

# THE GREENHOUSE EFFECT AND YOUR FAMILY'S CONTRIBUTION TO IT

Stephen E. Schwartz



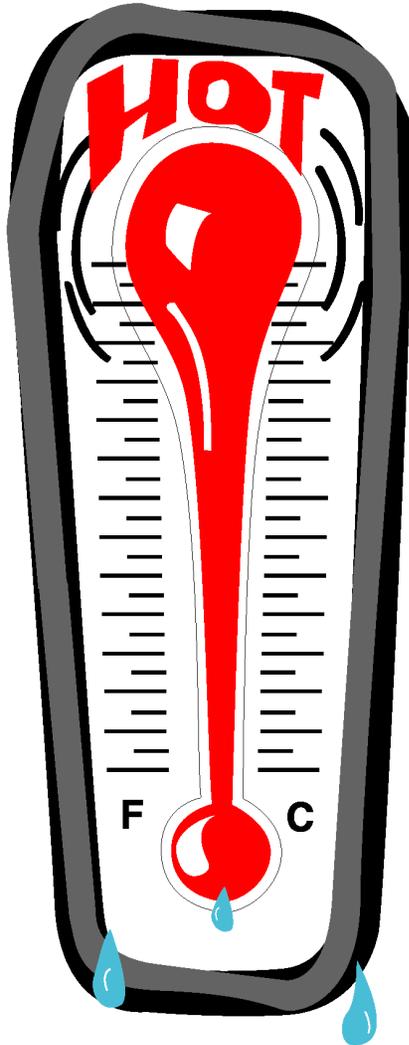
The GREENS MENS GROUP



Half Hollow Hills Library  
Dix Hills, N. Y.

June 6, 2006

*<http://www.ecd.bnl.gov/steve>*





by far the most terrifying film  
you will ever see.

# an inconvenient truth

A GLOBAL WARNING

now playing in select theaters

PARTICIPANT

TIME MAGAZINE, APRIL 3, 2006



# TIME MAGAZINE, APRIL 3, 2006



## Greenland is Melting

Scientists say the ice is thinning and global warming is to blame; ocean levels are rising, due to a combination of thermal expansion of the water and melting of polar ice.

PHOTO BY JOHN MCCONNICO / AP

[www.time.com](http://www.time.com)

# CANADA



# INDIA



# INDIA



# NEW ORLEANS



# ALASKA



# UPSALA GLACIER, ANDES, ARGENTINA

1928



2004



# RETREAT OF MID-LATITUDE GLACIERS

## South Cascade Glacier, Washington

1928



2000



[http://ak.water.usgs.gov/glaciology/south\\_cascade/1928-2000comparison.htm](http://ak.water.usgs.gov/glaciology/south_cascade/1928-2000comparison.htm)

# PASTERZE GLACIER, AUSTRIA 1875 - 2004



About 2 km shorter.

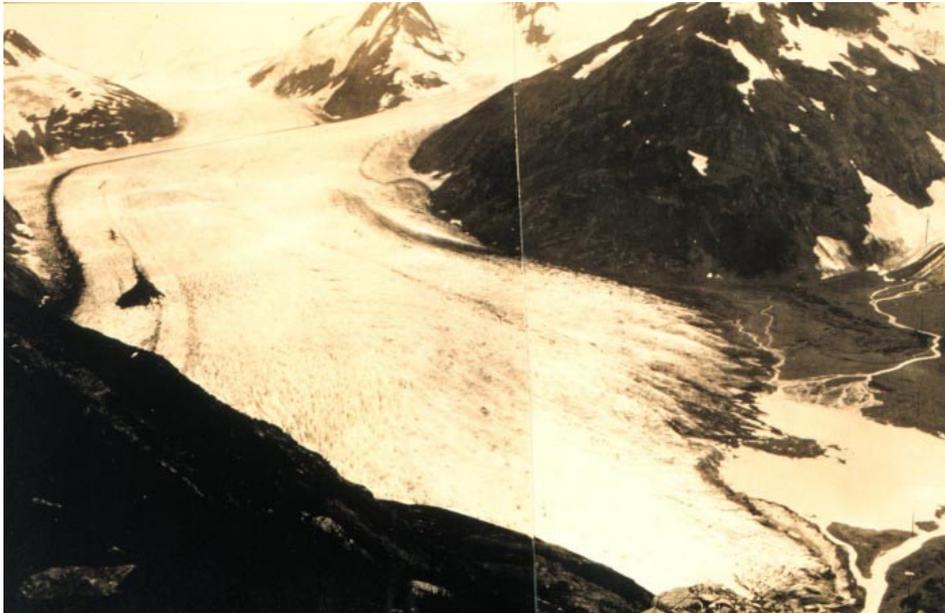
Terminus replaced by artificial lake.

Decrease in length about 15 meters per year.

In 2003, decrease was 30 m in length and 6.5 m in thickness.

<http://www.worldviewofglobalwarming.org/pages/glaciers.html>

# PORTAGE GLACIER, ALASKA 1914 - 2004



<http://www.worldviewofglobalwarming.org/pages/glaciers.html>

# RHONE GLACIER, VALAIS, SWITZERLAND 1859 - 2001



Glacial retreat is 2.5 km.

Base is 450 meters higher.

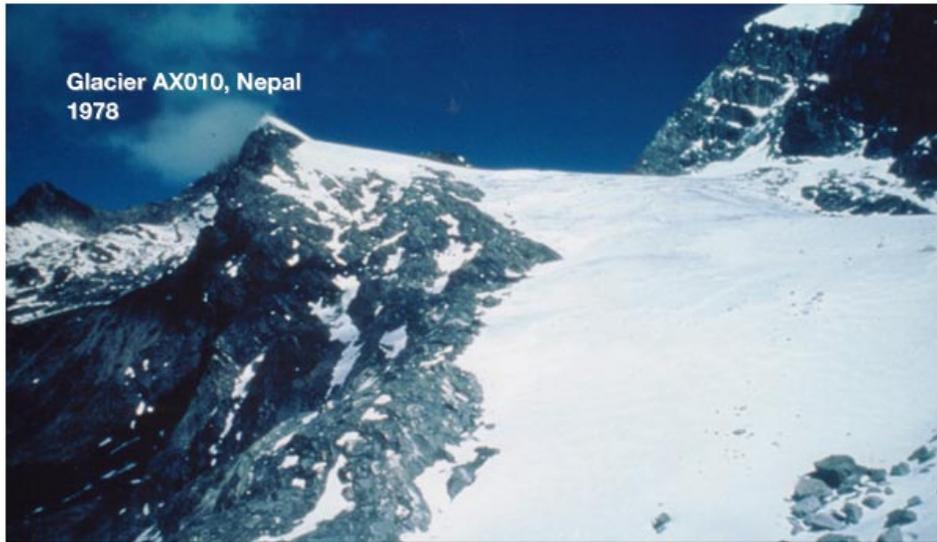
<http://www.worldviewofglobalwarming.org/pages/glaciers.html>

# GRINNELL GLACIER GLACIER NATIONAL PARK 1911 - 2000



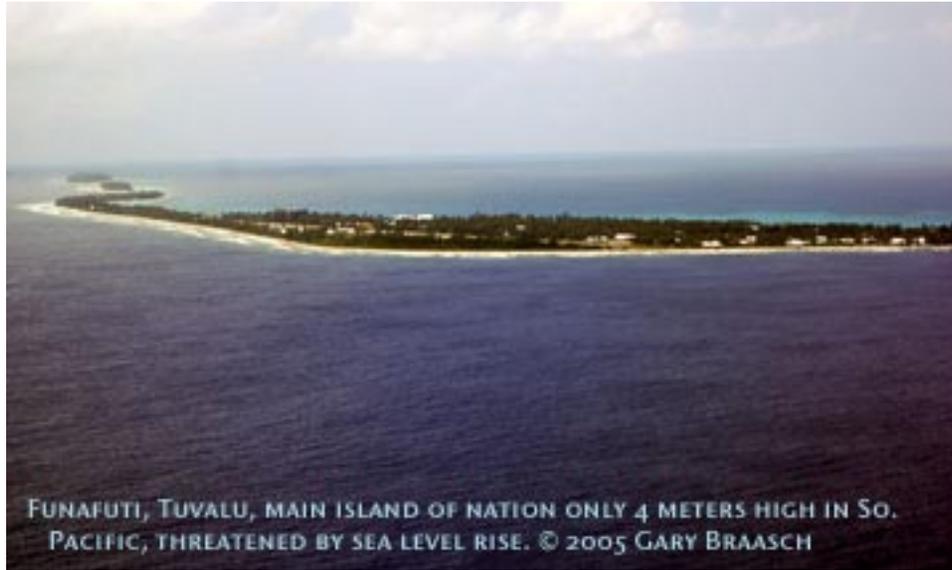
<http://www.worldviewofglobalwarming.org/pages/glaciers.html>

# GLACIER AX010, NEPAL, 1978-2004



<http://snowman.ihis.nagoya-u.ac.jp/download/photo/AX010.html>

# FUNAFUTI, TUVALU

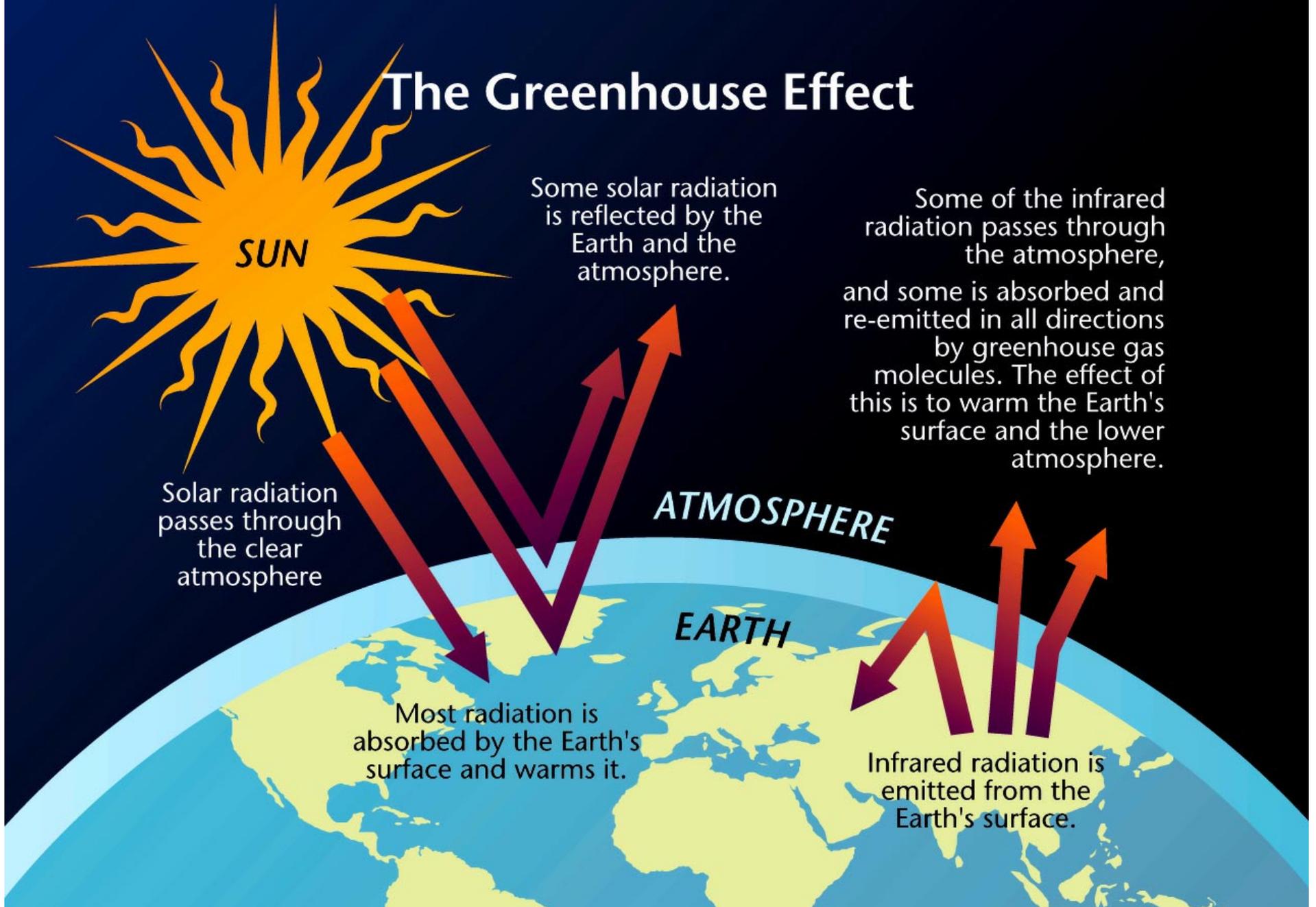


The 11,000 Tuvaluans live on nine coral atolls with typical elevation 2 meters and not exceeding 5 meters.

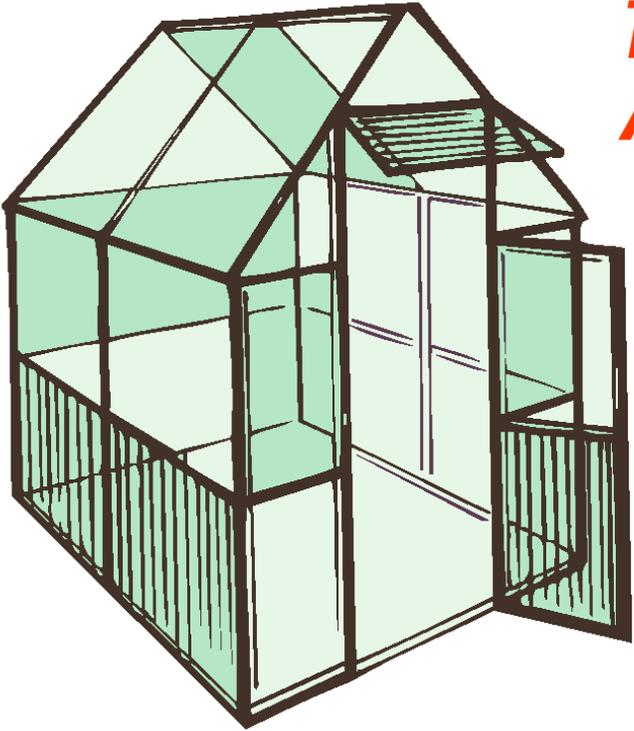
“Our whole culture will have to be transplanted.”

