

Seasonal Outlook for winter 2009/2010 over Japan

- Winter forecast under the El Niño condition -

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Outline

1. Introduction
2. Grounds for JMA's seasonal forecast for 2009/2010 winter
 - 2.1 Current Oceanic Condition and El Niño Outlook
 - 2.2 Numerical Prediction
 - 2.3 Long-term trend including decadal variation
3. Summary
 - Result of CGCM introducing next Feb.

1. Introduction

Outline of JMA's cold season forecast

Main forecast elements

Probabilities of 3 categories
(below, near, above normal)
of DJF mean temperature,
precipitation, and snowfall
(only Sea of Japan side)

| | | | |
|-------------|---------------------|--------------------|---------------------|
| Climatology | Below Normal, 33 | Near Normal, 33 | Above Normal, 33 |
|-------------|---------------------|--------------------|---------------------|

(Categories are based on 1971-2000)

Issue date

Around 25th September
(revision around 25th October)



Geographical subdivisions of Japan

Forecast tools

■ Numerical Prediction Model

- AGCM (TL95L40) with prescribed SST
- SST is statistically predicted based on the observed anomalies and El Niño prediction by JMA-CGCM3
- Ensemble size is 51
- Evaluated by 22-years hindcast

■ Statistical Models

- OCN (Recent 10-years mean) : Long-term trend & Decadal variation signal
- CCA (Lag relation between large scale SST pattern and Temp. & Prec. in Japan) : ENSO and Long-term trend & Decadal variation signal

2. Grounds for JMA's seasonal forecast for 2009/2010 winter

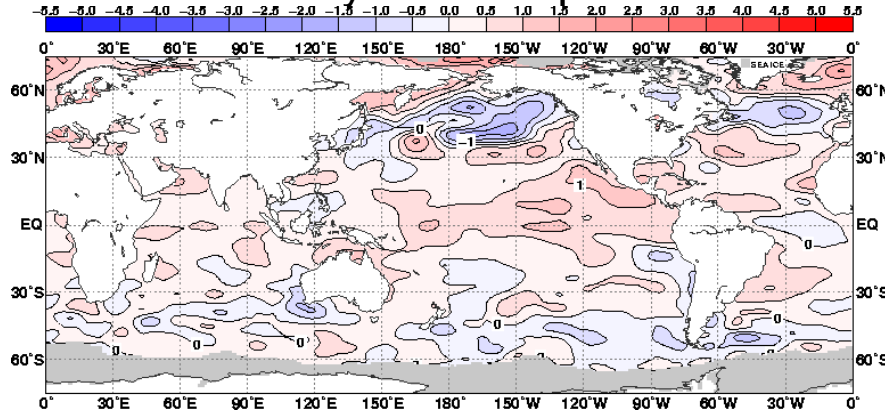
2.1 Current Oceanic Condition and El Niño Outlook

2.2 Numerical Prediction

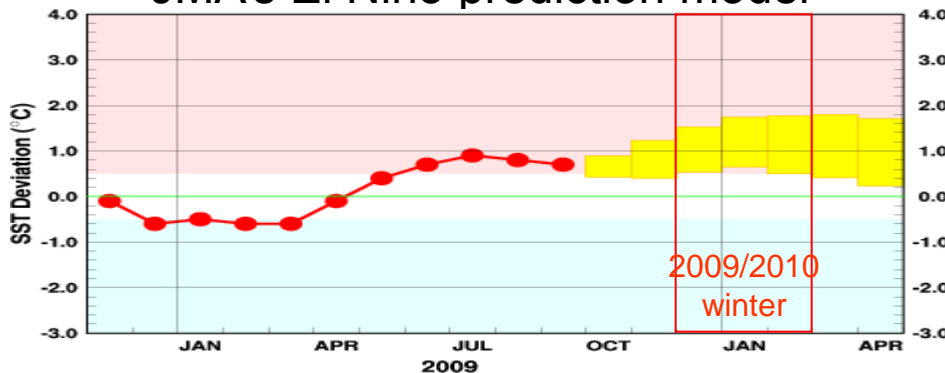
2.3 Long-term trend including decadal variation

Oceanic condition and outlook of El Niño

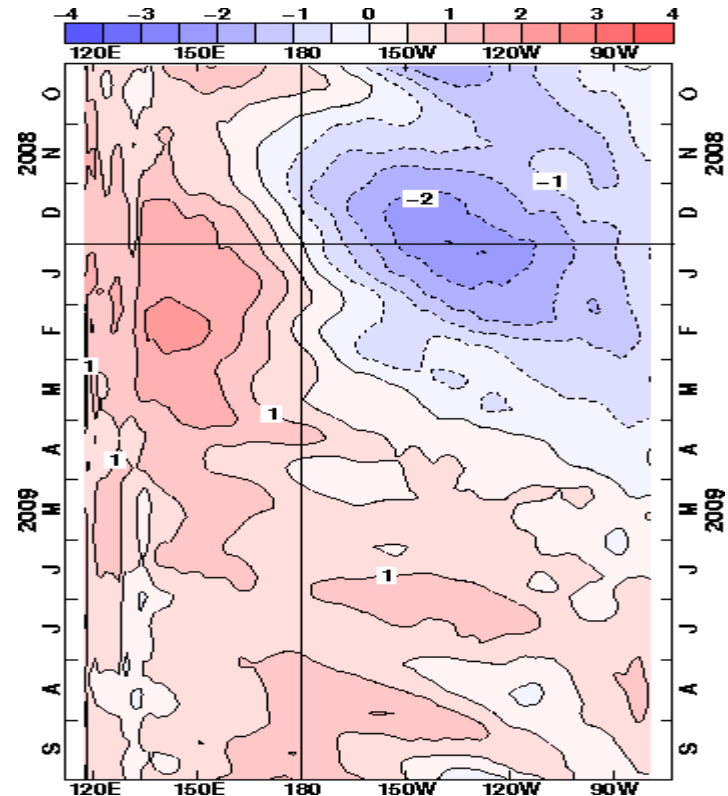
SST Anomaly 2009 Sep.



SST deviation over Niño.3 by JMA's El Niño prediction model



Time-longitude cross section of OHC in the equatorial (5S - 5N)



- SSTs were above normal in the whole equatorial Pacific.
- In the western and central Pacific, warm waters have been accumulated and are expected to migrate eastward.
- JMA's El Niño prediction model says NINO.3 will be above normal during winter.

2. Grounds for JMA's seasonal forecast for 2009/2010 winter

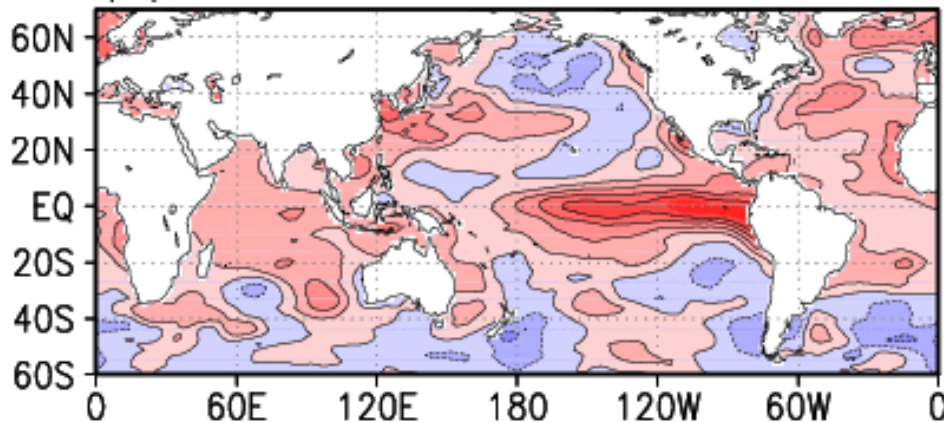
2.1 Current Oceanic Condition and El Niño Outlook

2.2 Numerical Prediction

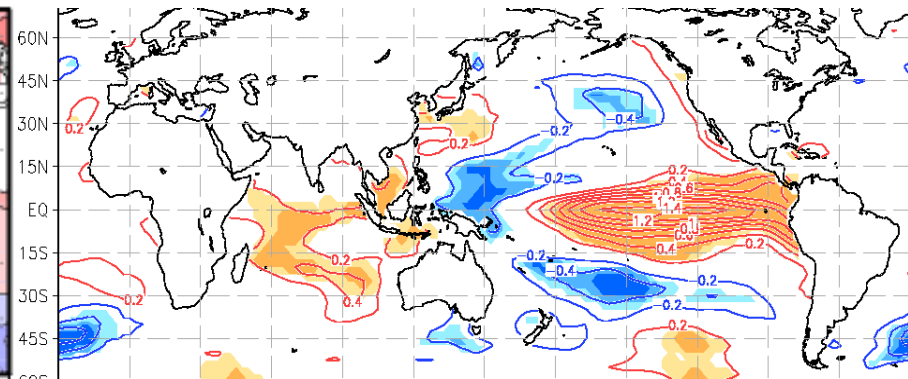
2.3 Long-term trend including decadal variation

SST anomalies fed to the model (DJF)

SSTA fed to the model (DJF 2009/2010)

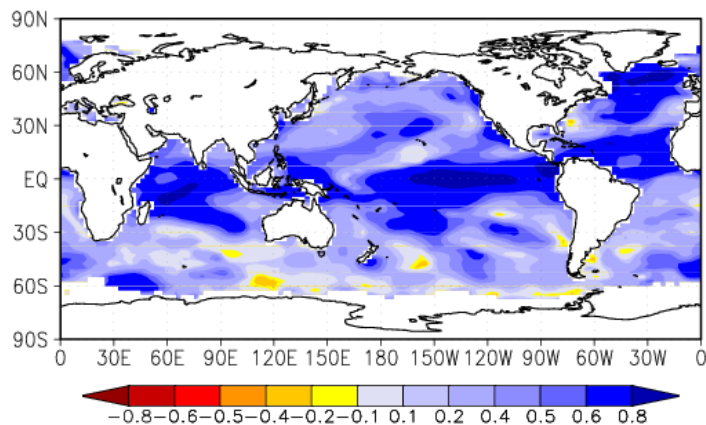


SSTA El Niño composite map (DJF)



Dark and light shadings show 95%, 90% confidence level based on T-test.

