

Late 20th century simulation of Arctic sea-ice and ocean properties in the CCSM4

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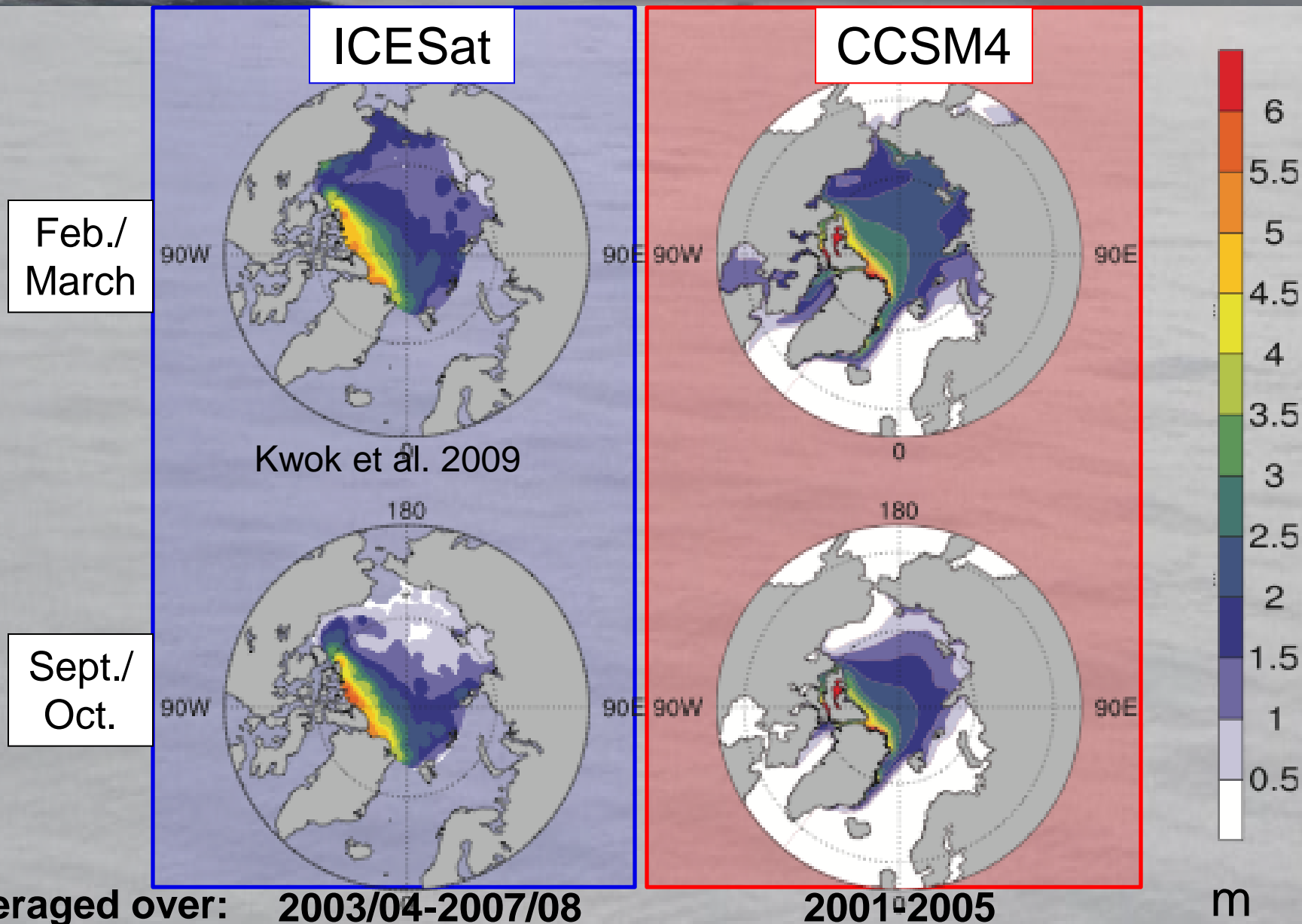
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Objective and Method

