

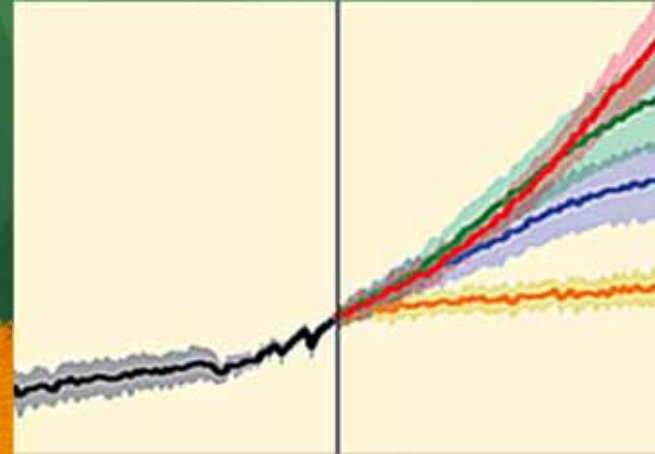


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NASA/UCAR: Predicting Future Climate and Considering Solutions

Presented by: Dr. Lisa Gardiner

Wednesday, April 28, 2010



Predicting Future Climate and Considering Solutions

A web seminar for the NSTA community
By the UCAR Office of Education and Outreach,
with support from NASA.

Overview

- What is a climate model?
- Future predictions of climate and the role of the IPCC
- Two online interactives:
 - *The Very, Very Simple Climate Model*
 - *Energy Choices and Climate Change*
- The path towards sustainability
 - *Watch Where You Step*, an activity from Facing the Future

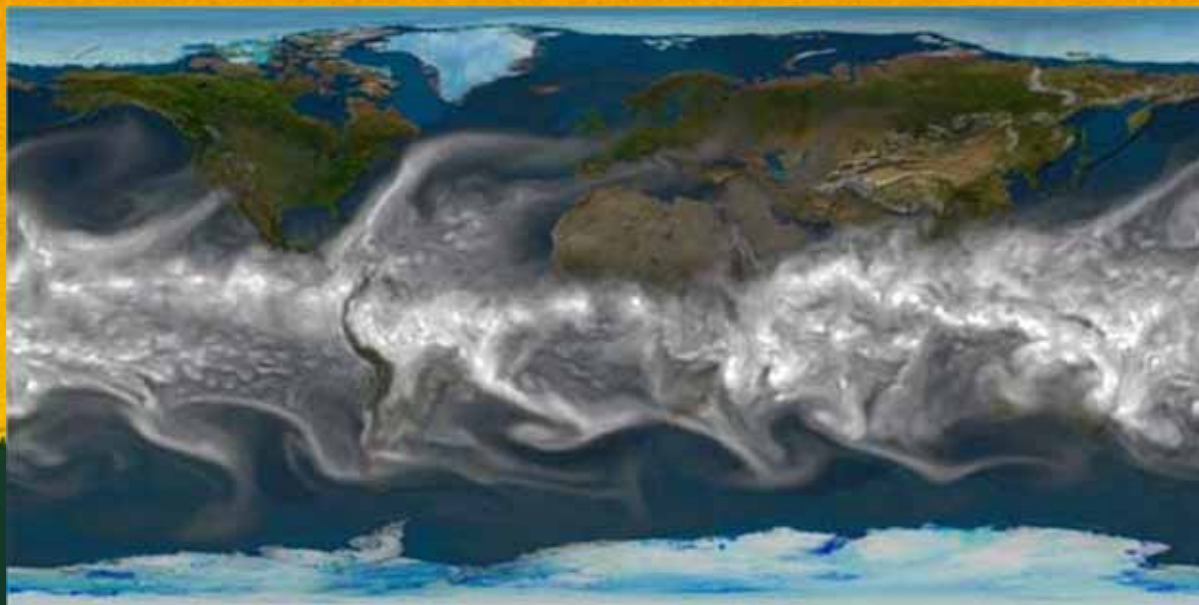


Presenter:
Dr. Lisa Gardiner
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UCAR
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and Outreach





What is a climate model?



The Earth is a System



Parts of the Earth System



Air



Water



Life



Land



Ice

- The **atmosphere** (air) extends from the Earth surface for several hundred km.
- The **hydrosphere** (water) includes the ocean, rivers, lakes, groundwater, vapor.
- The **biosphere** (life) includes bacteria, protists, plants, and animals.
- The **geosphere** (land) includes minerals, rocks, molten rock, sediments, soils.
- The **cryosphere** (ice) includes snow, glaciers, and sea ice.

How does a climate model describe the Earth system?



- Global climate models use mathematical equations to describe the behavior of factors that impact climate.
- Factors include
 - Atmosphere
 - Ocean
 - Land surface
 - Living things
 - Sea ice
 - Solar radiation

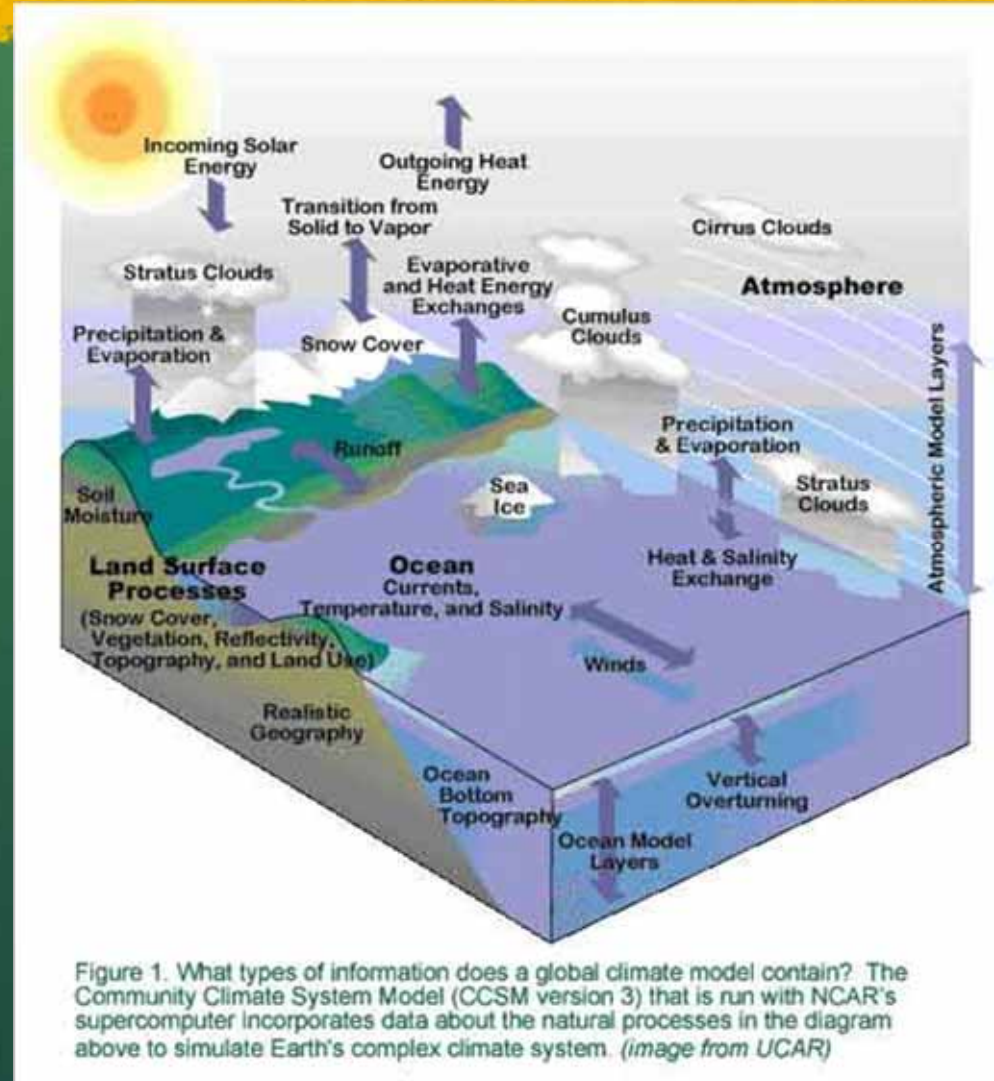


Figure 1. What types of information does a global climate model contain? The Community Climate System Model (CCSM version 3) that is run with NCAR's supercomputer incorporates data about the natural processes in the diagram above to simulate Earth's complex climate system. (image from UCAR)

Supercomputers: Then and Now



NCAR Bluefire supercomputer has a peak speeds of more than 76 teraflops (76 trillion operations per second).



