Climate, Climate Change Nuclear Power and the Alternatives

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PHYC 40050

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Lecture 6

EdGCM

A Global Climate Model for Research and Education

The EdGCM Cooperative Project, Columbia University

Support provided by: NSF Paleoclimate Program and NASA High-Performance Computing Program

Ed GCM Project Goal

To improve the teaching and learning of climate change science by providing the education community with access to:

1) A research quality global climate model (GCM)
2) A user-friendly interface to operate the GCM and organize the results
3) Educational materials to make the GCM a useful tool for learning about the climate system

*What is Ed*GCM?

***Ed*ucational *G*lobal *C*limate *M*odel**

- A Global Climate Model
- Computer-based modelling program
- Relational Database
- Graphical User Interface
- Post-Processing Software
- Scientific Visualization Tools (EVA)
- Software for constructing scientific manuscripts and publishing them to the web.

What is a GCM?

General Circulation Model
Global Climate Model

And why should we be interested in it?

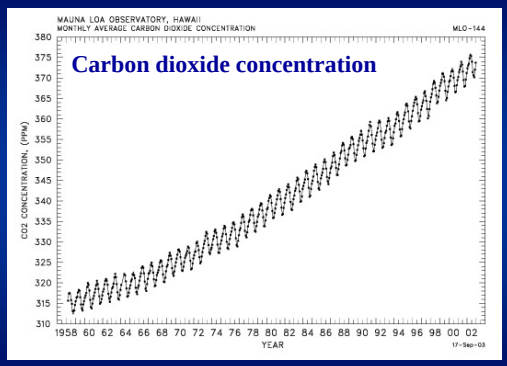
Climate change is in the news

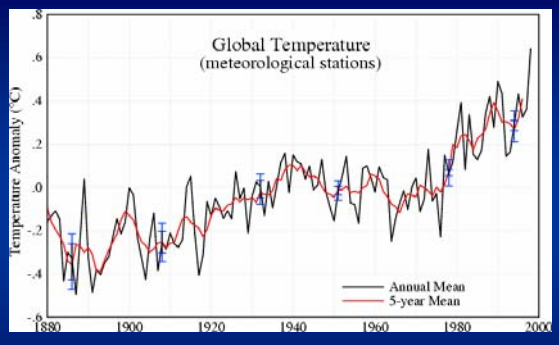
It's in the science news!

CAUSE ⟶ **EFFECT**

Recent Climate Change:
Observed forcings and results.

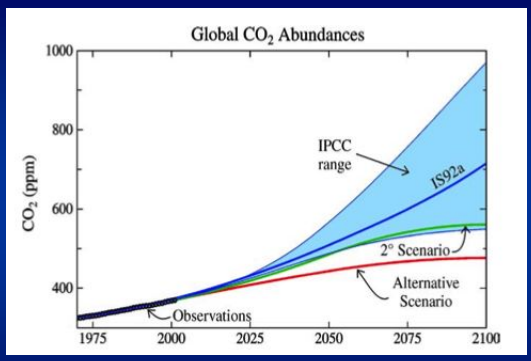
The Keeling curve (Charles Keeling)





CAUSE ⟶ **EFFECT**

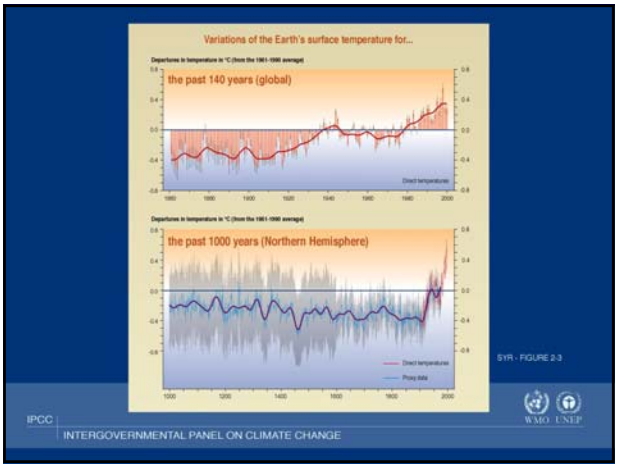
Future Climate Change:
Uncertainty of forcing.



