Global Warming
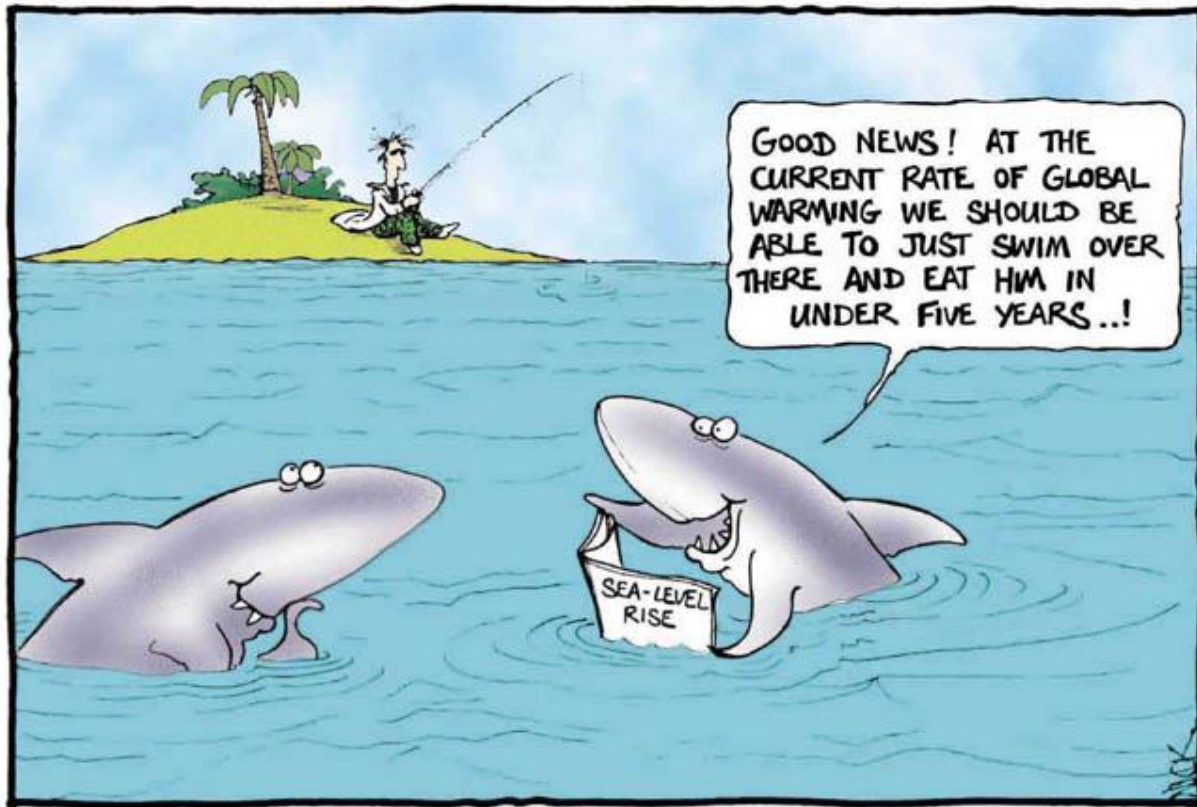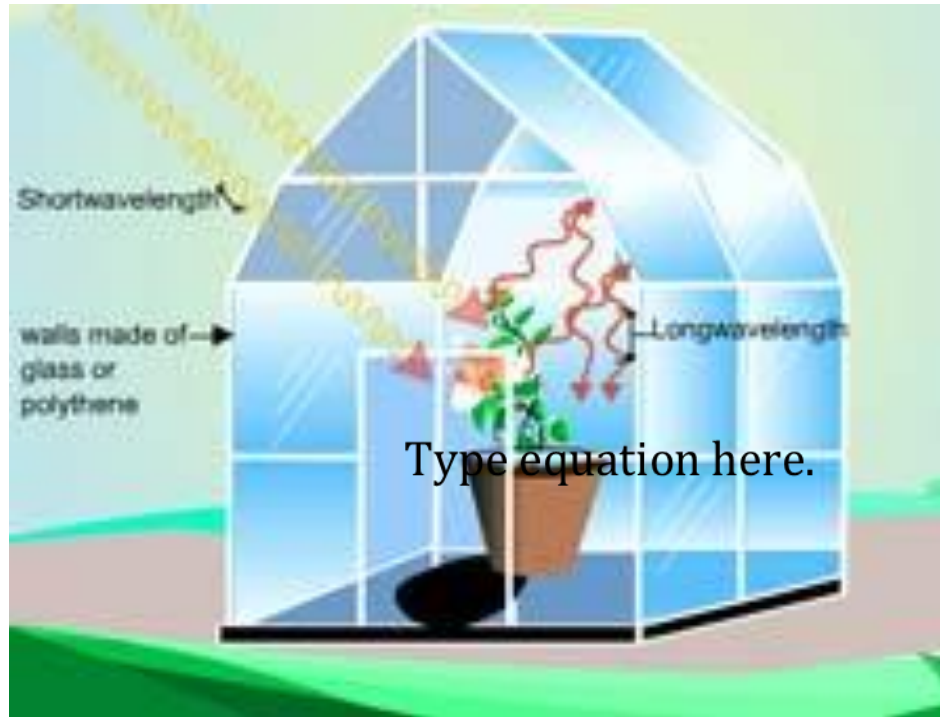

Heat is Not Always Comforting

1. Gases

- These gases accentuate the greenhouse effect and bring about global warming.