The Cray 1A (1970s – a computer you could stand within!

It had computing power similar to a cell phone today.

Model resolution



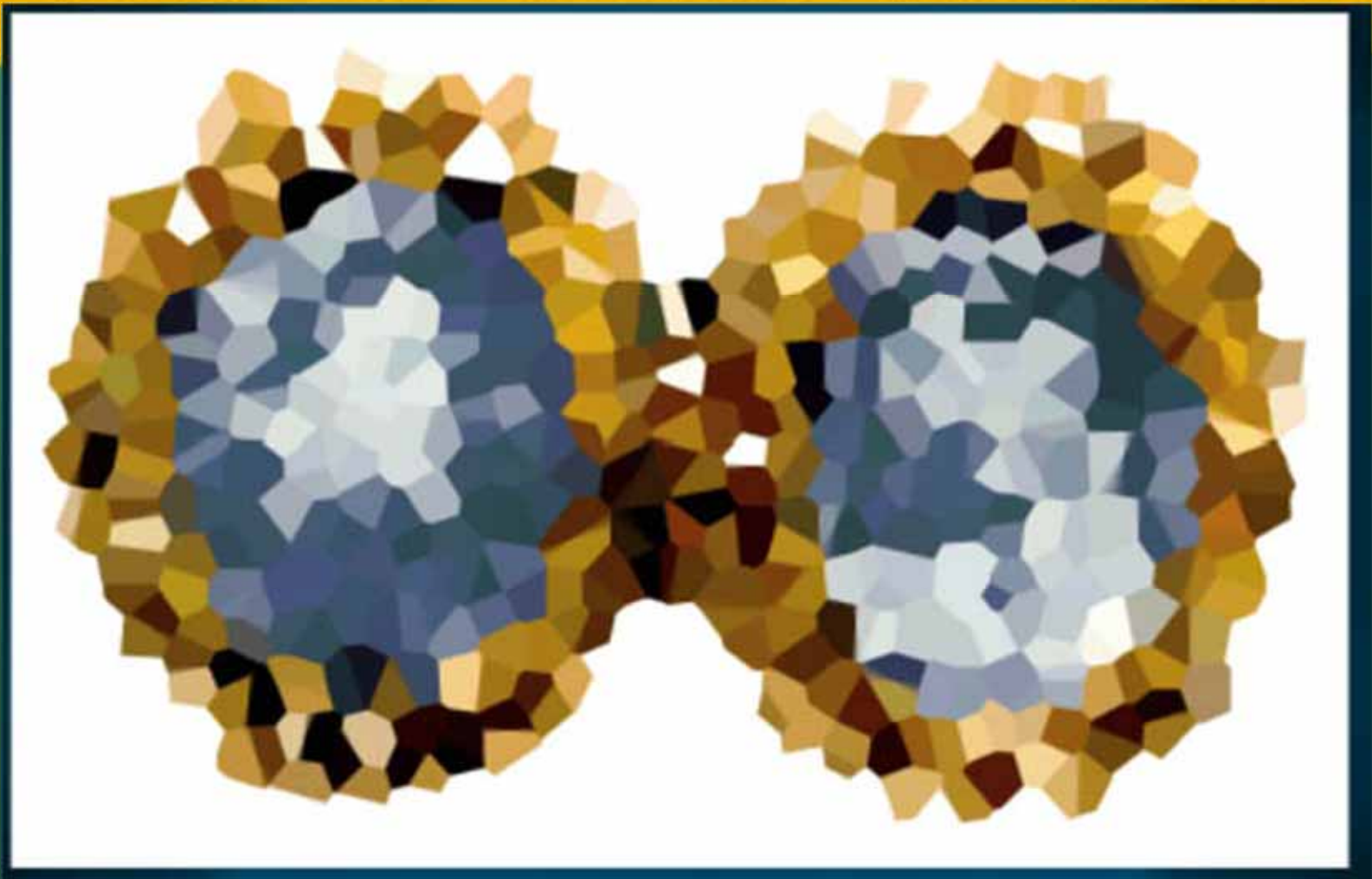
- High resolution models are more detailed, and take tremendous computing time.
- Low resolution models are less detailed, and take less computing time.
- As super computers have become faster, climate models have gotten higher in resolution.

What is this a picture of?



- Low resolution image

Can you tell what this is now?



