GLOBAL WARMING

THE GREENHOUSE EFFECT

AND YOUR FAMILY'S CONTRIBUTION TO IT

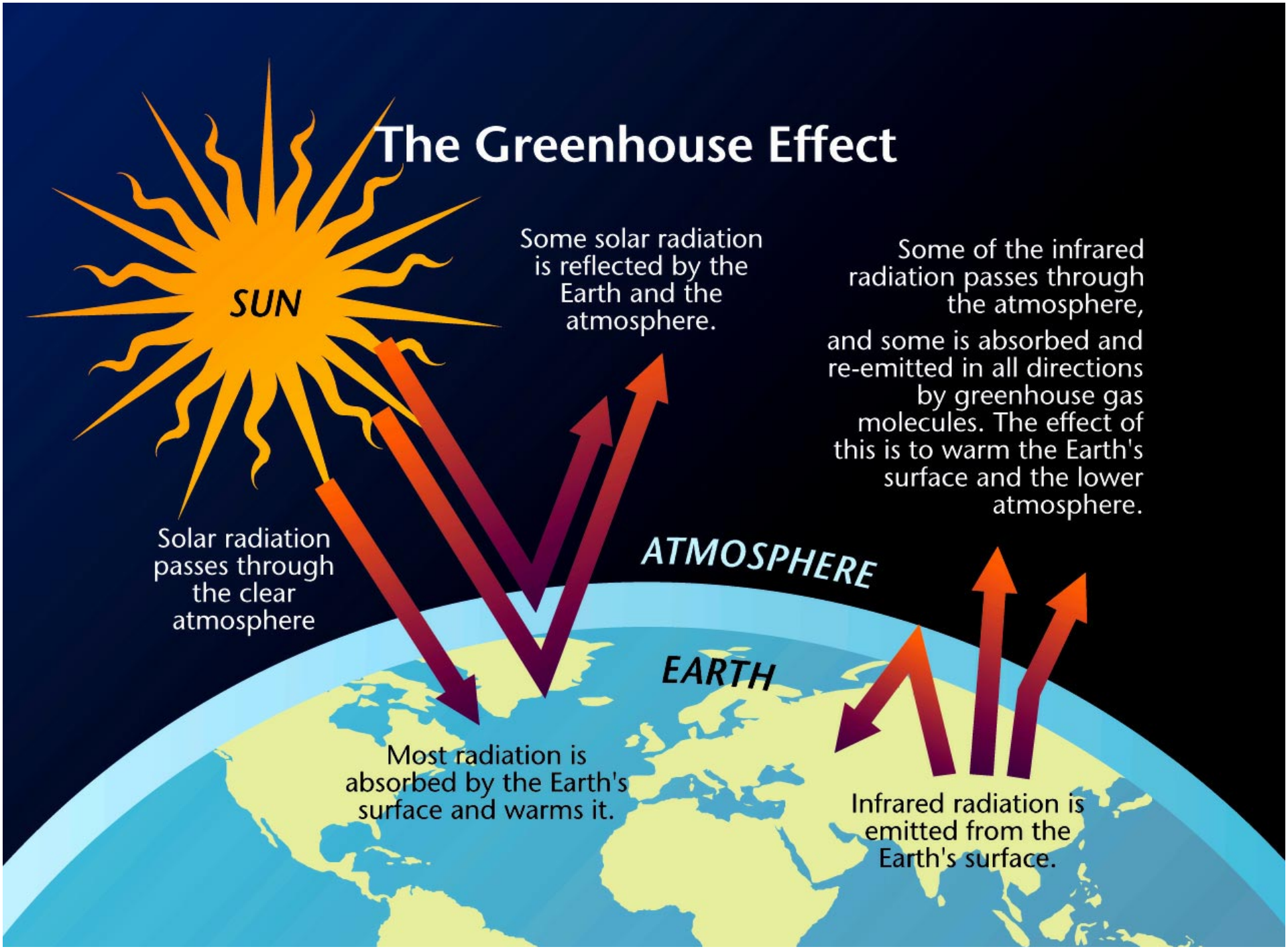
Stephen E. Schwartz

Environmental Sciences Department

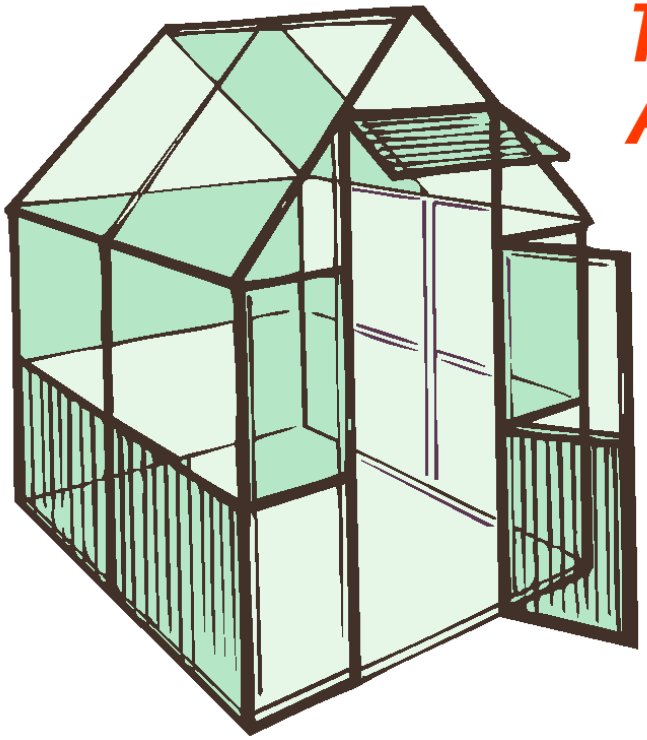
BROOKHAVEN NATIONAL LABORATORY

September 14, 2004

http://www.ecd.bnl.gov/steve/schwartz.html


The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere,
and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.

THE GREENHOUSE EFFECT



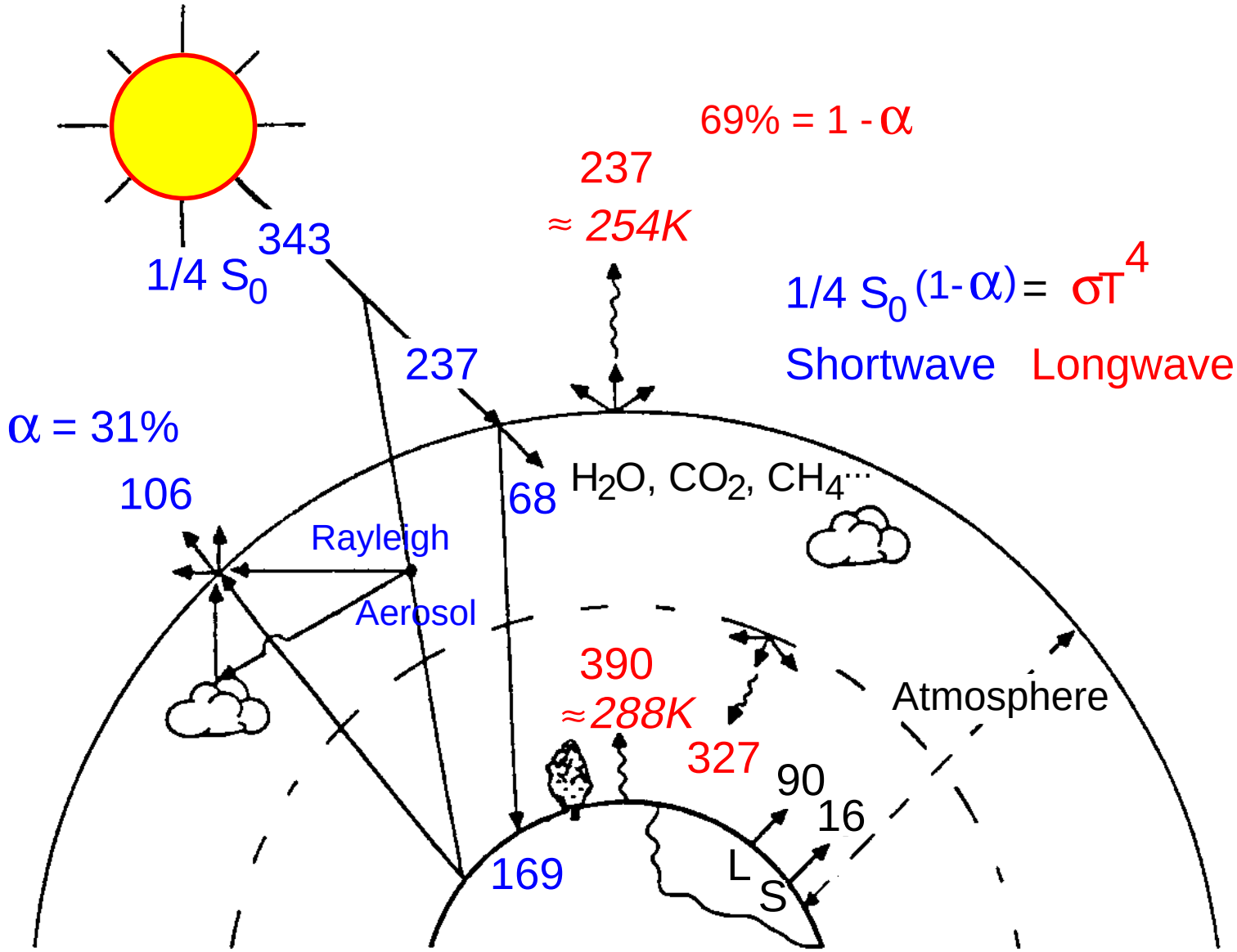
THE EARTH'S ENERGY BUDGET: A DELICATE BALANCE

