THE GREENHOUSE EFFECT

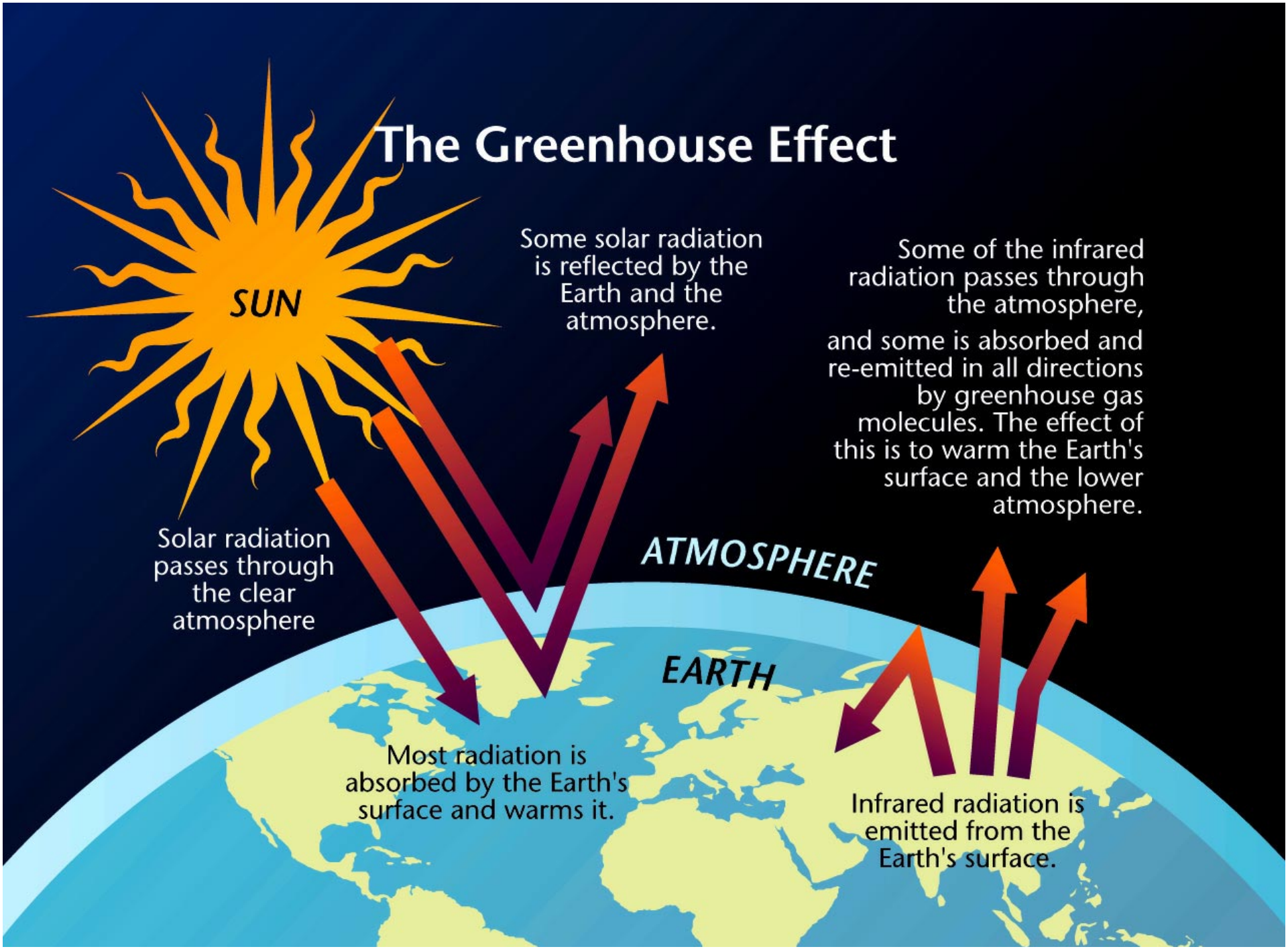
Stephen E. Schwartz

Atmospheric Sciences Division

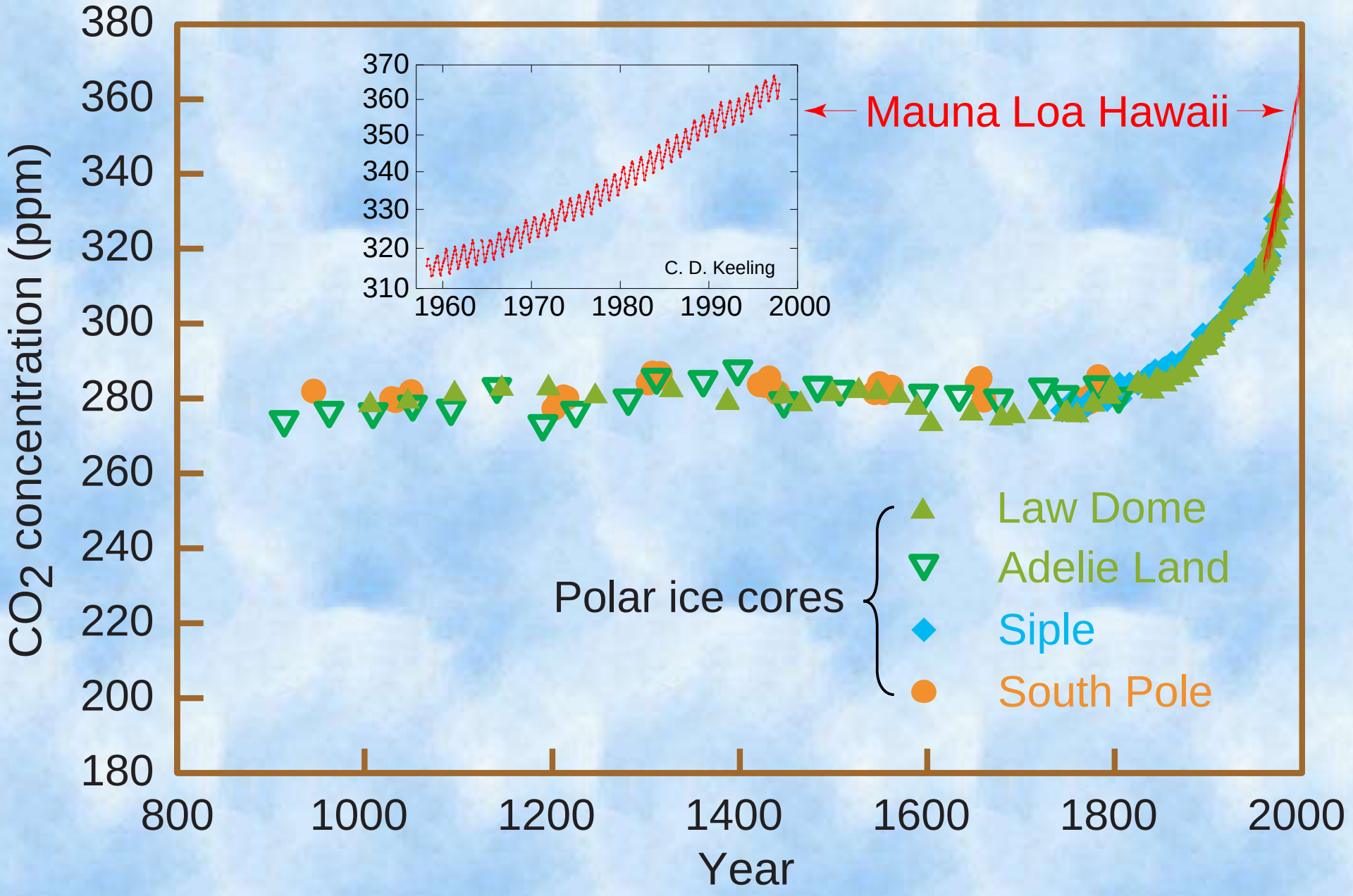
CSSP Lecture

July 30, 2002

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

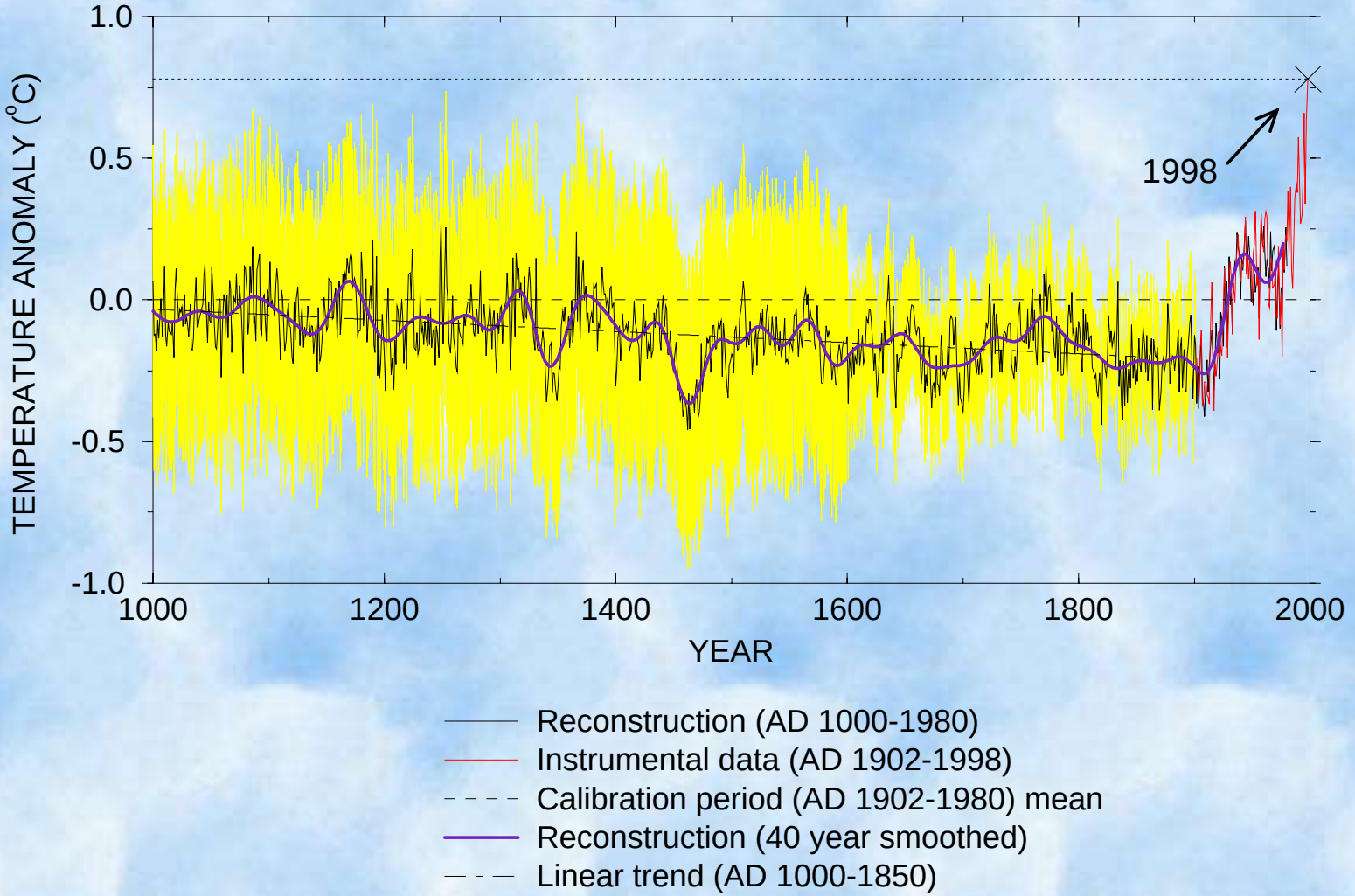

