

Arctic Amplification and Eurasian Climate: Revisit

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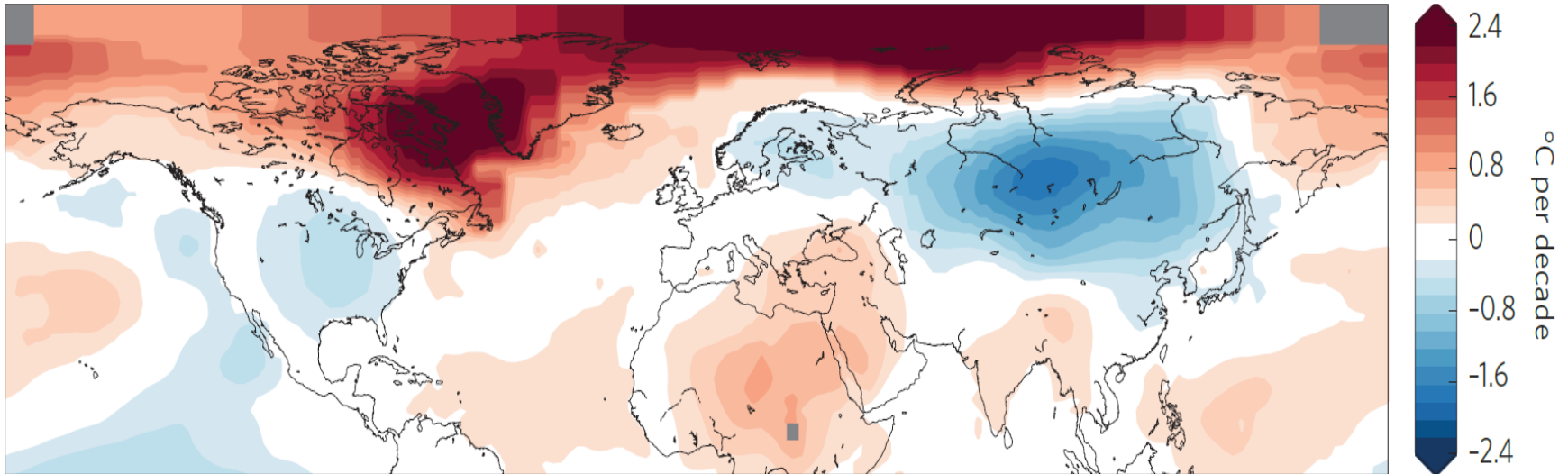
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Arctic Warming and Eurasian Cooling

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

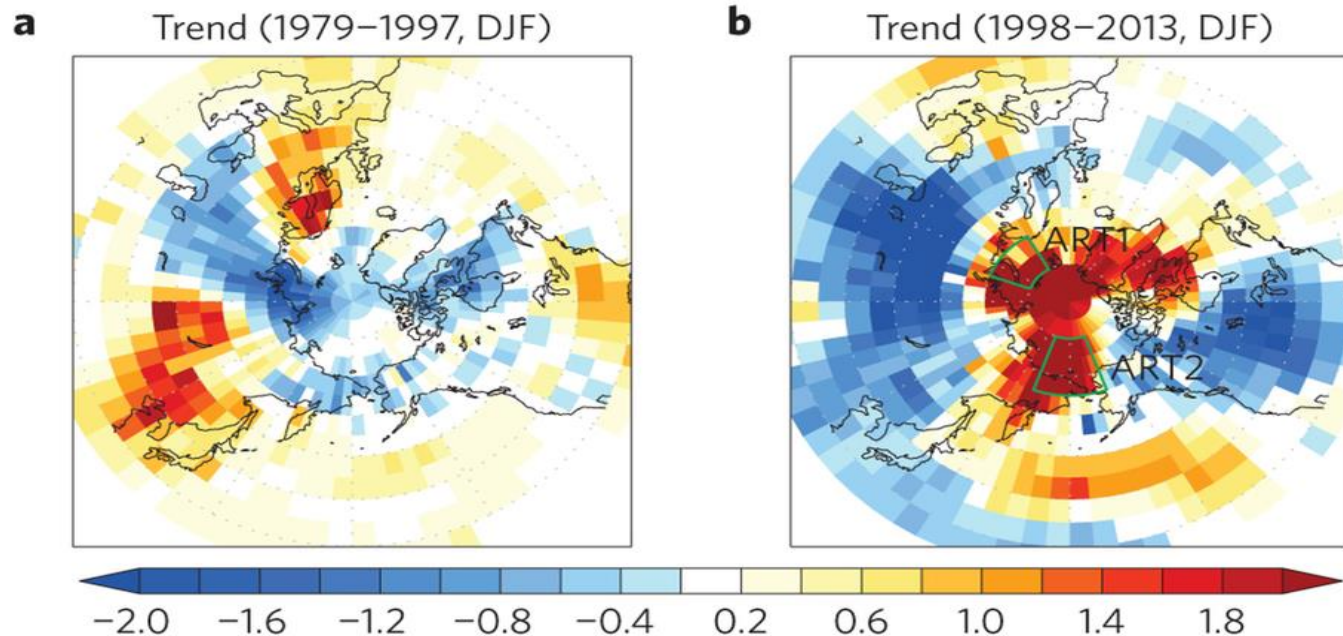


Arctic Warming (Amplification)

