中央氣象局海氣耦合模式季內尺度預報分析

Exploring the MJO forecast skill for CWB 1T(OP) -- On bias removal issue & MJO index

陳雲蘭、吳子榆、劉邦彥、陳建河

The CWB participates in the CPC MJO forecast services.

National Weather Service
Climate Prediction Center

HOME > Climate & Weather Linkage > Dynamical Model MJO Forecasts

Dynamical Model MJO Forecasts

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WCRP - WWRP/THORPEX YOTC MJO Task Force

Phase Plots of MJO Index Forecasts					
NCPE	NCPB	NCPO	NCFS	UKME	UKMA
CMET	ECMF	ECMM	CPTC	JMAN	TCWB
EMON	EMOM	IMDO	BOMM	TCWBT1	

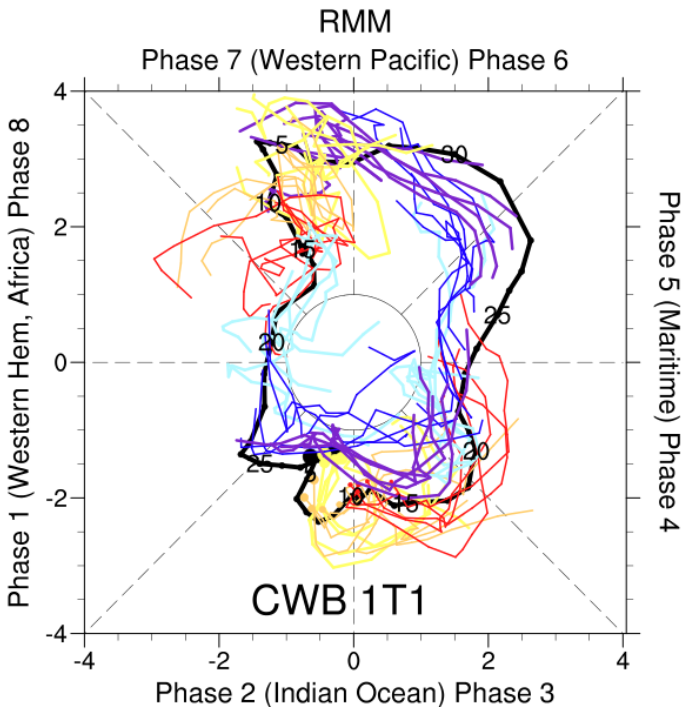
CWB 1Tier
(Coupled seasonal forecast OP model. With long-term hindcast, the MJO forecast skill is waiting for exploring.)

TCWB : CWB GEPS
(No coupled weather OP model. Lack of model climatology. The current forecast products are no bias corrected.)

Verification for **2018 Jan-Feb**

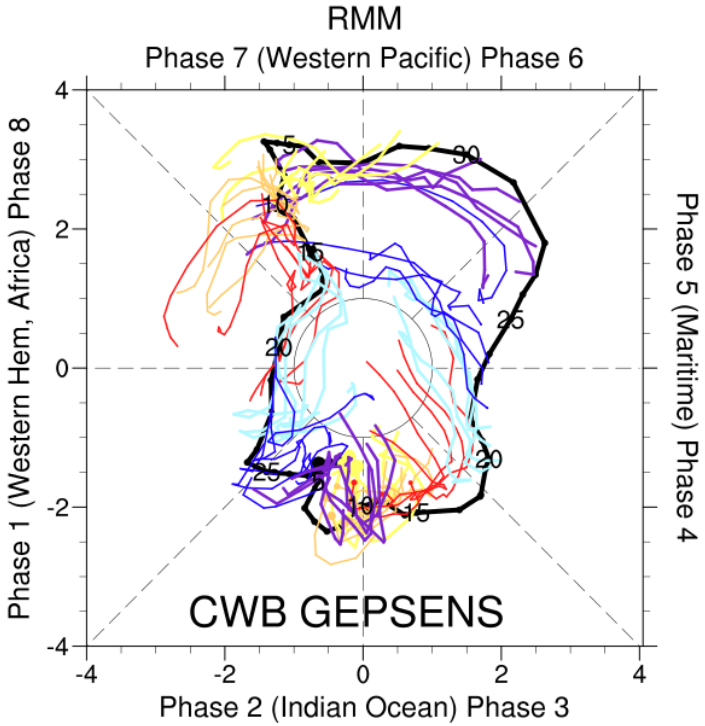
CWB1T1

No bias corrected



CWB GEPSENS

No bias corrected



Observed / Analysis

15-day forecasts from Jan1~Feb28 (color is changed by every 5 days)

CPC Dynamical model MJO forecast

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CLIVAR/clivar_wh.shtml

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Phase Plots of MJO Index Forecasts

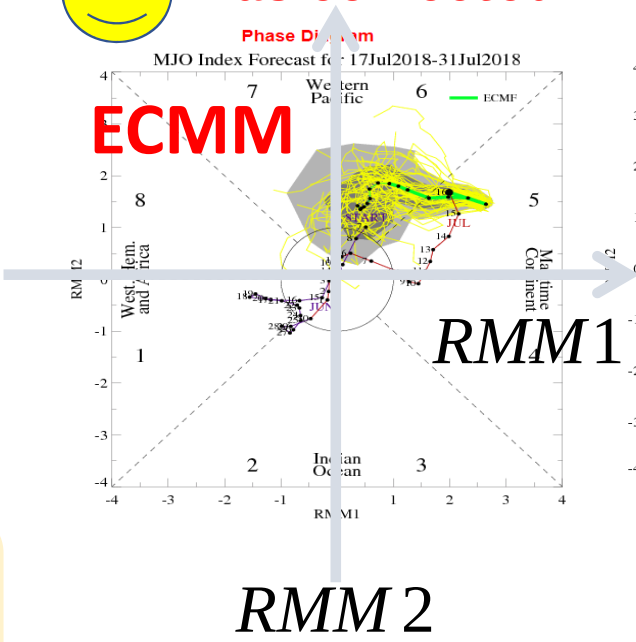
NCPE	NCPB	NCPO	NCFS	UKME	UKMA
CMET	ECMF	ECMM	CPTC	JMAN	TCWB
EMON	EMOM	IMDO	BOMM		

: **Bias corrected** forecasts
NCPB / ECMM / EMOM / BOMM

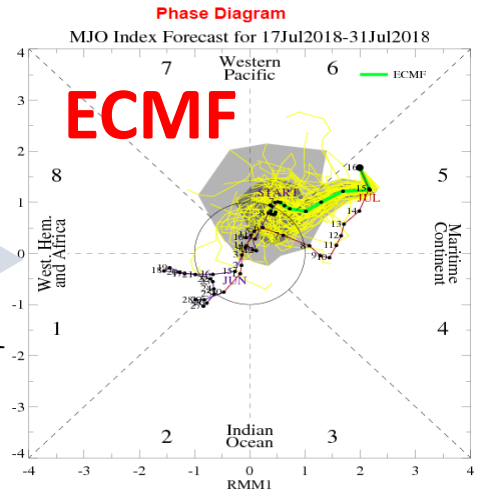
Others : No bias corrected forecasts (?)
NCPE, NCFS, CMET,JMAN…

How to interpret the forecasts properly ?

Bias corrected

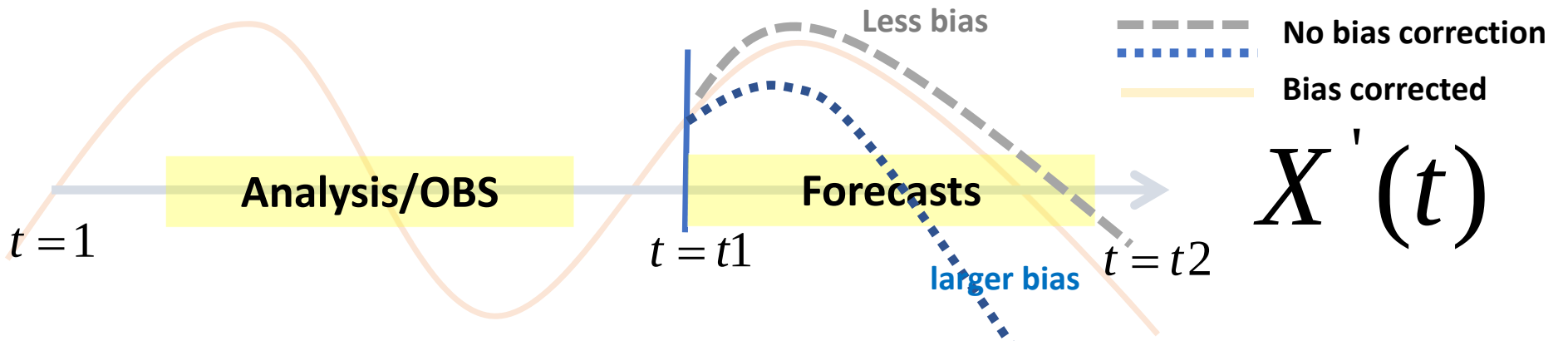


No bias corrected



Systematic-bias removal helps more skillful forecasts

$$X'(t) = Xobs'(t) \cup Xfst'(t)$$
$$= (Xobs(t) - Xcmt(t)) \cup (Xfst(t,ld) - Xcmt(t,ld))$$



Observation anomaly relative to obervation climatology

Forecast anomaly relative to forecast model climatology from the corresponding day (t) and lead time (ld)

1. On Bias removal

Motivation and Expectation

- Guidance for **using biased/unbiased forecasts**.
- Approaches for **obtain unbiased forecasts**.