Hansen, 2004

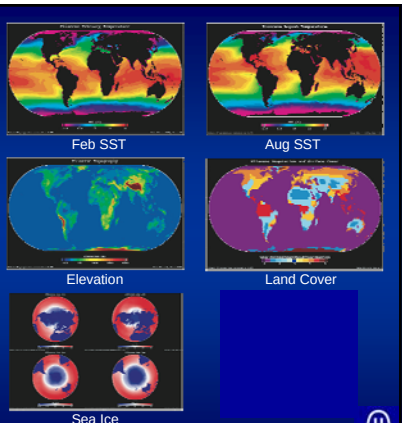
CAUSE ⟵ **EFFECT**

Past Climate Change:
Observed results. Uncertain forcings.

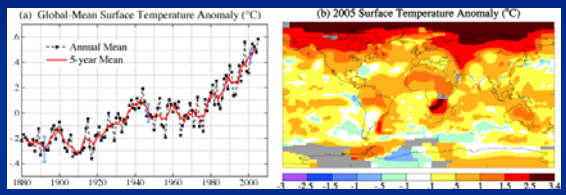


Pliocene
Research,
Interpretation
and
Synoptic
Mapping

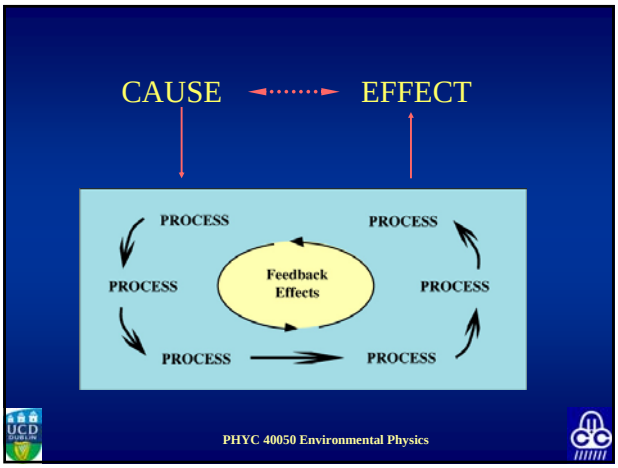
PRISM



2005 - Warmest Year on Record



http://data.giss.nasa.gov/gistemp/2005/



Climate Sceptics (from BBC website)

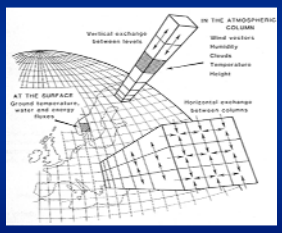
While I am prepared to accept that there may be global warming, nothing I have seen shows a causal connection. Tim, UK

One of the most persistent arguments made by those who do not believe that climate change is caused by human activity is that there is "no consensus" amongst climatologists about this. Tim Dennell, Sheffield, United Kingdom

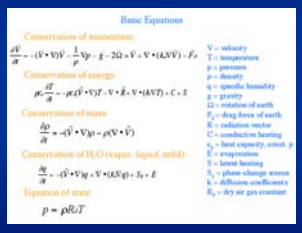
Five hundred years ago the scientific consensus was that the world was flat. Thirty years ago, we were about to enter another ice age. Twenty years from now we will all have a good laugh about "global warming". Thumper31

