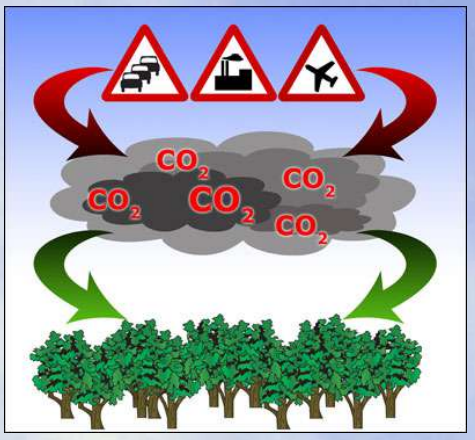
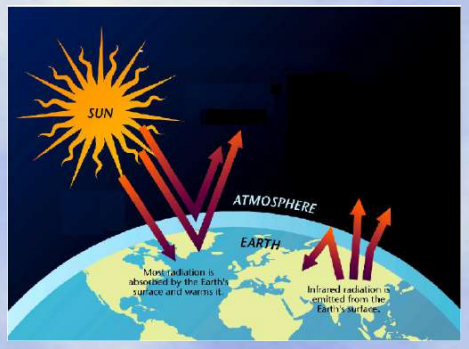




Energy, CO_2, Climate, and YOU!

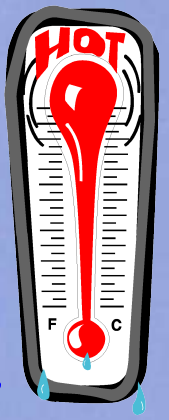
Dr. Steve

(Doctor of Chemistry)

Stephen E. Schwartz

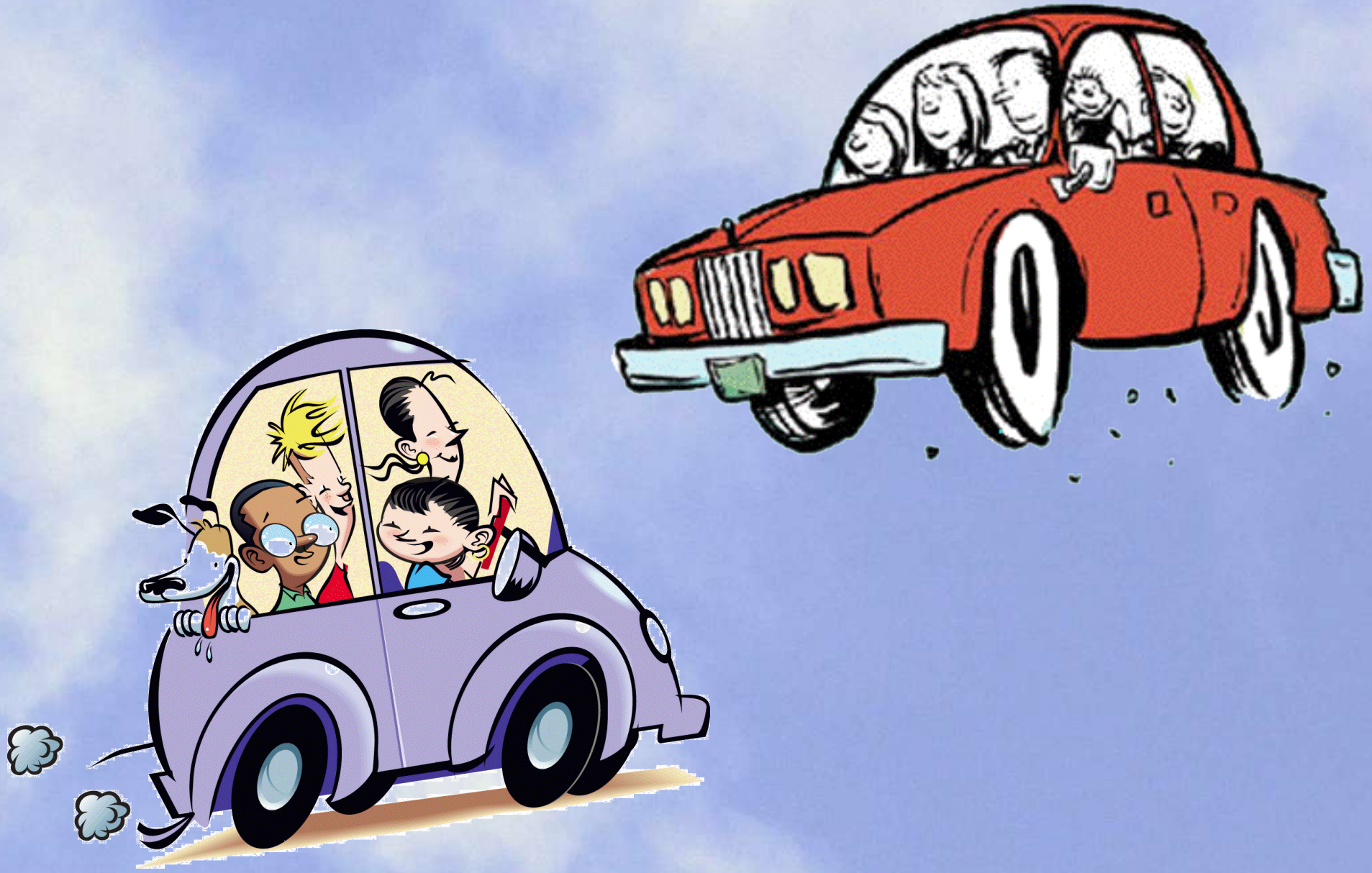
BROOKHAVEN NATIONAL LABORATORY

summer sundays



www.bnl.gov/envsci/schwartz

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!

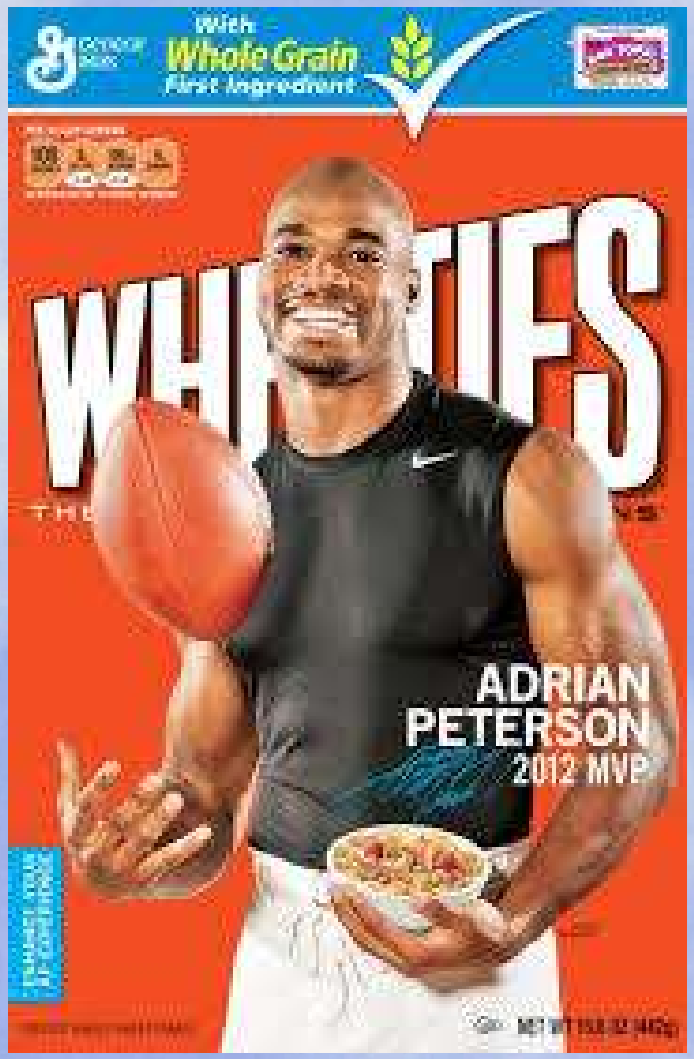
CARPOOLING CAN SAVE MORE THAN GAS

Energy

WHERE DO YOU GET YOUR ENERGY?

WHERE DO YOU GET YOUR ENERGY?

