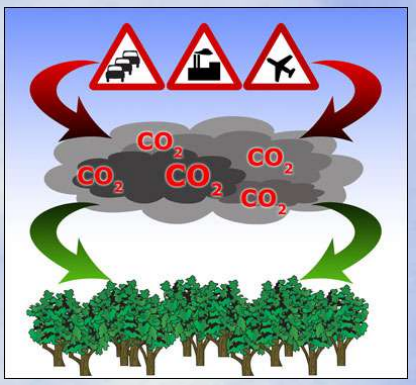
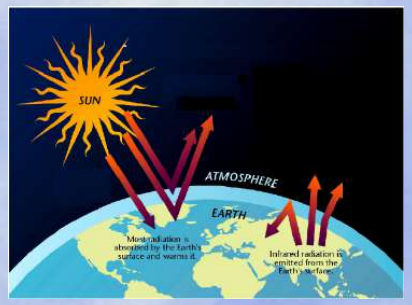
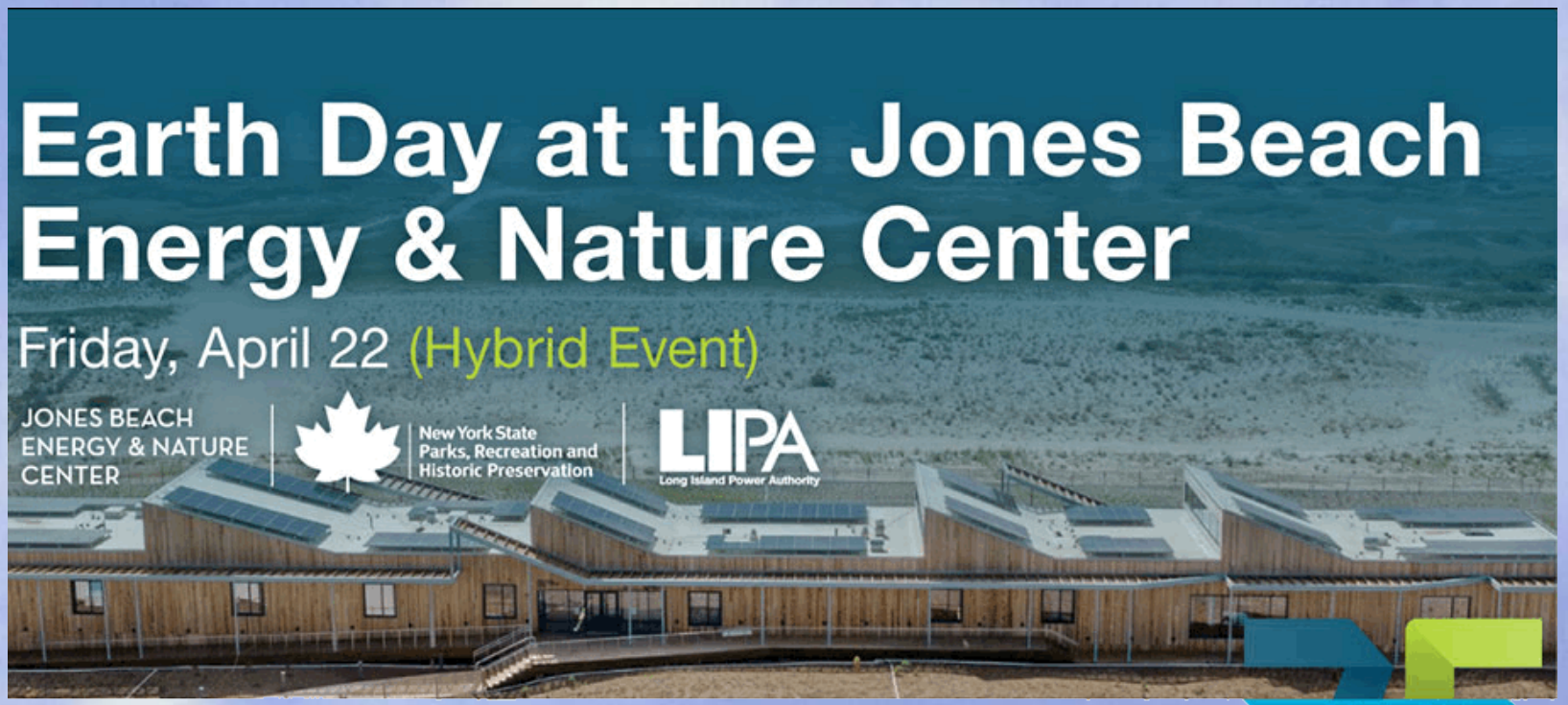
Energy, CO_2, Climate, and YOU!

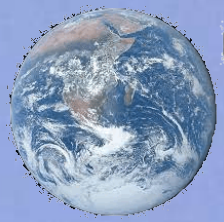




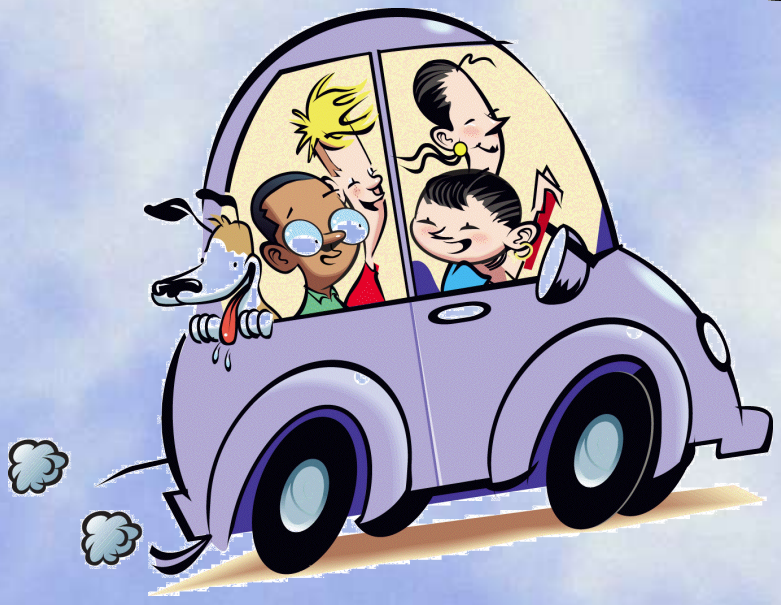


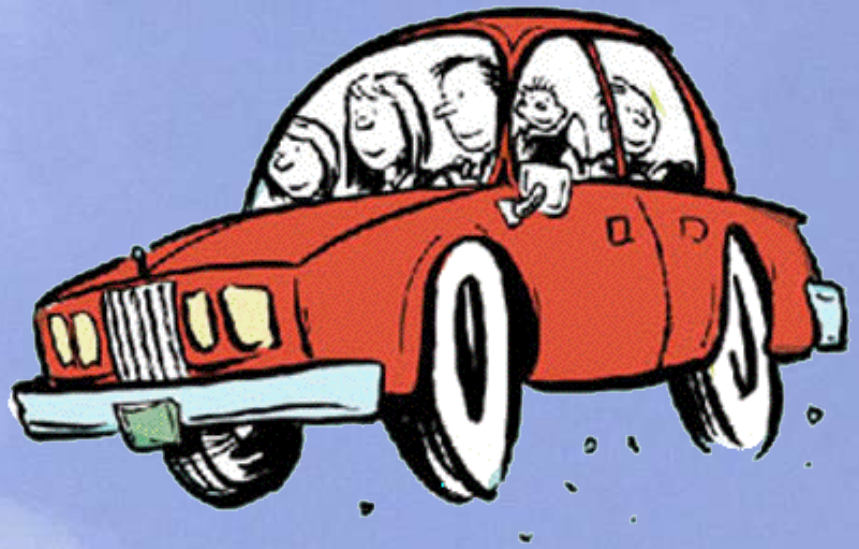
Brookhaven National Laboratory

Dr. Steve
(Doctor of Chemistry)
Stephen E. Schwartz



COMING TO EARTH DAY AT JONES BEACH





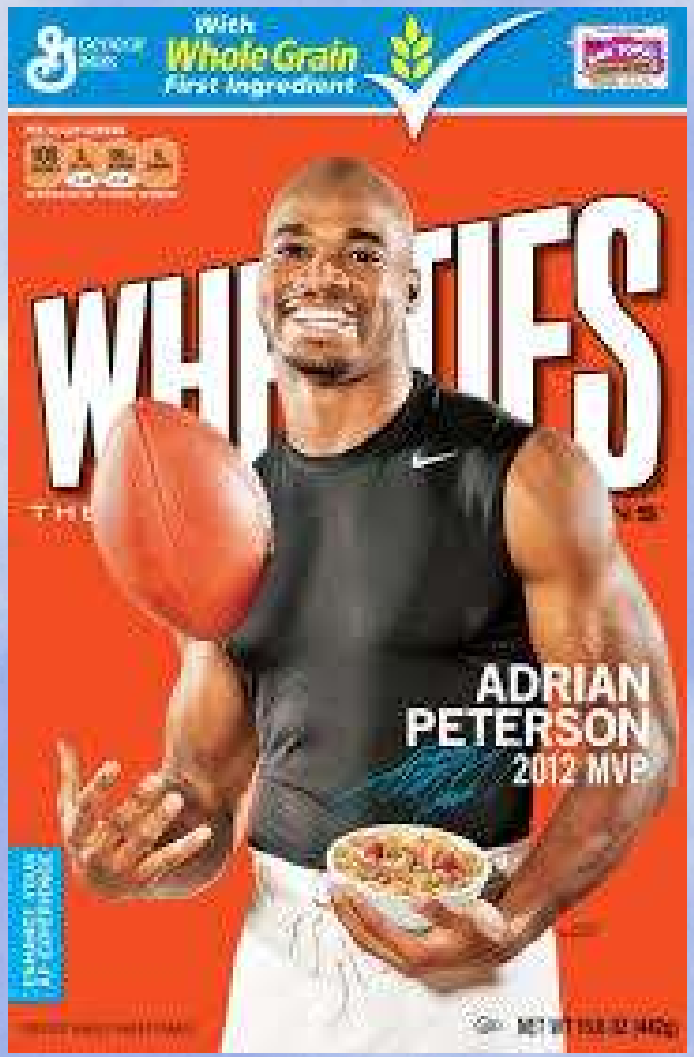
CARPOOLING CAN SAVE MORE THAN GAS

Energy

WHERE DO YOU GET YOUR ENERGY?

