Predictable seasonal temperature variability in the East Asian winter monsoon

Yuhei Takaya*1, 2
(ytakaya@met.kishou.go.jp)

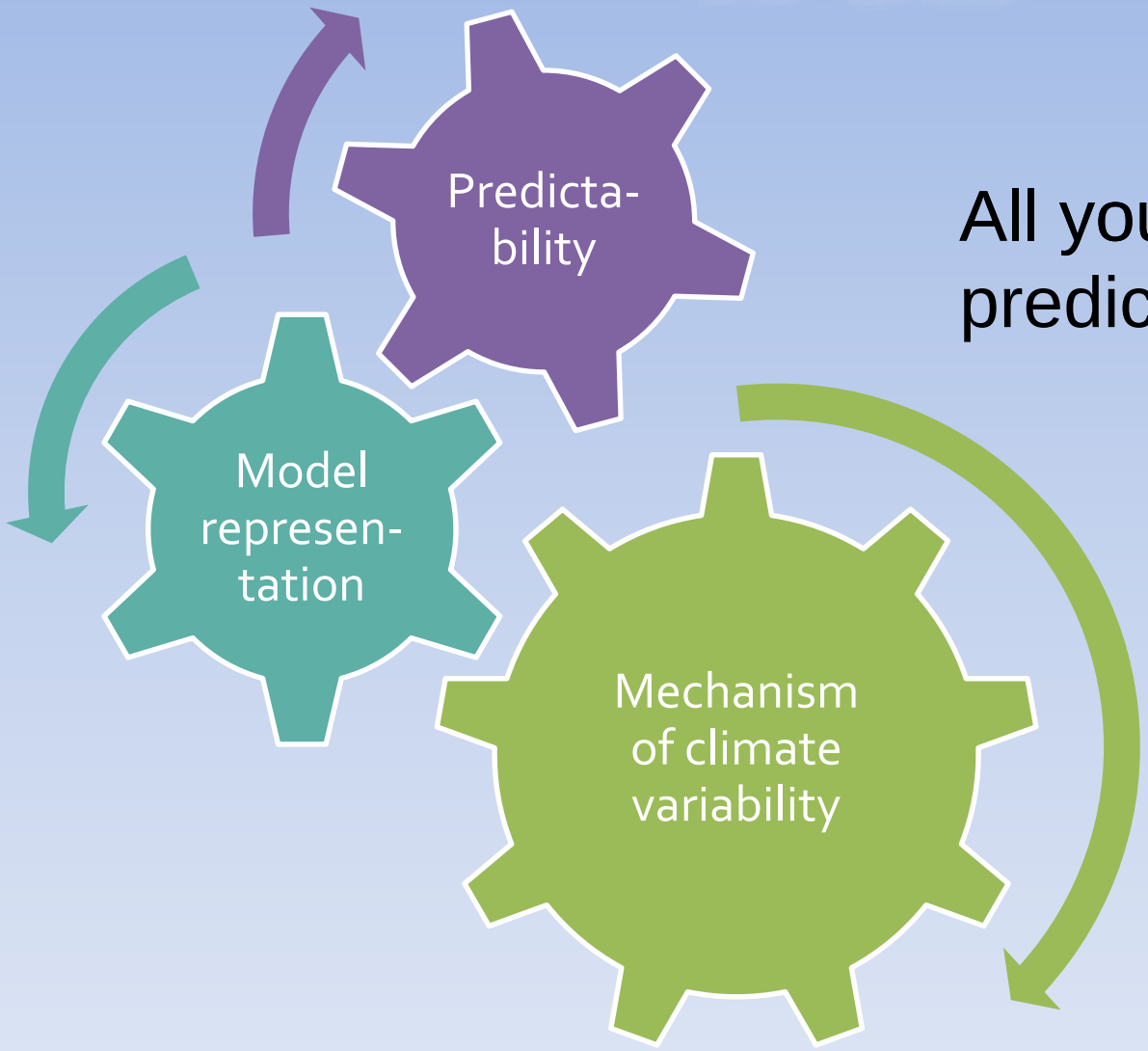
*1 Climate Research Department
Meteorological Research Institute,
Japan Meteorological Agency

*2 Climate Prediction Division
Japan Meteorological Agency

Contents

- Overview of East Asian winter monsoon (EAWM) and its representation in a seasonal forecast model
  - Dominant variability of EAWM
  - Sources of Predictability for EAWM
- Prediction for 2011/12, 2013/14 Winter
- Unpredictable factors for EAWM
- Summary

Toward better predictive understanding of the EAWM



All you need is …
predictive understanding

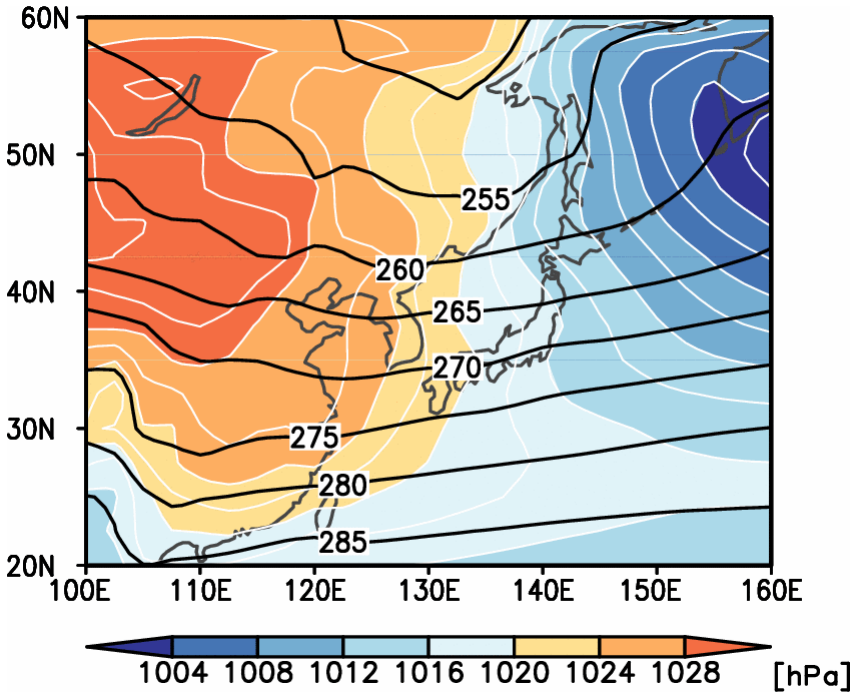
Overview of the EAWM and its representation in a seasonal forecast model (JMA/MRI-CPS1)

Takaya and Sato (2015) AOGS Sapporo

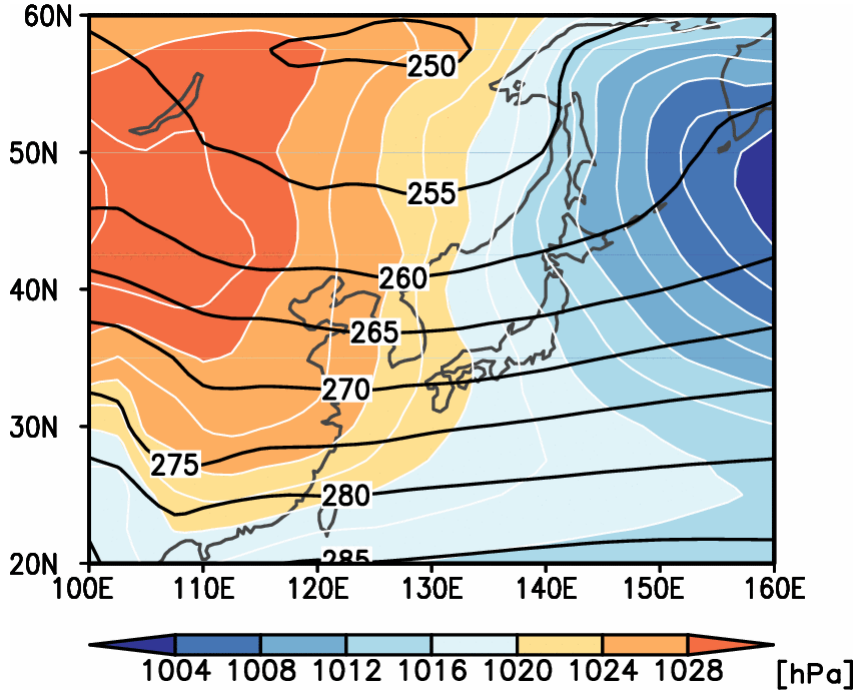
- Results shown here are for JMA/MRI-CPS1, but reproducibility in the latest system (JMA/MRI-CPS2) is similar.