The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere,
and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower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

ATMOSPHERIC CARBON DIOXIDE IS INCREASING



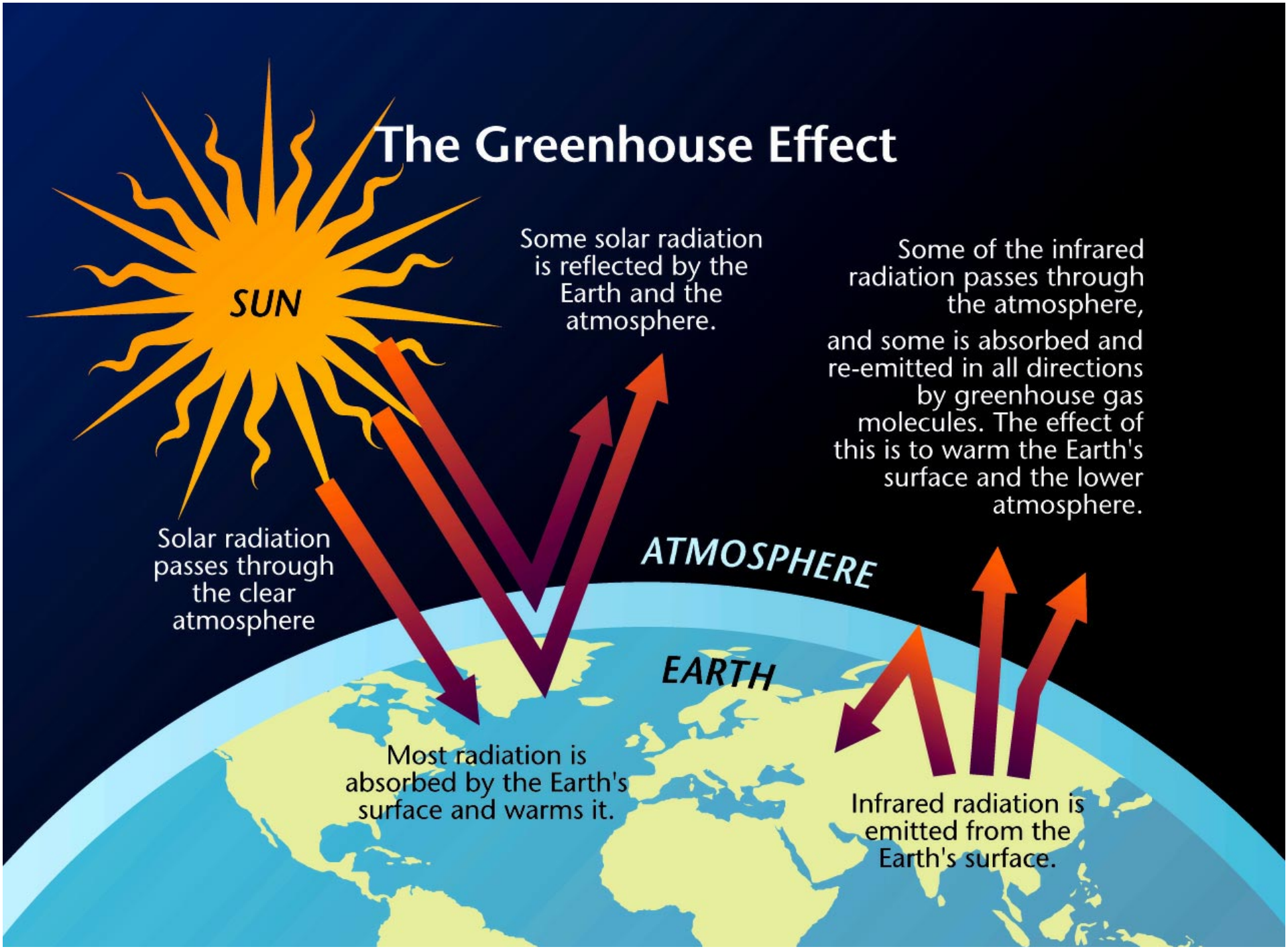
Global carbon dioxide concentration over the last thousand years