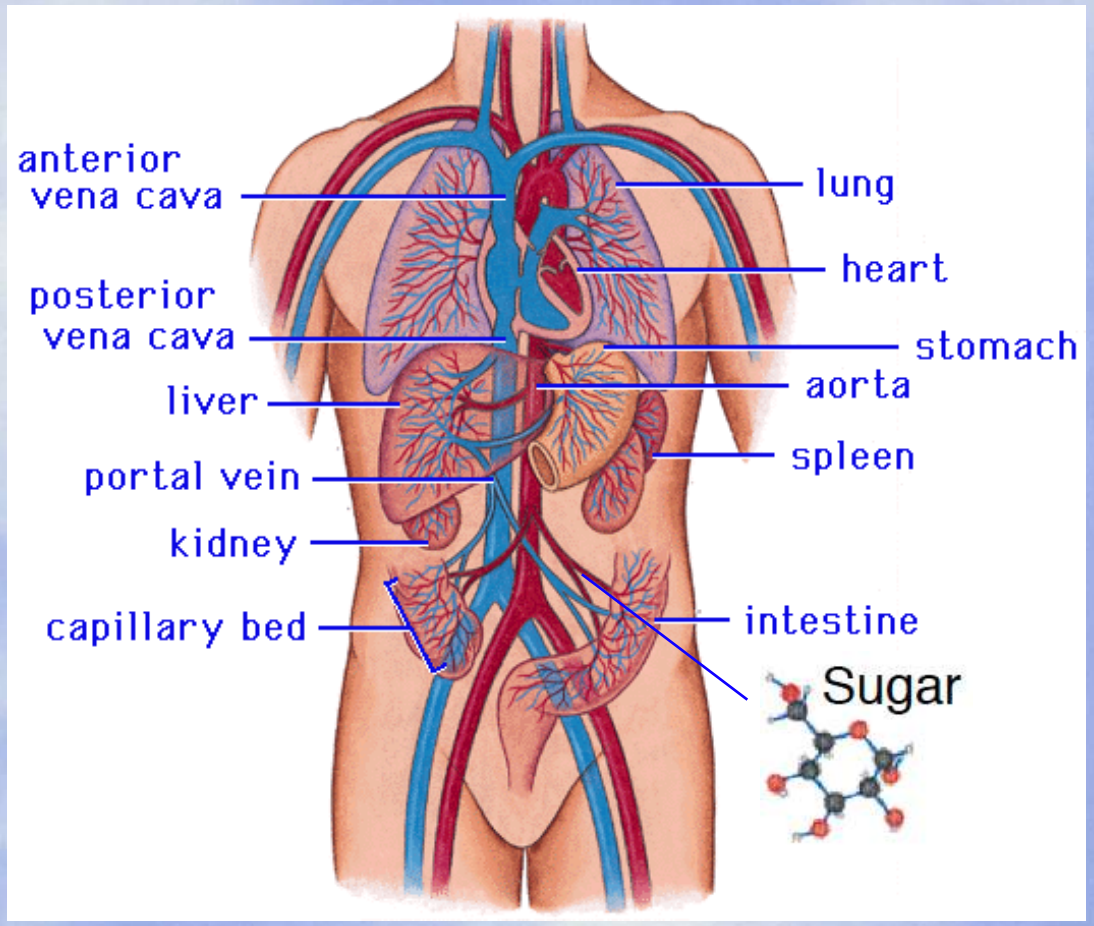
WHERE DO YOU GET YOUR ENERGY?

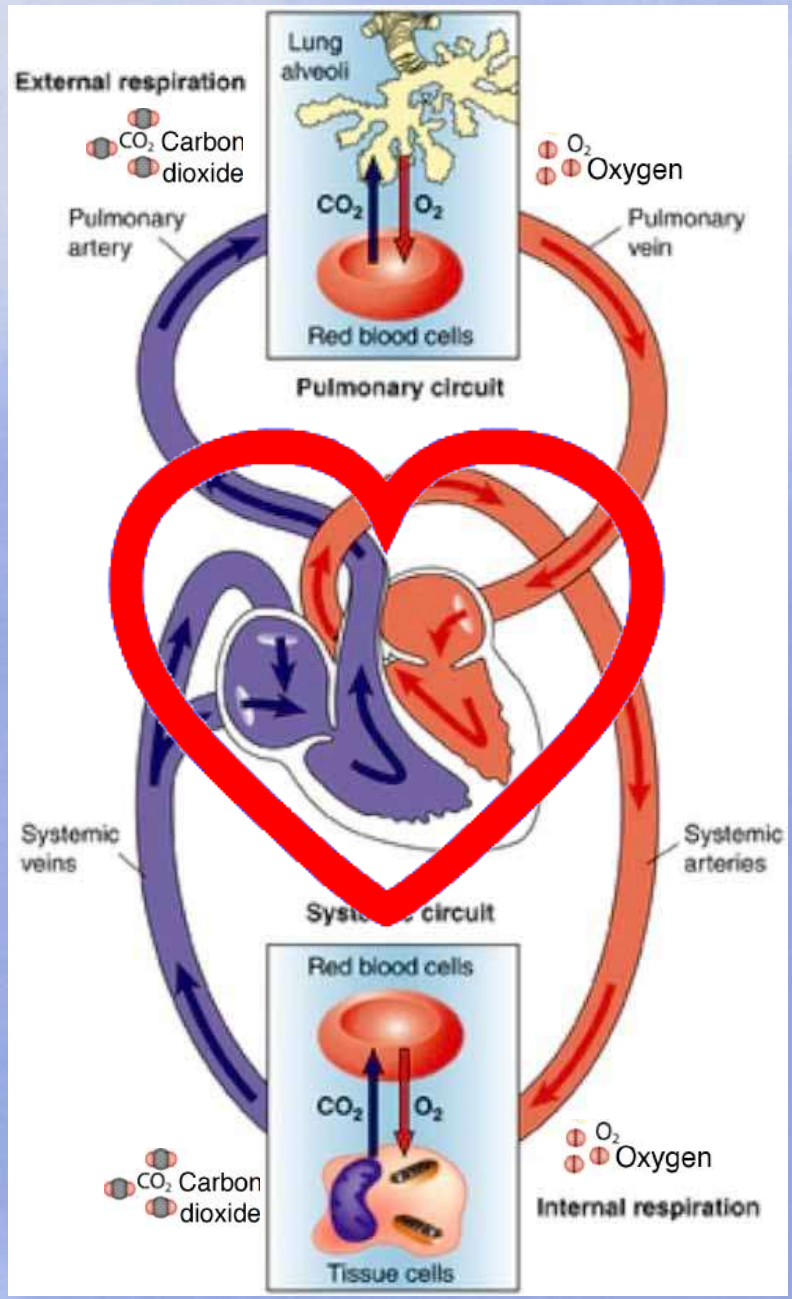
FOOD



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

BLOOD

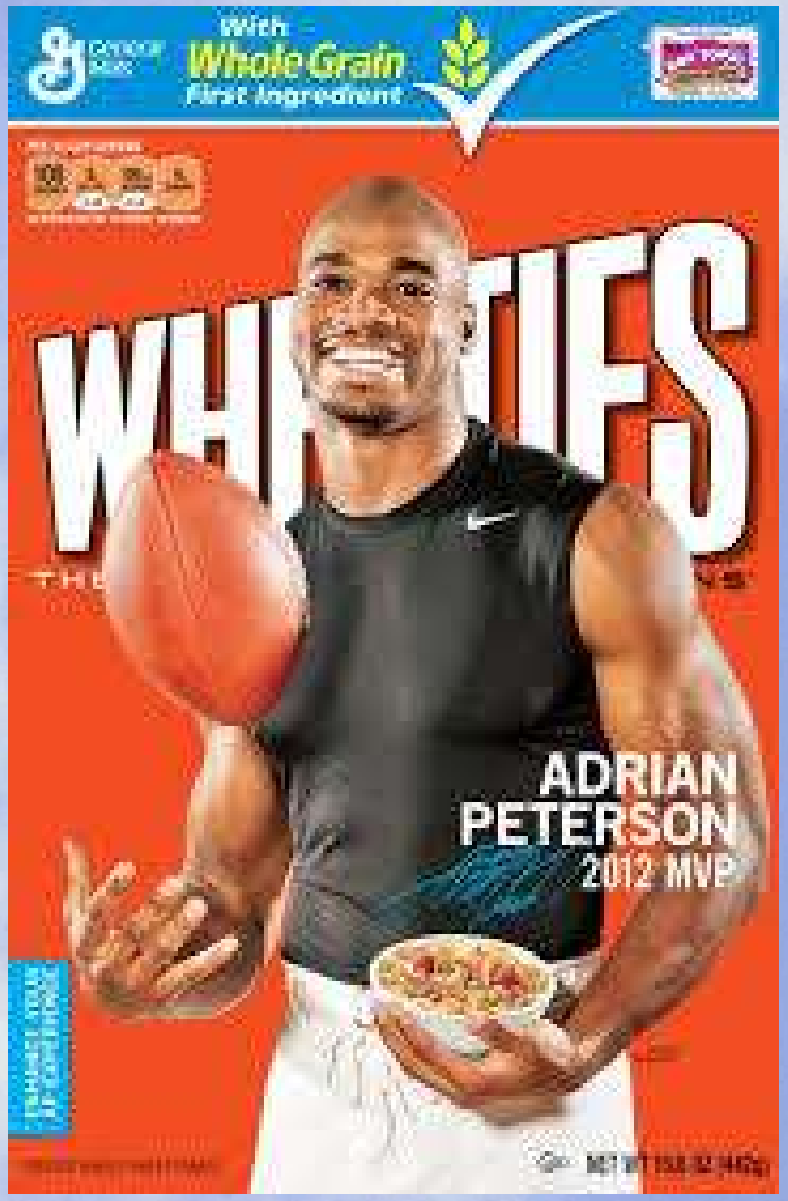




http://library.thinkquest.org/5777/cir1.htm

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

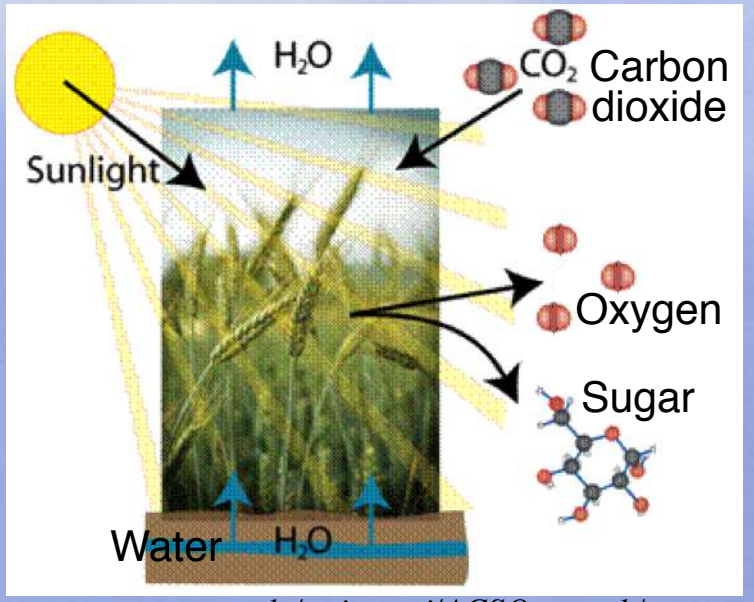
WHERE DOES YOUR FOOD GET *ITS* ENERGY?



