

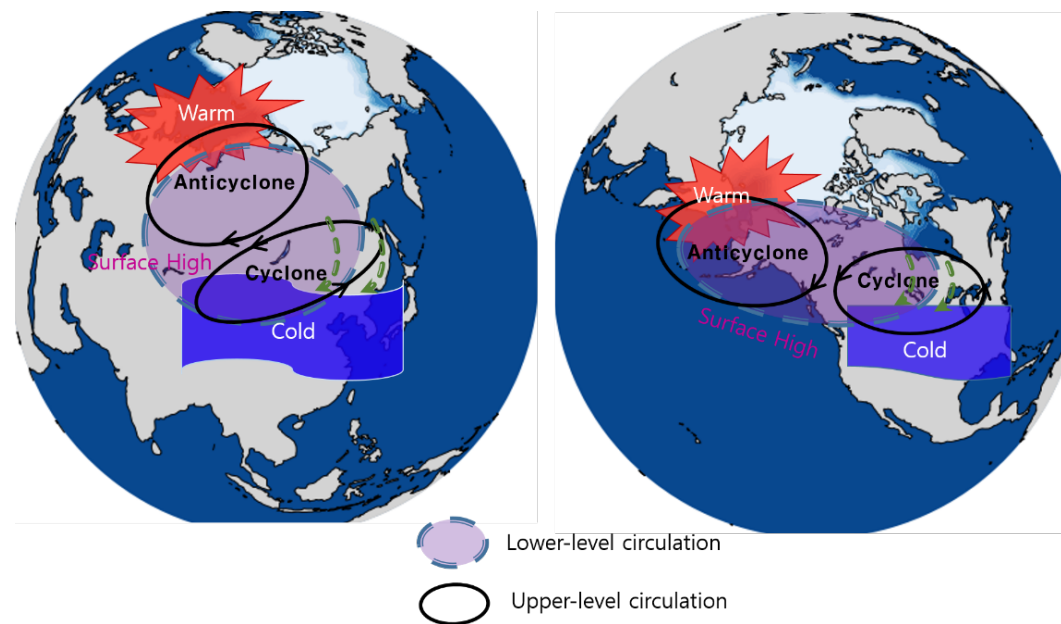
# Two distinct influences of Arctic warming on cold winters over East Asia and North America

*Jee-Hoon Jeong<sup>1</sup>, Jong-Seong Kug<sup>2</sup>, Yeon-Soo Jang<sup>2</sup>, Baek-Min Kim<sup>3</sup>,  
Chris K. Folland<sup>4,5</sup>, Seung-Ki Min<sup>1</sup>, Seok-Woo Son<sup>6</sup>, Eui-Hyun  
Jeong<sup>1,6</sup>, Jong-Ho Kim<sup>1</sup>*

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<sup>4</sup>Met Office Hadley Centre, <sup>5</sup>Gothenburg University, <sup>6</sup>Seoul National University*

# Two distinct influences of Arctic warming on cold winters over North America and East Asia

Jong-Seong Kug<sup>1</sup>, Jee-Hoon Jeong<sup>2\*</sup>, Yeon-Soo Jang<sup>1</sup>, Baek-Min Kim<sup>3</sup>, Chris K. Folland<sup>4,5</sup>,  
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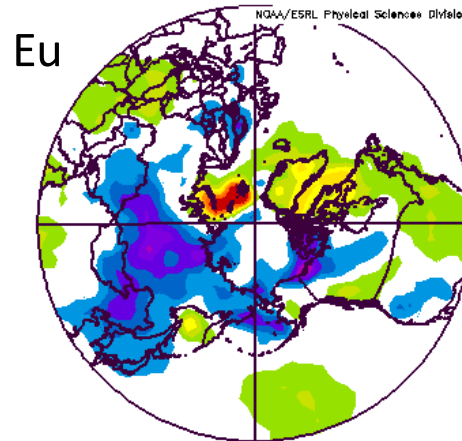


Published last August

# Successive cold winters over East Asia and North America

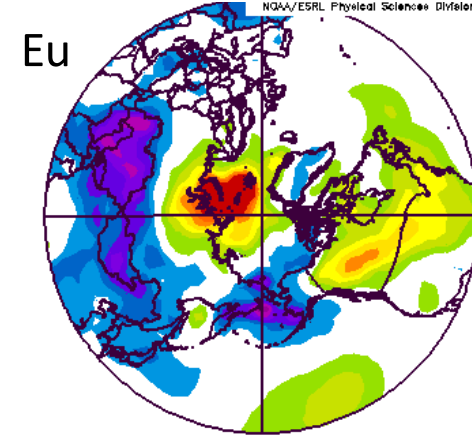
Arctic warming and associated changed in atmospheric circulation might have played a central role.

2012/13 DJF



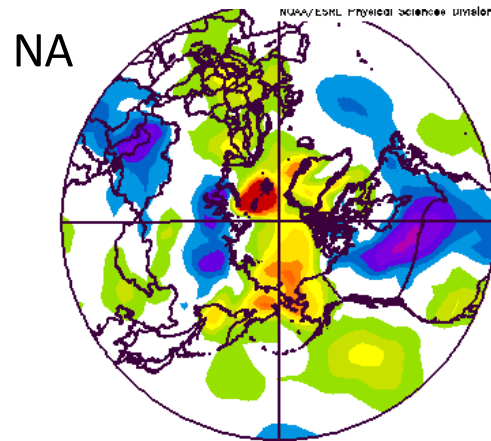
Surface Air Temperature (K) Composite Anomaly (1981–2010 Climatology)  
12/1/12 to 2/28/13  
NCEP/NCAR Reanalysis

2011/12 DJF



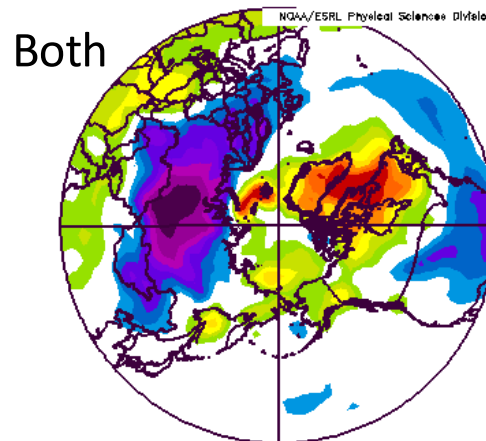
Surface Air Temperature (K) Composite Anomaly (1981–2010 Climatology)  
12/1/11 to 2/28/12  
NCEP/NCAR Reanalysis

2013/14 DJF



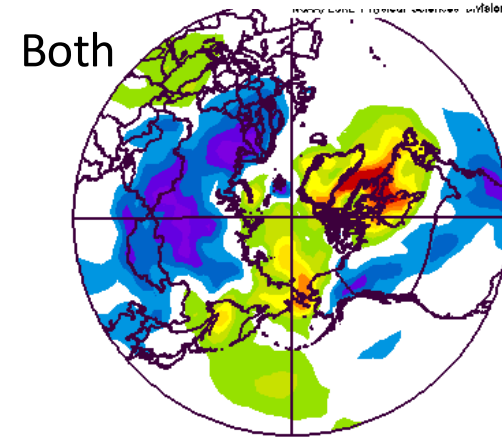
Surface Air Temperature (K) Composite Anomaly (1981–2010 Climatology)

2009/10 DJF



Surface Air Temperature (K) Composite Anomaly (1981–2010 Climatology)

