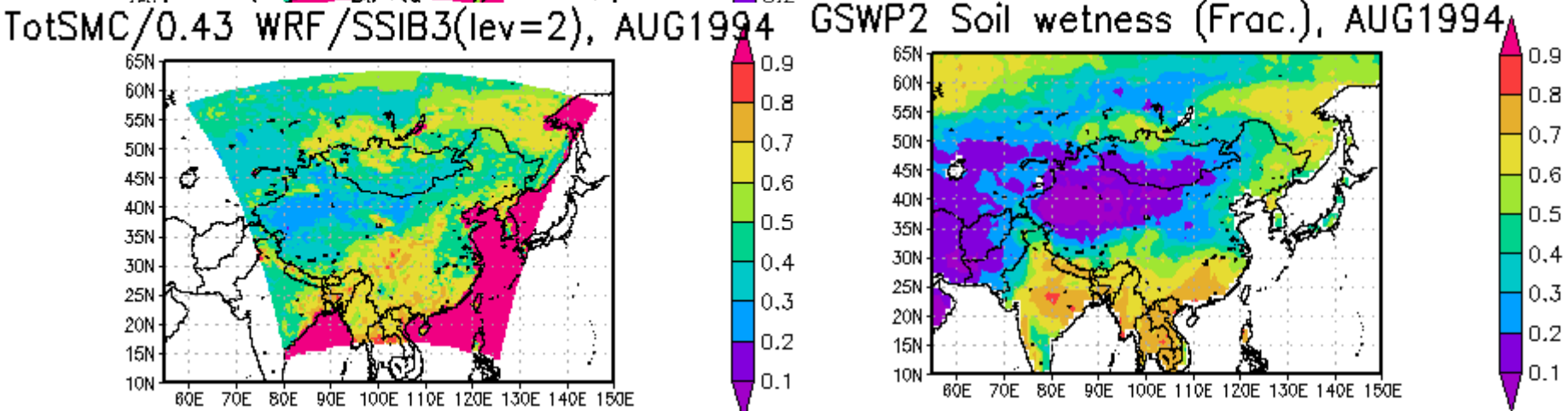
Model domain and area for analysis



Control (NCEP2 driven) **Soil Moisture** GSWP-2

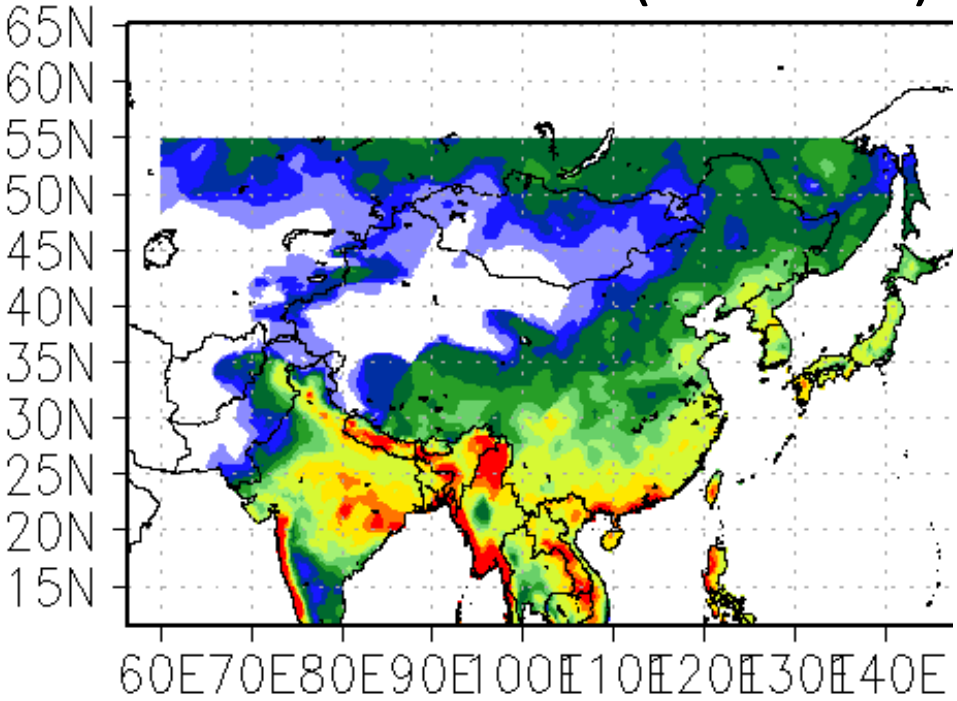




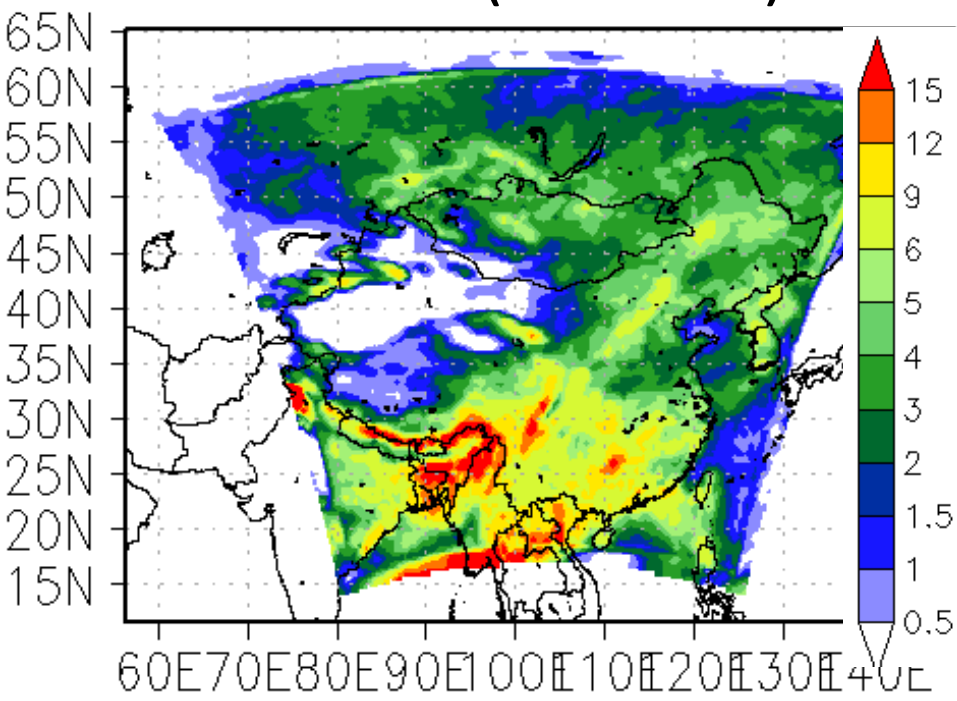


Evaluation of Control experiment

Pr. Observation (JJA 2001)

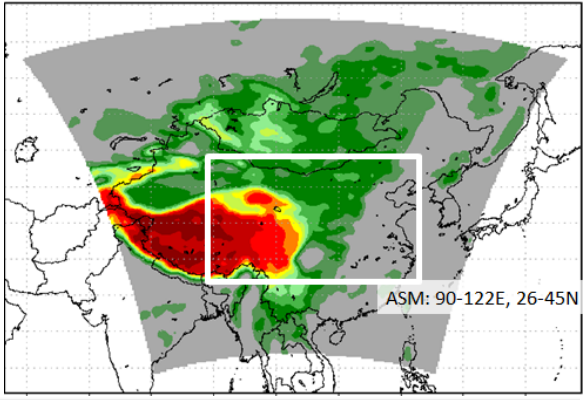


Pr. Control (JJA 2001)

