

# Arctic Amplification and Eurasian Climate: a short review

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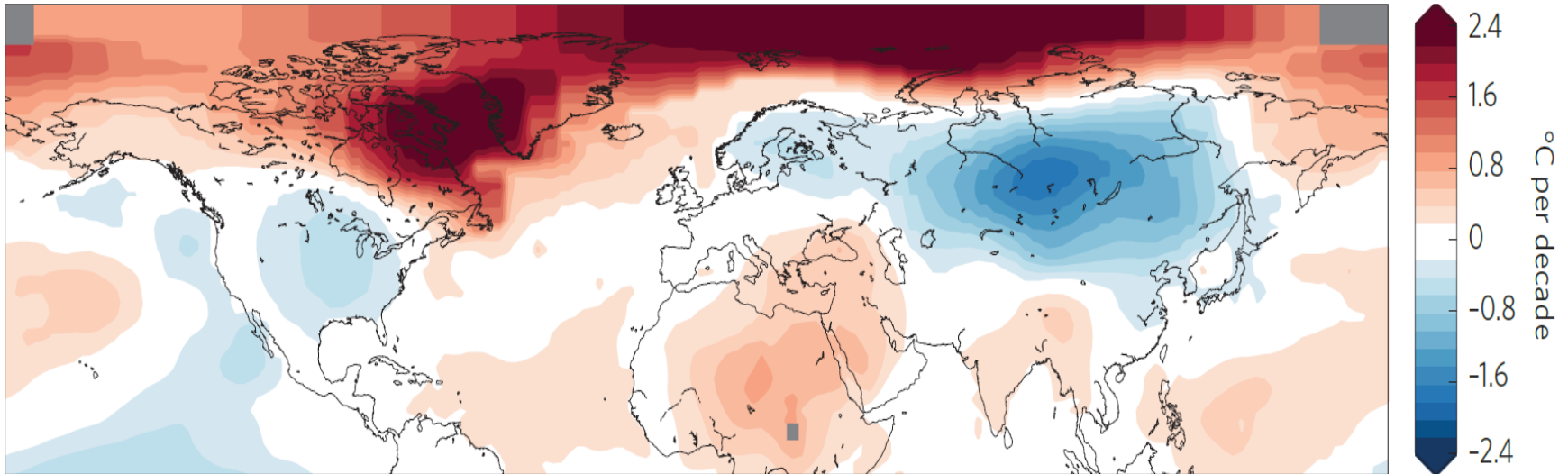
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Chinese Academy of Sciences, Beijing, China**

**3 University of Bergen, Norway**



# Arctic Warming and Eurasian Cooling

DJF surface temperature trends (1990-2013)



**Cohen et al., 2014**



# Arctic Warming (Amplification)

**Concept of Polar/Arctic amplification of changes in Earth surface temperature induced by changes in concentration of gases in atmosphere was hypothesized in 1896 by Arrhenius**

**Courtesy of Leonid Bobylev**

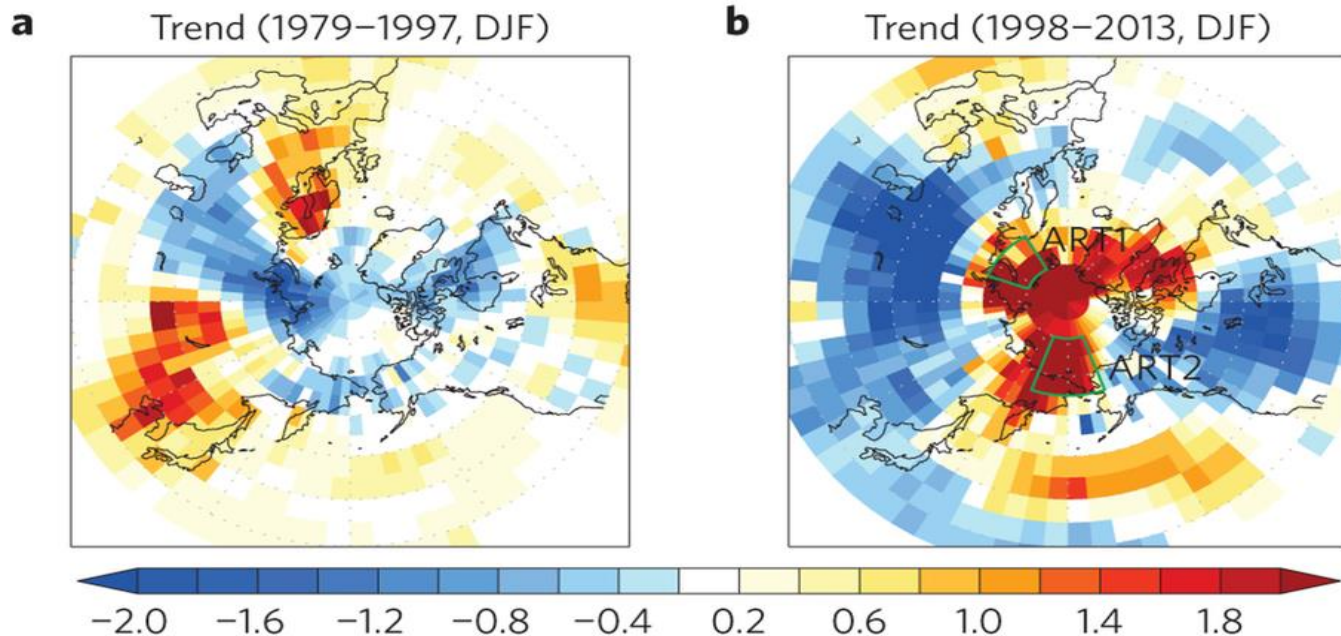


# Arctic Warming (Amplification)

- ✓ **Sea ice**
- ✓ **Heat and moisture transport**
- ✓ **Inflows of Atlantic and Pacific waters**
- ✓ **Local radiative effect**
- ✓ **Increased emittance of blackbody**
- ✓ **Reduced air pollution**
- ✓ **Phytoplankton**

