JMA's seasonal forecast system and its application

Kiyotoshi TAKAHASHI

Climate Prediction Division
Japan Meteorological Agency

On behalf of
Dr.Kiyoharu TAKANO, the director of CPD/JMA

APCC Simpo 2008

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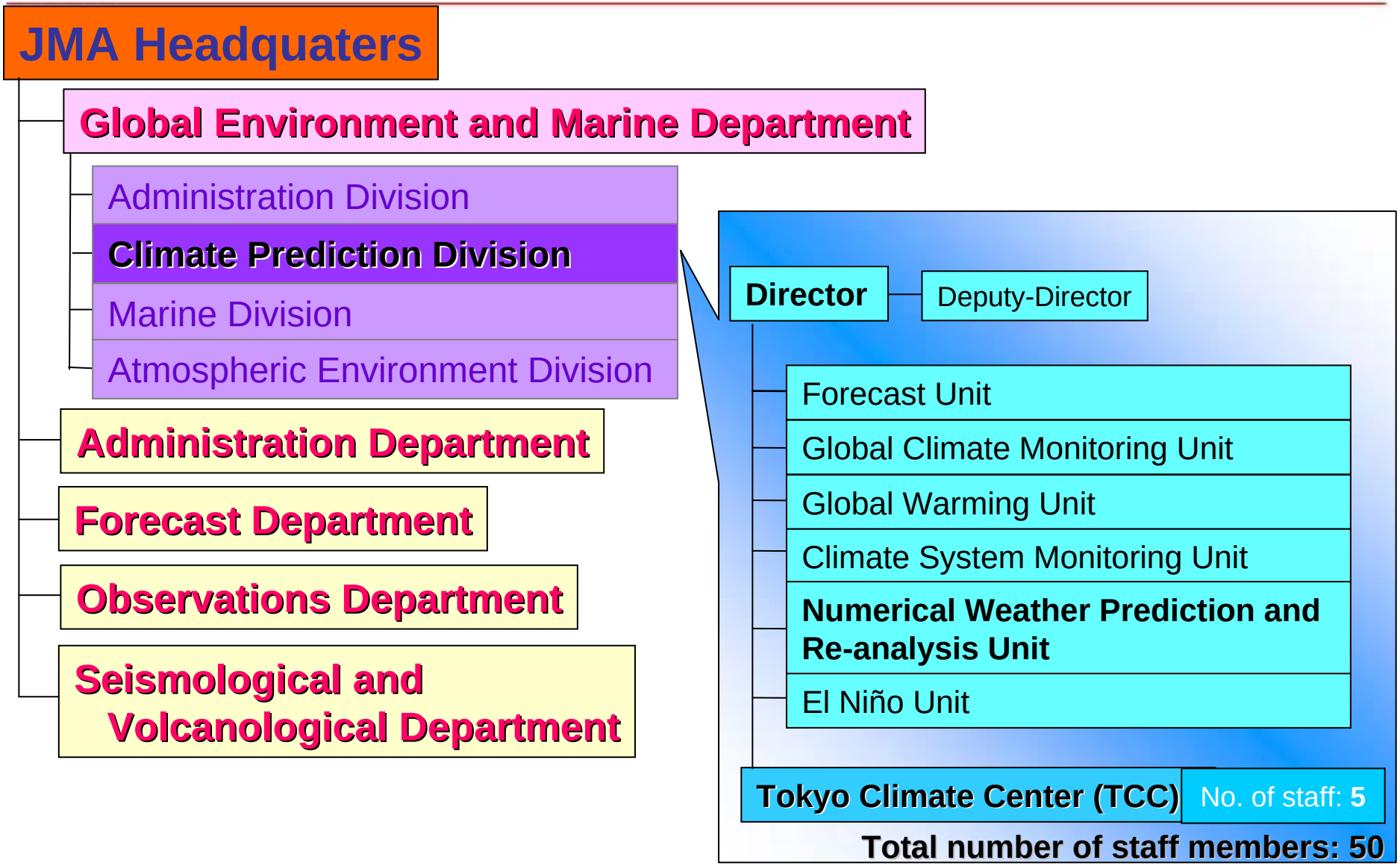
1. JMA's seasonal forecast system
Organization of the Climate Prediction Division



1. JMA's seasonal forecast system
Type of seasonal forecasts

At present we use three models for seasonal prediction.

- **One-month Forecast**
- Early Warning Information on Extreme Weather (within two-weeks) New Info (March 2008~)

- **Three-month Forecast**
- **Warm/Cold seasonal Forecast**

Unified

- **El- Niño Outlook**

1. JMA's seasonal forecast system
Outline of EPS systems

One-month Forecast

- TL159: 1.125deg
- L60: top=0.1hPa
- Ensemble size: **50**
- I. Perturbation: **BGM/LAF**
- Frequency: **Once a week**
- Forecast period: **34 days**
- Land: SiB
- SST: **Persisted anomaly**

Early Warning

- Forecast period: **17 days**

Seasonal Forecast

- TL95: 1.875deg
- L40: 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**

El Niño Outlook

Atmosphere

- TL95: 1.875deg
- L40: top=0.4hPa

Ocean

- 1º (lon) x 1º (lat), (1º (lon) x 0.3º (lat) near equator) 50 vertical levels

- Ensemble size: **12**
- I. Perturbation: **LAF (5 days interval)**
- Frequency: **once a month**
- Forecast period: **15 months**
- Land: SiB

1. JMA's seasonal forecast system Outline of Verification

Standard **V**erification **S**ystem for **L**ong **R**ange **F**orecast (SVSLRF)

- WMO standard tool to verify skill in seasonal models
- Two kind of verification
  1) Deterministic : MSSS
  2) Probabilistic : ROC, Reliability diagram (BSS)
- Verification data recommended
  T2m(Surface 2m temp.) : CRU or ERA-40
  Precipitation : GPCP

If recommended data is not available, the center can use the center own reanalysis. → **JRA-25 in the case of JMA**

2. Application products
2.-1. Introduction of TCC

Tokyo Climate Center (TCC) was established in April 2002.

Mission :

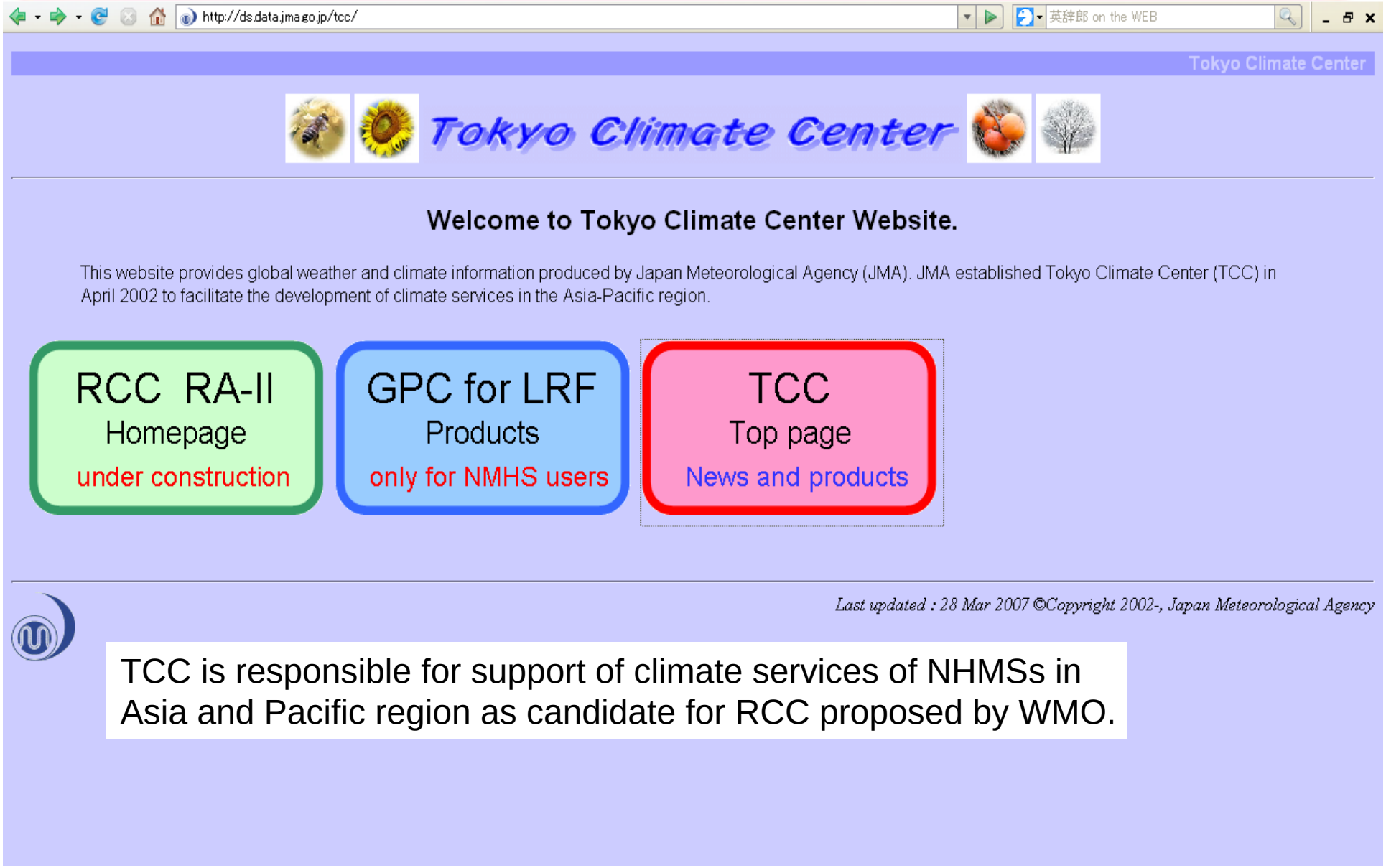
- **To assist Climate Services of NHMSs in the Asia-Pacific region**
- **With the aim of mitigating climate-related disasters and contributing to the sustainable development in the region**

TCC provides NHMSs data and information as follows,

Climate monitoring,
Seasonal forecasts,
El Niño monitoring and outlook,
Global warming,
other related information,

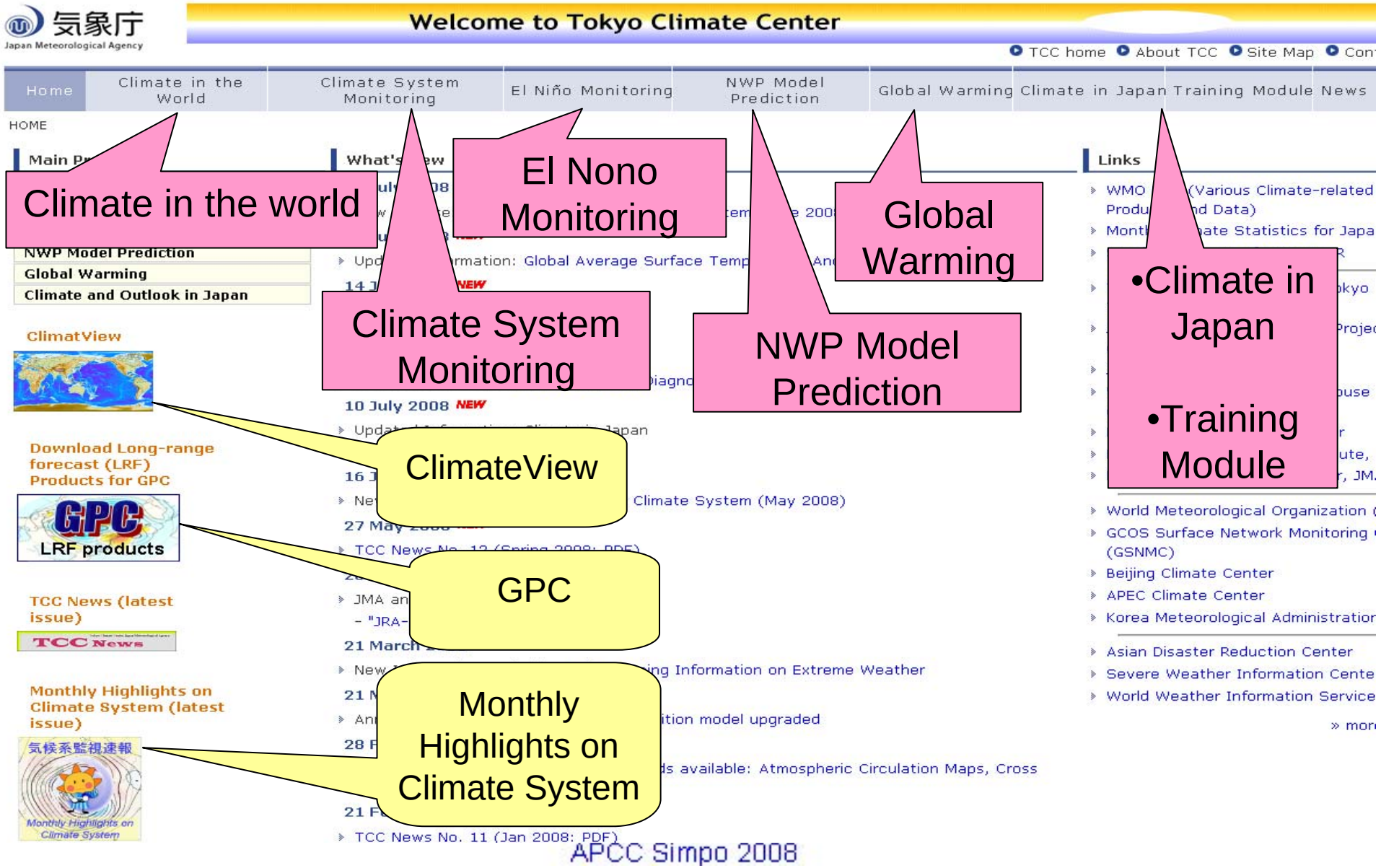
and supports capacity building through seminars or training courses.