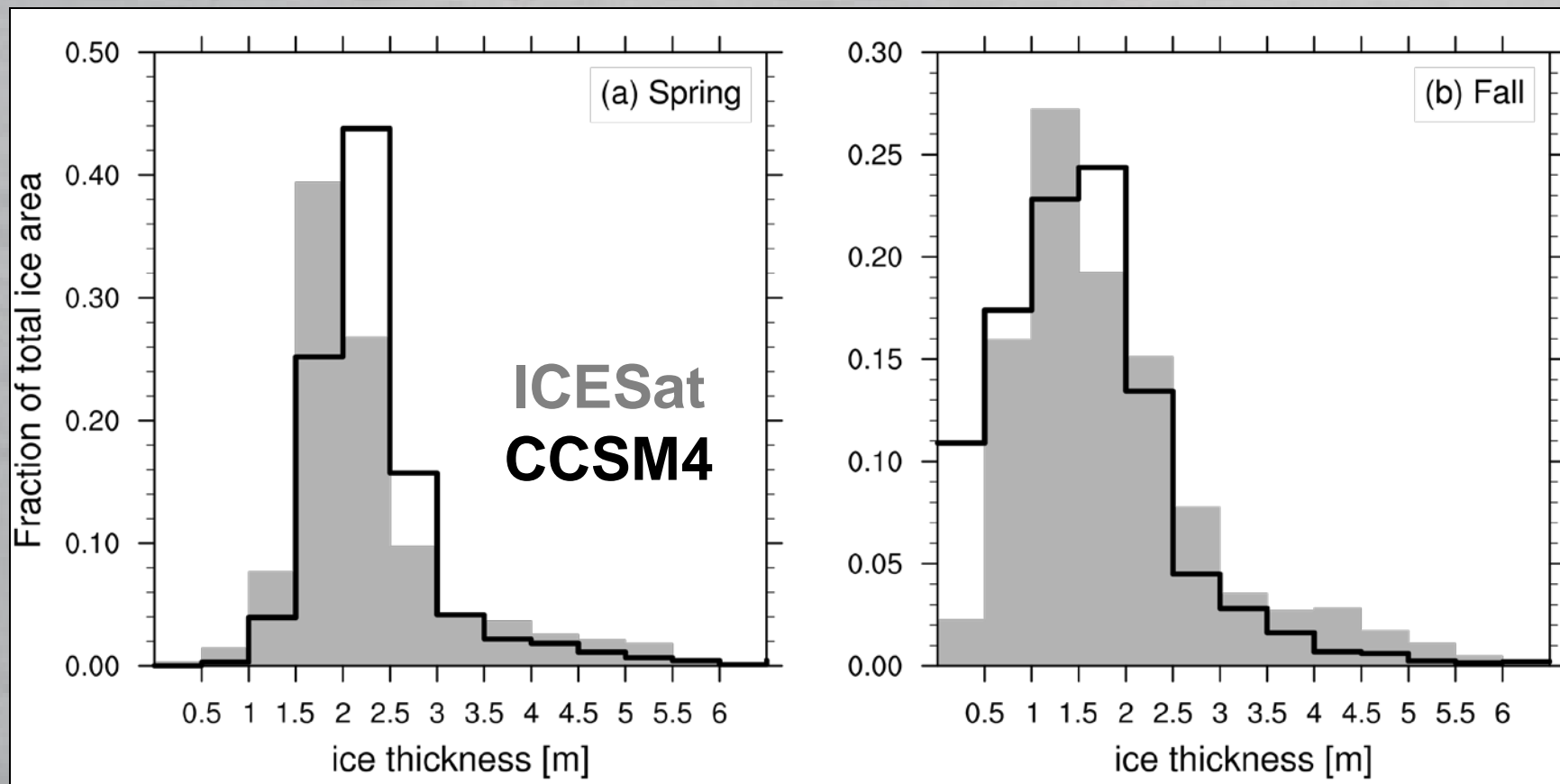
- **Objective:** Establish how well the CCSM4 simulates the late 20th century Arctic sea ice and ocean properties
 - This is important in order to evaluate future CCSM4 projections for the Arctic
- **Method:** compare the six available 1981-2005 CCSM4 ensemble simulation with available observations

- **Sea ice:** several satellite derived datasets with monthly resolution for 1979-2005 (except ICESat sea-ice thickness data, which only includes spring and fall for 5 years)
 - **Problem:** often satellite data does not provide the same variables as the model
- **Ocean:** climatological datasets for temperature, salinity and flux measurements from cruises and moorings → *not covered today, see paper*

Sea ice thickness



Sea ice thickness

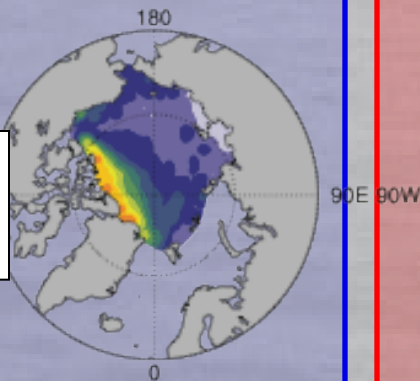


Sea ice thickness

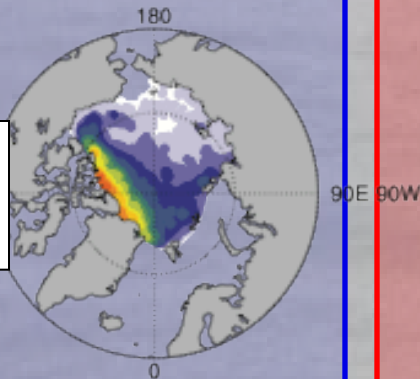
ICESat

Kwok et al. 2009

Feb./
March



Sept./
Oct.

