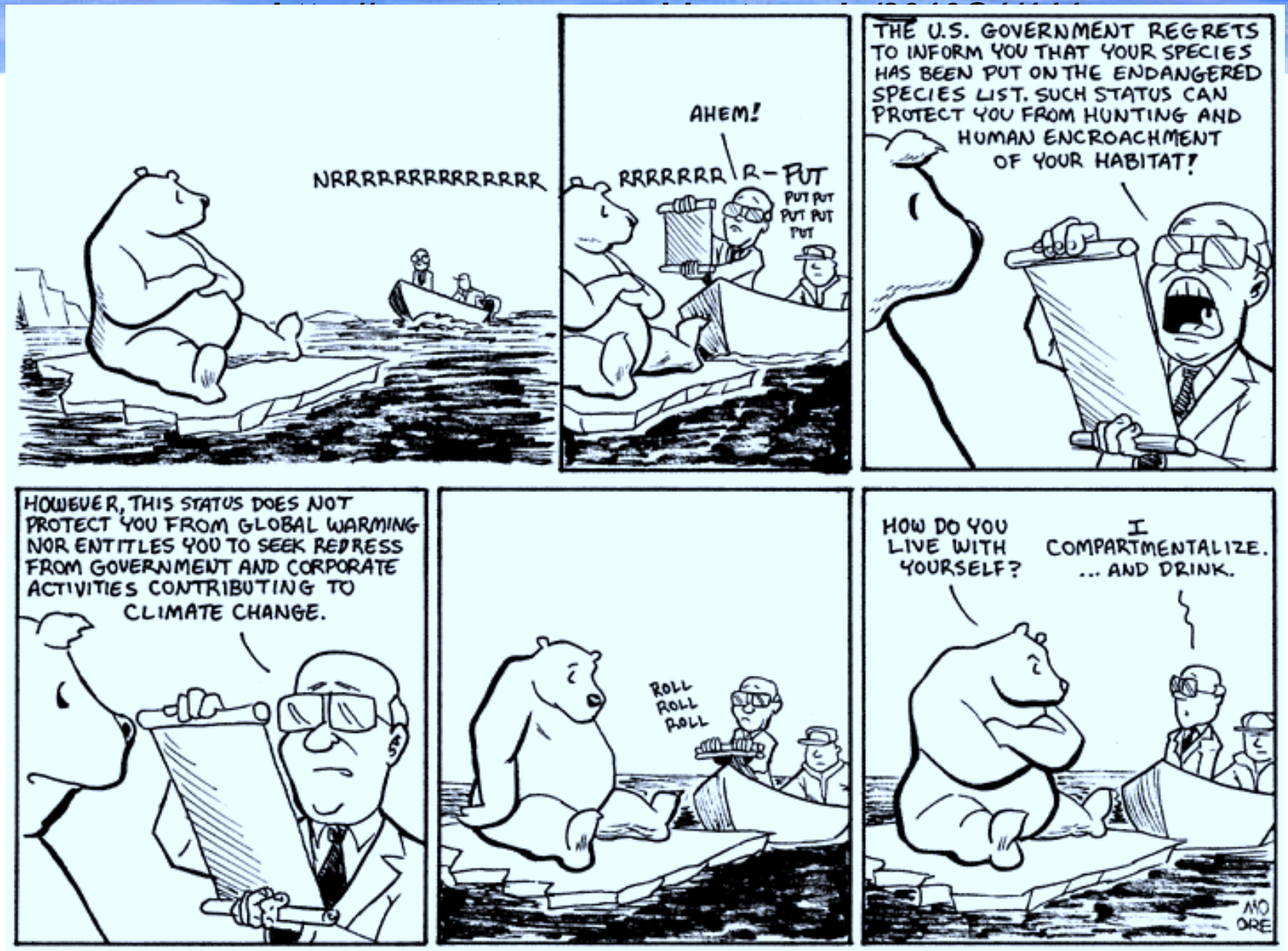
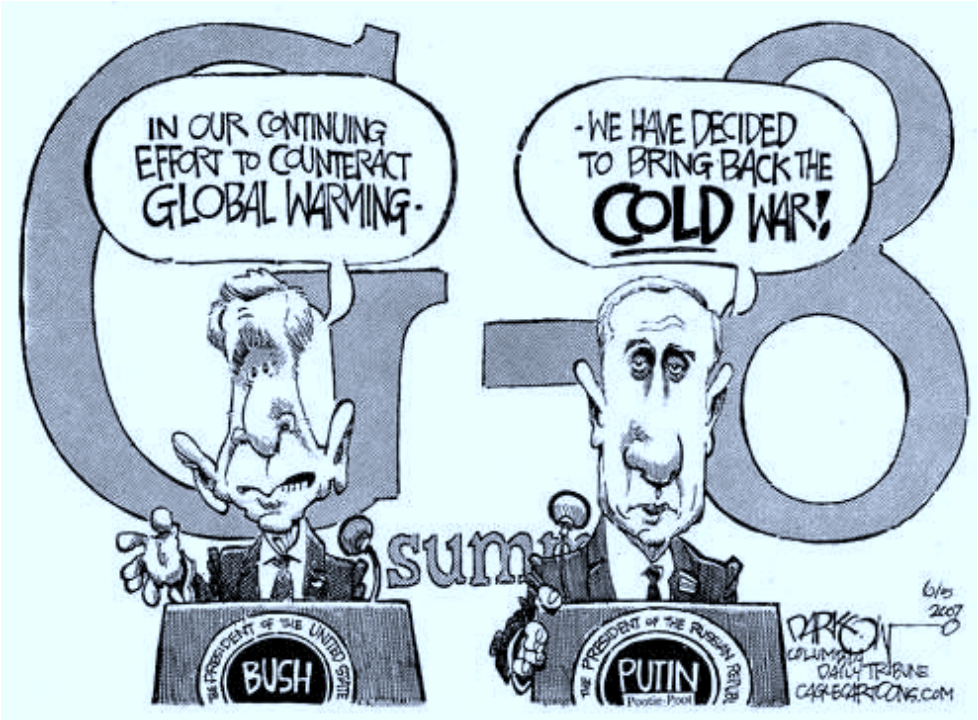
Welcome to ATMS 111 Global Warming



Today's Overview

Lecture:
Political Solutions
Class Summary and Review



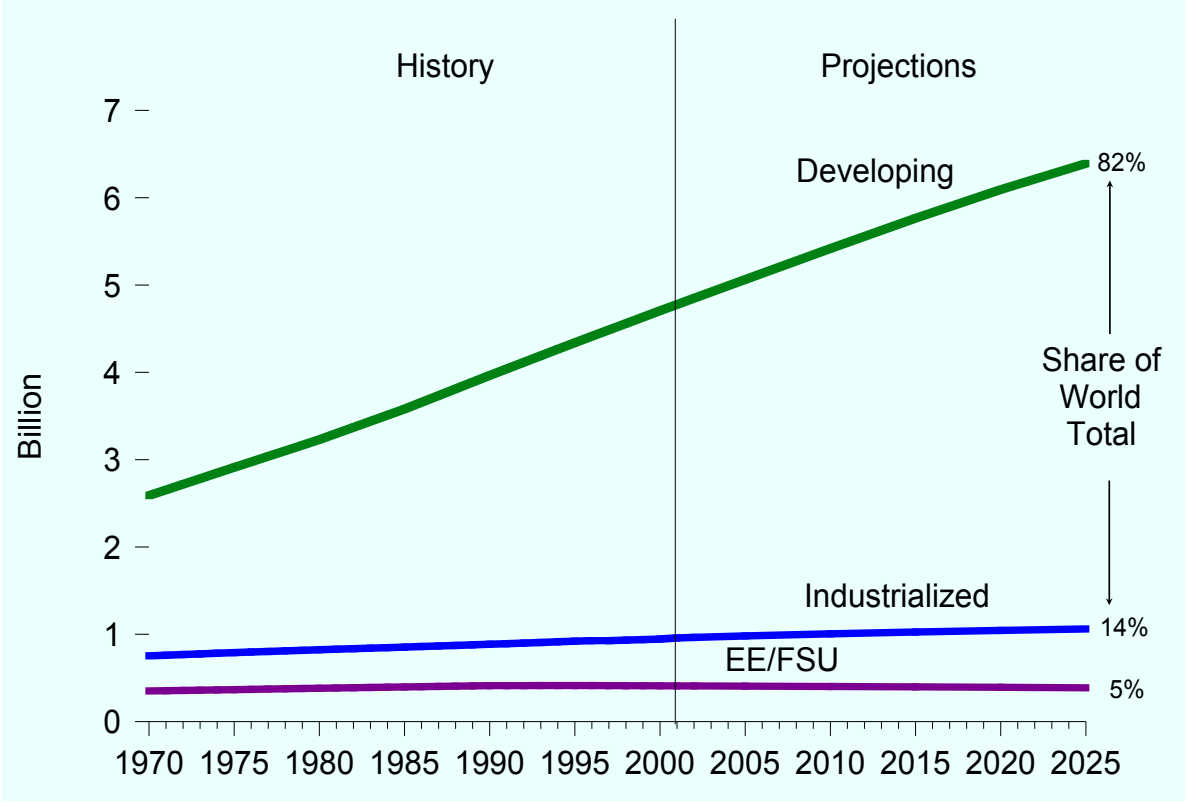
Final Wednesday Mar 17, 4:30-6:20. Here!

Bring Scantron and pencil

From the Cartoon Introduction to Economics
by Grady Klein and Yoram Bauman (UW)