2.-1. Introduction to TCC
TCC Web page (http://ds.data.jma.go.jp/tcc/)



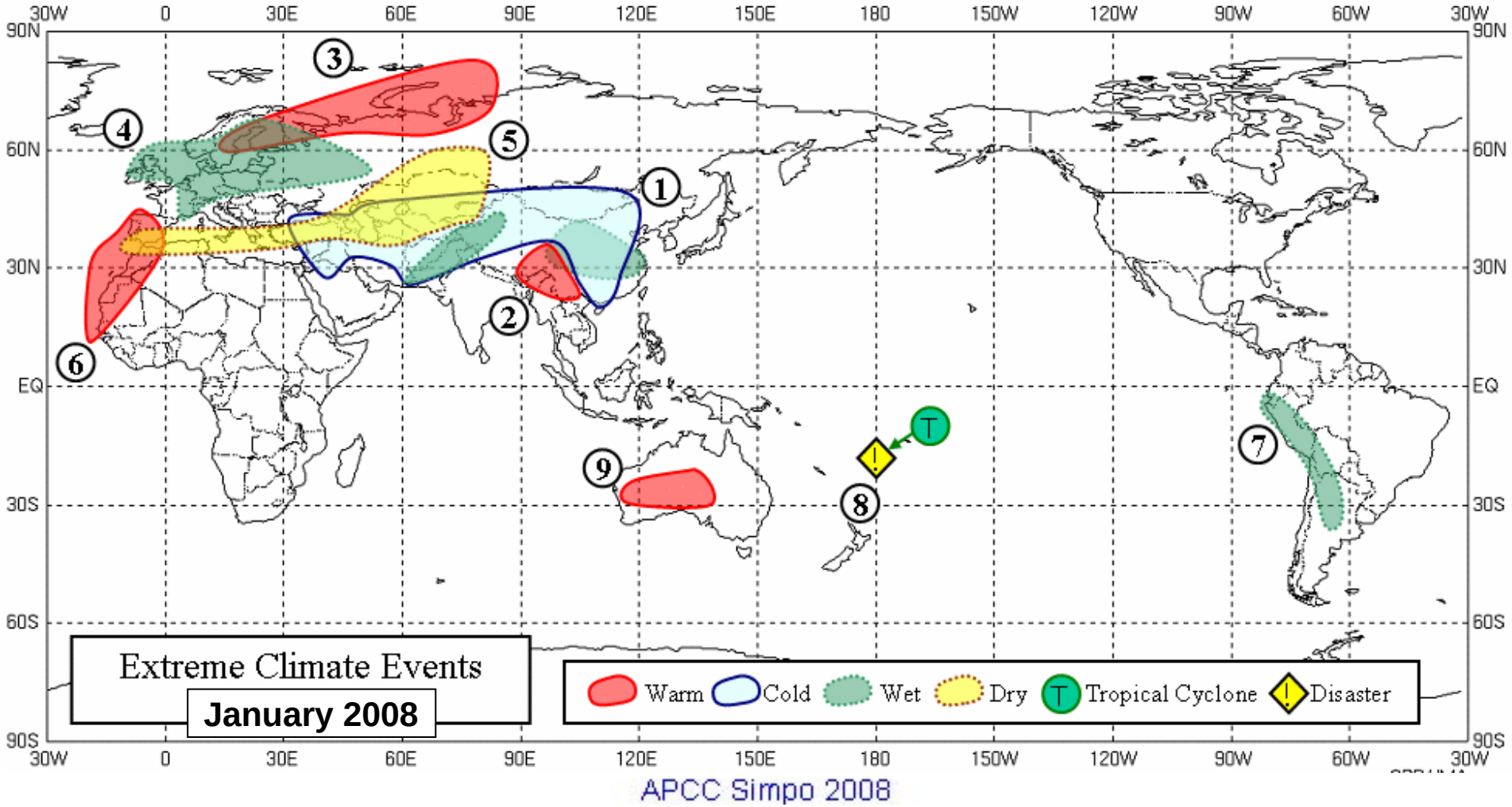
TCC is responsible for support of climate services of NHMSs in Asia and Pacific region as candidate for RCC proposed by WMO.

2.-1. Introduction to TCC
TCC Web page (http://ds.data.jma.go.jp/tcc/tcc/index.html)



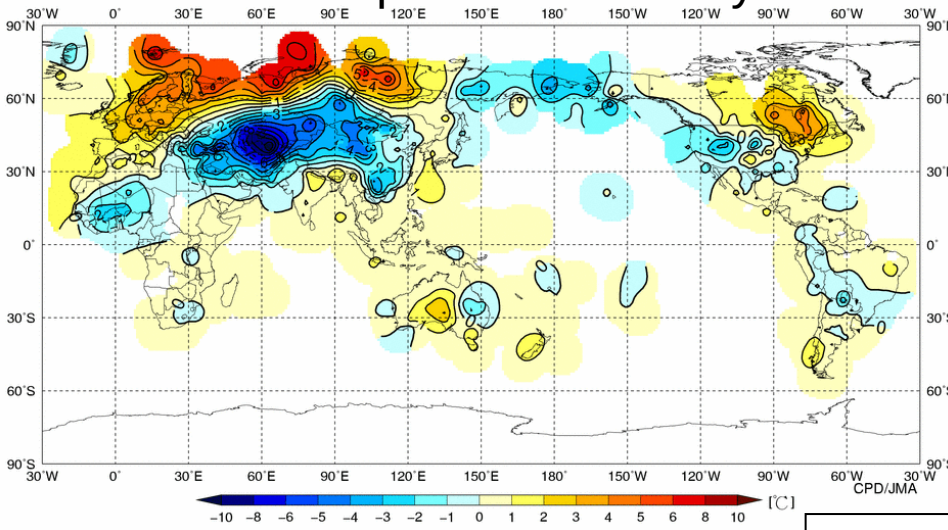
2.-1. Introduction to TCC
TCC Web page (**Climate in the world**)

Weekly, Monthly, Seasonal and Annual Temperature/Precipitation
Hazardous Climatic Events (Flood / Drought / Tropical Cyclone)

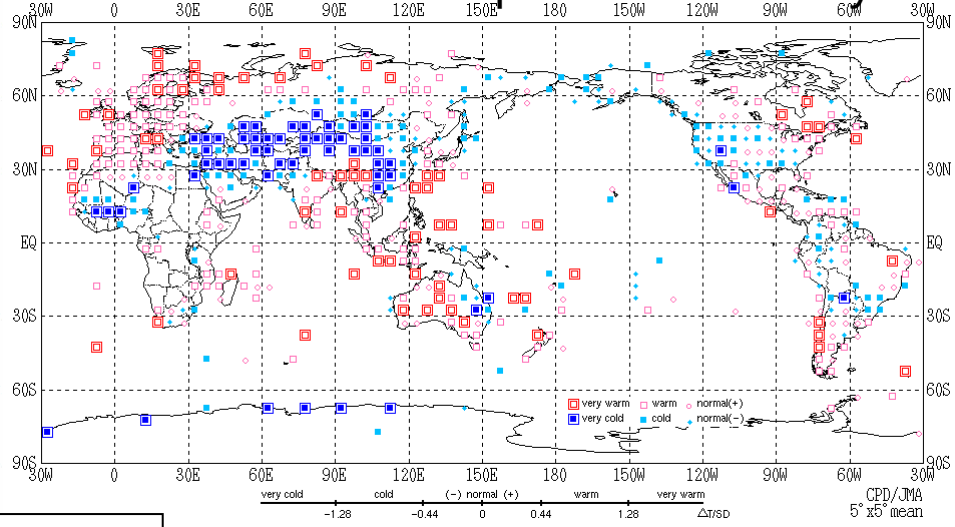


2.-1. Introduction to TCC
TCC Web page (**Climate in the world**)

Temperature Anomaly

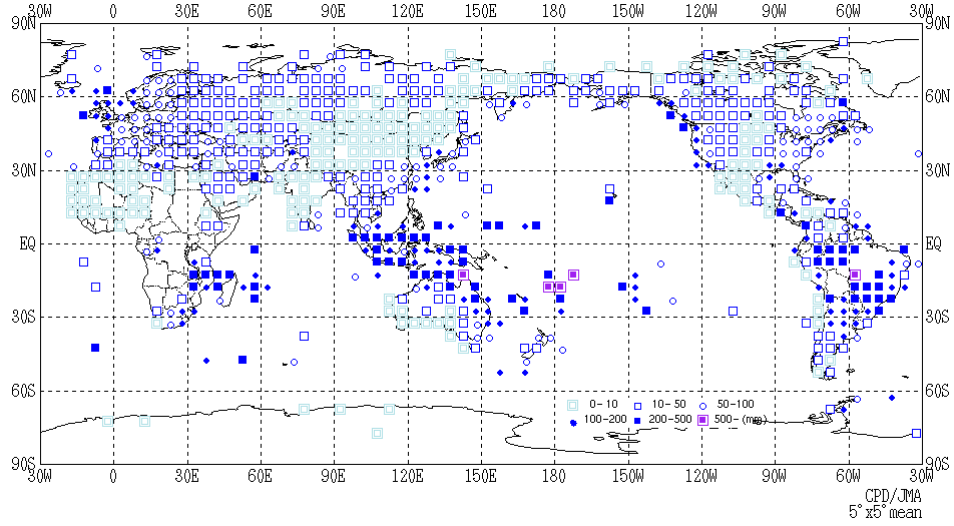


Normalized Temperature Anomaly

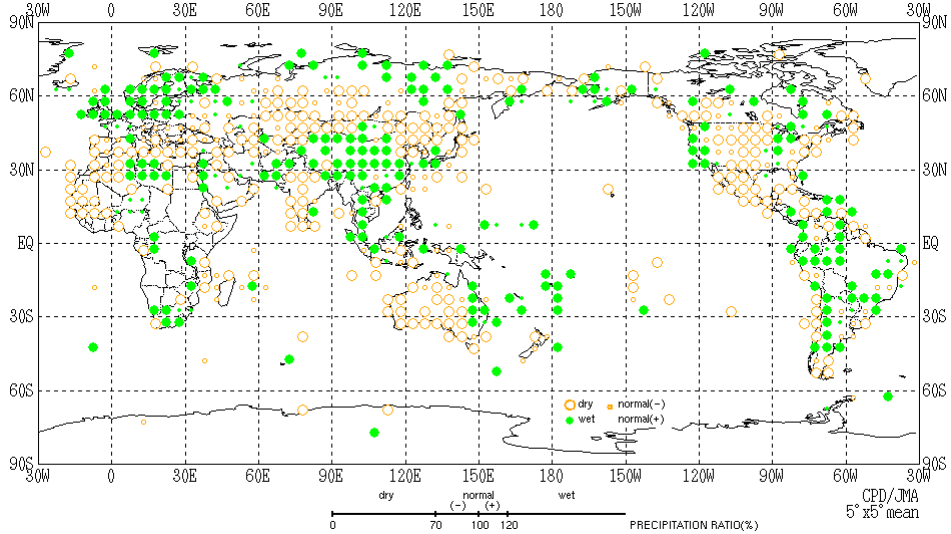


January 2008

Precipitation



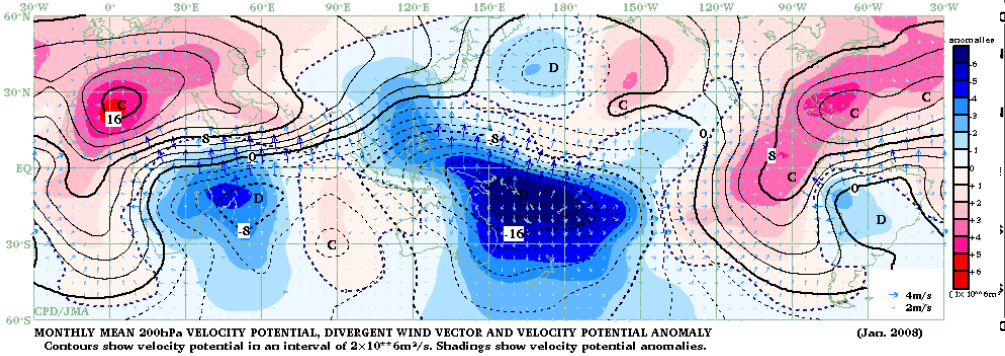
Precipitation Ratio



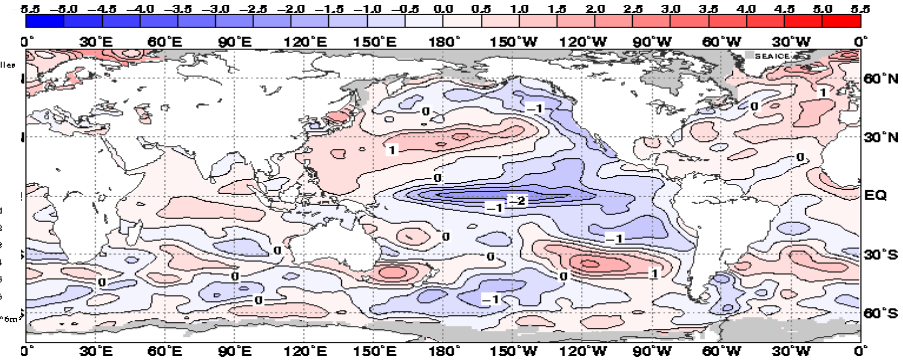
2.-1. Introduction to TCC
TCC Web page (**Climate System Monitoring**)

Summary ⟶ Monthly Highlights on Climate System

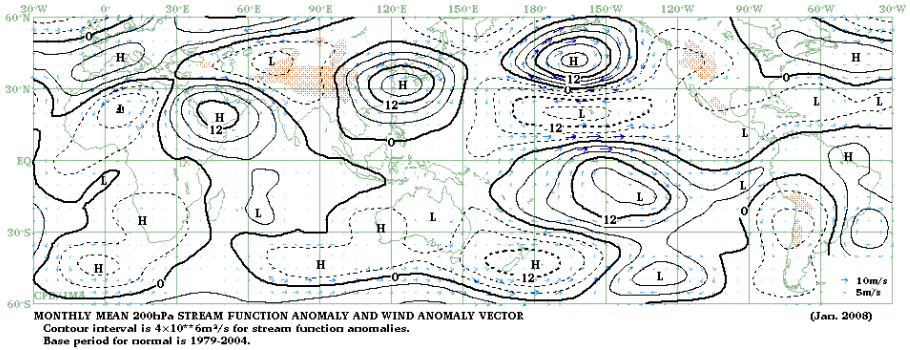
Velocity Potential and anomaly (JRA-25/JCDAS)



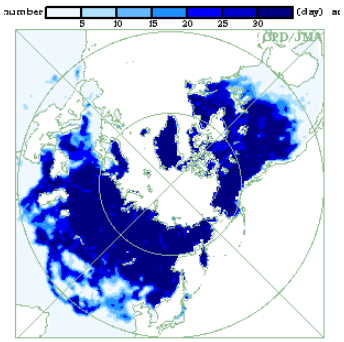
SST anomaly (COBE-SST)