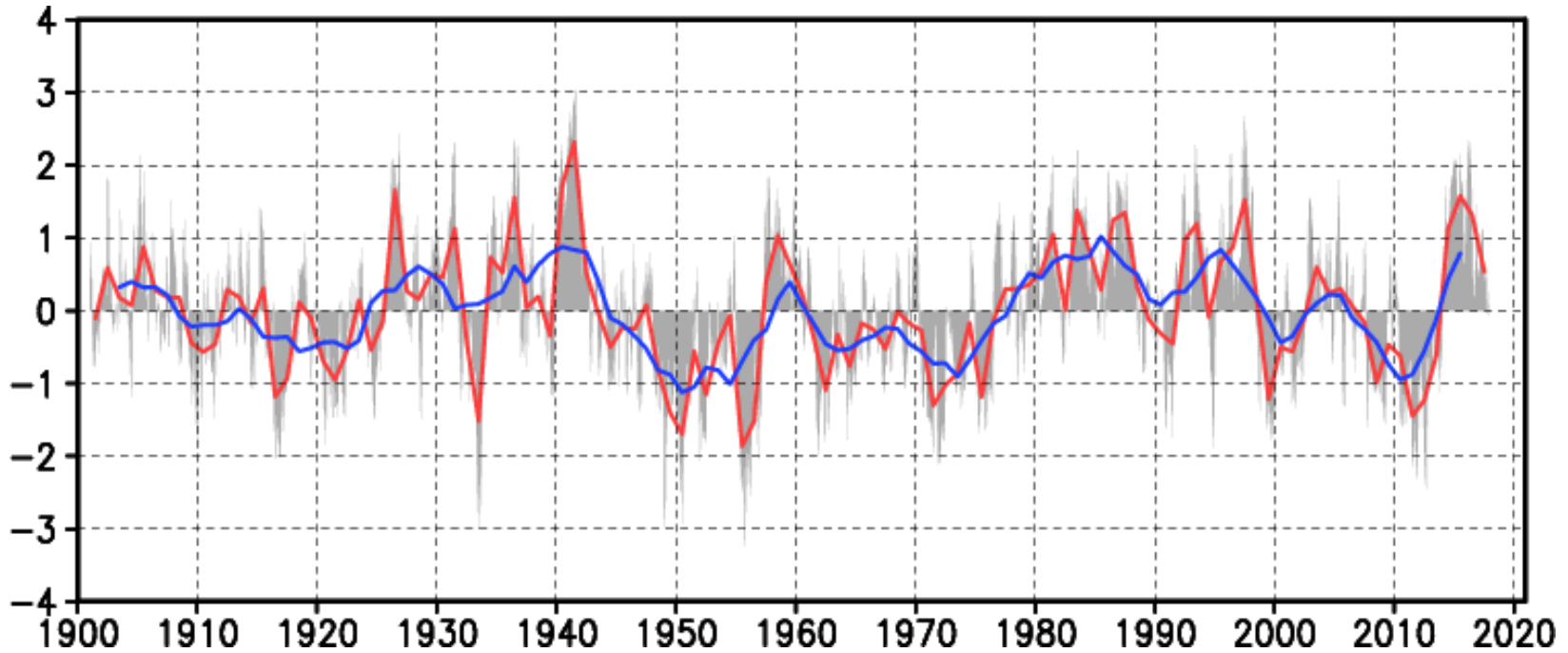


# Arctic Warming



Kug et al. 2015

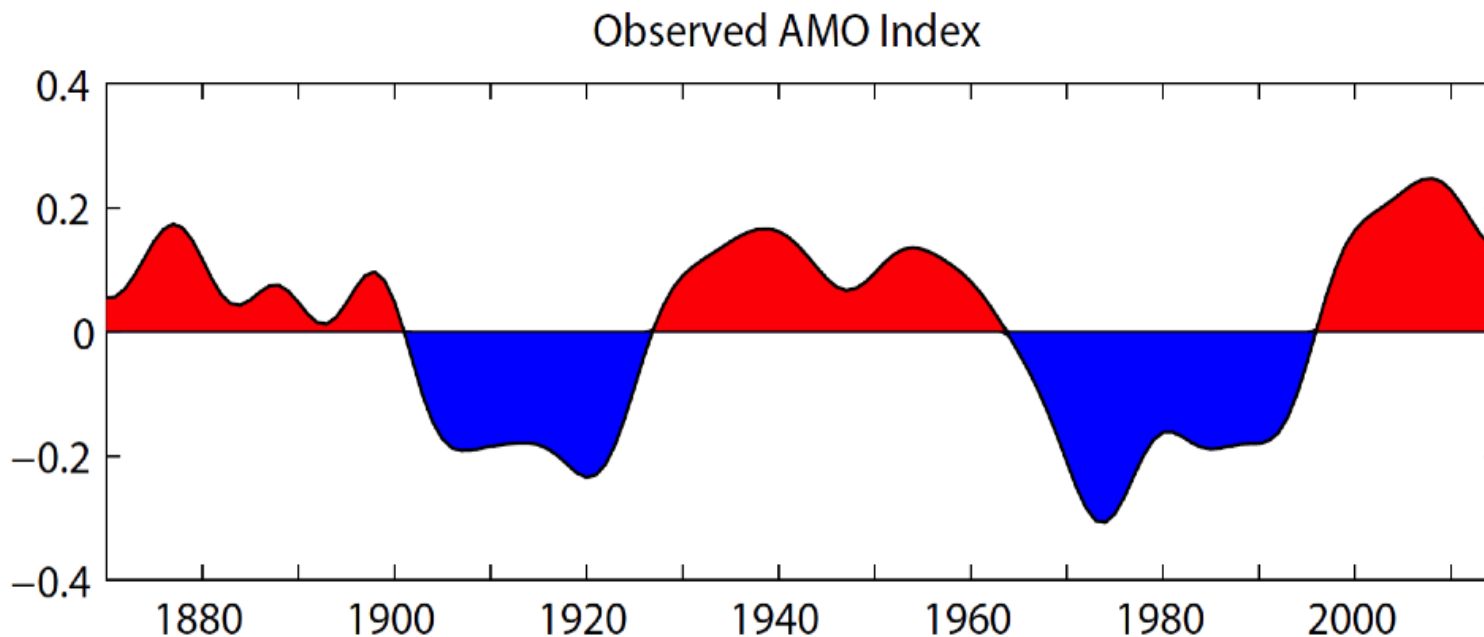
# PDO (1901-2017)



[http://ds.data.jma.go.jp/tcc/tcc/products/elnino/decadal/pdo\\_doc.html](http://ds.data.jma.go.jp/tcc/tcc/products/elnino/decadal/pdo_doc.html)