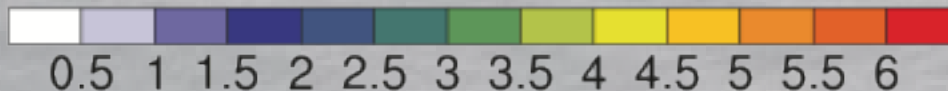
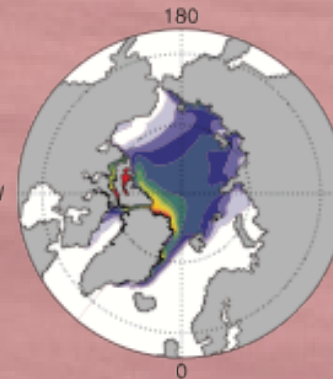
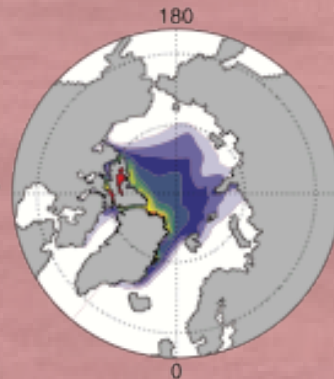
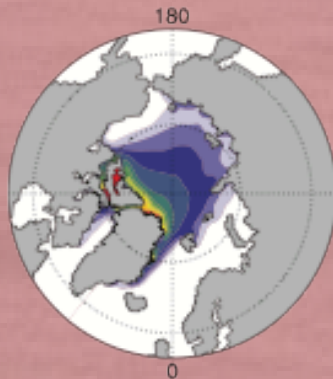
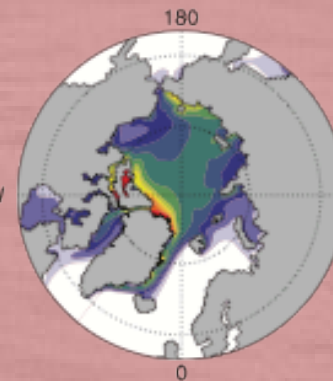
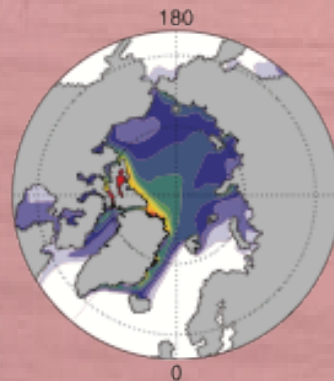
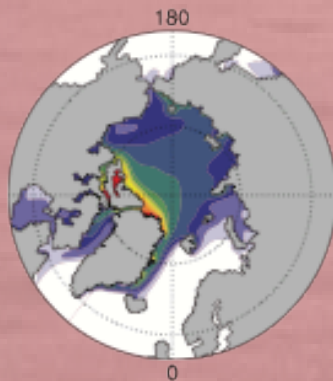


