Arctic Sea Ice and East Asia Monsoon

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Nansen Environmental and Remote Sensing Center

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Arctic Sea Ice and Weather

- Arctic Warming-Westerlies-Mid-Lat Extremes
- Arctic Sea Ice-Cold Eurasian and NAm
- Arctic Sea Ice-Wet European Summer
- Arctic Sea Ice-Rainfall in Midterranean
- Arctic Sea Ice-Asian Monsoons

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East Asia Summer Monsoon: Shift in Precipitation

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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***

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Cold Spells

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 planenary waves over the Eurasian continent.

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Atmospheric Impact

Fletcher (1968) speculated that the complete removal of Arctic sea ice would cause weaker meridional temperature gradient and weaker zonal circulation, and would be accompanied by more high-latitude snowfall due to increased evaporation over the Arctic Ocean

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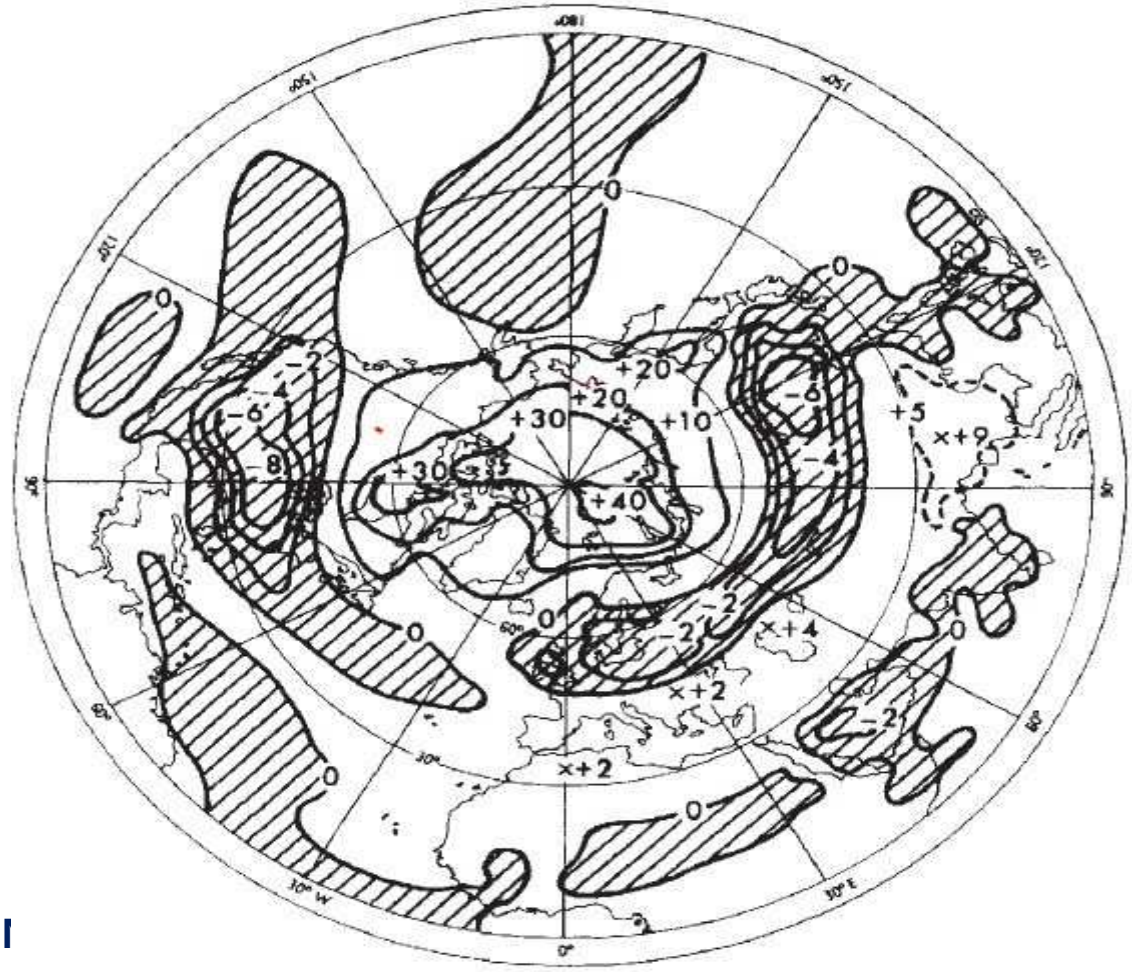
Atmospheric Impact (Model)



Newson, 1973, I

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Atmospheric Impact (East Asia, Model)

More than normal sea ice cover in Greenland-Barents Seas can lead to increased precipitation over Southeastern China