Recall it is most efficient if every country participates

Global Population Trends

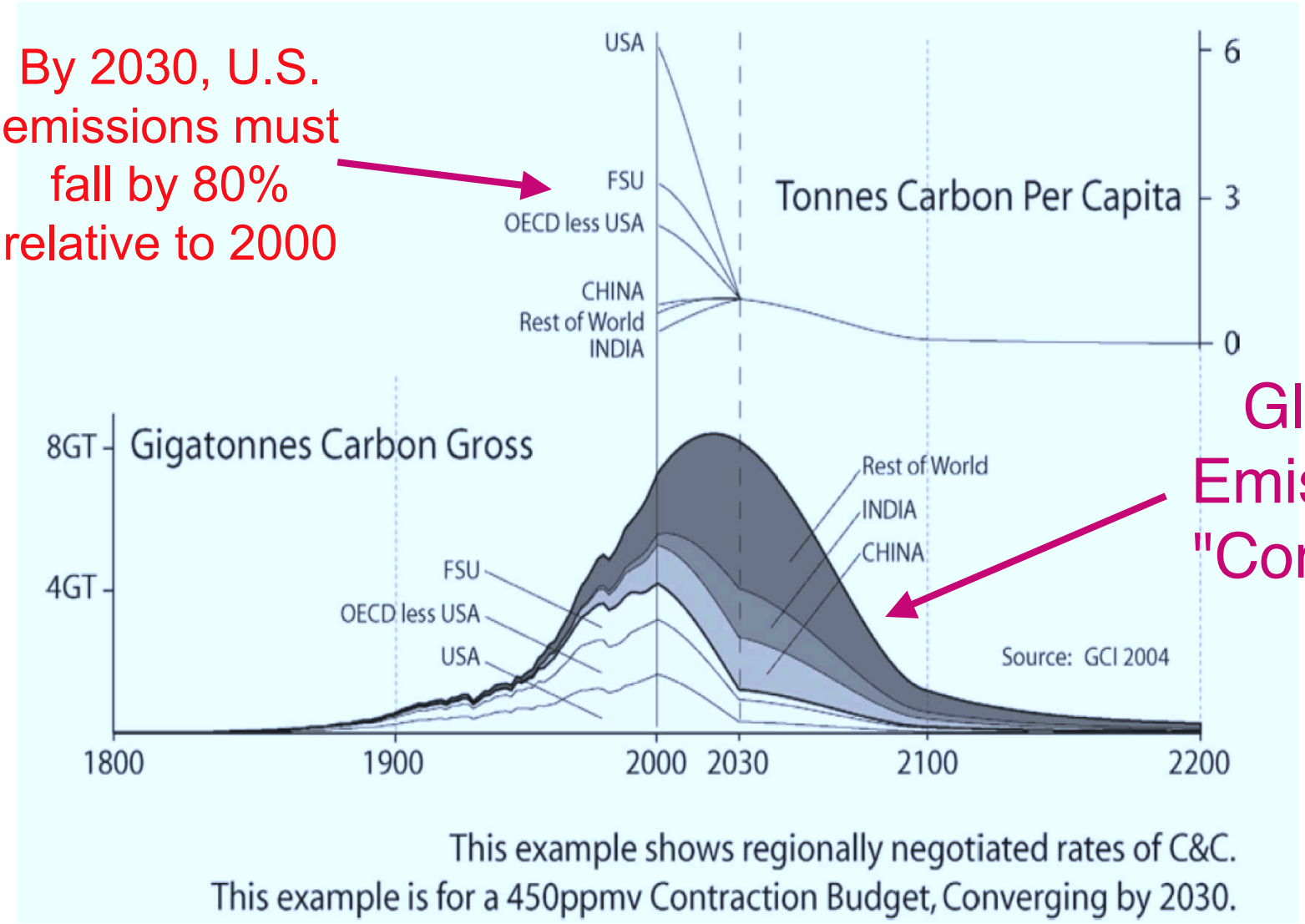


EE/FSU = Eastern Europe/Former Soviet Union

Major points for global warming:

1. Population is growing among lowest emitters
2. Developing Countries have a HUGE potential to raise emissions if they gain affluence

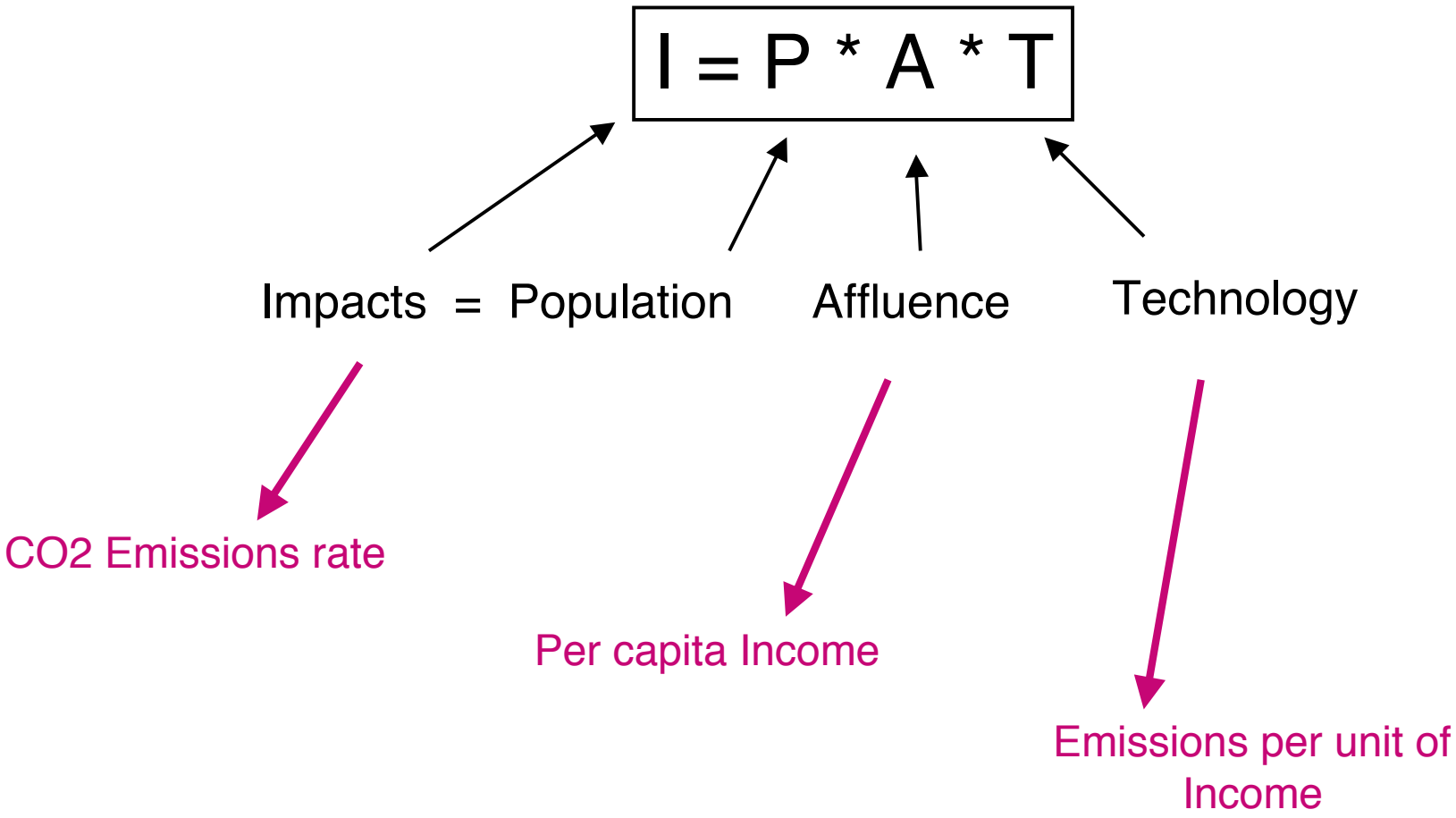
Contraction and Convergence: 450ppm target



Source: http://www.gci.org.uk/briefings/ICE.pdf

[Rough Guide, p. 298]

IPAT Identity for analyzing CO2 emissions



Managing Climate Change:
Current International Agreements

UNCED United Nations Conference on the Environment and Development "Earth Summit" in Rio de Janeiro, Brazil, June 1992

Resulted in a treaty known as the UN Framework Convention on Climate Change, UNFCCC

Annual meetings called "Conference of the Parties" COP

Kyoto Protocol was negotiated at COPs in 1997/2001

Copenhagen was COP 15

"The Earth Summit" 1992, Rio de Janeiro

Rio Declaration on *Environment* and *Development*

Representatives of 160 nations met to discuss:

- resources needed for development, and
- long-term protection of the environment.

Rio Declaration of UNFCCC lists 27 lofty core principles.

Signed by all 160 nations, including the United States.

Ratified by the United States Senate giving the force of law within this country.

Rio Declaration 1992:

Precautionary Principle

"Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

Rio Declaration 1992:

Principle of Equity

"The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations."

"All States and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development..."

Rio Declaration 1992:

Common but Differentiated Responsibilities

“The parties agreed that:
1)the largest share of historical and current global emissions of greenhouse gases originated in developed countries
2)per capita emissions in developing countries are still relatively low
3)the share of global emissions originating in developing countries will grow to meet social and development needs.”

UNFCCC, treaty from Rio 1992

"The ultimate objective of this Convention... is to achieve... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

behavior is *encouraged*, nothing binding

- Signed by the U.S. President, Summer, 1992.
- Ratified by the required 2/3 of the U.S. Senate, Fall, 1992.

Kyoto Protocol, 1997 RG, p.290-5

A treaty with *mandatory* emissions reductions

Goal: To prevent dangerous anthropogenic interference with the climate system

Annex 1 Countries: Developed nations that agreed to take the lead in reducing GHG emissions.

Emission Targets: Reduce emissions by 5.2% on average from 1990 emissions to be achieved by 2012

EU -8%, US -7%, Japan -6%, Russia 0%, Australia +8%, …

Complementary actions to promote sustainable development, share technology, ease economic impacts

Kyoto Protocol, 1997

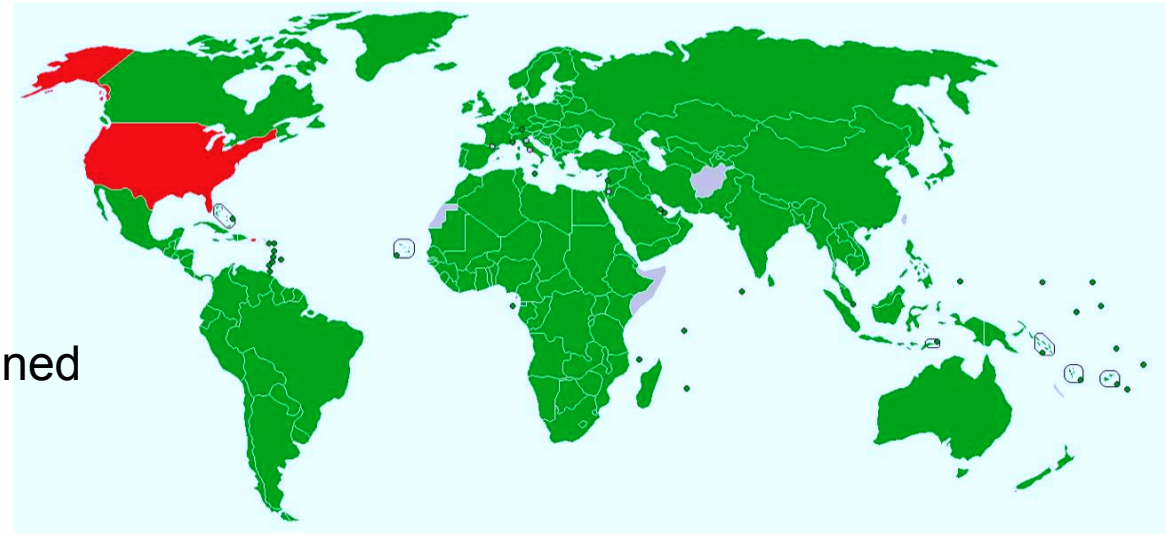
- Signed by the U.S. President Clinton in 1997

- never submitted to the Senate for ratification (therefore, never became U.S. law)

- U.S. President Bush officially withdrew in 2005

-Came into effect later in 2005, after Russia signed, meeting the threshold participation of 55% Annex 1 countries

-Australia signed in 2007.



Green countries signed
grey are undecided

Kyoto Mechanisms

Joint Implementation:

Allows developed countries to collaborate in projects that reduce emissions or increase "sinks". (A way of sharing the credit.)

Clean Development Mechanism:

Allows developed countries to get credit for projects that reduce emissions in developing countries. (This aids the goal of technology transfer, essential to long-term reductions by the entire world.)

