

# Climate Change Denialism (Merchants of Doubt) and the need for a Carbon Tax

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*5/12/2013*

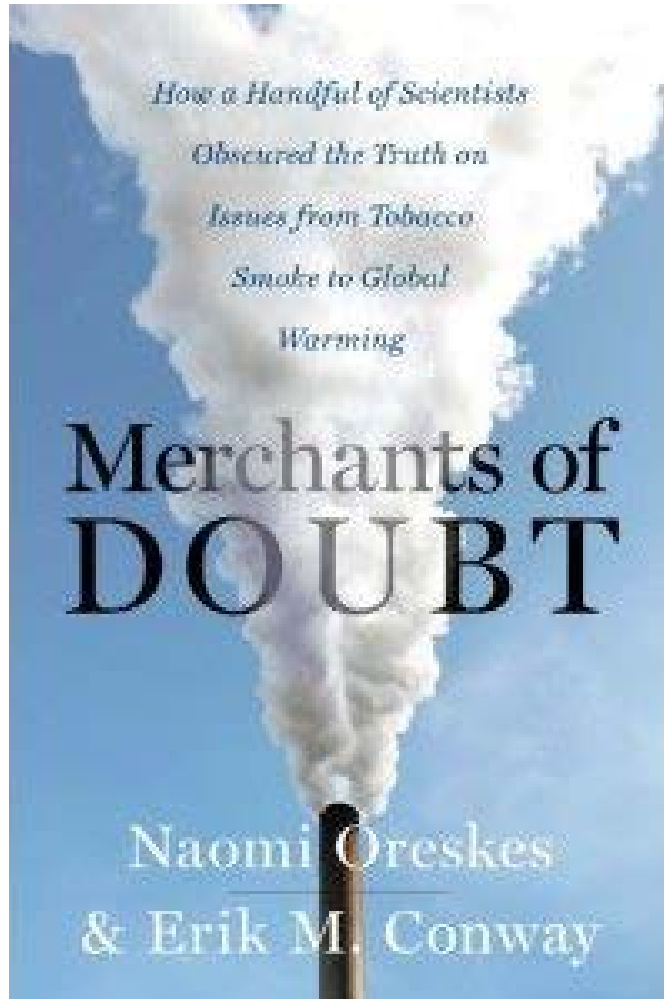
**Mark McCaffrey** 20 May 2012 lecture

# **The Climate & Energy Literacy Imperative:**

Toward an Adult Conversation about  
21<sup>st</sup> Century Science

Mark S. McCaffrey  
Programs & Policy Director  
National Center for Science Education  
Oakland, CA 94609

# Merchants of Doubt



**Fred Seitz** - solid state physicist. Manhattan project. former president. NAS

**Fred Singer** - physicist. First dir. Nat. Weather Satellite Service

**Bill Nierenberg** - physicist, former director of Scripps Oceanographic

**Robert Jastrow** - physicist, director of Goddard Inst. for Space Scientists

**Richard Lindzen** - MIT meteorology professor

Book Discusses campaigns to misinform on:

Acid Rain

Ozone Hole and CFC regulation

Tobacco and Cancer

Ban on DDT

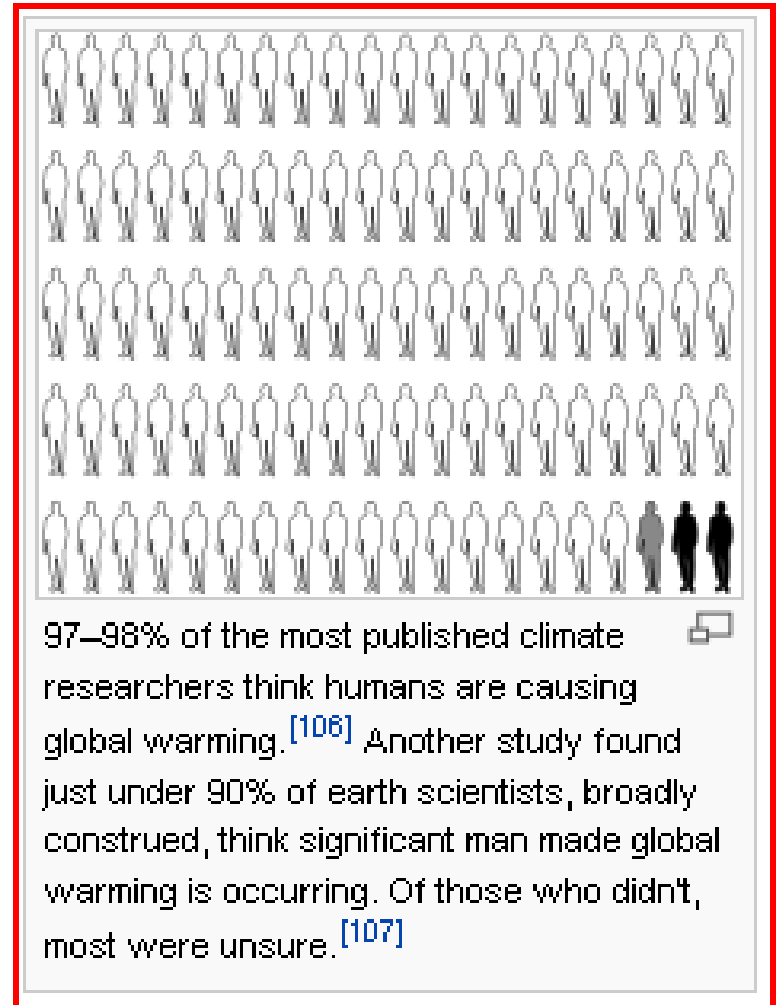
Global Warming

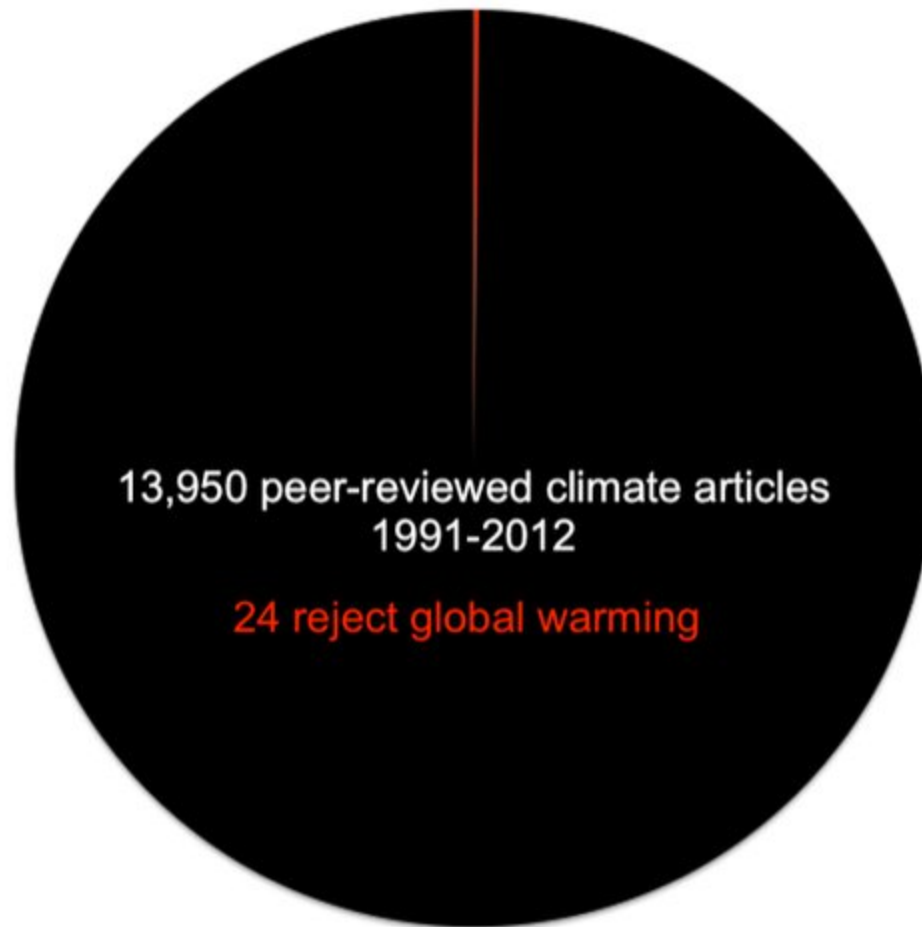
# National Academies of Science

- [American Association for the Advancement of Science](#) as the world's largest general scientific society 2006:

The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society....The pace of change and the evidence of harm have increased markedly over the last five years. The time to control greenhouse gas emissions is now.

- [US National Academy of Sciences](#): "In the judgment of most climate scientists, Earth's warming in recent decades has been caused primarily by human activities that have increased the amount of greenhouse gases in the atmosphere.." <sup>[117]</sup>





Of 13,950 scientific papers published between 1 January 1991 and 9 November 2012, 24, or **0.17%**, or 1 in 581, that clearly reject global warming or endorse a cause other than CO2 emissions for observed warming.

<http://www.treehugger.com/climate-change/pie-chart-13950-peer-reviewed-scientific-articles-earths-climate-finds-24-rejecting-global-warming.html>  
<http://www.desmogblog.com/2012/11/15/why-climate-deniers-have-no-credibility-science-one-pie-chart>

# Every National Academy of Science of Every Major Country in the World Confirms Anthropogenic Global Warming

African Academy  
of Science

Australia

Belgium

Brazil

Cameroon

Canada

The Caribbean

China

France

Ghana

Germany

Indonesia

Ireland

Italy

India

Japan

Kenya

Madagascar

Malaysia

Mexico

Nigeria

New Zealand

Russia

Senegal

South Africa

Sudan

Sweden

Tanzania

Turkey

Uganda

United Kingdom

United States

Zambia

Zimbabwe

# National Academies *Rejecting* the Science of Anthropogenic Global Warming

None

# Tobacco Denier-ism

1930 German researchers in Cologne found statistical relationship between cancer and smoking

1954 UK Medical Research Council confirms link between smoking and cancer

1964 US Surgeon General says cigarette smoking is a health hazard

1975, Minnesota enacted the Minnesota Clean Indoor Air Act imposed Non-smoking sections in restaurants

1988 Reagan signs law making less than 2 hour domestic flights smoke free

1990 San Luis Obispo bans indoor smoking in bars and restaurants

1995 California Statewide ban

**21 years from UK report to first restriction on smoking in Minnesota**

**"Doubt is our product,"** a cigarette executive once observed, "since it is the best means of competing with the 'body of fact' that exists in the minds of the general public. It is also the means of establishing a controversy."



# Fairness Doctrine in Media?

## Equal Time for 0.17% ?

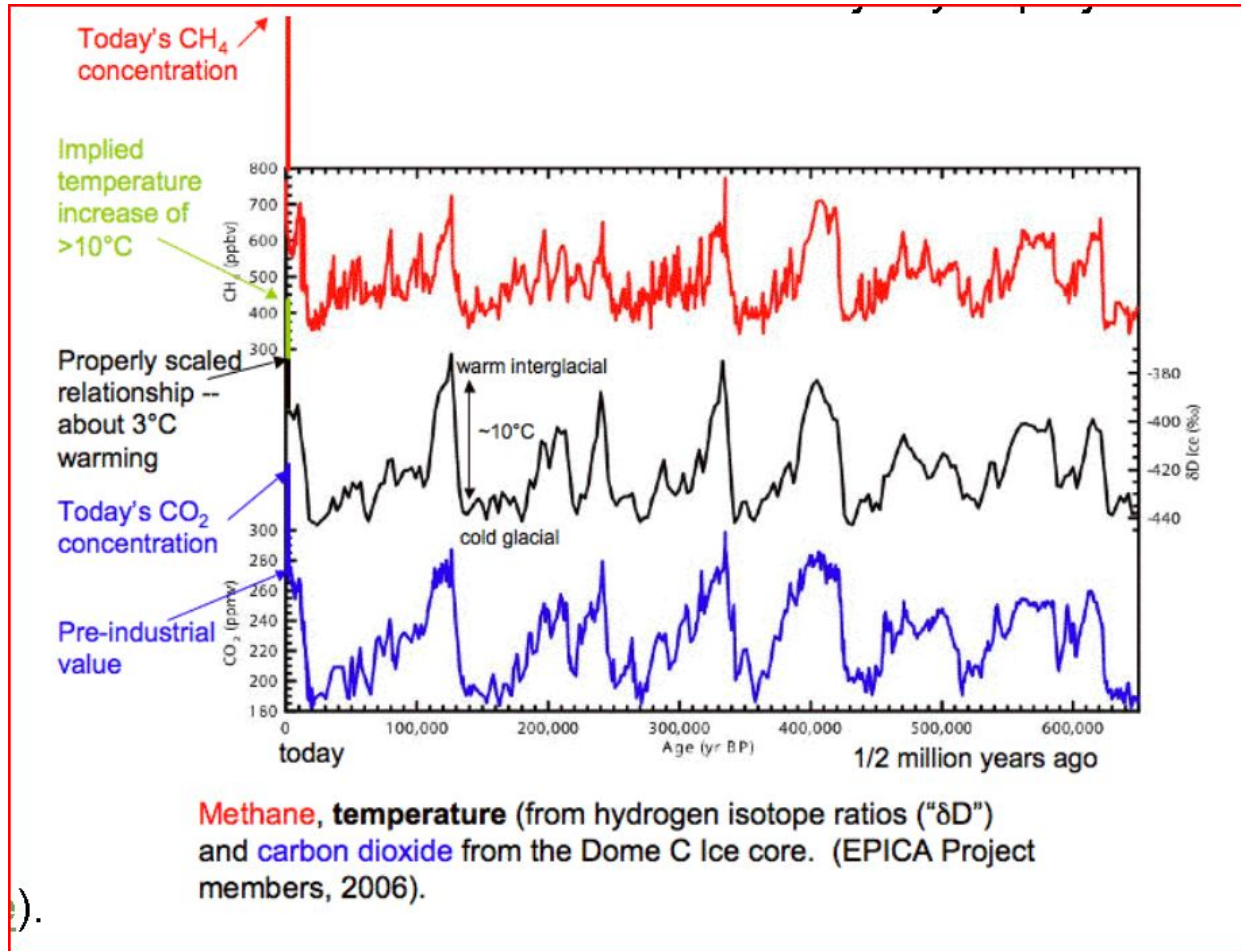
1949 broadcast journalists required to dedicate airtime to controversial issues in a “balanced manner”

No need to give equal time to Hitler vs Churchill

A review of publications at UCSF in 1999 showed:

Between 1992 and 1994, 62% of newspaper and magazine articles on effects of passive tobacco smoke still indicated that the research is controversial. M.O.D. p 242 (Gail Kennedy, Lisa Bero)

# Temperature vs CO2 -- historical



We are currently at **400 ppm CO<sub>2</sub>**, 400,000 year historical high 290 ppm  
 Currently **1850 ppb methane**, 400,000 year historical high 700 ppb  
 Milankovitch cycles: precession: 26,000 years, obliquity: 41,000 years

<http://www.realclimate.org/index.php/archives/2007/04/the-lag-between-temp-and-co2/>

# DO THE MATH: Bill McKibben

## 6 Numbers you need to remember

- **2 degrees C** – Eemian period was 120,000 years ago  
Number from Copenhagen climate conference in 2009
- **31.6 GT** current CO2 emissions per year worldwide
- **565 GT** Estimated limit in models to stay below 2 degrees
- **2795 GT** Estimated emissions if we burn everything

$565/31.6 = 17.87$  years left to get completely off Carbon

Sea Level was 5-7 meters higher in Eemian

Just crossed **400 PPM**, Need to be **below 350 PPM**

<http://www.rollingstone.com/politics/news/global-warmings-terrifying-new-math-20120719>

# Lifetime of CO<sub>2</sub> in atmosphere

Sea Level Rise:  $3.3 \pm 0.4$  mm ( $1/8^{\text{th}}$  inch) per year from 1993 to 2009, [\[5\]](#)  
a faster rate of increase than previously estimated. [\[6\]](#)

More than half of the CO<sub>2</sub> emitted is removed from the atmosphere within a century.

