Improvement in Operational Seasonal Forecast Using JMA/MRI-CGCM

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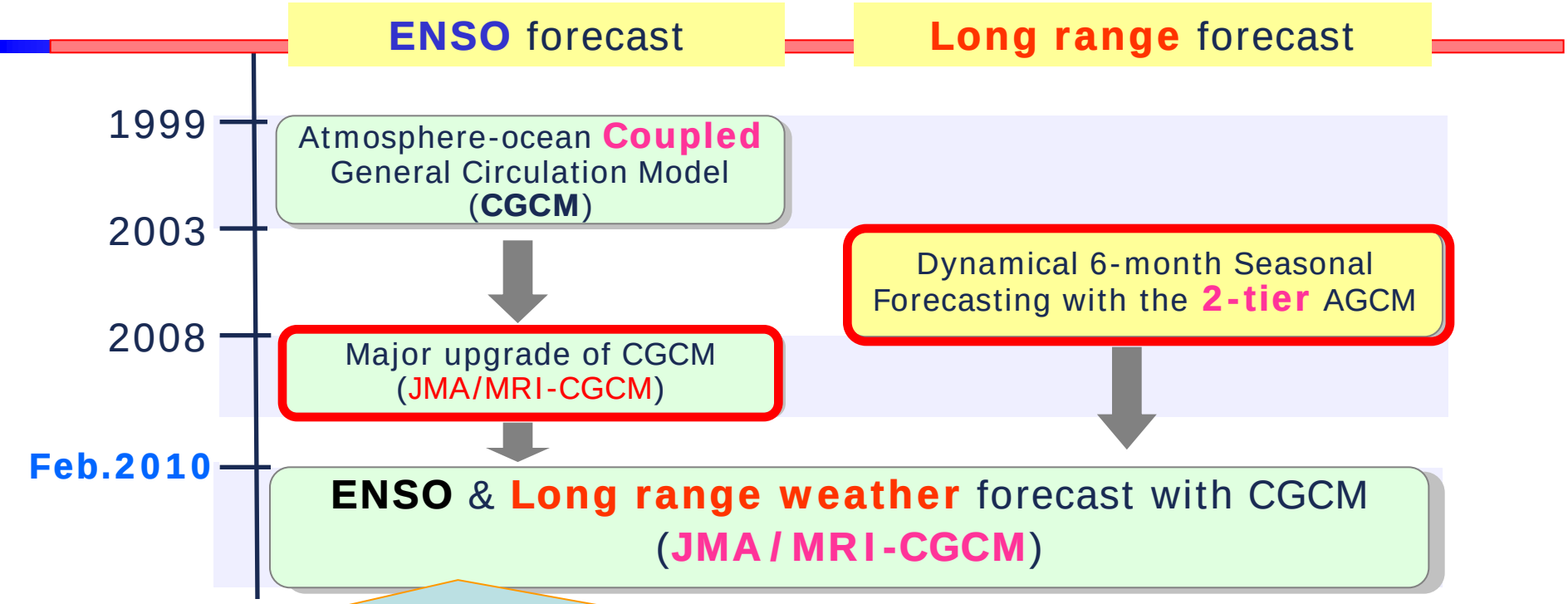
Outline

1. **Introduction of the New Long Range Forecast System at JMA**

2. **Performance Comparison of Old and New system**

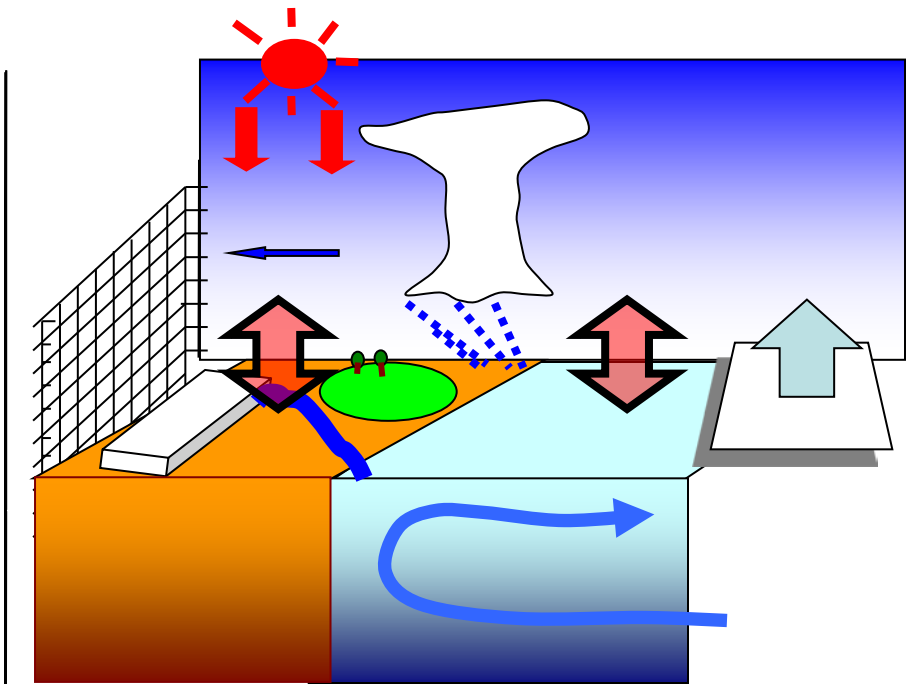
3. **Improvement of Numerical Guidance for the climate in Japan**

History



In 1999, JMA introduced the atmosphere-ocean coupled GCM into our ENSO forecasting service. In 2003, 2-tier dynamical ensemble prediction system began to be used in the long range weather forecast service. In 2008, an entirely new coupled forecast system developed by JMA and Meteorological Research Institute(MRI) became an operational ENSO forecast system. We finally introduced this coupled system for the long range weather forecasting services in February 2010.

Outline of the EPS for seasonal forecast



ENSEMBLE: BGM&LAF

- Combination of BGM and LAF
- 9 members for each initial date
- Size: 51 (ENSO forecast: 30)
- Once a month

CGCM: JMA/MRI-CGCM

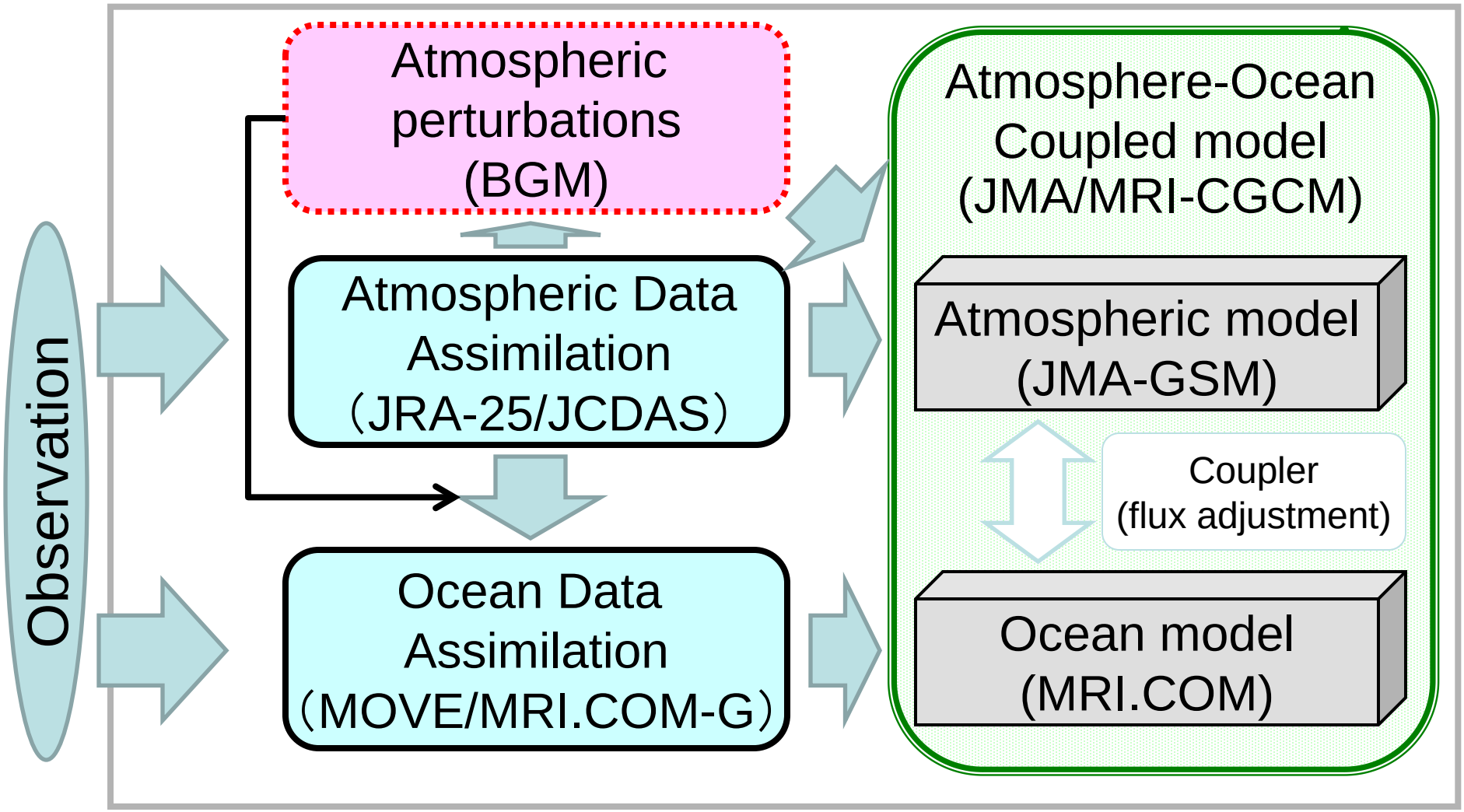
AGCM: JMA-GSM based on JMA/MRI unified model

- TL95: 1.875 deg ~ 180km
- L40: model top = 0.4hPa
- Land: SiB
- Sea ice: climatology
- Initial condition: JRA-25/JCDAS
- Initial perturbation: BGM (TRO, NH)

OGCM: MRI.COM

- 1.0deg in lon. X 0.3-1.0 deg in lat.
- 75N-75S, 0-360E
- L50
- Initial condition: MOVE/MRI-COM-G
- Initial perturbation: driven with BGM (TRO) of AGCM