Emissions Trading:

Allows developed countries to purchase credits from other developed countries. Creates a market in "carbon credits".

Developing countries have no mandatory requirements. If they reduce emissions anyway, they may sell credit

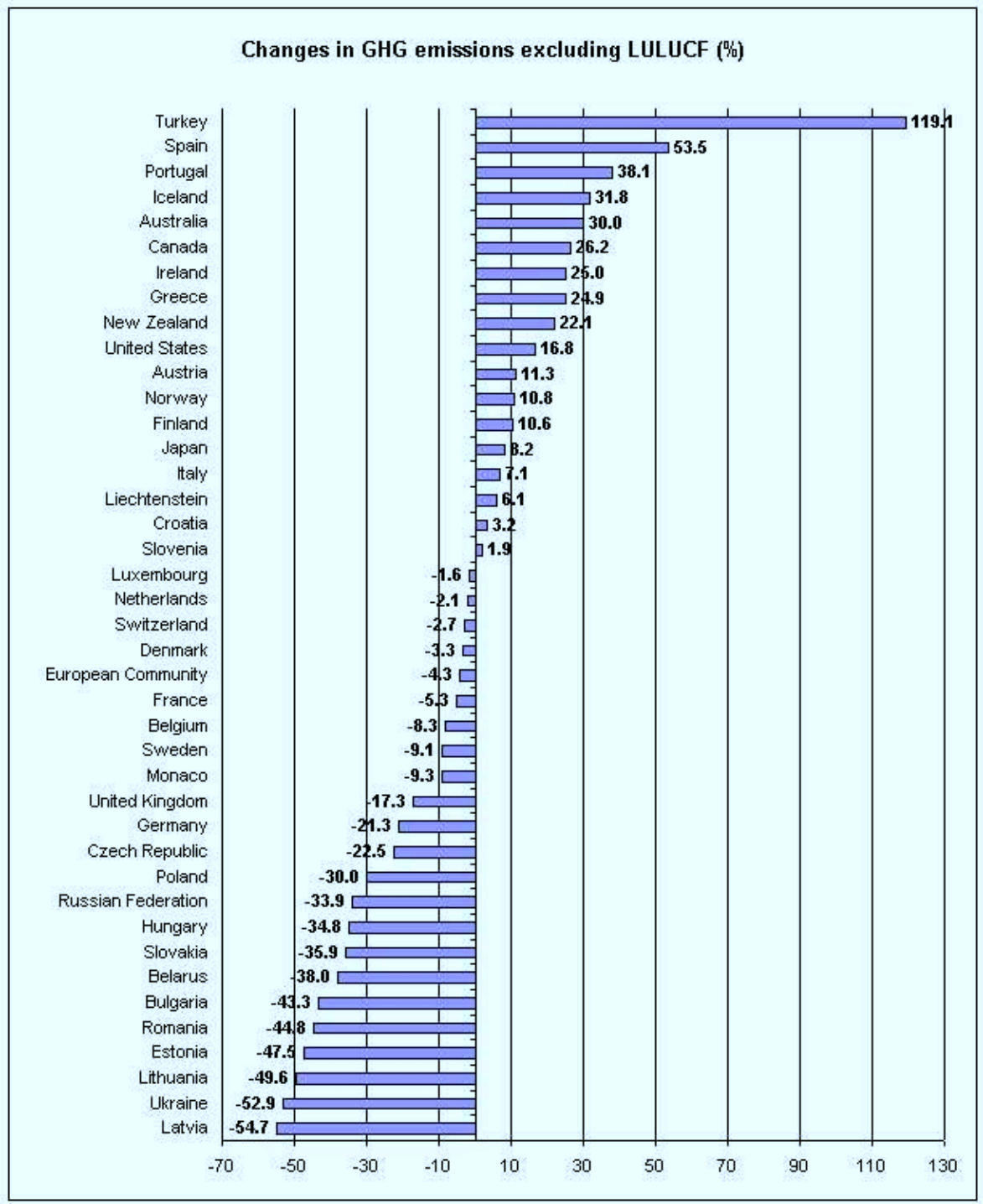
Is Kyoto Working?

2007 relative to 1990

Positive means emissions rose

http://unfccc.int

LULUCF is land use



Is Kyoto Working?

Country	Change in greenhouse gas Emissions (1990–2007) including LULUCF	EU Assigned Objective for 2012	Treaty Obligation 2008–2012
Denmark	-5.6%	−20%	−11%
Germany	-20.8%	−21%	−8%
Canada	+46.7%	n/a	−6%
Australia	+82.0%	n/a	+8%
Spain	+55.3%	+15%	−8%
Norway	-22.0%	n/a	+1%
New Zealand	+18.3%	n/a	0%
France	-11.8%	0%	−8%
Greece	+25.2%	+25%	−8%
Ireland	+22.6%	+13%	−8%
Japan	+8.2%	n/a	−6%
United Kingdom	-17.8%	−12.5%	−8%
Portugal	+30.8%	+27%	−8%
EU	-5.6%	n/a	−8%

http://en.wikipedia.org/wiki/Kyoto_Protocol

Change in Emissions 1992-2007

Country	Change in greenhouse gas Emissions (1992-2007)
India	+103%
China	+150%
United States	+20%
Russian Federation	-20%
Japan	+11%
Worldwide Total	+38%

US pledge on Kyoto (not ratified) was 5.2% reduction below 1990 emissions by 2012

http://en.wikipedia.org/wiki/Kyoto_Protocol

What are the penalties for noncompliance?

The Enforcement Branch may

Raise the reduction requirement in the second commitment period (which doesn't exist) by 30%

and/or

Suspend the right to emissions trade

Ends in 2012. What next?

Copenhagen Accord December 2009

A statement of intent, negotiated by US, China, Brazil, India, and South Africa, other countries “took note”

Key points

•Aim to keep temperatures from rising more than 2 deg Celsius (3.6 deg F) above preindustrial levels

•Developing nations will report every two years on their voluntary actions to reduce emissions, richer nations can “commit”

•Richer nations will finance up to $30 billion from 2010-12 for poorer nations' projects to mitigate and adapt to climate change

•Set a "goal" of mobilizing $100 billion-a-year by 2020 for further developing world adaptation and mitigation purposes

Copenhagen Accord Appendix 1 Commitment by the U.S.

Recall that the accord called for a commitment by 31 January 2010, to be added to Appendix 1

APPENDIX I

Annex I Parties	*Quantified economy-wide emissions targets for 2020*	
	Emissions reduction in 2020	Base year
United States of America	In the range of 17%, in conformity with anticipated U.S. energy and climate legislation, recognizing that the final target will be reported to the Secretariat in light of enacted legislation. [1]	2005

http://unfccc.int/home/items/5264.php for commitments by 55 countries (representing 78% of global emissions).

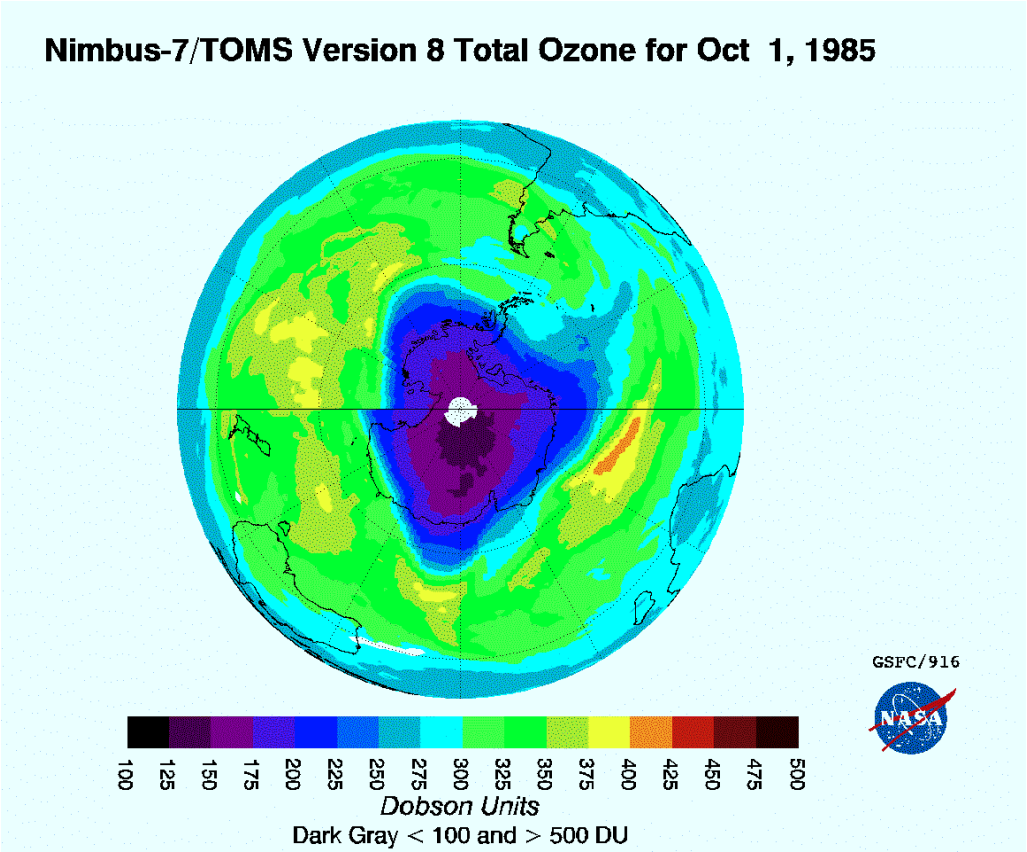
Europe Union committed to up to a 30% reduction relative to 1990 if other nations follow suit

China has pledged to reduce its emissions growth – not make absolute cuts – by up to 45% from 2005 levels by 2020.

India also pledged to reduce emissions growth by up to 25% from 2005 levels by 2020.

