DATA SUPPORTING ANTHROPOGENIC GLOBAL WARMING:

BALANCING ECOLOGY WITH ECONOMICS

I will present data supporting the American Physical Society (APS) National Policy Statement:

"Emissions of greenhouse gases from human activities are changing the atmosphere in ways that affect the Earth's climate… Global warming is occurring." *http://www.aps.org/policy/statements/07_1.cfm*

Paul H. Carr, Ph. D.

AF Research Laboratory & U Mass Lowell Emeritus

Web page: www.MirrorOfNature.org

Paul H. Carr, Ph. D., debated with **Prof Laurence I. Gould, University of Hartford,** on Saturday, Nov 19. 2011 at the New England Section of the American Physical Society Meeting at the University of Massachusetts at Amherst.

DATA SUPPORTING ANTHROPOGENIC GLOBAL WARMING: BALANCING ECOLOGY WITH ECONOMICS

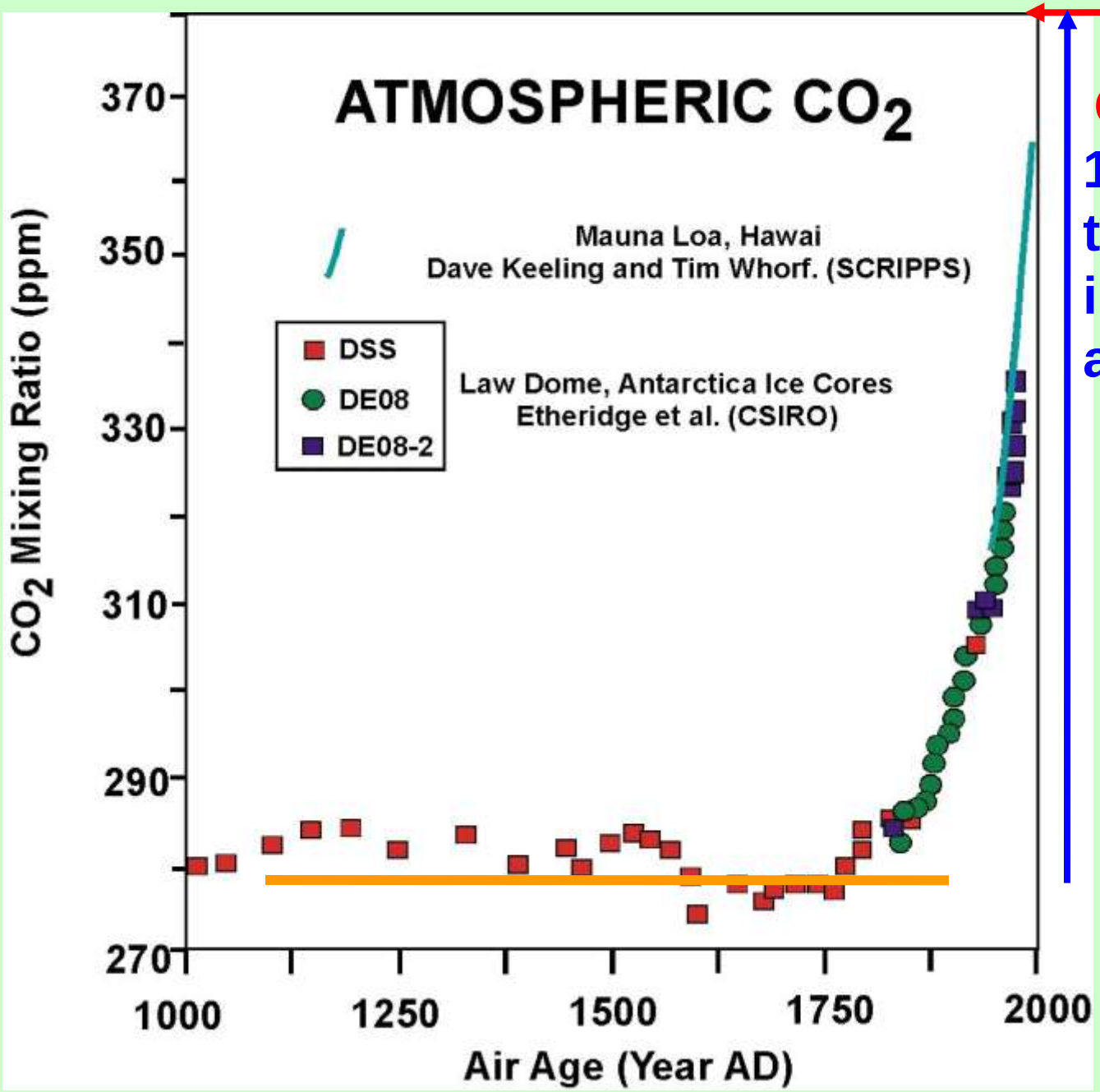
1. DATA ON HUMAN GLOBAL WARMING

2. LEARNING FROM PHYSICAL MODELING

3. INNOVATIVE NON-CARBON EMITTING TECHNOLOGY
Solution to Global Warming & Energy Independence

1. DATA ON ANTHROPOGENIC GLOBAL WARMING

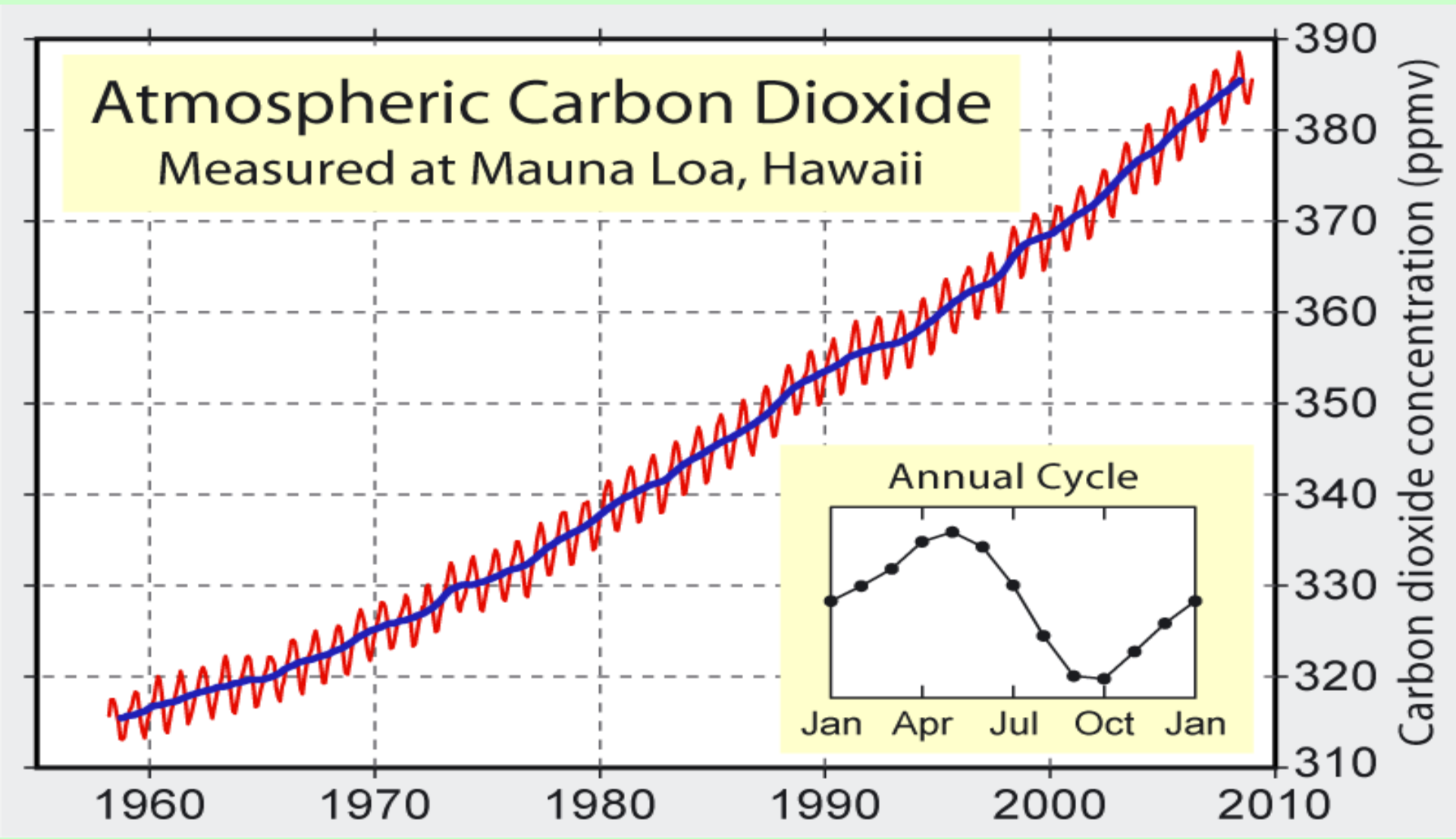
- Correlation of C02 and temperature increases since 1900.
- Carbon dioxide, CO2, is from burning fossil fuels (Carbon Dating).
- Increased greenhouse gases (C02) blanket and *warm* the earth's surface, allowing less heat to reach the stratosphere, which is *cooling*.
- Solar irradiance has not increased since 1940 (sunspot cycles).
- CO2 level of 390 ppm is 30% higher than in the last 600,000yrs.
  - Extrapolates to 900 ppm by 2100.
  - Present sea levels projected to increase 2.5 – 6 ft by 2100.
- In the next 1000 years, sea levels could be 100s of feet higher, as it was 51 M yrs ago, when earth was ice-free, & CO2 was 1000 ppm



CO2 levels now 110 ppm above the pre-industrial average

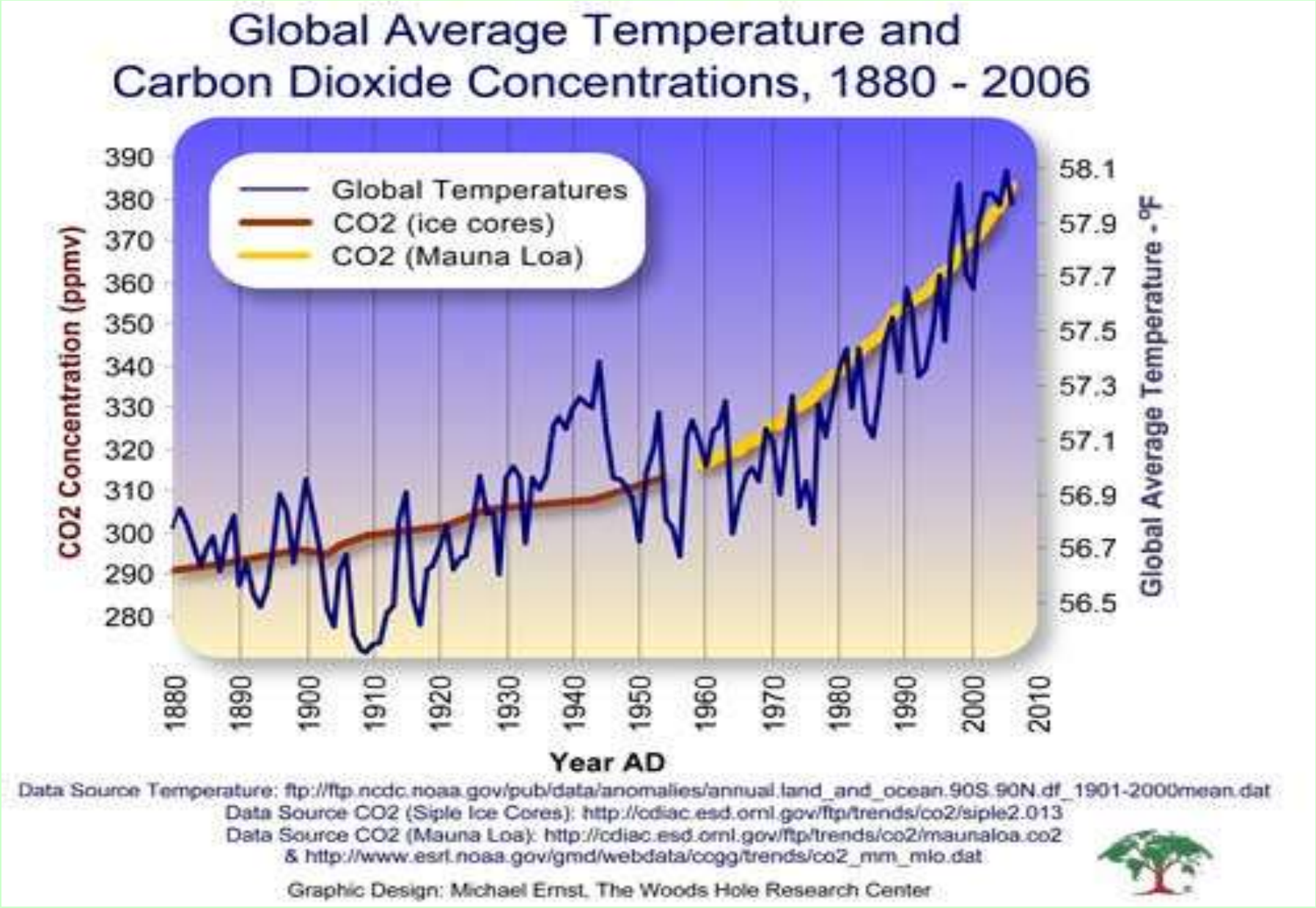
- Carbon isotope ratios indicate the CO2 increase since 1850 is from burning ~300 million yr old fossil fuels.

1875



•Seasonal variations, 6 ppm or 2%, are superposed on the C02 increase.

- Deciduous plants start to reduce CO2 in the spring.
- CO2 from fossil fuels starts to increase in the fall.



CORRELTAION BETWEEN TEMP AND CO2 INCREASE. IS THERE A PHYSICAL PROCESS LINKING TEMPERATURE INCREASE TO THAT OF GREENHOUSE GAS CO2?

