A modelling study of the possible role of clouds in strong polar amplification during warm climates

PAMIP workshop
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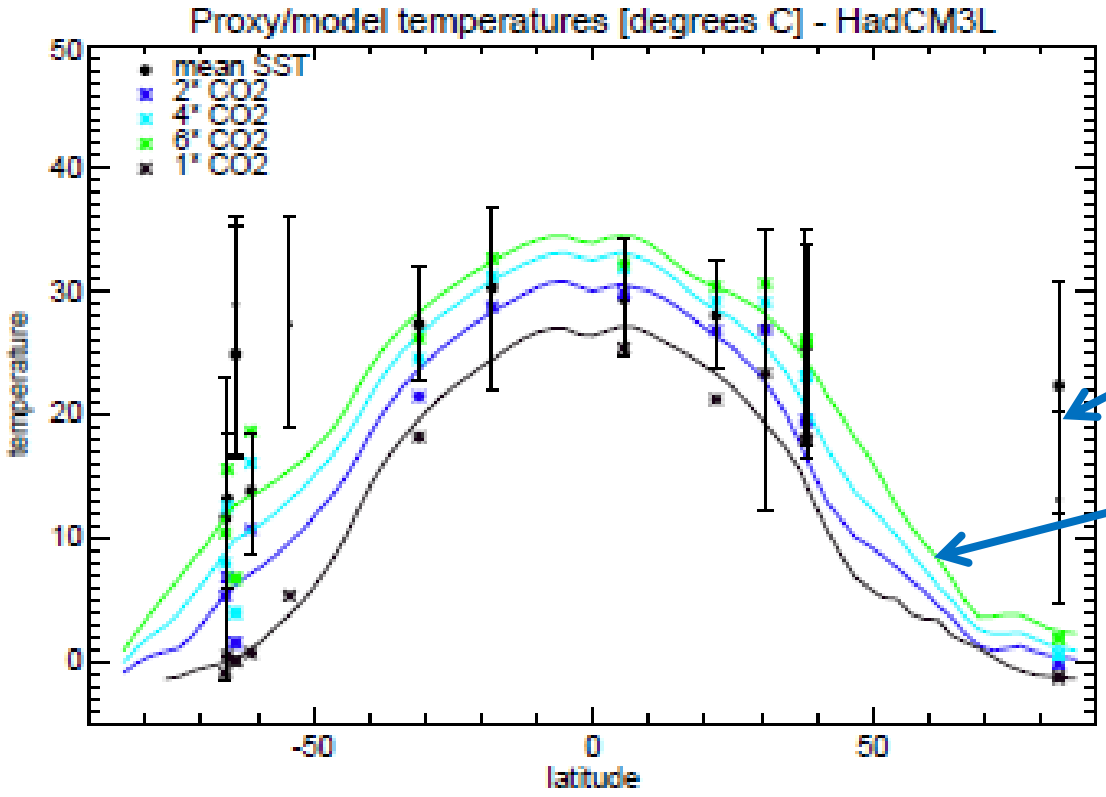
Climate Change Research Centre

UNSW SYDNEY

climate extremes
ARC centre of excellence

HadCM3L model,
Early Eocene (~53-51 million years ago) geography
Different CO_2 concentrations