# AMO (1870-2015)

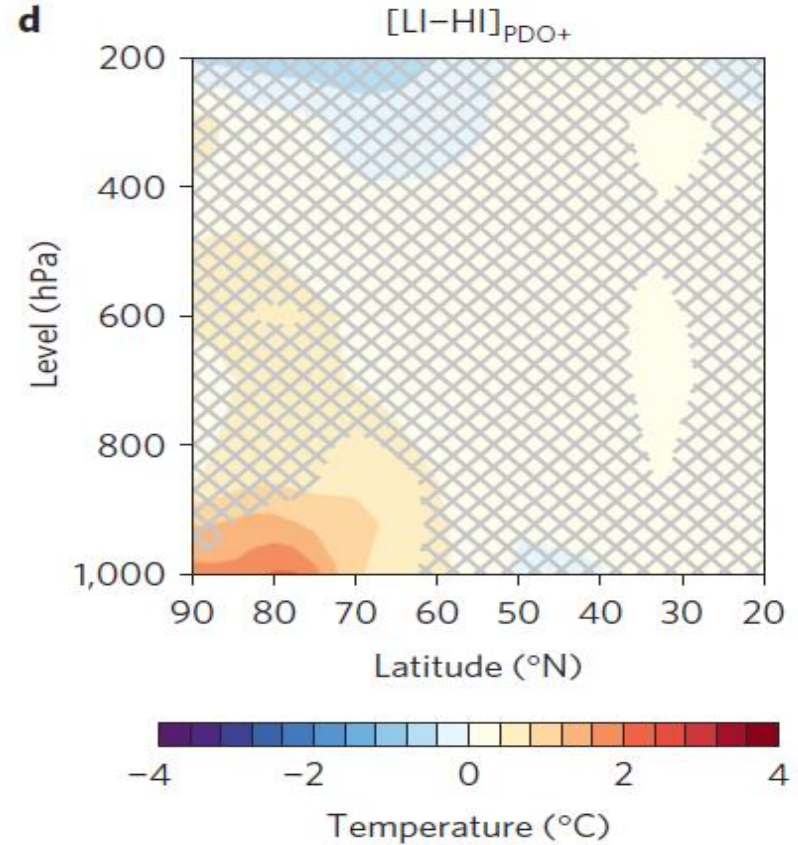
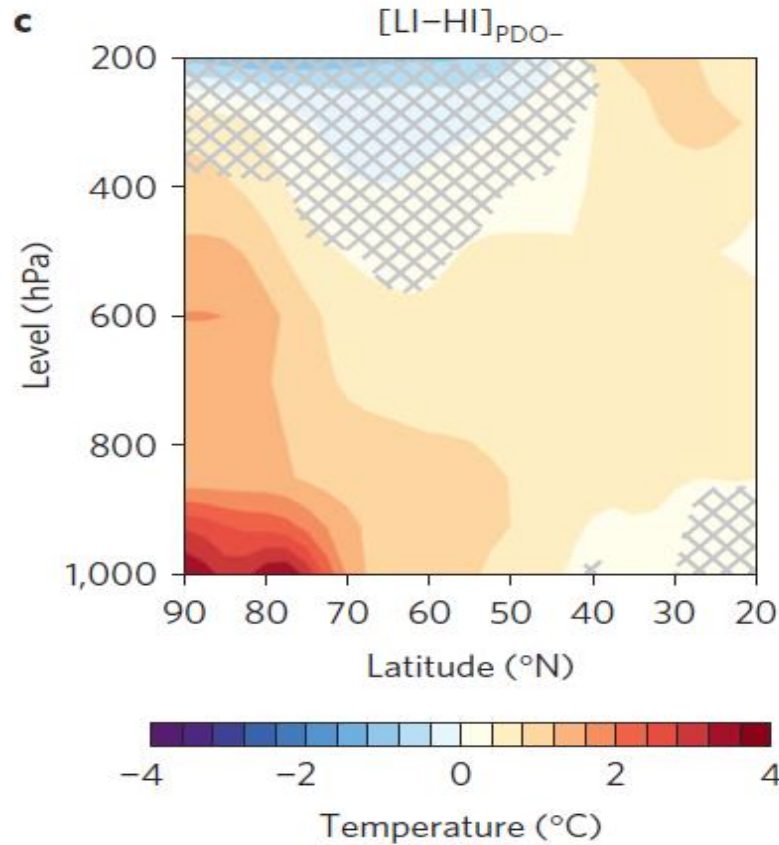


<https://climatedataguide.ucar.edu/climate-data/atlantic-multi-decadal-oscillation-amo>





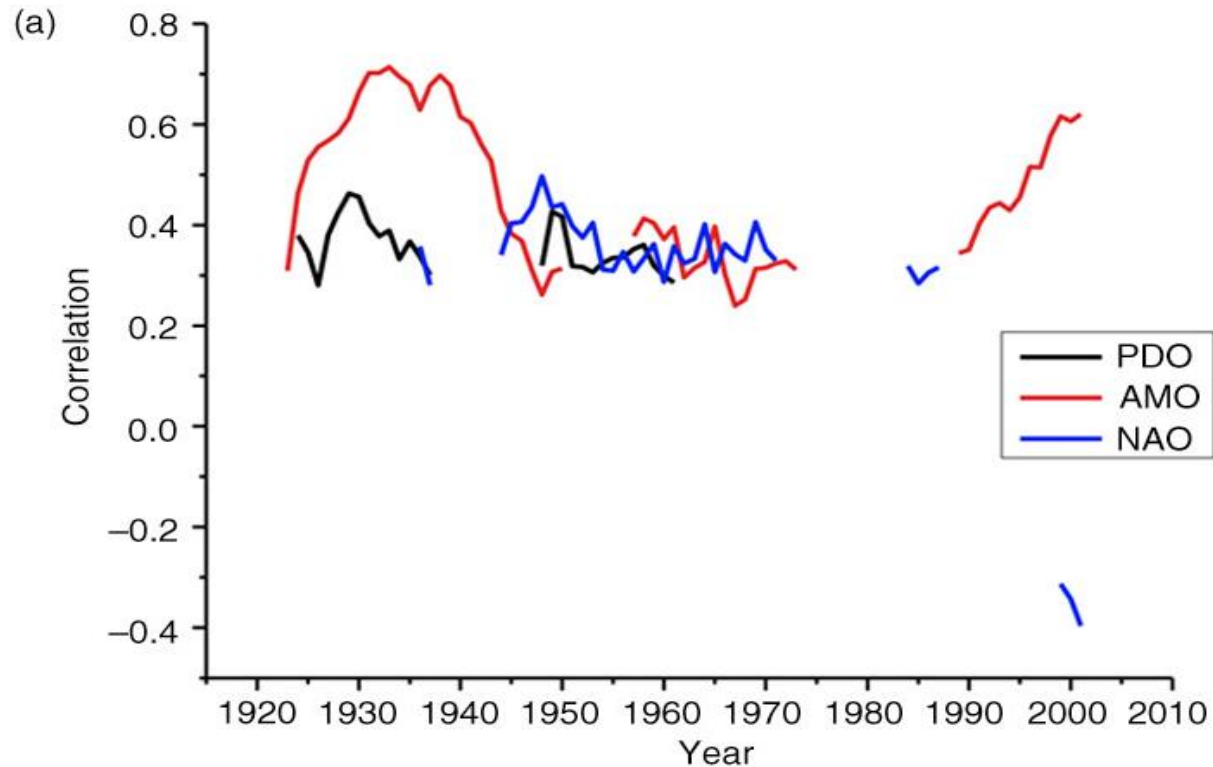
# Arctic Warming (PDO)



