

Agenda, Class 17, June 4

- **Reminders**

- List of references for Presentation #2 from each team
- Individual summary for Presentation #2 due next Tuesday

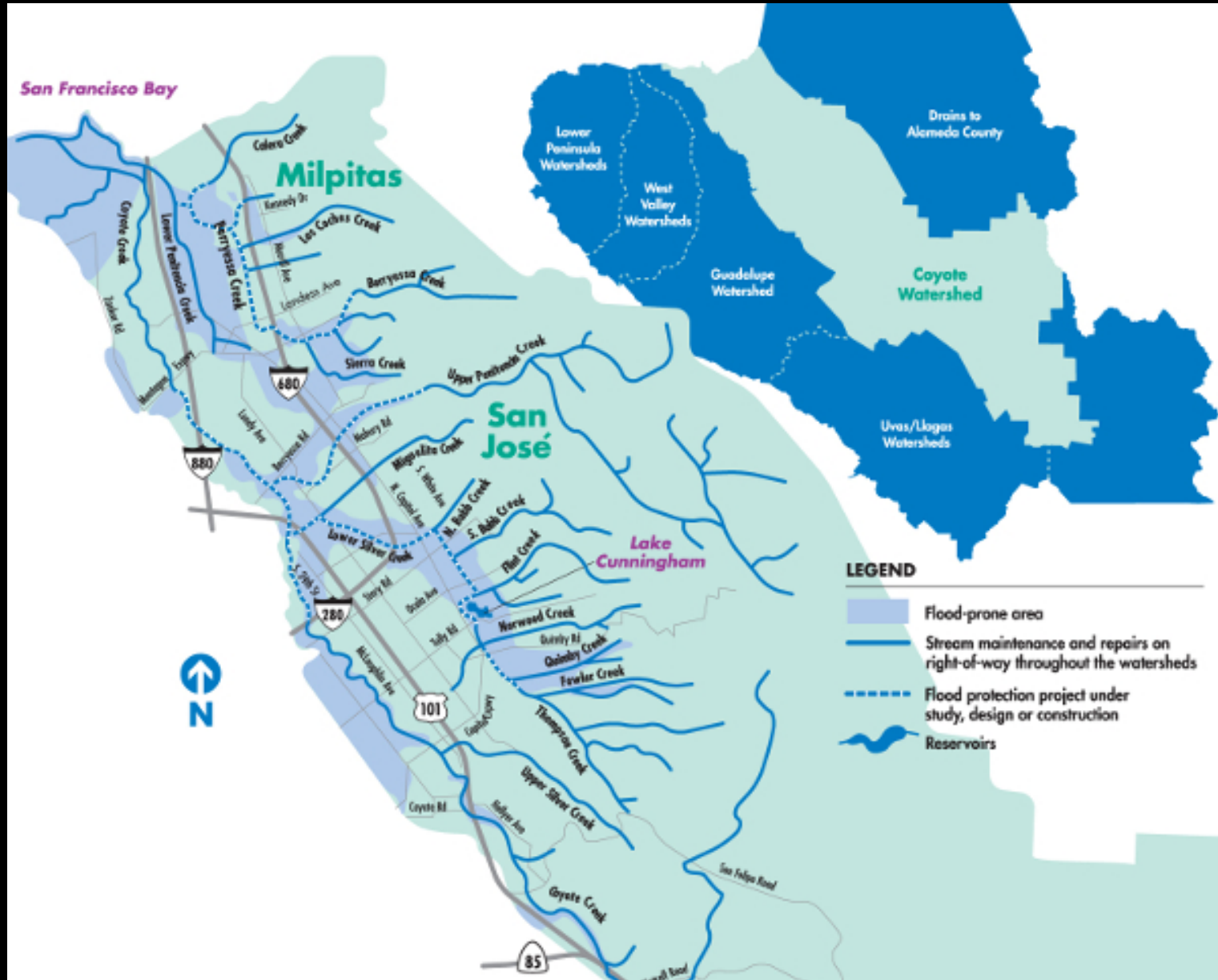
- **Quiz highlights**

- Q1: In-class research activity on California's Biodiversity from Class 10
- Q2: Ecosystem services: Meaning
- Q3: *Freshwater Fishes*, not all fishes
- Are your journal entries complete?

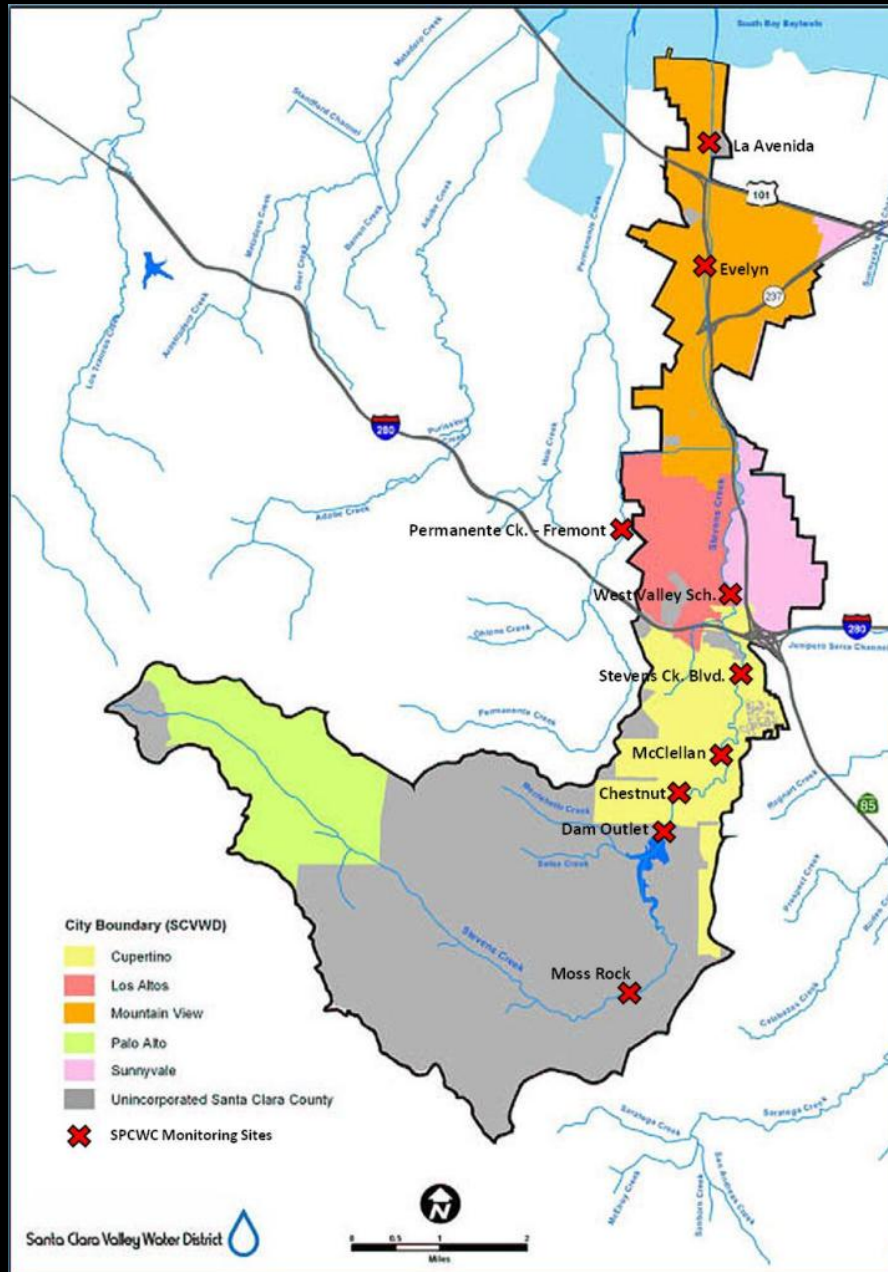
Agenda, Class 17, June 4

- 1:40-2:15
 - **Lecture:** Greenhouse Effect and Global Warming
- 2:15-2:45
 - **Video:** Climate Change: Lines of Evidence
by National Research Council
- 2:45-3:20
 - **In-class Activity:** Greenhouse Effect, Global Warming and Consequences