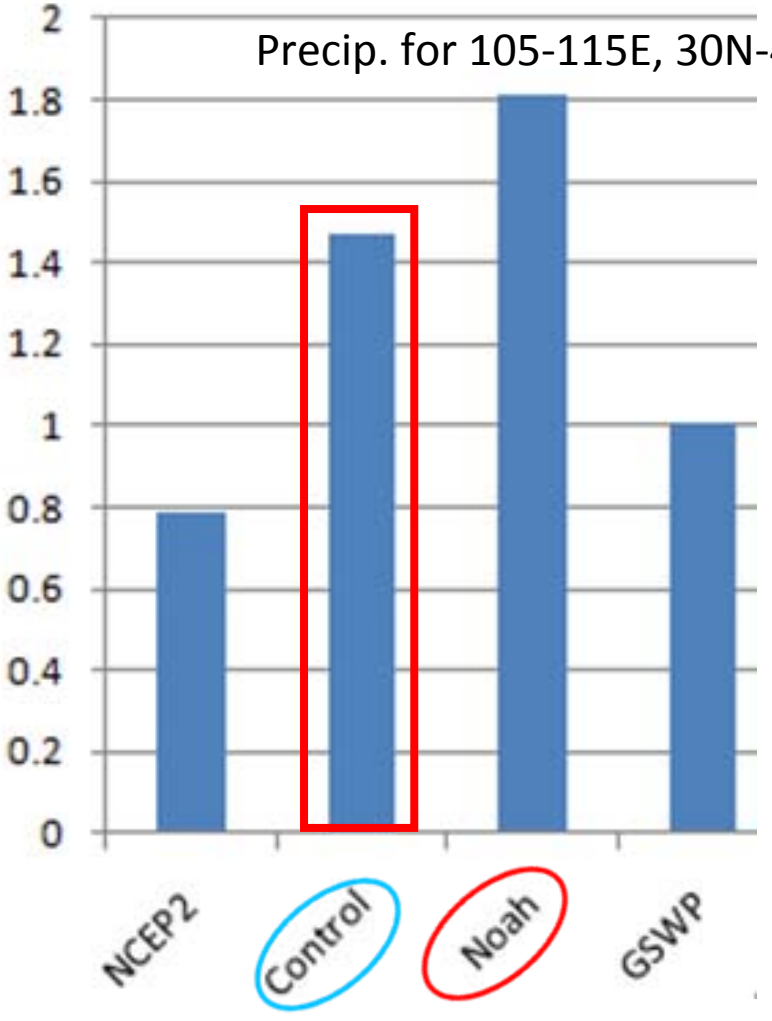


JJA-mean precipitation for **East China** in 2001

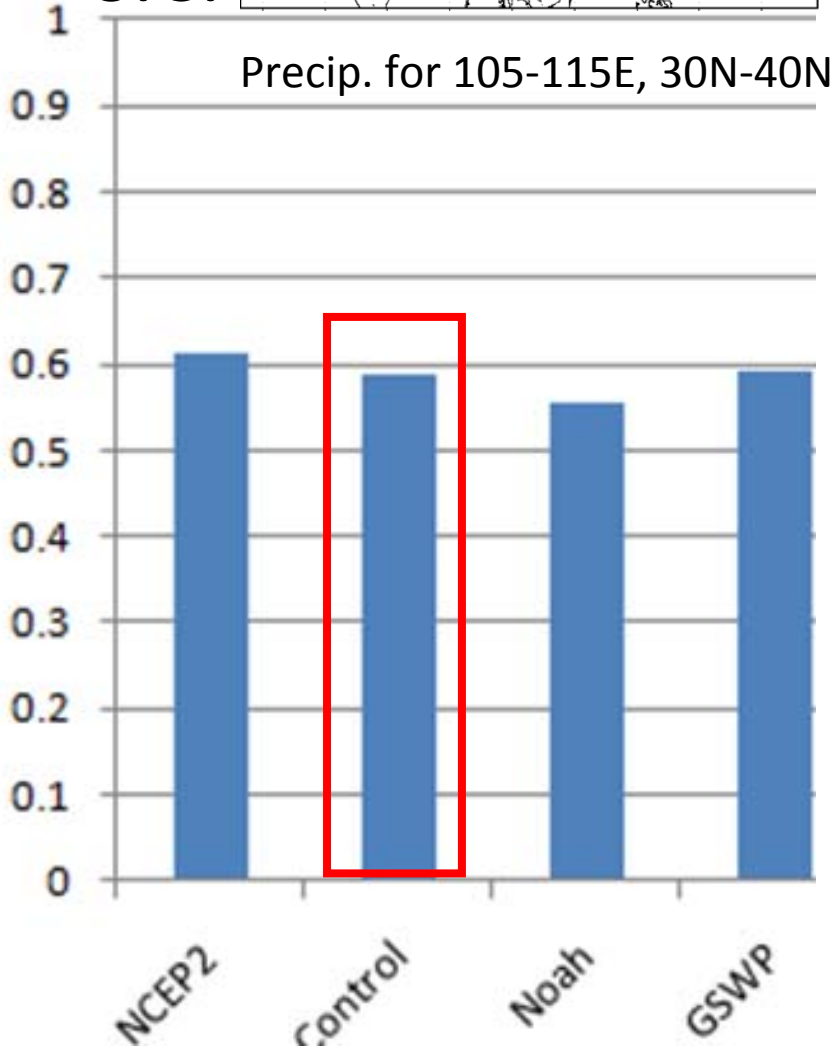
Reference is observation (APHRODITE)



