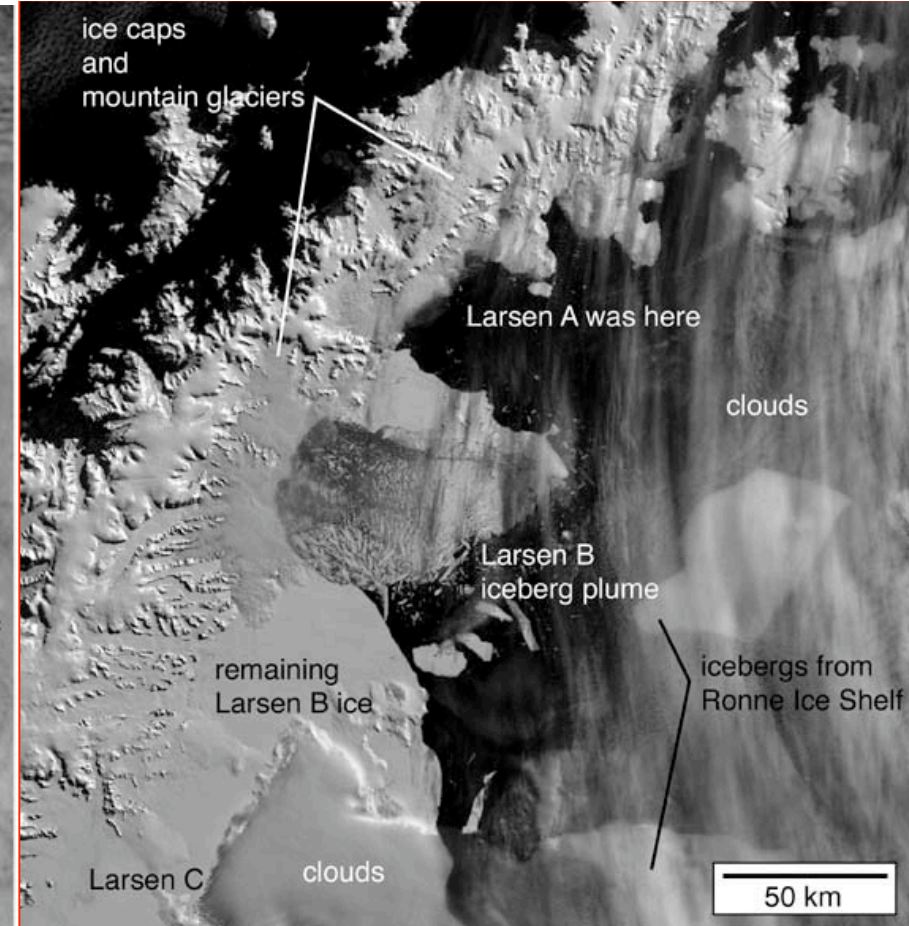
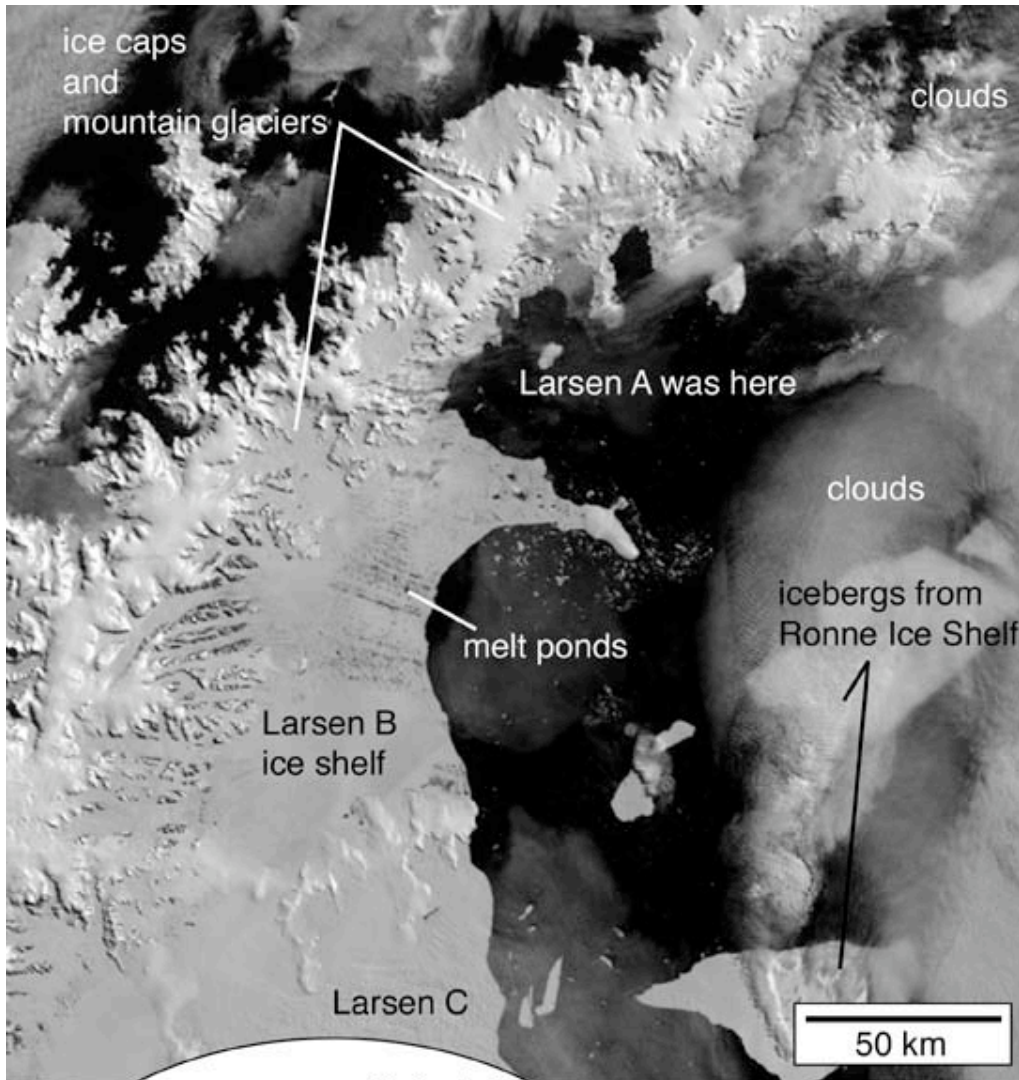
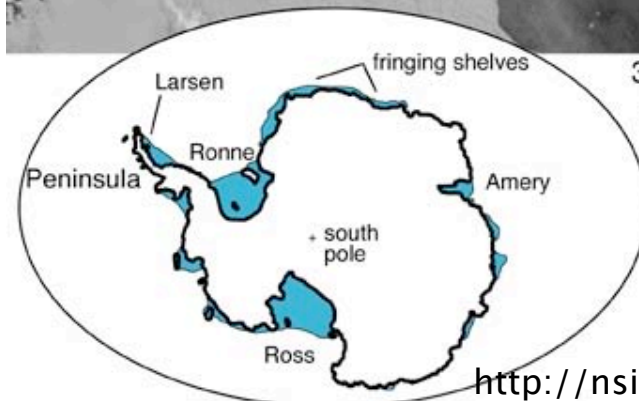