Prediction skill of SST
(Anomaly correlation) init:0810



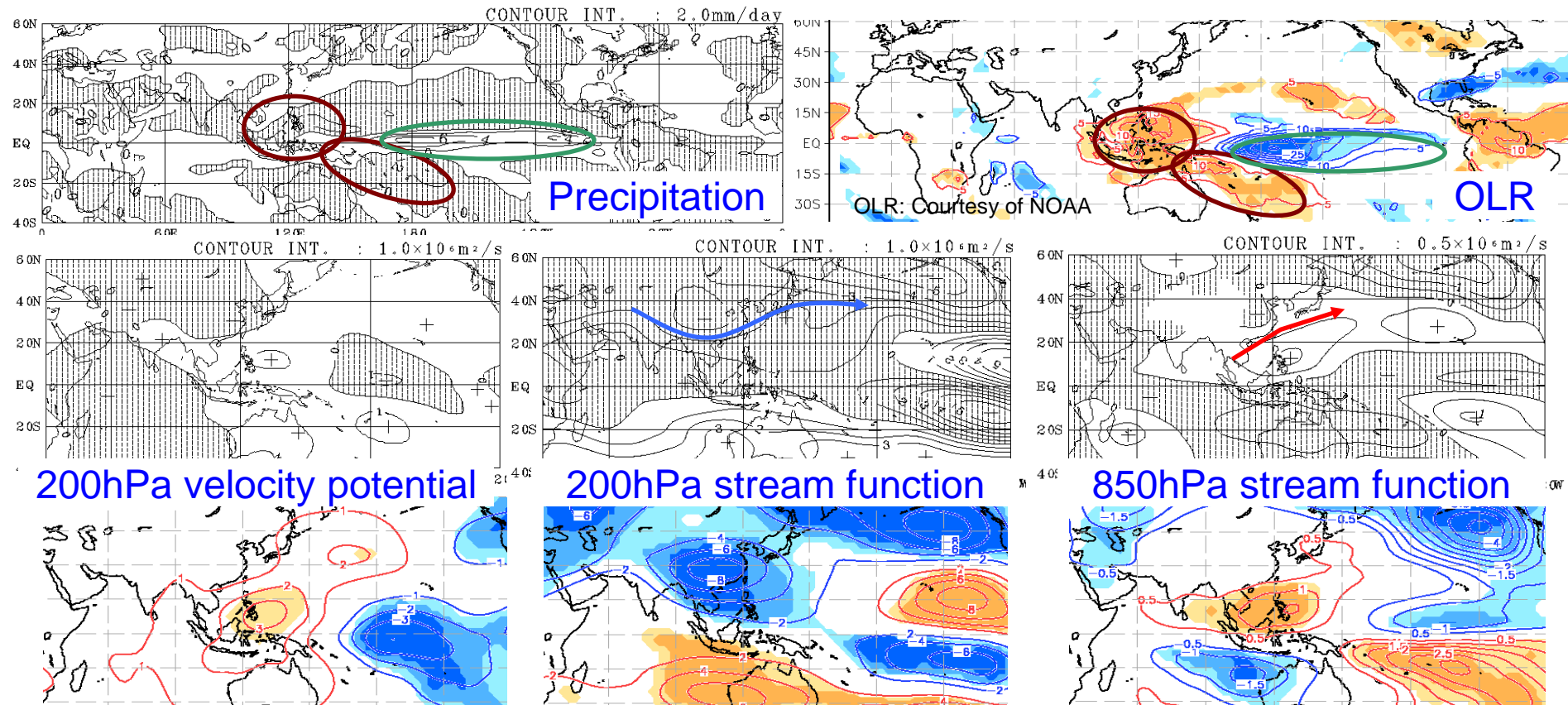
- The SST anomaly pattern fed to the atmospheric global model is very similar to that of El Niño events.

- Below normal western Pacific and above normal in the central and eastern Pacific, and in the Indian Ocean.

- Prediction skill of SST above key areas for ENSO is very high.

Tropics and sub-tropics (DJF)

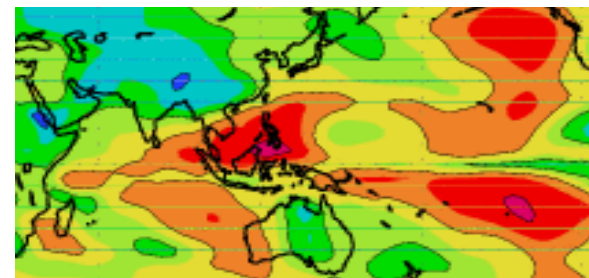
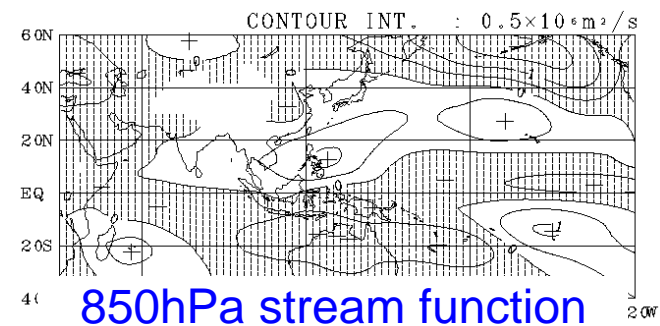
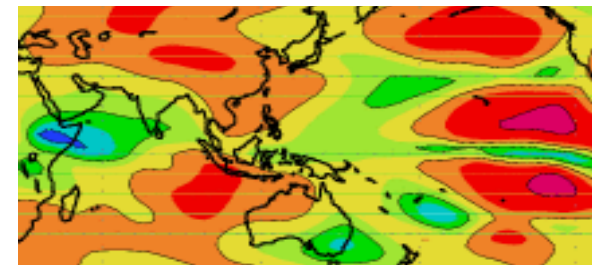
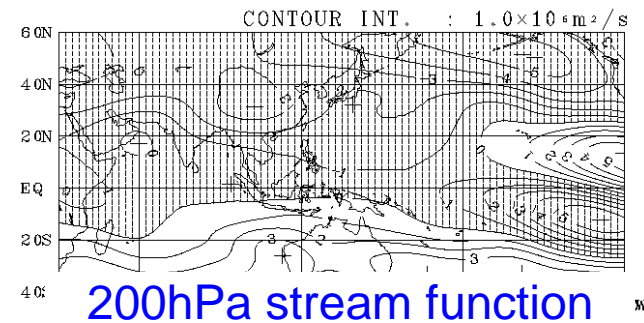
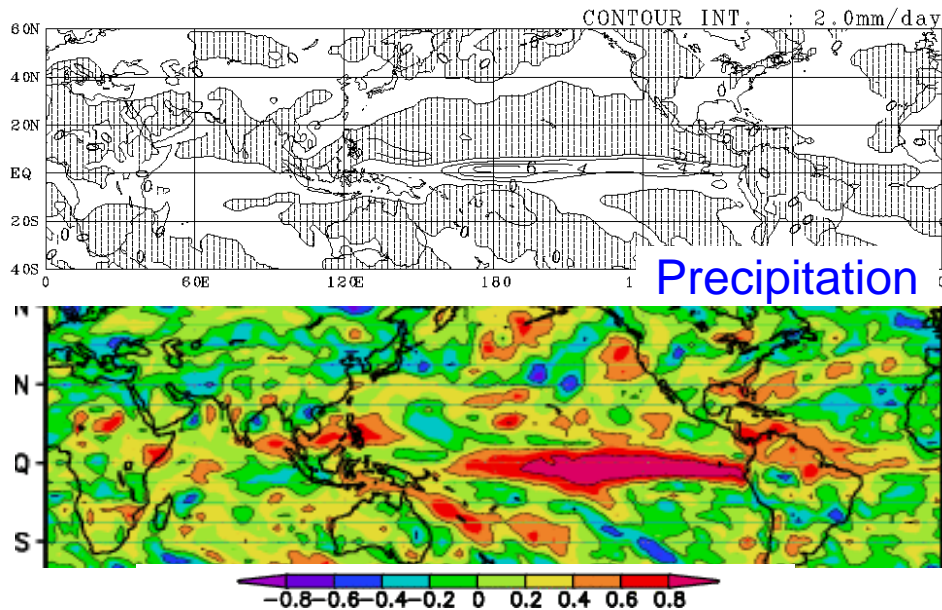
Black and white: numerical prediction (anomaly), Color: El Niño composite (anomaly)



- The predicted anomaly pattern is also very similar to that of El Niño events.
- In the lower troposphere, anti-cyclonic anomalies extending to the south of Japan suggests warm and humid air is likely to flow into the south of Japan.
- In the upper troposphere, cyclonic anomalies over East Asia indicates the subtropical jet stream shifts southward over China and northward over Japan, suggesting weak winter monsoon activity around Japan.

Prediction skill in the tropics

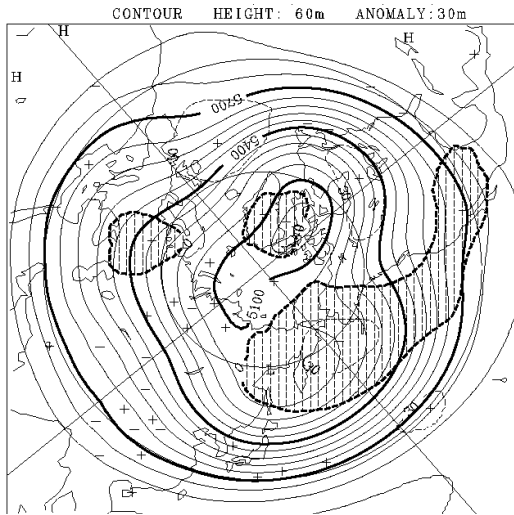
Black and white: numerical prediction (anomaly),
Color: Prediction skill (anomaly correlation)



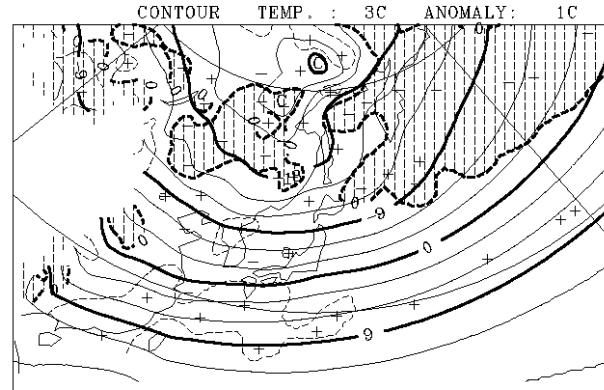
- These anomaly patterns associated with ENSO have high prediction skill according to the hindcast (22 years from 1984 to 2005).

