



Global Warming:

The known, the unknown,
and the unknowable

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Changes in Greenhouse Gases From Ice Age to Modern Data

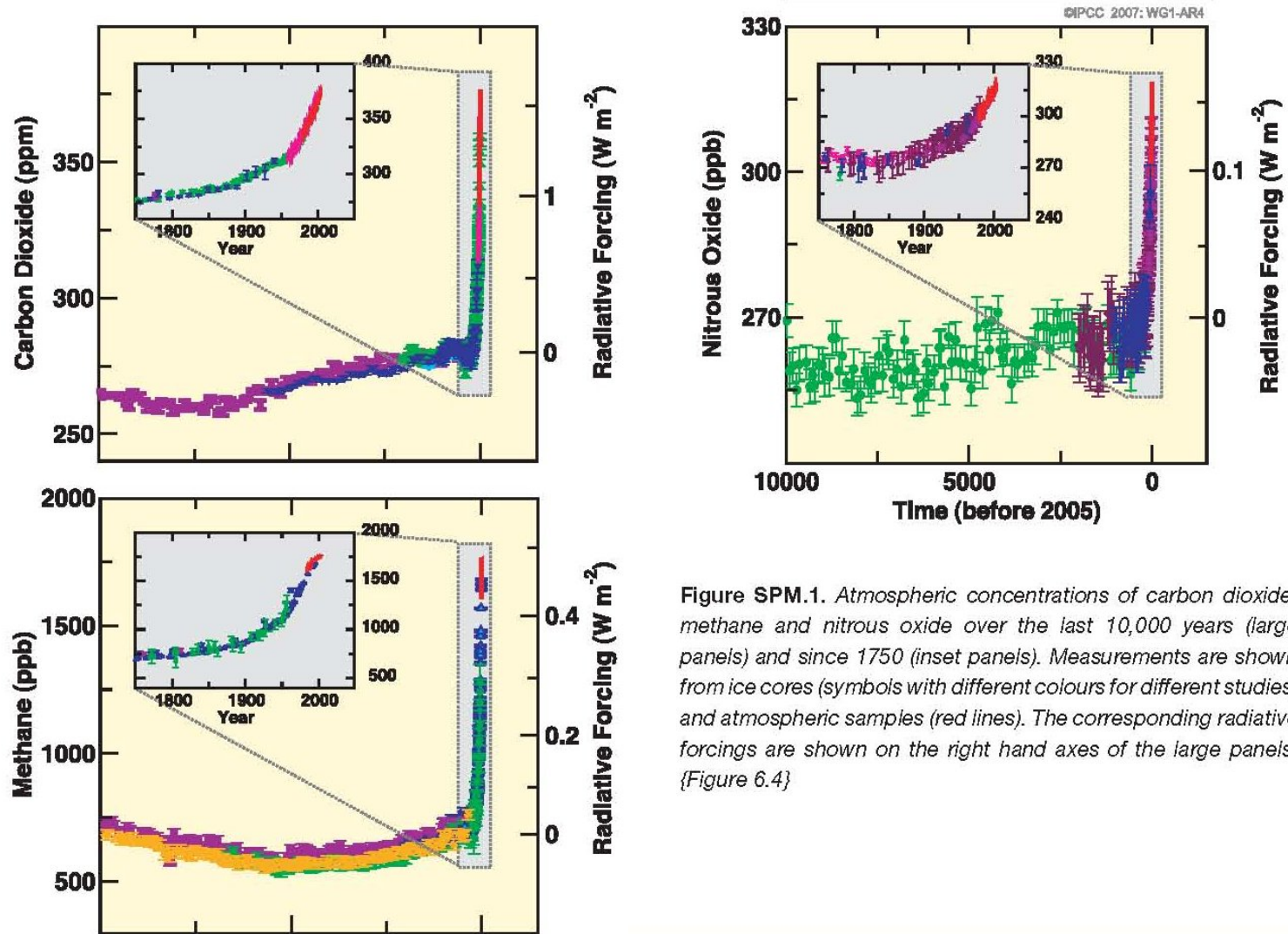


Figure SPM.1. Atmospheric concentrations of carbon dioxide, methane and nitrous oxide over the last 10,000 years (large panels) and since 1750 (inset panels). Measurements are shown from ice cores (symbols with different colours for different studies, and atmospheric samples (red lines). The corresponding radiative forcings are shown on the right hand axes of the large panels. {Figure 6.4}

Intergovernmental Panel on Climate Change (IPCC)

IPCC has been established by WMO and UNEP to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.