$\frac{1}{4}$  of the 90 million tons of CO<sub>2</sub> we emit per day will be here more than 10,000 years from now – still trapping heat.

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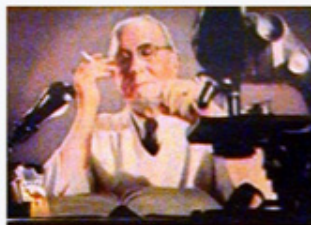
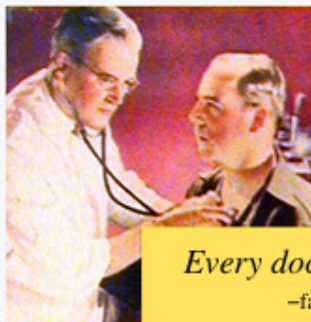
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*Every doctor in private practice was asked:*

*—family physicians, surgeons, specialists...  
doctors in every branch of medicine—*

*“What cigarette do you smoke?”*



*According to a new Nationwide survey:*

## More Doctors Smoke Camels

*than any other cigarette!*

**not a guess, not just a trend . . . but an actual fact based on  
the statements of doctors themselves to 3 nationally  
known independent research organizations.**

**THE  
“T-ZONE” TEST  
WILL  
TELL YOU**



The “T-Zone” — T for taste and T for throat — is your own laboratory, your proving ground, for any cigarette. For only your taste and your throat can decide which cigarette tastes best to you . . . and how it affects your throat. On the basis of the experience of many, many millions of smokers, we believe Camels will suit your “T-Zone” to a “T.”



R. J. Reynolds Tobacco Co.

**Y**ES, your doctor was asked . . . along with thousands and thousands of other doctors from Maine to California.

And they've named their choice — the brand that more doctors named as their smoke is *Camel*! Three nationally known independent research organizations found this to be a fact.

Nothing unusual about it. Doctors smoke for pleasure just like the rest of us. They appreciate, just like you, a mildness that's cool and easy on the throat. They too enjoy the full, rich flavor of expertly blended costlier tobaccos. Next time, try Camels.

# DDT Resistant Mosquitos

Rachel Carson is NOT a mass murderer

Concerted effort to vilify Rachel Carson. [RachelWasWrong.org](http://RachelWasWrong.org) is hosted by the [Competitive Enterprise institute](http://CompetitiveEnterpriseInstitute.org), a free-market public policy group in Washington, D.C.

Even picked up by John Tierney in NY Times in 2007. Spread like wildfire.

## Sri Lanka

1948 2.8 million cases of malaria then start DDT

1963 Only 17 cases of malaria

1968 Malaria flared up DDT could not control

1969 2.5 million cases of malaria

1975 Restarted DDT with no affect on malaria



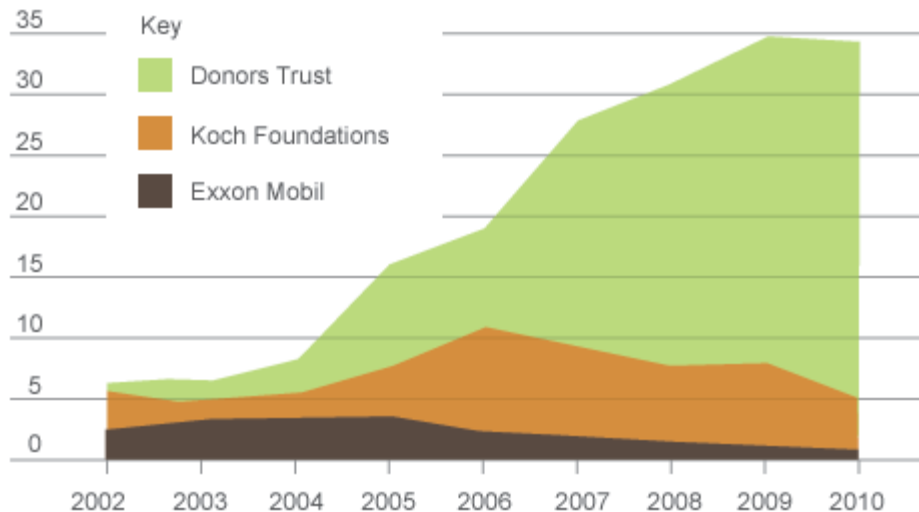
# Denier-ism

*Conservative billionaires used a secretive funding route to [channel nearly \\$120 million to more than 100 groups](#) casting doubt about the science behind climate change, helping build a vast network of think tanks and activist groups working to redefine climate change from neutral scientific fact to a highly polarizing 'wedge issue'*

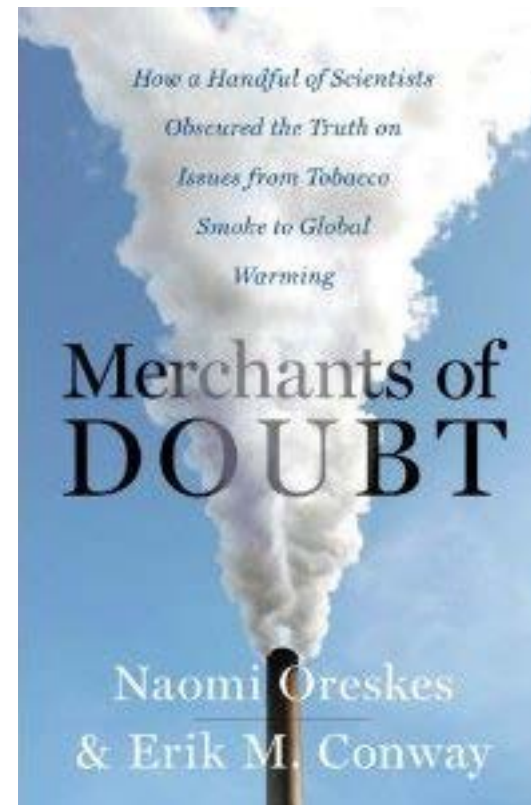
## Climate denial funds from fossil sources

Amount given to climate denial groups

40 million dollars



SOURCE: GREENPEACE





# Climate Change Deniers

[Deniers are] spending hundreds of millions of dollars each year on misleading advertisements in the mass media; hiring four anti-climate lobbyists for every member of the U.S. Senate and House of Representatives.

Rolling Stone Magazine: Al Gore June 22, 2011

[Greenpeace's ExxonSecrets](#) project has documented the nearly \$25 million spent by ExxonMobil since 1998 to fund climate denier groups

**“It is difficult to get a man to understand something when his salary depends upon his not understanding it.”**

[Upton Sinclair quotes](#) (AKA: Upton Beall Sinclair, Jr. [American Novelist](#) and polemicist, [1878-1968](#))

# Charles and David Koch

Each own 42% of Koch Industries with revenues of **\$113 billion**  
60,000 employees

Products: [refining](#) and [distribution](#)<sup>[1]</sup> of [petroleum](#), [chemicals](#), [energy](#), fiber, intermediates and [polymers](#), [minerals](#), [fertilizers](#), [pulp and paper](#), chemical technology equipment

Subsidiaries: Georgia Pacific, Invista, Flint Hills Resources  
(Port Arthur, TX refining including Canadian Tar Sands)

Father, Fred C. Koch built refineries in USSR and became staunchly anti-communist.

From 1999 to 2003, Koch Industries was assessed "more than \$400 million in fines, penalties and judgments." for environmental violations.

Koch Industries has spent more than \$50 million to lobby in Washington between 2006 and October 2011, according to the [Center for Responsive Politics](#).<sup>[38]</sup>

[https://en.wikipedia.org/wiki/Koch\\_Industries](https://en.wikipedia.org/wiki/Koch_Industries)

# Charles and David Koch bid to purchase L.A. Times, Chicago Tribune

**Fact:** The Koch brothers spent up to \$400 million in the 2012 elections attempting to elect right-wing candidates to the White House, the U.S. Senate, the U.S. House and governorships. Those efforts will continue in the future.

**Fact:** The Koch brothers, who have made their fortune in the fossil fuel industry, are strongly supporting a massive disinformation campaign to deny the reality of the planetary crisis of global warming.

**And now, the Koch brothers want to expand their power by taking over the Tribune Newspaper chain — the nation's second largest newspaper publisher.** The Tribune Company chain includes such newspapers as the Chicago Tribune, the Los Angeles Times, the Hartford Courant, the Orlando Sentinel, the South Florida Sun-Sentinel, the Baltimore Sun, the Daily Press and The Morning Call — among other papers.

[Senator Bernie Sanders \(May 8, 2013\):](http://www.berniesanders.org/uncategorized/koch-brothers-tribune-company-update/)  
<http://www.berniesanders.org/uncategorized/koch-brothers-tribune-company-update/>

# OIL Company Profits

TABLE 1

## Profits up, production down

Big Oil's profits soar as oil-equivalent production decreases from 2010 to 2011

Company	Total profit, 2010 (in billions)	Total profit, 2011 (in billions)	Percent increase in profit from 2010 to 2011	Oil-equivalent production, 2010 (millions of barrels per day)	Oil-equivalent production, 2011 (millions of barrels per day)	Percent change in production from 2010 to 2011
BP	\$(4)	\$26	114%	3.8	3.5	-10%
Chevron	\$19	\$27	42%	2.8	2.7	-3%
ConocoPhillips	\$11	\$12	9%	1.9	1.7	-9%
ExxonMobil	\$31	\$41	31%	4.4	4.5	1%
Shell	\$20	\$31	54%	3.3	3.2	-3%
<b>Total</b>	<b>\$78</b>	<b>\$137</b>	<b>75%</b>	<b>16.2</b>	<b>15.6</b>	<b>-4%</b>

Source: Company profit reports

<http://www.americanprogress.org/issues/green/news/2012/02/07/11145/big-oils-banner-year/>

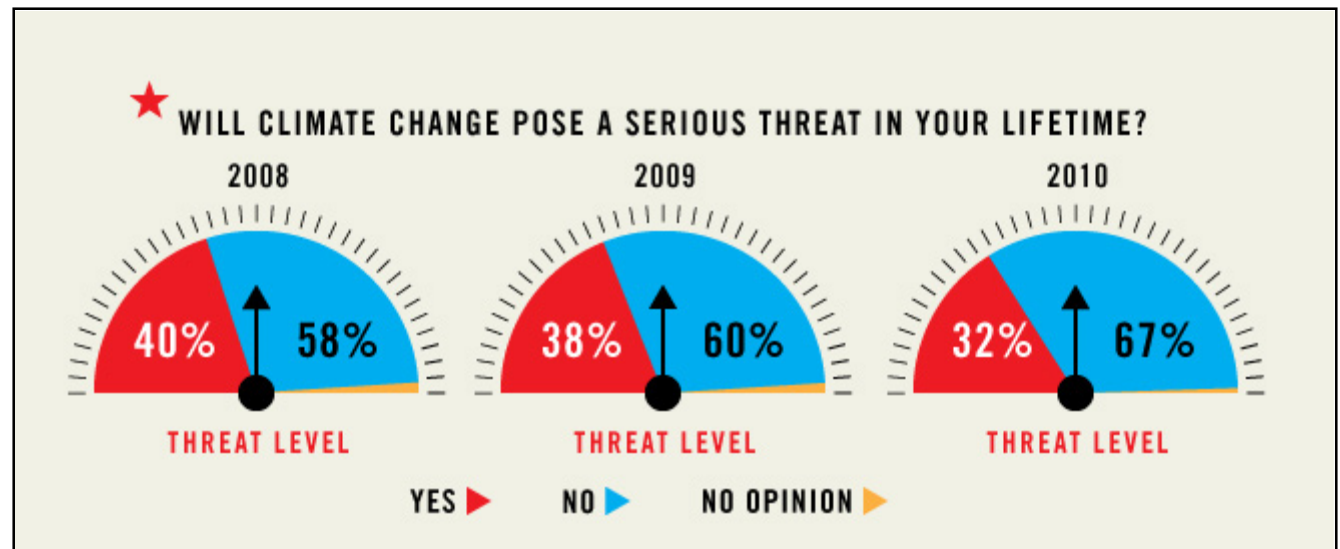
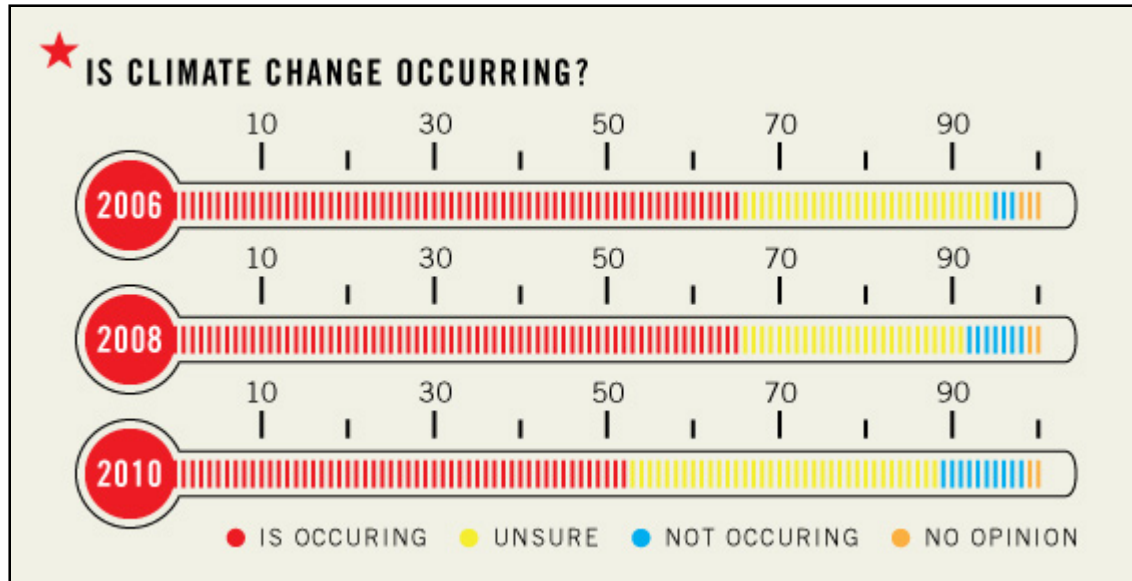
# Carbon Bubble / Stranded Assets