- Paani Laupepa, Former Assistant Environmental Minister  
later Assistant Secretary for Foreign Affairs

# The Greenhouse Effect



# 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.

# ***ATMOSPHERIC RADIATION***

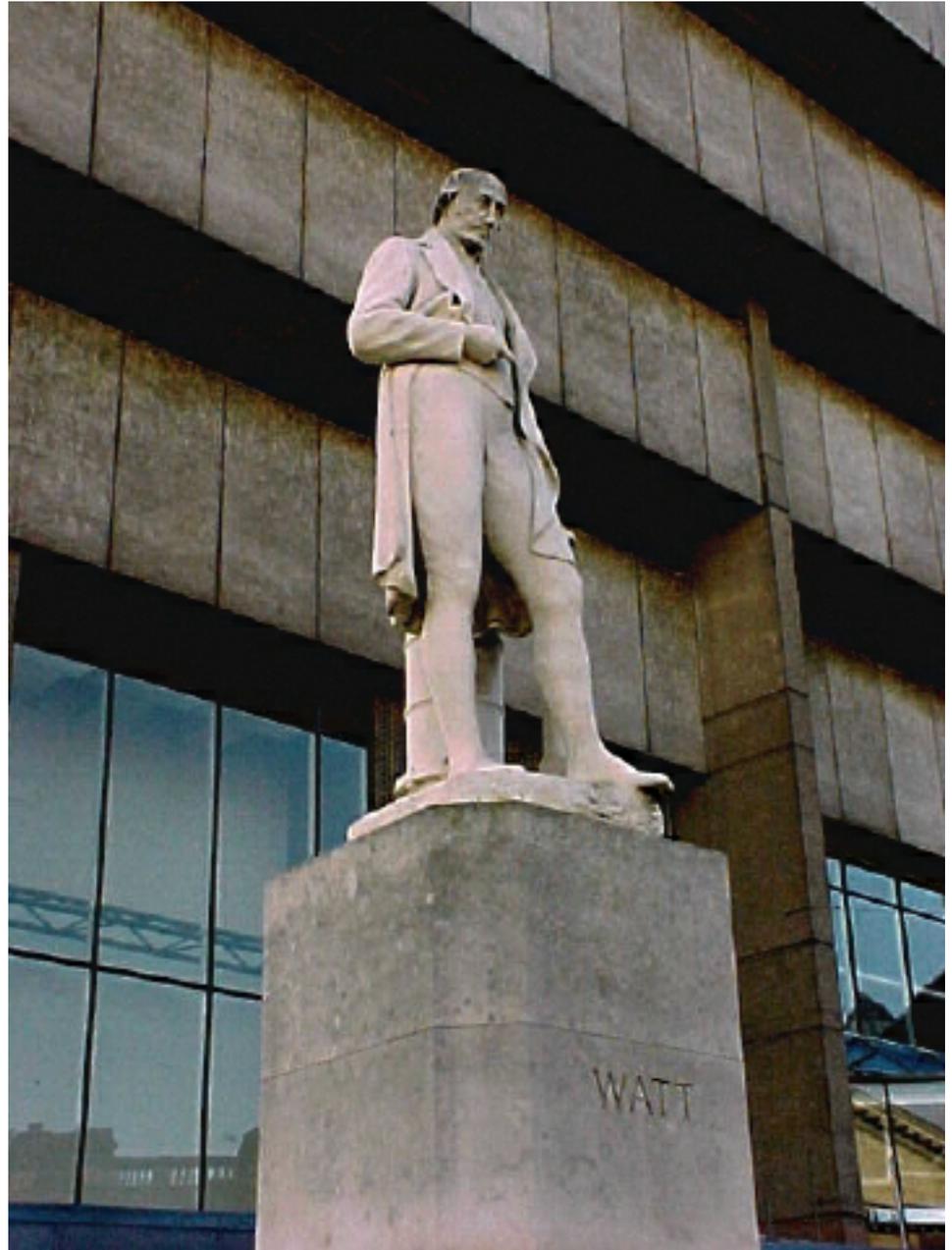
***Energy per area per  
time***

***Power per area***

***Unit:***

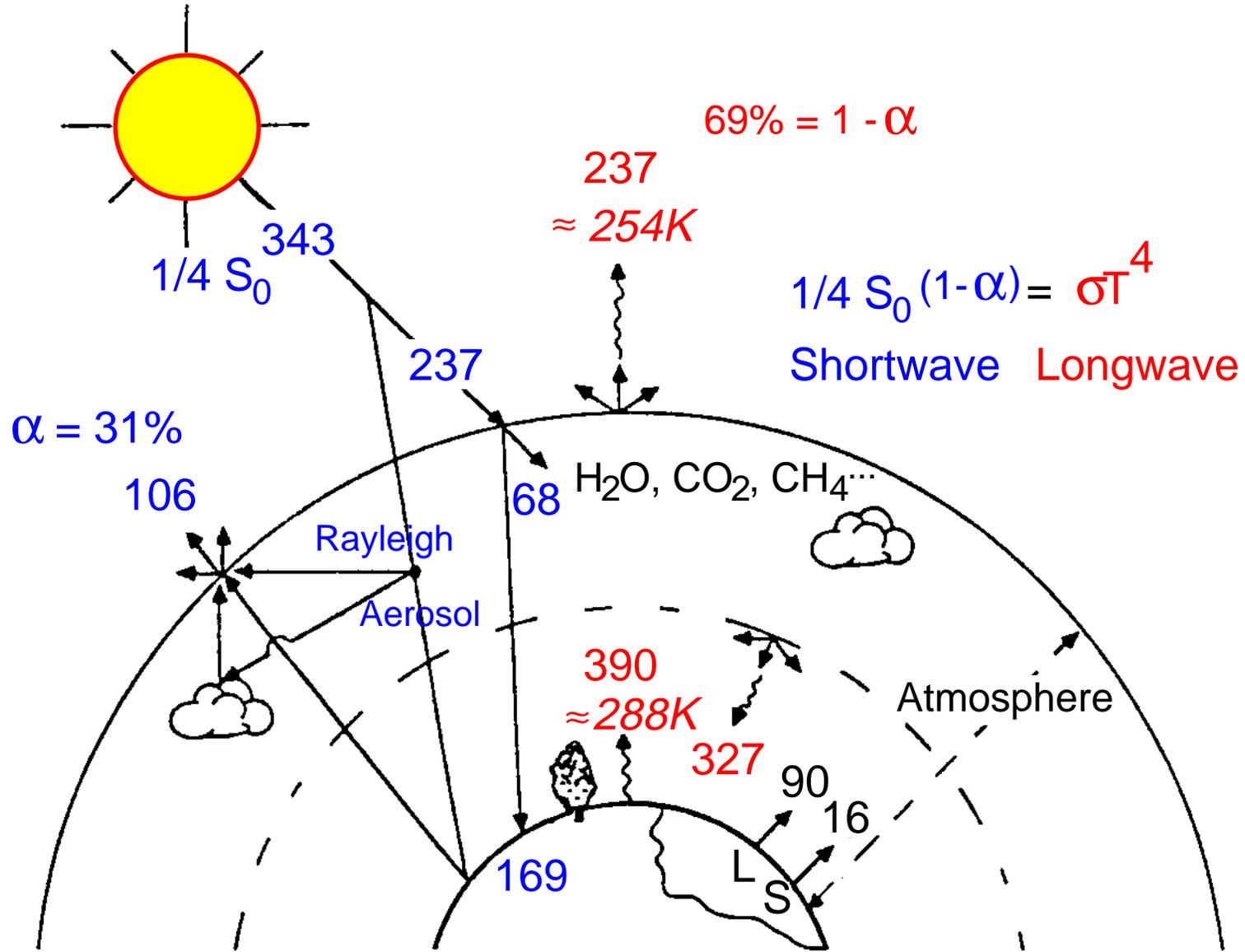
***Watt per square meter***

***$W m^{-2}$***



# GLOBAL ENERGY BALANCE

Global and annual average energy fluxes in watts per square meter



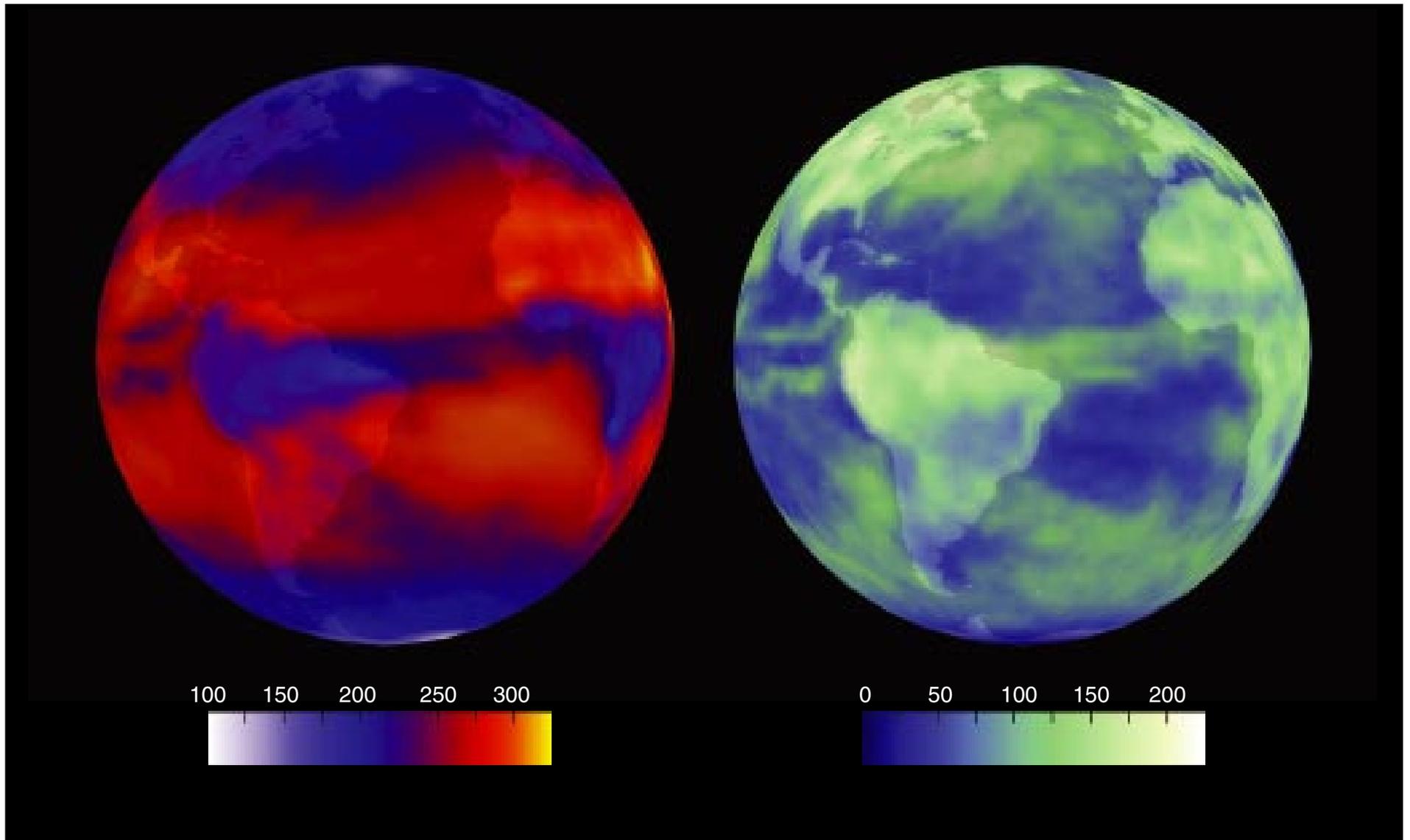
*Schwartz, 1996, modified from Ramanathan, 1987*

# GEOGRAPHICAL VARIATION OF ATMOSPHERIC RADIATION

Annual average radiative flux at top of atmosphere,  $\text{W m}^{-2}$

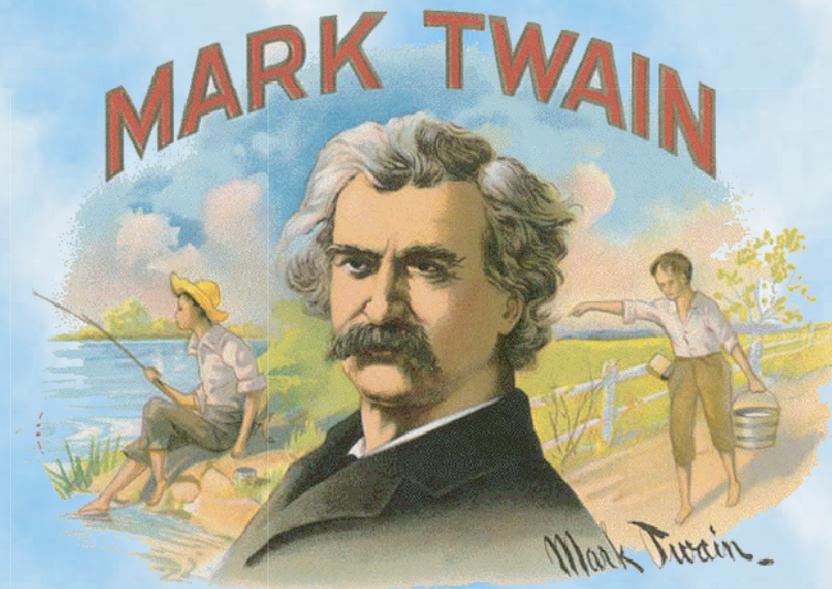
Emitted thermal infrared

Reflected shortwave



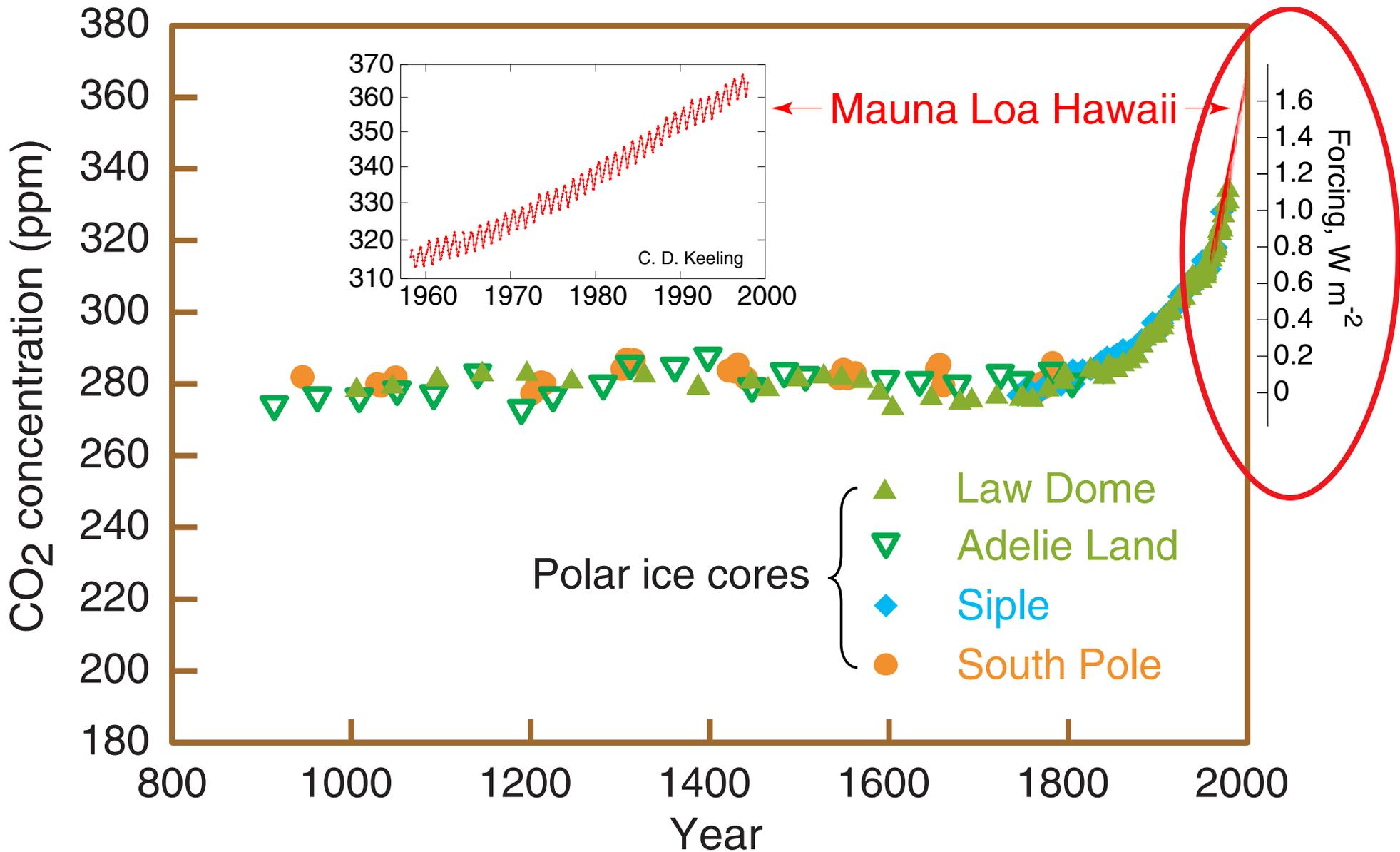
CERES (Clouds and Earth's Radiant Energy System satellite, March, 2000 - May, 2001

