

Teleconnection and External Forcing of Asian Monsoons

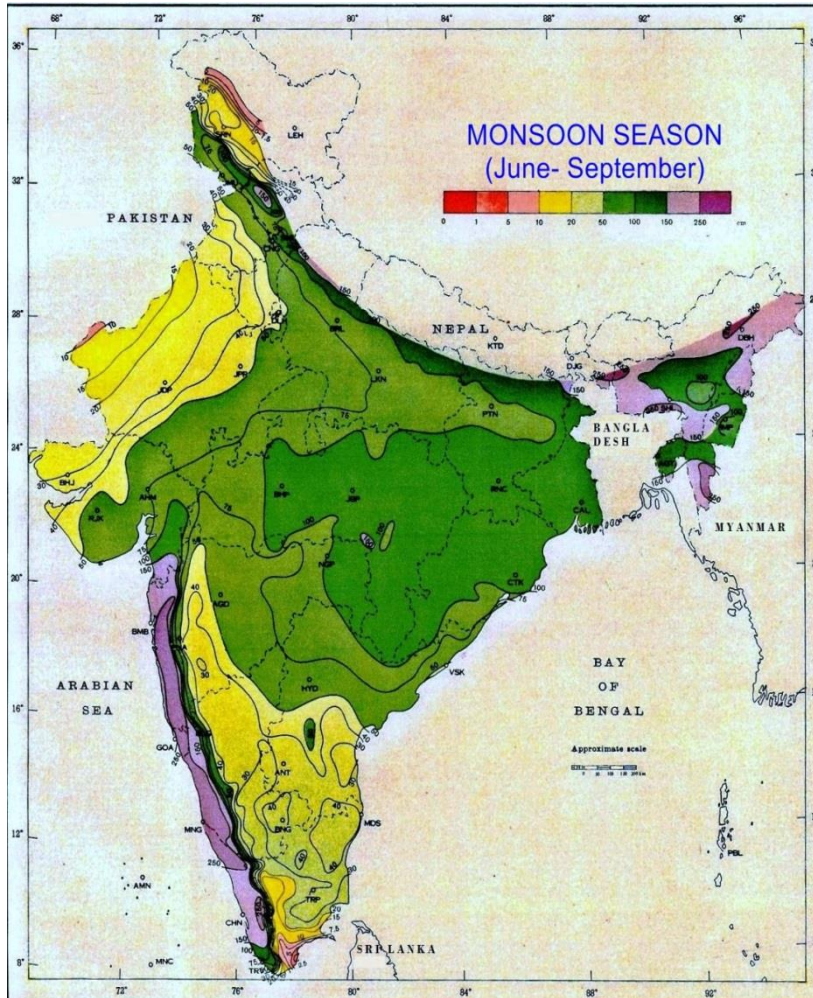
Yongqi Gao^{1,2}, Xuedong Cui²

¹ Nansen Environmental and Remote Sensing Center, Bergen, Norway

² Nansen-Zhu International Research Center, Beijing, China



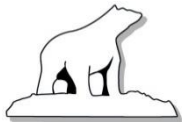
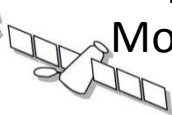
Indian Summer Monsoon



<http://www.aau.ac.in/dee/Monsoon.php>

<http://www.pinterest.com/pin/508203139172175846/>

NERSC



NZC



East Asia Summer Monsoon: Shift in Precipitation



XINHUANET

Xinhua



Factors Impacting Asia Monsoons

- Eurasian land surface temperature, including Tibet Plateau
- ENSO and PDO
- Siberian snow cover
- Vegetation
- Upper troposphere cooling
- North Atlantic SST
- Antarctic Oscillation
- Indian Ocean SST
- *Arctic Oscillation*
- *Arctic Sea Ice*