- CO_2 (from fossil fuel burning for transportation and electricity)

- CH_4 (from agriculture)

- CFC's

- N_2O

- H_2O (strong GH gas but man-made amount is unimportant compared to natural humidity)

2. What is the Greenhouse Effect?

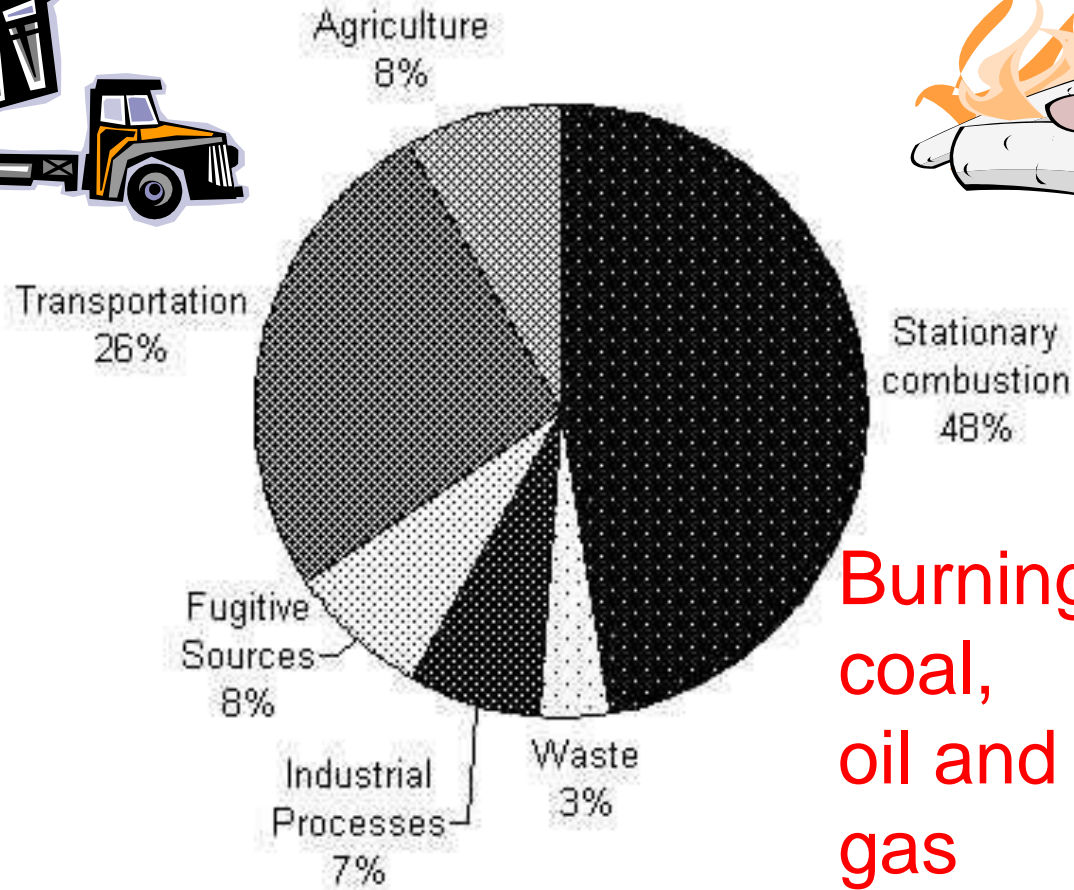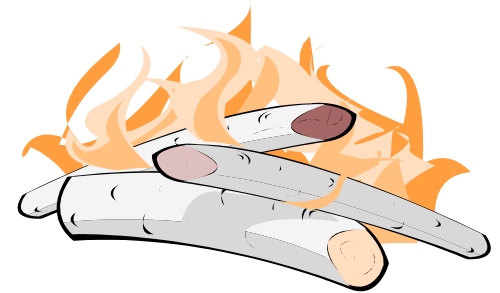What happens to visible light of shorter wavelength?

Most penetrates the glass and the soil, pots and floor
which convert it to heat

What happens to longer light wavelengths (infrared= heat)?

Some of it bounces off the glass and remains
Inside the greenhouse.