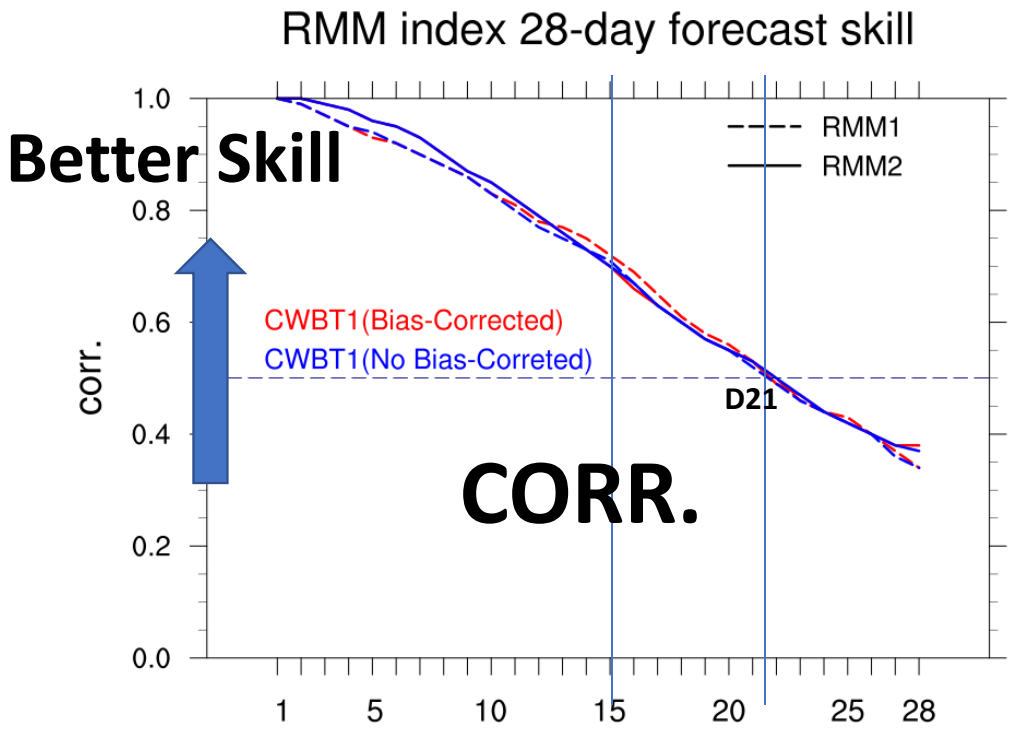
Study Issues

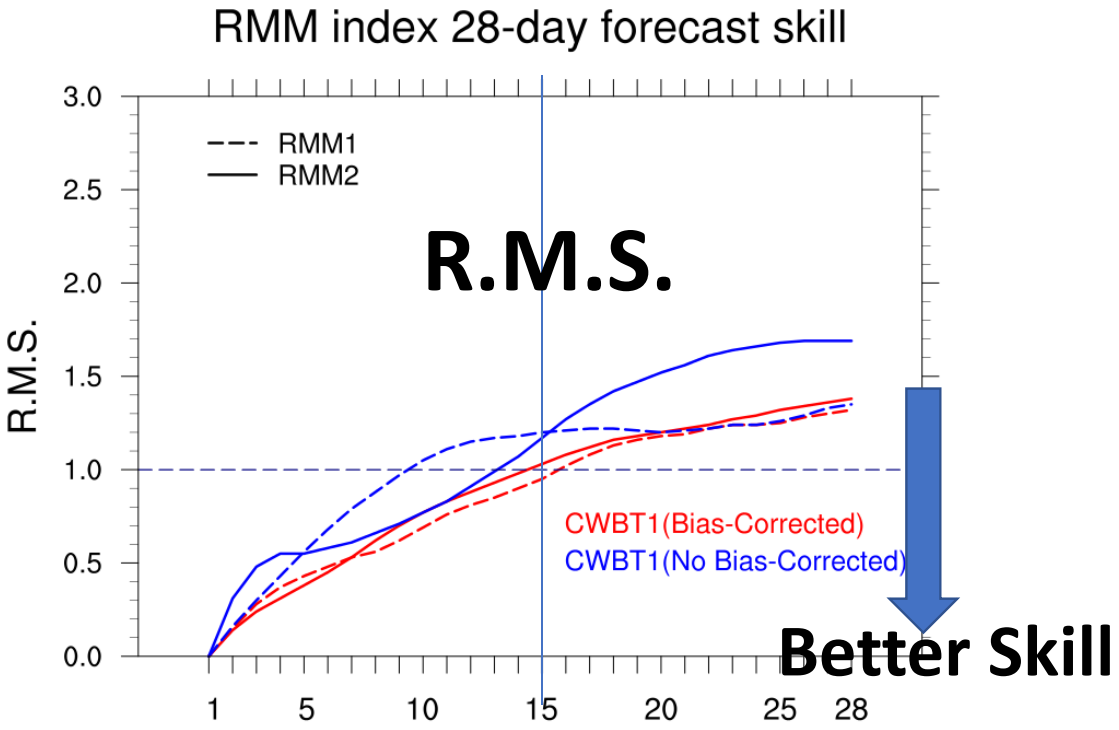
- **1.1 The effect of bias correction** for MJO(RMM) forecast skill.
  - Estimate the model climatology mean bias from hindcast/historical forecast data.
  - Comparing the forecast skill with/without bias removal.
- **1.2 An alternative scheme for bias removal by using near-term data**.
  - Comparing **hindcast bias** and the **statistical bias from recent N days**.
  - Sensitivity test on the choice of N-day running average.

Study 1.1 : Effect of bias removal on RMM forecast skill score

Model : CWB 1-Tier seasonal forecast model (CWBT1)

Data : 2012-2018 DJFM



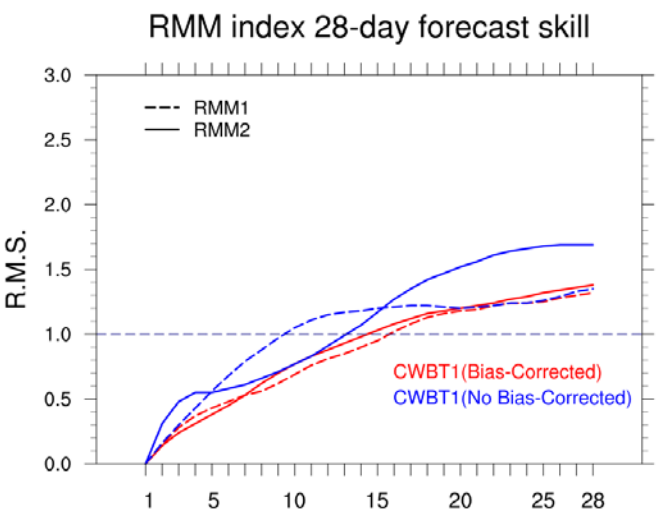


For RMS, bias corrected forecast(Red) have better skill, while comparable skill was seen from correlation measurement. This might imply no bias corrected forecasts also can catch the MJO variation tendency.

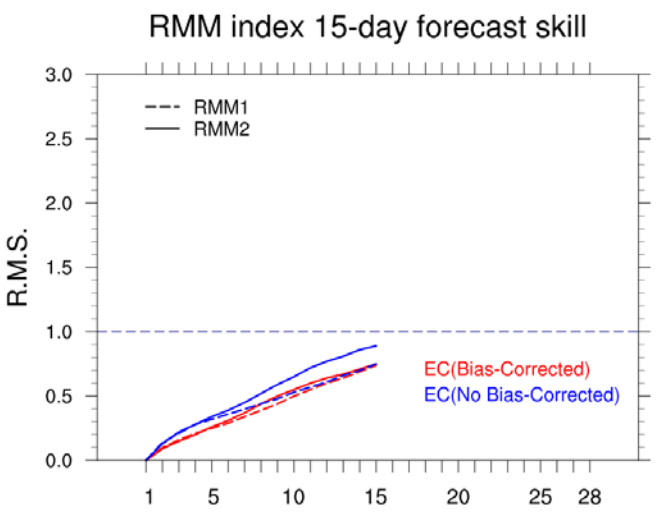
Effect of bias removal on RMM forecast skill score

R.M.S.

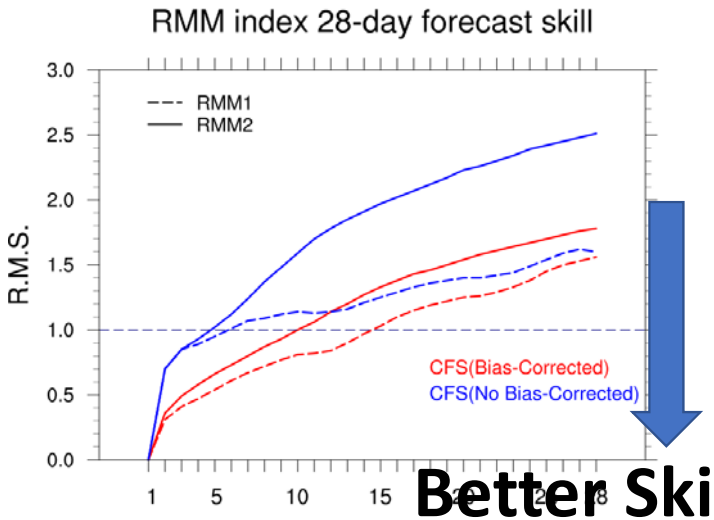
Model : CWB 1-Tier



Model : EC



Model : CFS (data from NCEI)



Better Skill

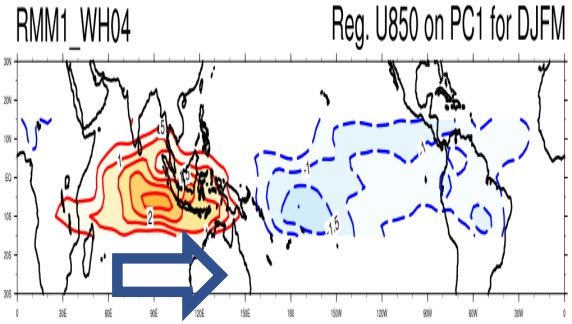
RMM1
RMM2

The effect of bias removal on RMM2 seems to be larger than RMM1.