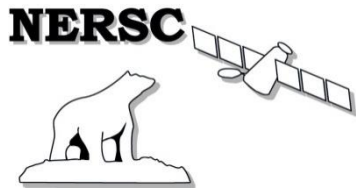
NERSC



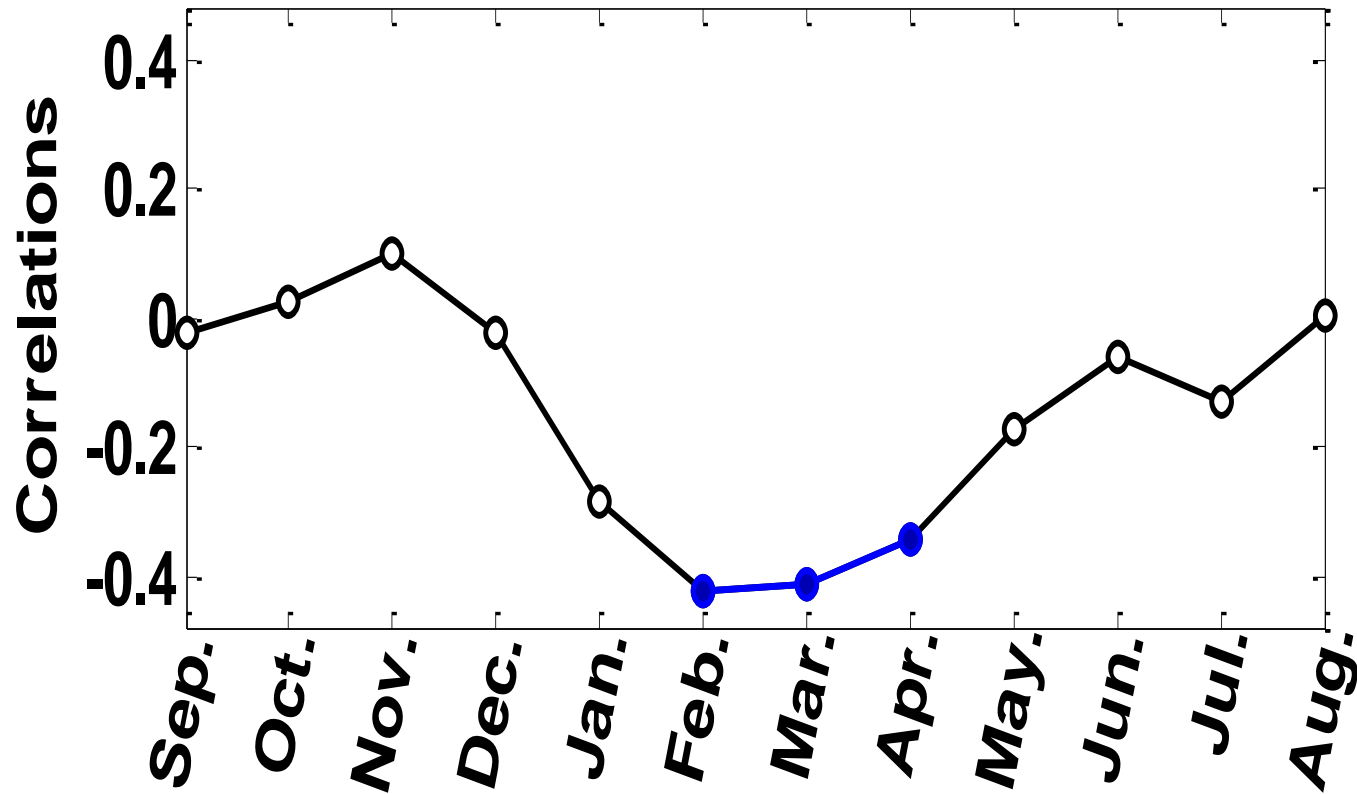
NZC



Asian Monsoon and High Latitude Forcing: Arctic Sea Ice and Arctic Oscillation

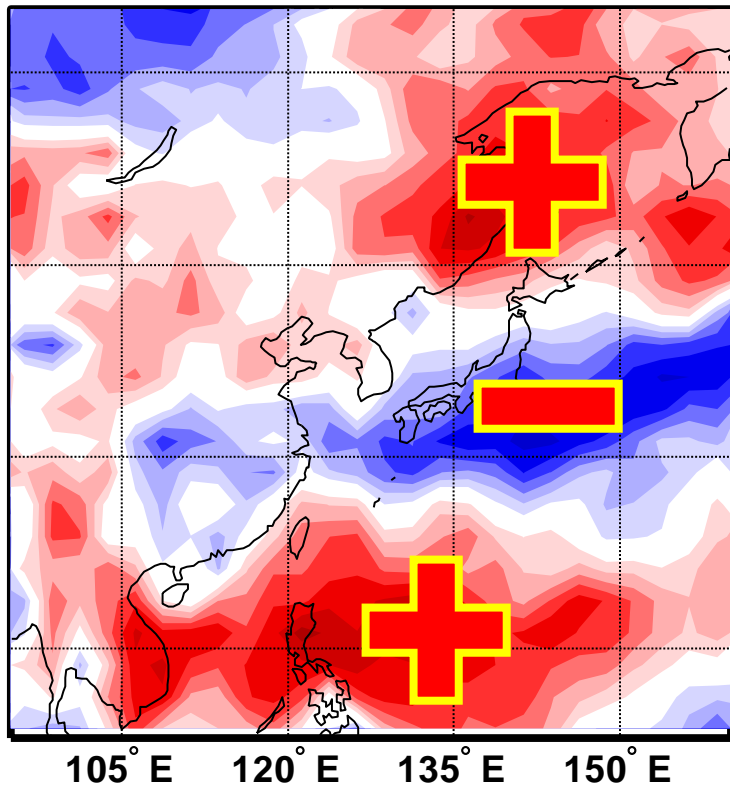


East Asia Summer Monsoon (EASM) vs. Arctic Sea Ice

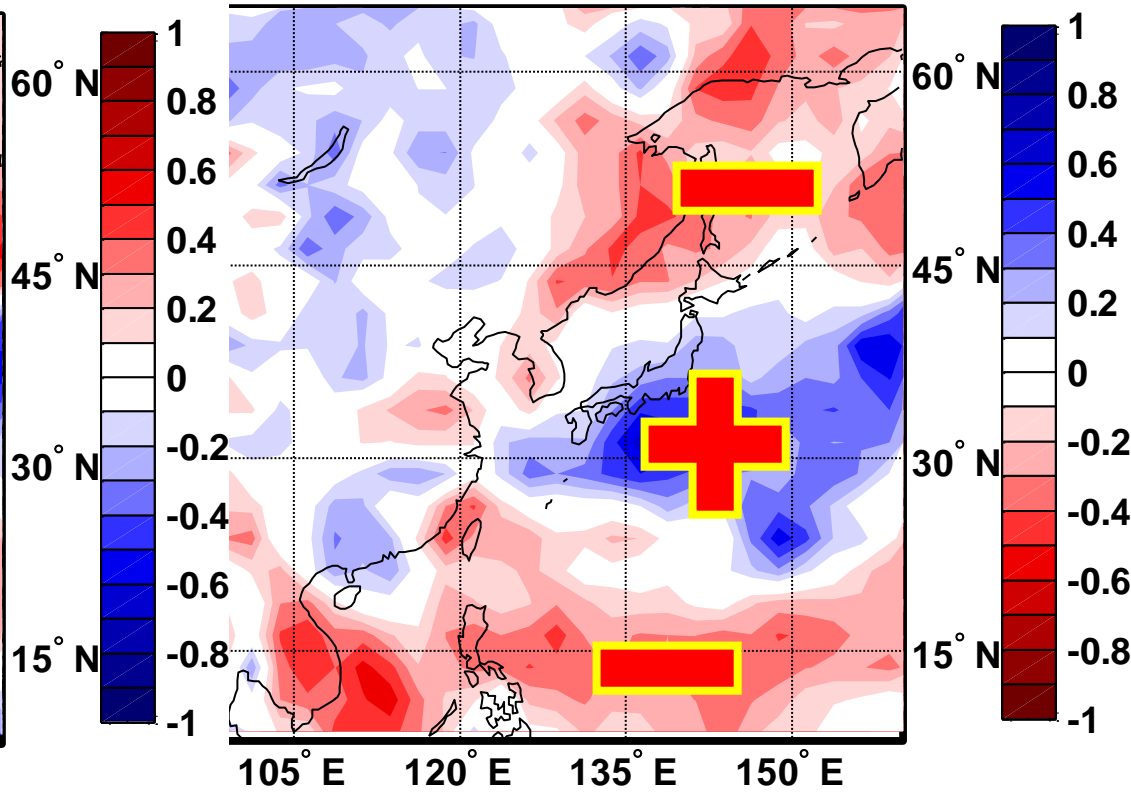


Precipitation & Arctic Sea Ice

(a) Corr. Precip.&EASMI



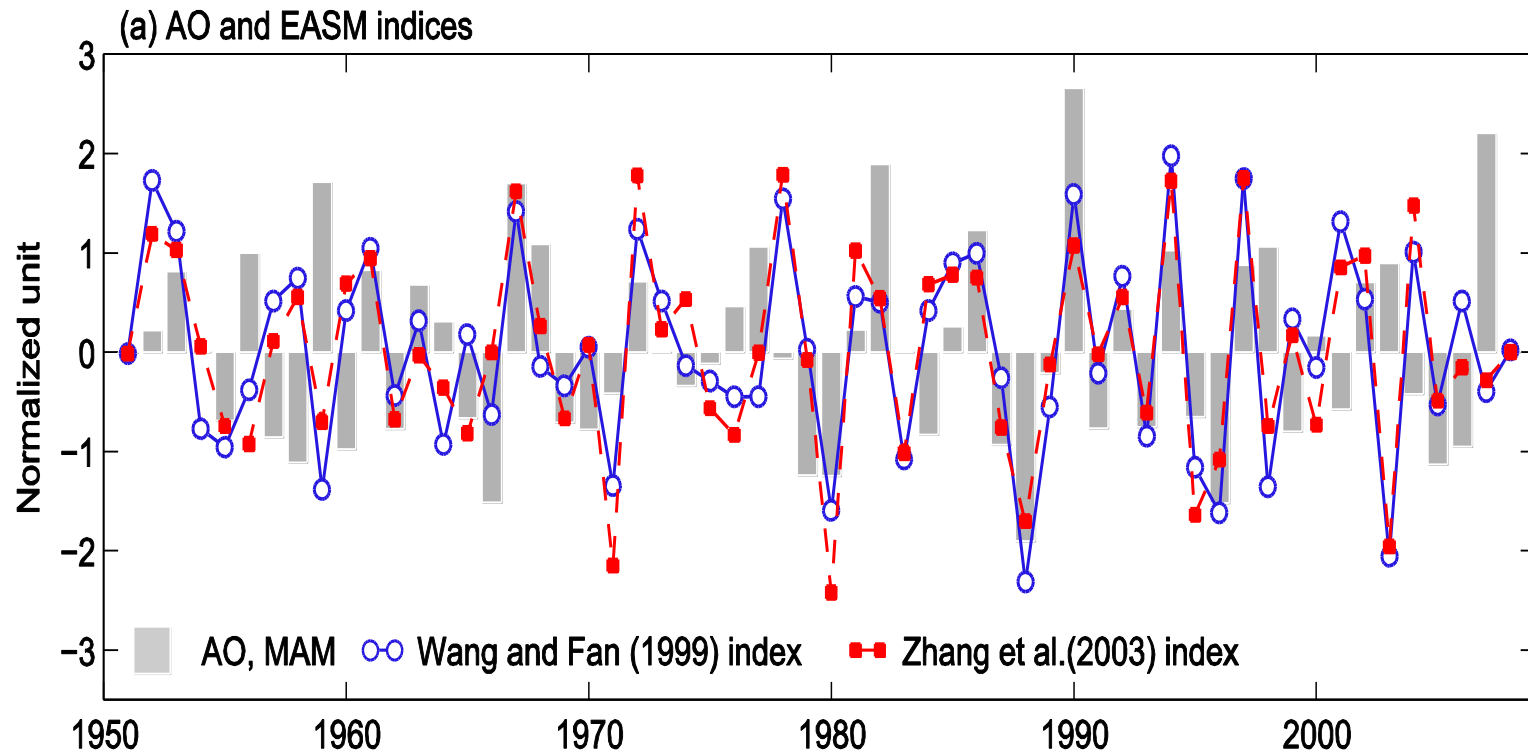
(b) Corr. Precip.&SIAI