# Lecture 33

1. Impacts of rising sea-level
2. Global warming deniers or so-called “skeptics”



5 March 2002 image of the northeastern Antarctic Peninsula  
 The northern part of the Larsen B ice shelf has disintegrated, sending approximately 720 cubic kilometers of icebergs into the ocean. Because the ice was already floating, it does not affect sea level. The southern edge of the break-out tracks to the melt-pond boundary observed in the 31 January image.



31 January 2002 image of the northeast Antarctic Peninsula  
 The Peninsula's fringing ice shelves are retreating, in response to recent warming.

720 km<sup>3</sup> of Larsen B iceshelf disintegrated Jan-Mar 2002 = 29 trillion bags of party ice!

<http://nsidc.org/iceshelves/larsenb2002/>

# Ice shelves continued

## LARSEN B ICE SHELF DISINTEGRATION, ANTARCTICA

Air temperatures on the Larsen peninsula rose 2.5°C in the 20th century. Shelf thinned by up to 18 m from 1992-2001

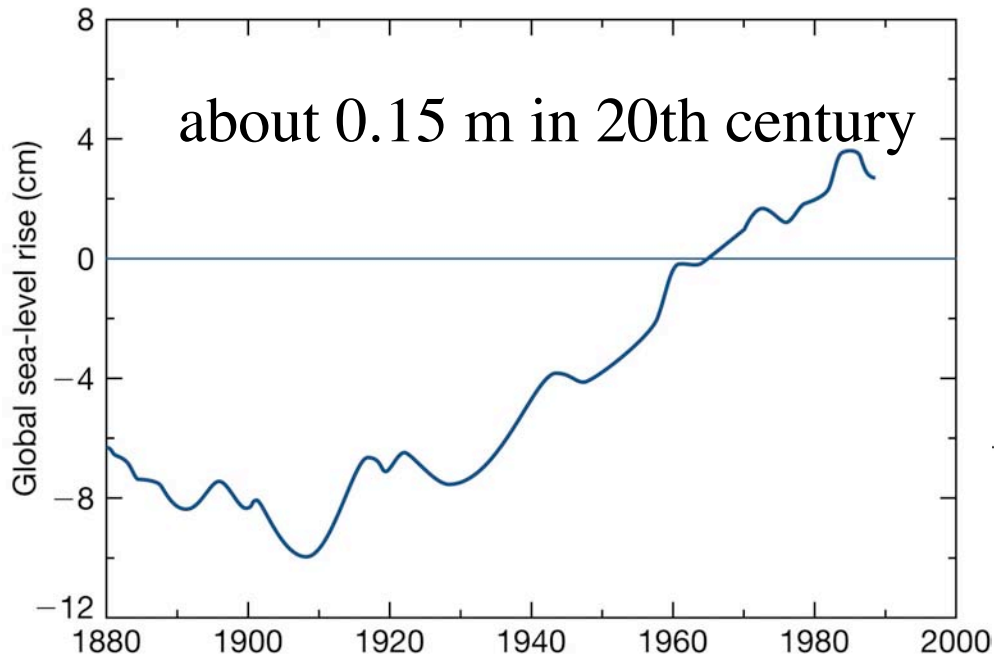
**Dec 2003:** Glaciers flowing down to Larsen B have sped up from 2000 to 2003 by 250% according to satellite image data.

This shows what would happen if the much larger **Ross Ice Shelf** were to disintegrate, i.e. not a gradual thinning but a non-linear step response (c.f. Hansen (2004) *Sci. Amer.* , concerned that IPCC has underestimated sea-level rise).