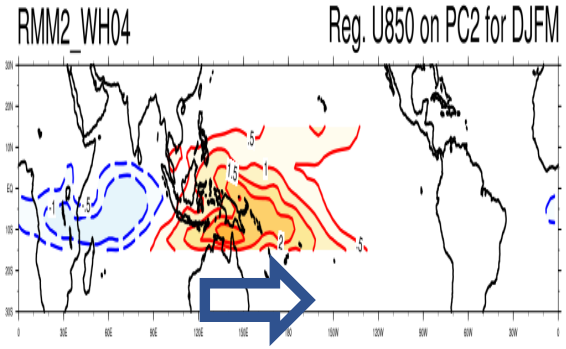
Reg. of U on RMM

U850

Reg(U850, RMM1)

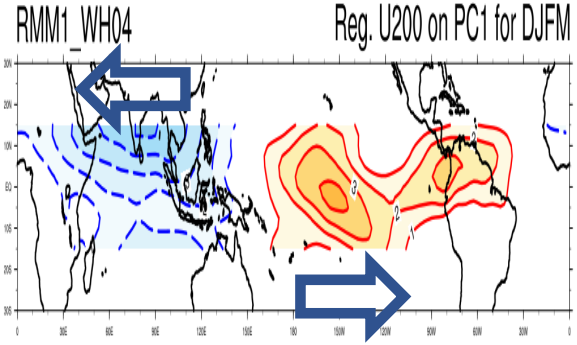


Reg(U850, RMM2)

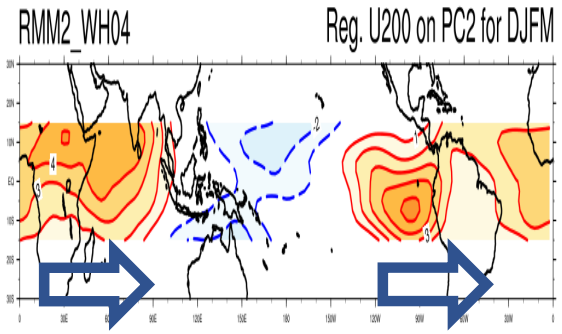


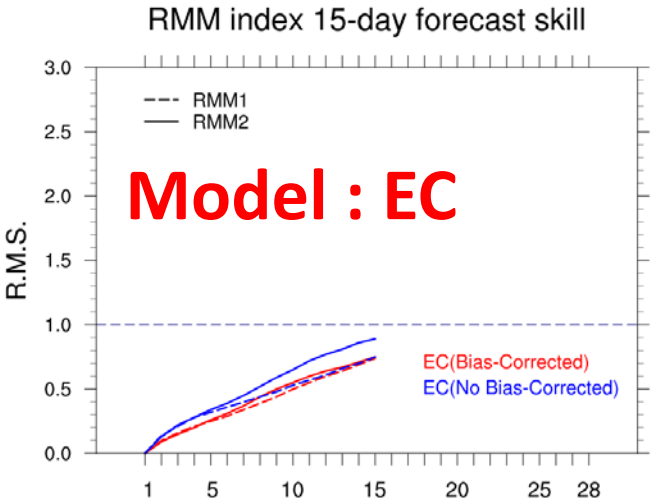
U200

Reg(U200 RMM1)



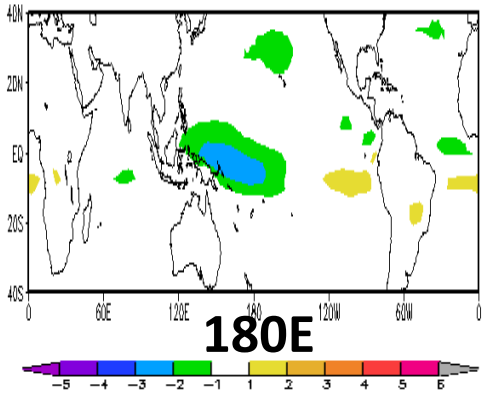
Reg(U200, RMM2)



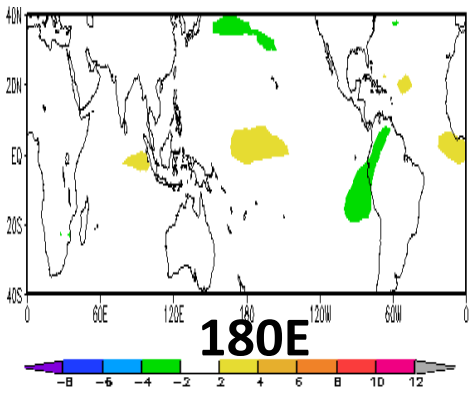


EC climatology mean bias
Average over lead days for 1~15d

U850

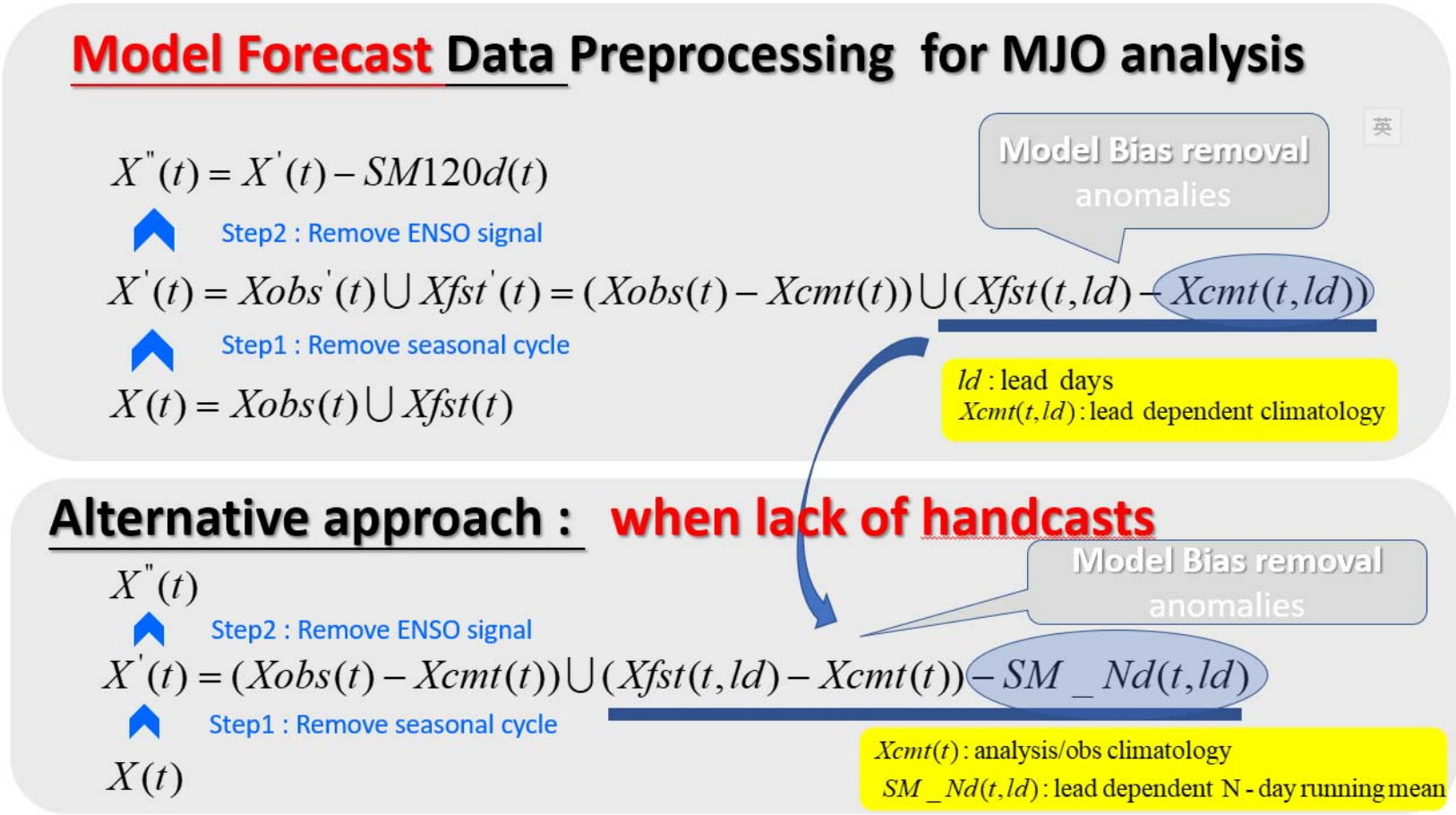


U200



The effect of bias removal on MJO forecast skill seems also depends on the spatial structure of model mean bias.

