Terrascope – Guiding Principles

- The Earth system provides a context for learning basic science and engineering concepts
- Students put those concepts to use in creative ways to understand the interdependency of physical, chemical, and biological processes that shape our planet
- Students explore how these concepts may be used to design protocols to ensure a sustainable environment
- Program emphasizes both theory and practice, and puts a premium on active learning

Terrascope – Structure

First Semester

- Solving Complex Problems--Mission 2xxx

Second Semester

- 1.016
- Terrascope Field Experience (Spring Break)
- Terrascope Radio

Solving Complex Problems

- Multidisciplinary, project-based learning experience
- Students work toward a solution to a deceptively simple problem related to Earth's environment
- Each year's theme is different and referred to as "Mission XXXX", where XXXX refers to the graduation year of the class involved

Solving Complex Problems--Motivation

- To build in you the capacity to tackle the “big” problems that confront society
- To encourage you to take charge of the learning process
- To show you how to do independent research, to evaluate the quality of information sources, and to synthesize different information streams

Solving Complex Problems--Motivation

- To encourage you to think about optimal solutions rather than correct solutions

- To help you learn how to work effectively as part of a team

- To improve your communication skills using two media: the web site and the formal oral presentation

- To convince you of your potential!!

Past Missions

- Develop a viable plan for the exploration of Mars with the aim of finding evidence for life
- Design permanent, manned, underwater research laboratories and develop detailed research plans for the first six months of their operation
- Design the most environmentally sensitive strategy for hydrocarbon resource extraction from the Arctic National Wildlife Refuge and determine whether or not the value of the resource exceeds its financial and environmental cost

Past Missions

- To develop strategies for developing countries in the Pacific basin to cope with tsunami hazards and disasters. Due to the unique needs of each country, we specifically focused on developing plans for Peru and Micronesia.

- To develop a plan for the reconstruction of New Orleans and the management of the Mississippi River and the Gulf coast. The reconstruction of New Orleans and the management of the Mississippi River and the Gulf coast.

Past Missions

- To develop strategies to deal with the collapse of the global fisheries and the general health of the oceans

- To develop a plan to ensure the availability of fresh clean water for western North America for the next 100 years.

Subject Structure

Problem divided into approximately ten tasks; students divided into teams

Each team assigned a Teaching Fellow, Alumni Mentors, and Disciplinary Mentors

Four meeting styles:

- Presentations on methodology
- Case-study discussions
- Team workshops
- Coordination meetings

Subject Deliverables

- Each student develops a personal wiki
- Each team will communicate through wiki-based structure
- Each class describes and justifies its overall plan in a web site
- Each class explains the design in a two-hour presentation before a panel of experts and a general audience

Text removed due to copyright restrictions. Please see the complete article here: http://www.nytimes.com/2009/09/06/opinion/06hopkins.html

Nancy Hopkins, a professor of biology at M.I.T., has been teaching since 1973.

Extracted from OP-ED contribution in New York Times, September 5 2009

Subject Grading

Individual performance (30%)

Team performance (30%)

Class accomplishment (40%)

Wikis

Share files in teams, class

- Avoid large attachments (please!)
- All files online
- Set permissions - who can read, edit
- Know about others' work
  - Avoid doubling up, missing topics
- Get good quality writing early
  - You'll be happy later, we promise

Wikis - structure

- One wiki
- One section per team
  - All read, team read/write
- One section per student inside team
  - All read, student read/write