[mm/d] Bias

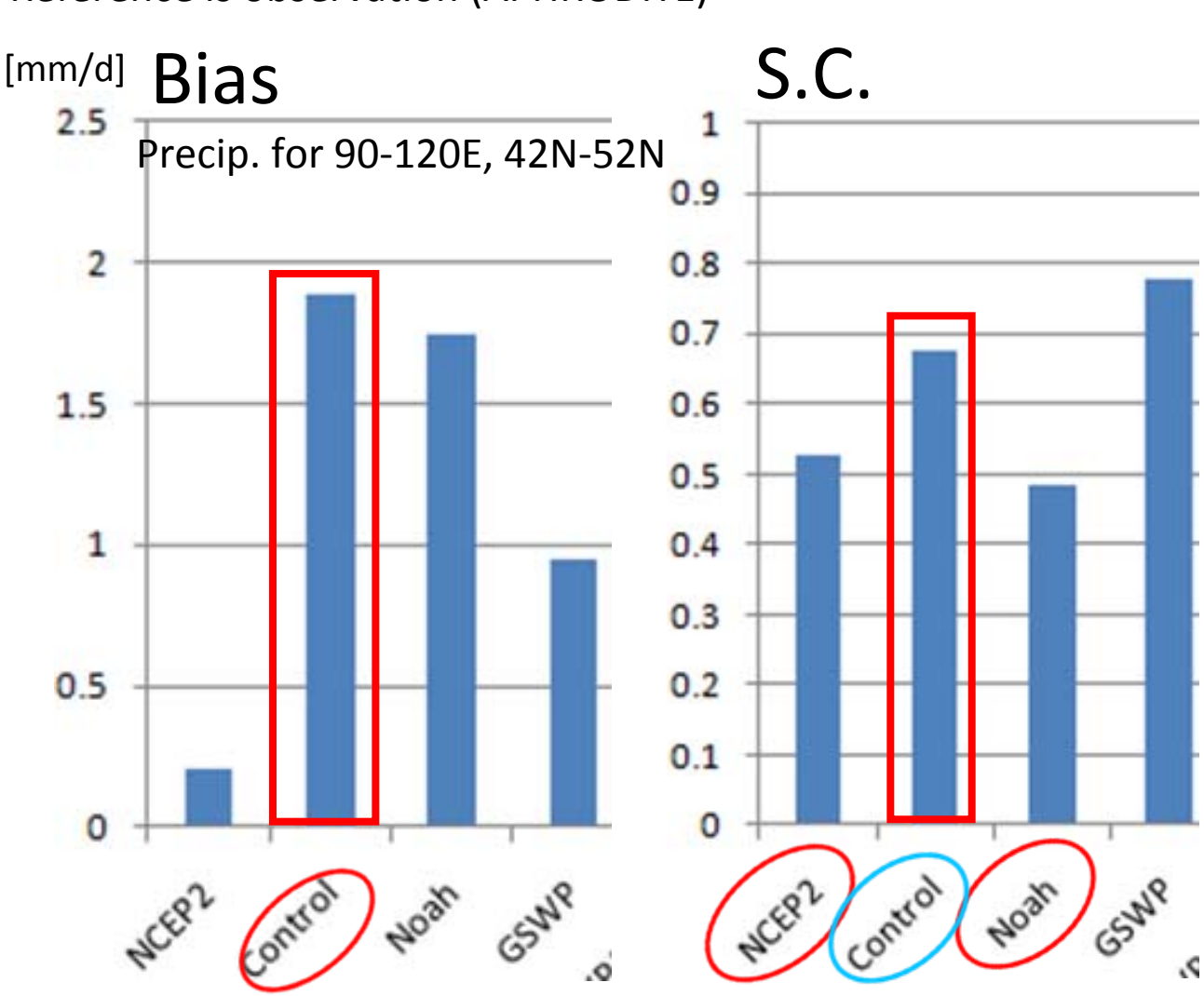


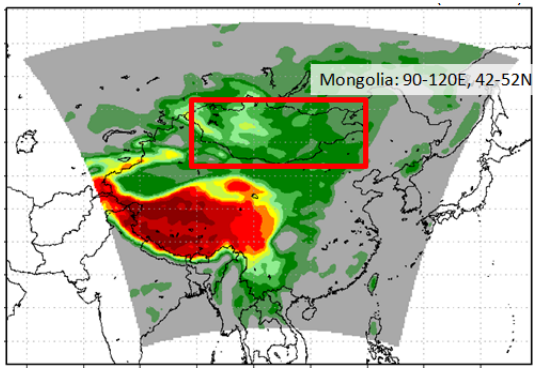
S.C.



JJA-mean statistics for **Mongolia** in 2001

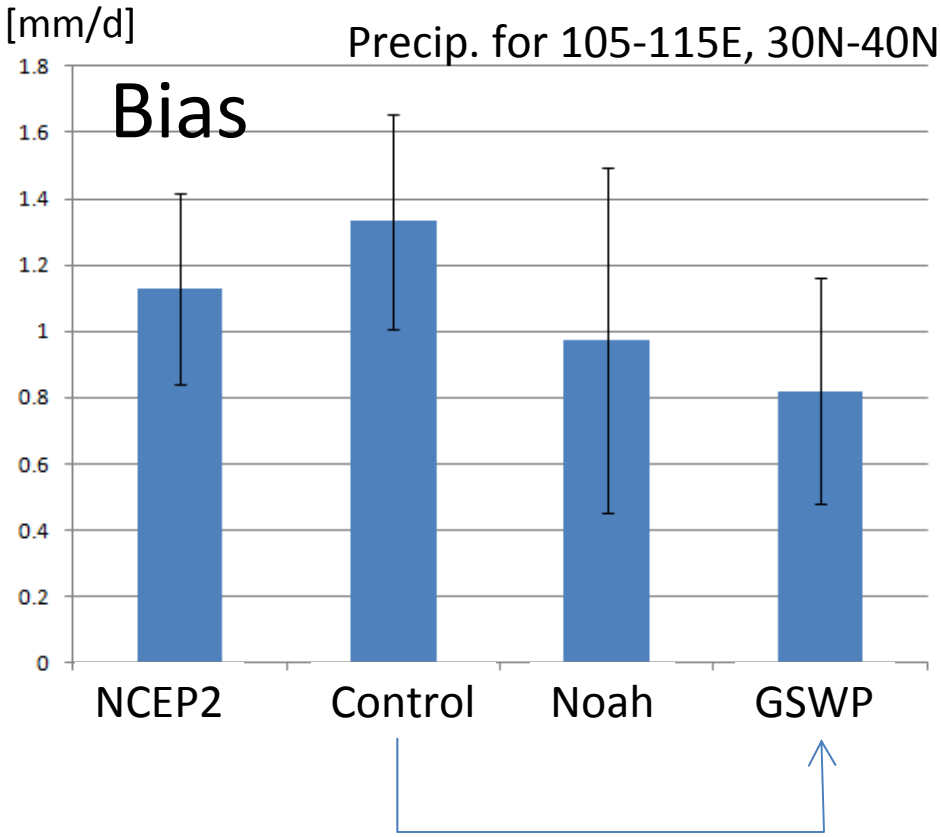
Reference is observation (APHRODITE)

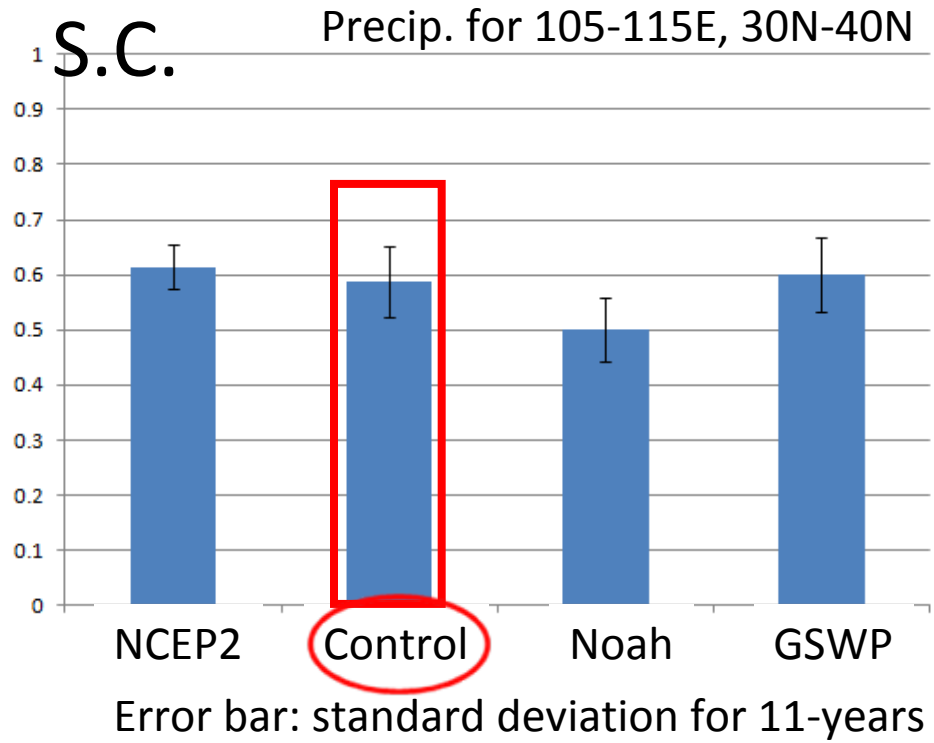




- Dynamical downscaling is very effective for reproducing spatial pattern in Mongolia in case SSiB is adopted.
- Use of realistic initial soil moisture improves the SC and BIAS significantly.

