Interpretation of Outputs from Numerical Prediction System

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Points of Your Presentations

- Evaluation of the numerical model results
  - Convective activity including MJO
  - Atmospheric circulation
    (internal variability and response to the convection)
  - Prediction skill (ACC maps)
  - Temporal change (1st, 2nd and 3-4th week maps)
- Evaluation of the guidance
- Your final forecast

Contents

- Access to the forecast/verification maps from TCC-HP
- Interpretation of the model outputs (initial: 7 Nov. 2018)
  - 1-month average
  - 1^{st}, 2^{nd} and $3\text{-}4^{th}$ weeks

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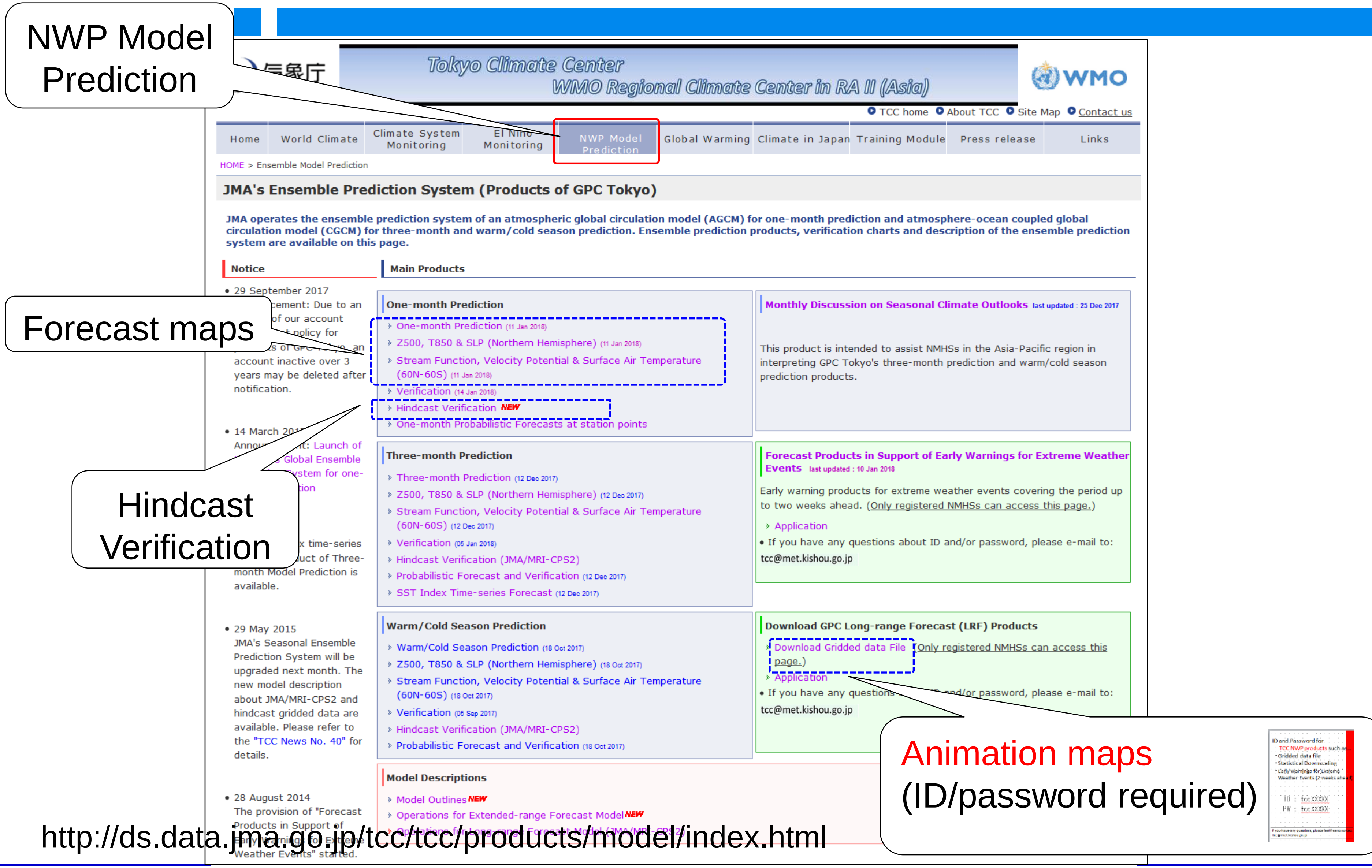
Access to the EPS Products on TCC-HP

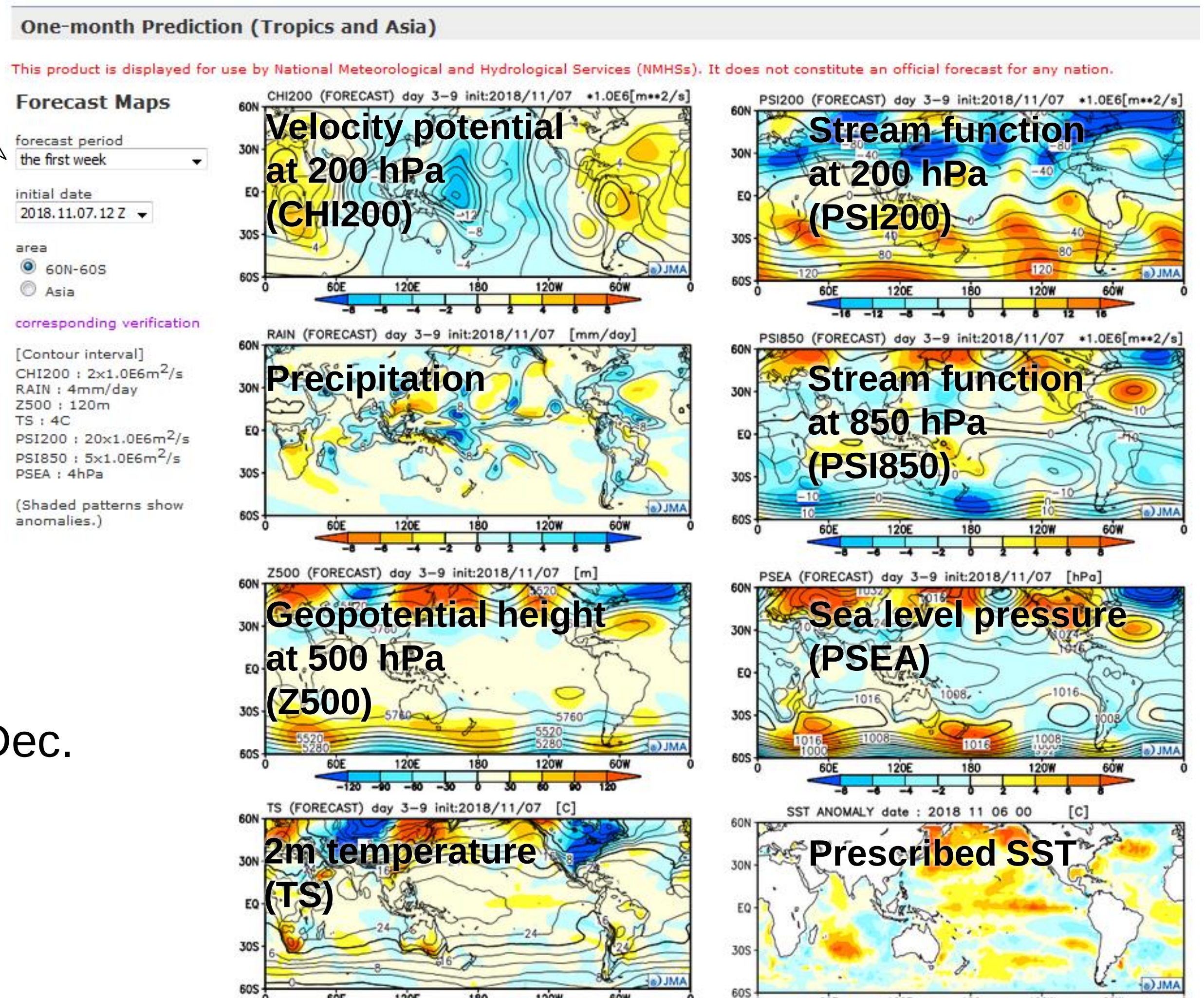


http://ds.data.jma.go.jp/tcc/tcc/products/model/index.html

Forecast Map (Tropics)

1st week: 3-9 days
2nd week: 10-16 days
3rd & 4th week: 17-30 days
28 days mean: 3-30 days

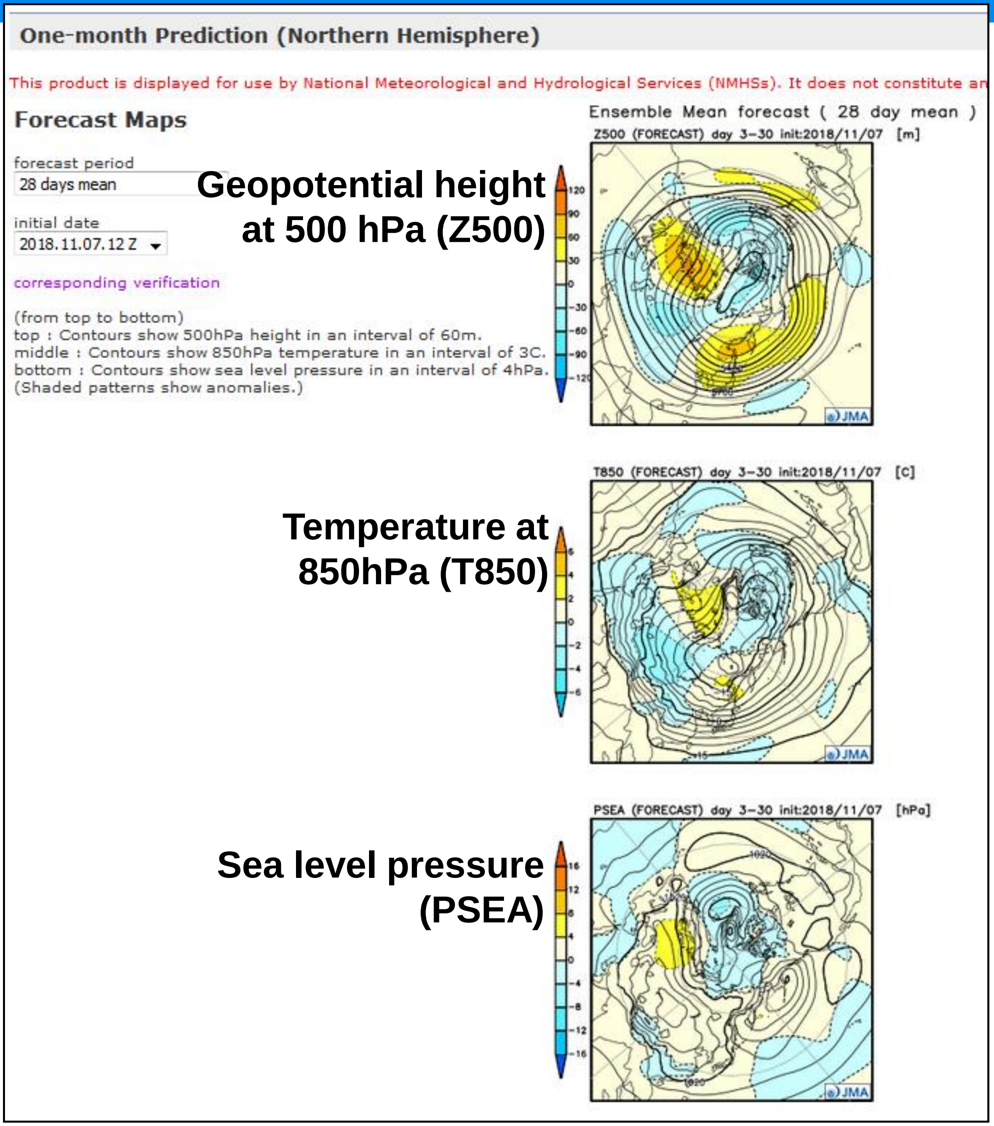
Initial date
In this seminar,
2018.11.07.12Z



- ✓ Initial date: 7 Nov. 2018
  - 1st week: 10-16 Nov.
  - 2nd week: 17-23 Nov.
  - 3-4th week: 24 Nov. - 7 Dec.
- ✓ Ensemble mean
- ✓ **Contour: Actual field**
- ✓ **Shading: Anomaly**

http://ds.data.jma.go.jp/tcc/tcc/products/model/map/1mE/map1/zpcmap.php

Forecast Map (Northern Hemisphere)



http://ds.data.jma.go.jp/tcc/tcc/products/model/map/1mE/map1/pztmap.php

Verification Score Map (Hindcast)

http://ds.data.jma.go.jp/tcc/tcc/products/model/hindcast/1mE/tro_acor.html

Verification Score Map

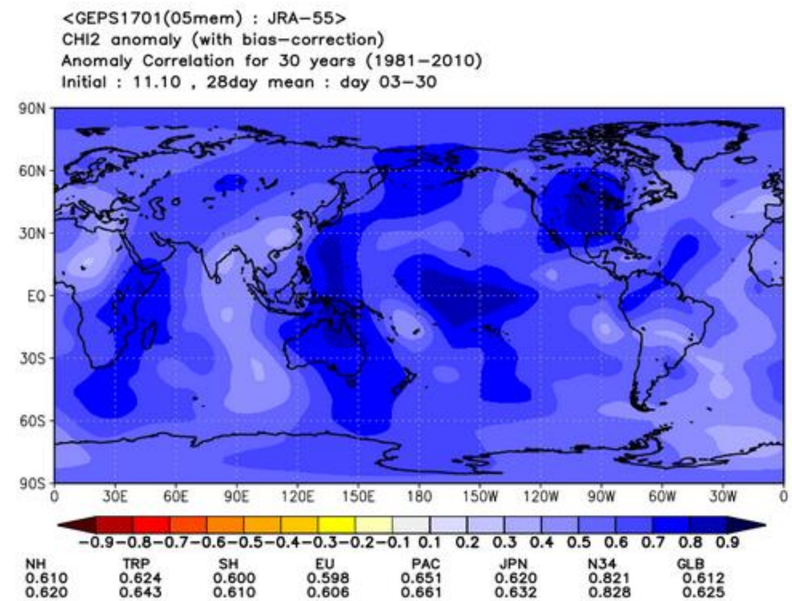
Note: "RAIN" is available only week-1 to 4 (4 weeks mean) forecast with the initial date of end of month.

Initial date:
11/10

- (•) ACOR
- ( ) RMSE

Element:
- (•) CHI200
- ( ) PSI200
- ( ) PSI850
- ( ) RAIN
- ( ) Z500
- ( ) T850
- ( ) SLP

Lead time:
- (•) week-1 to 4 (4 weeks mean) (day-3 to 30)
- ( ) the first week (day-3 to 9)
- ( ) the second week (day-10 to 16)
- ( ) the third and fourth week (2 weeks mean) (day-17 to 30)



Initial date.
In this seminar,
11/10

ACOR
(anomaly correlation)

You should select a parameter

You should select forecast period

If **RAIN** is selected as Element, Initial date must be **10/31**, and only **week-1 to 4** can be selected as Lead time.

Each map shows correlation between observation and model output for 1981-2010.
Model’s initial date is every year’s 10 Nov.

Blue color indicates positive correlation (high prediction skill)

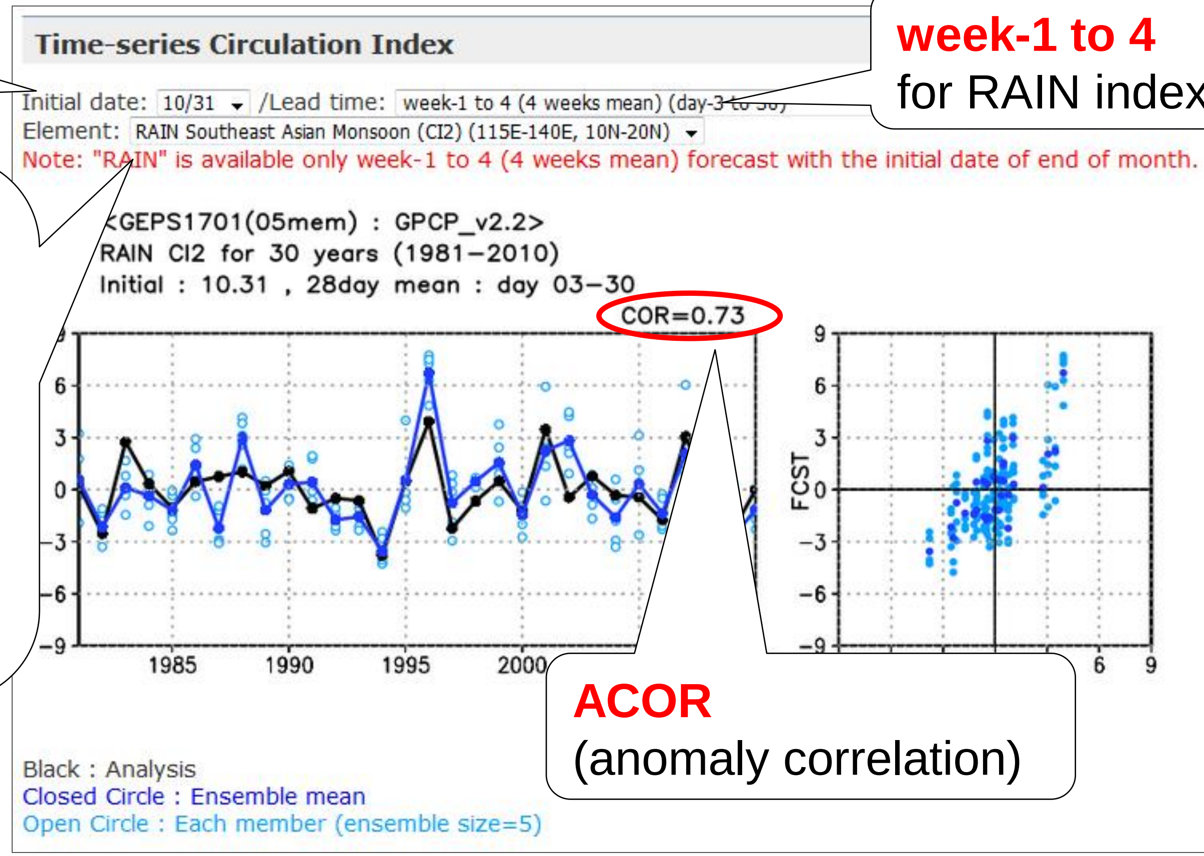
Time-series Circulation Index (Hindcast)

Initial date.
In this seminar,
10/31 for RAIN index

You should select an index (area-averaged rain)

- RAIN SAMOI (80-140E, 5-25N)
- RAIN WNPM (110-160E, 10-20N)
- RAIN WIO (40-70E, Eq.-20N)
- RAIN EIO (70-100E, Eq.-20N)
- RAIN CI1 (70-100E, 10-25N)
- RAIN CI2 (115-145E, 10-20N)
- RAIN MC (110-135E, 5S-5N)
- RAIN DL (170E-170W, 5S-5N)

http://ds.data.jma.go.jp/tcc/tcc/products/model/hindcast/1mE/jikeiretu.html



week-1 to 4
for RAIN index

ACOR
(anomaly correlation)

It is possible to evaluate the prediction skill of 1-month precipitation (convective activity) over some specific regions.