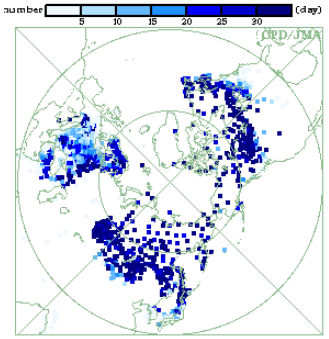
Stream function anomaly (JRA-25/JCDAS)



Snow distribution (SSM/I)



Snow depth (SNOP)



2.-1. Introduction to TCC
TCC Web page (**Climate System Monitoring**)

気象庁 Japan Meteorological Agency

Welcome to Tokyo Climate Center

Home | Climate in the World | Climate System Monitoring | El Niño Monitoring | NWP Model Prediction | Glo War

HOME > Climate System Monitoring > Monthly Mean Figures

Monthly Mean Figures of Atmospheric Circulation, Snow and

Region Extratropics Hist Hist & Anom

Element & Pressure Surface

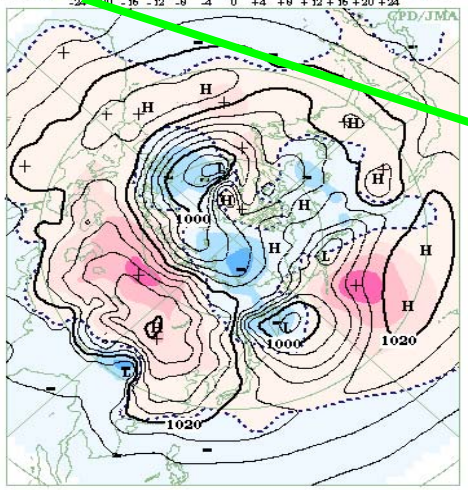
Sea Level Pressure & Anomaly in the Northern Hemisphere

Year 2008 Month 1 -> Draw

Oldest | −1 month | +1 month | Latest | Animation | Start | Stop | Slow | Fast | Direct

Normal

anomalies (hPa)



MONTHLY MEAN SEA LEVEL PRESSURE AND ANOMALY IN THE NORTHERN HEMISPHERE (Jan. 2008)
Contours show sea level pressure in an interval of 4hPa.
Shaded patterns show SLP anomalies.
Base period for normal is 1979-2004.

Tokyo Climate Center, Climate Prediction Division, 1-3-4 Otemachi, Chiyoda-ku, Tokyo, Japan.

Element & Pressure Surface

Sea Level Pressure & Anomaly in the Northern Hemisphere

- Sea Level Pressure & Anomaly in the Northern Hemisphere
- 500hPa Height & Anomaly in the Northern Hemisphere
- 100hPa Height & Anomaly in the Northern Hemisphere
- 30hPa Height & Anomaly in the Northern Hemisphere
- 850hPa Temperature & Anomaly in the Northern Hemisphere
- 200hPa Wind Speed & Vectors in the Northern Hemisphere
- Wave Activity Flux at 300hPa in the Northern Hemisphere
- Sea Level Pressure & Anomaly in the Southern Hemisphere
- 500hPa Height & Anomaly in the Southern Hemisphere
- 100hPa Height & Anomaly in the Southern Hemisphere
- 30hPa Height & Anomaly in the Southern Hemisphere

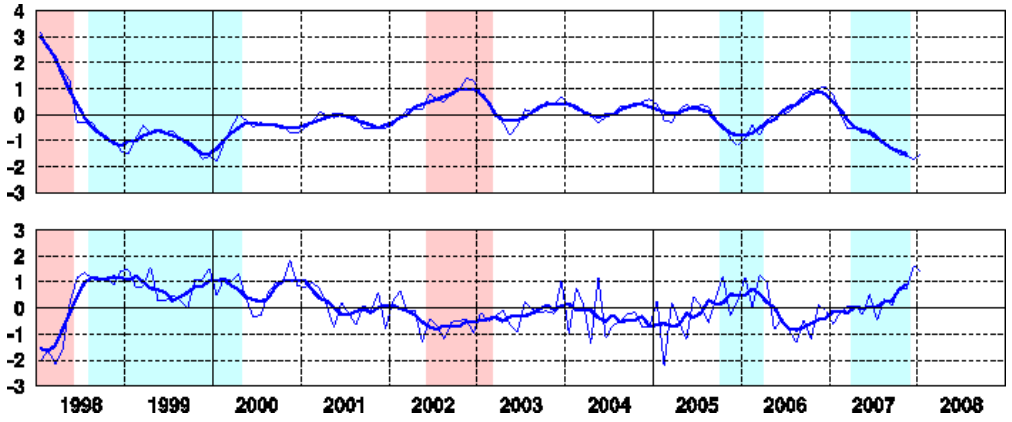
Year 2008

Oldest 1979

Normal

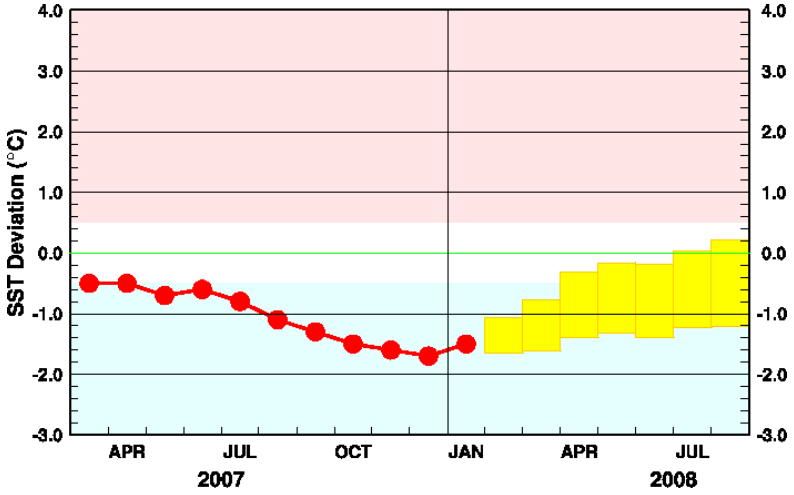
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989

2.-1. Introduction to TCC
TCC Web page (**El Niño Monitoring & outlook**)

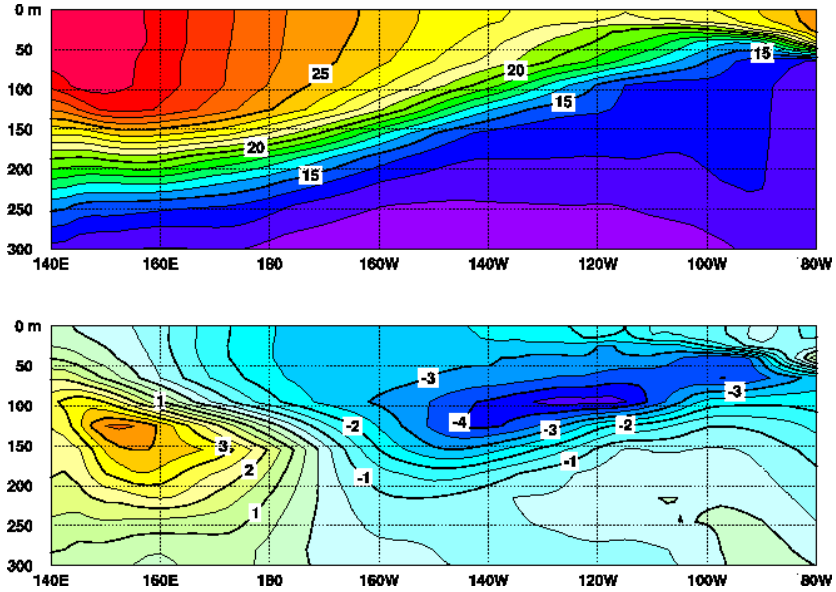


Time Sequence of ENSO indices
upper: Nino.3 SST lower: SOI

Analysis : MOVE/MRI.COM-G
Forecast : JMA/MRI-CGCM



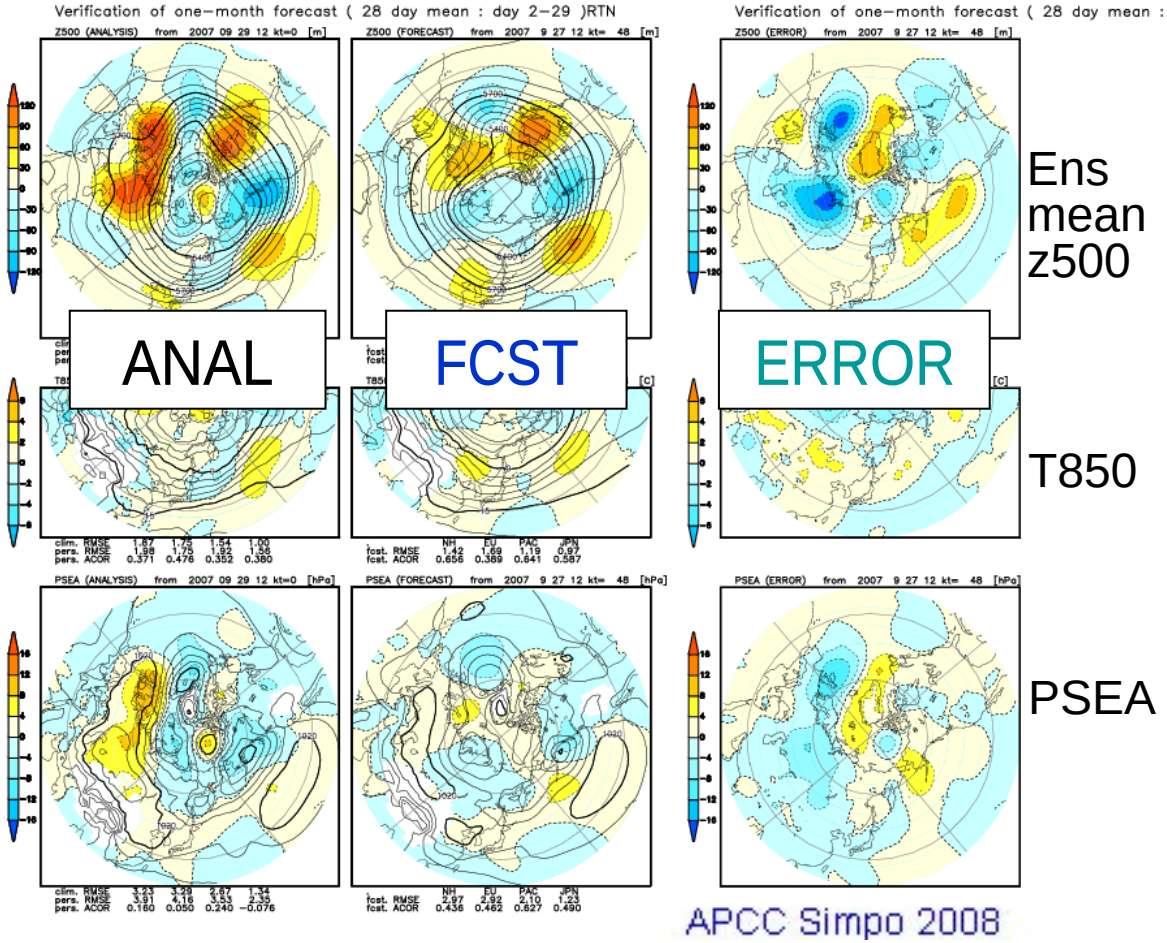
Outlook of the SST Deviation for Nino.3



Longitude-Depth Cross-section of Temperature(upper) and Anomaly(lower) along the Equator (January 2008)

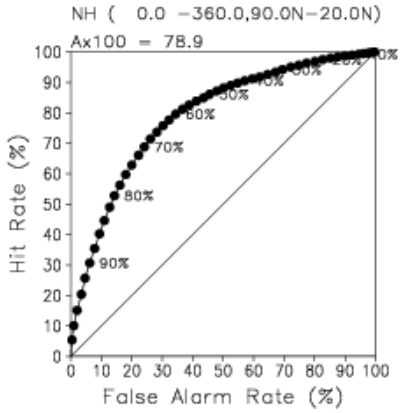
2.-1. Introduction to TCC
TCC Web page (**NWP Model Prediction**)

One month Forecast : Every Friday
Three-month Forecast : Every month (around 25th)
Warm/Cold season Forecast : Feb., Mar. and Apr. (Warm season)
Sep. and Oct. (Cold season)

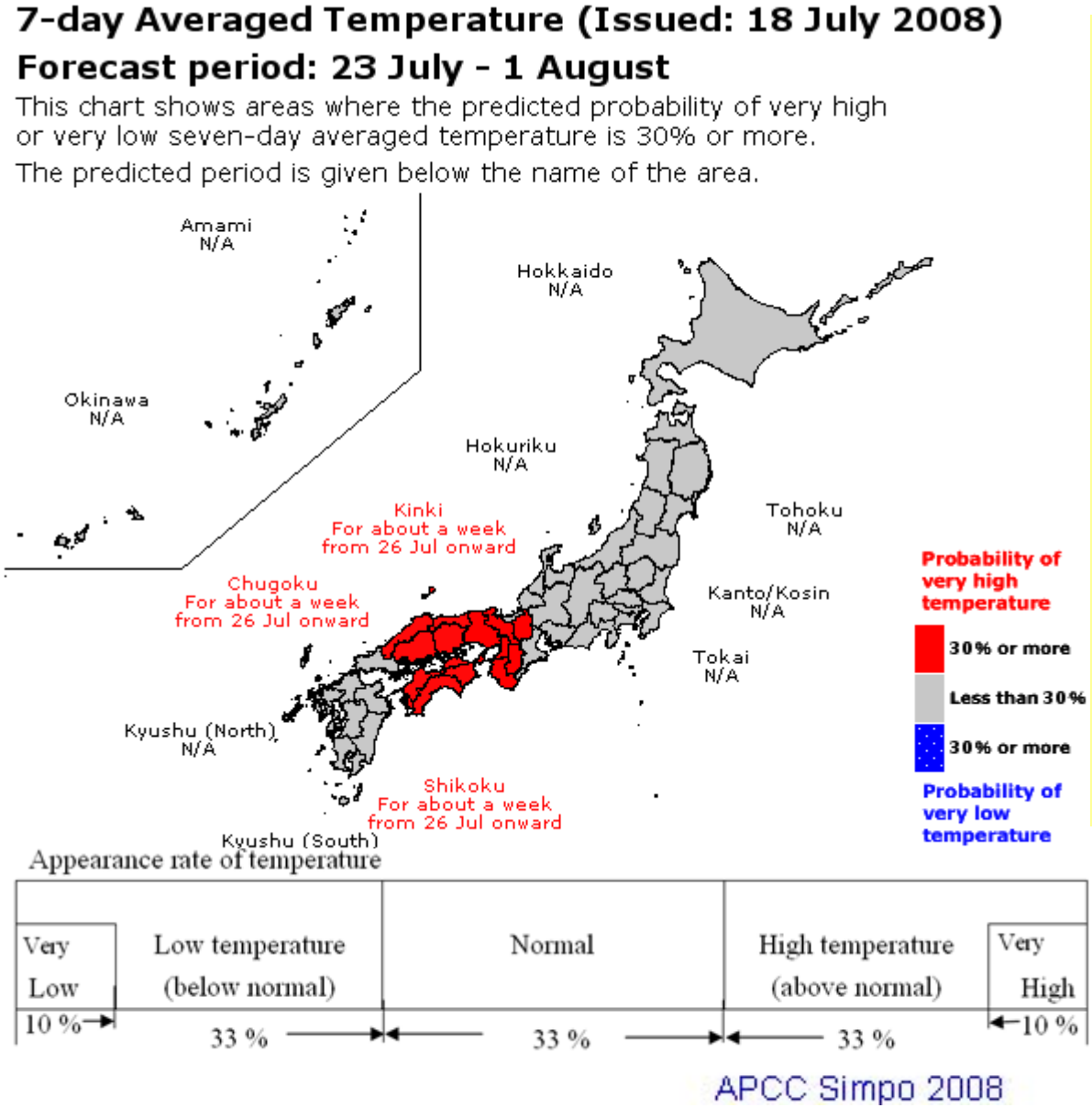


One-month forecast
28-day average
Initial: 27 Sep, 2007

Verification is also available on TCC web site.



