

Arctic Sea Ice and Clouds in the SPCCSM4

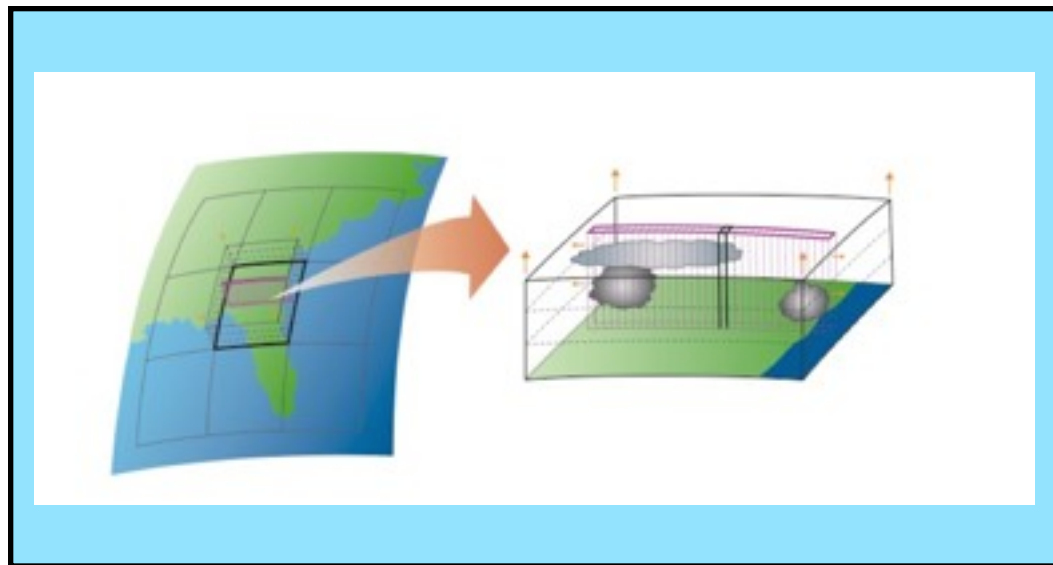
Melissa Burt

January 23, 2013

**Coupled Model and Climate Change Breakout
14th CMMAP Team Meeting**

Model and Simulation Info

SpCCSM4 Model Info	
Atmosphere and Land Model resolution	Finite Volume - 1.9° x 2.5° 30 vertical levels
Ocean and Sea Ice Model resolution	1°
CO2 Concentration	368.9 ppmv (Control) 1475.6 ppmv (4xCO2)
CRM resolution	4 km
CRM microphysics	SAM 1 moment
Simulation length	30 years



Schematic of superparameterization

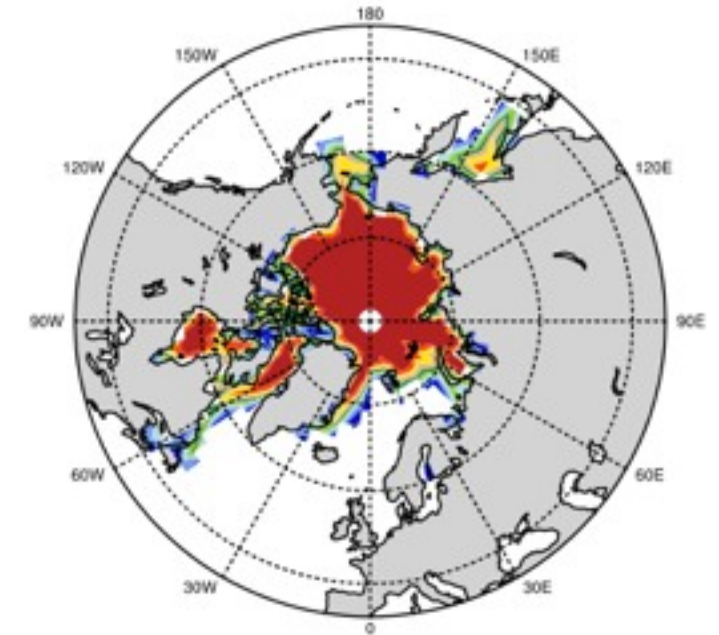
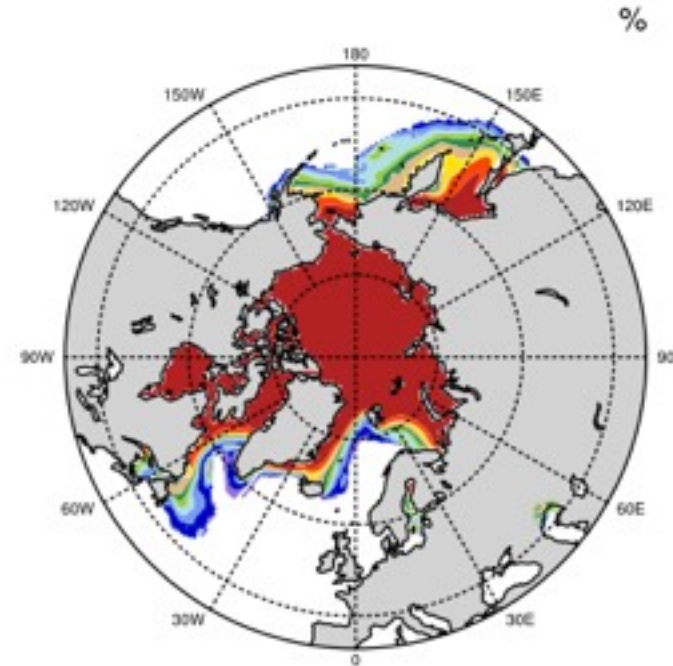
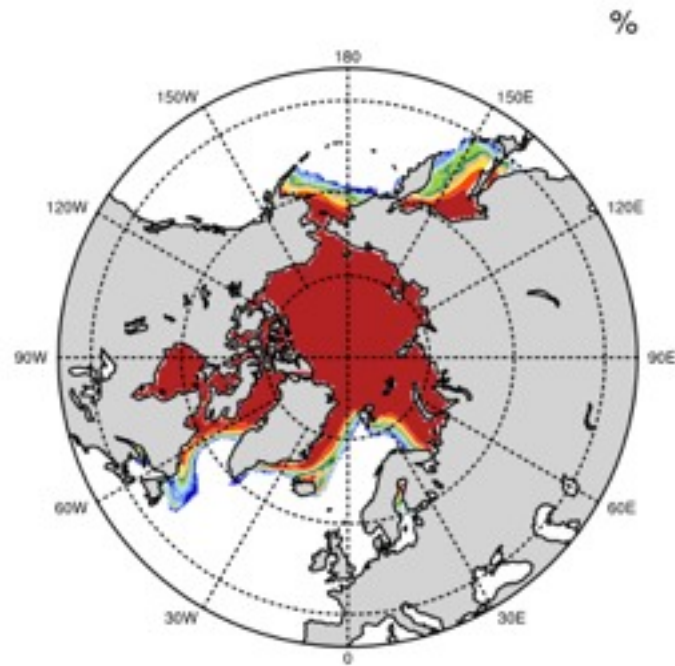
Sea Ice Area - Present Day

SpCCSM4

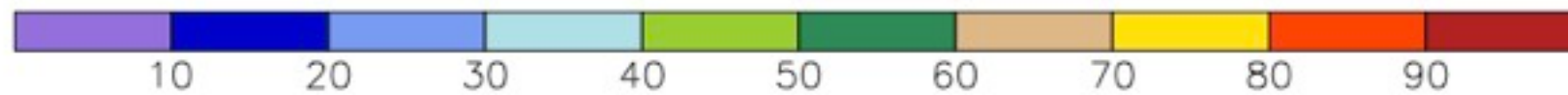
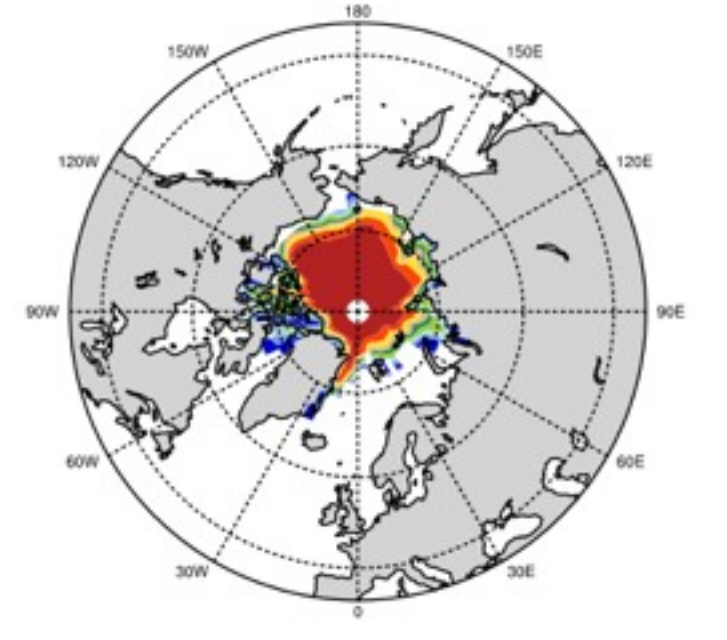
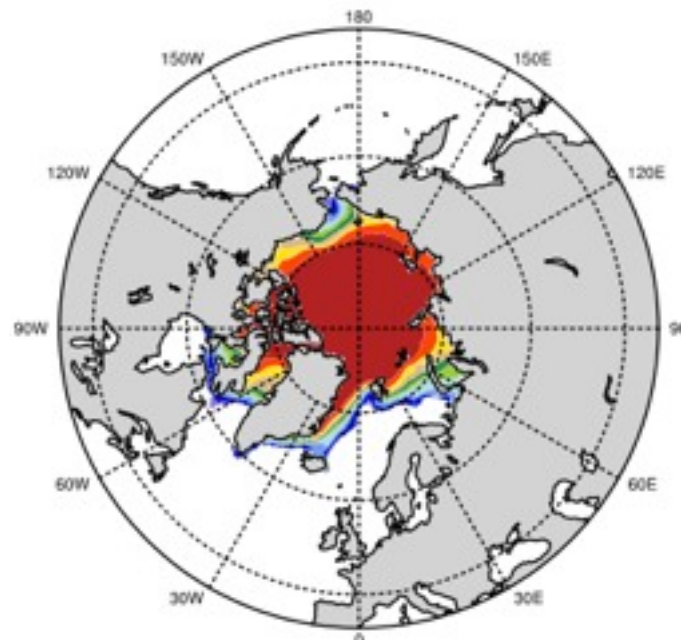
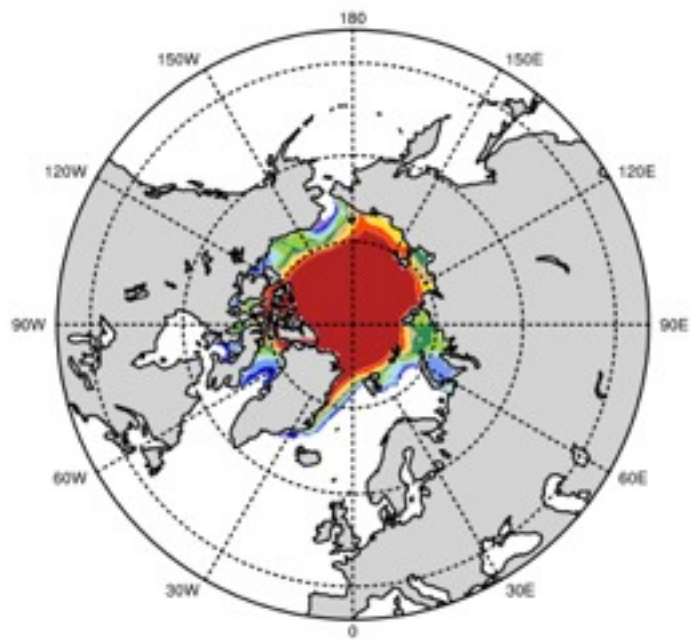
CCSM4