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

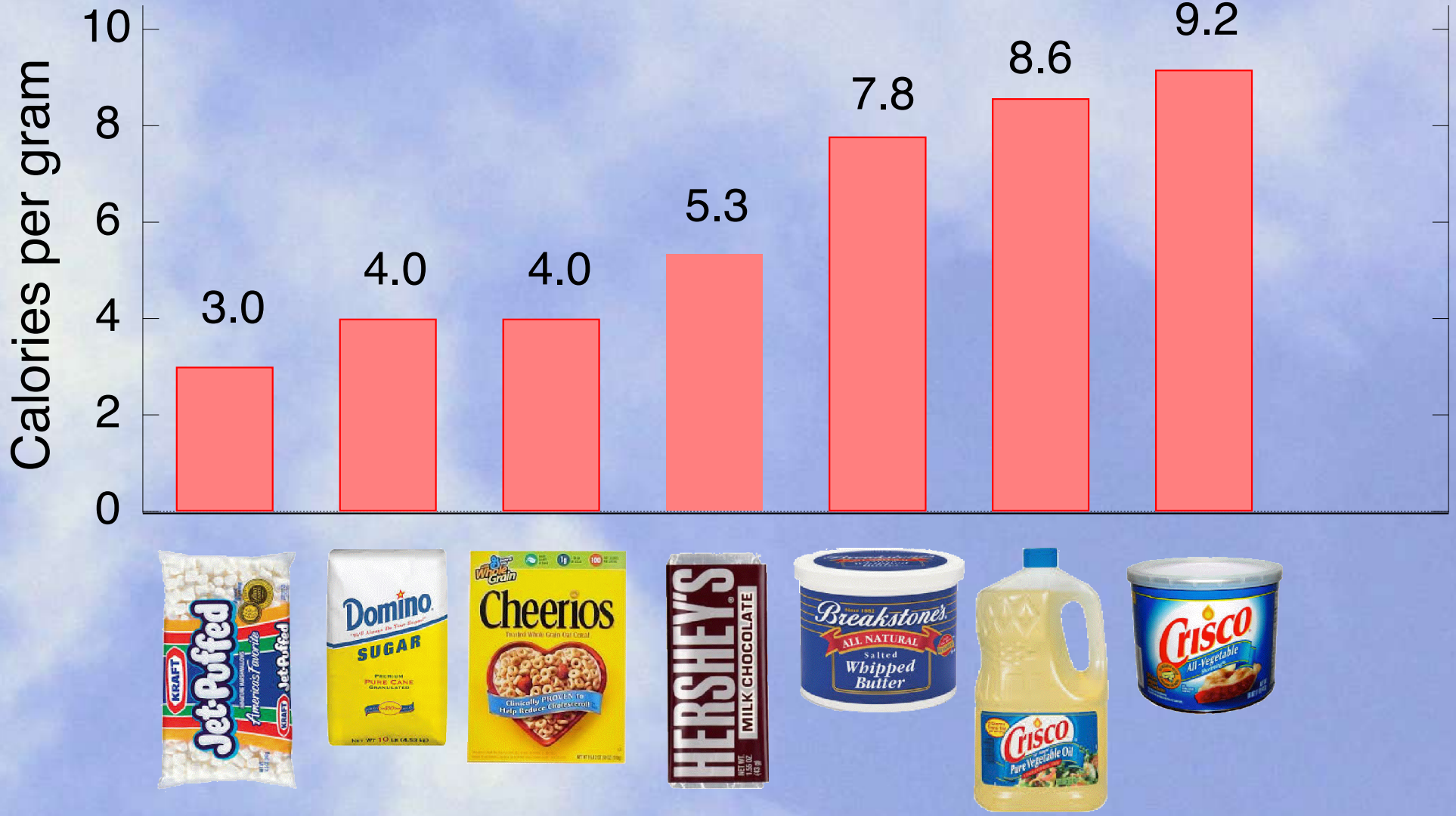
Calories	90
Calories from Fat	0
Total Fat	0g
Sodium	80mg
Potassium	5mg
Carbohydrates	70g
Sugars	53.3g
Protein	3.3g

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

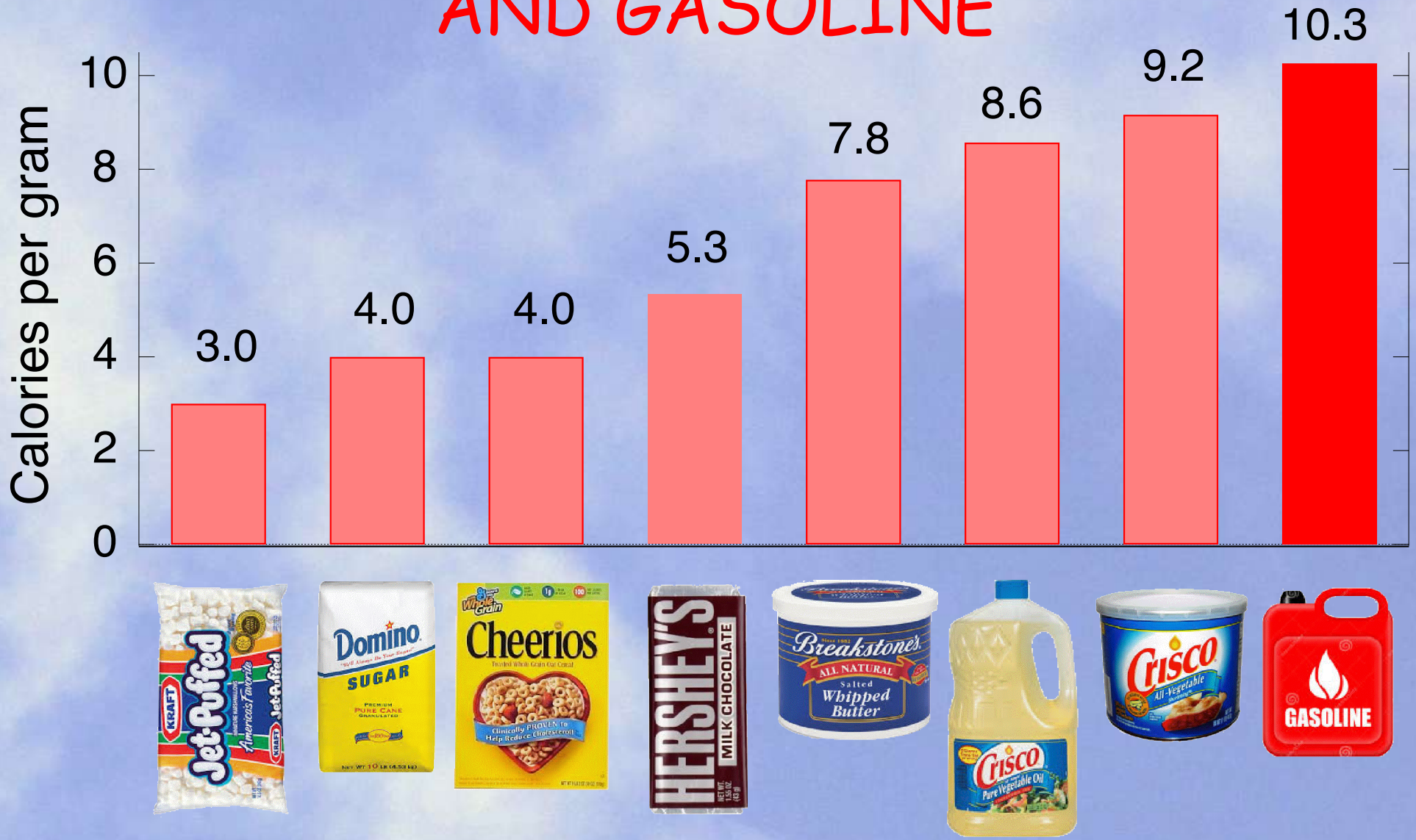


HOW MUCH ENERGY DOES IT TAKE TO TRAVEL ONE MILE?

WHERE DOES YOUR CAR GET *ITS* ENERGY?

WHERE DOES YOUR CAR GET *ITS* ENERGY?

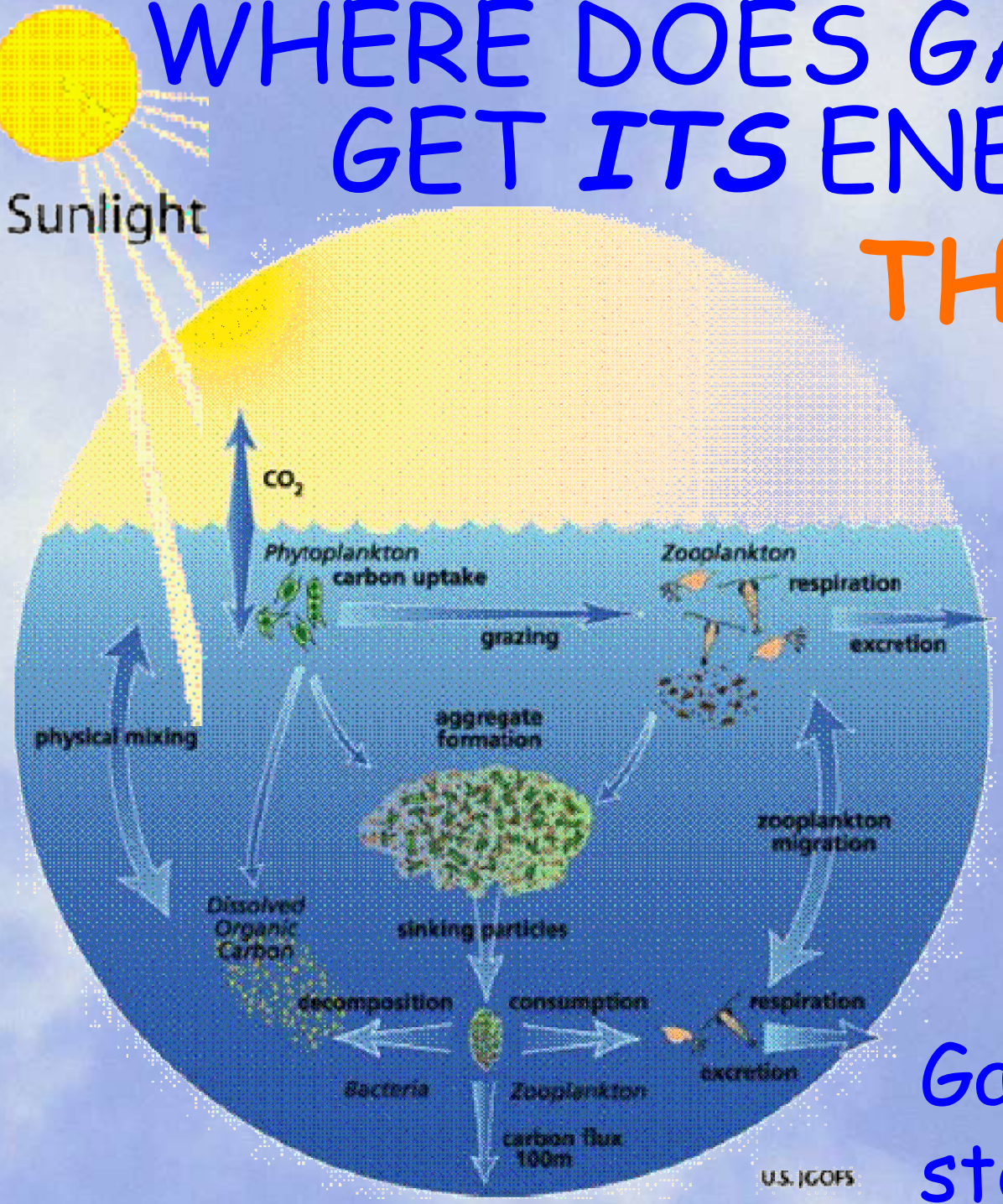
CALORIE CONTENT OF ENERGY FOODS AND GASOLINE

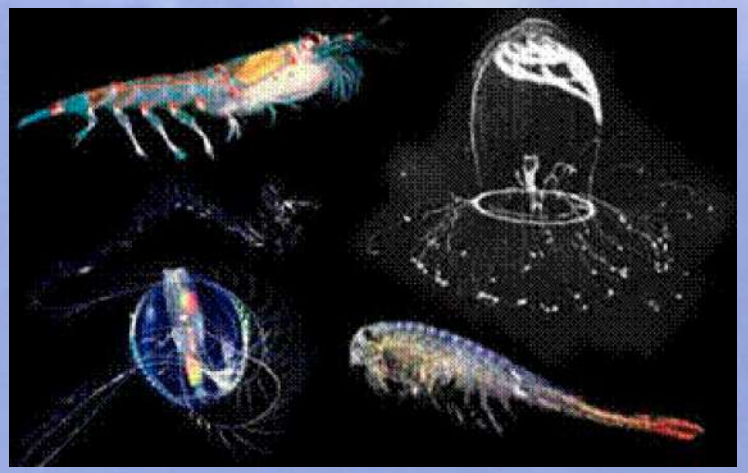


WHERE DOES GASOLINE GET *ITS* ENERGY?