E. China statistics for 11 year integration

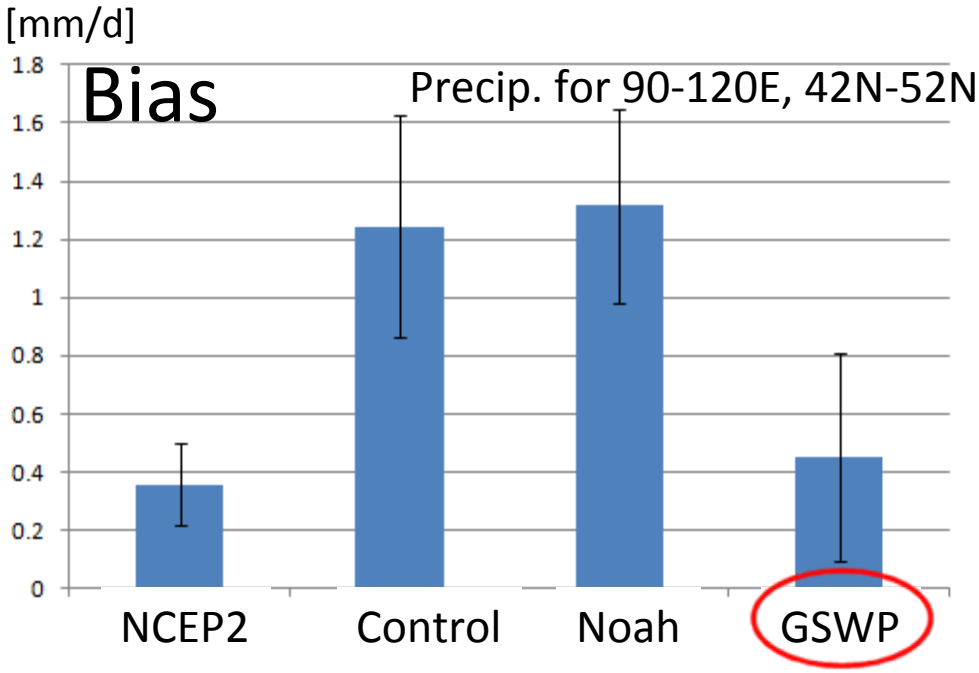


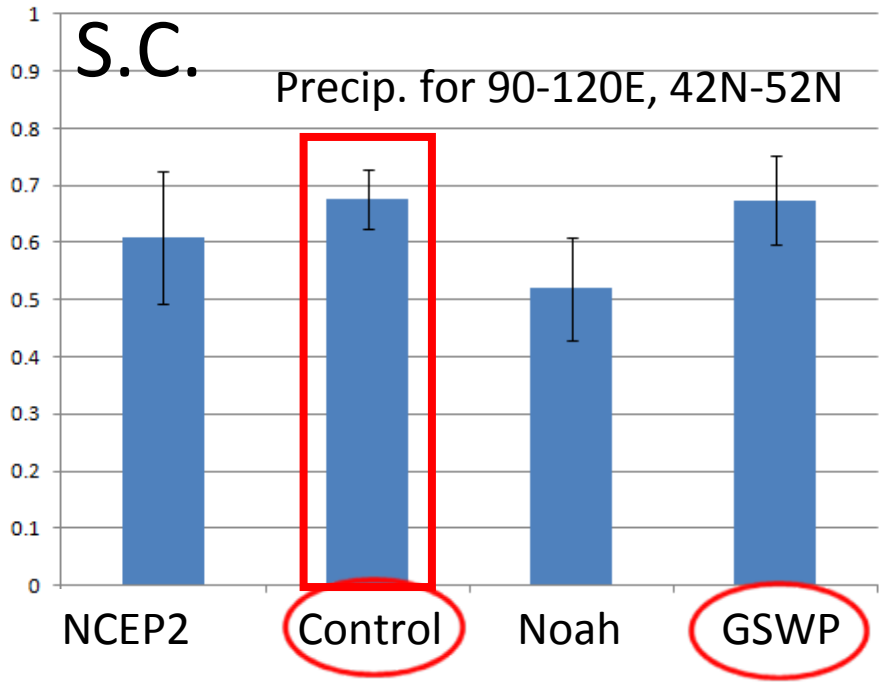


- SSiB has higher performance than Noah LSM
- WRF/ARW shows similar score for S.C. with reanalysis

Considering interannual variation for **Mongolia** in JJA

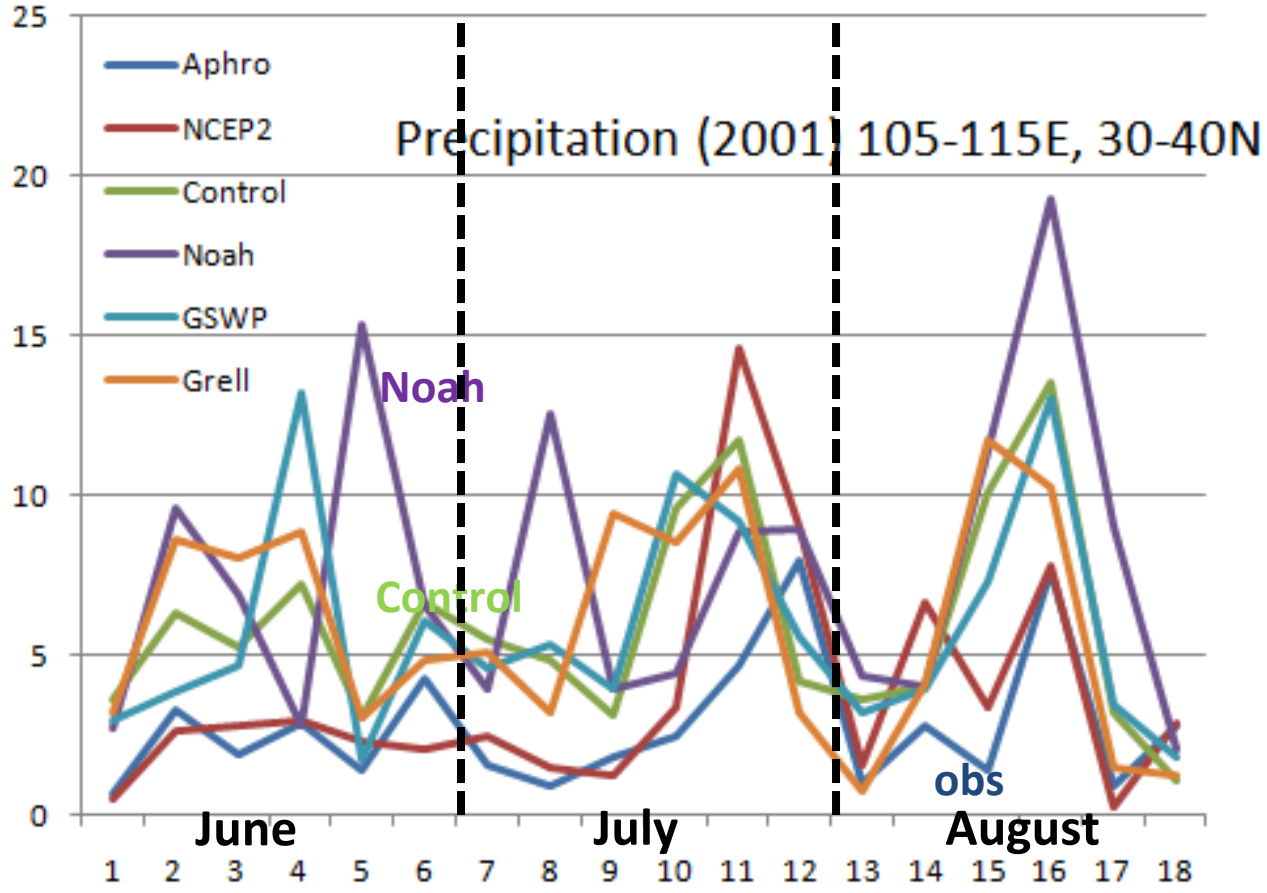
Observed data accounts for about 2 mm/d in JJA





Error bar: standard deviation for 11-years

- SSiB keeps higher spatial correlation for most years.
- Realistic initial soil moisture reduces model bias significantly even with a climatological mean value.

