



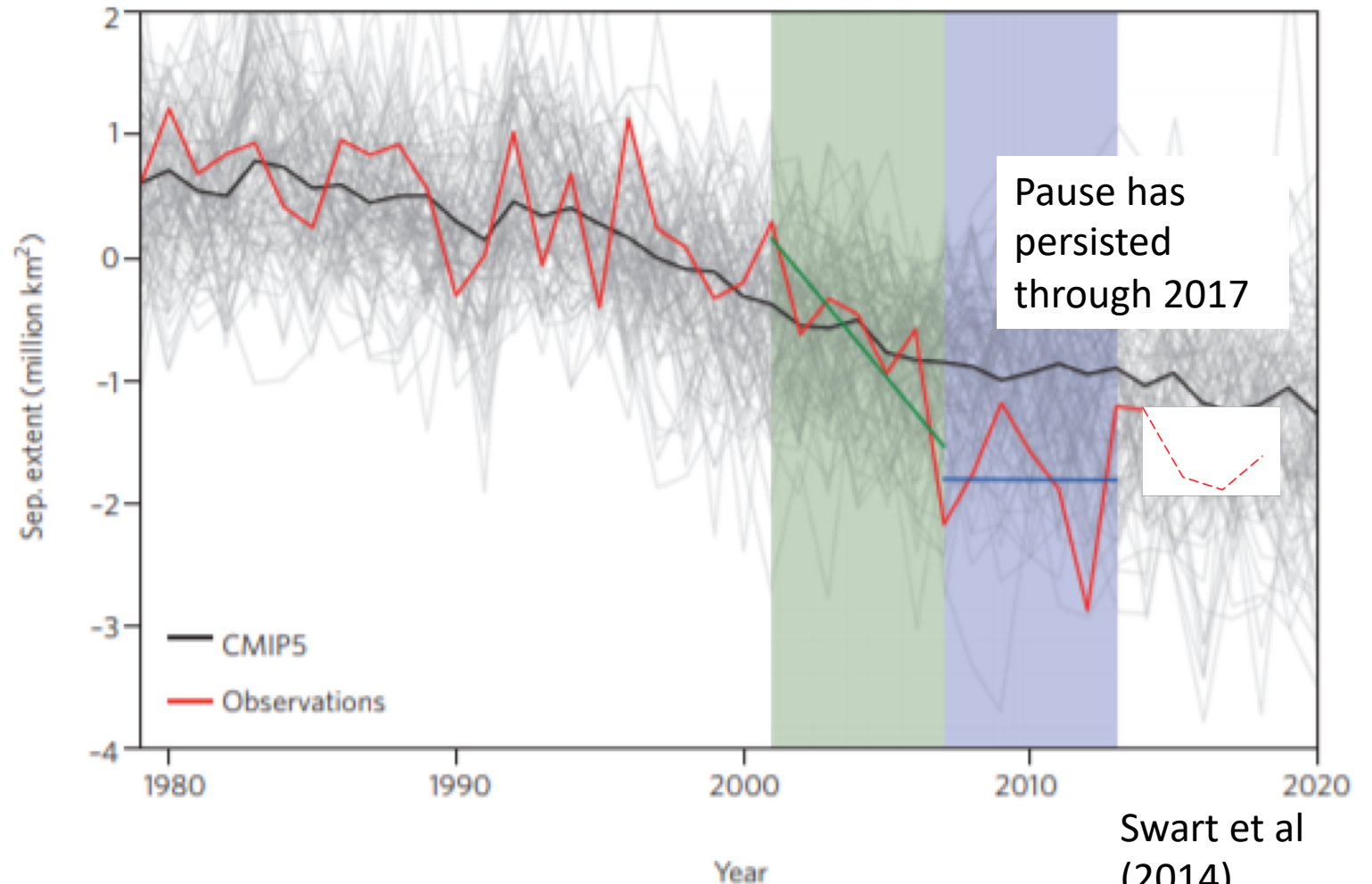
Recent slow melt of summer Arctic sea ice due to tropical Pacific SST changes

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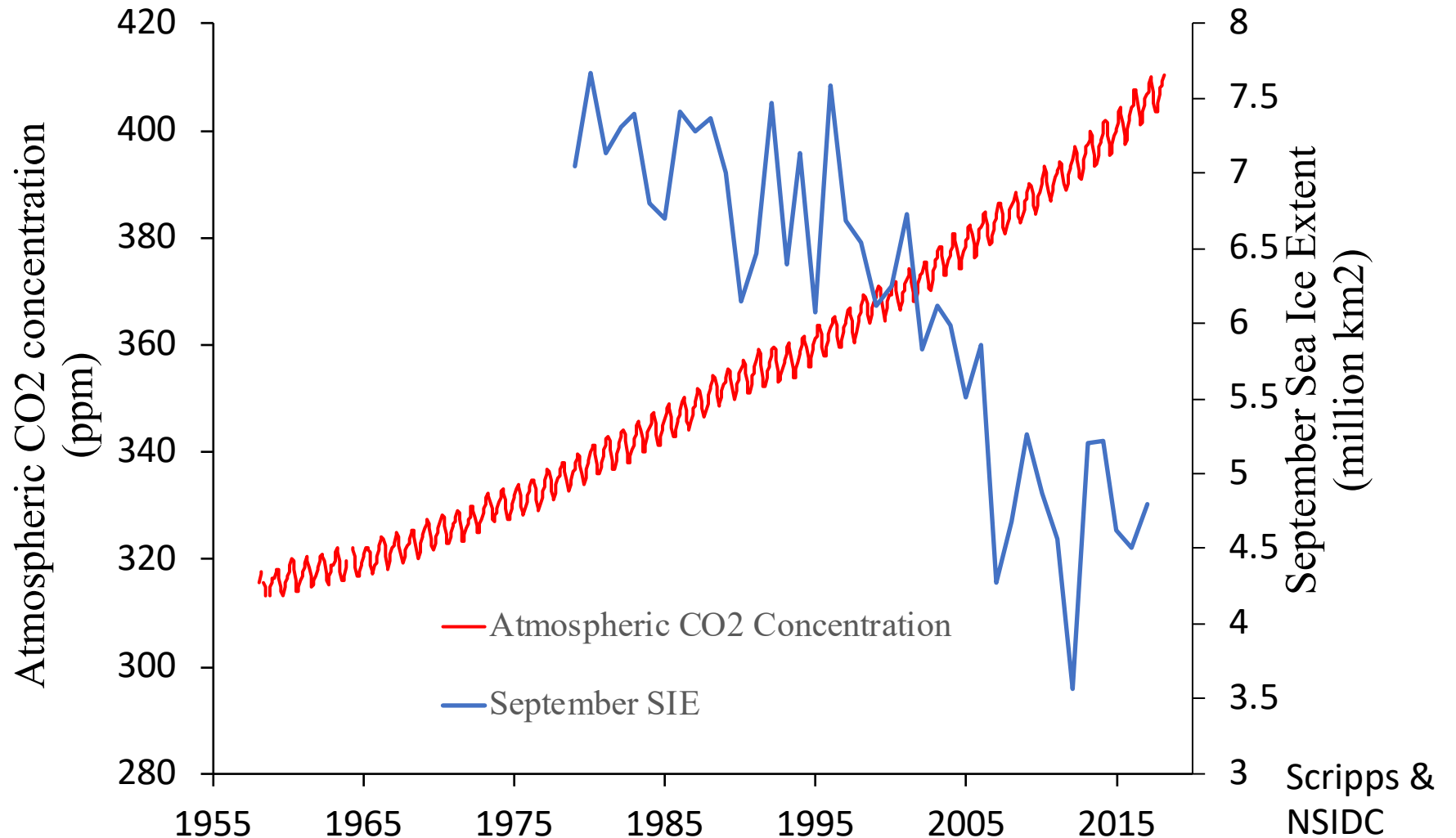
Identification of a pause

- Pause identified in September Sea Ice Extent (red line) 4 years ago.
- Black line is the ensemble average
- Grey lines are individual members from the CMIP5 model ensemble

