Global Warming: Fact, Fiction or Future?

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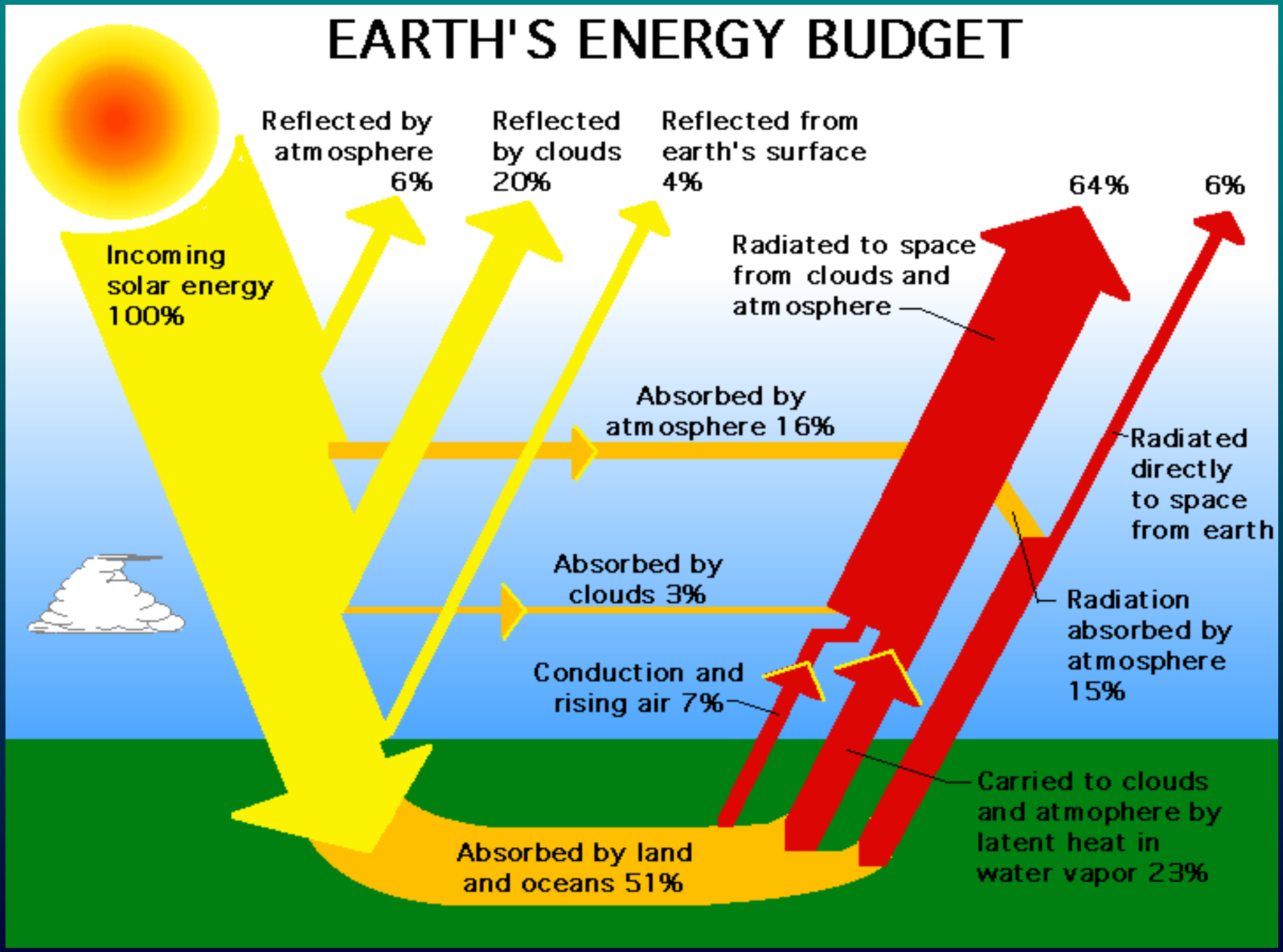
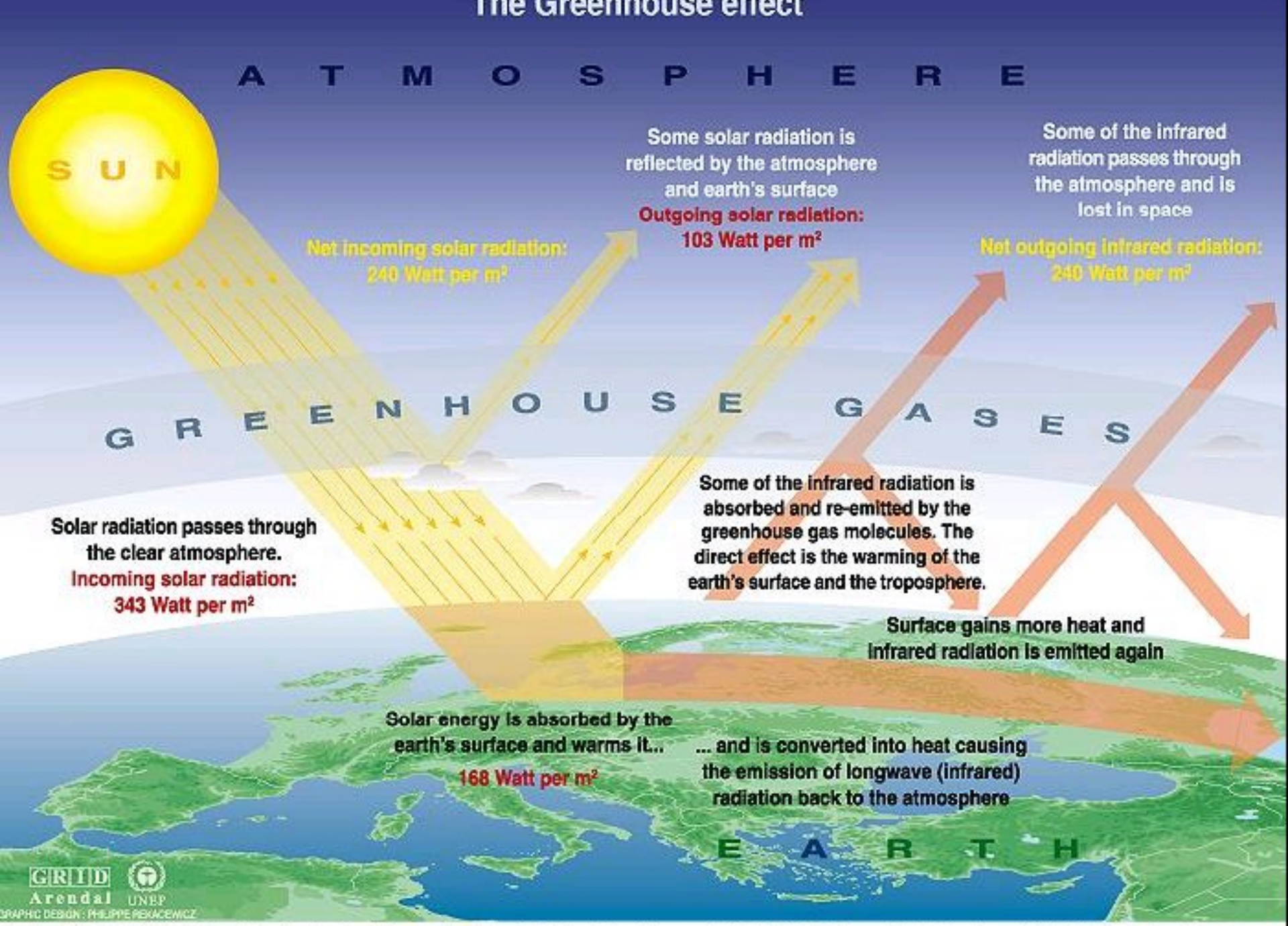
What controls the Earth's Temperature?

- Almost all of the energy is received from the Sun
- Earth radiates heat to space
- Small amount of heat from interior (left over from the formation of the earth and nuclear reactions)

