S2S conference 09/18/2018

Theme A2: Modelling issues in S2S prediction

Process-based MJO hindcast evaluation in SubX

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Kathy Pegion (George Mason Univ.), Deepthi Achuthavarier (GMAO/NASA GSFC)

* Kim, Vitart, Waliser, 2018: Prediction of the Madden-Julian Oscillation: A Review (*J. Climate*)

Subseasonal Experiment (SubX)

- Funded by NOAA, NWS, ONR, NASA
- Seven prediction systems/models
- Real-time forecast
- 17 years of retrospective forecast (1999-2015/16)

MODELS:

- NCEP Environmental Modeling Center, Global Ensemble Forecast System (EMC-**GEFS**)
- NASA GMAO Goddard Earth Observing System, version 5 (GMAO-**GEOS5**)
- Naval Research Laboratory, Navy Earth System Model (NRL-**NESM**)
- NCAR CCSM version 4 run at the University of Miami (RSMAS-**CCSM4**)
- NOAA Earth System Research Laboratory (ESRL) (ESRL-**FIM**)
- NCEP Climate Forecast System, version 2 (NCEP-CFSv2)
- Environmental and Climate Change Canada Global Ensemble Model (ECCC-GEM)

Pegion et al. (BAMS, in prep)

Data

Eight Subseasonal Hindcasts

Model	Ens size	Initialization Interval	Hindcast period	Source
SubX (GEFS, GEOS5, FIM, NESM, CCSM4)	3~10	5~7 days	1999-2015/6	SubX
NCAR CESM1 (L30,L46)	20	1/week	1999-2015	SubX
ECMWF Cy43R3	11	2/week	1997-2016	S2S
UKMO/KMA GloSea5-GC2	3	4/month	1991-2010	S2S

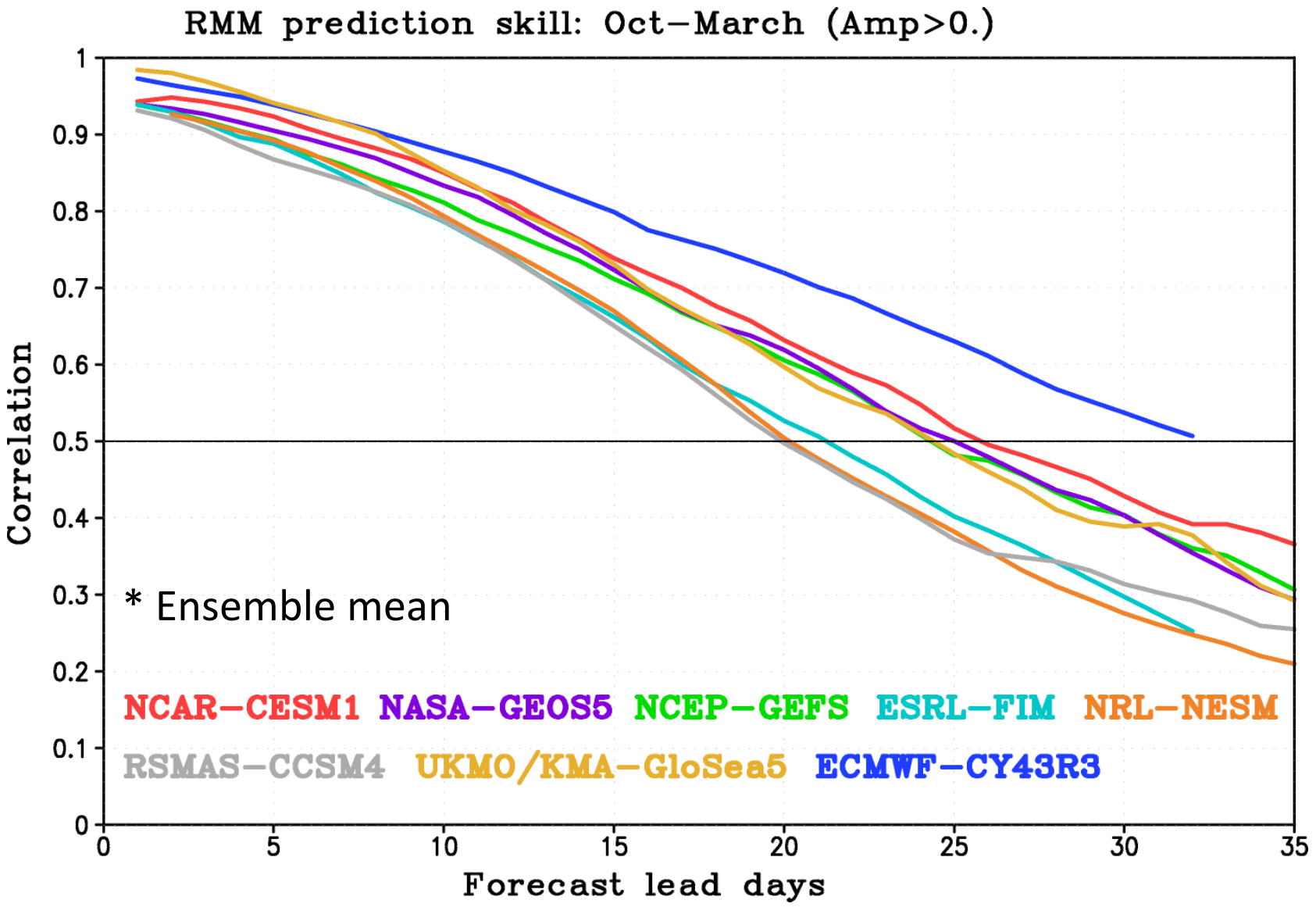
SubX: http://cola.gmu.edu/kpegion/subx/
S2S: http://s2sprediction.net/

- RMM index (Wheeler and Hendon, 2004)

- Verification data: ERA Interim, NOAA CDR OLR, GPCP daily precipitation (1979~2017)

- October to March (boreal winter only)