Screen and Francois 2016 *Nature Climate Change*



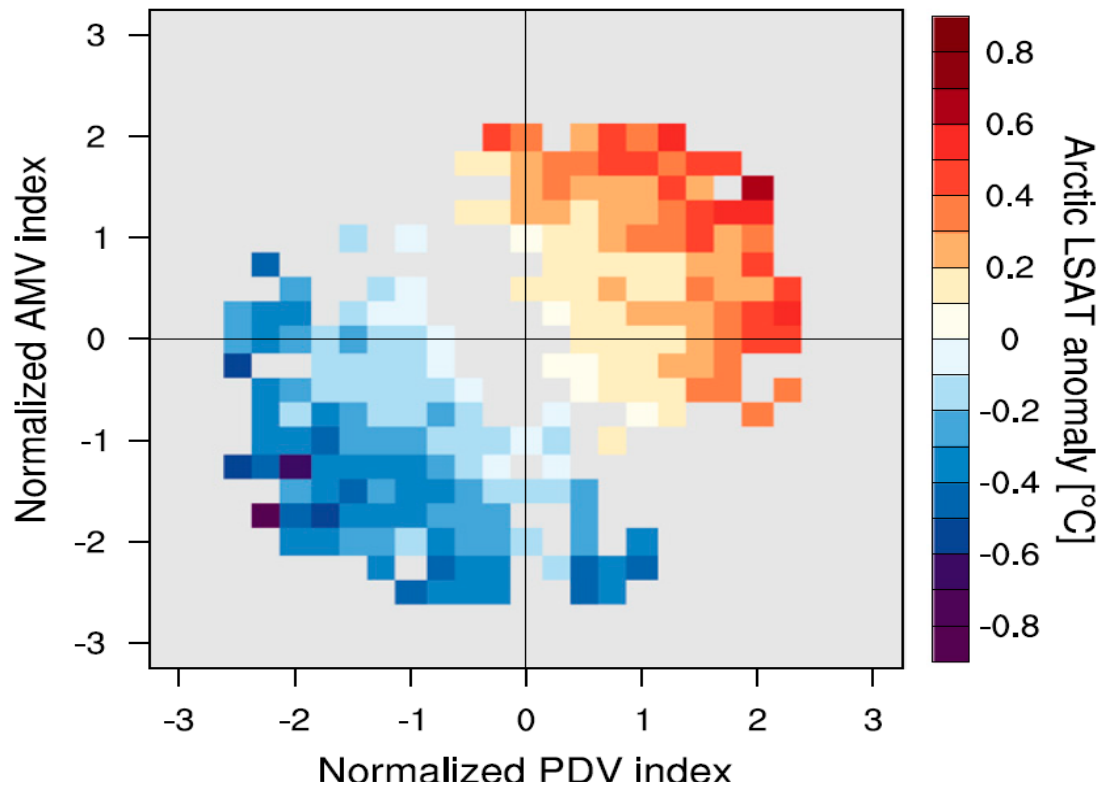
# Arctic Warming (AMO)



Johannessen et al. 2016 *Tellus*



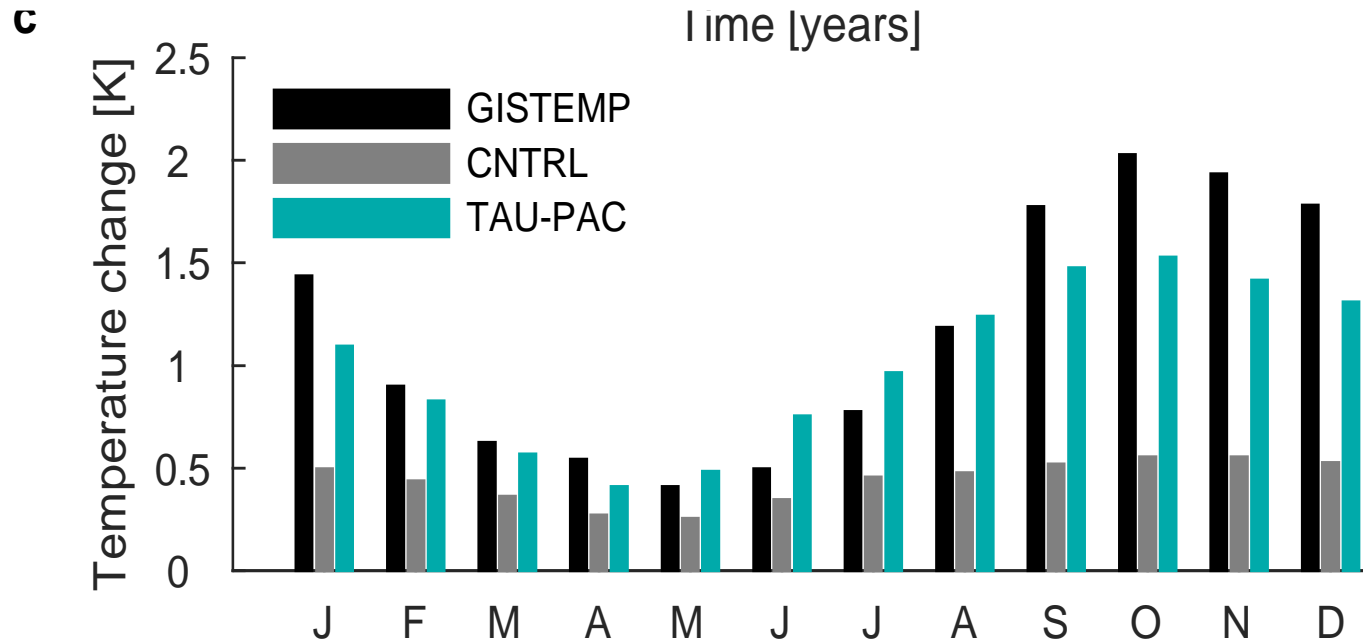
# Early Arctic Warming AMO and PDO



Tokenaga et al. 2017, PNAS

# Early Arctic Warming PDO

Svendsen, L., Keenlyside, N., Bethke, I., Gao, Y.Q., Omrani, N.E. (2018): Pacific contribution to the early 20th century warming in the Arctic. *Nature Climate Change*, <http://dx.doi.org/10.1038/s41558-018-0247-1>