*Everybody talks about the weather —  
But nobody does anything about it.*



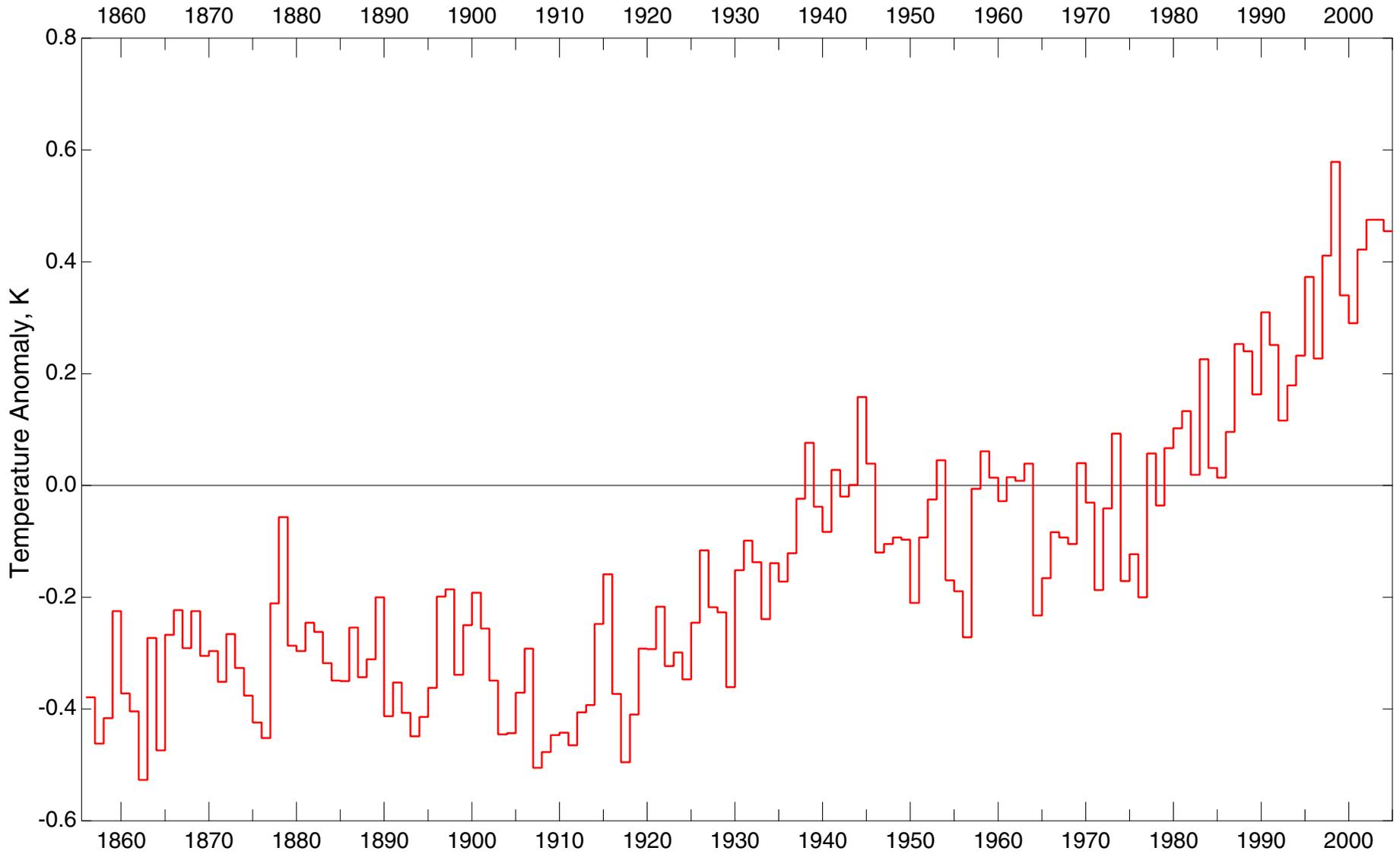
*Now with the greenhouse effect,  
we ARE doing something about it.  
What are we doing?*

# ATMOSPHERIC CARBON DIOXIDE IS INCREASING



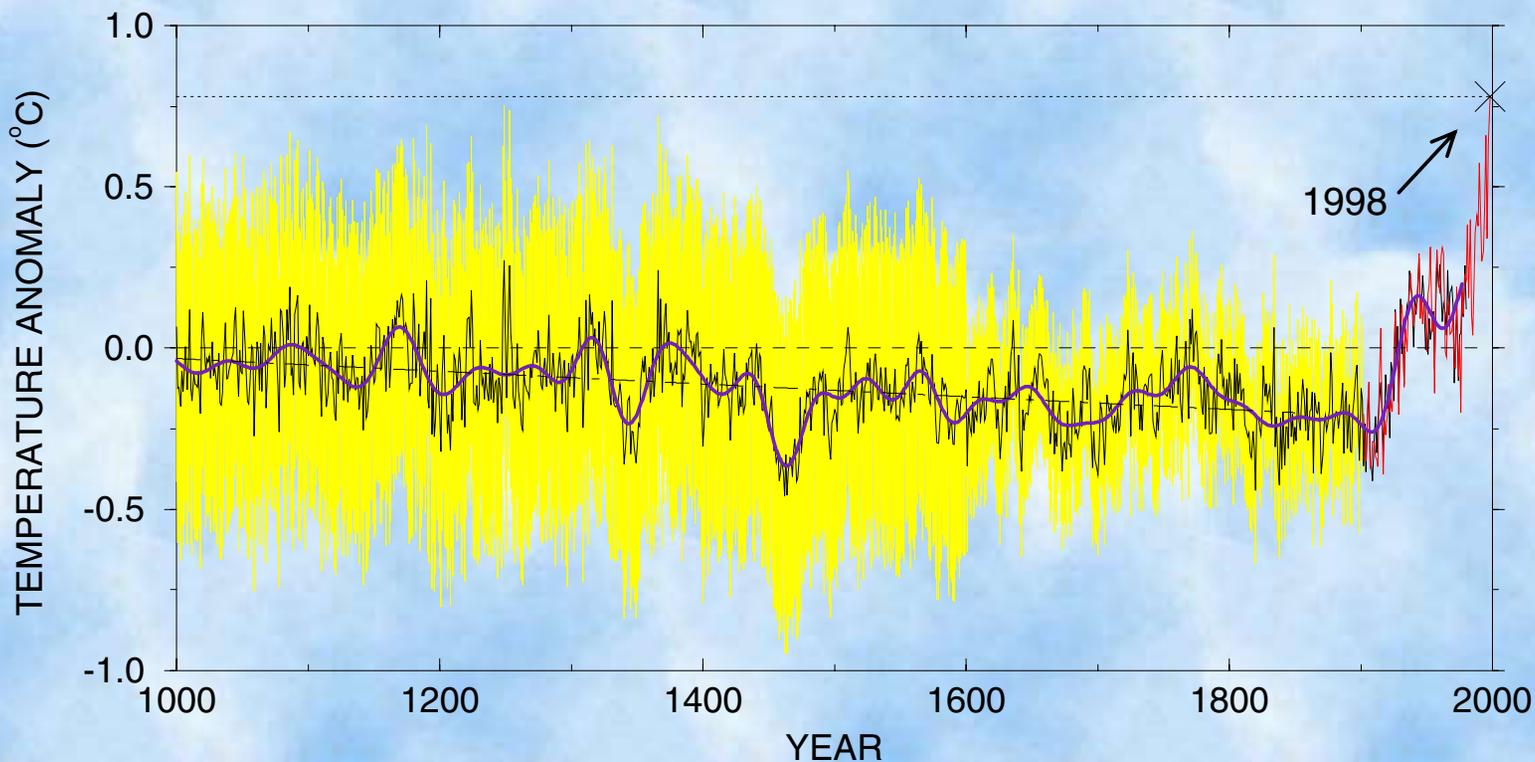
Global carbon dioxide concentration and infrared radiative forcing over the last thousand years

# CHANGE IN GLOBAL MEAN SURFACE TEMPERATURE 1855-2004



*Climate Research Unit, University of East Anglia, UK*

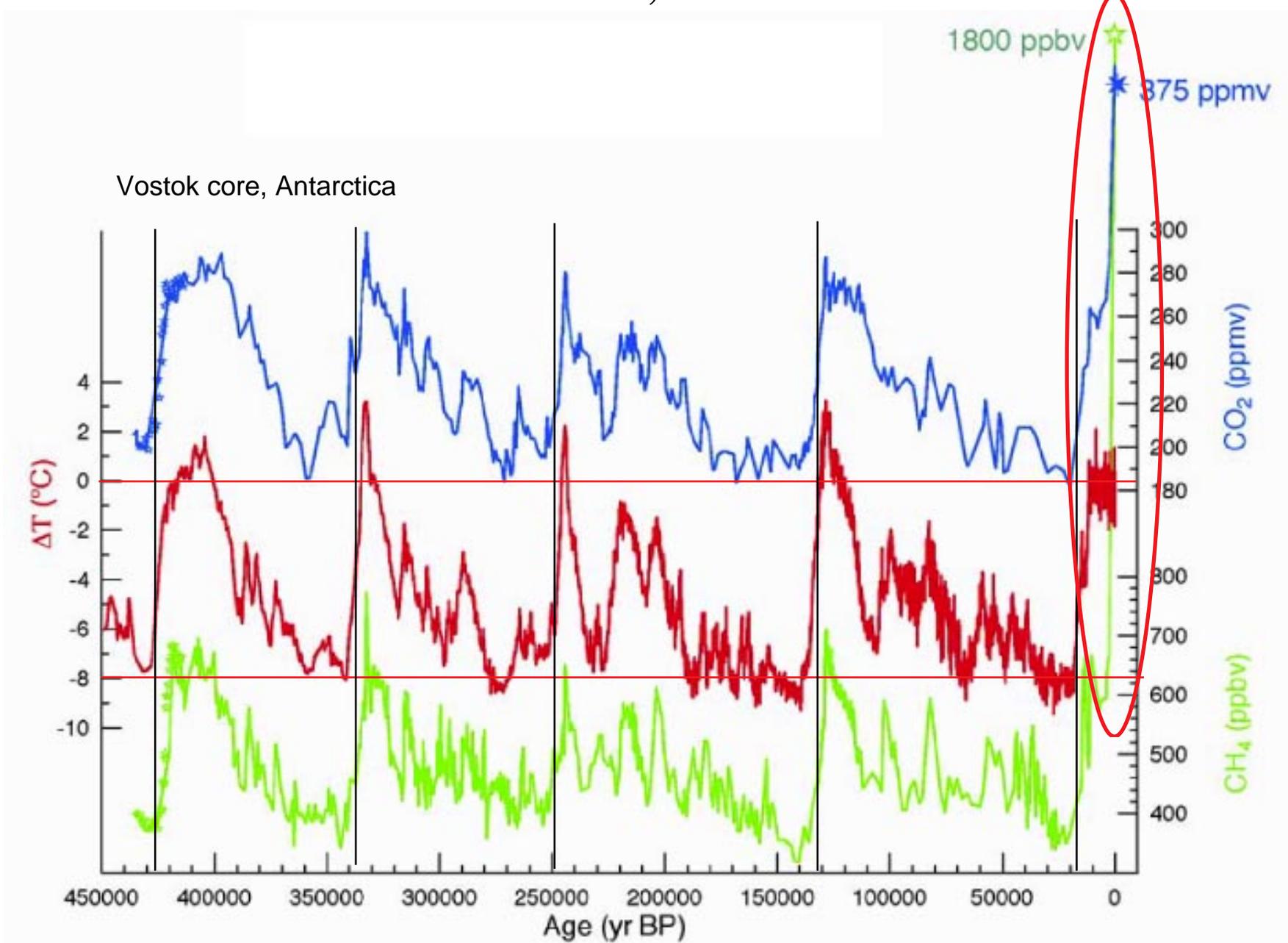
# THE TEMPERATURE'S RISING



- Reconstruction (AD 1000-1980)
- Instrumental data (AD 1902-1998)
- - - Calibration period (AD 1902-1980) mean
- Reconstruction (40 year smoothed)
- - - Linear trend (AD 1000-1850)