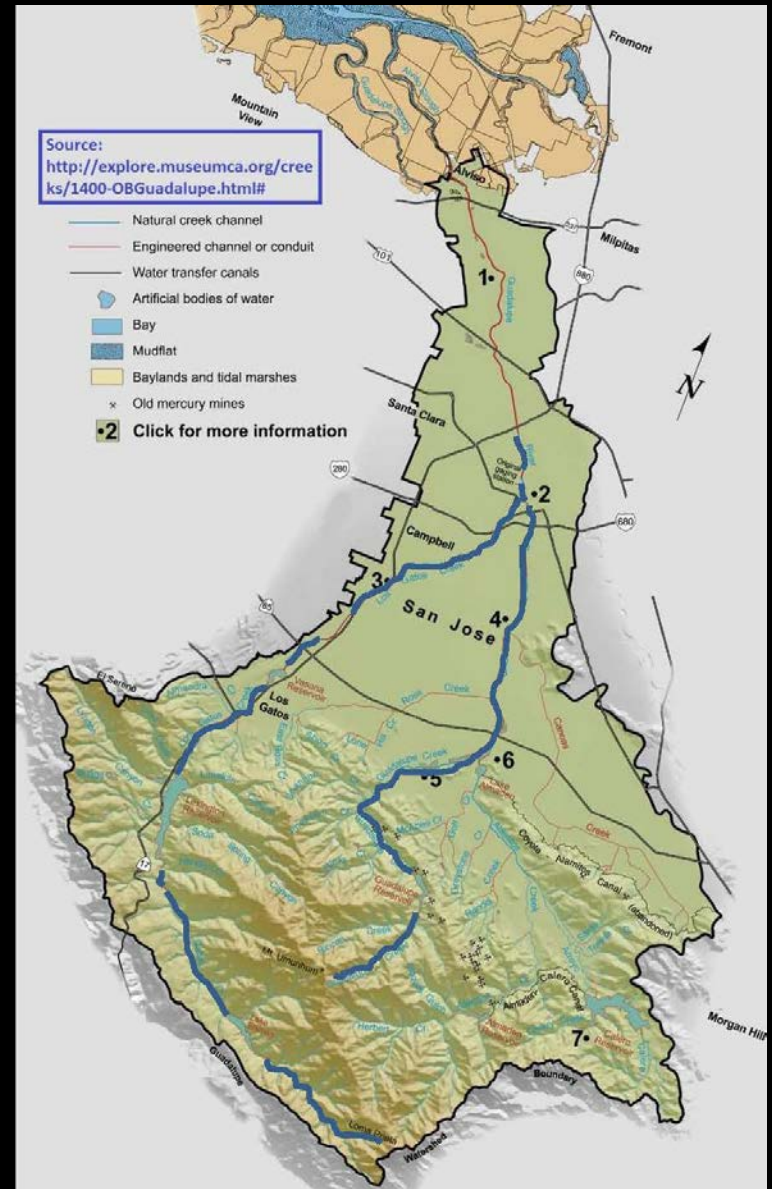
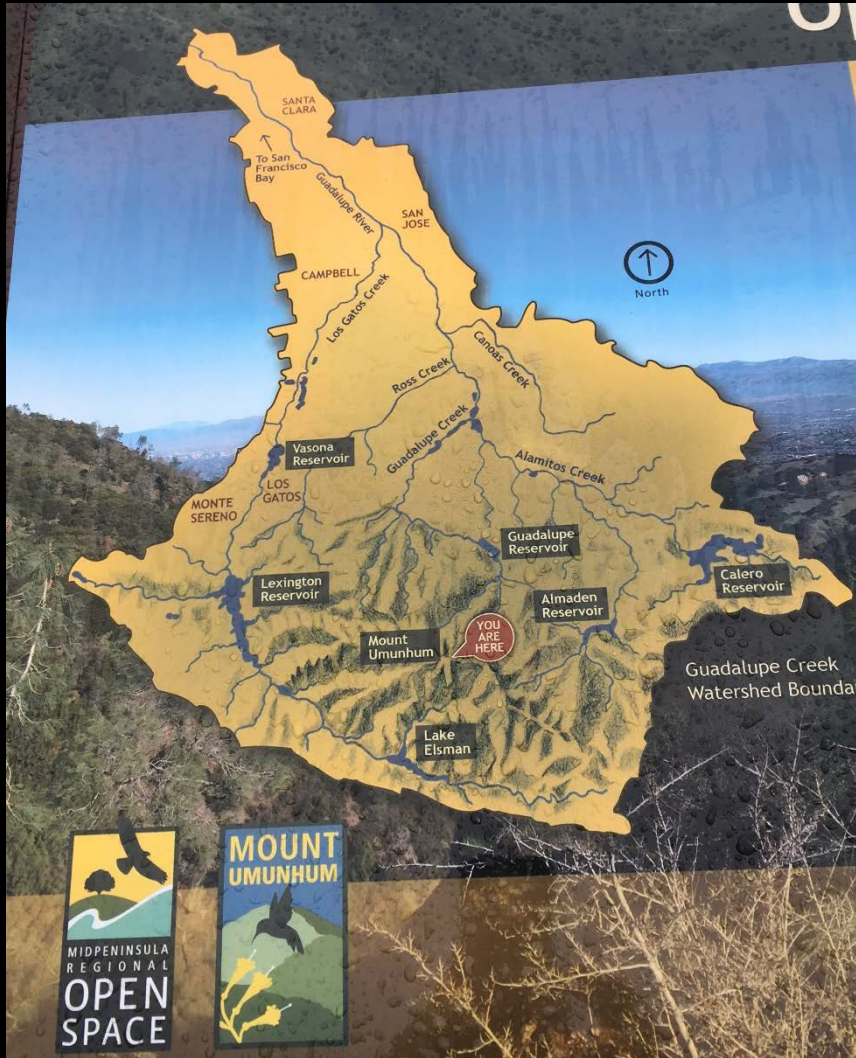
Coyote Creek Watershed



Stevens Creek Watershed



Los Gatos Creek / Guadalupe River



Natural Resources: WASEEM

Water

Air

Soil

Ecosystem

Energy

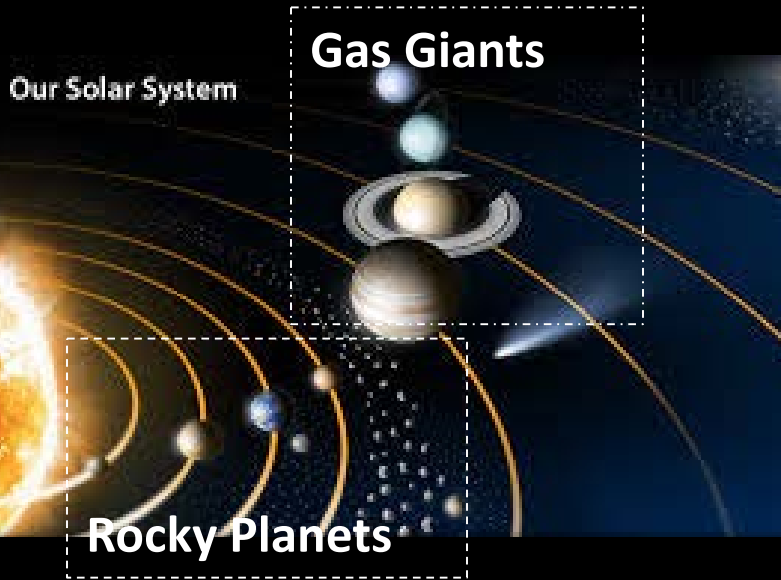
Minerals



Global Warming
Climate Change

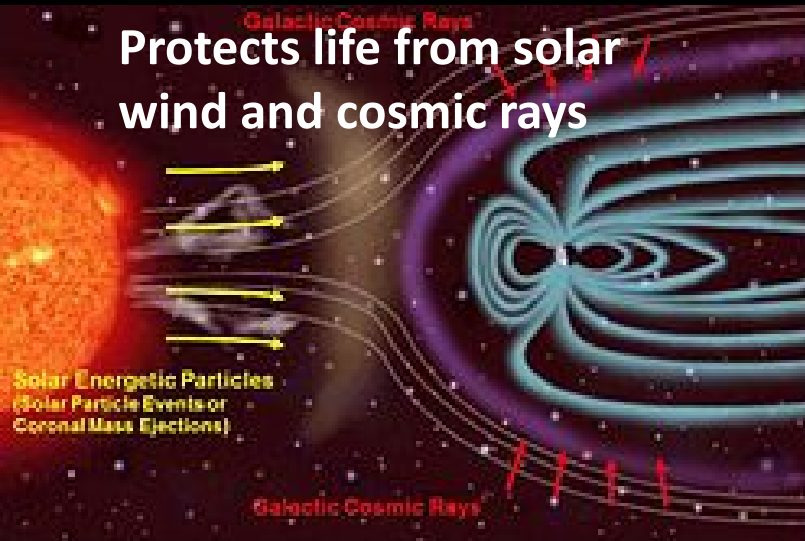
Why Earth Supports Life

Rocky surface



Magnetic Field

Protects life from solar wind and cosmic rays



Atmosphere

Moderates surface temperatures

Protects surface from harmful radiation

Planets and atmospheres

Mars
Thin atmosphere
(Almost all CO₂ in ground)
Average temperature : - 50°C



Earth
0,03% of CO₂ in the atmosphere
Average temperature : + 15°C



Venus
Thick atmosphere
containing 96% of CO₂
Average temperature : + 420°C



GRID
Arendal UNBP

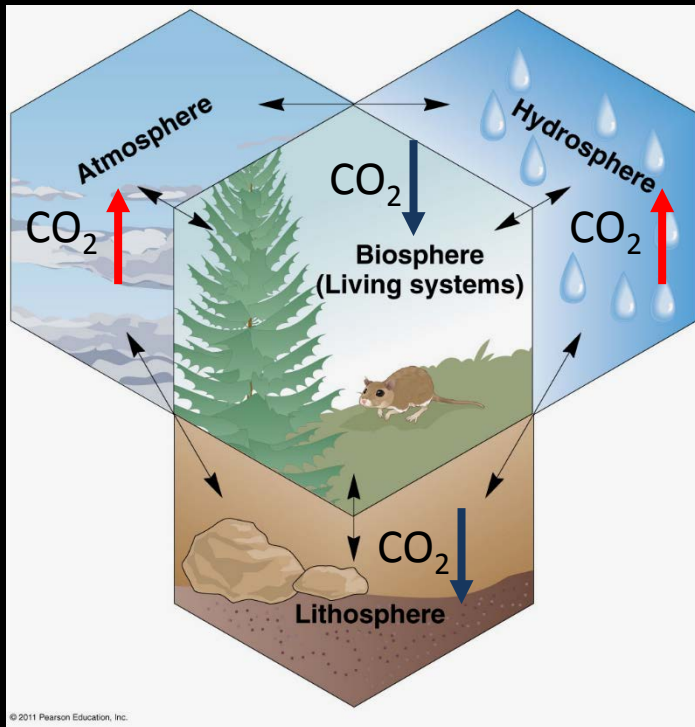
GRAPHIC DESIGN : PHILIPPE REKAGEWICZ

Sources: Calvin J. Hamilton, Views of the solar system, www.planetscapes.com; Bill Arnett, The nine planets, a multimedia tour of the solar system, www.seds.org/bills/nineplanets.html

Protective Equilibrium

A delicate balance of matter and energy within Earth's Four major systems

- Changing in the short term but predictable long term



**E.g., Stable Climates,
Stable Ecosystems**

**Life on Earth flourishes
because of stable Earth
Systems**

**Human Activity is
disturbing the equilibrium**

How Does Earth's atmosphere support life?