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

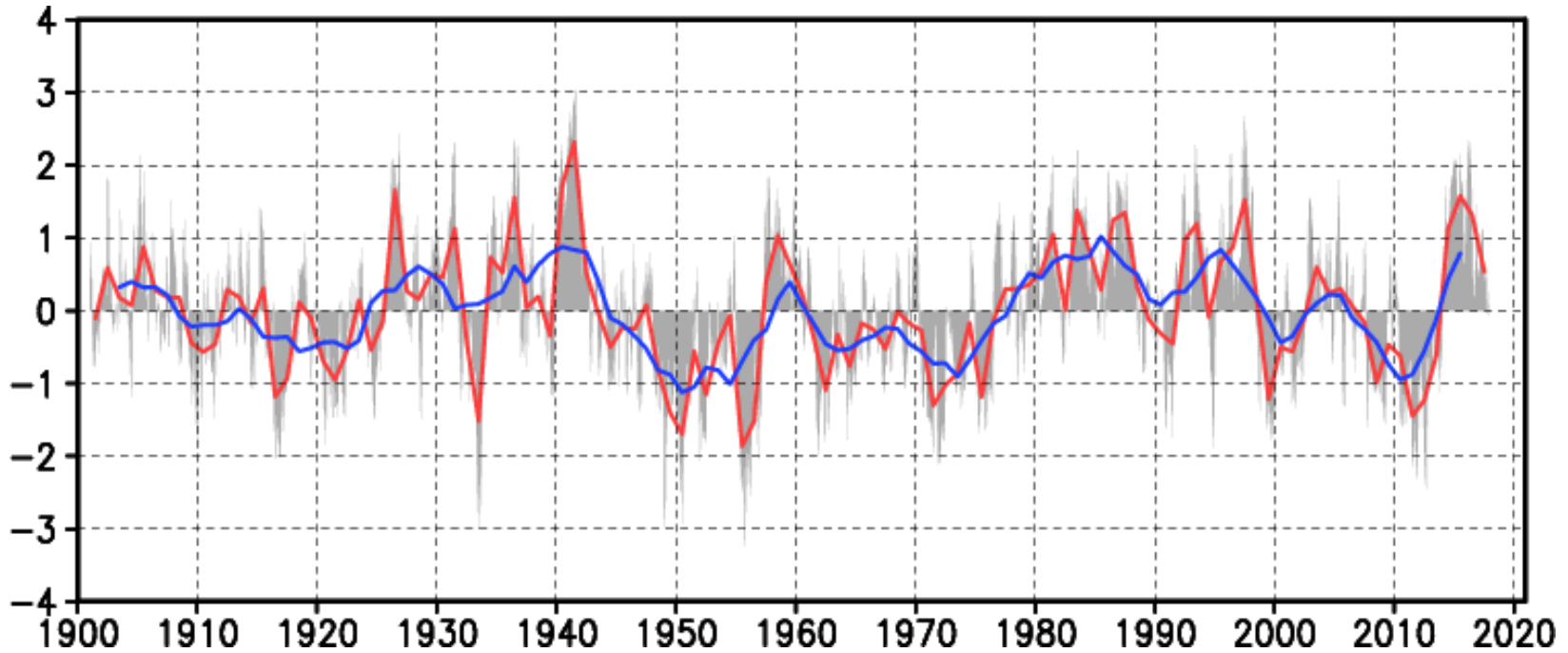


Arctic Warming



Kug et al. 2015

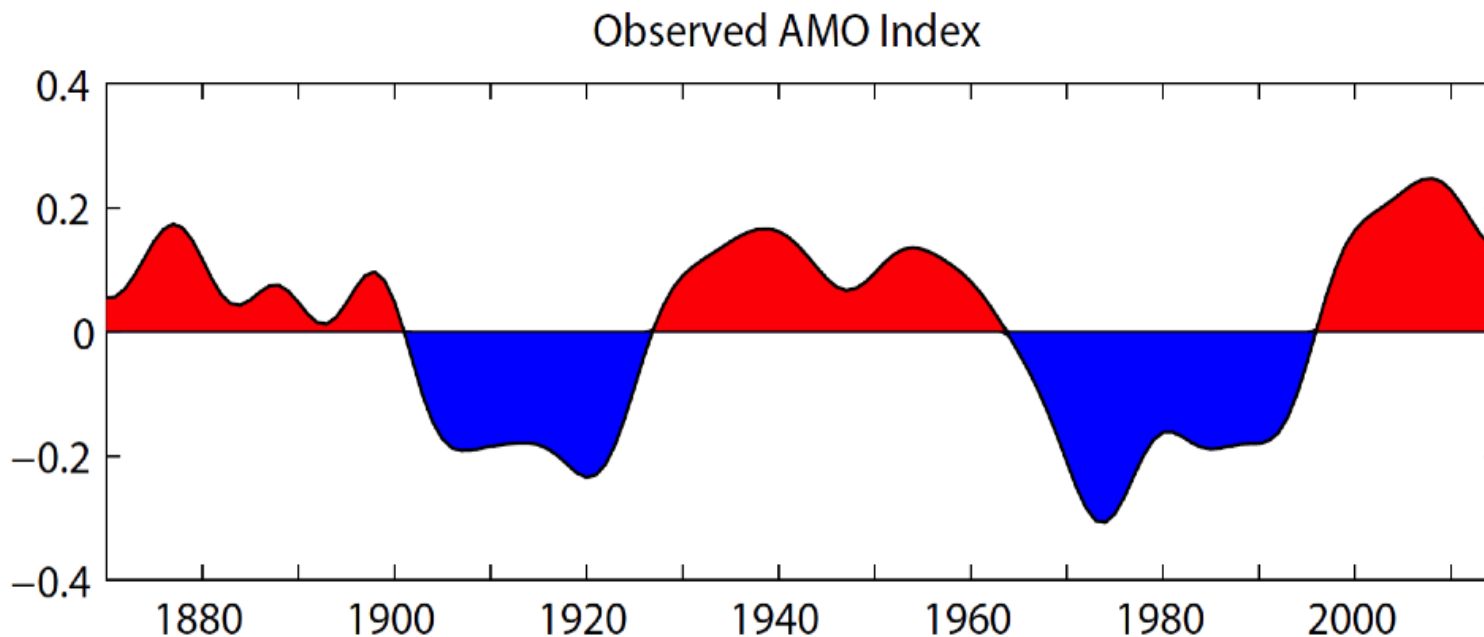
PDO (1901-2017)