Yang et al., 1994

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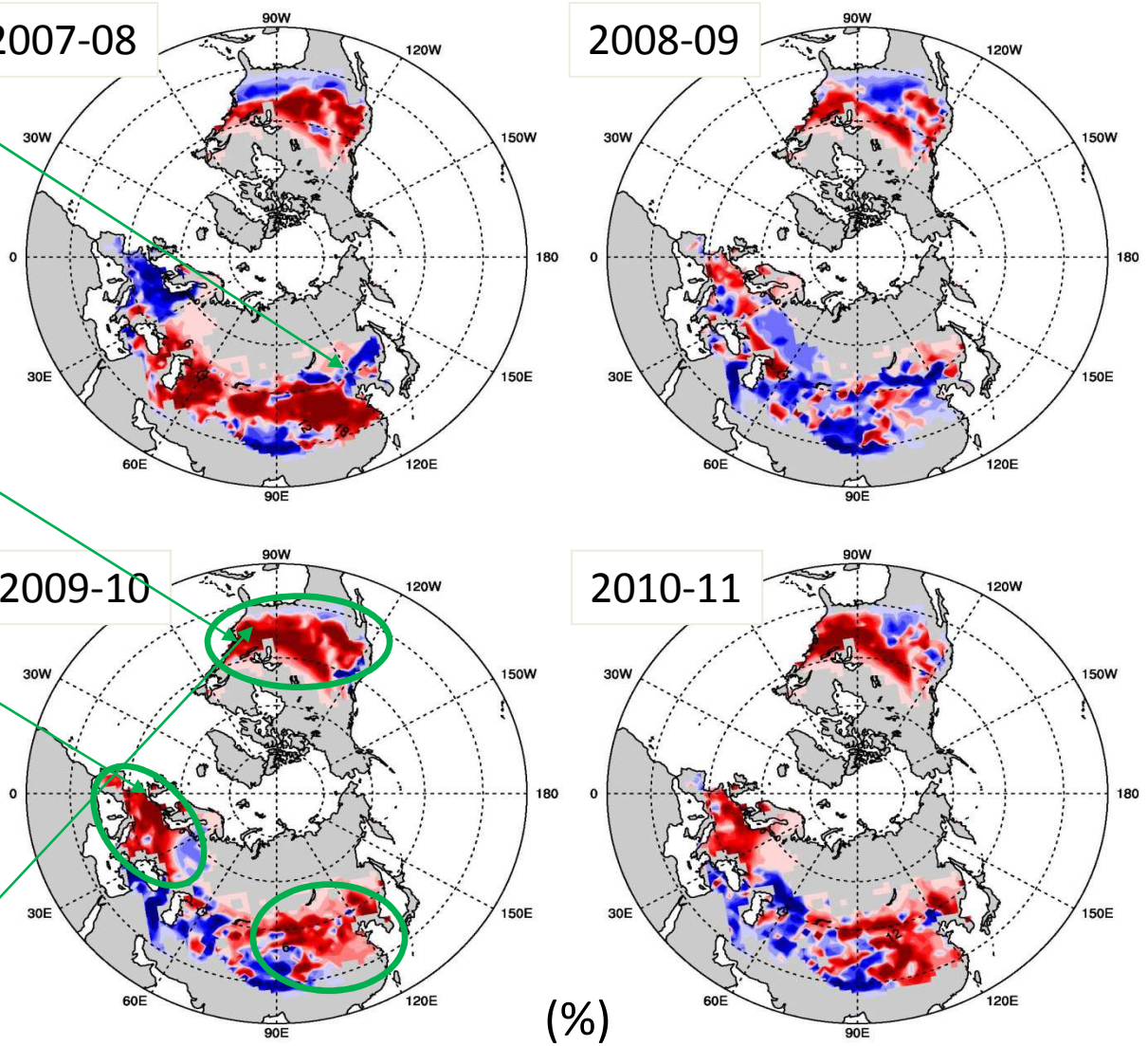
Recent winter snow cover anomalies
Liu, Curry and Wang, PNAS, 2012



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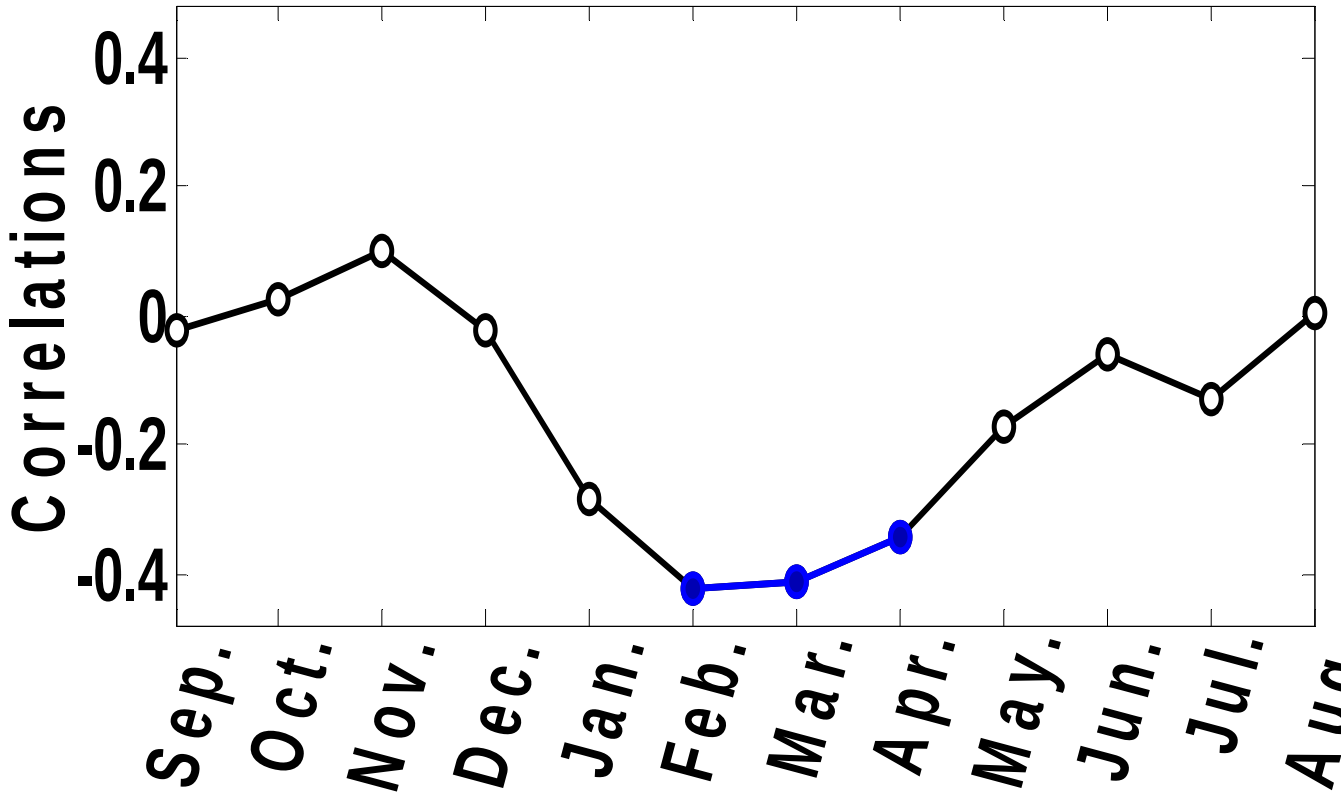
East Asia Summer Monsoon (EASM) vs. Arctic Sea Ice