Atmospheric Layers

- **Stratosphere**

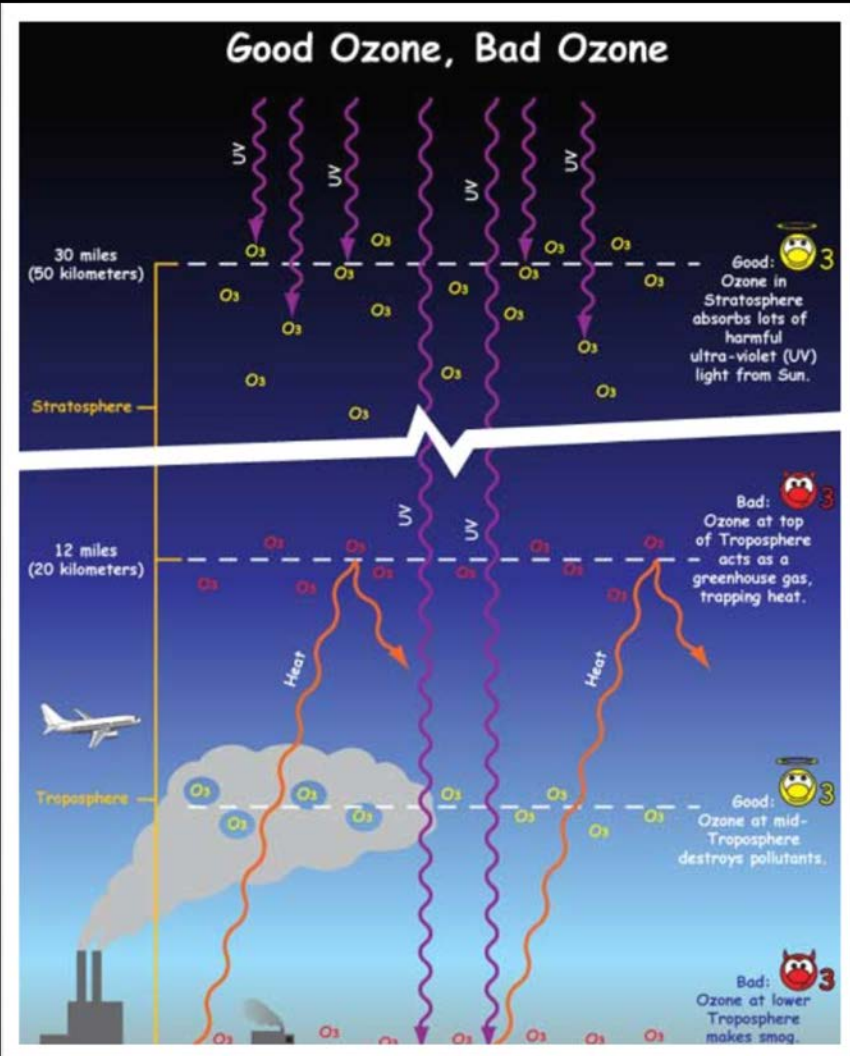
- The Ozone in this layer protects life from UV rays
- Ozone hole refers to this layer

- **Troposphere**

- **Natural Greenhouse Effect**
- Higher forms of life live and breathe here
- Climate/Weather happen here
- Global warming refers to this layer



Protective Ozone (O₃) Layer in *Stratosphere*



O₃ in Stratosphere is good

- Protects Life from harmful UV radiation

Depleting O₃ from Stratosphere is bad (since 1960s)

- Creates “Ozone Hole” near poles, larger in Southern Hemisphere
- Can lead to skin cancer
- Caused by *CFCs (aerosol sprays and refrigeration)*
- *Montreal Protocol* helping to fix it
 - 1989 International Treaty regulating CFCs globally

O₃ near Earth's surface is bad
Leads to Respiratory Problems

Why is Earth not like Mars?

Natural Greenhouse Effect

Due to Greenhouse Gases In the Troposphere
Warms Earth, Prevents Extreme Temperatures
Supports life

