Seasonal Forecasting and Related TCC Products

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Climate Prediction Division /JMA

Outline

- Introduction
- Overview of JMA operational Seasonal Forecast System
- Procedure to make JMA Seasonal Forecast
- TCC products for Seasonal Forecast
- Summary

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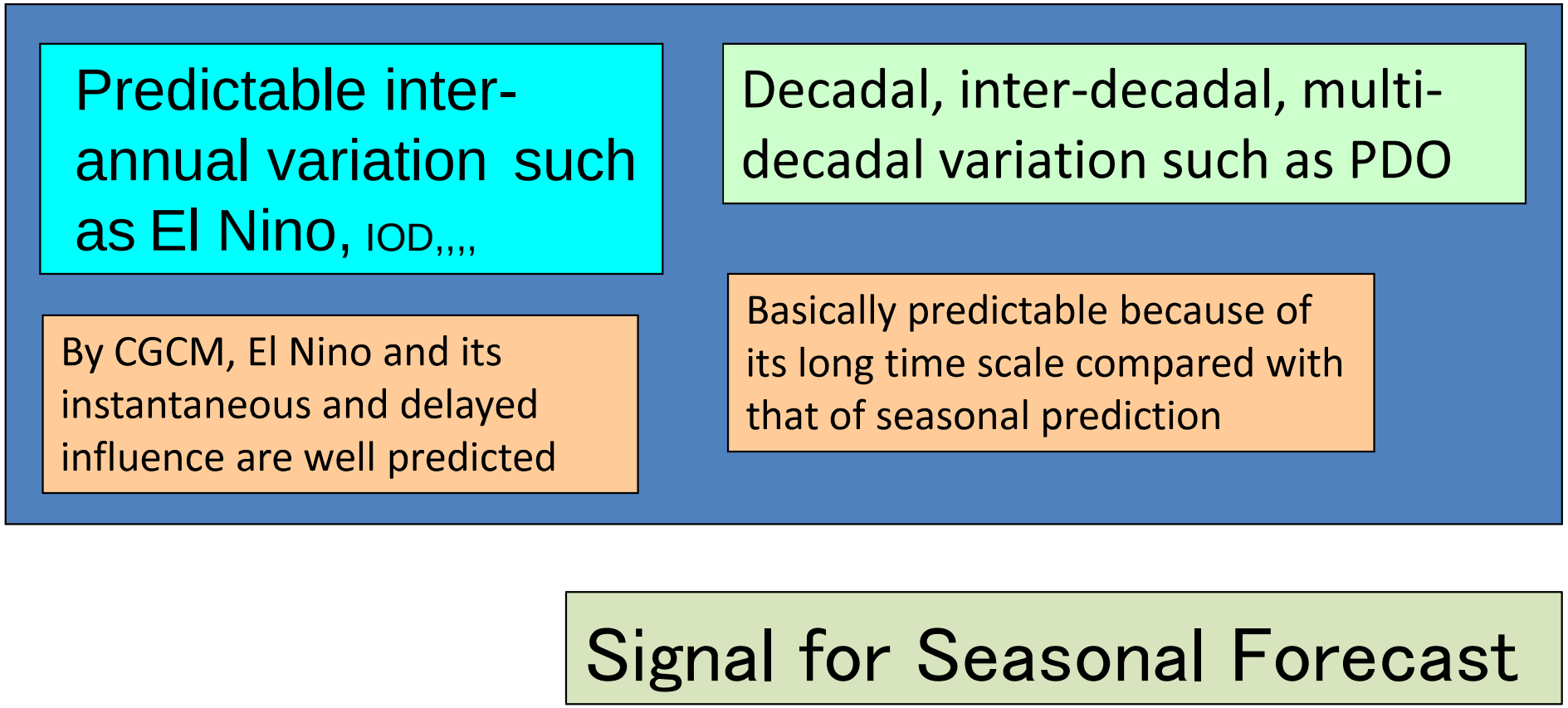
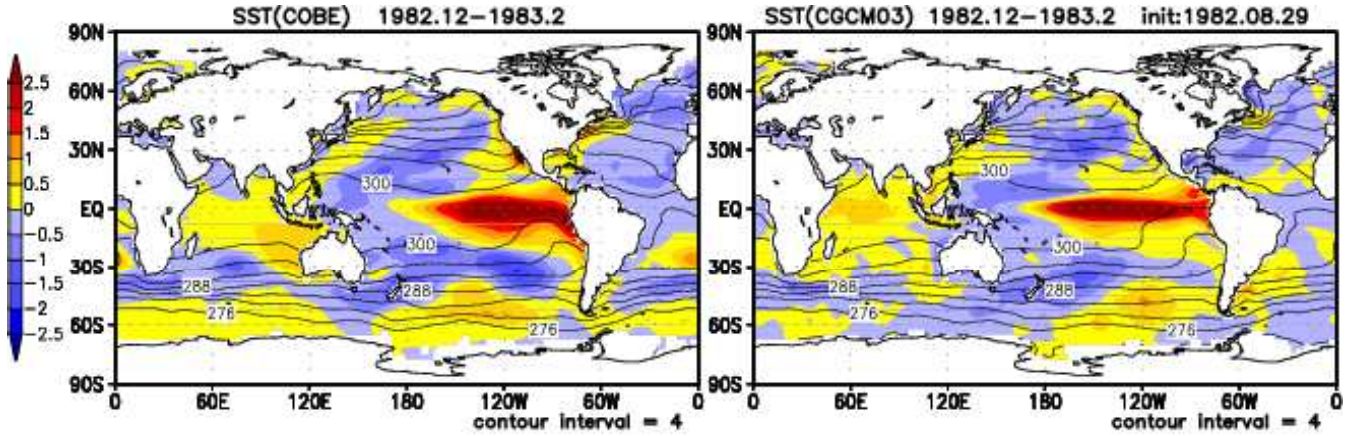
Why seasonal forecast is possible?

Because, there are predictable slow variations of the climate system which are deeply influenced by the Ocean



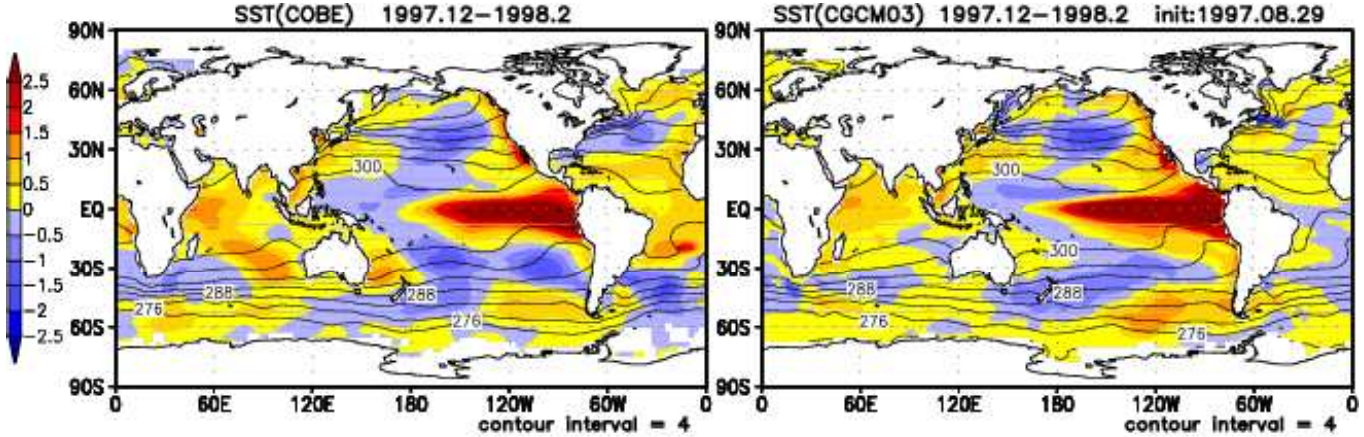
Example of El Niño prediction

OBS. Prediction

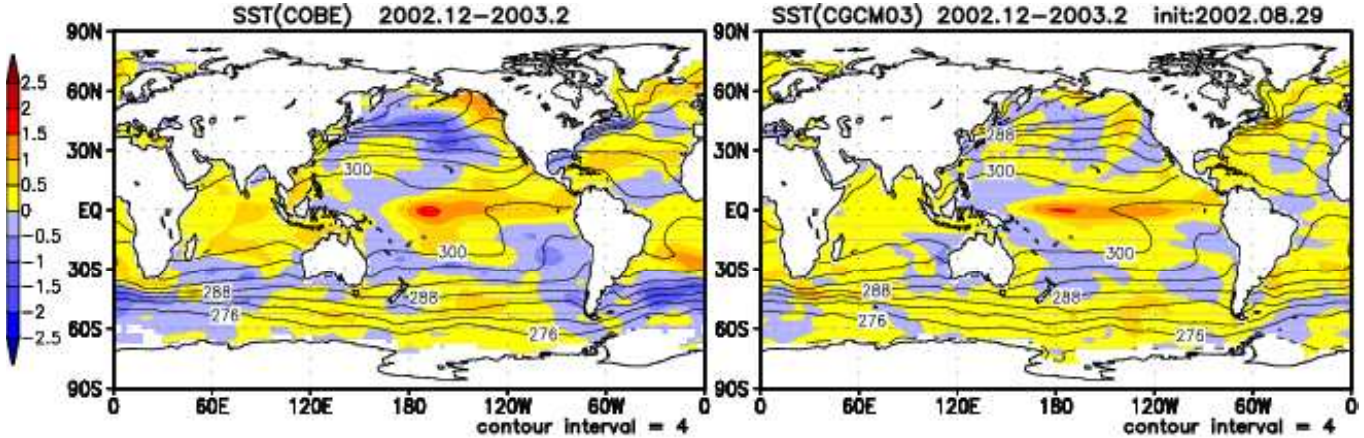


SST and anomaly

Initial Condition :1982.8.29
Prediction
:1982.12～1983.2



Initial Condition :1997.8.29
Prediction
:1997.12～1998.2

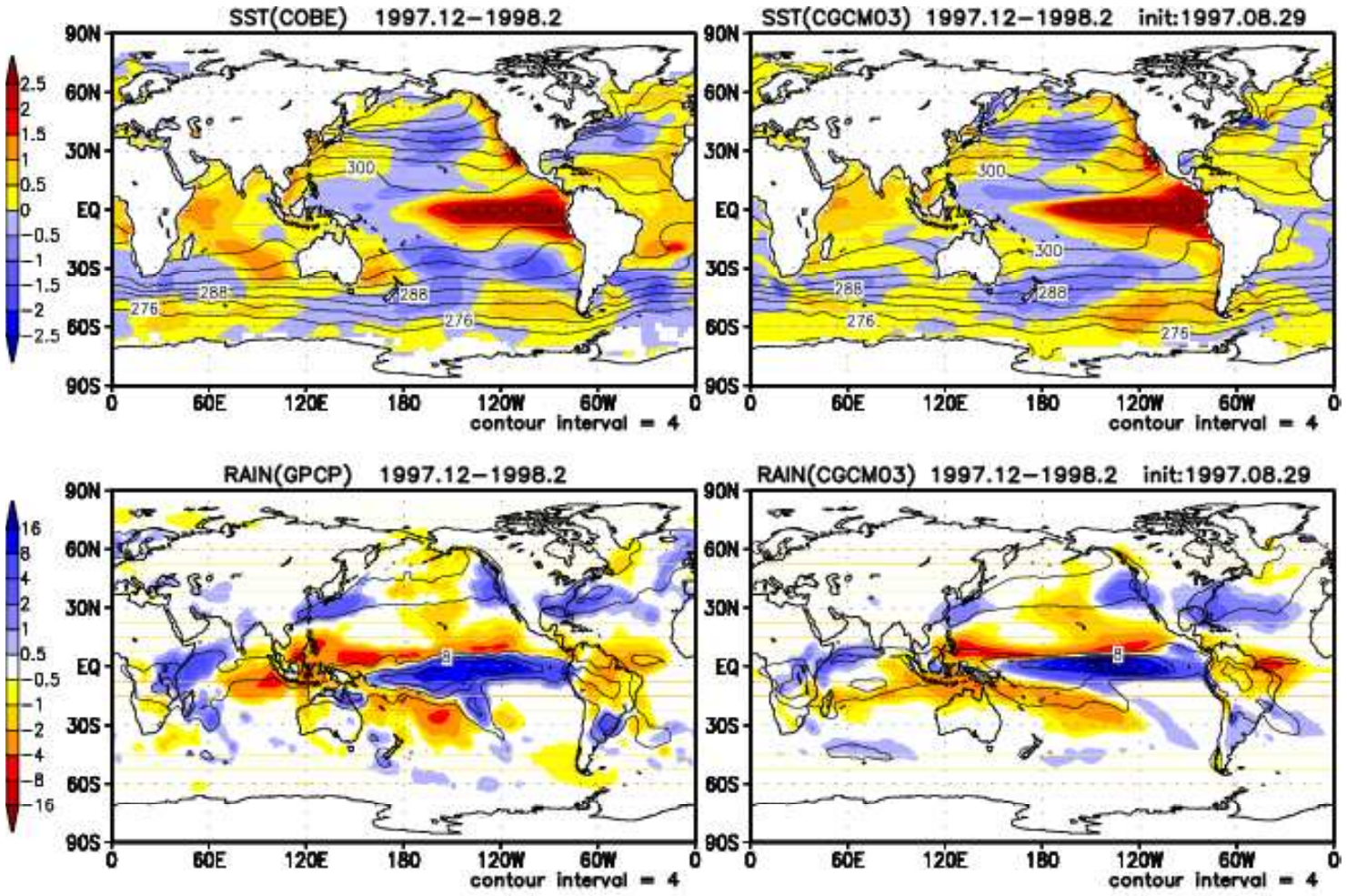


Initial Condition :2002.8.29
Prediction
:2002.12～2003.2

Example of El Niño prediction

Initial Condition :1997.8.29　Prediction :1997.12～1998.2

Observation　　**Prediction**



SST

Precipitation

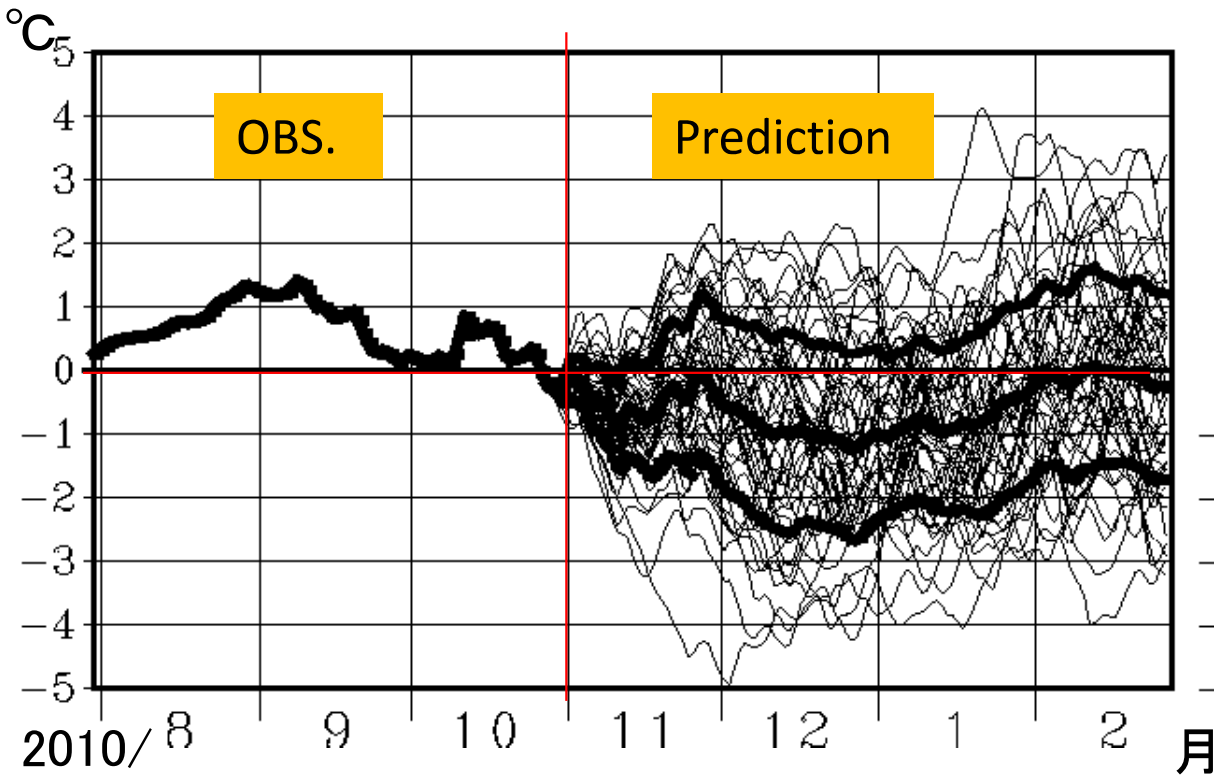
Characteristics of each El Nino are well predicted

Why seasonal forecast is difficult？

・In the mid– and high latitudes, internal variability of the atmosphere, which is not fully influenced by the ocean, is dominant.
・Since such variability shows chaotic features that small differences in the current status cause huge differences in the future, it is difficult to predict.

Noise for Seasonal Forecast

Predicted 30–day mean T850 anomalies in Western Japan in 2010/11 winter



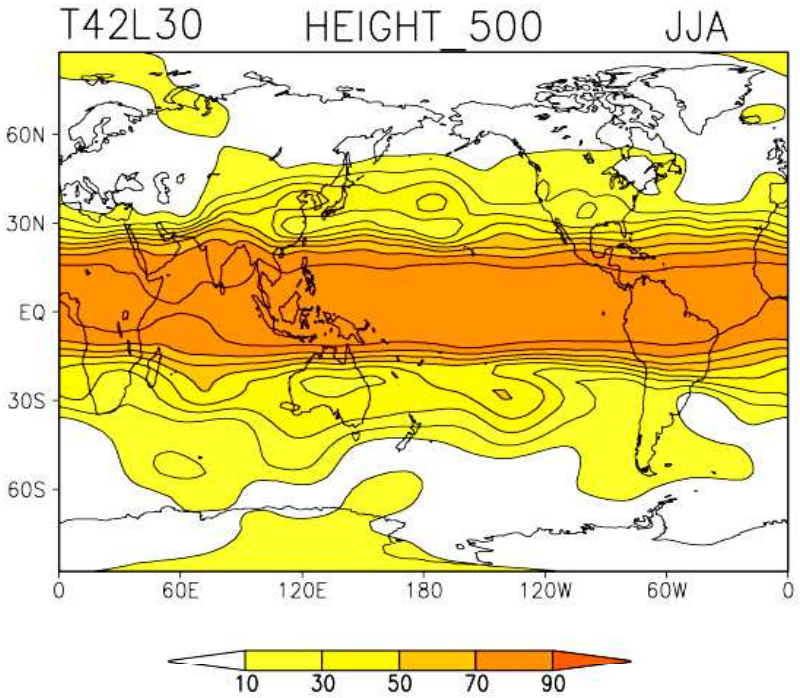
Thin line: each ensemble member
Thick line: Observation and ensemble mean prediction, and ±σ

How about is Signal/Noise ratio?