http://ds.data.jma.go.jp/tcc/tcc/products/elnino/decadal/pdo_doc.html



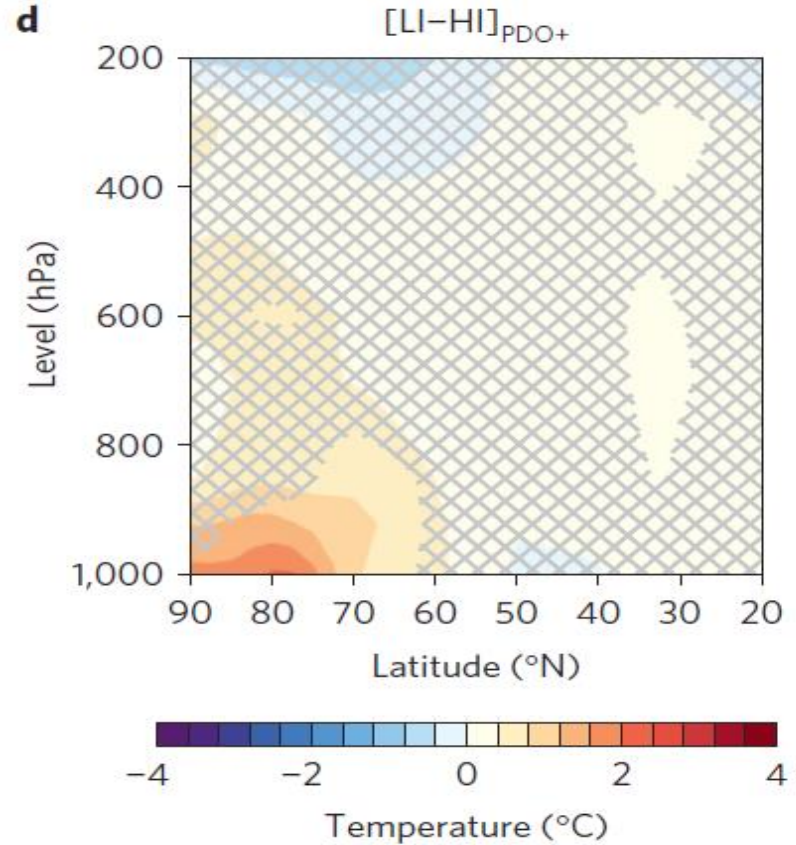
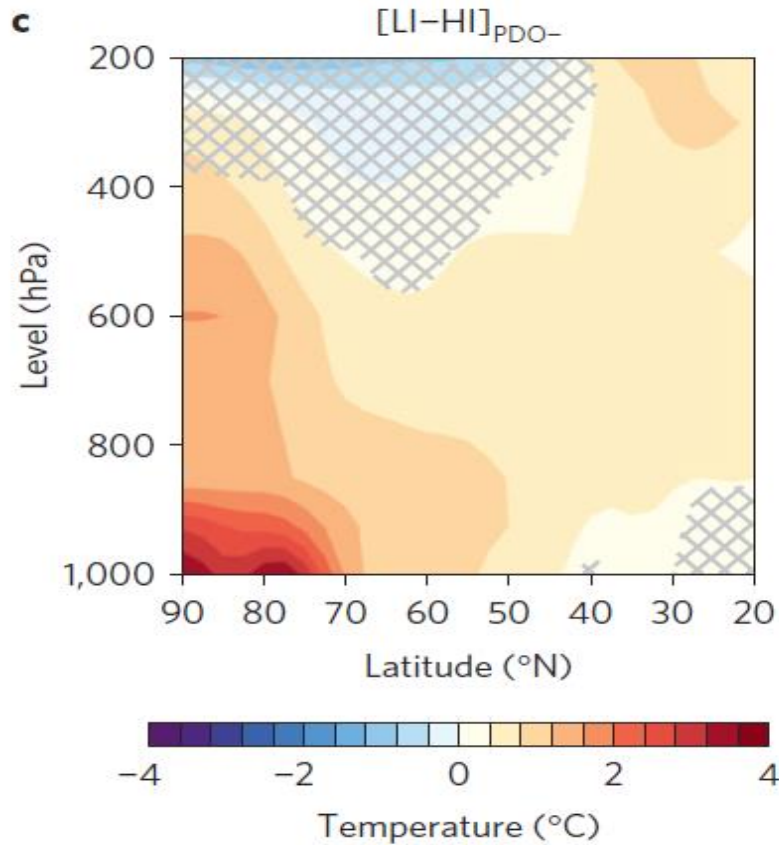
AMO (1870-2015)



