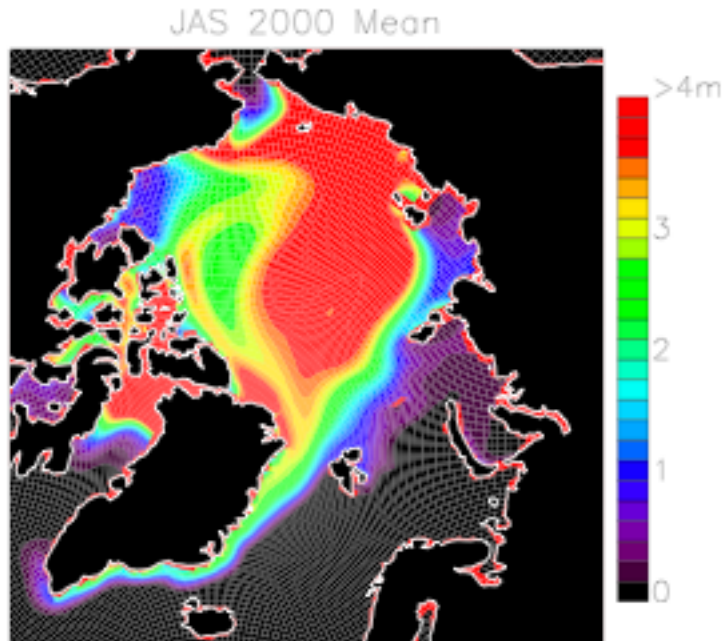# Update on Progress Towards CCSM4
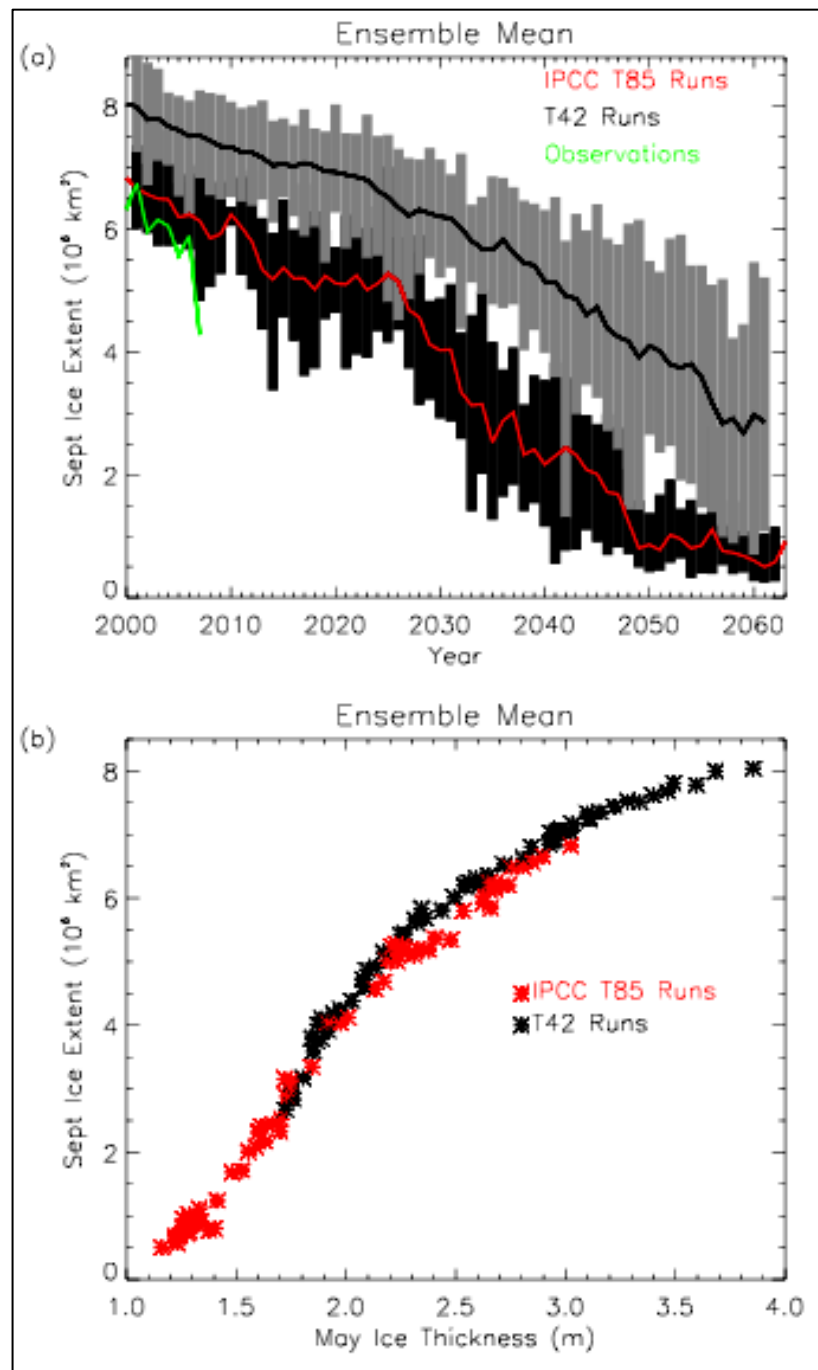
Marika Holland and David Bailey

NCAR

CCSM3 Update

- Large (30 member) ensemble from 2000-2060 performed by CVWG/CCWG
- Uses T42-gx1 res; A1B scenario
- Available for analysis via ESG

Summer Mean 2000 Ice Thickness

http://www.ccsm.ucar.edu/working_groups/Variability/experiments/ccsm3-t42lgens-data.html

Towards CCSM4

- Interim Model version CCSM3.5
    - Development model code;
    - Has number of code changes that are desired for CCSM4, but not all of them
    - Used for Tuning, BGC Spin Up

Sea Ice Model

- CICE4.0 Base Code
- Delta-Eddington Radiative Transfer (Briegleb and Light)
- Melt Pond Parameterization
- 3-layer Snow Model
- Arbitrary Number of Tracers (for example - age added, being tested)
- Albedo synchronization, different timestep functionality, other numeric/SE changes
- On table for CCSM4 - Possible snow aging parameterization

Ocean Model

- POP2 base code,
- Vertical resolution and topography changes,
- Modified anisotropic horizontal viscosity,
- Near-surface eddy flux parameterization,
- Vertically varying tracer diffusivities,
- Tidal driven mixing parameterization,
- Passive tracer infrastructure and ecosystem codes are operational.
- For CCSM4 - Possible overflow parameterization (Briegleb, Danabasoglu, Large); other possible changes

Atmospheric Model

- Finite Volume Atmosphere (1.9x2.5),

- Convective Momentum Transports (CMT) (Richter and Rasch, 2008, J Climate, in press)

- Dilution approximation for the calculation of Convective Available Potential Energy (CAPE) (Neale and Mapes, 2008, in prep; Neale et al., 2008, accepted, J. Atmos Sci.)

