



2007

TCU ENERGY INSTITUTE

2018



Our Domestic Energy Focus

The “Big 3”



>30 National Conference Invited Energy Talks--2015-2018



The Global Energy Dilemma

Energy

Food

Water



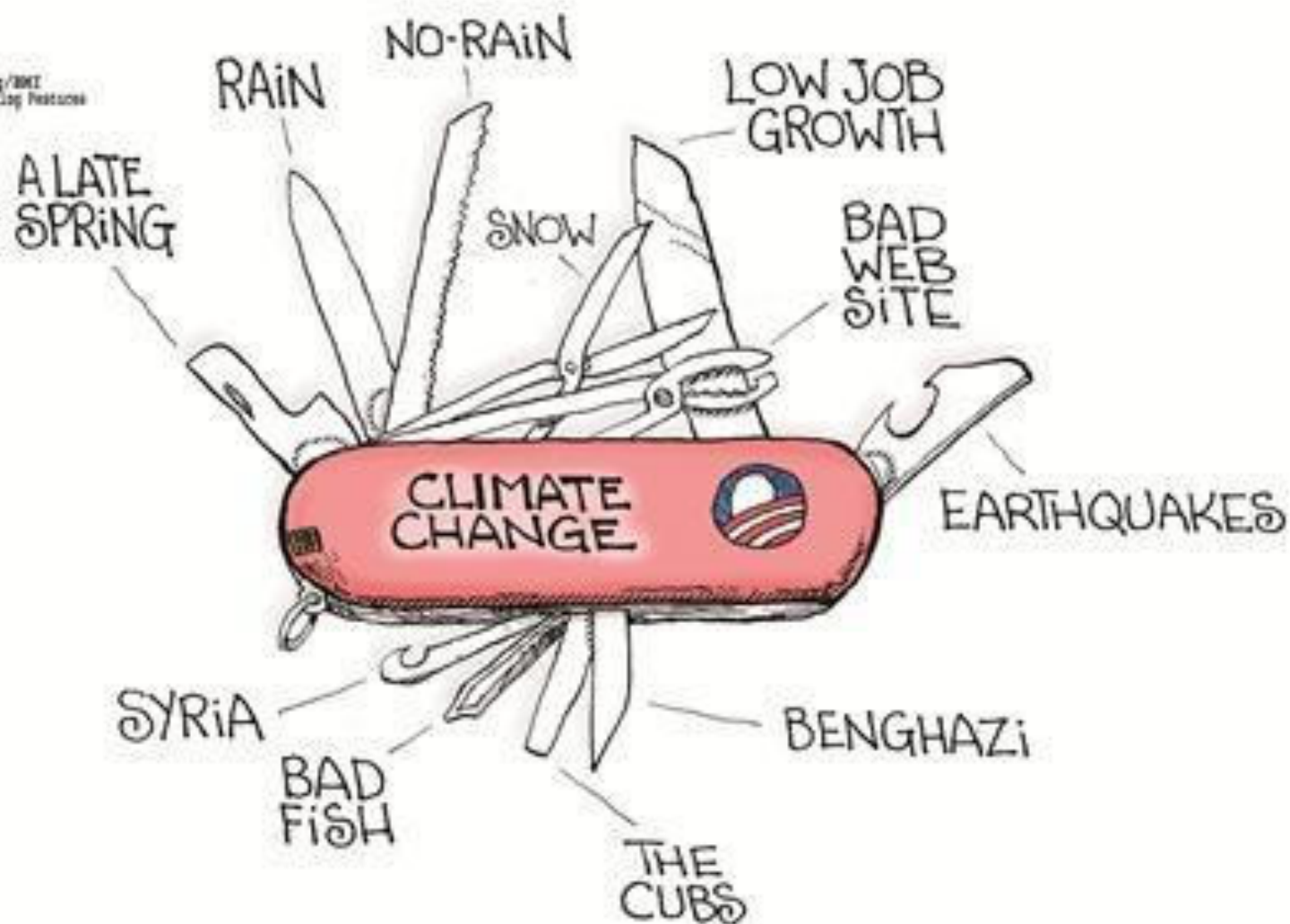
Let's Look At Climate Change



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7DN ©2014
HRC, ocy/BMT
Blat by Klap Features



THE EXCUSE FOR EVERYTHING

Don't Want To pick On Anyone...But!



Al Gore: Jets, limousines, 100' houseboat, 22 room mansion...

"Americans should buy cars and other products that have the least impact environmentally"

Natural Factors Influencing Earth's Climate



Extraterrestrial

Solar
Output

Earth-Sun
Geometry

Interstellar Dust

Earth's Internal

Volcanic
Eruption

Mountain Building

Continental Drift

Atmospheric Chemistry

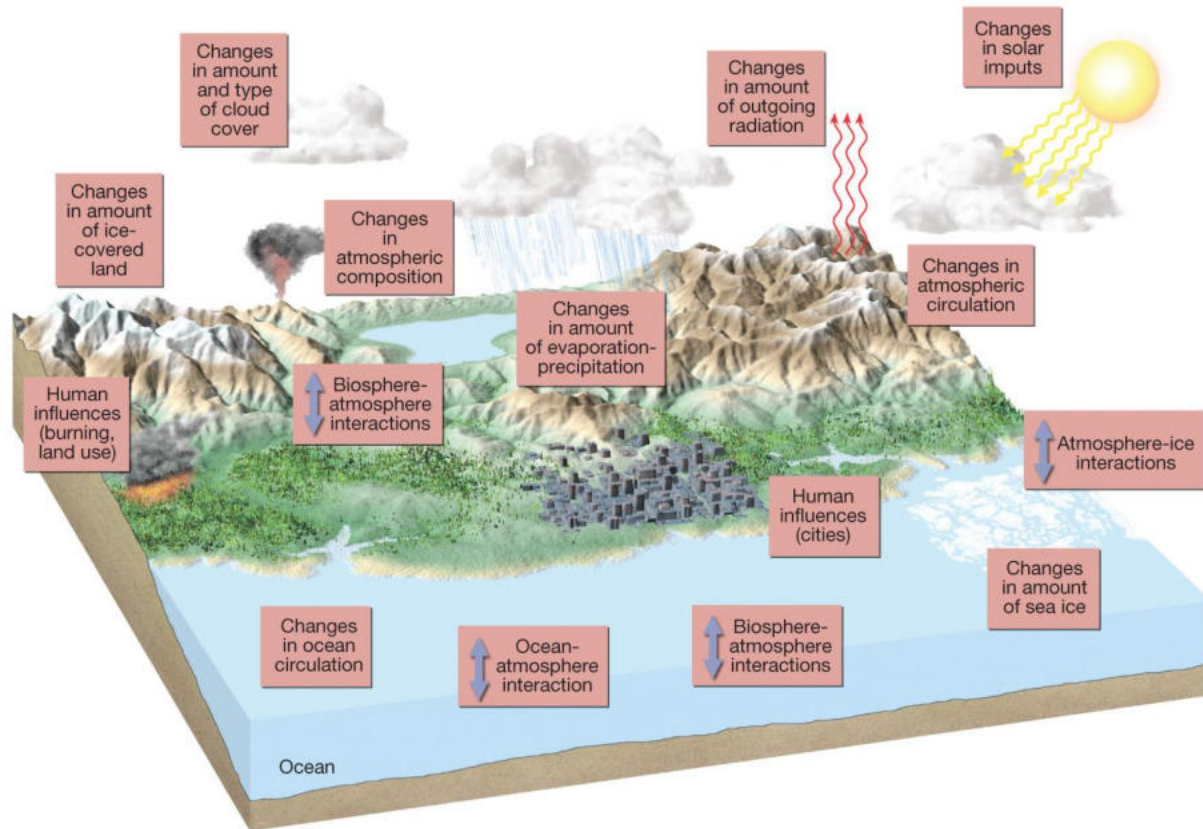
Atmosphere-Ocean Heat
Exchange



The Climate System Is Complex

- **The climate system includes the:**

- **Atmosphere**
- **Hydrosphere**
- **Geosphere**
- **Biosphere**
- **Cryosphere
(Ice & Snow)**



How Is Climate Change Measured

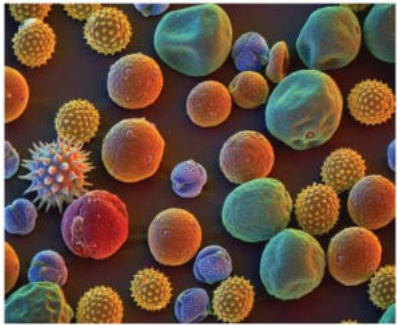
- **Some Techniques Used**



B.

Short Term (10's to 100's of Years)

- Growth of tree rings
- Pollen contained in sediment and coral reefs
- Atmospheric Measurements
- Ocean Temps

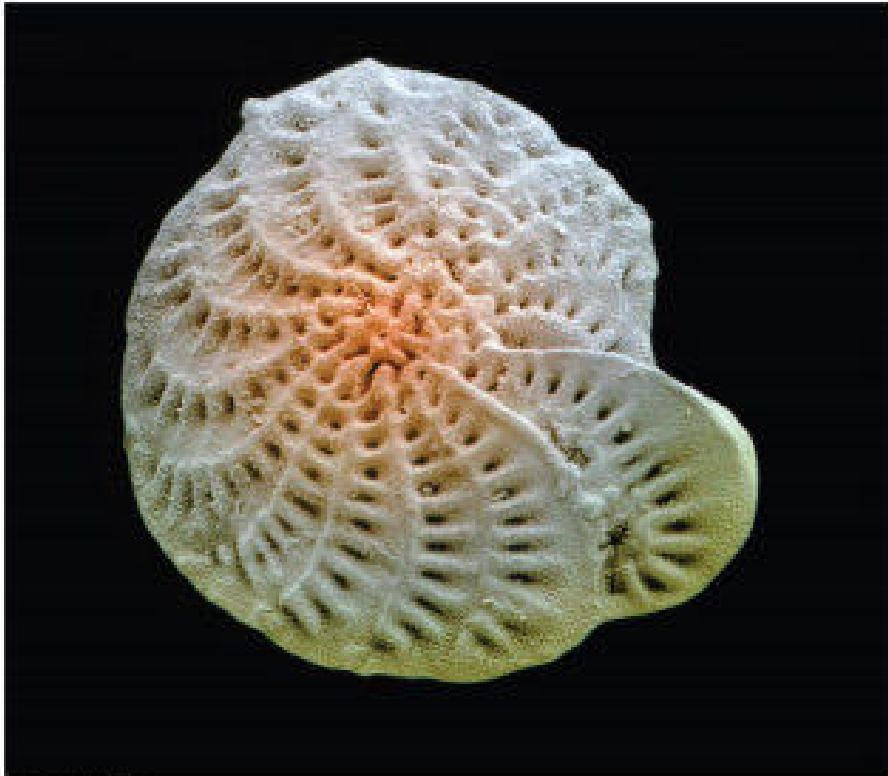


Longer Terms (1,000's to Millions of Years)

- Drill cores in glacial ice
- Seafloor Sediments
- O-18 (warm) in ancient sea shells

Which Tells Us The Most About Climate Change?

Many Now Believe These Two Critters Are Critical To Understanding Climate Change

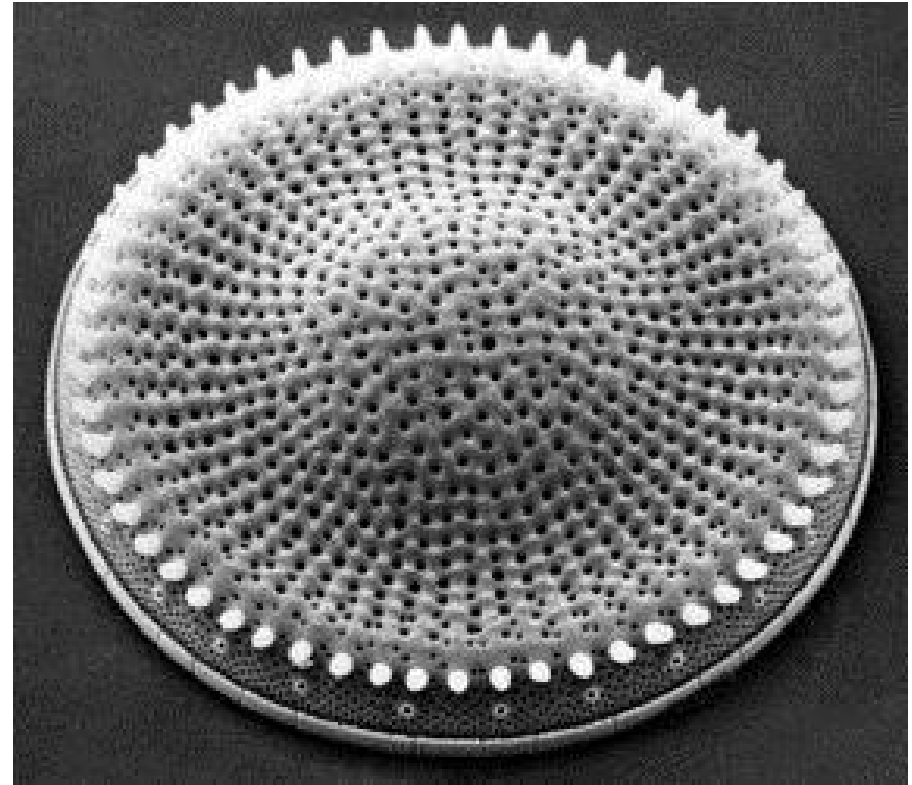


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Foram shells

Warm Water = High O^{18}

Cold Water = Low O^{18}



Diatoms

Eats Up CO_2

Produces O_2

Back To Our Story..Natural Causes of Climate Change

- **Several explanations have been formulated to explain climate change, including:**
 - **Exposed Land Surface Changes**
 - **Variations in Earth's orbit—eccentricity, obliquity, and precession**
 - **Volcanic activity**
 - **Changes in the Sun's output associated with sunspots**

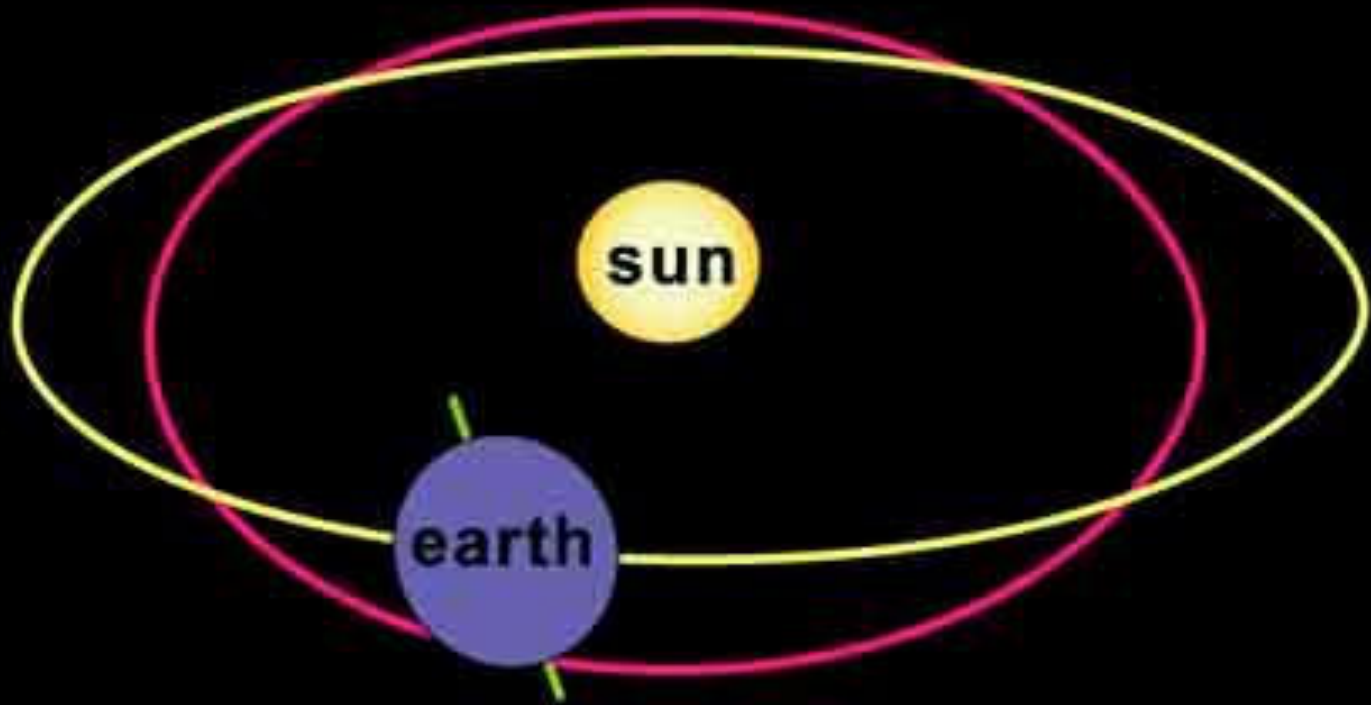
Changing Land Surface Elevation



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More Land At Higher Elevations (Mts)—Cooler Earth??

