

# Performance of JMA atmosphere-ocean coupled model



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# Outline

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**1. Introduction**

**2. Current and new EPS systems  
for JMA Seasonal Prediction**

**3. Comparison of performance**

**4. Summary**



# 1. Introduction

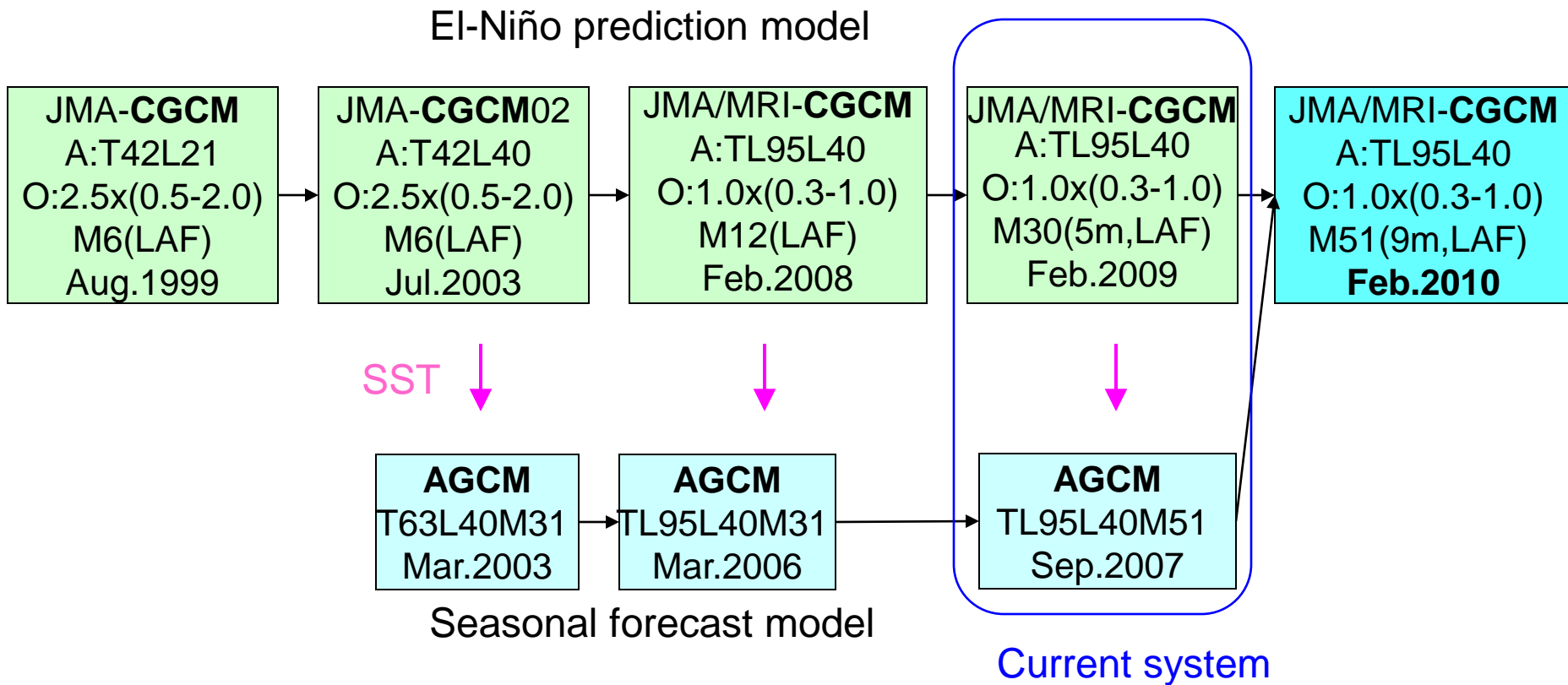
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- **JMA is going to replace EPS system for seasonal forecasts in February 2010.**
  - ⇒ **Unification of seasonal forecast and El-Niño models**
- **Direct utilization of an atmosphere-ocean coupled model for seasonal forecasts as well as for El-Niño outlook**
  - ⇒ **Important step for seasonal forecast in JMA**
- **Improvement of predictability, particularly in long-range forecast will be presented here.**



# 1. Introduction

Flow of models for seasonal forecast and El-Niño outlook





## 2. Current and new EPS system for JMA Seasonal Prediction

	<b>El-Niño model</b>	<b>Current system</b>	<b>Next system</b>
AGCM	GSM0603C (TL95L40)	GSM0703C (TL95L40)	GSM0603C (TL95L40)
Ocean model	MRI.COM (1° × 0.3-1° 、 50levels) 75N-75S,0-360E	—	MRI.COM (1° × 0.3-1° 、 50levels) 75N-75S,0-360E
Member size (Ensemble method)	30 (5 BGM,5days LAF) BGM on TL159L60 with 20N-20S & 20N-90N	51 (Singular Vector)	51 (9 BGM,5days LAF) BGM on TL95L40 with 20N-20S & 20N-90N
Initials of atmosphere	JCDAS	JMA global analysis	JCDAS
Initials of ocean	MOVE (Ocean Data Assimilation)	—	MOVE (Ocean Data Assimilation)
SST	1-tiered (flux adjustment)	2-tiered (persisted anomaly +Prediction)	1-tiered (flux adjustment)
Sea Ice	Climatology	Climatology	Climatology
Initials of lands	Climatology	Climatology	Climatology
CO <sub>2</sub>	constant	constant	trend



## 2. Current and new EPS system Configuration of hindcast

### Configuration of hindcast experiments

#### Current system: 2-tiered

Period: 1984-2005

Perturbation: SV and SST uncertainty, 11 members, once a month

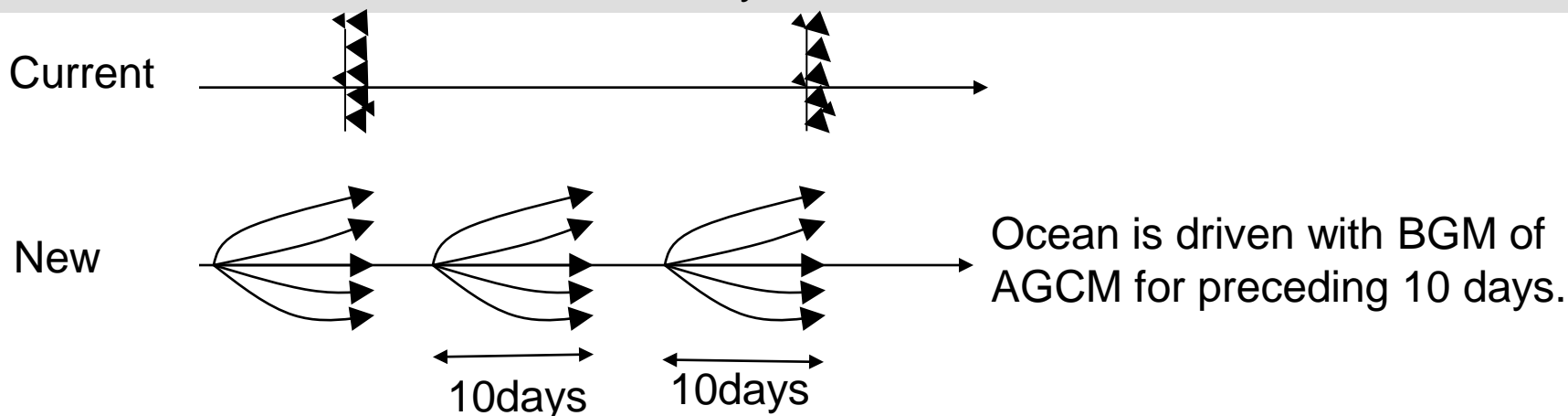
#### New system: 1-tiered

Period: 1979-2008(30 years) (1984-2005 for verification)

Perturbation: atmosphere: BGM, 5 members, the last & 15th day of each month  
ocean : driven with AGCM/BGM (wind stress, heat flux)  
for preceding 10 days to the initial time