Observations

March



September



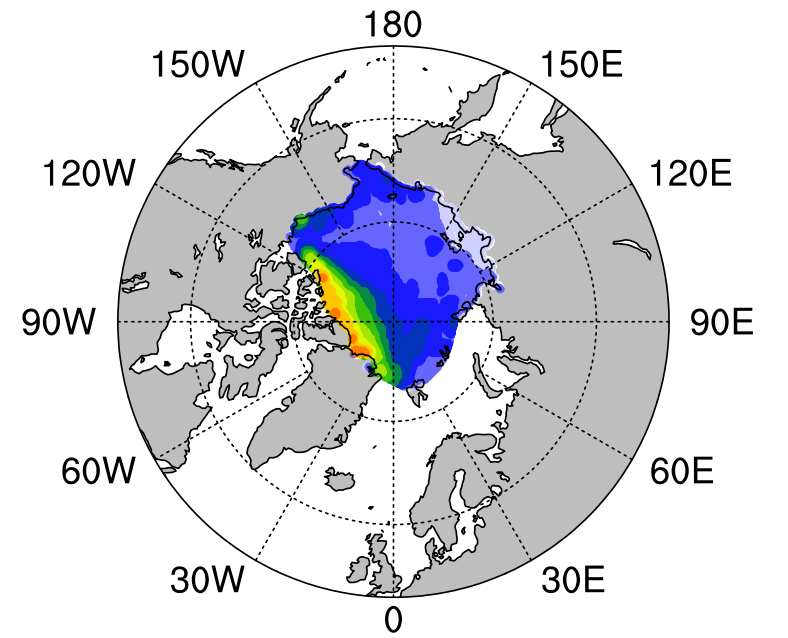
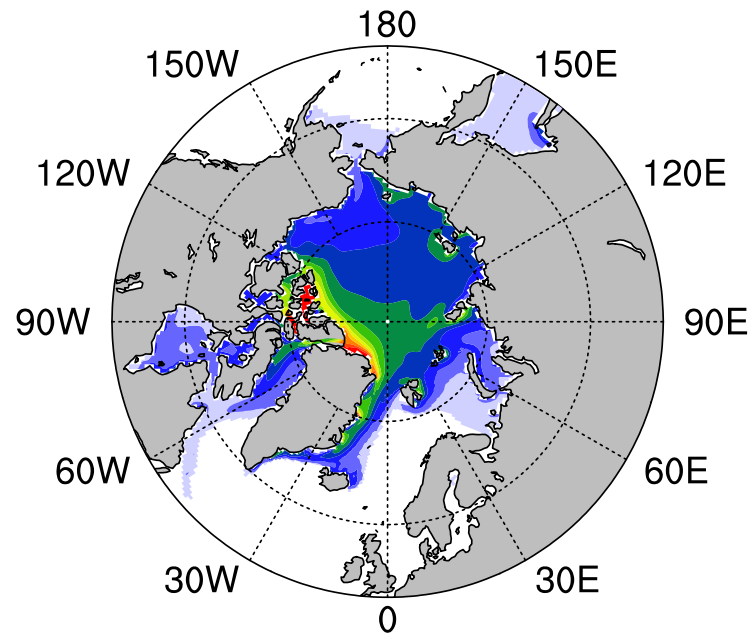
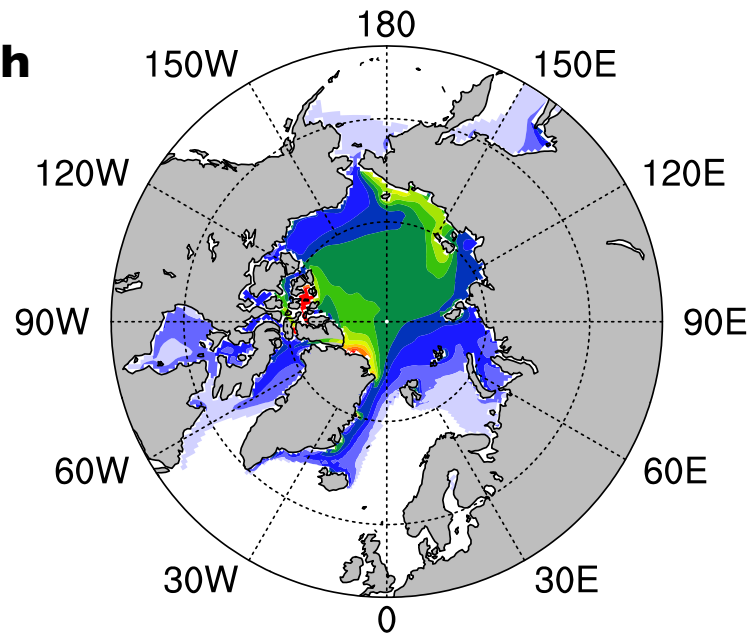
Sea Ice Thickness - Present Day

SpCCSM

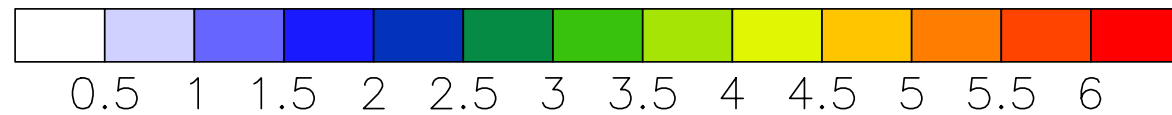
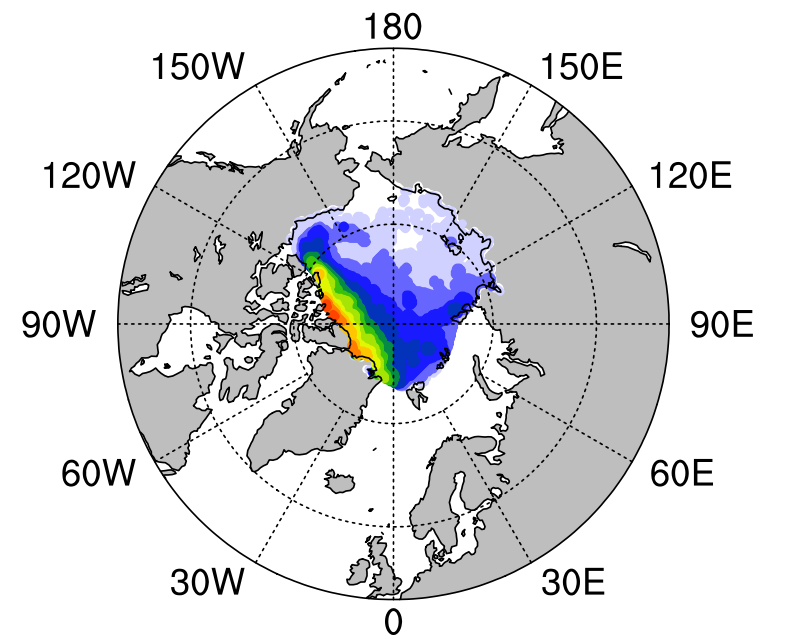
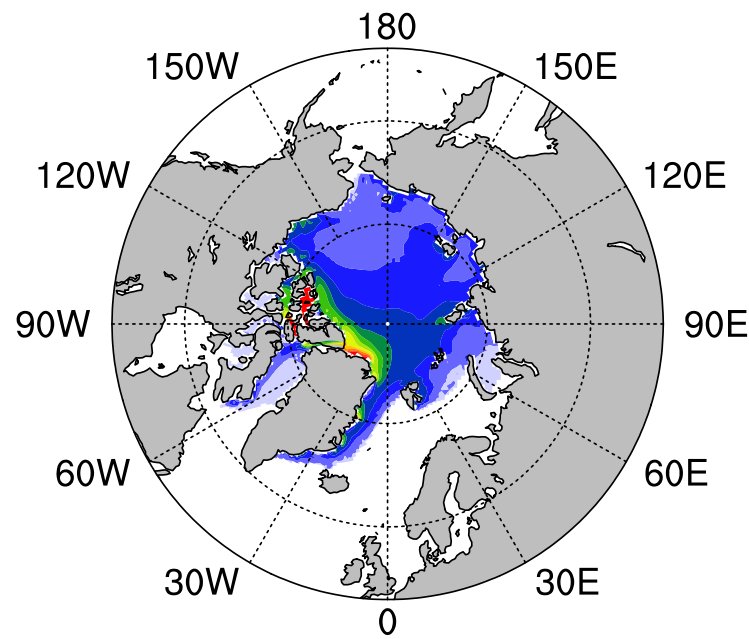
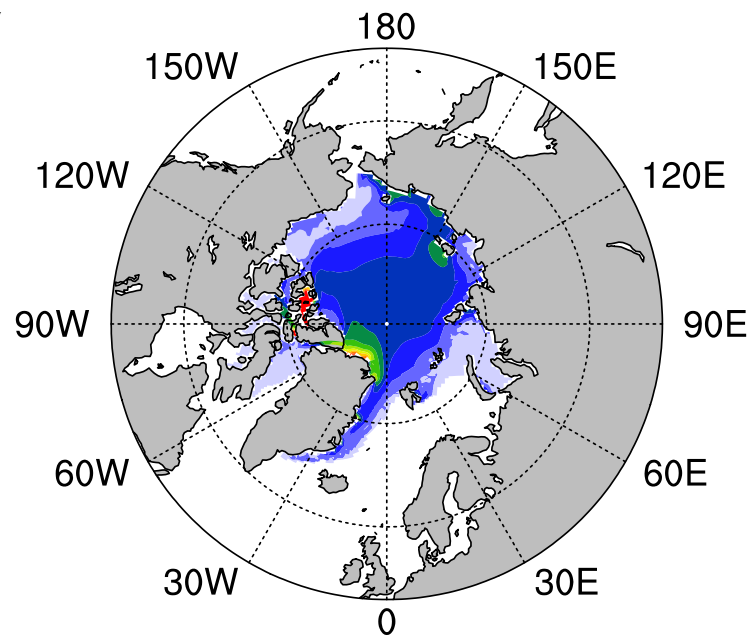
CCSM