Ozone hole – Antarctic ozone hole

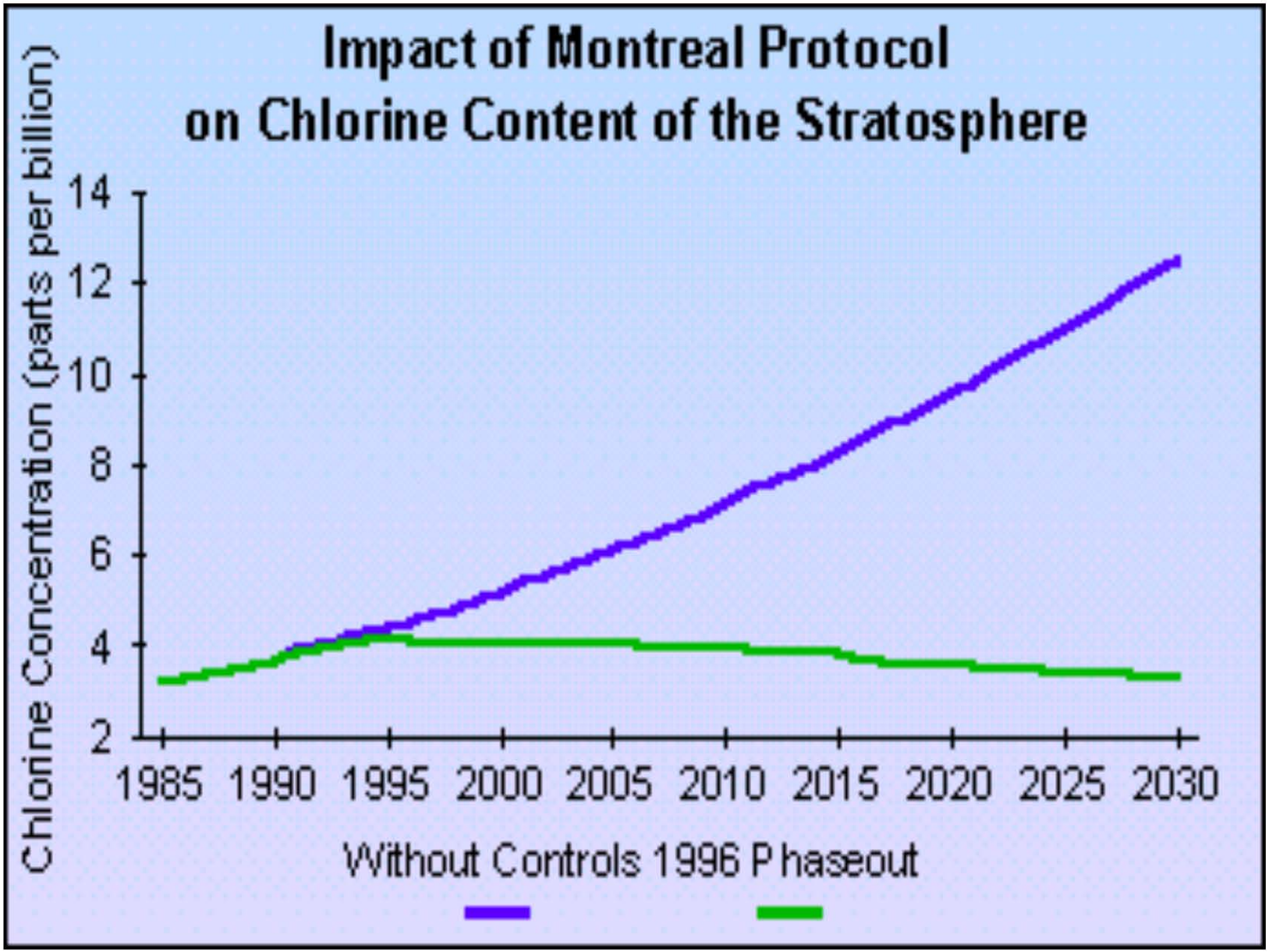
- the Antarctic ozone “hole” is a region of extreme ozone loss (up to 60%) that has been appearing since the 1970s.
- Very harmful locally in spring, then mixes and depletes ozone globally
- Caused by Chlorine from human-made freone (CFC)



Montreal Protocol (1987)

Poses strict limits on CFC emissions and other ozone destroying agents

- decrease Cl to levels as before ozone hole (2 ppb) by 2060
- decrease Cl to natural level, within a century


Impact of Montreal Protocol
on Chlorine Content of the Stratosphere
Chlorine Concentration (parts per billion)
14
12
10
8
6
4
2
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
Without Controls
1996 Phaseout

Why has the effort to fight ozone depletion been so successful?

(1) CFCs and ozone destruction connected by sound science.

(2) Chemical industry fearing federal regulation, developed viable alternatives to CFCs, within a year or two.

(3) Equity issues between developed and developing nations were recognized.

- developing nations phased out later
- fund established by the wealthy countries

global commitment to solving the problem.

Massachusetts v. Environmental Protection Agency EPA
and the Greenhouse Endangerment Finding

In 2003, the EPA made two determinations:
1)the EPA lacked authority under the Clean Air Act to regulate carbon dioxide and other greenhouse gases (GHGs)
2)even if the EPA did have such authority, it would decline to exercise it.

This determination was challenged and brought to the Supreme Court

Petitioners: 15 states including Massachusetts, California, and Washington; a number of environmental protection organizations; and public interest groups.

Respondents: EPA; four major automobile and truck manufacturers' organizations, CO2 Litigation Group, Utility Air Regulatory Group; and 10 states including Michigan, Alaska, and Texas.

The Supreme Court Decision in 2007

The court decided 5-4

1)Massachusetts did have “standing” (or could be injured by EPA’s decision)

2)The “harms associated with climate change are serious and well recognized”

3) The 1971 Clean Air Act gave the EPA authority to regulate carbon dioxide and other greenhouse gases (GHGs)

4)The EPA must reconsider its decision not to regulate them

EPA's Greenhouse Endangerment Finding
December 7, 2009

1) The current and projected concentrations of the 6 key well-mixed greenhouse gases — CO_2 CH_4 etc. — threaten the public health and welfare of current and future generations.

2) The combined emissions of these well-mixed GHGs from new motor vehicles contribute to the GHG pollution which threatens public health and welfare.

These findings finalized the EPA's proposed greenhouse gas emission standards for light-duty vehicles

The EPA has received 9 petitions for reconsideration, many citing the stolen emails and supposed errors in the IPCC

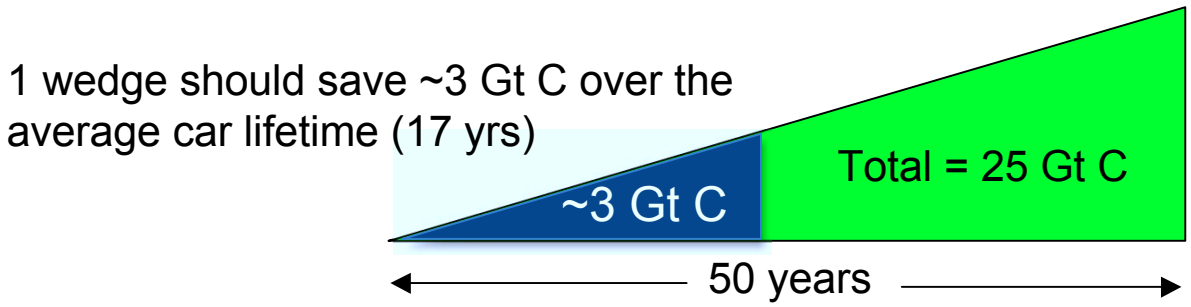
EPA's Regulations on Light-Duty Vehicles
September 15, 2009

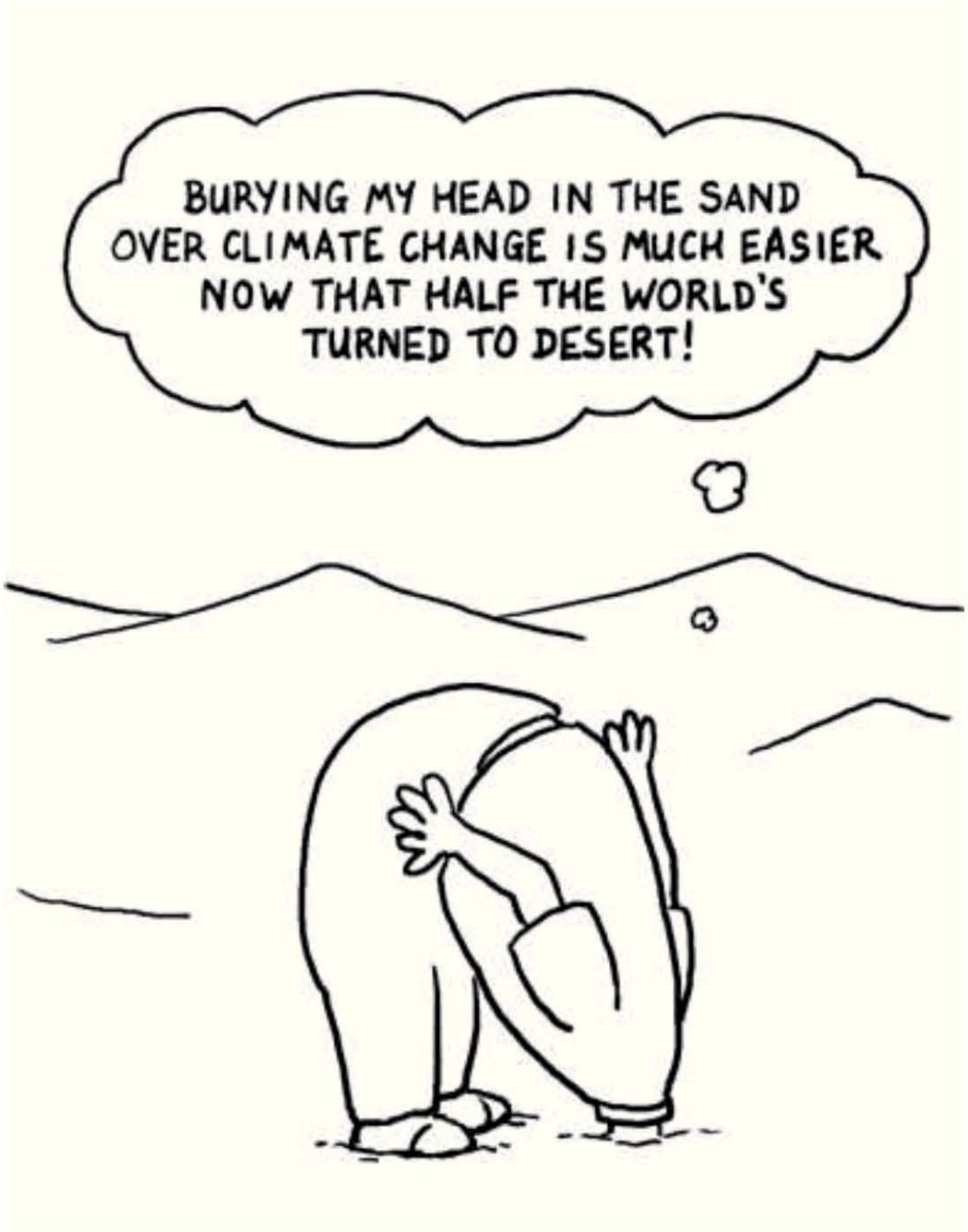
Joint proposal with the Department of Transportation's proposed:

Vehicles sold 2012-2016 meet an estimated combined average emissions level of 250 g of CO_2 per mile, equivalent to 35.5 MPG

Would apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles

Would cut emissions by ~0.3 Gt C over the lifetime of the vehicles sold under the 5-yr program, or ~1/10 of a wedge over that lifetime




BURYING MY HEAD IN THE SAND OVER CLIMATE CHANGE IS MUCH EASIER NOW THAT HALF THE WORLD'S TURNED TO DESERT!

Americans favor GHG regulations

Do you think the federal government should regulate the release of greenhouse gases from sources like power plants, cars and factories in an effort to reduce global warming?