Orbit & Tilt Changes



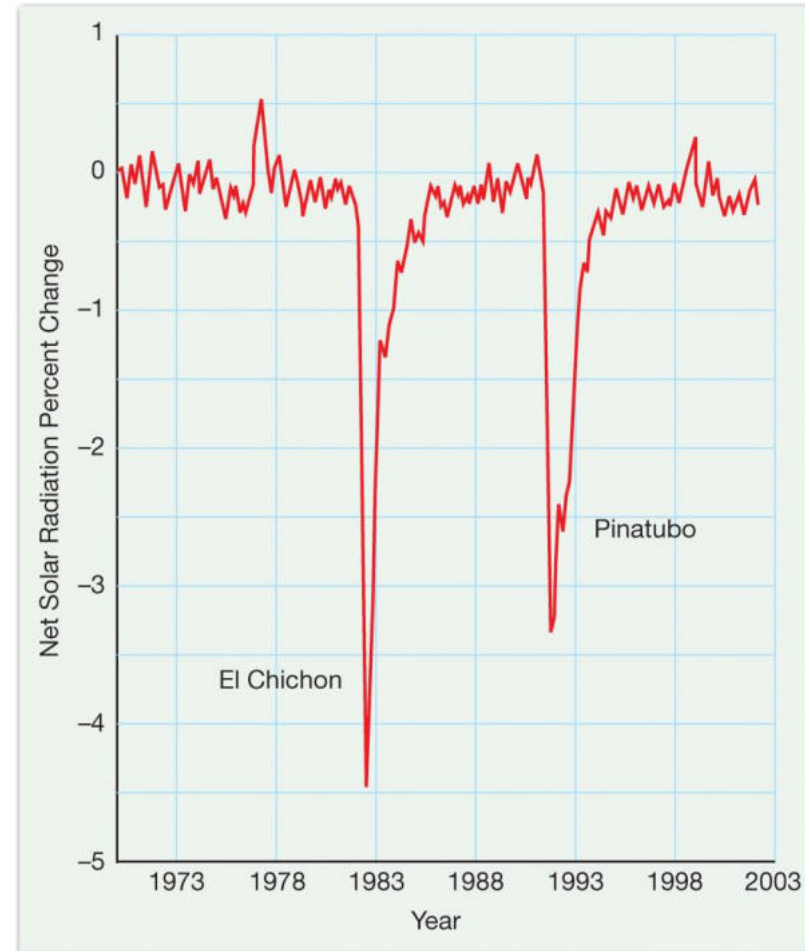
**VARIATION IN EARTH'S ORBIT CYCLE
ABOUT 100,000 YEARS**

Effect of Volcanic Activity on Solar Radiation



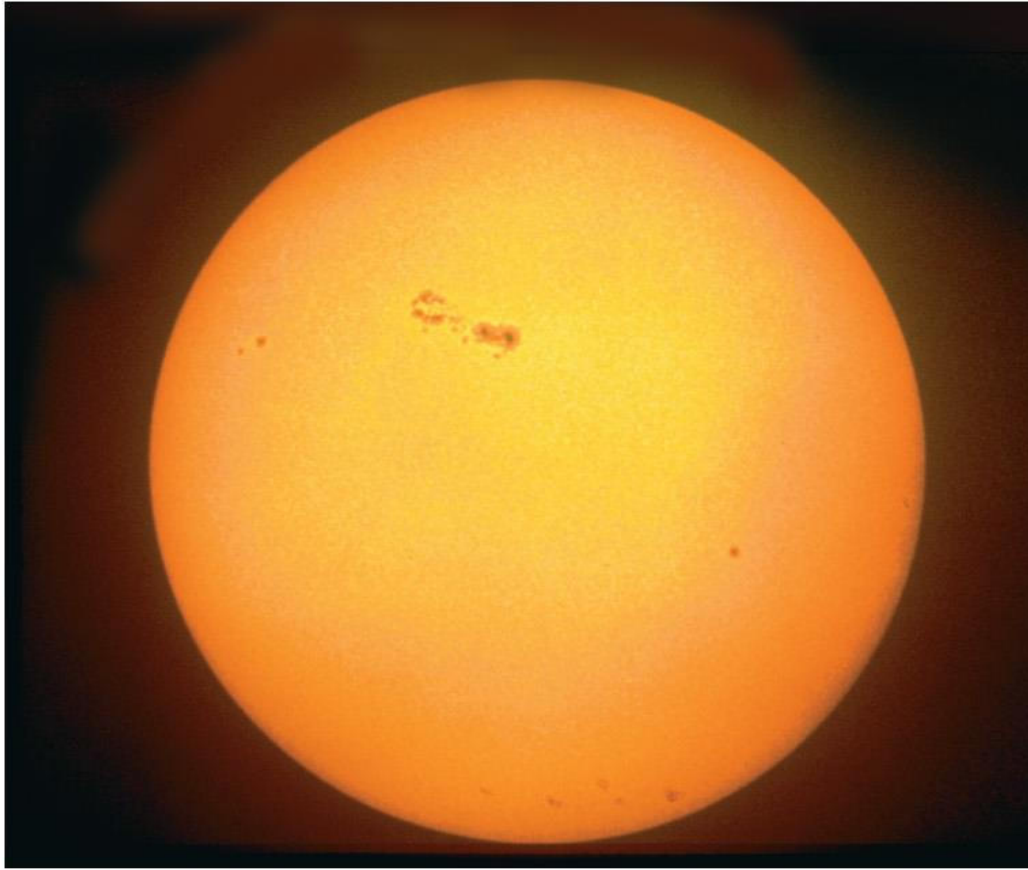
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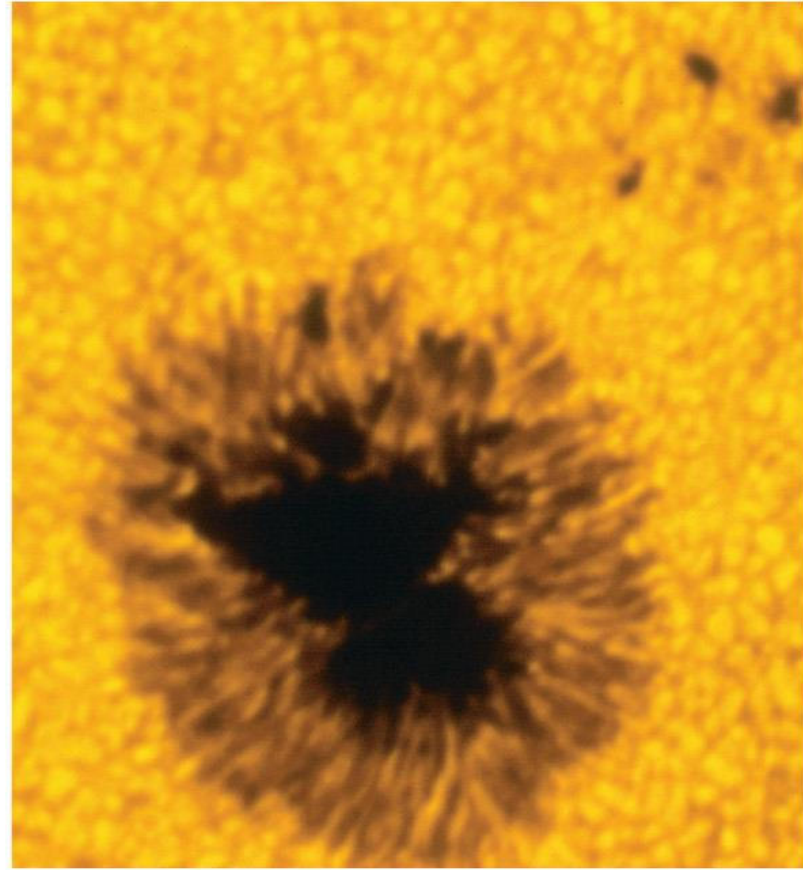
B.

Sun Spots??

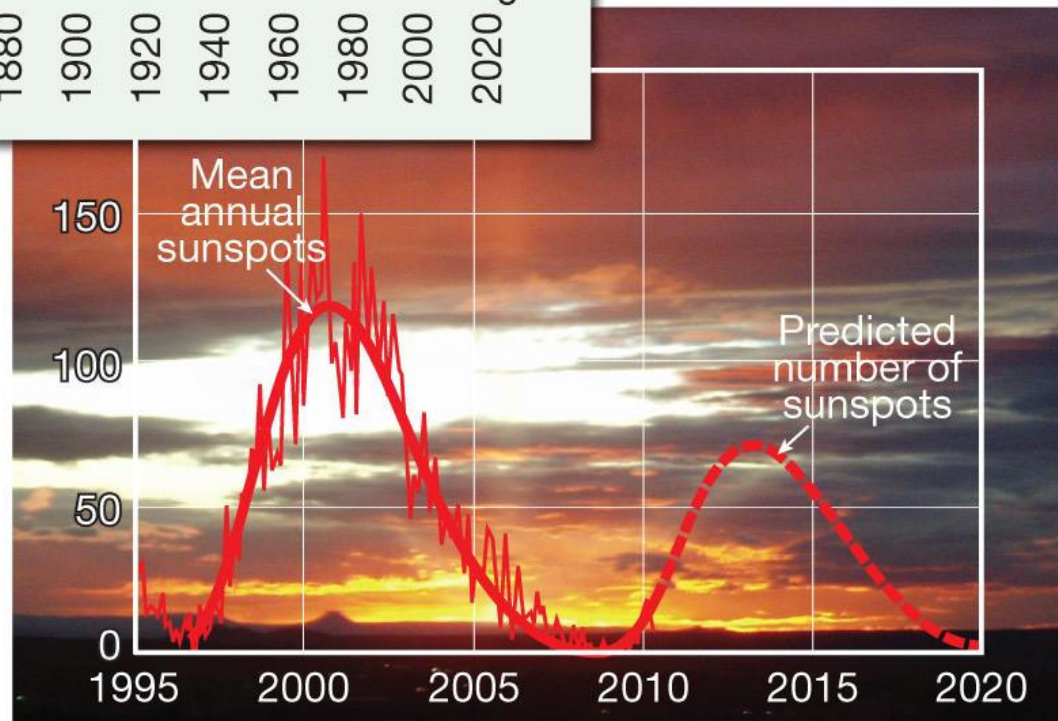
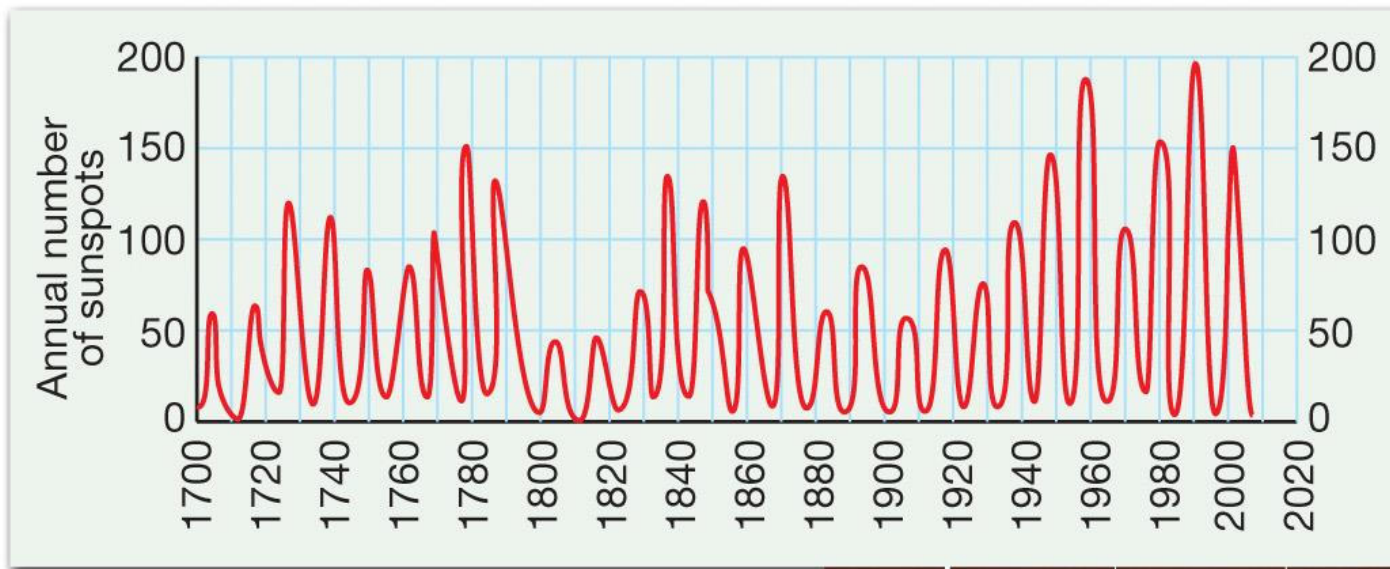


A.

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B.

