Fighting Climate Change through Production Agriculture

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2017 Wisc. Association of Ag Educators

Welcome!

- **Introductions** (me: former farm kid, former ag teacher, current researcher, an author of AFNR).

- **Overview of Today**
  - 1. The Standards - AFNR (3-Circle) & NGSS (3-D Learning)
  - 2. Is climate change real? How do we know?
  - 3. Impacts of Climate Change
  - 4. Is climate change because of human activity?
  - 5. What can we do? What can ag do?

Rules of Engagement

- **1. Assume best intentions.**
- **2. Back claims with evidence.**
- **3. It is ok to question and challenge, as long the intent is to clarify.**
- **4. It is ok to ask me to clarify or further explain something (slow me down if need be).**
- **5. It is ok to be unsure about something.**

Last items

- **Everything is online! Wuhsag.weebly.com**
- **We have scheduled breaks but you're free to leave if you need to.**
- **Feel free to scroll through materials or websites as I talk.**

Overview of the AFNR Standards

AFNR Structure & Format

- **AFNR 3-Level Structure**
- **1. CCTC Standards – CTE Common Core**
- **2. Performance Indicators – The Actual Standards**
- **3. Sample Measurements – Hypothetical means to achieving the Performance Indicators.**
  - **The sample measurements are divided into three progression levels:**
    1. Awareness: comprehension of content
    2. Intermediate/Interaction: use of content for problem solving
    3. Mastery: use of content in novel, real-world situations

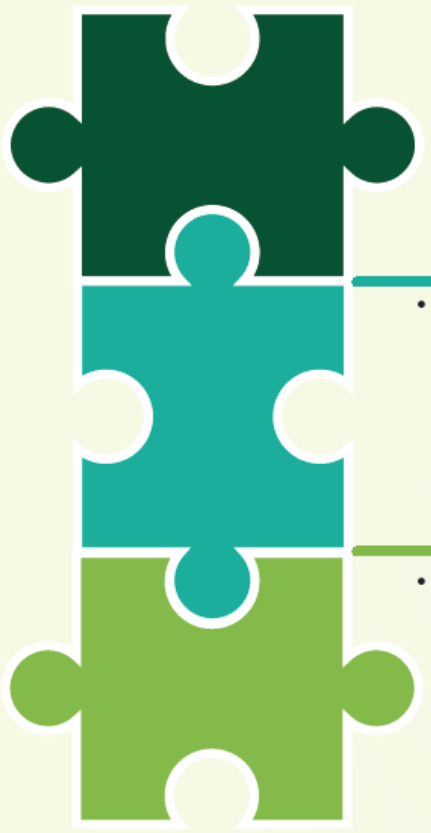
2015 AFNR Standards (Env. Systems)

PURPOSE: The career pathway content standards outline technical knowledge and skills required for future success within this discipline. The content standards are intended to provide state agricultural education leaders and educators with a forward-thinking guide for what students should know and be able to do after completing a program of study in this career pathway. State leaders and local educators are encouraged to use the standards as a basis for the development of well-planned curriculum and assessments for Agriculture, Food and Natural Resource (AFNR)-related Career and Technical Education (CTE) programs. Adoption and use of these standards is voluntary; states and local entities are encouraged to adapt the standards to meet local needs.

SCOPE: The Environmental Service Systems (ESS) Career Pathway encompasses the study of systems, instruments and technology used to monitor and minimize the impact of human activity on environmental systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of environmental service systems in AFNR settings.

SAMPLE CAREERS: Environmental Conservationist, Waste Management Specialist, Water Quality Specialist, Environmental Sampling Specialist, Naturalist, Hazardous Material Handler, Hazardous Material Technician, Toxicologist, Solid Waste Manager

DEFINITIONS: Within each pathway, the standards are organized as follows:



- **Common Career Technical Core (CCTC) Standards** – These are the standards for Environmental Service Systems (AG-ESS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- **Performance Indicators** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.
- **Sample Measurements** – The statements are ***sample*** measureable activities that students might carry out to indicate attainment of each performance indicator at three levels of proficiency – awareness (a), intermediate (b), and advanced (c). This is not intended to be an all-encompassing list; the sample measurements are provided as examples to demonstrate a logical progression of knowledge and skill development pertaining to one or more content areas related to the performance indicator. State and local entities may determine the most appropriate timing for attainment of each level of proficiency based upon local CTE program structures.

CCTC's → P.I.'s → S.M.'s (A.I.M.)

S	**NRS.01. Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.**
I	**NRS.01.01. Apply methods of classification to examine natural resource availability and ecosystem function in a particular region.**
M	Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities, at different levels of proficiency, to assess students' attainment of knowledge and skills related to this performance indicator. The topics represented by each strand are not all-encompassing.

NRS.01.01.01.a. Summarize and classify different kinds of natural resources using common classification schemes (e.g., living versus non-living, renewable versus nonrenewable, native versus introduced, etc.).	**NRS.01.01.01.b.** Assess the characteristics of a natural resource to determine its classification.	**NRS.01.01.01.c.** Devise strategies for the preservation of natural resources based on their
NRS.01.01.02.a. Summarize the components that comprise all ecosystems.	**NRS.01.01.02.b.** Analyze the interdependence of organisms within an ecosystem (e.g., food webs, impact of keystone species, etc.) and assess the dependence of organisms on nonliving components (climate, geography, energy flow, nutrient cycling, etc.).	**NRS.01.01.02.c.** Evaluate analyses of ecosystems and document interactions of living species and resources.
NRS.01.01.03.a. Summarize and classify different kinds of living species based on evolutionary traits.	**NRS.01.01.03.b.** Analyze how biodiversity develops through evolution, natural selection and adaptation; explain the importance of biodiversity to ecosystem function and availability of natural resources.	**NRS.01.01.03.c.** Evaluate biodiversity in ecosystems and devise strategies to enhance the function of an ecosystem and the availability of natural resources by increasing the level of biodiversity.

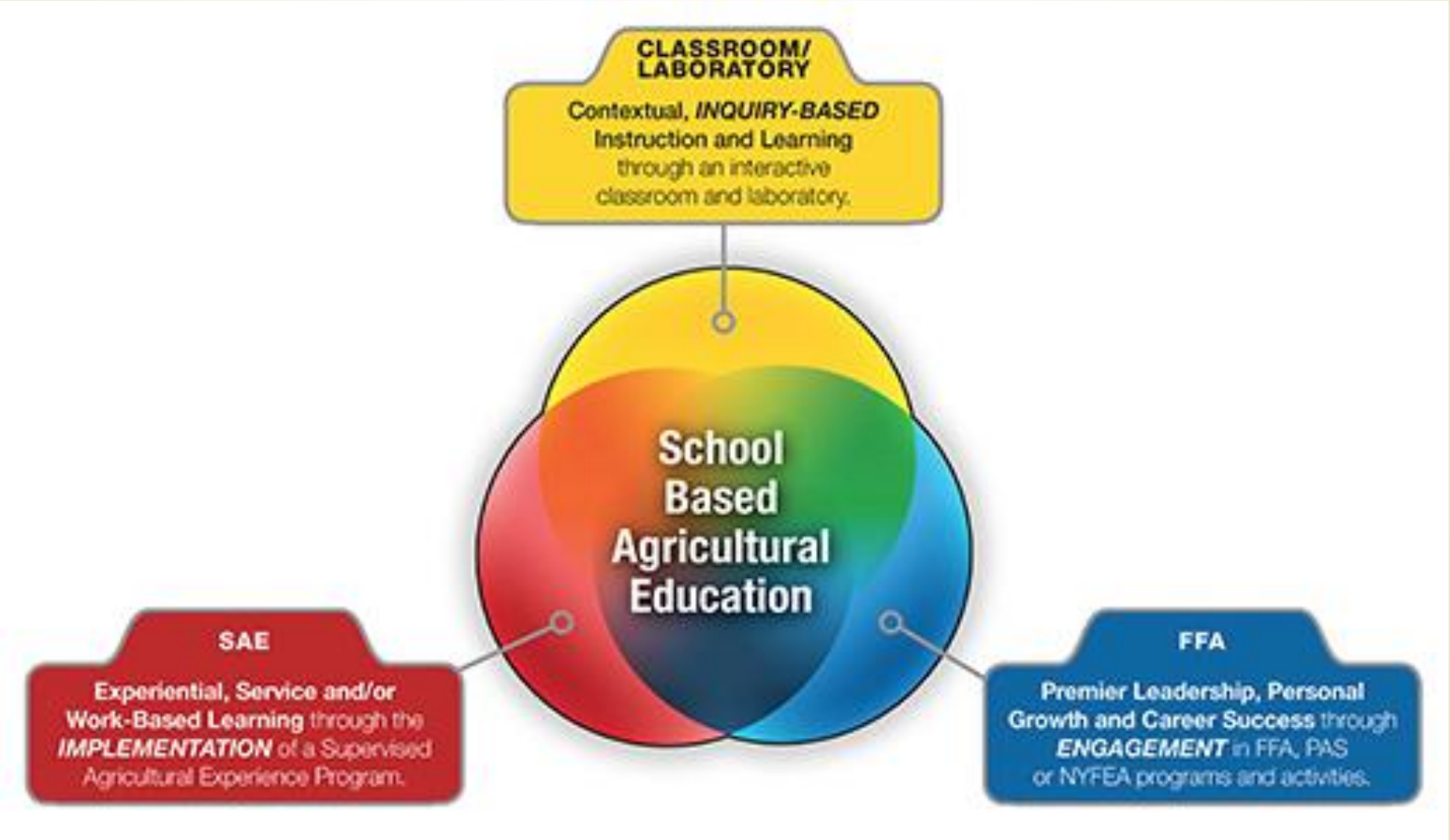
Awareness

Interaction

Mastery

Overview of the 3-Circle Model

3-Circle Model



3-Circle Model

- **Classroom & Lab Instruction**
  - Standards-backed, inquiry-based instruction that is reflective of real-world scenarios and situations.
  - Curriculum that begins with *agricultural literacy** and proceeds to career proficiency in upper-level courses.
    - *Ag Literacy – systems-based learning of universal core concepts, not facts & trivia about the industry.*
- **Career Experiential Learning (aka SAEs)**
  - Firsthand career experiences (shadowing, service, paid labor, research, entrepreneurship, etc.) outside of a regular class.
  - Assessed as part of a course grade.
- **Personal Development (usually FFA in our programs)**
  - Opportunities for students to engage in communities of practice in which they can apply academic, career, and social knowledge to student-led situations.
  - Key to integrating academic content into personal identities.

Overview of the NGSS Standards

NGSS Overview

- **NGSS is composed of three dimensions of learning:**
  - 1. Disciplinary Core Ideas
  - 2. Crosscutting Concepts
  - 3. Scientific/Engineering Practices

- **A curriculum is NOT aligned to NGSS unless it uses all three of these dimensions of learning in a coherent, continuous manner.**

3D Learning in Next Generation Science

- **Practice**
  - Describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems
- **Crosscutting Concepts**
  - Crosscutting concepts have application across all domains of science
- **Disciplinary Core Ideas**
  - Have **broad importance** across multiple sciences or engineering disciplines or be a **key organizing concept** of a single discipline

http://www.nextgenscience.org/three-dimensions

Next Generation Science Standards

Science and Engineering Practices

- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information.

Disciplinary Core Ideas

Physical Sciences
PS1: Matter and its interactions
PS2: Motion and stability: Forces and interactions
PS3: Energy
PS4: Waves and their applications in technologies for information transfer

Life Science
LS1: From molecules to organisms: Structures and processes
LS2: Ecosystems: Interactions, energy, and dynamics
LS3: Heredity: Inheritance and variation of traits
LS4: Biological evolution: Unity and diversity

Earth and Space Sciences
ESS1: Earth's place in the universe
ESS2: Earth's systems
ESS3: Earth and human activity

Engineering, Technology, and Applications of Science
ETS1: Engineering design
ETS2: Links among engineering, technology, science, and society

Crosscutting Concepts

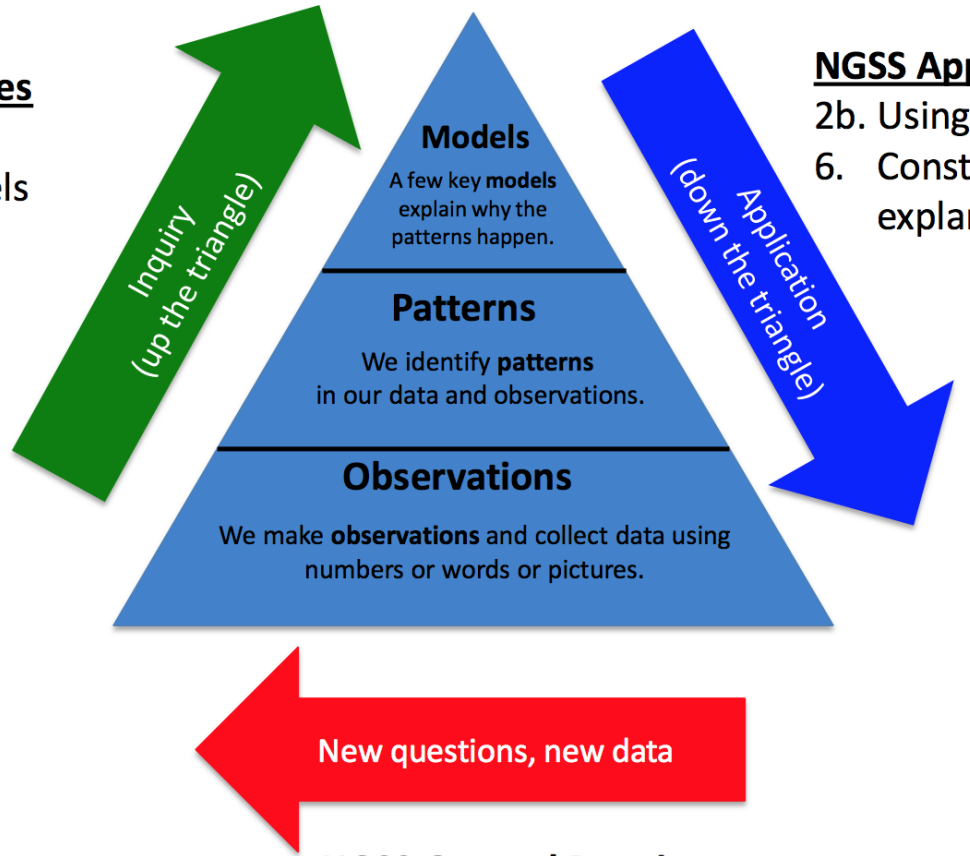
- Patterns
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, conservation
- Structure and function
- Stability and change

Next Generation Science Standards

Representing Scientific Knowledge and Practice

NGSS Inquiry Practices

1. Asking questions
2a. Developing models
3. Investigations
4. Analyzing & interpreting data
7. Argument from evidence



NGSS Application Practices

2b. Using models
6. Constructing explanations

NGSS General Practices

5. Using mathematics and computational thinking
8. Obtaining, evaluating, and communicating information

Overlap between AFNR & NGSS

AFNR & NGSS: AIM vs. 3D Learning

- **Awareness:** Developing an awareness and comprehension of Disciplinary Core Ideas and Cross Cutting Concepts

- **Intermediate/Interaction:** Use of Cross Cutting Concepts and Scientific/Engineering Practices in guided application situations.