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

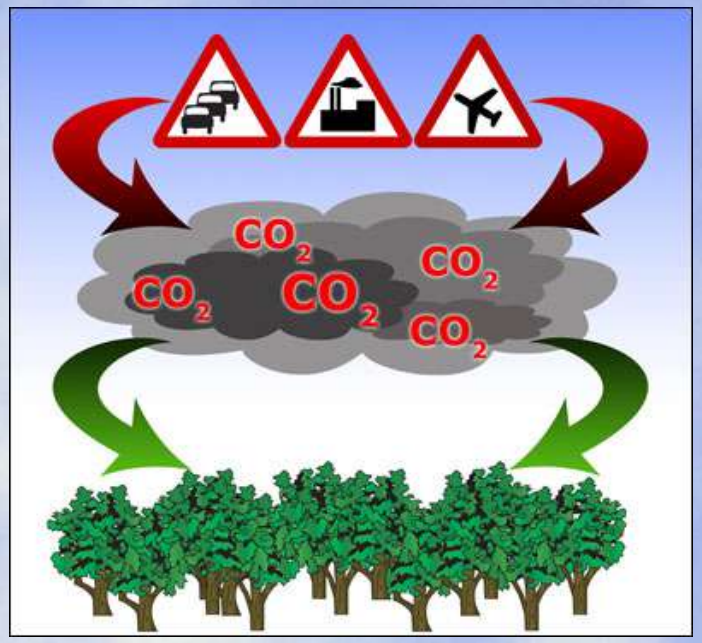
Equivalent to 100 watts

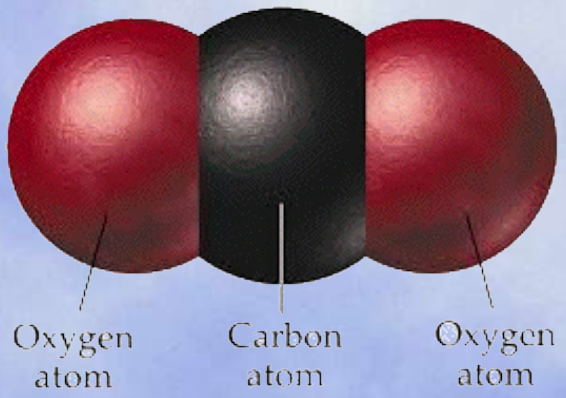
Per capita energy US use: 10,000 watts
100 100-watt light bulbs, 24 – 7

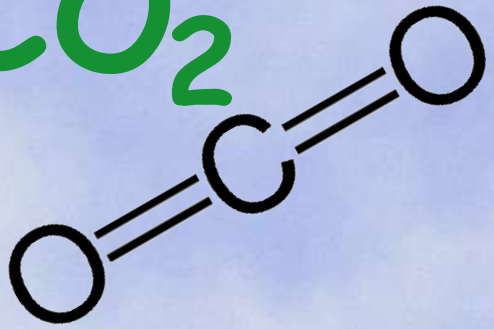
Equivalent to 100 people!

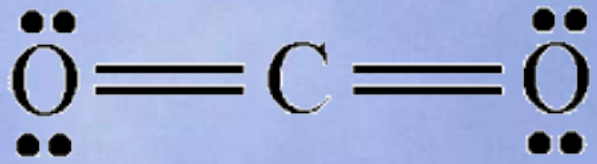
And all these "people" are exhaling CO_2!

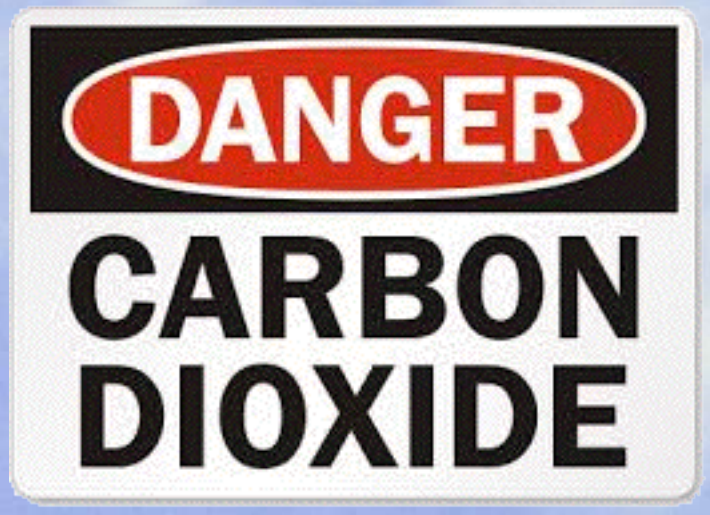
Carbon Dioxide CO_2

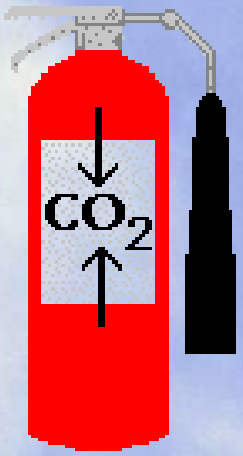


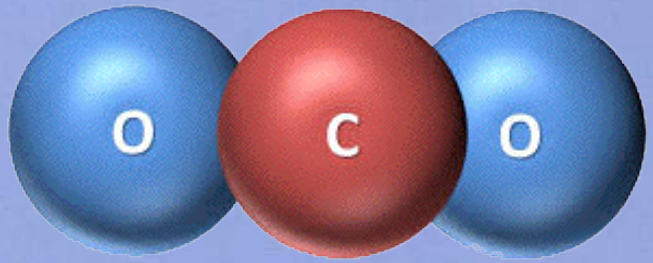












GLACIERS ARE OUR TIME MACHINE

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

C. D. Keeling

Mauna Loa Hawaii

CO_2 concentration (ppm)

420
400
380
360
340
320
300
280
260
240
220
200
180

1960 1970 1980 1990 2000 2010 2020

800 1000 1200 1400 1600 1800 2000

Antarctic ice cores

Law Dome
Adelie Land
Siple
South Pole

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?

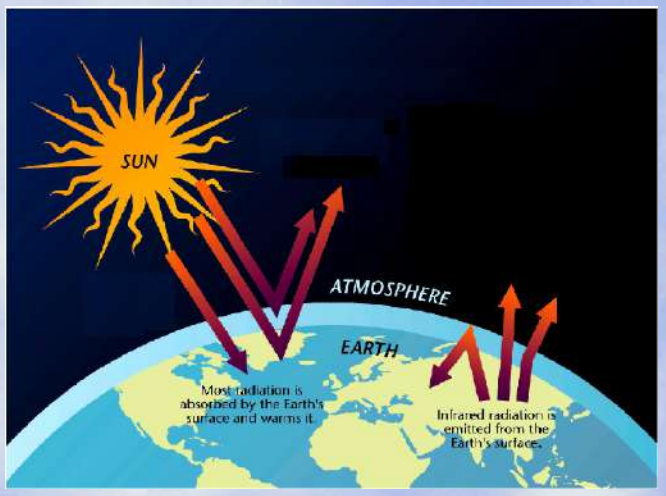
2 lbs?

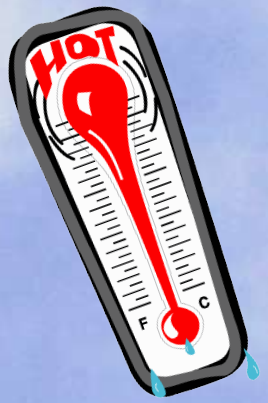
3 lbs!?

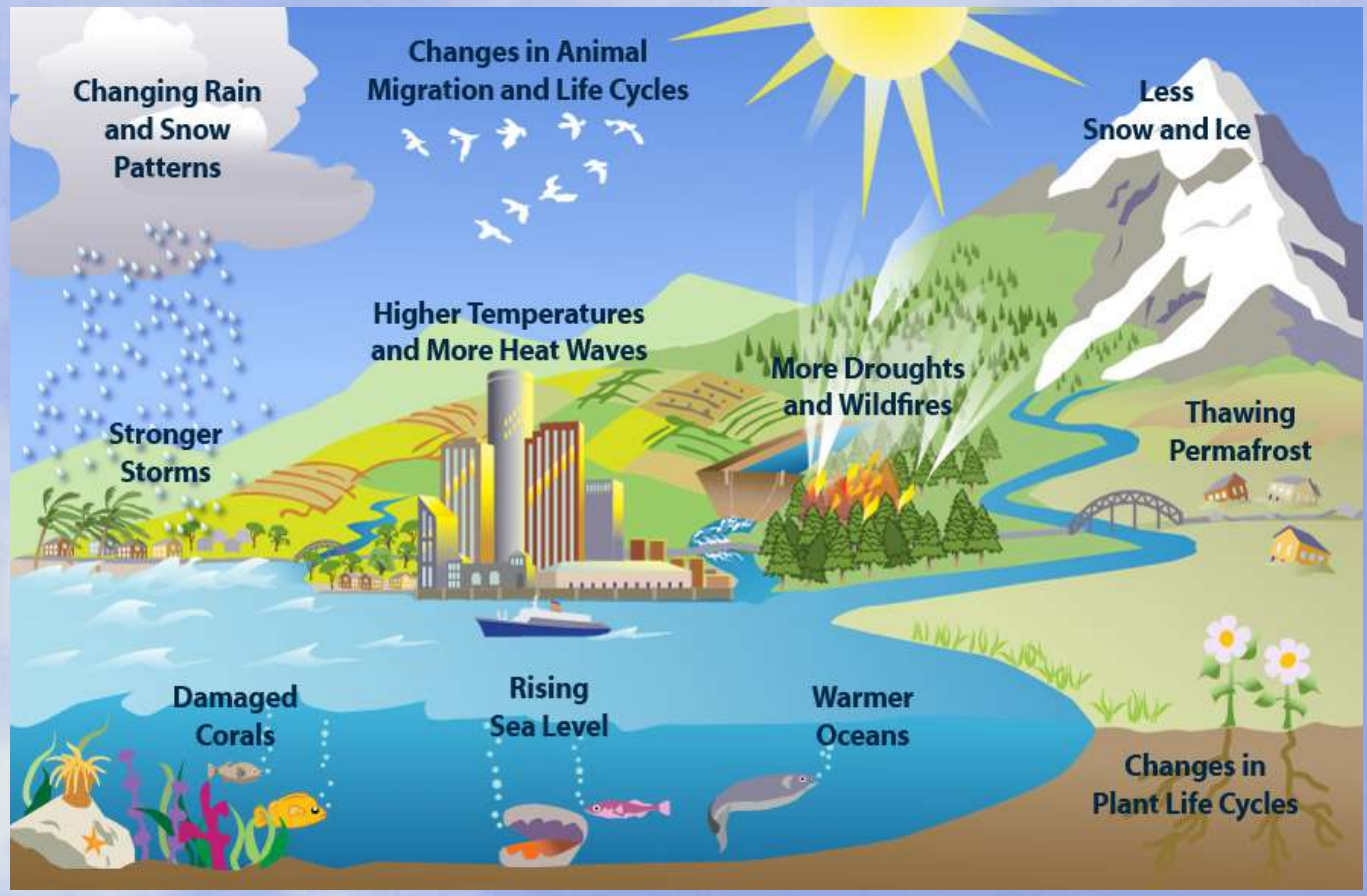
5 lbs!?!

