Climate Outlook for Winter 2016/2017

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KMA

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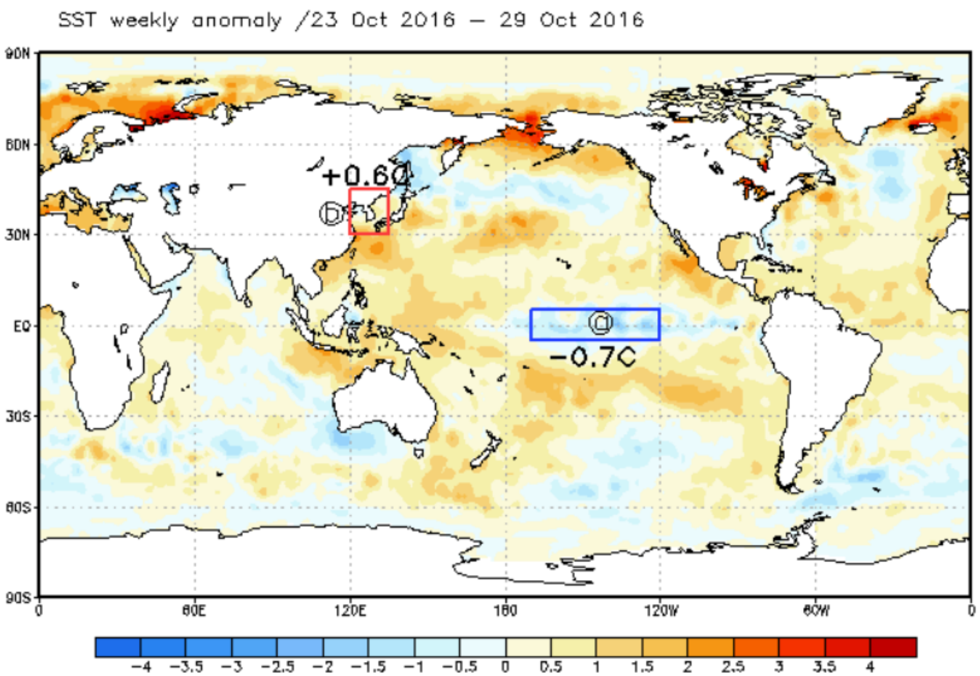
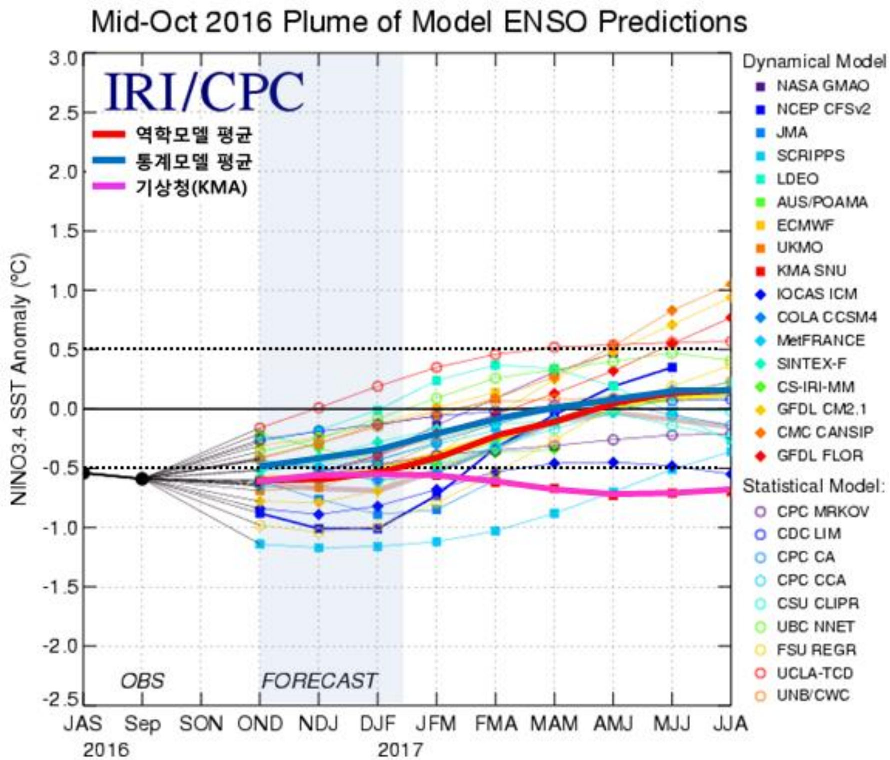
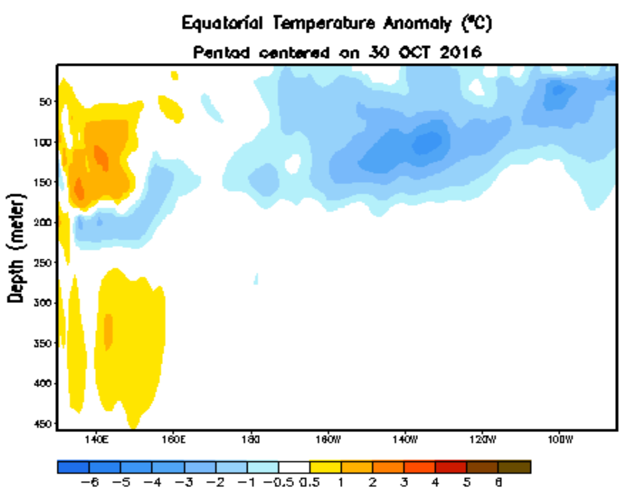
Consideration elements for winter prediction

- o ENSO
- o Dynamical model (GloSea5, WMO Lead Center for MME)
- o Arctic Sea Ice
- o Snow cover for Eurasian Continent
- o AO (Arctic Oscillation)
- o Blocking Activity

ENSO condition and prediction



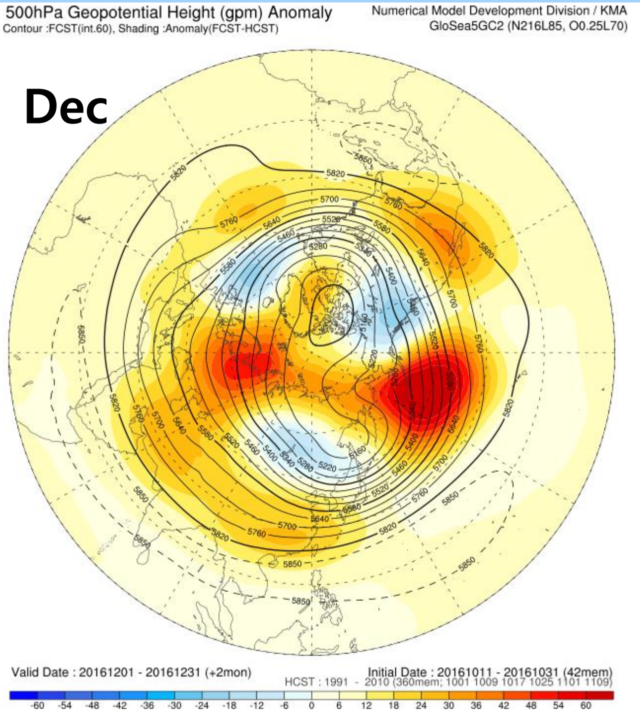




Currently, the Niño3.4 region of the tropical Pacific Ocean is likely to be in La Niña thresholds. The majority of international climate outlook models and expert opinion suggest that La Niña is approximately 50-60% likely during the remaining period of 2016, lasting into early 2017. The most likely strength of La Niña, if it prevails, is weak.

500hPa GPH and SST (GloSea5)

Dec



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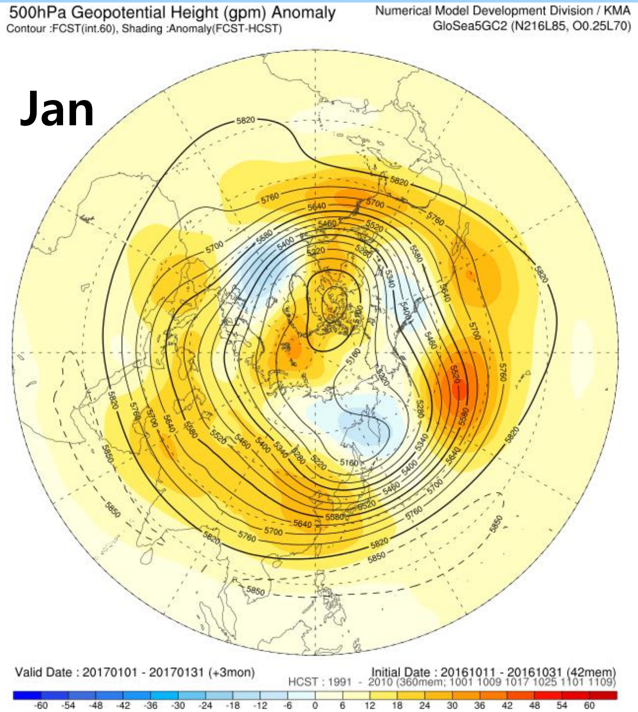
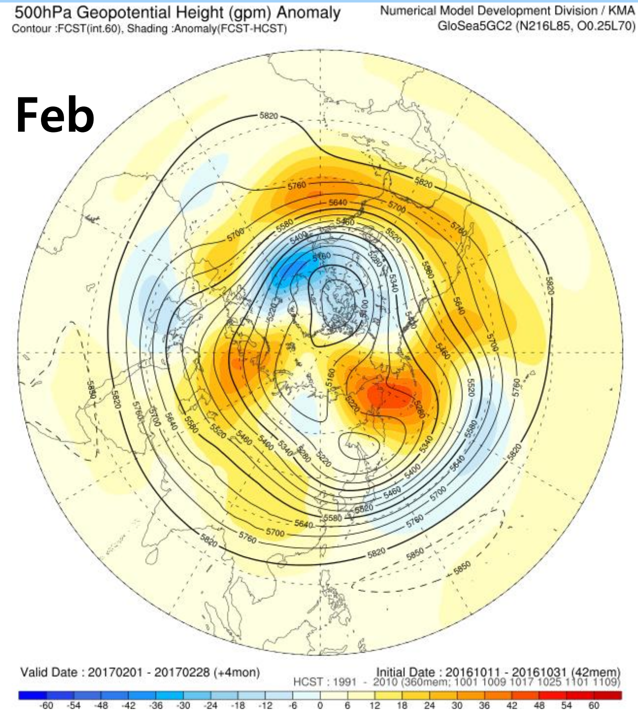
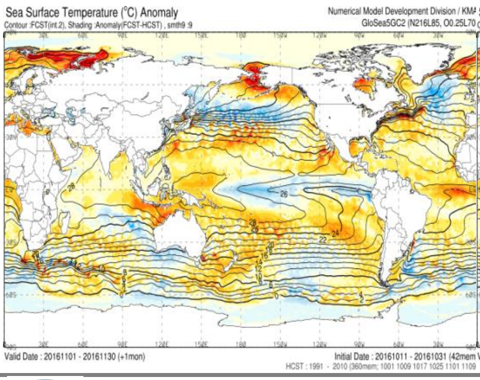