- **Mastery:** Seamless use of DCIs, CCCs, Scientific/Engineering Practices in an increasingly un-coached, unstructured, real-world setting.

Scientific Literacy

- **The primary goal of NGSS is scientific literacy.**
  - 90% of students in general science courses do not become scientists or engineers.
  - As such, we are moving away from a 'mile wide, inch deep' curriculum to one that prepares all students to be able to **think** like scientists & engineers.
- **NGSS is about the mainline (literacy), not the pipeline (careers).**
  - General science courses are about preparing students to be future sense-makers and functionally literate in science.
  - Higher-level & elective science courses are still available for the pipeline science-career students.
- **AFNR is a mix of *mainline* (literacy) and *pipeline* (careers).**
  - Your classes might fall into both categories (e.g. *Intro Ag* may be about agriscience literacy, while higher level courses may be about pipeline agriscience-career students).
  - Ideally, you should begin with courses that emphasize general ag literacy while allowing for upper level courses that enable mastery and proficiency in a career.

Questions & Discussion


TIME
for a
BREAK!

Is Climate Change Real?

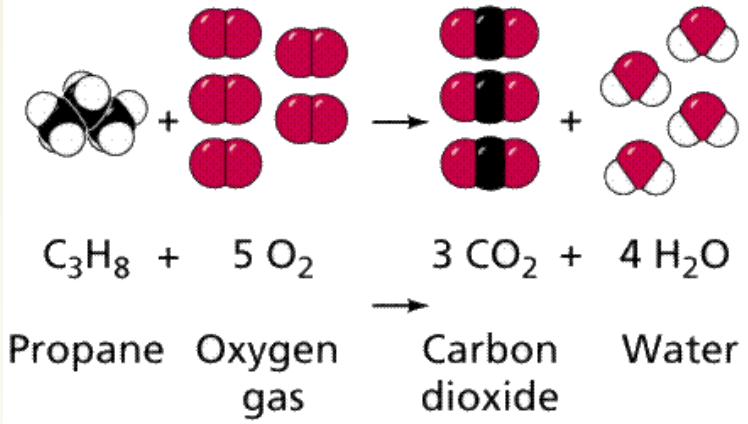
The Climate Change Debate

- **In small groups (3-5) of your choosing, consider the following questions. Be prepared to offer responses.**
  - 1. What evidence is there to suggest that climate change is happening?
  - 2. What evidence is there to suggest that climate change is happening primarily because of human activity?
  - 3. Is there a sufficient amount of evidence to negate either of these claims (i.e. that climate is not happening or is not due to human activity)?
  - 4. Do we have enough scientific evidence to justify any kind of action?
  - 5. What is the harm of not taking action on climate change?

Group Discussion Time

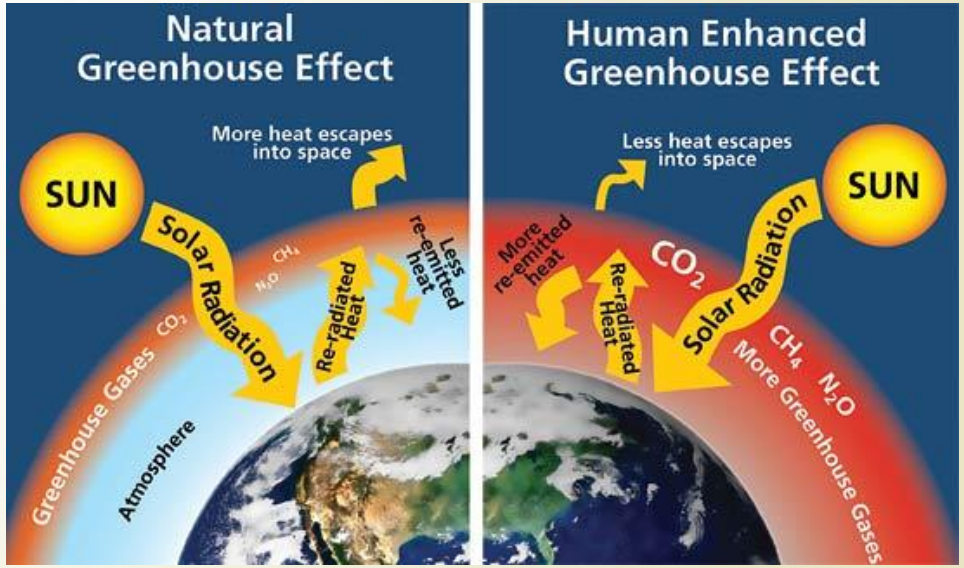
Climate Change Basics

- When a carbon-based substance (such as wood, coal, oil, natural gas, or ethanol) are burned, the carbon molecules are rearranged into CO2 and H2O.

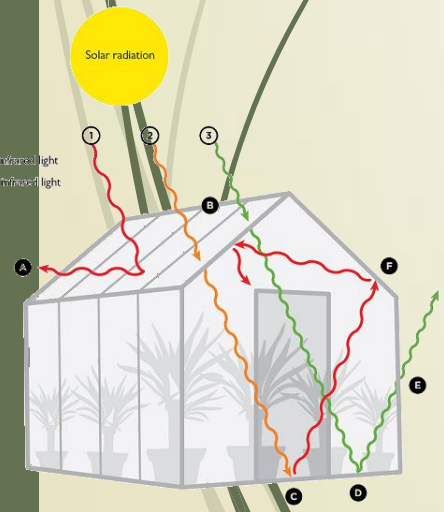


Source: Watts Up With That?

- CO2 is a greenhouse gas. When sunlight passes through the atmosphere and shines on an object, it is converted into heat. CO2 slows the loss of this heat from the surface of the earth.

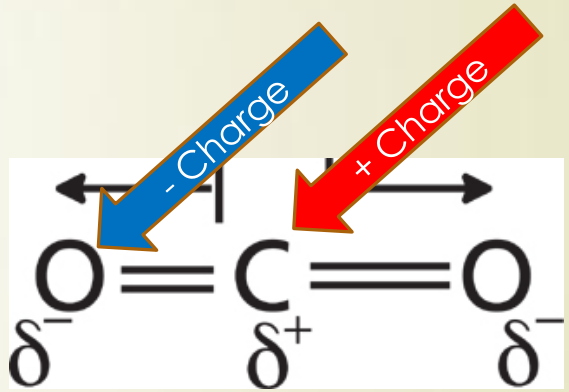


Source: https://cdn.comsol.com/wordpress/2013/05/Greenhouse-effect-how-a-greenhouse-works.png

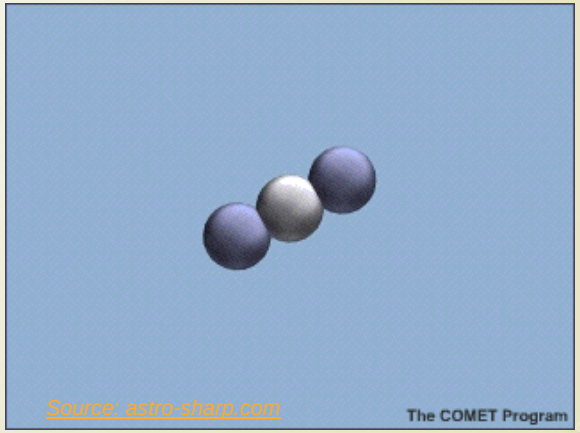


But why is CO2 a greenhouse gas?

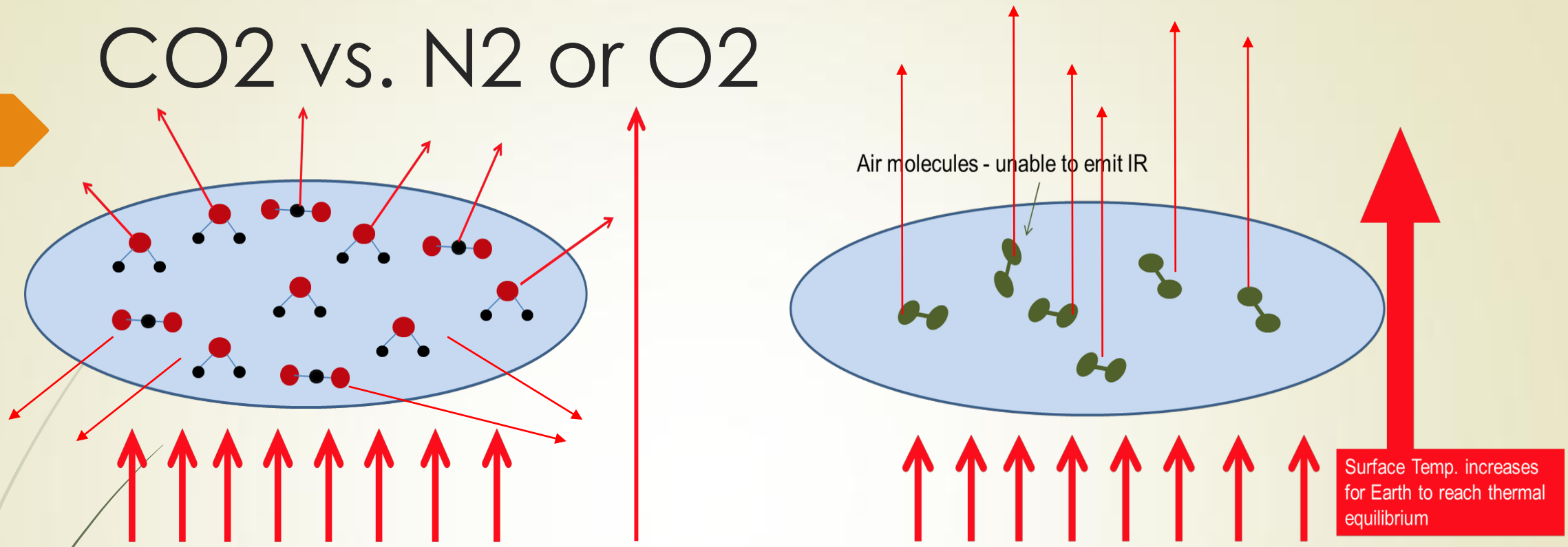
- **One argument against the validity of climate change is that CO2 comprises a very small percent of the earth's atmosphere.**
  - However, the properties of CO2 are more related to its chemical and physical properties than to its relative abundance in the atmosphere.
- **The individual atoms in a CO2 molecule can scatter thermal radiation in all directions because they have pos/neg net charges.**
  - This enables CO2 to reflect the energy in all directions, including back towards the earth.
  - This slows the loss of thermal radiation (aka heat) from the surface of the earth (similar to how a jacket slows the loss of heat from your body).
  - Even though CO2 comprises less than 1% of the atmosphere, without it the world would be 34^{O} C cooler. But CO2 is only good in moderation.



Source: Spectroscopy Online



CO2 vs. N2 or O2



- **For a molecule to be a greenhouse gas, its individual atoms have to have a net charge (pos. or neg.).**
  - The oxygen atoms in CO2 are more negative and the carbon atom is more positive.
  - This allows it to re-emit heat energy in all direction (including back towards earth. N2 and O2 comprise a much larger portion of the earth's atmosphere but because they have a neutral charge, they allow heat energy to pass through out to space.

Image source: https://wstannard.wordpress.com/the-greenhouse-effect-2/physics-of-the-infra-red/

The more you burn, the hotter it gets.