Observations

Feb-March

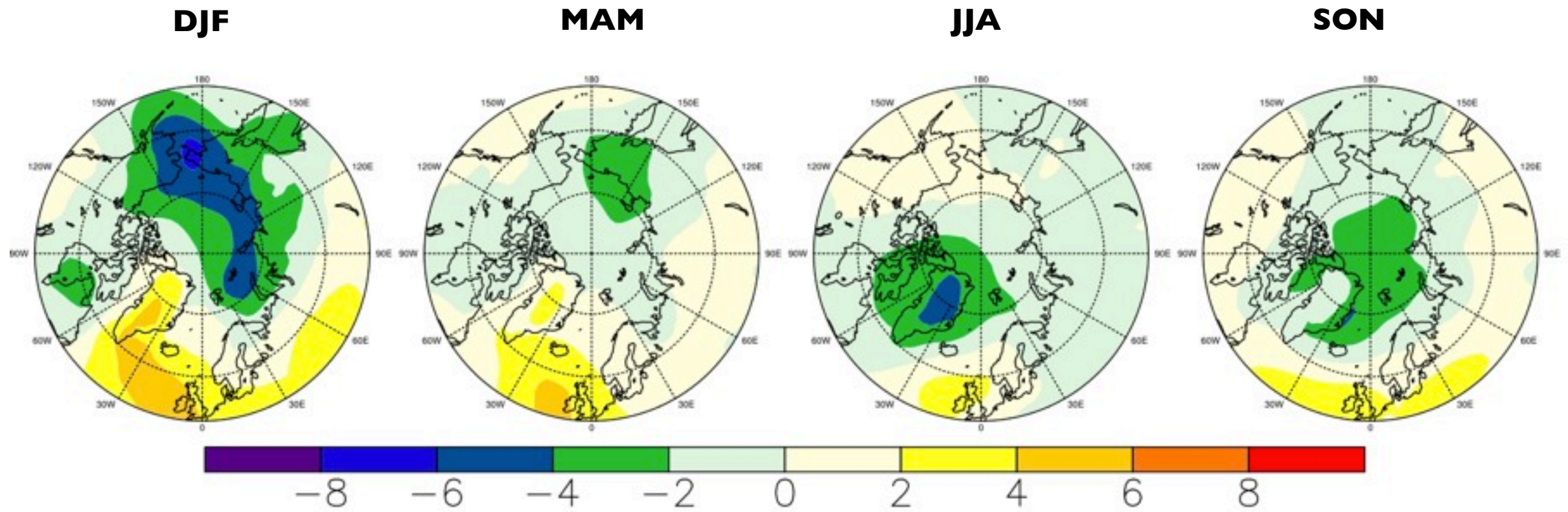


Oct-Nov

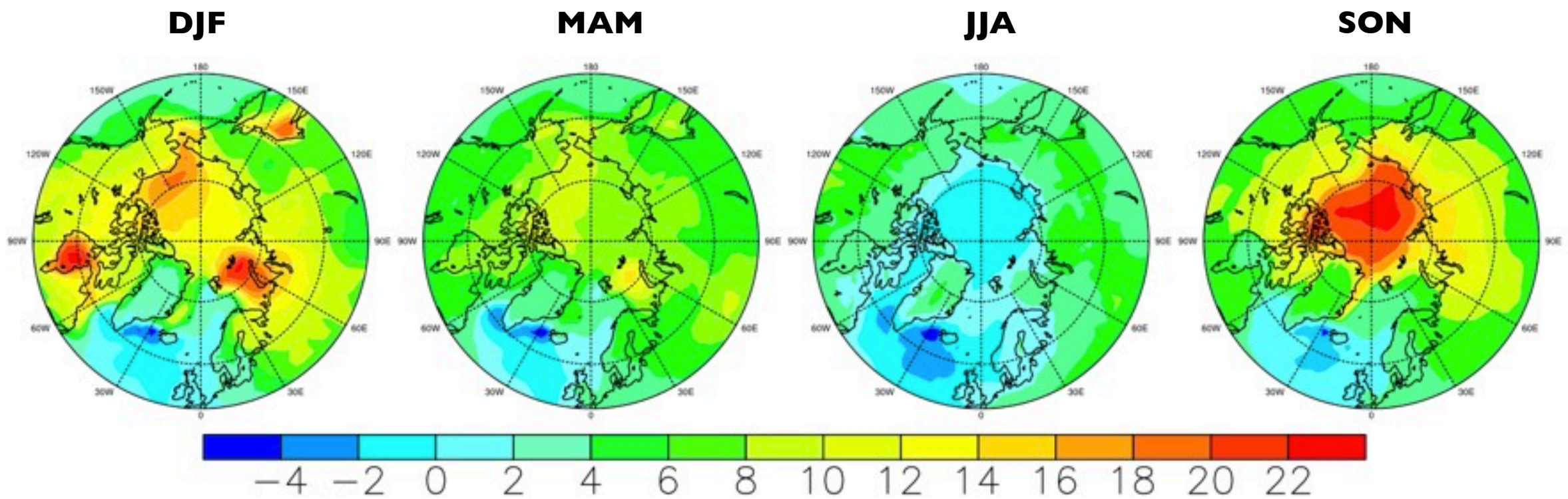


Arctic Climate Change in SpCCSM4

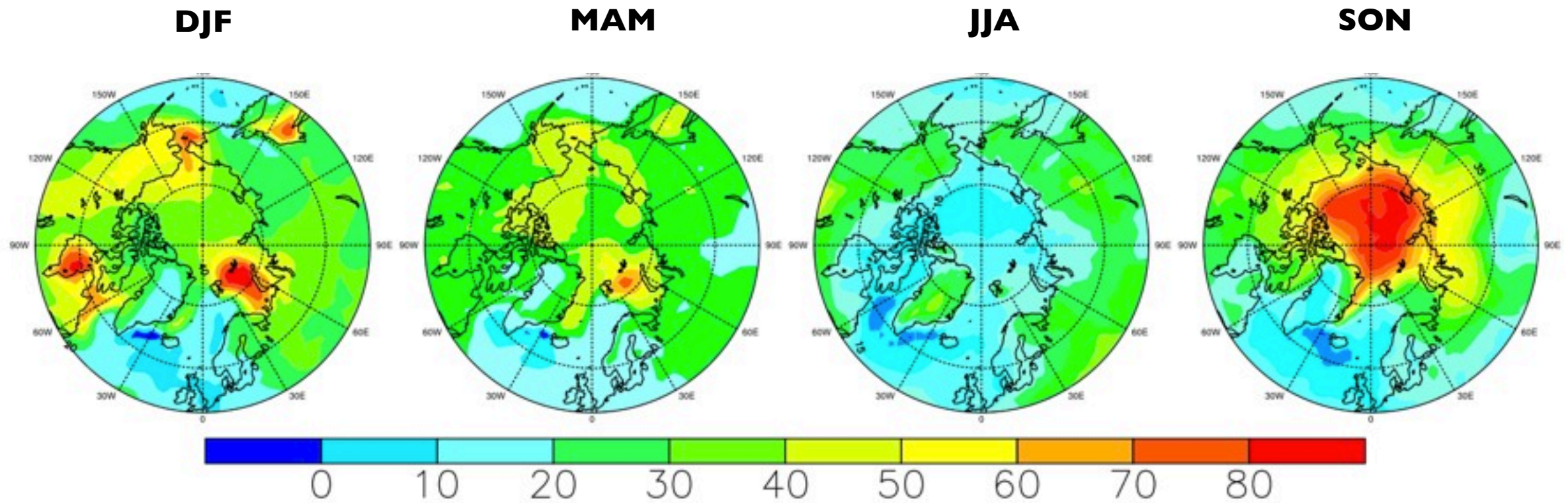
Mean Sea Level Pressure (mb)



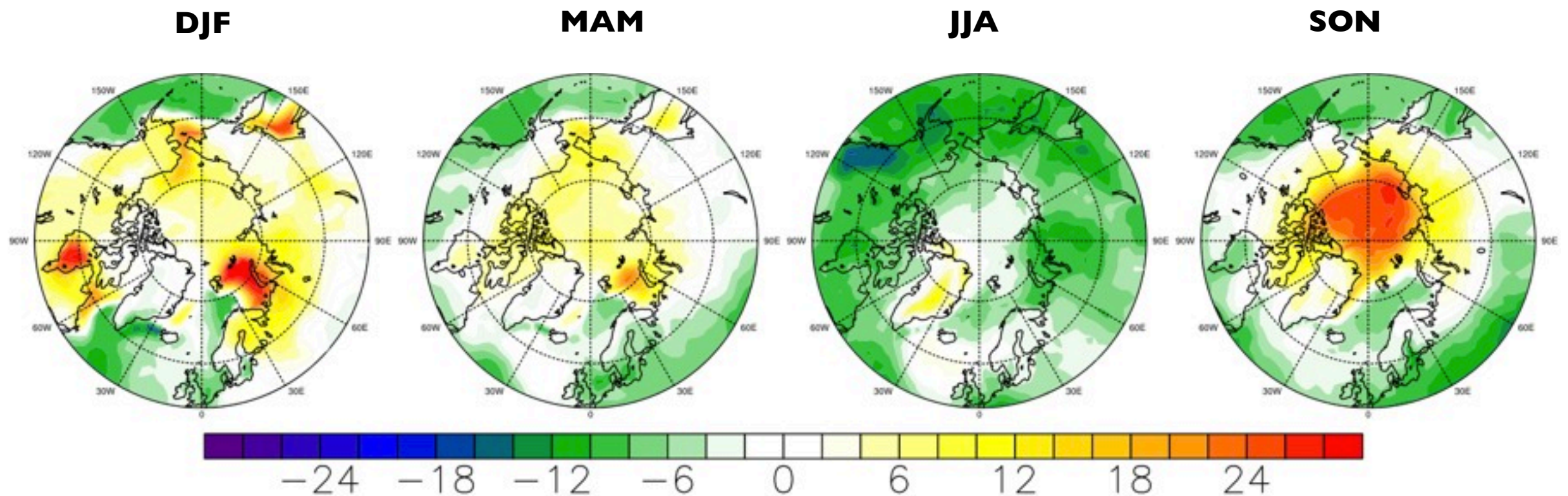
Surface Temperature (K)



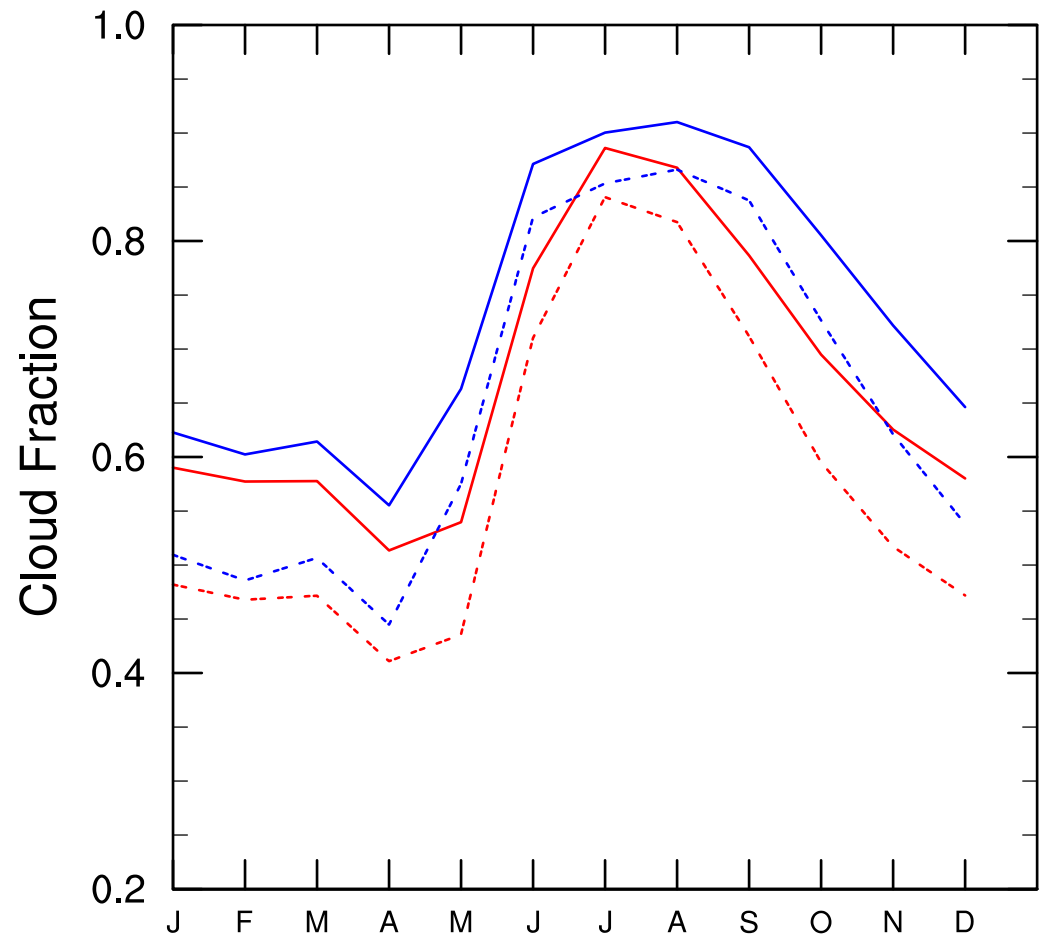
Downwelling Longwave Radiation (Wm^{-2})