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

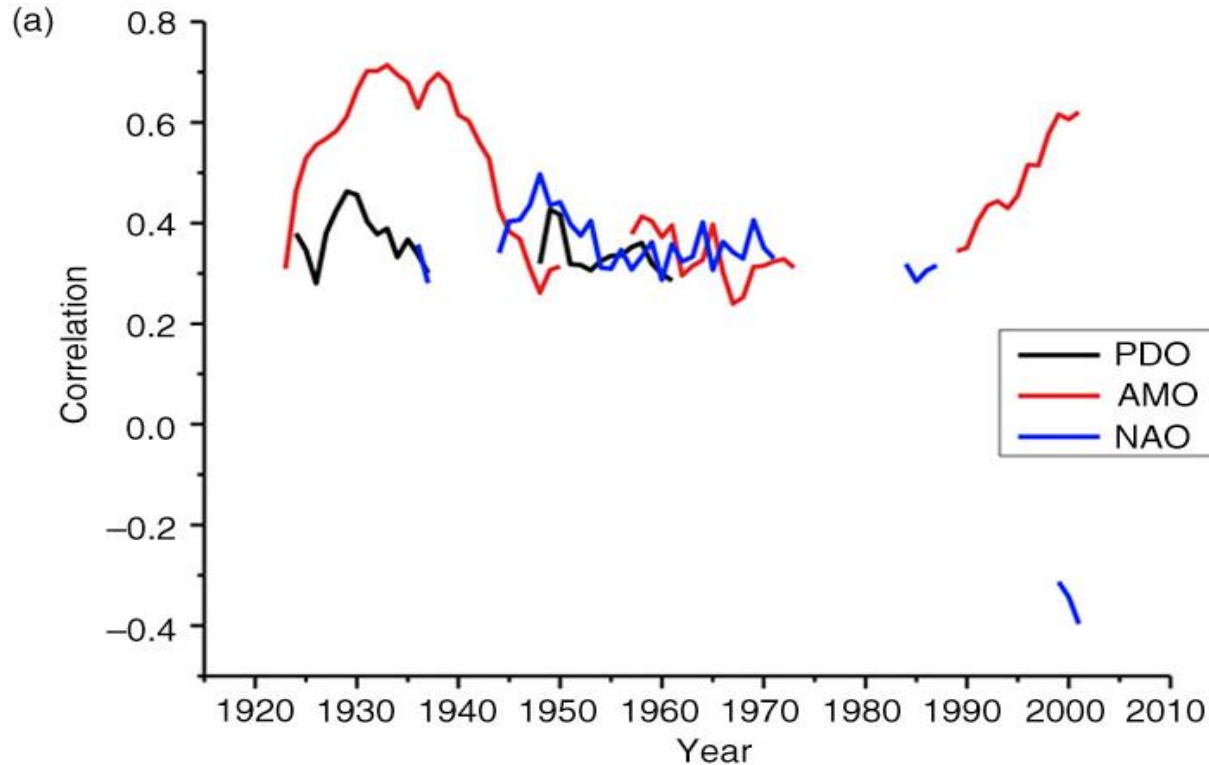


Arctic Warming (PDO)



Screen and Francois 2016 *Nature Climate Change*

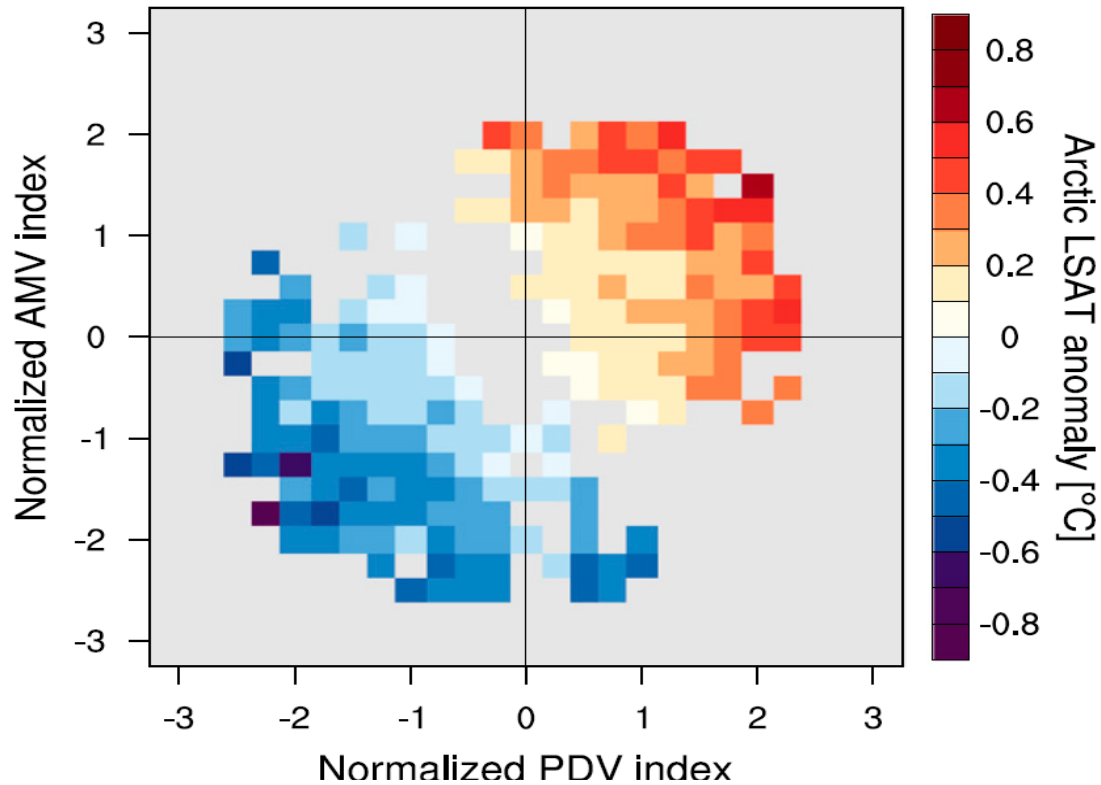
Arctic Warming (AMO)