- **Key Facts:**

1. **Burning a substance convert those carbon-based molecules into CO2 and H2O.**

2. **CO2 is a greenhouse gas (so is H2O*).**
   **H2O is not as big of a concern because it has a much shorter lifecycle in the atmosphere (i.e. it rains water, not CO2 ;)*

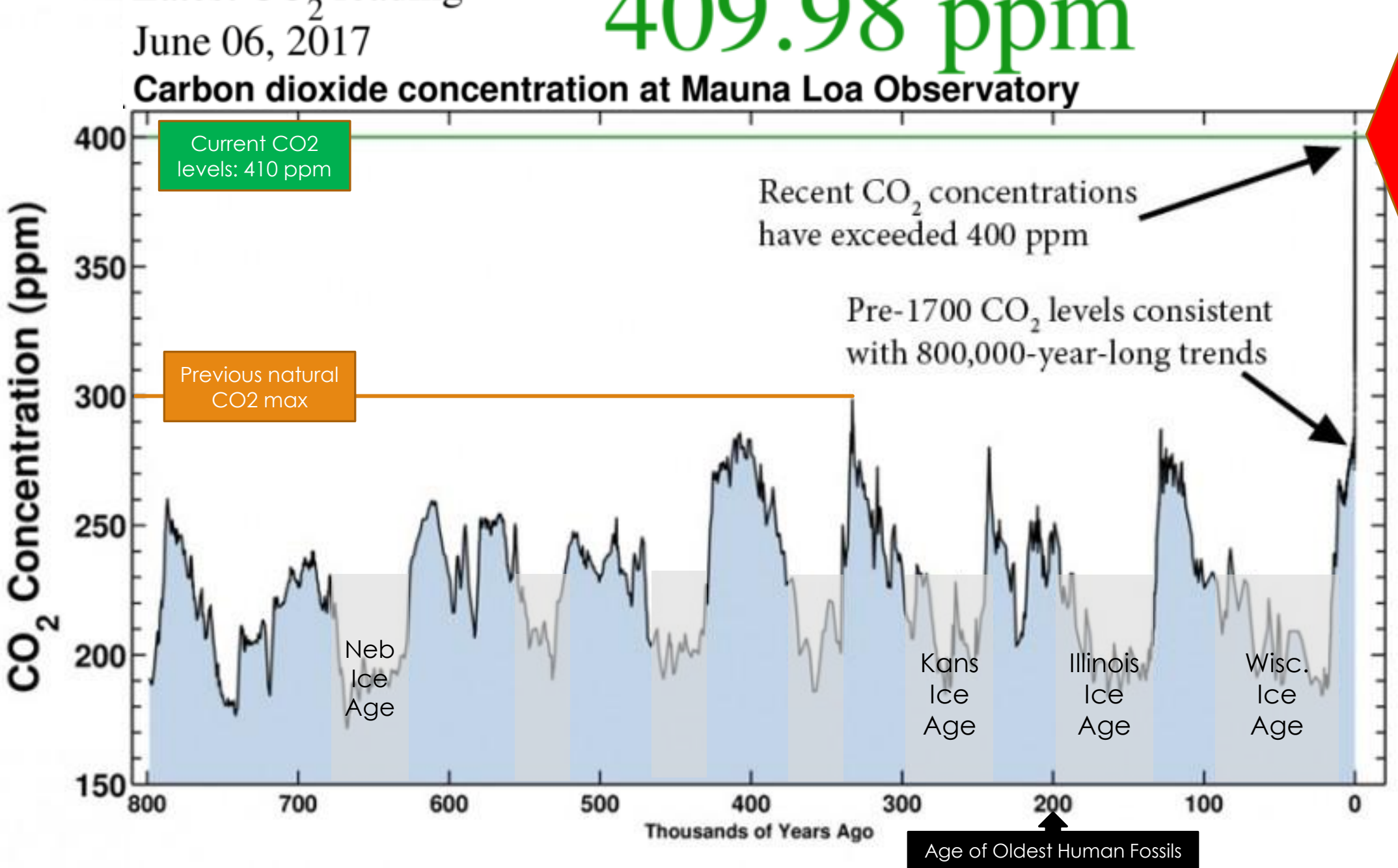
3. **Greenhouse gases slow the loss of heat from the planet.**

4. **The more that is burned, the more CO2 is released, and the more that heat is reflected back to the earth.**

5. **CO2 levels have increased extremely rapidly due to much greater rates of combustion from human activity.**

Latest CO_2 reading
June 06, 2017

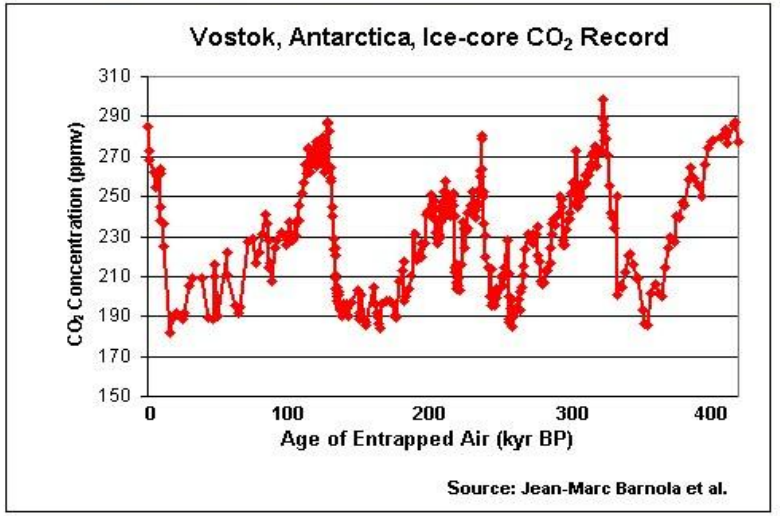
409.98 ppm



Current rate of increase is 100x the historical average

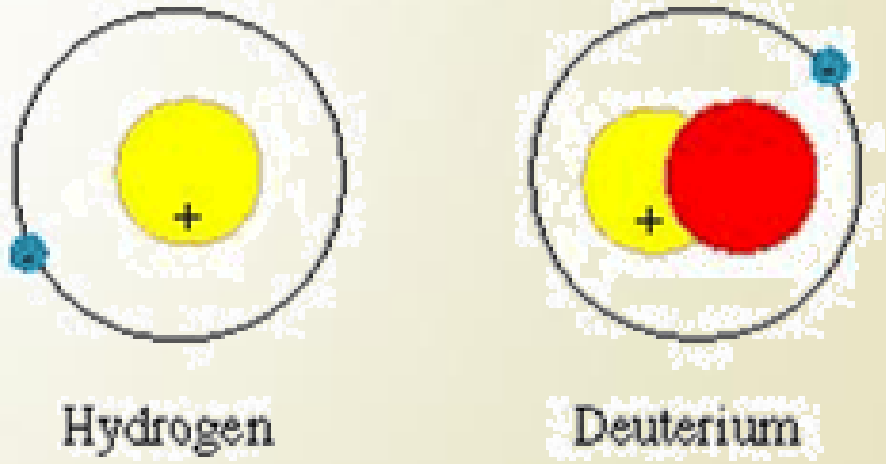
How do we know this?

- **How can we know what the earth's climate was like 800,000 years ago if we can't even predict the weather 5 days from now?**
  - First, weather & climate are very different concepts.
- **The best evidence is from Antarctica.**
  - Most of the data comes from the Vostok Research Station.
  - As layers of snow accumulate, they become compressed into ice.
  - As the ice forms, it traps the surrouding air in small bubbles.
  - This air remains undisturbed and completely preserved in that ice.



Vostok Ice

- **The air bubbles in the ice core data can be dated, measured, and analyzed to tell us what a "natural change" would look like.**
  - Greenhouse gases can be measured with simple probes (similar to a Vernier probe you may use in your classroom).
- **Scientists are also able to determine the average annual temperature for each year using an isotope of hydrogen called <u>deuterium</u>.**
  - <u>Deuterium</u> is essentially a 'heavy' form of hydrogen.
  - The more deuterium in the air, the warmer the atmosphere was for that particular year.



Source: http://genesismission.jpl.nasa.gov/science/mod2_aei/fig12.gif

Vostok Ice Graph Activity

- **Summary Description: students use data from Antarctic ice core samples to determine what "natural" changes to CO2 and temperature would look like in order to determine if current climate changes are natural or the result of human activity.**

- ***See Activity***

Tabletop Climate Change Activity

- **Summary Description: students utilize fermenters or sealed mason jars and Alka-seltzer tablets to create small-scale atmospheric increases to CO2. They then compare temperature changes that occur as a result of the insulating effects of CO2.**

- ***See Activity***

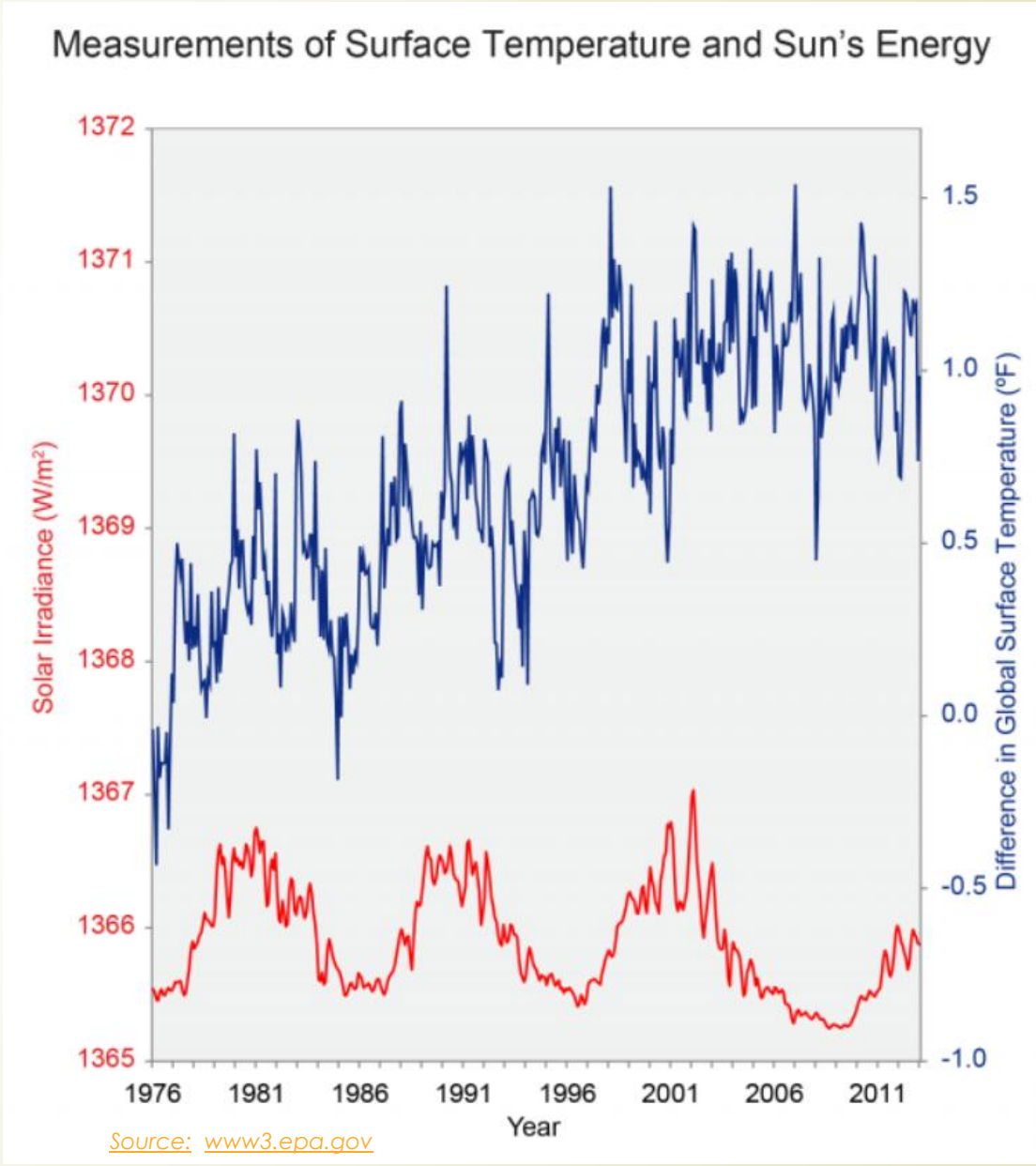
Lake Mendota Ice Graph Activity

- **Summary Description: students use ice duration data from Madison's Lake Mendota to determine if any changes have occurred to the local climate.**

- ***See Activity***

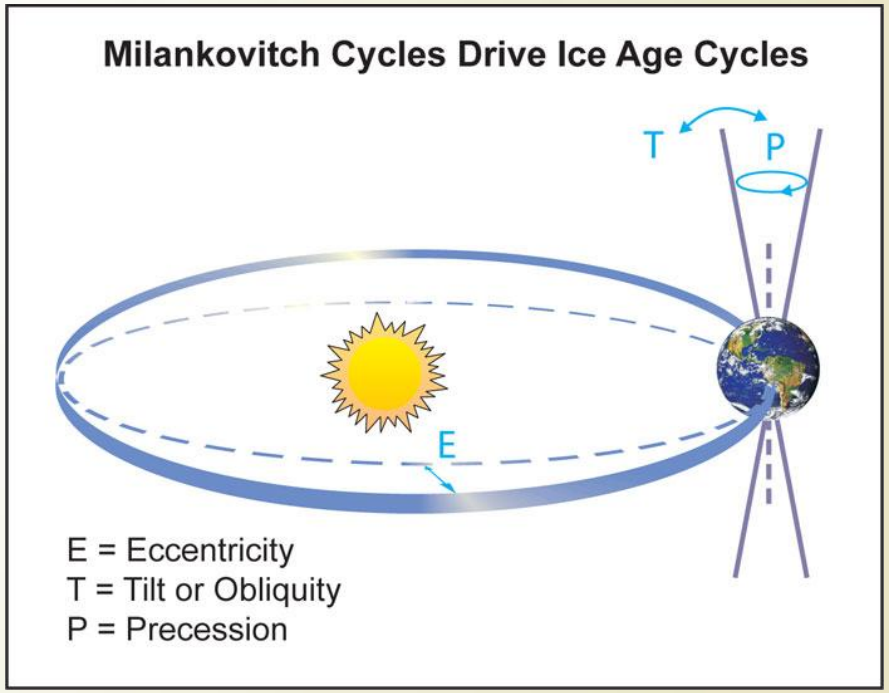
Other Sources of Evidence

- **The sun's energy-output does fluctuate on a fairly regular basis.**
  - However, while these long-term fluctuations have remained fairly consistent, the temperature on the surface of the earth has continued to rise.
- **This relationship strongly indicates that the cause of the warming of the earth is unrelated to the output of energy from the sun.**



Other Sources of Evidence

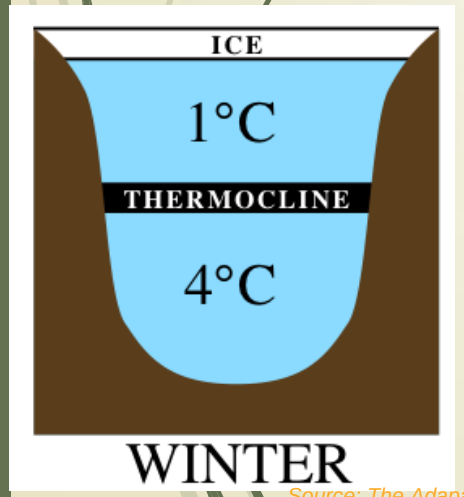
- **The earth has changes to its rotation and orbit that can affect its climate.**
  - These changes (called Milankovitch Cycles) are a major cause of changes to the Earth's climate, including ice ages.
- **However, the rate of change is ten to hundreds of thousands of years for these cycles.**
  - The rate of change we are currently experiencing is thousands of times faster than what would occur from the Milankovitch Cycles.
    - *E = 100,000 years; T = 41,000 years; P = 23,000 years*
      Climate Change =