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*

# GREENHOUSE GASES AND TEMPERATURE OVER 450,000 YEARS

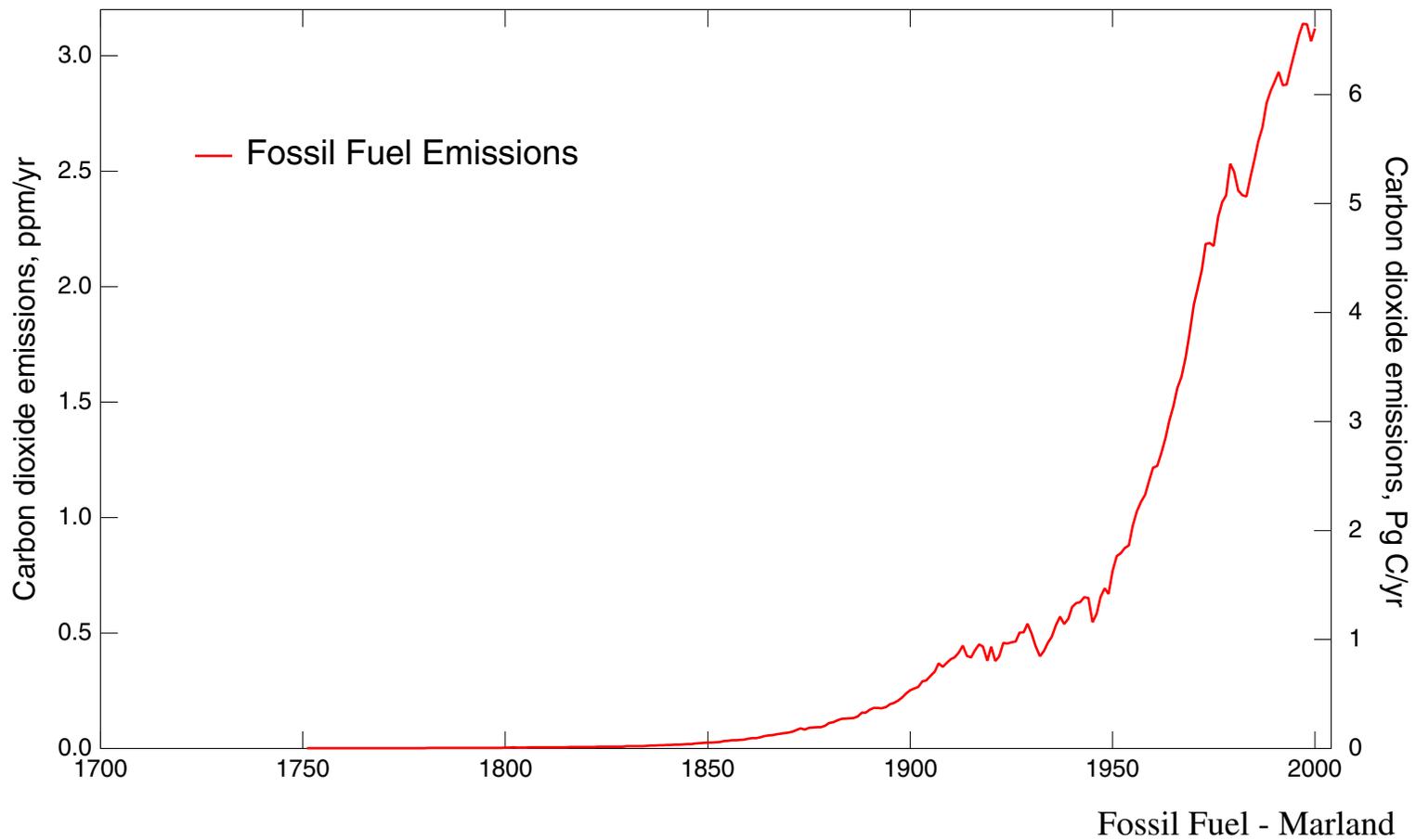


Modified from Petit et al., Nature, 1999

# INCREASES IN CO<sub>2</sub> OVER THE INDUSTRIAL PERIOD

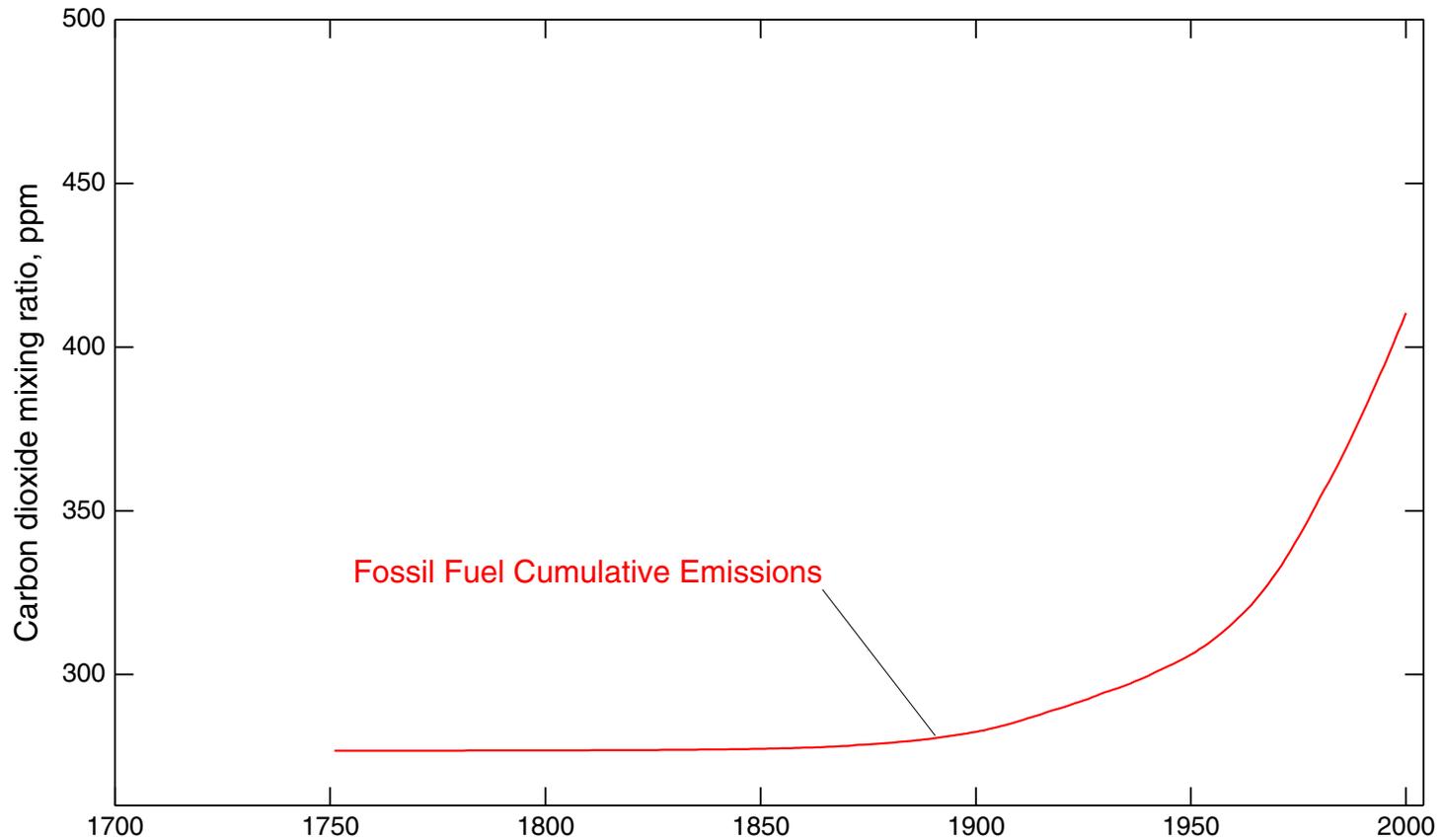
# ATMOSPHERIC CO<sub>2</sub> EMISSIONS

## Time series 1700 - 2003



# ATMOSPHERIC CARBON DIOXIDE

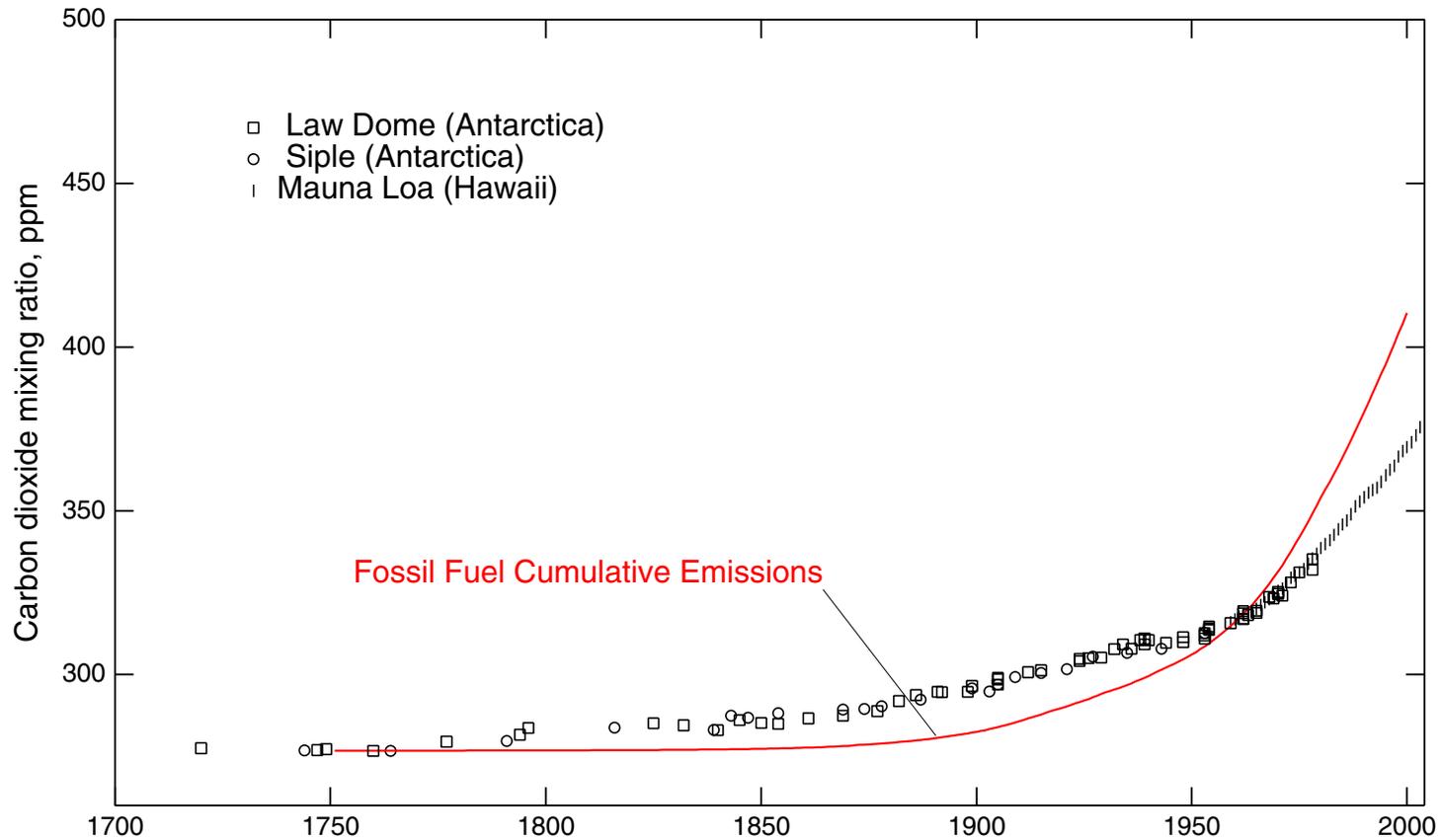
## Time series 1700 - 2003



Fossil Fuel - Marland

# ATMOSPHERIC CARBON DIOXIDE

## Time series 1700 - 2003



Law - Etheridge et al.  
Siple - Friedli et al.  
Mauna Loa - Keeling  
Fossil Fuel - Marland