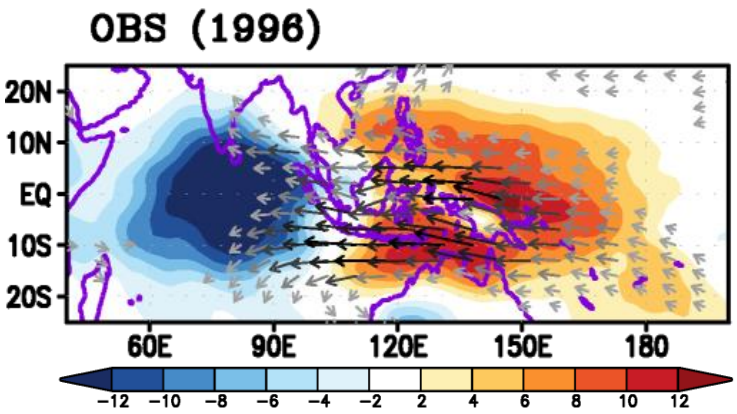
MJO prediction skill

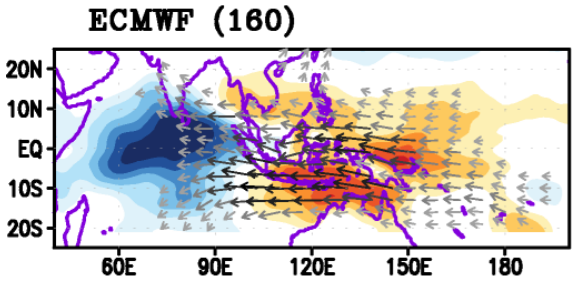


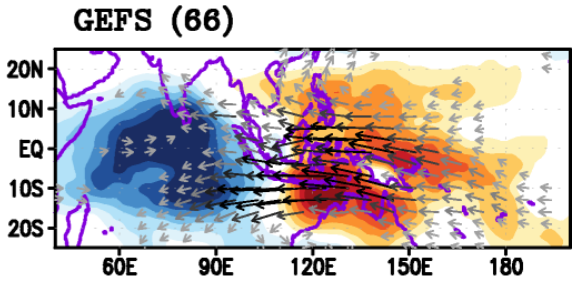
MJO propagation

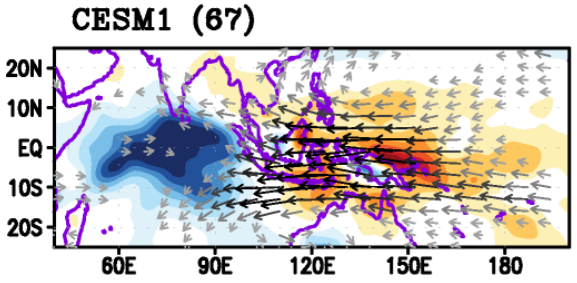
Forecast DAY **01**

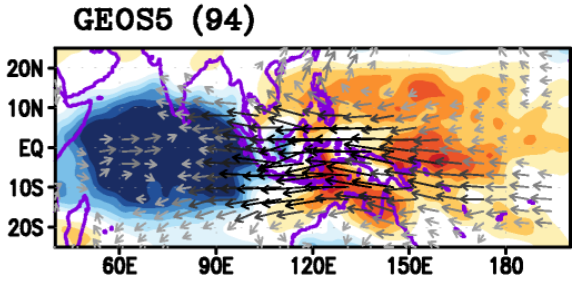
OLR & 850hPa Wind ano

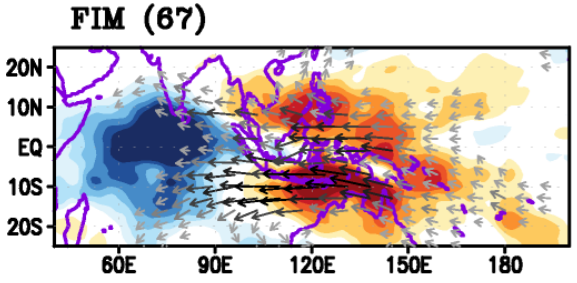


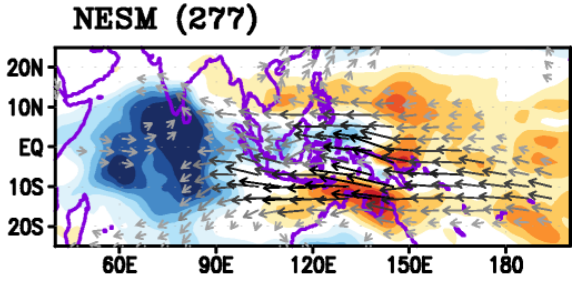


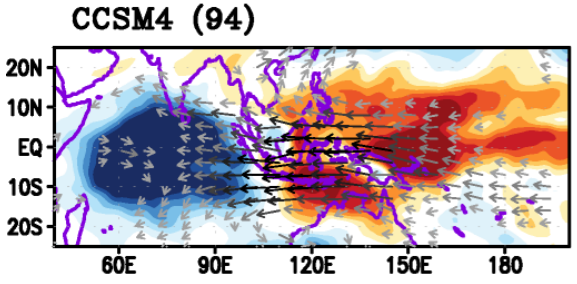


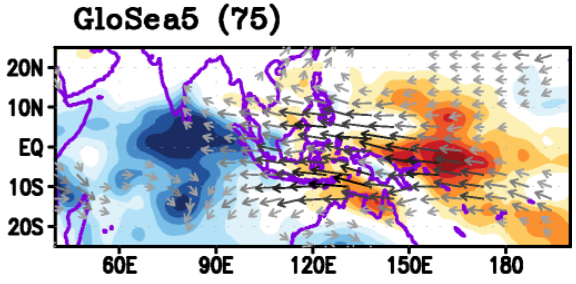












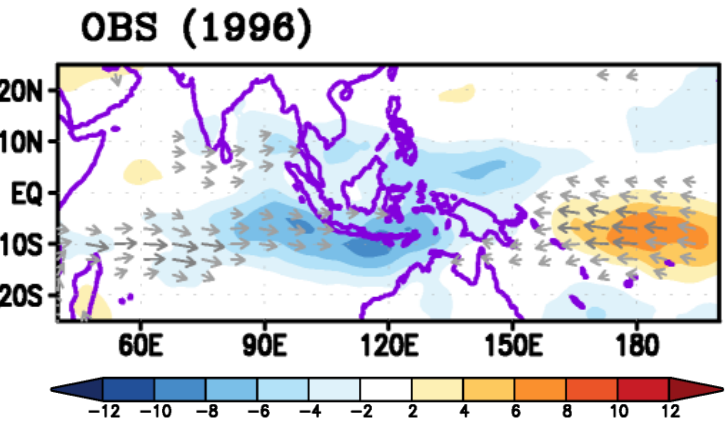
*** MJO event selection**

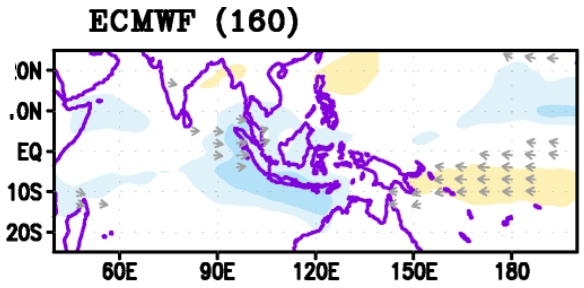
- Initial Phase 1 & 2
- Strong MJOs (RMM amp>1.0)
- Number of events