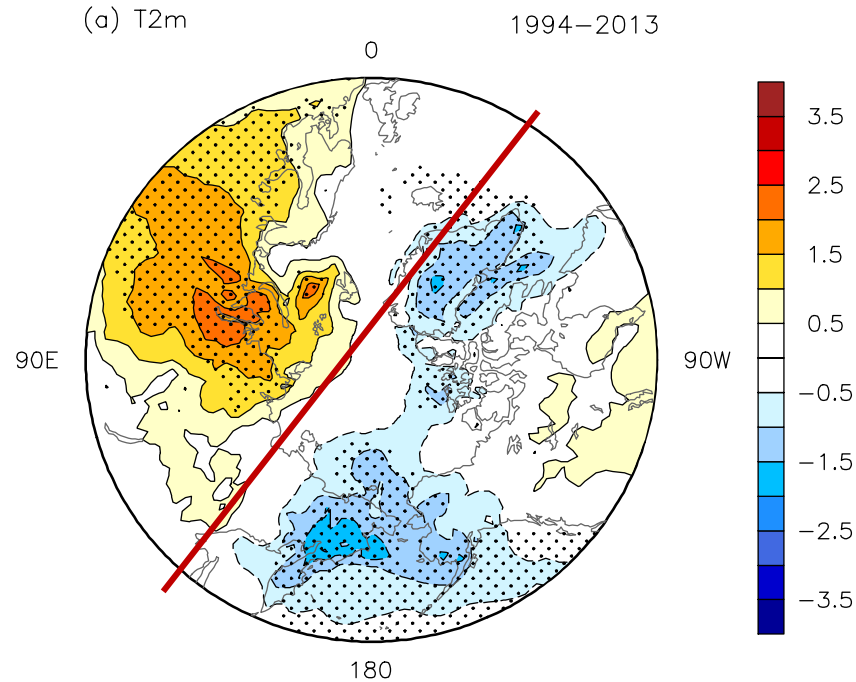
# Extratropical Ocean Warming since the 1990s

*Li, F., Wang H.J. and Gao Y.Q. (2015), Journal of Climate*

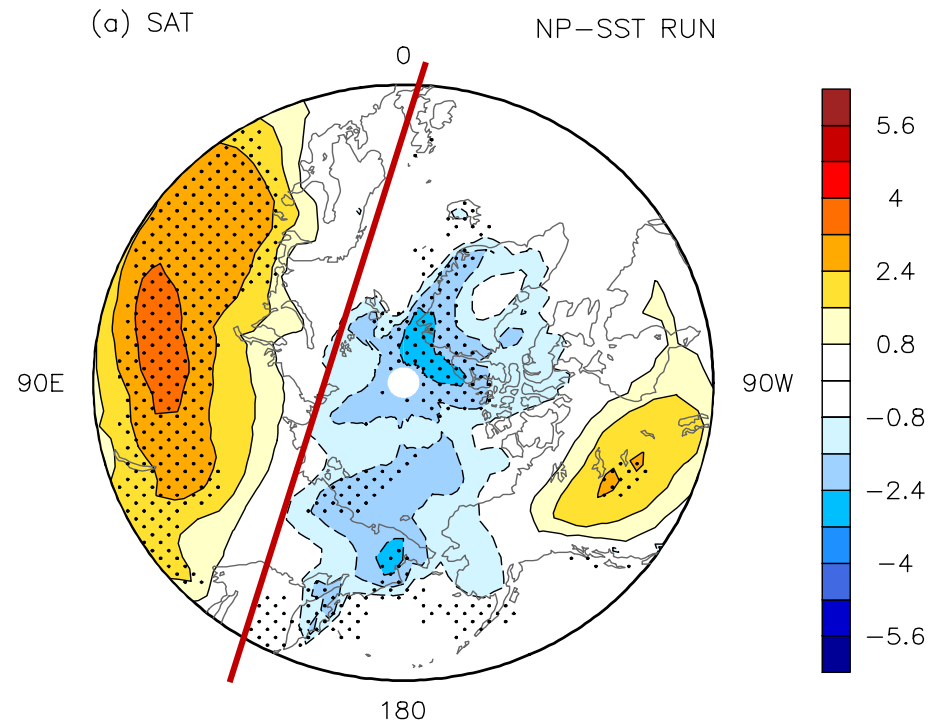


# Teleconnection of ET warming

## Air temperature at 2 m

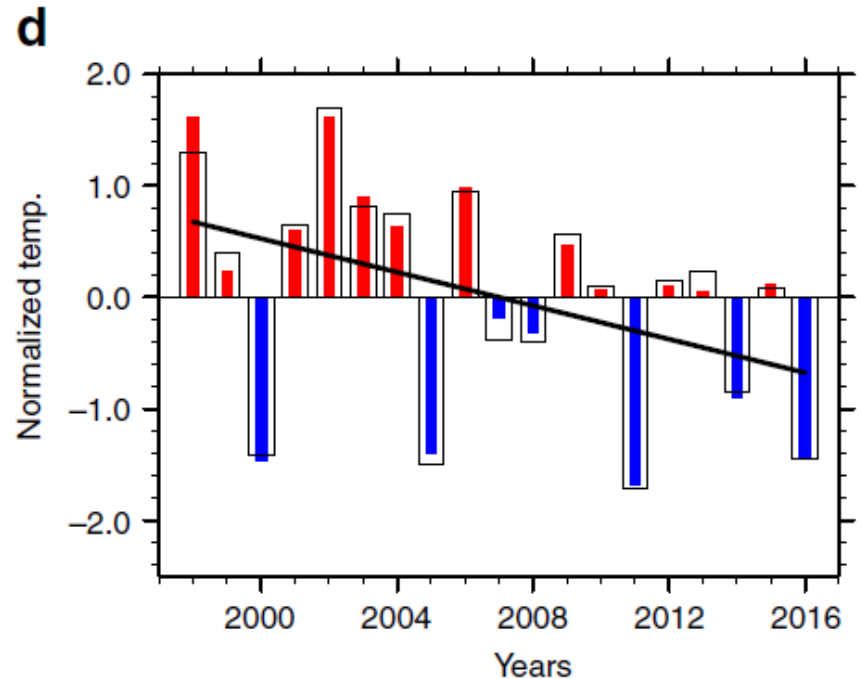
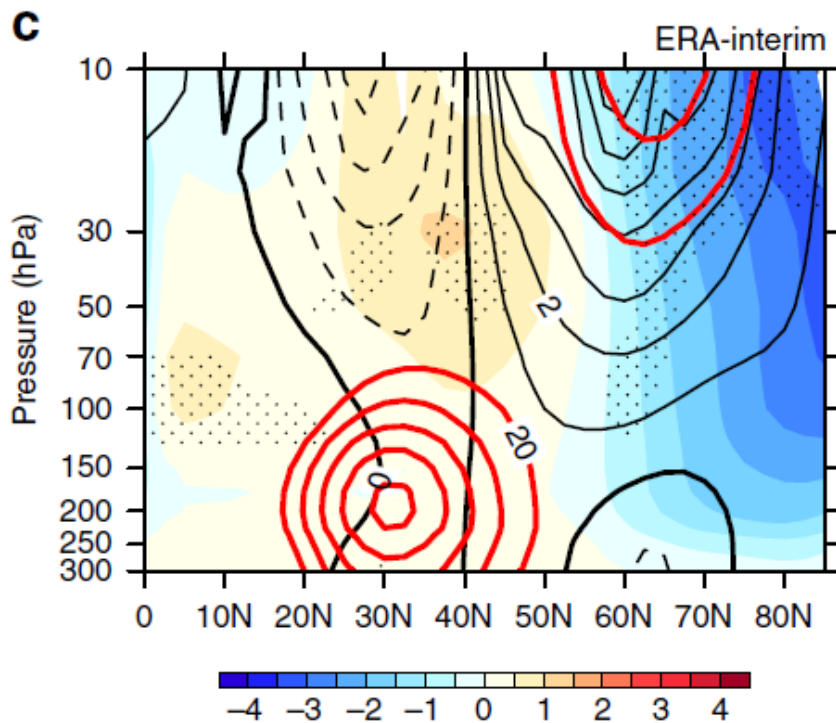