Mid- and high-latitudes (DJF)

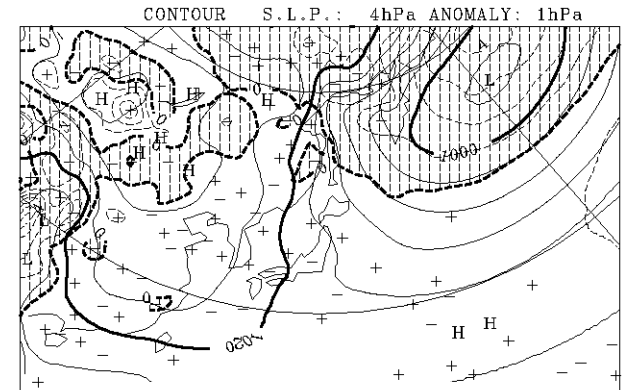
Black and white: numerical prediction (anomaly), Color: El Niño composite (anomaly)



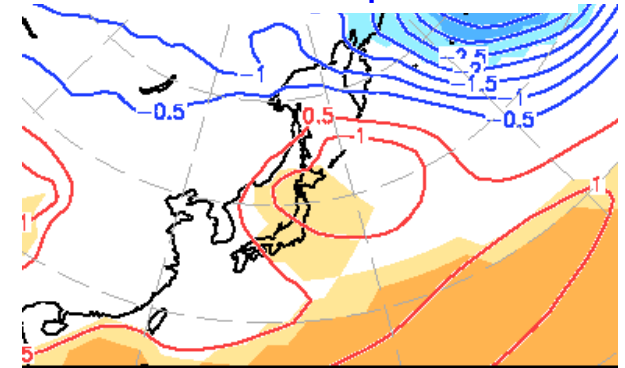
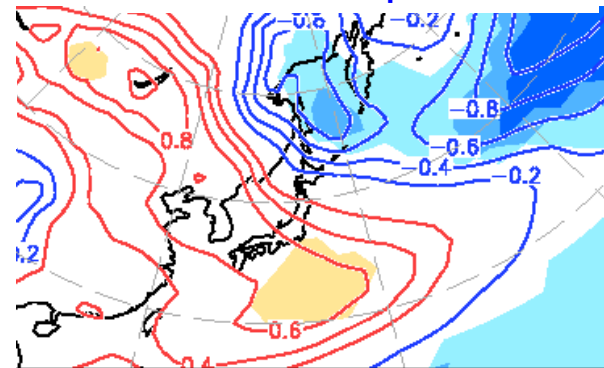
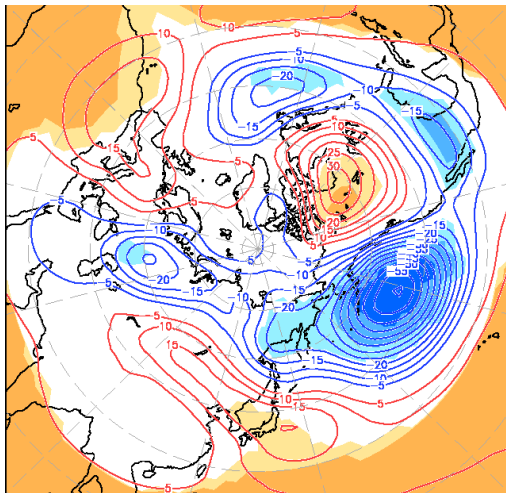
500hPa height



850hPa temperature



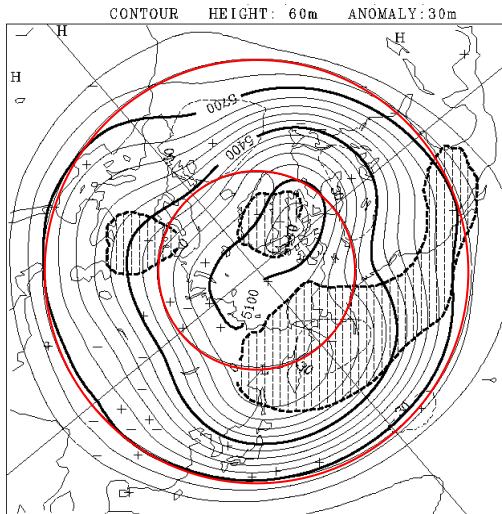
Sea surface pressure



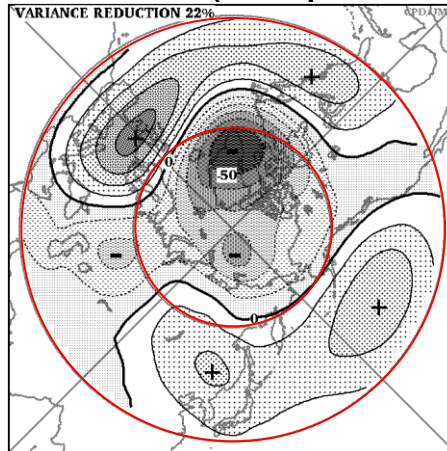
- The predicted anomaly pattern is also similar to that of El Niño events even in the extratropics.
- Positive anomaly is predicted around Japan, suggesting weak winter monsoon around Japan.
- However, eastward shift of the Aleutian lows is not clearly predicted. It suggests cold air might flow into the north of Japan more than typical El Niño events.

Prediction of the Arctic Oscillation (AO)

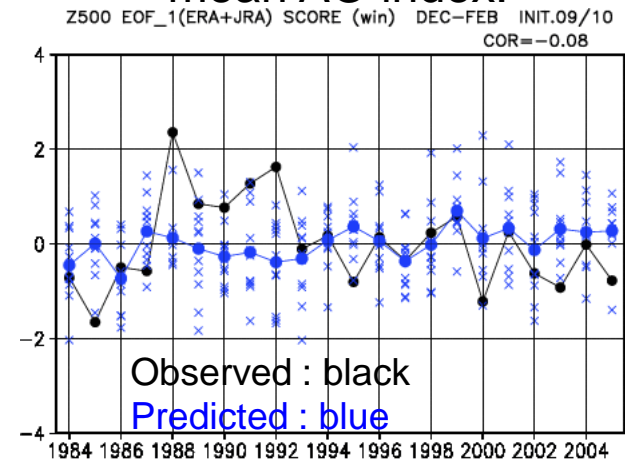
500hPa height (DJF)



EOF1 of 500hPa height in DJF (AO pattern)

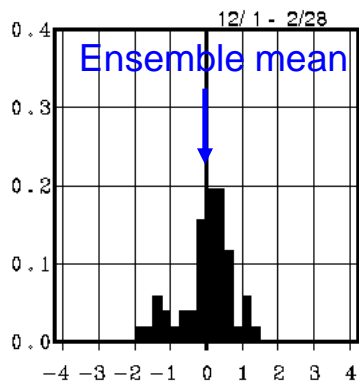


Observed and predicted DJF mean AO index.



Correlation : -0.08

Prediction of EOF1 score (AO index) for 2009/2010 DJF



- Positive (negative) phase of AO tends to cause weak (strong) winter monsoon, and above-normal (below-normal) temperature in northern part of Japan.
- The neutral phase of the Arctic Oscillation (AO) is predicted.
- However, the result of hindcast suggests the model does not have enough skill to predict the AO.

Numerical Prediction guidance



| | Temperature anomalies (deg) | Probabilities of three categories (%) | | |
|----------------|-----------------------------|---------------------------------------|----|----|
| | | B | N | A |
| Northern Japan | 0.5 | 18 | 27 | 55 |
| Eastern Japan | 0.7 | 5 | 31 | 64 |
| Western Japan | 0.7 | 8 | 37 | 55 |
| Okinawa/Amami | 0.8 | 3 | 15 | 82 |

B: Below Normal N: Near Normal A: Above Normal
 (Base period of normal is 1971-2000)

- Area averaged temperature anomalies obtained from the numerical prediction model is above normal whole of Japan.
- However, taking into consideration of neutral phase of AO, temperature anomaly in Northern Japan should be shifted to the climatological normal.

3. Summary

Conclusion

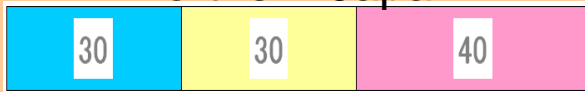
- From the numerical prediction, in response to the El Niño condition, above-normal temperature is expected in the winter in whole Japan with high confidence.
- However, considering the prediction skill of the AO, it is likely that temperature in Northern Japan will be lower than the result of the numerical prediction.
- As for the precipitation, favorable condition for the formation of cyclones over the south of Japan is expected to be above-normal precipitation in the Pacific side and southern part of Japan.



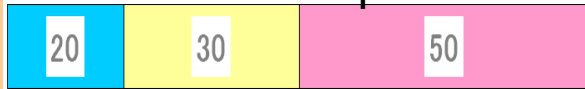
Summary of the outlook in 2009/2010 winter

Temperature

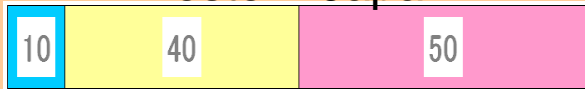
Northern Japan



Eastern Japan



Western Japan



Okinawa/Amami



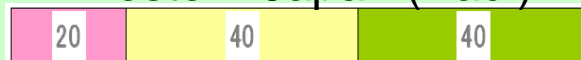
Precipitation

Only shown areas with significant probabilities

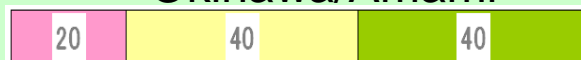
Eastern Japan (Pac.)



Western Japan (Pac.)

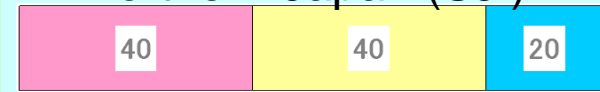


Okinawa/Amami



Snowfall

Northern Japan (SJ.)



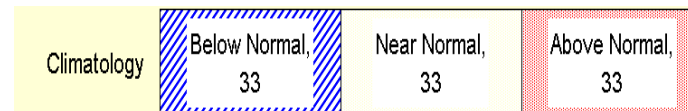
Eastern Japan (SJ.)



Western Japan (SJ.)



SJ. – Sea of Japan side
Pac.- Pacific side



JMA's CGCM

- JMA is preparing to replace the current 2-tiered long range forecast system (2-tiered AGCM) with the atmosphere-ocean coupled forecast system (CGCM) in February 2010.
- Outline of Model
- Verification (CGCM vs. 2-tiered AGCM)
- DJF 2009/2010 Forecast of CGCM

CGCM Outline

CGCM

| | |
|----------------------|---|
| AGCM | <ul style="list-style-type: none"> ■ T_L95L40 (horizontal resol. ~ 180km) ■ model top=0.4hPa |
| OGCM | <p>MRI.COM</p> <ul style="list-style-type: none"> ■ 75S-75N, 0-360E ■ horizontal resolution: lon 1.0°, lat 1.0° (lat 0.3° :tropics) ■ vertical resolution : 50 levels (23 levels in the upper 200m) |
| Ensemble size | <ul style="list-style-type: none"> ■ 51 |

