

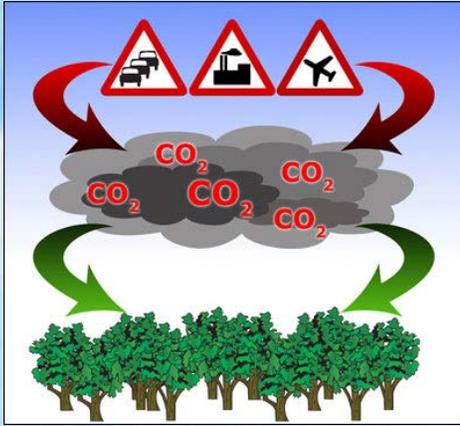


Energy, CO₂,

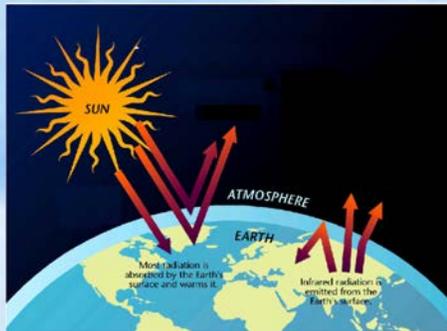


Climate, and YOU!

Stephen E. Schwartz



BROOKHAVEN
NATIONAL LABORATORY



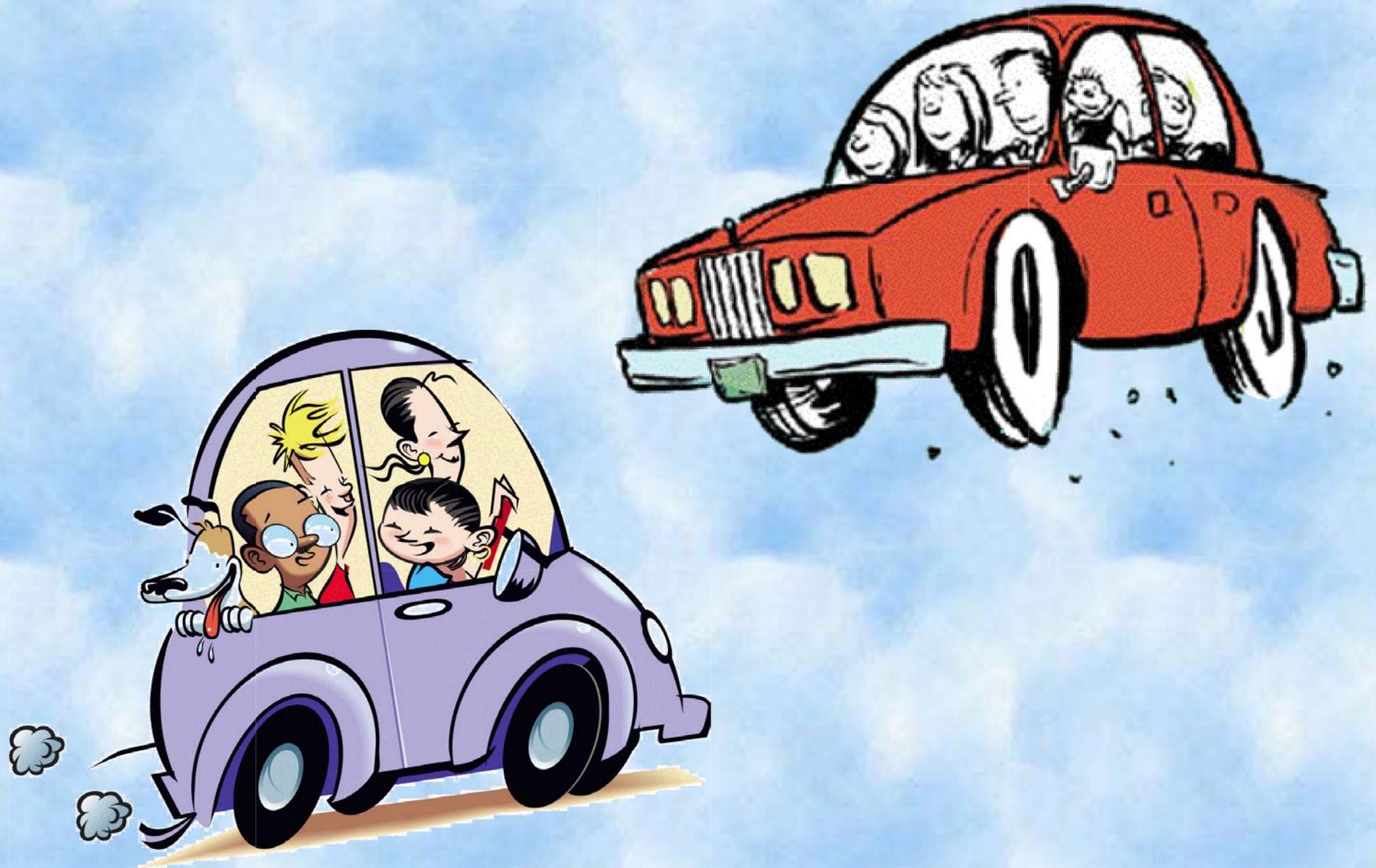
SUFFOLK Y JEWISH COMMUNITY CENTER



November 11, 2013

www.ecd.bnl.gov/steve

CARPOOLING TO SUMMER SUNDAY AT BNL



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

IS TO PUT TWO
PEOPLE IN IT!



