U2D14 - CER

U2D14 – Bell Ringer – 11/13

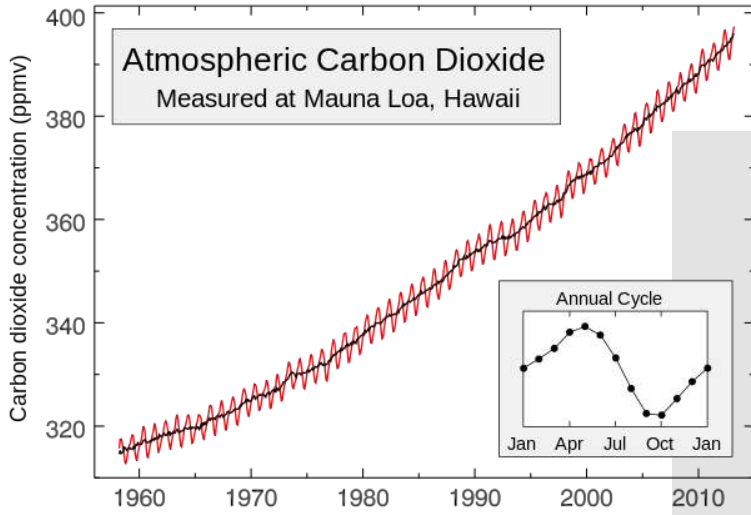
1. Refer to the graph shown above. Which of the following is a plausible explanation of why levels of CO_2 start to decrease in the spring and start to increase in the winter?

A. People use more energy in the winter releasing more CO_2 in the air.

B. Plants release more CO_2 in the winter than in the spring.

C. People drive less in the spring.

D. Both A and B are plausible explanations.



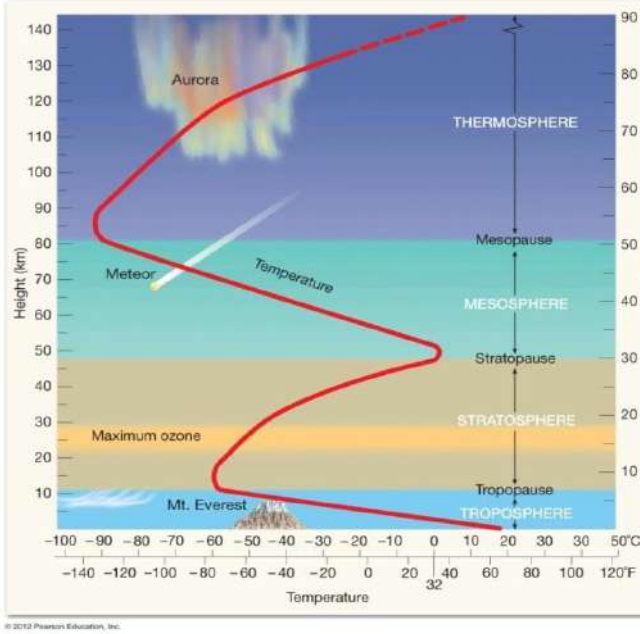
2. Coal is a major contributor of greenhouse gasses because it produces carbon dioxide when burned. The main use of coal in the USA today is for . . .

a. generating electricity b. grilling burgers

c. fuel for trains d. to burn waste

3. Which two atmospheric layers **increase** temperature with increased elevation?

4. Which two atmospheric layers **decrease** temperature with increased elevation?



Objectives

Content Objective: Compile evidence and reasoning into an explanation for how humans have impacted climate.

Language Objective: Combine multiple sources of evidence and reasoning into an explanation.

Essential Question:

- What is the major trend in Earth's temperature data and what is causing that to happen?

U2D14 – Scientific Explanation CER

U2D14 - Scientific Explanation CER

Tuesday, November 12, 2019 10:39 AM

Claim-Evidence-Reasoning Explanation Tool Scaffold

Essential Question	
What is the major trend in Earth's temperature data and what is causing that to happen?	
Evidence from data and observations **Evidence sources:** **lab results, graphs**	**Reasoning: Science Ideas and concepts you h learned for support, or explaining why your evidence relates to the question.** **Reasoning sources:** **Videos, bell ringers, notes, lab background**

Evidence: scientific data (quantitative or qualitative) that supports the claim.

Directly supports the claim (*relevant* data)

Data is cited in some or all of the following ways:

- **Cites specific data (e.g. When the water was 25°C, it took 15 seconds for the tablet to dissolve.)**
- Describes trends in the data (e.g. As the temperature of the water increased, the time to dissolve decreased.)
- Compares and contrasts data (e.g. The tablet took 10 seconds longer to dissolve in the 25°C water than in the 50°C water.)