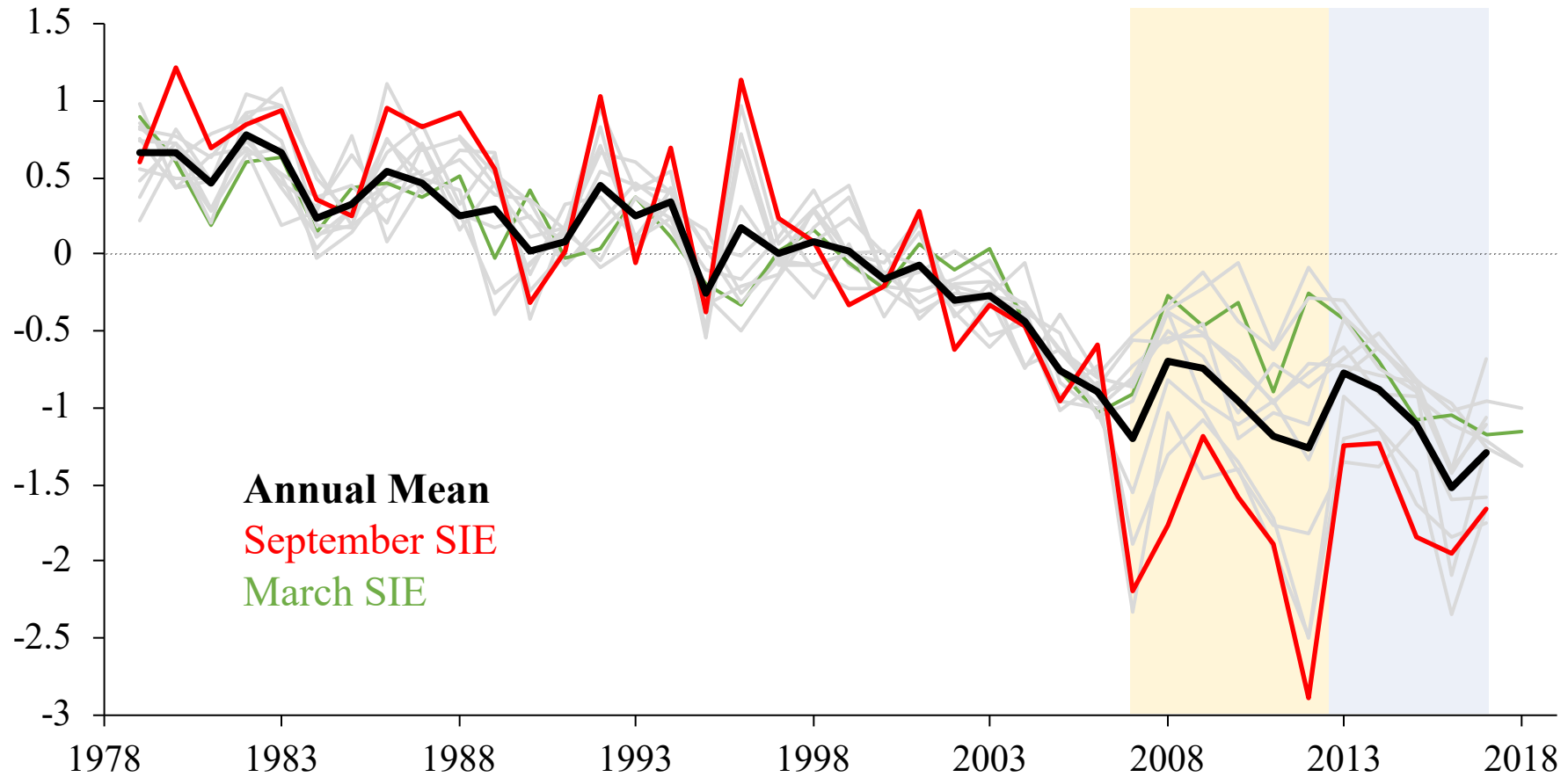


Relationship between carbon emissions and September sea ice extent

- CO2 emissions are increasing at 2ppm/year
- However, Arctic sea ice extent experienced rapid decline from 2002-2012 and this pause following 2013.
- Natural and anthropogenic aerosol forcing cannot explain shift either

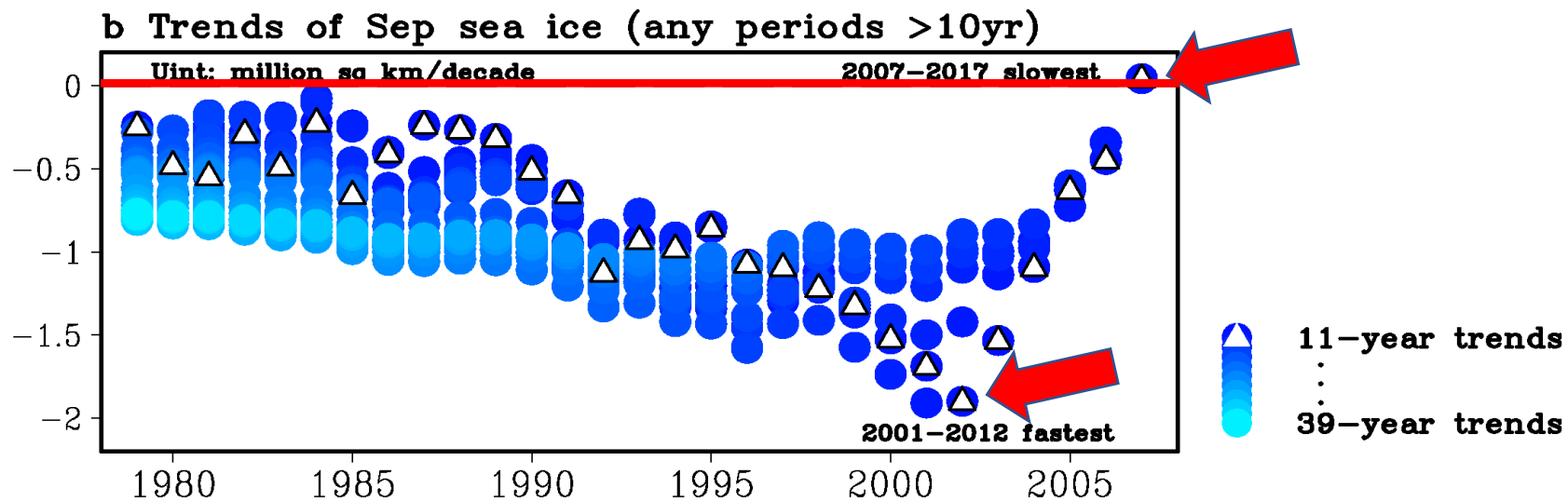
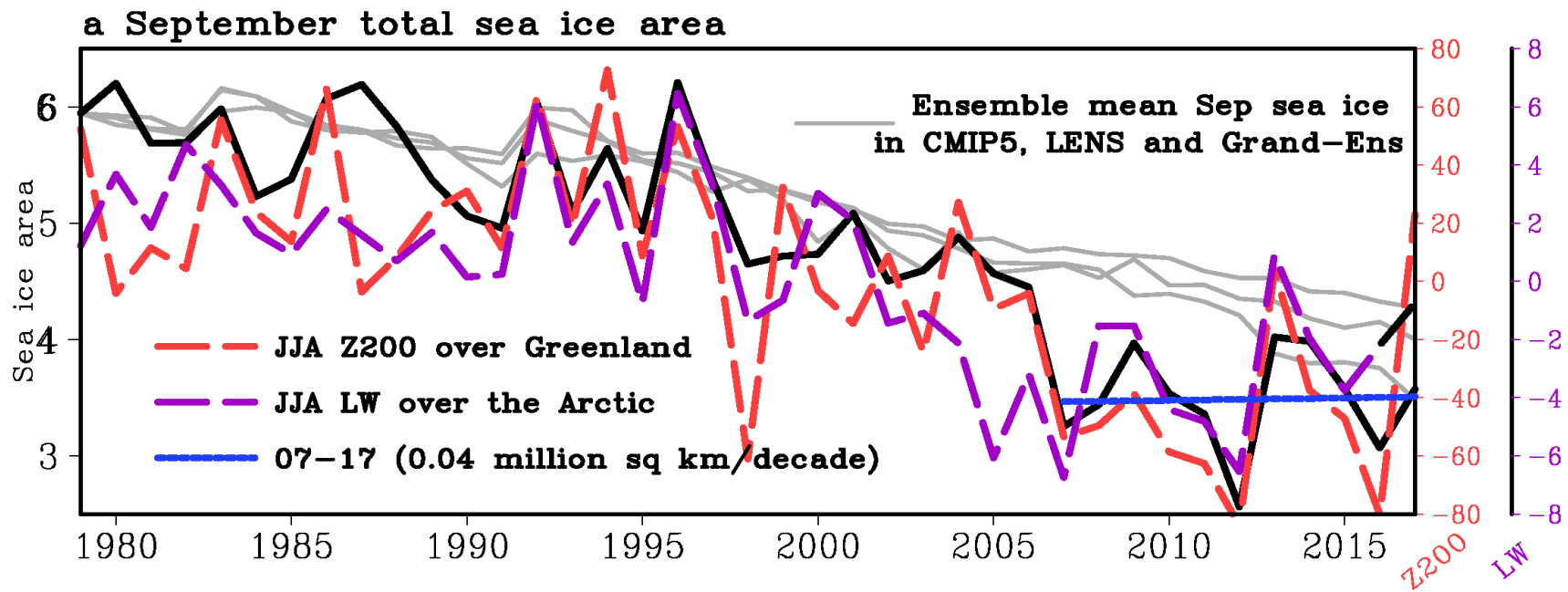


