JMA's Ensemble Prediction System for One-month and Seasonal Predictions

Akihiko Shimpo
Japan Meteorological Agency

Seasonal Prediction Modeling Team:
H. Kamahori, R. Kumabe, I. Ishikawa, T. Tokuhiro, S. Yabu, A. Shimpo, H. Sato, T. Motoyama, Y. Naruse, Y. Takaya, T. Soga, H. Mori

Contents

- Introduction
  - Outline of EPS for one-month / seasonal forecasts
  - Products on Tokyo Climate Center (TCC) web site
- Verification
- Recent developments
  - Physics (cumulus parameterization, radiation)
  - Initial perturbation
- Future Plan
  - Introducing a CGCM into seasonal forecast

Outline of EPS

One-month Forecast

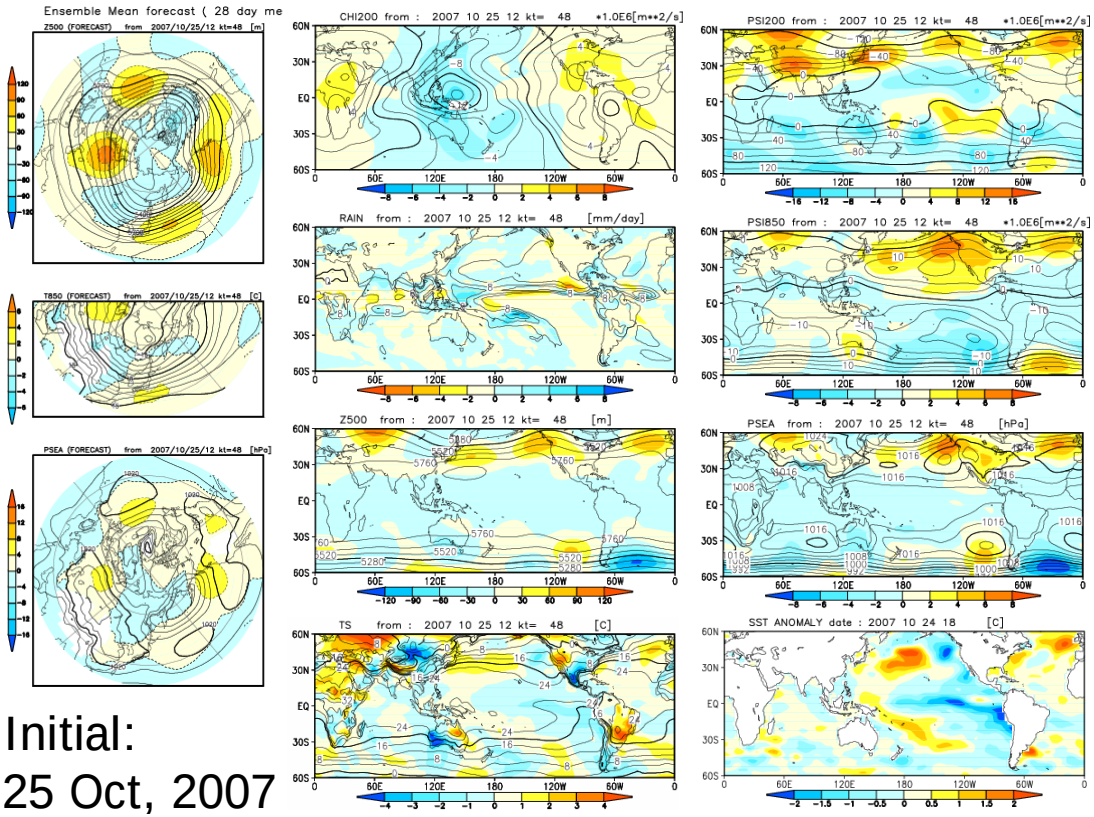
- T_L159: 1.125deg ~**110km**
- **L40**: model top=0.4hPa
- Ensemble size: **50**
- I. Perturbation: **BGM / LAF**
- Frequency: **Once a week**
- Forecast period: **34 days**
- Land: SiB
- SST: **Persisted anomaly**

Seasonal Forecast

- T_L95: 1.875deg ~**180km**
- **L40**: model top=0.4hPa
- Ensemble size: **51**
- I. Perturbation: **SV**
- Frequency: **Once a month**
- Forecast period: **120 / 210 days**
- Land: SiB
- **SST: Prescribed using persisted anomaly, climatology and ENSO prediction by CGCM**

Products on TCC web site

- Tokyo Climate Center (TCC) Welcome to Tokyo Climate Center
  http://ds.data.jma.go.jp/tcc/tcc/index.html
  ->"NWP Model Prediction"



Initial:
25 Oct, 2007

One-month Forecast

28-day average

(1st,2nd,3rd&4th weeks)

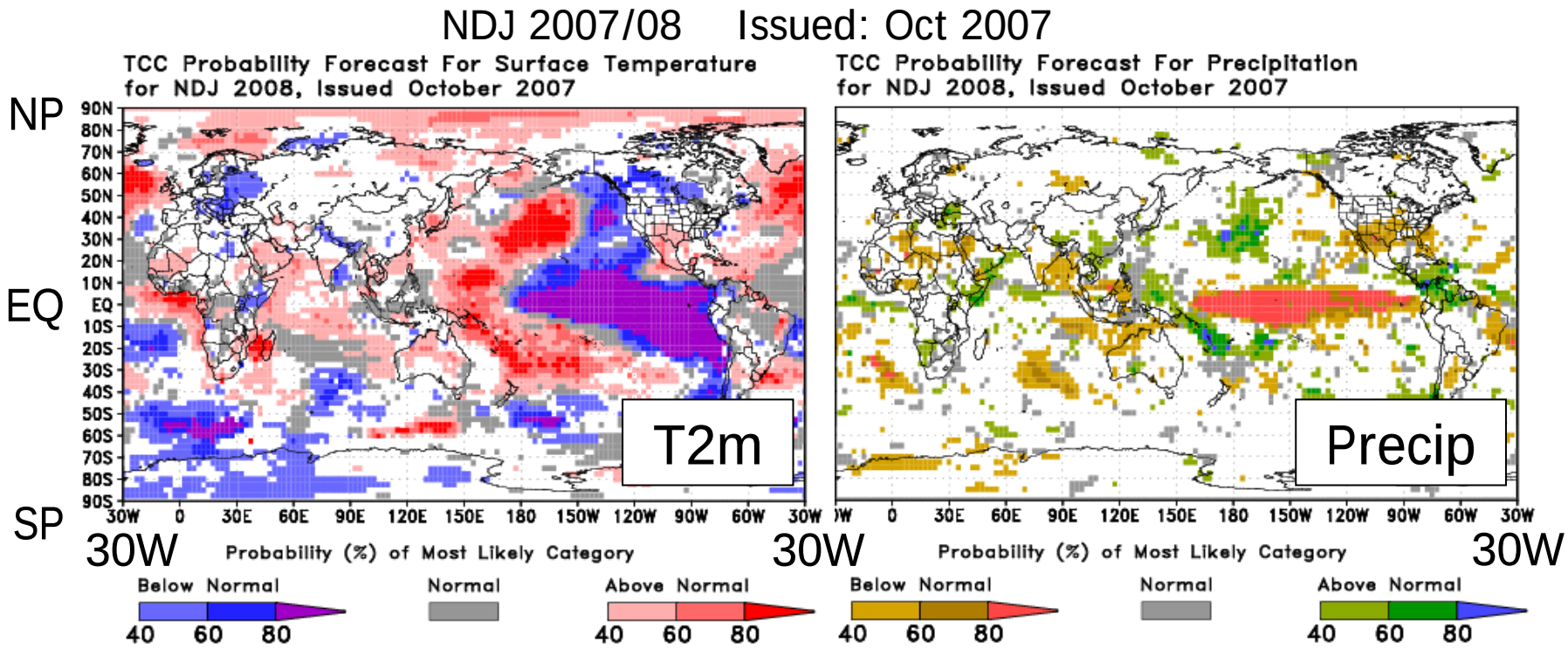
Elements: Z500, T850, Psea, VP200, RAIN, SF200, SF850, T2m, SST (persisted)