CCSM4

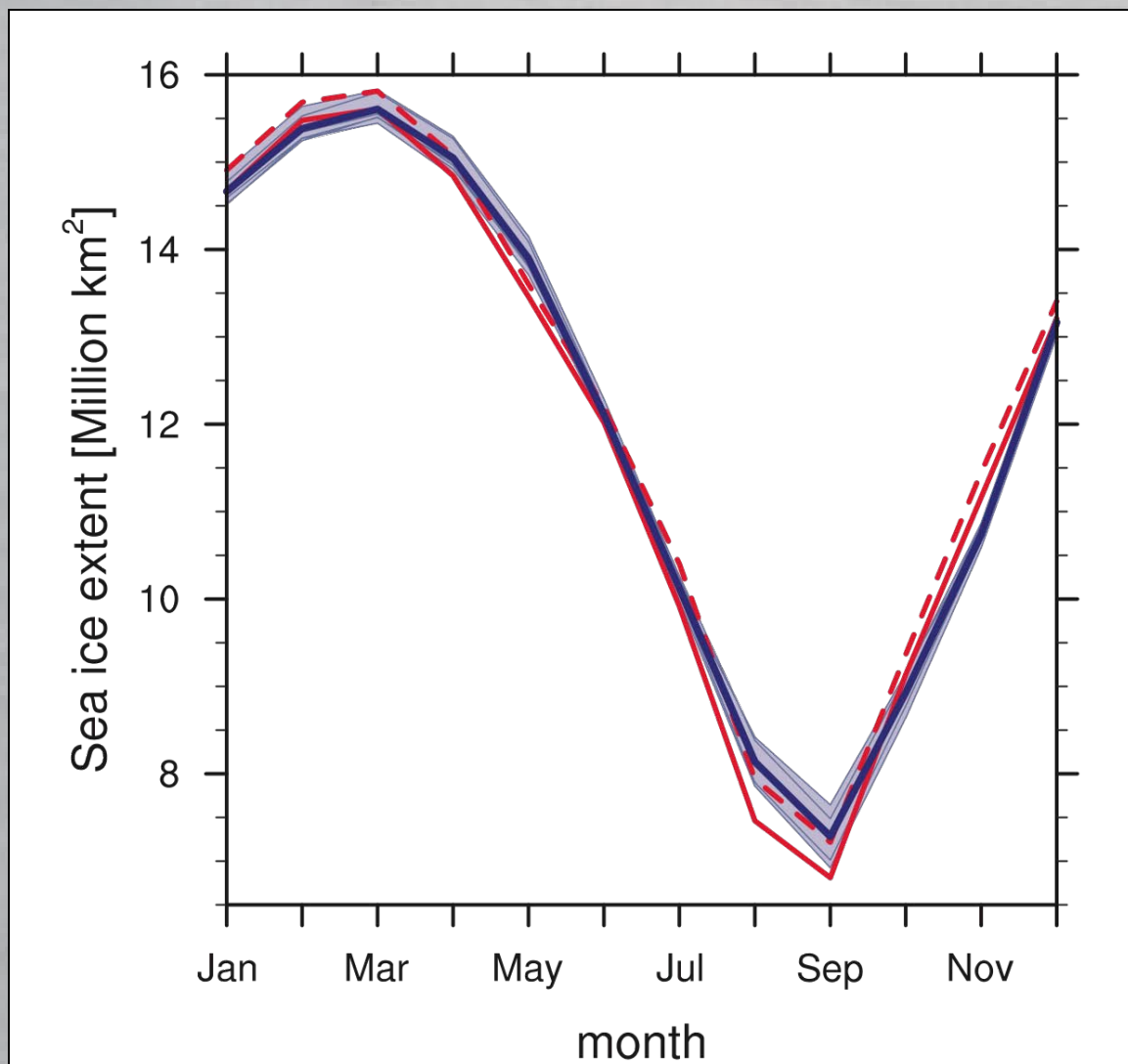
Ensemble mean

Minimum member

Maximum member

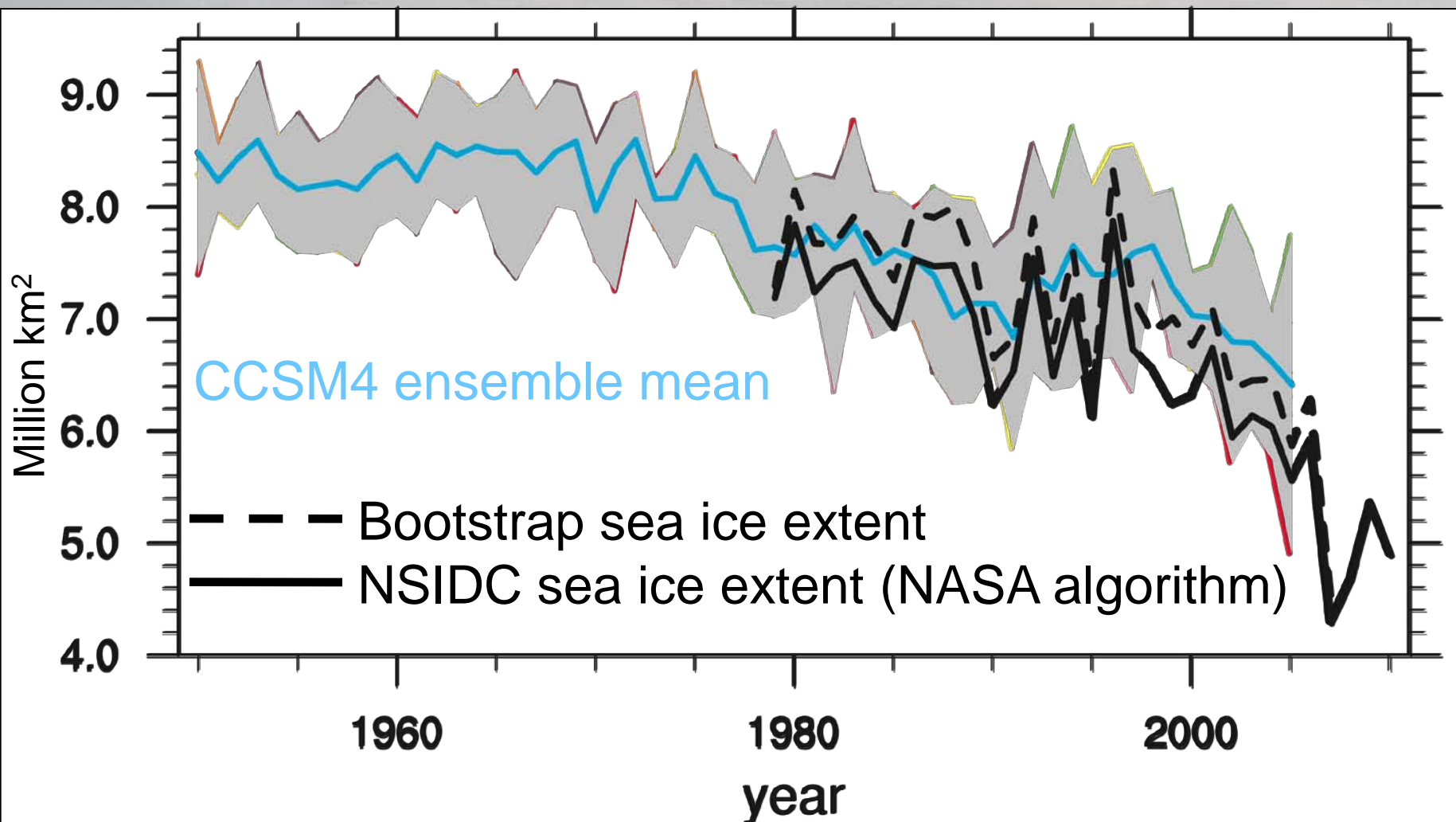


Seasonal cycle of ice extent

