T31_gx3v7 CESM: The Good, The Bad, and the Ugly

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Thanks to CCSM Co-Chairs

NCAR

OUTLINE

- Summary of good, bad, and ugly
- Control simulation details
- The Atmosphere
- The Land
- The Ocean
- The Ice
- Concluding remarks

THEMES: How has CESM1 T31_gx3 improved from CCSM3?

How does the T31_gx3 compare to the 2deg_x1?

The Good:

Ocean below 500 meters, ENSO, MOC
Antarctic Sea Ice
Southern Hemisphere PSL, LW Cloud Forcing
It is really FAST! (70 yrs per day on 3 "bluefire" nodes).

The Bad:

Ocean mixed layer depths in Labrador Sea, N. Atl Ocn Heat Transport
Arctic Sea Ice
Northern Hemisphere PSL

The Ugly:

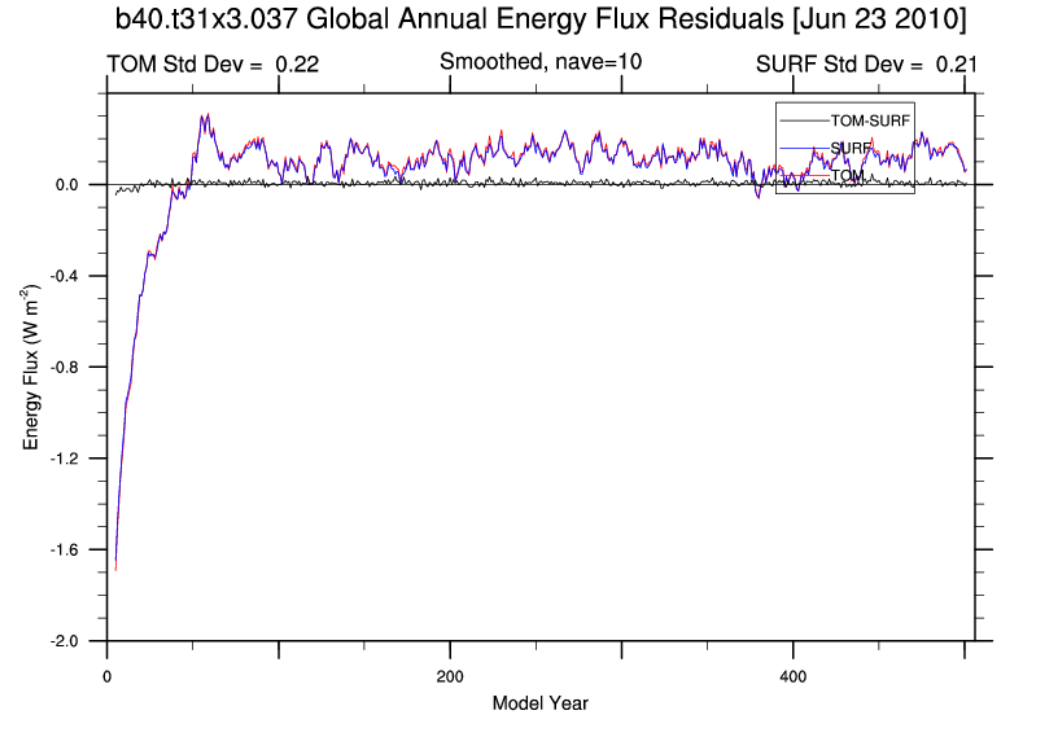
SST/Surface Air Temperature, SW Cloud Forcing

The OK:

Antarctic Circumpolar Current
Precipitation

Details of Simulation

T31_gx3v7
CN model “ON” 1850 Control
500 years, last 50 year TOA Balance ~ +0.09 W/m2
CESM1 code base, CAM4, CLM4,POP2, CICE4, CPL7
Physics differences from 1deg/2deg: TMS, lower snow albedos, ice runoff off

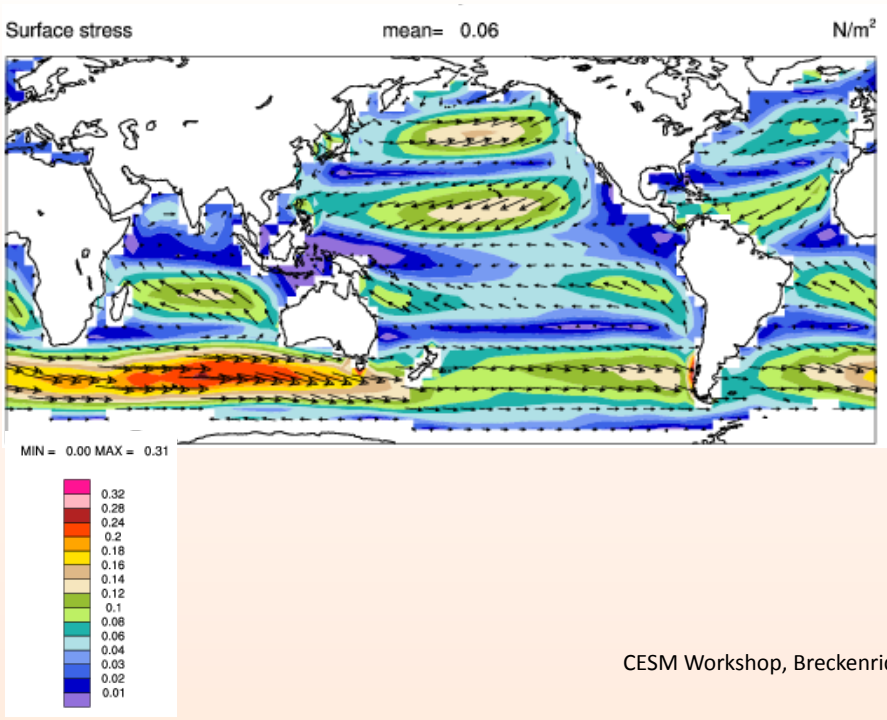


The Atmosphere

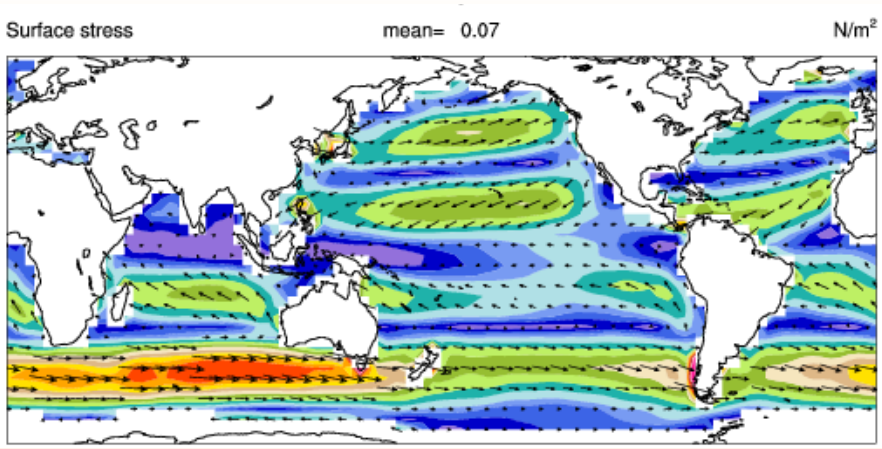
Physics differences from the 2deg (and 1deg) FV CESM1:
TMS, or the Turbulent Mountain Stress parameterization typically applied in WACCM

What does this predominately affect?
Surface Wind Stress, this addition significantly improves the ocean simulation and ENSO

TMS

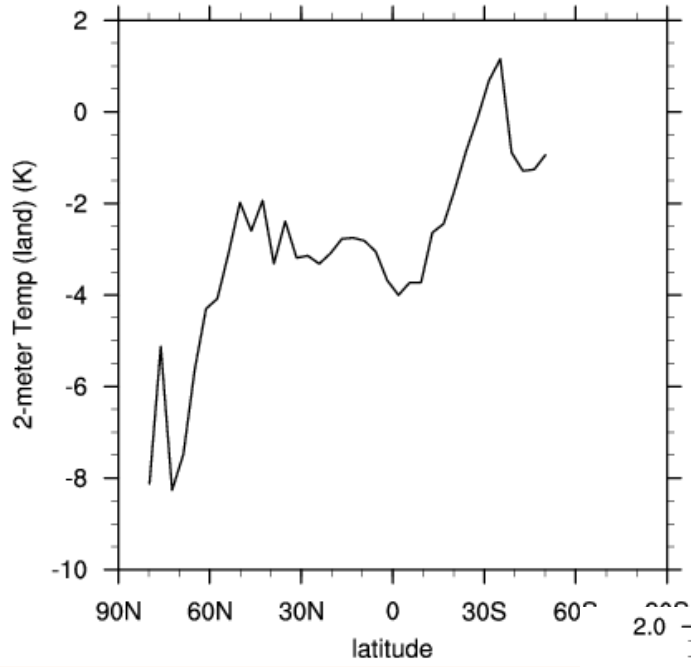


No TMS

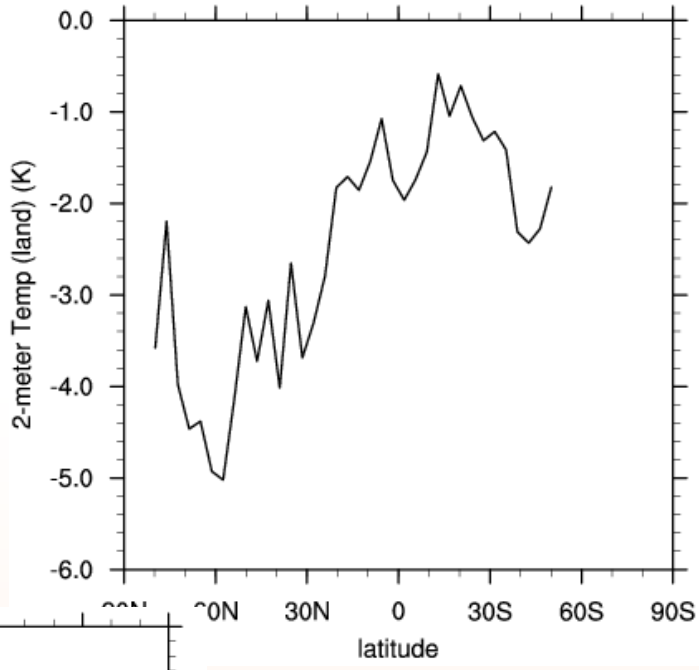


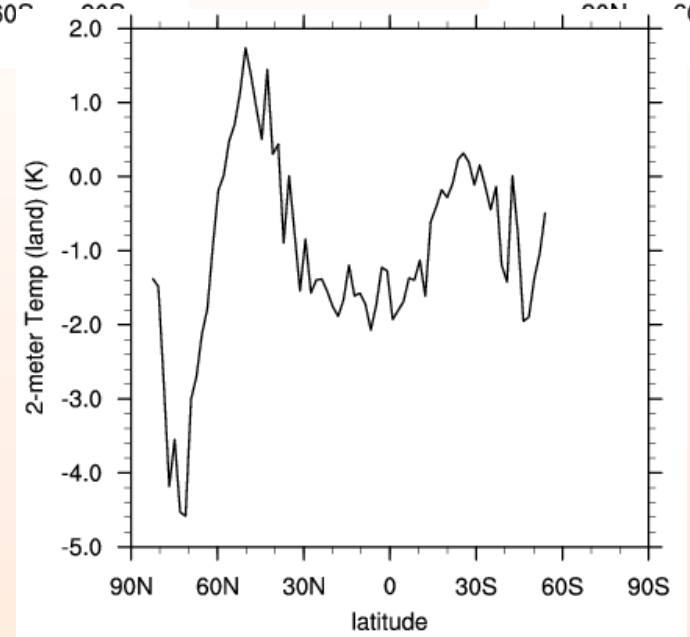
The Atmosphere Basic State: TREFHT

CESM1 T31 - IPCC/CRU
Global Avg Difference = -3.0°C



CCSM3 T31 – IPCC/CRU
Global Avg Difference = -2.8°C



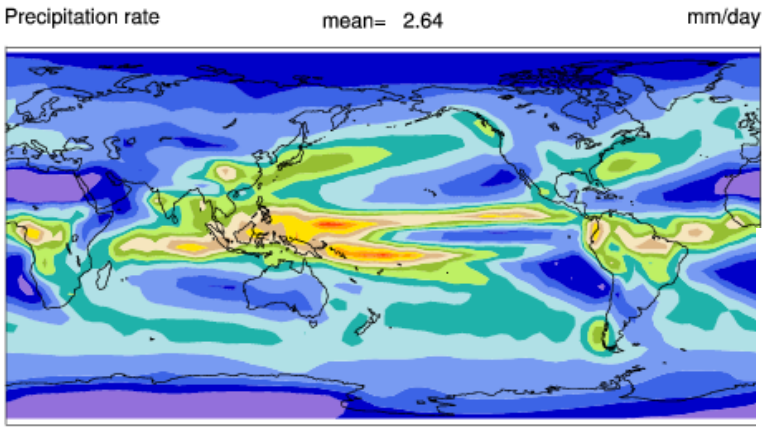


CESM1 2deg – IPCC/CRU
Global Avg Difference = -0.9°C

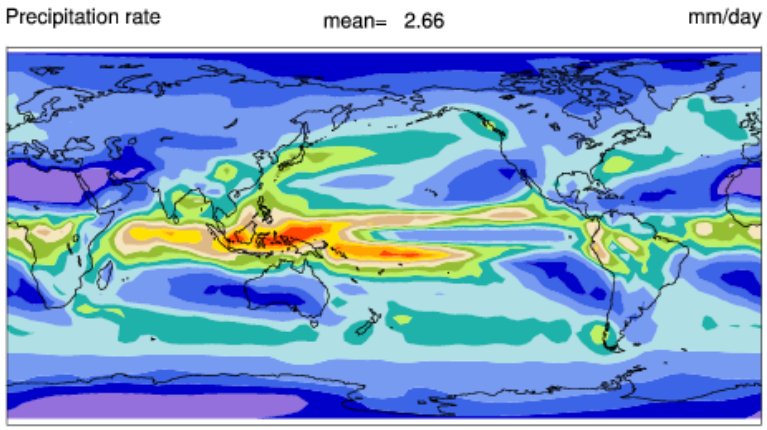
Comparison to present day obs is expected to be cooler by ~1°C, but the T31 is 3°C cooler.