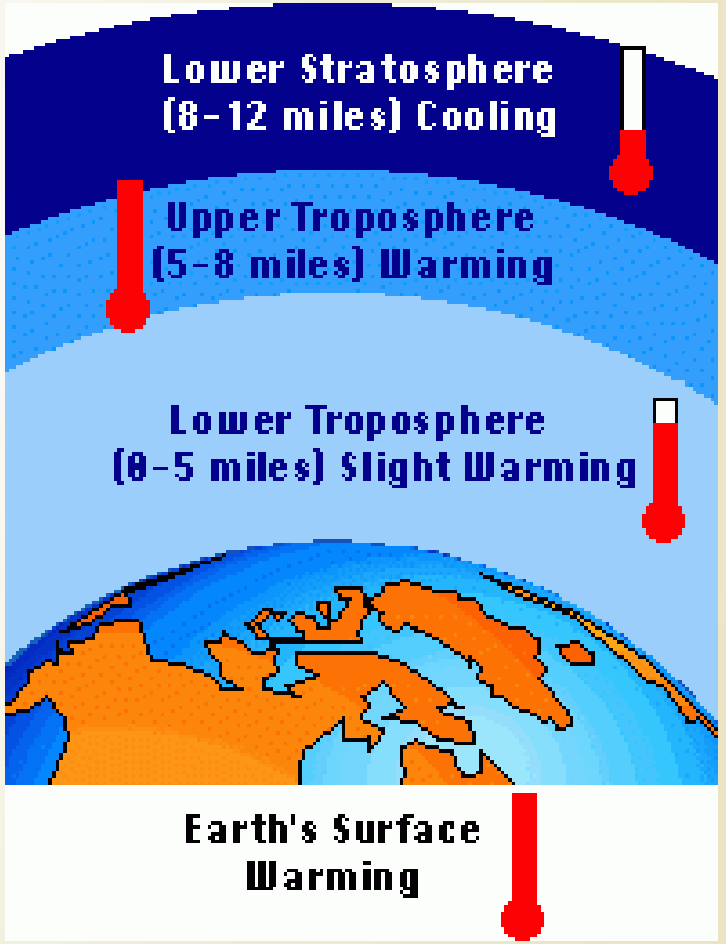
Source: http://www.southwestclimatechange.org/files/cc/figures/milankovitch.jpg

Other Sources of Evidence

- **The atmosphere is measurably warming.**
  - The earth's surface and the troposphere have experienced measurable warming at an unprecedented pace since the start of the Industrial Revolution.
  - However, the stratosphere has actually cooled. Many climate skeptics point to this as proof that climate change is not real (after all, heat rises…right…?).
- **The reason that the stratosphere is cooling is because of the depletion of the ozone layer in the 20th century.**
  - The ozone layer insulated the stratosphere.
  - Now that the ozone is depleted, heat can more easily escape, resulting in cooling.
  - Because the stratosphere is cooling while the troposphere is warming, it creates a thermocline (similar to lakes covered by ice).



Source: The Adapa Project



Source: https://science.nasa.gov/science-news/science-at-nasa/2000/ast21jul_1m

Our 5 Questions

- **Can we answer any of these questions?**
  - 1. What evidence is there to suggest that climate change is happening?
  - 2. What evidence is there to suggest that climate change is happening primarily because of human activity?
  - 3. Is there a sufficient amount of evidence to negate either of these claims (i.e. that climate is not happening or is not due to human activity)?
  - 4. Do we have enough scientific evidence to justify any kind of action?
  - 5. What is the harm of not taking action on climate change?

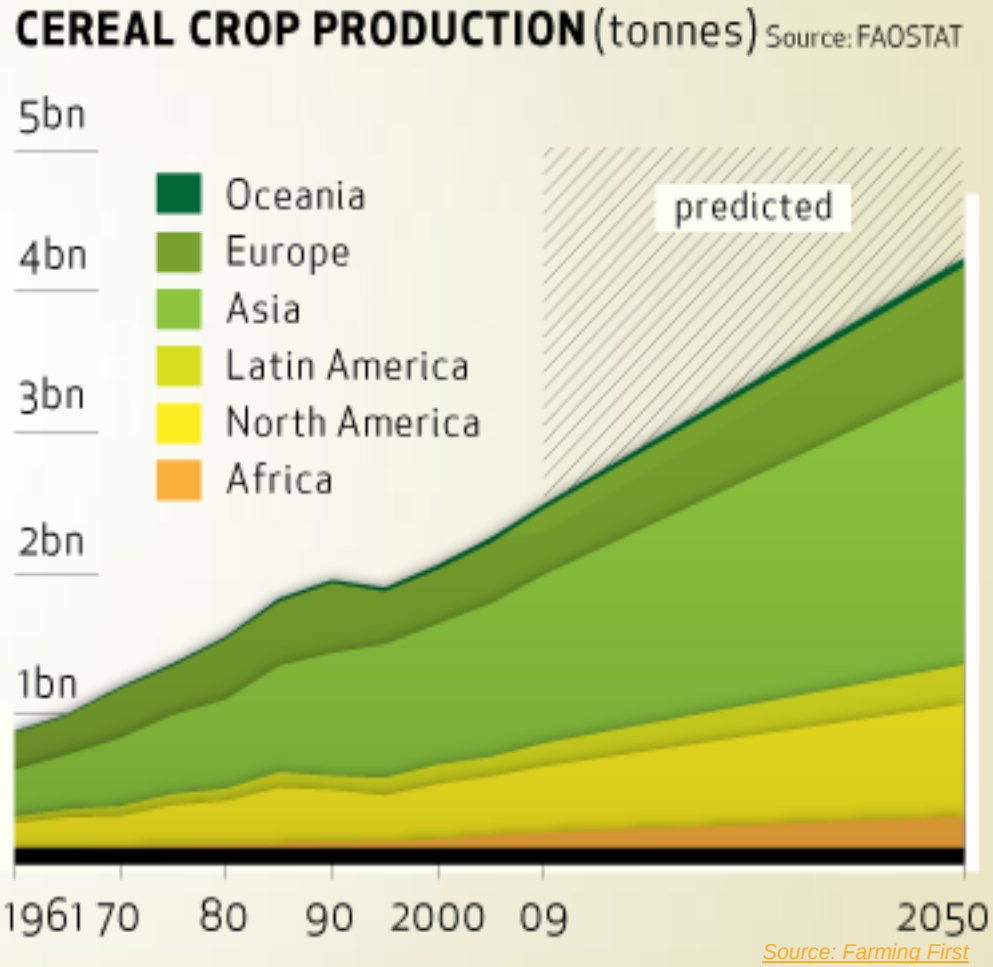
Group Discussion Time

Impacts of Climate Change on Ag

The 2050 Challenge

+70%

- **The world population is expected to increase to 9 billion people by 2050.**
  - This increase will require an increase in food production of 70%.
  - However, agriculture is at significant risk of a systemic failure due to climate change.

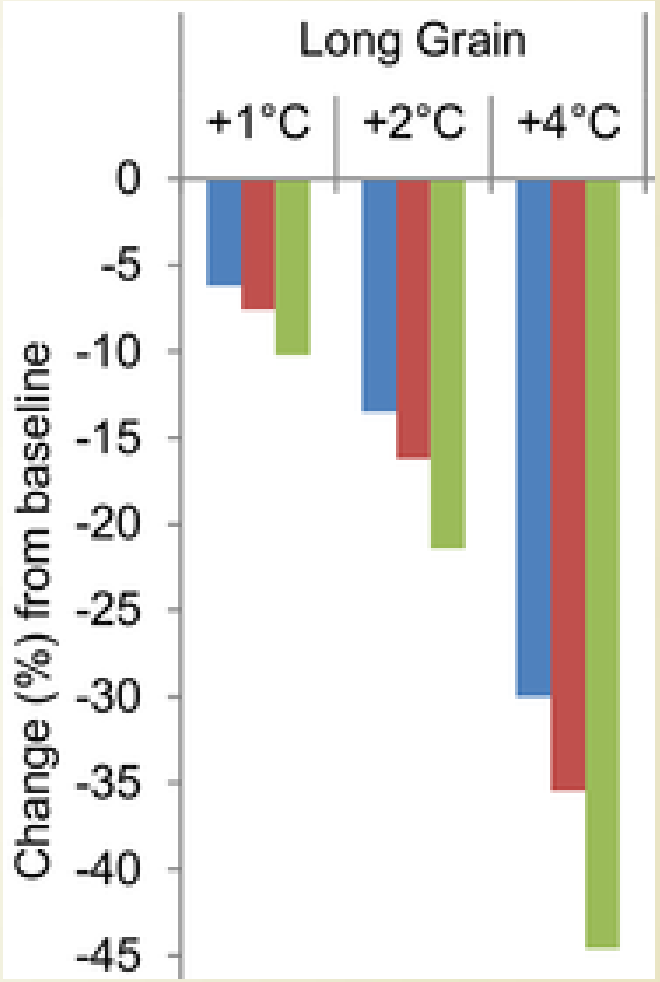


Source: Farming First

Decreased Rice Production +70%

- **Rice is the most widely consumed food staple in the world.**
  - A 1°C increase in average growing season temperature reduces rice yields by 6-11%.
  - In our lifetimes, temperatures are expected to rise by as much as 5.4°C.

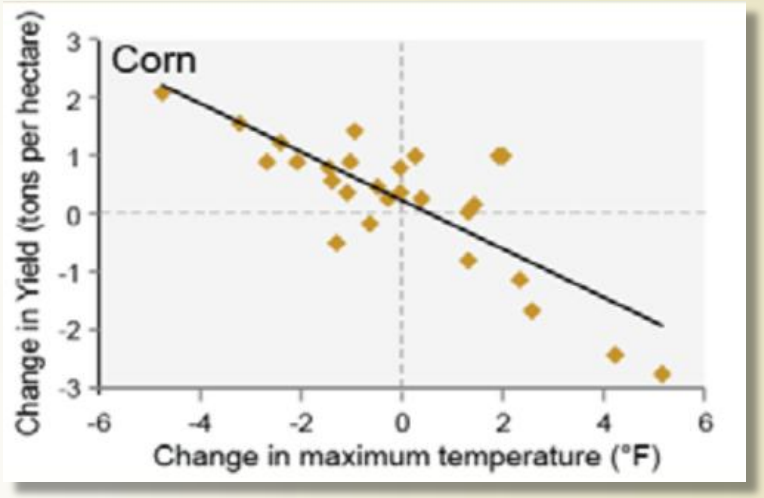
- Lyman NB, Jagadish KSV, Nalley LL, Dixon BL, Siebenmorgen T (2013) Neglecting Rice Milling Yield and Quality Underestimates Economic Losses from High-Temperature Stress. PLoS ONE 8(8): e72157. https://doi.org/10.1371/journal.pone.0072157



Corn & Wheat

+70%

- **Corn is the most widely consumed grain in the United States and 65% of US corn occurs in the Midwest.**
  - An increase of 10° F in the maximum summer temperature reduces corn yields by nearly 2 tons of grain per acre.



- **Adding a single additional growing degree day results in a 7.6% reduction in US wheat yields.**
  - The number of growing degree days is expected to increase by 30% by mid-century.

- Mishra, V., and K. A. Cherkauer (2010), Retrospective droughts in the crop growing season: Implications to corn and soybean yield in the Midwestern United States, Agricultural and Forest Meteorology, 150(7-8), 1030–1045
Tack, J., Barkley, A., & Nalley, L. L. (2015). Effect of warming temperatures on US wheat yields. *Proceedings of the National Academy of Sciences*, *112*(22), 6931–6936.
National Oceanic and Atmospheric Administration. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment Part 3. Climate of the Midwest U.S. NOAA Technical Report NESDIS 142-3

The Future of Agriculture

+70%

- **Currently the US dairy industry has 1.9% production losses due to climate change, representing $670 million in losses to the industry.**
  - This amount is expected to increase to 6.3%/losses of $2.2 billion by the end of the century.

- Mauger, G., Bauman, Y., Nennich, T., & Salathé, E. (2015). Impacts of Climate Change on Milk Production in the United States. *The Professional Geographer*, *67*(1), 121–131. Key, N., & Sneeringer, S. (2014). Potential Effects of Climate Change on the Productivity of U.S. Dairies. *American Journal of Agricultural Economics*, *96*(4), 1136–1156. AND Klinedinst, P. L., Wilhite, D. A., Hahn, G. L., & Hubbard, K. G. (1993). The potential effects of climate change on summer season dairy cattle milk production and reproduction. *Climatic Change*, *23*(1), 21–36.

Source: http://wallpaper-gallery.net/wallpapers/cow.html

Fruit is especially sensitive

+70%

- **An early thaw/freeze cycle can cause hundreds of millions of dollars in losses to fruit & berry crops.**
  - Premature budding due to a warm winter caused $220 million in losses of Michigan cherries in 2012.