## WARD HUNT ICE SHELF, Ellesmere Is., Canada (NW of Greenland)

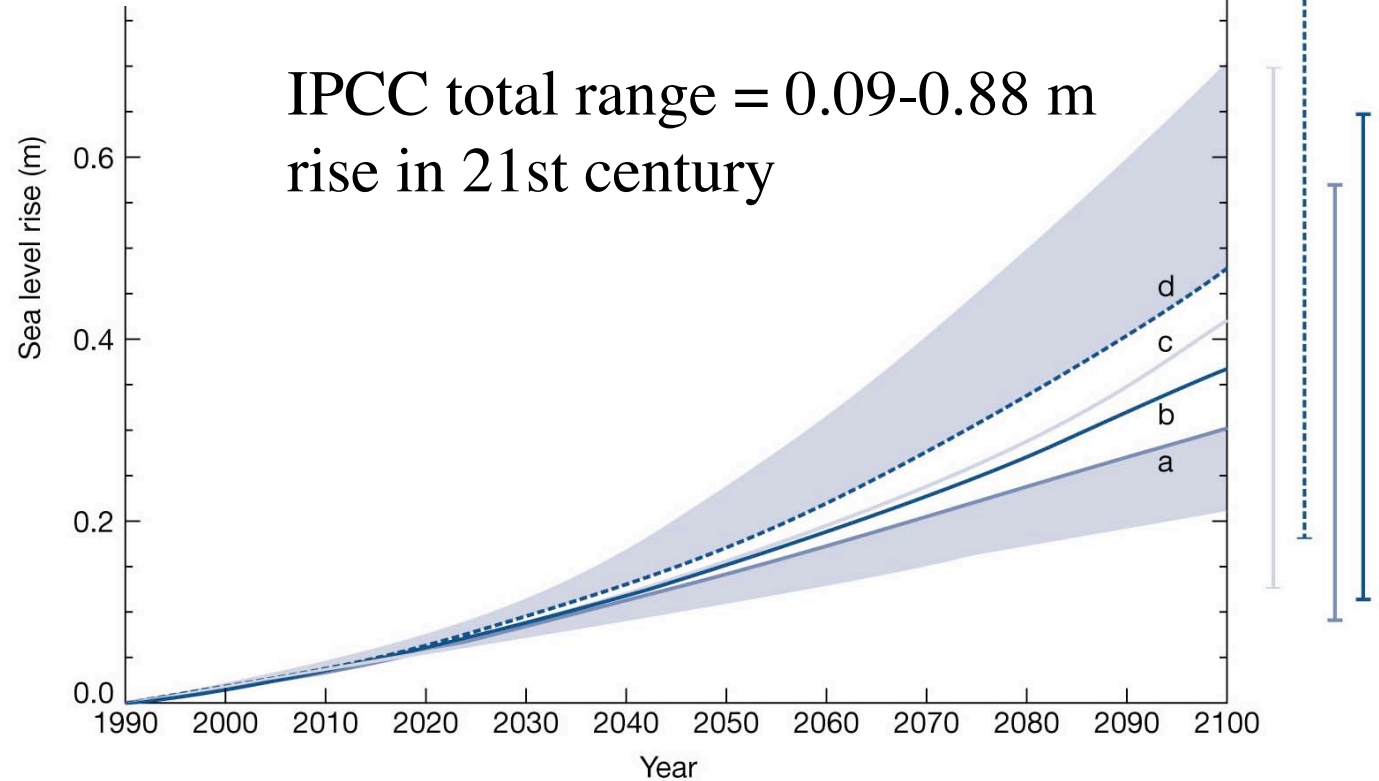
**Sept 2003:** A 3000-year old ice shelf fractured in two releasing the Northern Hemisphere's largest lake of ice-dammed freshwater into the sea. (About twice volume of Lake Washington).

# Sea-level rise: Past and Future



IPCC total range = 0.09-0.88 m  
rise in 21st century

IPCC assumes main contribution from thermal expansion; glacier/icesheet part is considered small



# Sea-level impacts

## **Storm surge flooding (IPCC)**

50 cm rise: increase of victims from 46m to 92m people /year

1 m rise: increase to 118m people/year

## **Flooding/submergence issues (IPCC)**

50 cm rise: inundate 8500-19000 km<sup>2</sup> of USA dry land  
eliminate 50% of coastal wetlands in USA

1 m rise: 17.5% of Bangladesh disappears (where most live)  
1% of Egypt (Nile area, where most agriculture)  
many small island states flooded/submerged  
displacement of 10s of millions of people

“[West Antarctic ice sheet] dynamics are still inadequately understood to make firm projections” (IPCC, 2001, p.642)

IPCC gave it a 5% chance of making a substantial contribution by 2100

# IPCC (2001) summary

## Main points

- The annual mean temperature of the Earth is increasing
- Most of the warming of the last 50 years can be attributed to humans
- GHGs (cause of warming) are projected to rise substantially
- aerosols (partial offset of warming) are not projected to rise substantially
  
- Mean annual surface temperature projection for 2100: +1.4 to +5.8 K
- Sea-level projection by year 2100: +0.1 to +0.9 m
  
- Projection in context:

"The projected rate of warming is much larger than the observed changes during the 20th century and is very likely to be without precedent during at least the last 10,000 years based on paleoclimate data."

# Global warming skeptics

Scientific skepticism = a healthy questioning of current paradigms based on uncertainty, new evidence, and/or the discovery of flaws in old science. This is how science advances.

So-called “skeptics” of global warming usually counter the paradigm of global warming with misinformation. Often they repeat old, discredited ideas, or falsehoods, or half-truths.

This is neither skepticism nor healthy.

Why spend classroom time on false arguments of skeptics? Because they are influential in

(a) public perception

(b) current US government policy -- e.g., skeptic “science” was influential in the defeat of the McCain-Lieberman Climate Stewardship Act of 2003.

## Leaked strategy document of Luntz Research, political consultants for the Bush Administration - What does this say about the attitude towards science?