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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ATMOSPHERIC RADIATION

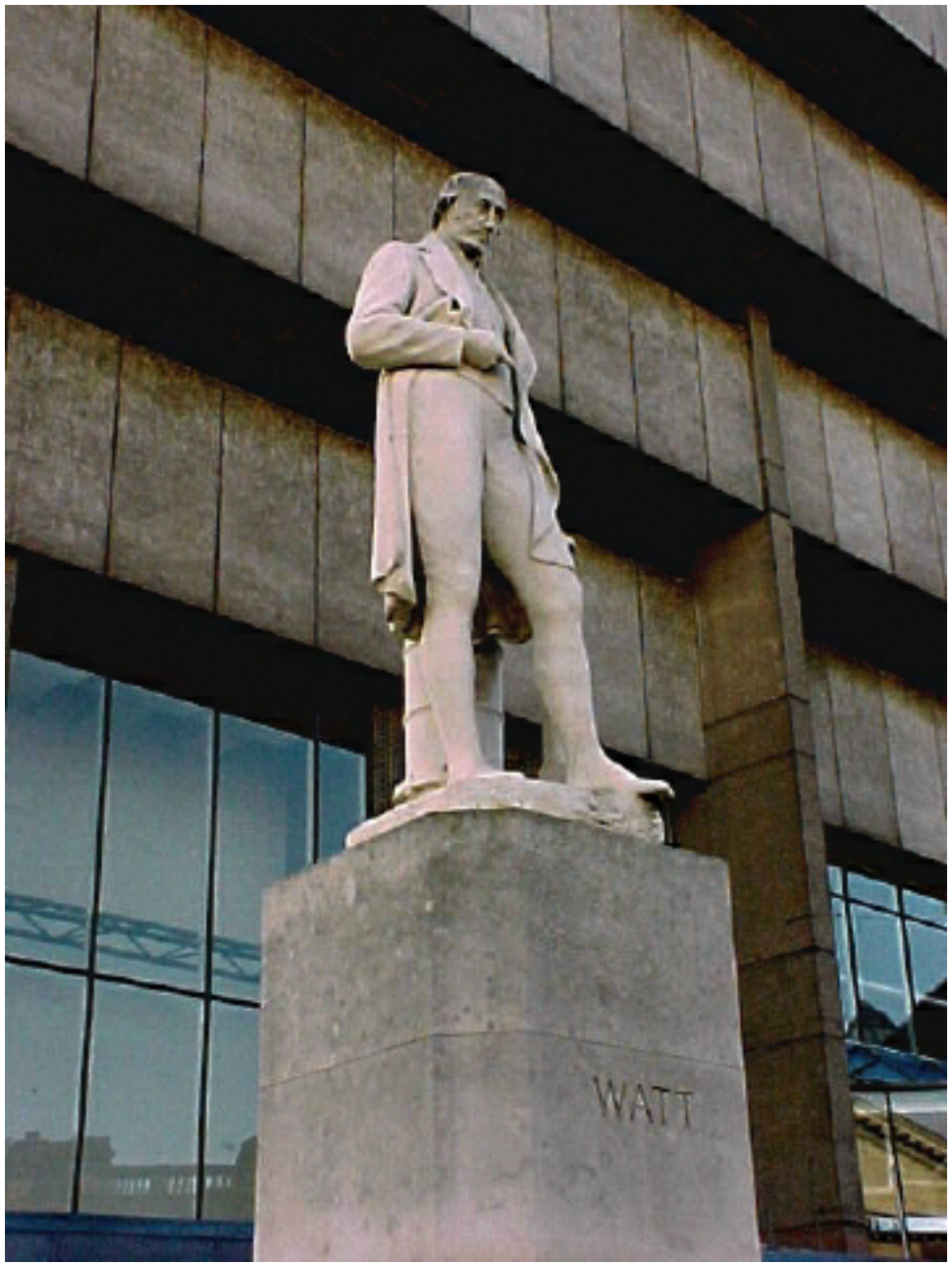
Energy per area per time

Power per area

Unit:

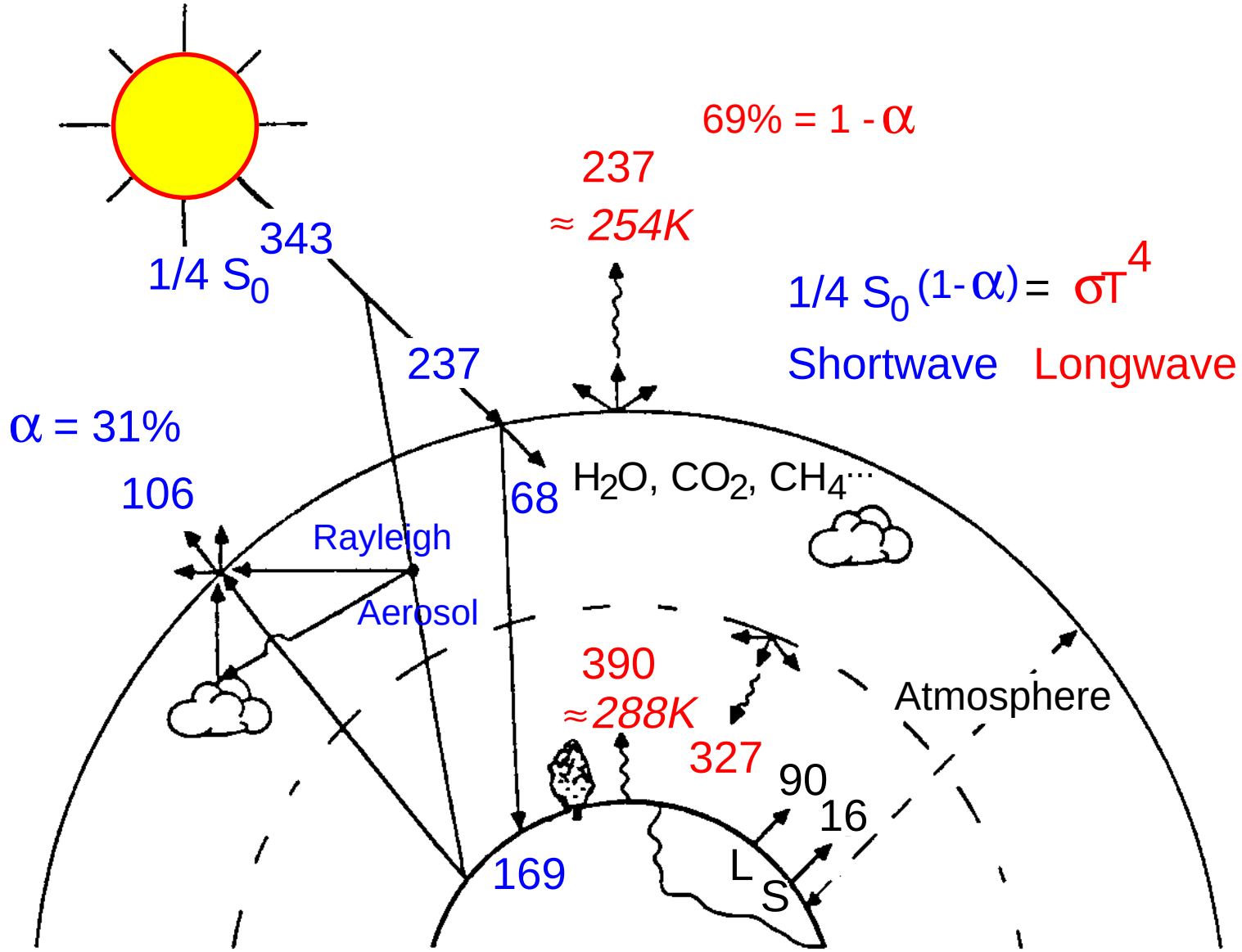
Watt per square meter

$W\ m^{-2}$



GLOBAL ENERGY BALANCE

Global and annual average energy fluxes in watts per square meter

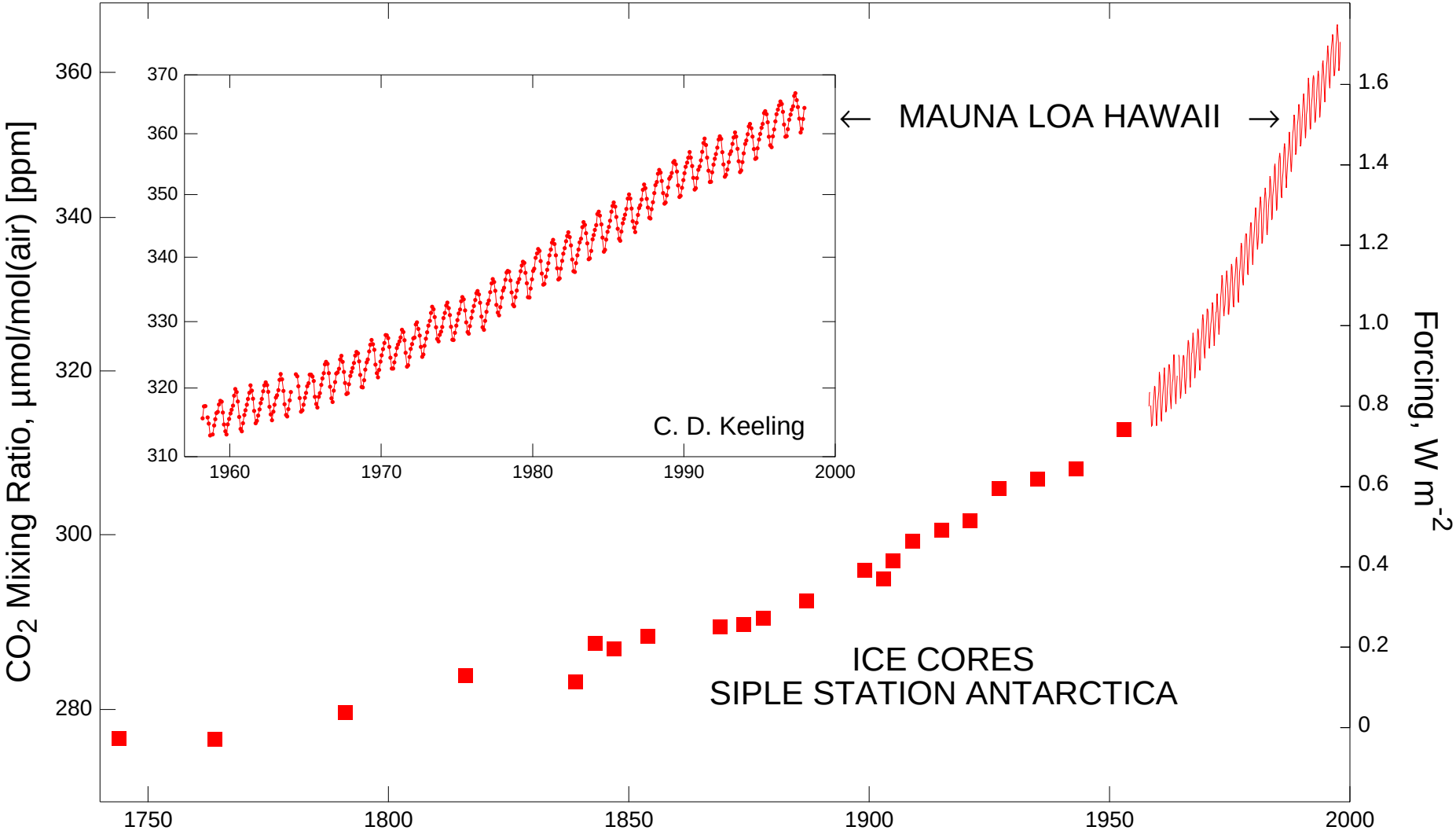


Schwartz, 1996, modified from Ramanathan, 1987

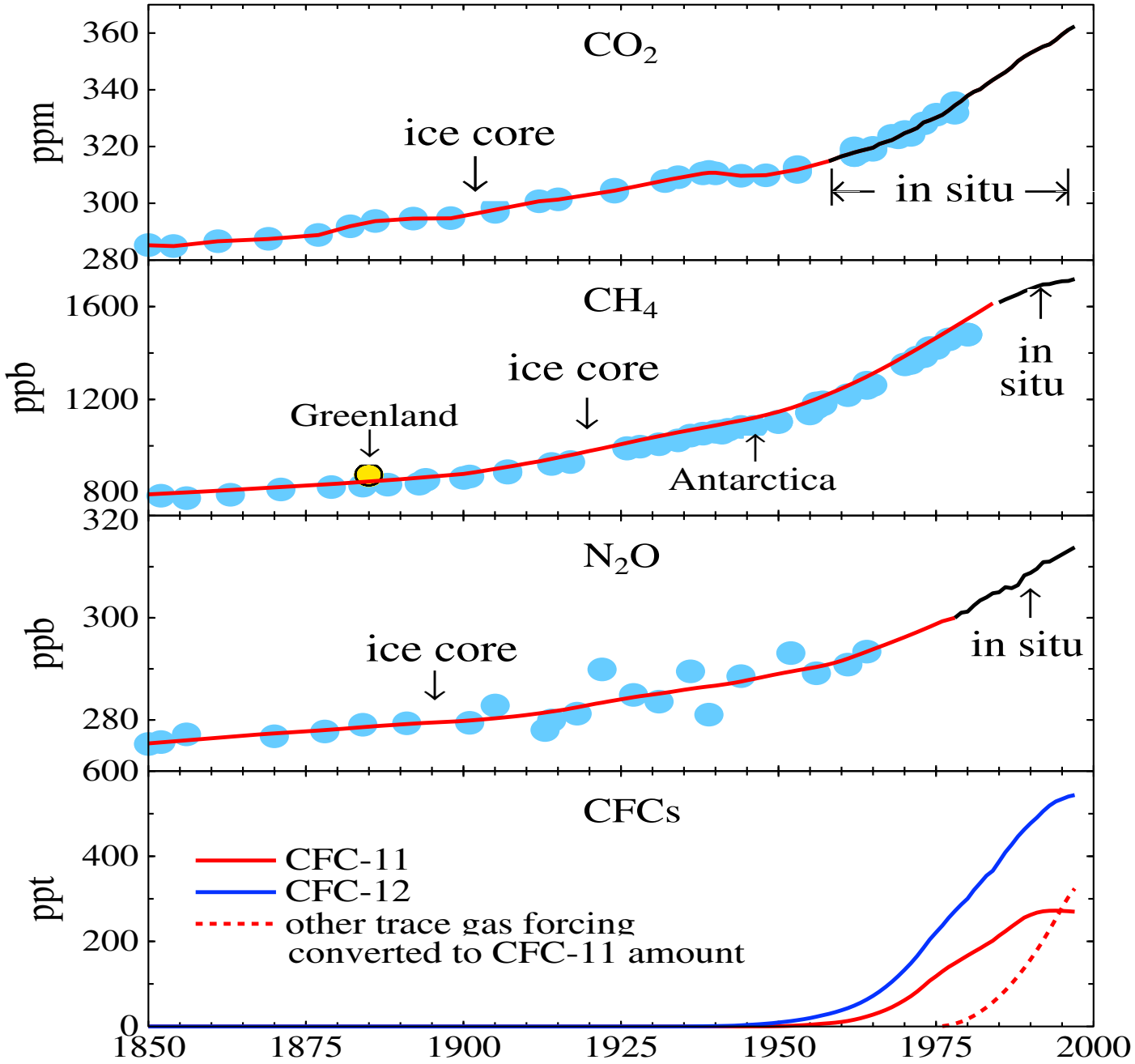
RADIATIVE FORCING

A ***change*** in a component of the Earth's radiation budget.