TEMPERATURES ON THE MOON

No greenhouse gas atmosphere

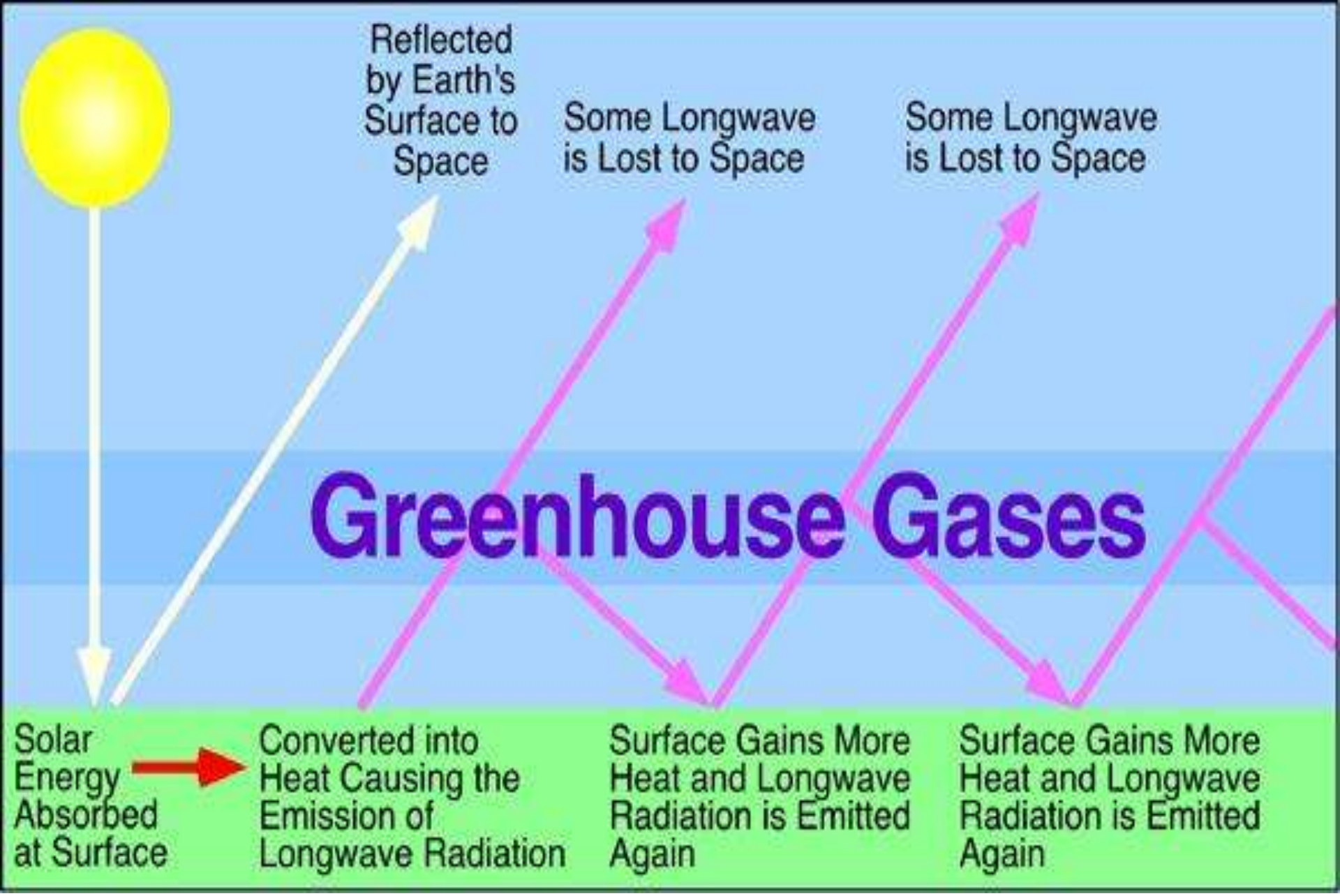
- Diurnal Variations:

Day 123 C (396 Kelvin)

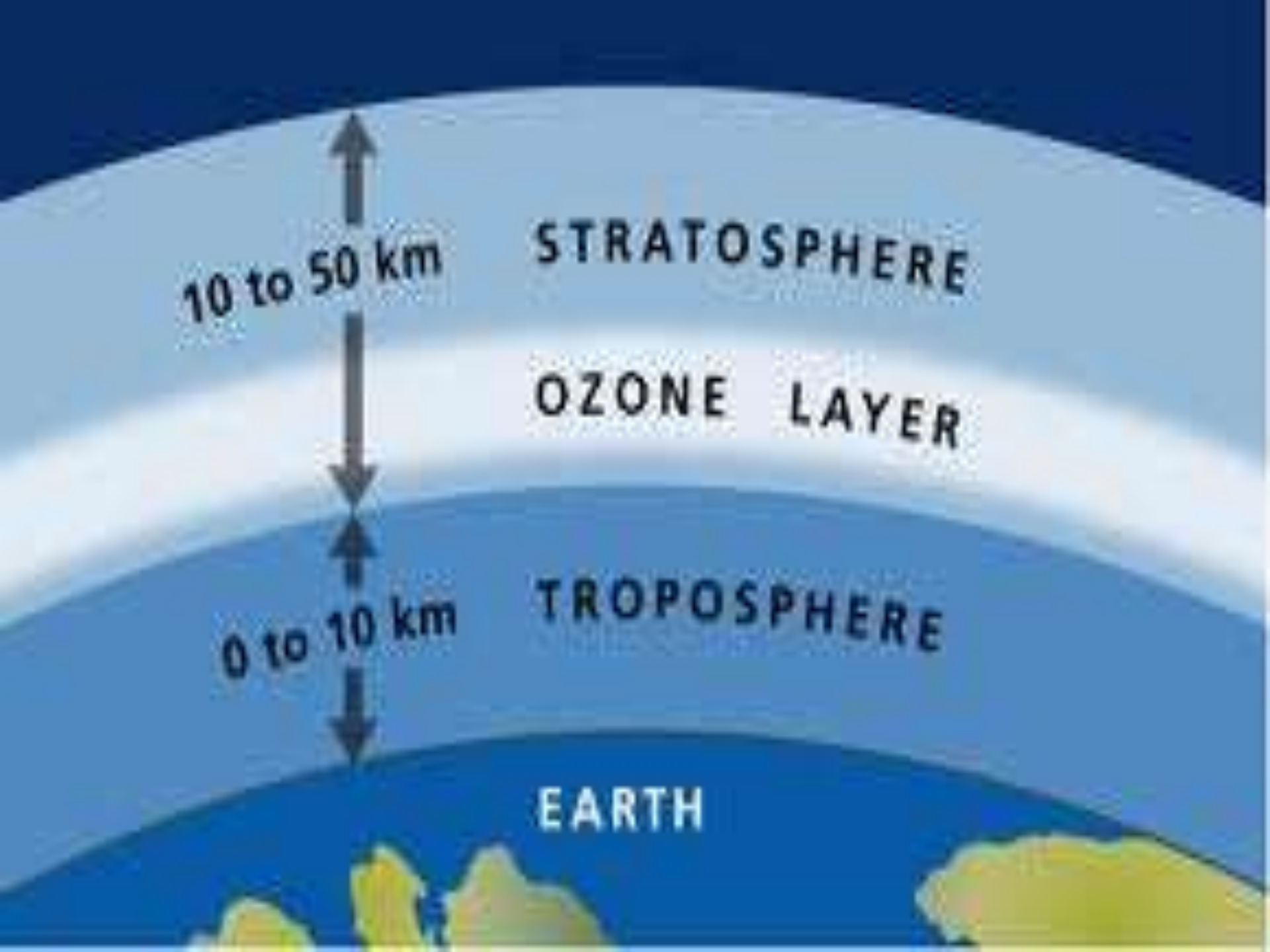
Night -233 C (40 Kelvin)

ON EARTH

- Greenhouse gasses, blanketing the **earth**, give much smaller variations.
- On cloudless nights, non-condensing, persistent, and increasing CO2, plus temperate dependent H20 vapor, keeps us warmer than on the moon.



Hypothesis: Increasing CO_2 gas density: 1. raises temperature of earth's surface. 2. reduces temperature of the stratosphere.


10 to 50 km
STRATOSPHERE
OZONE LAYER
0 to 10 km
TROPOSPHERE
EARTH

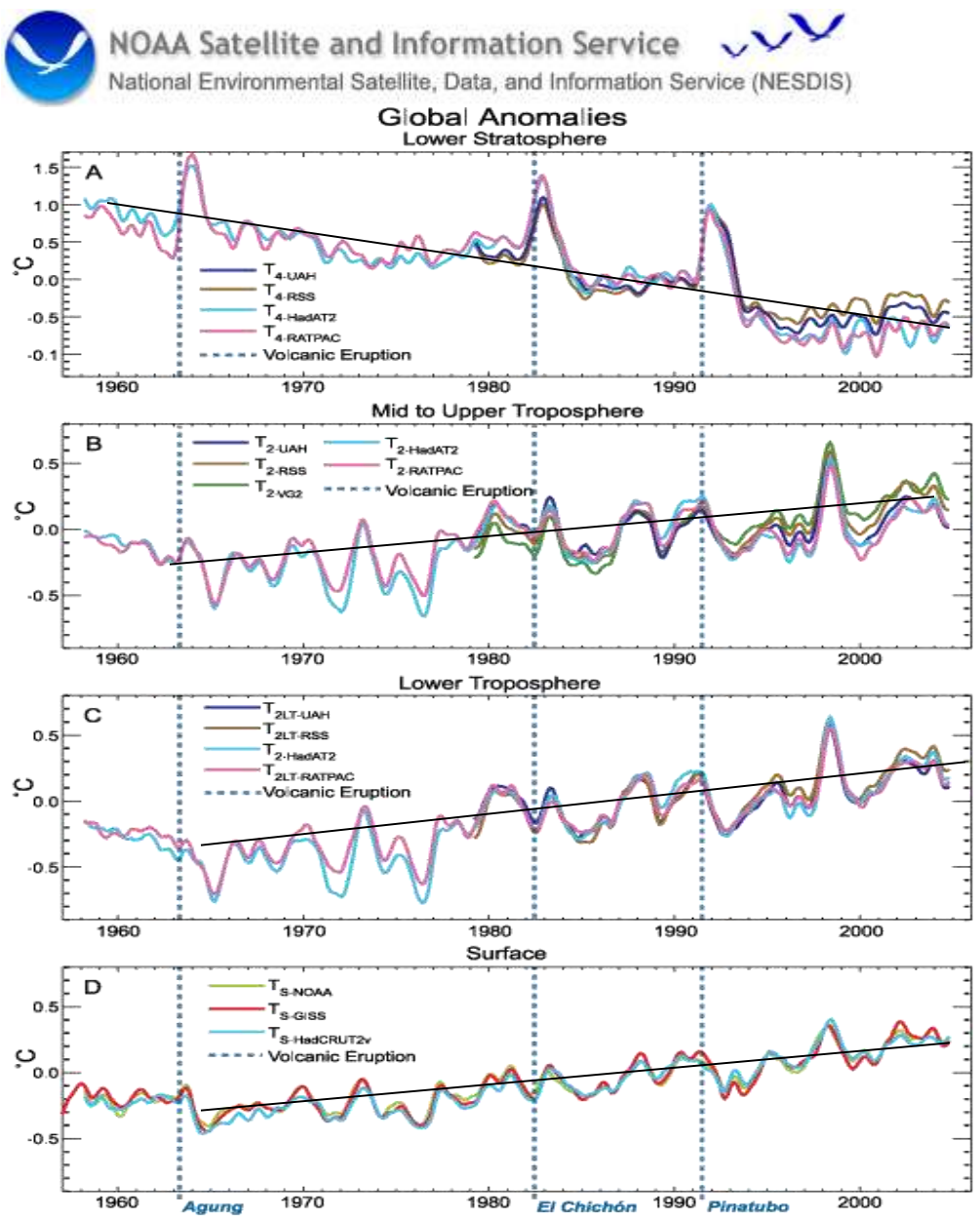


Figure 3.17. Observed surface and upper-air temperature anomalies (°C). (A) Lower stratospheric T4, (B) Tropospheric T2, (C) Lower tropospheric T2 MSU satellite analyses and UKMO HadAT2 and NOAA RATPAC radiosonde observations; and (D) Surface records from NOAA, NASA/GISS and UKMO/CRU (HadCRUT2v). All time series are monthly mean anomalies relative to the period 1979 to 1997 smoothed with a seven-month running mean filter. Major volcanic eruptions are indicated by vertical blue dashed lines. Adapted from Karl et al. (2006).

Satellite and Radiosonde (weather balloon) Data.

Lower Stratosphere (60,000ft) is cooling

The increased "blanketing" effect in the lower atmosphere holds in more heat, allowing less to reach the stratosphere

Earth's surface is warming.

If the solar irradiance were increasing, the surface & stratosphere would both increase.

opinion

Solar variability does not explain late-20th-century warming

Philip B. Duffy, Benjamin D. Santer, and Tom M. L. Wigley

Philip Duffy is scientific director in the Palo Alto, California, office and a senior research scientist at Climate Central Inc. **Benjamin Santer** is a physicist in the program for climate model diagnosis and intercomparison at Lawrence Livermore National Laboratory in Livermore, California. **Tom Wigley** is a senior scientist at the National Center for Atmospheric Research in Boulder, Colorado.

The hypothesis of Nicola Scafetta and Bruce West (see their Opinion piece, PHYSICS TODAY, March 2008, page 50), that most of the observed global warming trend since 1950 is due to variations in total solar irradiance (TSI), is at odds with observations and theory. They argue that near-surface temperatures are strongly influenced by both the well-known 11-year cycle in TSI and shorter-time-scale TSI variations.

As for the 11-year cycle in TSI, satellite measurements of TSI since 1979 show variations that are very small (about 0.1%) and cyclical (see figure 1). If Earth's surface temperature were highly sensitive to those variations, the 11-year cycle in TSI would produce an 11-year cycle in observed surface temperatures. The filtered and smoothed temperature record presented by Scafetta and West appears to show a significant 11-year cycle. However, an exhaustive analysis of the latter half of the 20th century by Gerald North and his collaborators found a temperature cycle with an amplitude of no more than a few hundredths of a degree Celsius, with a significance level of only 25%.[1] Even that small signal, which is

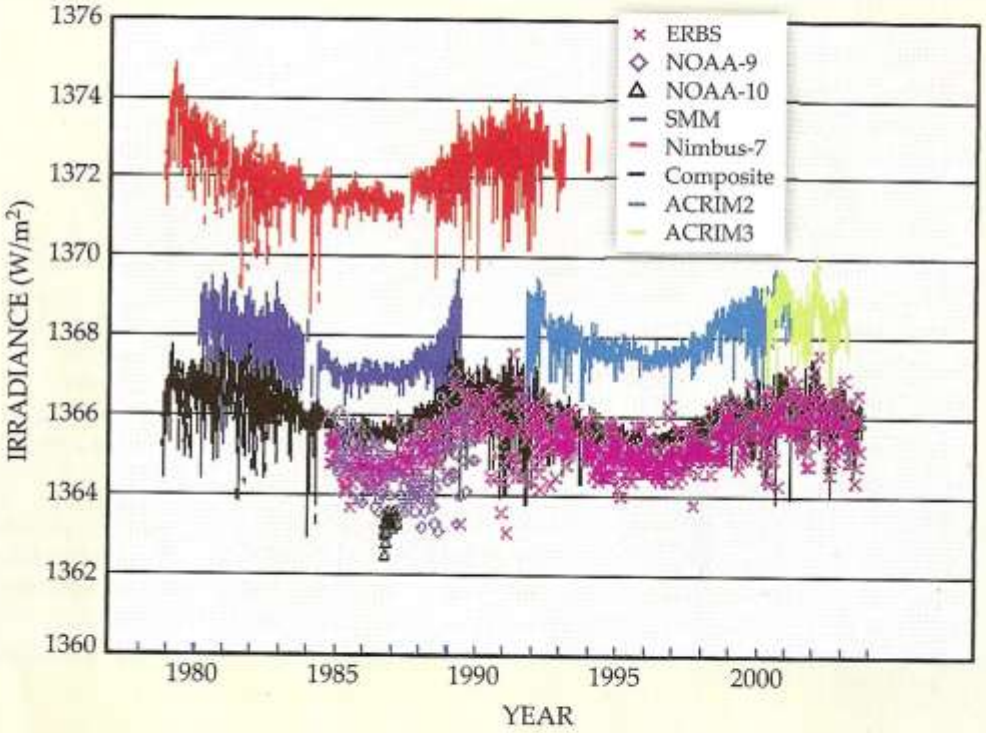


Figure 1. Satellite measurements of total solar irradiance show no increasing trend. ERBS, NOAA-9, NOAA-10, SMM, Nimbus-7, ACRIM2, and ACRIM3 are all measurements from specific satellites. The curve labeled composite is based on results from all the satellites. (Data are from the National Oceanic and Atmospheric Administration, National Geophysical Data Center, http://www.ngdc.noaa.gov/stp/SOLAR/IRRADIANCE/irrad.html.)