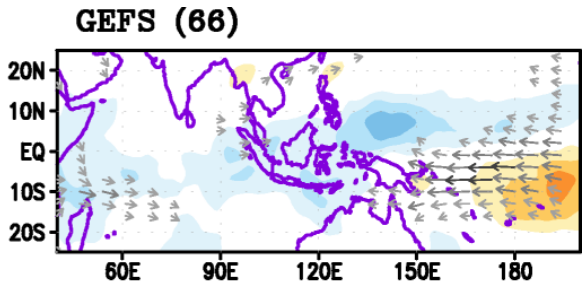
MJO propagation

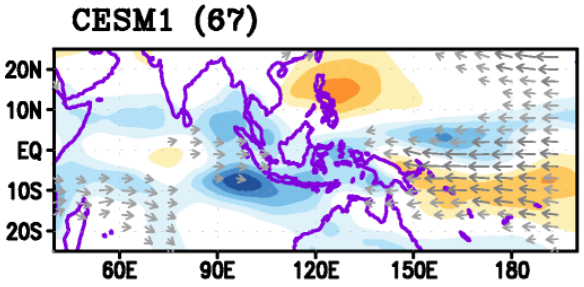
Forecast DAY **10**

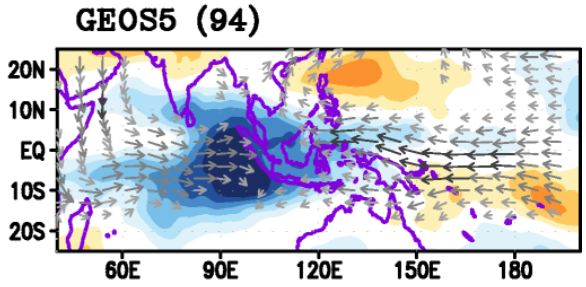
OLR & 850hPa Wind ano

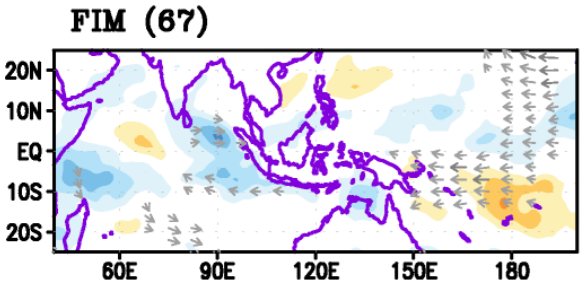


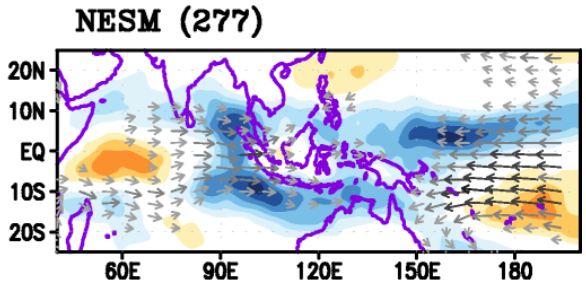


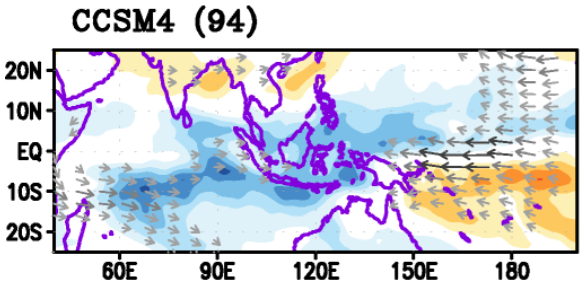


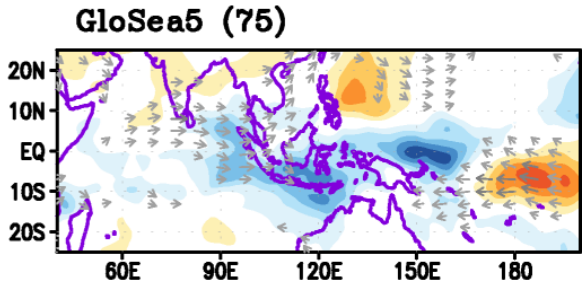












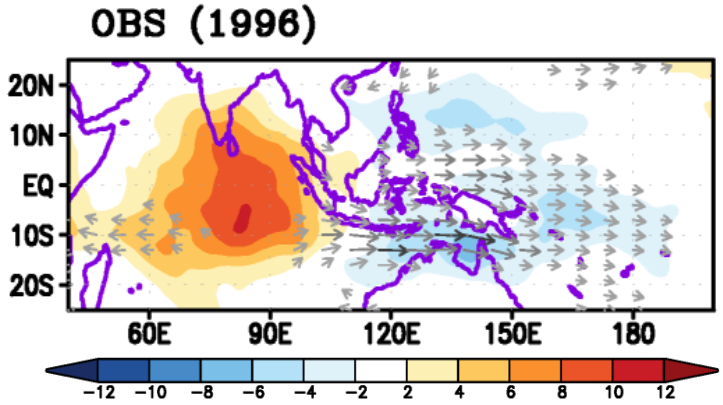
* **MJO detours** the Maritime Continent **southward** during boreal winter

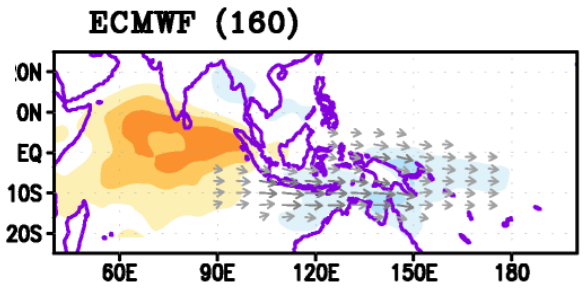
(e.g., Lau and Chen 1985, D. Kim et al. 2017)