The Atmosphere Basic State: Precipitation

CESM1 T31



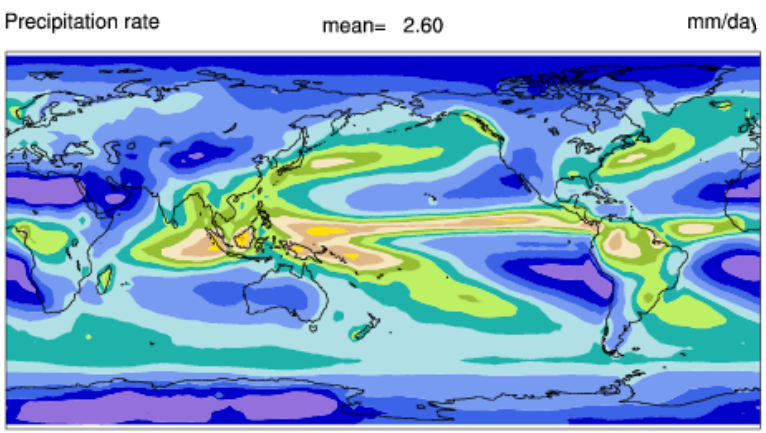
CCSM3 T31



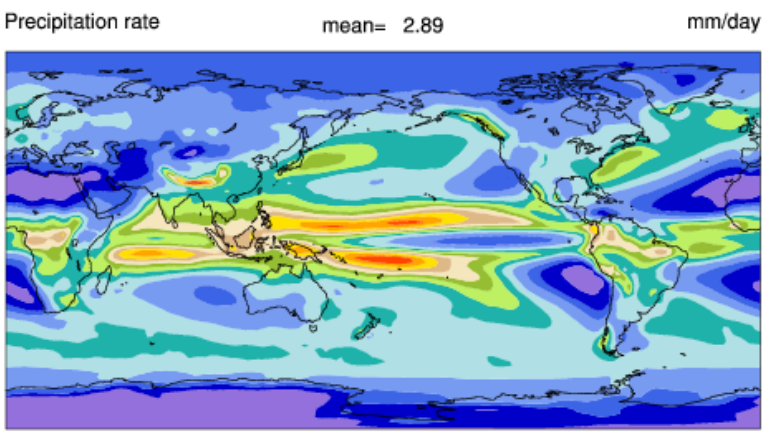
Min = 0.01 Max = 10.7

17
14
12
10
9
8
7
6
5
4
3
2
1
0.5
0.2

GPCP (1979-2003)

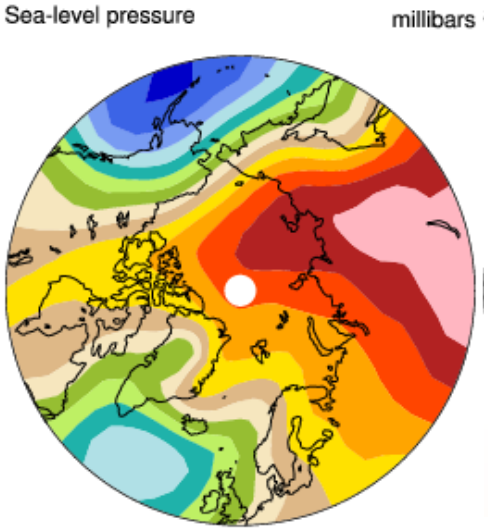


CESM1 2deg

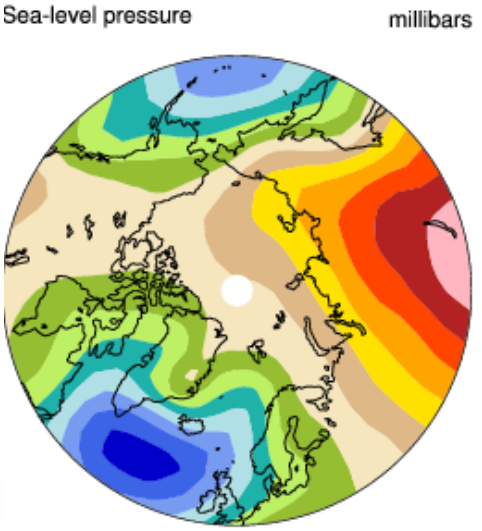


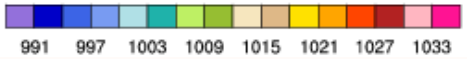
The Atmosphere Basic State: Winter PSL
Northern Hemisphere

CESM1 T31

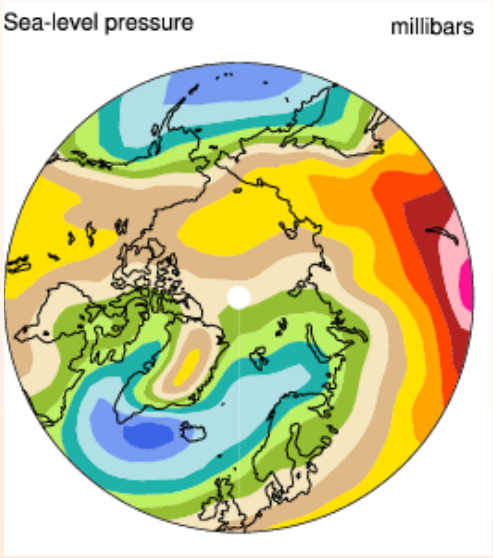


CCSM3 T31

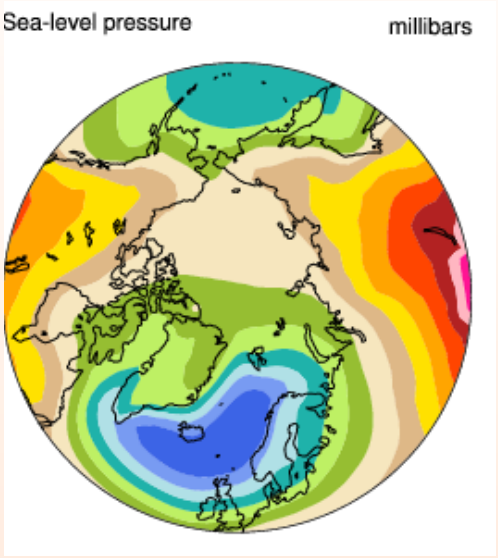




NCEP Reanalysis (1979-98)

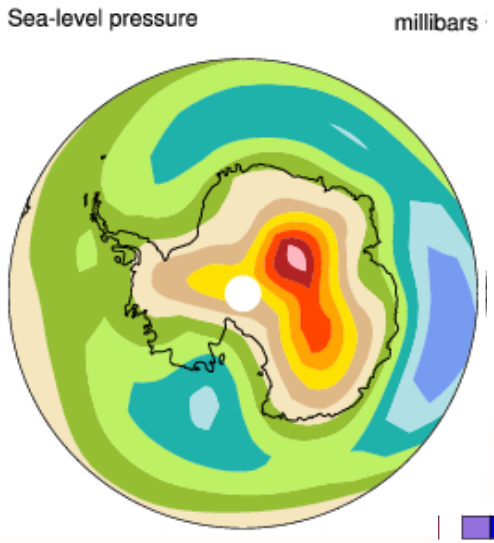


CESM1 2deg

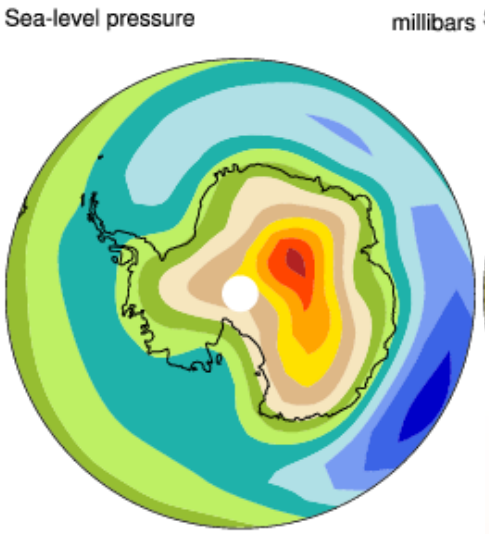


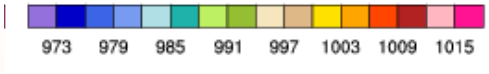
The Atmosphere Basic State: Winter PSL
Southern Hemisphere

CESM1 T31

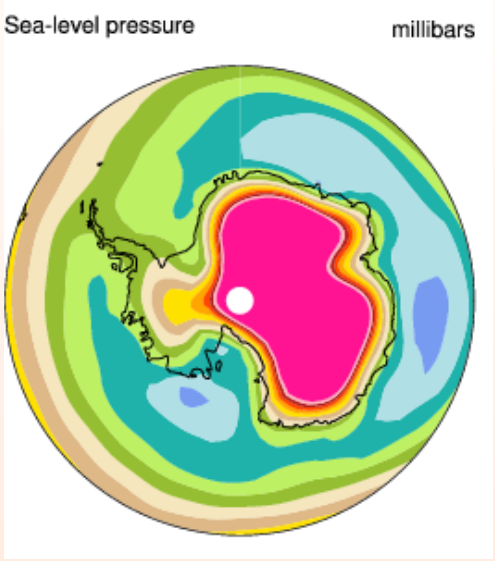


CCSM3 T31

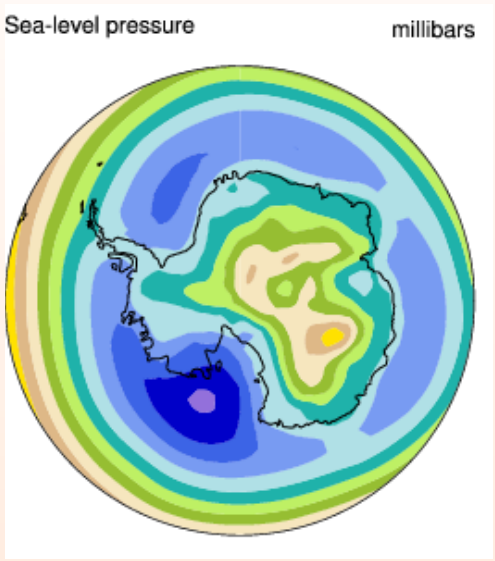




NCEP Reanalysis (1979-98)