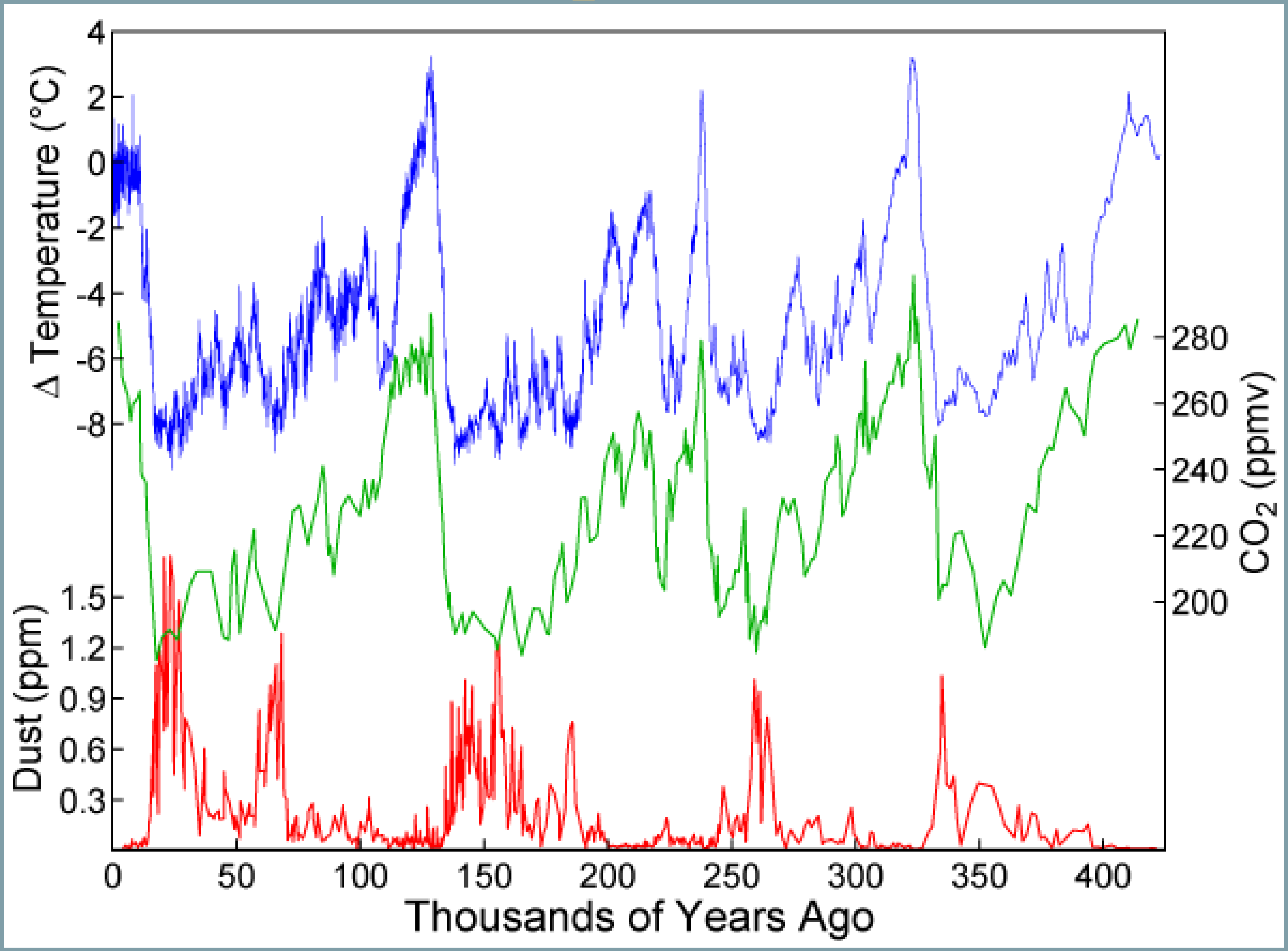
Wiki - requirements

- Each student:
  - Keep ongoing journal as a wiki page
    - Ideas, progress, problems
    - One or two paragraphs
  - UPDATE EVERY WEEK!!!!
- Each team:
  - Write research online, different pages per topics
  - Show progress every week

Mission 2013

Your Mission is to propose an integrated global solution to the rapid rise in atmospheric CO_2 that will stabilize concentrations at an economically viable and internationally acceptable level.