Source of Greenhouse Gases

Canadian CO$_2$ Emissions

- Agriculture 8%
- Transportation 26%
- Fugitive Sources 8%
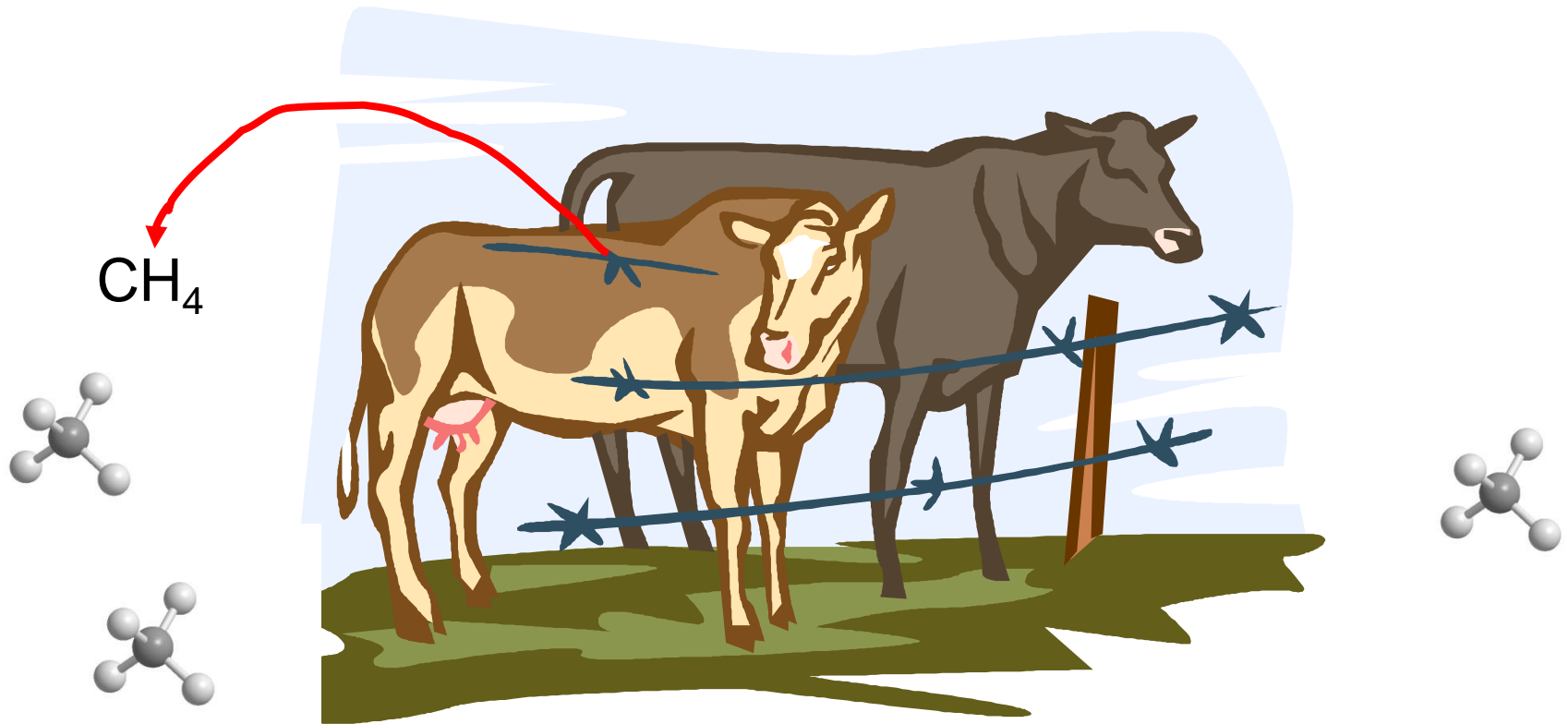- Industrial Processes 7%
- Waste 3%
- Stationary combustion 48%