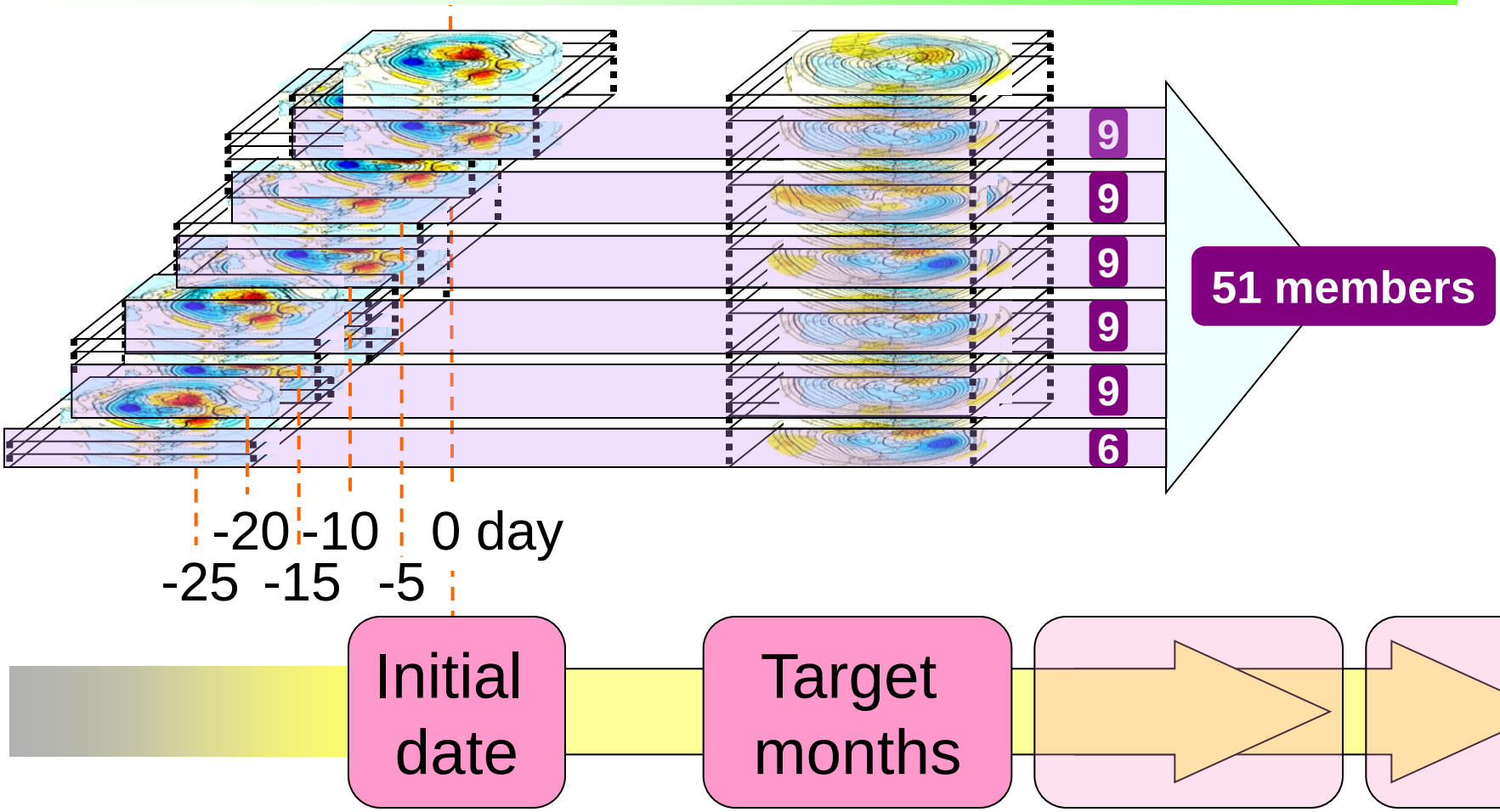
Schema of the new EPS



Schema of aggregation for the ensemble members

ENSEMBLE: BGM&LAF

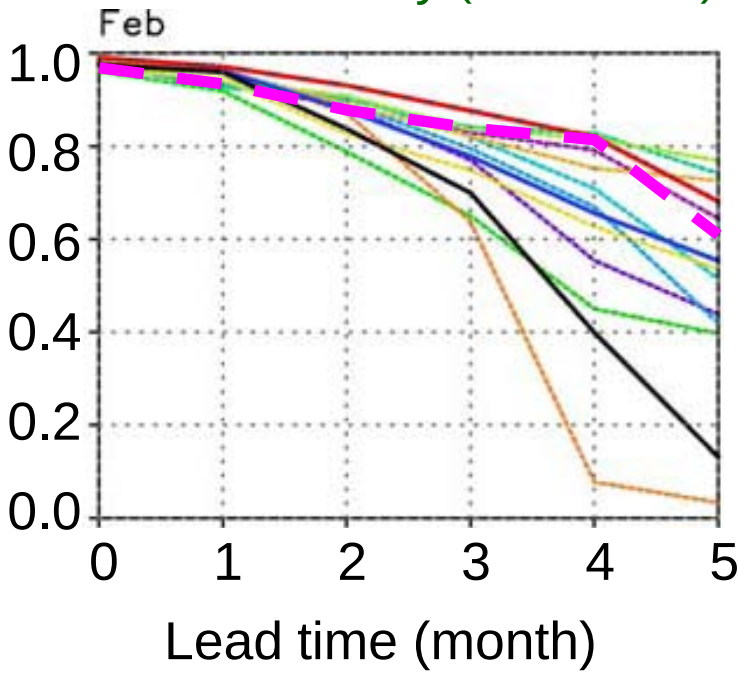
9 members for each initial date / Size: 51 (9 BGM, 5-day LAF(6 initials))



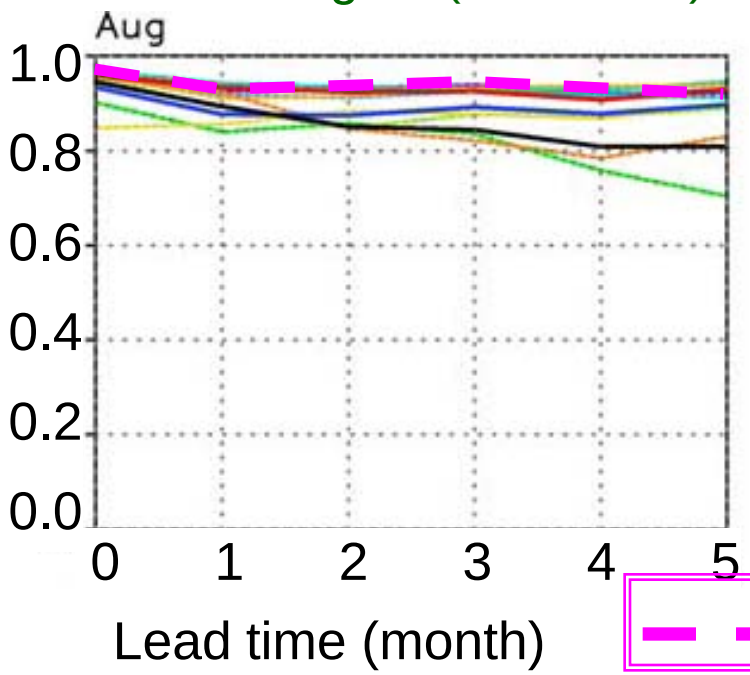
NINO.3.4 SST ACC: dependency on lead time

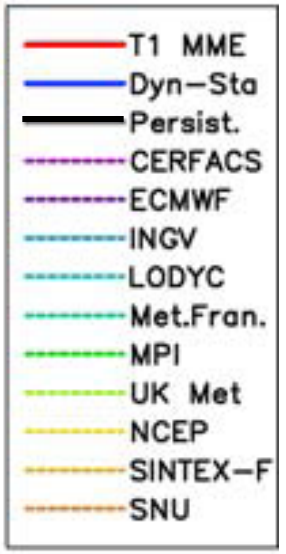
(quote from Fig. 8 of Jin et al. 2008)

Initial: February (1980-2001)



Initial: August (1980-2001)





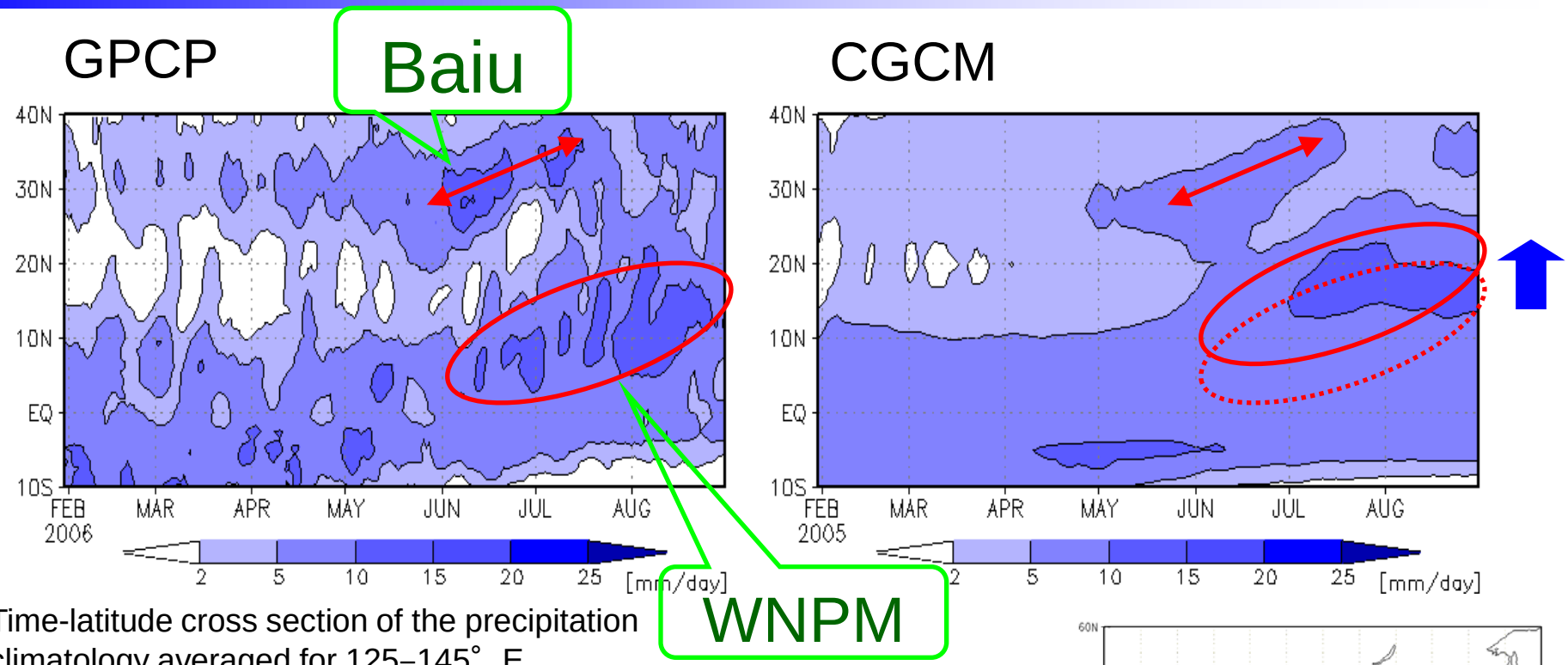
(JMA/MRI-CGCM)

NINO.3.4 region: 120W-170W, 5S- 5N

Jin E. K., James L. Kinter III, B. Wang, C.-K. Park, I.-S. Kang, B. P. Kirtman, J.-S. Kug, A. Kumar, J.-J. Luo, J. Schemm, J. Shukla and T. Yamagata, 2008: Current status of ENSO prediction skill in coupled ocean–atmosphere models. Clim. Dyn., **31**, 647–666.

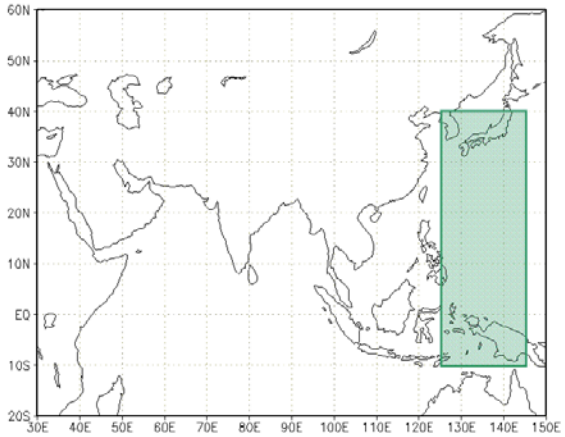
Seasonal Marching of Precipitation

(init. The end of Jan.)