Three-month Forecast

Warm/Cold season (JJA/DJF) Forecast

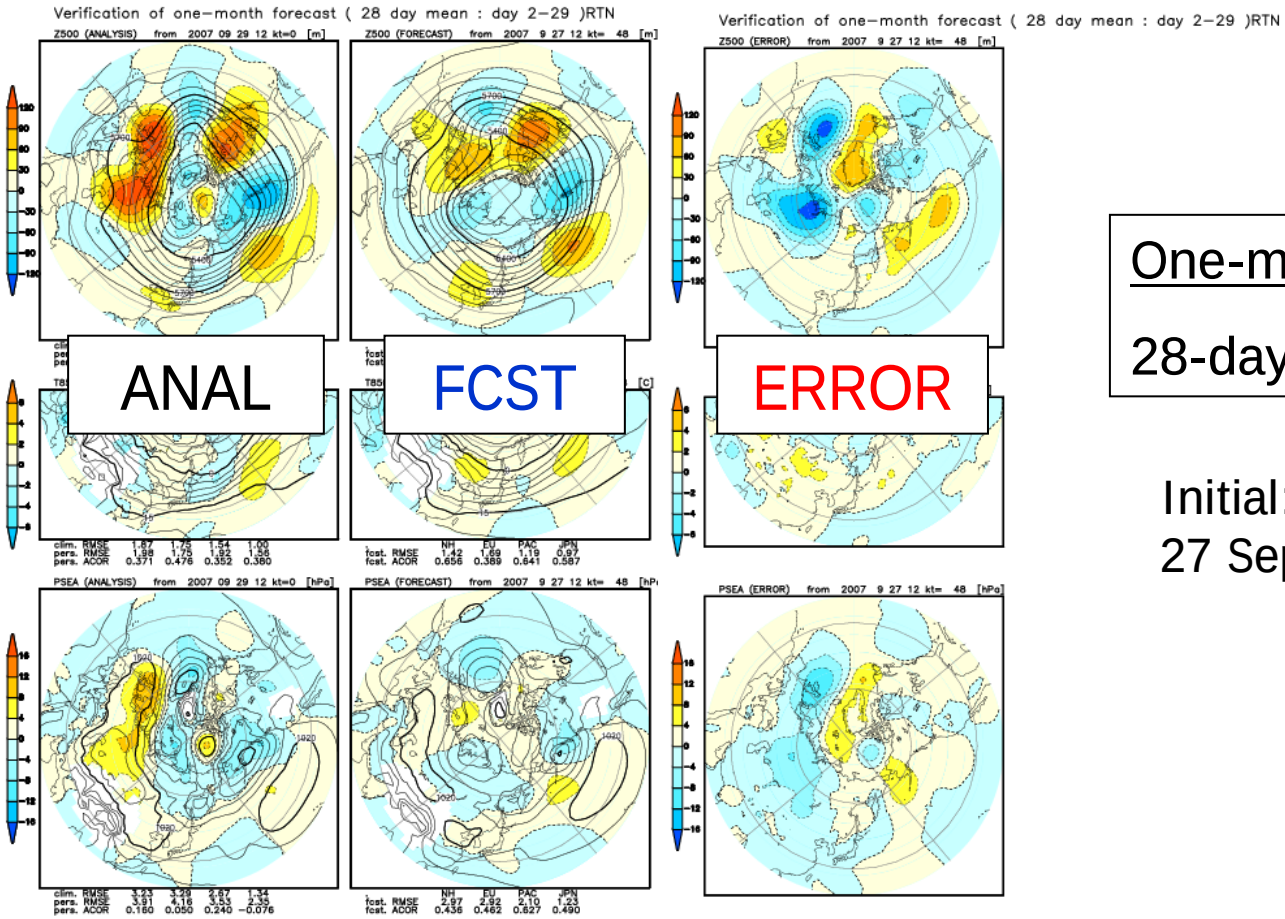
Products on TCC web site

- Experimental Probabilistic forecasts (three-month average)
- T2m, Precipitation



Products on TCC web site

- Verification is also available on TCC web site operationally.



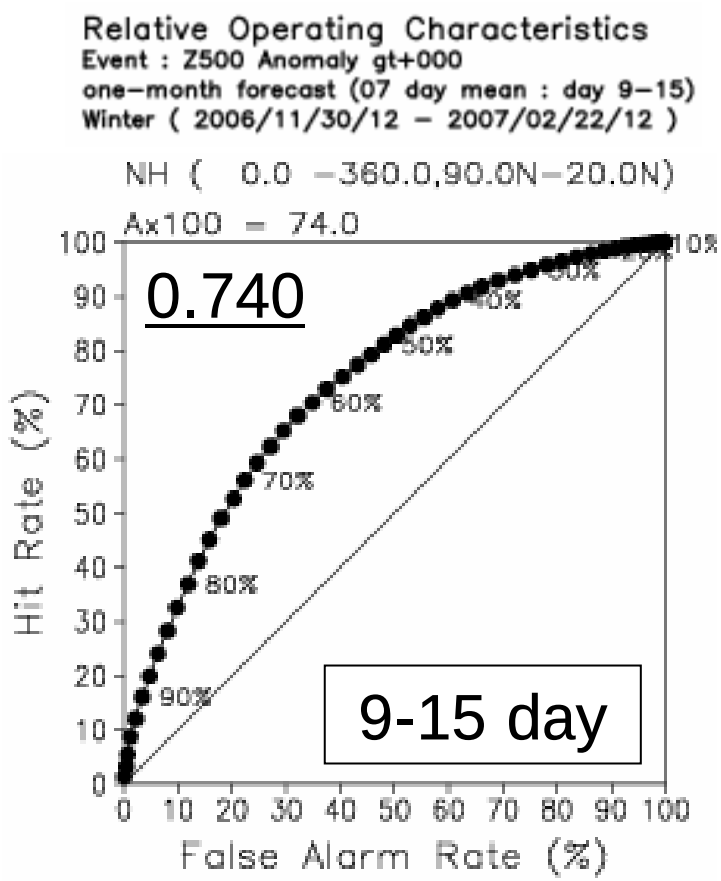
One-month forecast

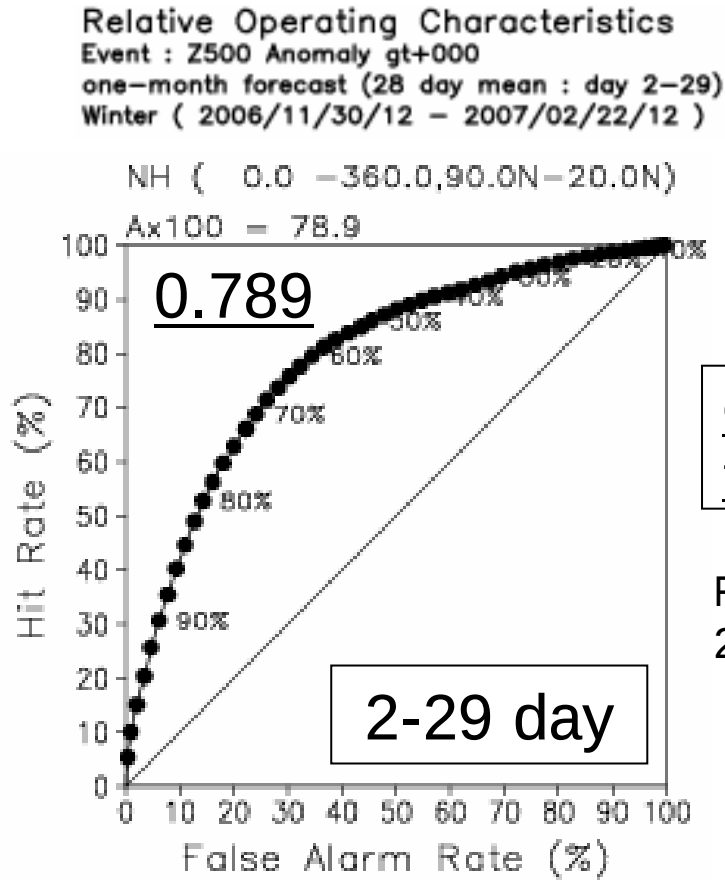
28-day average

Initial:
27 Sep, 2007

Products on TCC web site

- Verification is also available on TCC web site operationally.





One-month forecast

For Z500 during 2006/07 winter

(Anomaly>0)

Verification: Setting of Hindcast

One-month Forecast

- 1982-2001 (**20** years)
- Initial date:
  10th, 20th and
  the end of each month
- Ensemble size: **5**