- USGCRP (2014). Hatfield, J., G. Takle, R. Grotjahn, P. Holden, R. C. Izaurralde, T. Mader, E. Marshall, and D. Liverman, 2014: Ch. 6: Agri-culture. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 150-174

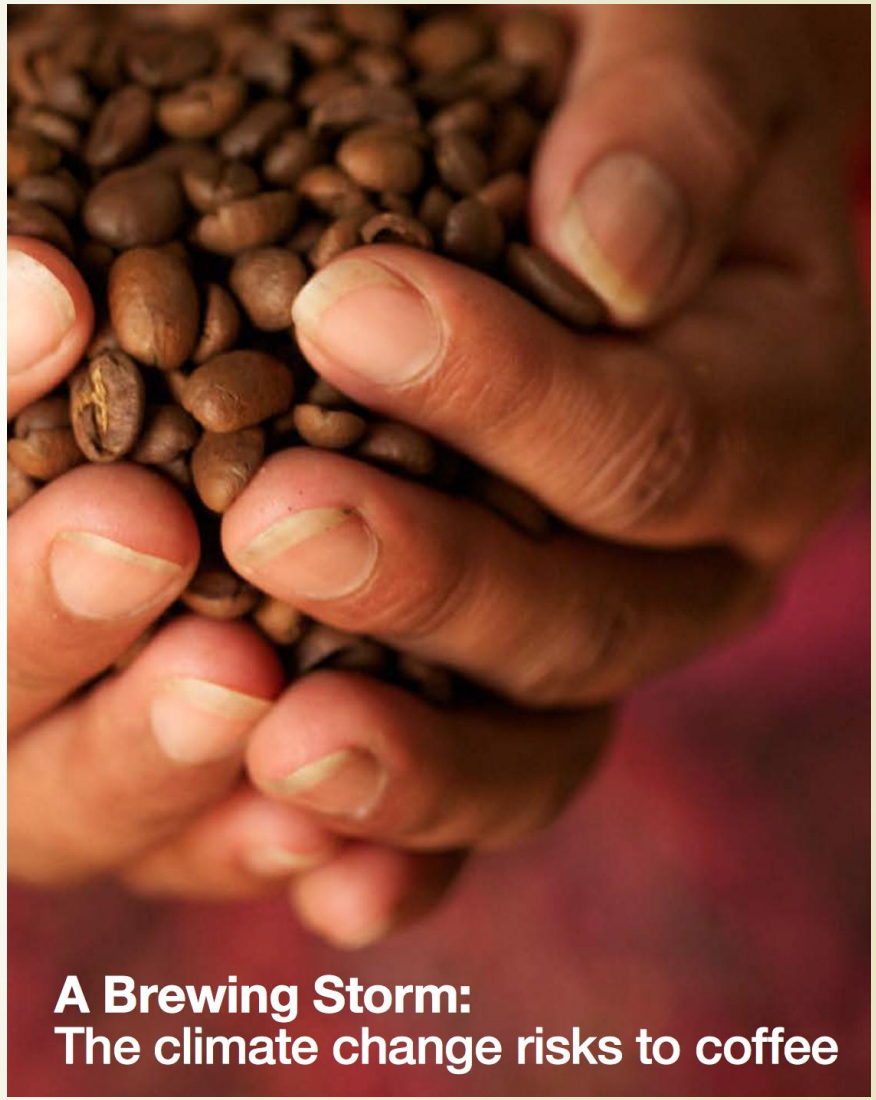
Source: SgForums.com

An uncaffeinated future?

+70%

- **"Climate change is projected to cut the global area suitable for coffee production by as much as 50% by 2050."**
  - "By 2080, wild coffee…could become extinct."

- The Climate Institute. (2016). A Brewing Storm: the climate change risks to coffee | The Climate Institute. Retrieved May 3, 2017, from http://www.climateinstitute.org.au/coffee.html



A Tenuous Future At Best

+70%

- **We face imminent decisions about the future of human civilizations.**
  - A simultaneous surge in human population and an unprecedentedly-rapid climate shift may be beyond the capacity of ecosystem services to support human civilizations.
  - Failure to adequately address these issues could result in global epidemics of widespread starvation and armed conflict.
  - Scientists are anticipating long-term impacts with a similar magnitude of ramifications to ag as the Dust Bowl.

Source: http://www.circleofblue.org/wp-content/uploads/2014/05/Farm2-Dalhart-Texas-LOC-1000-.jpg

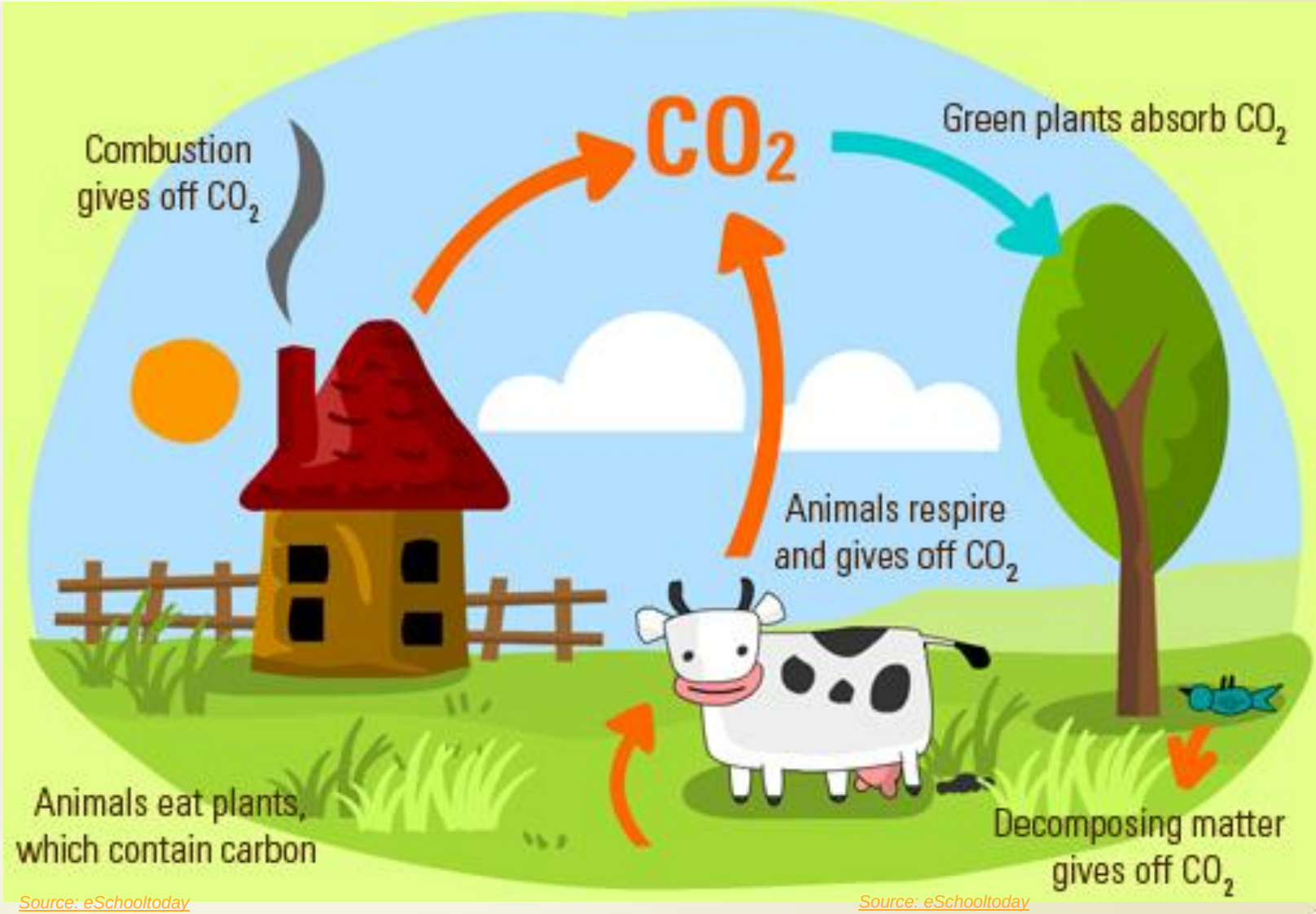
Questions & Discussion


TIME
for a
BREAK!

The Human Causes of Climate Change

Carbon Cycle 101

- What processes <u>add</u> CO2 to the air?
- What processes <u>remove</u> CO2 from the air?
- If we wanted to lower CO2 levels, how could we do it?
- Think/Pair/Share



Source: eSchooltoday

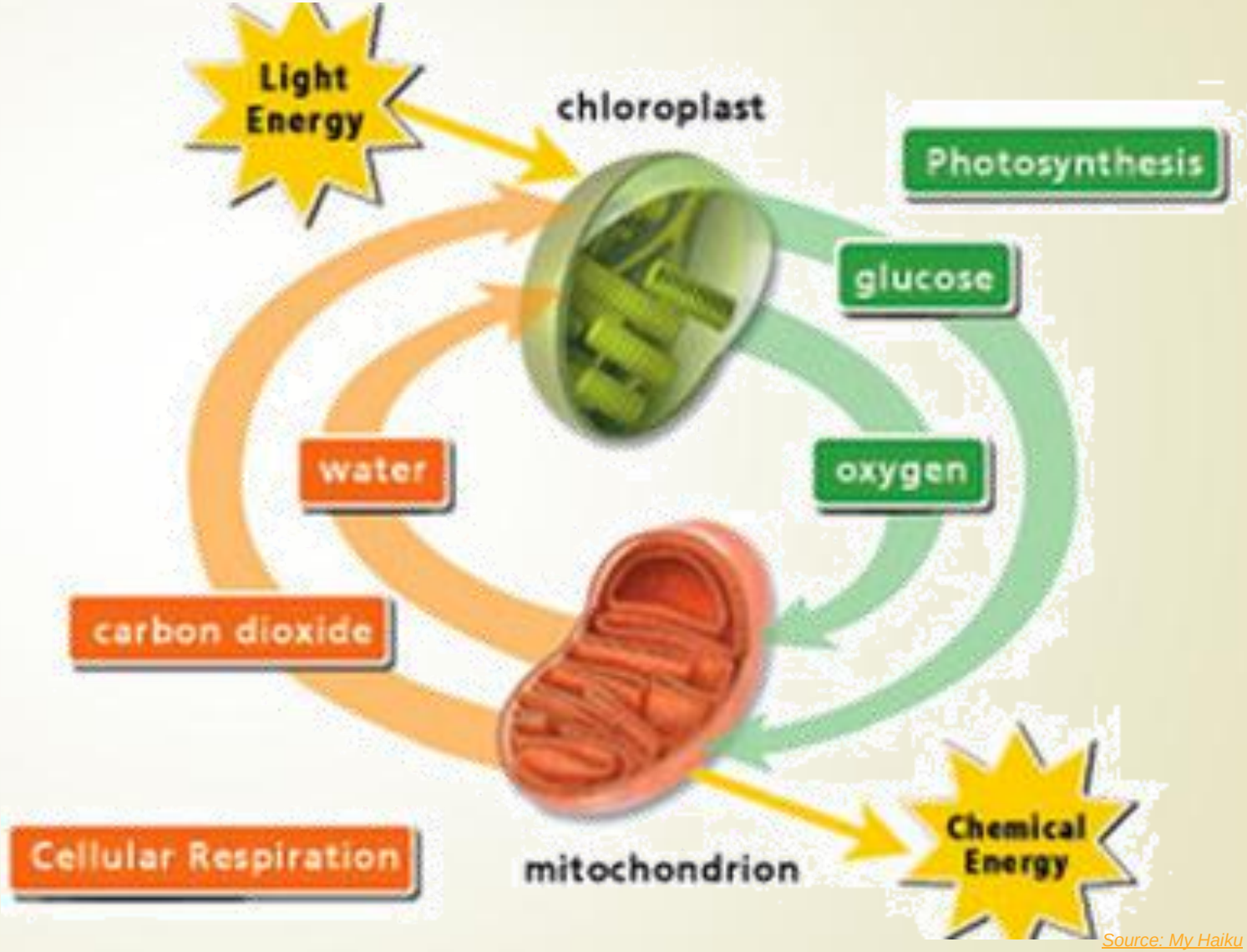
Source: eSchooltoday

At the molecular level

Using light energy, carbon dioxide and water molecules are rearranged to form glucose and O2 during photosynthesis.

Glucose is needed to carry hydrogen to the mitochondria so that it can turn ATP Synthase to make ATP (cell energy). Breathed oxygen removes used hydrogen from the mitochondria.

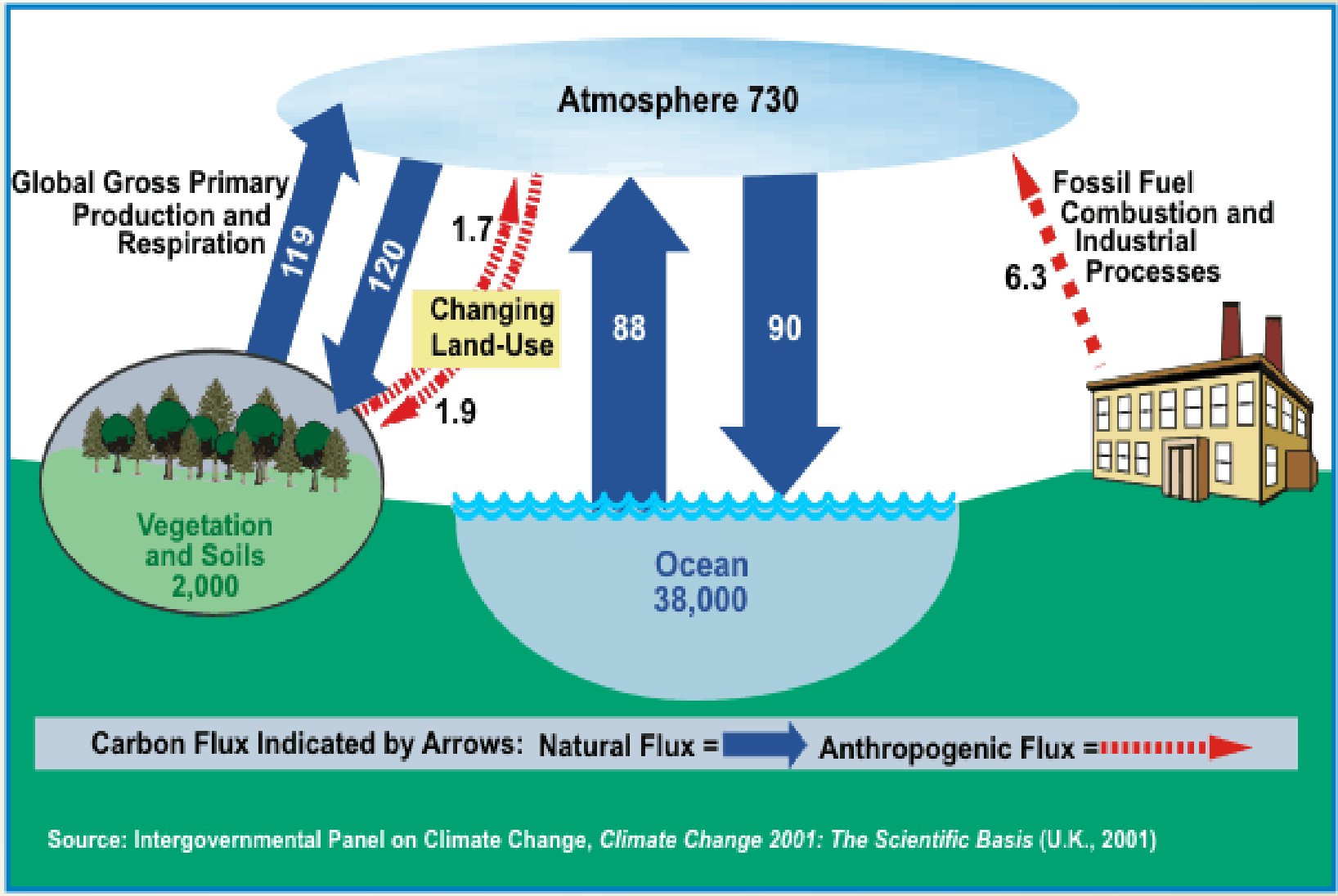
The carbon, oxygen, and hydrogen reform CO2 and H2O.