65% should

29% should not

Survey by Washington Post in Dec 2009

The House Bill "American Clean Energy and Security Act" (ACES)

(the Waxman-Markey Bill passed last summer)

- Cab and Trade system part grandfather part auction (see last lecture)
  - Invests in new clean energy technologies and energy efficiency including (approx $170 billion over 15 years)
  - Requires large electric power companies to produce 20% from renewable sources by 2020
  - Mandates significant increases in energy efficiency in buildings, home appliances, and electricity generation
  - Jet fuel still exempt (from cap and from all taxes)

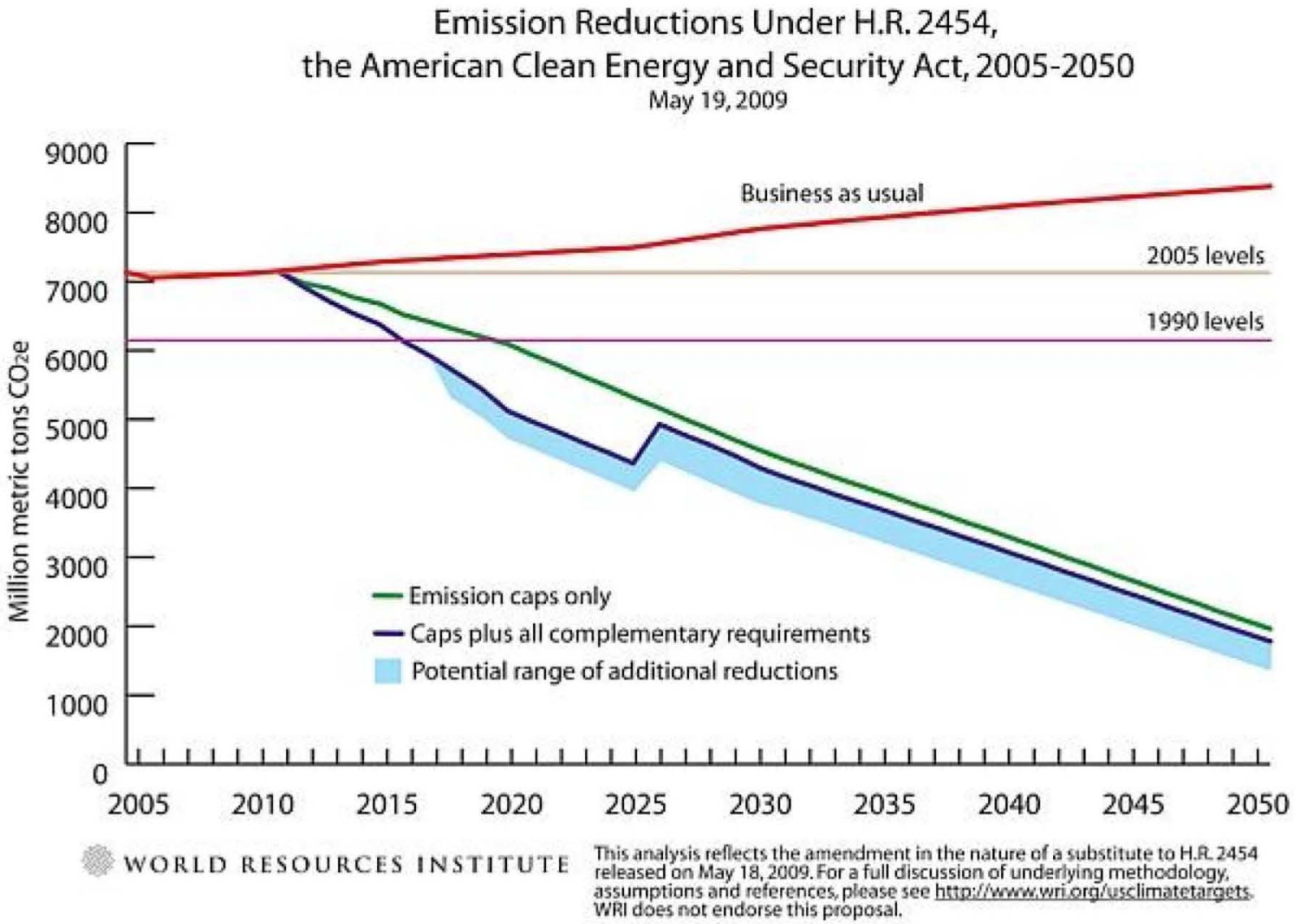
- Congressional Budget Office estimates the net impact of the bill would be 40$ per year savings for households in the lowest income bracket and 245$ per year loss for the highest income bracket

Senate Bill 1 “Clean Energy Jobs & American Power” (CEJ)

(the Kerry-Boxer Act introduced March 2009)

- Companion Bill to House Waxman-Markey Bill
- Some differences from House Bill
  - Retains EPA authority to regulate GHGs
  - Requires large electric power companies to produce 15% from renewable sources by 2020
- This senate and the house bill are criticized for complexity (800+ pages of regulations)

The Cap Reduces U.S. Emissions



Senate Bill 2 “Carbon Limits an Energy for American’s Renewal” (CLEAR)

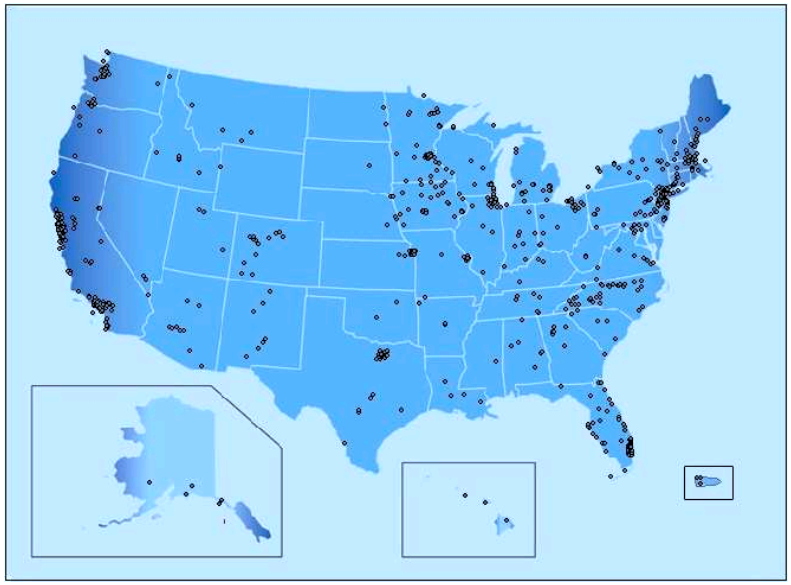
(the Cantwell-Collins Act introduced Dec 2009)

- Cab and Dividend system with all “shares” auctioned by government with price collar ($7 to $12 per ton in 2012)
  - Share exchange permitted without collar but transaction information must be made public
  - Dividend returns ¾ of auction revenue to individuals on equal per capita basis
  - The rest is invested ¼ in new clean energy technologies and energy efficiency including and to relieve financial stress of regulation to communities and businesses
- Congressional Budget Office estimates 80% of the population would end up either breaking even or making money under cap-and-dividend.
- The Bill is just 40 pages!

Mayors' Climate Protection Agreement

Over 1000 mayors have signed

Started in Seattle



Commitment to

Strive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from anti-sprawl land-use policies to urban forest restoration projects to public information campaigns;

UW Climate Action Plan

UW has joined the ACUPCC

American College and University Presidents Climate Commitment

Presidents signing the Commitment are pledging their institution to eliminate its contribution to global warming over time. This includes establishing an institutional structure to oversee the development and implementation of the school's program; completing an emissions inventory within a year and annually thereafter, establishing a climate neutrality action plan, taking some immediate steps to reduce greenhouse gas emissions, integrating sustainability into the curriculum and making their climate action plan, inventory and progress reports publicly available.

[ACUPCC Implementation Guide, Sept., 2007]

UW Climate Action Plan

Step 1: Campus Emissions Inventory (published Oct. 2007)

Step 2: Document outlining commitment to a strategy to reduce emissions over time (published Sept 15, 2009)

NOTES

UW Seattle electricity comes from Seattle City Light*, 89% of which is from hydropower, so electricity use is not counted.

