

CLIMATE CHANGE & ECOLOGICAL RELATIONSHIPS UNIT



Climate Change: Evidence & Choices

- What questions do you have about the climate change report?
- What are the basic messages from the report?
 - Greenhouse gases modulate earth's temperature
 - Human activities have greatly increased greenhouse gases
 - Multiple sources of evidence suggest that Earth is warming
 - There are complex climate processes that we/science do not fully understand
 - Scientific models suggest that human activity (at its current rate) will lead to more severe climatic changes

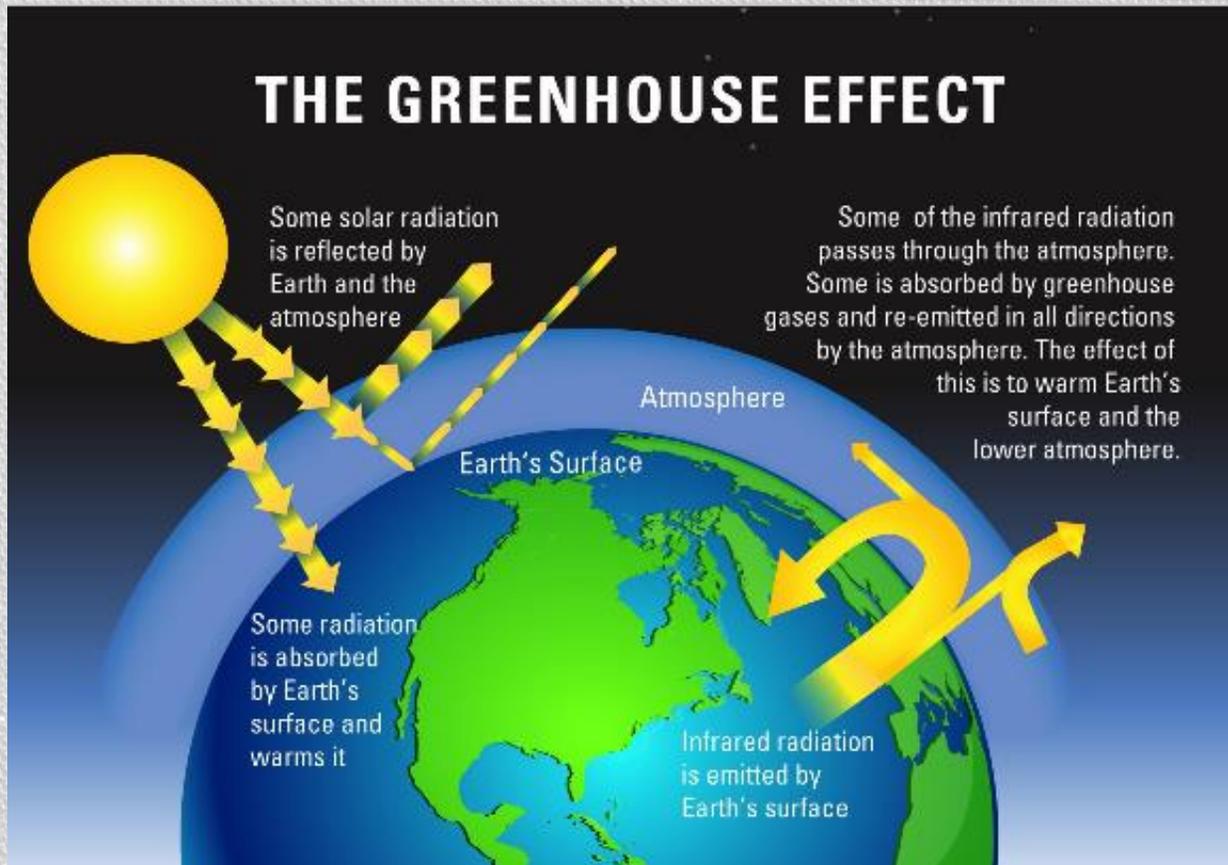
Know your sources...

- Who is (or what organization or company) presenting the information?
- What is the purpose of the publication?
- What expertise and/or relevant experience does the author (or organization or company) have?
- What biases does the author (or organization or company) have and how might those biases affect the presentation of information?
- Does the information presented seem to be accurately reported? Are the claims made in the presentation supported? Do any facts or analyses seem to be distorted?
- Does the presentation leave important information out? Does the presentation offer information that is unnecessary (particularly if the extra information distorts the message)?

Where/who does the climate change report come from?

- Authors/publishers: 1) National Academies of Science and 2) The Royal Society
- Greenhouse effect model: US EPA
- Data/graphs:
 - Scripps CO2 program
 - Research Journals: *Geophysical Research Letters*
 - Intergovernmental Panel on Climate Change (IPCC)
 - US National Oceanic & Atmospheric Association (NOAA)
- Group Task: Visit a website associated with 1 of the above sources and explore who they are and their credibility. Be prepared to report your findings to your peers.
- For links to the source websites, go to:
<http://restem4.wix.com/learning-resources>

Back to the report... What does it mean?



Greenhouse Gases

- Carbon dioxide - CO₂
- Methane – CH₄
- Nitrous oxide – N₂O
- Halocarbons

Where do these gases come from?

What role do humans play in this?

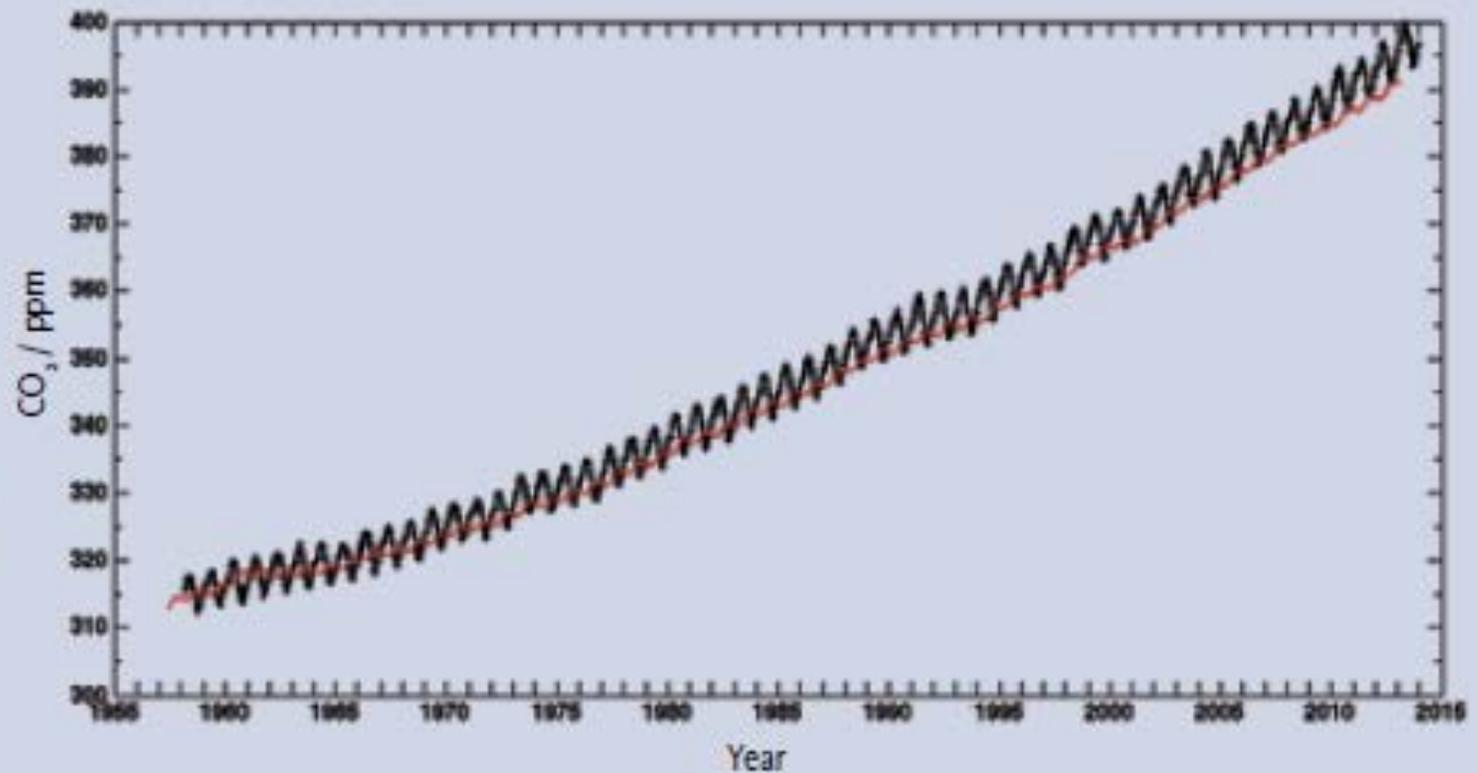
Analyzing the data

The CC report presents 4 graphs. For each graph conduct the following analyses:

1. What variables are represented in the graphs?
2. What do the axes represent? What units of measure are being used?
3. What is the scale of each axis?
4. Are the graphs based on data that have been collected or predictions from models?
5. What conclusions can be drawn from the graph?

Annual Measurements of Atmospheric CO₂

FIGURE B2. Measurements of atmospheric CO₂ since 1958 from the Mauna Loa Observatory in Hawaii (black) and from the South Pole (red) show a steady annual increase in atmospheric CO₂ concentration. (The measurements are made at remote places like those because they are not greatly influenced by local processes, so therefore are representative of the background atmosphere.) The small up and down saw-tooth pattern reflects seasonal changes in the release and uptake of CO₂ by plants. Source: Scripps CO₂ Program



Atmospheric measurements of CO₂ from 1000-2000

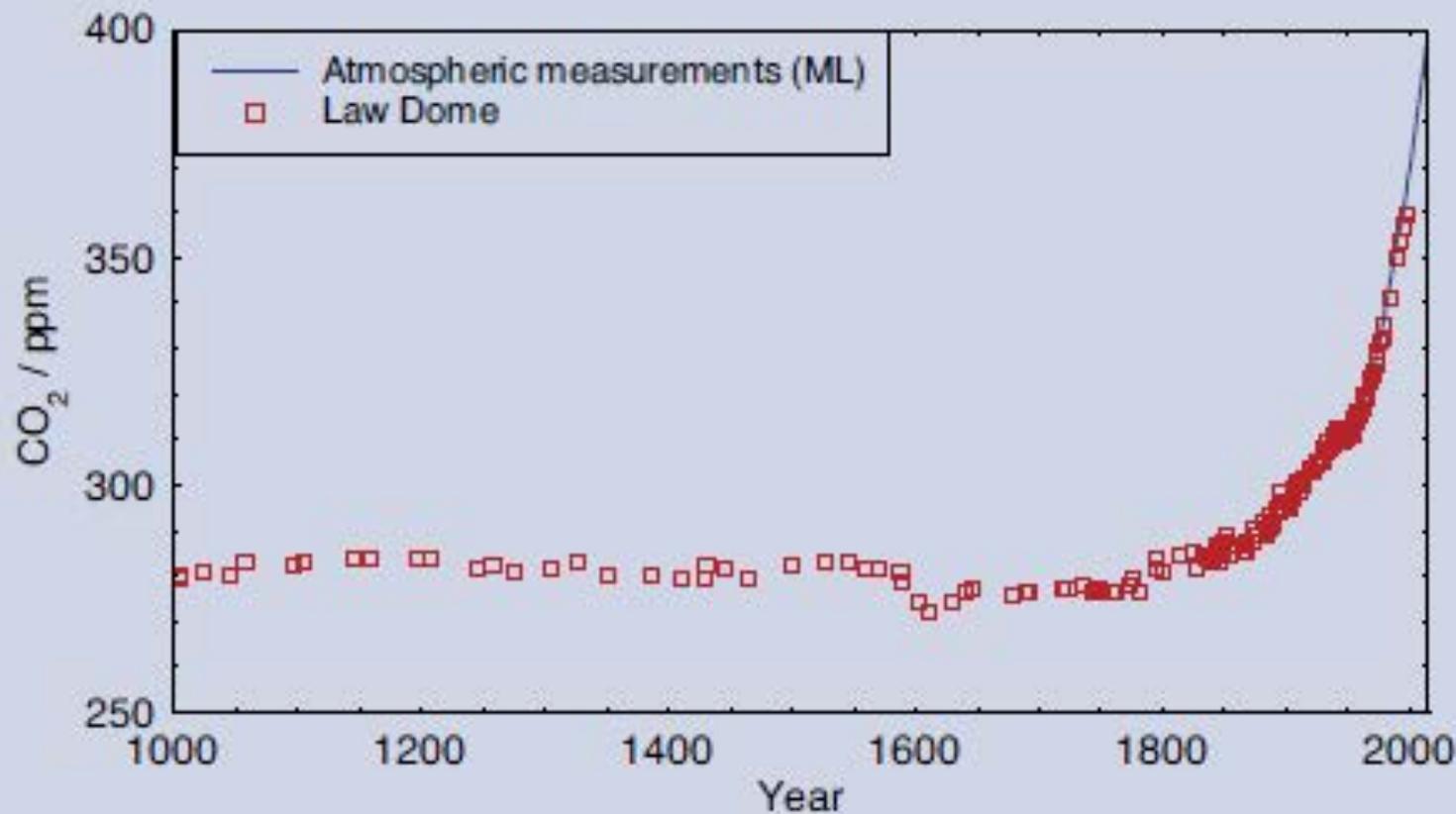


FIGURE B3. CO₂ variations during the past 1,000 years, obtained from analysis of air trapped in an ice core extracted from Antarctica (red squares), show a sharp rise in atmospheric CO₂ starting in the late 19th century. Modern atmospheric measurements from Mauna Loa are superimposed in blue. Source: figure by Eric Wolff, data from Etheridge et al., 1996; MacFarling Meure et al., 2006.