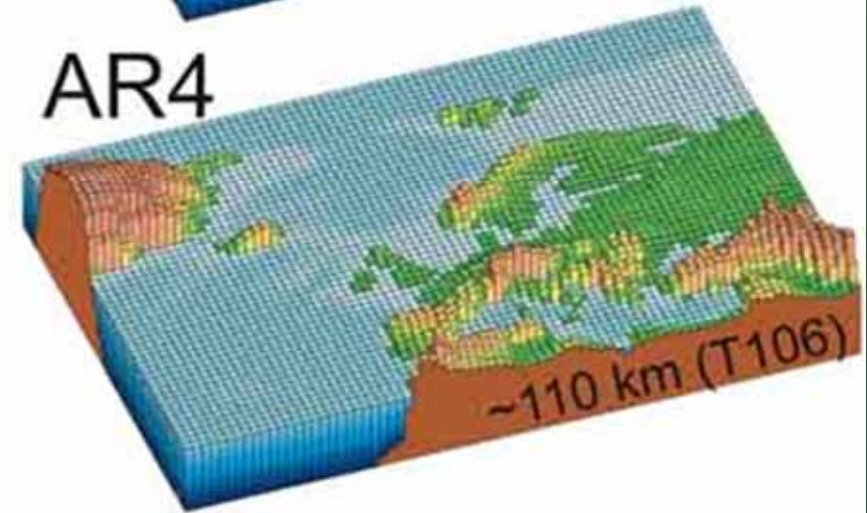
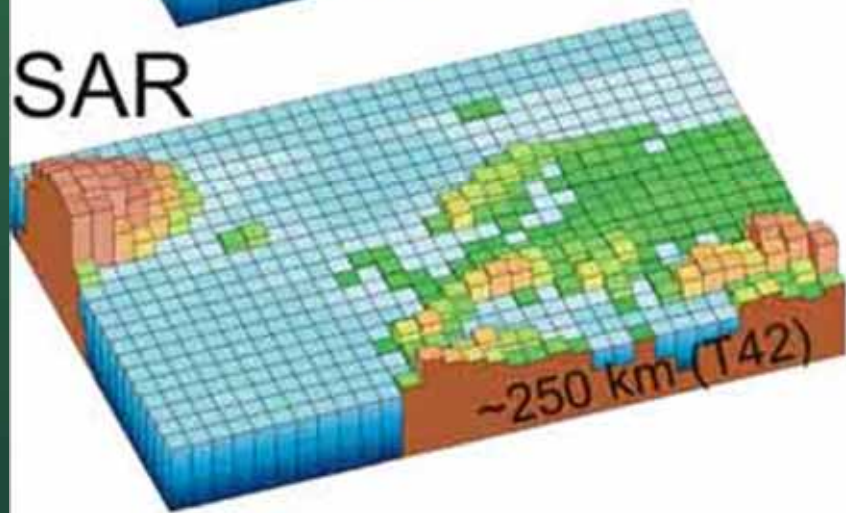
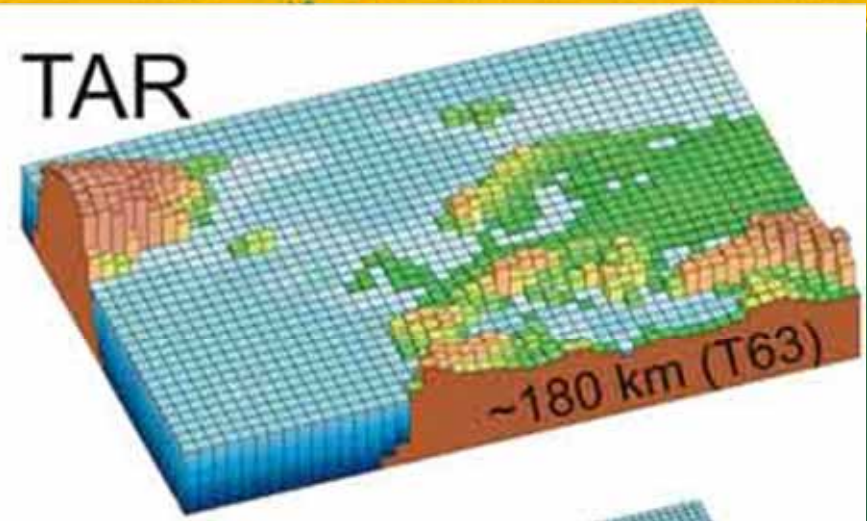
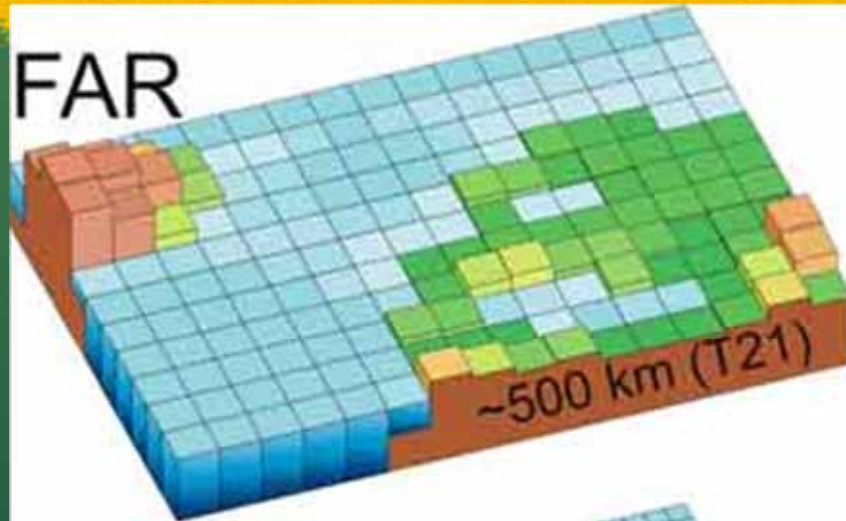
- Medium resolution image

How about now?