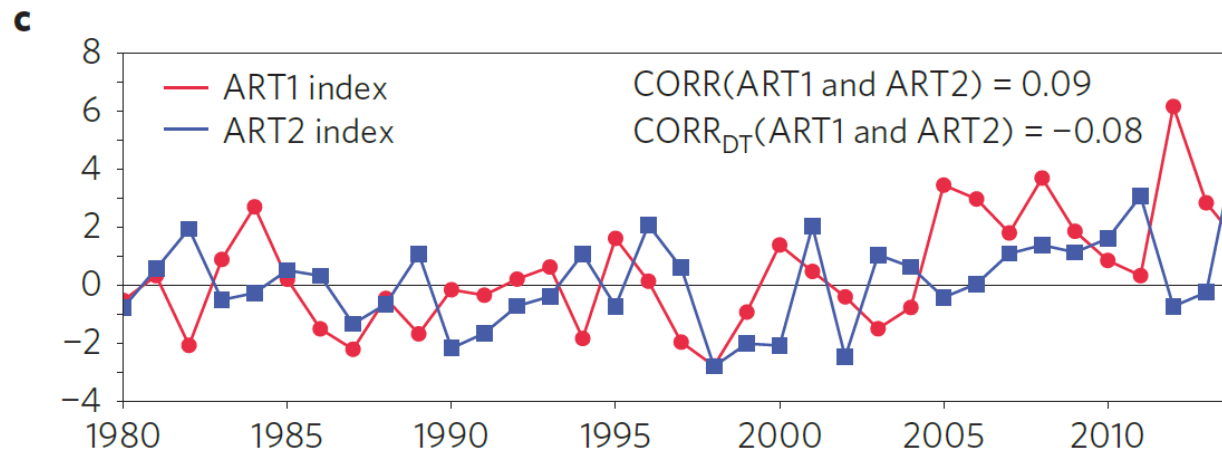
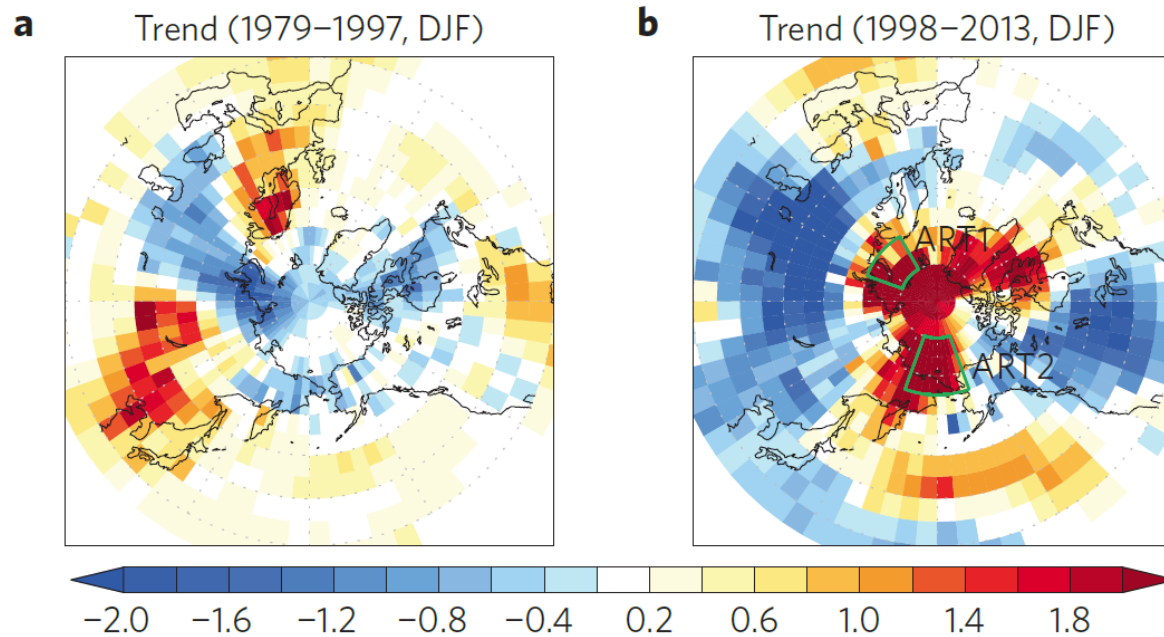
2010/11 DJF



Surface Air Temperature (K) Composite Anomaly (1981–2010 Climatology)

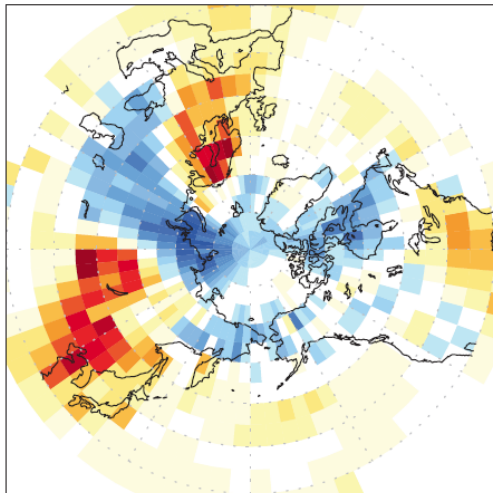
Cold Eurasia (11/12, 12/13), cold North America (13/14), cold both continents (09/10, 10/11).  
Are there distinctive mechanisms?

# Identified two 'hotspots' in the Arctic

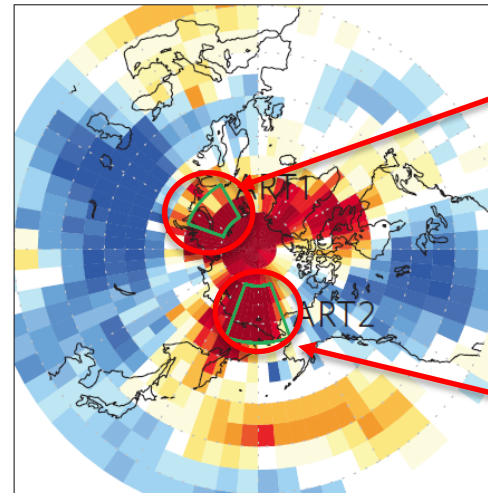


# Identified two 'hotspots' in the Arctic

**a** Trend (1979–1997, DJF)

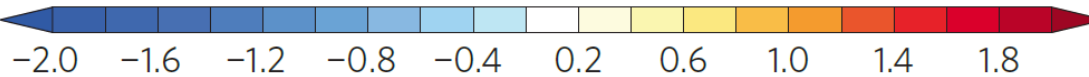


**b** Trend (1998–2013, DJF)

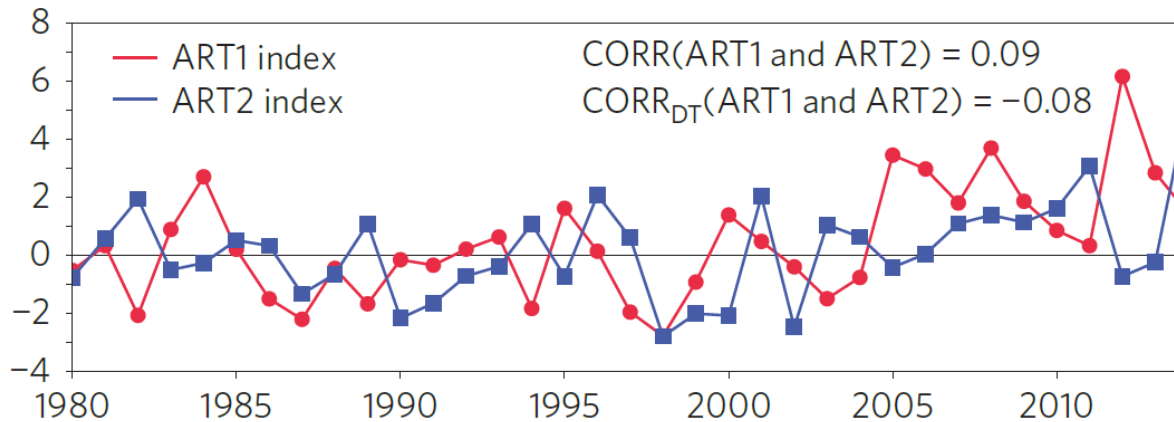


ART1: SAT anomalies over the Barents-Kara Sea

ART2: SAT anomalies over the east Siberian-Chukchi Sea

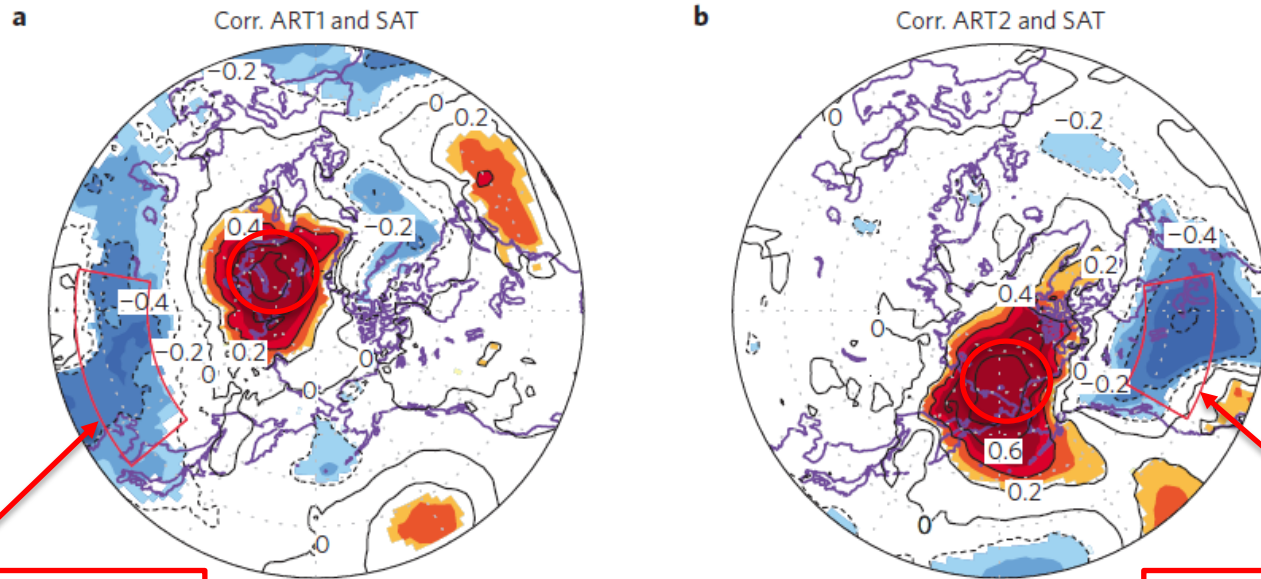


**c**



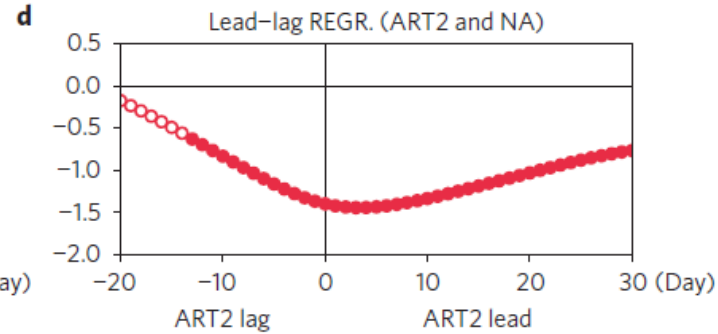
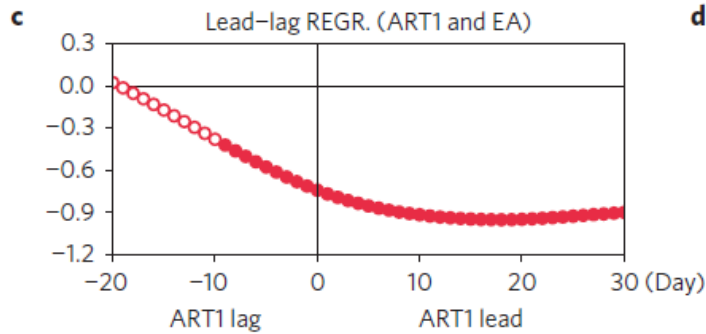
The two ART indices are almost independent with each other but both show positive trends