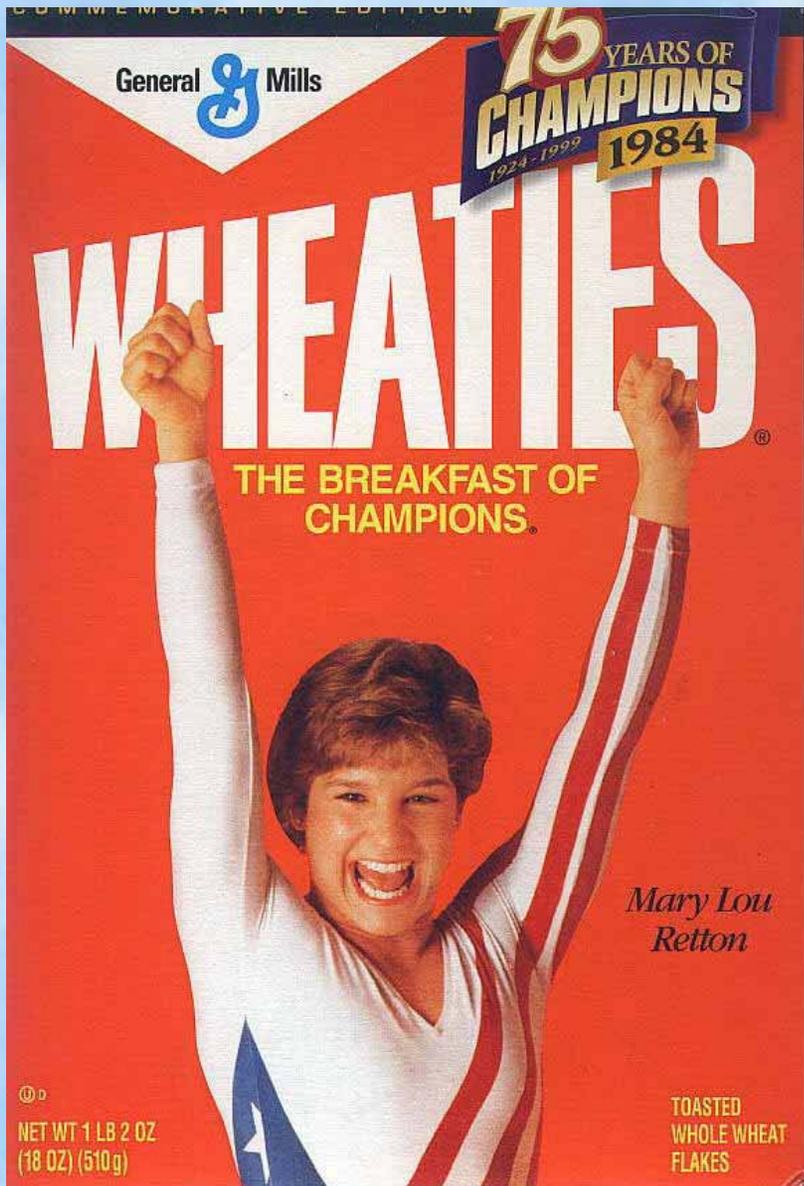
CARPOOLING CAN SAVE MORE THAN GAS



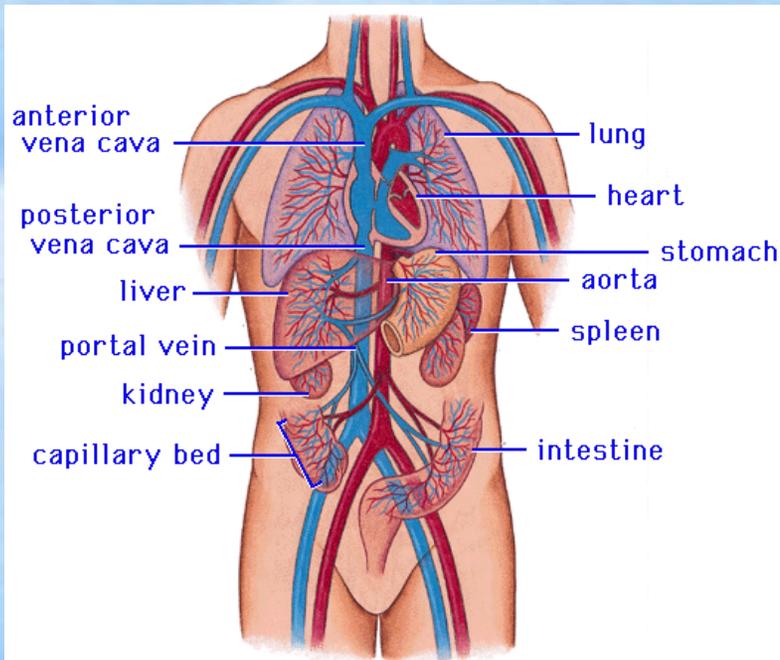
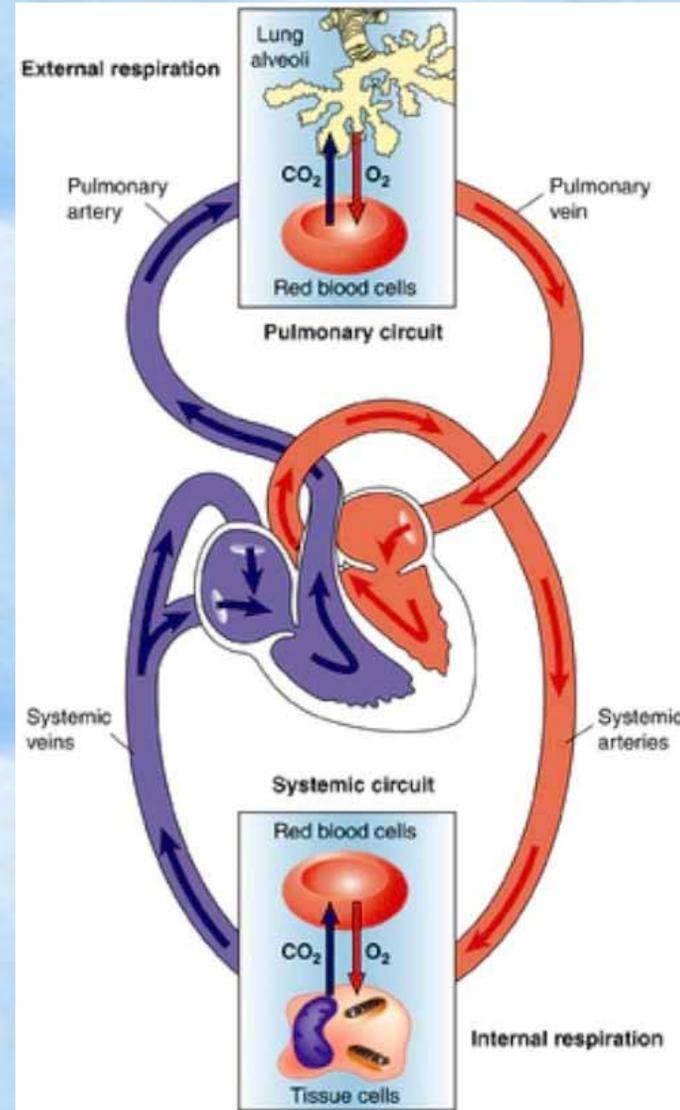
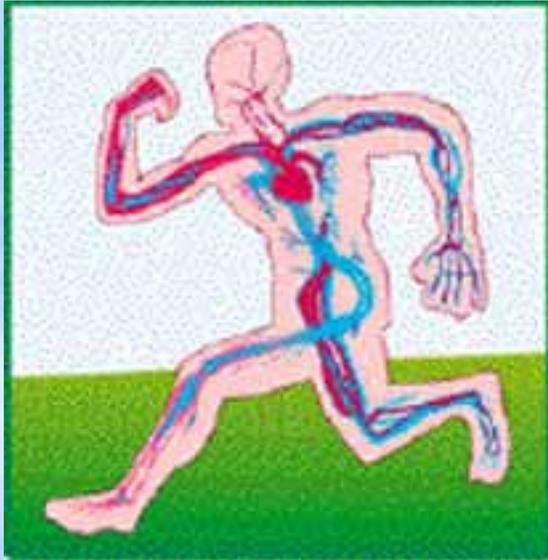


Energy

WHERE DO YOU GET YOUR ENERGY?



HOW DO ENERGY AND OXYGEN GET TO YOUR MUSCLES?

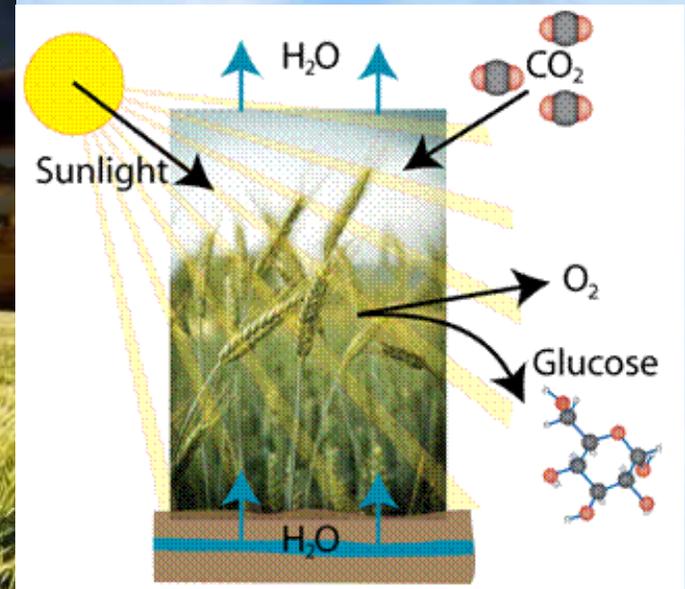


<http://www.prevent-stroke-and-heart-attack.com>

<http://library.thinkquest.org/5777/cir1.htm>

<http://newstt.com/how-is-circulatory-system-and-the-digestive-system-related/>

WHERE DOES YOUR FOOD GET ITS ENERGY?



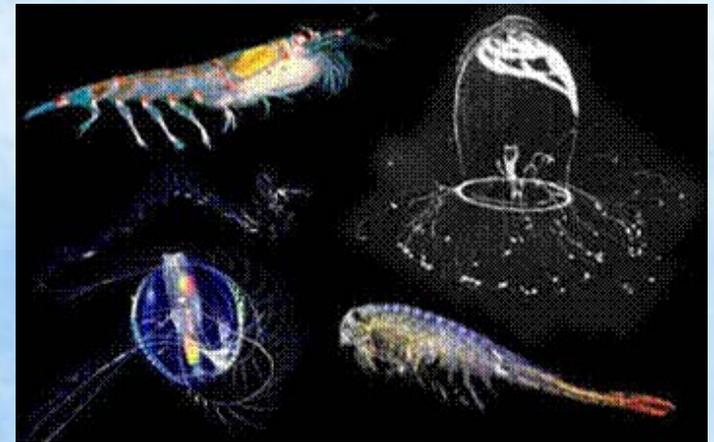
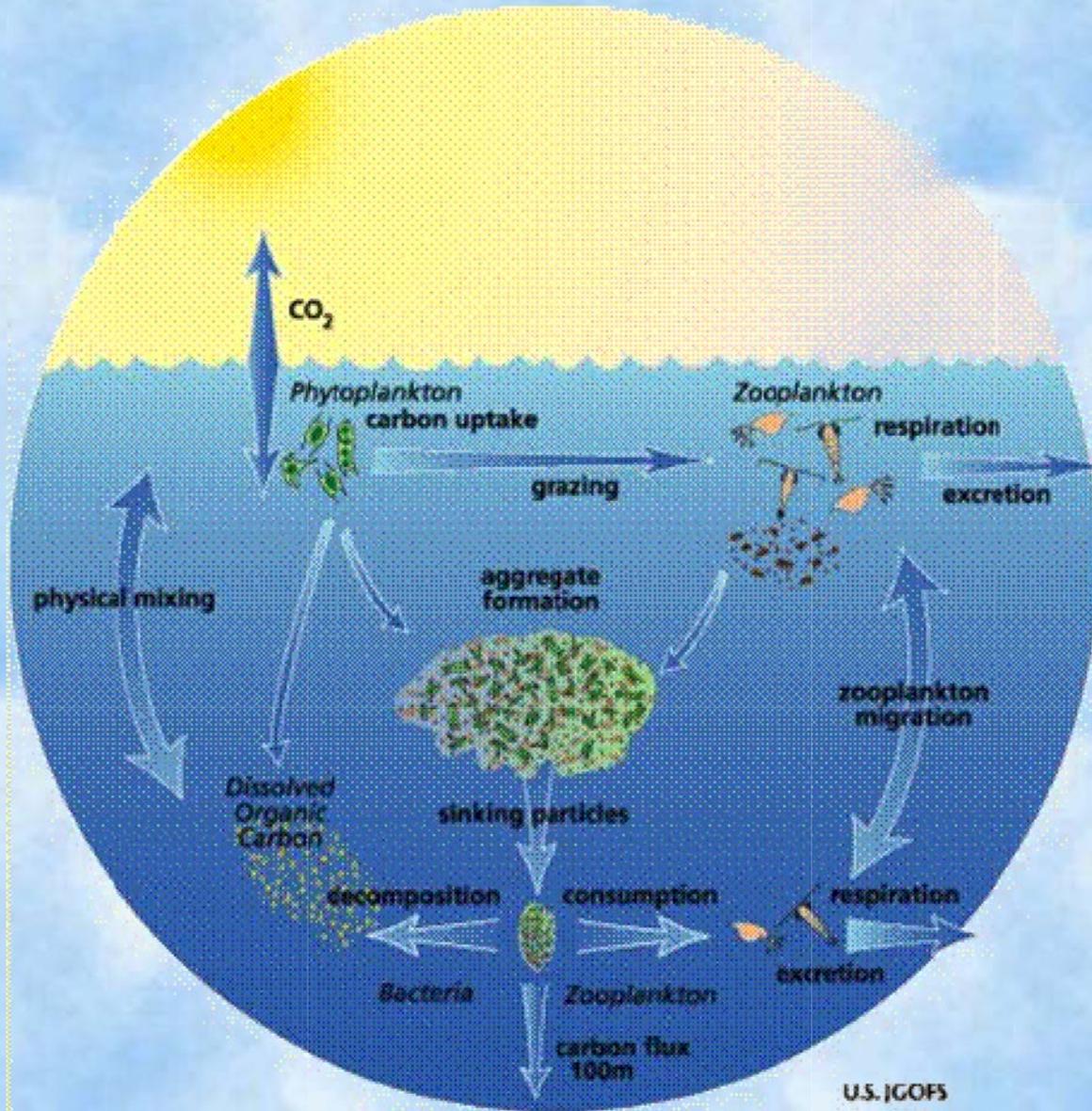
www.ems.psu.edu/~pisupati/ACSOutreach/Petroleum_1.html