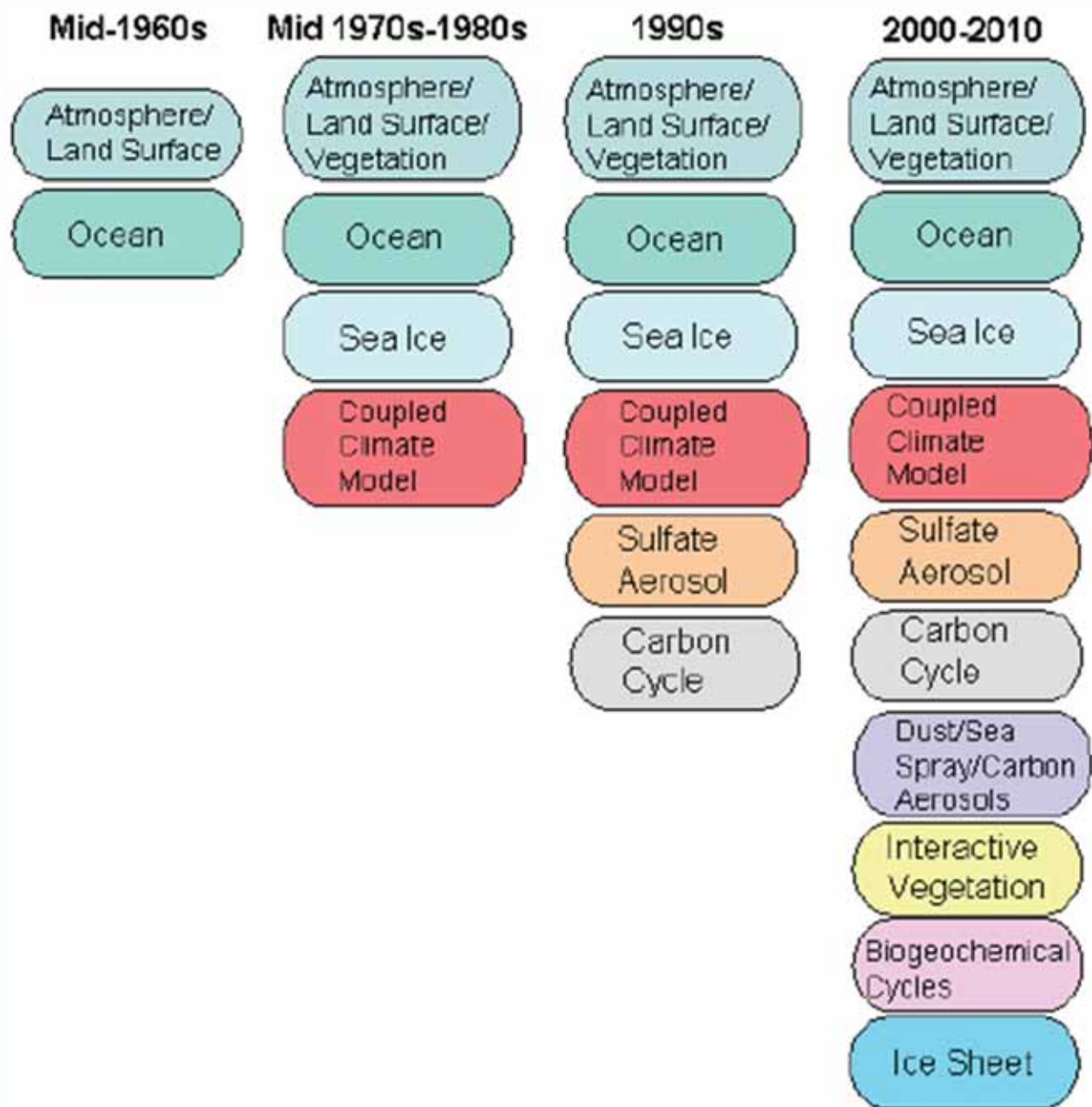


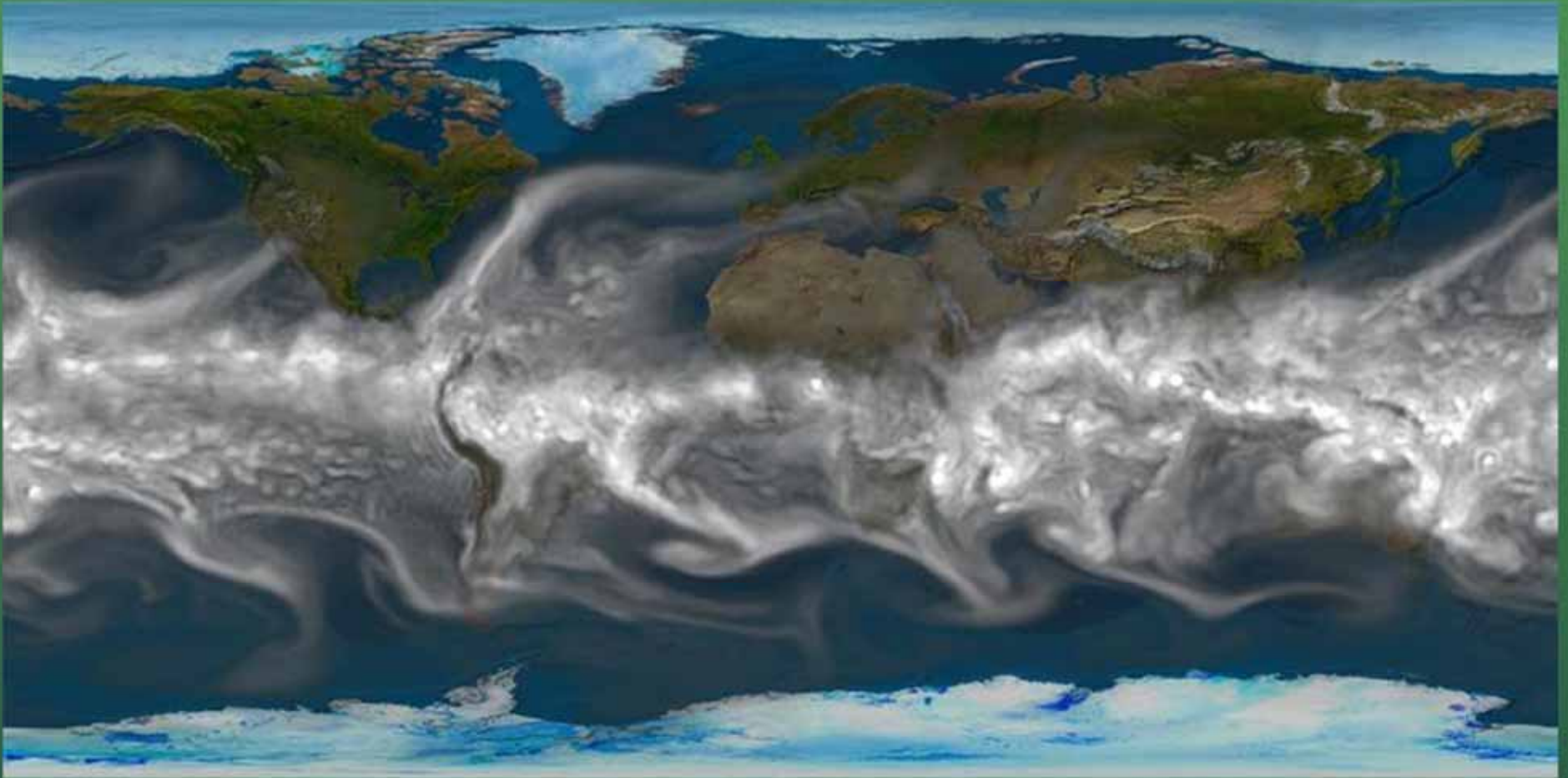
- High resolution image

Climate model resolution has increased
as computing speed has increased



Timeline of climate model development

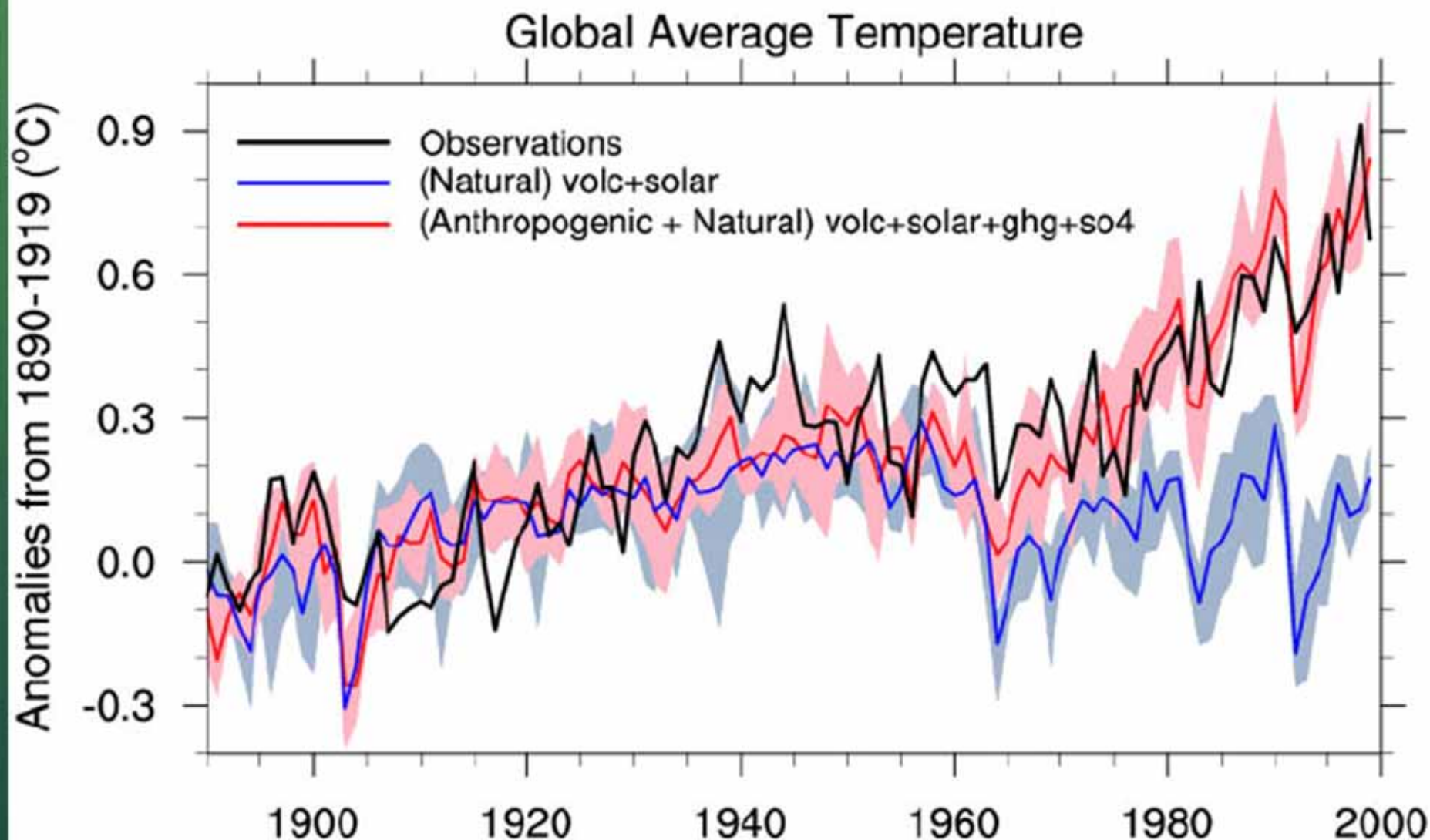




Example from a model of the Earth system:
The distribution of water vapor in the atmosphere at one moment in time during a climate simulation by the NCAR-based Community Climate System Model (CCSM).