2.-1. Introduction to TCC
TCC Web page (**Climate in Japan**)



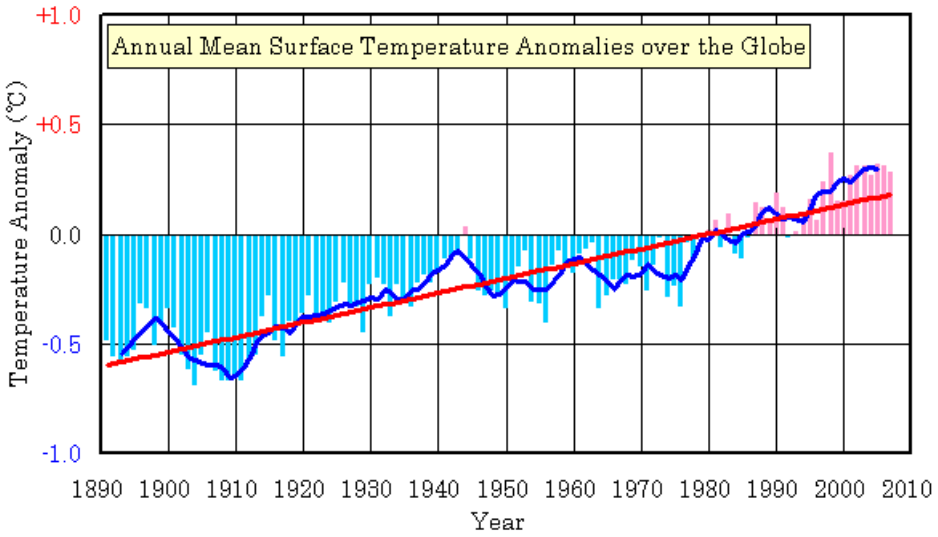
- **Early Warning Information on Extreme Weather** is issued on every Tuesday and Friday
- when a **high probability (30% or more)** of very high or very low **seven-day averaged temperature** is predicted
- in the week starting from five to eight days ahead of the date of announcement. **(in the second week)**

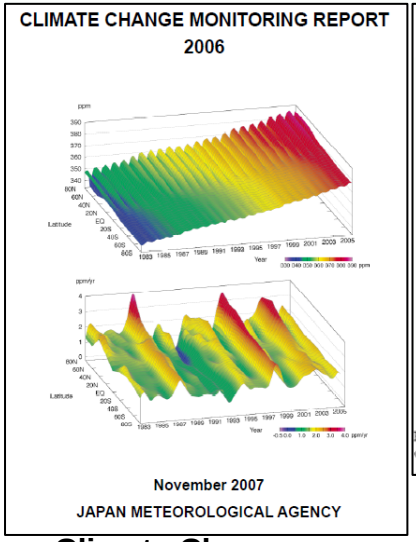
Widely used as reliable and useful Information

2.-1. Introduction to TCC
TCC Web page (**Global Warming**)

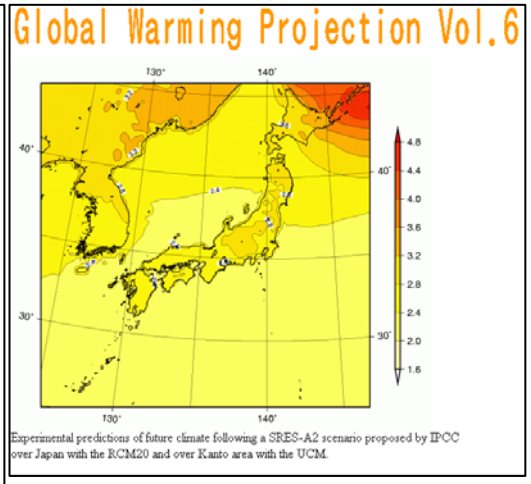
Global Temperature Monitoring

Annual anomaly of surface temperature over the globe (combined temperature of near-surface air temperature over land, and sea surface temperature)

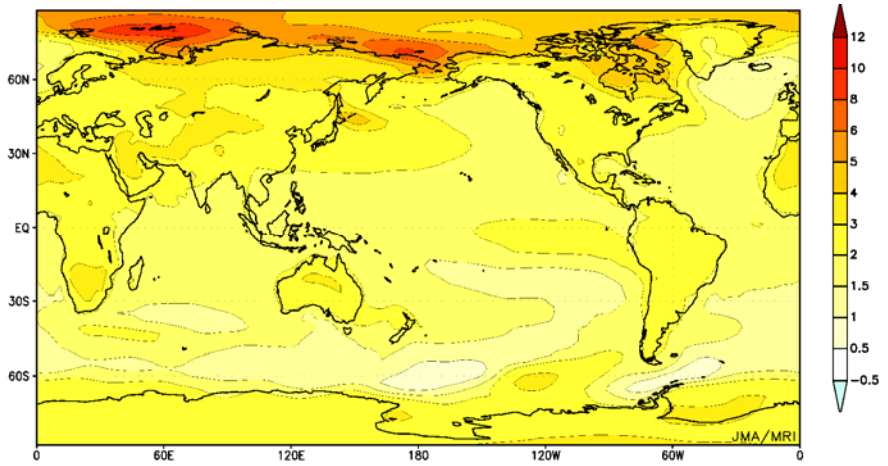




Climate Change Monitoring Report



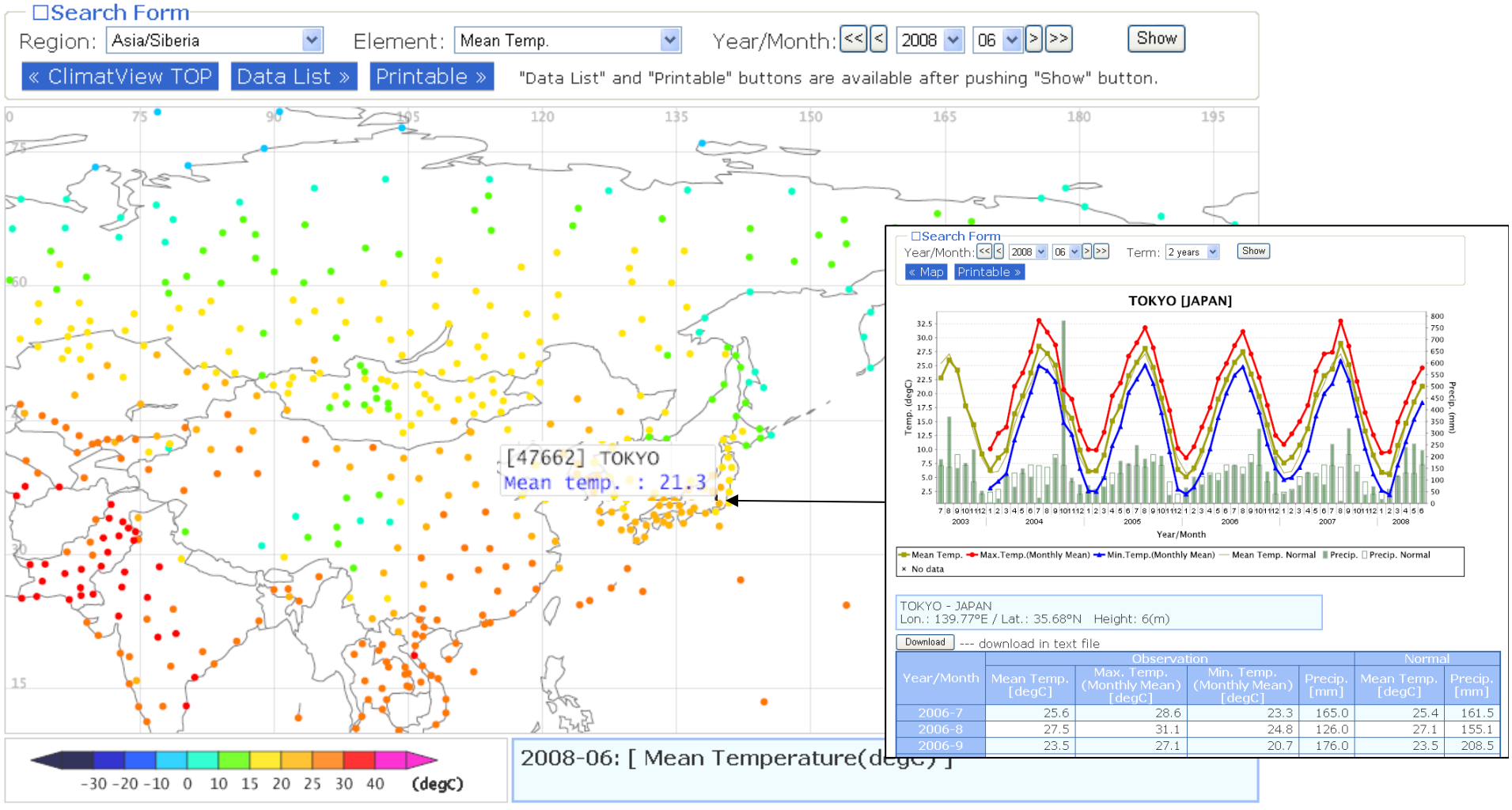
Global Warming Projection Report



Projected change in the annual mean temperature for the SRES scenario A2
(Unit: ºC)

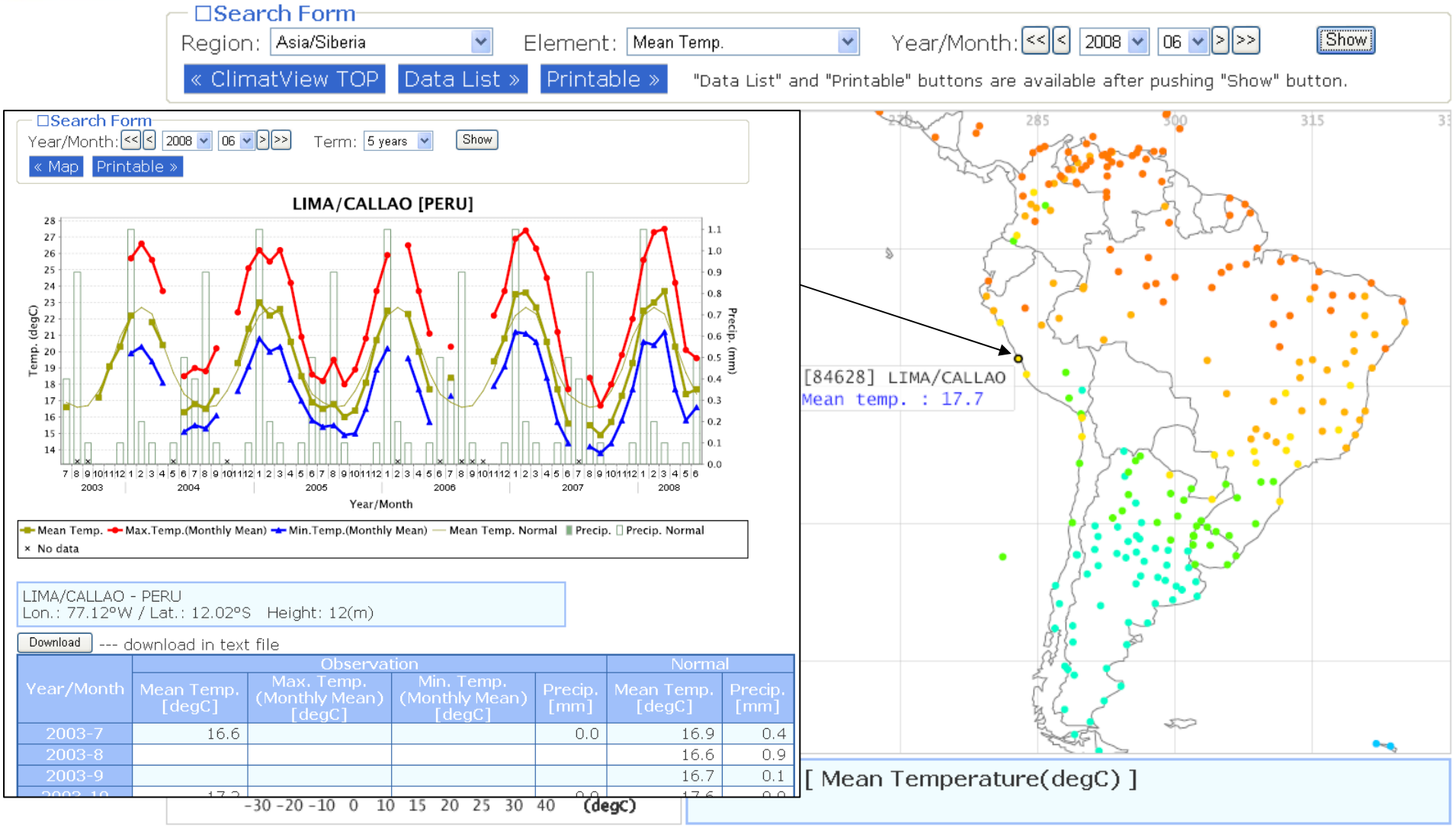
the change from 2071 to 2100 relative to the period from 1971 to 2000