Representation of Mean Climate (SLP, T850)

Analysis (JRA-55)



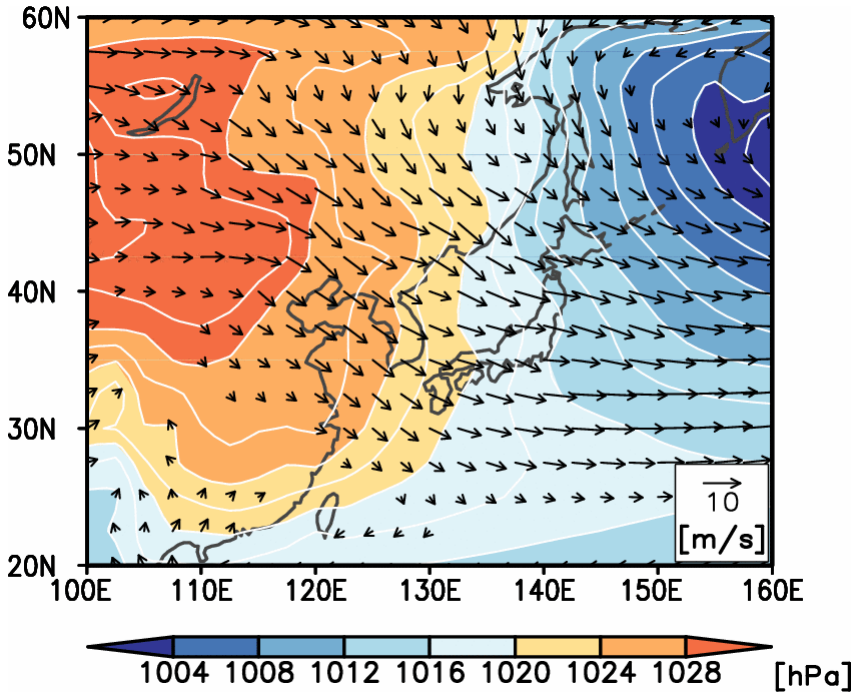
Model (JMA/MRI-CPS1)



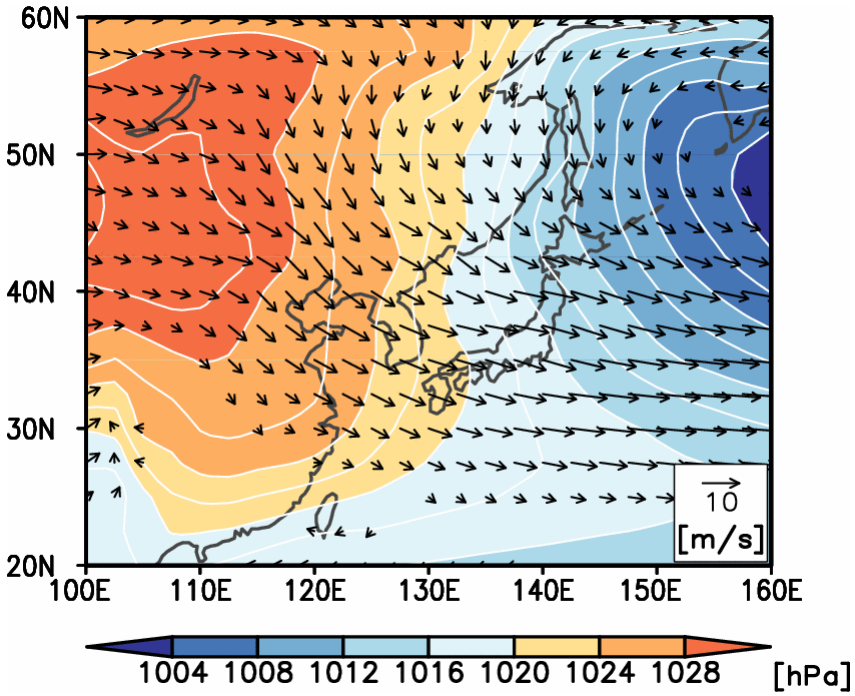
Period: 1981-2010 DJF
Ensemble size: 10
Lead time: 1 month

Representation of Mean Climate (SLP, UV850)

Analysis (JRA-55)



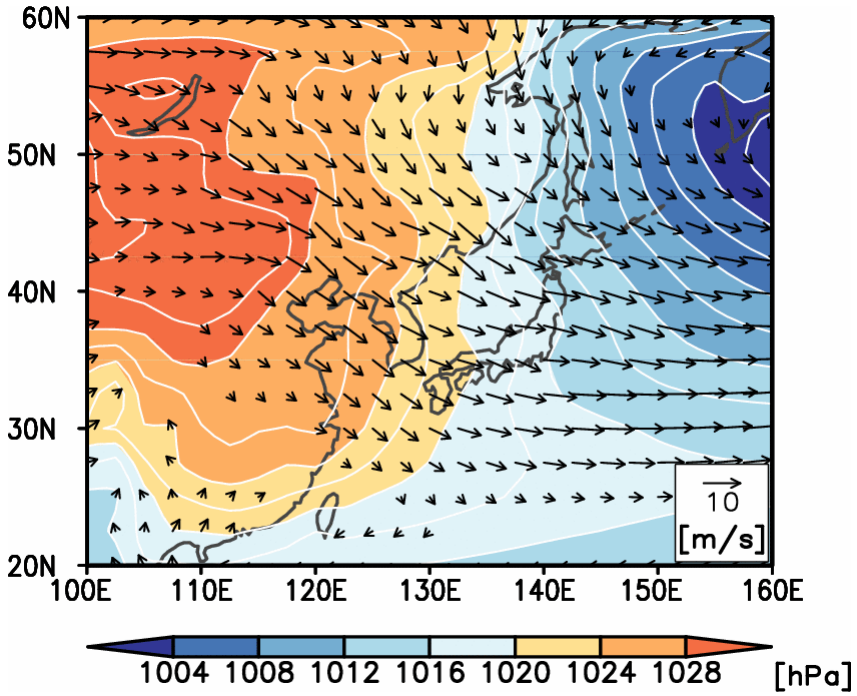
Model (JMA/MRI-CPS1)



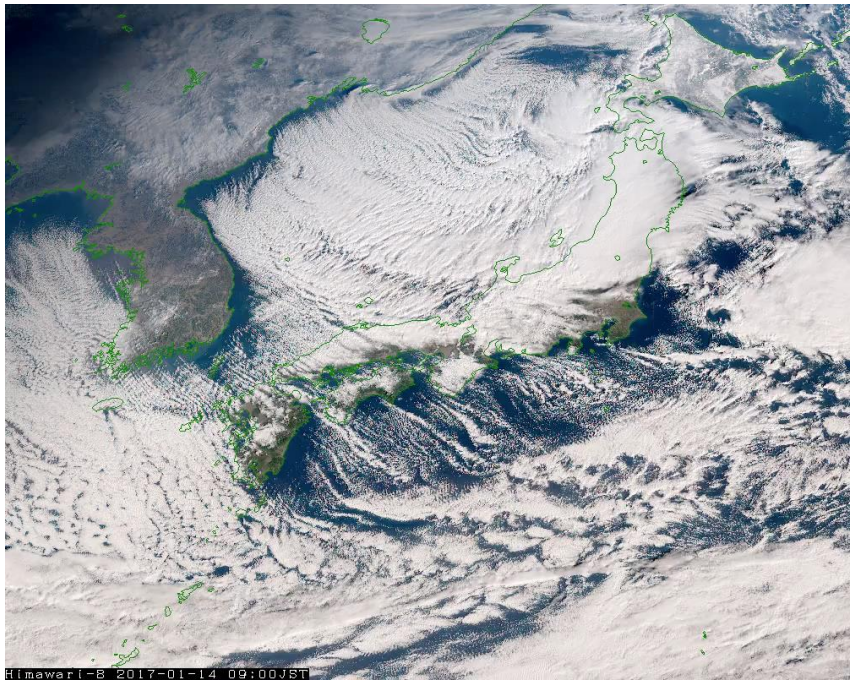
Period: 1981-2010 DJF
Ensemble size: 10
Lead time: 1 month

Representation of Mean Climate (SLP, UV850)

Analysis (JRA-55)



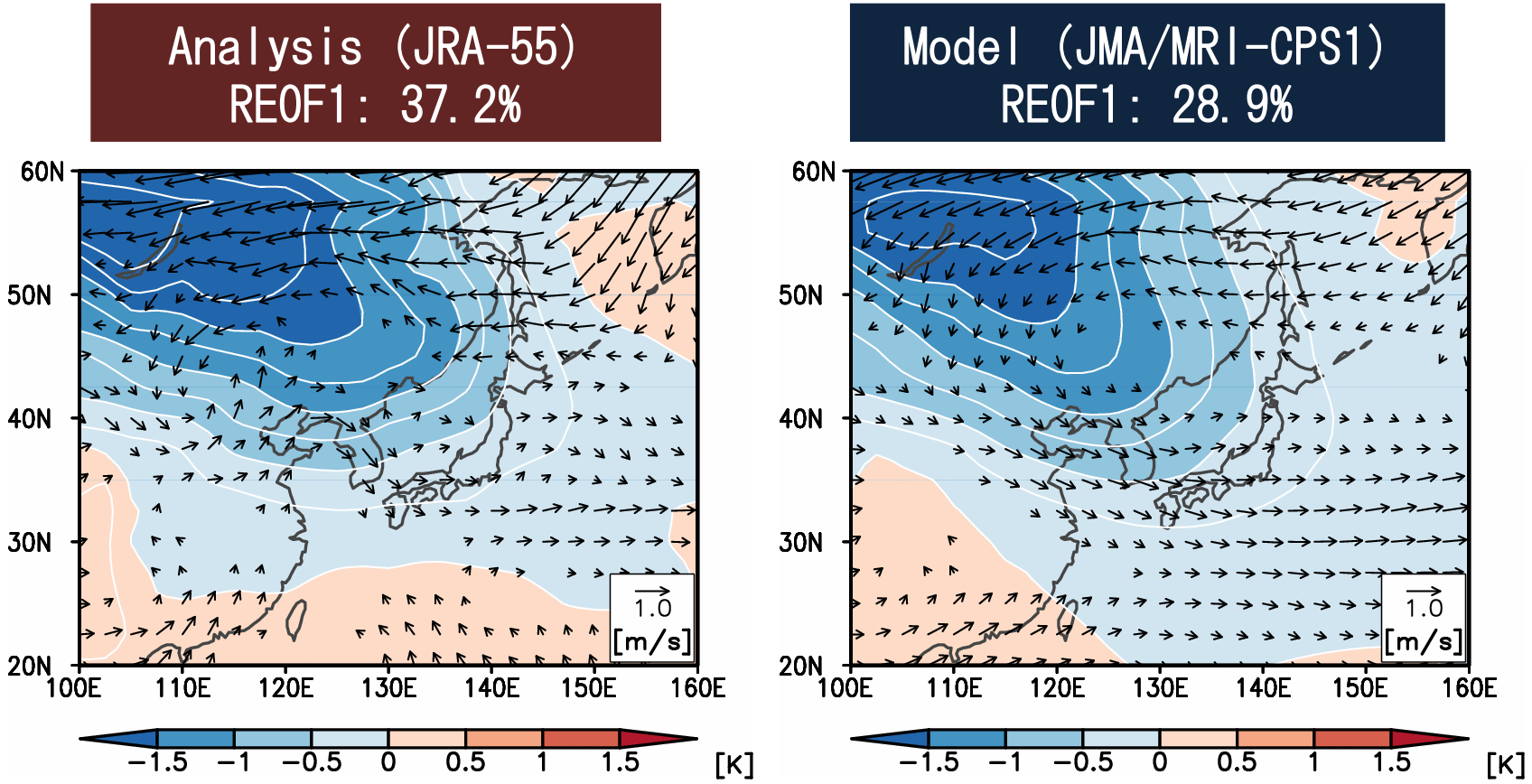
Himawari-8 IR image



14 Jan 2017
Source: JMA webpage

Interannual Variability: Lower-Troposphere Temperature Modes of EAWM (T850, UV850)

