

Climate Change Doesn't Just Happen

John Drake

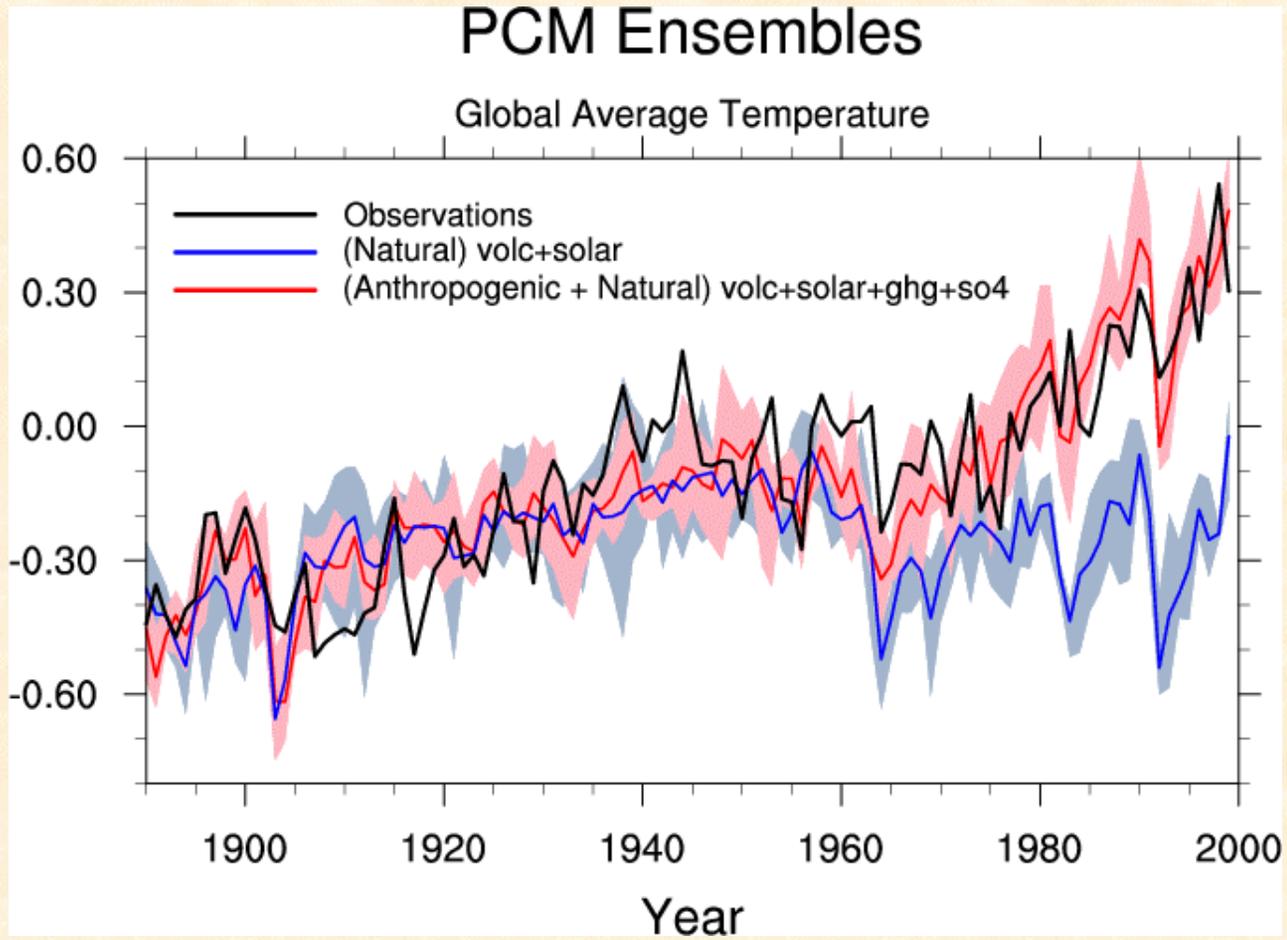
Computer Science and Mathematics Division

Oak Ridge National Laboratory

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Climate Change Doesn't Just Happen