*The most important principle in any discussion of global warming is your commitment to sound science. Americans unanimously believe all environmental rules and regulations should be based on sound science and common sense. Similarly, our confidence in the ability of science and technology to solve our nation's ills is second to none. Both perceptions will work in your favor if properly cultivated.*

*The scientific debate is closing [against us] but not yet closed. There is still a window of opportunity to challenge the science. Americans believe that all the strange weather that was associated with El Nino had something to do with global warming, and there is little you can do to convince them otherwise. However, only a handful of people believes the science of global warming is a closed question. Most Americans want more information so that they can make an informed decision. It is our job to provide that information.*

### LANGUAGE THAT WORKS

*"We must not rush to judgment before all the facts are in. We need to ask more questions. We deserve more answers. And until we learn more, we should not commit America to any international document that handcuffs us either now or into the future."*

*You need to be even more active in recruiting experts who are sympathetic to your view, and much more active in making them part of your message. People are willing to trust scientists, engineers, and other leading research professionals, and less willing to trust politicians. If you wish to challenge the prevailing wisdom about global warming, it is more effective to have professionals making the case than politicians. When you do enter the fray, keep your message short, concise, and refer to the source of the material you use. Back up your points with a limited number of facts and figures – but then explain why they matter.*

## General arguments of the "skeptics"

often  
used by  
the same  
skeptic!

### It isn't warming

- satellites do not show warming
- surface thermometers are biased by urban heat-island effect
- this or that region is not warming

### It is warming...but the warming is natural

- the Earth is still coming out of the Little Ice Age
- it was warmer during the Medieval Warm Period
- all changes are due to the Sun

### Climate models are hopelessly simplistic and unreliable

- past predictions have been wrong; why believe new ones?

### CO<sub>2</sub> does not cause warming

- it is a trivial part of the Earth's greenhouse effect, which is almost entirely due to water vapor
- all changes are due to the Sun (again)

### CO<sub>2</sub> and warming are beneficial; they will improve the Earth

- CO<sub>2</sub> is a plant fertilizer, not a pollutant
- a warmer Earth will be more productive biologically and more widely inhabitable, especially at high latitudes

## 1998 Petition

Petition mailed to thousands of U.S. people, mostly with bachelors degrees only, and nearly all not involved in climate research. Enclosed:

- "review article" formatted to look like a National Academy of Sciences publication that was, in fact, never published in any refereed journal.

### Petition

We urge the United States government to reject the global warming agreement that was written in Kyoto, Japan in December, 1997, and any other similar proposals. The proposed limits on greenhouse gases would harm the environment, hinder the advance of science and technology, and damage the health and welfare of mankind.

There is no convincing scientific evidence that human release of carbon dioxide, methane, or other greenhouse gases is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate. Moreover, there is substantial scientific evidence that increases in atmospheric carbon dioxide produce many beneficial effects upon the natural plant and animal environments of the Earth.

\_\_\_\_\_ Please sign here

Please send more petition cards for me to distribute.

My academic degree is B.S.  M.S.  Ph.D.  in the field of \_\_\_\_\_

# "Fake" article included in petition

## Environmental Effects of Increased Atmospheric Carbon Dioxide

ARTHUR B. ROBINSON ‡, SALLIE L. BALIUNAS †, WILLIE SOON †, AND ZACHARY W. ROBINSON ‡

‡Oregon Institute of Science and Medicine, 2251 Dick George Rd., Cave Junction, Oregon 97523 [info@oism.org]

†George C. Marshall Institute, 1730 K St., NW, Ste 905, Washington, DC 20006 [info@marshall.org]

January 1998

**ABSTRACT** A review of the research literature concerning the environmental consequences of increased levels of atmospheric carbon dioxide leads to the conclusion that increases during the 20th Century have produced no deleterious effects upon global weather, climate, or temperature. Increased carbon dioxide has, however, markedly increased plant growth rates. Predictions of harmful climatic effects due to future increases in minor greenhouse gases like CO<sub>2</sub> are in error and do not conform to current experimental knowledge.

### SUMMARY

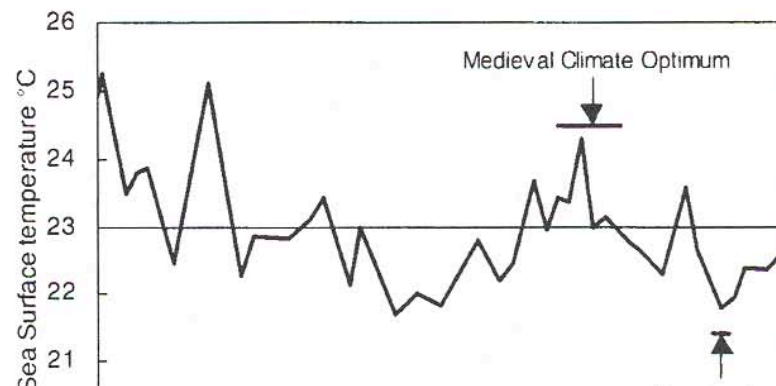
World leaders gathered in Kyoto, Japan, in December 1997 to consider a world treaty restricting emissions of "greenhouse gases," chiefly carbon dioxide (CO<sub>2</sub>), that are thought to cause "global warming" – severe increases in Earth's atmospheric and surface temperatures, with disastrous environmental consequences.

Predictions of global warming are based on computer climate modeling, a branch of science still in its infancy. The empirical evidence – actual measurements of Earth's temperature – shows no man-made warming trend. Indeed, over the past two decades, when CO<sub>2</sub> levels have been at their highest, global average temperatures have actually cooled slightly.