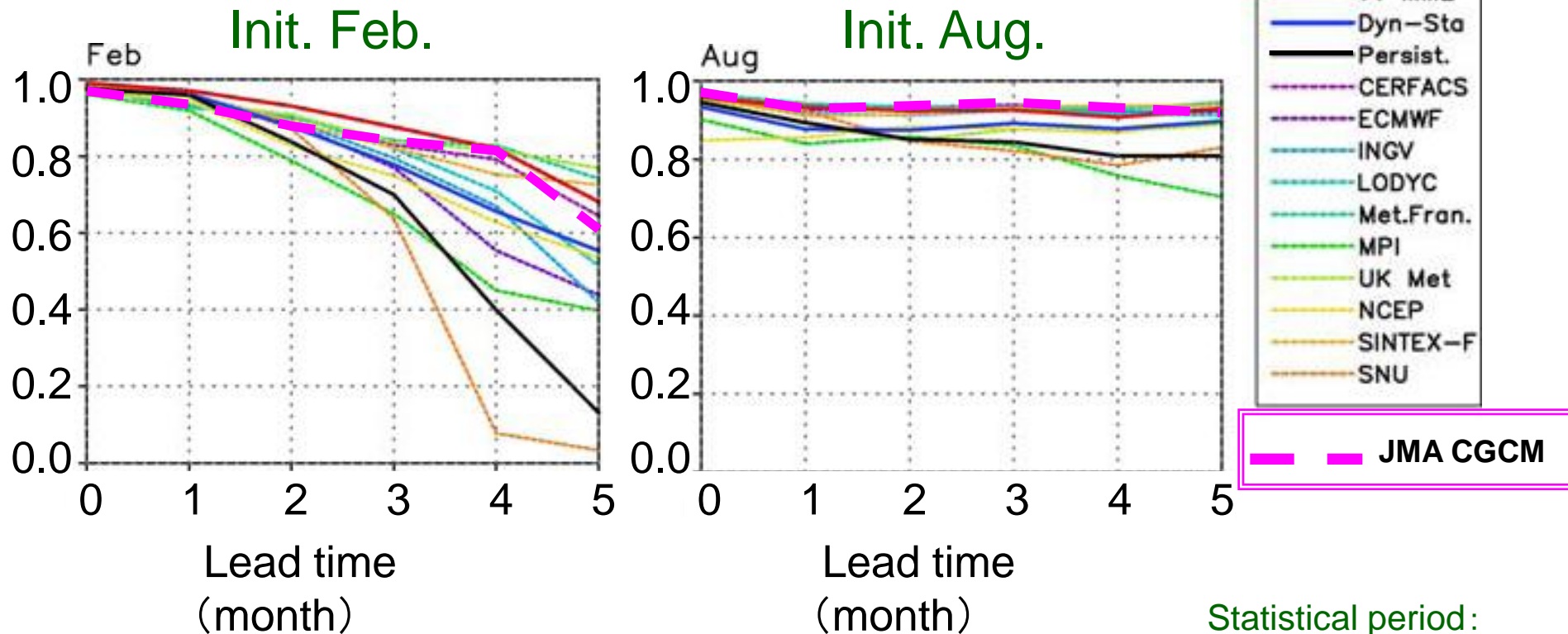
2-tiered AGCM

| | |
|----------------------|--|
| AGCM | <ul style="list-style-type: none"> ■ T_L95L40 (horizontal resol. ~ 180km) ■ model top=0.4hPa |
| SST | <ul style="list-style-type: none"> ■ Combination of Persisted anomaly + Predicted anomaly + Long-term trend |
| Ensemble size | <ul style="list-style-type: none"> ■ 51 |



Anomaly correlation of NINO.3.4 SST

Add the correlation of JMA's CGCM to Fig. 8 (Jin et al. 2008)



Statistical period:
1980-2001

NINO.3.4 in JMA's CGCM has the top level skill among many CGCM models.

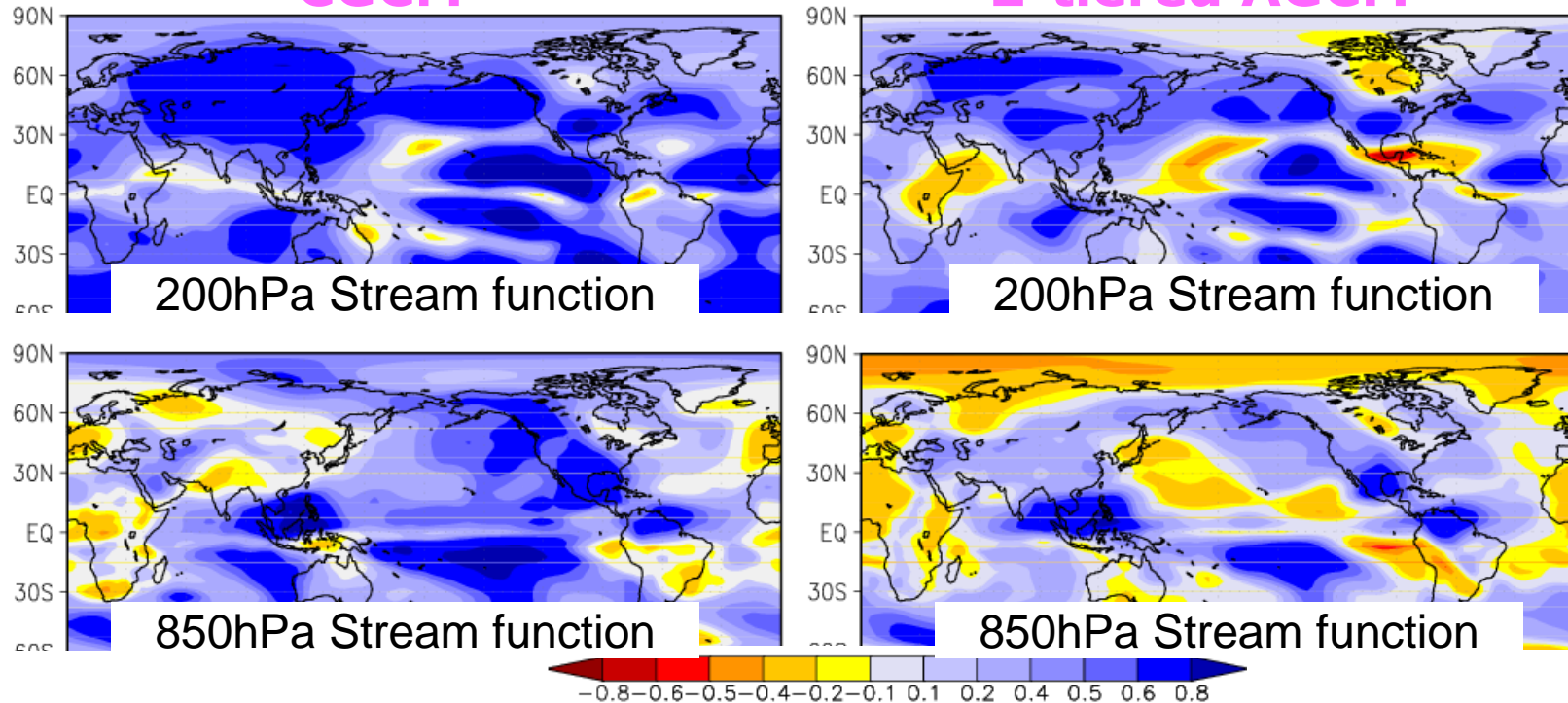
Jin E. K., James L. Kinter III, B. Wang, C.-K. Park, I.-S. Kang, B. P. Kirtman, J.-S. Kug, A. Kumar, J.-J. Luo, J. Schemm, J. Shukla and T. Yamagata, 2008: Current status of ENSO prediction skill in coupled ocean-atmosphere models. *Clim. Dyn.*, **31**, 647-666.

Comparison : CGCM vs. 2-tiered AGCM(2)

(ACC, 4-6 months lead prediction for DJF)

CGCM

2-tiered AGCM



Figures show correlation coefficients (ACC) between analyzed anomalies and ensemble mean anomalies of 200hPa (upper) and 850hPa (lower) stream function at each grid box. Verification period is 1984-2005 (22yr).

Circulation anomalies both lower and upper troposphere are predicted in the CGCM especially in the ENSO related areas much better than operational AGCM.

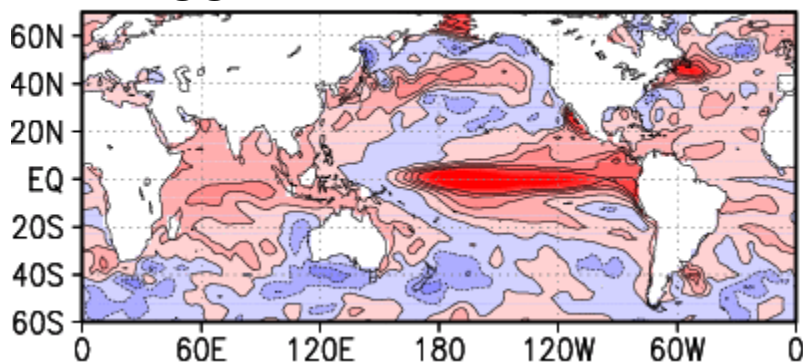
i.e. Equatorially symmetric anti-cyclonic and cyclonic circulation anomalies from the Indian Ocean to the Pacific.

>Forecast capability of Asian winter monsoon circulation especially in the upper troposphere is expected to be improved.

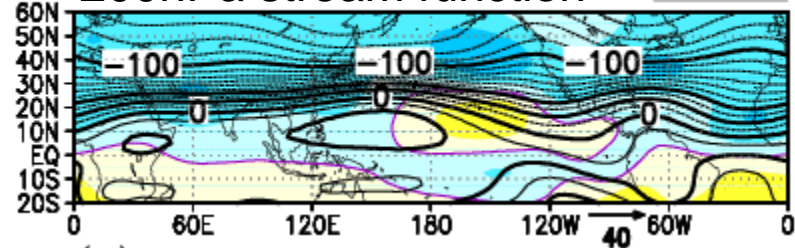
DJF 2009/2010 Forecast of CGCM

- SST, tropics and subtropics -

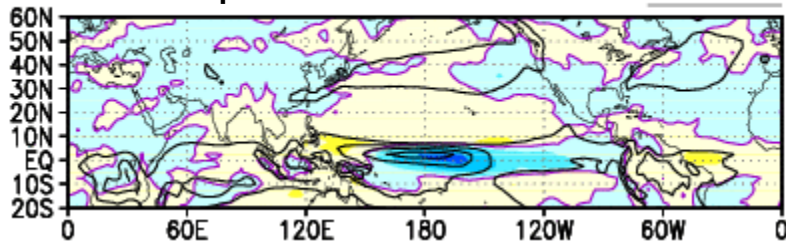
SST



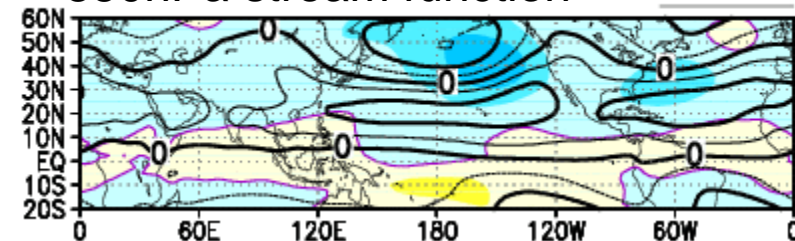
200hPa stream function



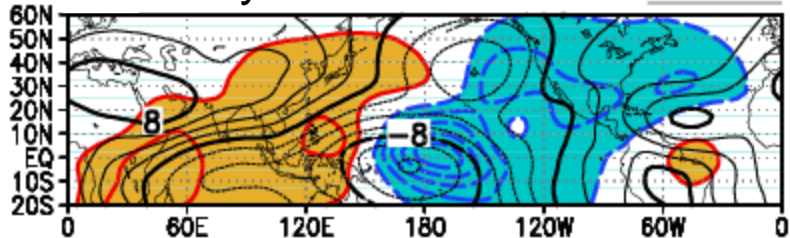
Precipitation



850hPa stream function



Velocity Potential



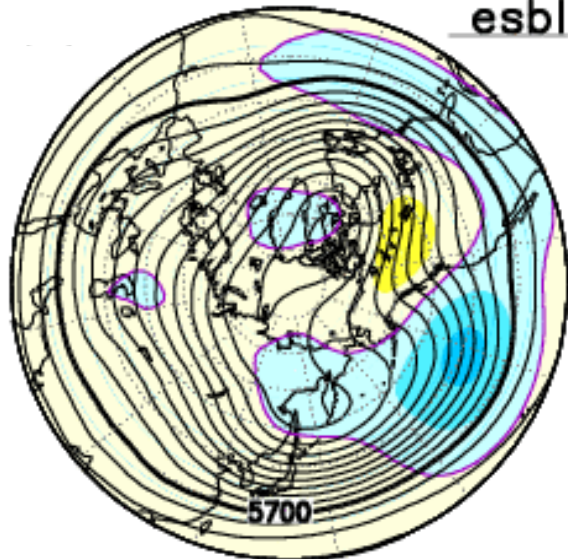
- El Niño pattern in the SSTA and El Niño response are clearly predicted in the precipitation and circulation anomalies.