<http://www.vets.ucar.edu/vg/T341/index.shtml>

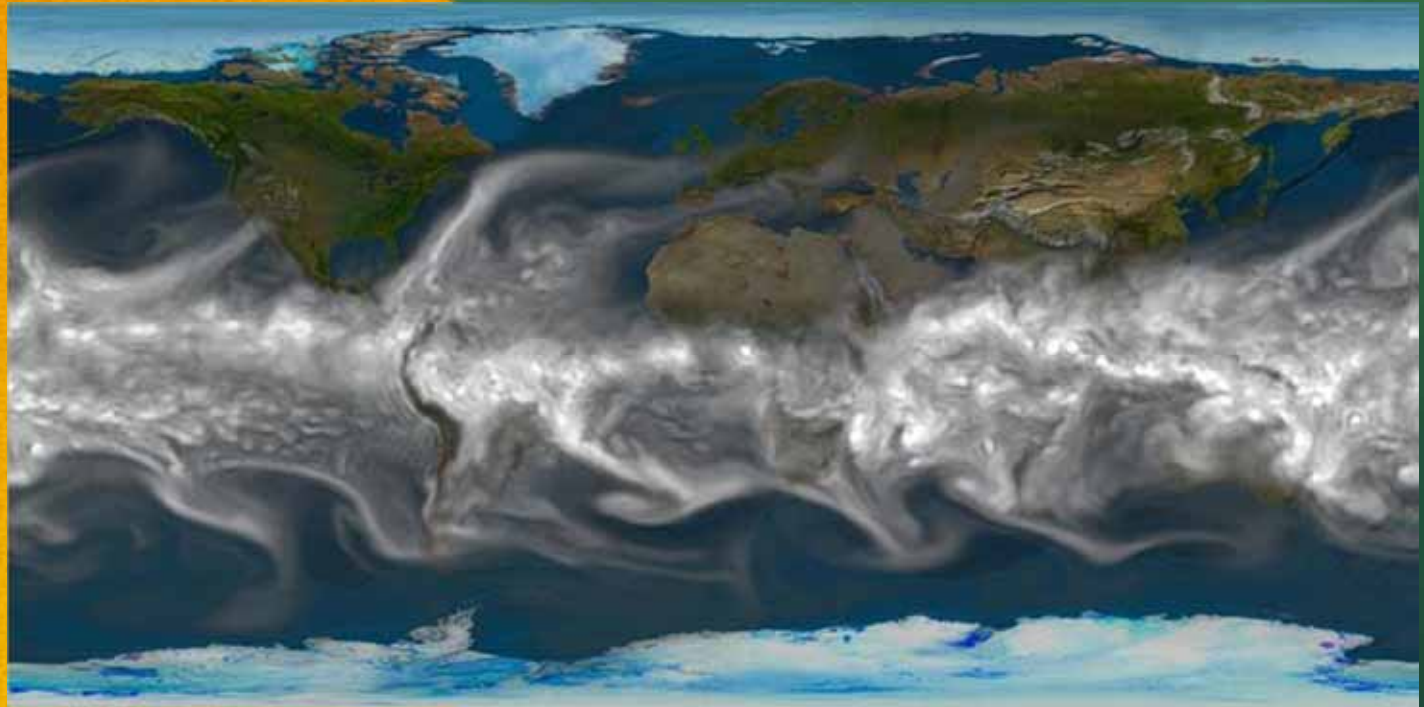
Simulation of 20th Century Warming



(Image: Meehl et al., 2004)

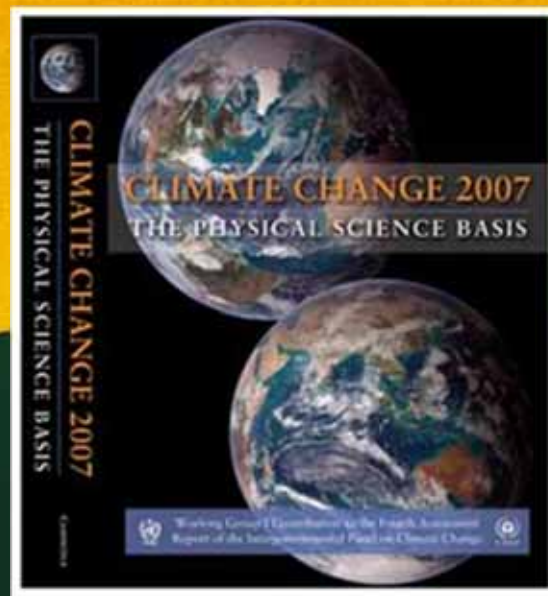


Questions?

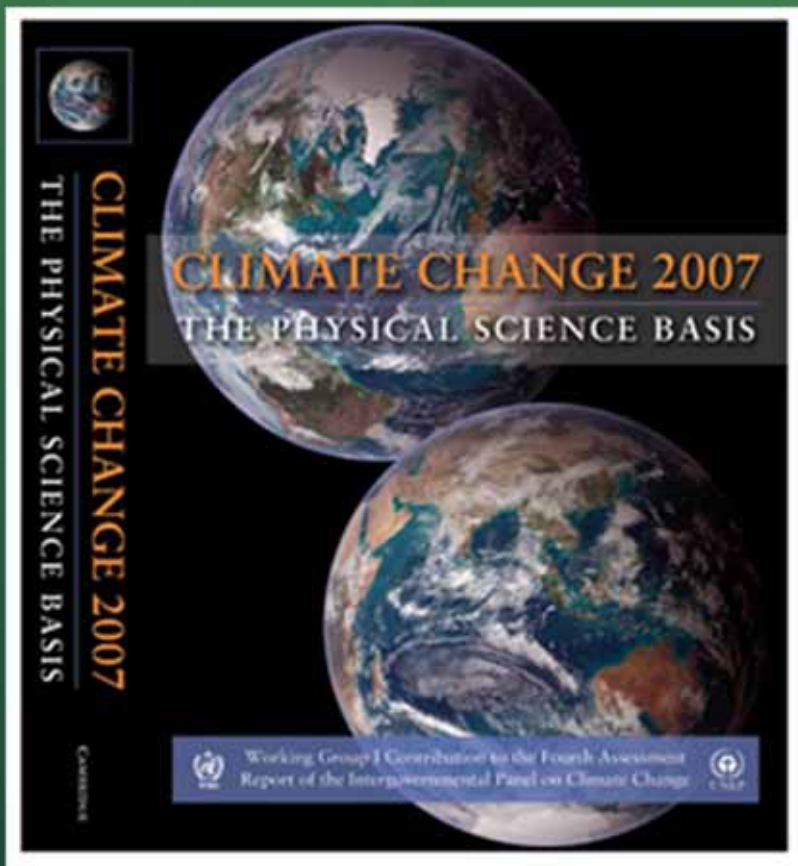




Future predictions of climate and the role of the IPCC



What is the Intergovernmental Panel on Climate Change?



- The IPCC, as it is known for short, is an international group that includes hundreds of climate scientists and government representatives.
- Every few years, IPCC scientists review our current state of understanding about climate: what we know and how certain we can be.