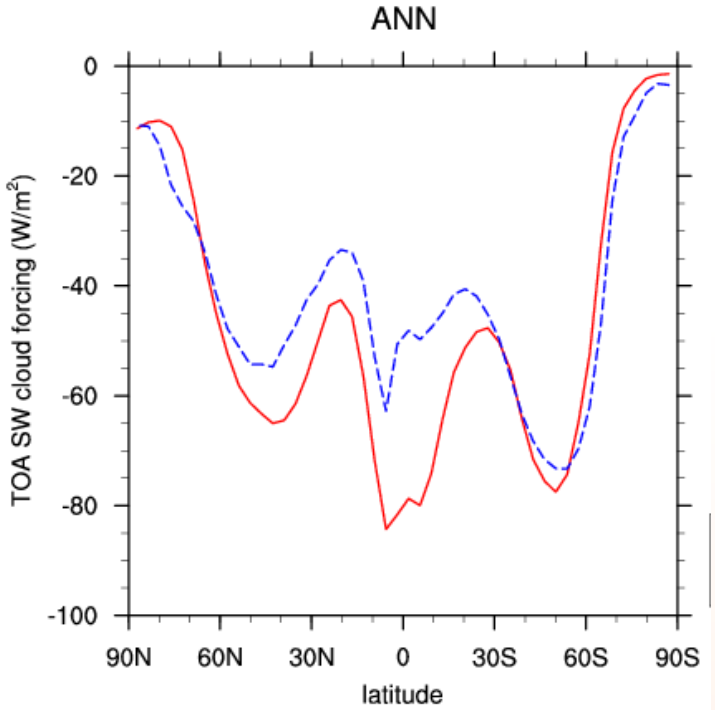


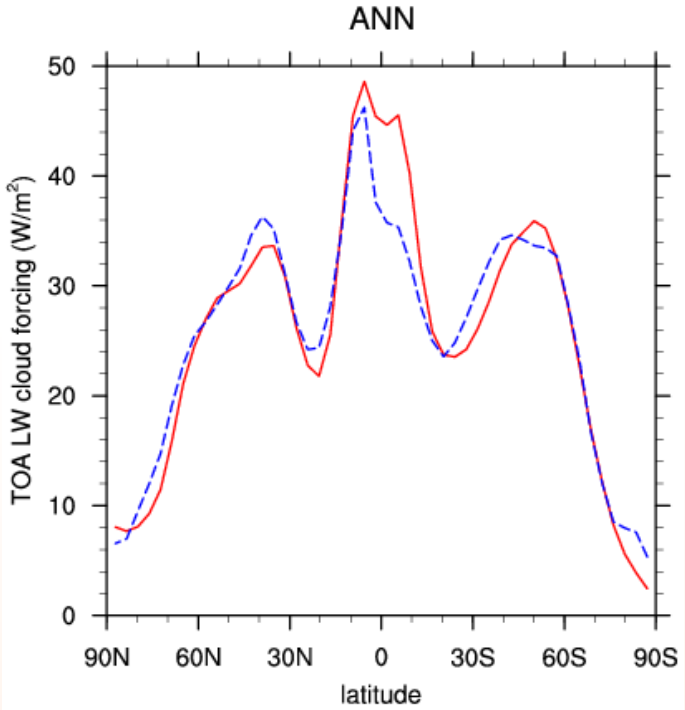
CESM1 2deg



The Atmosphere Basic State: Cloud Forcing

CESM1 T31



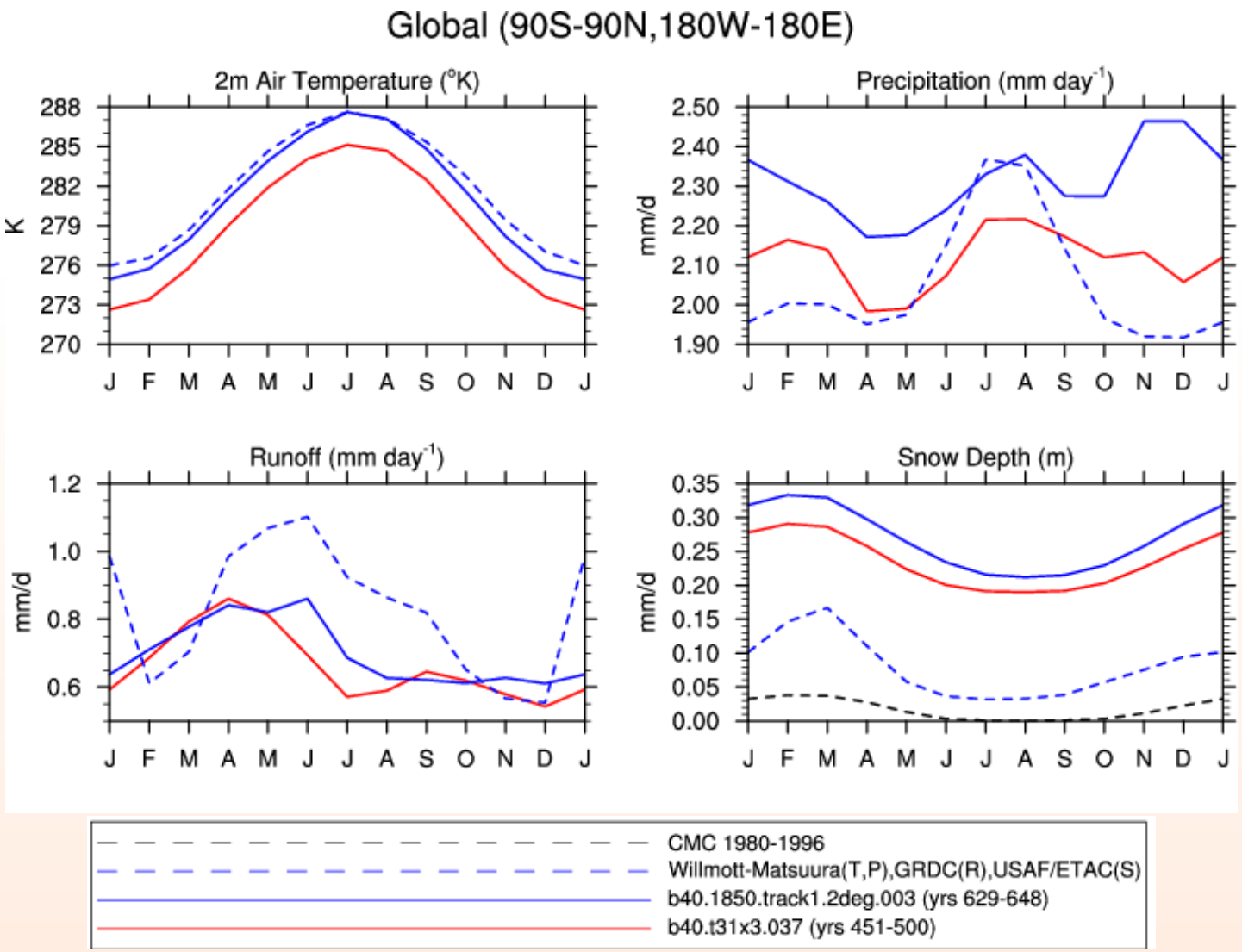


vs CESM1 2deg: SWCF is similar, T31 has better LWCF in the mid-latitudes

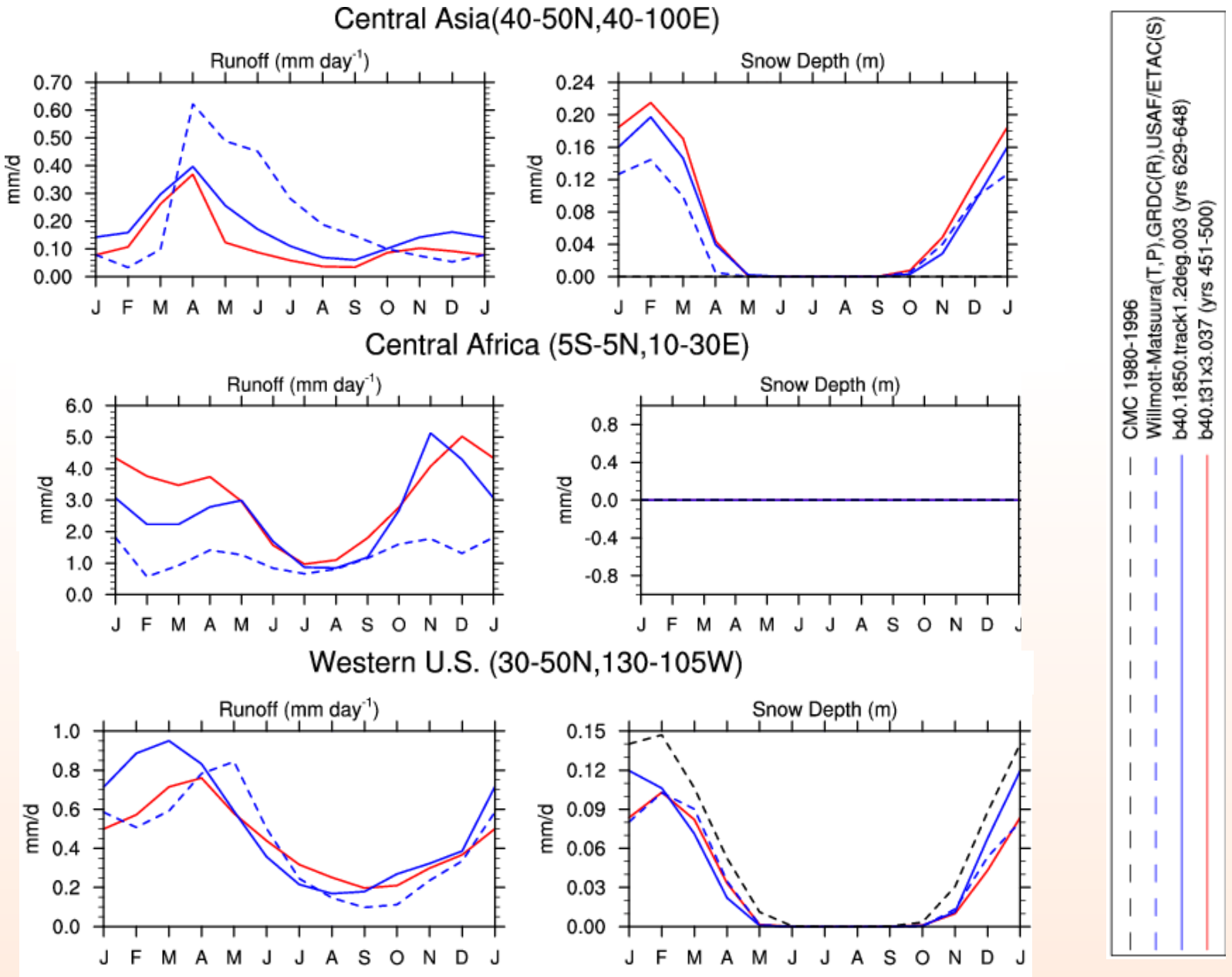
vs CCSM3 T31: CESM T31 SWCF is worse in the tropics, but is LWCF better overall

The Land

Physics differences from the 2deg CESM1: No ice runoff
What about runoff and snow depth?

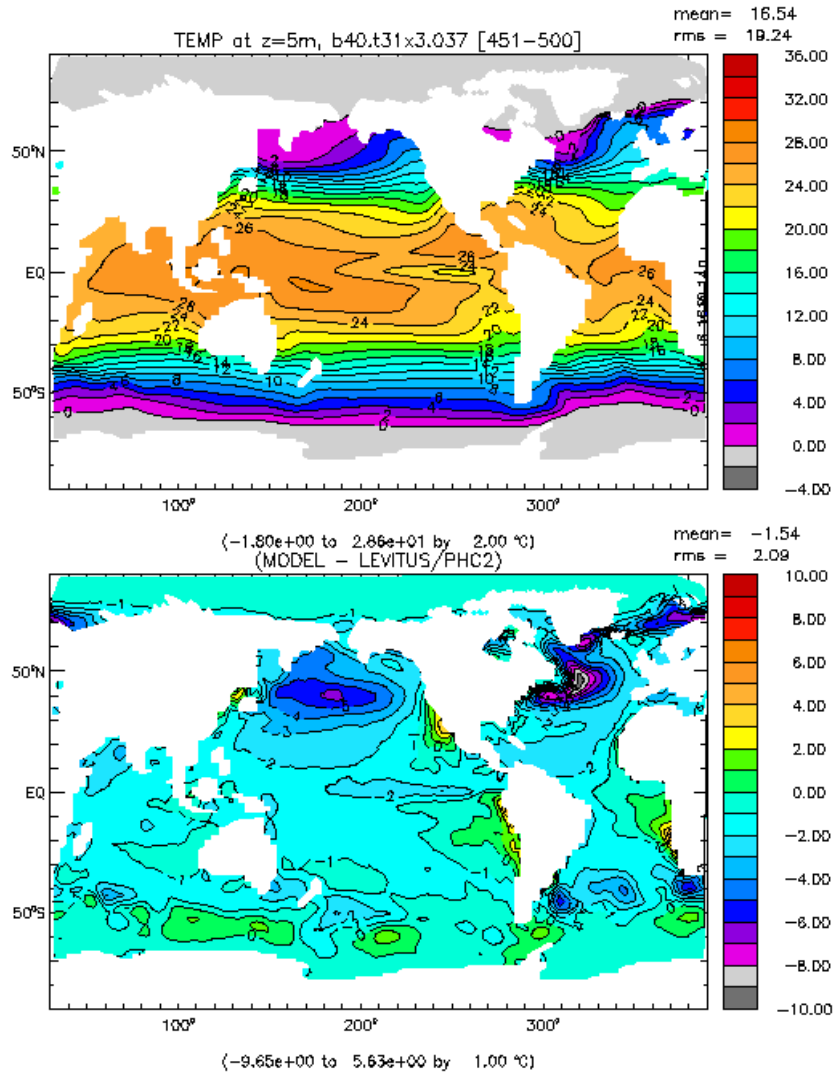


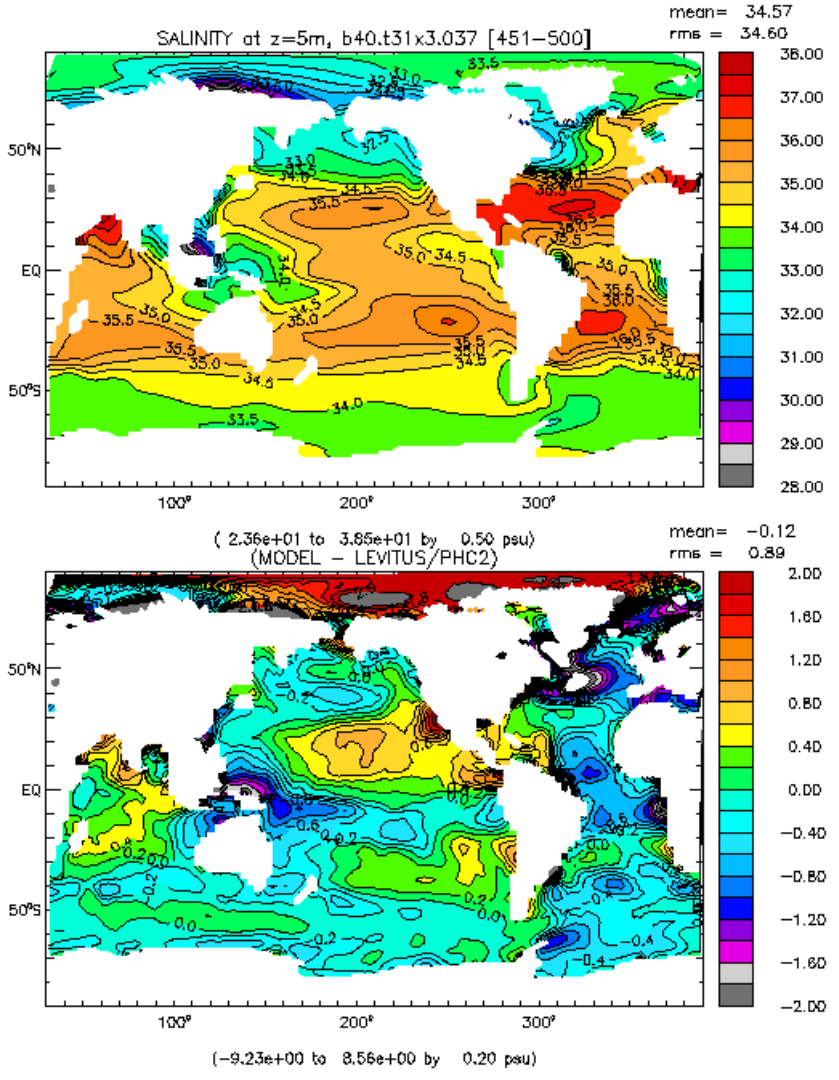
The Land: Regional Areas of Runoff and Snow Depth



The Ocean

No physics differences from the 2deg_gx1 CESM1
Basic State Variables: SST and SSS