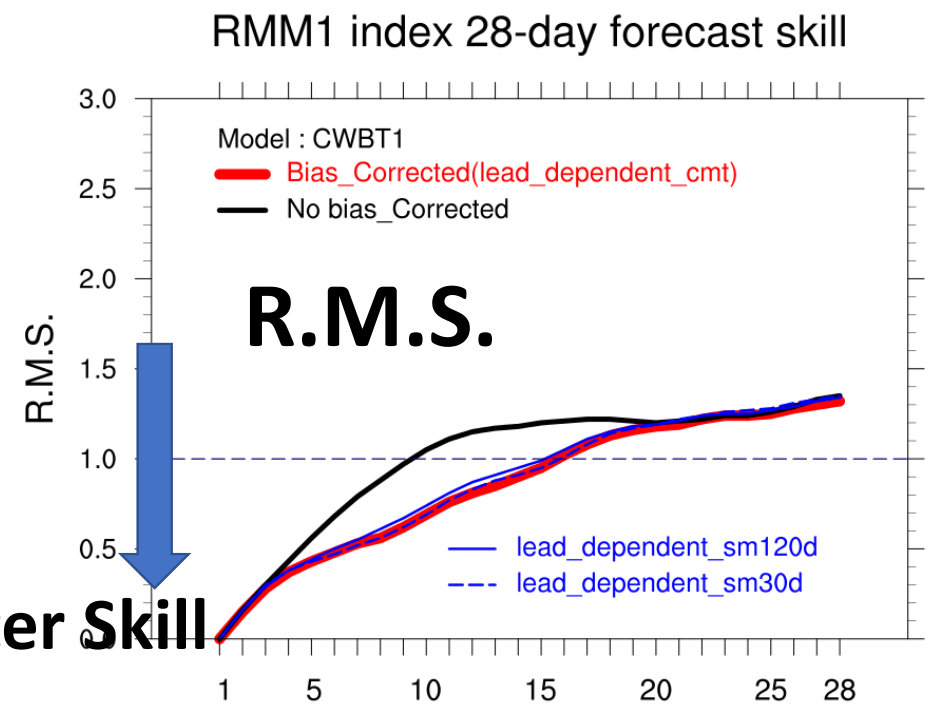
Study 1.2 : An alternative approach to **obtain model mean bias**
-- **By recent lead-dependent N-day running mean**



Recent N-day (N=30d, 120d) running mean might able to describe model mean bias

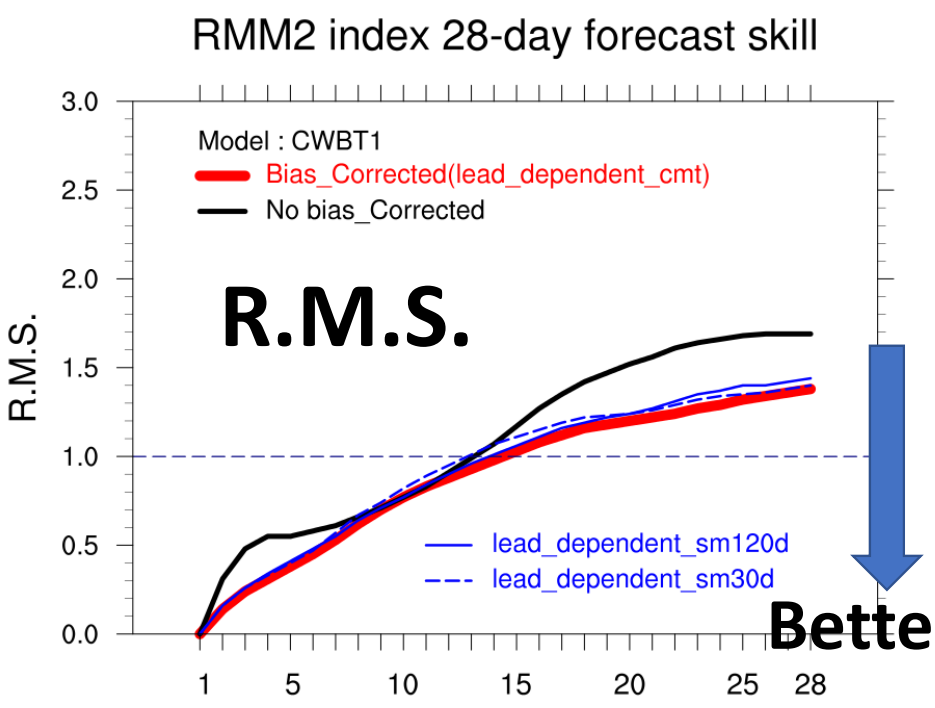
Model : CWBT1 (Data : 2012~2018 DJFM)

RMM1



Better Skill

RMM2

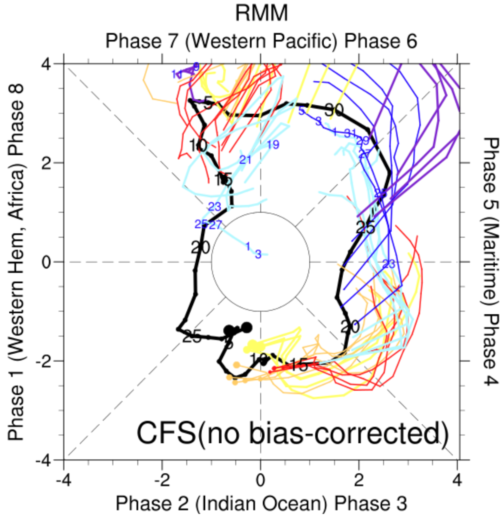


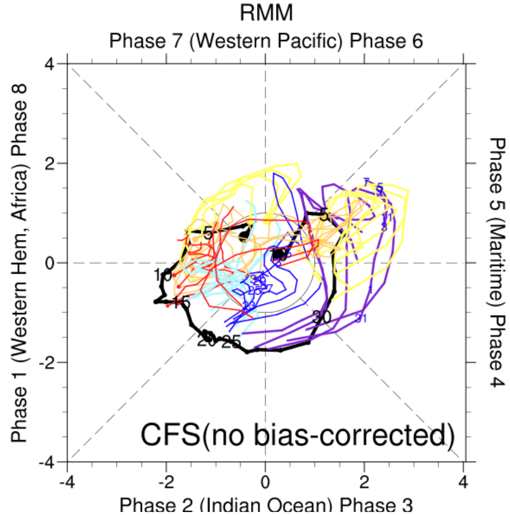
Better Skill

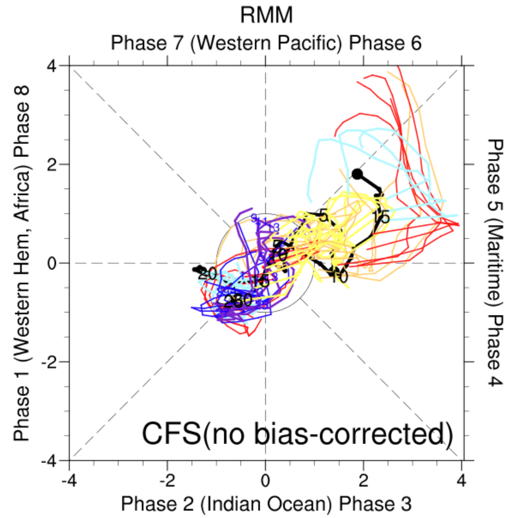
Model : CFSv2 (**Case analysis**, 4 member ensemble mean : init_00Z+init_06Z+init_12Z+init_18Z)

