Arctic Climate and Climate Change in the CCSM2.0

Evaluation and Comparison to Other Coupled Models

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Introduction

* The Community Climate System Model (CCSM2.0) has just recently been released

Control integration underway (at 600+ years)

1% increasing CO2 run performed (out to 4XCO2 levels)

Components of CCSM2 will take part in AOMIP and ARCMIP

* Brief Evaulation of CCSM2.0 Polar Simulation and Comparison to Observations

* Analysis of Climate Change Simulations

Comparison to Coupled Model Intercomparison Project

Indication of processes that modify simulated polar amplification

Model Description

Community Atmosphere Model

- Builds on CCM3
- 26 vertical levels, T42 resolution
- prognostic cloud water formulation
- generalized cloud overlap scheme
- new longwave absorption/emission by water vapor

Parallel Ocean Program

- anisotropic horizontal viscosity
- eddy mixing parameterization
- KPP vertical boundary layer mixing
- more accurate equation of state
- displace pole grid, <1 degree resolution
- open Bering Strait, CAA

Community Sea Ice Model (CSIM)

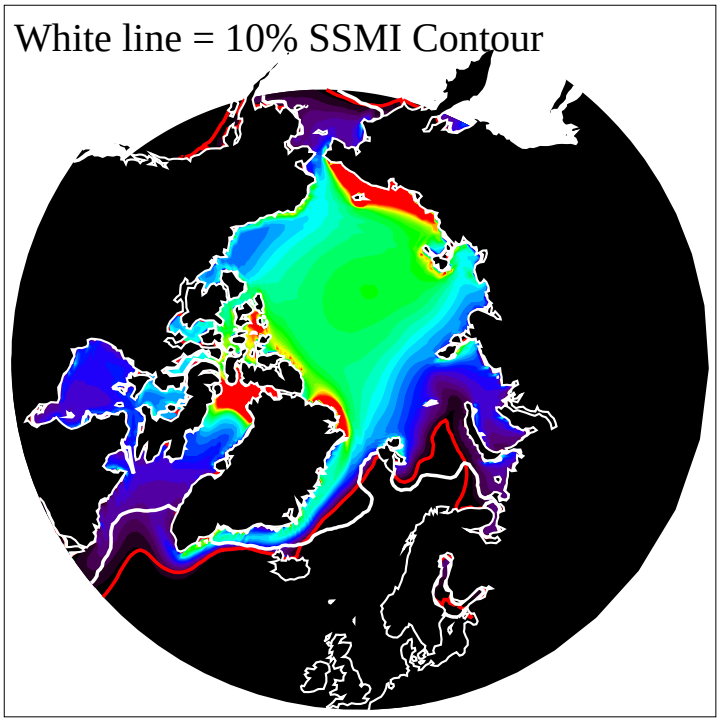
- subgridscale ITD
- multiple vertical layers
- EVP dynamics
- same resolution as ocean model

Community Land Model (CLM)

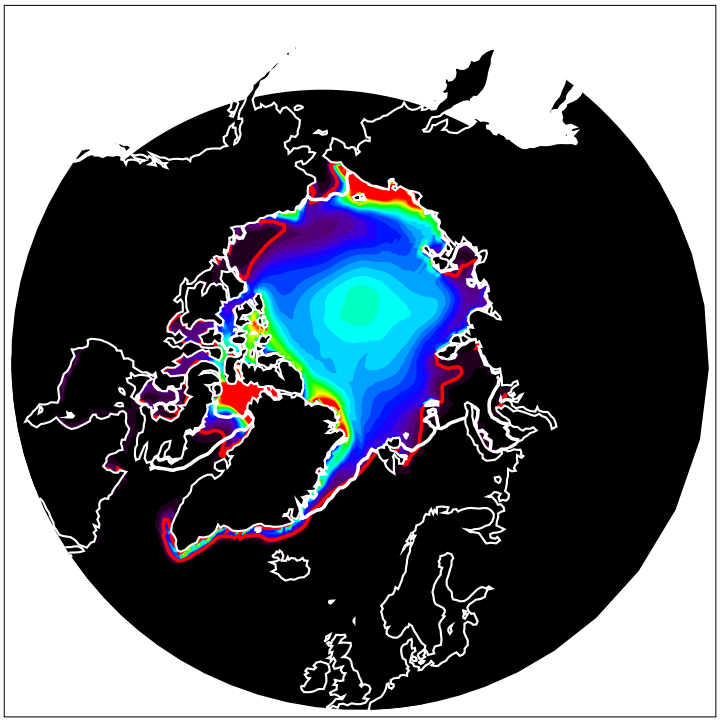
- sub−grid mosaic of land cover and plant types from satellite
- 10 layer soil model
- multi−layer snow model
- river routing scheme on 0.5 degree grid