Johannessen et al. 2016 *Tellus*



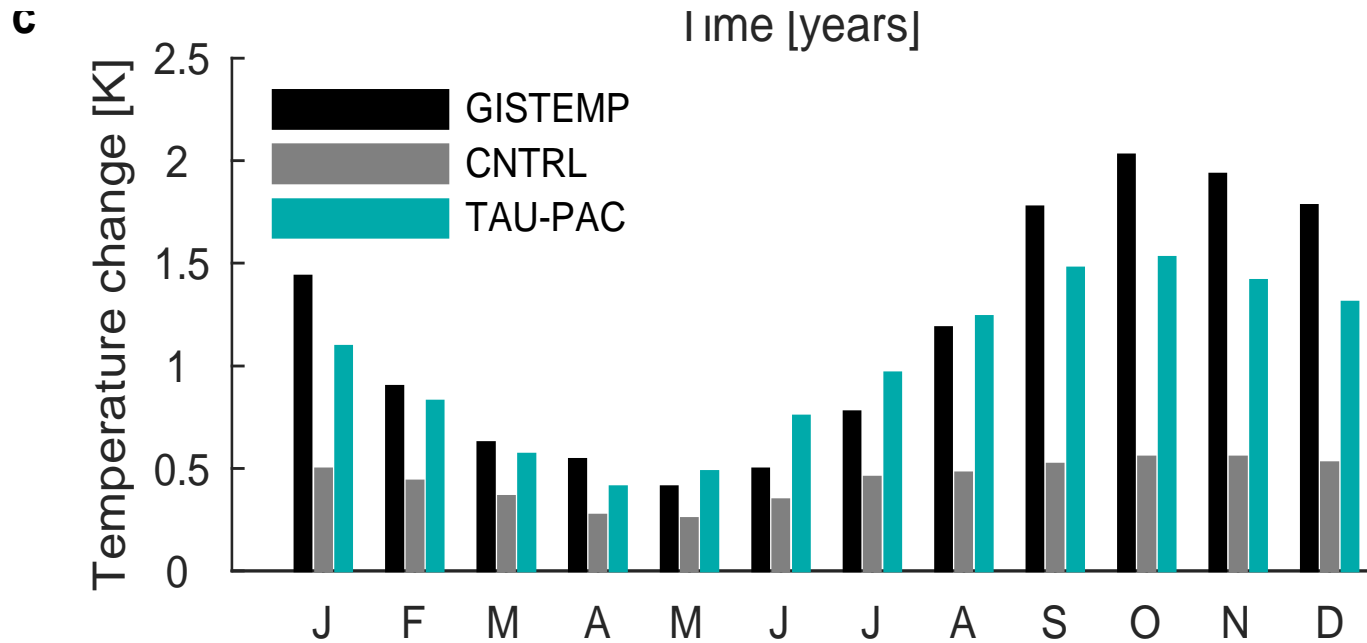
Early Arctic Warming AMO and PDO



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* (Accepted)



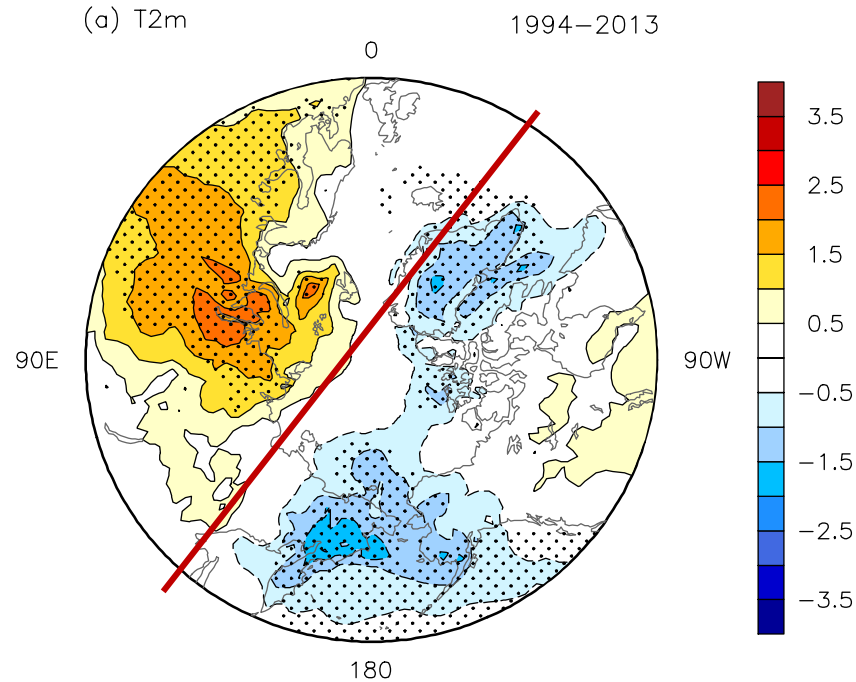
Extratropical Ocean Warming since the 1990s