Cloud Effect on DLR (Wm^{-2})



Cloud Fraction



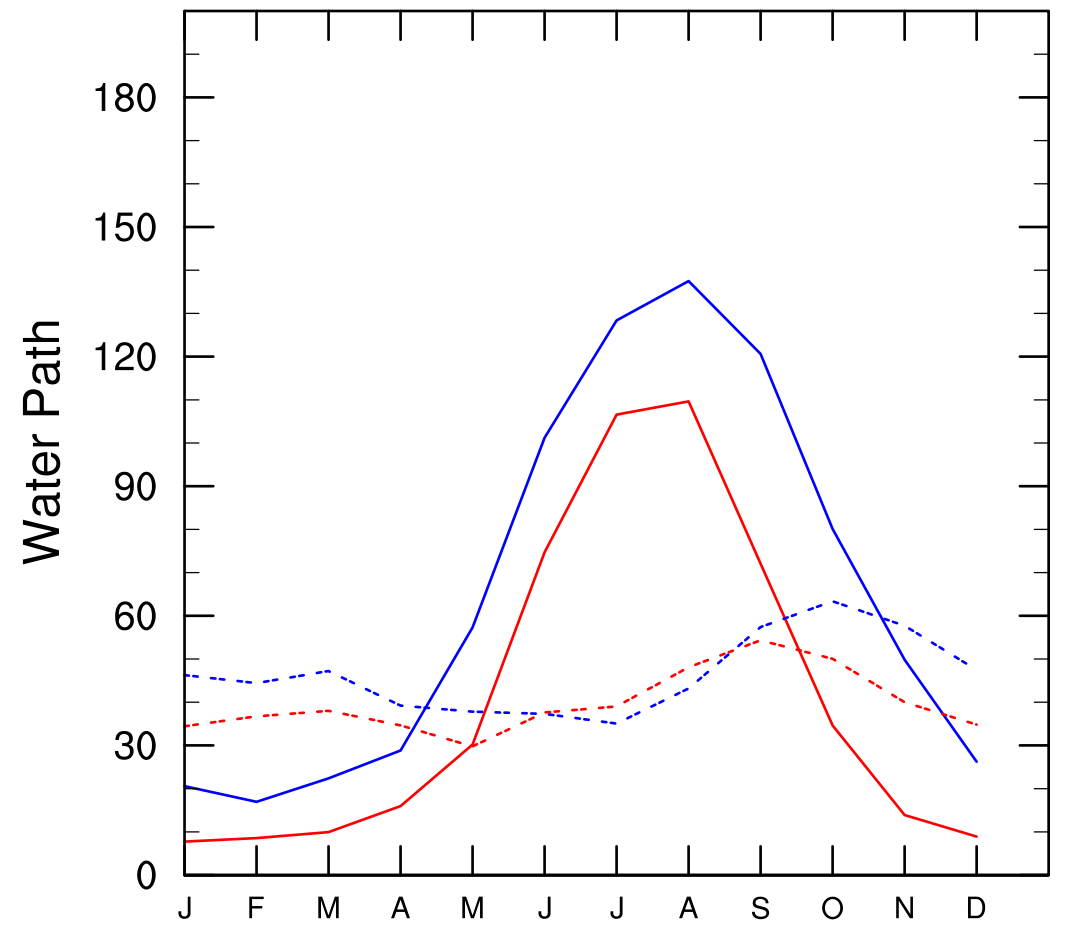
4xCO2
Control

low

—————

total

Liquid and Ice Water Path (gm⁻²)



4xCO2
Control

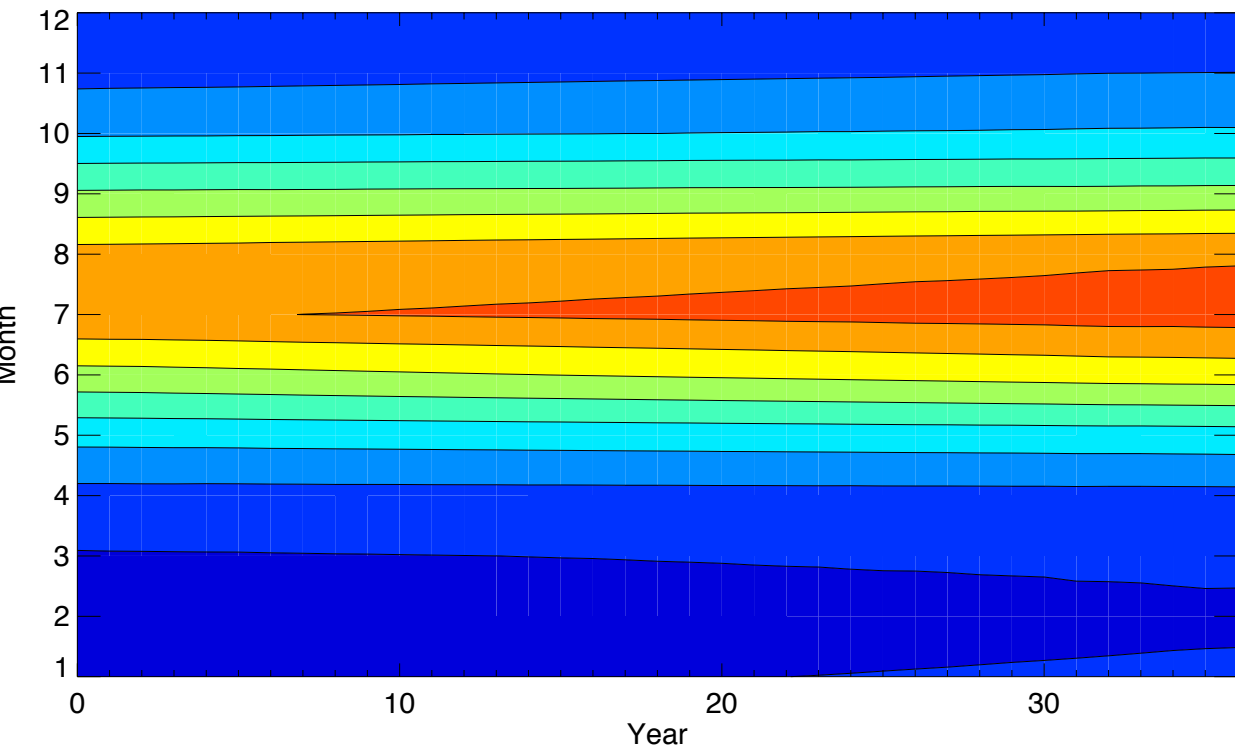
ice

—————

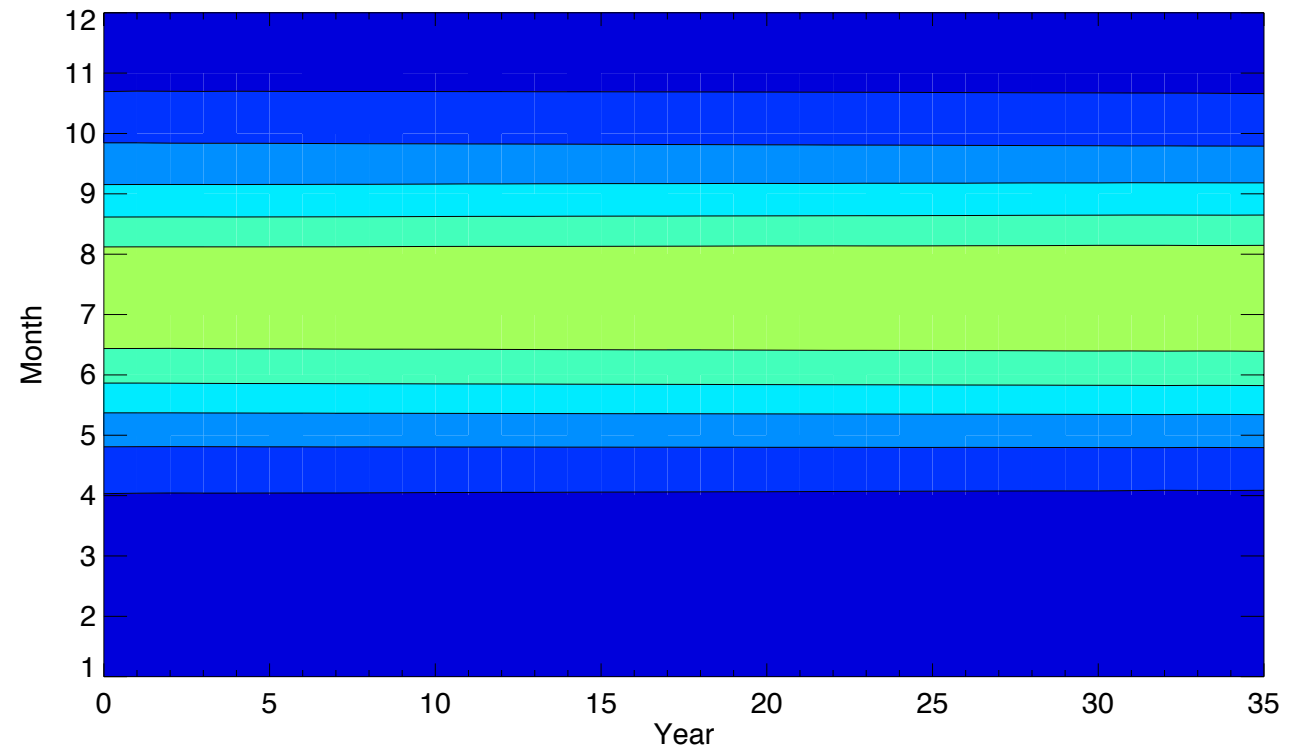
liquid

Precipitable Water (mm day⁻¹)