"Physics Today"

Jan 2009

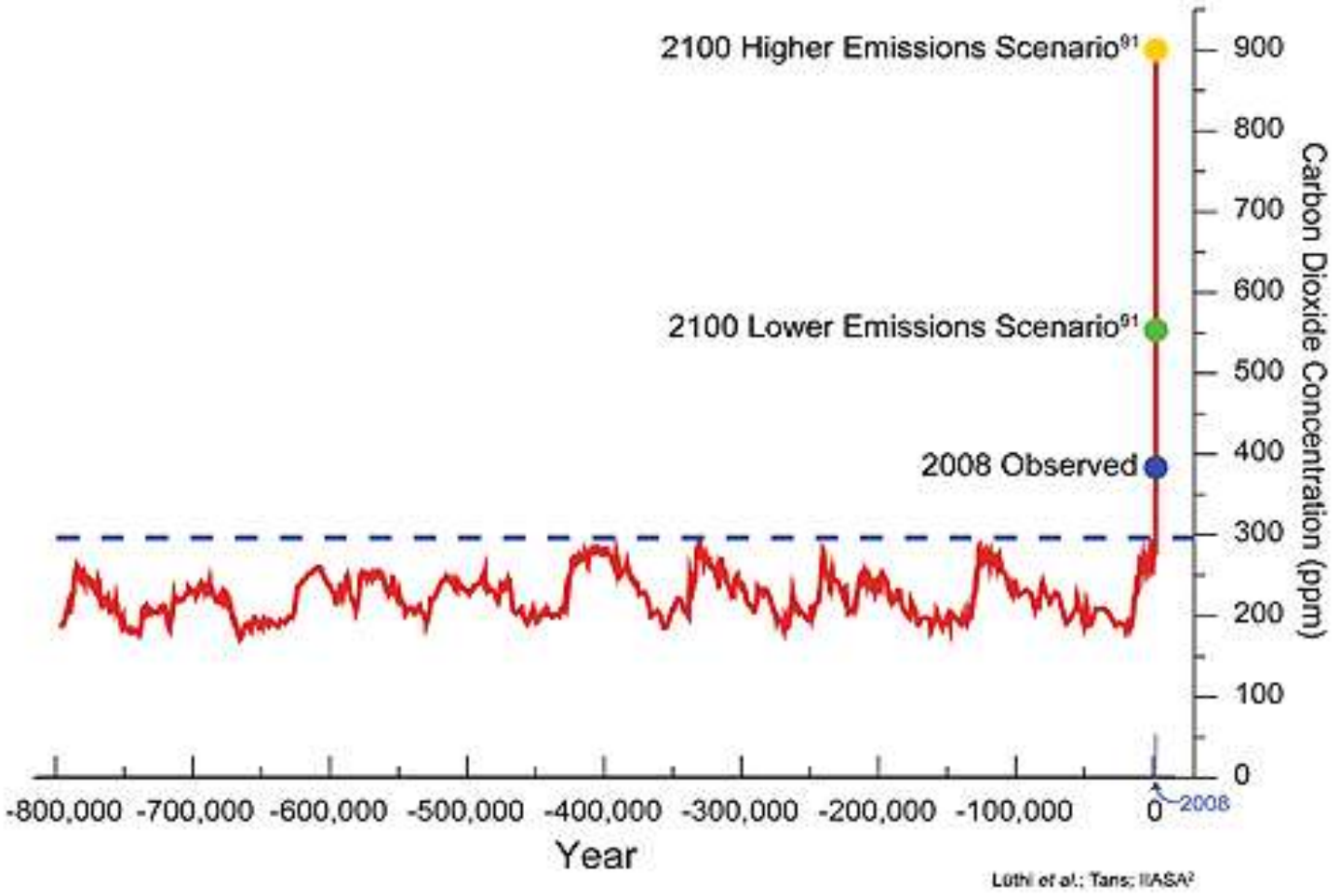
Pg. 48.

11- yr sun-spot cycle.

No increase

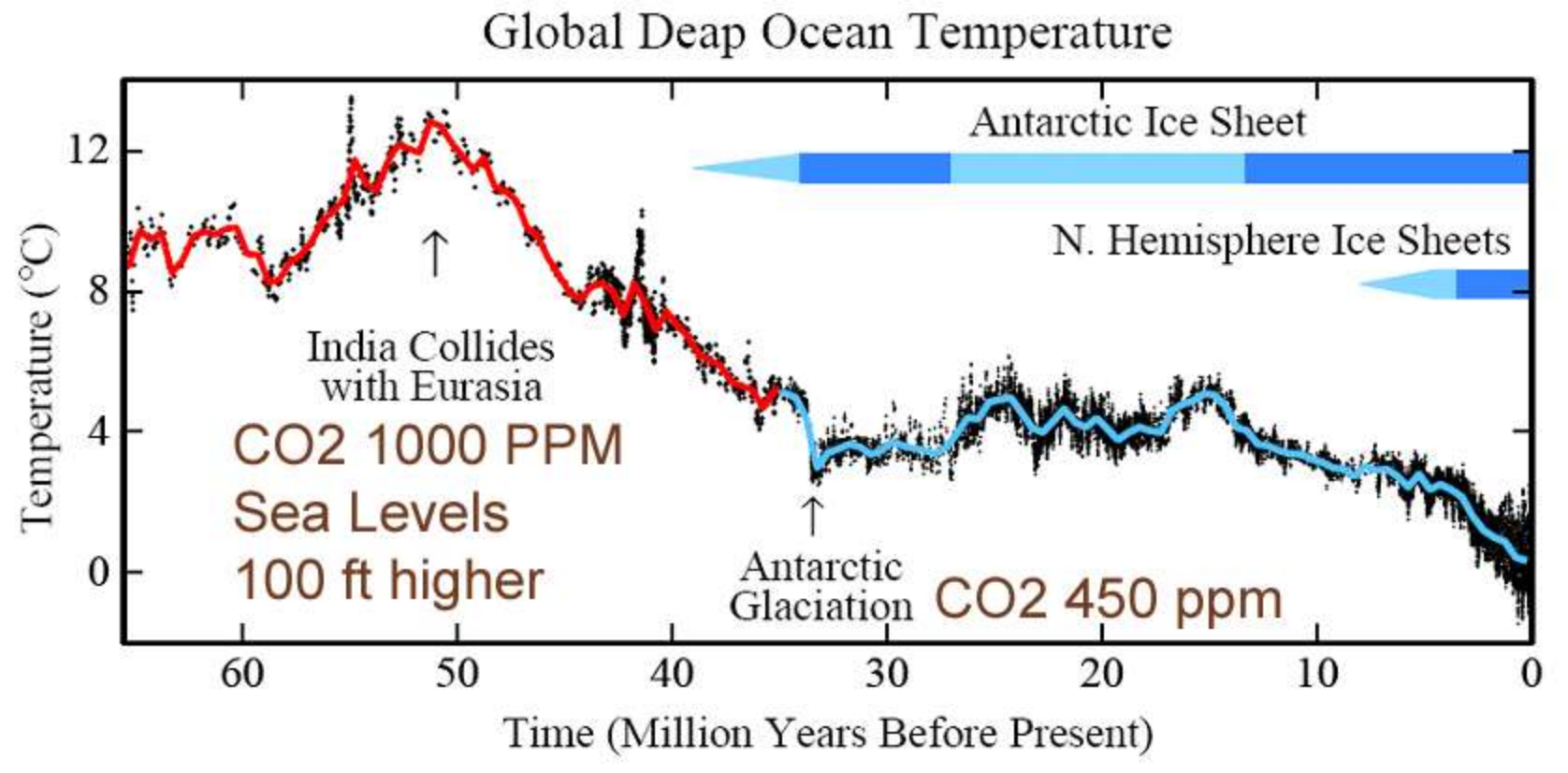
in solar irradiance since 1979.

CO2 CONCENTRATIONS HIGHEST (31%) IN 800,000 YRS.



Analysis of air bubbles trapped in an Antarctic ice core extending back 800,000 years documents the Earth's changing carbon dioxide concentration. Over this long period, natural factors have caused the atmospheric carbon dioxide concentration to vary within a range of about 170 to 300 parts per million (ppm). Temperature-related data make clear that these variations have played a central role in determining the global climate. As a result of human activities, the present carbon dioxide concentration of about 385 ppm is about 30 percent above its highest level over at least the last 800,000 years. In the absence of strong control measures, emissions projected for this century would result in the carbon dioxide concentration increasing to a level that is roughly 2 to 3 times the highest level occurring over the glacial-interglacial era that spans the last 800,000 or more years.

At 2 ppm rise per year, humans are increasing CO2 at a **rate that is about 80 times that of the fastest natural rate and almost 2000 times the average rate** over the past 800,000 years!



Dinosaur Extinction 65M yr

Figure from Dr. James Hansen, NASA GISS

- **Our present level of 390 ppm extrapolates to 900 ppm by 2100.**
- **Antarctica became ice-free when CO2 reached 450 ± 100 ppm.**
- **Global temperature peaked 51-55 million years ago,**

  -earth was was ice-free, sea levels 100s of feet higher.
- **Atmospheric CO_2 amount was ~ 1000 ppm 51 million years ago.**

Photograph by Ira Block **When the Ocean Went Dark**

National Geographic October 2011, vol 220. no 4. pg. 90

http://ngm.nationalgeographic.com/2011/10/hothouse-earth/kunzig-text

Paleoceanographer James Zachos holds a replica of a sediment core that shows an abrupt change in the Atlantic Ocean 51 -55 million years ago, at the onset of the Paleocene-Eocene Thermal Maximum (PETM). White plankton shells vanished from the seafloor mud, shifting its color from white to red. **As planet-warming CO2 and CH4 clathrates surged into the atmosphere**, Zachos says, **it also seeped into the seas, acidifying the water and dissolving the shells.**

Methane discovery stokes new global warming fears & shock, as retreat of Arctic ice releases greenhouse gas

13 Dec 2011 http://www.independent.co.uk/news/science/methane-discovery-stokes-new-global-warming-fears-shock-as-retreat-of-arctic-releases-greenhouse-gas-6276278.html

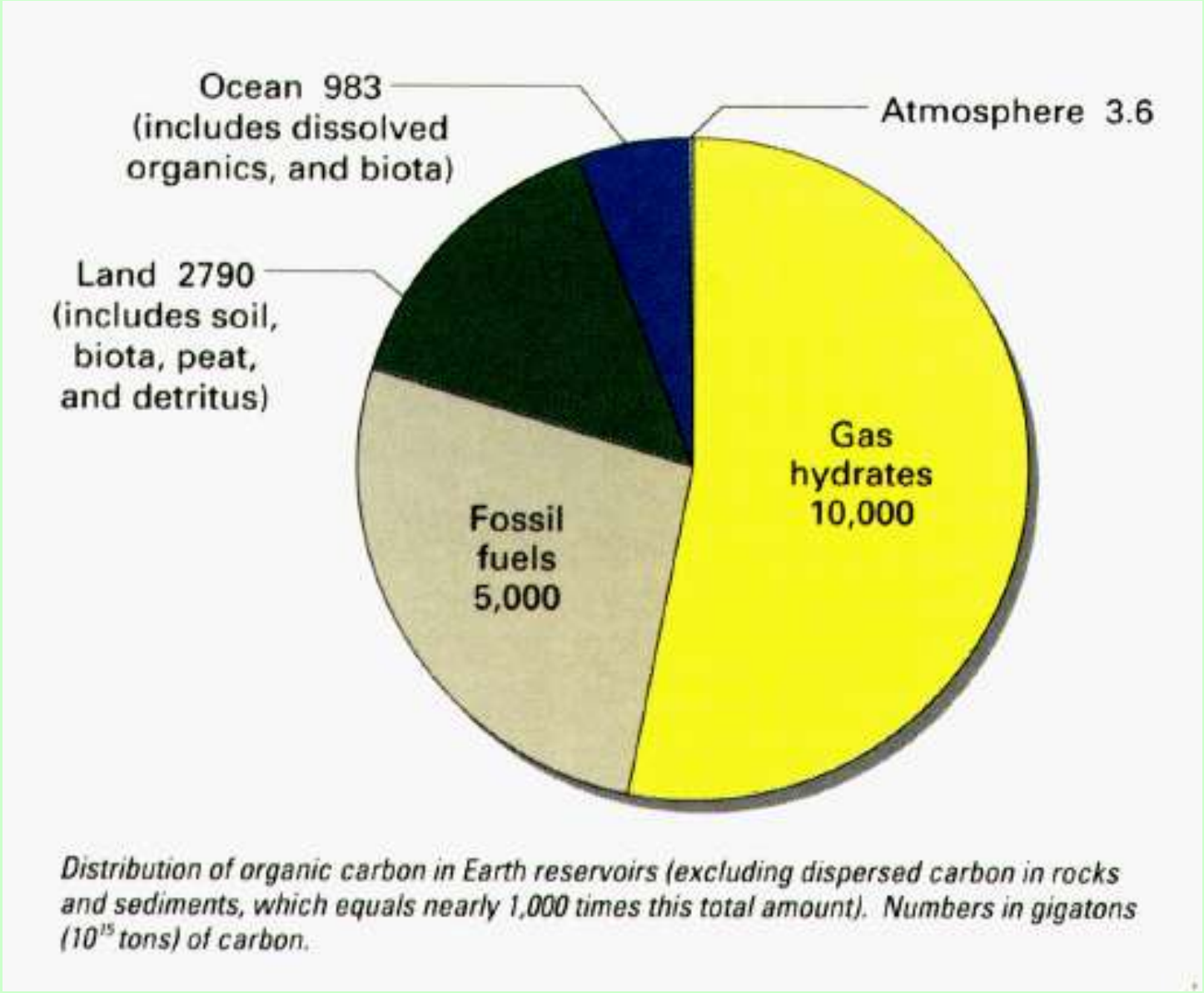
Methane, CH4, is a greenhouse gas 10 times more potent than carbon dioxide. CH4 oxidizes to C02 in 10 years.

“Earlier we found torch-like structures, but they were only tens of metres in diameter. This is the first time that we've found continuous, and impressive seeping structures more than 1,000 m in diameter.” Dr Semiletov American Geophysical Union meeting in San Francisco.

The total amount of methane stored beneath the Arctic is calculated to be greater than the overall quantity of carbon locked up in global coal reserves.