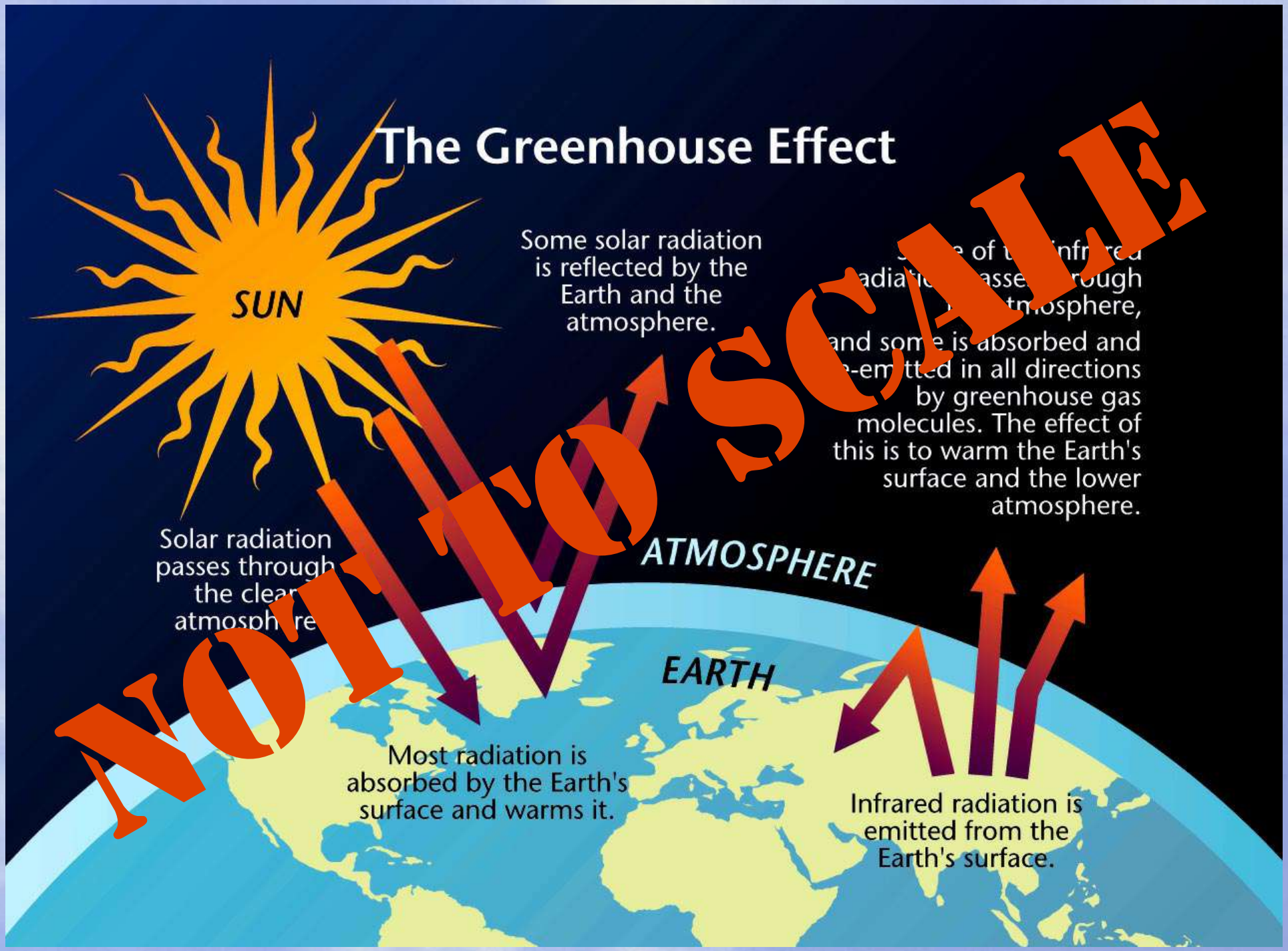
All of this carbon goes into the atmosphere as carbon dioxide when you burn the gasoline in your car.

Climate and The Greenhouse Effect

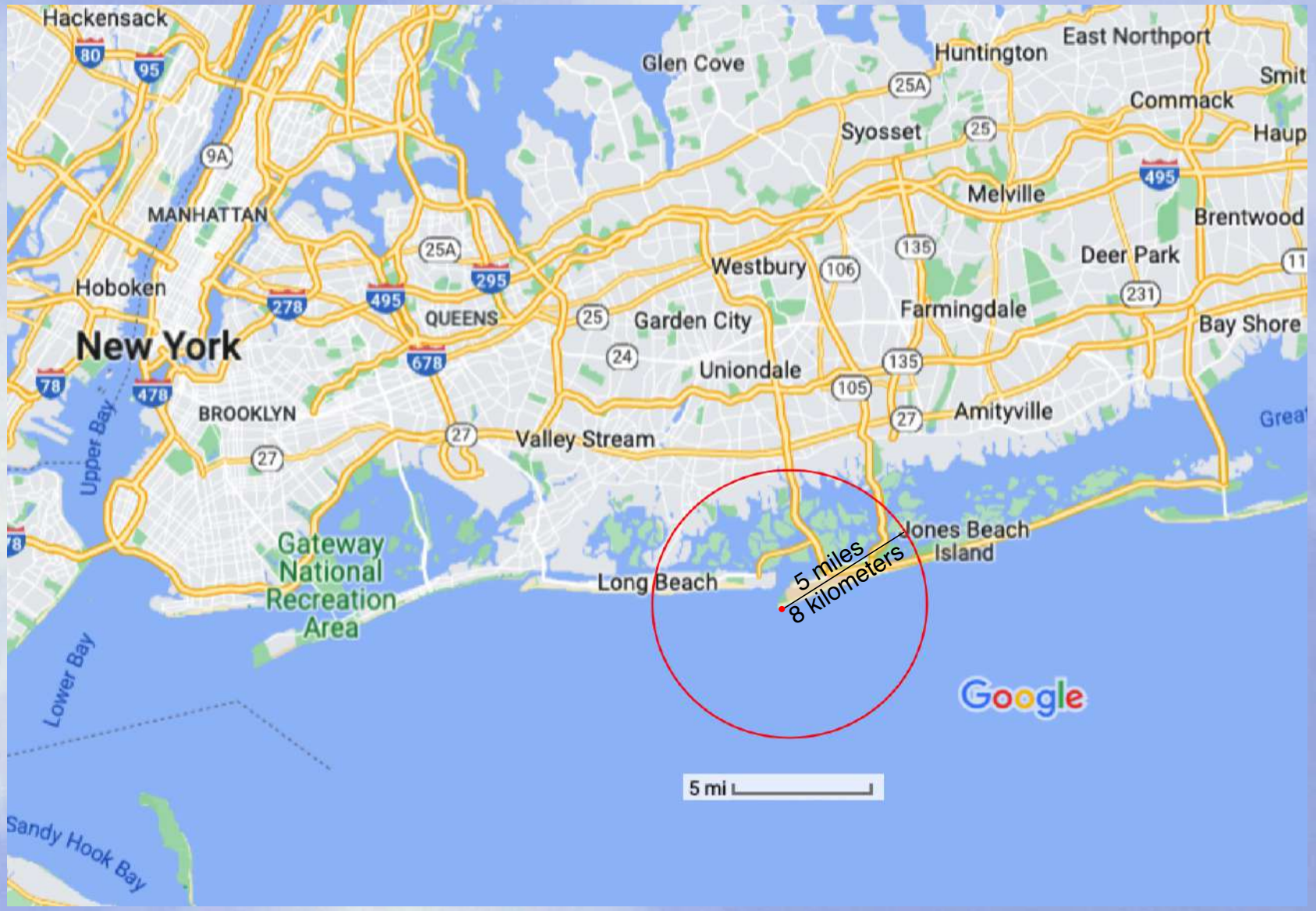







The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere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