External Energy Input = Energy Loss to Space over time

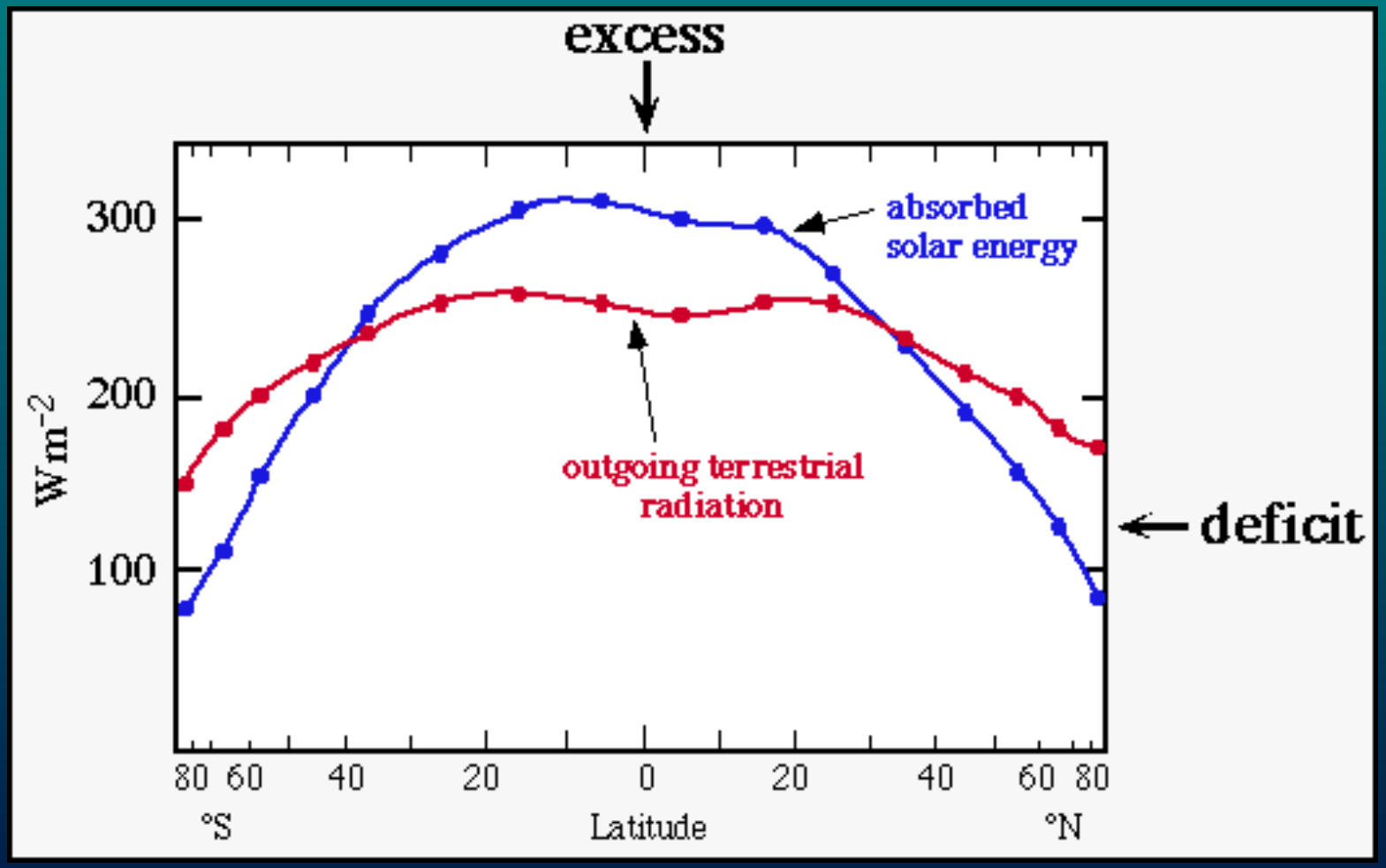

EARTH'S ENERGY BUDGET
Reflected by atmosphere 6%
Reflected by clouds 20%
Reflected from earth's surface 4%
64%
6%
Incoming solar energy 100%
Radiated to space from clouds and atmosphere
Absorbed by atmosphere 16%
Radiated directly to space from earth
Absorbed by clouds 3%
Radiation absorbed by atmosphere 15%
Conduction and rising air 7%
Carried to clouds and atmophere by latent heat in water vapor 23%
Absorbed by land and oceans 51%

The Greenhouse effect



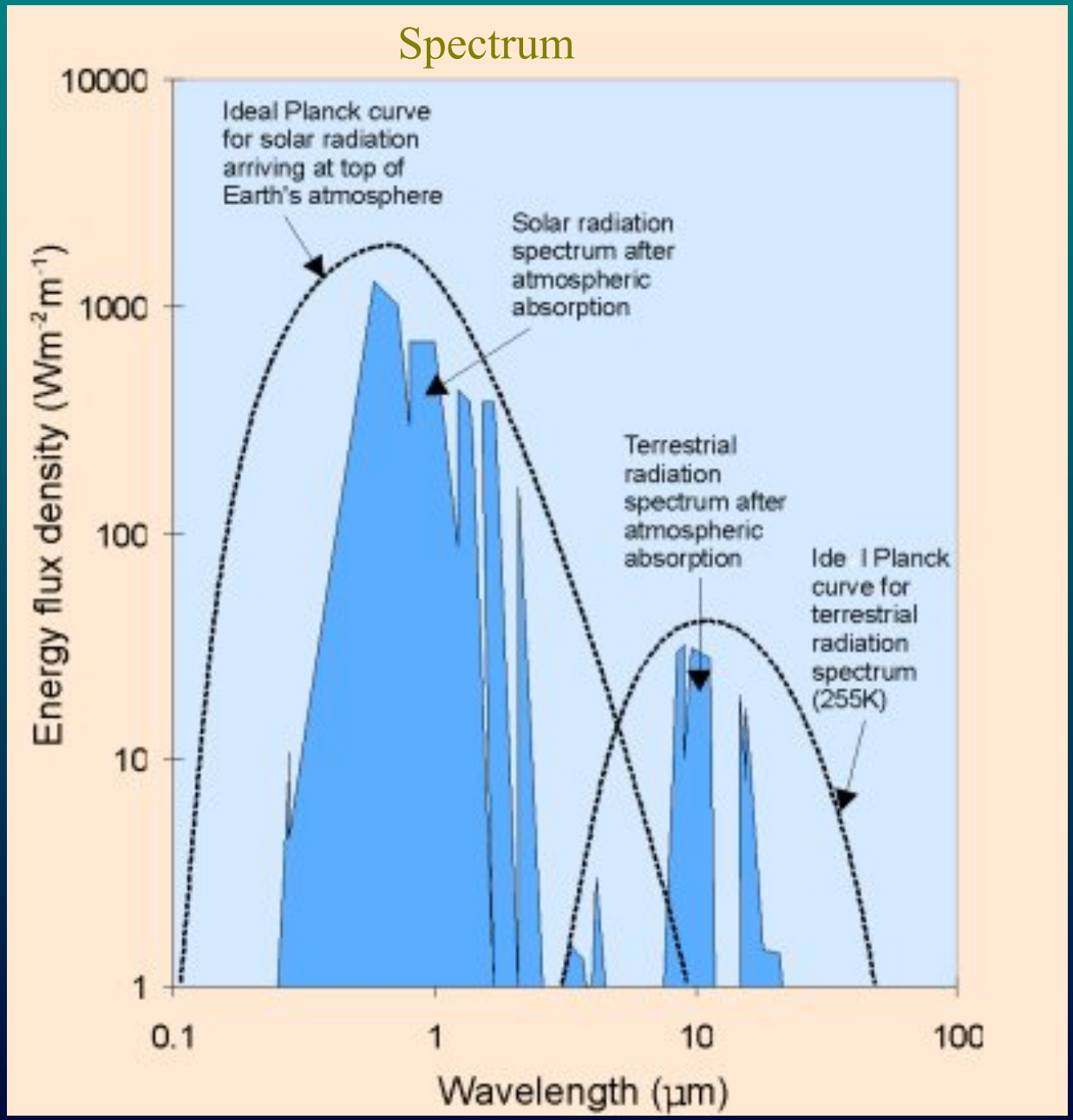
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995. The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change. UNEP and WMO. Cambridge university press. 1996.

Energy Transport to High Latitudes



Energy has to move toward the poles by ocean currents and winds - the reason we have weather systems.

What Controls the temperature of a planet?

