

A blue arrow graphic pointing to the right is positioned on the left side of the slide, partially overlapping the title text.

# Sensitivity of the Arctic climate forcing due to atmospheric physical parameterizations

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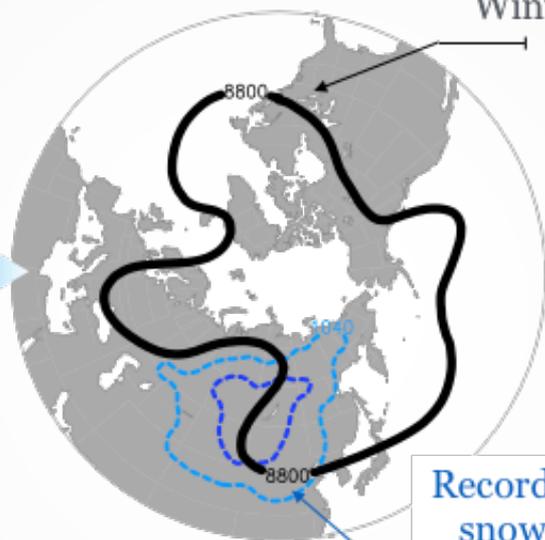
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21 Dec 2015



21 Jan 2016



Winter Storm Jonas  
(Jan 22-24)

Record Siberian High and  
snowfall in subtropical  
Asia (Jan 24-26)