Burning coal, oil and gas

Source of Greenhouse Gases (continued)
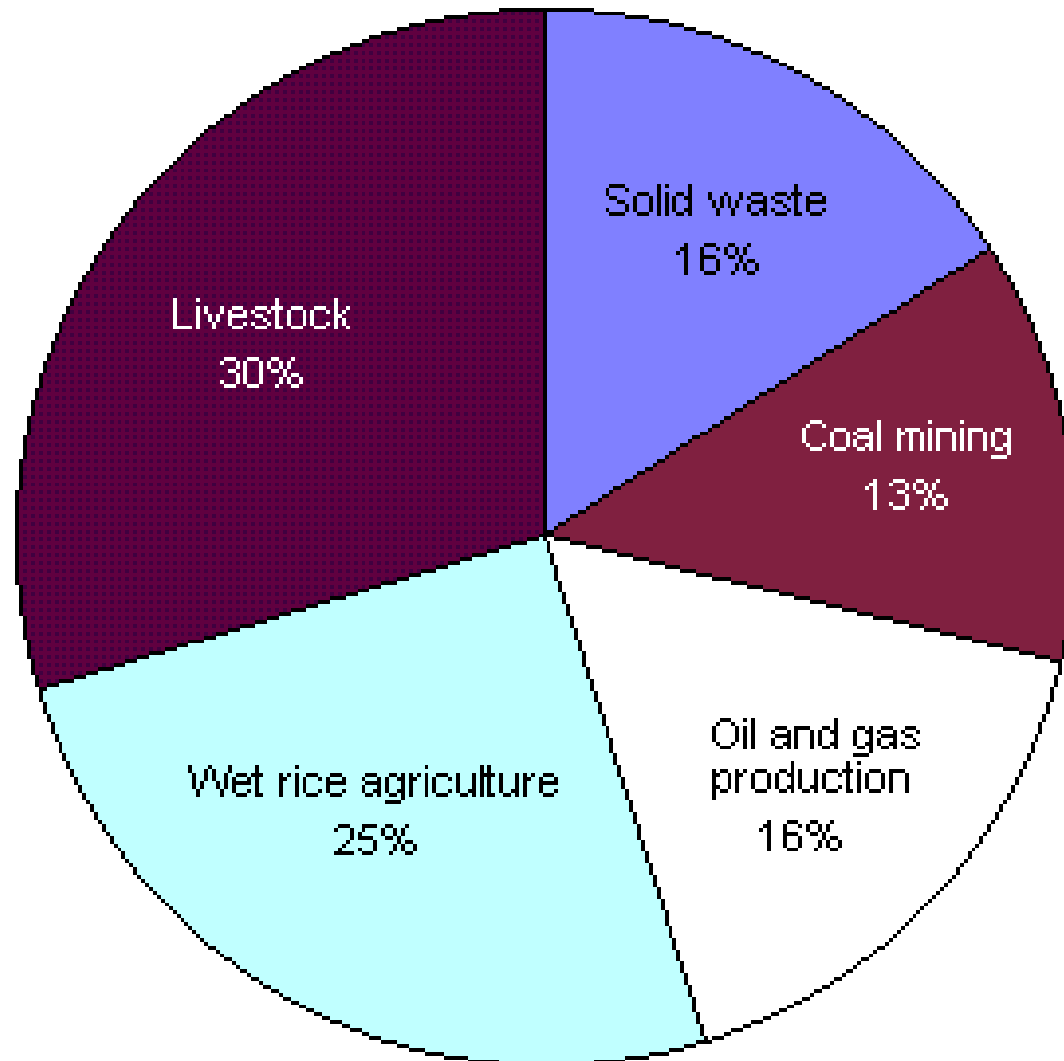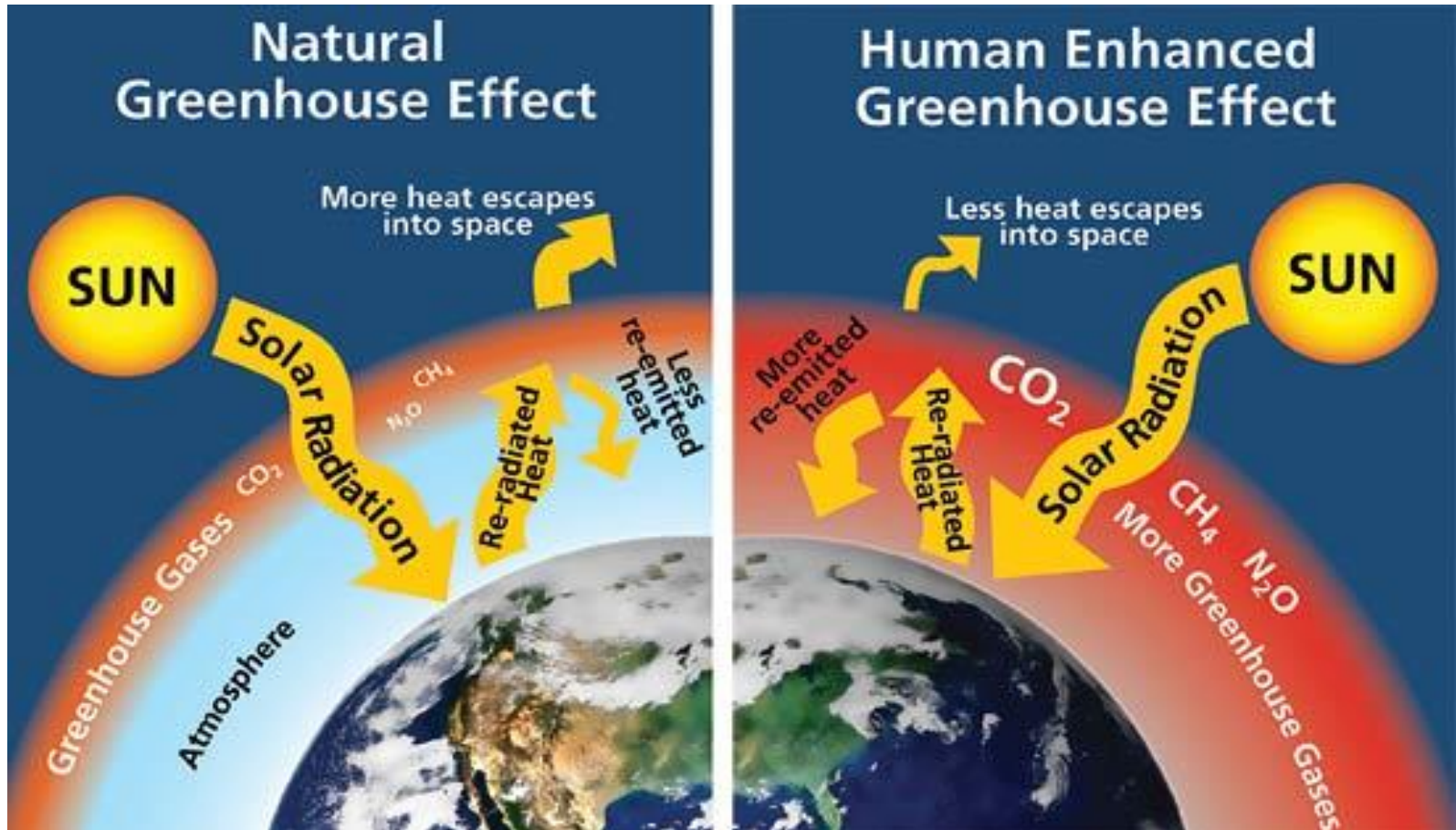

CH_4

Livestock flatulence (contribute to 30% of all methane)

Global Sources of Methane Emissions
Source: United Nations Environment Programme

2. What is the Greenhouse Effect?

Incoming Solar radiation = Visible light
Outgoing Heat = Infrared energy

3.
Evidence

CO_2

$^2H/^1H$:
Temperature indicator

Deuterium $\delta D (‰)$

CO_2 (p.p.m.v.)