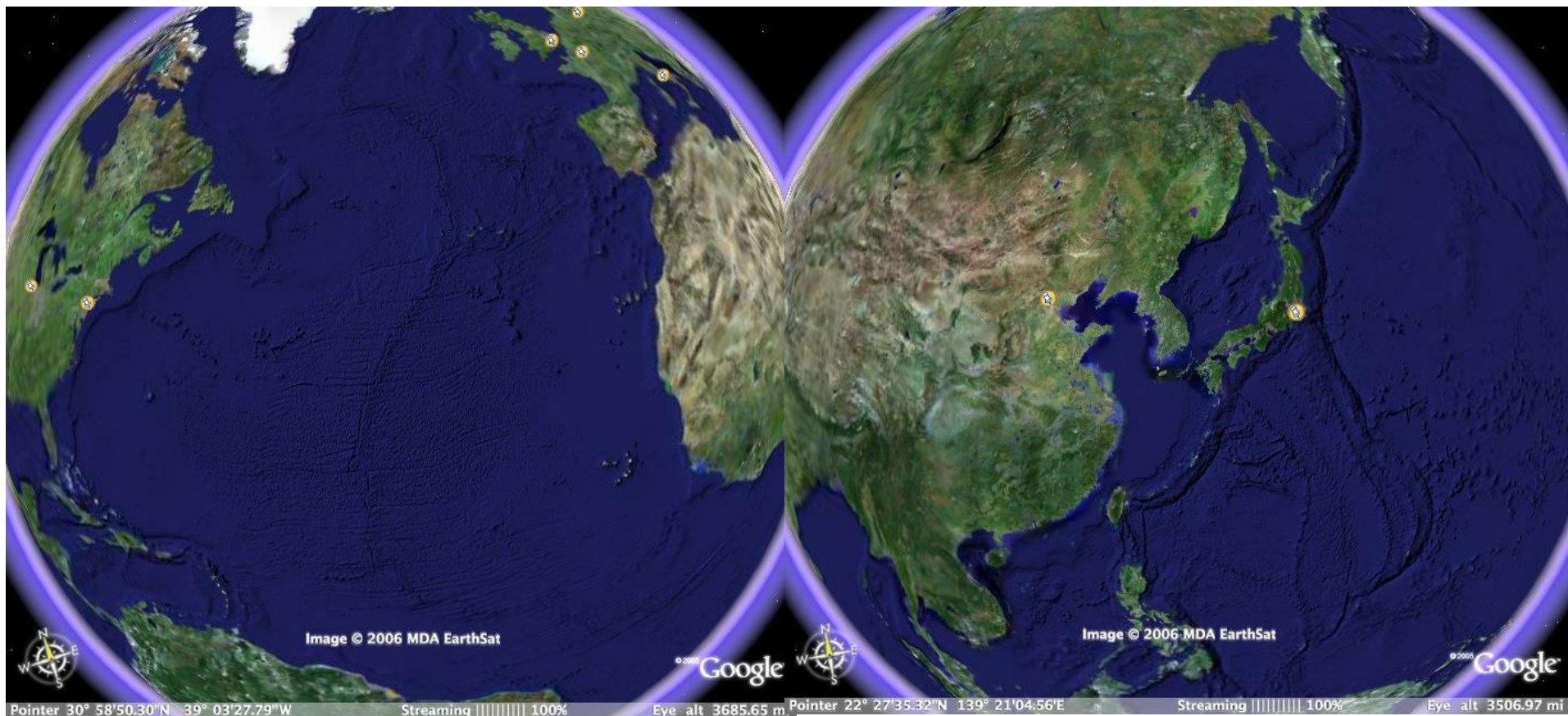


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More Sun Spots Over A Long Time = Warmer Earth??

Rock and Continents

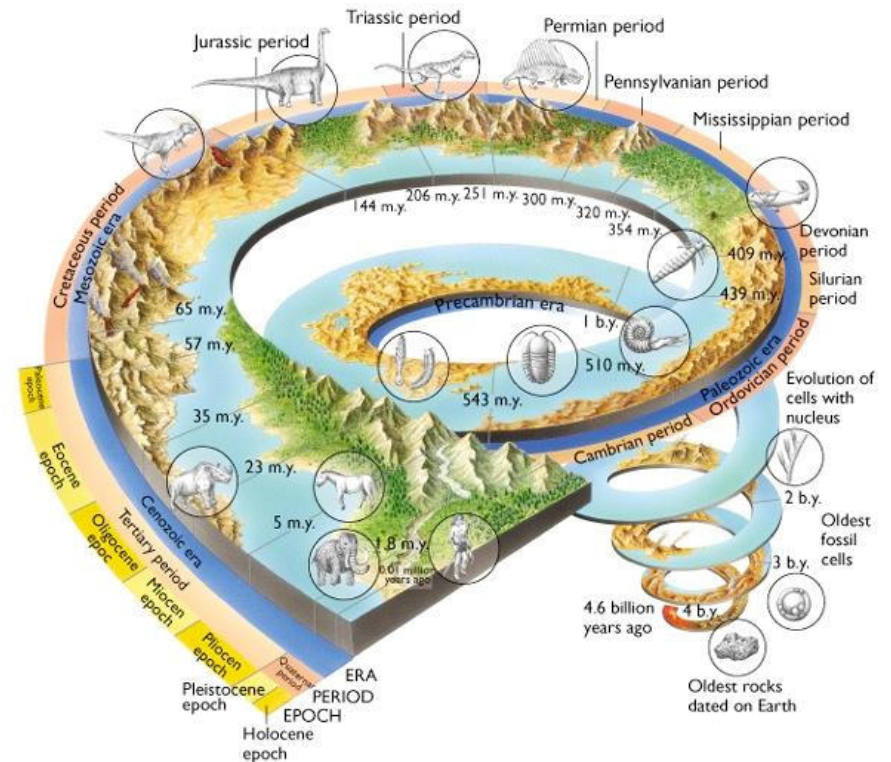
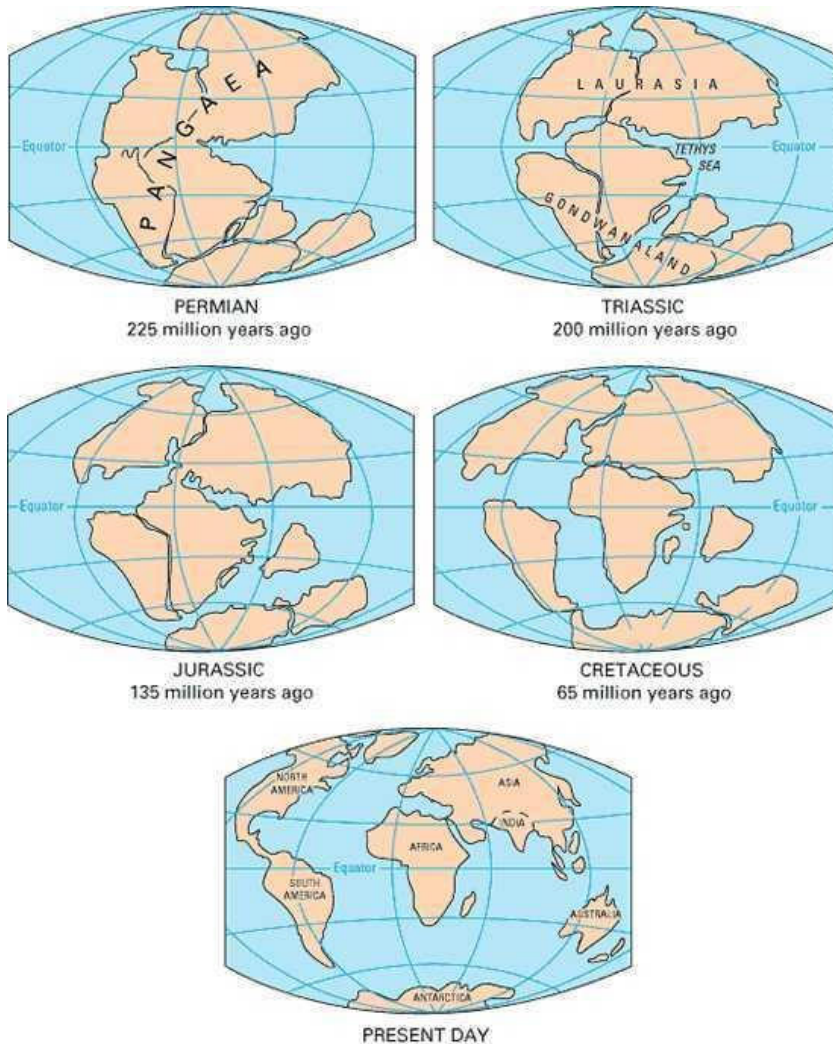
The Earth's Conveyor Belt!



Ridges—New Rocks

Trenches—Old Rocks

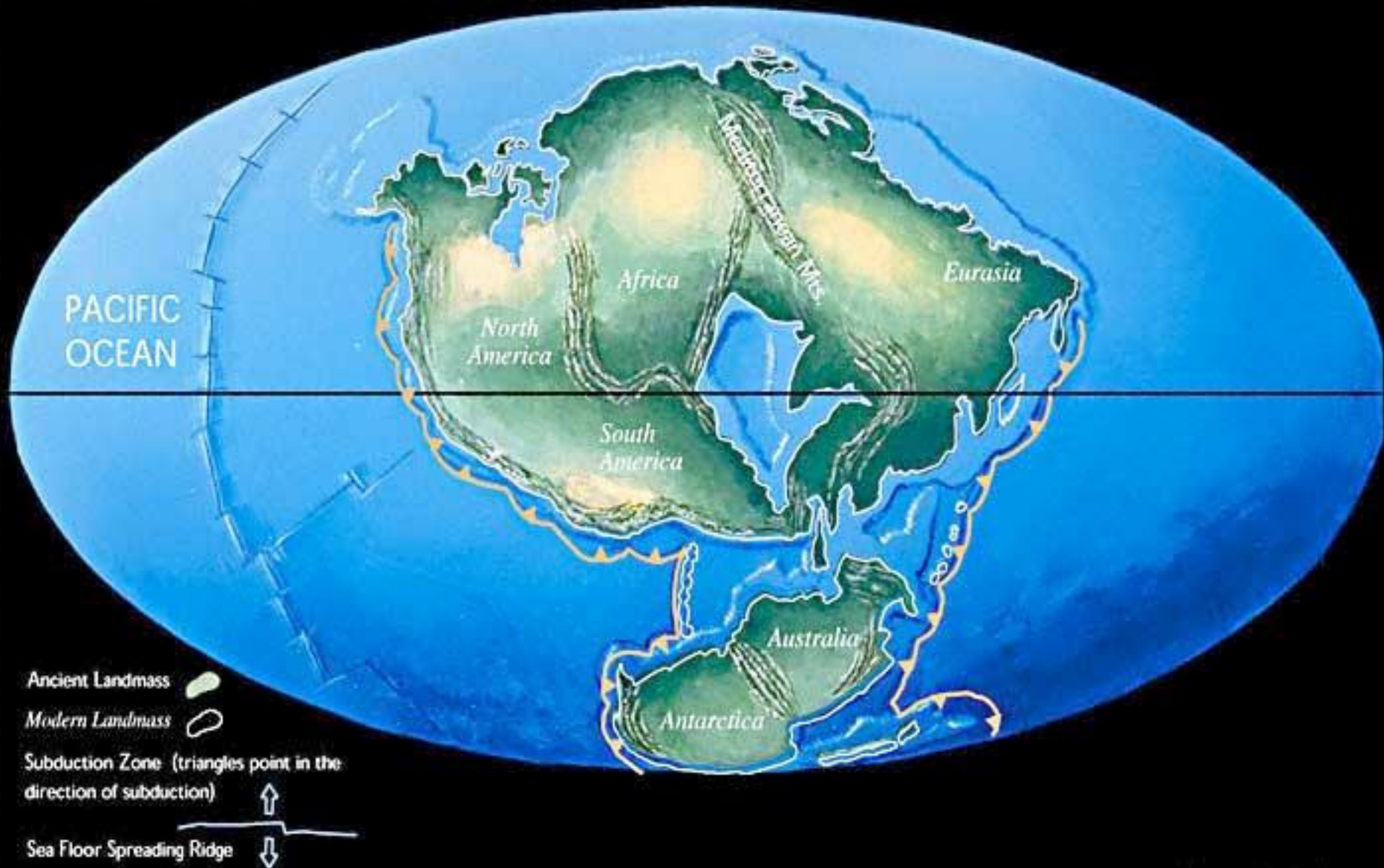
You See...The Earth Changes!



In Lots and Lots of Ways!!

Future Changes...Climates??!!

Future World + 250 Ma



*But...The Real and Undeniable
Climate Tracking Is All About....*



Glaciers: The Earth's Natural Thermometers!!

Let's Look At The Ice & Mud....

Deep Sediment Drilling & Core Analysis

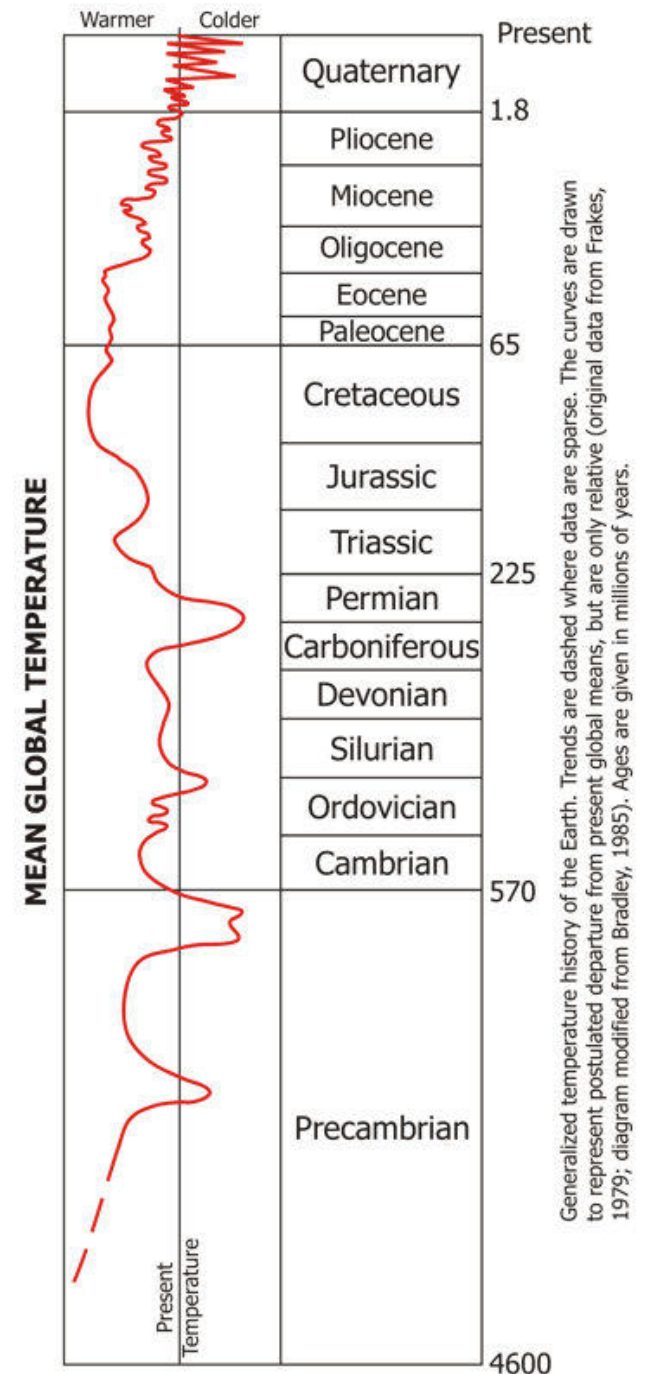
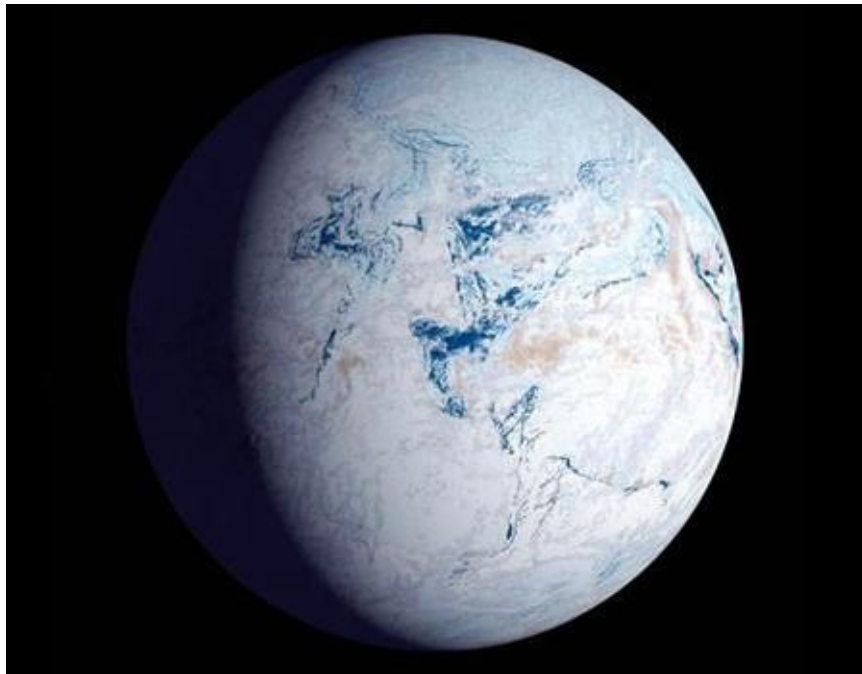


Ice Cores tell us the Temps!
Higher O_{18} = Warmer
Temps

What Has Happened Over Time?