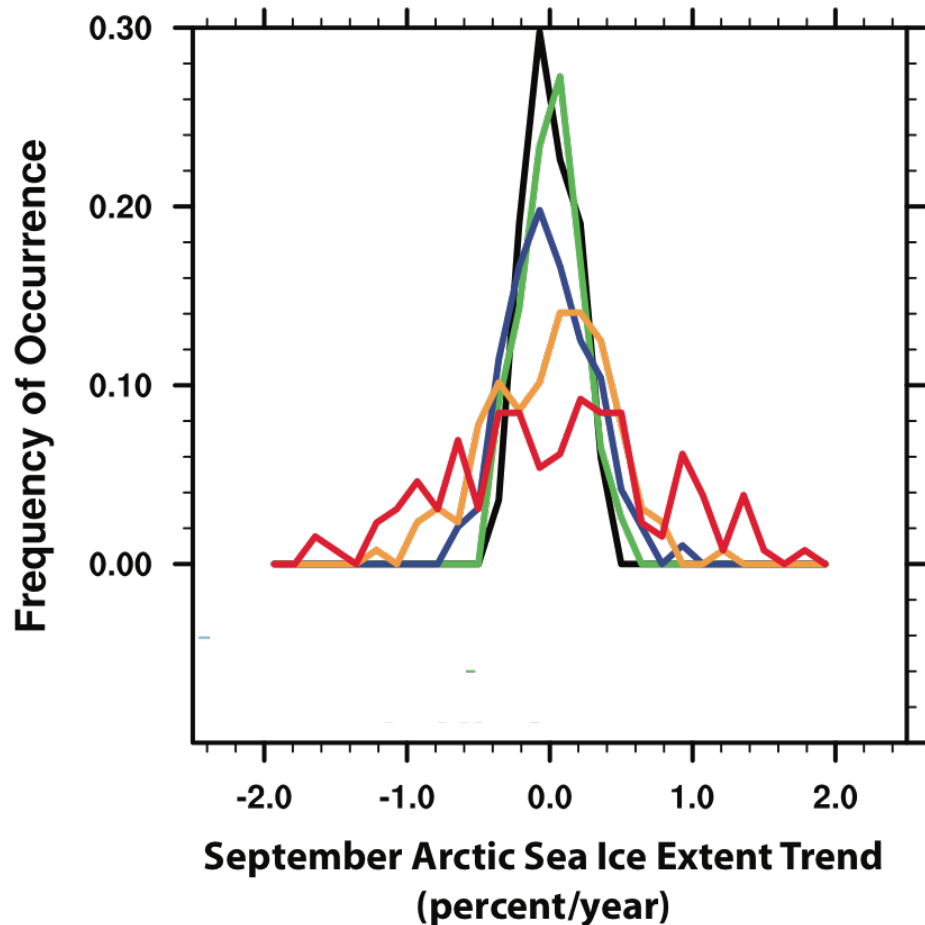


- NSIDC sea ice extent (Fetterer et al. 2002)
- - Bootstrap sea ice extent (based on ice concentration data from Comiso 1999)
- CCSM4 ensemble mean