WARM



88 °F during the afternoon and
73 °F around sunrise At Equator

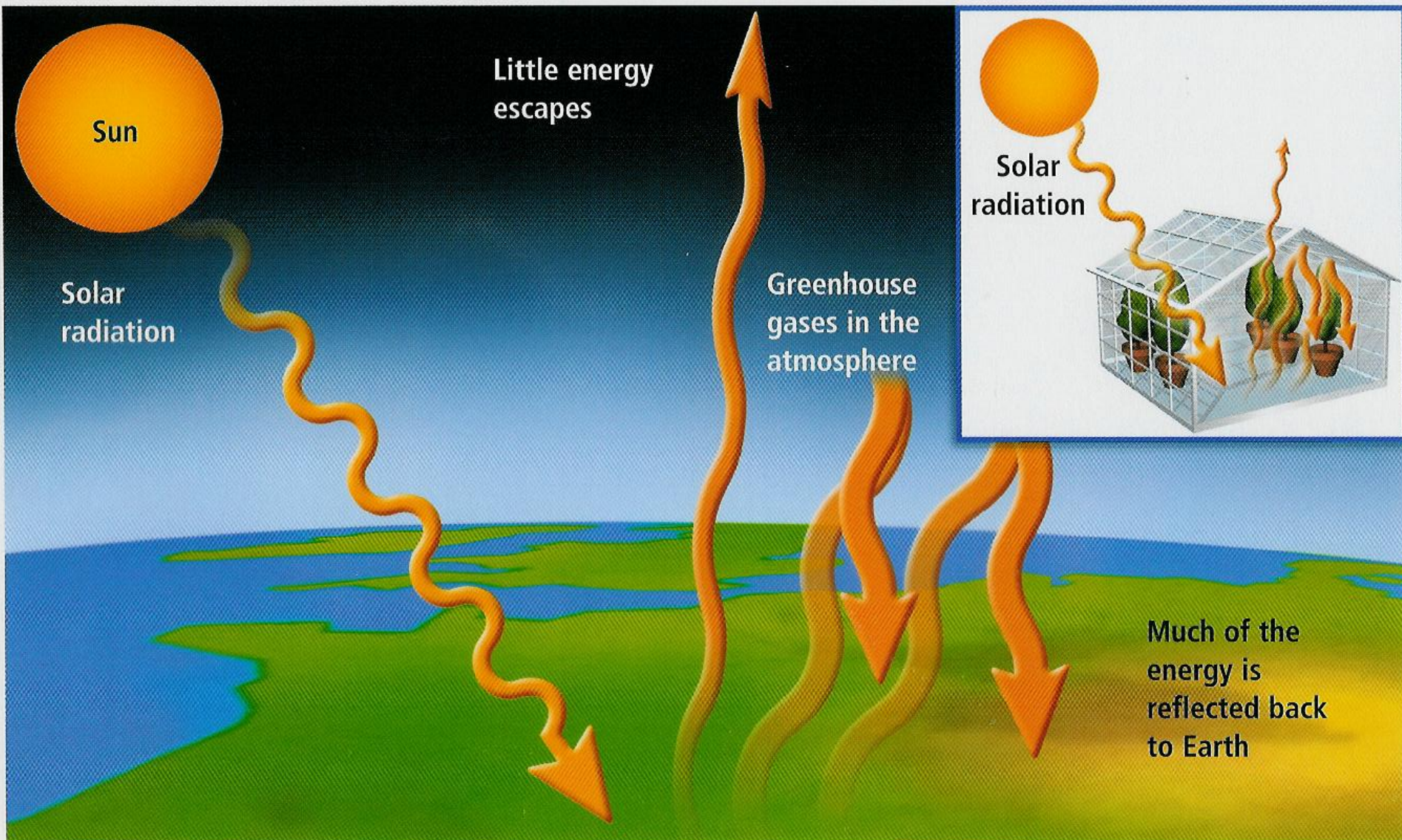
TOO HOT / COLD



70 °F Day and
-100 °F Night at Equator in Summer

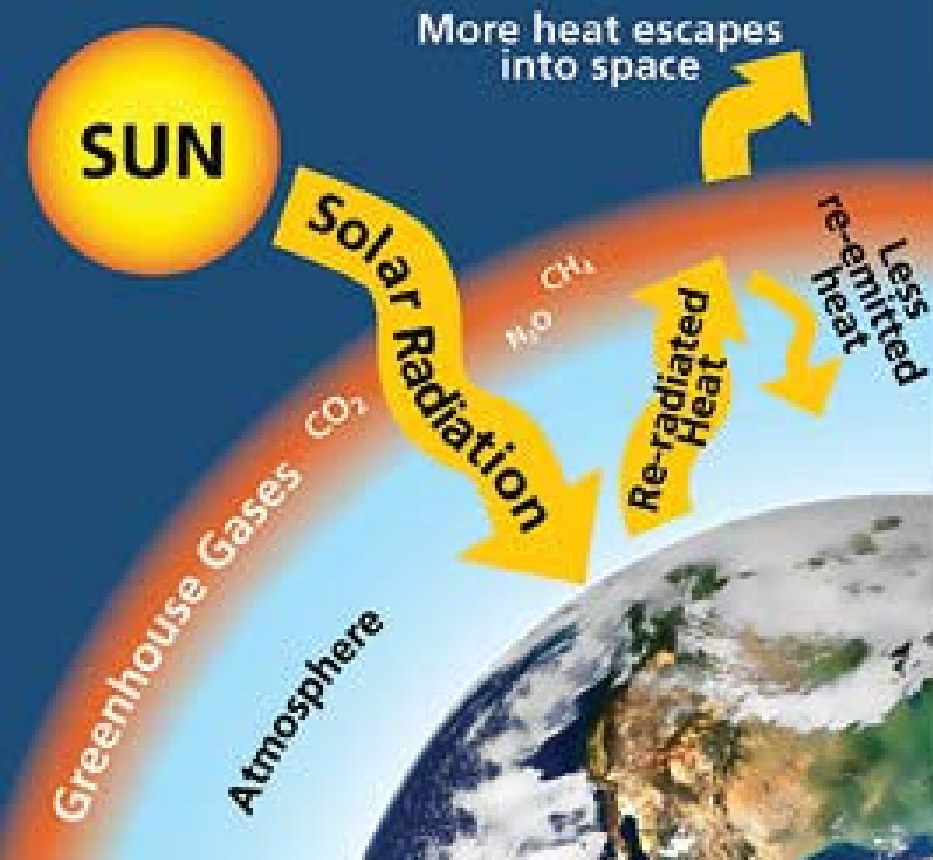
Vs

Greenhouse Effect

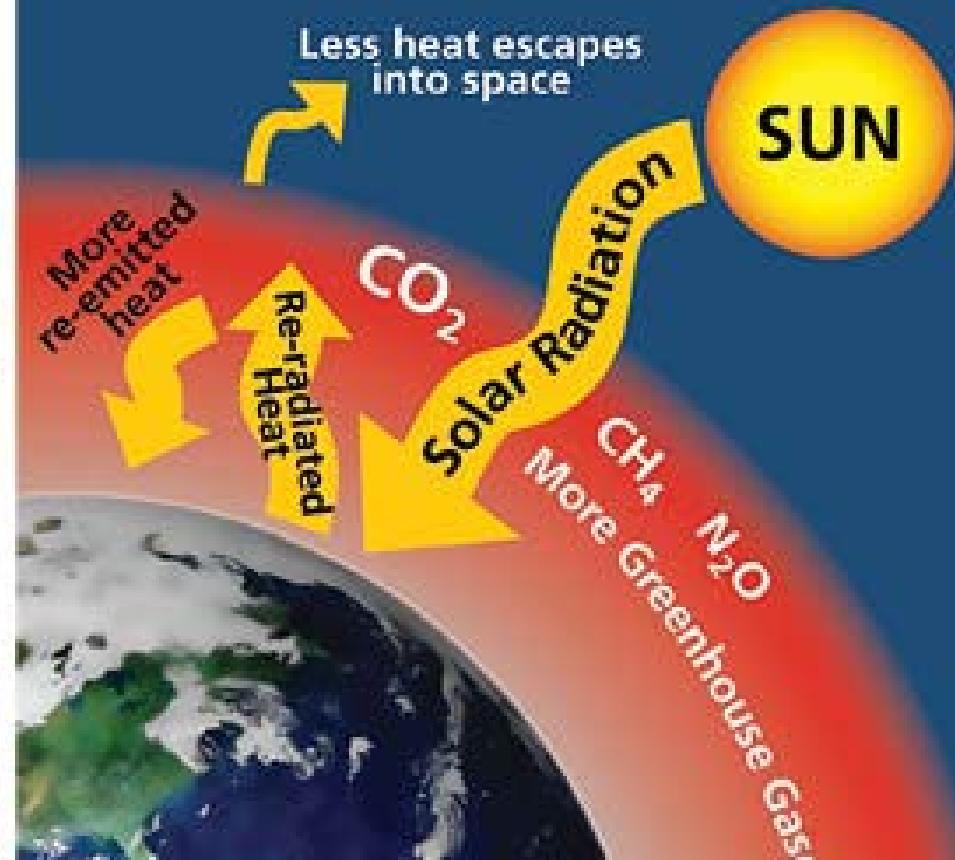


Natural Greenhouse Effect Absolutely Necessary for Life on Earth

Natural Greenhouse Effect



Human Enhanced Greenhouse Effect



Could Earth become like Venus?

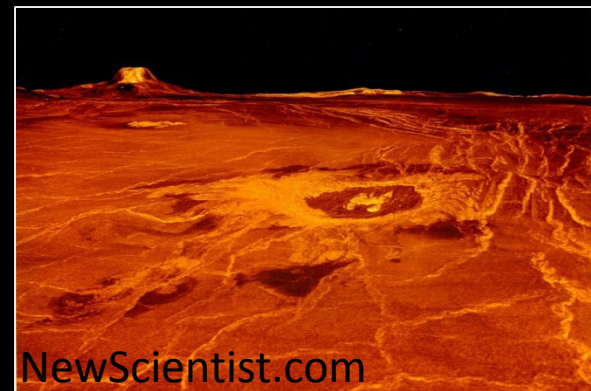
If Too Much Heat Stays In
Warms the planet too much
Toxic Gases in Atmosphere
Extinguishes Life