Seasonal Forecast

- 1984-2005 (**22** years)
- Initial date:
  10th of each month

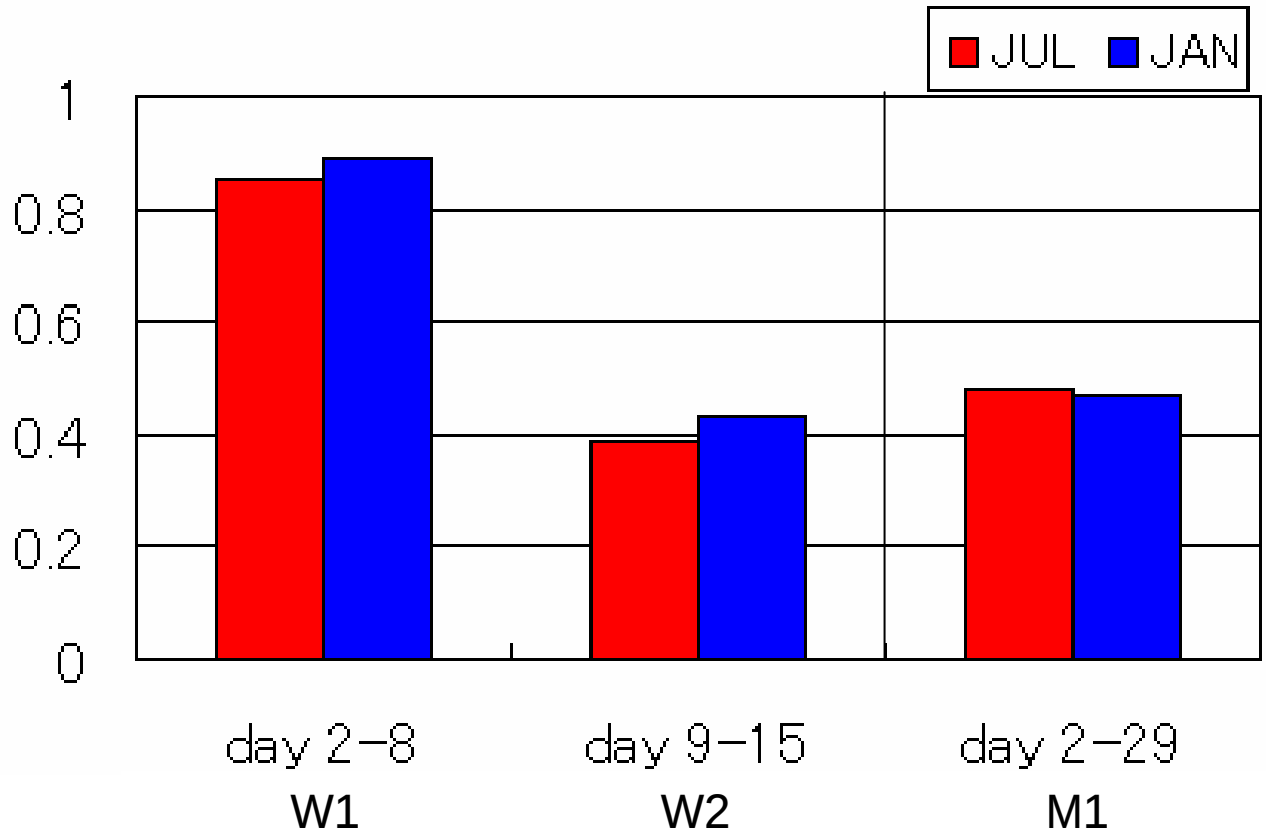
SVS-LRF

- Ensemble size: **11**

- Initial condition: **JRA-25**
- SST: **COBE-SST** (Ishii *et al.* 2005)
  (ENSO prediction by JMA-CGCM is also used for hindcast of seasonal forecast)
- Data for verification:
  JRA-25/JCDAS, ERA15-GANAL, ERA40, GPCP, CMAP

Verification: One-month Forecast

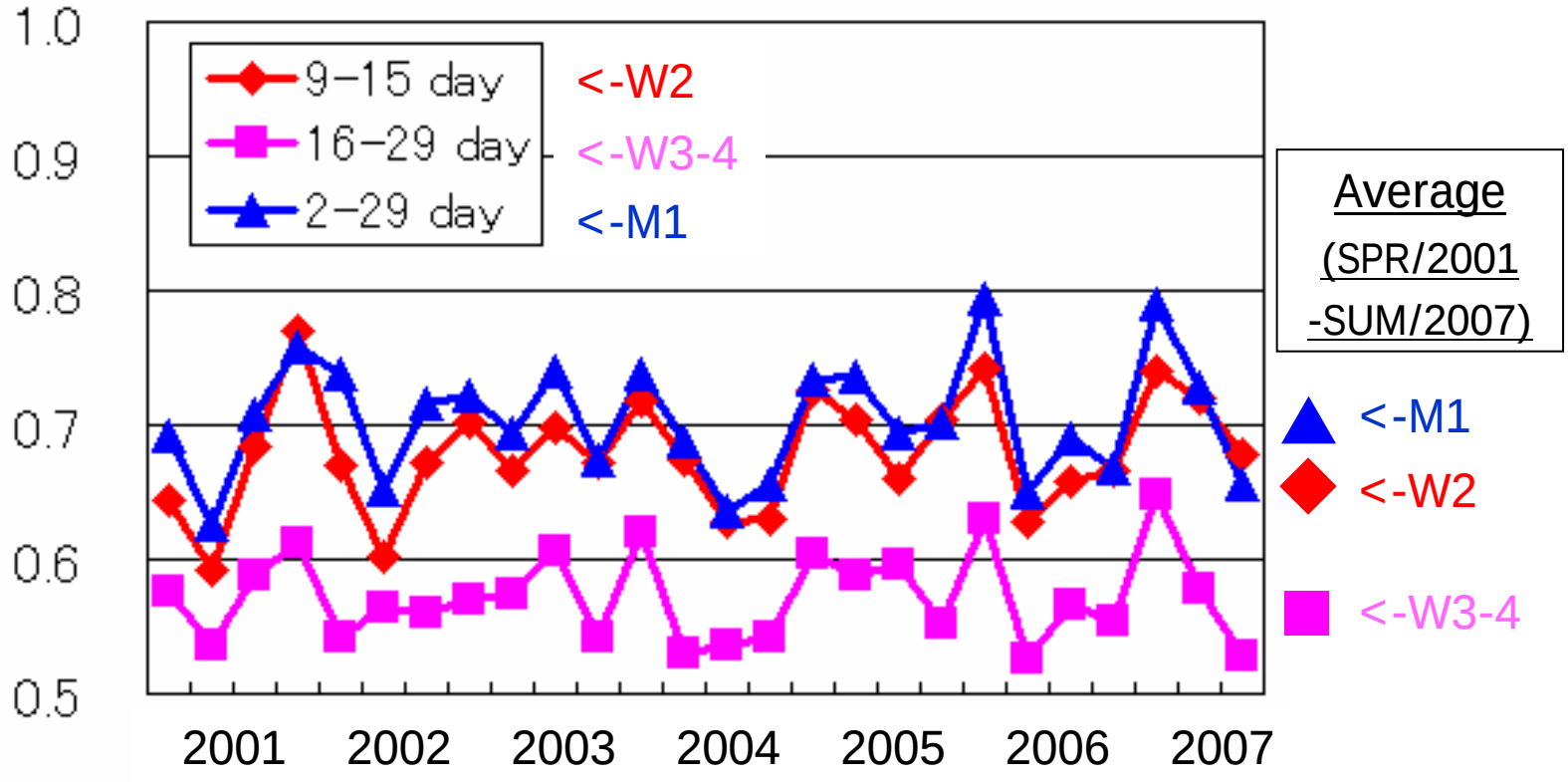
- Anomaly Correlation: Z500 over NH



(JUL) initial date: 30 Jun
(JAN) initial date: 31 Dec

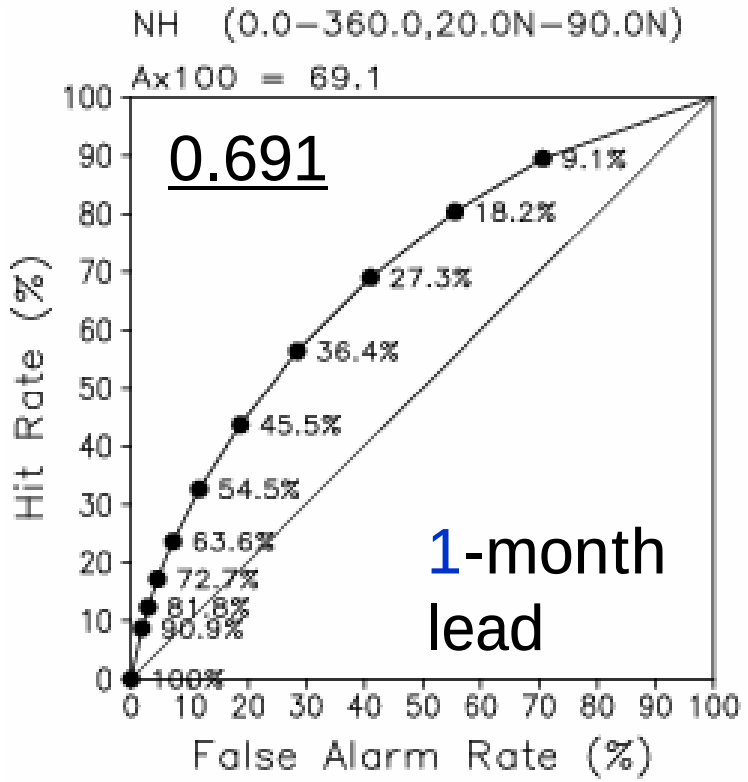
Verification: One-month Forecast

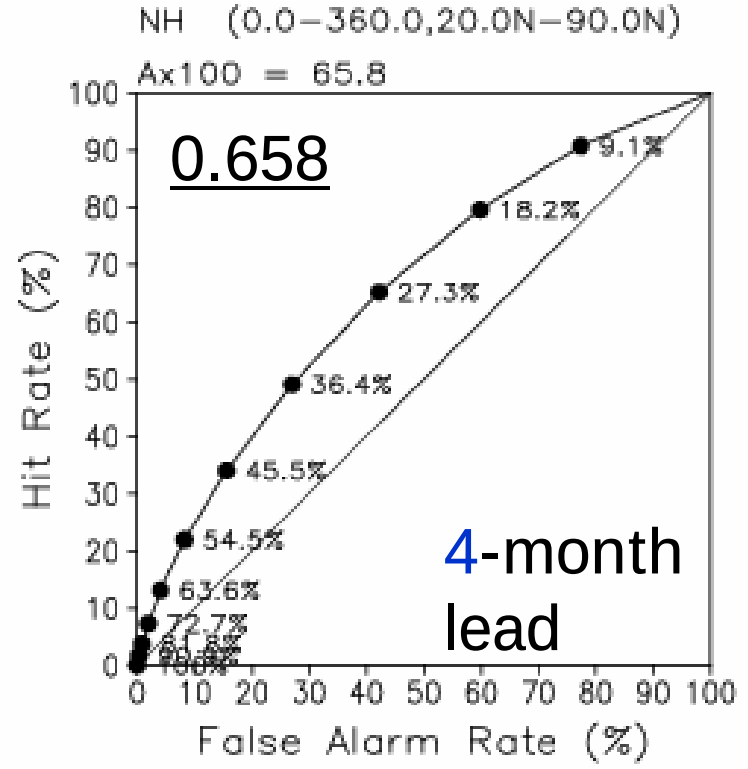
- ROC scores : Z500, Anom>0 over NH
  (from operational prediction; each season)