## East Asia cold snap kills 85 in Taiwan

ABS-CBN News  
Posted at 01/26/16 2

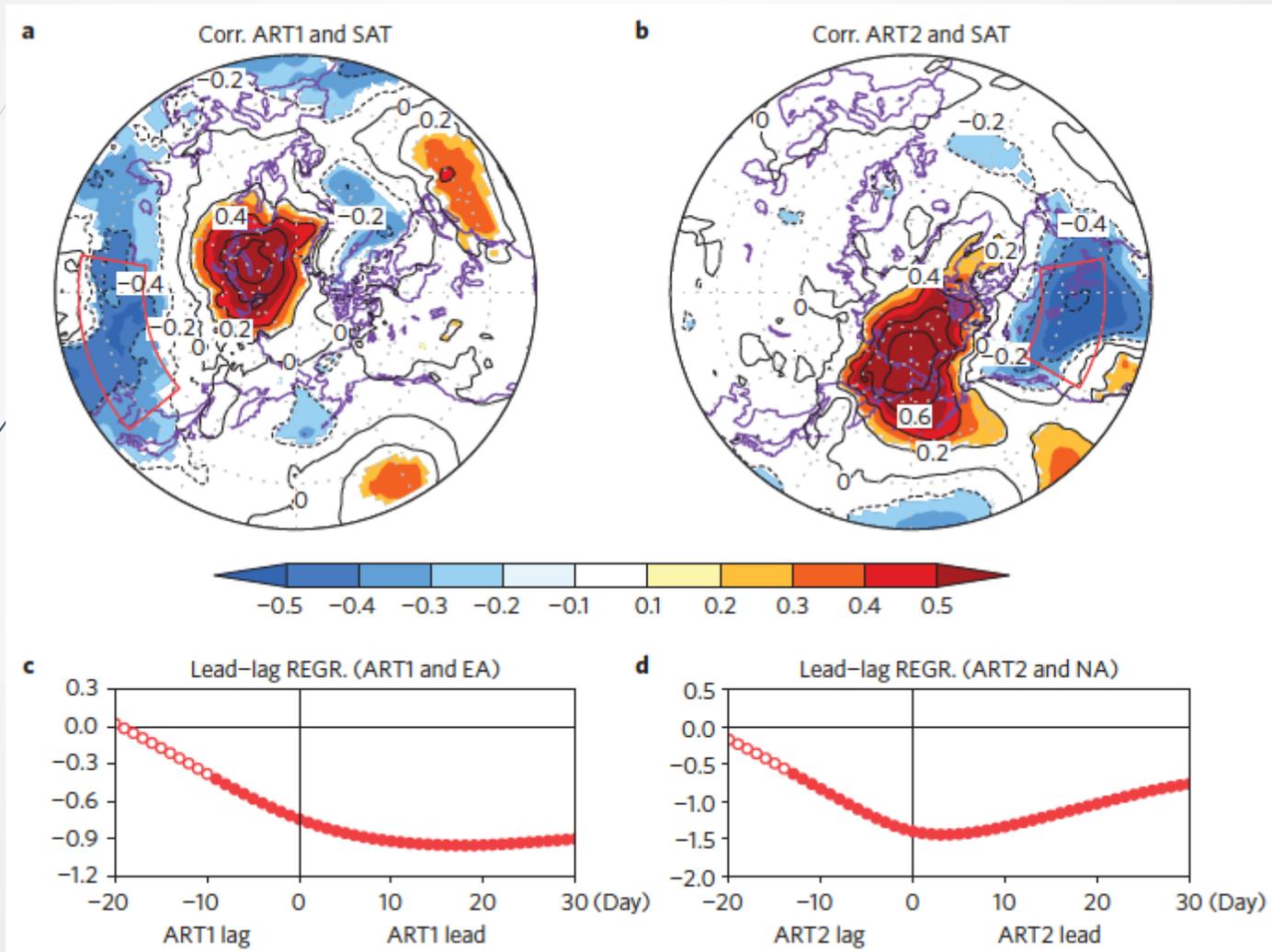




**Arctic warming** is pointed as a potential cause for extreme weathers in the mid latitudes.

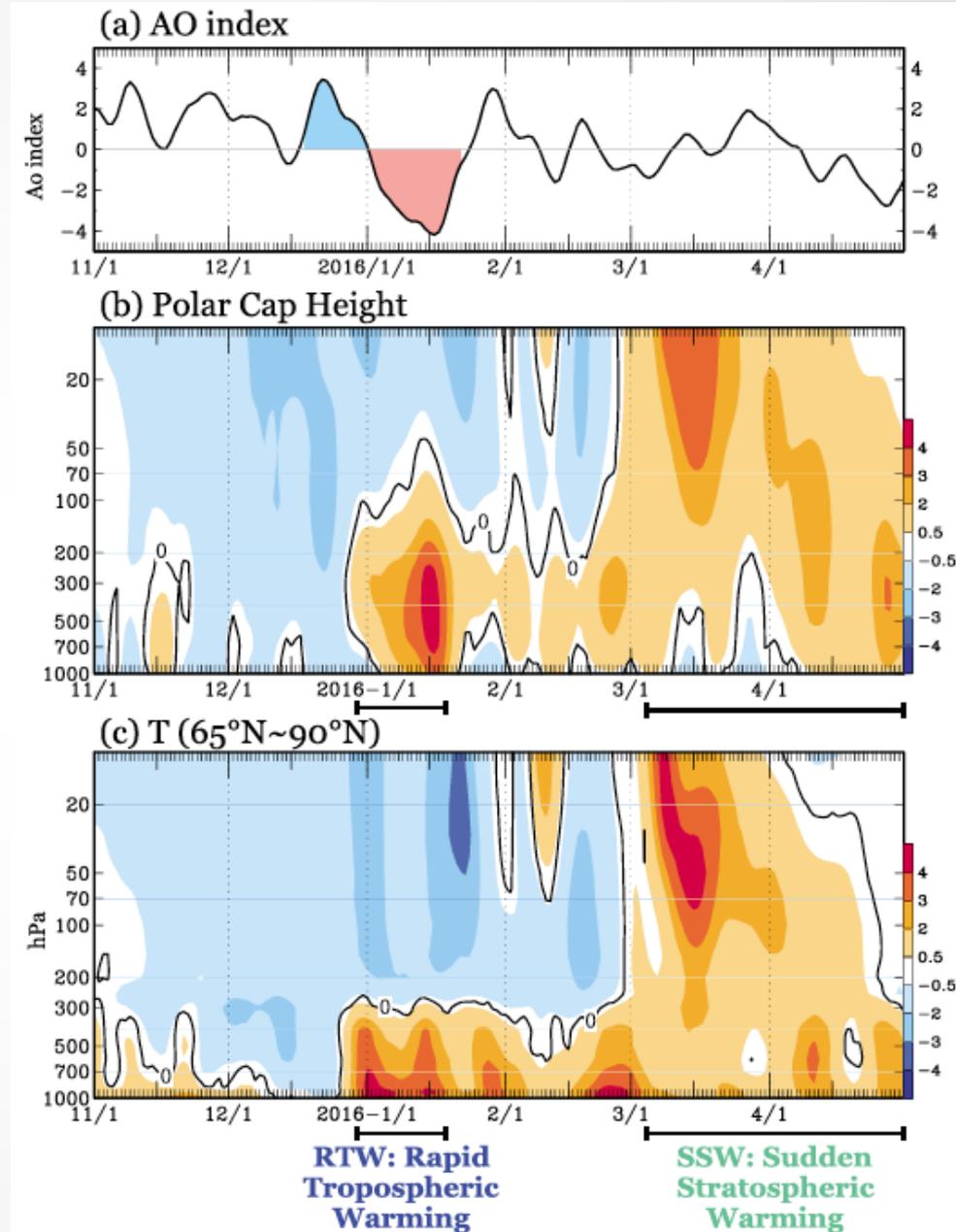


