
GLOBE

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presentation materials for:

Elizabeth City State University

November 2011

Acknowledgments

a special thanks to:

Linda Bailey Hayden,
Center of Excellence in Remote Sensing Education and Research

Darnell Johnson,
School of Education and Psychology

and Elizabeth City State University

Background



- Gore at Vanderbilt University Divinity School 1971-72
- Goes to congress in 1977 as a representative from Tennessee

Image:

Earth from Apollo 17, 1972

Effects: Snow and Ice



Grinnell Glacier, Glacier National Park
1900 and 2008




Climate Questions

- What changes climate?
- Is it real?
- How do we know?
- Why should we care?
- How sure are scientists?
- What next—what can we do?



What Changes?



Sun's output
Earth's orbit
Drifting continents
Volcanic eruptions
Greenhouse gases



Incoming solar radiation

Reflected by cloud and atmosphere

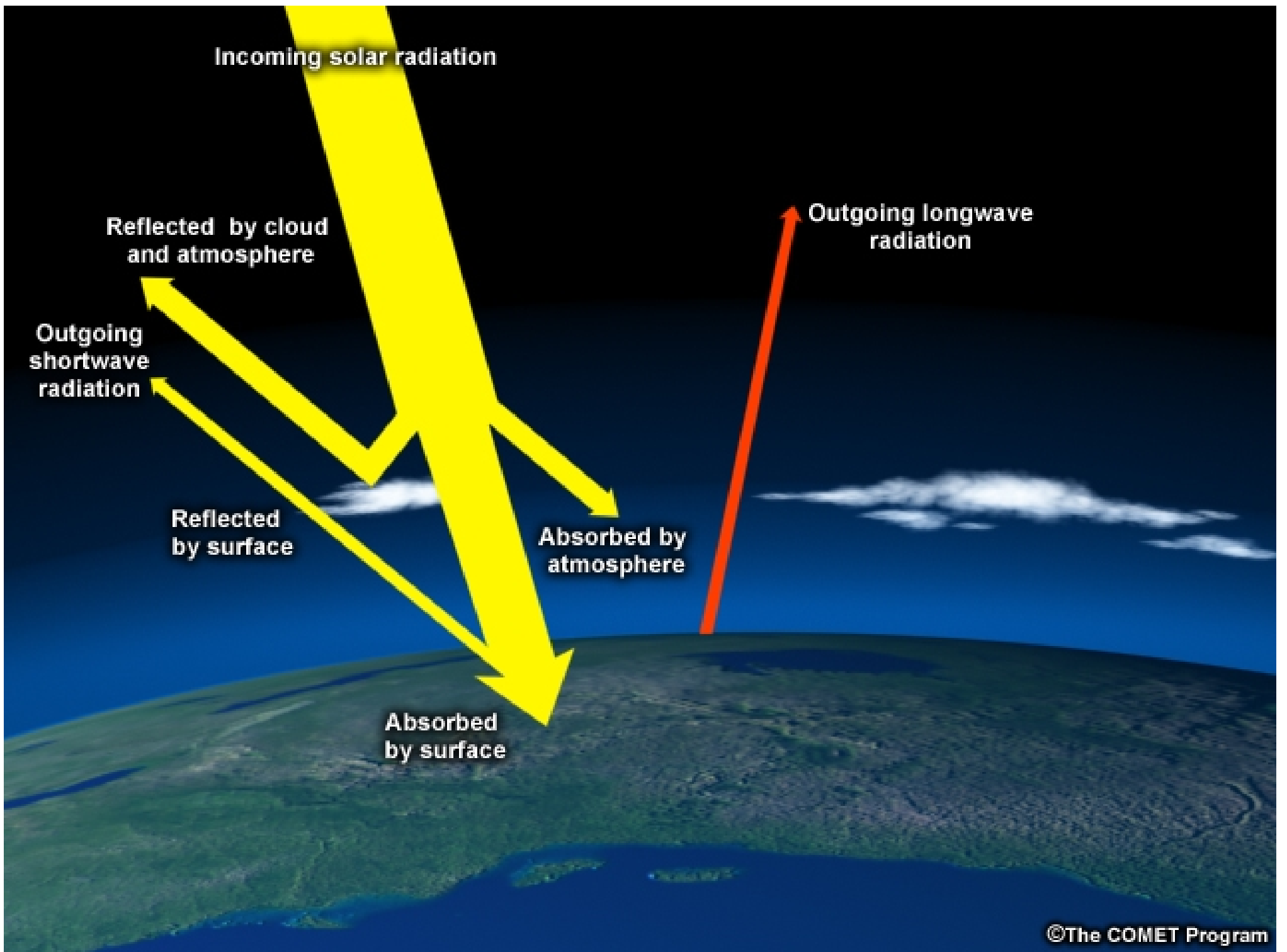
Outgoing shortwave radiation

Reflected by surface

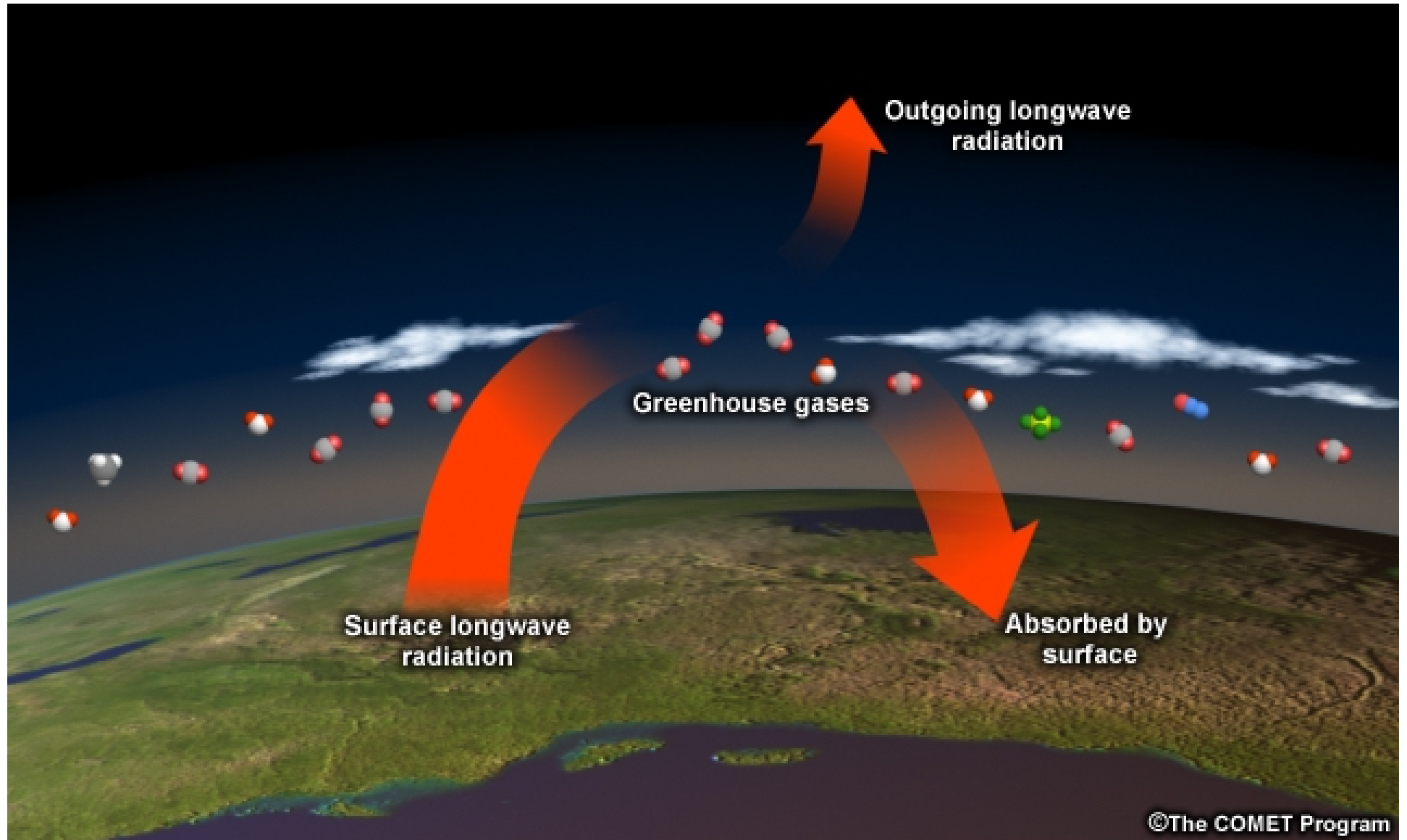
Absorbed by atmosphere

Absorbed by surface

Outgoing longwave radiation



Increasing GHGs Trap More Heat



Background

Global Learning and Observations to Benefit the Environment (GLOBE)

Al Gore

Earth in the Balance: Ecology and the Human Spirit 1992

"A Global Marshall Plan" pages 295-360

The basis for the GLOBE Program

diverse nations joined together
empowered by a common purpose
change its way of life

"the establishment of a cooperative plan for educating
the world's citizens about our global environment"

GLOBE Program

- National Aeronautics and Space Administration (NASA)
- National Oceanic and Atmospheric Administration (NOAA)
- National Science Foundation (NSF)
- U. S. Department of Education
- U. S. Department of State
- U. S. Environmental Protection Agency

GLOBE Program Office

- Administration
- International
- Science
- Education
- System

GLOBE Observations

Scientific protocols competed under NSF solicitations for unique observations only world wide students can make.