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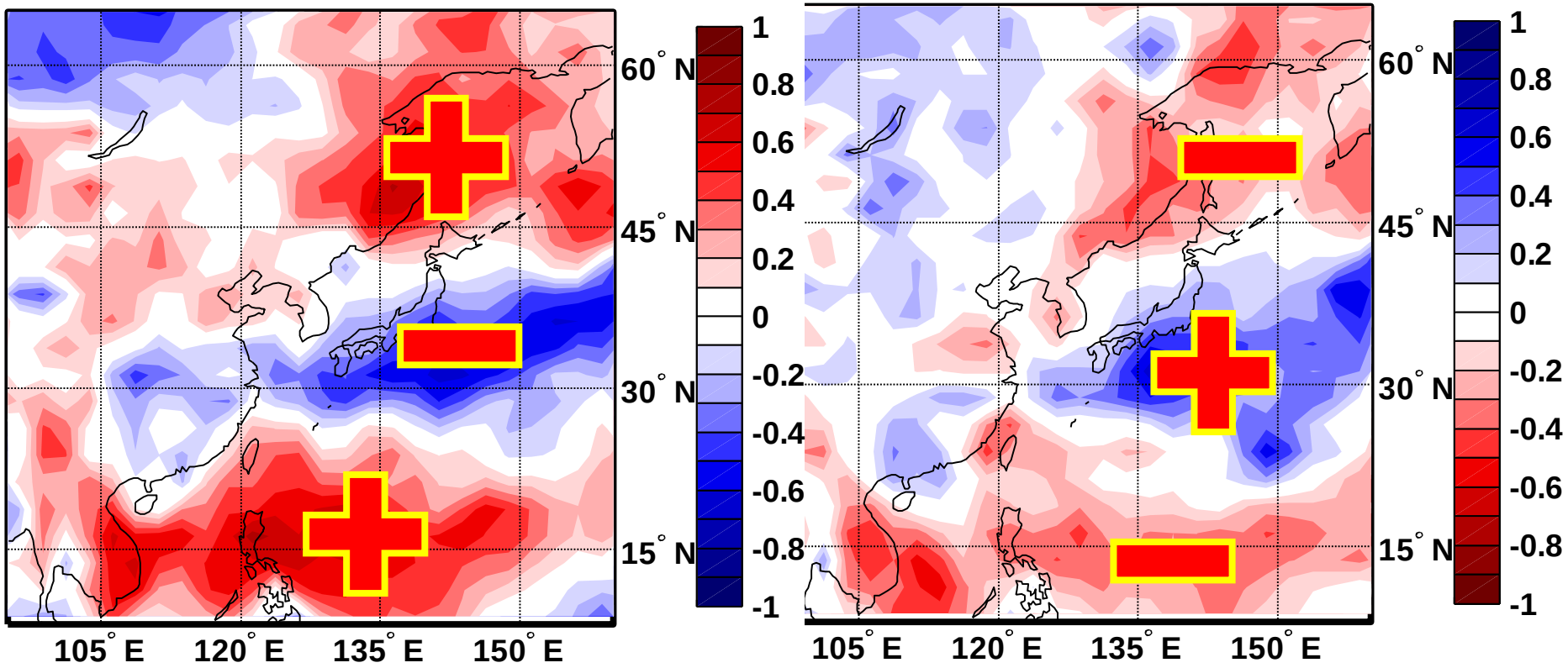
Precipitation & Arctic Sea Ice

(a) Corr. Precip.&EASMI



(b) Corr. Precip.&SIAI

Guo, D., Gao, Y.Q., Bethke, I., Gong, D.Y., Johannessen, O.M., Wang, H.J., 2013. TAC

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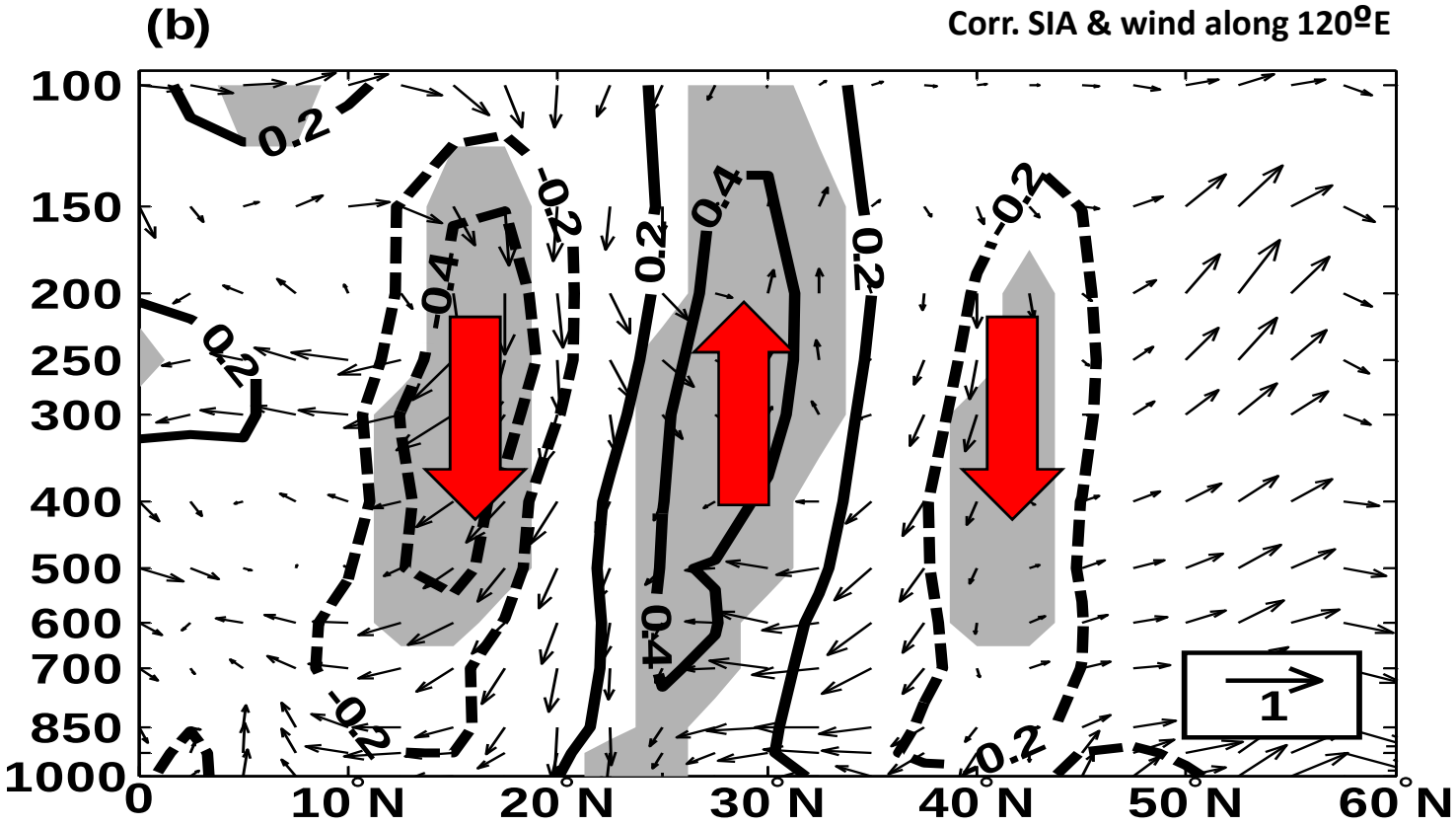
Sea Ice & Atmosphere Circulation