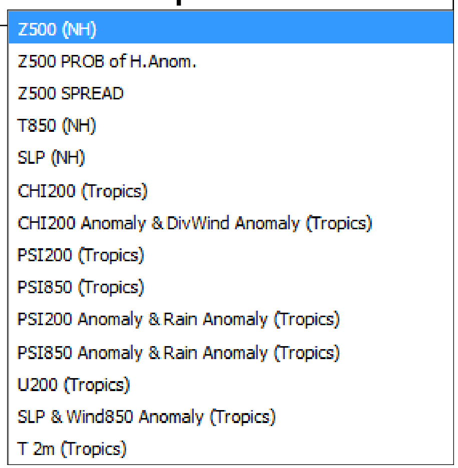
Animation (7-day Running Mean)

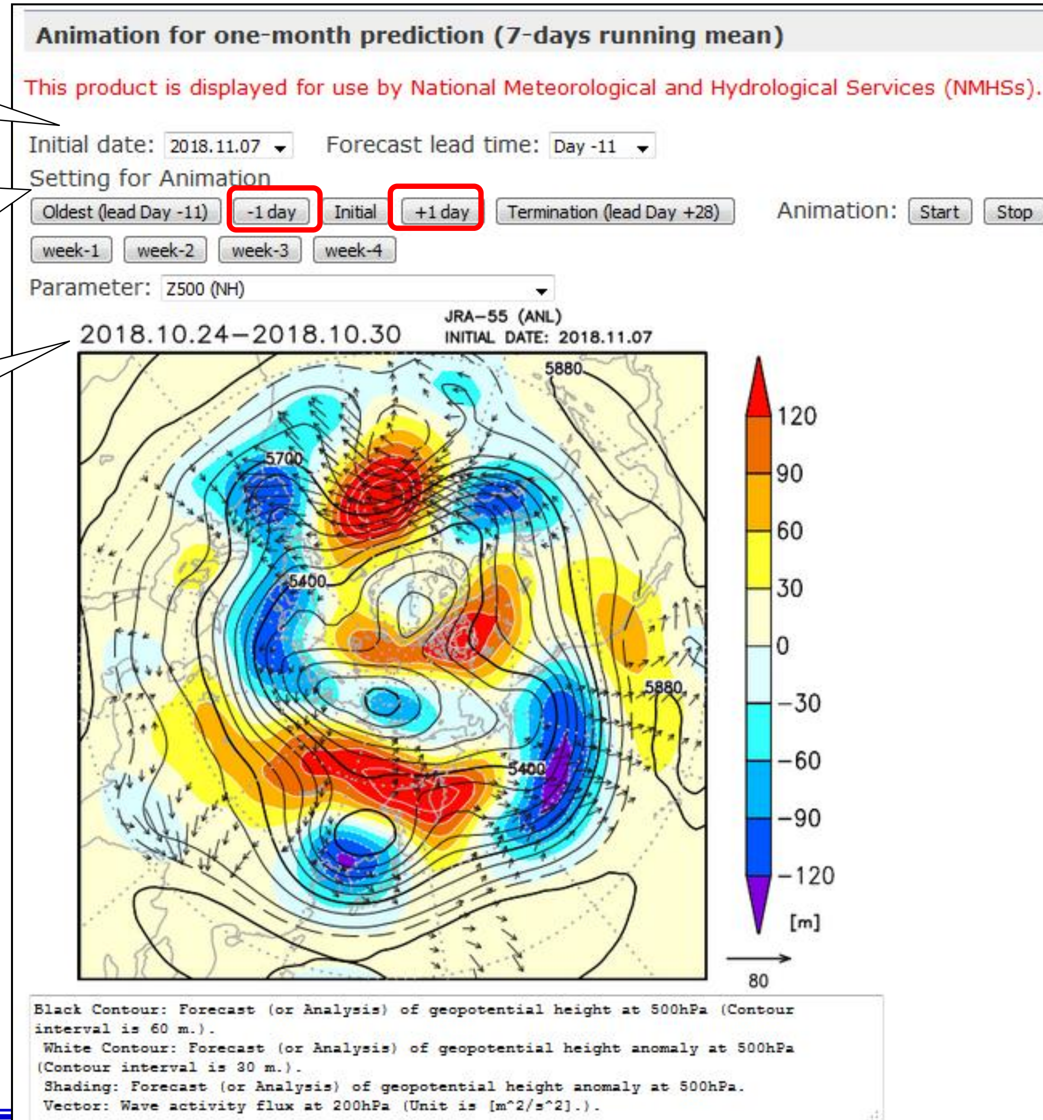
http://ds.data.jma.go.jp/tcc/tcc/gpv/model/Anime.1mE.experiment/anime.e.php

Initial date.
In this seminar, **2018.11.07**

+1 day to put the date forward
-1 day to put the date backward

You should select a parameter





It is possible to check the temporal evolution of atmospheric fields.

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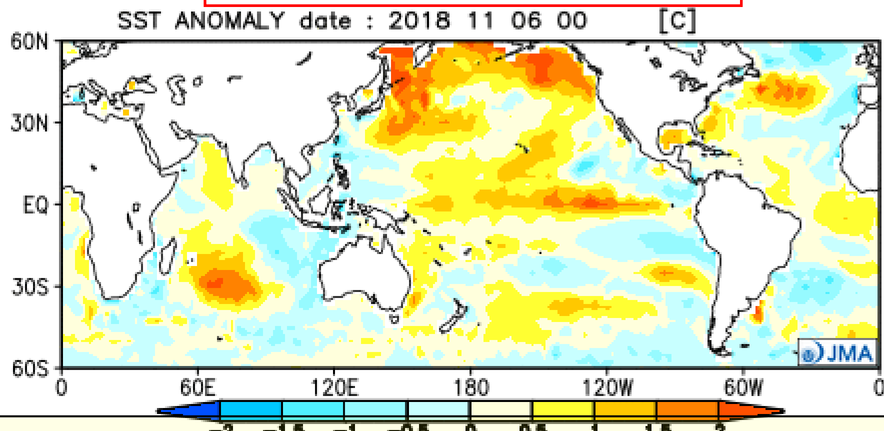
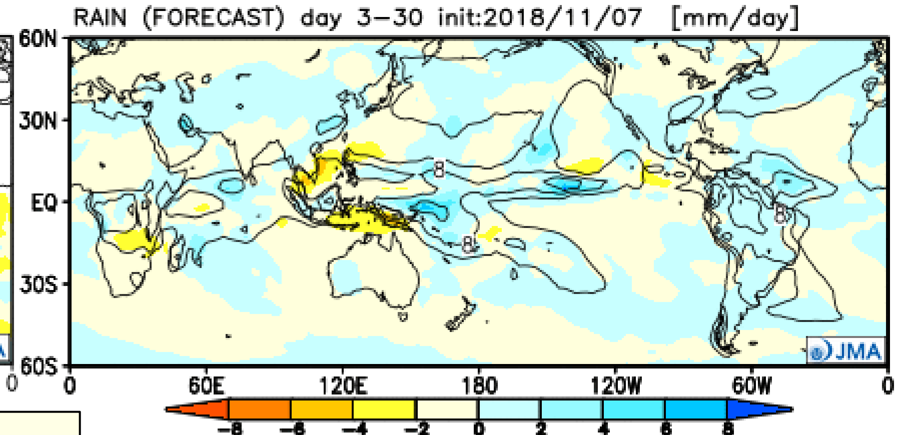
- 1-month: 10 Nov. - 7 Dec. (28-day ave.)
- 1st week: 10-16 Nov.
- 2nd week: 17-23 Nov.
- 3-4th weeks: 24 Nov. - 7 Dec. (14-day ave.)

SST (Boundary Condition) and Precipitation

Prescribed SST
(Boundary Condition)

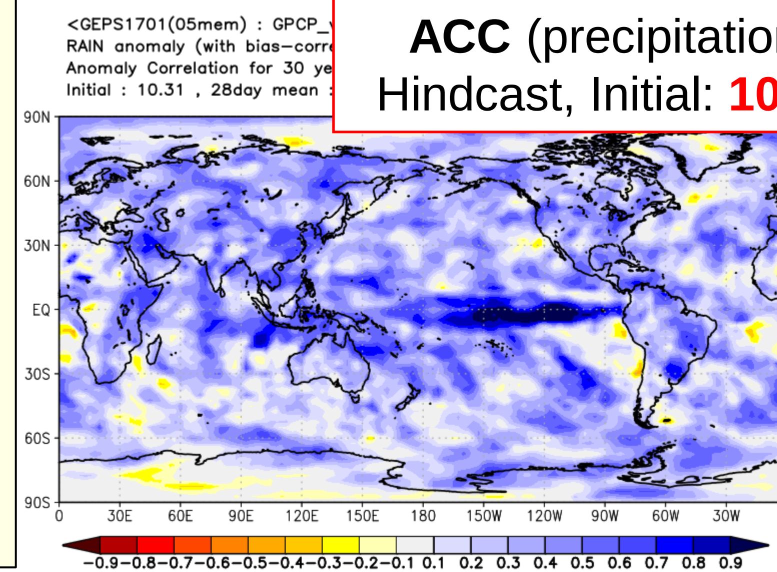


Forecast (Precipitation)



- SST boundary condition partly reflects the El Nino-like pattern.
- In the tropics, convective activities are predicted to be enhanced over the central – eastern Pacific, and suppressed around Southeast Asia.
- This pattern seems to be associated with the SST boundary condition.
- Prediction skill of precip. is good from the eastern Indian Ocean to the Pacific.

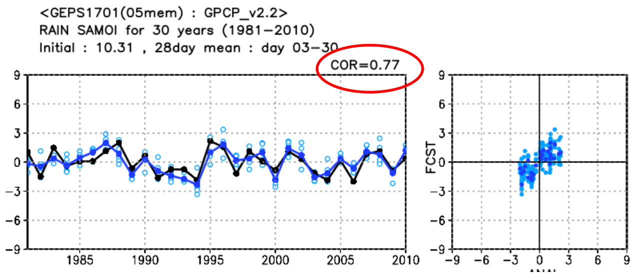
ACC (precipitation)
Hindcast, Initial: **10/31**



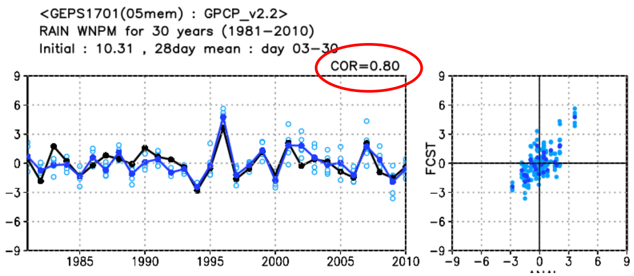
Hindcast ACC for Area-Averaged Rain

Initial: **10/31**

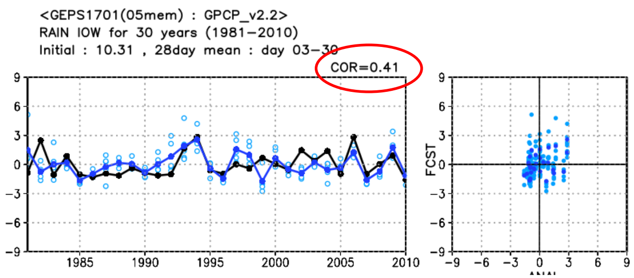
SAMOI
80-140E
5-25N
ACC=0.77



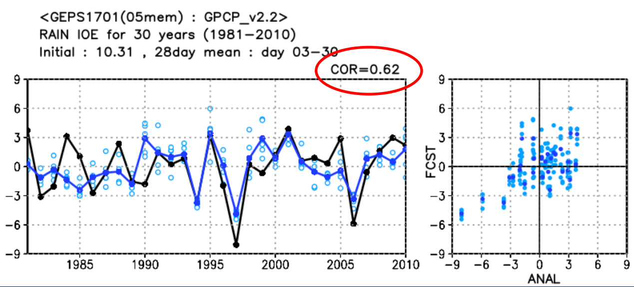
WNPM
110-160E
10-20N
ACC=0.80



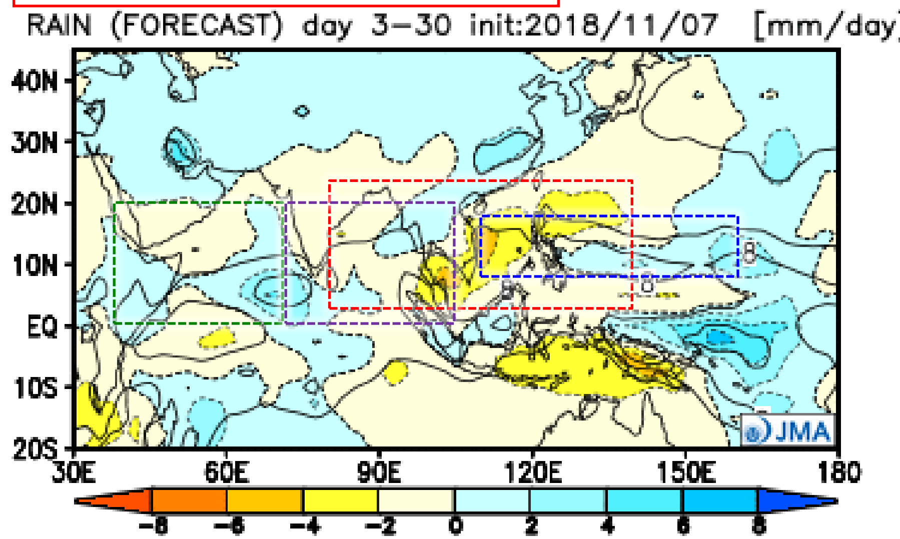
WIO
40-70E
Eq.-20N
ACC=0.41



EIO
70-100E
Eq.-20N
ACC=0.62



Forecast (Precipitation)

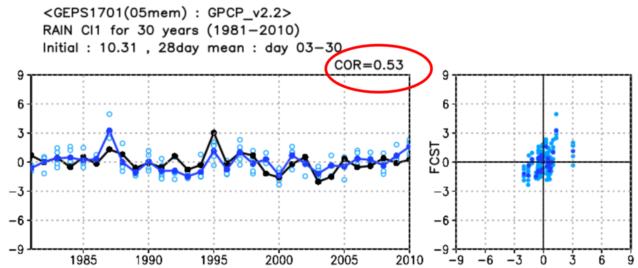


- Prediction skill is good from the eastern Indian Ocean to the Pacific.