- Atmosphere/Climate
- Hydrology
- Soil
- Phenology
- Land Cover/Biology

GLOBE Education

Lessons developed by GLOBE and also contributed by an international group of environmental and Earth Science programs.

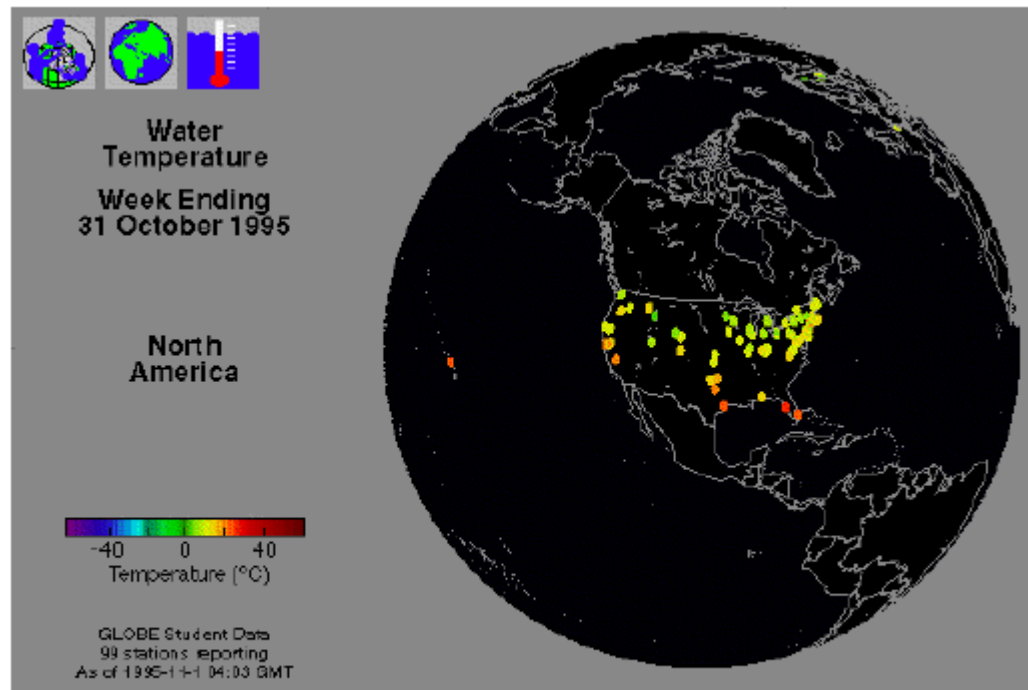
GLOBE System

- Data
- Visualization and Presentation
- Workstation Configuration/Software Application
- Network

Visualization Motivation

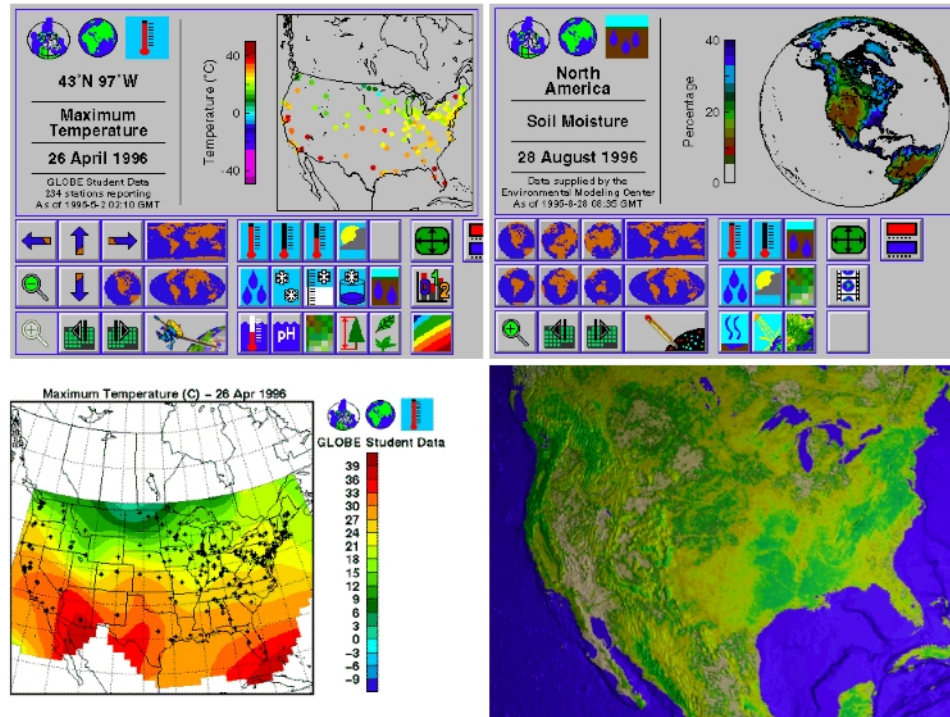
- Climate Change Mitigation
- Communicating Science to the Public
- Visualization of Earth and Planetary Data

Visualization



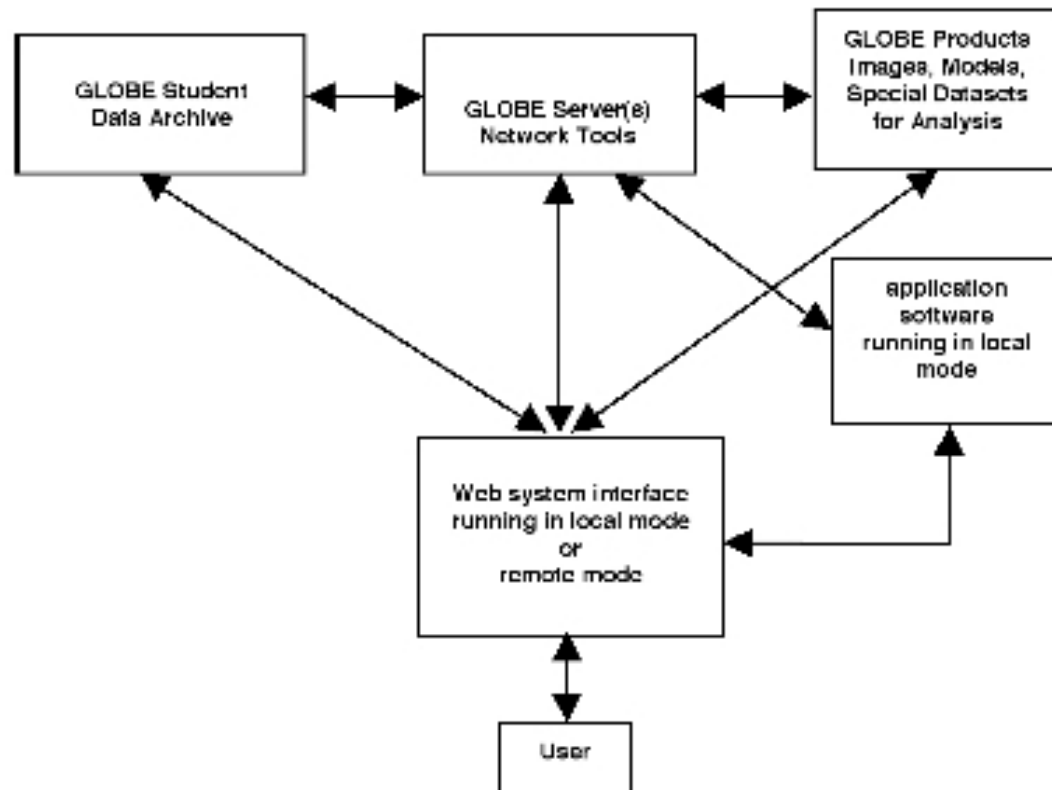
Earth - GLOBE: Operational Program Start April 1995

Visualization



GLOBE Web Interface NASA GSFC 1995

System



Gloria Brown Simmons, 1995

Recognition

- GLOBE received the 2004 Goldman Sachs Foundation Prize for Excellence in International Education in the Media and Technology Category
- The initial Visualization Sub-system is described in:
 - J. de L. Beaujardiere, J. Cavallo, A. F. Hasler, H. Mitchel, C. Ohandley, R. Shiri and R. White. "The GLOBE Visualization Project: Using WWW in the Classroom." *Journal of Science Education and Technology*, 6(1), 15-22, 1997.
- NASA Group Achievement Award, GLOBE Visualization Project
- Doors of Perception, Amsterdam, The Netherlands
- ACM SIGGRAPH Annual Conference

Impact

- Starting its 17th year
- 111 participating countries
- 54,000+ GLOBE-trained teachers
- 1.5+ million students
- 100 known scientific and pedagogical research publications
- Finnish students garnered top ranking amongst all 57 OECD nations plus 27 other administrative regions in science achievement for high school students (age 15)
- GLOBE Program cited in ministry educational materials in many GLOBE countries (Argentina, Bahrain, Cameroon, India, New Zealand, Peru, Thailand, etc.)
- GLOBE cited in the 7th Edition of GLOBAL SCIENCE.
- SRI undertook external reviews of the GLOBE Program from 1995 to 2006