Sea Ice Extent with Annual Cycle Removed

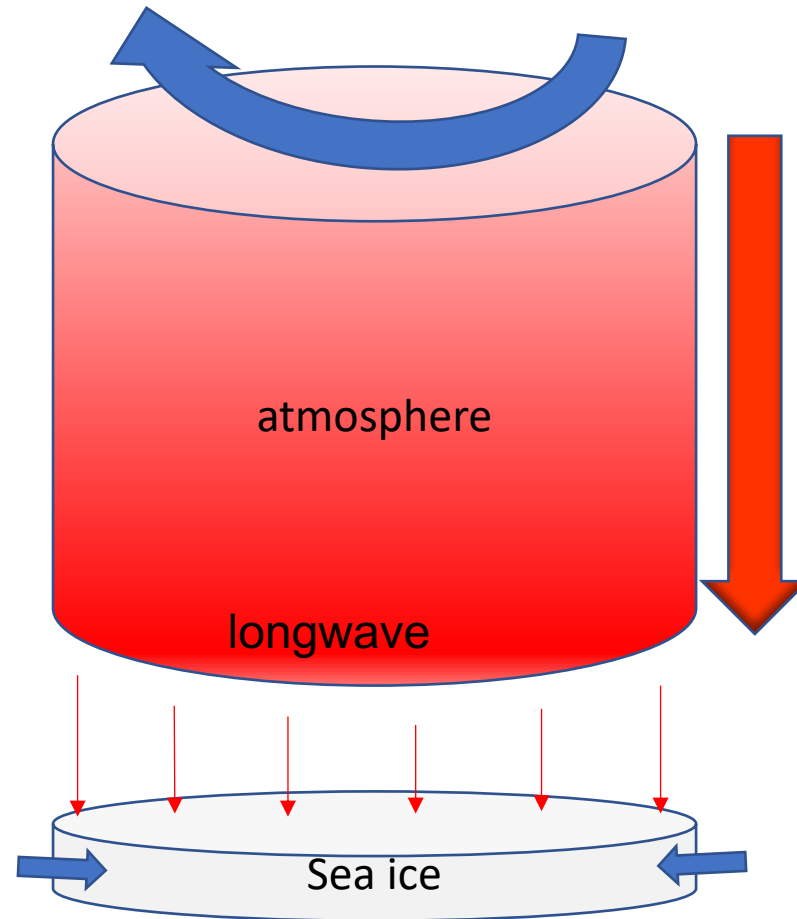


SST → Circulation → Sea Ice

- **Motivation:** To understand the possible drivers contributing to recent pause/slow-down in the September sea ice extent trend
- **Possible Explanations:** Climate noise or emergence of low-frequency tropical variability favoring enhancement/masking of anthropogenic forcing in the Arctic
- **Importance:** Understand the mechanisms contributing to changes in Arctic sea ice over the past 30 years and to project future changes (first ice-free summers)
- We establish connection through comparison of observations during three periods showing a shift in extratropical/tropical SST forcing.



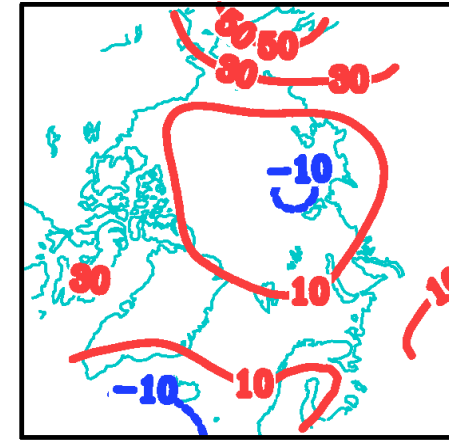
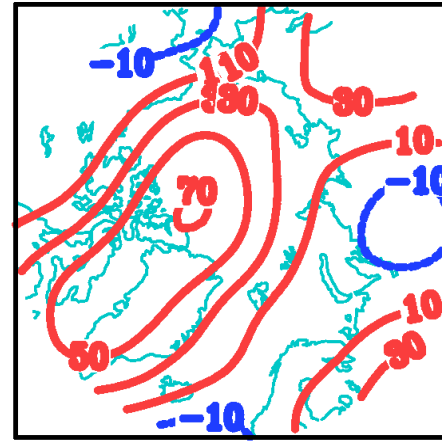
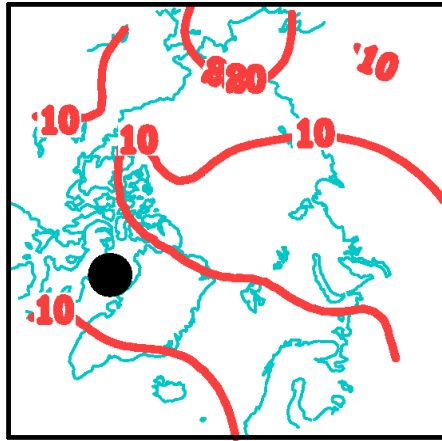
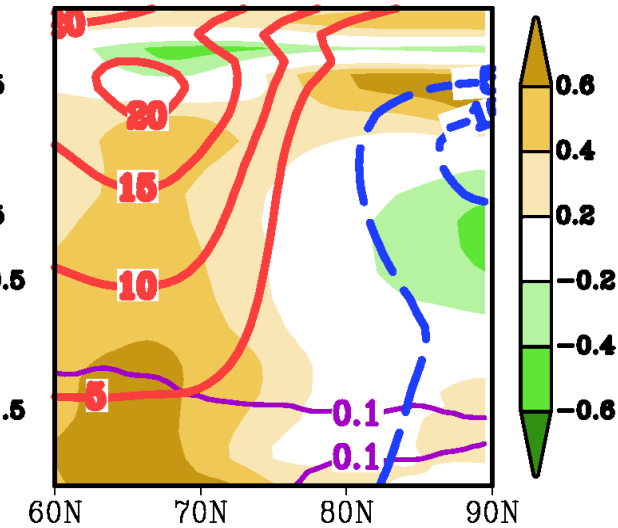
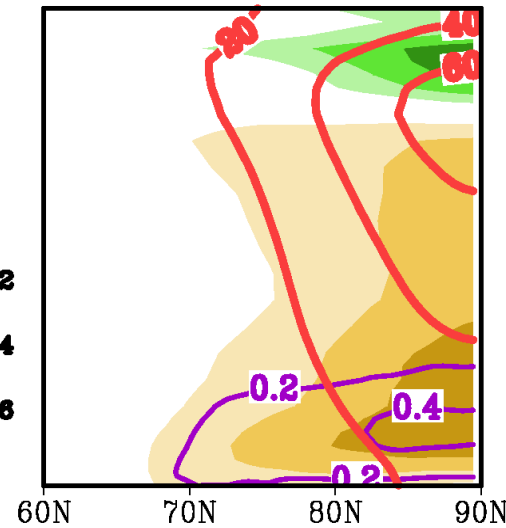
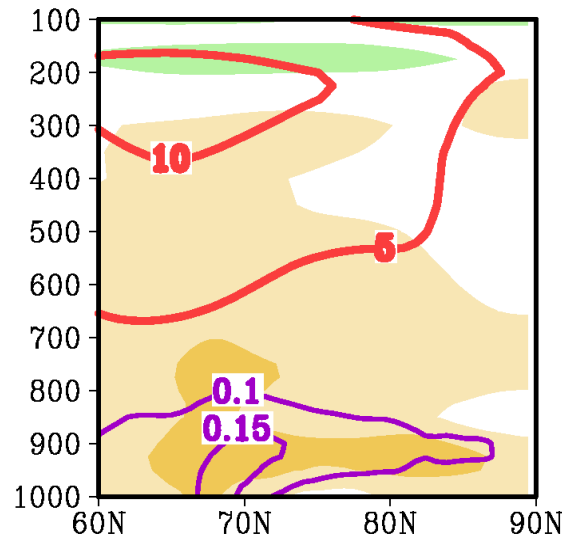
Anticyclone warms the Arctic by adiabatic processes



