State of the Community Climate System Model

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CCSM Scientific Steering Committee

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NCAR

Recent Science Highlights

CCSM *IJHPCA* Special Issue

- **Objectives**
  - Describe SE for climate models
  - Document performance and portability

- **13 papers published in Fall 2005, Volume 19, Number 3**

- **Authorship**
  - 32 External
  - 9 NCAR

NCAR

Recent Science Highlights

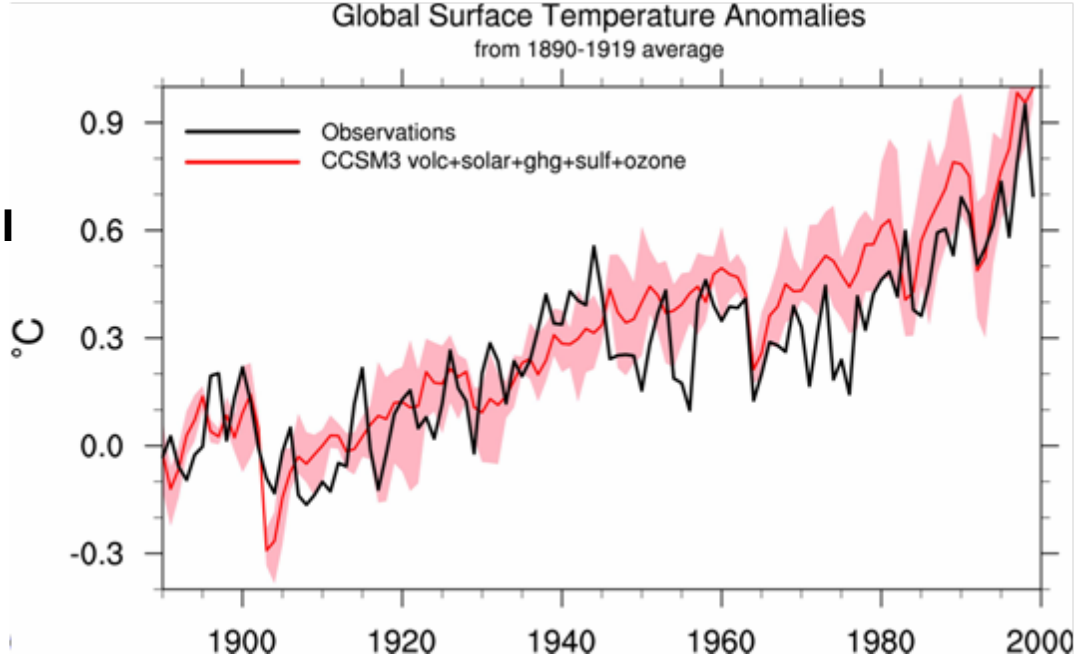
- **26 papers**
  - SSC (1)
  - Atmosphere Model (6)
  - Ocean Model (4)
  - Land Model (2)
  - Climate Change (2)
  - Climate Variability (4)
  - Polar Climate(4)
  - Paleoclimate (3)
- **510 pages**
- **Authorship**
  - 51 NCAR
  - 48 External

***J. Climate* Special Issue devoted to CCSM3: Vol 19, No 11, June 1, 2006**

NCAR

Contributions to IPCC Fourth Assessment

- Output: 10 GB/simulated year
- Data volume for IPCC: ~100 TB
- Largest contribution of any model
- Eight ensemble members at T85 for some experiments
- Data available online:
  - PCMDI (IPCC archive)
  - ESG (Control)
- Original history tapes: SCD
- Diagnostics on line (web)



Downloads of CCSM3 Data from NCAR via the Earth System Grid in 2005

Month	Requests	Volume (GB)
January	710	84
February	1229	86
March	2640	194
April	1285	189
May	1431	377
June	1259	195
July	1522	698
August	3033	871
September	3920	1500
October	5693	2130
November	9070	2080
December	5493	1860

Total was 37,285 requests; 10.25 TB of data downloaded.

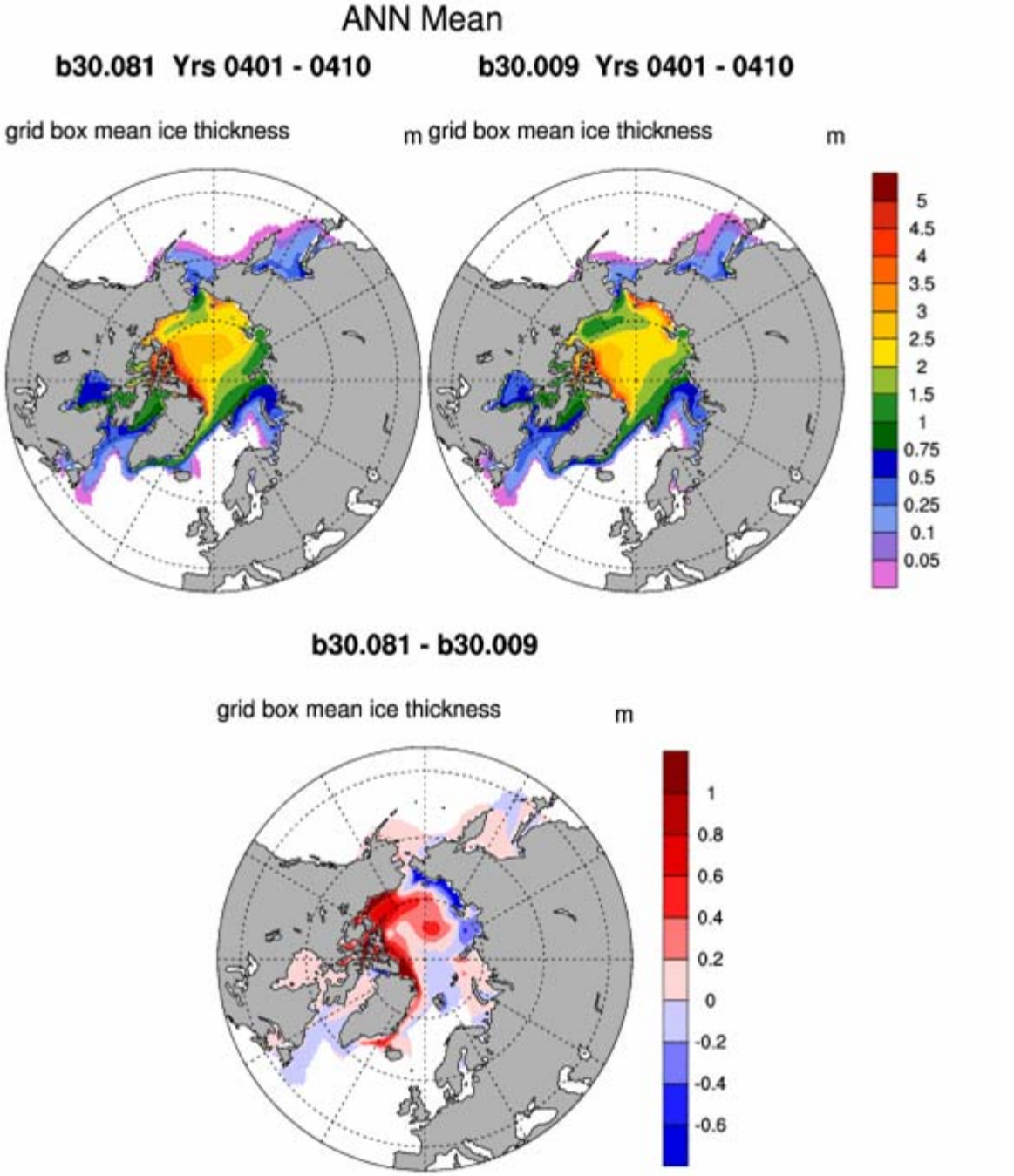
NCAR

Near-term Scientific Priorities

- **Get a good coupled simulation using the finite volume dynamical core; need a sea-ice distribution that is comparable to, or better than, the CCSM3 simulation.**
- **Improve the major biases in the CCSM3 simulations.**
- **The most eye-catching bias is the double ITCZ in the tropical Pacific Ocean and the high frequency of ENSO.**