Post GLOBE

- An Inconvenient Truth (Film 2006)
- An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It (Book 2006)
- 2007 Nobel Peace Prize
- Al Gore's 2009 TED Talk

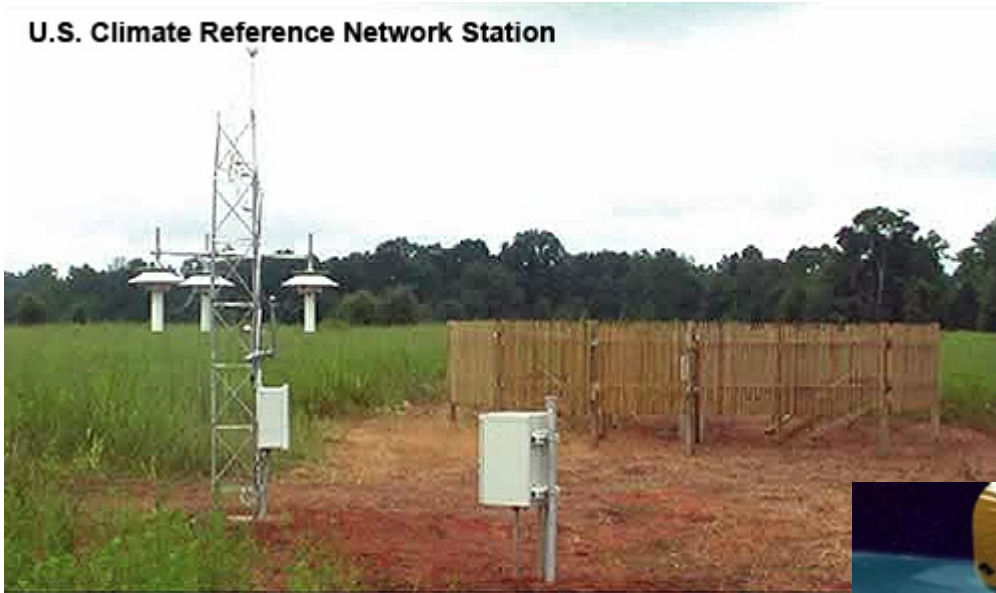
Current Climate Change

- 29 percent increase in the 1990-2010 period for the warming effect of greenhouse gas (GHG) emissions
- Highest increase in our 260 year old industrial age

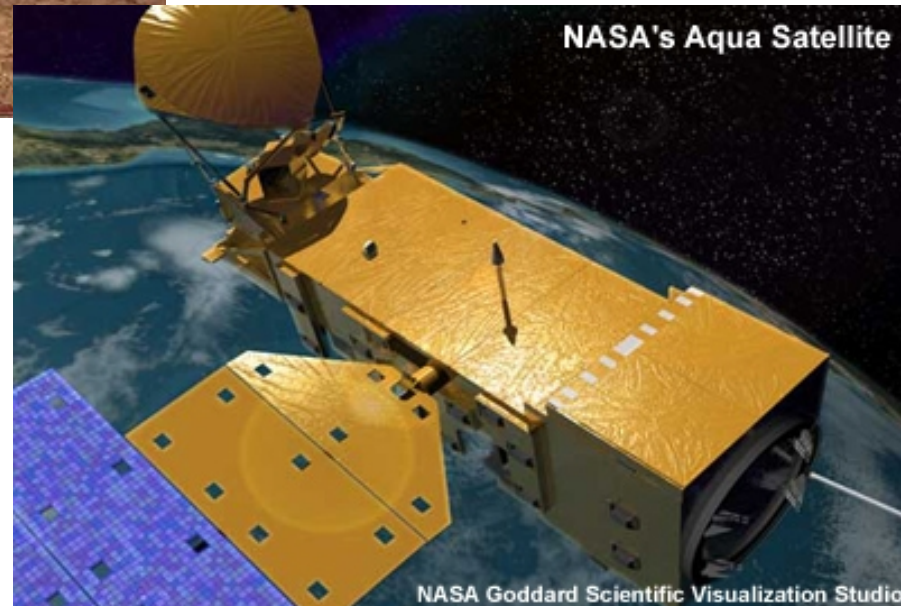


Current Observations

U.S. Climate Reference Network Station



NASA's Aqua Satellite

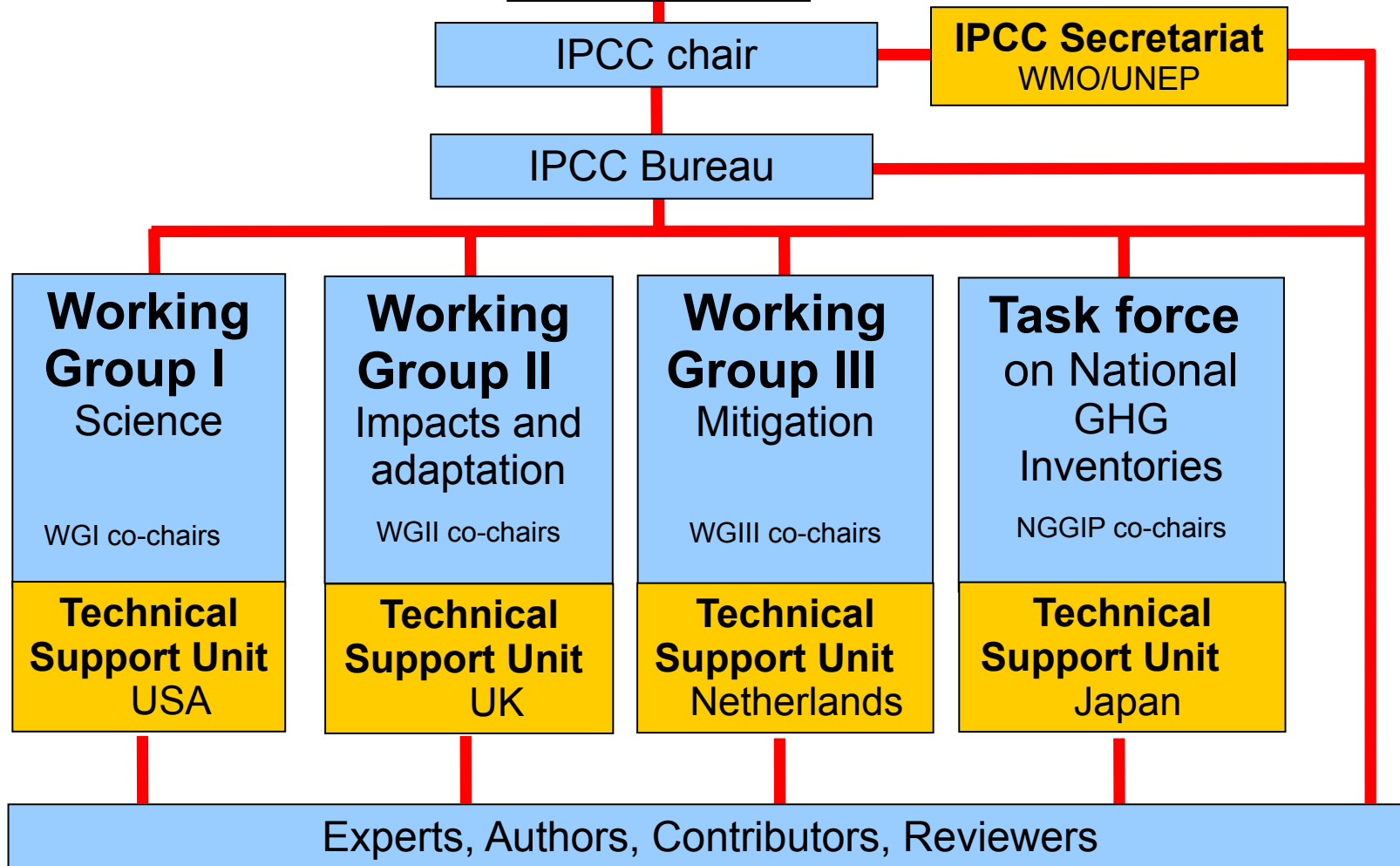


How Sure Are Scientists?



Is there some critical piece of the climate process we don't understand? How and when will our fossil fuel use change? Will future, yet-to-be-discovered technologies mitigate the problem? How will changing economics, global population, and political processes affect our ability to tackle the problem?







Courtesy of Kevin Trenberth / NCAR

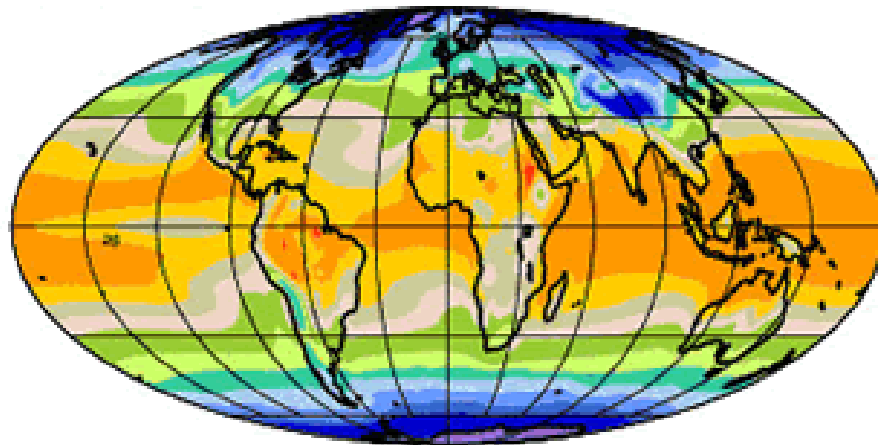
2007 Conclusions

- Warming of the climate system is unequivocal
- Very high confidence that global average net effect of human activities since 1750 one of warming
- Human-caused warming over last 30 years has likely had a visible influence on many physical and biological systems
- Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century.