- Unbalanced/unsustainable carbon use: Burn more than captured by plants, etc.
- At least two-thirds of these reserves will have to remain underground if the world is to meet existing [internationally agreed targets](#) to avoid the threshold for "dangerous" [climate change](#).
- [If the agreements hold](#), these reserves will be in effect unburnable and so worthless
- **Trillions of dollars of fossil fuels cannot be burned !**
- Far from reducing efforts to develop fossil fuels, the top 200 companies spent \$674bn (£441bn) in 2012 to find and exploit even more new resources, a sum equivalent to 1% of global GDP
- <http://www.guardian.co.uk/environment/2013/apr/19/carbon-bubble-financial-crash-crisis>

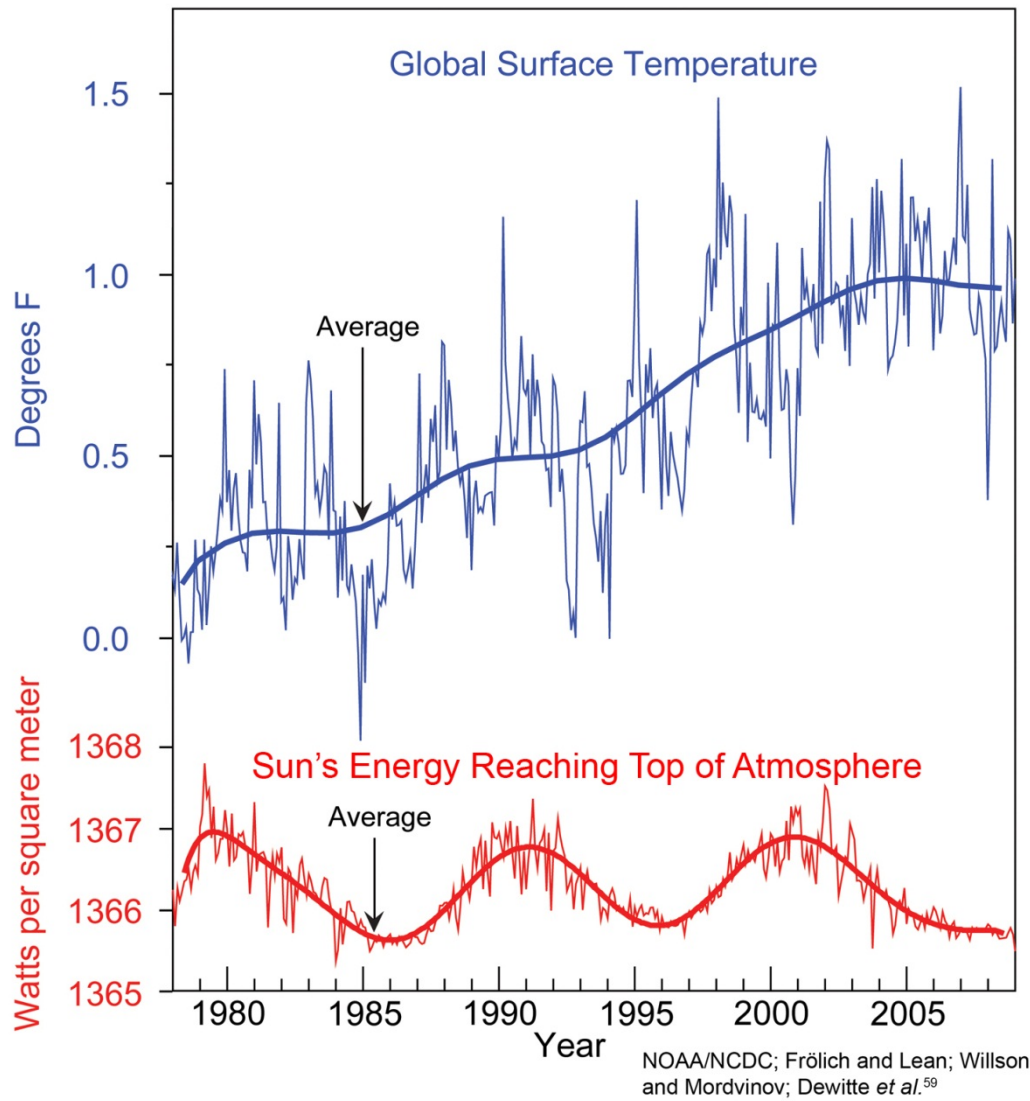
# Teaching Denial (Jan 2013)

- **Three States Pushing ALEC Bill To Require Teaching Climate Change Denial In Schools**
- The [American Legislative Exchange Council \(ALEC\)](#) - known by its critics as a "[corporate bill mill](#)" - has hit the ground running in 2013, pushing "models bills" mandating the teaching of climate change denial in public school systems.
- January hasn't even ended, yet ALEC has already planted its "[Environmental Literacy Improvement Act](#)" - which mandates a "balanced" teaching of climate science in K-12 classrooms - in the state legislatures of Oklahoma, Colorado, and Arizona so far this year.
- In the past five years since 2008, [among the hottest years in U.S. history](#), ALEC has introduced its "[Environmental Literacy Improvement Act](#)" in 11 states, or over one-fifth of the statehouses nationwide. The [bill has passed](#) in [four states](#), an undeniable form of "big government" this "free market" organization [decries in its own literature](#).

# Denialism works – Sell Doubt !



# Misconception: It's the Sun's Fault



- Claim: Global temperatures are rising because the sun is getting brighter, not because of fossil-fuel use.
- Facts: Since 1978, satellites have accurately measured the solar energy received at the top of Earth's atmosphere. The sun's energy output varies by small amounts with an 11-year cycle, but with little-to-no long-term trend. There is no observed correlation between temperature and solar fluctuations.

The Sun's energy received at the top of Earth's atmosphere has been measured by satellites since 1978. It has followed its natural 11-year cycle of small ups and downs, but with no net increase (bottom). Over the same period, global temperature has risen markedly (top).<sup>60</sup>



# What is an Externality?

Burning coal releases mercury which poisons people and animals. Coal mining companies don't pay for that cost, neither do power plants that burn the coal.

**Harvard Study estimates the true cost of coal to be \$500 billion/year in the US.**

“The impacts found are damages due to climate change; public health damages from NO<sub>x</sub>, SO<sub>2</sub>, PM<sub>2.5</sub>, and mercury emissions; fatalities of members of the public due to rail accidents during coal transport; the public health burden in Appalachia associated with coal mining; government subsidies; and lost value of abandoned mine lands.”

These ‘external’ costs borne by society would add to the cost of coal fired electricity, which would be roughly **9 –27 cents per kilowatt hour**.

According to the Environment Texas report, “the truck traffic needed to deliver water to a single fracking well causes as much damage to local roads as nearly 3.5 million car trips. The state of Texas has approved \$40 million in funding for road repairs in the Barnett Shale region.”

<http://cleantechnica.com/2011/02/17/cost-of-coal-500-billion-year-in-u-s-harvard-study-finds/>

<http://thinkprogress.org/climate/2013/03/19/1742171/long-term-costs-of-fracking-are-staggering/>

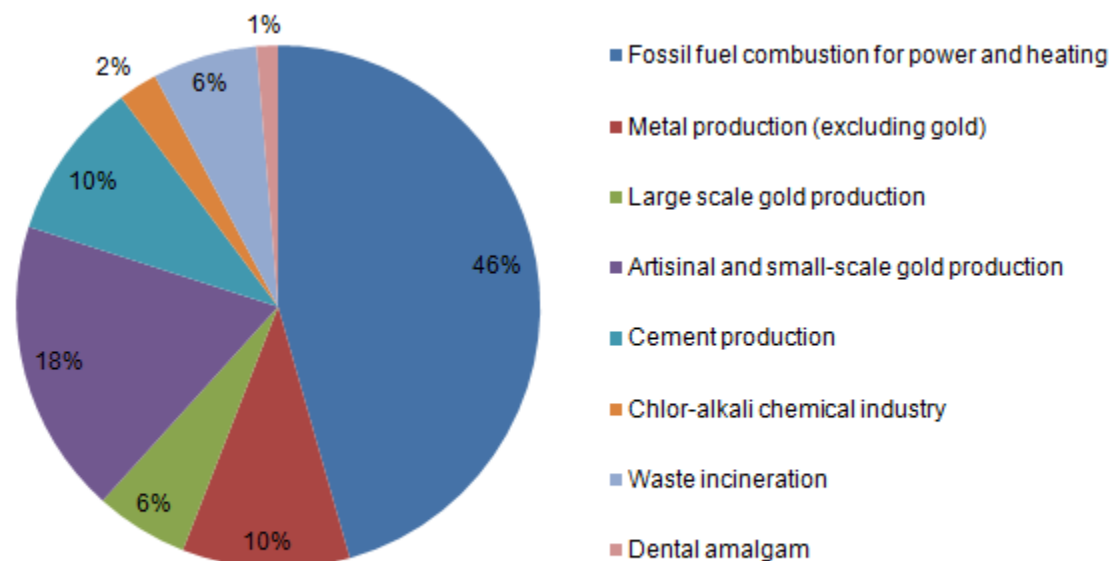
# Mercury and Tuna consumption

## Eating Tuna Safely

This table provides guidelines on how much canned tuna it is safe to eat, according to the Environmental Protection Agency. While mercury poses the most serious health threat to children and women who are pregnant or planning to become pregnant, others may also wish to use this list as a guide.

If you weigh:	Don't eat more than one can every:	
	White Albacore	Chunk Light
20 lbs	10 weeks	3 weeks
30 lbs	6 weeks	2 weeks
40 lbs	5 weeks	11 days
50 lbs	4 weeks	9 days
60 lbs	3 weeks	7 days
70 lbs	3 weeks	6 days
80 lbs	2 weeks	6 days
90 lbs	2 weeks	5 days
100 lbs	2 weeks	5 days
110 lbs	12 days	4 days
120 lbs	11 days	4 days
130 lbs	10 days	4 days
140 lbs	10 days	3 days
150+ lbs	9 days	3 days

Source: Food and Drug Administration test results for mercury and fish, and the Environmental Protection Agency's determination of safe levels of mercury.



Source: AMAP/UNEP, 2008. Technical Background Report to the Global Atmospheric Mercury Assessment. Arctic Monitoring and Assessment Programme/UNEP Chemicals Branch. Page 39.

<http://www.nrdc.org/health/effects/mercury/sources.asp>

# China Pollution cost \$230 Billion/year

BEIJING — The cost of environmental degradation in [China](#) was about \$230 billion in 2010, or 3.5 percent of the nation's gross domestic product — three times that in 2004, in local currency terms, an official Chinese news report said this week.

Outdoor air pollution contributed to 1.2 million premature deaths in [China](#) in 2010



On Jan 28, 2013 air pollution in Beijing hit 755 on a scale of 0-500

100 is hazardous to sensitive people

400 is hazardous to all

Bay Area Spare the Air Day is >100. \$500 fine for burning in fireplace

<http://www.economist.com/blogs/analects/2013/01/beijings-air-pollution>

<http://www.nytimes.com/2013/03/30/world/asia/cost-of-environmental-degradation-in-china-is-growing.html?hp>

<http://www.nytimes.com/2013/04/02/world/asia/air-pollution-linked-to-1-2-million-deaths-in-china.html>

# Weather Disasters Cost From Munich RE

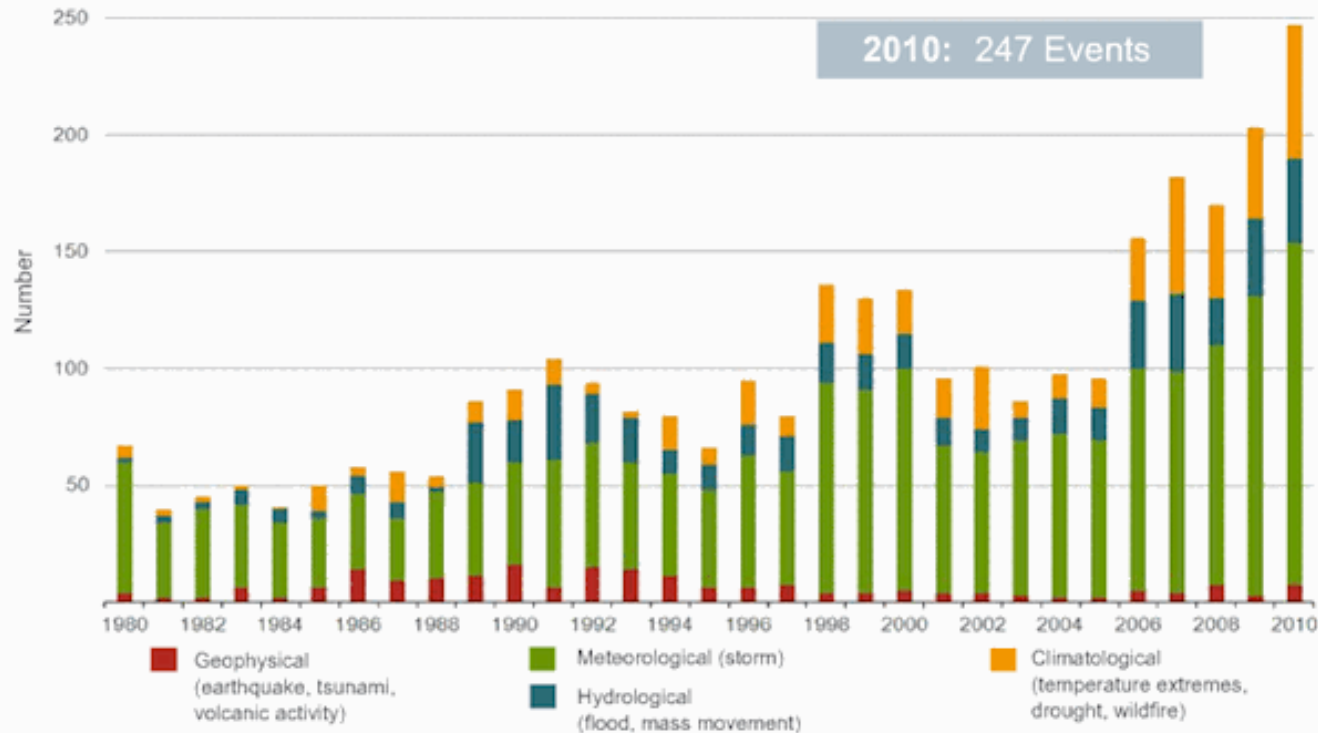
U.S. Natural Catastrophe Update

Natural Disasters in the United States, 1980 – 2010

Munich RE

Number of Events, Annual Totals

The number of events in the United States in 2010 set a new record.



September 2010, Munich Re one of the world's leading reinsurers, [wrote](#) "the only plausible explanation for the rise in weather-related catastrophes is climate change."