- Sunlight heats the Earth.
- The warm Earth radiates energy (in the form of infrared radiation, or heat) back out to space.
- Some of this infrared radiation is trapped in the atmosphere, giving Earth its temperate climate.

This is the greenhouse effect. Without it, the Earth's climate would be like the moon's, harsh and severe.

GLOBAL ENERGY BALANCE

Global and annual average energy fluxes in watts per square meter



Schwartz, 1996, modified from Ramanathan, 1987

ATMOSPHERIC RADIATION

Energy per area per time

Power per time

Unit:

Watt per square meter

W m^{-2}

ATMOSPHERIC RADIATION

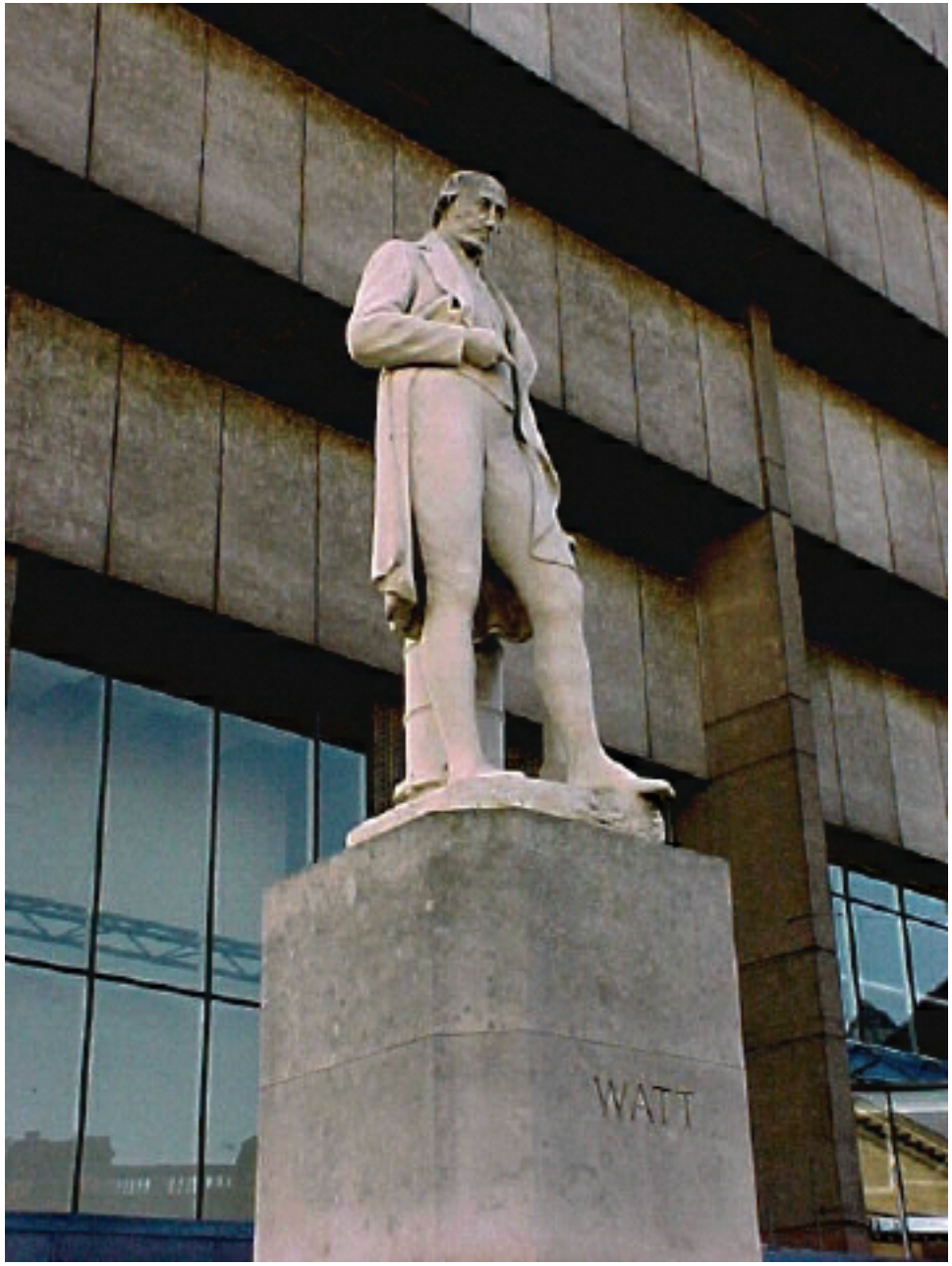
Energy per area per time

Power per time

Unit:

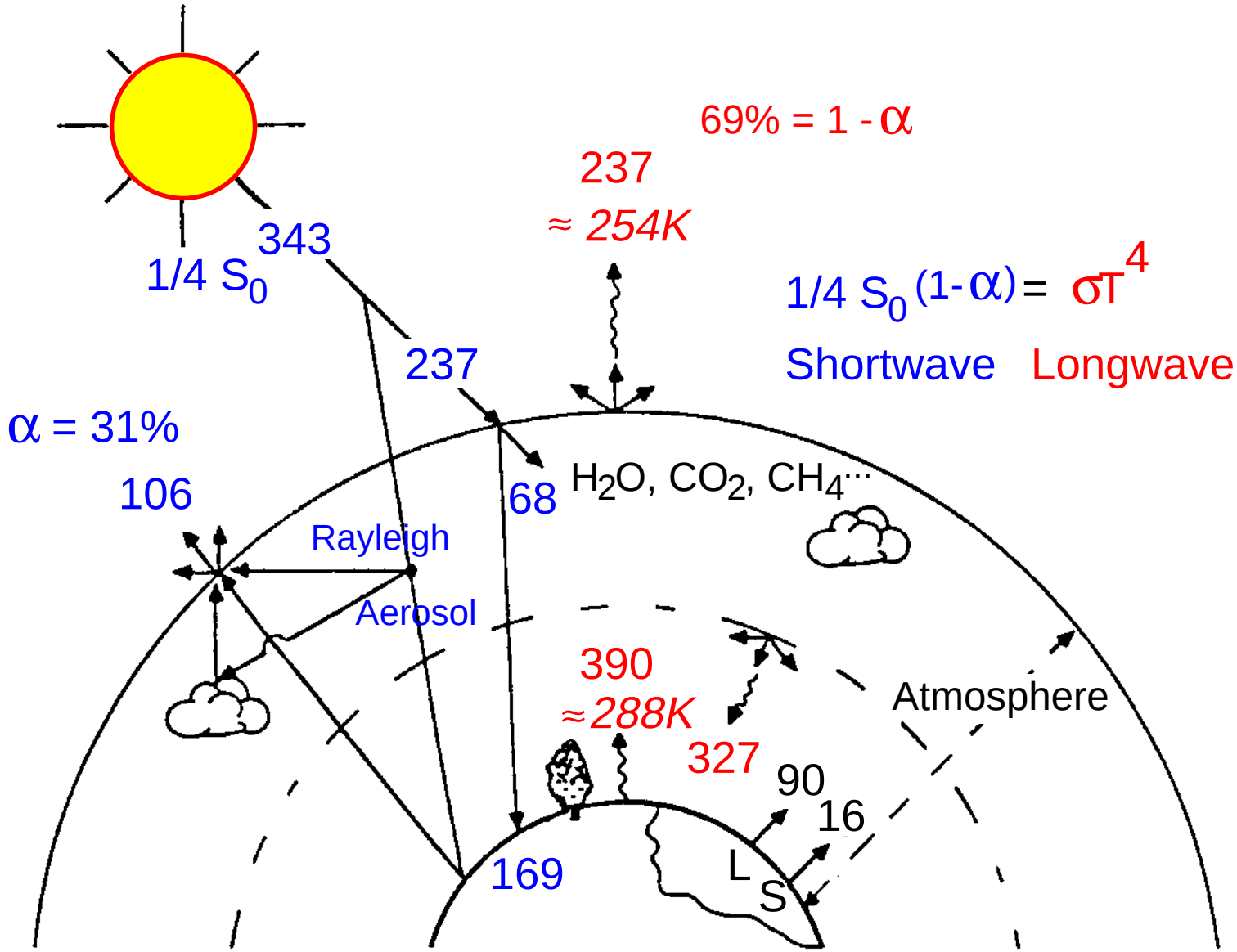
Watt per square meter

W m^{-2}



GLOBAL ENERGY BALANCE

Global and annual average energy fluxes in watts per square meter



Schwartz, 1996, modified from Ramanathan, 1987

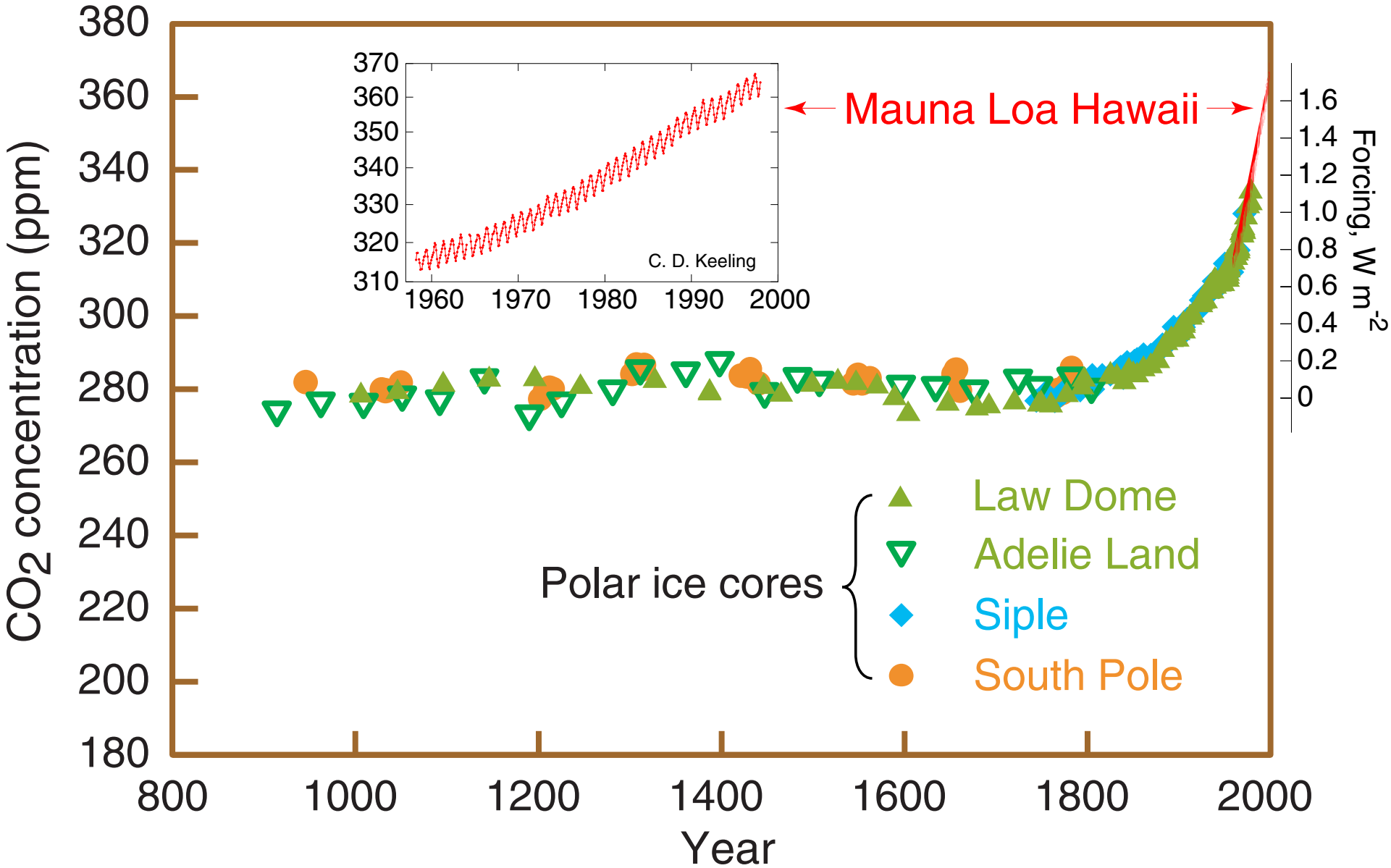
Everybody talks about the weather —

But nobody does anything about it.