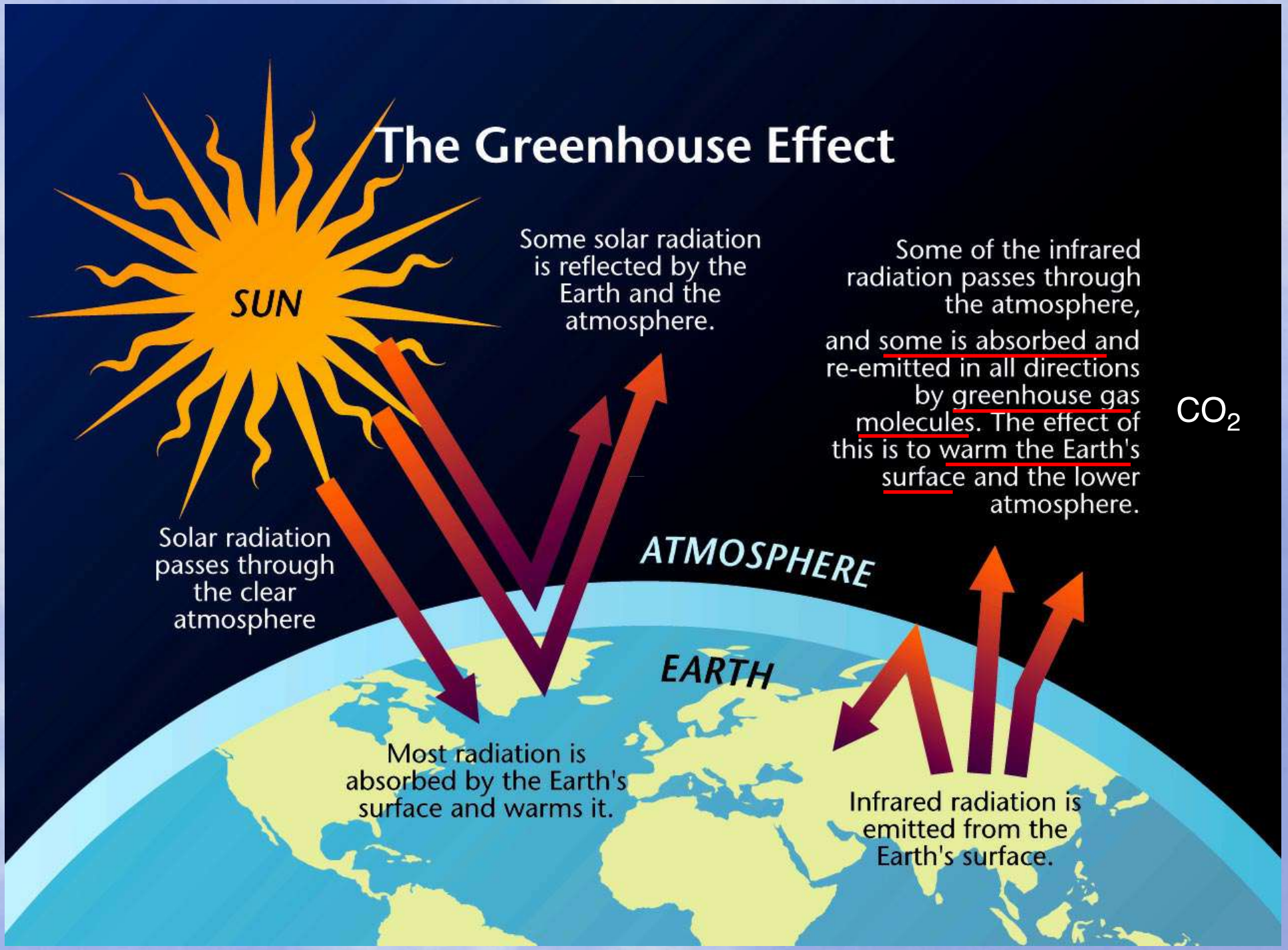
HOW THICK IS EARTH'S ATMOSPHERE?

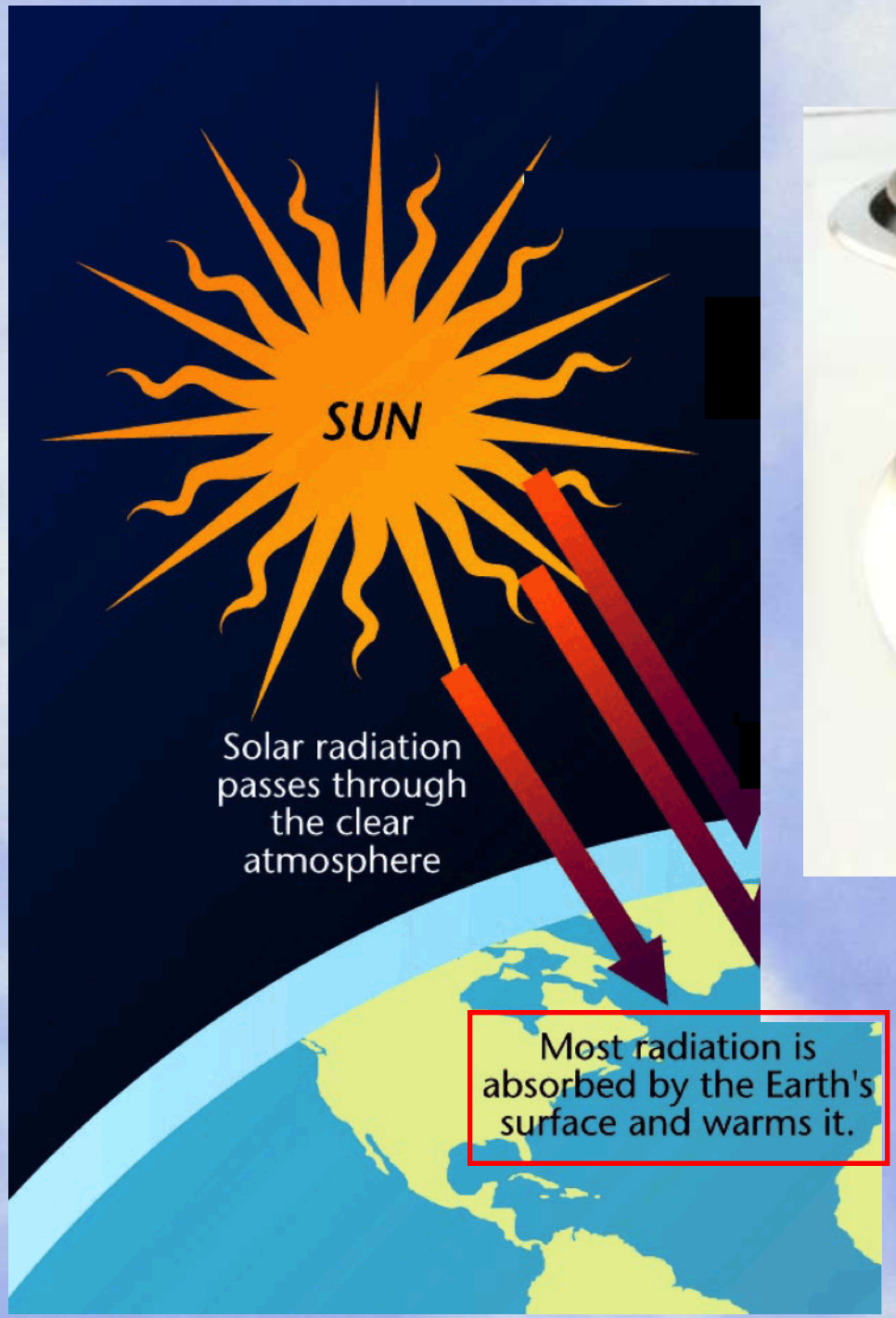


If the entire atmosphere were compressed to sea-level pressure, it would be about 8 km (5 miles) thick.

HOW THICK IS EARTH'S ATMOSPHERE?

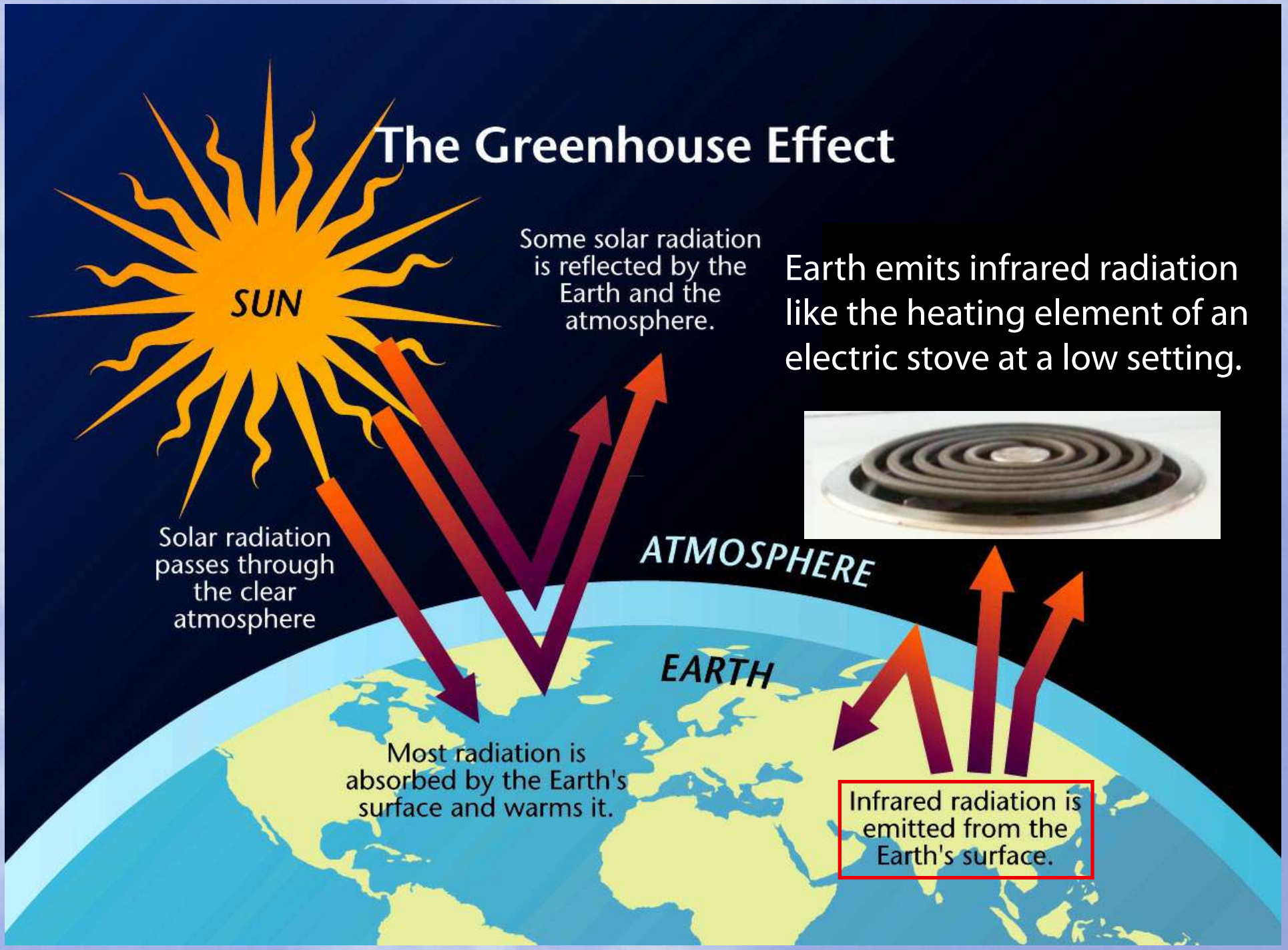
Like a coat of paint on a soccer ball


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
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.



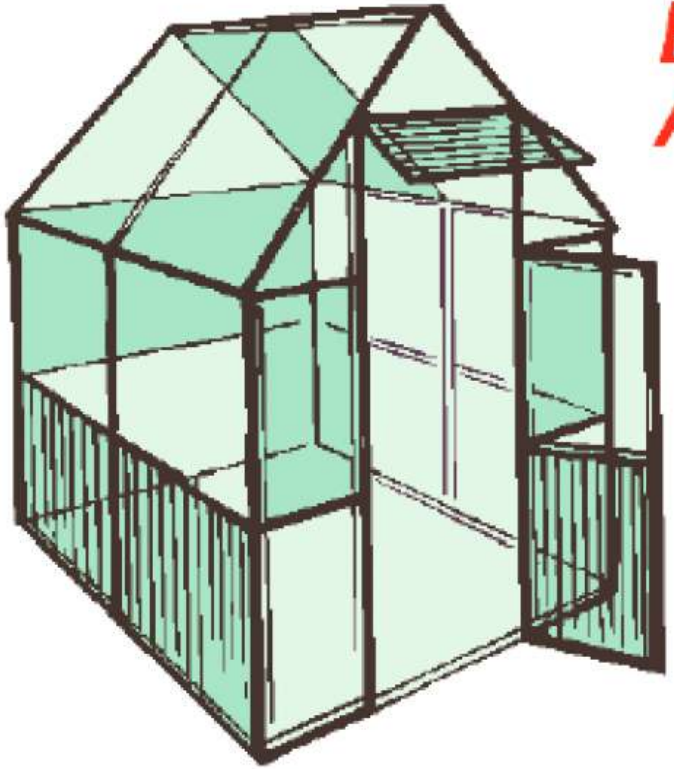
The Sun heats the Earth by radiant energy like the heating element of an electric stove at a high setting.