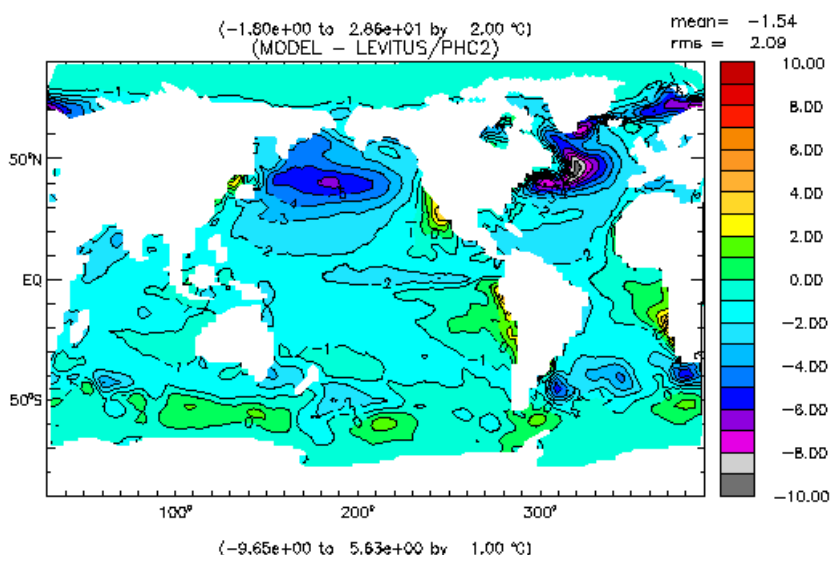


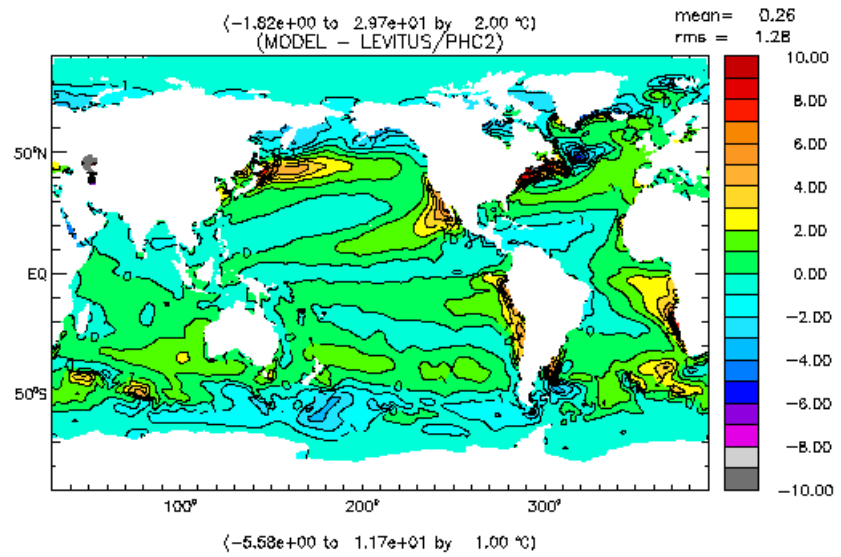
The Ocean: Basic State: SST and SSS

T31_gx3

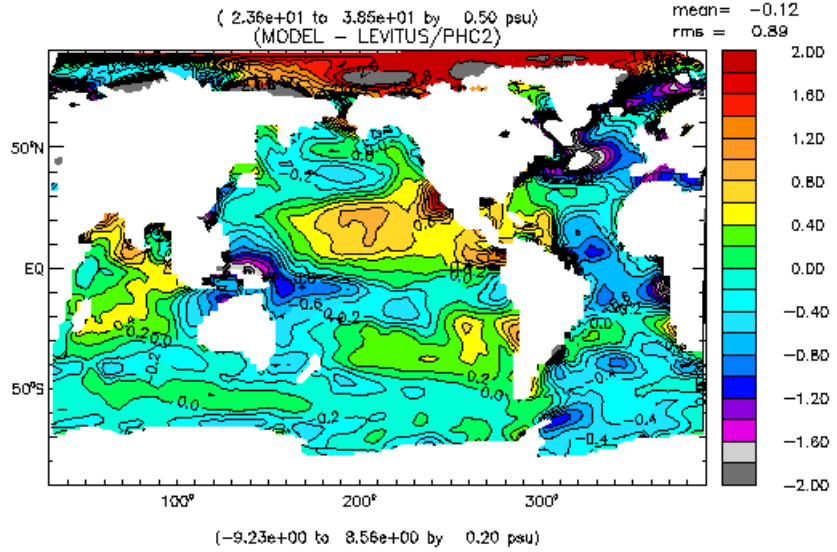
FV 2deg_gx1

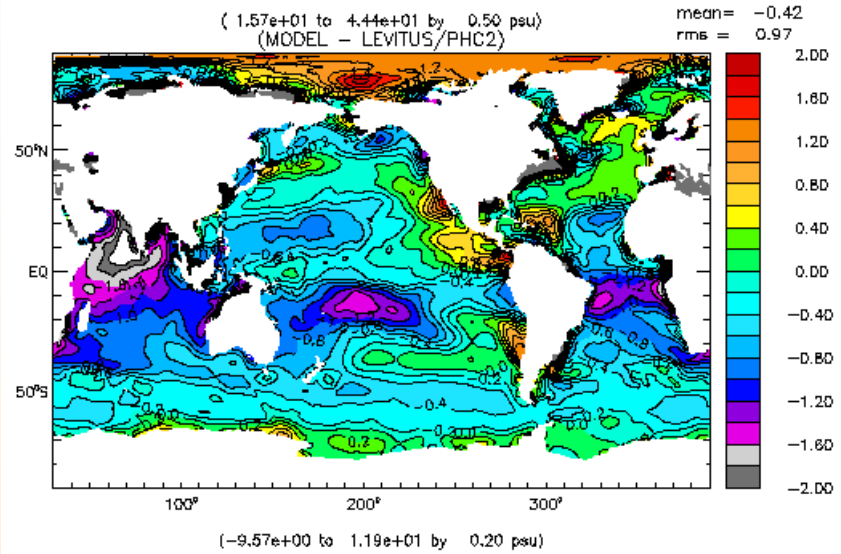
SST





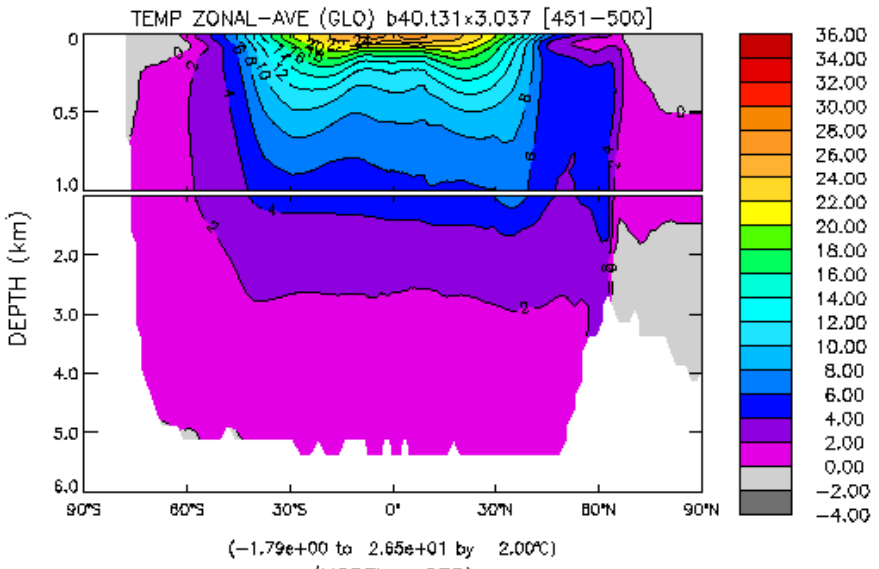
SSS

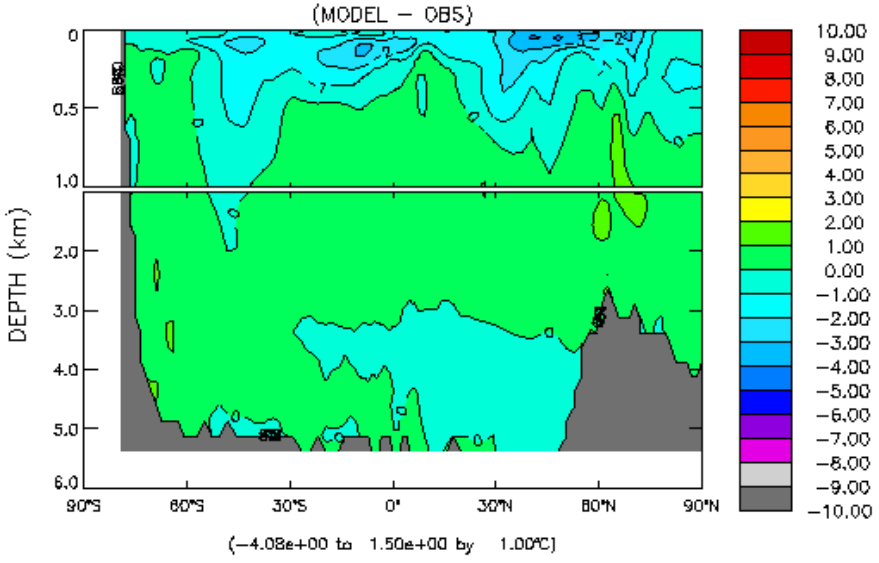




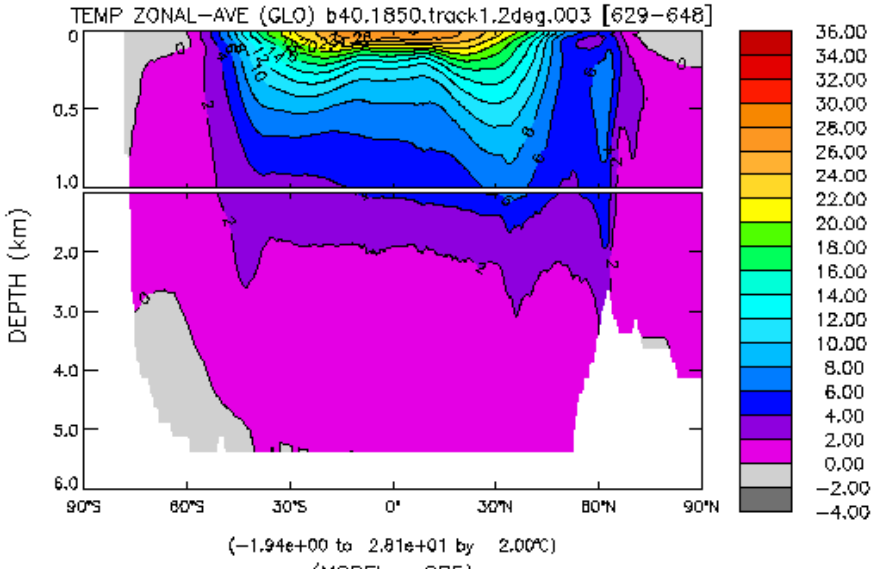
The Ocean: Basic State: TEMP

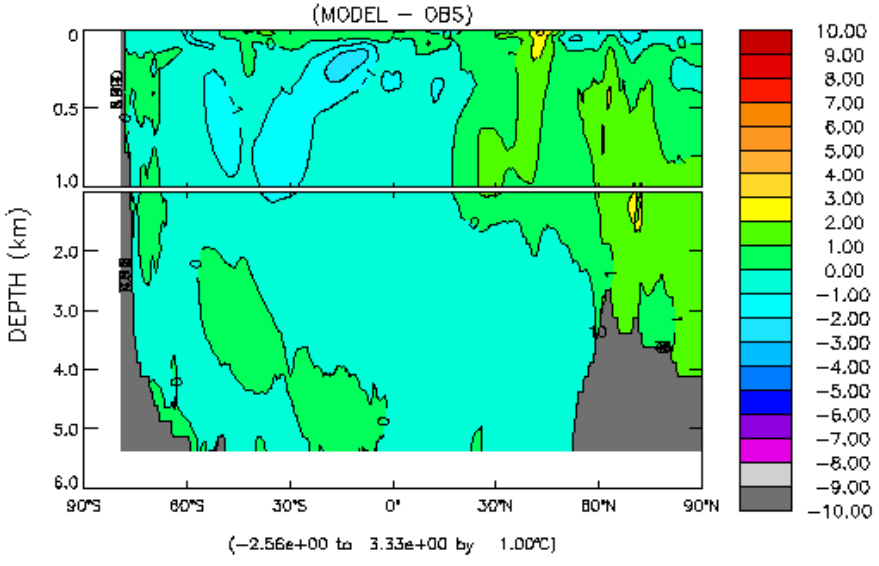
T31_gx3





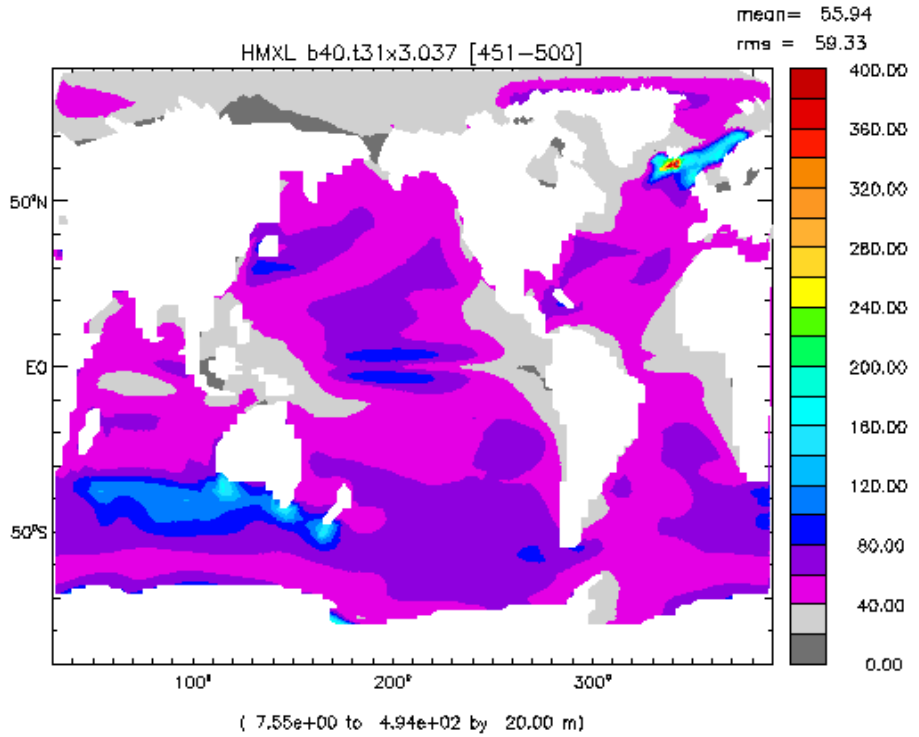
FV 2deg_gx1



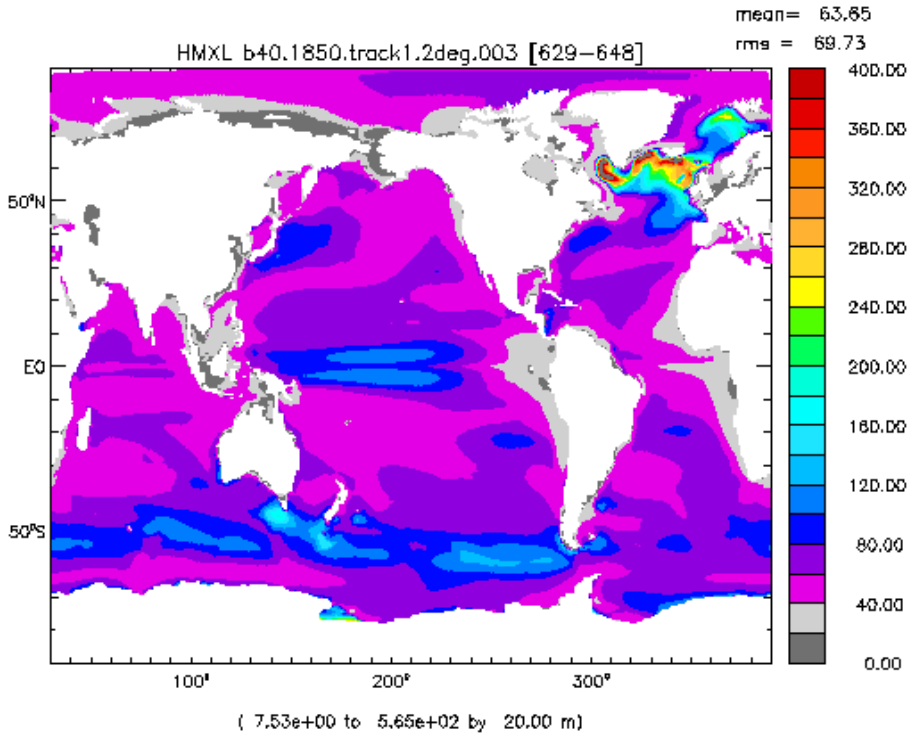