– Mark Twain

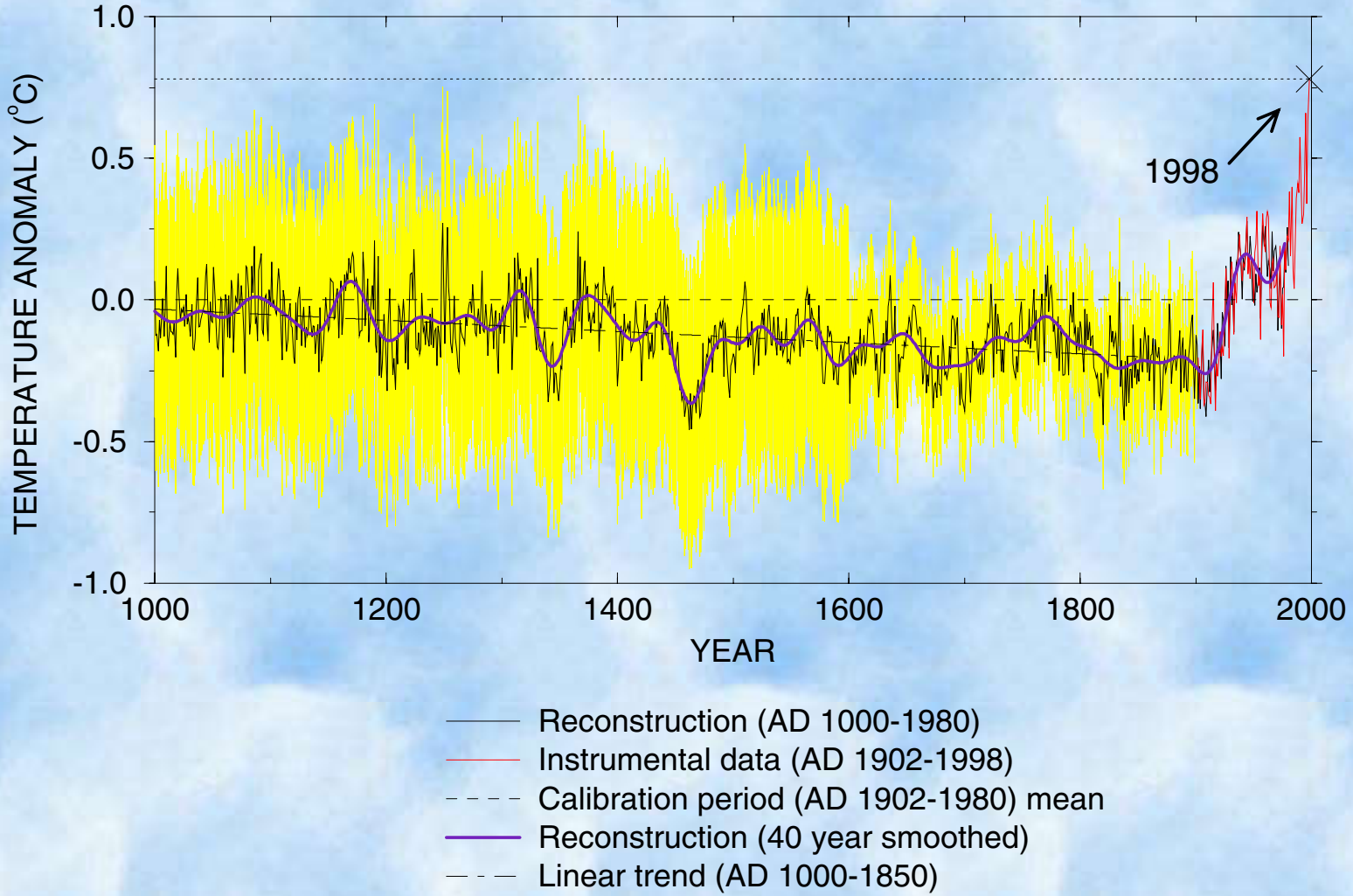
Now with the greenhouse effect,
we ARE doing something about it.
What are we doing?

ATMOSPHERIC CARBON DIOXIDE IS INCREASING



Global carbon dioxide concentration and infrared radiative forcing over the last thousand years

THE TEMPERATURE'S RISING

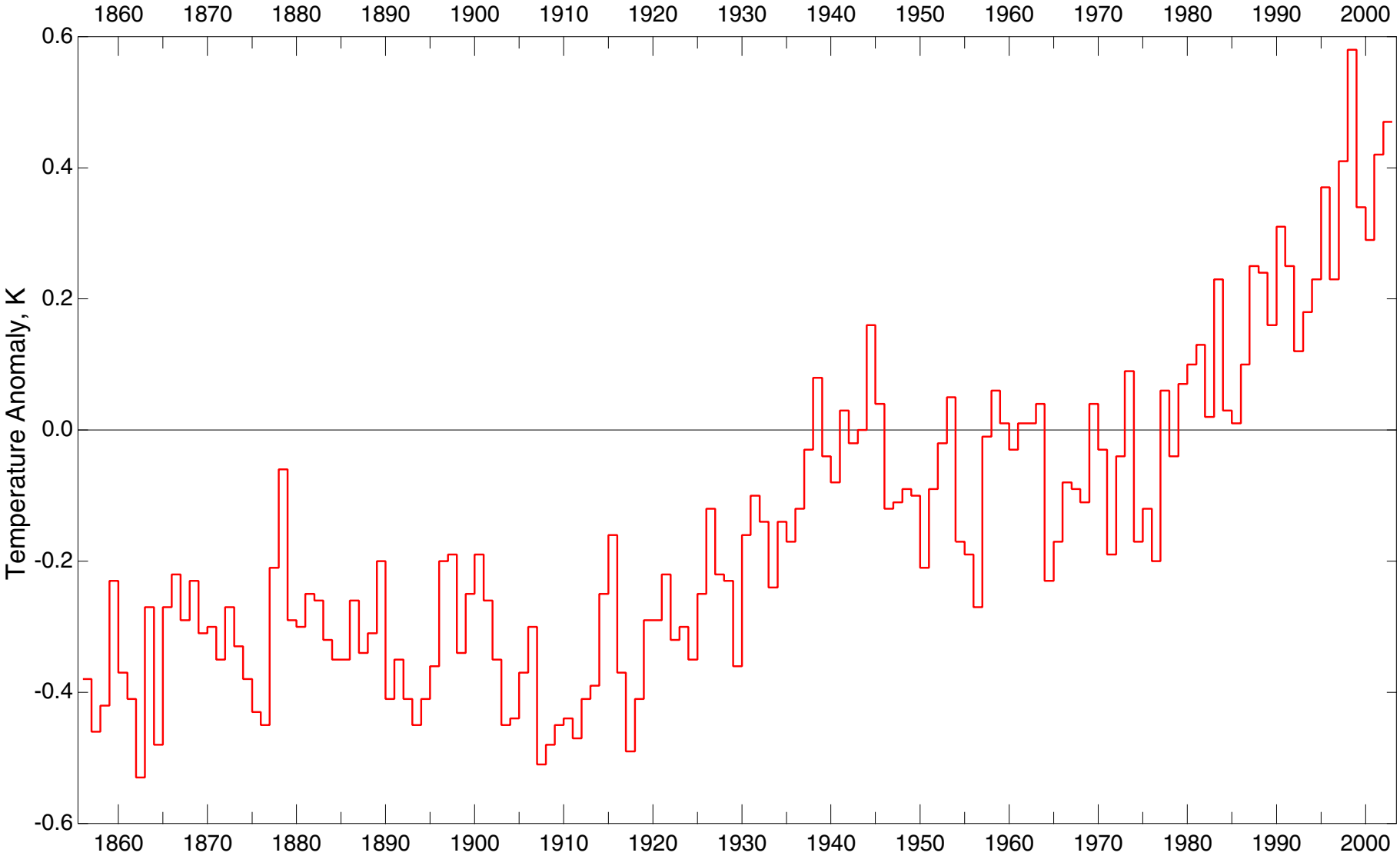


Northern Hemisphere temperature trend (1000-1998), from tree-ring, coral, and ice-core proxy records As calibrated by instrumental measurements. *Mann et al., Geophysical Research Letters, 1999*