Proxy derived SST

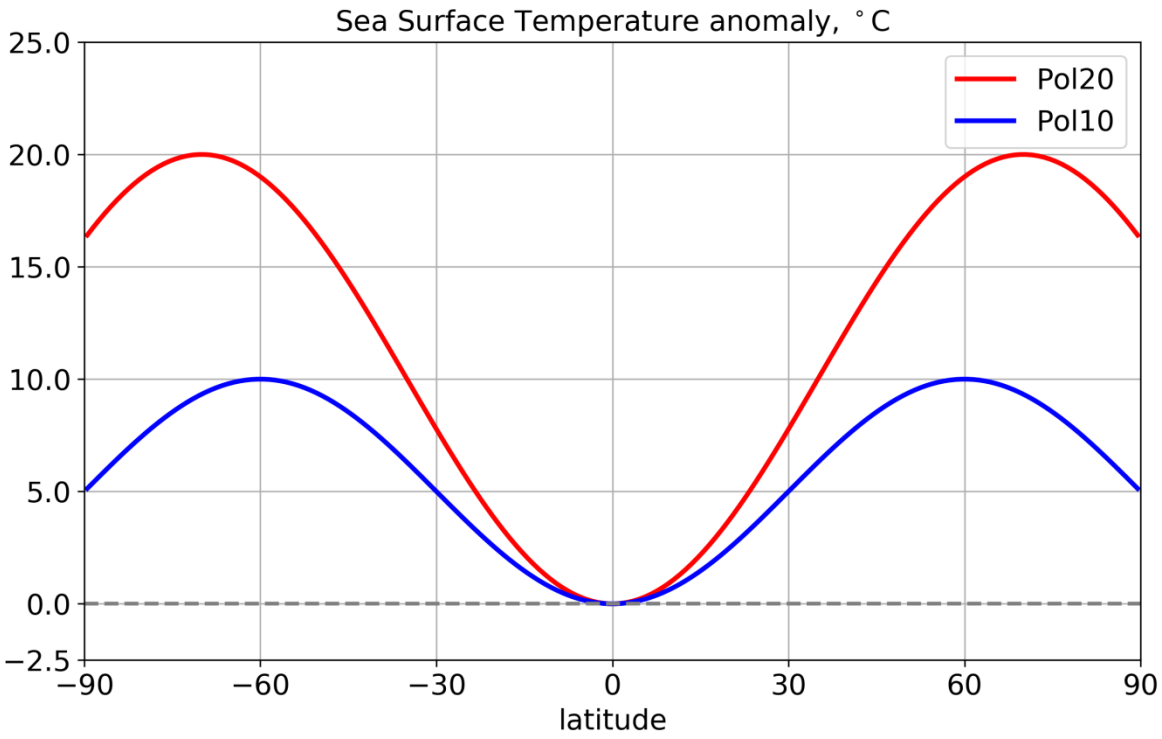
Model simulated SST

Lunt et al., (2012)

Possible causes of excessive Arctic warming during equable climates

1. Polar stratospheric clouds - Sloan and Pollard (1998)
2. Positive convective cloud feedback - Abbot and Tziperman (2008a)
3. Changes in atmospheric heat transport through deep convective clouds formation in the mid latitudes - Rose and Ferreira (2013)

Methodology and approach:



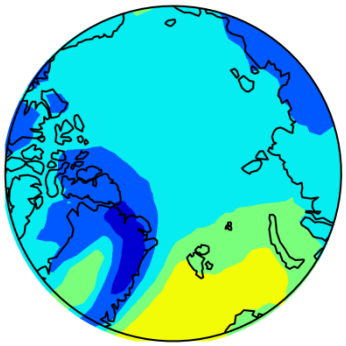
Model intercomparison:

- CAM4 and CAM5
- ACCESS, Bureau of Meteorology, Australia
  Atmospheric component -Unified Model (UM), version GA7