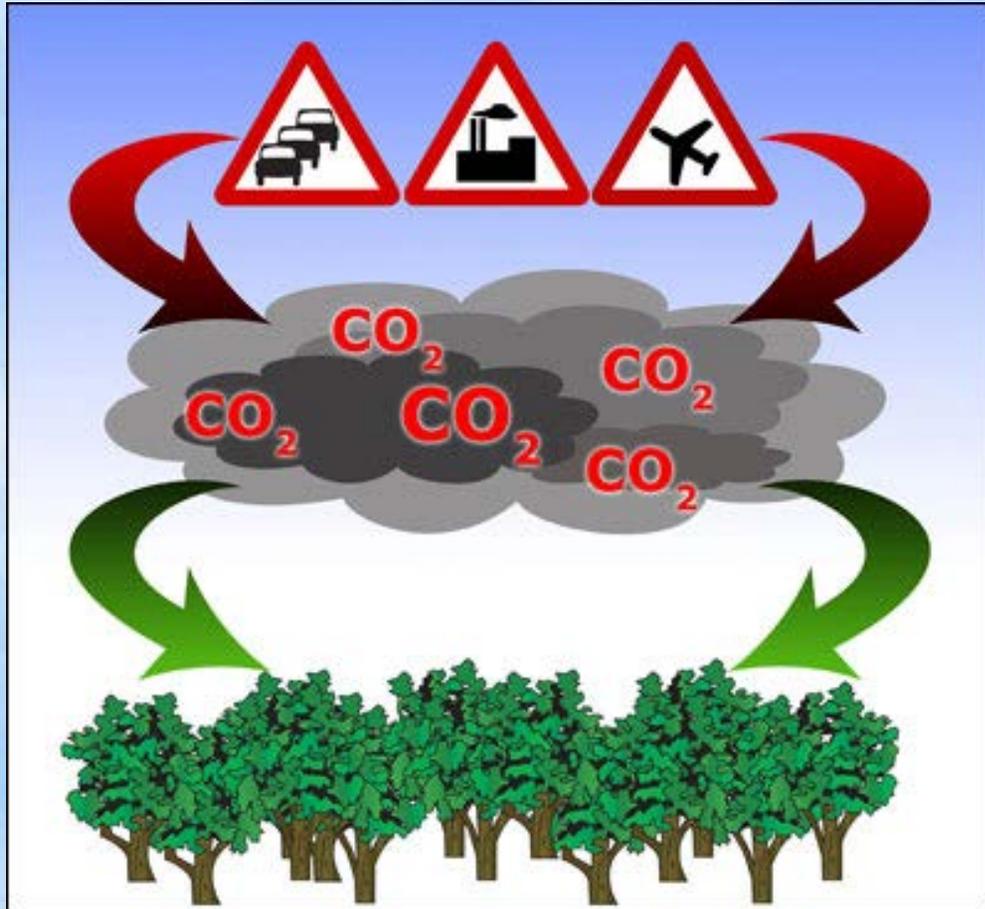
www.desktopwallpaperhd.com

WHERE DOES YOUR CAR GET ITS ENERGY?



WHERE DOES GASOLINE GET ITS ENERGY?

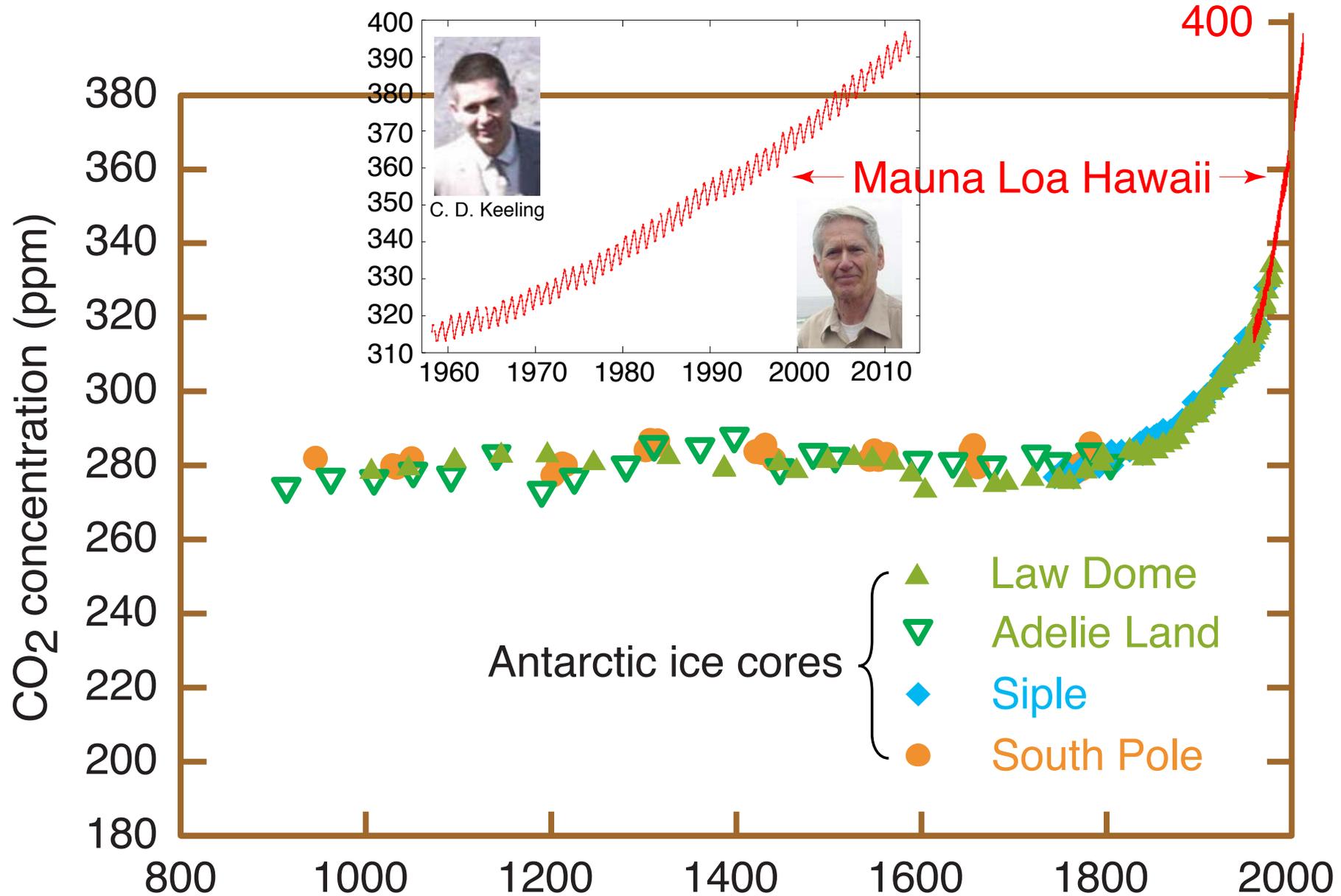




CO₂

Carbon Dioxide

ATMOSPHERIC CARBON DIOXIDE IS INCREASING



Global carbon dioxide concentration over the last thousand years

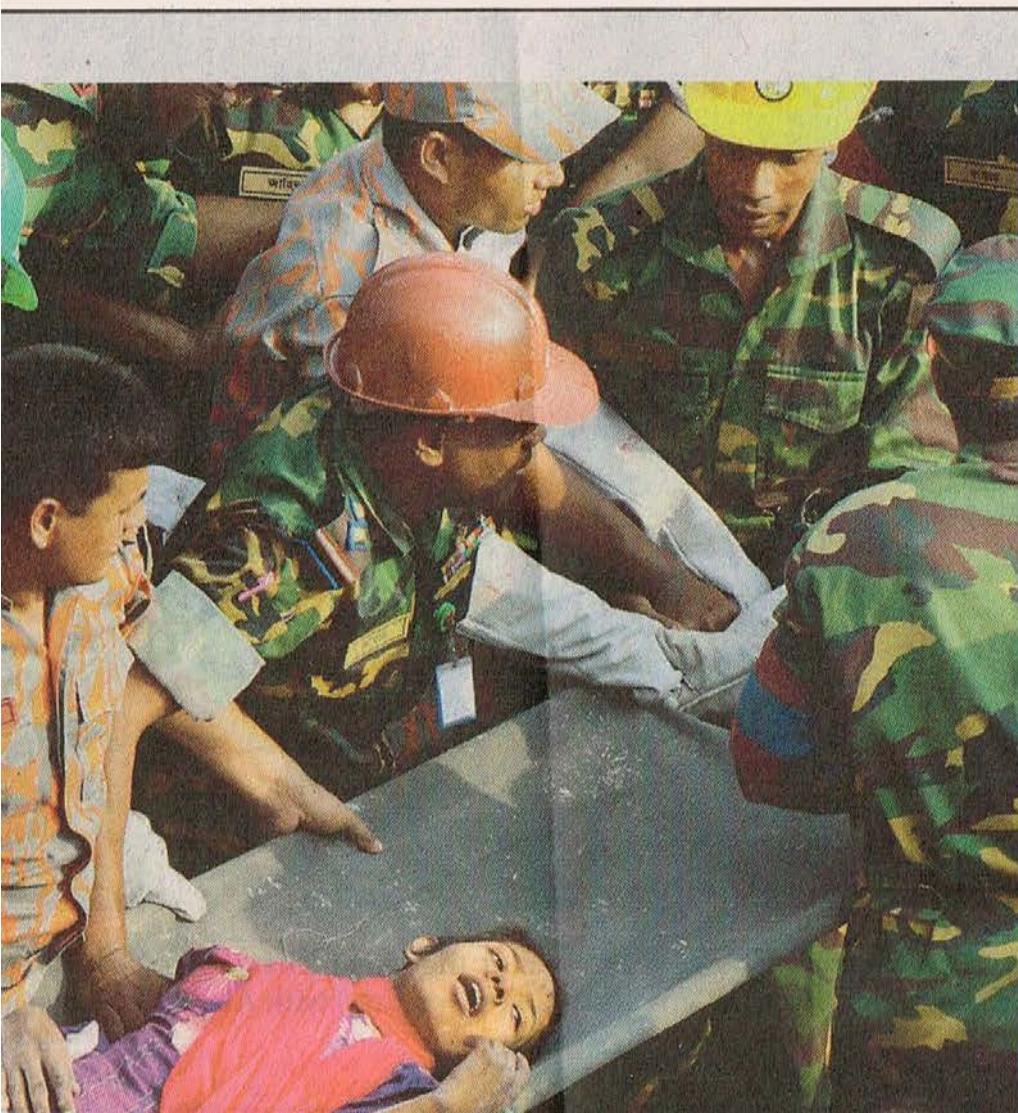
New York Times

Late Edition

Today, cloudy, showers, thunderstorms, high 74. Tonight, showers, storms, then clearing, low 55. Tomorrow, clouds and sun, breezy, high 69. Weather map, Page C8.