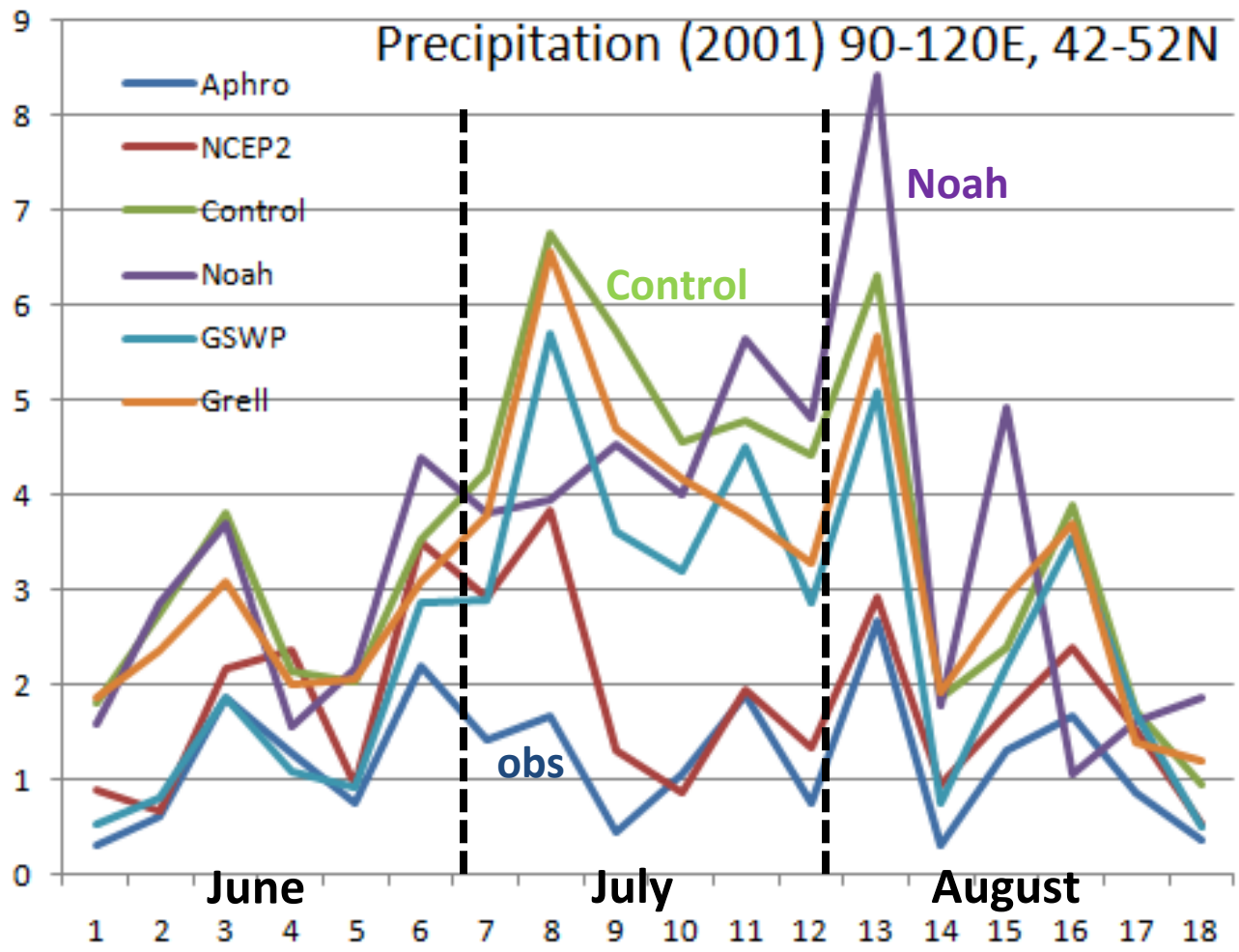


Intraseasonal variation in E. China

- SSiB simulates better intraseasonal change than Noah for all 11-years.
- GSWP does not always improve.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NCEP2	0.770964	0.542753	0.830591	0.836609	0.833047	0.805633	0.780982	0.765232	0.713823	0.830151	0.678001
Control	**0.634528**	**0.435079**	**0.431232**	**0.387671**	**0.638927**	**0.866117**	**0.583016**	**0.612346**	**0.472596**	**0.662363**	**0.660161**
Noah	0.387321	0.057137	-0.07274	0.290504	0.237218	0.721575	0.103816	0.181177	0.369002	0.142972	0.511247
GSWP	0.318995	-0.01742	0.531052	0.563893	0.782797	0.635857	0.495832	0.648149	0.434772	0.259021	0.578049

Intraseasonal variation in Mongolia



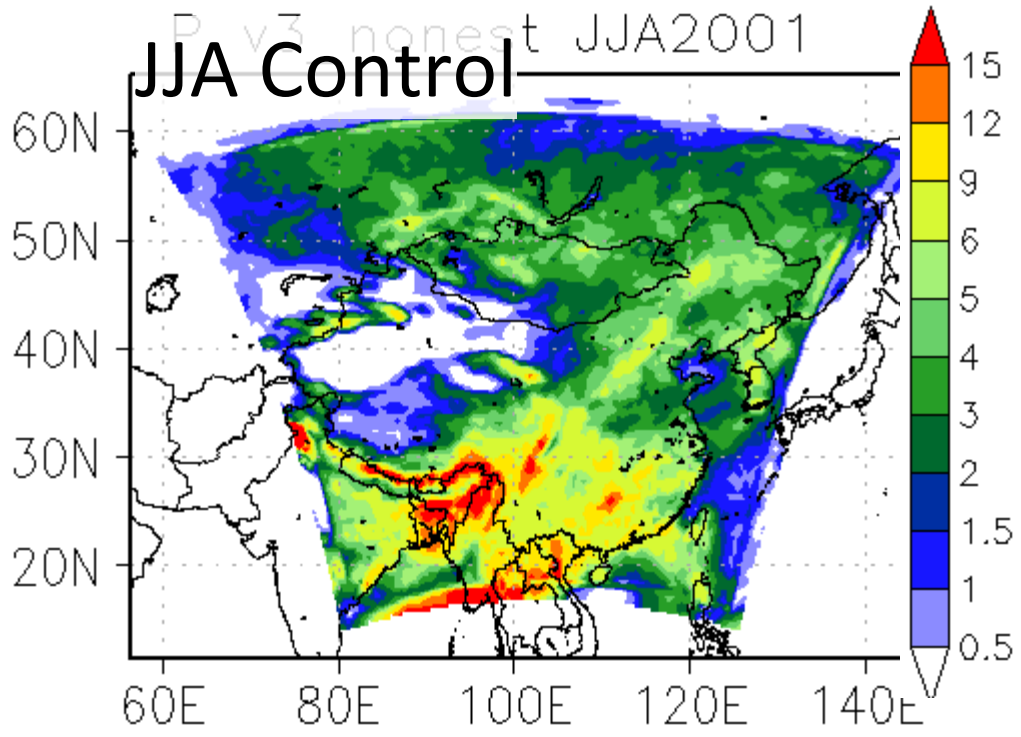
- Imapact of LSM strongly depends on the year
- Realistic initial soil moisture improves skill for intraseasonal variation