Total cloud fraction

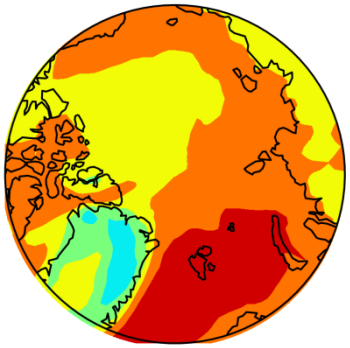
CAM4

AMIP,CAM4



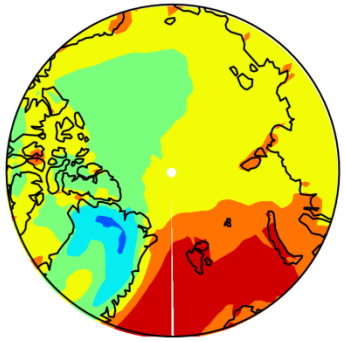
CAM5

AMIP,CAM5



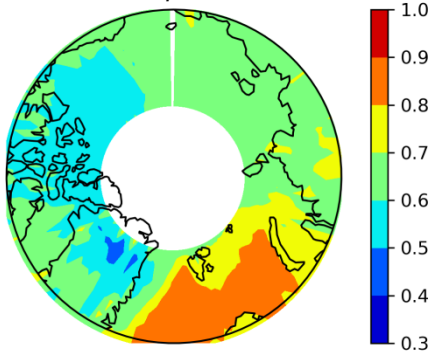
ACCESS-COSP

AMIP,ACCESS



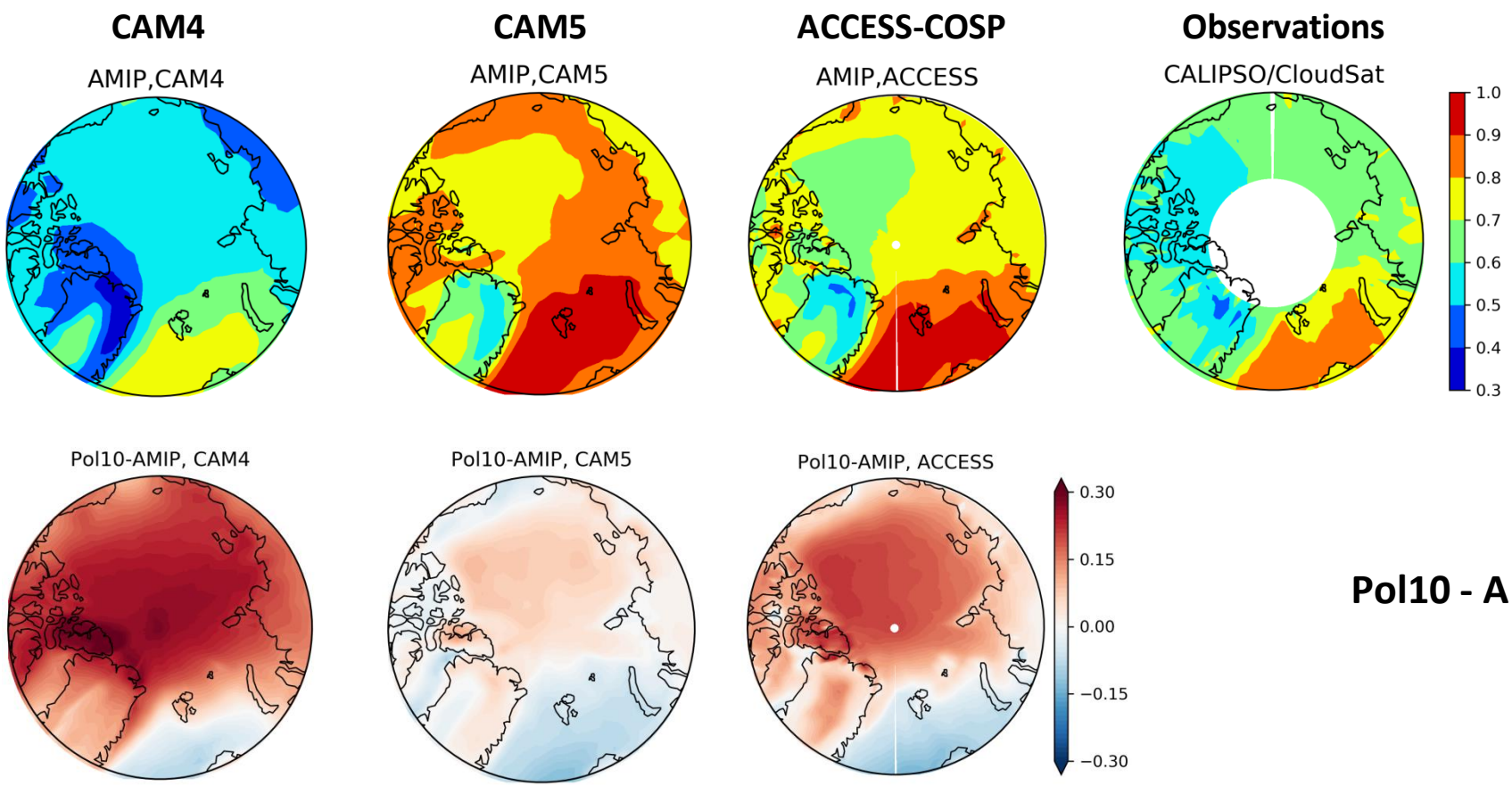
Observations

CALIPSO/CloudSat



AMIP

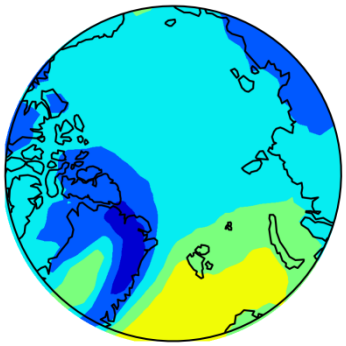
Total cloud fraction



Total cloud fraction

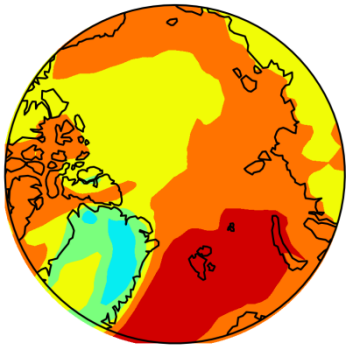
CAM4

AMIP,CAM4



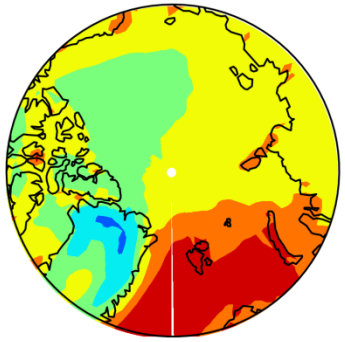
CAM5

AMIP,CAM5



ACCESS-COSP

AMIP,ACCESS



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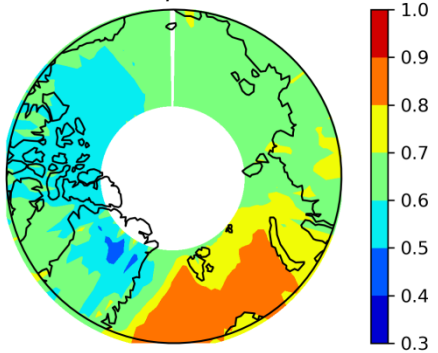
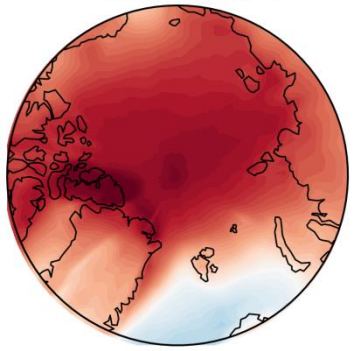
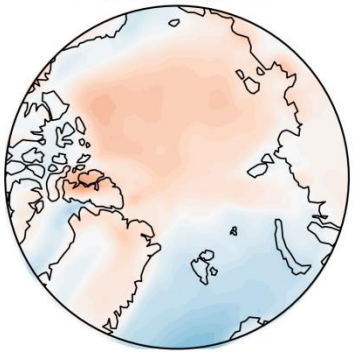