2018 Jan-Feb | 2018 May-Jun | 2018 Jun-Jul

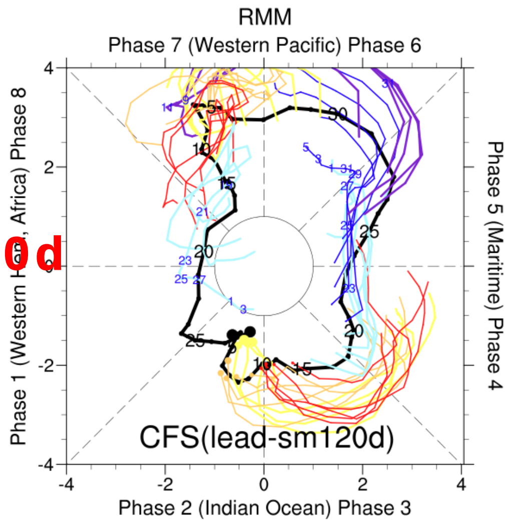
NO Bias corrected

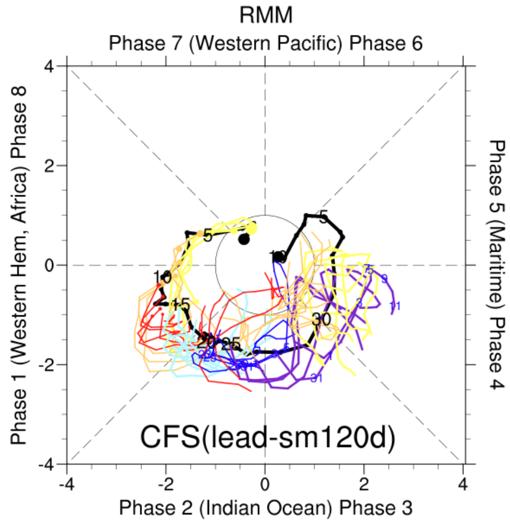


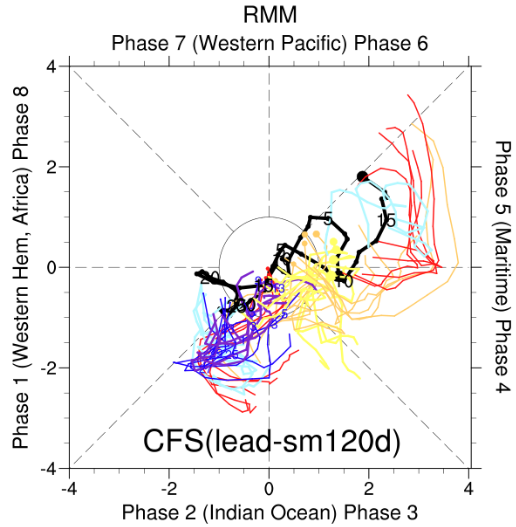




Bias corrected
By lead-dpt.-sm120d



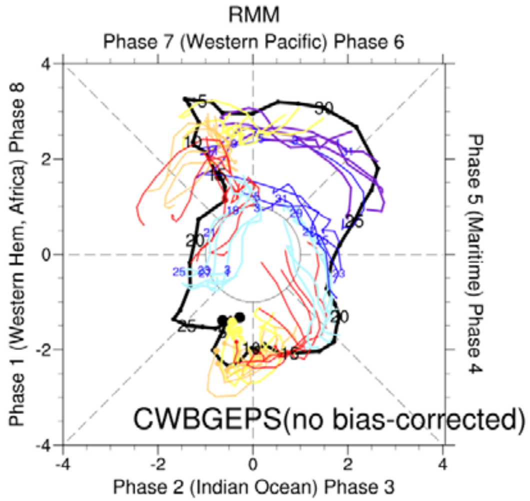


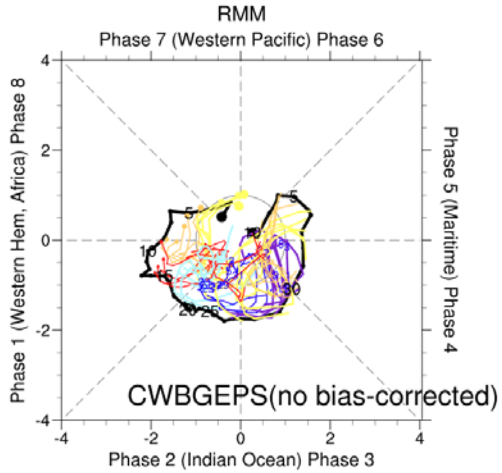


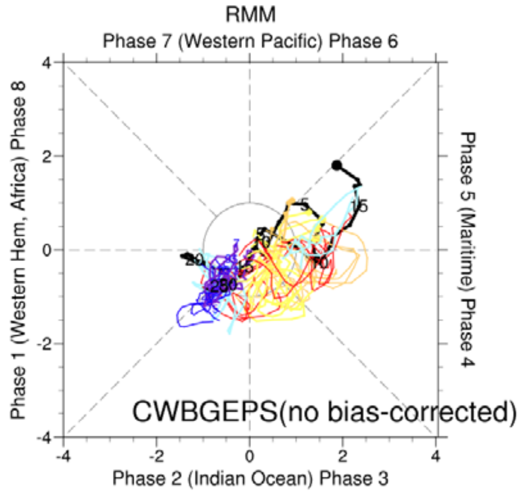
Model : CWBGEPS (**Case analysis**, 20 member ensemble mean : init_00Z)

	2018 Jan-Feb	2018 May-Jun	2018 Jun-Jul

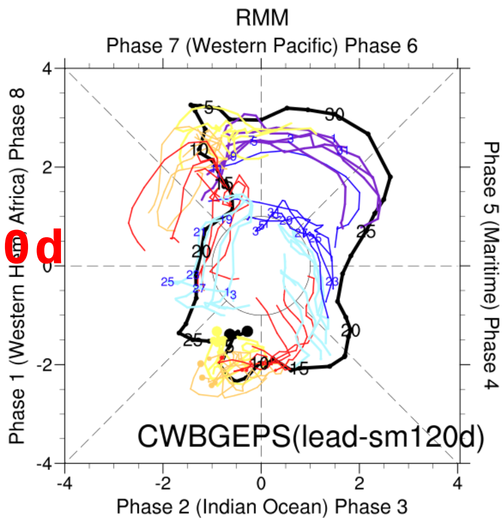
NO Bias corrected

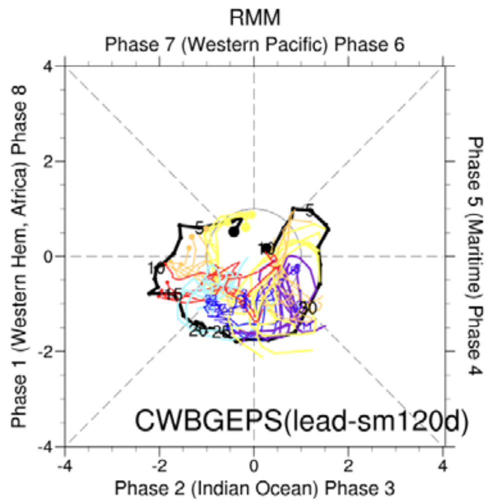


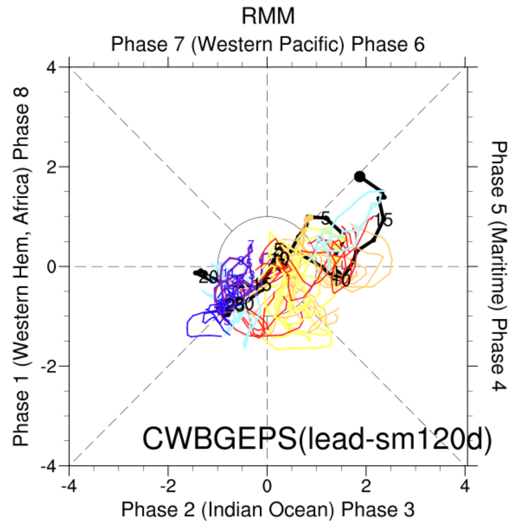




Bias corrected
By lead-dpt.-sm120d







2. On MJO index – SVD2D index for winter applications

Motivation

- Previous study suggested a winter based MJO index by SVD analysis approach(SVD2D) might help to identify the key tropical heating spatial structure that related to the extra-tropical weather through teleconnection. For the further practical application, It would be necessary to know how well the model would predict the MJO activities by using this SVD2D index.

Simmons et al. (1983), Ferranti et al. (1990)

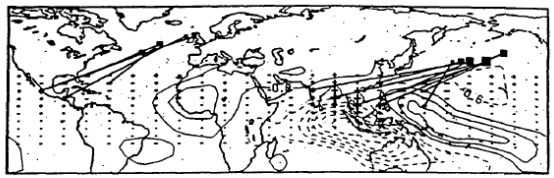
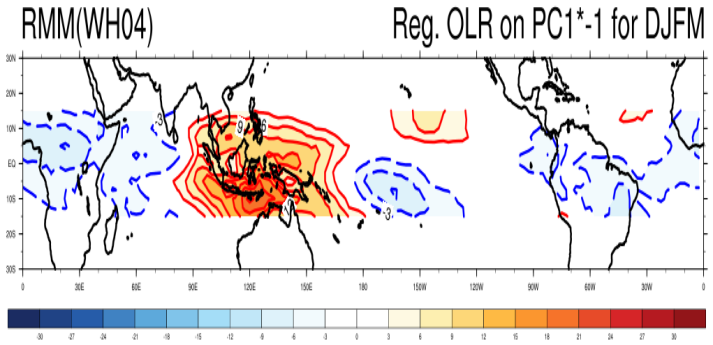


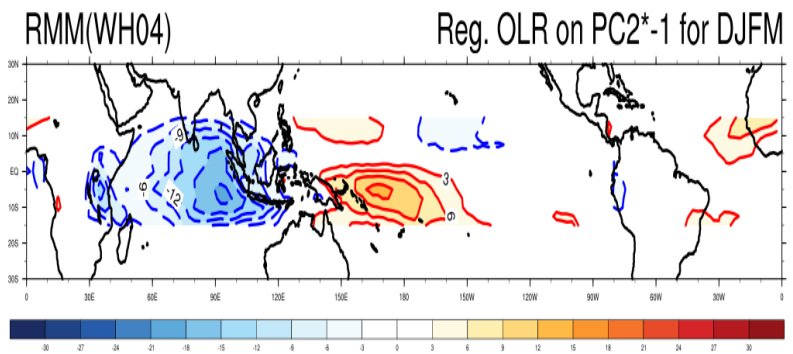
FIG. 8. Schematic illustration of the relationship between the location of the forcing region and the maximum midlatitude response excited from it. (From Simmons et al. 1983). Contours of the first EOF of OLR from the present study are superimposed.

A dipole heating structure over IO-WPC was seen from the SVD index, which is an important key feature in the tropical-extratropical interaction.