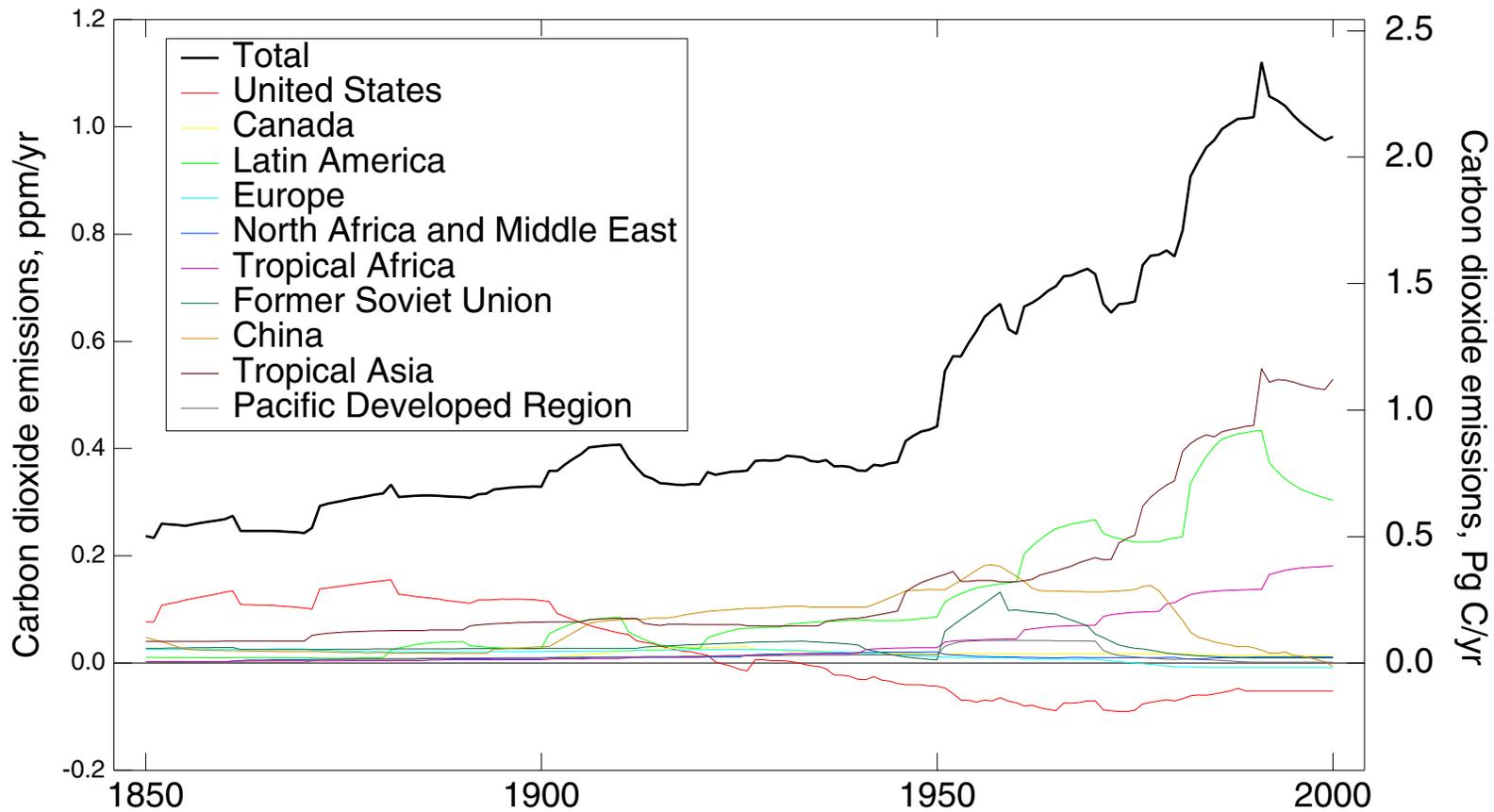
*What's missing from this story?*

# DEFORESTATION AS A SOURCE OF ATMOSPHERIC CO<sub>2</sub>



# ATMOSPHERIC CO<sub>2</sub> EMISSIONS

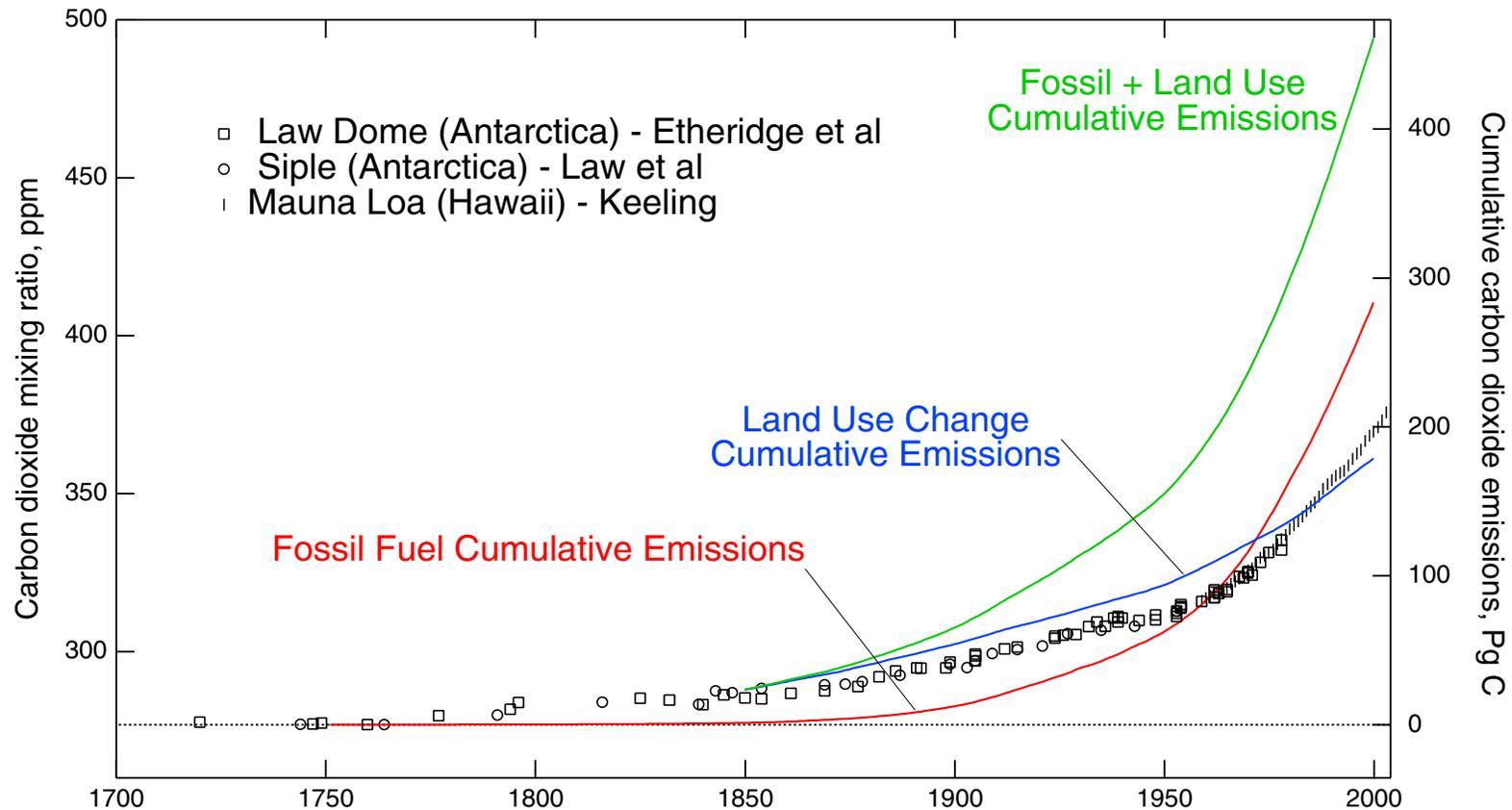
## Land-use changes 1850 - 2000



Houghton, *Tellus*, 1999; Houghton and Hackler, 2002

# ATTRIBUTION OF INCREASE IN ATMOSPHERIC CO<sub>2</sub>

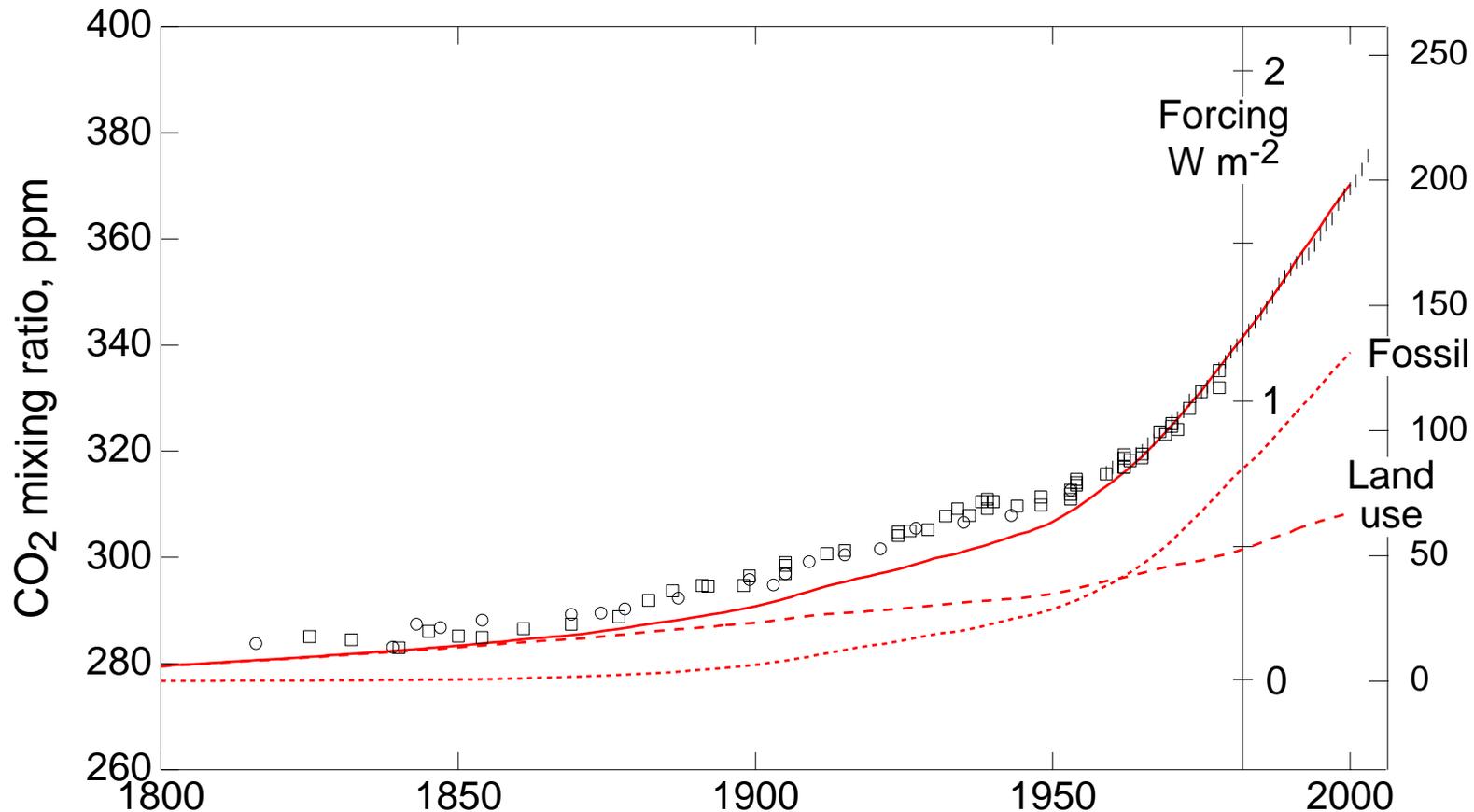
Comparison of *cumulative* CO<sub>2</sub> emissions from fossil fuel combustion and land use changes with measured increases in atmospheric CO<sub>2</sub>.



*Prior to 1970* the increase in atmospheric CO<sub>2</sub> was dominated by emissions from land use changes, not fossil fuel combustion.

# ATTRIBUTION OF ATMOSPHERIC CO<sub>2</sub>

Comparison of CO<sub>2</sub> mixing ratio *and forcing*  
From fossil fuel combustion and land use changes

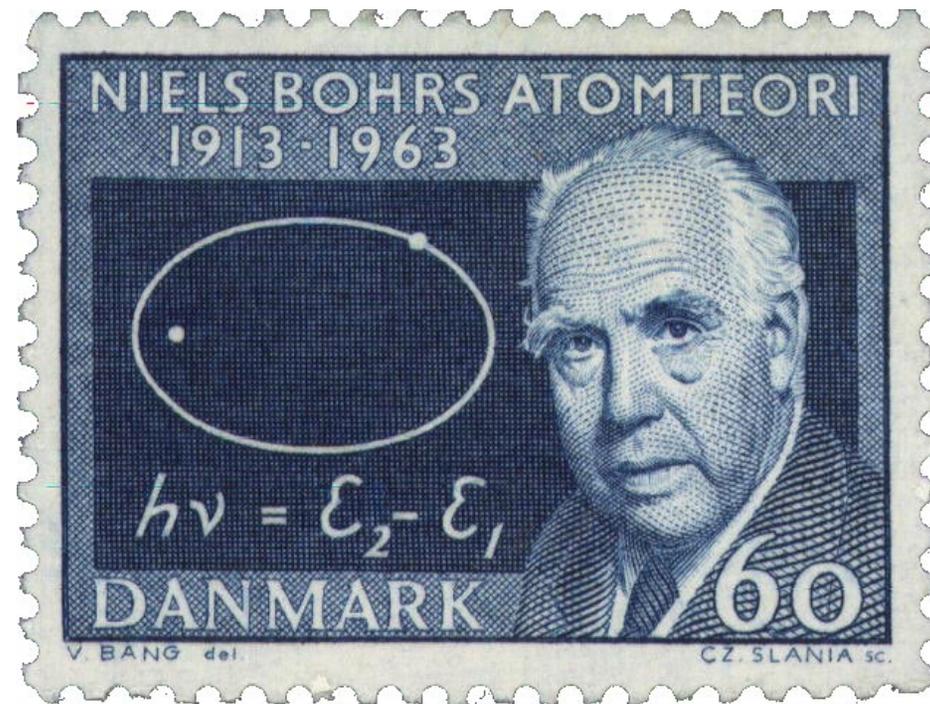


CO<sub>2</sub> from land use emissions – *not fossil fuel combustion* was the dominant contribution to atmospheric CO<sub>2</sub> *and forcing* over the 20<sup>th</sup> century.

*Looking to the  
Future . . .*



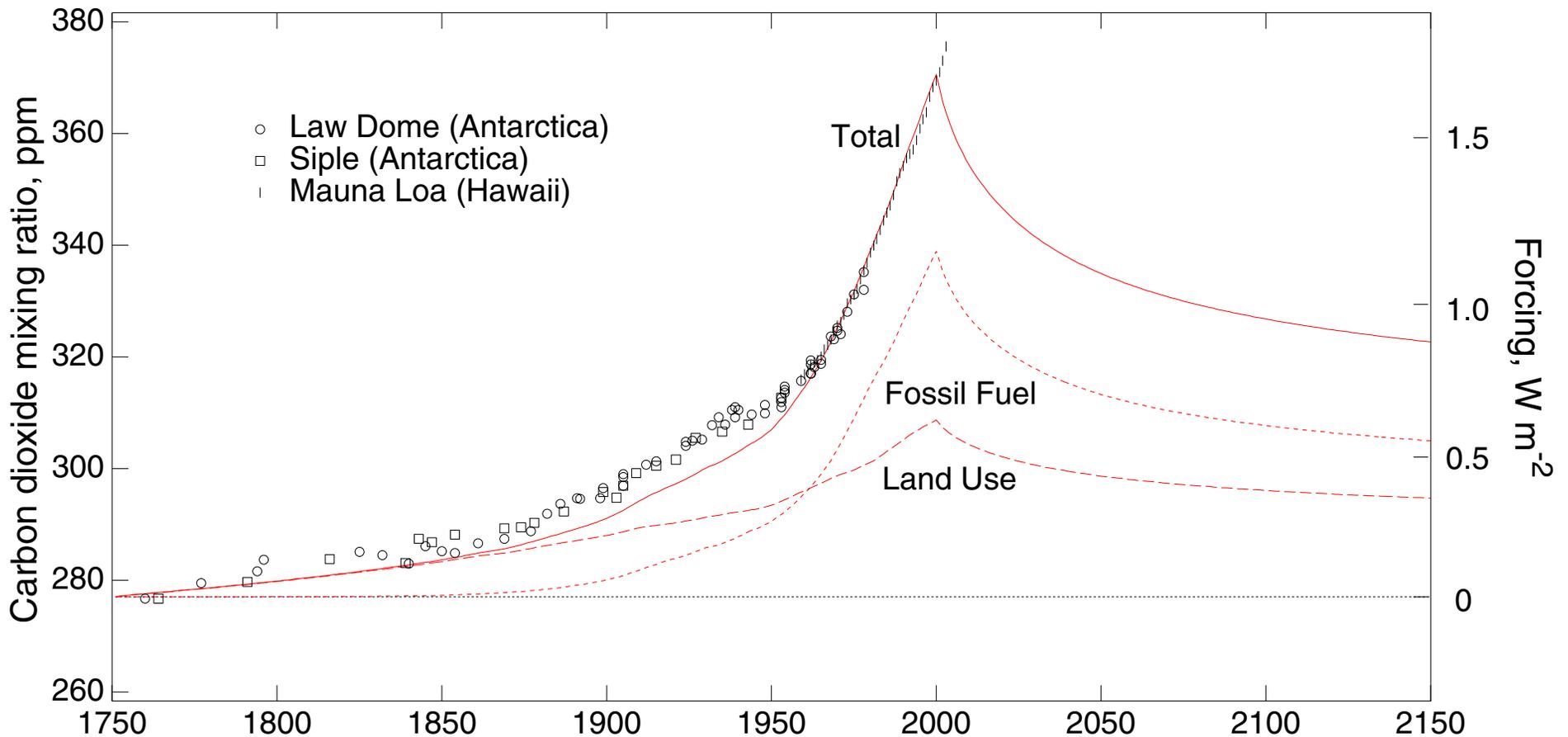
*Prediction is difficult,  
especially about the future.*