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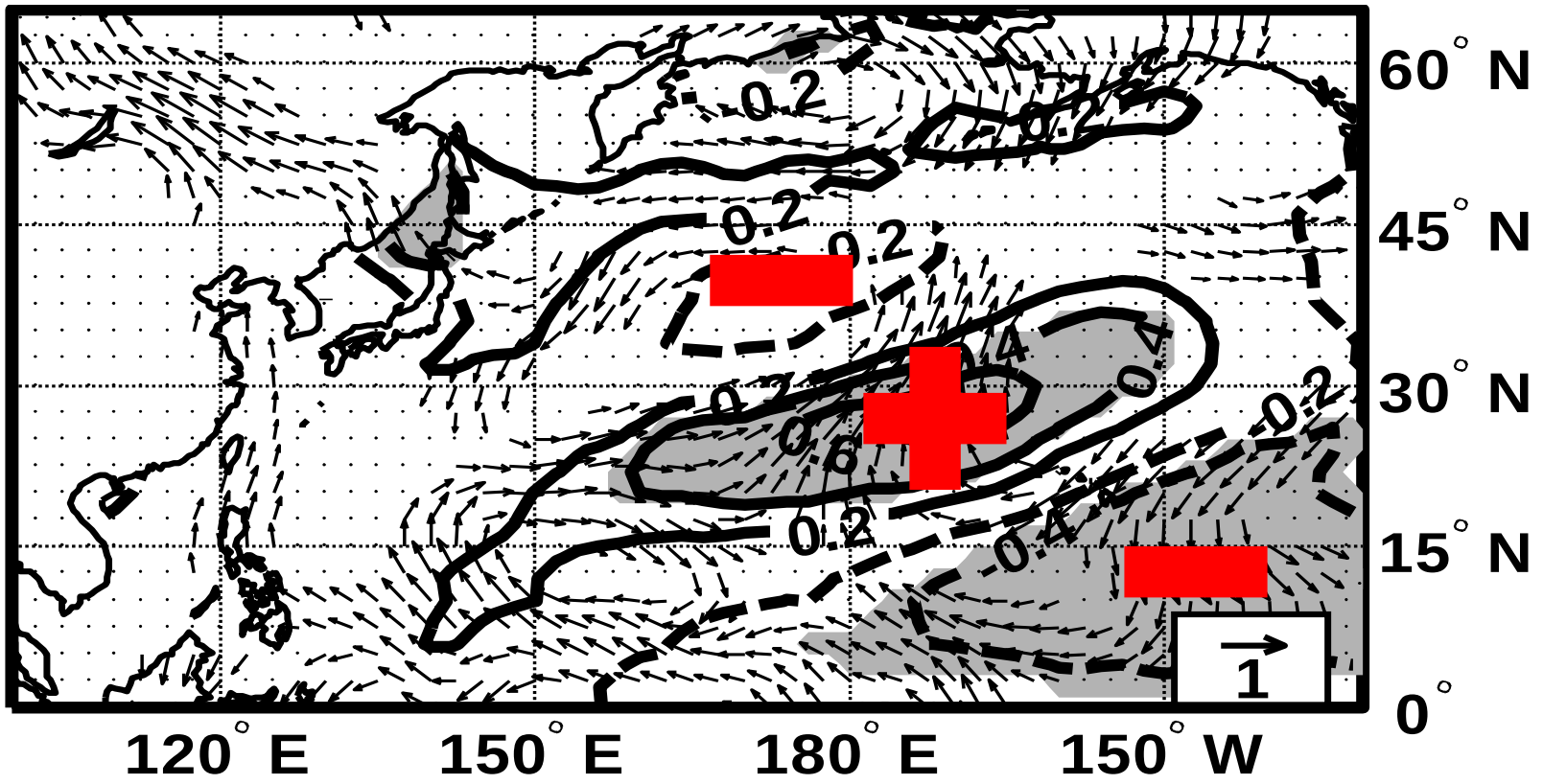
Arctic Sea Ice and SST

(c)SIC PC1,SST,UV850hPa, MJJ



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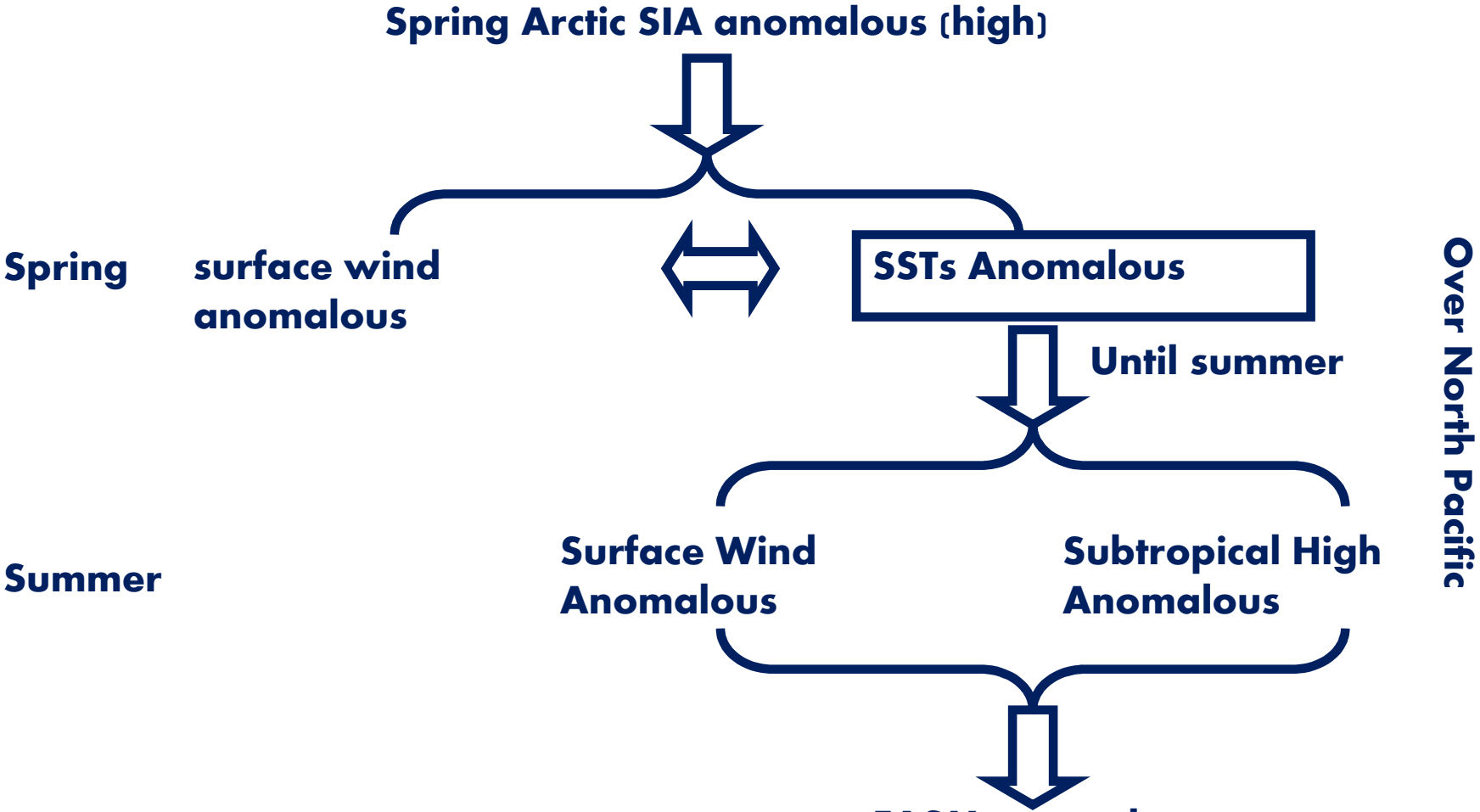
Hypothesis Mechanism