4xCO₂

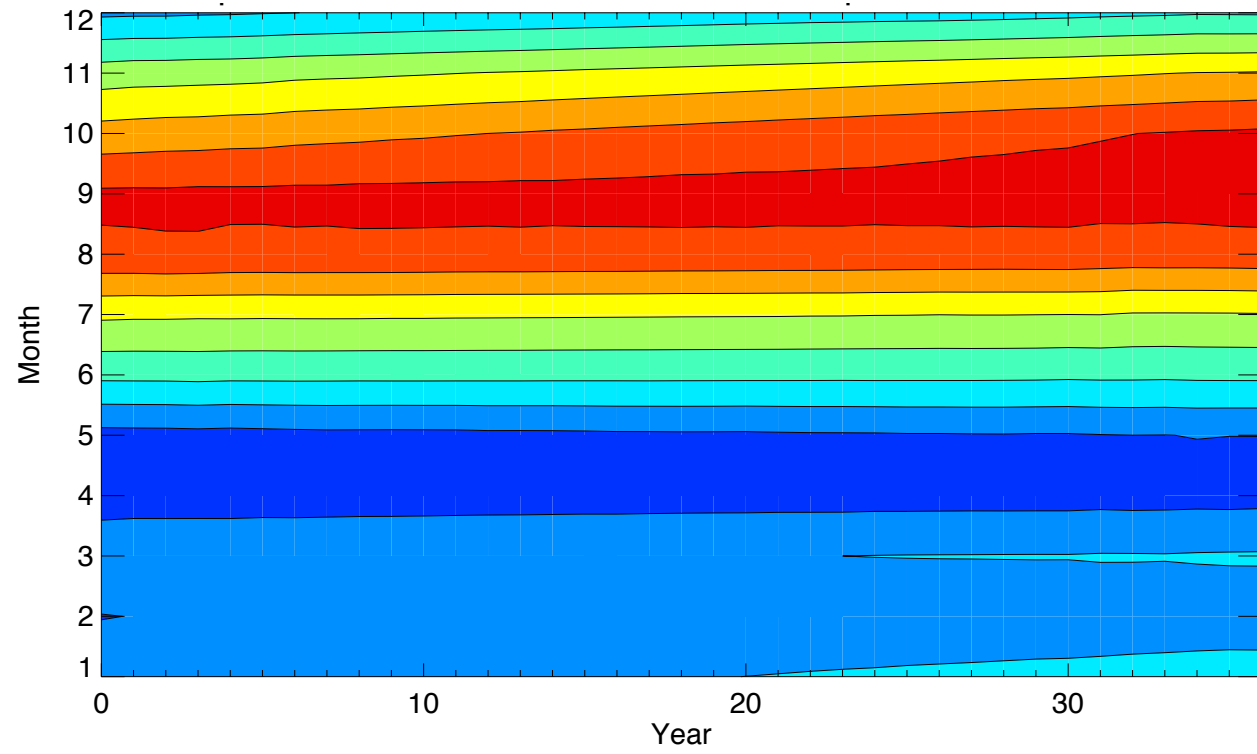


Control

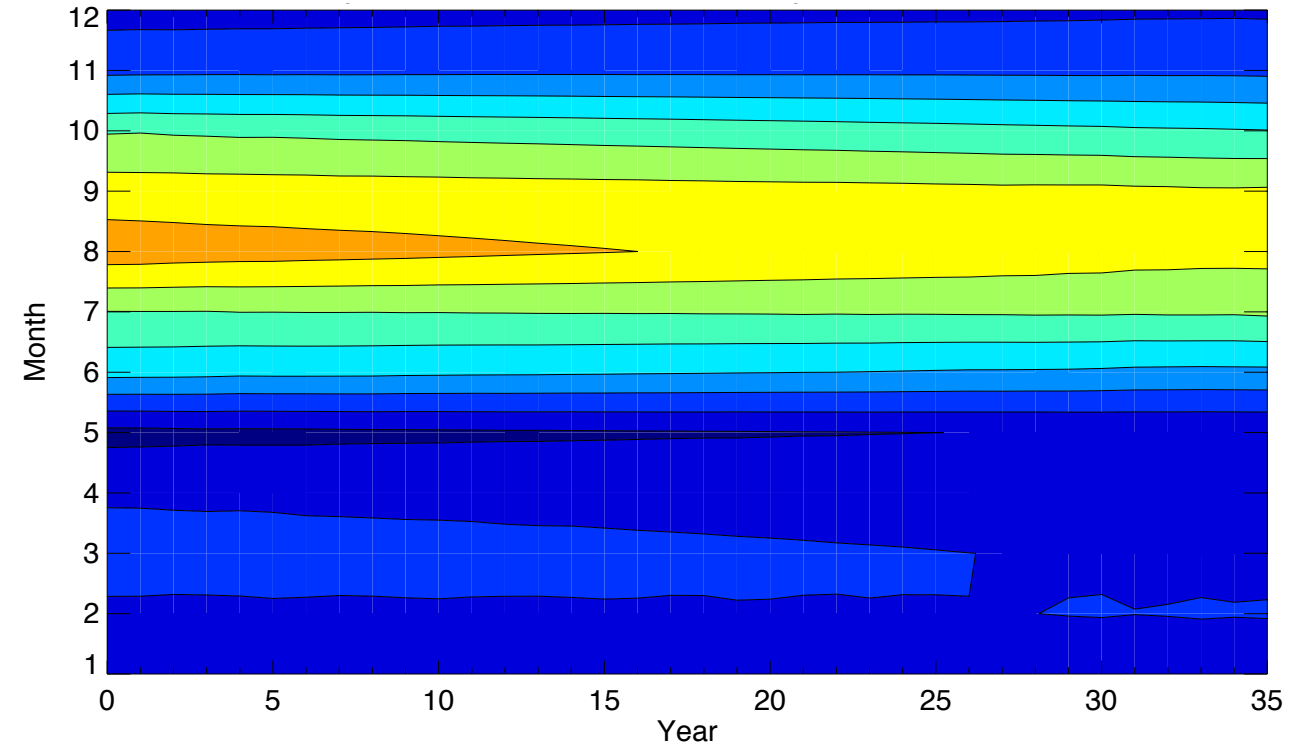


Total Precipitation (mm day⁻¹)

4xCO₂

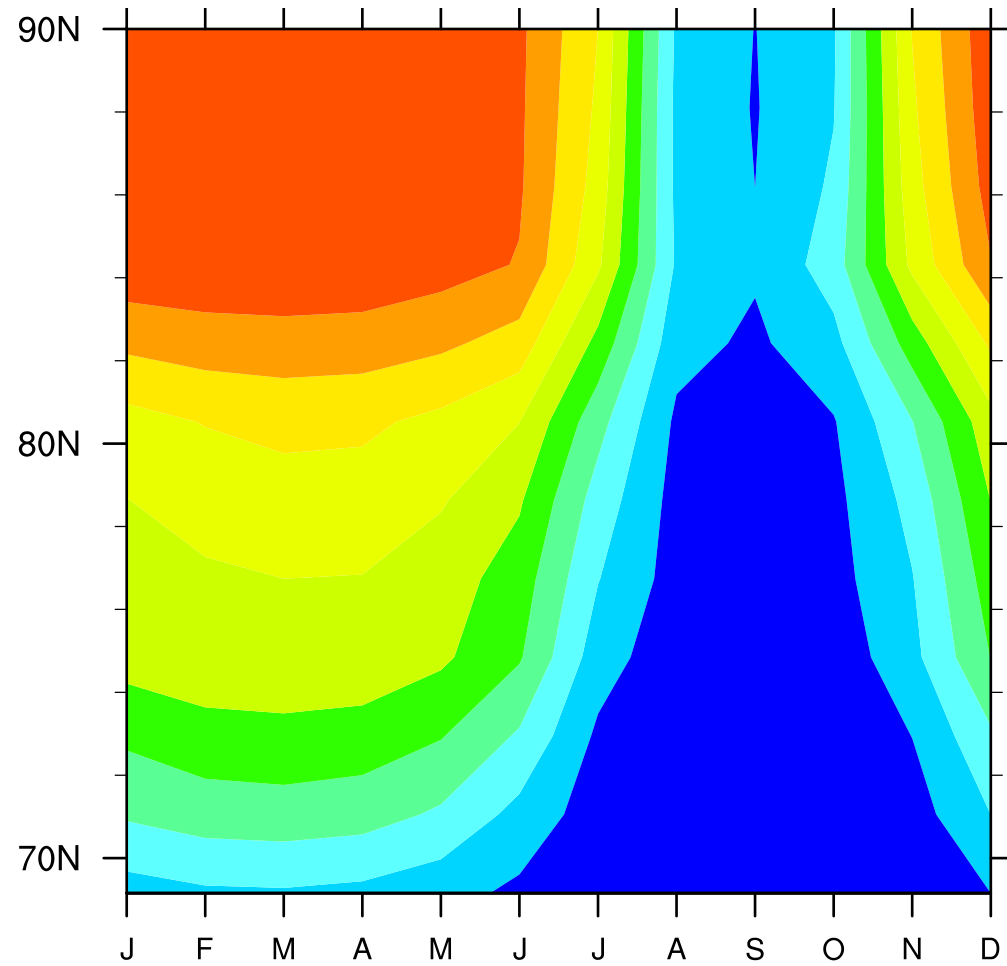


Control

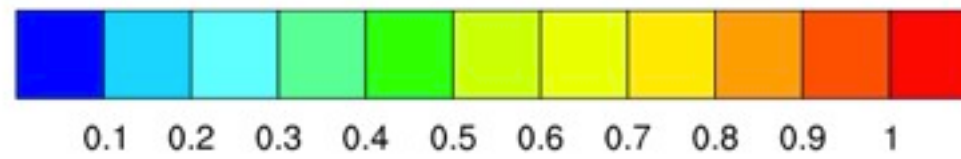
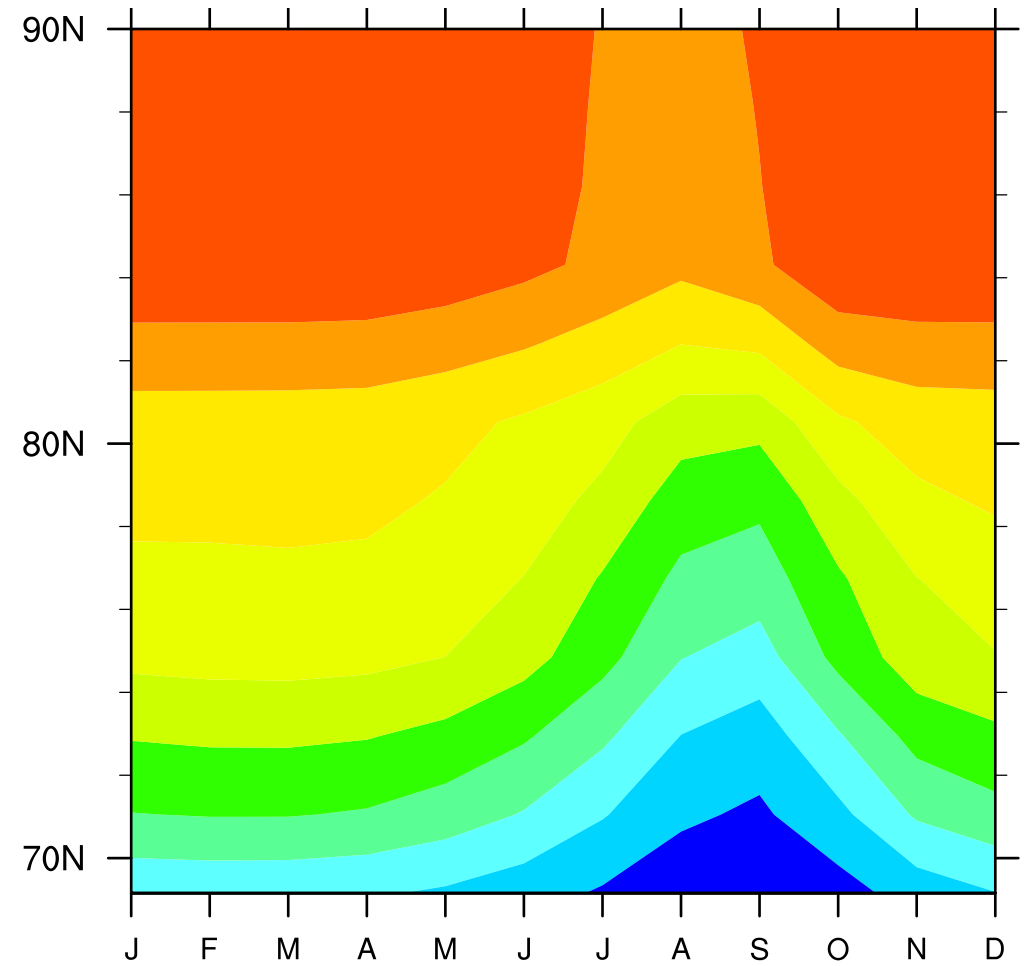