- "Freezedry" Low Cloud Parameterization (Vavrus)

- On table for CCSM4 - New boundary layer scheme; possibly new cloud microphysics (For more information see AMWG meeting)

Land Model

Major changes relevant to Polar Regions

- Hydrology completely reworked, including supercooled water, groundwater model, better partitioning of evapotranspiration fluxes

- Snow model changes

- Organic soil

- Deeper soil column

- CN-DGVM merge

- Shrub vegetation type in DGVM

- Fine mesh option

- GLIMMER coupling

Current Timeline

- CCSM4 model components to be frozen in Fall, 2008

- CCSM4 tuning/control runs performed

- CCSM4 to be released in summer, 2009

- Deadlines may change

CCSM3.5 Runs

- Numerous polar climate improvements as reported in June
- These still generally hold

- Although other problems have been diagnosed and remain
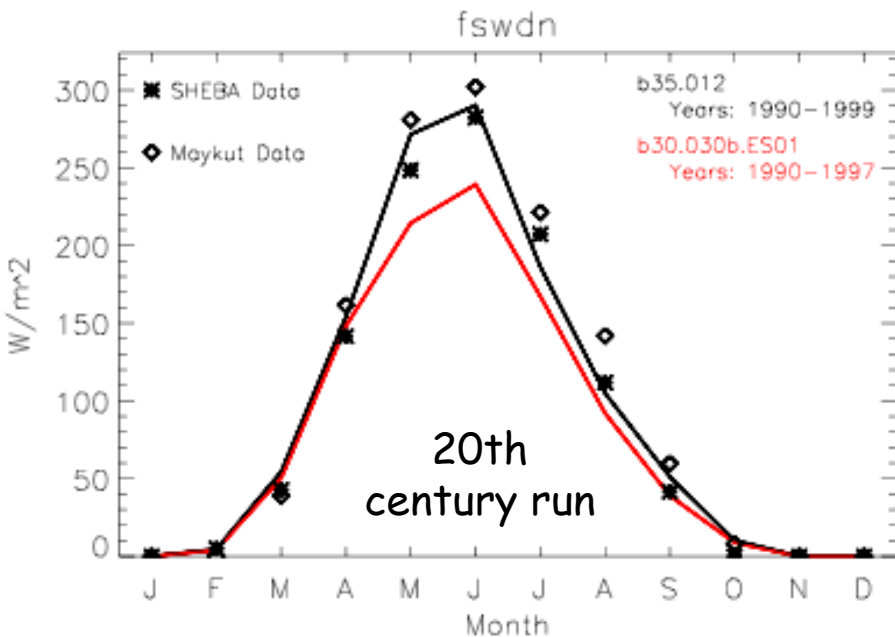
Downwelling SW Radiation in vicinity of the SHEBA point
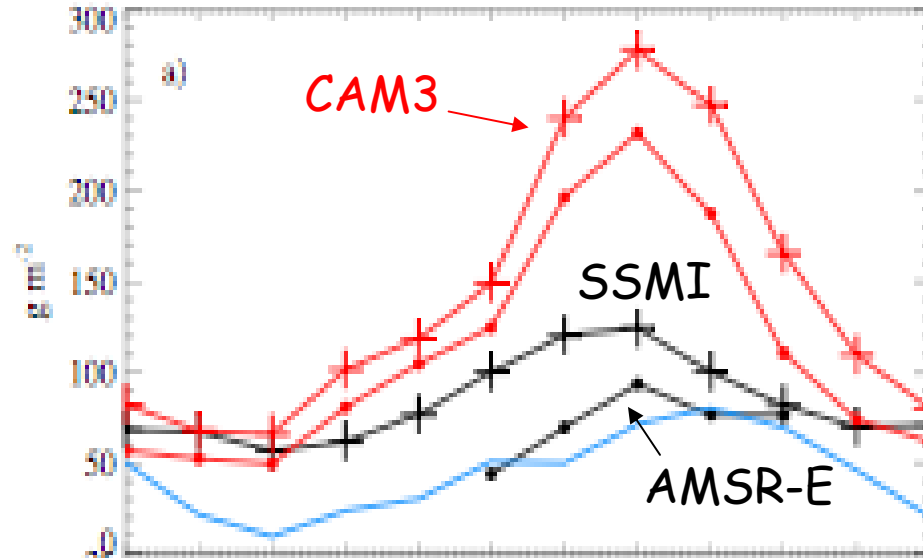
High-Latitude North Pacific Liquid Water Path

Zuidema and Joyce, JGR, in press

CCSM3.5 - 20th century simulation
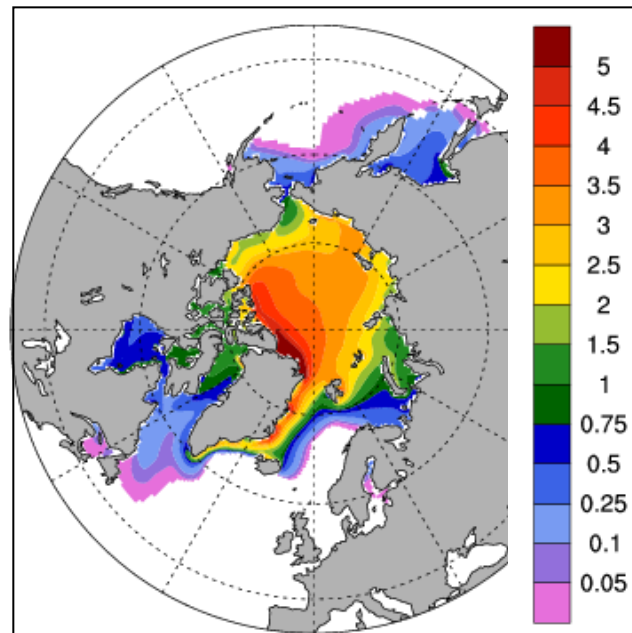
Ann 1980-1999 Thickness   JAS Ice Concentration   JFM Ice Concentration
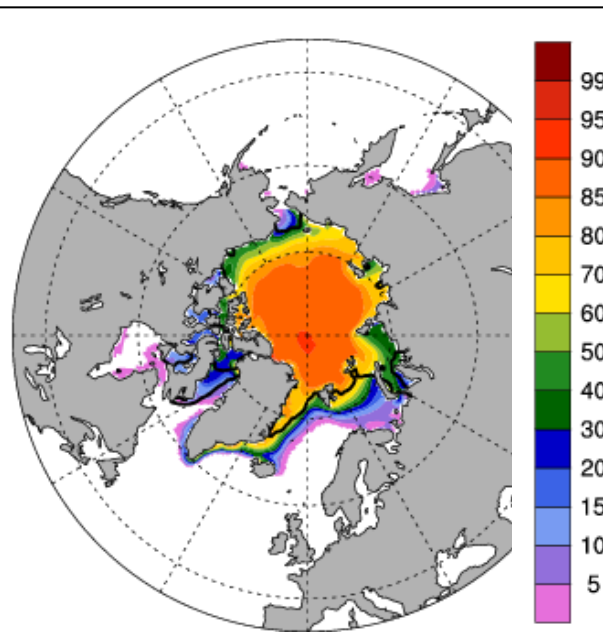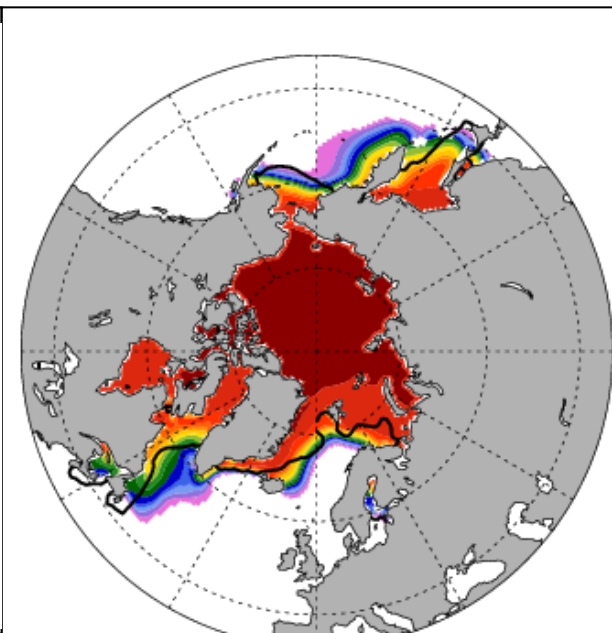
Atlantic Layer