#### TFSP/WCRP: 1-tiered

Period: 1984-2006, Perturbation: LAF by 12 hours, 10 members

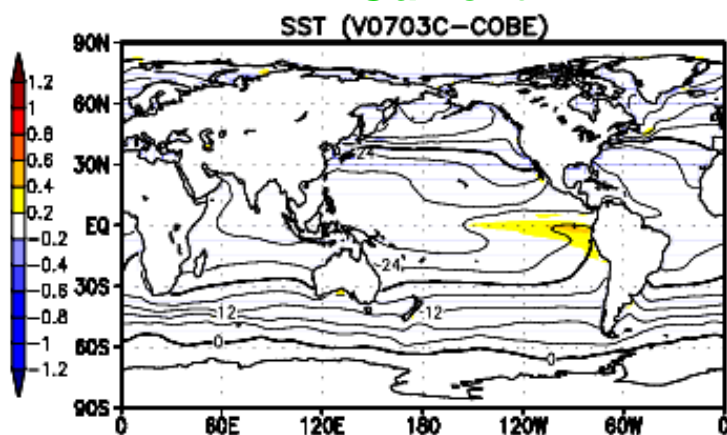




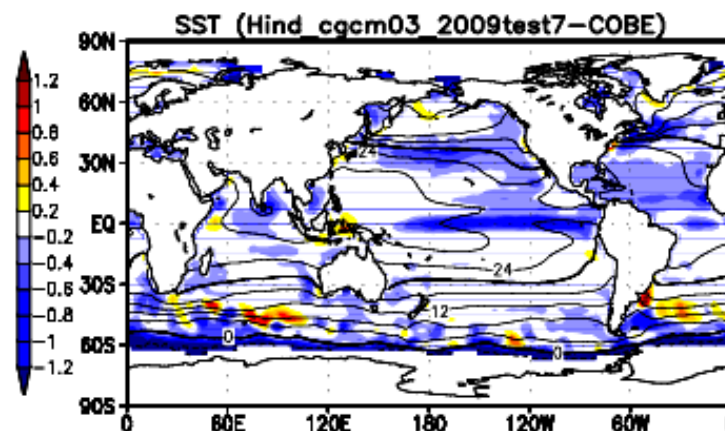
### 3. Comparison of performance SST Bias from COBE-SST

JJA prediction: Initial of the end of January  
(4 month lead)

Current



New



- JMA coupled model has negative bias in SST globally.

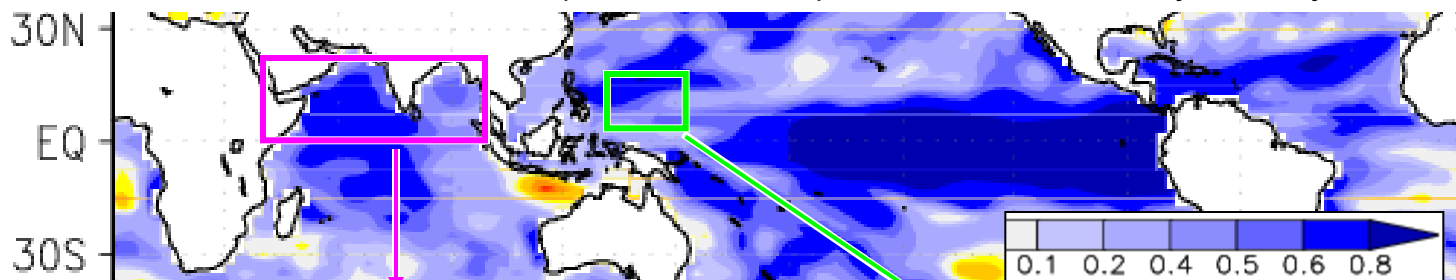


# 3. Comparison of performance SST between current and New systems

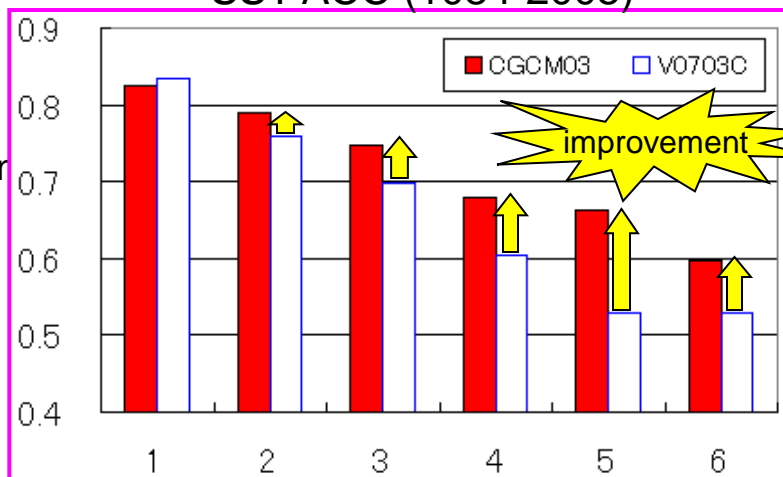
## Comparison of monthly SST ACC

- SST prediction by **new** EPS system
- Prescribed SST for **current** 2-tier system

SST ACC for Dec.(4 month lead), Initial: the last day of July

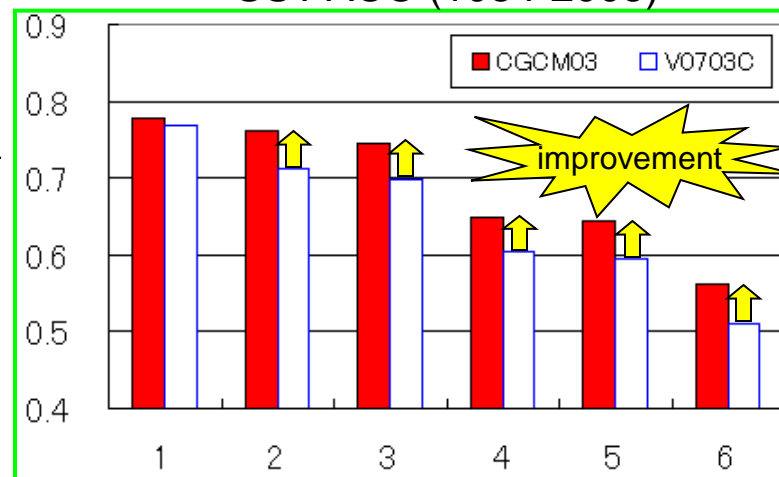


SST ACC (1084-2005)



Northern Indian Ocean

SST ACC (1084-2005)