**Guo, D., Gao, Y.Q., Bethke, I., Gong, D.Y.,
Johannessen, O.M., Wang, H.J., 2014. TAC**



Spring Arctic Oscillation and East Asia Summer Monsoon

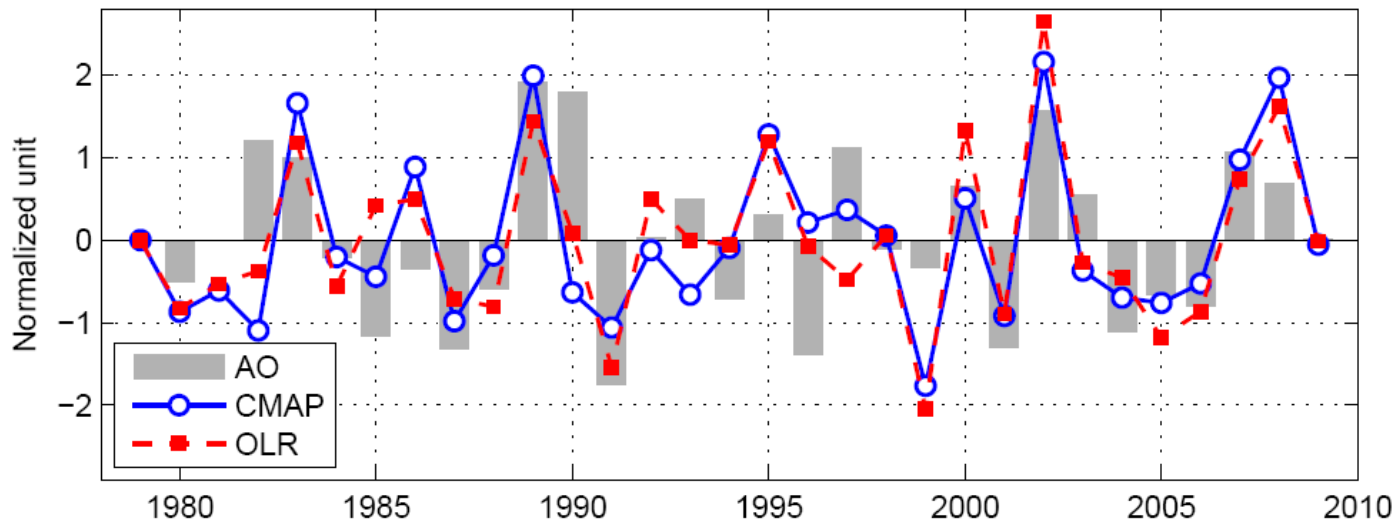


**Gong, D.Y., Yang, J., Kim, S.J., Gao, Y.Q.
Guo, D., Zhou, T.J., Hu, M. 2011, Climate
Dynamics**

NERSC



Arctic Oscillation and Tropical Indian Ocean Precipitation

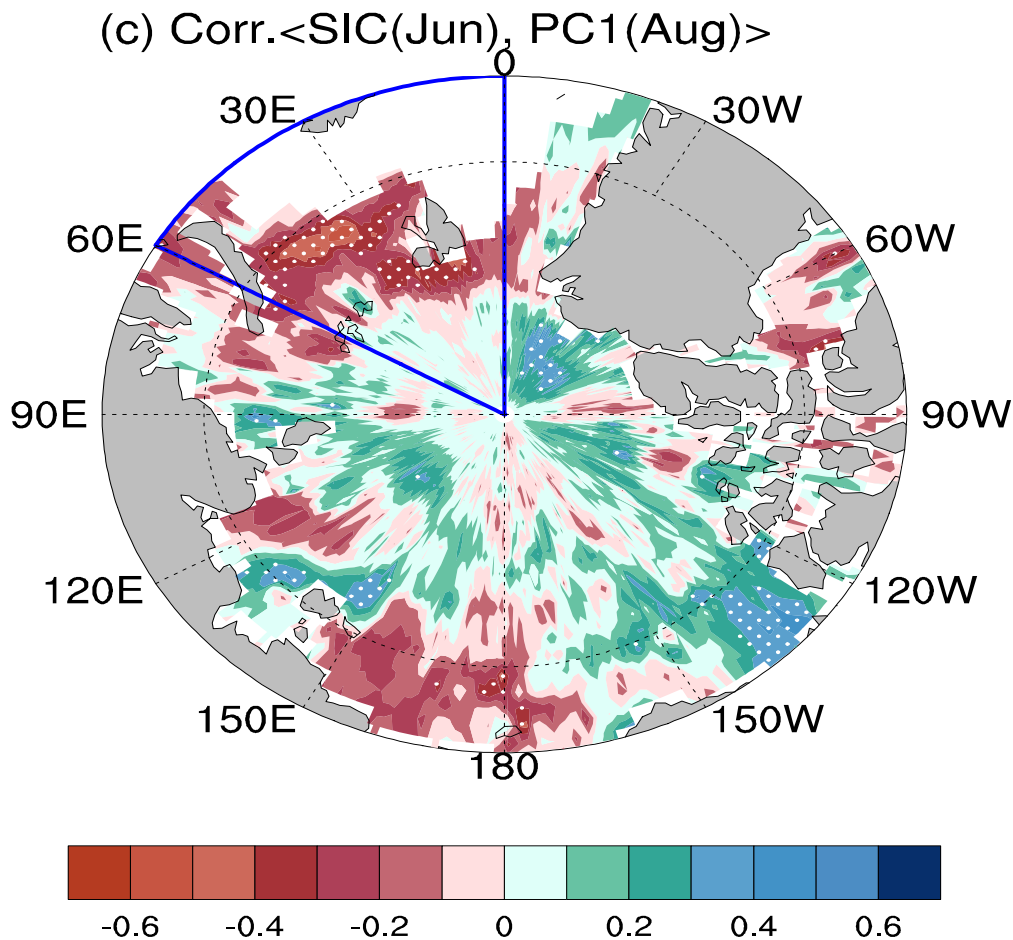


$$R(\text{AO}, \text{CMAP}) = +0.56; \quad R(\text{AO}, \text{OLR}) = -0.61$$

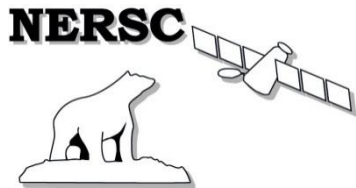