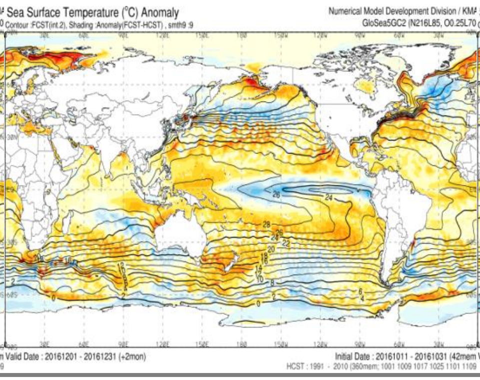
Feb



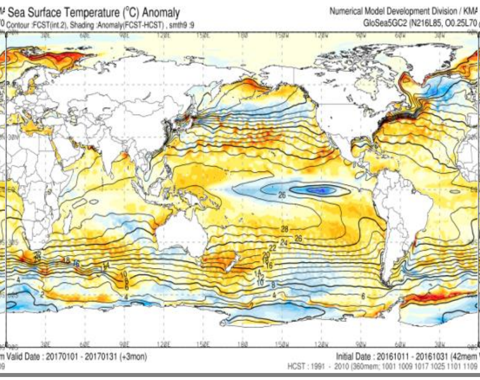
Nov



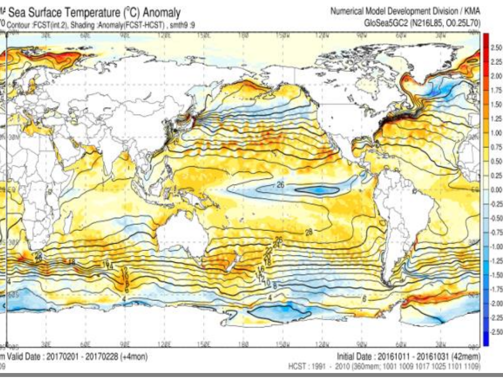
Dec



Jan

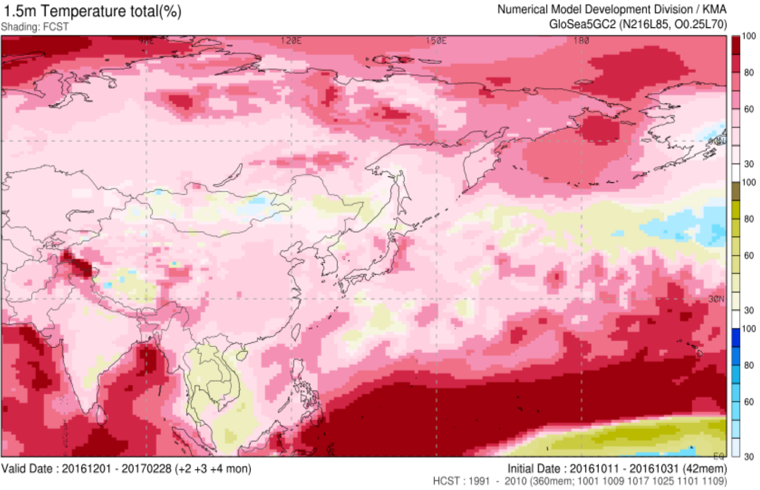


Feb

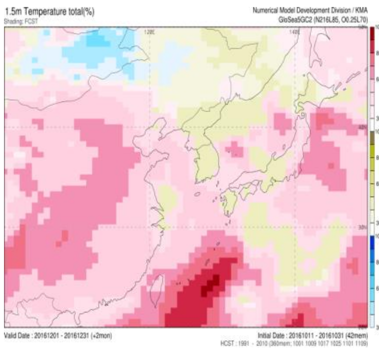


Ensemble prediction (GloSea5)

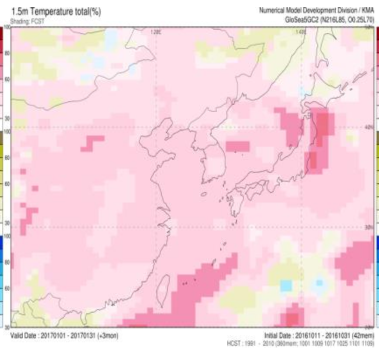
Probability of 1.5m temperature (DJF)



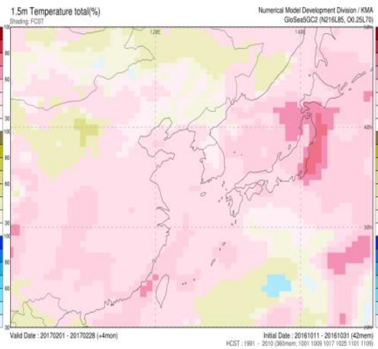
Dec



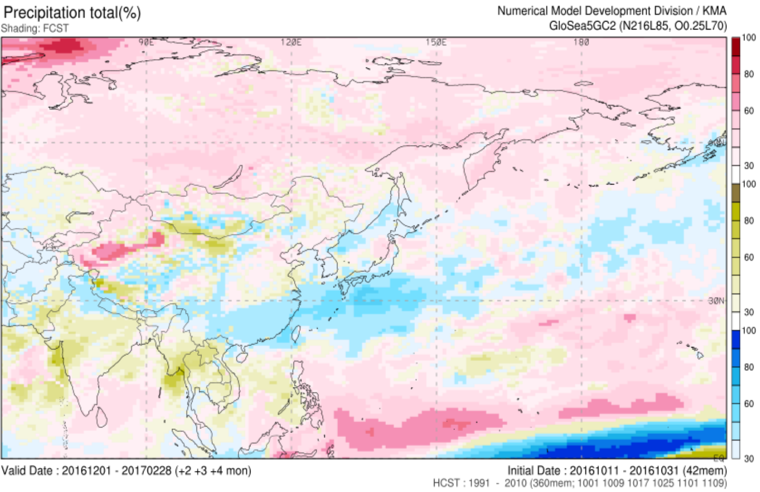
Jan



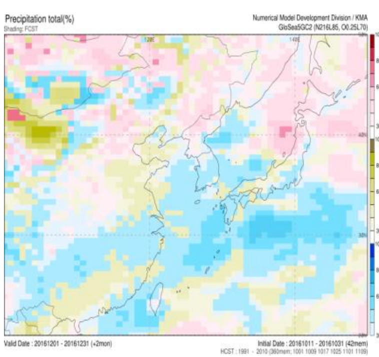
Feb



Probability of precipitation (DJF)



Dec



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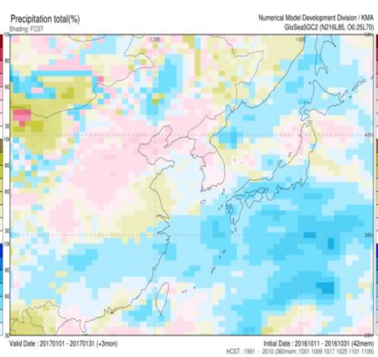
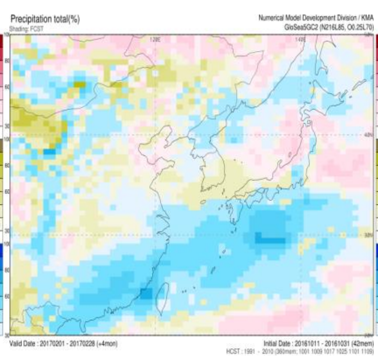