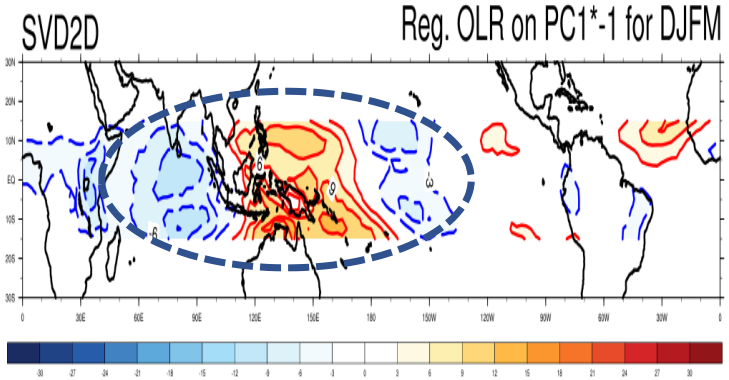
Reg (OLR , PC1) **Reg (OLR , PC2)**

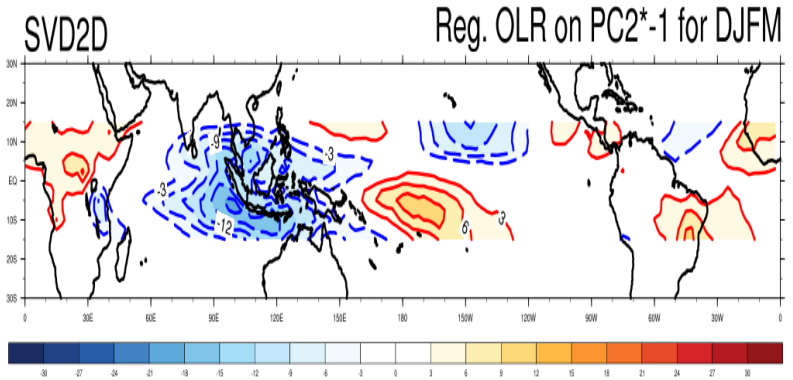
(a) RMM





(b) SVD





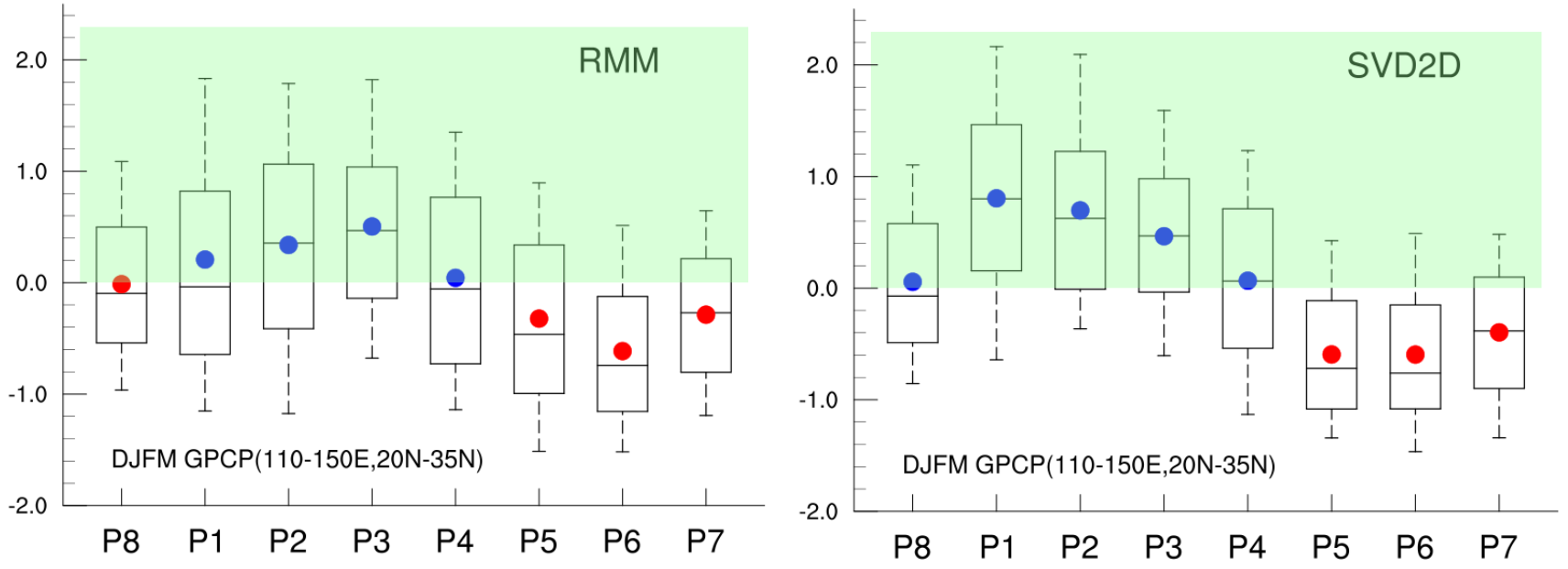
BLUE : WET **RED : DRY**

The spatial pattern of the two leading modes of OLR for (a) RMM(WH04), (b) SVD.

The rainfall anomalies distribution in terms of the 8 MJO phases : RMM & SVD

SVD composite for the complete cycle of evolution of the EA rainfall anomaly through the 8 MJO phases is more conspicuous, while the RMM composite is more ambiguous.

East Asia DJFM rainfall GPCP(110-150E,20N-35N)

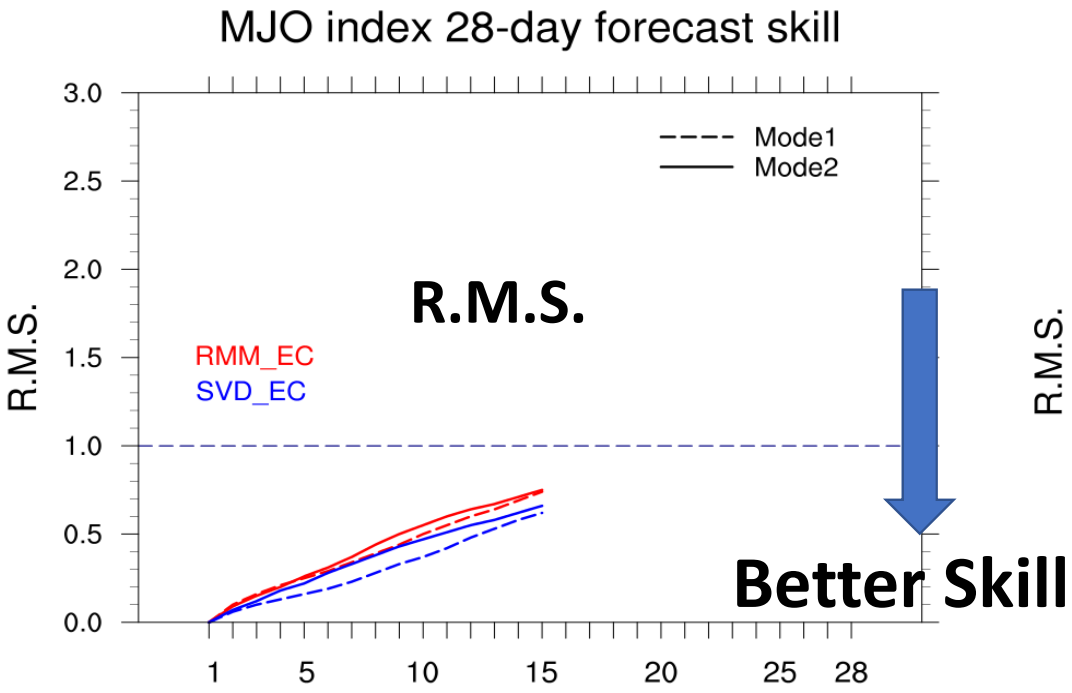


PDF of rainfall over EA jet entrance region(110-150E,20N-35N) in 8 MJO phases defined by: (a) RMM(WH04), (b) SVD. Solid dots denote the mean values.

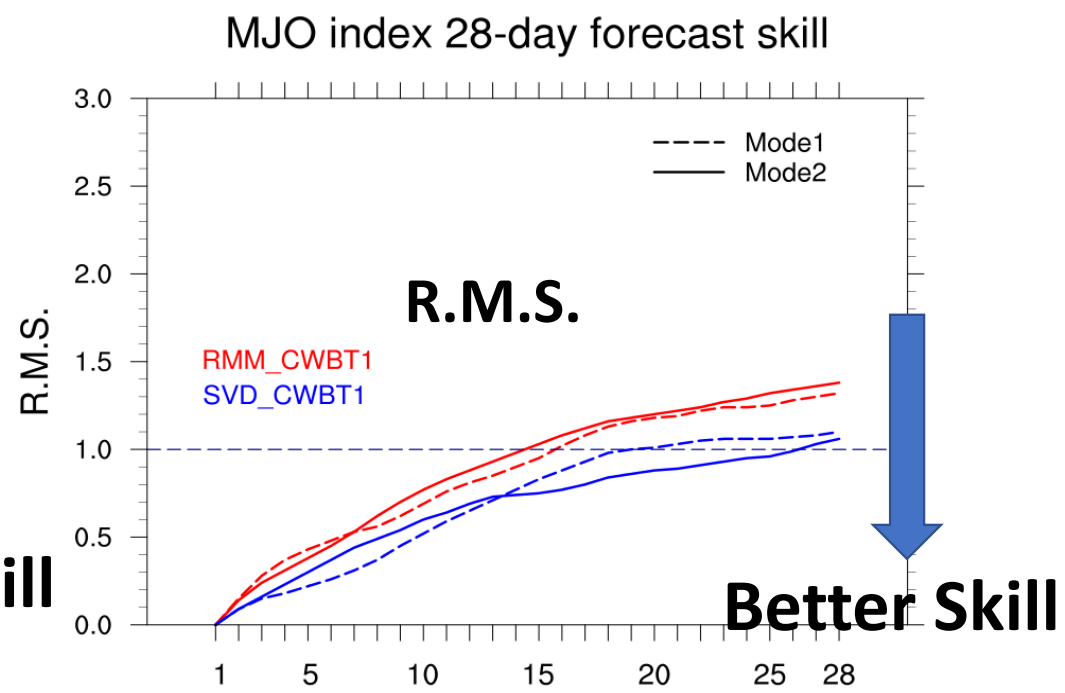
Bias-corrected forecasts

The winter-base MJO index(SVD2D) might have better forecast skill compared with RMM.