The Greenhouse Effect



Earth emits infrared radiation like the heating element of an electric stove at a low setting.

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.

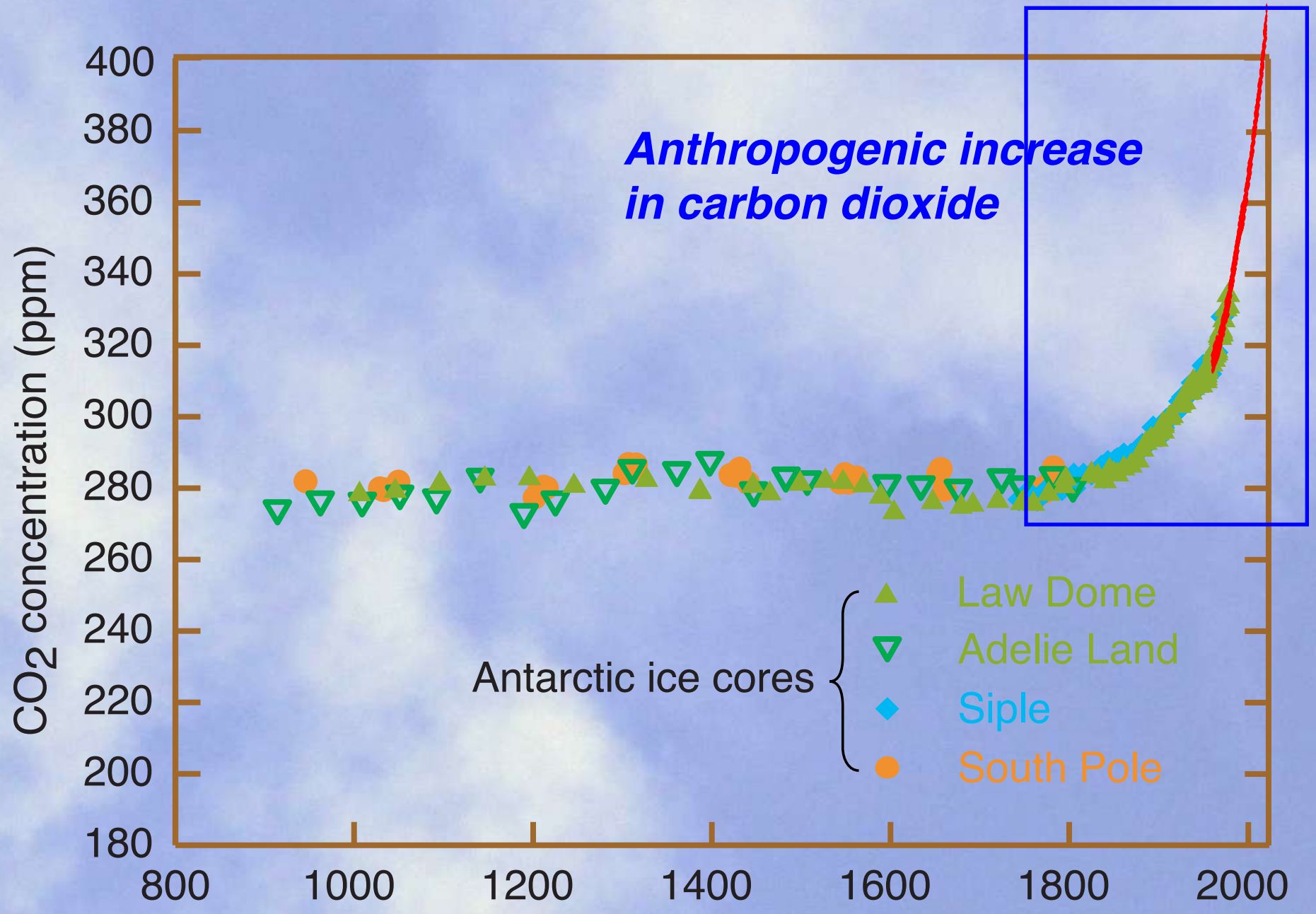
This is the greenhouse effect.

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

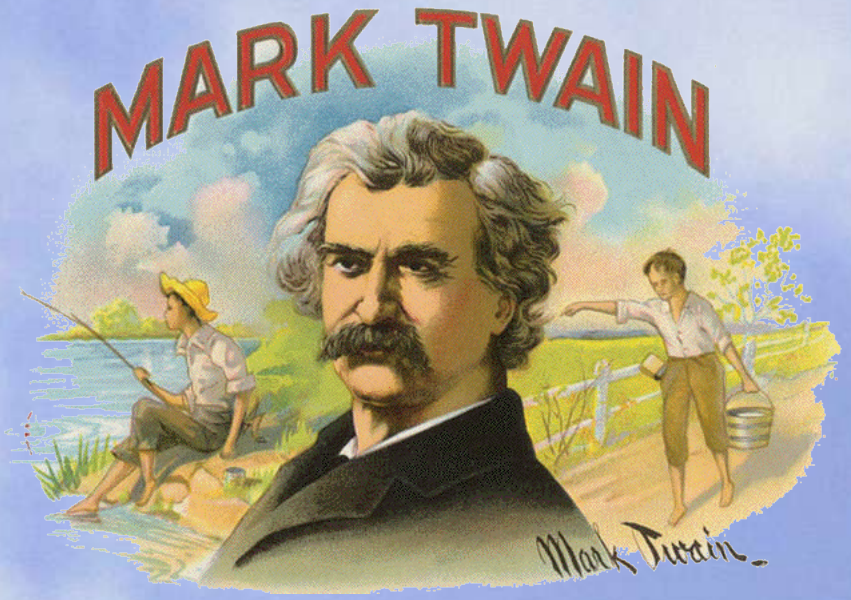
TOO MUCH OF A GOOD THING??