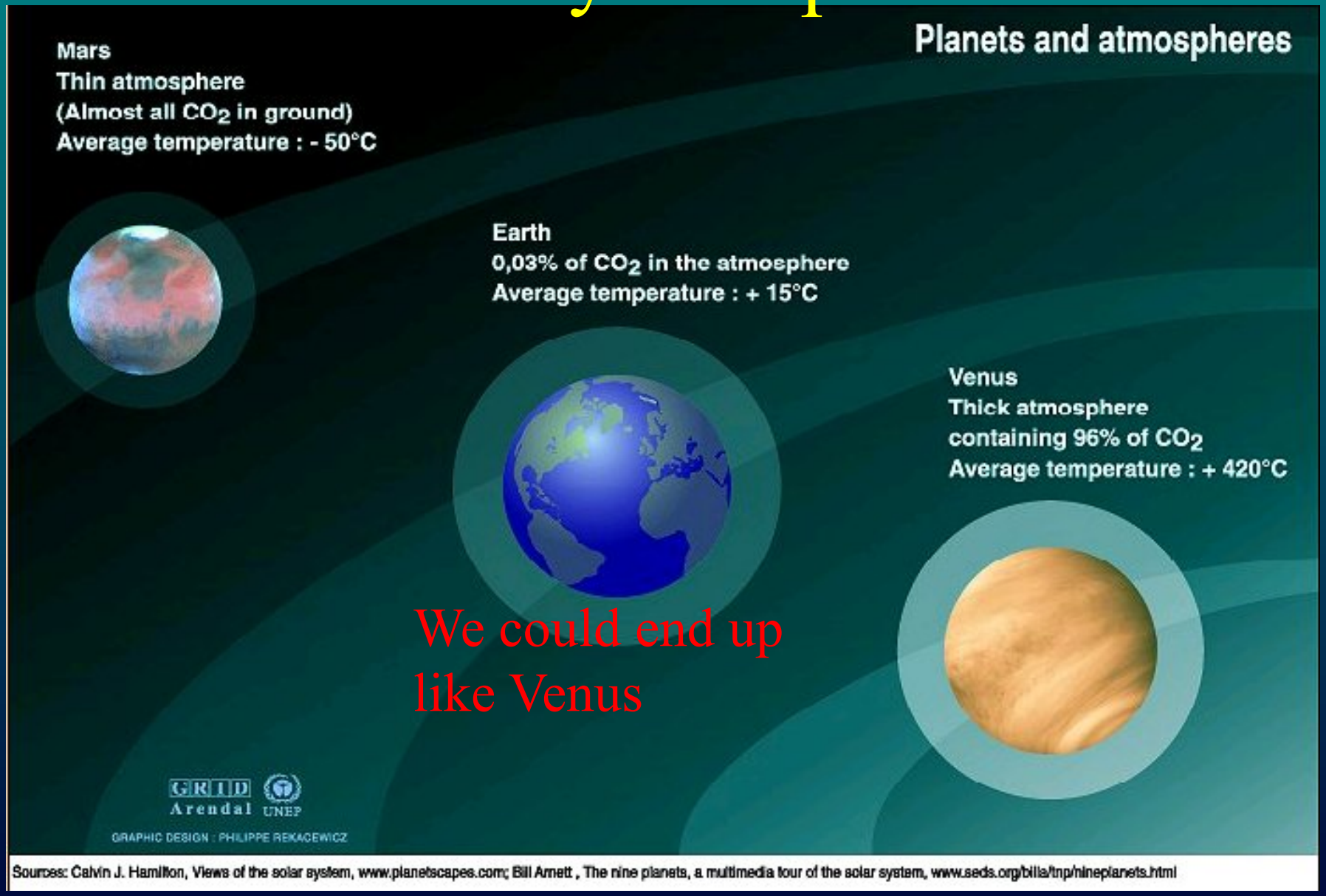


Heat Input and Loss for the Earth

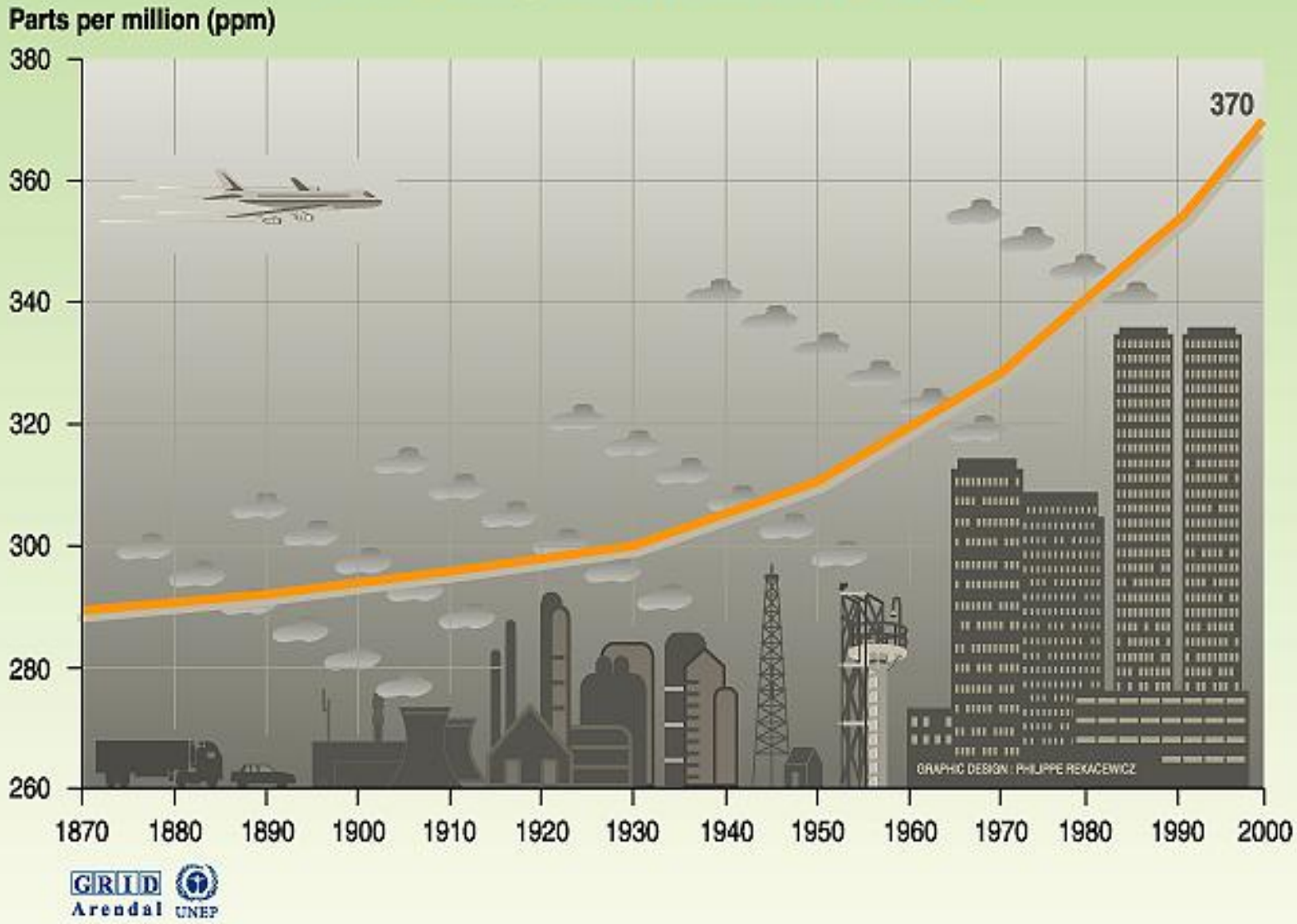
The Greenhouse Effect

- Sunlight (visible energy) is let through down to the surface of the earth during the day to heat the earth
- Its cooled by infrared radiation to space
- Atmospheric constituents, gasses and clouds obstruct some of the infrared cooling
- The earth's temperature is higher than its radiative balance because of green house radiative processes (largest gas is water vapor)

Planetary Comparison

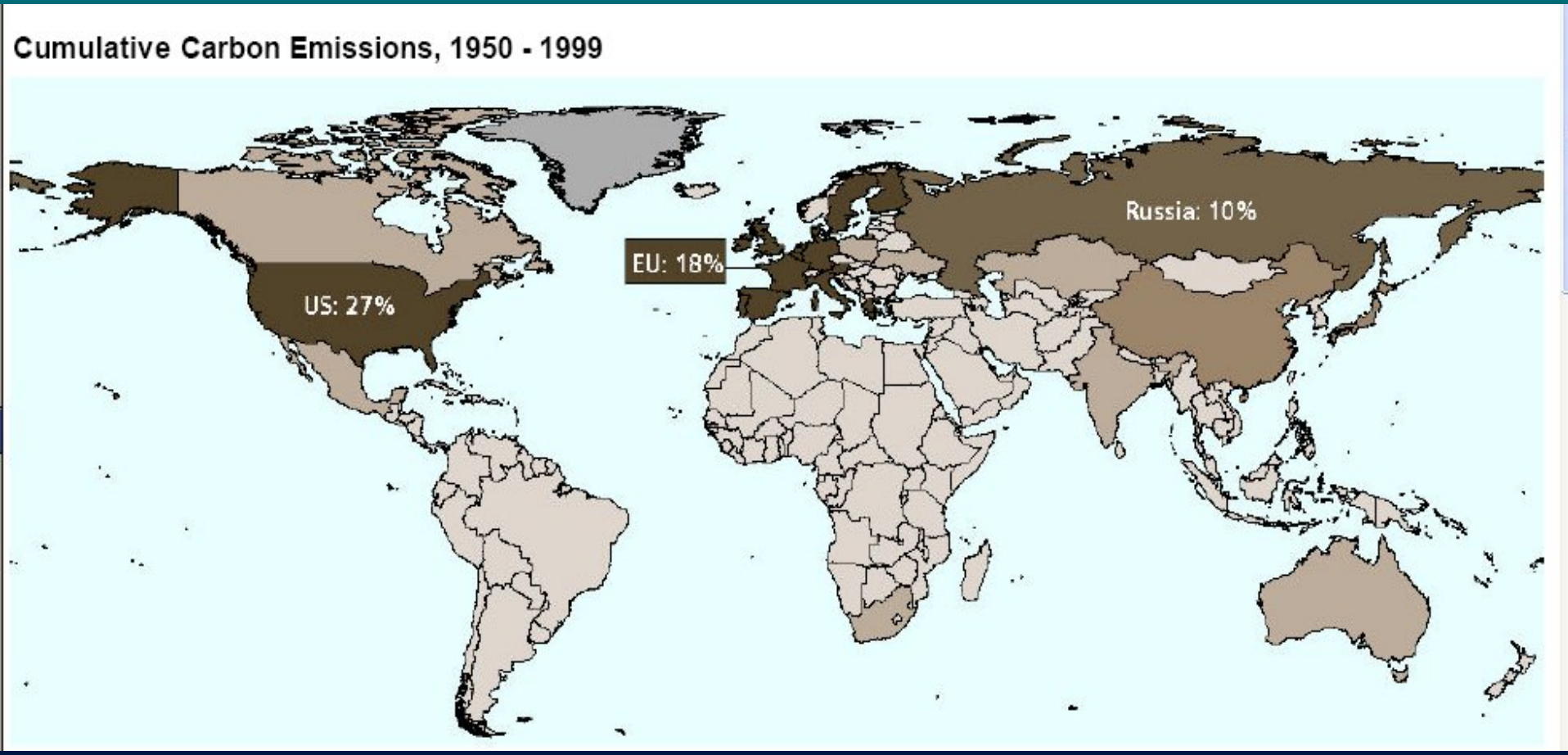


Global atmospheric concentration of CO_2



Sources: TP Whorf Scripps, Mauna Loa Observatory, Hawaii, institution of oceanography (SIO), university of California La Jolla, California, United States, 1999

Global Distribution of CO2 Emissions



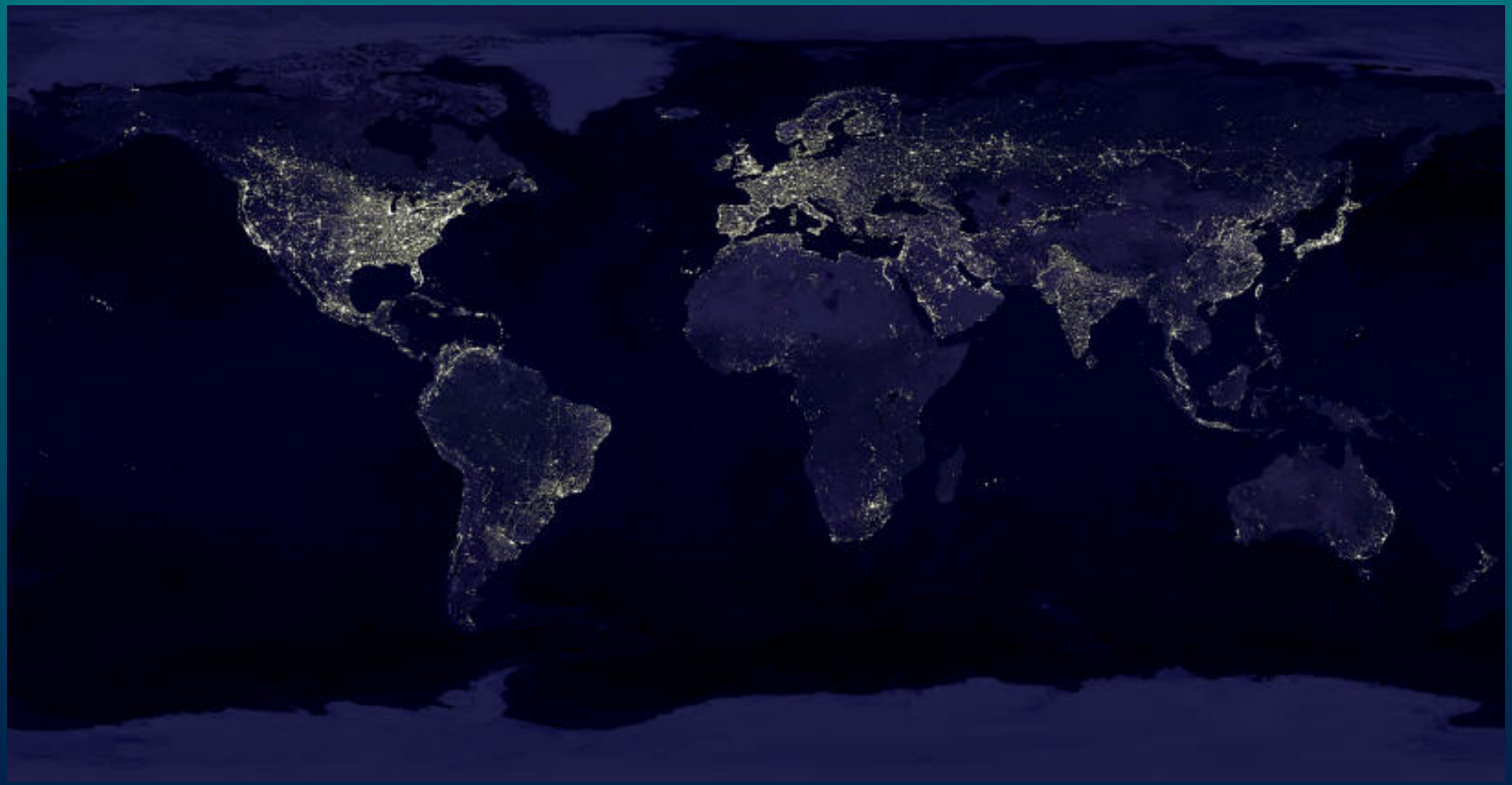
Other Sources of Greenhouse Gases

- Landfills for solid waste disposal
- Dormant volcanoes
- Release from oceans and large lakes