AMIP

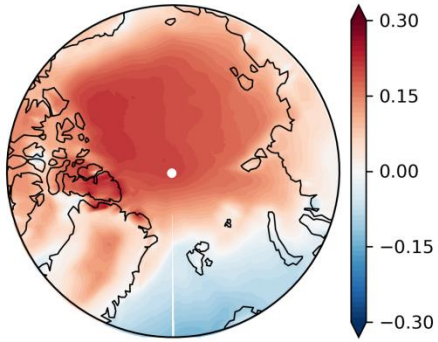
Pol10-AMIP, CAM4



Pol10-AMIP, CAM5

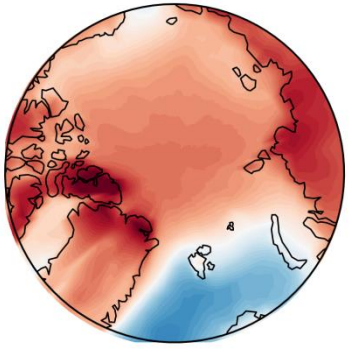


Pol10-AMIP, ACCESS



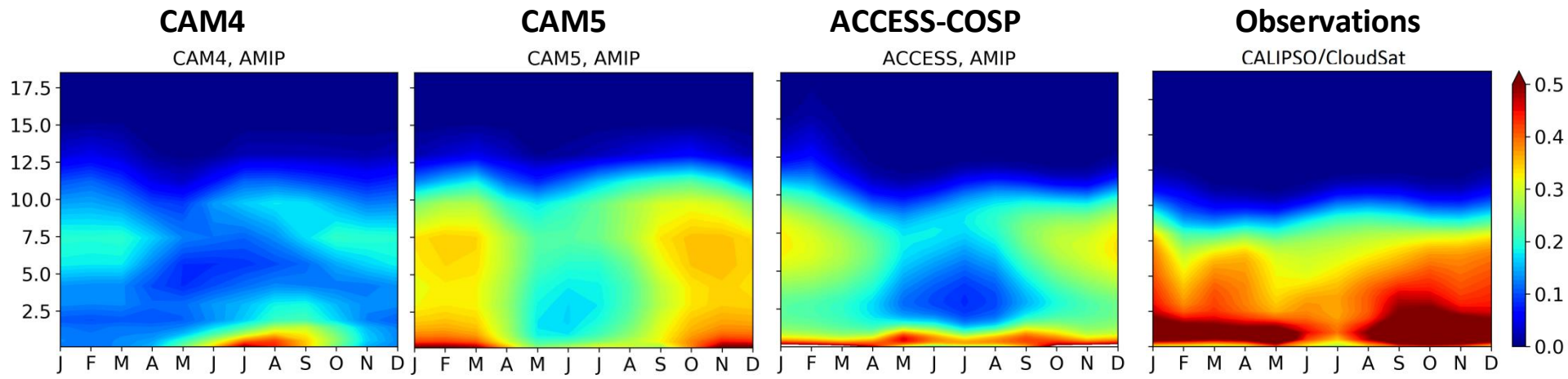
Pol10 - AMIP

Pol20-AMIP, CAM4

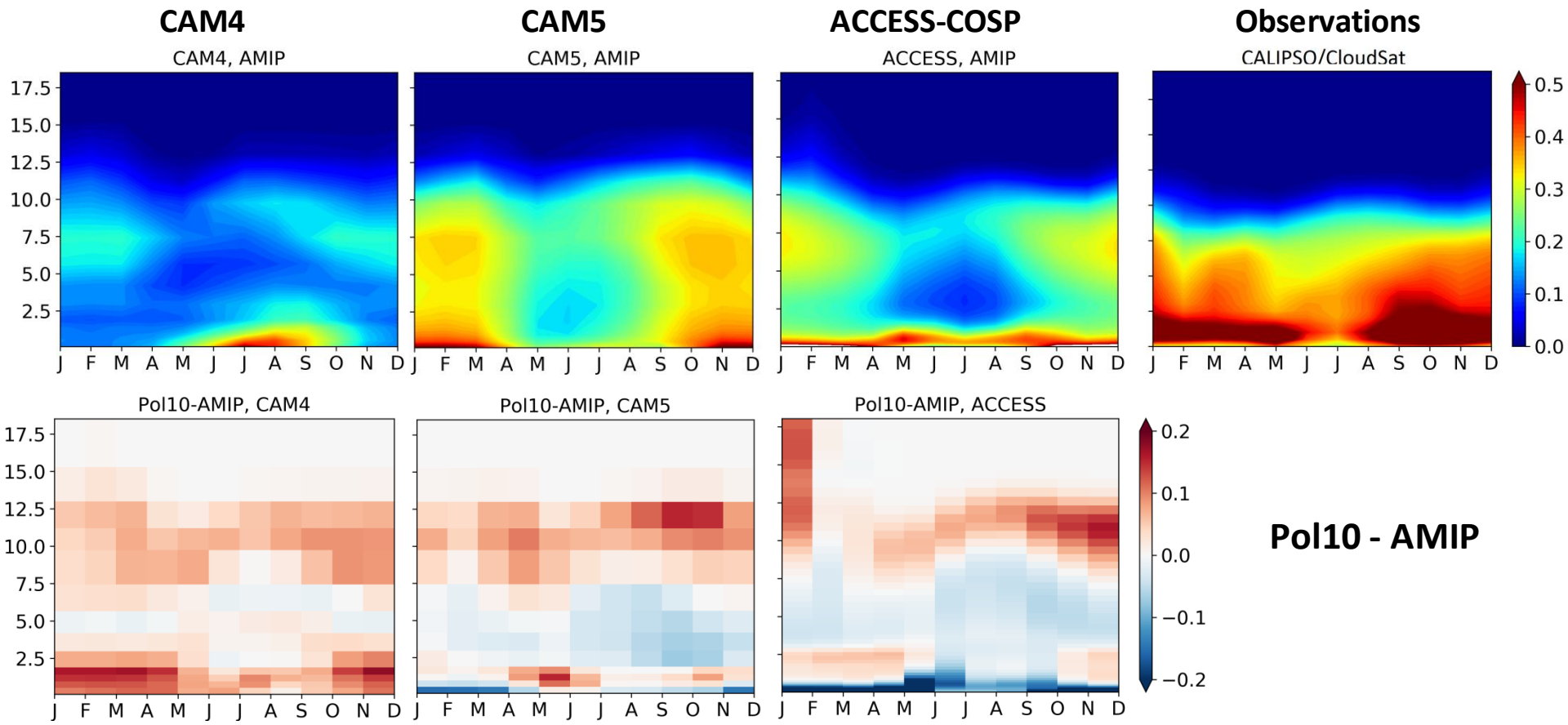