Verification: Seasonal Forecast

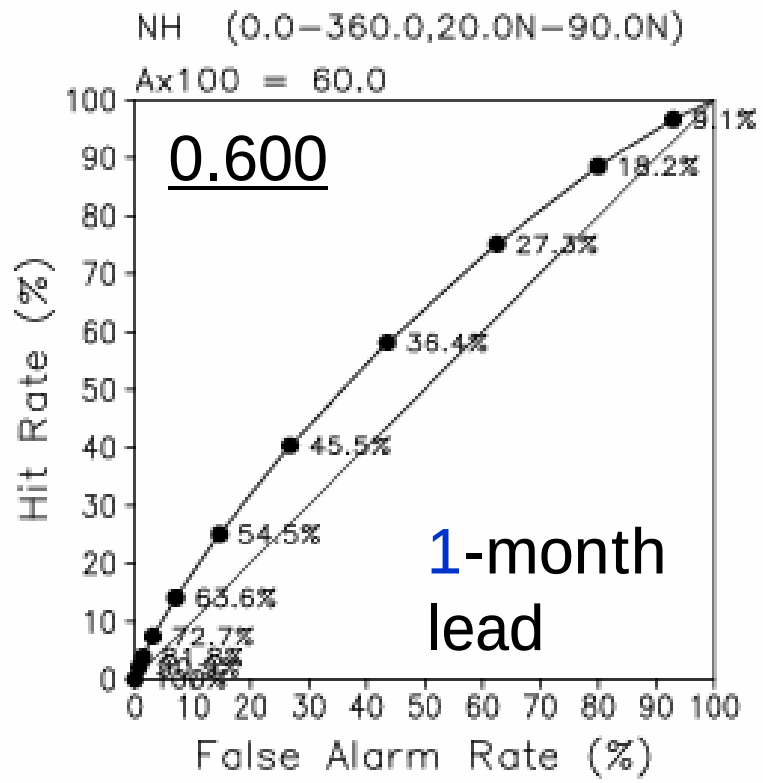
- ROC for T2m / 3-month average
  Upper tercile / Northern Hemisphere / all season

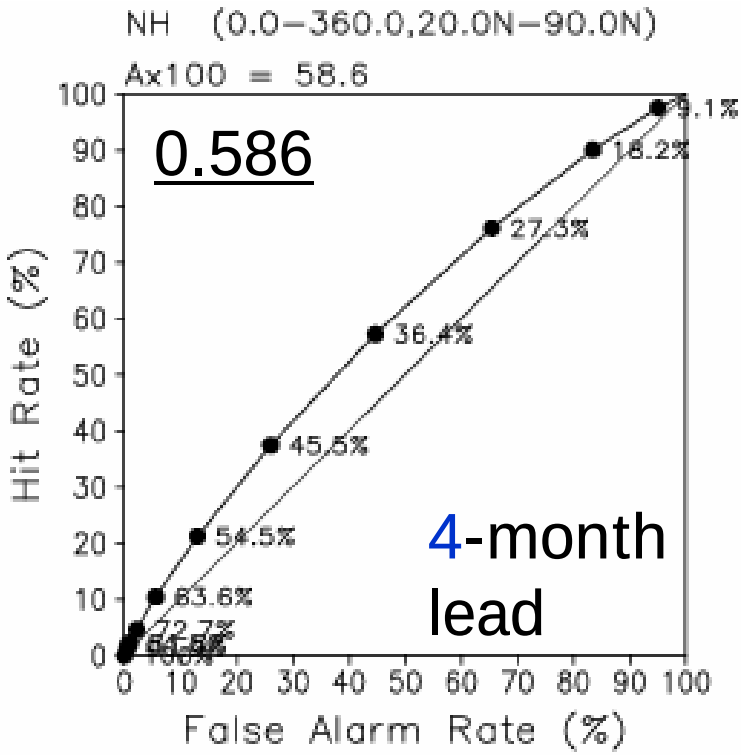




Verification: Seasonal Forecast

- ROC for Precipitation / 3-month average
  Upper tercile / Northern Hemisphere / all season



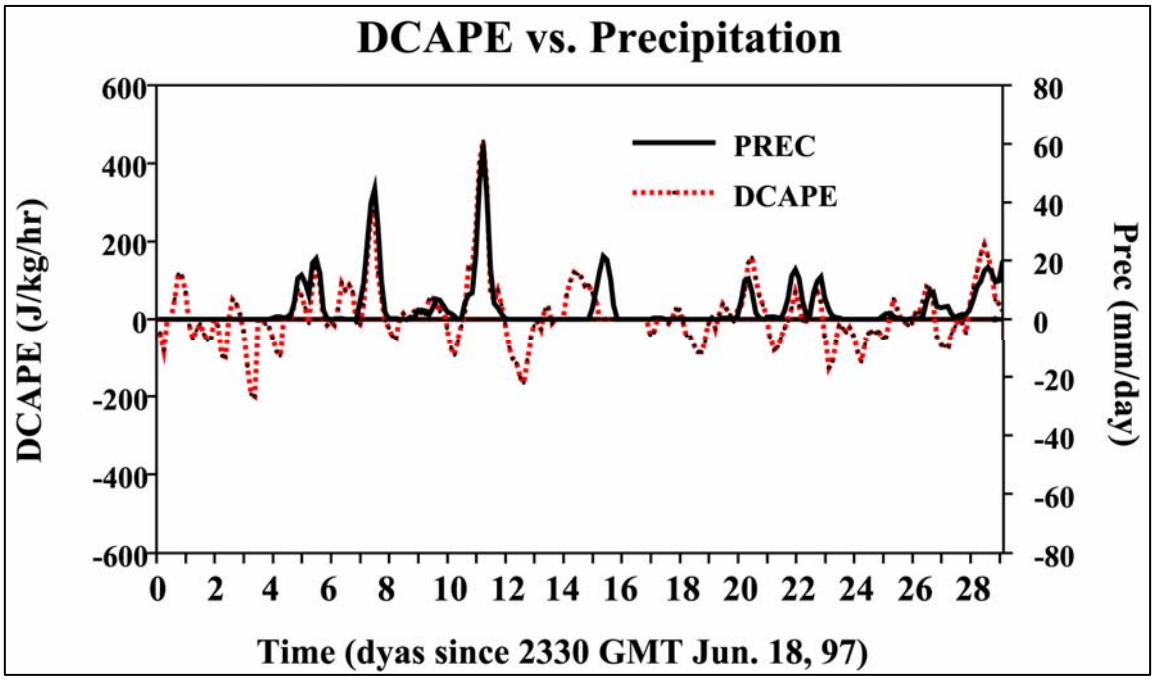


Recent Developments

- Cumulus parameterization
  - Trigger function (DCAPE)
- Radiation
  - Shortwave absorption by water vapor
  - Aerosol Climatology
- Initial Perturbation (BGM; for one-month forecast)
  - Extract growing mode associated with the instability of the MJO (Chikamoto *et al.* 2007)
- Implementation
  - One-month forecast : Mar. 2007~
  - Seasonal forecast : Sep. 2007~

Trigger Function (DCAPE)

- Incorporated a trigger function based on DCAPE (dynamic CAPE generation rate; Xie and Zhang 2000) into the cumulus parameterization.
- Convective precipitation occurs when DCAPE>0.