WARM

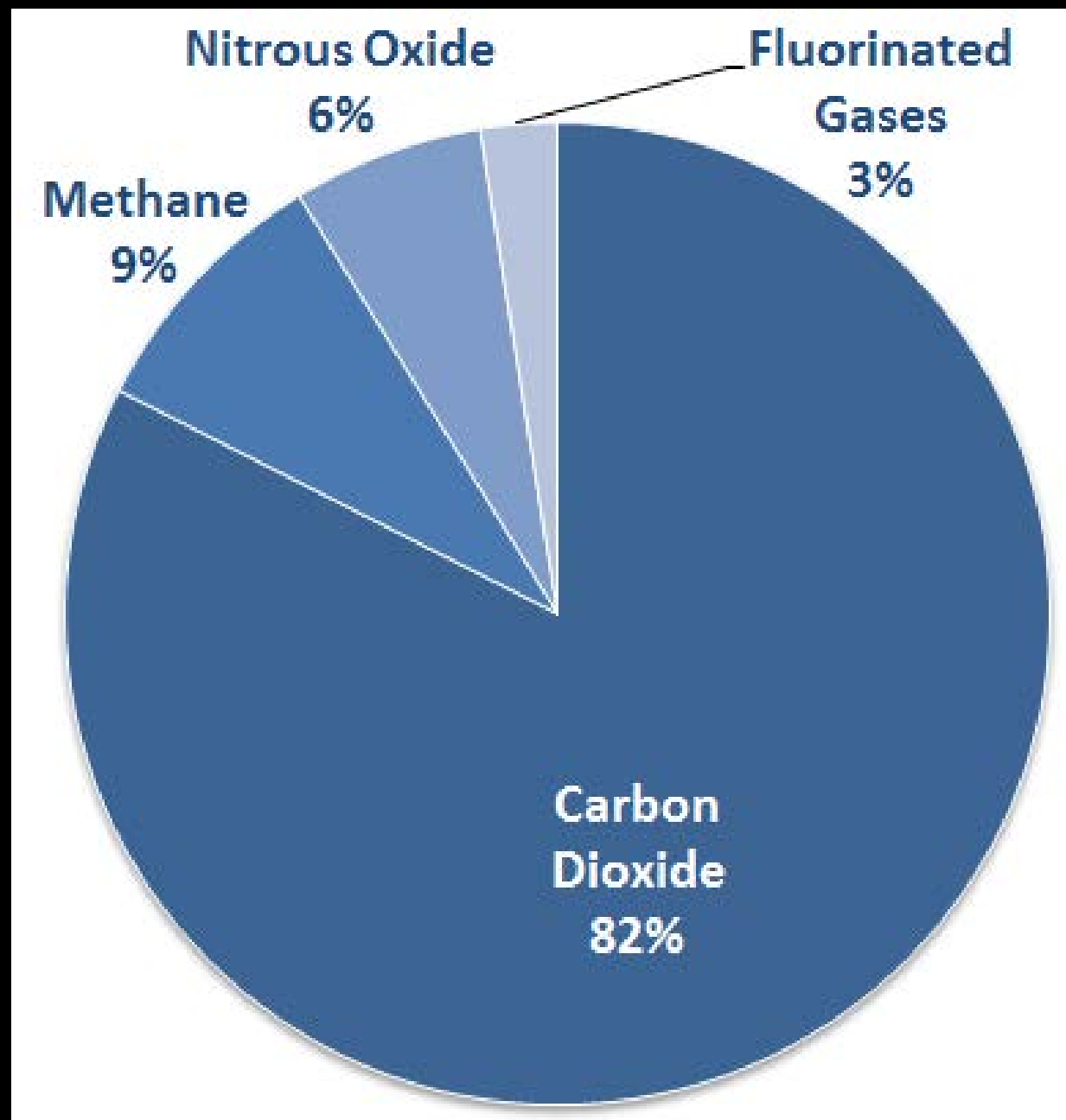


Vs

TOO HOT



GHG's



Greenhouse Effect and Greenhouse Gas: CO₂

Svante Arrhenius
1859 – 1927



Predicted that industrial coal burning would cause troposphere to heat up

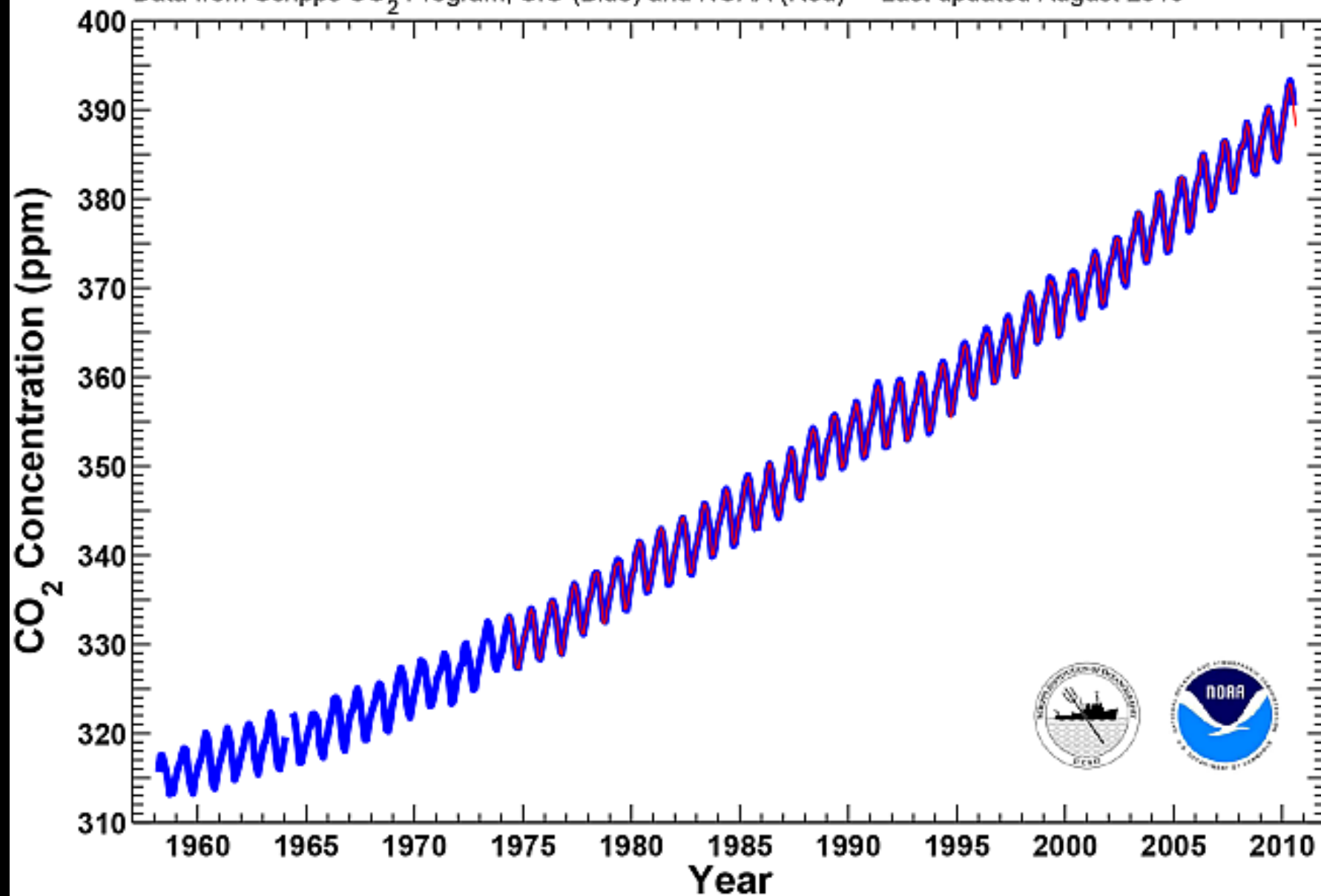
Charles Keeling
1928 – 2005



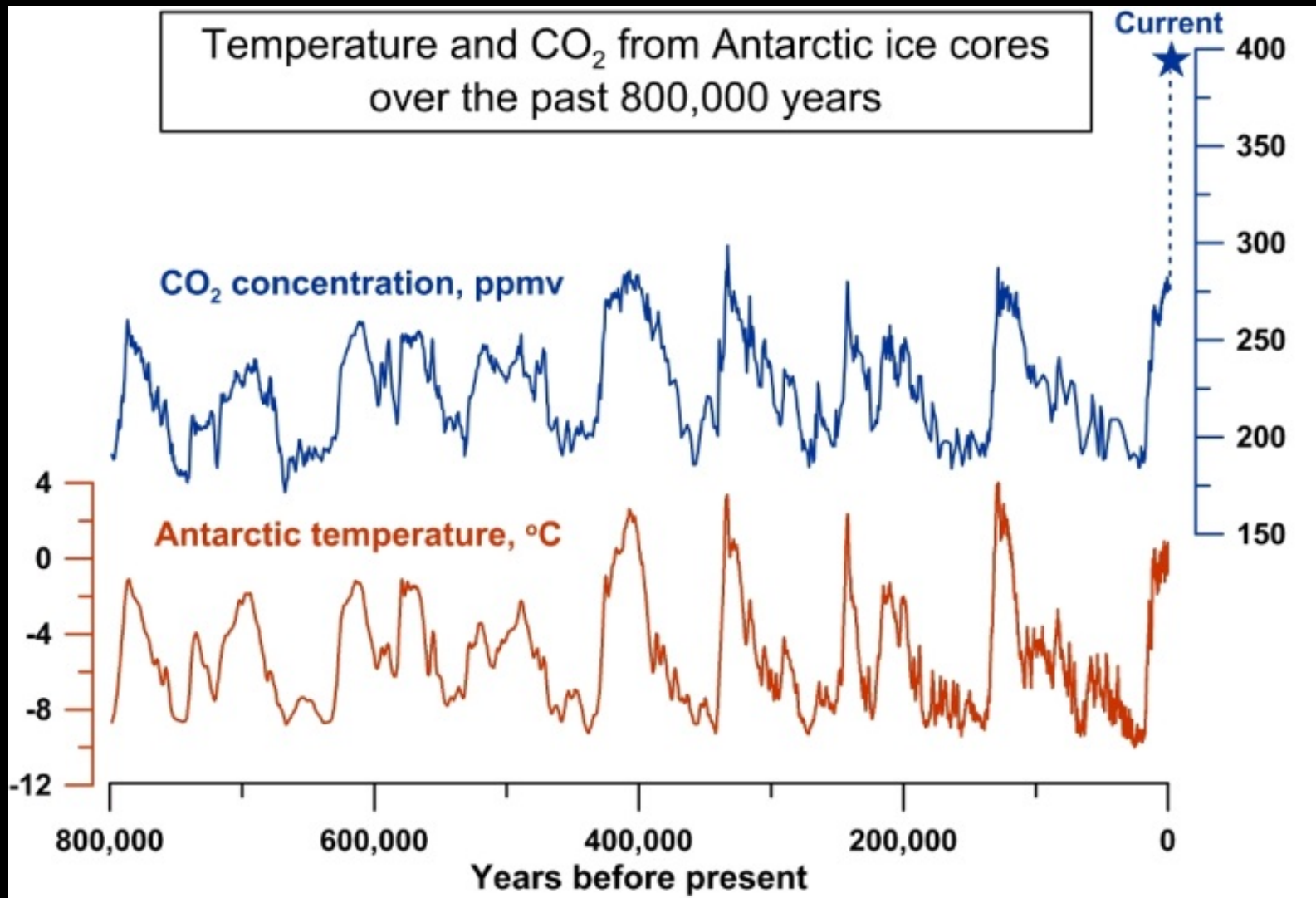
Measured CO₂ concentrations in atmosphere at several Geographic locations, including Mauna Loa

Mauna Loa Observatory, Hawaii Monthly Average Carbon Dioxide Concentration

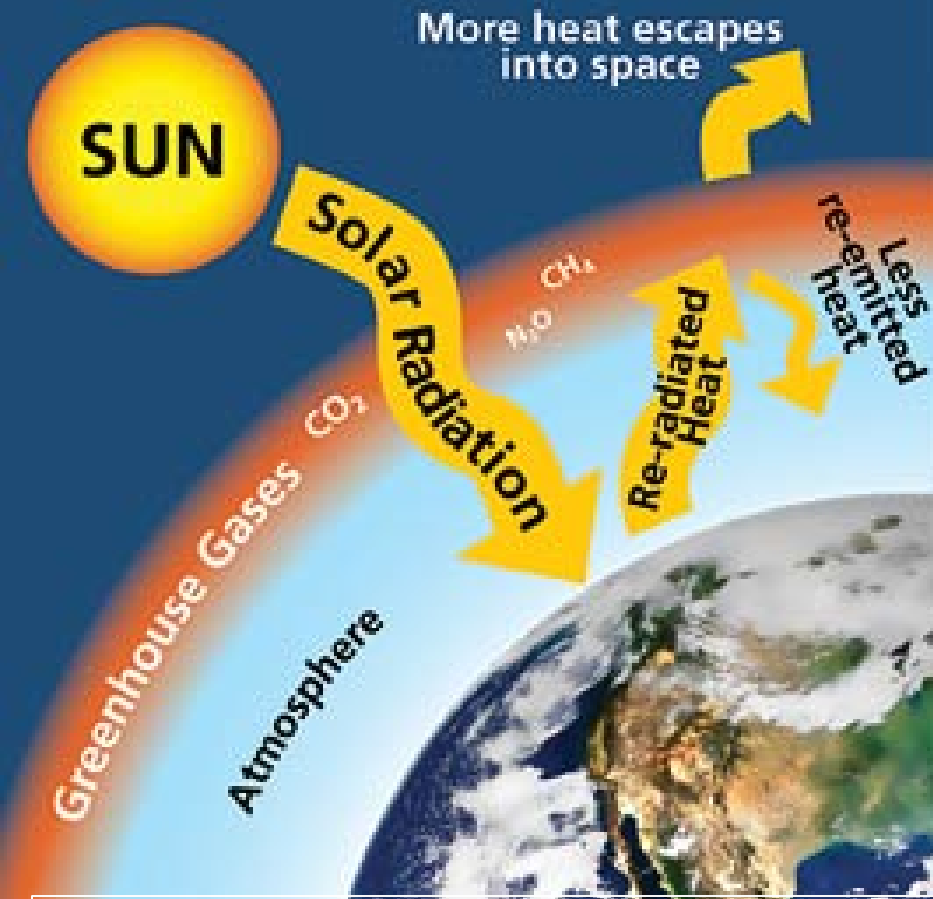
Data from Scripps CO₂ Program, SIO (Blue) and NOAA (Red) Last updated August 2010



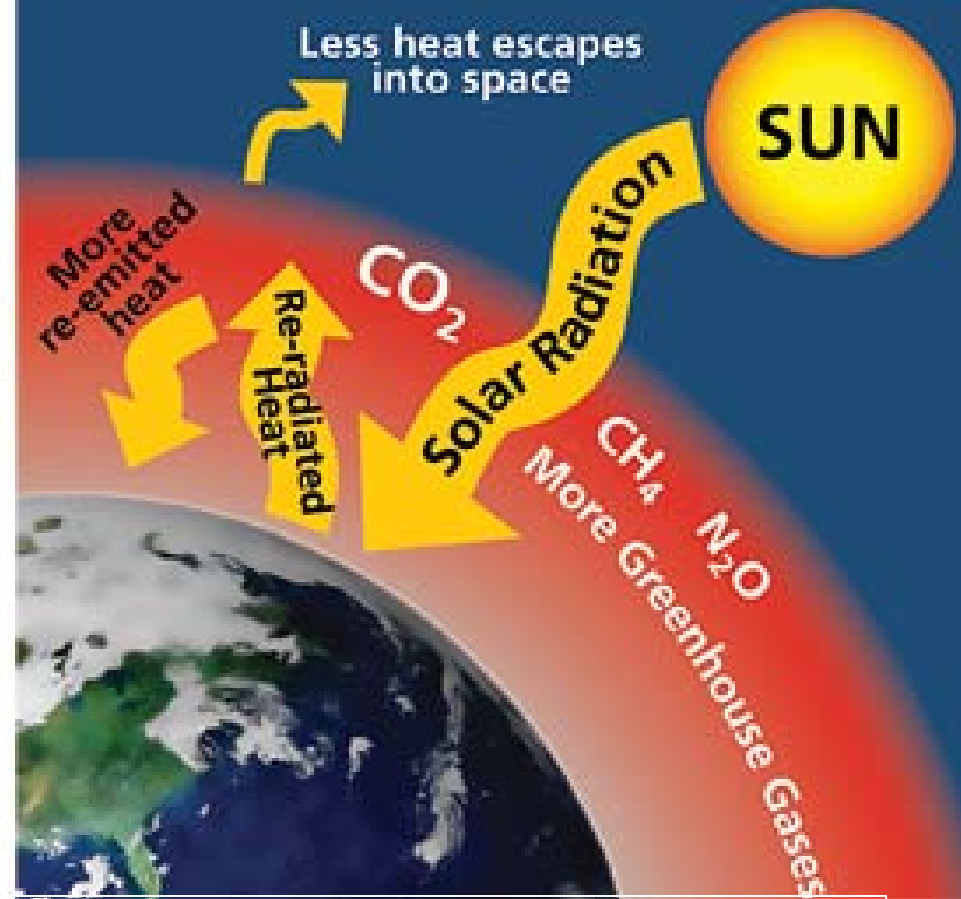
CO₂ Concentration in Atmosphere and Temperature Correlate!