Source: My Haiku

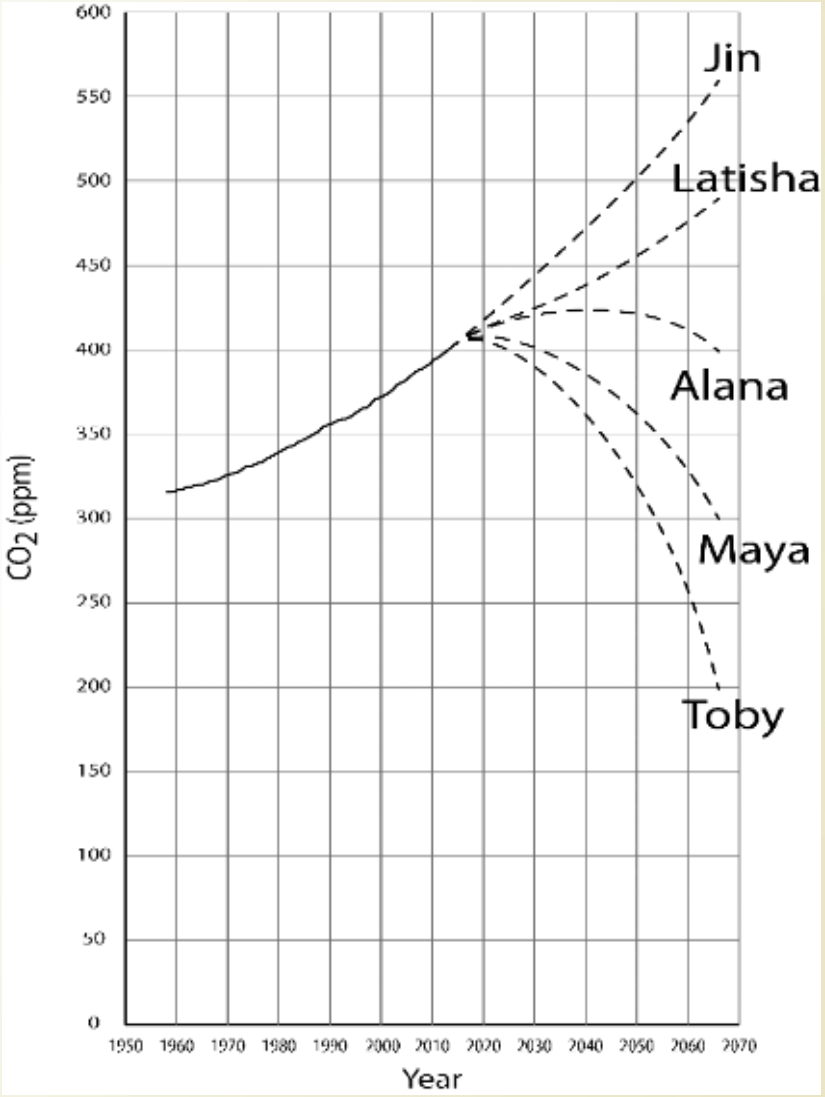
At the global level

- **In most respects, the carbon cycle is balanced.**
  - Most arrows into the atmosphere are balanced by equivalent arrows out.
  - But there is one exception…which arrow throws off this entire global cycle?

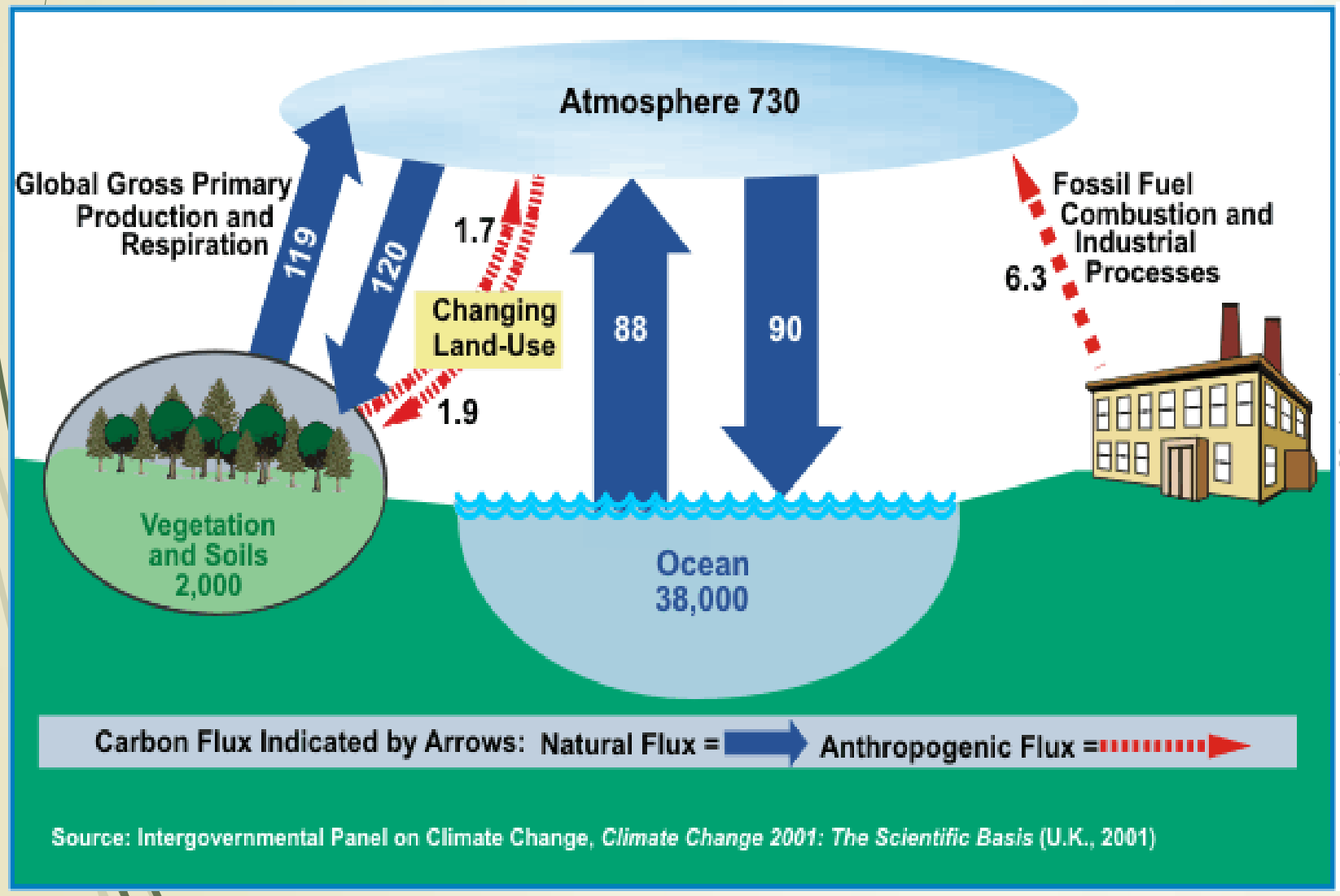


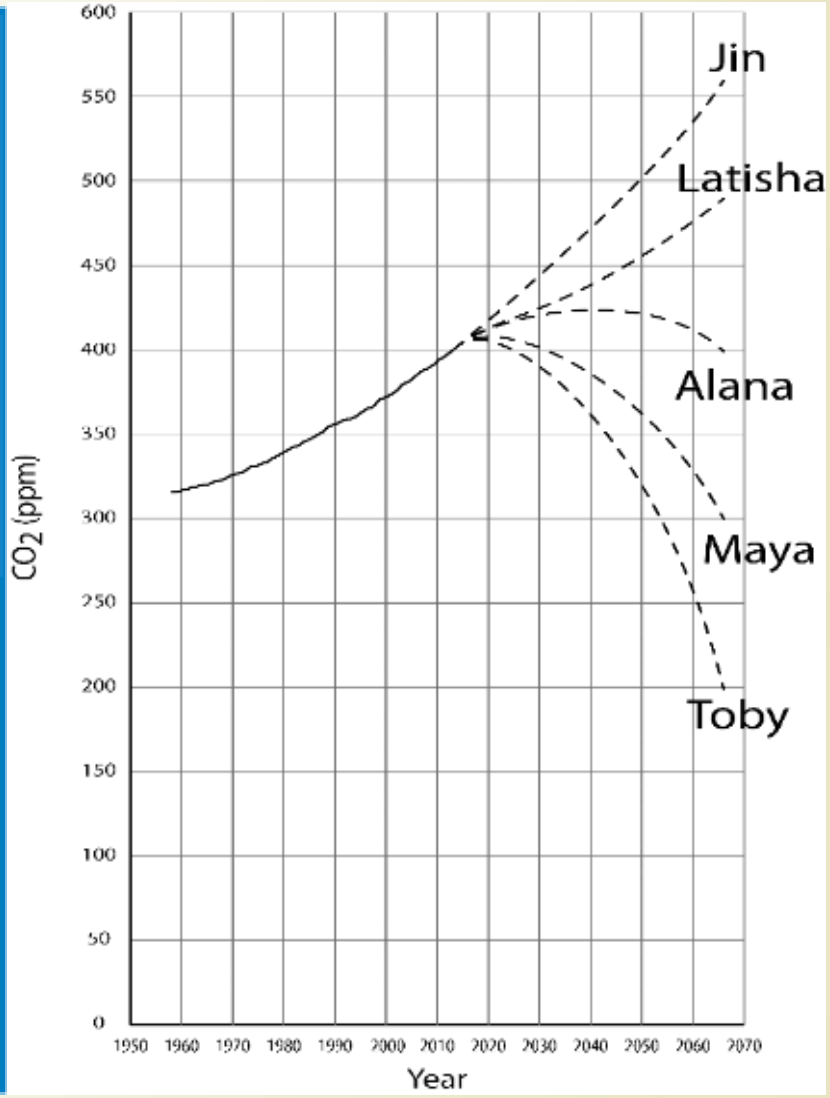
Halving Fossil Fuel Use

- **If the entire world could cut its use of fossil fuel in half and keep its fossil fuel use at that level indefinitely, which of the following scenarios would be the most likely outcome for atmospheric CO2 levels?**
  - Work in a small group and choose one of the 5 options.



Flux & Pool Diagram

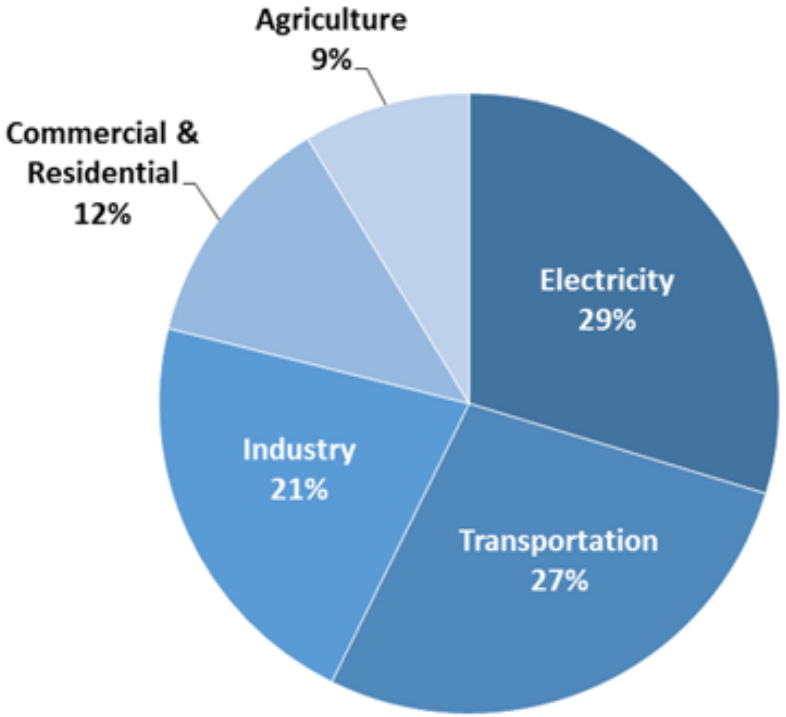




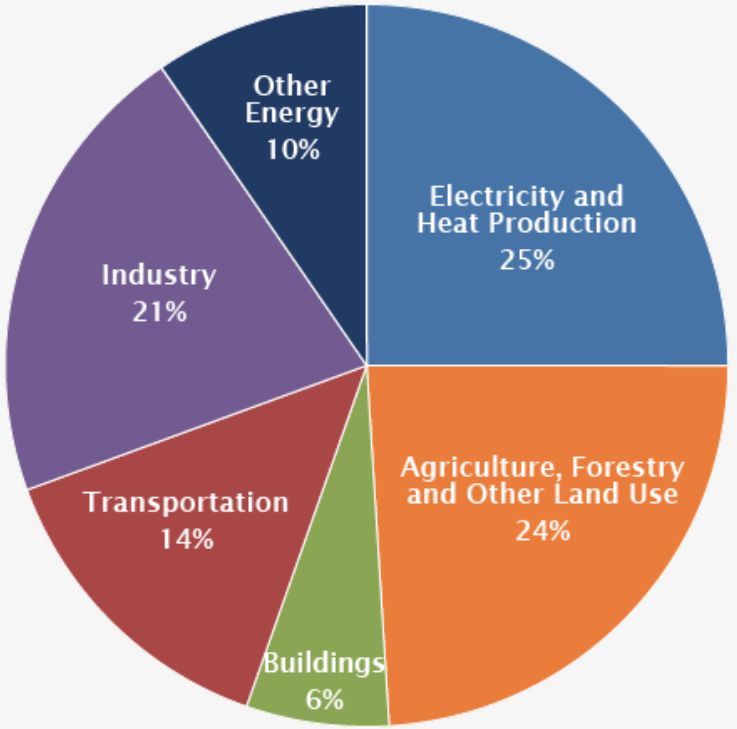
Where is all this carbon coming from?