Guess What...Forams Suggest
Global Temperatures Have Actually
“Changed Throughout Time!”

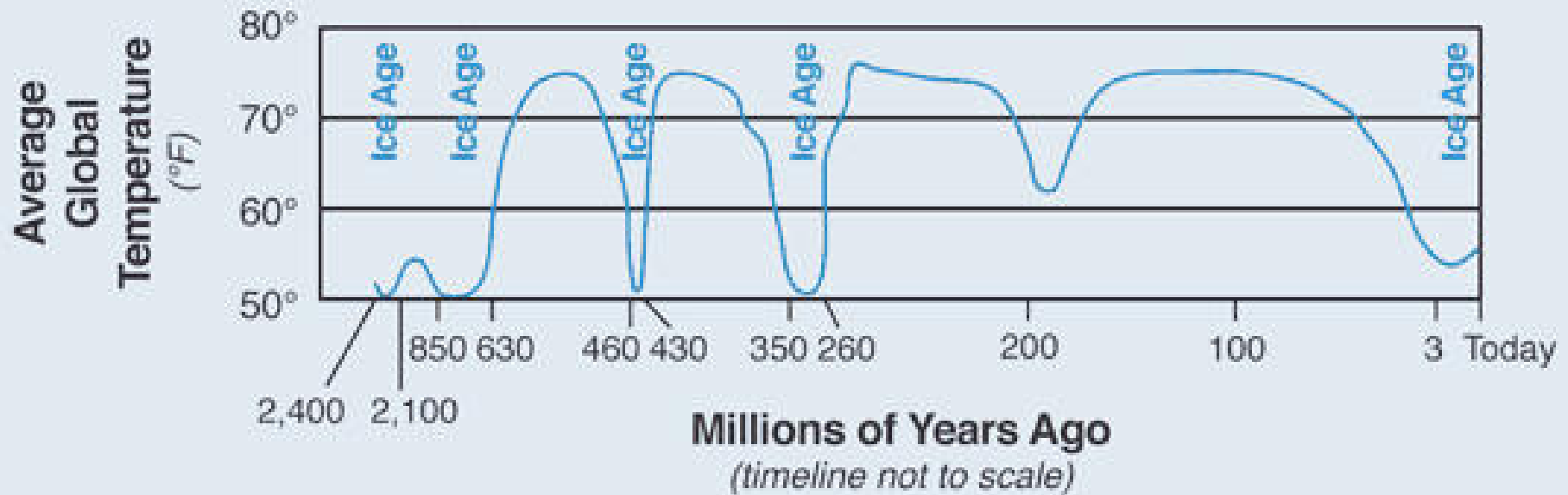
Snowball Earth-700 MYA!
Lasted 80 Million Years!



5-6 Giant Ice Ages!

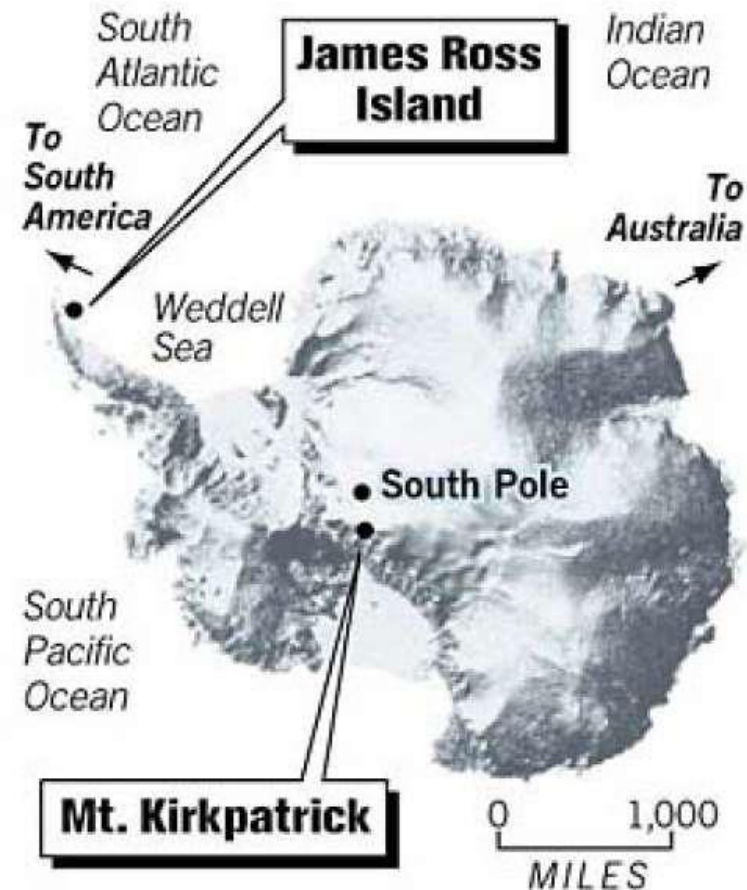
Followed By Major Global Warming!

Ice Ages during the past 2.4 billion years



Antarctic dinosaurs

Researchers working at separate sites found remains of two distinct dinosaurs more than a thousand miles apart on Antarctica.



Source: Chronicle research

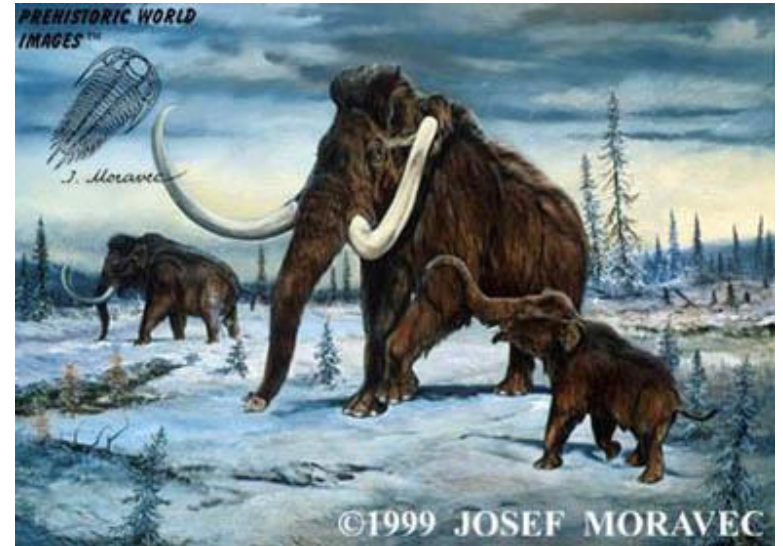
Chronicle Graphic

Climate Change Anyone?



Glaciers Come and Go...

Global Cooling And Warming!!



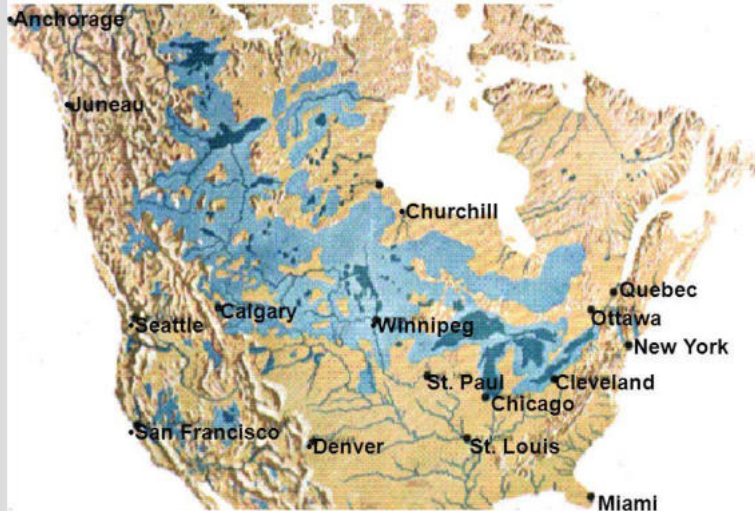
Just 8-10,000 yrs ago!
Chicago, Buffalo,
New York Under Ice Sheet

Most Recent Glacial Ice!

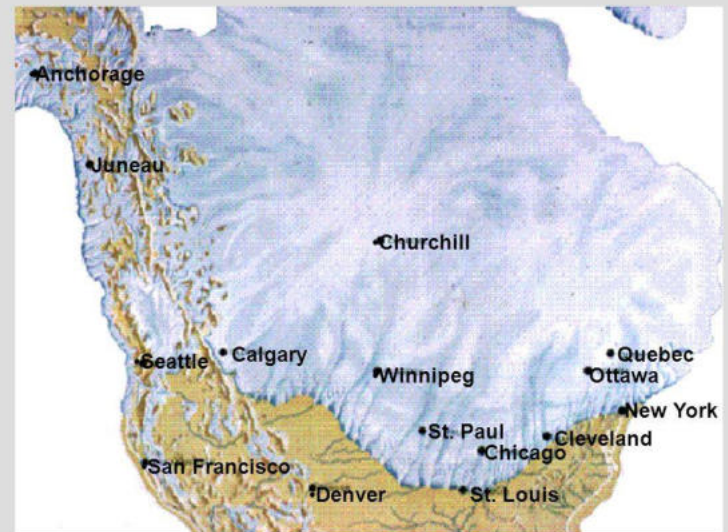
Last Glacial Maximum 18,000 years ago



Inland Lakes Resulting from Melt Water



Extent of Continental Glaciation





(a)



(b)

- **Just 18,000 years ago, the Earth was in an ice age where continental glaciers reached as far south as the Ohio River Valley over North America.**
- **Over Europe, the northern region and higher terrain were covered in thick sheet as well.**
- **The glacial advance/retreat occurred about 10 times over a 2 million year period.**

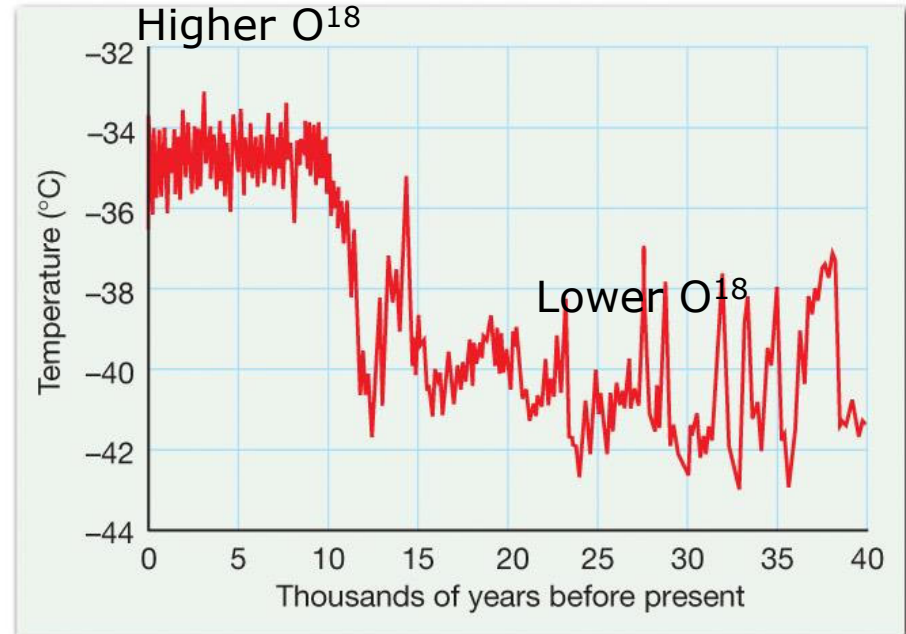
Ice Cores tell us the Real Temps!

Higher O₁₈ = Warmer Temps



A.

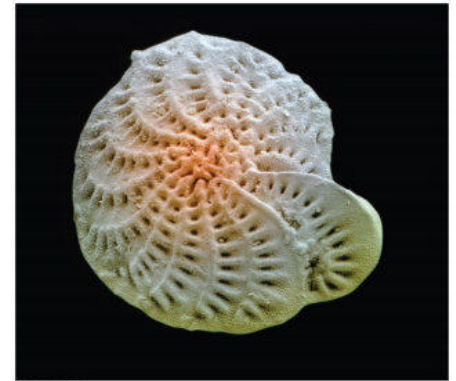
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B.

O₁₈ From Ice and Sea Shells

So What Has Happened in 15,000 Years?



We Have Been Warming...There Is No Denying!