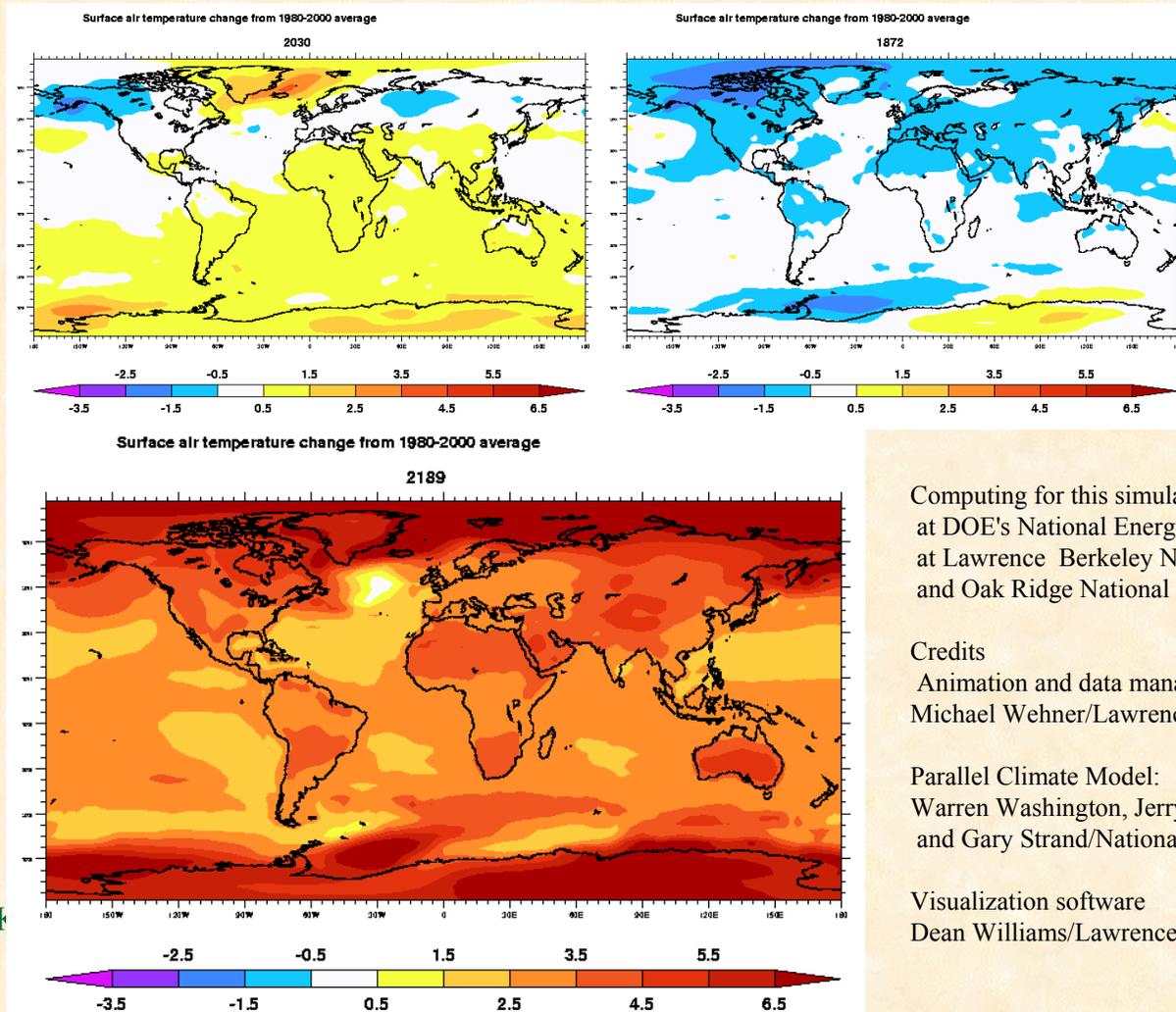
- A Key figure



PCM Ensembles of 21st Century Business as Usual

- Results show that the global warming trend since the late 1970's is likely to continue through much of the twenty-first century.
- Model includes a full range of greenhouse gas changes together with sulfate aerosol effects and no artificial flux adjustments.
- The pattern of surface warming from 1961-90 to 2070-99 under BAU scenario shows that warming ranges between 1 and 2 C over oceans and is above 2 C over many land areas, especially in northern high latitudes during winter where the warming is above 5 C.
- The meridional overturning in the North Atlantic is reduced by 20% from 1961-90 to 2070-99... reduced local vertical mixing causes cooling over the mid-latitude North Atlantic.
- Ensemble-averaged precipitation in BAU shows a 20%-40% increase at high latitudes during winter and a 10%-30% decrease over subtropical dry areas.

Simulation of Future Climates



Computing for this simulation was done at DOE's National Energy Research Scientific Computing Center (NERSC) at Lawrence Berkeley National Laboratory, NCAR and Oak Ridge National Laboratory Center for Computational Sciences (CCS).