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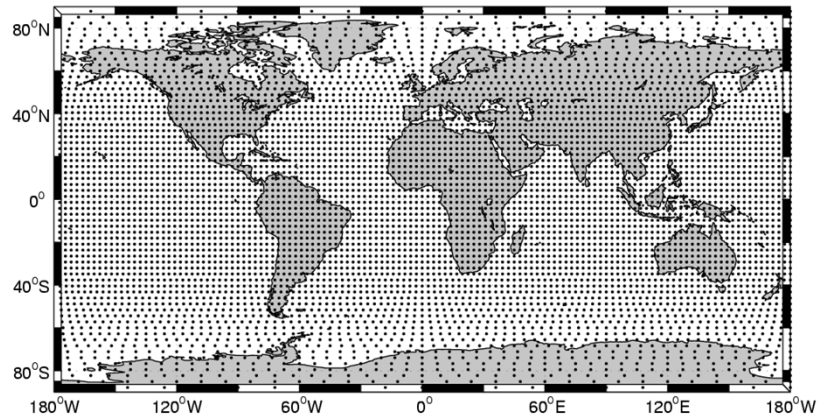
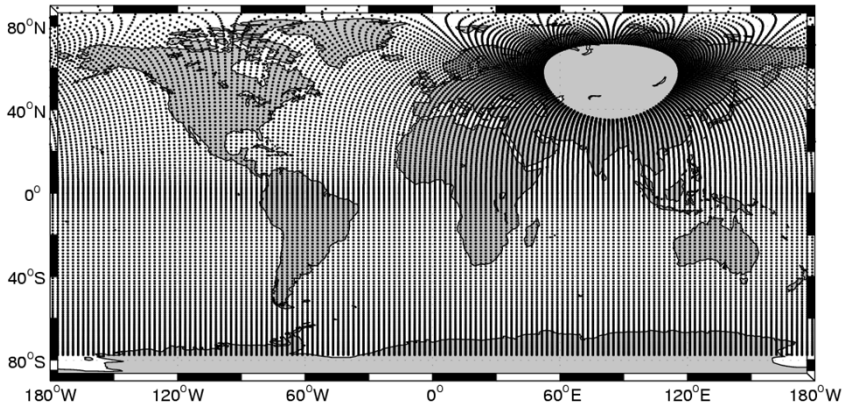
Bergen Climate Model (v2) (Otterå et al., 2009)

- **ARPEGE**
  - **Resolution: T42, ~2.8x2.8, 31 layers**
  - **Volcanic aerosols implemented**
- **MICOM**
  - **Resolution: ~2.4x2.4, 35 isopycnic layers**
  - **Reference pressure at 2000 m**
  - **Incremental remapping for tracer advection (better conservation)**
- **Thermodynamic and dynamic sea-ice module (GELATO)**
  - **Multi-ice categories**
- **No carbon cycle or vegetation!**

ARPEGE



MICOM



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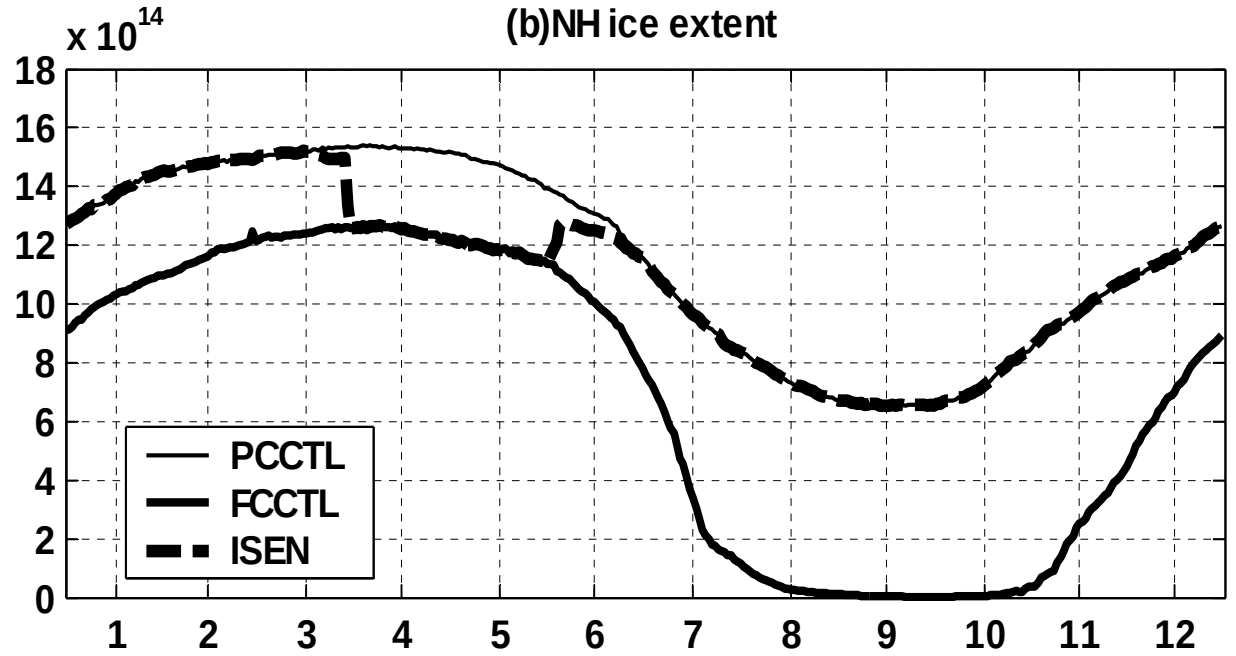
Arctic Sea Ice: Boundary Conditions