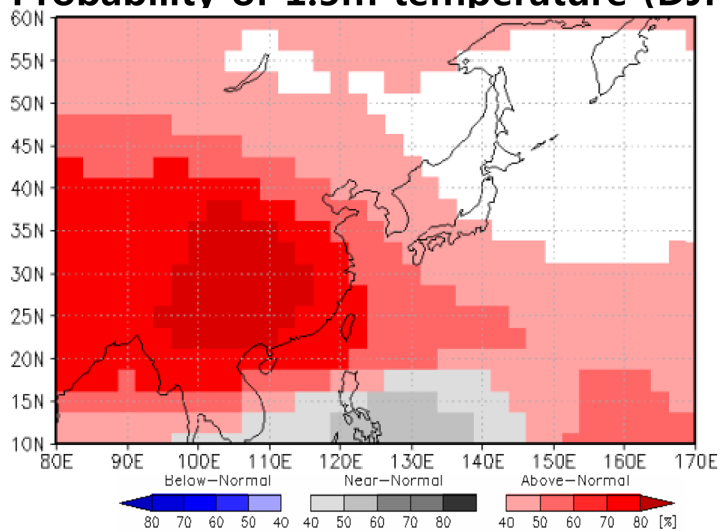
Feb



MME Prediction (WMO LC)

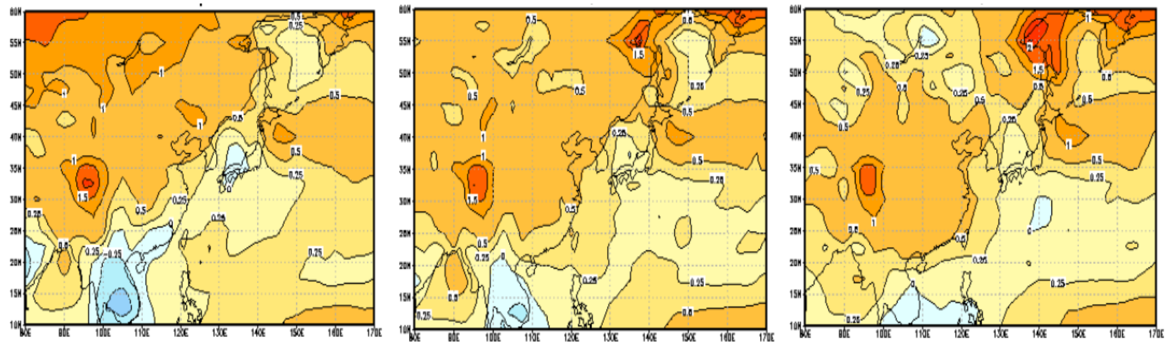
Seoul/Melbourne/ECMWF/EXETER/Montreal/Cptec/Beijing/Washington

Probability of 1.5m temperature (DJF)

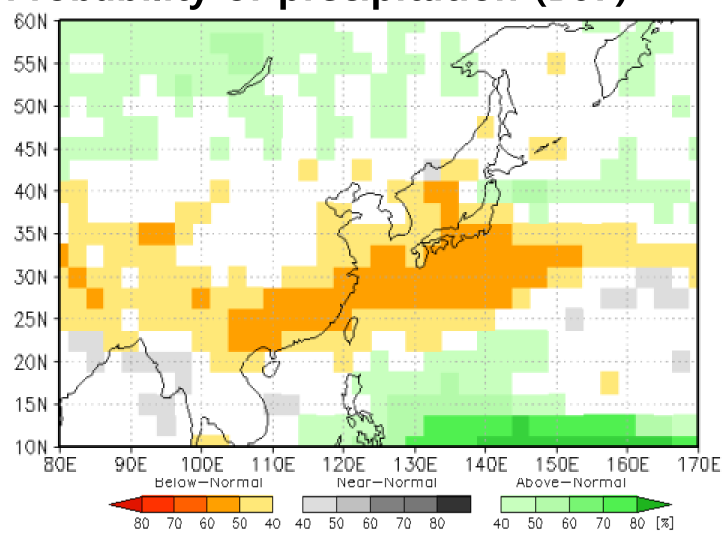


Ensemble mean for 1.5m temperature

Dec Jan Feb

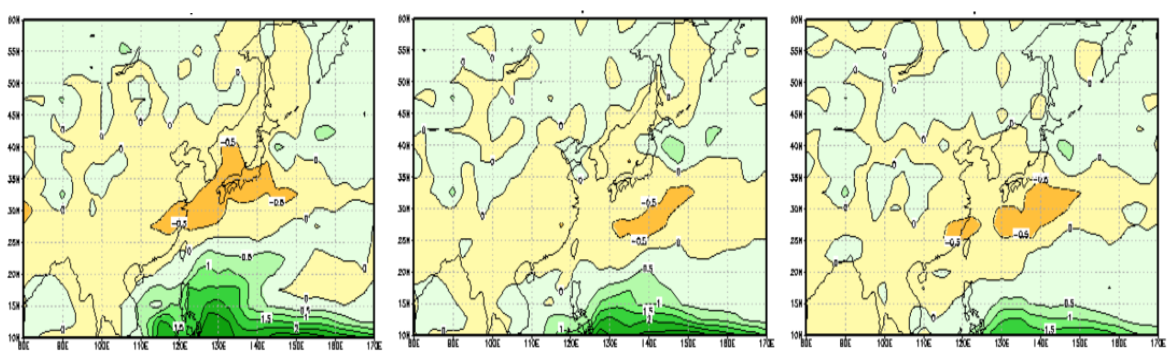


Probability of precipitation (DJF)



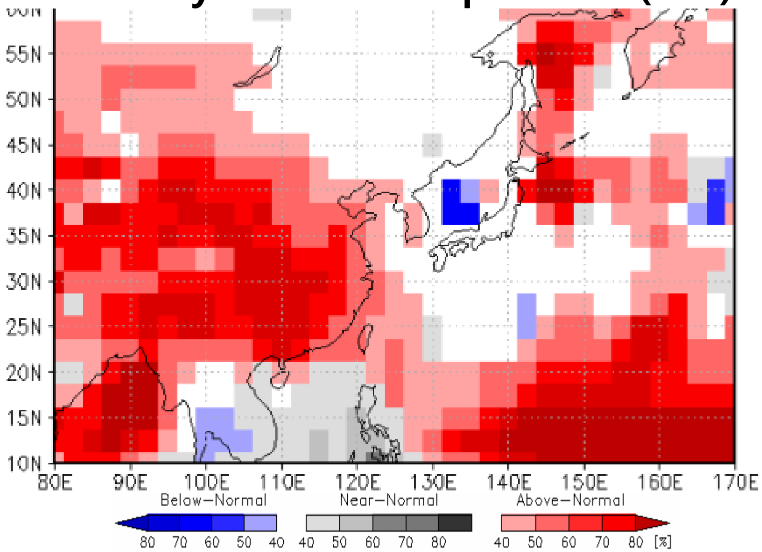
Ensemble mean for precipitation

Dec Jan Feb



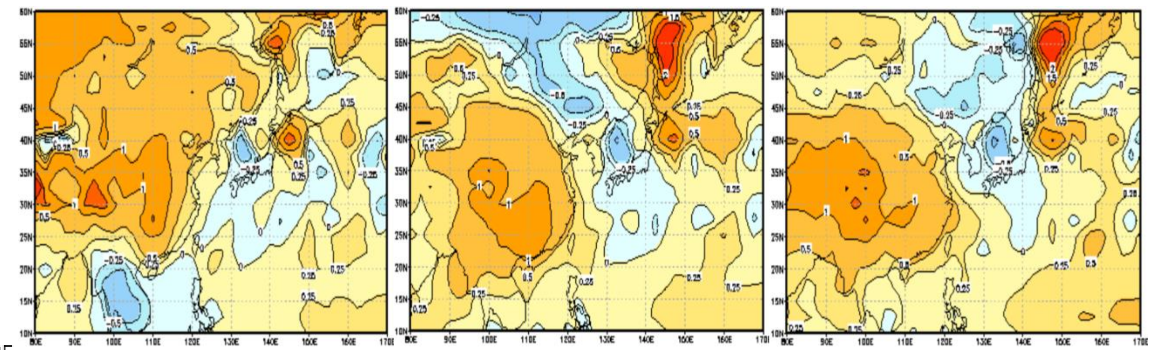
MME Prediction (ECMWF)

Probability of 1.5m temperature (DJF)

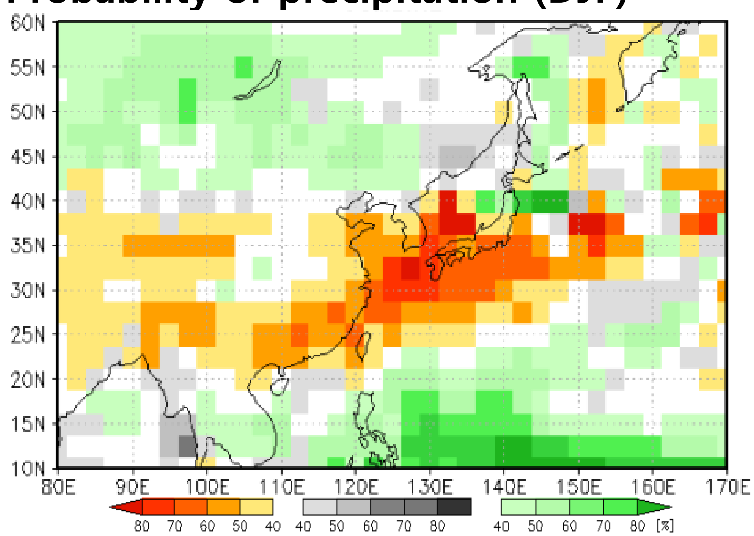


Ensemble mean for 1.5m temperature

Dec Jan Feb

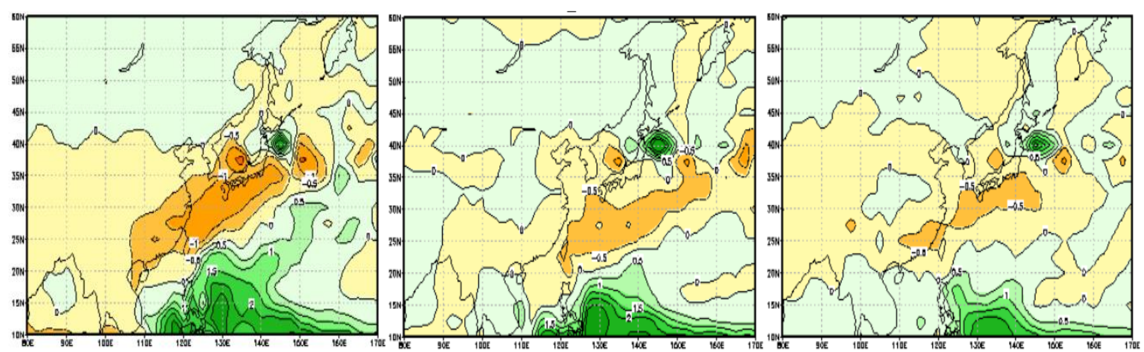


Probability of precipitation (DJF)