GLOBAL CARBON DIOXIDE OVER THE INDUSTRIAL PERIOD

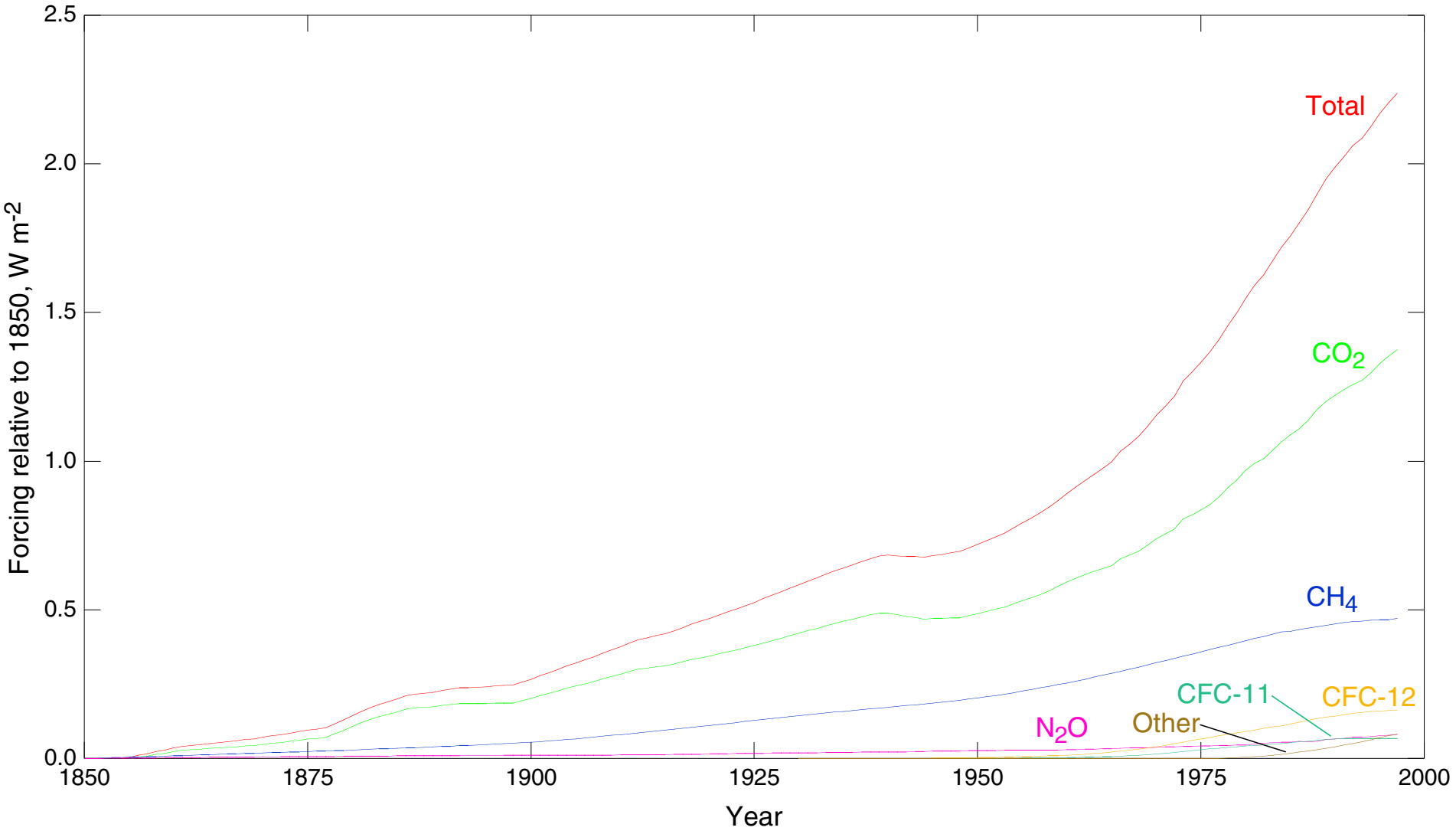


GREENHOUSE GAS MIXING RATIOS OVER THE INDUSTRIAL PERIOD



Hansen *et al.*, PNAS. 1998

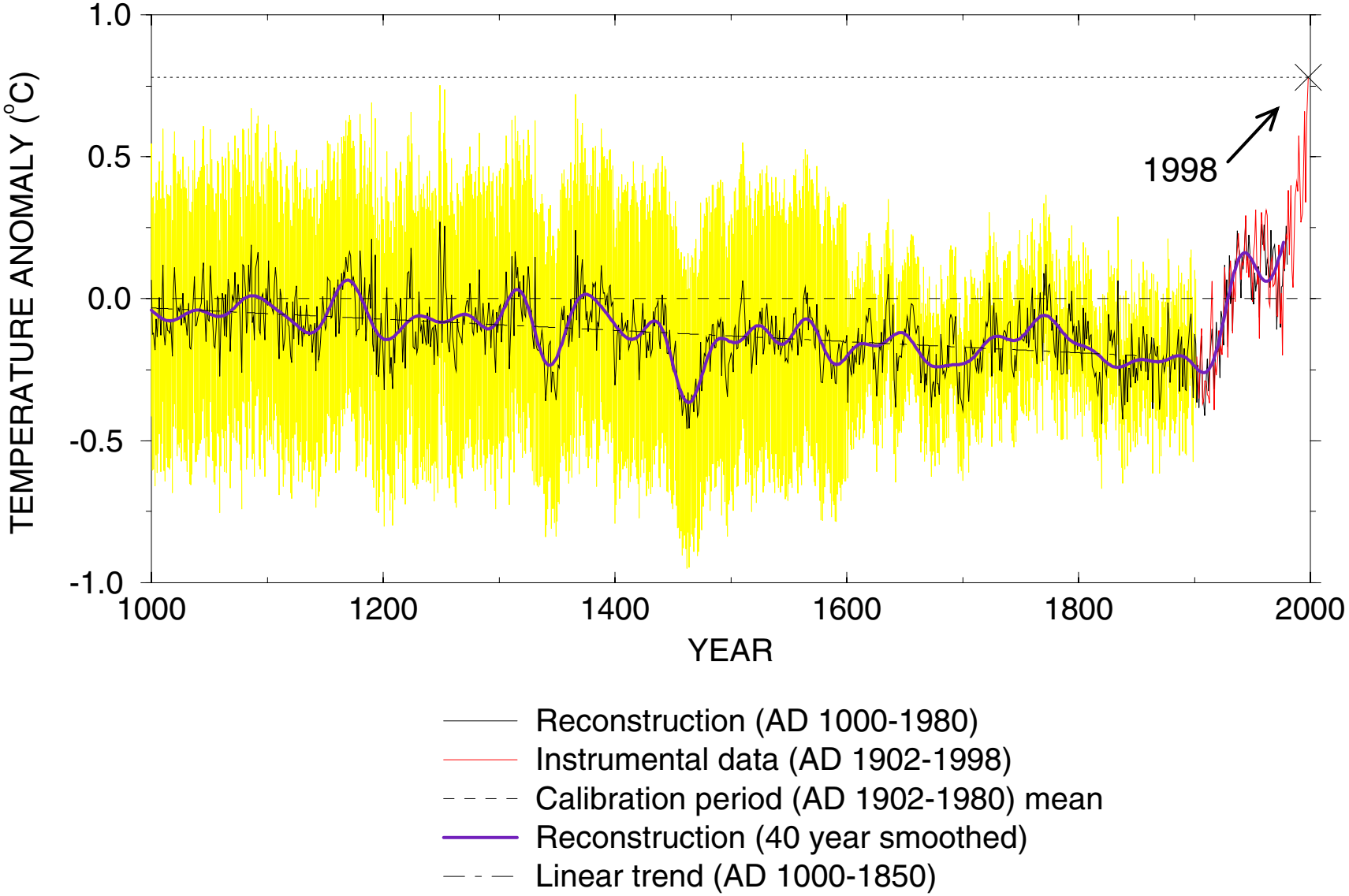
GREENHOUSE GAS FORCINGS OVER THE INDUSTRIAL PERIOD