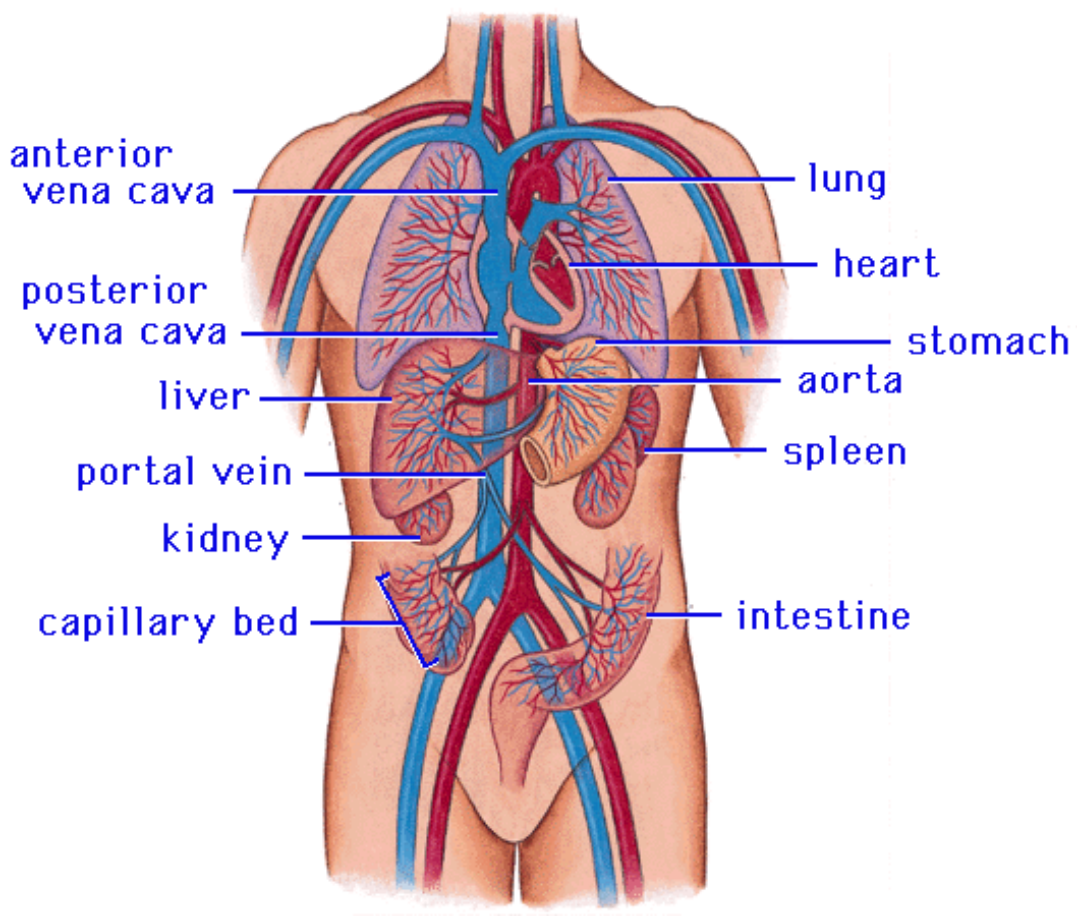
FOOD

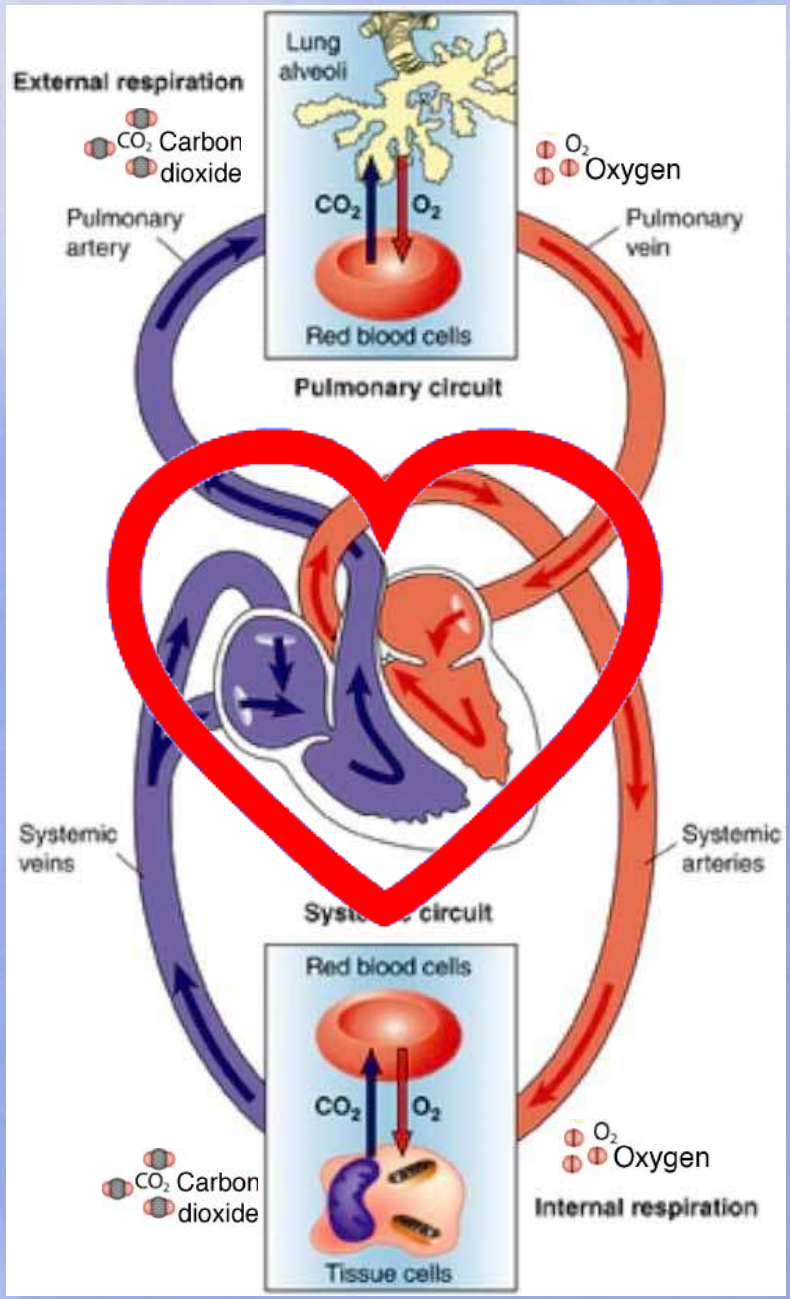


HOW DO ENERGY AND OXYGEN GET TO YOUR MUSCLES?

HOW DO ENERGY (AND OXYGEN) GET TO YOUR MUSCLES?

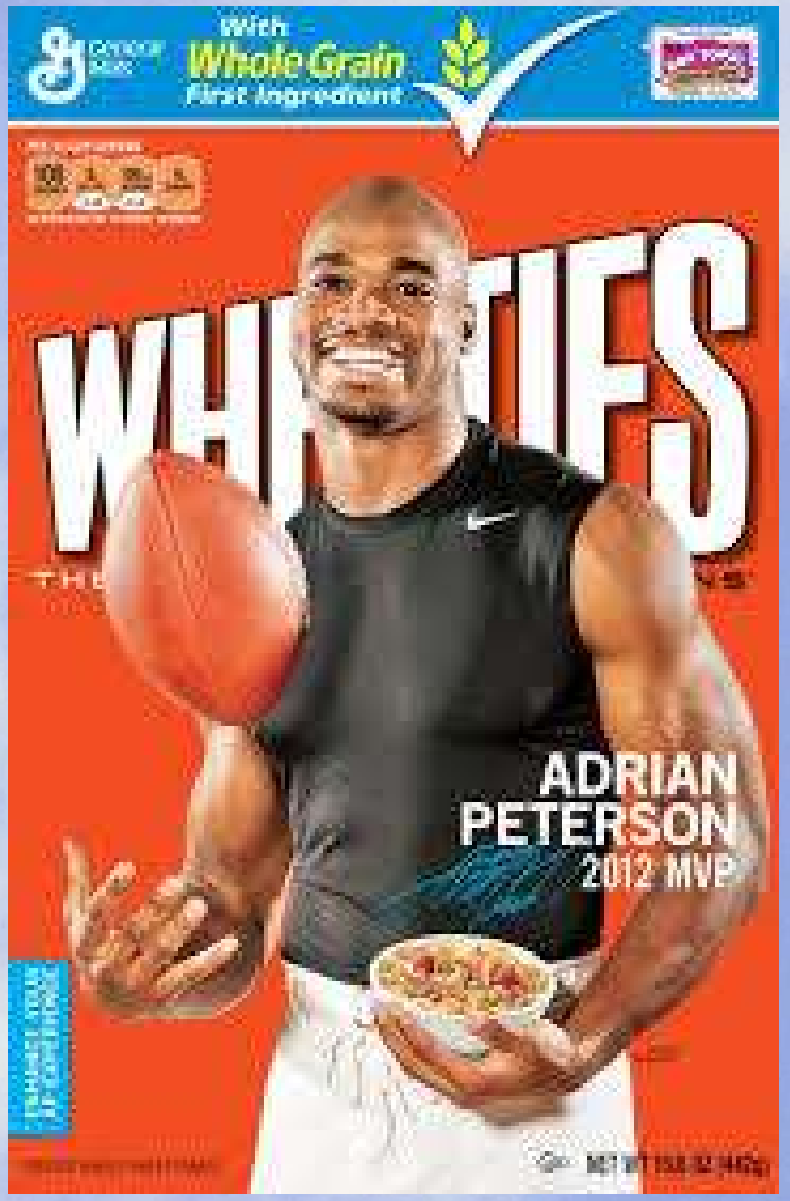
BLOOD





http://library.thinkquest.org/5777/cir1.htm
http://newstt.com/how-is-circulatory-system-and-the-digestive-system-related/

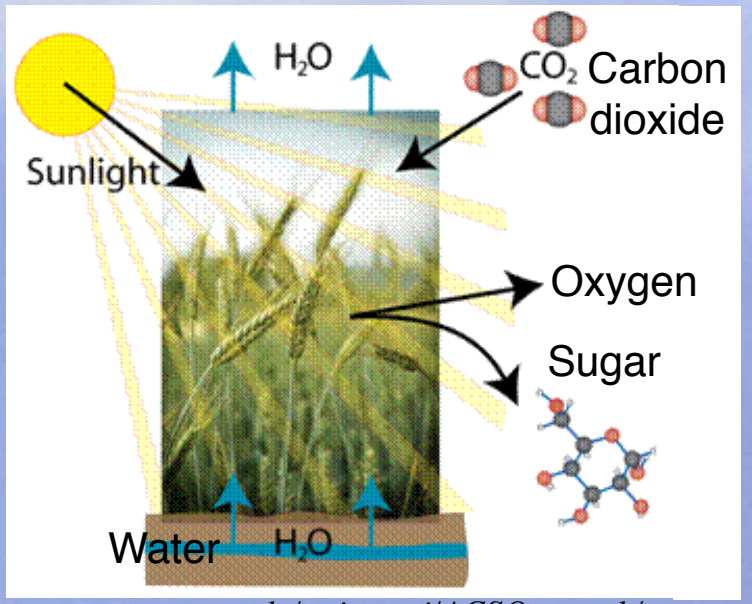
WHERE DOES YOUR FOOD GET *ITS* ENERGY?



WHERE DOES YOUR FOOD GET *ITS* ENERGY?

www.desktopwallpaperhd.com

THE SUN



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

Food is stored solar energy.

HOW MUCH ENERGY IS IN YOUR FOOD?

CALCULATE CALORIES PER GRAM

Nutrition Facts

Serving Size 1 serving (30 g)

Per Serving

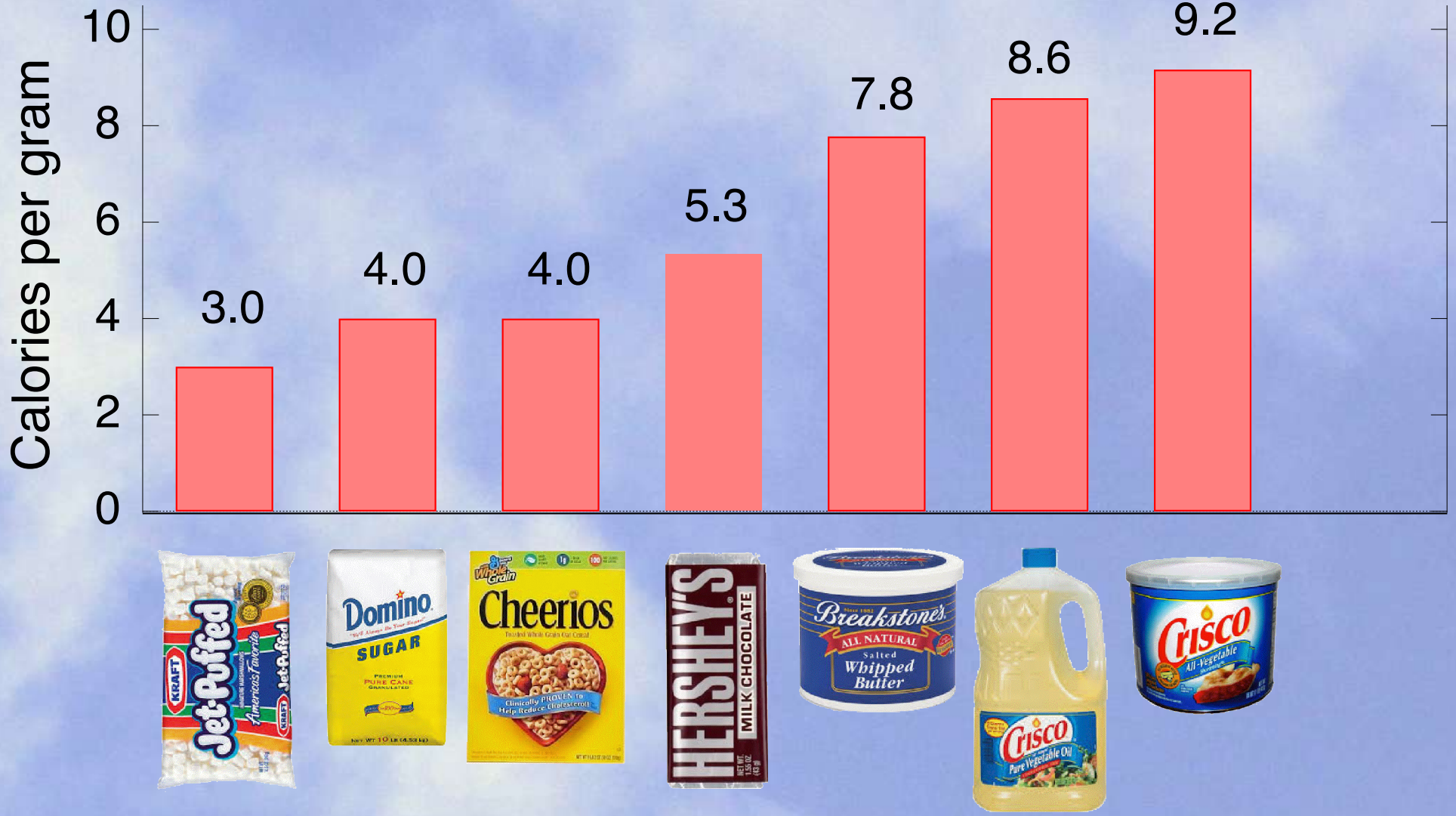
Calories	90
Calories from Fat	0
Total Fat	0g
Sodium	80mg
Potassium	5mg
Carbohydrates	70g
Sugars	53.3g
Protein	3.3g