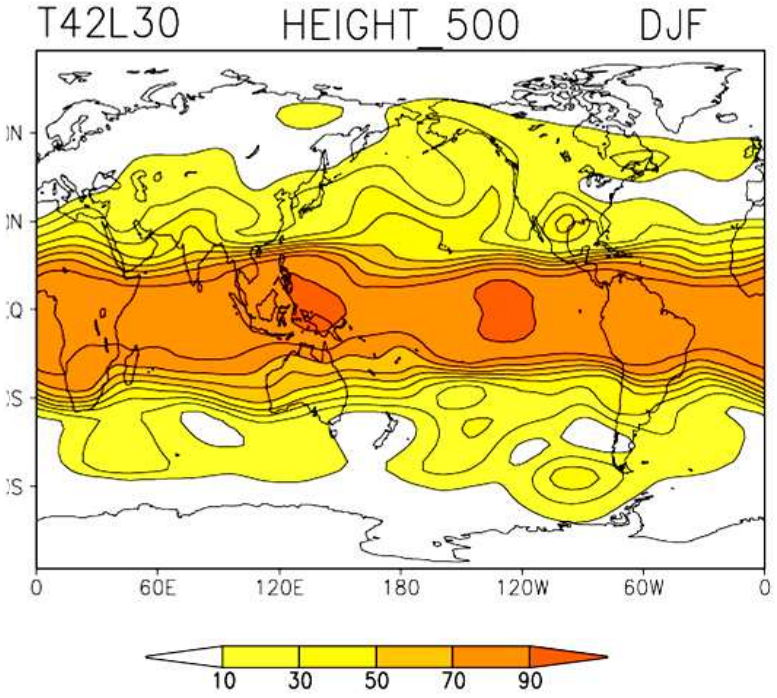
Predictable variance of Seasonal Mean Fields (500hPa height in JJA and DJF)

Signal / (Signal+Noise)

JJA



DJF



Sugi 2002

Estimation of predictable variance ratio in the atmosphere using GCM with prescribed SST

Requirements for Seasonal Prediction System

Adequate prediction of both Signal and Noise

- Observation (Atmosphere, Ocean, Land surface) to analyze current situation of climate system
- Numerical Prediction Model to predict Climate System variation
- Ensemble Prediction technique to estimate uncertainty of prediction
- Hindcast (Huge Numerical Experiments for past cases) to assess prediction skill
- Prediction calibration technique using hindcast data

Requirements for Forecaster

Ability to understand and interpret results of numerical prediction products

Knowledge on

- large scale climate system variation, such as El Nino, and their impacts on local climate
- predictability of variability with seasonal time scale
- characteristic of numerical prediction products

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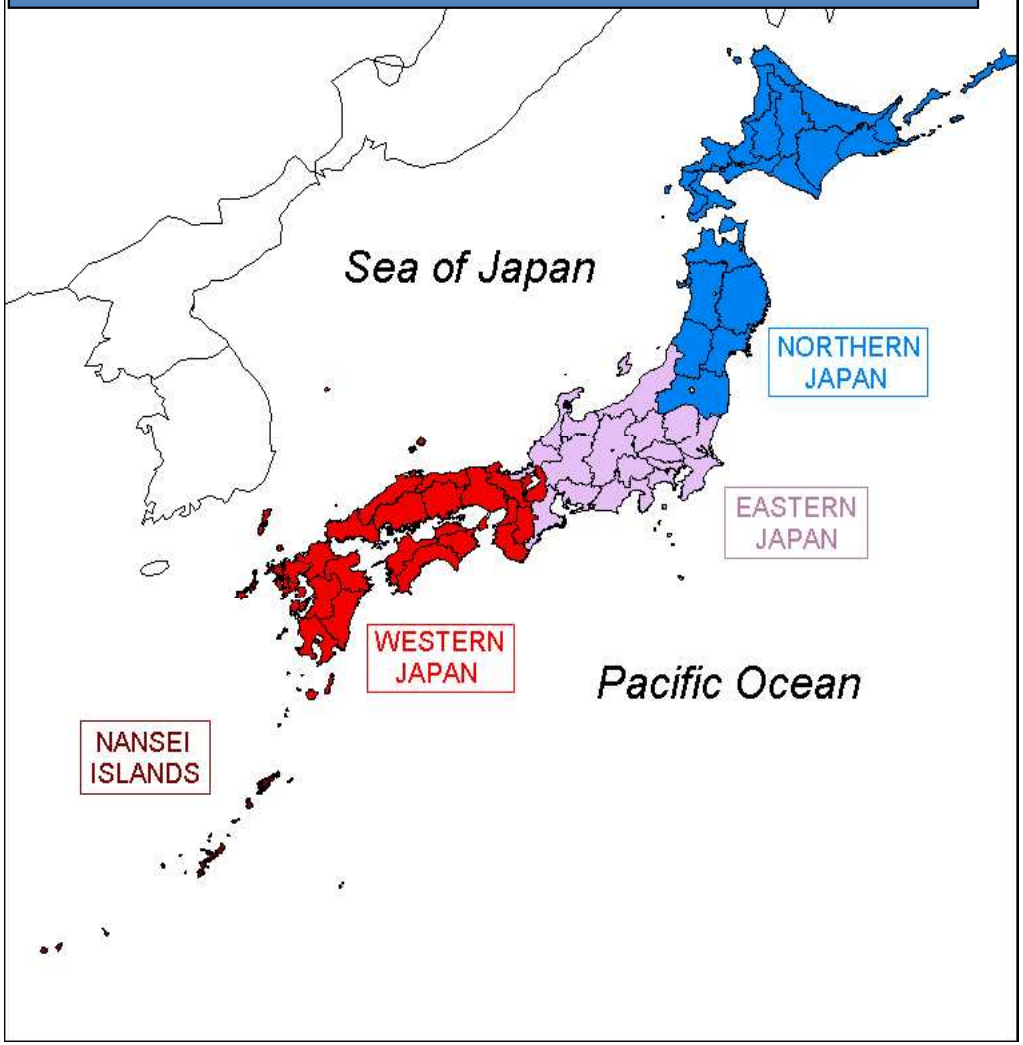
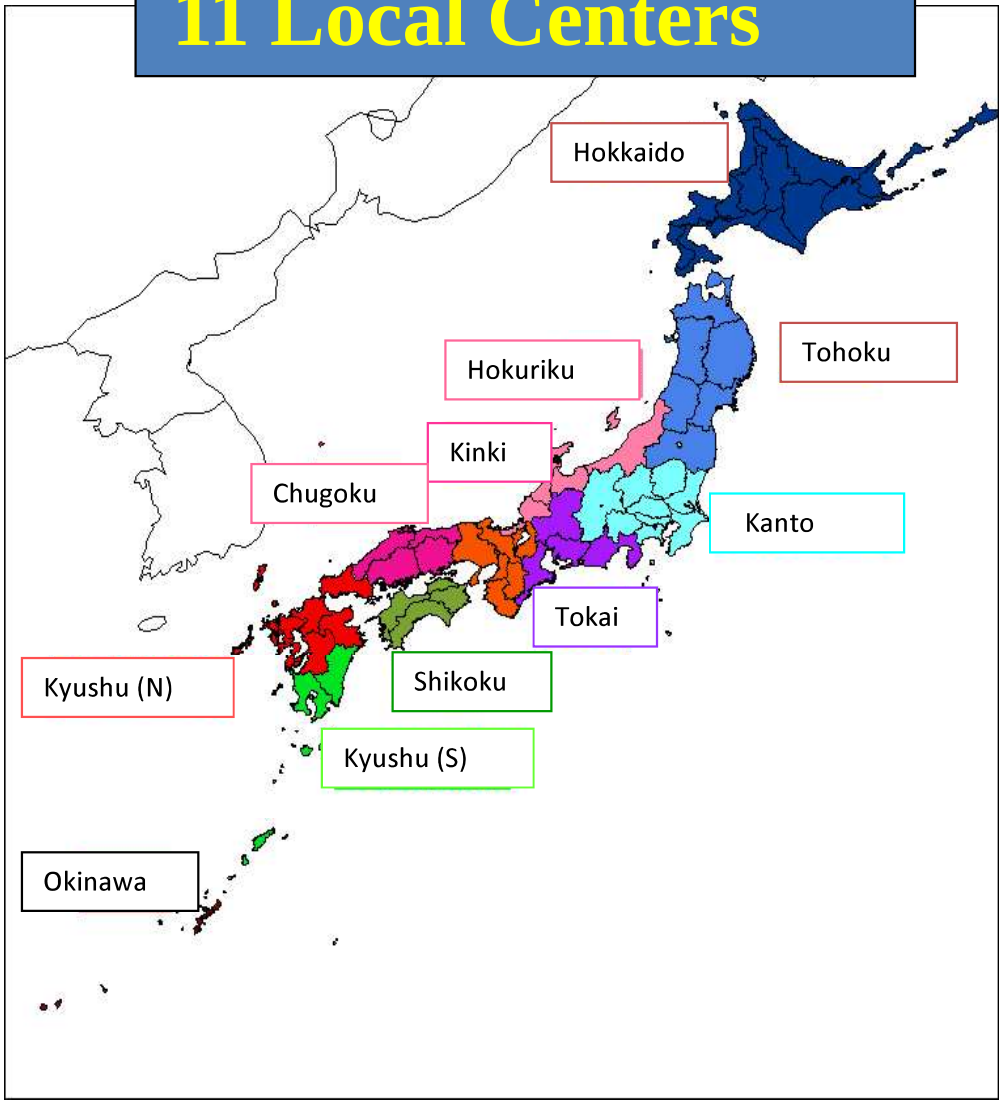
Operational Seasonal Forecast at JMA

Forecast regions

National Center (CPD/JMA)



11 Local Centers



Outline of JMA's Long-range Forecasts

Warm and Cold season forecast

Kind of Forecast	Warm season forecast (Mar. - Aug.)	Cold season forecast (Oct. - Feb.)
Date of issue	February 25th*	September 25th*
Contents	•Three-Month (Jun.-Aug.) mean temperature precipitation •Rainy season (Bai-u) precipitation •Seasonal features of expected weather	• Three-month (Dec.-Feb.) mean temperature precipitation snowfall amounts (Sea of Japan side area) • Seasonal features of expected weather
Forecast Method	・Atmosphere Ocean Coupled Model (CGCM) with ensemble method	

* The dates of issue are up when they fall on Fridays, Saturdays, Sundays or national holidays

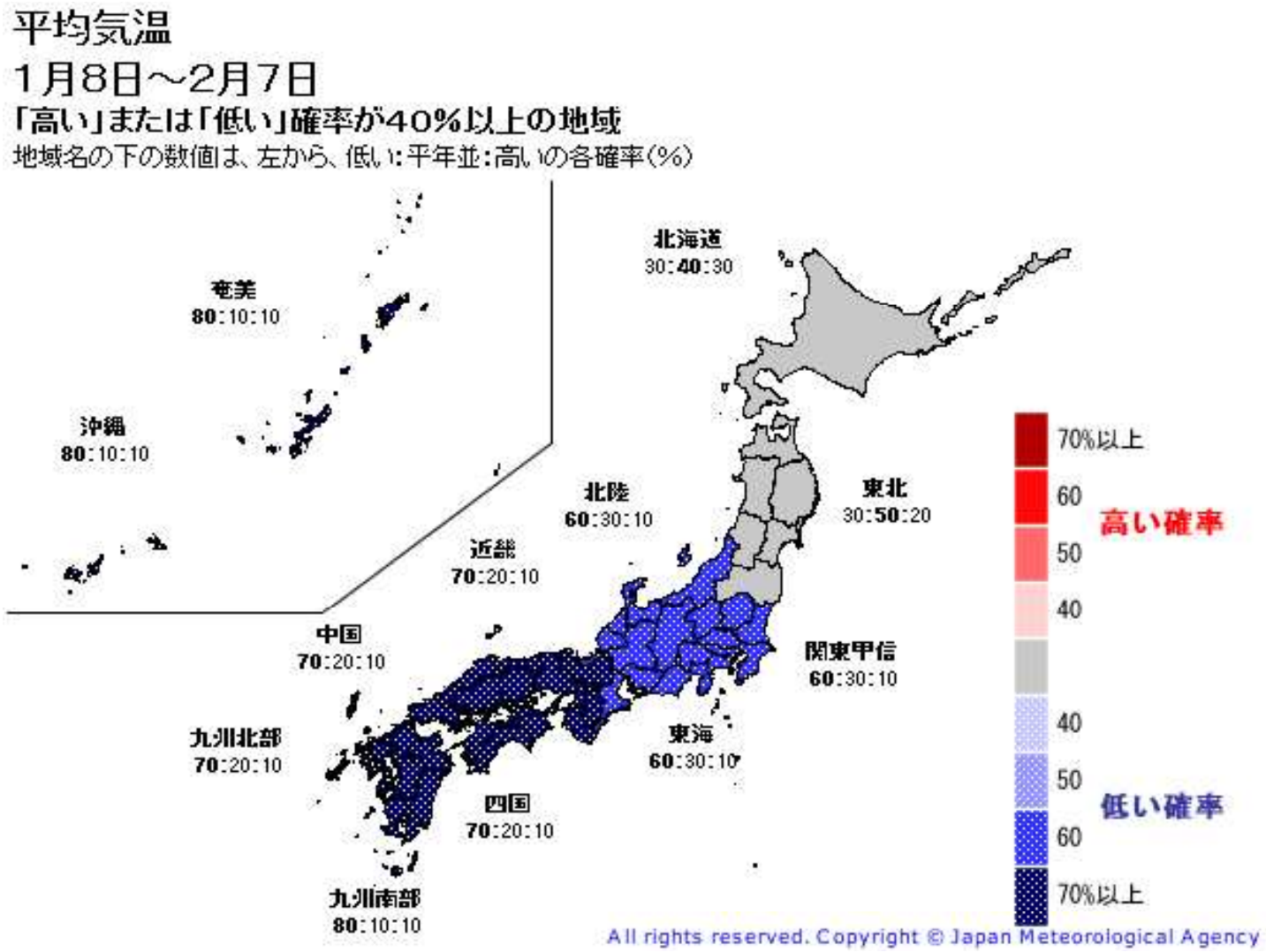
Outline of JMA's Long-range Forecasts

3-month forecast and 1-month forecast

Kind of Forecast	Three-month forecast	One-month forecast
Date of issue	**25th of the month** * The dates are up when they fall on Fri., Sat. Sun. or national holidays	**Every Friday**
Contents	・3-Month mean temperature 3-Month precipitation ・Monthly mean temperature Monthly precipitation ・Monthly features of expected Weather	• Monthly mean temperature Monthly precipitation Monthly sunshine duration Monthly snowfall • 1st,2nd,3rd - 4thweek mean temperature • Monthly features of expected Weather
Forecast Method	・CGCM with ensemble method	・Atmospheric Model (AGCM) with ensemble method

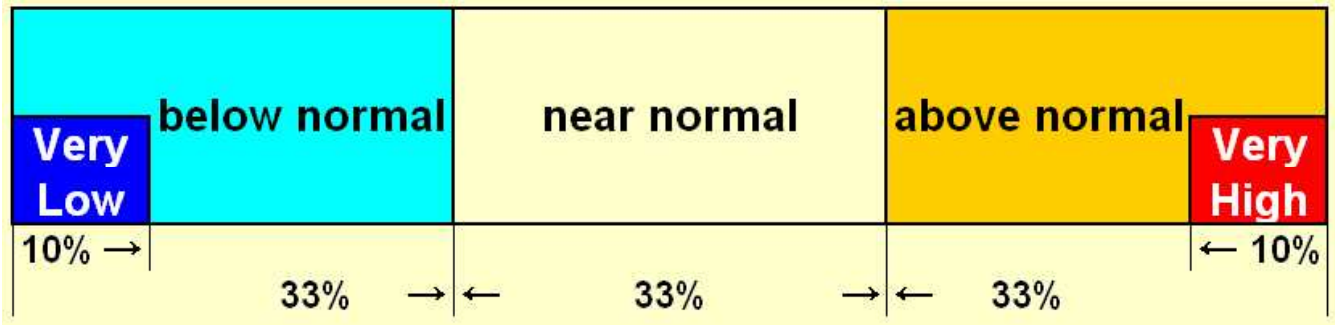
Probabilistic forecast

Issued probabilistic forecast of tercile (below normal, near normal, above normal) temperature and so on.

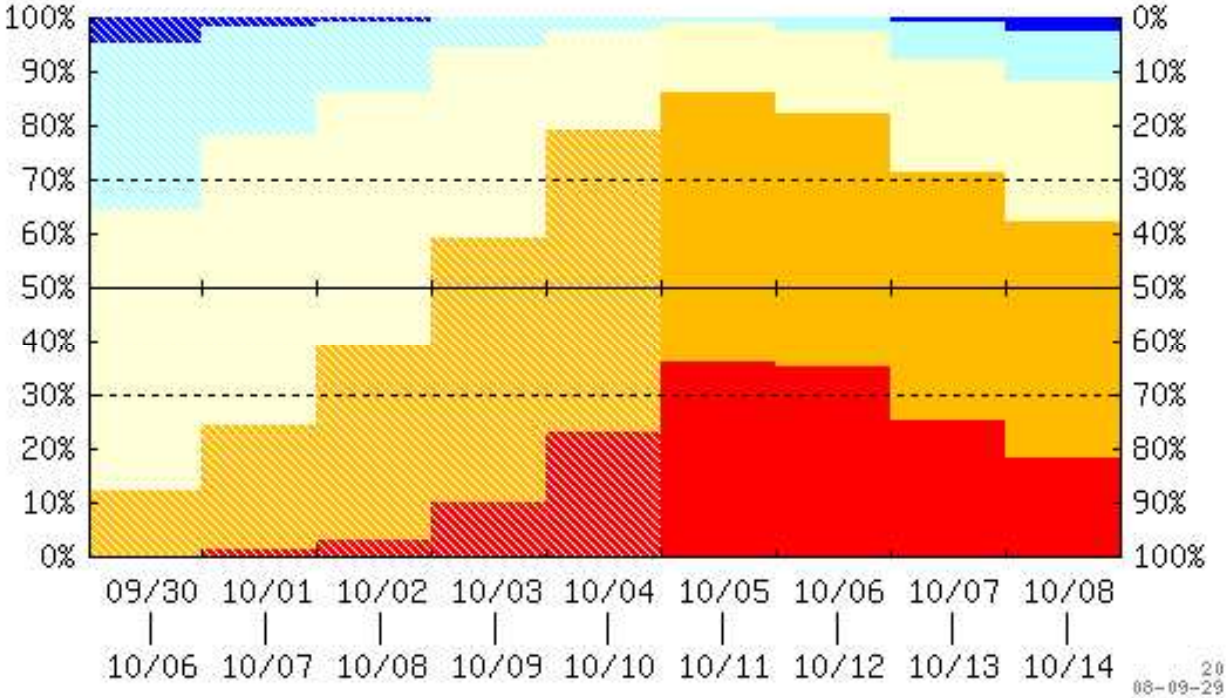


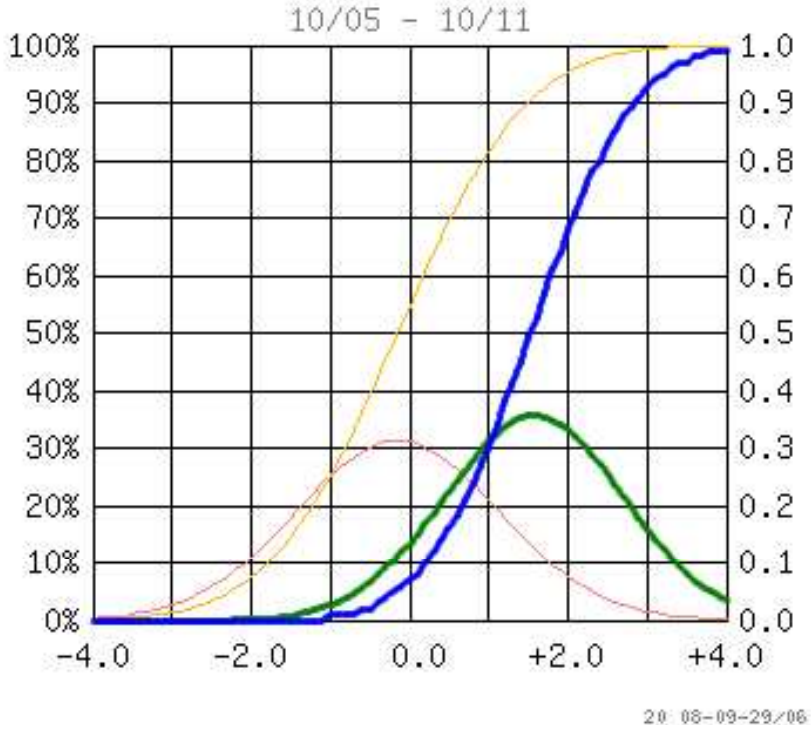
Early Warning Information on Extreme Weather