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

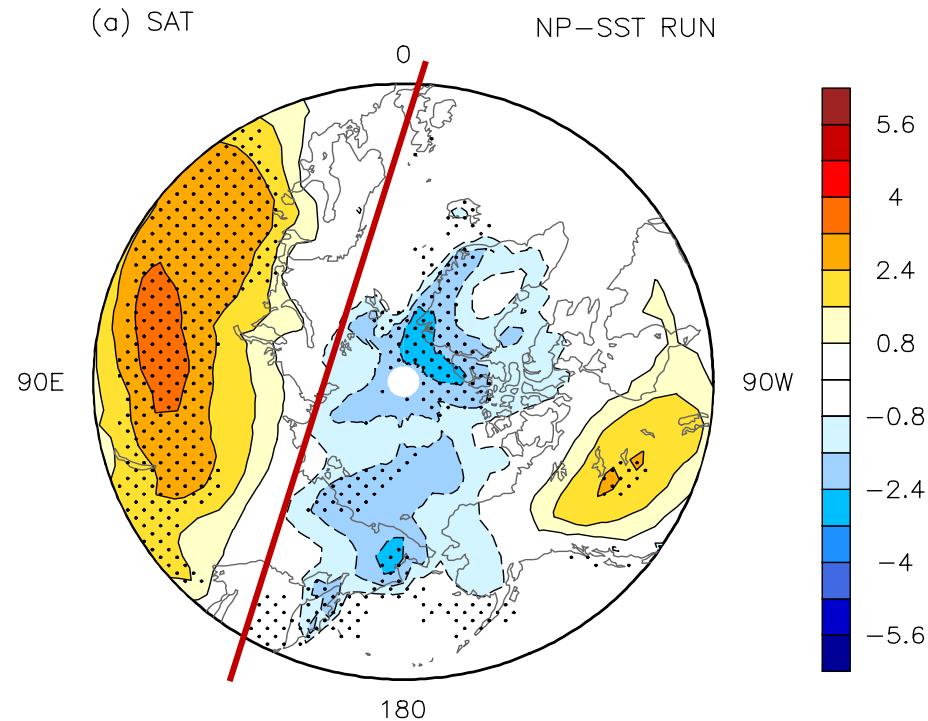


Teleconnection of ET warming

Air temperature at 2 m



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



Conclusion

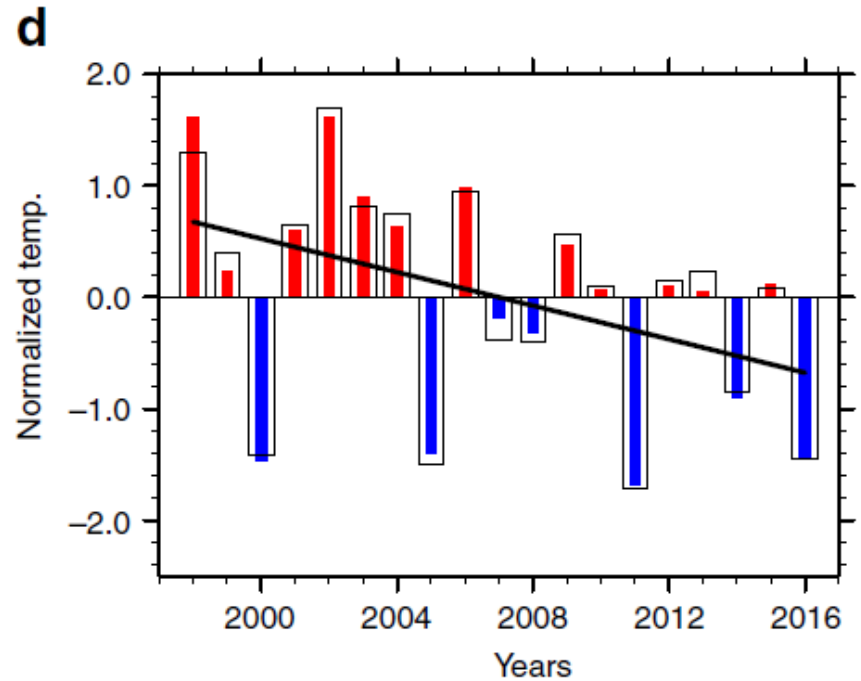
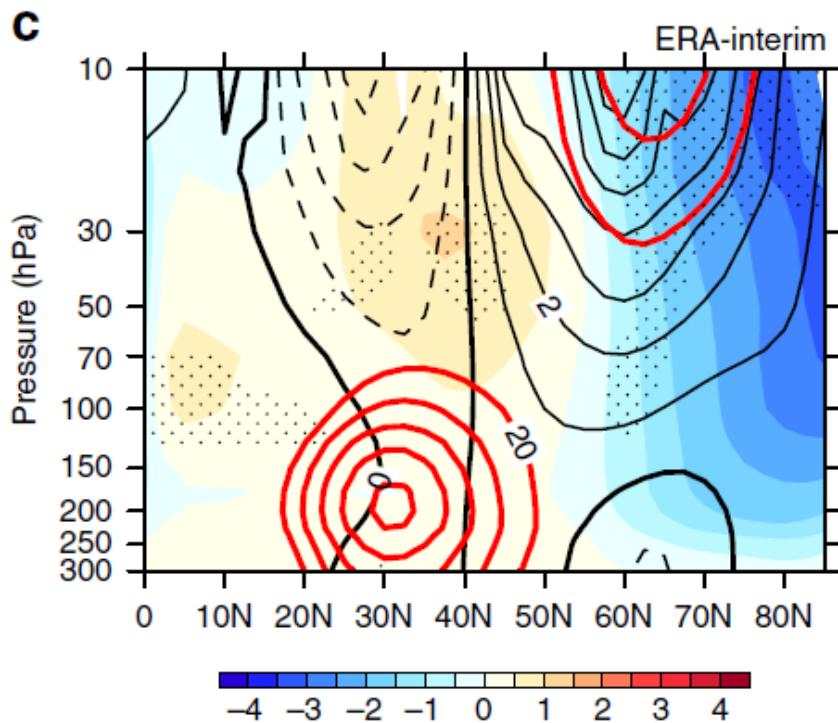
- **The winter extra-tropical warming (in particular, the warming in the Pacific) can influence the winter Arctic warming by strengthening the polar vortex and modulating the near surface atmospheric heat and moisture transport.**

Li et al. (2015), JC



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 20th 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