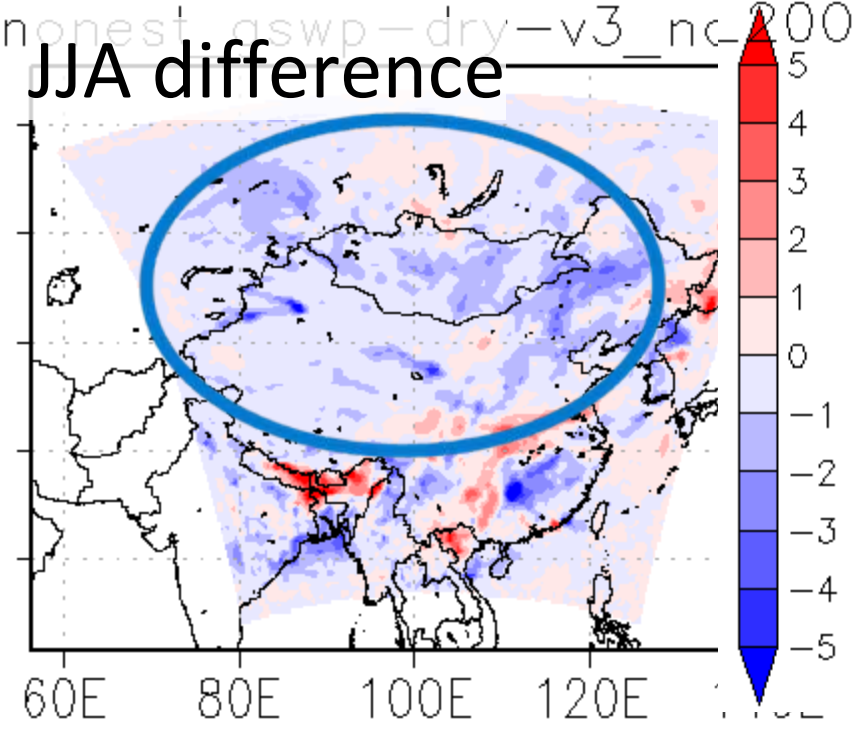
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NCEP2	0.936045	0.925071	0.881562	0.915196	0.949554	0.933038	0.762959	0.896354	0.817499	0.844011	0.939347
Control	0.639766	0.605748	0.245527	0.55541	0.553238	0.068659	0.465481	0.217598	0.574184	0.677733	0.756068
Noah	0.698346	0.249906	0.598591	0.497428	0.659302	0.685642	0.516351	0.178488	0.609357	0.702606	0.582296
GSWP	**0.645284**	**0.63483**	**0.411662**	**0.590456**	**0.456498**	**0.631894**	**0.327728**	**0.547805**	**0.67399**	**0.629147**	**0.783578**

Conclusion

- Regional climate model has high ability for simulating East/North Asian precipitation in terms of **spatial pattern**.
- Initial **soil moisture** has large impact for reducing precipitation bias for E. China and Mongolia.
- Land surface scheme causes a significant difference in precipitation pattern for E. China and Mongolia by modulating surface flux and ASM flow.
- Additional experiment will be carried out by using corrected initial soil moisture for each year.

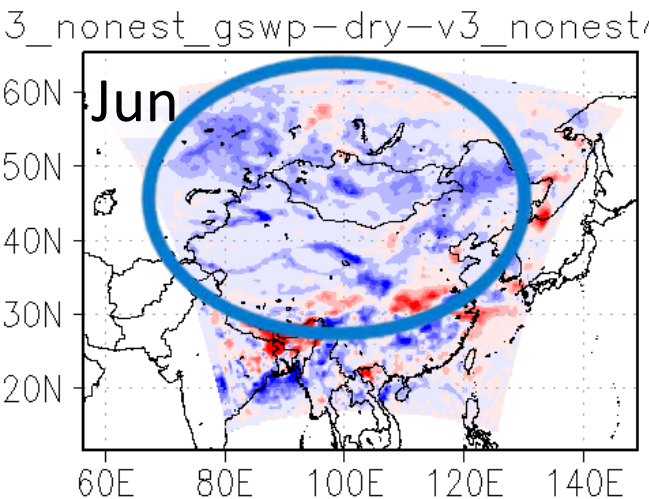
	SSiB	Noah	SSiB-GSWP(clim)	SSiB-GSWP
E. China mean state	○	△	◎	???
Mongolia mean state	○	△	◎	???
E. China intraseasonal	○	△	○	???
Mongolia intraseasonal	△	△	◎	???

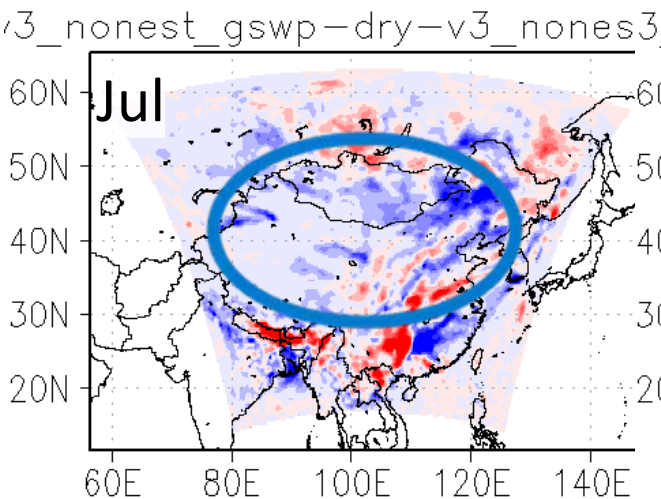


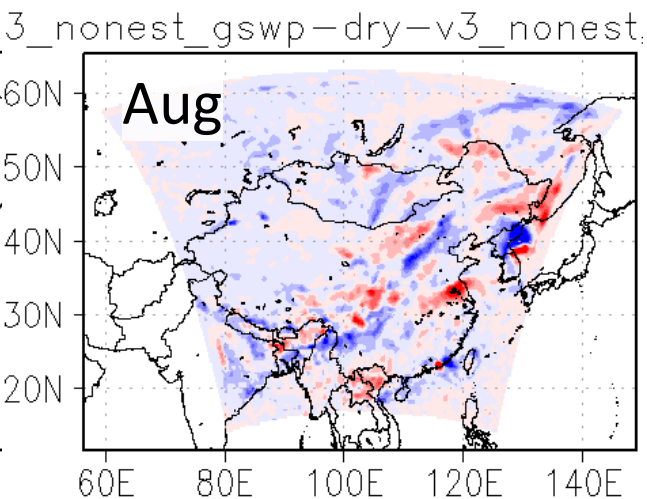


Soil moisture effect (GSWP3 - Control)

Decrease precipitation in inland area, especially in Jun-Jul.