Trends during 1979-2006

Anomalies during 2007-2012

Anomalies during 2013-2017

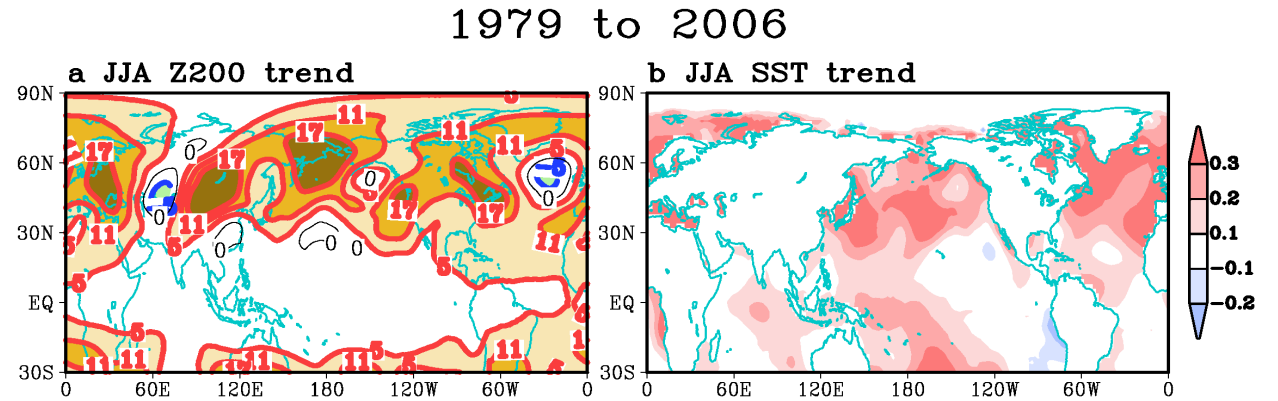
JJA Z200
(m)JJA zonal
mean
vertical
profiles (m)

T (K)

——— Positive JJA geopotential height (m)
 - - - - - Negative JJA geopotential height (m)

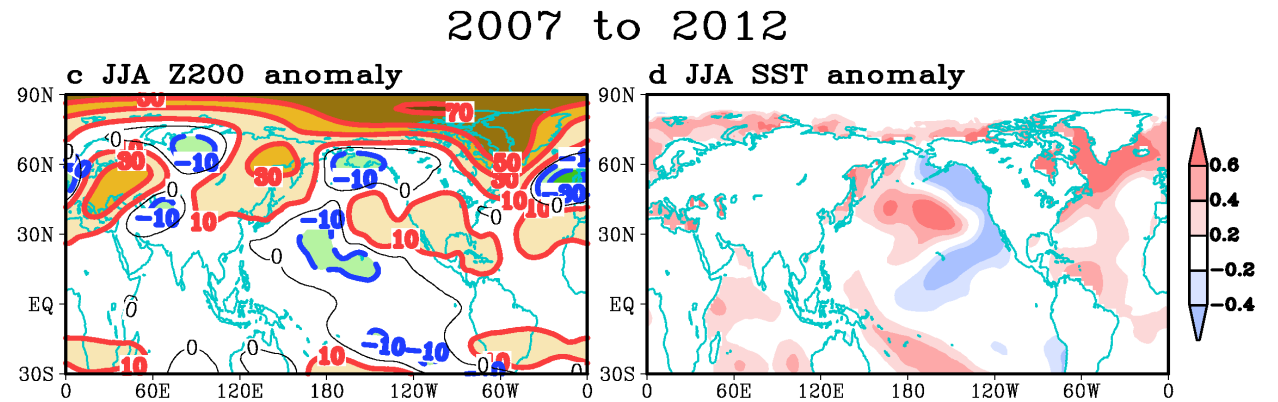
——— JJA Specific Humidity (g/kg)

Trends 1979-2006



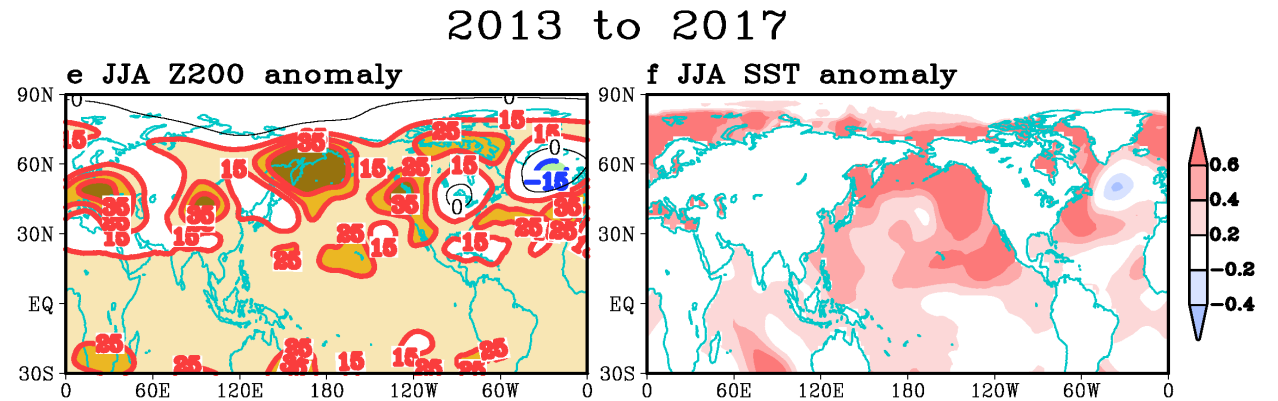
Anomalies 2007-2012

Period of enhanced PARC
cool Pacific-warm Arctic
phase.