Gong, D.Y., Gao, Y.Q., Guo, D., Mao, R., Yang, J., Hu, M., Gao, M.N. 2013 Climate Dynamics



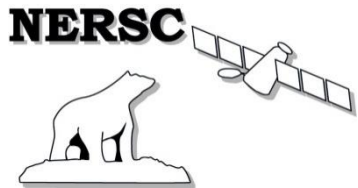
East Asia Summer Monsoon (EASM) vs. Arctic Sea Ice



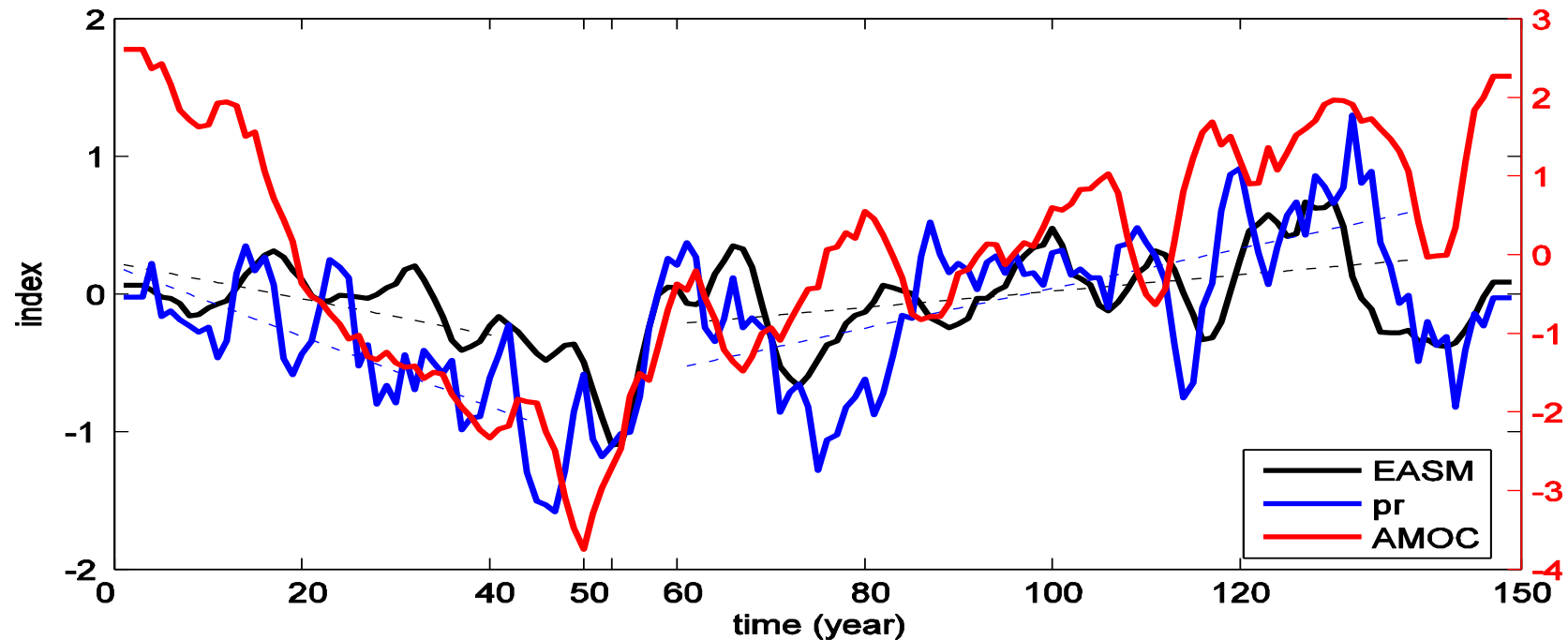
He, S.P., Gao Y.Q., Furevik T. et al. Submitted to AAS



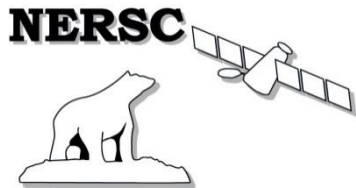
Asia Monsoon and Atlantic Forcing



Reduced AMOC and Asia Summer Monsoons Precipitation



Yu, L., Gao, Y.Q., Wang, H.J., Guo, D.,
Li, S.L, 2009. Chin. Sci. Bull.