DJF 2009/2010 Forecast of CGCM

- Extratropics -

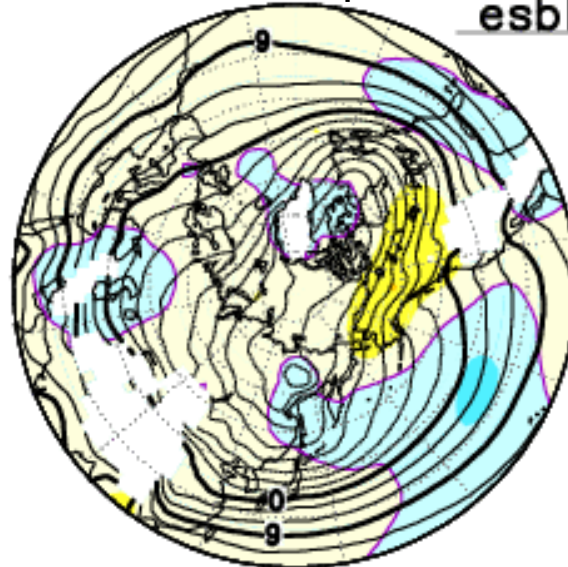
500hPa height

esbl



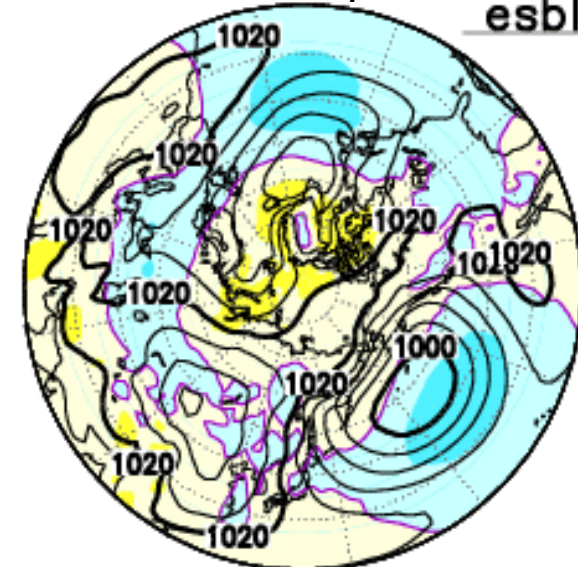
850hPa temperature

esbl



Sea surface pressure

esbl



- In the extratropics, El Niño responses are also clearly predicted such as eastward shift of Aleutian low and positive anomalies around Japan.
- These characteristics are almost the same as in the 2-tiered AGCM, except eastward shift of Aleutian low.

--> Our conclusion that warm winter is expected in Japan, is fortified by the new CGCM.



Thank you
for your attention!



The best Sumo wrestler 'Hakuho'
coming from Mongolia

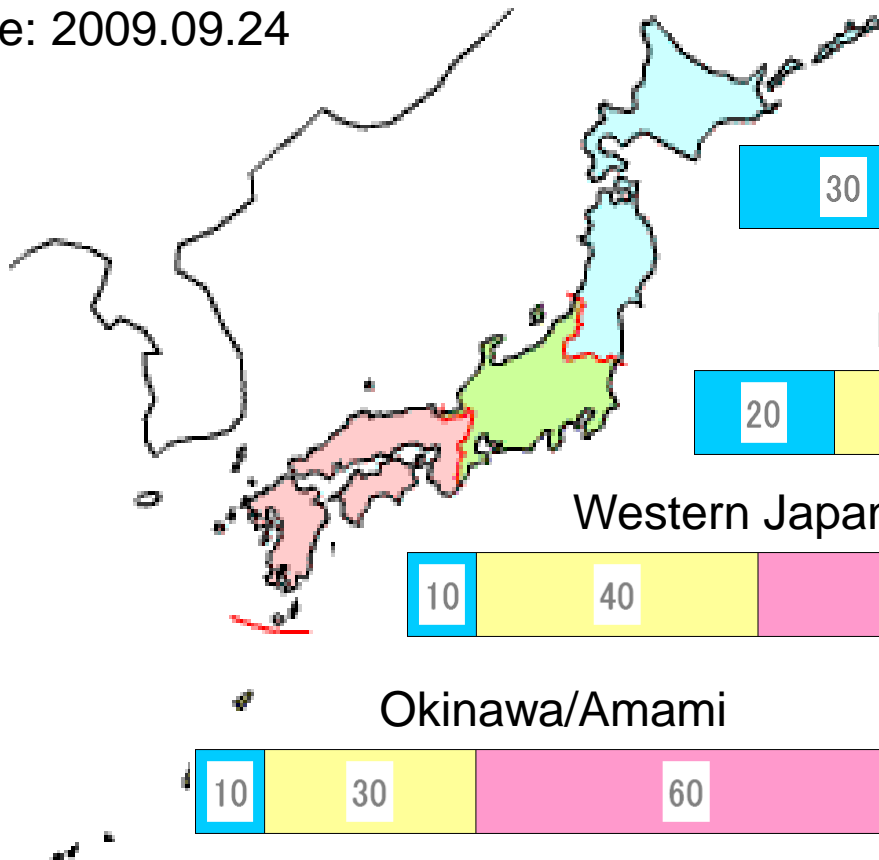
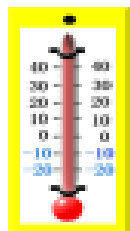
ありがとうございました