Annual Cycle of Sea Ice Area

4xCO2

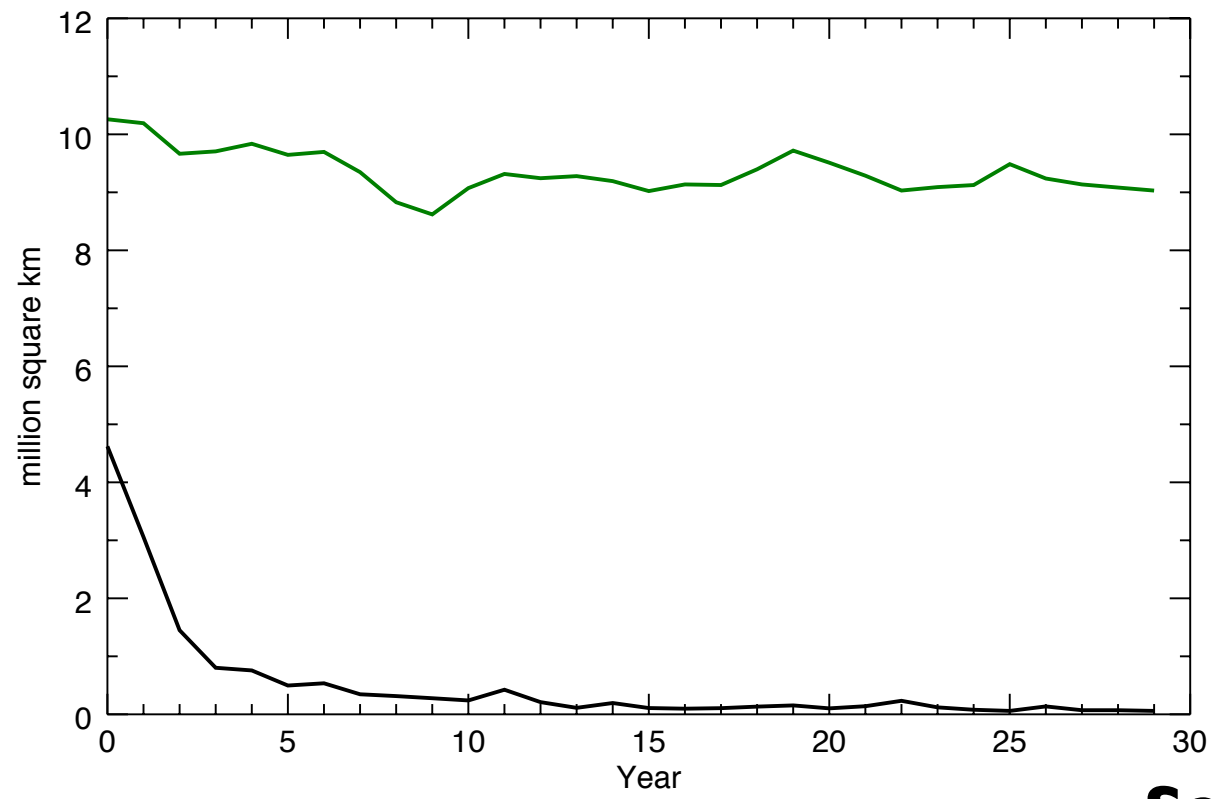


Control

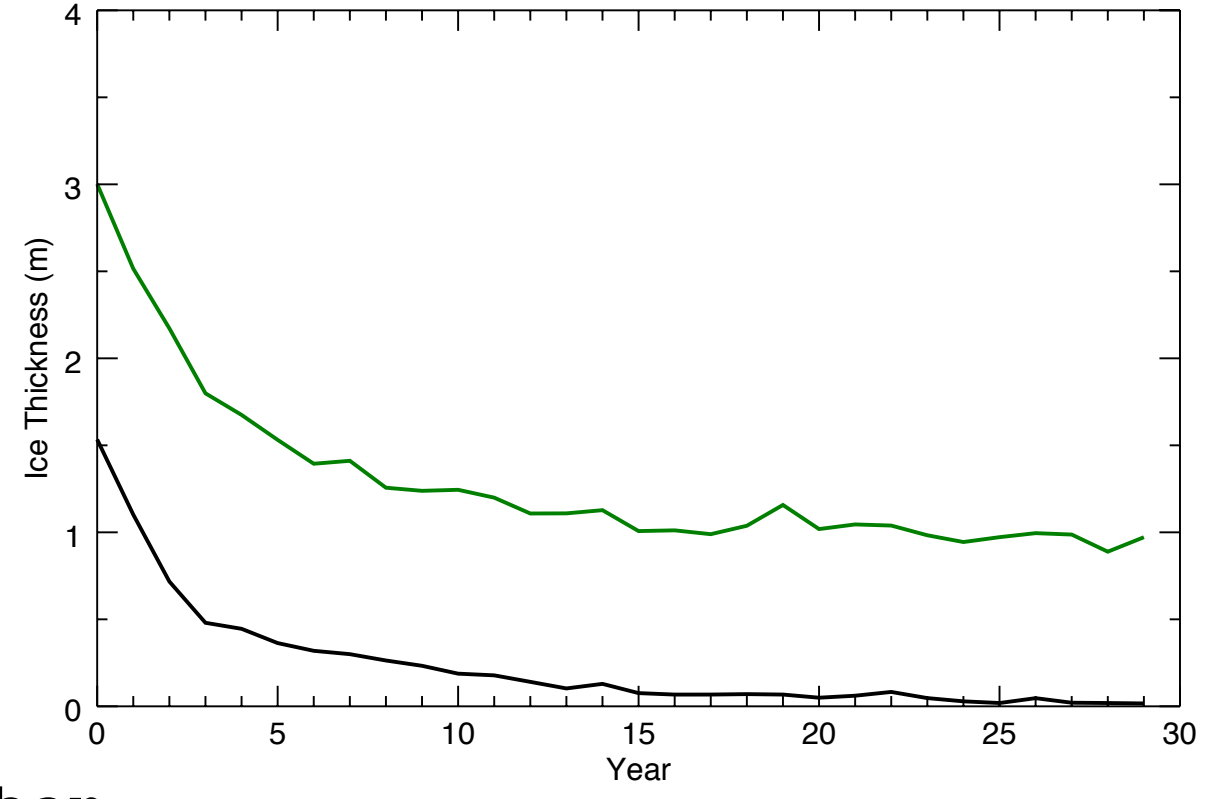


70-90N

Arctic Sea Ice Area 4xCO2

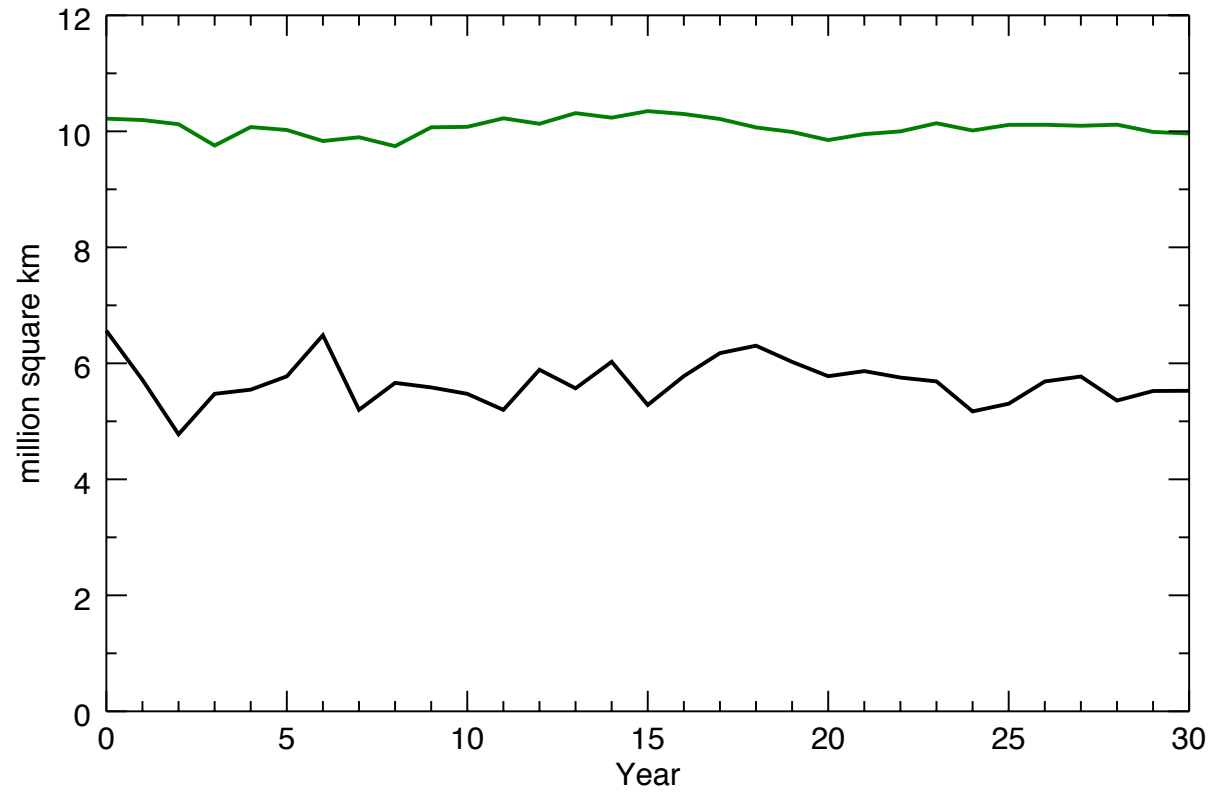


Arctic Sea Ice Thickness 4xCO2

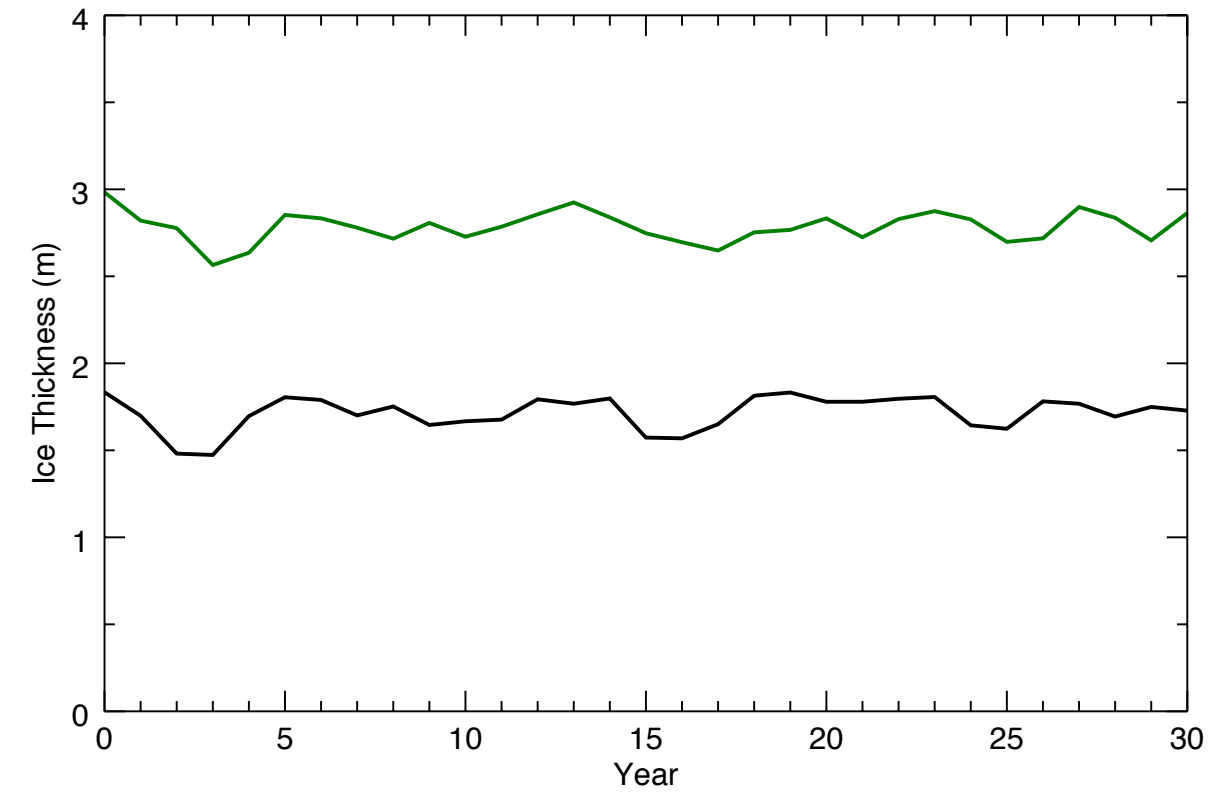


September
March

Arctic Sea Ice Area Control

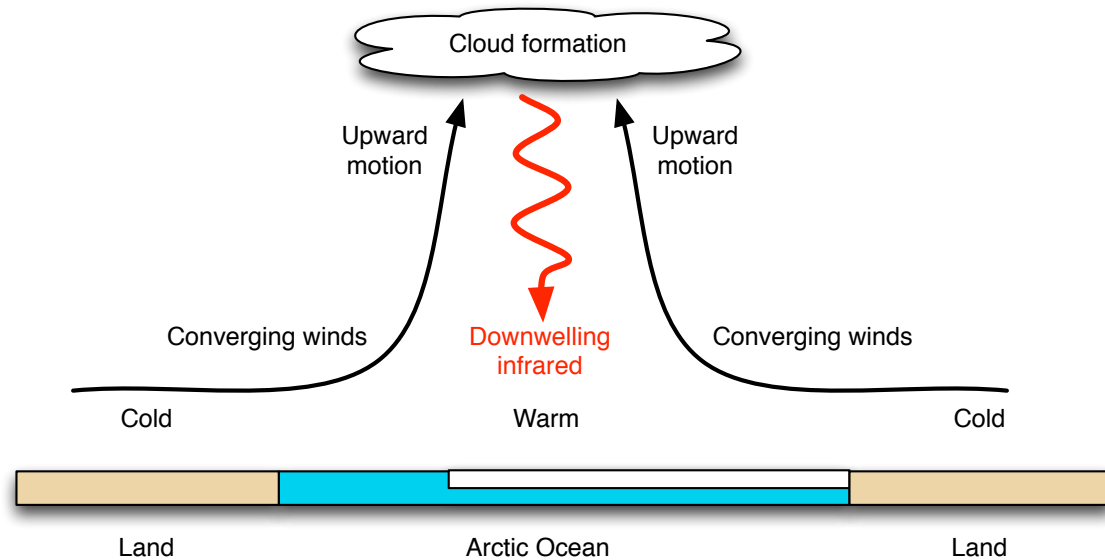


Arctic Sea Ice Thickness Control



Proposed Hypothesis

Cloud Feedback in the Arctic Winter



As the Arctic sea ice thins in a future warmer climate, the -2°C water below the ice will increasingly impress