*Local electricity fuel mix presented last week were from Puget Sound Energy

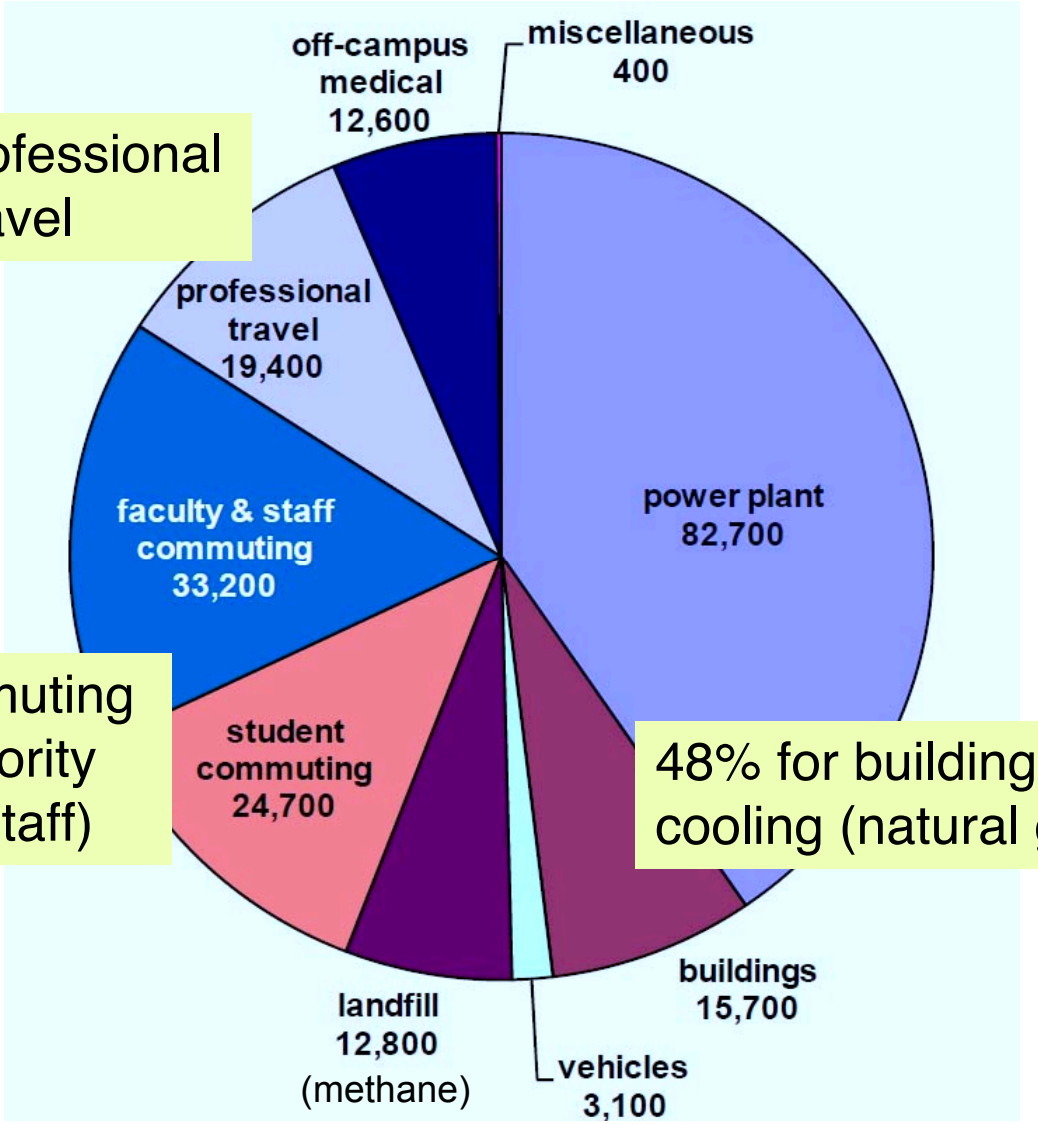
Step 1: UW GHG Emissions for 2005

Total: 206,000 tons CO2 equiv /yr

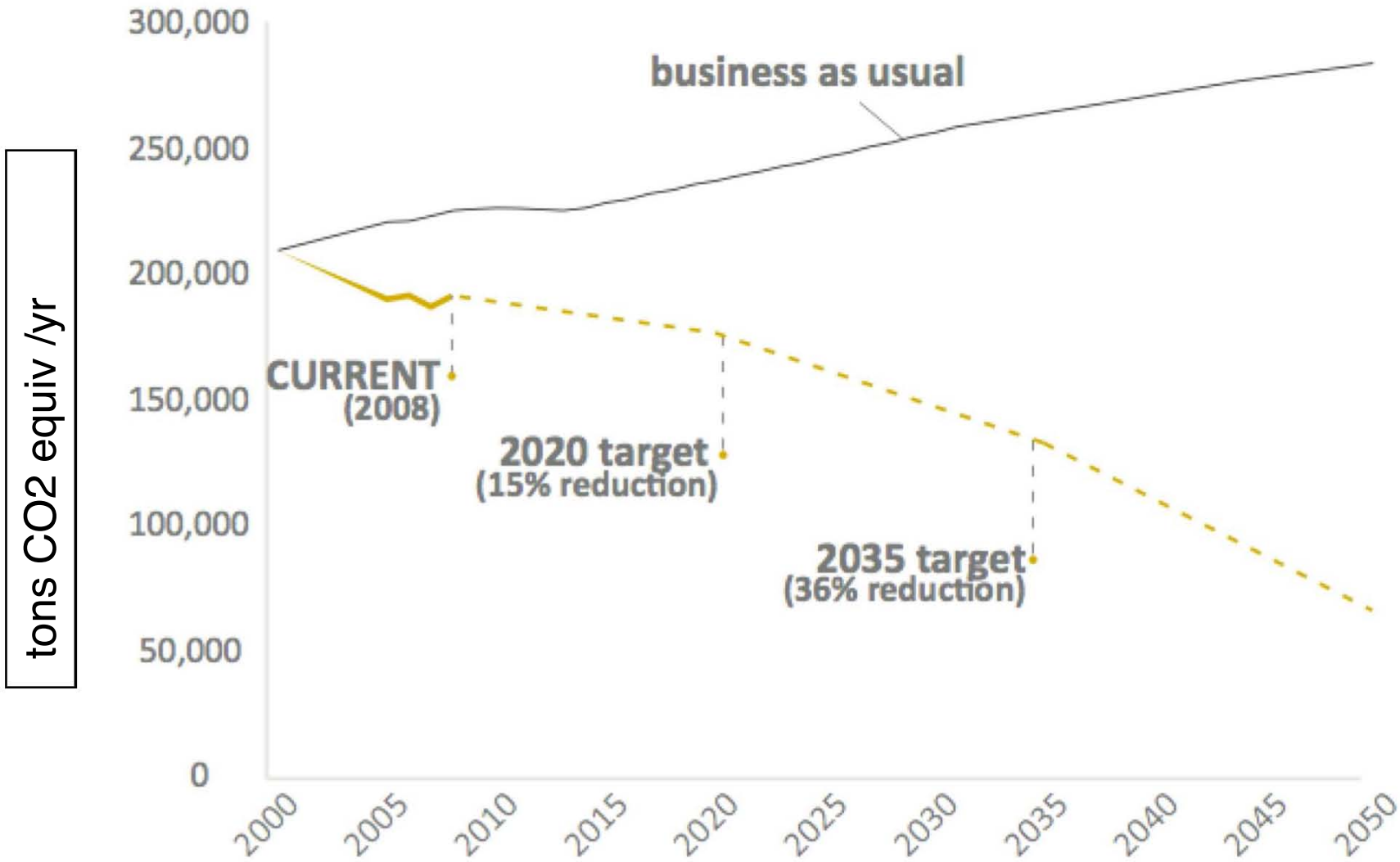
9% from professional air travel

28% from commuting to campus (majority by faculty and staff)

48% for building heating and cooling (natural gas)



Step 2: UW GHG Emissions PLAN



"Some say it's irrevocable, others say it's irreversible. Given such an absence of consensus I suggest we do nothing drastic."

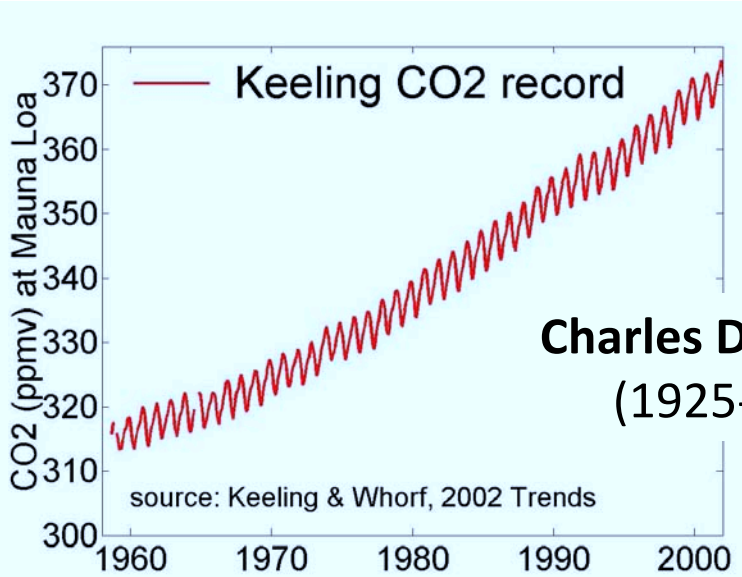
But the stolen emails have been damaging…

5 of 15 States with Resolutions Opposing EPA Greenhouse Endangerment Finding

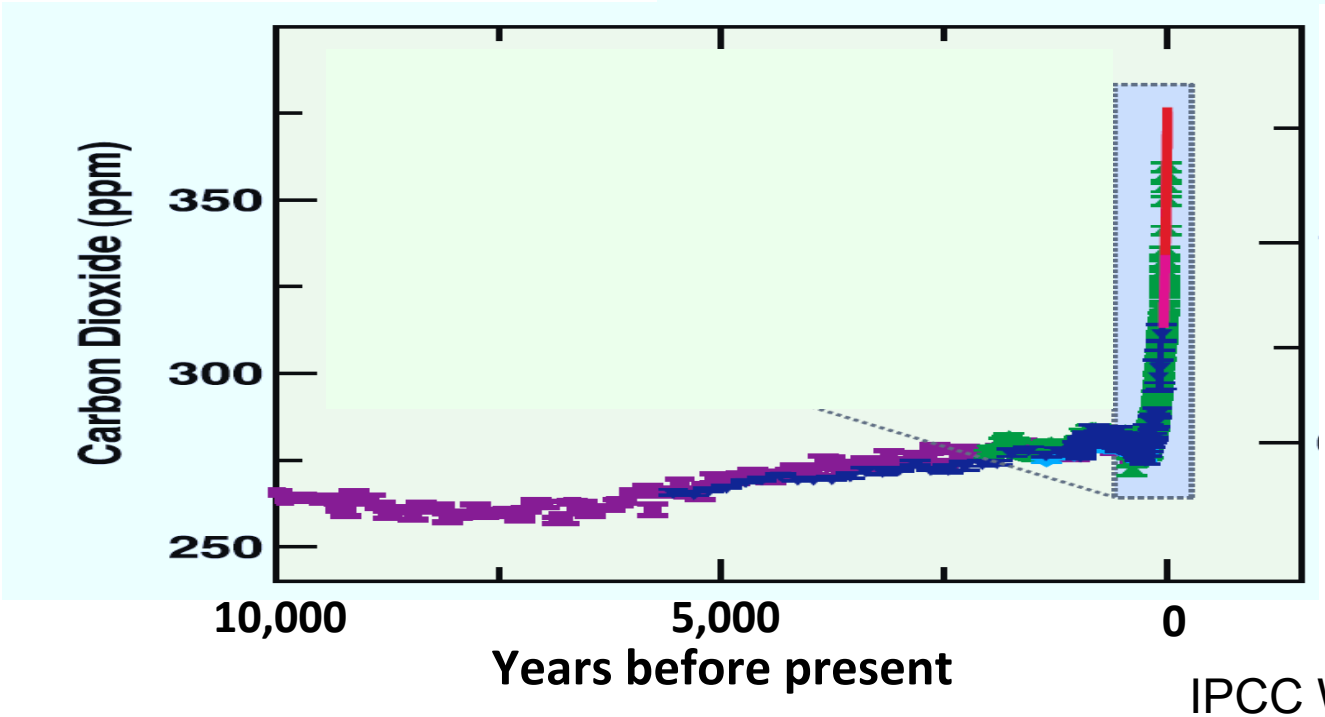
STATE	SPONSOR	STATUS	NOTES
OK	Lamb (R)	Adopted by Senate	Cites "unsettled" science to support overturn
UT	Gibson K (R)	Adopted	Cites "Climategate" to support EPA withdrawal
VA	Morefield (R)	Pending	"Carbon dioxide shall not be considered air pollution"
WA	"AN ACT Relating to express legislative authorization for any greenhouse gas or motor vehicle fuel economy program"		
WV	Shott (R)	Pending	Cites "vigorous, legitimate, and substantive" scientific debate to support Murkowski

From http://www.grist.org/article/2010-03-02-fifteen-states-have-polluter-driven-resolutions-to-deny-climate/

CO2 has risen by over 35%



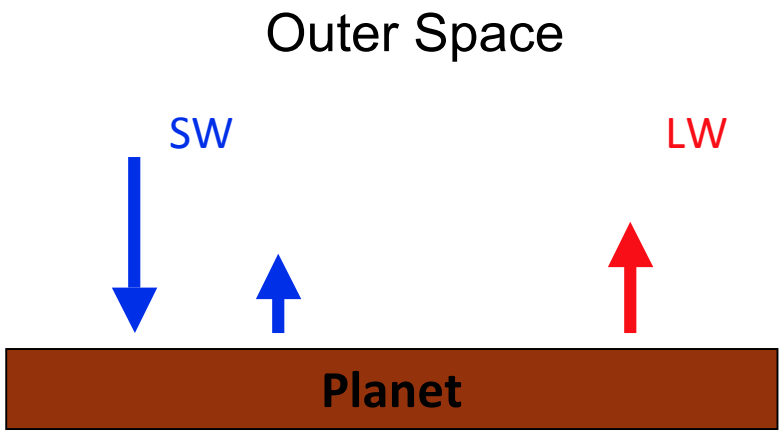
Charles D. Keeling
(1925-2005)