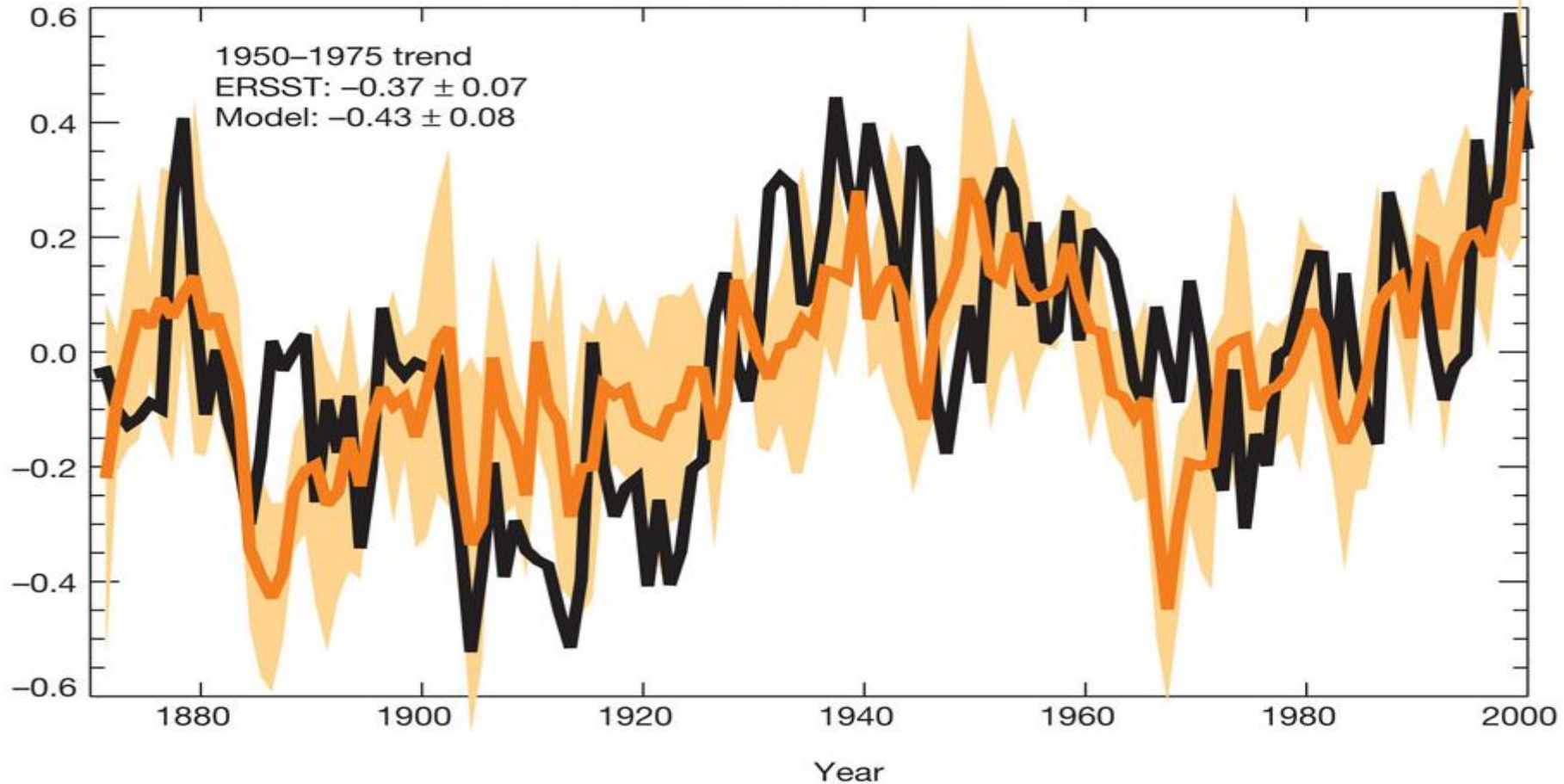


ISM and NAO: External Forcing



Aerosols and Atlantic SST

ERSST and HadGEM2-ES Atlantic response

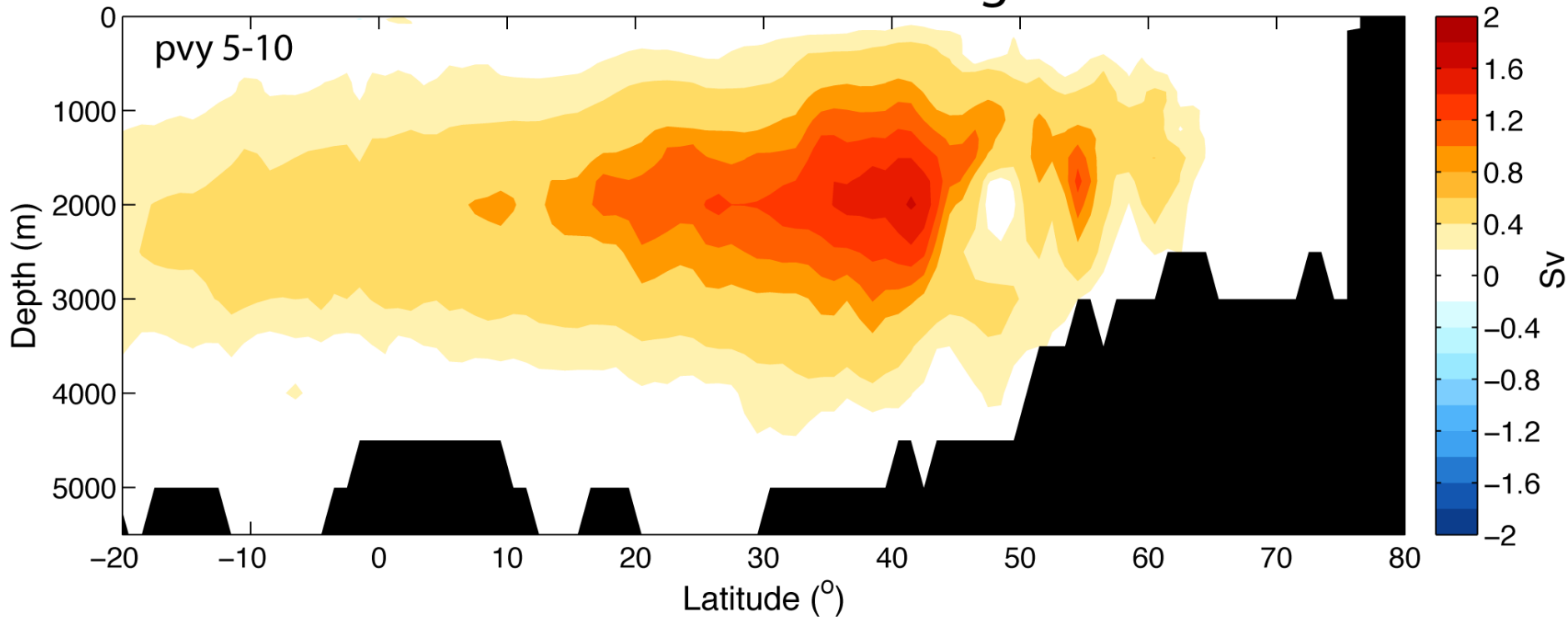


(Booth et al., 2012 Nature)