CO_2 and global temperatures



Correlation of global temperature and CO_2

CO_2 emissions

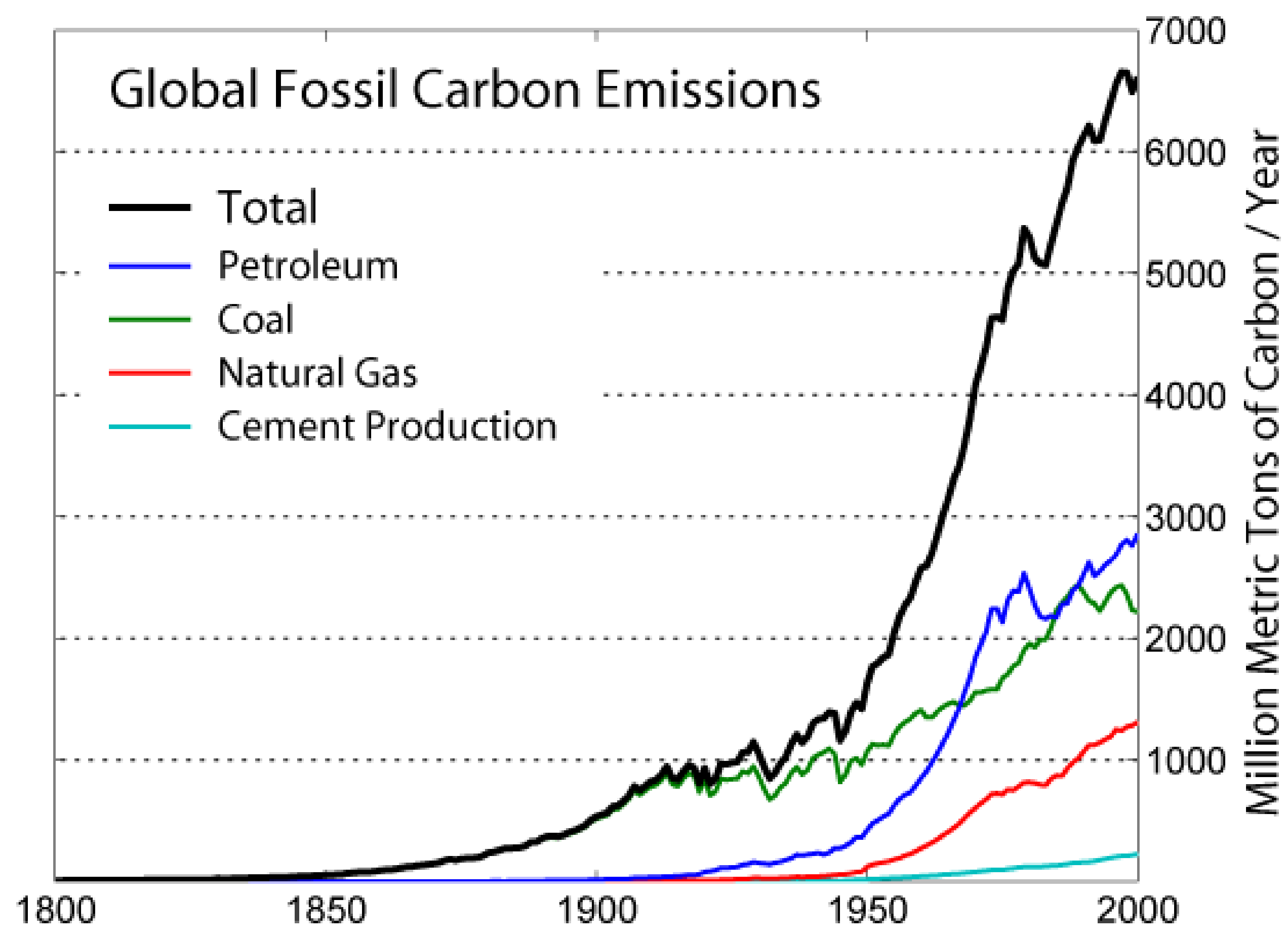


Image created by Robert A. Rohde / Global Warming Art. Used with permission.