Global carbon dioxide concentration over the last thousand years

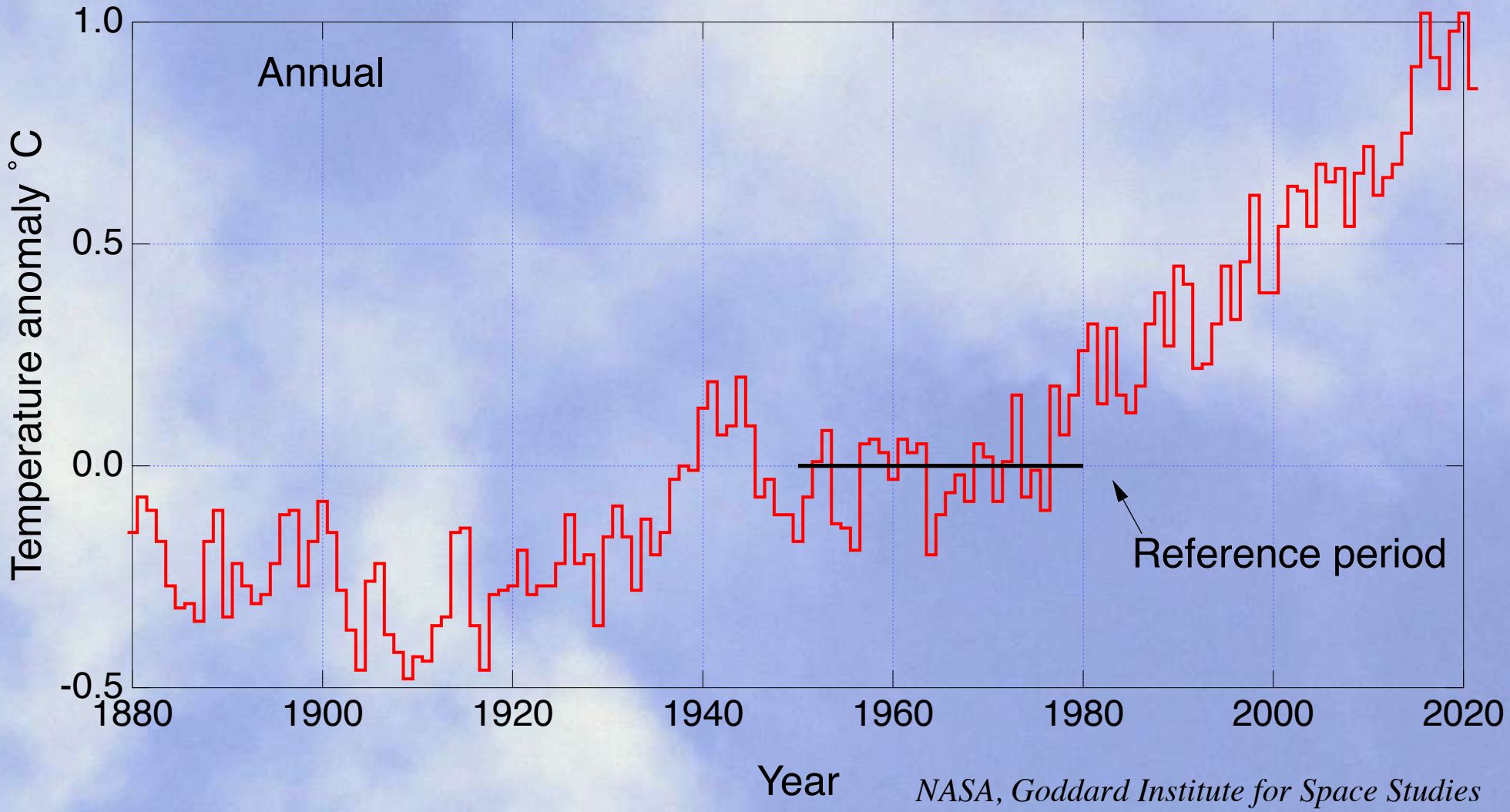
Everybody talks about the weather —

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

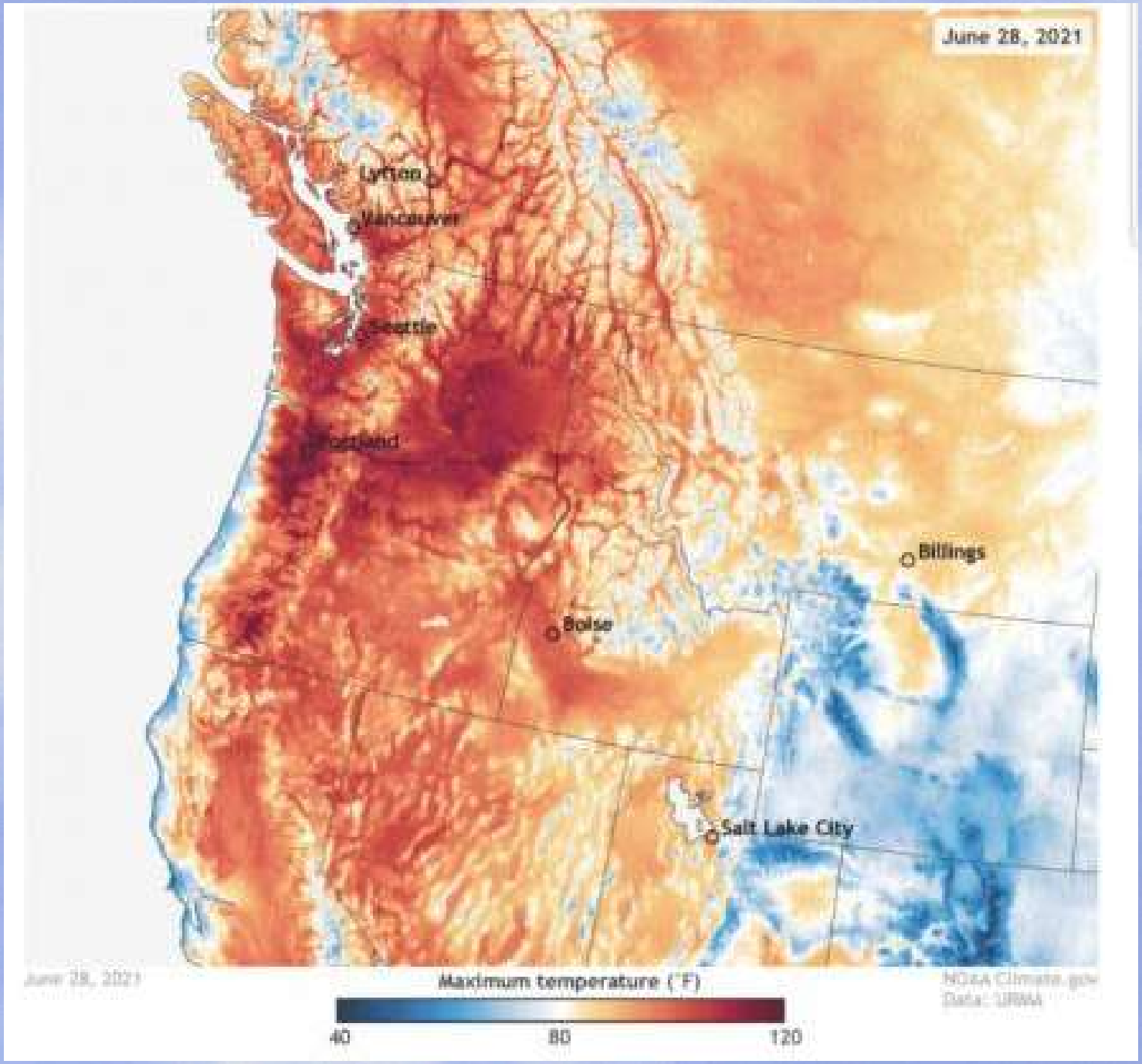


NASA, Goddard Institute for Space Studies

The last 8 years have been the hottest years on record.

19 of the hottest years in the record have been in the last 20 years.

HEAT WAVE IN NORTHWEST US, SOUTHWEST CANADA, JUNE, 2021



Greater frequency of extreme temperatures.

British Columbia records hundreds of deaths linked to heat wave

Sparks Lake wildfire, British Columbia, June 29, 2021

Breaks record for hottest temperature recorded in Canada, peaking at 121 ˚F.

Extreme weather leaves 719 people dead over seven days in BC.

Can be explained by climate change, says expert.

GLACIERS

A RECORD OF CHANGE

Sperry Glacier
Glacier National Park, MT

Circa **1930s**

Marble photo
K. Ross Toole Archives
University of Montana

2009

Chris Miller photo, USGS

The expanse of Sperry Glacier that once greeted hikers facing NE on Comeau Pass is in stark contrast to the bedrock and vegetation that has since emerged as the ice retreated. The Marble image, most likely taken in the 1920s or early 1930s, was featured on a postcard with this caption: " Sperry Glacier from the river."

USGS science for a changing world

USGS Repeat Photography Project
http://nrmsc.usgs.gov/repeatphoto/

Climate Change in Mountain Ecosystems

Grinnell Glacier

Glacier National Park, MT

1926

Morton Elrod photo
K. Ross Toole Archives
Mansfield Library, UM

2008

Lisa McKeon photo
USGS

This large boulder was used by Morton Elrod and other scientists as a baseline to measure the retreat of Grinnell Glacier's terminus. It is now referred to as "Elrod's Rock," and the glacier's terminus is no longer visible from this point.

USGS science for a changing world

USGS Repeat Photography Project
http://nrmsc.usgs.gov/repeatphoto/

Climate Change in Mountain Ecosystems

MUIR GLACIER - MUIR INLET
GLACIER BAY NATIONAL PARK, ALASKA

1941

2004

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

UPSALA GLACIER, ANDES, ARGENTINA

www.time.com

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.

RHONE GLACIER, VALAIS, SWITZERLAND

1859

2001

Glacial retreat is 2.5 km.

Base is 450 meters higher.

Iceboating on the Great South Bay

Line up of Scooter Race, 23 February 1903, at Patchogue, Long Island

A thing of the past!

YOU!

WHO IS RESPONSIBLE?

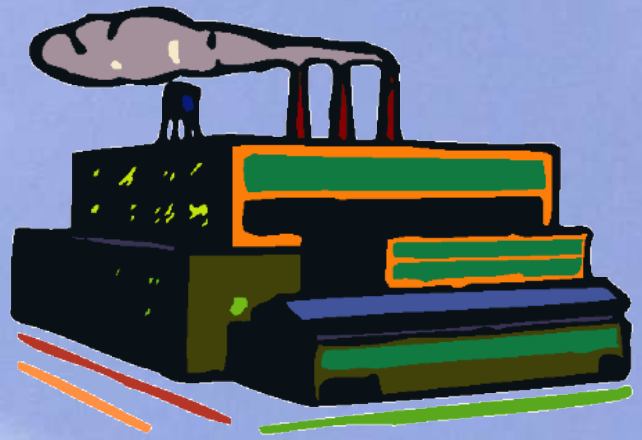
IS THERE ANYTHING WE CAN DO?

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 (CO_2), 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!

SOLAR FARM AT BNL

32 Megawatt – Power for 4500 homes

Brookhaven National Laboratory

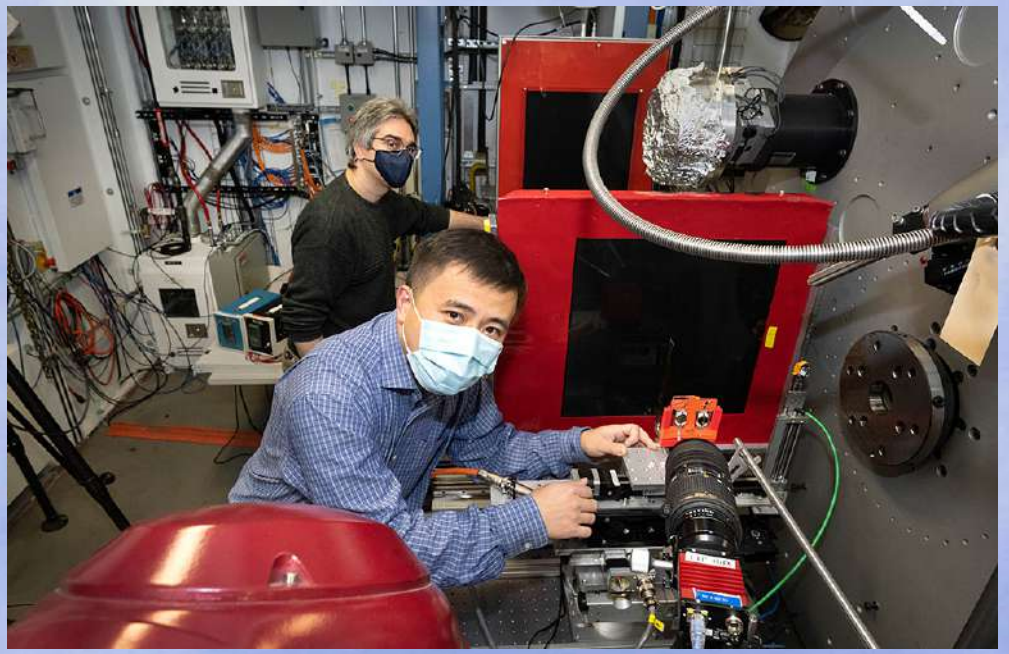
For more info: https://www.bnl.gov/SET/LISF.php

POWER YOUR CAR WITH ELECTRIC ENERGY

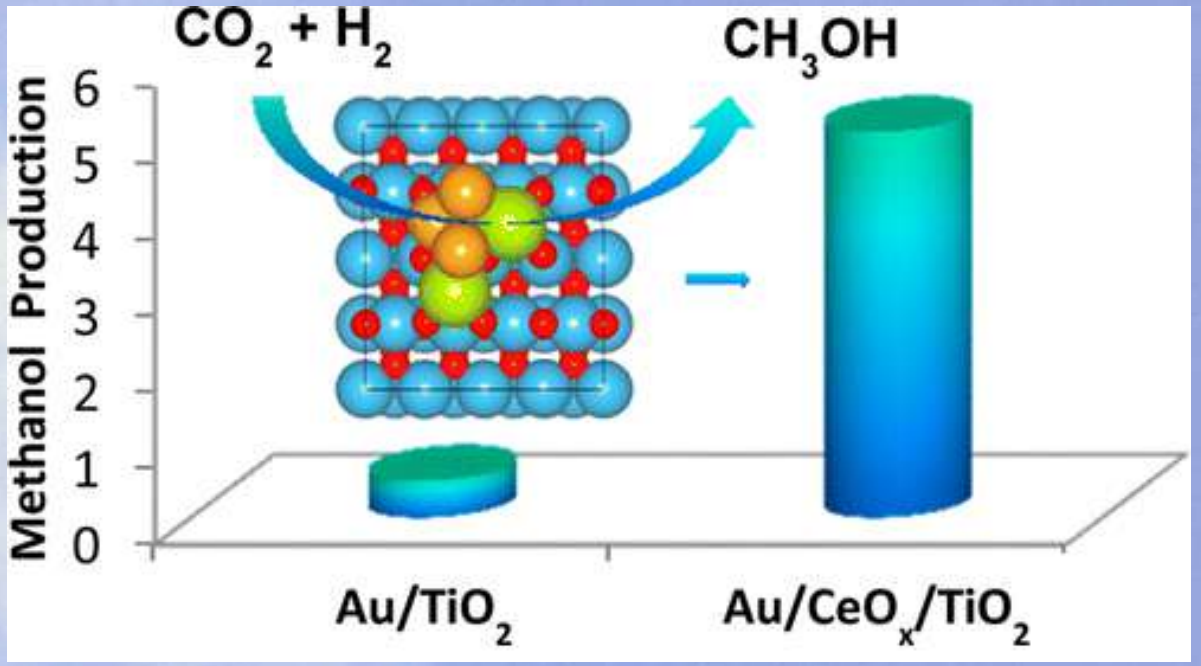
POWER YOUR CAR WITH SOLAR ELECTRIC ENERGY, FOR FREE

RESEARCH INTO NEW ENERGY STRATEGIES

Battery storage



Convert CO_2 to liquid fuels



Brookhaven National Laboratory

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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

Dr. Steve

Brookhaven National Laboratory