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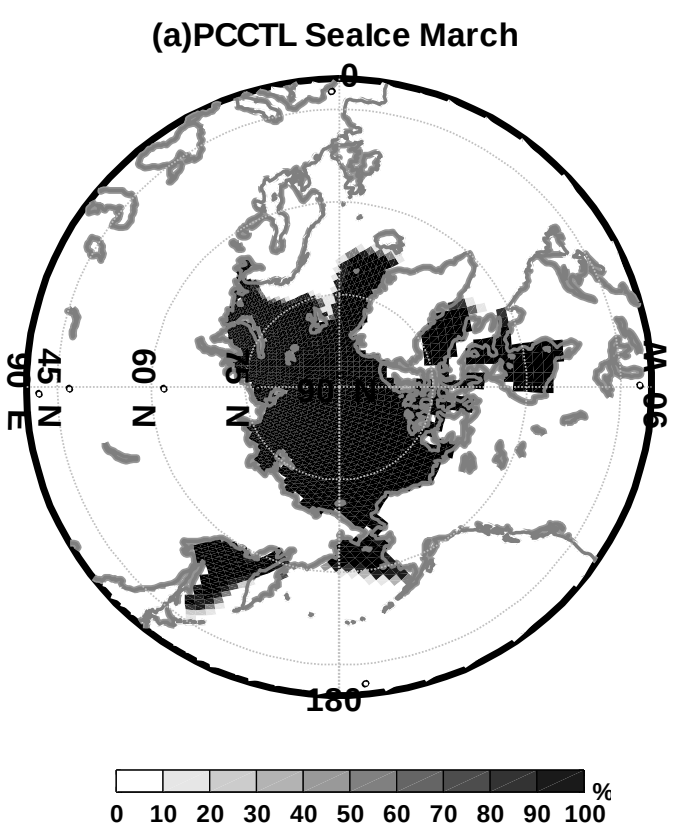

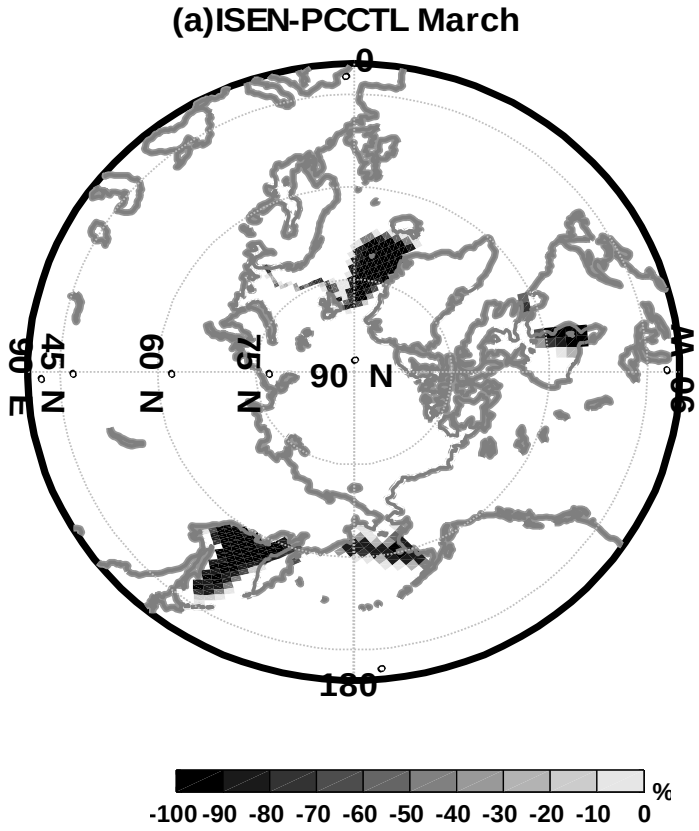

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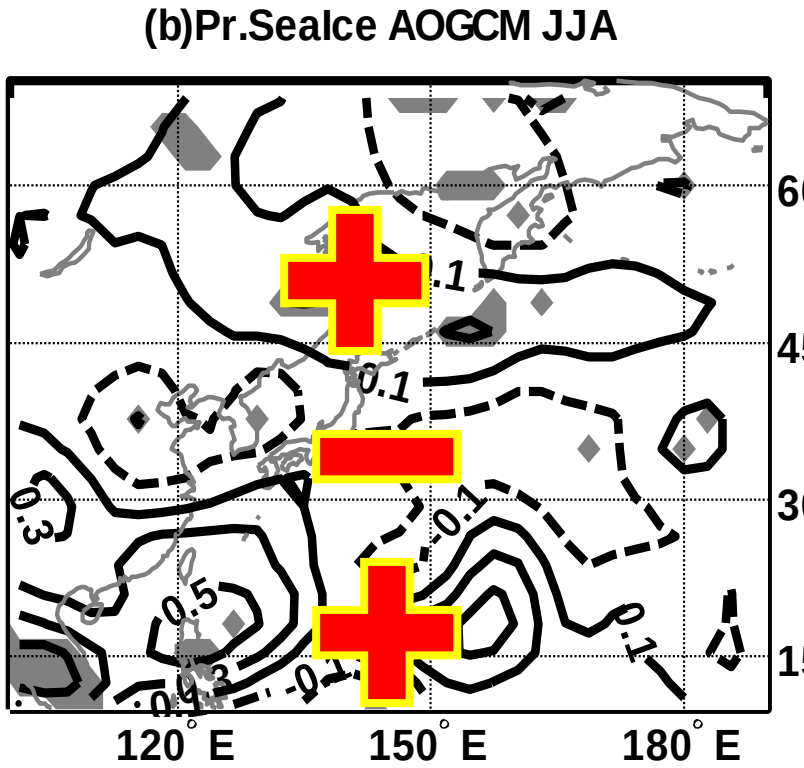
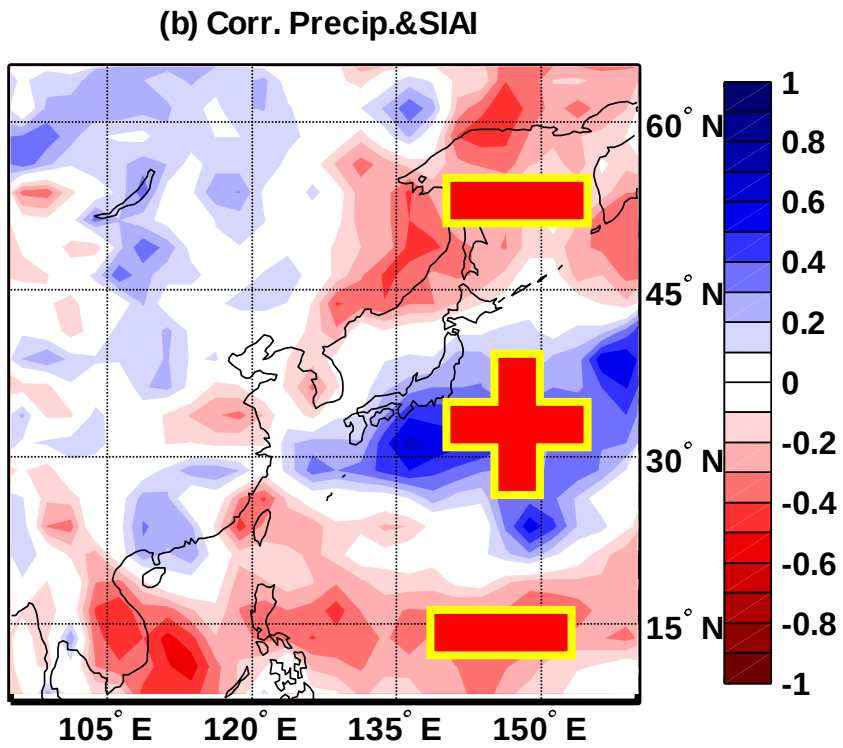
Arctic Sea Ice & Precipitation