September ice extent



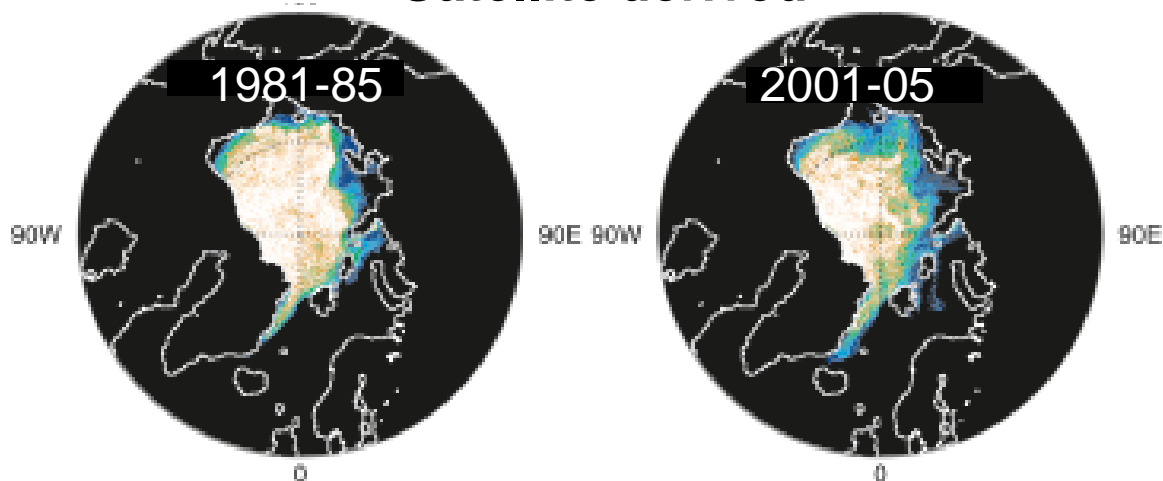
September sea ice extent trends



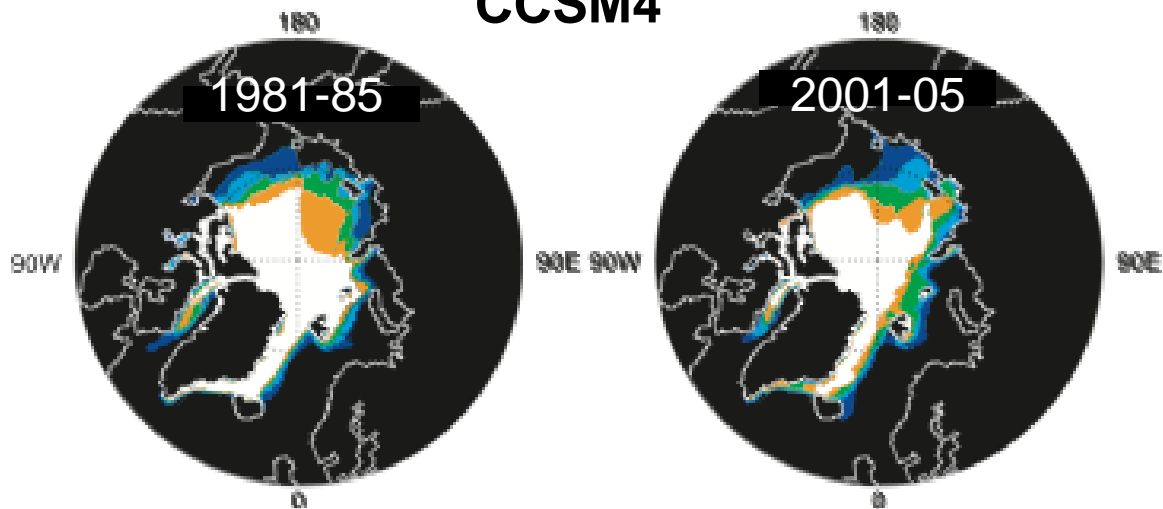
- 1850 CCSM4 control 30-year trend PDF
- 1850 CCSM4 control 25-year trend PDF
- 1850 CCSM4 control 20-year trend PDF
- 1850 CCSM4 control 15-year trend PDF
- 1850 CCSM4 control 10-year trend PDF

Multiyear ice