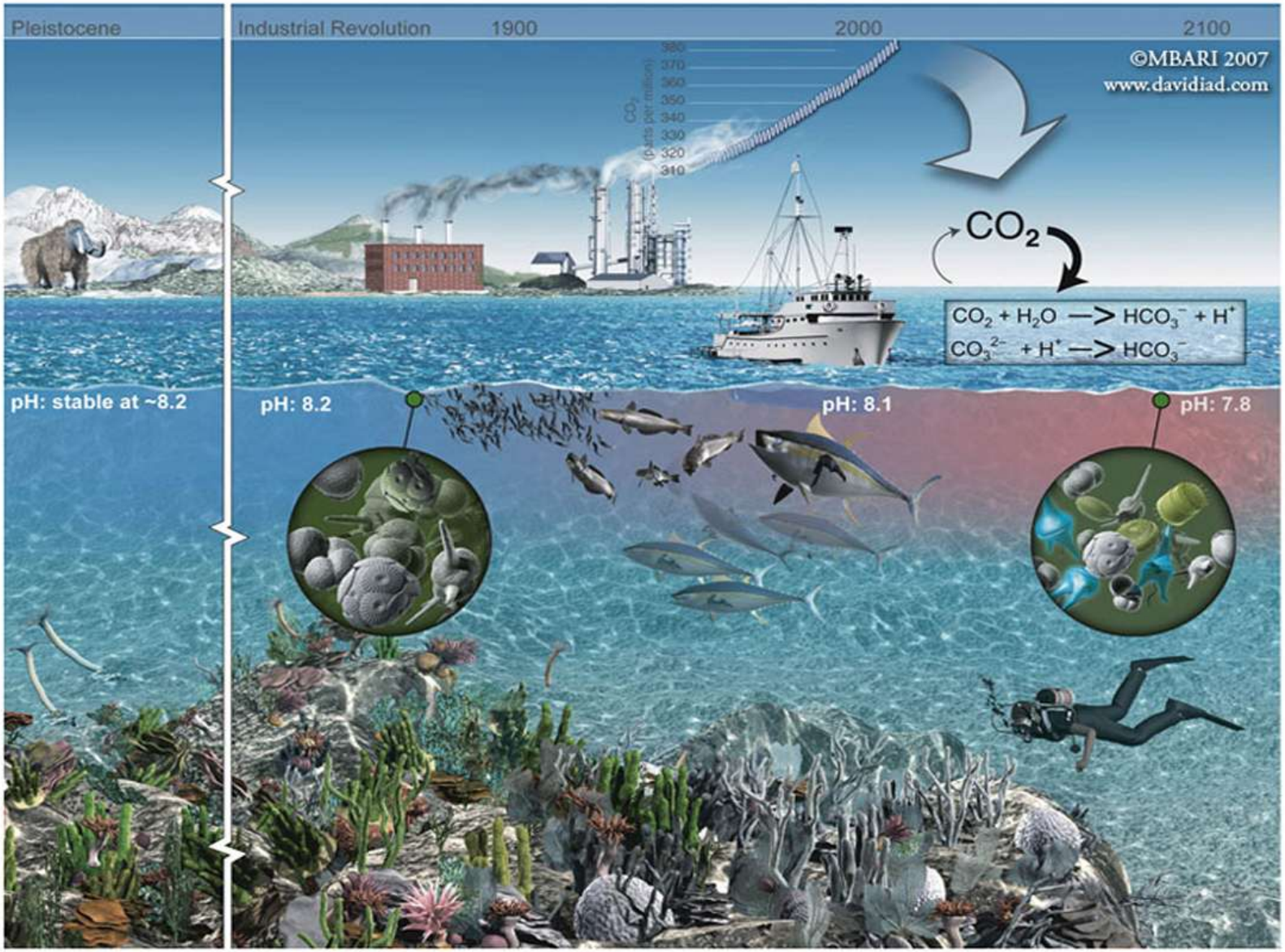
Methane hydrate,
"Fire ice natural gas hydrate" is a solid clathrate compound in which a large amount of methane is trapped within a crystal structure of water, forming a solid similar to ice.

Found where temperatures are low and water ice is common, significant deposits of methane clathrate have been found under sediments in the ocean.



Distribution of organic carbon in Earth reservoirs (excluding dispersed carbon in rocks and sediments, which equals nearly 1,000 times this total amount). Numbers in gigatons (10^{15} tons) of carbon.

Dr. William Dillon,
U.S. Geological Survey, Woods Hole, MA
http://marine.usgs.gov/fact-sheets/gas-hydrates/title.html



NATURE

SEQUESTERS

CARBON (C)

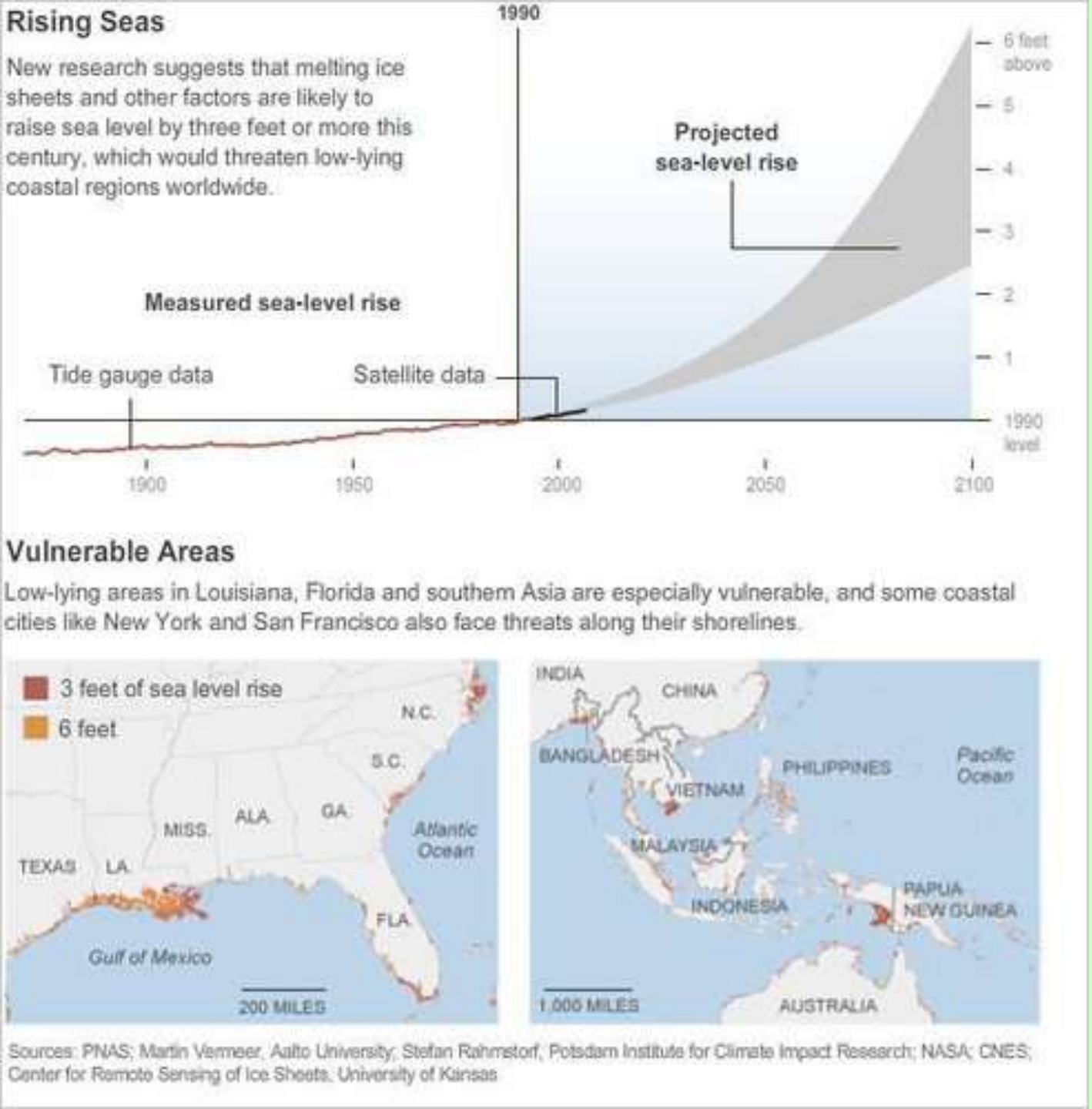
IN

SEA SHELLS

CaC03 &

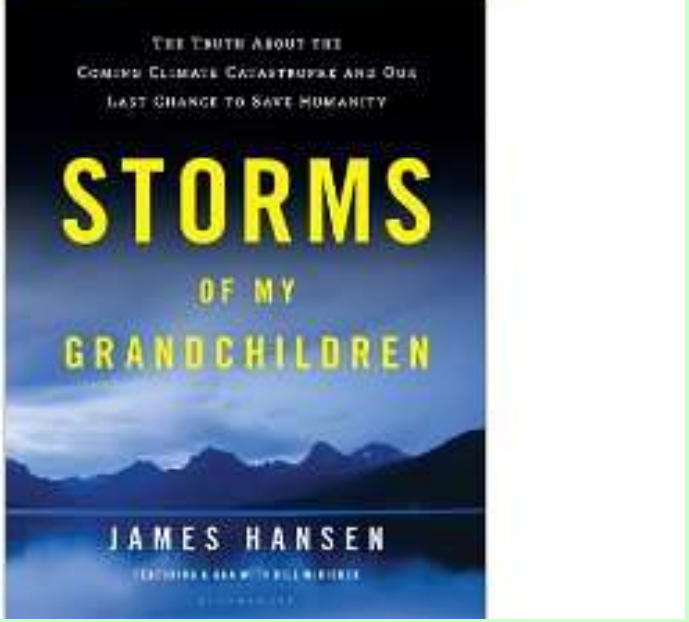
LIMESTONE

Absorbed CO2 increases acidity, reduces the calcification rate and nature's ability to sequester carbon.



"As Glaciers Melt, Science Seeks Data on Rising Seas"

Published: NY Times
November 13, 2010
Sources: PNAS, NASA



STORMS OF MY GRANDCHILDREN: The Truth About the Coming Climate Catastrophe and Our Last Chance to Save Humanity (2010)

By James Hansen

IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation
November 2011

http://www.ipcc.ch/news_and_events/docs/srex/SREX_fact_sheet.pdf

- **Economic losses** from weather & climate-related disasters vary from year to year and place to place, but overall have **increased**.

- The frequency of heavy precipitation will increase in the 21st century.

- Heat waves & droughts will increase in length, frequency, and/or intensity.

- The average maximum wind speed of hurricanes will increase.