20th Century Run

Original CCSM3.5 Run

enhanced near-surface diffusivities

Yrs 130-149 avg

PHC Data

1990-1999 avg

PHC Data

Atlantic Layer cont

Eurasian Basin

PHC

LOWVISC
Runs

CCSM3

Ocn Velocity
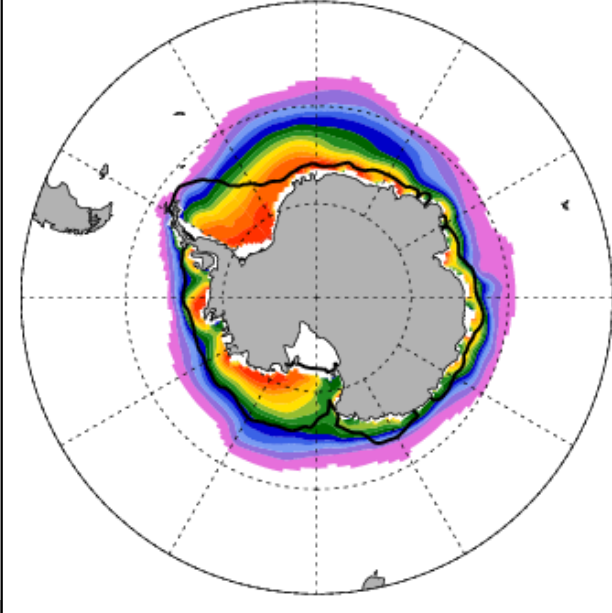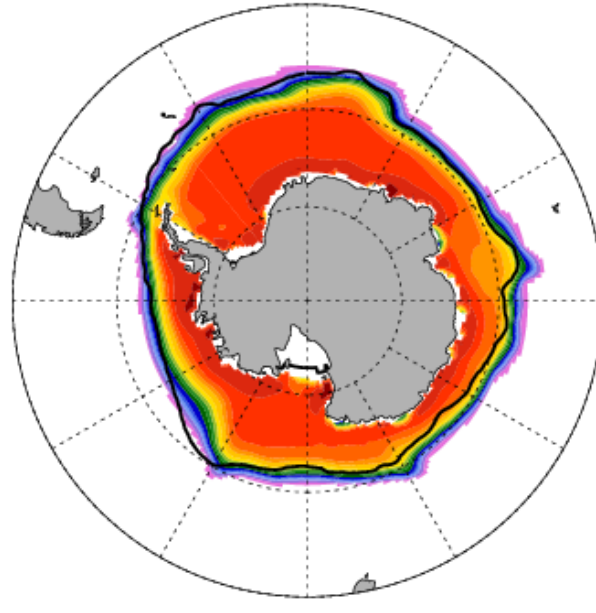