1st mode of rotated EOF analysis for 850-hPa temperature during 1981-2010 in 20-60N, 100-160E, and 850-hPa wind composite (PC1 > 1)



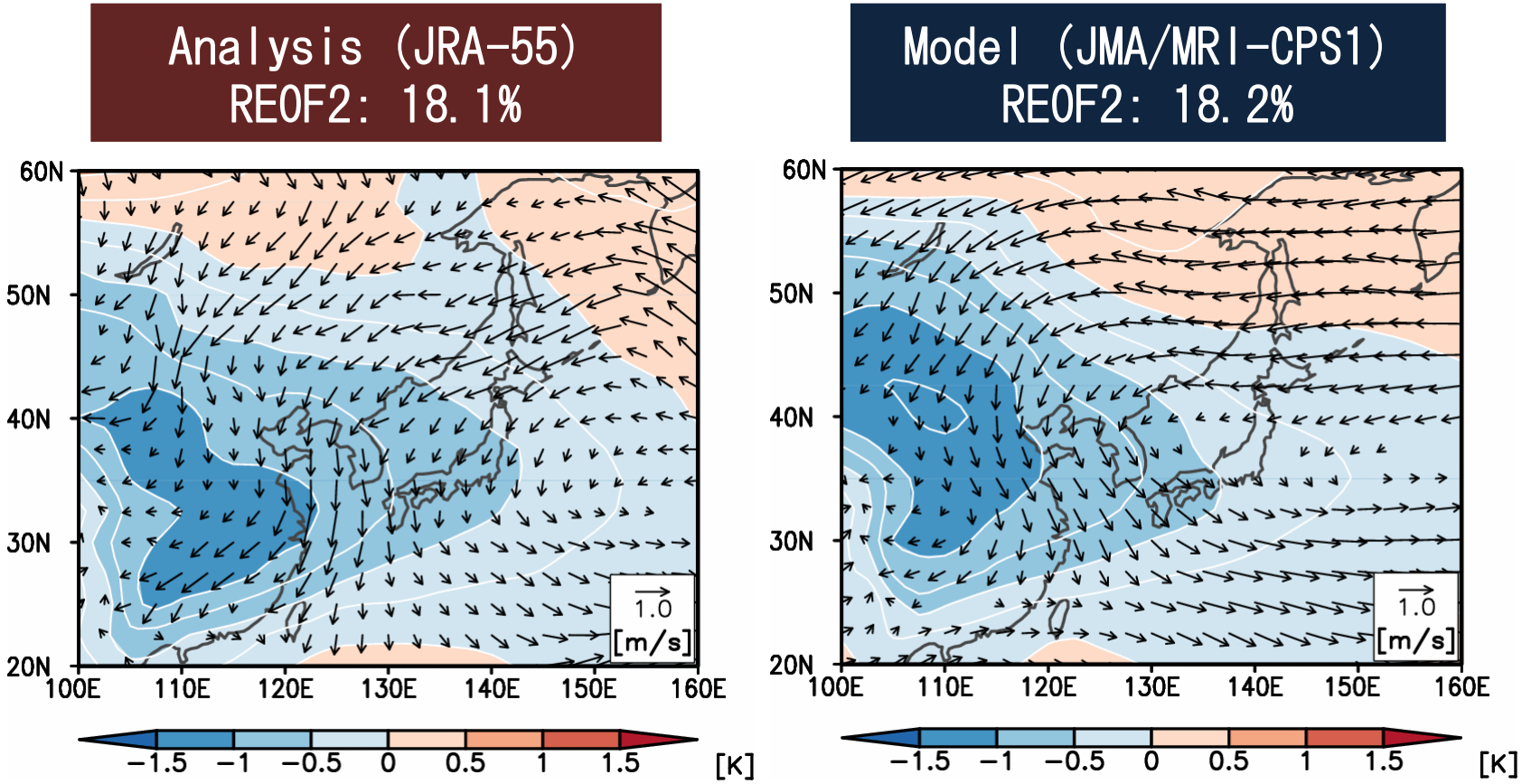
Years: 1984,1985, 2000, 2005, 2009

cf) Wang et al. 2010 JC

* Composite cases (year) are not coincident with the analysis and model.

Interannual Variability: Lower-Troposphere Temperature Modes of EAWM (T850, UV850)

2nd mode of rotated EOF analysis for 850-hPa temperature during 1981-2010 in 20-60N, 100-160E, and 850-hPa wind composite (PC2 > 1)



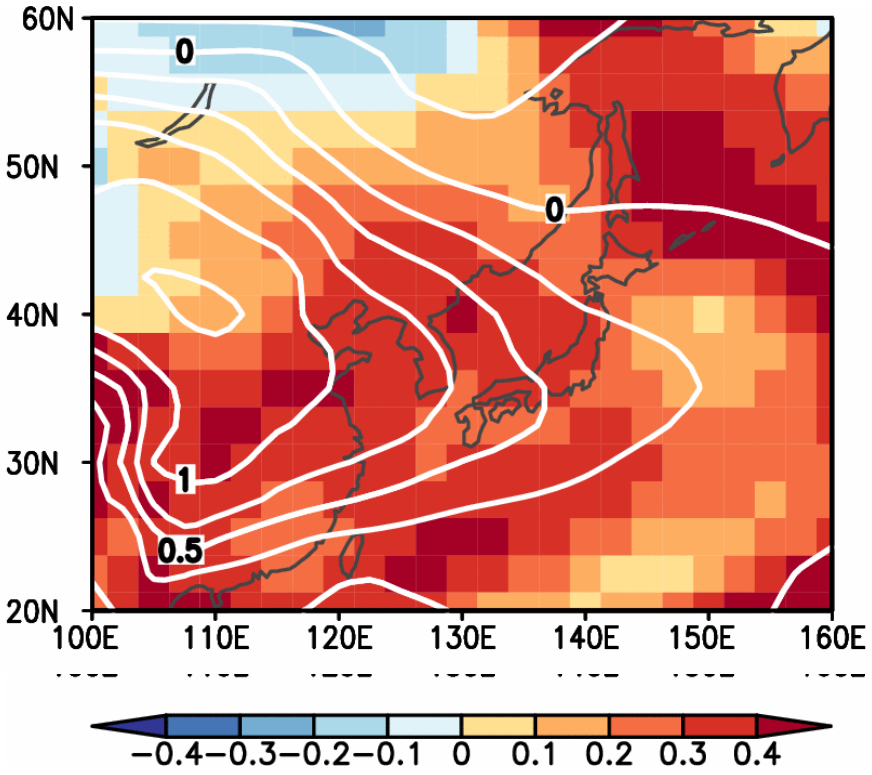
Years: 1983,1984, 1985, 1995, 2007, 2010 La Nina years

cf) Wang et al. 2010 JC

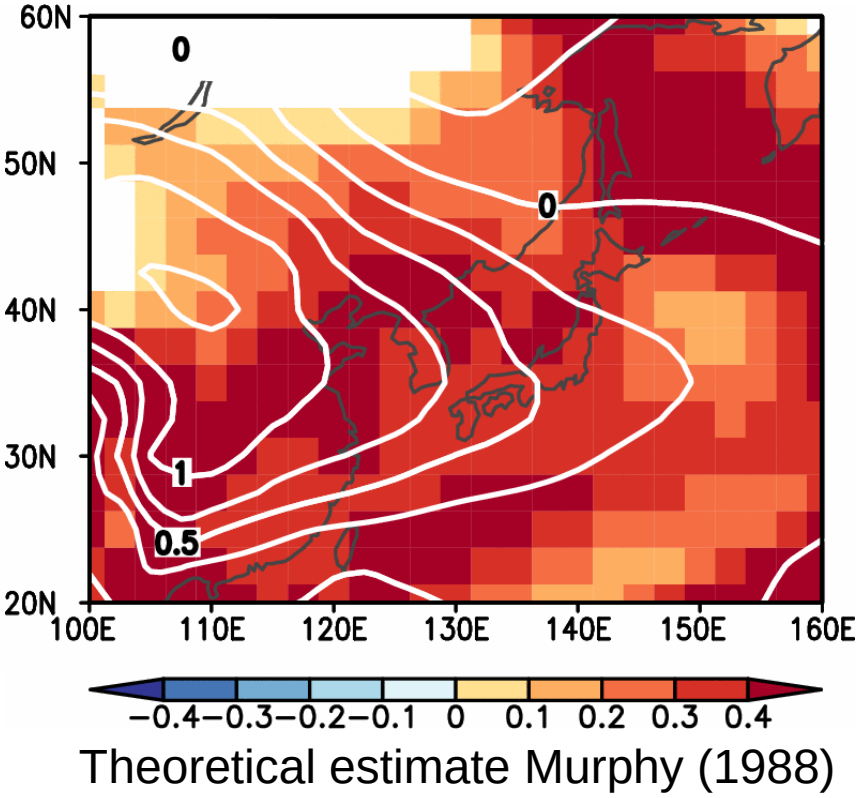
* Composite cases (year) are not coincident with the analysis and model.