*– Niels Bohr*

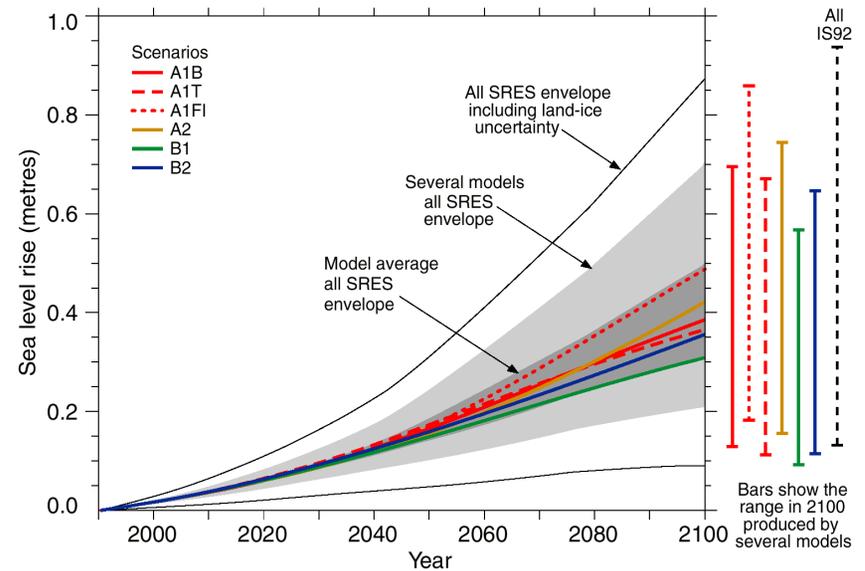
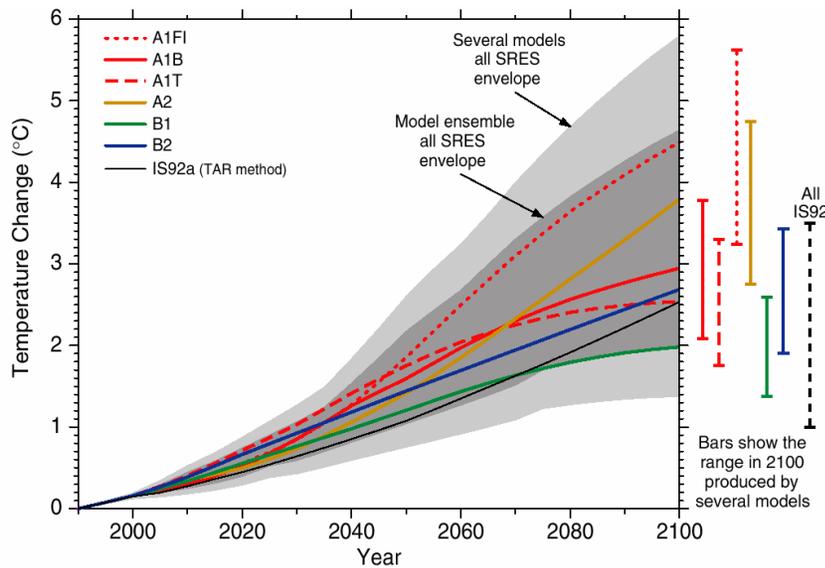
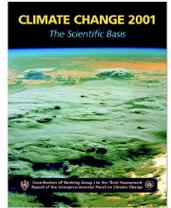
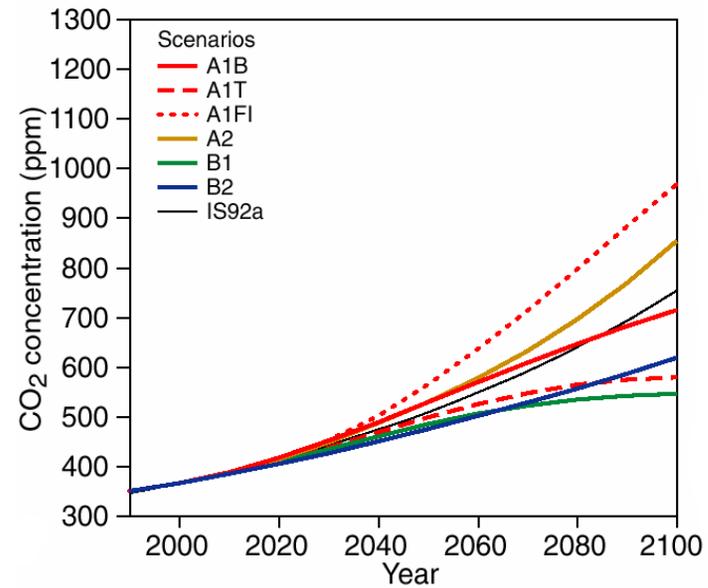
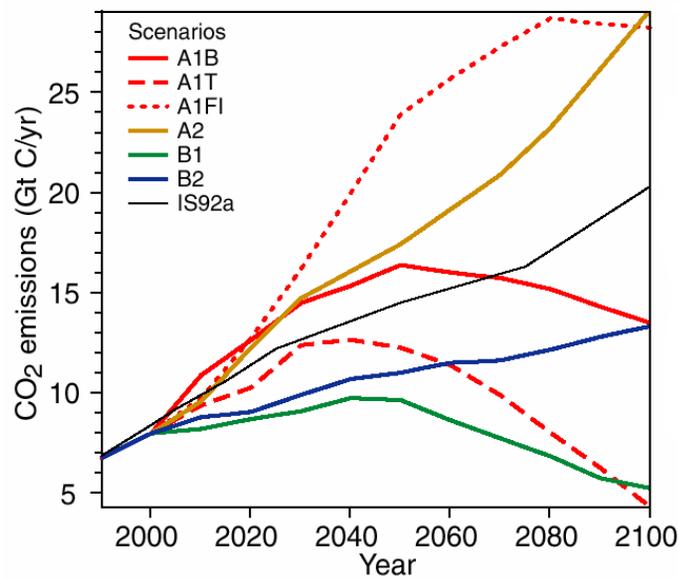
# FUTURE ATMOSPHERIC CO<sub>2</sub>

Projection of CO<sub>2</sub> *mixing ratio and forcing* due to anthropogenic emissions from 1750 to 2000



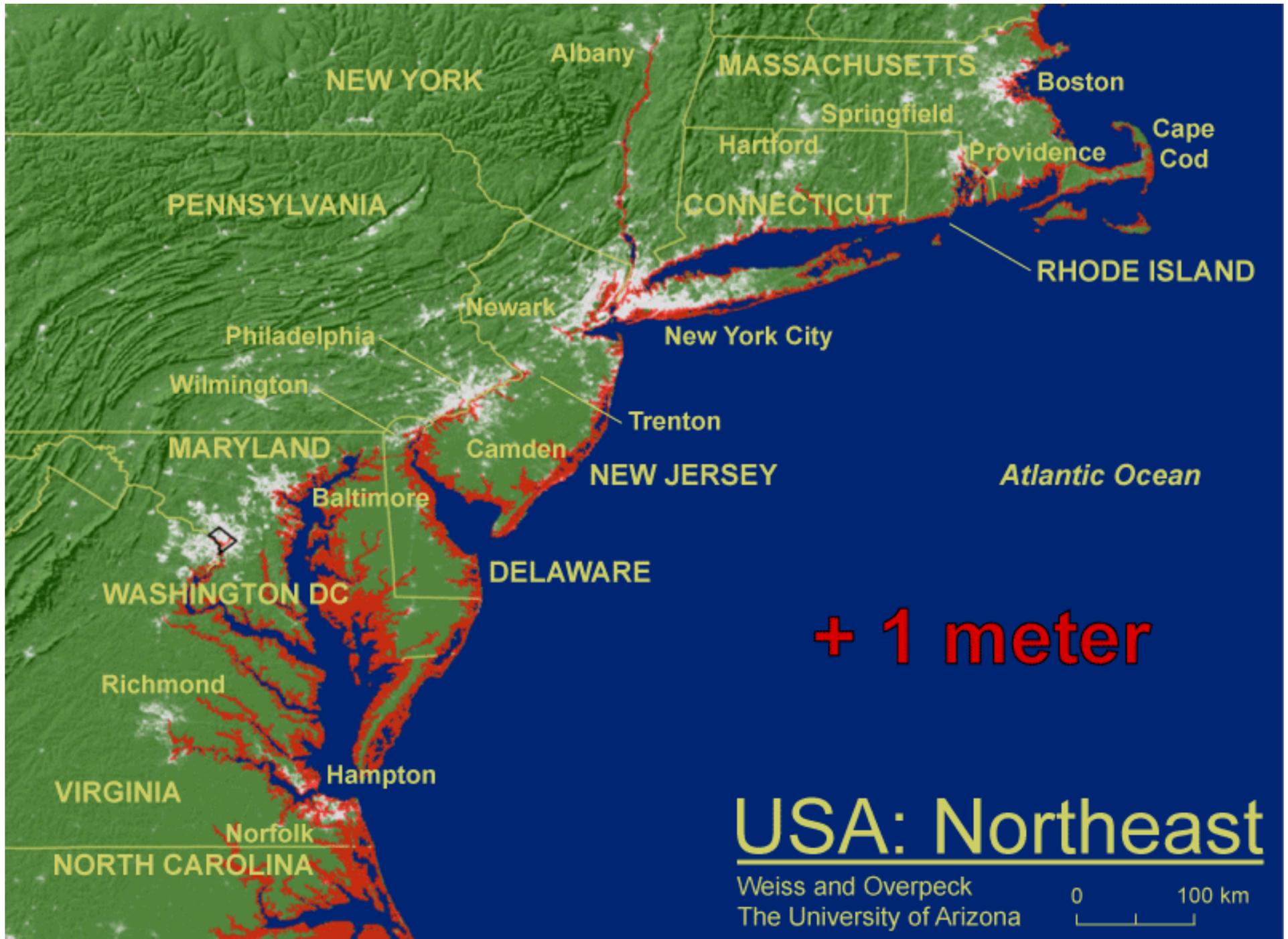
The footprint of prior CO<sub>2</sub> emissions lasts well beyond a century.

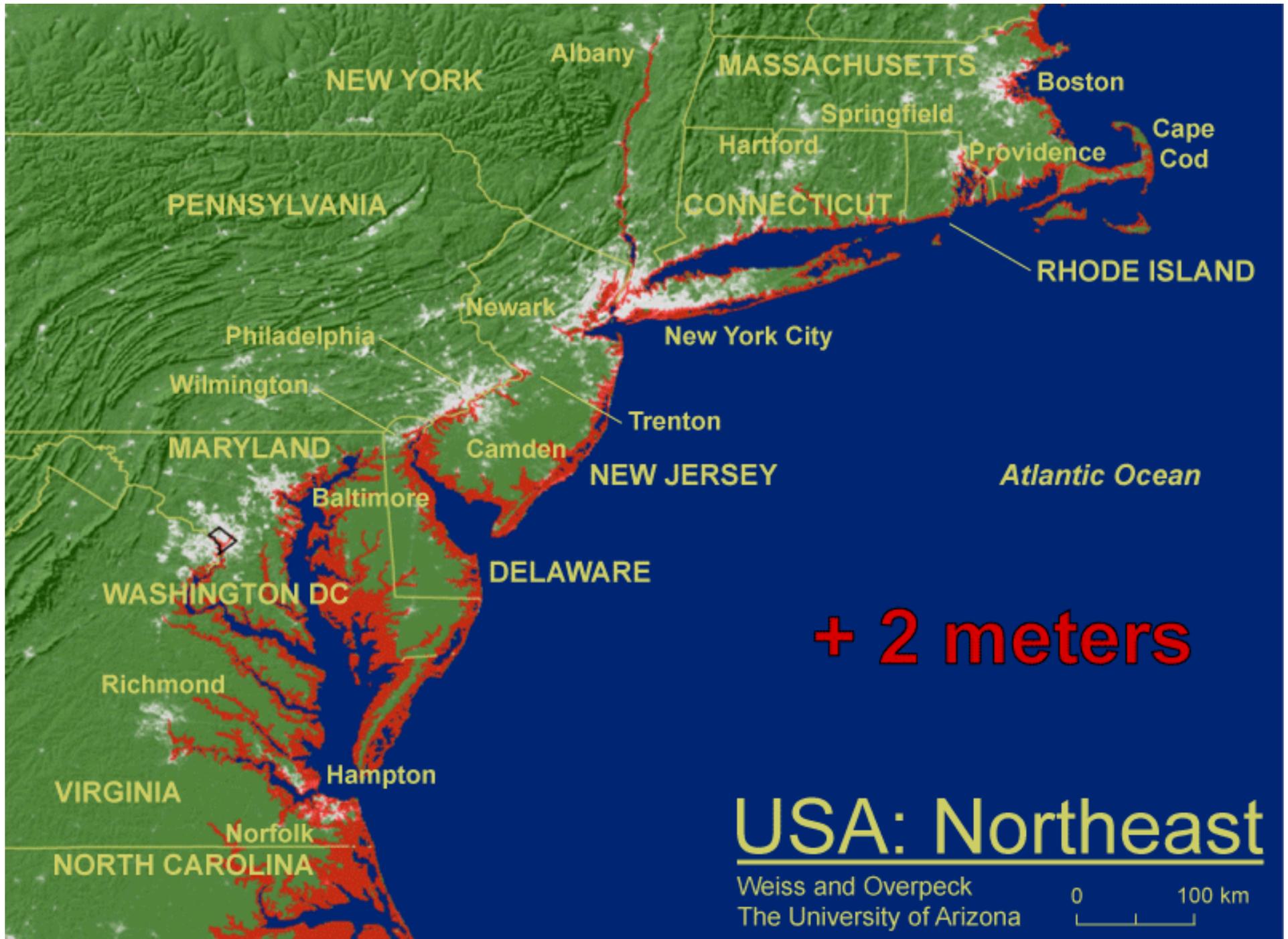
# PROJECTIONS OF FUTURE CO<sub>2</sub>, TEMPERATURE, AND SEA LEVEL

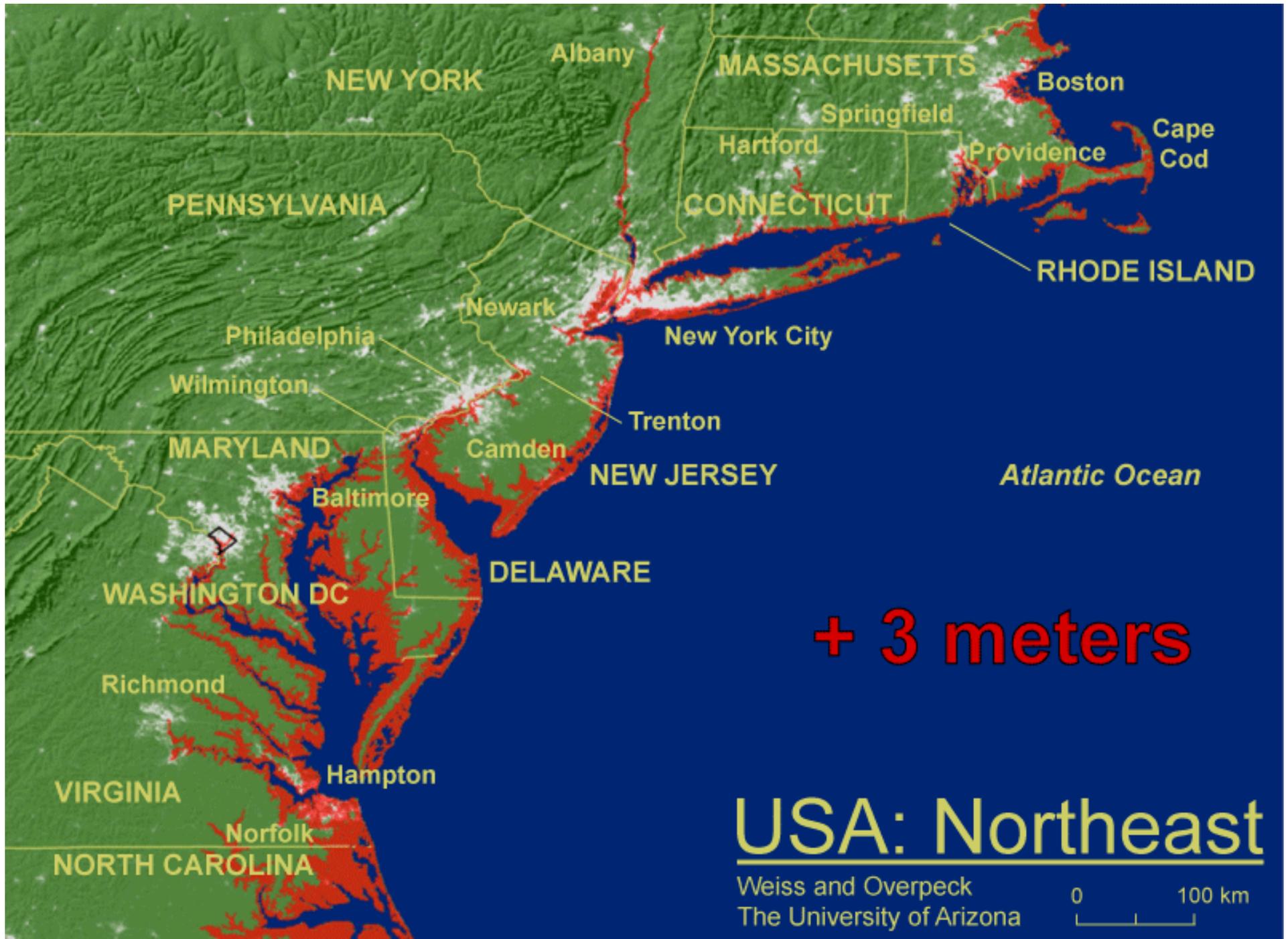


Contributors to uncertainty in future temperature include *emissions*, *concentrations*, and Earth's *climate sensitivity*.