# Correlation monthly ARTs & SAT anomalies [DJF]



ART1 leads cold east Asia about 15 days

ART2 leads cold N. America about 5 days

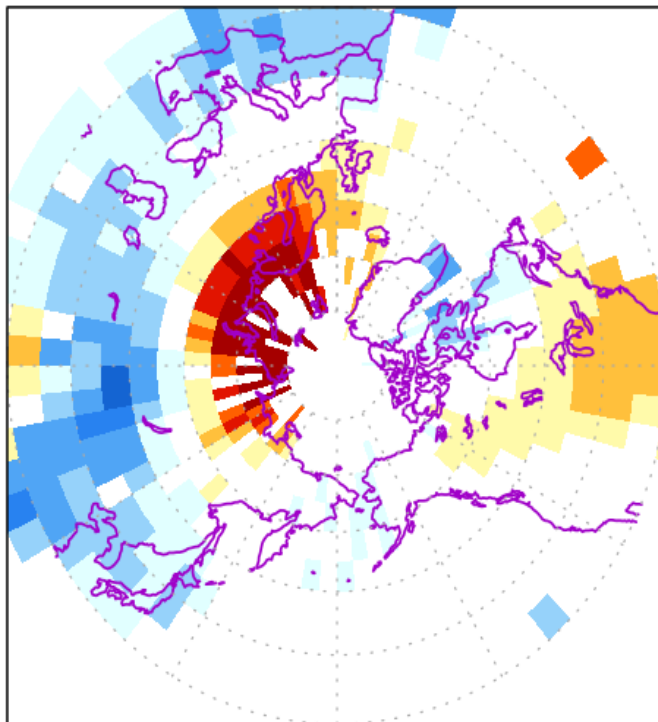


# Arctic-extratropics correlation is not something new...

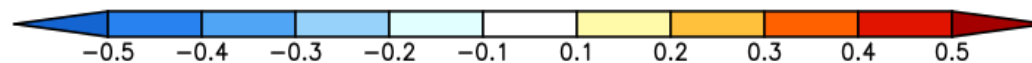
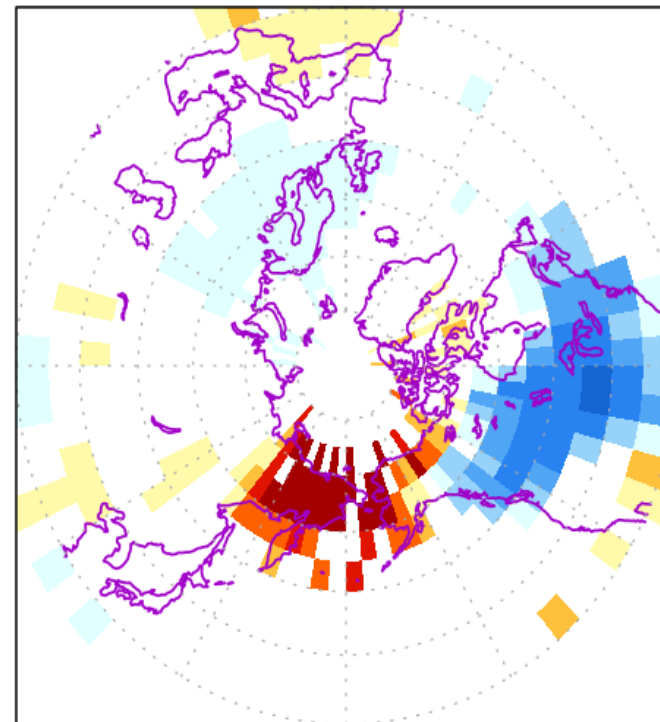
CRU: 1890-2013