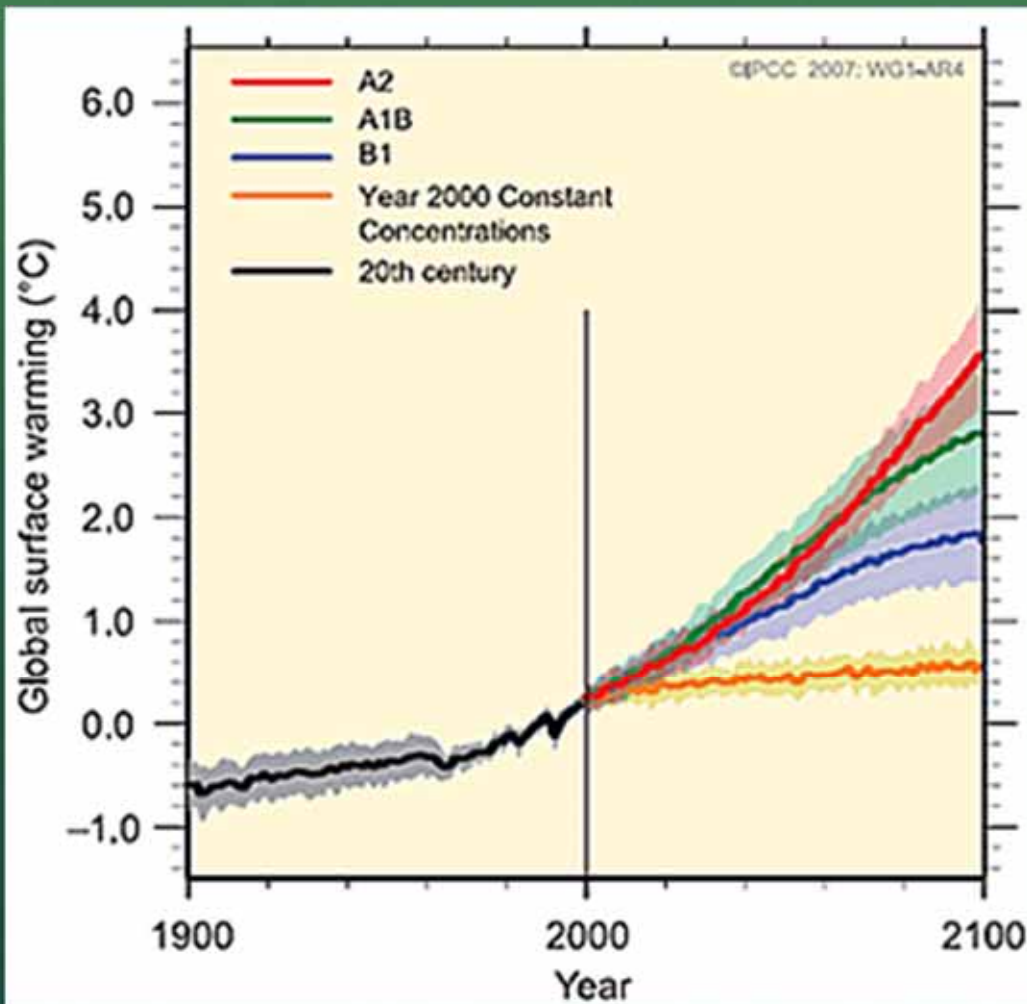
In predicting future climate, the largest unknown is...us.



- **A1B:** Rapid growth of technology and economies, but population grows slowly. There is less disparity between developing and developed countries.
- **A2:** Economies grow but there is more disparity between developing and developed countries. Energy use is high and population is growing rapidly.
- **B1:** Development is sustainable, deforested land is planted with trees, human population grows slowly, and energy use is low.

	Economic growth	Population growth	Energy use
A1B	Rapid	Slow	Moderate
A2	Moderate	Fast	High
B1	Moderate	Very slow	Low

Predictions of 21st Century Climate (according to the IPCC, 2007)



Temperature change as compared with 1980-1999 average, used as a baseline.

(The results of several climate models have been averaged in this graph.)

Movie: Climate Model Visualization



http://www.vets.ucar.edu/vg/IPCC_CCSM3/index.shtml

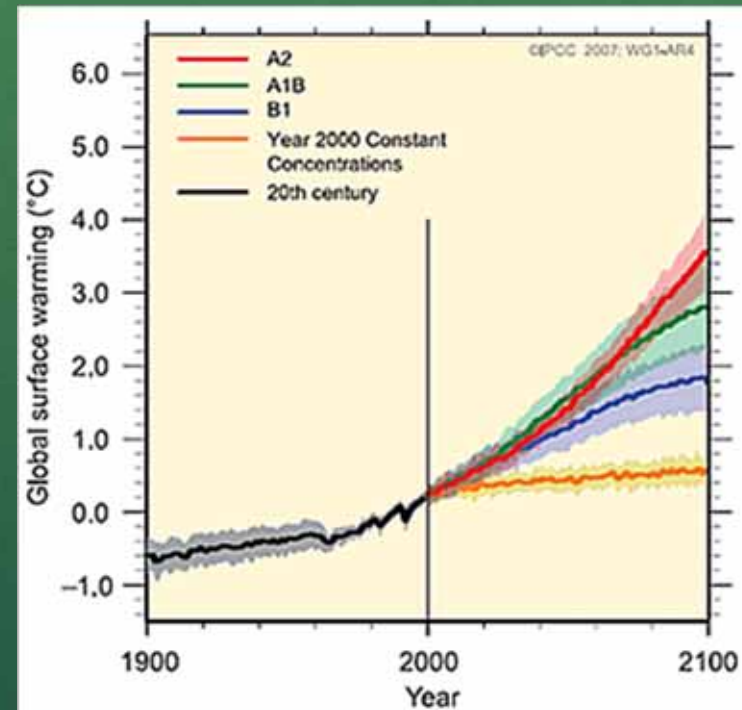
(Climate Change Simulation by NCAR CCSM model, ~3 min)

What did you notice?

- A. Climate is going to get warmer according to this model.
- B. Volcanic eruptions effect climate for two generations.
- C. There is only one possibility for warming in the 21st C.
- D. All areas of the planet will warm equally over time.



Questions?



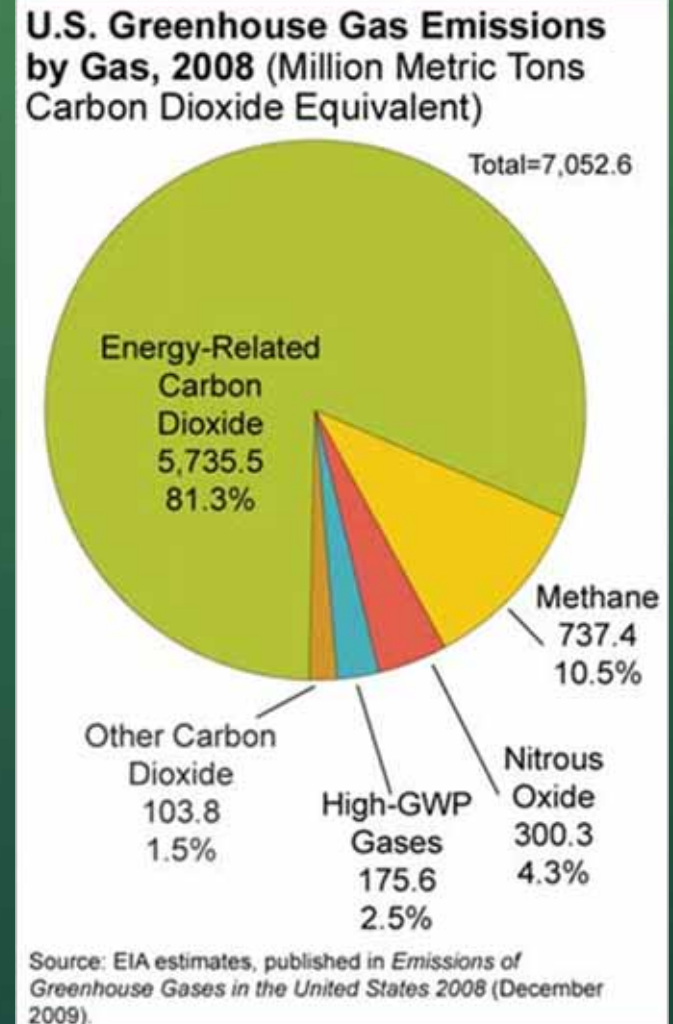


The Very, Very Simple Climate Model
and
Energy Choices and Climate Change
- two online interactives -

The relationship between energy and greenhouse gases



- Some sources of energy add greenhouse gases into the atmosphere. Others don't.
- Greenhouse gases emitted:
 - **Carbon dioxide and nitrous oxide** are released during fossil fuel combustion
 - **Methane** is released during coal mining and petroleum refining (as well as farming)



Try it #1!

The Very, Very Simple Climate Model

http://www.windows2universe.org/earth/climate/cli_model.html

Directions:

1. Set **CO₂ emissions rate**: Amount of CO₂ released per year
2. Set the **Timestep** depending on how far you want the model to jump ahead at each step.
3. Click “**Step Forward**” several times to see how temperature and CO₂ change over time.
4. Report the approximate CO₂ concentration and temperature your model shows for the year 2100 in the chat.