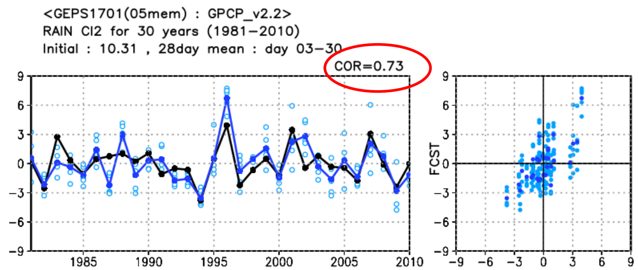
Hindcast ACC for Area-Averaged Rain

Initial: **10/31**

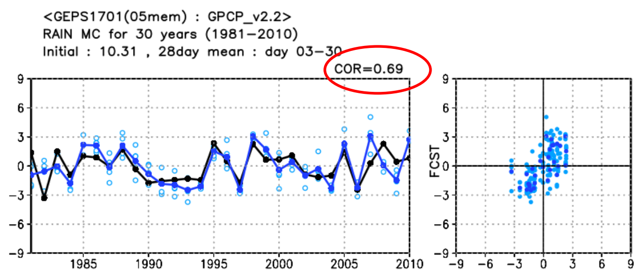
CI1
70-100E
10-25N
ACC=0.53



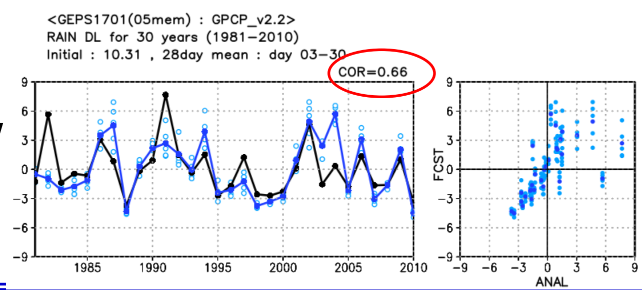
CI2
115-140E
10-20N
ACC=0.73



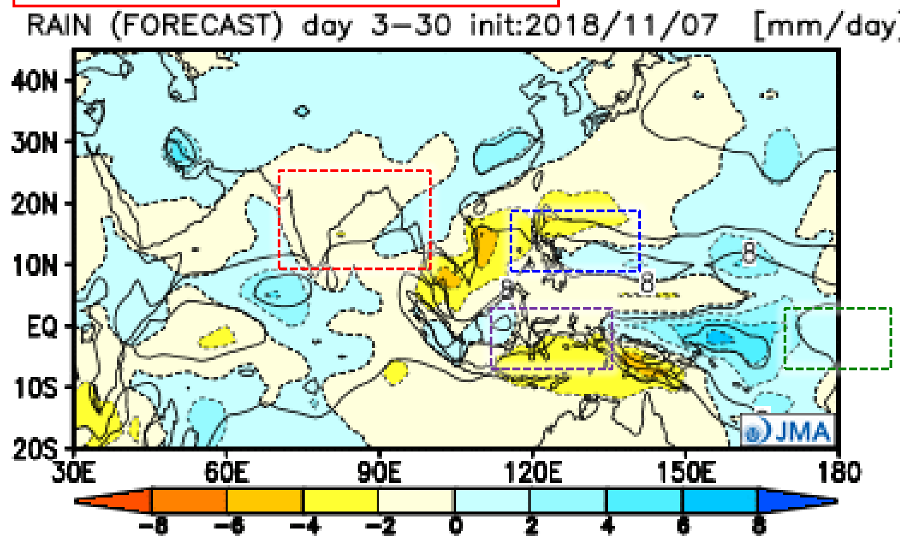
MC
110-135E
5S-5N
ACC=0.69



DL
170E-170W
5S-5N
ACC=0.66



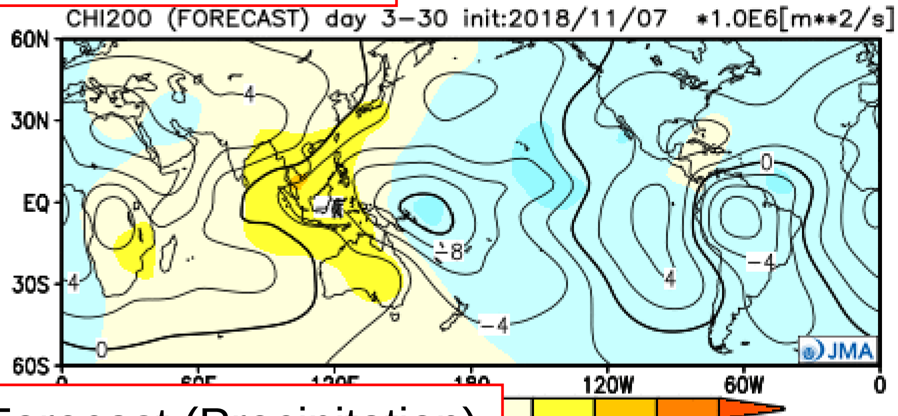
Forecast (Precipitation)



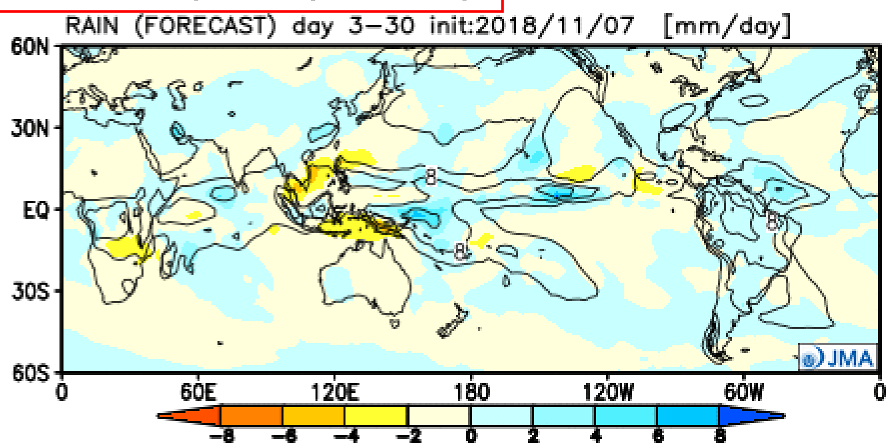
- Prediction skill is good from the eastern Indian Ocean to the Pacific.

Velocity Potential at 200hPa (CHI200)

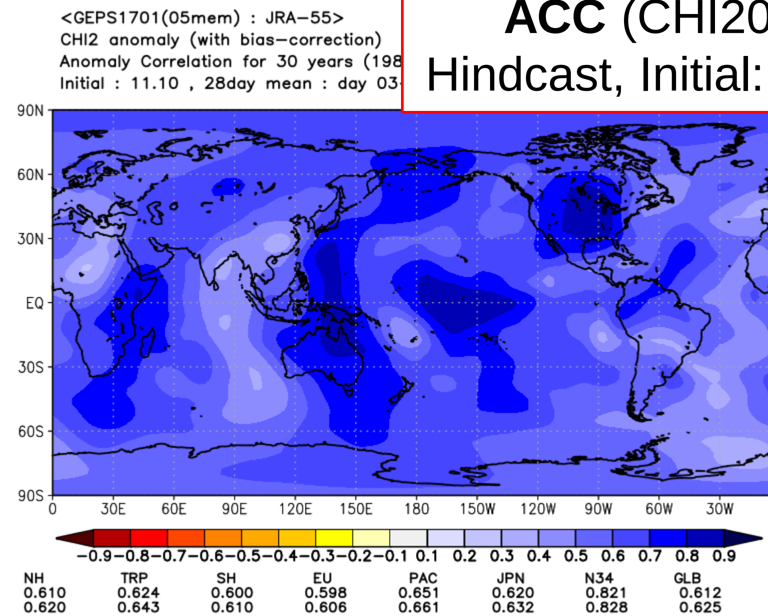
Forecast (CHI200)



Forecast (Precipitation)

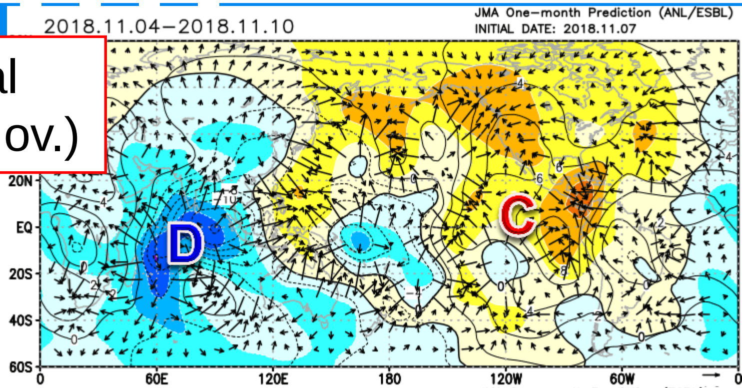


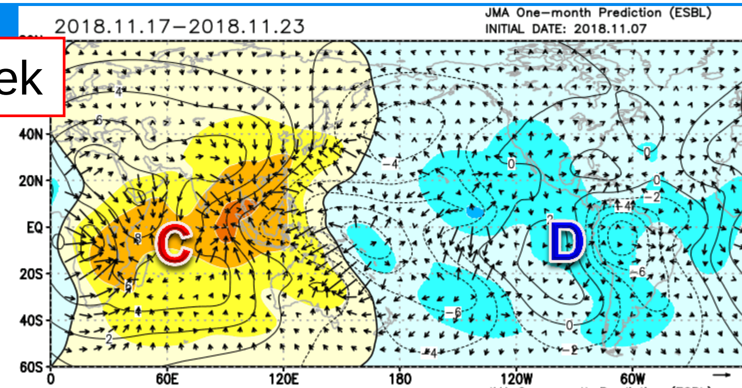
ACC (CHI200)
Hindcast, Initial: 11/10

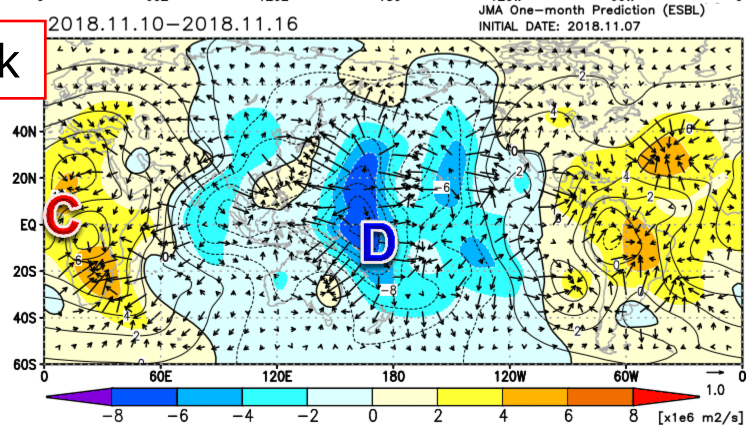


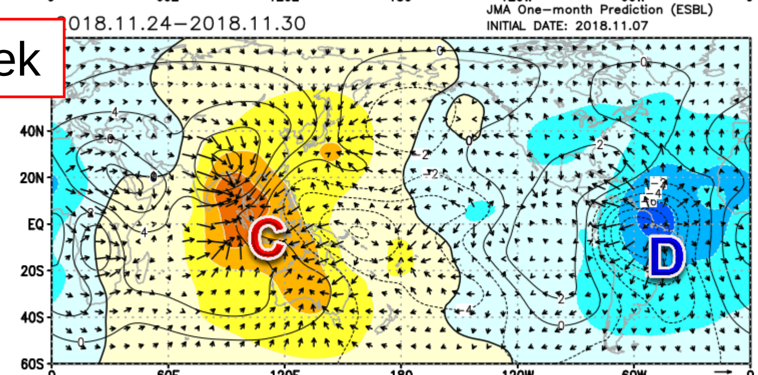
- Upper-level divergence anomalies are seen from the Pacific to the Atlantic.
- Convergence anomalies are predicted from the Indian Ocean to Southeast Asia.

MJO (Velocity Potential at 200hPa)

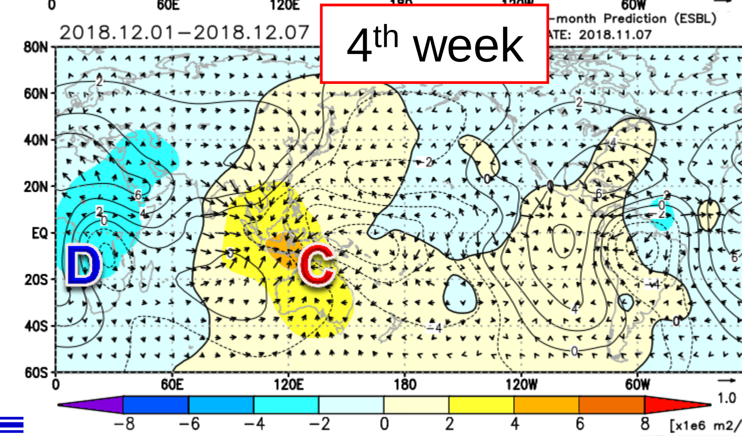






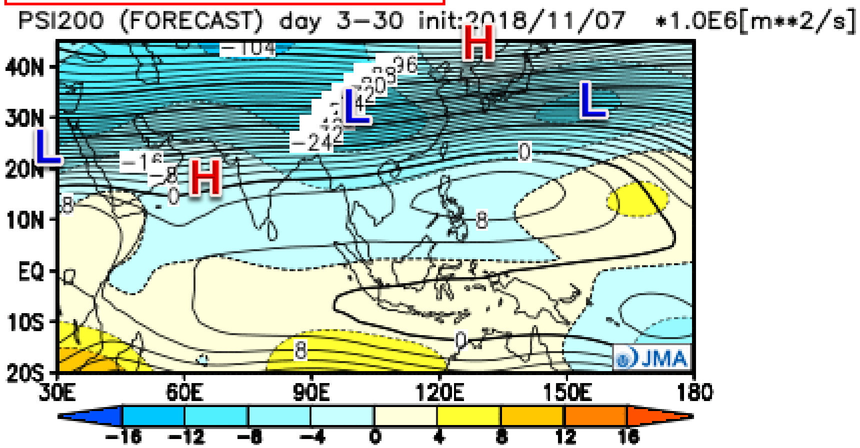


- Eastward propagation of MJO with active convection is clearly seen throughout the forecast period.
- Suppressed phase also propagates eastward. This may be partly affected by lower SST boundary condition around Indonesia.

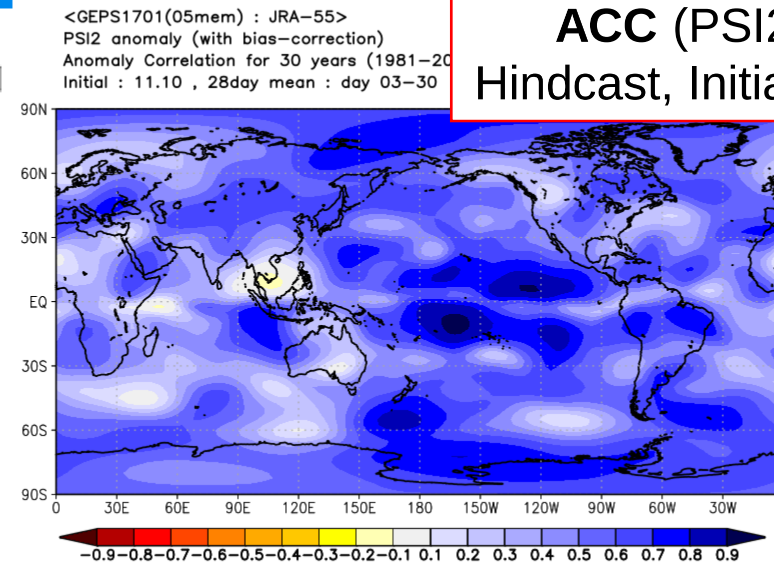


Stream Function at 200hPa (PSI200)

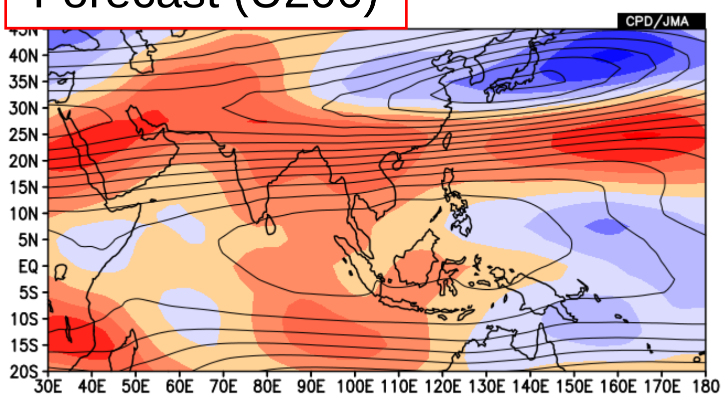
Forecast (PSI200)



ACC (PSI200)
Hindcast, Initial: 11/10



Forecast (U200)

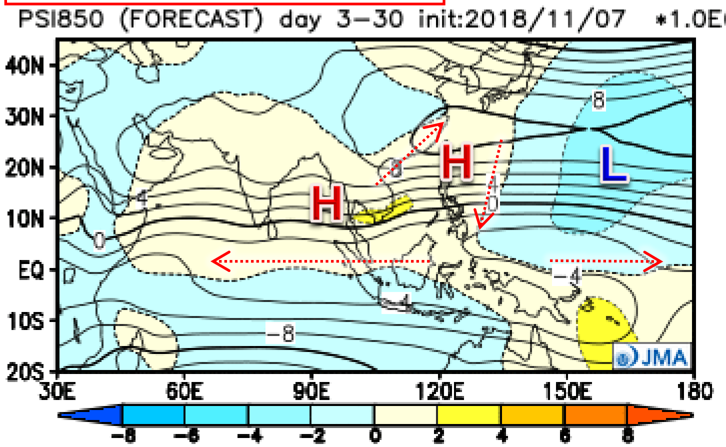


Red: westerly is stronger than normal
Contour: normal

- Negative anomalies are predicted over the continent, indicating the subtropical jet stream shifts southward.
- Rossby wave trains are seen along the subtropical jet stream, with cyclonic anomalies (southward meandering) in southern China.
- Suppressed convection from the Indian Ocean to Southeast Asia may contribute to these patterns.