# Warm Arctic → Cold continent

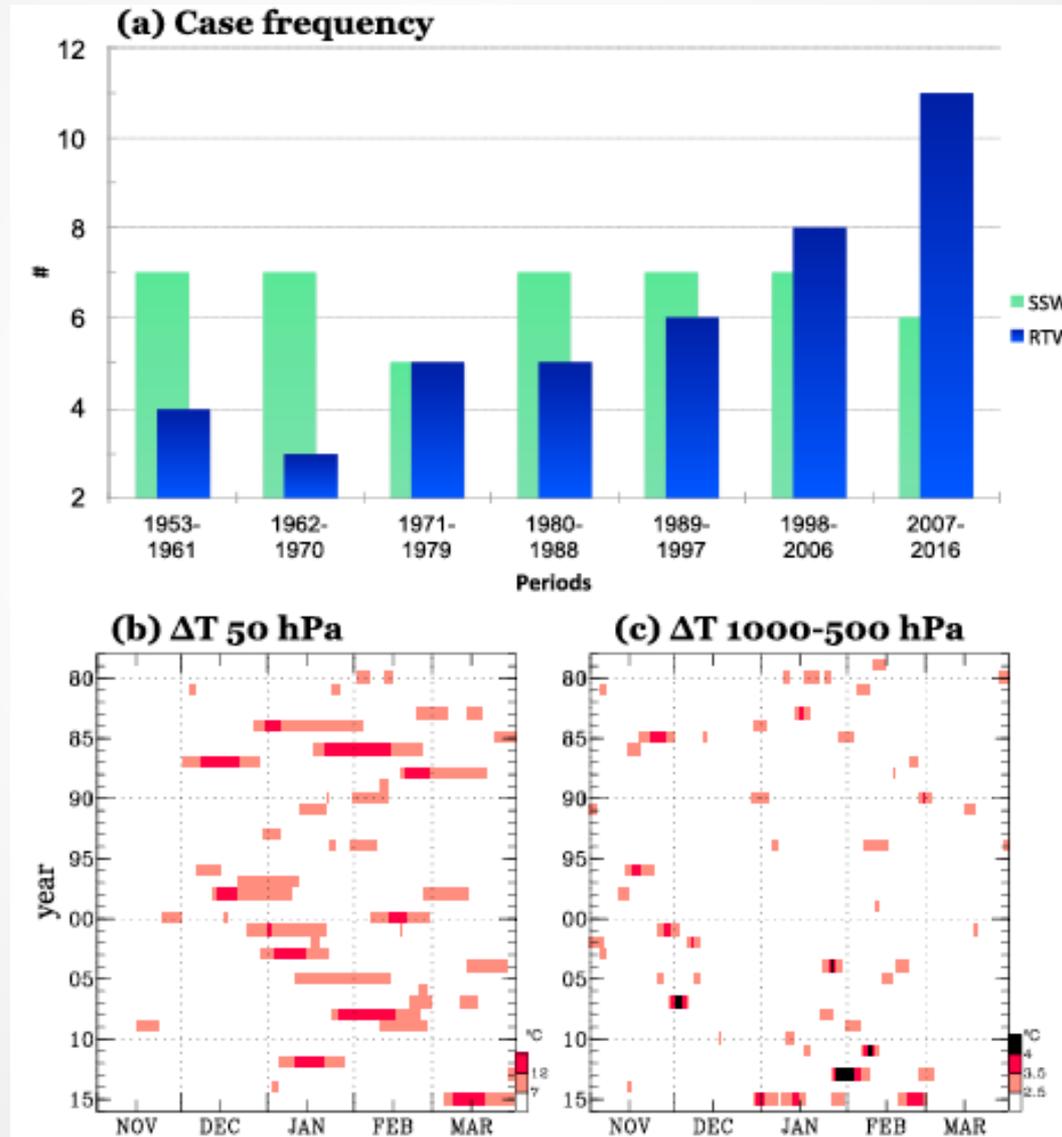


Kug\_etal(2015) in Nature Geoscience

# Two different types of warming in the Arctic



# RTW cases have been consistently increasing in the last 50 years.

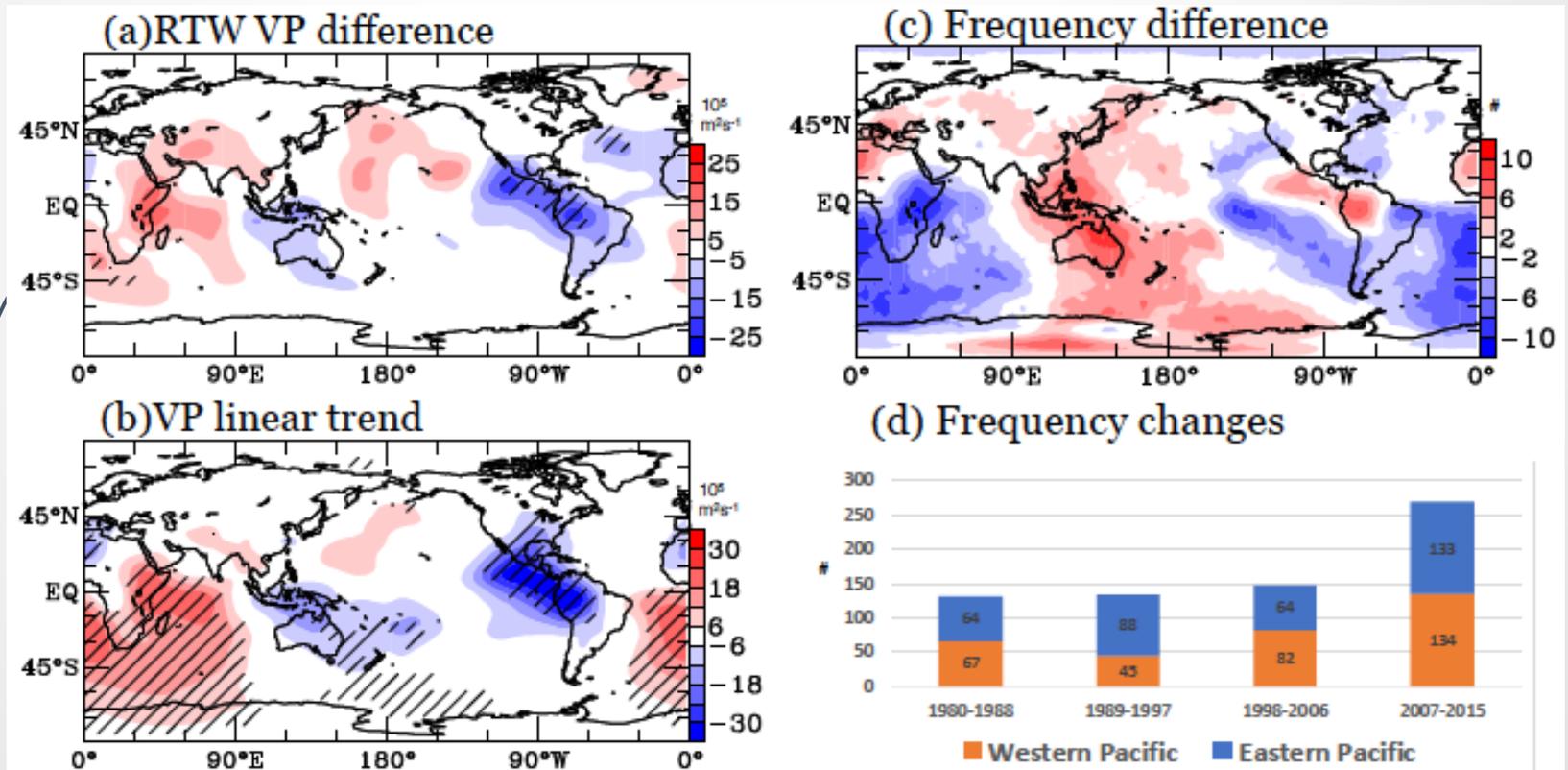