GLOBAL WARMING: POSITIVES & NEGATIVES

MYESSAYPOINT.COM



Two Scenarios Of Change For Global Warming



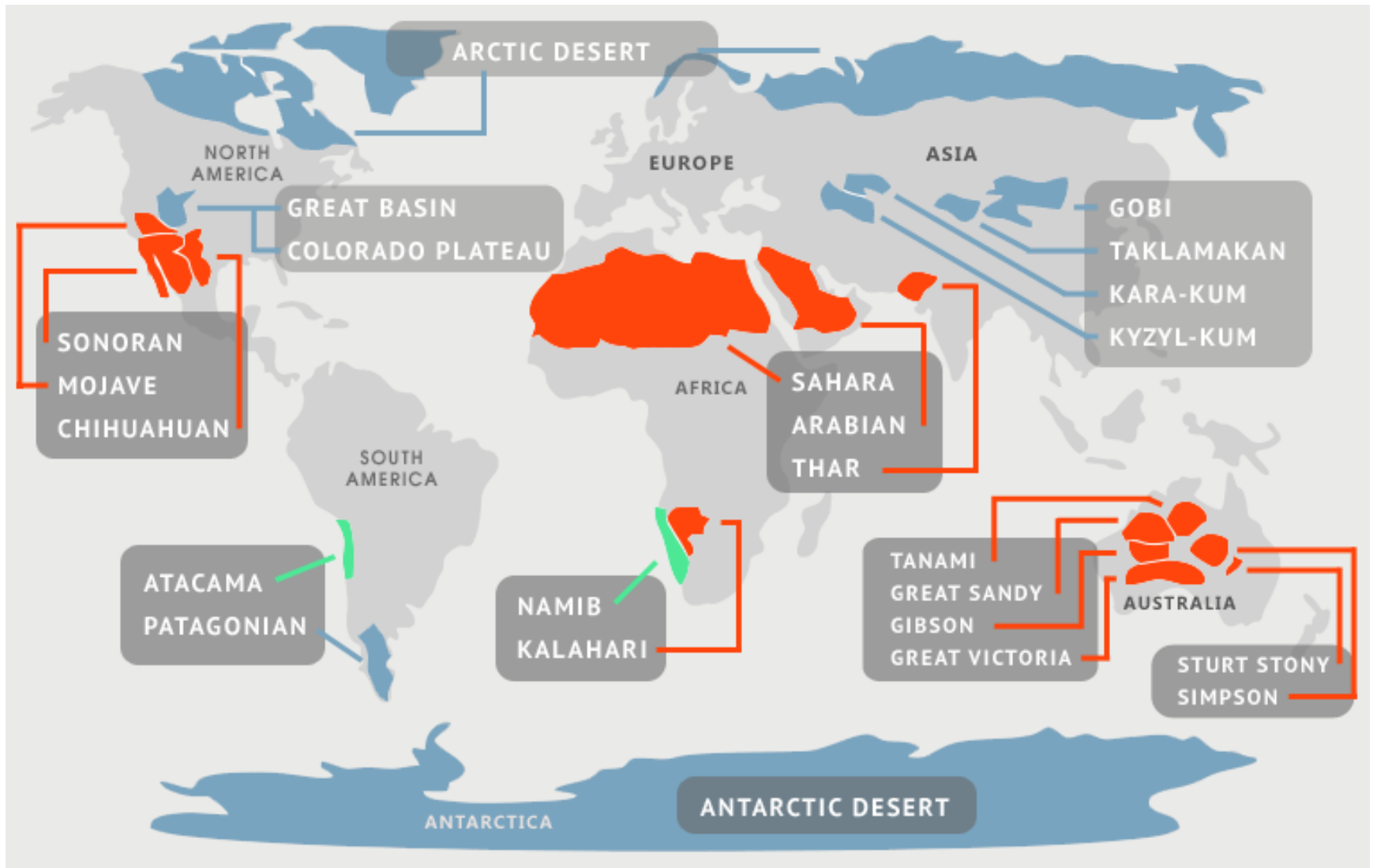
"Once again, there is no conclusive evidence of climate change. From Fairbanks, Alaska, this is Joe Matthews reporting."

Worse Earth vs Better Earth

Today, Fresh From The Ice Ages....

31% of Earth is Non Productive

Ice Sheets & Deserts!



Warm Earth in Geologic Times

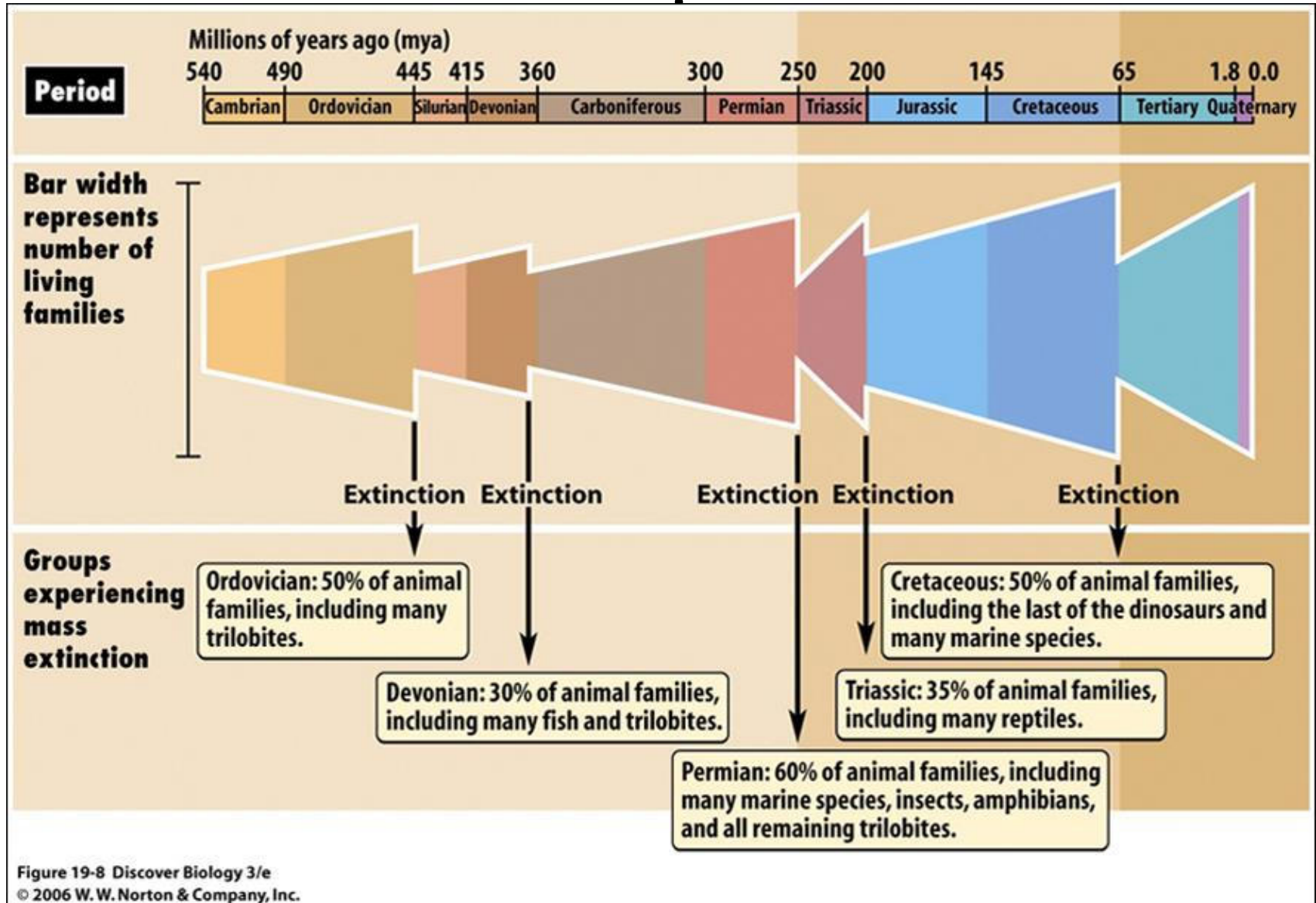


Marine Biodiversity

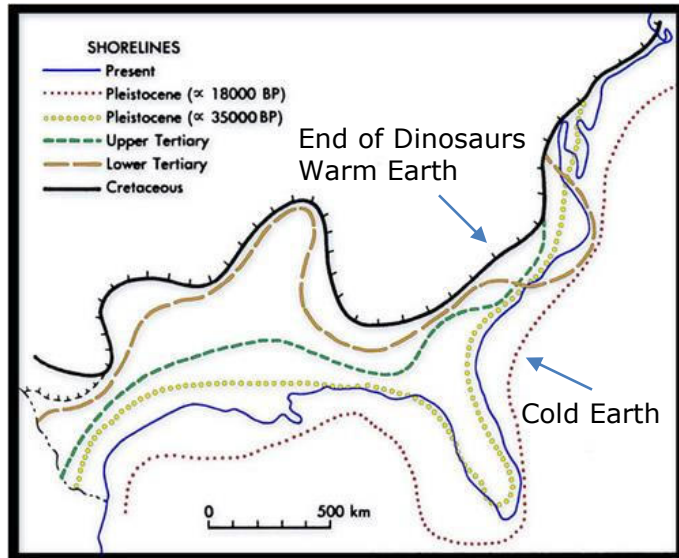


Anchorage??

Cold Earth = Massive Glaciers--5 Global Mass Extinctions Followed By Warm Earth = Explosion of Life!!

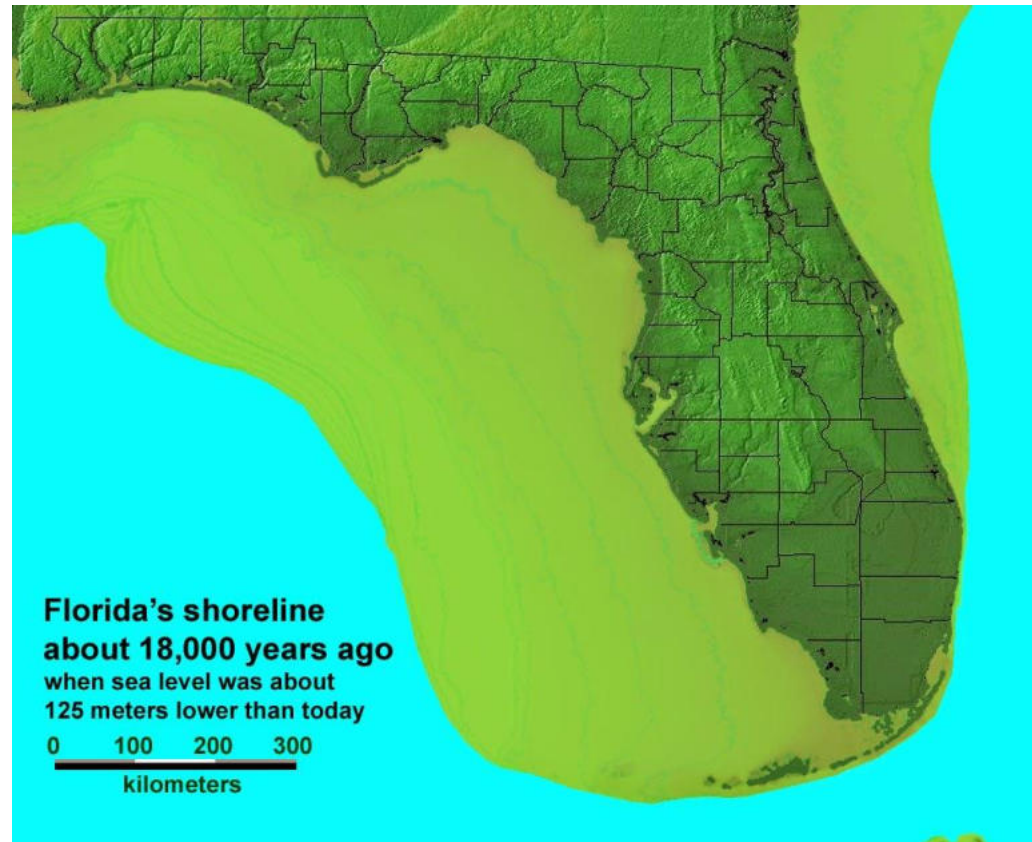


Going From a Colder Earth to A Warmer Earth...Change Happens

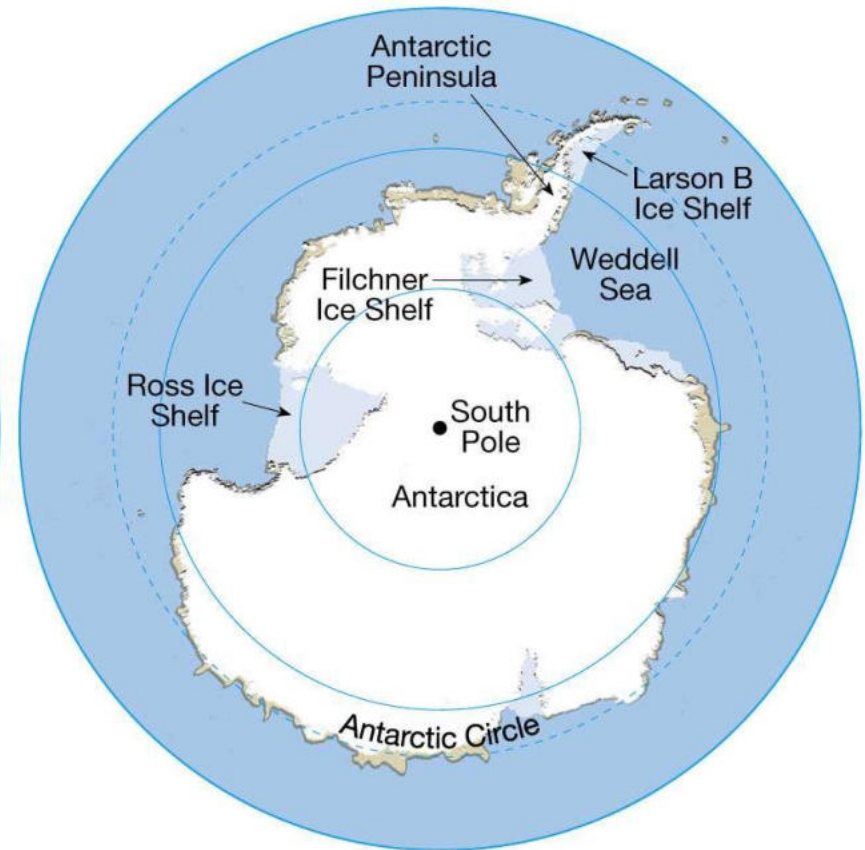


Lowered 125 m = 4500 inches
 $4500/18000 = 0.25$ in/yr!!

Today only 0.12 in/yr!!!!



Today...The Poles...