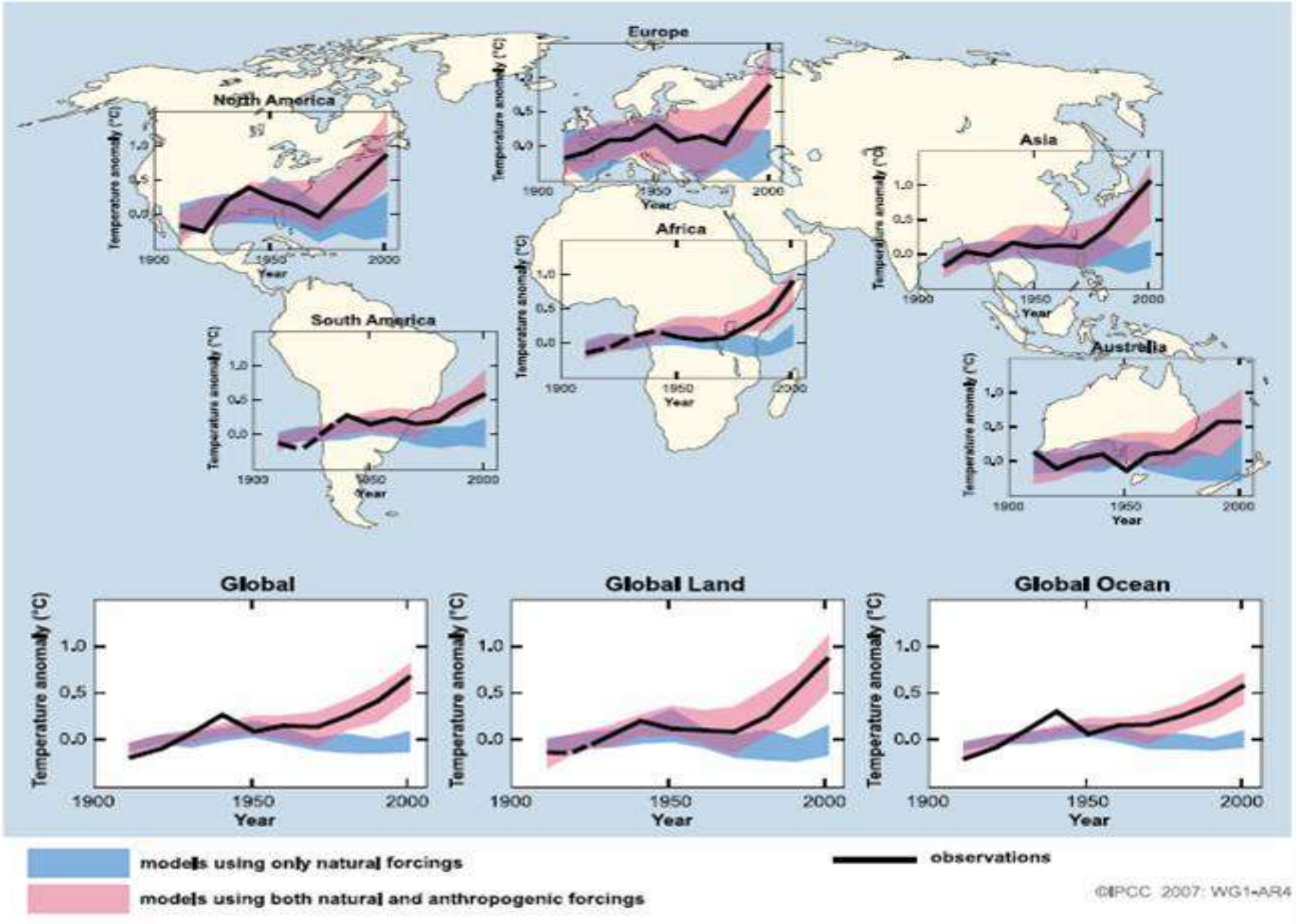
GLOBAL WAMING OVER THE CENTURIES

2. LEARNING FROM GLOBAL WARMING MODELING

1. Greenhouse gases must be included to explain temperature increases since 1957. (IPCC 2007)

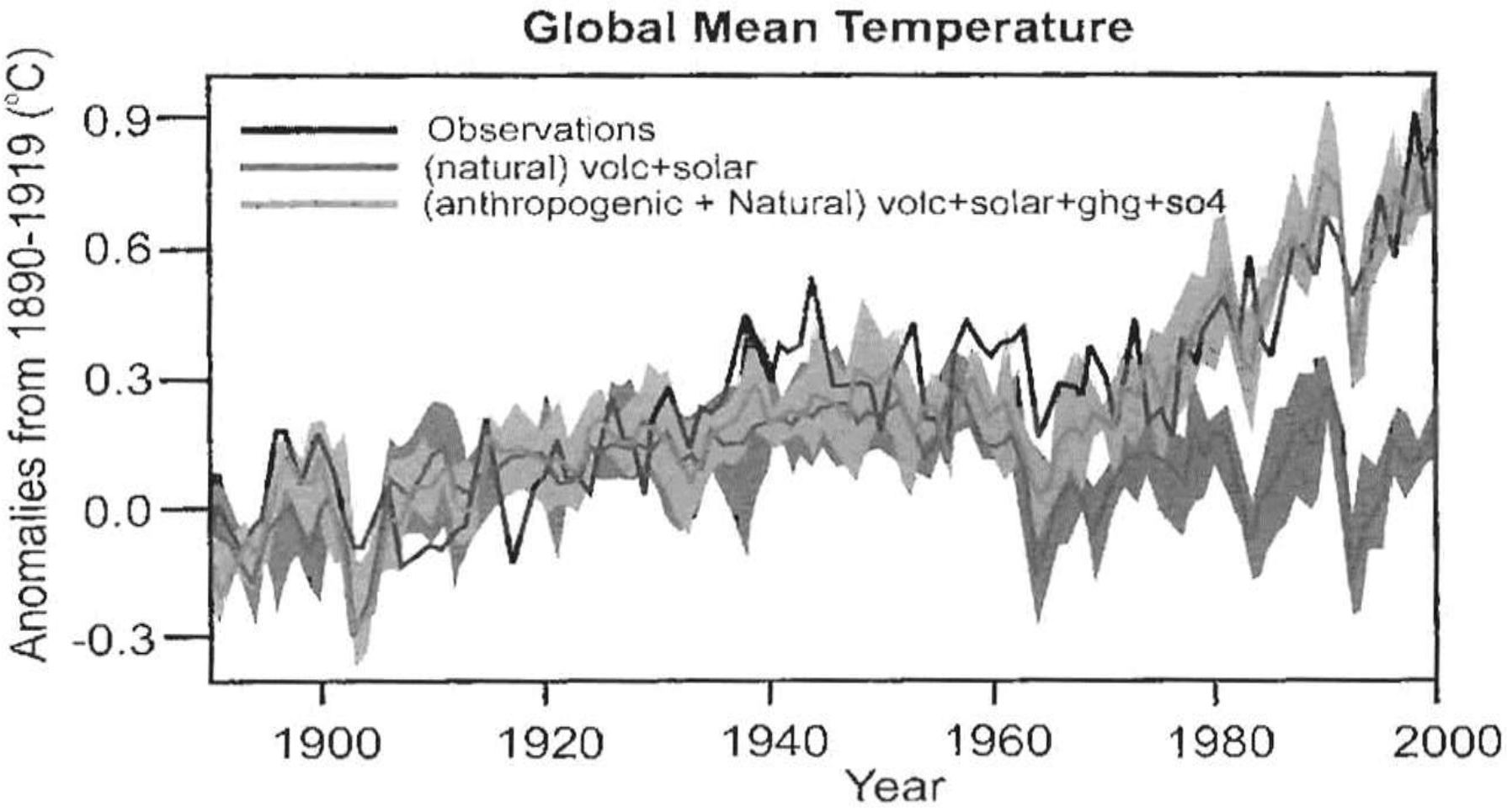
2. Without radiative forcing of noncondensing CO2, the terrestrial greenhouse would collapse, plunging the global climate into an icebound earth state. (*Science*, **330**, 356-359, 15 October 2010).

3. From 2004 to 2007 China doubled its burning of coal which produces sulfur aerosols. Their cooling effect countered any global temperature rise caused by increased levels of carbon dioxide 1998 – 2008. (*Proc. National Academy of Sciences, June 2011)*

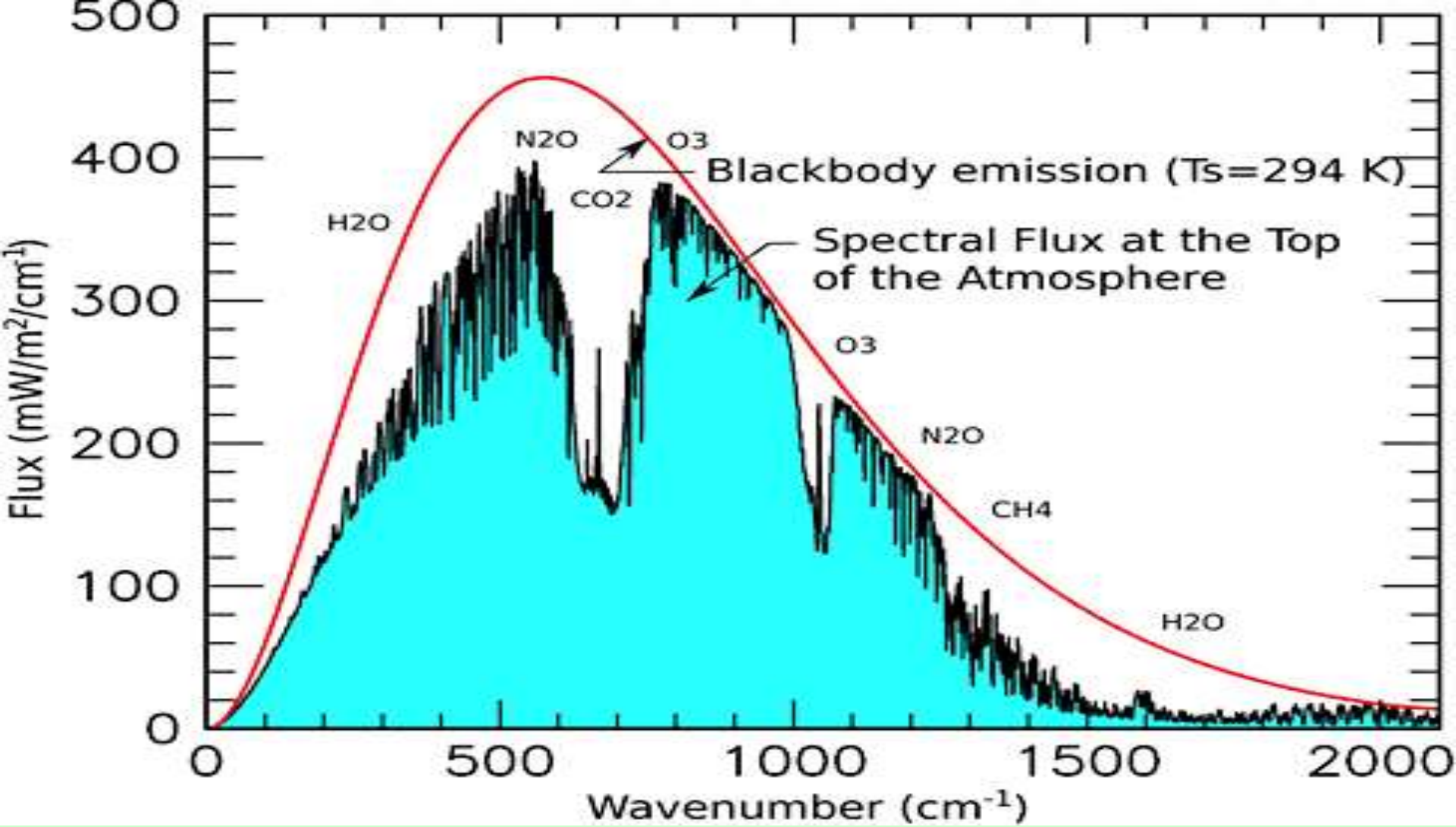


Natural Forcings cannot explain temperature increases: 1960 -2011

What We Know about Climate Change (2007)
by Kerry Emanuel, MIT Prof. of Atmospheric Science



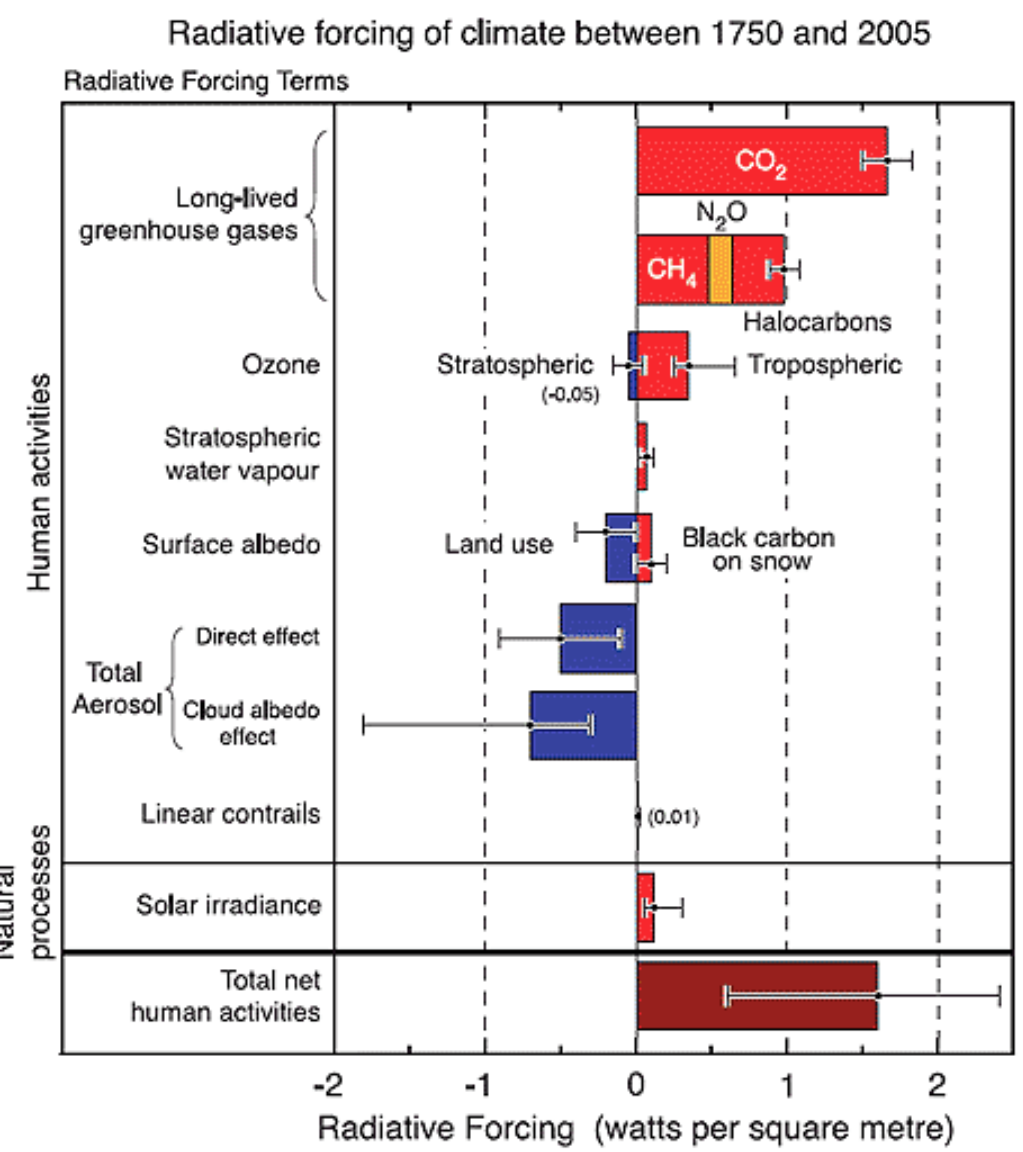
"From new estimates of the combined anthropogenic forcing due to greenhouse gases, aerosols and land surface changes, it is *extremely likely (95 % probable)* that human activities have exerted a substantial net warming influence on climate since 1750." UN IPCC, 2007



-Outgoing spectral radiance at the top of Earth's atmosphere showing the absorption at specific frequencies and **the principle absorber CO2 at 16 microns**. -

-Isotope ratios show the increasing C02 concentration is from ~300 M yr old fossil fuels.

-The red curve shows the flux from a classic "blackbody" at 294°K (≈31°C≈69.5°F). Schmidt, G.A., 2010 *J. Geophys. Res.*,**115**, D20106, doi:10.1029/2010JD014287.



FAQ 2.1, Figure 2. *Summary of the principal components of the radiative forcing of climate change. All these radiative forcings result from one or more factors that affect climate and are associated with human activities or natural processes as discussed in the text. The values represent the forcings in 2005 relative to the start of the industrial era (about 1750). Human activities cause significant changes in long-lived gases, ozone, water vapour, surface albedo, aerosols and contrails. The only increase in natural forcing of any significance between 1750 and 2005 occurred in solar irradiance. Positive forcings lead to warming of climate and negative forcings lead to a cooling. The thin black line attached to each coloured bar represents the range of uncertainty for the respective value. (Figure adapted from Figure 2.20 of this report.)*

1750-2005: Even if the cloud albedo effect is assumed to have the maximum cooling value, there would still be **a net warming of the climate due to human activities.** (Fig 2, IPCC 2007 Report)

Solar Irradiance increased by only 0.2% since 1750.