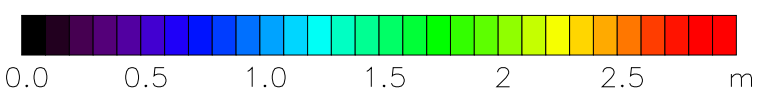
CCSM2 Ice Conditions

Mean JFM Ice Conditions

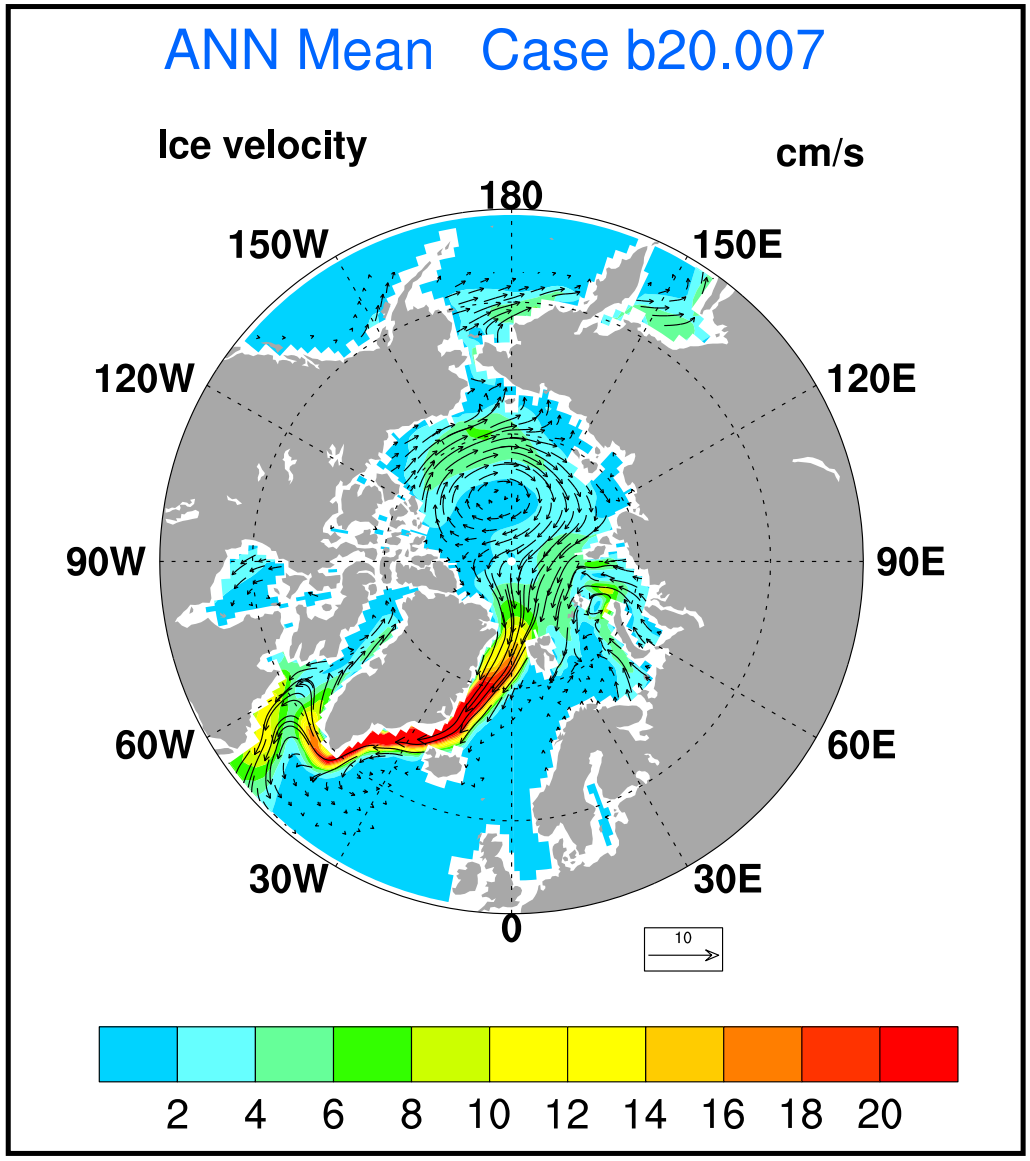


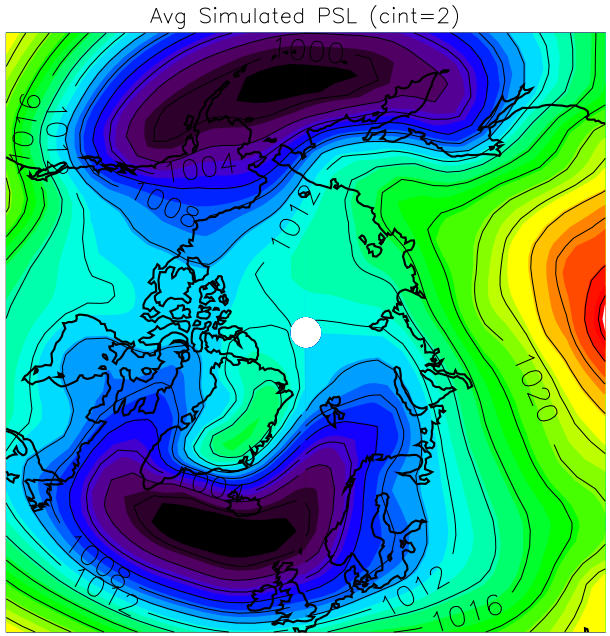
Mean JAS Ice Conditions

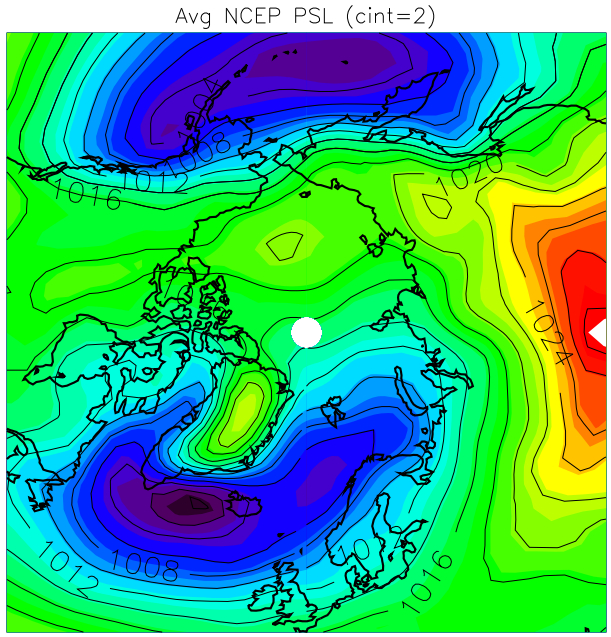




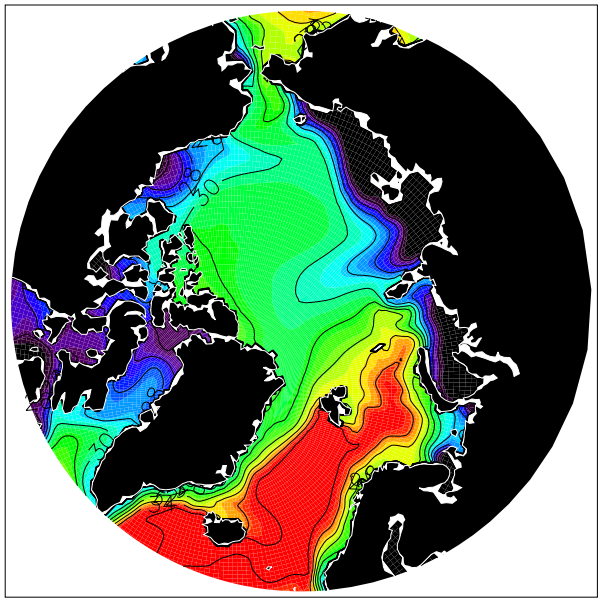
Ice Velocity and SLP