Model : EC



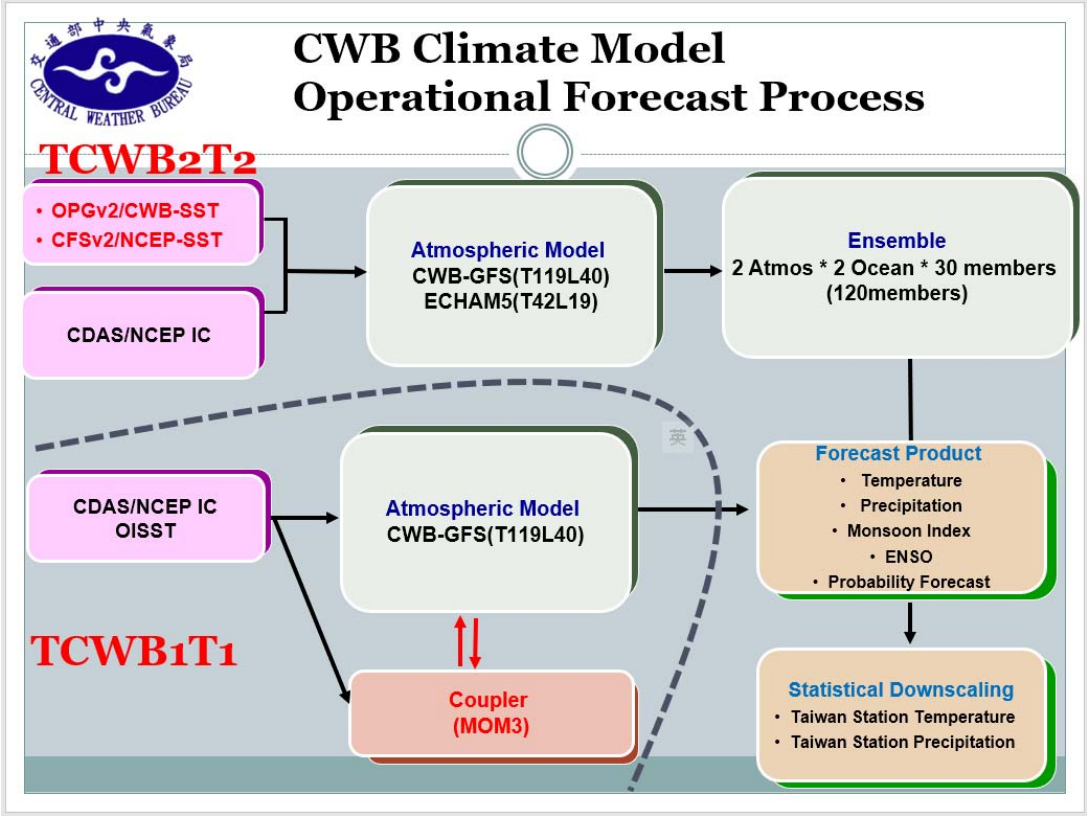
Model : CWBT1



(Data : 2012~2018 DJFM)

Summary

- This study is to explore the CWB 1-Tier OP model performance in MJO prediction. We start with issues related to the post-processing for MJO prediction – the effect of bias correction and the approaches for bias removal. Current results :
  - Preliminary analysis shows CWB1T1 has RMM forecast skill into the week3.
  - The skill for bias corrected forecast would be significantly improved for the model with significant mean bias.
  - To obtain the model mean bias for providing unbiased MJO forecast, we propose an alternative approach by using recent lead-dependent N-day running mean. Our results show it's workable as the hindcast bias.
  - The effect of bias removal on RMM2 seems to be larger than RMM1, we found the spatial structure of model mean bias might provide partial explanation.
  - The winter based MJO index by SVD analysis approach(SVD2D), which has been shown might be more useful than RMM for winter applications, also got better RMS forecast skill than RMM.



Climate Model Information

Atmospheric Model Resolution	T119(1° X 1°) and 40 Level
Ocean Forecast Data (2T):	NCEP-CSFv2 SST (Dynamical Model) CWB-OPGv2 SST (Statistical Model)
Ocean Model Resolution (MOM3) 74°S to 64°N (1T)	Zonal resolution: 1° domain-wide Meridional resolution: 1/3° from 10°S-10°N, increasing gradually to 1° meridional resolution poleward of 30°S and 30°N 40 vertical levels 10 m thickness from surface to 240 m, with 27 levels in the top 400 meters to resolve the mixed layer, Bottom depth is 4500 m with bottom layer thickness of about 511 m
radiation scheme	Fu and Liou. (1993)
Boundary layer parameterization	MRF PBL A first order non-local scheme (Hong and Pan 1996, Troen and Mahrt 1986)
Land Surface Model	Noah 4-layer soil model (Ek et al. 2003)
Cumulus Parameterization	New SAS (Han and Pan 2011)

Provided by Dr. C.T. Lee

Study 1.1 : An analysis **on the effect of bias removal** for RMM index forecast skill during DJFM

Model data used currently :

Models	Data period	Source	Forecast length/frequency	Note
ECMWF	2012-2018	EC TIGGE(*1)	**15-day / daily**	Control forecast of the ensemble **Next plan : S2S data for 28-day**
CWBT1	2012-2018	CWB	28-day / daily	1-tier (A: CWBGFS, O:MOM3)
CWBT2	2012-2018	CWB	28-day / daily	2-tier (A: CWBGFS, O:CFS forecasts)
CFS	**2002-2009**	NCEI (*2)	28-day /daily	**To be rerun** by new source from CPC
CFSv2	**366-day climatology**	NCEP (*3)		Download directly from NCEP website

*1. EC TIGGE : http://apps.ecmwf.int/datasets/data/tigge/levtype=sfc/type=cf/

*2. **CFS data source** : https://www.**ncei**.noaa.gov/thredds/catalog/cfs_refor_fl_6h_seasonal/catalog.html

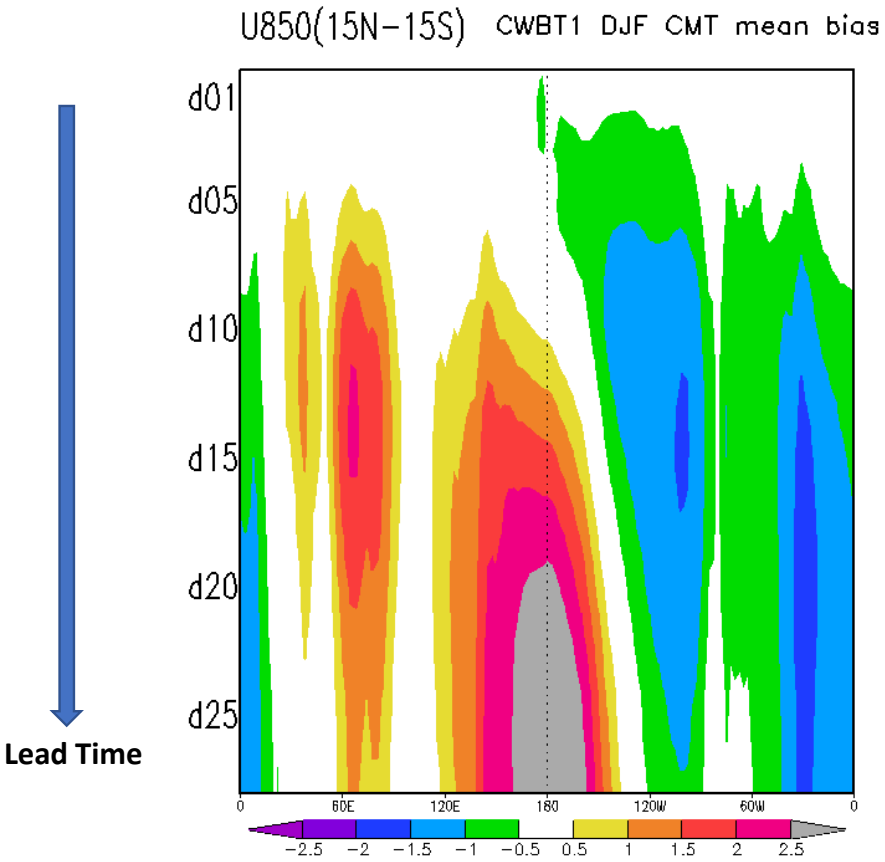
*3. **CFSv2 climatology** : http://cfs.ncep.noaa.gov/pub/raid1/cfsv2/climo_45day_1season_tser/

The current data served for a practice, further efforts are planned by using more appropriate data sources.