What is the source of this  
intraseasonal variability (RTW)?  
(Lin et al. 2019 in revision for GRL)



This increasing RTW case has been linked to tropical Pacific Oceans and intensifying...

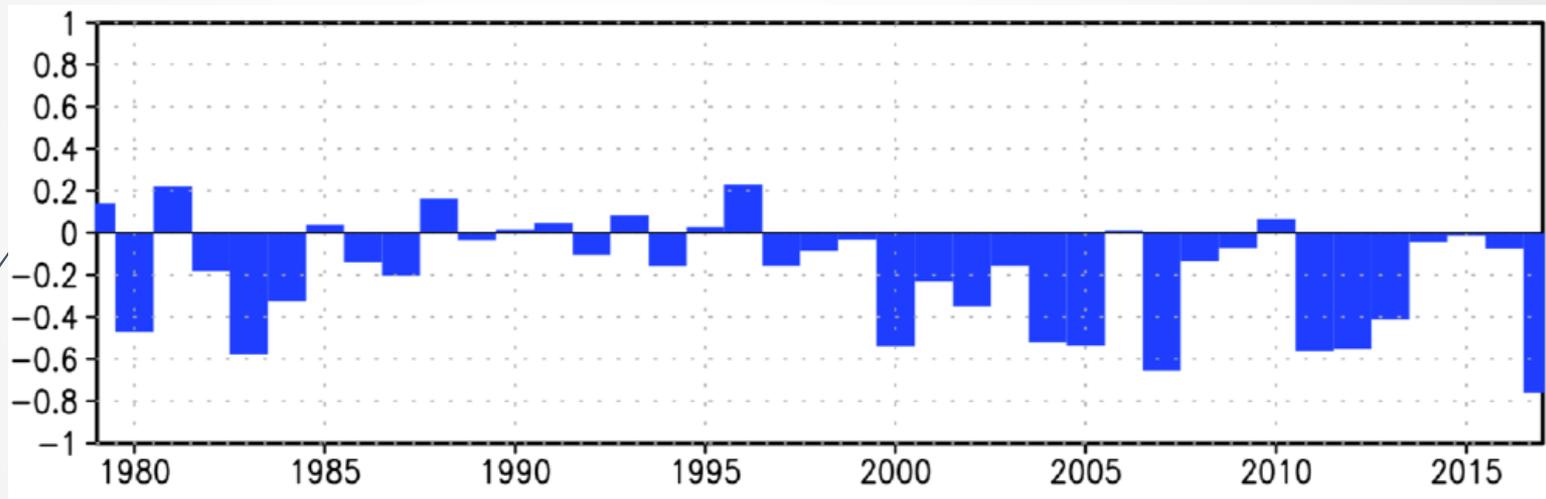




Warm Arctic – Cold Eurasia  
happens every year?