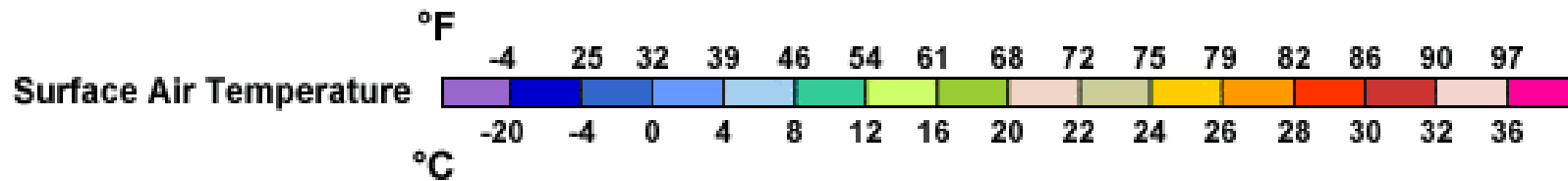
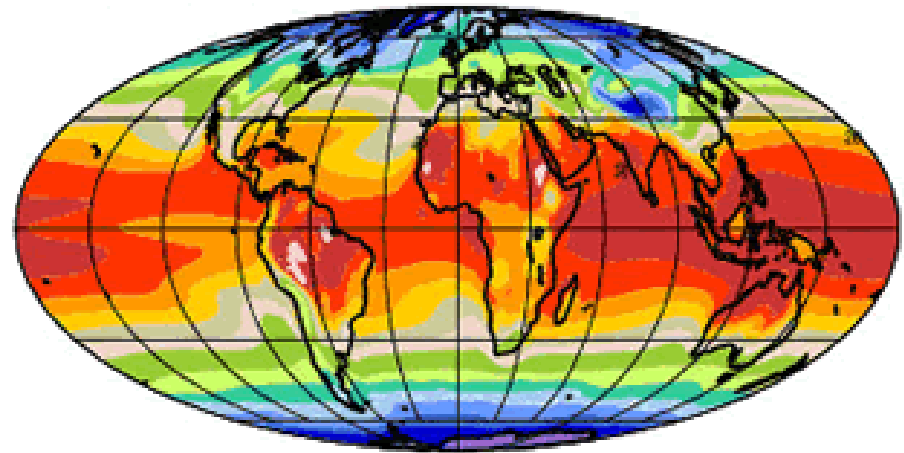


Why Should We Care?

Present Day
(1990s)



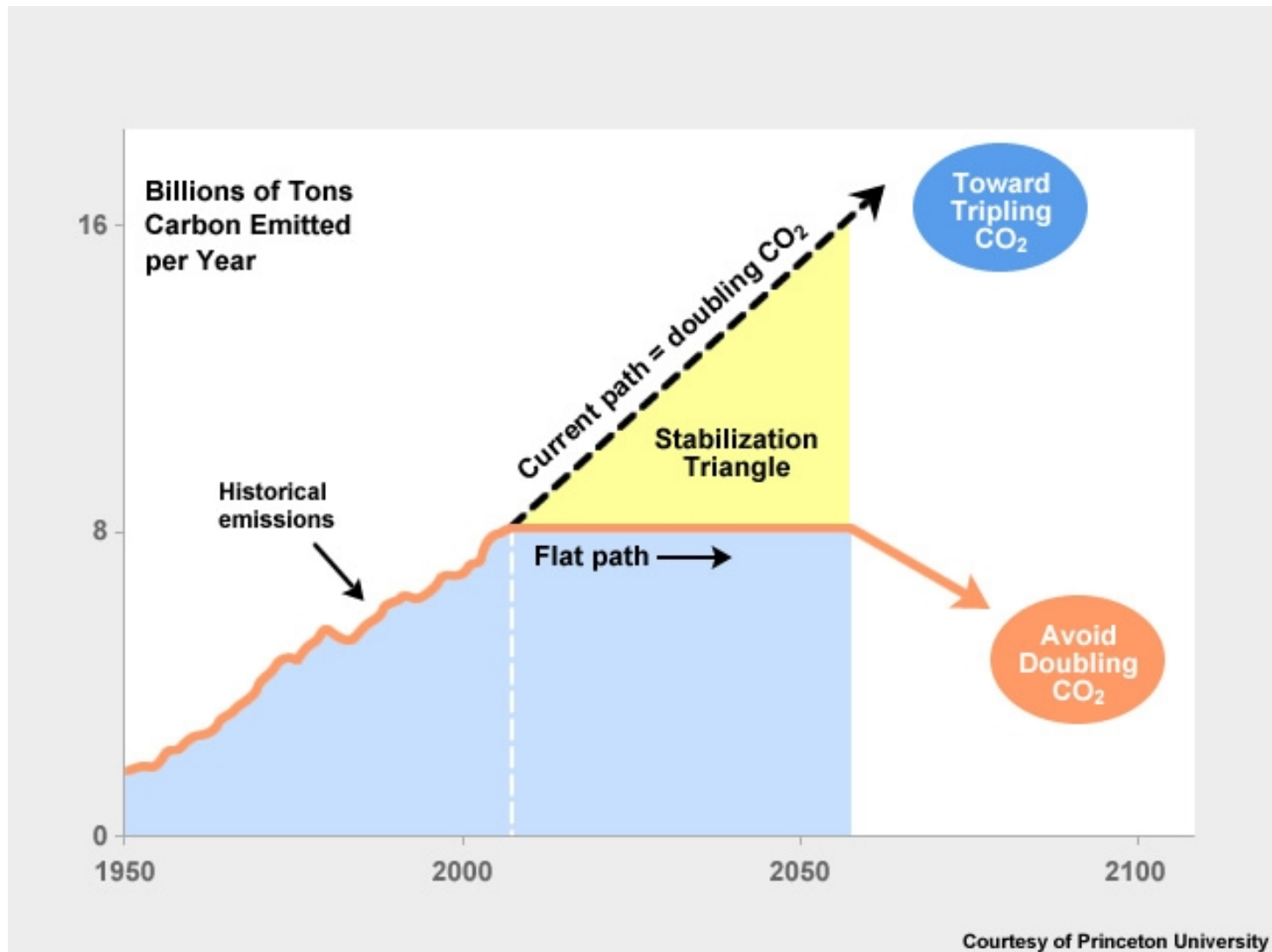
Possible Future
(2090s)