Credits

Animation and data management:
Michael Wehner/Lawrence Berkeley National Laboratory

Parallel Climate Model:

Warren Washington, Jerry Meehl, Julie Arblaster, Tom Bettge and Gary Strand/National Center for Atmospheric Research

Visualization software

Dean Williams/Lawrence Livermore National Laboratory

PCM Business as Usual and Stabilization Scenarios

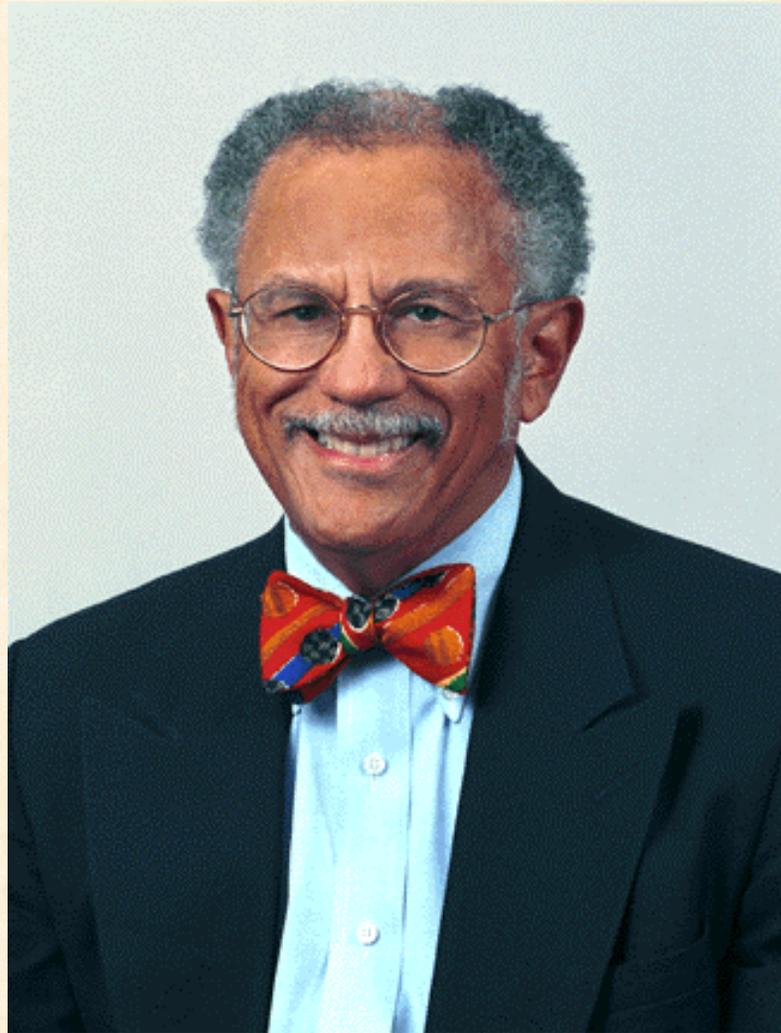
- The ensemble-mean temperatures under the BAU and STA550 scenarios start to diverge in 2040 but become significantly different only after the mid 2060's.
- Stabilized atmospheric CO₂ at 550ppm by 2150 will only slow down the warming moderately during the 21st century but could be large (1.5 C globally and 12 C in DJF at northern high-latitudes) by the later part of the 22nd century.

Dai, Meehl, Washington, Wigley, Arblaster, *Ensemble Simulation of Twenty-First Century Climate Changes, BAMS Vol 82, No. 11, November 2001*

Dai, Wigley, Meehl and Washington, *Effects of Stabilizing Atmospheric CO₂ on Global Climate in the Next Two Centuries, GRL Vol. 28, No. 23, December 2001*