http://www.globalwarmingart.com/wiki/File:Global_Carbon_Emission_by_Type_png

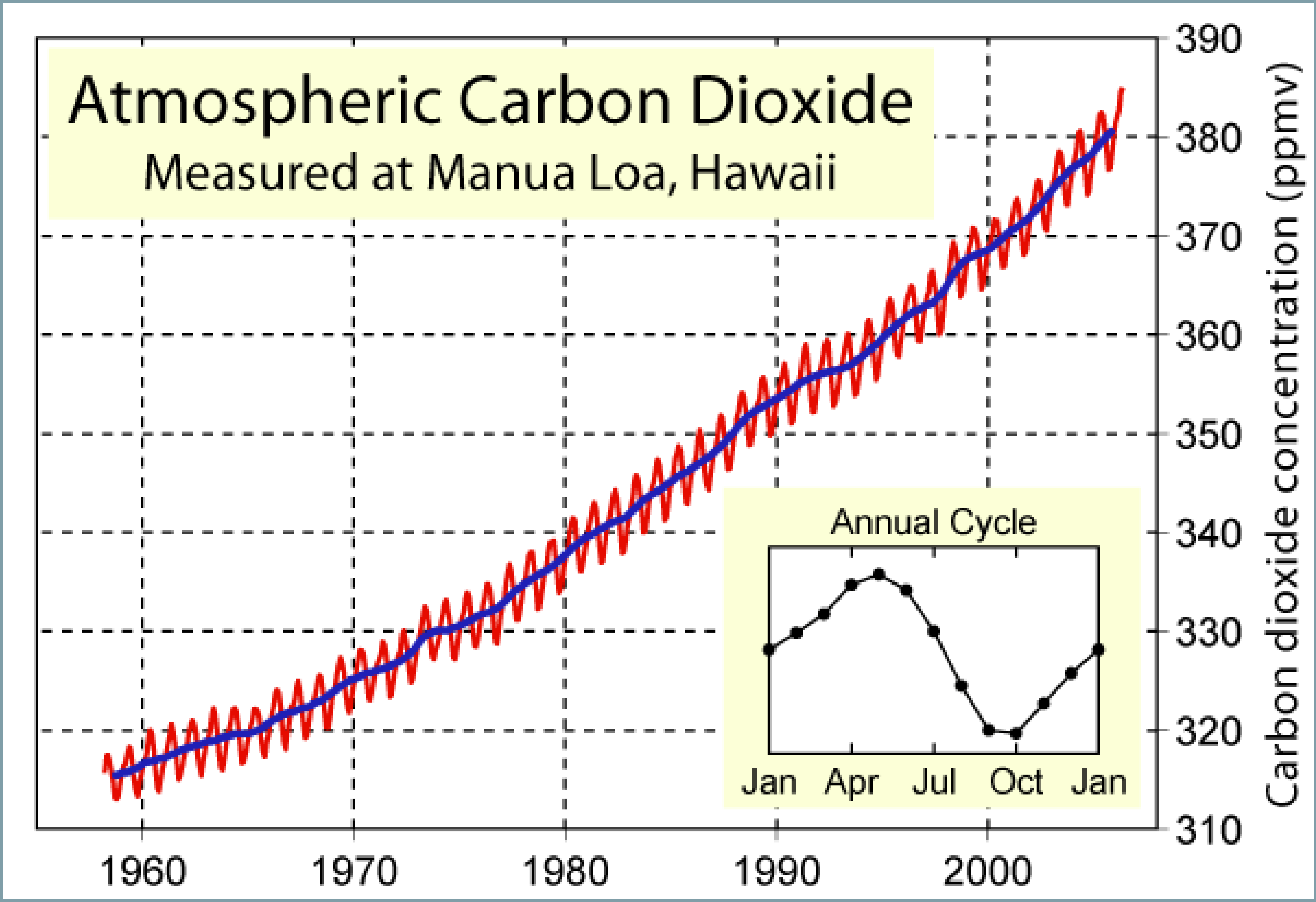
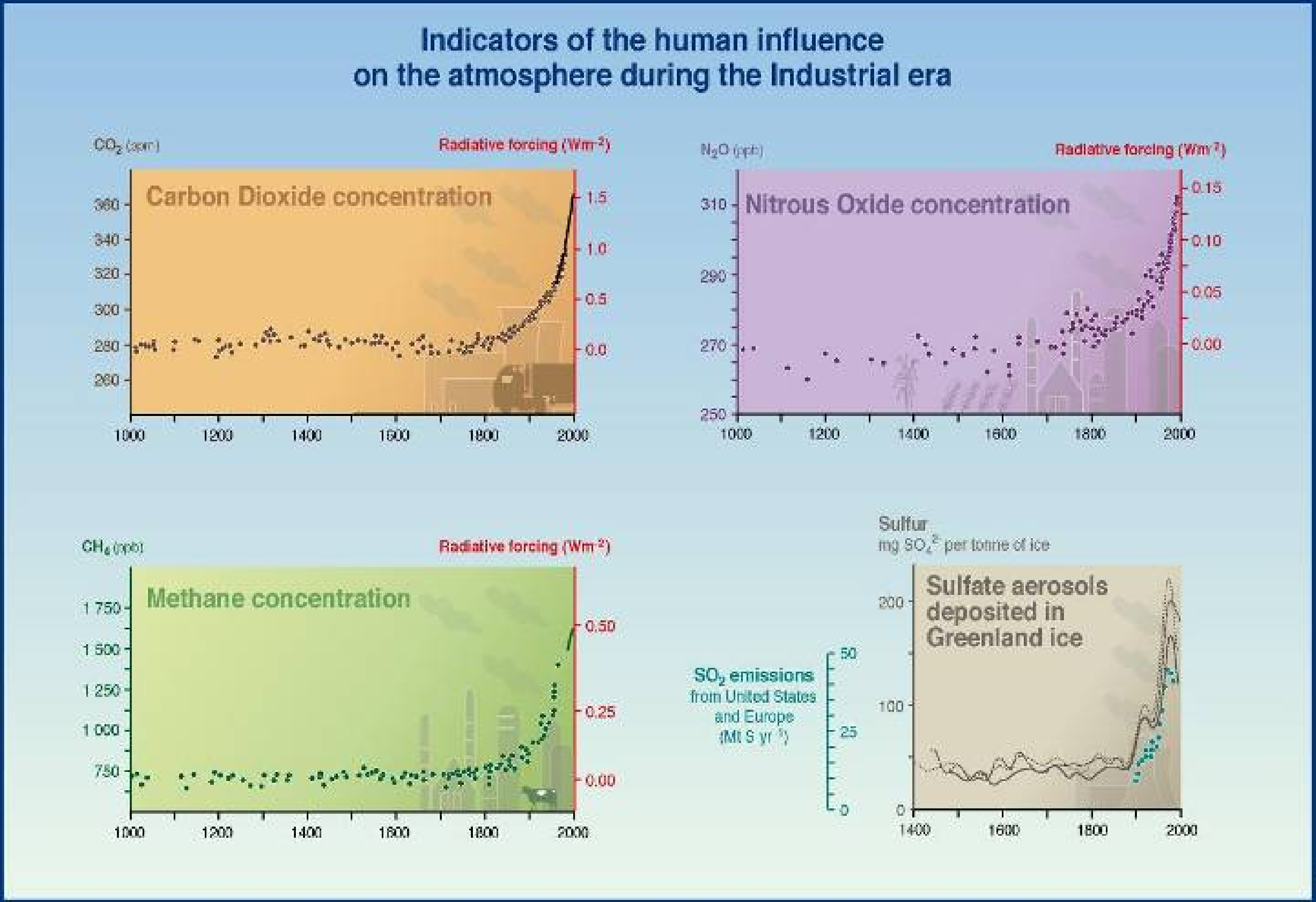
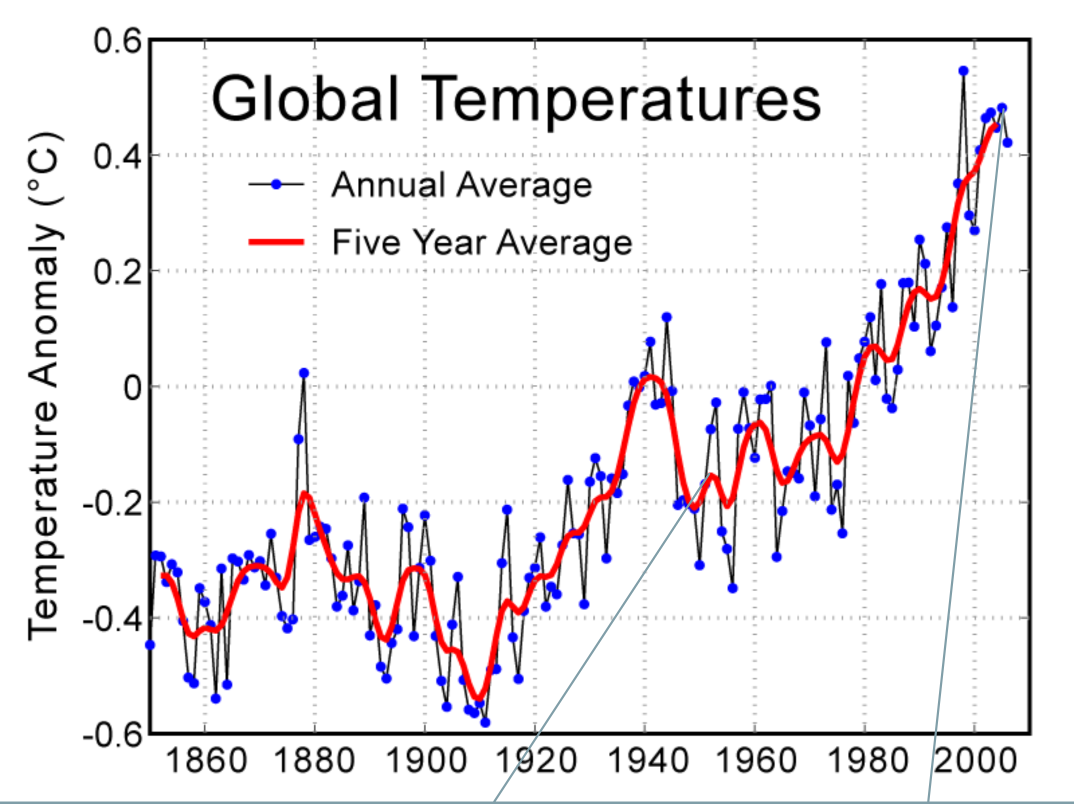