パヤル“ル, ラ～,
コマプスムニダ
シェーシェー



Probability of 2009/2010 DJF Temperature

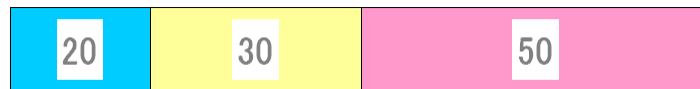
Issue date: 2009.09.24



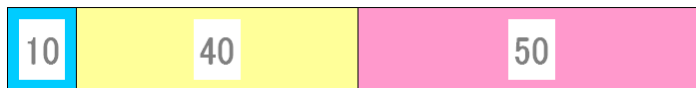
Northern Japan



Eastern Japan



Western Japan



Okinawa/Amami



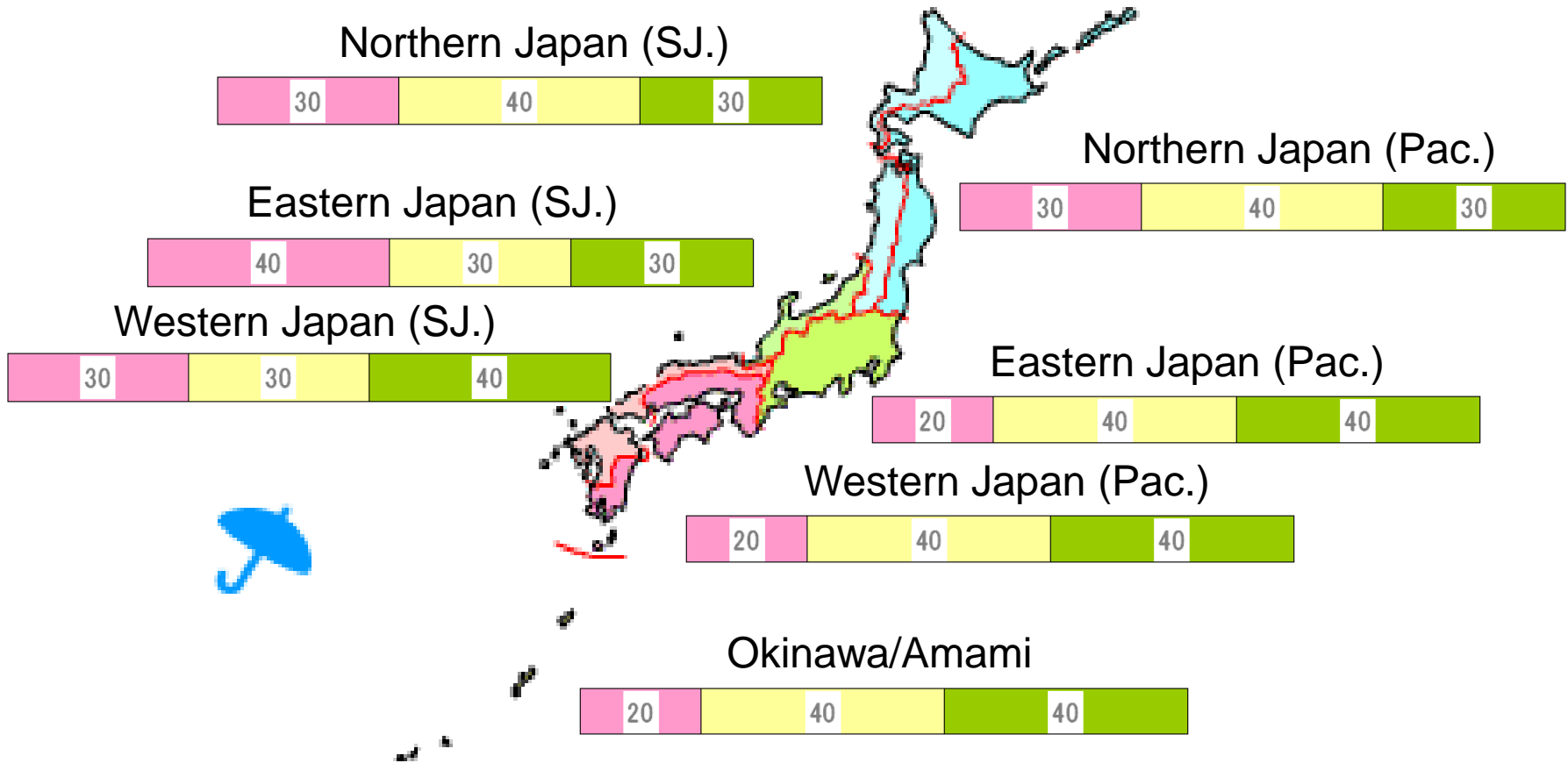
Climatology



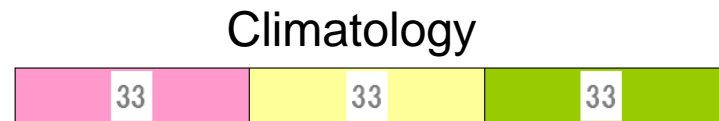
Base period of normal is 1971-2000

Probability of 2009/2010 DJF Precipitation

Issue date: 2009.09.24



SJ. – Sea of Japan side
Pac.- Pacific side

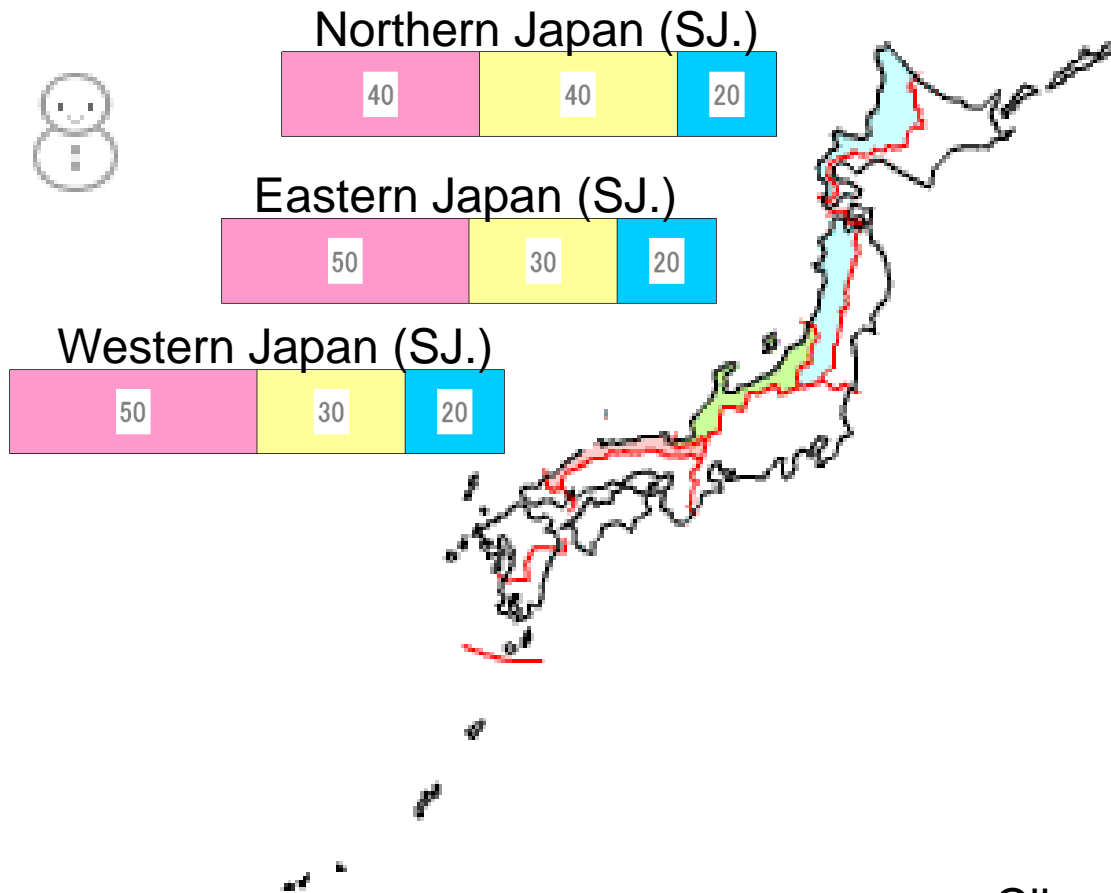


Base period of normal is 1971-2000



Probability of 2009/2010 DJF Snowfall

- Only the Sea of Japan side -



SJ. – Sea of Japan side

Pac.- Pacific side

Climatology

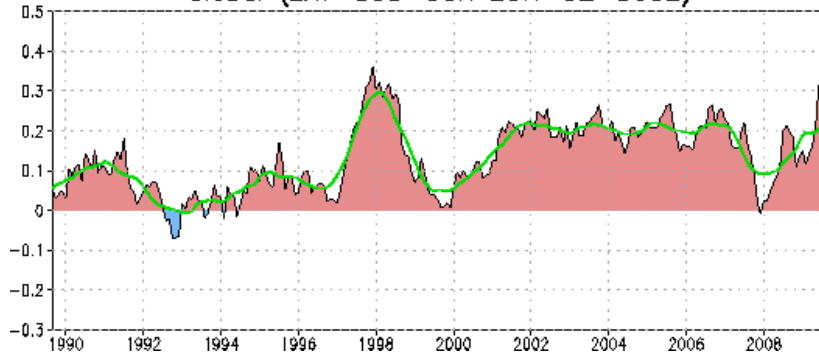


Base period of normal is 1971-2000

Time series of global SST anomalies

Global SSTA

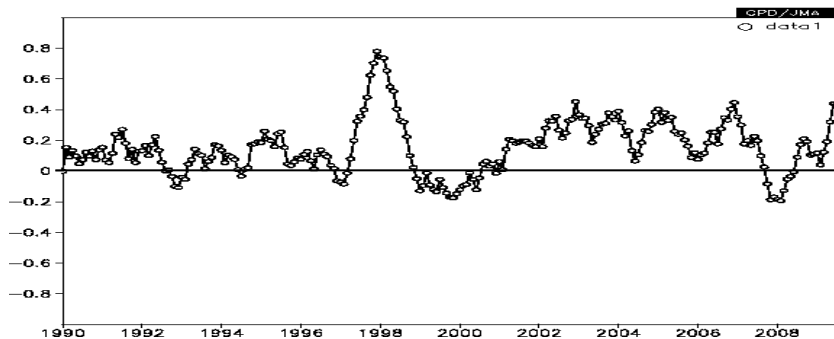
Global (LAT=80S-80N LON=0E-360E)



10 warmest years of global SST since 1880

| Rank | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|------|------|------|------|------|------|------|------|------|------|
| 1 | 1998 | 1998 | 1998 | 1998 | 1998 | 2009 | 2009 | 2009 | 1997 |
| 2 | 2007 | 2007 | 2002 | 2002 | 2005 | 1998 | 1998 | 1998 | 2006 |
| 3 | 2005 | 2004 | 2003 | 2005 | 2002 | 2002 | 2005 | 2005 | 2009 |
| 4 | 2002 | 2005 | 2005 | 2001 | 2009 | 2005 | 2007 | 2006 | 2003 |
| 5 | 2004 | 2002 | 2001 | 2006 | 2006 | 2001 | 2003 | 2003 | 2005 |
| 6 | 1988 | 2003 | 2004 | 2004 | 2003 | 2006 | 2001 | 1997 | 2004 |
| 7 | 2006 | 1988 | 2007 | 2003 | 2001 | 2003 | 1997 | 2008 | 2001 |
| 8 | 2009 | 2006 | 2006 | 2009 | 2004 | 1997 | 2006 | 2004 | 2008 |
| 9 | 2003 | 2001 | 2009 | 2007 | 1997 | 2007 | 2008 | 2001 | 2002 |
| 10 | 1983 | 1983 | 1988 | 1997 | 2007 | 2004 | 2002 | 2002 | 1987 |

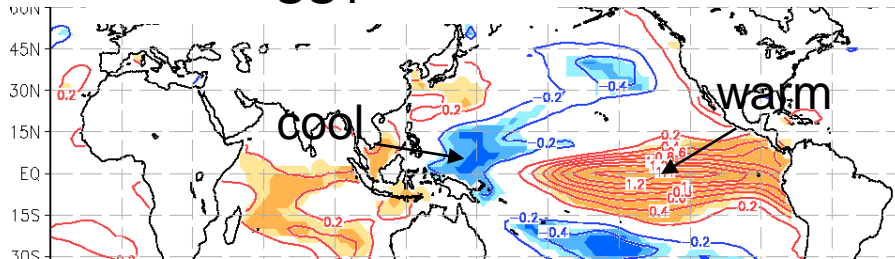
Tropical SSTA(-20S~20N, 0-360E)



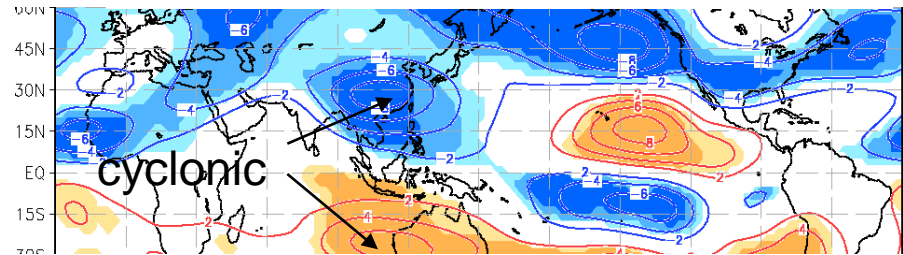
- In recent years, positive global SSTA has persisted.
- In particular, from June to August 2009, global SSTA consecutively set a new record for the month.
- Since the El Niño condition will continue, global SSTA will continue to be above normal during the coming winter.

El Niño composite maps (DJF) – tropics

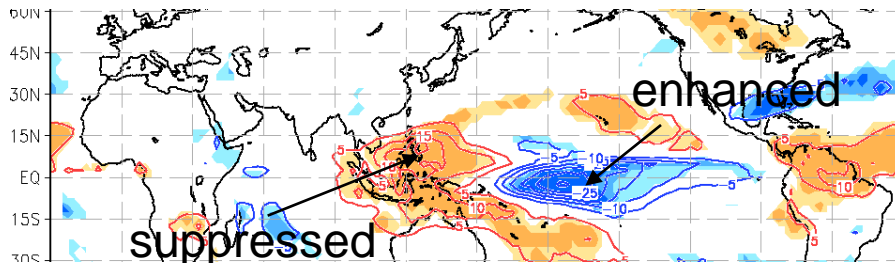
SST



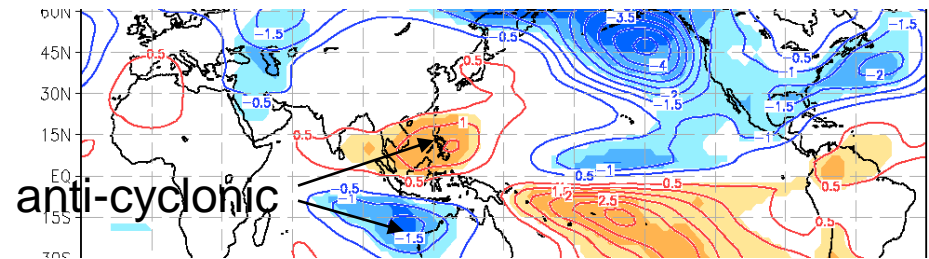
200hPa stream function



OLR



850hPa stream function

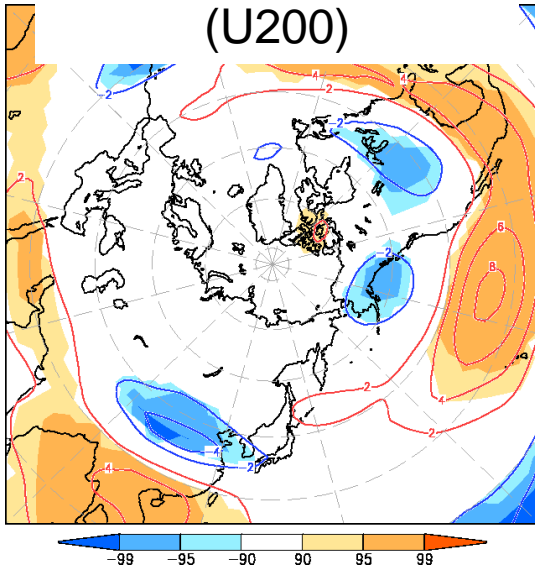


Dark and light shadings show 95%, 90% confidence level based on T-test.