Methane

- Methane is emitted from a variety of both human-related (anthropogenic) and natural sources. It is estimated that 60% of global methane emissions are related to human-related activities (IPCC, 2001c). Natural sources of methane include wetlands, gas hydrates, permafrost, termites, oceans, freshwater bodies, non-wetland soils, and other sources such as wildfires.
- Methane emission levels from a source can vary significantly from one country or region to another, depending on many factors such as climate, industrial and agricultural production characteristics, energy types and usage, and waste management practices. Also, the implementation of technologies to capture and utilize methane from sources such as landfills, coal mines, and manure management systems affects the emission levels from these sources.

Where People Live… landfills are not too far!



Night time portrait of the Earth from Satellite Images:
The industrialized part of the earth

U.S. Methane Emissions by Source ($TgCO_2$ Equivalents)

Methane Source	1990	1997	1998	1999	2000	2001	2002	2003
Landfills	172.2	147.4	138.5	134.0	130.7	126.2	126.8	131.2
Natural Gas Systems	128.3	133.6	131.8	127.4	132.1	131.8	130.6	125.9
Enteric Fermentation	117.9	118.3	116.7	116.8	115.6	114.5	114.6	115.0
Coal Mining	81.9	62.6	62.8	58.9	56.2	55.6	52.4	53.8
Manure Management	31.2	36.4	38.8	38.8	38.1	38.9	39.3	39.1
Wastewater Treatment	24.8	31.7	32.6	33.6	34.3	34.7	35.8	36.8
Petroleum Systems	20.0	18.8	18.5	17.8	17.6	17.4	17.1	17.1
Rice Cultivation	7.1	7.5	7.9	8.3	7.5	7.6	6.8	6.9
Stationary Sources	7.8	7.4	6.9	7.1	7.3	6.7	6.4	6.7
Abandoned Coal Mines	6.1	8.1	7.2	7.3	7.7	6.9	6.4	6.4
Mobile Sources	4.8	4.0	3.9	3.6	3.4	3.1	2.9	2.7
Other	3.2	3.7	3.7	3.7	3.7	3.3	3.3	3.3
Total for U.S.	**605.3**	**579.5**	**569.3**	**557.3**	**554.2**	**546.7**	**542.3**	**544.9**

http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2005.html

Landfills

EPA's U.S. inventory report provides a detailed description on methane emissions from landfills and how they are estimated (see the Chapter entitled "Waste").

Landfills are the largest human-related source of methane in the U.S., accounting for 34% of all methane emissions. Methane is generated in landfills and open dumps as waste decomposes under anaerobic (without oxygen) conditions. The amount of methane created depends on the quantity and moisture content of the waste and the design and management practices at the site.

Reduce, Reuse, Recycle

- Any reduction in the solid waste ending up in the landfills helps reduce emission of greenhouse gases…

Featured farm power project

Holsum Irish Dairy, Hilbert, WI.

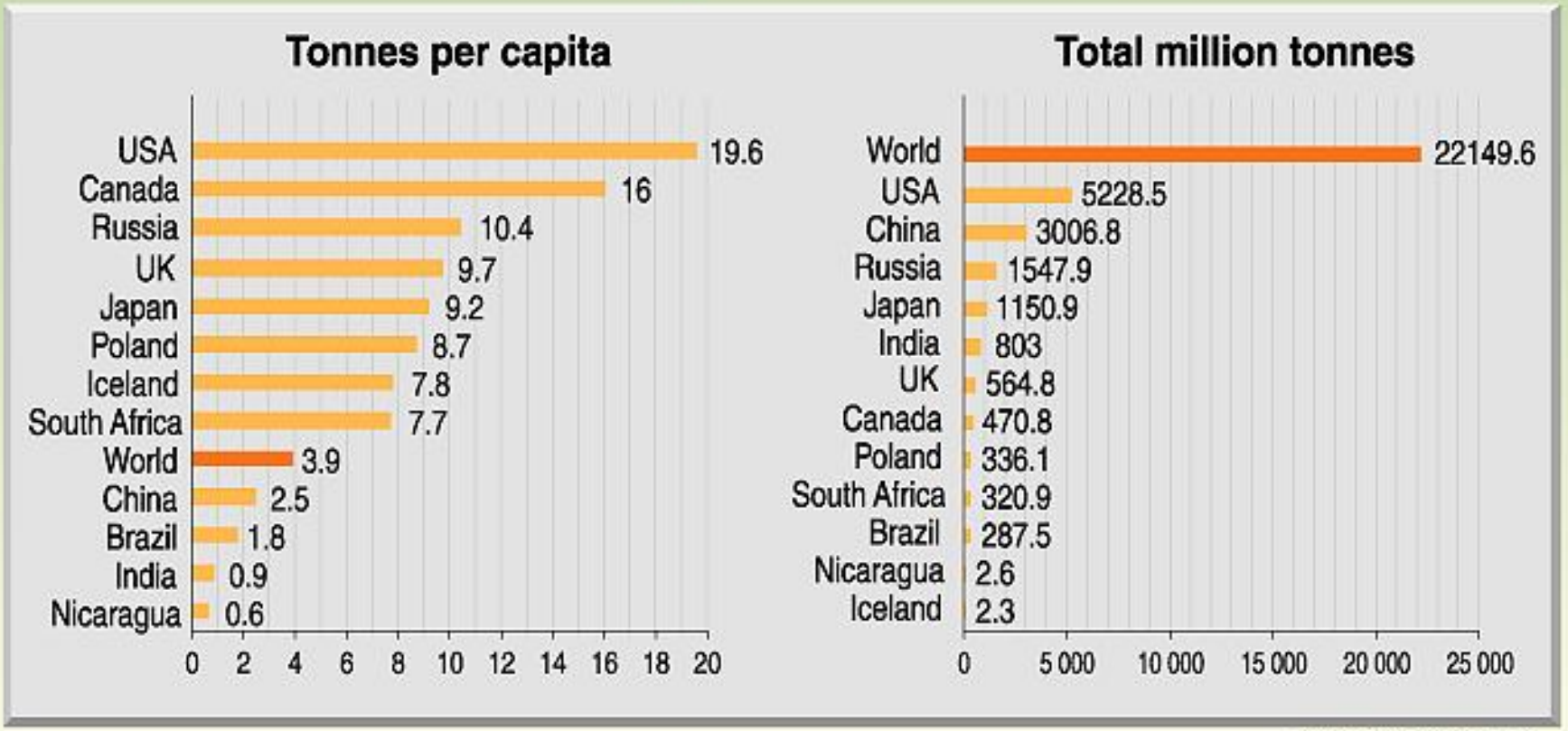
About 30 miles south of Green Bay, Wisconsin 3500 cows chew their cud. While each one awaits her turn in the milking parlor, her chewing does more than fill her udders with milk. Dairy cows are well-fed so they produce lots of milk and, let's face it, cows are like people in that the more they eat, the more waste they produce.

When Holsum Irish welcomed its first cows, its waste handling system consisted of a flush system and a lagoon. Water ran underneath the barn's slotted floors, washing the waste into a large outdoor pond with bermed edges. And there it sat underneath the liquid, the organic solids decomposed. Unlike compost-style processes which give off carbon dioxide - completing a balanced carbon cycle - the collected manure decayed without oxygen and hence produced methane gas, which bubbled to the top of the pond and escaped to the atmosphere. Methane is 21 times as damaging as carbon dioxide when it comes to global warming, so the methane's escape was not good for the planet.

Featured farm power project...cont.

Kenn Buelow, Holsum's manager, decided to install an anerobic digester. they're like a next-generation pond, a waste receptacle with engineering added. Today, the digester and associated changes in waste handling allow Holsum to capture the methane and feed it to generators which power the dairy. The digester also transforms the products left over when the methane is gone. They're not waste. The digested solids are clean and used as cow bedding. The nitrogen-rich liquid is used a fertilizer and can now be pumped over the fields instead of trucked. It's a win-win-win-win.