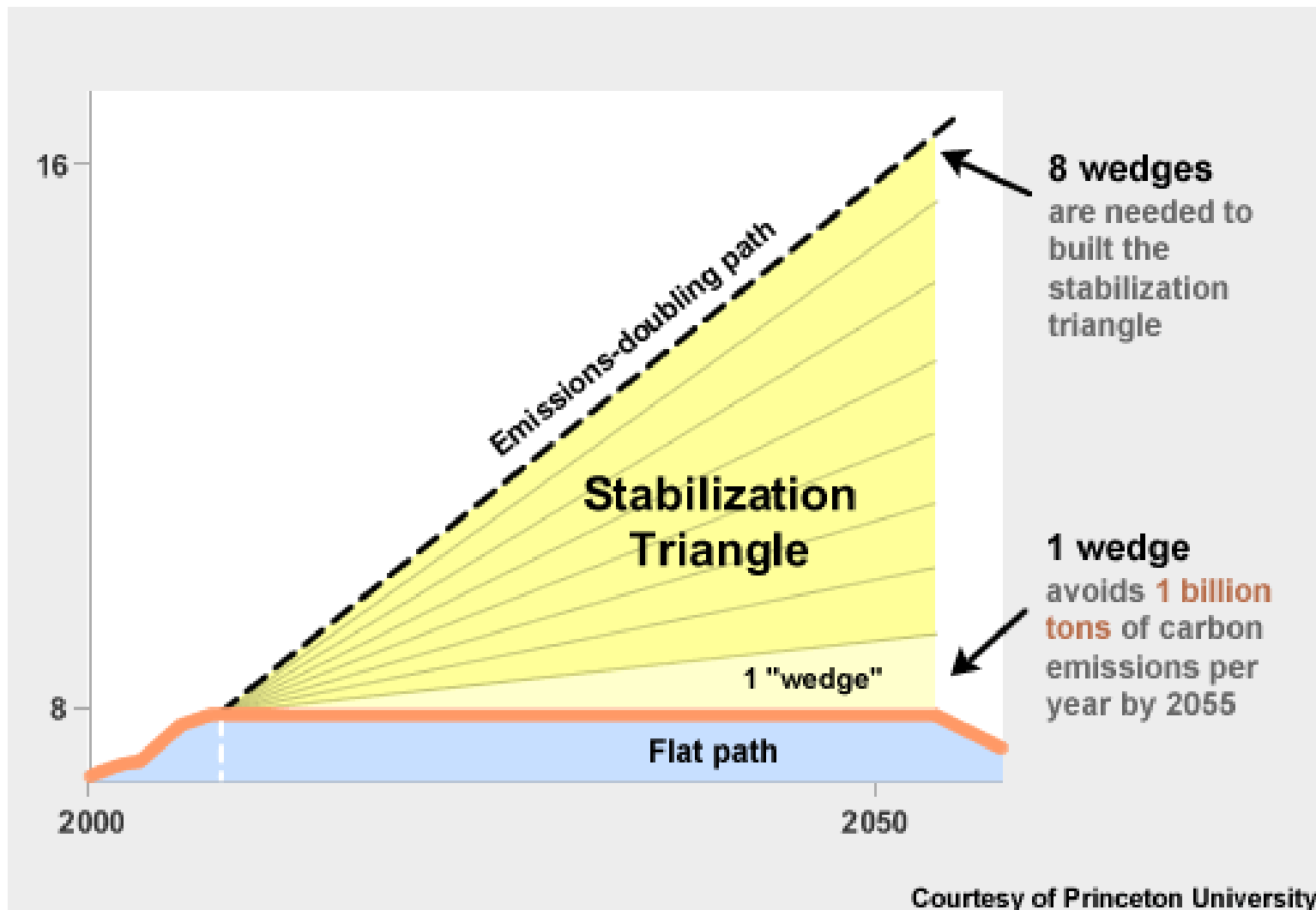
NCAR



What Next—What Can We Do?



What Next—What Can We Do?



Geo-Engineering

Arctic Geoengineering

Green House Gas Remediation

Heat Transport

Solar Radiation Management

Gregory Benford

Bill Gates

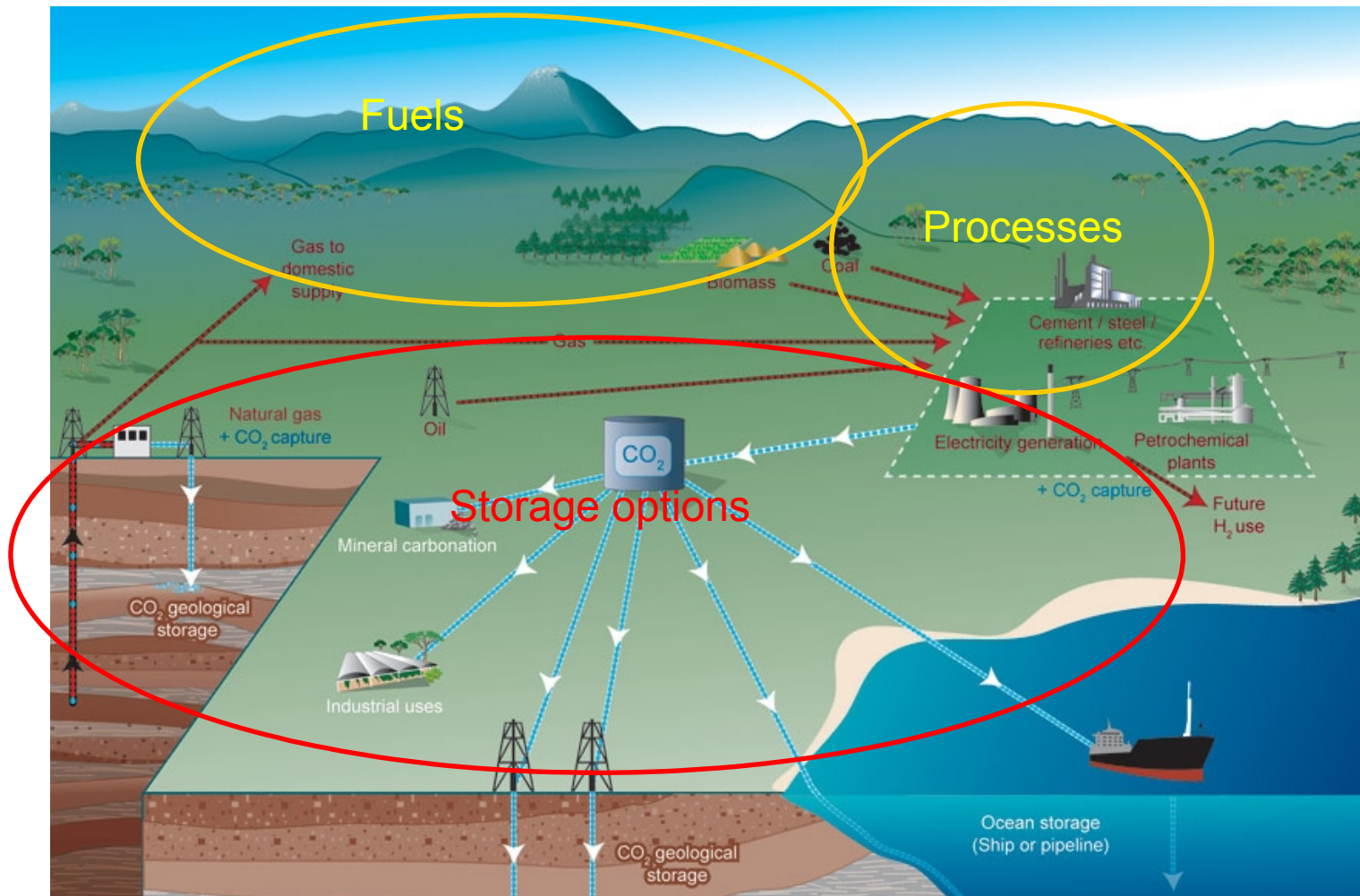
Ray Kurzweil

Green House Gas Remediation

Intergovernmental Panel on Climate Change (IPCC)
Working Group Three (WGIII) - Mitigation

special report on
Carbon Dioxide Capture and Storage

CO₂ Capture and Storage System



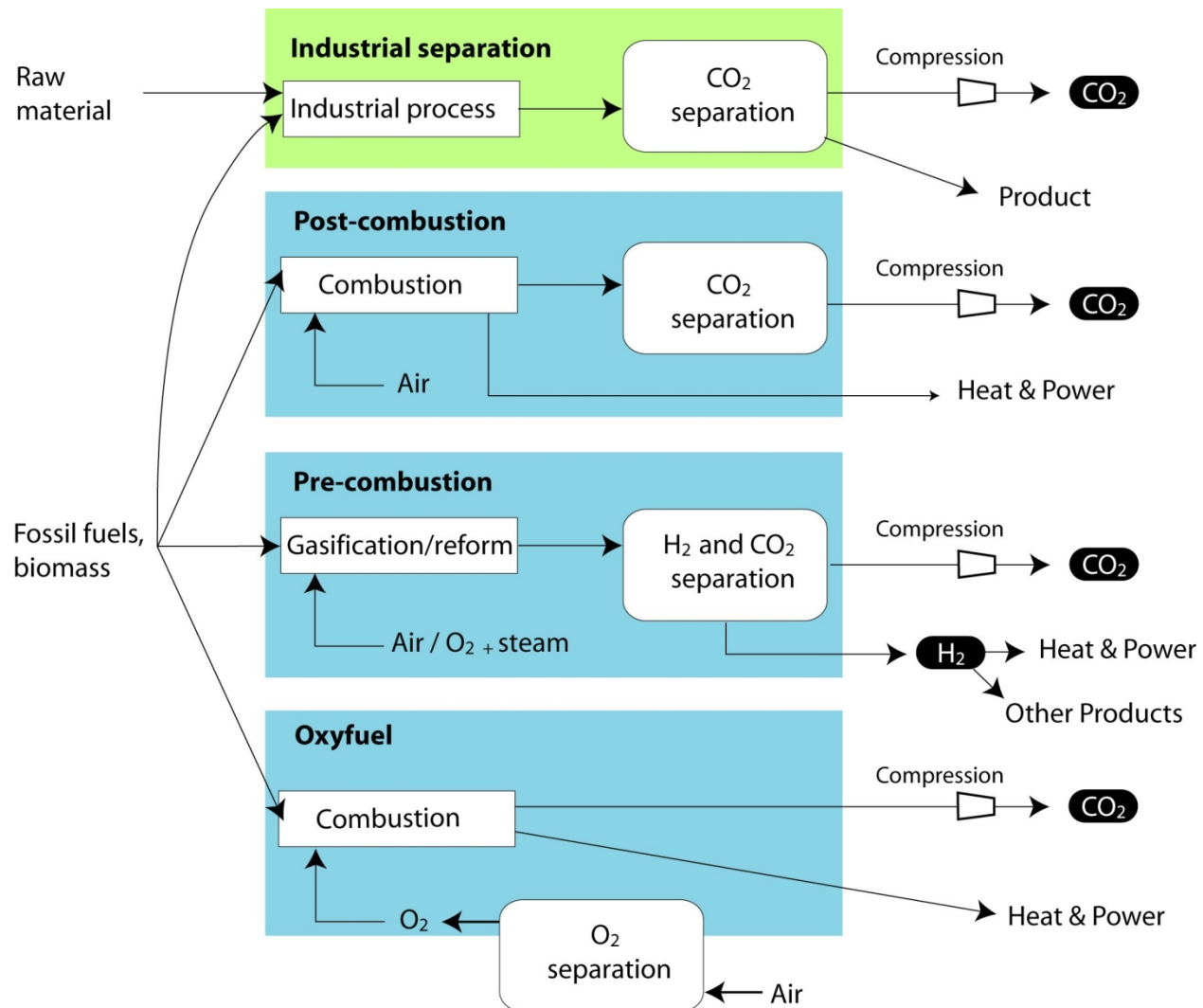
Qualifying CO₂ Sources

- Large stationary point sources
- High CO₂ concentration in the waste, flue gas or by-product stream (purity)
- Pressure of CO₂ stream
- Distance from suitable storage sites