NEW YORK, SATURDAY, MAY 11, 2013

\$2.50



Heat-Trapping Gas Passes Milestone, Raising Fears

CO₂ at Level Not Seen in Millions of Years, Portending Major Climate Changes

By JUSTIN GILLIS

The level of the most important heat-trapping gas in the atmosphere, carbon dioxide, has passed a long-feared milestone, scientists reported Friday, reaching a concentration not seen on the earth for millions of years.

Scientific instruments showed that the gas had reached an average daily level above 400 parts per million — just an odometer moment in one sense, but also a sobering reminder that decades of efforts to bring human-produced emissions under control are faltering.

The best available evidence

the high level.

The new measurement came from analyzers atop Mauna Loa, the volcano on the big island of Hawaii that has long been ground zero for monitoring the worldwide trend on carbon dioxide, or CO₂. Devices there sample clean, crisp air that has blown thousands of miles across the Pacific Ocean, producing a record of rising carbon dioxide levels that has been closely tracked for half a century.

Carbon dioxide above 400 parts per million was first seen in the Arctic last year, and had also

***WHERE IS ALL
THIS CO₂
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.





HOW MUCH CARBON IS IN A GALLON OF GASOLINE?



1 lb?

3 lbs!?



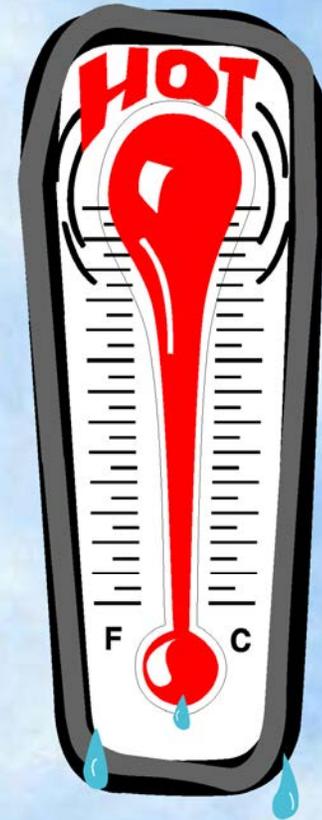
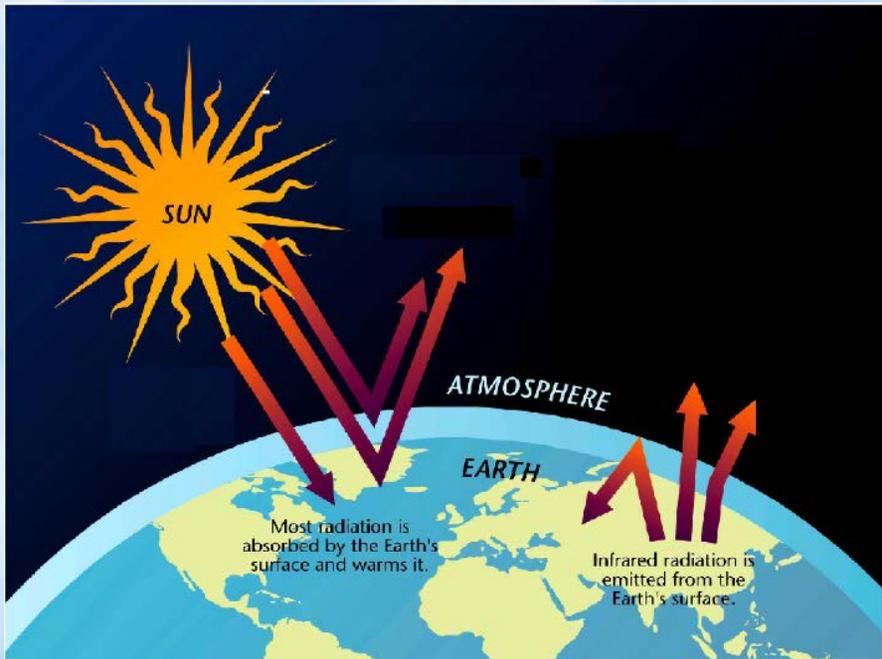
2 lbs?

5 lbs!?!?

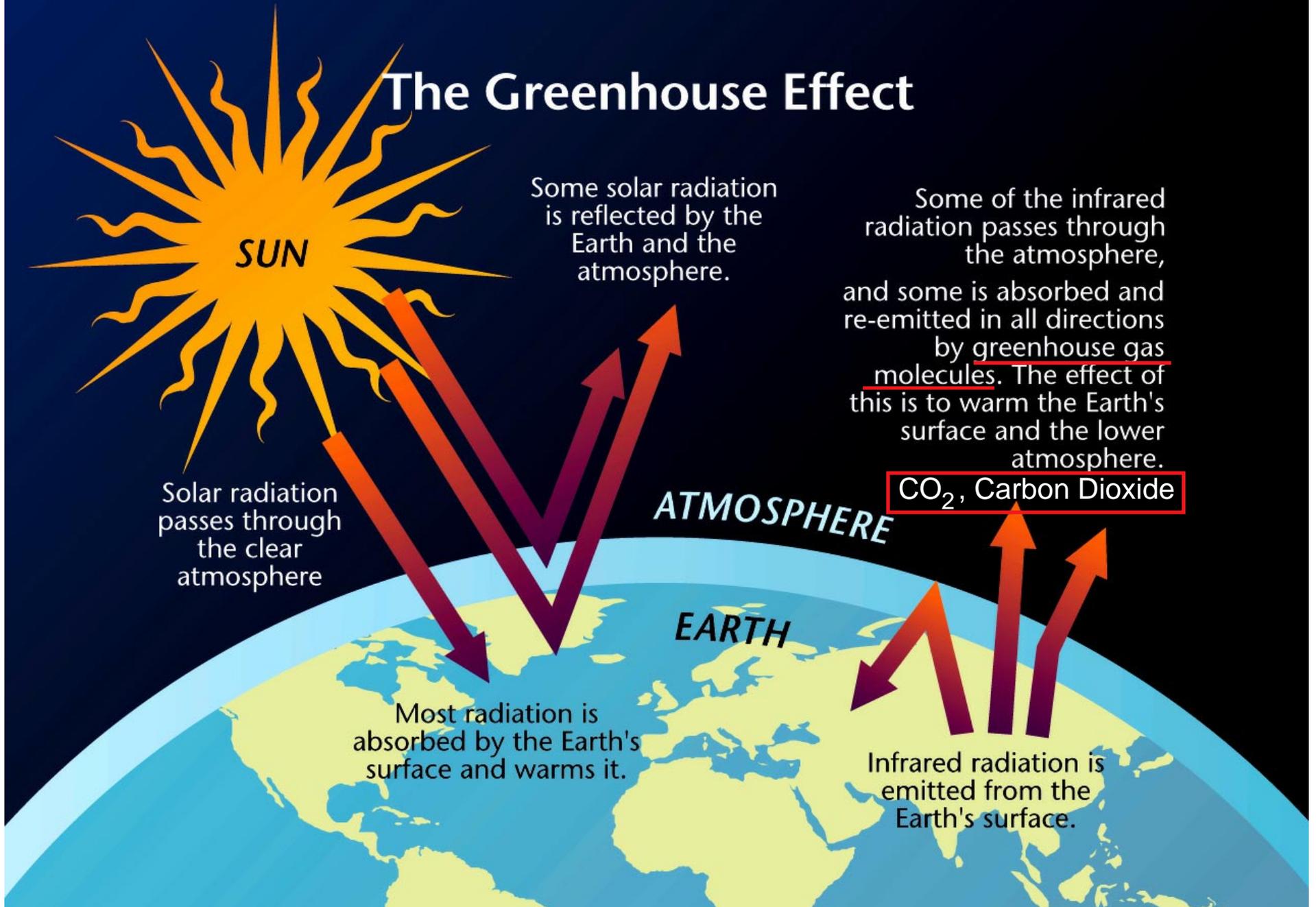
All of this carbon goes into the atmosphere as carbon dioxide when you burn the gasoline in your car.



Climature



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.

CO₂, Carbon Dioxide

Solar radiation passes through the clear atmosphere

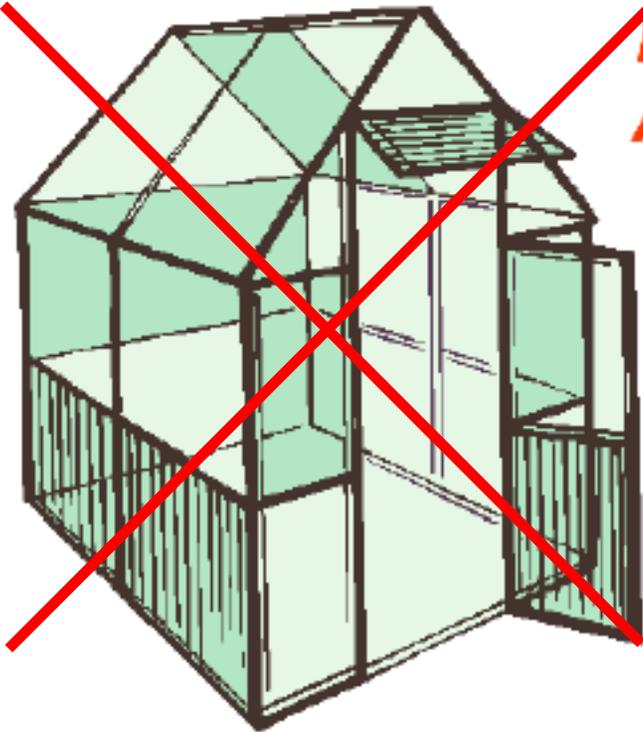
ATMOSPHERE

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



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.