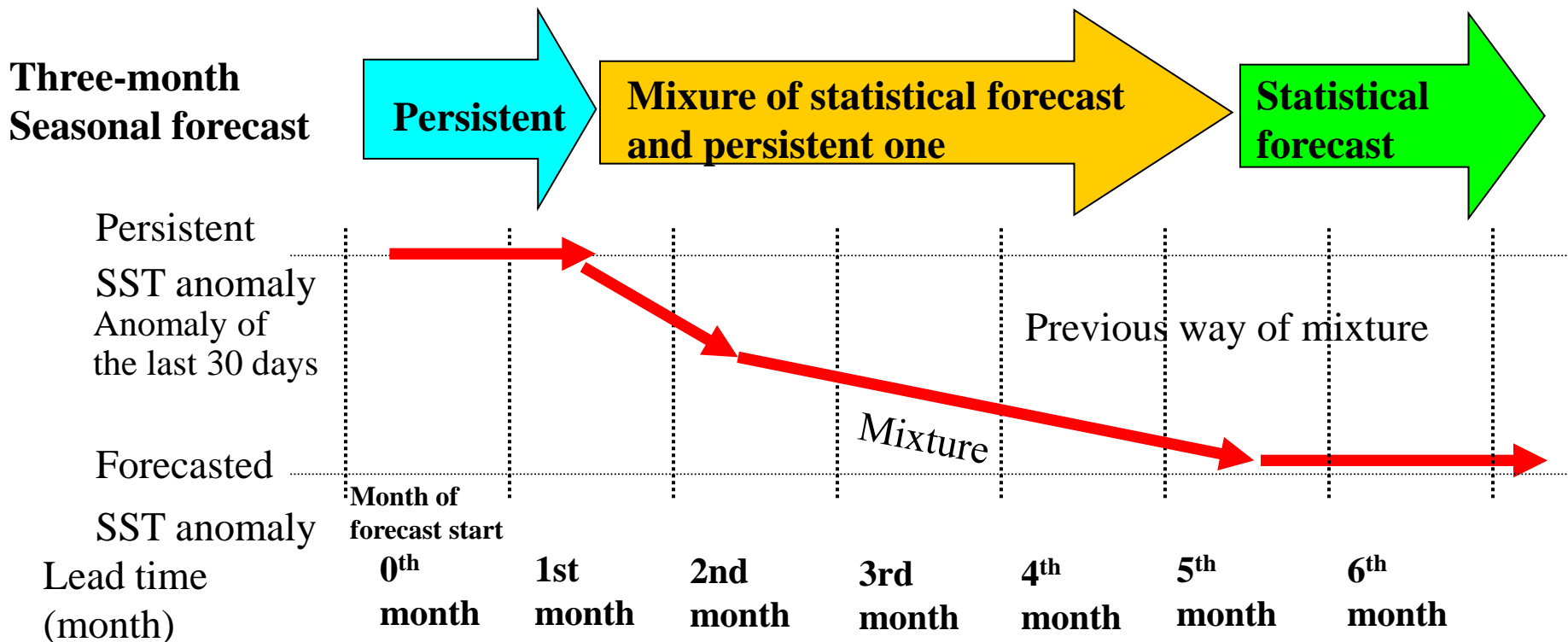


Tropical Western Pacific



### 3. Comparison of performance SST prescribed for the current system

#### SST for the current EPS system



Persisted:  $SST = \text{Anomaly at the initial time} + \text{climatology}$

Forecast :  $SST = \text{forecasted statistically based on Nino-3 forecast}$

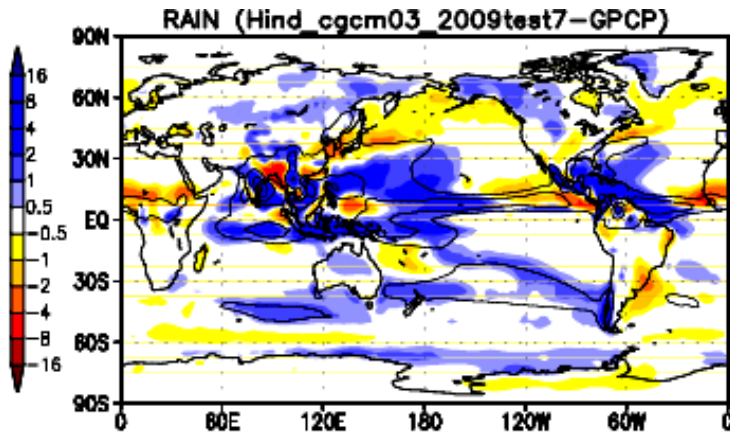
with the El-Niño model



# 3. Comparison of performance

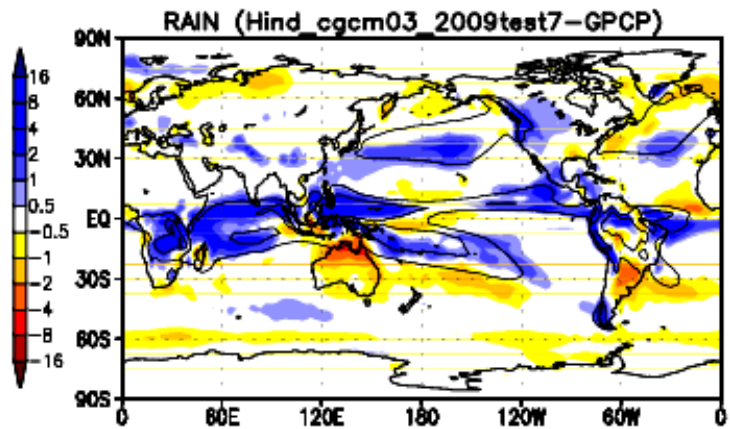
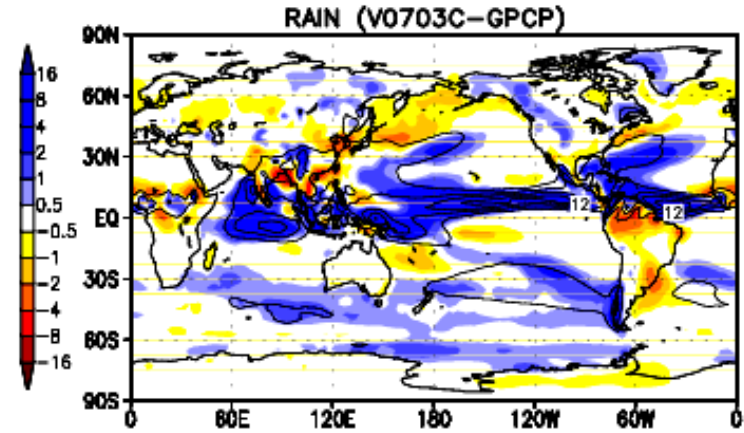
## Precipitation bias : 3 month mean (4 month lead)

New

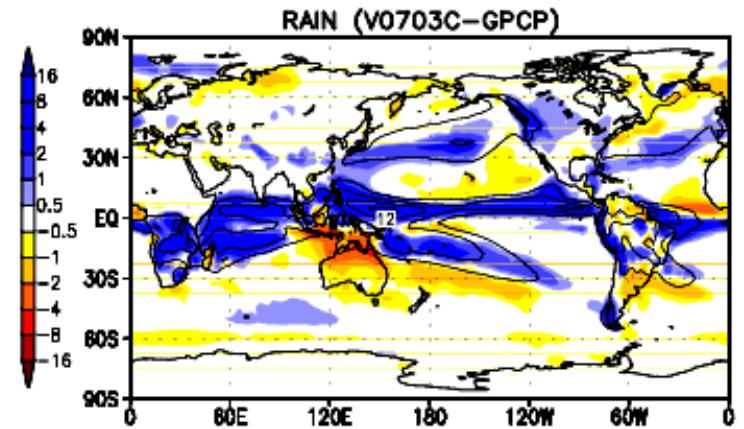


JJA  
(Initial:  
end of Jan)

Current



DJF  
(Initial:  
end of Jul)



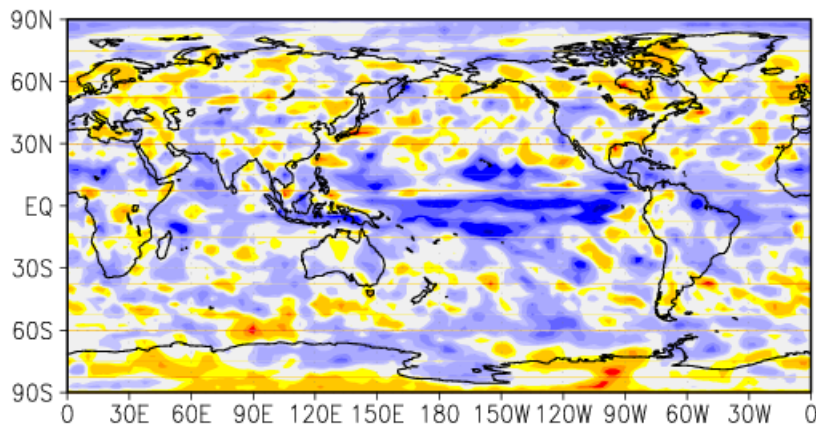
- Bias from the GPCP around the equator in the new system is smaller than current system.



# 3. Comparison of performance

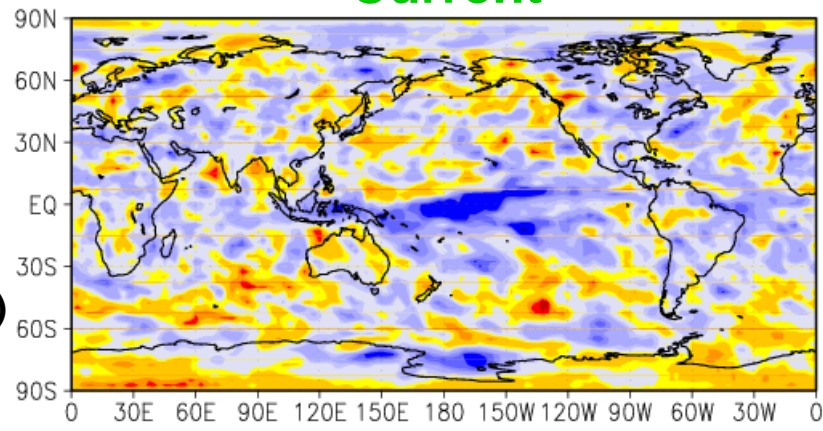
## ACC of Precipitation: 3 month mean (4 month lead)

**New**



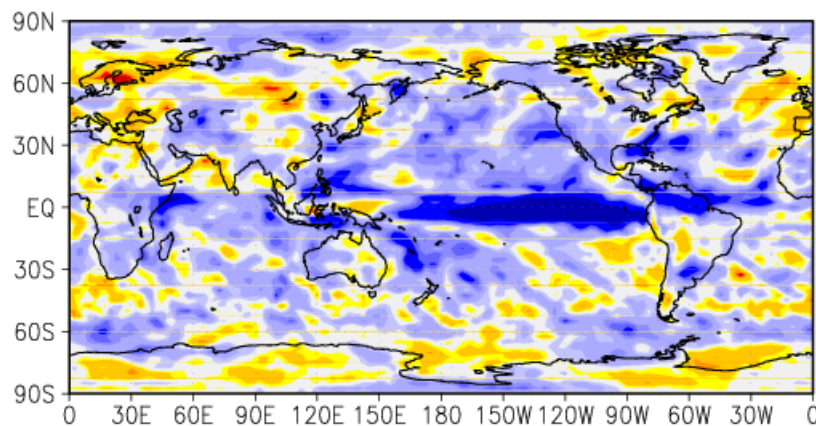
**JJA**  
(Initial:  
end of Jan)