# GeoEngineering ??

- Earth cools after volcanoes
- Volcanoes put Sulfur in atmosphere
- GeoEngineering: Put millions of tons of Sulfur in stratosphere
- According to estimates by the [Council on Foreign Relations](#), "one kilogram of well placed sulfur in the stratosphere would roughly offset the warming effect of several hundred thousand kilograms of carbon dioxide."<sup>[8]</sup>
- DOES NOT ADDRESS OCEAN ACIDIFICATION !
- [http://en.wikipedia.org/wiki/Stratospheric\\_sulfur\\_aerosols\\_%28geoengineering%29](http://en.wikipedia.org/wiki/Stratospheric_sulfur_aerosols_%28geoengineering%29)

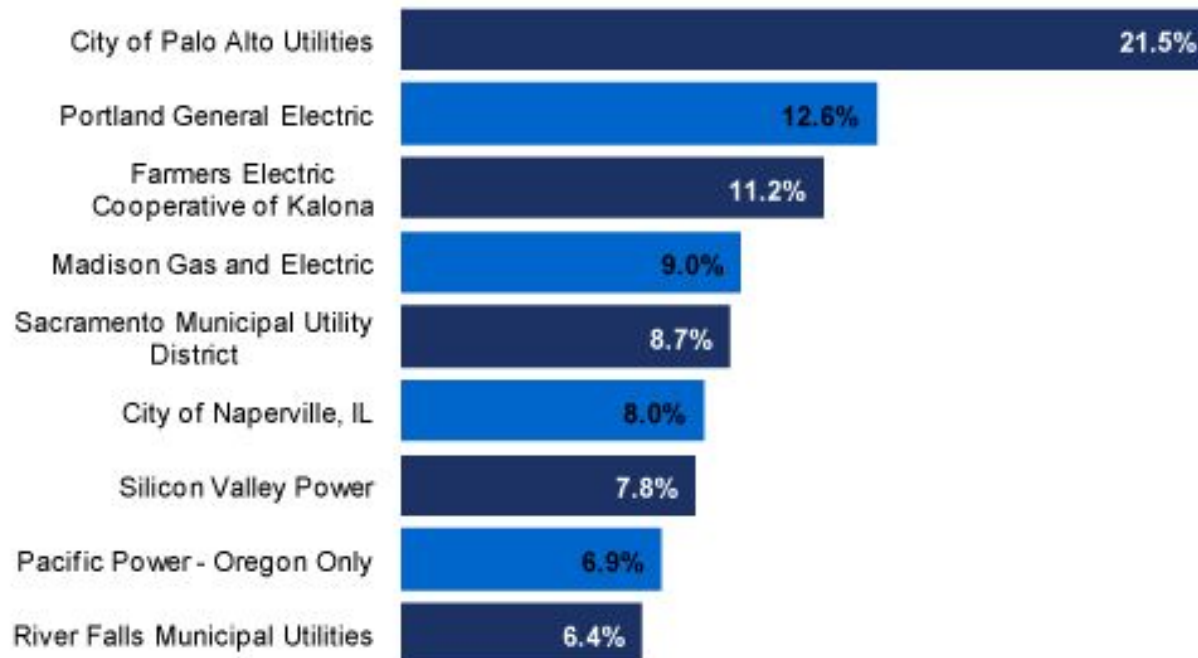
# What motivates deniers?

- **Money** and Shareholder value  
(CEOs have a responsibility to shareholders)
  - **Ideology** – Free Marketers – regulation is a slippery slope to communism – U.N. taking over (Agenda 21) .
    - Cold Warriors → Acid Rain, Tobacco, Ozone hole, Climate Change
- Fred Seitz – solid state physicist. Manhattan project. former president. NAS
- Fred Singer – physicist. First dir. Nat. Weather Satellite Service
- Bill Nierenberg – physicist, former director of Scripps Oceanographic
- Robert Jastrow – physicist, director of Goddard Inst. for Space Scientists
- Fred C Koch – worked in Stalin’s Soviet Union and hated communism.
  - We have a fossil fuel based economy/standard of living. Free Marketers see regulations on Carbon as a way to get their hands in to everything.
  - Gus Speth: Most environmental degradation is a result of “failures of capitalism we have today”
  - Nicholas Stern (former head of World Bank) : Climate Change is “the greatest and widest ranging market failure ever seen”

# Purchase Green Power

## Top 10 Green Power Programs, by Participation Rate

(% of total customers, as of Dec. 2010)



**environmental**  
**LEADER**  
www.environmentalleader.com

Source: DOE, National Renewable Energy Lab, May 2011

Silicon Valley Power charges 1.5 cents extra for Green (Renewable) Power

# Carbon Free Palo Alto

## **Palo Alto Electricity Supply 100% Carbon Neutral Retroactive to 1/1/2013**

On March 4, 2013, the Palo Alto City Council ratified the Carbon-Free electricity proposal with a unanimous vote. This means that starting on March 4, 2013, and retroactive back to Jan 1, 2013, the City of Palo is providing 100% carbon-free electricity to all of its customers.

The plan has two phases:

**Near term (2013 through 2016)**---the City will purchase short-term renewable resources and/or renewable energy certificates (RECs) to supplement existing and committed long-term renewable and hydroelectric resources, which account for 65% to 83% of the portfolio.

**Longer term (beyond 2016)**---long-term renewable resources will provide about a 50% RPS level within the existing 0.5 ¢/kWh annual RPS rate limit. Since about 50% of the electric supply portfolio is already sourced from carbon-free hydroelectric resources, the additional cost of achieving carbon neutrality between 2017 and 2020 is very small.

<http://carbonfreepaloalto.org/>



# Carbon Tax/Price (Pigovian Taxes) pay for externalities

Citizens Climate Lobby's Fee and Dividend Legislation Proposal

- \$15/ton CO<sub>2</sub> increasing by \$10/ton/year – predictable
- Place fee on primary extraction source of fossil fuels
- Return 100% to consumers in equal dividend checks
- Border adjustments
- Does not bet on any given technology – Solyndra
- Prices in externalities of fossil fuels
- Market driven so appeals to free marketers
- Example:
- \$100/ton adds \$1 to cost of gasoline
- Hummer = 15,000/11 → \$1368/year
- Prius = 15000/50 → \$300/year
- If dividend = \$700/year , Prius owner might make money

<http://citizensclimatelobby.org/>

# Divestment from Fossil Fuels

Similar to divesting from South African Apartheid regime

By 1988, 155 educational institutions had divested from South Africa, according to [one analysis](#).

Individuals, pension funds and universities

## **Colleges that Agreed to Some Form of Fossil Fuel Divestment (Apr 2013):**

[Unity College](#)

[Hampshire College](#)

[Sterling College](#)

[Santa Fe Art Institute](#)

[College of the Atlantic](#)

Read more: <http://www.insidehighered.com/news/2013/04/18/fossil-fuel-divestment-movement-picking-steam-and-unlikely-go-away#ixzz2T3XIYTPL>

Inside Higher Ed

<http://campaigns.gofossilfree.org/petitions/stanford-university>

# Failed Gun Control Legislation Apr. 17, 2013

90 % of Americans support background checks.

Failed to get 60% of Senators to pass a weak gun control law.

Why?

Gun Dealers, Gun Manufacturers – have a vested interest – even spread lies according to Obama : There is no Big Brother registry.

<http://www.csmonitor.com/Commentary/Opinion/2013/0418/Why-the-90-percent-lost-on-gun-background-checks>

Money is thoroughly corrupting our politics.

<http://www.opensecrets.org/bigpicture/stats.php?cycle=2010&type=A&display=A>  
Candidates need millions of dollars to run.

House						
Party	No. of Cands	Average Raised	Average Spent	Average Cash on Hand	Average from PACs	Average from Indivs
All	1897	\$574,068	\$570,617	\$88,143	\$174,490	\$340,249
Dems	620	\$832,331	\$874,044	\$129,671	\$317,241	\$467,567
Repubs	1116	\$508,777	\$479,794	\$77,600	\$120,216	\$315,998

Senate						
Party	No. of Cands	Average Raised	Average Spent	Average Cash on Hand	Average from PACs	Average from Indivs
All	308	\$2,411,115	\$2,348,864	\$267,204	\$295,834	\$1,532,008
Dems	105	\$2,948,691	\$3,000,142	\$311,161	\$417,256	\$1,958,939
Repubs	156	\$2,655,122	\$2,498,219	\$315,290	\$287,855	\$1,611,093

# California Clean Money

## Move to Amend

- **AB 1648, California DISCLOSE Act**
- **Requires the three largest funders of political ads to be clearly identified with their names and logos** — on the ads themselves, so voters know who is actually paying for them.
- MOVE TO AMEND:  
<https://movetoamend.org/>
- Competitive Enterprise Institute is [listed as a "Gold Sponsor"](#) of the Heartland Institute's Seventh International Conference on Climate Change (ICCC7).
- **Exxon Mobil** — \$1,690,000 to CEI. In 2007 ExxonMobil [reported](#) that they would no [longer be funding CEI](#).

Prop 23 Nov 2010 ballot.  
Donations to reverse AB32

According to Cal-Access, as of October 1, donations to Initiative Committee":<sup>[17]</sup>

Donor	Amount
Valero	\$4,050,000
Tesoro	\$1,525,000
Flint Hills Resources LP (subsidiary of Koch Industries)	\$1,000,000
Adam Smith Foundation	\$498,000
Occidental Petroleum	\$300,000
National Petrochemical and Refiners Association	\$100,000

Over \$235 million was spent on CA ballot measures in 2010

# Leadership

Need to get serious: WW2 Sized effort worldwide

After Pearl Harbor, President Roosevelt proposed 60,000 planes, 45,000 tanks, 20,000 anti-aircraft guns.

No automobiles built between 1942 and 1945 (4 million cars in 1941 to zero)

Tires, gasoline, fuel oil and sugar were rationed.

US produced (1942 to 1944):

- 334,750 aircraft ( ~2200/week)
- 88,400 tanks
- 2.38 million military trucks
- 2.68 million machine guns
- 5000 ships

# Backup Slides

# Confusing the Debate



Heartland funded by Exxon-Mobil

Working to develop a “[global warming curriculum](#)” for elementary schoolchildren that presents climate science as “a major scientific controversy.” This effort, at a cost of \$100,000 a year, will be developed by Dr. [David E. Wojick](#), a [coal-industry consultant](#).

[Their website](#) still asserts, “**the most prominent advocates of global warming aren’t scientists. They are murderers, tyrants, and madmen.**”

As economist Ross McKittrick said in an a [strongly-worded letter](#) to Heartland yesterday:  
**You cannot simultaneously say that you want to promote a debate while equating the other side to terrorists and mass murderers.**

# Exxon and Koch-funded Willie Soon

- Dr. Willie Soon is a [Smithsonian Institution](#) astrophysicist **paid by Charles Koch, ExxonMobil, the American Petroleum Institute and coal utility Southern Company** to write papers dismissing climate change, publish op-eds saying coal pollution won't affect our health, refute the seriousness of ocean acidification, and apparently anything else he can be paid to deny. Dr. Soon has misrepresented himself by repeatedly claiming affiliation with Harvard University and using his credentials as an astrophysicist to make people believe he's a climate expert, and he shows no sign of stopping. Indeed, he told students in Madison, "[I am as as qualified as anyone on the planet on this topic.](#)"
- In both Madison, Wisconsin and East Lansing, Michigan, Dr. Soon was caught with his pants down. As the [Michigan State News](#) documented in its article and accompanying [audio interview](#), **Soon claims that all the scientists around the world who study and recognize the seriousness of climate change are motivated by money, yet somehow his funding from coal and oil companies for his [extremely marginalized viewpoints](#) doesn't matter.**
- **2013:** Soon's [ongoing "research" funding](#) is now hidden through **Donors Trust**, a network used by the Kochs and other secretive interests who don't want their financial influence to be traced. [Donors Trust](#) is the sole source of almost half of recent budgets for CFACT, which [paid for Soon's campus tour](#).
- <http://www.desmogblog.com/node/7044>



# A first Scientific Report in 1965

## RESTORING THE QUALITY OF OUR ENVIRONMENT



The climatic changes that may be produced by the increased CO<sub>2</sub> content could be deleterious from the point of view of human beings. The possibilities of deliberately bringing about countervailing climatic changes therefore need to be thoroughly explored. A change in the radiation balance in the opposite direction to that which might result from the increase of atmospheric CO<sub>2</sub> could be produced by raising the albedo, or reflectivity, of the earth. Such a change in albedo could be

THE WHITE HOUSE  
NOVEMBER 1965

### OTHER POSSIBLE EFFECTS OF AN INCREASE IN ATMOSPHERIC CARBON DIOXIDE

*Melting of the Antarctic ice cap.*—It has sometimes been suggested that atmospheric warming due to an increase in the CO<sub>2</sub> content of the atmosphere may result in a catastrophically rapid melting of the Antarctic ice cap, with an accompanying rise in sea level. From our knowledge of events at the end of the Wisconsin period, 10 to 11 thousand years ago, we know that melting of continental ice caps can occur very rapidly on a geologic time scale. But such melting must occur relatively slowly on a human scale.

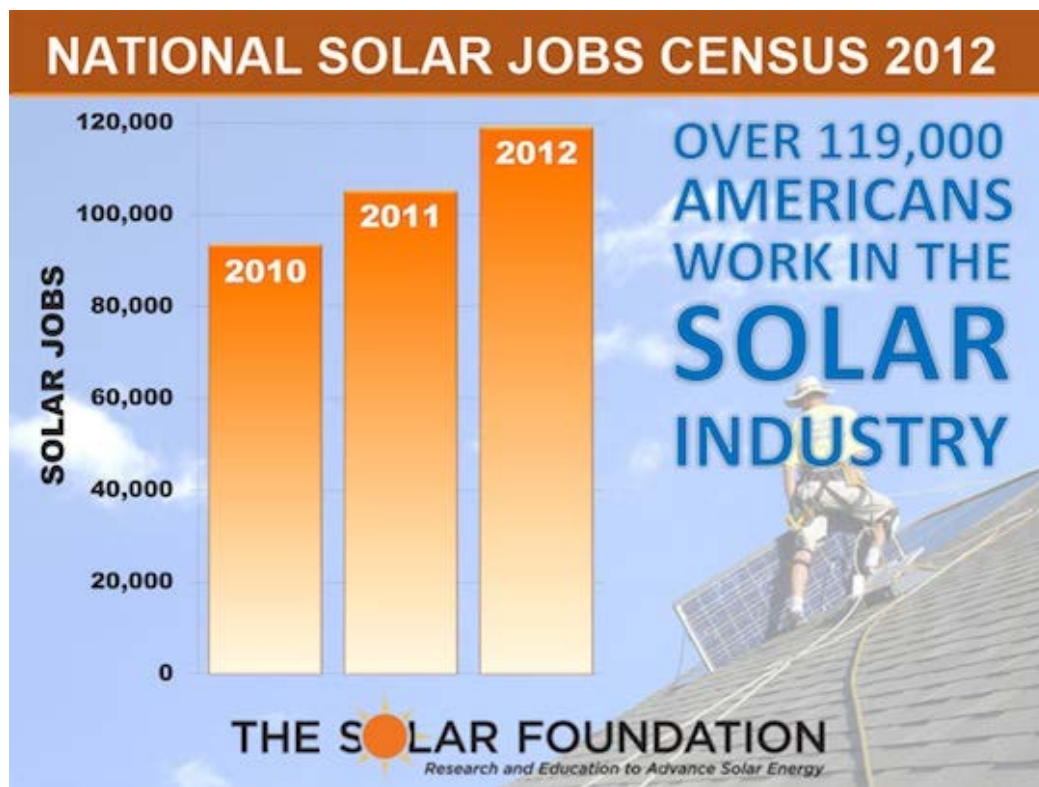
The Antarctic ice cap covers 14 million square kilometers and is about 3 kilometers thick. It contains roughly  $4 \times 10^{16}$  tons of ice, hence  $4 \times 10^{24}$  gram calories of heat energy would be required to melt it. At the present time, the poleward heat flow across 70° latitude is  $10^{22}$  gram calories per year, and this heat is being radiated to space over Antarctica without much measurable effect on the ice cap. Suppose that the poleward heat flow were increased by 100% through an intensification of the

and sea level would rise about 1 meter every 10 years, 10 meters per century. This is a hundred times greater than present worldwide rates of sea level change.