Anomaly Correlation of Lower-Troposphere Temperature (T850)

Anomaly Correlation
(10 member ensemble mean)



Anomaly Correlation
(50 member ensemble mean)



Theoretical estimate Murphy (1988)

This verification illustrates that the southern mode is more predictable than the northern one.

Sources of Predictability for EAWM

- EAWM is influenced by the convective activity from tropical Indian Ocean to western Pacific (eq. Jhun and Lee, 2004, Sakai and Kawamura 2009, Sakai et al. 2010, Wang et al., 2000, Wang et al. 2010)

ENSO→ Convection near MC → Circulations in EA

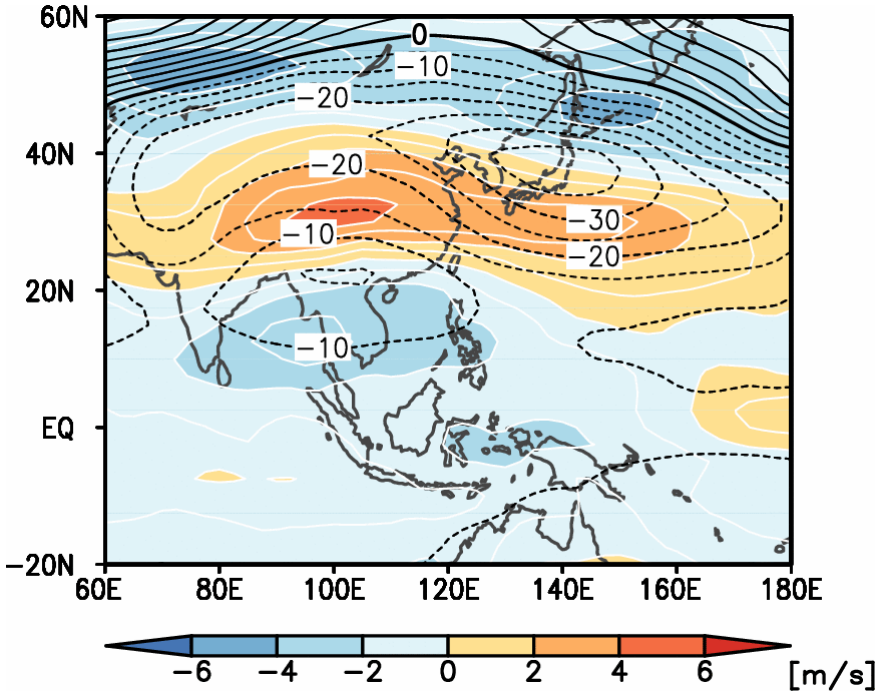
Strong Winter Monsoon REOF2(T850, PC2>1) and ENSO

Year	Number of Members (out of 10)			Average
Analysis (PC2>1)	Model (PC2>1)	Model (PC2>0.5)	Model (PC2>0)	Model PC2
1983	0	3	5	0.05
1984	3	6	9	0.80
1985	4	5	5	0.41
1995	1	3	5	0.02
2007	2	3	4	-0.02
2010	2	4	6	0.31

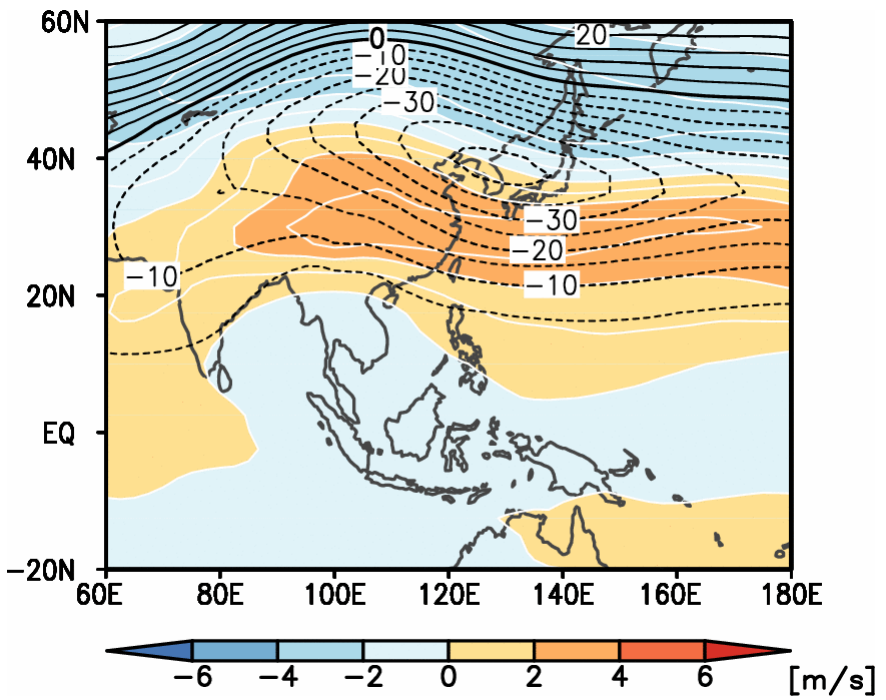
La Nina years

U300, Z500 Composites for Strong Monsoon REOF2(T850, PC2>1)

Analysis (JRA-55)



Model (JMA/MRI-CGCM)



Years: 1983,1984, 1985, 1995, 2007, 2010

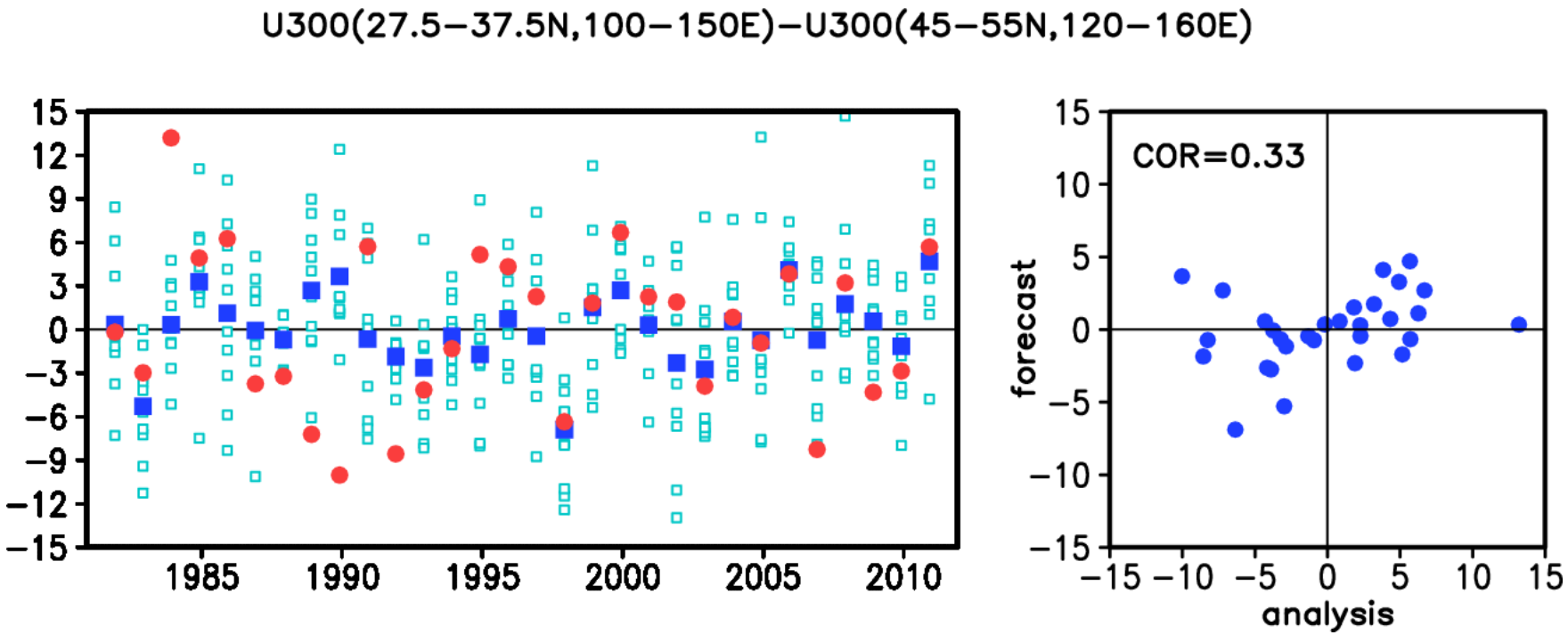
La Nina years

Cases:
81(4),82(1),84(3),85(4),86(2),88(3),89(3),
90(2),91(1),94(2),95(1),96(2),98(2),99(2),
01(2),02(1),04(2),05(2),06(2),07(2),10(2)

cf) Jhun and Lee 2004, Li and Yang 2010, Jian et al. 2013

* Composite cases (years) are not coincident with the analysis and model.

