Climate Change and IEQ

Some realities

Healthy School Environments Across Texas

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Action Planning Guide

As you listen to this presentation, use the chart in your Action Planning Guide to write down any key strategies to install the Six Technical Solutions in your district.

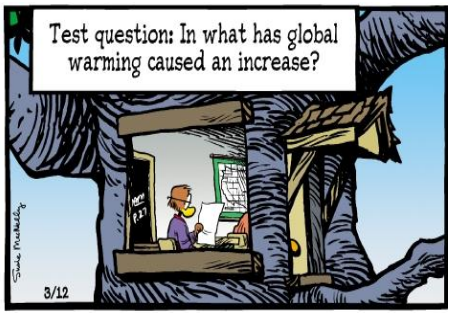
Why Talk About Climate Change in an IEQ Meeting?

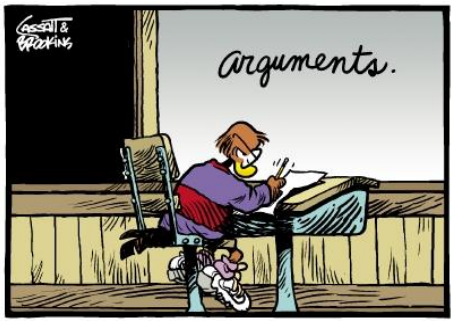
- Climate affects outdoor air quality
- Indoor air comes from outdoors
- Climate change may affect school construction and operating costs

IEQ depends on what's happening outdoors!

Topics for Discussion Today

- **Are We Experiencing Global Warming?**
- **What are we doing that might cause it?**
- **Are human activities enough to cause it?**
- **What does it have to do with IEQ?**
- **How does all this affect school designers and operators?**

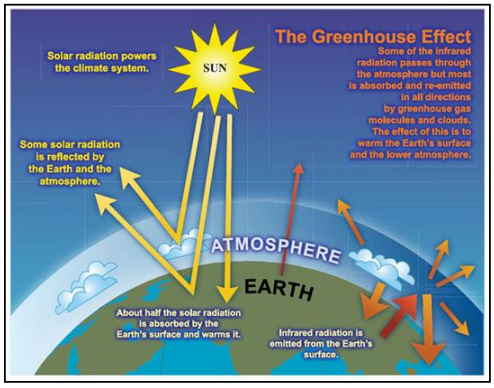




Some Terminology

- **Weather** = Short-term patterns of temperature, precipitation, barometric pressure, wind and humidity.
- **Climate** = Long-term patterns of weather.
  - *Weather normally changes in historic time.*
  - *Climate normally changes in geologic time.*

What is the warming mechanism that makes the earth habitable?



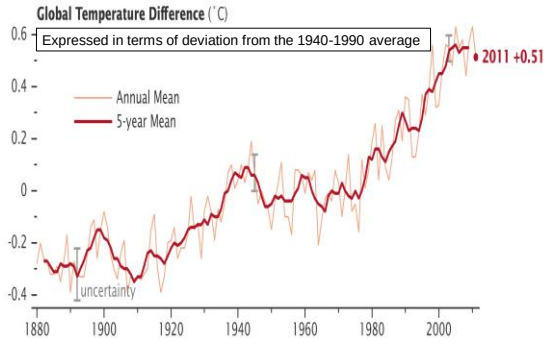
http://www.global-greenhouse-warming.com/graphs-diagrams-of-global-warming-and-climate.html

Are We Experiencing [Additional] Global Warming?