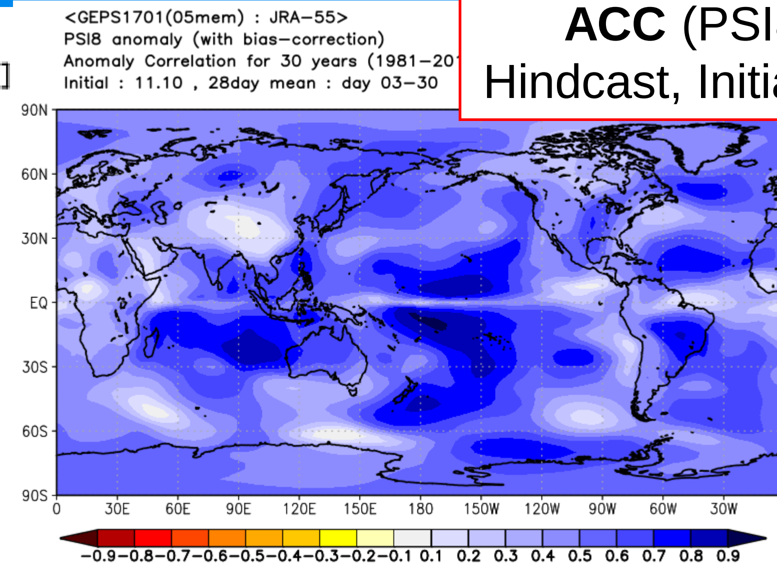
Stream Function at 850hPa (PSI850)

Forecast (PSI850)

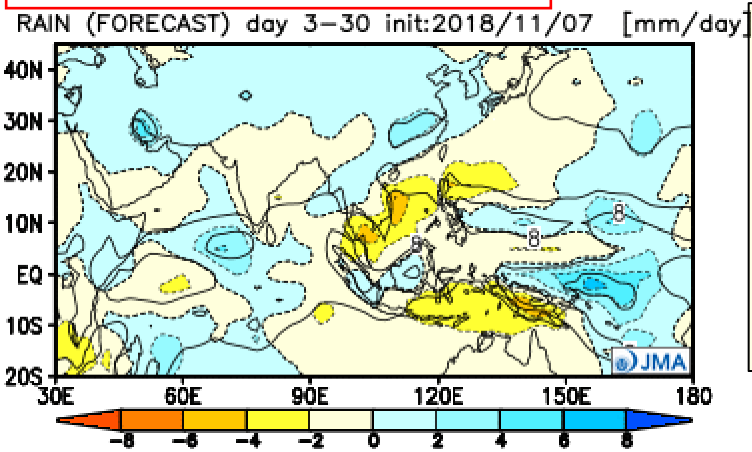


ACC (PSI850)

Hindcast, Initial: 11/10



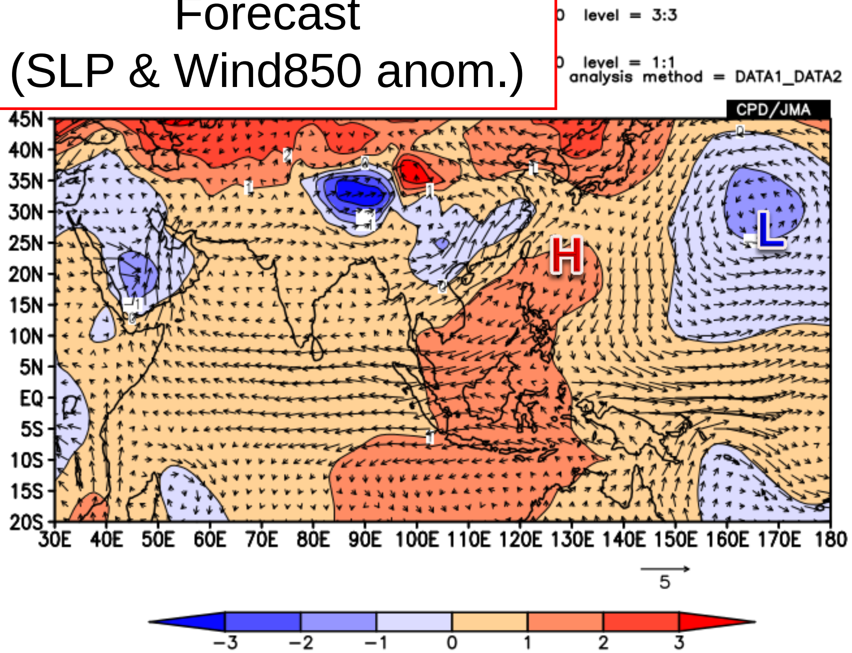
Forecast (Precipitation)



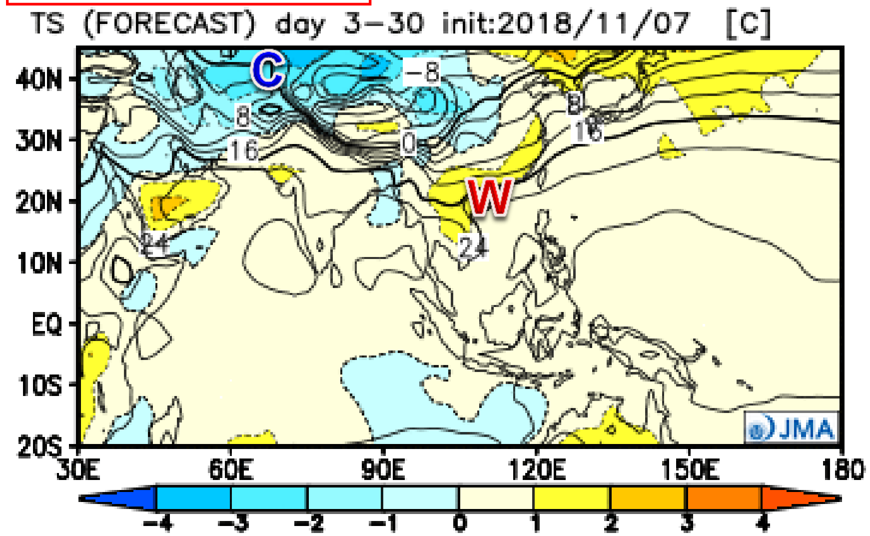
- Cyclonic anomalies are predicted over the western North Pacific, which seems to be a response to the active convection in the Pacific.
- Anti-cyclonic anomalies are seen in the Indian Ocean and around the Philippines as a response to the suppressed convection.

Wind & Surface Temperature (TS)

Forecast
(SLP & Wind850 anom.)



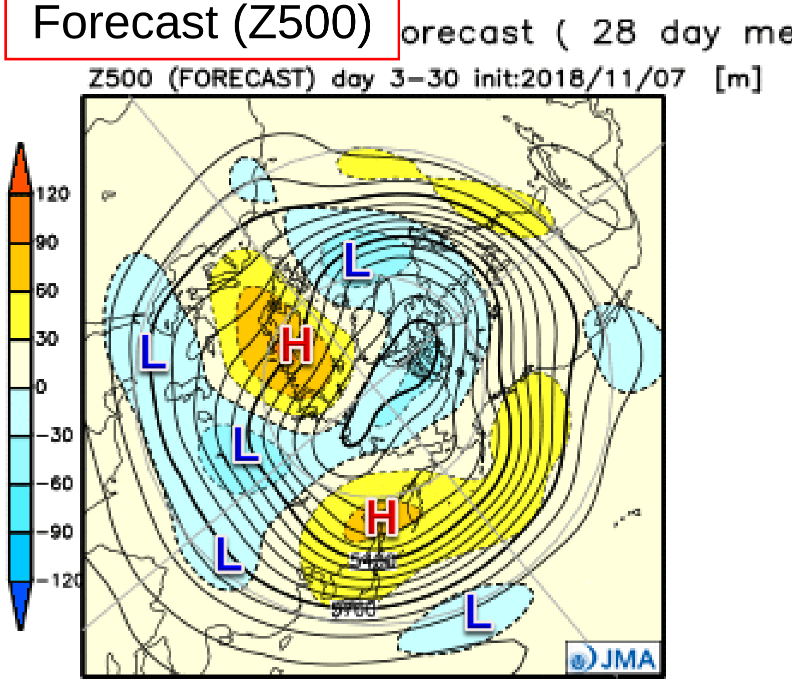
Forecast (TS)



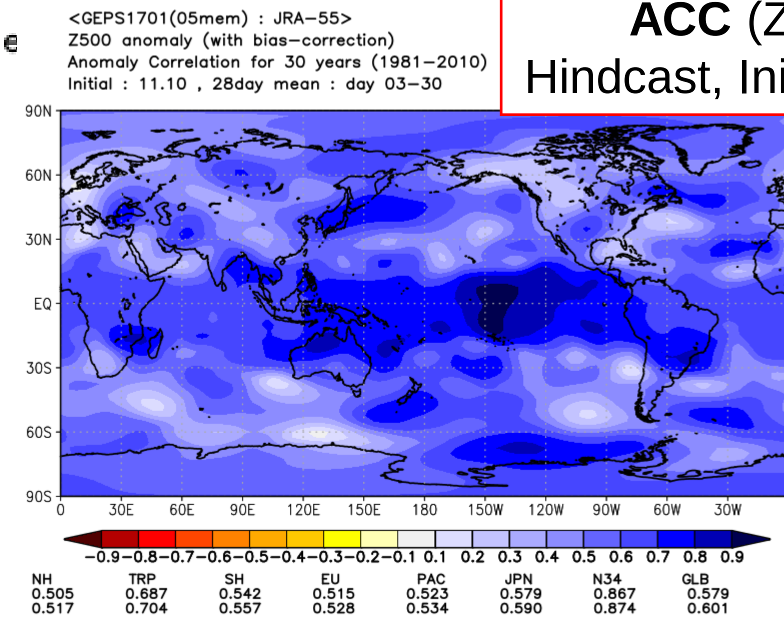
- Southerly anomalies prevail from the Indochina Peninsula to southern China, where above-normal temp. is predicted.
- Northerly anomalies are around the Philippines to the South China Sea
- Easterly anomalies are from the Malay Peninsula to the tropical Indian Ocean.
- Below-normal temp. is predicted in mid-latitudes of the continent, which may be related to the southward shift or meandering of the subtropical jet stream.

Geopotential Height at 500hPa (Z500)

Forecast (Z500)



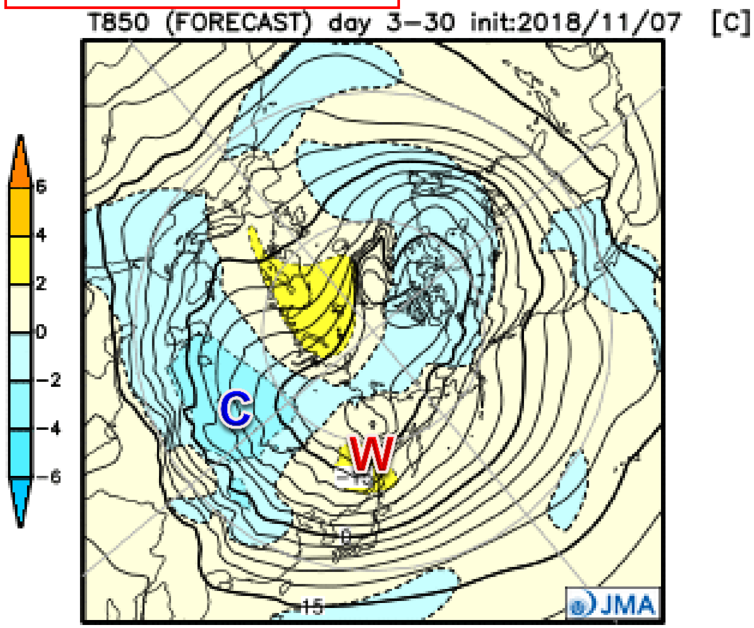
ACC (Z500)
Hindcast, Initial: 11/10



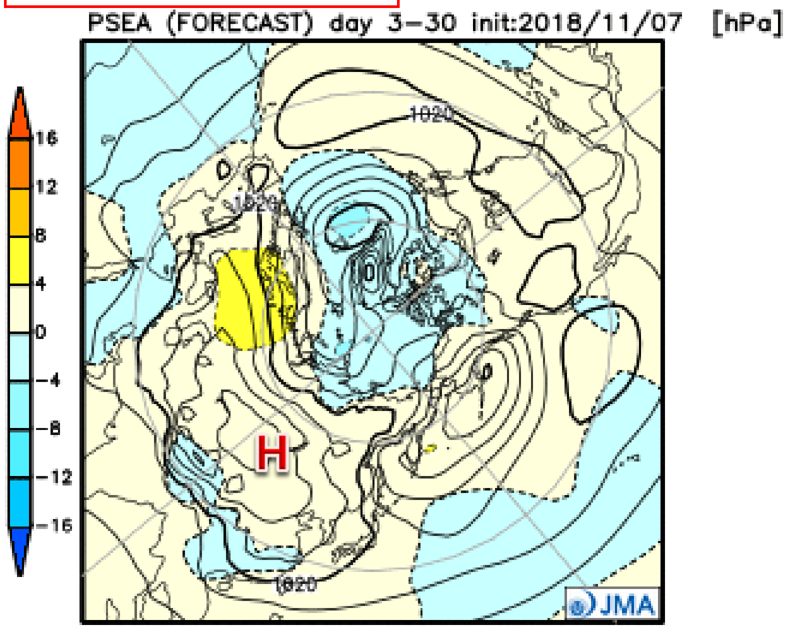
- Rossby wave trains are predicted along the sub-polar jet stream, with negative anomalies (southward meandering) around Central Asia (i.e. negative phase of EU pattern).
- Negative anomalies along 30-40N on the continent seems to be related to the southward shift of the subtropical jet stream.
- AO signature is unclear.

850hPa Temperature (T850) & SLP

Forecast (T850)



Forecast (SLP)



- Below-normal temp. is predicted widely around central Asia, which seem to be related to the southward meandering/shift of the jet streams.
- The Siberian High is predicted to be enhanced, which corresponds to the below-normal temp. there.

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• 1st week:	10-16 Nov.
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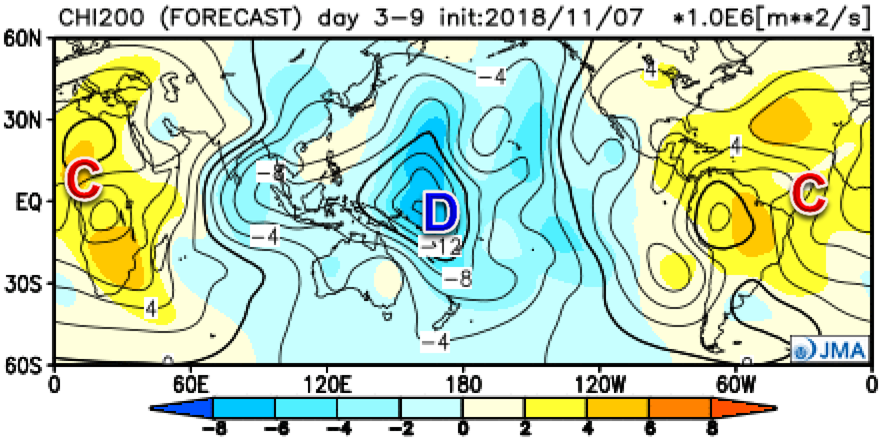
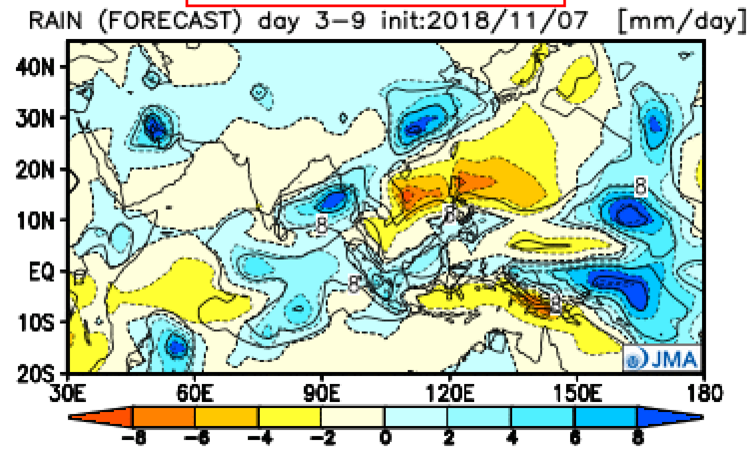
• 3-4th weeks:	24 Nov. - 7 Dec. (14-day ave.)

1st week (10-16 Nov.)

CHI200



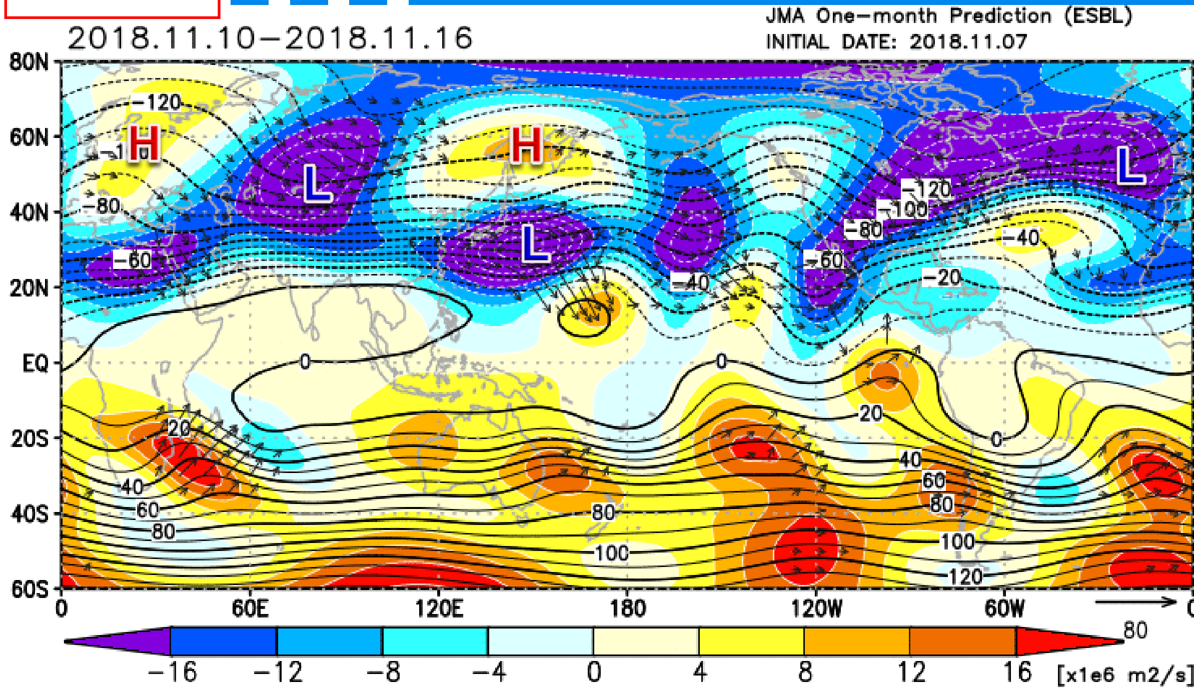
Precipitation



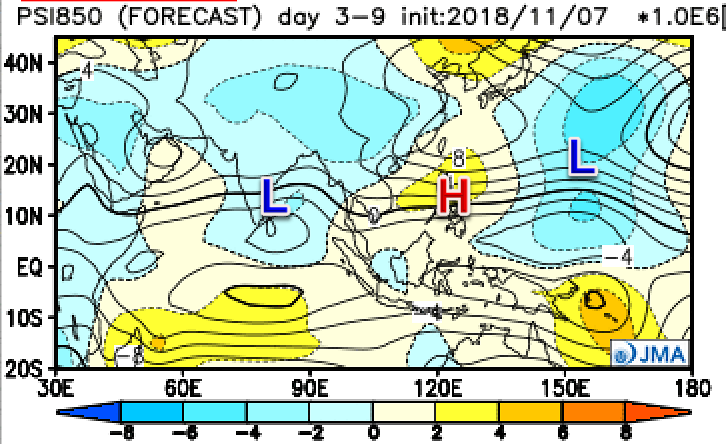
- MJO with active convection, located over the Indian Ocean at initial, is predicted to move to the western Pacific.
- Suppressed phase moves to South America and Africa.