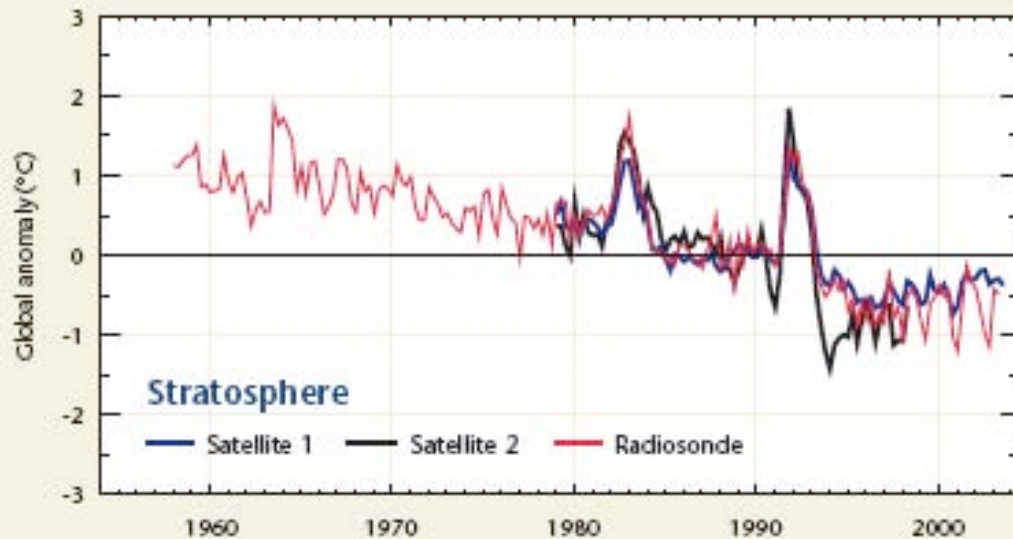
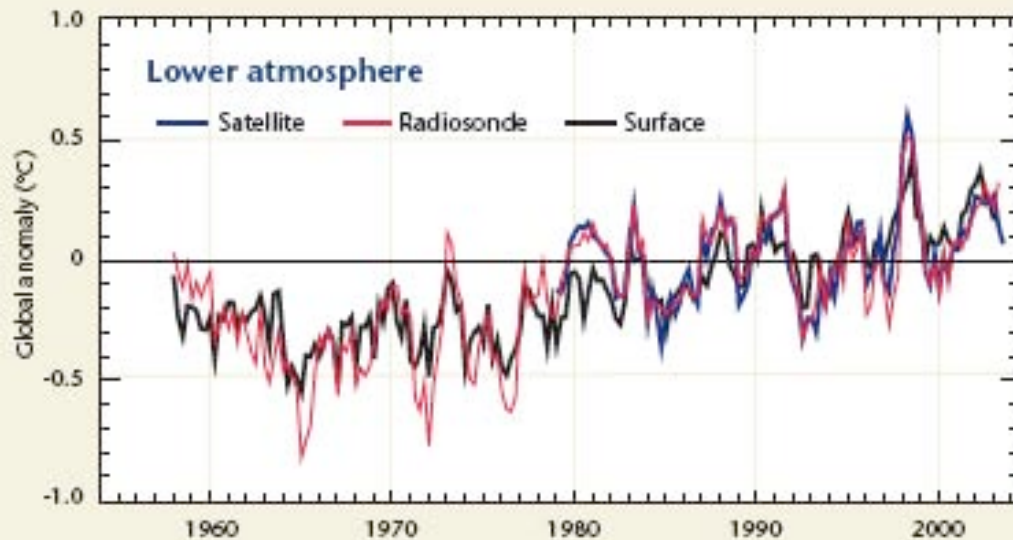
To be sure, CO<sub>2</sub> levels have increased substantially since the Industrial Revolution, and are expected to continue doing so. It is reasonable to believe that humans have been responsible for much of

figure 1 are the result of seasonal variations in plant use of carbon dioxide. Solid horizontal lines show the levels that prevailed in 1900 and 1940 (2). The magnitude of this atmospheric increase during the 1980s was about 3 gigatons of carbon (Gt C) per year (3). Total human CO<sub>2</sub> emissions – primarily from use of coal, oil, and natural gas and the production of cement – are currently about 5.5 GT C per year.

To put these figures in perspective, it is estimated that the atmosphere contains 750 Gt C; the surface ocean contains 1,000 Gt C; vegetation, soils, and detritus contain 2,200 Gt C; and the intermediate and deep oceans contain 38,000 Gt C (3). Each year, the surface ocean and atmosphere exchange an estimated 90 Gt C; vegetation and the atmosphere, 60 Gt C; marine biota and the surface ocean, 50 Gt C; and the surface ocean and the intermediate and deep oceans, 100 Gt C (3).



# The satellite temperature record



*Global average atmospheric temperatures in the lower atmosphere (troposphere) and in the stratosphere. The results are expressed relative to a 1981 to 2000 reference period.*

Global warming deniers say that the satellite data since 1979 shows no warming of the troposphere.