Emissions of CO_2 - selected countries (1995)



GRAPHIC DESIGN : PHILIPPE REKACEWICZ

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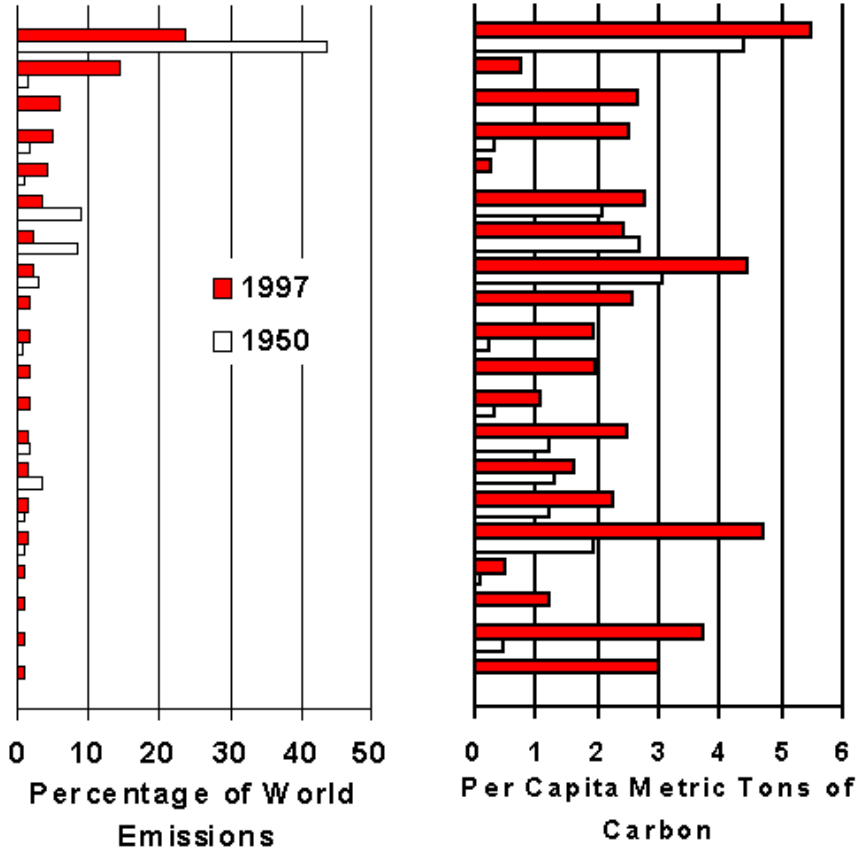
Source : International Energy Agency, 1998.

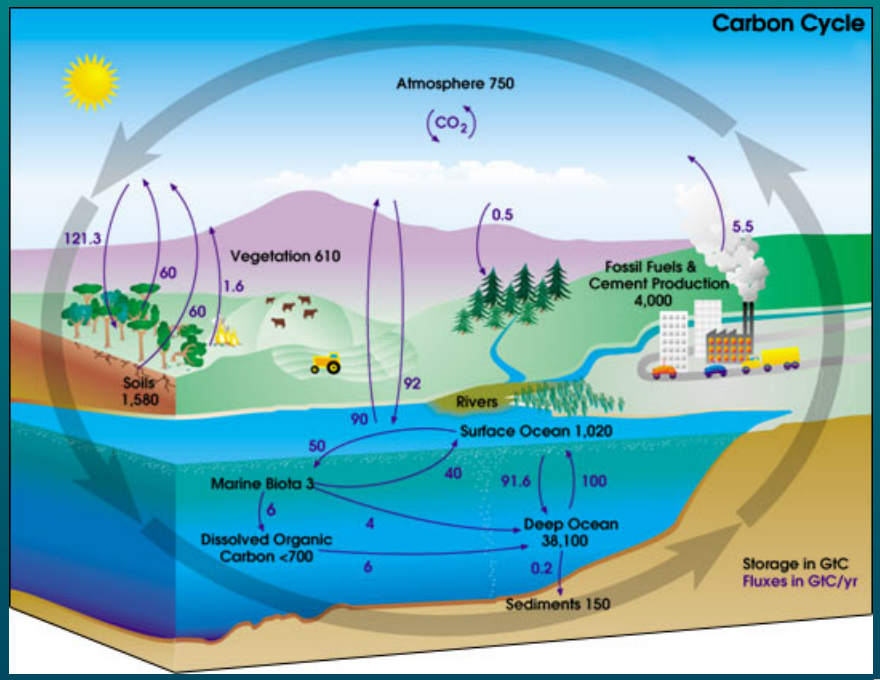
http://cdiac.esd.ornl.gov/trends/emis/graphics/1997top20.gif

Top 20 (1997 total CO_2 emissions)

1997 Rank		1950 Rank
(1)	USA	(1)
(2)	China	(10)
(3)	Russia	(FSU=2)
(4)	Japan	(9)
(5)	India	(13)
(6)	Germany	(3)
(7)	UK	(4)
(8)	Canada	(7)
(9)	South Korea	(58)
(10)	Italy	(17)
(11)	Ukraine	(FSU=2)
(12)	Mexico	(20)
(13)	Poland	(8)
(14)	France	(5)
(15)	South Africa	(14)
(16)	Australia	(15)
(17)	Brazil	(25)
(18)	Iran	(164)
(19)	Saudi Arabia	(47)
(20)	North Korea	(73)

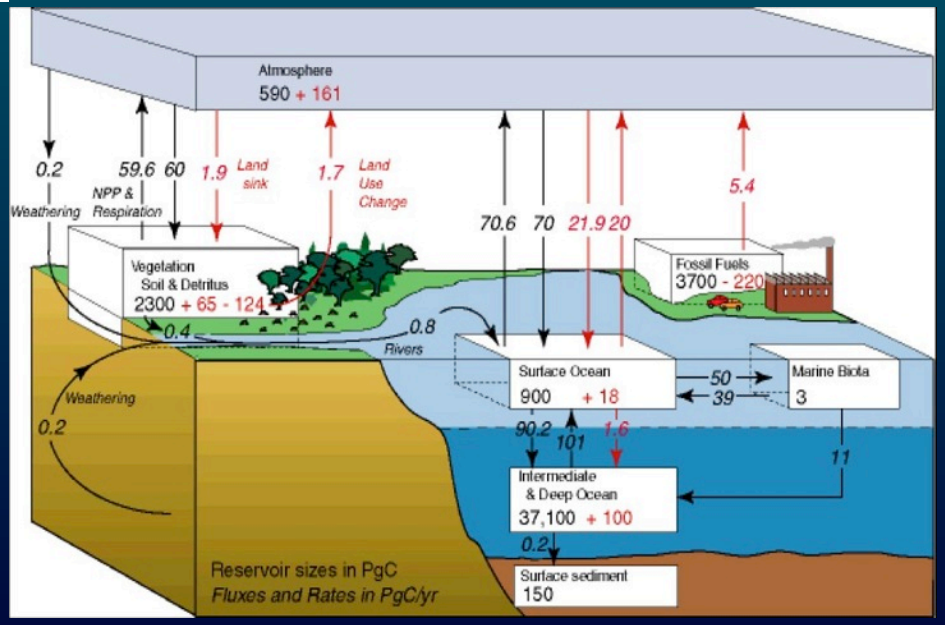


Industrial developing countries are rapidly increasing CO2 output !!