90 Calories in 30 grams
(about 1 ounce)

$90 \div 30 = 3$

3 Calories in one gram
(3 Calories per gram)

CALORIE CONTENT OF ENERGY FOODS

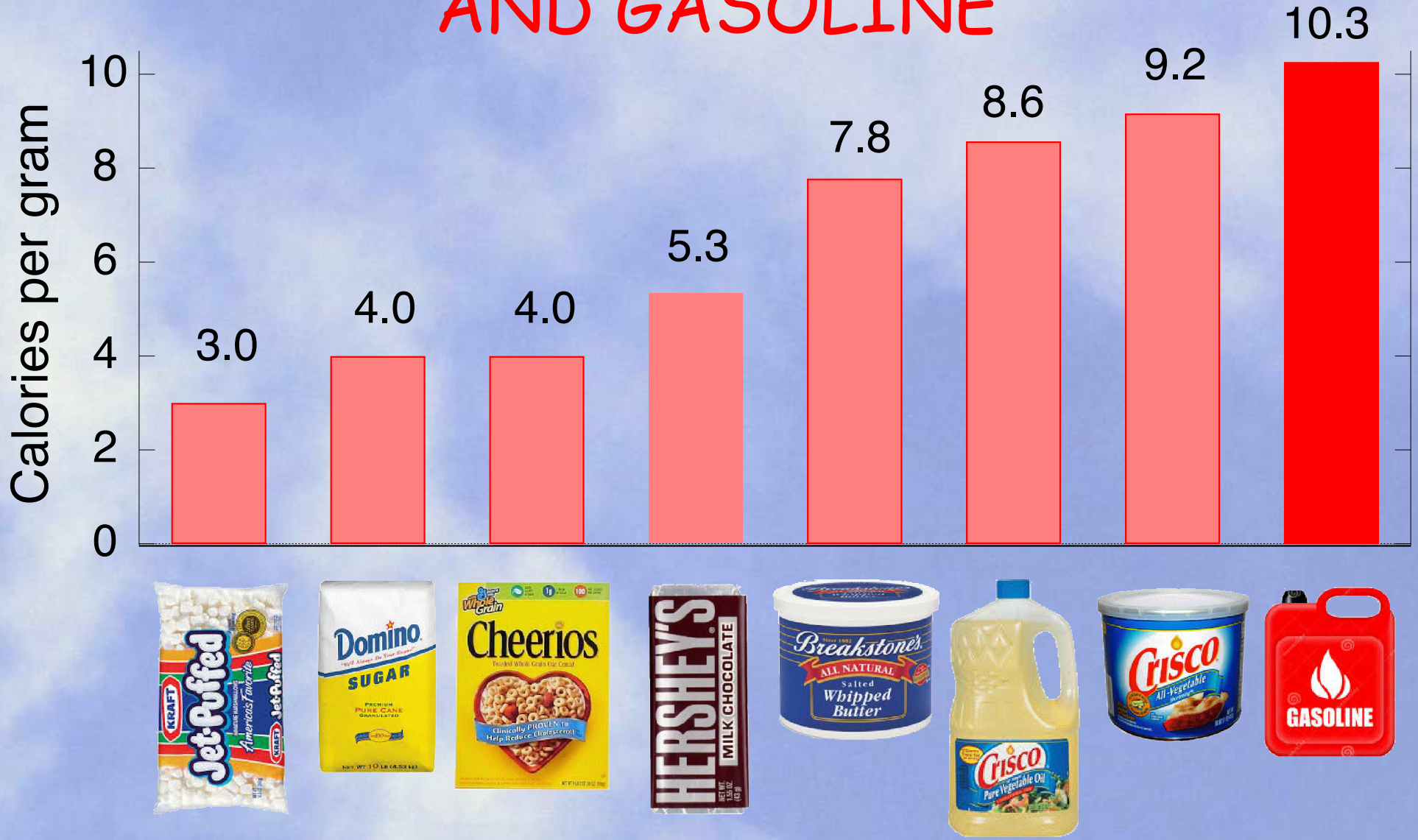


HOW MUCH ENERGY DOES IT TAKE TO TRAVEL ONE MILE?

WHERE DOES YOUR CAR GET *ITS* ENERGY?

WHERE DOES YOUR CAR GET *ITS* ENERGY?

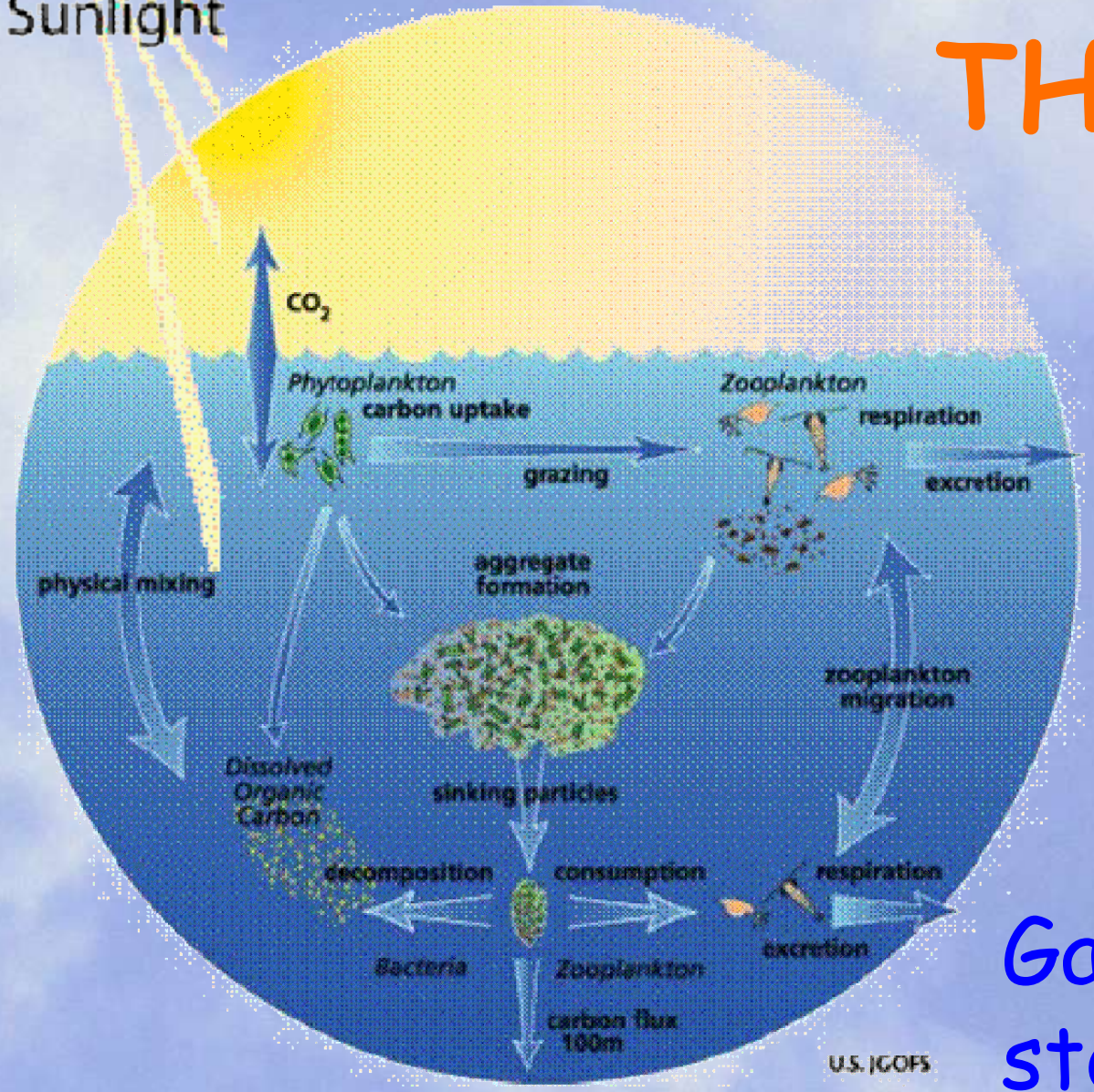
CALORIE CONTENT OF ENERGY FOODS AND GASOLINE

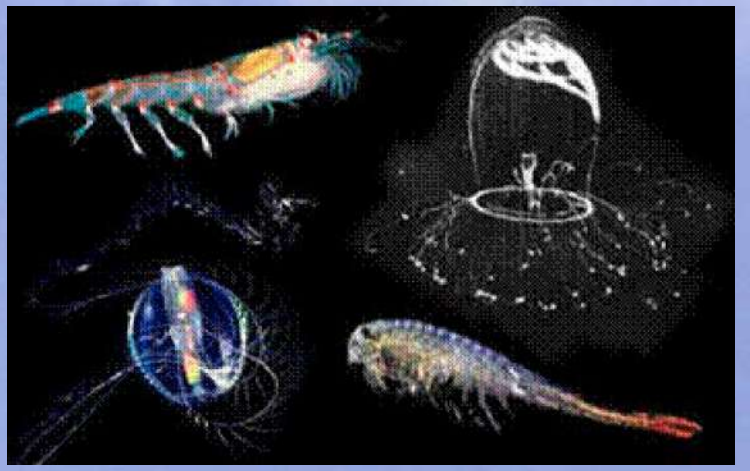


WHERE DOES GASOLINE GET *ITS* ENERGY?

WHERE DOES GASOLINE GET *ITS* ENERGY?

THE SUN





Gasoline is also stored solar energy.

OUR COLLECTIVE ENERGY USE

Standard diet US adult:
2000 Calories per day

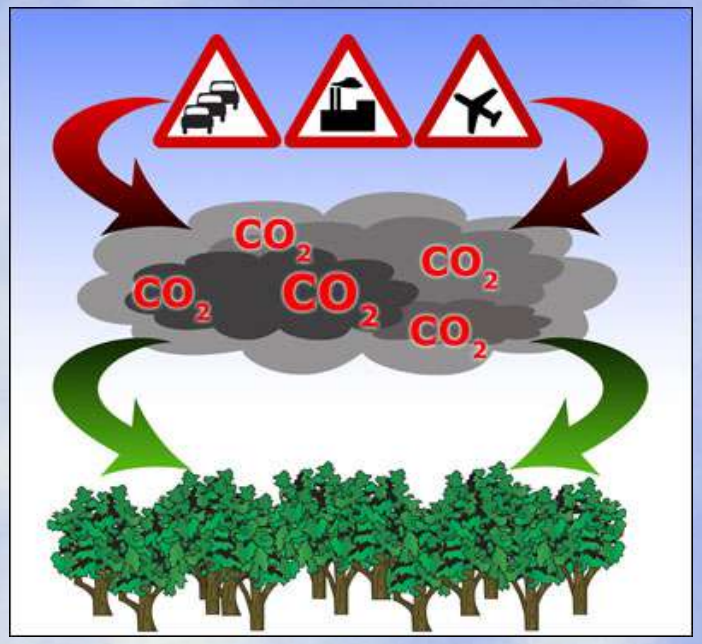
Equivalent to 100 watts

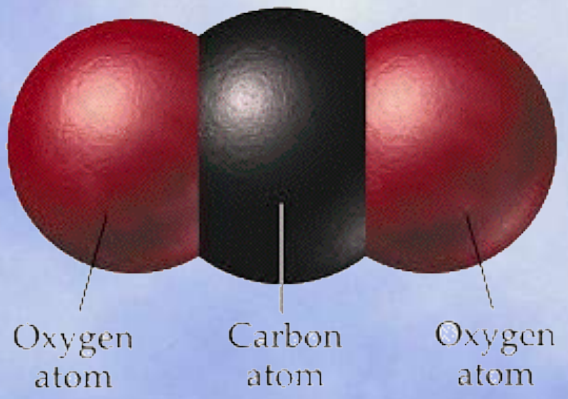
Per capita energy US use: 10,000 watts
100 100-watt light bulbs, 24 – 7

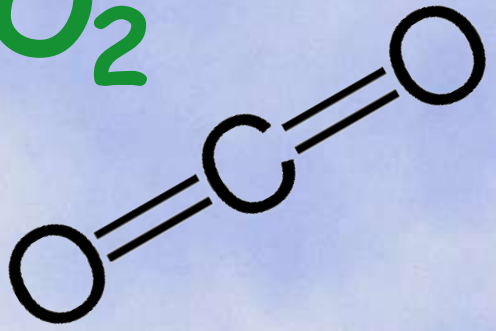
Equivalent to 100 people!

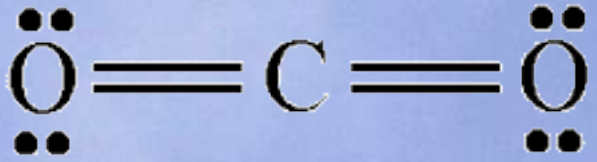
And all these "people" are exhaling CO_2!