CO₂ Sources - Emissions > 0.1 MtCO₂/year

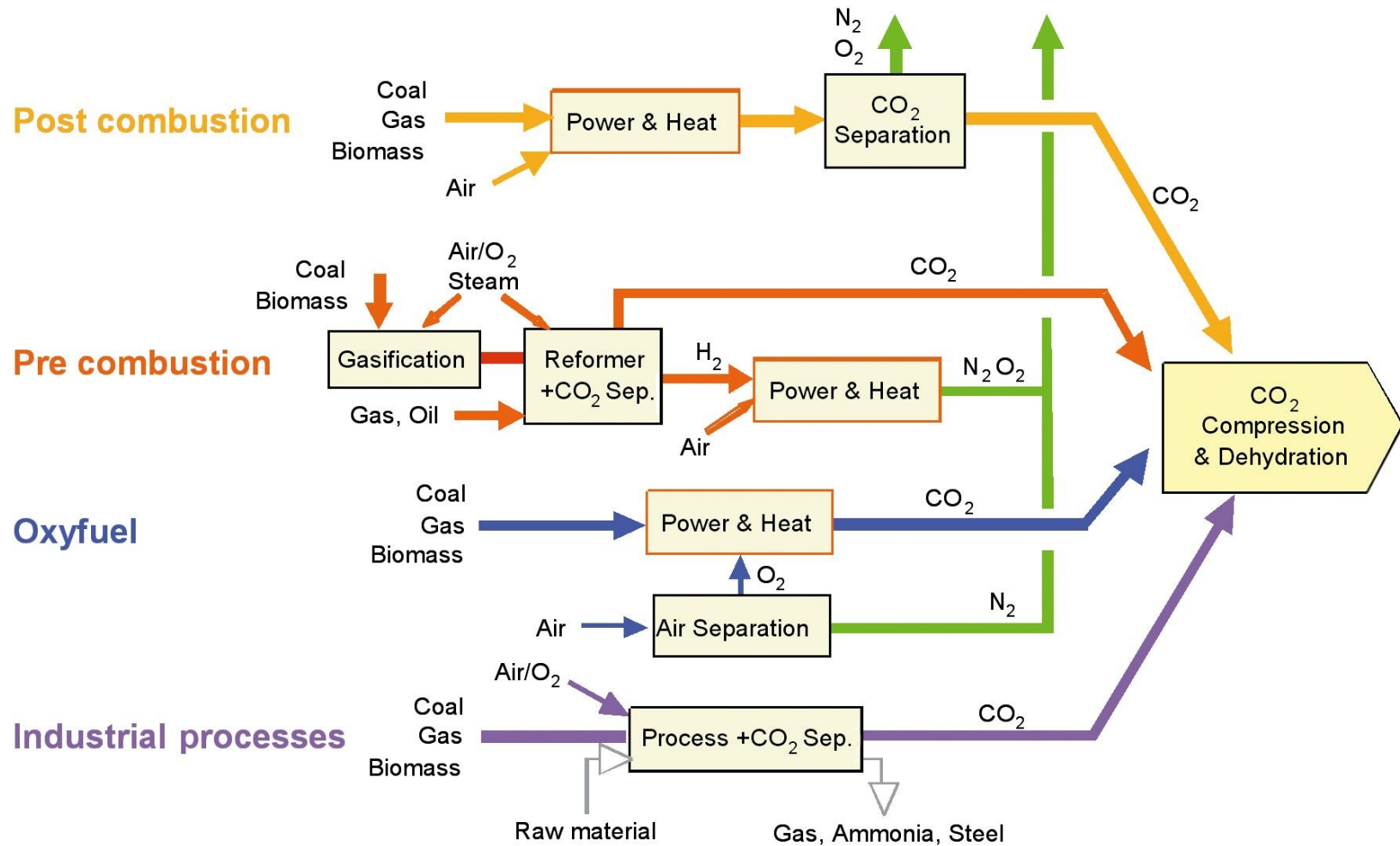
Process	# of Sources	Emissions (MtCO ₂ /yr)
Fossil Fuels		
Power (coal, gas, oil and others)	4942	10539
Cement production	1175	932
Refineries	638	798
Iron and steel industry	269	646
Petrochemical industry	470	379
Oil and gas processing	N/A	50
Other sources	90	33
Biomass		
Bioethanol and bioenergy	303	91
Total	7887	13466

Capture of CO₂



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

Capture of CO₂



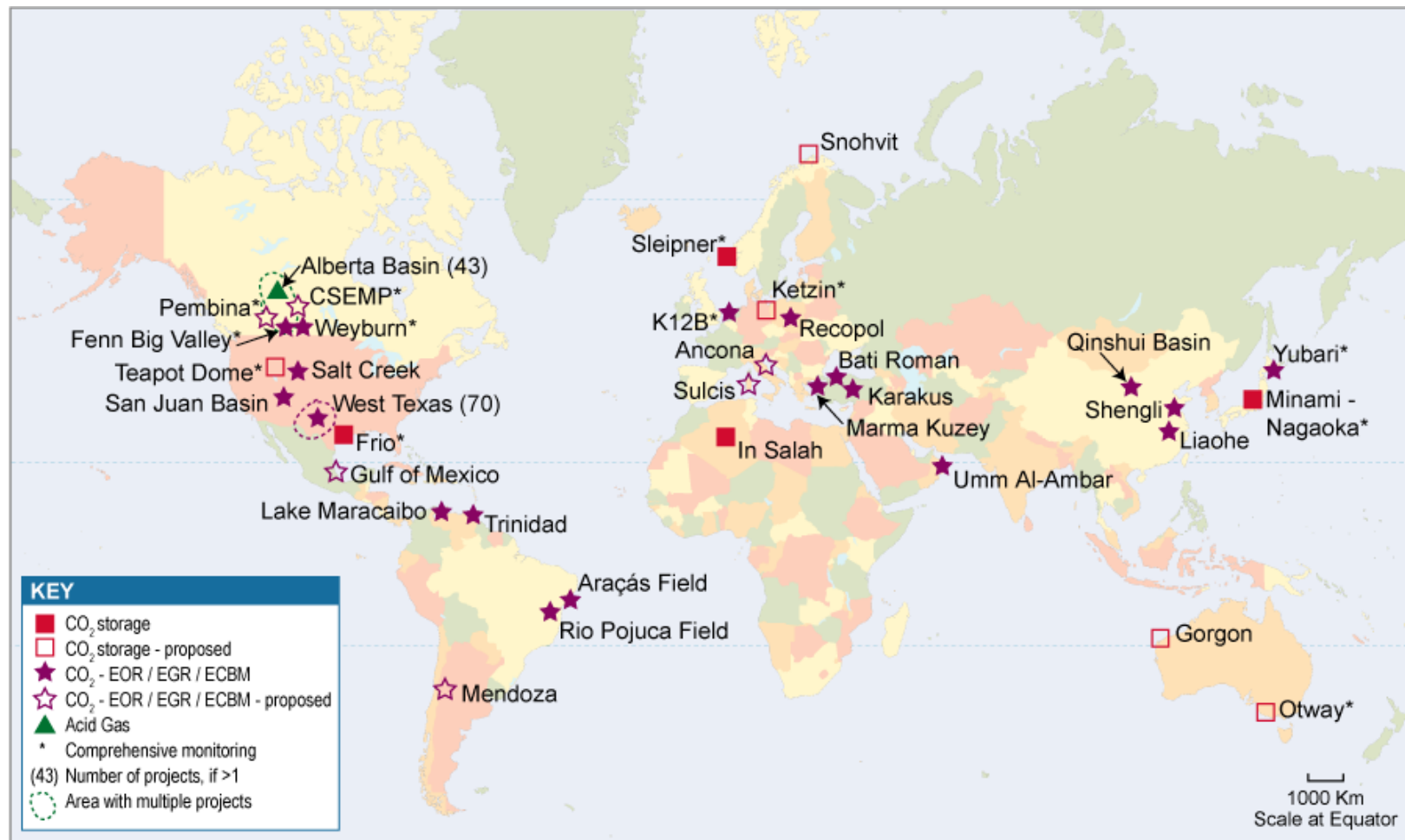
Source: IPCC SRCSS

Examples of Existing CO₂ Capture Installations



(Courtesy of Mitsubishi Heavy Industries)