GLOBAL AVERAGE TEMPERATURE TREND

1856-2002

Temperature Anomaly Relative to Base Period 1961-1990



Climate Research Unit, East Anglia UK

INDICATIONS OF SYSTEMATIC WARMING IN RECENT YEARS

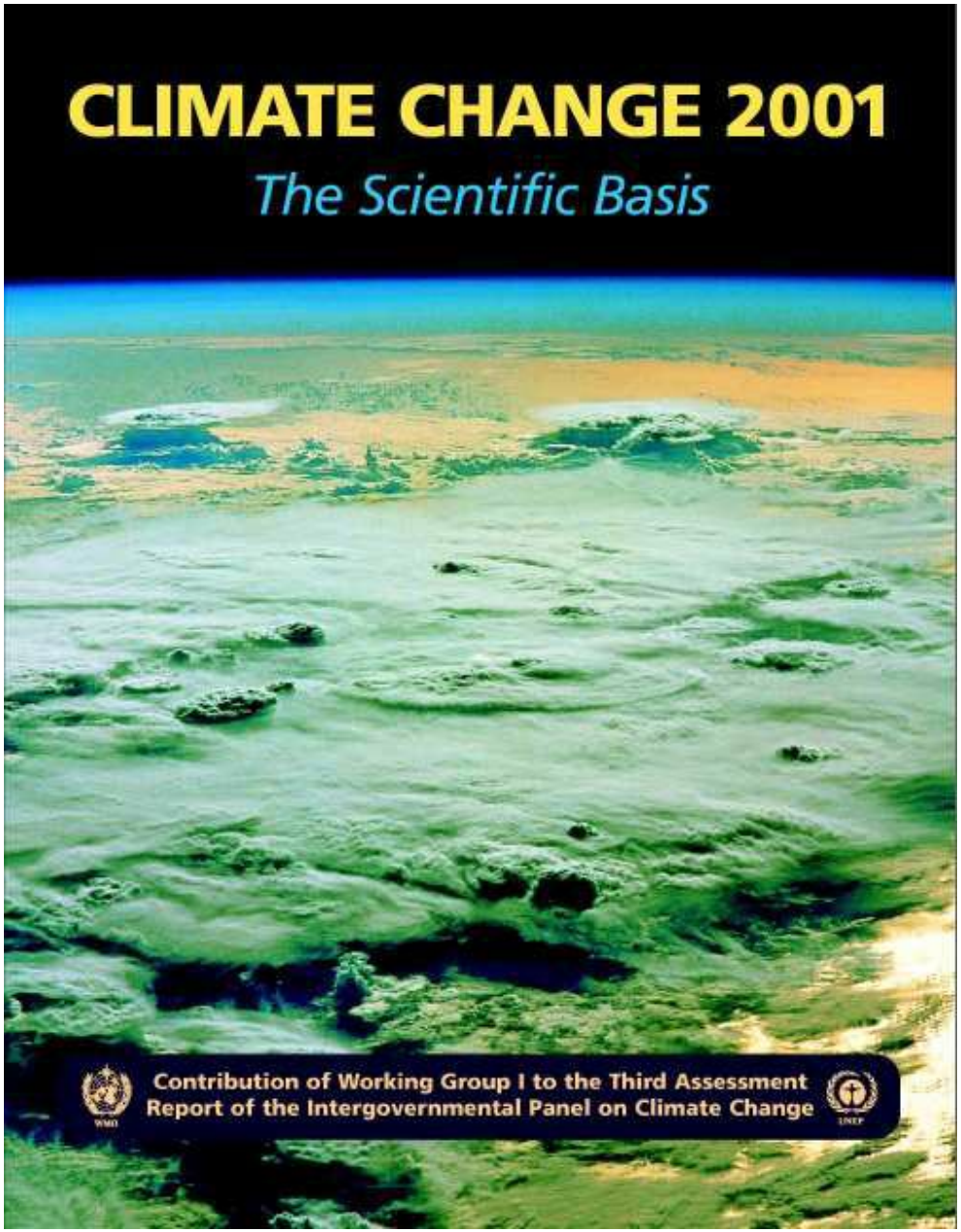
The 1990s were the ***warmest decade*** in the instrumental record.

The ***warmest two years*** of the entire instrumental record have been 1998 and 2002.

The ***nine warmest years*** globally have now occurred in the 1990s and 2000s.

THE “BIBLE” OF CLIMATE CHANGE RESEARCH

WMO

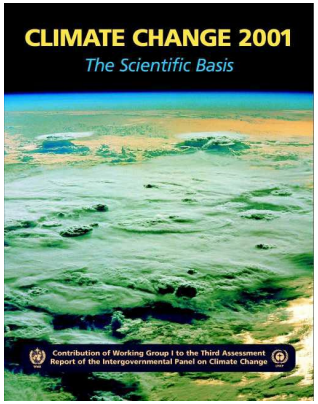


UNEP

Cambridge University Press, 2001

http://www.grida.no/climate/ipcc_tar/wg1/

EVIDENCE OF GLOBAL WARMING OTHER THAN SURFACE TEMPERATURE ANOMALY



The global ocean has warmed significantly since the late 1940s: more than half of the increase in heat content has occurred in the upper 300 m, ***mainly since the late 1950s***.

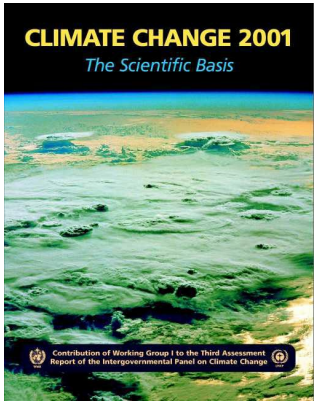
Night minimum temperatures are continuing to increase, lengthening the freeze-free season in many mid- and high latitude regions.

There has been a ***reduction in the frequency of extreme low temperatures***, without an equivalent increase in the frequency of extreme high temperatures.

Over the last twenty-five years, it is likely that ***atmospheric water vapour has increased*** over the Northern Hemisphere in many regions.

Widespread increases are likely to have occurred in the proportion of total ***precipitation derived from heavy and extreme precipitation events*** over land in the mid- and high latitudes of the Northern Hemisphere.

MORE EVIDENCE OF GLOBAL WARMING OTHER THAN SURFACE TEMPERATURE ANOMALY



Arctic sea-ice extent in spring and summer has decreased 10 to 15% since the 1950s.

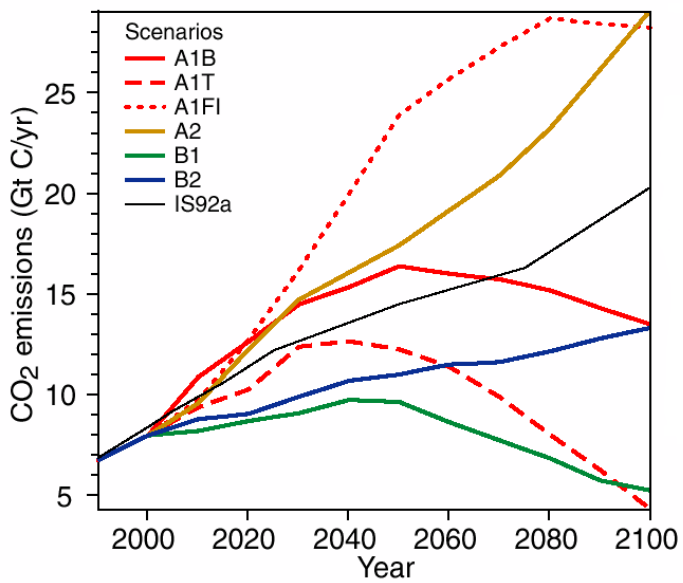
The average ***thickness of summer Arctic sea ice has decreased*** nearly 40% over approximately the last thirty years.

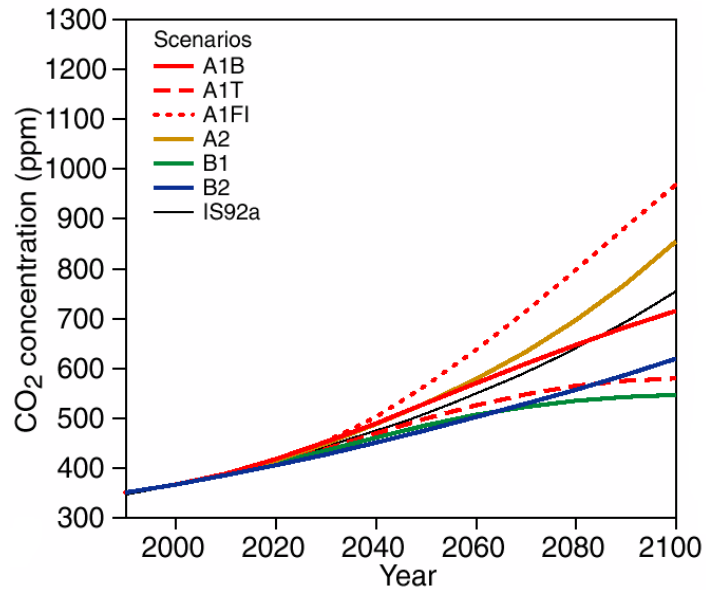
Alpine and continental glaciers have extensively retreated.