Atmospheric CO2: Principal Control Knob Governing Earth's Temperature

Andrew A. Lacis,* Gavin A. Schmidt, David Rind, Reto A. Ruedy

Science, **330**, 356-359, 15 October 2010

http://pubs.giss.nasa.gov/docs/2010/2010_Lacis_etal.pdf

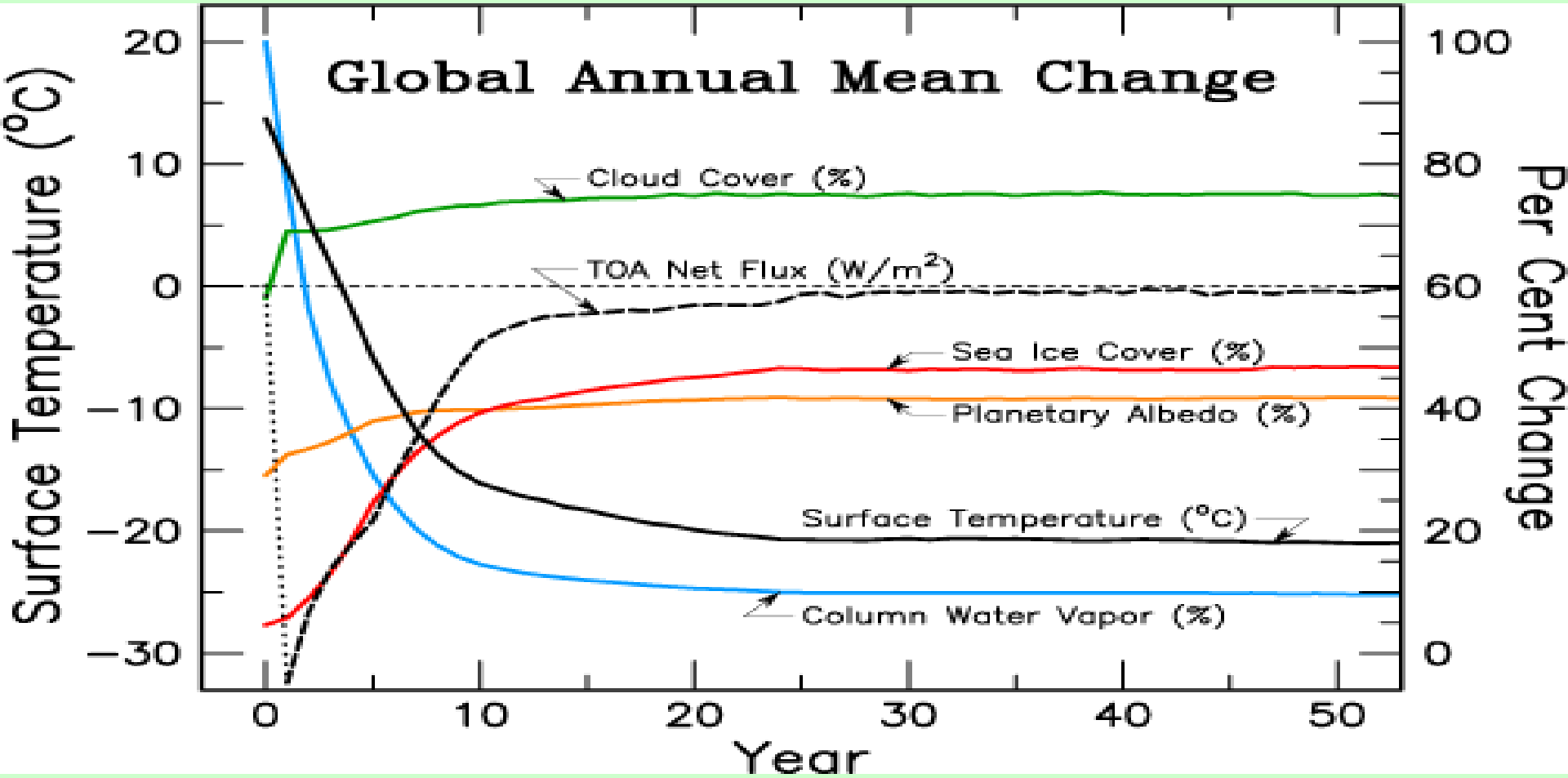
Ample physical evidence shows that carbon dioxide (CO2) is the single most important climate-relevant greenhouse gas in Earth's atmosphere. This is because CO2, like ozone, N2O, CH4, and chlorofluorocarbons, does not condense and precipitate from the atmosphere at current climate temperatures, whereas water vapor can and does.

Noncondensing greenhouse gases, which account for 25% of the total terrestrial greenhouse effect, **thus serve to provide the stable temperature structure** that sustains the current levels of atmospheric water vapor and clouds via feedback processes that account for the remaining 75% of the greenhouse effect.

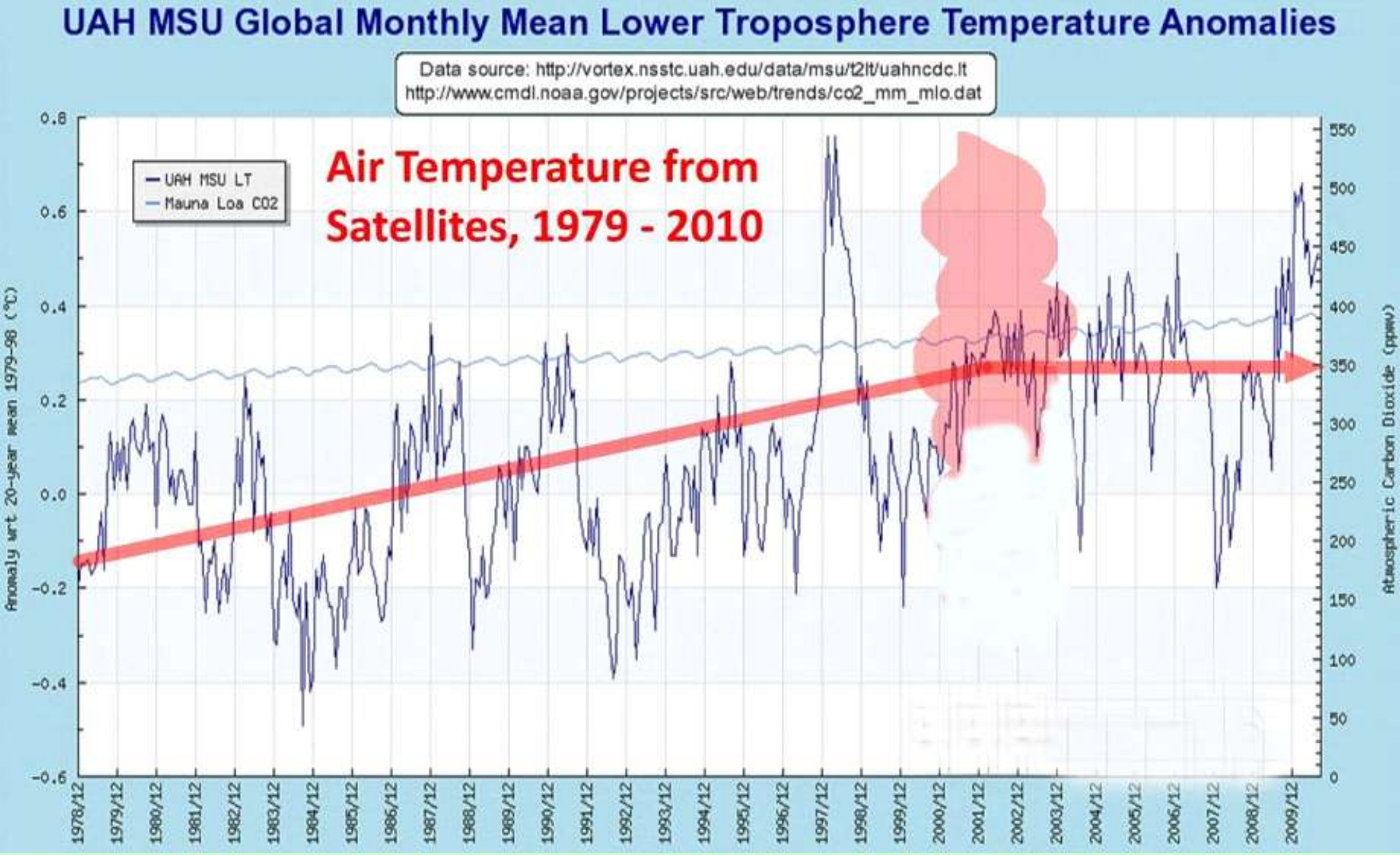
Without the radiative forcing supplied by CO2 and the other noncondensing greenhouse gases, **the terrestrial greenhouse would collapse, plunging the global climate into an icebound Earth state.**

Cooling from zeroing out all the noncondensing GHGs and aerosols.

Below 0 C, water vapor becomes snow & ice



Time evolution of global surface temperature, top-of-atmosphere (TOA) net flux, column water vapor, planetary albedo, sea ice cover, and cloud cover, **after zeroing out all the non-condensing greenhouse gases.** The model used in the experiment is the GISS 2°×2.5° AR5 version of ModelE with the climatological (Q-flux) ocean energy transport and the 250 m mixed layer depth. The model initial conditions are for a pre-industrial atmosphere. Surface temperature and TOA net flux utilize the left-hand scale.



El Nino Peaks occur in warmest years: 1997 & 2010.

Why did temperature increase level off 1998 -2008?

Reconciling anthropogenic climate change with observed temperature 1998–2008

by Robert K. Kaufmann et al. Proc. National Academy of Sciences 2011

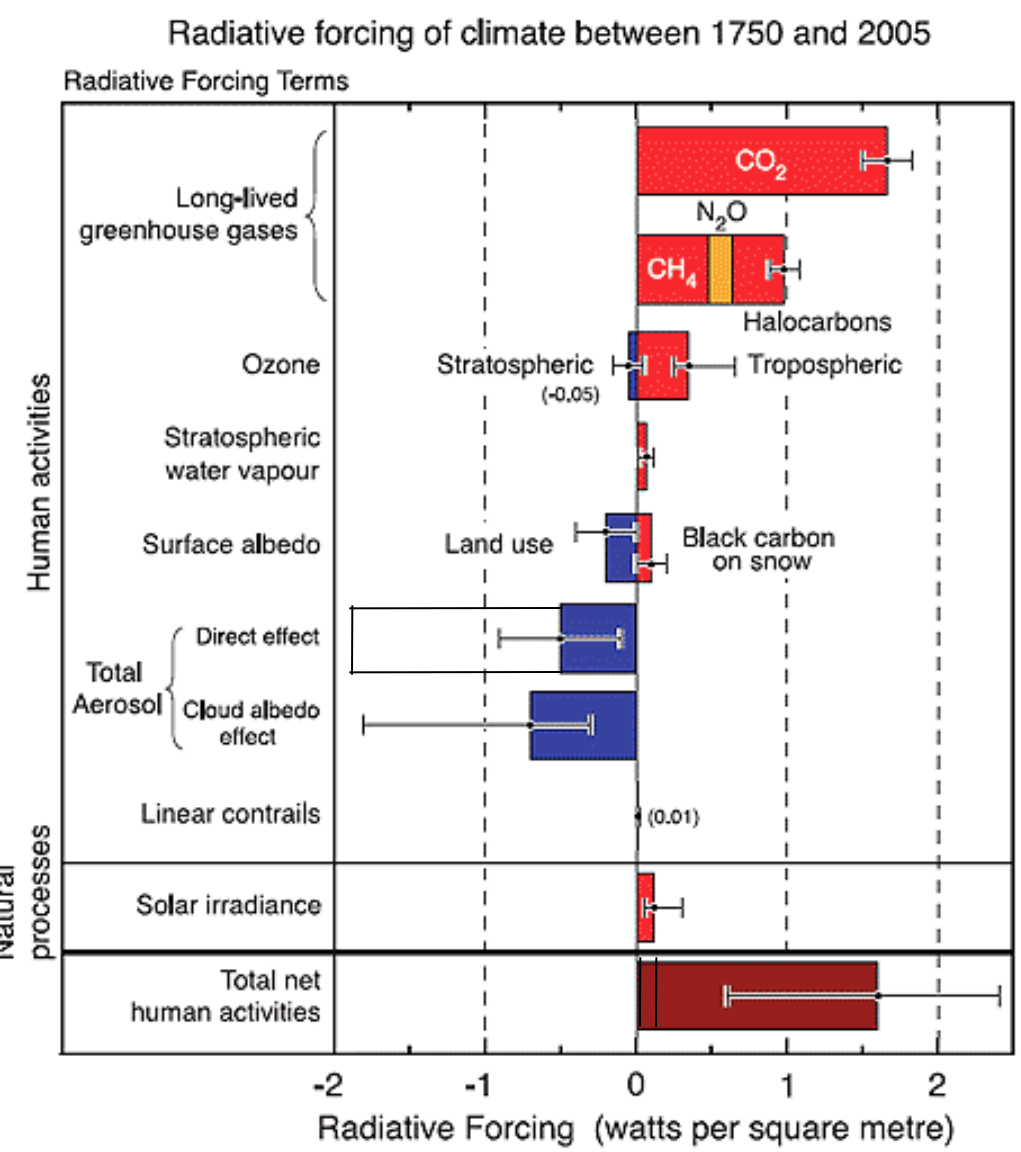
http://www.pnas.org/content/early/2011/06/27/1102467108

- **China more than doubled its consumption/burning of coal** from 2004 to 2007.

- **Sulfur aerosol emissions created by burning coal tend to have a net cooling effect on the atmosphere.**

- **The cooling effects of sulfur aerosols has essentially countered any global temperature rise caused by increased levels of carbon dioxide.**

- This balancing act between sulfur and carbon dioxide, along with the slight decrease in solar energy during the solar minimum and the cool La Nina, meant there was essentially no statistically meaningful change in the global temperature from 1998 to 2008.



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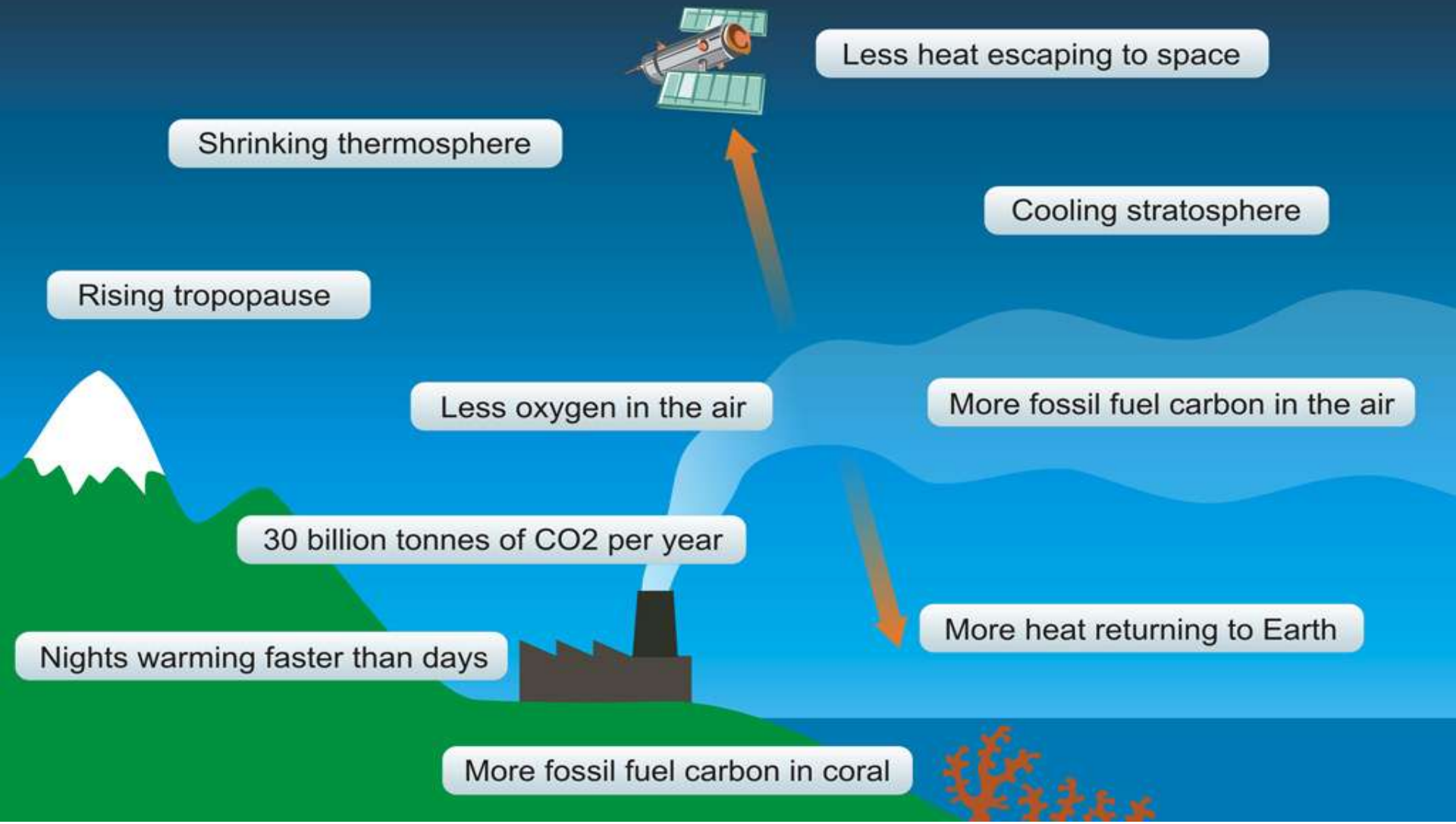
1750-2005: Even if the cloud albedo effect is assumed to have the maximum cooling value, there would still be **a net warming of the climate due to human activities.** (Fig 2, IPCC 2007 Report)

- **1998 -2008**: The cooling effects of sulfur aerosols from China's coal burning increase has essentially countered any global temperature rise caused by increased levels of carbon dioxide.