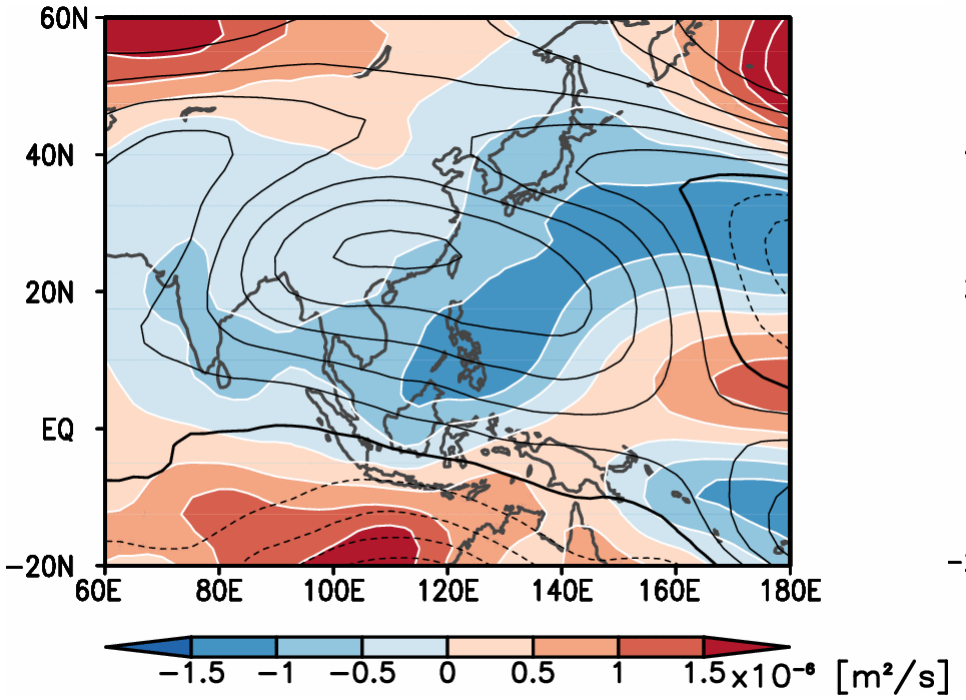
Predictive skill of U300 pattern



- JRA-25 Analysis
- 10-mem ensemble mean
- Individual members

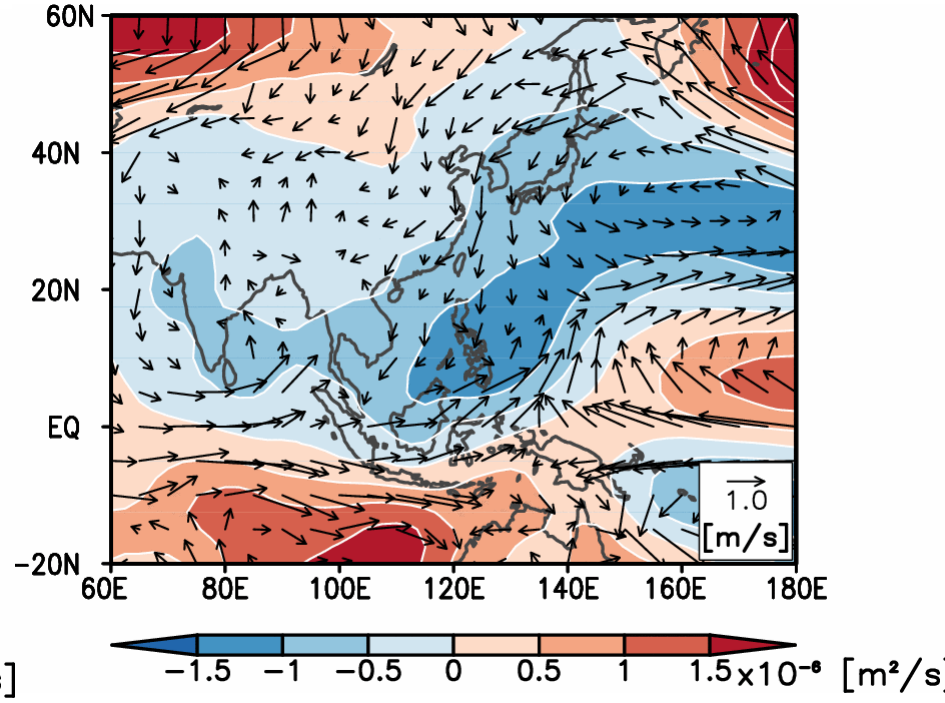
PSI200, PSI850 UV850 Composites for Strong Monsoon REOF2(T850, PC2>1)

Analysis (PSI200, PSI850)



Color Shadings :PSI850 anomaly
Black contours: PSI200 anomaly

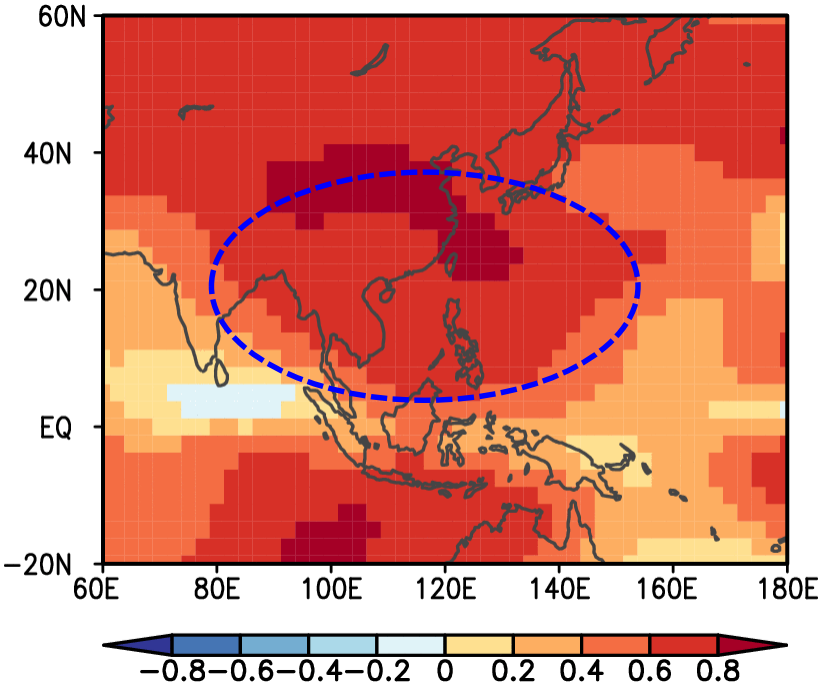
Analysis (UV850, PSI850)



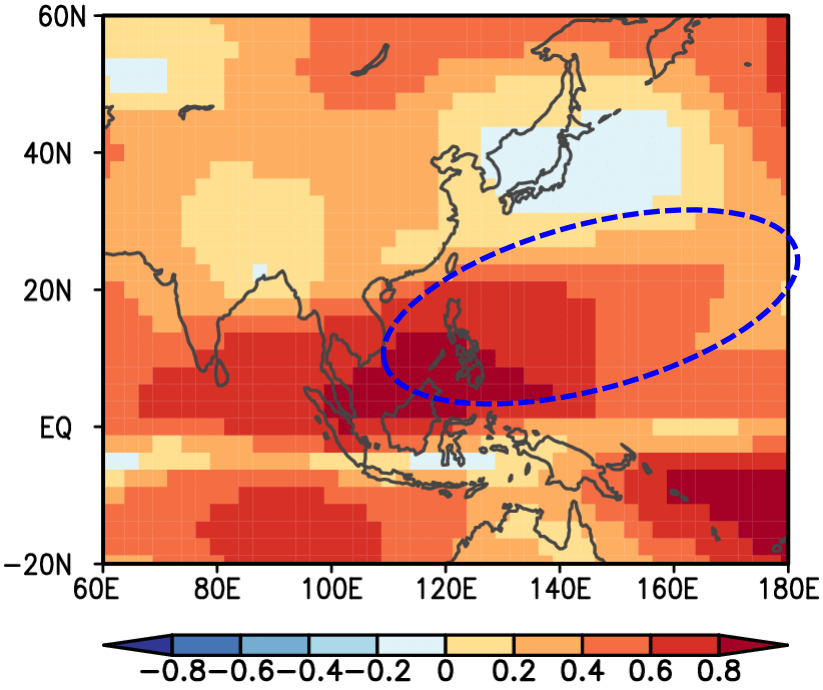
Color Shadings :PSI850 anomaly
Vectors: UV850 anomaly

Anomaly Correlation of Stream Function at 200 hPa and 850 hPa.

PSI200
(10 member ensemble mean)



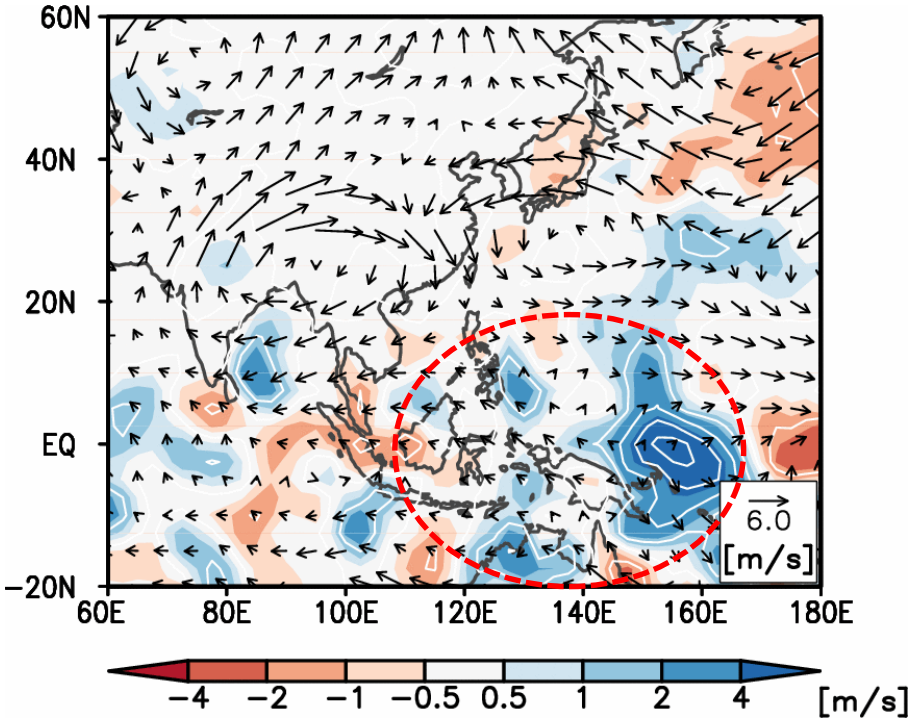
PSI850
(10 member ensemble mean)