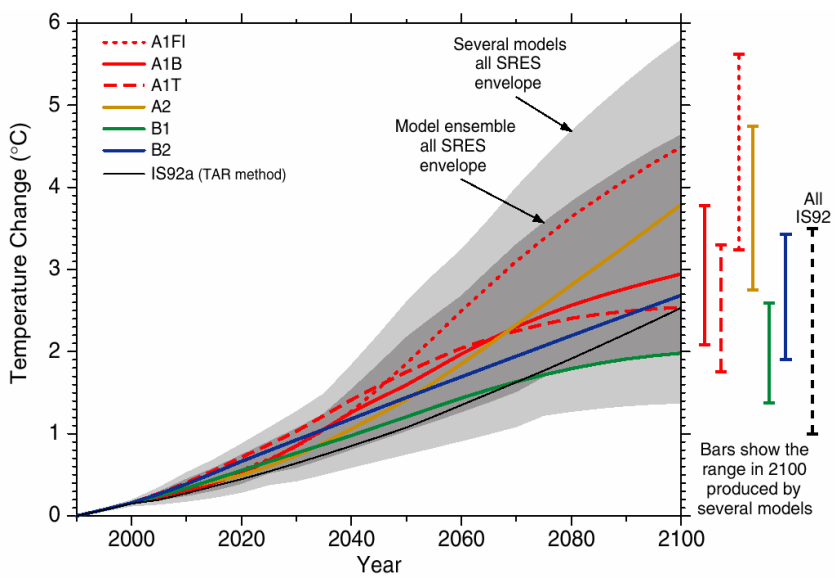
The duration of Northern Hemisphere lake-ice and river-ice cover over the past century, or more, ***shows widespread decreases*** averaging to about two fewer weeks of ice cover.

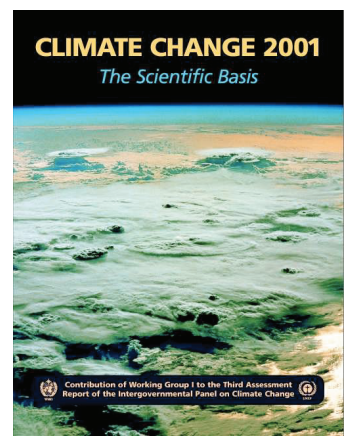
Northern Hemisphere spring snow cover extent has decreased by about 10% since 1966.

FUTURE CLIMATE IS HIGHLY UNCERTAIN









(*IPCC, 2001*)

Contributors to uncertainty include ***emissions***, ***concentrations***, and Earth's ***climate sensitivity***.

WHERE IS ALL THIS CO_2 COMING FROM?

WHO IS RESPONSIBLE?

HOW MUCH CARBON IS IN A GALLON OF GASOLINE?

1 lb?

2 lbs?

3 lbs!?

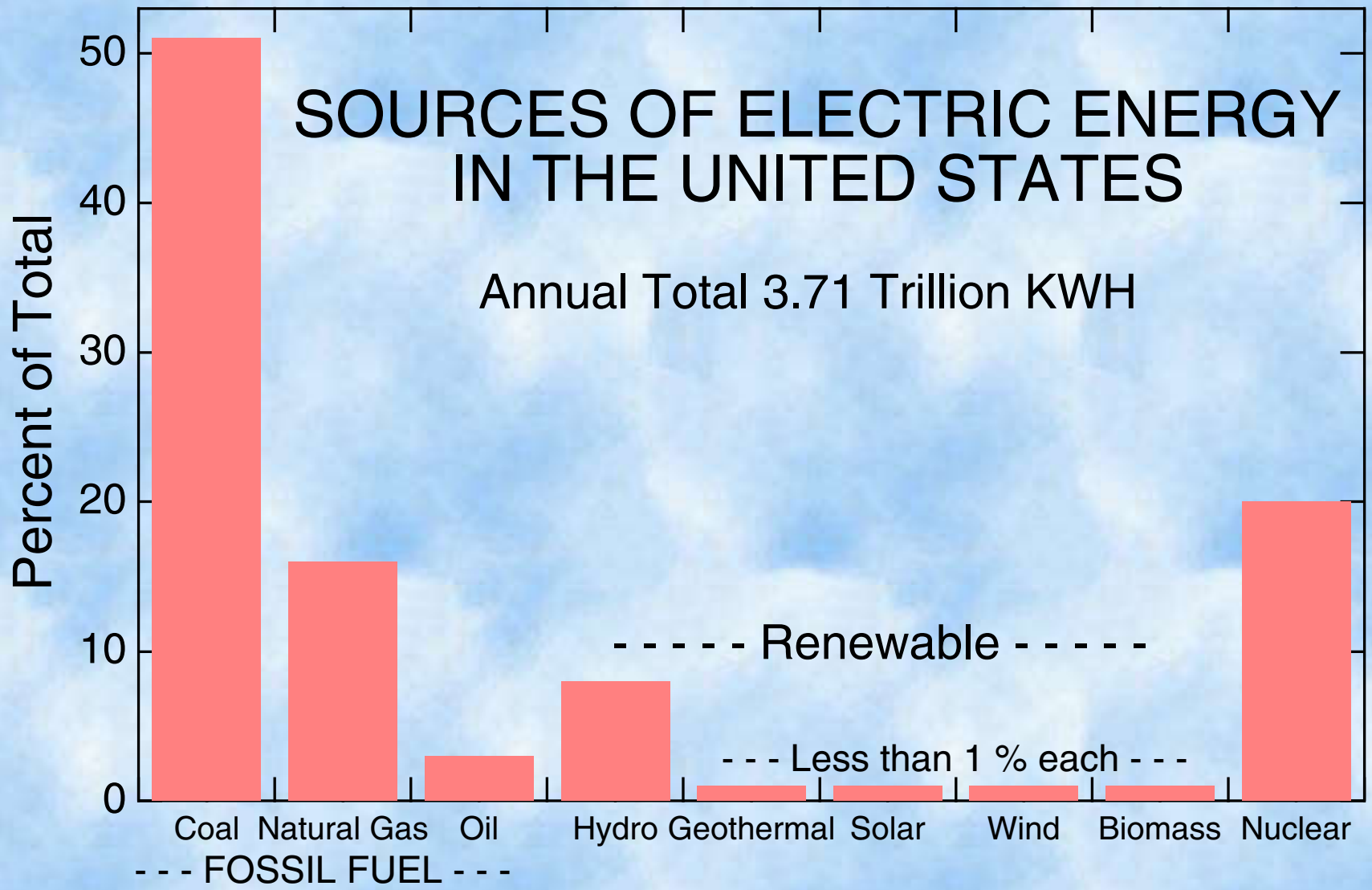
5 lbs!?!

All of this carbon goes into the atmosphere as carbon dioxide when you burn the gasoline in your car.

THE MOST EFFECTIVE WAY TO DOUBLE THE FUEL ECONOMY OF A CAR . . .