Age (kyr BP)

4. Consequences

MELTING ICECAPS LEADS TO HEAVY PACK ICE

SHORT WET WINTERS, LONG DRY SUMMERS

SHARP FALL IN GRAIN CROP YIELDS

SHARP FALL IN GRAIN CROP YIELDS

POOR RICE CROP

RISE IN SEA LEVEL

INCREASE IN FARMING

FAILURE OF ANCHOVY FISHERIES

RISE IN SEA LEVEL

More severe storms

MORE HUMID THAN BEFORE

DRIER THAN BEFORE

FLOODING THROUGH RISE IN SEA LEVEL

Summer sea-ice extent:
- September 16th 2012
- September 18th 2007
- 1979-2000 average

90° E

RUSSIA

Sea of Okhotsk

SIBERIA

ARCTIC CIRCLE - 66.6°

Kara Sea

Barents Sea

FINLAND

SWEDEN

SVALBARD (to NORWAY)

NORWAY

East Siberian Sea

North Pole

Fram Strait

Greenland Sea

0°

North Sea

Norwegian Sea

180°

ARCTIC

Bering Sea

Chukchi Sea

OCEAN

ICELAND

Beaufort Sea

GREENLAND (to DENMARK)

ALASKA (to UNITED STATES)

ATLANTIC OCEAN

Parry Channel

Baffin Bay

PACIFIC
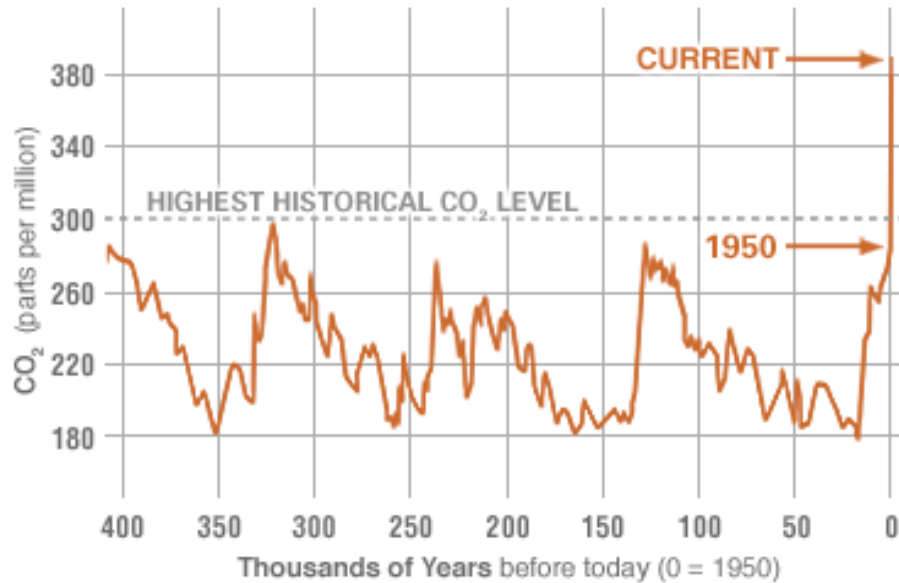
CANADA

OCEAN

90° W

Source: NSIDC

Carbon Dioxide Concentration

PROXY (INDIRECT) MEASUREMENTS

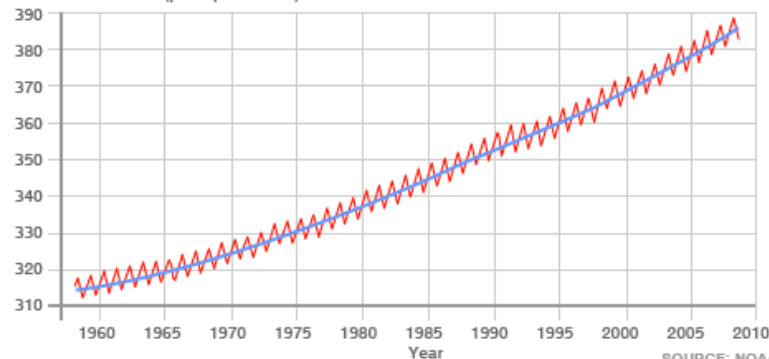Data source: Reconstruction from ice cores.
Credit: NOAA