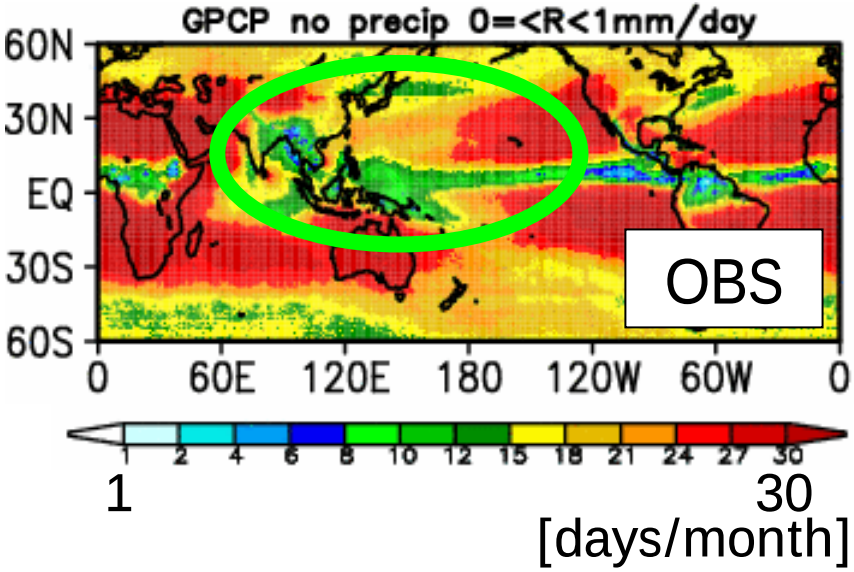
$$DCAPE = [CAPE(T^*,q^*)-CAPE(T,q)]/\Delta t$$
$$T^* = T + (\partial T/\partial t)_{adv} \times \Delta t$$
$$q^* = q + (\partial q/\partial t)_{adv} \times \Delta t$$

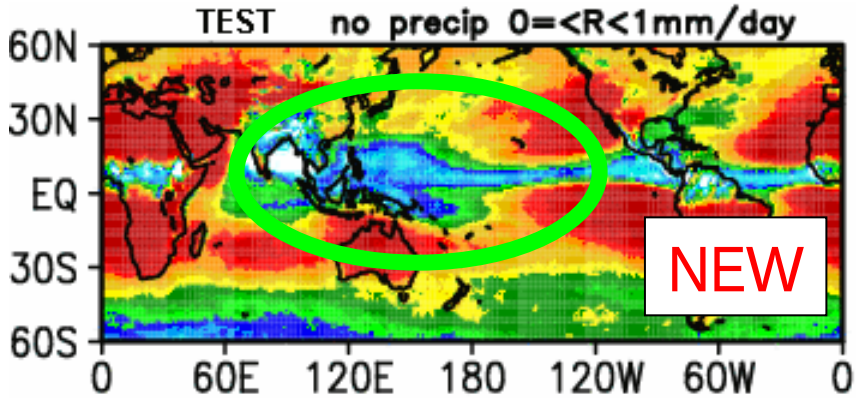
Xie and Zhang (2004) / ARM 97 Summer IOP

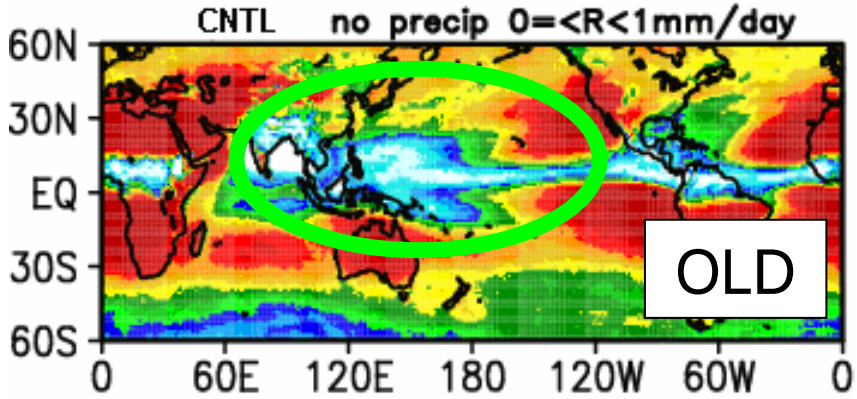
Trigger Function (DCAPE)

- Trigger function is expected to suppress weak precipitation.
- The number of no precipitation days becomes closer to those of observation (GPCP-1DD) in tropics.

Distribution of the number of no precipitation days per month (July)



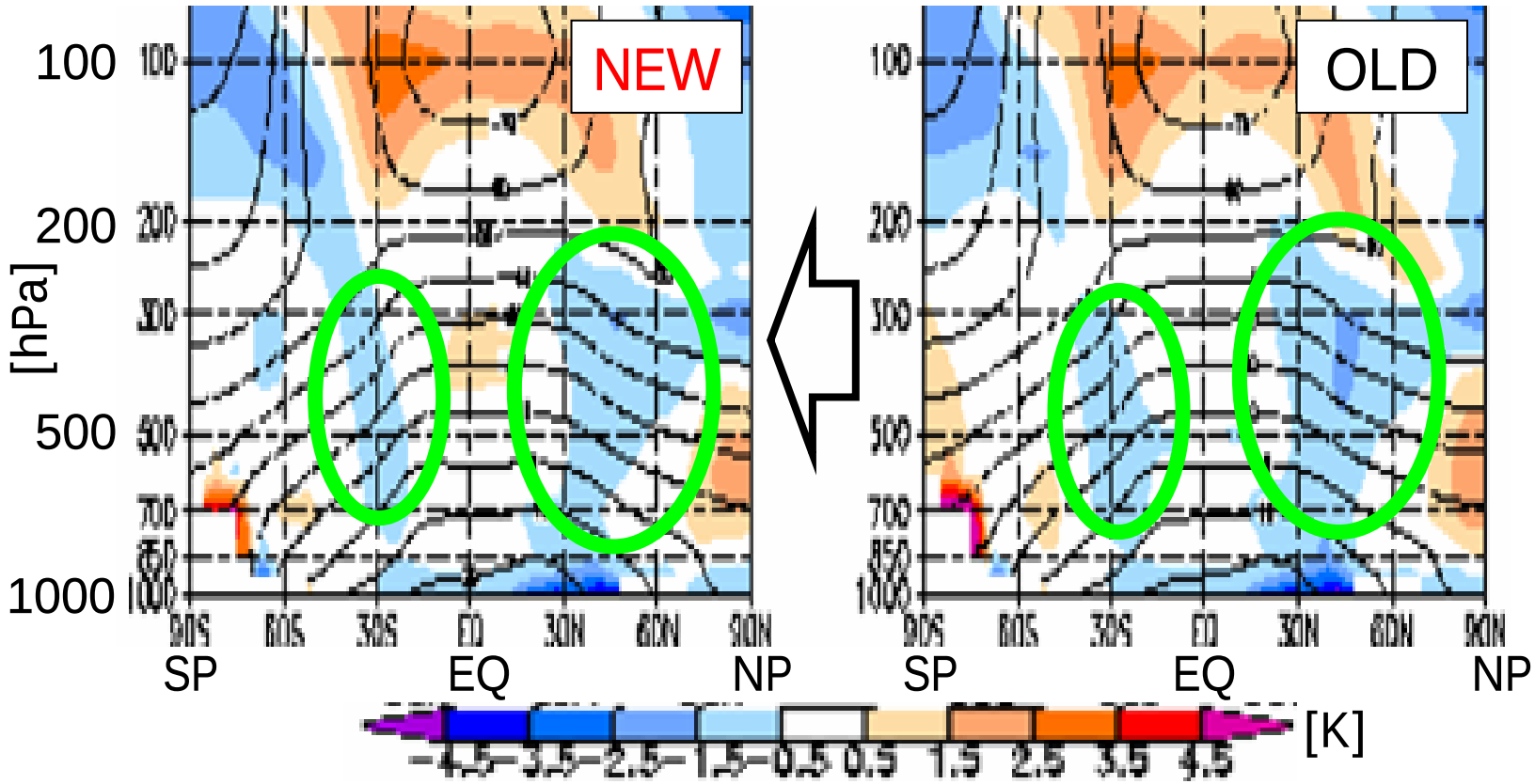




Shortwave Absorption by Water Vapor

- Shortwave absorption increases in troposphere.
- Low temperature bias seen in mid-latitude is reduced.