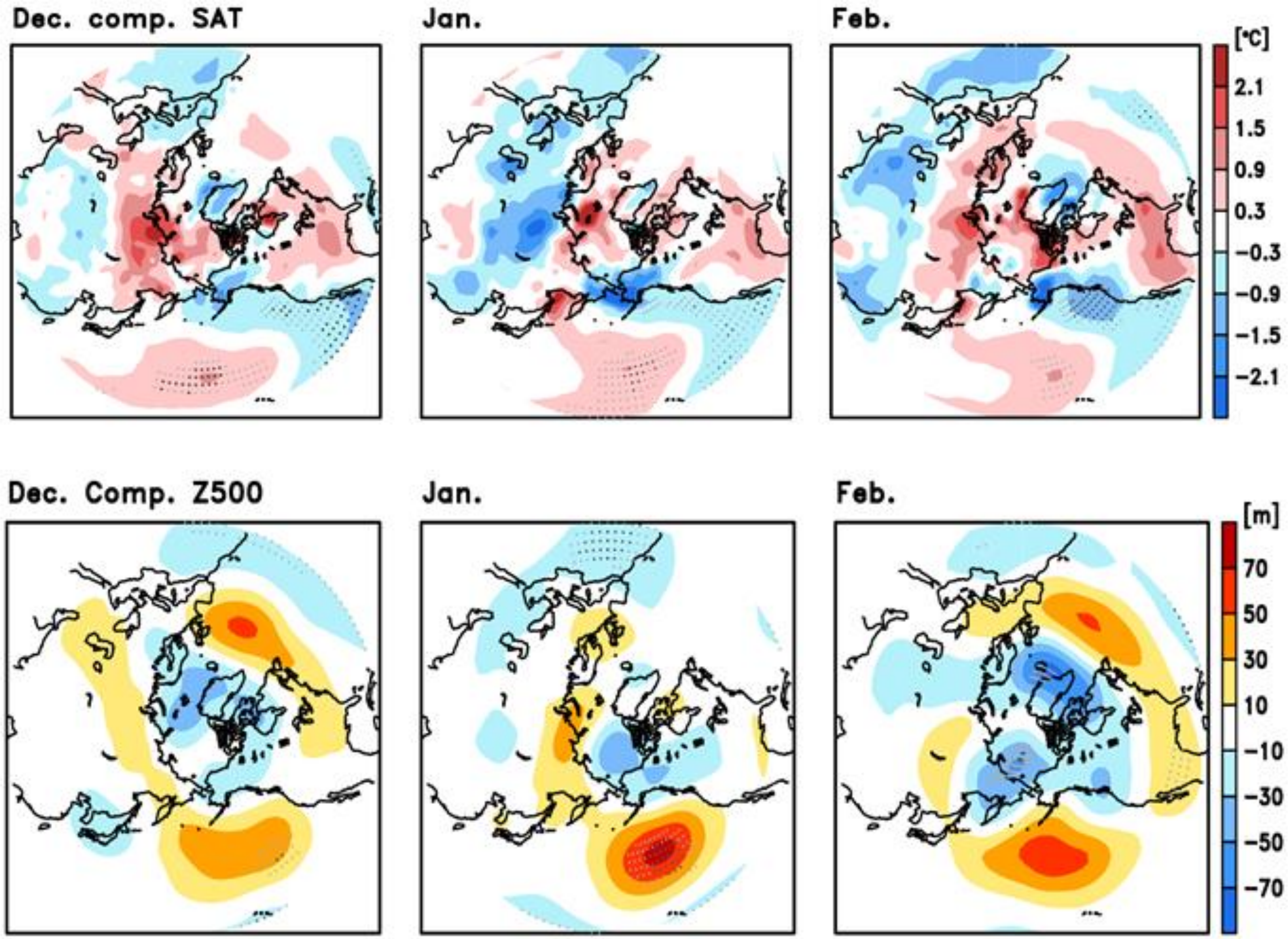


Ensemble mean for precipitation

Dec Jan Feb



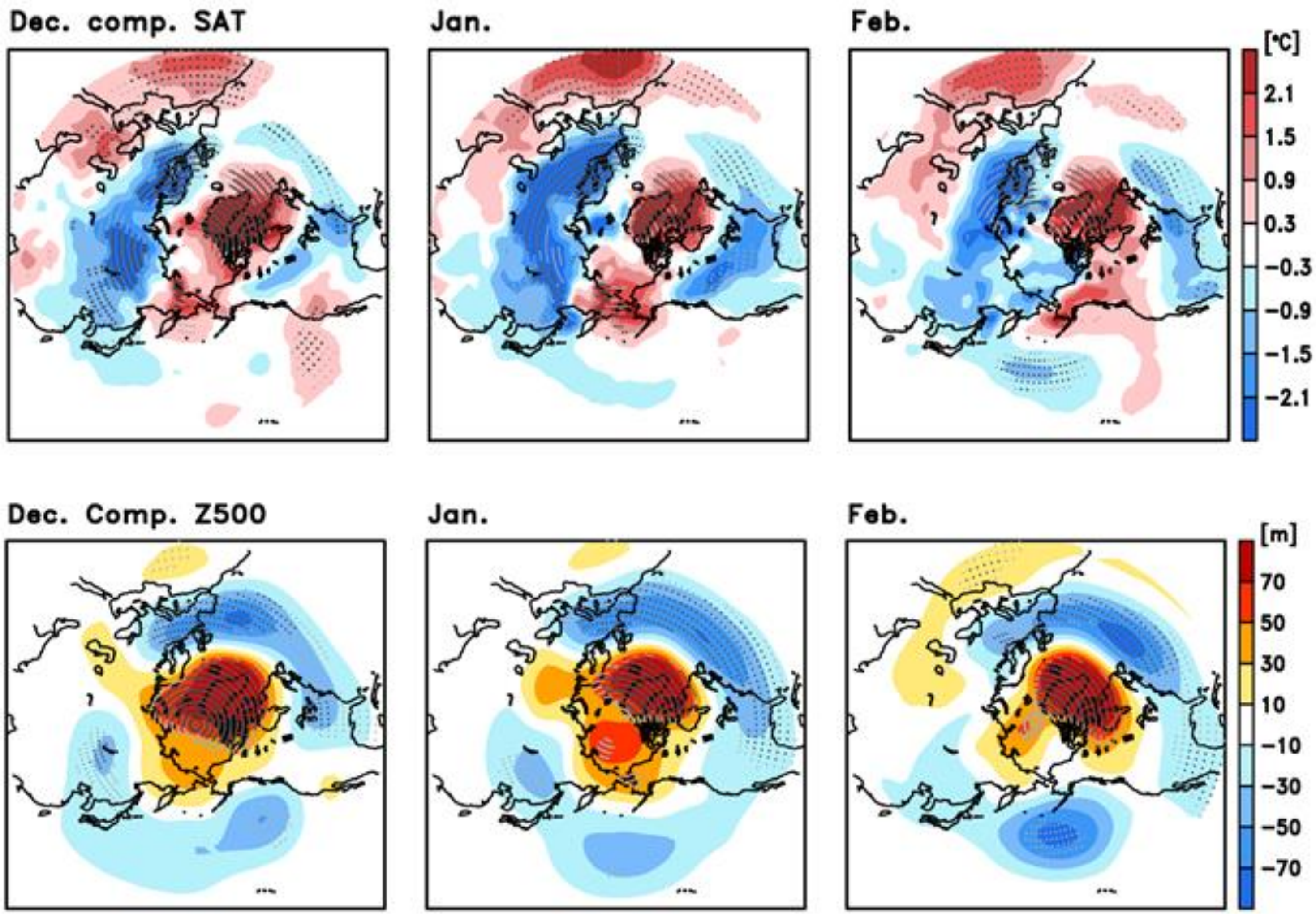
Impact of ENSO – La Nina years composite