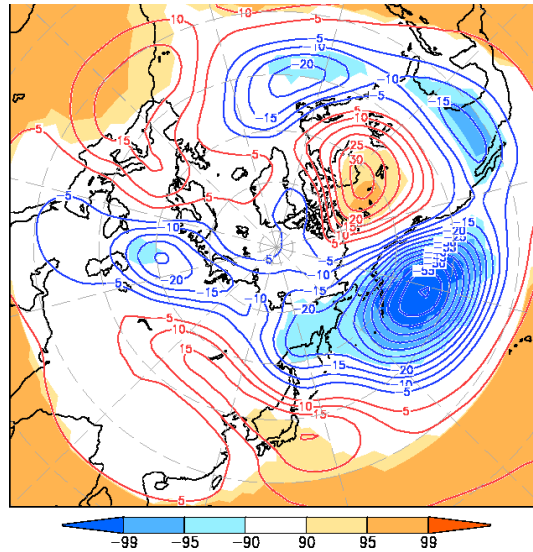
- OLR : Convective activities are enhanced over central to eastern Pacific, while they are suppressed over the Maritime continent.
- 850hPa S. F. : Equatorially symmetric anti-cyclonic and cyclonic circulation anomalies are seen from the Indian Ocean to Indonesia.
- 200hPa S. F. : Equatorially symmetric cyclonic and anti-cyclonic circulation anomalies are seen over East Asia and the South Indian Ocean.

El Niño composite maps (DJF) - extratropics

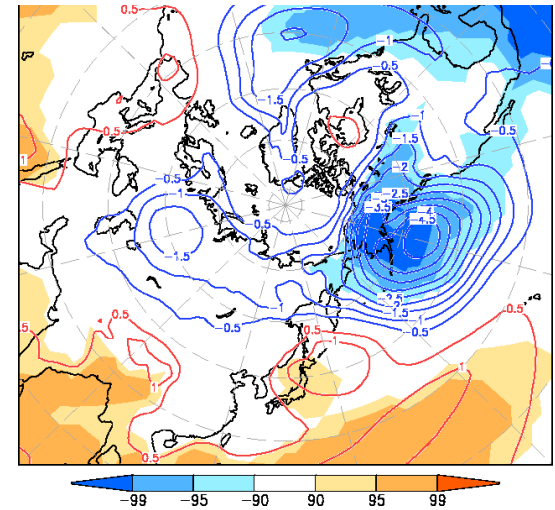
200hPa zonal wind
(U200)



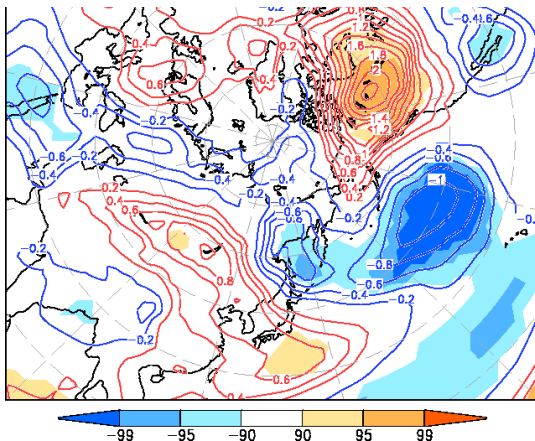
500hPa height (Z500)



Sea surface pressure
(Psea)



850hPa temperature
(T850)



- Z500 (Psea) : Aleutian low shifts eastward and positive anomaly is seen around Japan, suggesting weak winter monsoon around Japan.
- T850 : Positive anomaly is seen over Japan except northern edge.
- U200 : The subtropical jet stream shifts southward over China and northward over Japan.

2. Grounds for JMA's seasonal forecast for 2009/2010 winter

2.1 Current Oceanic Condition and El Niño Outlook

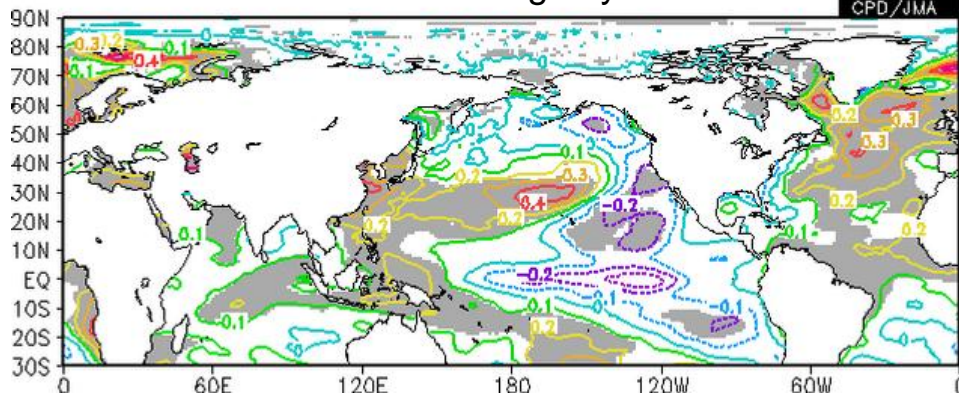
2.2 Numerical Prediction

2.3 Long-term trend including decadal variation

DJF Oceanic and Atmospheric fields

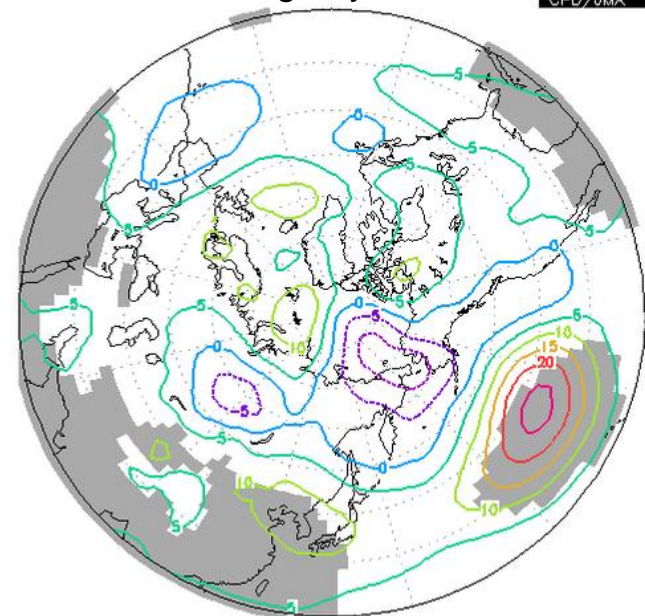
- linear trend from 1979 to 2008 -

SST deg/30year

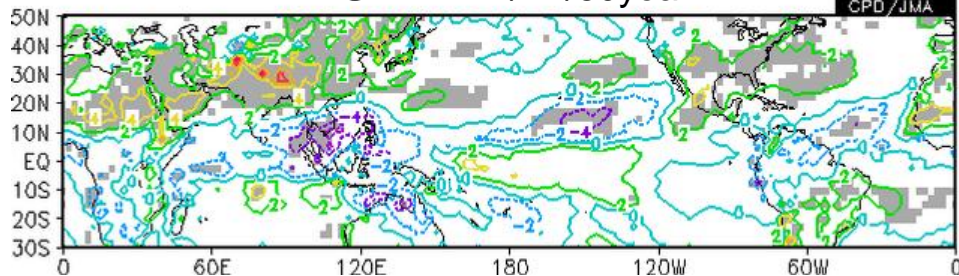


500hPa height

deg/30year

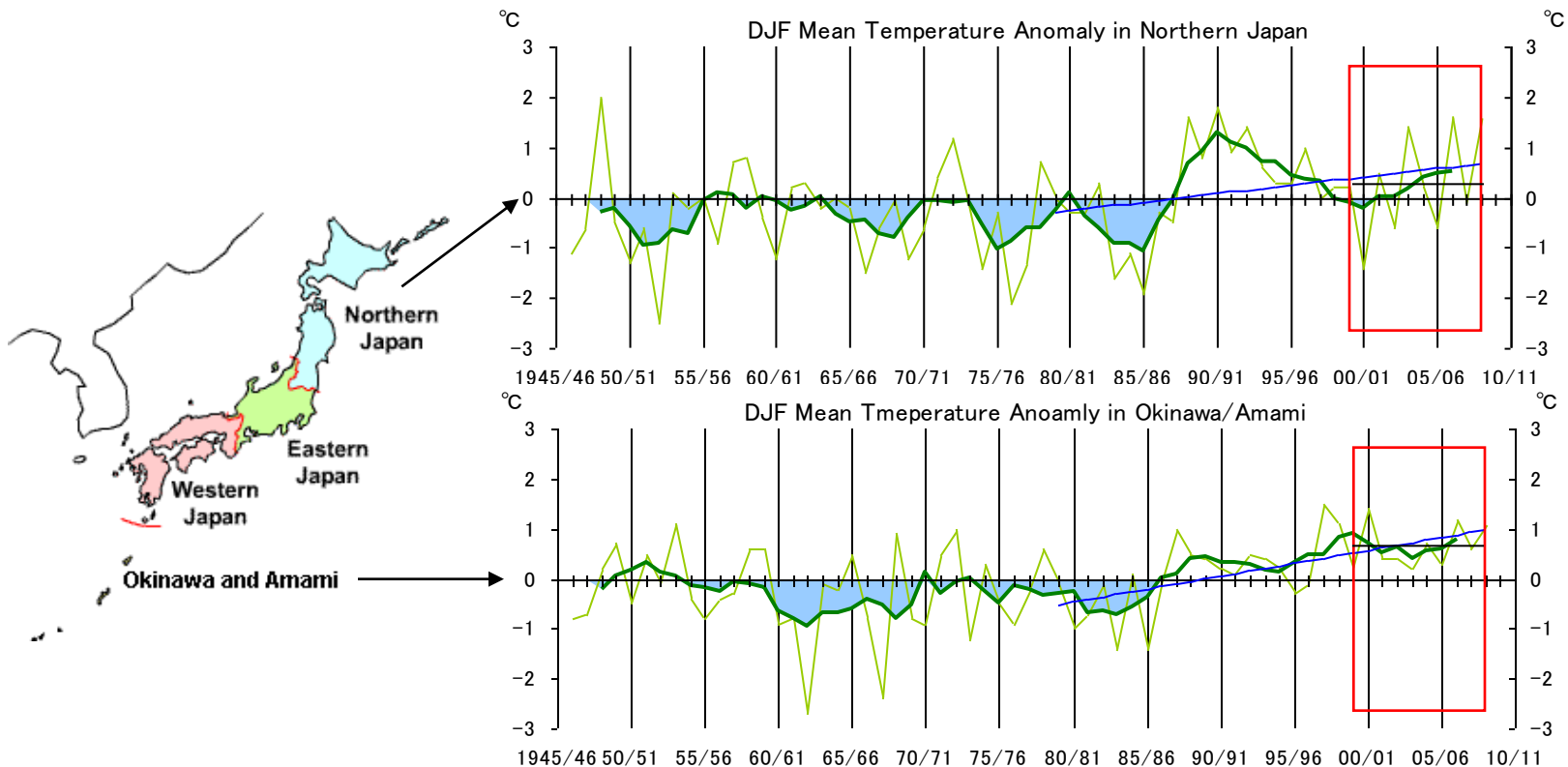


OLR $W/m^2/30year$



- La Niña like trend is seen in SST.
- Active convection is seen over the Maritime Continent.
- Positive trend in 500hPa height is observed from southern Eurasia to eastern Japan.
- Negative trend in 500hPa height is observed over northern part of the North Pacific.