Data: GISS

NORTHERN HEMISPHERE TEMPERATURE TREND (1000-1998)

From tree-ring, coral, and ice-core proxy records
As calibrated by instrumental measurements



Mann et al., GRL, 1999

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!?

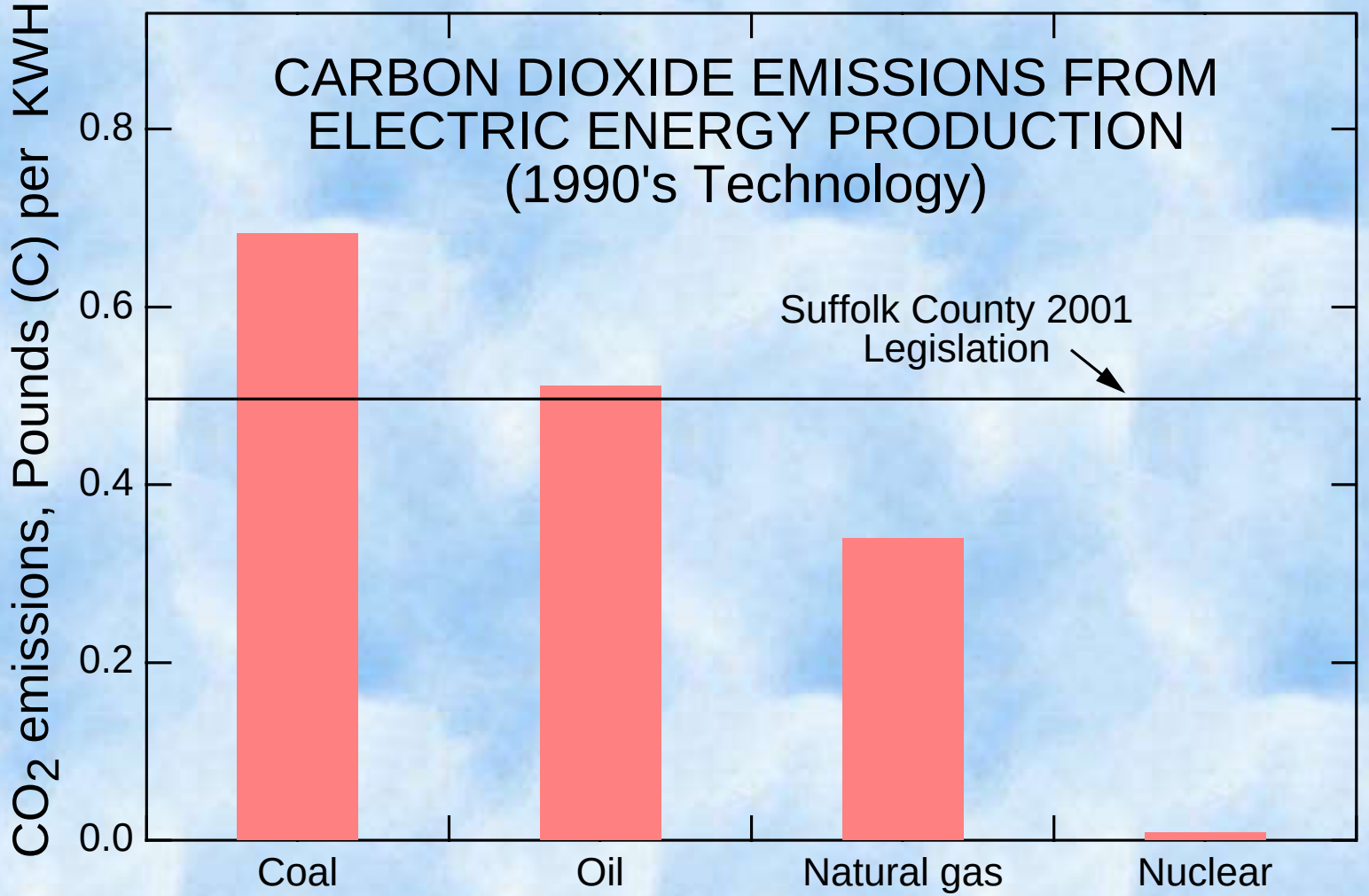
5 lbs!?!

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!

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

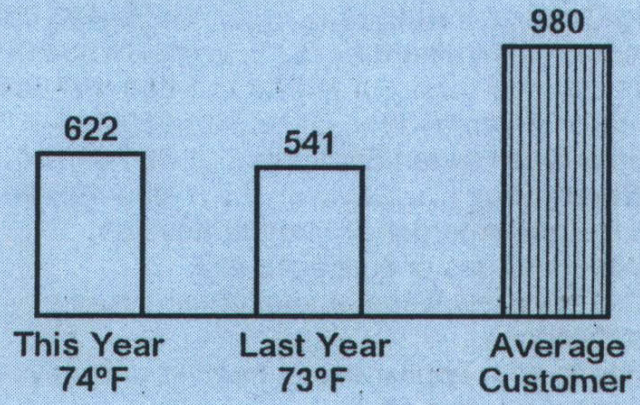
Meter Readings Meter # 15790134

	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.