Average Global Surface Temperature from 1850-2012

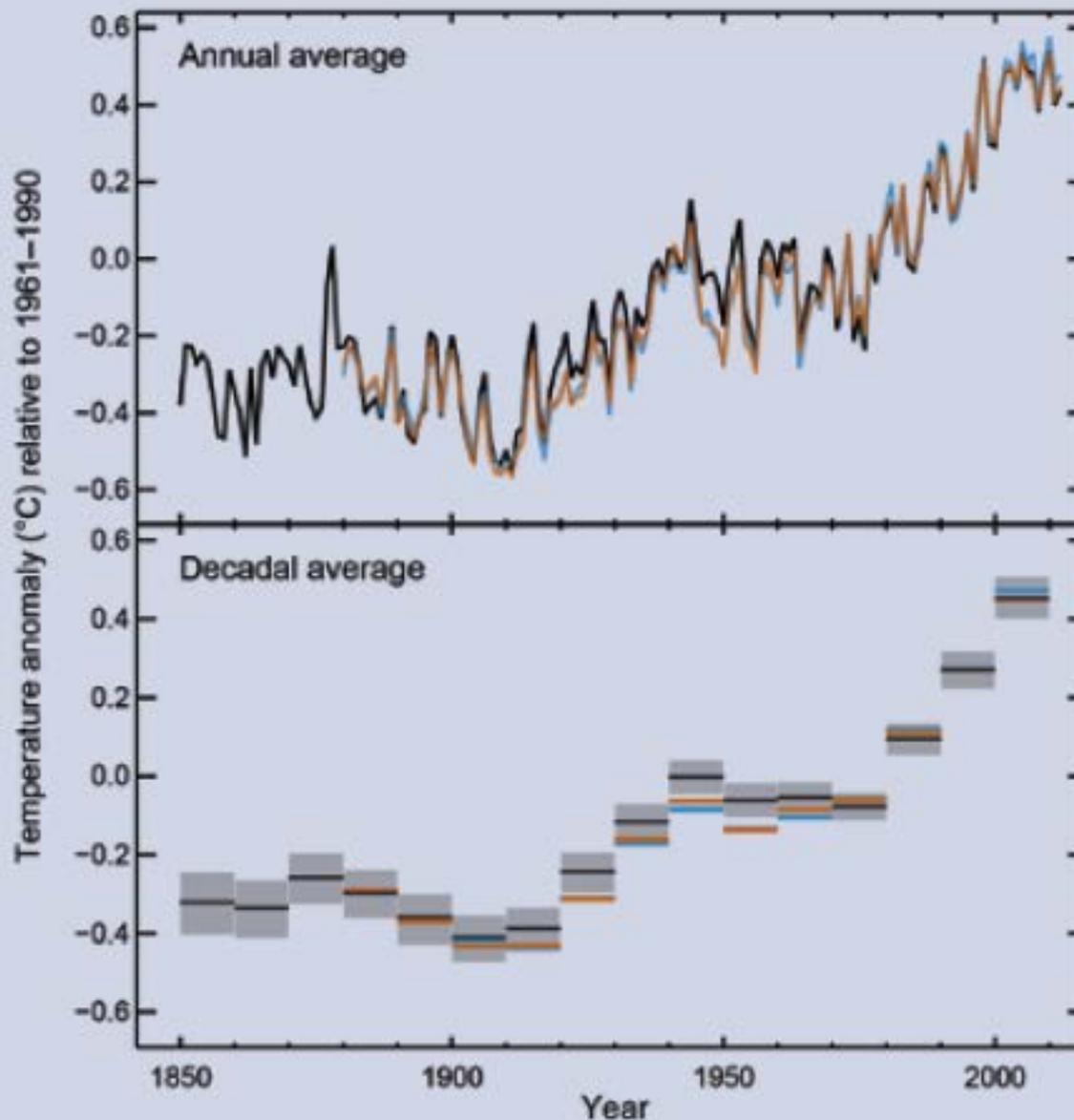
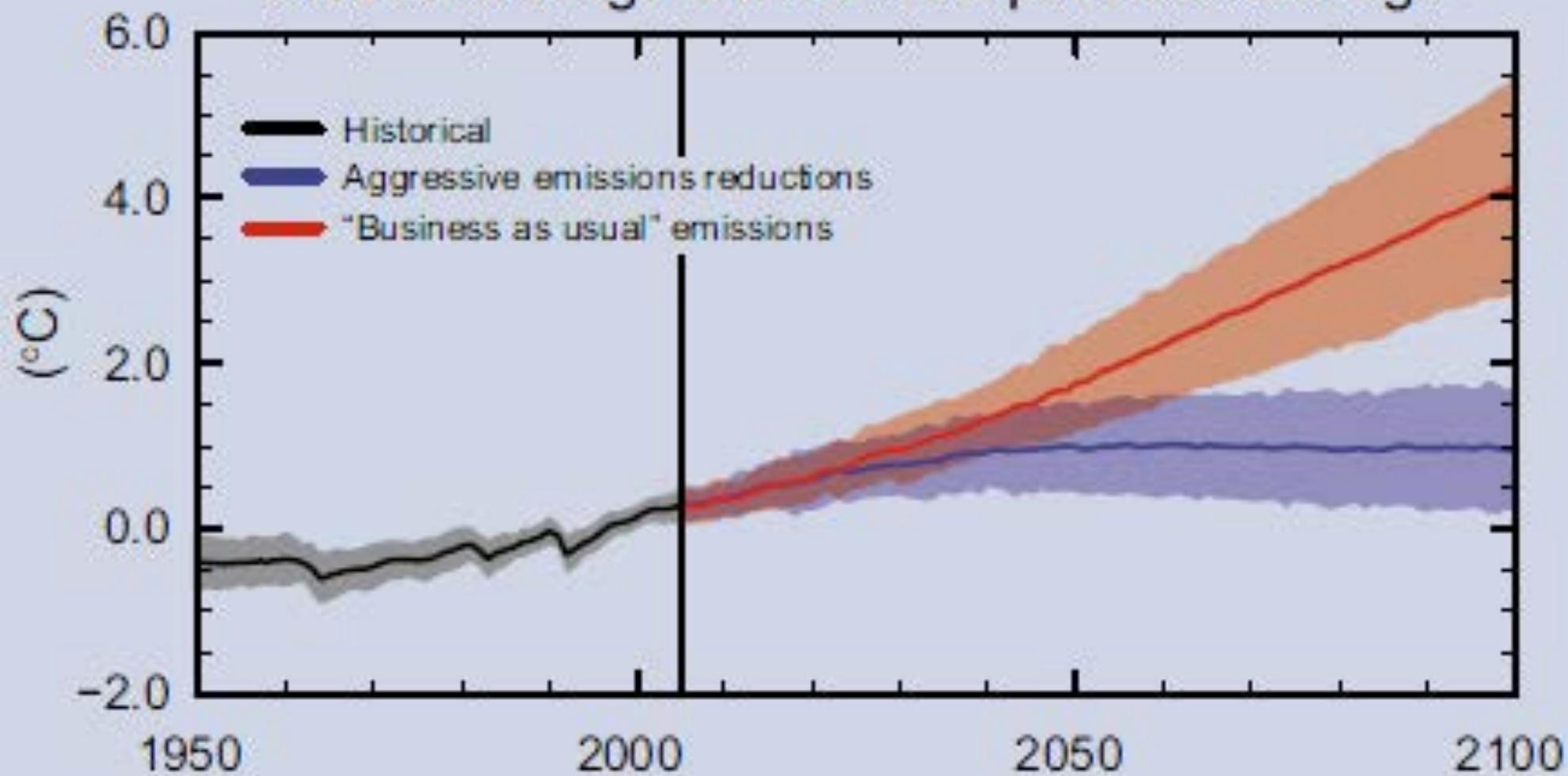


FIGURE B4. Earth's global average surface temperature has risen as shown in this plot of combined land and ocean measurements from 1850 to 2012, derived from three independent analyses of the available data sets. The top panel shows annual average values from the three analyses, and the bottom panel shows decadal average values, including the uncertainty range (grey bars) for the black (HadCRUT4) dataset. The temperature changes are relative to the global average surface temperature, averaged from 1961–1990. Source: IPCCAR₅ data from the HadCRUT₄ dataset (black), UK Met Office Hadley Centre, the NCDC MLOST dataset (orange), US National Oceanic and Atmospheric Administration, and the NASA GISS dataset (blue), US National Aeronautics and Space Administration.

Global average surface temperature change



The science related to climate change seems to be well-understood.

If this is the case, why is the issue controversial?