Reasoning: a justification that connects the evidence to the claim.

Uses scientific principles (facts that have already been established)(e.g. Certain types of molecules absorb infrared radiation and re-emit heat to the surface.)

Allows the reader to easily follow the logic (e.g. Therefore, when the lid was on the box, more infrared radiation was absorbed, and heat was reflected to the surface, which increased the temperature. This is different than the box with no lid, where more radiation was reflected into space, which explains why the temperature didn't increase as quickly.)

Clearly connects back to the claim(e.g. The atmospheric condition that absorbed radiation and re-emitted it to the surface increased temperature more, showing an atmospheric condition with more greenhouse gasses will have a higher temperature.)

Claim A claim is a statement that answers the original question.

It is clear to the reader what the question was without having to look at the question.

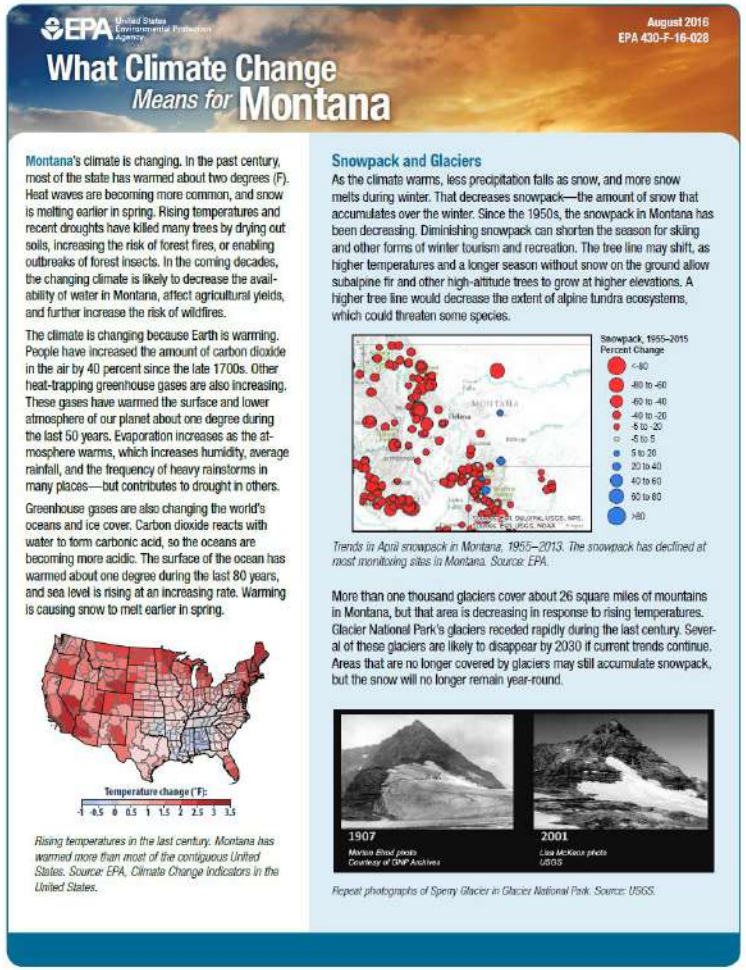
Uses specific language (avoids vague pronouns like “it” and “that”)

Rubric

U2D15 - CER

U2D15 – Bell Ringer – 11/14

1. Click the PDF above and open the article about climate change impacts in Montana from the United States Environmental Protection Agency
2. Identify two impacts that we have and will experience.
3. How should we prepare for or react to those impacts?



EPA United States Environmental Protection Agency

August 2016
EPA 430-F-16-028

What Climate Change Means for Montana

Montana's climate is changing. In the past century, most of the state has warmed about two degrees (F). Heat waves are becoming more common, and snow is melting earlier in spring. Rising temperatures and recent droughts have killed many trees by drying out soils, increasing the risk of forest fires, or enabling outbreaks of forest insects. In the coming decades, the changing climate is likely to decrease the availability of water in Montana, affect agricultural yields, and further increase the risk of wildfires.

The climate is changing because Earth is warming. People have increased the amount of carbon dioxide in the air by 40 percent since the late 1700s. Other heat-trapping greenhouse gases are also increasing. These gases have warmed the surface and lower atmosphere of our planet about one degree during the last 50 years. Evaporation increases as the atmosphere warms, which increases humidity, average rainfall, and the frequency of heavy rainstorms in many places—but contributes to drought in others.

Greenhouse gases are also changing the world's oceans and ice cover. Carbon dioxide reacts with water to form carbonic acid, so the oceans are becoming more acidic. The surface of the ocean has warmed about one degree during the last 80 years, and sea level is rising at an increasing rate. Warming is causing snow to melt earlier in spring.