Suffolk County Limits CO_2 Emissions

Breath of Fresh Air

Gaffney signs bill to limit greenhouse gas emissions

Newsday July 25, 2001

By Emi Endo

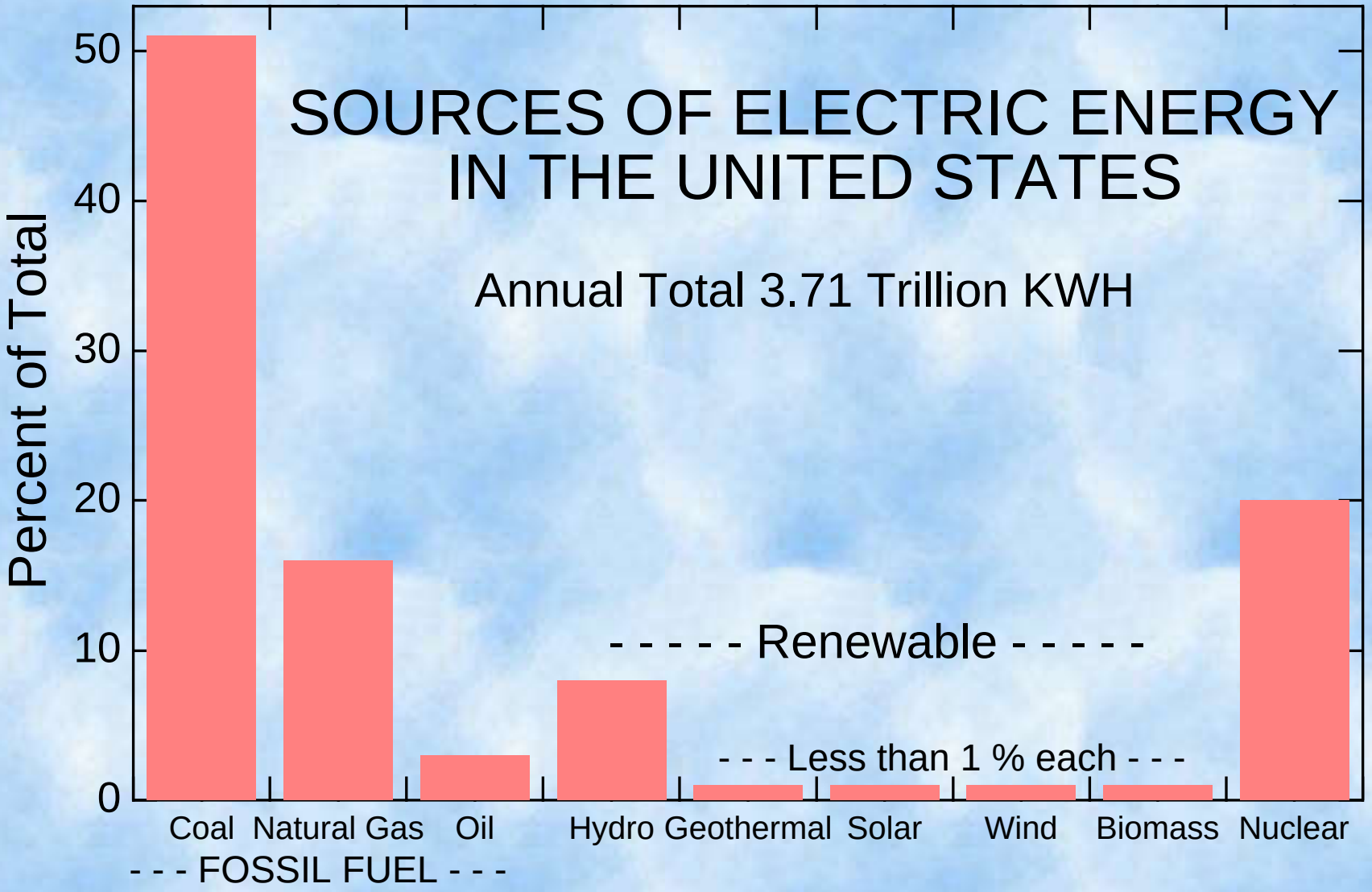
Suffolk County Executive Robert Gaffney yesterday signed into law a bill aimed at limiting greenhouse gas emissions locally, although critics questioned how much it would actually reduce the emissions.

Beginning in March, for every 100 megawatts of new generation added in the county, the emissions rate must be reduced by 1 percent, until a 20-percent reduction is achieved. Power plants that exceed the standard would face fines.

During negotiations, Fisher raised the emissions limit from less than 1,500 pounds to 1,800 pounds of carbon dioxide per megawatt hour and cut the penalties from $5 for each ton of carbon dioxide emissions exceeding the limit to $2.

0.49 lbs Carbon per KWH

WHERE DOES YOUR ELECTRIC ENERGY COME FROM?



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

WHAT COUNTRY USES THE MOST ELECTRIC POWER?

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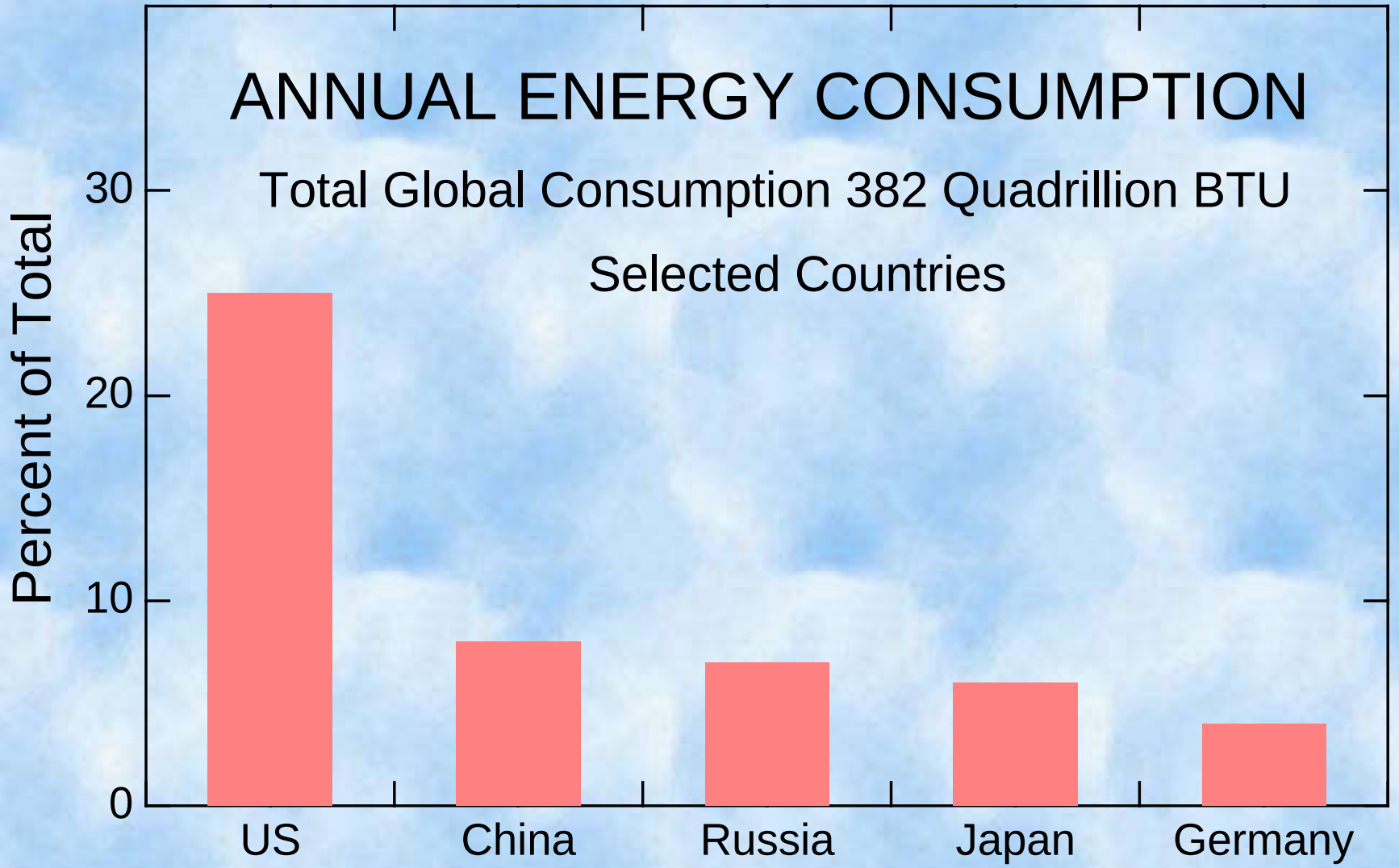

No surprise. It's the United States.