The Ocean: Basic State: HXML

T31_gx3

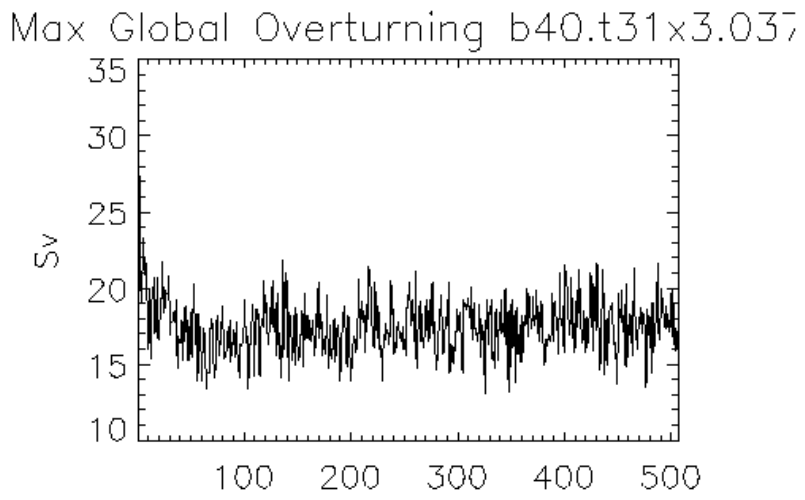


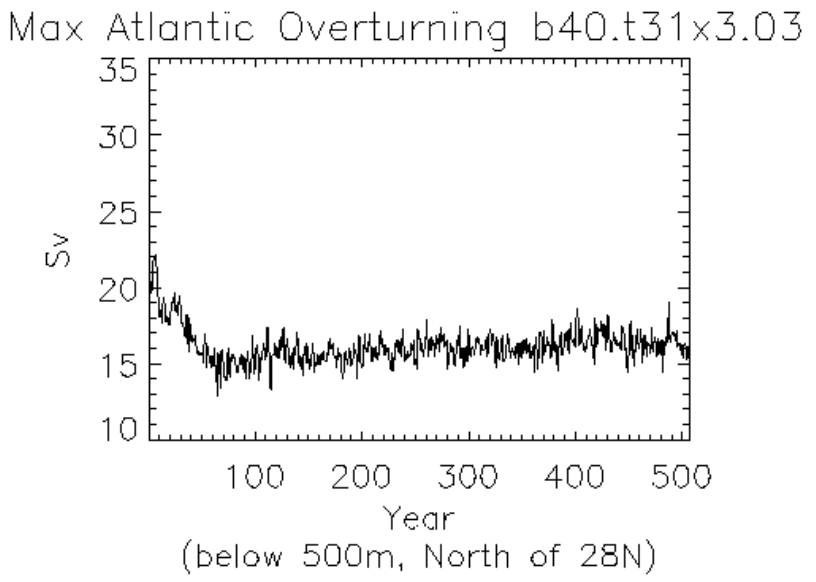
FV 2deg_gx1



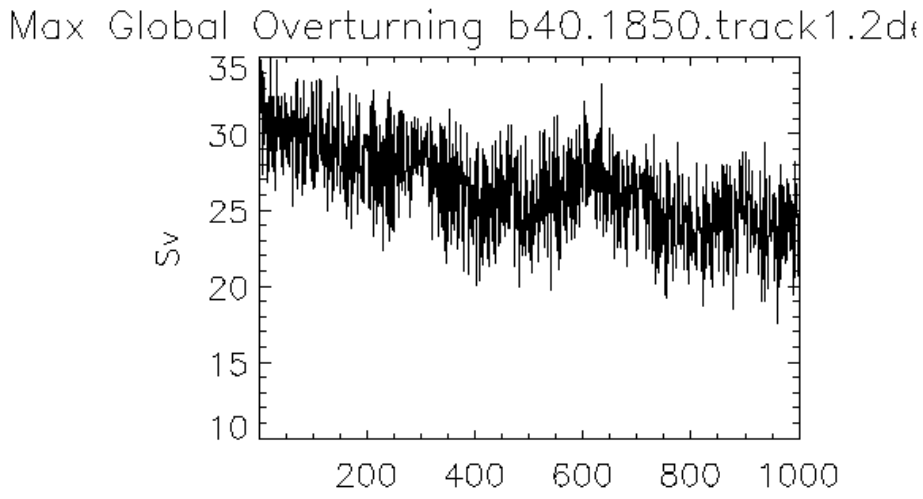
The Ocean: Basic State: MOC

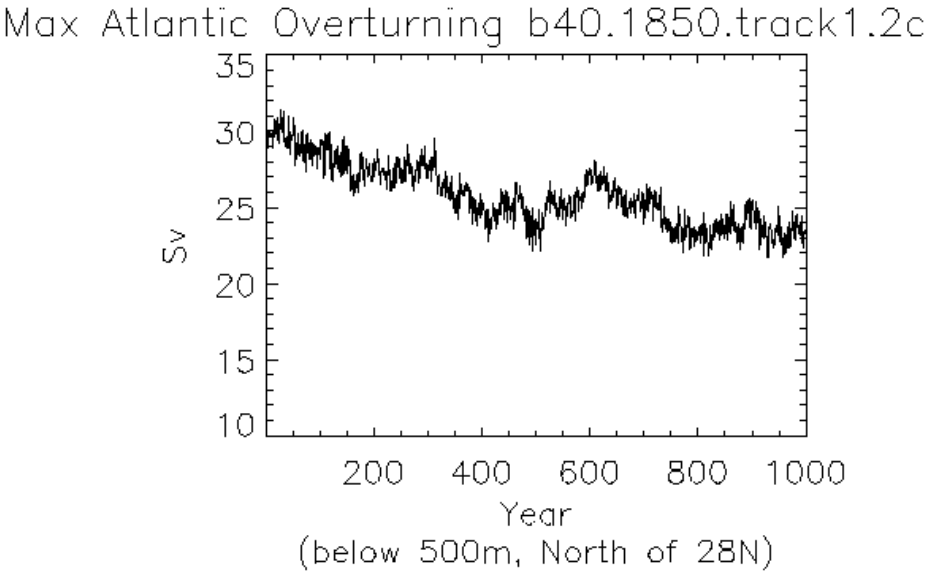
T31_gx3





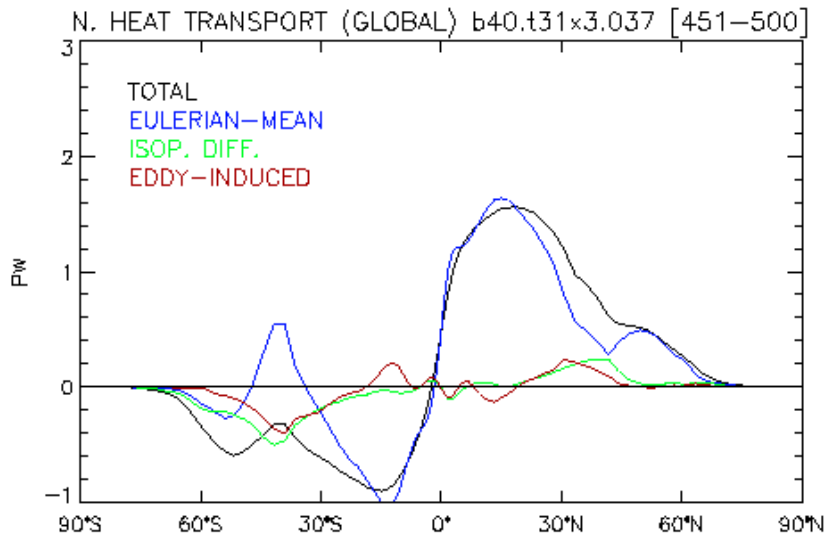
FV 2deg_gx1

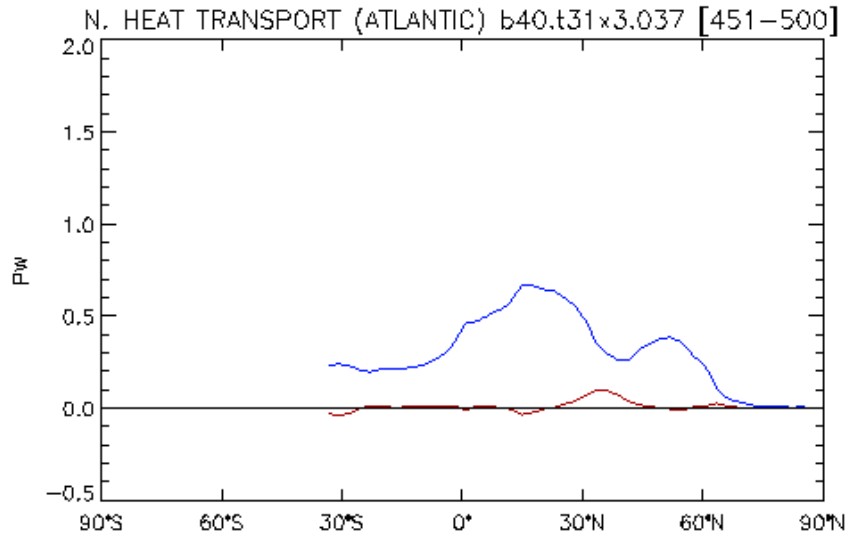




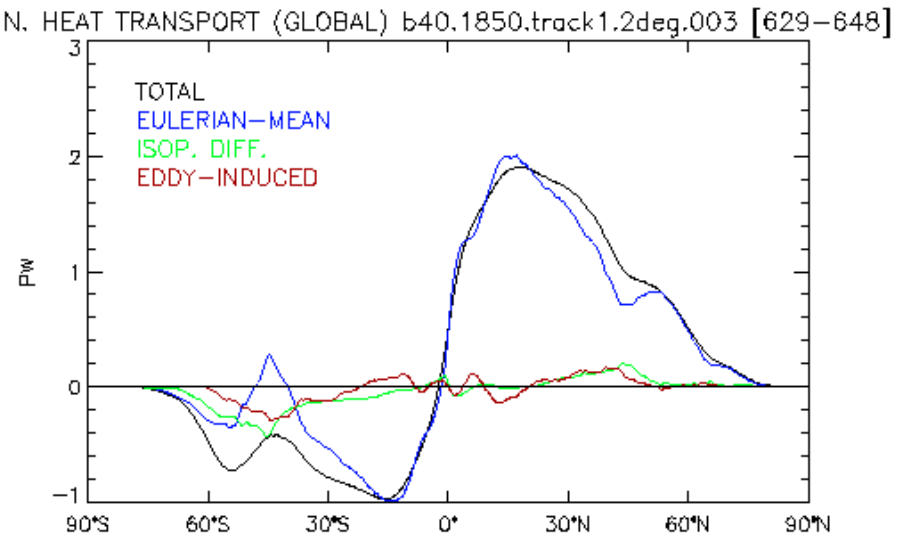
The Ocean: Basic State: NHT

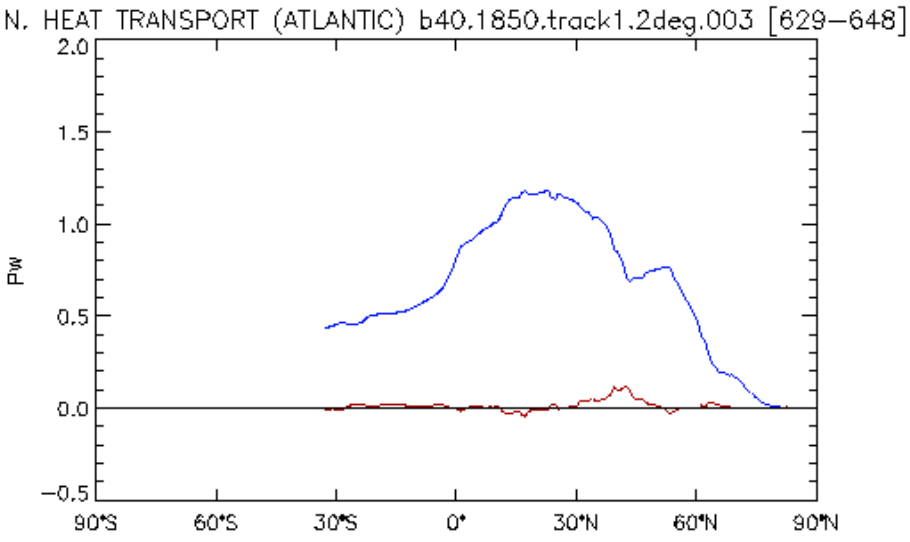
T31_gx3





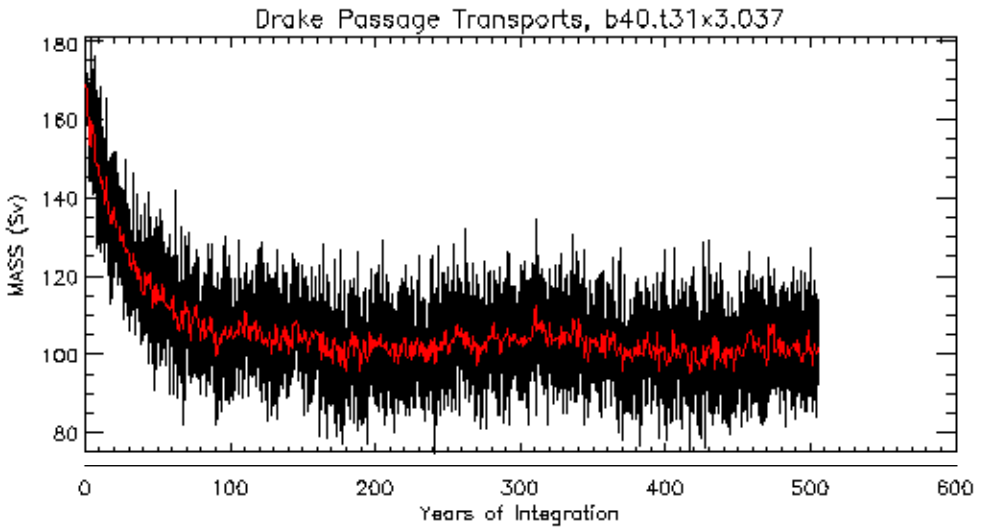