**Current**

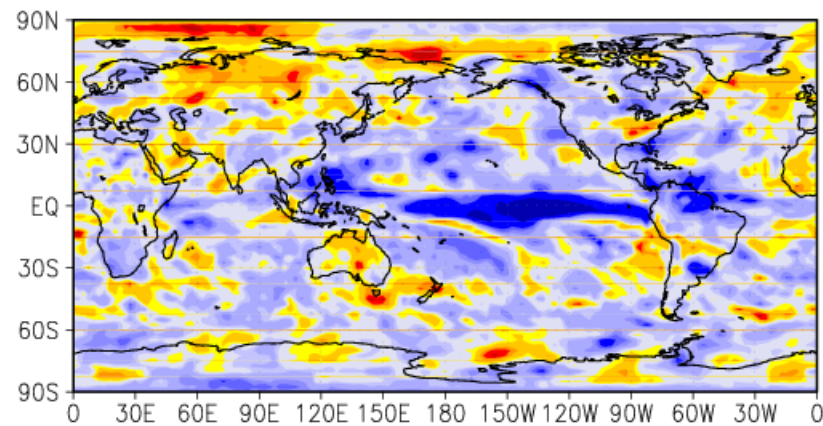


Negative 0.8 -0.6 -0.5 -0.4 -0.2 -0.1 0.1 0.2 0.4 0.5 0.6 0.8 Positive

-0.8 -0.6 -0.5 -0.4 -0.2 -0.1 0.1 0.2 0.4 0.5 0.6 0.8



**DJF**  
(Initial:  
end of Jul)



-0.8 -0.6 -0.5 -0.4 -0.2 -0.1 0.1 0.2 0.4 0.5 0.6 0.8

-0.8 -0.6 -0.5 -0.4 -0.2 -0.1 0.1 0.2 0.4 0.5 0.6 0.8

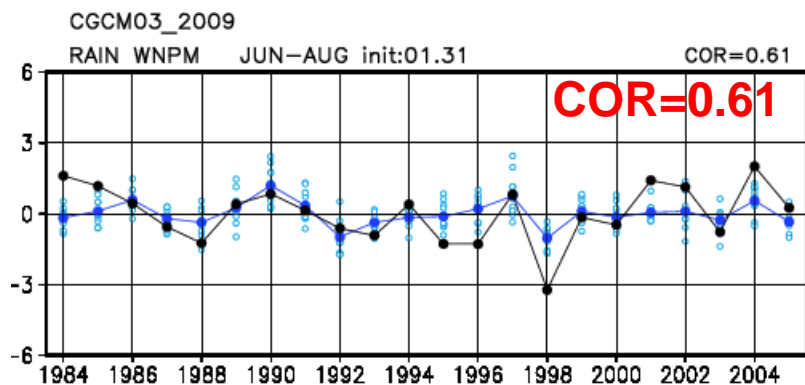


# 3. Comparison of performance

## WNPM area precipitation: year-to-year variation

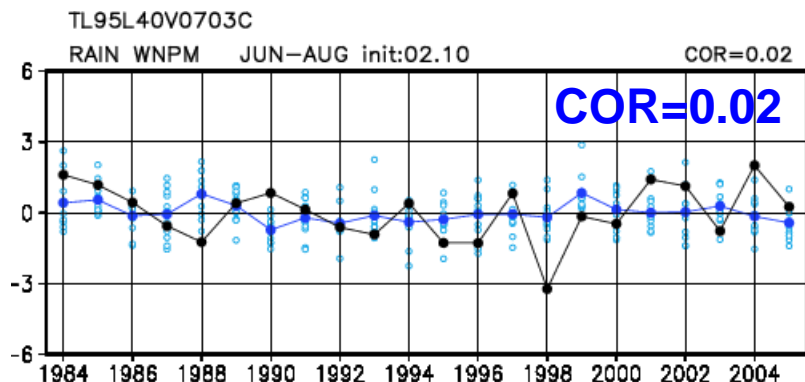
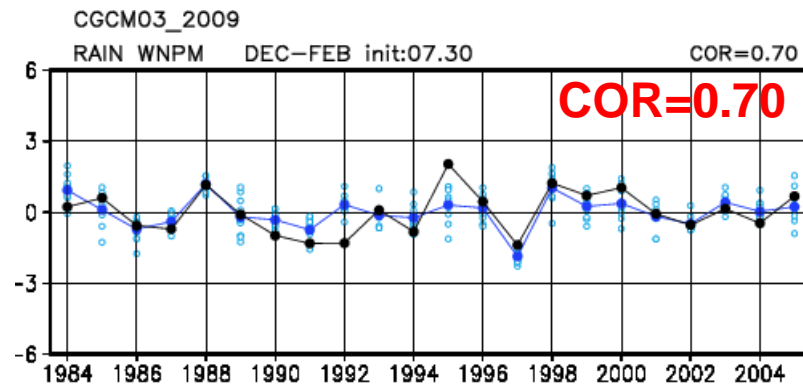
WNPM: Western North Pacific Monsoon (110-160E, 10-20N)

**JJA** (Initial: end of Jan.)

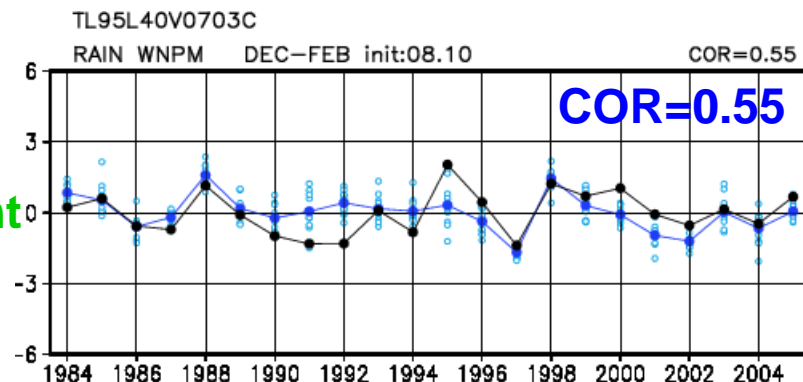


New

**DJF** (Initial: end of Jul.)

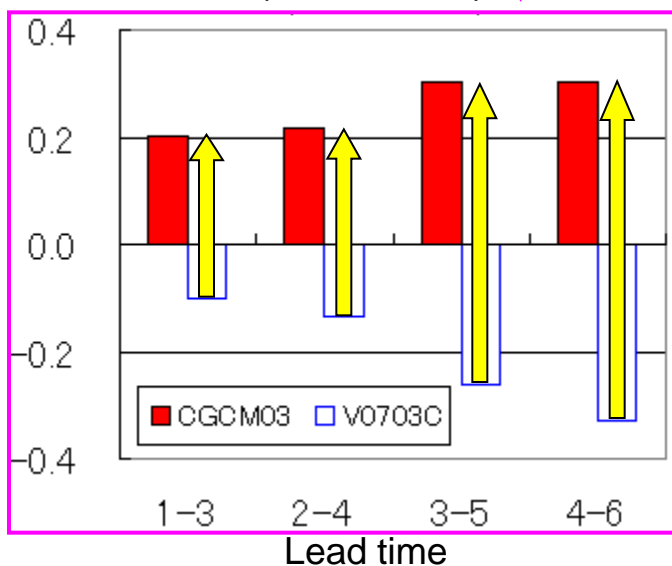
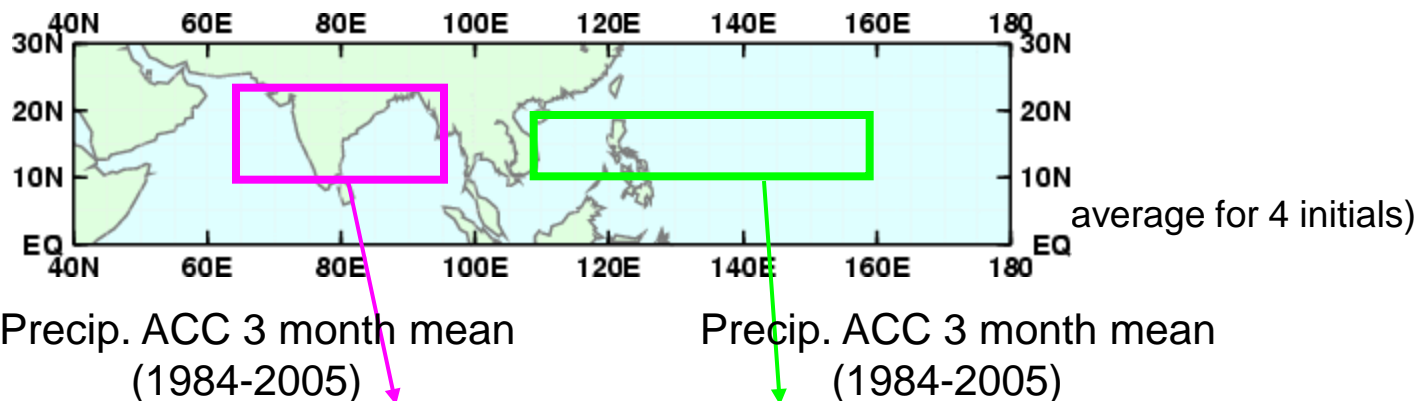