Corr – ART & TS (DJF) 1890–2013

(a) ART1

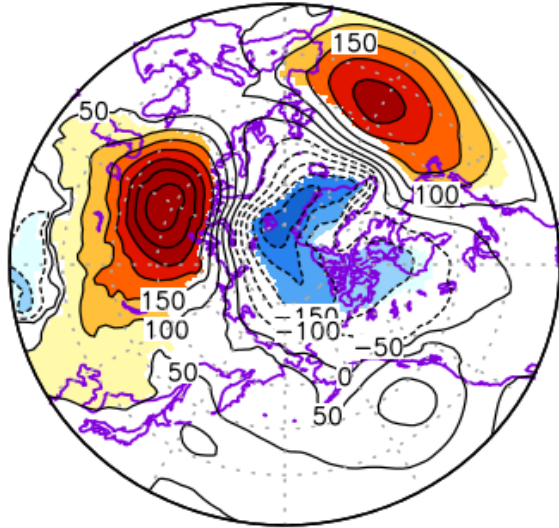


(b) ART2

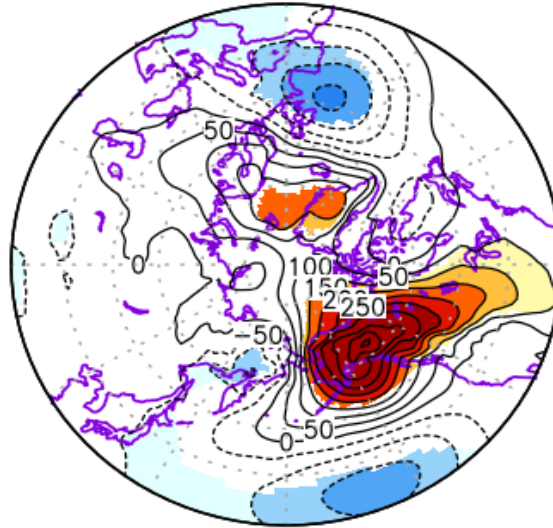


# Dynamical process: SLP and Z300 associated with ARTs

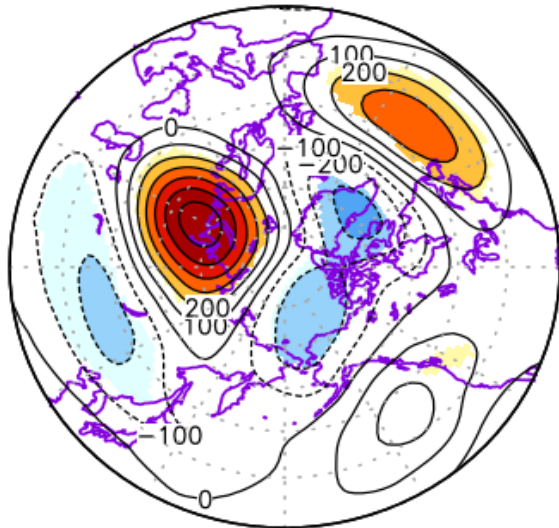
(a) ART1 SLP



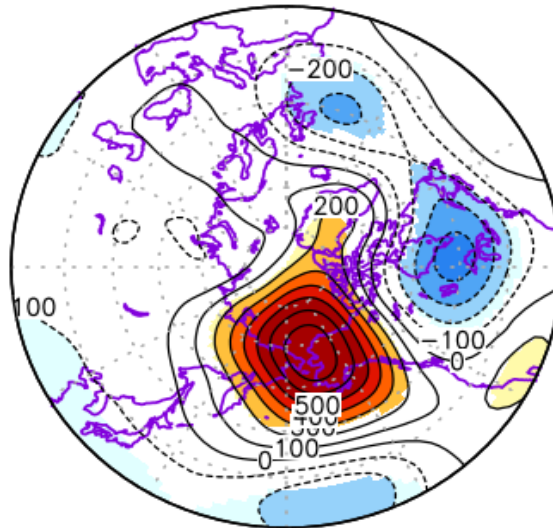
(b) ART2 SLP



(c) ART1 Z300



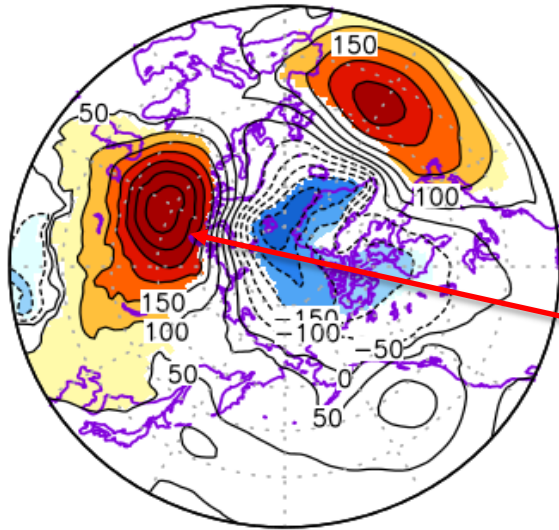
(d) ART2 Z300



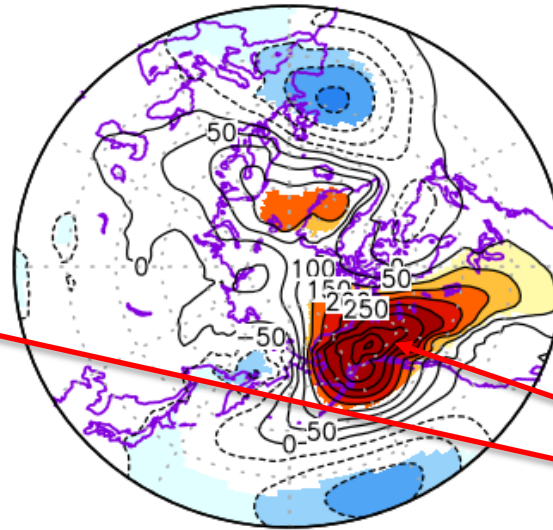


# Dynamical process: SLP and Z300 associated with ARTs

(a) ART1 SLP

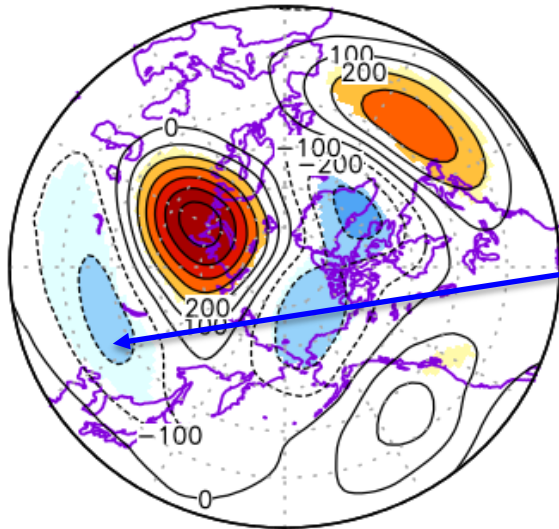


(b) ART2 SLP

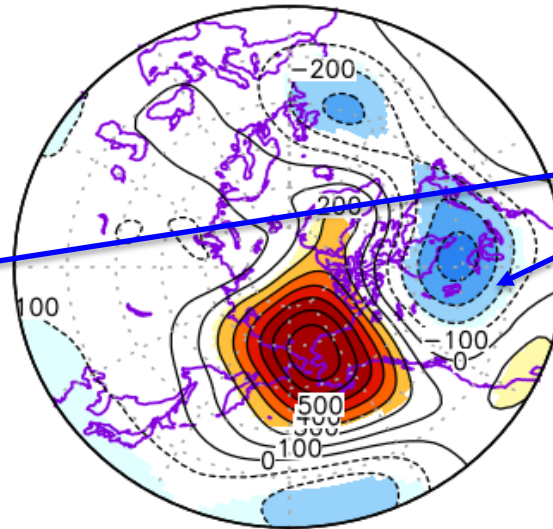


Anticyclonic circulation anomalies

(c) ART1 Z300

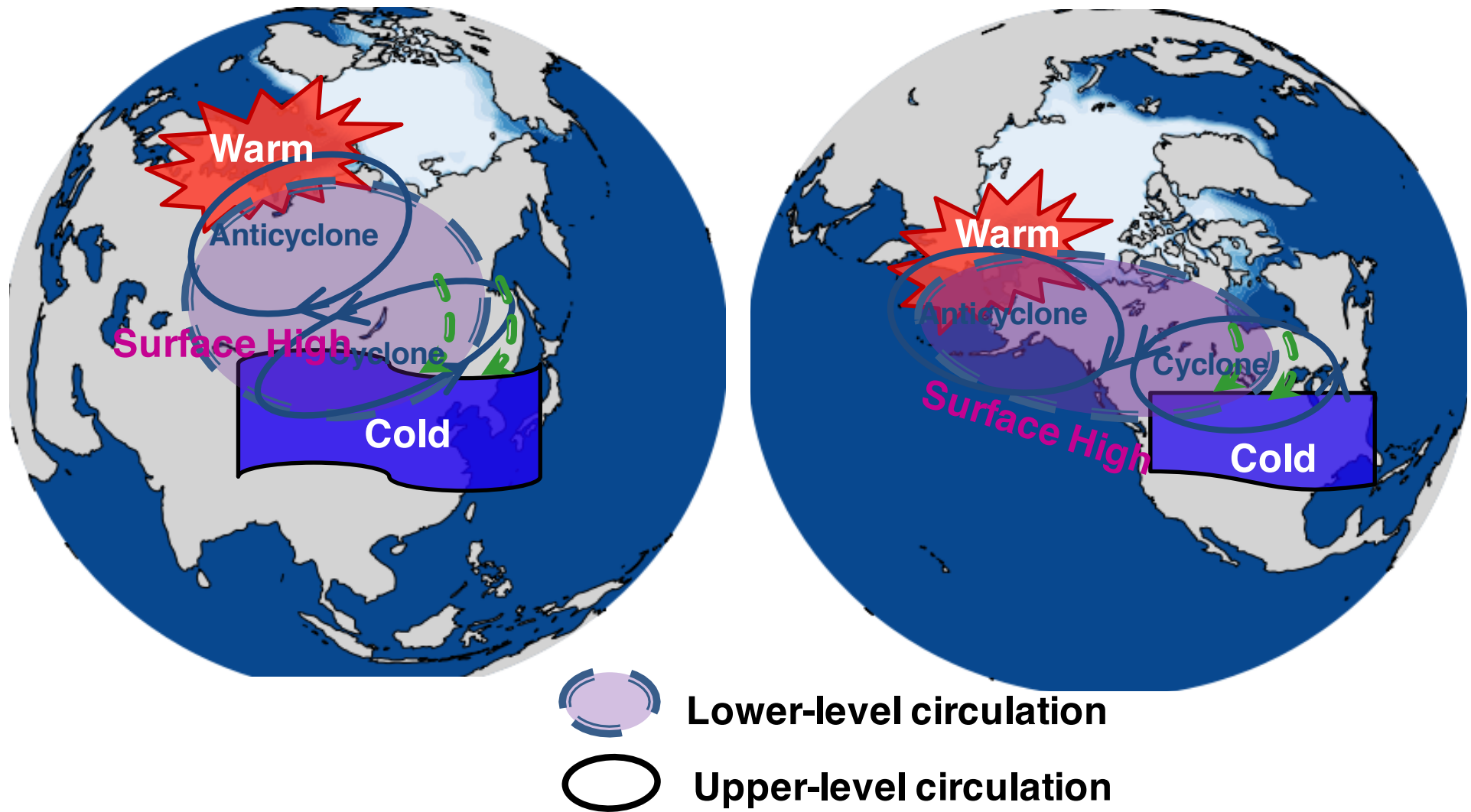


(d) ART2 Z300



Downstream development of mid-latitude trough

# Dynamical Processes for Arctic-to-extratropical connection



# Model (CM2.1) captures this teleconnection

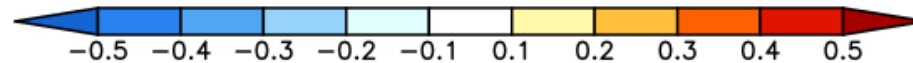
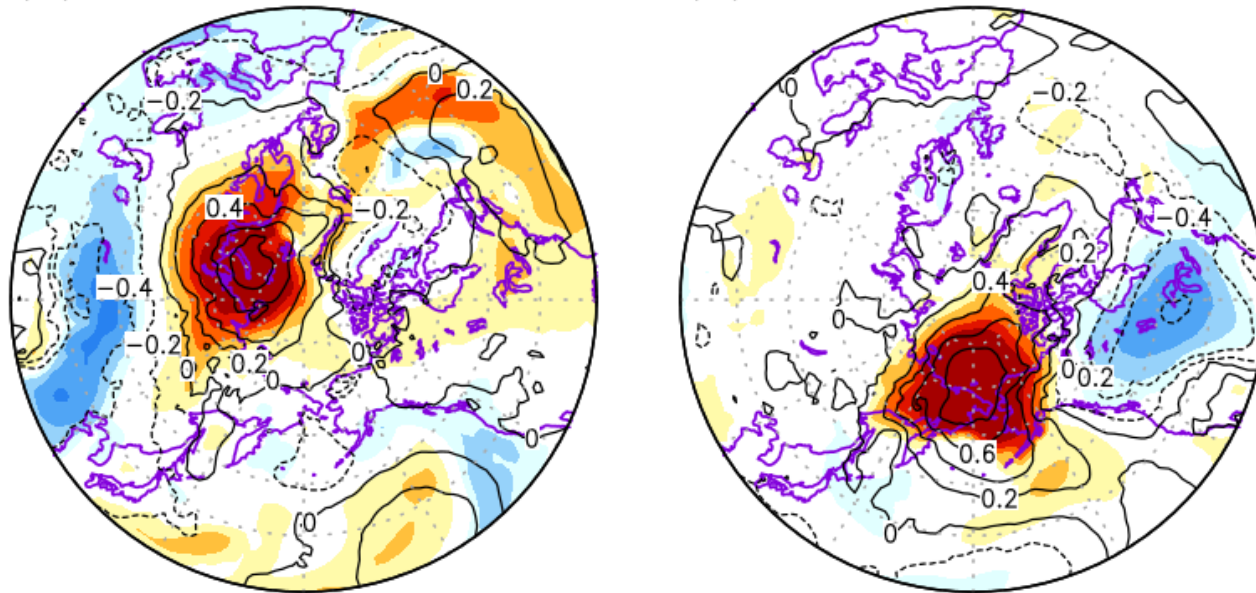
CM2.1 Model experiments, restoring SST to observation (north of 70N)  
Fully coupled in the other Ocean; 6-ensemble members