Time-latitude cross section of the precipitation climatology averaged for 125–145° E.

The CGCM model well reproduces the seasonal marching of the Baiu.

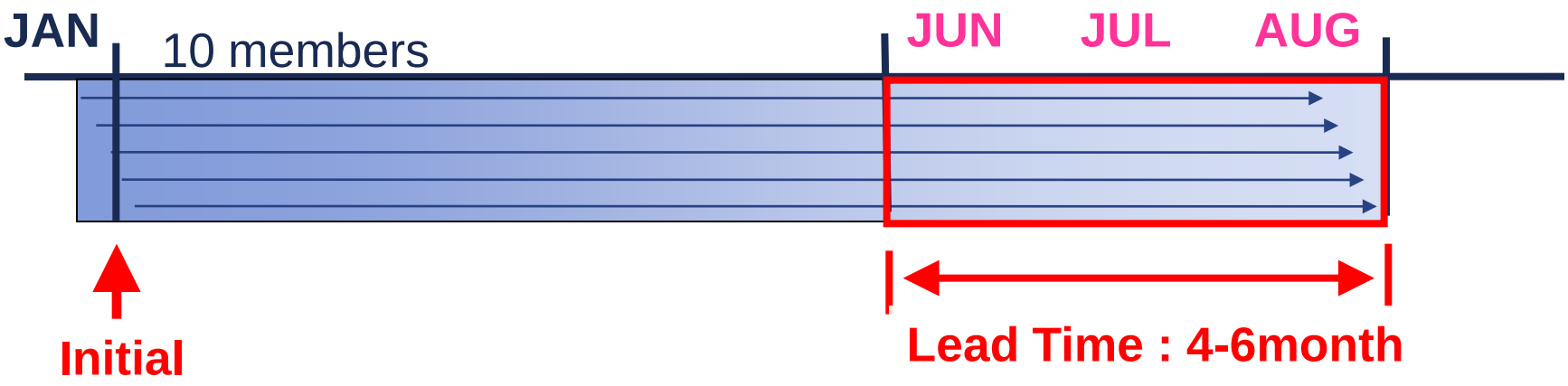


1. Introduction of the New Long Range Forecast system at JMA

2. **Performance Comparison of Old and New system**

3. Improvement of Numerical Guidance for the climate in Japan

Hindcast Experiments Design



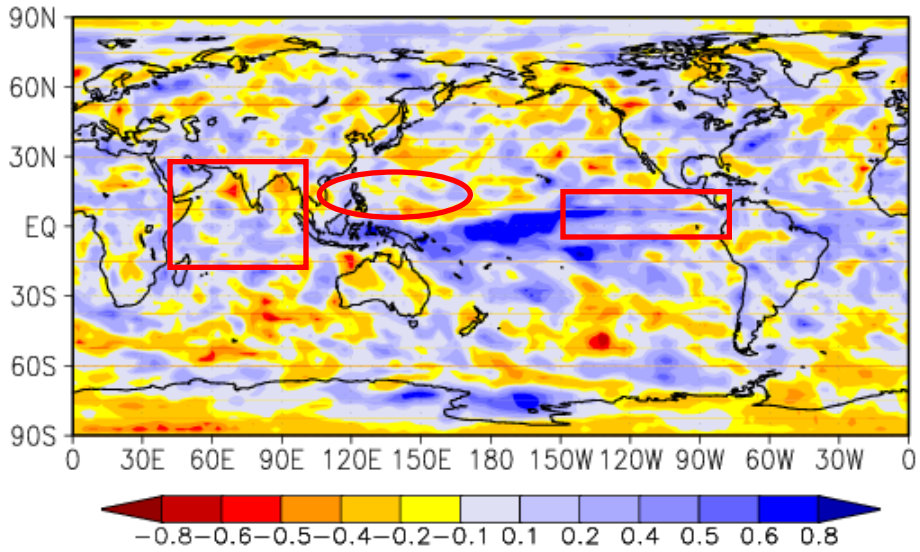
- The **CGCM** hindcast experiments are started from the end of January.
- Those of the **2-tier AGCM** are started from Feb. 10$^{th.}$
- Period of the hindcast is 22 years (1984-2005).
- CO_2 concentration is updated during the hindcast period in CGCM.
- Sea-ices are fixed to the climatological values.

Improvement of precipitation

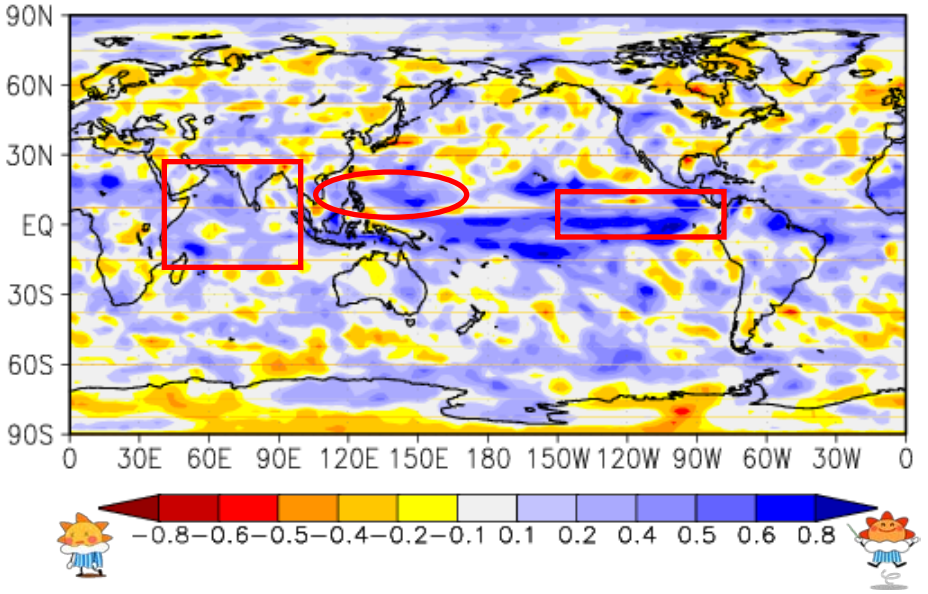
(JJA predictions, init. month of Feb.)

Anomaly correlation of precipitation (1984-2005)

AGCM



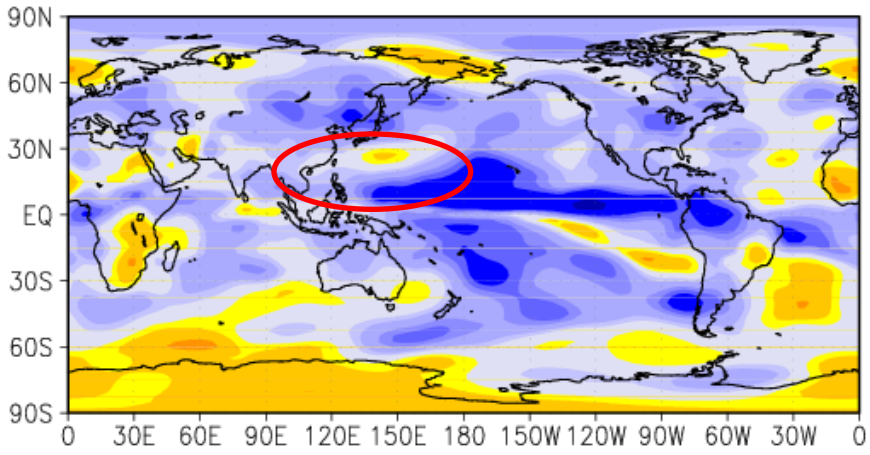
CGCM



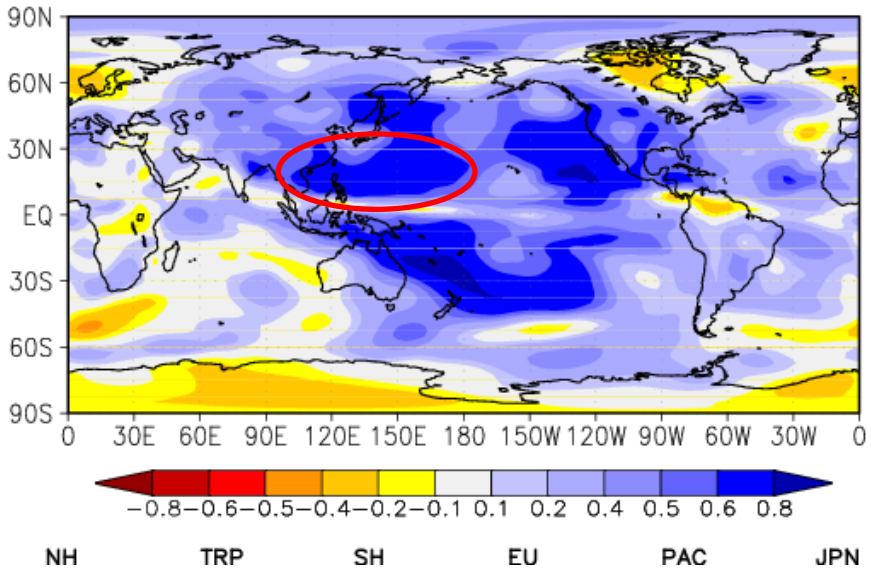
Improvement of circulation in lower troposphere (JJA predictions, init. month of Feb.)

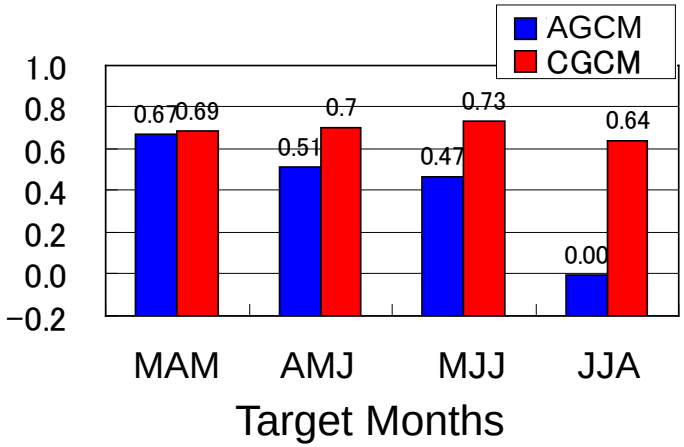
Anomaly correlation of 850hPa stream function (1984-2005)

AGCM



CGCM





Anomaly correlation of precipitation over WNPM region

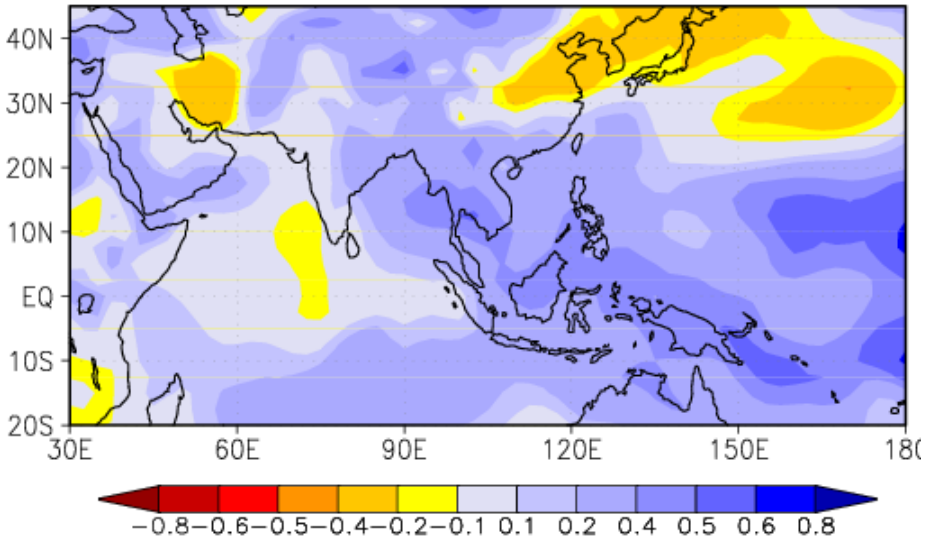
Western North Pacific Monsoon region; (10N-20N, 110E-160E)

Decline of CGCM's skill is small even transit of monsoon season.