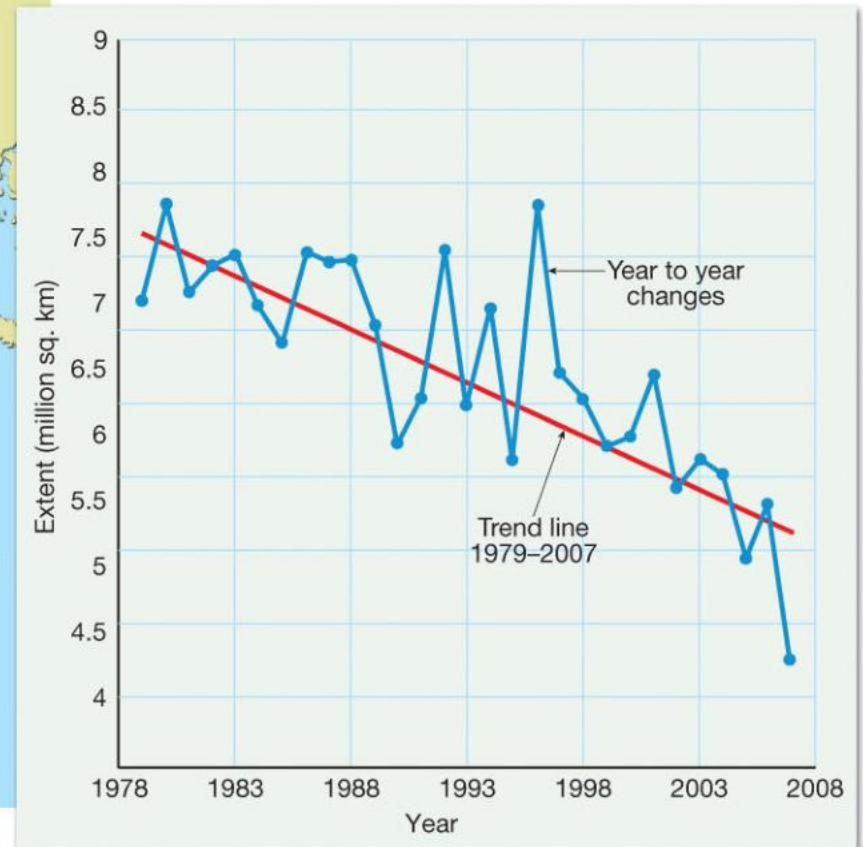
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Net Effect: Changes in Arctic Sea Ice



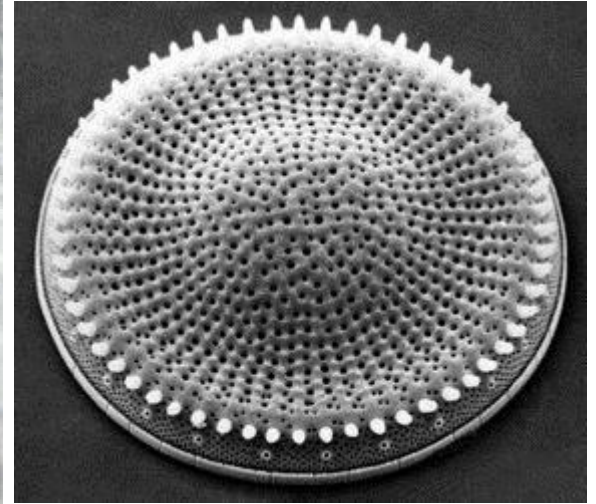
A.

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B.

Ohh..Glaciers and Diatoms



Need Silica to Grow

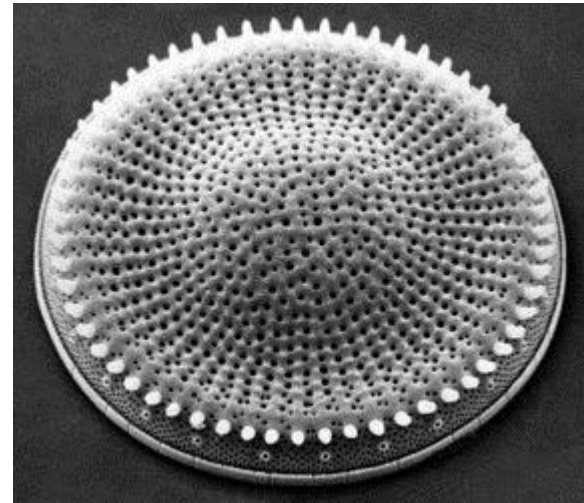
Melting Glaciers—Full Of Silica From Rocks

Remember What Diatoms Do?
Diatoms suck up CO₂
Produces O₂ !!!!

Producing Oxygen On Earth



Takes in CO_2 produces O_2



60% Atm Oxygen from Diatoms!
Must Have Glacial Melting..



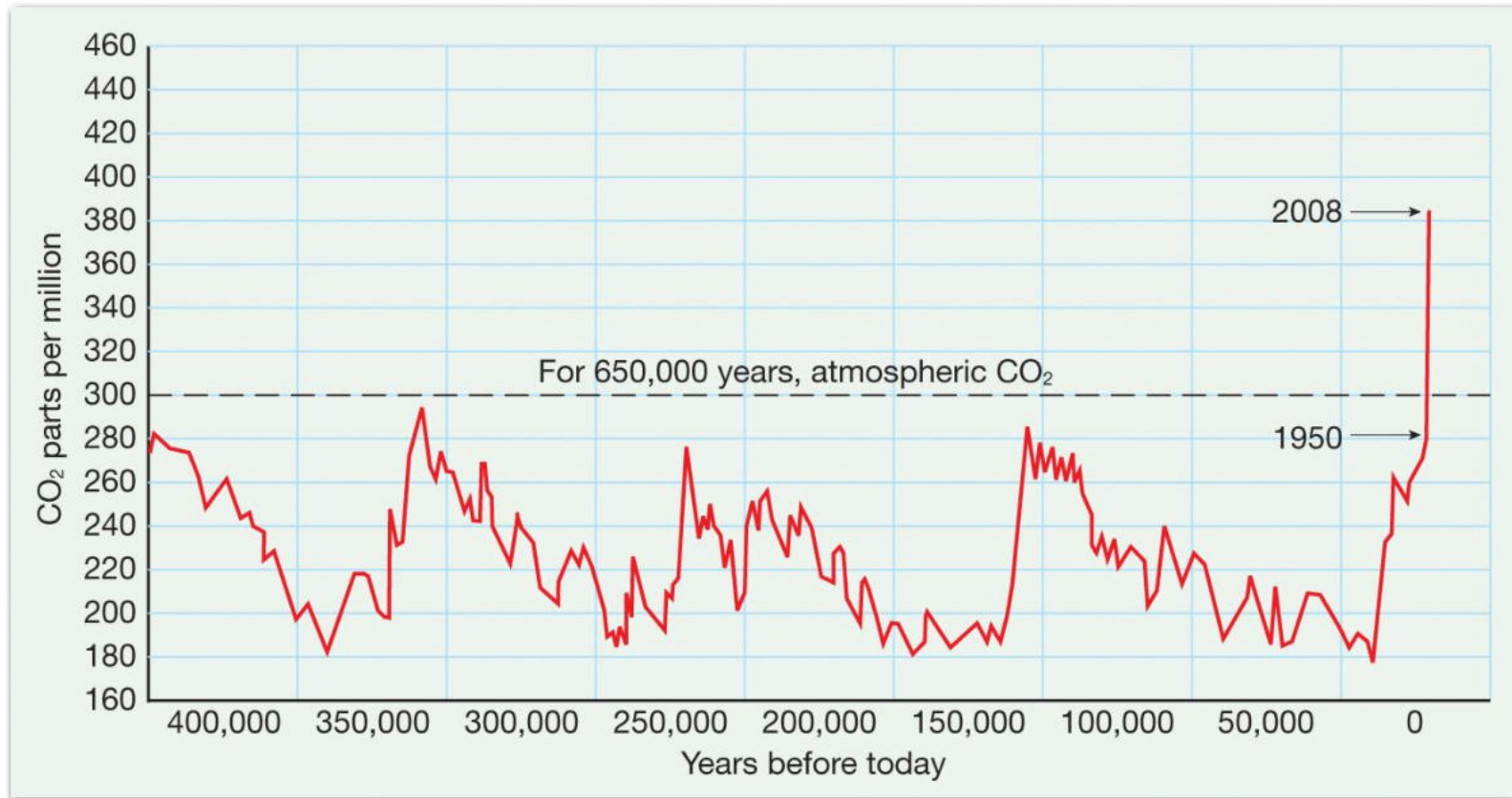
The Global Energy Dilemma



Being Good Stewards Of The Earth



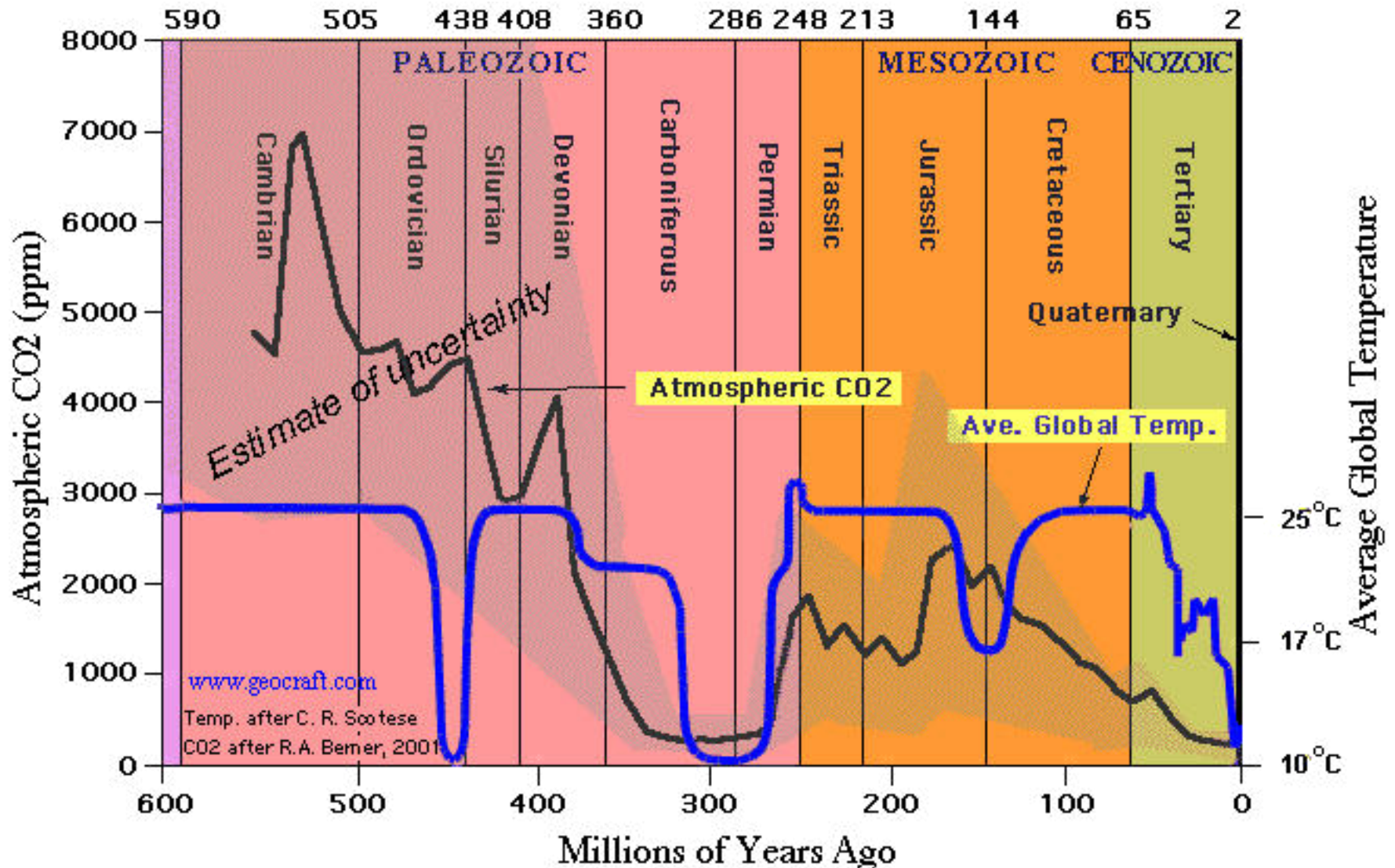
CO₂ Concentrations Over the Past 400,000 Years (Famous “Hockey Stick” Graph)



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The Problem..Based mostly on Tree Rings!

CO₂ vs Temp over Time

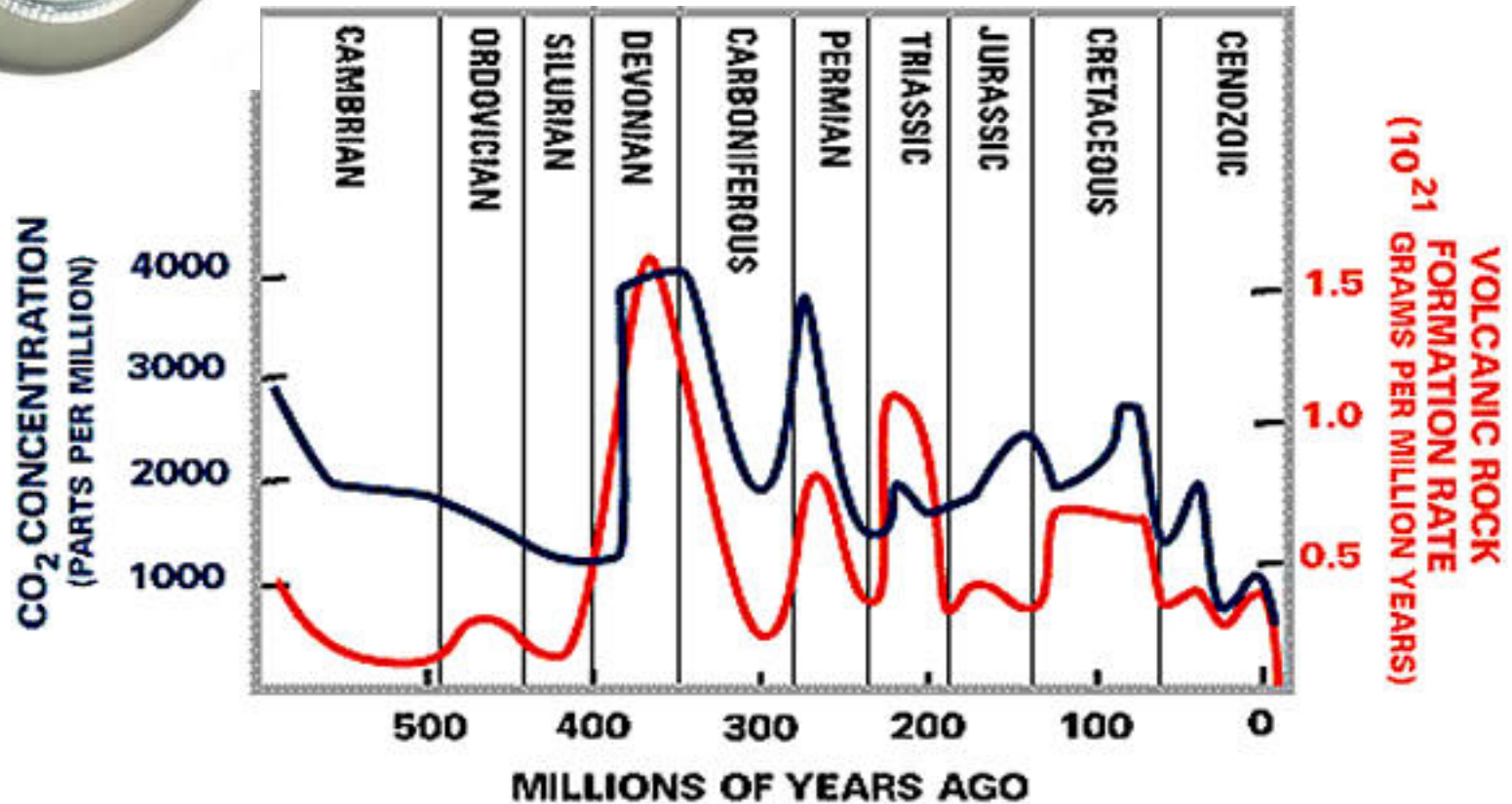


26 C = 79 F

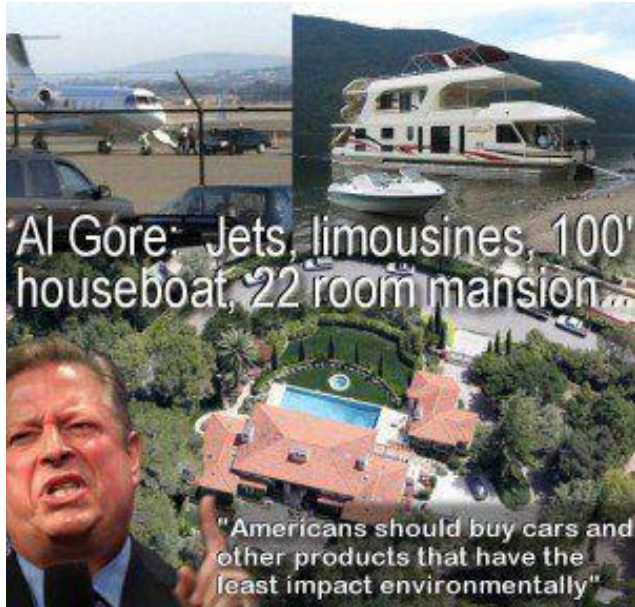
15 C = 59 F

20 F Difference!

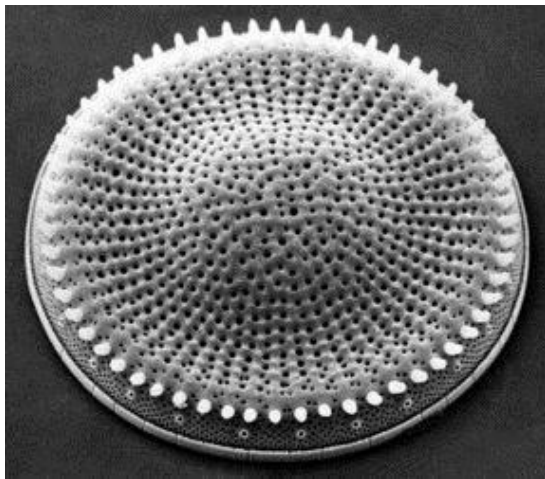
Shhh...We Think it Has to do with Volcanos!!