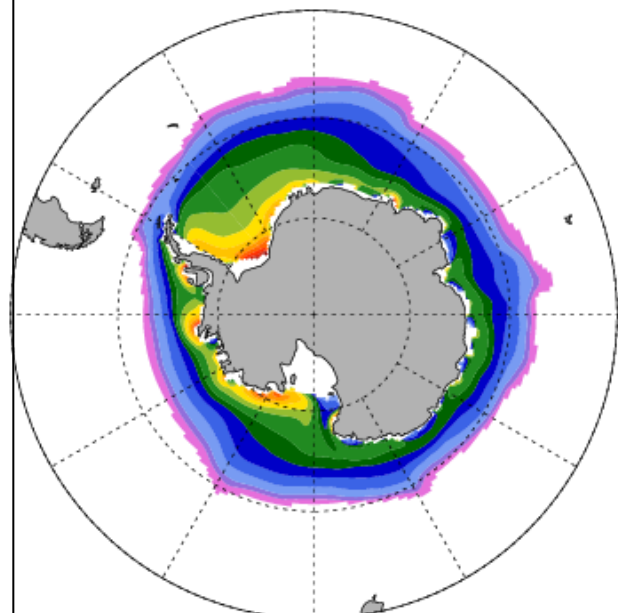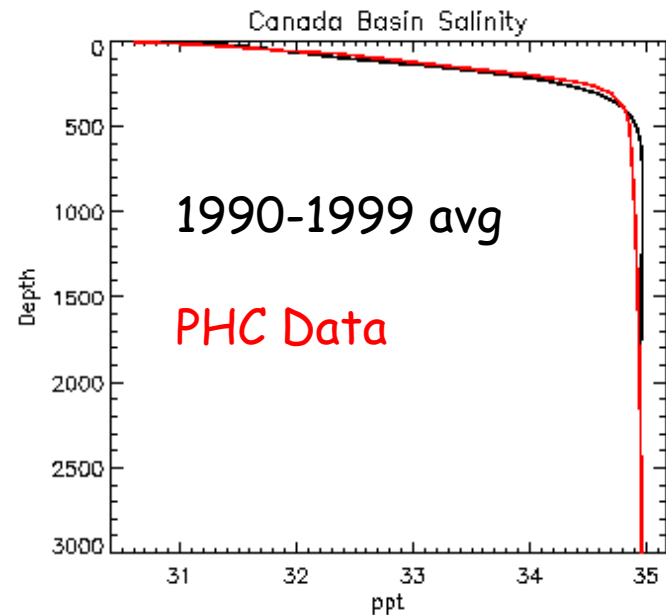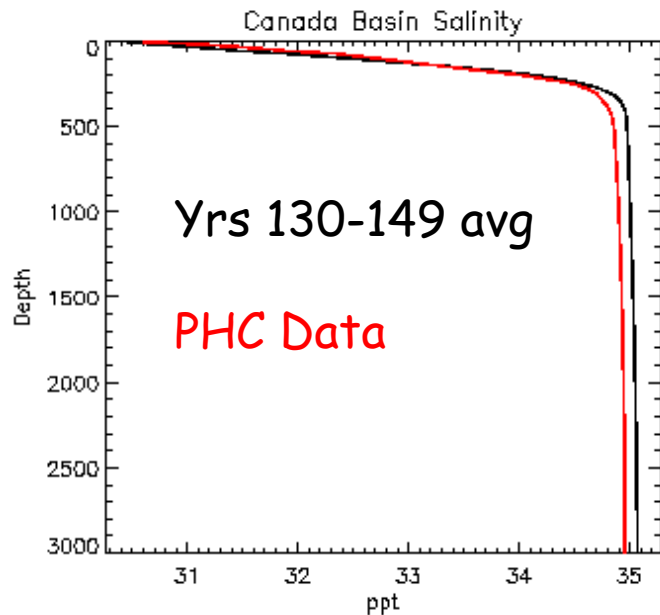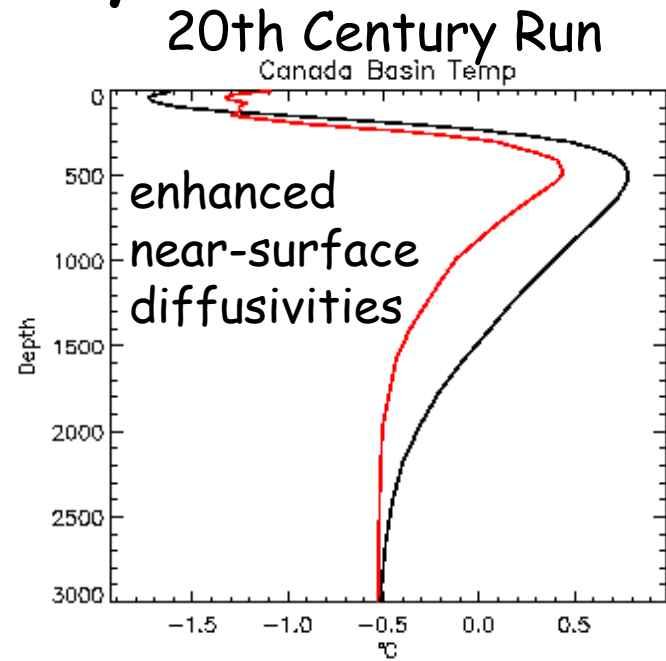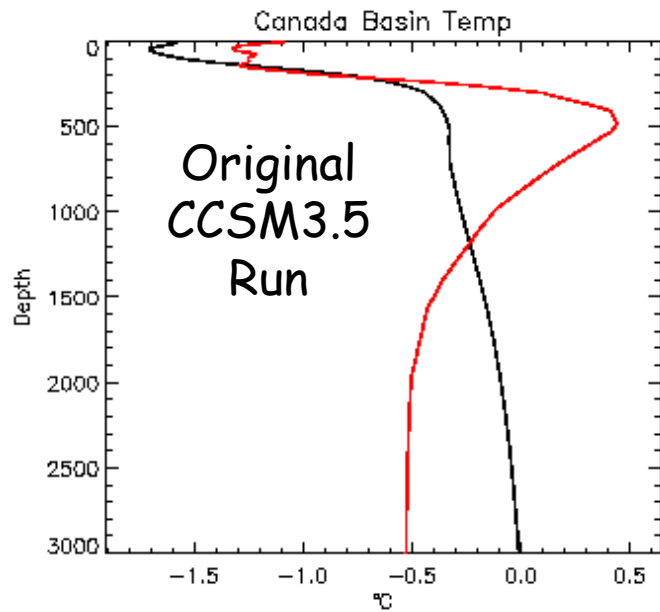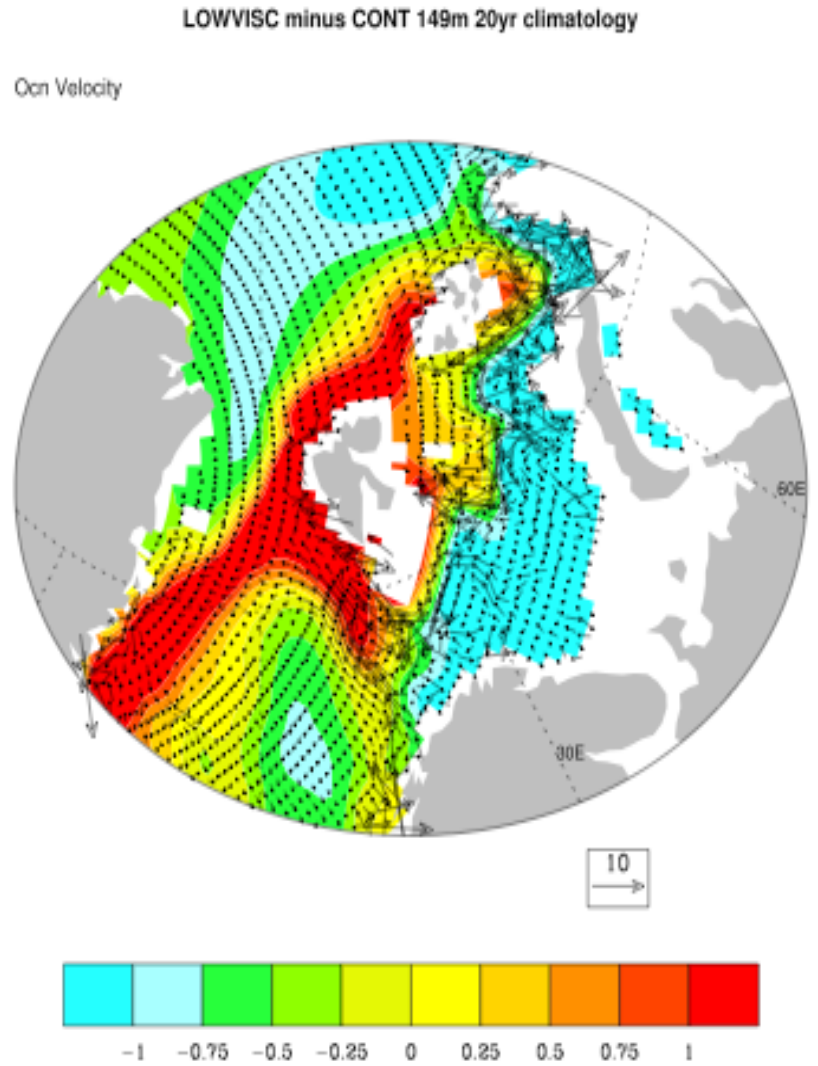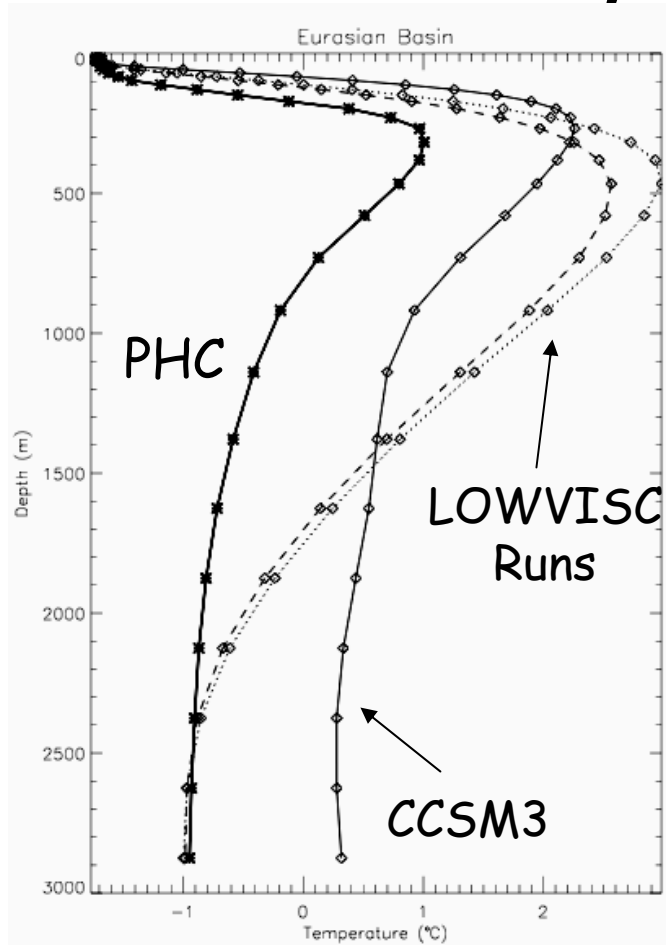
Heat transport in TW