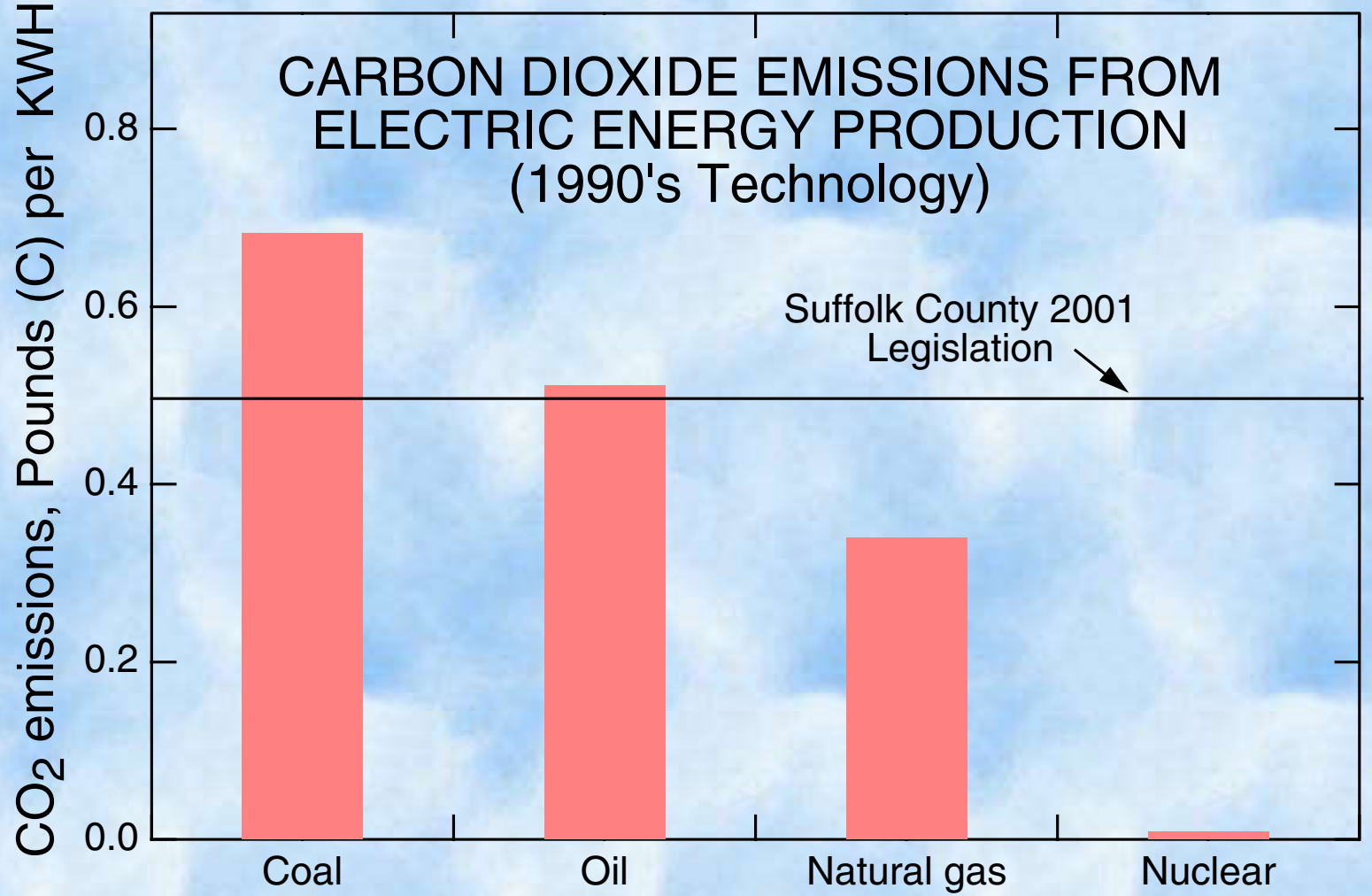
IS TO PUT TWO PEOPLE IN IT!

WHERE DOES YOUR ELECTRIC ENERGY COME FROM?



On Long Island most electric energy derives from combustion of oil.

YOUR FAMILY'S CONTRIBUTION TO THE GREENHOUSE EFFECT



A typical household using 1000 kilowatt hours of electricity per month is responsible for emission of 3 tons of carbon a year in the form of carbon dioxide.

How much does your household contribute?

YOUR CONTRIBUTION TO THE GREENHOUSE EFFECT

ELECTRIC SUPPLY AND DELIVERY FROM LIPA

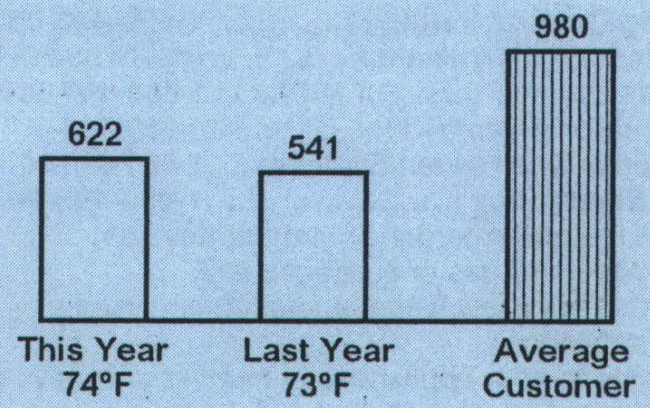
Meter Readings Meter # 15790134

	Jul 24	93155	Actual
	Jun 26	92533	Actual
Use	28 **Days**	622 **KWH**	

Cost Rate 880 - Water and Home Heating

Basic Service: 28 Days @ 17.90¢	$5.01
Use: 233 KWH @ 12.49¢	29.10
140 KWH @ 13.67¢	19.14
249 KWH @ 9.78¢	24.35
Excess Fuel Price Surcharge	4.28
PILOTs and Credits	1.40
Shoreham Credit	-.59
Sales Tax: @ 1%	.83
Total	$83.52

Comparisons KWH



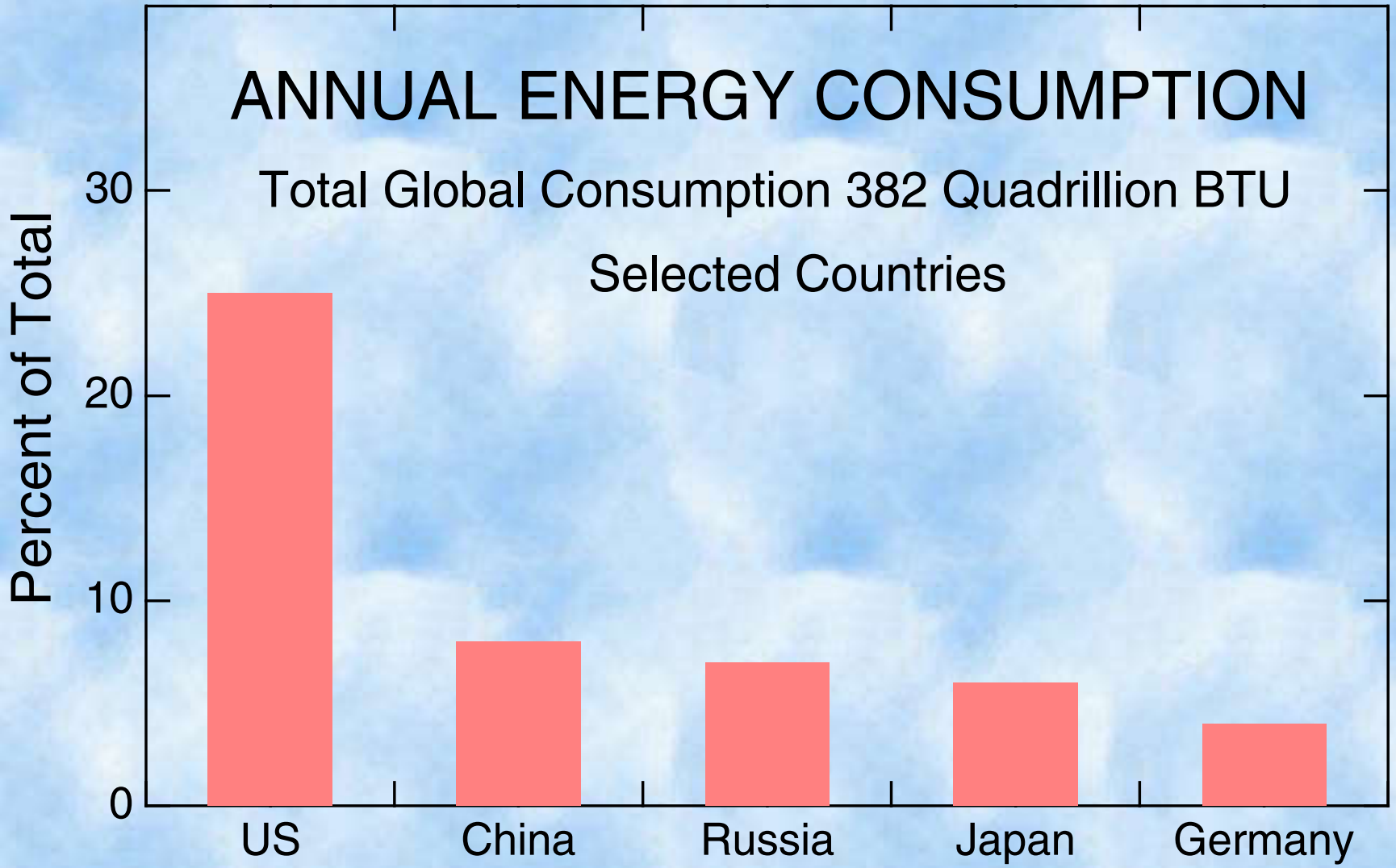
LIPA Long Island Power Authority

Jul 25, 2001	927 20 1805 3 5	1-800-490-0025	See Back Of Bill
Date	Account Number	Any Questions?	Service Problems

At half a pound of carbon per KWH, the average household is responsible for emission of 500 pounds of carbon a month .