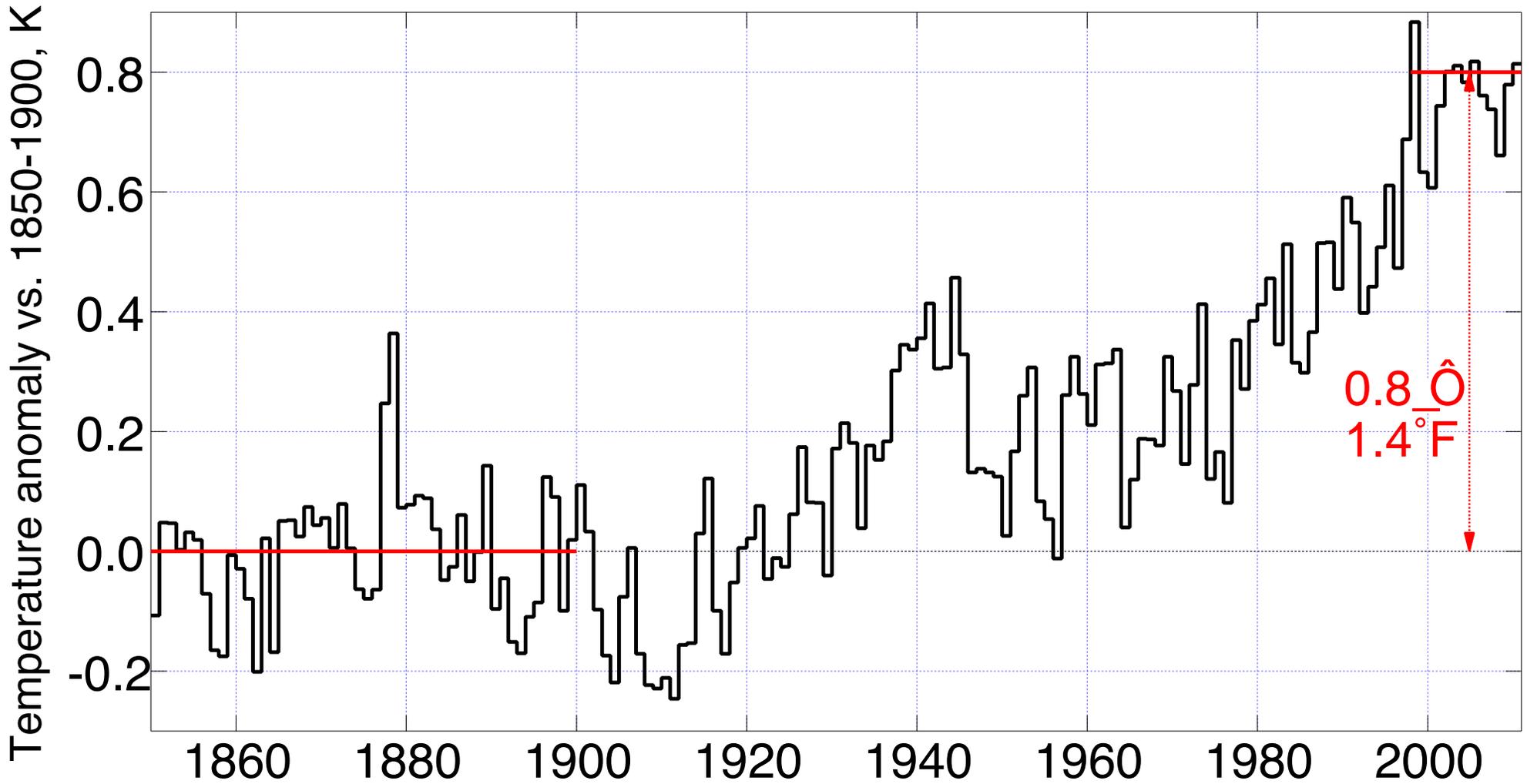
This is the greenhouse effect.

Global average temperature 15°C or 59°F

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

Global average temperature -19°C or -2 °F

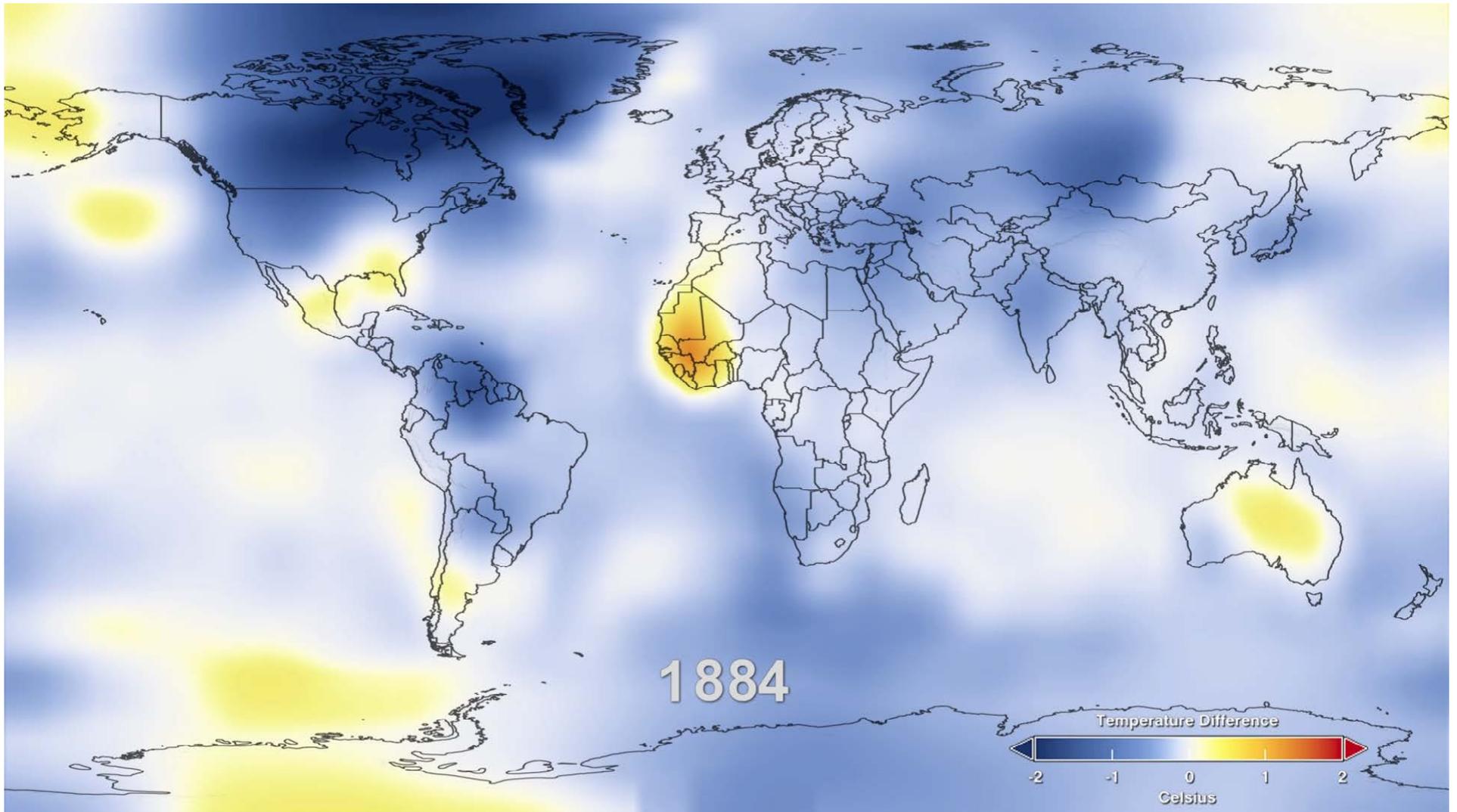
GLOBAL TEMPERATURE CHANGE SINCE 1850



Climatic Research Unit, East Anglia, UK

THE WARMING PLANET

Five-Year-Average Temperature Anomalies Relative to Mid 20th Century



NASA Goddard Institute for Space Studies

GLACIERS

A RECORD OF CHANGE

PASTERZE GLACIER, AUSTRIA 1875 - 2004



About 2 km shorter.

Terminus replaced by artificial lake.

Decrease in length about 15 meters per year.

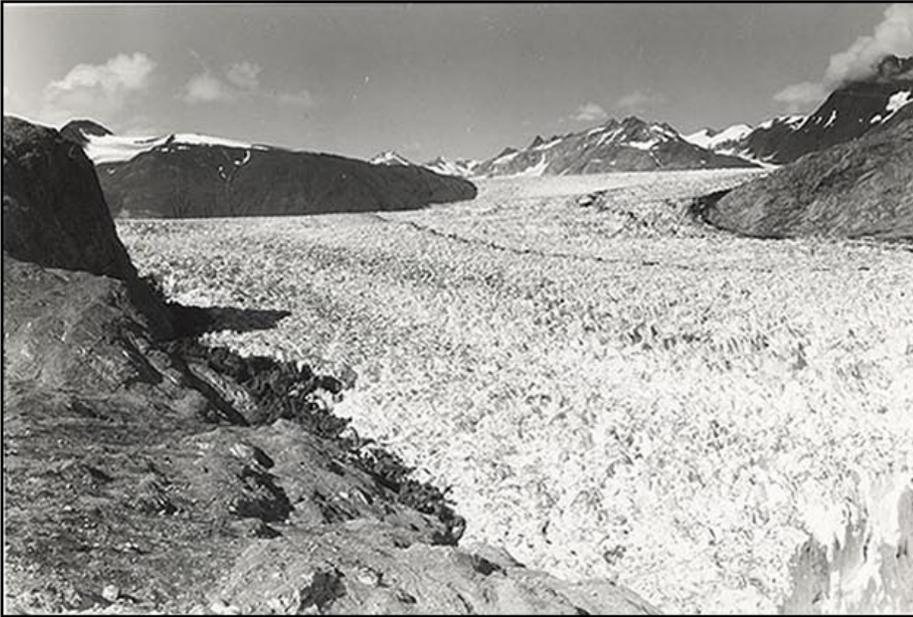
In 2003, decrease was 30 m in length and 6.5 m in thickness.