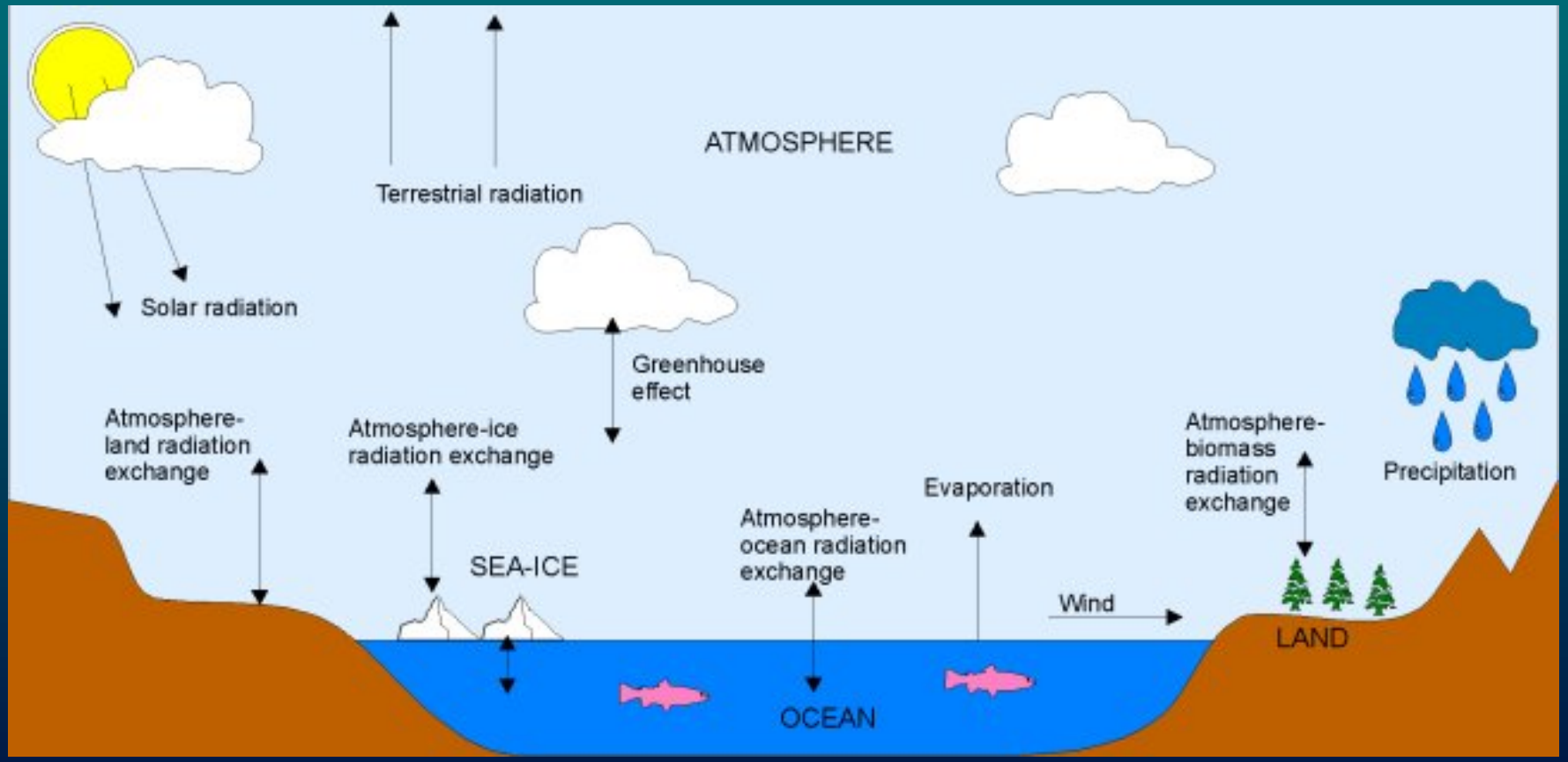


Modeling and prediction is difficult

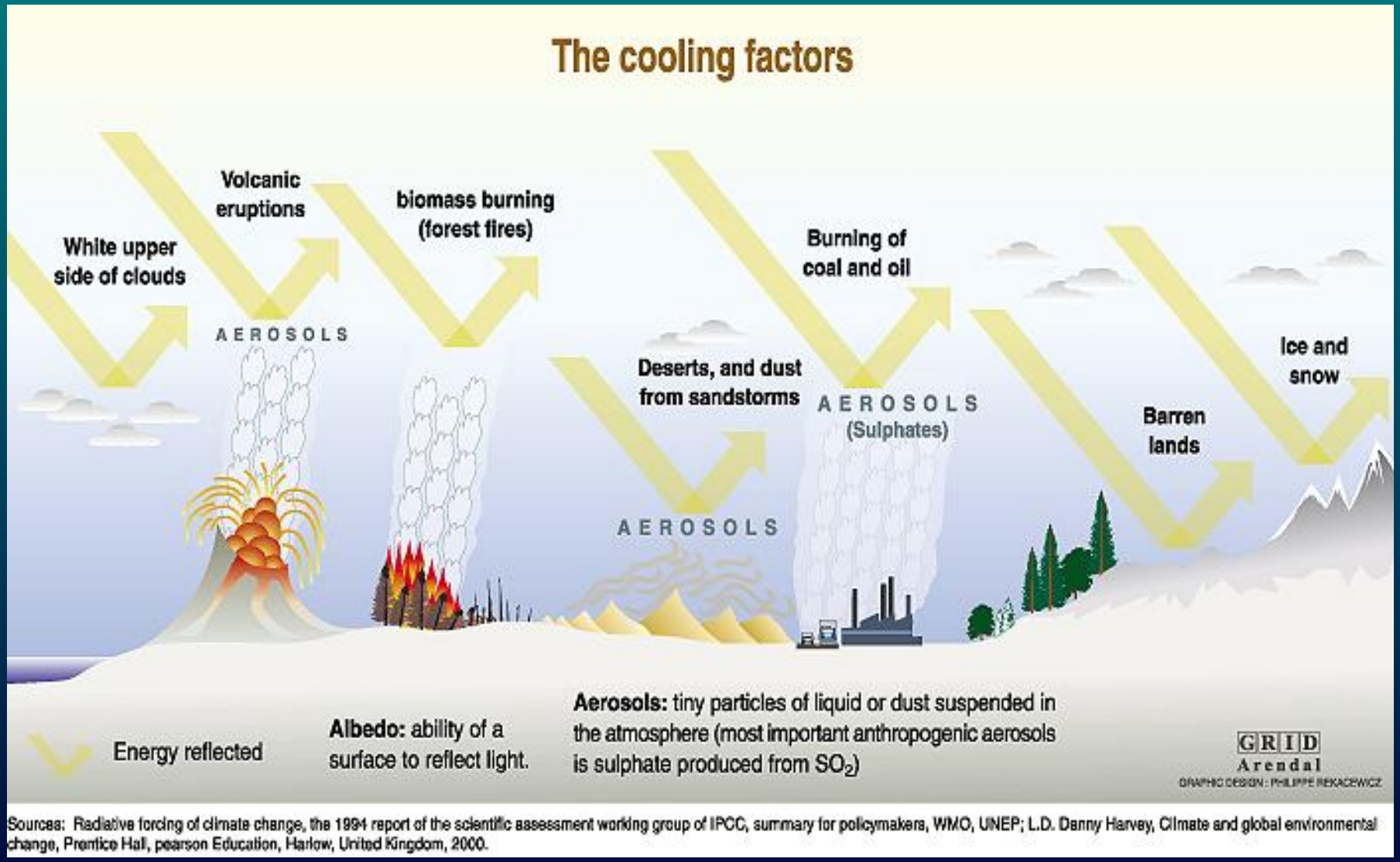
many process are hard to quantify



Energy Exchange Processes to Consider in Modeling and Prediction

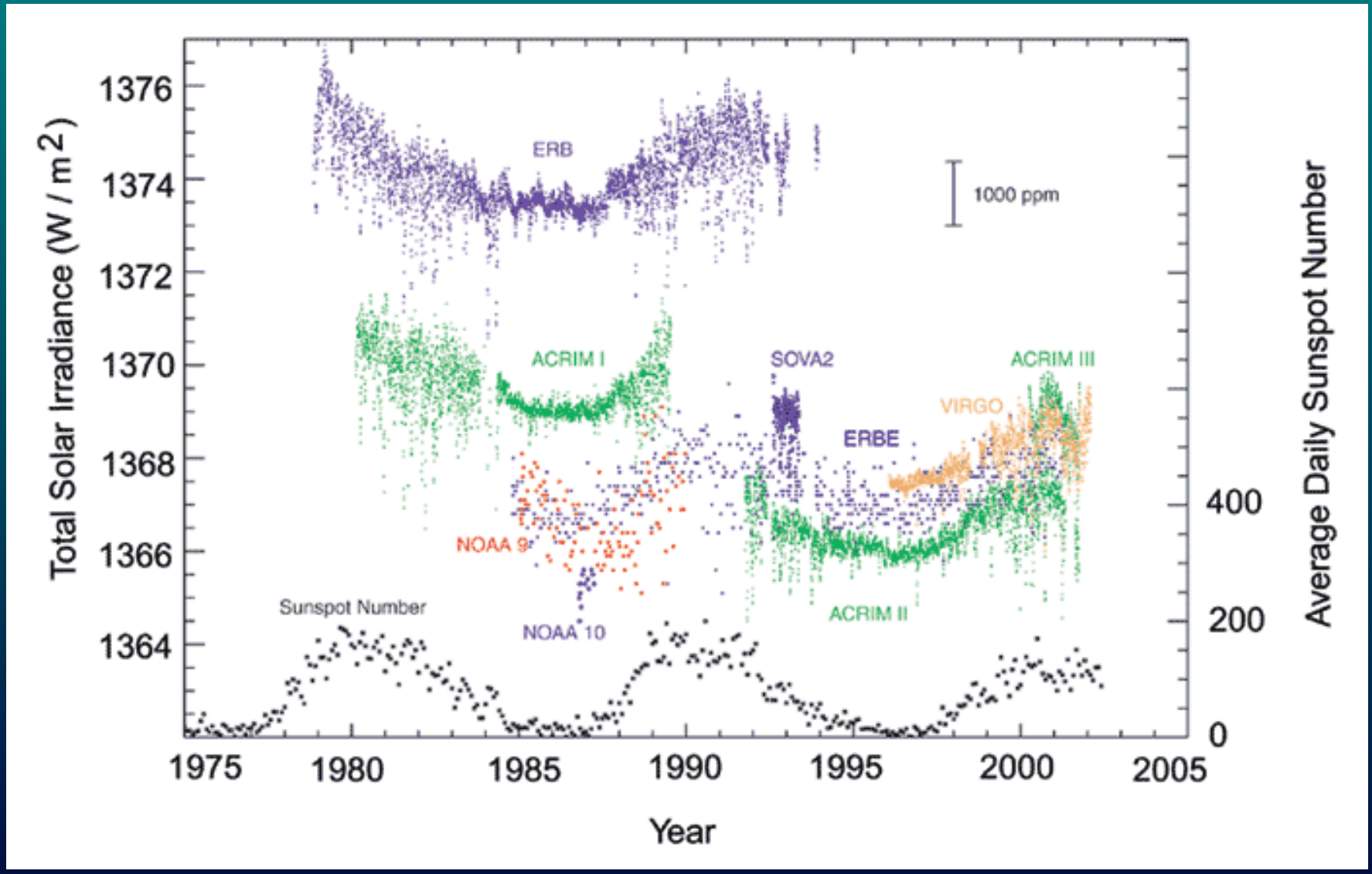


Offsetting Processes

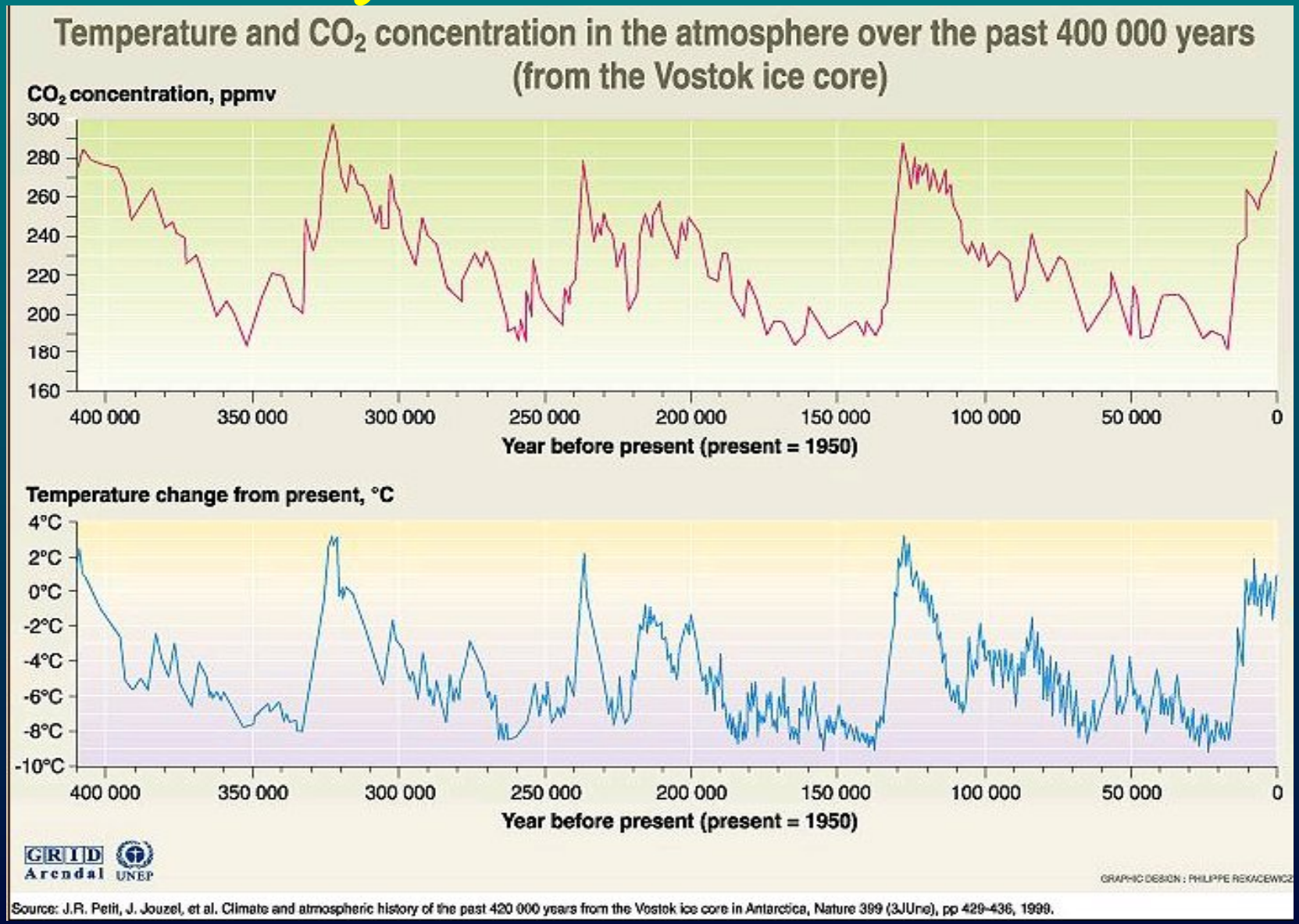


Sources: Radiative forcing of climate change, the 1994 report of the scientific assessment working group of IPCC, summary for policymakers, WMO, UNEP; L.D. Danny Harvey, Climate and global environmental change, Prentice Hall, pearson Education, Harlow, United Kingdom, 2000.