- (·) : statistically significant level with 95(90)%

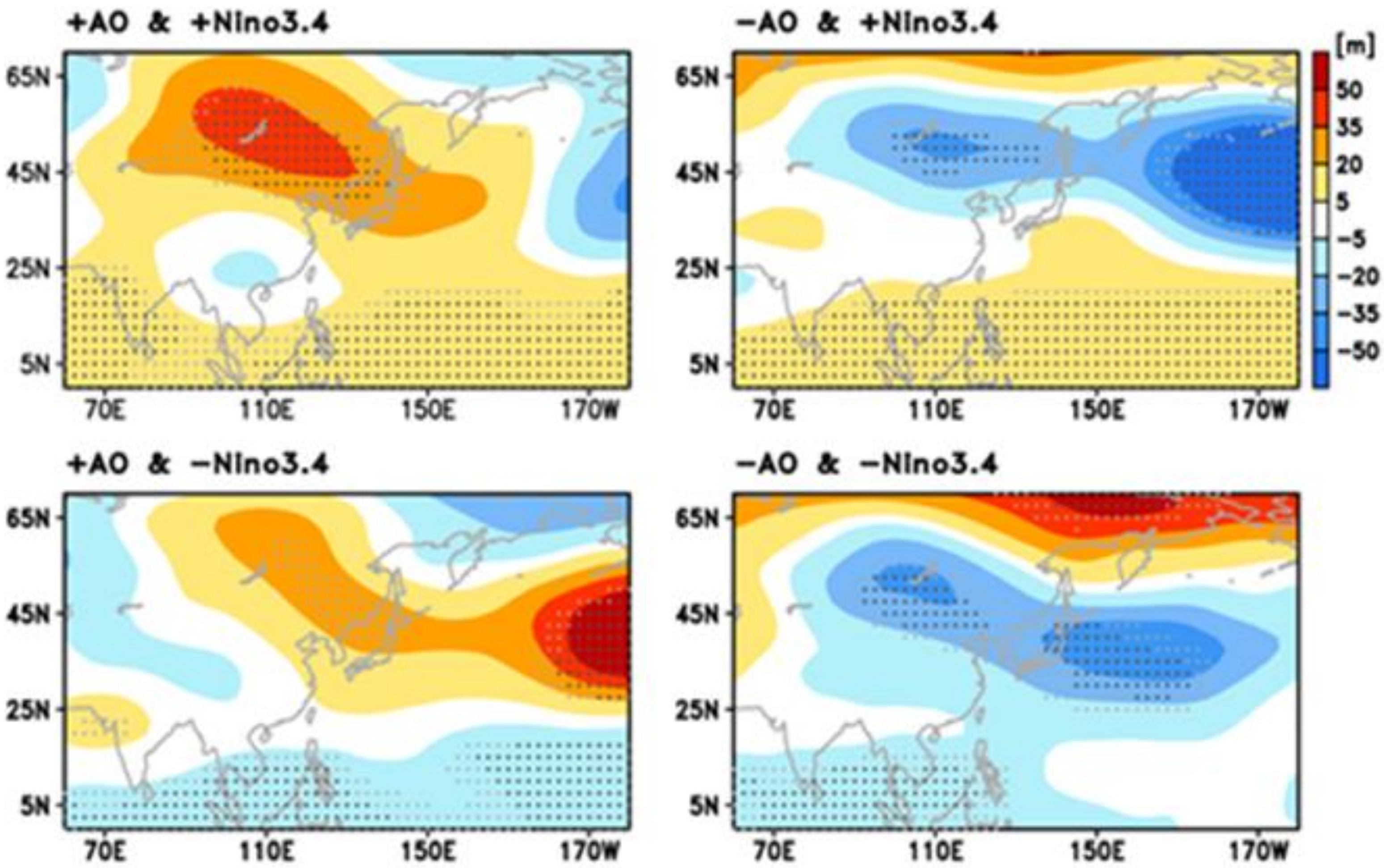
La Nina years : 1973/74, 1975/76, 1984/85, 1988/89, 1995/1996, 1998/99, 1999/2000, 2005/06, 2007/08, 2008/09, 2010/11, 2011/12

Impact of Arctic Oscillation : -AO composite



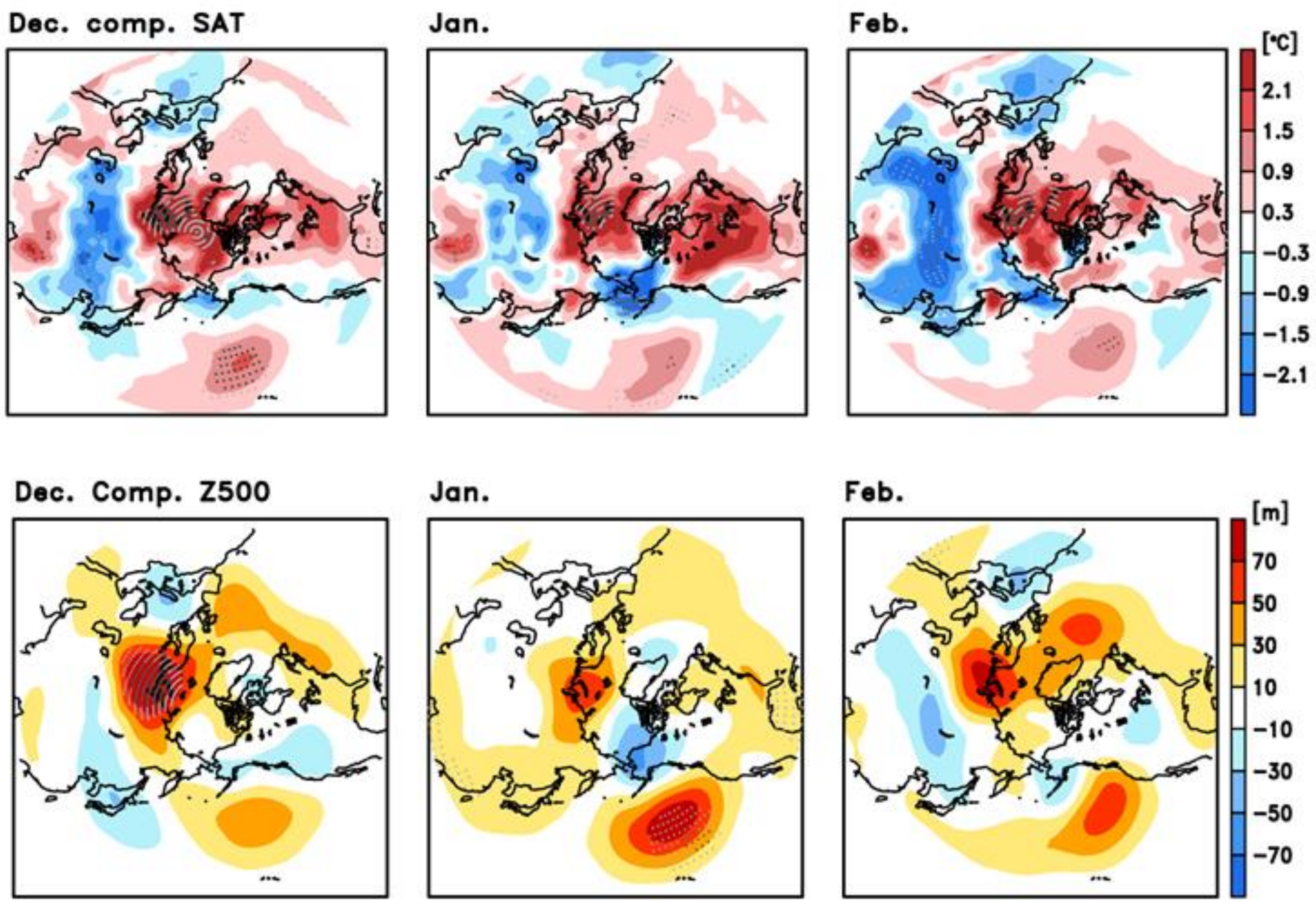
- (•) : statistically significant level with 95(90)%