DIRECT MEASUREMENTS: 2005-PRESENT

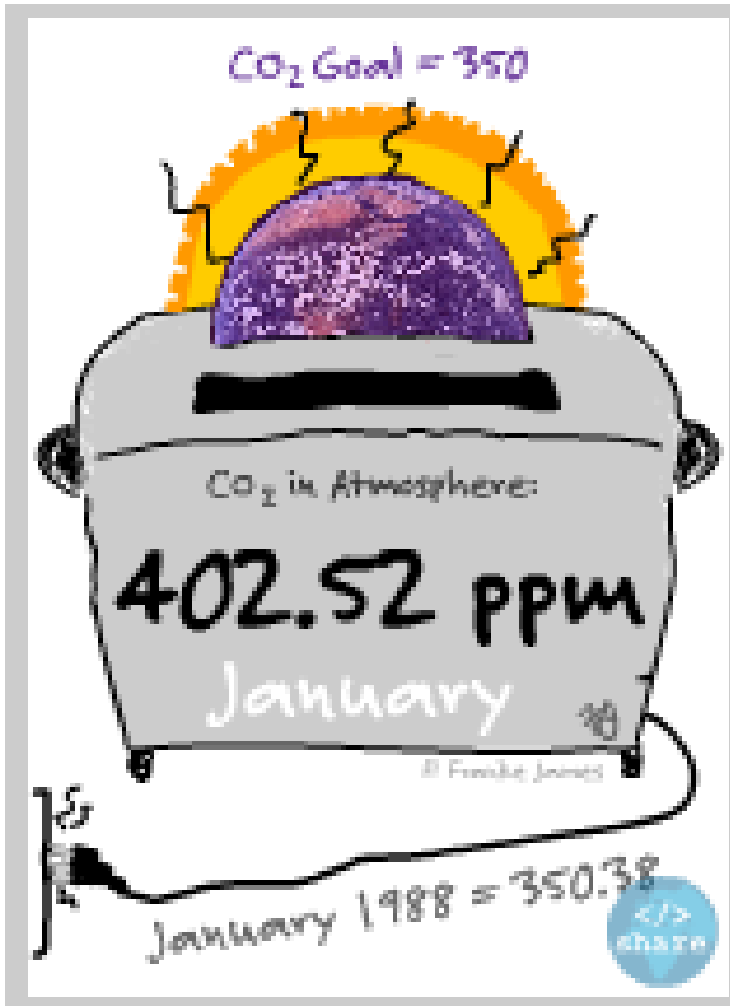Data source: Monthly measurements (corrected for average seasonal cycle). Credit: NOAA

396.97 ppm

ATMOSPHERIC CO2 AT MAUNA LOA OBSERVATORY
CO^2 concentration (parts per million)