- **Arbitrary 7-day mean temperature anomaly up to two weeks ahead**
- **Issuing the Information as the probability of very high / low over 30%**
- **11 local centers issuing for each area**
- **Information is updated twice a week (every Tuesday and Friday)**
- **Probabilistic Products are Provided JMA's web site**



Early Warning Information on Extreme Weather

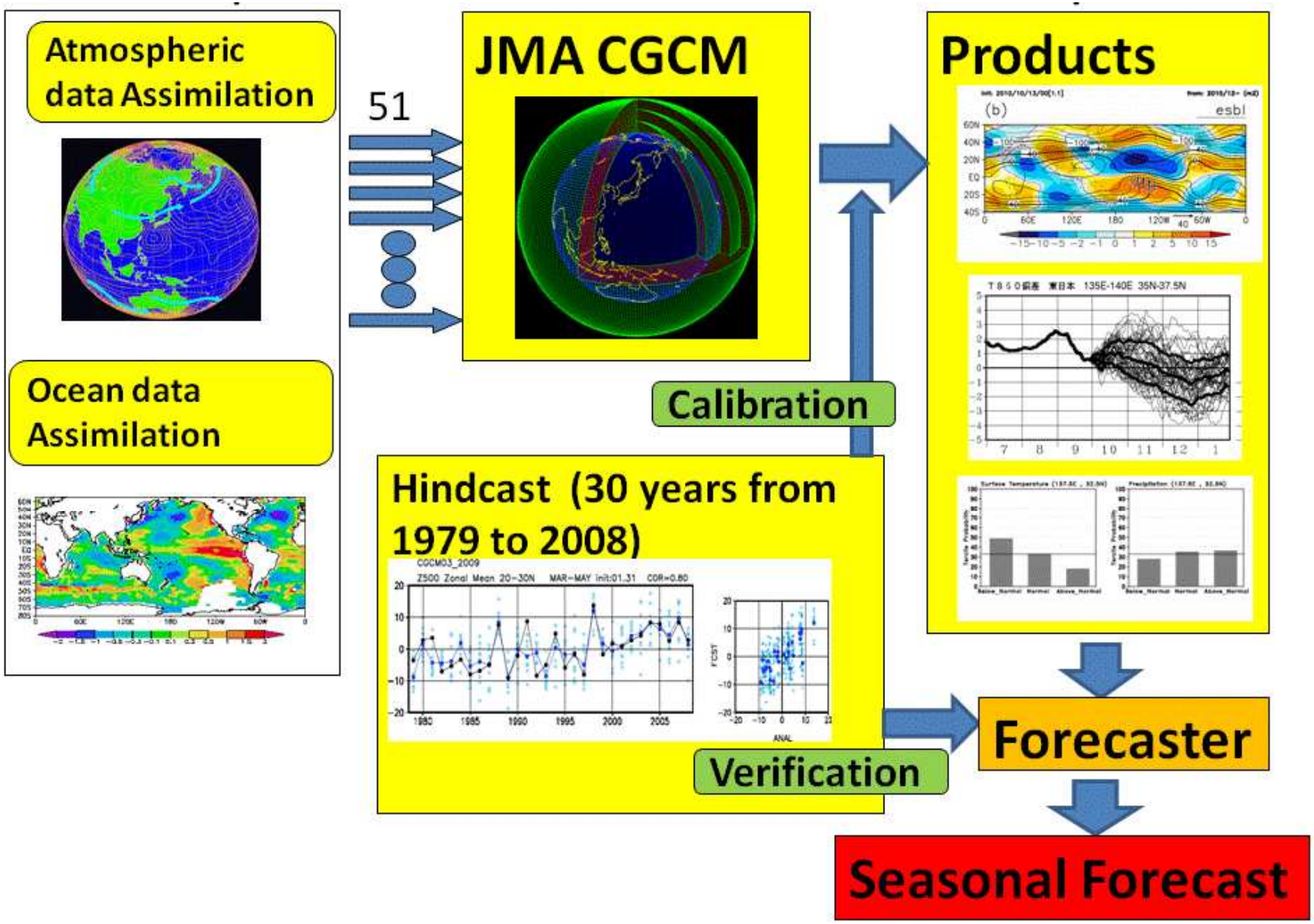




Example of Probabilistic Products for Early Warning Information at JMA's Web Site

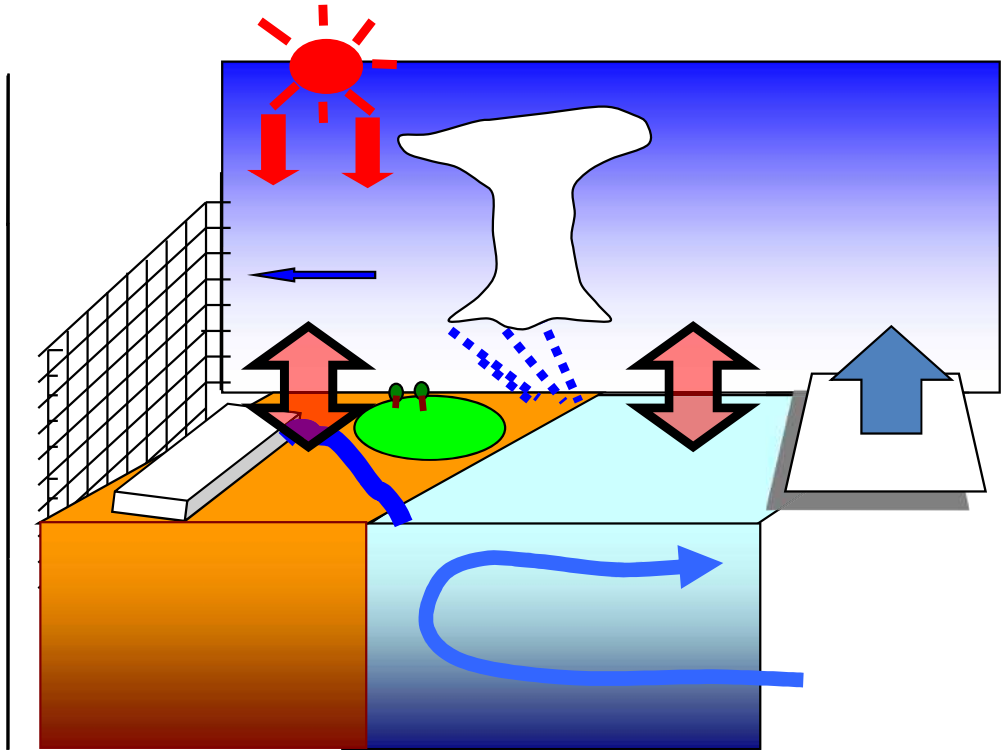
Operational Seasonal Forecast System at JMA

JMA Operational Seasonal Forecast System



For 3-month, cold season and warm season forecast

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

See Tokuhiro's lecture

Hindcast

Period : 30 years from 1979 to 2008

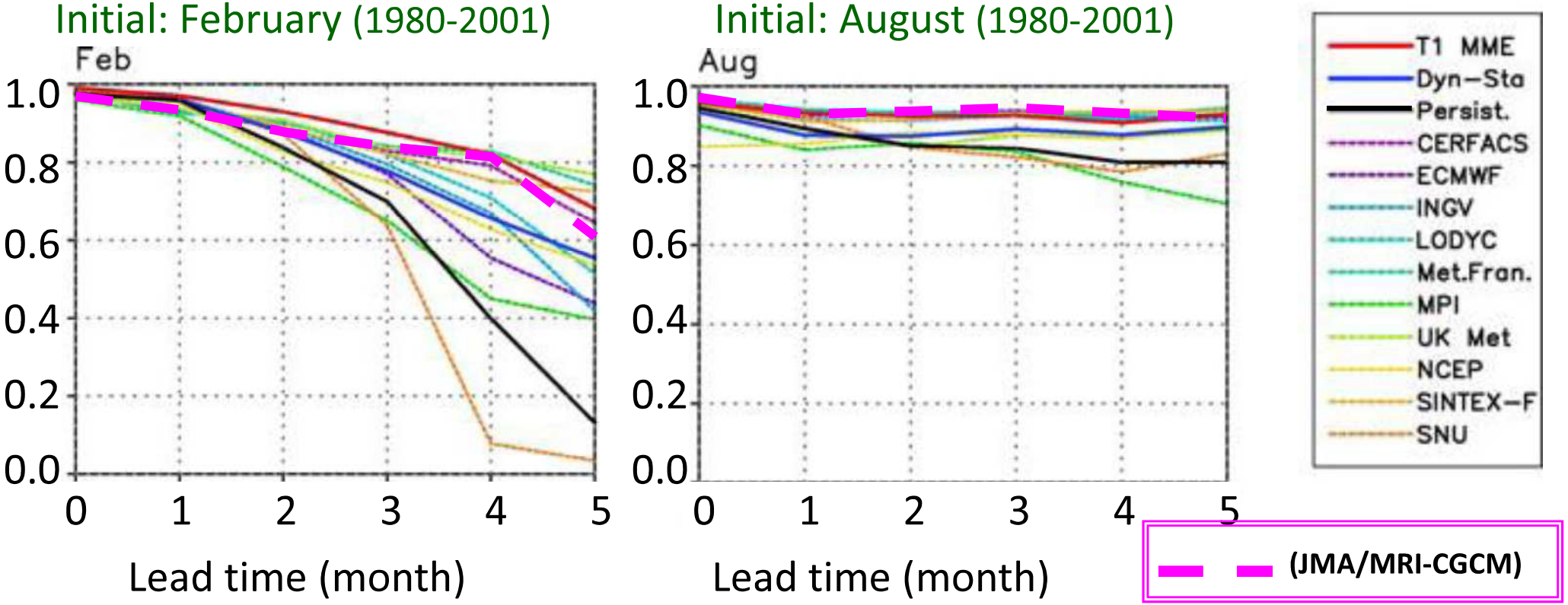
Initial date : around the end of every month

Integration time : 7 months

Ensemble size : 10

NINO.3.4 SST ACC: dependency on lead time

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

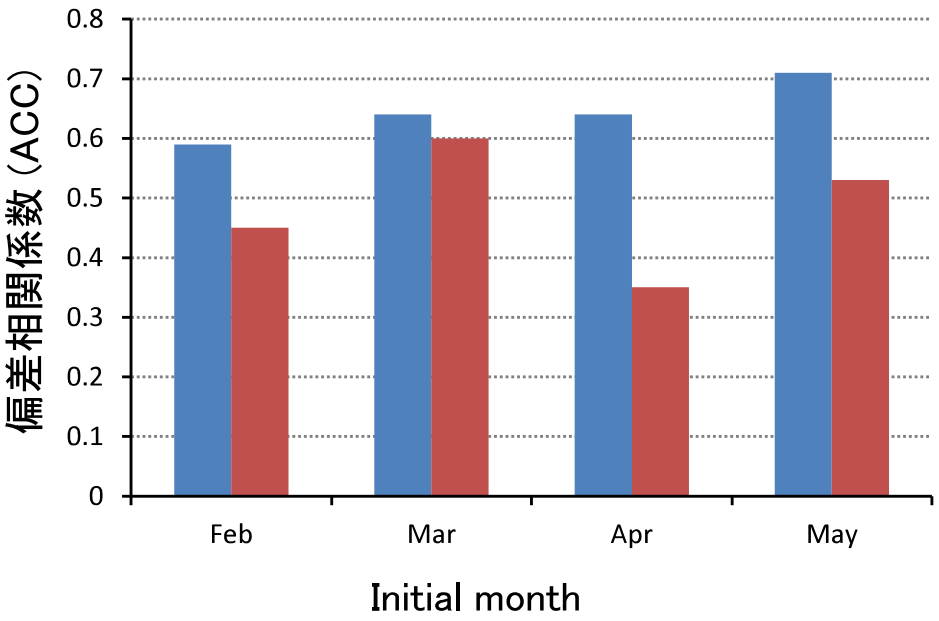


NINO.3.4 region: 120W-170W, 5S- 5N

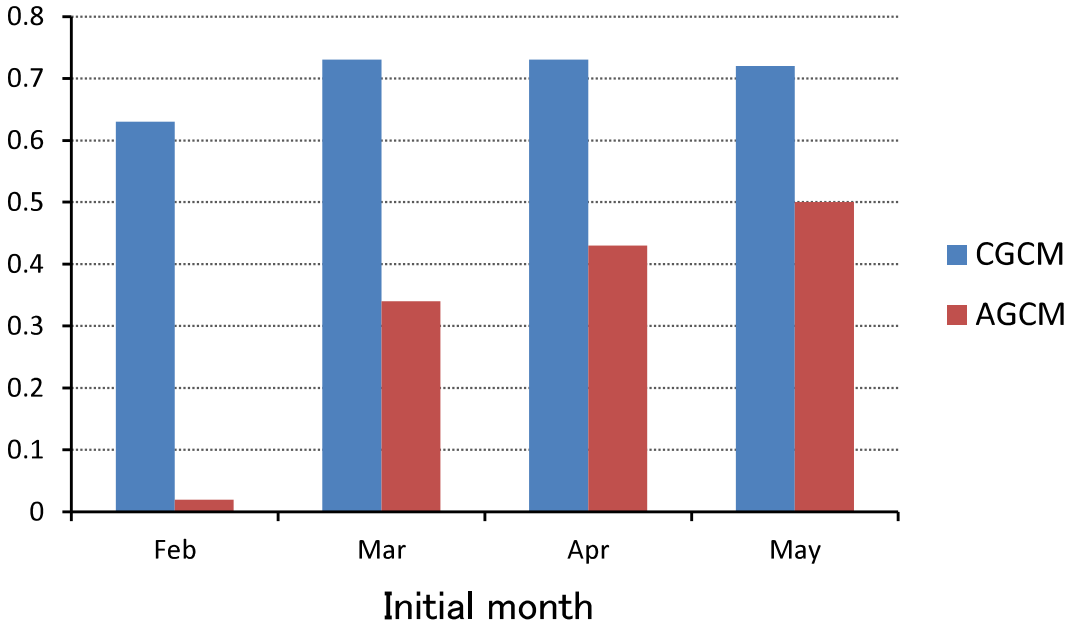
Jin E. K., James L. Kinter III, B. Wang, C.-K. Park, I.-S. Kang, B. P. Kirtman, J.-S. Kug, A. Kumar, J.-J. Luo, J. Schemm, J. Shukla and T. Yamagata, 2008: Current status of ENSO prediction skill in coupled ocean–atmosphere models. Clim. Dyn., **31**, 647–666.

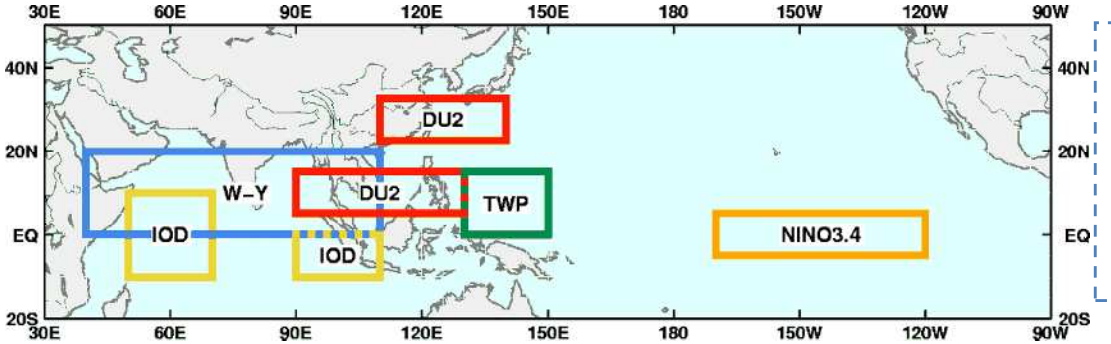
Asia Monsoon Circulation (JJA)

WY : Webster Yang (1992)



DU2 : Wang and Fan (1999)

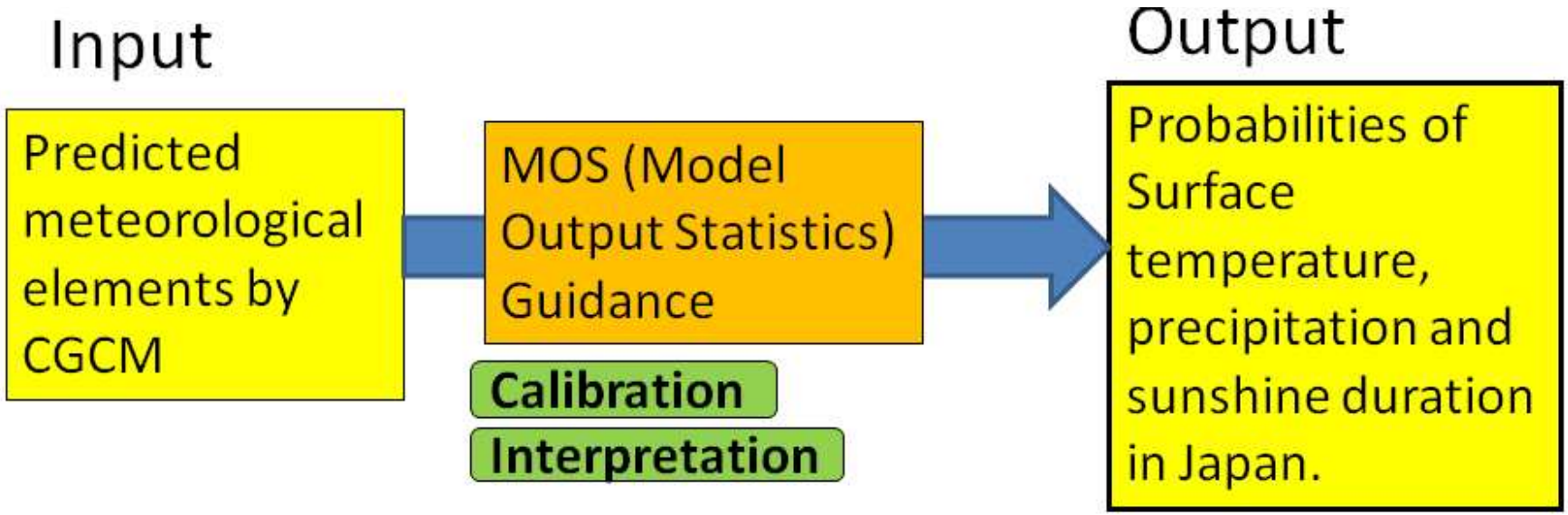




WY index : U850−U200
(0−20N, 40−110E)
DU2 index: U850 (5−15N,90−130E)
− U850(22.5−32.5N,110−140E

Based on hindcast with the new seasonal forecast system (1984−2005)