Zonal mean temperature error in JJA



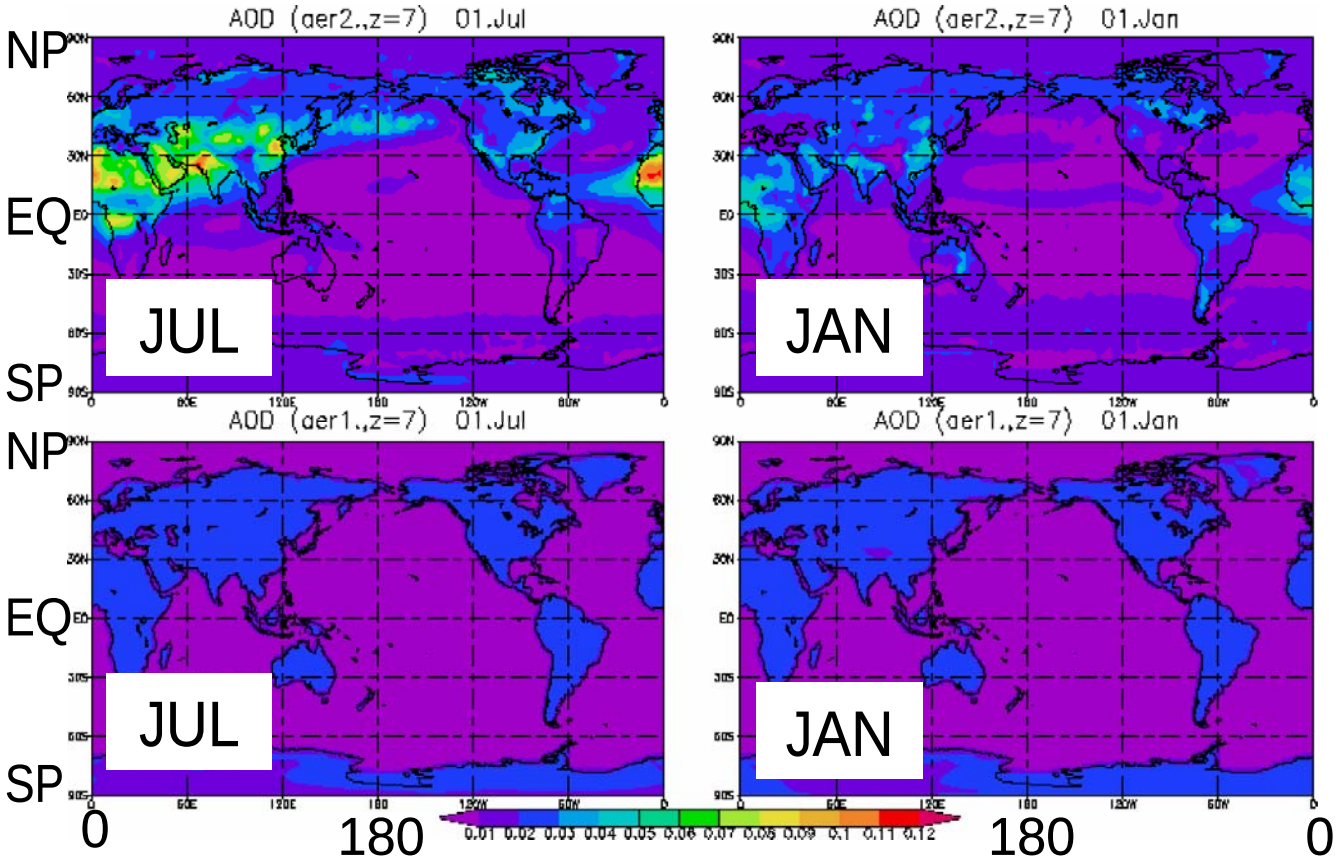
Aerosol Climatology

- Use realistic aerosol distribution based on satellite observations with seasonal change.

Optical thickness associated with aerosol at 850hPa

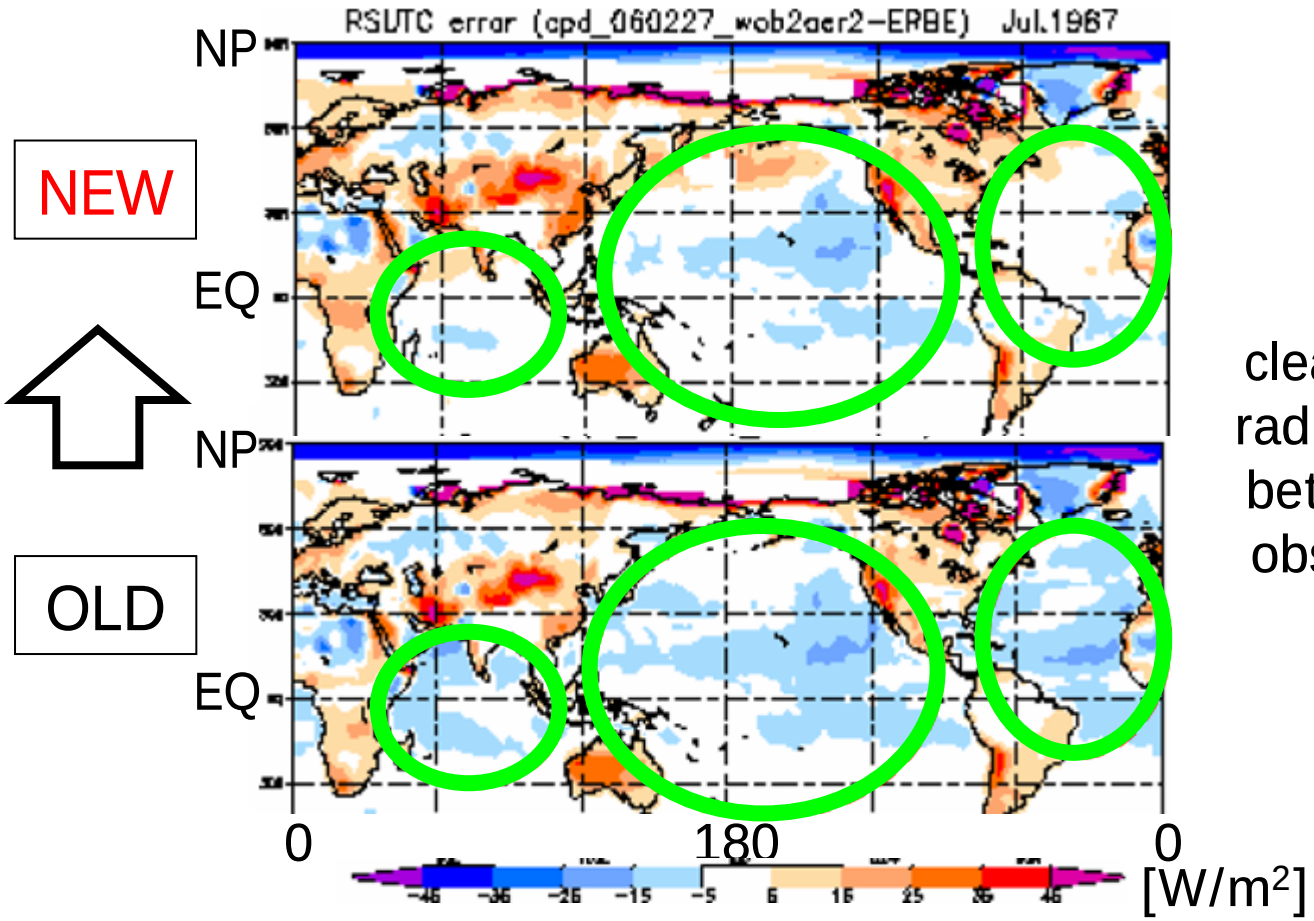
NEW

OLD



Aerosol Climatology

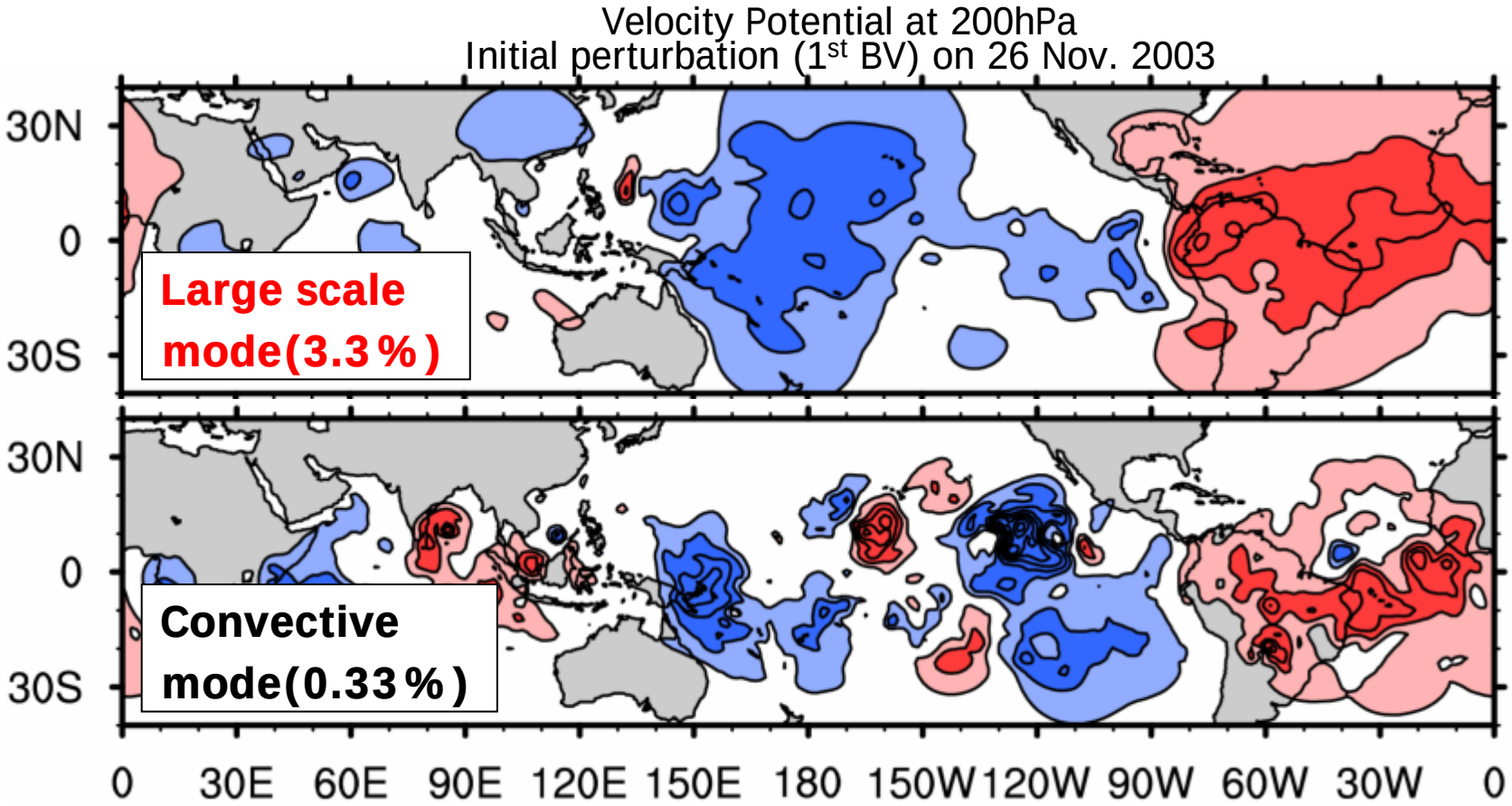
- Improvement in bias of clear-sky shortwave radiation flux at TOA over the ocean.