1st week (10-16 Nov.)

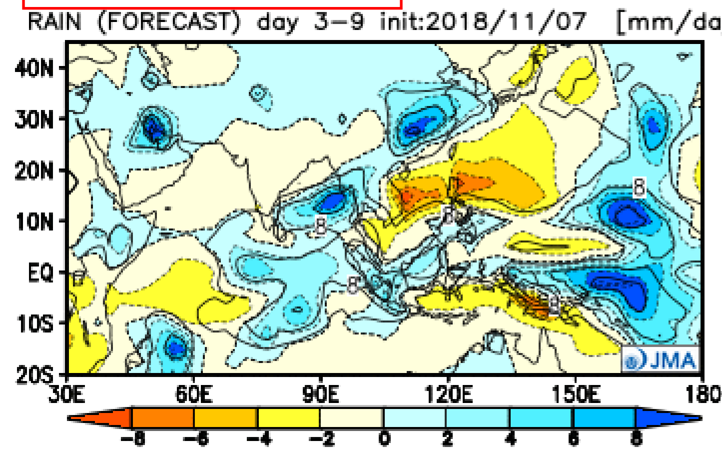
PSI200



PSI850



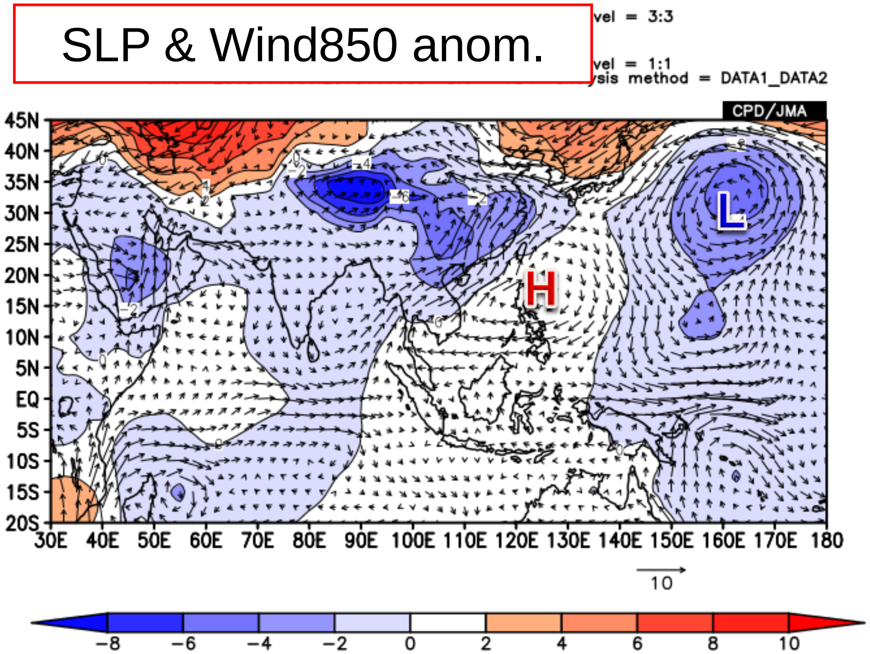
Precipitation



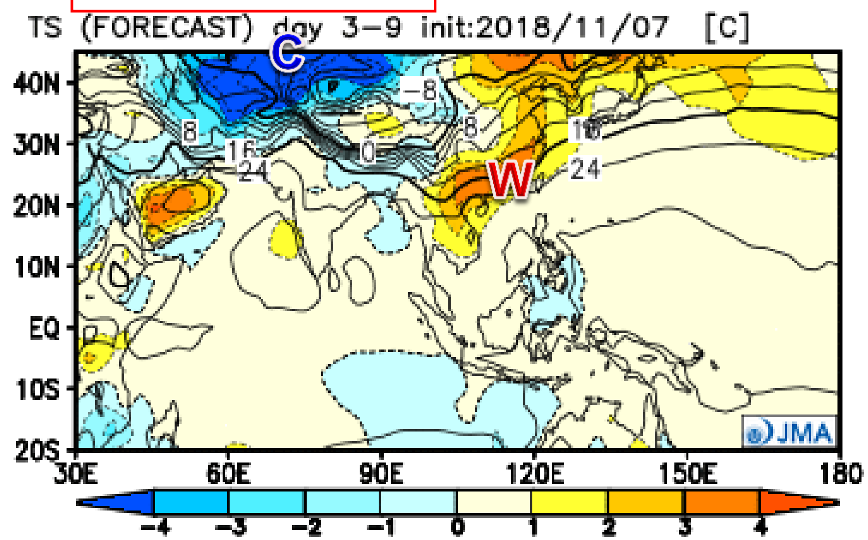
- In upper-level, southward meandering of the subtropical jet stream is seen to the east of the Caspian Sea, which is a part of Rossby wave trains propagated from the Atlantic.
- In lower-level, cyclonic anomalies are seen over the western Pacific and the eastern Indian Ocean as a response to the active convection.

1st week (10-16 Nov.)

SLP & Wind850 anom.

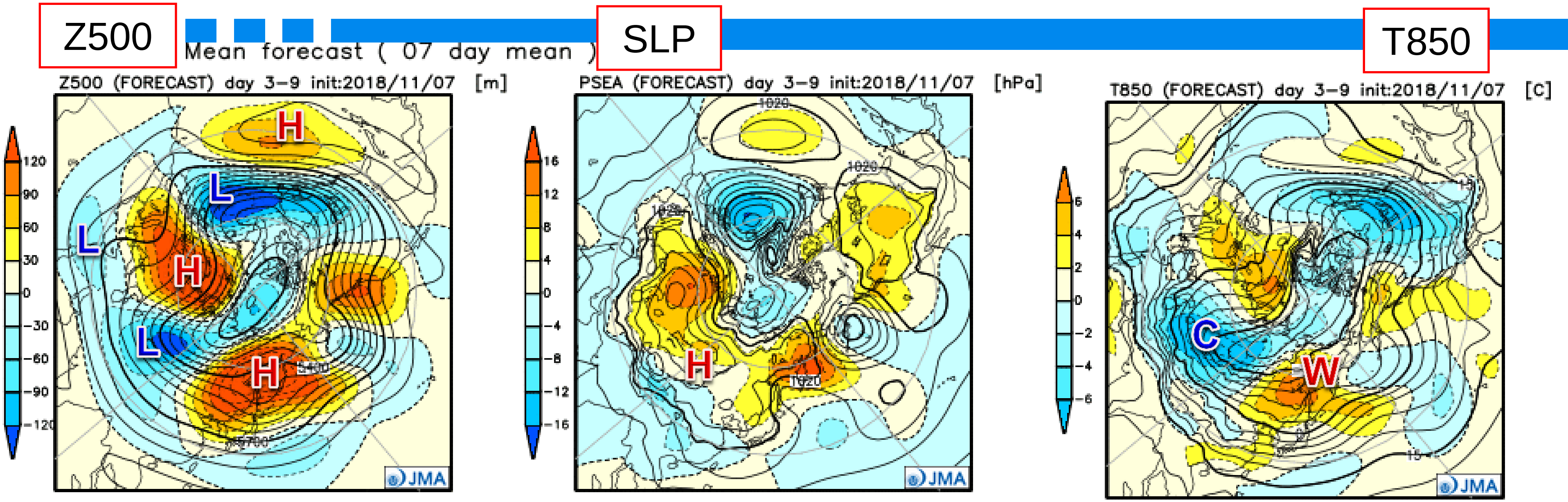


Surface Temp.



- Southerly anomalies prevails from the Indochina Peninsula to eastern China, where above-normal temp. is predicted.
- Northerly anomalies are seen in the southern Philippines.
- Westerly anomalies are seen over the tropical Indian Ocean.
- Below-normal temp. is predicted to the east of the Caspian Sea, associated with the southward meandering of the subtropical jet stream.

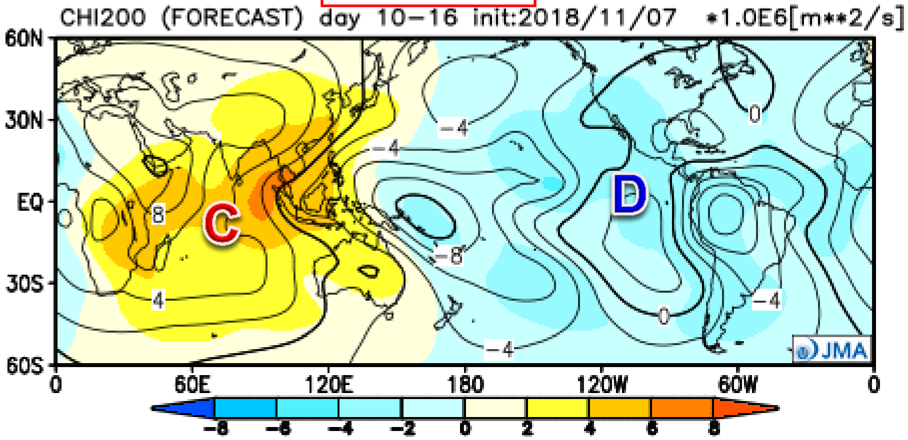
1st week (10-16 Nov.)



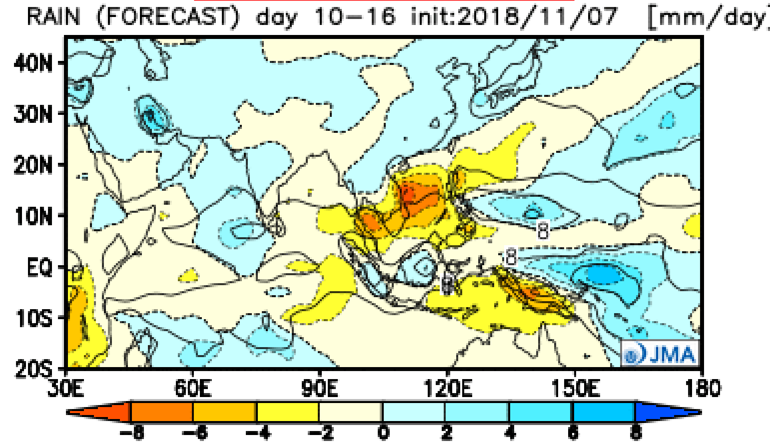
- In Z500, Rossby wave trains are clearly seen along the sub-polar jet stream, with negative anomalies (southward meandering) around Central Asia, and positive ones (northward meandering) in East Asia.
- Below- and above-normal temp. is predicted around Central and East Asia, respectively, corresponding to the meandering of the jet streams.
- In SLP, the development of the Siberian High towards East Asia is not clear.

2nd week (17-23 Nov.)

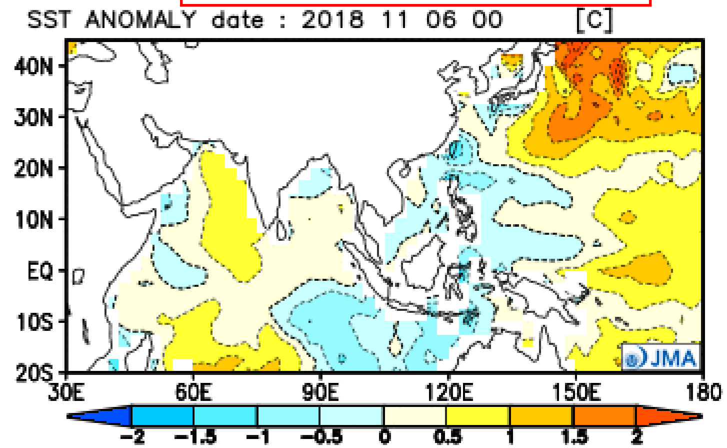
CHI200



Precipitation



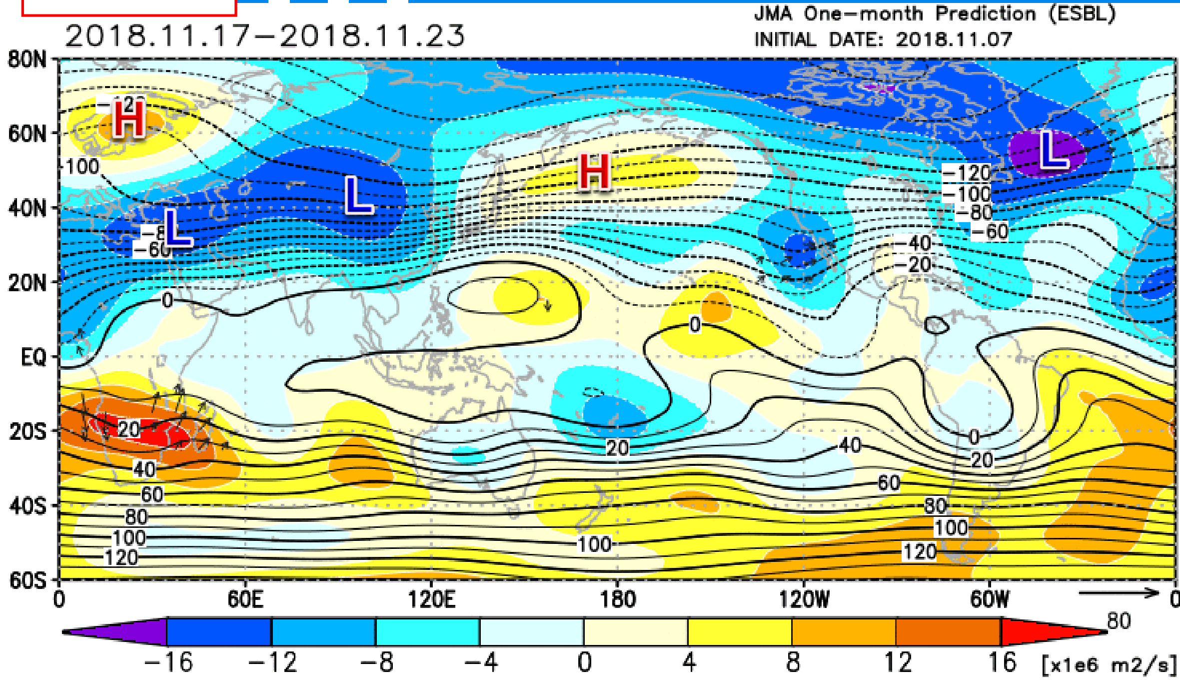
Boundary Condition (SST)



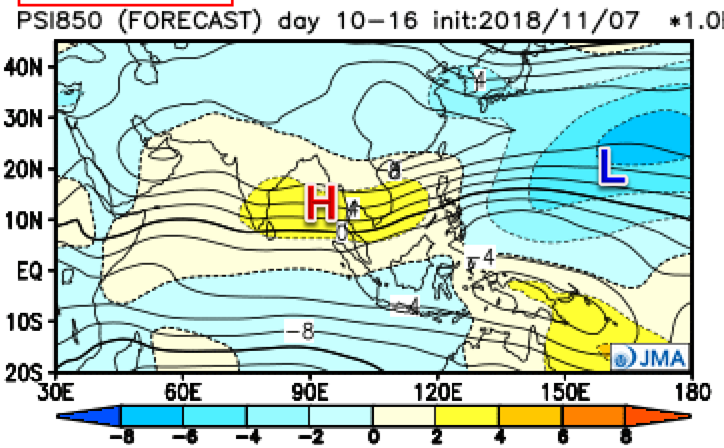
- MJO with active convection is predicted to move to the eastern Pacific.
- Suppressed phase moves to the Indian Ocean and Southeast Asia, and below-normal precip. are widely seen in Southeast Asian countries.

2nd week (17-23 Nov.)

PSI200



PSI850



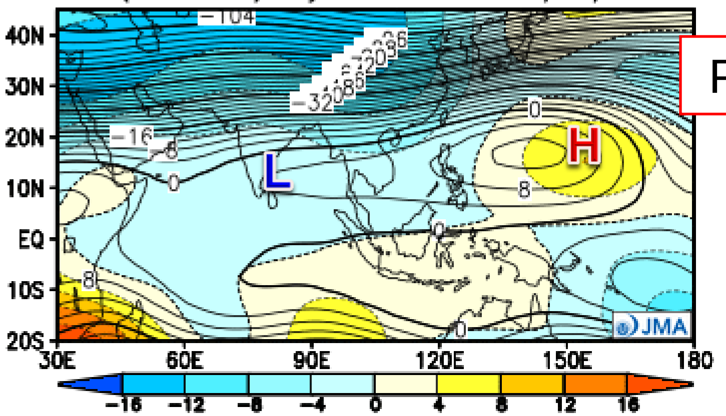
- In upper-level, the subtropical jet stream is predicted to meander southward over southern China as a part of Rossby wave trains from the Atlantic.
- In addition, southward shift of the jet stream is seen on the continent.
- In lower-level, anti-cyclonic anomalies are from the eastern Indian Ocean to the South China Sea.
- These patterns seem to be related suppressed convection from the Indian Ocean to Southeast Asia.

2^{nd} week (17-23 Nov.)