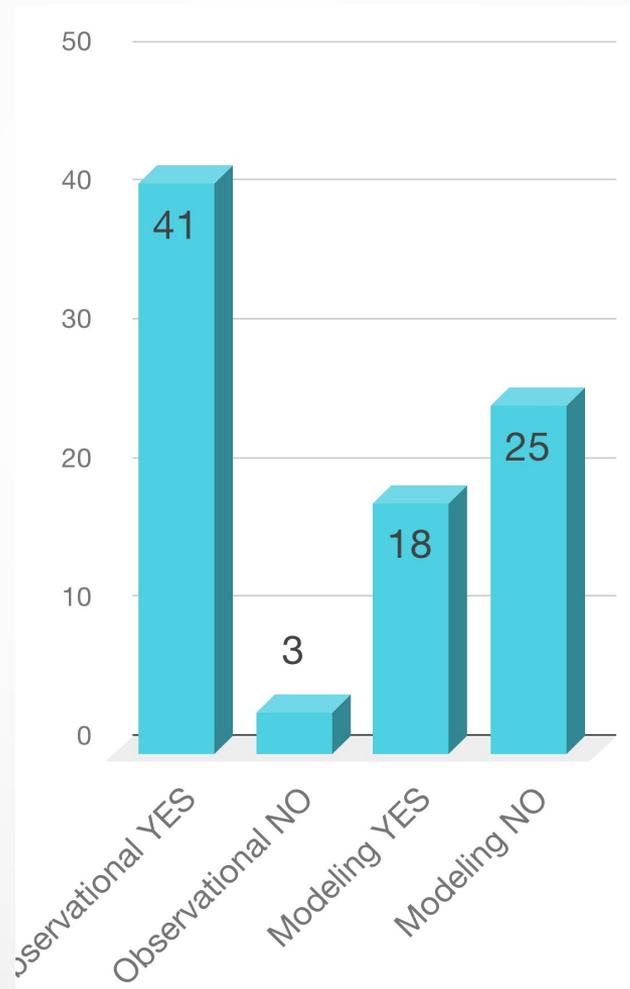


Not really... very strong interannual & longer term variability of this pattern

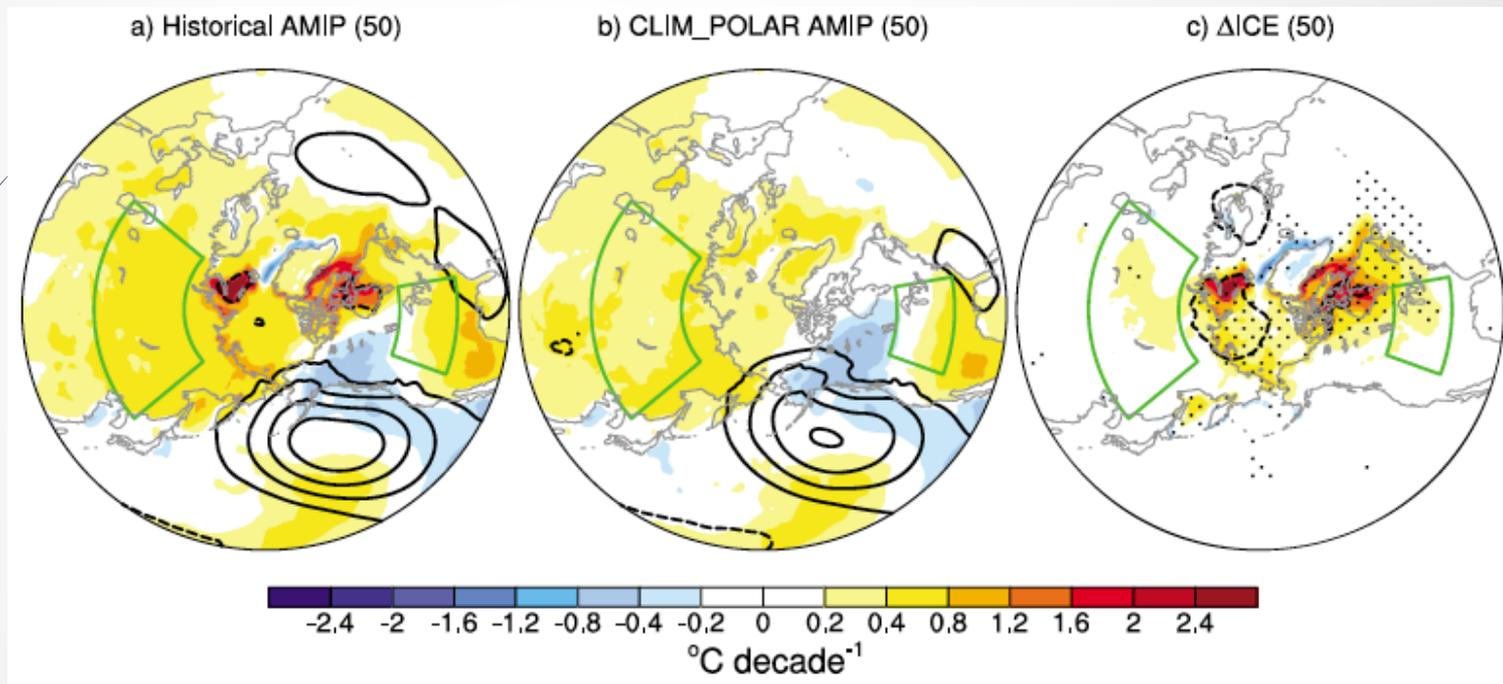


Tas (Siberia) during DJFM

Using observation, relationship between Arctic and mid-latitude temperature is relatively clear, but...