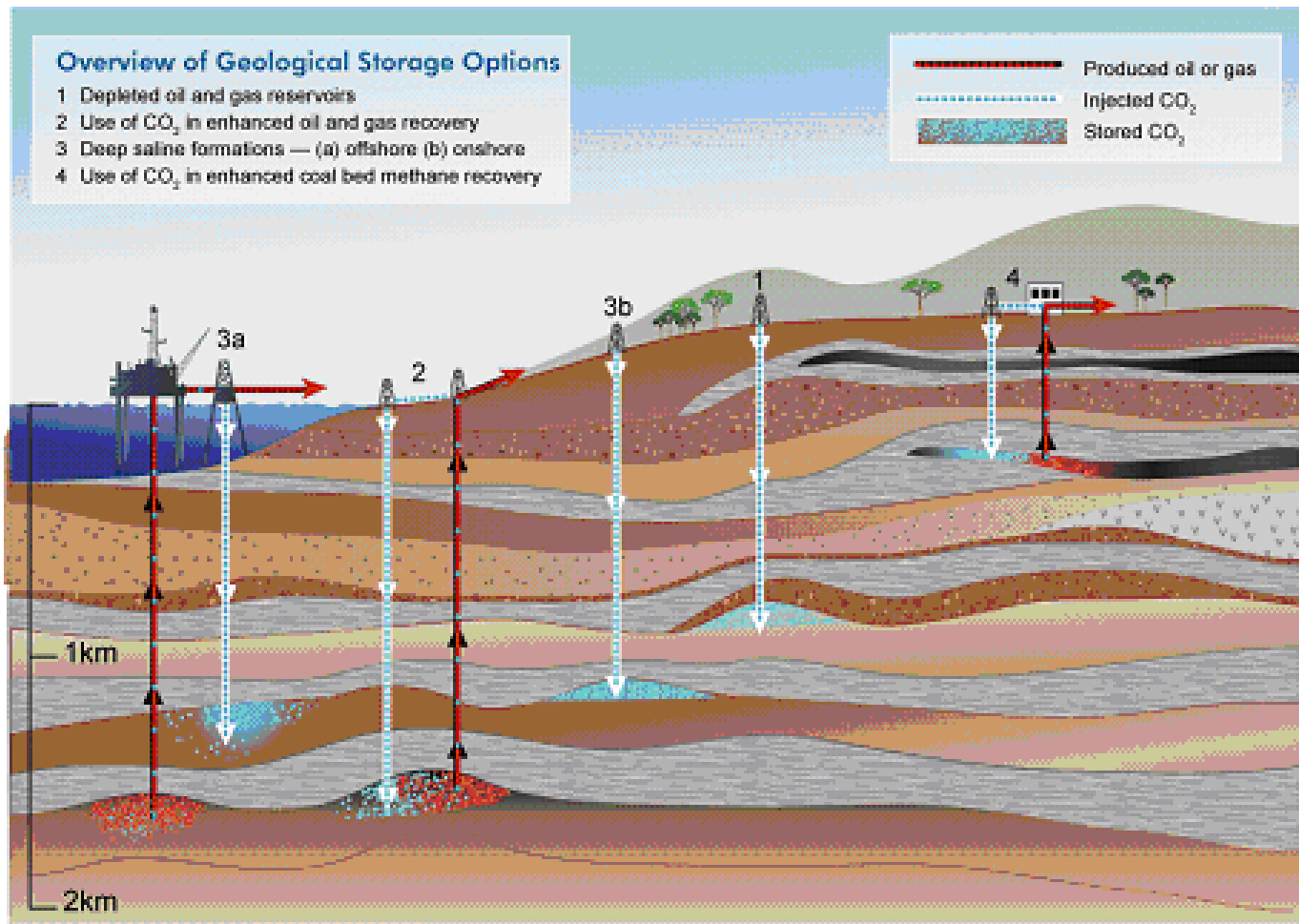
Planned and Current Locations of Geological Storage



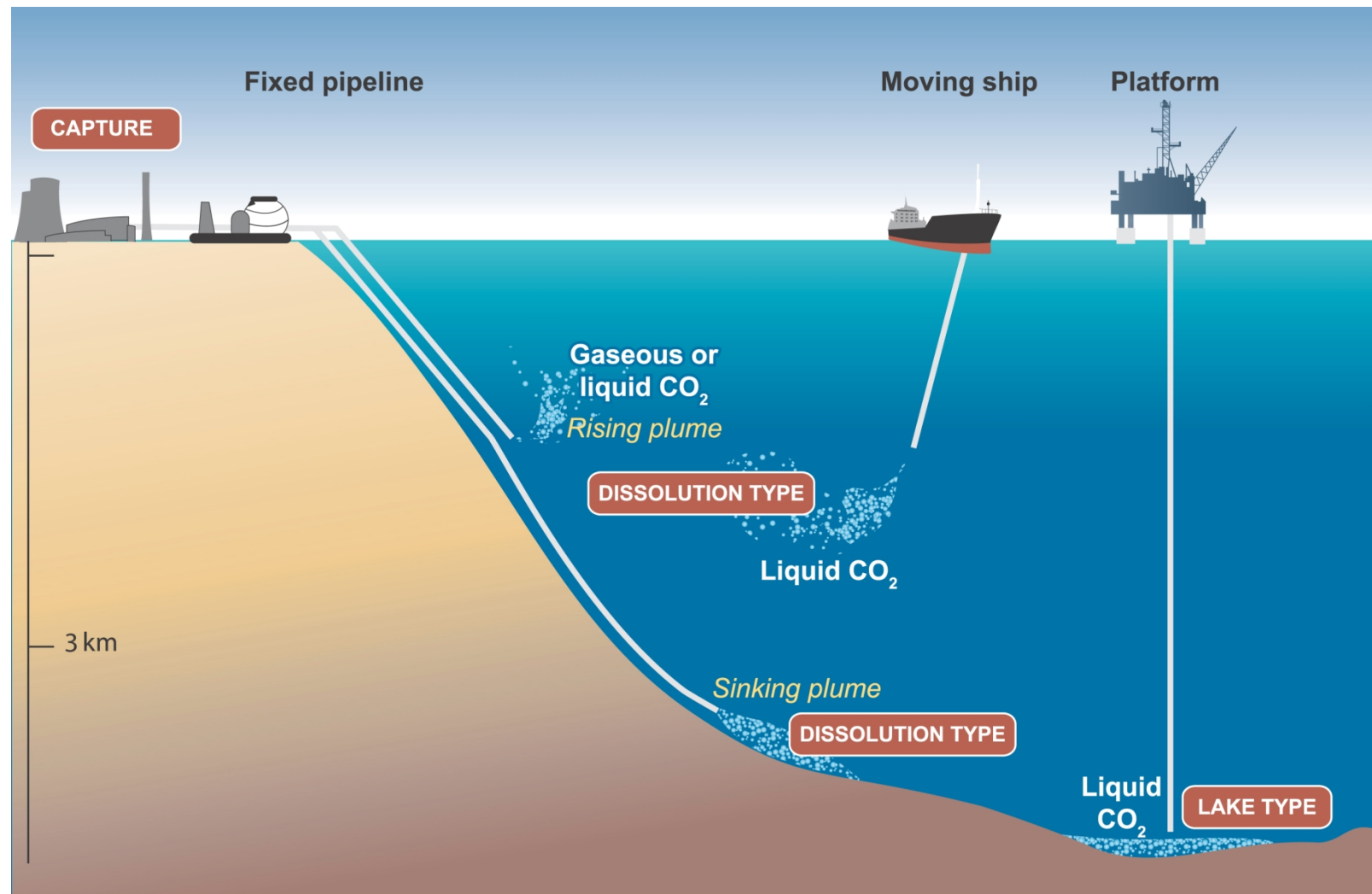
Current Locations of Geological Storage

Project Name	Country	Injection Start	Daily Injection (tCO ₂ /day)	Total Planned Storage (tCO ₂)	Reservoir Type
Weyburn	Canada	2000	3,000 - 5,000	20,000,000	EOR
In Salah	Algeria	2004	3,000 - 4,000	17,000,000	Gas Field
Sleipner	Norway	1996	3,000	20,000,000	Saline formation
K12B	Netherlands	2004	100	8,000,000	EGR
Frio	United States	2004	177	1,600	Saline formation

Geological Storage



Ocean Storage



Storage Potential

- **Geological storage:** likely at least about 2,000 GtCO₂ in geological formations
"Likely" is a probability between 66 and 90%.
- **Ocean storage:** on the order of thousands of GtCO₂, depending on environmental constraints
- **Mineral carbonation:** can currently not be determined
- **Industrial uses:** Not much net reduction of CO₂ emissions

Back to the Future

- GLOBE Teacher Certification 2010
- After school and summer programs in 3 Asbury Park schools and 1 Red Bank school (grades 4-8)
- NY Metro GLOBE Teacher Training (K-12) for 8 Red Bank Borough teachers



Lessons Learned

- Extend informal education outreach beyond the classroom into the living environment and every day lifestyle
- Reduce the complexities of understanding human impact and mitigation strategies
- Provide tools for mitigation with active learning and observational feedback mechanisms