Temperature change (°F):
-1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5

Rising temperatures in the last century. Montana has warmed more than most of the contiguous United States. Source: EPA, Climate Change Indicators in the United States.

Snowpack and Glaciers

As the climate warms, less precipitation falls as snow, and more snow melts during winter. That decreases snowpack—the amount of snow that accumulates over the winter. Since the 1950s, the snowpack in Montana has been decreasing. Diminishing snowpack can shorten the season for skiing and other forms of winter tourism and recreation. The tree line may shift, as higher temperatures and a longer season without snow on the ground allow subalpine fir and other high-altitude trees to grow at higher elevations. A higher tree line would decrease the extent of alpine tundra ecosystems, which could threaten some species.

Snowpack, 1955–2015
Percent Change
<-80
-80 to -60
-60 to -40
-40 to -20
-5 to -20
-5 to 5
5 to 20
20 to 40
40 to 60
60 to 80
>80

Trends in April snowpack in Montana, 1955–2013. The snowpack has declined at most monitoring sites in Montana. Source: EPA.

More than one thousand glaciers cover about 26 square miles of mountains in Montana, but that area is decreasing in response to rising temperatures. Glacier National Park's glaciers receded rapidly during the last century. Several of these glaciers are likely to disappear by 2030 if current trends continue. Areas that are no longer covered by glaciers may still accumulate snowpack, but the snow will no longer remain year-round.

1907
Montana Bland photo
Courtesy of GNP Archives

2001
Lisa McKeon photo
USGS

Repeat photographs of Sperry Glacier in Glacier National Park. Source: USGS.

Precipitation and Water Resources

Changing the climate is likely to increase the demand for water and make it more available. Warmer temperatures increase evaporation and water use by plants. Increases in rainfall, however, are likely to offset these losses so that soil moisture increases slightly or remains about the same as today. More water is likely to run off into the upper Missouri River and its tributaries.

In areas that depend on melting snow, however, the supply of water is likely to decline. Mountain snowpacks are natural reservoirs that collect the snow that falls during winter and release water when the snow melts during spring and summer. Dams capture meltwater and retain it for use later in the year. But upstream of these dams, as the snowpack declines, less water is available during droughts for ecosystems, water-based recreation, and landowners who draw water directly from a natural lake or flowing river.

Agriculture

Rising temperatures and changes in rainfall are likely to have both positive and negative effects on Montana's farms and ranches, and the net effect is unknown. Higher temperatures reduce yields of wheat, but higher concentrations of carbon dioxide are likely to increase yields by a similar amount. Warmer and shorter winters may allow for a longer growing season, which could allow two crops per year instead of one in some instances. But warmer winters may also promote the growth of weeds and pests.

Rising carbon dioxide concentrations are likely to increase the productivity of rangelands. Provided that the quality of forage does not deteriorate, the higher range productivity would increase cattle production.

Warmer winters could also benefit ranches by reducing losses to winter storms. During the winter of 1996–1997, for example, high winds and heavy snow killed half of the newborn calves and 100,000 adult cows in the Northern Great Plains. But warmer summers would at least partly offset the benefit of warmer winters, because hot weather causes cows to eat less and grow more slowly, and it can threaten their health. Over the next 70 years, the number of days above 100°F in Montana is likely to double.

Wildfires

Higher temperatures and drought are likely to increase the severity, frequency, and extent of wildfires in Montana, which could harm property, livelihoods, and human health. On average, about 2 percent of the land in the state has burned per decade since 1984. Wildfire smoke pollutes the air and can increase medical visits for respiratory and heart problems.

Firefighters battle the Taylor Creek blaze in southeastern Montana in 2012. Credit: Gerald Vickers, National Wildfire Coordinating Group.

Forests

Longer growing seasons and increased carbon dioxide concentrations could increase the productivity of forests, but warmer conditions also make forests more susceptible to pests. Temperature controls the life cycle and winter mortality rates of pests such as bark beetles, which have infested millions of acres and killed millions of trees across the West in recent decades. With higher winter temperatures, some pests can persist year-round, and new pests and diseases may become established. Drought also reduces the ability of trees to mount a defense against attacks from beetles and other pests.

Human Health

Extremely hot and cold days can be unhealthy—even dangerous. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor. The elderly may be particularly prone to heat stress and other heat-related health problems, including dehydration, cardiovascular strain, and respiratory problems. Those with low incomes may be particularly vulnerable if they lack air conditioning. Power failures due to severe weather can also present risks, especially in lightly populated areas where access to the necessary support services may be limited. While these risks will increase as the climate becomes warmer, illnesses and deaths due to cold weather and snow are likely to decline.