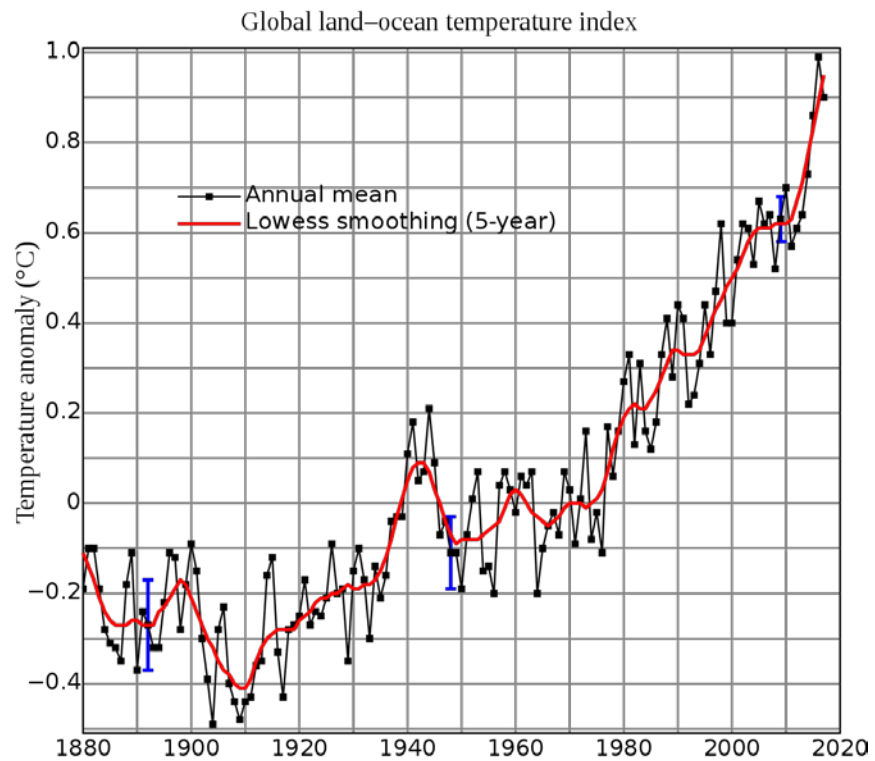
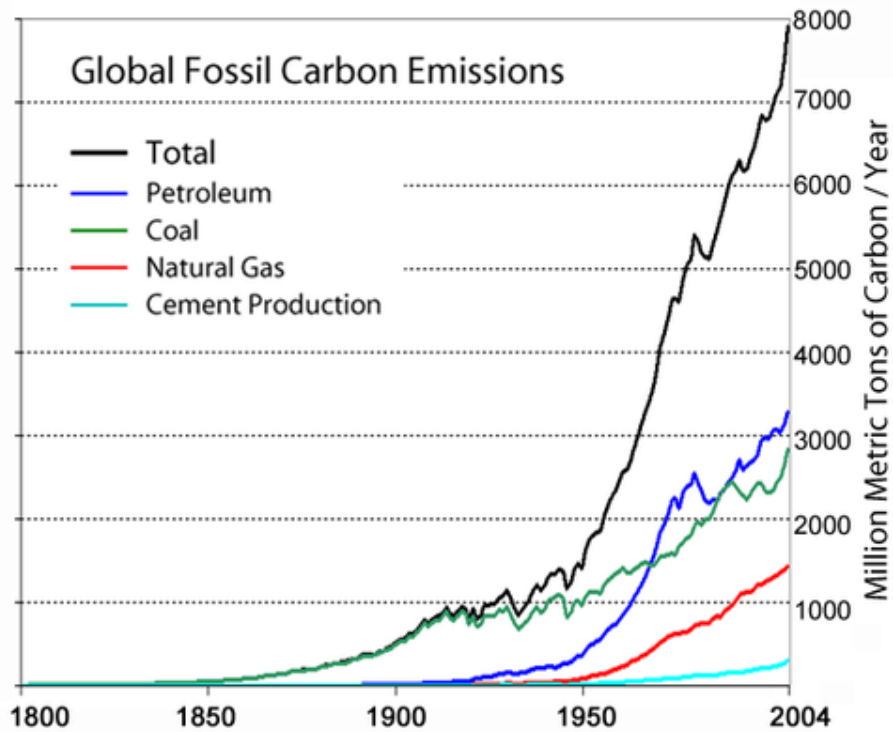
Natural Greenhouse Effect



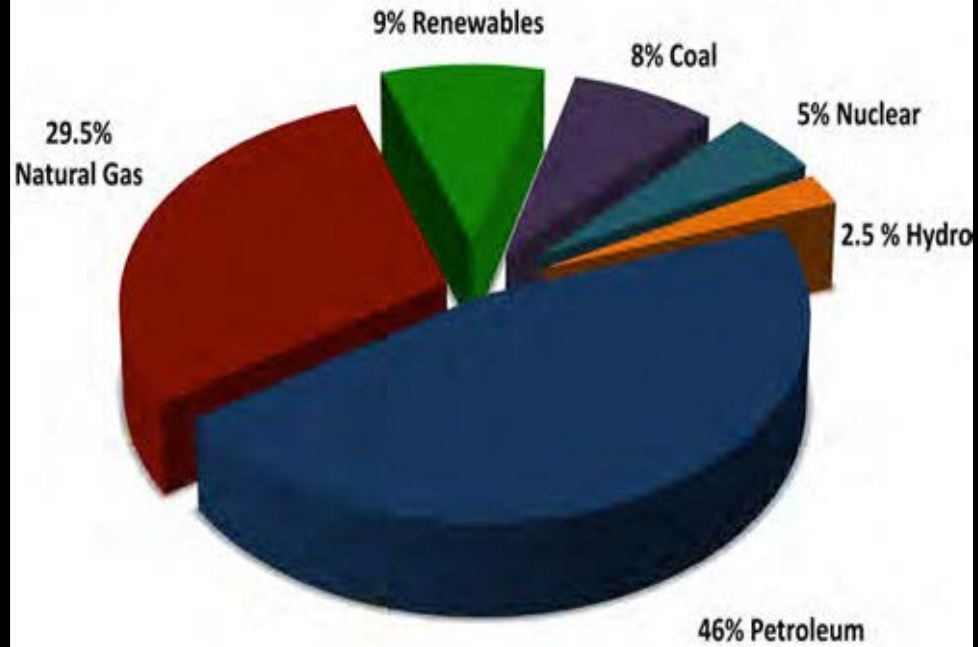
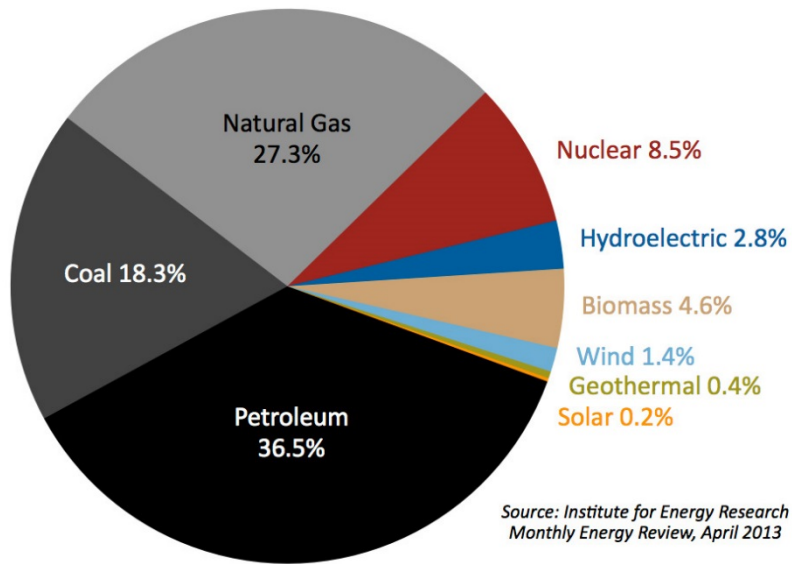
Human Enhanced Greenhouse Effect



A hotter atmosphere → A hotter ocean
→ Large scale changes in atmospheric and ocean currents
→ Climate Change