NWP Guidance

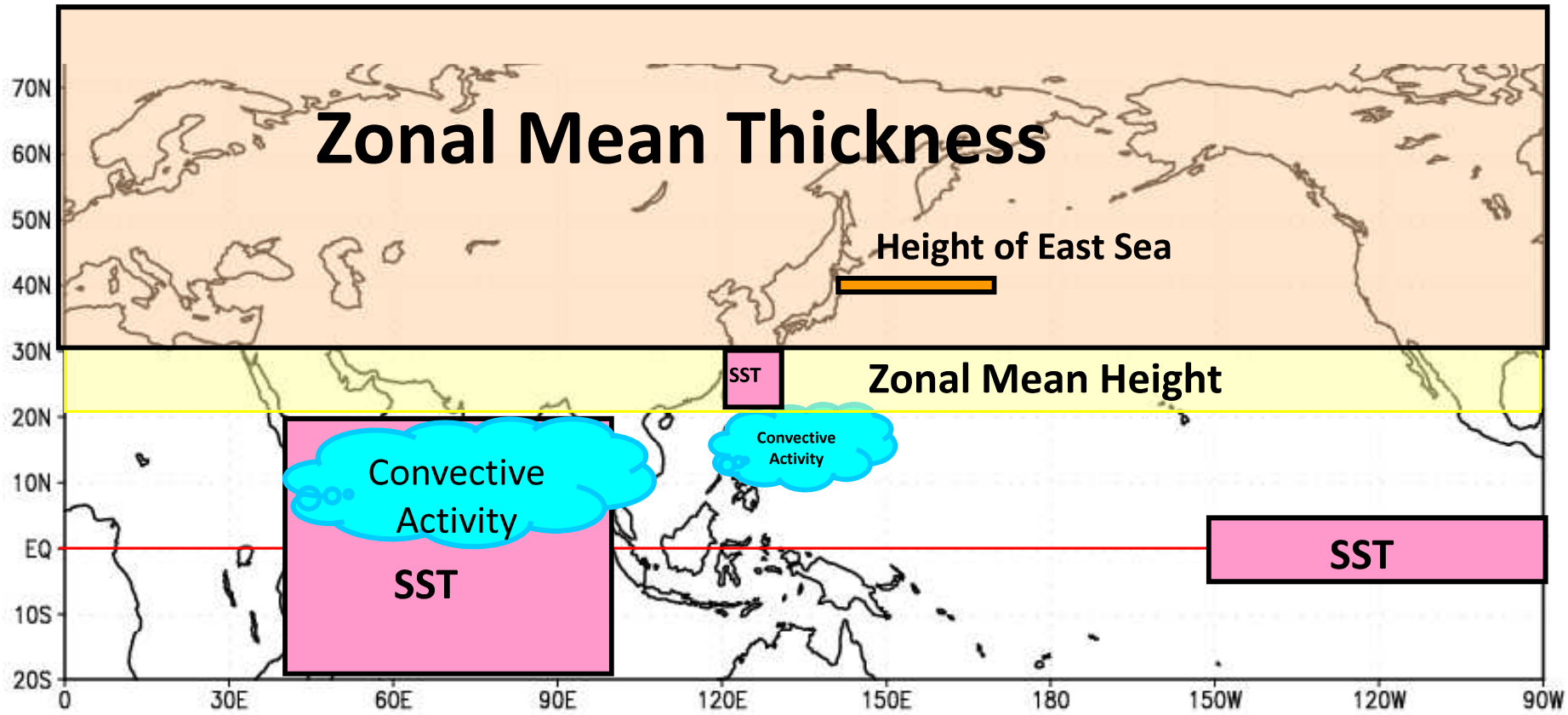


	9月－11月	Sep.- Nov.		
	気温 Temp.		確率（%） Prob.	
	（℃）	低 B	並 N	高 A
N. Japan 北日本	0.5	8	34	58
E Japan 東日本	0.4	13	30	57
W Japan 西日本	0.6	10	18	72
Okinawa/ Amami 沖縄・奄美	0.5	4	15	81

See Dehara's lecture

Predictors

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

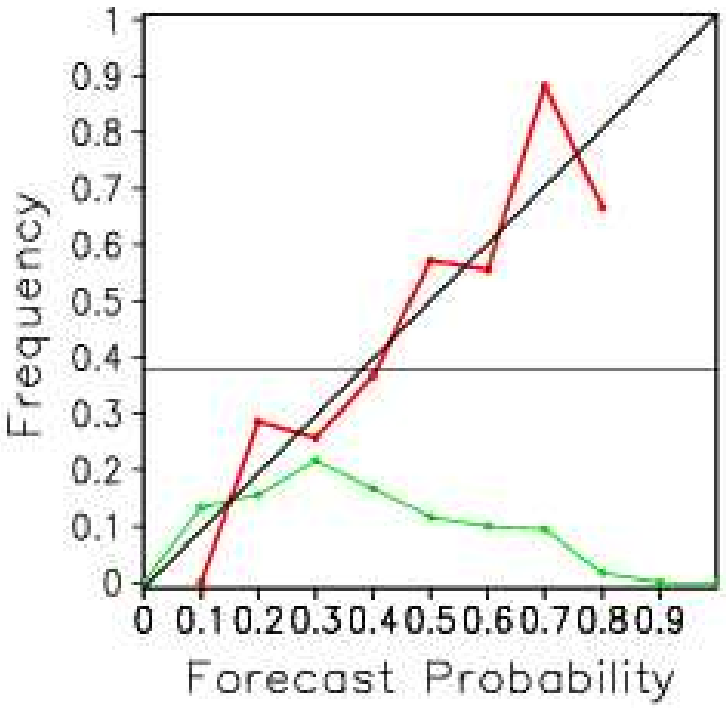


Predictands are surface temperature, precipitation and sunshine duration in Japan.

Skill of the Numerical Guidance
(JJA temperature)

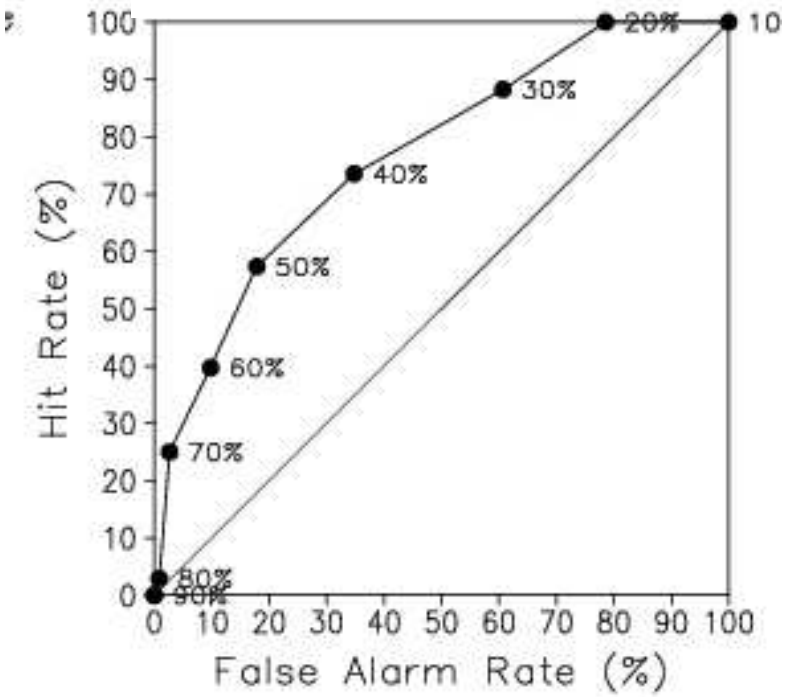
Reliability Diagram

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

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Procedure (1)

Check up 'signal' using ensemble mean prediction maps

SST in the tropics → Precipitation in the tropics → Upper tropospheric large scale divergent flow in the tropics → Lower and upper tropospheric large scale rotational flow in the tropics → their influences to Japan

Figure out the relationship between predicted large scale predictable climate variability, such as El Nino, and variability around Japan

Procedure (2)

Check up prediction skill using hindcast verification charts

Check up ‘noise’ using each member prediction maps

Figure out uncertainty of predicted fields

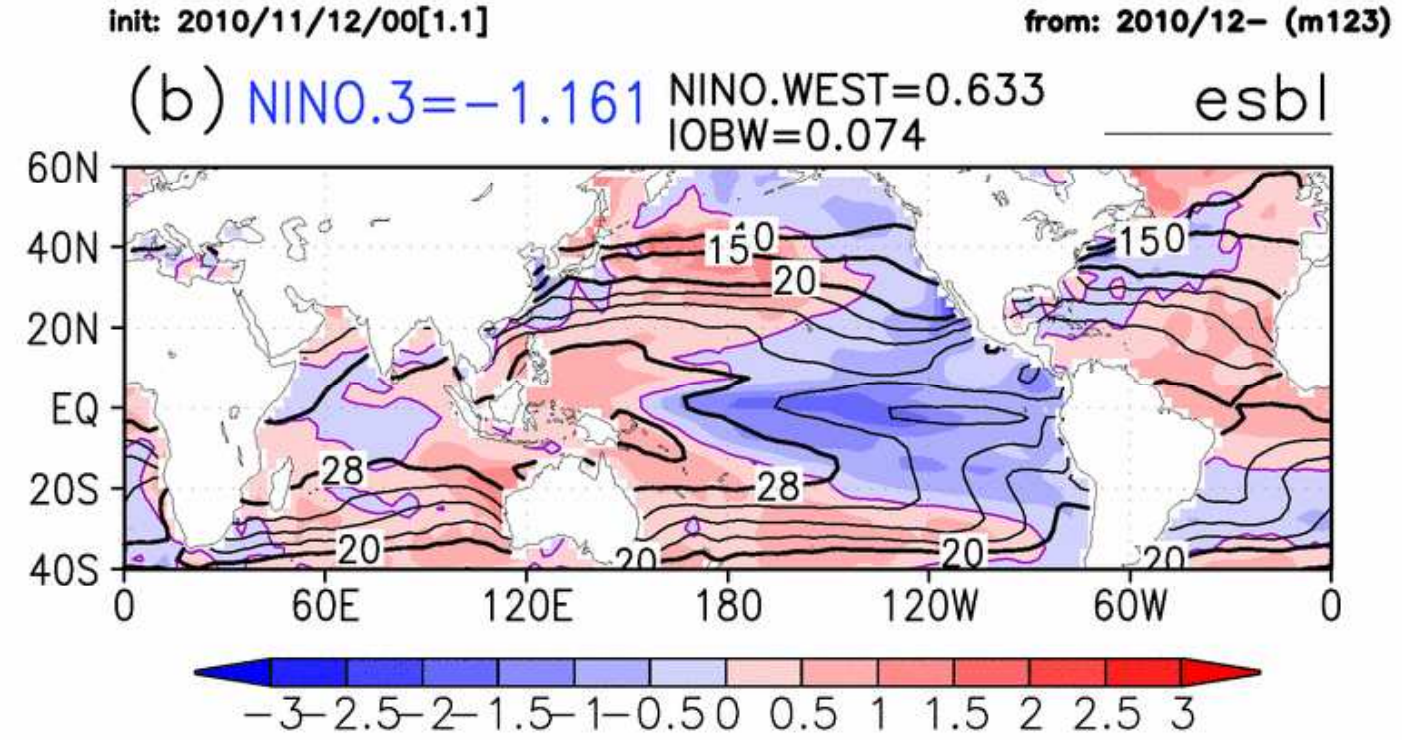
Procedure (3)

Check up predicted probabilities by NWP guidance, and modify the probabilities of NWP guidance based on results of procedure 1 & 2, skills of the guidance, and characteristic of recent climate

Make decision

Ex. Seasonal forecast for 2010/2011 winter from Nov. 2010

Predicted DJF SST anomalies (ensemble mean)

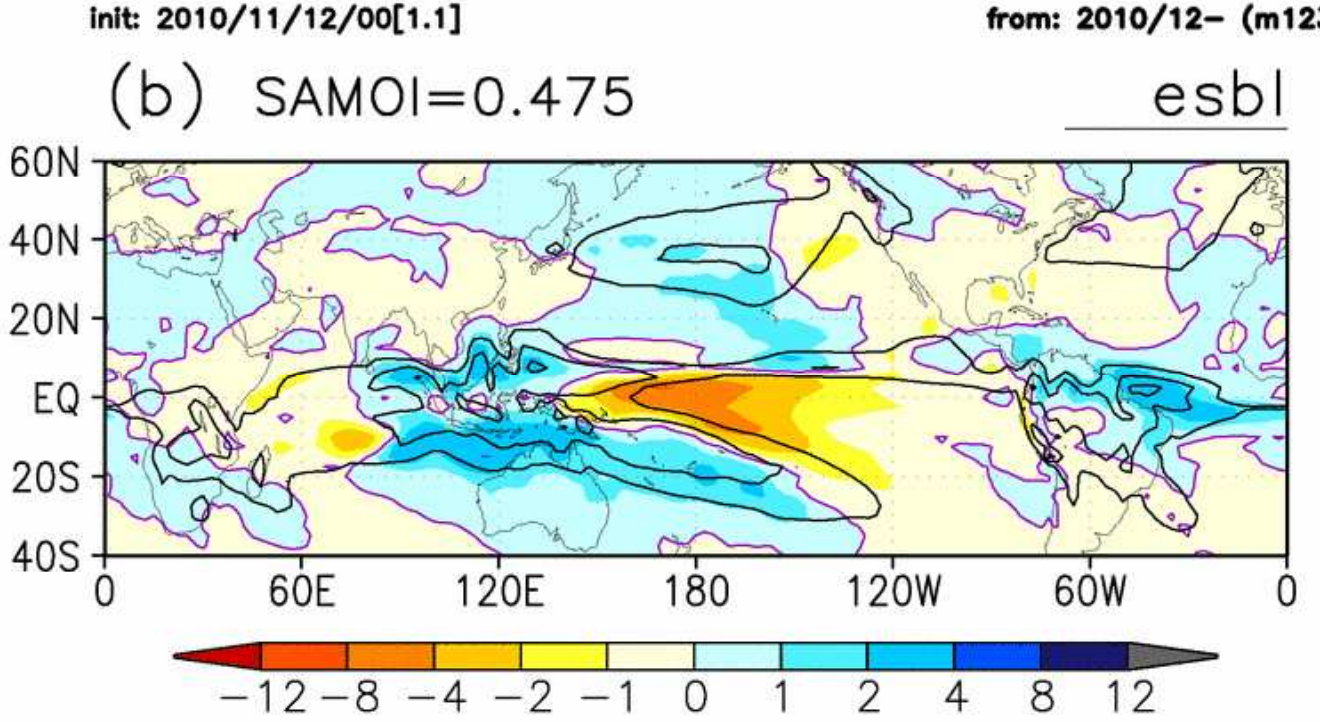


@La Nina will continue

@ Positive SSTA around the Maritime Continent and the tropical Western Pacific

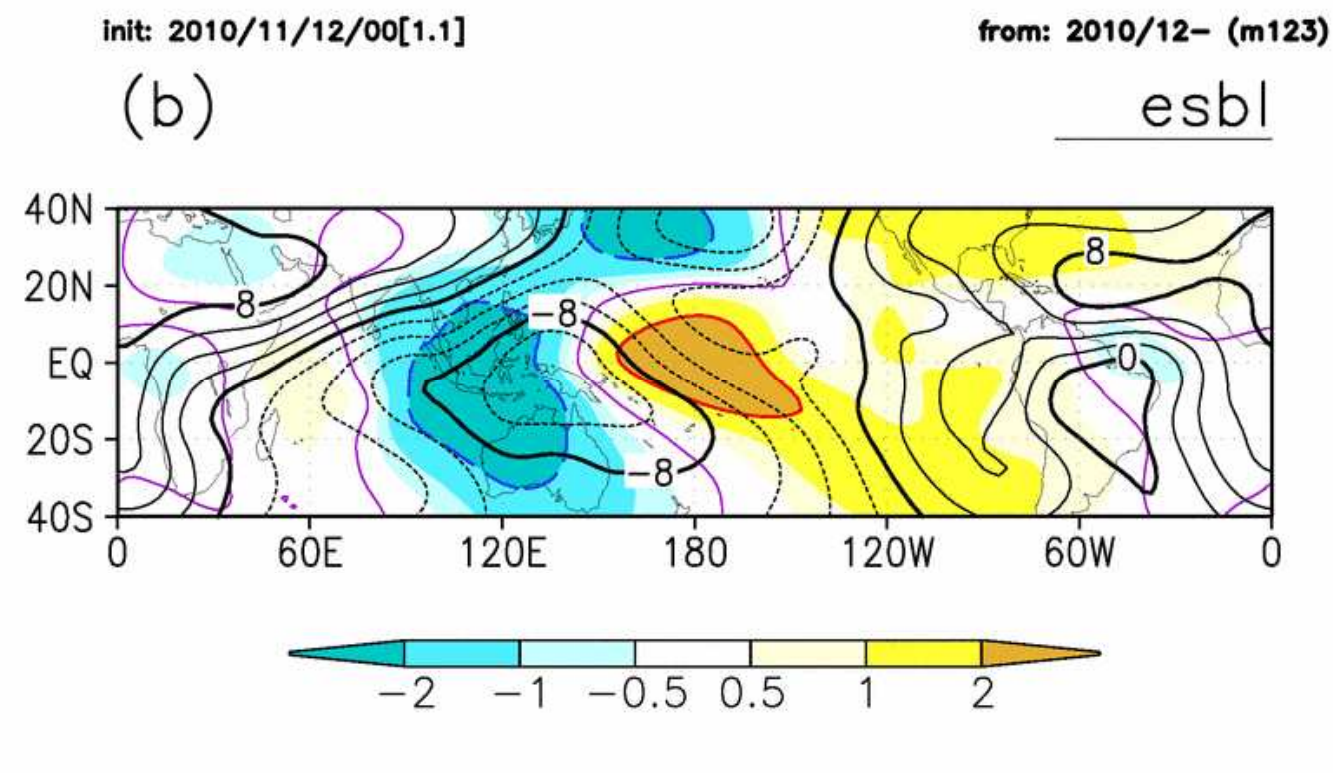
Signal predicted by the Numerical Model

Predicted DJF precipitation anomalies (ensemble mean)



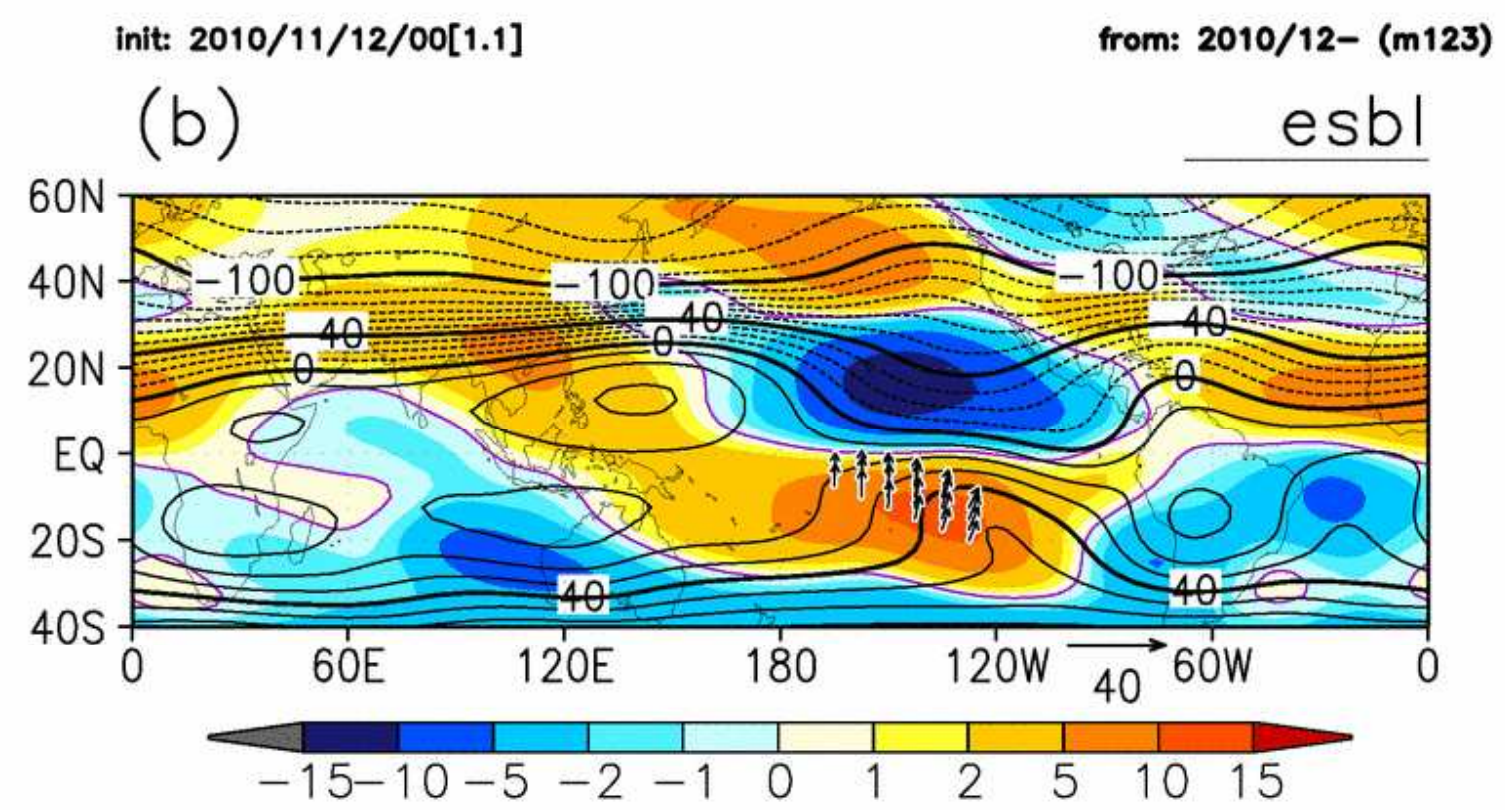
@Positive Precipitation anomalies around the Maritime Continent and the tropical Western Pacific associated with the La Nina condition