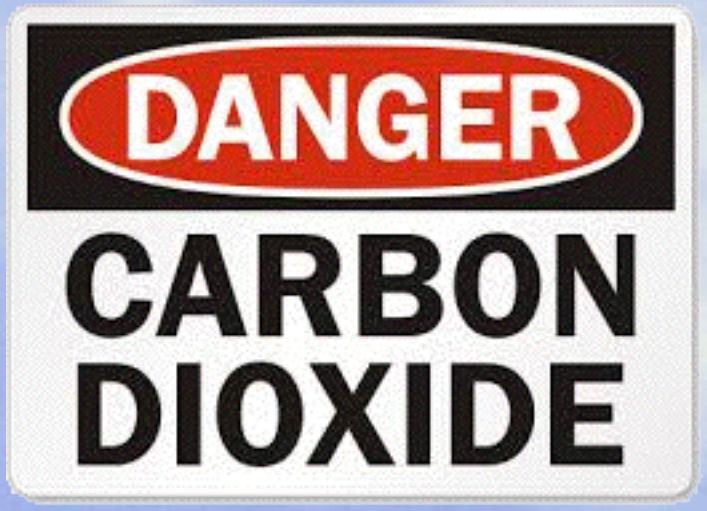
Carbon Dioxide CO_2

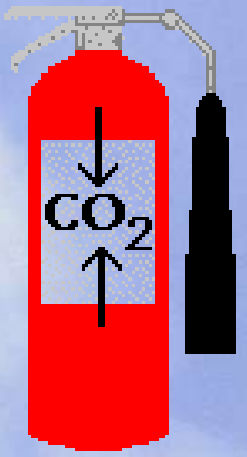


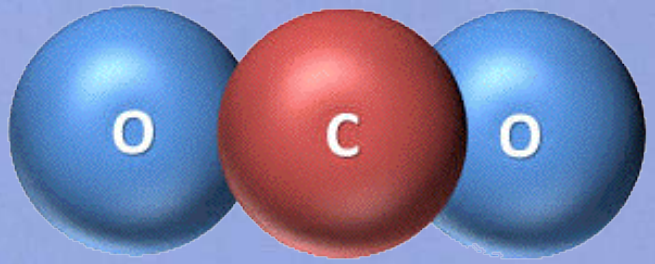










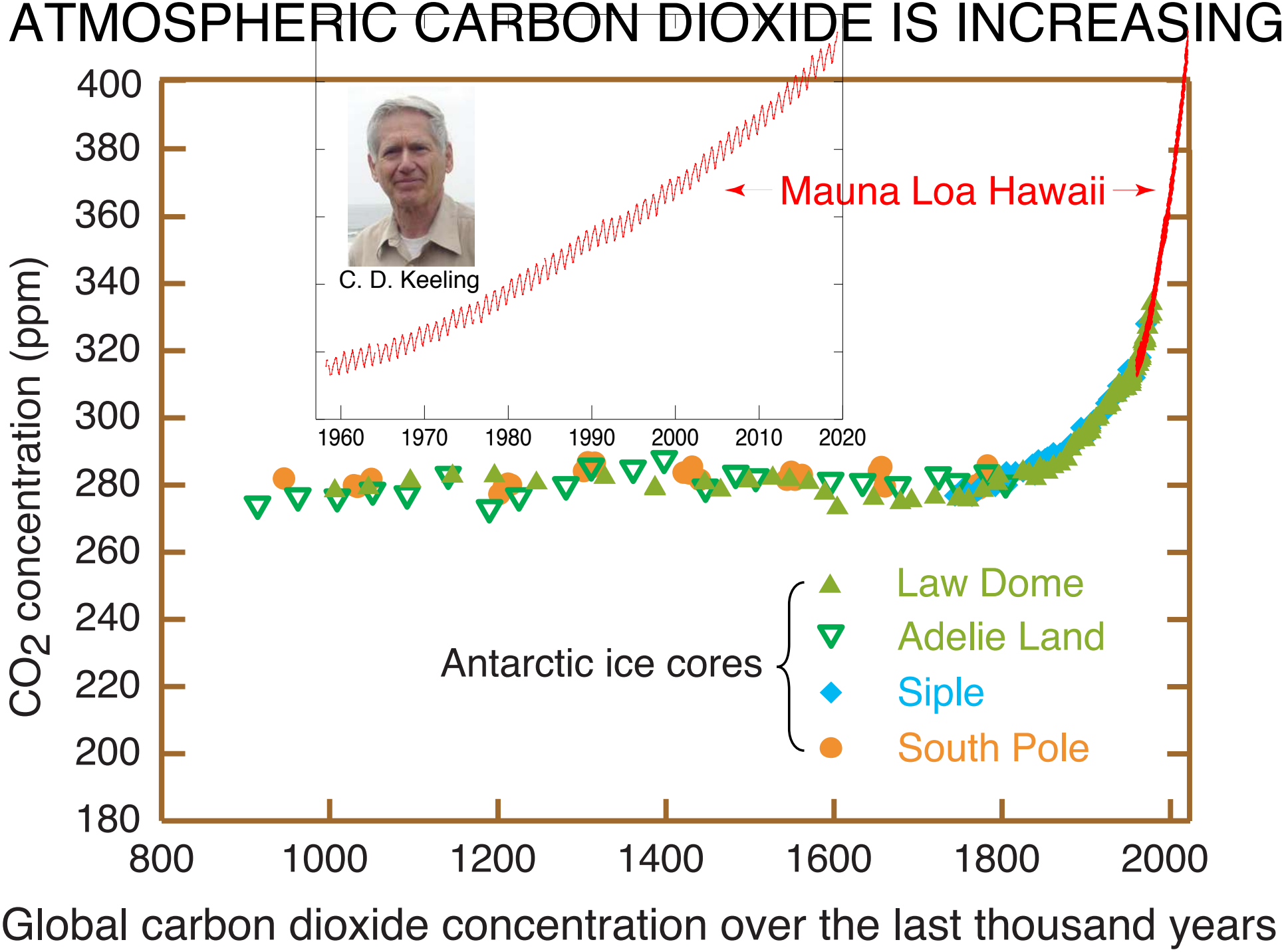


GLACIERS ARE OUR TIME MACHINE

New York Times, July 2, 2012

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

ATMOSPHERIC CARBON DIOXIDE IS INCREASING



Global carbon dioxide concentration over the last thousand years

WHERE IS ALL THIS CO_2 COMING FROM?

WHO IS RESPONSIBLE?

HOW MUCH CARBON IS IN A GALLON OF GASOLINE?

1 lb?

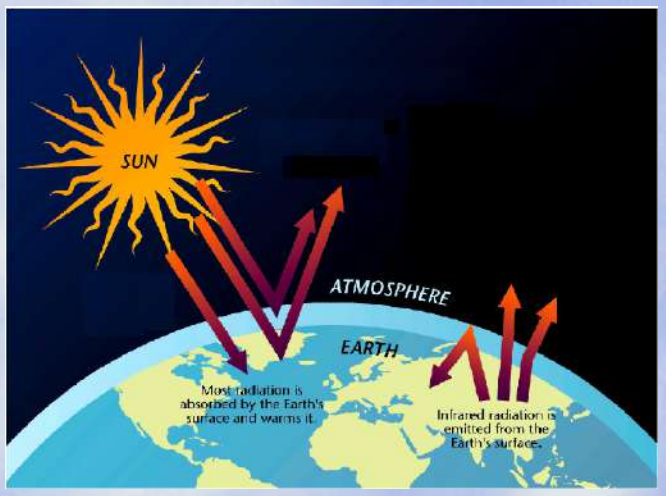
2 lbs?

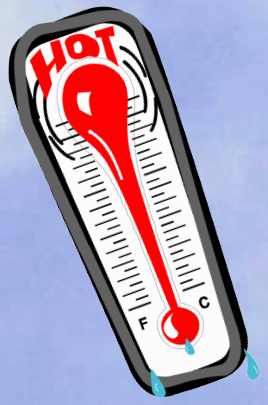
3 lbs!?

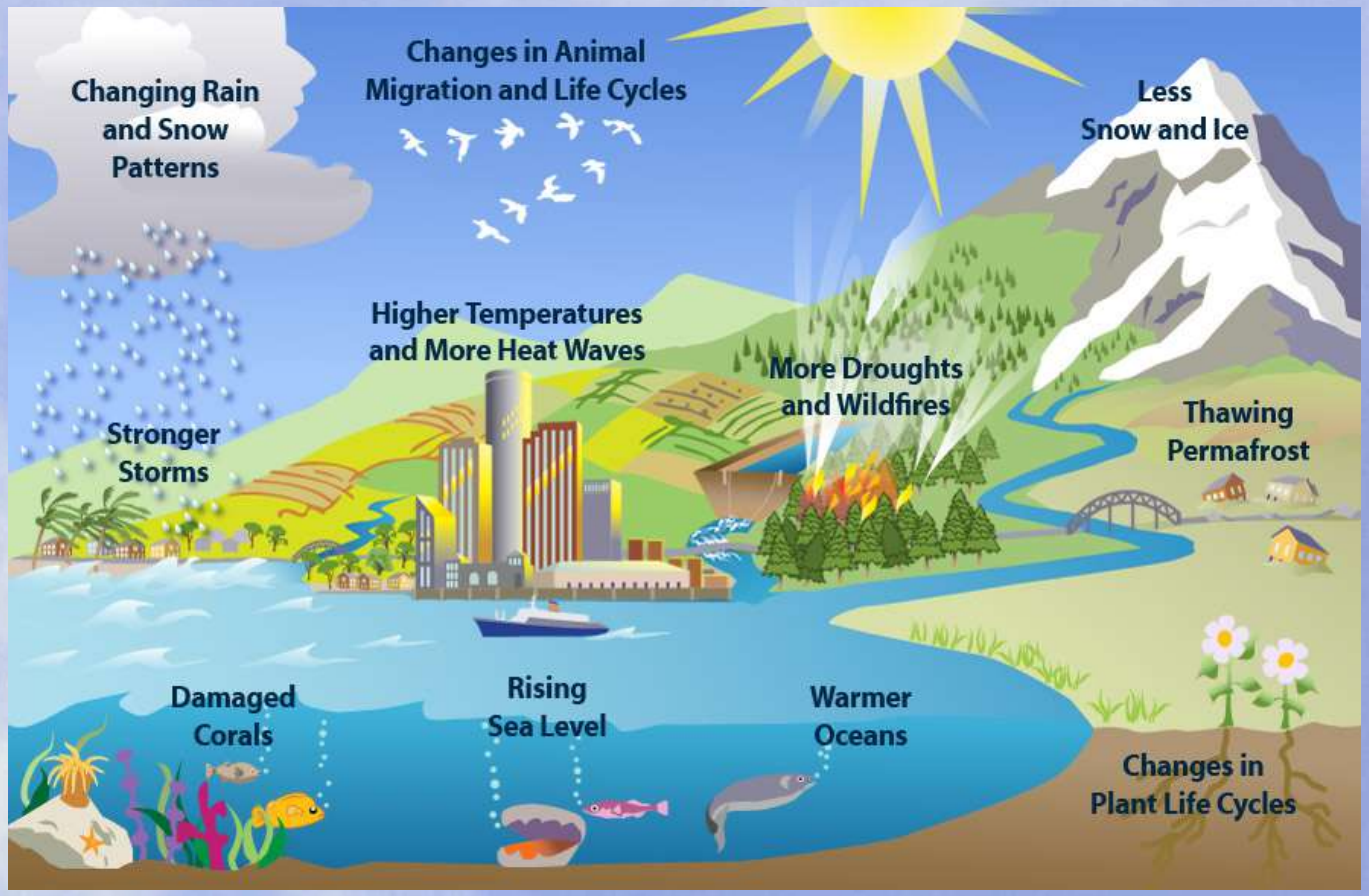
5 lbs!?!