SOURCE: NOAA

2016

Atmospheric CO$_2$ at Mauna Loa Observatory

Scripps Institution of Oceanography
NOAA Earth System Research Laboratory

PARTS PER MILLION

380

360

340

320

1960   1970   1980   1990   2000   2010

YEAR

January 2009
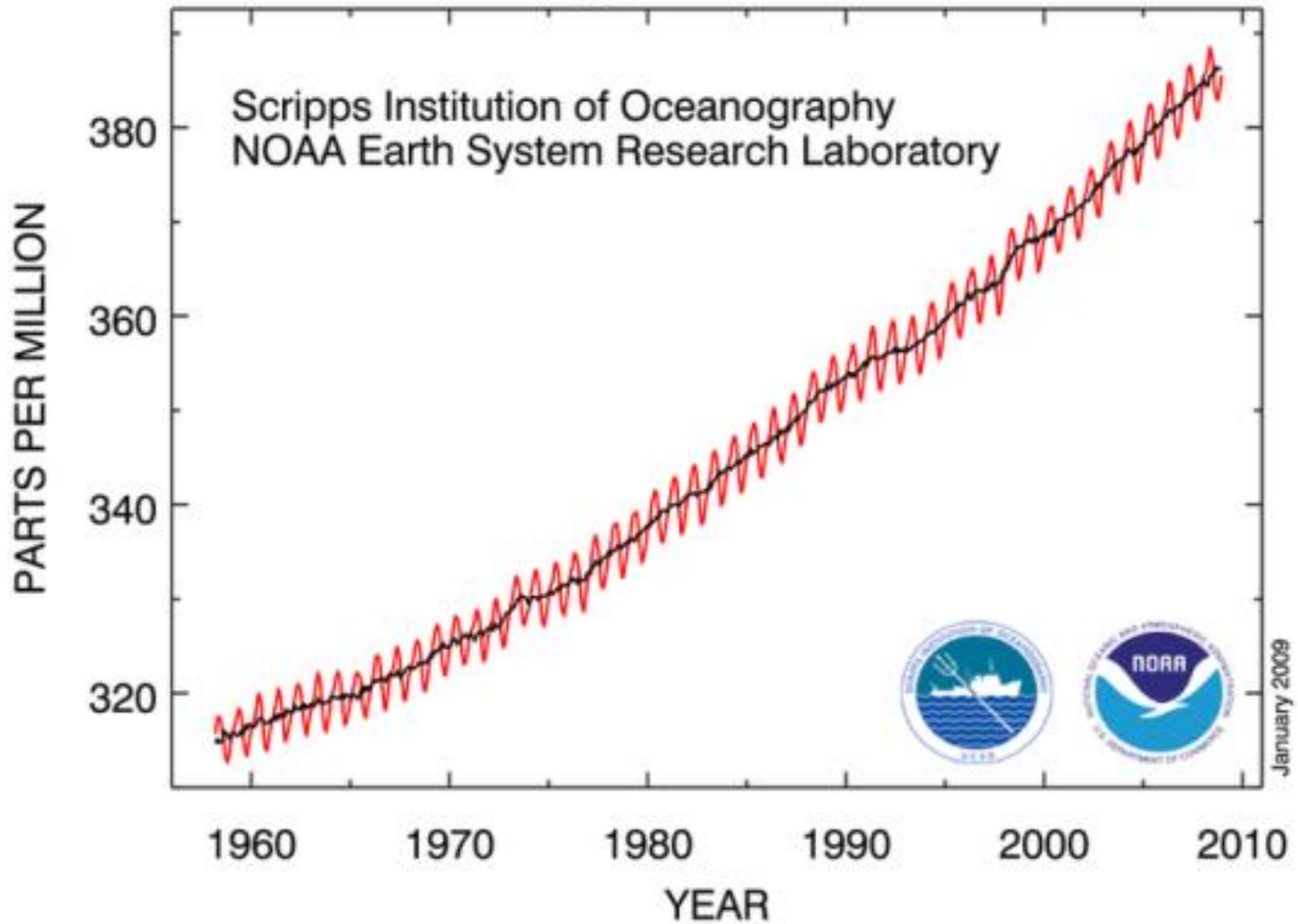
2006	max	**2006 avg**	**2012**	**2011**	**1971-2000**	min	highest	lowest	rain(mm)	Snow (cm)	total	
Jan	-0.7	**-4.5**			**-10.2**	-8.3	8.1	-18.6	92.2	53.6	147.8	13
Feb	-3.2	**-6.8**			**-8.4**	-10.4	6.8	-18.8	38.6	25.7	64.5	9
Mar	3.6	**-0.6**			**-2.3**	-4.8	22	-17.1	24.8	4.2	29.4	0
Apr	13.3	**7.6**			**5.7**	1.8	24	-5.5	105.8	8.2	114	0
May	19.2	**14.5**			**13.4**	9.8	30.8	-0.2	173.4	0	173.4	0
Jun	24	**19.2**			**18.2**	14.3	32.4	8.8	104.2	0	104.2	0
Jul	27.5	**22.6**			**20.9**	17.7	32.3	12.9	135.2	0	135.2	0
Aug	24.5	**19.3**			**19.6**	14.1	34	7.9	154.4	0	154.4	0
Sep	19.4	**15**			**14.6**	10.6	27.4	3.7	65.4	0	65.4	0
Oct	11.6	**7.9**			**8.1**	4.2	20.9	-2.5	179.4	T	179.4	0
Nov	7.9	**4.4**			**1.6**	0.9	17.5	-4.7	71.4	T	71.4	0
Dec	2.4	**-1.2**			**-6.3**	-4.8	11.8	-17.5	80.4	30.6	104	10
Sum									1225.2	122.3	1343.1	978 (30 yr avg)
Avg	12.5	**8.2**	**8.5**	**8.5**	**6.2**	3.8						