Image created by Robert A. Rohde / Global Warming Art. Used with permission.
Updated through 2010 here: http://www.globalwarmingart.com/wiki/File:Mauna_Loa_Carbon_Dioxide_png



SYR - FIGURE 2-1
WG1 FIGURE SPM-2

Image created by Robert A. Rohde / Global Warming Art. Used with permission.
http://www.globalwarmingart.com/wiki/File:Instrumental_Temperature_Record_png



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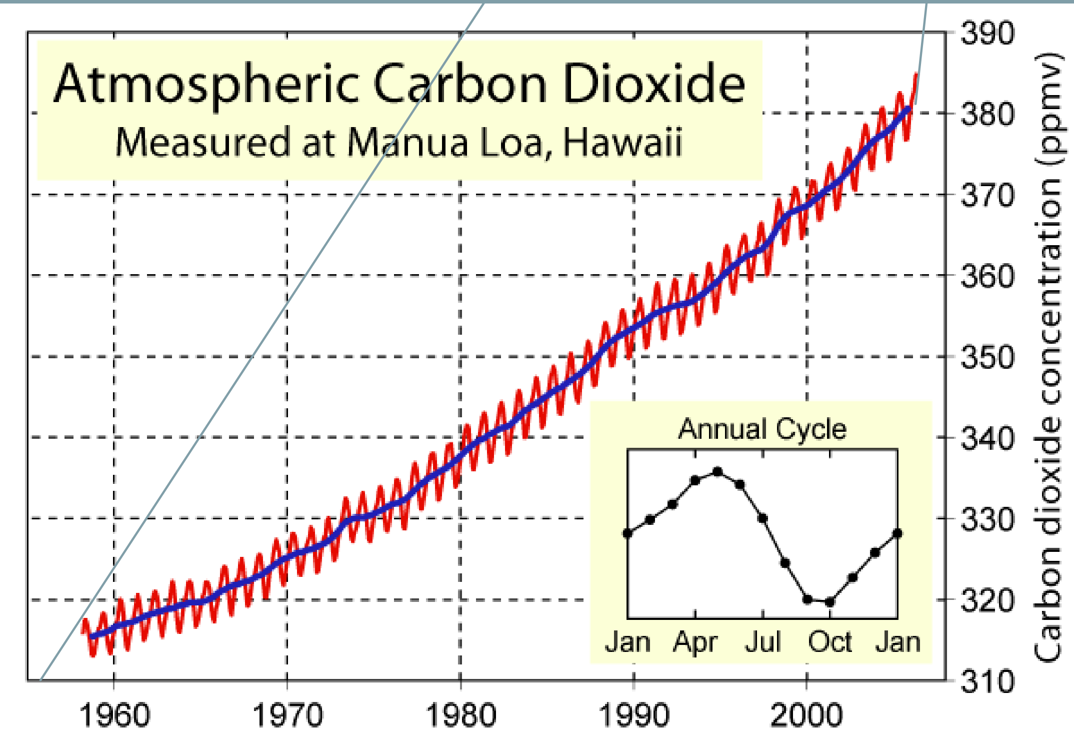
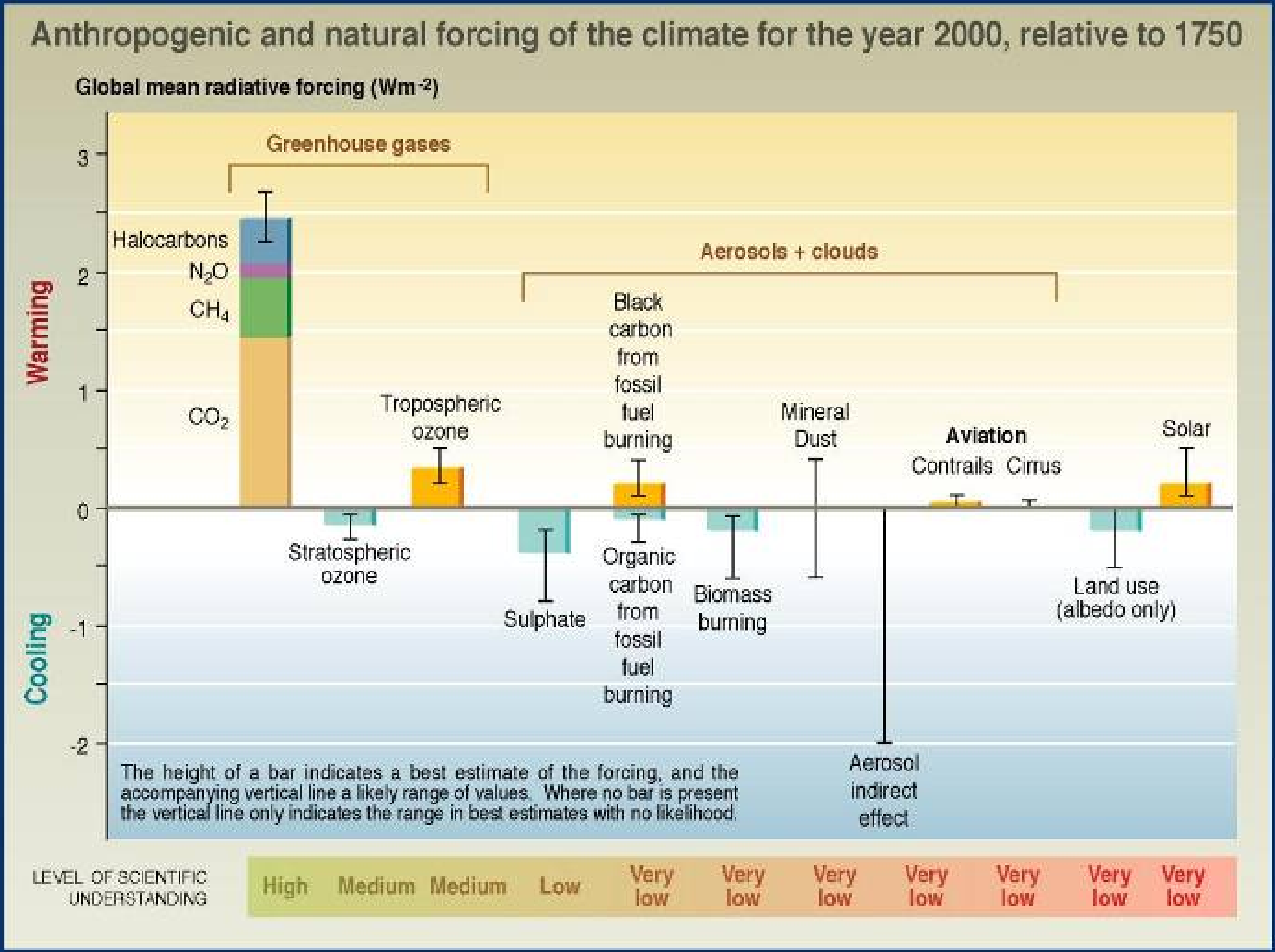