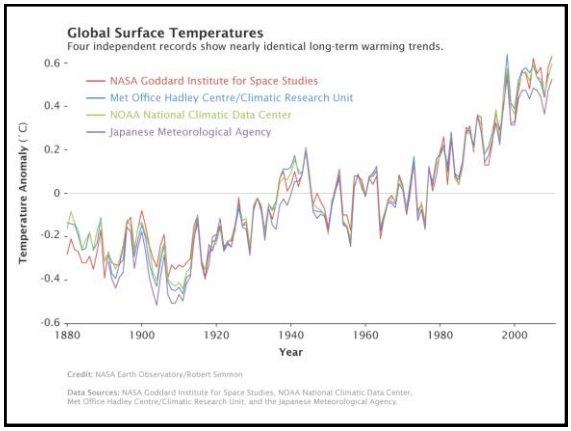
World Meteorological Organization
Confirms 2011 as 11th Warmest Year on Record

- **WMO** … announced preliminary findings of the upcoming Decadal Global Climate Summary, showing that climate change accelerated in **2001-2010**, which **was the warmest decade ever recorded in all continents of the globe**.

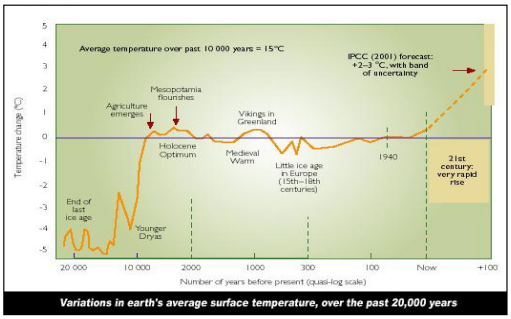
http://www.wmo.int/pages/prog/wcp/wcdmp/documents/1085_en.pdf



http://www.nasa.gov/images/content/616910main_gisstemp_2011_graph_lrg[1].jpg



Warming is not new



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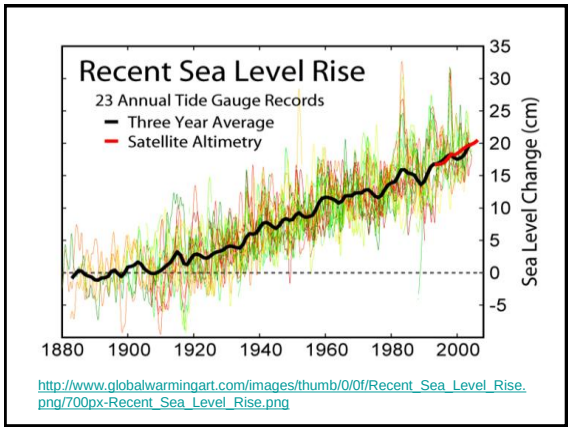
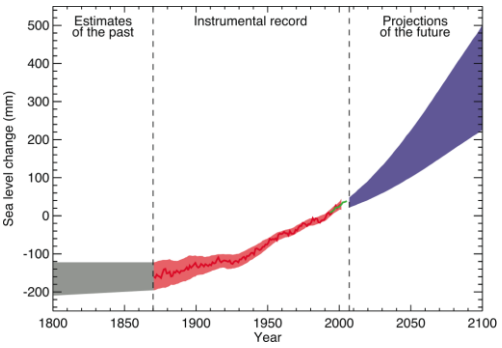
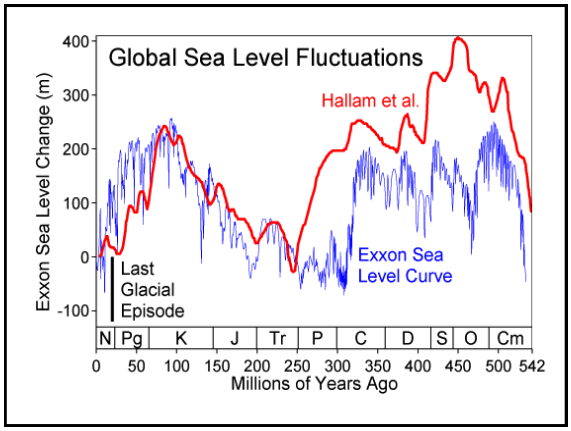
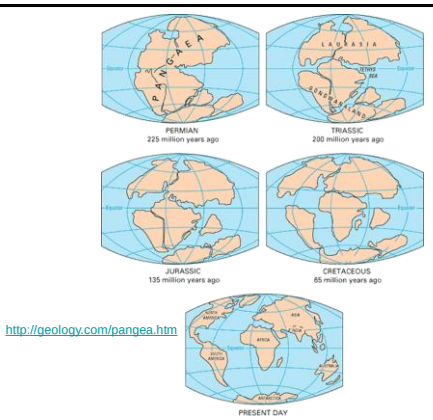