ART-SAT correlation

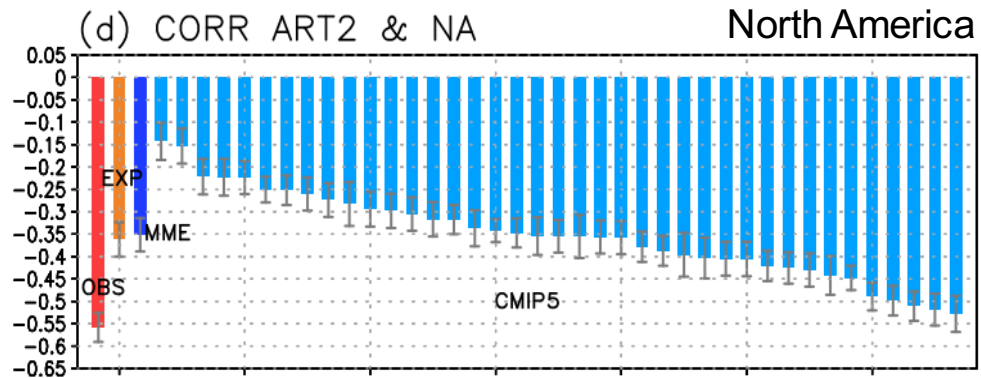
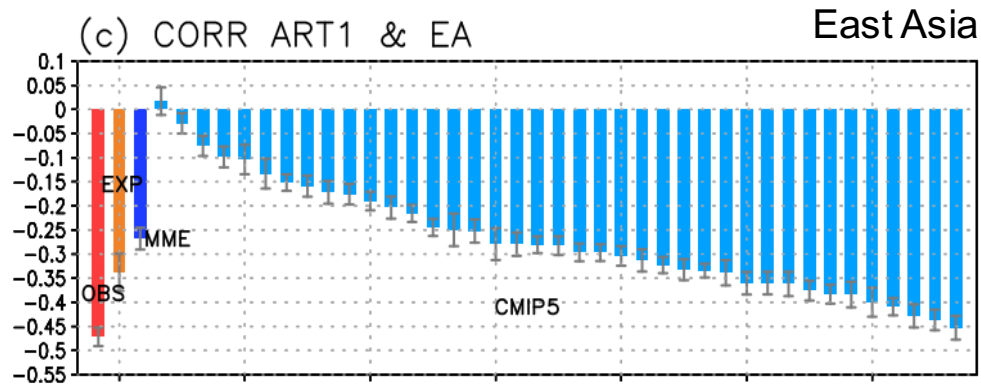
Contour: observation, shaded: model simulation

(a) ART1 (PCORR = 0.79)

(b) ART2 (PCORR = 0.84)

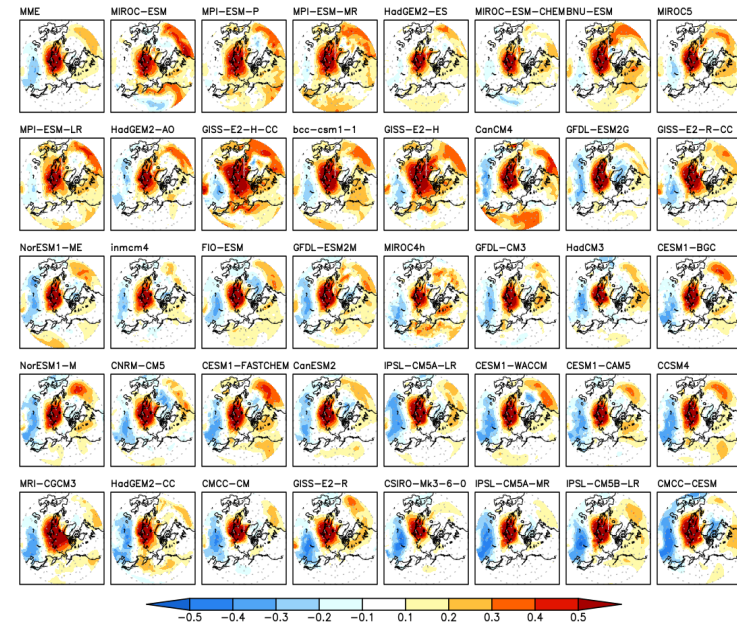


# CMIP5 models capture this teleconnection

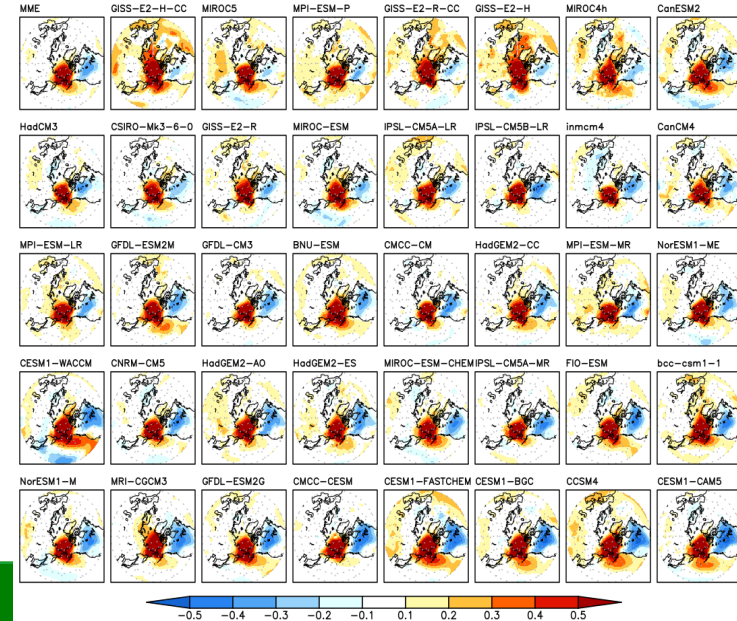


CMIP5 models mostly capture the ART-related correlation. A natural variability provoked by the local warmth over the Arctic?

ART1 correlation



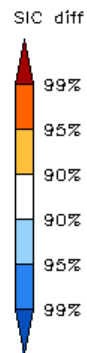
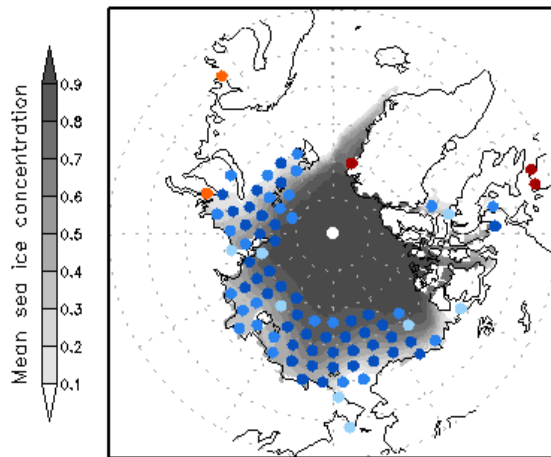
ART2 correlation



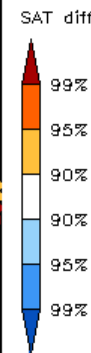
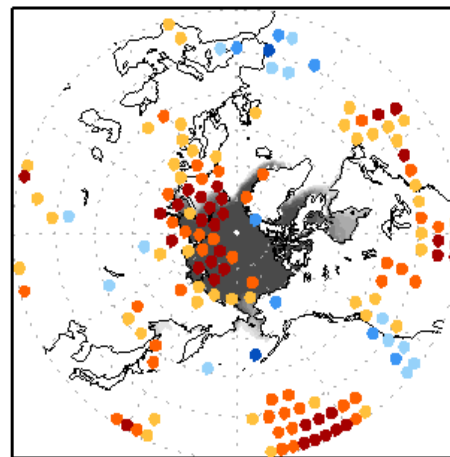
# Are ARTs predictable?