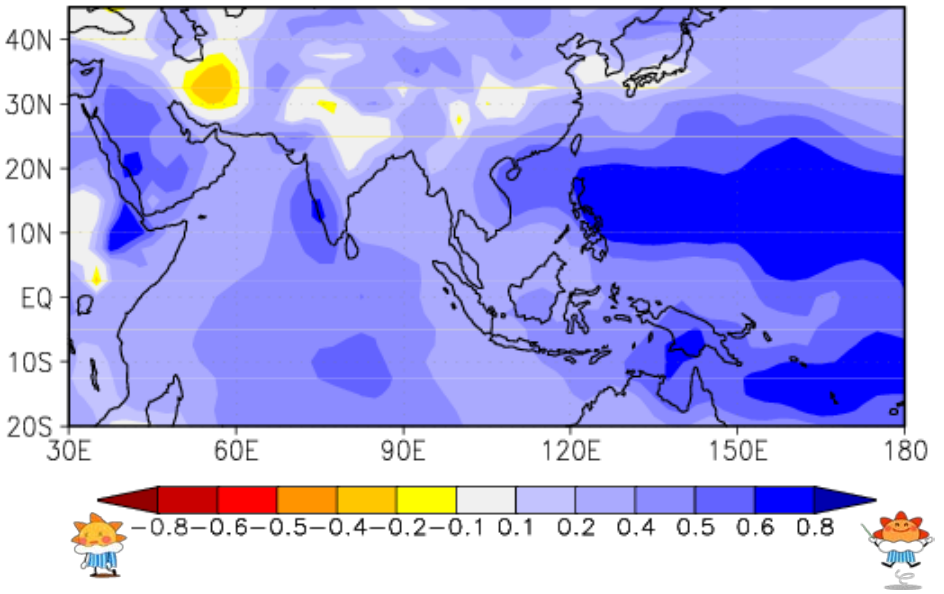
Improvement of Surface Pressure
(JJA predictions, init. month of Feb.)

Anomaly correlation of surface pressure (1984-2005)

AGCM



CGCM



1. Introduction of the New Long Range Forecast system at JMA

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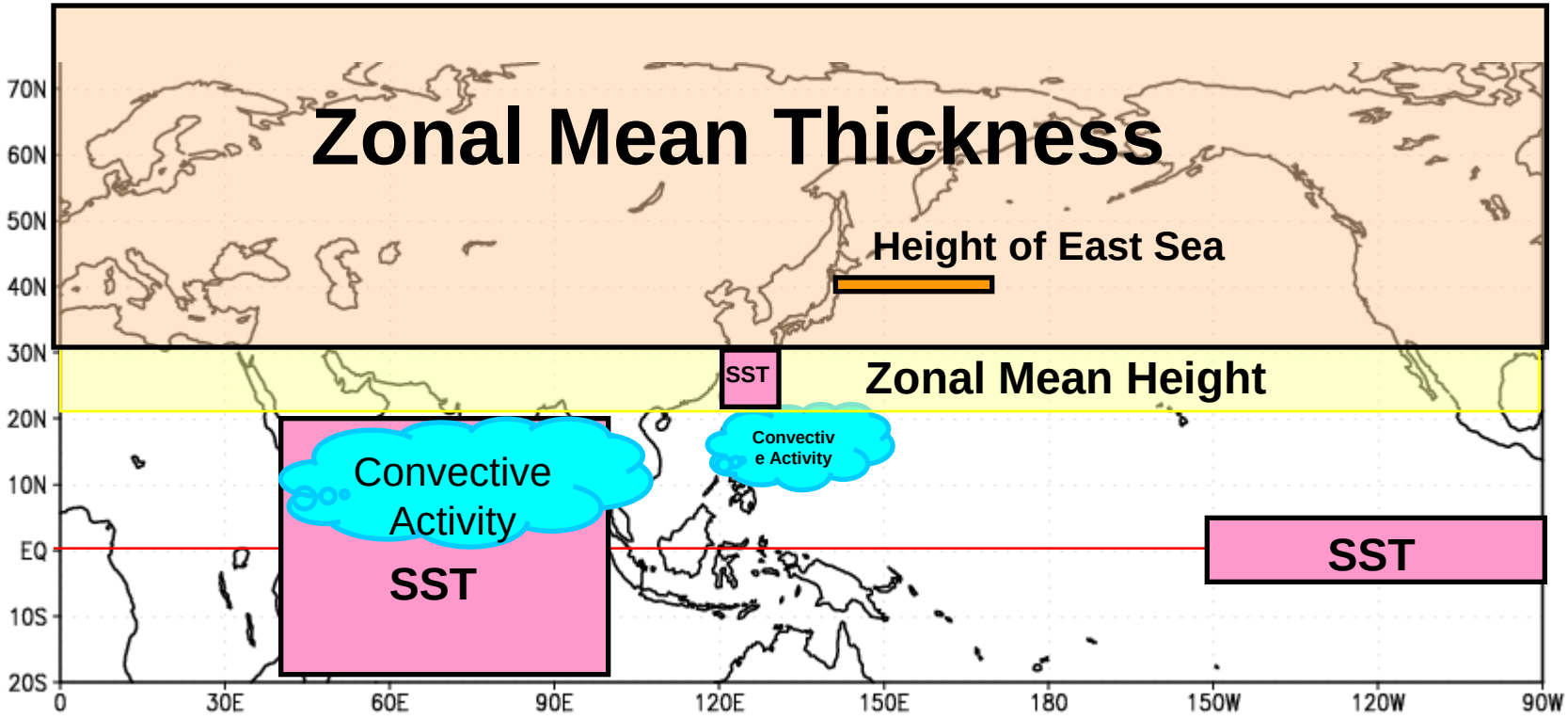
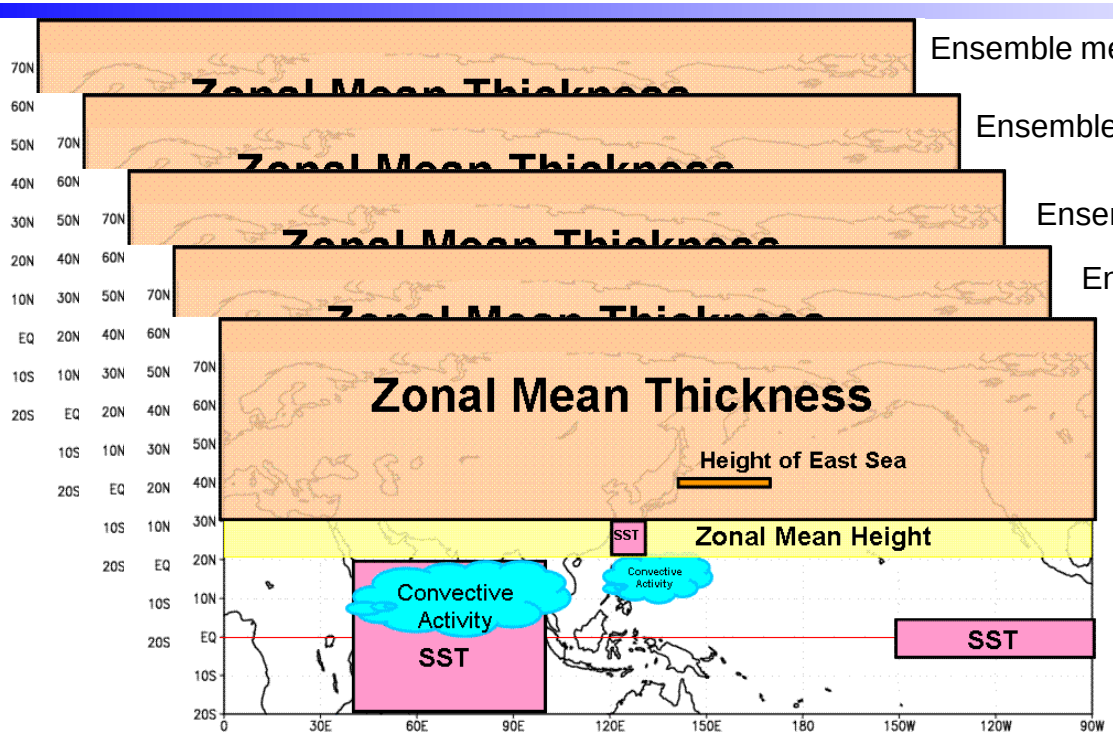
Predictors

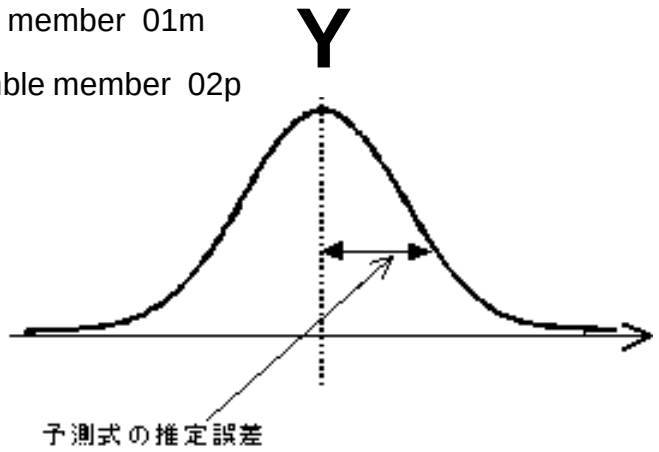
We considered the predictors to grasp signals of the tropical variation and global warming.



Predictands are surface temperature, precipitation and sunshine duration in Japan.