Satellite derived



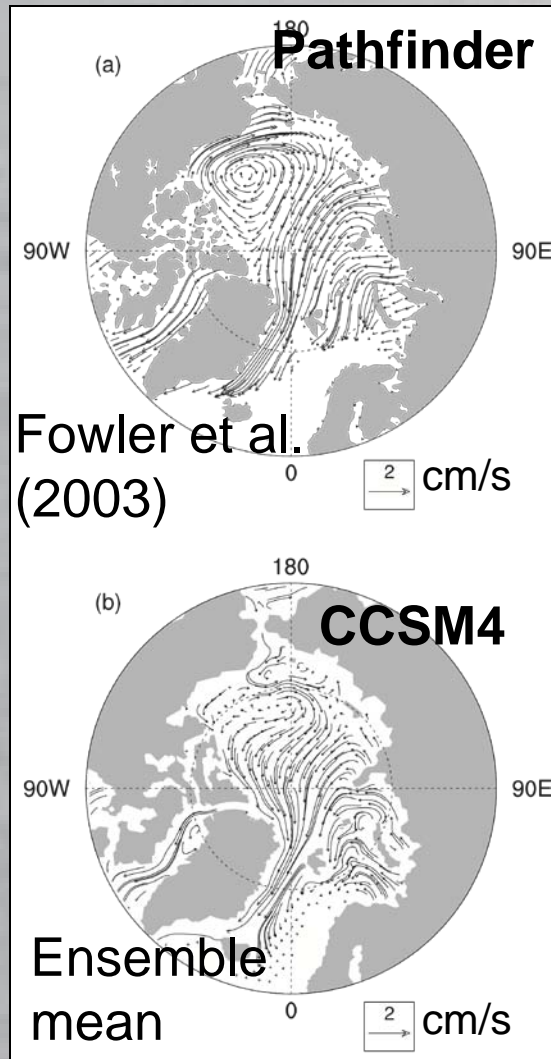
CCSM4



% of occurrence in 5 year period

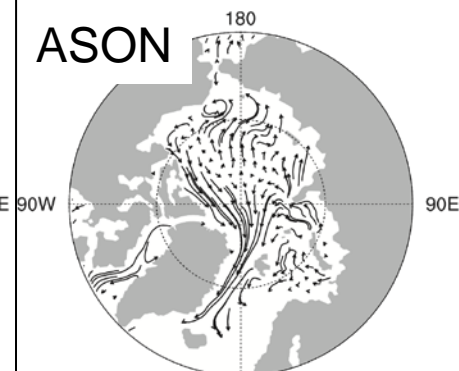
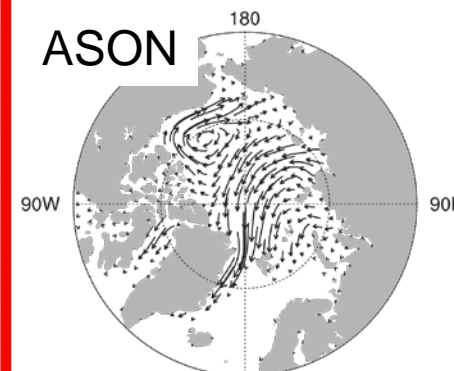
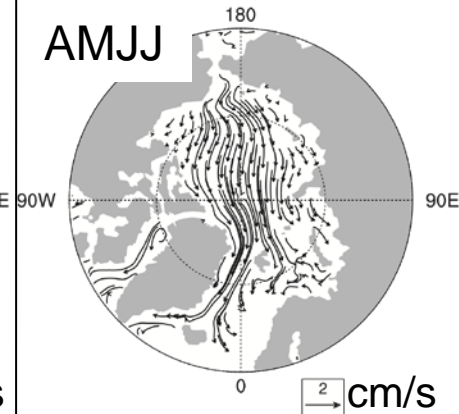
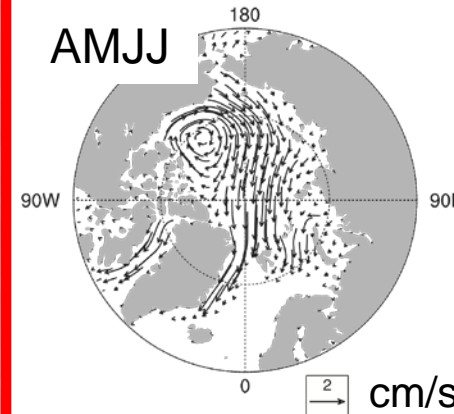
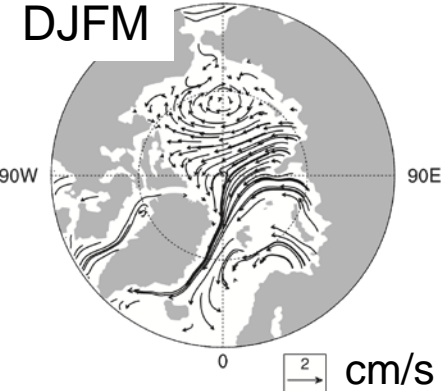
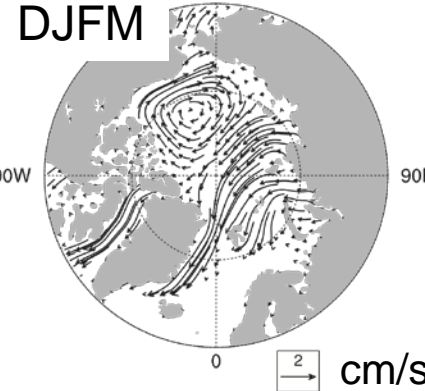
Sea ice velocity