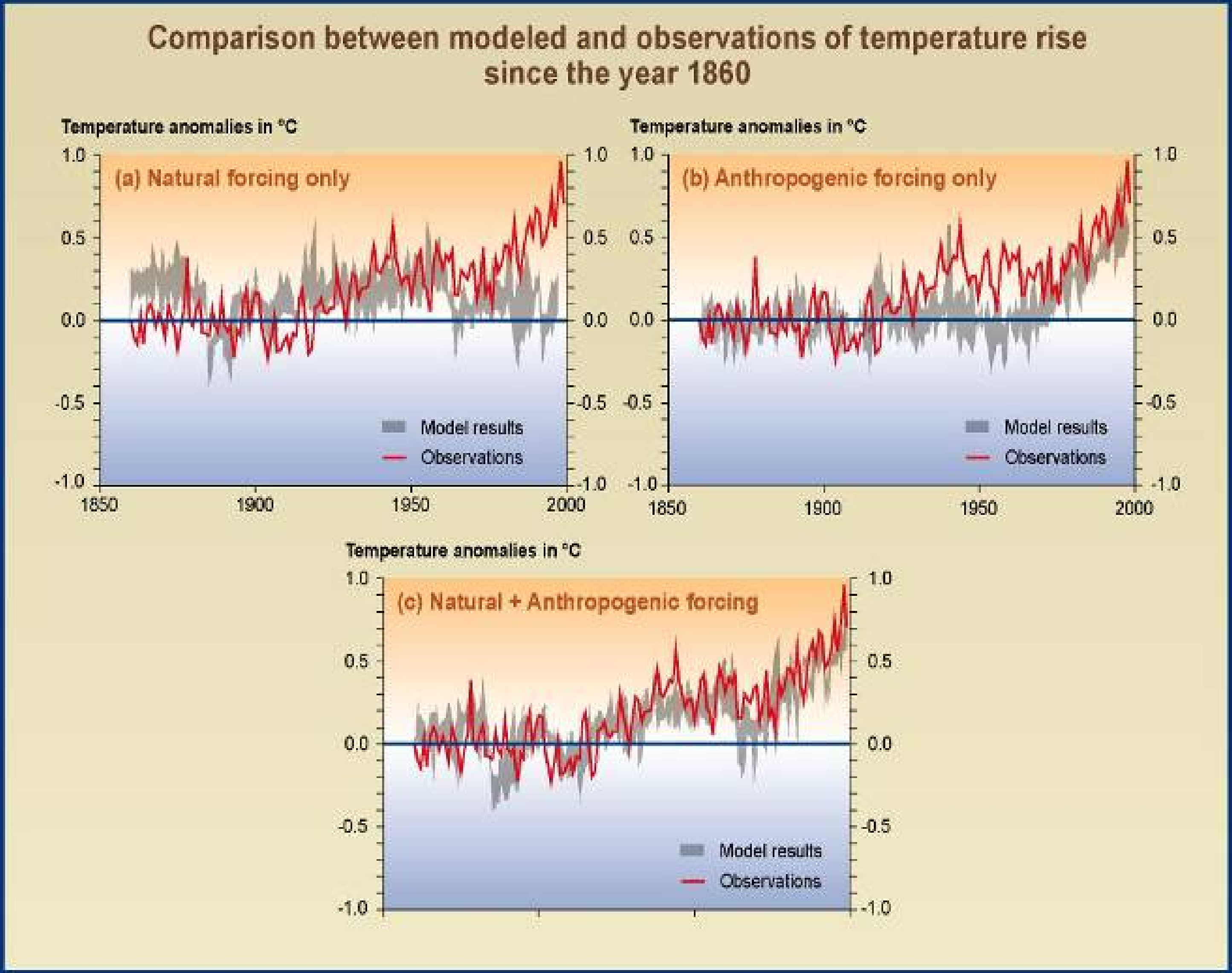


SYR - FIGURE 2-2

Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press.
Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.