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

GRINNELL GLACIER GLACIER NATIONAL PARK 1911 - 2000



MUIR GLACIER - MUIR INLET GLACIER BAY NATIONAL PARK, ALASKA 1941 vs. 2004



Muir Glacier, William O. Field on 13 August 1941 and by Bruce F. Molnia on 31 August 2004

UPSALA GLACIER, ANDES, ARGENTINA

1928



2004



RHONE GLACIER, VALAIS, SWITZERLAND 1859 - 2001



Glacial retreat is 2.5 km.

Base is 450 meters higher.

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

STUDYING EARTH'S CLIMATE HISTORY

“A Climate Scientist Battles Time and Mortality”



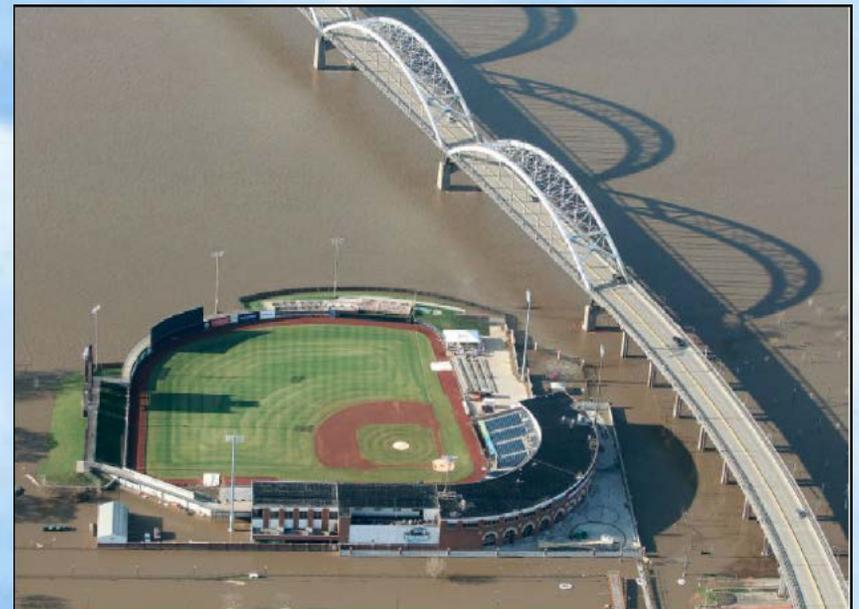
New York Times, July 2, 2012

Lonnie Thompson, Ohio State University glaciologist, studies Earth's climate history by the ice archive.

The glaciers are melting, erasing our history.



THE NEW NORMAL?



THE NEW NORMAL?

Souris River, Minot, North Dakota, June, 2011



The river surpassed its 1881 record level of 1,558 feet above sea level, and flooded an estimated 4,000 homes in the city.

THE NEW NORMAL?

Vicksburg, Mississippi, May, 2011



Second highest flood on record; highest since 1937.

THE NEW NORMAL?

Morehouse, Missouri, May, 2011



THE NEW NORMAL?

LaGrange, Missouri, April, 2013



THE NEW NORMAL?

Davenport Iowa, April, 2013



THE NEW NORMAL?

The New York Times

Friday, July 20, 2012

Widespread Drought Is Likely to Worsen



Ashley, Illinois

“It really is a crisis,” said Gov. Pat Quinn of Illinois after touring ravaged farms in the southern part of the state. “I don’t think we’ve ever seen anything like this in my lifetime.”

THE NEW NORMAL?

The New York Times

Friday, July 20, 2012

Widespread Drought Is Likely to Worsen



El Dorado, Kan

THE NEW NORMAL?

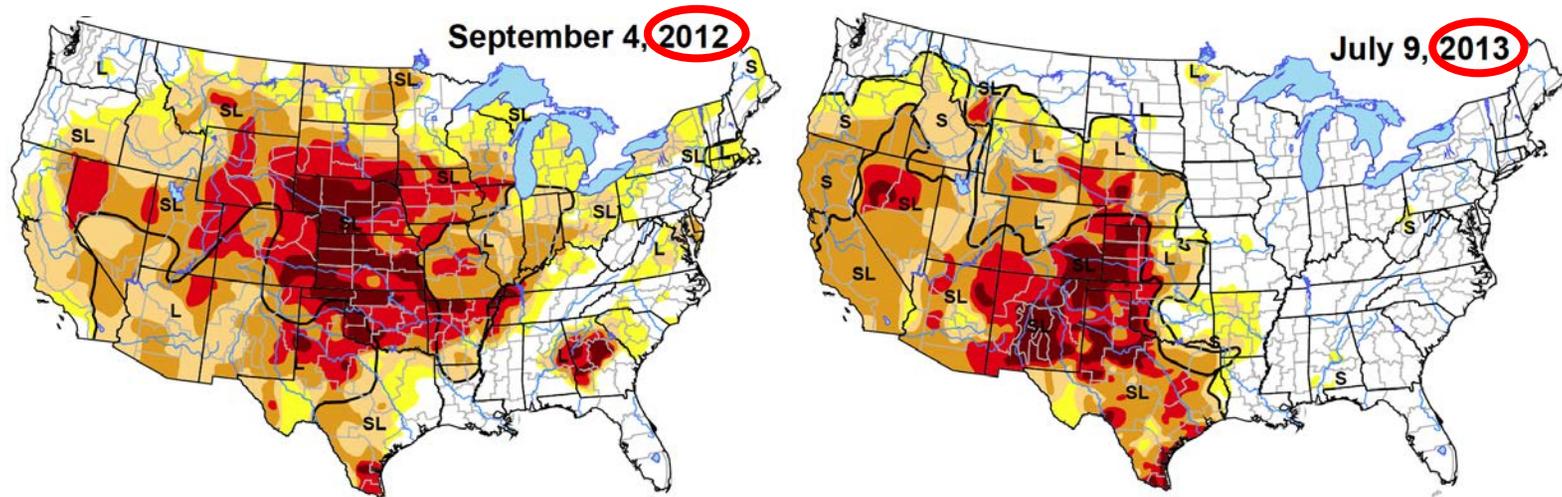
Keeping the Boats Moving Along a Mississippi Dwindled by Drought



January, 2013

THE NEW NORMAL?

U.S. Drought Monitor



Intensity:

-  D0 Abnormally Dry
-  D1 Drought - Moderate
-  D2 Drought - Severe
-  D3 Drought - Extreme
-  D4 Drought - Exceptional

Precipitation deficits for the period May through August 2012 were the *most severe since official measurements began in 1895*, eclipsing the driest summers of 1934 and 1936 that occurred during the height of the Dust Bowl.

THE NEW NORMAL?

Tornado, Joplin, Missouri, May, 2011



Multiple-vortex EF5 tornado.

THE NEW NORMAL?

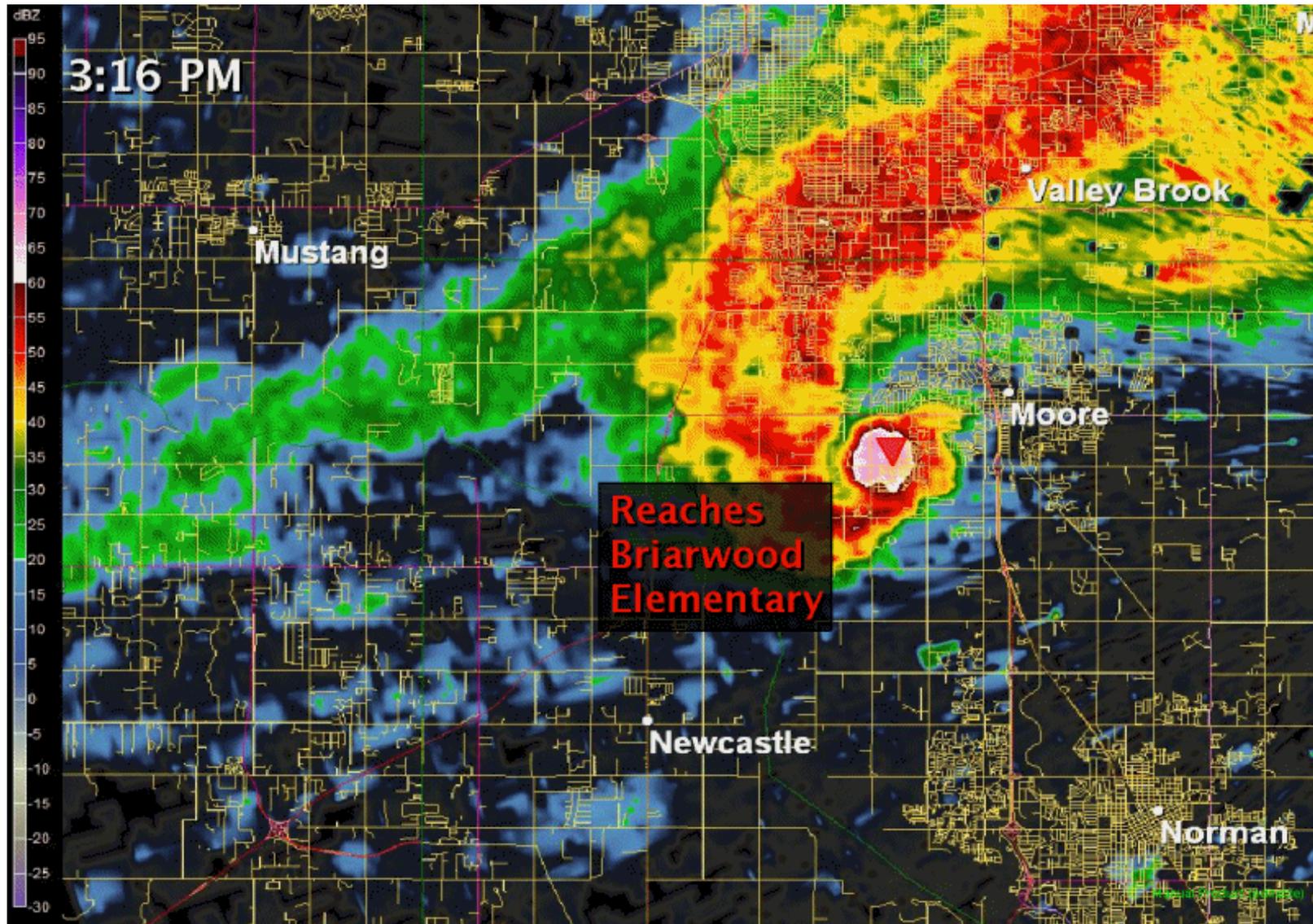
Springfield, Massachusetts, June, 2011



Seven tornadoes from Connecticut to Maine in rare New England outbreak.