FV 2deg_gx1



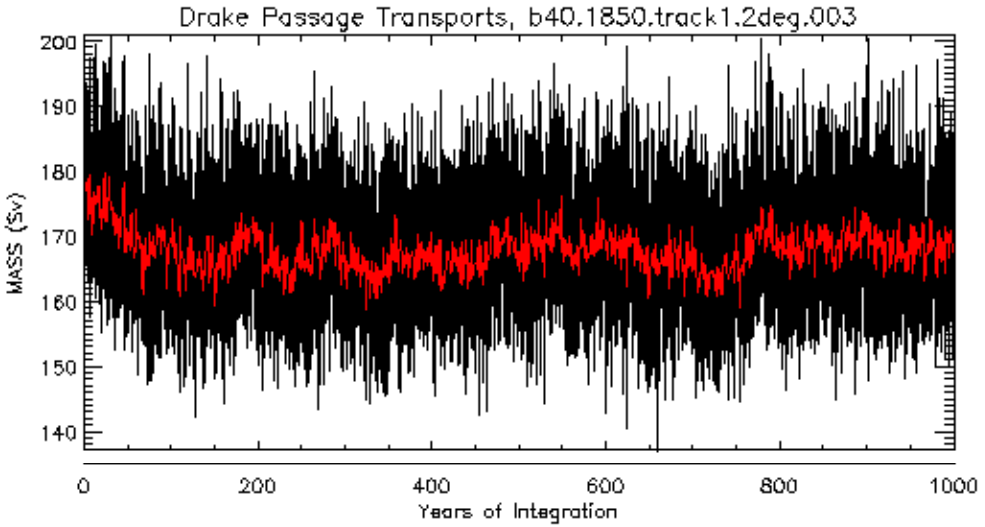


The Ocean: Basic State: ACC

T31_gx3

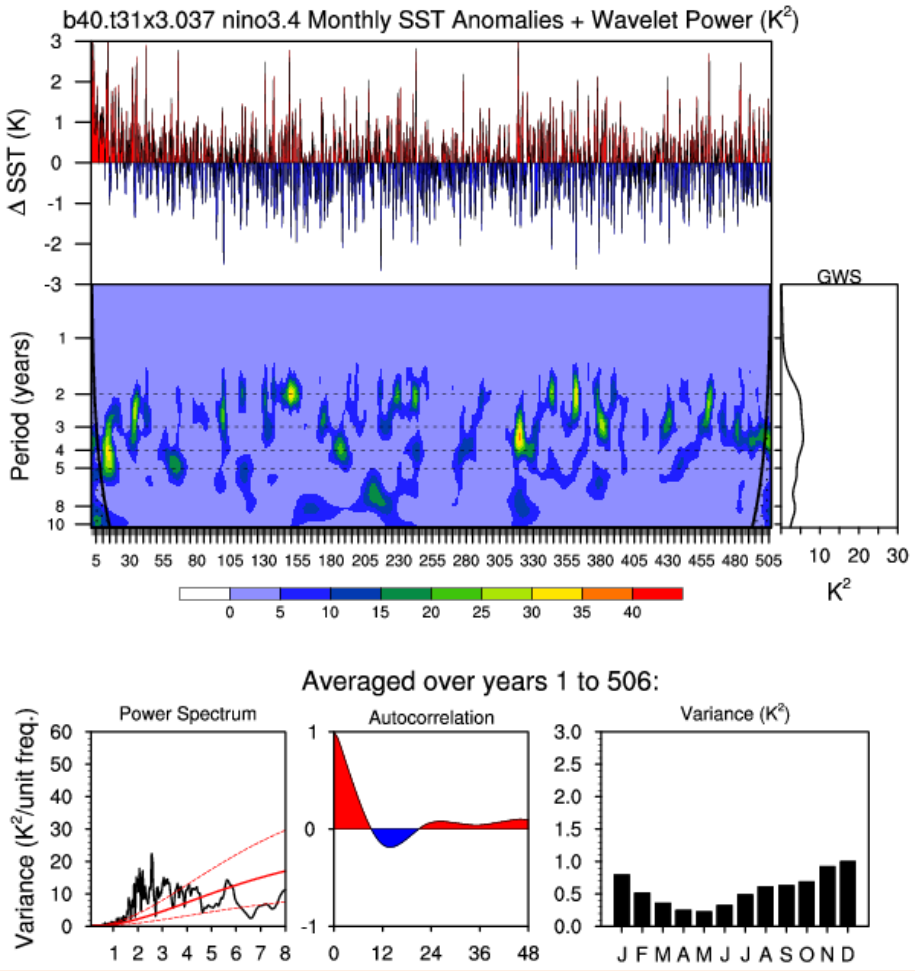


FV 2deg_gx1



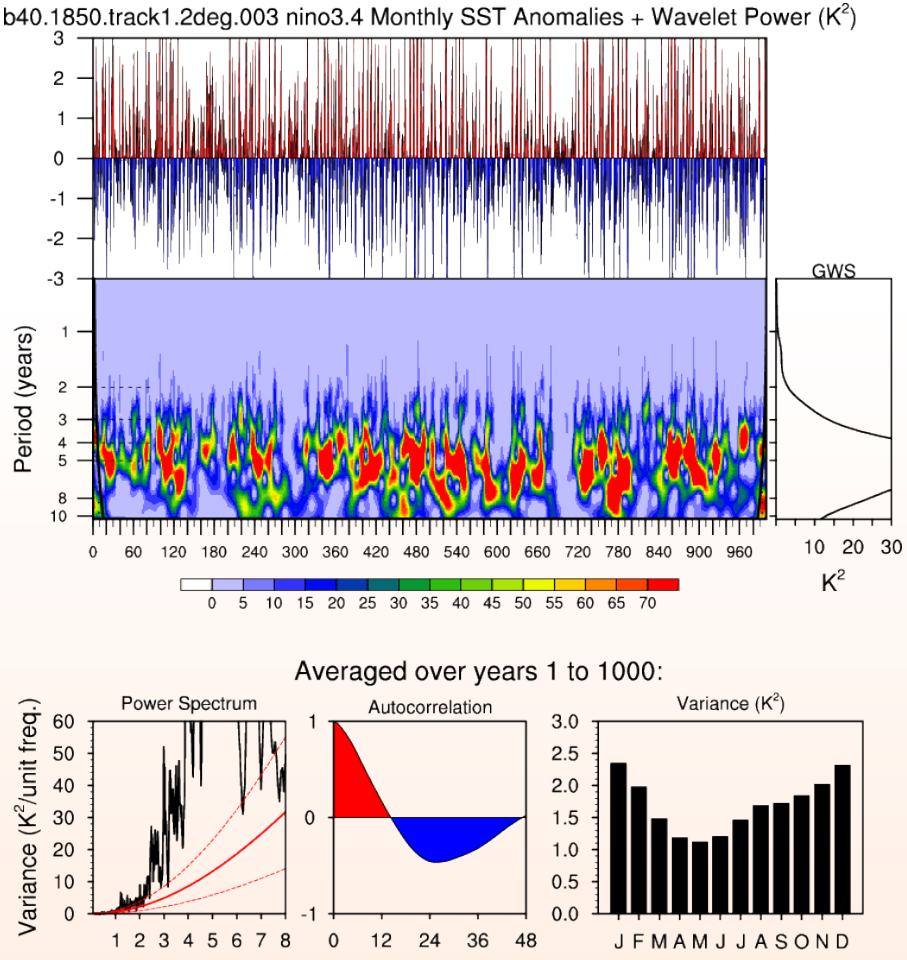
The Ocean: Variability: ENSO

T31_gx3
TMS On



Std dev Nino3.4 = 0.775 (Obs = 0.824)

FV 2deg_gx1
TMS OFF

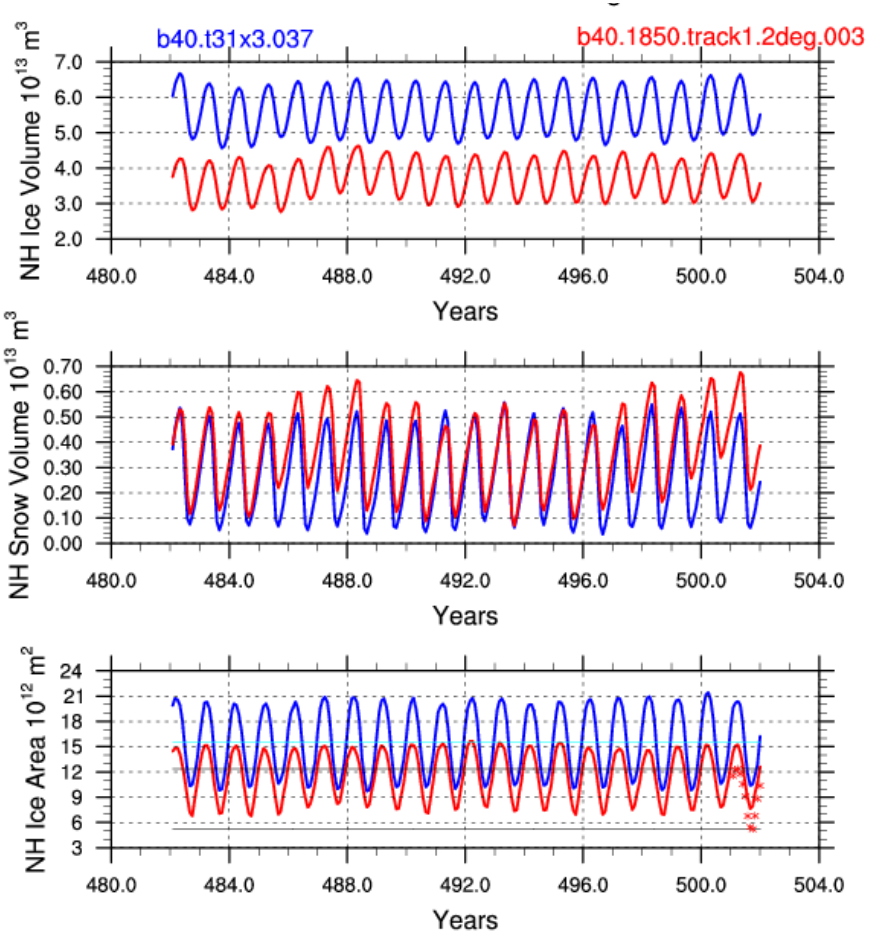


Std dev Nino3.4 = 1.283

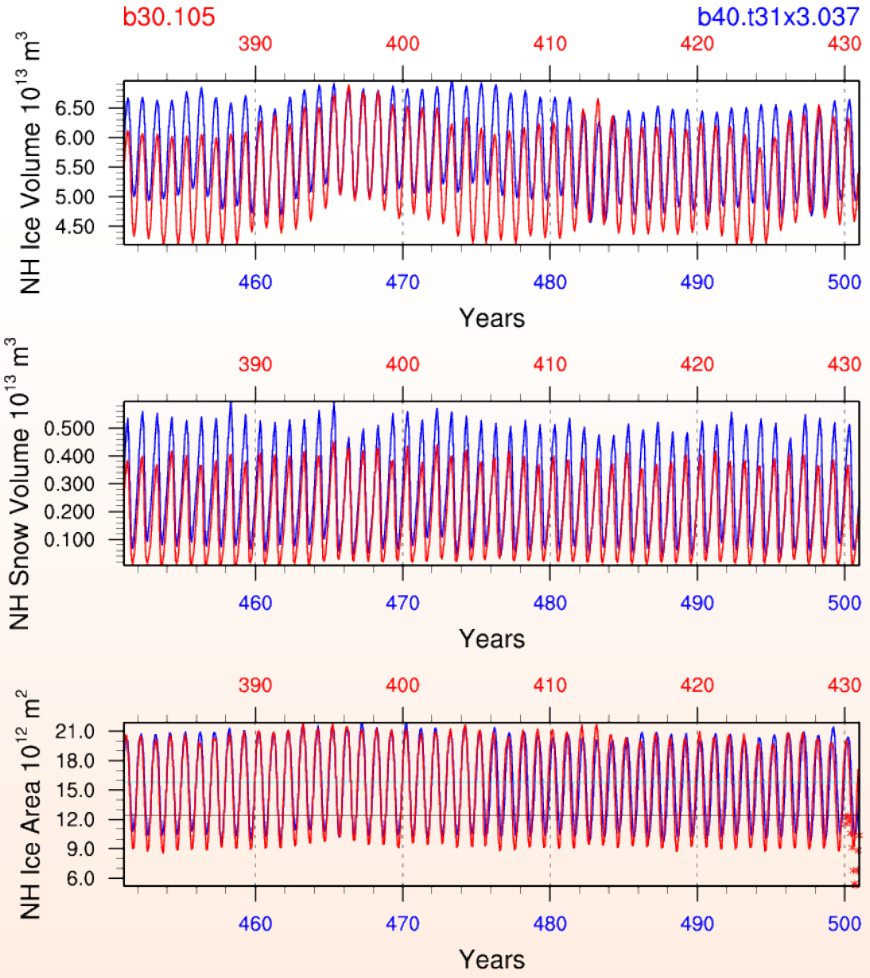
The Ice

Physics Difference from the gx1 CESM1: Lower snow albedos
Ice Basic State: NH Ice/Snow Volume, Ice Area