http://www.globalwarmingart.com/images/thumb/0/0f/Recent_Sea_Level_Rise.png/700px-Recent_Sea_Level_Rise.png







http://geology.com/pangea.htm

Kiribati to Purchase Fiji Land as "Climate Change Insurance"15 March 2012:

The UN International Strategy for Disaster Reduction (UN/ISDR) has announced that the Kiribati Cabinet has recently agreed to purchase land in neighboring Fiji, as "climate change insurance" for its population. The decision comes as Kiribati President Anote Tong renews calls to the international community to address the effects of climate change threatening to submerge many of Kiribati's low-lying atolls.

According to UN/ISDR, Kiribati is currently negotiating the purchase of 6,000 acres of land on Viti Levu, Fiji's main islands. Tong underscored that the initiative will apply to a younger generation, for whom moving will be a "matter of survival," and that Kiribati may become uninhabitable by the 2050s due to rising sea levels and salination provoked by climate change.

Kiribati: Formerly the Gilbert Islands

The IEQ Effect

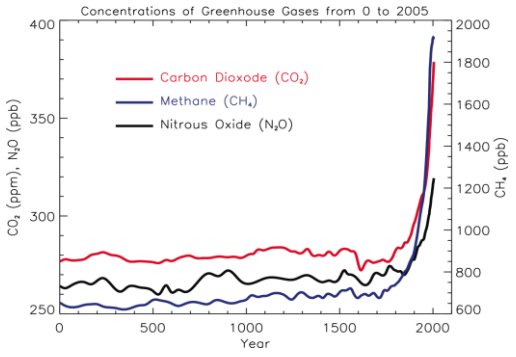
- **The indoor air comes from outdoors.**
- **How fresh is the fresh air?**

When do the Ozone Action Days Occur?

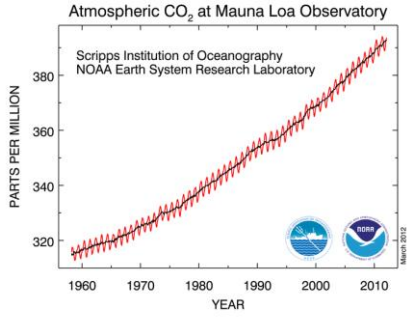
When it's hot outdoors!

Ah ha!

What are we doing that **might** cause global warming?



Source: IPCC AR4



http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo_full

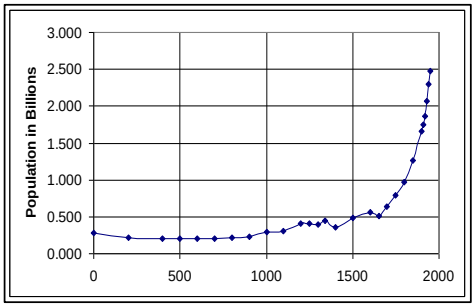
Why is this happening?

$$Emissions = (Emissions/Capita) \times Population$$

Country	Emissions Per Capita 2010	Population Millions 2010	CO2 Emissions 2010
World	49	6,852	33,508
India	17	1,340	2,070
China	62	1,210	8,241
U.S.	176	313	5,492

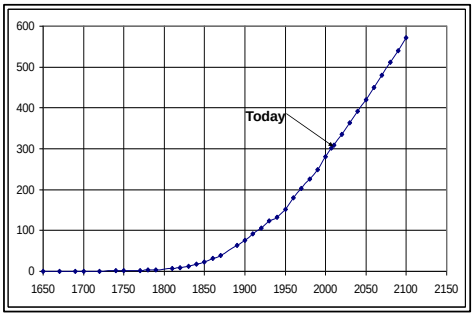
http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions#List_of_countries_by_2010_emissions_estimates