WHAT COUNTRY USES THE MOST ELECTRIC POWER?

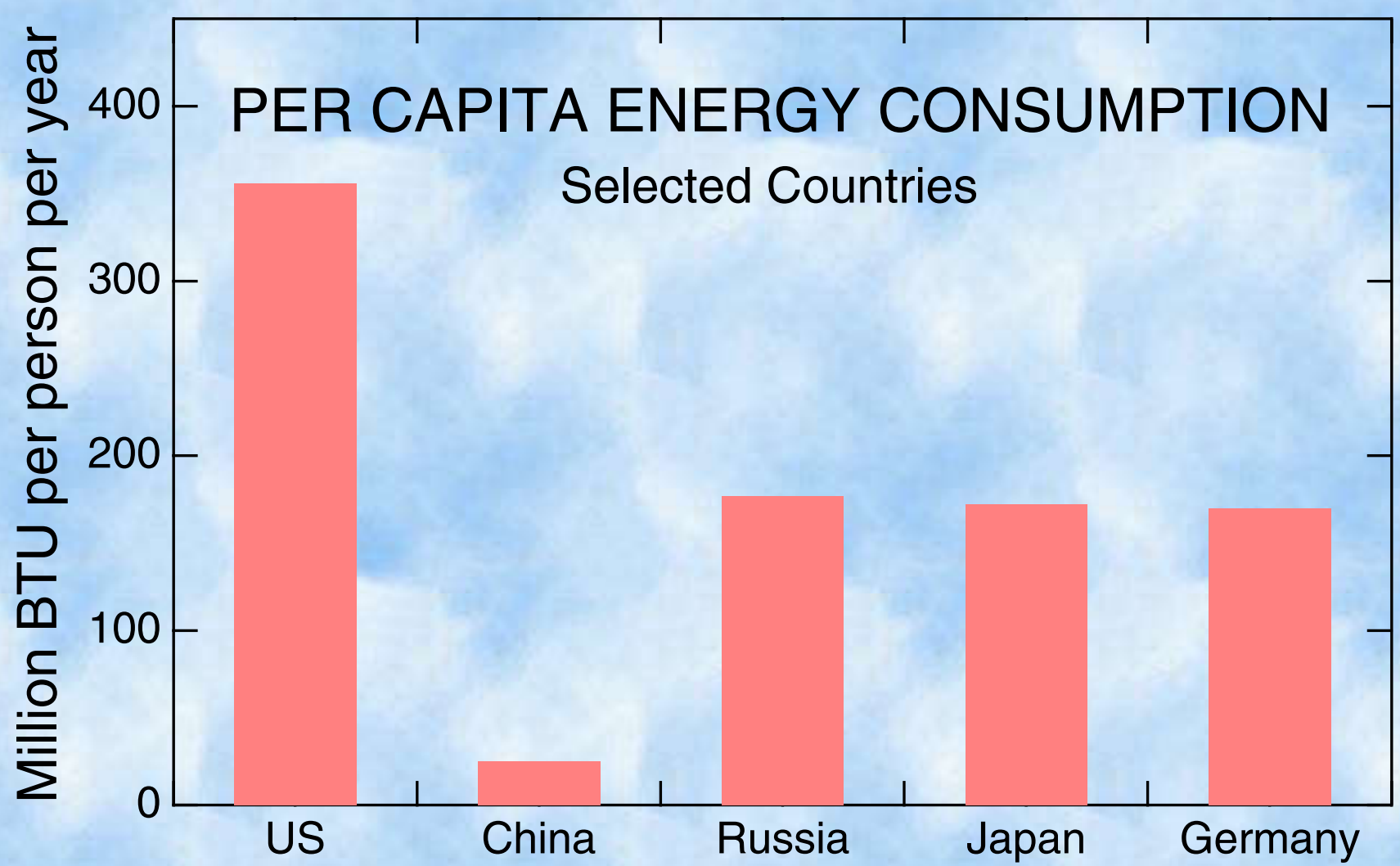
WHAT COUNTRY USES THE MOST ELECTRIC POWER?



No surprise. It's the United States.

WHAT COUNTRY USES THE MOST ELECTRIC POWER ***PER CAPITA***?

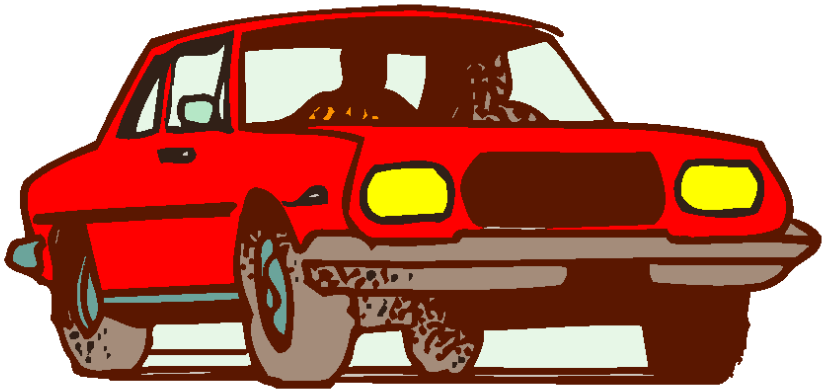
WHAT COUNTRY USES THE MOST ELECTRIC POWER ***PER CAPITA***?



No surprise. It's the United States again.

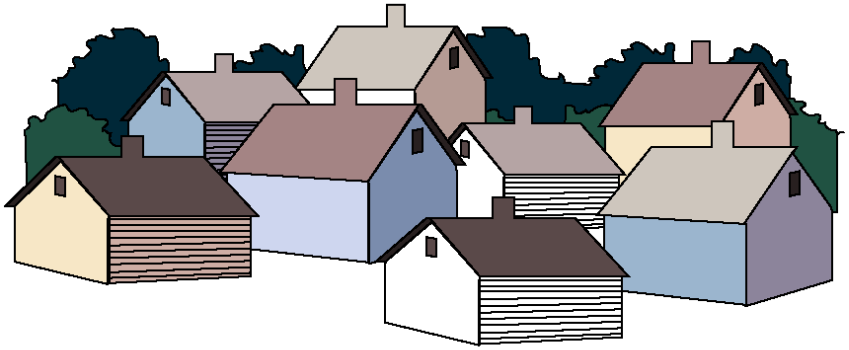
WHERE IS THIS CARBON DIOXIDE COMING FROM?

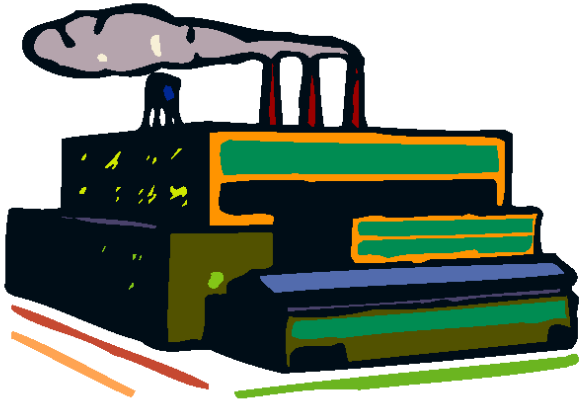
WE ARE ALL RESPONSIBLE.



Burning a gallon of gasoline in your car puts 5 pounds of carbon in the atmosphere as carbon dioxide (CO_2), and it will stay there for decades — maybe a century!

Other sources are home heating and electric power production.





Global Atmosphere, Global Warming

QUESTIONS ABOUT GLOBAL WARMING

- IS IT REAL?
- IS IT IMPORTANT?
- WHAT IS IT DUE TO?
- HOW MUCH MORE CAN WE EXPECT?
- ARE WE SEEING JUST THE TIP OF THE ICEBERG?

RESEARCH AT BROOKHAVEN NATIONAL LABORATORY IS HELPING TO ANSWER THESE QUESTIONS.