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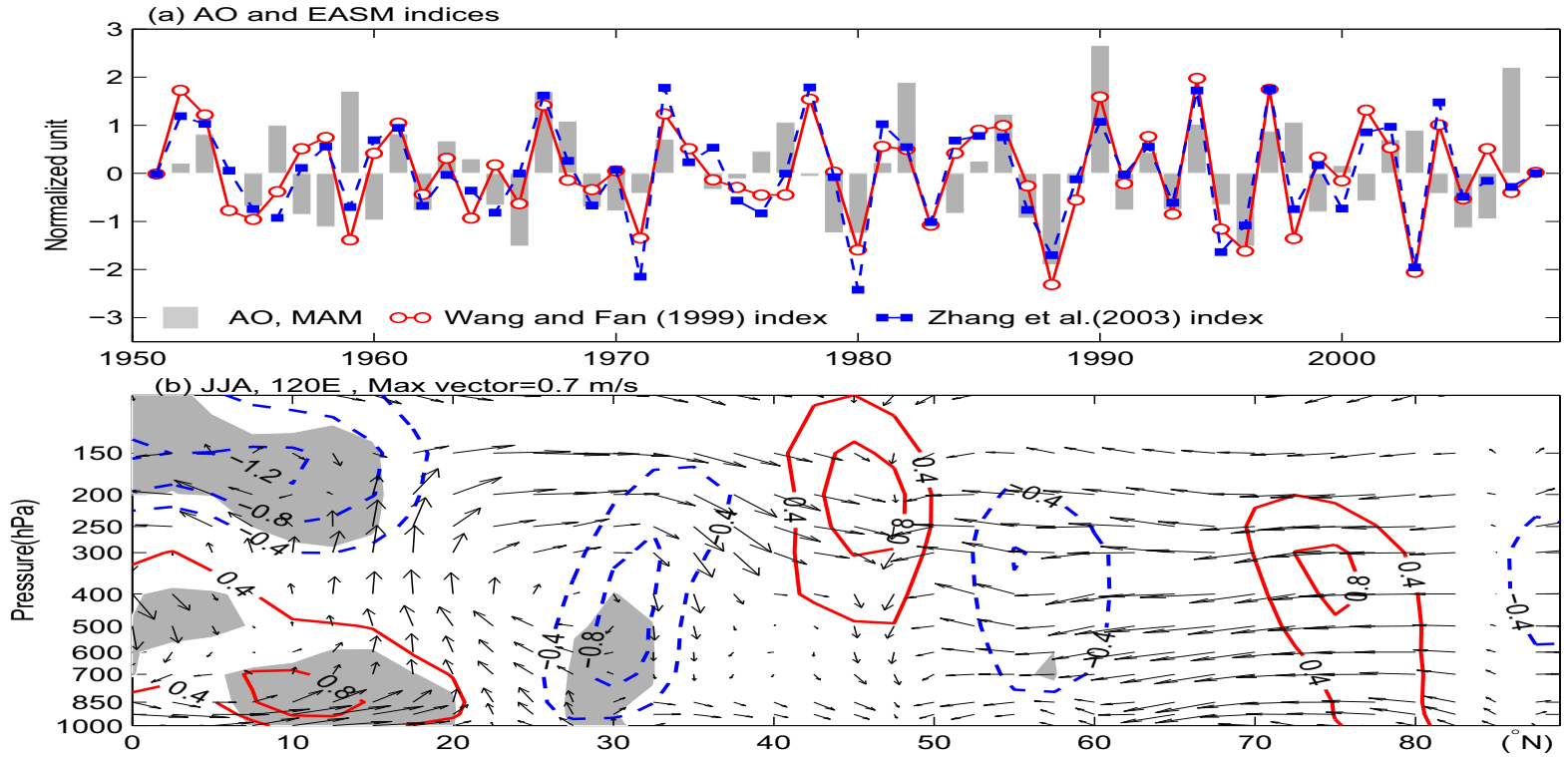
Spring Arctic Oscillation and East Asia Summer Monsoon



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

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Conclusions

- The SST in North Pacific bridge the spring Arctic sea ice cover and the East Asian summer monsoon precipitation
- The mediating role of SST changes is highlighted by the result that only the AOGCM, but not the AGCM, reproduces the observed sea ice-EASM linkage