IPCC WG1 SPM Fig 1

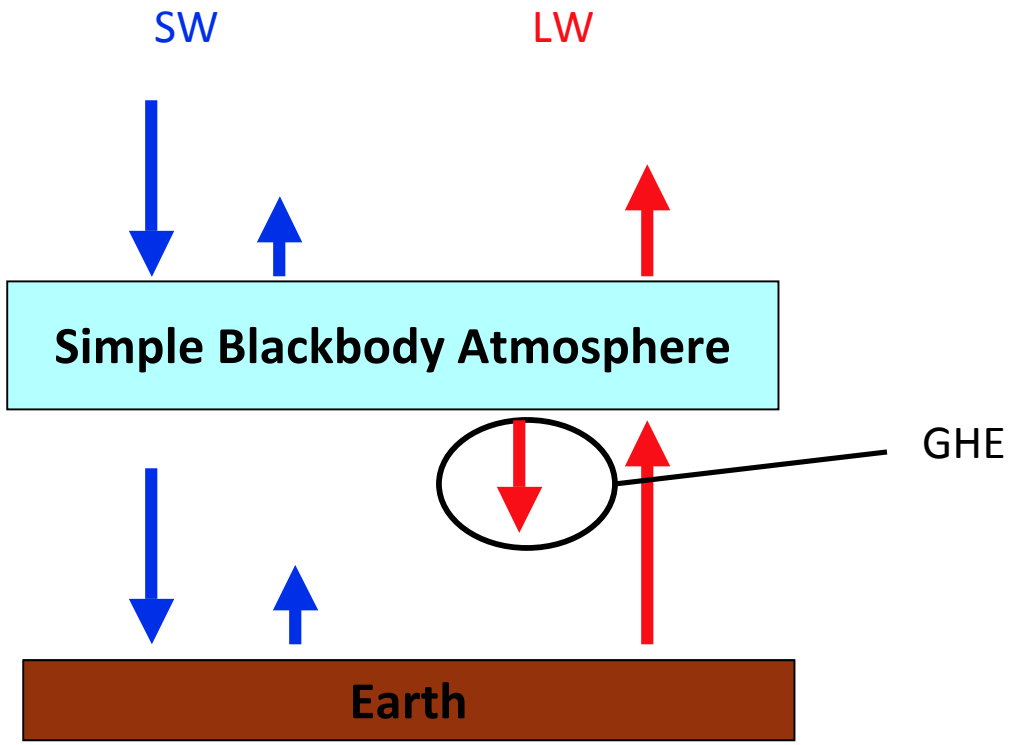
Consider Planet with No Atmosphere
Model A

A model of heat entering and leaving the surface.
Incident sunlight is partly absorbed and reflected.



Arrow lengths indicate relative fluxes. Red arrow length also indicates relative temperature. Planet is in balance if they sum to zero.

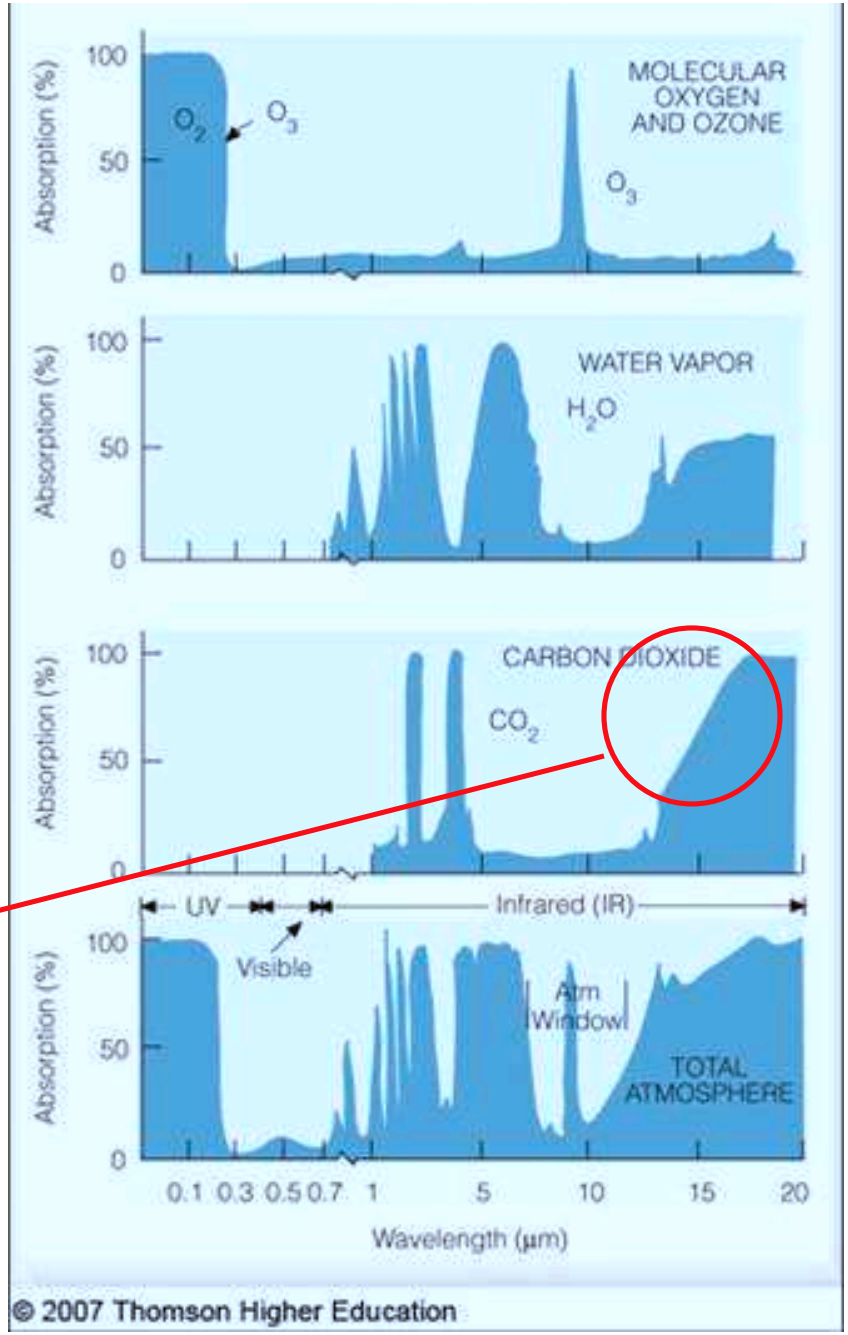
Earth with a Simple 1-Layer Blackbody Atmosphere Model B



Scientist can compute the GHE accurately with models of many layers.

These models take into account the unique absorption and emission spectra of individual GHGs, which are selective absorbers as opposed to black bodies.

Bottom line, adding more CO2 to the atmosphere increases absorption where it is ~10-90%



Global Mean Surface Temperature Supports Global Warming Theory

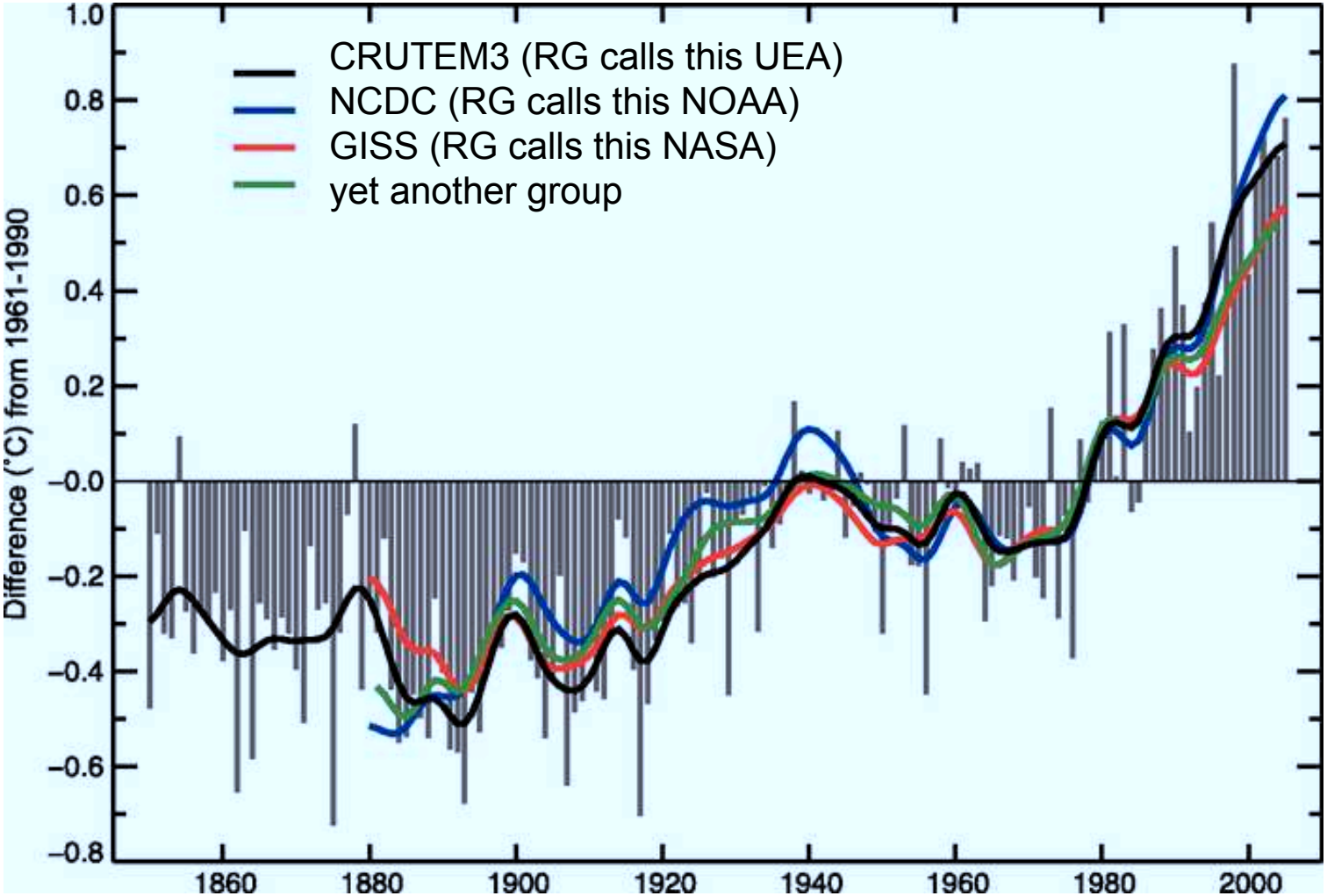
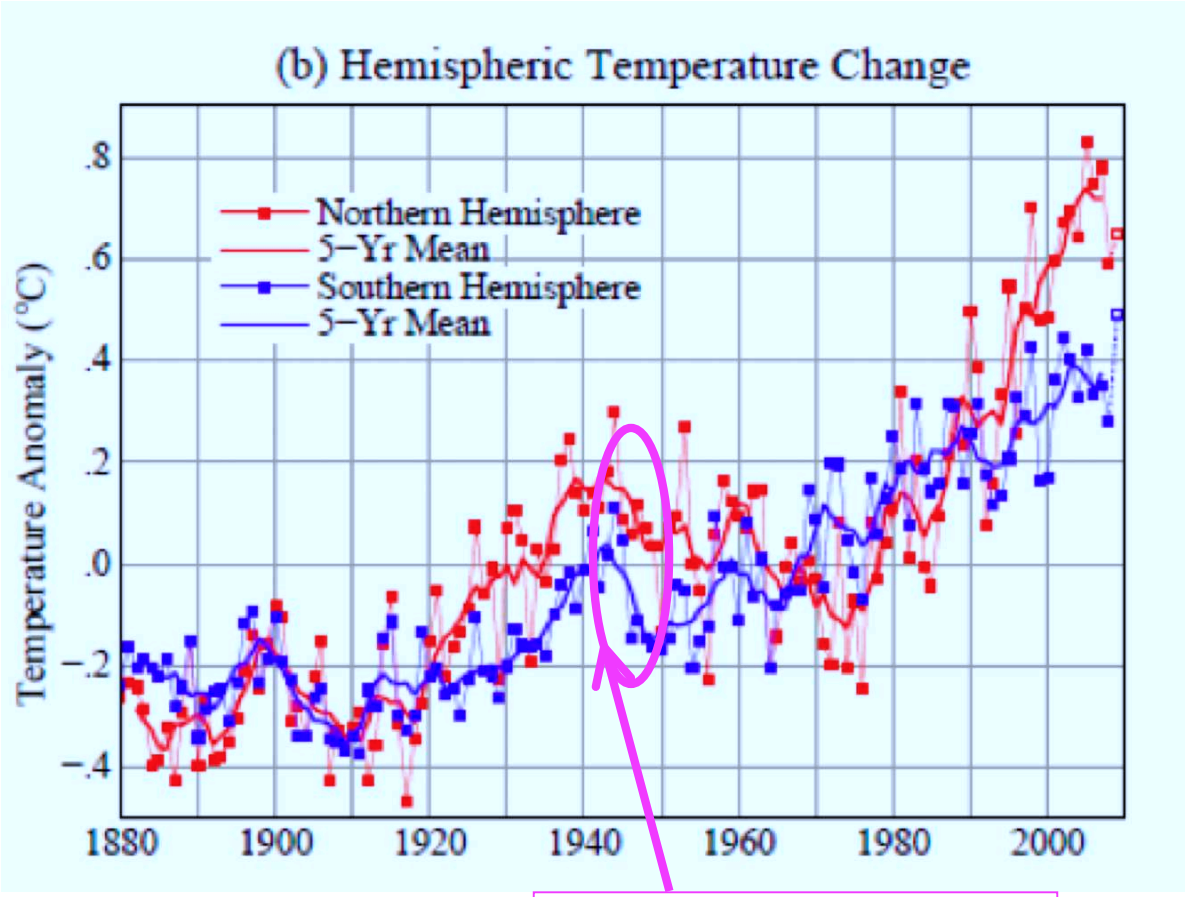