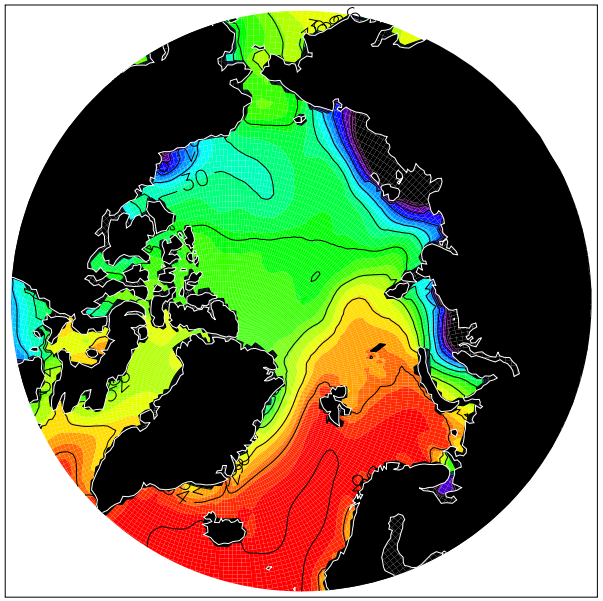


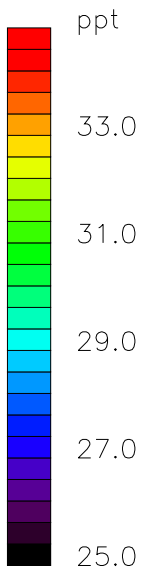


Annual Avg SSS from b20.007

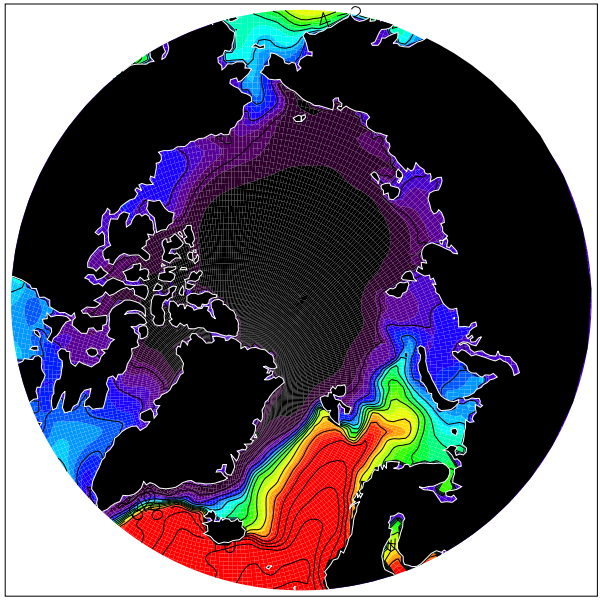


Annual Avg SSS from PHC Climatology

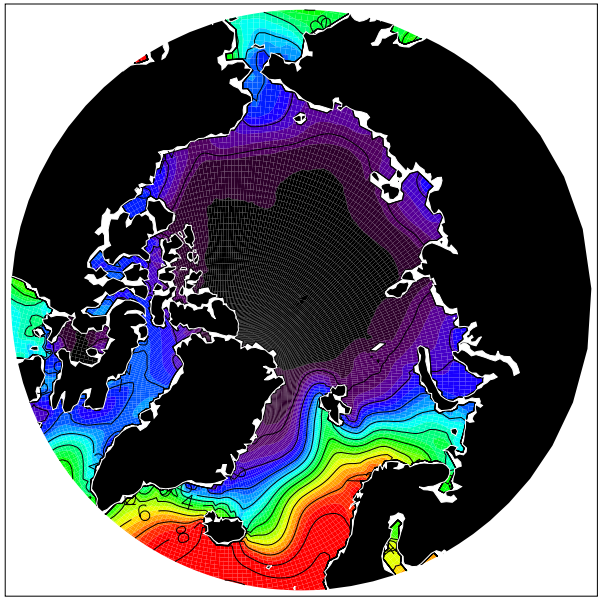


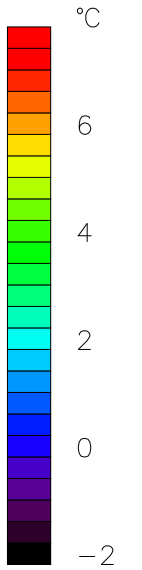


Annual Avg SST from b20.007