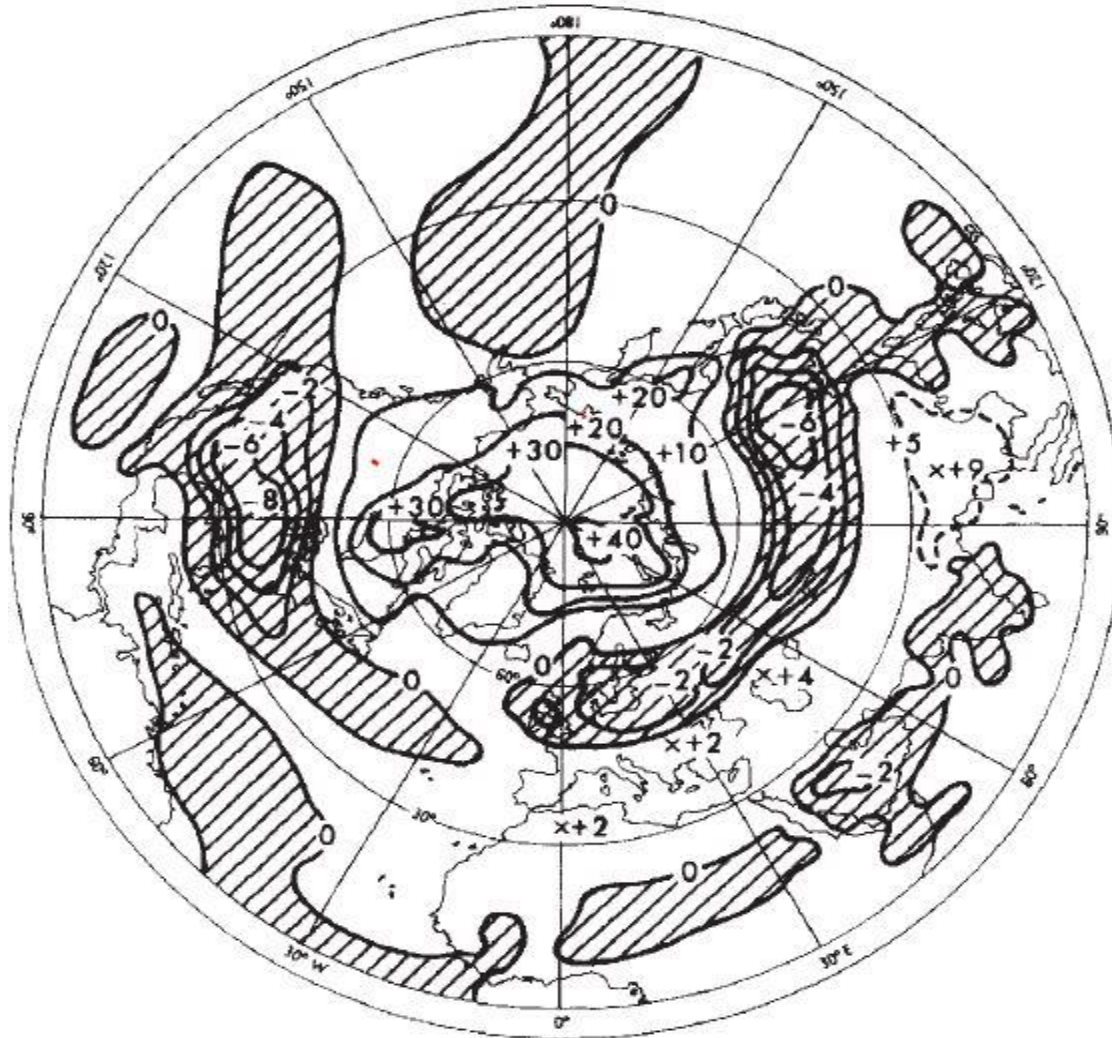
陶詩言

(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

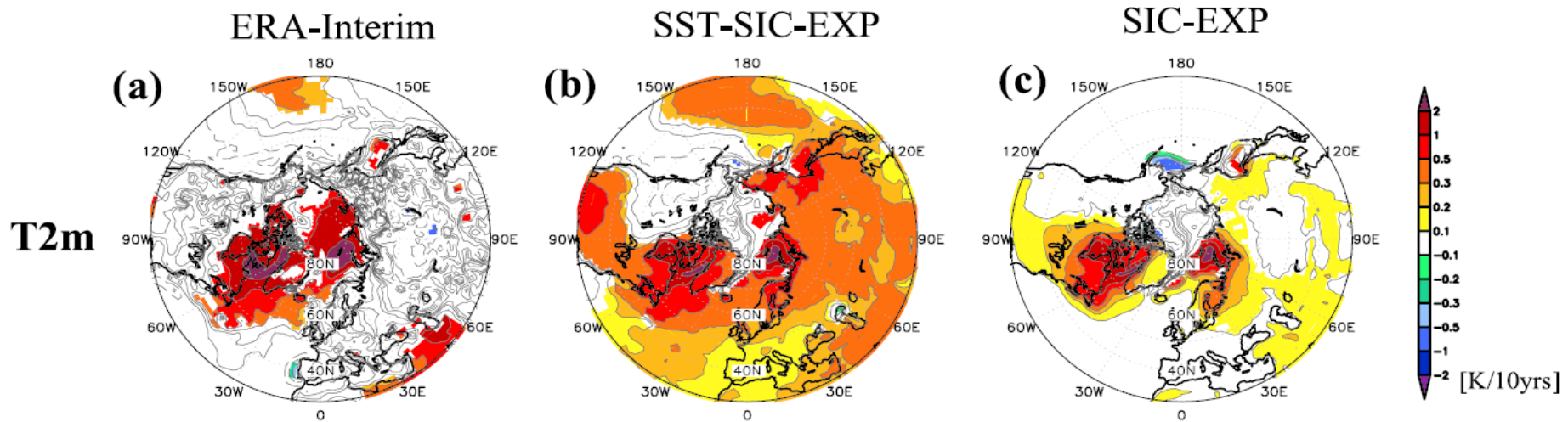


Eurasian Cooling

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

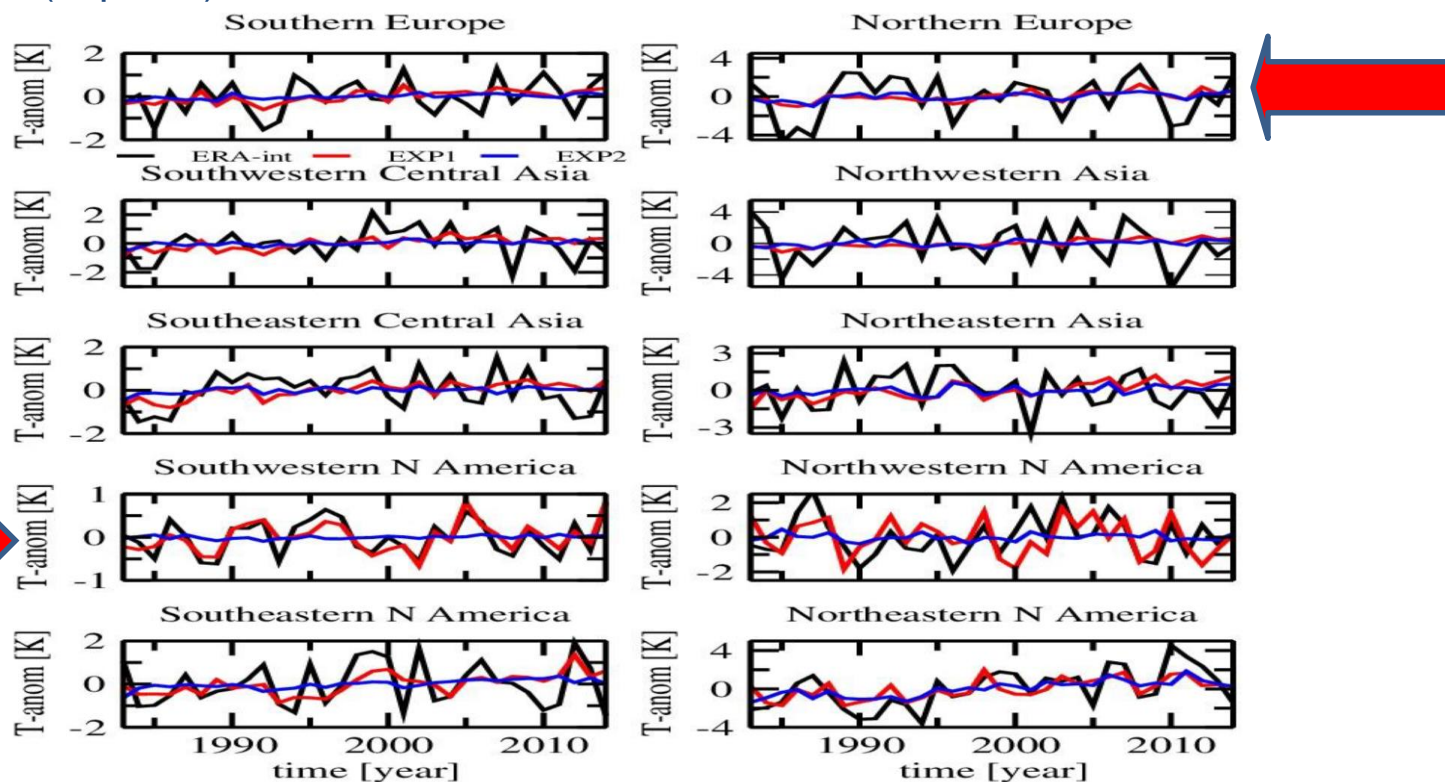