World Population



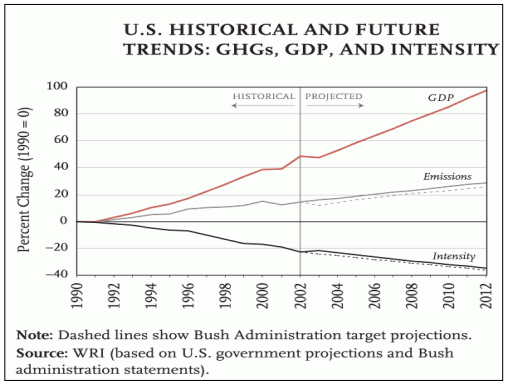
http://www.census.gov/ipc/www/worldhis.html

US Population -- Millions



Measures of Equity

- Emissions per capita [annual].
- Emissions per capita, cumulative since the beginning of the industrial revolution. --- Rather extreme position of some developing country representatives.
- Emissions intensity [tons of CO_2/$ of GDP] --- US tendency.



Are human activities sufficient to cause Climate Change [Global Warming]?

The Scientific and the Legislative Process Parallel

Observations
Scenarios

→

Models
Analysis

→

Estimates
Forecasts
Conclusions

Legislation

Scientific

IPCC results are to be:
•Policy Relevant, not
•Policy Prescriptive

Legislative/Regulatory

Legislation and Regulations are, by definition, policy prescriptive

Who are the Science Experts?

- The IPCC formed in 1988 by the WMO and UNEP.
  - **I**ntergovernmental **P**anel on **C**limate **C**hange
  - **W**orld **M**eteorological **O**rganization [a UN body]
  - **UN E**nvironmental **P**rogramme
- The IPCC operates on a consensus basis and draws on the [mostly] peer-reviewed work of thousands of independent scientists.
- The IPCC assessment reports are "policy-relevant but not policy-prescriptive" [roughly quadrennial].

The IPCC received the Nobel Peace Prize in 2007 for their work.

Questions the Scientists are Asking

- What causes change?
- How much change has occurred?
- What are the societal consequences of change?
- How can we limit change?
- How can we adapt to change?

What are the Scientists Seeing?

- **GHG are rising.**
- Air quality thrusts are reducing aerosols.
- Glaciers and the Ice Sheets are shrinking.
- Global temperatures are increasing.
- Sea Level is rising.

Changes so far are quite small but the underlying processes have great momentum and very long time constants.

Universally Accepted Facts

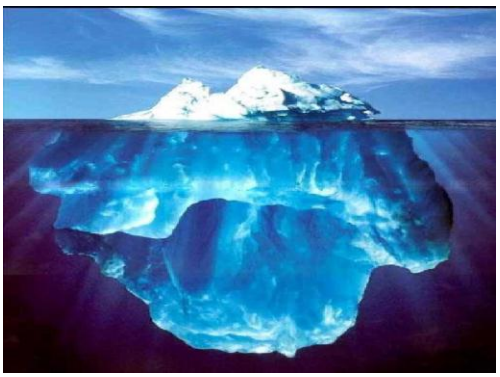
- Carbon dioxide, methane and nitrous oxide trap heat in the lower atmosphere.
- These GHGs help moderate the Earth's temperatures.
- These GHGs have increased significantly since the 1700's, and continue to increase at an increasing rate.
- Man is the cause of the increase.

Divergent Views on the Balance of Nature

- **Stable** Equilibrium - self-correcting - negative feedback
  - Example: A vertical rod suspended by a pivot at the upper end [a pendulum]
- **Unstable** Equilibrium - not self-correcting - Positive feedback
  - Example: A vertical rod standing on end.

The notion of unstable equilibrium includes the concept of a "trigger point" – a point of no return.

And…things are not always as they seem!