Climate Change Doesn't Just Happen

- Another Key figure



Model Building / Team Building



Warren Washington

Bette Otto-Bliesner

Stephanie Shearer

Caspar Ammann

Julie Arblaster

Tom Bettge

Esther Brady

Aiguo Dai

Aixue Hu

Jerry Meehl

Christine Shields

Gary Strand

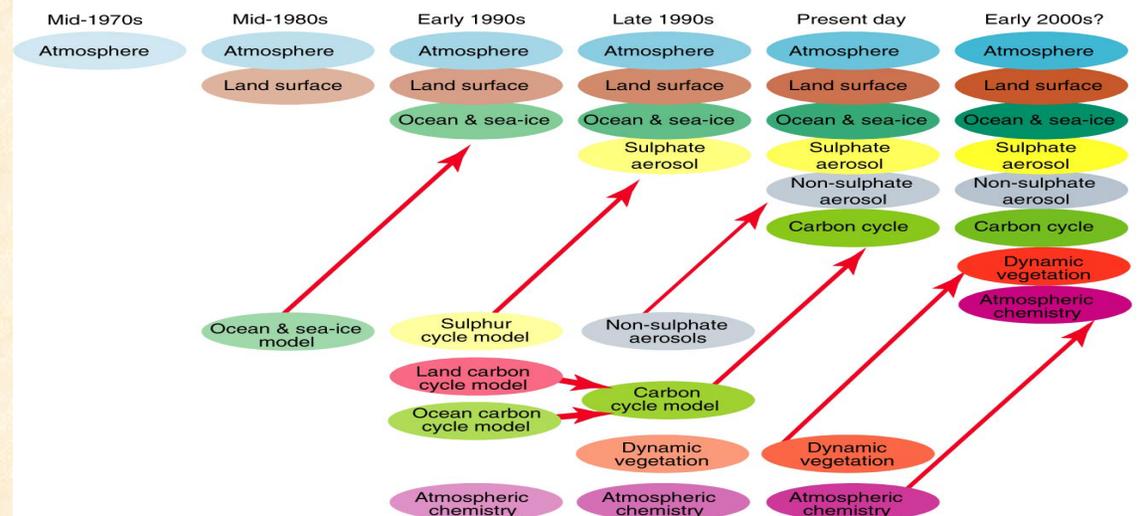
Vince Wayland

John Weatherly

Albert Semtner

William Kellogg

The Development of Climate models, Past, Present and Future





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SciDAC

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DO E
L BNL

Pacific Northwest
Los Alamos
Nat'l Center of Atmo. Res.
Argonne
Lawrence Livermore
Oak Ridge
Department of Energy
Lawrence Berkeley



Data Assimilation Office

DOE, NSF and NASA working
together to build the
Community Climate System Model

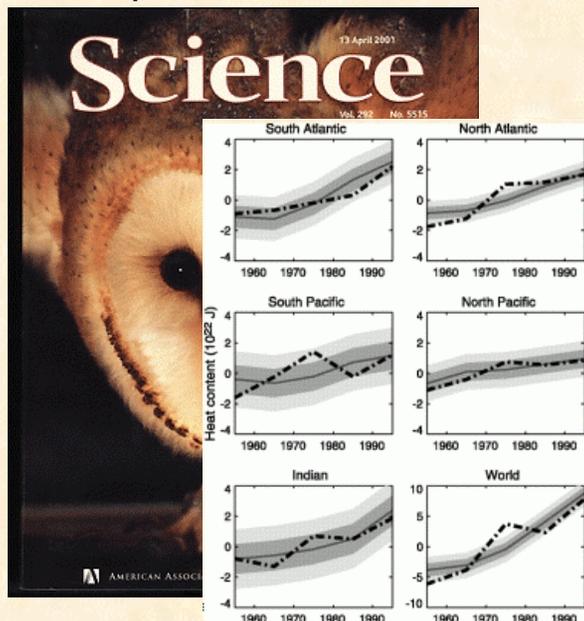
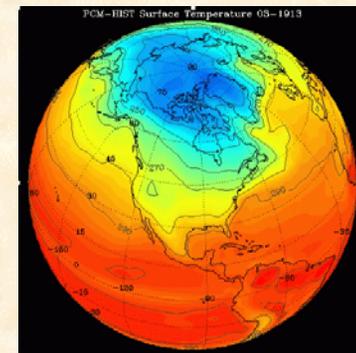


Climate Simulation with PCM

Method: Ensemble simulations of the DOE Parallel Climate Model (PCM)

Results:

- Detection of Anthropogenic Climate Change in the Worlds Oceans
- Ensembles establish 95% confidence intervals of model predictions
- Simulated ocean heat storage matches historical record of rising ocean temperatures



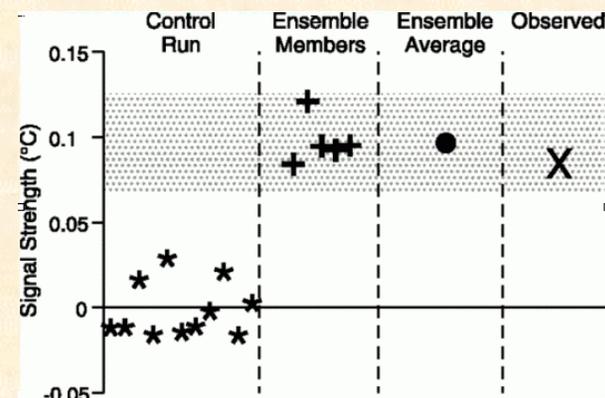
Science 13 April 2001: "Detection of Anthropogenic Climate Change in the Worlds Oceans," Barnett, Pierce, Schnur

Firsts:

- Coupled model reproducing ocean response
- Establishing new level of US model quality

Enabling Technology:

- Parallel Climate Model developed in collaborative effort lead by Warren Washington (NCAR)
- Component model development of NSF, DOE
- Terascale computing resources



How Many Terabytes of PCM Output?

- IBM, Compaq, Clusters at NCAR, NERSC, ORNL, San Diego, Pittsburgh -----all running PCM
- PCMDI Archive contains >3600 years of coupled simulation



In Conclusion

- **We should take notice of all that Warren has done to advance climate change as a scientific endeavor**