2.-1. Introduction to TCC
TCC Web page (ClimateView)



Year/Month	Observation				Normal	
	Mean Temp. [degC]	Max. Temp. (Monthly Mean) [degC]	Min. Temp. (Monthly Mean) [degC]	Precip. [mm]	Mean Temp. [degC]	Precip. [mm]
2006-7	25.6	28.6	23.3	165.0	25.4	161.5
2006-8	27.5	31.1	24.8	126.0	27.1	155.1
2006-9	23.5	27.1	20.7	176.0	23.5	208.5

2.-1. Introduction to TCC
TCC Web page (ClimateView)



Year/Month	Observation				Normal	
	Mean Temp. [degC]	Max. Temp. (Monthly Mean) [degC]	Min. Temp. (Monthly Mean) [degC]	Precip. [mm]	Mean Temp. [degC]	Precip. [mm]
2003-7	16.6			0.0	16.9	0.4
2003-8					16.6	0.9
2003-9					16.7	0.1

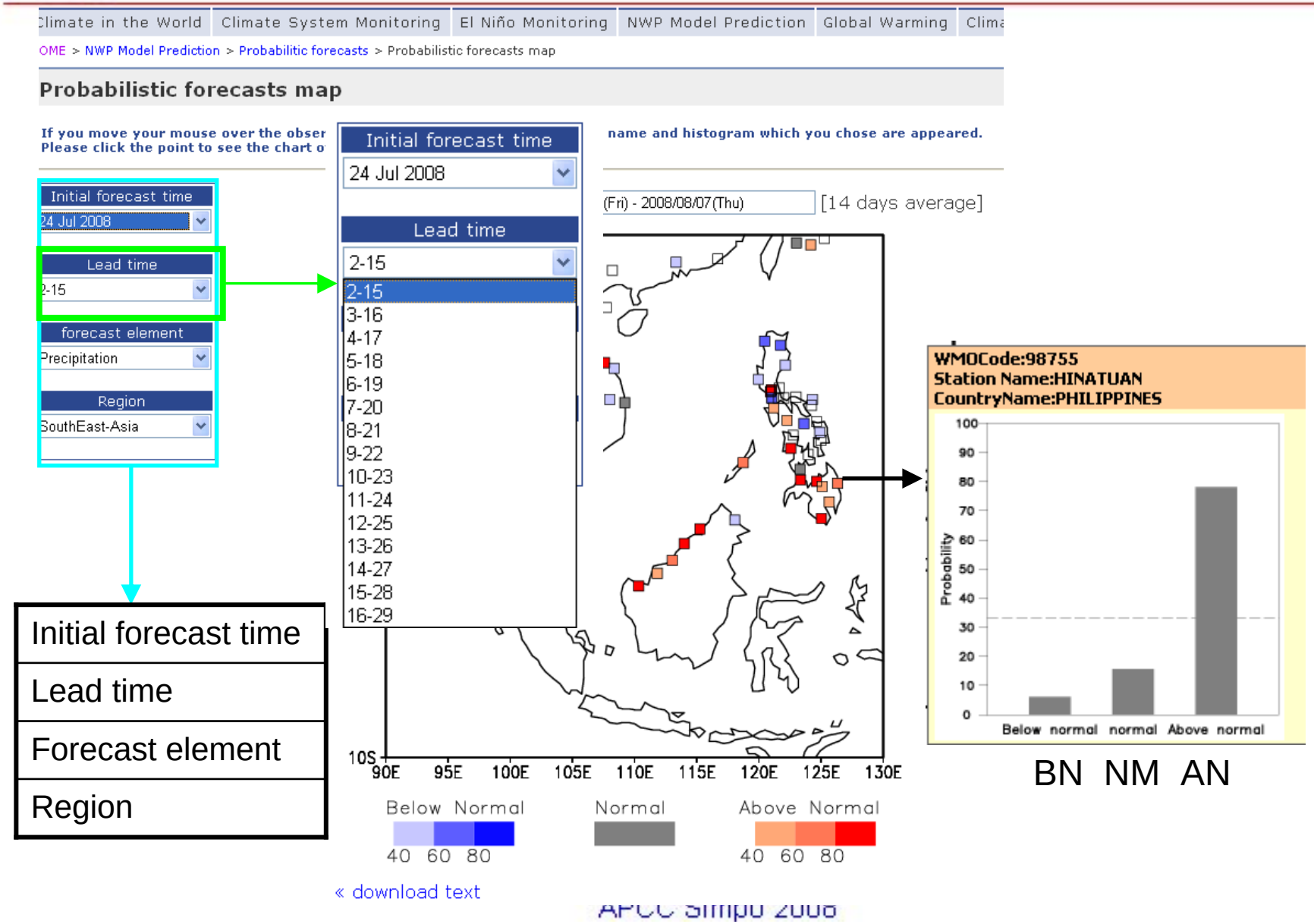
2.2 Statistical Down Scaling

One month probabilistic forecasts at station points

- **Japan Meteorological Agency (JMA) has started probabilistic one-month forecast for 7day-average surface temperature and 14day-avearge precipitation.**
- **The Model Output Statistics (MOS) technique based on the 20 years (1982-2001) hindcasts generate the forecasts,**
- **The Gauss-distribution method is used as the statistical tool of the MOS. The thresholds of tercile are determined as making each category become 33.3% of station's observation in 1982-2002.**

2.-2 Statistical Down Scaling

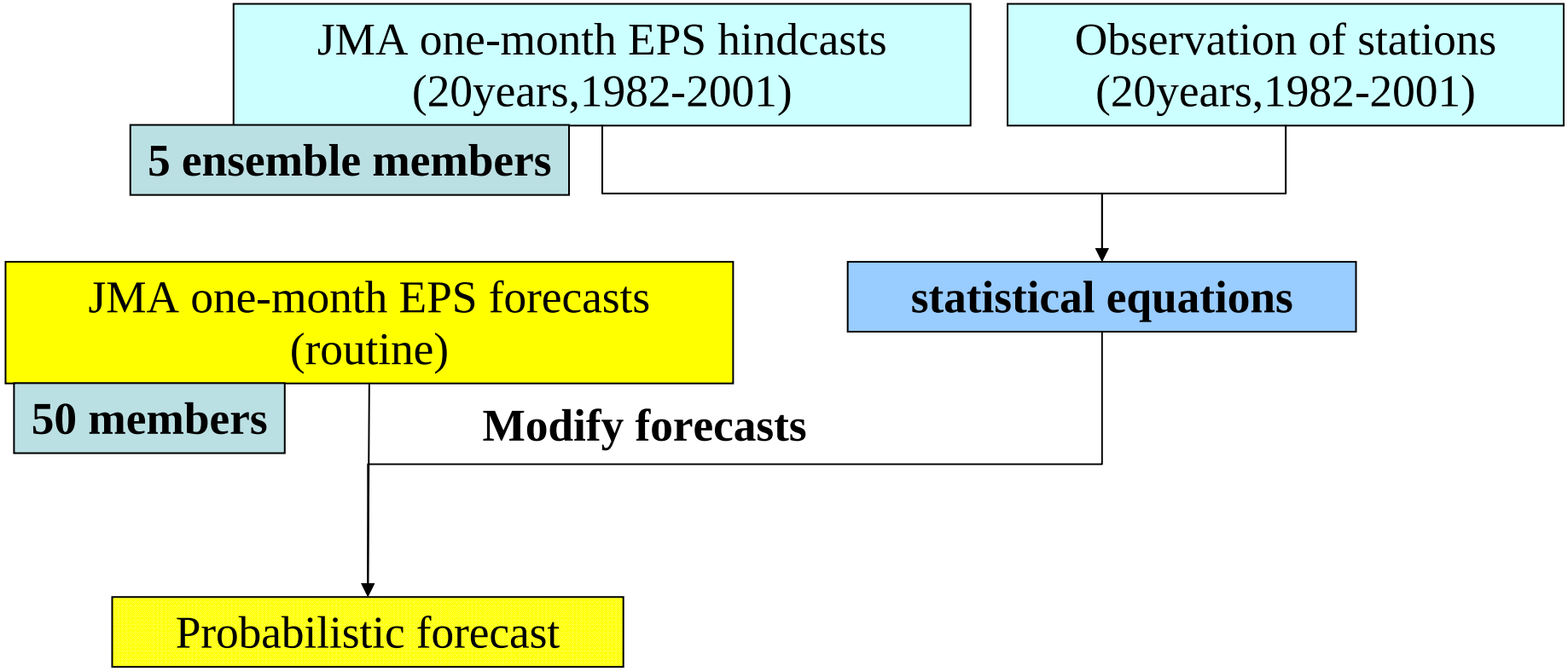
One month probabilistic forecasts at station points



2.2 Statistical Down Scaling

One month probabilistic forecasts at station points

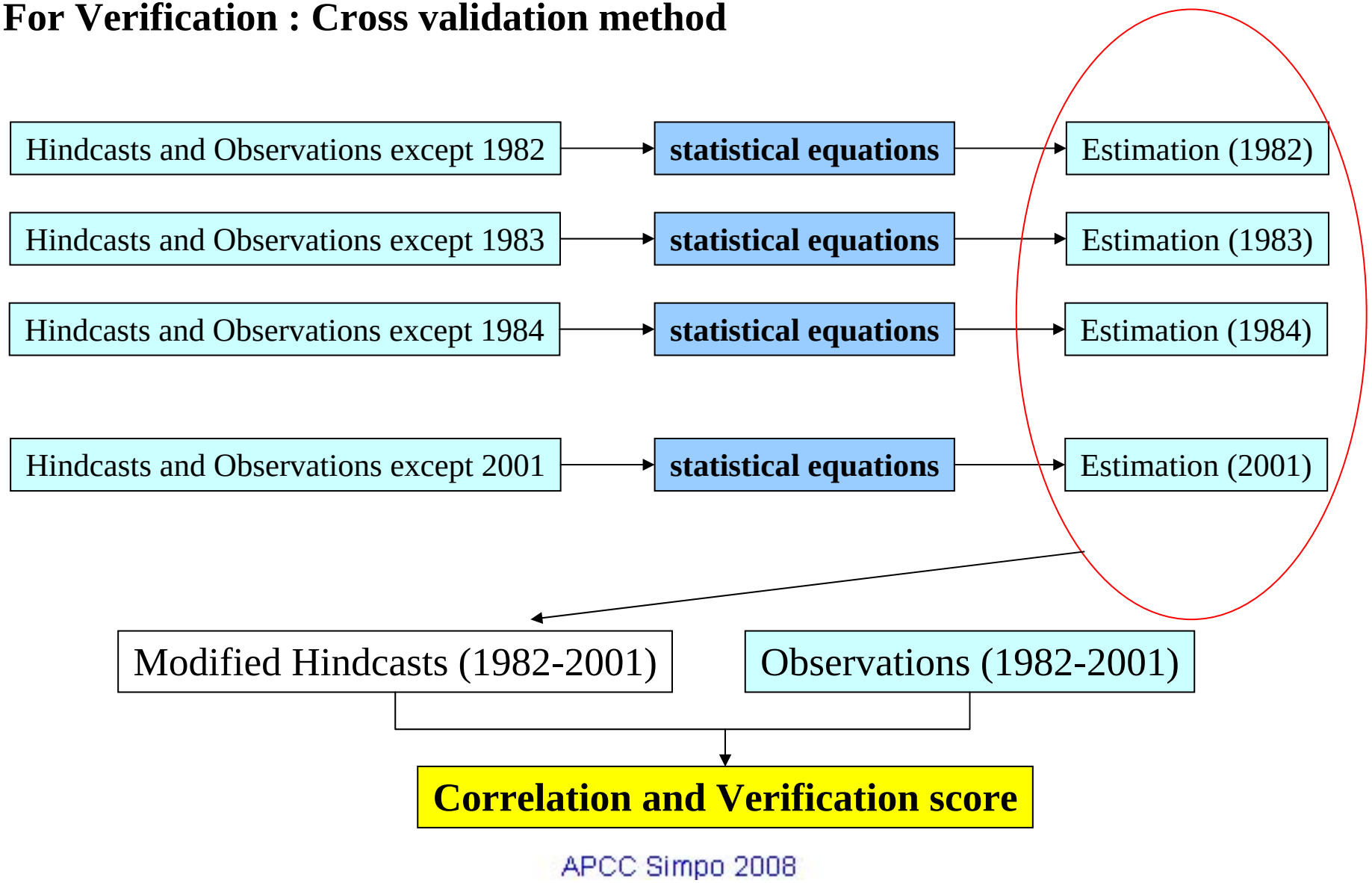
For Forecasts



2.2 Statistical Down Scaling

One month probabilistic forecasts at station points

For Verification : Cross validation method



2.2 Statistical Down Scaling

One month probabilistic forecasts at station points

Techniques used in statistical down scaling

Multiple regression formula:

-Multiple regression : $\mathbf{Y = A_1X_1 + A_2X_2 + \cdots + B}$

Method of variable selection : **Stepwise selection**

selected variables vary in points and seasons

Four seasons:

-winter dry season (Jan-Mar)

-pre-monsoon season (Apr-May)

-summer monsoon season (Jun-Sep)

-post-monsoon season (Oct-Dec)

For example

station1

Modified forecast = A_1 forecast + A_2X_2

station2

Modified forecast = A_1 forecast + A_2X_2 + A_3X_3

2.2 Statistical Down Scaling

One month probabilistic forecasts at station points

Selectable predictors in Multiple Regression:

-**model precipitation** **(to power of 1/4)** or **model 2m temperature**

-**topographical upward motion** **(U850 x slope of terrain)**
(eight kinds of terrain data from 0.083 to 1.25 degree)

Topographical factor = $\vec{\mathbf{U}}\mathbf{850}\cdot\nabla\mathbf{h}$

> 0 upward motion
< 0 downward motion

-**MJO-Index** **(RMM1 and RMM2)** (Wheeler and Hendon,2004)
EOFs of near-equatorially averaged 200hPa velocity potential and 850hPa and 200hPa U (zonal wind)
RMM1 and RMM2 are time coefficients of EOF1 and EOF2.