Pol20 - AMIP

Seasonal variation in cloud cover over the Arctic (70°-90°N)



Seasonal variation in cloud cover over the Arctic (70°-90°N)



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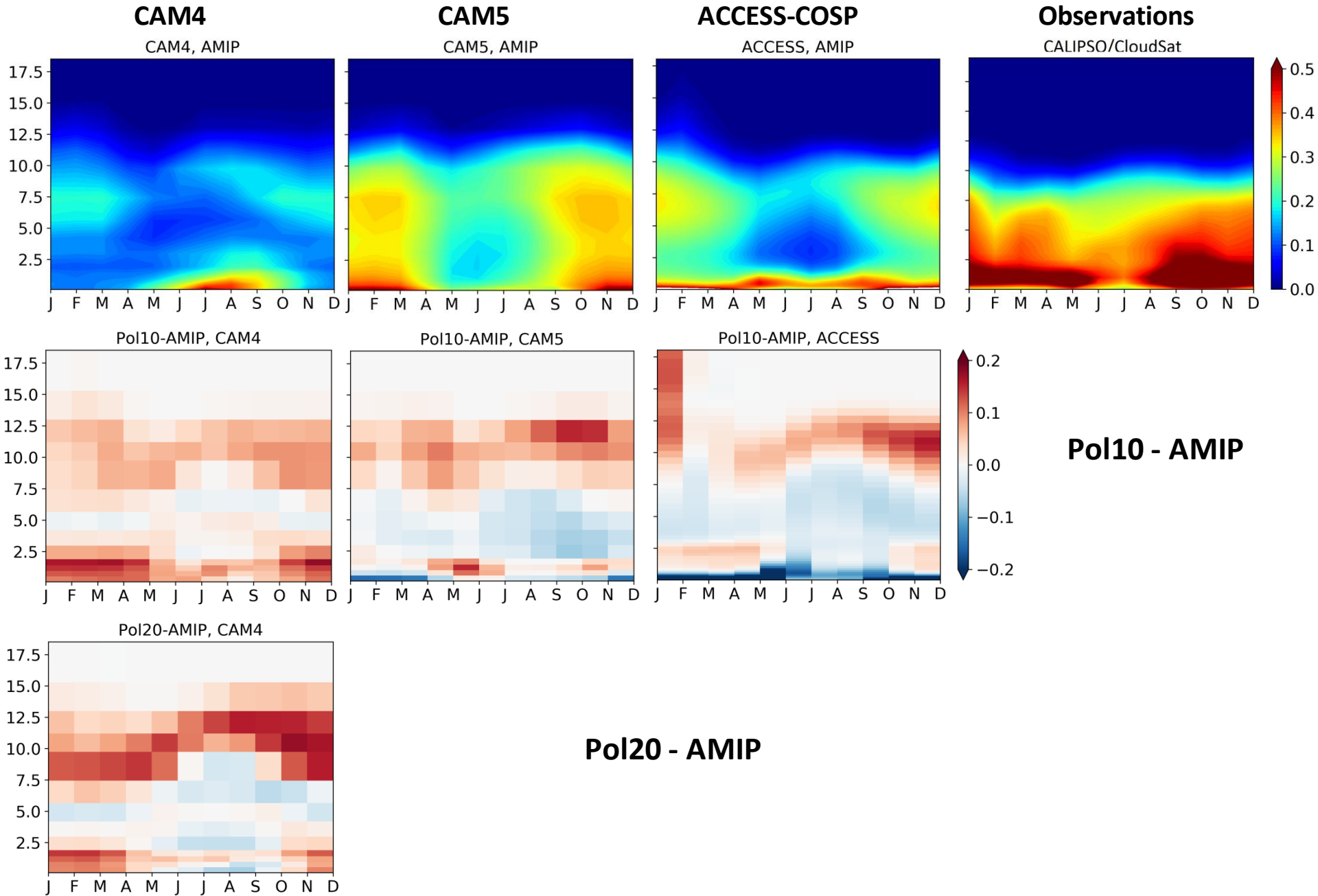
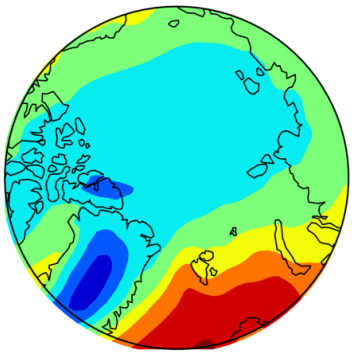