Methods of the Numerical Guidance (Model Output Statistics)





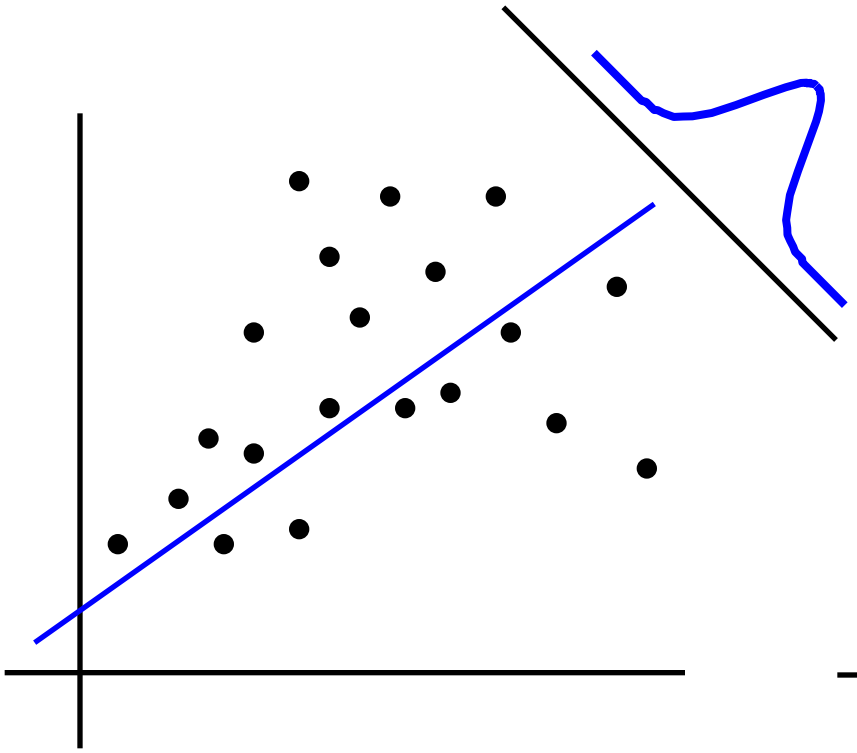
$$Y = A_i X_i + B$$

A Normal distribution is assumed as probability density function.

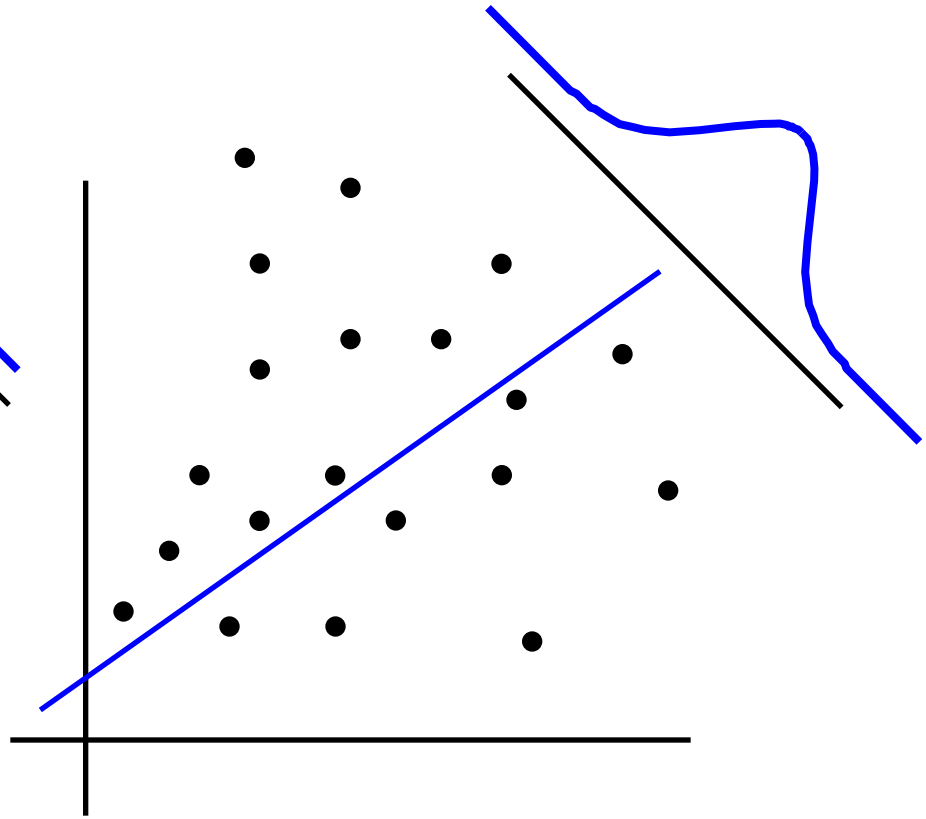
The ensemble mean predictors are applied to the multi-regression equations based on the output of the hindcast experiments.

Relationship between predictors and predictands:

strong



weak



The predicted probability density function:

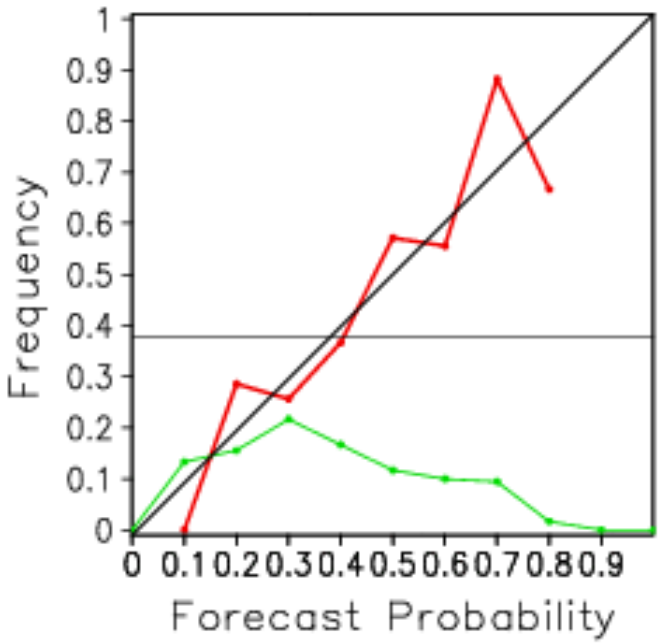
Sharpened distribution

Wide distribution

Skill of the Numerical Guidance (JJA temperature)

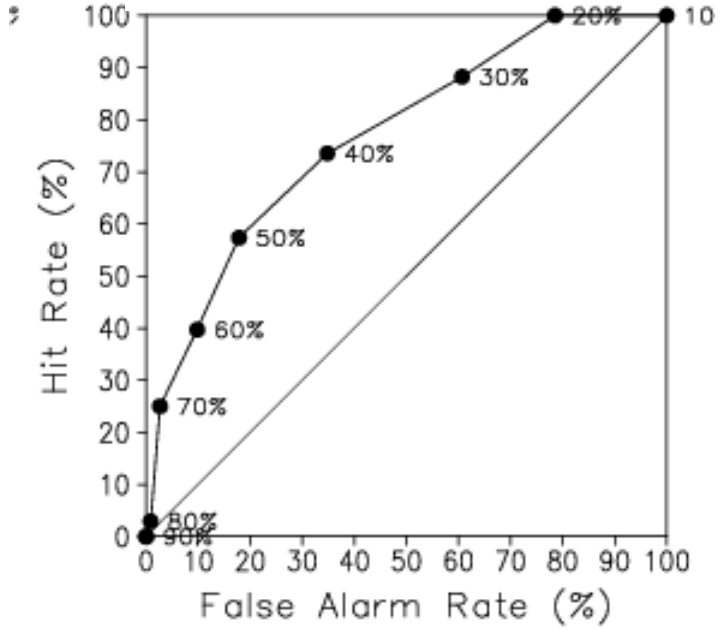
Reliability Diagram

BSS:0.21



Relative Operating Characteristics

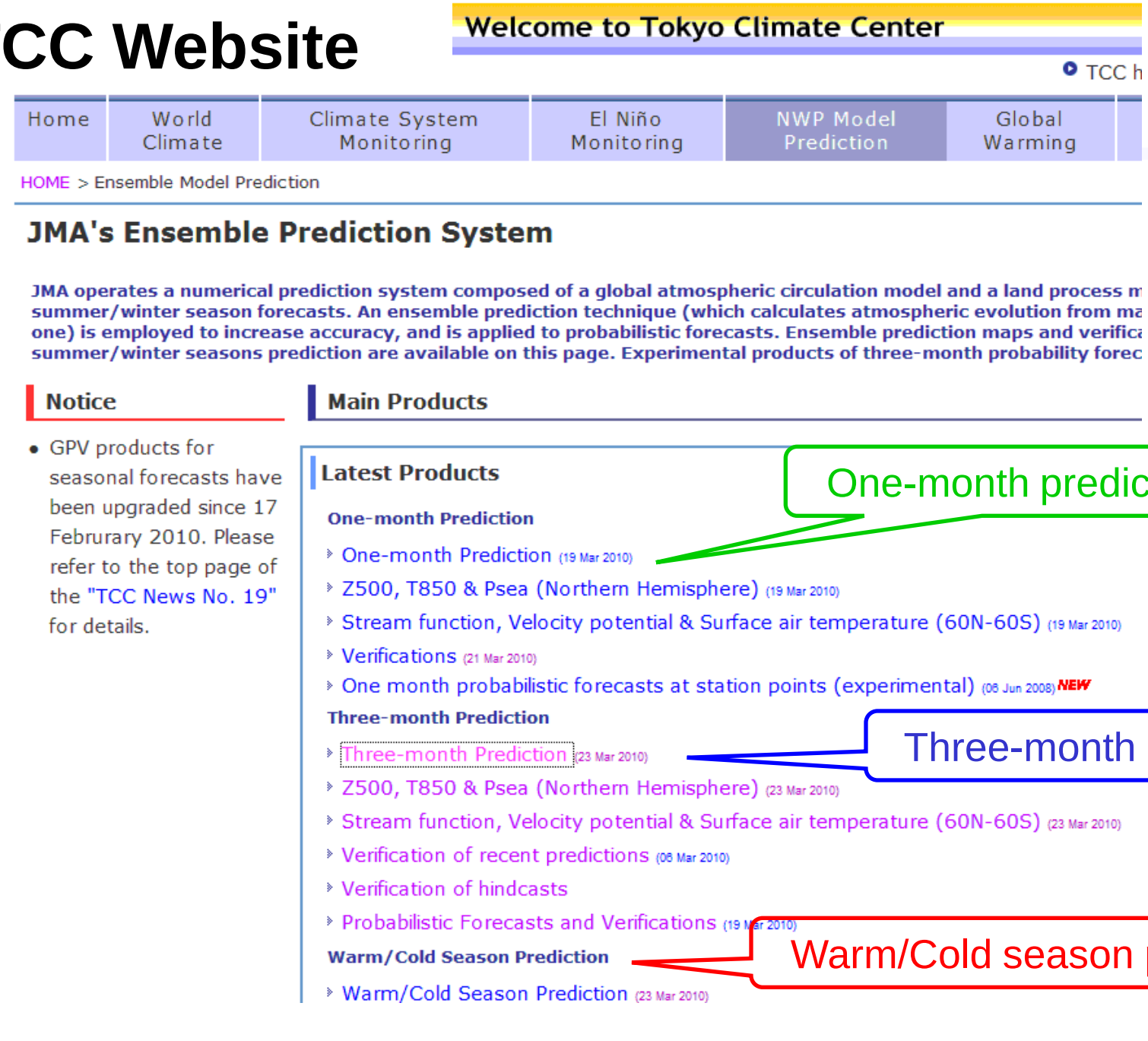
ROC score:0.77



The thresholds of tercile are determined so that the climatological chance of occurrence for each category is 33.3 % from 1971 to 2000.