Difference of clear-sky shortwave radiation flux at TOA between model and observation (ERBE)

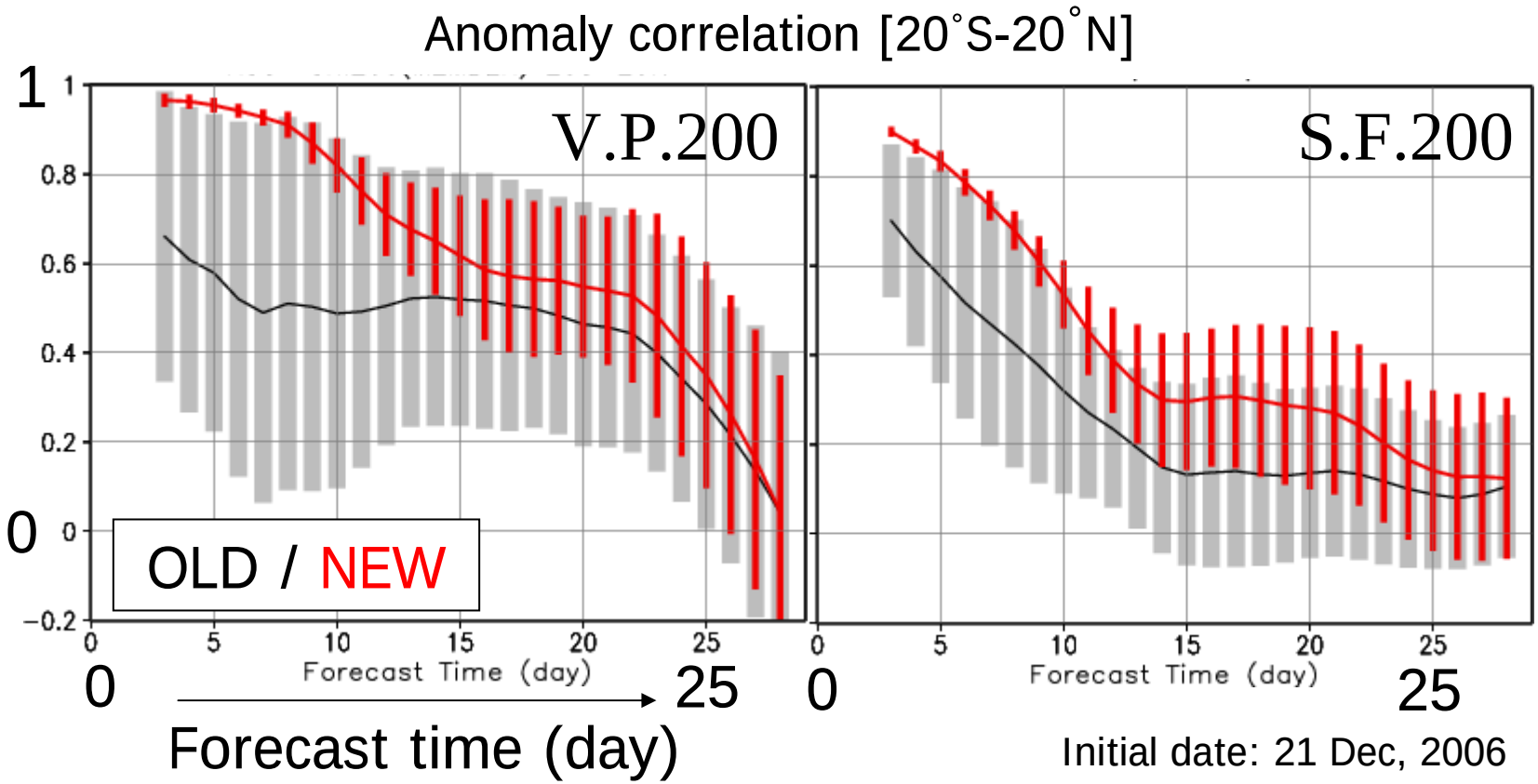
Initial Perturbation (BGM)

- Growing mode associated with the instability of the MJO is able to be obtained selecting appropriate magnitudes of norm. (Chikamoto *et al.* 2007)



Initial Perturbation (BGM)

- Forecast skill around equator using the new initial perturbations is better than that using the old perturbations.



Initial date: 21 Dec, 2006
50 members

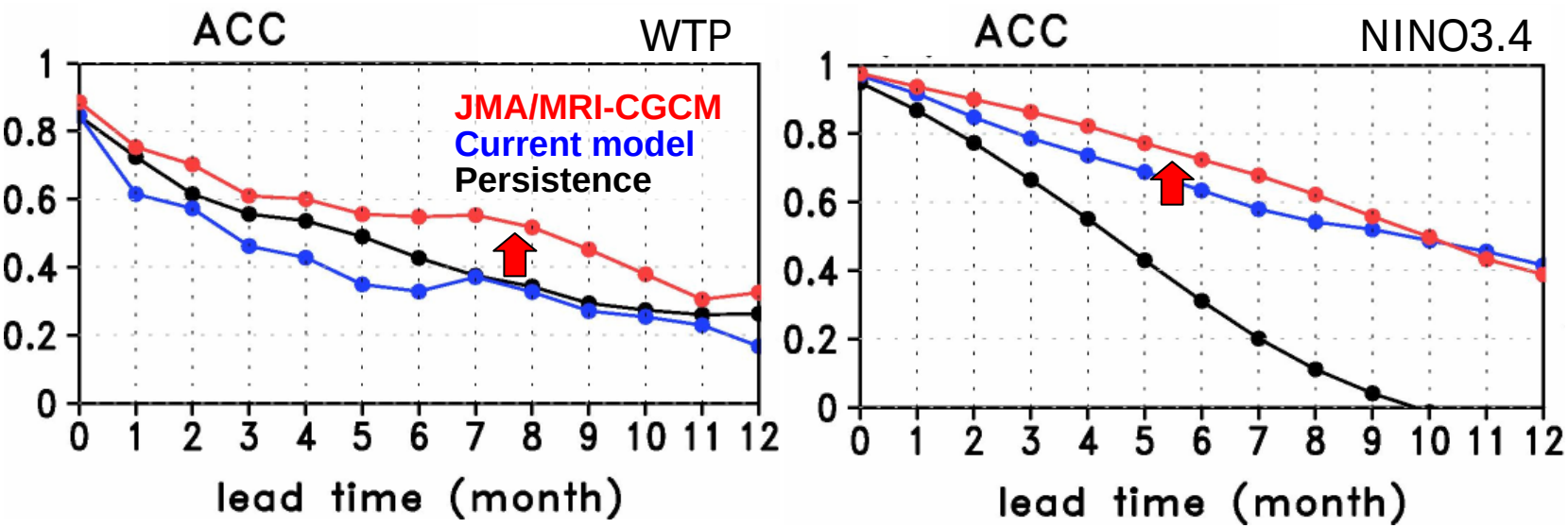
Future Plan

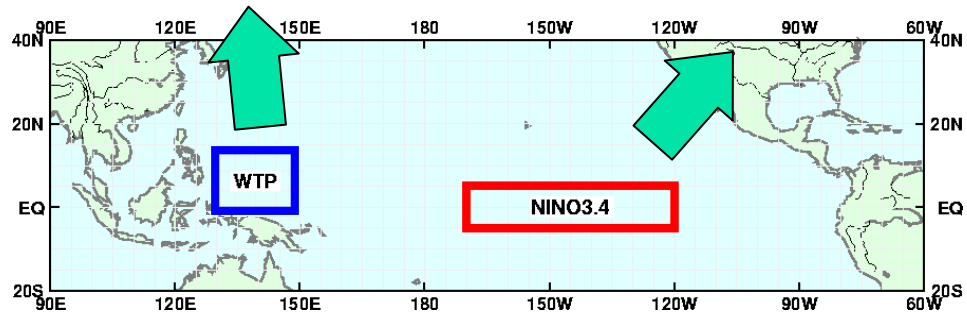
- In 2010, JMA plans to introduce a CGCM into seasonal forecast, which is a new version of JMA's operational ENSO forecast model from Mar 2008.

AGCM	**JMA/MRI Unified AGCM** ▪ $TL95L40$ (horizontal resolution ~ 180km)
OGCM	**MRI.COM** Ishikawa *et al.* (2005) ▪ 75S-75N, 0-360E ▪ horizontal resolution: lon 1.0˚, lat 0.3-1.0˚ ▪ vertical resolution : 50 levels (23 levels in the upper 200m)
Coupler	▪ coupling interval : 1 hour ▪ flux adjustment for heat and momentum flux

Forecast Skill of SSTs

- Forecast skill of SSTs with the new version of CGCM is better than that with the current CGCM for ENSO forecast.