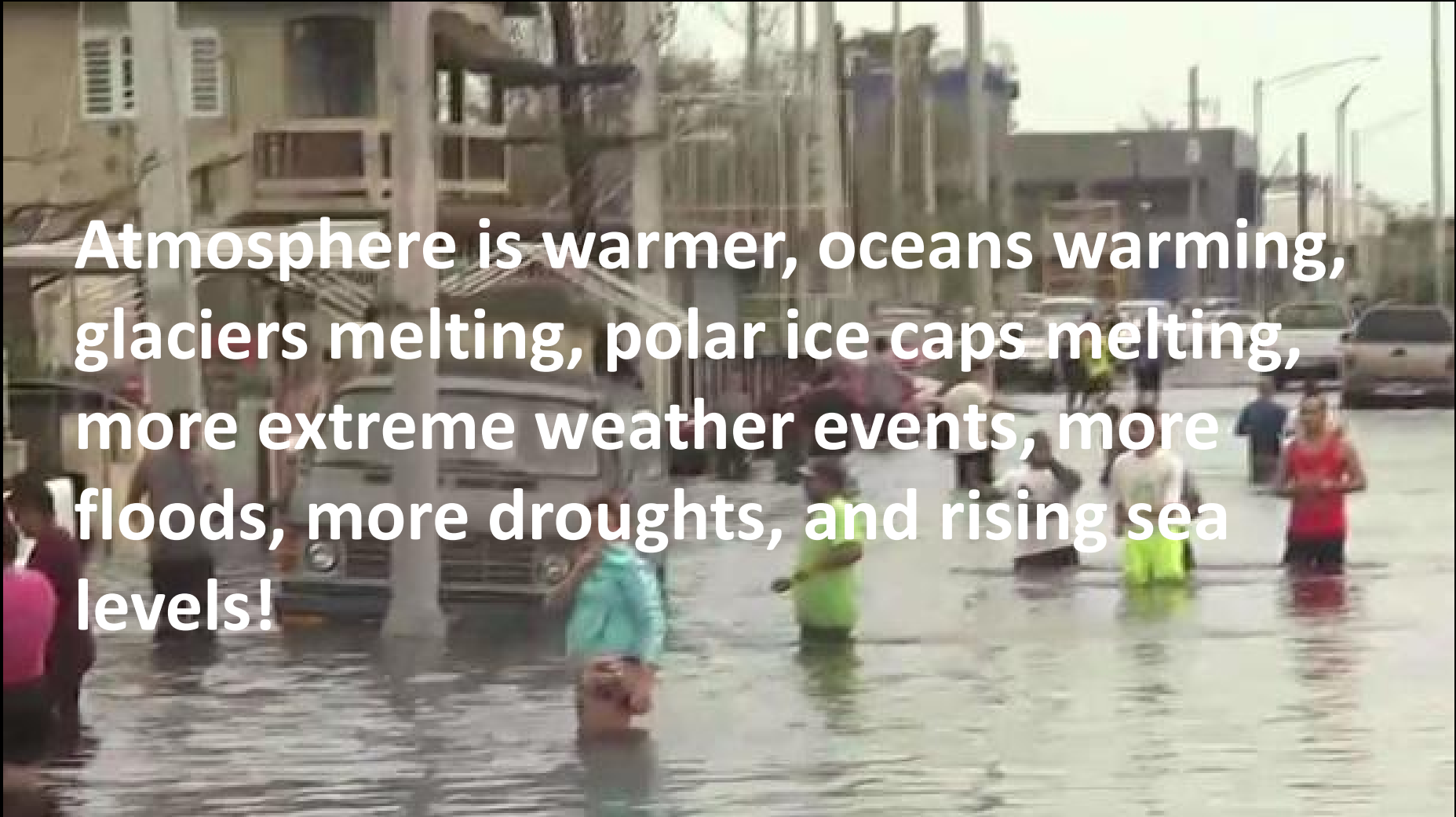


U.S. Energy Consumption 2013



As a Result

Atmosphere is warmer, oceans warming, glaciers melting, polar ice caps melting, more extreme weather events, more floods, more droughts, and rising sea levels!



Chacaltaya glacier,
Bolivia



Grinnell glacier,
USA

1922

Morton Elrod photo
K. Ross Toole Archives
University of Montana



2008

Lisa McKeon photo
USGS



View from north moraine of Grinnell Glacier

Greenland Ice Sheet

1992

2002

For an interactive graphic article, see,
<https://www.nytimes.com/interactive/2015/10/27/world/greenland-is-melting-away.html>

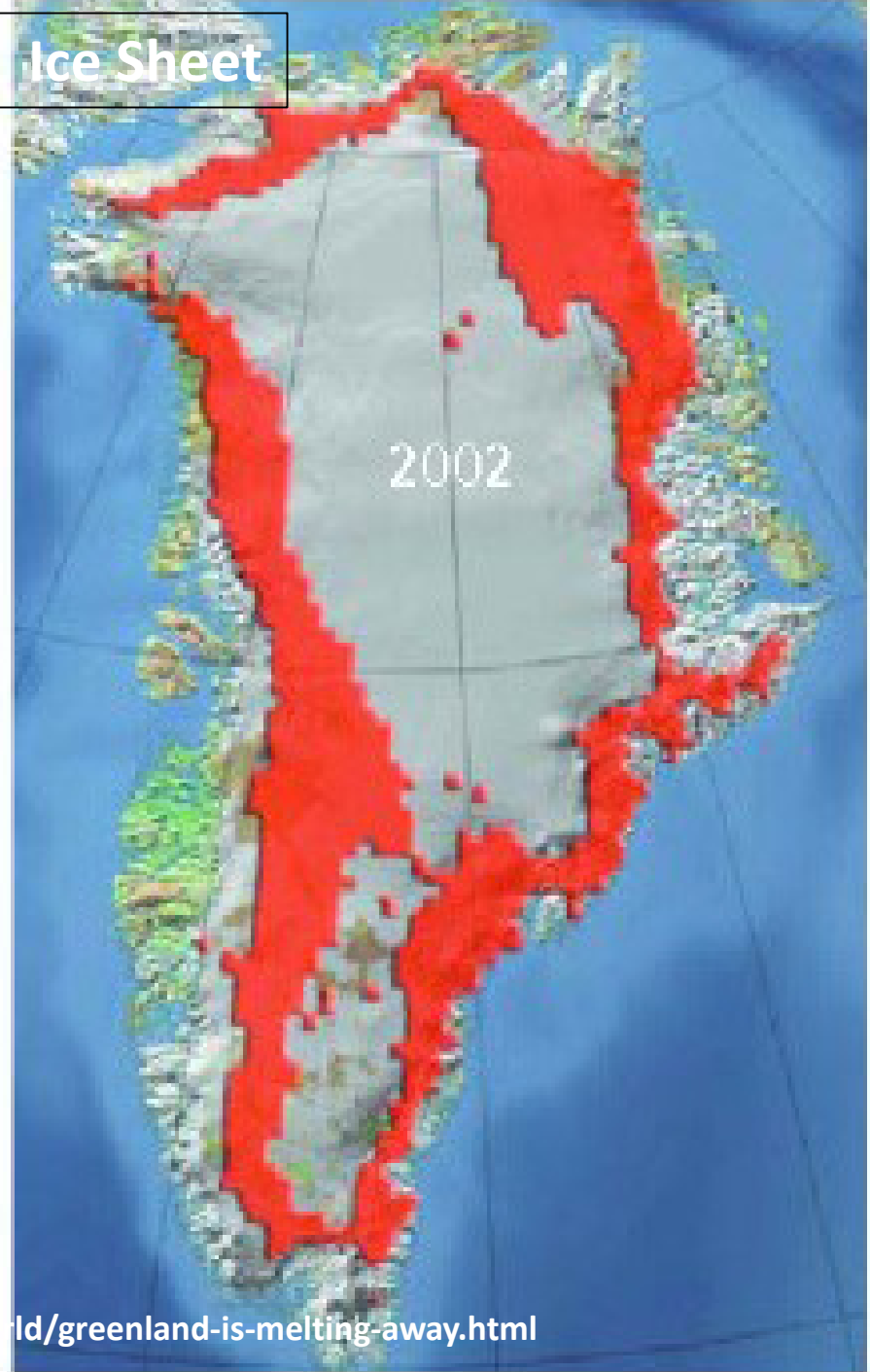
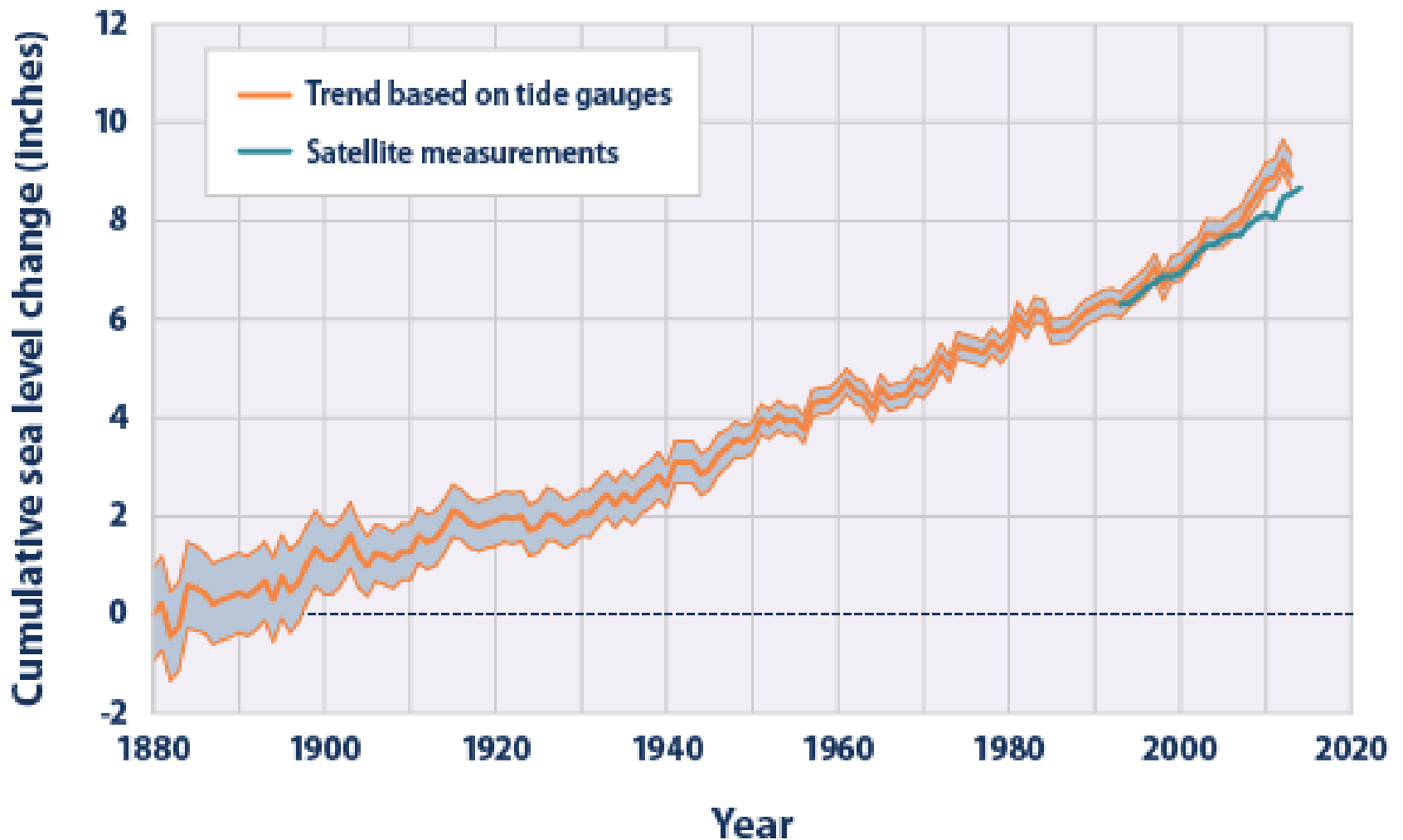


Figure 1. Global Average Absolute Sea Level Change, 1880–2014



Kivalina, Alaska



Impacts of Sea Level Rise on the California Coast



Areas and infrastructure vulnerable to flooding and erosion

Please see [full report](#) for assumptions, methods, and conclusions.