- Target event: lower tercile and upper tercile
- Target periods: 1979-2008

TCC Website


Welcome to Tokyo Climate Center
TCC h
Home
World Climate
Climate System Monitoring
El Niño Monitoring
NWP Model Prediction
Global Warming
HOME > Ensemble Model Prediction
JMA's Ensemble Prediction System
JMA operates a numerical prediction system composed of a global atmospheric circulation model and a land process m
summer/winter season forecasts. An ensemble prediction technique (which calculates atmospheric evolution from ma
one) is employed to increase accuracy, and is applied to probabilistic forecasts. Ensemble prediction maps and verifica
summer/winter seasons prediction are available on this page. Experimental products of three-month probability forec
Notice
GPV products for seasonal forecasts have been upgraded since 17 Februrary 2010. Please refer to the top page of the "TCC News No. 19" for details.
Main Products
Latest Products
One-month Prediction
One-month Prediction (19 Mar 2010)
Z500, T850 & Psea (Northern Hemisphere) (19 Mar 2010)
Stream function, Velocity potential & Surface air temperature (60N-60S) (19 Mar 2010)
Verifications (21 Mar 2010)
One month probabilistic forecasts at station points (experimental) (06 Jun 2008) NEW
Three-month Prediction
Three-month Prediction (23 Mar 2010)
Z500, T850 & Psea (Northern Hemisphere) (23 Mar 2010)
Stream function, Velocity potential & Surface air temperature (60N-60S) (23 Mar 2010)
Verification of recent predictions (06 Mar 2010)
Verification of hindcasts
Probabilistic Forecasts and Verifications (19 Mar 2010)
Warm/Cold Season Prediction
Warm/Cold Season Prediction (23 Mar 2010)
One-month prediction
Three-month prediction
Warm/Cold season prediction

TCC Website

Home | World Climate | Climate System Monitoring | El Niño Monitoring | NWP Model Prediction | Global Warming

HOME > Download GPV

Download GPV files

Latest prediction

Hindcast

Notice

- GPV products for seasonal forecasts will be upgraded since 17 Februrary 2010. Please refer sample data.

- TCC provides GPV data for long-range forecast through TCC website, which has been made available to registered National Meteorological and Services (NMHSs). A warning e-mail message titled [JMA/JDDS Your password will expire in a few days] will be automatically sent to user's registered e-mail address every day from seven days before the expiry. On receiving this message, users should access the website http://ds.data.jma.go.jp/changepasswd/ to set a new password, otherwise the

Main Products

NWP Model Prediction

1-month (19 Mar 2010)
- Statistics (GRIB2)
- All Members (GRIB2)
- GRIB1

3-month (19 Mar 2010)
- Statistics
- All Members

7-month (19 Mar 2010)
- Statistics
- All Members

Hindcast GPV Data

1-month
- Daily data

3-month
- Monthly mean data

7-month
- Monthly mean data

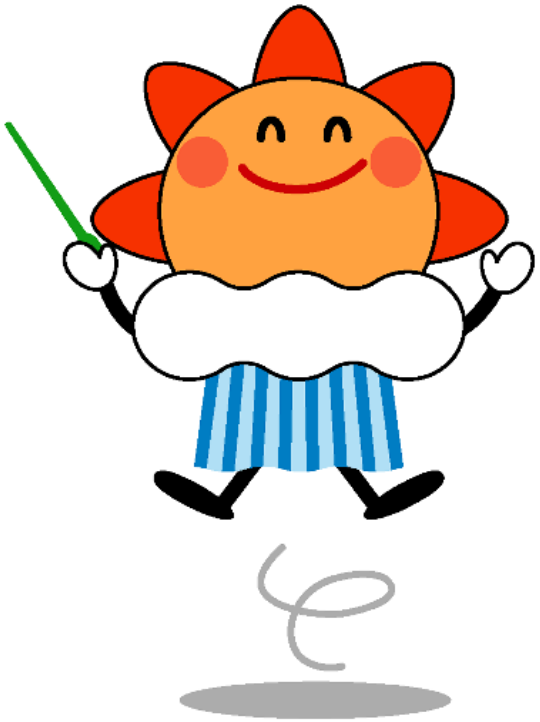
Tips

- Visualization with GrADS

Summary

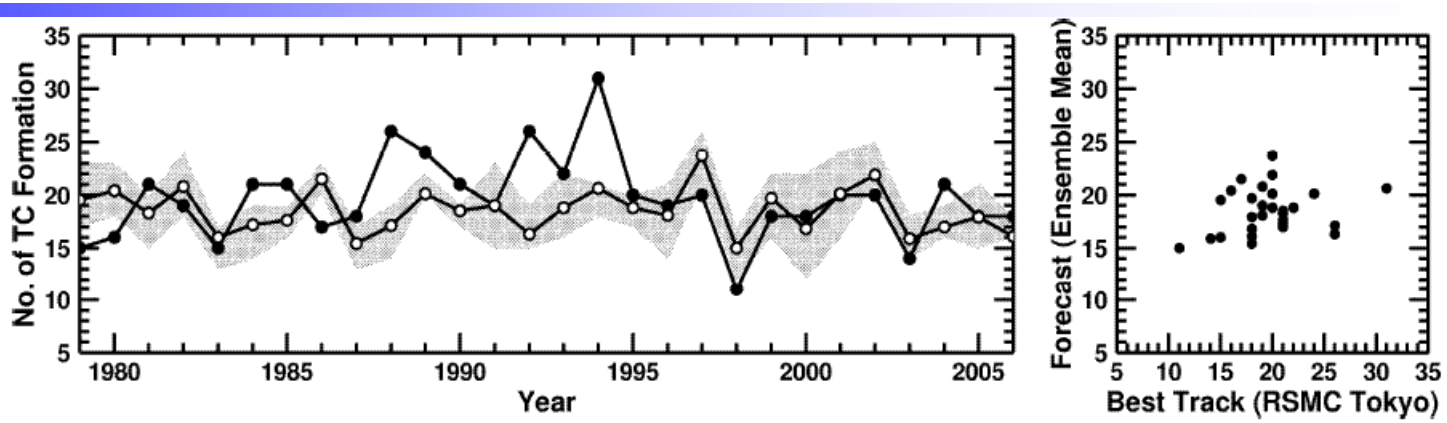
- **JMA/MRI-CGCM shows far better forecast skill in the subtropical region compared with the old 2-tier system.**
- **We have developed the numerical guidance using MOS methods and it has a good reliability for summertime temperature.**
- **We offer verification results of hindcasts in addition to the forecast maps and GPVs of the CGCM at Tokyo Climate Center website.**

Thank you for your attention!



Dynamical Seasonal Prediction of Typhoons (quote from Takaya et al. 2008)

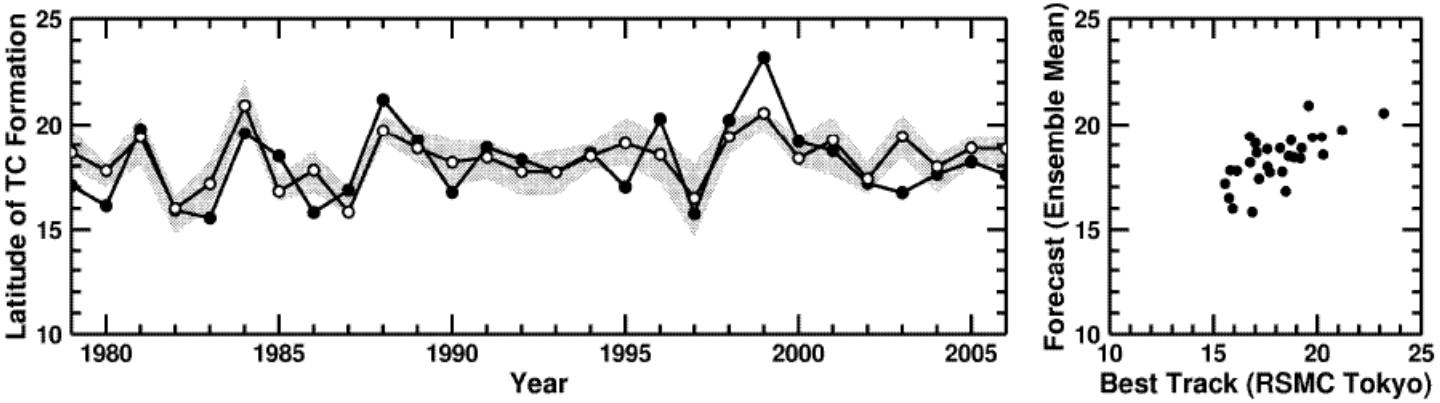
Number of TC formation



The upper figure shows the forecast result of the number of TC formation in the western North Pacific.

Open circles denote prediction.

Mean latitude of TC formation



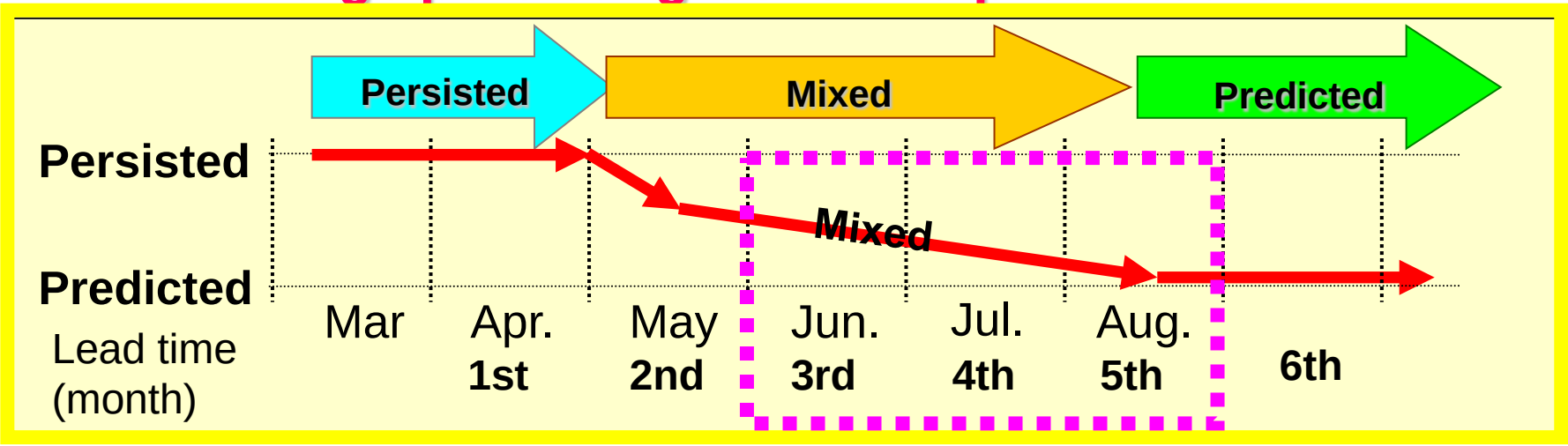
The lower figure shows the interannual variability of the mean latitude of TC formation

Outline of the Old EPS

AGCM
Atmosphere : TL95L40
SST : refer to the chart below

Ensemble method :
Singular Vector
Ensemble size :
51 members

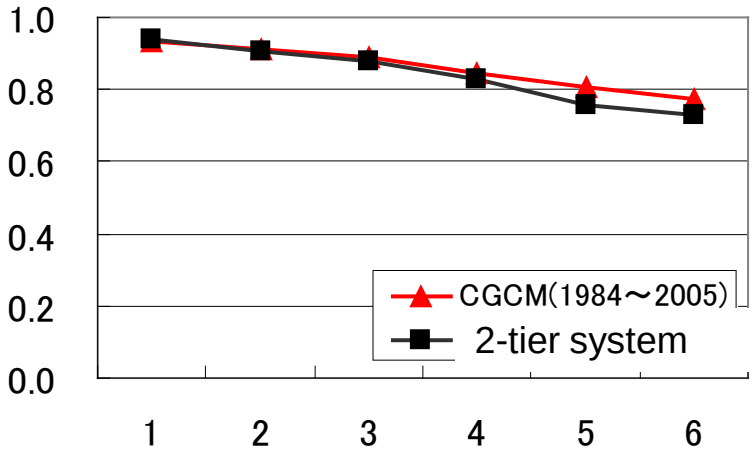
How to merge persisting SSTs and predicted SSTs



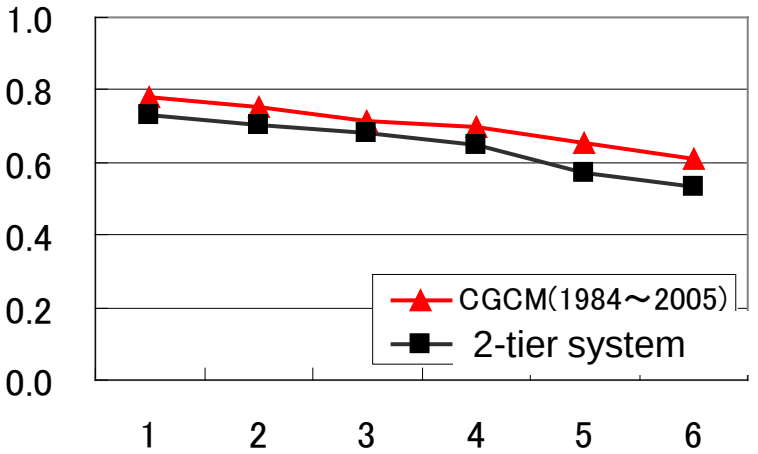
Climatology + long-term trend + statistically estimated SST field using dynamically forecasted NINO.3 SSTA using El Nino forecast model.