Working Group I: The Physical Science Basis

Working Group II: Impacts, Adaptation and Vulnerability

Working Group III: Mitigation of Climate Change

- **Largest number of U.S. scientists: nominated by the U.S. Govt.**
- **Highest skepticism : “U.S. Govt.”**

The Knowns (Observed)

- **CO₂ emissions have grown by 80% between 1970 and 2004.**
(2005: 379 ppm; All GHG: 455 ppm (CO₂ equivalent);
Primary reason: fossil fuel use and land-use change)
- **Rate of increase of CO₂, CH₄, N₂O was the largest in 10,000 years.**
- **Aerosols have partly offset the warming by CO₂.**
- **Global mean surface temp. increase (linear trend) 0.76°C in 100 years (1906-2005).**
- **Eleven of the past twelve years are the warmest on record.**
- **In the past 500 years, the warmest 50 years were 1951-2000.**

The Knowns (Observed)

- Sea level has risen 1.8 mm/yr since 1961; 3.1 mm/yr since 1993.
- Arctic sea ice extent reduced by 2.7% per decade since 1978. (The summer minimum on record; 2007)
- Enhanced run-off and earlier spring peak discharge in many glaciers and snow-fed rivers.
- Extreme hot nights have increased ; frost days have decreased.
- Earlier timing of spring events (blooms) on land.
- Poleward and upward shifts in plant and animal ranges.
- Changes in algal, plankton, and fish abundances (~Temp.).
- Increase in the acidity of oceans.

The Knowns (Models)

- **Limits of deterministic prediction**
(attribution of an event (Katrina) is not possible)
- **No model can explain the past 50 year observed global warming without increase in the green house gases (GHG).**
- **Sun and volcanoes would have produced cooling.**
- **There is no mechanism known to scientists that can explain the global structure of warming in the A, O, L without GHG.**
- **Warming and sea level rise would continue for centuries, even if GHG were stabilized.**
- **Increase in the frequency of heat waves and heavy precipitation.**
- **Entire disappearance of arctic late summer sea ice (~ 2100).**

The Unknowns

- **Predictability of climate models for small regions and extreme events.**
- **Change in the frequency and intensity of tropical cyclones.**
- **Timing for complete elimination of the Greenland ice sheet.
(sea level will rise by 7 meters)**
- **Antarctic ice sheet : too cold?, gain mass due to more snowfall?**
- **The probability of large abrupt climate change.**
- **Level of warming for extinction of species
(1.5 – 2.5°C: 20 - 30% ; > 4°C: > 40%)**
- **Carbon uptake by the oceans.**



STERN REVIEW:

The Economics of Climate Change

- 1. Ignoring climate change will damage economic growth. The damages accelerate as the world gets warmer.
(The poorest countries and people will suffer earliest and most)**
- 2. The damage will be on a scale similar to those associated with the great wars and the economic depression of the first half of the twentieth century.**
- 3. It will be difficult or impossible to reverse changes.**
- 4. The earlier effective action is taken, the less costly it will be.**
- 5. Expected annual cost of emissions reductions for stabilization at 550 ppm CO₂-eq. is likely to be around 1% of GDP by 2050. The cost of mitigation is modest relative to no action (risk ~ 5% loss of GDP per year).**

Adaptation, Mitigation, and Sustainable Development

1. Adaptation can reduce vulnerability to climate change.
2. Adaptive capacity is uneven across society and is connected to social and economic development
3. Substantial adaptation and mitigation can be achieved with existing technology.
4. Carbon pricing, either through taxes or cap-and-trade systems, is an essential incentive for implementing mitigation options.
5. There is a large low-cost mitigation potential between now and 2030 (energy infrastructure investment ~ 20 trillion dollars).

The Unknowables

1. Breakthrough in Science and Technology

- Alternative Source of Energy
- Carbon Capture and Storage Technology

2. Response of Social System to Global Change

- Behavior of Humans (Life Style and Consumption)
- Behavior of Govts. (War; Immigration; etc.)

3. Abrupt and Catastrophic Climate Change

- Sustainability of Population (Health, Agriculture)
- Breakdown of Social Order

4. What will be the Weather on 1 January 2100 ?

What should “we” do ?

- **Immediate action on conservation and energy efficiency**
- **Educate the public and help elect enlightened leaders and policymakers**
- **International dialogues and negotiations**
- **Social, economic, scientific, technological research to suggest options for adaptation and mitigation**
- **Develop next generation models (climate, social, economic) for improved projections of climate change and consequences**