Impact of ENSO and AO



• (•) : statistically significant level with 95(90)%

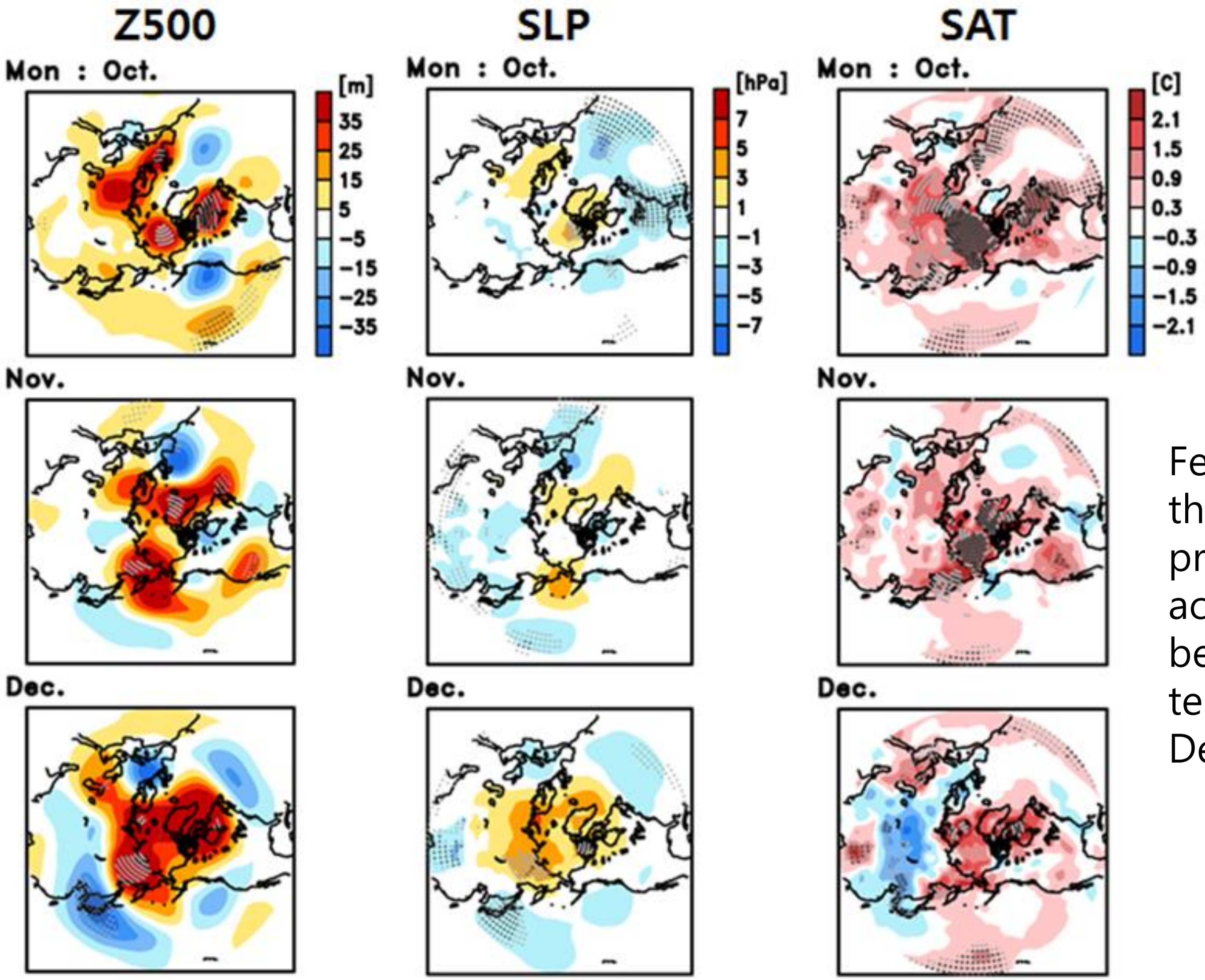
Impact of Barents / Kara sea ice



• (•) : statistically significant level with 95(90)%

Severe winters across East Asia are associated with anomalous warmth in the Barents-Kara Sea region.

Impact of Laptev sea ice



• (•) : statistically significant level with 95(90)%

Fewer sea ice over the Laptev Sea for previous October is accompanied by the below-normal temperature for December for Korea.

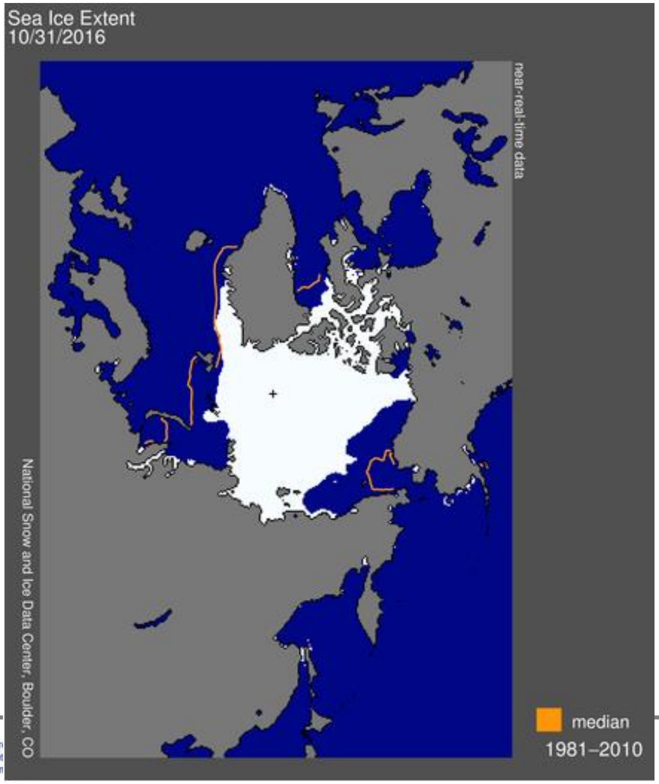
Impact of Arctic Sea Ice

o Analysis data are 1973~2014, and the * means statistically significant value

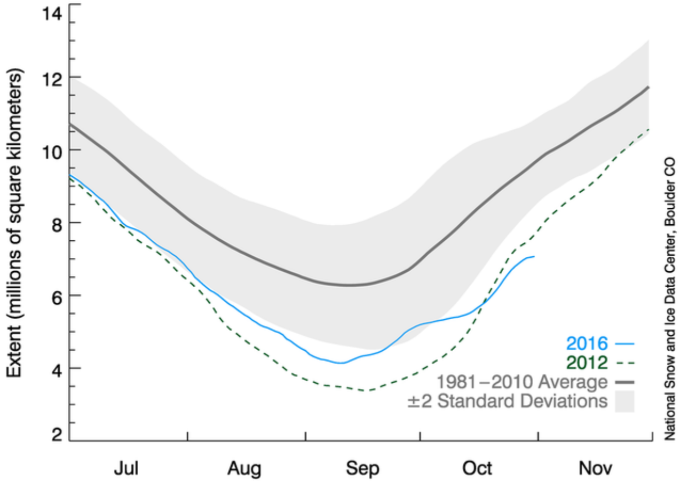
✓ Sea Ice Concentration over Kara-Barents(65-80N, 60~100E)

Korea	Dec	Jan	Feb
SAT	**0.43***	0.04	**0.47***
PRCP	-0.15	0.11	0.15

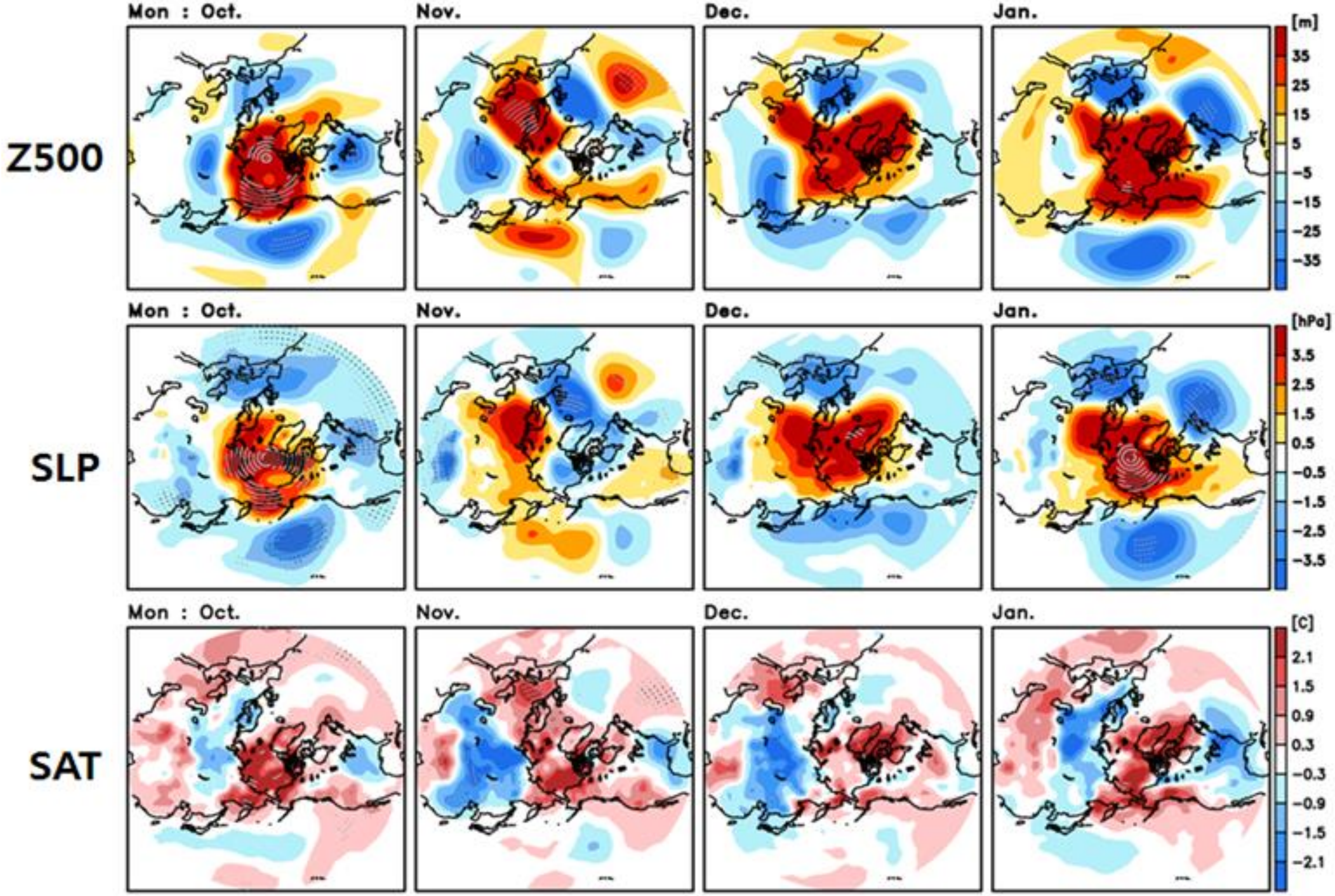
✓ October Sea Ice Concentration over Laptev(65-80N, 105~150E)