Improvement of SST

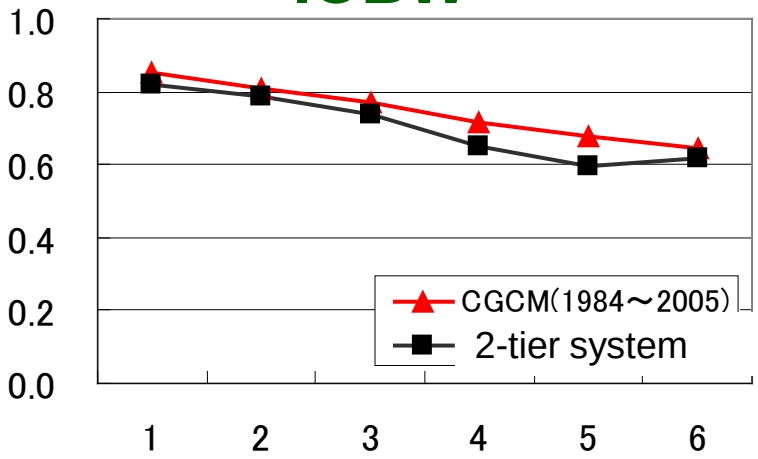
NINO.4

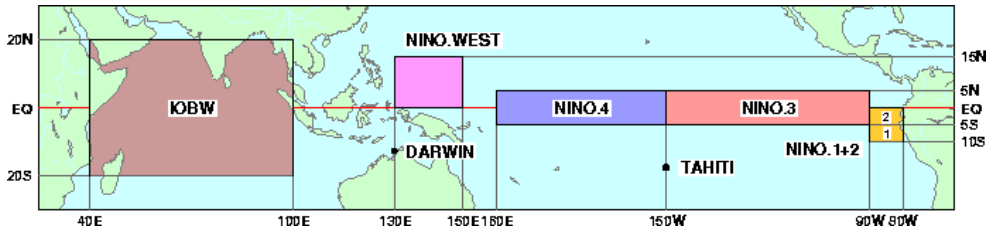


NINO.WEST



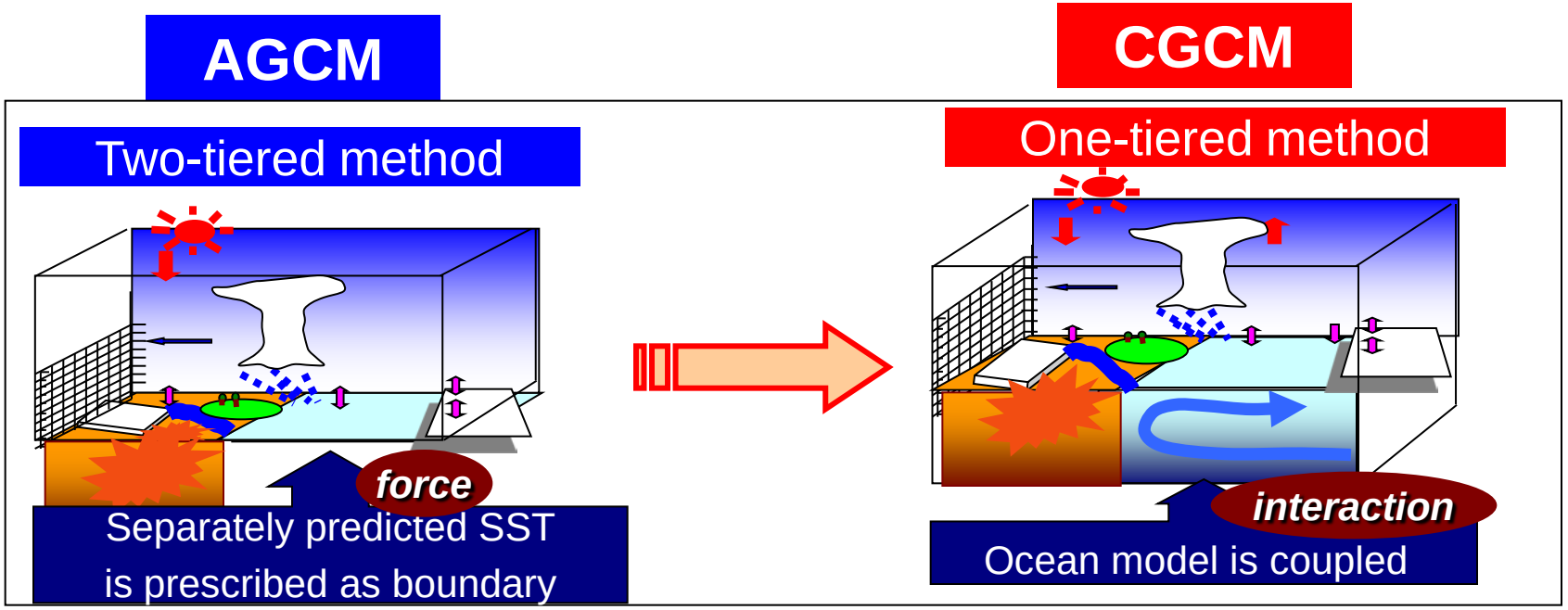
IOBW





Replace EPS for seasonal predictions in February 2010

- Introducing the atmosphere-ocean coupled model (CGCM) into operational seasonal prediction



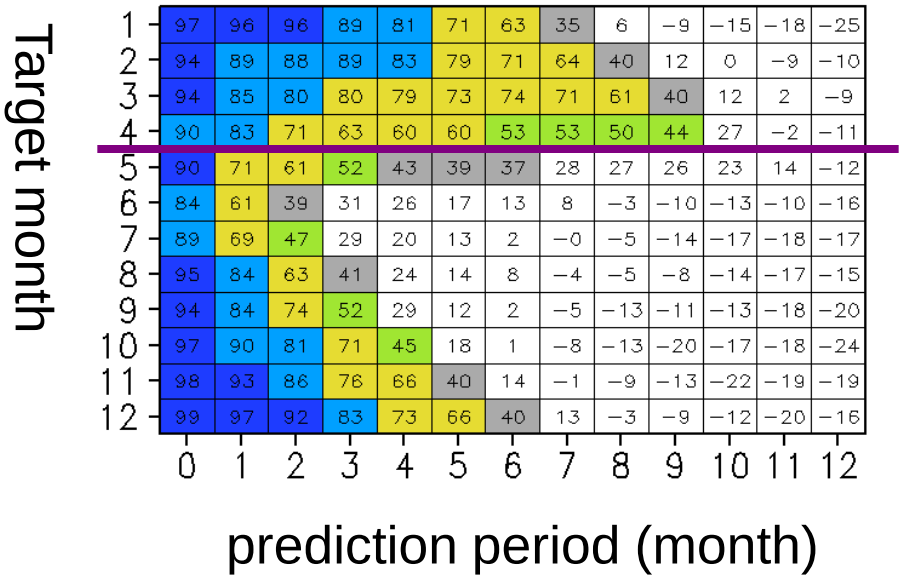
Anomaly Correlation of NINO.3.4 SST in the JMA's CGCM

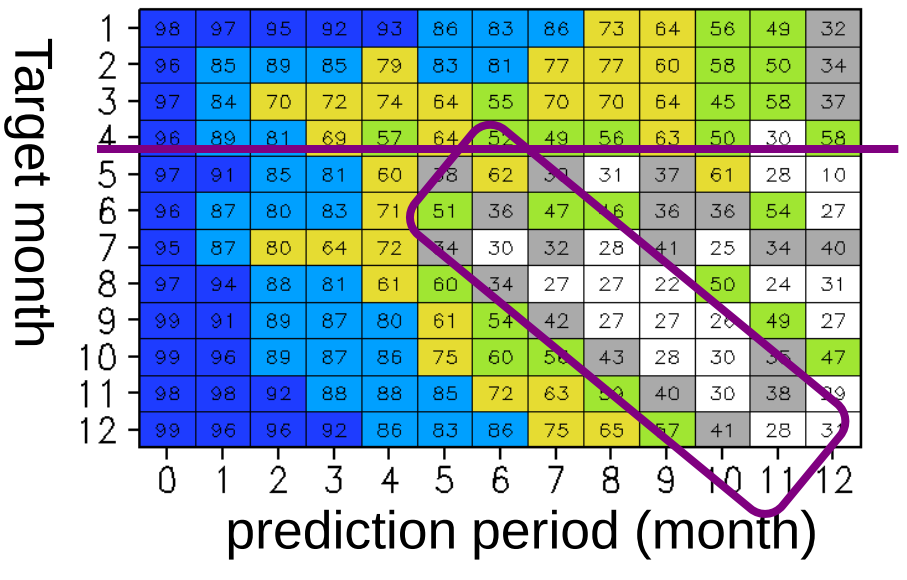
Prediction skill has target month dependency.