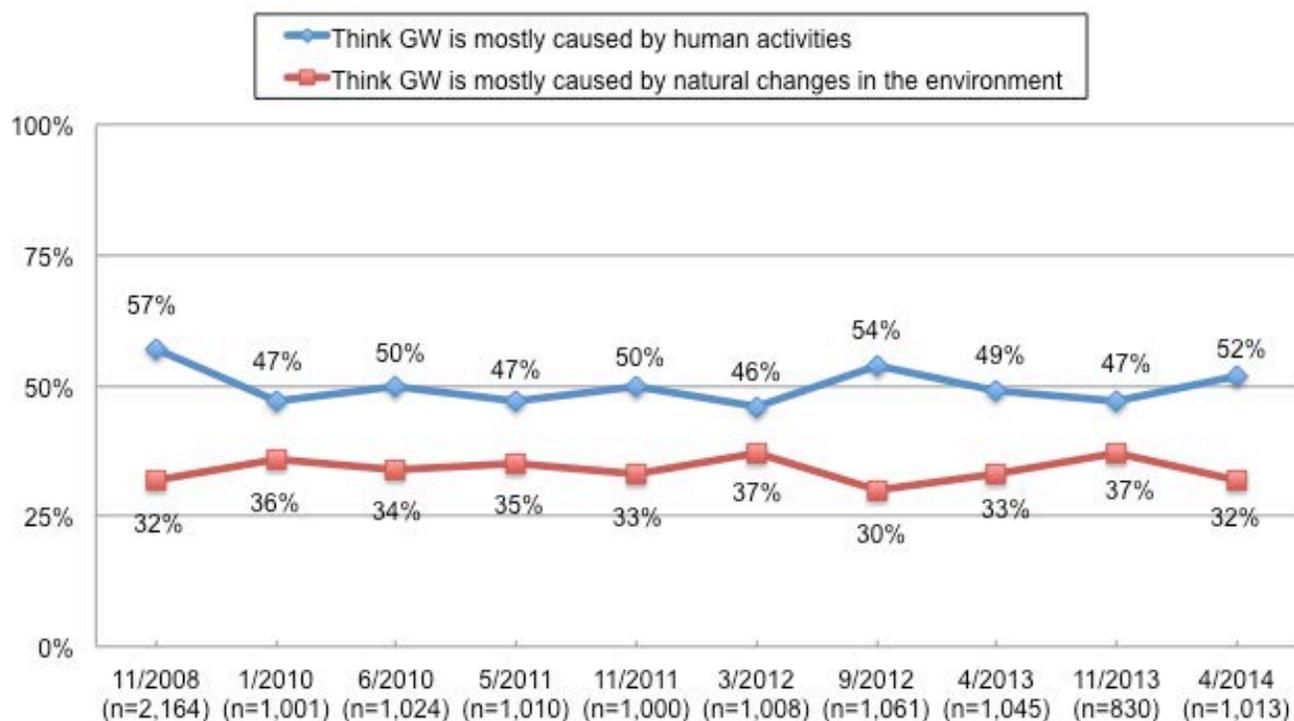
Agreement Continuum...

Position yourself along an agreement continuum to best reflect your own agreement with the following statements.

- Earth's climate is changing.
- Human activity is largely responsible for the rate of change in Earth's climate.
- Humans should make significant changes (like reducing reliance on fossil fuels) in order to limit the degree of climate change.

What do we know about how others think about climate change?

About Half of Americans Think That If Global Warming Is Happening, It Is Mostly Human Caused



Assuming global warming is happening, do you think it is...

Base: Americans 18+. April, 2014.



George Mason University
Center for Climate Change Communication

Source: Study from Yale School of Forestry & Environmental Studies

Interactive Map of Public Opinion on numerous Climate Change Questions

- <http://environment.yale.edu/poe/v2014/>



What do SCIENTISTS think about Climate Change?

- Analysis of 11,944 peer-reviewed scientific studies of climate change (1991-2011): **97.1%** of the studies support the idea that human activity is driving climate change.

Cook, J. et al., (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, 8 (2).

- Survey of scientists who study various dimension of climate and climate change: 90% agree that human release of greenhouse gases is the primary driver of climate change.
Verheggen, B. et al. (2014). Scientists' views about attribution of global warming. *Environmental Science & Technology*, 48, 8963-8971.

Other Voices and Perspectives

- People with various backgrounds and interests have diverse perspectives on the extent to which humans are responsible for the changing climate and the extent to which we should do anything about climate change.

A Range of Perspectives

- Climate change is real, human-induced and will have devastating consequences. We must act NOW.
- Climate change is real, human-induced and will have tough consequences. We should probably do something as soon as possible.
- Climate change is probably related to human activity but we can't be sure.
- Climate change is probably happening, but trying to stop it will have huge economic costs.
- Earth's Climate is always changing—this is just a natural part of Earth's cycles.

Exploring different perspectives

- Access and read/view at least 4 media resources listed on the “Climate Change Learning Resources” webpage (<http://restem4.wix.com/learning-resources>)

Writing Assignment

- Describe three different perspectives on climate change.
- Why do you think people have such varied responses to climate change and/or responses climate change?



ECOLOGY

Ecology

- The study of organisms' relationships with each other and their environment.
- Looks at the complex interactions between biotic and abiotic factors.
 - Biotic—Living
 - Abiotic—Non-living



Image from pixels.com

Levels of Organization

Individual / Organism—

a single organism;
either unicellular or multicellular



Population—a group of
of the same species
same area.

Images from pixel.com

Levels of Organization

Community—populations of organisms living in the same area

Ecosystem—communities of living things together with their non-living environment.



Image from: <http://kerryg.hubpages.com/hub/Attracting-Birds-With-Prairie-Plants>



Image from: pixel.com

Levels of Organization

Biosphere—all the parts on earth that supports life—land, water, & atmosphere. The sum of all the ecosystems.



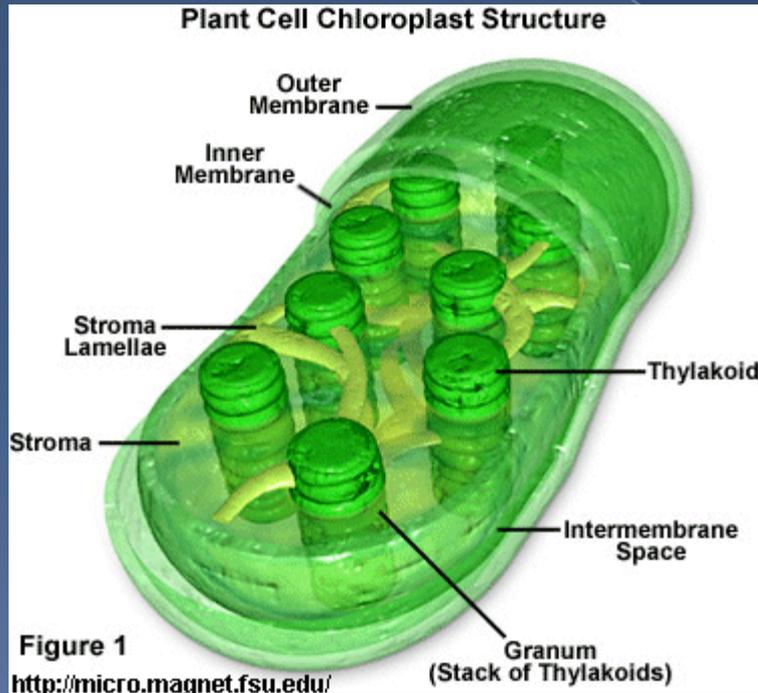
Photosynthesis

- Purpose?
 - > Convert light energy into stored chemical energy (=glucose) that the plant can use
- Who does it?
 - > Autotrophs
- Where does it happen?
 - > Chloroplasts



Photosynthesis

○ Chloroplasts



Formula:



Two Major Parts to Photosynthesis

- Light Dependent Reactions
 - > Occur in Thylakoids
 - > Trap light energy
- Light Independent Reactions
 - > Occur in Stroma
 - > Traps CO_2 to make glucose

Cellular Respiration

- Purpose

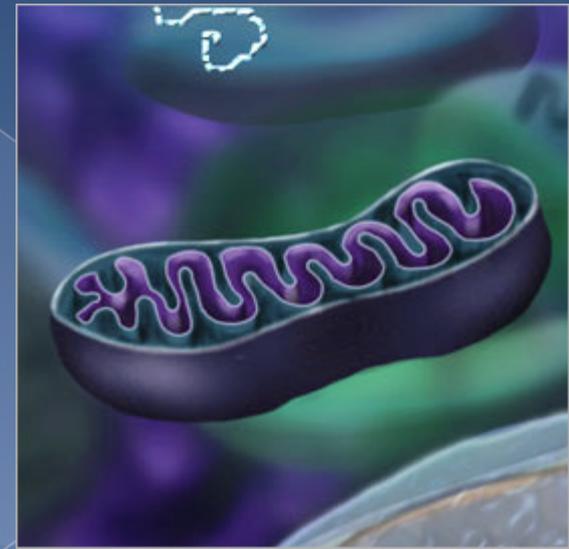
- > Convert stored chemical energy into useable energy (=ATP)

- Who does it?