Current

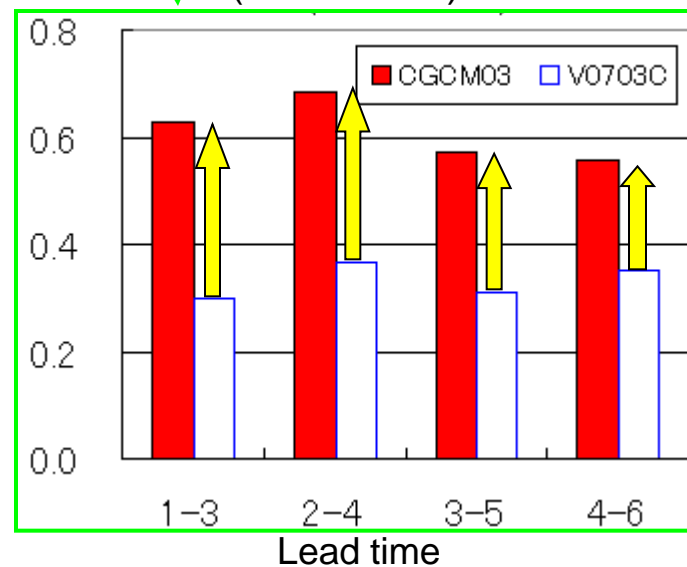




### 3. Comparison of performance precipitation ACC: dependency on lead time



Indian monsoon area

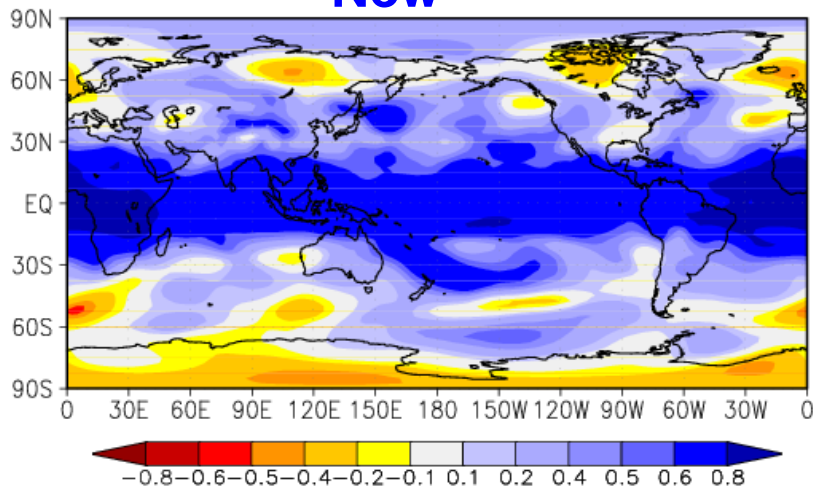


North Western Pacific  
monsoon are



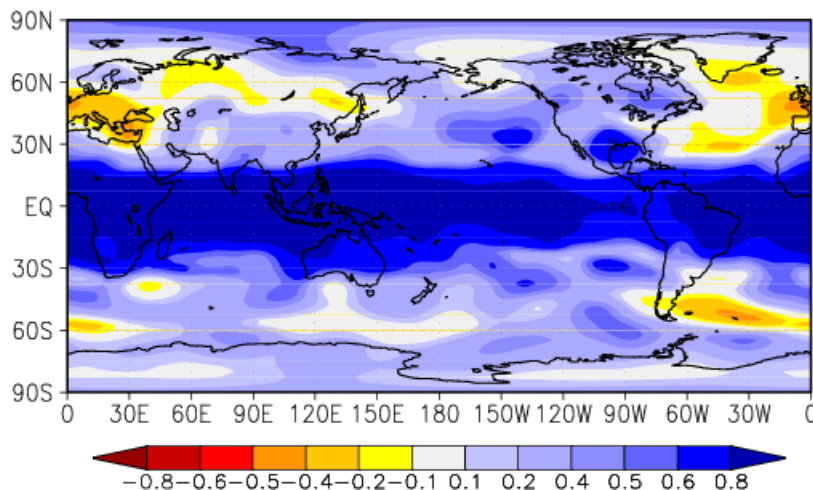
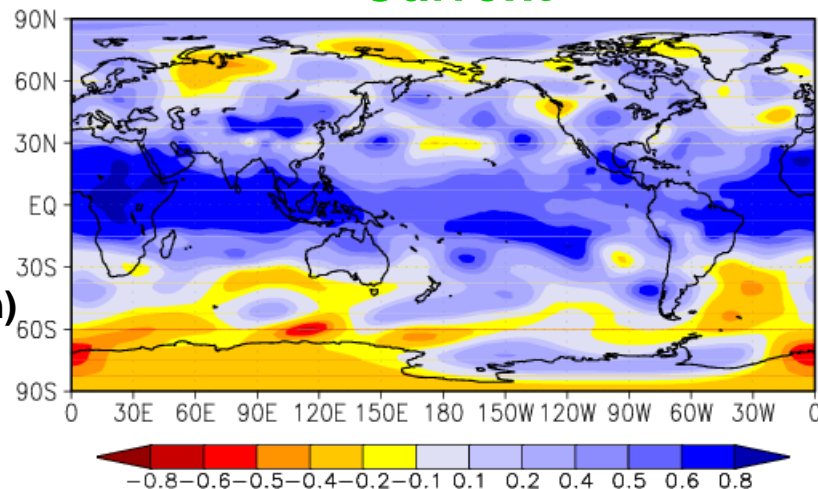
# 3. Comparison of performance 500hPa height : ACC