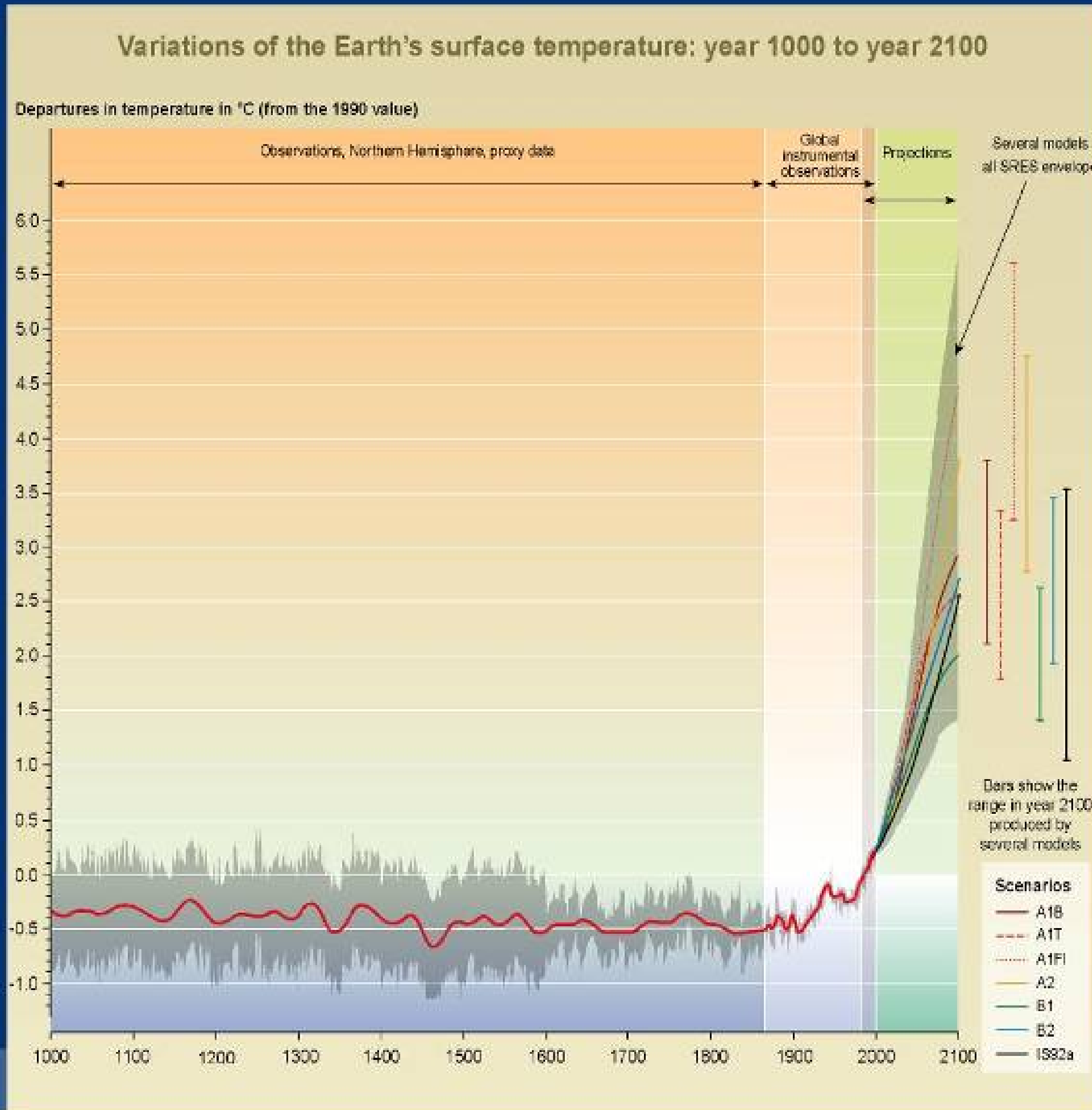
IPCC

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



SYR - FIGURE 2-4

Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press.



SYR - FIGURE 9-1b

IPCC

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

Mission 2013

Humans depend on the consumption of massive amounts of fossil fuels that in turn pump large amounts of greenhouse gases into the atmosphere.

Mission 2013

Increased CO_2 may lead to mean global temperatures that will destabilize ice sheets, raise sea-level, and decrease pH of seawater.

All of these could disrupt life as we know it for billions of people.

Mission 2013

If we continue to consume fossil fuels at current rate for next 300 years we will have levels of CO_2 not attained for the past 55 million years!