Korea	Dec	Jan	Feb
SAT	**0.51***	0.17	0.24
PRCP	-0.05	0.12	-0.01



Impact of Snowcover

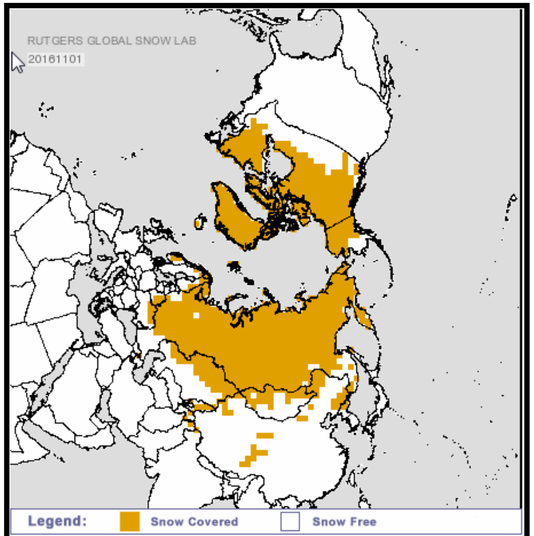


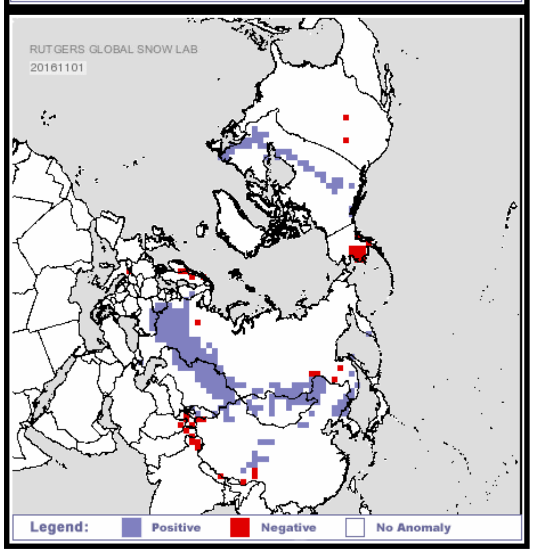
More snowcover over the Eurasian continent and its fast progress for the previous October are significantly related to below-normal temperature for early winter

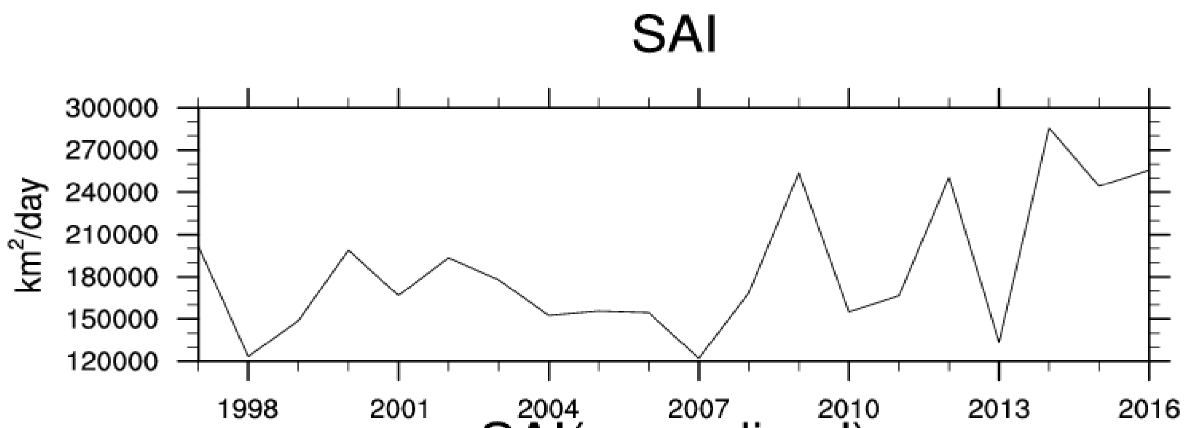
Impact of Snowcover

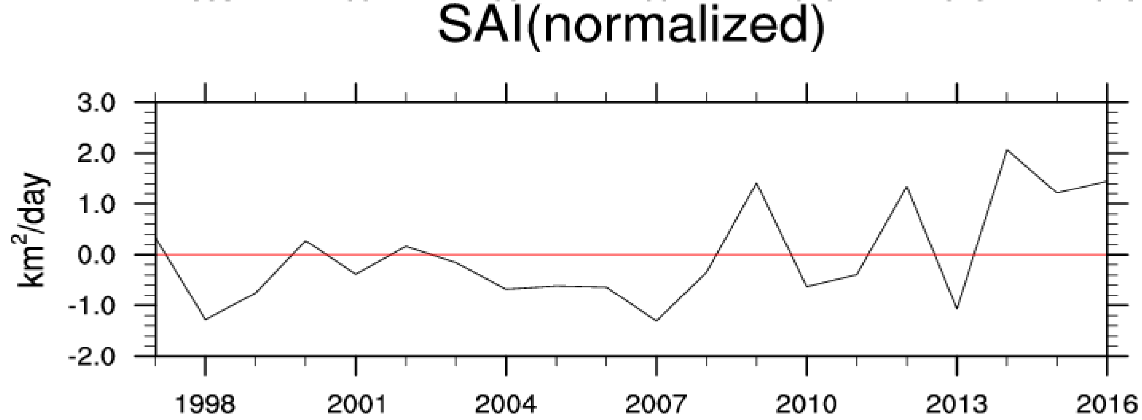
- ✓ **October Snow Advanced Index(SAI)**

Korea	Dec	Jan	Feb
SAT	**-0.31***	**-0.32***	-0.10
PRCP	0.11	-0.19	-0.11









Summary

▣ Consideration for prediction

- Weak La Niña is expected
- Most dynamic model results show slightly above-normal temperature and below-normal precipitation for the following winter
- Most statistical analyses(La Nina, arctic sea ice, and Eurasian snowcover) give us below-normal temperature for early winter, near- or above-normal temperature after mid winter, and below-normal precipitation

▣ 2016/17 winter outlook

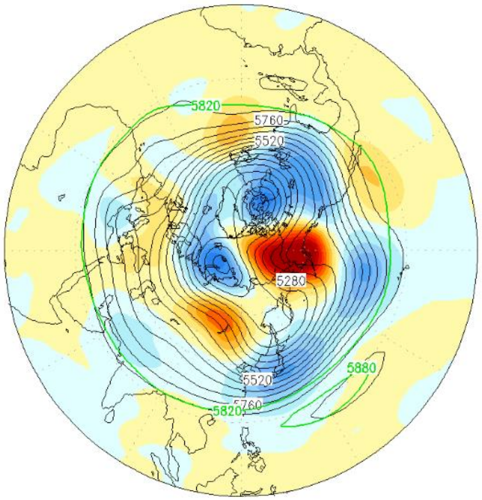
- Near normal winter monsoon is expected
- Strong intra-seasonal variation

	Temperature			Precipitation		
	Below Normal	Near normal	Above normal	Below Normal	Near normal	Above normal
Winter	30	50	20	50	30	20

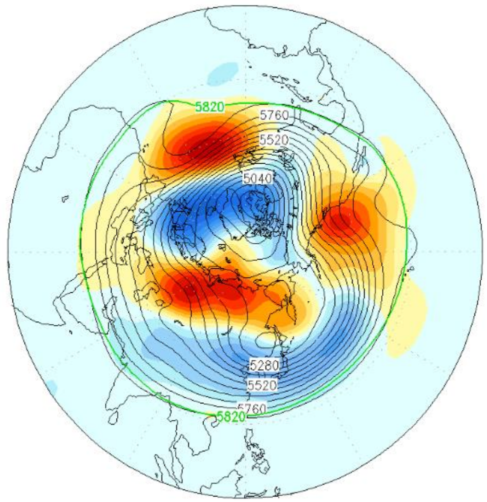
Thank you !!

Comparison with La Nina years after strong El Nino years

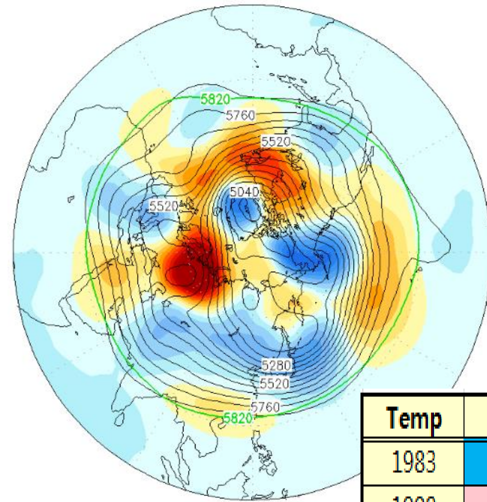
Dec 1983



Jan 1984

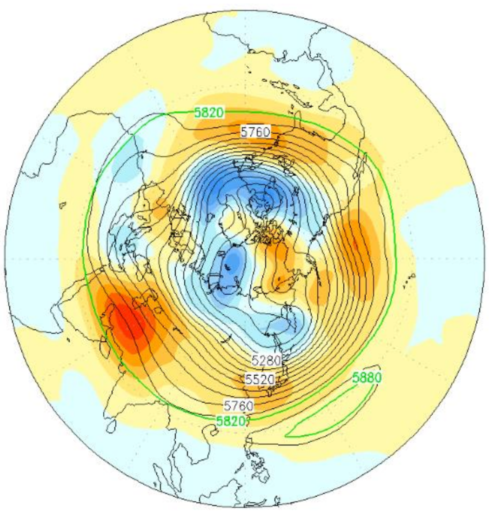


Feb 1984

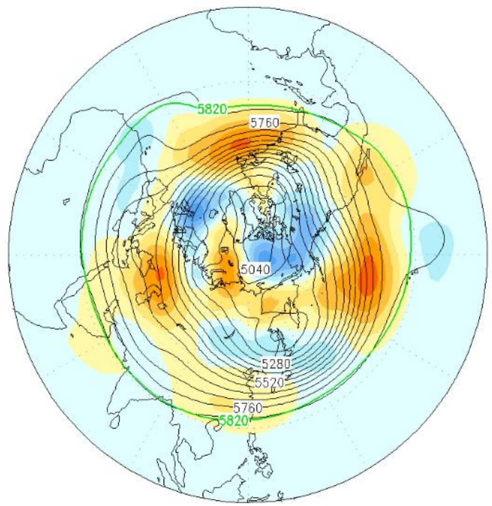


Temp	Dec	Jan	Feb	Year
1983	-1.5	-3.0	-3.3	1984
1998	1.4	1.3	0.6	1999
Prcp	**Dec**	**Jan**	**Feb**	**Year**
1983	38	28	43	1984
1998	24	59	45	1999