Annual mean 1981-2005

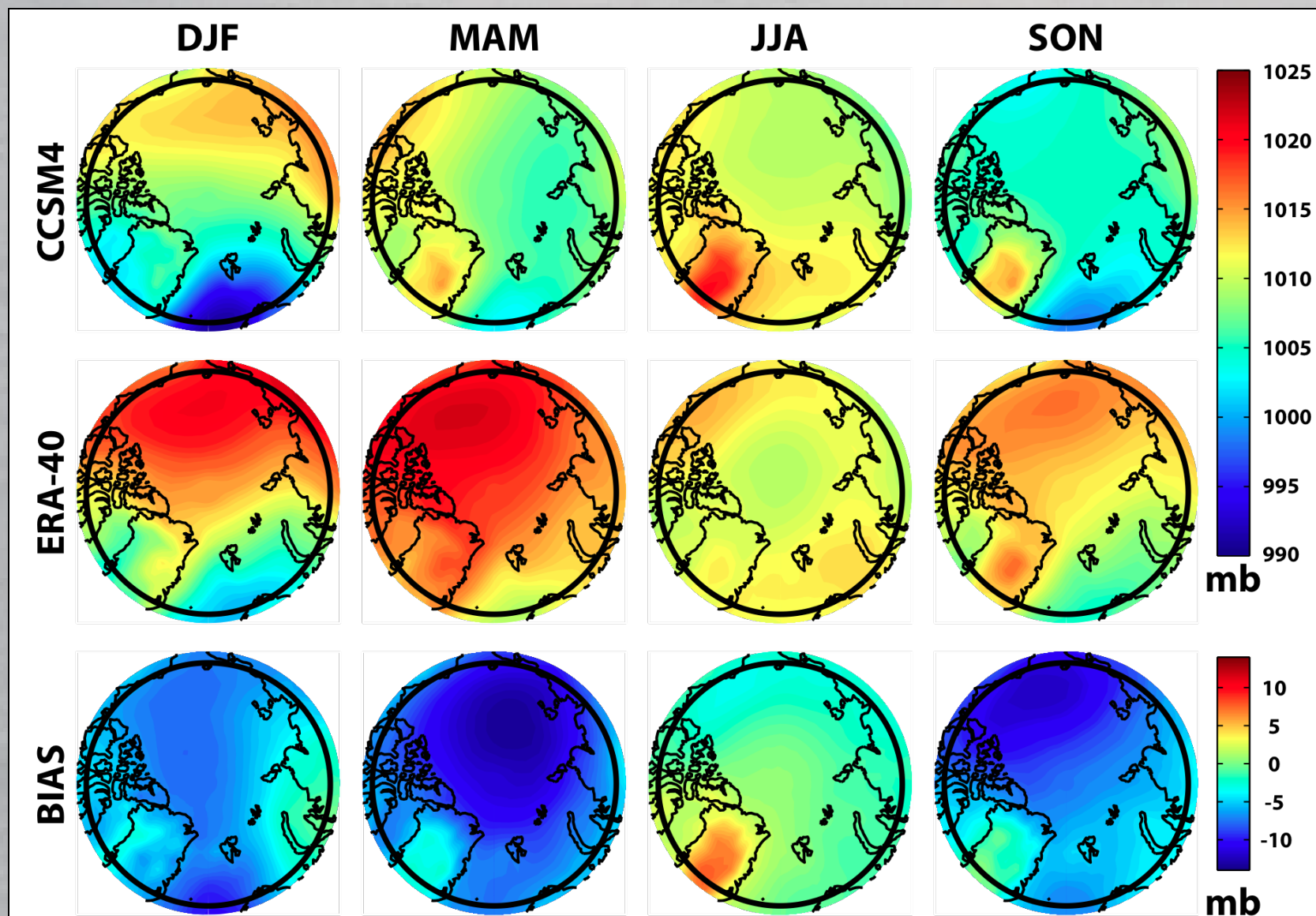


Pathfinder

CCSM4



SLP bias



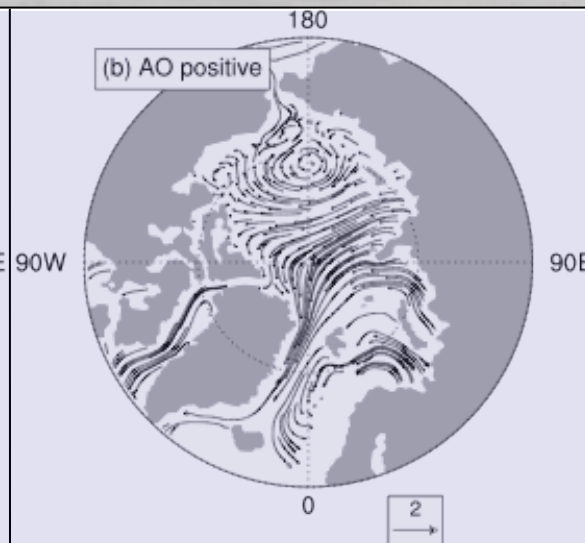
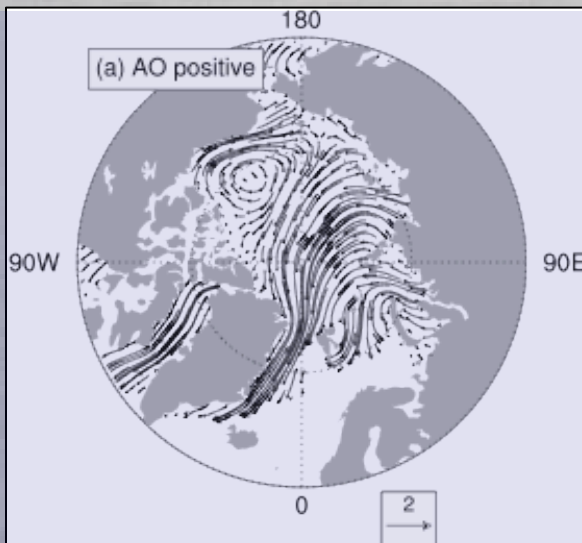
de Boer et al. (2011)

Sea ice velocity (DJFM)

Pathfinder

CCSM4

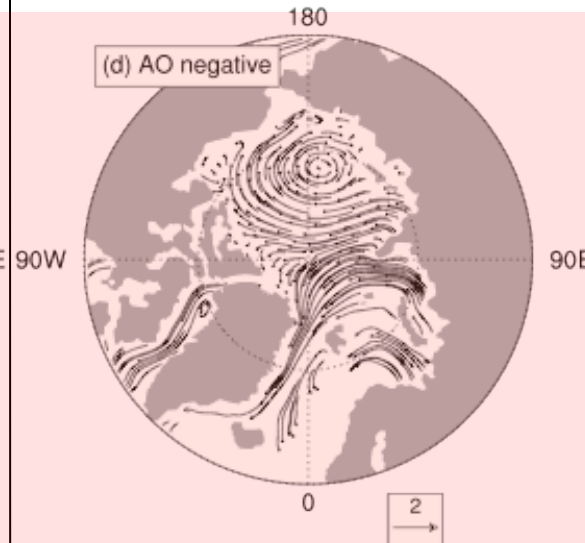
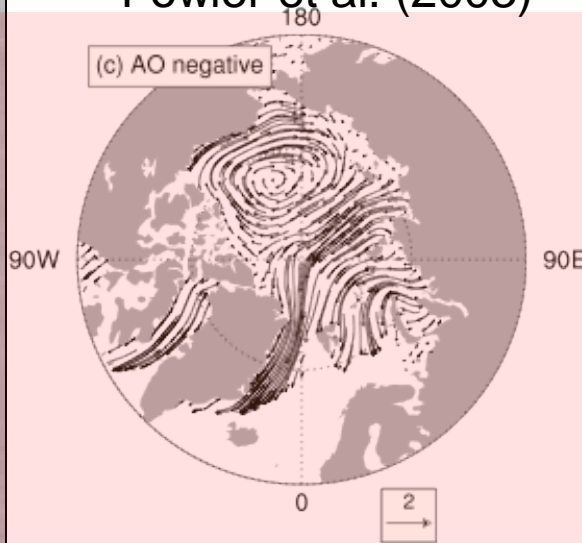
**AO
positive
composite**



**More cyclonic
circulation
→ weaker
Beaufort Gyre**

Fowler et al. (2003)

**AO
negative
composite**



**More
anticyclonic
circulation
→ stronger
Beaufort Gyre**

Summary



- The CCSM4 simulates the sea-ice thickness, multi-year sea ice cover, sea ice extent, and qualitative regime shifts in the sea-ice motion well compared to observations
- Individual ensemble members show important differences in sea-ice thickness patterns and sea-ice extent trends over 1981-2005, due to the imprint of natural variability
- Large biases in the sea-ice simulation exist mainly in the circulation pattern of the sea-ice, especially between spring and fall, and a displaced Beaufort Gyre

A sunset over the ocean with the word "Thanks!" overlaid in the center. The sun is low on the horizon, creating a bright orange and yellow glow that fades into a dark blue sky. The ocean is dark and textured with small waves. In the distance, there are silhouettes of landmasses or islands.

Thanks!

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