Time Trend of Solar Radiation



History of CO2 and climate



What We Would Like to Know

- Will the warming go to and extreme like Venus?
- What are the physical processes (and variables) that cause and control climate?
- How well can we predict climate?

Simple Arguments to Consider

- Models used to predict climate change can not run backwards to explain our current climate.
- Regional changes have been over predicted
- Accurate prediction of weather events can only be done out to ~5 days (currently)
- The Earth's past very warm periods were very biologically productive
- The radiative effect of CO2 while being small is constant and growing and will not be diminished by weather itself
- There is a correlation of CO2 with climate changes in the past

Summary - What We Know

- CO2 is increasing and will continue to increase
- Our climate is warming
- Biological species are changing …..

What we are recognizing

- Environmental changes induced by global warming are now recognized even as possible causes of conflicts:

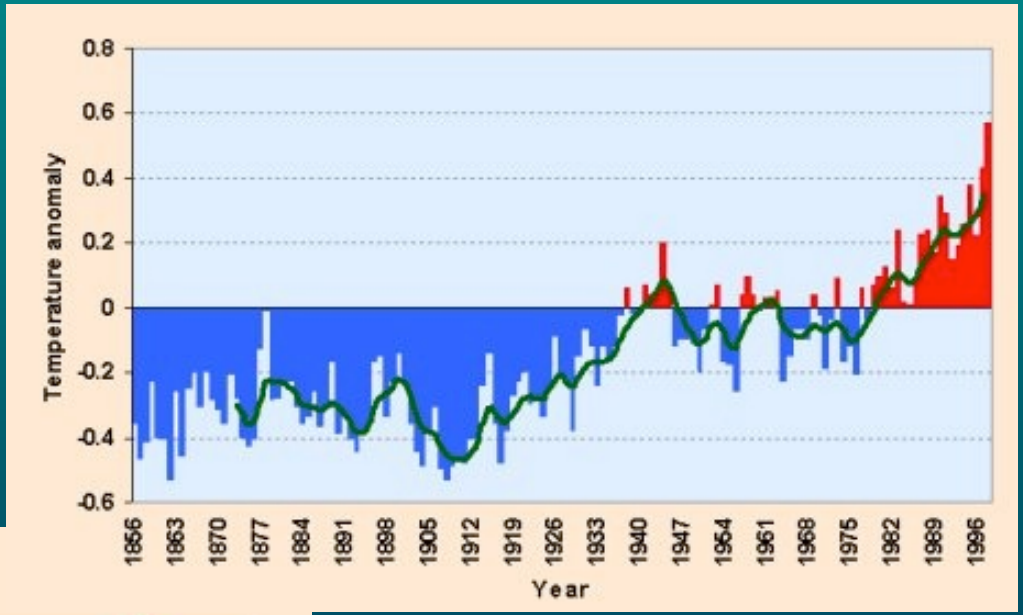
- *There is little hope of peace in war-ravaged Sudan unless it addresses widespread environmental damage and climate change, a UN study has found*

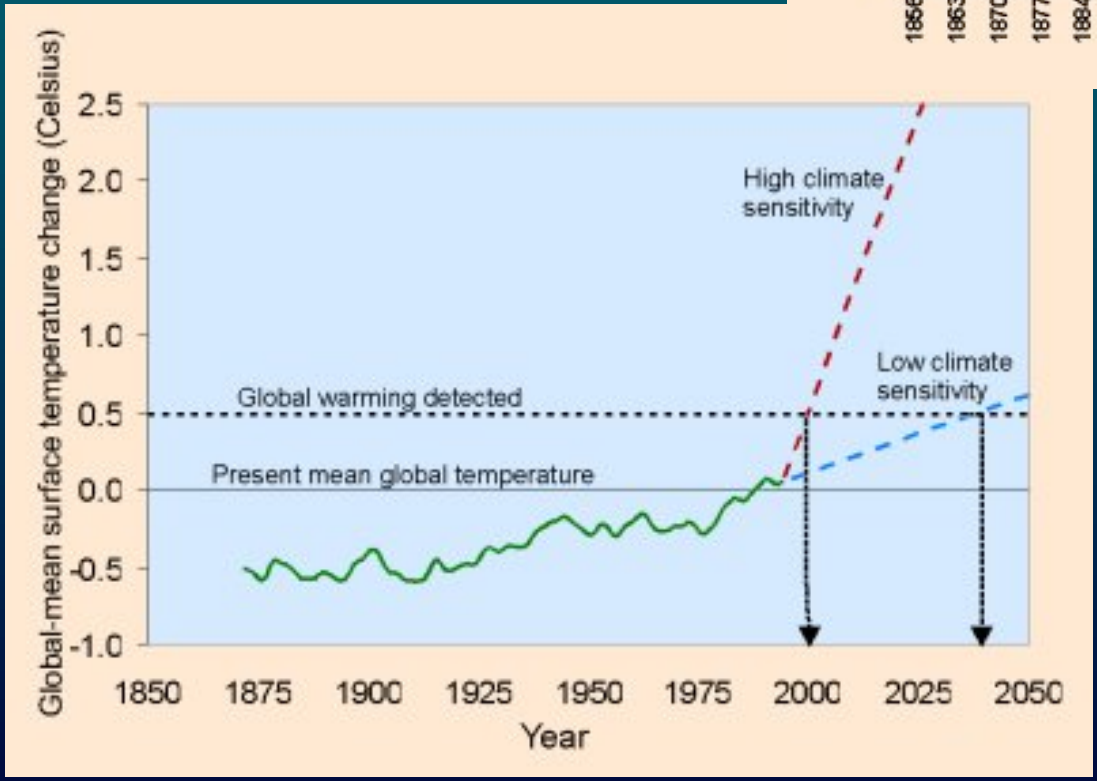
(from BBC http://news.bbc.co.uk/2/hi/africa/6230616.stm)

Future…

- Carbon dioxide emissions increasing
- Earth will warm up more
- Ocean currents could change
- Models predict more weather extremes
- Sea levels expected to rise

Observed Average Earth ⇒
Temperature

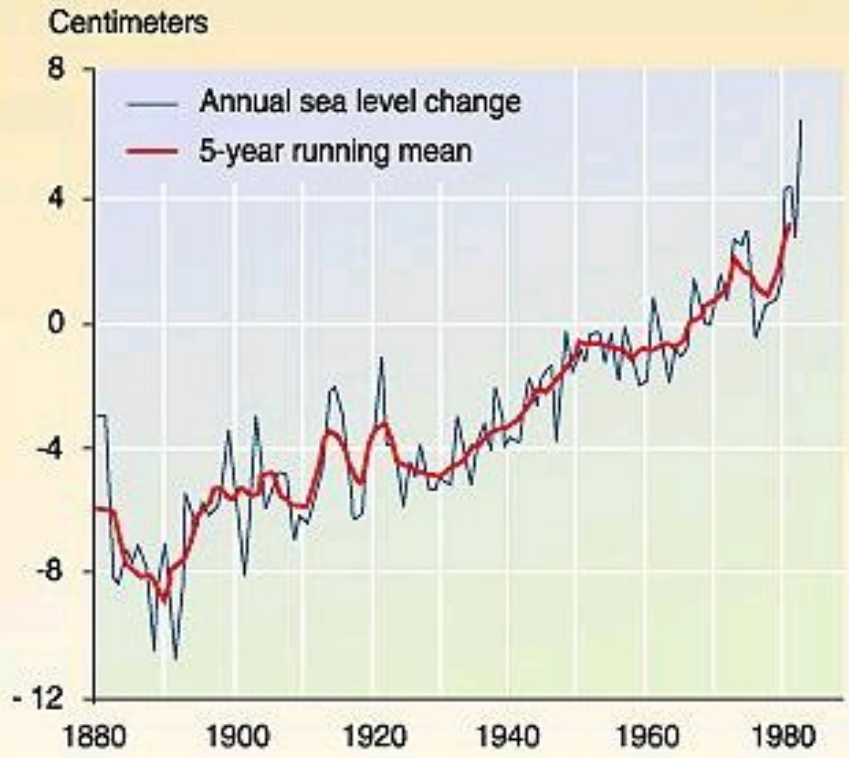




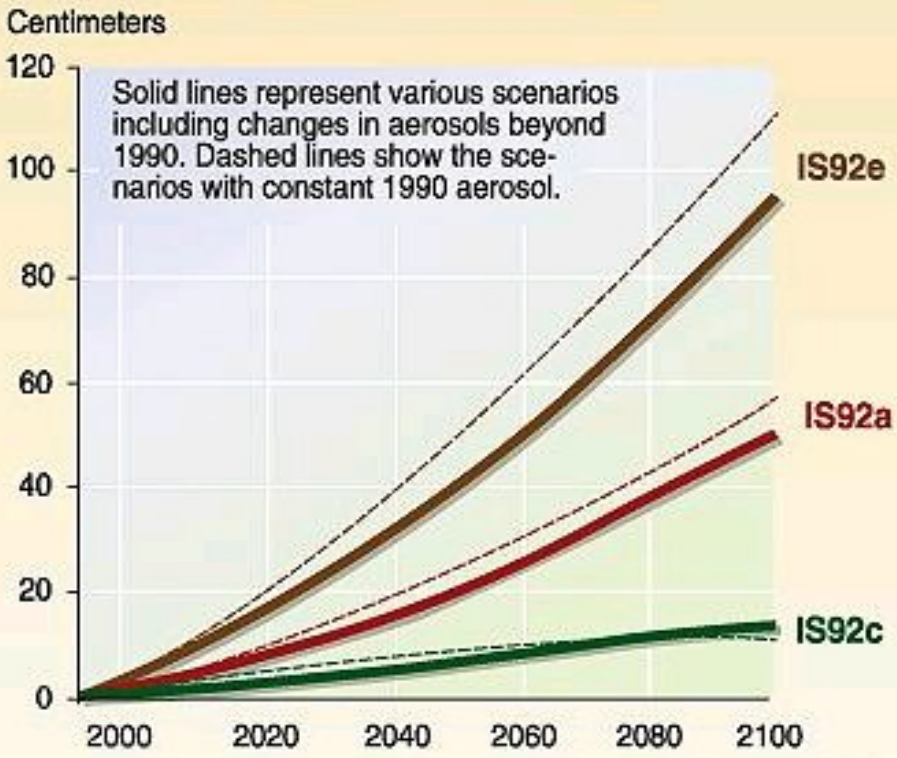
⇐ Projected Earth
Average Temperature

Sea level rise due to global warming

Sea level rise over the last century



Sea level rise scenarios for 2100



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GRAPHIC DESIGN : PHILIPPE REKACEWICZ