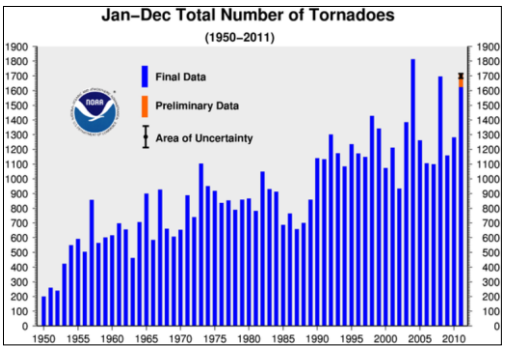


A Piece of the Larsen Ice Shelf of Antarctica [2002]

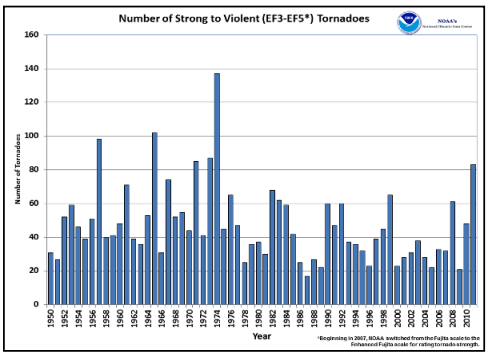
The Rhine at Cologne is about 160 feet above sea level. The record flood level occurred in 1355 AD.

The ARAL Sea

http://news.nationalgeographic.com/news/2010/04/photogalleries/100402-aral-sea-pictures/



http://www.ncdc.noaa.gov/sotc/tornadoes/2011/13



http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html#history

Highest Average Annual Precipitation Extremes

Continent	Highest Avg. (Inches)	Place	Elevation (Feet)	Years of Record
South America	523.6 ≈ 44 ft.	Lloro, Colombia	520	29
Asia	467.4	Mawsynram, India	4597	38
Oceania	460.0	Mt. Waialeale, Kauai, HI	5148	30
Africa	405.0	Debundscha, Cameroon	30	32
South America	354.0	Quibdo, Colombia	120	16
Australia	340.0	Bellenden Ker, Queensland	5102	9
North America	256.0	Henderson Lake, British Colombia	12	14
Europe	183.0	Crkvica, Bosnia-Hercegovina	3337	22

http://www.ncdc.noaa.gov/oa/climate/globalextremes.html#lowpre

What are the atmospheric scientists asking?

Is it possible to prevent mankind from adversely changing climate on earth?

What's the urgency?

- **Some GHGs have atmospheric lifetimes of tens, hundreds, thousands or tens of thousands of years.**
- **Carbon dioxide, the major controllable GHG, has a very long atmospheric lifetime.**
- **What we are doing now will affect our descendants for generations.**

Why do anything Now?

The "precautionary principle"

We all practice the precautionary principle every day when we use seat belts or other safety devices or protective measures because we are unwilling to accept the consequences of the adverse turn of events.

The precautionary principal oversimplified:
Err in the conservative direction.

Divergent Views on the Balance of Natural Forces

- **Stable** Equilibrium - self-correcting - **negative feedback**
- **Unstable** Equilibrium - not self-correcting -**Positive feedback**

The notion of unstable equilibrium includes the concept of a "trigger point" – a point of no return at which stable equilibrium becomes unstable.

What Can You Do About It?

- **Design for maximum building efficiency**
- **Minimize fossil-derived energy use**
- **Commission and maintain systems for maximum efficiency**
- **Educate your students to be environmentally sensitive in their private lives**

Remember that IEQ depends on the quality of the outdoor air!

~~The End~~

The beginning of a new chapter of life on Earth.

Appendices

Global Cooling ?

In the 1970s, there was increasing awareness that estimates of global temperatures had shown cooling since 1945. Of those scientific papers considering climate trends over the next century, slightly under 10% inclined towards future cooling, while most papers predicted future warming. The general public had little awareness of carbon dioxide's effects on climate, although Paul R. Ehrlich mentions climate change from the greenhouse gases in 1968. By the time the idea of global cooling reached the public press in the mid-1970s, the temperature trend had stopped going down, and there was concern in the climatological community about carbon dioxide's effects. It was known that both natural and man-made effects caused variations in global climate.