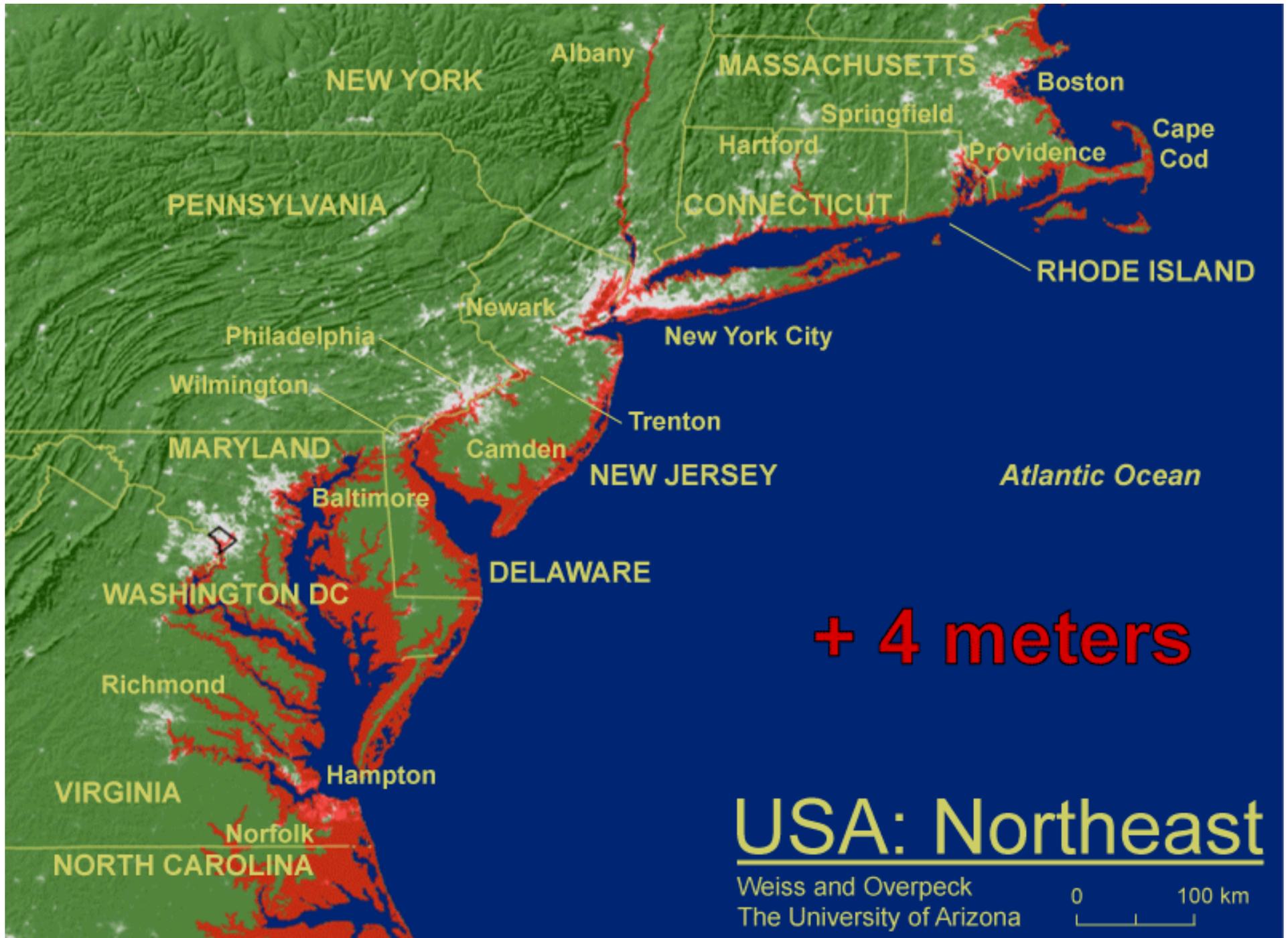


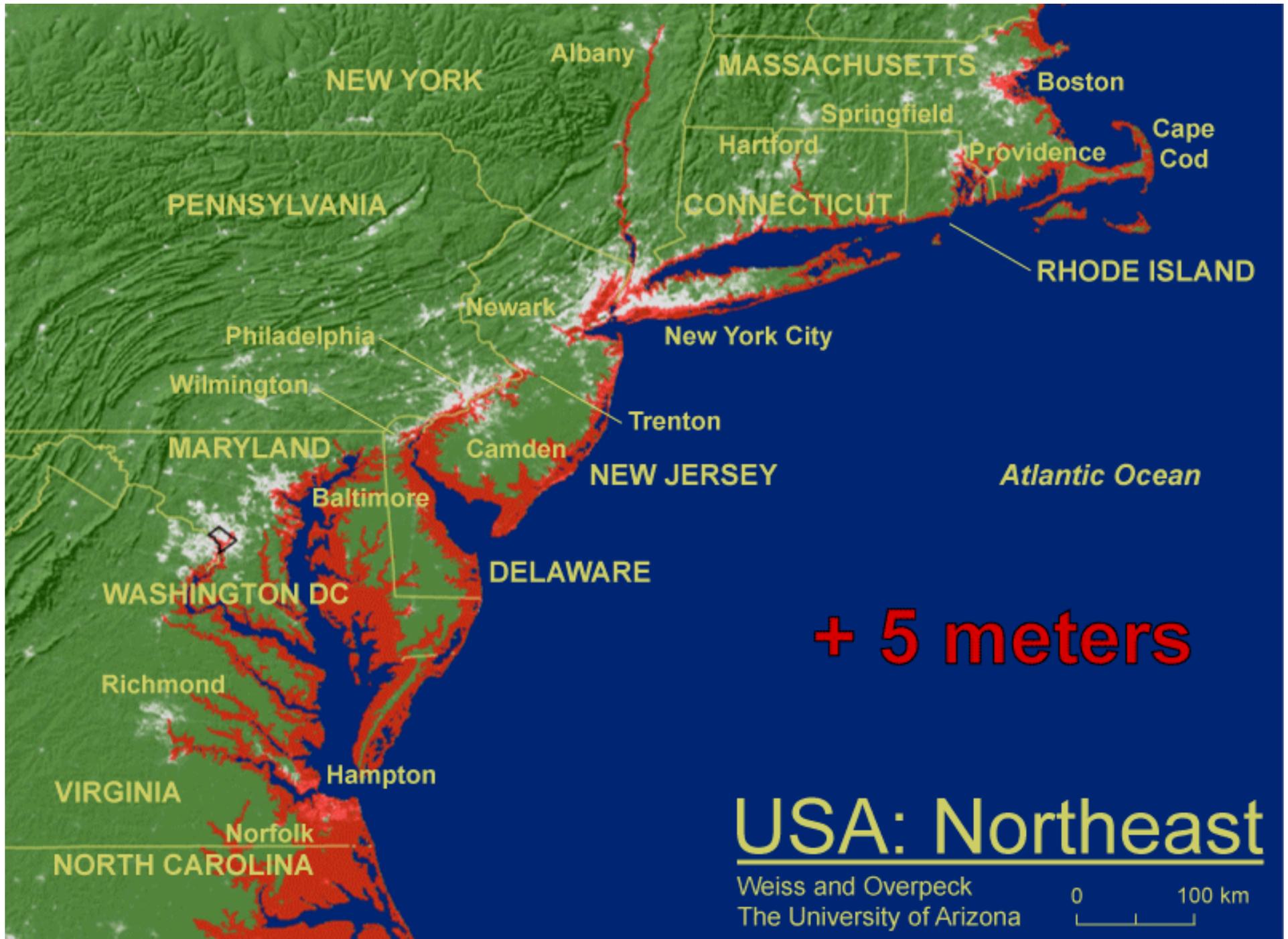
**+ 3 meters**

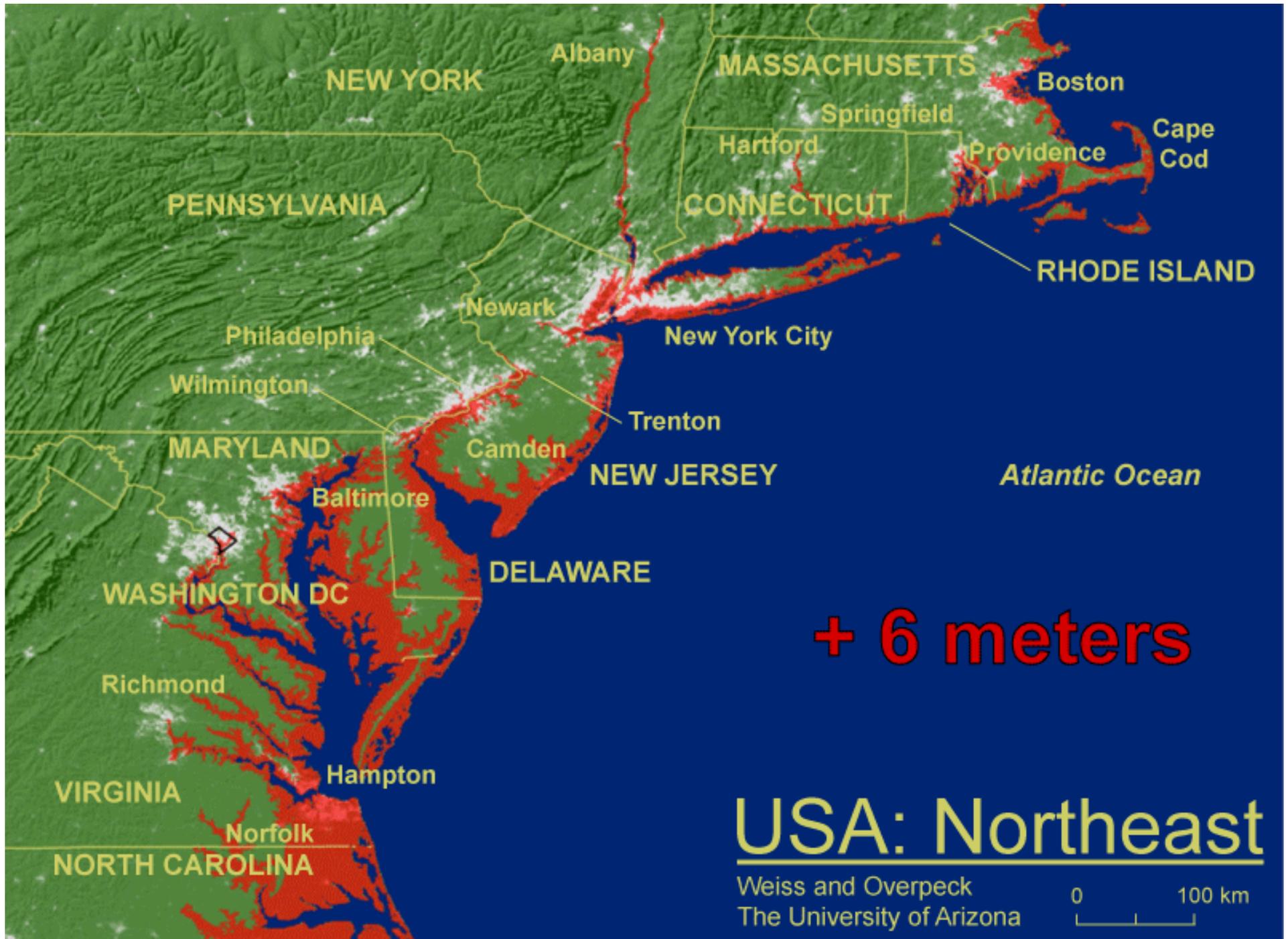
# USA: Northeast

Weiss and Overpeck  
The University of Arizona











*"Gentlemen, it's time we gave some serious thought to the effects of global warming."*

***WHERE IS ALL  
THIS CO<sub>2</sub>  
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.

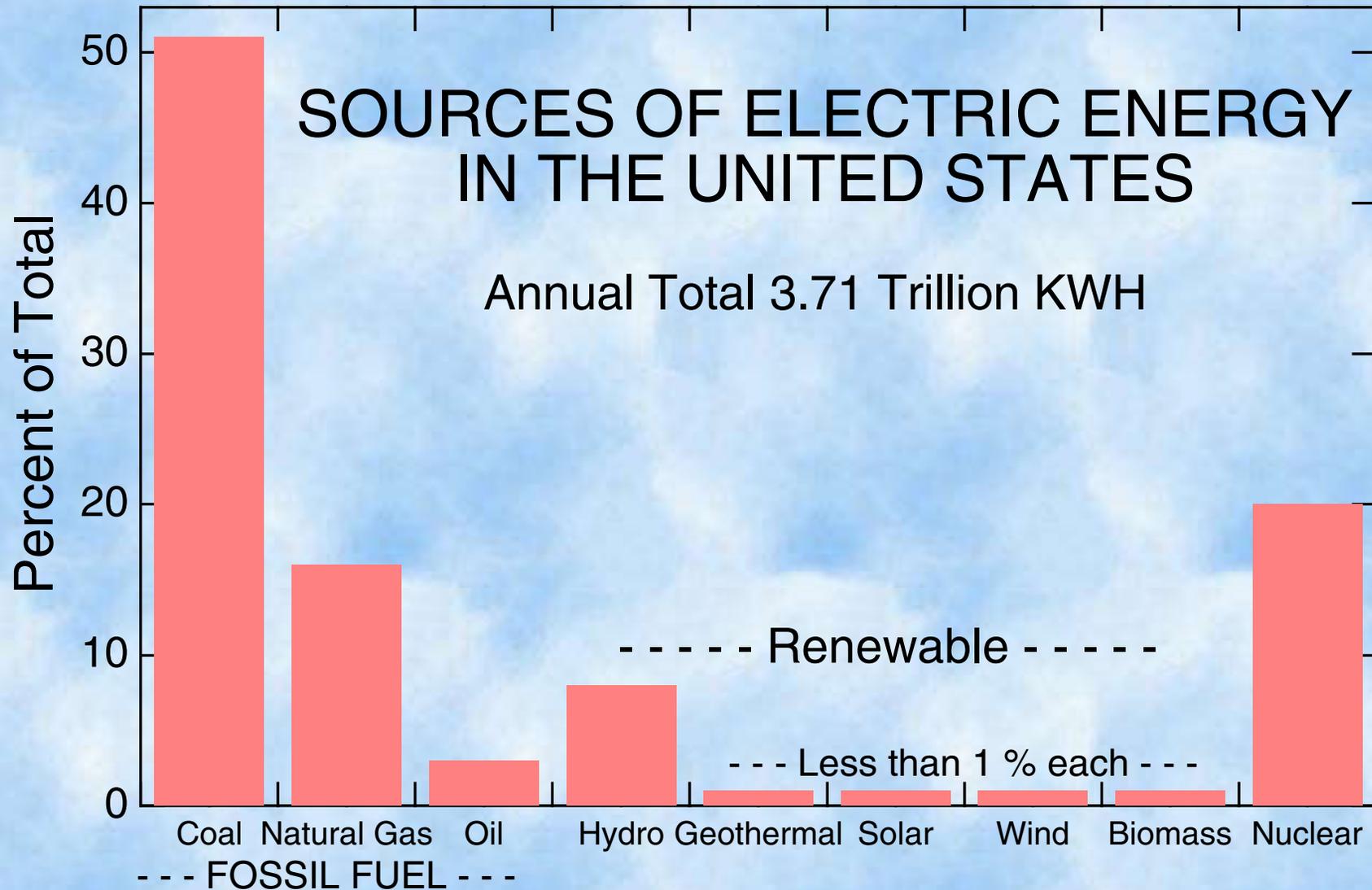


THE MOST EFFECTIVE WAY TO  
DOUBLE THE FUEL ECONOMY  
OF A CAR . . .