b30.081 is FV 2.2x1.9

b30.009 is CCSM3 T85



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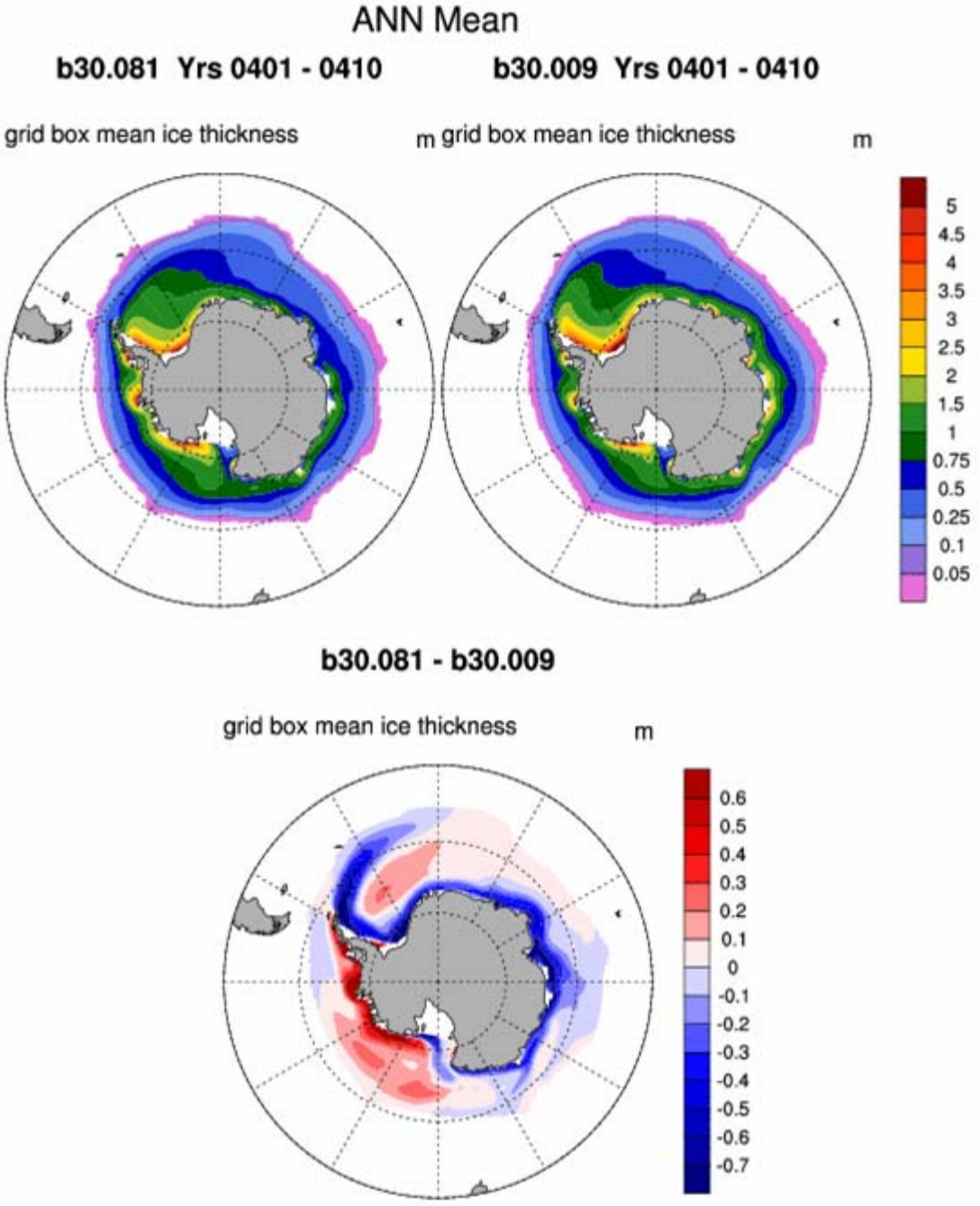

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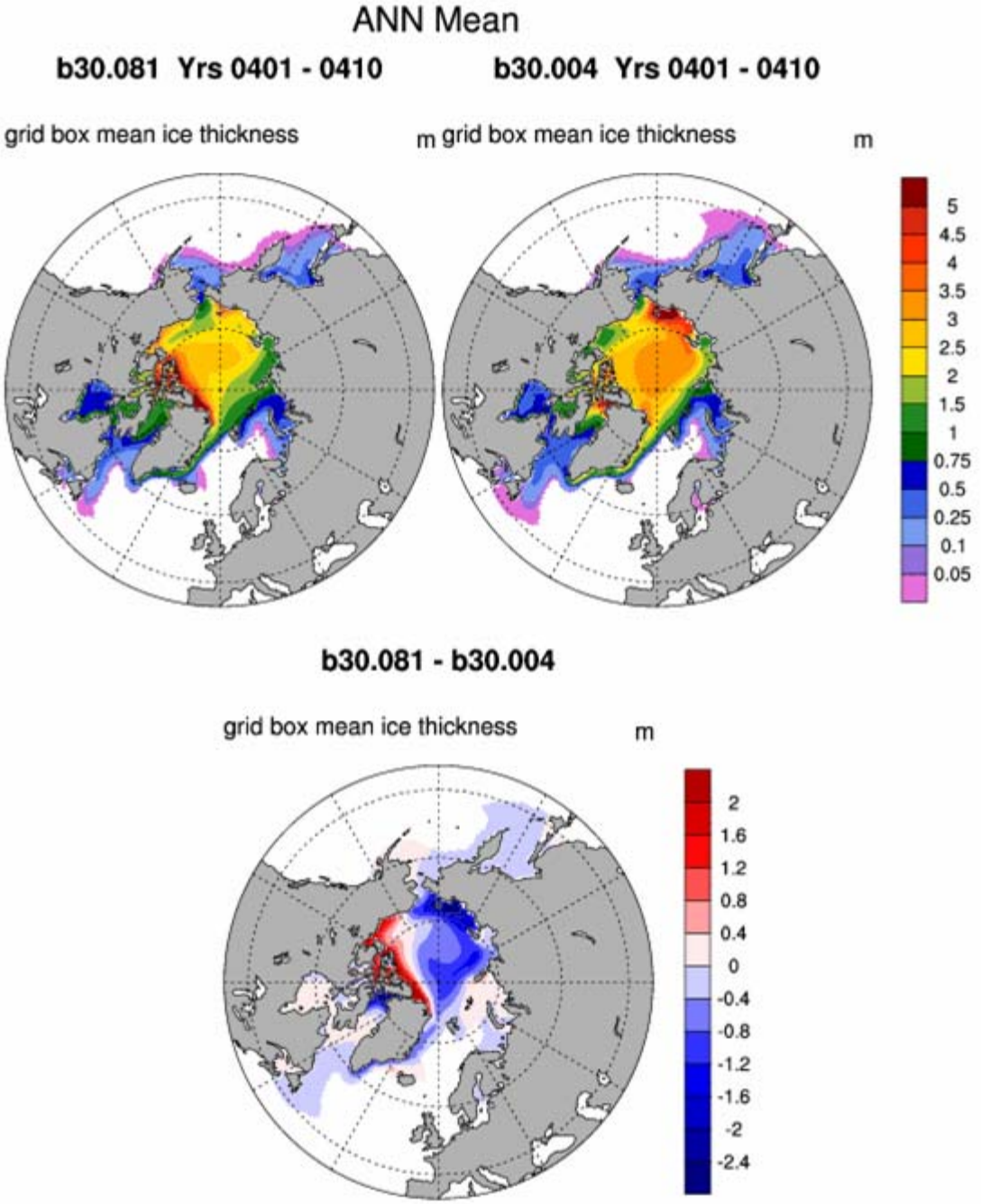
b30.004 is CCSM3 T42