Energy sources that emit greenhouse gases when burned



- **Fossil fuels**

- Coal
- Petroleum (oil)
- Natural gas



- **Biofuels**

- *(however, biofuels are renewable and take CO₂ out of the atmosphere when re-grown.)*

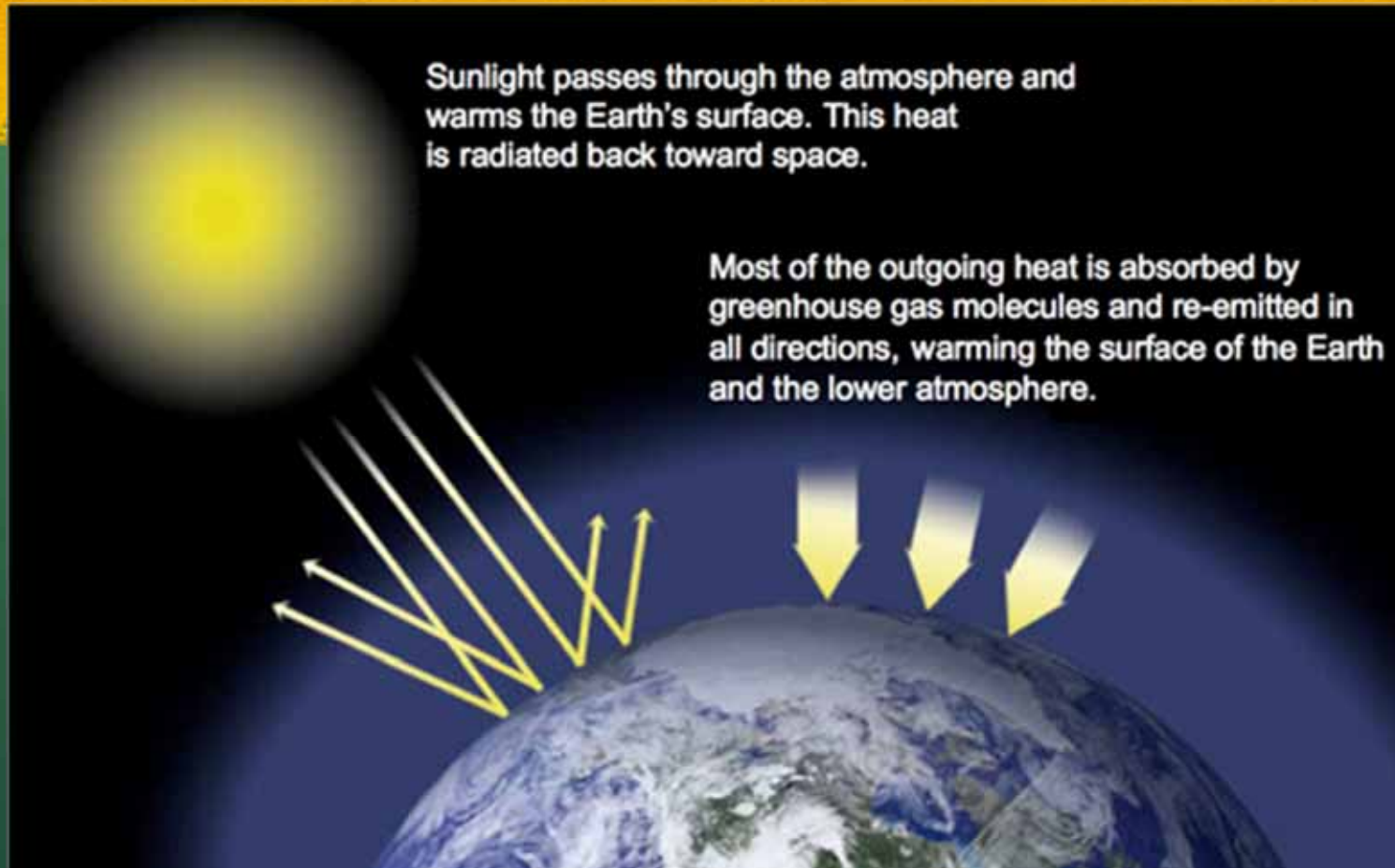


Energy sources that do not emit greenhouse gases into the atmosphere

- Renewable energy
 - Wind
 - Solar
 - Waves/hydropower
 - Geothermal
- Non-renewable
 - Nuclear (creates other waste)



Greenhouse gases trap heat.



- Greenhouse gases are a natural part of the atmosphere.
- The amount is now high due to emissions by humans.

Energy Choices and Climate Change an online module from NCAR/UCAR



- In the module, you make decisions about the types and amount of energy used.
- See what effect decisions have on the amount of greenhouse gases emitted to the atmosphere.
- Goal: reduce the amount of greenhouse gases added to the atmosphere from fossil fuel emissions while keeping costs within reason.

<http://www.windows2universe.org/modules/energy/>

Exploring the module

How do the choices we make about energy affect CO₂ emissions?

Dive into one of the two module scenarios to explore this question!





Scenario: The Joules Family

Your goal:

Choose how to change the way a hypothetical family uses energy at home and for transportation with the aim of reducing the family's carbon dioxide emissions while keeping costs less than long-term savings.





Scenario: Ruler of the World

Your goal:

Make decisions about the mix of energy sources that will be used worldwide with the aim of reducing emissions and meeting global energy demand while monitoring costs and societal implications.

Module Features



- **Scenario tabs:** Users click through tabs that describe a scenario and allow them to make choices about energy use.
- **Background information:** Additional information about energy can be found in the the accordion tabs at the right.
- **Dashboard:** Meters at the top of the screen show how choices affect GHG, money, energy use, and other factors.

DASHBOARD
keeps track of how changes affect CO2 emissions and other factors

TABS
click each tab to make changes to energy use or fuel type in each category.

BACKGROUND INFORMATION
learn more about energy by browsing the information under each blue heading



Try it #2: The Joules Family

- The Joules family currently produces over 19,500 pounds of CO₂ heating and cooling their home.
- Cast your vote: Which saves the most energy?
 - A. Turn down the heat
 - B. Insulate and seal gaps
 - C. Move to a smaller home





Try it #3: The Joules Family

- Kelly drives an SUV that gets 14 mpg. In the past year, she's driven it 16,000 miles.
- Cast your vote: How can Kelly save the most gasoline?
 - A. Telecommute two days per week
 - B. Take the bus instead of driving
 - C. Carpool with a neighbor
 - D. Trade in the SUV for a more fuel efficient car



1 pound of carbon dioxide would fill...



61 gallon jugs



Questions?





The path towards sustainability: climate mitigation & adaptation

(Watch Where You Step from Facing the Future)

What can we do?

- We can try to adapt to changing climate
 - **Adaptation:** protecting people/places by making them less vulnerable to climate impacts
- We can try to slow or stop warming
 - **Mitigation:** slowing global warming by lowering levels of greenhouse gases in the atmosphere



Goal: keep Earth livable

Sustainability: meeting our present needs without compromising the ability of future generations to meet their needs



Brainstorm Examples

Adaptation

Mitigation

Choose the text tool and write in an answer on this slide.