Simulated AMOC Response

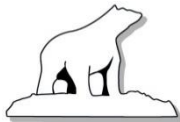
Atlantic Meridional Overturning Circulation



Strengthened AMOC in post-volcano years (pv)

Otterå, O.H., Bentsen, M., Drange, H., Suo, L.L. 2010, *Nature Geosci.*

NERSC

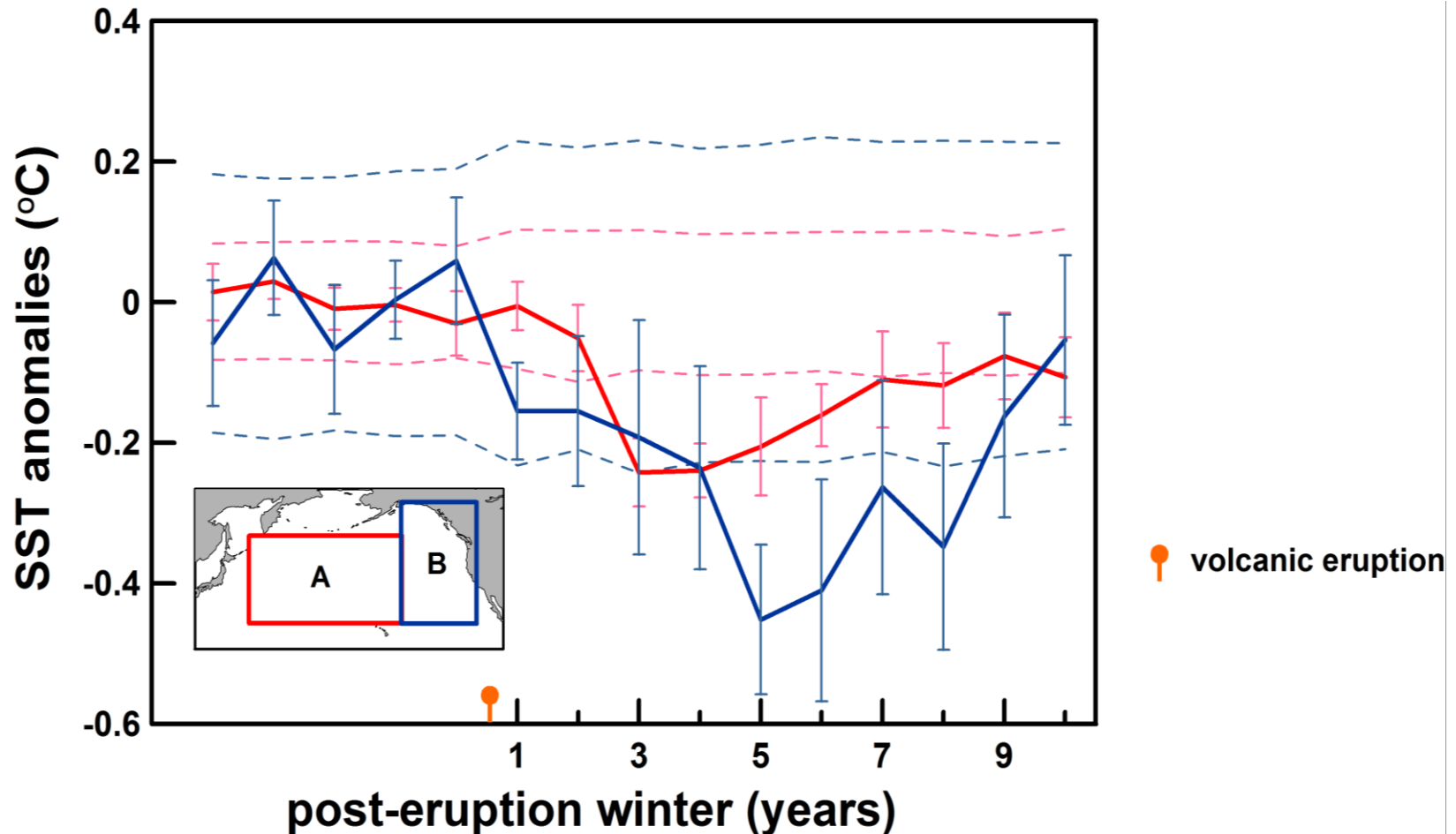


Courtesy of Odd Helge Otterå

NZC



Volcano and PDO



● volcanic eruption

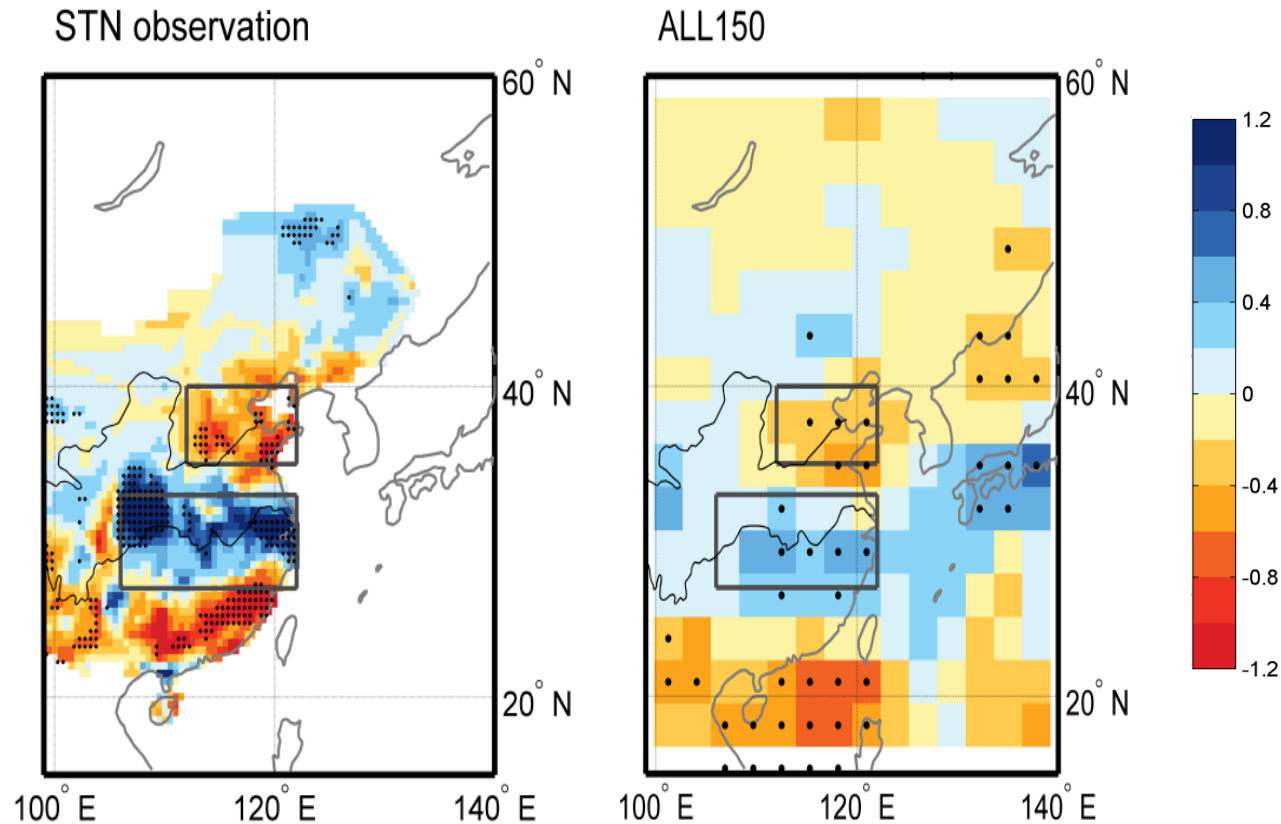