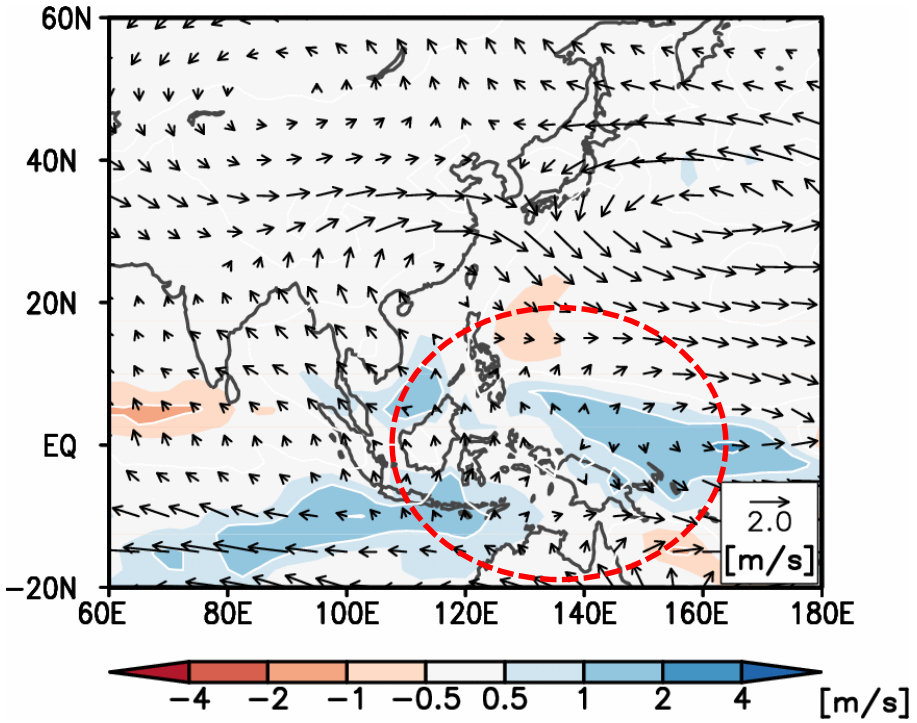
Case study: 2013 and 2011 Winter

Prediction for 2013/14 Winter(DJF)
Precip, UV200

Analysis (JRA-55)



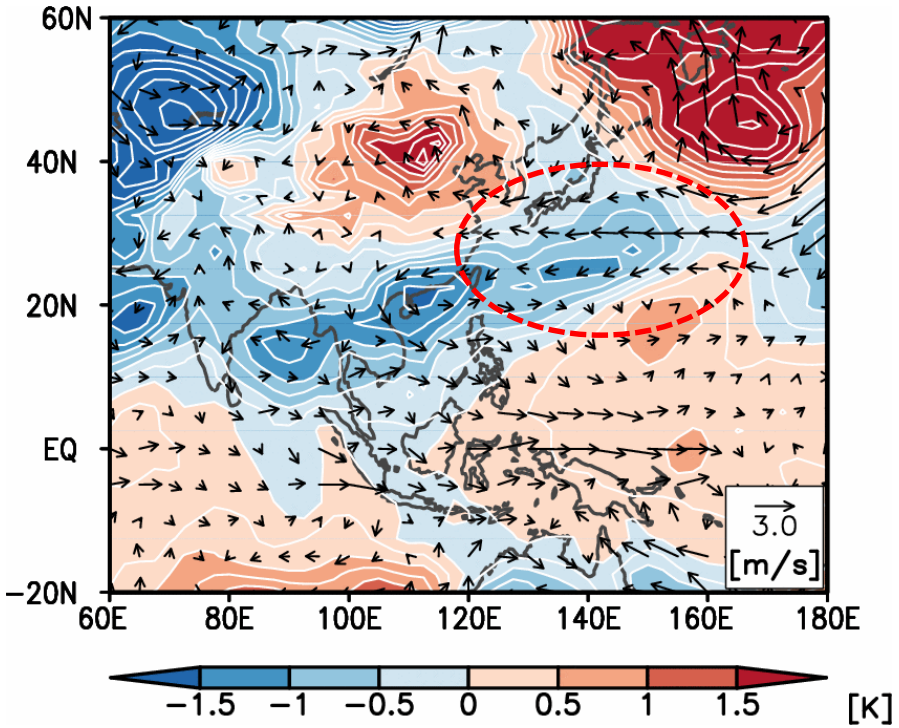
Model (JMA/MRI-CGCM)



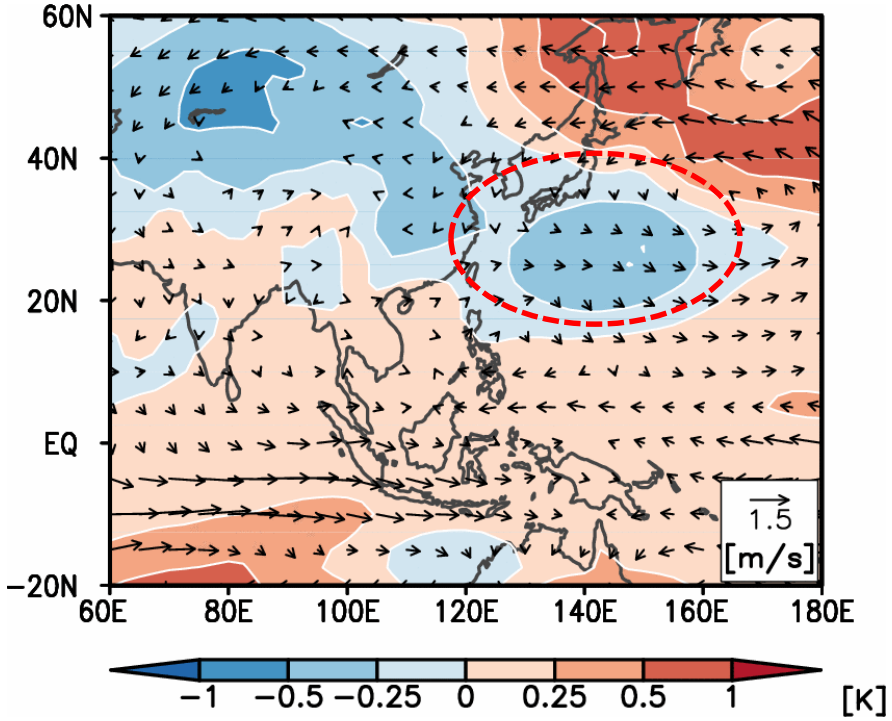
Operational Prediction with 50 ensemble members.

Prediction for 2013/14 Winter(DJF)
T850, UV850

Analysis (JRA-55)

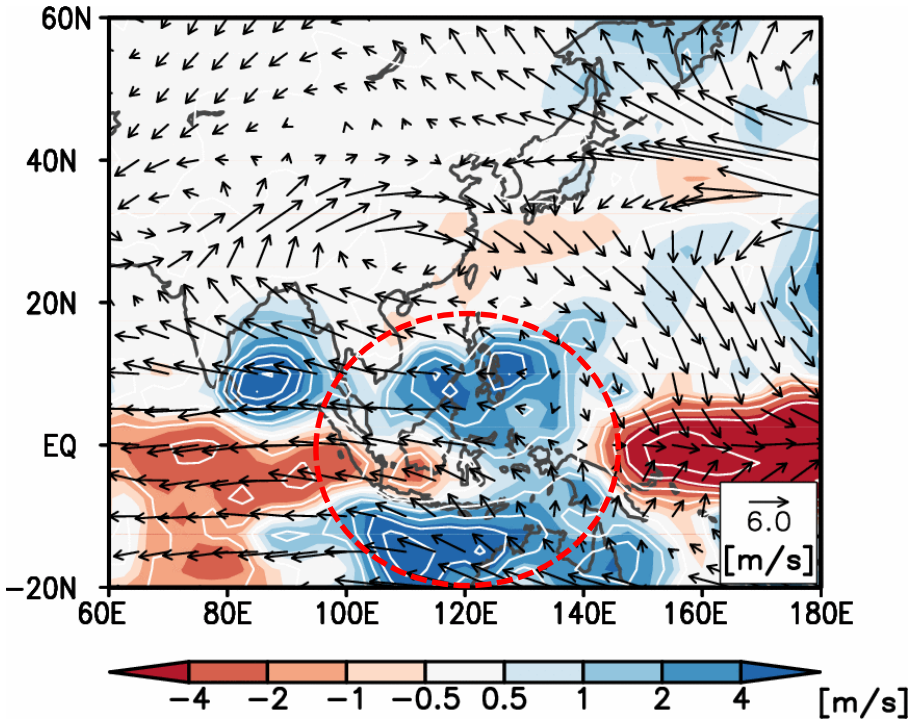


Model (JMA/MRI-CGCM)