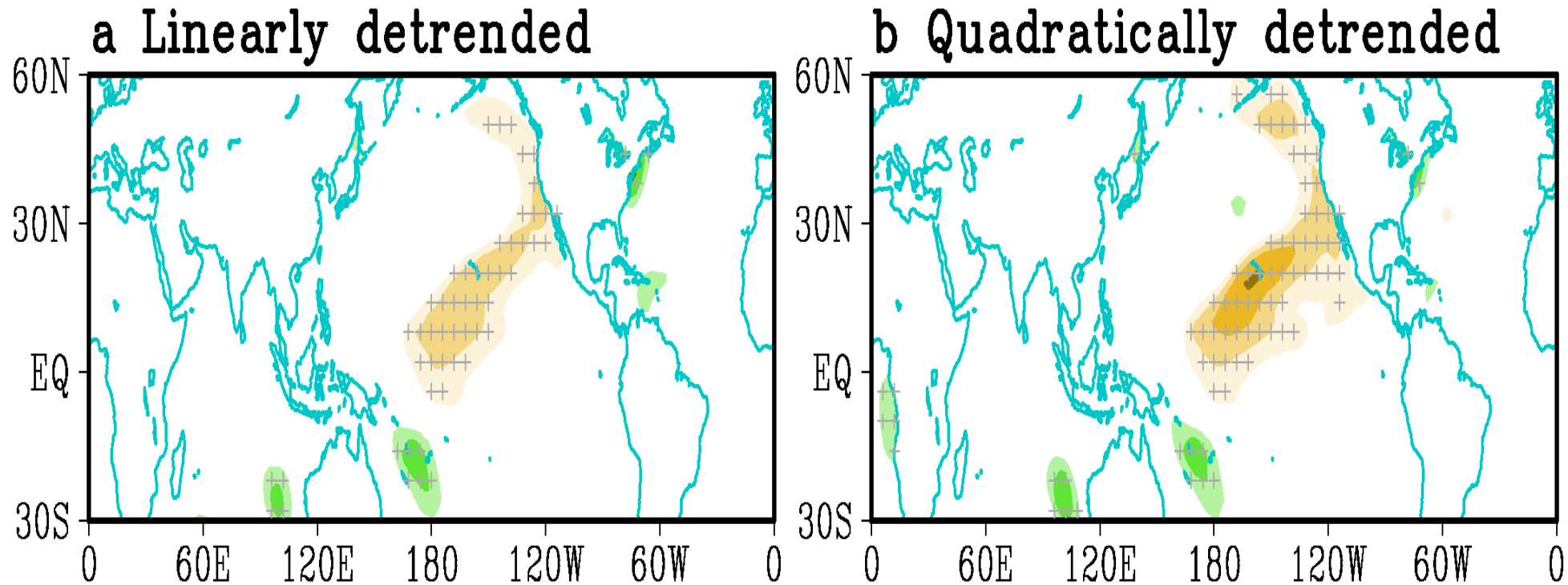
Anomalies 2013-2017

Warm Pacific with weak
Arctic cooling.



 Positive Z200 (m)  Negative Z200 (m)

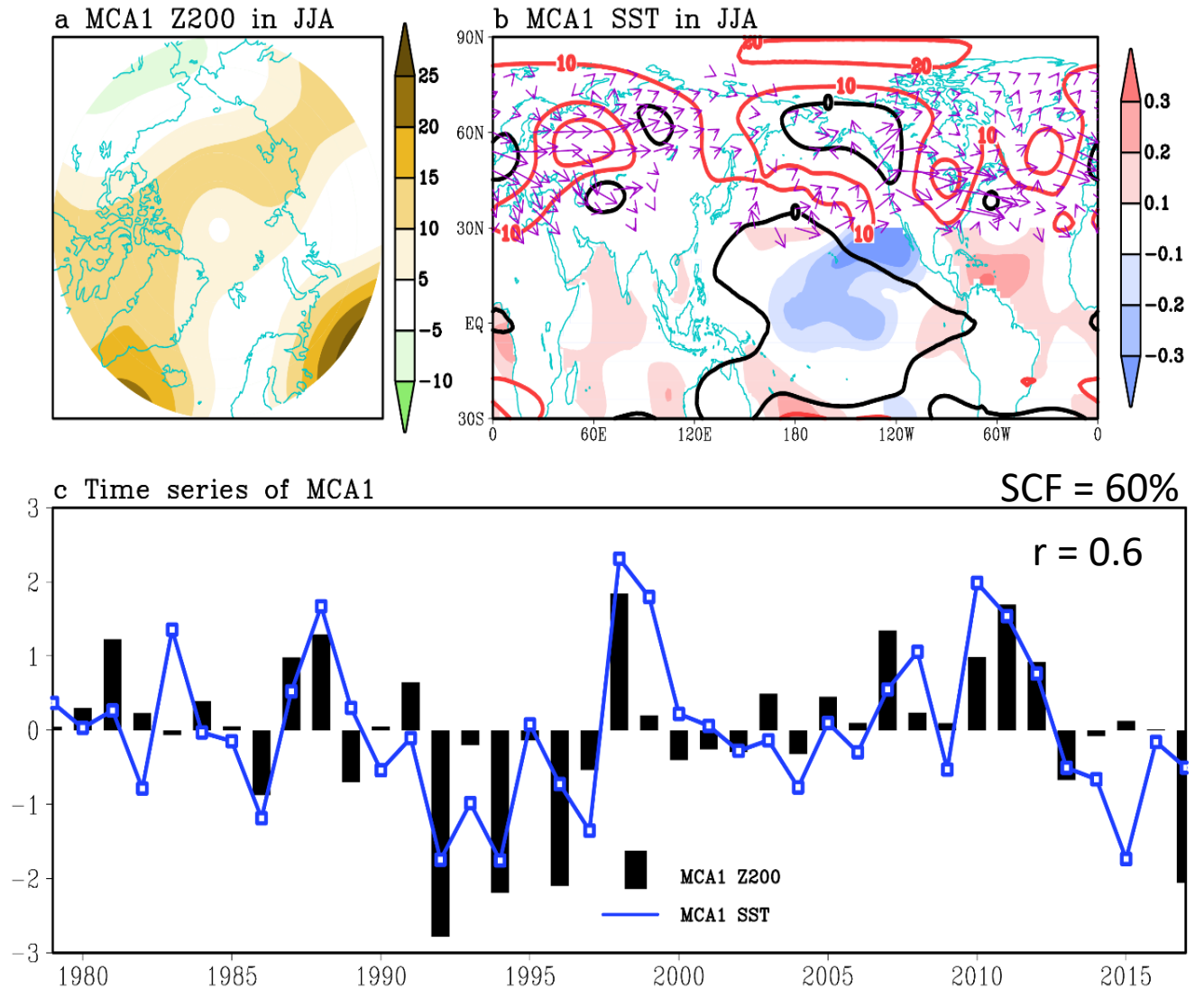
Correlation map between detrended JJA SST and September sea ice area



Stippling indicates statistical significance at the 95% confidence level

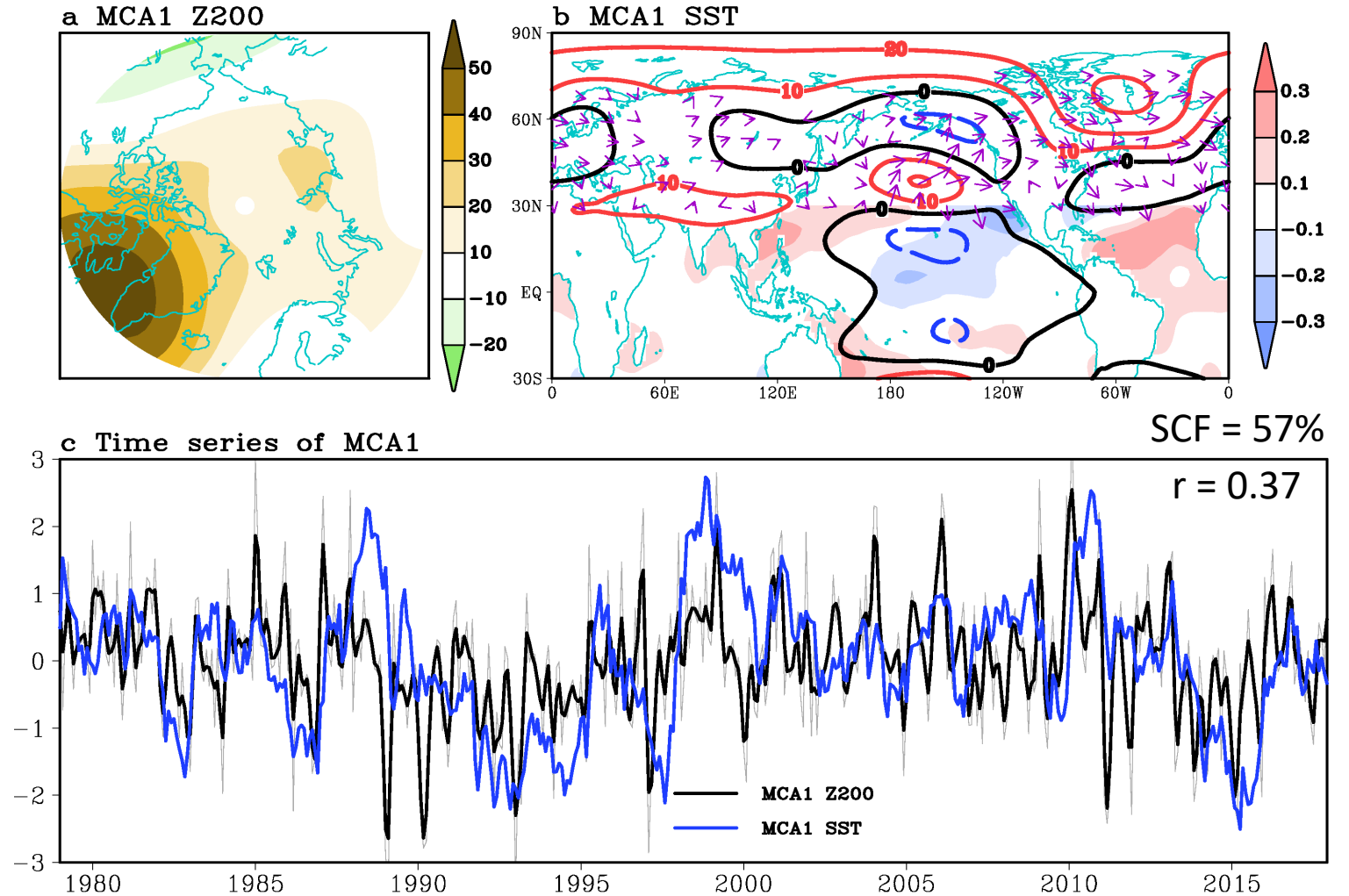
Maximum Covariance Analysis

Leading mode of covariance obtained using SVD of a covariance matrix between **detrended JJA SST** in the tropics and JJA 200 hPa **geopotential height** in the Arctic