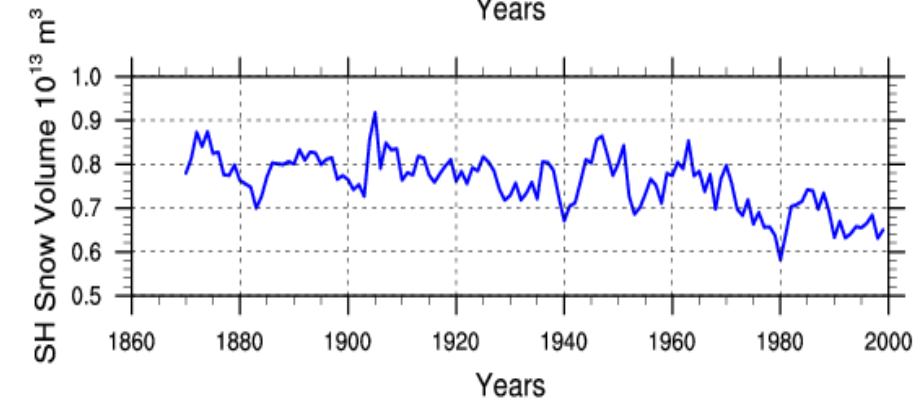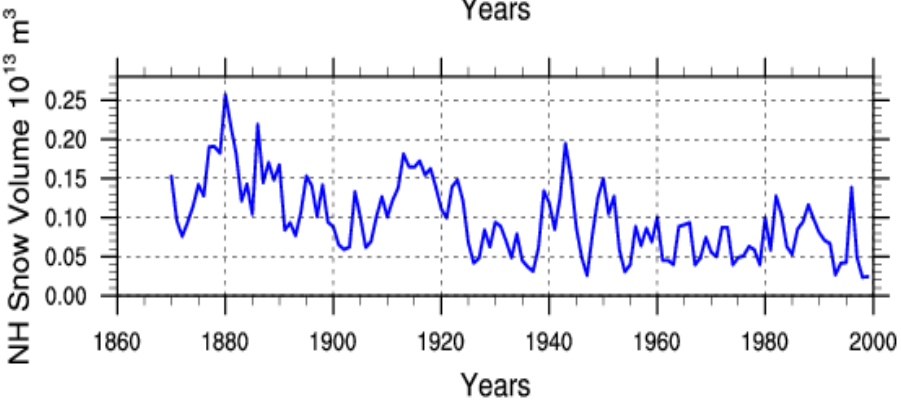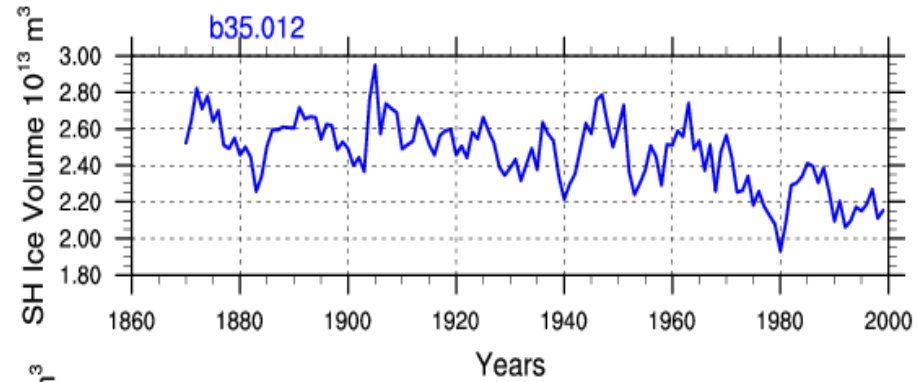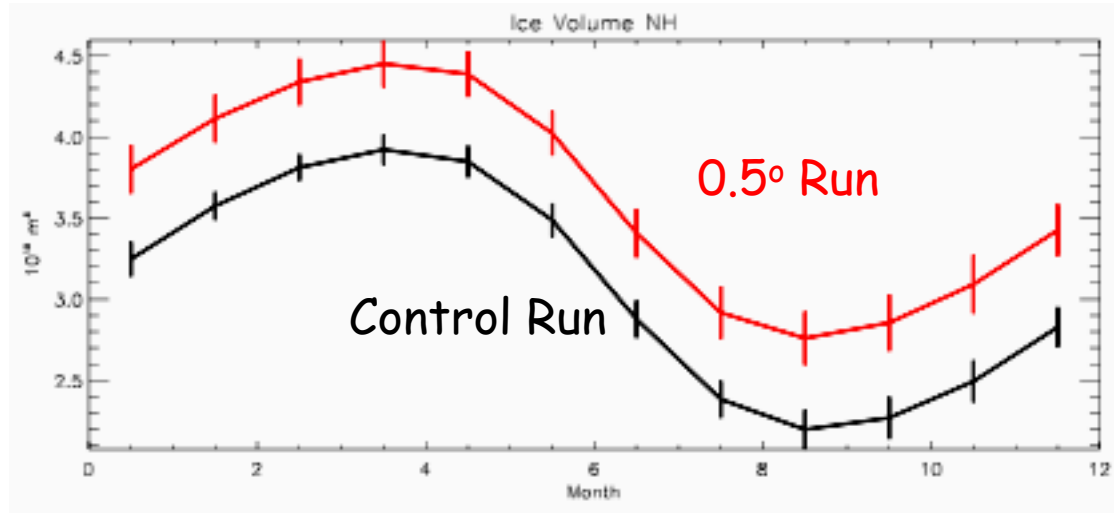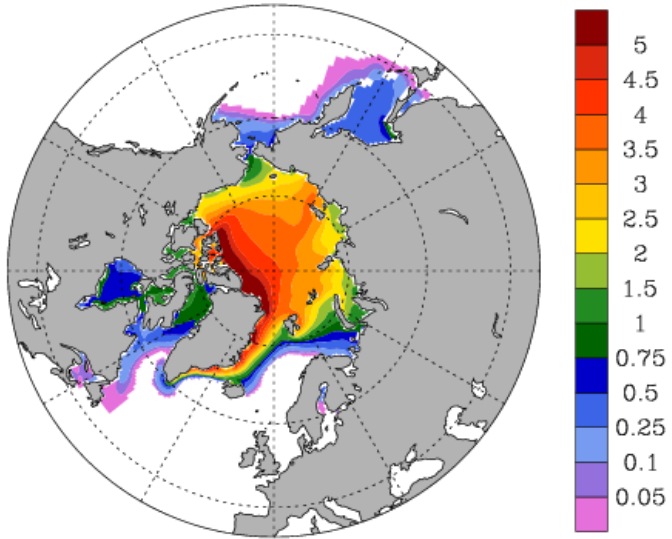|	Barents	WSC	EGC
Lowvisc	49	26	-14.6
Control	74	8	-8.9