The GCM in EdGCM: GISS Model II

Cartesian Grid General Circulation Models

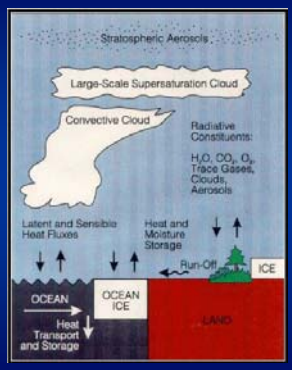


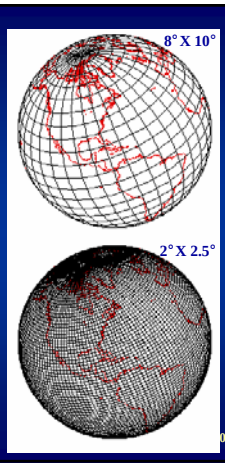
(Henderson-Sellers, 1985)

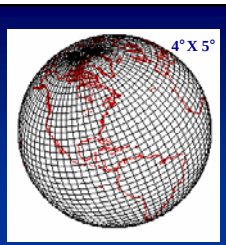


(Hansen et al., 1983)

Climate Model Parameterizations

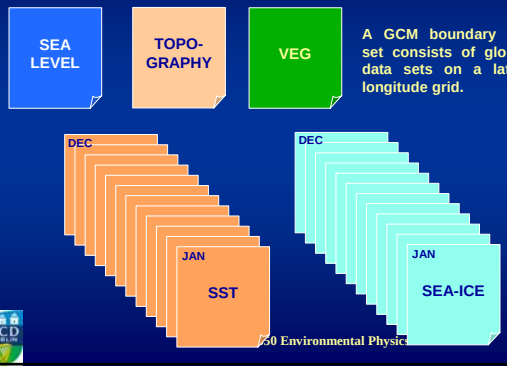






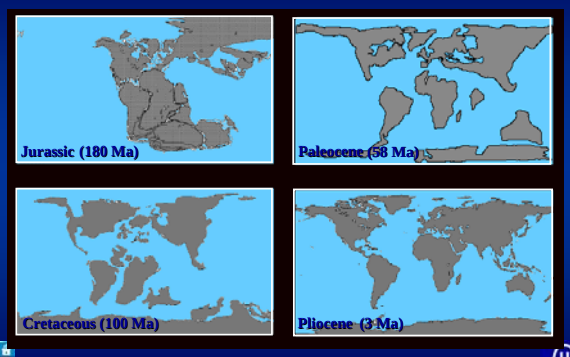
GISS Global Climate Model Grid Resolutions

GCM Boundary Condition Data Files



A GCM boundary condition set consists of global scale data sets on a latitude by longitude grid.

Paleogeography Throughout Earth History



Prescribed Climate Forcings

- Solar Luminosity
- Orbital Parameters
- Radiatively Significant Trace Gases
- *Volcanic Aerosols*
- *Other Natural and Anthropogenic Aerosols*

Ed GCM Project Objectives

1) Allow teachers to run a NASA global climate model on a desktop computer, ***encouraging students to participate in the full scientific process*** including: experiment design, running simulations, analyzing data and reporting results.

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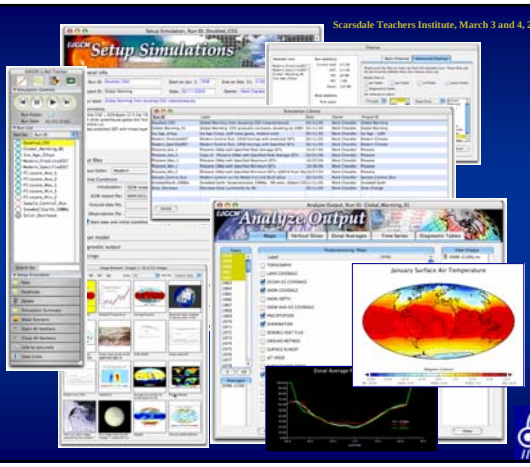
2) Facilitate collaborations between the education community and research institutions and among universities. In this way, ***students will become familiar with the role that teamwork plays in scientific research.***