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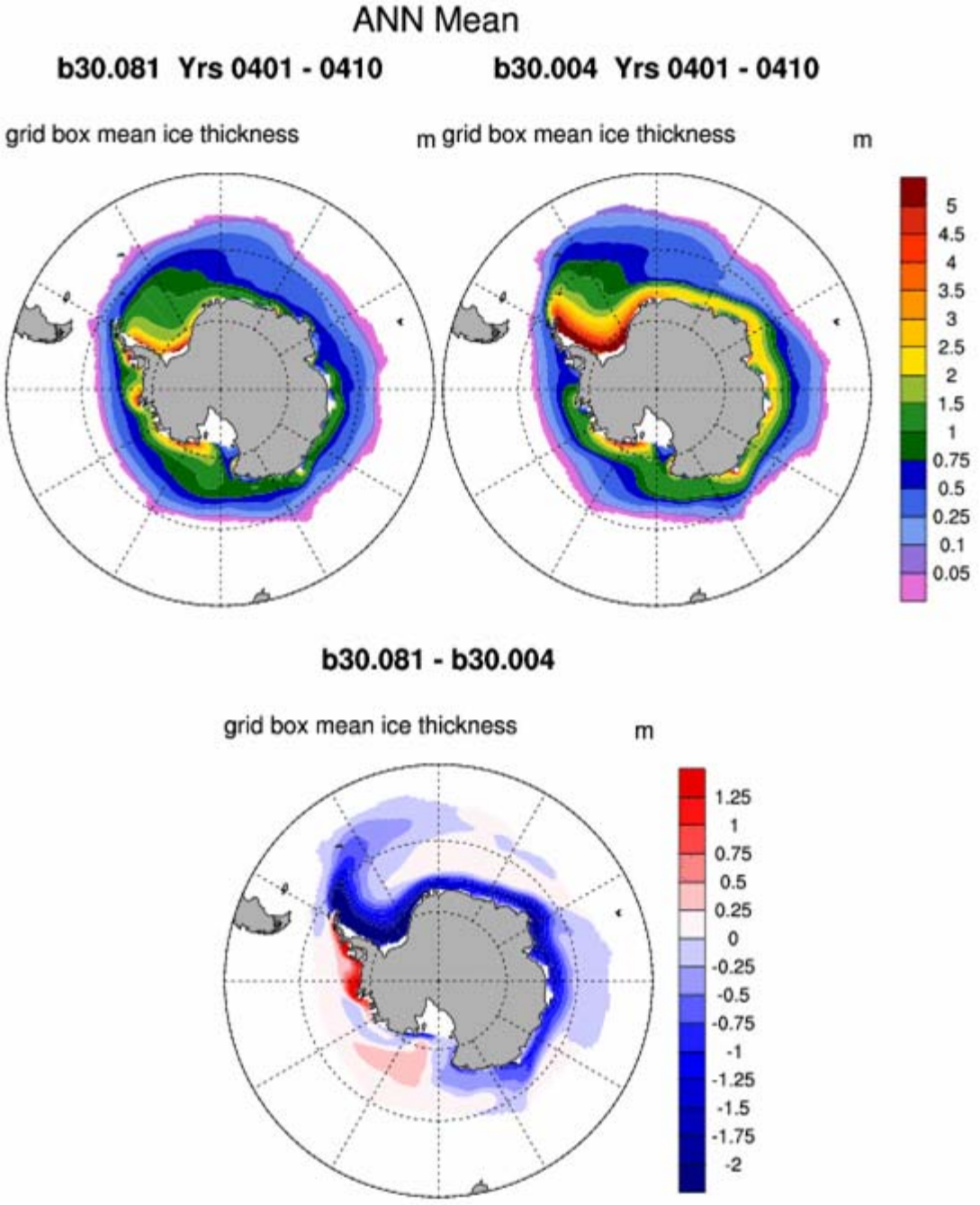
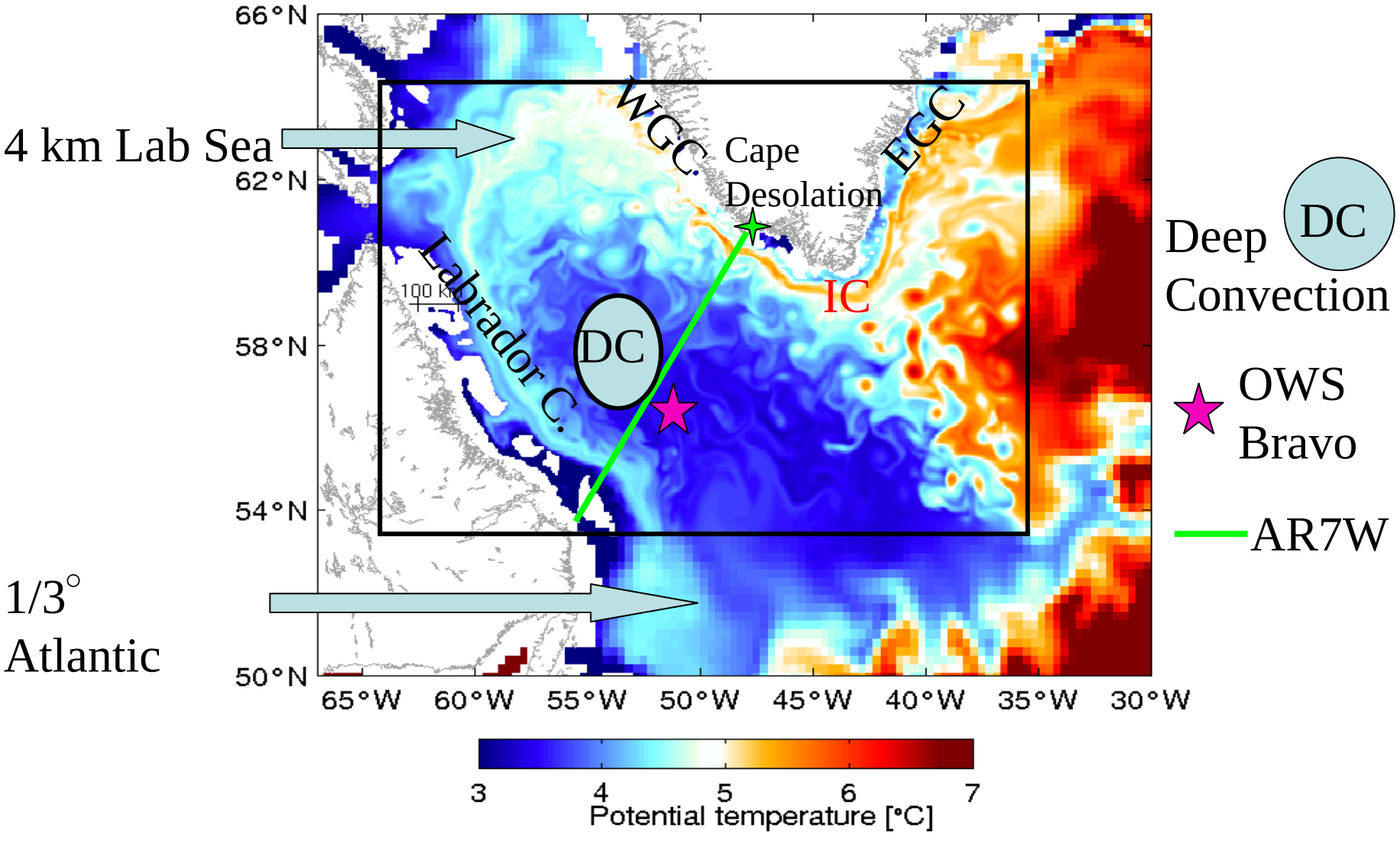
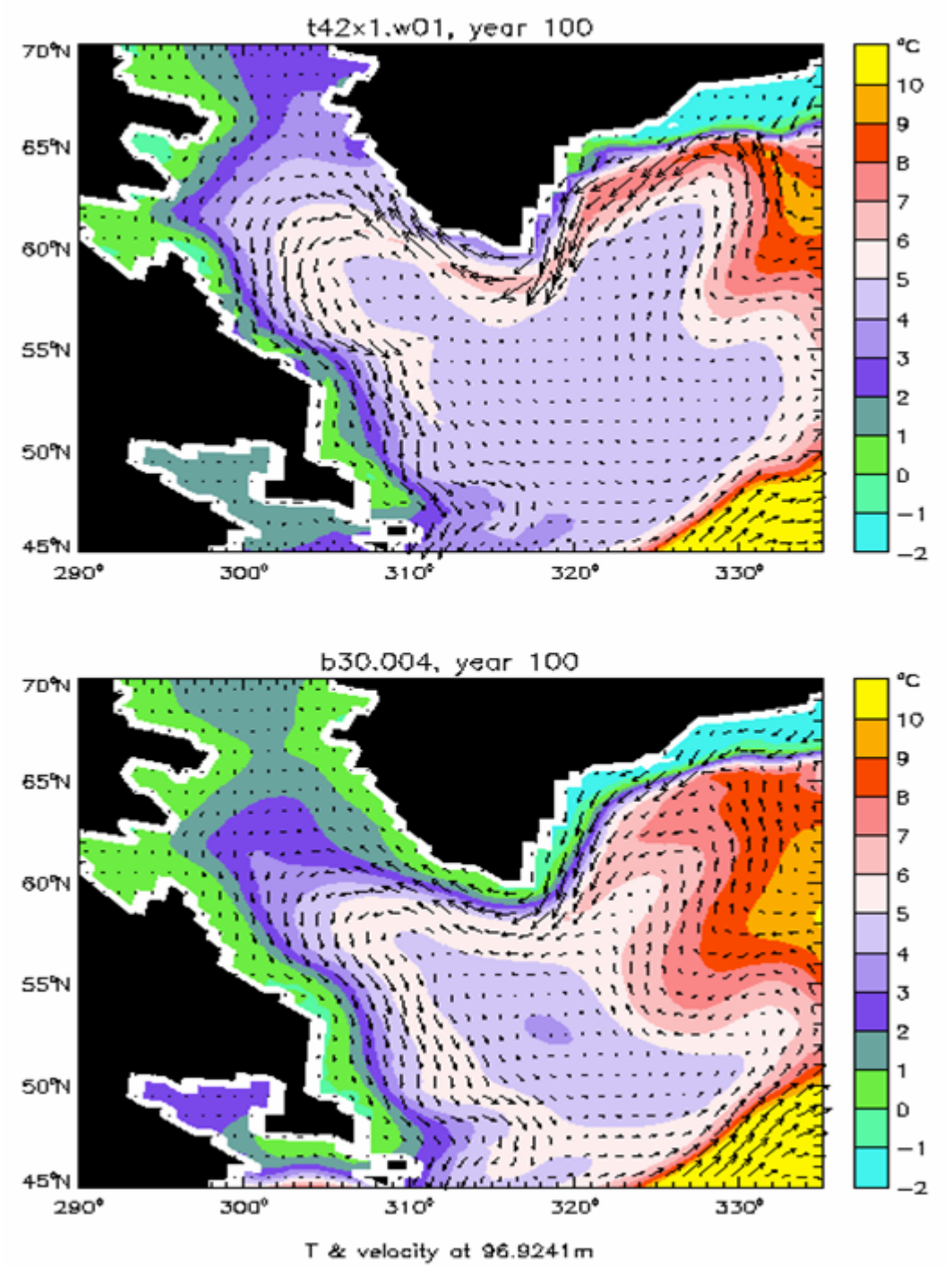