Predicted DJF 200hPa velocity potential anomalies (ensemble mean)



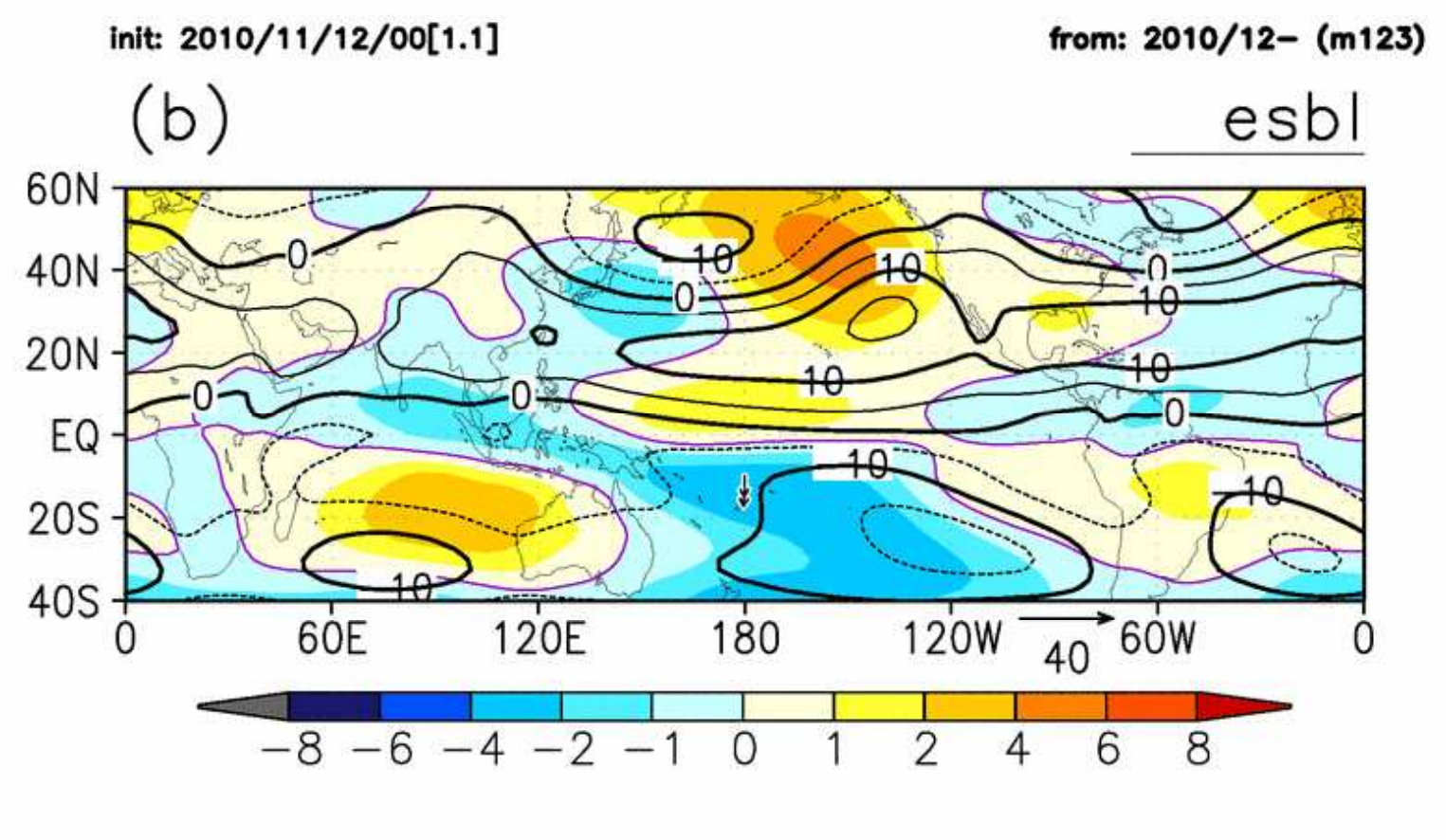
@ Divergence flow anomalies in the upper troposphere around the Maritime Continent associated with precipitation anomalies

Predicted DJF 200hPa stream function anomalies
(ensemble mean)



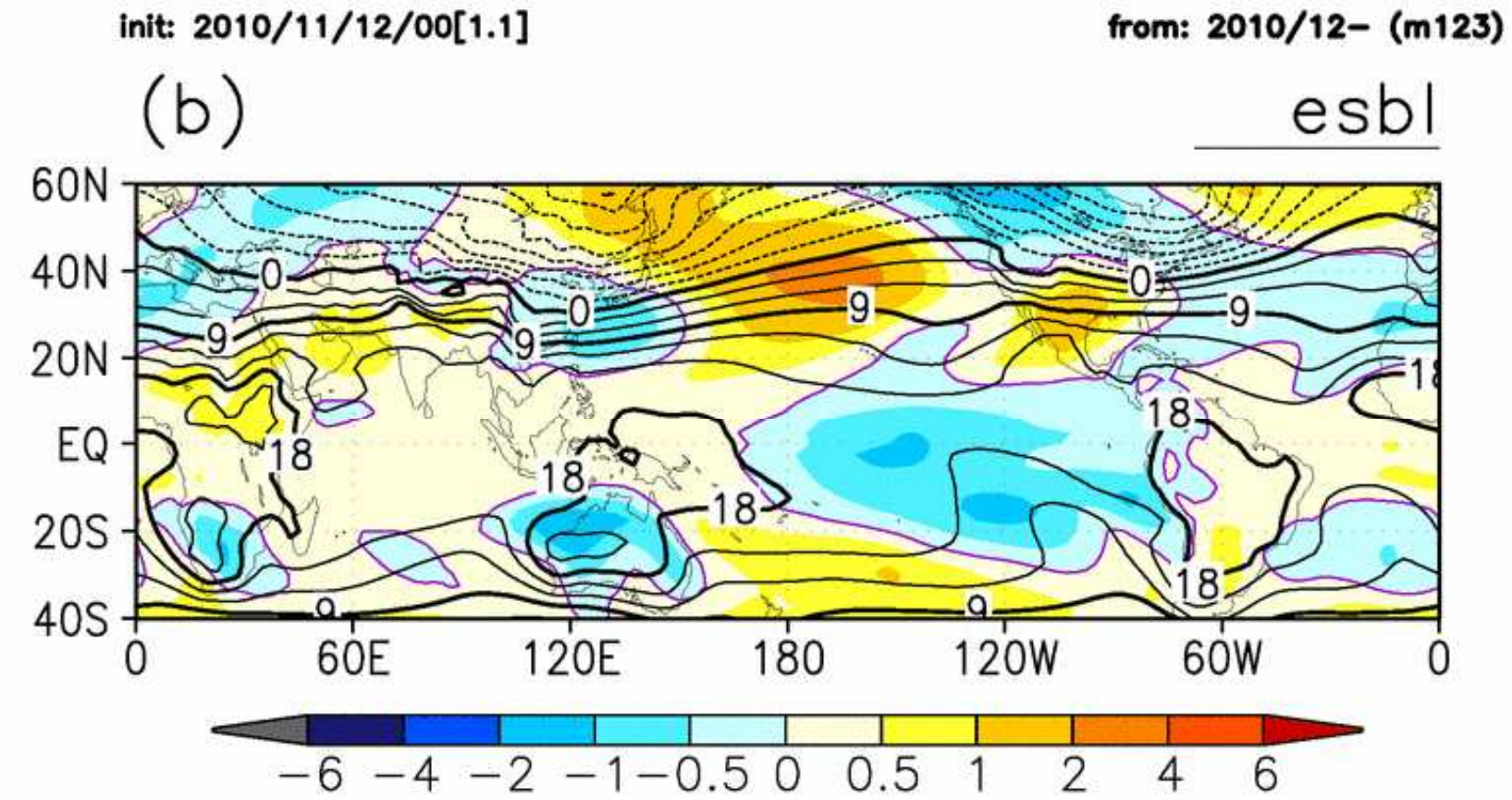
@ Anticyclonic circulation anomalies in the upper troposphere around the south-east Asia, and cyclonic circulation anomalies near Japan. This wave like pattern is suggested to be a stationary Rossby wave train forced by divergence flow anomalies in the upper troposphere around the Maritime Continent

Predicted DJF 850hPa stream function anomalies
(ensemble mean)



@ Cyclonic circulation anomalies in the lower troposphere, which is corresponding to the cyclonic circulation anomalies in the upper troposphere around Japan

Predicted DJF 850hPa temperature anomalies (ensemble mean)

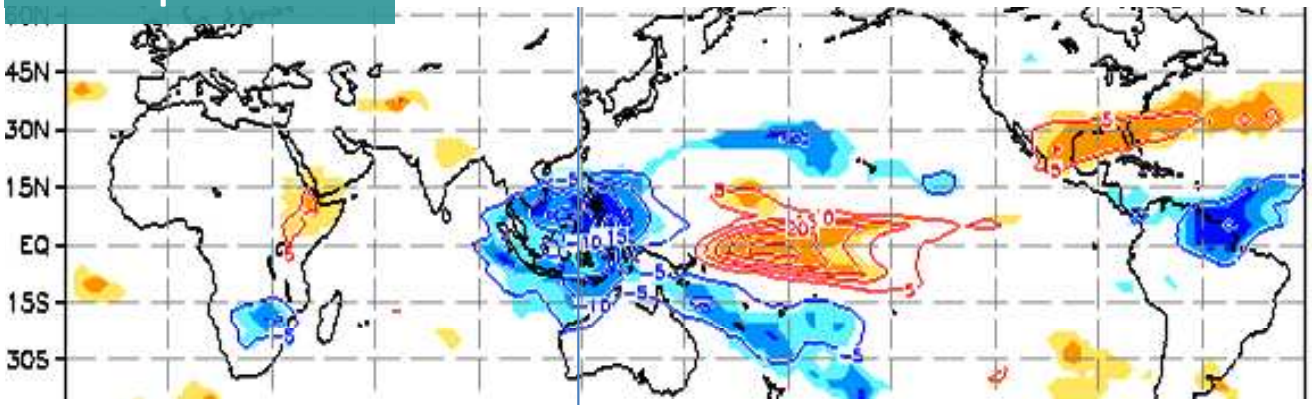


@ Negative T850 anomalies around the Western Japan and Okinawa/Amami, and positive T850 anomalies around the Eastern and Northern Japan corresponding to the circulation anomalies.

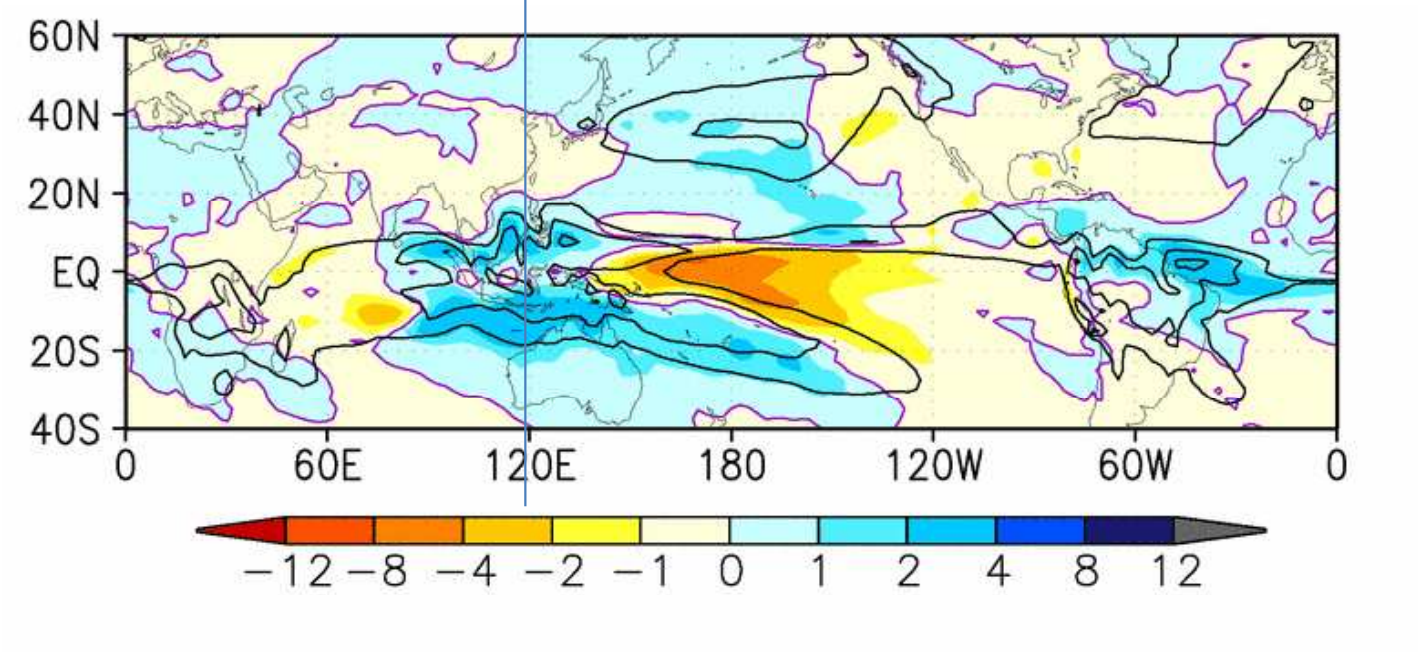
Comparison with observed La Nina winters