Wang, T., Otterå, O.H., Gao, Y.Q.,
Wang, H.J., 2012 Climate Dynamics



Aerosol and Inter-decadal Shift in Precipitation in East China

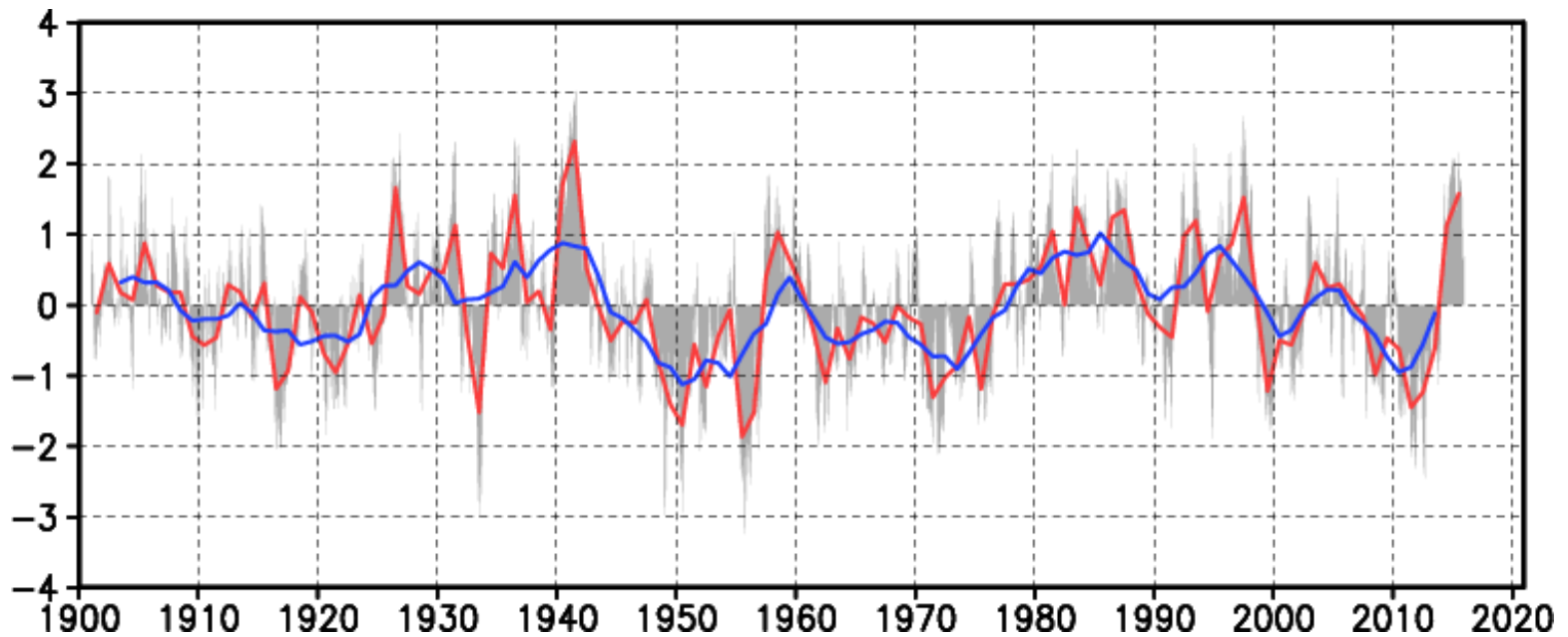
1978-1995 minus 1958-1977 differences of JJA precipitation (mm/d)



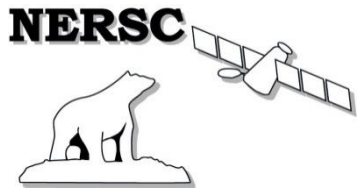
**Wang, T., Wang, H.J., Otterå, O.H., Gao, Y.Q.,
Suo, L.L., Furevik, T., Yu, L. 2013, ACP**



PDO (1901-2015)