CO_2 Sequestration

- Burial in spent petroleum reservoirs
- Burial in saline aquifers
- Disposal in Basalt
- Disposal in deep ocean
- Disposal in lakes beneath ice caps
- Mineralization of Magnesium-rich rocks
- Disposal in seafloor basalts

Global Gardening

- Plant an area the size of France and Germany
- Plant biomass eg., timber
- Allow a quarter century of growth

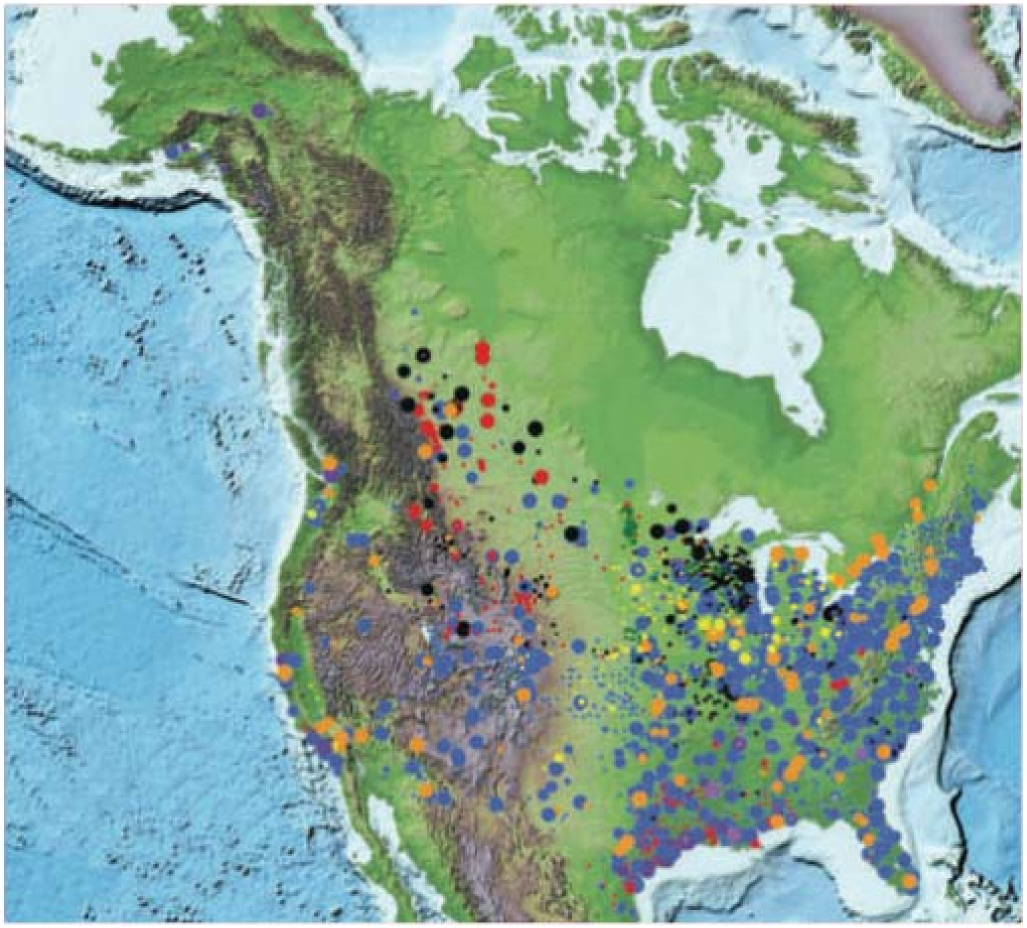
This volume and timescale could return atmosphere to pre-industrial CO_2 levels

Vision: "...an array of plantations supplying commodities such as energy and timber, as well as a livelihood for countless communities."

Criticism: Some scientists question whether biomass planting on this scale is "…a dream or a nightmare…"

Questions remain surrounding crop choice and productivity, implementation, and land use

Nature v. 451 Jan, 2008



Known stationary CO_2 sources

- Blue = electricity generation
- Orange = cement manufacturing
- Red = petroleum and natural gas processing

Locations of deep saline formations

- Sequester from 920-3400 billion tonnes of CO_2
- Existing oil and gas reservoirs and Unminable coal seams
  - 82 and 184 billion tonnes

But--"..turning saline formations from dream reservoir to sequestration reality remains a challenge."

Coral Calcification

•Reef-building corals are under physiological stress
  •Changing climate and increased ocean absorption of atmospheric CO_2

•Great Barrier Reef corals show decline in growth
  •Calcification decrease of 14.2% since 1990
  •Linear growth down 13.3%

•Unprecedented in last 400 years

•Calcification increases with increasing (overall) sea surface temperature

Cause of decline is unknown

Possibly increased temperature stress and/or declining

aragonite saturation in seawater

De'ath, Lough, and Fabricius

Important Questions to Address

- **Is there an acceptable, economically viable level of CO_2 that we should attain in the next several decades?**

Can we make reduction of greenhouse gases a matter of international consensus without stopping economic development?

- **Should we consider an Actinide based energy future as a replacement for Carbon based energy?**

Important Questions to Address

- **How do we sequester large amounts of CO_2 in geologically stable (10^4->10^6 years) locations?**

- **Can we extract CO_2 from the atmosphere as well as capture it at the point of production?**

- **What are the consequences of doing nothing?**

Class Structure

We will present possible team topics and allow you to "self-organize"

- Each of you will be assigned to a team, and each team will be assigned at least one upperclass teaching fellow (UTF), a library liaison, and multiple alumni mentors
- Each team will be responsible for proposing to the class one or more options for its assigned part of the solution
- Teams will work independently and will be responsible for their own solutions, although mentors and volunteer faculty resources may be called upon as "sounding boards".

First Assignment (Due Friday by noon)

- What are coal and petroleum made from?
- How much CO_2 is produced by burning a ton of coal?
- Where and how is the electricity generated that you use at home?
- Is there a relationship between human activities, CO_2 concentrations and global temperature?