Source: http://en.wikipedia.org/wiki/Global_cooling

Society is Responding as Though The Threat of Climate Change is Real and Severe

- UN Framework on Climate Change – 1992
- Kyoto Protocol [2008-2012] – 1997/ 200X
- Negotiations for the next period [2012- 20??]
- State GHG initiatives – California leads
- Lieberman-Warner [Cap & Trade] – In the works – To reduce US emissions of CO_2 by ??% by 20??.

Points Disputed by Some

- Observed climate changes are [primarily] attributable to human activity.
- Human influence is sufficient to change the climate.
- Changes are being observed: Glacial melting, Iceberg calving, Sea level rising; Atmospheric temperature rising.
- Prompt action is required to avert major disturbances.

Natural Climate Change Factors

- Solar cycles [11 yr. + longer (little ice age 1400-1700)
- Orbital eccentricity change [100k yr.]
- Axis tilt [41k yr.]
- Axis precession [23k yr.]
- Continental drift
- Plate tectonics
- Atmospheric composition

Human* Climate Change Factors

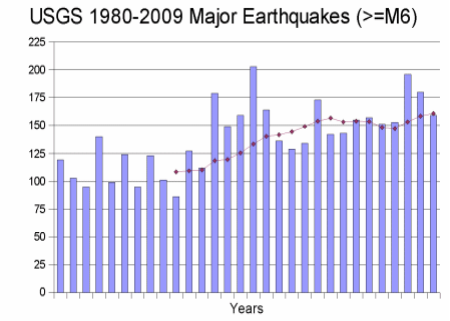
- Earth albedo
- Atmospheric composition
  - –Greenhouse Gases [GHGs]
  - –Particulates
    - Cloud nuclei
    - Radiatively active particles

*Anthropogenic

What is the US doing about it?

- Congress: Lieberman-Warner, Boxer & Markey – GHG "Cap and Trade", with a Decreasing cap.
  [This didn't pass, but the idea didn't die.]
- EPA: Emissions inventories
- States [esp. CA]: Emissions inventories
- Cities: Inventories, emission limits, efficiency standards
- Regional alliances

At this time, most of this is work in progress.



http://www.science20.com/florilegium/blog/why_so_many_earthquakes_decade-65178

What's the Kyoto Protocol?

- Commitment by 37 nations to roll back GHG emissions by 5% from 1990 levels between 2008 and 2012.
- Basket of GHGs: Carbon dioxide, nitrous oxide, methane, HFCs, SF_6, PFCs.
- US signed Kyoto but has not ratified it.

The Kyoto Protocol Commitment [re:1990]

- Australia 108 %
- Austria 92
- Belgium 92
- Bulgaria* 92
- Canada 94
- Croatia* 95
- Czech Republic* 92
- Denmark 92
- Estonia* 92
- European Community 92
- Finland 92
- France 92
- Germany 92
- Greece 92
- Hungary* 94
- Iceland 110
- Ireland 92
- Italy 92
- Japan 94
- Latvia* 92
- Liechtenstein 92
- Lithuania* 92
- Luxembourg 92
- Monaco 92
- Netherlands 92
- New Zealand 100
- Norway 101
- Poland* 94
- Portugal 92
- Romania* 92
- Russian Federation* 100
- Slovakia* 92
- Slovenia* 92
- Spain 92
- Sweden 92
- Switzerland 92
- Ukraine* 100
- United Kingdom of Great Britain and Northern Ireland 92
- United States of America 93

Aggregate: 5% reduction of CO_2 Equivalent

Cast of Characters

- **WMO**: World Meteorological Organization
- **UNEP**: UN Environmental Programme
- **ICSU**: International Council for Science
- **IPCC**: Intergovernmental Panel on Climate Change
- **UNGA**: UN General Assembly
- **UNFCCC**: UN Convention on Climate Change
- **UNCED**: UN Conference on Environment and Development
- **INC**: Intergovernmental Negotiating Committee for the UNFCCC