Detrended Monthly MCA

Leading mode of covariance obtained using SVD of a covariance matrix between detrended JJA SST in the tropics and JJA 200 hPa geopotential height in the Arctic



ECHAM GCM

Experiment

Model Set Up: ECHAMv4.6 GCM coupled to slab ocean.

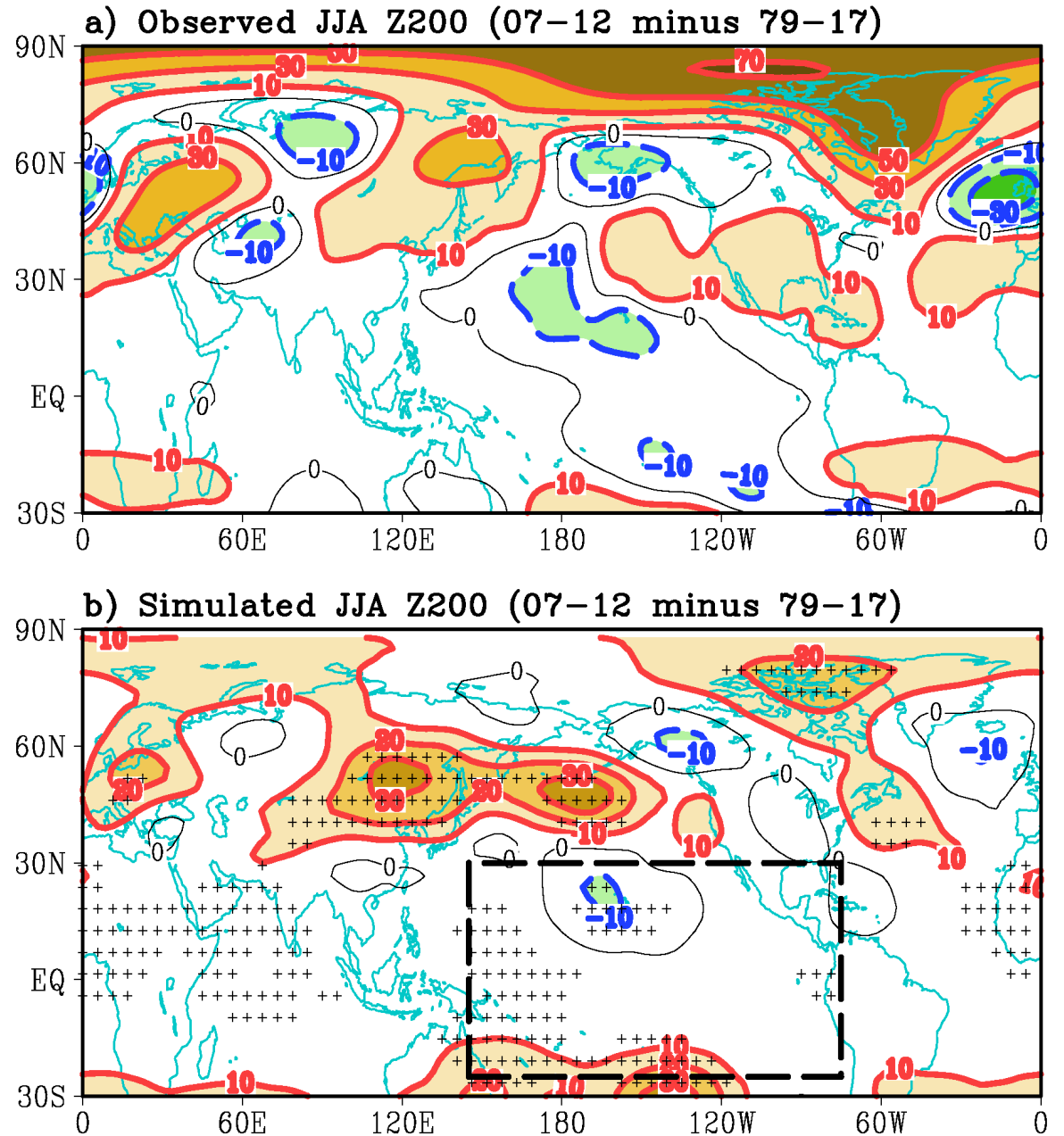
The ocean temperature or sea-ice condition at each grid point is affected only by heat exchange across the air-sea interface.

Anthropogenic forcing is fixed at constant levels.