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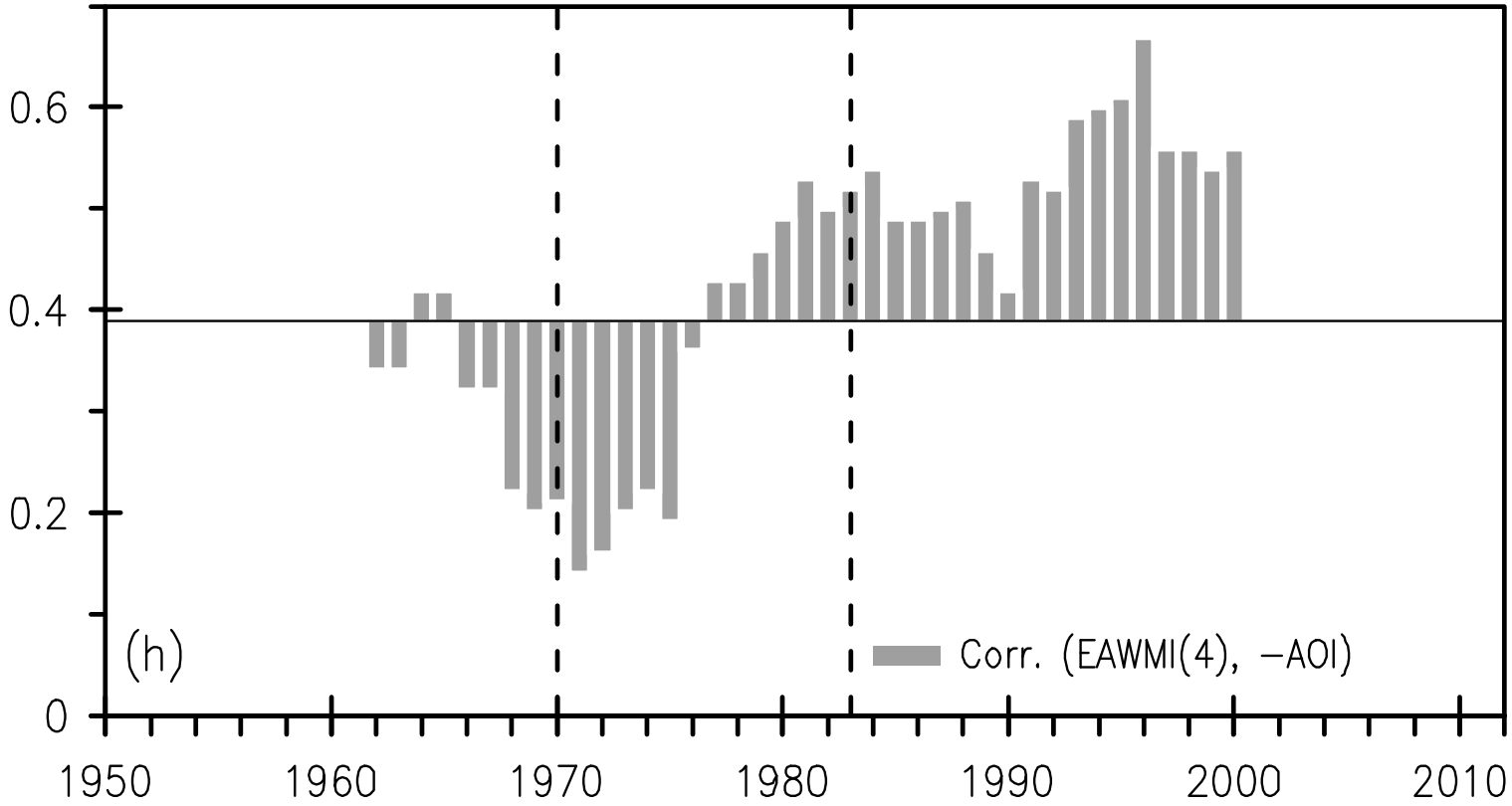
AO and East Asia Winter Monsoon



Li, F., Wang, H.J, Gao, Y.Q. 2014, Journal of Climate

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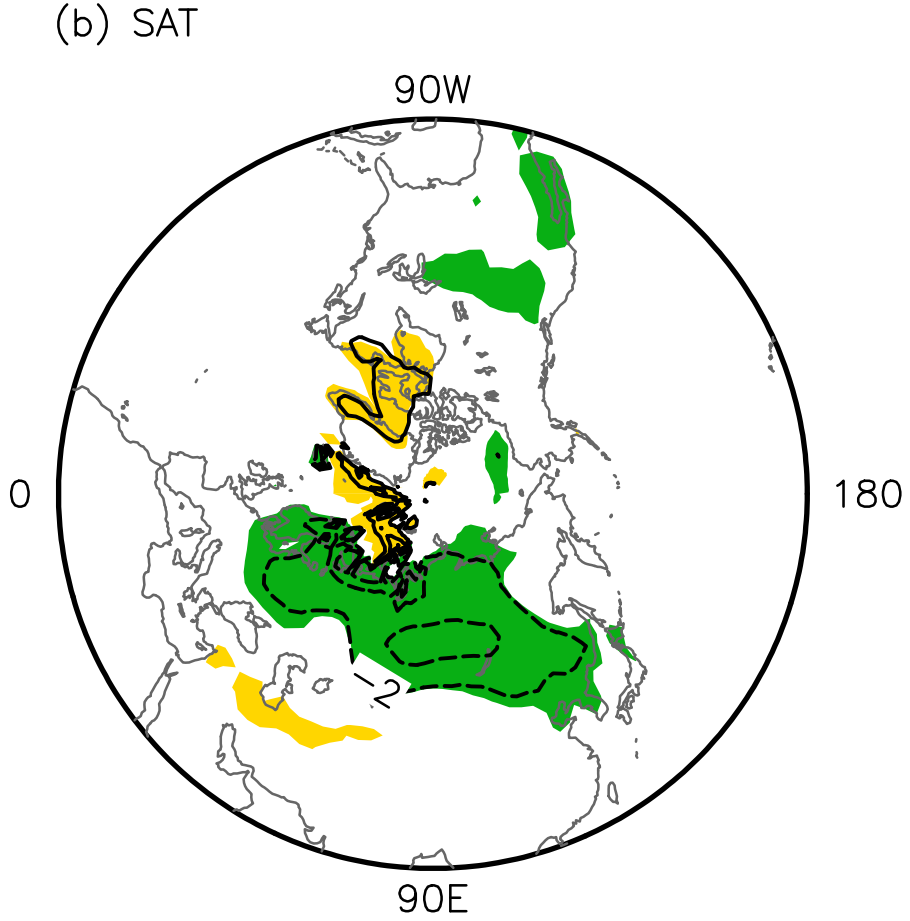
Sea Ice Impact: Eurasian Cooling (CAM3)



Li, F., Wang, H.J, Gao, Y.Q. 2014, Journal of Climate

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Conclusion

- **Autumn Arctic sea ice reduction leads to Eurasian cooling. It in turn results in westward extension of EAJS and bridge the AO and EAWM**

Li, F., Wang, H.J, Gao, Y.Q. 2014, Journal of Climate

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