Hazard Zones

- [Area at risk from a 100-year coastal flood event](#)
 - Current area at risk
 - Area at risk with a 1.4 meter sea-level rise
- [Erosion](#)
 - Area at risk from erosion in 2100 with a 1.4 meter sea-level rise
- [Wetland Frontier](#)
 - Areas where wetlands may migrate by 2100 if unimpeded

Data Layer Opacity

-

Infrastructure at Risk

Click map icon for details

- [CA Coastal Zone](#)
- Health-care facilities
- Schools
- Police stations
- Fire stations
- Wastewater treatment plants
- EPA-regulated sites

Consequences of Climate change?



Coral Bleaching

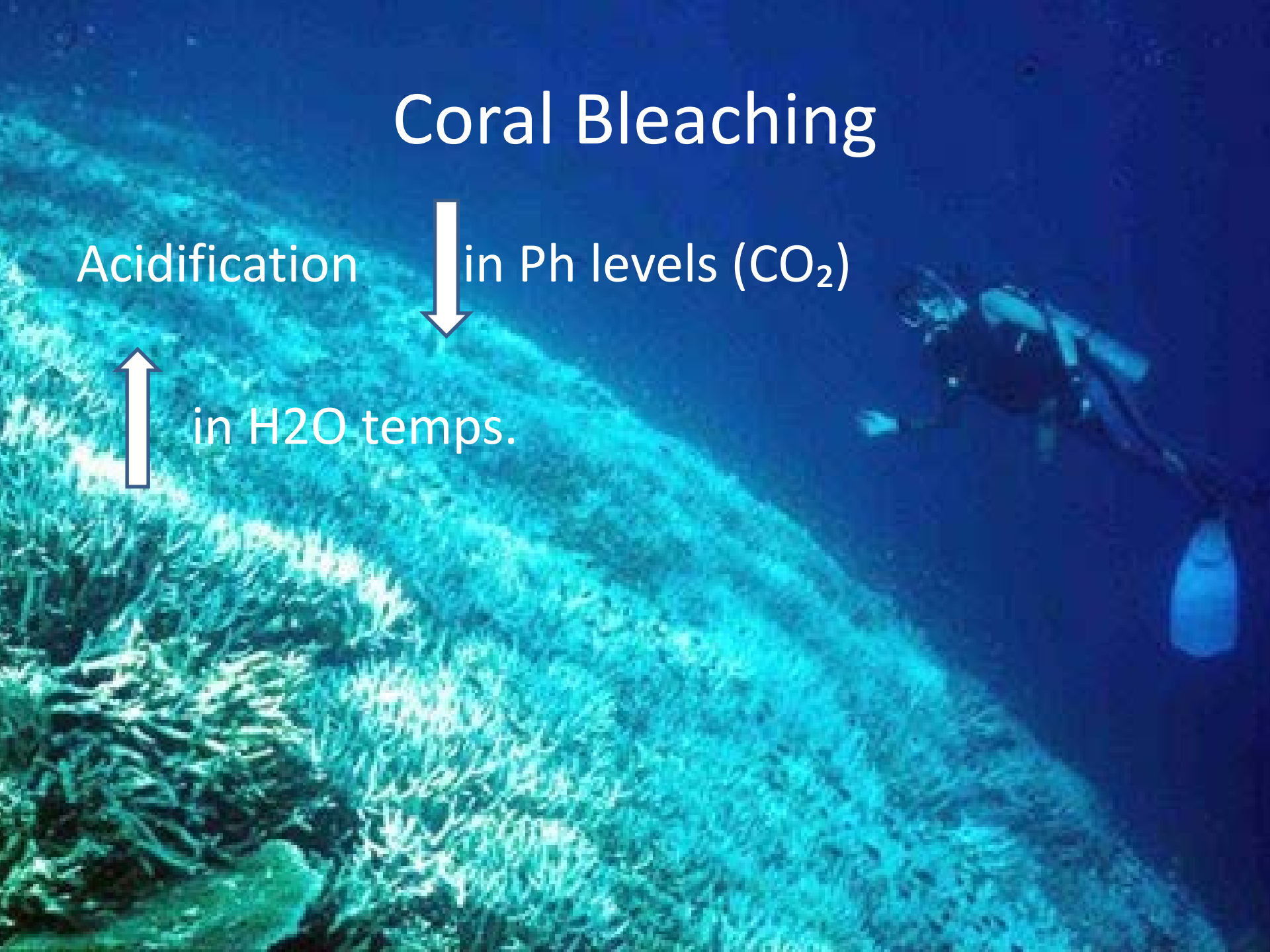
Acidification



in Ph levels (CO_2)



in H₂O temps.





How will
species adapt?

Shift their
ranges?



Arctic and Red Fox

DESPERATE

Struggling to adapt to global warming, wildlife species are changing their diets, behaviors and, in a few cases, even their genetic makeup

By Jessica Sevour Swartz

As a security officer on Alaska's Prudhoe Bay oil field, Bill Petersen is charged with dutifully recording unusual occurrences. So his video camera was within easy reach on a dim November evening when he spotted a red fox chasing an Arctic fox out from under a building erected on stilts.

Small and snowy white, the native Arctic foxes have always been a familiar sight around the oil field operations, especially in winter, when a natural drop in prey sends them dumpster diving. In recent years, Petersen and his coworkers have also been seeing larger and lankier red foxes—more common to forests south of the Alaskan tundra. Sometimes they would glimpse one of the reds chasing Arctic foxes from the ramp-garbage.

But this was different. As Petersen watched, the red fox continued its chase—beneath several trucks and out over a parking lot. As the two teams began to rumble and fight, Petersen started filming. The Arctic fox leapt and knelt as it tried to match an opponent nearly twice its size. It took 10 seconds for the red fox to find its mark.

MEASURES



AN ARCTIC FOX (left) and red fox feed on food scraps in Canadian tundra. As red foxes expand their range northward, they have begun to prey on the smaller foxes, which also are losing hunting grounds as a result of global warming.

Warm temperature pests thrive as winter gets shorter



The mountain pine beetle has thrived in interior B.C. thanks to warmer winters, recent droughts and an excess of mature lodgepole pines.

PINE BEETLE INFESTATION [VIEW](#)

As the outbreak spreads, the beetle is eating itself out of its traditional habitats and into new ones.



- 2001
- 2004
- 2006

PINE TREE REDUCTION [VIEW](#)

As the beetle sweeps across the province it leaves a trail of dead and dying trees in its wake, creating a rush to process the trees before they lose their economic value.



- 2004
- 2007

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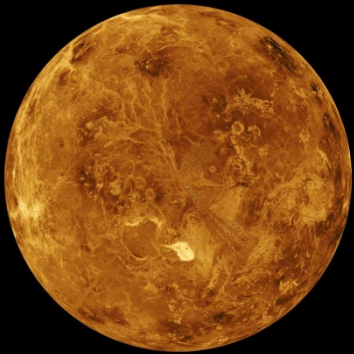
Extinctions

Golden Toad in Costa Rica



Venus

Too much GHG does
not support life



96% CO₂ T_{av} = 823F

Earth

Moderate GHG
Supports life



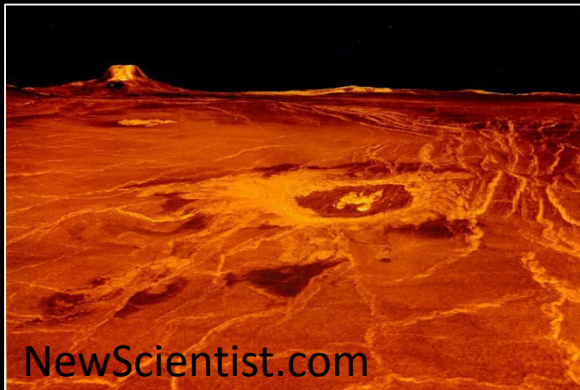
0.03% CO₂ T_{av} = 60F

Mars

Too little GHG does
not support life



0% CO₂ T_{av} = -81F



Can humans adjust to climate change?

- Yes, humans have better technology and can move around more than other species
- But, politically is it feasible?
- How are people in many countries reacting to migrants? In the US?
- Many political unrests could be either started or exacerbated due to climate change.
- What do you think your country should do about climate refugees?

Finding Solutions

What can be done to halt and reduce the impact?

- **Climate Policy (UN Framework Convention on Climate Change)**
- **Better land use practices**
- **More than emissions reduction! We need near 0 emissions!**
- **Therefore we need COMPLETE transition to renewable sources in ALL countries!**

Team Activity Class 17: Greenhouse Effect, Global Warming and Consequences

1. List the GHGs found in the Earth's atmosphere
2. Work with your team to draw your own diagram of the Greenhouse Effect.
3. Explain the difference between the natural and human-enhanced Greenhouse Effect (1/2 page)
4. List the consequences of Global Warming