ART1

(a) ICE (OBS) ON



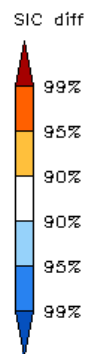
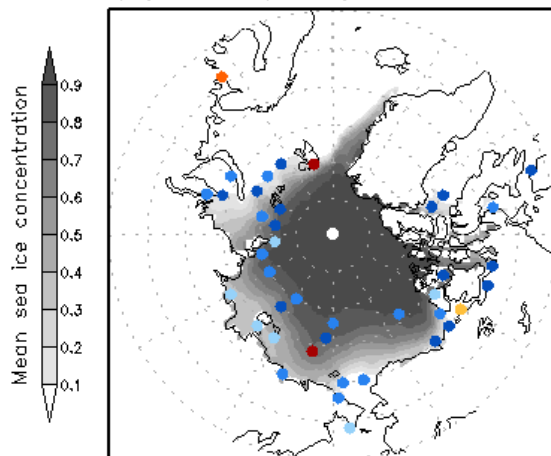
(b) ICE&TS (OBS) ND



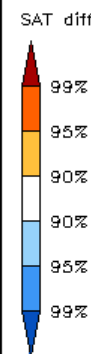
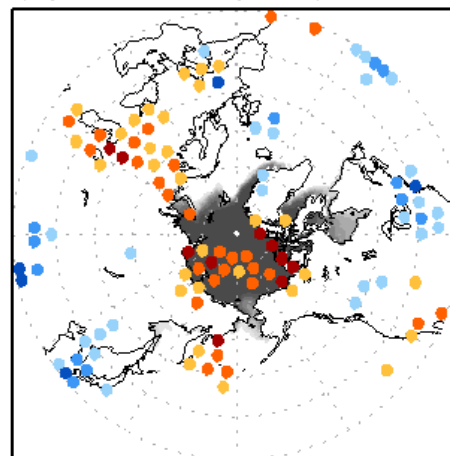
SIC (Oct-Nov) and TS(Nov-Dec) anomalies preceding winter (DJF) ARTs

ART2

(a) ICE (OBS)



(b) ICE&TS (OBS)

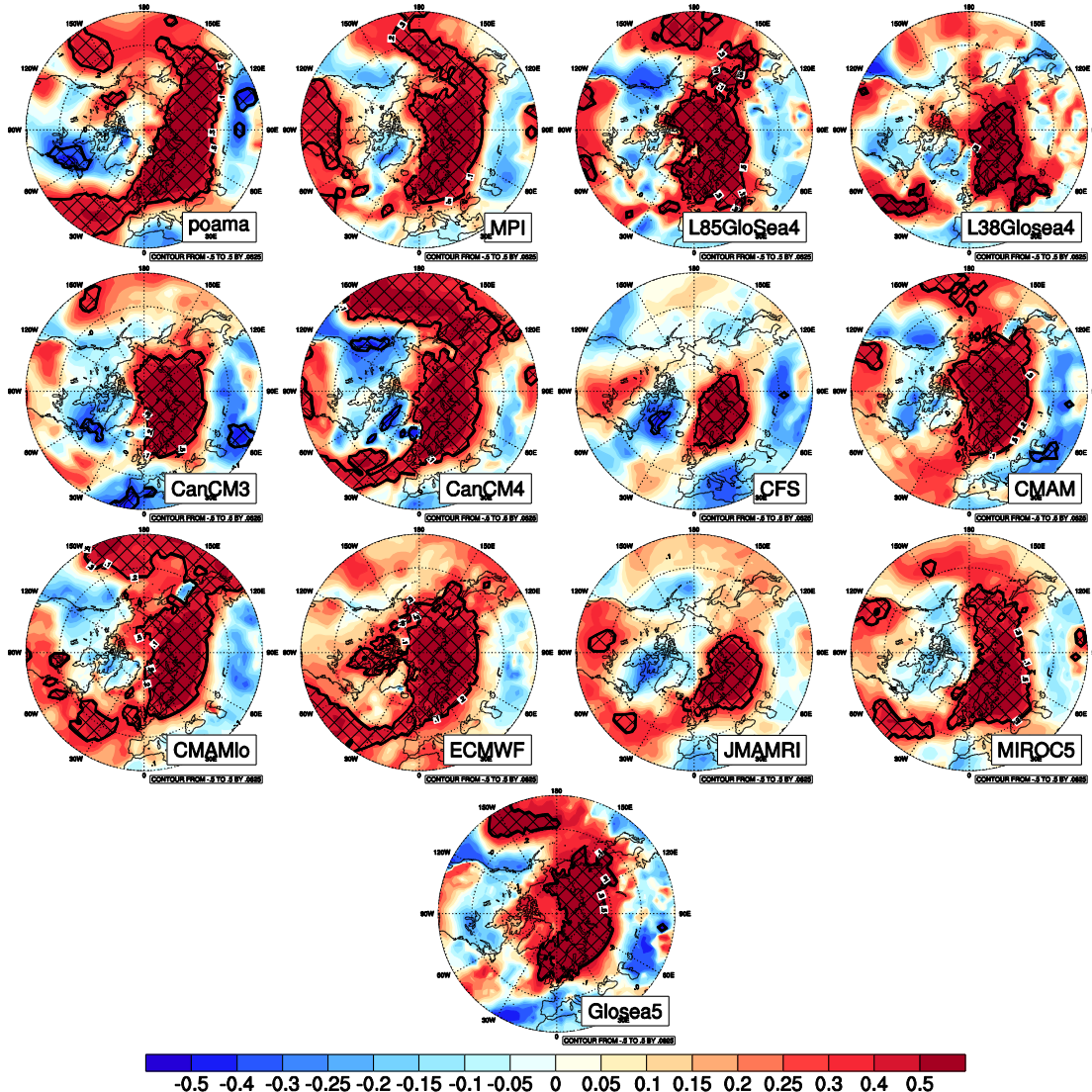


Ice reduction in late summer and early autumn could be followed by warmer upper ocean and therefore enhanced turbulent heat flux and atmospheric warming in winter.

There exist some precursory signal in sea ice and SST but not that clear.

# ART1 in the operational climate models

Corr. bw model ART1 and model SAT



CHFP: Climate-system Historical Forecast Project; archive of ensemble prediction for (more than) 10 centers

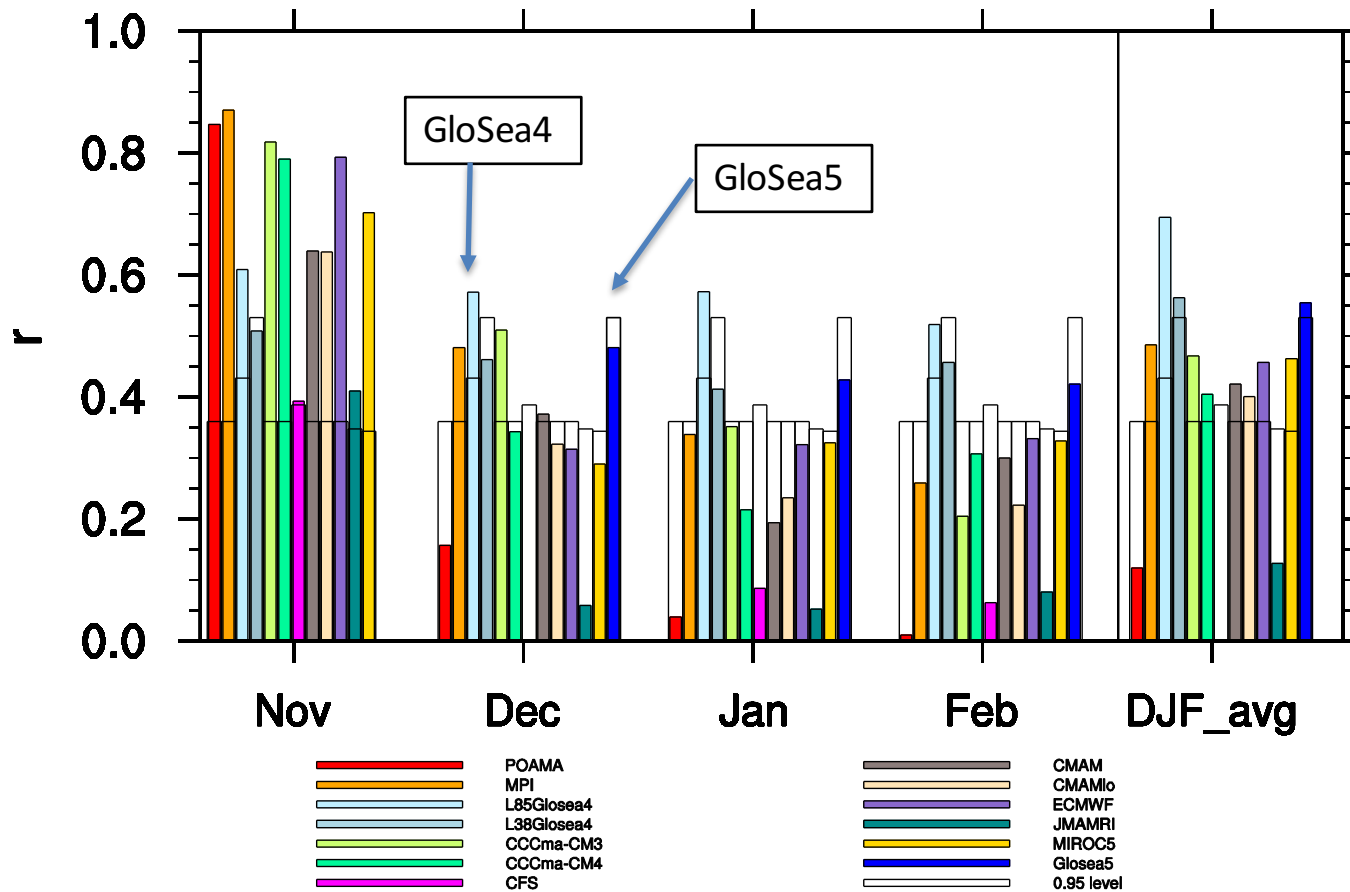
[left] monthly ART1-SAT correlation for winter from predictions initialized at 1<sup>st</sup> of Nov

Some CHFP models have potential to capture the ART1-EA correlation. Worse than CMIP5: problems in initialisation of SIC and ocean?