-**NINO.3.SST anomaly** (5S-5N,150W-190W)
using previous month value

2.2 Statistical Down Scaling

One month probabilistic forecasts at station points

Independent variables:

-Observation data source

APN Workshop data ,
ASEAN project on climate statistics,
GSN(GCOS Surface Network),
SYNOP reports,
GAME project

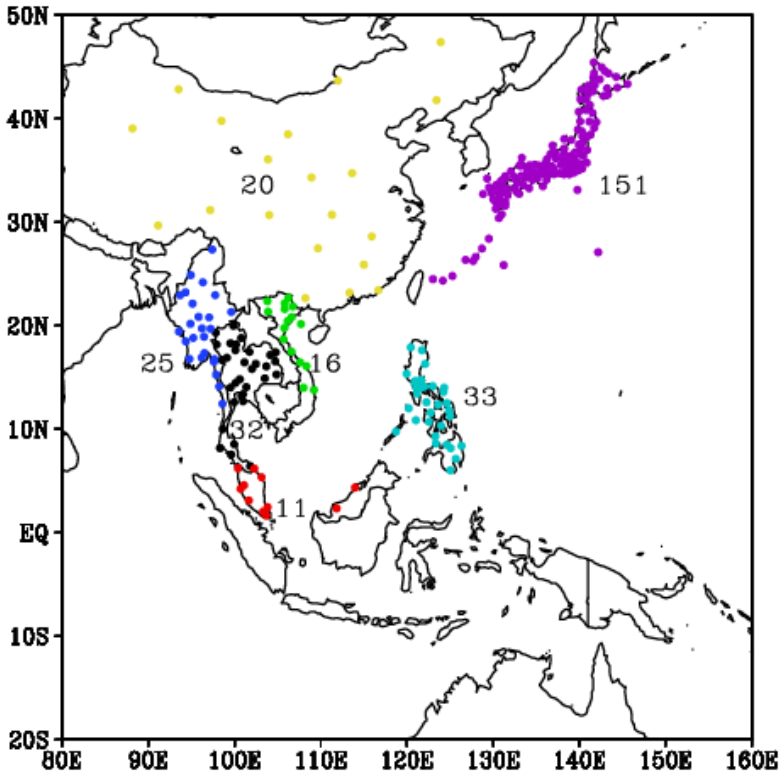
-Selection target stations

-Period for making climatology

1971 ~ 2001 : 24 years or longer with 330 days or more with available daily observation

-Period of hindcasts

1982 ~ 2001 : 16 years or longer with 330 days or more with available daily observation



312 station points including 151 Japanese stations

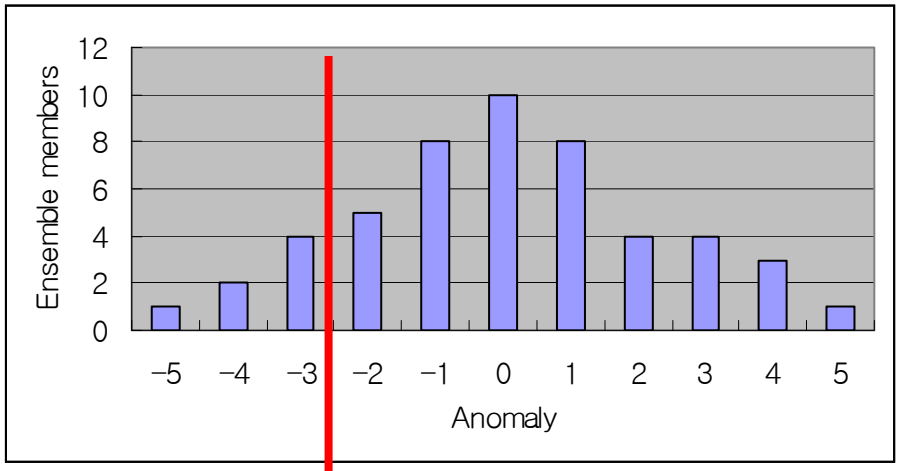
2.2 Statistical Down Scaling

How to make probability

Base method

Make probability directly from the anomaly of all ensembles members of forecasts

For example : probability of below normal (< -2)



7 members | 43 members = 50 members

Probability of below normal

7 / 50 x 100 = 14 %

2.2 Statistical Down Scaling

How to make probability

Gauss-distribution method

Assumption : Observation ,ensemble mean forecast and noise are normally distributed.

$$\sigma_y^{\,2} = \sigma_s^{\,2} + \sigma_n^{\,2}$$

$$\sigma_n^{\,2} = \left(1 - r^2\right)\sigma_y$$

σ_y : Standard deviation of observation

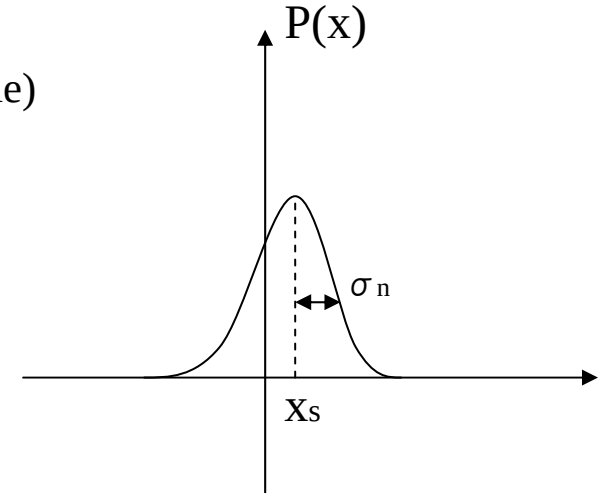
x_s : Ensemble mean forecast (single or multiple regression)

σ_s : Standard deviation of Ensemble mean forecast

σ_n : Standard deviation of noise

r : Correlation coefficients (no-regression or single or multiple)

$$P(y) = \frac{1}{\sqrt{2\pi}\sigma_n} \exp\left(-\frac{\left(y - x_s\right)^2}{2\sigma_n^{\,2}} \right)$$



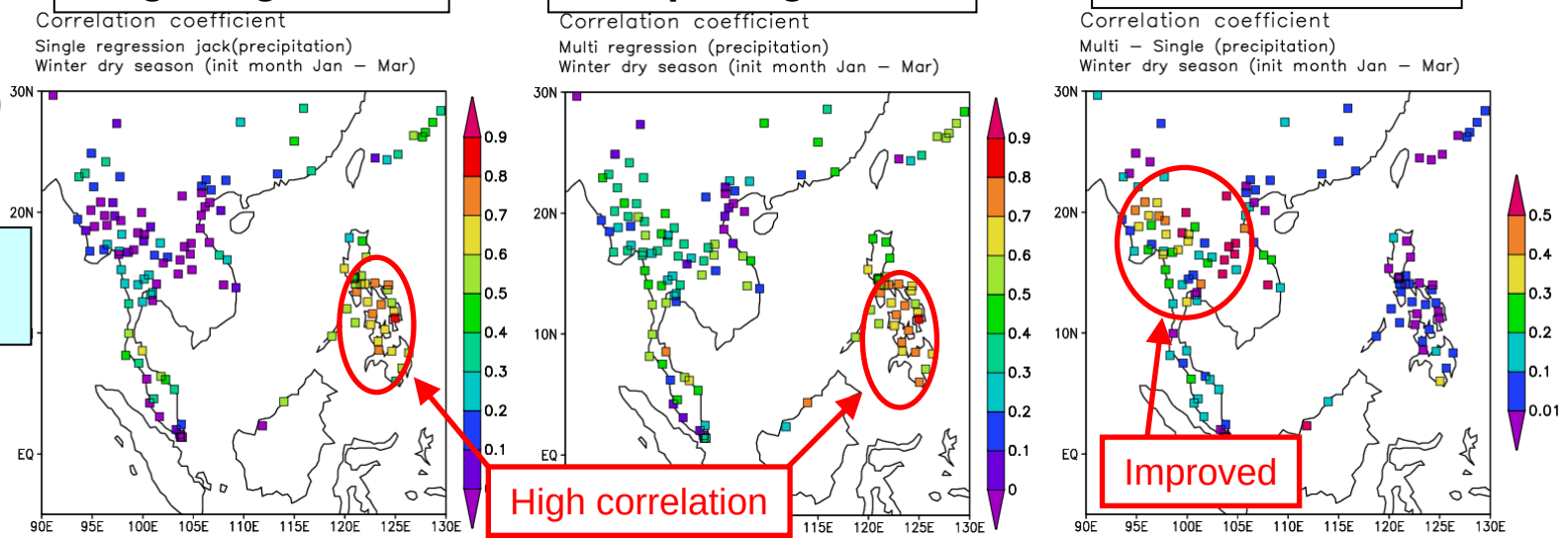
2.2 Statistical Down Scaling

Correlation of 28days (2nd-29th day forecast) average of precipitation with station observation

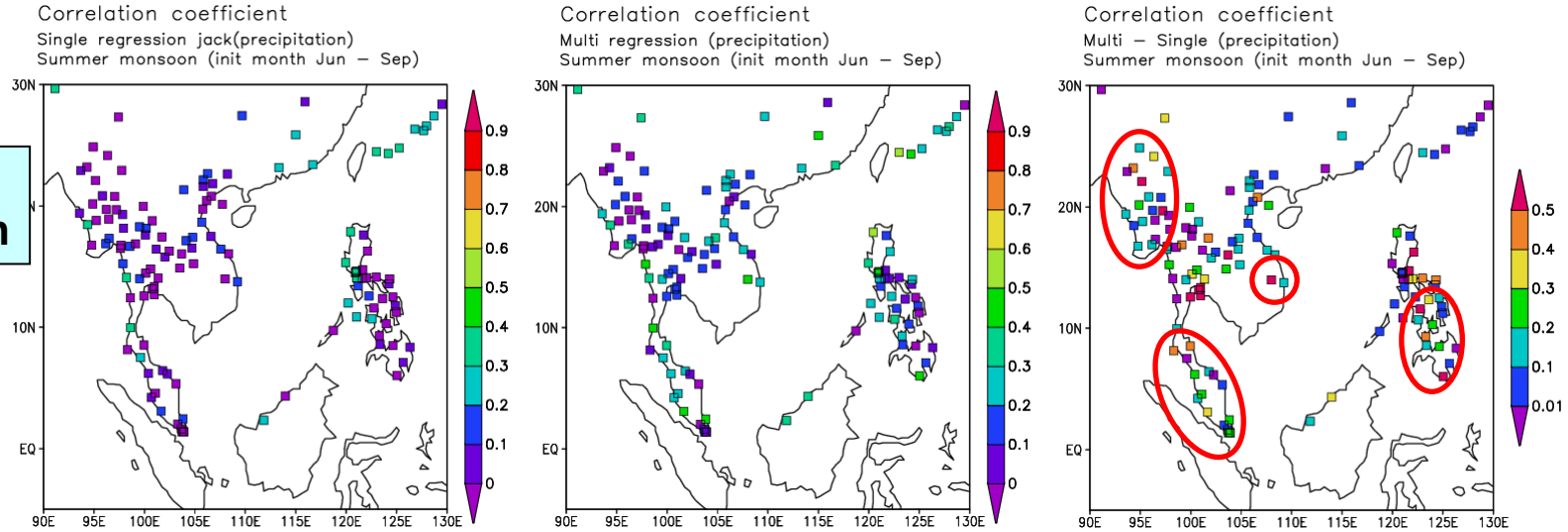
Based on
10 years HC
(11members)