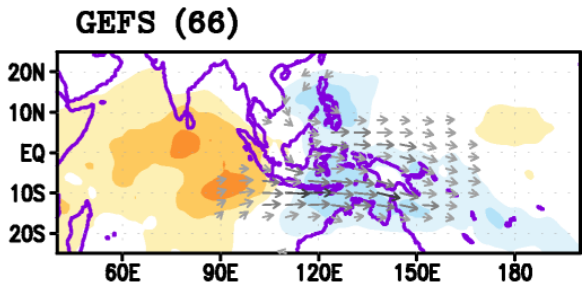
MJO propagation

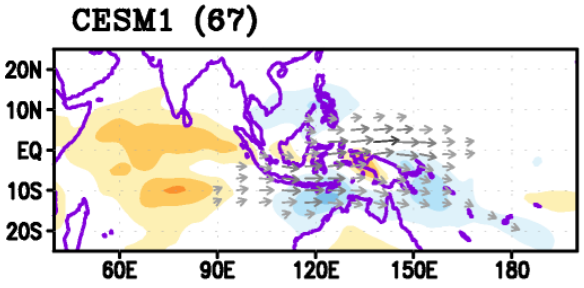
Forecast DAY **20**

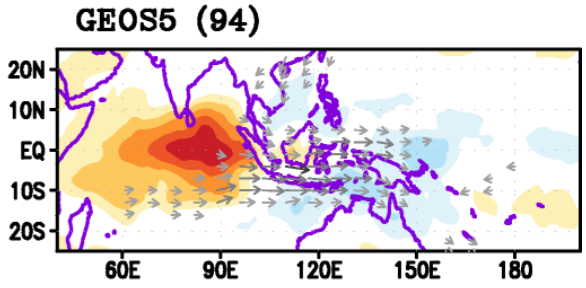
OLR & 850hPa Wind ano

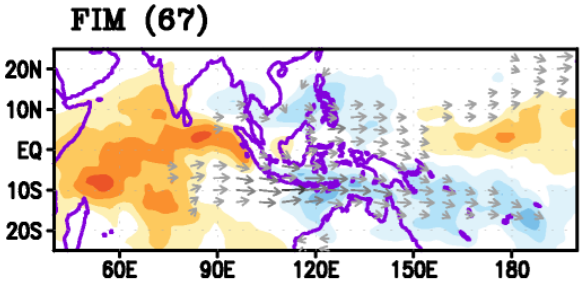


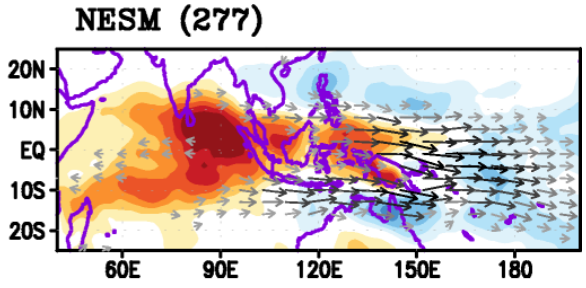


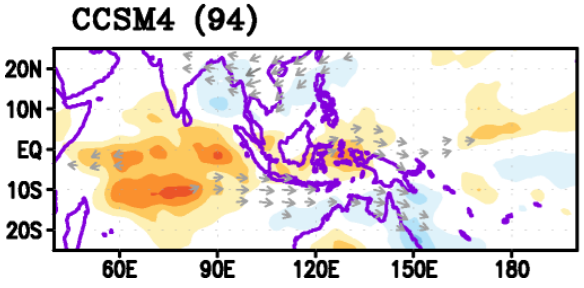


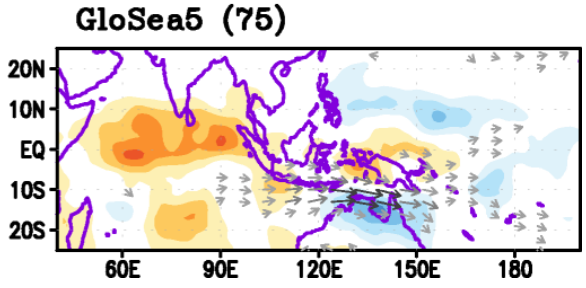








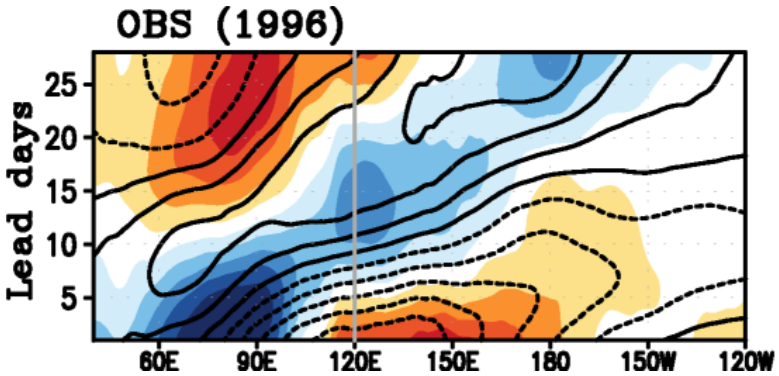




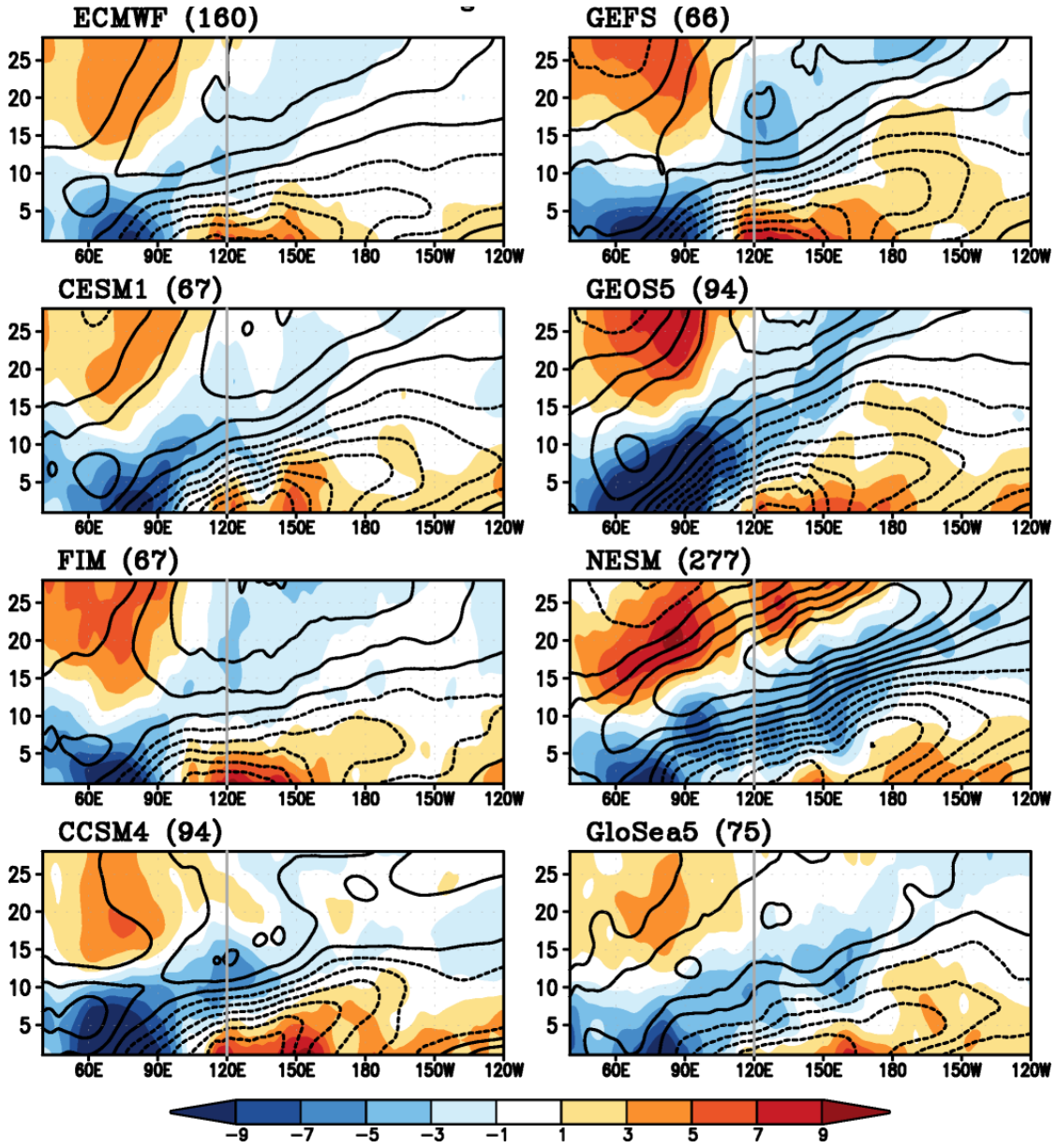
MJO propagation

Longitude-forecast time
OLR & U850

[20°S-10°N average]