Labrador Sea, T(182m), Year 10



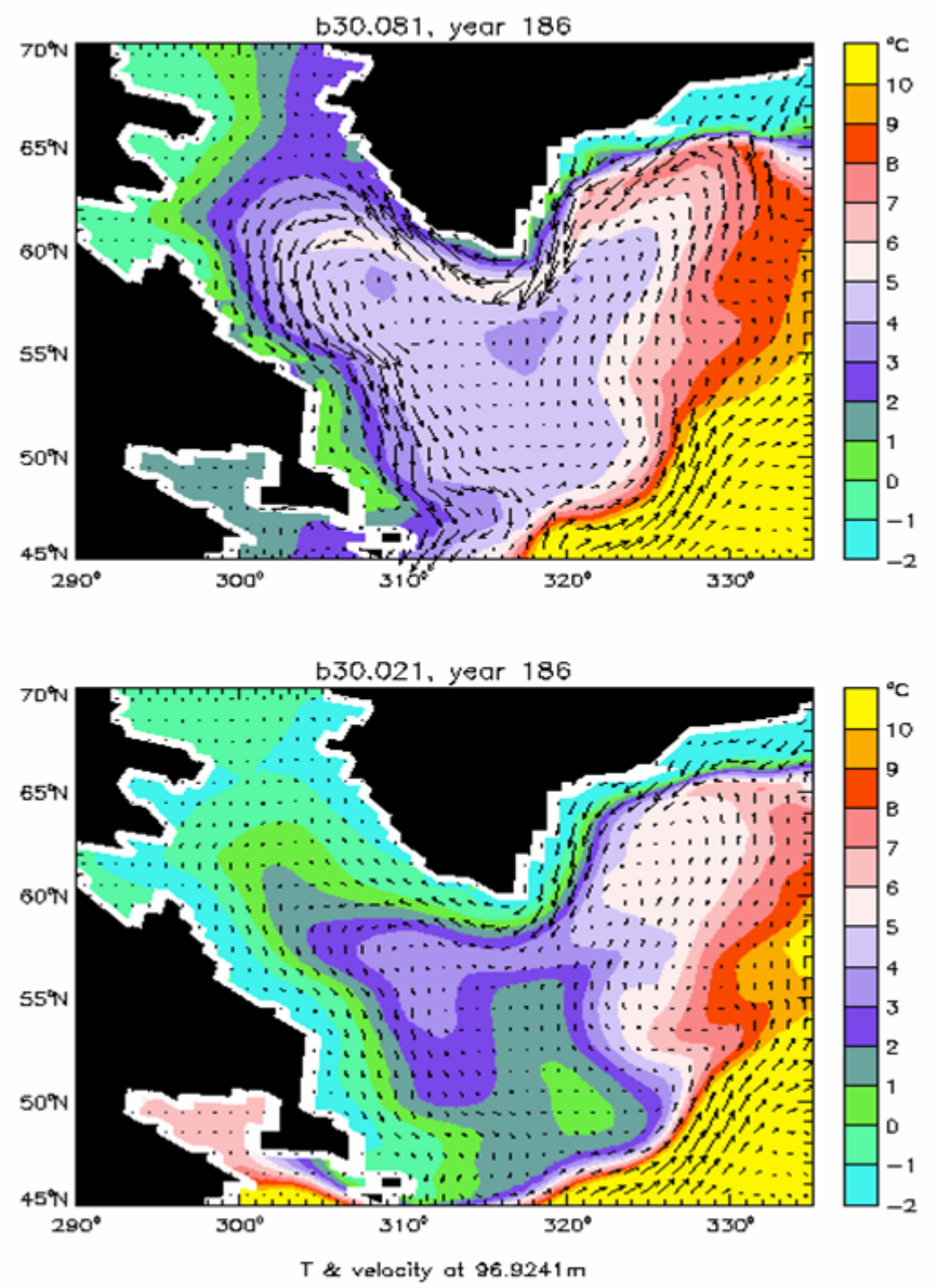


CCSM3
T42x1

Without
Smag

Temp and
Velocity
at 97 m.

With Smag



FV2.2x1.9

Without Smag

Temp and Velocity at 97 m.

With Smag

Some major issues in CCSM3 simulations

- **Temperature and Precipitation**
  - Biases in continental temperature and precipitation
  - SSTs in coastal stratus regions
  - Semi-annual cycle in SST for the E. Pacific
  - Arctic low cloud and temperature biases
  - Tropical tropopause biases
  - Double ITCZ in the Pacific
- **Representation of major modes of variability**
  - El Nino / Southern Oscillation
  - The Madden-Julian Oscillation

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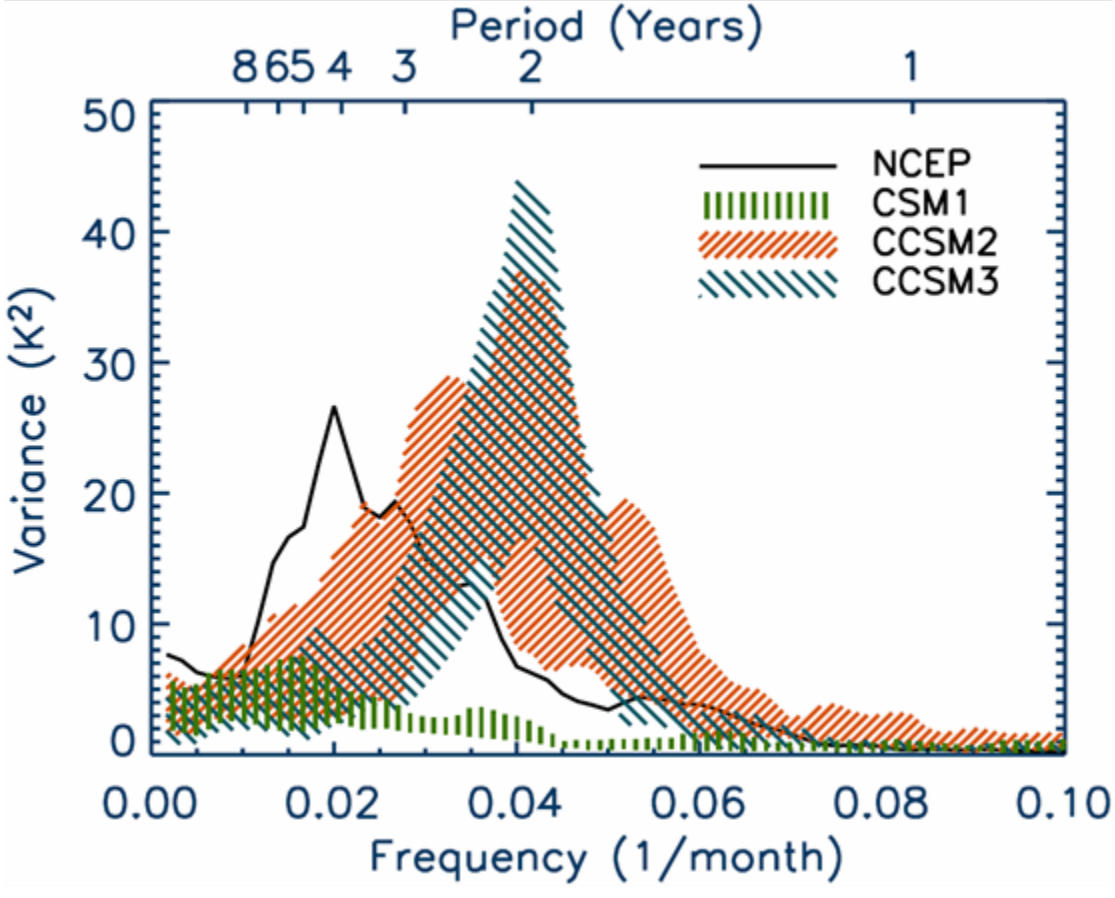
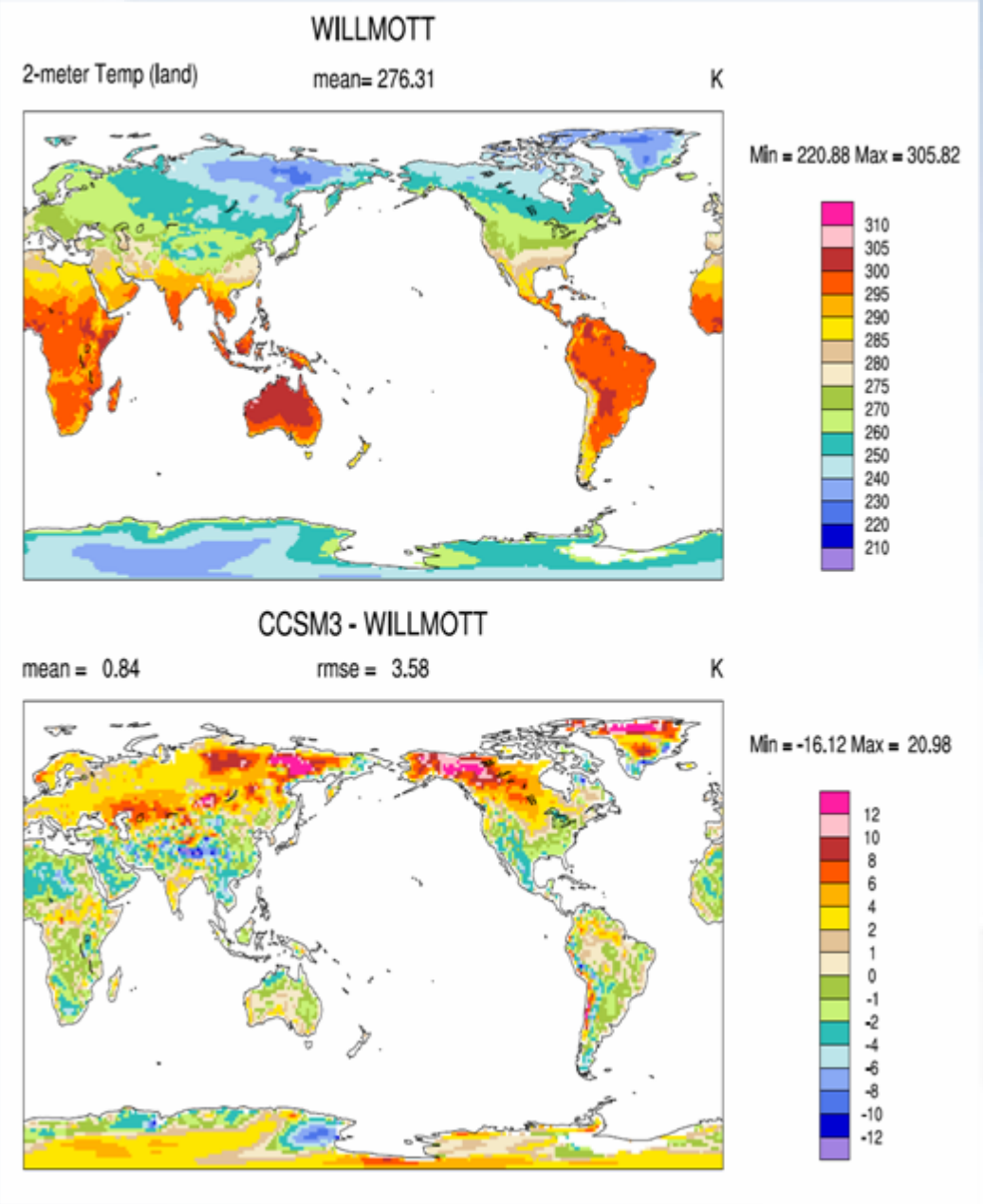
Nino3 SST Power Spectra