Human Influences



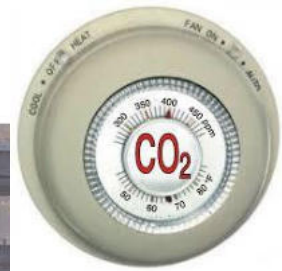
Remember this Guy?
Or This One?



Annual CO₂ Contribution of an Average American



17,000 pounds
of CO₂ by using
1,100 kilowatt-hours
of electricity
per month



8,800 pounds
of CO₂ by using
6,300 cubic feet
of natural gas
per month



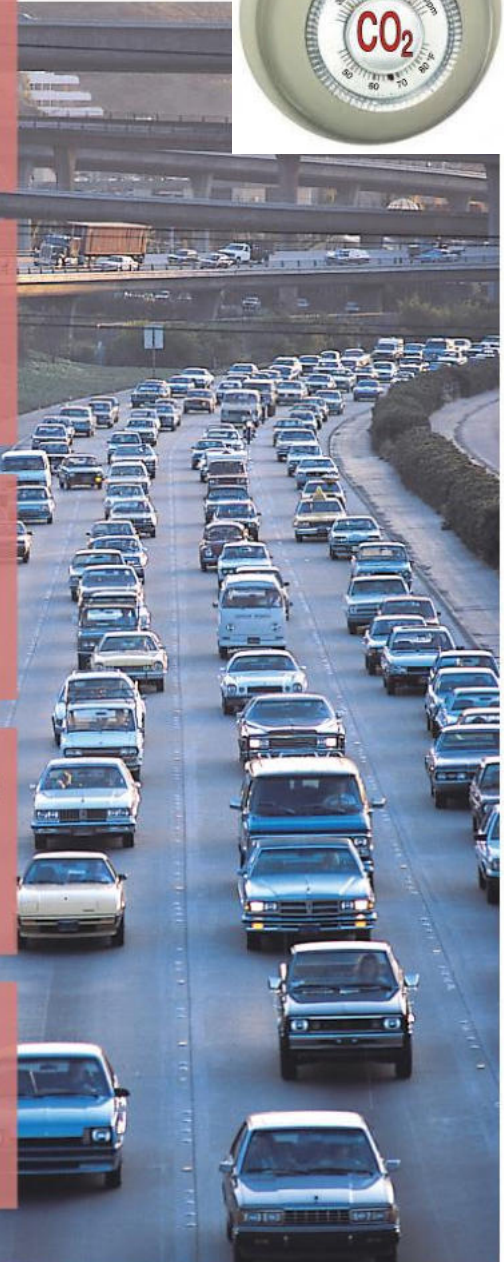
1,000 pounds
of CO₂ by creating
4.5 pounds
of trash
per day



8,900 pounds
of CO₂ by
driving
160 miles
per week



1,000 pounds
of CO₂ by
flying
1,900 miles
per year

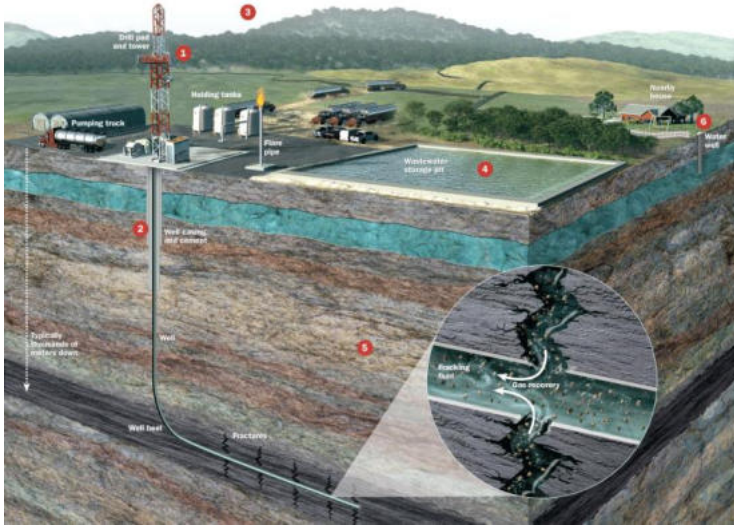


Alternative Fueled Vehicles

AFV's



Hydraulic Fracturing



VS Rare Earth's From China



7000 Batteries!

"May be Hazardous To your Health If You Work in China"

Rare Earth = Problems!!



Air, Water and Land Environmental Disaster!!

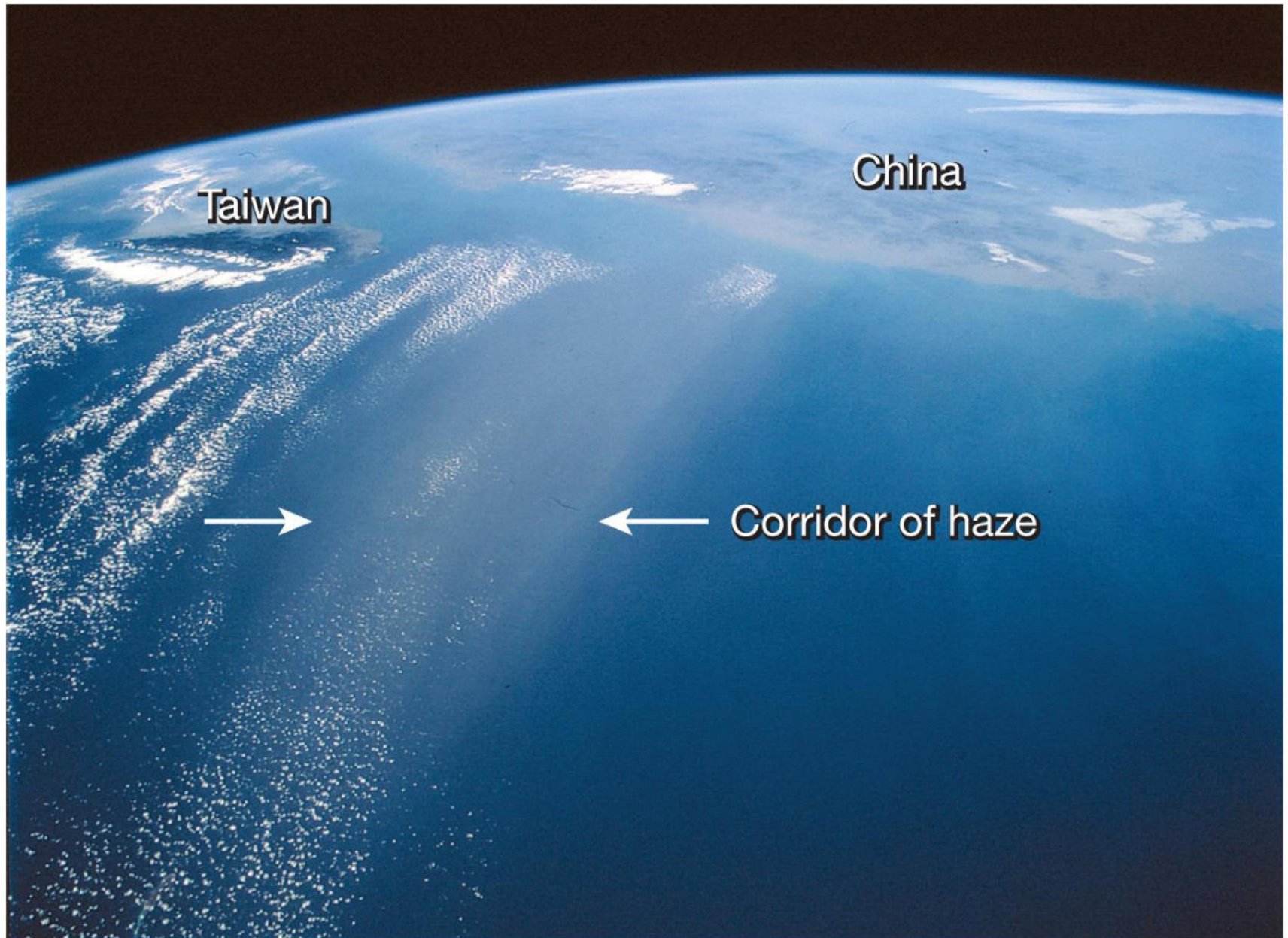
1 Ton of Mining of Rare Earths Produces:

- 1 Ton Radioactive Waste Liquids
- 10,000 M³ Waste Gas (S, HF etc)
- 2,000 Tons of Mine Tailings

Source: EWI.ORG, 2016

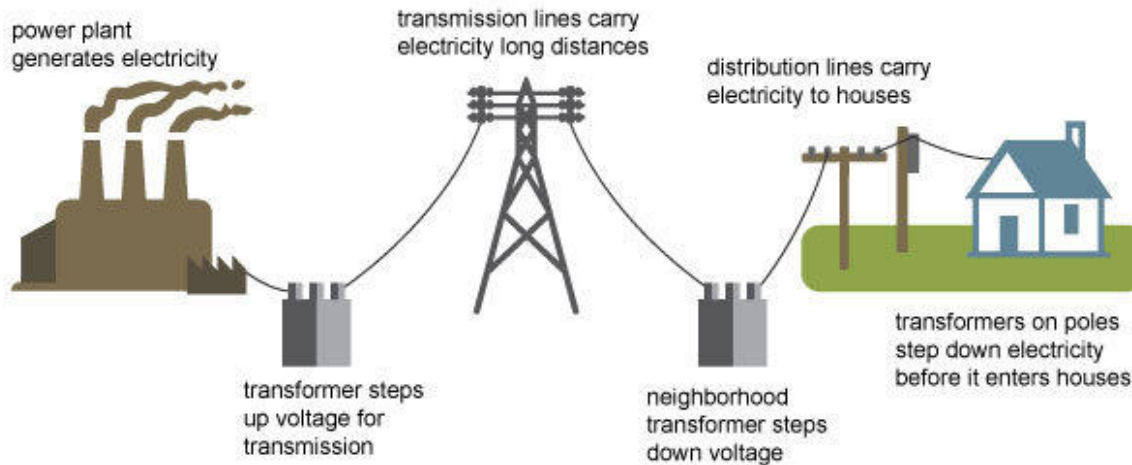
Google: China, Rare Earths, Leukemia!!

Air Pollution Haze from China-Climate Change?



Needs Electricity!

Electricity generation, transmission, and distribution



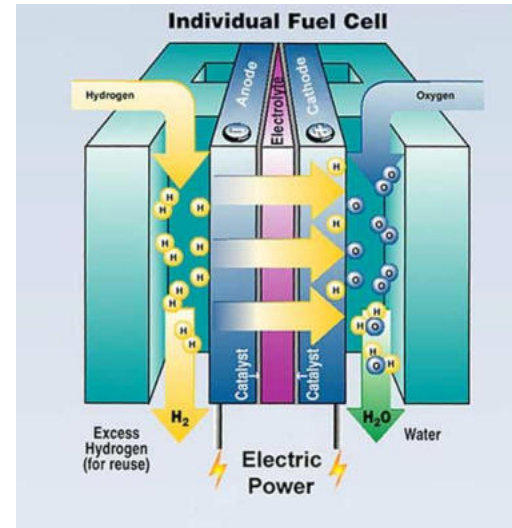
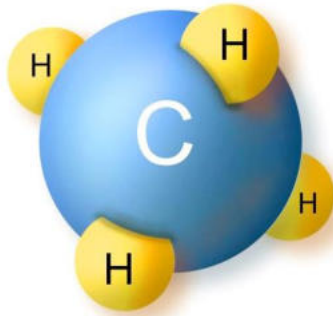
Source: Adapted from National Energy Education Development Project (public domain)



About 2 Million on World Roads-Project 100 M by 2030
50% of World's Electricity Comes From???



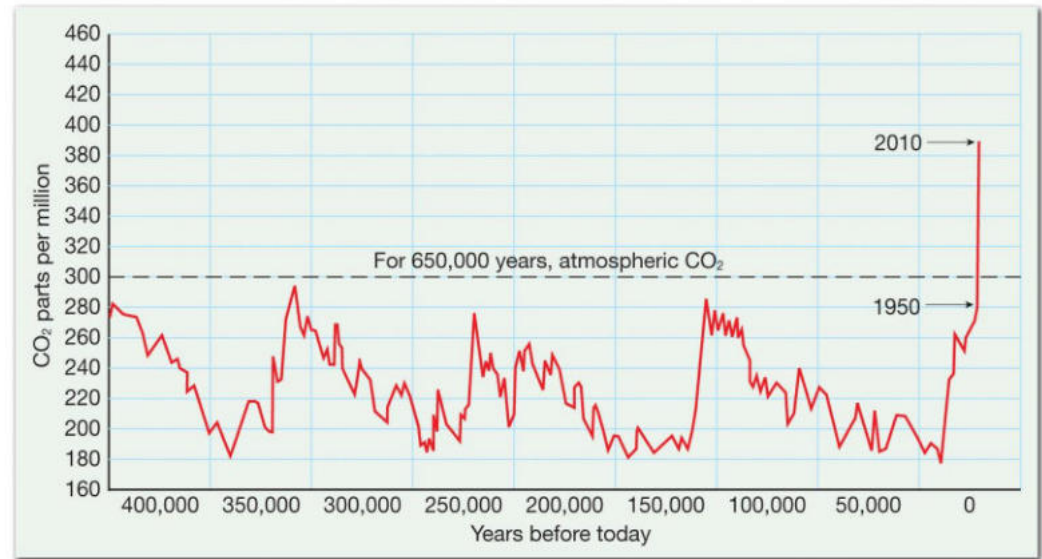
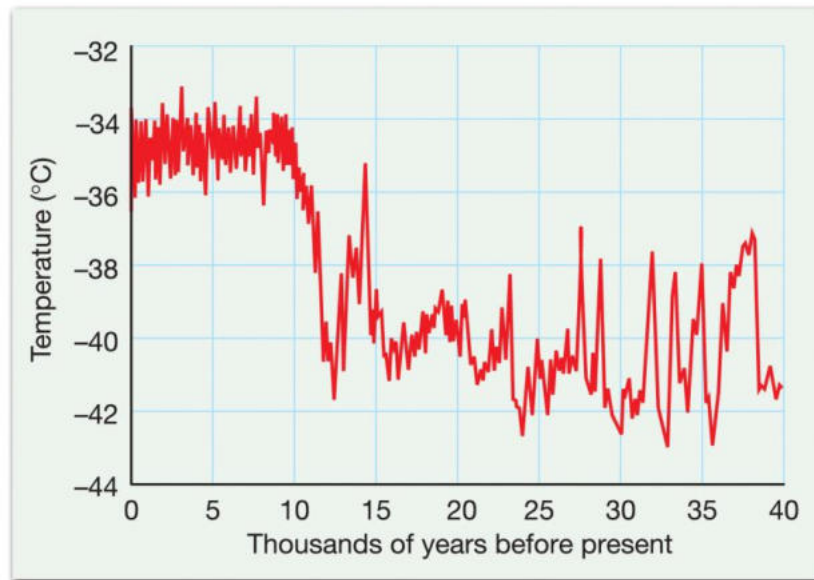
Nat Gas to Hydrogen: The Energy End Game



One Battery!!!!