Act LOCAL Think GLOBAL

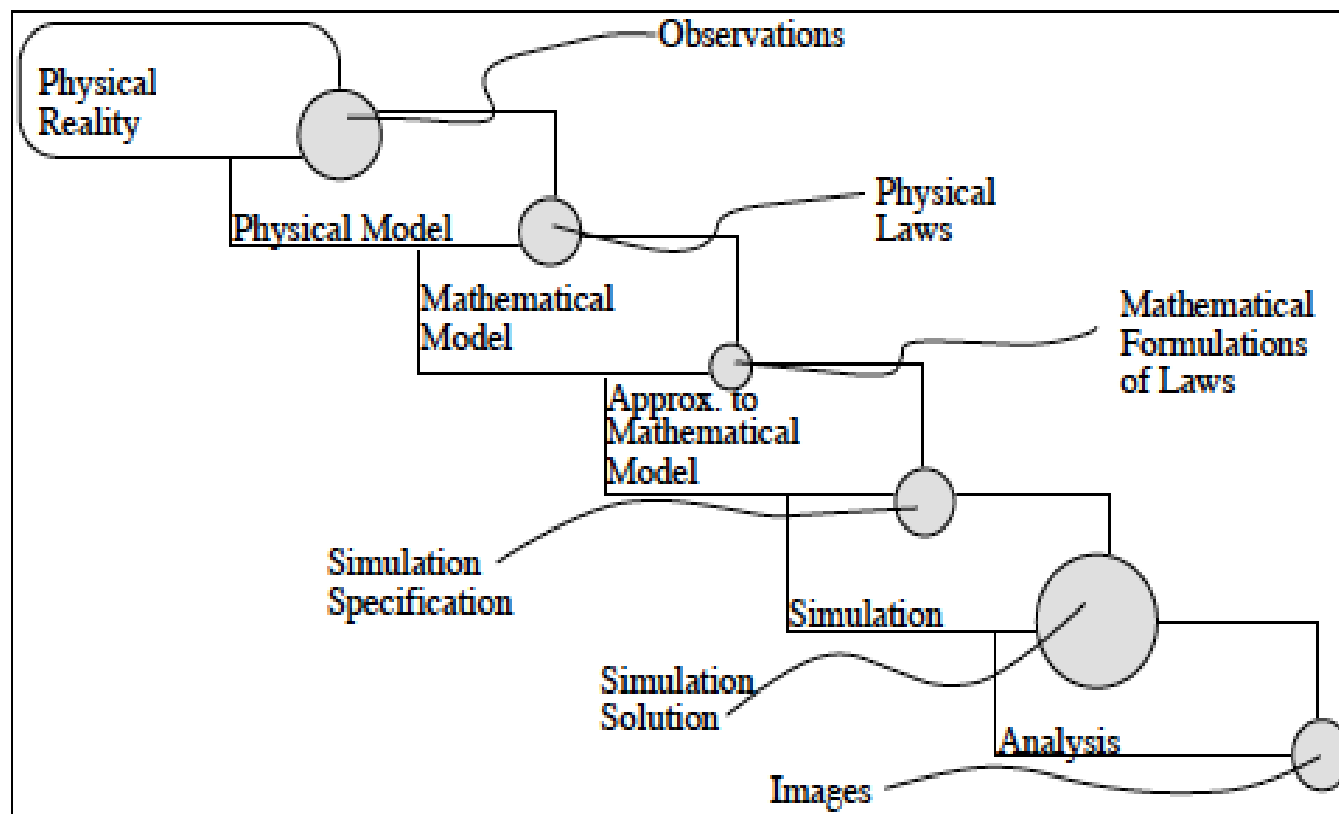
- How can visualization experts contribute to the reduction of GHG and human impact on the environment?
- Can we conceive of systems that are both highly visual while at the same time a geoengineering strategy?
- What are the scenarios that would be most fitting for a highly visual and interactive mitigation system?
- What are the metrics of such a system? How many people would have to participate to make a significant reduction in GHG?

Towards Closing the Circle

- Earth and Planetary System Science Game Engine 2006
- MIT/NEON Asthma Project, Springfield, MA, USA
- Immersive Oceanarium, Peter Chermayeff/MIT
- Information Appliances 1999 - present
- MIT NOAA proposal for data driven spherical display

Analysis

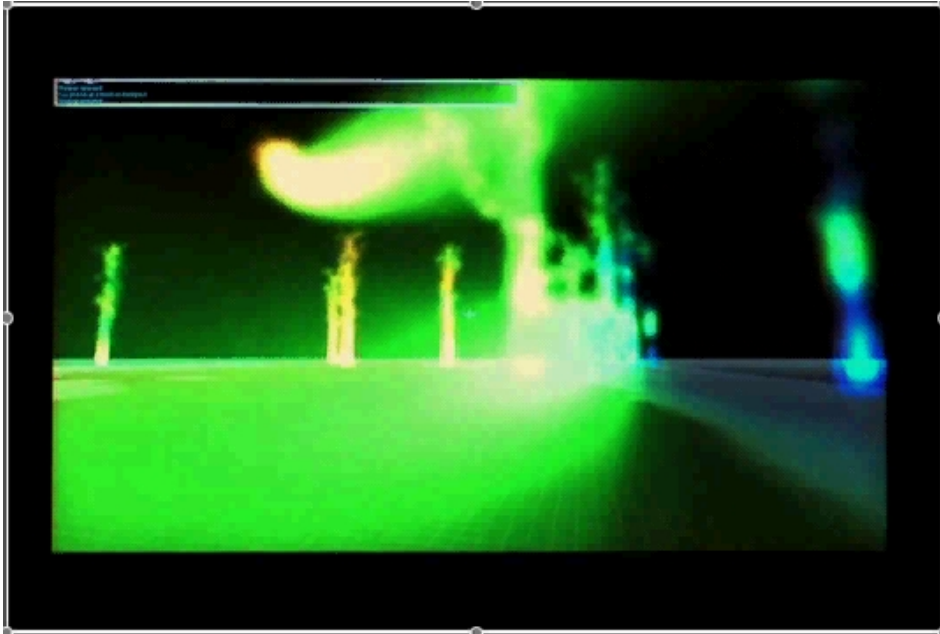
- Simulating natural phenomena: the boxes represent processes, the circle's size indicates the relative volume of information passing between each pair of processes. (after Earnshaw and Wiseman, 1992)



Games

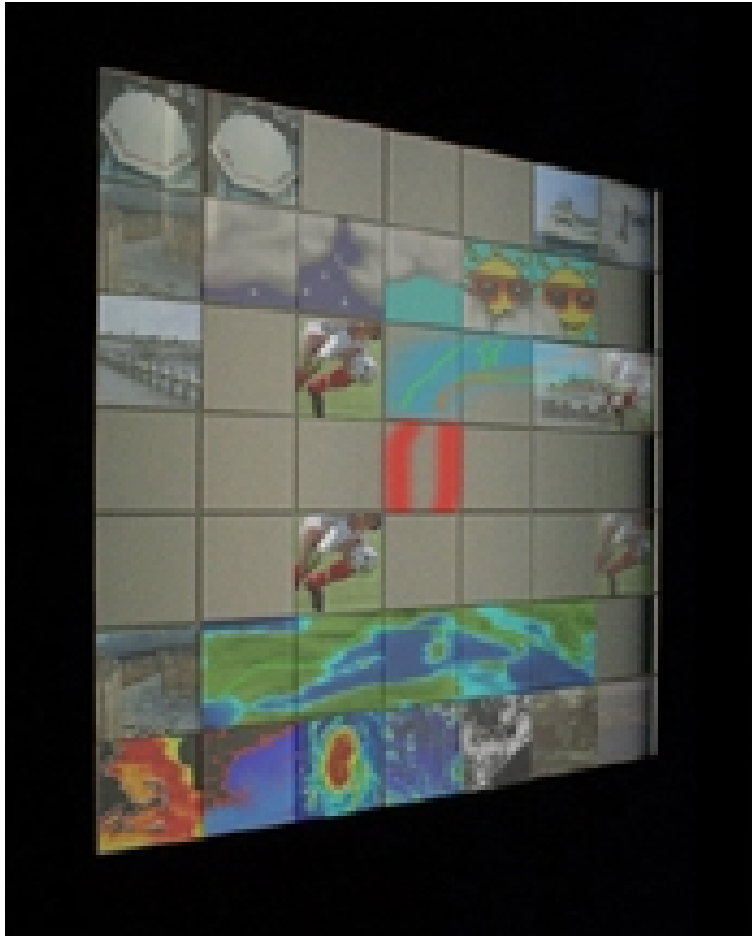
- Games address the inability to directly observe the phenomena which Libarkin suggests is a limiting factor to climate change comprehension
- Participants develop principles of how geophysical models can be “forced” by simply interacting with them (representation of models)
- Participants see how they can achieve positive environmental results of their collective behavior in the real world

Massive Multiplayer Online Games



- Research on geophysical representation techniques, human visual system, games and education
- Using avatar to present first person interaction with a climate system
- First MMOG to incorporate climate models (IPCC NCAR CCSM & INM-CM3.0)

Information Appliances



- Engaging in climate change through a highly visual approach
- Connecting individuals with remote natural resource managers and service providers
- Merging leisure new technology usage with informal education

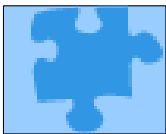
Resources



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)



Intergovernmental Panel on Climate Change (IPCC) Special Report on Carbon Dioxide Capture and Storage published by Cambridge University Press (order at www.cambridge.org); documents and powerpoint presentation to download available on www.ipcc.ch; for more information contact ipcc3tsu@mnp.nl.



The complete COMET climate presentation can be downloaded from <http://www.earthgauge.net/wp-content/climate%20presentation.ppt>