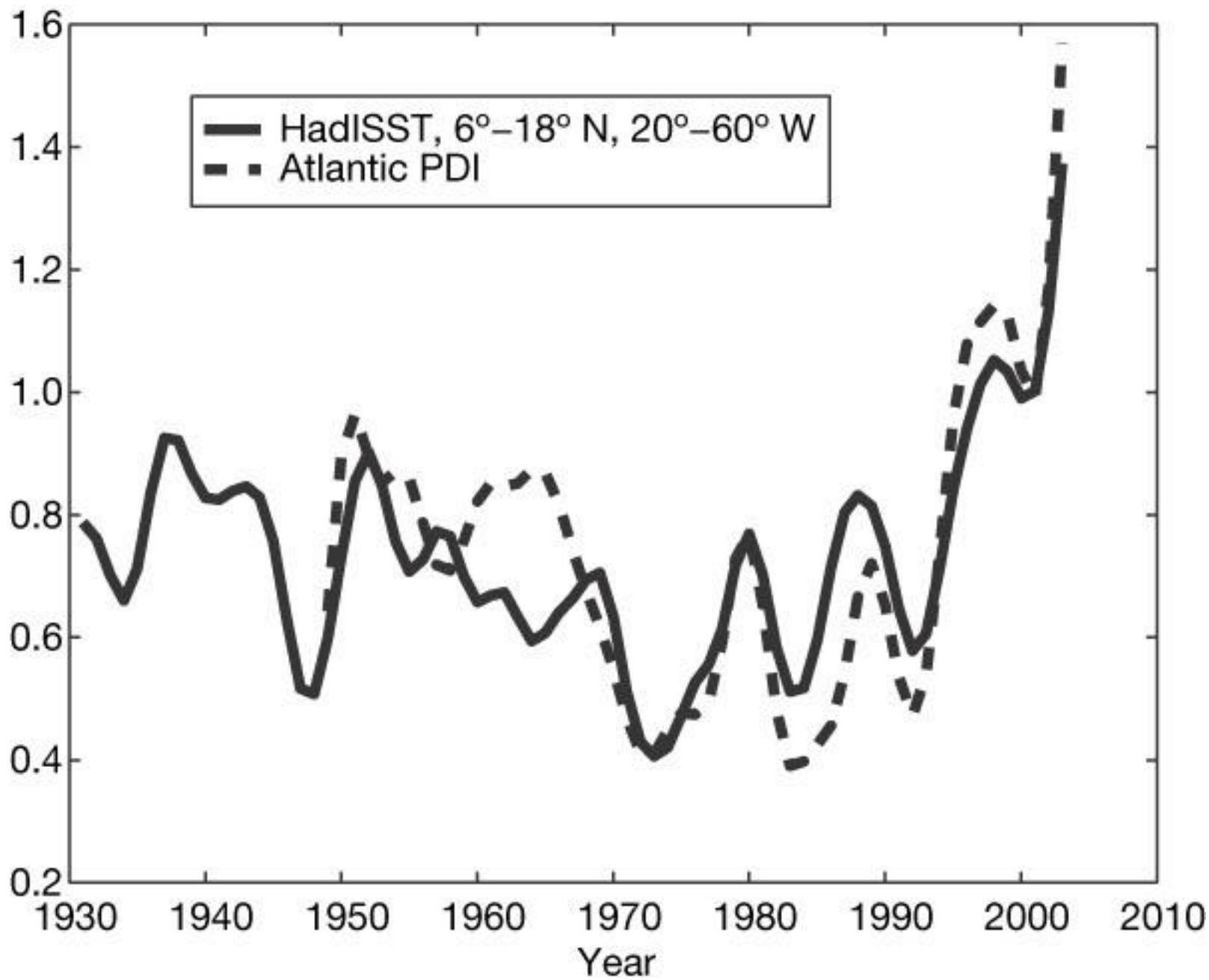
5. Fixing the Problem
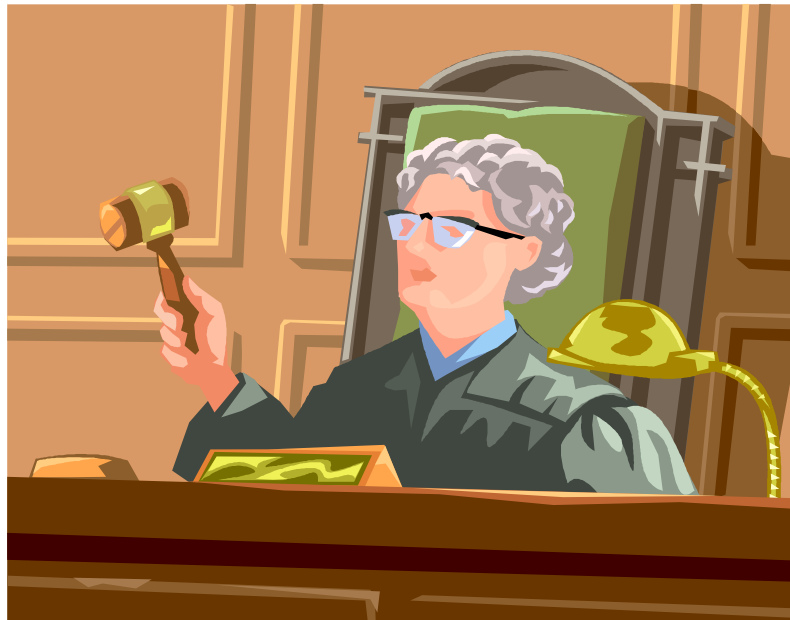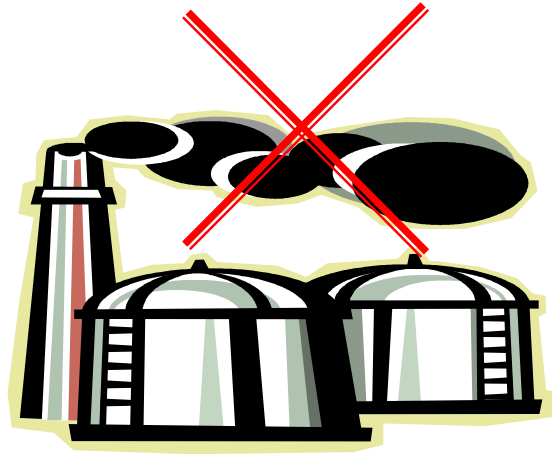
(1)Cleaner Energy: generate from hydro, wind, tidal, solar and geothermal
(2) Conserve energy—consume less

Practical Examples from Around the Globe

**This offshore wind farm in Denmark includes 72 turbines
and generates enough clean energy to power 110,000 homes.
(http://www.windows.ucar.edu/tour/link=/earth/climate/ipcc_may2007.html)**

APS built a solar power plant at the Yucca Power Plant in Somerton, Arizona
This plant generates 100 kW of power, enough to serve about 31 homes.
(http://www.aps.com/_files/renewable/SP009YuccaPowerPlant.pdf)

66.2 MPG
1.5 gal/100 mi, 3.6 liters/100 km

115.4 Wh/mile
Watt hours used per mile

65% fewer
CO_2 emissions
vs. the average car in America

Plug-in Hybrid | Toyota Prius

A plug-in hybrid (PHEV) is essentially a regular hybrid car with an extension cord.
You can fill it up at the gas station, and you can plug it in to any 120-volt outlet.
It's like having a second fuel tank that you always use first -- only you fill up at home, from a regular outlet, at an **equivalent cost of under $1/gallon**.