***IS TO PUT TWO  
PEOPLE IN IT!***

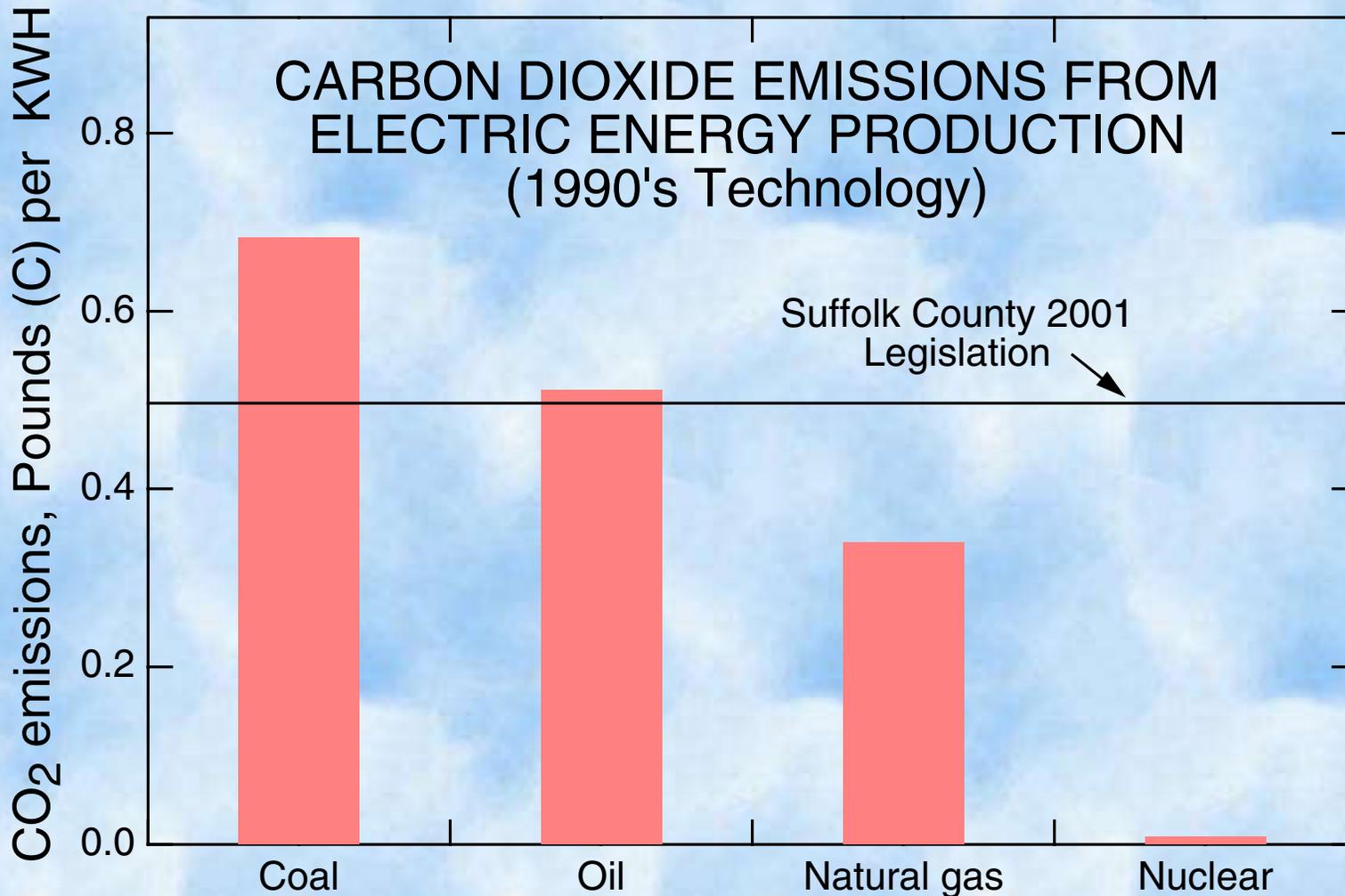


# WHERE DOES YOUR ELECTRIC ENERGY COME FROM?



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

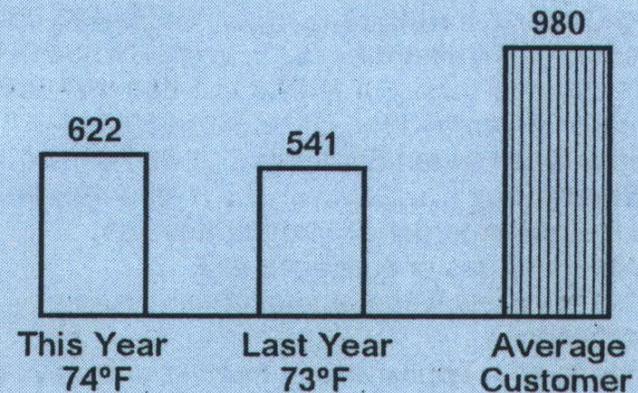
**Meter Readings**      Meter # 15790134

Jul 24    93155 Actual

Jun 26    92533 Actual

**Use**      28 Days      622 KWH

**Comparisons**      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

Jul 25, 2001

Date

927 20 1805 3 5

Account Number

1-800-490-0025

Any Questions?

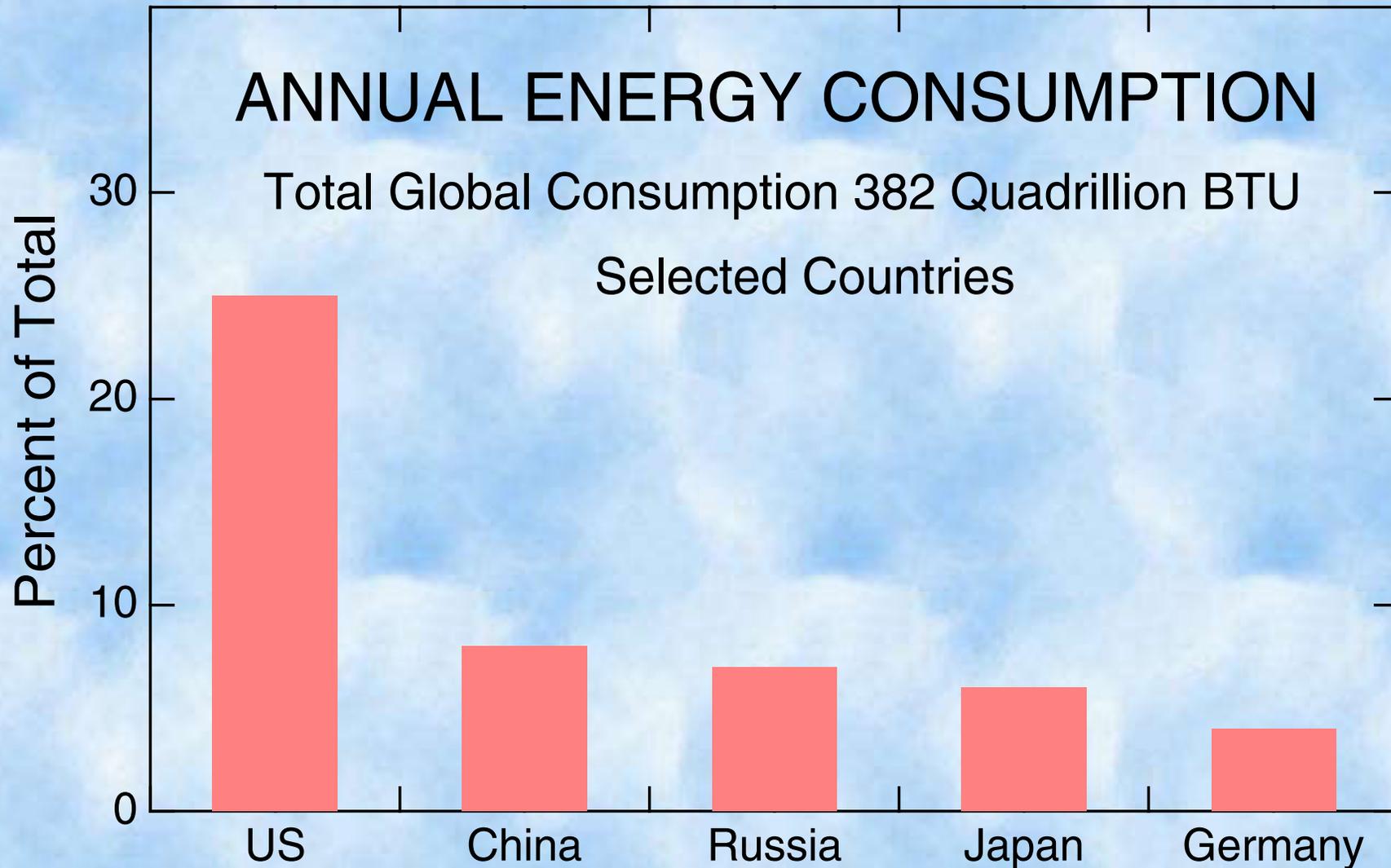
See Back Of Bill

Service Problems



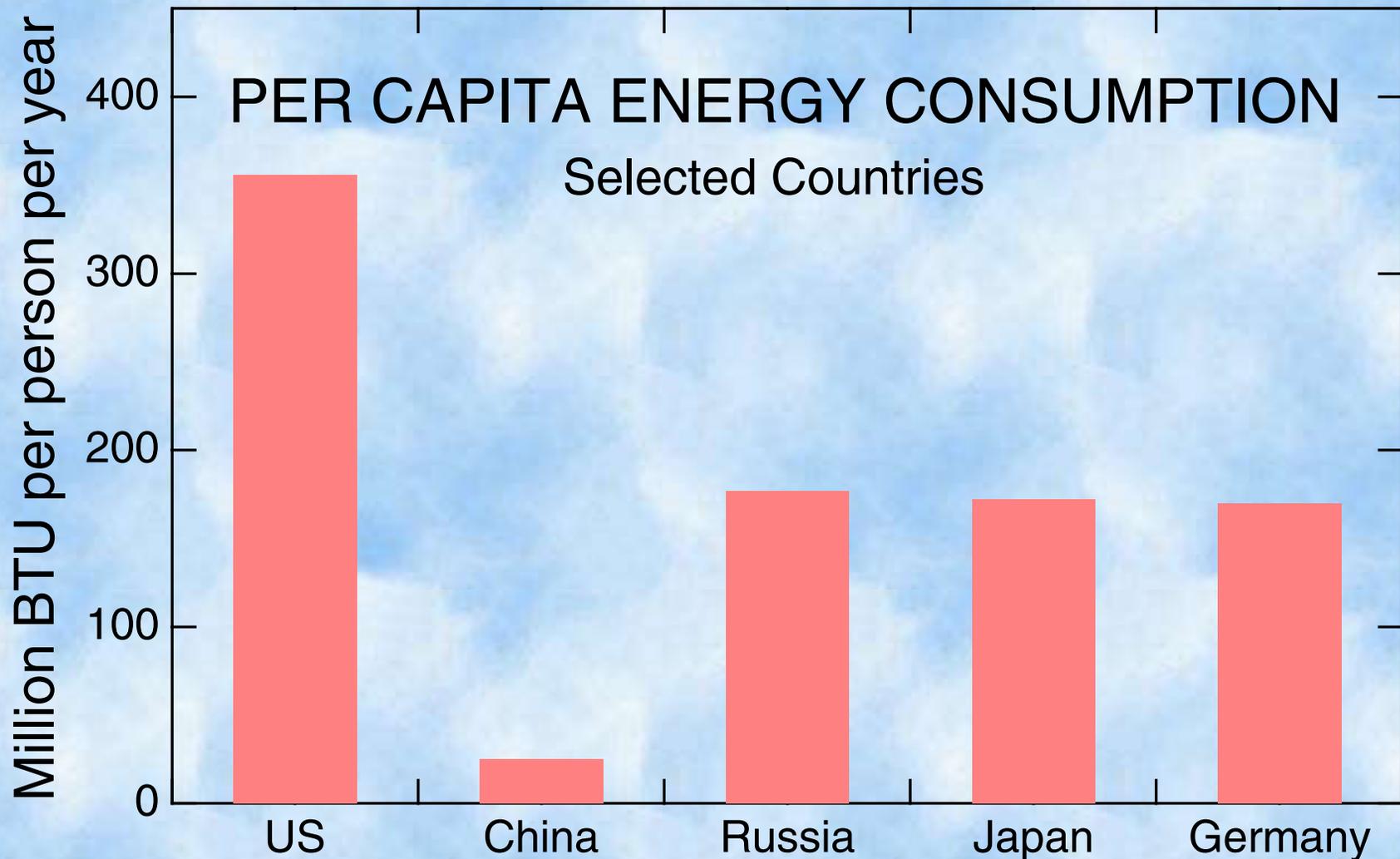
At half a pound of carbon per KWH, the average household is responsible for emission of 500 pounds of carbon a month .

# WHAT COUNTRY USES THE MOST ELECTRIC POWER?



No surprise. It's the United States.

# 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<sub>2</sub>), 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 IS HELPING  
TO ANSWER THESE QUESTIONS.***

***[www.ecd.bnl.gov/steve](http://www.ecd.bnl.gov/steve)***