Composite in La Nina winter

Precipitation



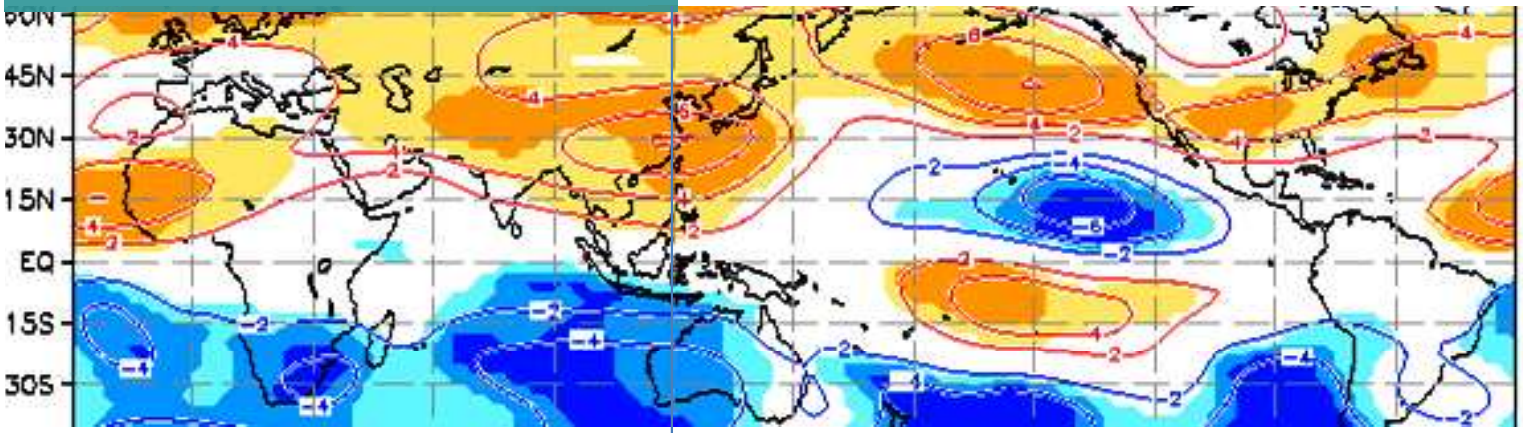
Prediction



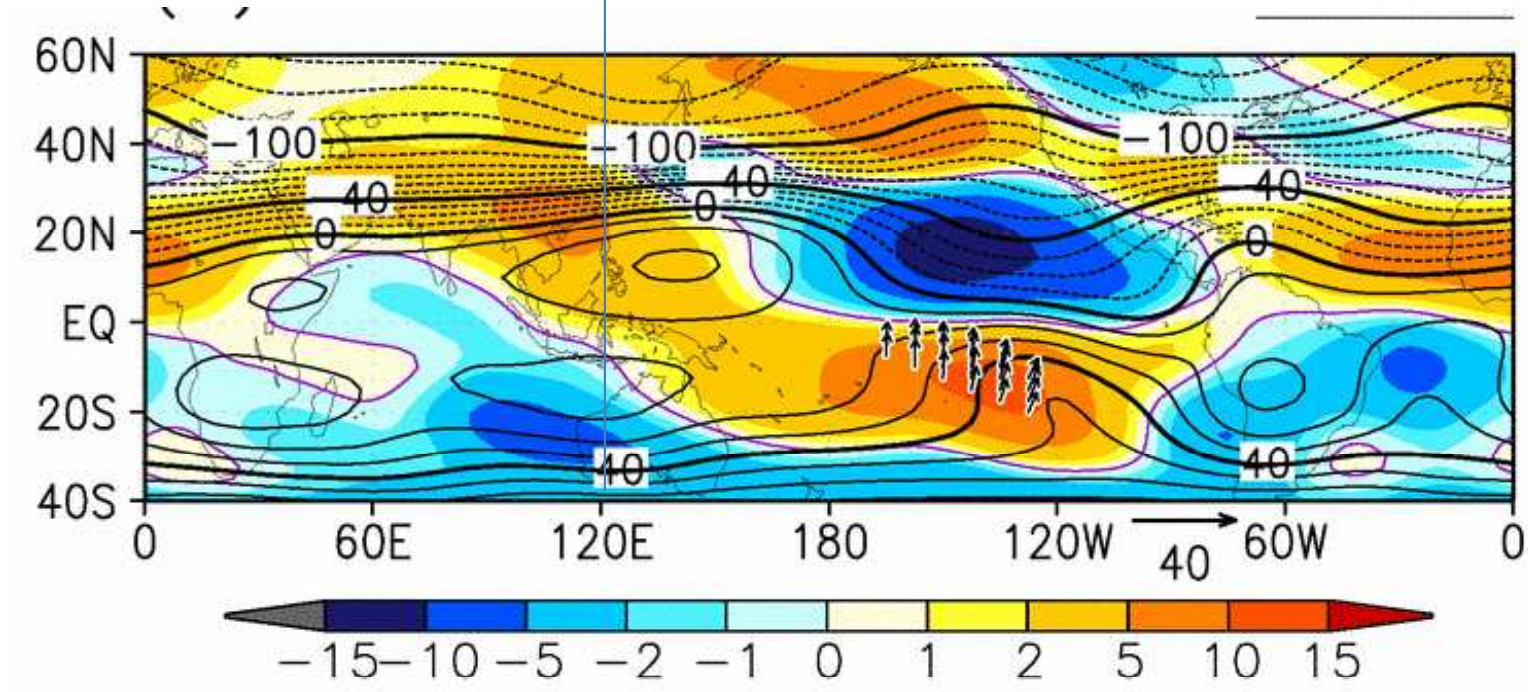
Westward shift

Composite in La Nina winter

200hPa stream function



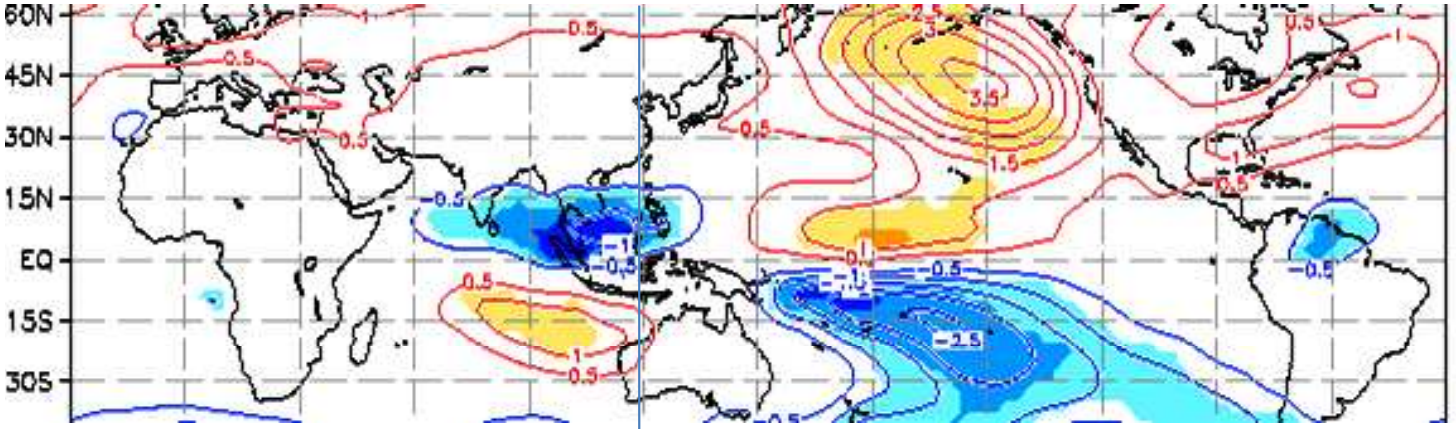
Prediction



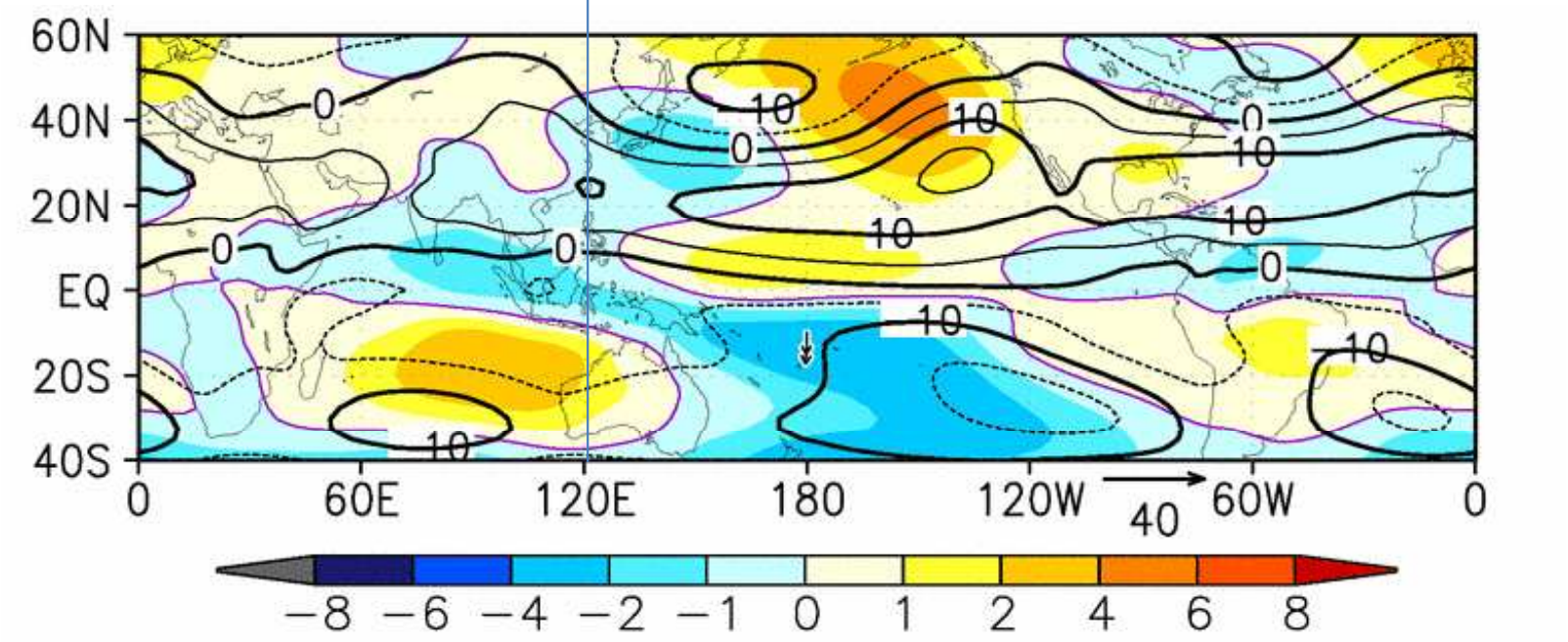
Westward shift and clear cyclonic circulation anomalies near Japan

850hPa stream function

Composite in La Nina winter



Prediction



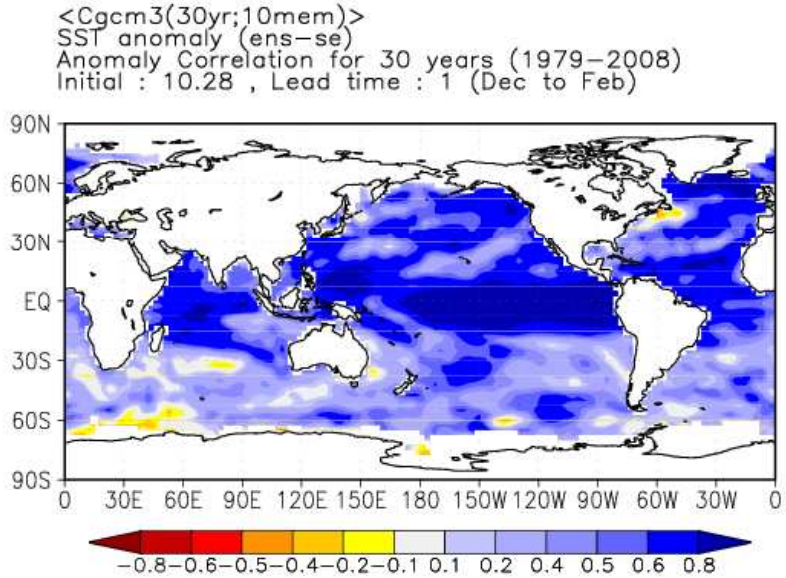
Westward shift and clear cyclonic circulation anomalies near Japan

Summary of Predicted Signal

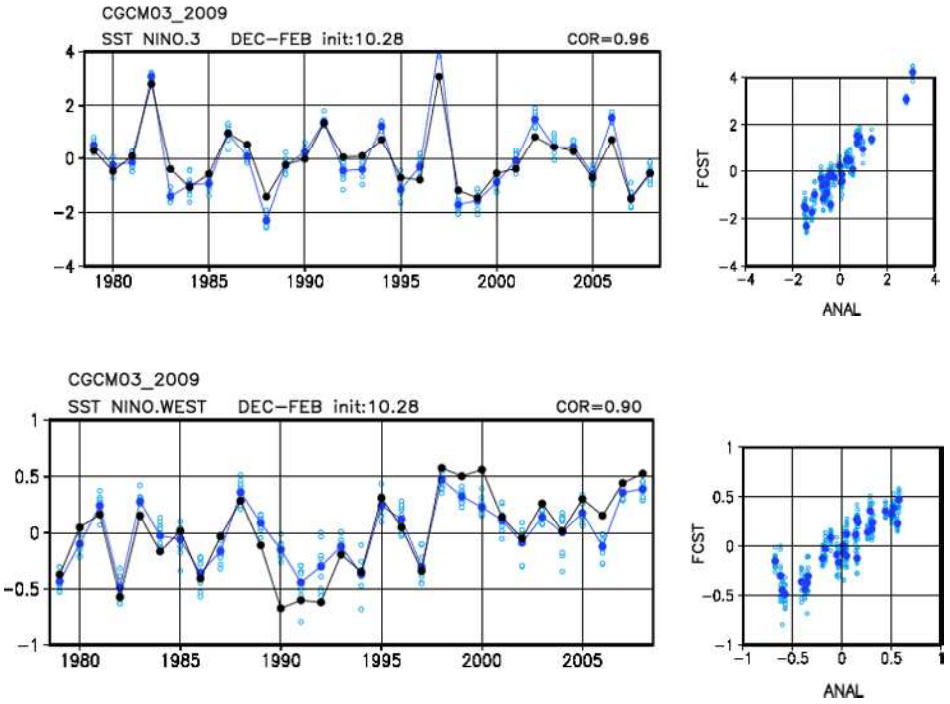
@La Nina will continue
@Around Japan, circulation pattern which is expected in La Nina winter is predicted, but the pattern is westward shift compared with the typical circulation anomalies in La Nina winters

@Corresponding to the circulation pattern, negative temperature anomalies in the Western Japan and Okinawa/Amami, and positive temperature anomalies in the Northern Japan are predicted

Prediction Skill evaluated by 30 years Hindcast



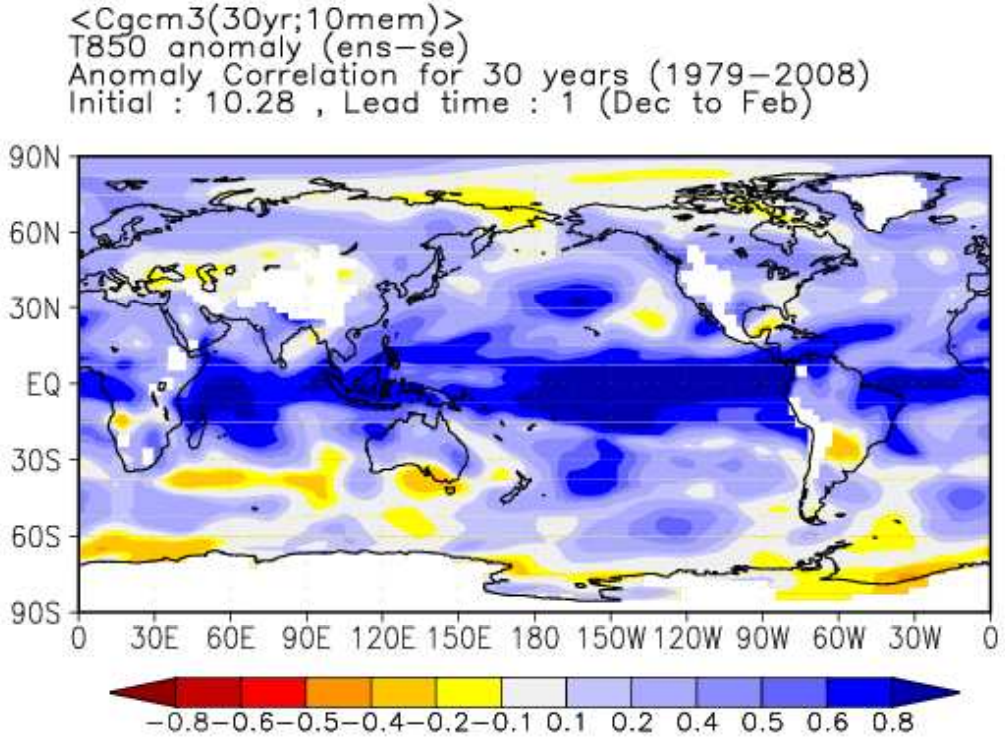
SST Anomaly Correlation for DJF prediction from the end of Oct.



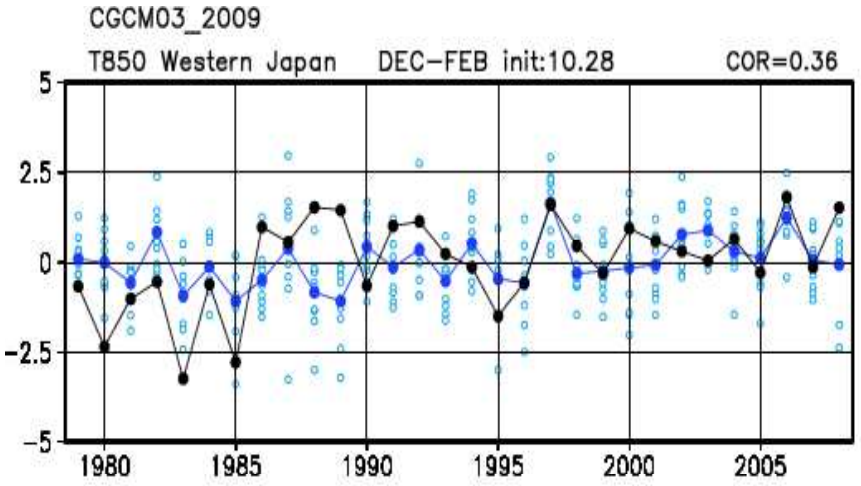
SST Anomalies in NINO.3 (upper)and the NINO.WEST(lower)for DJF prediction from the end of Oct.

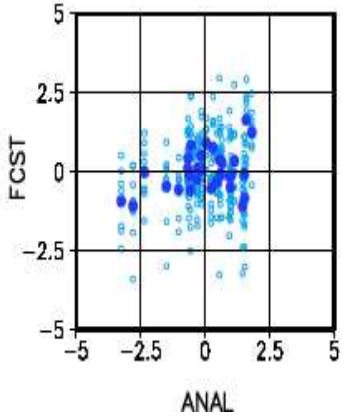
Prediction skill of SST in the tropics is very good!!

Prediction Skill evaluated by 30 years Hindcast



T850 Anomaly Correlation for DJF prediction from the end of Oct.



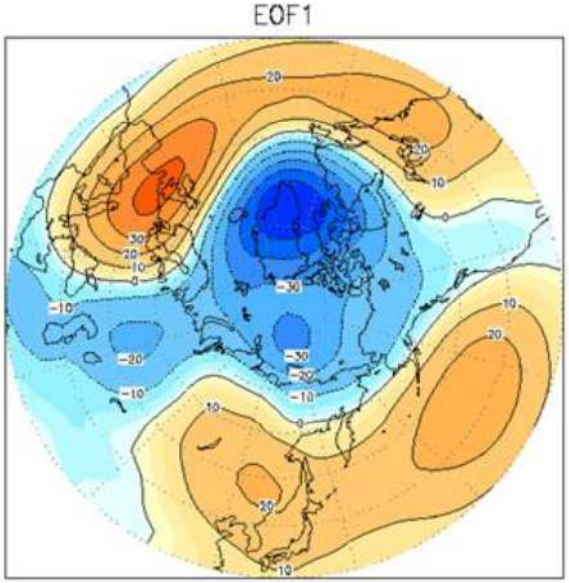


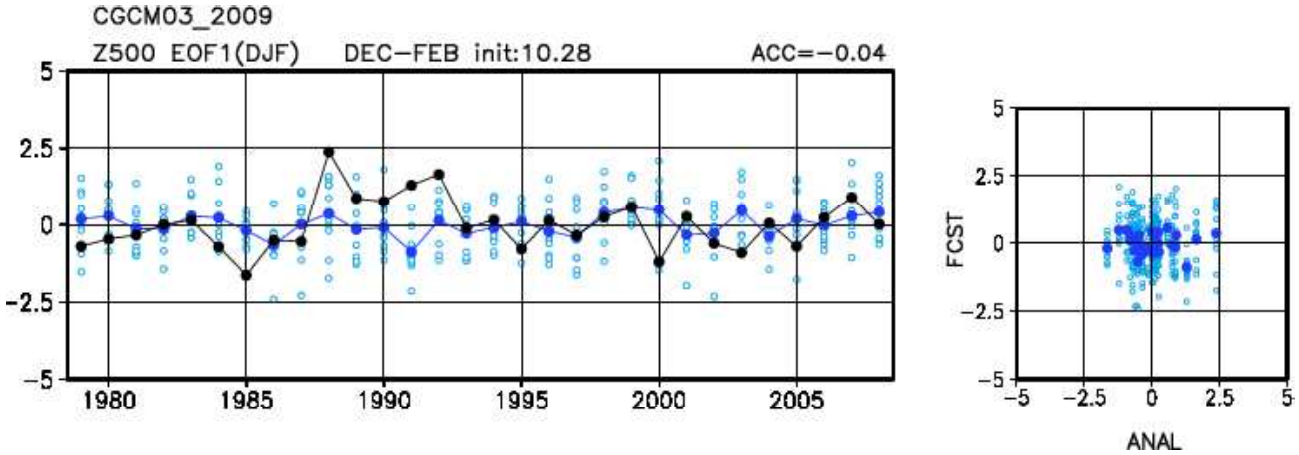
T850 Anomaly in the Western Japan for DJF prediction from the end of Oct.

Prediction skill of T850 near Japan is not so good but positive!!

Prediction Skill evaluated by 30 years Hindcast

EOF1 of NHZ500 in DJF (AO)

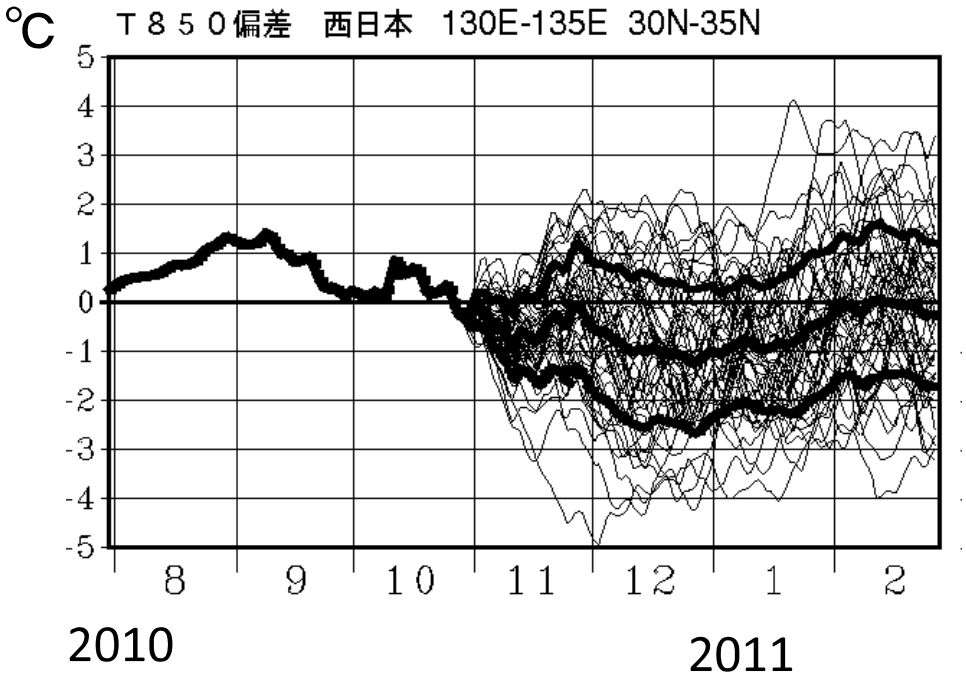




NHZ500 EOF1 (AO) for DJF prediction from the end of Oct.