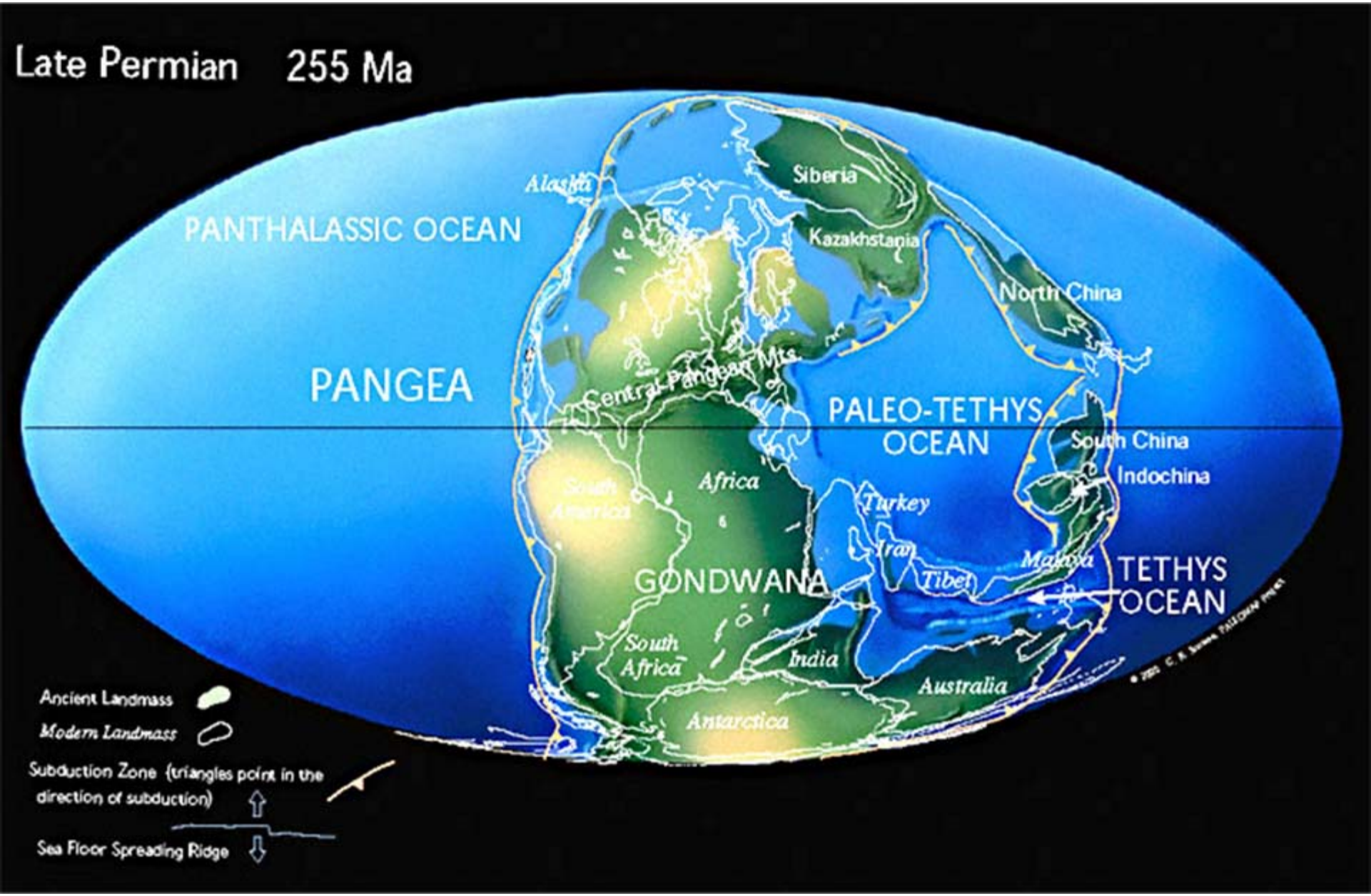
Gent and Kiehl, 2004; Collins et al, 2006

Continental Temperature

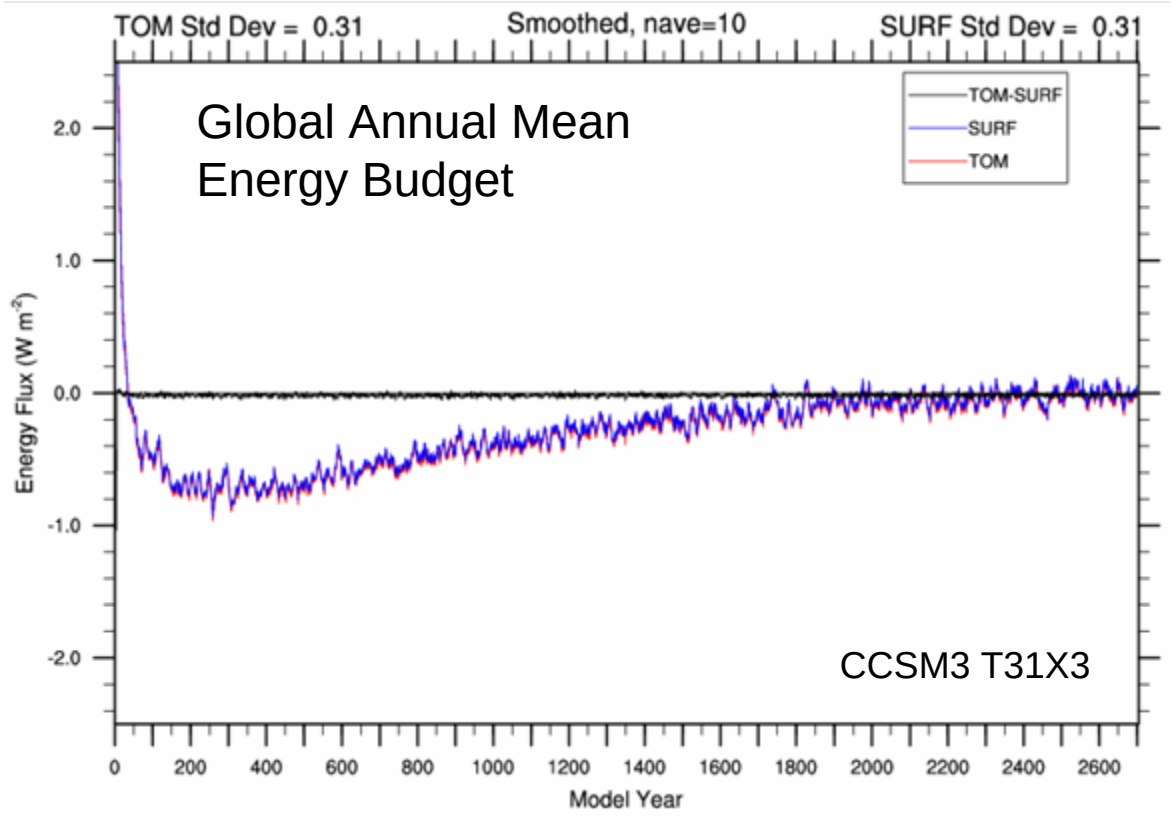


Collins et al, 2006

NCAR


Late Permian 255 Ma
PANTHALASSIC OCEAN
PANGEA
Alaska
Siberia
Kazakhstania
North China
Central Pangean Mts.
PALEO-TETHYS OCEAN
South China
Indochina
Africa
South America
Turkey
Iran
Malaya
Tibet
GONDWANA
TETHYS OCEAN
South Africa
India
Australia
Antarctica
Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge

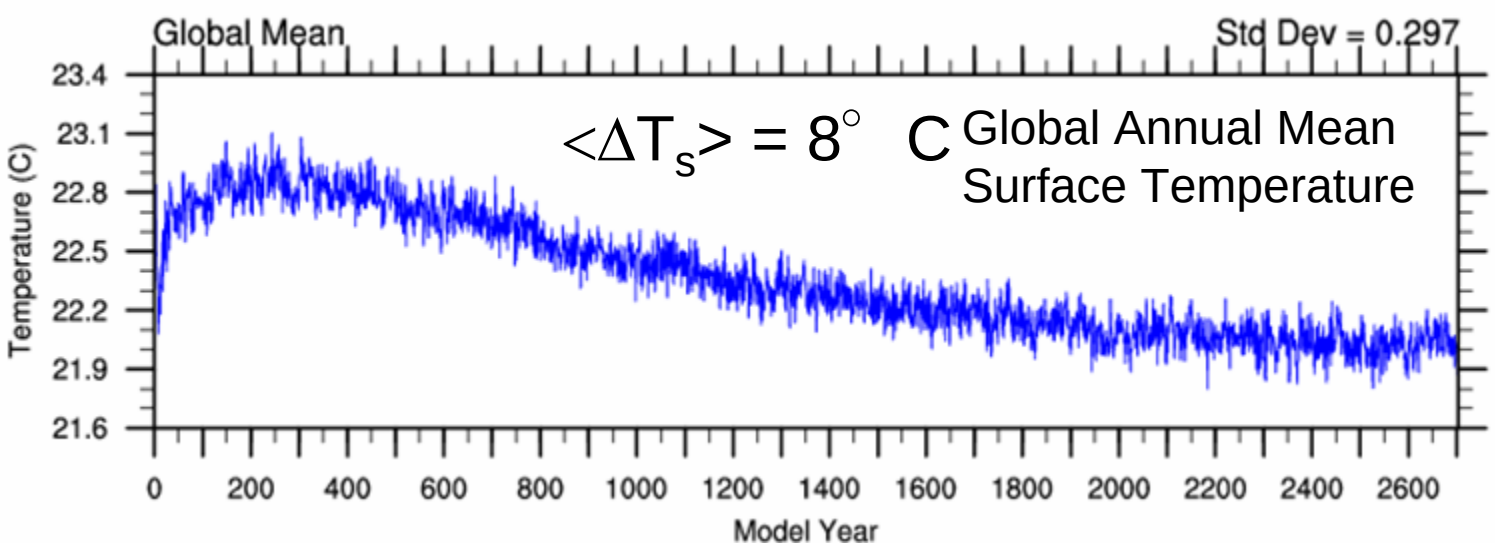
Forcing of 10X increase in CO_2 and Permian paleogeography



Permian coupled model run for 2700 years to new equilibrium state

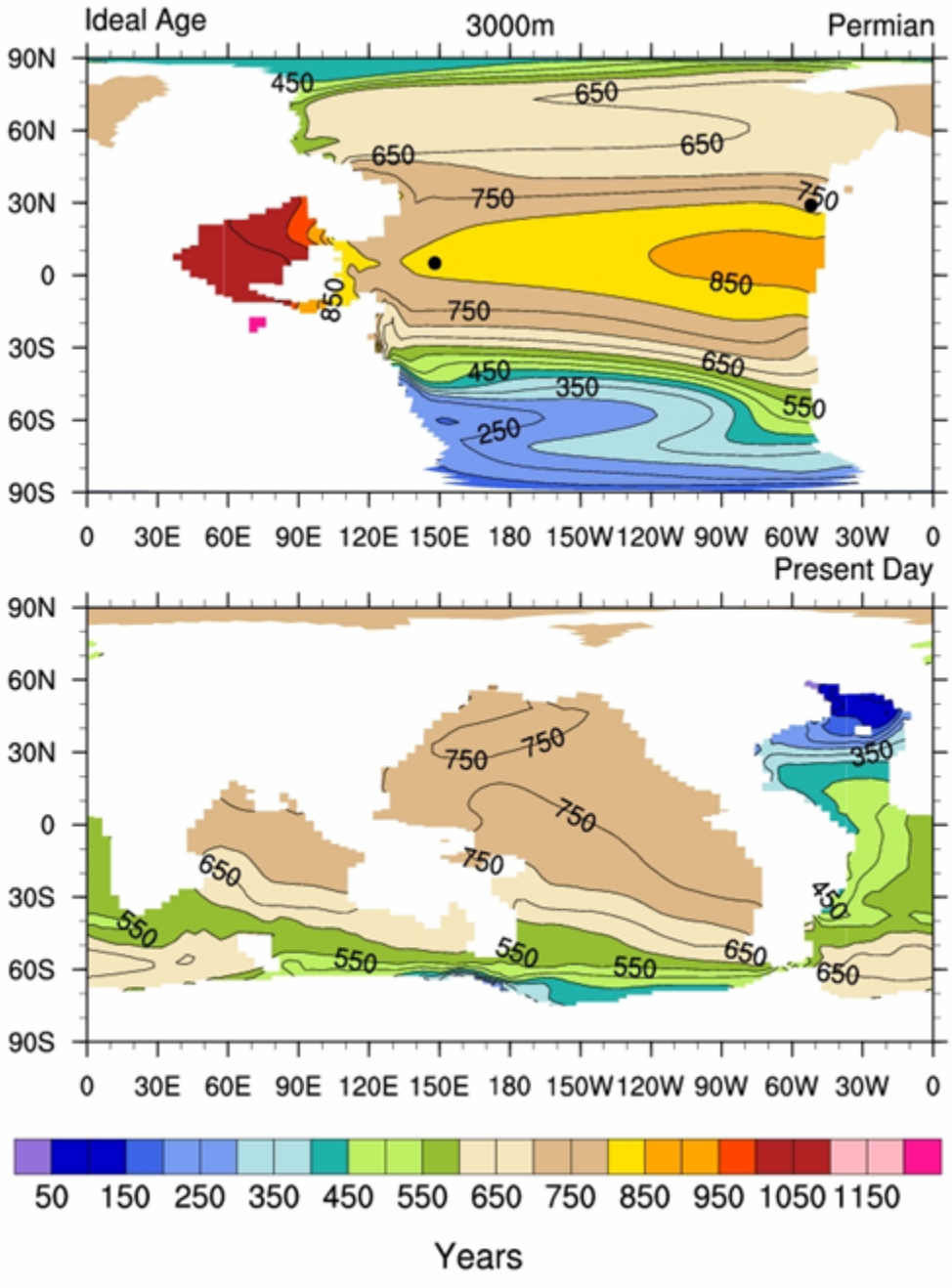
Kiehl and Shields

(2005)



Ideal age at 3km depth in ocean.