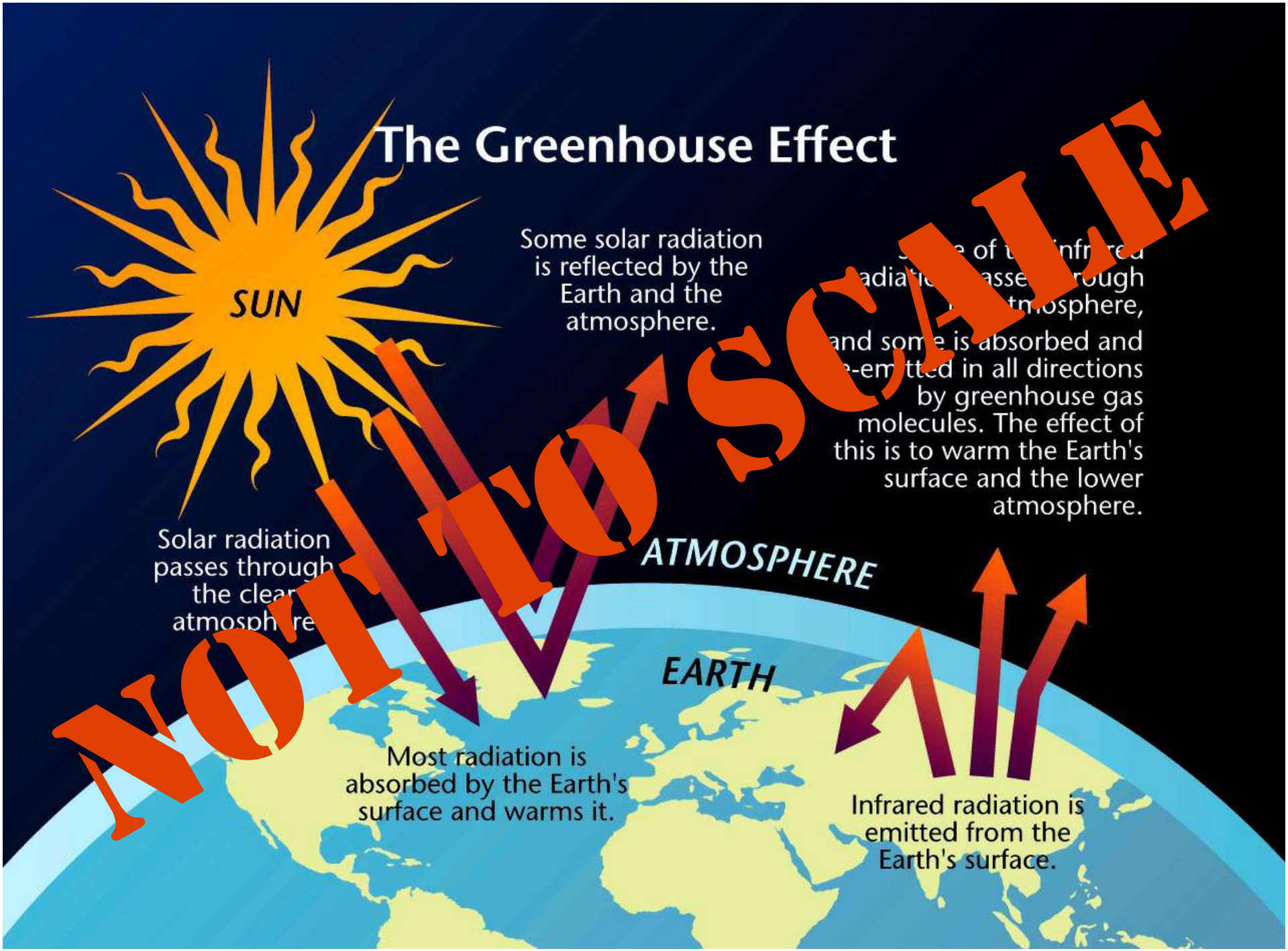
All of this carbon goes into the atmosphere as carbon dioxide when you burn the gasoline in your car.

Climate and The Greenhouse Effect

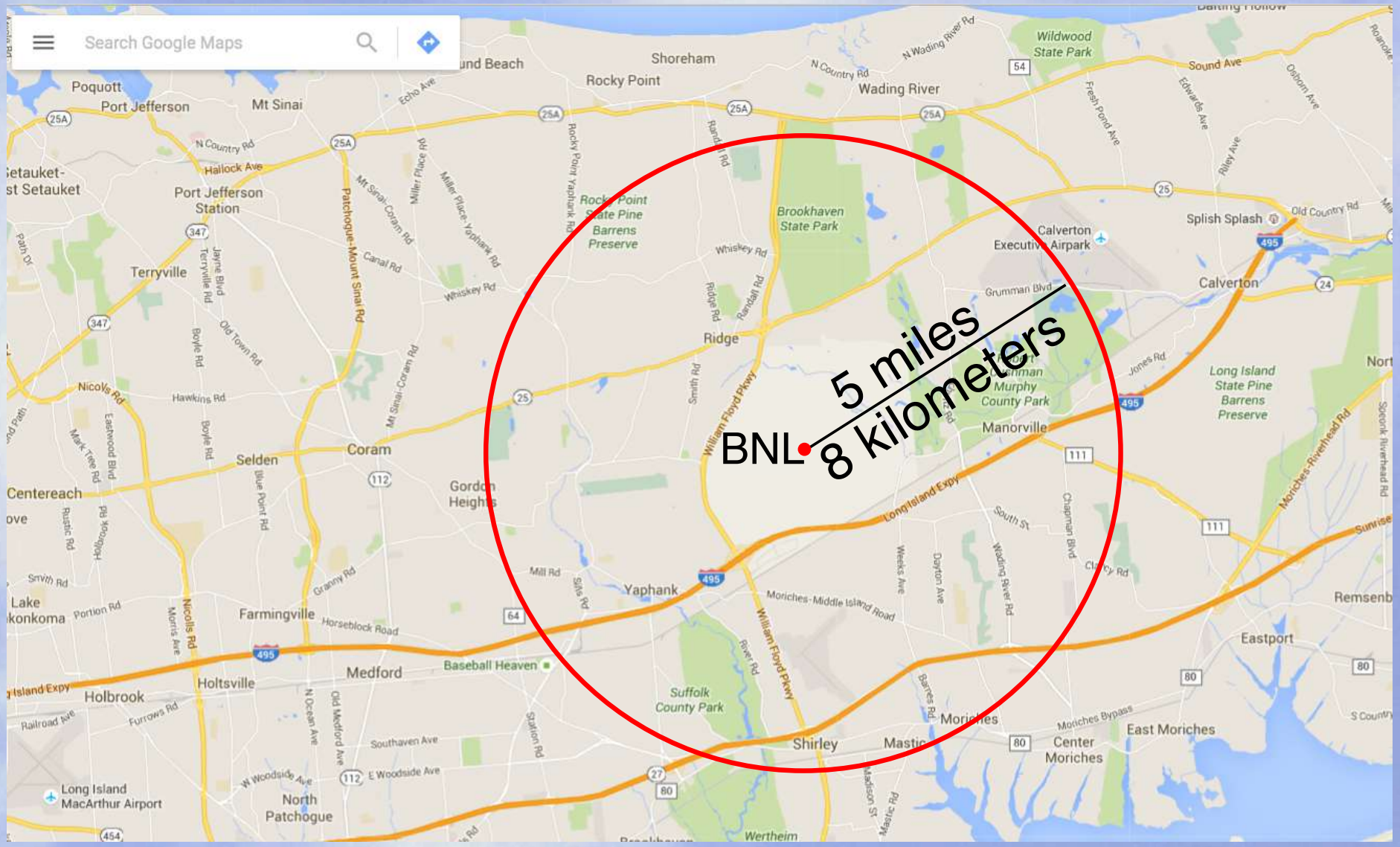







The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.
NOT TO SCALE

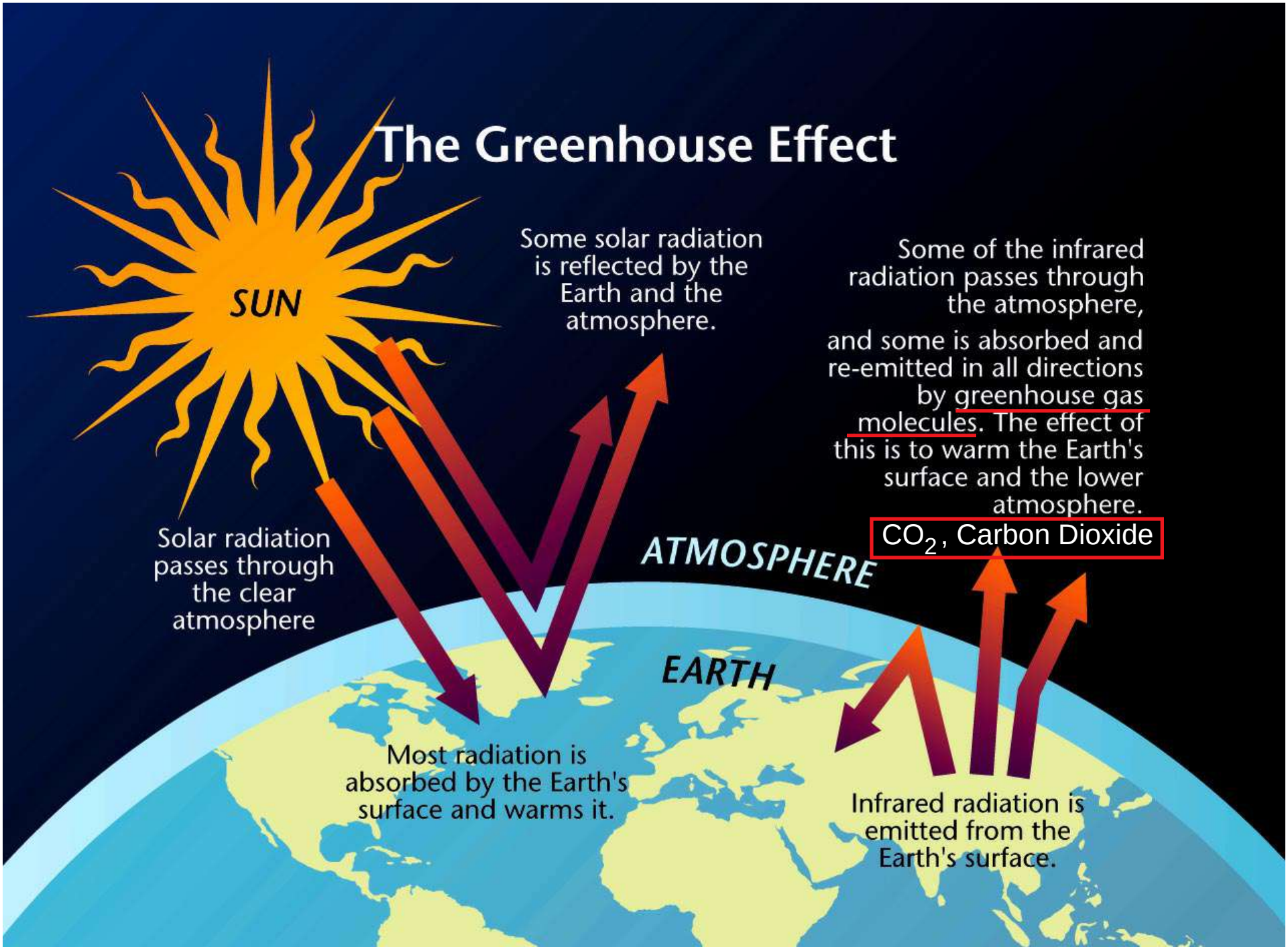
HOW THICK IS EARTH'S ATMOSPHERE?



If the entire atmosphere were compressed to sea-level pressure, it would be about 8 km (5 miles) thick.

HOW THICK IS EARTH'S ATMOSPHERE?

Like a coat of paint on a soccer ball


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.
CO_2, Carbon Dioxide
Solar radiation passes through the clear atmosphere
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
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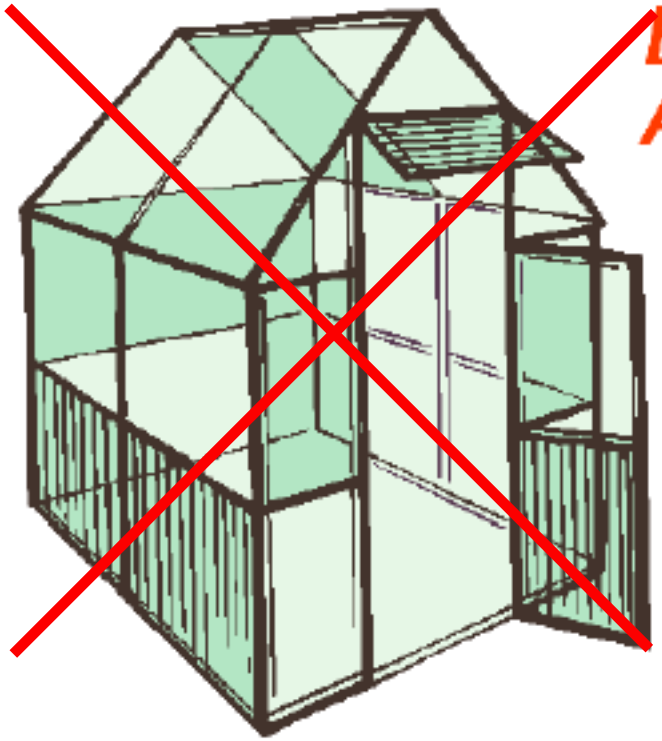
THE GREENHOUSE EFFECT



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.