# Simulated impact of NP-SST (Exp.4 minus Exp.2)



# Strengthening of SPV

Hu, D., Guan, Z.Y., Tian, W.S., Ren, R.C. (2018): Recent strengthening of the stratospheric Arctic vortex response to warming in the central North Pacific. *Nature Communication*





# Arctic Sea Ice Impact

- Dating back in early 20<sup>th</sup> century...



# Cold Spells (East Asia)

Tao (1959) Almost all cold spells in China (East Asia) were originated from Arctic Ocean, particularly from the Barents/Kara Seas. When cold spells took place, there was an adjustment of planetary waves over the Eurasian continent.



## 十年来我国对东亚寒潮的研究

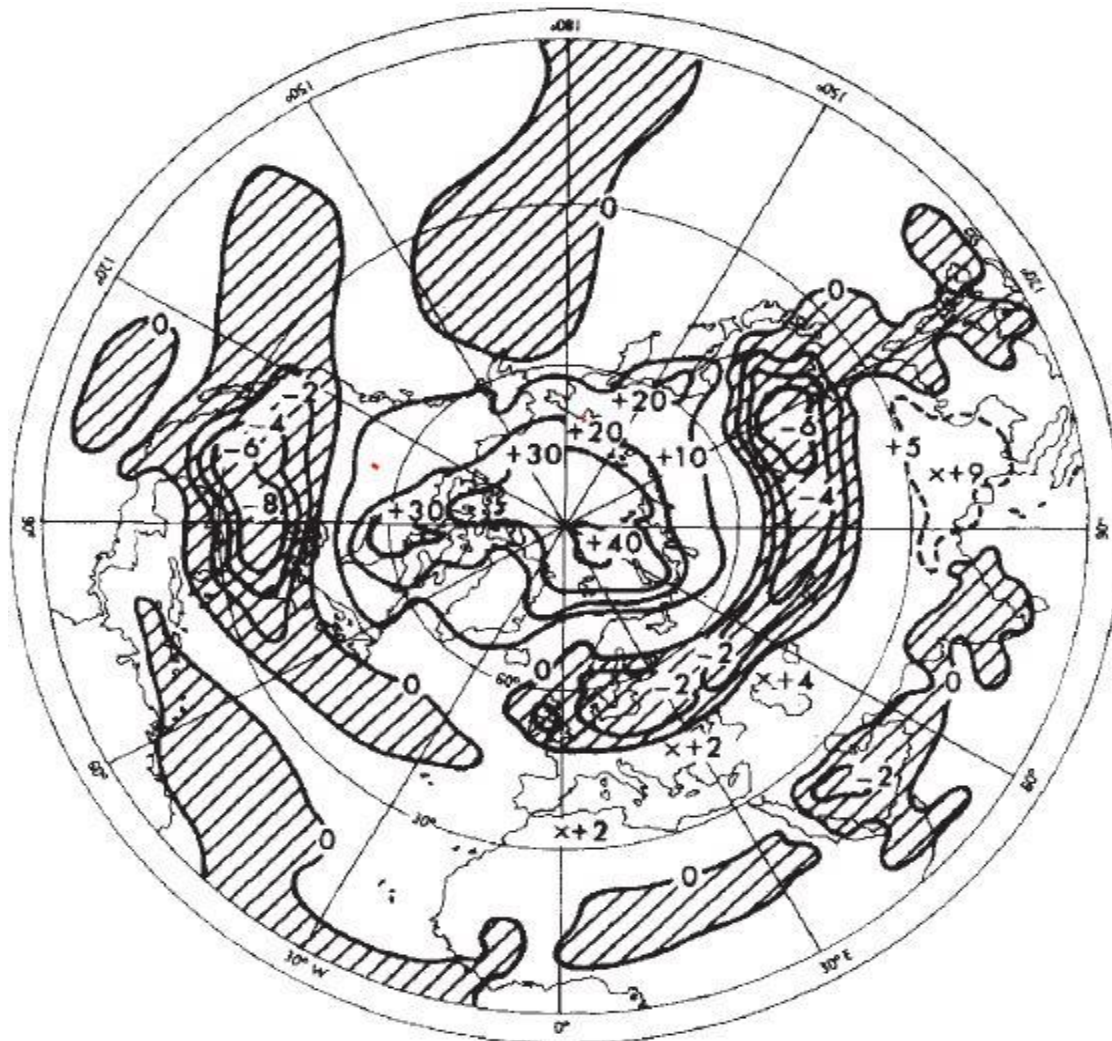
陶詩言

(中国科学院地球物理研究所)

解放后十年来,随着天气预报业务的建立,天气预报的研究也有了迅速的发展,其中寒潮研究的論文占据相当大的数量.这是可以理解的,因为东亚的寒潮活动不但会引起灾害性天气,而且寒潮的活动往往同許多重要天气系統的发生和发展相联系.本文的目的,就想将最近十年来有关东亚寒潮活动的一些問題,例如寒潮的过程和爆发条件,寒潮冷鋒的結構,以及寒潮和天气等等,作一簡短的总结.下面准备就五个方面来討論这个問題.