- > ALL organisms (even plants!)

- Where?

- > Mitochondria



Formula:



Note: Enzymes

- Enzymes involved in both reactions (PS & CR)
 - > Different enzymes = specificity
 - > Increase speed of chem rxns
 - > Lower activation energy (so cell won't fry)

Note: ATP

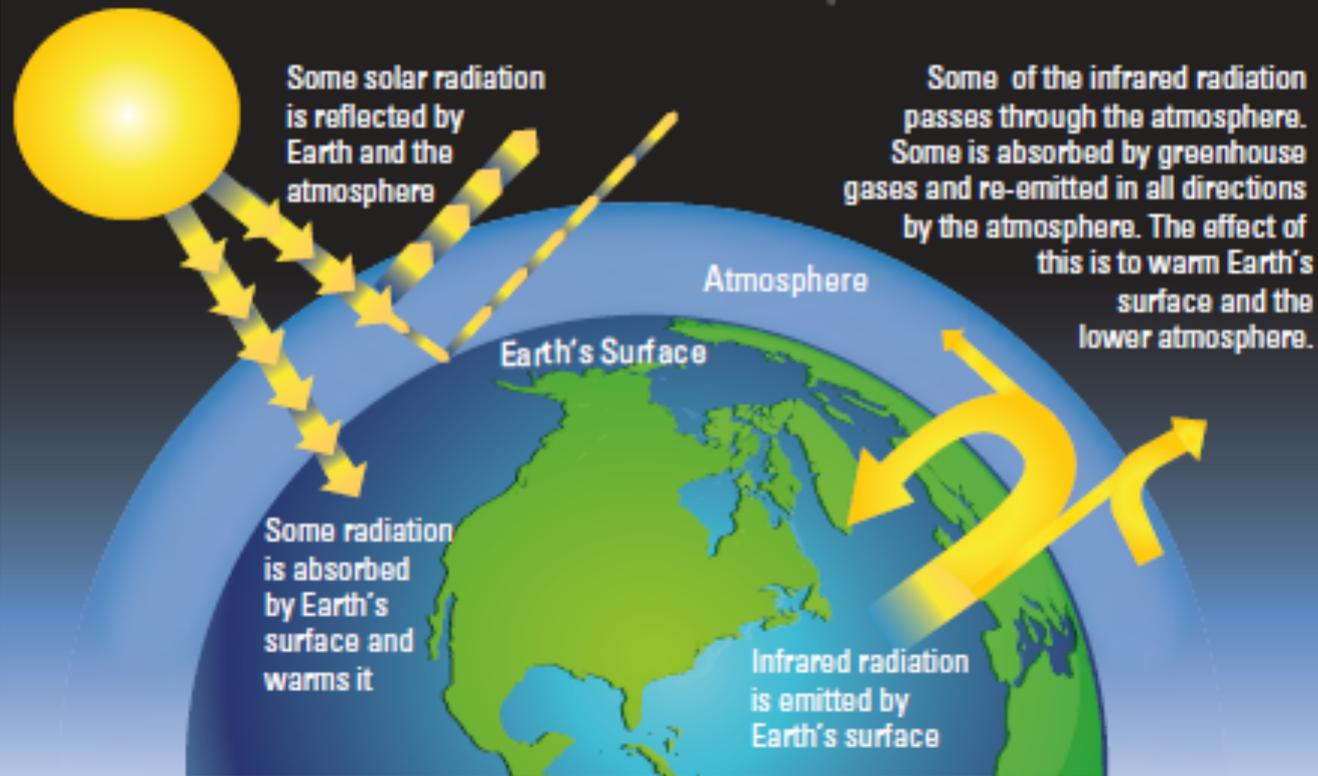
- ⦿ ATP= chemical energy used to do WORK
 - > Usable Energy stored in bonds (A-P~P~P) that is released when bonds are broken
 - > Used for movement & breakdown of molecules
 - > Comes from glucose breakdown!
 - > Energy not recycled, but nutrients and matter are

How does it all fit together?

- Go back to your Elodea / Fishy Models.
- Fix and add to your explanations.

Why Climate Change?