*Warming of sea water.*—If the average air temperature rises, the temperature of the surface ocean waters in temperate and tropical regions could be expected to rise by an equal amount. (Water temperatures in the polar regions are roughly stabilized by the melting and freezing of ice.) An oceanic warming of 1° to 2°C (about 2°F) oc-

# Solar Jobs versus Oil and Gas

- [Fast-Growing U.S. Solar Industry Now Employs Over 119,000 Led By California, Arizona And New Jersey](#)
- By [Joe Romm](#) on Apr 19, 2013 at 11:40 am
- At a national level, the solar industry data added nearly 14,000 new jobs in 2012, a 13% growth rate over 2011 — 5 times the job growth rate of the overall economy.



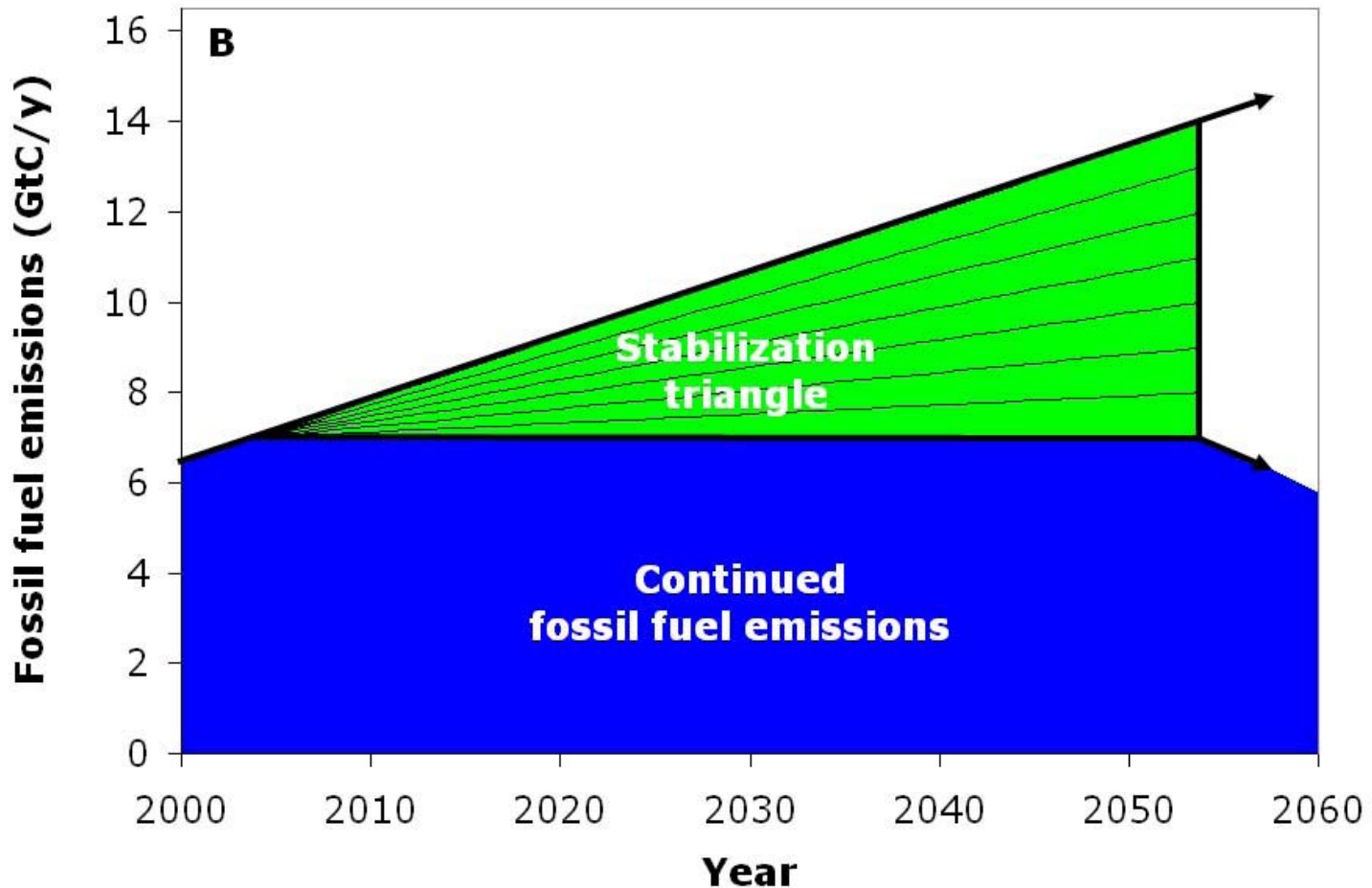
Compare this to  
181,580 total jobs in oil and gas  
Extraction (May 2012)

[http://www.bls.gov/oes/current/naics4\\_211100.htm](http://www.bls.gov/oes/current/naics4_211100.htm)

**43,000 solar jobs in California**

# Carbon Wedges

Robert Socolow, Princeton University



Must use multiple technologies to remove each wedge of carbon

<http://cmi.princeton.edu/wedges/intro.php>

# Carbon Wedges -- The Challenge

Dr. Joseph Romm (Acting Assistant Secretary of Energy for Energy Efficiency and Renewable Energy during the Clinton Administration) argues that [at least 14 wedges](#) would be necessary to stabilize atmospheric CO<sub>2</sub> at 450 ppm. Romm proposes what he believes to be the [most plausible way to achieve 16 wedges](#):

- 1 wedge of vehicle efficiency — **all cars 60 mpg**, with no increase in miles traveled per vehicle.
- 1 of wind for power — **one million large** (2 MWp) wind turbines
- 1 of wind for vehicles — another 2000 GW wind. Most cars must be plug-in hybrids or pure electric vehicles.
- 3 of concentrated solar thermal power — **~5000 GW peak**.
- 3 of efficiency — one each for buildings, industry, and cogeneration/heat-recovery for a total of 15 to 20 million GW-hrs.
- 1 of coal with carbon capture and storage — 800 GW of coal with CCS
- 1 of nuclear power — **700 GW** plus 10 Yucca mountains for storage
- 1 of solar PV — 2000 GW peak [or less PV and some geothermal, tidal, and ocean thermal]
- 1 of cellulosic biofuels — using one-sixth of the world's cropland [or less land if yields significantly increase or algae-to-biofuels proves commercial at large scale].
- 2 of forestry — **End all tropical deforestation. Plant new trees over an area the size of the continental U.S.**
- 1 of soils — Apply no-till farming to all existing croplands.

# Failed Gun Control Legislation Apr. 17, 2013

90 % of Americans support background checks.

Could not get 60% of Senators to pass a weak gun control law.

Why?

Gun Dealers, Gun Manufacturers – have a vested interest – even spread lies according to Obama : no Big Brother registry.

Money is completely corrupting our politics.

Candidates need millions of dollars to run.

Oil Companies have made record profits, they have the deepest pockets and a vested interest in status quo.

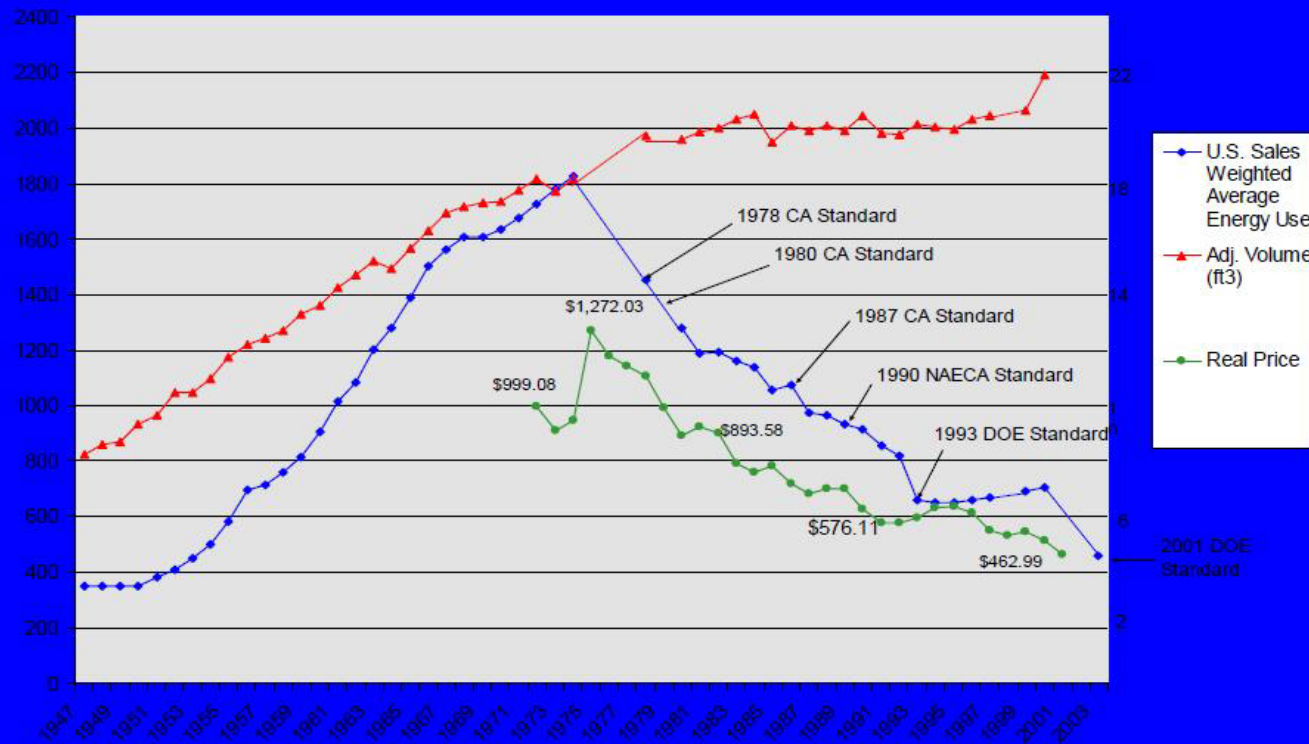
Most people have some type of investment and want to see the largest return – they will even look the other way if that investment is an oil company polluting and supporting rigged elections in Nigeria.

Every University has investments – Divest. It's the best way to put pressure on the corporations to think about externalities. It worked in South Africa.

<http://www.csmonitor.com/Commentary/Opinion/2013/0418/Why-the-90-percent-lost-on-gun-background-checks>