T31_gx3 vs 2deg_gx1



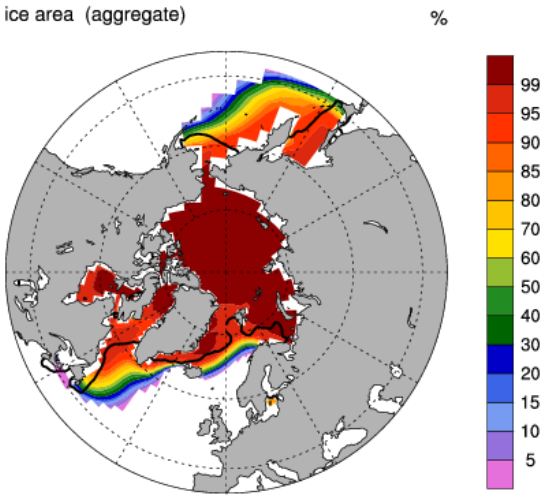
T31 CESM1 vs CCSM3



The Ice: Basic State: Ice Area

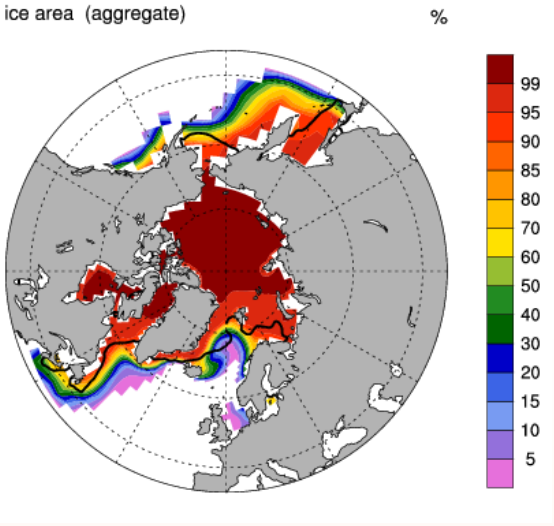
CESM1 T31_gx3

JFM



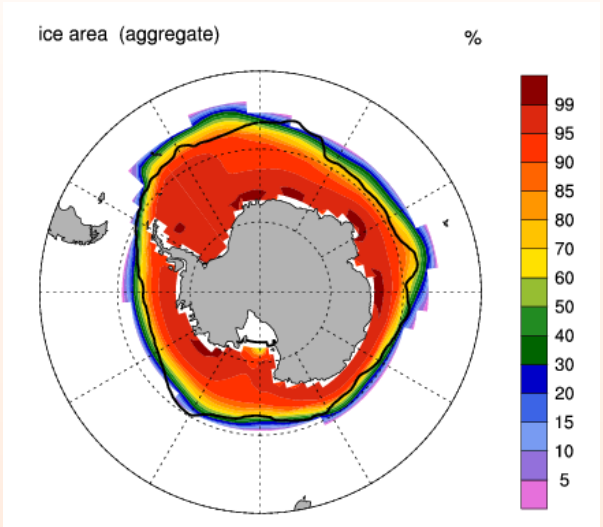
CCSM3 T31_gx3

JFM

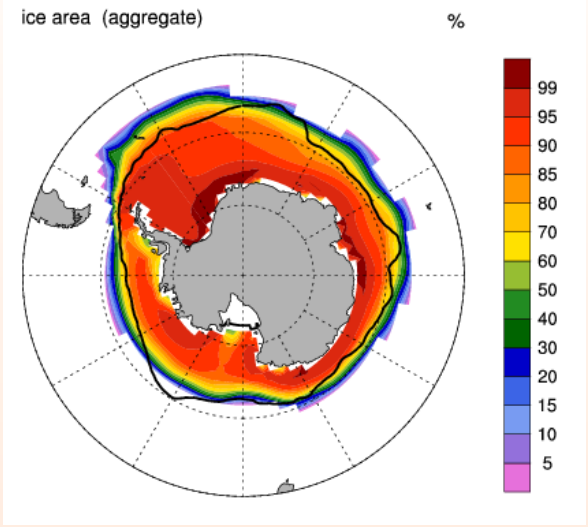


Degraded N. Atlantic

JAS



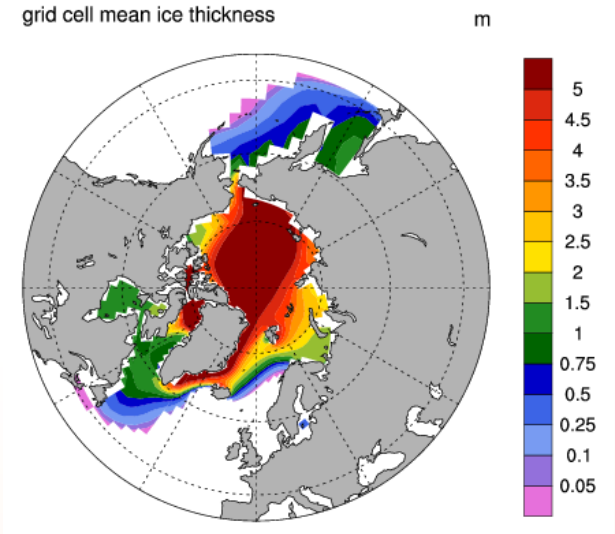
JAS



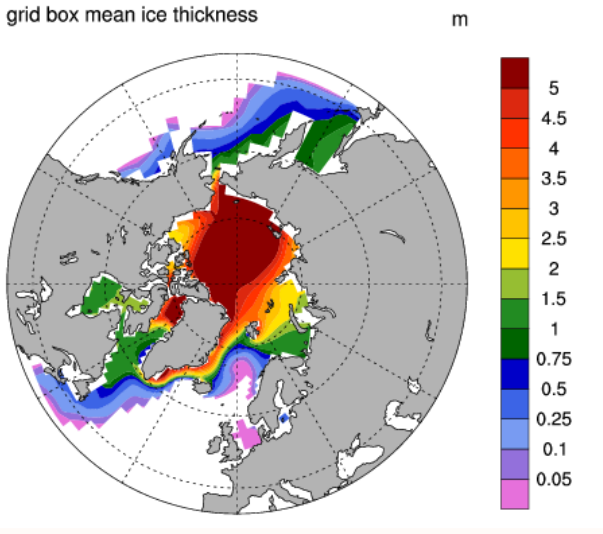
Similar SH

The Ice: Basic State: Ice Thickness

CESM1 T31_gx3
JFM

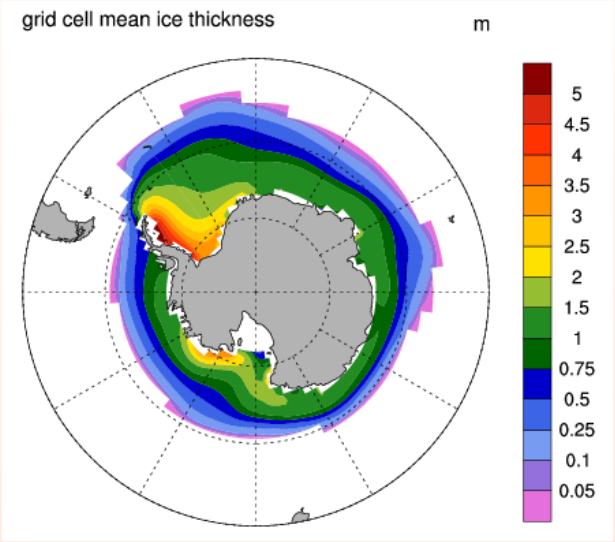


CCSM3 T31_gx3
JFM



Slightly degraded N. Atlantic and Greenland Sea

JAS



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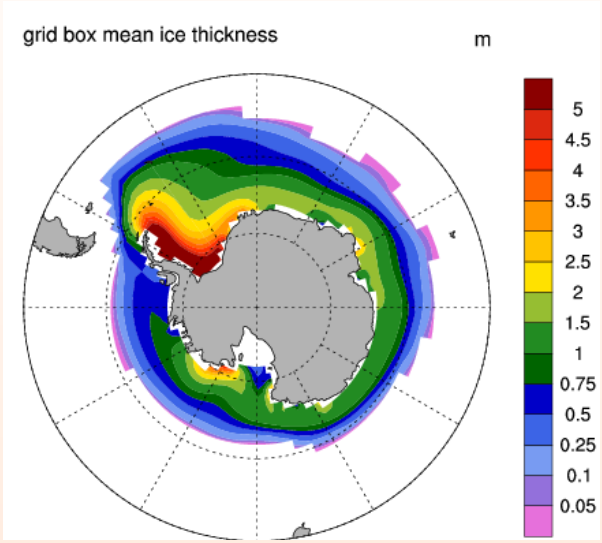


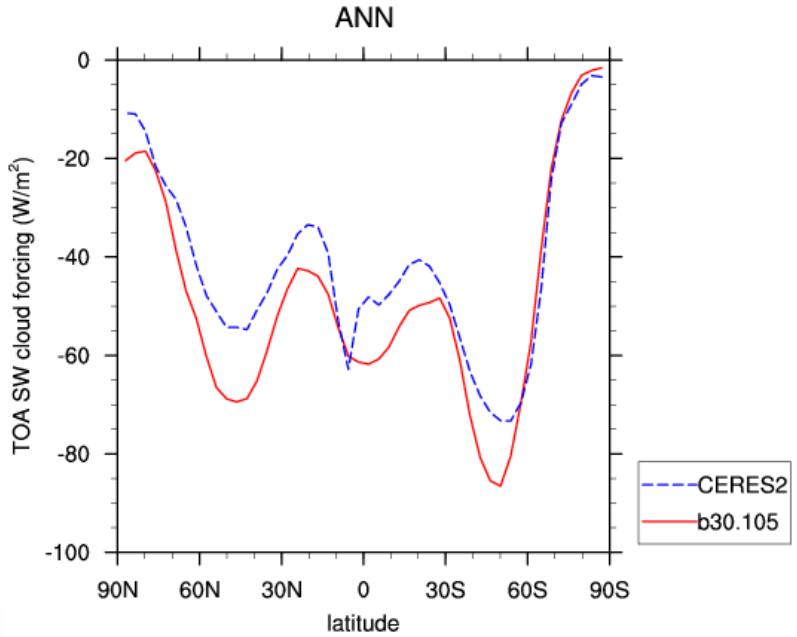
Improved Weddell Sea

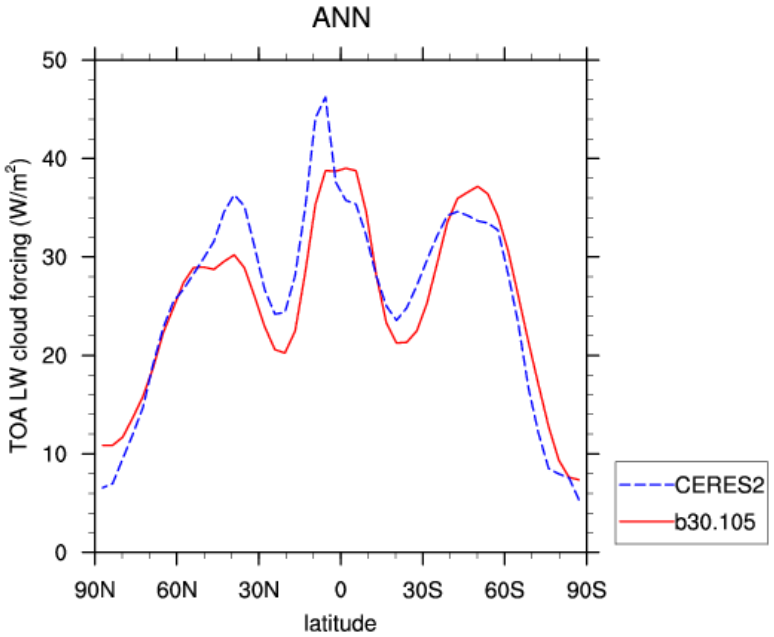
Concluding Remarks

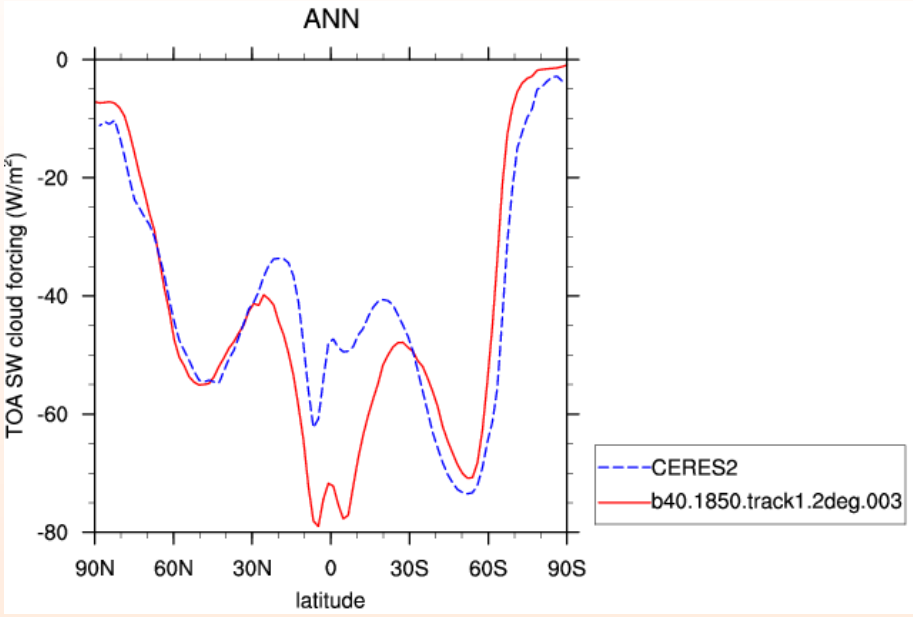
1. CESM1 T31_gx3 is generally too cold, significantly so in the northern hemisphere, even for a Pre-Industrial simulation. This is most likely due to poor northward heat transport, a reality of a low resolution model.
2. CESM1 T31_gx3 is comparable to CCSM3 T31_gx3, especially so in terms of surface temperatures.
3. CESM1 T31_gx3 has an improved simulation over Antarctica compared to CCSM3.
4. CESM1 T31_gx3 has a more reasonable ENSO than the FV2deg_gx1 . This is likely NOT due to resolution differences, but the application of the TMS parameterization in CAM4.
5. CESM1 T31_gx3 is fast and cheap model for many applications.