its temperature on the surface of the ice -- Arctic Ocean may become warmer than the continents (fall/winter)

Formation of a low-pressure system over the Arctic Ocean

Low-level convergence and tropospheric rising motion (promotes increased transport of WV into Arctic)

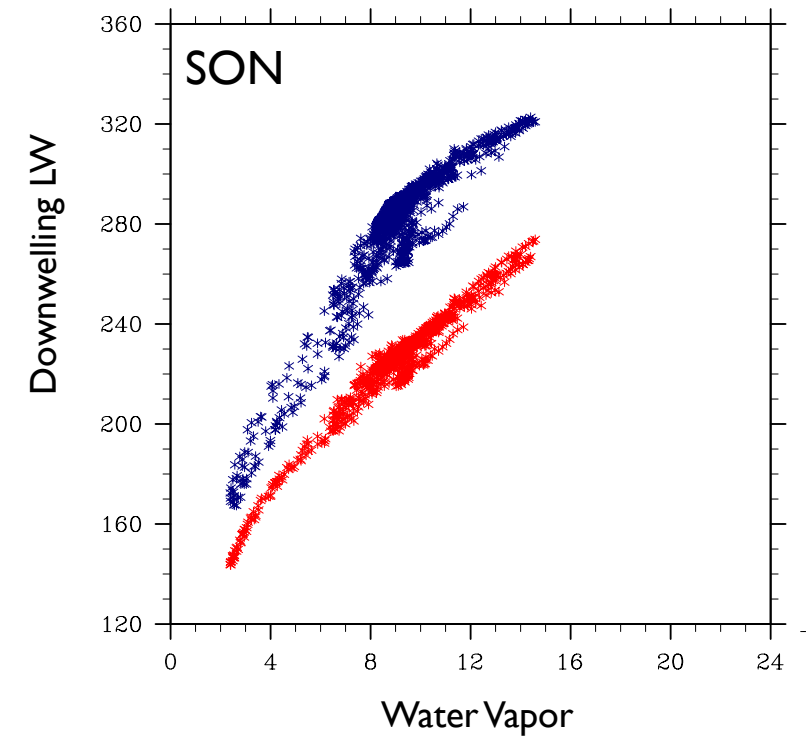
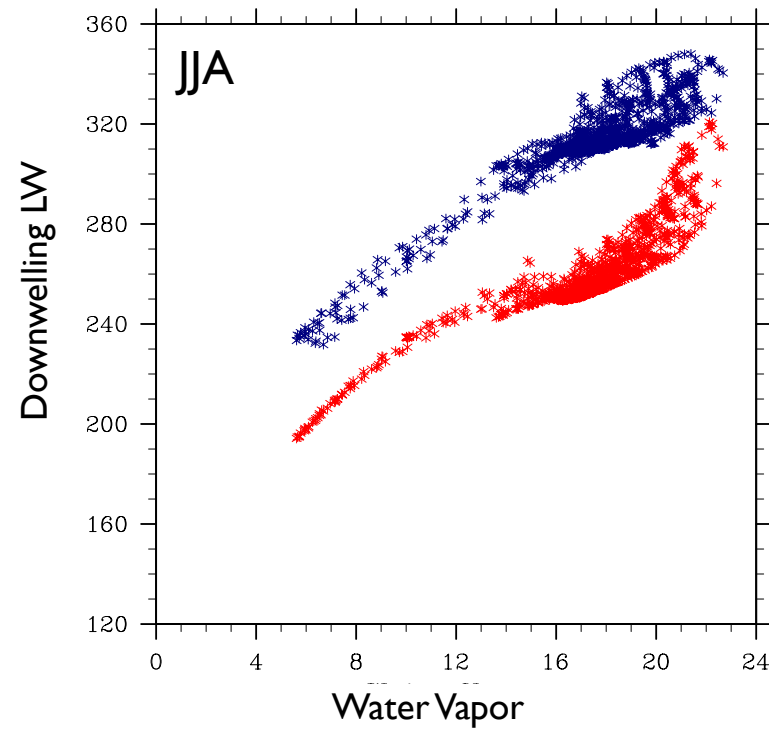
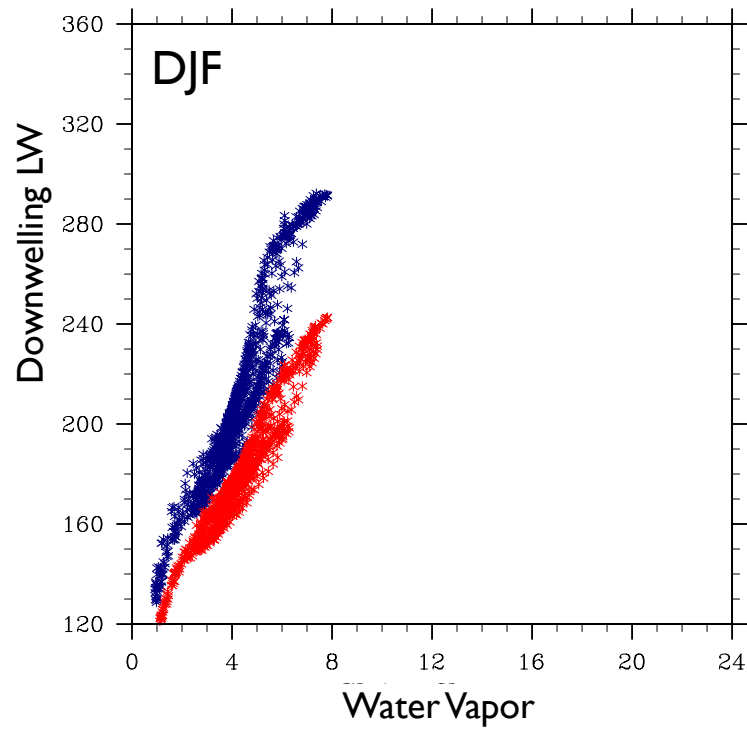
Water vapor + tropospheric rising motion = deep humid layer and additional cloud formation

Radiative effects which include an increase in the downwelling longwave radiation (DLR)