THE NEW NORMAL?

Tornado, Moore, Oklahoma, May, 2013



EF5 tornado kills 23, injures over 300.

THE NEW NORMAL?

Tornado, Moore, Oklahoma, May, 2013



THE NEW NORMAL?

Tornado, Moore, Oklahoma, May, 2013



THE NEW NORMAL?

Sierra Vista, Arizona, June, 2011



Third largest fire in Arizona history.

THE NEW NORMAL?

Monument Fire, Arizona, June, 2011



THE NEW NORMAL?

Yarnell, Arizona, June, 2013



Nineteen firefighters killed fighting blaze.

THE NEW NORMAL?

Yarnell, Arizona, June, 2013



Are June fires the new normal?

THE NEW NORMAL?

Colorado Springs, June, 2012



THE NEW NORMAL?

Colorado Springs, June, 2012



THE NEW NORMAL?

Colorado Springs, June, 2013



THE NEW NORMAL?

Colorado Springs, June, 2013



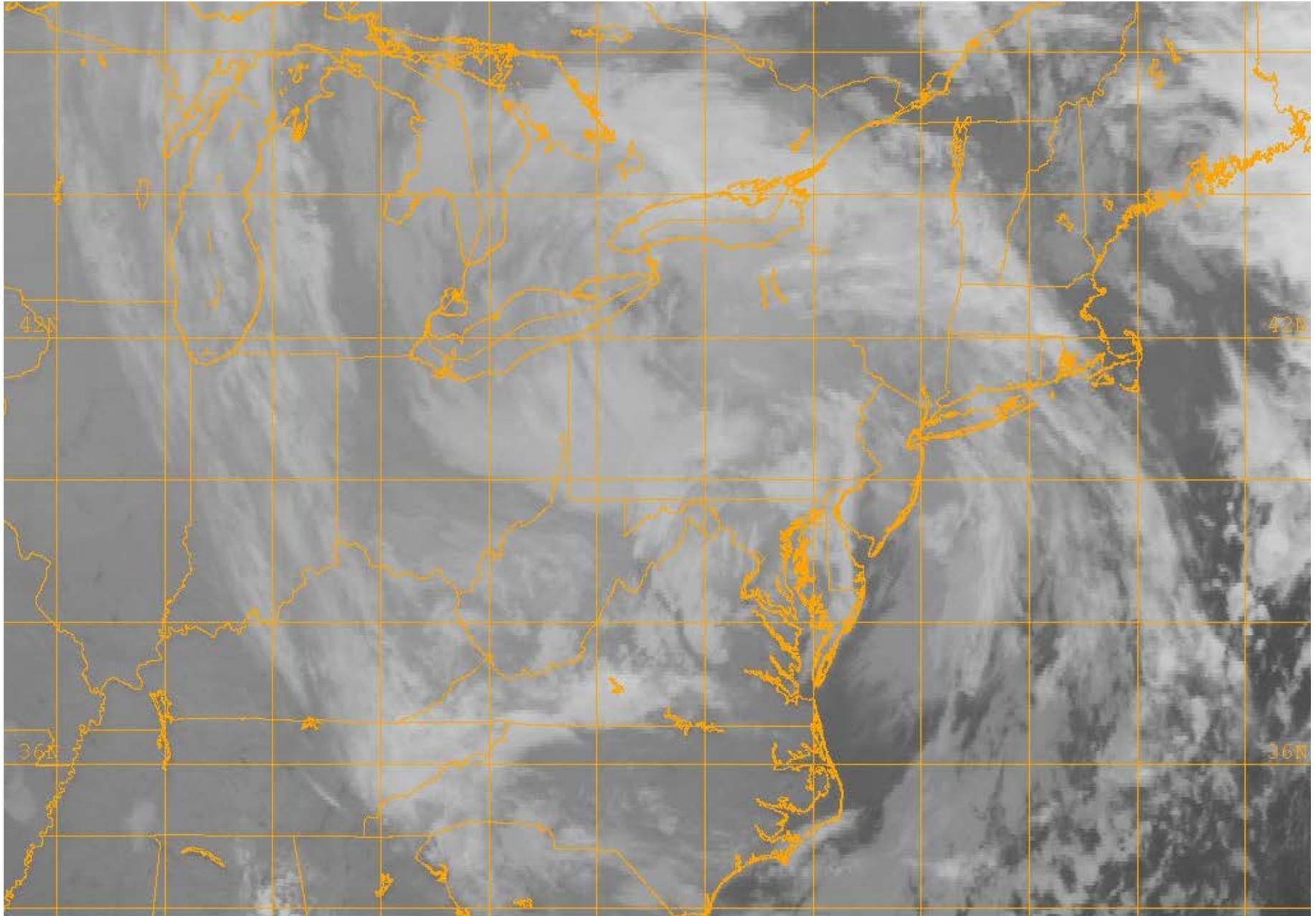
Are spring wildfires the new normal?

SUPERSTORM SANDY



THE NEW NORMAL?

SUPERSTORM SANDY – THE NEW NORMAL?



Sandy extended from Carolinas to Canada, Atlantic to Great Lakes

SUPERSTORM SANDY – THE NEW NORMAL?

New York City



SUPERSTORM SANDY – THE NEW NORMAL?

Breezy Point, Queens, NYC



SUPERSTORM SANDY – THE NEW NORMAL? NYC Subway



SUPERSTORM SANDY – THE NEW NORMAL?

Subway, NYC



SUPERSTORM SANDY – THE NEW NORMAL?

Verizon Building, NYC



SUPERSTORM SANDY – THE NEW NORMAL?

Hoboken NJ



SUPERSTORM SANDY – THE NEW NORMAL?

Fenwick Island, DE



SUPERSTORM SANDY – THE NEW NORMAL?

Rockaway, Queens, NY



SUPERSTORM SANDY – THE NEW NORMAL?

Fort Lauderdale, FL



SUPERSTORM SANDY – THE NEW NORMAL?

Lake Erie, Near Cleveland OH



SANDY ON LONG ISLAND – THE NEW NORMAL?



SANDY ON LONG ISLAND – THE NEW NORMAL?



SANDY ON LONG ISLAND – THE NEW NORMAL?



SANDY ON LONG ISLAND – THE NEW NORMAL?



SANDY ON LONG ISLAND – THE NEW NORMAL?



SANDY ON LONG ISLAND – THE NEW NORMAL?