Source: Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1995; Sea level rise over the last century, adapted from Gornitz and Lebedeff, 1987.

Expectations

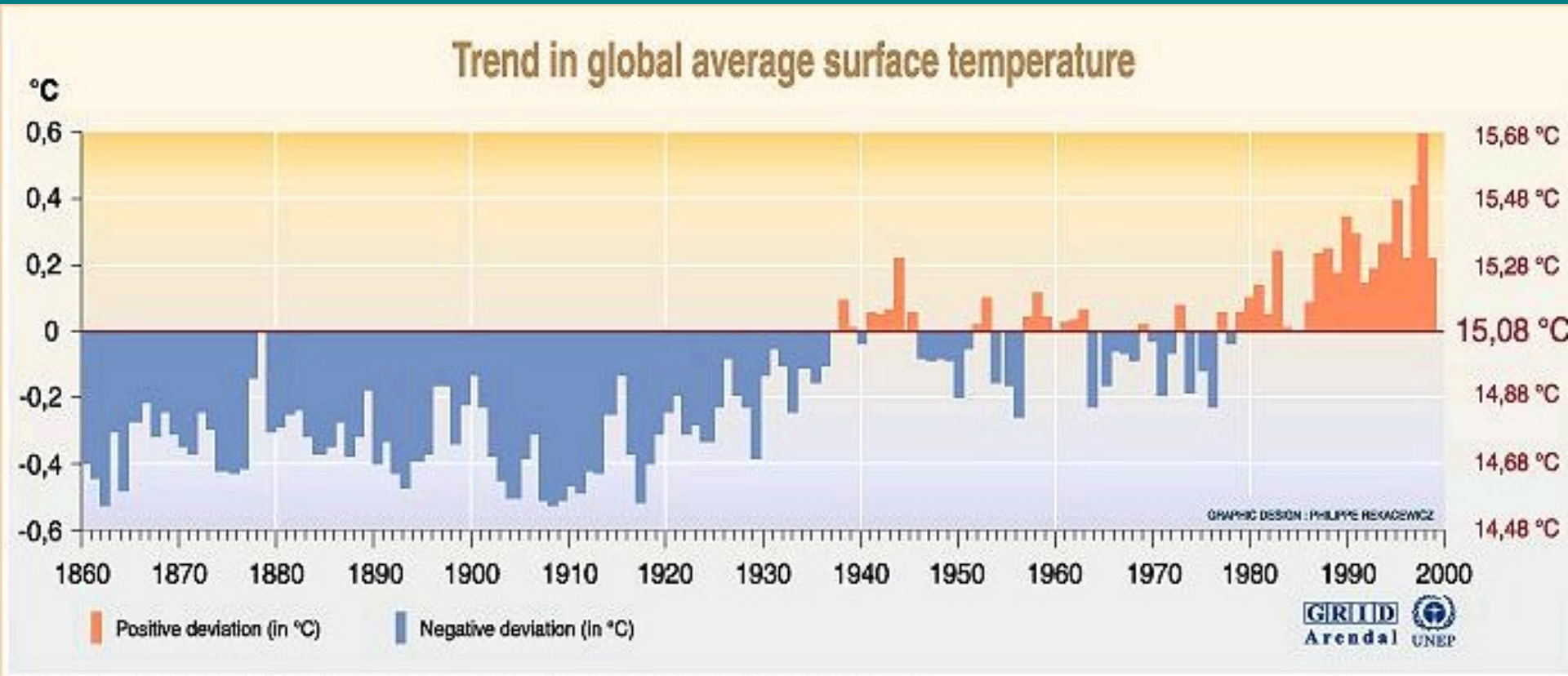
- Greater weather variability and weather extremes, especially at higher latitudes
- Changes in agricultural output and geographic zones of “native” species
- Sea Level changes
- Unknown, but anticipated economic impacts

Final Thoughts

- The news media is giving attention mostly to the prediction of climate disaster rather then focusing on possible solutions to mitigate human influence on global warming.
- Based on scientific evidence, there is full consensus in the scientific community that human activity is influencing the climate through increased carbon dioxide emissions from fossil fuels. This is being done inspite of the uncertainty of the models because by the time a CO2 affect could be proved, we may not be able to fix the problem.

Things we can do ..

- Reduce, Reuse, Recycle
- Use Less Heat and Air Conditioning
- Change a Light Bulb
- Drive Less and Drive Smart
- Buy Energy-Efficient Products
- Use Less Hot Water
- Use the "Off" Switch
- Plant a Tree
- Get a Report Card from Your Utility Company
- Encourage Others to Conserve

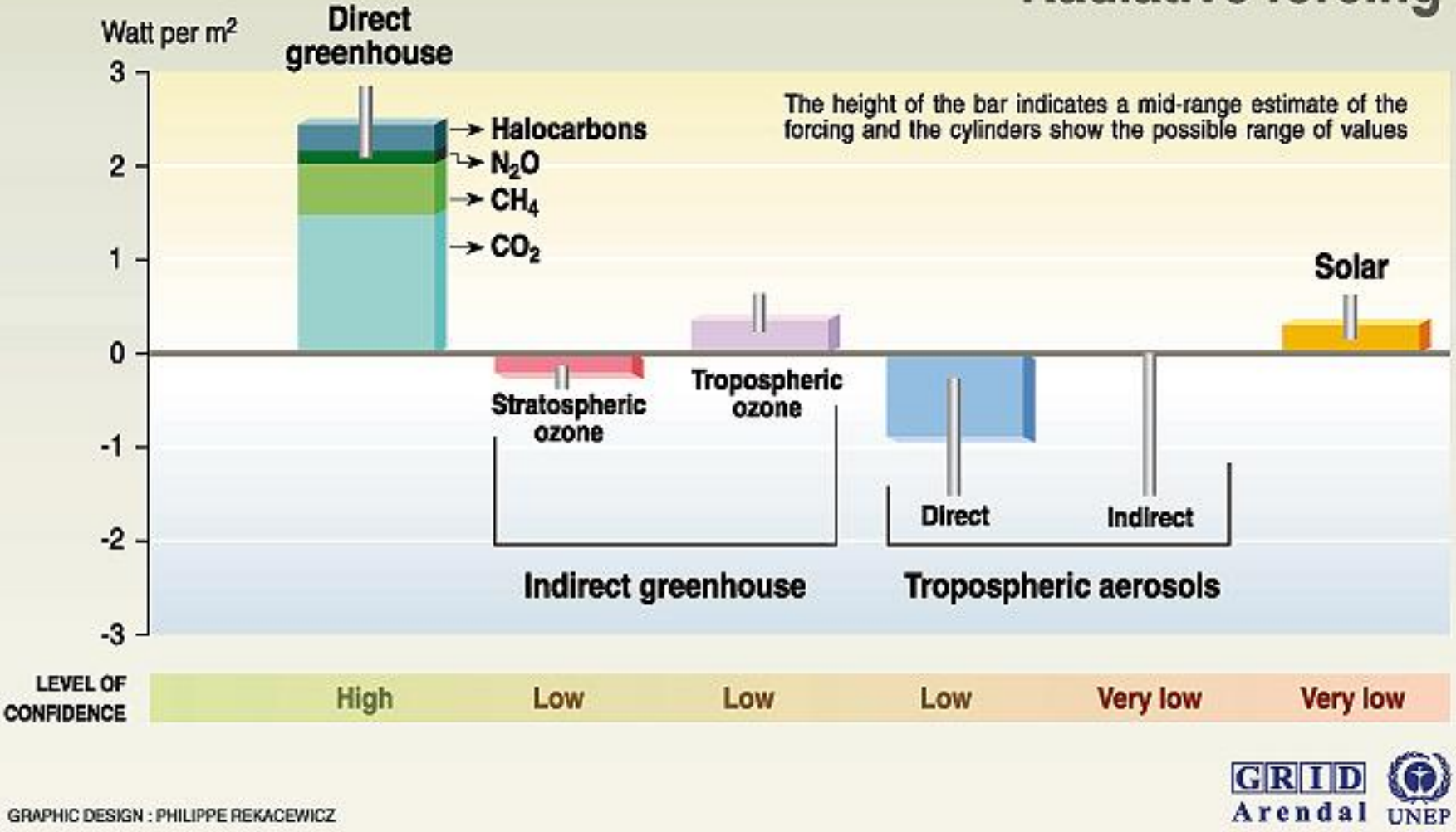


Source: School of environmental sciences, climatic research unit, university of East Anglia, Norwich, United Kingdom, 1999.

15. The figure shows the combined land-surface air and sea surface temperatures (degrees Centigrade) 1861 to 1998, relative to the average temperature between 1961 and 1990

.The mean global surface temperature has increased by about 0.3 to 0.6°C since the late 19th century and by about 0.2 to 0.3°C over the last 40 years, which is the period with most reliable data. Recent years have been among the warmest since 1860 - the period for which instrumental records are available.

Radiative forcing



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