Figure 3.1 from 2007 IPCC

This record since 1850 is ONLY THERMOMETER DATA

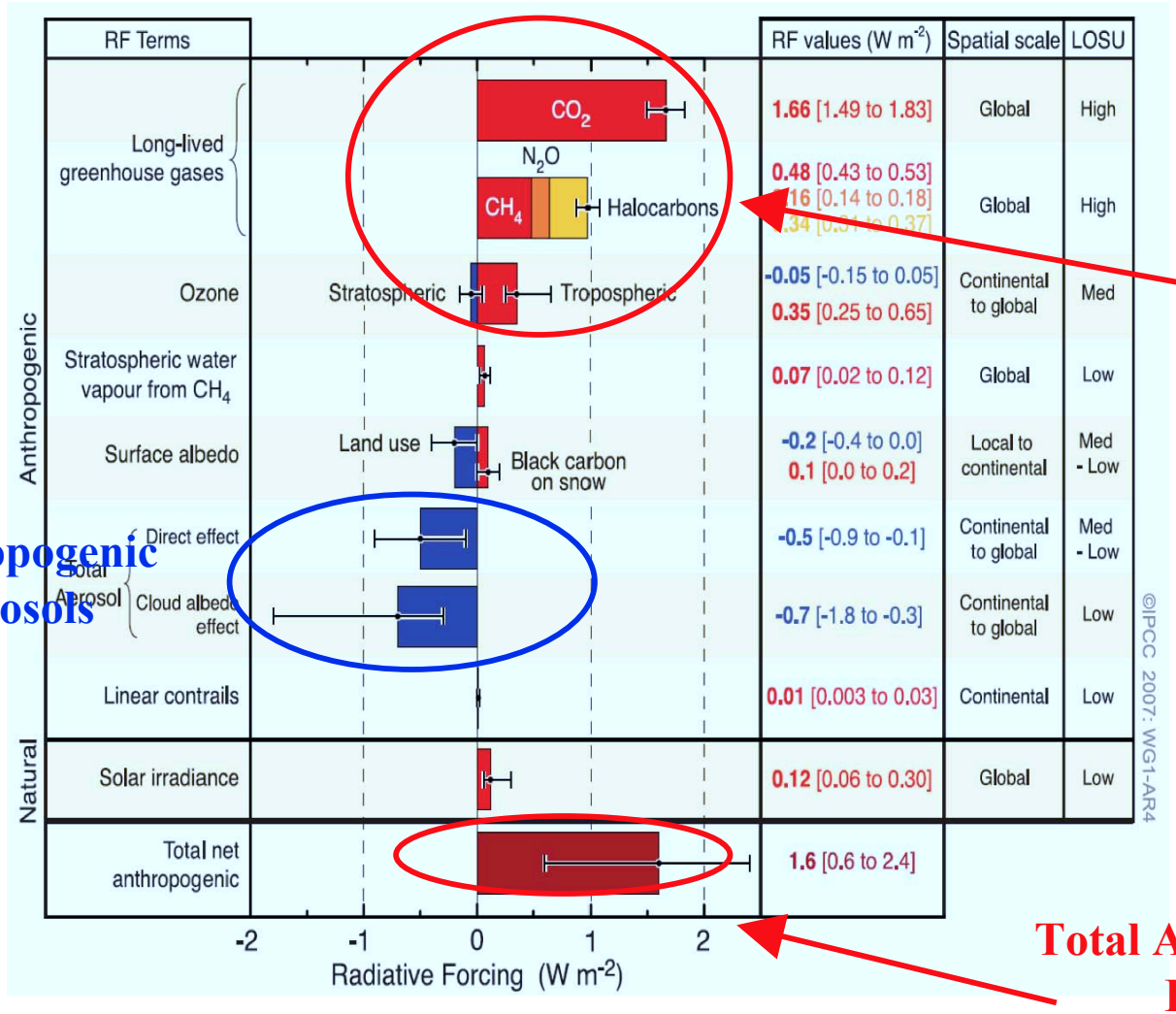
Even more evidence from hemispheric means



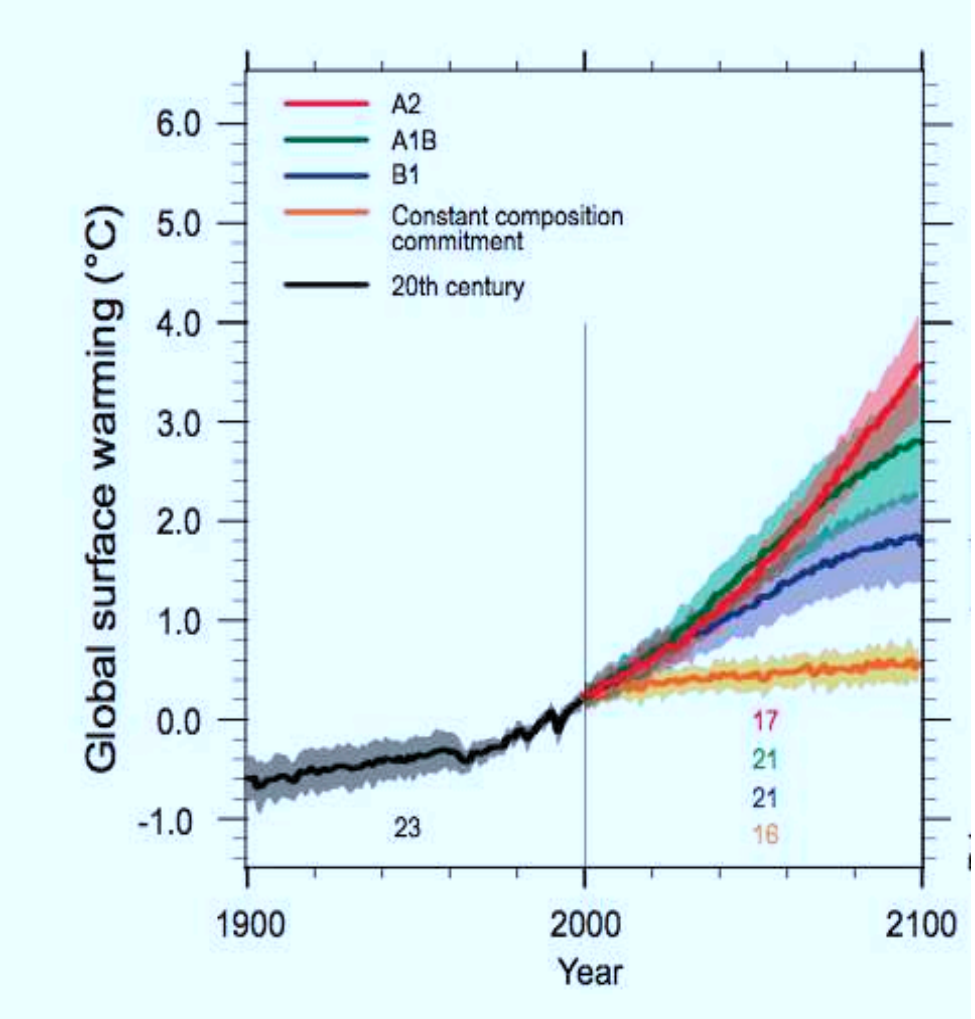
1) NH warms faster because ocean heat uptake is very large in SH
2) NH 1945-1975 cooling likely caused by anthropogenic aerosols which don't affect the SH very much (Clean Air Act in 1971)

Radiative Forcing from 1870-2000

If Aerosol Forcing was at the high end of uncertainty, the total forcing might have been quite low. If so, the future, which is inevitably going be very strongly driven by GHGs with diminishing role for aerosols, could have very high warming.



Projections of Future Warming in Climate Models



Lack of knowledge about aerosol forcing means we have high uncertainty of climate response in the future

Plus we don't know which scenario will unfold

1.6 to 4 C warming relative to 2000 is the IPCC Forecast this century. It could be even higher according to ClimatePrediction.net

2007 IPCC Figure