Arctic Sea Ice and East Asia Monsoon

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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
East Asia Summer Monsoon: Shift in Precipitation
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
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.
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
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
Recent winter snow cover anomalies
Liu, Curry and Wang, PNAS, 2012
East Asia Summer Monsoon (EASM) vs. Arctic Sea Ice
Precipitation & Arctic Sea Ice

(a) Corr. Precip.&EASMI

(b) Corr. Precip.&SIAI

Sea Ice & Atmosphere Circulation

Corr. SIA & wind along 120°E

(b)
Arctic Sea Ice and SST

(c)SIC PC1,SST,UV850hPa, MJJ
Hypothesis Mechanism

Spring Arctic SIA anomalous (high)

Spring surface wind anomalous

SSTs Anomalous

Until summer

Summer Surface Wind Anomalous

Subtropical High Anomalous

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

- **ARPEGE**
  - Resolution: $T_{42}$, $2.8\times2.8$, 31 layers
  - Volcanic aerosols implemented
- **MICOM**
  - Resolution: $2.4\times2.4$, 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!
Arctic Sea Ice: Boundary Conditions
Arctic Sea Ice: Boundary Conditions

(a) PCCTL Sealce March

(a) ISEN-PCCTL March
Arctic Sea Ice & Precipitation

(b) Pr. Sealce AOGCM JJA

(b) Corr. Precip. & SIAI

NERSC

NZC
Spring Arctic Oscillation and East Asia Summer Monsoon

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.
AO and East Asia Winter Monsoon

Sea Ice Impact: Eurasian Cooling (CAM3)

(b) SAT

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