Evaluating Impacts of Recent Arctic Sea Ice Loss on the Northern Hemisphere Winter Climate Change

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)

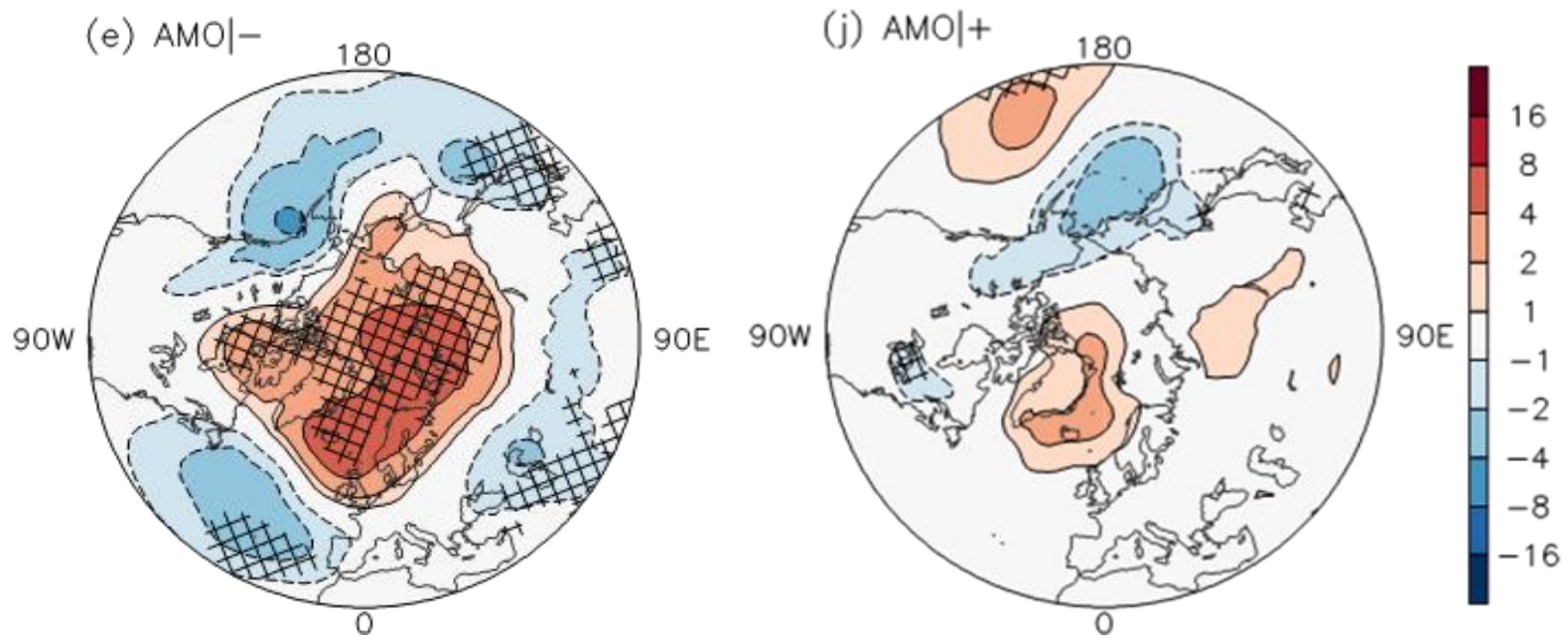


Response of AO

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>



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 !