TYPHOON HAIYAN

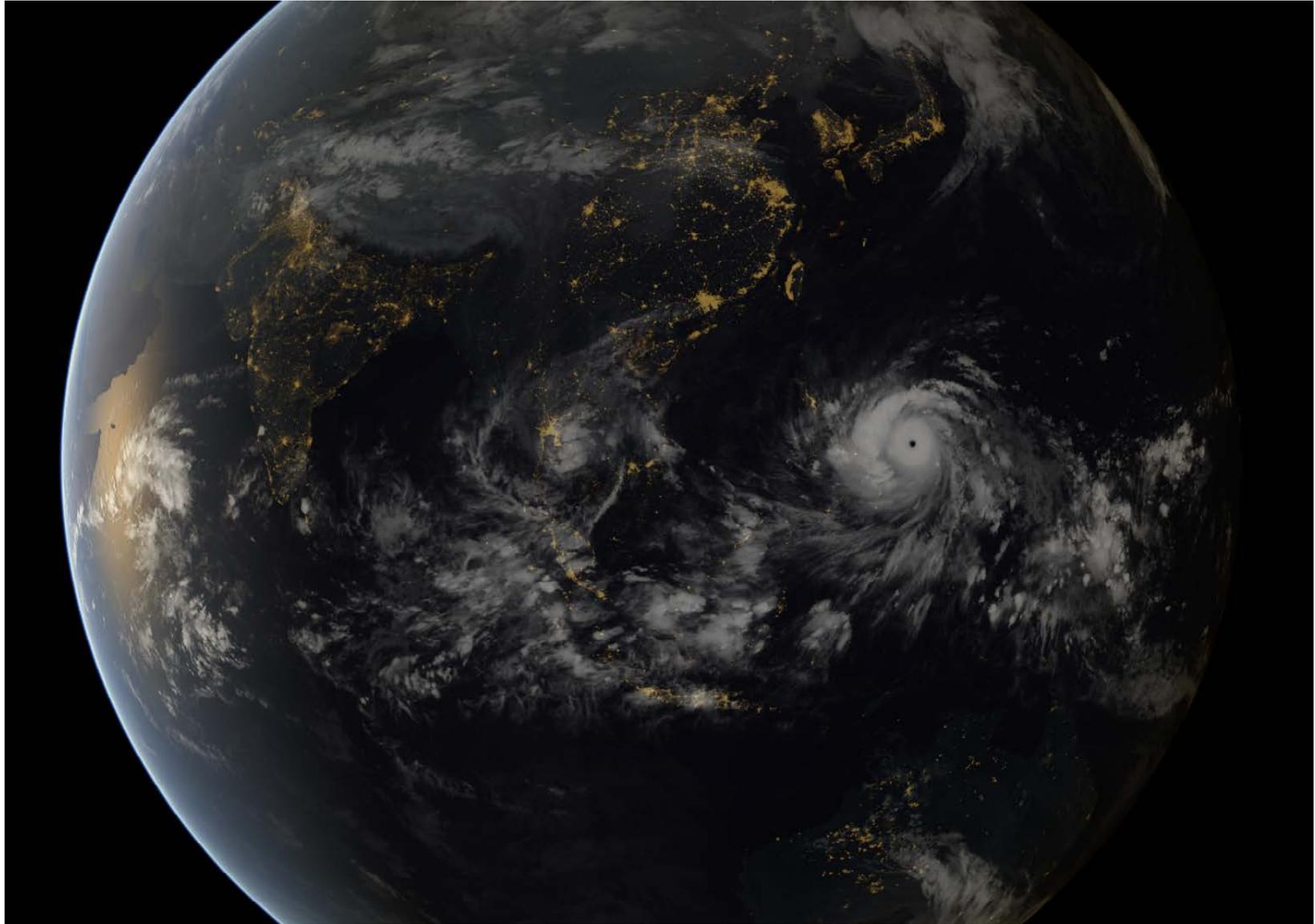
Sustained winds, 190 miles per hour



NASA, Nov. 7, 2013, 0425 UTC.

TYPHOON HAIYAN

Sustained winds, 190 miles per hour



Composite, Japanese and European weather satellites, Nov. 7, 2013, 1300 UTC.

TYPHOON HAIYAN

Thirteen foot wall of water inundates city



THE NEW NORMAL?

Haiyan, the Fourth Typhoon to Hit the Philippines in 2013

Typhoon Haiyan, Leyte, November 7, Category 5, 190 mph winds, killing estimated 10,000.

Typhoon Nari, Luzon, October 11, Category 3, 115 mph winds, killing five.

Typhoon Utor, Luzon, August 12 , Category 4 , 140 mph winds, killing fourteen, \$25 million in damage.

Typhoon Krosa, northern Luzon, October 31, Category 2, 105 mph winds, killing five, \$5 million in damage.

Jeff Masters' WunderBlog

GREAT HURRICANE OF 1938

Providence, RI

Currently on Exhibition in
the Providence Journal
Rhode Island
Room:

Hurricane Season—The Hurricane of 1938

The hurricane that struck New England in September of 1938 remains the most destructive to ever visit the area. But it was by no means the first hurricane to cause major suffering and loss for New Englanders.

The items on display here include images of the 1938 storm and some of its predecessors, newspaper accounts, materials used in a nonfiction account of the storm and the words of survivors attempting to describe what would be one of the most traumatic days of their lives.

On Display Through August 15th



GREAT HURRICANE OF 1938

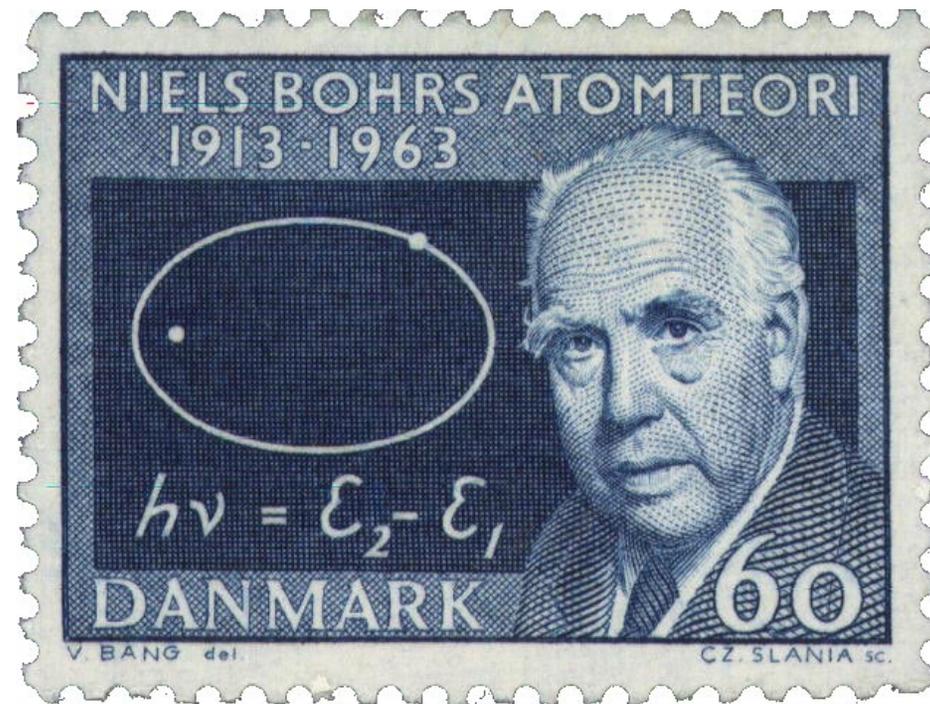
Providence, RI



*Looking to the
Future . . .*



*Prediction is difficult,
especially about the future.*



– Niels Bohr

WHAT WILL BE THE FUTURE CLIMATE OF ILLINOIS?

It will be as if you move Illinois 200 miles south.



But we don't know if it will be moving to Georgia or the Texas panhandle.



present



1 meter

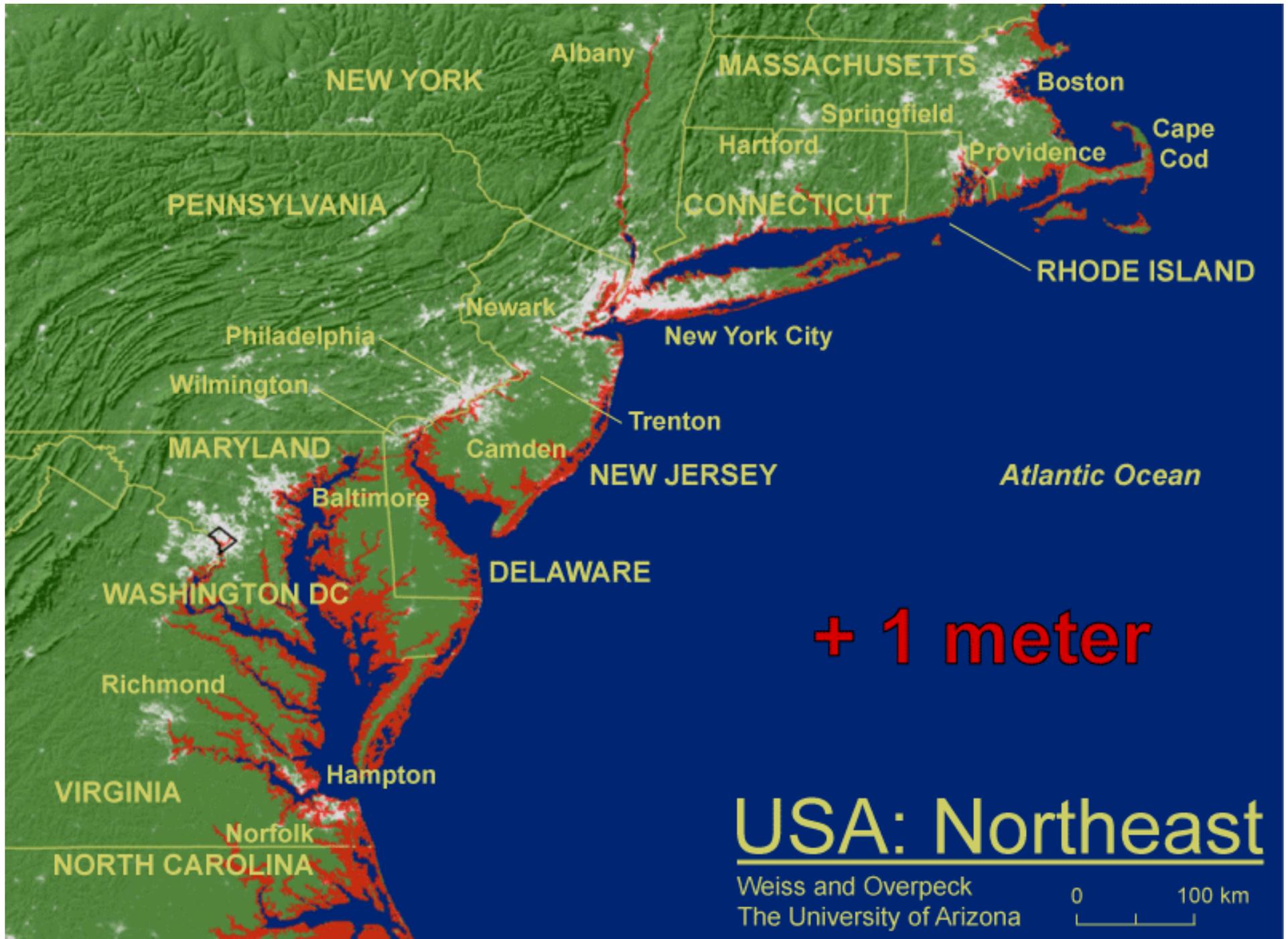


Present

USA: Northeast

Weiss and Overpeck
The University of Arizona







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



you!

IS THERE
ANYTHING
WE CAN DO?

***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 (CO₂), and it will stay there for decades — maybe a century!

Other sources are home heating and electric power production.



SOLAR PHOTOVOLTAIC ENERGY

Decrease your carbon legacy by generating your own electricity



Decrease your electric bill, too; maybe even to zero!

ENERGY EFFICIENT CARS

Decrease your carbon legacy by driving an energy efficient car



Decrease your gasoline bill, and drive in HOV lane, too!

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

THANK YOU



www.ecd.bnl/steve