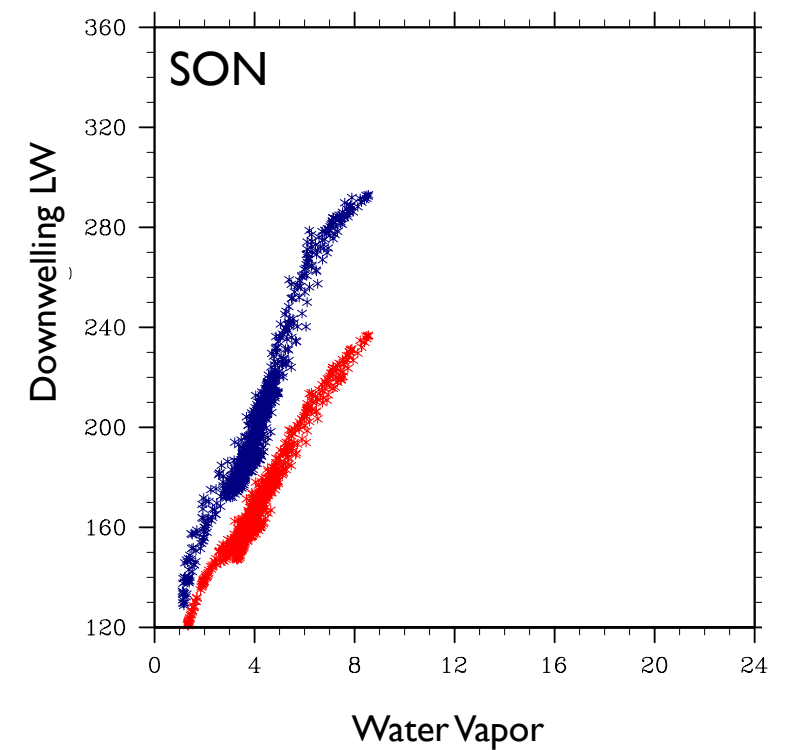
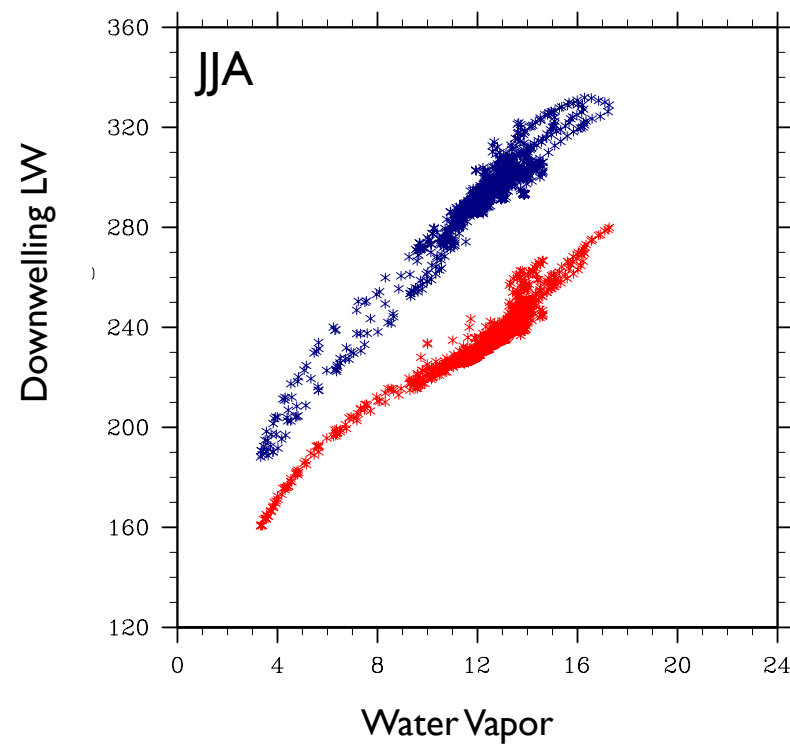
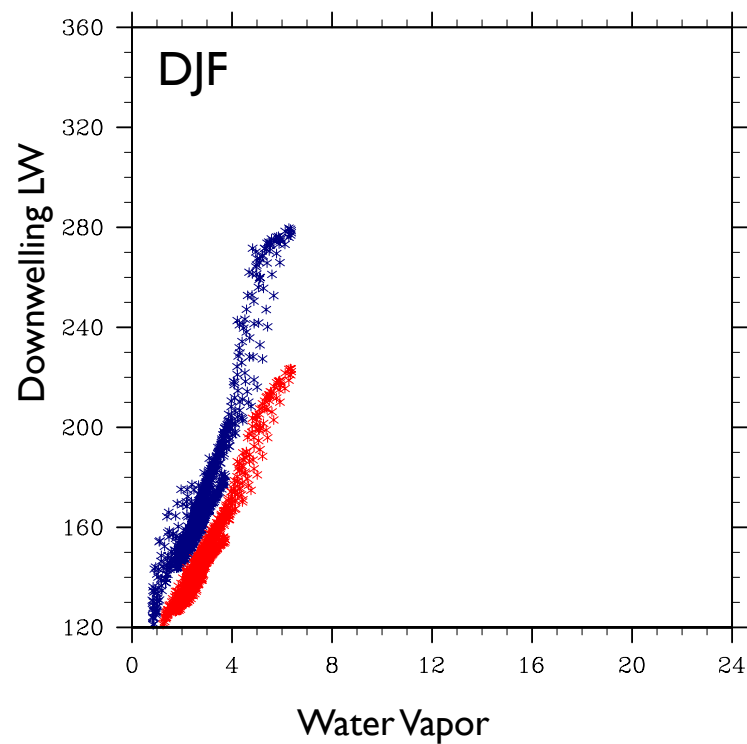
Increased DLR will promote further thinning of the sea ice, thus providing a positive feedback

Downwelling Longwave Radiation vs. Water Vapor

SpCCSM 4xCO2

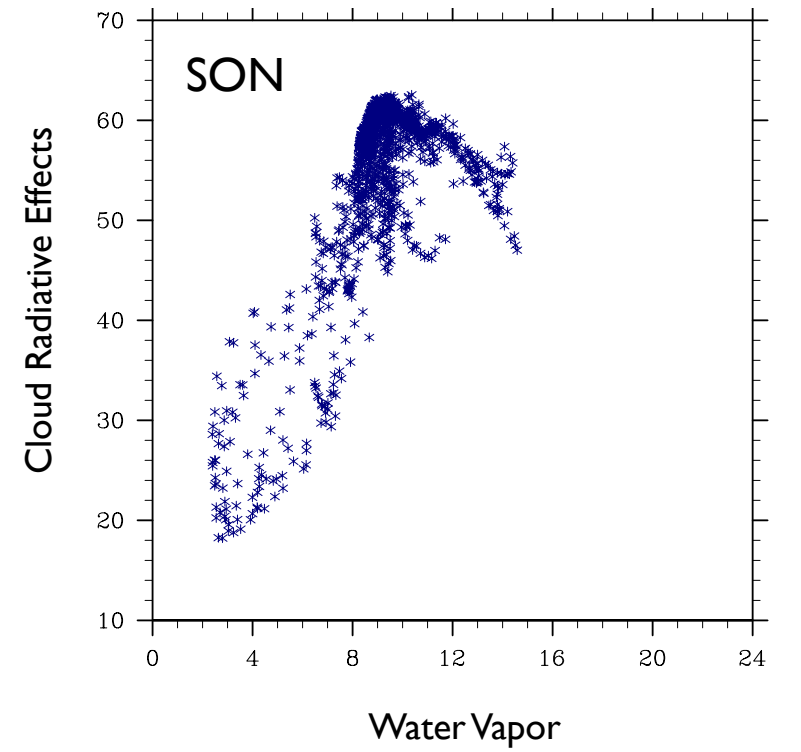
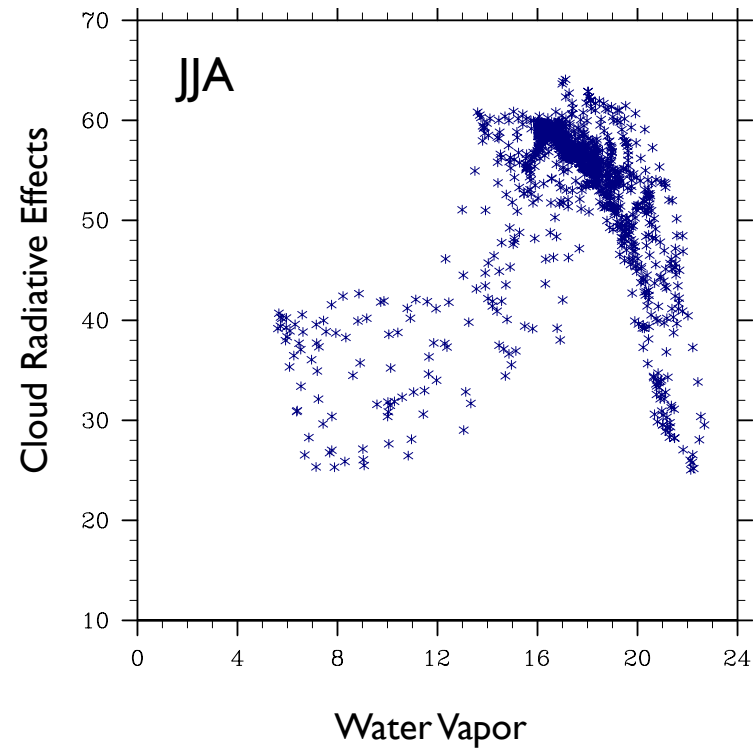
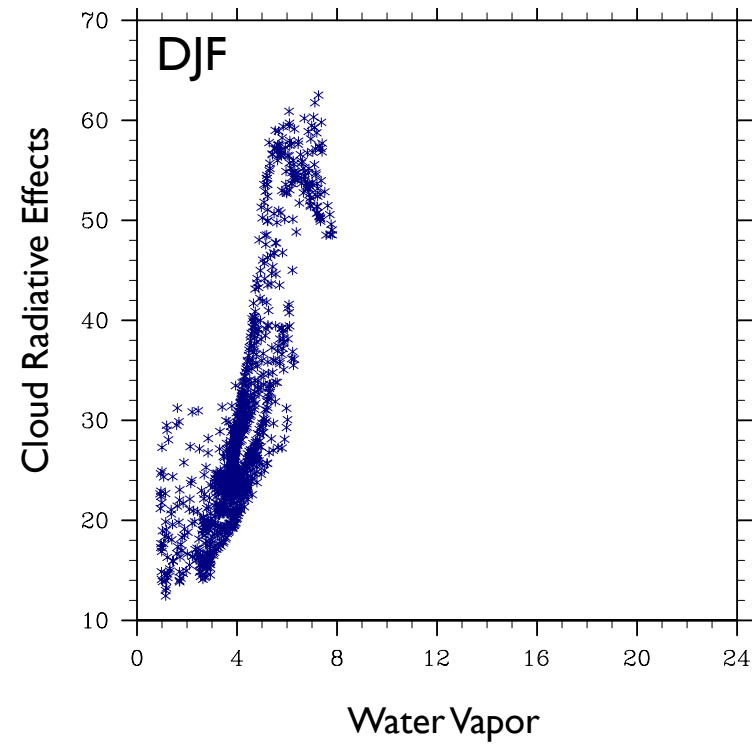


SpCCSM Control



Cloud Radiative Effects (DLR) vs. Water Vapor

SpCCSM 4xCO2



SpCCSM Control