Prediction skill of AO is near zero

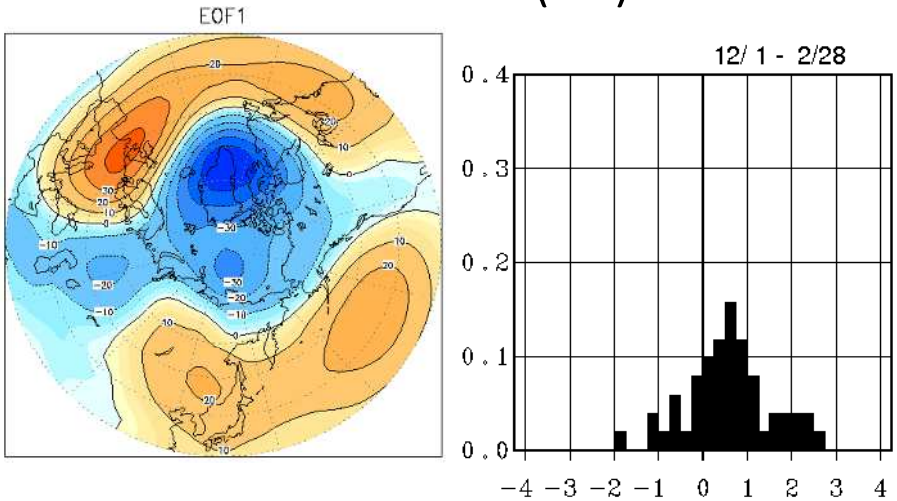
Noise estimation by each member prediction



T850 Anomaly (30 day running mean) prediction in the Western Japan for DJF prediction from the end of Oct.

Spread (= standard deviation of each prediction) is more then 1℃

EOF1 of NHZ500 in DJF (AO)



DJF AO index is predicted to be +0.5 with large spread

Recent winter climate in Japan

DJF	DJF Temperature anomalies(0.1°C) and rank			
	N. Japan	E. Japan	W. Japan	Okinawa/Amami
2000/01	-14 (-)	-01 (0)	04 (0)	14 (+)*
02	05 (+)	07 (+)	08 (+)	04 (+)
03	-06 (-)	-01 (0)	03 (0)	04 (+)
04	14 (+)*	09 (+)	06 (0)	02 (0)
05	02 (0)	07 (+)	05 (0)	07 (+)
06	-06 (-)	-08 (-)	-05 (-)	03 (0)
07	16 (+)*	17 (+)*	16 (+)*	12 (+)*
08	-01 (0)	01 (0)	03 (0)	06 (+)
09	16 (+)*	15 (+)*	11 (+)	11 (+)*
10	06 (+)	09 (+)	10 (+)	06 (+)

(+)* : significantly above normal

In recent 10 years, near or above normal temperatures are frequently observed nationwide

Summary of NWP prediction and recent climate

Signal

@Around Japan, circulation pattern which is expected in La Nina winter is predicted, but the pattern is westward shift compared with the typical circulation anomalies in La Nina winters

@Corresponding to the circulation pattern, negative temperature anomalies in the Western Japan and Okinawa/Amami, and positive temperature anomalies in the Northern Japan are predicted

Summary of NWP prediction and recent climate

Noise/uncertainty & prediction skill

@Prediction skill for temperature around Japan is not so good, but positive !!

@Spread of temperature prediction is very large

@No skill for AO prediction

NWP guidance

@Above normal : 40-50%, Below normal: 20-30% nation wide associated with positive zonal mean thickness temperature in NH

Recent Climate

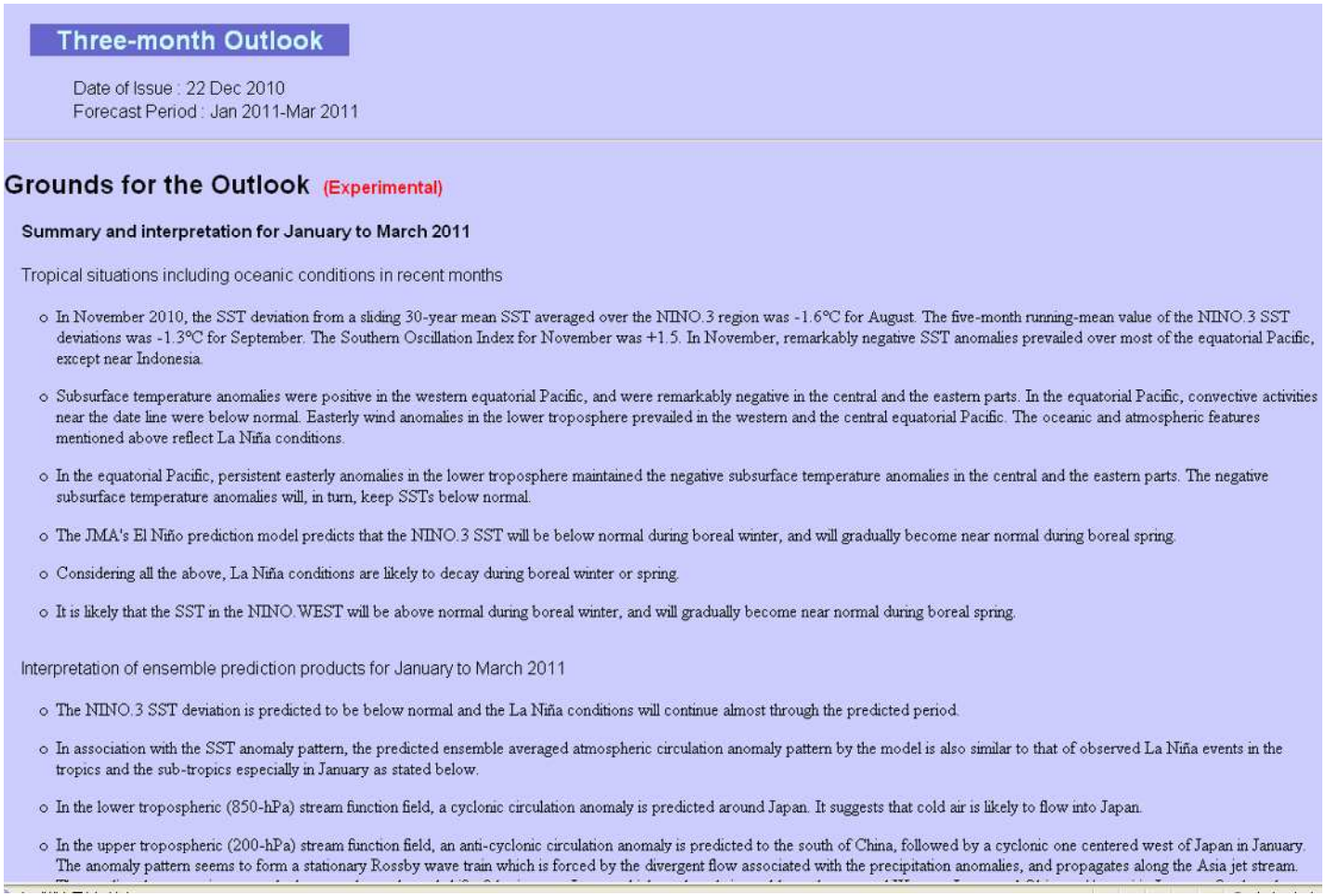
@In recent 10 years, near or above normal temperatures are frequently observed nationwide

Issued forecast : DJF mean temperature 2010/11/25

	Probability(%)
	B N A
N. Japan	**30:30:40**
E. Japan	**30:40:30**
W. Japan	**40:30:30**
Okinawa/Amami	**40:30:30**

Grounds for JMA Seasonal Forecast

http://ds.data.jma.go.jp/tcc/tcc/products/japan/outlooks/outlook2t.html



Three-month Outlook

Date of Issue : 22 Dec 2010
Forecast Period : Jan 2011-Mar 2011

Grounds for the Outlook (Experimental)

Summary and interpretation for January to March 2011

Tropical situations including oceanic conditions in recent months

- In November 2010, the SST deviation from a sliding 30-year mean SST averaged over the NINO.3 region was -1.6°C for August. The five-month running-mean value of the NINO.3 SST deviations was -1.3°C for September. The Southern Oscillation Index for November was +1.5. In November, remarkably negative SST anomalies prevailed over most of the equatorial Pacific, except near Indonesia.
- Subsurface temperature anomalies were positive in the western equatorial Pacific, and were remarkably negative in the central and the eastern parts. In the equatorial Pacific, convective activities near the date line were below normal. Easterly wind anomalies in the lower troposphere prevailed in the western and the central equatorial Pacific. The oceanic and atmospheric features mentioned above reflect La Niña conditions.
- In the equatorial Pacific, persistent easterly anomalies in the lower troposphere maintained the negative subsurface temperature anomalies in the central and the eastern parts. The negative subsurface temperature anomalies will, in turn, keep SSTs below normal.
- The JMA's El Niño prediction model predicts that the NINO.3 SST will be below normal during boreal winter, and will gradually become near normal during boreal spring.
- Considering all the above, La Niña conditions are likely to decay during boreal winter or spring.
- It is likely that the SST in the NINO.WEST will be above normal during boreal winter, and will gradually become near normal during boreal spring.

Interpretation of ensemble prediction products for January to March 2011

- The NINO.3 SST deviation is predicted to be below normal and the La Niña conditions will continue almost through the predicted period.
- In association with the SST anomaly pattern, the predicted ensemble averaged atmospheric circulation anomaly pattern by the model is also similar to that of observed La Niña events in the tropics and the sub-tropics especially in January as stated below.
- In the lower tropospheric (850-hPa) stream function field, a cyclonic circulation anomaly is predicted around Japan. It suggests that cold air is likely to flow into Japan.
- In the upper tropospheric (200-hPa) stream function field, an anti-cyclonic circulation anomaly is predicted to the south of China, followed by a cyclonic one centered west of Japan in January. The anomaly pattern seems to form a stationary Rossby wave train which is forced by the divergent flow associated with the precipitation anomalies, and propagates along the Asia jet stream.

Outline

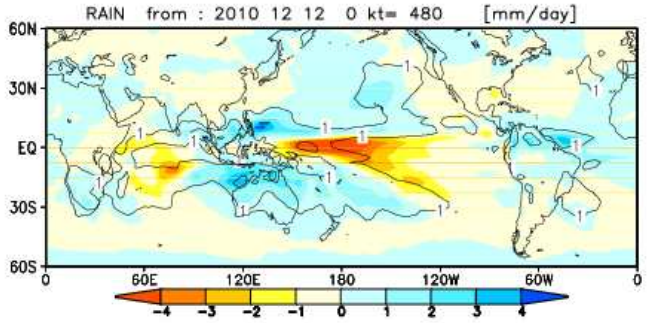
- Introduction
- Overview of JMA operational Seasonal Forecast System
- Procedure to make JMA Seasonal Forecast
- TCC products for Seasonal Forecast
- Summary

TCC Web Top Page

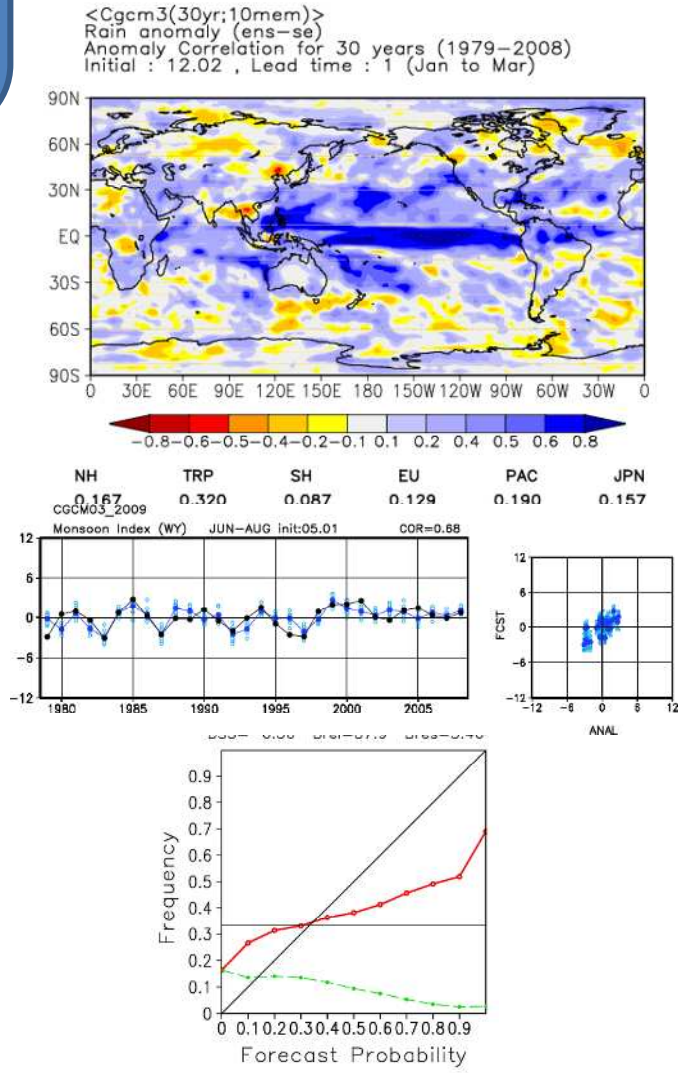
http://ds.data.jma.go.jp/tcc/tcc/index.html

Kinds of products for Seasonal Forecast

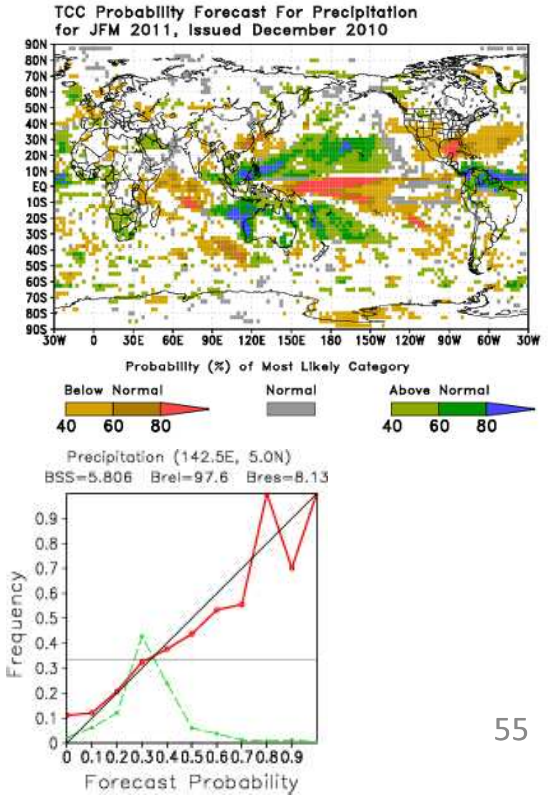
NWP Forecast maps (ensemble mean & spread)



NWP verification charts



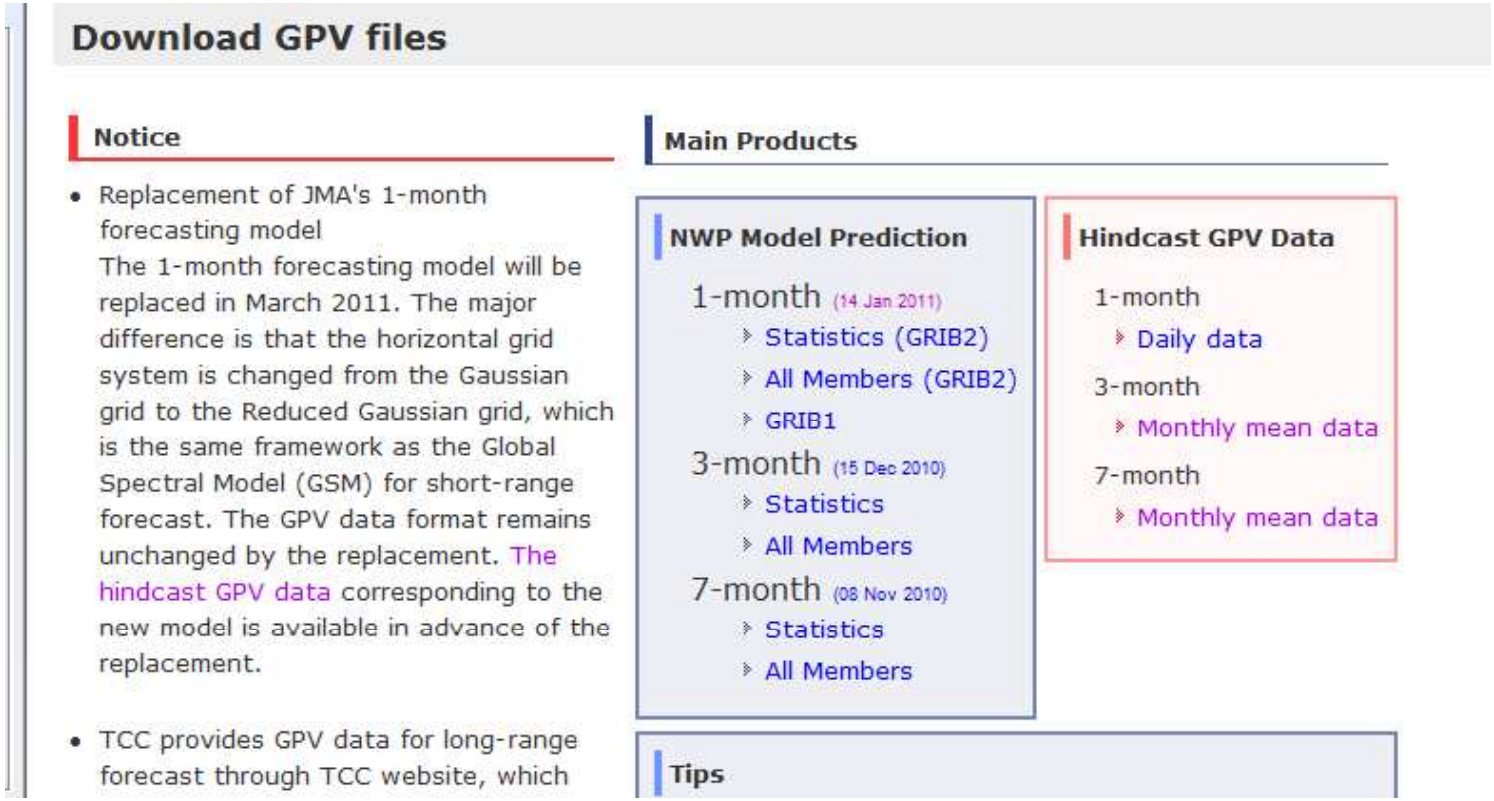
NWP calibrated Probability Forecast and verification charts



Kinds of products for Seasonal Forecast

GPV: NWP Model Prediction

GPV: Hindcast



Download GPV files

Notice

- Replacement of JMA's 1-month forecasting model
  The 1-month forecasting model will be replaced in March 2011. The major difference is that the horizontal grid system is changed from the Gaussian grid to the Reduced Gaussian grid, which is the same framework as the Global Spectral Model (GSM) for short-range forecast. The GPV data format remains unchanged by the replacement. The hindcast GPV data corresponding to the new model is available in advance of the replacement.
- TCC provides GPV data for long-range forecast through TCC website, which