**New**

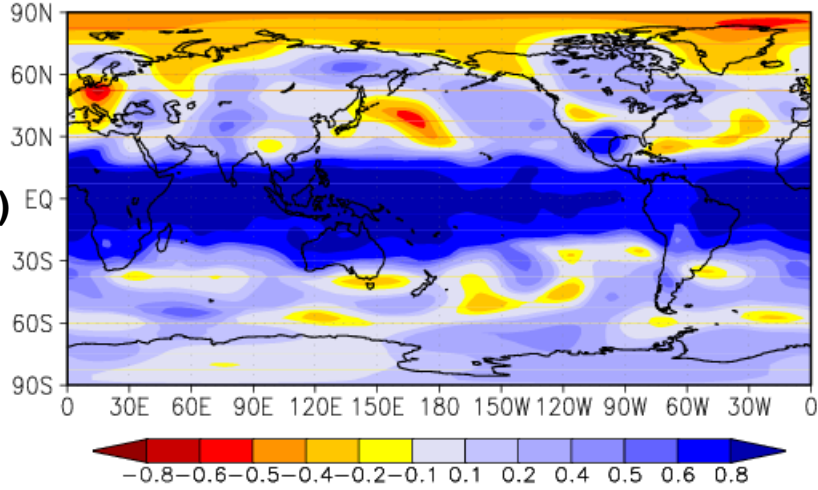


**JJA**  
(Initial:  
end of Jan)

**Current**



**DJF**  
(Initial:  
end of Jul)



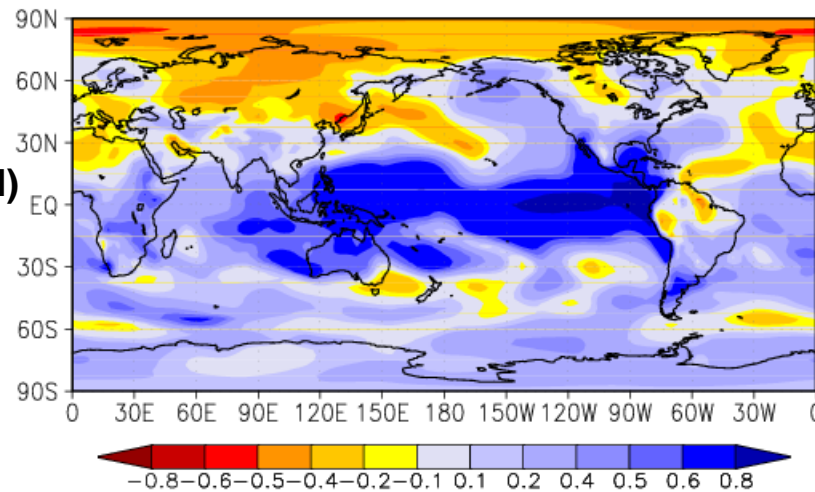
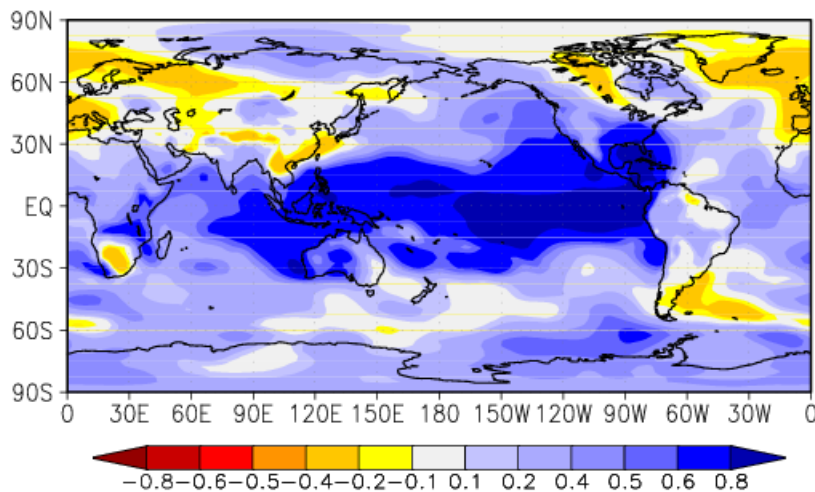
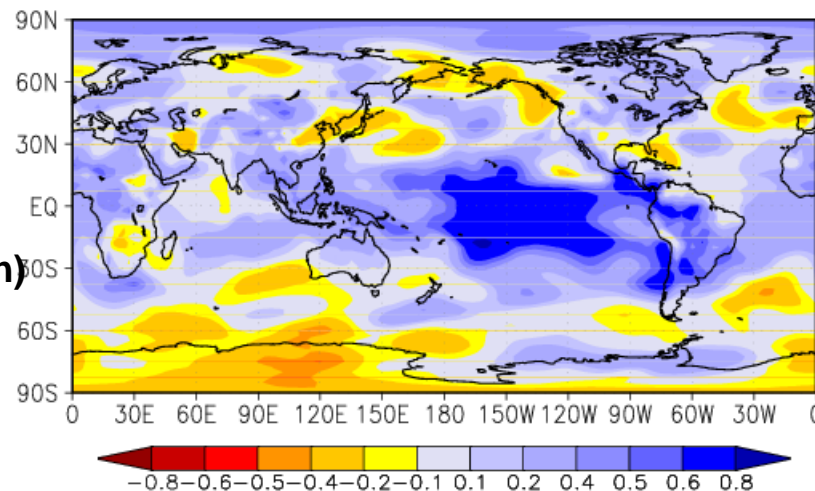
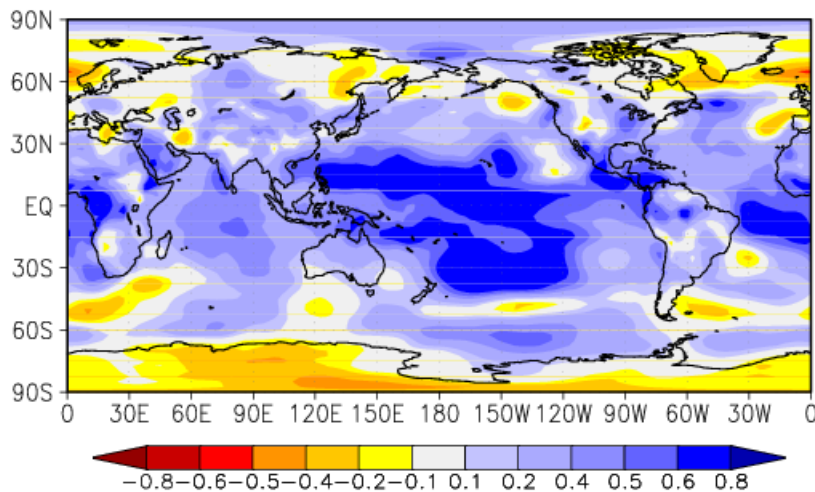


# 3. Comparison of performance

## SLP : ACC

**New**

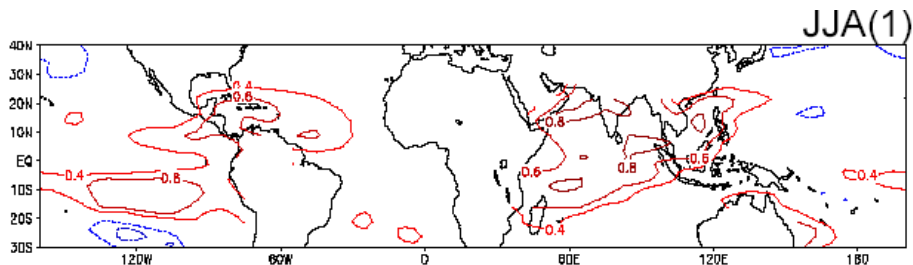
**Current**





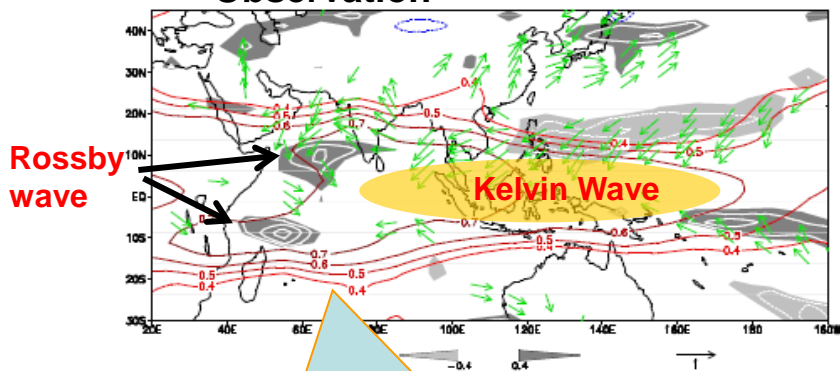
### 3. Comparison of performance

Speculation on the improvement from Xie .et al(2009)



Basin-wide warming of Indian Ocean SST in the succeeding summer of El-Nino (correlation of SST between JJA(1) and NDJ(0))

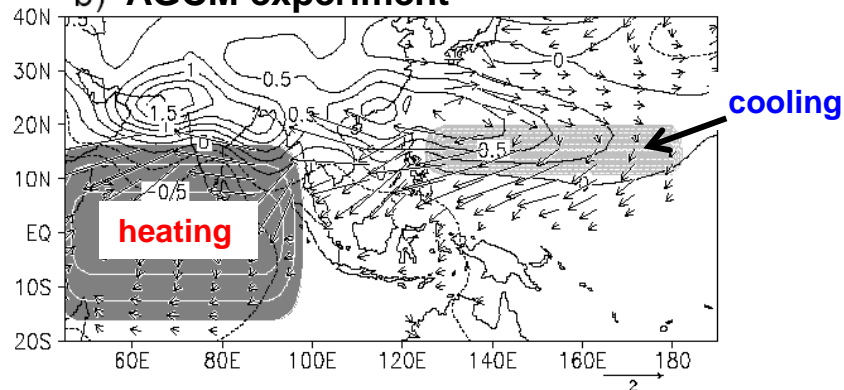
Observation



Matsuno-Gill type pattern

Correlation coefficients between winter NINO3.4 SST and succeeding summer tropospheric temperature (contours), precipitation (shades) and surface wind ( vectors)