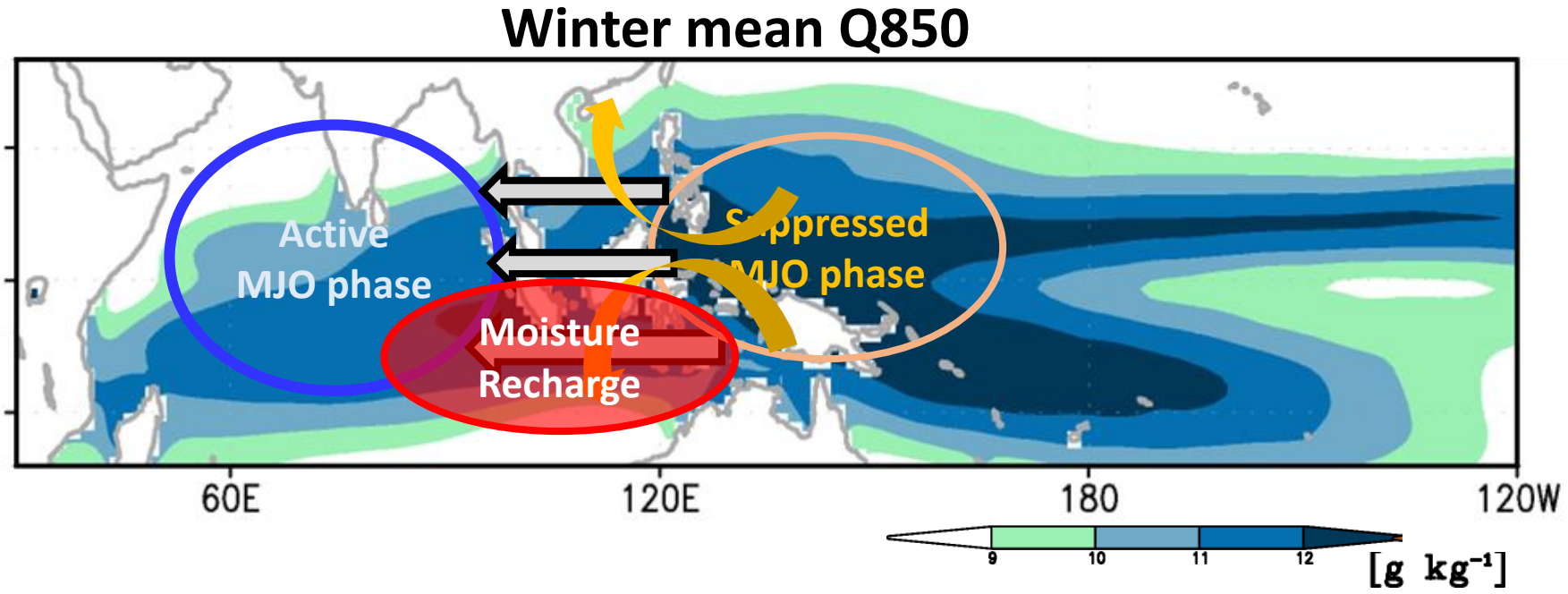


* MJO Phase & amplitude error in models

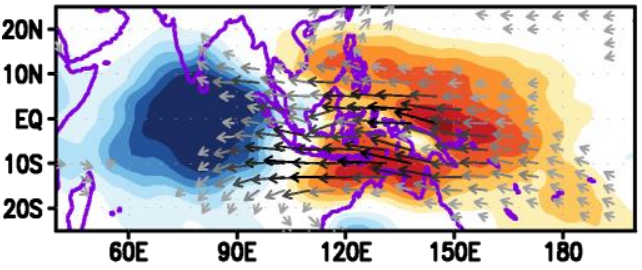


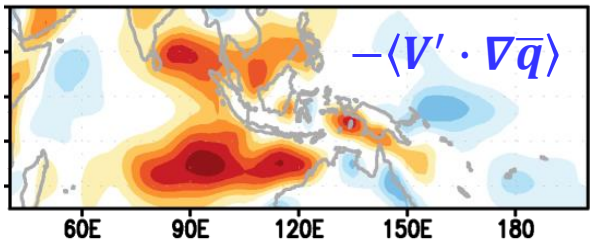
Moisture Recharge Process

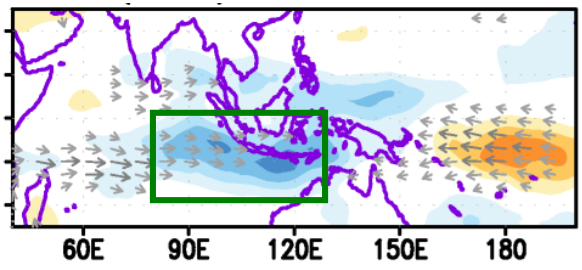
Observation



MJO (day 01) → Moisture recharge (day 01) → MJO detours (day 10)