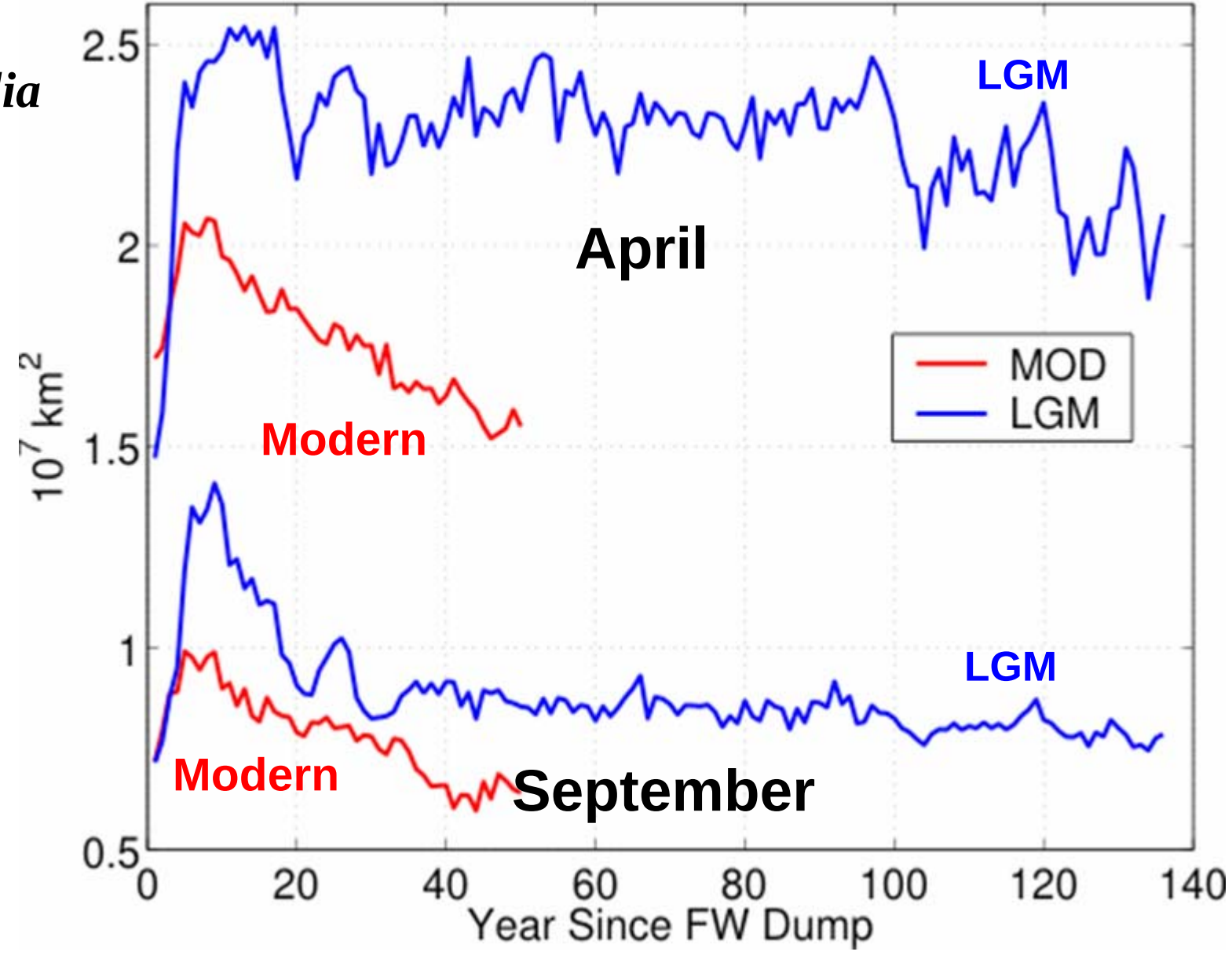
Inefficient mixing in Permian ocean indicative of anoxia



Kiehl and Shields (2005)

Arctic Sea Ice Area in Hosing Experiments

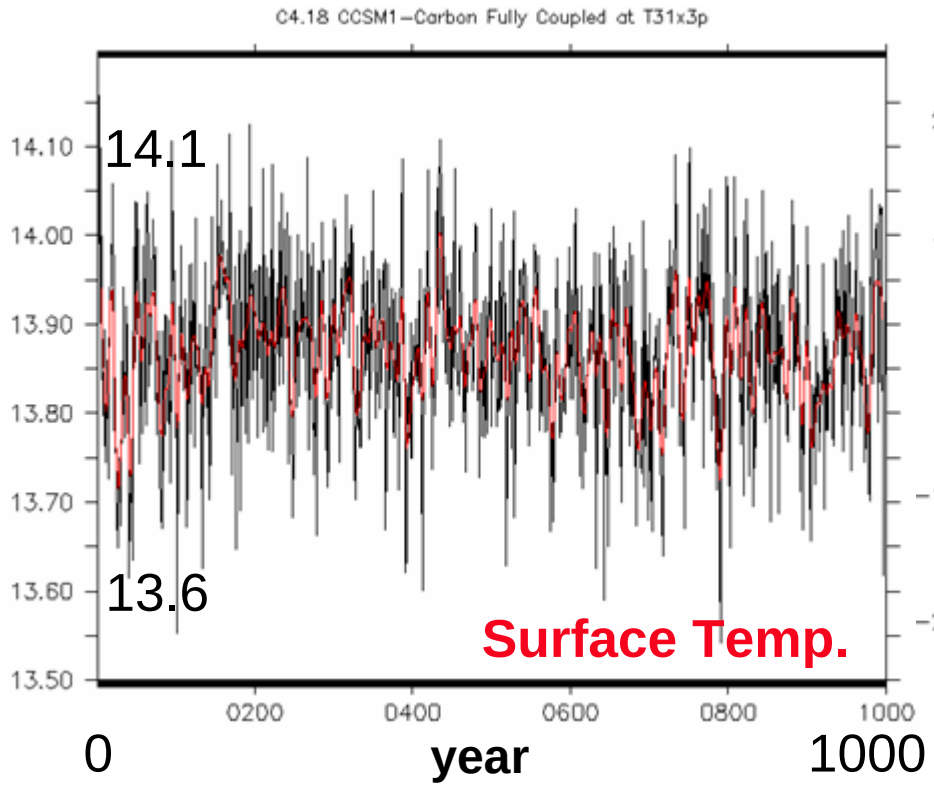
Cecilia Bitz et al.

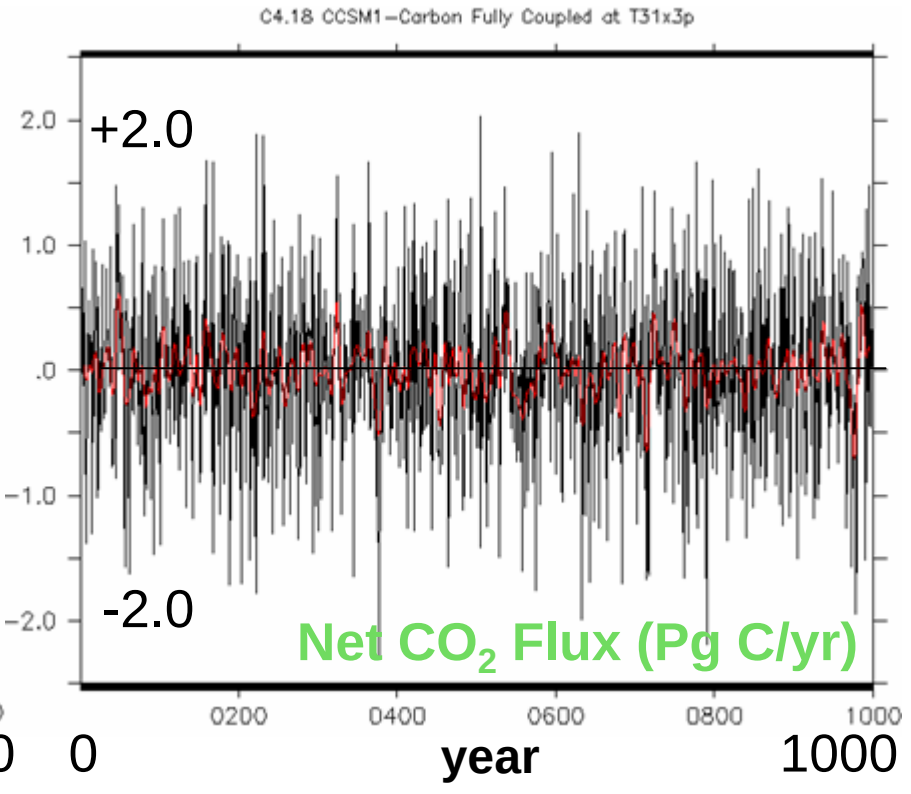


Longer-term Scientific Priorities

- **Include biogeochemistry and ocean ecosystem model for the carbon cycle.**
- **Include both the direct and indirect effects of aerosols.**
- **Include a land ice sheet model.**
- **Include interactive vegetation and land use changes in the land component.**
- **Atmospheric chemistry component has been added to CAM3; include the effects of tropospheric ozone.**