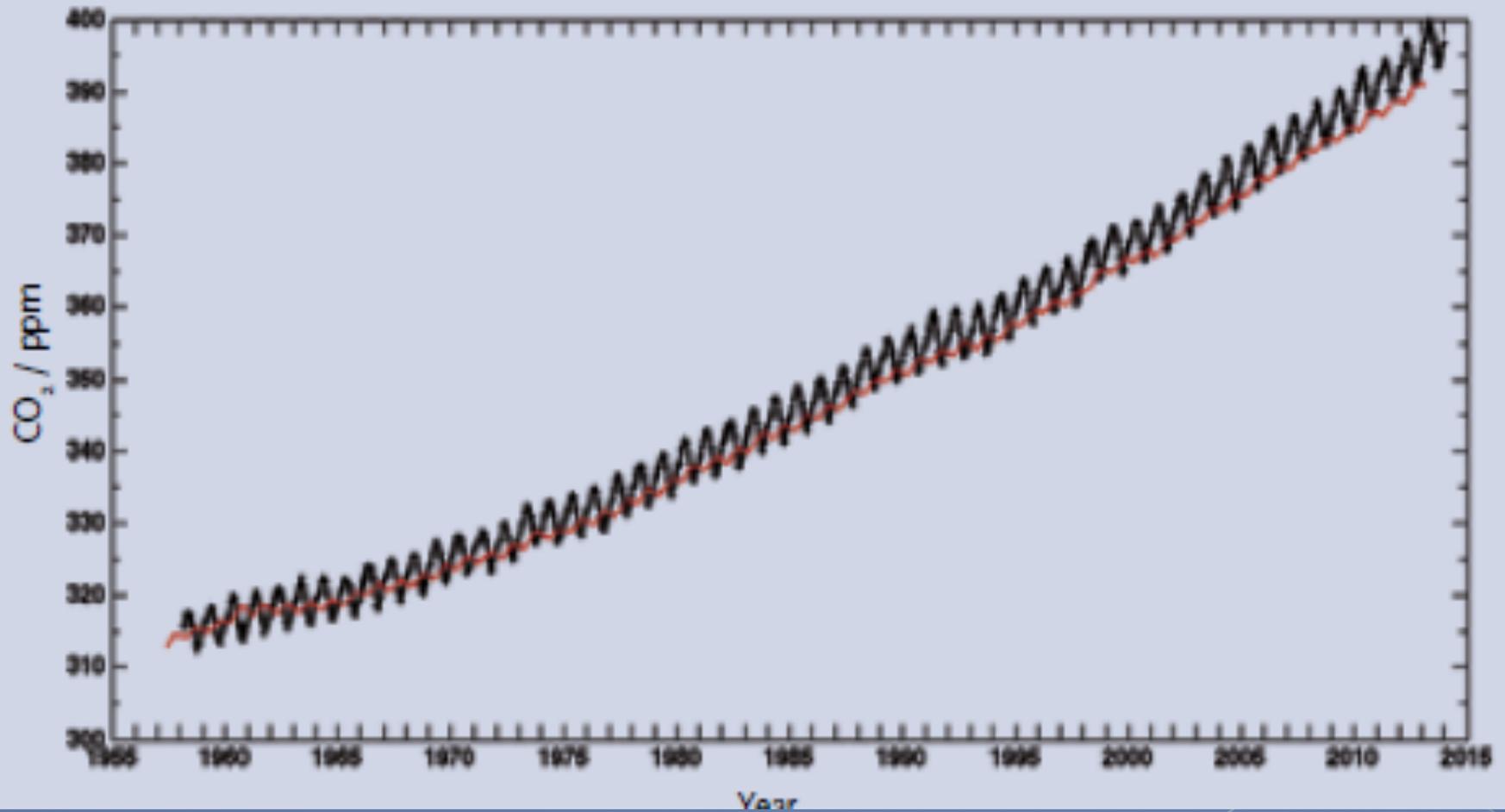
THE GREENHOUSE EFFECT



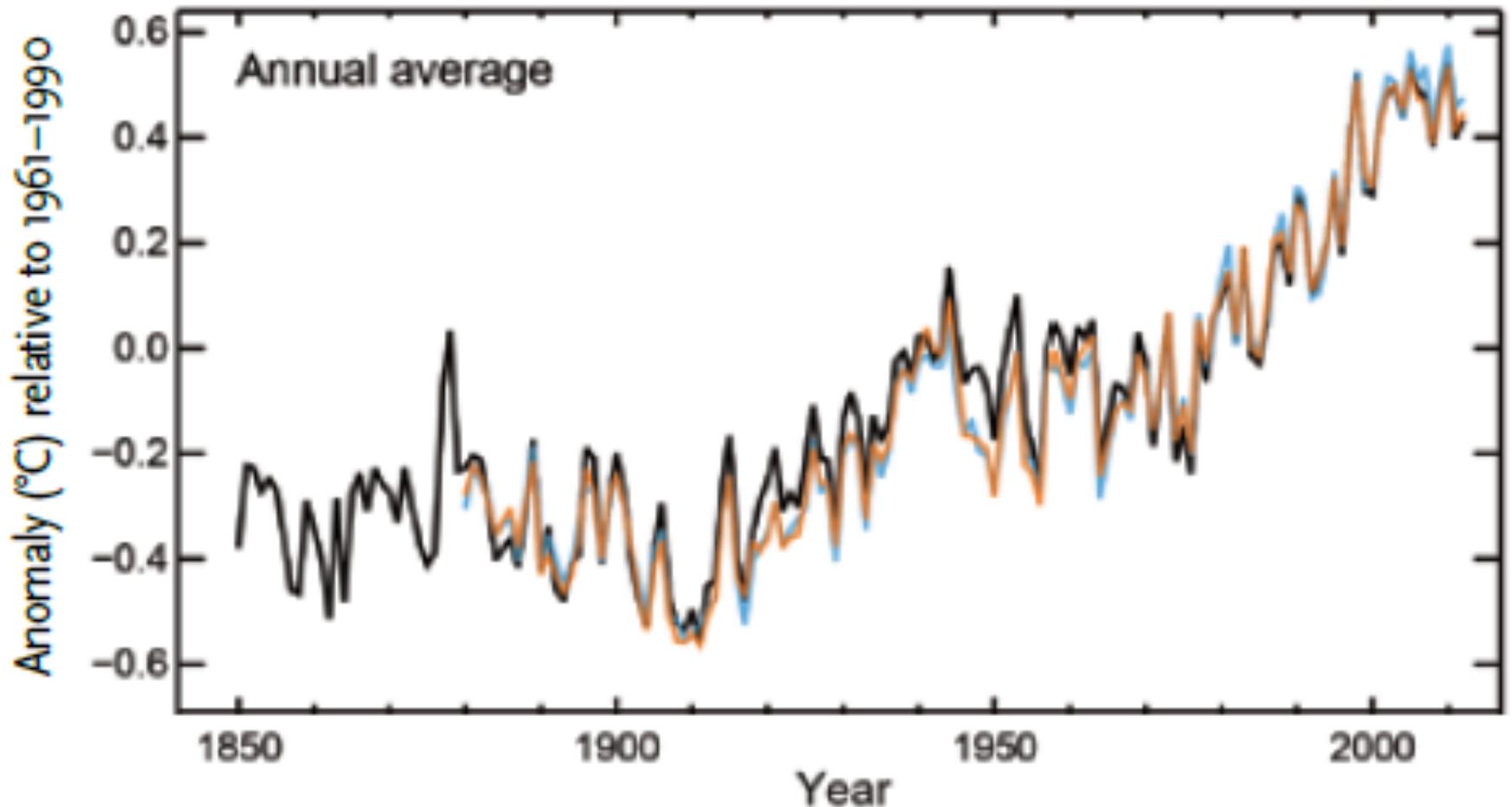
Connecting the Pieces

How does your Carbon Cycle Model relate to these graphs?