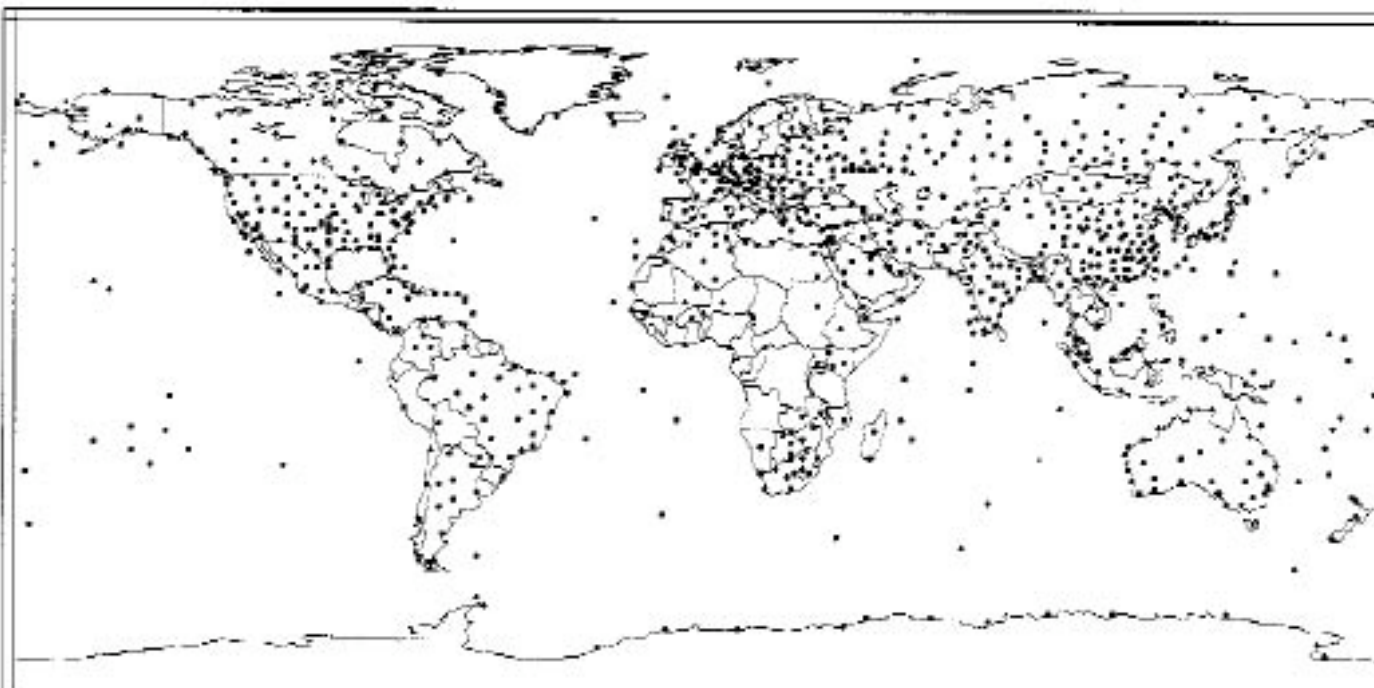
In fact the data (along with radiosondes (weather balloons)) tell us basically the same story as the surface temperature records. Note the coherent variations between records.

As expected with global warming, the stratosphere has cooled. (Qu.) Why is this expected with global warming?

Fig source:

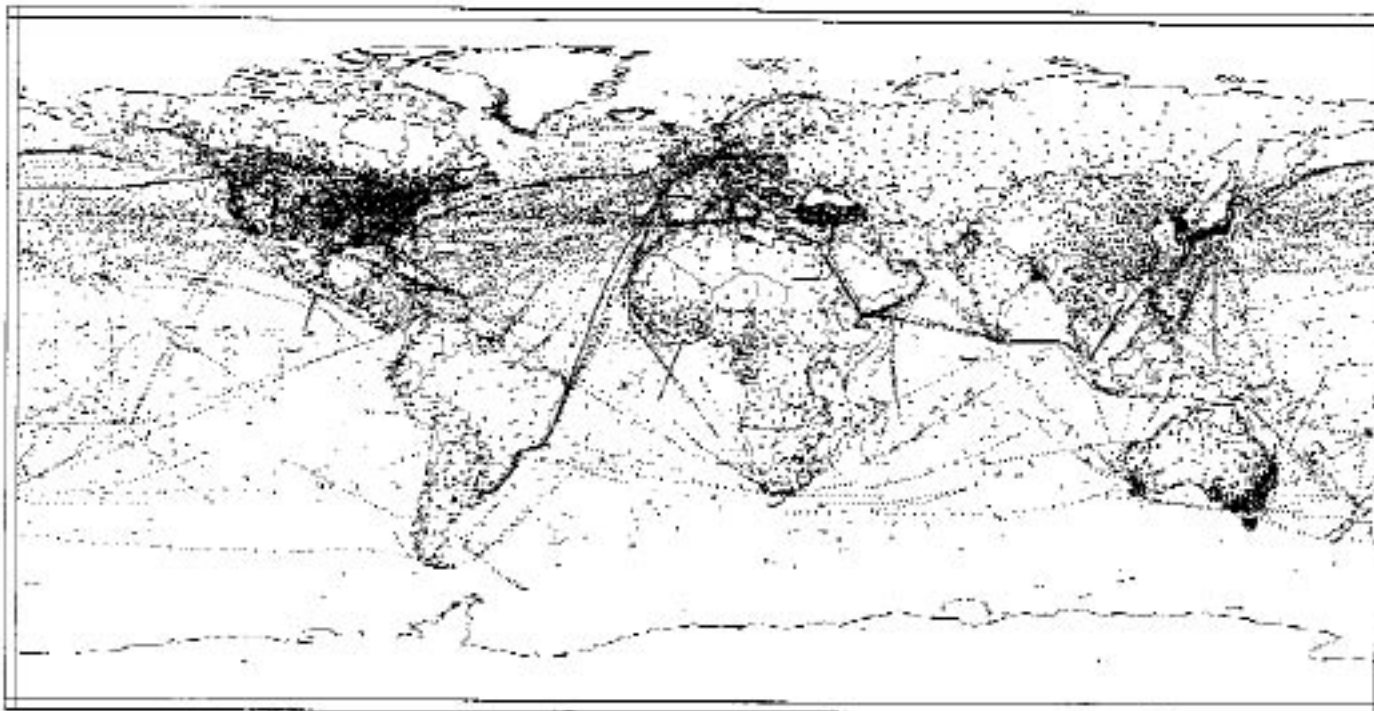
Hadley Centre Report, Dec 2003

<http://www.met-office.gov.uk/research/hadleycentre/index.html>



WMO  
(World  
Meteorological  
Organization)  
radiosonde  
network

-sparse over  
oceans,  
high latitudes



WMO surface  
station network,  
including  
ship-based,  
and buoys

Source: National  
Academy of Sciences  
(2000) report

# Solar-cycle hypothesis in *Wall Street Journal*, Dec 4, 1997

THE WALL STREET JOURNAL THURSDAY, DECEMBER 4, 1997

## Science Has Spoken: Global Warming Is a Myth

By ARTHUR B. ROBINSON  
And ZACHARY W. ROBINSON

Political leaders are gathered in Kyoto, Japan, working away on an international

ring and is unlikely ever to occur.