Some other models could not simulate  
“Warm Arctic Cold Continent” pattern with  
the similar boundary condition changes...



For example, Sun et al. (2016)

# Why?



# Hypothesis

- ▶ The response to reduced sea ice producing a teleconnection pattern depends upon specific aspects of certain physical processes in a global climate model.
- 

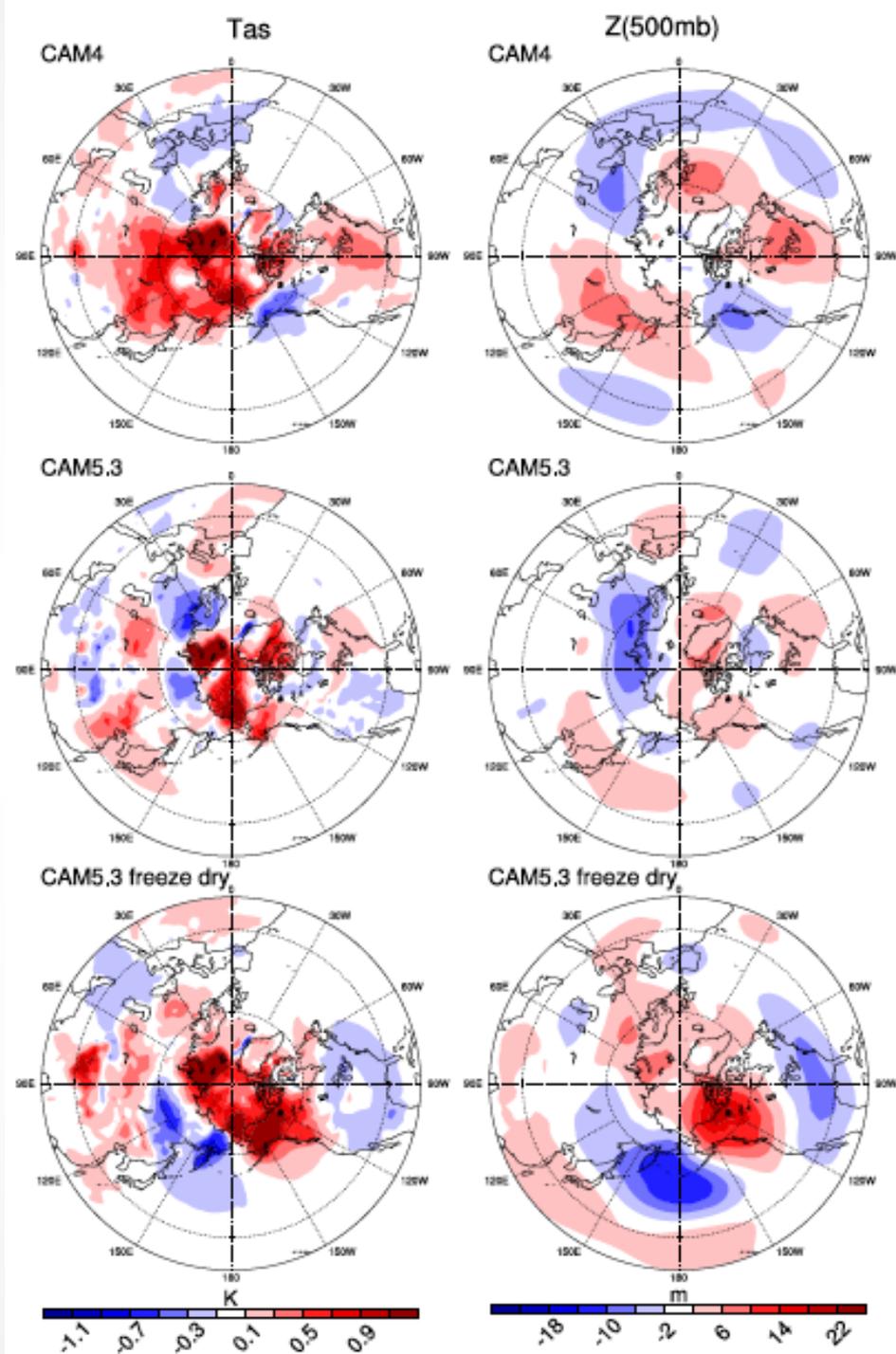


# Using CESM1.2.0

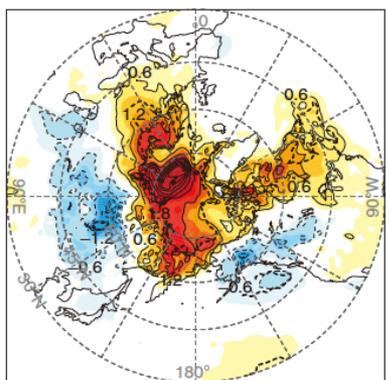
- ▶ CAM5 with freeze dry (Vavrus and Waliser 2008): producing a change in low liquid cloud fraction during cold times of the year
- ▶ CAM5 (default)
- ▶ CAM4
  