10 Indicators of a Human Fingerprint on Climate Change



http://www.skepticalscience.com/10-Indicators-of-a-Human-Fingerprint-on-Climate-Change.html

3. INNOVATIVE NON-CARBON EMITTING TECHNOLOGY

- THE US SPENDS $365 B PER YEAR ON IMPORTED OIL

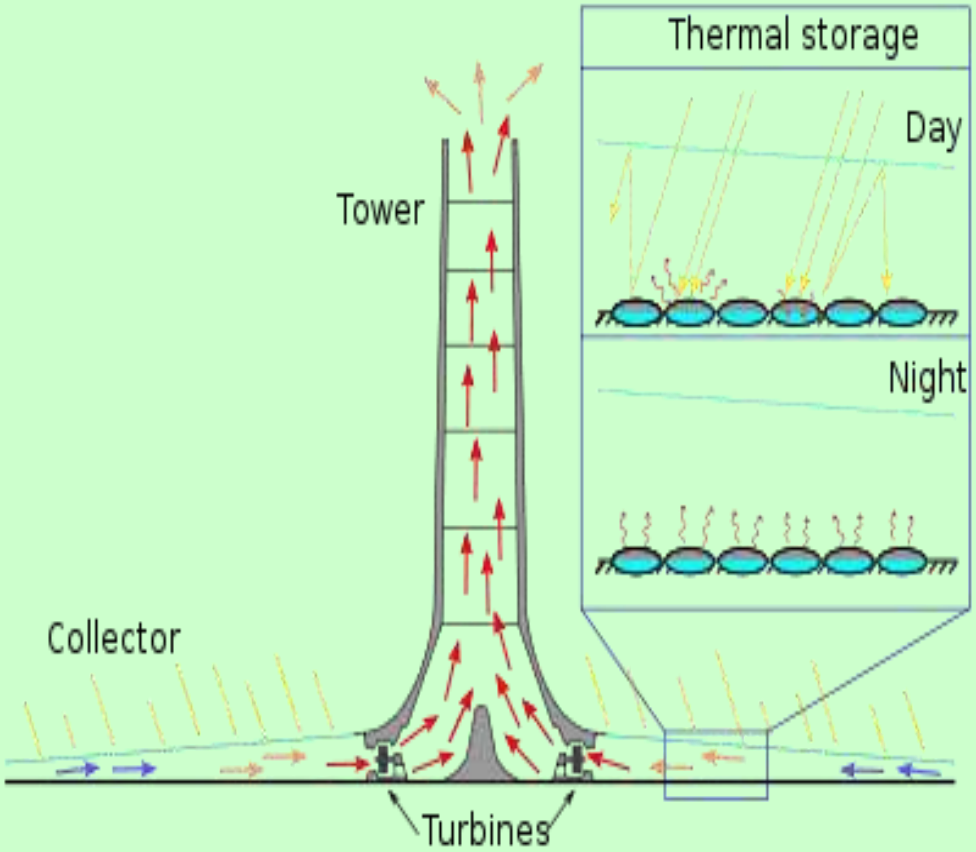
- THE SOLUTION TO ENERGY INDEPENDENCE & GLOBAL WARMING IS THE SAME.

Presently they seem to cost about $6/ sq. ft but will come down with production increases. Any-way, $15K for a 2500 sq. ft. house means a **payback of about 6 years.** Gene Norris, FL

Sunny future: Dow Chemical hopes to transform the solar power industry by integrating solar cells with conventional roofing shingles. Credit: Dow Chemical

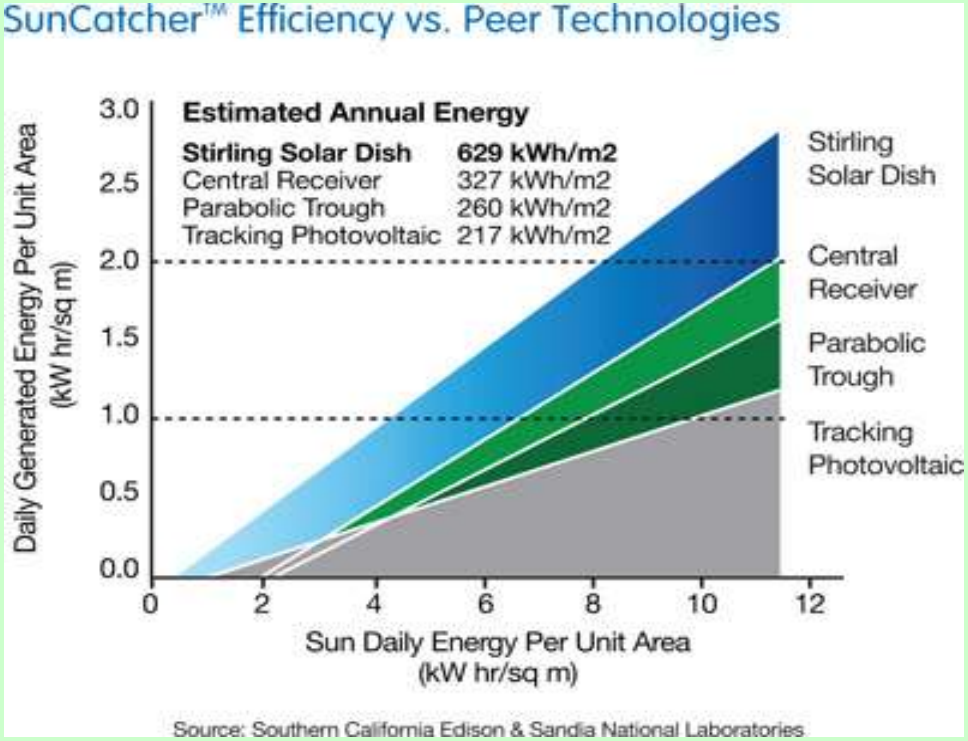
Innovative SOLAR UPDRAFT TOWER

Aug 2011, a contractor was selected to build two 200 MW Solar Updraft Towers in Western Arizona. Construction Cost **$0.15/Watt ---** Lifetime expected to be 80 years. --Operates at night



SOLAR ENERGY FROM OUR STAR IS FOREVER (5 B YEARS)

Sterling Energy Systems' Highest Efficiency (31%) SunCatcher™ Exploits 200 Year Old Technology.



•Parabolic dish focuses solar energy to heat gas, which expands & drives the piston of a Sterling, engine invented in 1816. This in turn drives a 25 kW electrical generator. -
Highest efficiency of 31%.

- No water is required for cooling, a big advantage in the desert.
- Jobs for unemployed automobile workers. (Henry Ford Technology)

‘Artificial leaf’ makes fuel from sunlight

Solar cell bonded to recently developed catalyst can harness the sun, splitting water into hydrogen and oxygen.

MIT’s 'artificial leaf,‘ is a silicon device that can harness sunlight to split water into hydrogen and oxygen without needing any external connections, is seen with some real leaves, which also convert the energy of sunlight directly into storable chemical form.

Photo: Dominick Reuter

SCIENCE
September 29 2011

ARTIFICAL LEAF: H and O Fuel from Sunlight

Wireless Solar Water Splitting Using Silicon-Based Semiconductors and Earth-Abundant Catalysts

Steven Reece PhD ’07*, Prof. David Nocera, et al. MIT

We describe the development of solar water-splitting cells comprising earth-abundant elements that operate in near-neutral pH conditions, both with and without connecting wires. The cells consist of a triple junction, amorphous silicon photovoltaic interfaced to hydrogen and oxygen evolving catalysts made from an alloy of earth-abundant metals and a cobalt|borate catalyst, respectively. The devices described herein carry out the solar-driven water-splitting reaction at efficiencies of 4.7% for a wired configuration and 2.5% for a wireless configuration when illuminated with 1 sun of AM 1.5 simulated sunlight. Fuel-forming catalysts interfaced with light-harvesting semiconductors afford a pathway to direct solar-to-fuels conversion that captures many of the basic functional elements of a leaf.

***** Reece now works at Sun Catalytix, a company started by Prof. Nocera to commercialize his solar-energy inventions

SUMMARY

- **HUMANS INFLUENCE GLOBAL WARMING, 1960 – 2011, By BURNING FOSSIL FUELS & DEFORESTATION**

- **THE US SPENDS $365 B PER YEAR ON IMPORTED OIL**
  - Security Issue for DOD, National Intelligence Council, & NAS

- **THE SOLUTIONS to ENERGY INDEPENDENCE & CLIMATE CHANGE ARE THE SAME: INNOVATIVE NON-C02-EMITTING TECHNOLOGY**

American Physical Society's National Policy 07.1 CLIMATE CHANGE

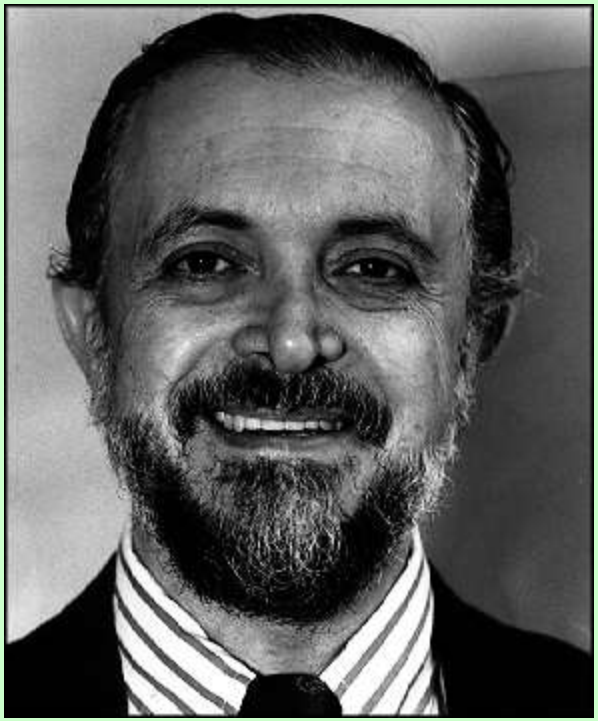
"Because the complexity of the climate makes accurate prediction difficult, the APS urges an enhanced effort to understand the effects of human activity on the Earth's climate, and to ***provide the technological options for meeting the climate challenge in the near and longer terms."***

Talks are available:
http://MirrorOfNature.org

Click on PowerPoint Presentations

http://mirrorofnature.org/GlobalWarmingDebateNESAPS.pdf

Larry Gould, Professor of Physics,' talk is on his web page:
http://uhaweb.hartford.edu/lgould/



MIT Prof. **Mario J. Molina** shared the 1995 Nobel Prize in Chemistry for his work in atmospheric chemistry concerning the formation and decomposition of ozone.

At the 2002 Sigma Xi Research Symposium I asked Prof. Molina what he thought about **global warming**.

He answered: “Global weather forecasting and predicting are complex and difficult.”

However if your question is,
“Should we do something about global warming?”

my answer is: **“YES!”**

Complexity Principal:
OCHAM'S BROOM

In a complex system like the weather,
what does not agree with my
hypothesis or paradigm,
I will sweep under the rug.

(alternatively called "Cherry Picking.)

The Structure of Scientific Revolutions

By Thomas S. Kuhn (1962)

- Science is structured by paradigms,
that provide tools for solving problems.

- Anomolies that can't be answered by the ruling paradigm leads to a crisis, which then leads to an entire **shift in paradigms**.

"Science progresses one funeral at a time.“
-- Max Planck

INNOVATE or EVAPORATE !

To Learn More

Paul H. Carr:

Data Supporting Anthropogenic Global Warming: Balancing Economics and Ecology, http://mirrorofnature.org/GlobalWarmingDebateNESAPS.pdf.

"The Beauty of Nature vs. Its Utility," Chap 9, Beauty in Science & Spirit (2006). www.BeechRiverBooks.com, www.MirrorOfNature.org

CLIMATE CHANGE COURSE

http://www.ei.lehigh.edu/eli/cc/overview.html

The unit begins with an investigation using Google Earth to explore global temperature changes during a recent 50 - 58 year period. Students explore, analyze, and interpret climate patterns of 13 different cities, and analyze differences between weather and climate patterns. Next, students are introduced to the four main Earth spheres (atmosphere, lithosphere, hydrosphere, and biosphere) and explore the structure and composition of the atmosphere with an emphasis on greenhouse gases and the role that ozone plays in the troposphere and stratosphere.