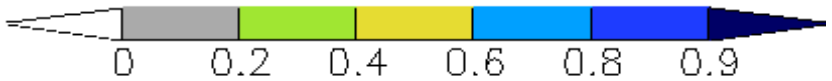
- Persistence barrier from spring to summer
- Anomaly correlation is small for model from spring to summer.
  = "**spring barrier**" ; common issues for all numerical model

Persisted anomaly

CGCM



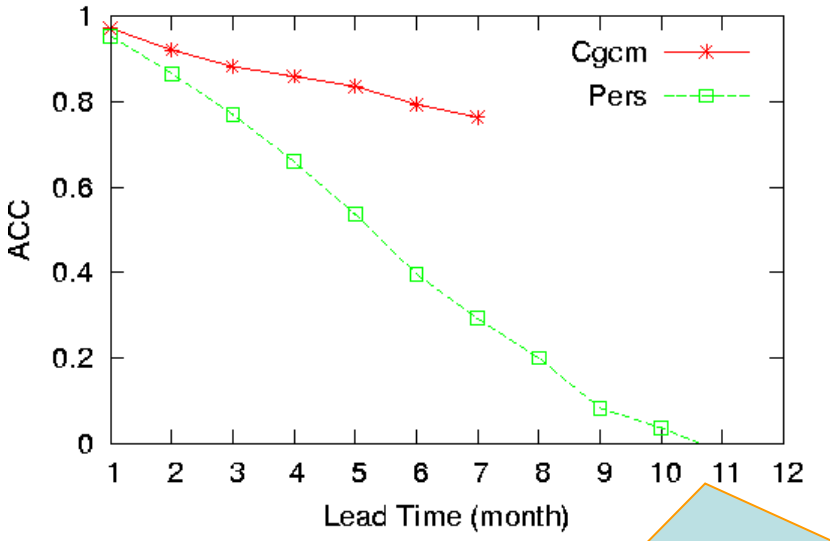




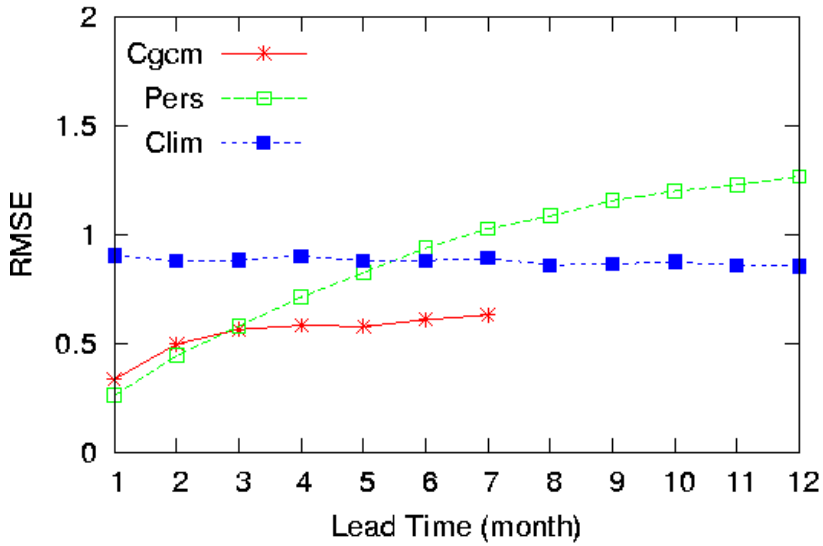
period: 1979～2007

ENSO forecast skill of JMA/MRI-CGCM3

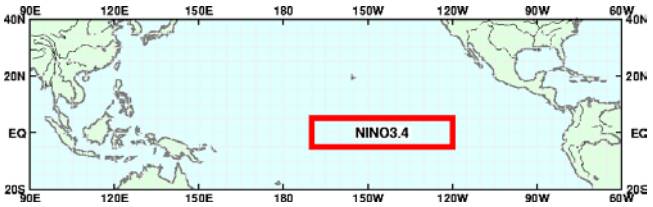
(a) Anomaly Correlation (ACC)



(b)Root Mean Square Error (Deg.C.) (RMSE)



•ACC with CGCM are higher than 0.8 within 5-6 month lead time and higher than that with persistence forecast not only for long but also for short lead times.



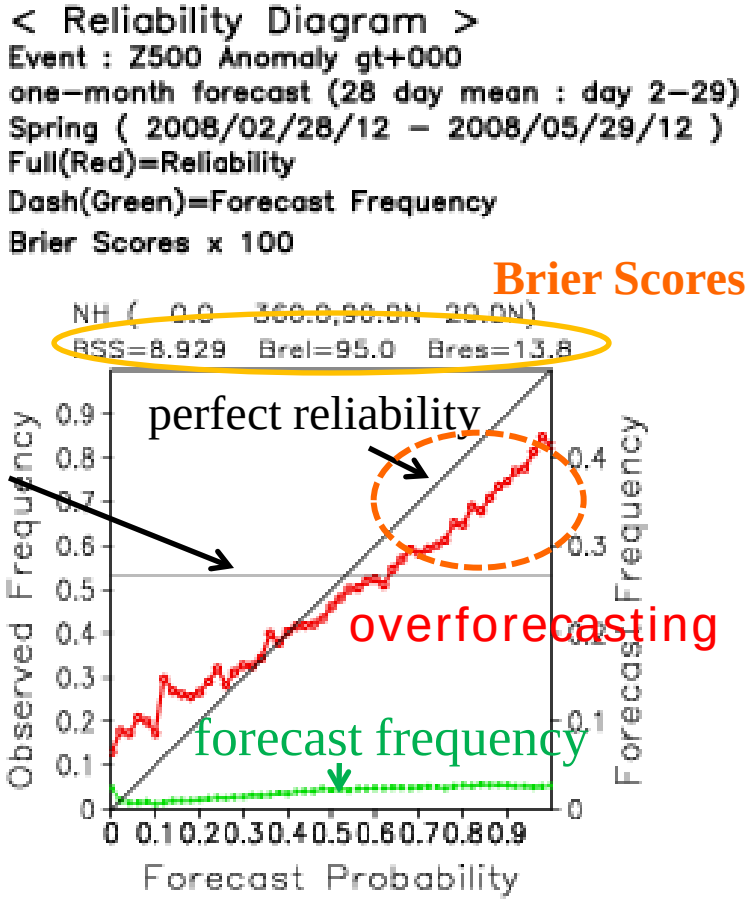
a) Anomaly correlation coefficients and b) RMSE of NINO3.4 index during 1984-2005 with respect to lead time after removing the mean bias. Red lines for JMA/MRI-CGCM, green lines for persistence forecast and a blue line for standard deviation of NINO3.4

Reliability diagram

The reliability diagram plots the observed frequency(Y-axis) against the forecast probability(X-axis).

The diagonal line indicates perfect reliability (observed frequency equal to forecast probability for each category).

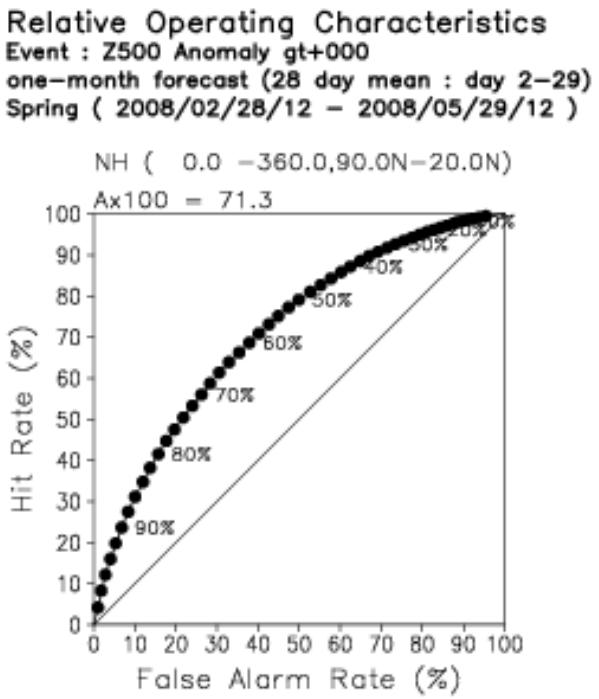
Points below(above) the diagonal line indicate overforecasting (underforecasting).



Relative Operating Characteristics (ROC)

- ROC is created by plotting the hit rate(Y-axis) against the false alarm rate(X-axis) using increasing probability thresholds to make the yes/no decision.

- The area under the ROC curve (=ROC area) is frequently used as a score.

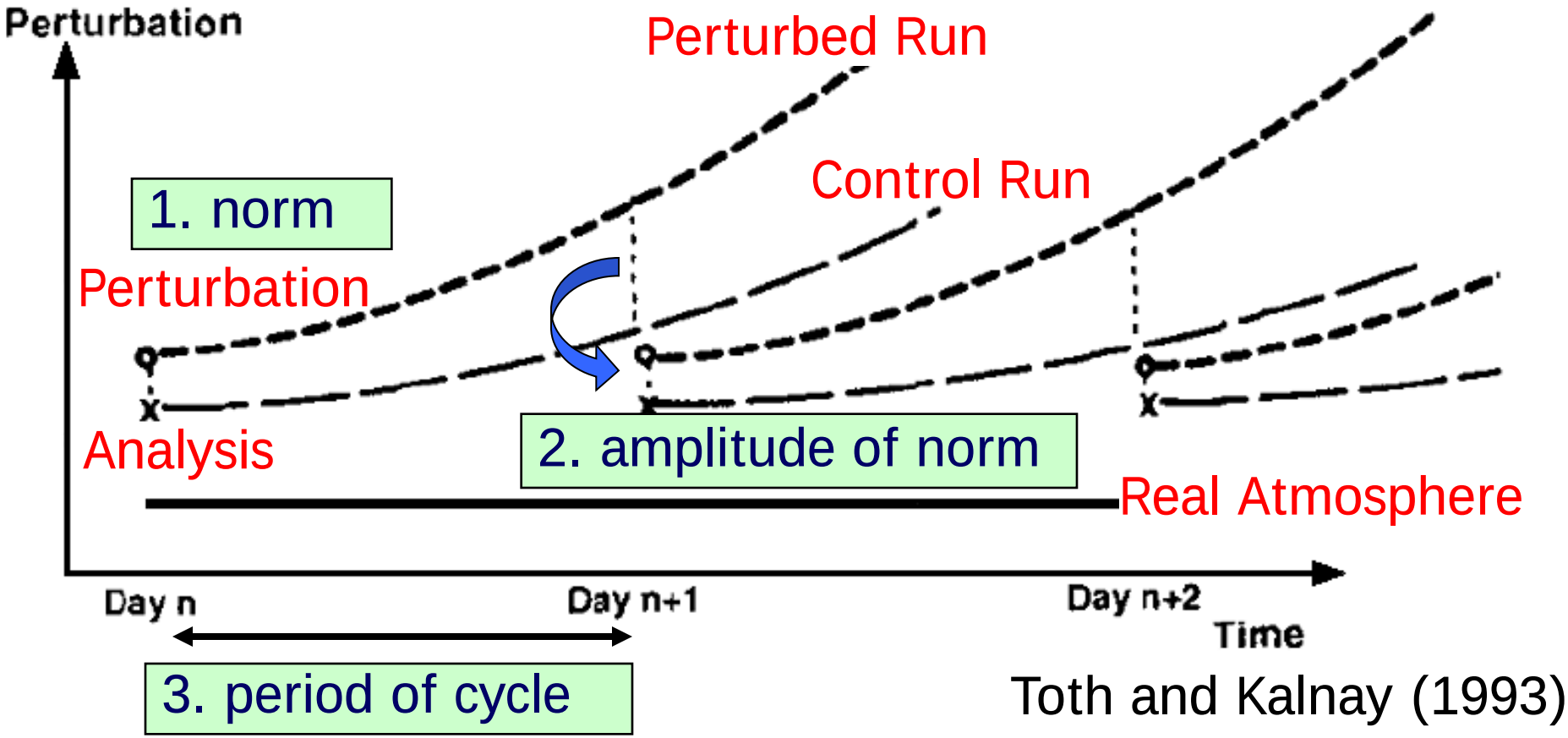


	Forecast	Not forecast	Totals
Observed	H	M	H + M
Not observed	F	R	F + R
Totals	H + F	M + R	H + M + F + R

Hit rate: H/(H+M)

False alarm rate: F/(F+R)

Perturbation produced by the BGM method



Toth and Kalnay (1993)

The model is integrated for 12 hours from the perturbed and the unperturbed initial conditions. The differences between the unperturbed control and the perturbed forecasts are normalized and used as an atmospheric perturbations.