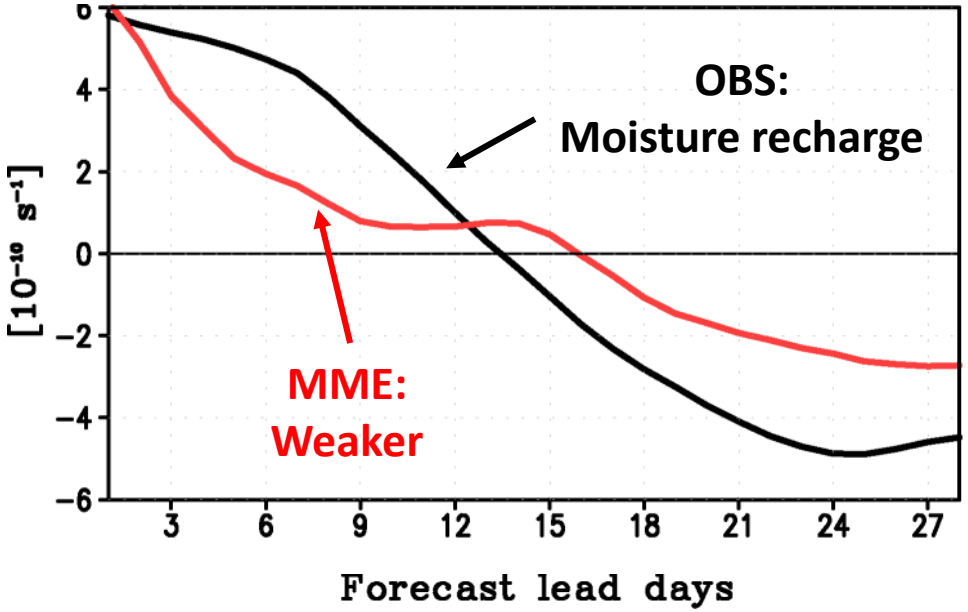


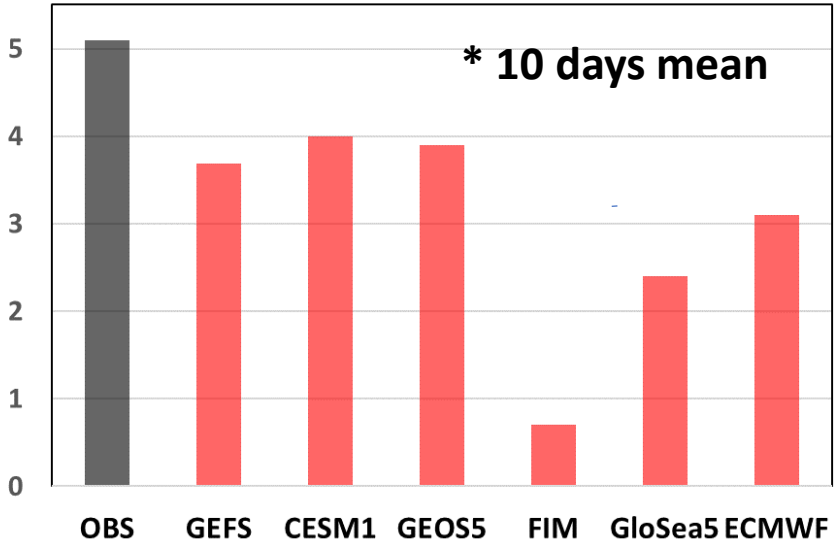




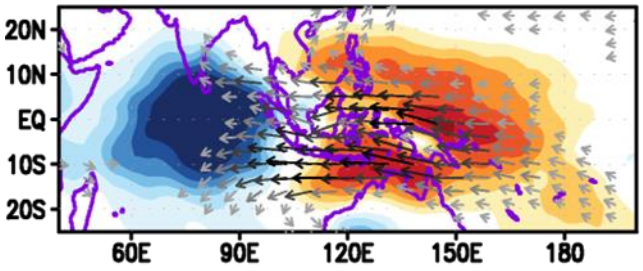
Moisture Recharge Process

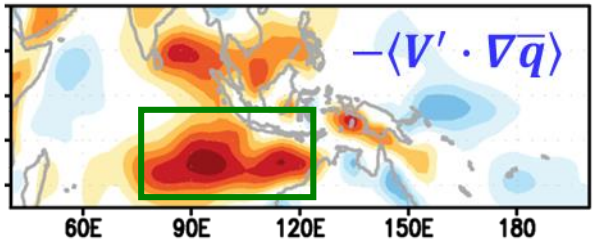
Moisture advection ($-V' \cdot \nabla\overline{q}$)