Jochum et al, JGR
accepted

20th Century Change

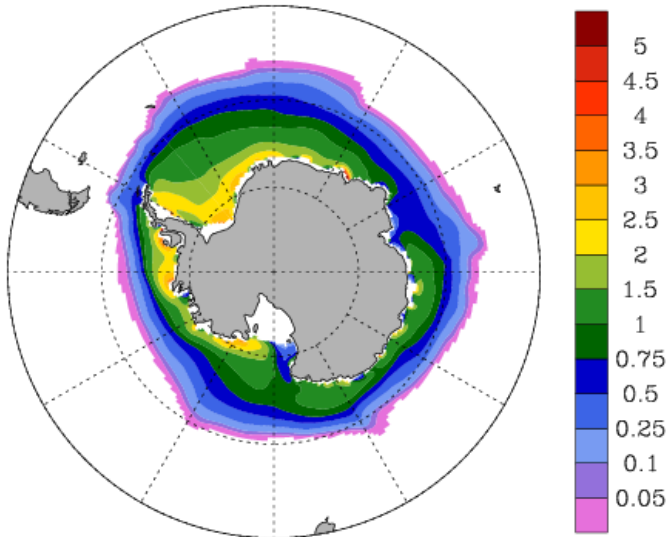JAS Mean b35.012 — NH Ice Volume, NH Snow Volume, NH Ice Area; JAS Mean b35.012 — SH Ice Volume, SH Snow Volume, SH Ice Area
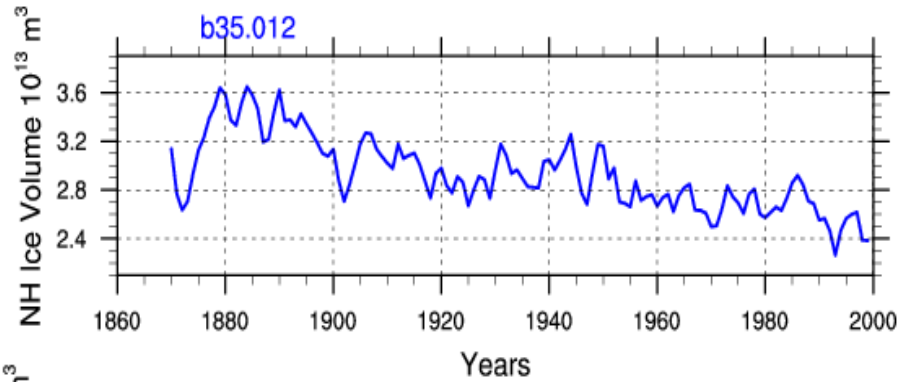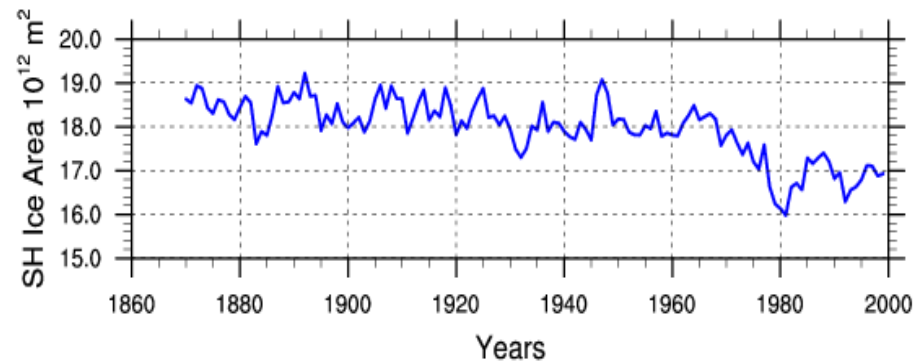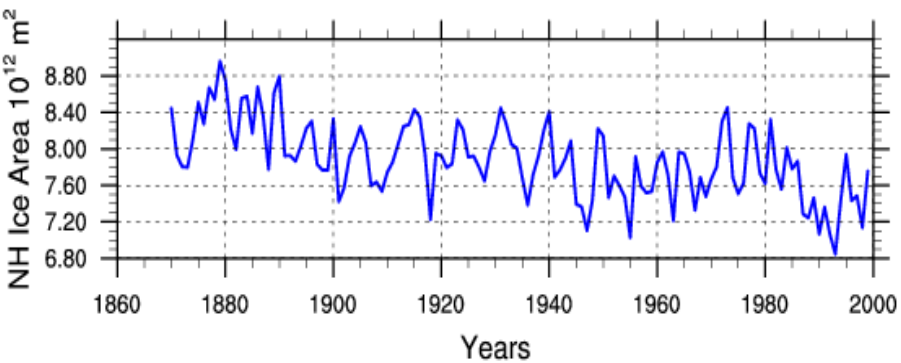