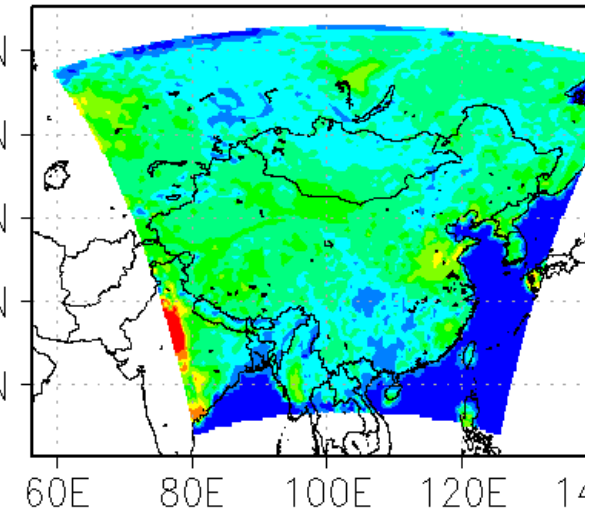




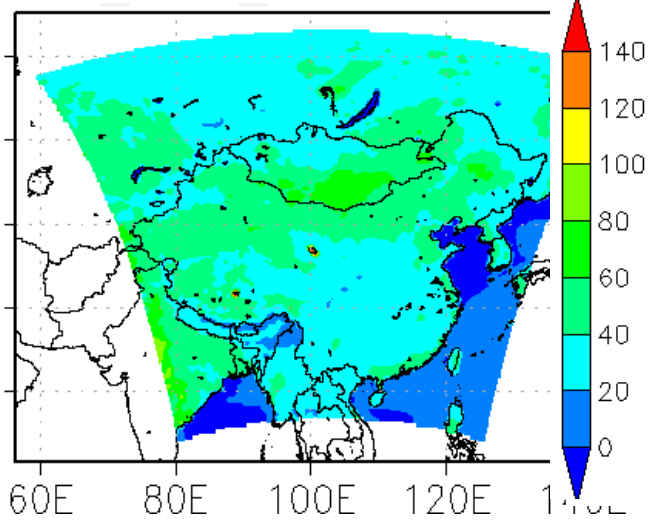
Surface heat fluxes (LSM difference)

JJA2001

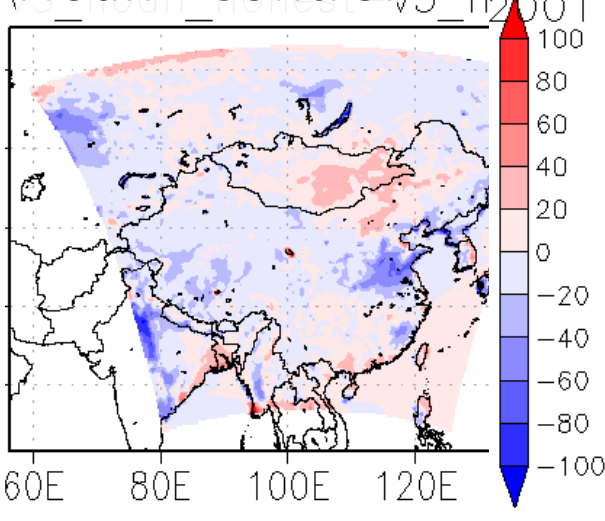
Sensible heat (Control)



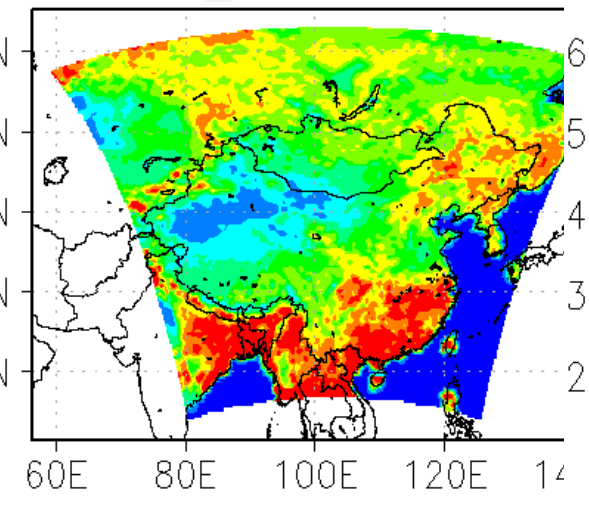
Sensible heat (Noah)



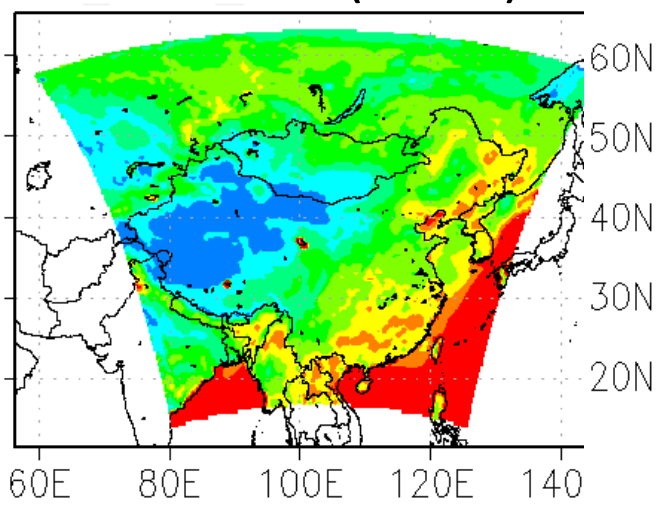
Noah - Control



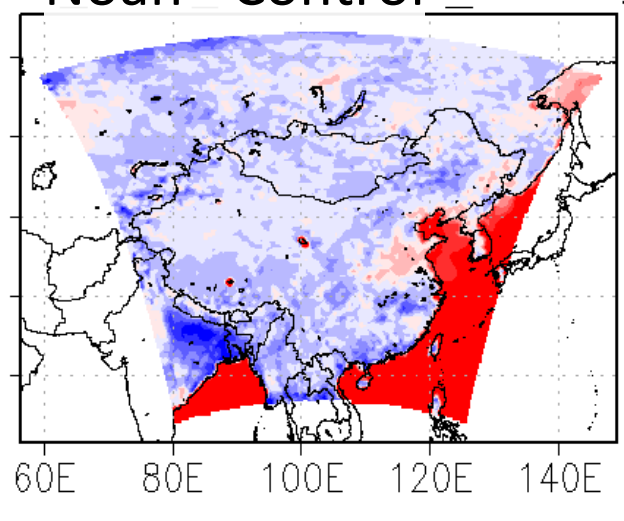
Latent heat (Control)