The temperature of the atmosphere fluctuates over a wide range, the result of solar activity and other influences. During

rise significantly, indeed catastrophically, if atmospheric carbon dioxide rises. Most of the increase in atmospheric carbon dioxide has occurred during the past 50

beyond current capabilities.

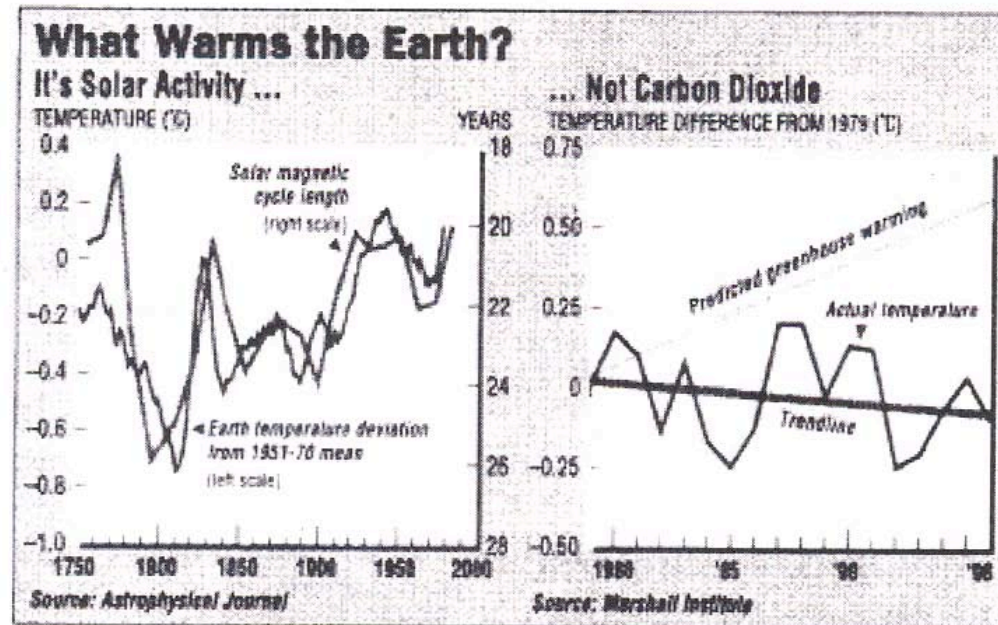
So we needn't worry about human use of hydrocarbons warming the Earth. We also needn't worry about environmental

it released.

er, and a few other house gases." For their physics and admit more solar here than they all, things are not so these substances in es and with other here in complex understood. Still, it theseize that rising xide levels might peratures to rise. "global warming," in extreme green-atmosphere leading onmental conse-

hypothesis, how- le. Scientists have

changes in solar activity.



The highest temperatures during this period occurred in about 1940. During the

such predictions. Although it is reason-

able to hope that these methods will eventually become useful, for now computer

### Lush Environmen

What mankind i drocarbons from be ing them into livin ing in an increasin of plants and anim carbon dioxide im will enjoy an Earth plant and animal li we now are blessed and unexpected gif revolution.

Hydrocarbons ar lift from poverty va across the globe. Thi all human beings to healthy, productive technological factor the increase in the quantity of human li expanded and un Earth's hydrocarbo proven reserves to



PERGAMON

Journal of Atmospheric and Solar-Terrestrial Physics 65 (2003) 801–812

ATMOSPHERIC AND  
SOLAR-TERRESTRIAL  
PHYSICS

[www.elsevier.com/locate/jastp](http://www.elsevier.com/locate/jastp)

## Solar activity and terrestrial climate: an analysis of some purported correlations

Peter Laut

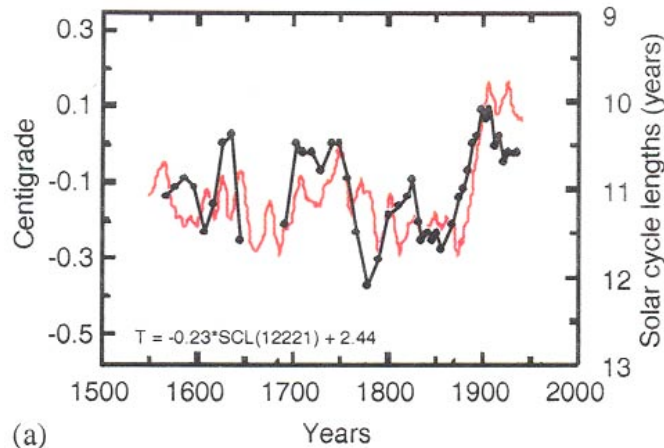
*Department of Physics, Technical University of Denmark, DK-2800 Lyngby, Denmark*

Received 14 February 2002; received in revised form 23 January 2003; accepted 4 February 2003

### **Abstract:**

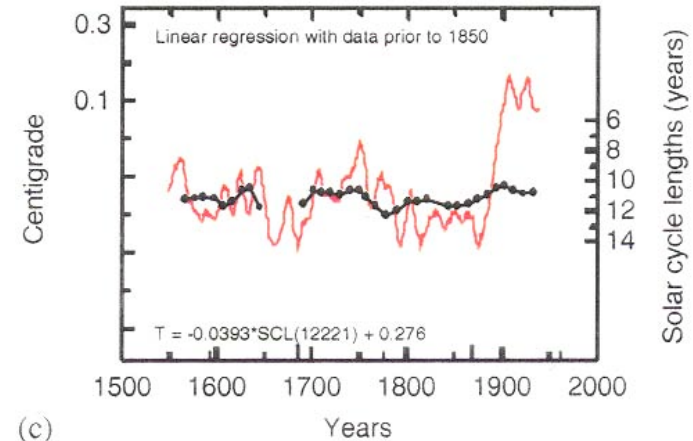
Hypotheses about solar-climate connections have been raised in both public and scientific debates about the possibility of man-made global climate change. I have analyzed a number of published graphs that have played a major role in these debates and which have been claimed to support solar hypotheses. My analyses show that **the apparent strong correlations displayed on these graphs have been obtained by an incorrect handling of the physical data.**

## Solar-cycle length vs GAAST: last 4 centuries



(a)

Friis-Christensen (2000): optimal correlation to industrial-era data (improper method for testing the cause of industrial-era warming)



(c)

Objective replotting by Laut (2003): by optimal correlation to pre-industrial data (known to lack human influence). Test of whether solar variations explain the industrial-era warming now fails.