# CHFP models' predictability of ART1

CORR(predicted and obs ART1)

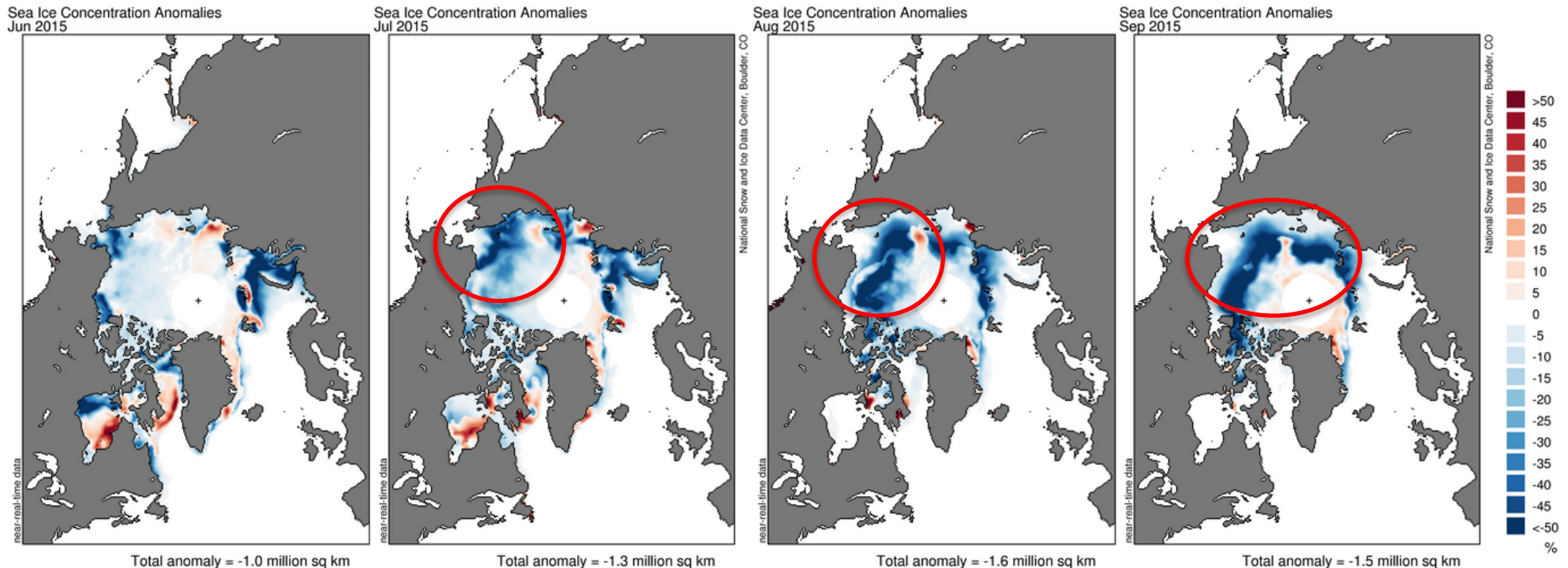
Predictability( $r$ ) of SAT anomaly for ART1 region



Models have 0-1 month predictability on ART1

# What about this winter?

## Observed Arctic SIC anomalies

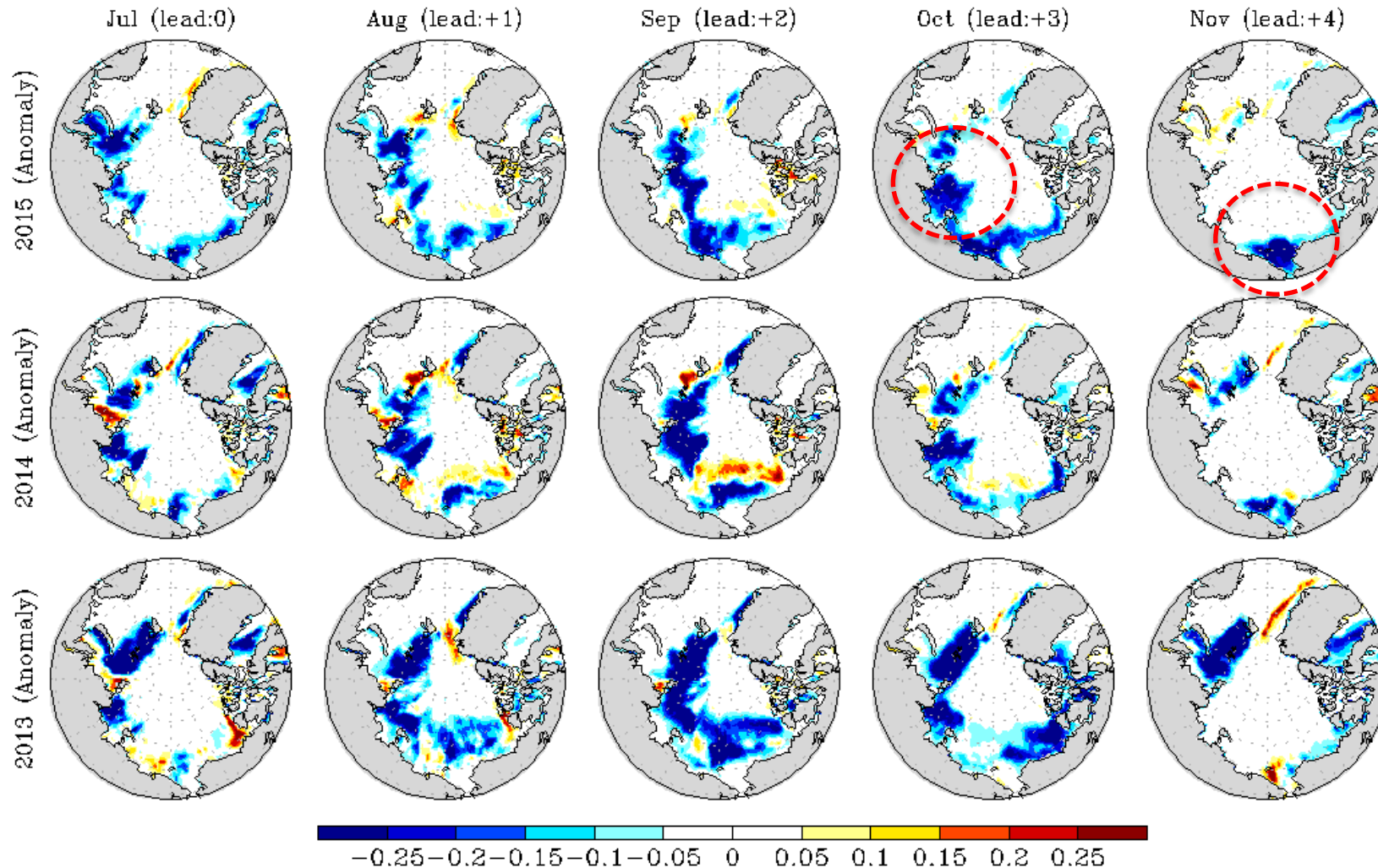


This summer, there was a large reduction of SIC over Chukchi, E-Siberia Sea, Canada basin, Laptev Sea



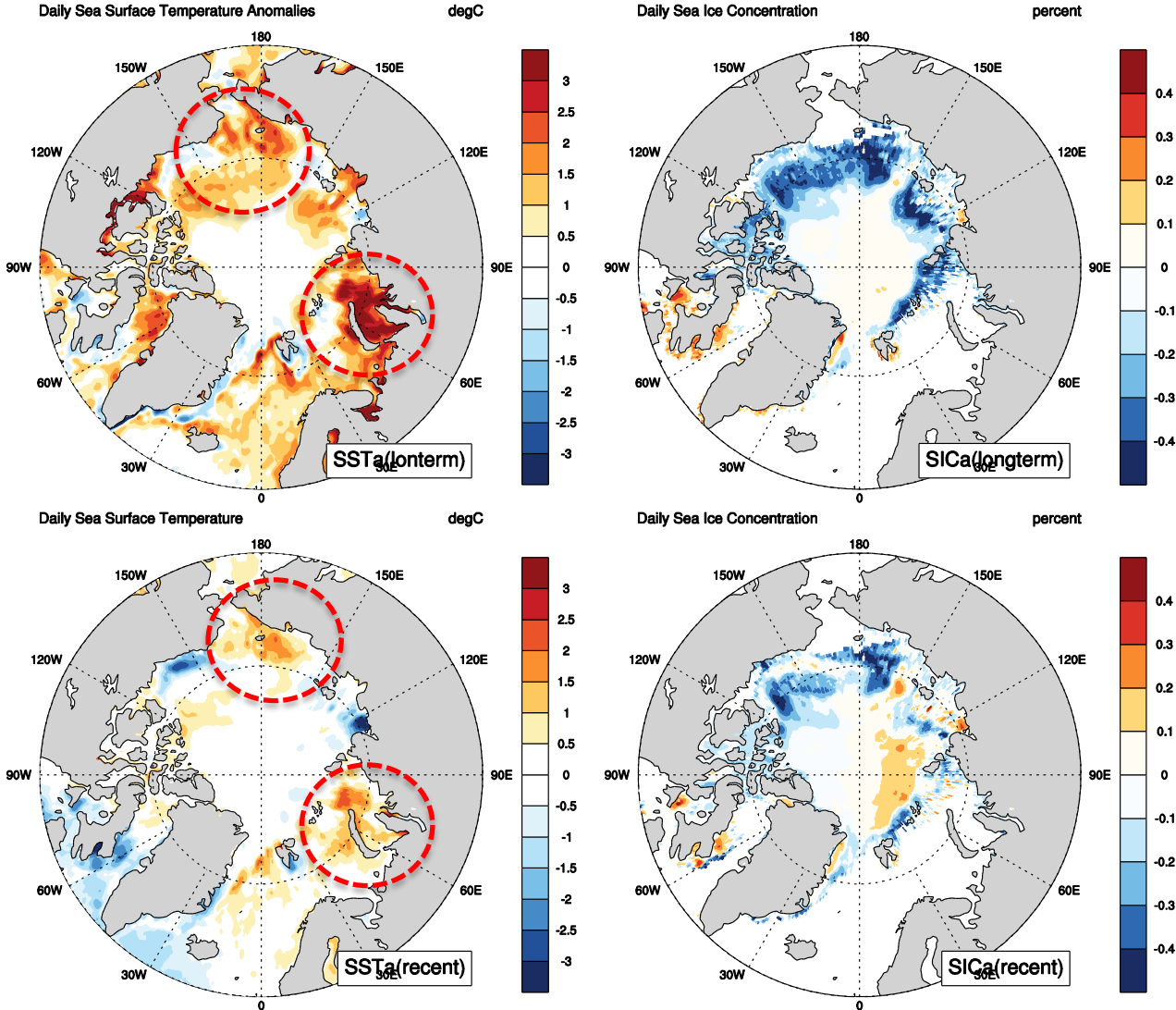
# What about this winter?