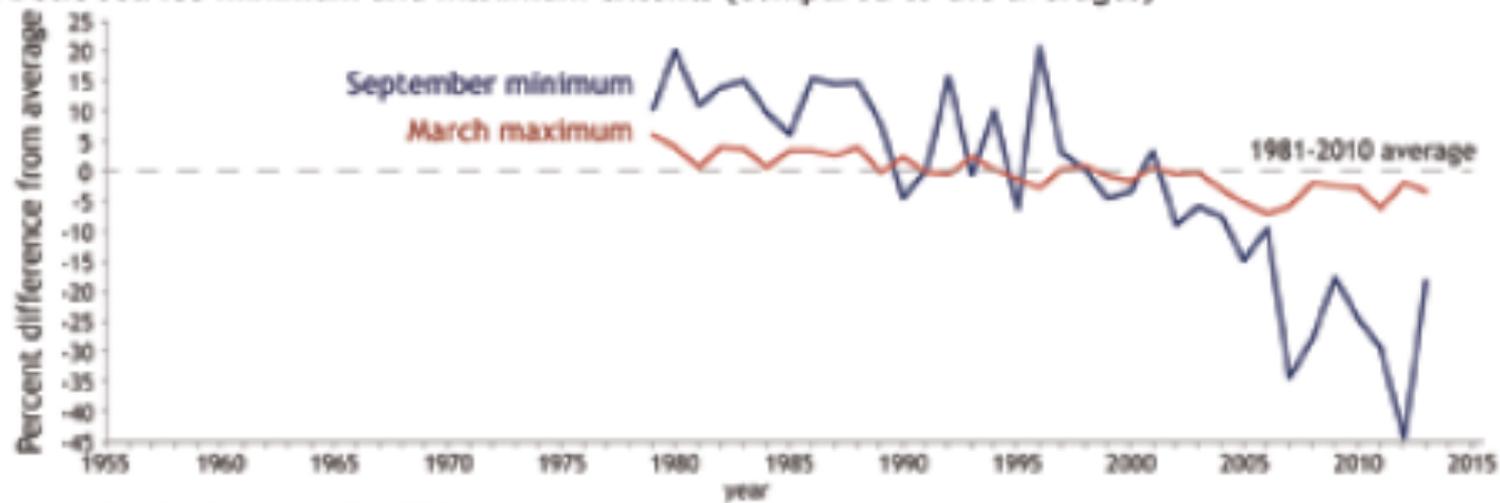
Atmospheric CO₂ 1955-2014



Average Annual Land & Ocean Surface Temperatures 1850 - 2012

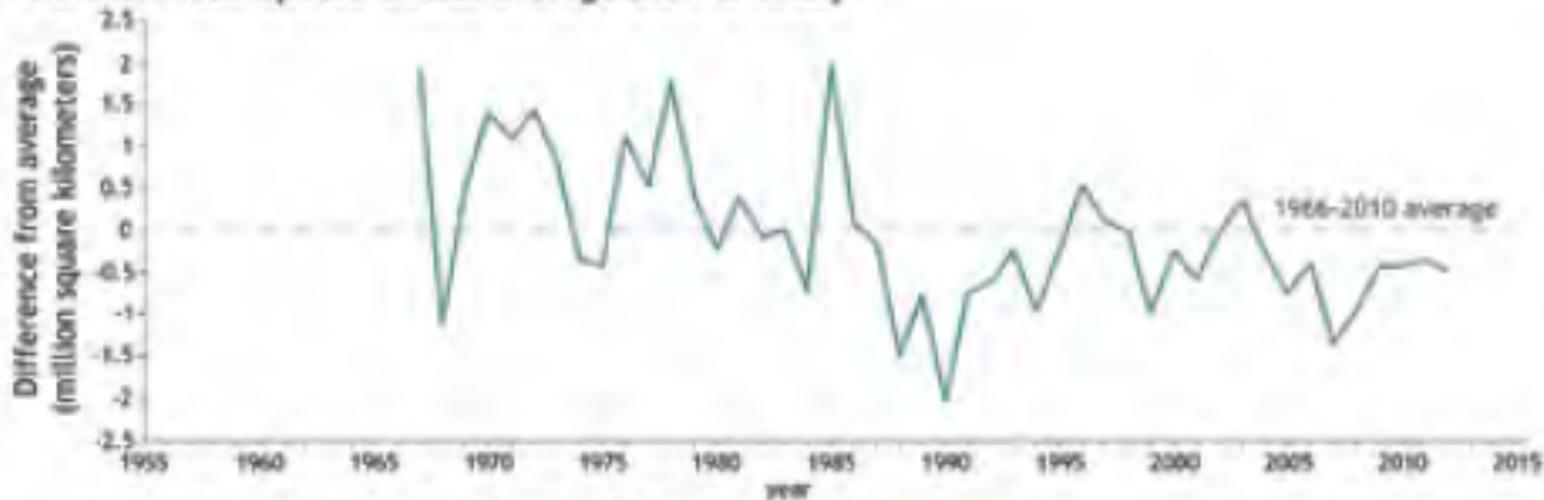


Arctic sea ice minimum and maximum extents (compared to the averages)



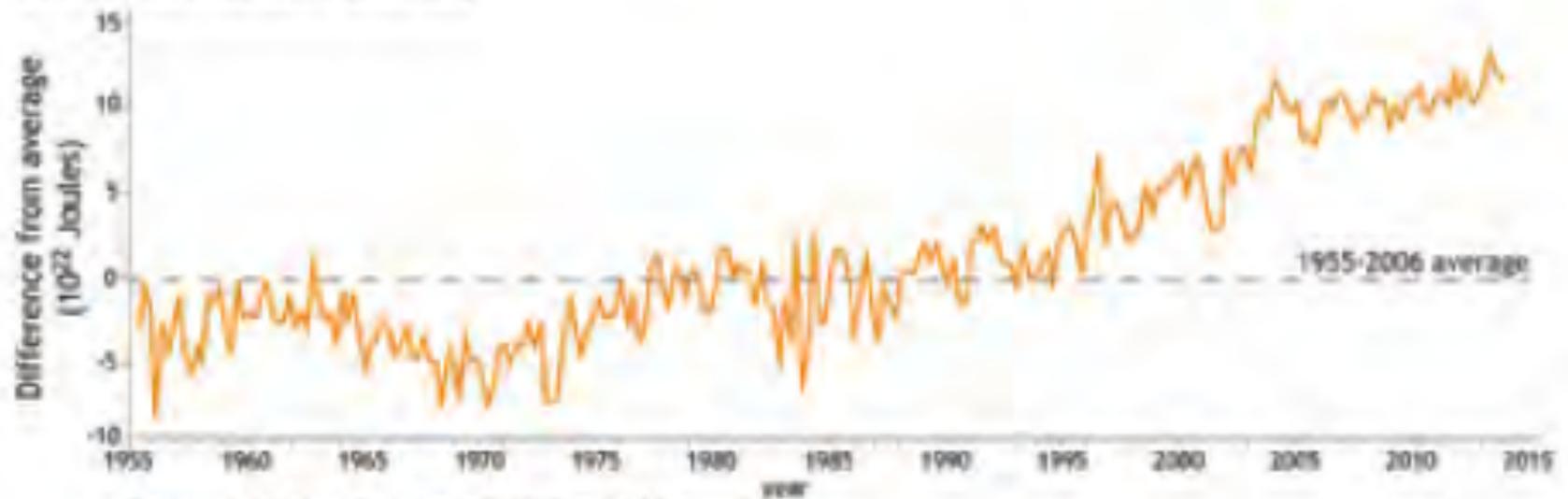
Based on data provided by NSIDC.

Northern Hemisphere annual average snow anomaly



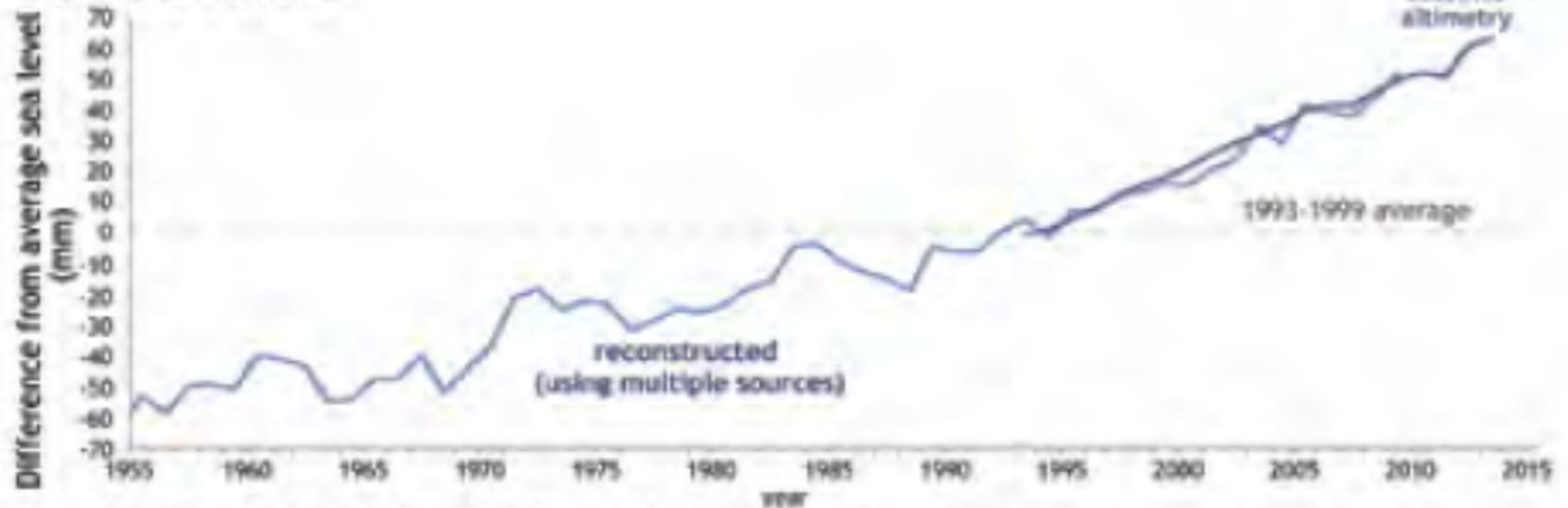
Adapted from Figure 1.1(h) in the BAMS State of the Climate report.