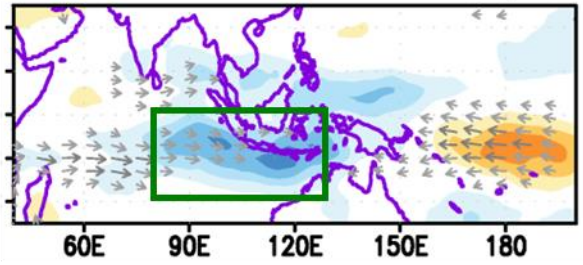




MJO (day 01) → Moisture recharge (day 01) → MJO after 10 days

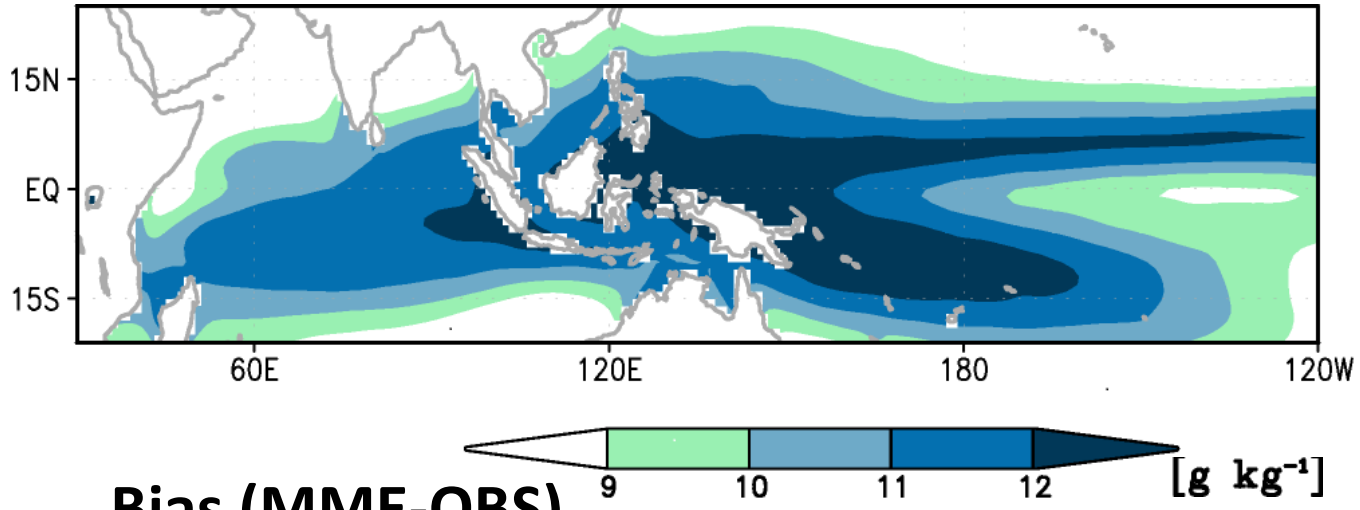




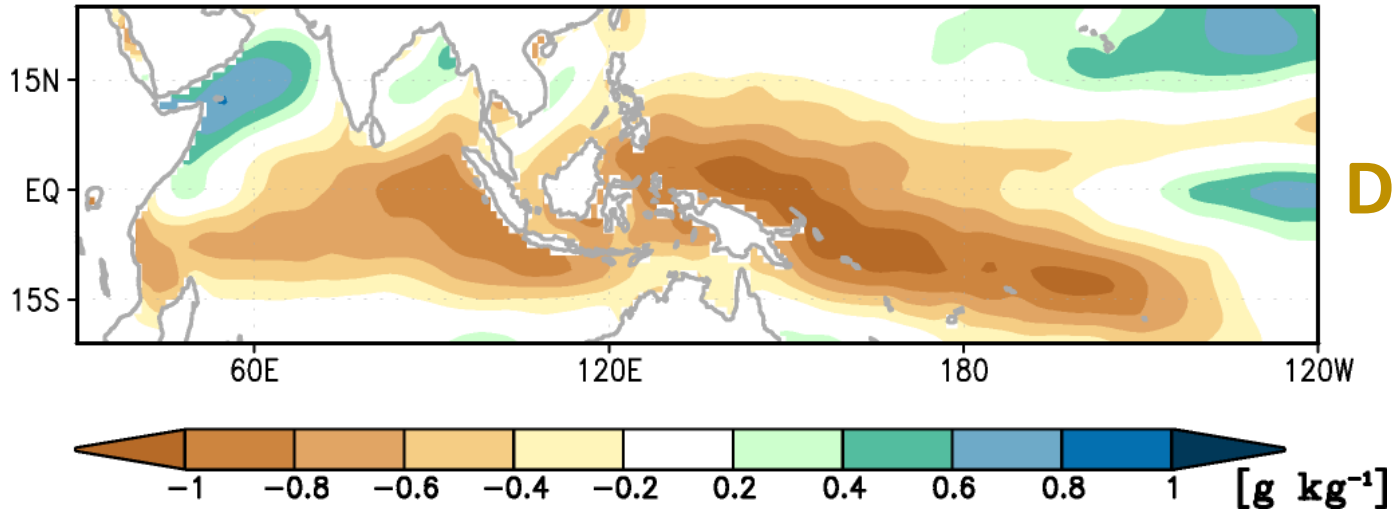


Mean state: Q850

OBS

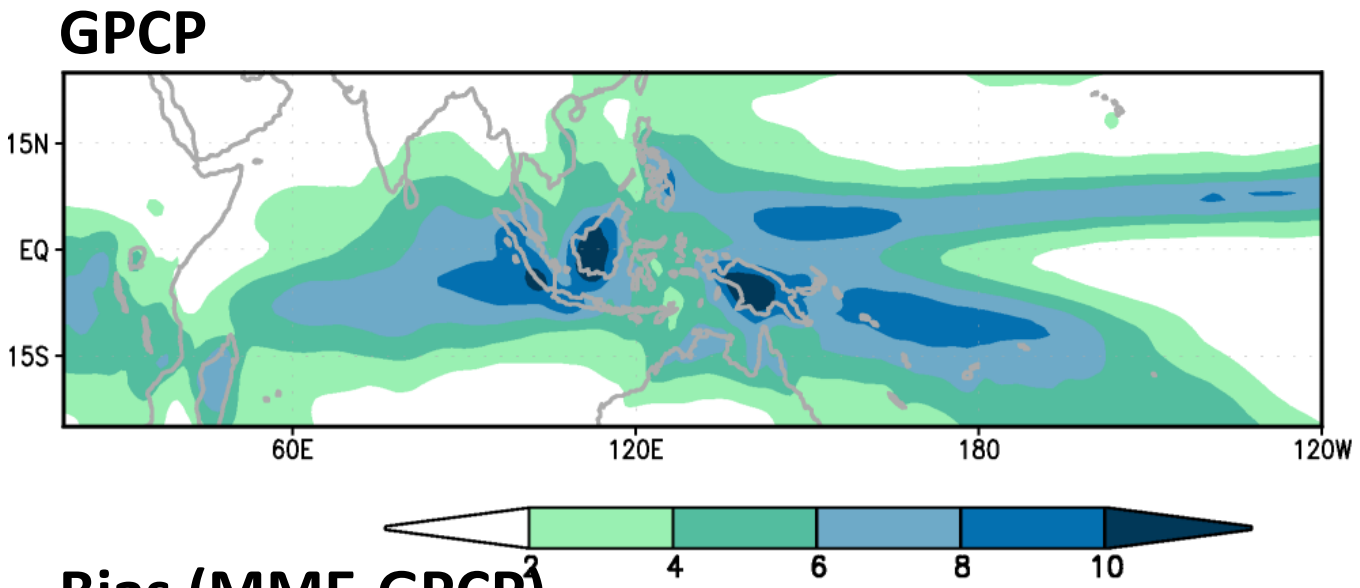


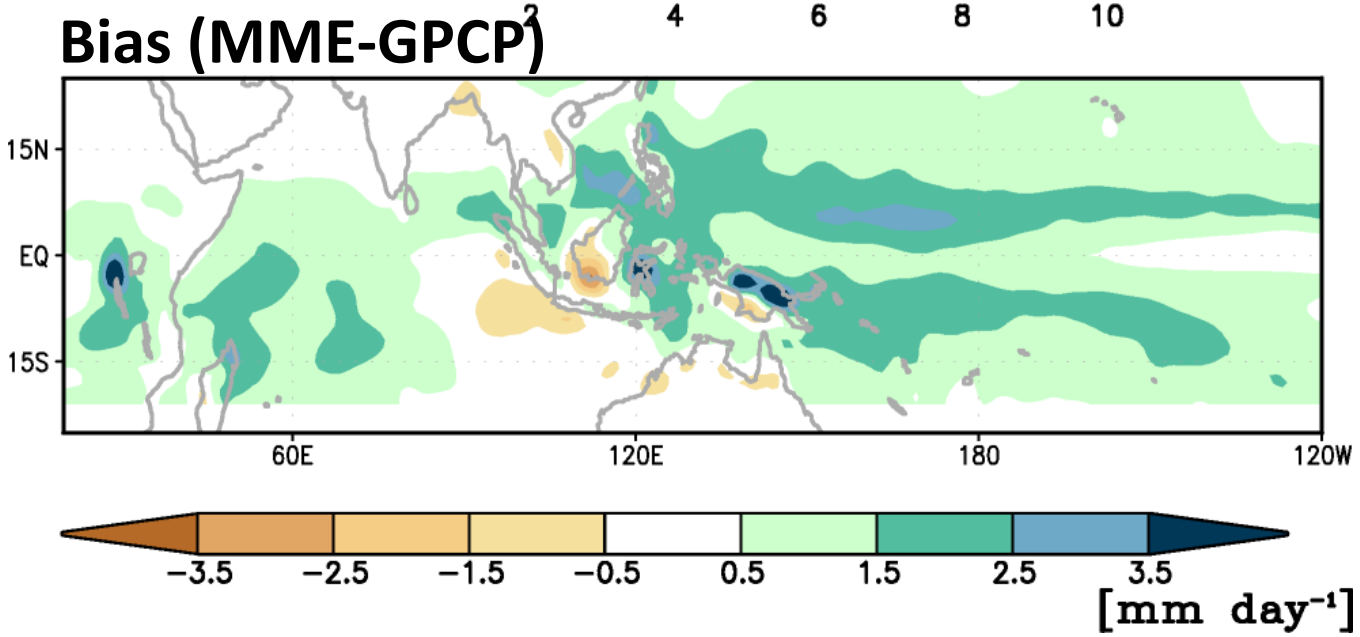
Bias (MME-OBS)