Single regression | **Multiple regression** | **Multiple−Single**

Winter dry season



Summer monsoon



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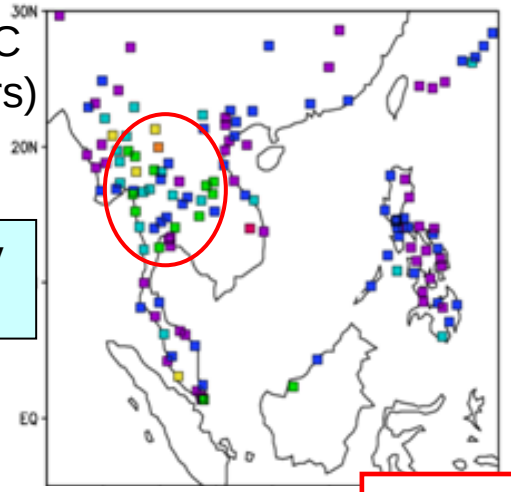
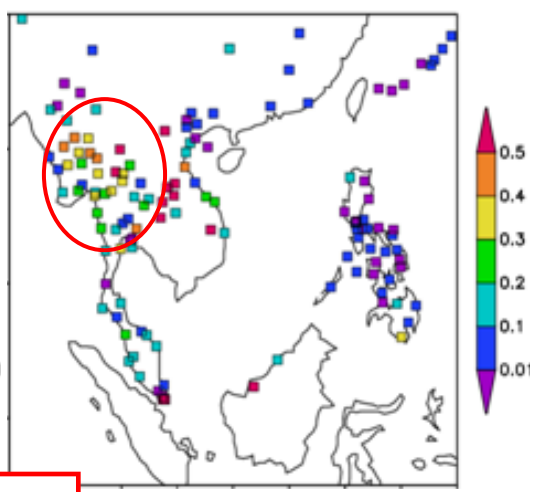
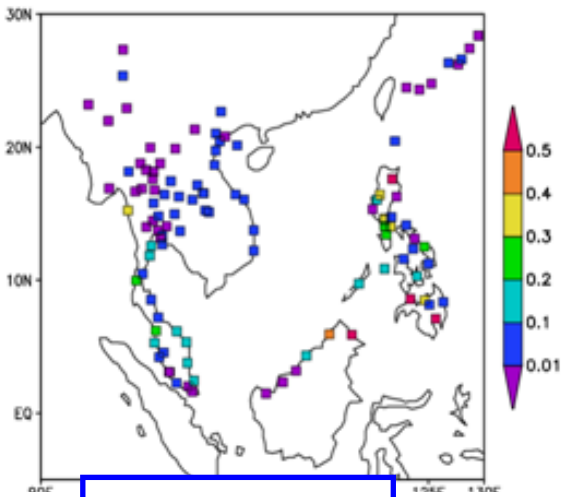
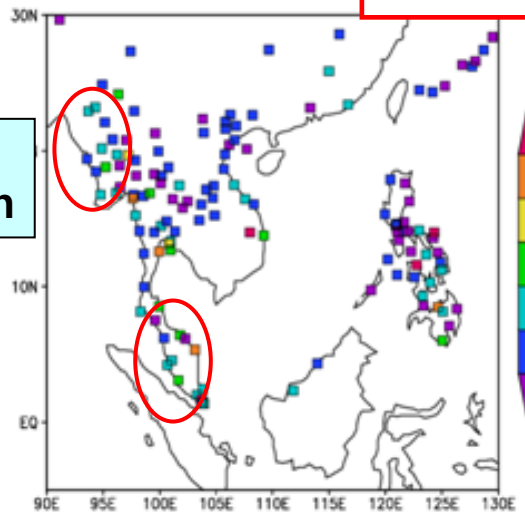
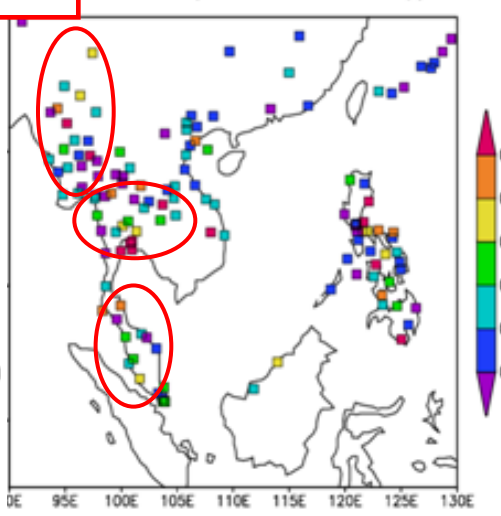
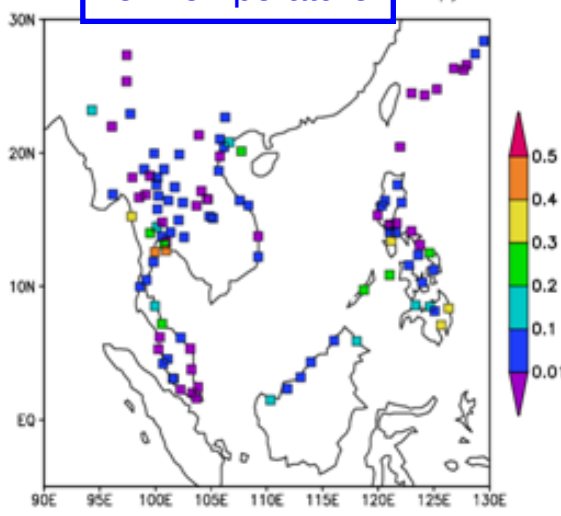
2.2 Statistical Down Scaling

Deference of Correlation, Multiple – Single regression for 14 days (2nd-15th) and 28 days (2nd-29th) average with station observation

Based on
10 years HC
(11members)

	14 days Precipitation	28 days Precipitation	14 days Temperature
Winter dry season			
Summer monsoon			

more improved for 28 days

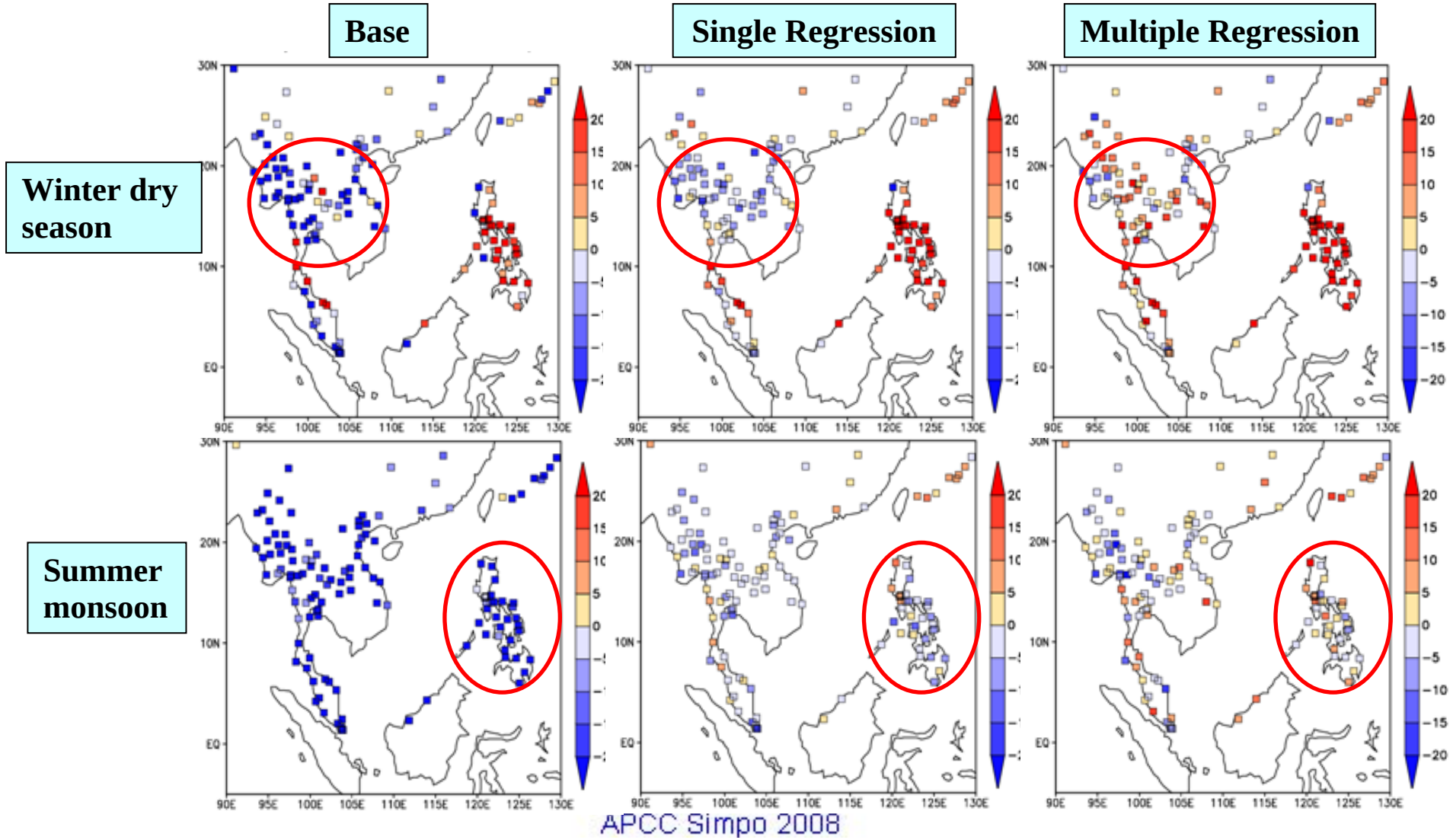
less improved for Temperature

APCC Simpo 2008

2.2 Statistical Down Scaling

Verification of one month probabilistic forecasts at station points

28 days (2nd–29th) average precipitation Cross-validation BSS (Above Median)



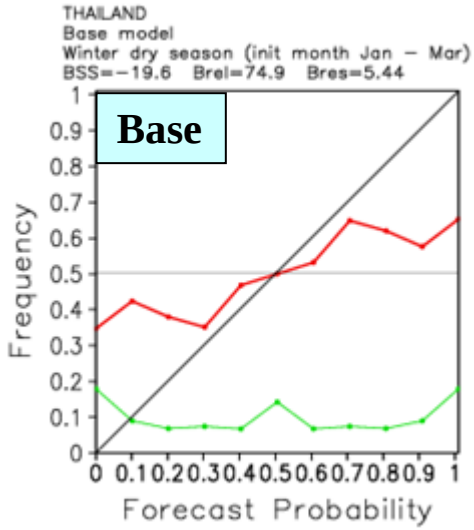
2.2 Statistical Down Scaling

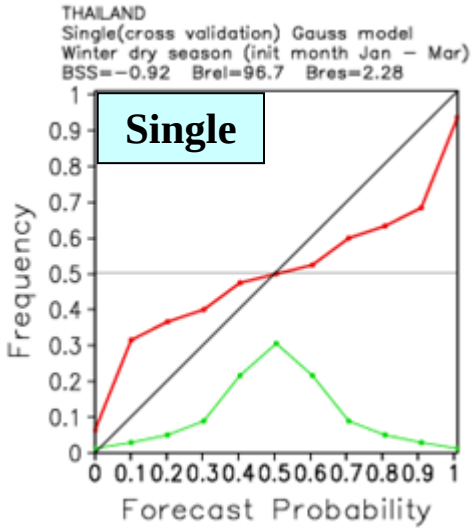
Verification **of o**ne month probabilistic forecasts at station points

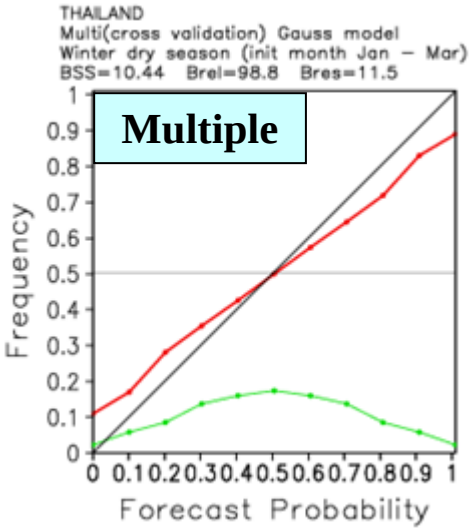
28 days (2nd–29th) average precipitation Cross-validation Reliability Diagram (Above Median)

Thailand

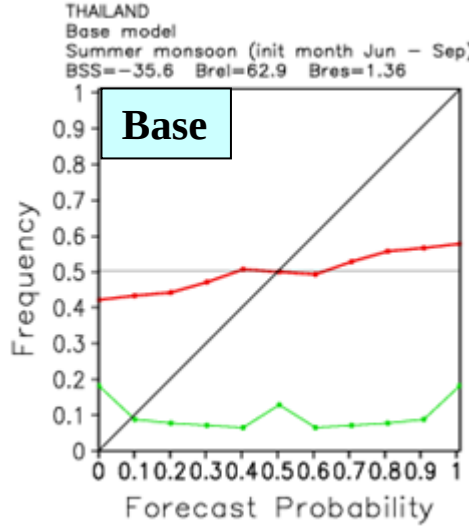
Winter dry season

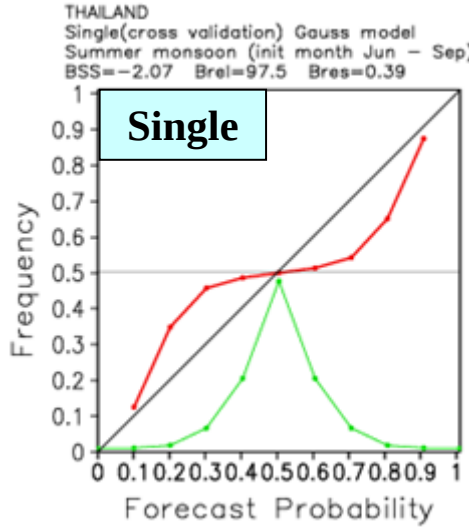


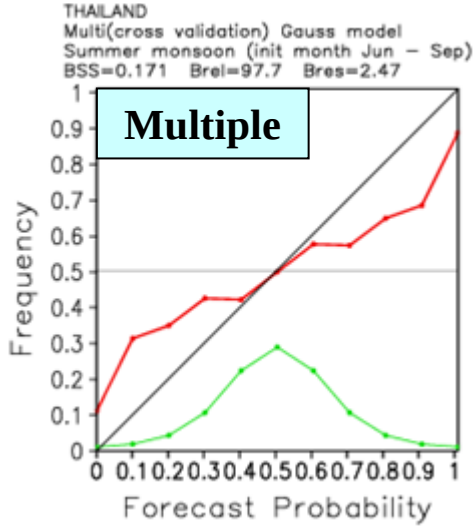




Summer monsoon







2.2 Statistical Down Scaling

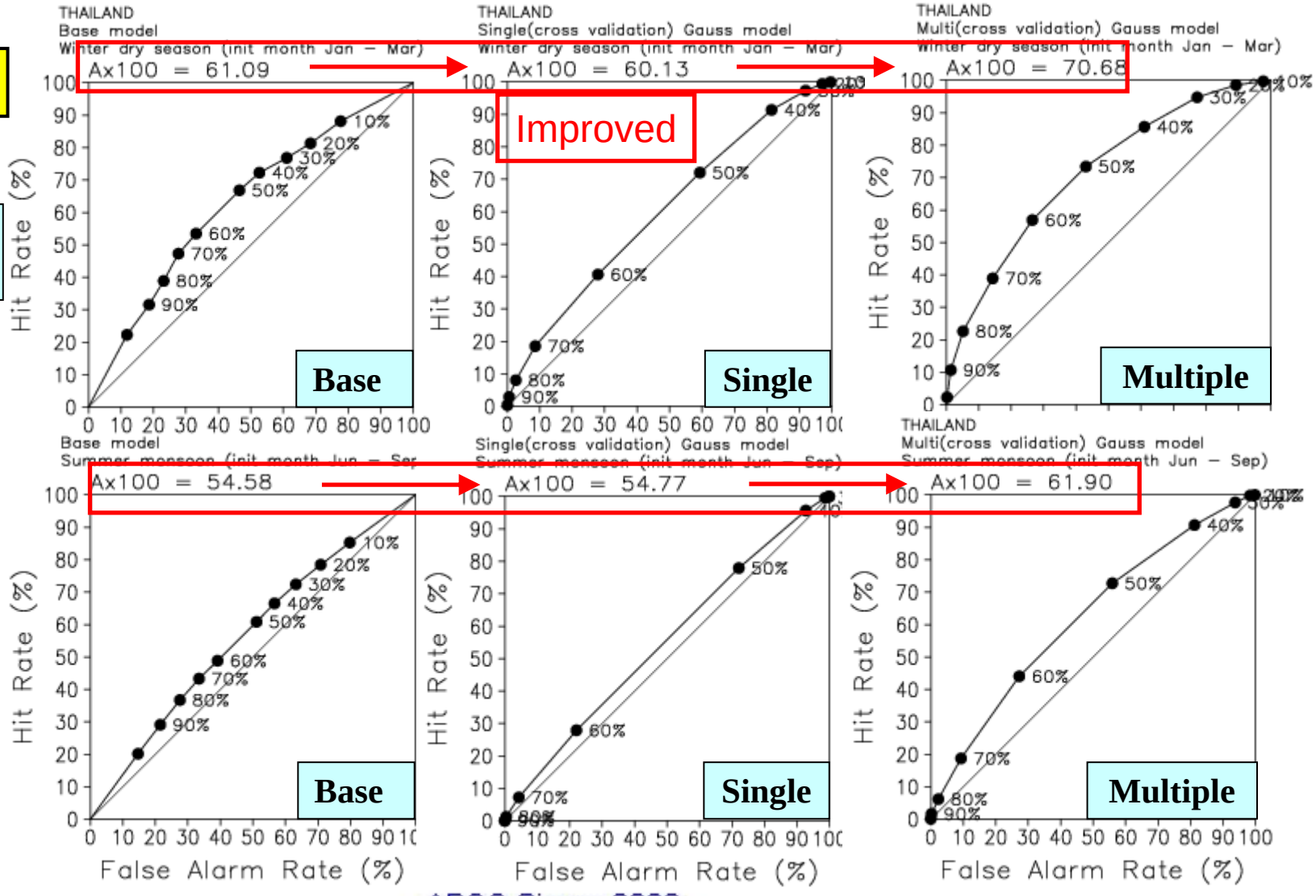
Verification of one month probabilistic forecasts at station points