Statistical prediction of Arctic SIC (initialized at July)



# What about this winter?

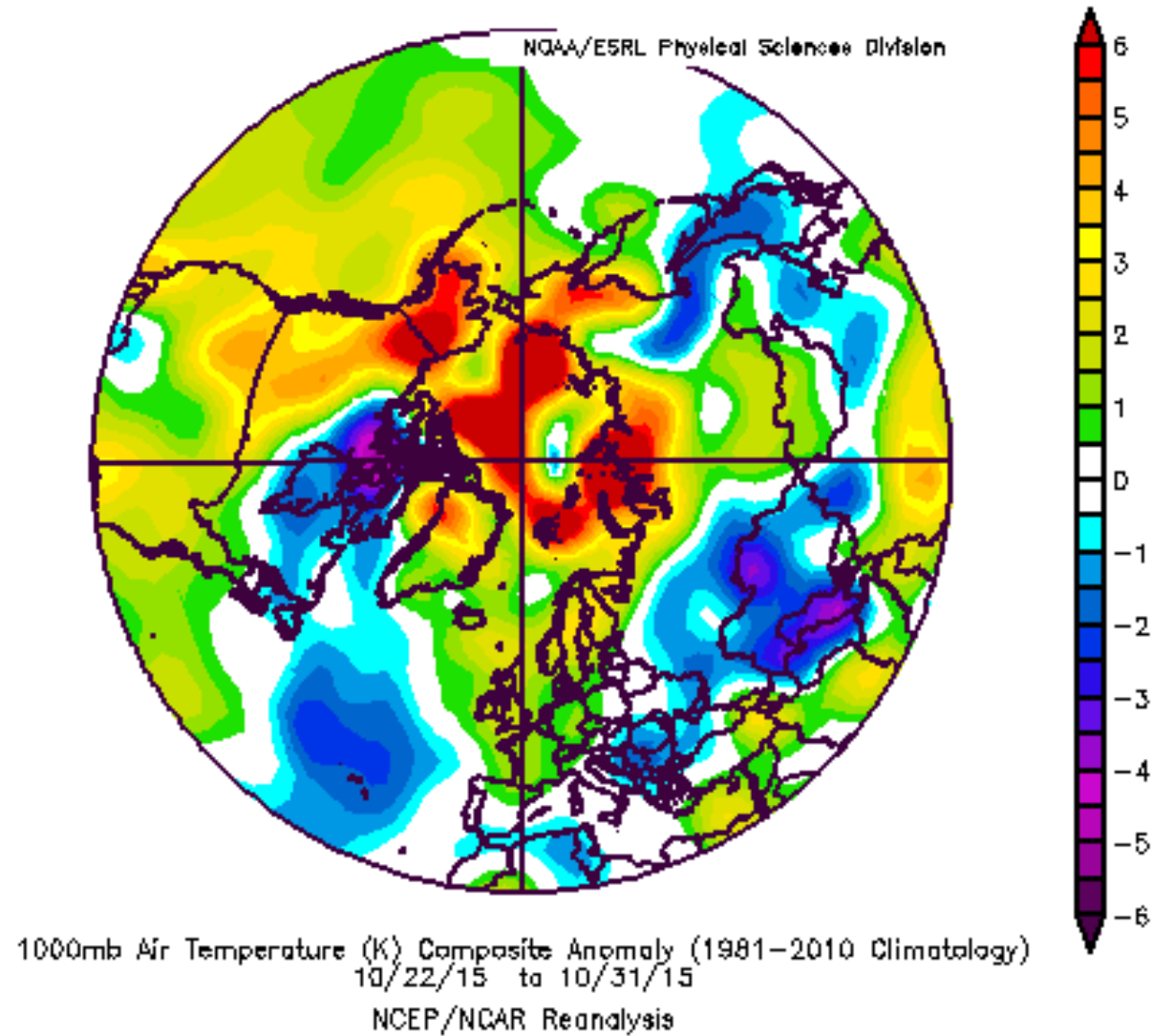
SST and SIC anomalies for 1August-15OCT



w.r.t. 1981-2010 climatology

w.r.t. 2010-2014 climatology

# SAT anomalies for 22-31 October



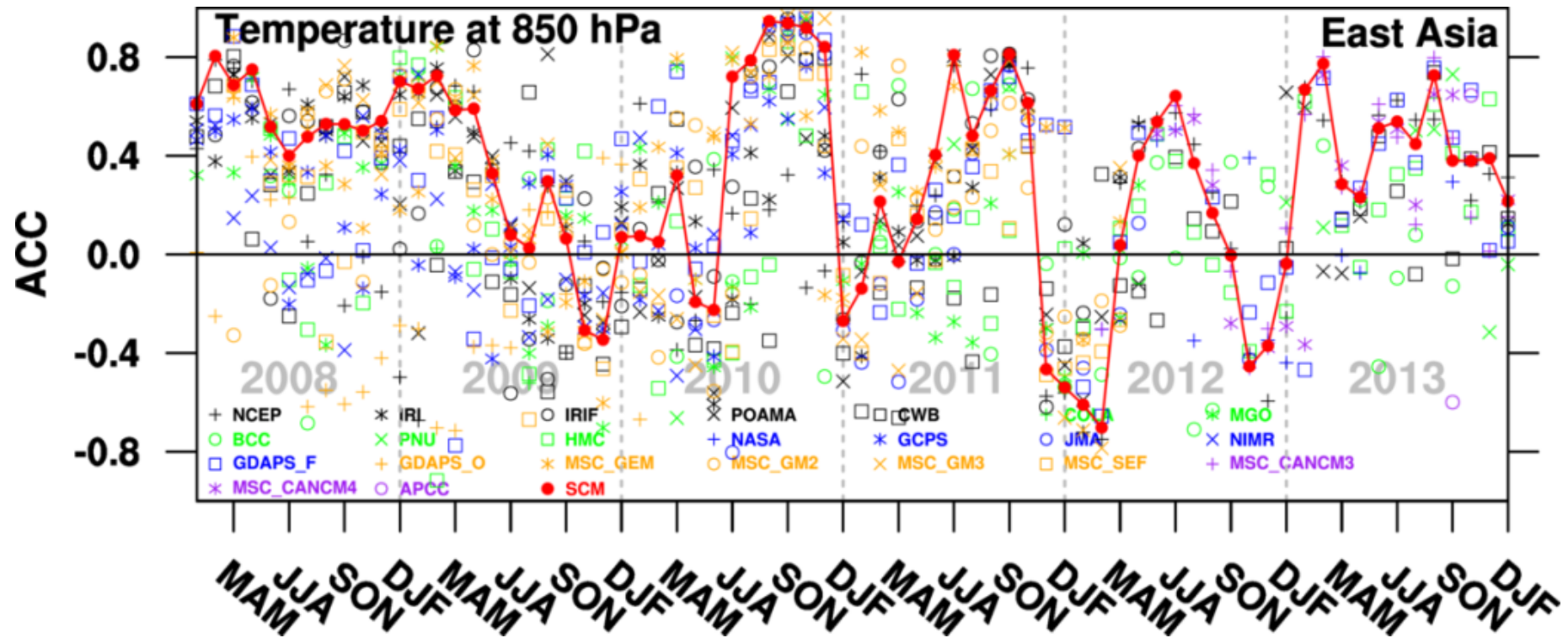
# Summary

- Cold winter temperatures in East Asia and North America followed warm temperatures in the Barents-Kara Sea (ART1) and East Siberian-Chukchi Sea region (ART2) by a week or two.
- Climate models have potential to simulate the Arctic-extratropics correlation but proper initialisation is required to predict ARTs-related climate variabilities over the East Asia.
- In this winter, large reduction in SIC over the Chukchi-E. Siberian Sea, Barents-Kara Sea may lead to positive ART1 and 2.

**Thanks for attention!**

# Models failed to simulate the cold

APCC models' anomaly correlation of T850 over East Asia [1month-lead, seasonal mean]



From APCC (JH Yoo)

Low predictability for the last several winters with severe cold  
APCC models' have failed to predict cold winters