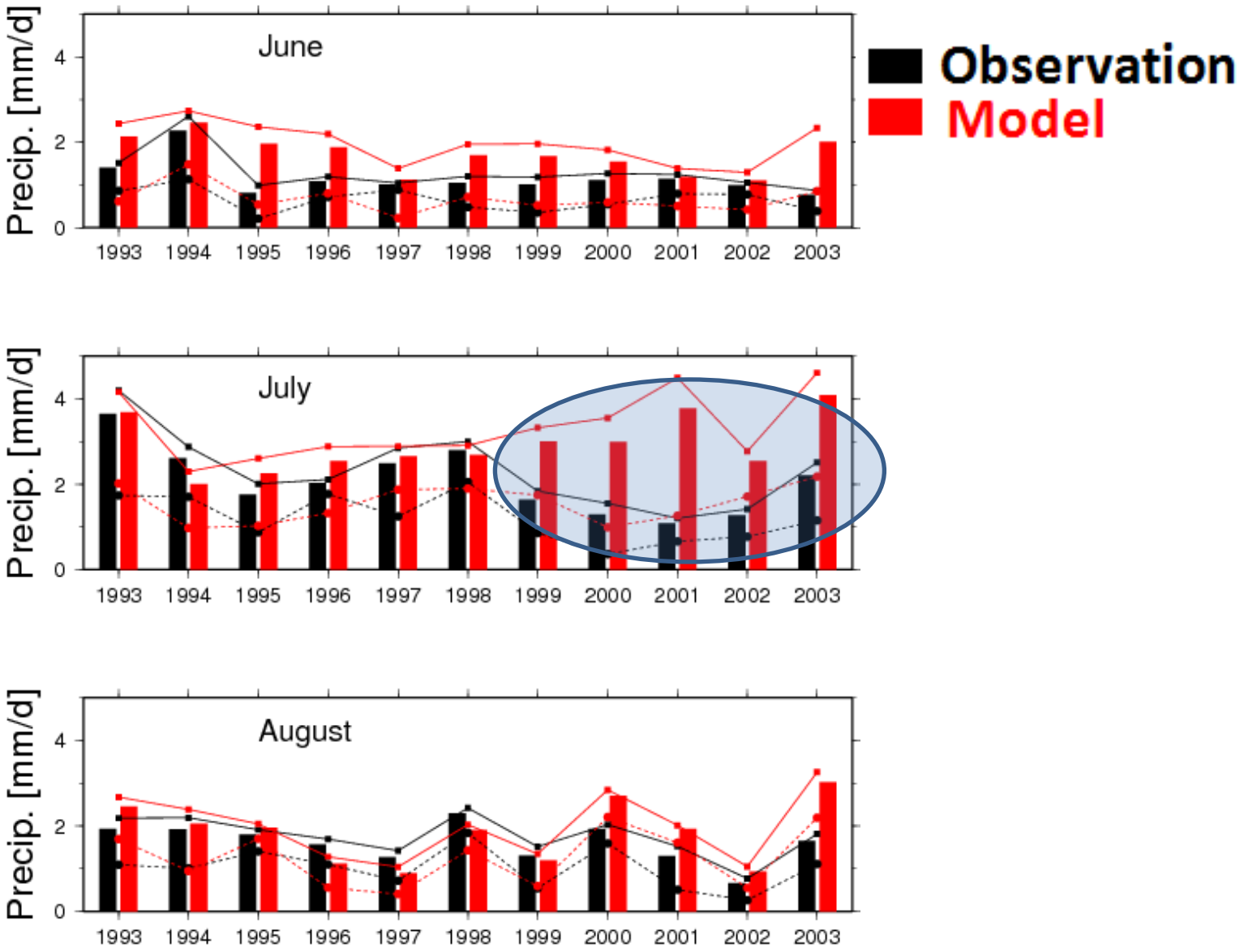
Latent heat (Noah)

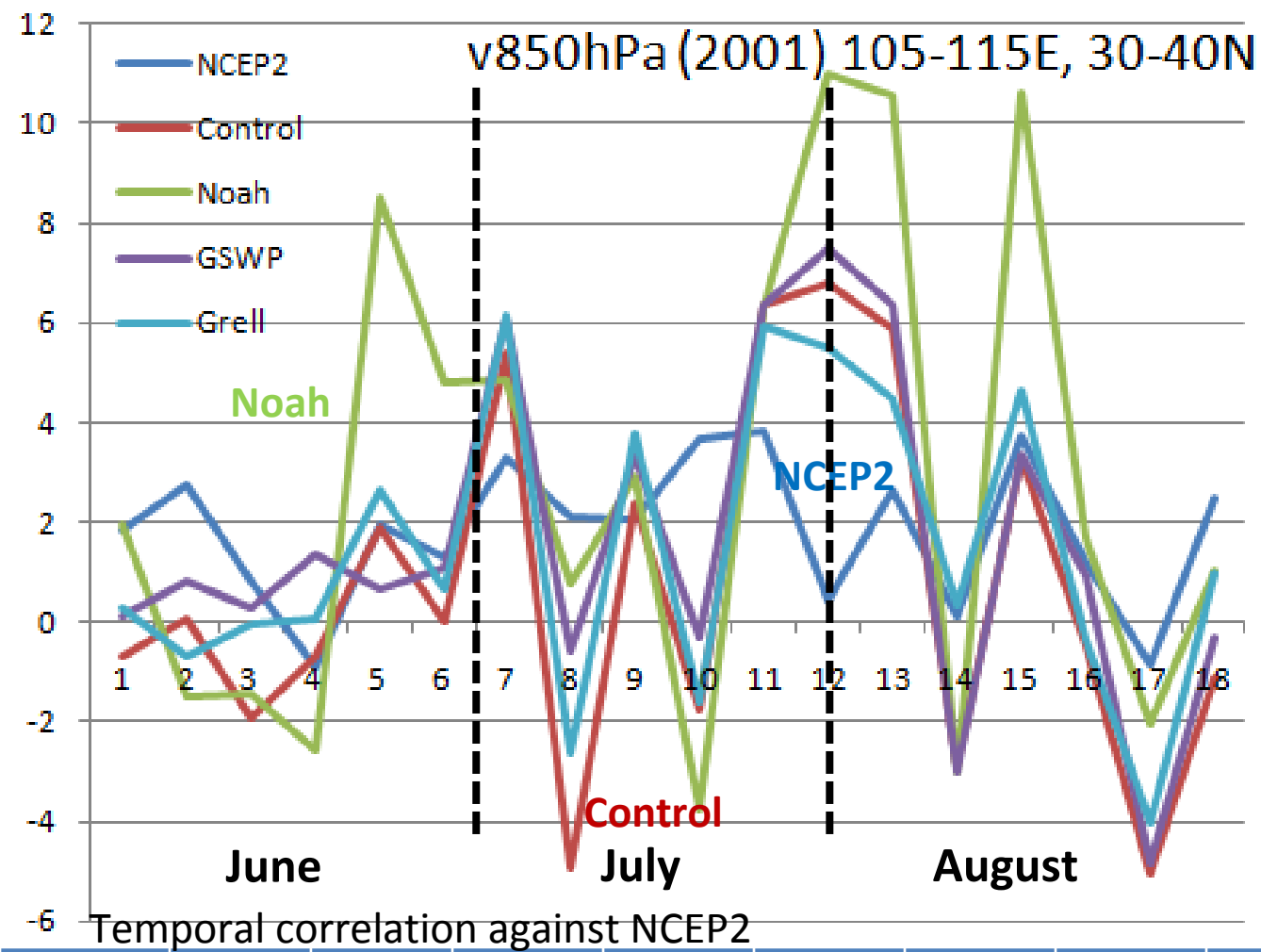


Noah - Control



Why climate models are not able to reproduce Mongolian precipitation for **dry years** in **July**? → **Theme for future study**





N.E. China Monsoon flow

- SSiB simulates better intra-seasonal variation in most years.
- Responses to initial soil moisture and cumulus scheme vary year by year.

Temporal correlation against NCEP2

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NCEP2	1	1	1	1	1	1	1	1	1	1	1
Control	**0.741122**	**0.55552**	**0.798476**	**0.800875**	**0.834408**	**0.746221**	**0.361219**	**0.779272**	**0.447433**	**0.176727**	**0.769717**
Noah	0.241353	0.610305	0.555463	0.551993	0.541887	0.415647	0.253135	0.718612	0.359703	0.24945	0.689942
GSWP3	0.673522	0.648355	0.813582	0.754953	0.854855	0.773705	0.38278	0.783368	0.452324	0.423968	0.661194

SOIL moisture correction