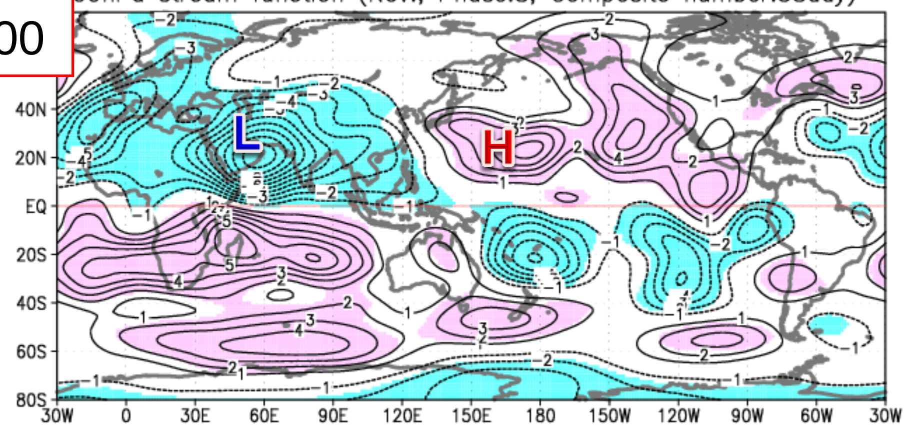
Forecast

Composite maps in Nov. when MJO is located **from the eastern Pacific to the Atlantic**

PSI200 (FORECAST) day 10–16 init:2018/11/07 *1.0

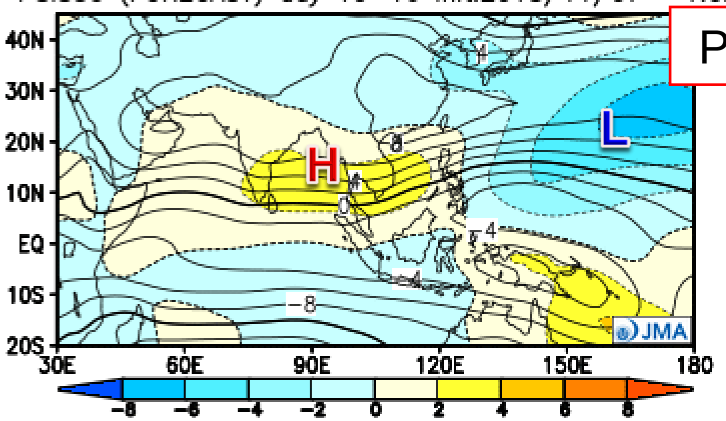


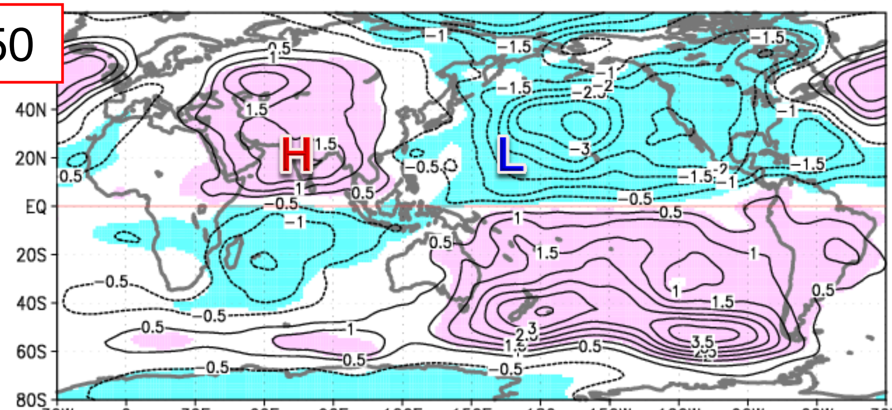
200hPa stream function (Nov., Phase:8, Composite number:58day)



PSI200

PSI850 (FORECAST) day 10–16 init:2018/11/07 *1.0





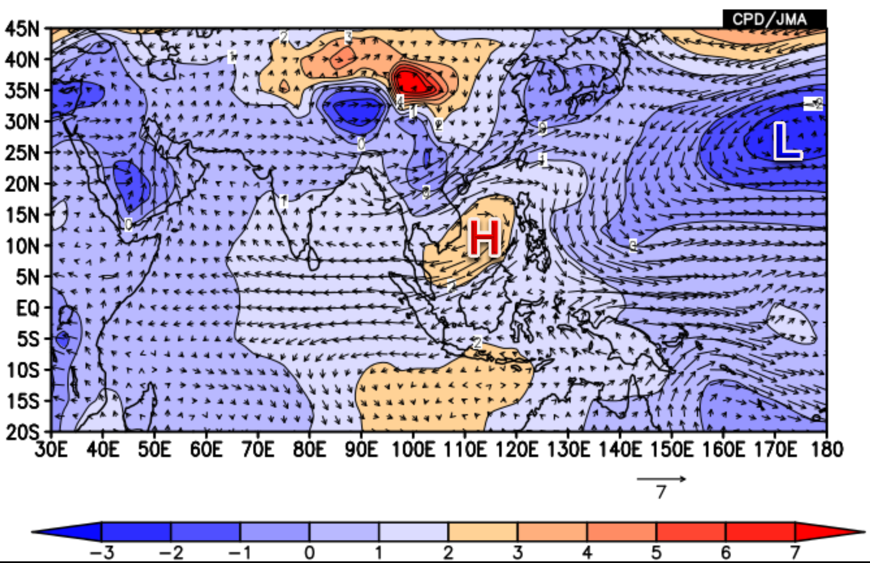
PSI850

http://ds.data.jma.go.jp/tcc/tcc/products/clisys/mjo/composite.html

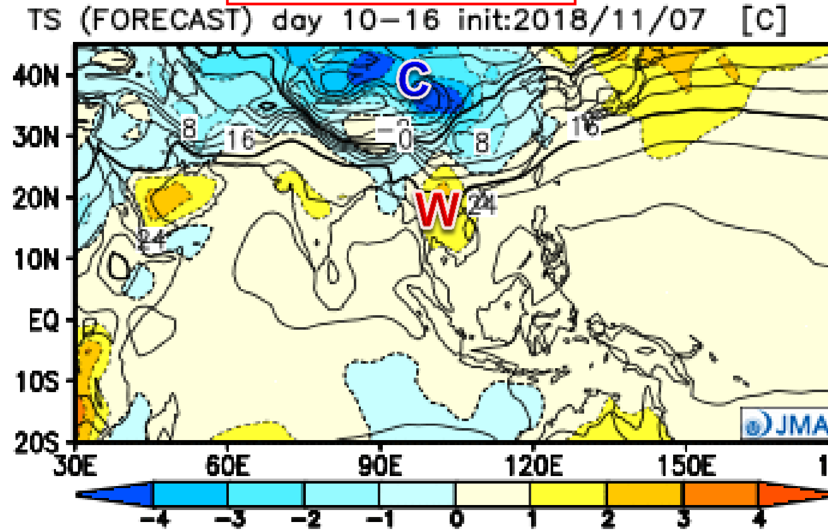
- Forecast maps are similar to the composite maps in the tropics, suggesting that 2^{nd} week fields are affected by MJO and its suppressed phase.

2nd week (17-23 Nov.)

SLP & Wind850 anom.

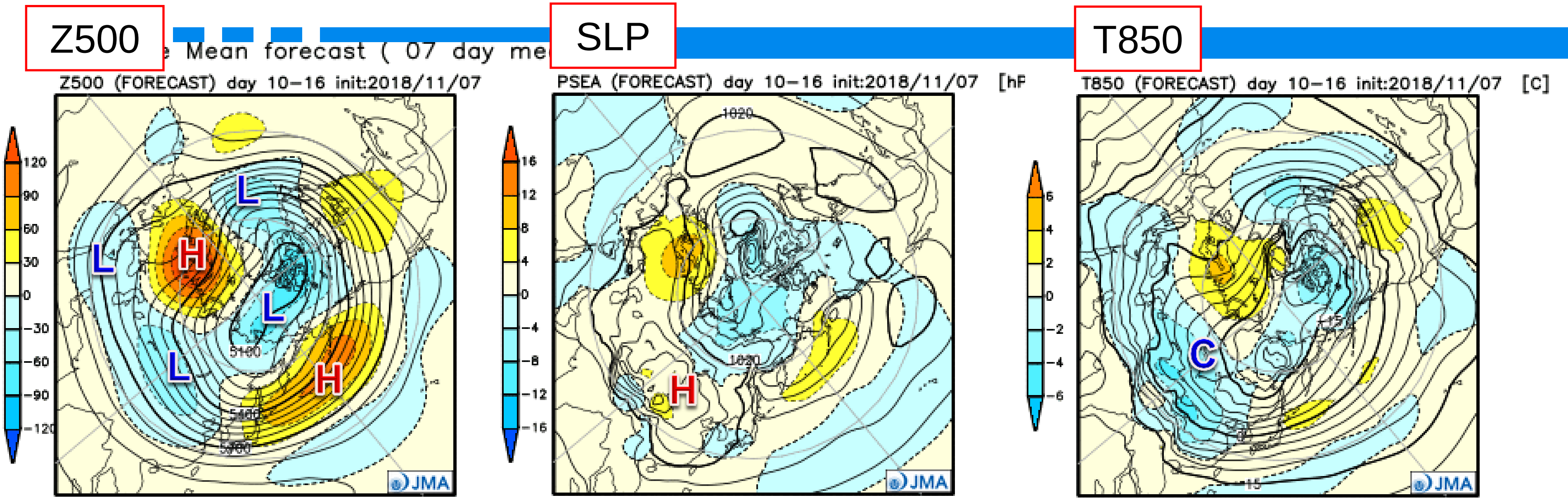


Surface Temp.



- Southwesterly anomalies prevails from the Indochina Peninsula to southeastern China.
- Northeasterly anomalies are seen in the South China Sea and the Malay Peninsula.
- Easterly anomalies are dominant over the tropical Indian Ocean.
- Below-normal temp. is predicted in mid-latitudes of the continent, which may be related to the southward shift or meandering of the subtropical jet stream.

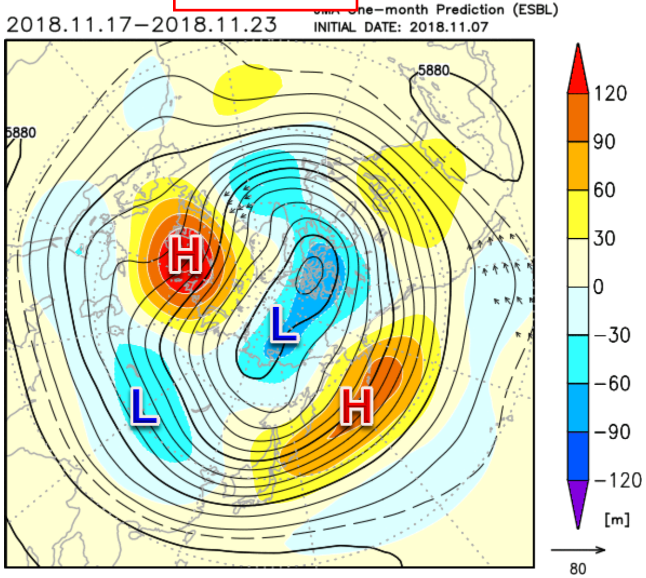
2nd week (17-23 Nov.)



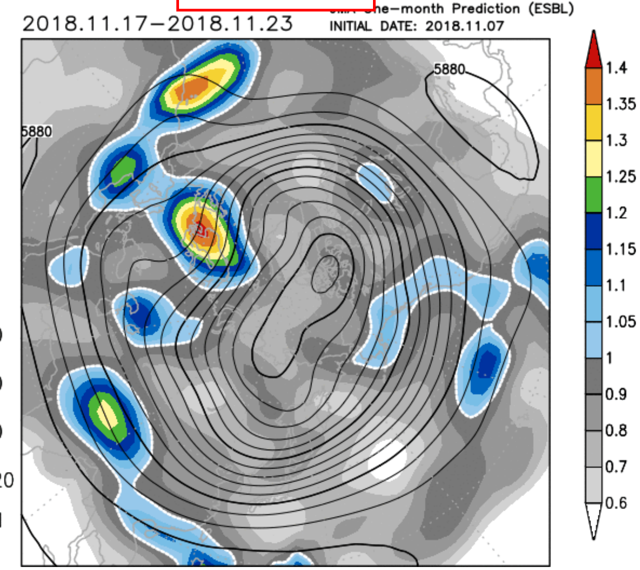
- In Z500, Rossby wave trains are predicted along the sub-polar jet stream, with negative anomalies (southward meandering) from Central Asia to Mongolia (negative EU pattern).
- In T850, below-normal temp. is predicted widely over mid-latitudes of the continent, corresponding to the southward shift/meandering of the jet streams.
- In SLP, the Siberian High develops and extends towards southern China, corresponding to the below-normal temp.

2nd week (17-23 Nov.)

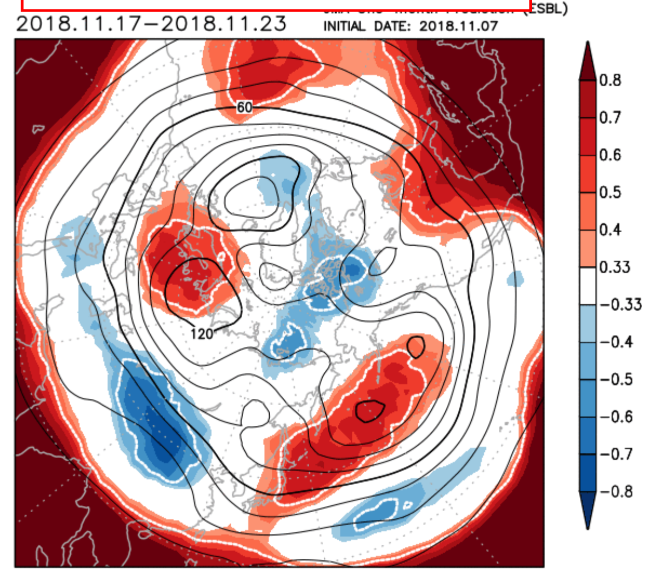
Z500



Spread



Prob. of Large Anom.

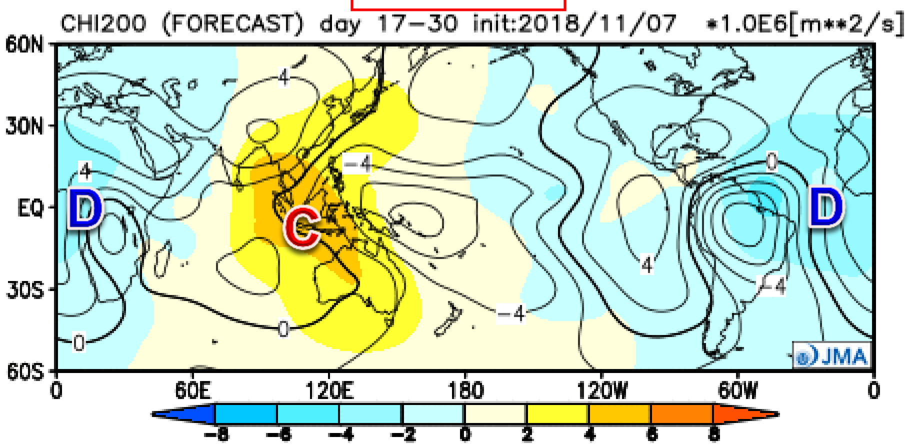


- Spread over East Asia is relatively small.
- A lot of ensemble members predict large negative anomalies from Central Asia to Mongolia.

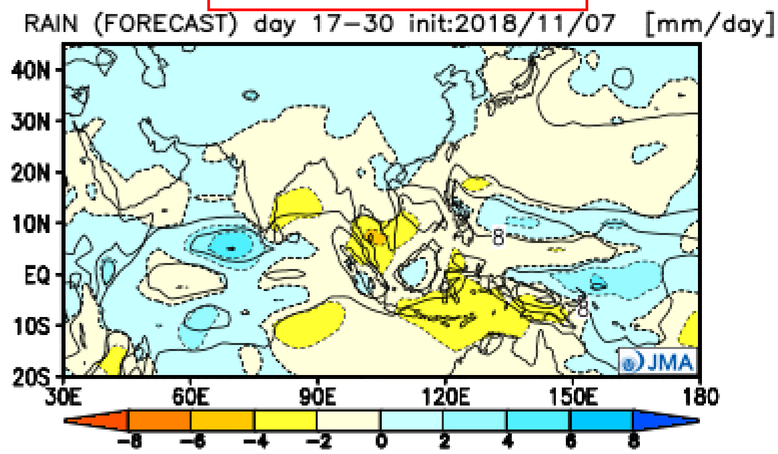
Spread: Standard deviation among ensemble members.
Value of >1 (color shading) indicates that spread is larger than interannual variability.
Generally the less spread, the more reliable forecast.
Probability of large anomalies:
Red (blue) shading indicates more than 1/3 ensemble members predicts large positive (negative) anomalies, suggesting that large anomalies are expected with high prob.

3–4th weeks (24 Nov. – 7 Dec.)

CHI200

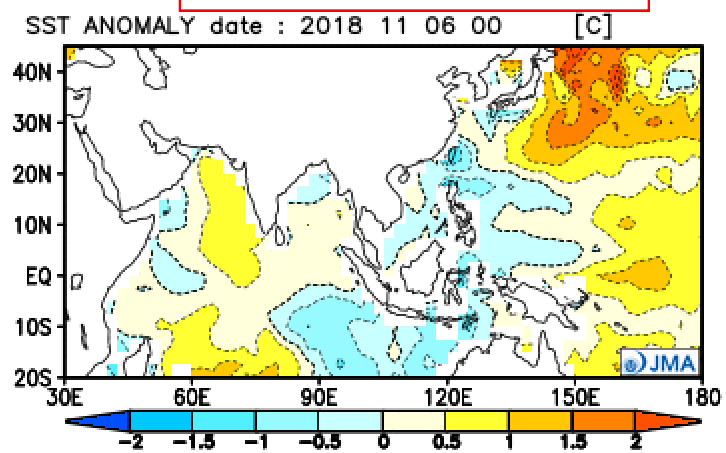


Precipitation



- MJO with active convection moves to the Atlantic and Africa.
- Suppressed phase stays over the Indian Ocean and Southeast Asia. This may be partly affected by lower-than-normal SST boundary condition.