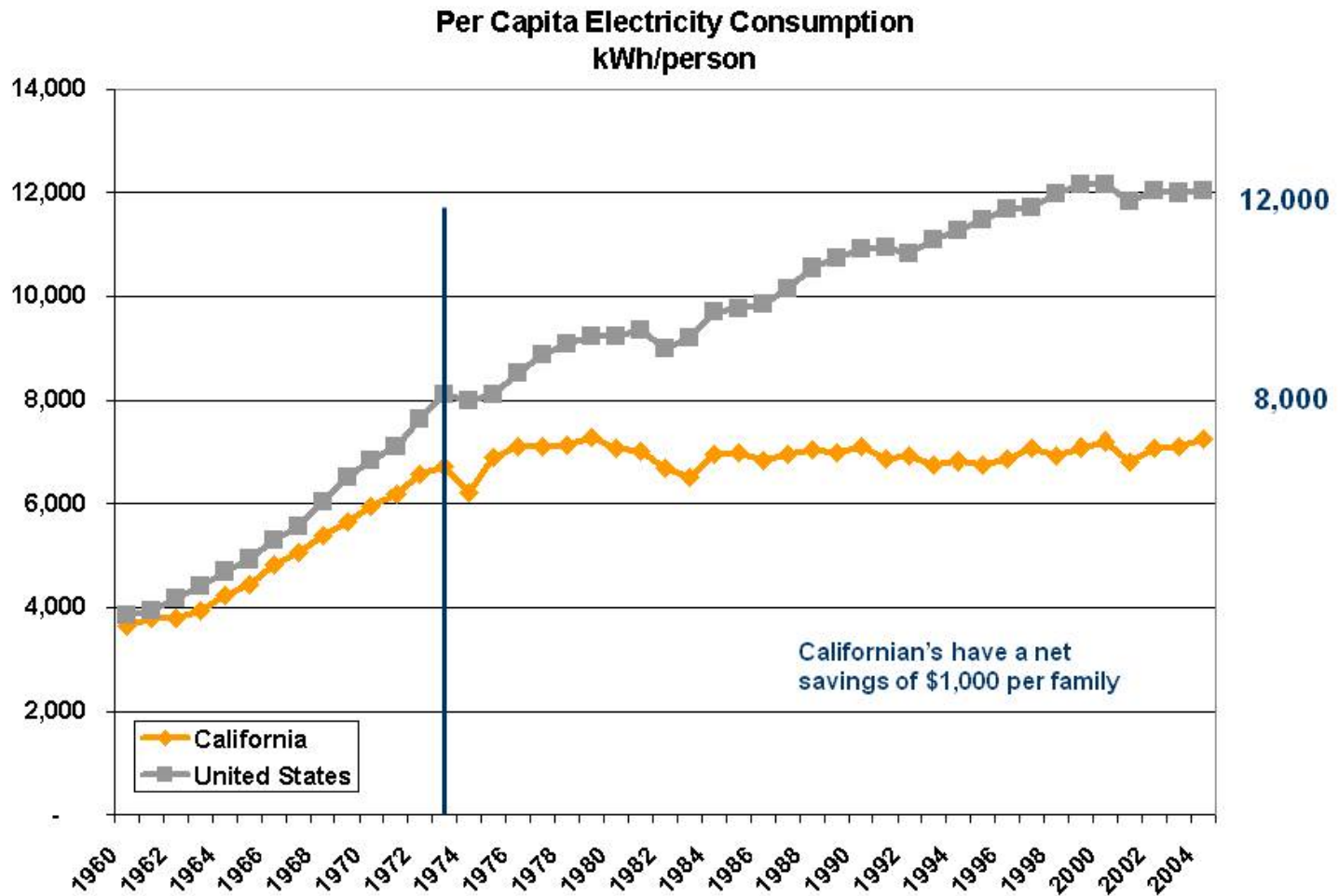
# Energy Efficiency is NOT expensive

## U.S. Refrigerator Energy Use v. Time with Price



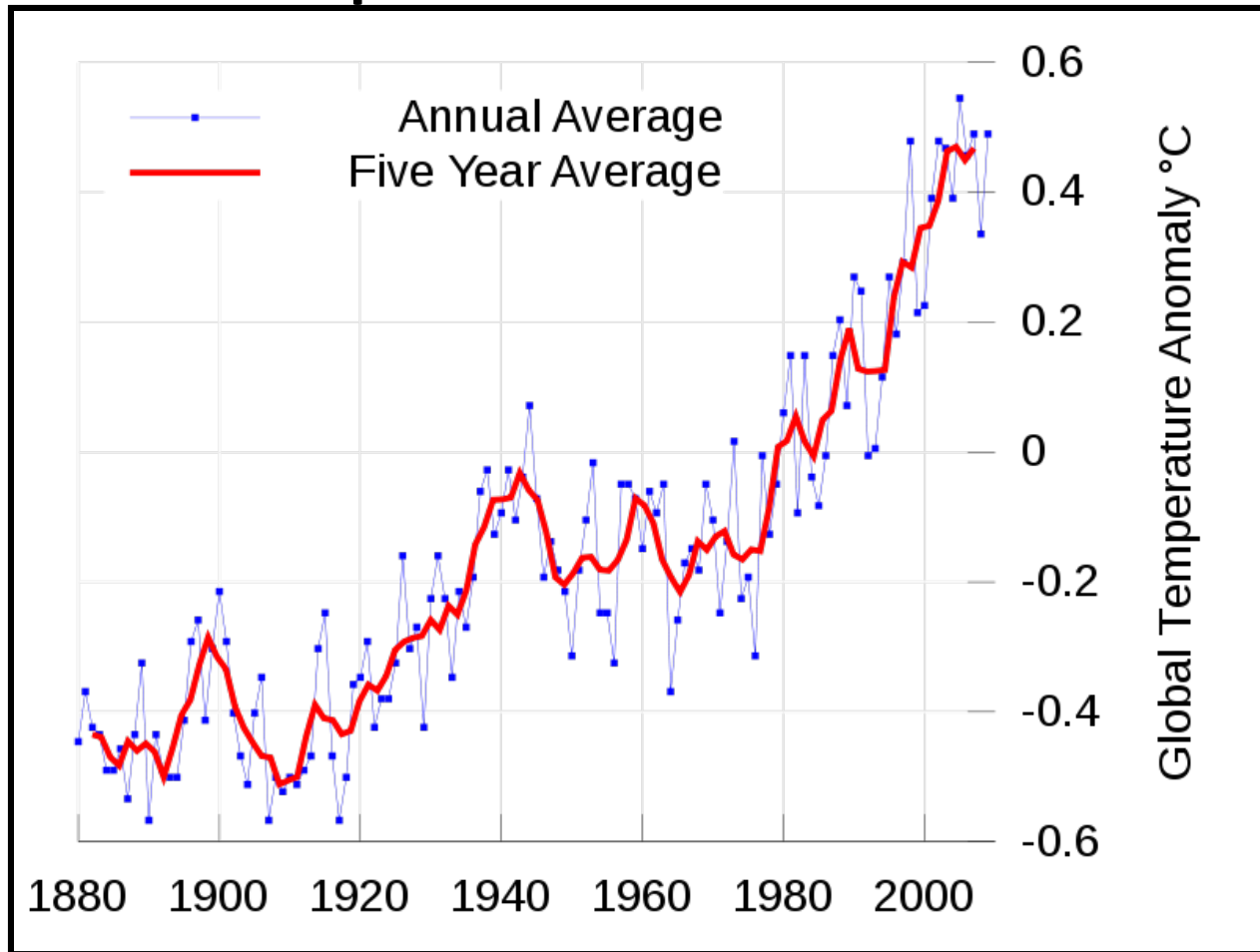
400 large coal plants that were expected to be needed but now are not.

# Why California is so great?



Source: [http://www.eia.doe.gov/emeu/states/sep\\_use/total/csv/use\\_csv](http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv)

# Temperature Record

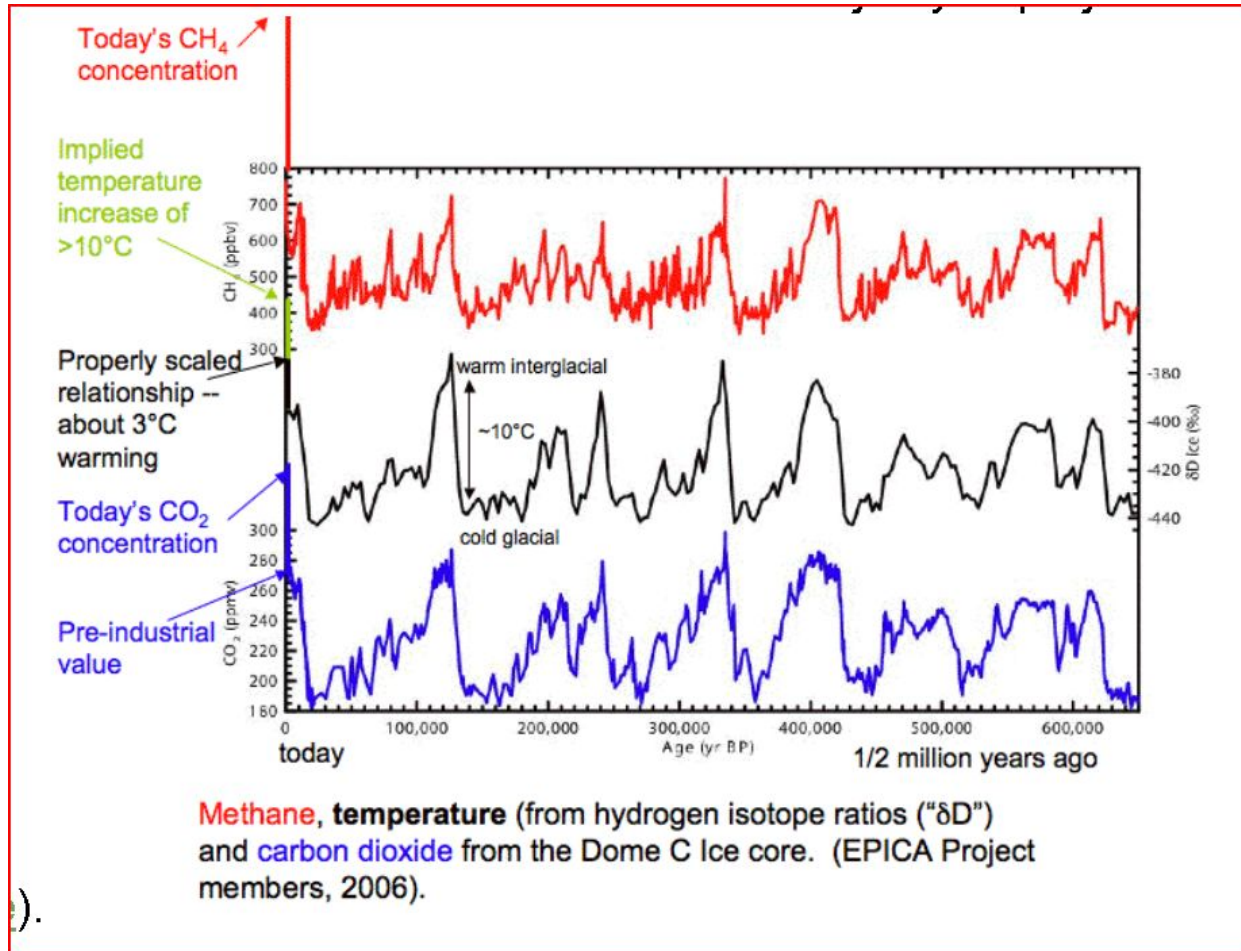


[http://en.wikipedia.org/wiki/File:Instrumental\\_Temperature\\_Record\\_%28NASA%29.svg](http://en.wikipedia.org/wiki/File:Instrumental_Temperature_Record_%28NASA%29.svg)

This image shows the instrumental record of global average [w:temperatures](#) as compiled by the [w:NASA's](#) [w:Goddard Institute for Space Studies](#).



# Temperature vs CO2 -- historical



We are currently at **390 ppm CO2**, 400,000 year historical high 290 ppm  
 Currently **1850 ppb methane**, 400,000 year historical high 700 ppb  
 Milankovitch cycles: precession: 26,000 years, obliquity: 41,000 years

<http://www.realclimate.org/index.php/archives/2007/04/the-lag-between-temp-and-co2/>

# What is an Ice Core ?

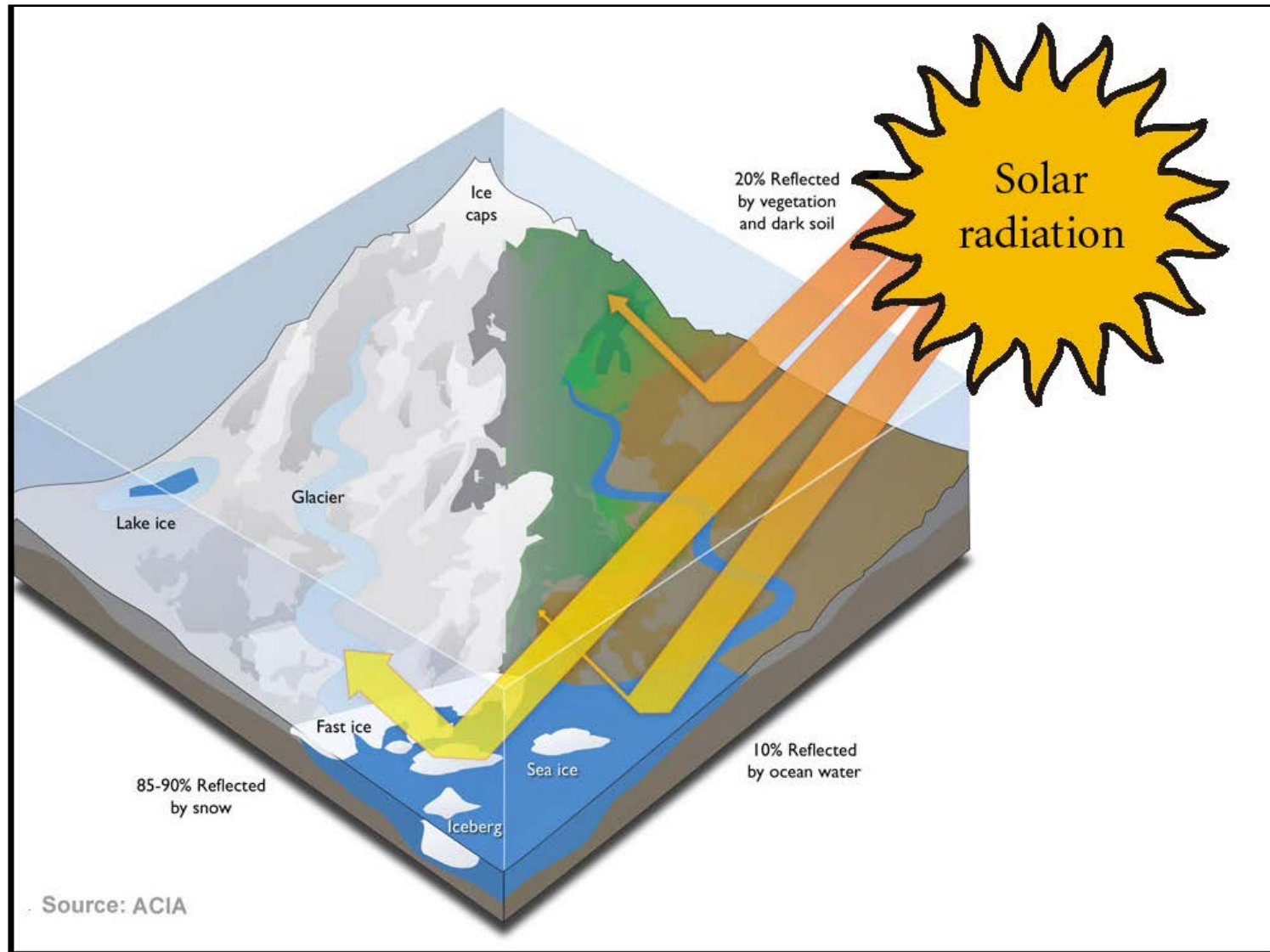


Ice core is 3345 meters long = 436,000 years

Stored at  $-55^{\circ}\text{C}$

Source: [http://www.ncdc.noaa.gov/paleo/slides/slideset/15/15\\_305\\_slide.html](http://www.ncdc.noaa.gov/paleo/slides/slideset/15/15_305_slide.html)

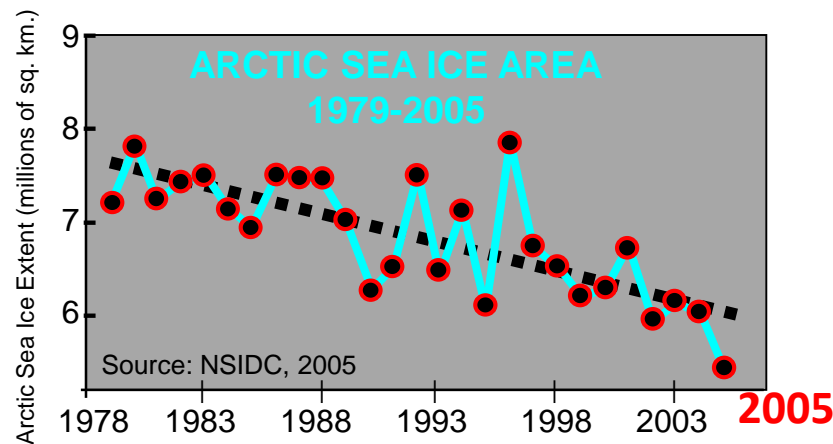
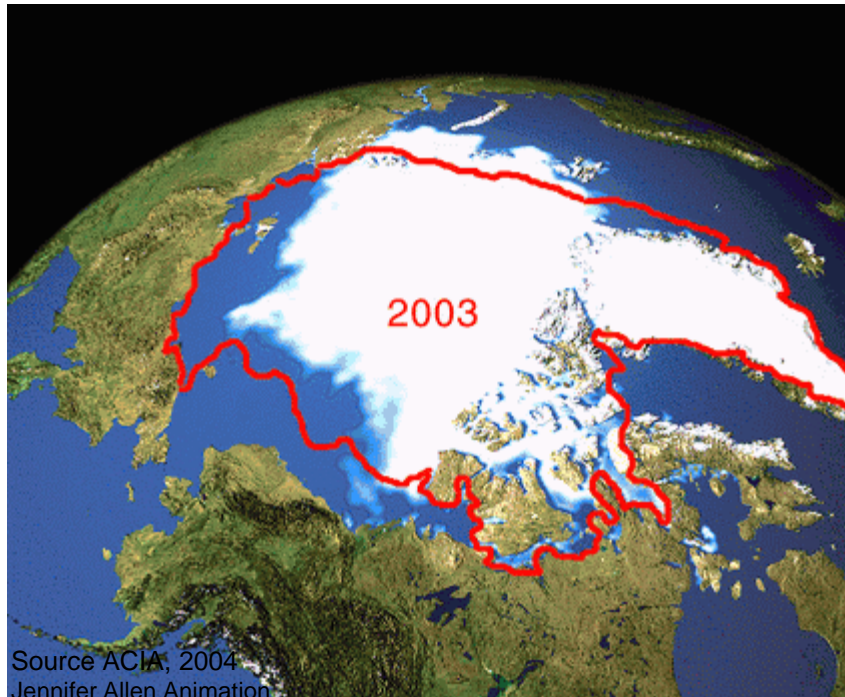
# Albedo Effect – positive feedback



Source: <http://www.kuuvikriver.info/uploads/science/albedo-physics.png>



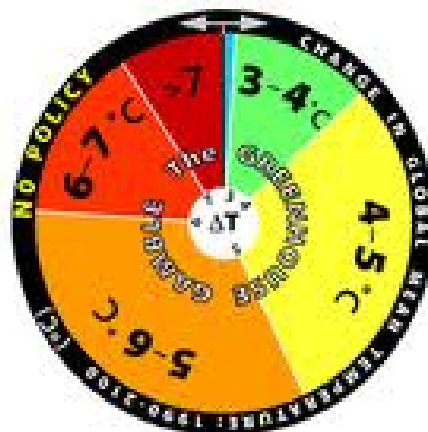
# Melting Sea Ice



- An area twice the size of Texas has melted away since 1979 (over 20% decrease). (National Snow and Ice Data Center 2005)
- Ice 40% thinner. (Rothrock, D.A., et al. 1999)
- Ice only 6 – 9 feet thick at North Pole (NOAA FAQ 2007).
- Northwest passage opened Aug 21, 2007

# MIT 2009 Report

- Ran 400 different models if we continue on current course
- New 2100 prediction is 5.1 degrees C
- Old prediction was 2.4 degrees C.