<http://ds.data.jma.go.jp/tcc/tcc/products/elnino/decadal/pdo>

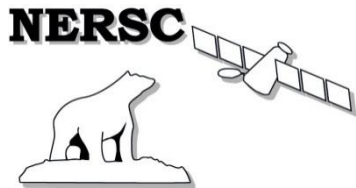
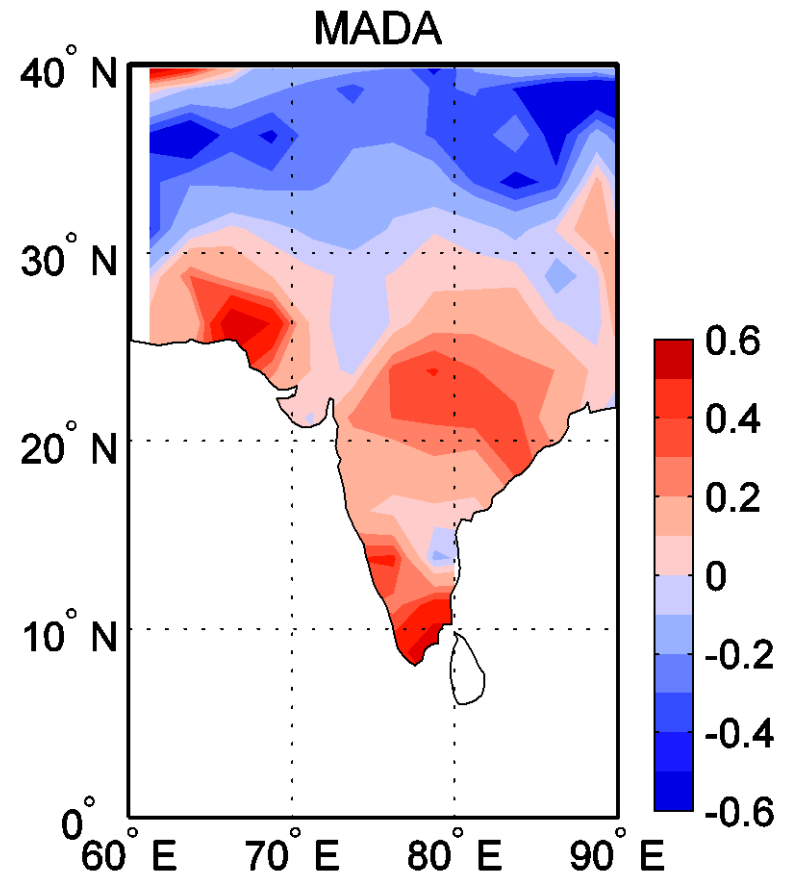
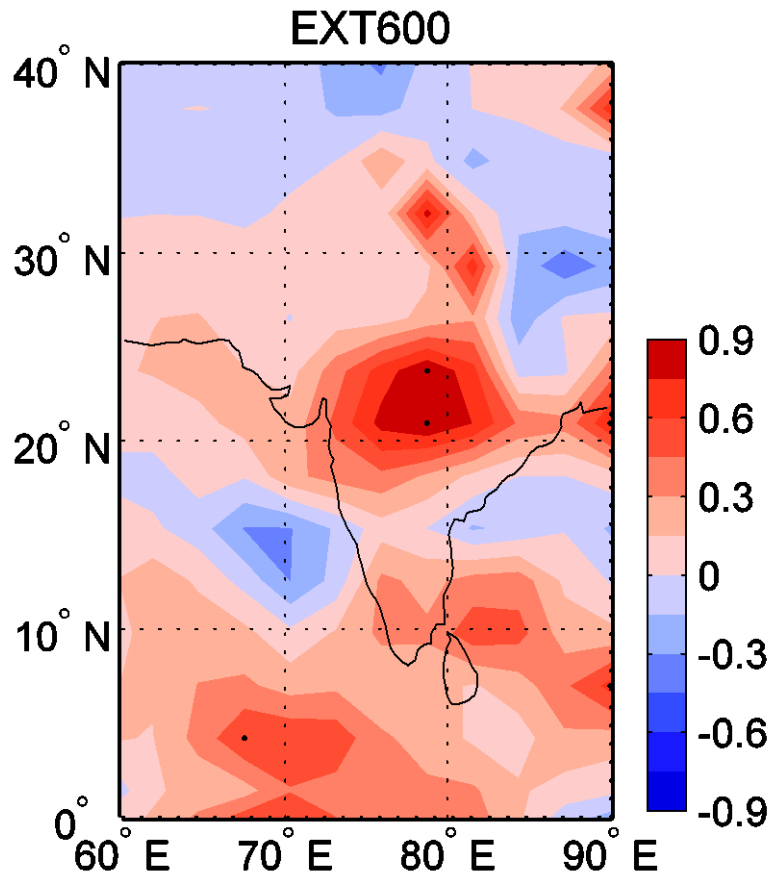


NAO and ISM is Under-Debate

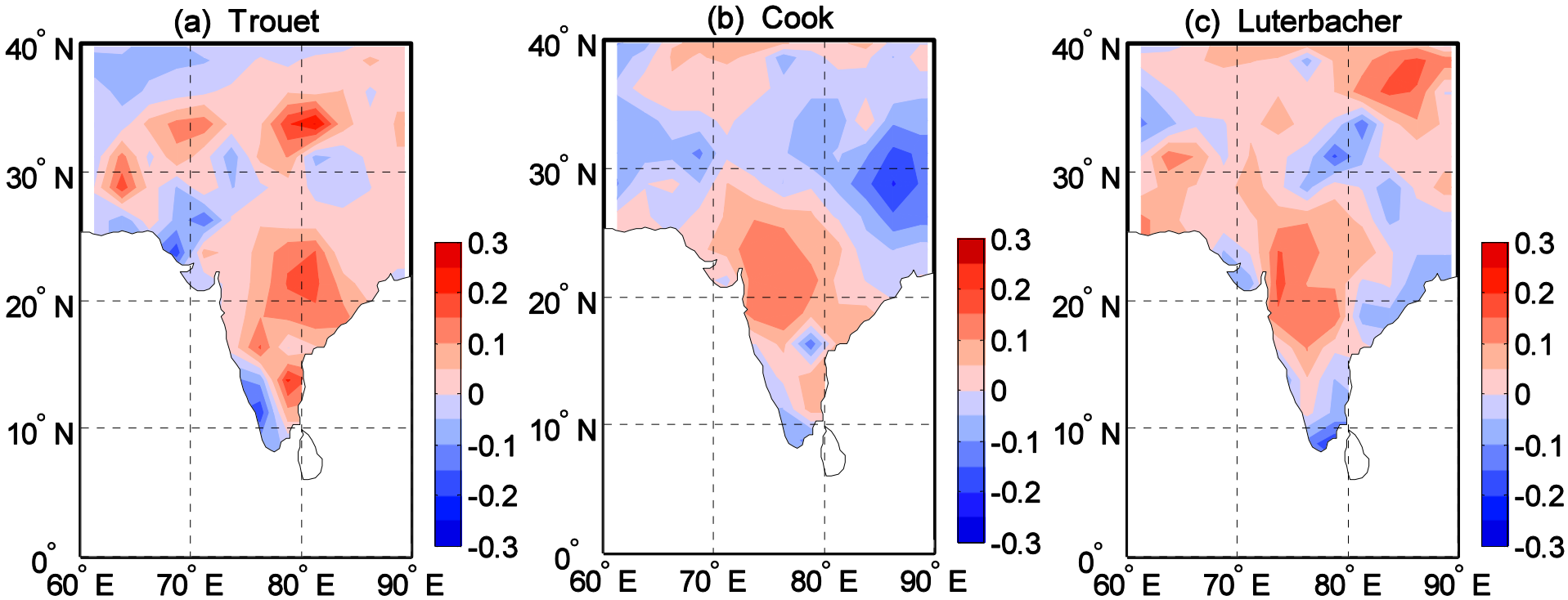
- **Inverse relationship (Dugam et al., 1997)**
- **Positive relationship (Goswami et al, 2006)**
- **No relationship (Li, et al., 2008)**



Indian Rainfall and Volcanic Eruptions



NAO and ISM from Reconstructed Data



Conclusions

- **External forcing factors, by affecting both the Indian Ocean SST and the winter NAO, could likely produce a stronger statistical but not causal relationship between the winter NAO and the ISM rainfall on inter-decadal timescale.**

**Cui, X.D., Gao, Y.Q., Sun, J.Q., Guo, D., Li, S.L.,
Johannessen, O.M. 2014**