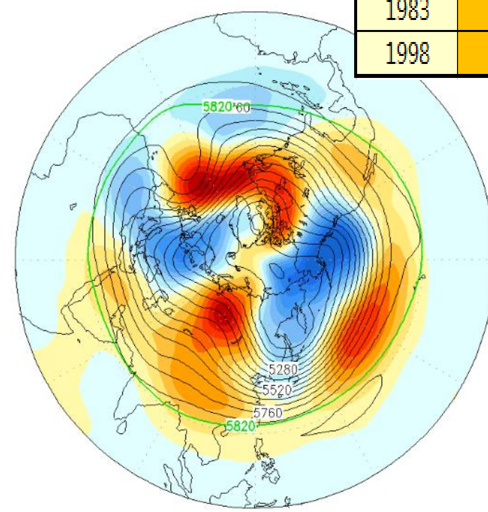
Dec 1998



Jan 1999



Feb 1999



Impact of Arctic Sea Ice

nature geoscience LETTERS
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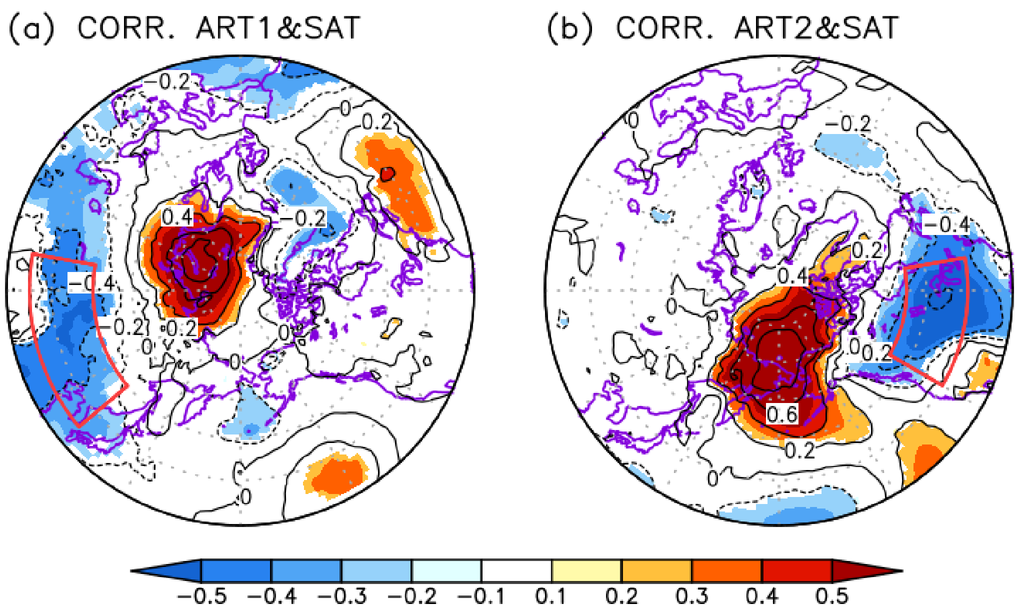
Two distinct influences of Arctic warming on cold winters over North America and East Asia

Jong-Seong Kug[1], Jee-Hoon Jeong[2]*, Yeon-Soo Jang[1], Baek-Min Kim[3], Chris K. Folland[4,5], Seung-Ki Min[1] and Seok-Woo Son[6]

❖ **ART(ARctic Temperature Indices) : Index for Arctic regional Warming/Cooling**

- **ART1 : SAT averaging over Barents-Kara Seas(30-70E, 65-85N)**
- **ART2 : SAT averaging over East Siberia-Chukchi Seas(160E-160W, 65-80N)**



✓Warming in Barents-Kara Seas → **East Asia Cooling**

✓Warming in East Siberia-Chukchi Seas → **North America Cooling**

Similar cases for La-Niña developing years

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1981	-0.2	-0.4	-0.4	-0.3	-0.2	-0.3	-0.3	-0.3	-0.2	-0.1	-0.1	0
1982	0	0.1	0.2	0.5	0.6	0.7	0.8	1.0	1.5	1.9	2.1	2.1
1983	2.1	1.8	1.5	1.2	1.0	0.7	0.3	0	-0.3	-0.6	-0.8	-0.8
1984	-0.5	-0.3	-0.3	-0.4	-0.4	-0.4	-0.3	-0.2	-0.3	-0.6	-0.9	-1.1
1985	-0.9	-0.7	-0.7	-0.7	-0.7	-0.6	-0.4	-0.4	-0.4	-0.3	-0.2	-0.3
1986	-0.4	-0.4	-0.3	-0.2	-0.1	0	0.2	0.4	0.7	0.9	1.0	1.1
1987	1.1	1.2	1.1	1.0	0.9	1.1	1.4	1.6	1.6	1.4	1.2	1.1
1988	0.8	0.5	0.1	-0.3	-0.8	-1.2	-1.2	-1.1	-1.2	-1.4	-1.7	-1.8
1989	-1.6	-1.4	-1.1	-0.9	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.2	-0.1
1990	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3	0.4	0.4
1991	0.4	0.3	0.2	0.2	0.4	0.6	0.7	0.7	0.7	0.8	1.2	1.4
1992	1.6	1.5	1.4	1.2	1.0	0.8	0.5	0.2	0	-0.1	-0.1	0
1993	0.2	0.3	0.5	0.7	0.8	0.6	0.3	0.2	0.2	0.2	0.1	0.1
1994	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.6	0.9	1.0
1995	0.9	0.7	0.5	0.3	0.2	0	-0.2	-0.5	-0.7	-0.9	-1.0	-0.9
1996	-0.9	-0.7	-0.6	-0.4	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5
1997	-0.5	-0.4	-0.2	0.1	0.6	1.0	1.4	1.7	2.0	2.2	2.3	2.3
1998	2.1	1.8	1.4	1.0	0.5	-0.1	-0.7	-1.0	-1.2	-1.2	-1.3	-1.4
1999	-1.4	-1.2	-1.0	-0.9	-0.9	-1.0	-1.0	-1.0	-1.1	-1.2	-1.4	-1.6
2000	-1.6	-1.4	-1.1	-0.9	-0.7	-0.7	-0.6	-0.5	-0.6	-0.7	-0.8	-0.8
2001	-0.7	-0.6	-0.5	-0.3	-0.2	-0.1	0	-0.1	-0.1	-0.2	-0.3	-0.3
2002	-0.2	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.2	1.3	1.1
2003	0.9	0.6	0.4	0	-0.2	-0.1	0.1	0.2	0.3	0.4	0.4	0.4
2004	0.3	0.2	0.1	0.1	0.2	0.3	0.5	0.7	0.7	0.7	0.7	0.7
2005	0.6	0.6	0.5	0.5	0.4	0.2	0.1	0	0	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.2	0.0	0.1	0.2	0.3	0.5	0.8	0.9	1.0
2007	0.7	0.3	0	-0.1	-0.2	-0.2	-0.3	-0.6	-0.8	-1.1	-1.2	-1.3
2008	-1.4	-1.3	-1.1	-0.9	-0.7	-0.5	-0.3	-0.2	-0.2	-0.3	-0.5	-0.7
2009	-0.8	-0.7	-0.4	-0.1	0.2	0.4	0.5	0.6	0.7	1.0	1.2	1.3
2010	1.3	1.1	0.8	0.5	0	-0.4	-0.8	-1.1	-1.3	-1.4	-1.3	-1.4
2011	-1.3	-1.1	-0.8	-0.6	-0.3	-0.2	-0.3	-0.5	-0.7	-0.9	-0.9	-0.8
2012	-0.7	-0.6	-0.5	-0.4	-0.3	-0.1	0.1	0.3	0.4	0.4	0.2	-0.2
2013	-0.4	-0.5	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3
2014	-0.5	-0.6	-0.4	-0.2	0	0	0	0	0.2	0.4	0.6	0.6
2015	0.5	0.4	0.5	0.7	0.9	1.0	1.2	1.5	1.8	2.1	2.2	2.3
2016	2.2	1.9	1.5	1.1	0.6	0.1	-0.3	-0.5				

기후인자별 위상과 우리나라 기온 편차 및 강수량 평년비

예측인자	북극진동	엘니뇨/라니냐	10월 눈덮임속도	바렌츠/카라 해빙	10월 랍테프 해빙	기온 평년편차 (°C)	강수량 평년비 (%)
1983	•	•	−	•	+	−1.5	38
1998	+	−	•	•	+	1.4	24
2010	−−	−	•	•	−−	−0.6	124
1988	+	−−	−	•	•	−0.4	57
1995	−	•	•	•	−−	−1.6	18
2005	−	•	•	−	−	−3.7	62
2007	•	−	•	−	−−	1.2	126

※ + (++): 각 기후인자 지수가 +0.75(+1.5) 표준편차 이상

− (−−): 각 기후인자 지수가 −0.75(−1.5) 표준편차 이하