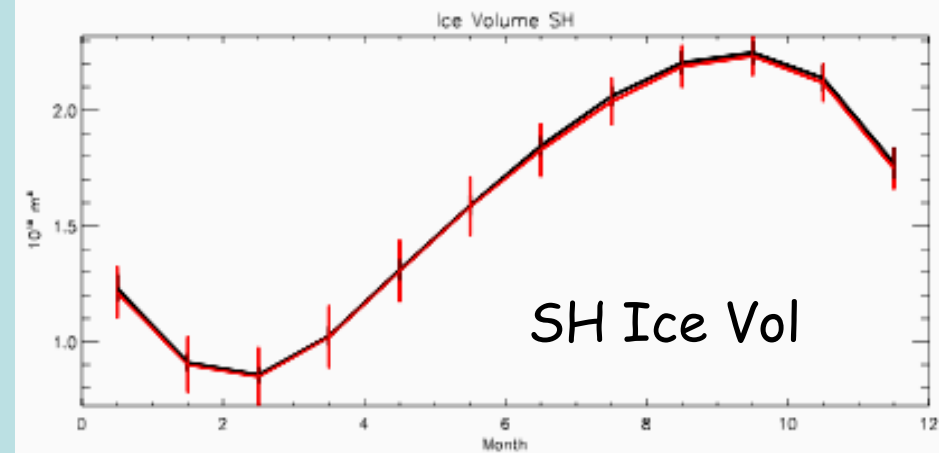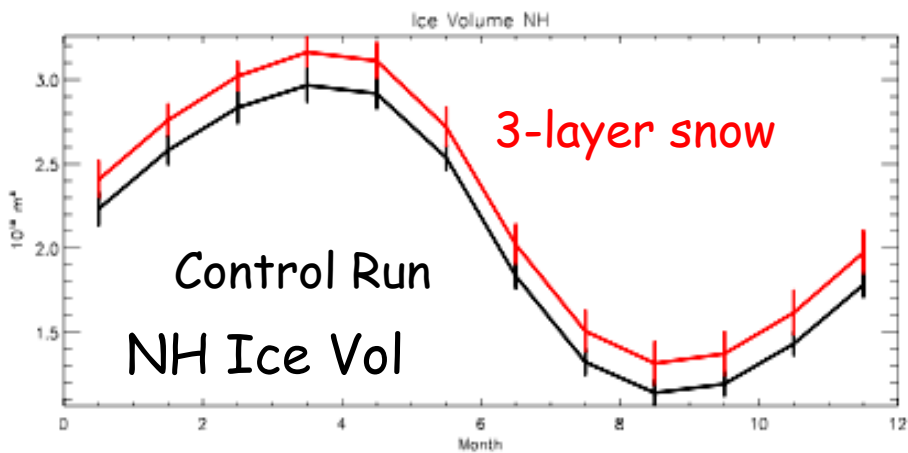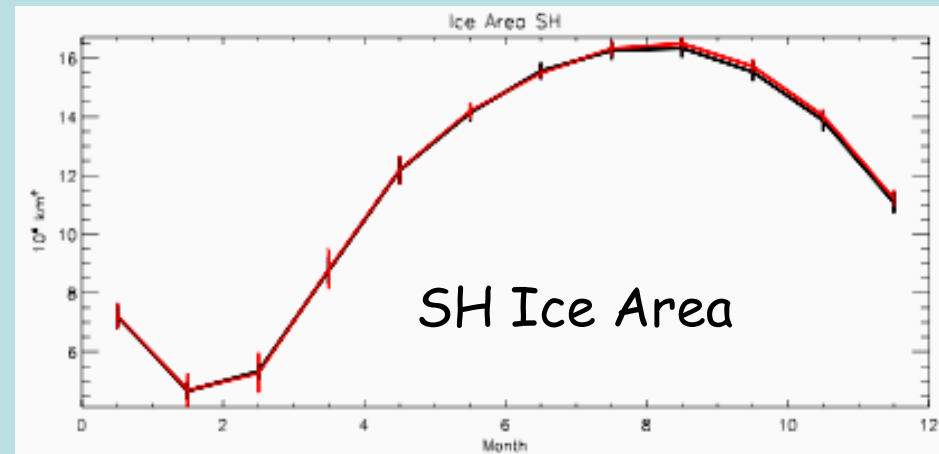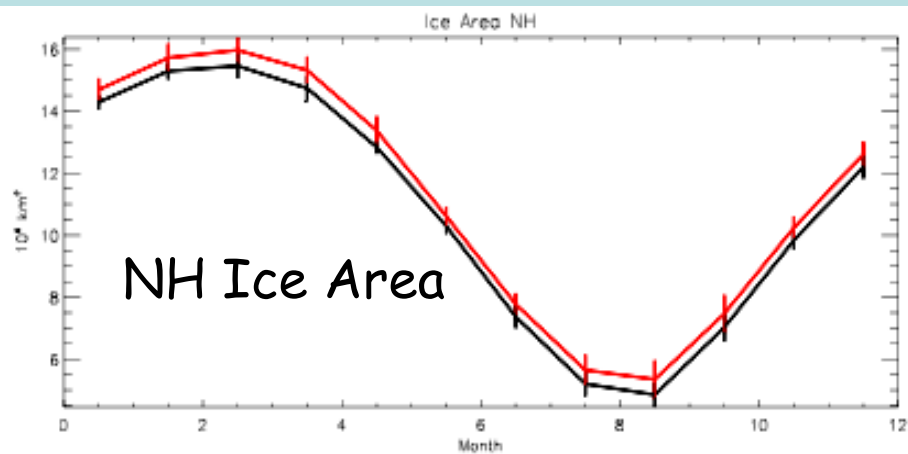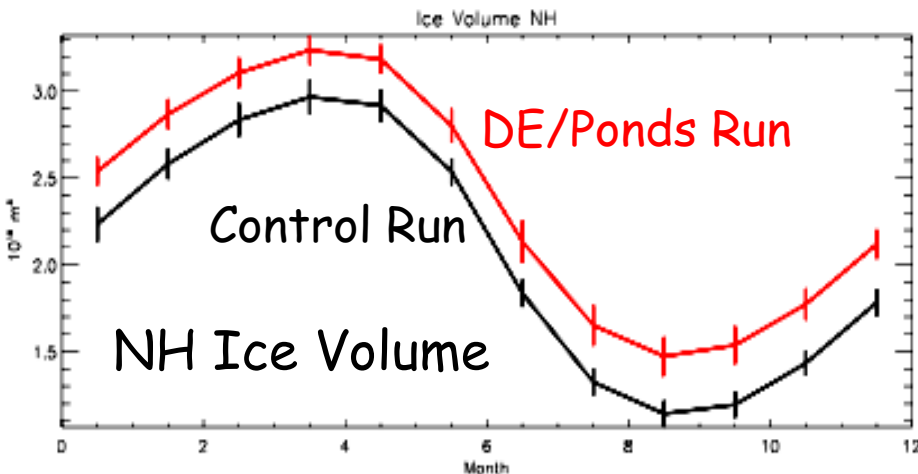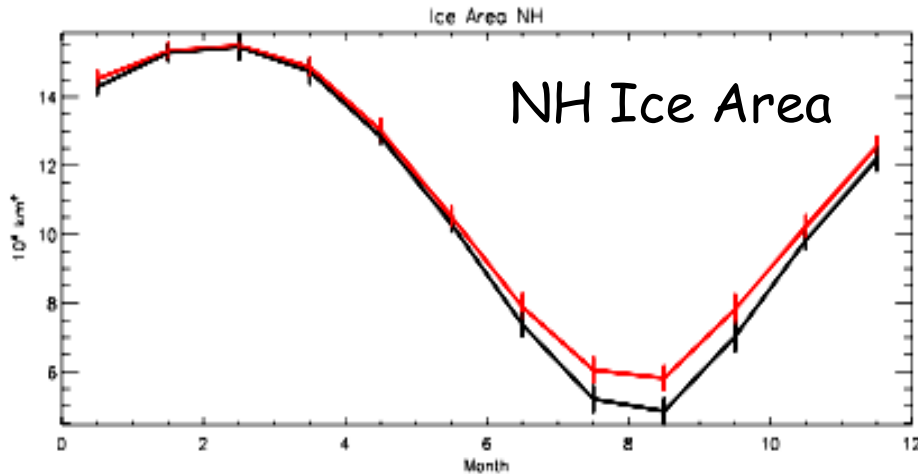
0.5 Degree Resolution Run
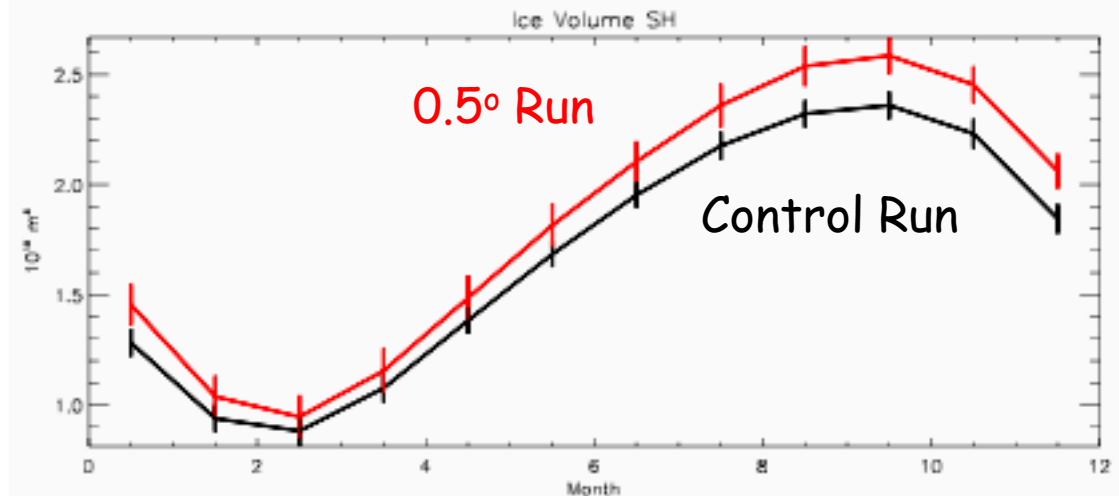
Testing Sea Ice Parameterizations