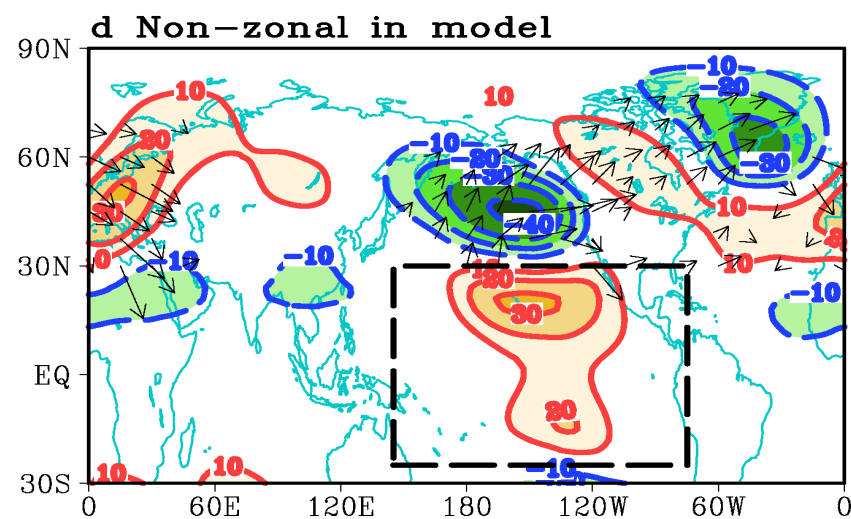
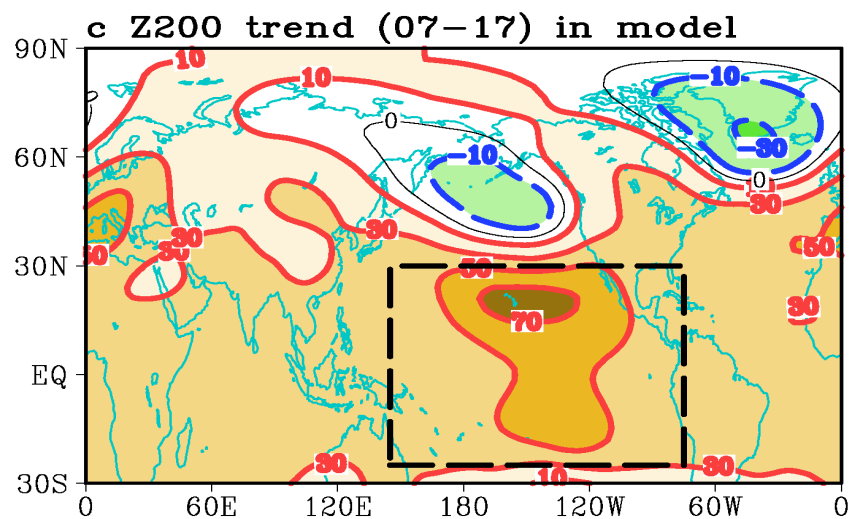
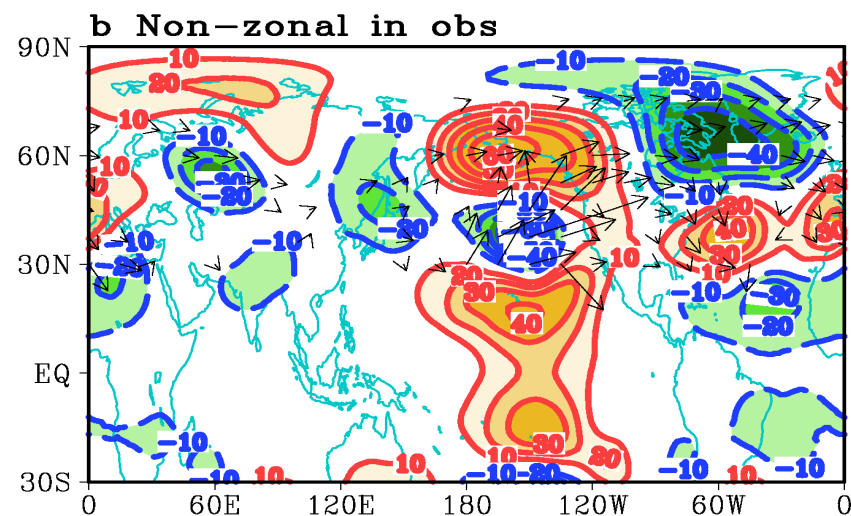
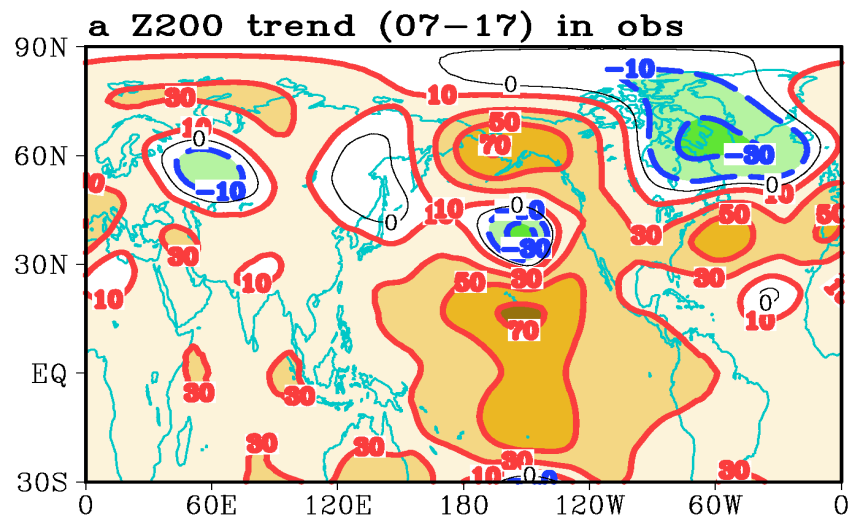
Both pacemaker simulations are integrated for 40 years (10 year spin up).

Sensitivity Run: Forced by observed tropical Eastern Pacific SST averaged from 2007-2012 (dashed black box).

Control Run: Forced with climatological (1979-2017) observed SST (12-month annual cycle) everywhere.



Annual mean transient experiment results 07-17

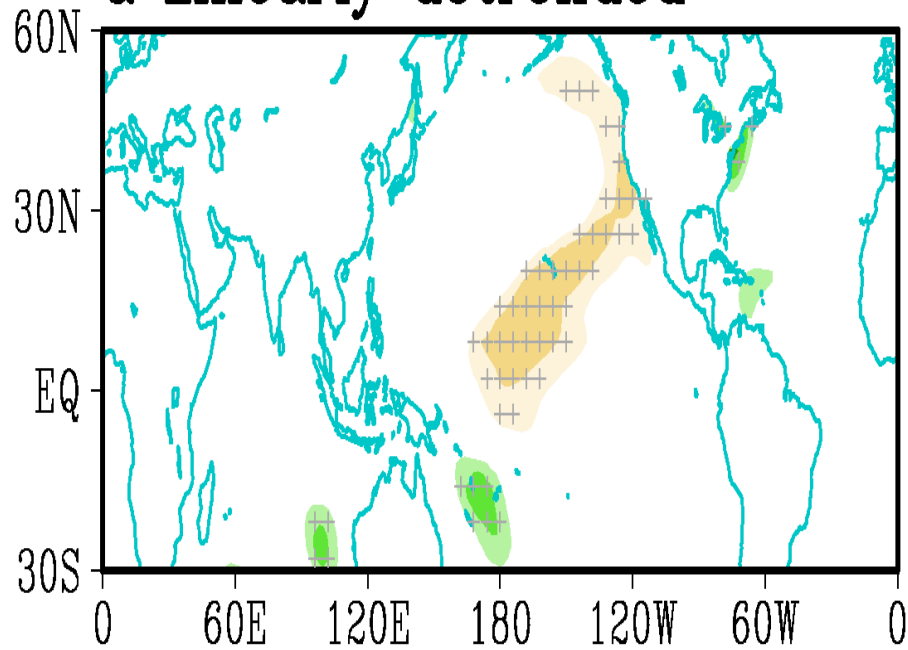


Conclusions

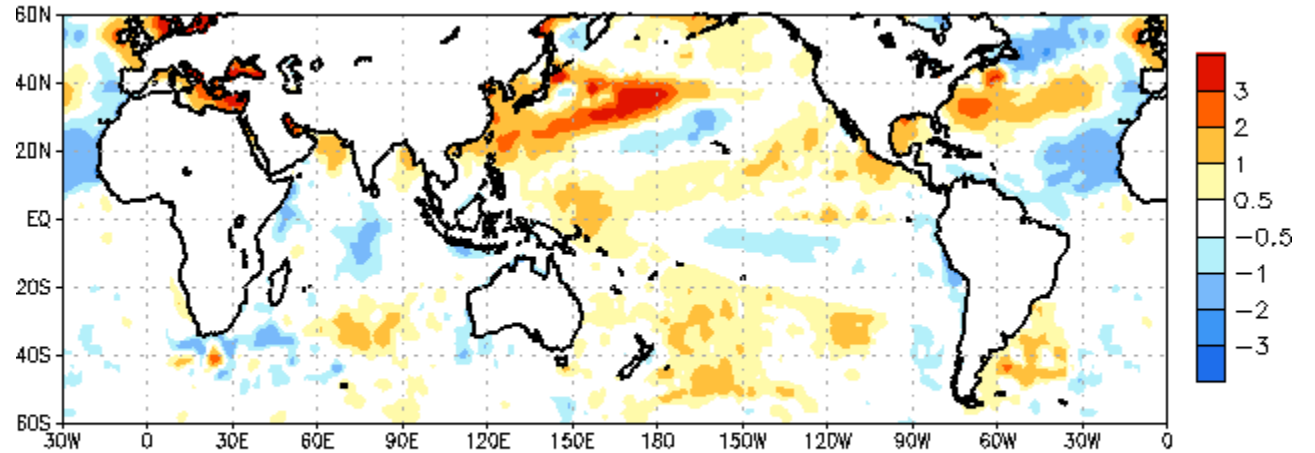
- Arctic sea ice extent has exhibited a near-zero trend since 2007 that appears inconsistent with the Arctic amplification theory used widely to explain Arctic climate change in the past decades.
- This slowdown in Arctic sea-ice loss is due to tropically-driven atmospheric teleconnections which switched from enhancing to masking the effect of anthropogenic forcing.
- A better understanding of this tropical Arctic teleconnection is important for the prediction of sea ice loss in global climate model simulations