Surface Air Temperature

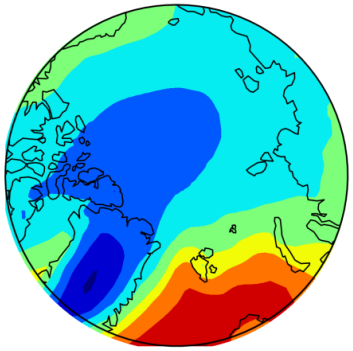
CAM4

CAM4, AMIP



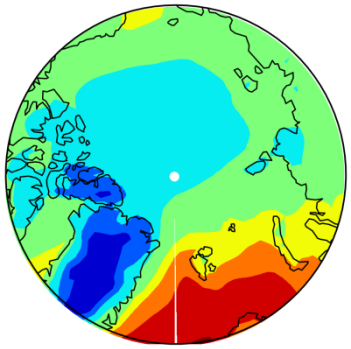
CAM5

CAM5, AMIP



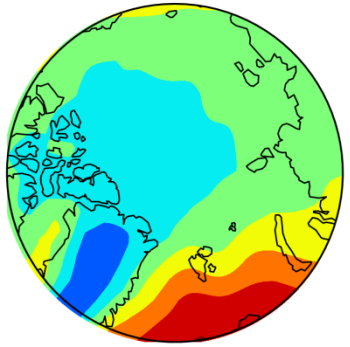
ACCESS

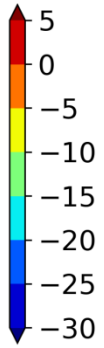
ACCESS, AMIP



NCAR Reanalysis

NOAA/NCAR Reanalysis

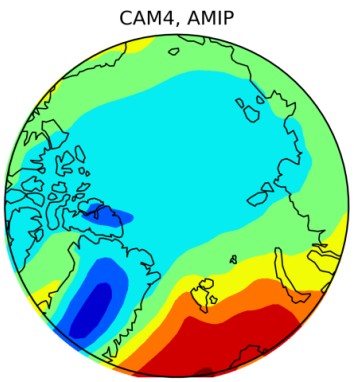




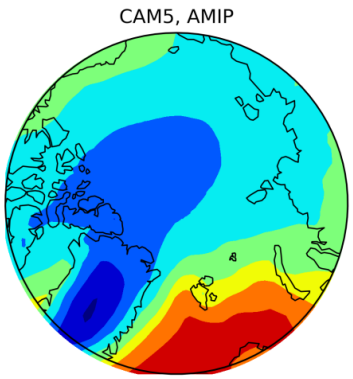
AMIP

Surface Air Temperature

CAM4



CAM5



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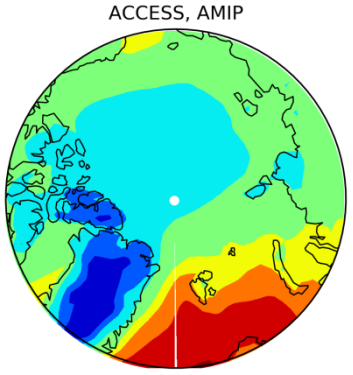
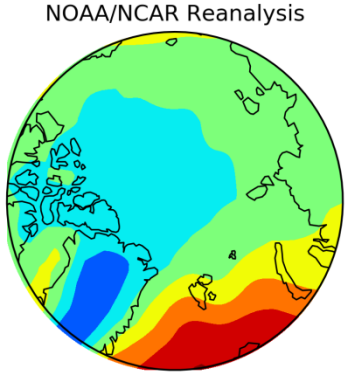
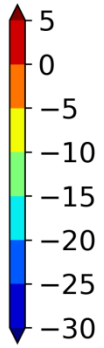
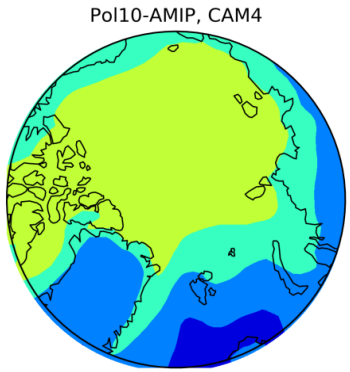