Warming for 100 years or 10,000 years?



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Ice Cores-Temps

CO₂ Tree Ring Studies

These Places Know About Change:



New Orleans
Flooding



Fukushima
Earthquakes

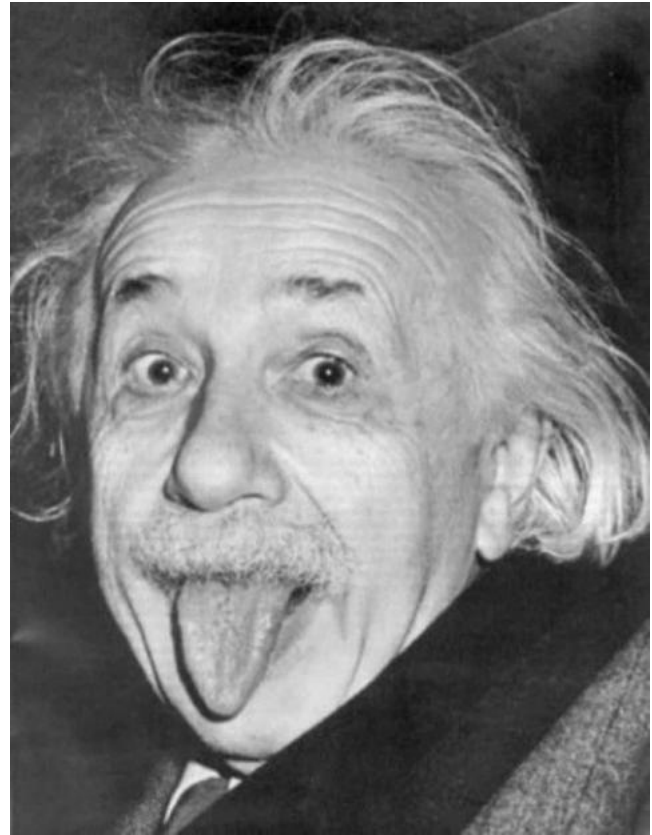


Hawaii
Volcanos

It's About Change..Right?

- Temps Changes Over Time
- O₂ Changes Over Time
- CO₂ changes Over Time
- Species Change Over Time
- Volcanos Change Over Time
- Glaciers Change Over Time
- Our Orbit Changes Over Time
- The Sun Changes Over Time
- The Earth Changes Over Time

Doesn't Really Mind Change!

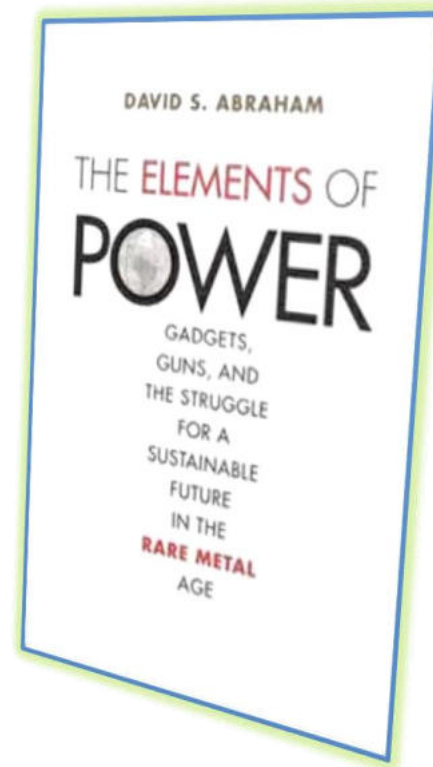
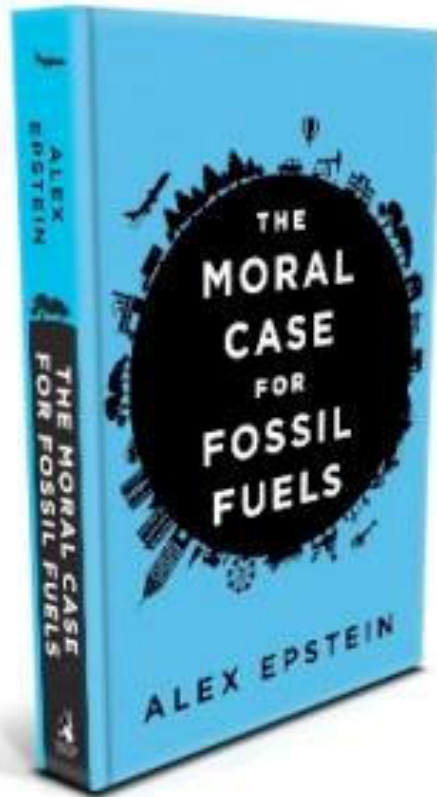




Not Big On Change!



2 Books to Read!!



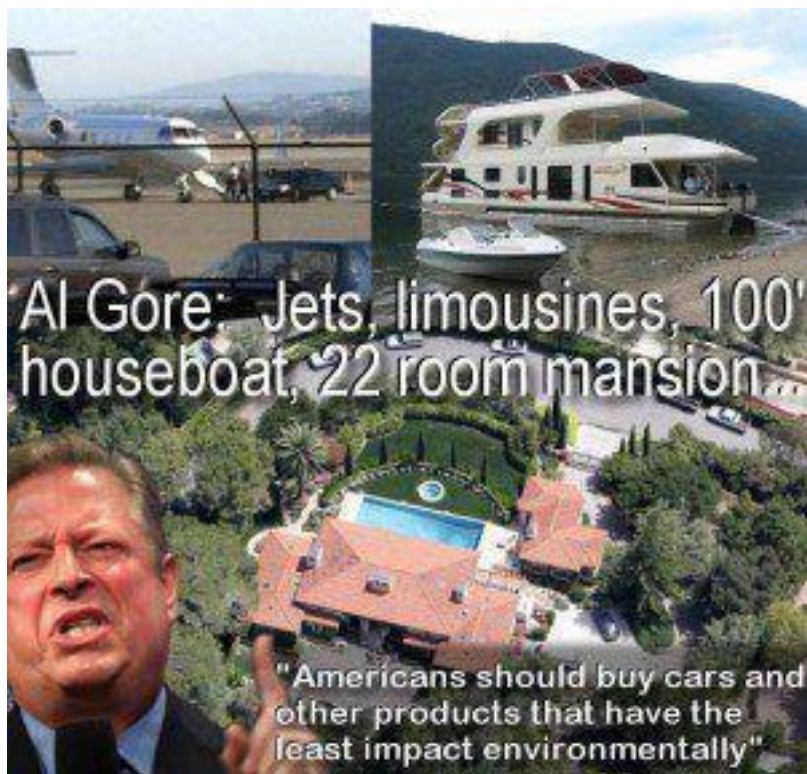
I ♥ global warming

Global Warming

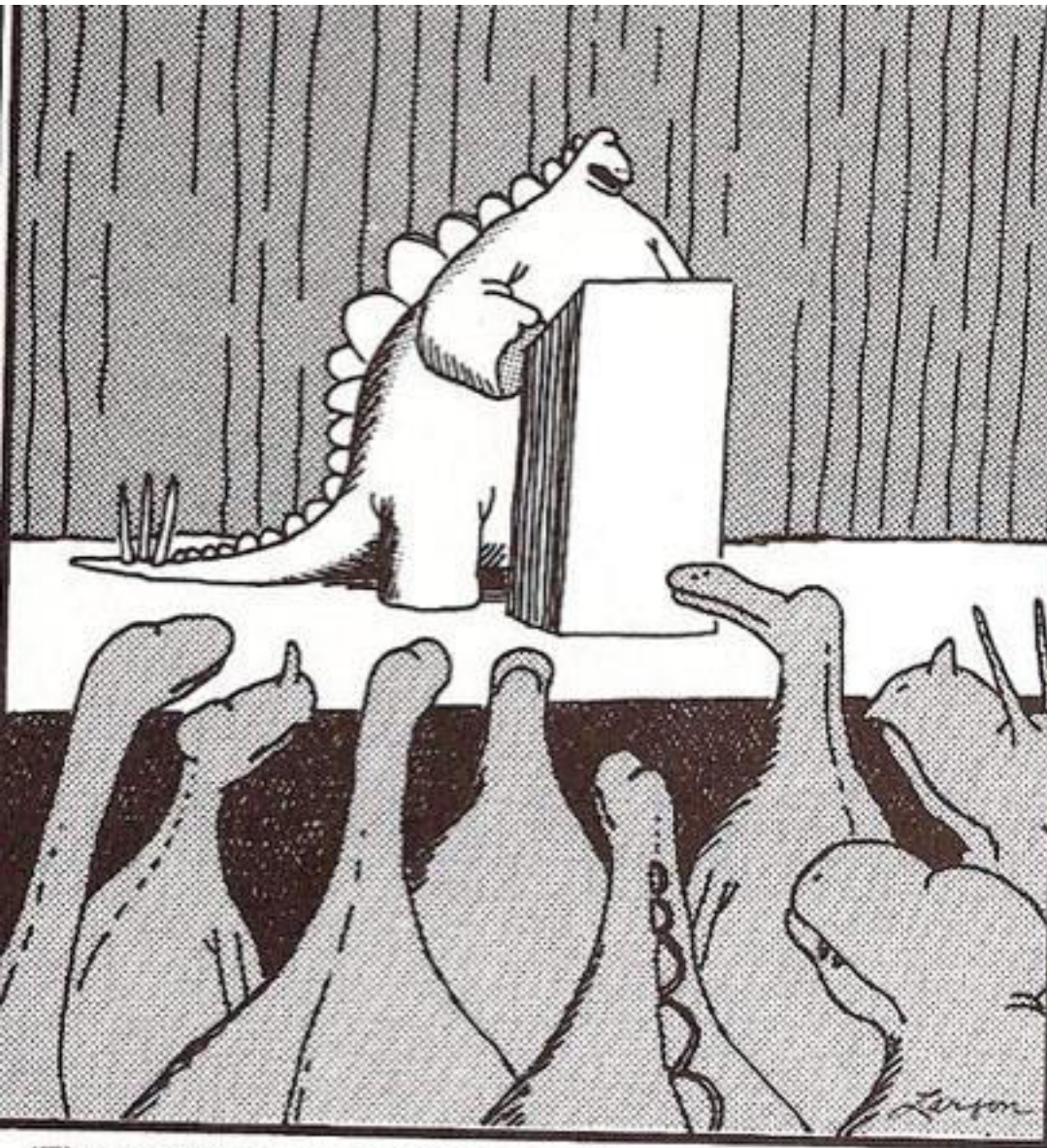
- **Possible Effects** – Global warming could have some positive and negative effects
 - **Positive Effects** – A global climate change could have positive effects in areas that are currently considered hostile
 - Areas currently too cold for farming could warm up enough to produce good crops
 - Amounts of rain could increase in desert areas enough to create forests
 - Extremely hot areas could become cooler with more moderate temperatures

**IT'S THE EMPTY
CAN THAT MAKES
THE MOST NOISE.**

**ENGLISH PROVERB.
FOLLOW @E_PROVERB FOR MORE.**



It's All About Change...



"The picture's pretty bleak, gentlemen. ... The world's climates are changing, the mammals are taking over, and we all have a brain about the size of a walnut."



Get Used to It!!

TCU ENERGY INSTITUTE

Dr. Ken Morgan, Director
Veronica Merrill, Program Coordinator



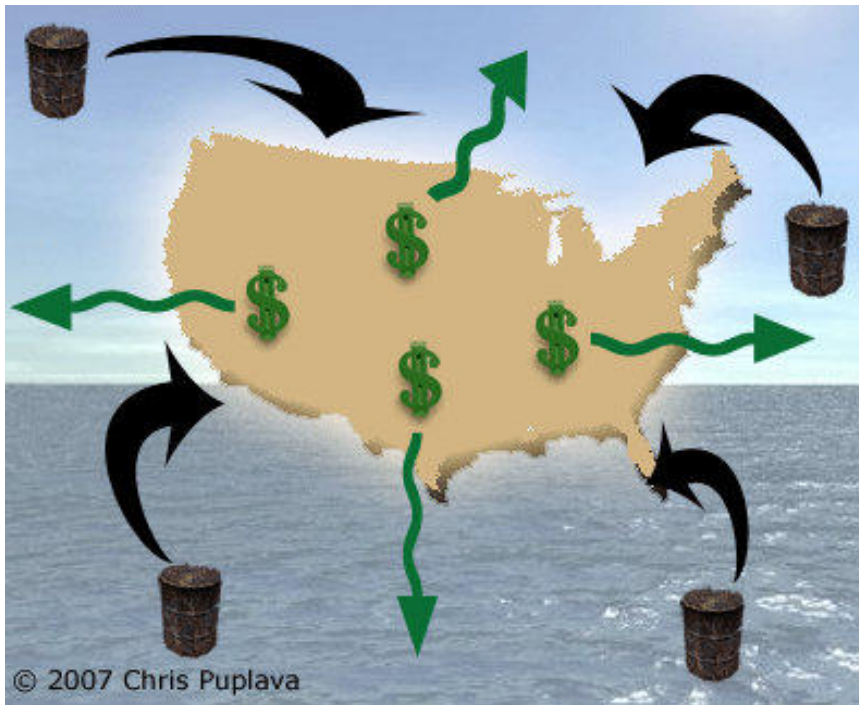
RESEARCHING OUR ENERGY FUTURE!!

Global Sellers-Buyers



What will the U.S. be by 203

Update On Importing Fast Lane!



OIL IMPORTS--EIA

Oct 2017-10 million bbls/day!!

OIL EXPORTS (since August)

Oil = 1 m bbls/day to 2 m bbls/day!!

Refined Products = 6 m bbls/day!!

Total = 7.5 m bbls/day!

Net Imports: $10 - 8 = 2$ m bbls/day!!!

WE ARE SELLING EVEN MORE!!!