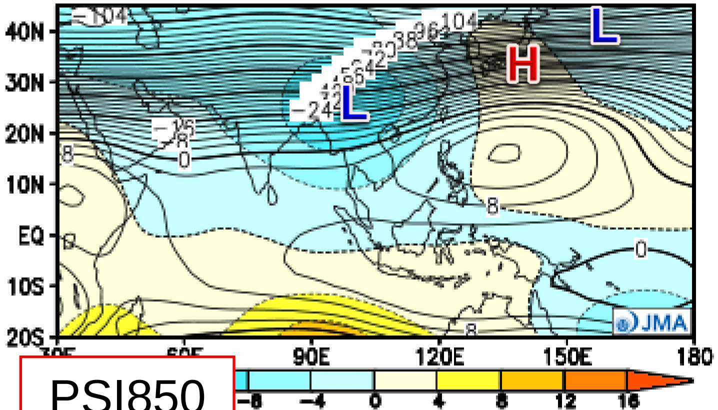
Boundary Condition (SST)



3–4th weeks (24 Nov. – 7 Dec.)

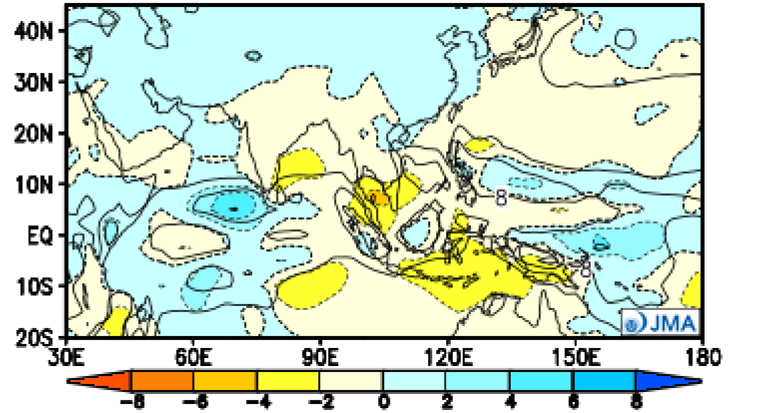
PSI200

PSI200 (FORECAST) day 17–30 init:2018/11/07 *1.0E6[m**2/s]



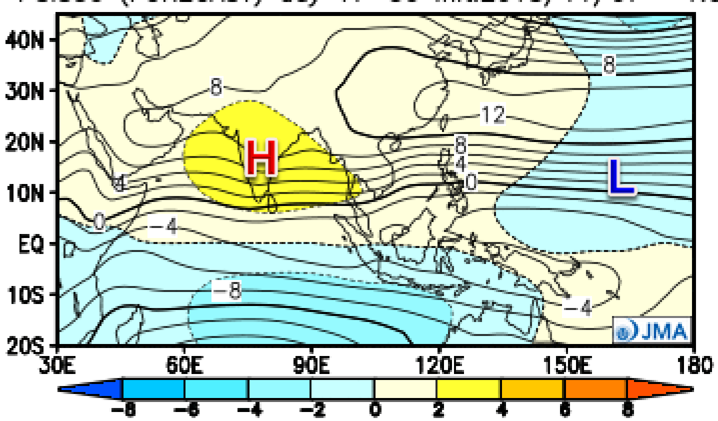
Precipitation

RAIN (FORECAST) day 17–30 init:2018/11/07 [mm/day]



PSI850

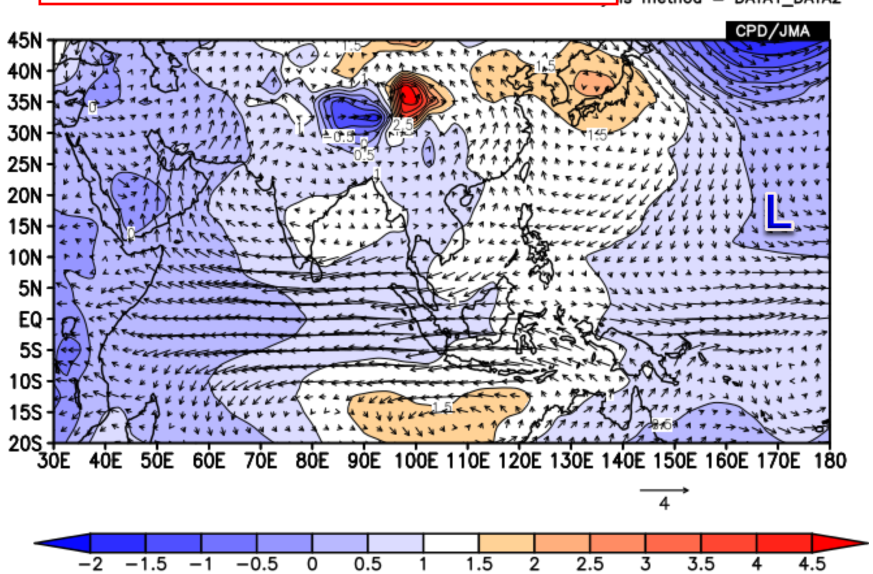
PSI850 (FORECAST) day 17–30 init:2018/11/07 *1.0E6[m**2/s]



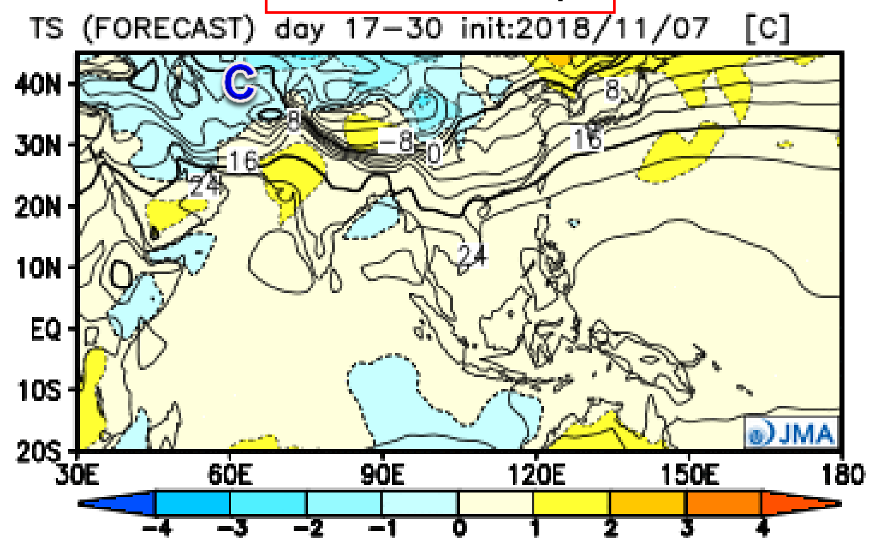
- In upper-level, southward meandering of the subtropical jet stream is predicted over the continent.
- In lower-level, anti-cyclonic anomalies are seen from the Indian Ocean to Southeast Asia.
- These patterns seem to be responses to suppressed convection.

3–4th weeks (24 Nov. – 7 Dec.)

SLP & Wind850 anom.

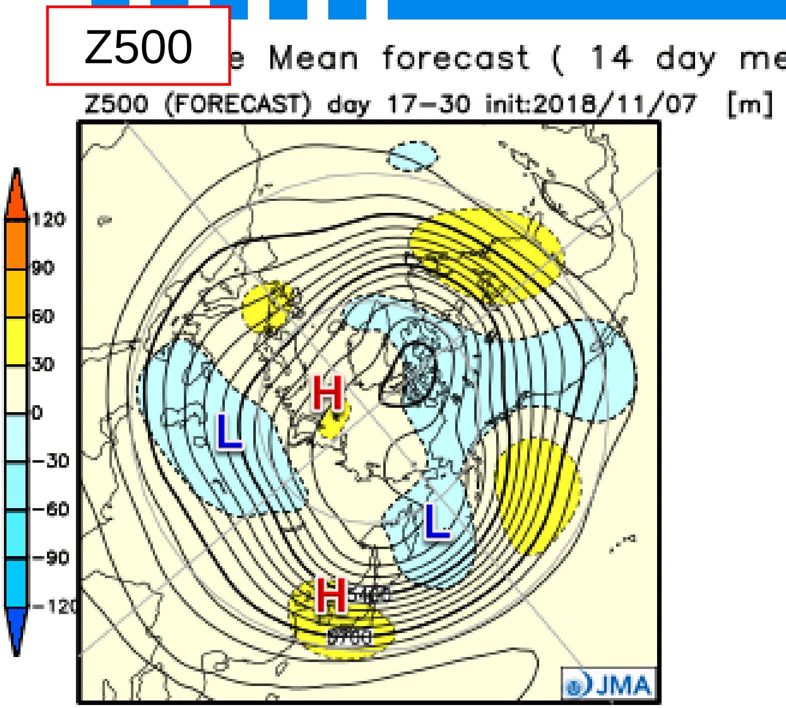


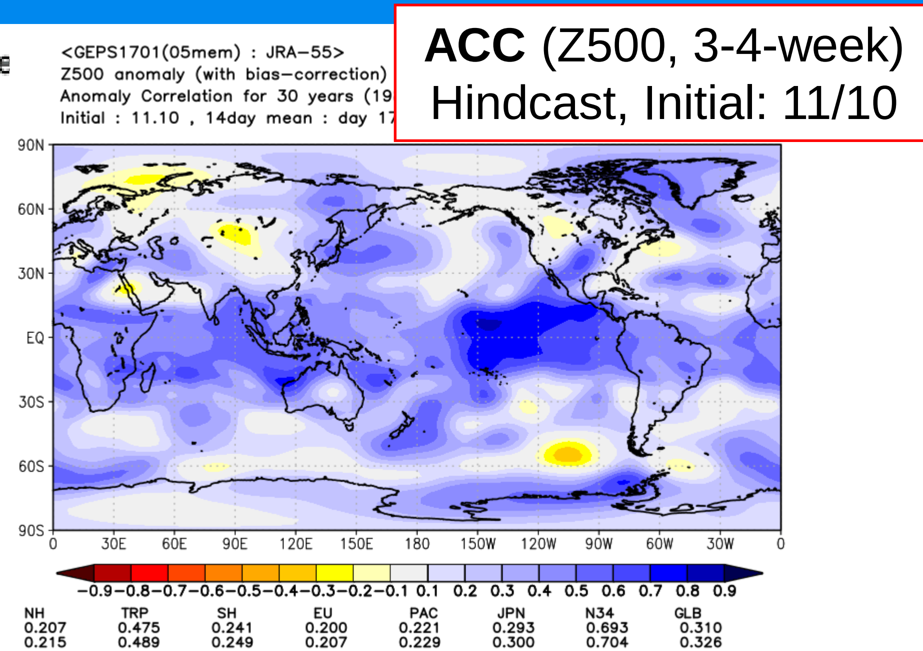
Surface Temp.



- Easterly anomalies continues from Indonesia to the tropical Indian Ocean.
- Below-normal temp. is predicted around Central Asia, associated with the southward shift of the subtropical jet stream.

3–4th weeks (24 Nov. – 7 Dec.)





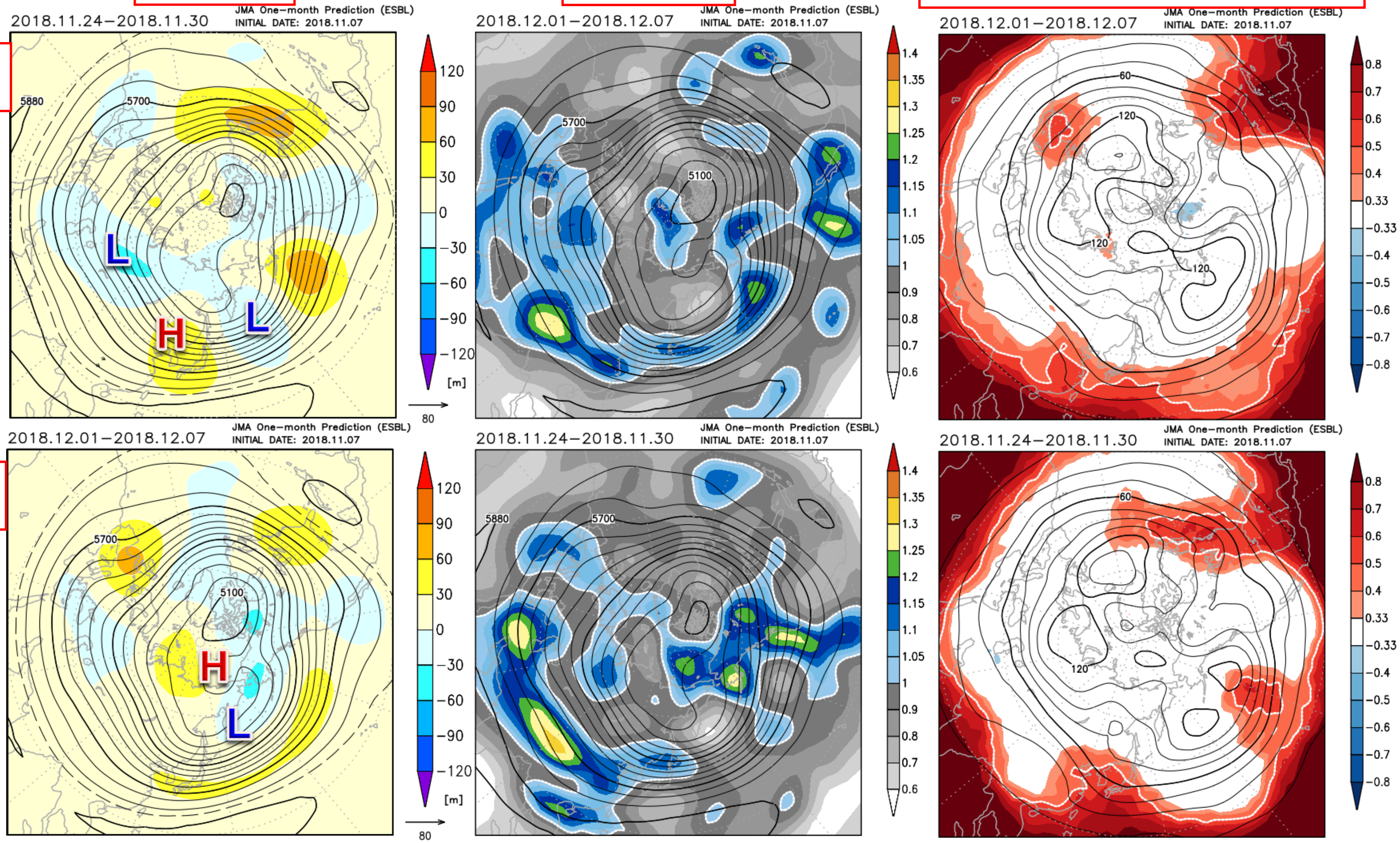
- Wave trains propagating from southwest are seen, with positive and negative anomalies around Japan and to the northeast of the country, respectively.
- Positive anomalies are predicted around the Arctic (tendency of negative AO) although the prediction skill of AO for long lead-time is low.
- ACC on the continent is relatively low.

3–4th weeks (24 Nov. – 7 Dec.)

Z500 | Spread | Prob. of Large Anom.

3rd week

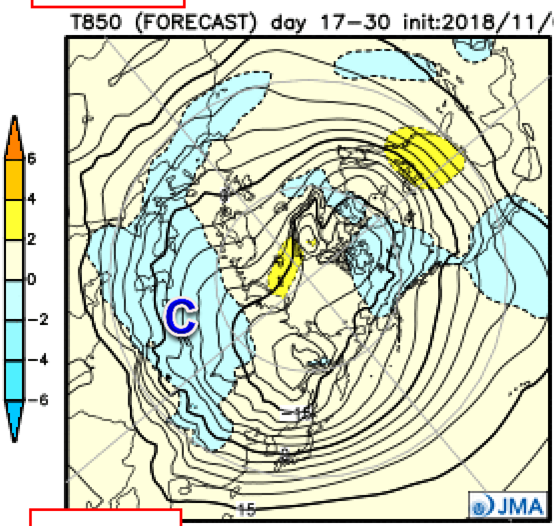
4th week



- In 3rd week, negative EU pattern is predicted to remain.
- In 3-4th weeks, spreads become large, suggesting large uncertainty.

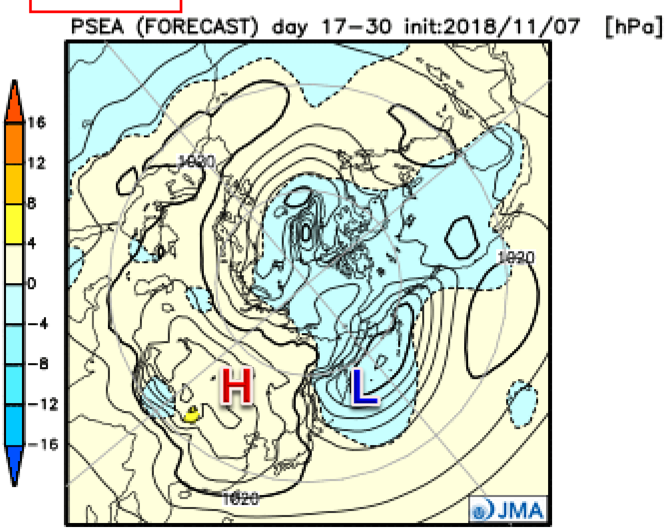
3–4th weeks (24 Nov. – 7 Dec.)

T850



- In T850, below-normal temp. is predicted around Central Asia, because of the southward shift/meandering of the jet streams.
- In SLP, the Aleutian Low is enhanced associated with the negative anom. seen in Z500.
- The strength of the Siberian High is near-normal.