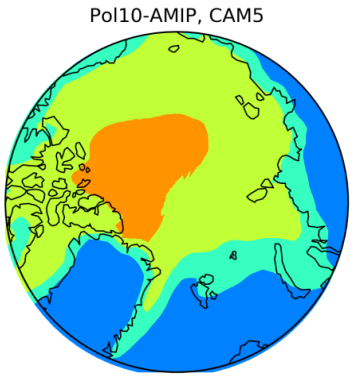
NCAR Reanalysis

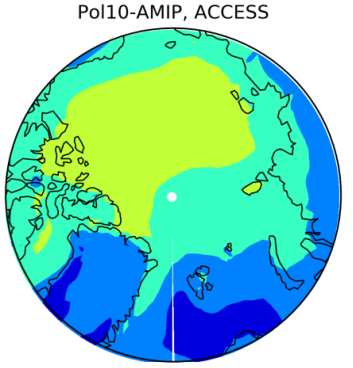




AMIP



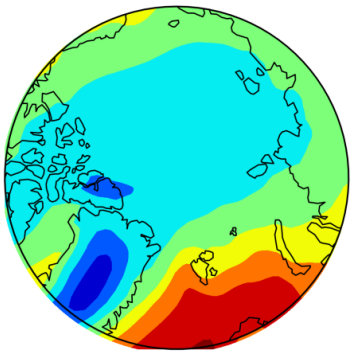




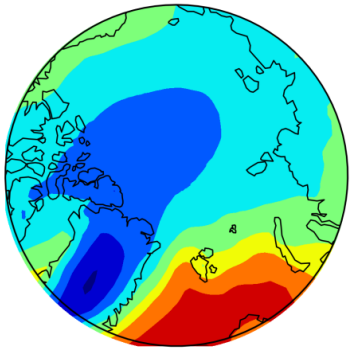
Pol10 - AMIP

Surface Air Temperature

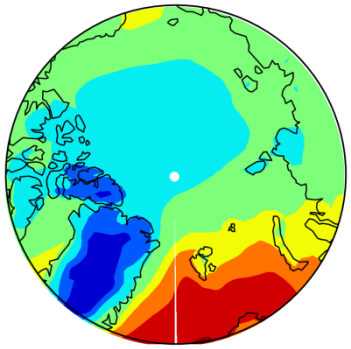
CAM4



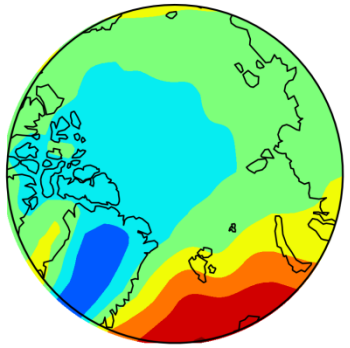
CAM5

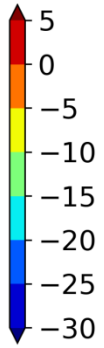


ACCESS

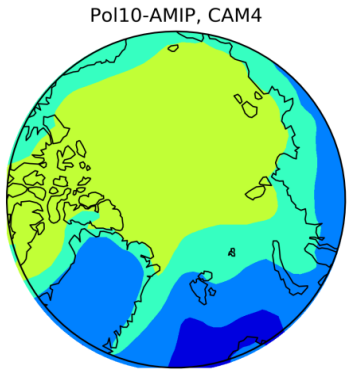


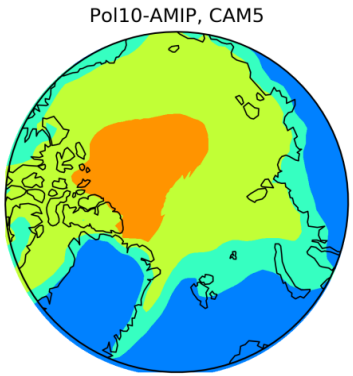
NCAR Reanalysis

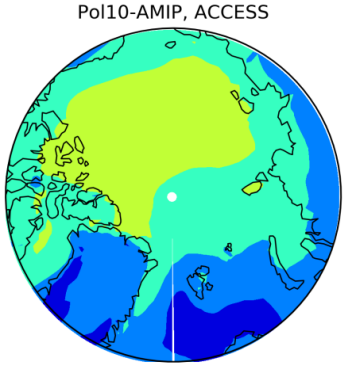




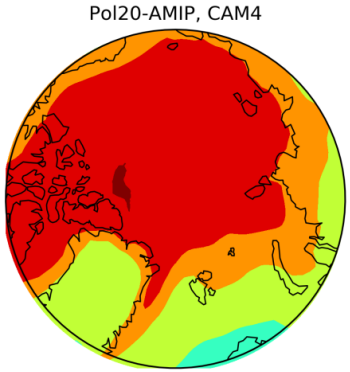
AMIP



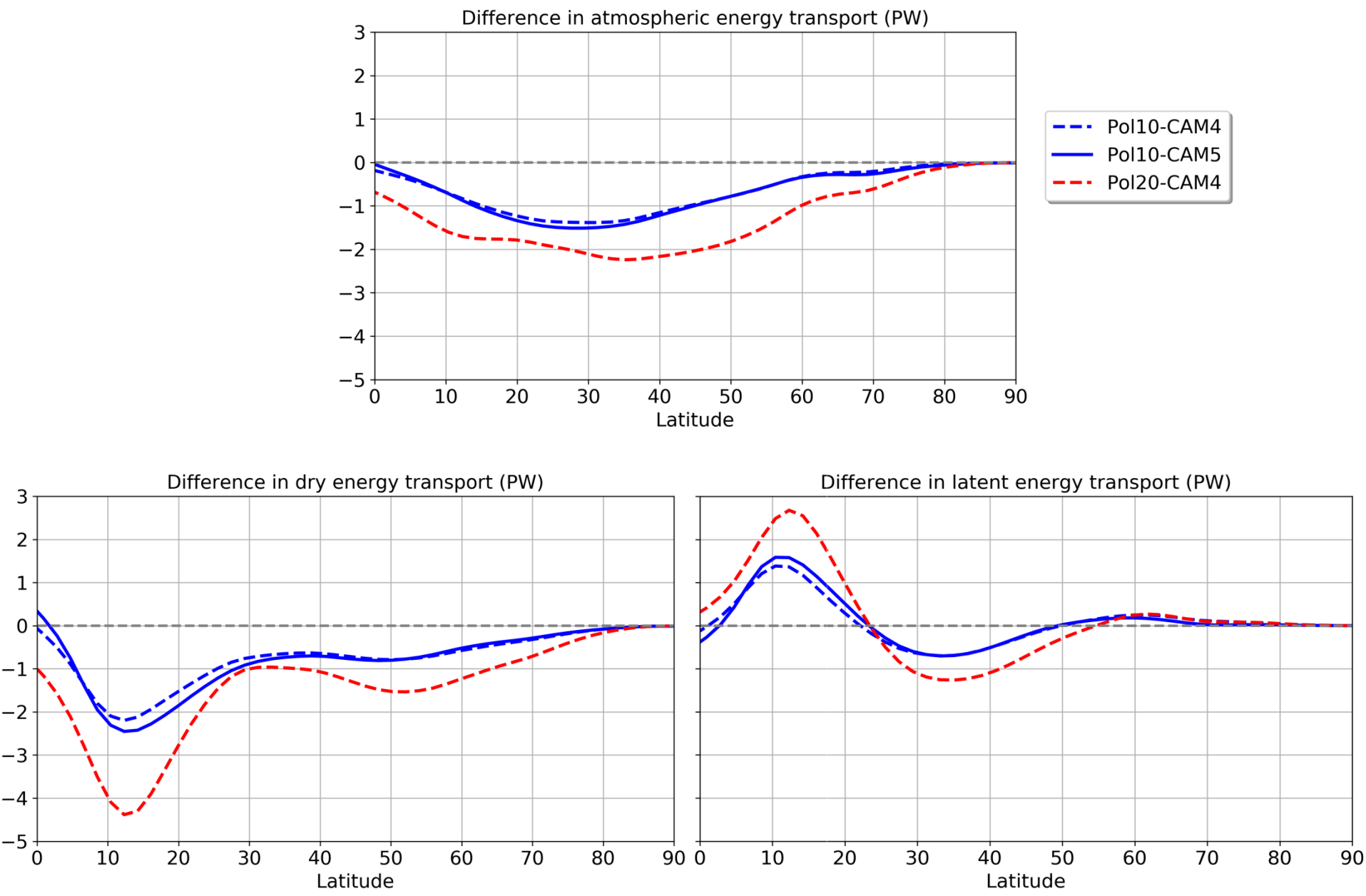




Pol10 - AMIP



Pol20 - AMIP


Difference in atmospheric energy transport (PW)
Pol10-CAM4
Pol10-CAM5
Pol20-CAM4
Latitude
Difference in dry energy transport (PW)
Latitude
Difference in latent energy transport (PW)
Latitude

Summary:

a. Performance of CAM5 and ACCESS is better than CAM4 for present day simulations.

b. Polar amplified sea surface temperatures (SSTs) increase cloud cover.

c. Polar amplified SSTs reduce poleward atmospheric heat transports.

d. Further analysis is required to identify the influence of regional physical processes and large scale atmospheric heat and moisture transport responsible for the simulated changes in cloud cover.