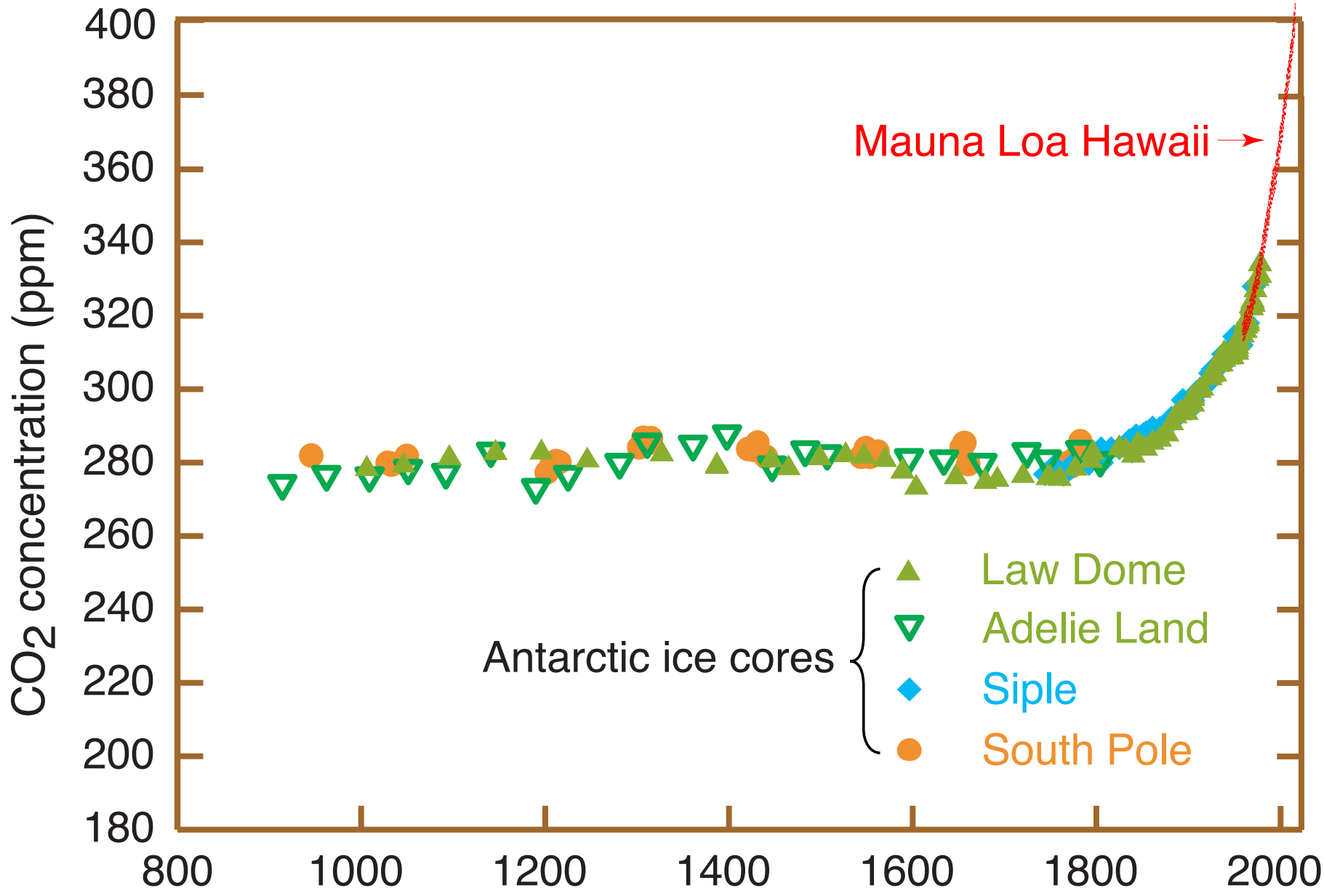
This is the greenhouse effect.

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

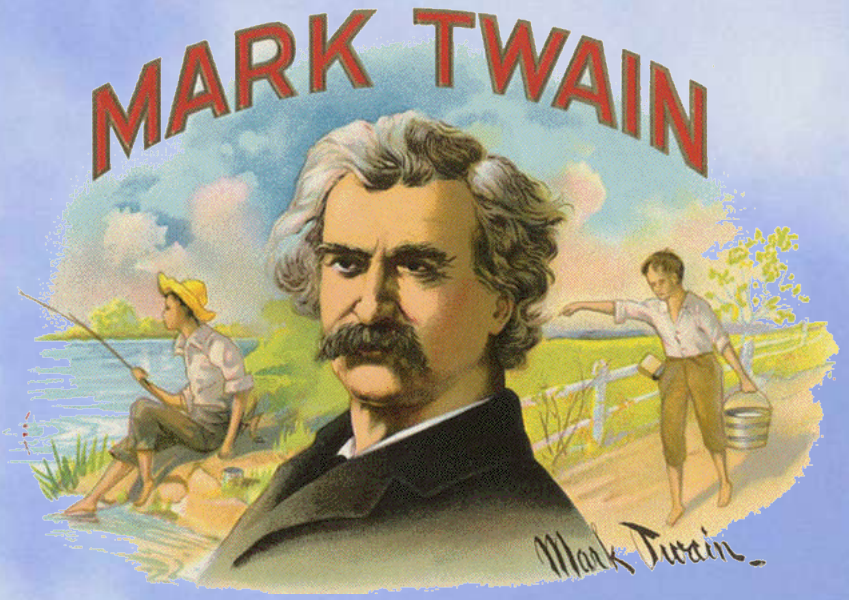
TOO MUCH OF A GOOD THING??



Global carbon dioxide concentration over the last thousand years

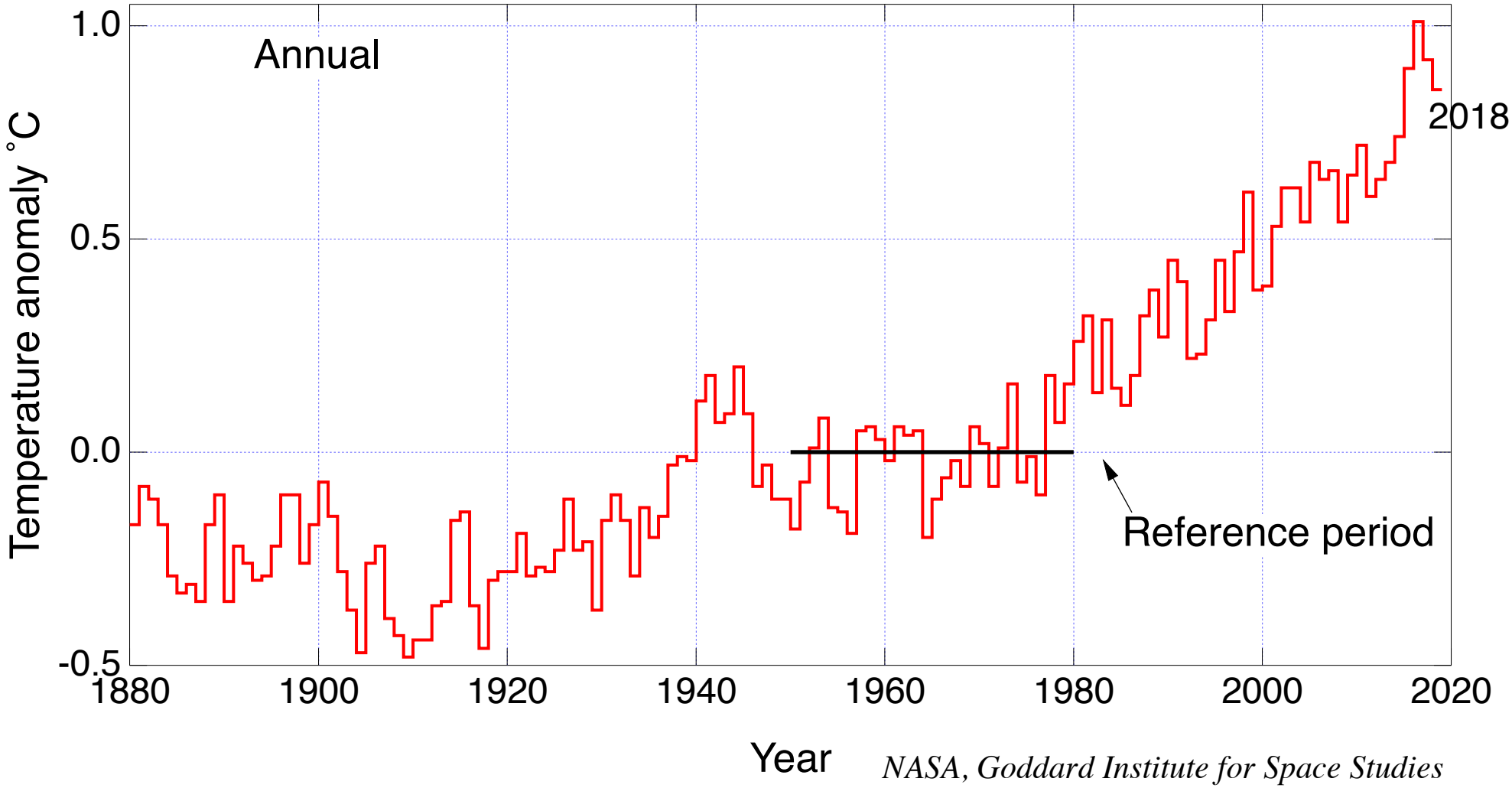
Everybody talks about the weather —

But nobody does anything about it.



Now with the increase in carbon dioxide, we ARE doing something about it. What are we doing?

GLOBAL TEMPERATURE CHANGE SINCE 1880



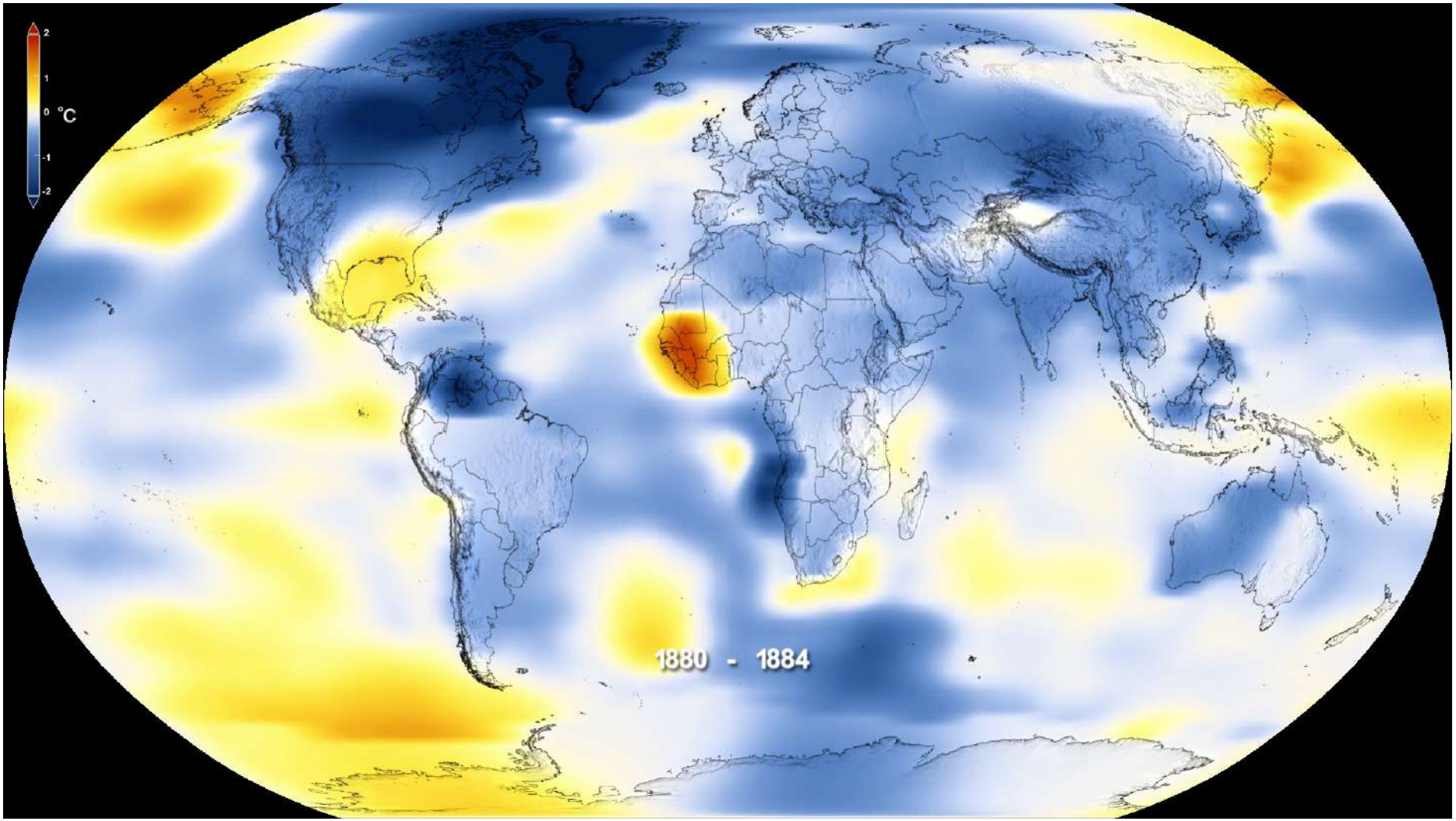
NASA, Goddard Institute for Space Studies

The last 5 years have been the hottest years on record.