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

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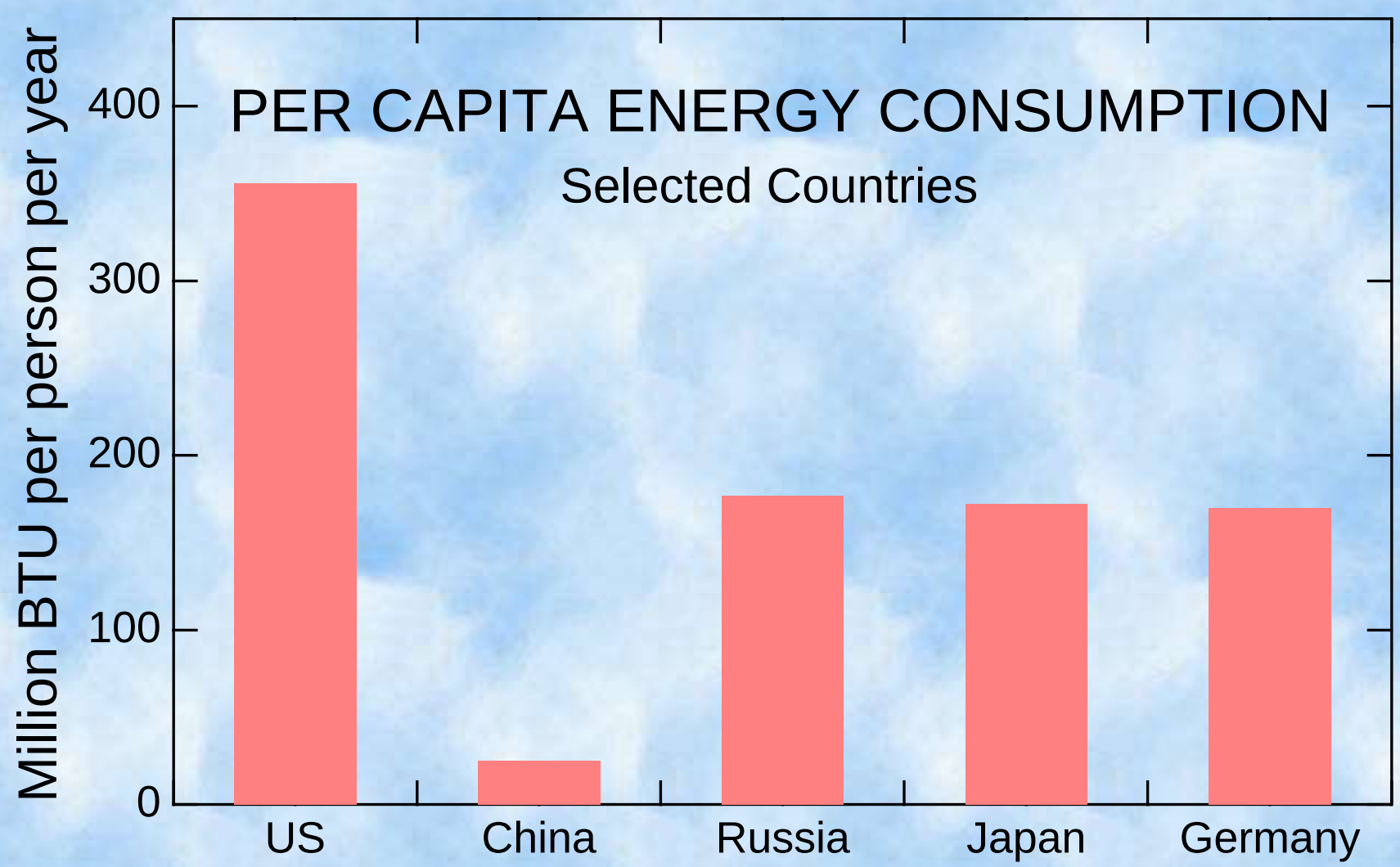
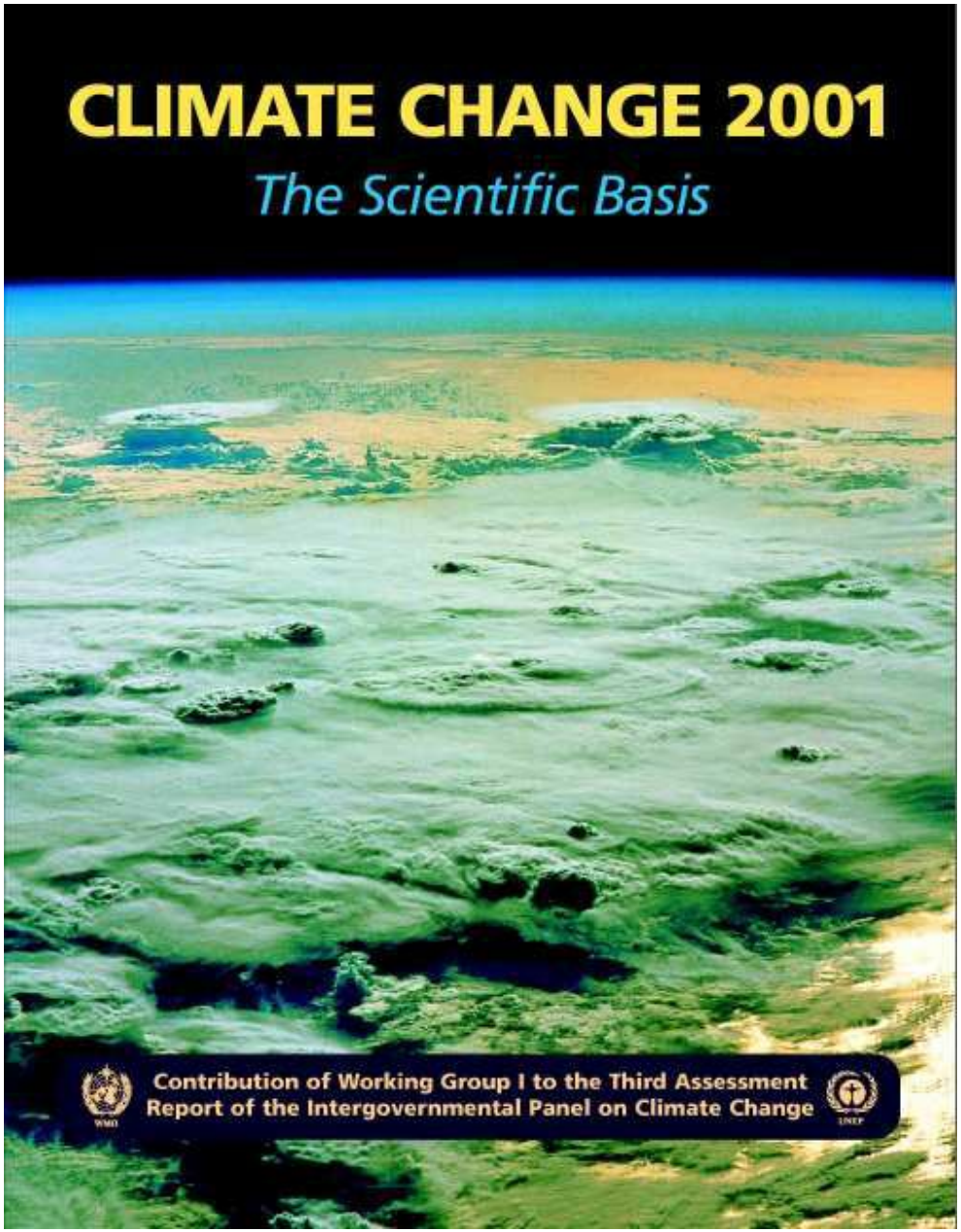


No surprise. It's the United States again.

THE "BIBLE" OF CLIMATE CHANGE RESEARCH



Cambridge University Press, 2001