# Atmospheric Impact (AGCM)



Newson, 1973  
*Nature*



# Arctic Sea Ice and Climate (Weather)

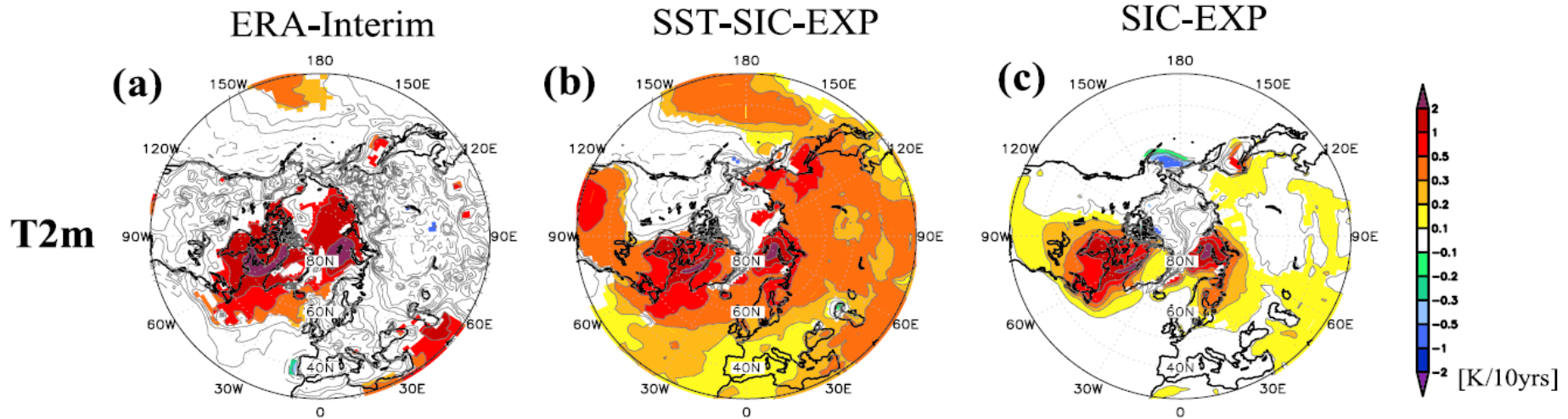
- Bodikova (2009)
- Bader et al. (2011)
- Vihma (2014)
- Cohen et al. (2014)
- Gao et al. (2015)
- Overland et al. (2015)
- Coumou et al. (2018)

# Eurasian Cooling

- **Arctic warming (sea ice decline);**
- **La Nina impact;**
- **AMO impact**
- **Natural variability**

# Evaluating Impacts of Recent Arctic Sea Ice Loss on the Northern Hemisphere Winter Climate Change

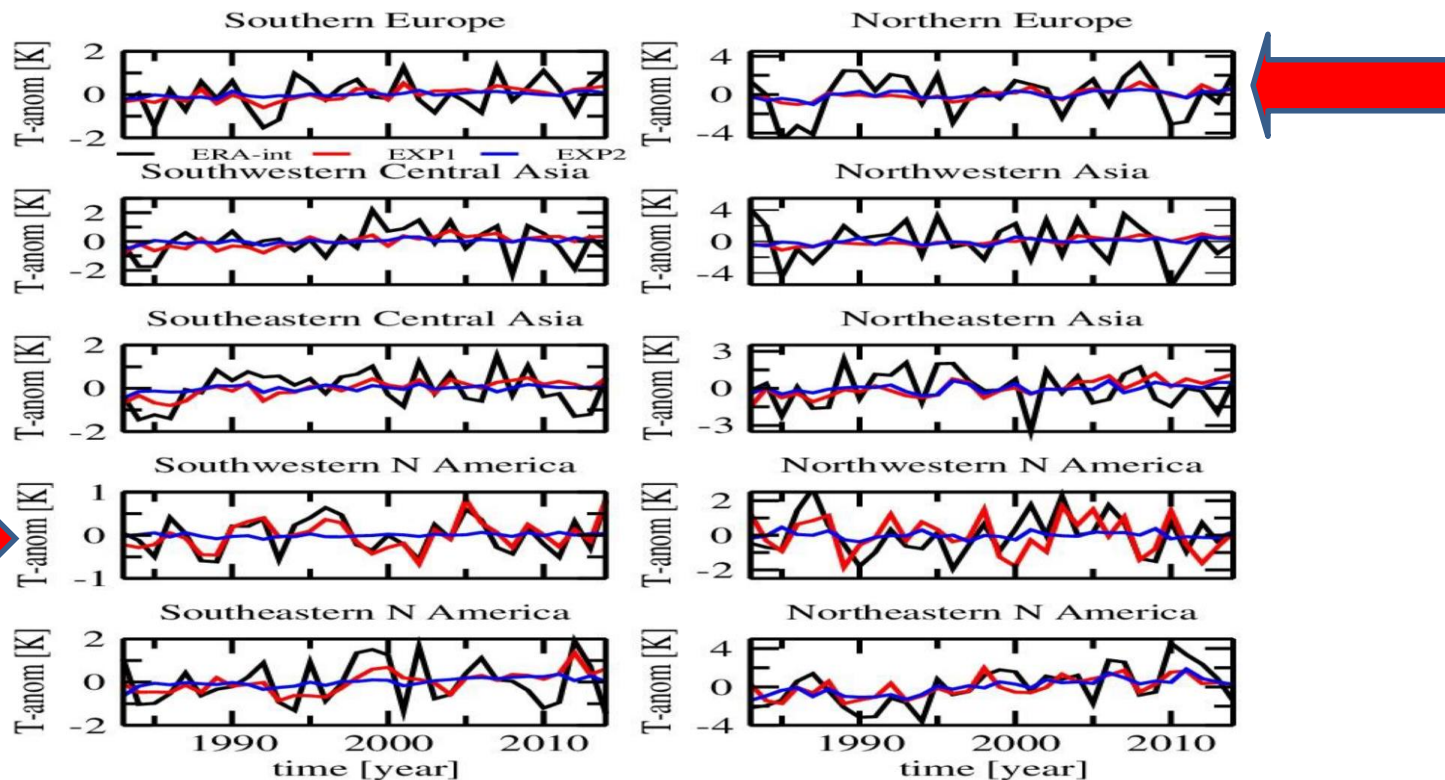
Ogawa, F., Keenlyside, N., **Gao, Y.Q.**, Koenigk, T., Yang, S.T., Suo, L.L., Wang, T., Gastineau, G., Nakamura, T., Cheung, H.N., Omrani, N.E., Ukita, J., Semenov, V. (2018): Evaluating impacts of recent Arctic sea-ice loss on the northern hemisphere winter climate change. *Geophysical Research Letters*, doi:10.1002/2017GL076502