Main Products

NWP Model Prediction

1-month (14 Jan 2011)
- Statistics (GRIB2)
- All Members (GRIB2)
- GRIB1

3-month (15 Dec 2010)
- Statistics
- All Members

7-month (08 Nov 2010)
- Statistics
- All Members

Hindcast GPV Data

1-month
- Daily data

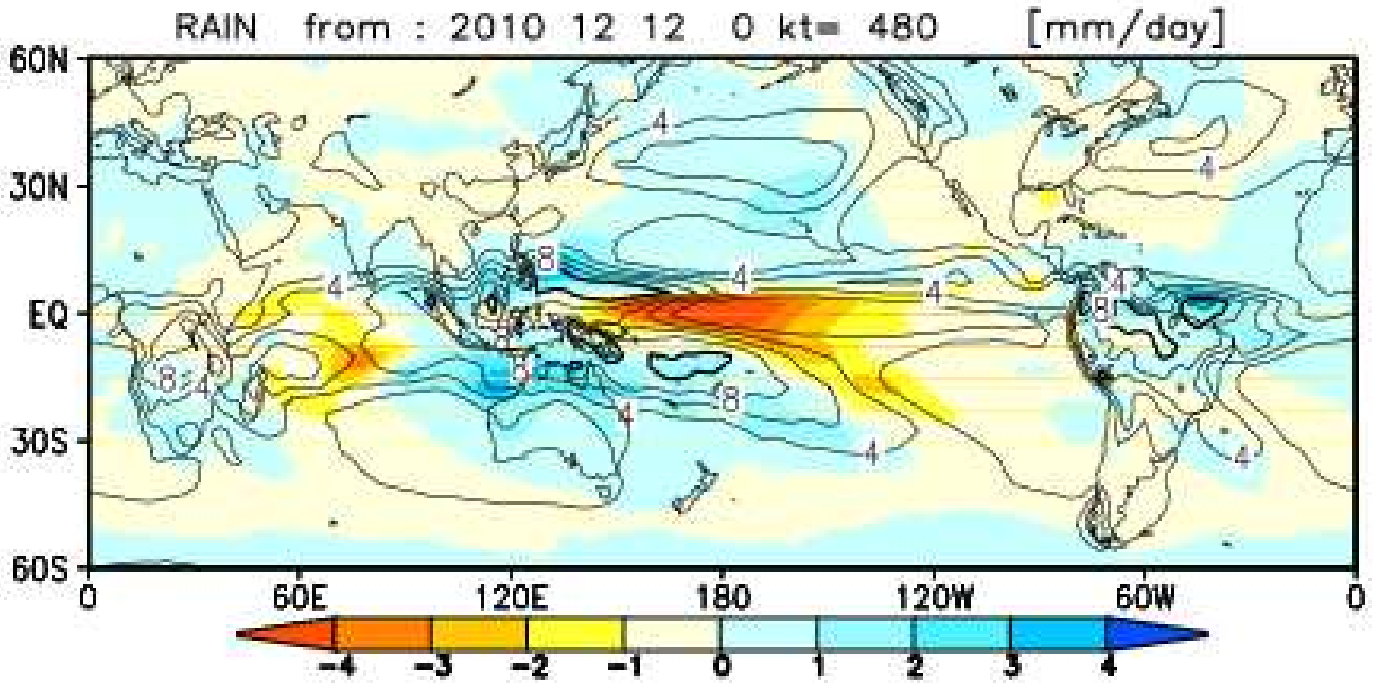
3-month
- Monthly mean data

7-month
- Monthly mean data

Tips

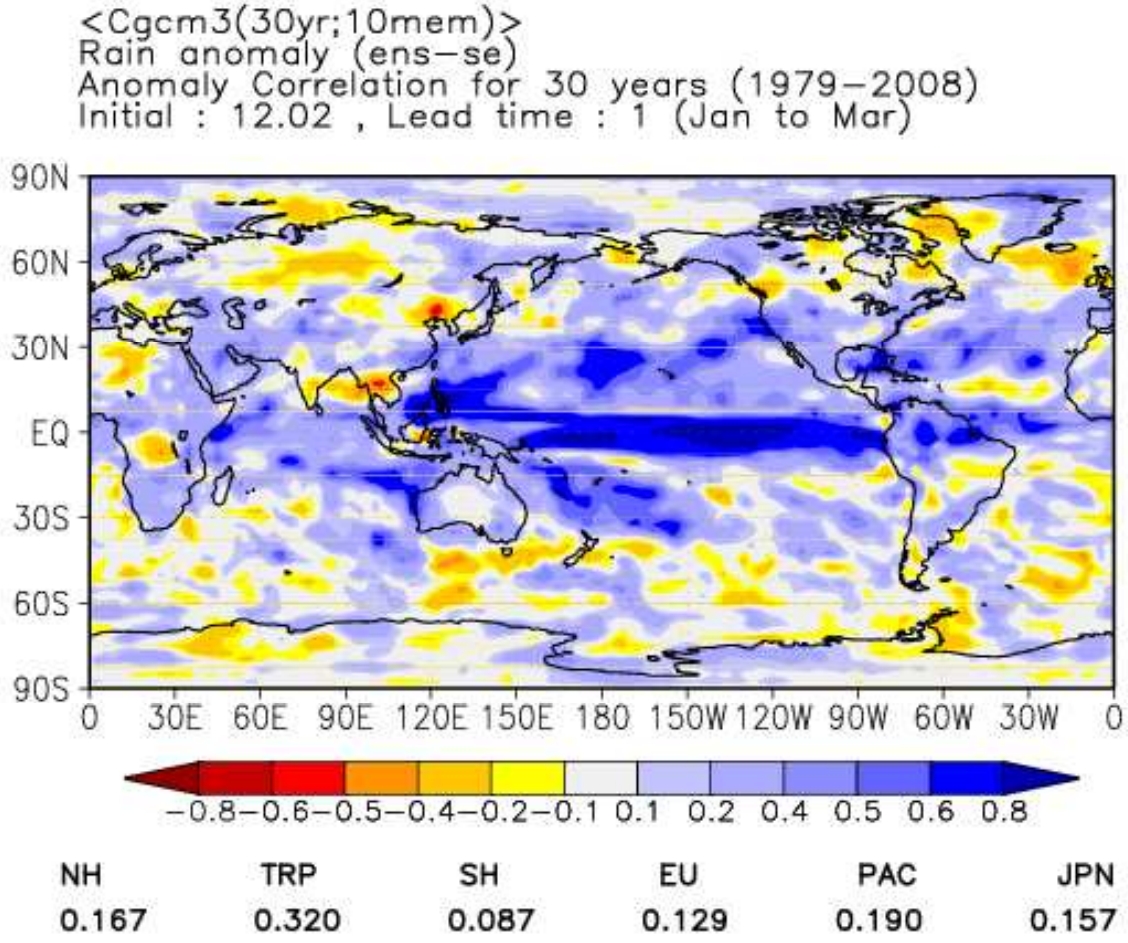
NWP Forecast maps

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



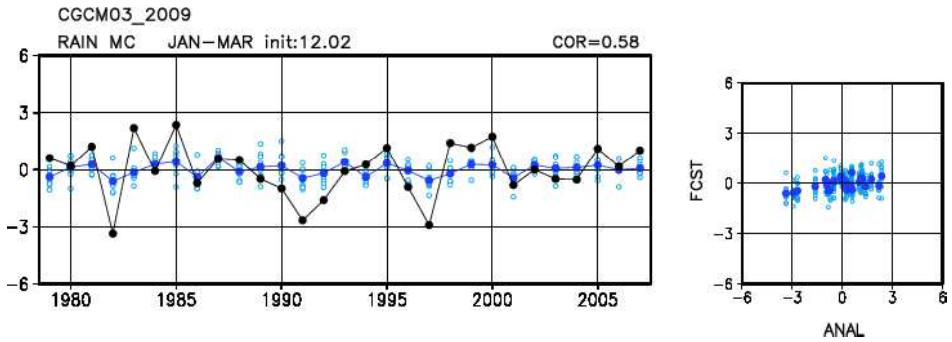
NWP verification charts

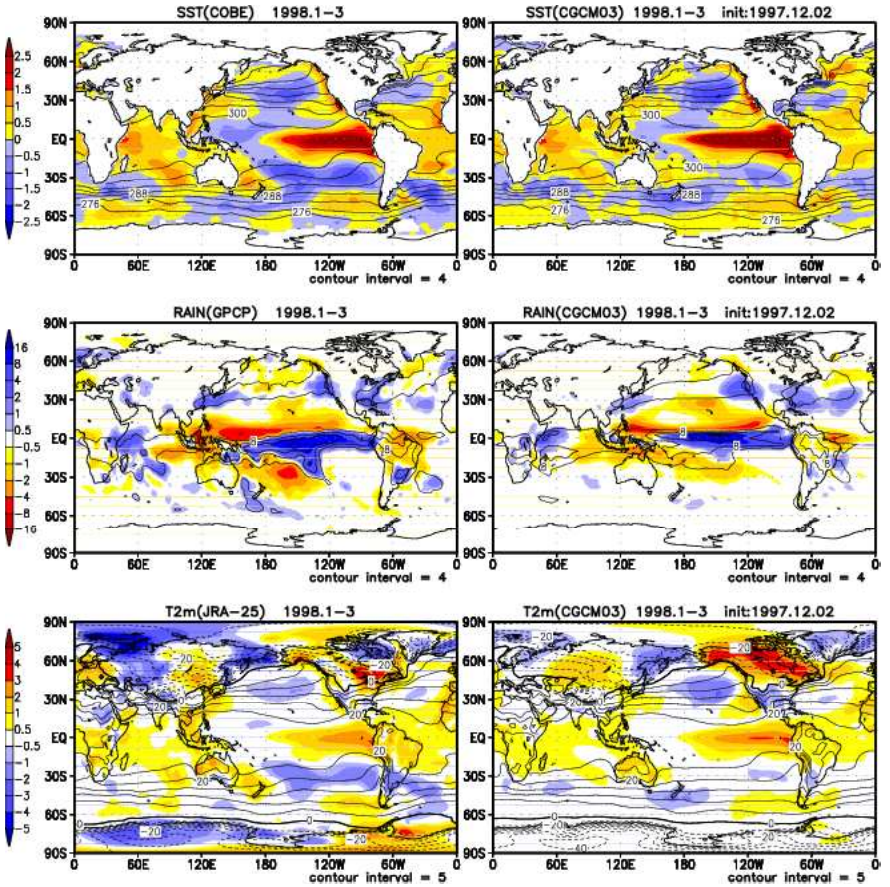
http://ds.data.jma.go.jp/tcc/tcc/products/model/hindcast/4mE/svs/index.html



Verification Charts

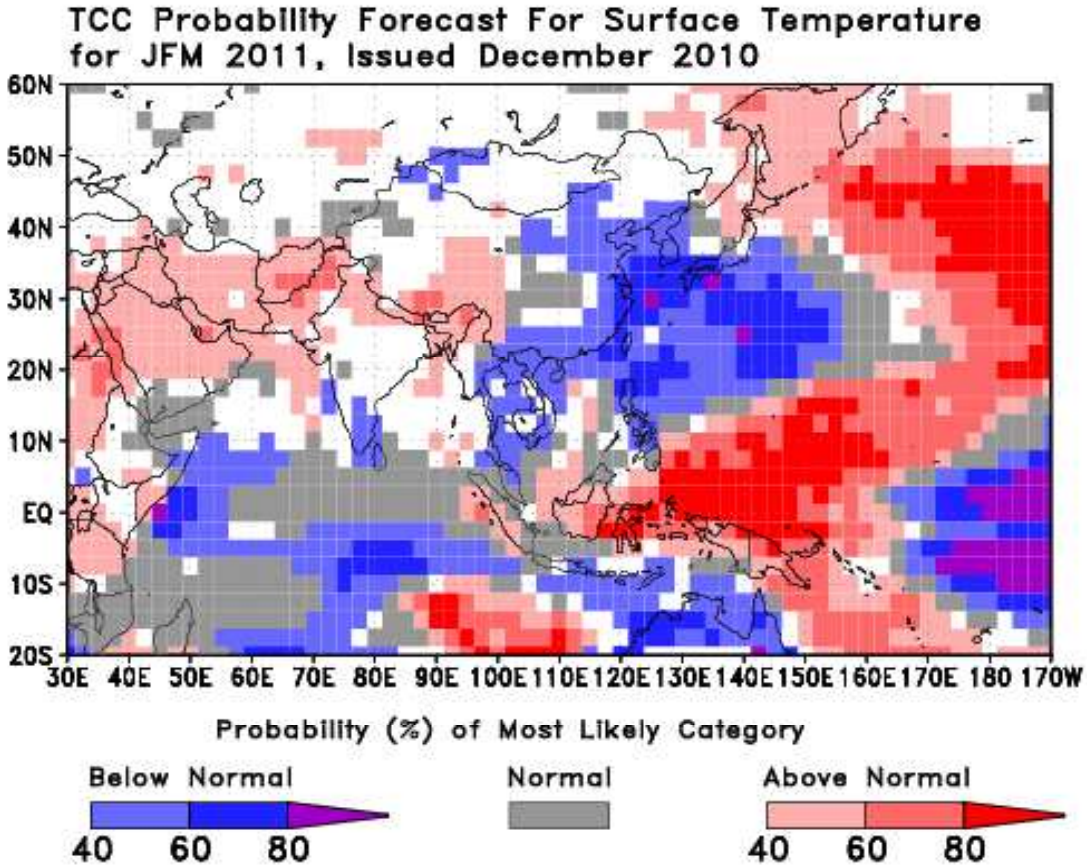
http://ds.data.jma.go.jp/tcc/tcc/gpv/model/hindcast_map/

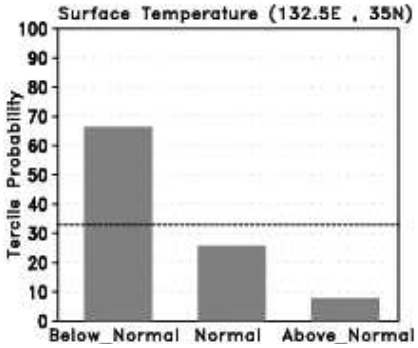


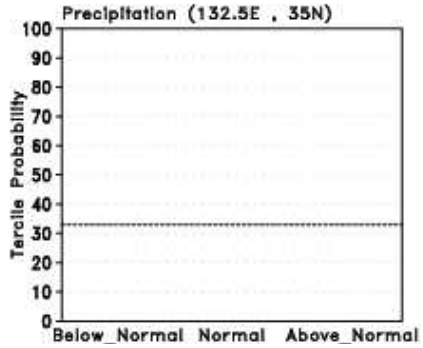


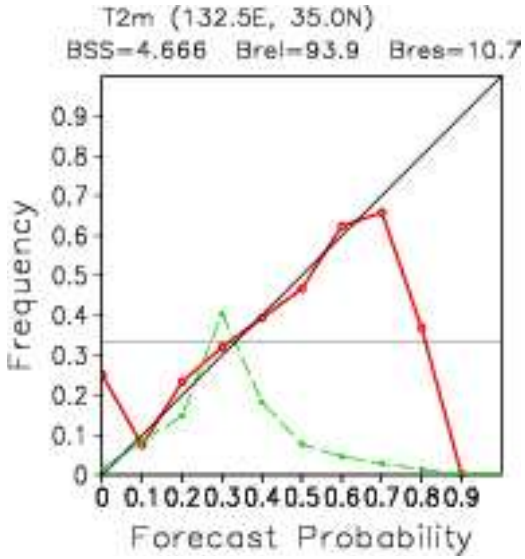
NWP calibrated Probability Forecast and verification charts

http://ds.data.jma.go.jp/tcc/tcc/products/model/probfcst/4mE/index.html



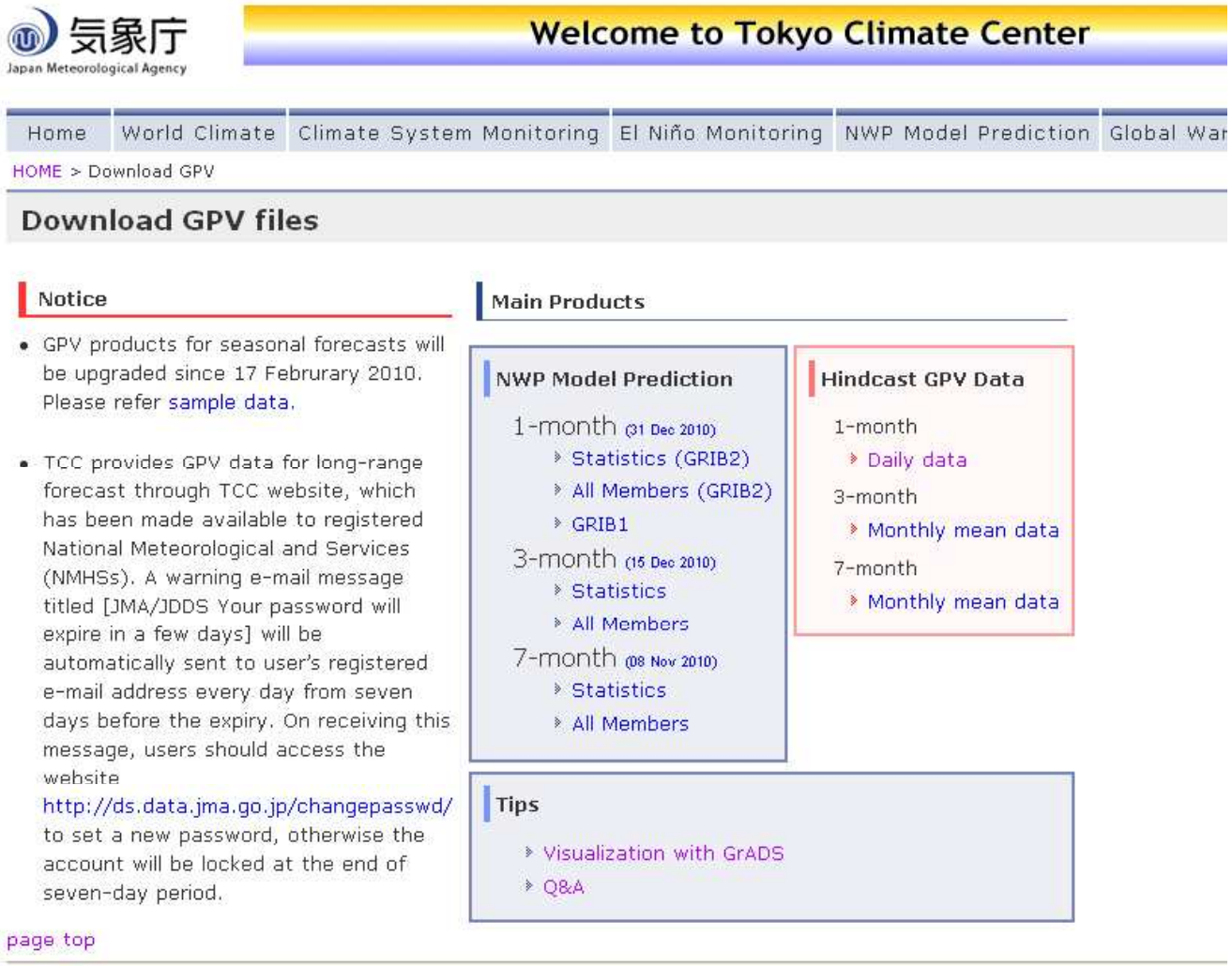






GPV: NWP Model Prediction and Hindcast

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



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Summary

- To make Seasonal Forecast, it is necessary to predict not only ‘signal’ but also ‘noise’ for Seasonal Forecast.
- Characteristics of JMA Seasonal Forecast System is fulfilling hindcast, verification, and usage of the results.
- Characteristics of TCC’s products related to Seasonal Forecast is also fulfilling verification charts to check prediction skills.