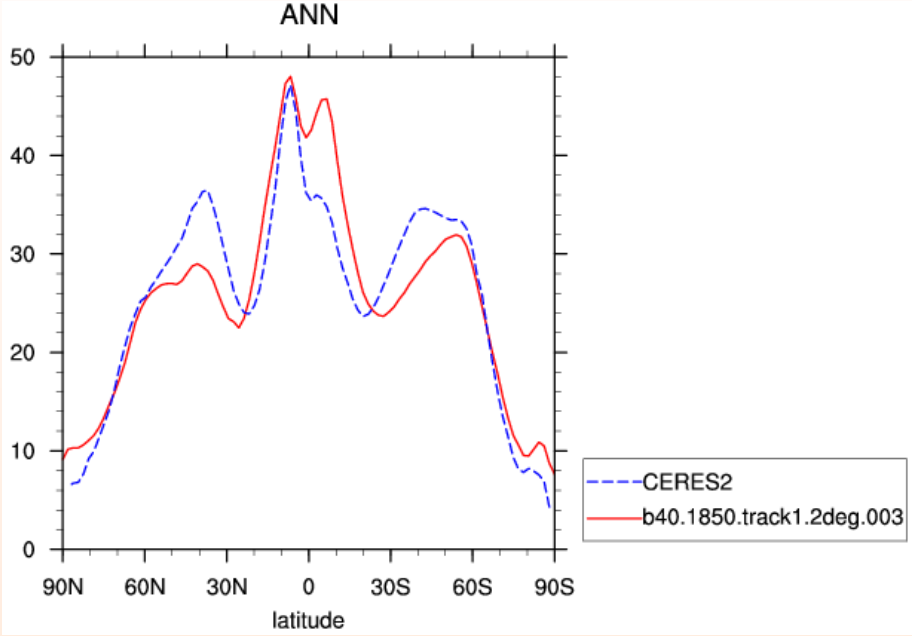
The End

EXTRA SLIDES: LWCF and SWCF for CCSM3 and CESM 2deg



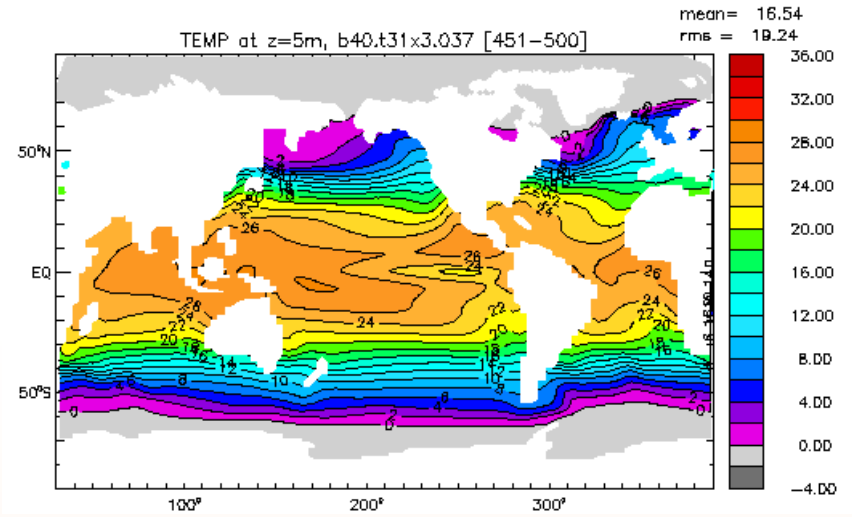


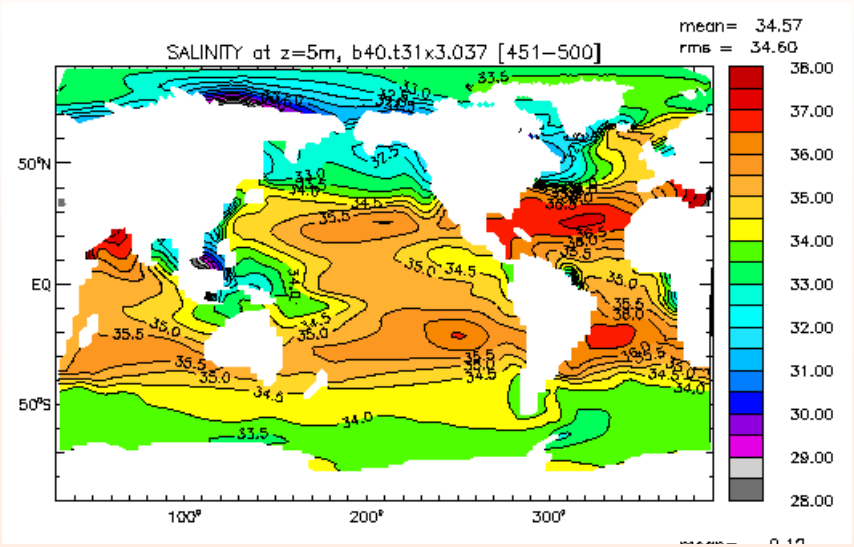




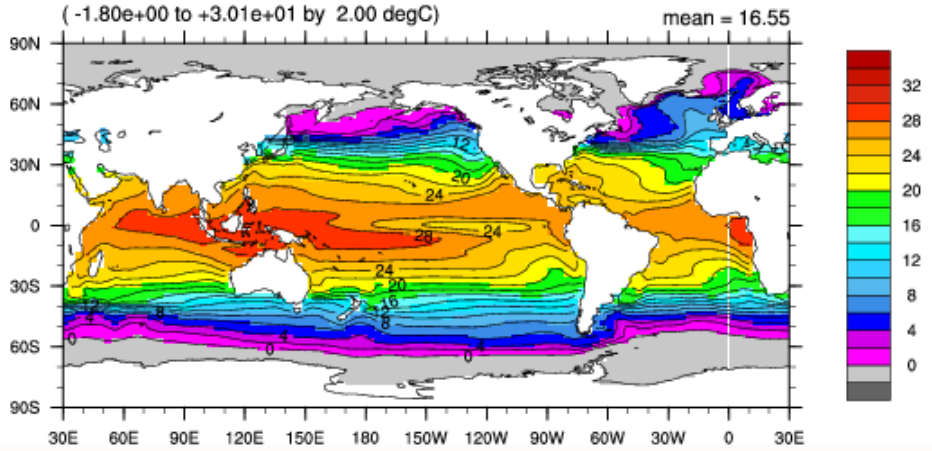
The Ocean: Basic State: SST and SSS

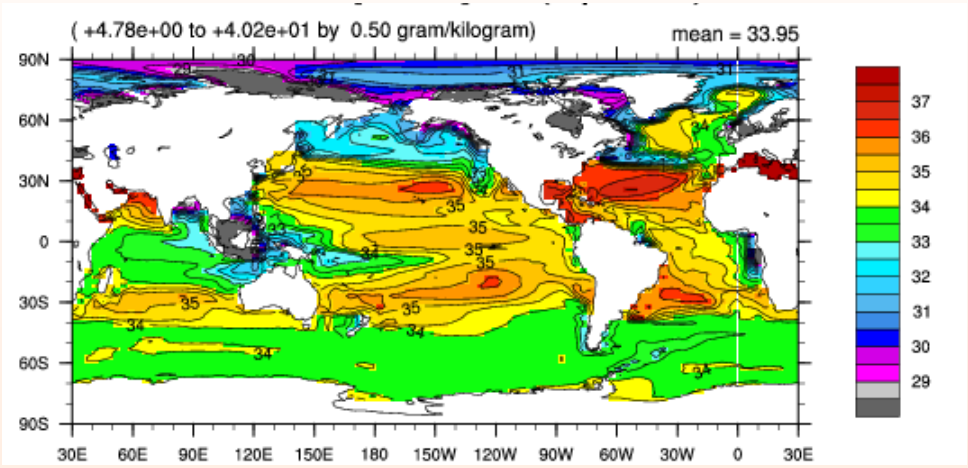
CESM1 T31_gx3





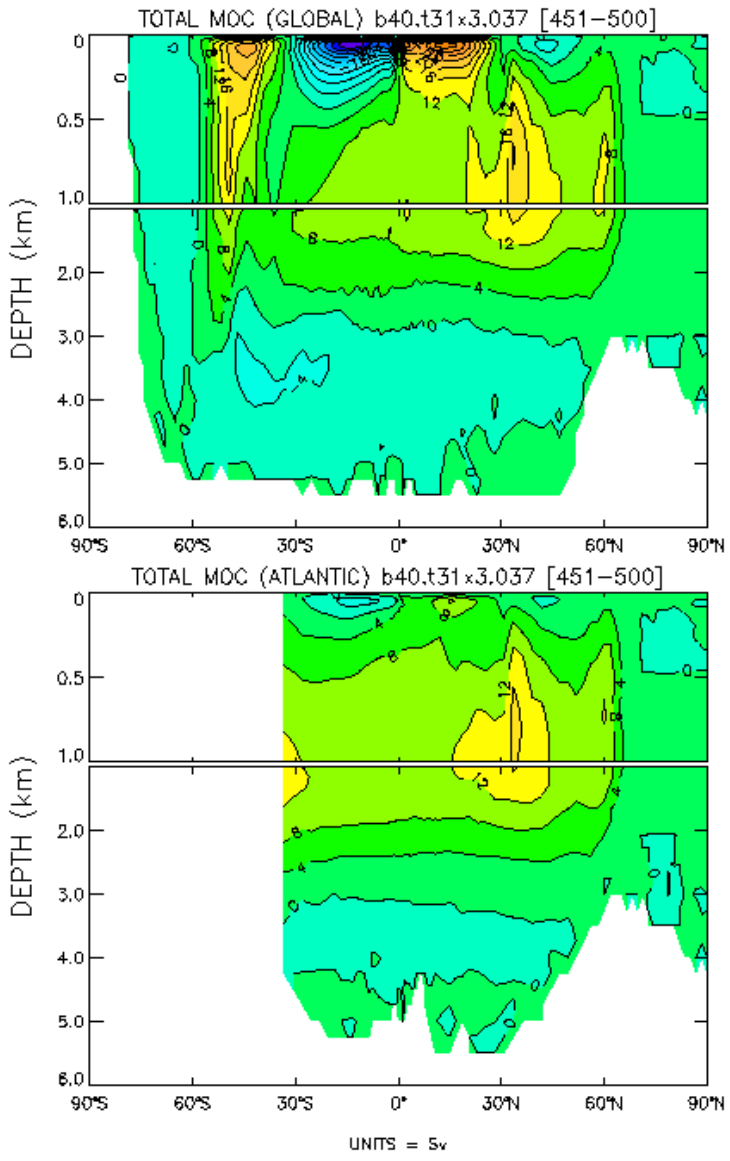
CCSM3 T31_gx3



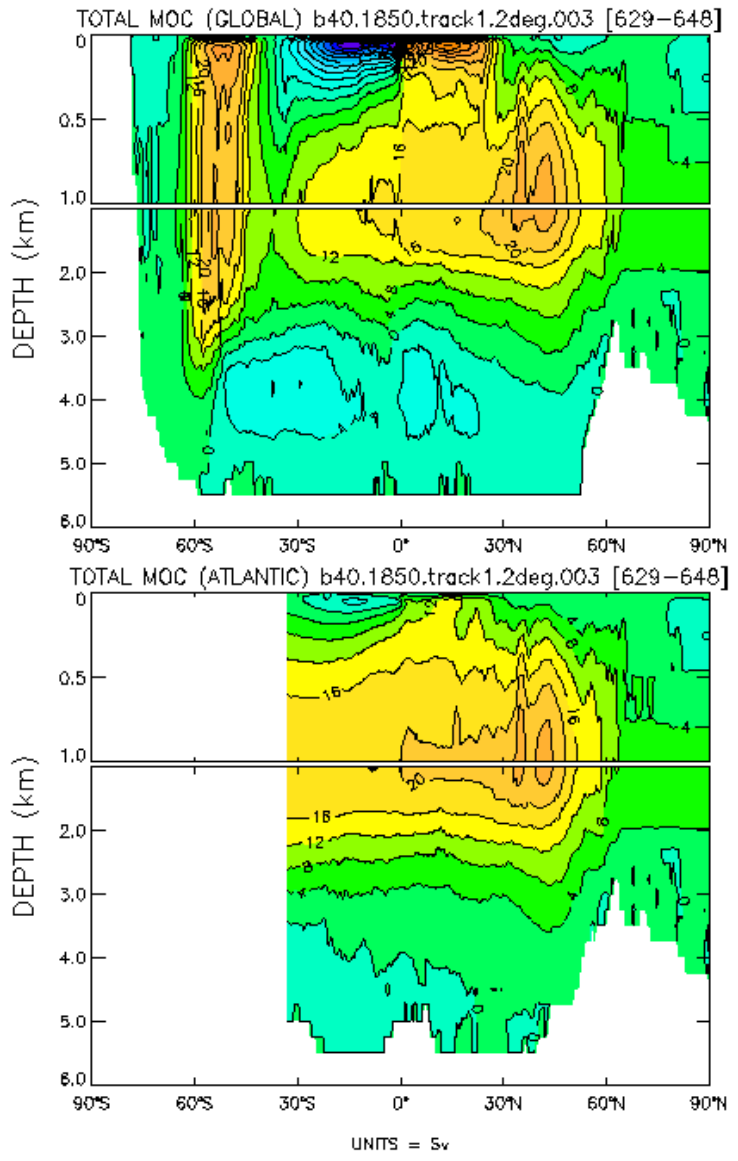


The Ocean: Basic State: MOC

T31_gx3

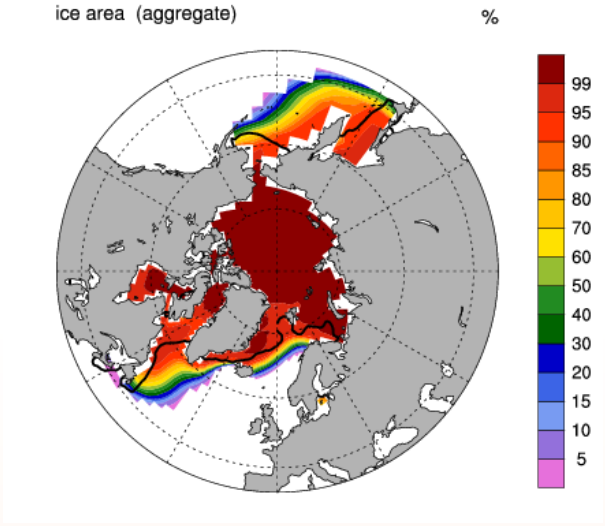


FV 2deg_gx1



The Ice: Basic State: Ice Area

T31_gx3
JFM



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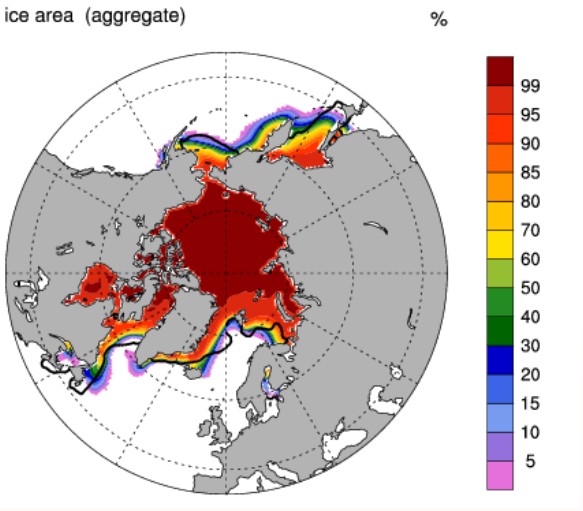

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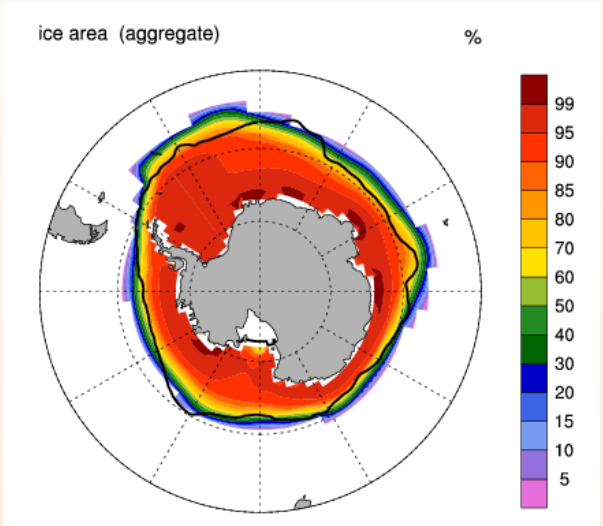

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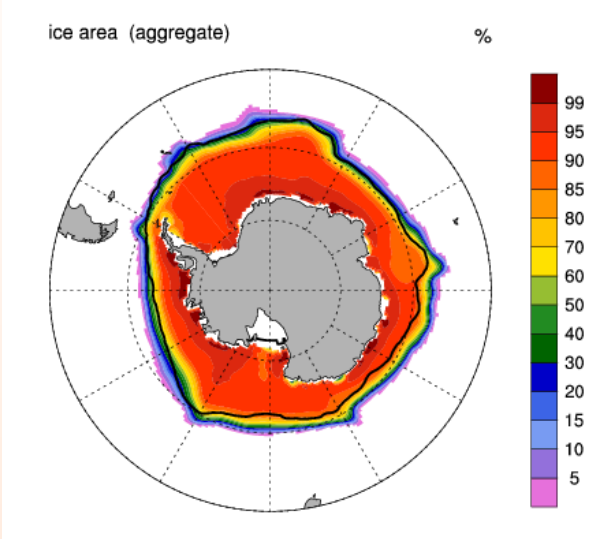
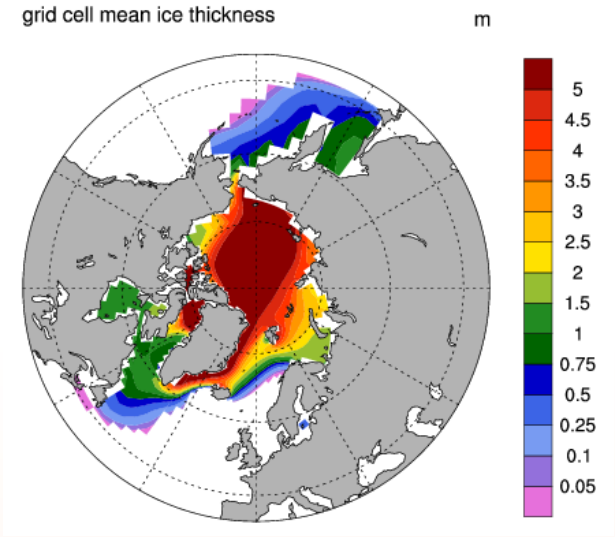


The Ice: Basic State: Ice Area

T31_gx3
JFM



FV 2deg_gx1
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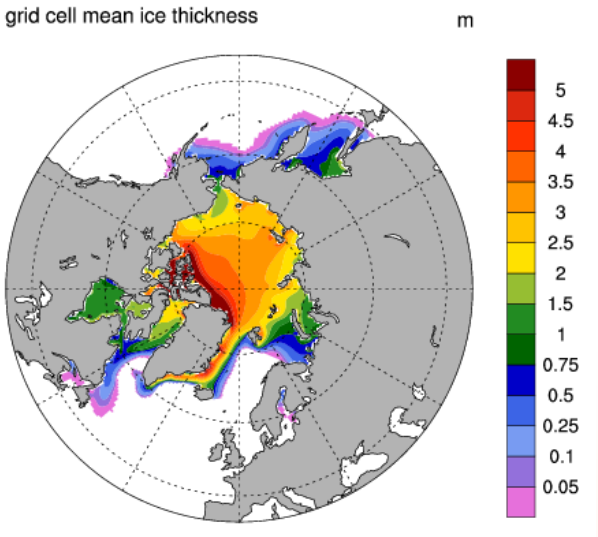

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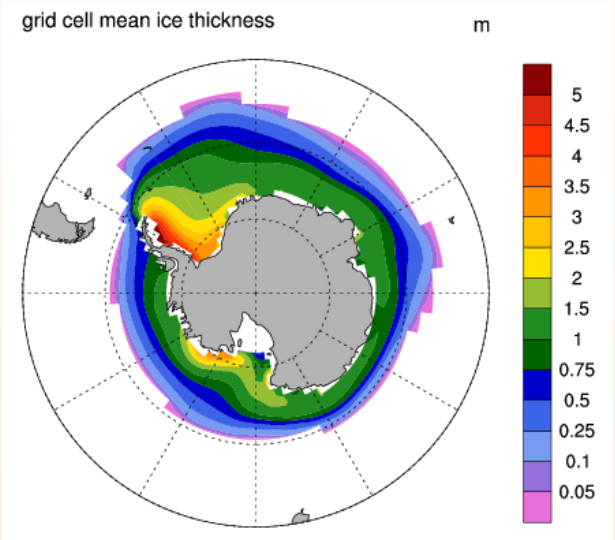

JAS