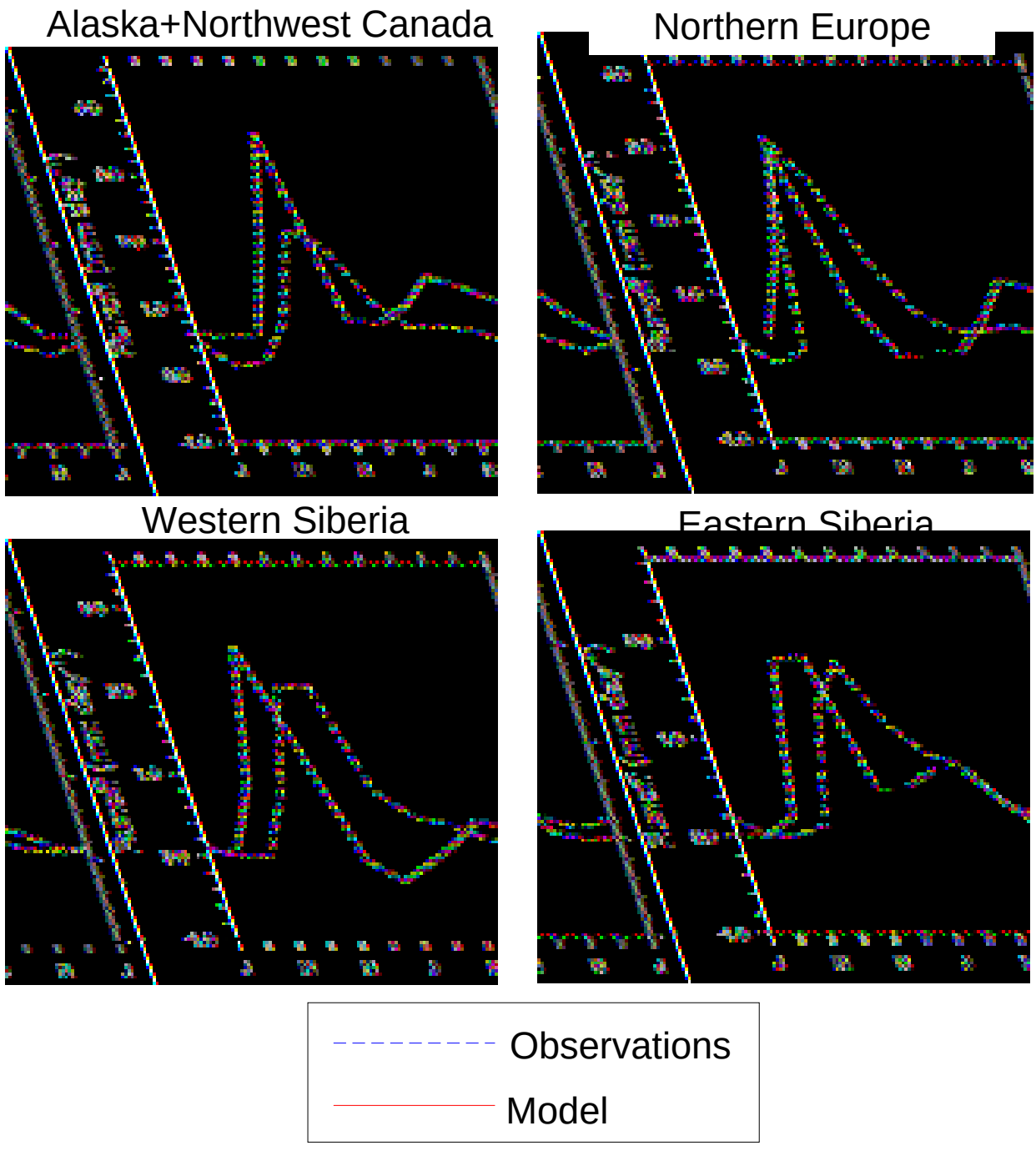


Annual Avg SST from PHC Climatology

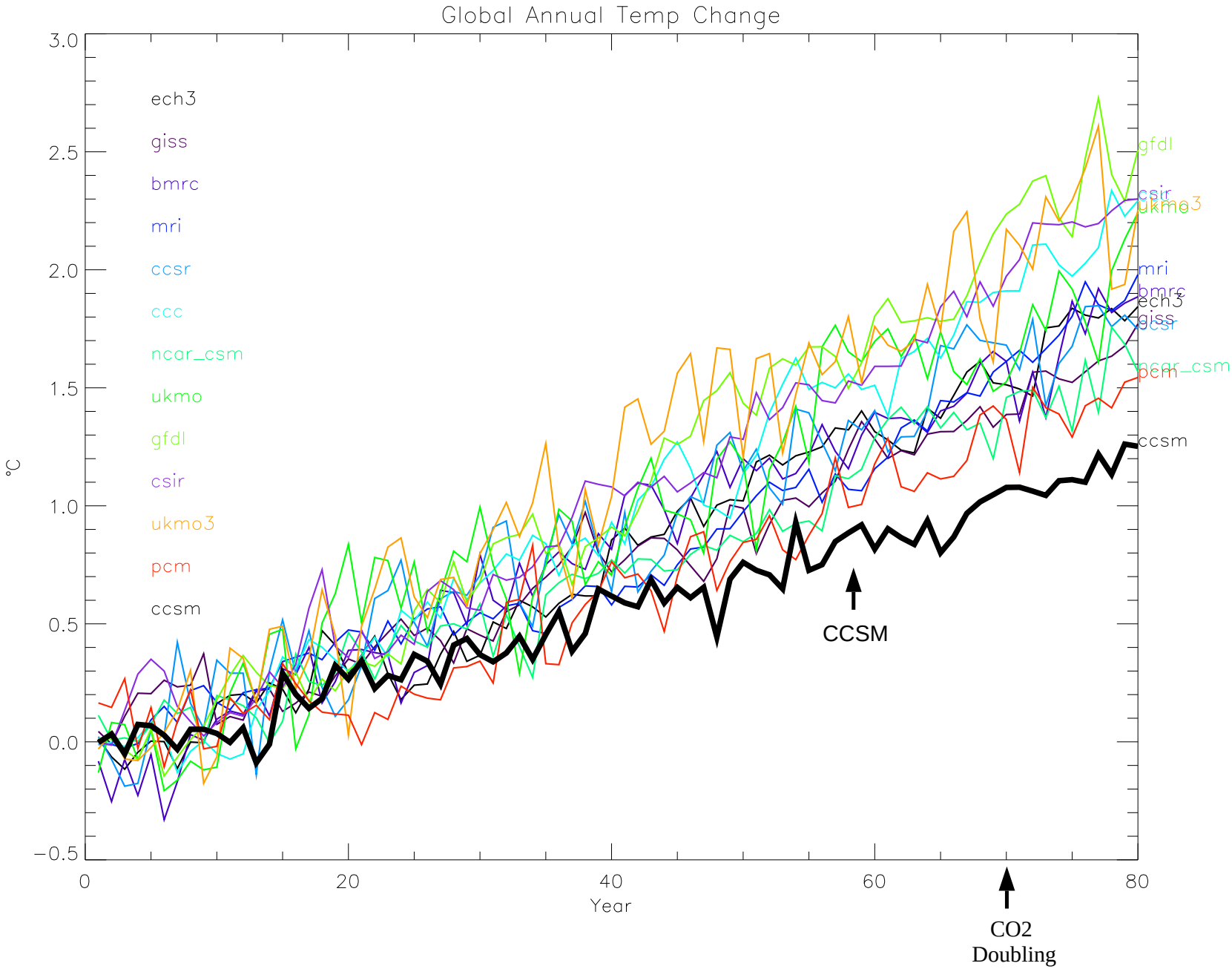




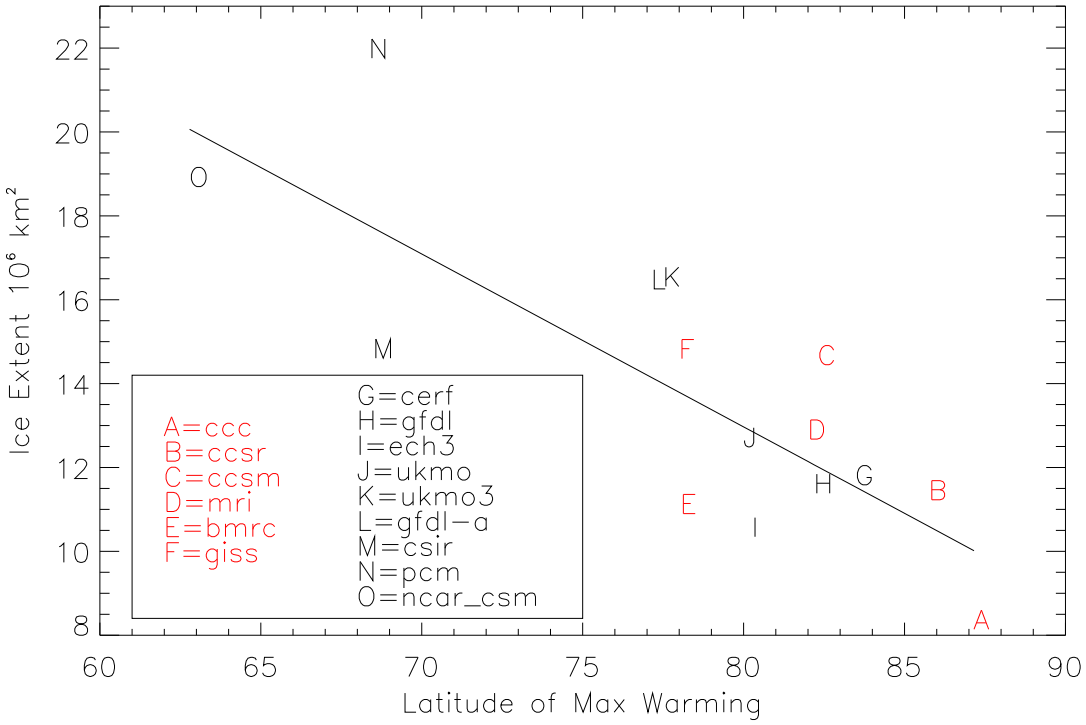
Average River Runoff



Global Average Temperature Change



Influence of Ice Extent on Location of Warming



Models with larger ice extent in the control simulation generally obtain maximum warming further south

Correlation of ice extent and latitude of maximum warming = -0.79

Conclusions/Discussion

CCSM2 has a number of substantial improvements in the Arctic simulations although deficiencies remain.

Polar amplification

* Ranges from < 2 to > 4 X the global average warming.

* Location of maximum warming varies considerably

* Magnitude of the polar amplification is related to the control climate sea ice conditions
  - larger amplified warming associated with thin ice
  - higher amplification with larger ice extent
  - more southerly warming with larger ice extent

* Some models do not agree with these conclusions, related to feedbacks associated with other model physics (ocn transport, clouds, etc)

Across model comparison generally agrees with Rind et al studies. This further indicates the need for realistic sea ice simulations in climate models.