# Impact of Arctic sea ice variations on winter temperature anomalies in northern hemispheric land areas

Koenigk, T., Gao Y.Q., Gastineau G., , N. Keenlyside, N., Nakamura T., Ogawa F., Orsolini Y., Semenov V., Suo L.L., Tian T., Wang T., Wettstein J.J., Yang S. (2018): Impact of Arctic sea ice variations on winter temperature anomalies in northern hemispheric land areas. *Climate Dynamics* (in press)

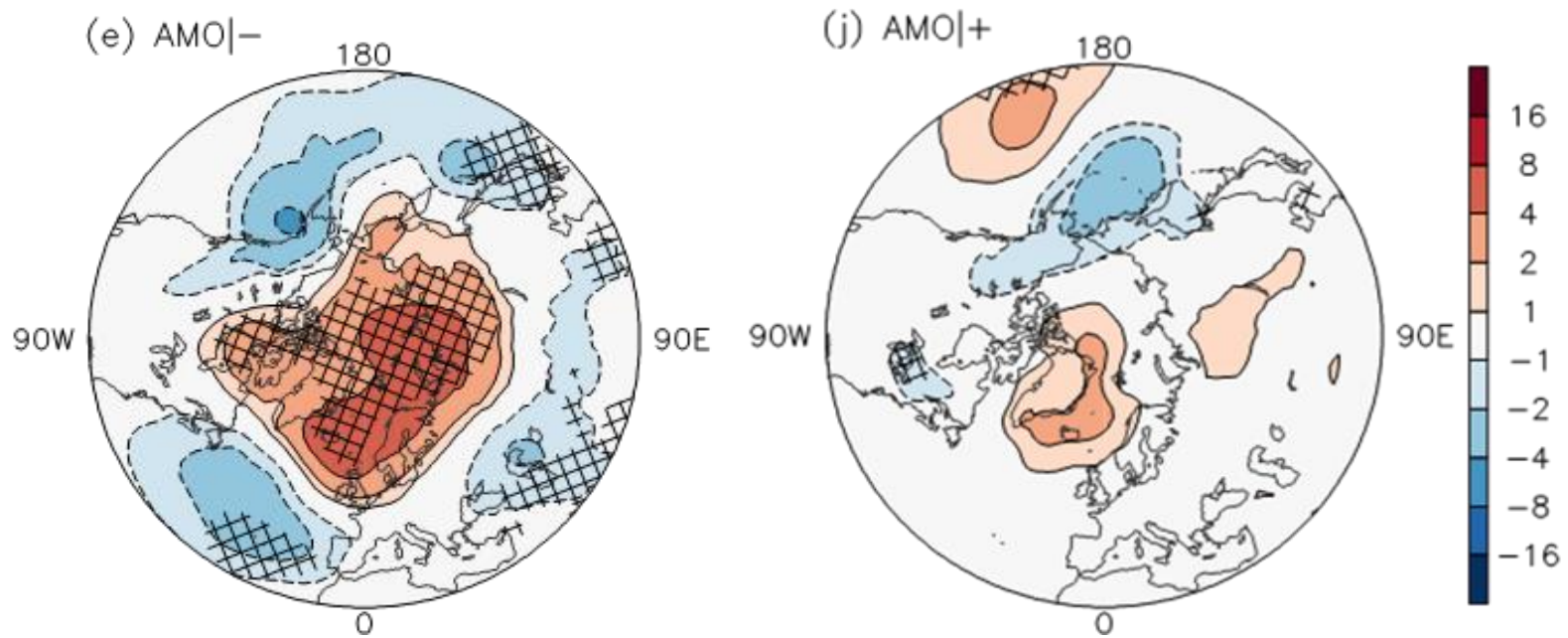


# Response of AO

1. **Negative AO** (e.g. Kim et al. 2014)
2. **Positive AO** (e.g., Orsolini et al., 2012)
3. **Weak Response** (e.g., Screen et al., 2013)
4. **Forcing Dependent Response** (e.g., Petoukhov and Semenov 2010)
5. **Background state dependent** (Smith et al., 2017)

# Atlantic Multidecadal Oscillation vs. Impacts of Arctic Sea Ice

Li, F., Orsolini, Y. J., Wang, H., J. Gao, Y.Q., & He, S.P. (2018). Atlantic multidecadal oscillation modulates the impacts of Arctic sea ice decline. *Geophysical Research Letters*, 45. <https://doi.org/10.1002/2017GL076210>



# EU's Arctic project cluster 2016-2021

**EU PolarNET**  
Coordination action

**APPLICATE**  
Modelling – forecasting

**INTAROS**  
observing systems

**BLUE ACTION**  
Modelling – forecasting

**NUNATARYUK**  
permafrost

**ARICE**  
infrastructure

**INTERACT**  
research station network

**ARC-ICE**  
FP7

Other infrastructure projects:  
ACTRIS, ICOS, SIOS, ENVRI PLUS, ++

# EU H2020 Blue-Action (2016.12-2021.02)

Model	NorES M	IPSL- CM	EC- Earth	CMCC -CM	ECHA M5	IAP- AGCM	HadG EM	ICON	EC- Earth
Hor. (km)	100	100	100	100	100	100	40	40	40
Part.	NERS C	CNRS - LOCE AN	DMI	CMCC	IAP- RAS	IAP- NZC	UoS	MPI-M	NLeS C



# Belmont/JPI InterDec (2016.08-2020.02)

The potential of seasonal-to-decadal-scale inter-regional linkages to advance climate predictions



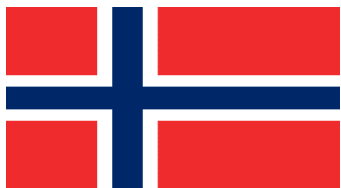
NZC/IAP



MPIM  
GEOMAR



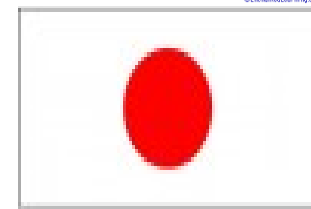
ECMWF  
UoR



NERSC  
UoB



SMHI



UoT  
NU



# Concept

- **Sea ice decline**  $\neq$  **Arctic surface warming**
- **Arctic surface warming**  $\neq$  **Arctic troposphere warming**



# Discussions

- **Quantification of Arctic Warming/Key Process**
- **Arctic Warming versus Eurasian Cooling: PDO versus AMO**
- **Call for long-term observation, multi-model coordinated experiments, improvement of models**
- **Seasonal-to-decadal climate prediction**

*Thank you !*