NATIONAL ACADEMY OF SCIENCES http://dels.nas.edu/Report/Americas-Climate-Choices/12781

National Intelligence Assessment on the National Security Implications of Global Climate Change to 2030 http://www.dni.gov/testimonies/20080625_testimony.pdf

DEPARTMENT OF DEFENSE http://www.defense.gov/QDR/QDR%20as%20of%2029JAN10%201600.pdf

CLIMATE SCIENCE RESOURCES http://www.uml.edu/centers/climate-change/Resources.html

http://http://realclimate.com/

Seashell

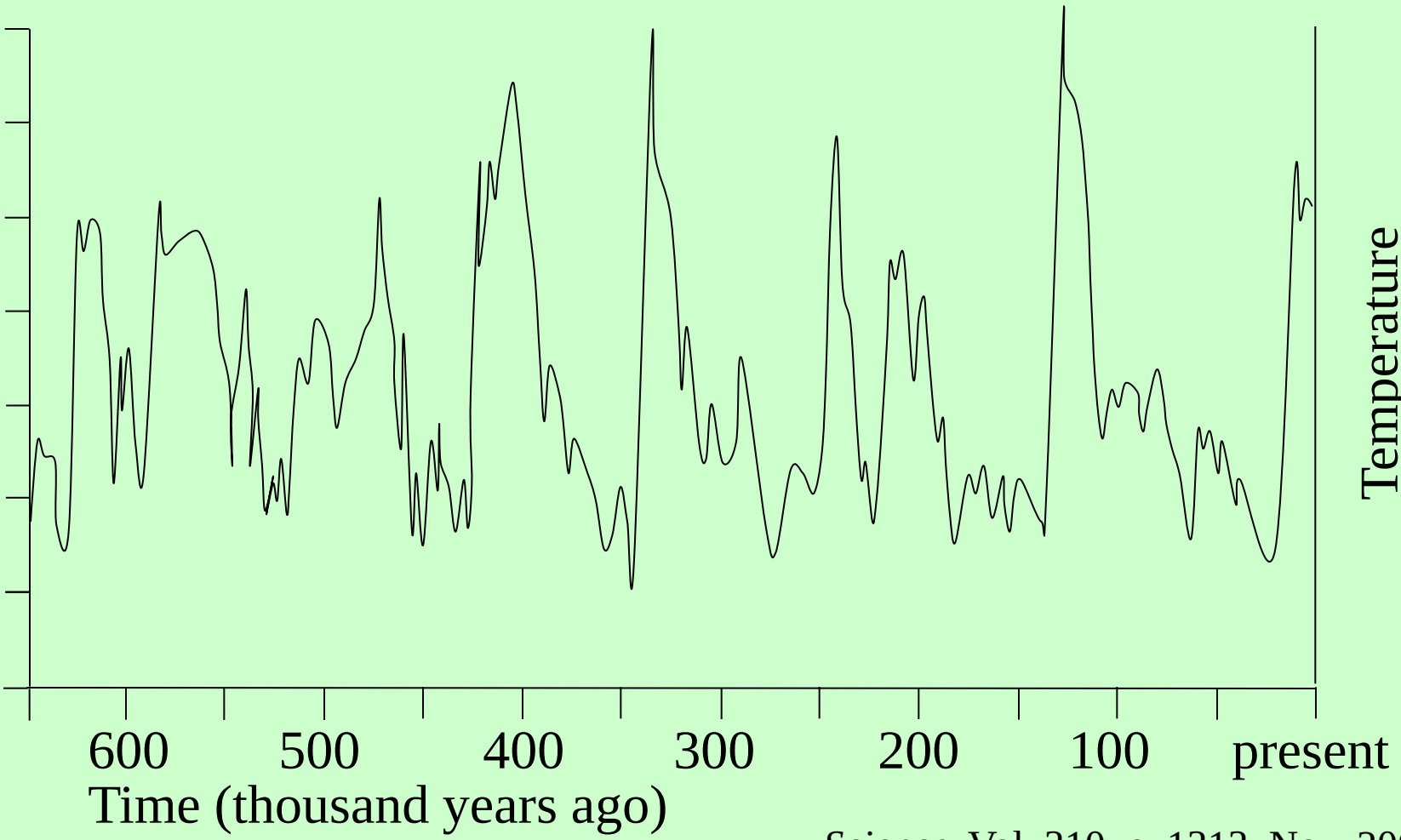
After 2week soak in vinegar

CaC03 powder after

Vinegar evaporated

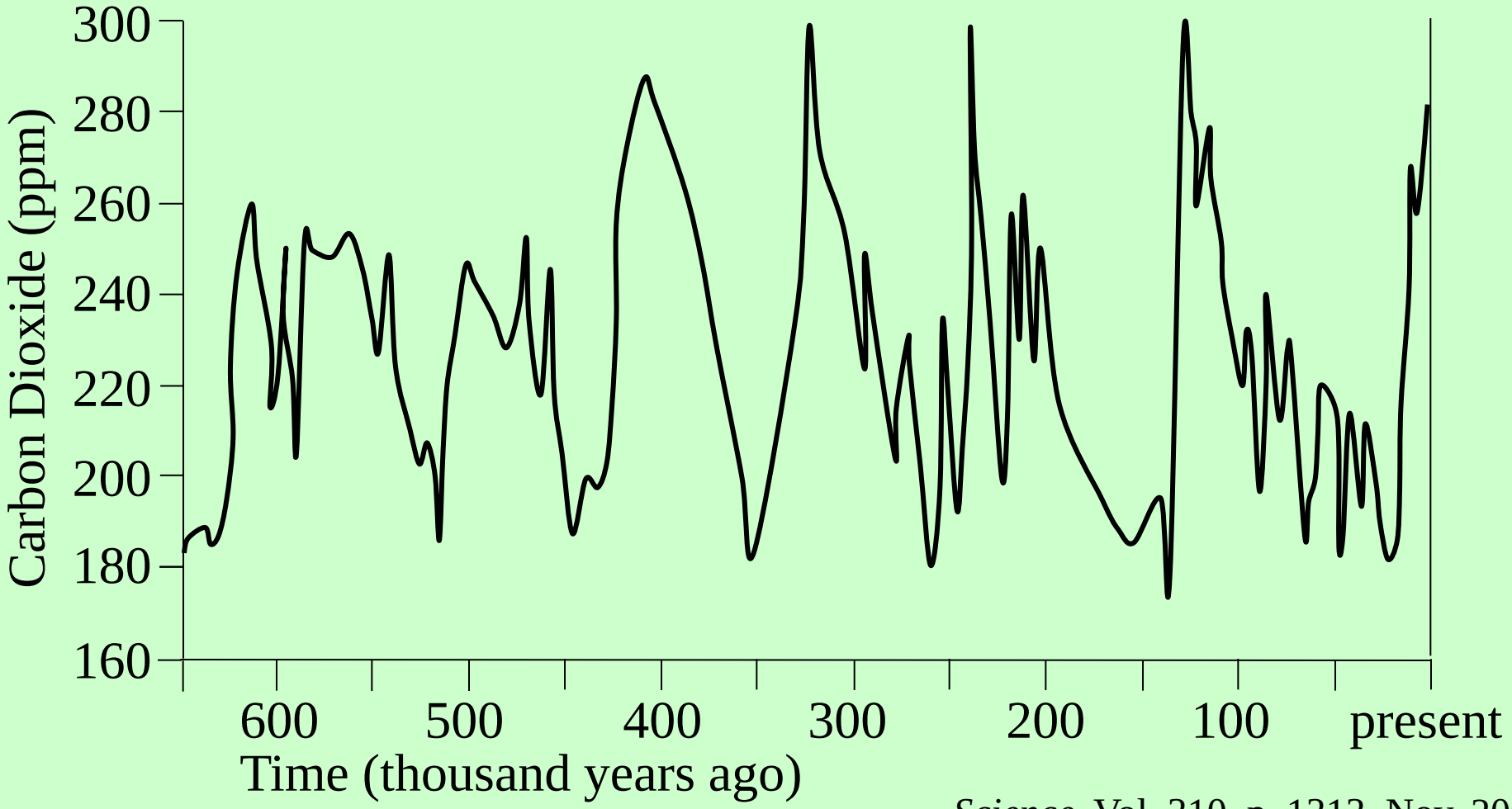
ACID DISSOLVES SEA SHELLS.

Historical Temperature



Science, Vol. 310, p. 1313, Nov. 2005

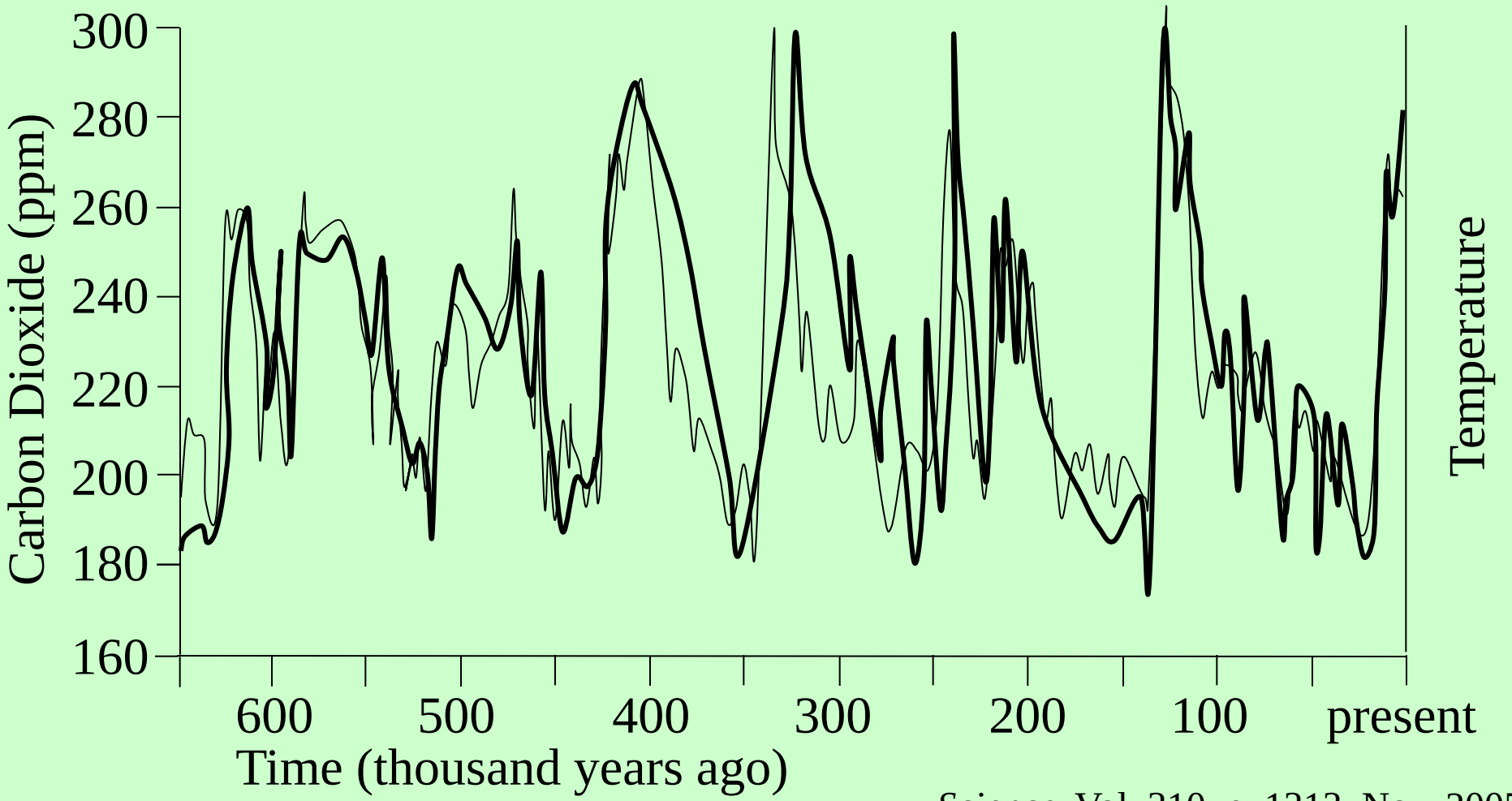
Historical CO_2 Concentration



Science, Vol. 310, p. 1313, Nov. 2005

than any in the last 600,000 years.

They are projected to reach 620 ppm in the next 45 years.



Science, Vol. 310, p. 1313, Nov. 2005

“I would put my money on the sun and solar energy.

What a source of power!

I hope we don’t have to wait until oil and coal run out before we tackle that.” (1931)

Thomas Edison

Necessity is the Mother of Invention

BERKELEY EARTH SURFACE TEMPERATURE

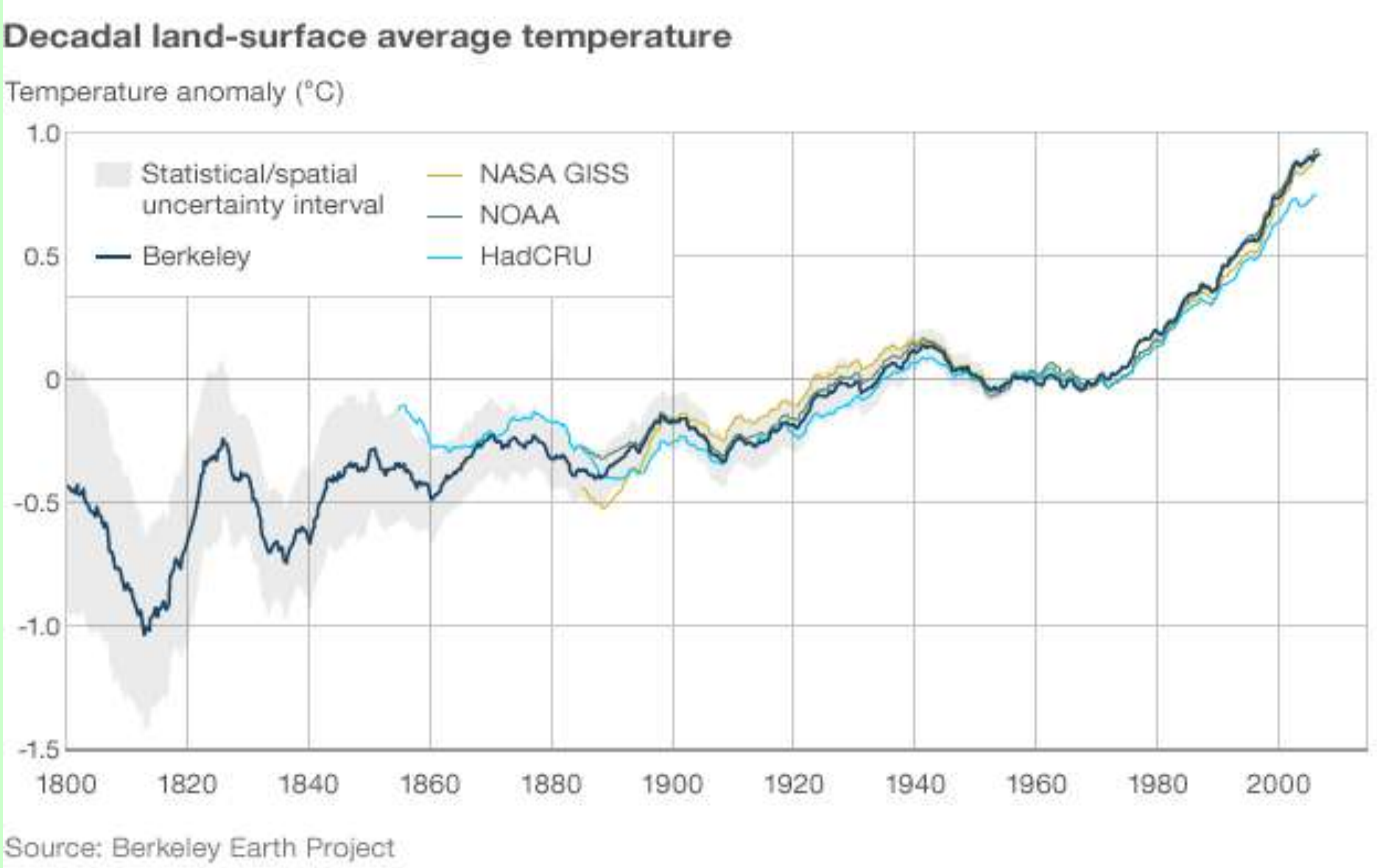
http://www.berkeleyearth.org/

UC Berkeley Physics Prof. Richard Muller, member American Academy of Arts & Sciences, was skeptical of all the conflicting data (B.S.) and wanted to resolve “climategate” issues.

He now leads a 10 person group, which includes physics Nobel Laureate Paul Purlmutter. The team is funded by private sources including the Bill Gates and the Koch Brothers.

Prof. Muller’s testimony before the US House Committee on Science, Space, and Technology, 31 Mar 2011 was:

- **Confirmed temperature increase** since 1957 of **0.8 C** by GISS, NOAA, HadCRU
- **The human component was 0.4 to 0.8 C**, which will be refined by more data analysis



Temperature Increase since 1957-2010 50 yr. : 0.8 C (CO2 387ppm)

Increase 1800 -1940 , 140 years: 0.6 C (CO2 310ppm)

Data before 1900, not as accurate as after.