28 days (2nd–29th) average precipitation Cross-validation ROC curve (Above Median)

Thailand

Winter dry season

Summer monsoon



APCC Simpo 2008

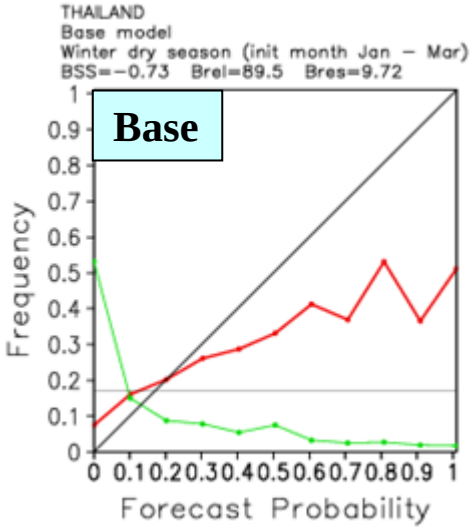
2.2 Statistical Down Scaling

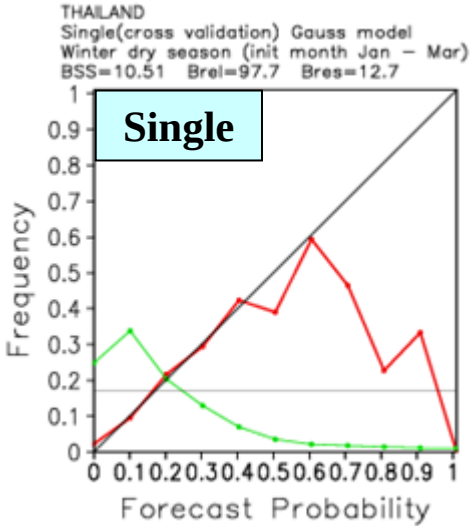
Verification of one month probabilistic forecasts at station points

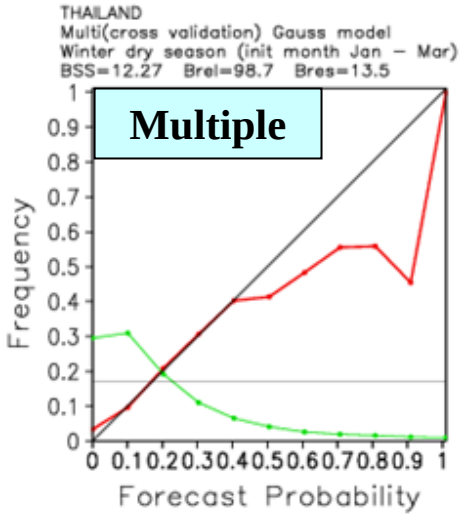
7 days (9th–15th) average 2mT Cross-validation Reliability Diagram (Above/Blow SD)

Thailand

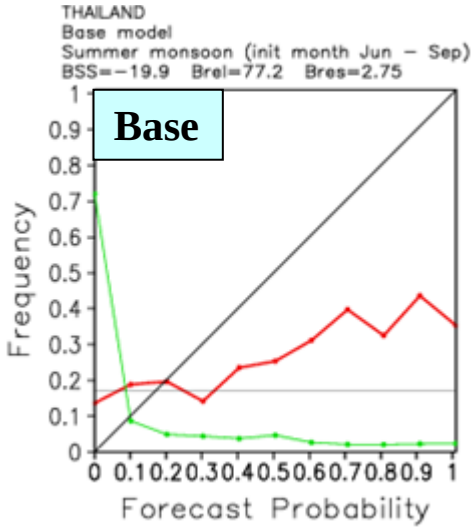
Winter dry season

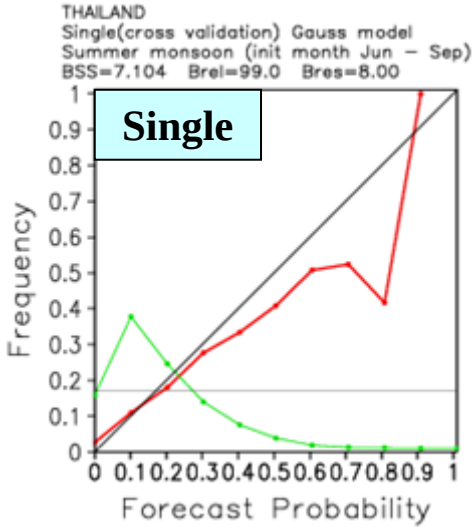


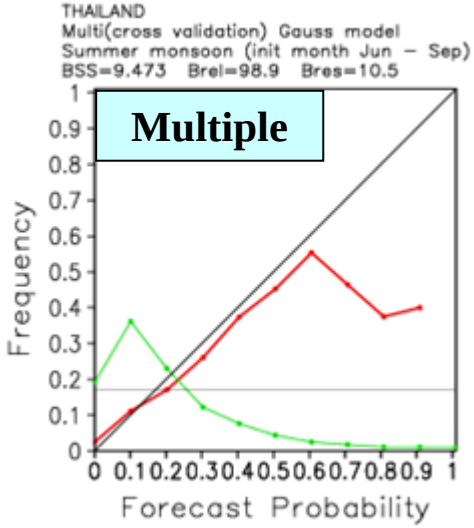




Summer monsoon







2.2 Statistical Down Scaling

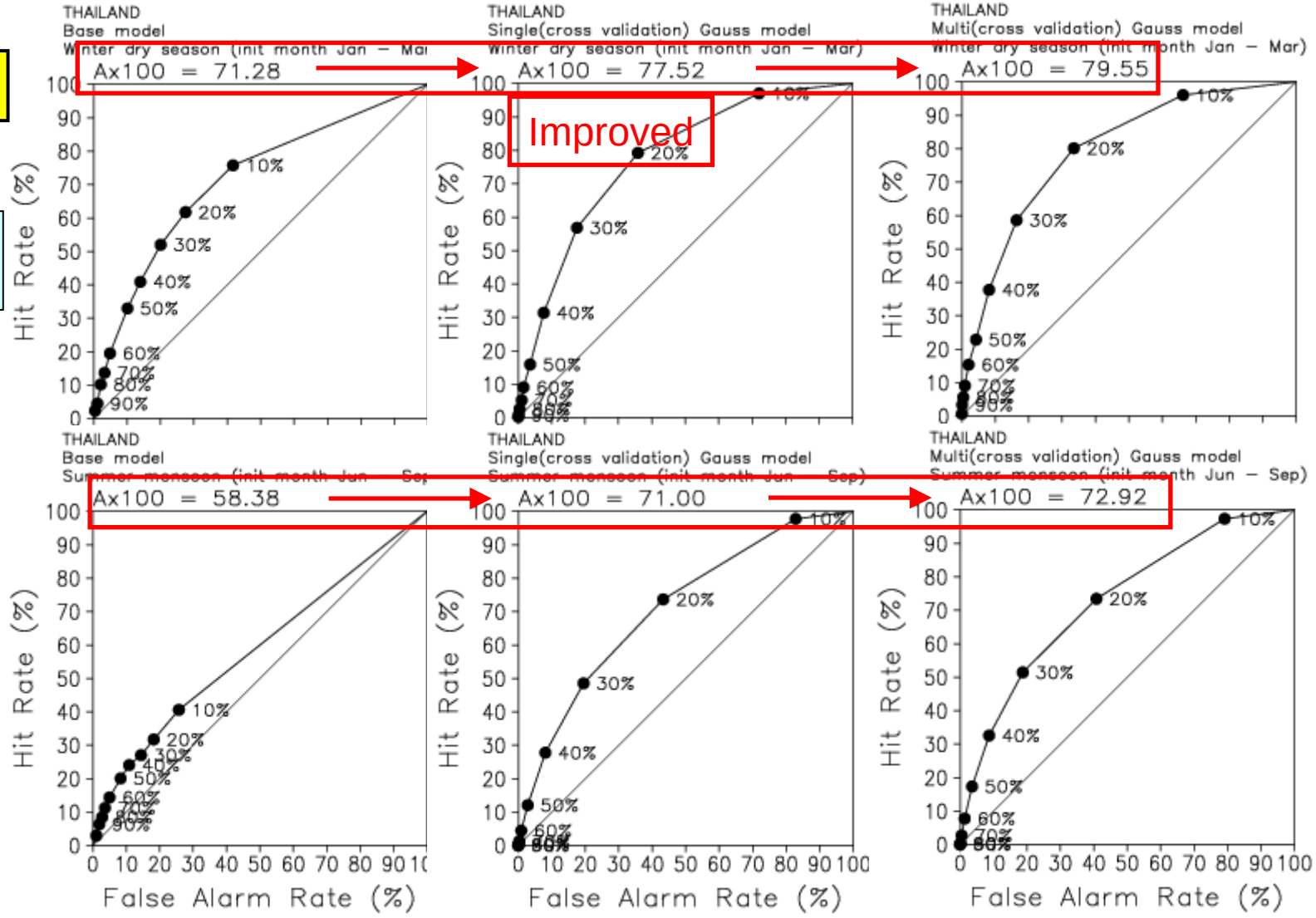
Verification of one month probabilistic forecasts at station points

7 days (9th–15th) average 2mT Cross-validation ROC curve (Above/Blow SD)

Thailand

Winter dry season

Summer monsoon



2.2 Statistical Down Scaling

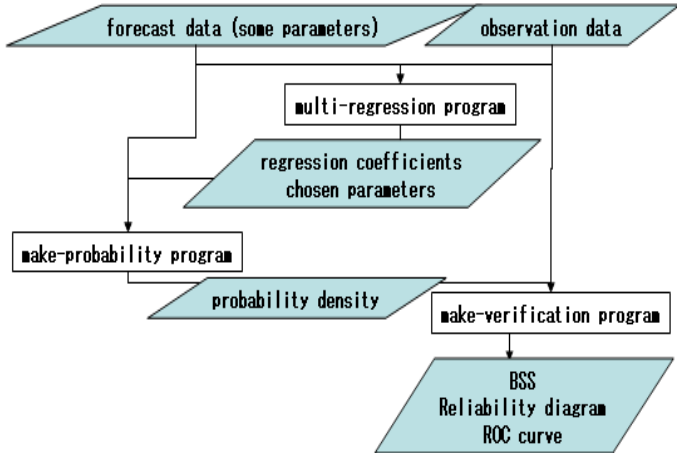
TCC's Support to NHMSs

- Through the TCC web page, users can access to the latest probabilistic forecast at selected stations over the Southeast Asia and Japan.

- Users can download a sample code for the statistical downscaling through the TCC web page http://ds.data.jma.go.jp/tcc/tcc/products/guidancetst/download_src.html with the manual documentation.

- TCC disseminates the use of this services through seminars and training courses.

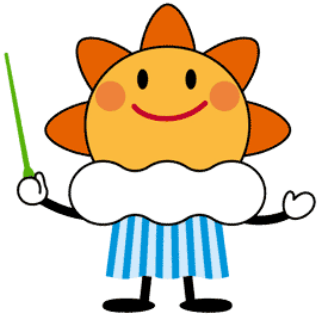
Meeting in TMD on 6 March



3. Summary

- **Seasonal Prediction is one of important tasks for JMA.**
- **Tokyo Climate Center (TCC) is responsible for supporting NHMSs as a center for climate information in the Asia-Pacific region (RCC).**
- **Major functions of TCC is as follows.**
  - **Provision of Climate information**
    Climate (system) monitoring, Seasonal forecasts, El Niño monitoring and outlook, Global Warming
  - **Capacity Building (Seminar, training course, etc)**
- **One month probabilistic forecasts at station points is new useful information as an application of numerical prediction with statistical downscaling technique, especially for the Southeast Asian region.**

Thank you
for your attention



JMA

View from CPD/JMA

2.2 Statistical Down Scaling

Frequency ratio of selection of each predictor in the Southeast Asia and Japan

most frequent **secondly frequent**

14 days average (2^{nd}-15^{th}) precipitation

Southeast Asia(%)	Model precipitation	Inner product of U and land slope gradient	MJO index	NINO3 SSTA
Winter dry season	93	45	32	51
Pre monsoon	80	43	60	46
Summer monsoon	83	59	61	22
Post monsoon	95	64	77	40

28 days average (2^{nd}-29^{th}) precipitation

Southeast Asia(%)	Model precipitation	Inner product of U and land slope gradient	MJO index	NINO3 SSTA
Winter dry season	77	61	46	67
Pre monsoon	58	48	52	61
Summer monsoon	50	56	82	39
Post monsoon	89	66	70	50

Japan(%)	Model precipitation	Inner product of U and land slope gradient	MJO index	NINO3 SSTA
Winter dry season	91	35	58	56
Pre monsoon	76	28	48	36
Summer monsoon	96	52	58	34
Post monsoon	87	30	66	19