Warming Possibilities in 2100  
Under No Policy Scenario



Warming Possibilities in 2100  
Under Policy Scenario

# What is geoengineering?

- The deliberate and (hopefully) judicial intervention into the earth system to avoid climate disruption -Plan B
- We've been doing accidental "geoengineering" for the last 200 years
  - Introducing plant and Animal Species
  - Building dams (slowed rotation of the earth)
  - Introducing over 85,000 synthetic chemicals
  - Sulfur Dioxide -- Acid rain
  - Biggest one of all: 31 billion tons of CO<sub>2</sub> in atmosphere annually

(The cane toad was introduced originally in the 1920s and 1930s to control pests in agriculture and is now threatening native species from the [Caribbean](#) to [Australia](#). It spread rapidly, out-competing native species and devouring native insect life.)

# Ocean Iron Fertilization

- 1930s when English [biologist](#) Joseph Hart speculated that the ocean's great "desolate zones" (areas apparently rich in nutrients, but lacking in plankton activity or other sea life) might simply be iron deficient.
- Since 1993, thirteen international research teams have completed ocean trials demonstrating that phytoplankton blooms can be stimulated by iron addition.<sup>[1]</sup>
- Hazards: red-tide, depletion of oxygen
- In 2012 [Russ George](#), founder of Planktos, and collaborators conducted an iron fertilization experiment dumping 100 tonnes of iron sulphate into the [Pacific Ocean](#) from a fishing boat in an eddy 200 nautical miles west of the islands of [Haida Gwaii](#) which resulted in increased algae growth over 10,000 square miles. Critics allege George's actions violated the [United Nations Convention on Biological Diversity](#) (CBD) and the [London convention on the dumping of wastes at sea](#) which according to them contain moratoriums on geoengineering experiments.<sup>[27][28]</sup>

# Precautionary Principle

- "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."  
[[Full Wingspread Statement.](#)]
- **"better safe than sorry."**
- There are 85,000 synthetic chemicals approved for market use today, from preservatives in our lipstick to flame retardants in our sofas, from plasticizers in our water bottles to pesticides on our fruit and vegetables. **Less than ten percent of these chemicals have been tested for their effects on human health.**
- it is the responsibility of an activity proponent to establish that the proposed activity will not (or is very unlikely to) result in significant harm.
- The [Body Shop International](#), a UK-based cosmetics company, recently included the Precautionary Principle in their [2006 Chemicals Strategy](#).



# Oxford Principles

- Oxford Geoengineering Institute, which was founded by Oxford Principles coauthor Tim Kruger
- **Principle 1: Geoengineering to be regulated as a public good**
- **Principle 2: Public participation in geoengineering decision-making**
- **Principle 3: Disclosure of geoengineering research and open publication of results**
- **Principle 4: Independent assessment of impacts**
- **Principle 5: Governance before deployment**

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# Why are we even thinking about Geoengineering?

- Planet has a fever - Global Warming
- Problem on a planetary scale
- Will probably require drastic measures

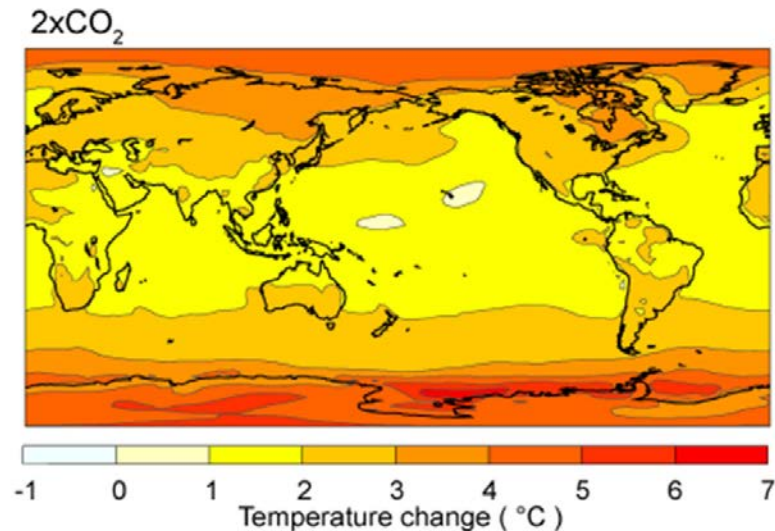
# Geoengineering Revival

- Started in earnest by a paper in journal "Climate Change" by Paul Crutzen, Max Planck Institute in 2006
- Suggested putting 5.3 M tons of sulfur per year in the stratosphere
- Passionate discussions, pro and con before publication
- "Pinatubo option" : Mt Pinatubo volcano 1991 : 10-20 Mt of sulfur , followed by .5 deg drop in global temperature
- Well understood that this is no panacea
- Possible negative side effects , winners and losers

# Another view of its global effects (Wood &Caldera)

## NO SRM Intervention

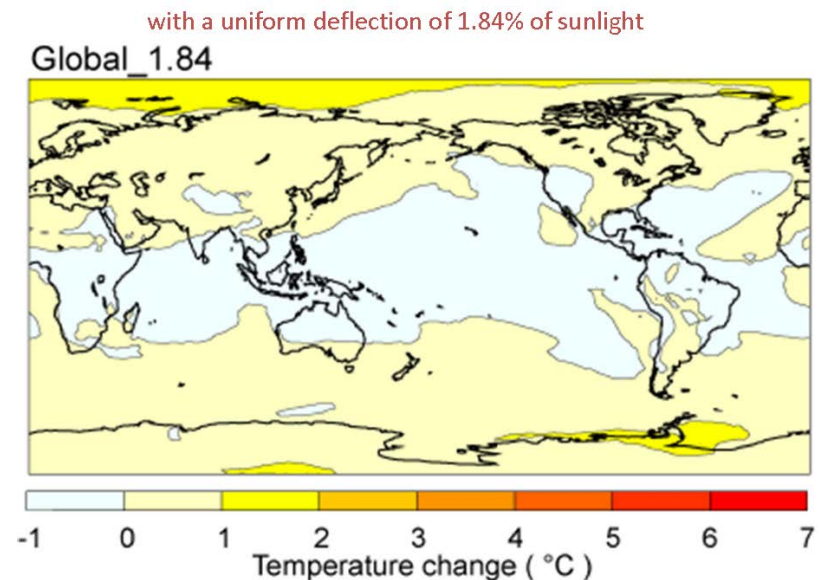
Temperature effects of doubled CO<sub>2</sub>



Caldeira and Wood, 2008

## With SRM Intervention

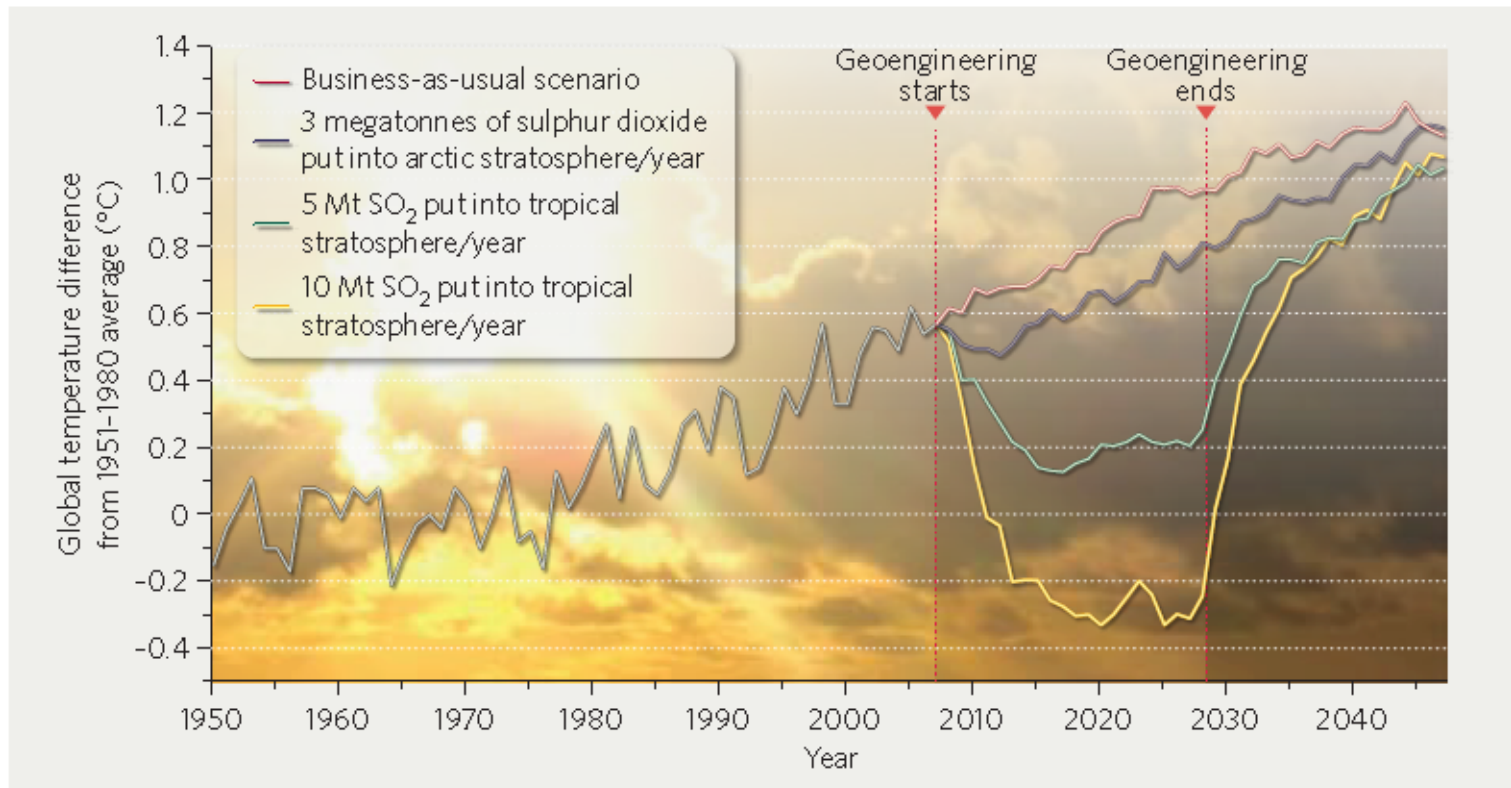
Temperature effects of doubled CO<sub>2</sub>



Caldeira and Wood, 2008

# What might it do for us ? (Keith et al)

IMAGE: F. M. I. FLORES; DATA SOURCE: REF. 3



**Figure 1 | Turning down the heat.** A model<sup>3</sup> shows how quickly solar-radiation management (SRM) might alter global temperature, and how conditions might rebound after the geoengineering stops.

# Realistically : 2 viable SRM methods

## Stratospheric sulfur

- Yearly, put 1-5 Mt Sulfur particles in the stratosphere
- Individual Particles scatter sunlight
- Will work
- Long duration effect (2 yr)
- Globally distributed; hard to test on small scale
- Easy to deploy, fleet of special airplanes
- Long term environmental concerns

## Marine Cloud Brightening

- Uses ultrafine seawater spray at sea level
- Clouds get denser, and whiter
- Probably will work
- Effect very temporary (1 wk)
- Very localized; small scale test
- Easy to deploy, adapt to existing ships
- Environmentally benign (?)