Dry bias

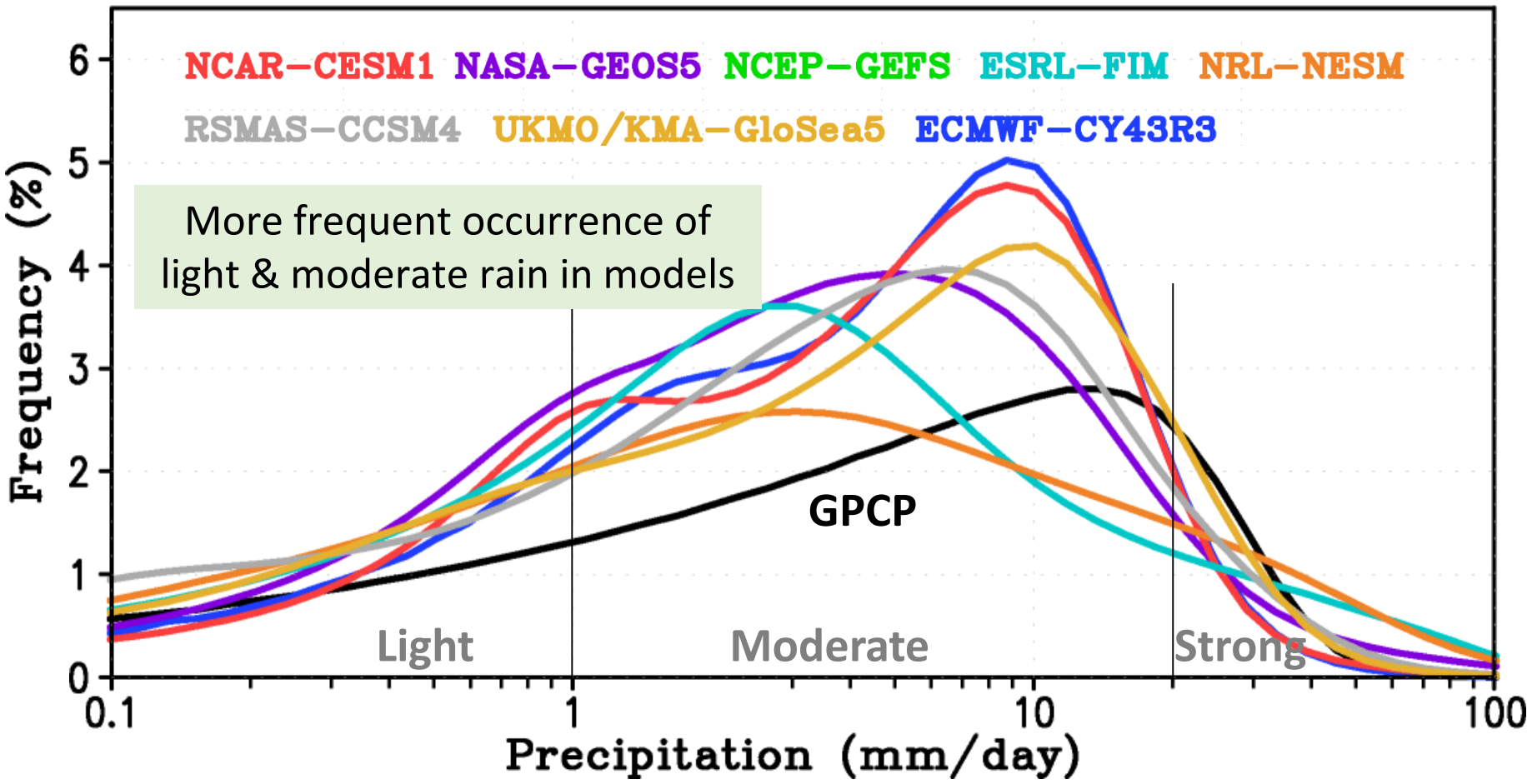
Mean state: Precipitation





More rain

Frequency of Precipitation Days

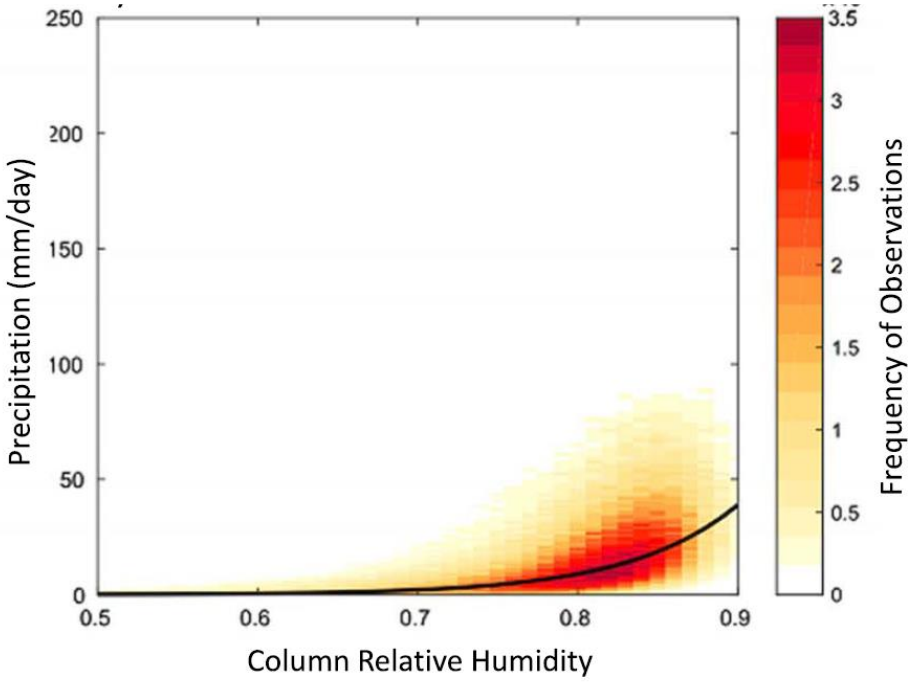


- Precipitation days/Total days
- 30 days average, [60E-180E, 15S-15N]
- Control simulation (single ensemble)
- Land area excluded

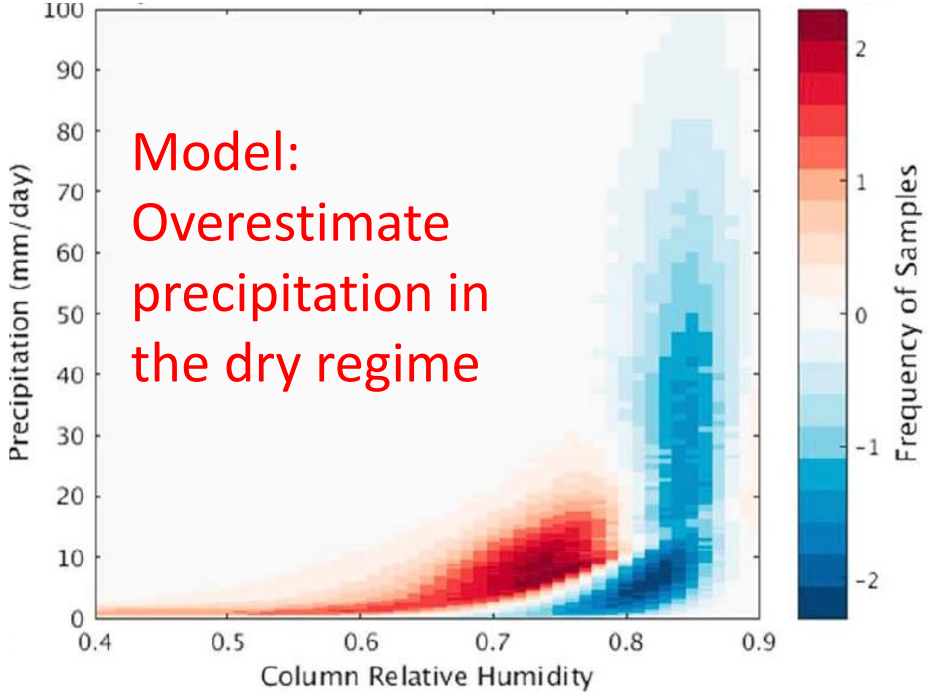
Moisture-Precipitation Relationship

Column Relative Humidity vs. Precipitation

OBS (SSM/I v7)



Bias (CMIP5-OBS)



* SSM/I: Special Sensor Microwave Imager

Rushley, D. Kim, Bretherton, Ahn (2018)

Summary

- SubX/S2S models successfully predict the MJO up to 4-5 weeks
- MJO propagation is not well predicted (both in phase & amplitude)
- Models have **dry mean bias** in the low-troposphere → weakens moisture recharge process → causes error in MJO propagation
- Models have more frequent occurrence of light & moderate rain