- **Take a moment and look at the graphs of emissions.**
  - If you were going to suggest 3 ways in which America could fix climate change, what would you suggest?
  - What are some changes that would be less effective in fixing climate change?

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2015



Global Greenhouse Gas Emissions by Economic Sector



Source: United States Environmental Protection Agency

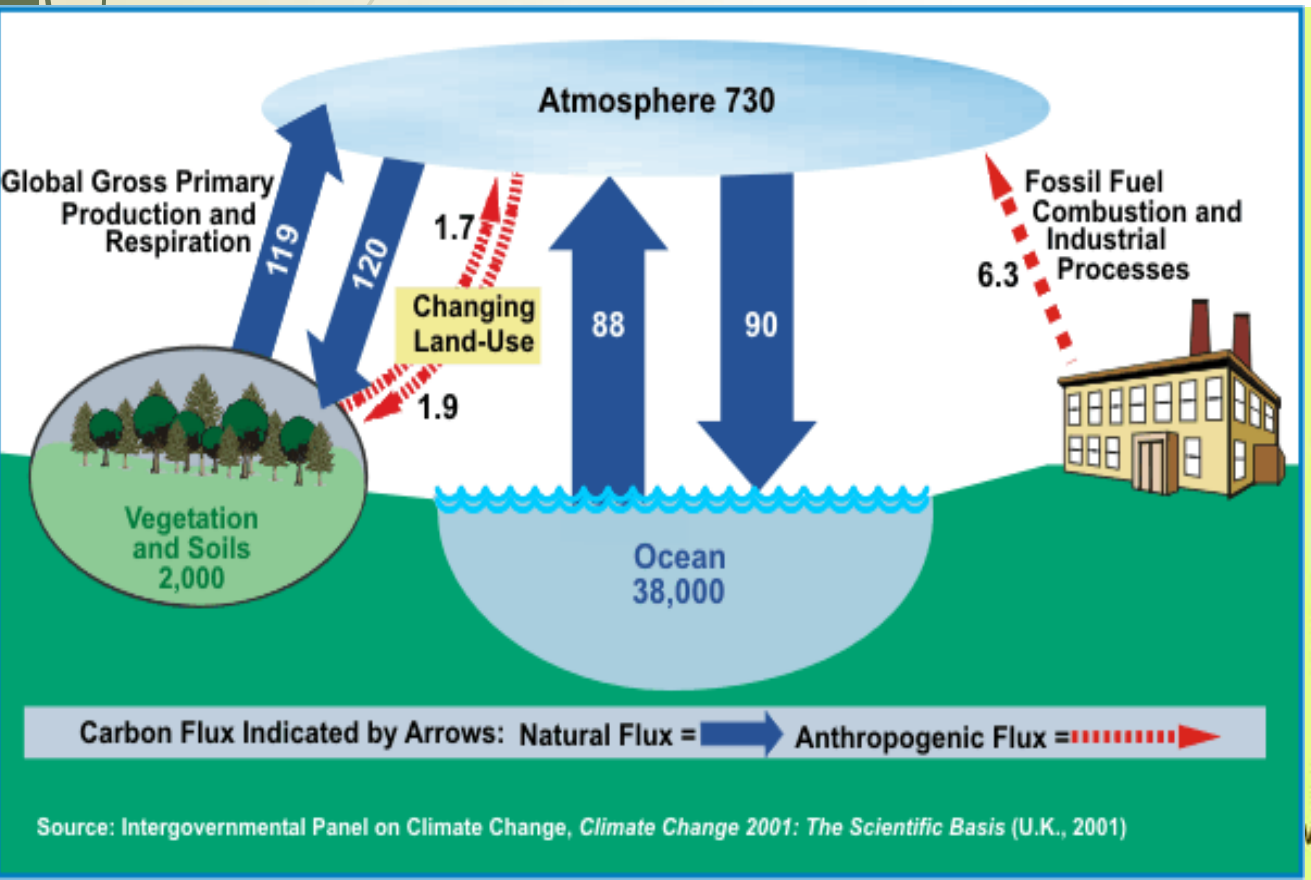
Debunking common claims

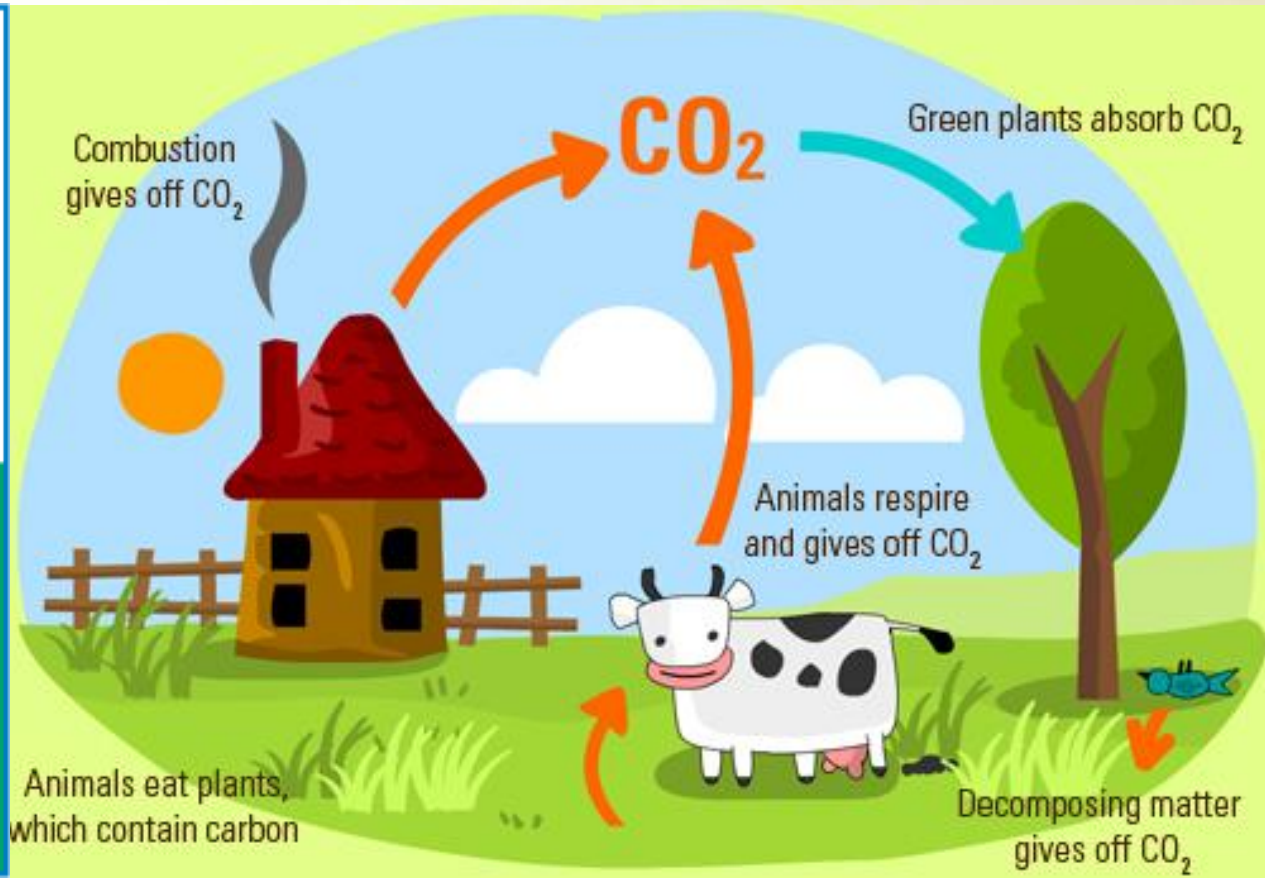
1. "The rise in temperature is due to changes to the sun (sun spots, solar activity, etc.) and not CO2."
2. "CO2 is a naturally-occurring gas that is necessary for life on earth. It's not a problem"
3. "Volcanoes are far more likely to be the cause."
4. "The earth always goes through natural cycles. This is just another natural cycle."
5. "The amount of CO2 from human activity is far smaller than the amount from natural sources."
6. "A warmer planet may be good for humans. It may mean that we can grow more food."
7. "During Medieval times, Greenland was warm and green. Global warming is nothing new, nor is it caused by people."
8. "In the middle of the 20th century, scientists thought we were going to have an ice age, now its warming. Why should we believe them now?
9. "There is nothing we can do. Why waste money trying to fix it?"

What can we do about Climate Change?

Reducing CO2

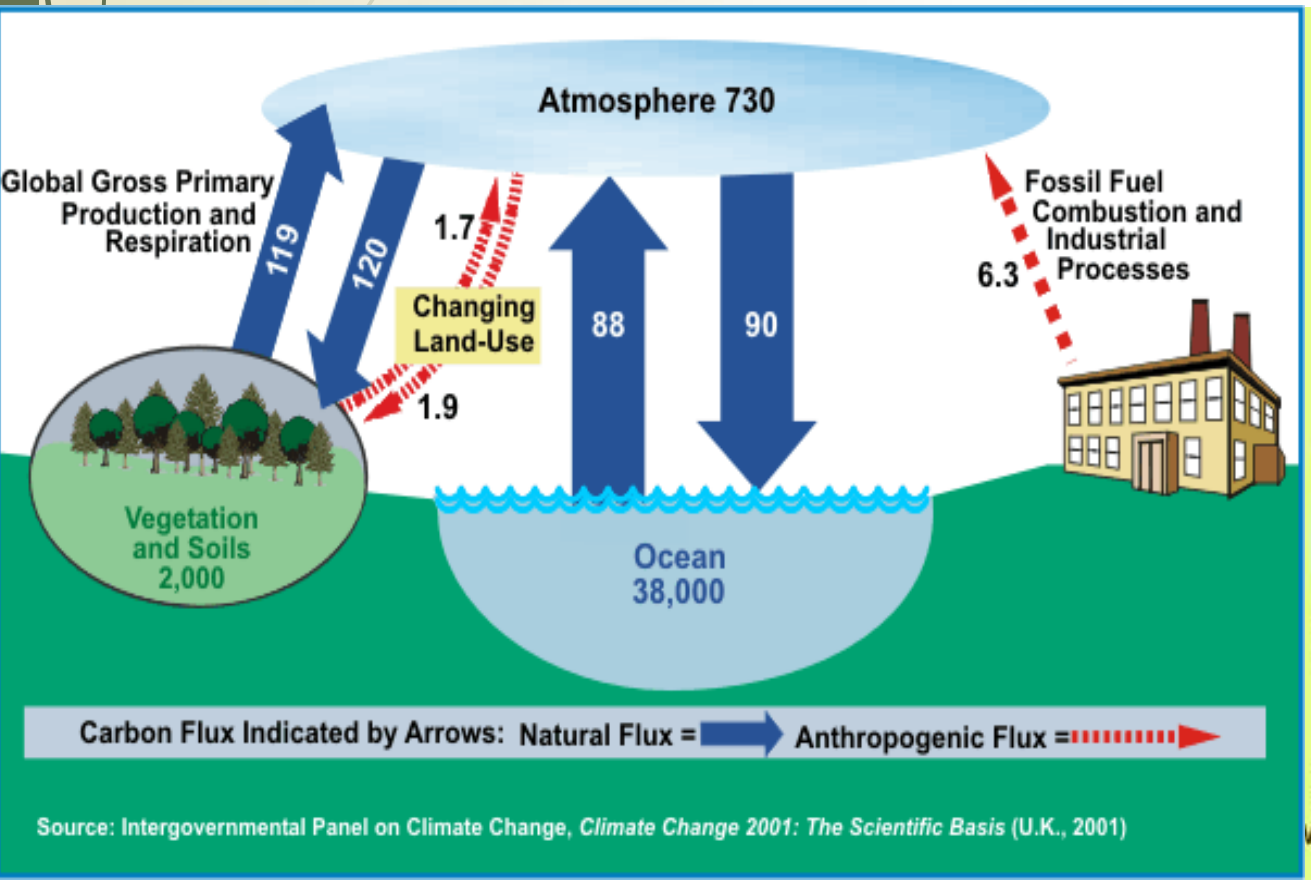
- Look at the two images below and use this information to suggest at least 3 ways in which atmospheric CO2 levels could be reduced.