Coupled Runs with
- 3-layer snow model
- Delta-Eddington radiation and melt ponds

3-layer snow has minimal impact

Delta-Eddington/Pond Runs

Pond parameterization: 15% of melt water accumulates on ice, partitioned into area/depth based on SHEBA obs, no ponds if snow present on ice category

For these simulations,

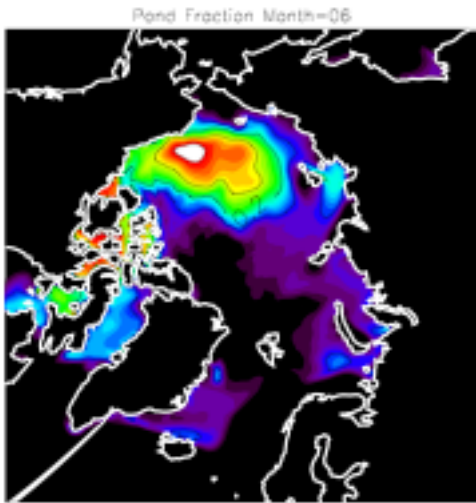the pond fraction remains very small

Increase in ice volume is simulated
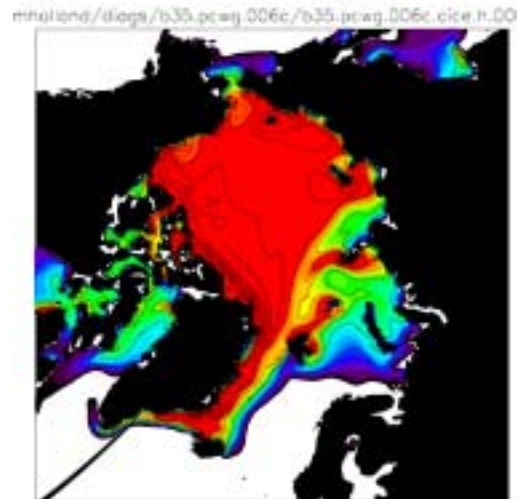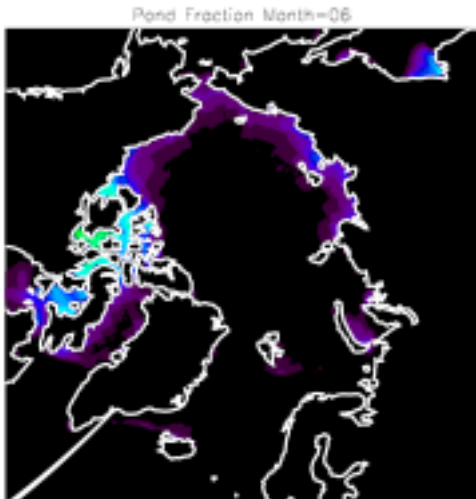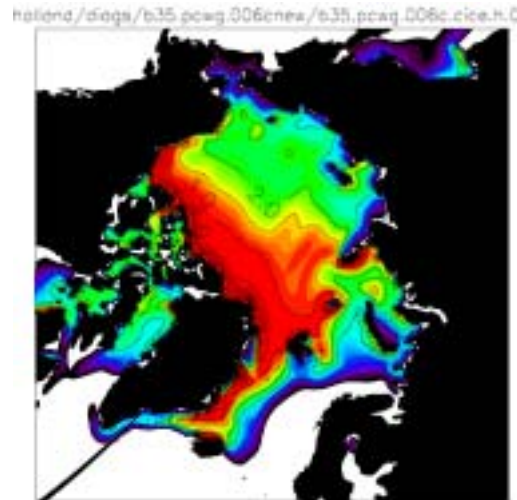
Albedo generally increased

Alternative Pond Formulation

Meltwater accumulation linear function of ice fraction (more water remains on less concentrated ice); Ponds allowed to form on snow-free ice fraction

June Pond Fraction   May Ice Thickness

- Larger pond fractions present

- Leads to reduced albedo

- Thinner ice cover

- Pond formulation is highly "tunable"

- Looking into data to help constrain parameters

Summary

- Good progress being made towards CCSM4

- Many polar improvements in development runs

- Need to initiate discussions on what polar aspects are desirable for next generation Earth System Model development

  - Types of improvements in standard components
  - BCG developments
  - Ice sheet/ice shelf/iceberg models
  - Societal/human impact considerations
  - Others?