b) AGCM experiment

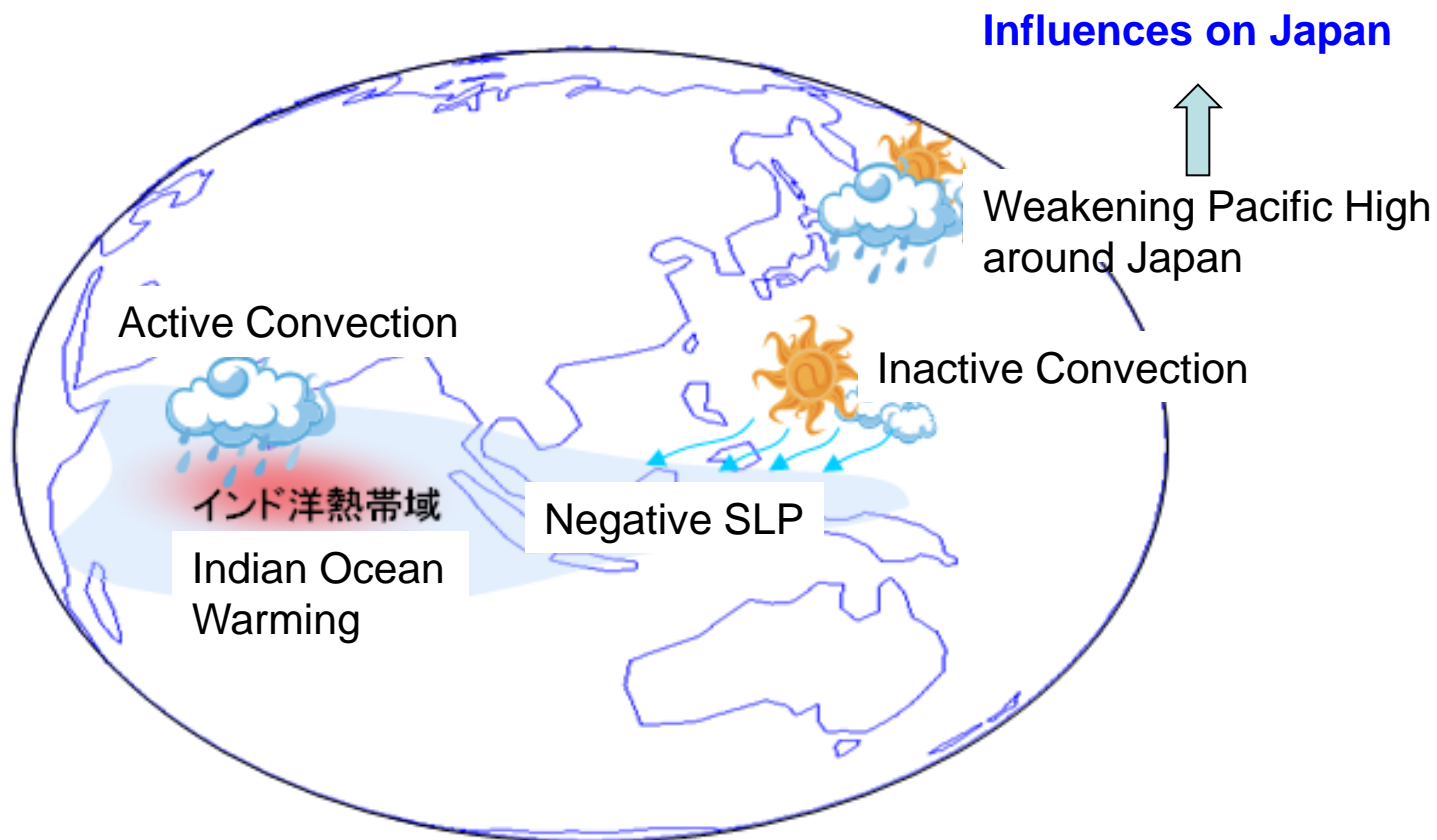


- Kelvin waves emanating from the Indian Ocean to the Maritime Continent
- Induced low-level divergent wind
- Ekman pumping mechanism low-level anti-cyclonic response
- Suppression of the convective activities in WNP



### 3. Comparison of performance

Speculation on summertime SLP forecast skill improvement

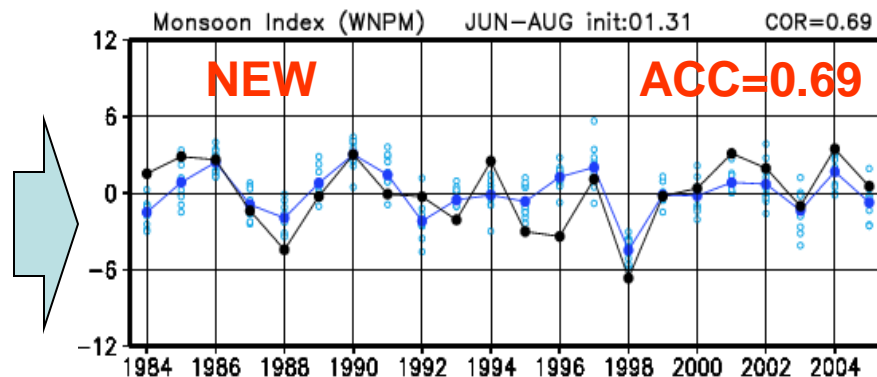
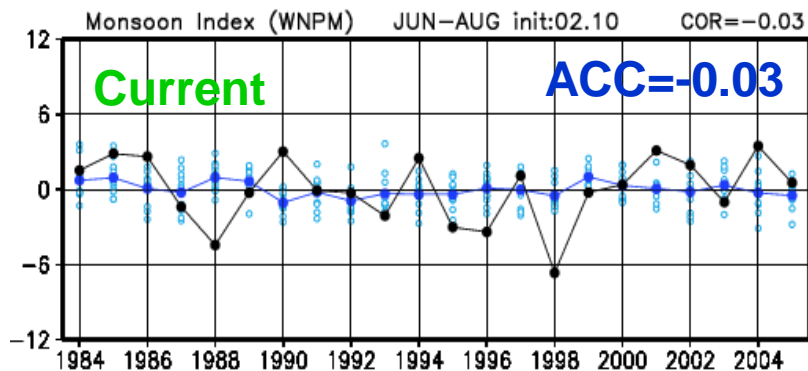


Ref. Xie et. al.(2009)

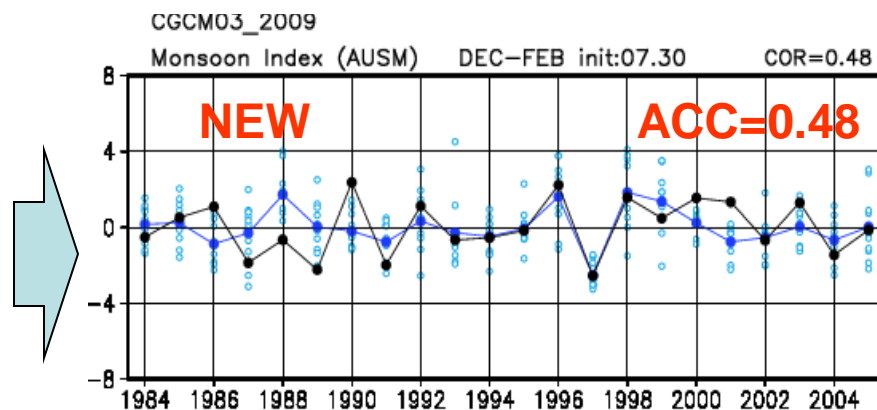
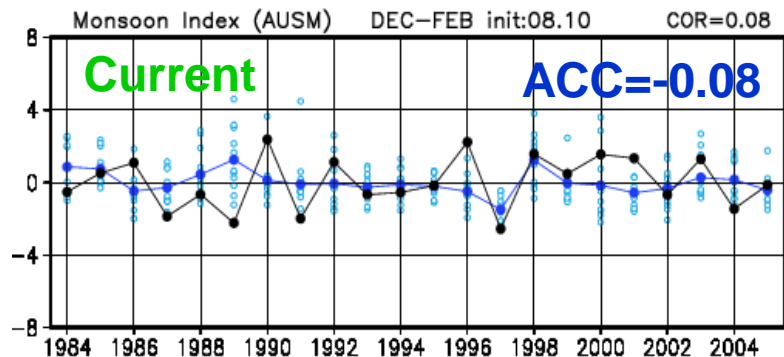


### 3. Comparison of performance Monsoon activity

**WNPM (Western North Pacific Monsoon) Index**  
(JJA, initial of the end of January, 4 month lead)  
U850(100E-130E,5N-15N)-U850(110E-140E,20N-30N)