17 of the hottest 18 years have been since 2000.

THE WARMING PLANET

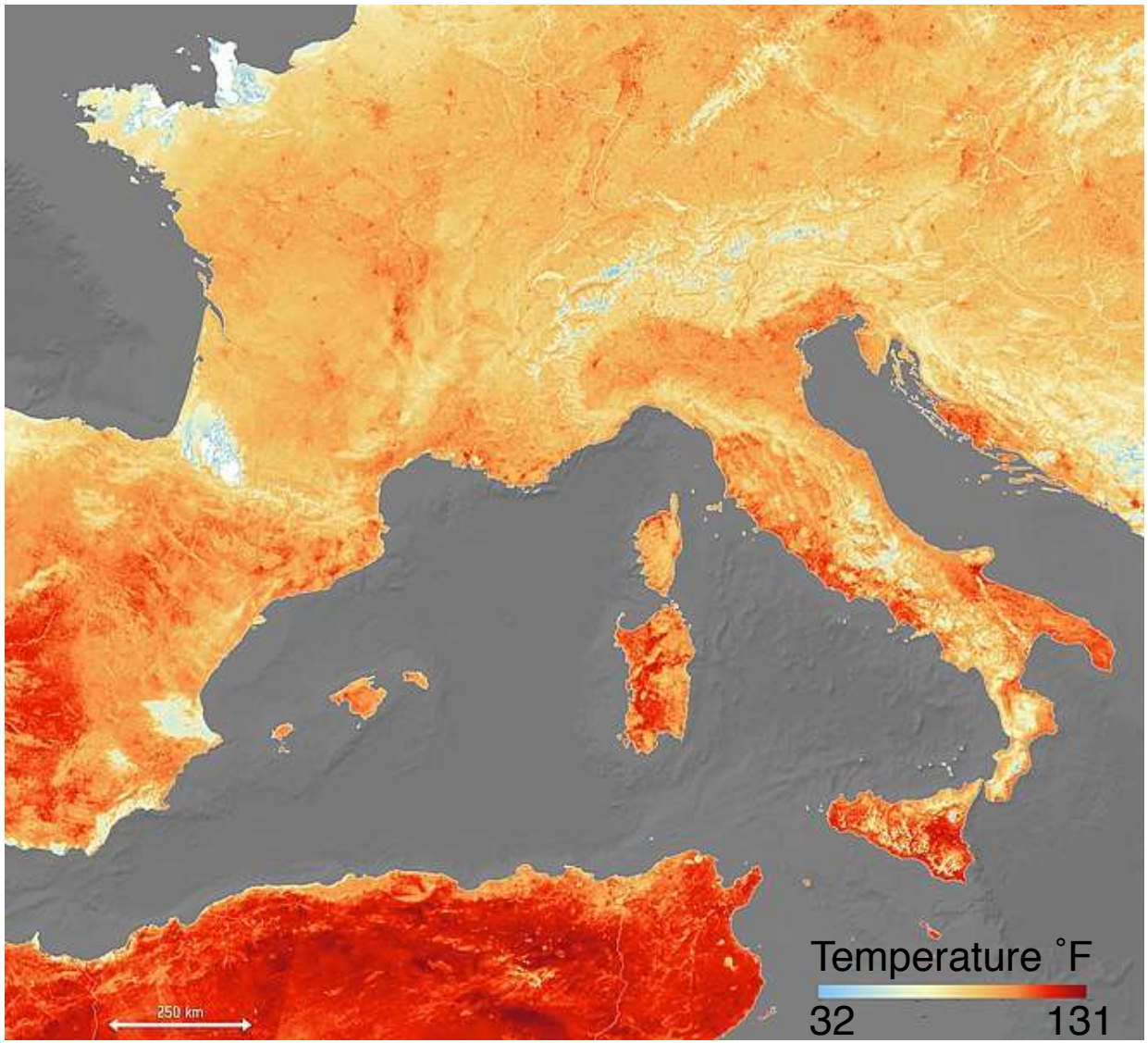
Five-Year-Average Temperature Anomalies Relative to 1950–1980



NASA Goddard Institute for Space Studies

EUROPEAN HEAT WAVE, JUNE-JULY 2019

Temperature of the land on 26 June



The 2019 European heat wave resuted in the hottest June ever recorded in Europe. France experienced temperatures in excess of 113 °F for the first time in recorded history.

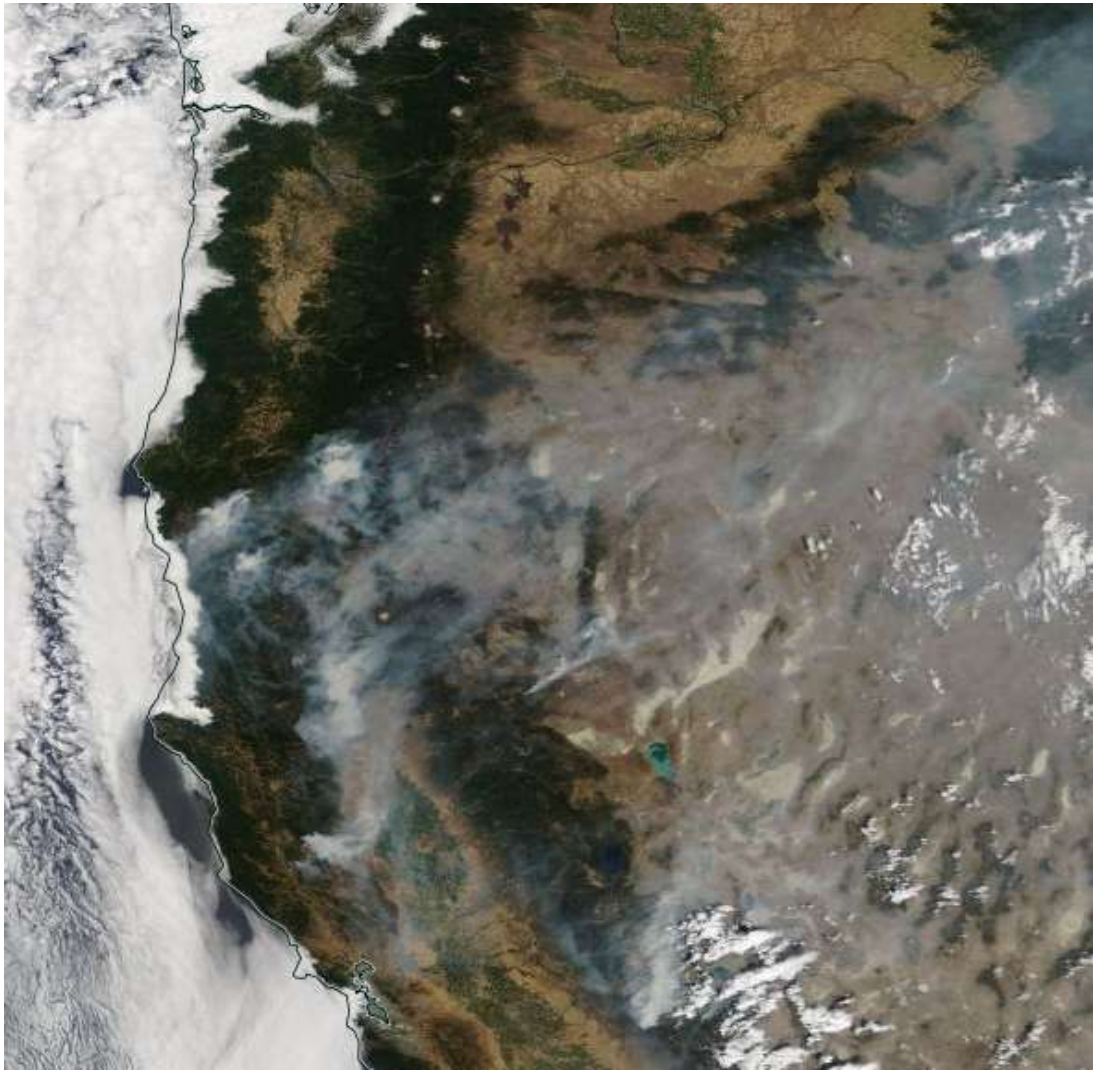
EUROPEAN HEAT WAVE, JUNE-JULY 2019

THE NEW NORMAL?

CALIFORNIA WILDFIRES, 2018

CALIFORNIA WILDFIRES

Satellite image August 1, 2018



The 2018 wildfire season was the deadliest and most destructive wildfire season on record in California, with a total of 8,527 fires burning an area of almost 2 million acres, the largest area of burned acreage recorded in a fire season.

MIDWEST USA FLOODS 2019

DAVENPORT IOWA, May 1, 2019

Play ball!

DAVENPORT IOWA, May 2, 2019

Play ball!

DAVENPORT IOWA, July 5, 2019

Play ball!

SAND SPRINGS, OKLAHOMA, May 28, 2019

SAND SPRINGS, OKLAHOMA, May 29, 2019

Highway flooding along Arkansas River

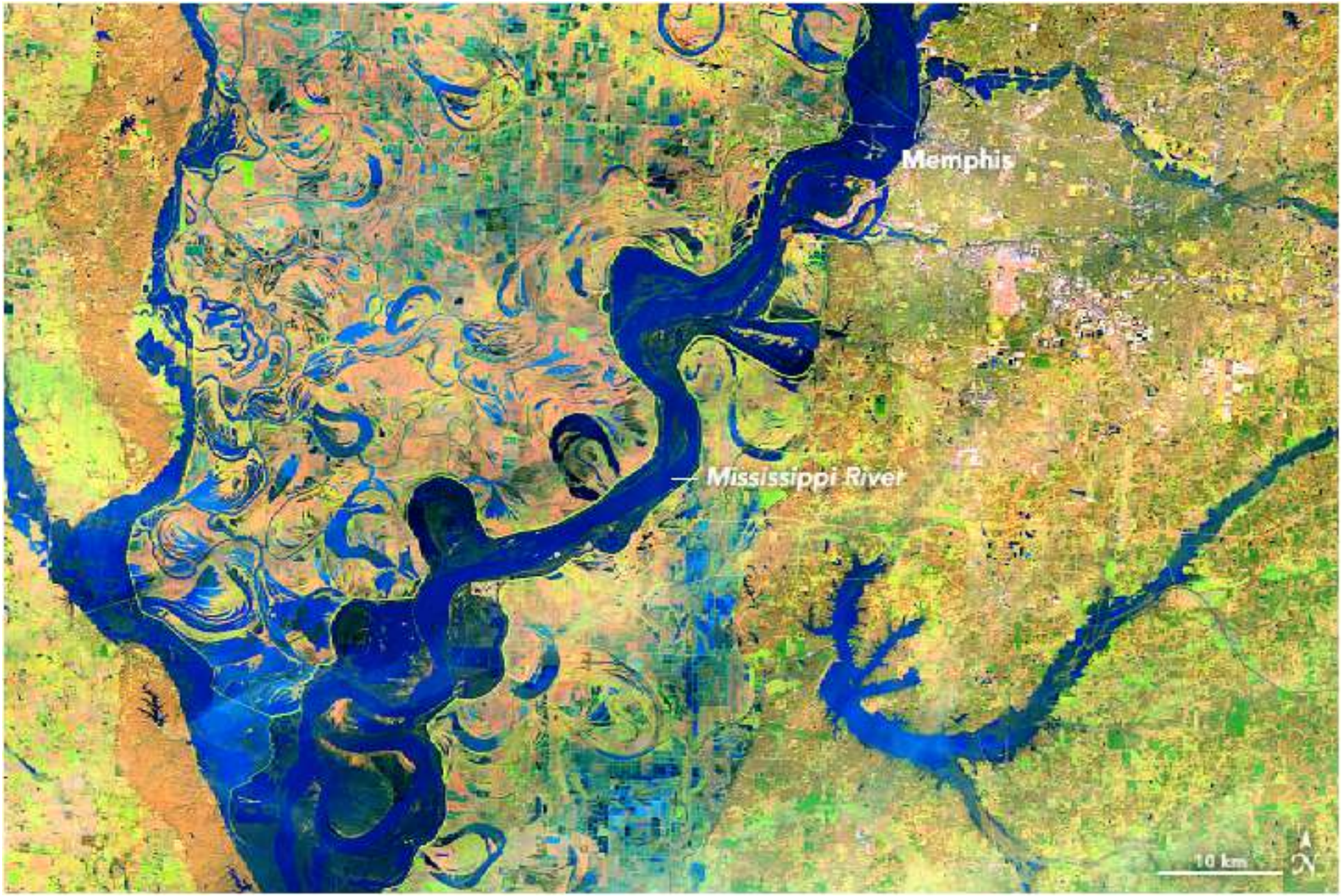
FORT SMITH, ARKANSAS, May 29, 2019

MISSISSIPPI RIVER, NEAR MEMPHIS, TENNESSEE
February 27, 2014

NASA, false color image: soil, brown; vegetation, green; water, blue.