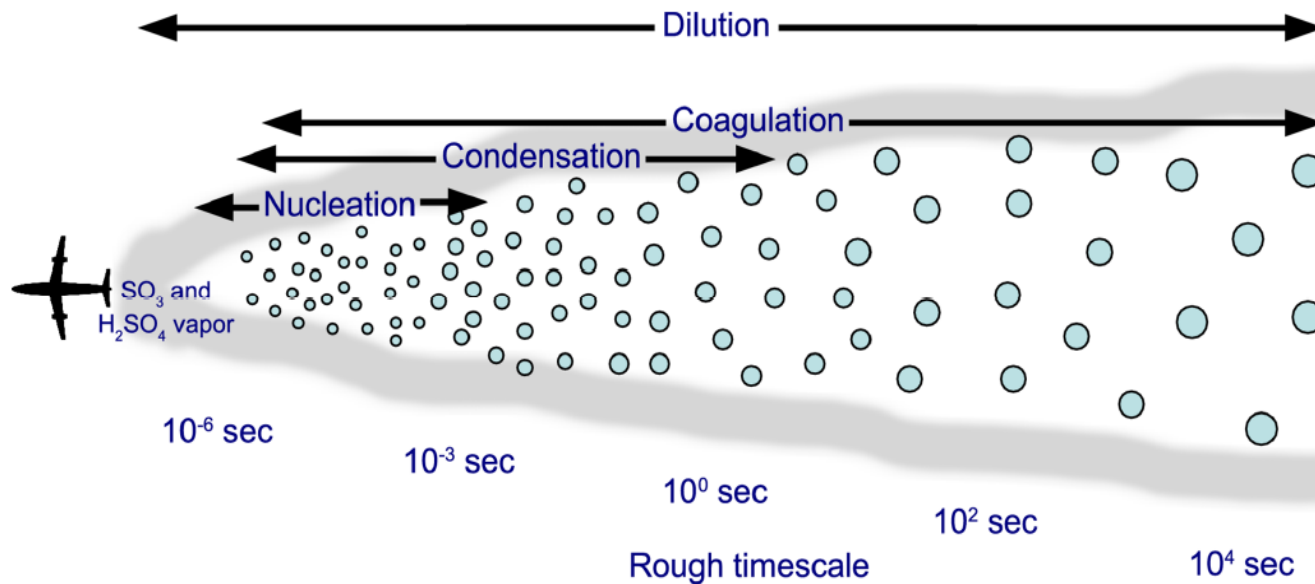
Might be used together

# Stratospheric Sulfur Deposition (Keith)

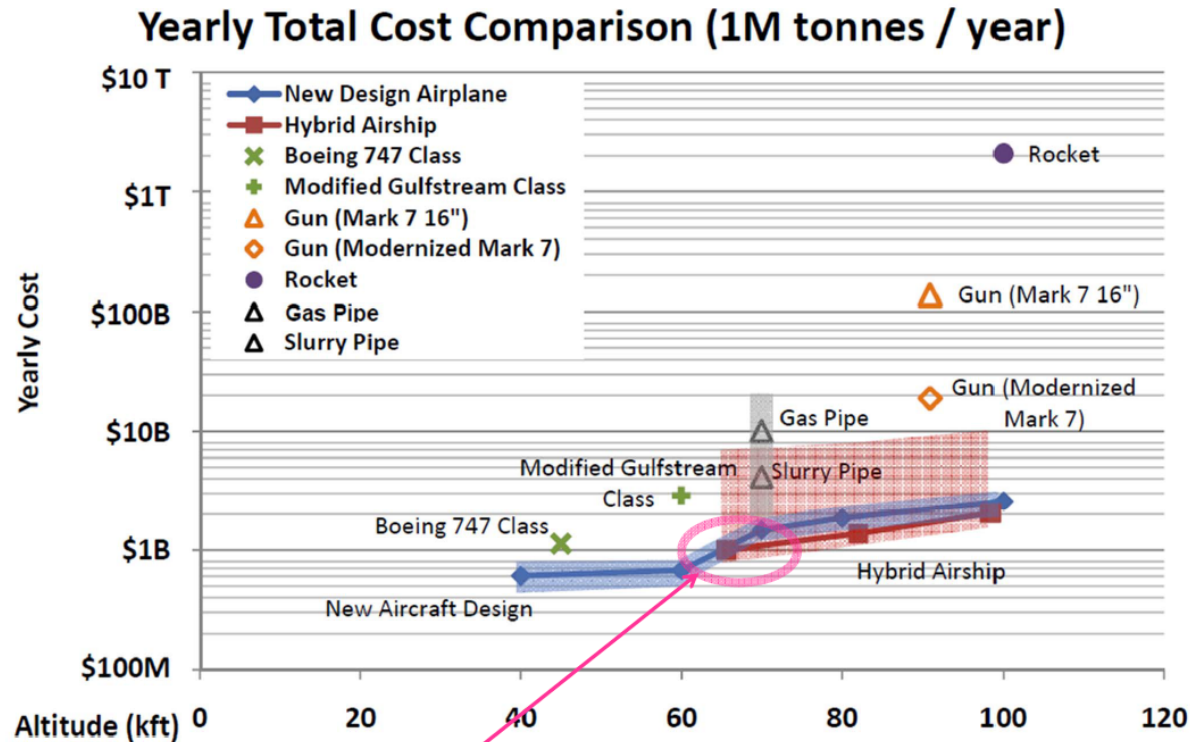
## A possible solution

Release a condensable gas ( $\text{H}_2\text{SO}_4$ ) directly into an aircraft plume produces high local vapor concentrations so homogeneous nucleation and rapid coagulation dominate and almost all mass goes to produce new particles.

By varying the spray rate expansion we can control the size distribution of the resulting particles.



# Estimation of Sulfur cost per year (Keith)



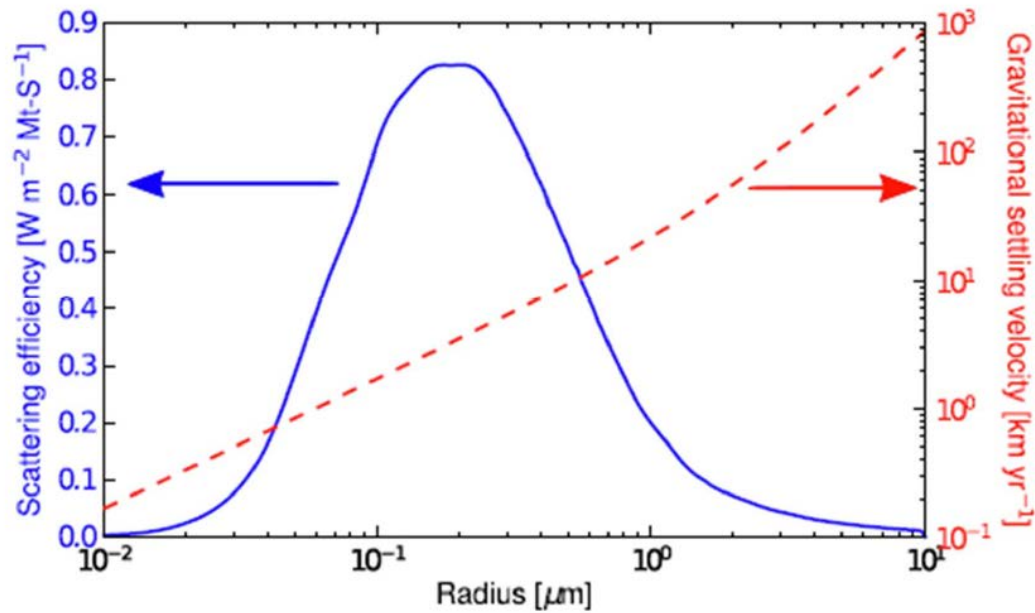
About 1 \$/kg to the lower or middle stratosphere by several methods

Kilometers:	12.2	18.2	21.3	24.4	30.5
Thousands of Feet (kft):	40	60	70	80	100



# Best particle size : .2 $\mu\text{m}$

Scattering efficiency and settling rate vs size



# Stratospheric Sulfur : Summary

## Advantages

- The technology seems feasible
- The cost is relatively modest
- Likely to work effectively.

## Disadvantages

- Difficult to sell to the public
- Difficult to do small-scale experiments
- Sulfur may deplete the ozone layer as observed during volcanic explosions
- The experiment can't be undone in a short time
- Unusual atmospheric effects

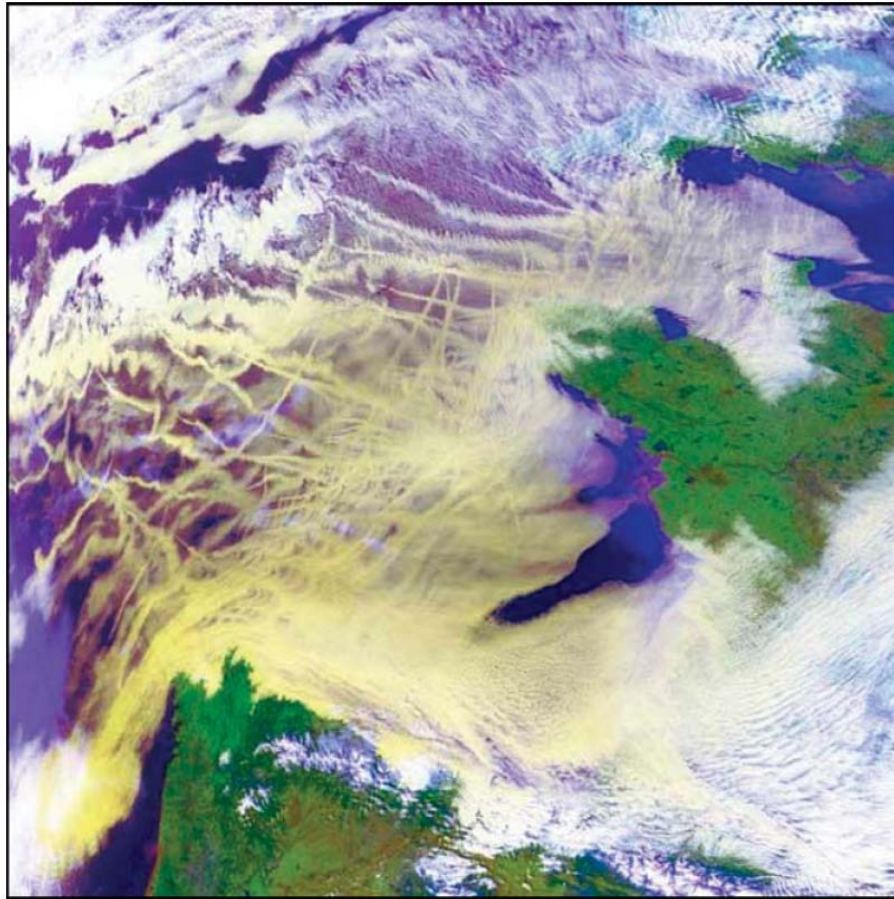
# Marine Cloud Brightening

- Principle was conceived by John Latham in 1990
- 25% of the ocean is covered with Marine Boundary Layer clouds (about 250 -300 m high)
- Shallow clouds with low reflectivity (30/60 %)
- Increasing the cloud density and its reflectivity by 5% could change the earth's reflectivity by about 1%, reflect more incoming sunlight
- Conceptually simple and environmentally benign

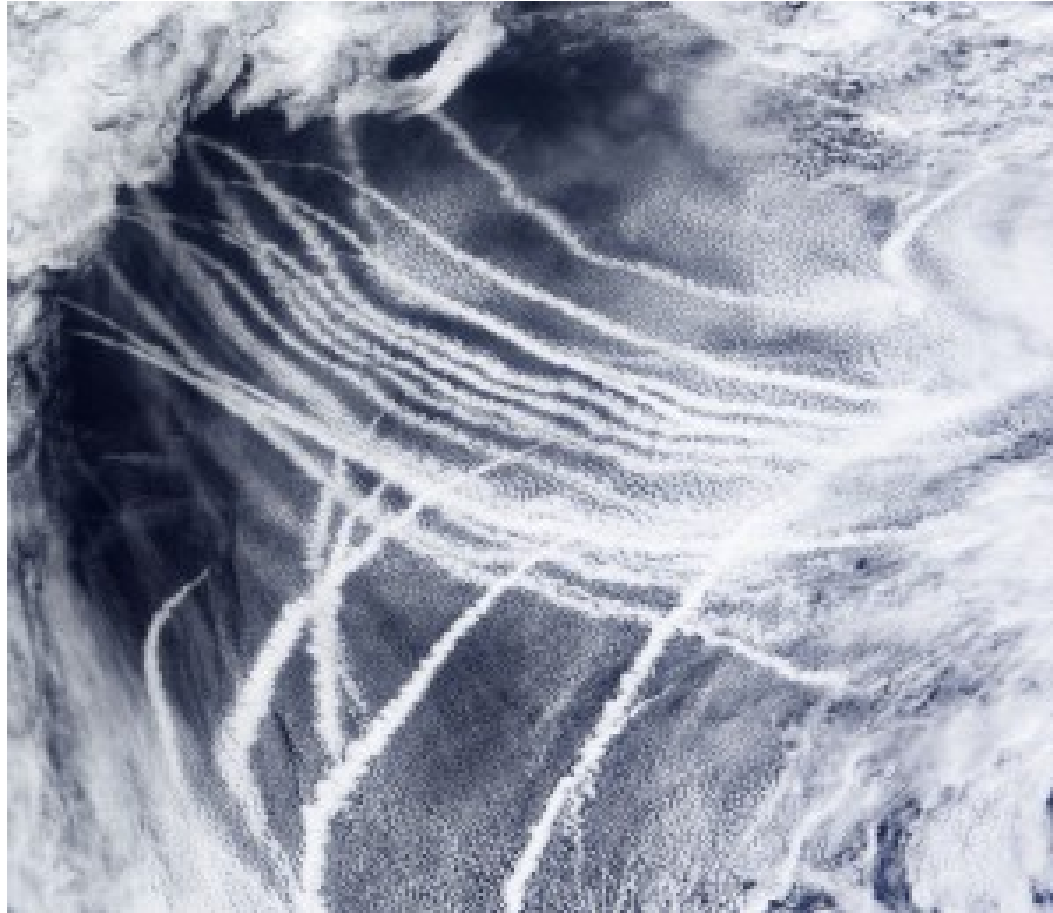
# Elementary Cloud Physics

- MBL Clouds consist of droplets 10  $\mu\text{m}$  in diameter, 2 mm apart
- Droplets form around nuclei when there is a sufficient supersaturation (.5 %) in the atmosphere
- Cloud nuclei are typically very small hygroscopic crystals of salt (waves, bubbles), dimethylsulfide (algae) or sulfates.
- Warm air rises above the ocean during the day and expands, cools and creates a small supersaturation
- An entrained salt crystal 40 nm cube,  $7 \times 10^{-20}$  kgm will then convert into a cloud droplet
- These salt crystals may be obtained by an ultrafine spray of seawater (a hundred times smaller than an inkjet)

Will this work ? Probably yes (Twomey effect)



# Ship Tracks (Twomey effect)



NASA Image


A satellite image shows the trails left behind by ships as they cross the Pacific Ocean.

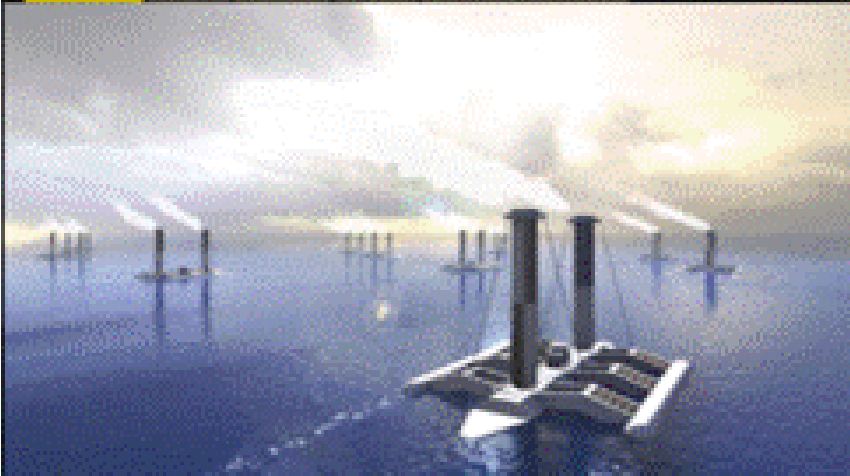
# Early Estimate of Global Requirements


- To offset 1 % of incoming solar radiation
  - 1600 ships worldwide (in the right region)
  - Each ship produces  $10^{15}$  to  $10^{17}$  nuclei /sec
  - Spray 0.5 to 50 t/s seawater worldwide , 0.3 to 30 l/s per ship
  - What is important is the number of nuclei formed is, not the amount of water sprayed
  - Droplets .8 um diameter, .2um salt when dry
  - Deployment with remote controlled sailing ships?

# Fleet of autonomous sailing ships?

**EARTH OVERHAUL**  
NEXT PRIMETIME Airing  
Thu Aug 25 10P

Overview Video Photos Facts Production Journal 



**NEXT PRIMETIME Airing**   
**THU AUG 25 10P**

A group of scientists are thinking outside the box for ways to reverse the effects of global warming. And who better to save the earth than NOC's host of the World's Toughest Fixes, Sean Riley? He'll join these experts in the labs and in the field to see what wacky new technologies are being developed, like sending mirrors into space and reducing the greenhouse emissions chickens produce.



Conceptual illustration of cloud-seeding vessel  
Image courtesy of John McNeill



# Polar Bears and Habitat Loss

- U.S. Geological Survey predicts two-thirds of the world's polar bears will disappear by 2050
- Shrinking sea ice → shrinking habitat
- Ice-floe breakup in western Hudson Bay is currently occurring three weeks earlier than it did 30 years ago which reduces the polar bear's feeding season
- Female weight : 290 kg (640 lb) in 1980 and 230 kg (510 lb) in 2004. [\[107\]](#)
- Between 1987 and 2004, the Western Hudson Bay population declined by 22%. [\[119\]](#)