Activity: Watch Where You Step

© *Facing the Future*



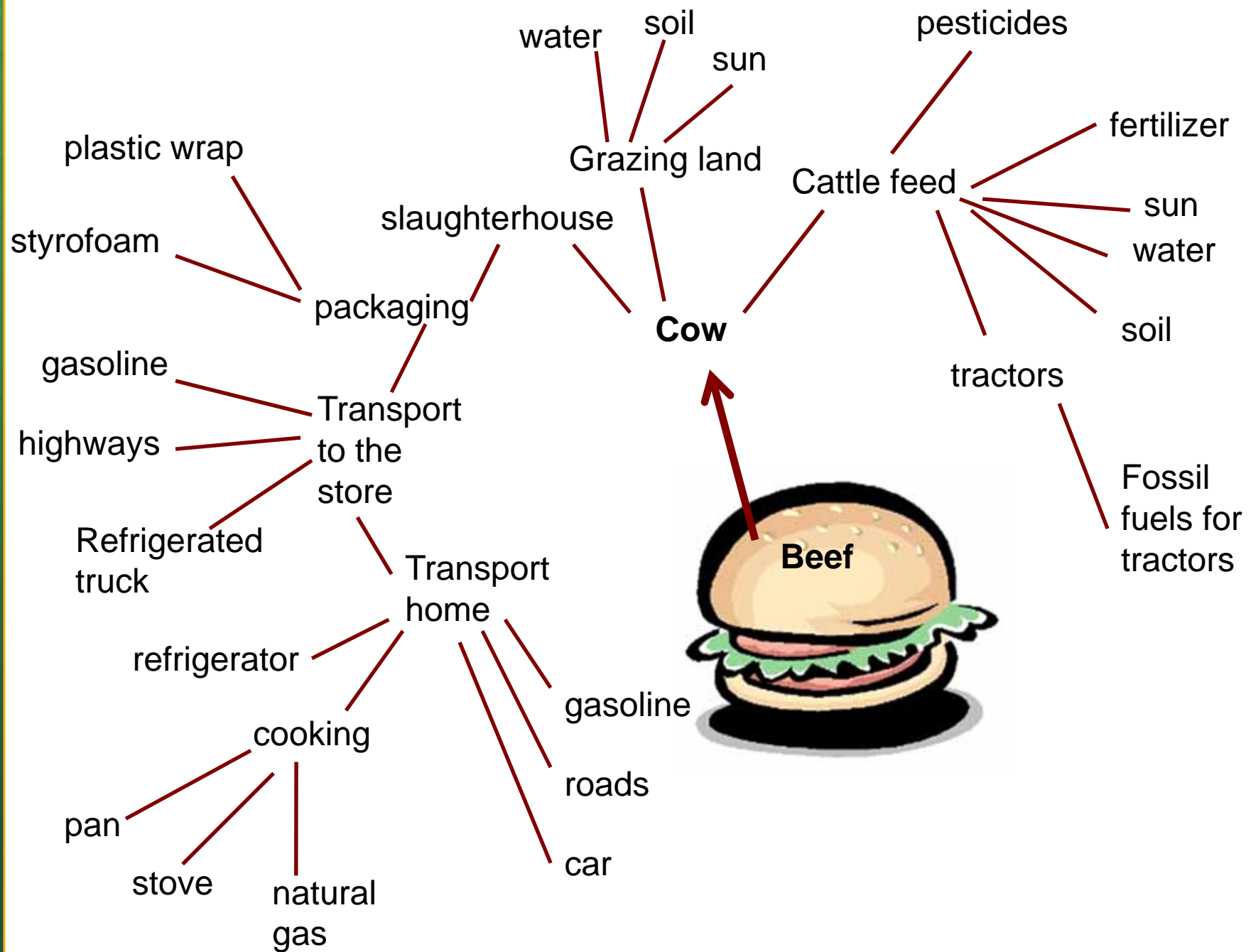
First, Choose:

- A Favorite Meal
- A Favorite Object
- A Piece of Clothing
- A Mode of Transportation



Then, Diagram:

- Resources needed
- Processes needed
- Impacts on the environment



Guiding Questions



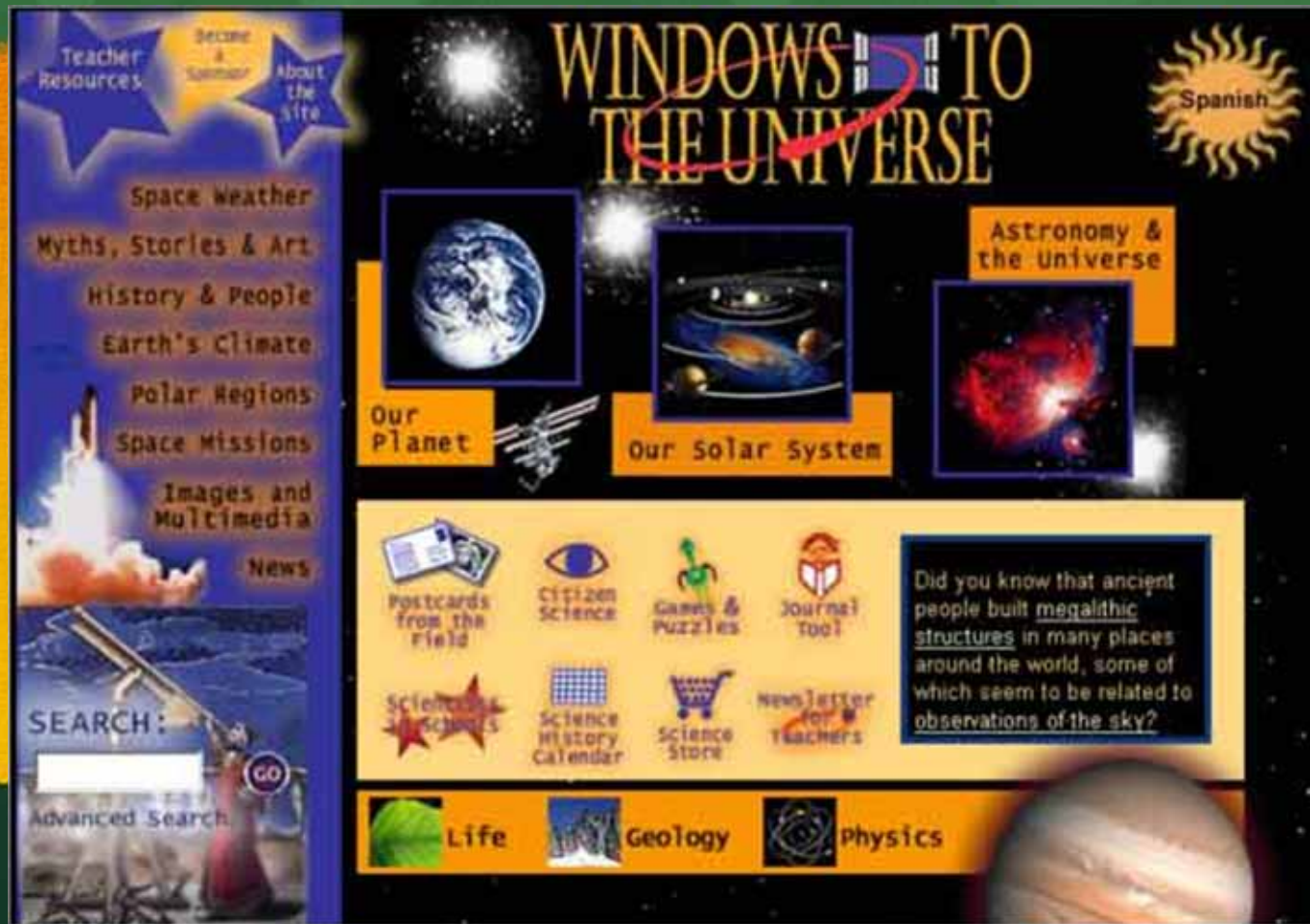
- What's it made of?
- What resources are needed to make it?
- What processes are needed to make it?
- Is transportation required?
- Are fossil fuels required?
- What are the possible impacts?



Questions?



Climate and Global Change on Windows to the Universe



<http://www.windows2universe.org>



Climate Discovery

A series of online professional development courses for middle and high school educators

CD 501 – Introduction to Climate Change

CD 502 – Earth System Science: A Climate Change Perspective

CD 503 – Understanding Climate Change Today

<http://ecourses.ncar.ucar.edu>

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Information

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Insights See All

181.1 ★★★★★
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See More

 **Web Seminar: Predicting Future Climate and Considering Solutions**
Time: 5:30PM Wednesday, April 28th
Location: (Time listed is Eastern Standard Time)

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