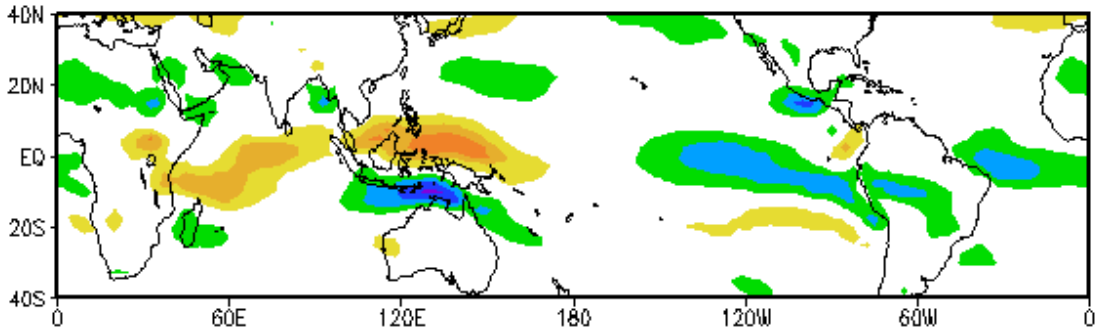
U850 Mean bias for each forecast lead

Model : CWBT1

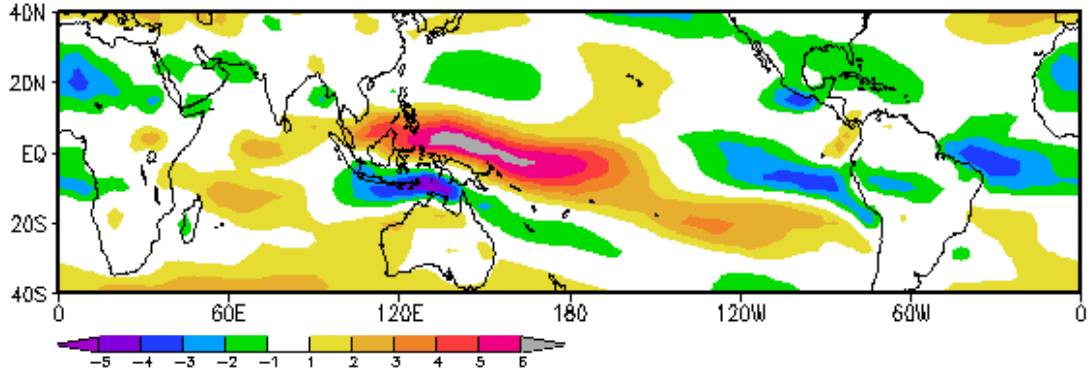
Season : DJF



Average over lead days for 1~15d **avg(L1~L15)**



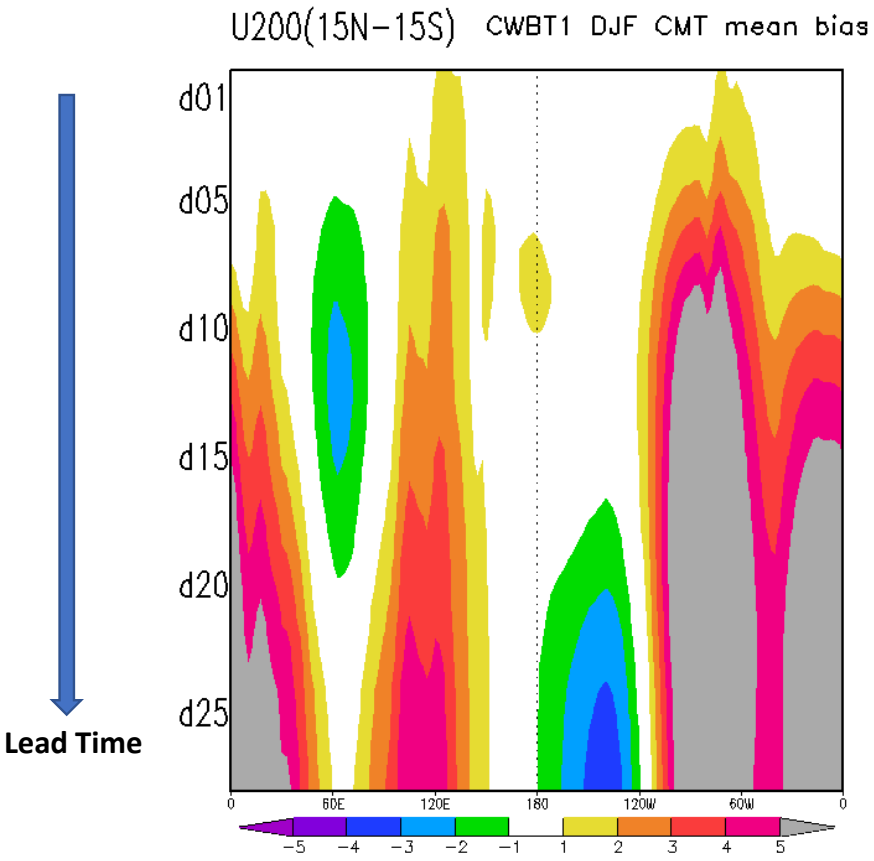
Average over lead days for 16~30d **avg(L16~L30)**



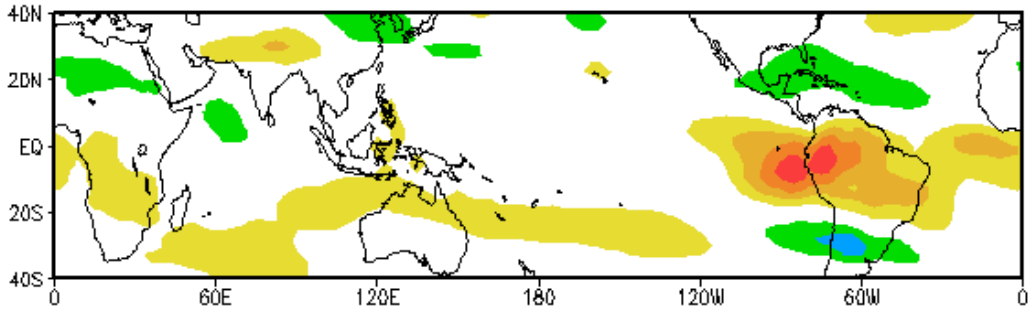
U200 Mean bias for each forecast lead

Model : CWBT1

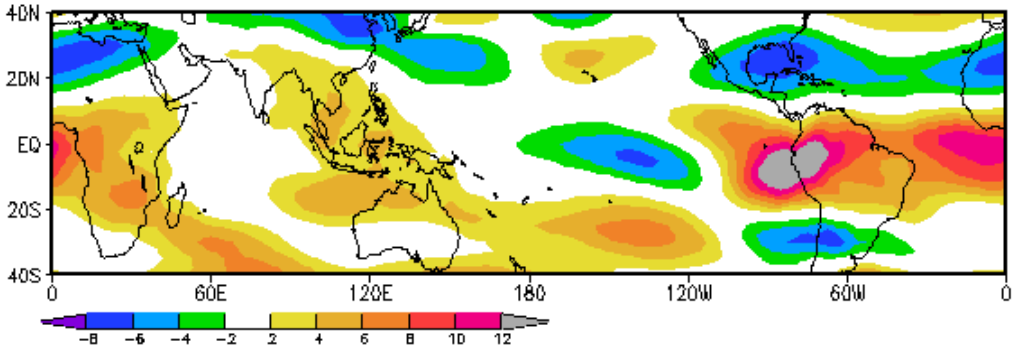
Season : DJF



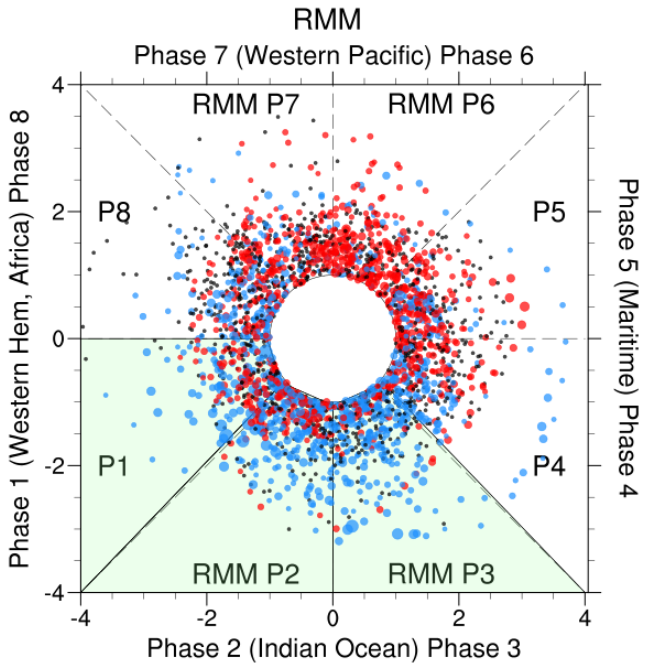
Average over lead days for 1~15d **avg(L1~L15)**



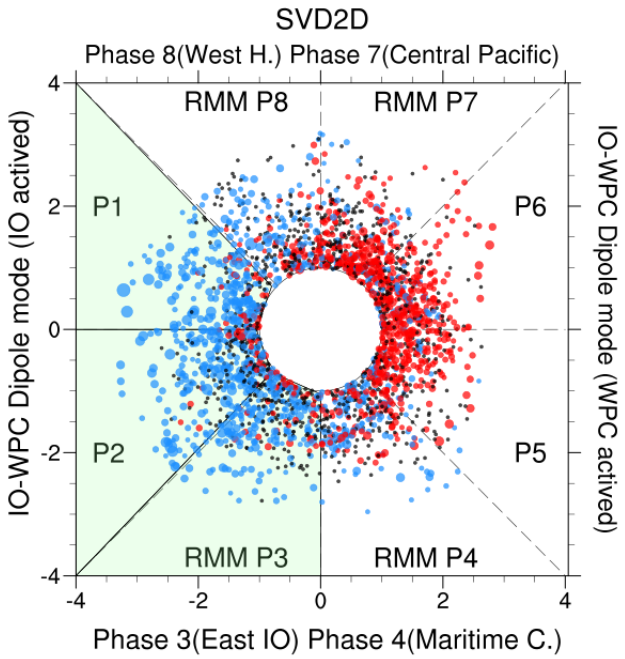
Average over lead days for 16~30d **avg(L16~L30)**



(a) RMM(WH04)



(b) SVD



Rainfall anomalies in the EA jet entrance region: **blue** indicates above normal rainfall, **red** indicates below normal rainfall.