*Period:1979-2005

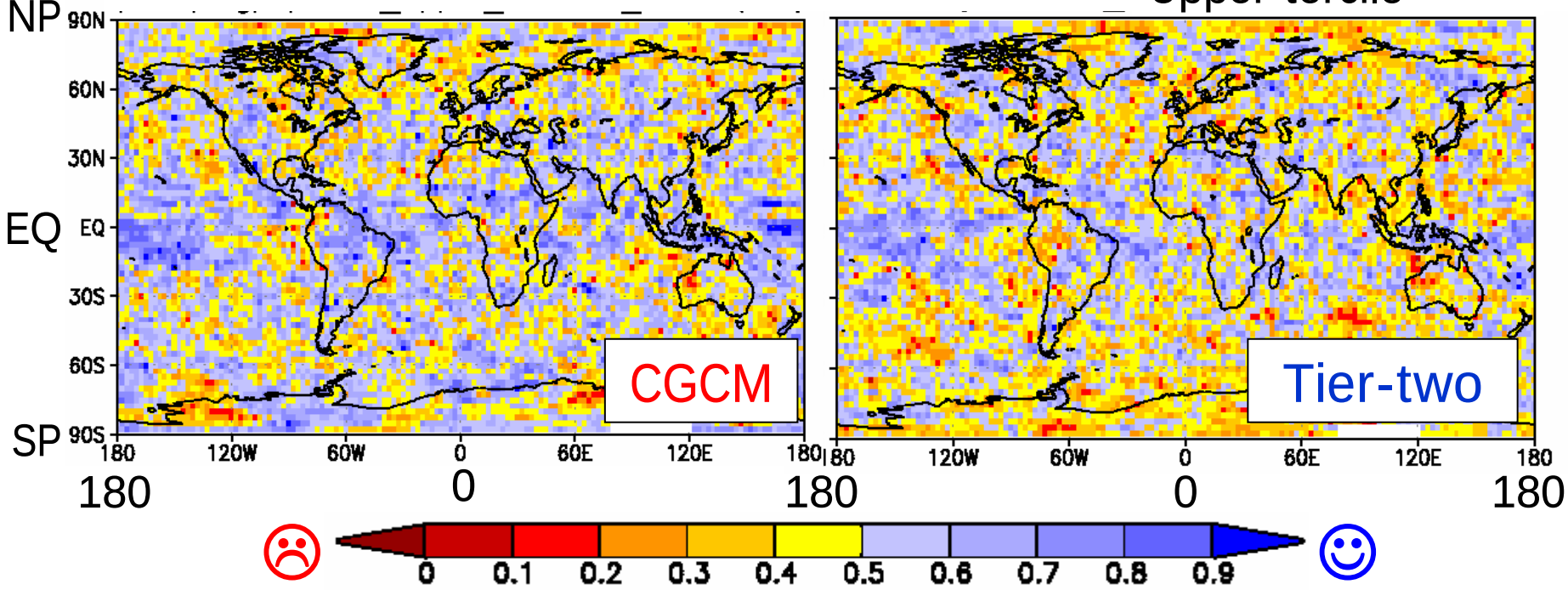
*1 member forecast started from the end of every month (NOT ensemble forecast)

Forecast Skill of Precipitation

- JMA/MRI-CGCM shows better skill than the current seasonal prediction model

ROC for Precipitation in JJA

Four months lead
Upper tercile



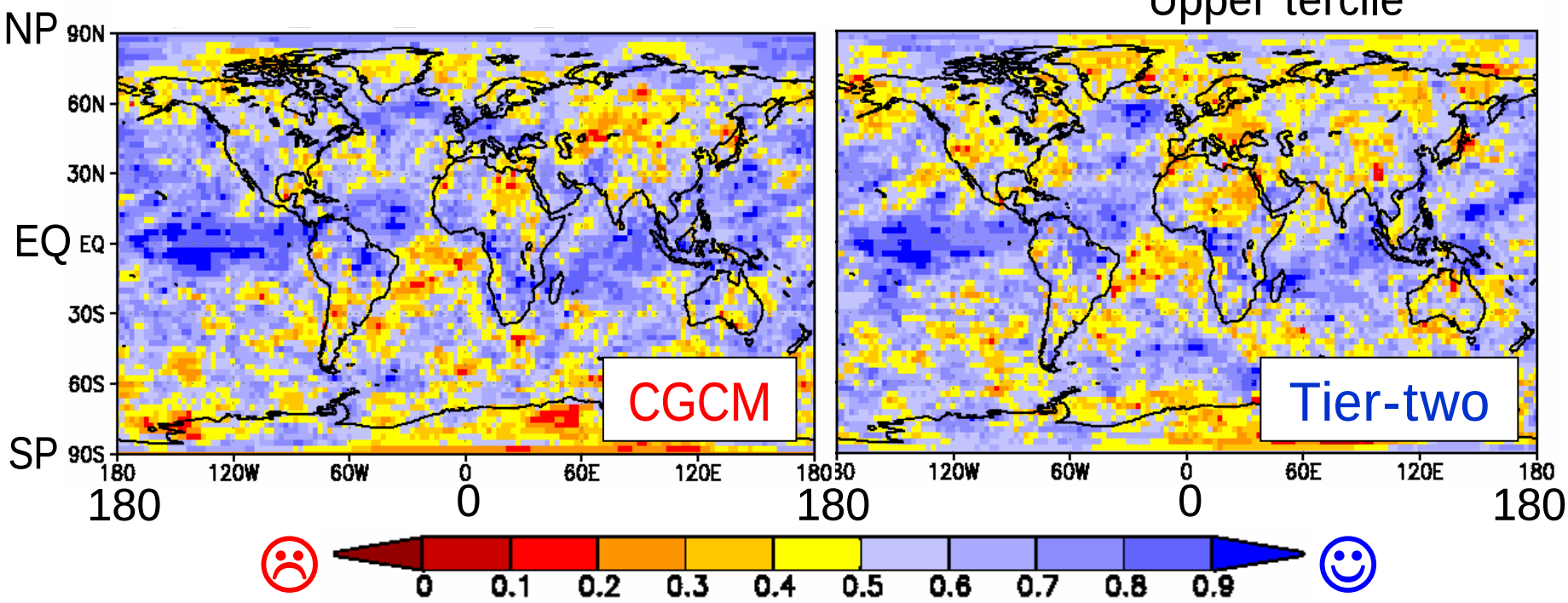
*Period:1984-2005(22 years)
*10-member ensemble forecast started from the end of January

Forecast Skill of T2m

- JMA/MRI-CGCM shows better skill than the current seasonal prediction model

ROC for T2m in DJF

Four months lead
Upper tercile



*Period:1984-2005(22 years)
*10-member ensemble forecast started from the end of January

Summary

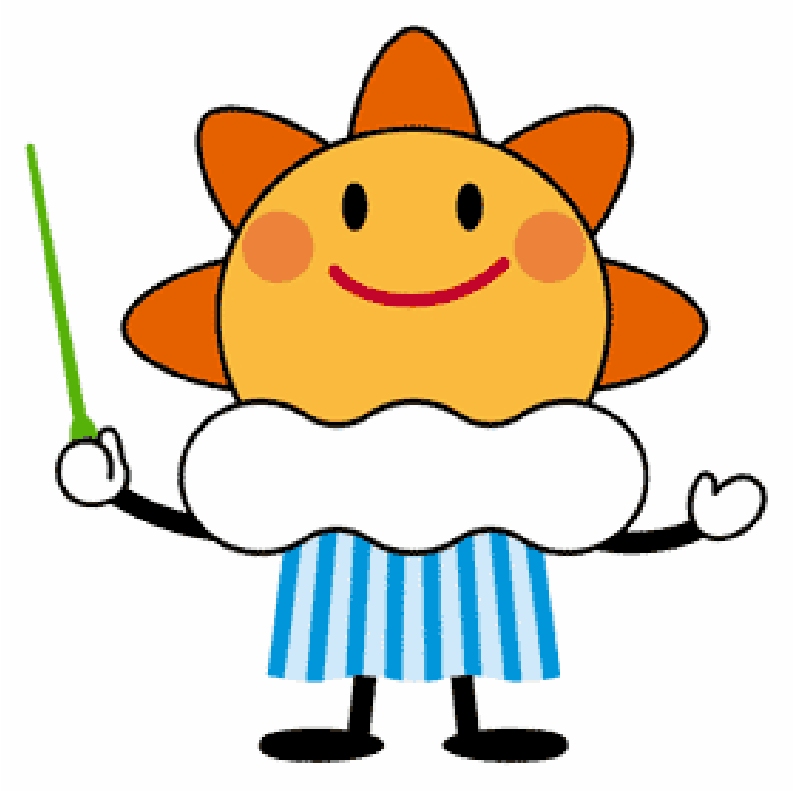
- JMA's products and verifications for one-month and seasonal forecasts are available on TCC web site.

  http://ds.data.jma.go.jp/tcc/tcc/index.html

- Developments for one-month and seasonal forecast models have been done to improve forecast skills.

- Future Plan: In 2010, JMA plans to introduce a CGCM into seasonal forecast.

Thanks !



"Harerun", JMA's mascot