SLP



Summary

- Propagation of MJO is clearly seen throughout the forecast period.
- Suppressed phase of MJO tends to stay from the Indian Ocean to Southeast Asia partly because of lower-than-normal SST boundary condition.
- The response to the suppressed convection is seen over the tropical Indian Ocean to the Southeast Asia. This may also bring southward meandering/shift of the subtropical jet stream.
- Negative EU pattern is seen up to 3rd week, which brings southward meandering of the sub-polar jet stream from Central Asia to Mongolia.
- 2nd week fields in the tropics is considered to be affected by suppressed phase of MJO.
- In 2nd week, colder air accumulates on the continent due to the southward meandering of the sub-polar jet stream, and the Siberian High develops.

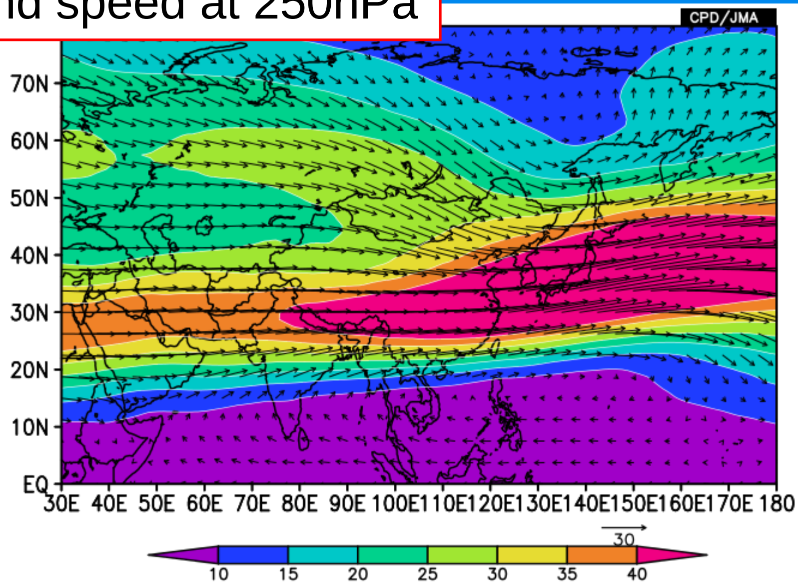
Discussion

- How do you evaluate the evolution of MJO? Is the model reliable especially in 3-4th week? (Lower SST boundary condition may affect the evolution.)
- How does the suppressed phase of MJO affect the circulation fields in model, and do you adopt the influence of MJO in your forecast?
- Considering that relatively lower prediction skill in the extratropics, to what extent do you evaluate the uncertainty especially in 3-4th week? (negative AO tendencies or negative EU pattern)
- What type of weather is expected in your country from the predicted circulation pattern (convection, wind, SLP and position of jet stream)?

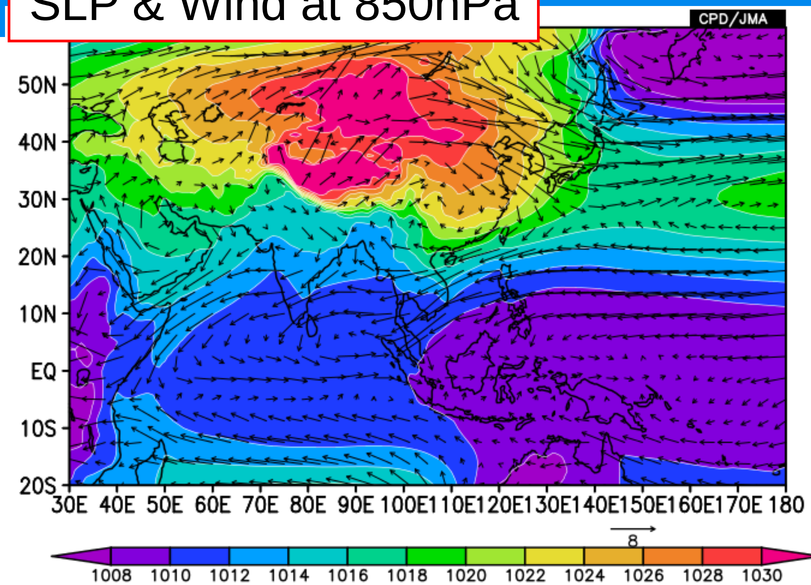
What is the signal in your forecast? How about the uncertainty?
If signal is strong and reliable, you can allocate high probability.
If uncertainty is large, probability should be close to climatology (ex. 30%-40%-30%).

Normal Fields (10 Nov. – 7 Dec.)

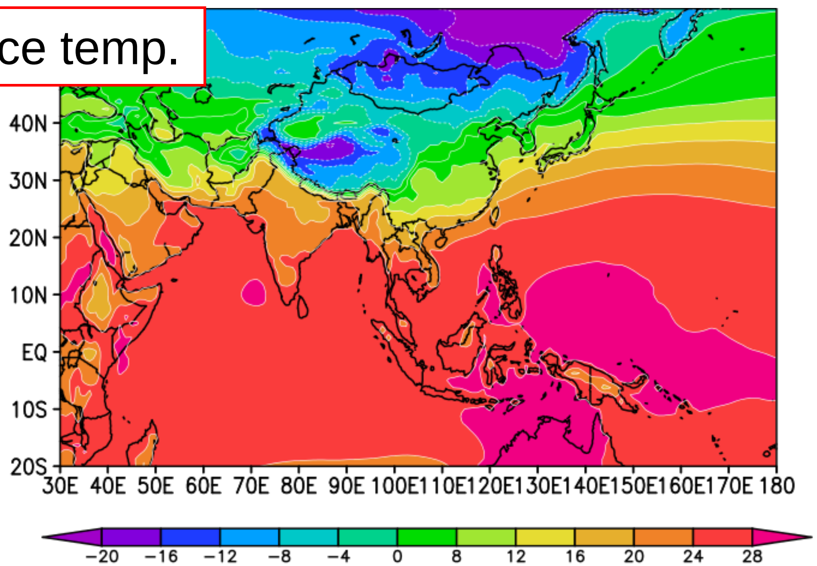
Wind speed at 250hPa



SLP & Wind at 850hPa

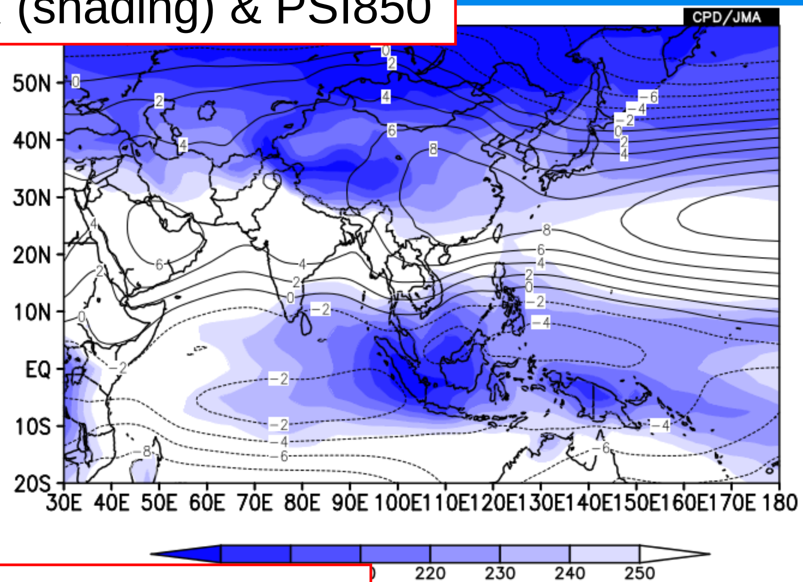


Surface temp.

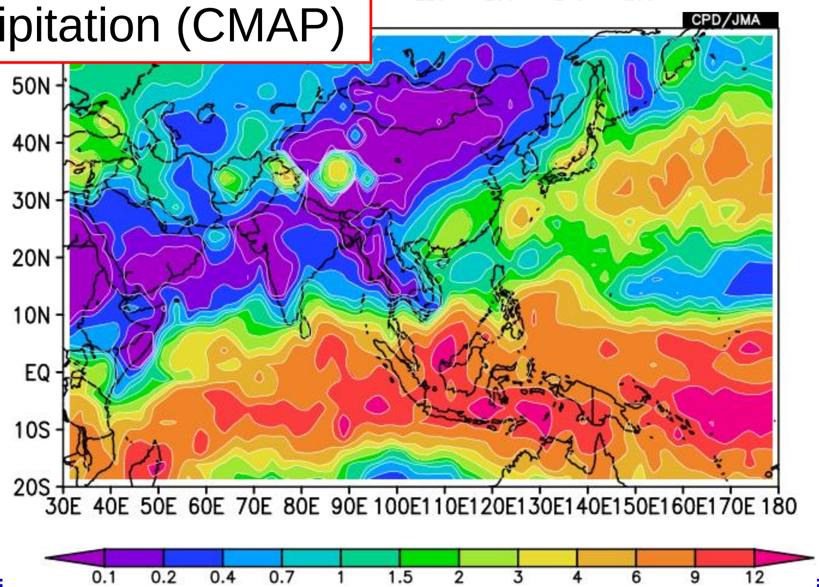


Normal Fields (10 Nov. – 7 Dec.)

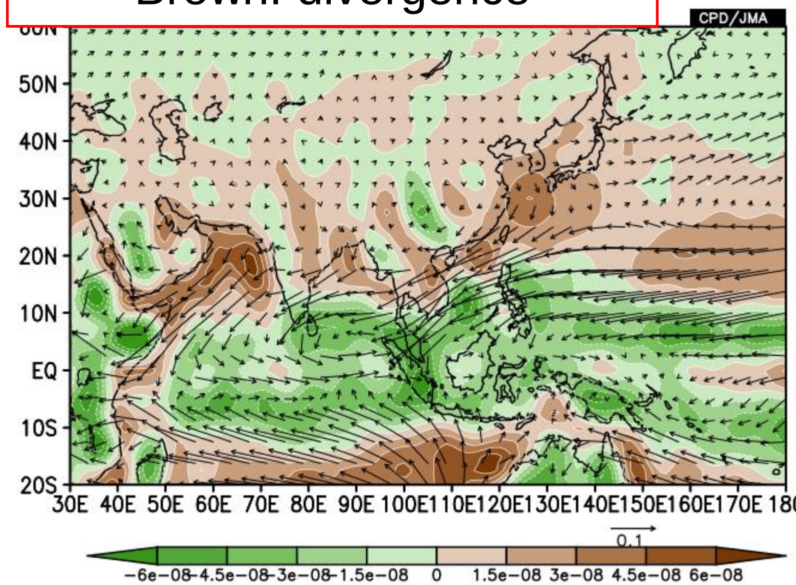
OLR (shading) & PSI850



Precipitation (CMAP)

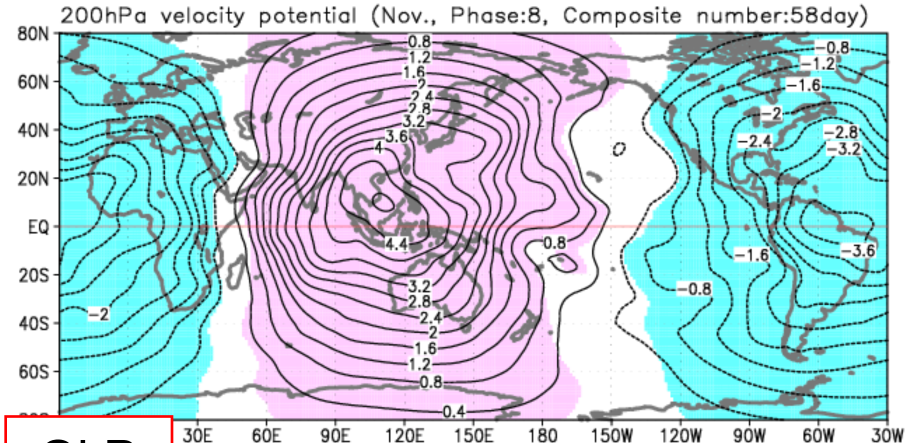


Water vapor flux at 925hPa
Green: convergence
Brown: divergence

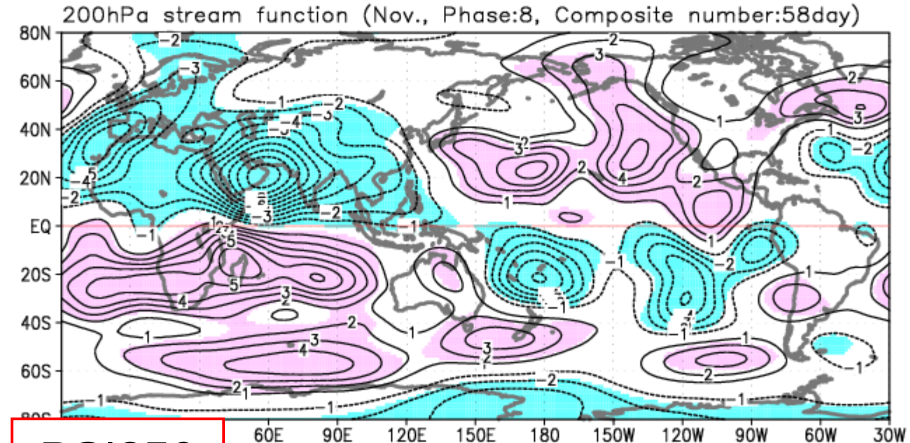


Composite Maps in Nov. (MJO phase 8)

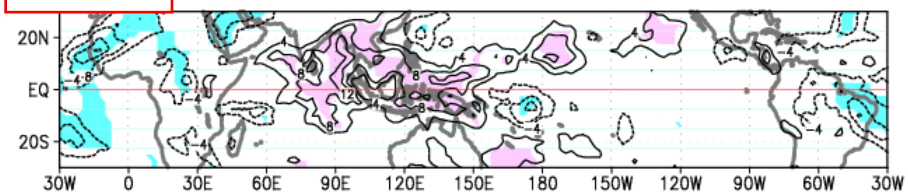
CHI200



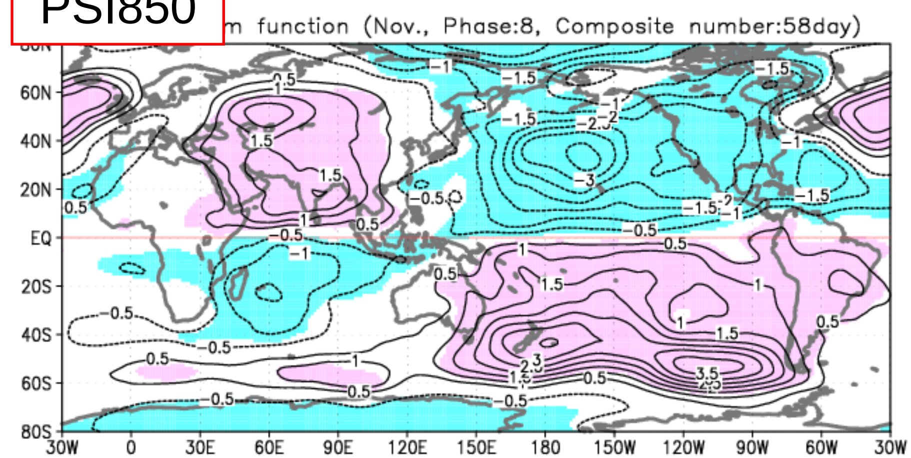
PSI200



OLR

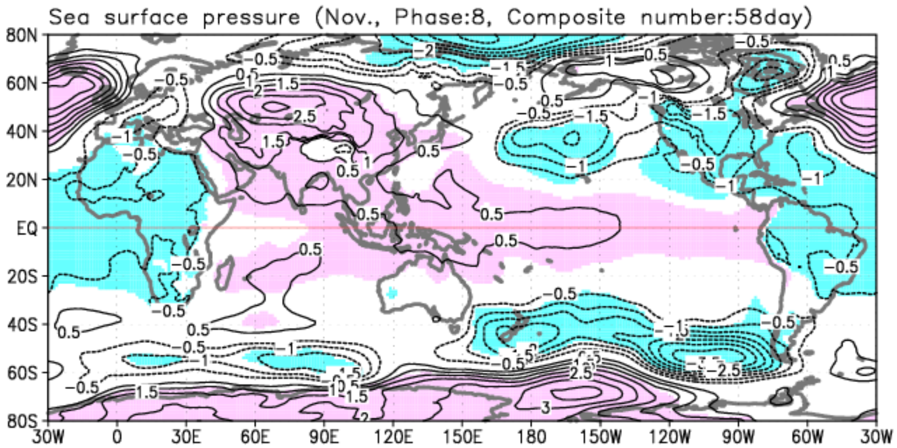


PSI850

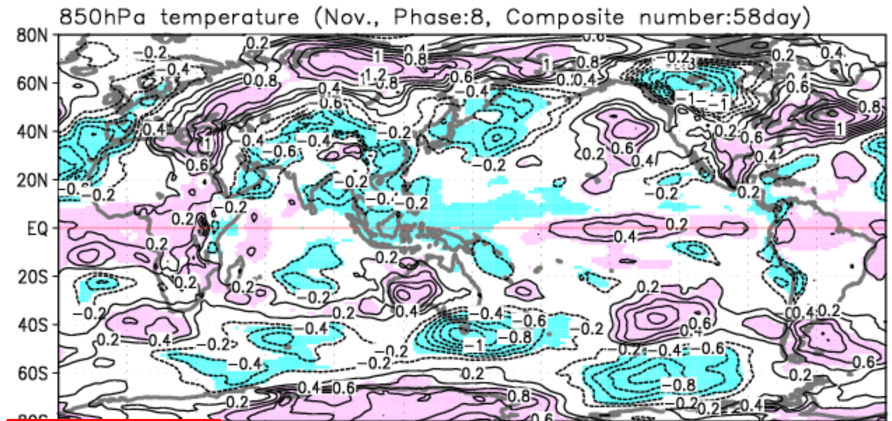


Composite Maps in Nov. (MJO phase 8)

SLP



T850



Z500