Ocean heat content anomaly



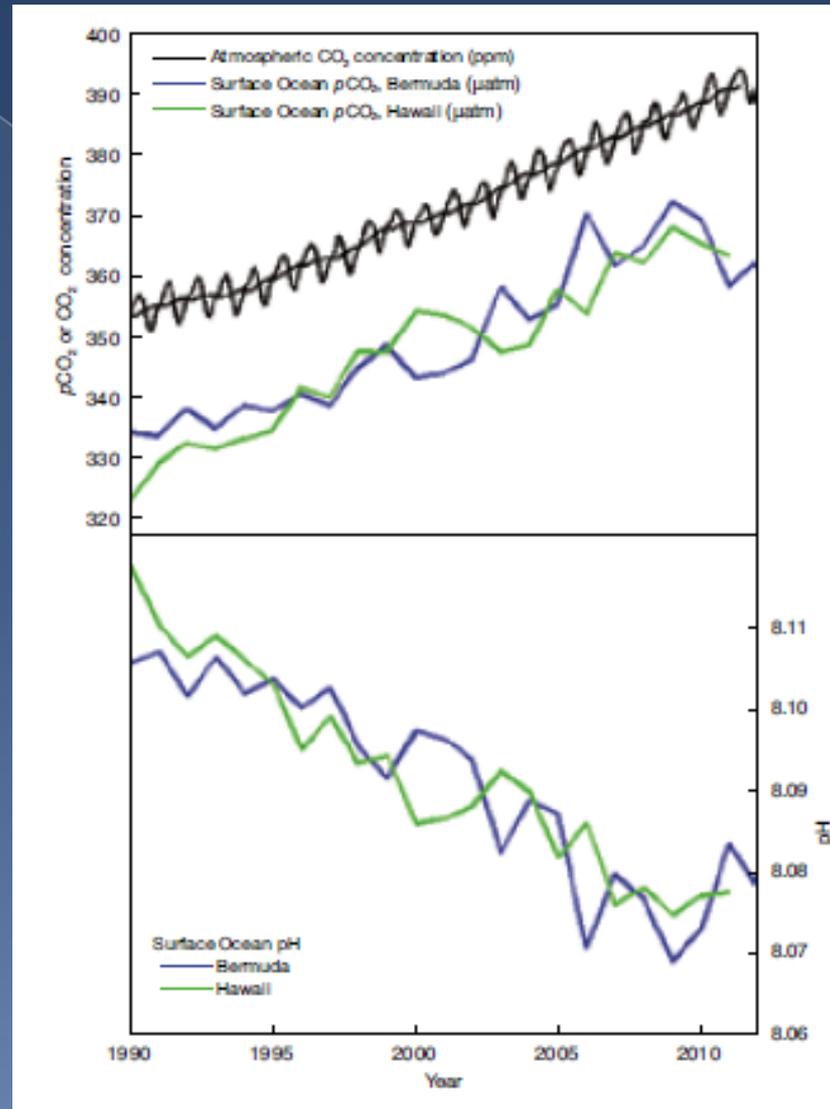
Data provided by the National Oceanographic Data Center.

Global sea-level rise

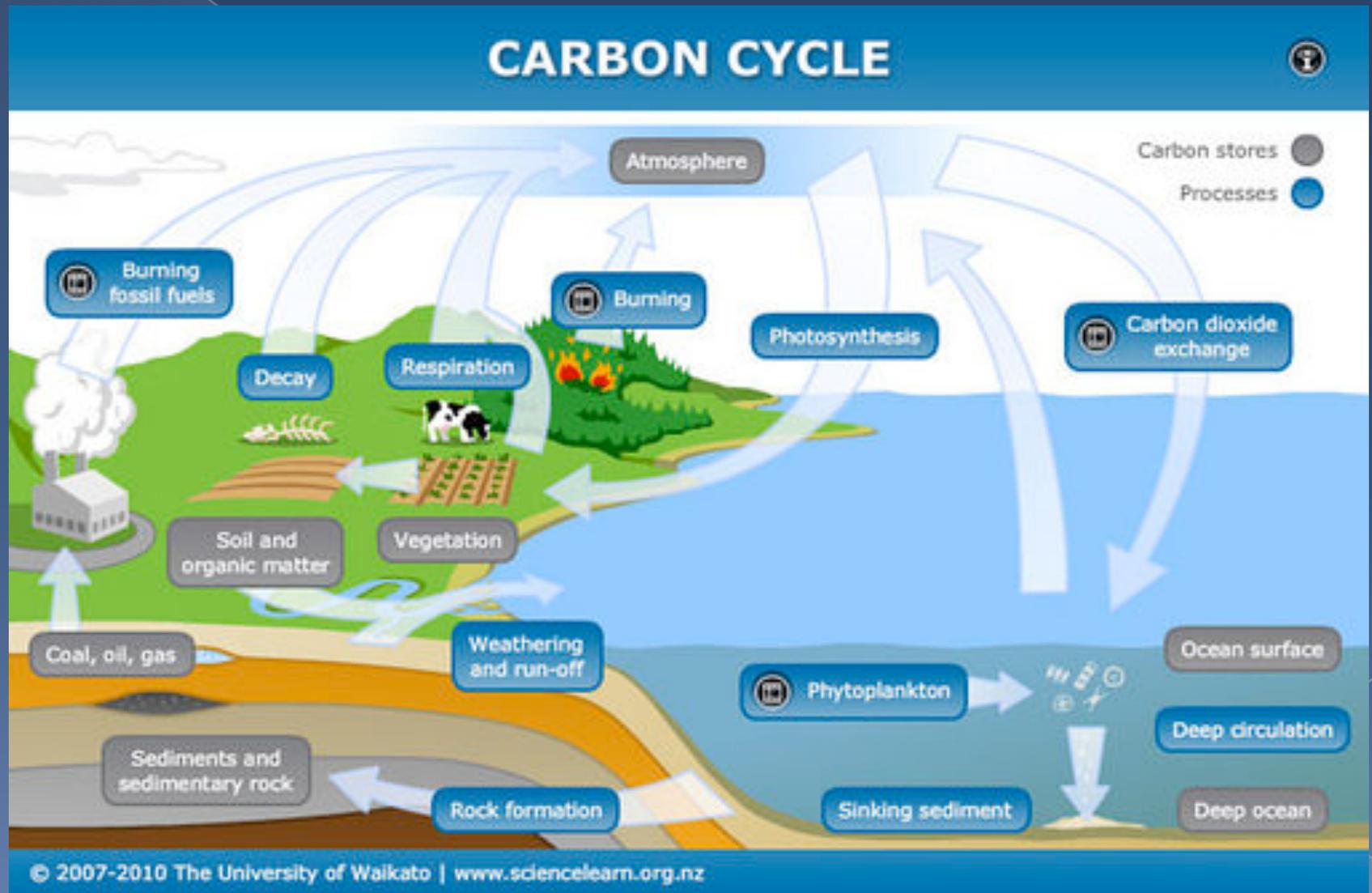


Data from C.K. Shum, Chungyei Kuo, Benoit Meyssignac, Junkun Wen.

Atmospheric CO₂, Ocean CO₂, & Ocean pH from 1990 to 2014



The Carbon Cycle





TUCKER PRAIRIE

Field Trip Information

- Climate change is a GLOBAL phenomenon and
It has LOCAL impacts (everywhere).
- Evidence suggests that Climate change is impacting weather patterns and ecosystems in Missouri, but we are not sure how Missouri ecosystems are being affected.
- Dr. Rico Holdo and a team of scientists are studying the impacts of climate change on tall grass prairies in the Midwest...
Tucker Prairie



Tucker Prairie

- Located east of Columbia (right off I-70)



- Last remnant of Missouri's "Grand Prairie" and one of the last examples of a tallgrass prairie in the US that has never been farmed.

- Over 200 native plant species; seeds from these plants are collected and used for prairie restoration efforts around the Midwest.

Images: <http://mdc.mo.gov/> & <http://opulentopossum.blogspot.com/>

Why is Tucker Prairie Important?

- At one time MO was covered in over 15 million acres of Prairie
- 99% of this prairie land has been lost
- Seeds for dozens of native species are collected in Tucker Priarie and used for prairie restoration efforts around the Midwest.



Image from: <http://kerryg.hubpages.com/hub/Attracting-Birds-With-Prairie-Plants>



Dr. Holdo works on a weather station in Tucker Prairie.

This weather station collects data on temperature, humidity, soil moisture, light, rainfall & wind. Dr. Holdo uses these data to explore if/how climate and weather are changing in the prairie and how these changes may be related to changes in the organisms found there.

Exploring Tucker Prairie

- Tucker Prairie and Henslow's Sparrow Website—
 - Explore the website listed below. Thoughtfully answer the questions at the bottom of the website.
 - Purpose: Introduce you to the prairie ecosystem and the potential impacts of climate change on the ecosystem.

<http://hcmfh3.wix.com/tuckerprairie>