Scientific Research Involves Teamwork

Organizing and Designing Scientific Experiments

Step 1: Setting Up Climate Model Simulations

```
Snowball_sim2.R  Model II 8/24/2000

Owner: Dr. Mark Chandler, chandler@giss.nasa.gov
Group: Paleoclimate Group
This experiment simulates a time period approximately 600 million years ago. There is
evidence that a "super" ice age occurred that effected even tropical continents. Did the
Earth freeze over entirely???

Object modules:
MainC9
DiagC9
RadC9
FFTC9
UTILC9

Data input files:
7=G8X10_600Ma
9=NOV1910.rsf_snowball
15=O8X10_600Ma
17=
25=Modern_OceanTransports
19=CO8X10_600Ma
23=V8X10_600Ma
26=Z8X101_600Ma
21=RTAU.G25L15
22=RPLK25
29=Snowball_Earth_Regions

Label and Namelist:
Snowball_sim2 (Snowball Earth Experiment: 600 million years ago)

 &INPUTZ
  TAUI=10176.,IYEAR=1900,
  KOCEAN=1, SRCOR=.95485638151,
  S0X=1.,CO2=.31746031746031,
  USET=0.,TAUE=35040.,
  USESLP=-12.,
  ISTART=3,KCOPY=2,NDPRNT=-1,TAUE=10177.,TAUP=95616.,
 &END
```

Analyzing the Results of Scientific Experiments

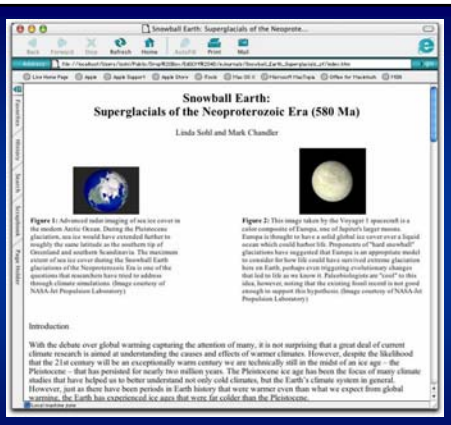
Step 2: Post-processing of raw GCM output

Step 3: Visualization of climate model variables

Reporting Results of Scientific Experiments

Step 4: Generating scientific-style manuscripts

Step 5: "Publishing" and presenting results



The EdGCM website is a focal point for collaborations, which will allow for:

- **Downloads of EdGCM software, materials, and updates**
- **Simulation exchanges**
- **Discussion groups**
- **A location to publish results**
- **Development work**
- **News, EdGCM Excercises, and Community Showcases**

A Few Final Points

1. EdGCM is designed to support a broad range of National and State Science Education Standards

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   - Technical manual
   - Software downloads
   - Quicktime video tutorials - coming soon

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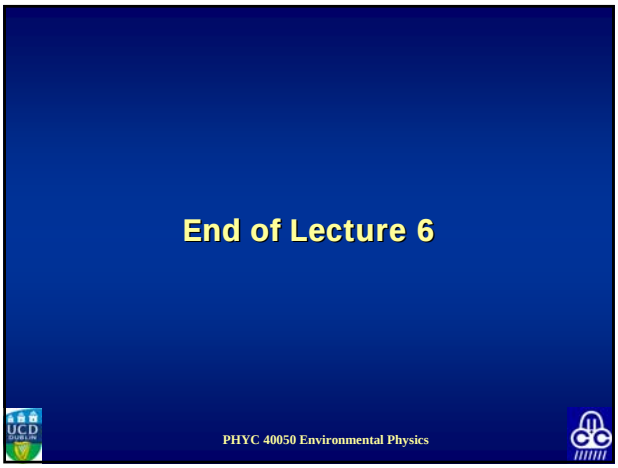
3. Information Resources and Educational Materials
   - Electronic Support Forums
   - Frequently Asked Questions Guide
   - Community Showcase
   - Simulation and eJournal Exchanges
   - Climate Science in Action - EdGCM Excercises

http://edgcm.columbia.edu


End of Lecture 6
PHYC 40050 Environmental Physics