10 km (6 mi)

MISSISSIPPI RIVER, NEAR MEMPHIS, TENNESSEE
February 25, 2019



NASA, false color image: soil, brown; vegetation, green; water, blue.

10 km (6 mi)

NEW ORLEANS, July 10, 2019

The calm before the storm

NEW ORLEANS, July 11, 2019

National Guard reinforces levee protecting refinery.

NEW ORLEANS, July 11, 2019

Lines to tank up before the storm.

NEW ORLEANS
July 10, 2019

End of the line

NEW ORLEANS, July 13, 2019

SLATE

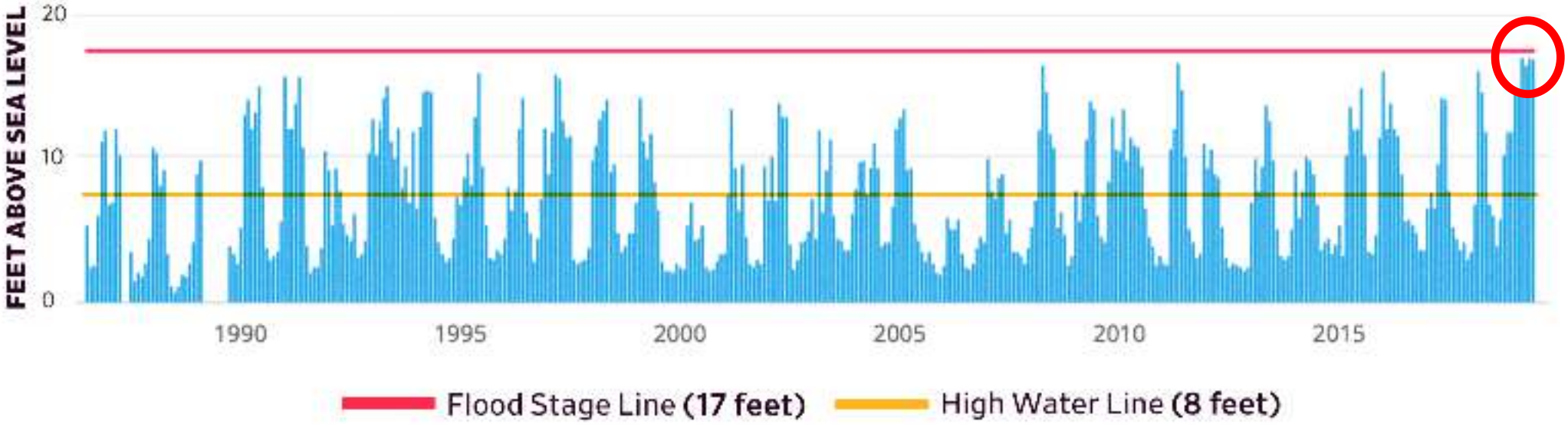
Hell Is High Water

When will the Mississippi River come for New Orleans?

By HENRY GRABAR

JUNE 18, 2019

Average Height of the Mississippi River in New Orleans by Month



SLATE

Hell Is High Water

When will the Mississippi River come for New Orleans?

By HENRY GRABAR

JUNE 18, 2019

What has happened is ***the weather changed***. The 12 months ending in April were the ***wettest yearlong period in the United States*** and caused devastating flooding across the watersheds of the Mississippi.

This is not explicitly a product of climate change, but it does align with our expectation of how the warmer atmosphere will alter—and is already altering—precipitation patterns.

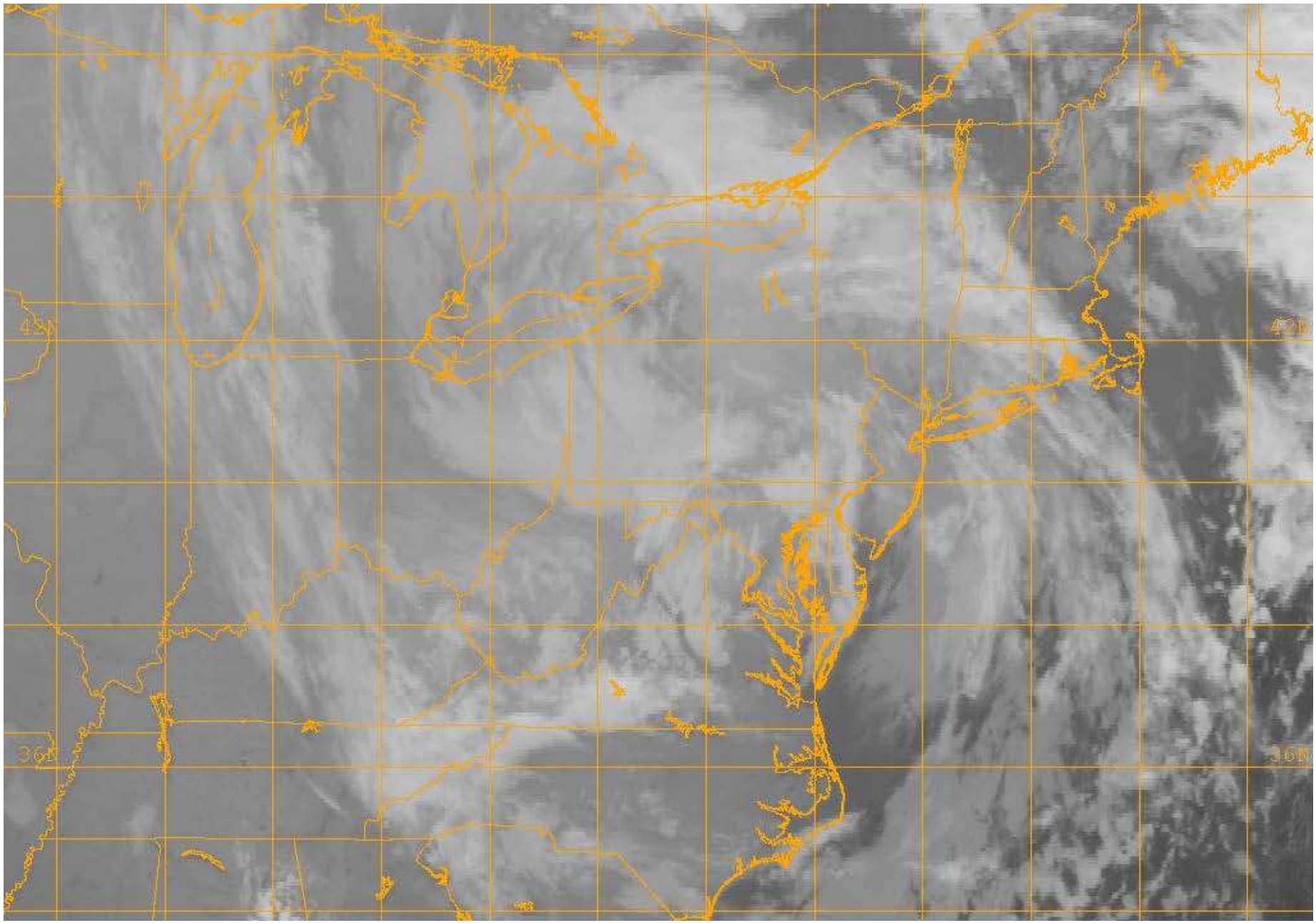
One of the most unnerving aspects of this year's record high water is that it now ***coincides with the start of hurricane season***.

For now, that is an unlikely event that should not keep the 1.275 million people in Greater New Orleans up at night. ***Big hurricanes don't typically arrive in the gulf until late August and September***.

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?

Breezy Point, Queens, NYC

SUPERSTORM SANDY – THE NEW NORMAL?

Hoboken NJ

SUPERSTORM SANDY – THE NEW NORMAL?

Fenwick Island, DE

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?

YOU!

WHO IS RESPONSIBLE?

WHO IS RESPONSIBLE?

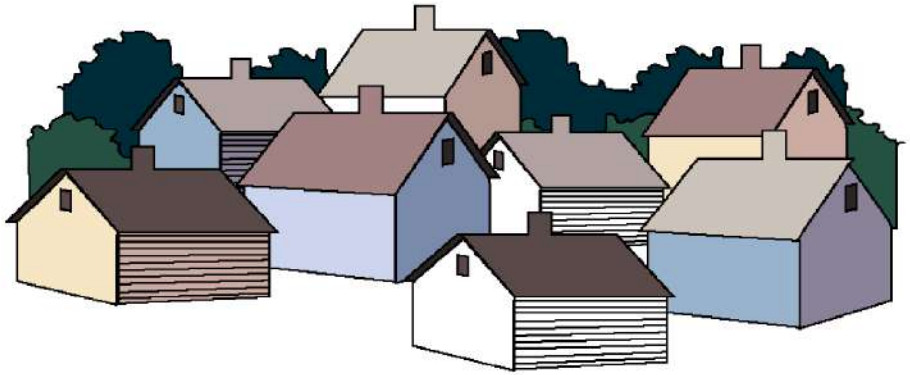
IT'S ALL OF US!

Pogo, Walt Kelly, Earth Day, 1971

WHERE IS THIS CARBON DIOXIDE COMING FROM?

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.

Other sources are home heating and electric power production.



WE ARE ALL RESPONSIBLE.

IS THERE ANYTHING WE CAN DO?

Planting a Trillion Trees May Be the Best Way to Fight Climate Change, Study Says

TIME July, 2019

This would require reforestation of an area equal to that of the continental United States!

SOLAR PHOTOVOLTAIC ENERGY

Decrease your carbon legacy by generating your own electricity

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

SOLAR FARM AT BNL

32 Megawatt – Power for 4500 homes

For more info: https://www.bnl.gov/SET/LISF.php

POWER YOUR CAR WITH ELECTRIC ENERGY

POWER YOUR CAR WITH SOLAR ELECTRIC ENERGY, FOR FREE

NEW YORK STATE TAKES THE LEAD

Senate Bill S6599

2019-2020 Legislative Session

New York state climate leadership and community protection act

FINDINGS

Severity and frequency of ***extreme weather events***, such as storms, flooding, and heat waves.

Rising sea levels, which exacerbate damage from storm surges and flooding.

Increased average temperatures, which increase the demand for air conditioning and refrigeration.

Exacerbation of ***air pollution***.

Increase in the incidences of infectious diseases, asthma attacks, heart attacks, and other ***negative health outcomes***.

www.nysenate.gov/legislation/bills/2019/s6599

NEW YORK STATE TAKES THE LEAD

Senate Bill S6599

2019-2020 Legislative Session

New York state climate leadership and community protection act

Statewide greenhouse gas emissions limits

No later than one year after the effective date of this article, the department shall establish a statewide greenhouse gas emissions limit as a percentage of 1990 emissions, as follows:

2030: 60% of 1990 emissions.

2050: 15% of 1990 emissions.

www.nysenate.gov/legislation/bills/2019/s6599

The New York Times SUNDAY, JULY 14, 2019

Counting Down to a Green New York

New York plans to be carbon neutral by 2050, and housing is one of the biggest polluters. Can this dirty old town clean up its act in time?

Nearly airtight building envelope and a system that exchanges indoor and outdoor air.

Solar panels and a cogeneration system that makes use of otherwise wasted thermal energy to help heat the building's water.

Uses about 60 to 80 percent less energy than conventional buildings.

BNL RESEARCH TO ENHANCE OUR ENERGY FUTURE

Developing materials for converting solar energy to electricity or fuels.

Improving efficiency and lifetime of batteries.

Examining effects of solar and wind energy on grid stability.

Optimizing sizing, siting, and operation of energy storage systems.

Improving energy yields of biofuels.

Forecasting impact of clouds on solar energy production at time scales of minutes to hours to days.

Forecasting severe storms in support of electric utility preparedness.

Improving understanding of effects of energy related emissions on climate change.

BROOKHAVEN
NATIONAL LABORATORY

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?

BNL RESEARCH IS HELPING TO ANSWER THESE QUESTIONS.

THANK YOU!

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