- ▶ Atmosphere only: one with climatological SICE/SST and the other with reduced SICE/SST
- ▶ Focus on the colder season (November – March)

# Tas and Z(500mb)

- ▶ CAM5.3 tends to produce "Warm Arctic Cold Continent pattern" but with very different location compared to CAM5.3 with freeze dry.

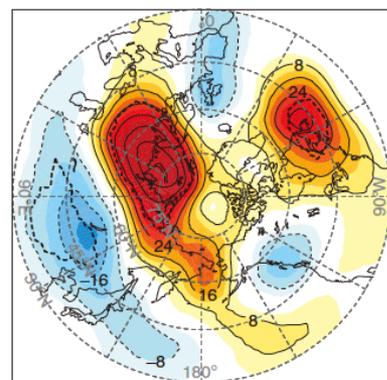


ΔSAT for ND, composite



(°C)

b ΔZ500 for ND, composite

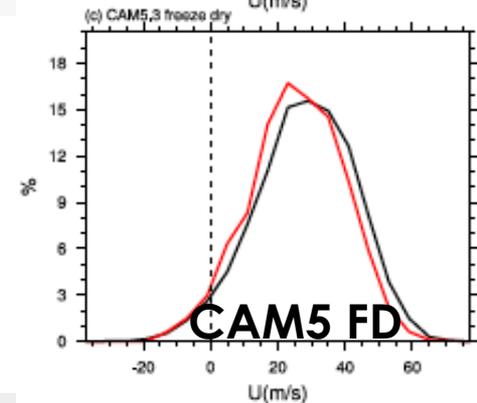
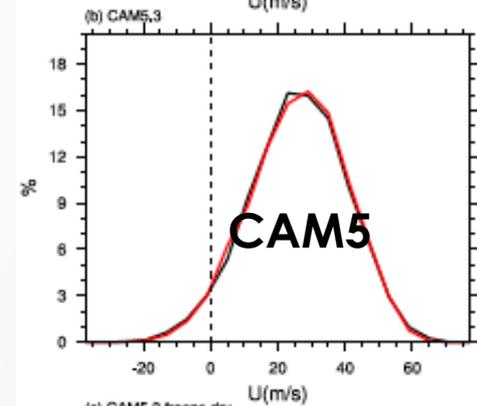
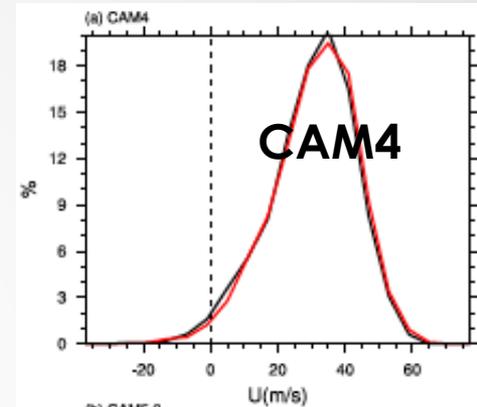


(gpm)

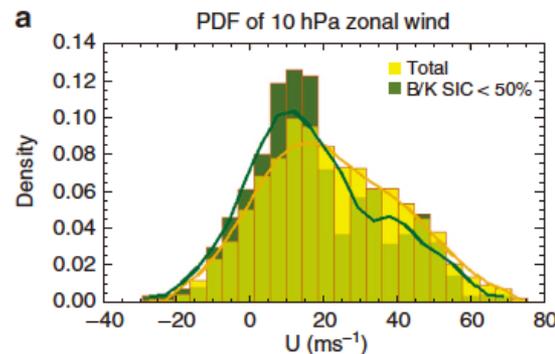
# Polar vortex variability

**Control**  
**Reduced SICE**

- ▶ Observation shows a slight increase in the frequency of weakened zonal winds when SIC is lower.
- ▶ CAM4 and CAM5 no change in polar vortex variability
- ▶ CAM5 with FD ~
- ▶ → close to obs.