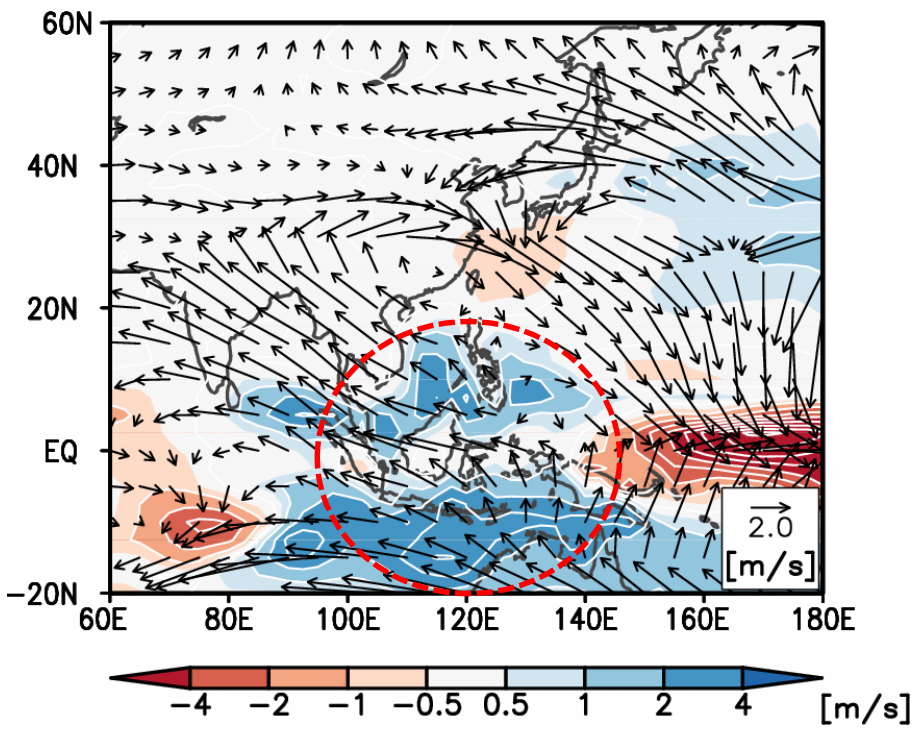


Prediction for 2010/11 Winter(DJF)
Precip, UV200

Analysis (JRA-55)



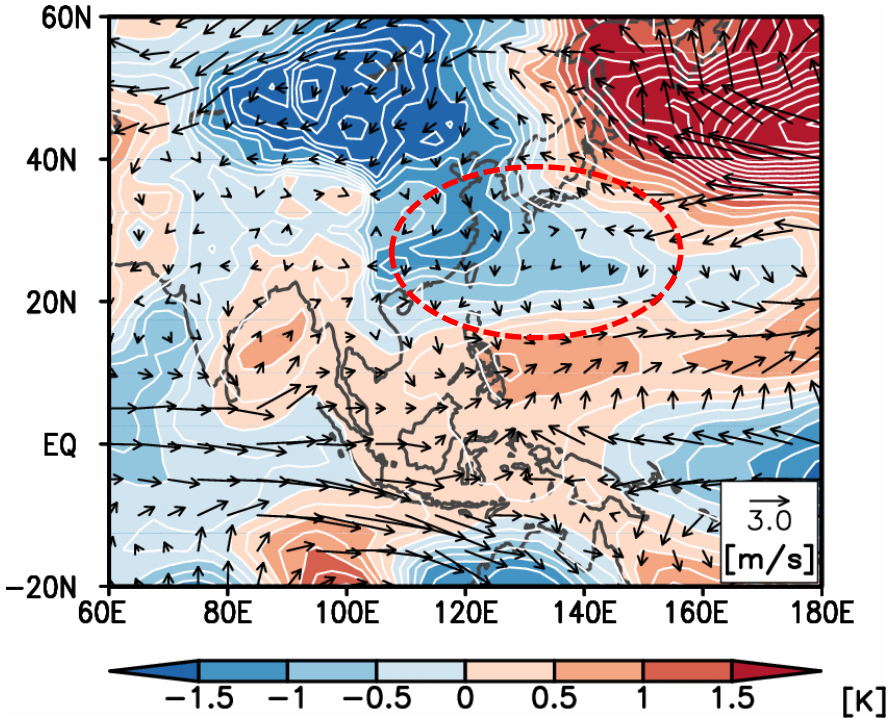
Model (JMA/MRI-CGCM)



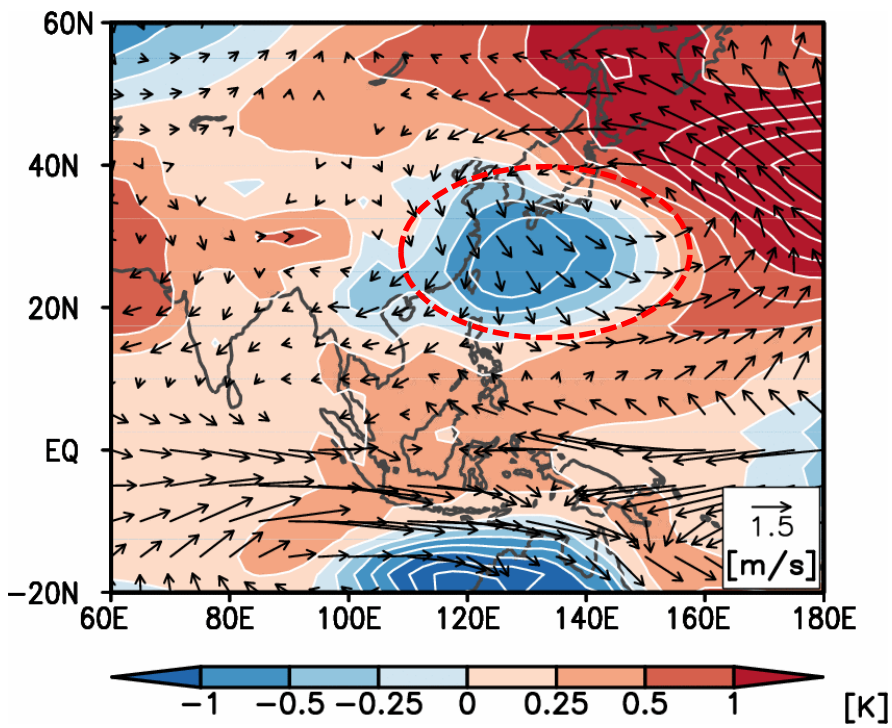
Operational Prediction for the Last La Nina Year

Prediction for 2010/11 Winter(DJF)
T850, UV850

Analysis (JRA-55)

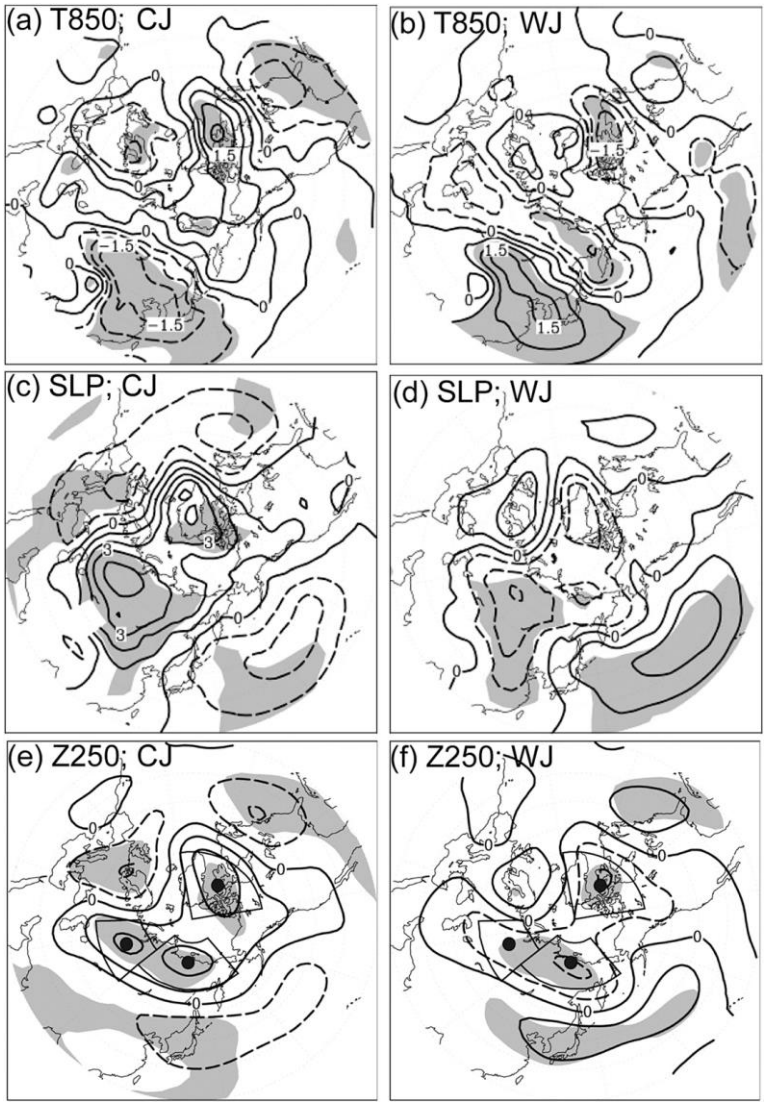


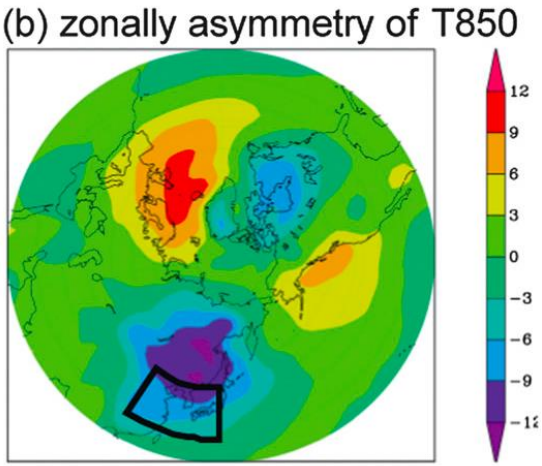
Model (JMA/MRI-CGCM)