## Questions that "skeptics" fail to confront

### First some indisputable facts

- CO<sub>2</sub> is increasing due to human activity
- CO<sub>2</sub> absorbs infrared radiation and participates in the Earth's greenhouse effect
- anthropogenic CO<sub>2</sub> currently imposes a climate forcing of +1.5 W/m<sup>2</sup> (more than 10-times any time-averaged variations in solar energy across many solar cycles - see **Lecture 28**)
- doubled CO<sub>2</sub>, almost certain by 2100, will impose a forcing of +4 W/m<sup>2</sup> (equivalent to increasing solar energy by 1.5%)

These facts lead to the following questions:

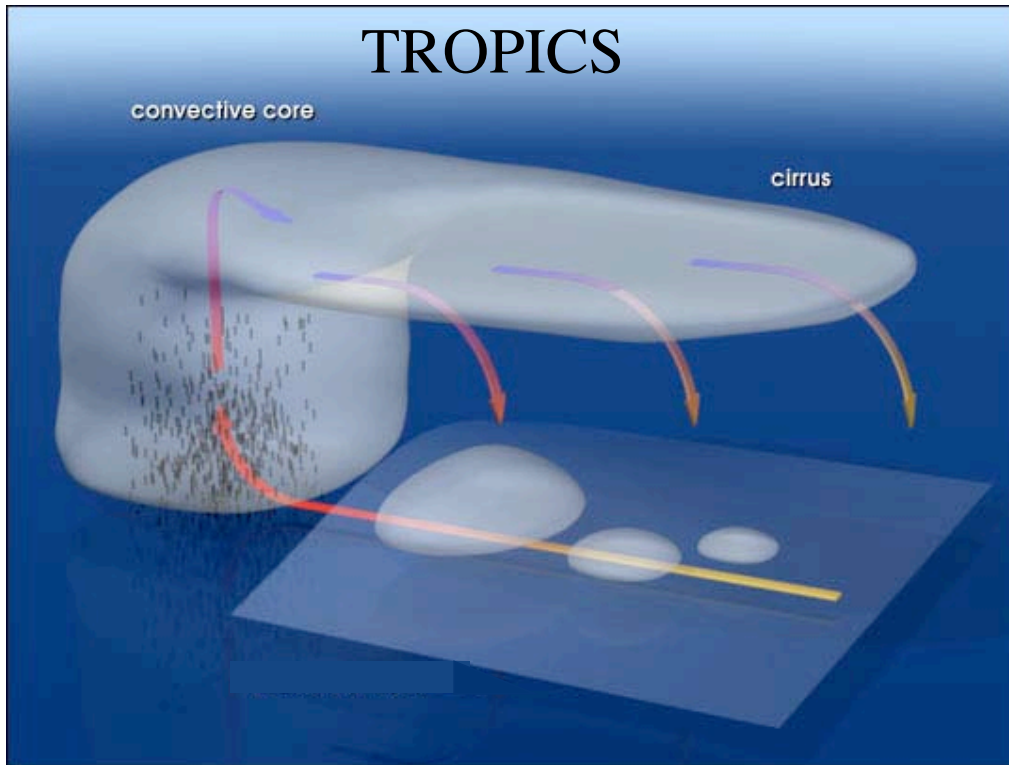
- How can a sustained, positive forcing be imposed upon the Earth without leading to a change in surface temperature?
- In other words, what strong negative feedback operates in the Earth's climate system that prevents temperature change in spite of imposed forcings? (And why does it not operate over Milankovich cycles, but only in the 20<sup>th</sup> and 21<sup>st</sup> centuries?)

# Lindzen

## Richard Lindzen's search for a negative feedback

- skeptical through peer-reviewed scientific research; a respectable approach
- assumes: that the Earth's climate over the past 10,000 years has been too stable. Assumes there MUST be a strong, negative feedback.
- His efforts have focused research on important and neglected aspects of the Earth's climate - in particular, the links between tropical convection and upper tropospheric water vapor.
- To date, he has put forward three or four versions of his negative feedback hypothesis. But all have failed to pass scientific scrutiny.

# Lindzen's adaptive iris hypothesis



- cirrus clouds add to warming (lets through visible, traps IR)
- low-level stratus clouds cool (albedo)

Lindzen argued that warmer sea surface temperature (SST) leads to more efficient precipitation in the cumulus convective cloud  
□ less cirrus => less warming  
i.e., a negative feedback in a key warm area of the Earth.

Lindzen et al. (2001): "Does the Earth have an adaptive infrared iris?", *Bulletin of the American Meteorological Society (BAMS)*, 82, 417-432.

But this hypothesis has been discredited by 4 scientific articles, e.g.

Hartmann and Michelsen (2002) "No Evidence for Iris", *BAMS* - used same data and showed that Lindzen's analysis was incorrect.

Lin et al (2002) - The Iris Hypothesis: A Negative or Positive Cloud Feedback? *Journal of Climate*: 15, 3-7. - larger range of observations, found a positive feedback