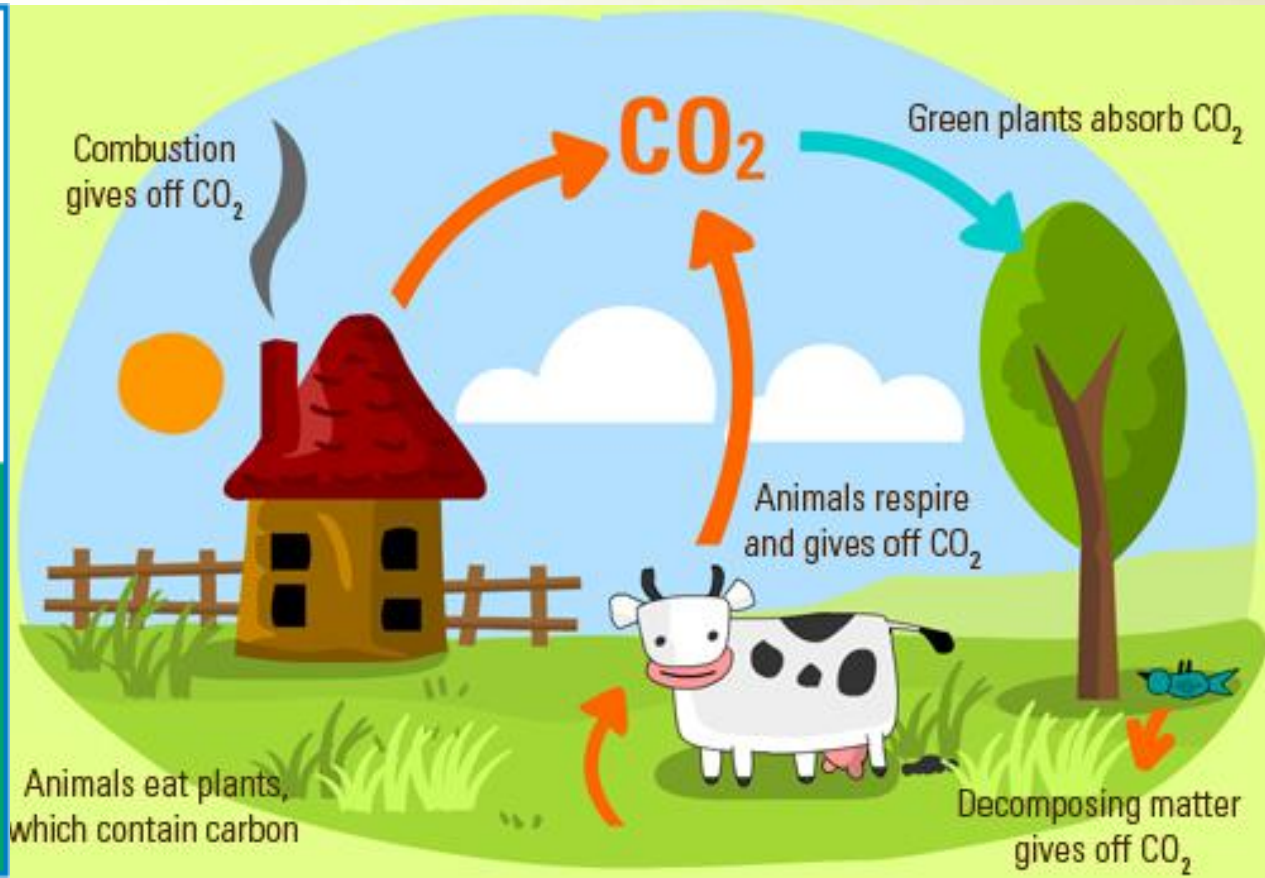




Reducing CO2 through Agriculture

- **Now try to suggest at least 3 ways in which atmospheric CO2 levels could be reduced through production agriculture specifically.**





One way to fix climate change: Beer

FOOD FOR THOUGHT

After A Long Day Of Fighting Climate Change, This Grain Is Ready For A Beer

October 26, 2016 · 4:00 PM ET

ALASTAIR BLAND

Climate Change and Your Classroom

Great Lakes Bioenergy Research Center

Secure https://www.glbrc.org/education

Apps TE902SS17SyIDRA... Educational Theor...

GREAT LAKES BIOENERGY RESEARCH CENTER

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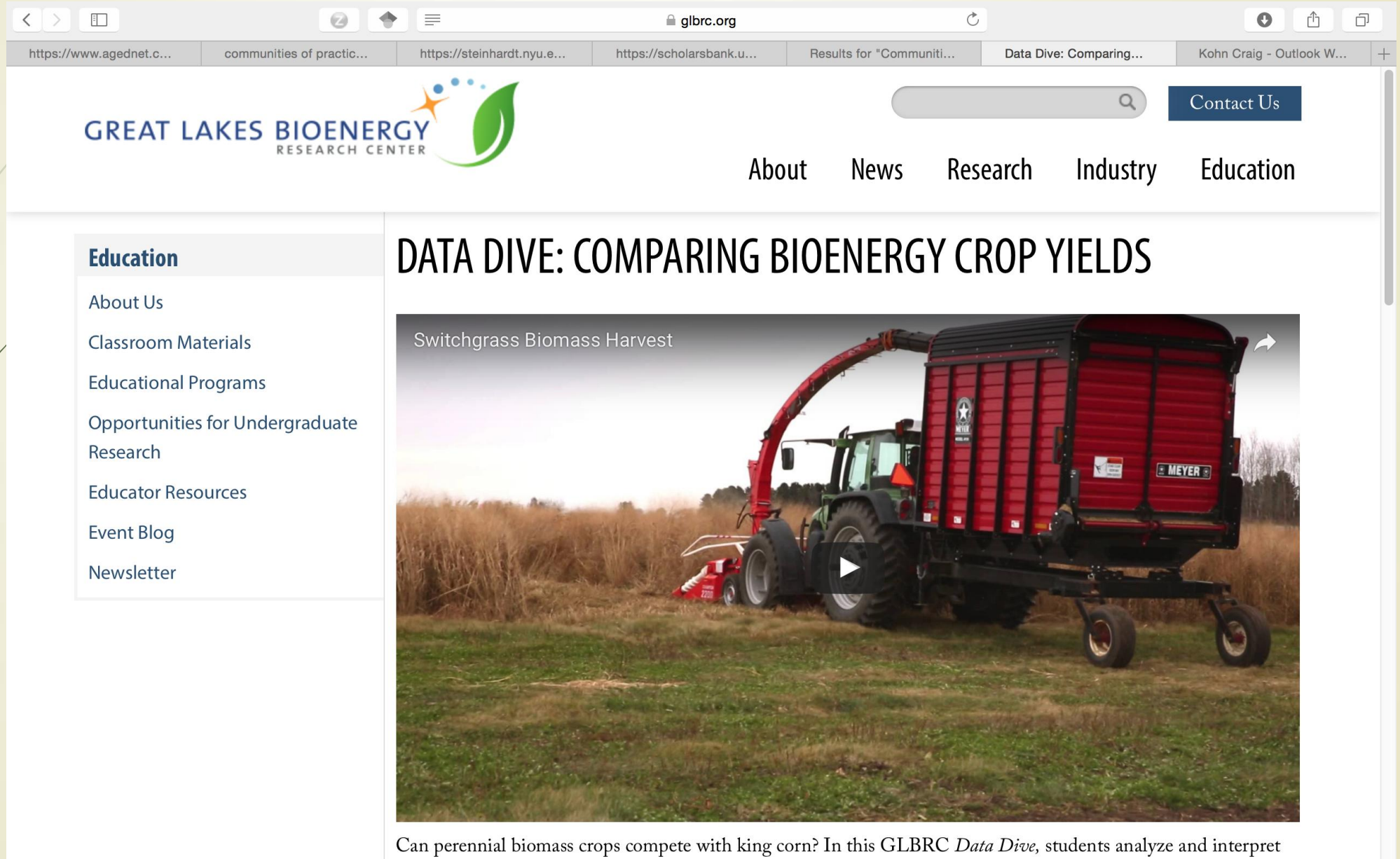
The mission of GLBRC Education & Outreach is to inform a variety of audiences about bioenergy research, energy concerns, and sustainability issues affecting our planet. Our goal is to broaden the understanding of current issues in bioenergy for the general public, and students and educators at the K-16 levels.

GLRBC Activities – Data Dives



GLRBC Activities – Fields of Fuel Game

GREAT LAKES BIOENERGY RESEARCH CENTER

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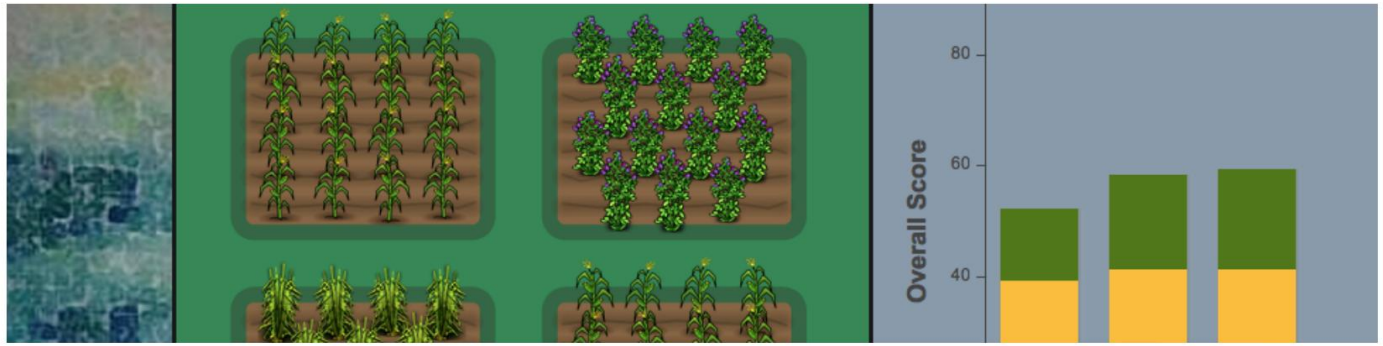
FIELDS OF FUEL COMPUTER GAME



In this game, players—both students and the public—take on the role of farmers working to sustainably grow crops to produce energy resources, earn income and improve ecosystem services. In doing so, players engage in sophisticated systems-level thinking and learn about:

- Ecological and economic aspects of sustainability
- Short and long term dynamics of the sustainable systems
- Local and global impacts of individual farmer management decisions

Interacting with and making sense of game dynamics demonstrates the complexity involved with the sustainable production of bioenergy crops and facilitates engagement with current research and sustainability in ways that are difficult with traditional instructional approaches. Extend the learning by combining this activity with The

GLBRC Activities – Carbon Footprints

Name _____ Teacher _____ Date _____

Activity 7.1: Preparation for Future Learning Introduction

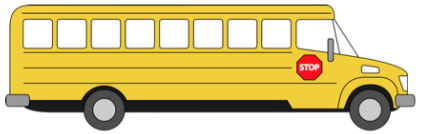
You will be determining the carbon dioxide emissions from your school's bus fleet and will calculate how many trees you would have to plant per year to completely offset these emissions. In this activity, you will be introduced to the activities that will enable you to make this determination.

Background: There are roughly a half million school buses in the United States that are used to transport students to school. Each of these buses uses an average of about 1700 gallons of fuel per year, and that fuel is mostly converted into carbon dioxide and water when it is combusted.

Because the amount of carbon dioxide in the atmosphere continues to rise each year, there is a growing interest in becoming **carbon neutral**. This means that actions are taken to remove the carbon dioxide from the atmosphere that was emitted as a result of human activity. Becoming carbon neutral is one way to reduce your **carbon footprint**, or the amount of carbon dioxide that is emitted as a result of human activity.

One option for becoming more carbon neutral is to plant trees. Trees sequester carbon dioxide and water to produce glucose and oxygen during photosynthesis. While some of that glucose is converted back into carbon dioxide when trees undergo cellular respiration, trees can also **sequester** carbon atoms as they undergo biosynthesis. In other words, trees store carbon atoms as part of the molecules that comprise the wood and other solid materials of the tree. The more carbon atoms that are sequestered as a part of trees and other plants, the lower the carbon dioxide levels in the atmosphere.

In this activity, you will determine how many trees you would have to plant per year to negate the carbon footprint of your school's bus fleet. In other words, you will determine how many trees it would take to completely sequester the carbon dioxide that is emitted from bus transportation at your school. You will also consider whether or not it would be better to ride the bus to school or ride in a car.



Forestry & Carbon Sequestration *by C. Kohn, Agricultural Sciences – Waterford WI*

Name: _____ Hour _____ Date: _____

Date Assignment is due: *end of the week* (Day of Week) _____ (Date) Why late? _____ (If your project was late, describe why) Score: + ✓ –

Directions: This sheet will be due upon the completion of the week. This assignment is graded on a + / ✓ / - scale. This lab is based on calculations and published material from the Trees for the Future organization and was created with help from Jeremy Solin, *et. al* of LEAF Forestry Education Program at the University of Wisconsin – Stevens Point. **A calculator is needed for this lab.**

1. How many trees do you think it would take to offset the carbon dioxide produced by your lifestyle? Write your best estimate below:

   I estimate I would need _____ trees per year to offset my lifestyle:

   Why did you choose this number? Briefly explain how you came up with this amount:

   _____

   _____

2. Based on what you know, what you've learned, and what you have heard, why should we care how much carbon dioxide is produced by our lifestyle? What impact does carbon dioxide have on the environment?

   _____

   _____

   _____

3. Determine the height of your tree:
   a. You can do this in a few different ways….(see attached methods)
      i. Shadow Method
      ii. Student Method
      iii. Clinometer Method

   Height of your Tree: _____ feet

4. What is the diameter of your tree? (Use a measuring tape to measure your circumference and divide by 3.14)

   Circumference: _____ in. ÷ 3.14 = _____ in (diameter)

   Diameter of your Tree: _____

The Climate Change Debate

- **In small groups (3-5) of your choosing, reconsider the following questions. Be prepared to offer responses.**
  - 1. What evidence is there to suggest that climate change is happening?
  - 2. What evidence is there to suggest that climate change is happening primarily because of human activity?
  - 3. Is there a sufficient amount of evidence to negate either of these claims (i.e. that climate is not happening or is not due to human activity)?
  - 4. Do we have enough scientific evidence to justify any kind of action?
  - 5. What is the harm of not taking action on climate change?

What you can do as a teacher

- **Climate change is a serious problem that can only be fixed by largescale societal action.**
  - However, we also face unparalleled resistance in this country to the kind of action necessary to solve this problem.
  - Misleading information and outright falsehoods are being used to dissuade action that will be necessary for the future agriculture.
  - As a teacher, you are on the frontlines of this issue.
- **What you can do:**
  - Don't be quiet around deniers – silence is agreement.
  - Know the evidence and use it.
  - Emphasize evidence-based reasoning on a daily basis.
  - Attend workshops and training as often as you can.
  - Vote, speak up, and recognize your role as one of the most influential people in your community.

Future Work

- **Research by Redman & Redman (2014) also came to the conclusion that teaching about sustainability alone does not result in behavioral changes; procedural and social knowledge are vital to this goal.**
  - Chawla and Cushing's 2007 concluded that the most effective sustainability education had extended duration of time, allowed for opportunities to learn and practice skills, and resulted in the accomplishment of a specific goal.
  - These instructional models are similar to the 3-circle model of ag ed, leading to the submission of a Graduate Research Fellowship application with the National Science Foundation (NSF).
- **Michigan State University and the NSF has fully funded my research for 5 years on this topic.**
  - Current intention is to draft a curriculum this year, implement a pilot test in 2018-19, and implement a full version in 2019-20.
  - If interested in being a part of this project, please visit wuhsag.weebly.com.