An attempt at prediction

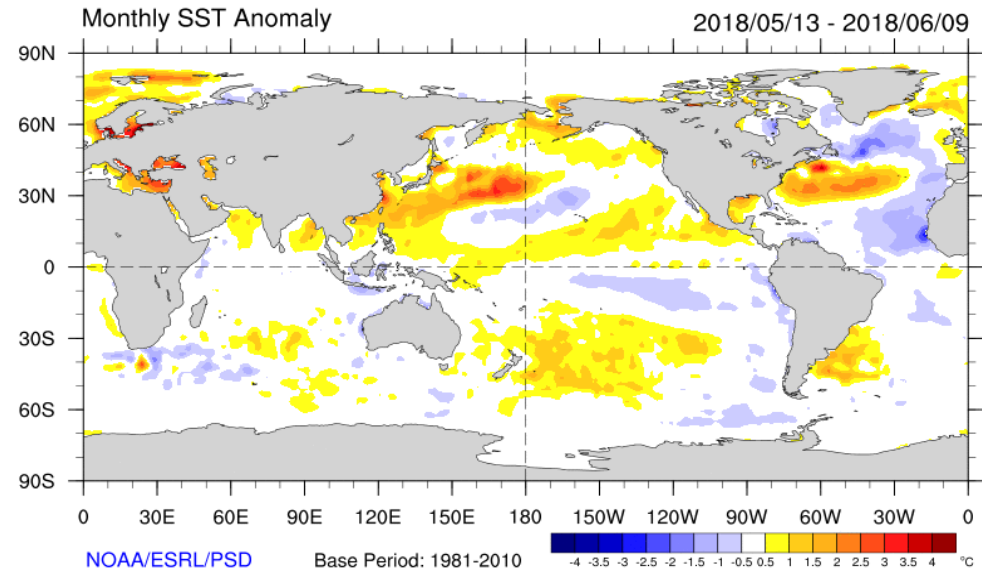
a Linearly detrended



Weekly Ave. SST Anomalies (°C) 06JUN2018

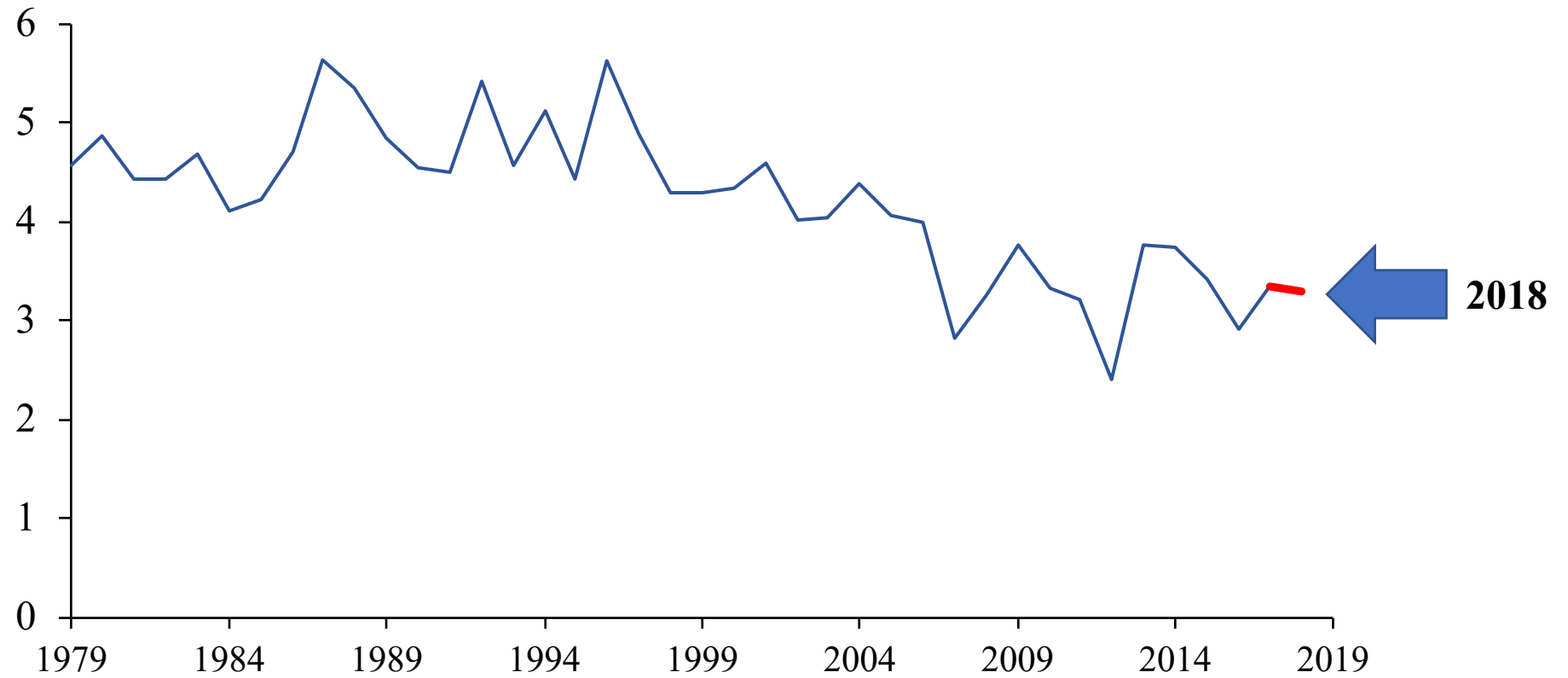


Data Source: NCEP Global Sea Surface Temperature Analyses
Climatology (1981–2010)

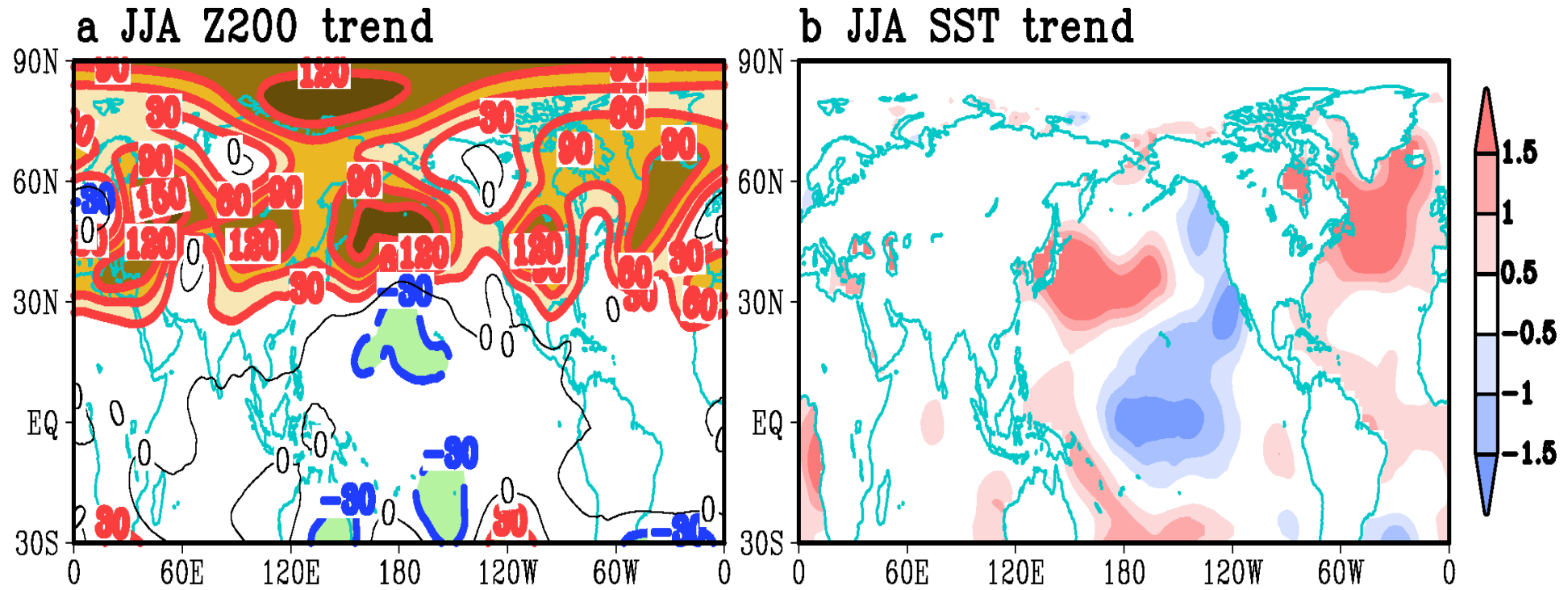


Thank you!

September Arctic sea ice area index



1992 to 2000



References

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