Multi-Century Coupled Carbon/Climate Simulations



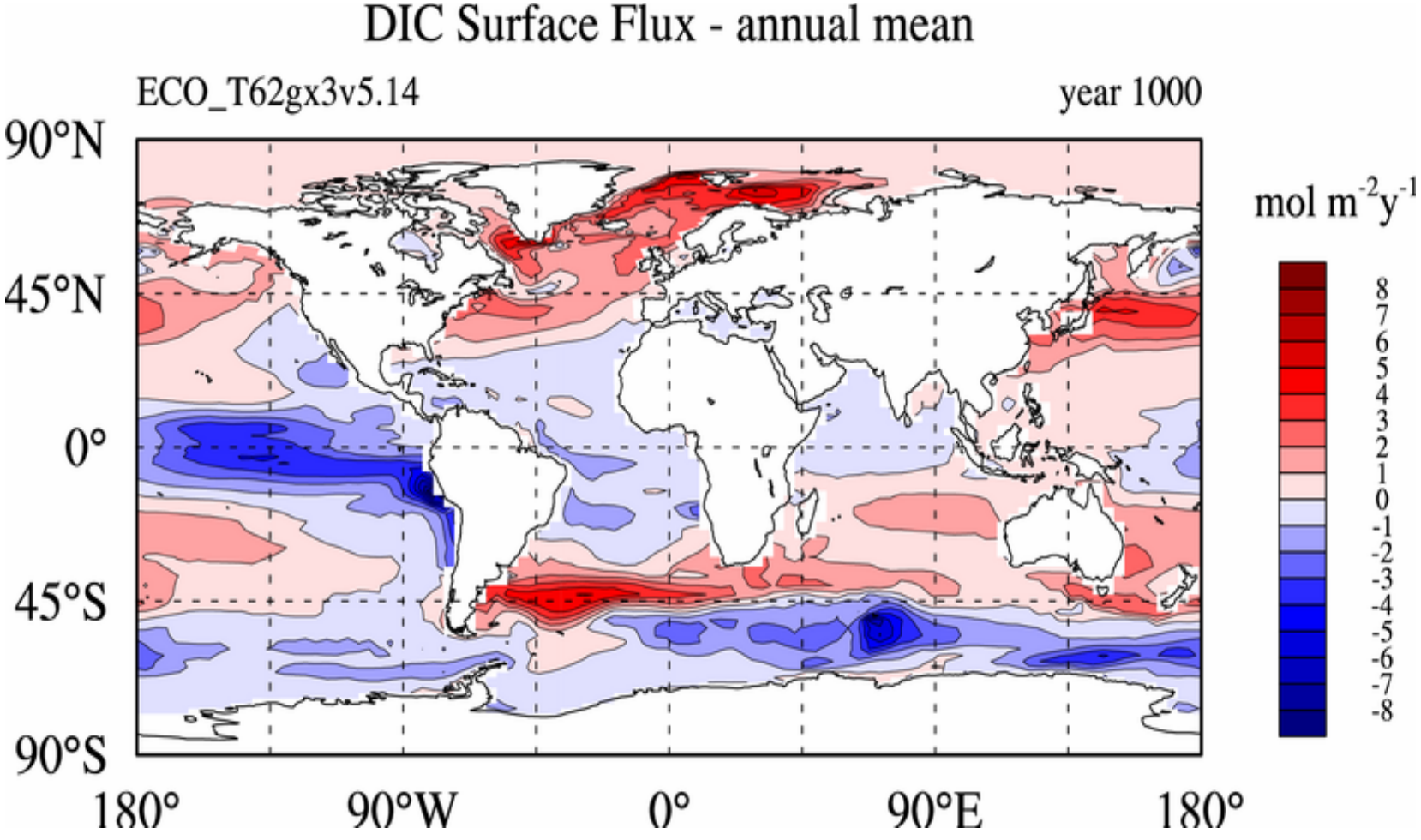


- Fully prognostic land/ocn BGC and carbon/radiation
- Atm-Land CO_2 flux: 70 PgC/yr ↑↓; Atm-Ocean CO_2 flux: 90 PgC/yr ↑↓
- Net Land+ocean CO_2 flux: 0±1 PgC/yr
- "Stable" carbon cycle and climate over 1000 years

Doney, Lindsay, Fung and John: Accepted by J Climate

Flux of CO_2 into the world oceans

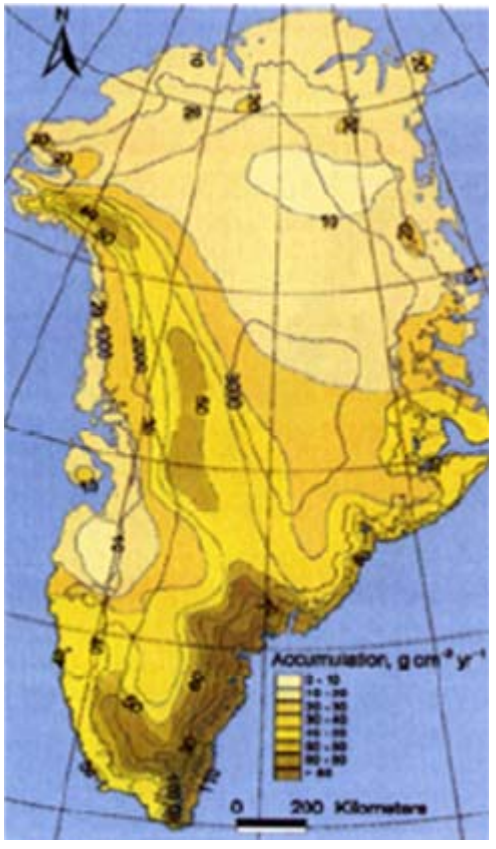
(Ocean ecosystem model)



Moore, Doney, and Lindsay

Greenland ice sheet

- Volume ~ 2.8 million km^3
  (~7 m sea level equivalent)
- Area ~ 1.7 million km^2
- Mean thickness ~ 1.6 km
- Accumulation ~ 500 km^3/yr
- Surface runoff ~ 300 km^3/yr
- Iceberg calving ~ 200 km^3/yr



Annual accumulation
(Bales et al., 2001)

Bill Lipscomb, LANL

Unstable Glaciers

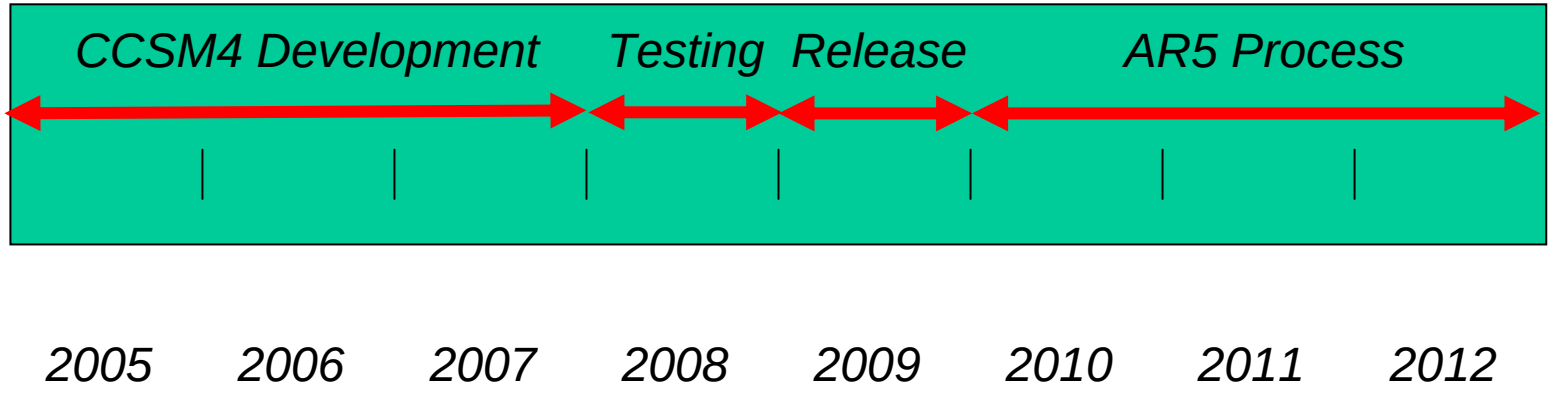
Surface melt on Greenland ice sheet descending into moulin, a vertical shaft carrying the water to base of ice sheet.

Source: Roger Braithwaite

The timeline for IPCC AR5

Assumptions:

- It is likely that the AR5 report will be issued 6 years after AR4, in 2013.
- Following the precedent in AR4, the simulations will have to be finished three years ahead, in 2010.
- **Thus, CCSM4 has to be ready for production in 2009.**
- **CCSM4 has to be ready for testing in 2008.**



Current SSC Members and Terms

Gordon Bonan, NCAR	8/1/2003	7/31/2007
Chris Bretherton, U Washington	1/1/2002	12/31/2006
Julie Cole, U Arizona	1/1/2006	12/31/2007
Bill Collins, NCAR	1/1/2006	12/31/2007
Scott Doney, WHOI	6/1/2002	6/30/2008
Peter Gent, NCAR	7/1/2005	6/30/2007
Steve Ghan, PNNL	1/1/2006	12/31/2007
Jim Hurrell, NCAR	No term	
Bill Large, NCAR	1/1/2003	12/31/2006
Danny McKenna, NCAR	1/1/2001	12/31/2006
Ben Santer, UCA/PCMDI	8/1/2003	7/31/2007
Mariana Vertenstein, NCAR	9/15/2004	9/14/2006

CONCLUSIONS

- IPCC work and special journal issues have gone well.
- There is now a 420 yr coupled integration with the FV core that is equivalent to the CCSM3 IPCC simulations.
- There are other biases in the CCSM3 that are currently being addressed, with varying degrees of success.
- Updated CSM1 biogeochemistry is running in CCSM3.
- The land component intercomparison is underway.
- Work on including indirect aerosol effects, the land ice component, and atmospheric chemistry have started.

The CCSM Distinguished Achievement Award for 2006

- This award was presented to Byron Boville.
- The ceremony was held at NCAR on Friday, May 26th 2006.

Byron Arthur Boville

8/25/1953

6/6/2006