DJF mean temperature in Japan



- Long-term upward trends are clearly seen in winter mean temperatures over Okinawa/Amami, especially in recent 30 years.
- In Northern Japan, the winter mean temperature has large year-to-year fluctuations and the recent ten-winters-mean temperature is near normal partly affected by weak negative phase of AO decadal oscillation.

Statistical guidance : OCN

OCN : Optimal Climate Normal

Statistical guidance based on the recent 10-years climate

(Prediction based on Long-term trend & Decadal variation)



| | Temperature anomalies (deg) | Probabilities of three categories (%) | | |
|----------------|-----------------------------|---------------------------------------|----|----|
| | | B | N | A |
| Northern Japan | 0.3 | 30 | 30 | 40 |
| Eastern Japan | 0.5 | 10 | 40 | 50 |
| Western Japan | 0.5 | 10 | 60 | 30 |
| Okinawa/Amami | 0.7 | 0 | 30 | 70 |

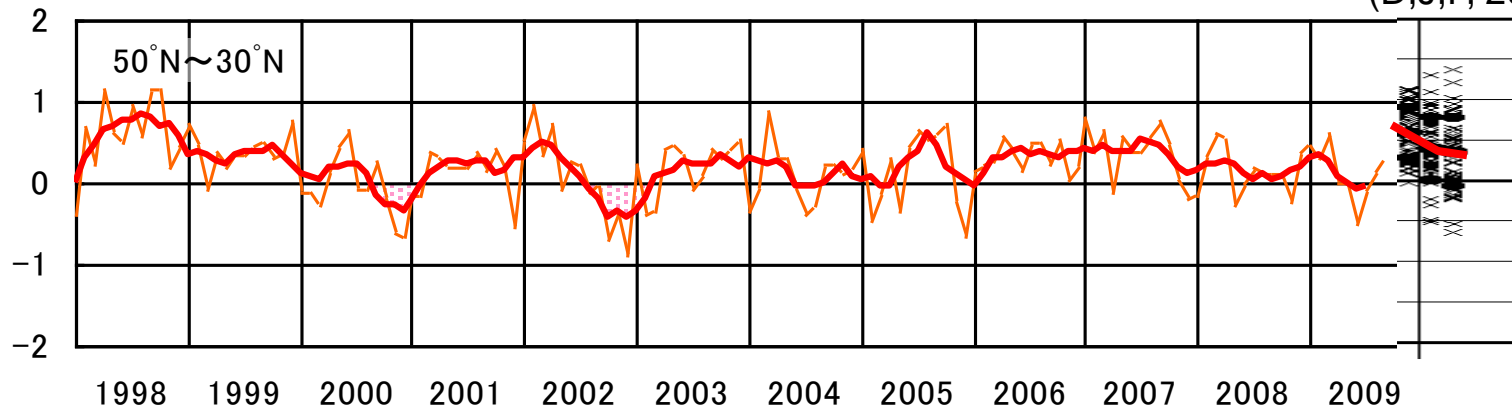
B: Below Normal N: Near Normal A: Above Normal
 (Base period of normal is 1971-2000)

- In Northern Japan, the recent ten-winters-mean temperature does not have clear tendency.
- In Eastern and Western Japan, the recent ten-winters-mean temperature is near or above normal.
- In Okinawa/Amami, it is above normal.

Tropospheric temperature in the mid-latitude

Zonal mean tropospheric temperature anomaly in the mid-latitude (300-850hPa, 30-50N)

Numerical prediction
(D, J, F, 2010)



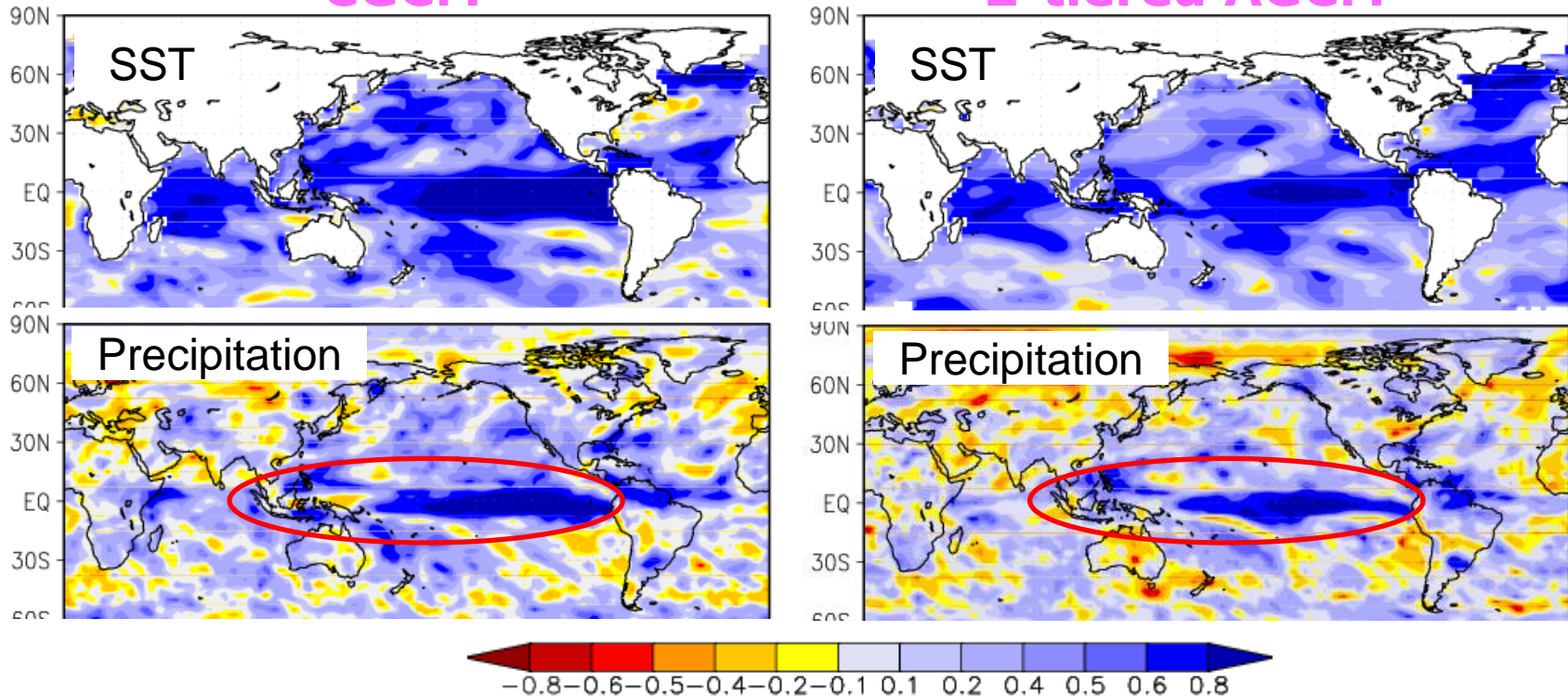
- The tropospheric thickness temperature averaged over the mid-latitudes of the Northern Hemisphere (30 N - 50 N) is positively correlated with temperature in Japan.
- It tends to be above normal since 2006.
- It is predicted to continue to be above normal because of (record-breaking) positive global SST anomaly.

Comparison : CGCM vs. 2-tiered AGCM(1)

(ACC, 4-6 months lead prediction for DJF)

CGCM

2-tiered AGCM



Figures above show correlation coefficients (ACC) between analyzed anomalies and ensemble mean anomalies of SST (upper figures) and precipitation (lower figures) at each grid box. Verification period is 1984-2005 (22yr) and verification datasets used here are COBE-SST for SST, and GPCP for precipitation. ACCs are positive in the areas colored blue.

SST anomalies and precipitation anomalies are well predicted in the CGCM from the Maritime Continent to the tropical Pacific.

1) Oceanic conditions

- El Niño conditions currently prevail and are likely to continue until the coming winter.
- Since El Niño events are the most important climate events as grounds for the seasonal prediction and high predictability of the coming winter season prediction is expected.
- In recent years, above normal SST anomalies have persisted over most of the world. As the El Niño condition will continue, the global averaged SST anomaly will continue to be above normal during the coming winter.

2) Numerical Prediction

- The SST anomaly pattern fed to the atmospheric global model is very similar to that of El Niño events.
- The predicted ensemble averaged atmospheric circulation anomaly pattern is also very similar to that of El Niño events.
- In the lower troposphere, anti-cyclonic anomalies predicted over Indonesia extending to the south of Japan suggests warm and humid air is likely to flow into the south of Japan and create favorable condition for the formation of cyclones.
- In the upper troposphere, cyclonic circulation anomalies predicted over East Asia indicates subtropical jet streams shift southward over China and northward over Japan, suggesting weak winter monsoon activity.
- These anomaly patterns associated with the El Niño event have high prediction skill according to the hindcast (22 years from 1984 to 2005).
- On the other hand, the AO predicted neutral phase does not have enough skill according to the hindcast.

3) Long-term trend and decadal variation

- In Northern Japan, the winter mean temperature has large year-to-year fluctuations and the recent ten-winters-mean temperature is near normal partly affected by weak negative phase of AO decadal oscillation.
- The tropospheric temperature over the mid-latitudes (30 N - 50 N) is predicted to continue to be above normal because of world wide positive SST anomaly.

The outline of Current and New seasonal prediction system at JMA

| Outline | Current system (AGCM) | New system (CGCM) |
|------------------------------------|---|---|
| AGCM | GSM0703C [TL95(~180 km)L40] | GSM0603C [TL95(~180 km)L40] |
| Ocean GCM | --- | MRI.COM ^{※1} 1.0 deg in longitude, 0.3-1.0 deg in latitude and 50 levels 75N-75S, 0-360E |
| Ensemble size (Ensemble method) | 51 (SV; Singular Vector) | 51 (9 BGM, 5-day LAF) Ocean is driven with 5 BGM of AGCM for preceding 10 days) |
| SST | 2-tiered (persisted anomaly + Prediction) | 1-tiered (flux adjustment) |
| CO ₂ | constant | trend |
| Initials of atmosphere | JMA global analysis | JCDAS ^{※2} |
| Initials of ocean | --- | MOVE/MRI.COM-G ^{※3} (Ocean Data Assimilation) |
| Sea Ice, Initials of lands | Climatology | Climatology |
| Hindcast | Current system (AGCM) | New system (CGCM) |
| forecast range | 120-210 days | 7 months |
| ensemble size | 11 (SV) | 10 (5 BGM, 15-day LAF) |
| period | 1984-2005 (22 years), once a month | 1979-2008 (30 years), the last & 15 th day of each month |
| Verification data | Atmosphere elements: JRA-25/JCDAS, SST: COBE-SST, Precipitation: GPCP | |

Details of the system can be found at

※1 http://ds.data.jma.go.jp/tcc/tcc/products/elnino/jmamri_cgcm_doc.html ※2 http://jra.kishou.go.jp/JRA-25/index_en.html

※3 http://ds.data.jma.go.jp/tcc/tcc/products/elnino/move_mricom_doc.html