**AUSM (AUStralian Monsoon) Index**  
(DJF, initial of the end of July, 4 month lead)  
U850(110E-130E,15S-5S)





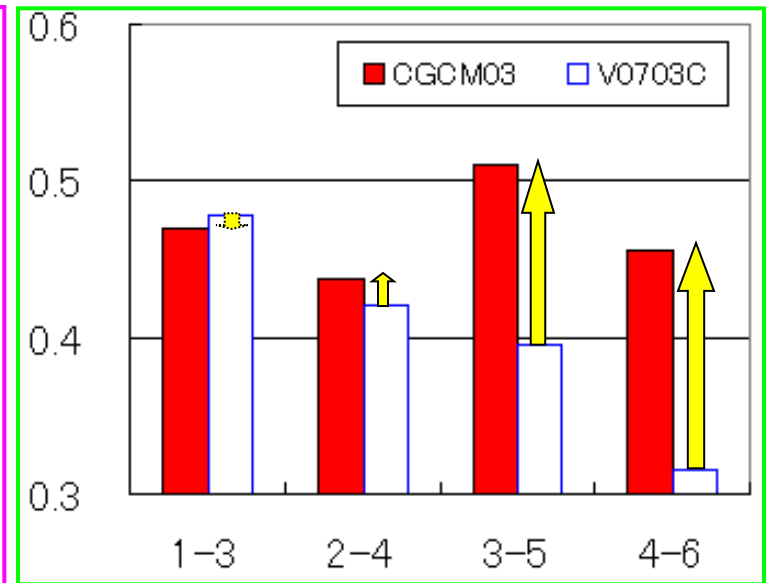
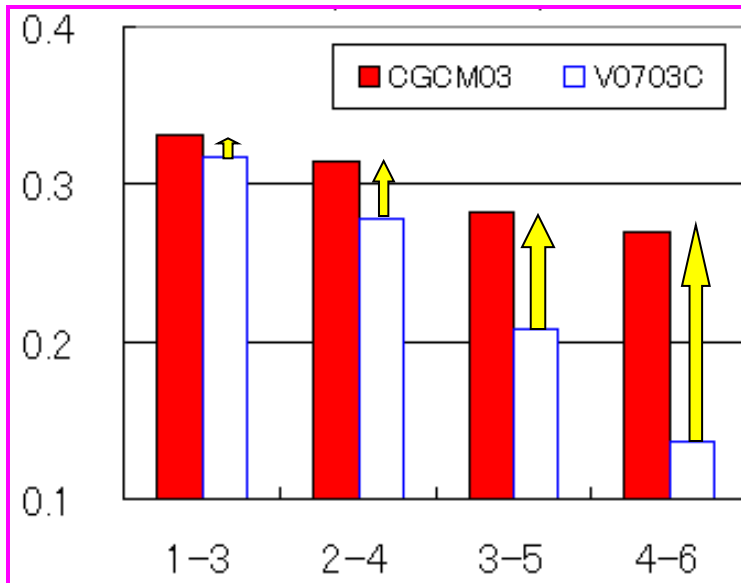
# 3. Comparison of performance Improvement of Z500 ACC over the mid-latitude

ACC of 3-month averaged Z500 for 1984-2005  
(average for 4 initials)

- New EPS system (CGCM03)
- Current 2-tier system (V0703C)

Japan area (100E-170E, 20N-60N)

Zonal average for 40N-40N



Lead time

Lead time



# 3. Comparison of performance Dependency on lead-time: Z500 ACC

500hPa height Anomaly Correlation

Over the North Pacific (20N-90N,90E-90W): 4 initials mean

- TFSP experiment (1-tiered)
- Current system (2-tiered)

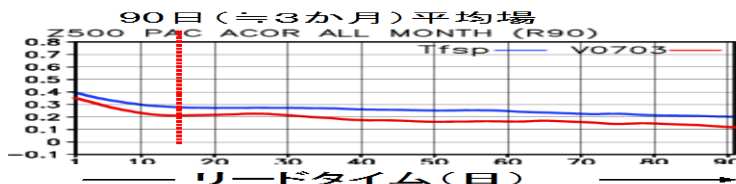
90 days mean

30 days mean

## 大気海洋結合モデルと現業モデルとの予測精度比較

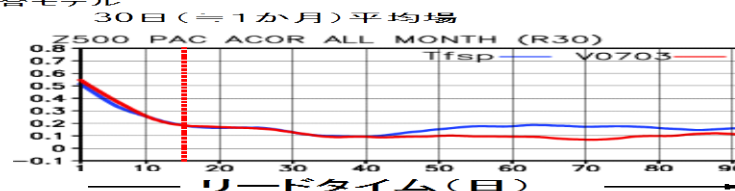
- 1984~2005年(22年分)、1月末、4月末、7月末、10月末の予報実験結果から北太平洋域(20~90N, 90E~90W)500hPa高度のアノマリー相関係数

赤: 現大気モデル 青: 大気海洋結合モデル



90日(≒3か月)平均場では大気海洋結合モデルによる予測精度向上が明瞭。一方、30日(≒1か月)平均場では明瞭でない。予測精度の面からは、大気海洋結合モデル導入のメリットは3か月平均の予測の精度向上。

Lead-time (day)



期待されるのは夏(冬)を予測する暖(寒)候期予報と、3か月予報のうち3か月平均の予報の精度向上  
3か月予報のうち月毎の予報精度向上は、あまり期待できない(1か月目も)

Lead-time (day)

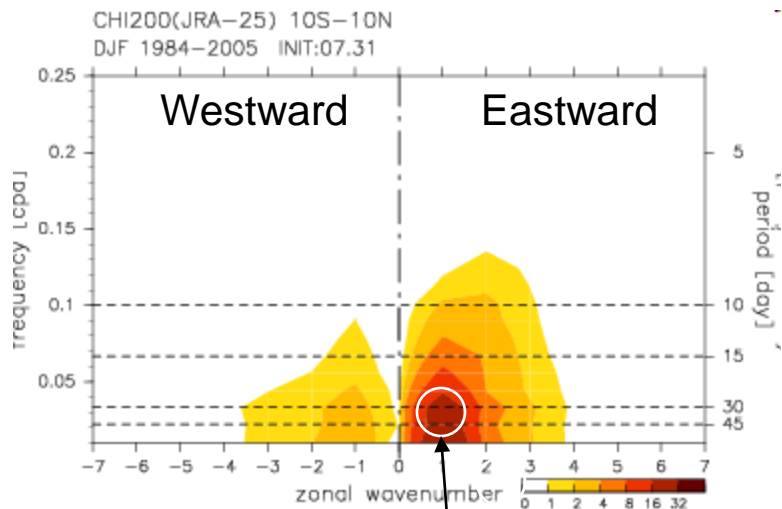
- TFSP results show better score over all lead-time with 90 days mean.
- On the other hand, in case of 30 days mean, TFSP is almost the same as the current system.



### 3. Comparison of performance

Time-Space Spectral Analysis of 200hPa velocity potential anomaly over 10S-10N

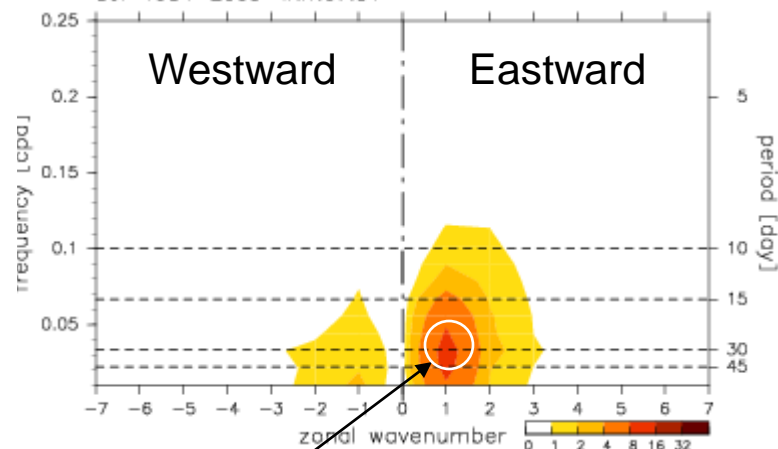
JRA-25 (Observation)  
Period: DJF (1984-2005)



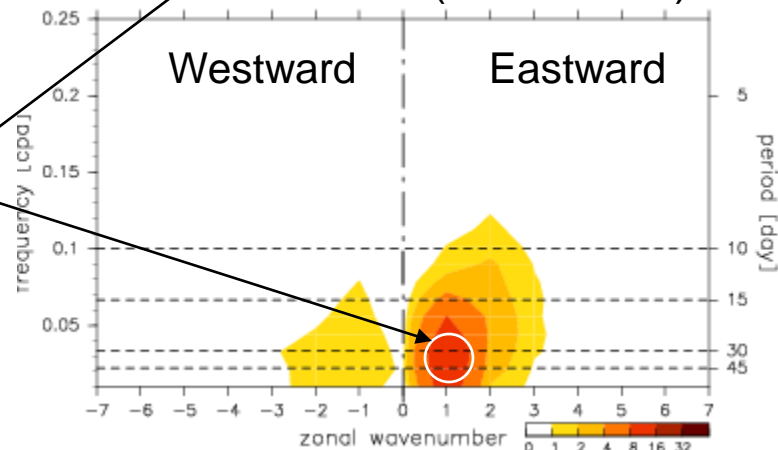
30-45 days period and wave-number 1

Eastward moving signal with wave-number one is not so prominent in the MJO period.

TFSP(1-tiered)  
Forecast: DJF (1984-2005)



Current(2-tiered)  
Forecast: DJF (1984-2005)





## 4. Summary

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- JMA will replace seasonal forecast EPS system in February 2010, from 2-tiered system to 1-tiered system (the current El-Niño model).
- Forecast performance will be improved, especially in longer-lead time range, while in shorter-lead time performance isn't so improved.
- Improvement is seen, in particular, over the tropical region.
- In the mid-latitude, improvement can be seen to some degree.
- MJO forecast is still difficult, but further investigation is needed with new system hindcast data.



# END

Thank you for your attention!





# 4. Summary

## Ensemble method for New EPS system

- 9 members per 1 initial, 13 months forecast
- Execution by every 5 day → LAF. LAF for a month
- 6 initials → **51 members** are used for one-month forecast