Note on Lifetimes

- Lifetime = τ as defined by $C=C_0 \cdot e^{-t/\tau}$
- Refrigerants have lifetimes from 1.3 yr to hundreds of year.
- Some gases have lifetime of tens of thousands of years.
- Methane has τ of 14 yr. and N_2O has 114 yr.
- Exception: CO_2 where the decay equation has three time constants [1.186, 18.51, 172.9 yr.] plus a constant term.

Some Regulatory Parallels

- 1978 National Energy Act & PURPA
- 1978 Energy Tax Act [ethanol tax break]
- 1987 NAECA
- 1992 EPACT
- 1998 Energy Conservation Reauthorization Act
- 2005 Energy Policy Act [HR6]
- 2007 Energy Independence and Security Act [HR6 ENR]
- 2008 Lieberman-Warner, Boxer, Markey: GHG Cap and Trade [Died in the House]

States and cities are also striving to play a positive role in GHG reductions.

Time series of global mean sea level (deviation from the 1980-1999 mean) in the past and as projected for the future. For the period before 1870, global measurements of sea level are not available. The grey shading shows the uncertainty in the estimated long-term rate of sea level change (Section 6.4.3). The red line is a reconstruction of global mean sea level from tide gauges (Section 5.5.2.1), and the red shading denotes the range of variations from a smooth curve. The green line shows global mean sea level observed from satellite altimetry. The blue shading represents the range of model projections for the SRES A1B scenario for the 21st century, relative to the 1980 to 1999 mean, and has been calculated independently from the observations. Beyond 2100, the projections are increasingly dependent on the emissions scenario (see Chapter 10 for a discussion of sea level rise projections for other scenarios considered in this report). Over many centuries or millennia, sea level could rise by several metres (Section 10.7.4).

The Ironic History of Cap-and-Trade

The phrase "cap-and-trade" is relatively new, but the idea of marketable pollution allowances goes back several decades. Conventional pollution laws impose direct mandates on polluters, telling each polluter precisely what level of pollution control is required. For a variety of reasons, economists have always disapproved of this approach. They prefer pollution taxes (a/k/a effluent charges) or marketable permit systems as a lower cost method of reaching environmental goals. The U.S. twisted the arms of the Europeans into accepting cap-and-trade as part of the Kyoto Protocol. The EU has since fallen in love with the idea, but of course the U.S. never ratified the Protocol. Now, the idea of cap-and-trade seems virtually dead in D.C., though there's always a chance of a revival. At least part of the problem, it would seem, is that the concept is difficult to understand; in addition, people are suspicious of market mechanisms since the financial meltdown.

The great irony is that cap-and-trade is now considered by many to be a suspect liberal (if not socialist) concept. So much for trying to harness the power of the market to address environmental problems!

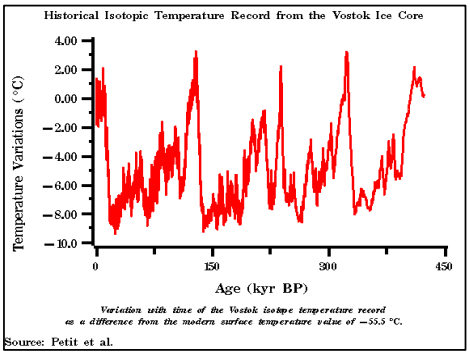
http://legalplanet.wordpress.com/2010/02/28/the-ironic-history-of-cap-and-trade/
Published by Berkeley Law and UCLA Law

US At Night

http://apod.nasa.gov/apod/ap960617.html

Photo By US Astronaut

http://earthobservatory.nasa.gov/Study/CitiesAtNight/



http://cdiac.ornl.gov/trends/temp/vostok/graphics/tempplot5.gif