Unpredictable factors

Two types of extratropical EAWM patterns





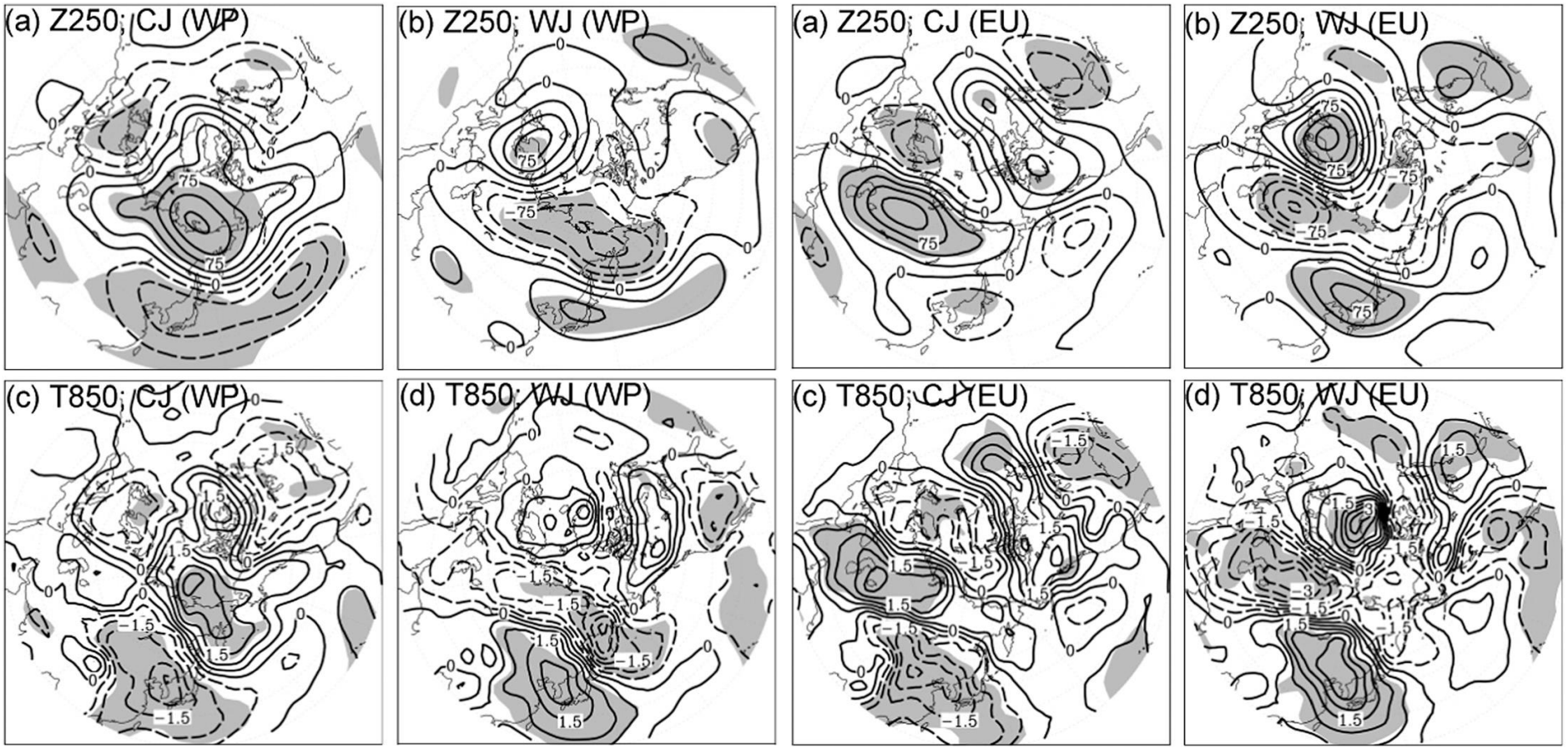
Cold/warm January events accompany tropospheric teleconnection patterns.

K. Takaya and Nakamura 2013

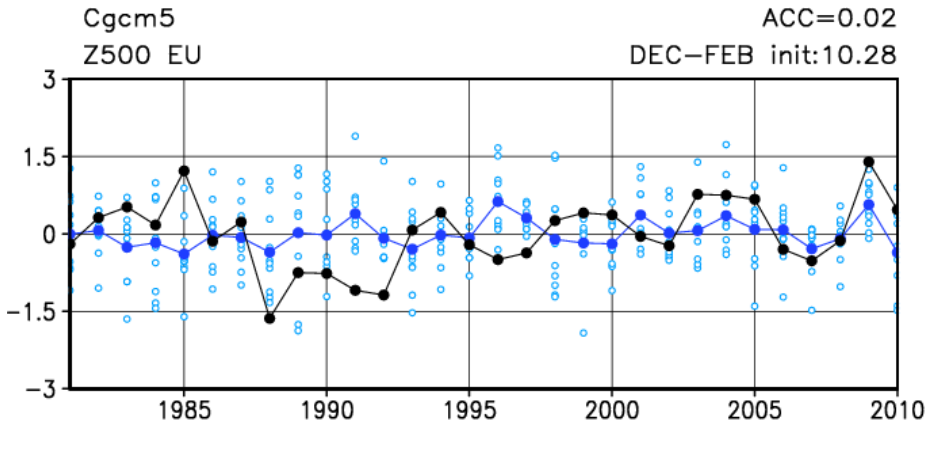
Two types of extratropical EAWM patterns

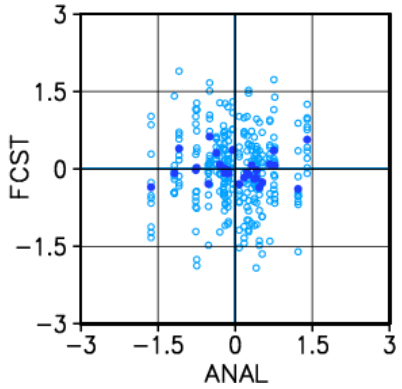
WP-like pattern

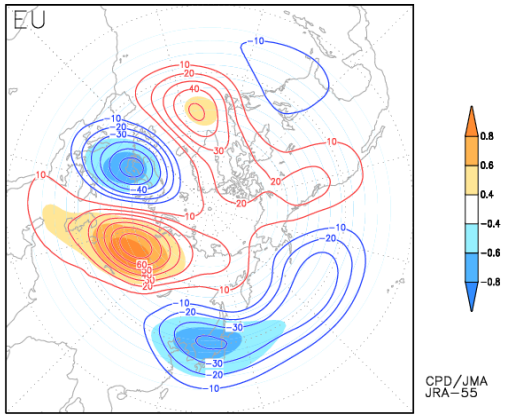
EU-like pattern

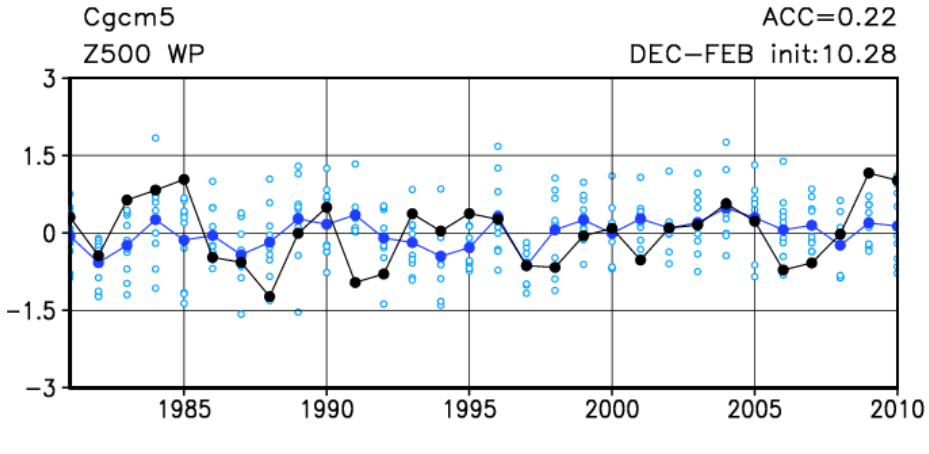


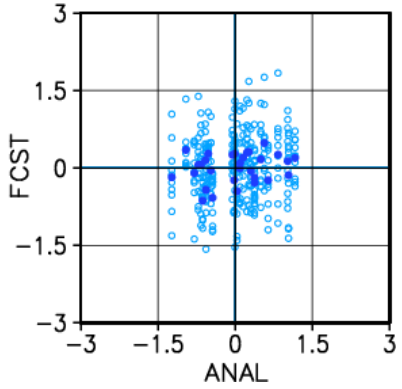
Skill in predicting EU, WP pattern

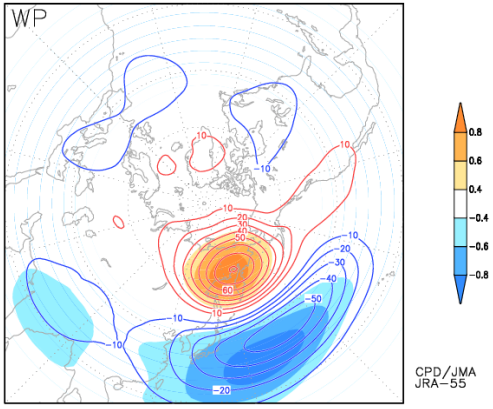












Results based on JMA/MRI-CPS2, but similar to those of CPS1.

Summary (Take home messages)

- State-of-the-art seasonal prediction systems have ability to represent the major characteristics of the southern temperature mode of EAWM.
- The predictability of the southern temperature mode links to the tropical convective activity around the maritime continent to some extent.
- The operational system relatively well predicted 2010/11, 2013/14 cold winters, indicating usefulness of operational dynamical seasonal forecasting.
- Stumbling blocks that limit the predictability of EAWM in the current system are influences of less-predictable extratropical teleconnections.

Thank you for your kind attention.