**Observation**



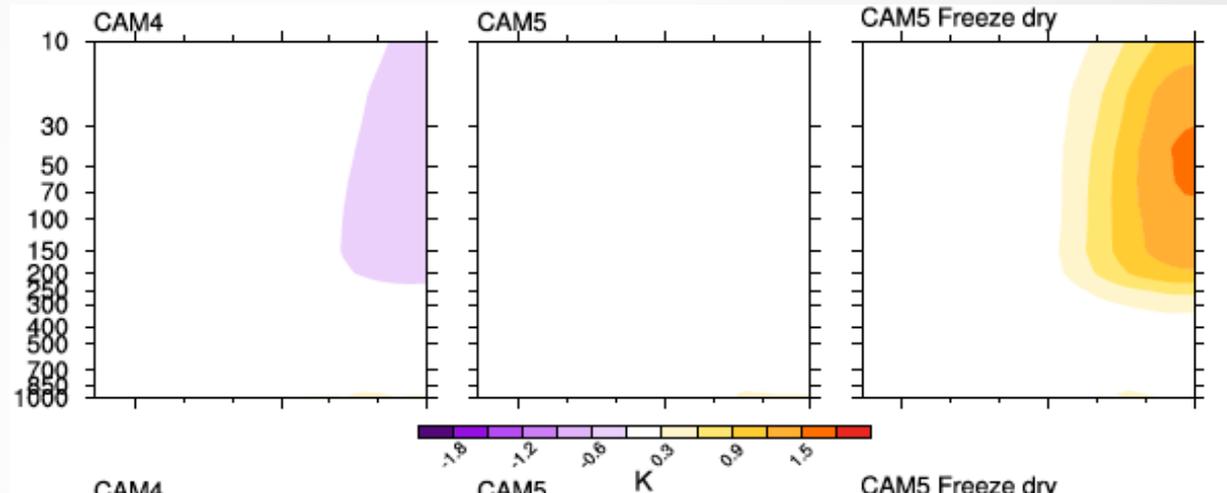


# Do we have any physical mechanism to explain this difference?

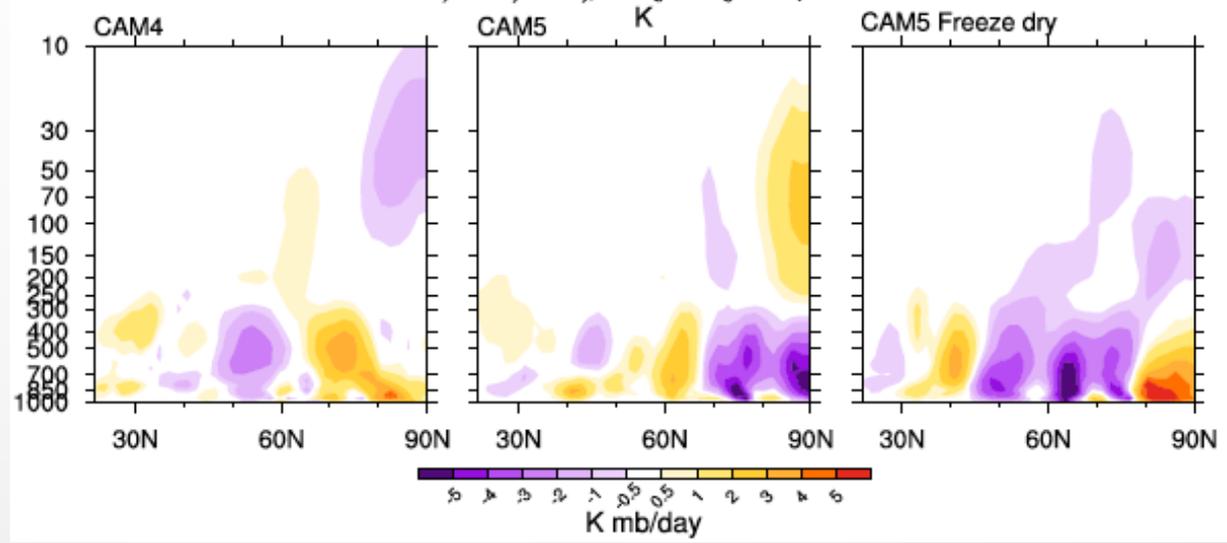
- ▶ 1) CAM5 with freeze dry produces fewer clouds during cold seasons
- ▶ 2) Clouds is likely to prevent emission of energy
- ▶ 3) CAM5 with FD could transport heat energy, which is from reduced Arctic Sea Ice to upper troposphere more efficiently than without freeze dry.

# Change in temperature and vertical transient eddy heat flux

Temperature



Vertical transient eddy heat flux





# Another possibility?

- ▶ Different teleconnection pattern could be initiated by difference in the mean climate.
- ▶ Also, high-top model with better stratosphere was suggested as a key. (Zhang et al. 2018)



# Plan to participate PAMIP

- ▶ CAM5 variation: one with FD and another with HiLAT modification in atmospheric physics
- ▶ GAIA model developed by KIOST
- ▶ At least Tier 1 will be done in Fall.

# KIOST\_ESM (Thanks to Young-Ho Kim at KIOST)

Framework adopted from GFDL CM2.5 → Applying new physics  
Some of them have been newly developed





# Take home messages

- ▶ Climate models do show consistent patterns as observation depending on model configuration including clouds, stratosphere, and so on.
- ▶ This indicates Arctic – midlatitude linkage is very sensitive in nature.
- ▶ Also, Arctic – midlatitude linkage is not just in seasonal mean scale but also in synoptic – S2S time scales.



Thank you very much!!