The sources of information about climate and the impacts of climate change in this publication are: the national climate assessments by the U.S. Global Change Research Program, synthesis and assessment products by the U.S. Climate Change Science Program, assessment reports by the Intergovernmental Panel on Climate Change, and EPA's *Climate Change Indicators in the United States*. Mention of a particular season, location, species, or any other aspect of an impact does not imply anything about the likelihood or importance of aspects that are not mentioned. For more information about climate change science, impacts, responses, and what you can do, visit EPA's Climate Change website at www.epa.gov/climatechange.

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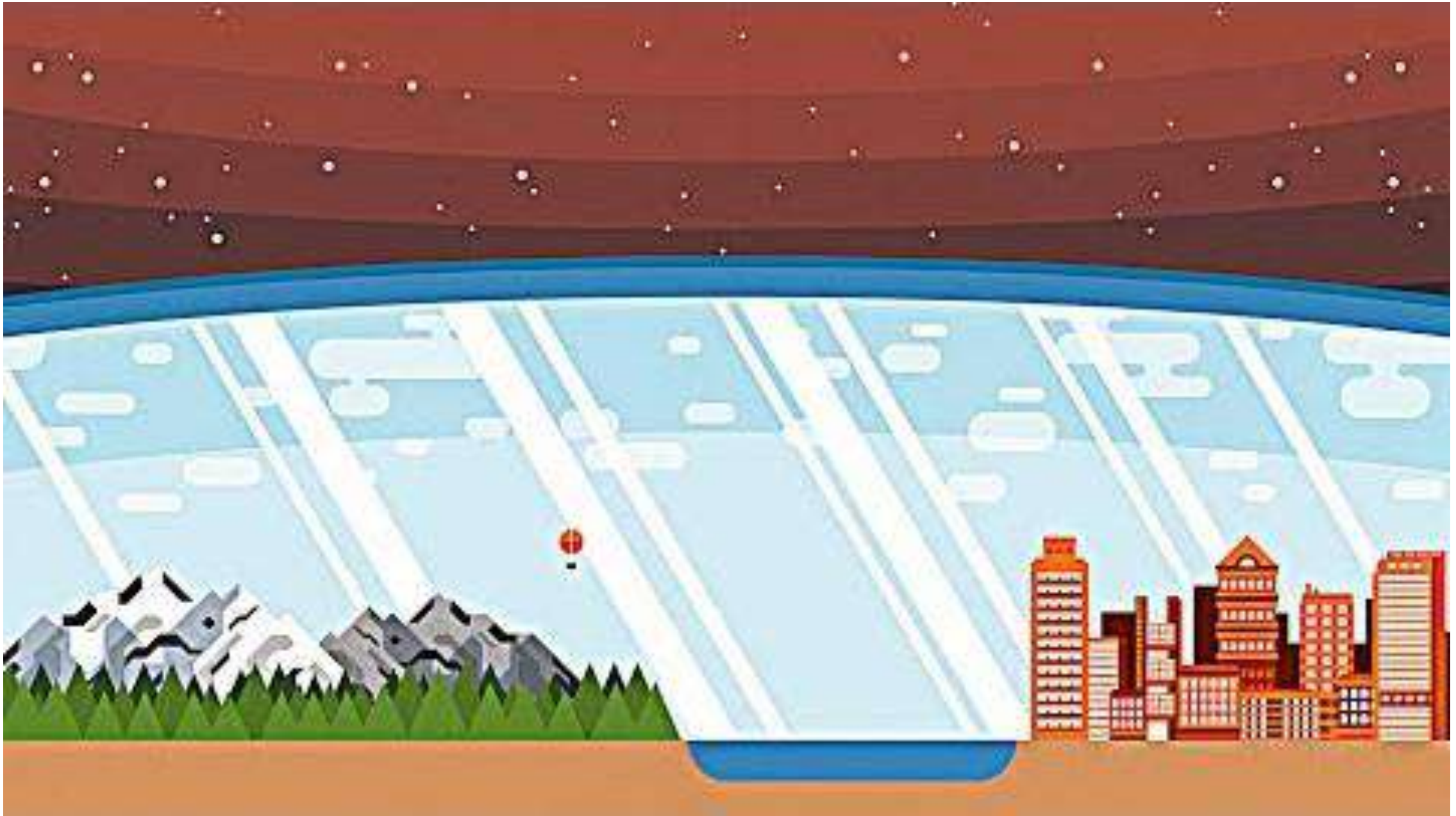
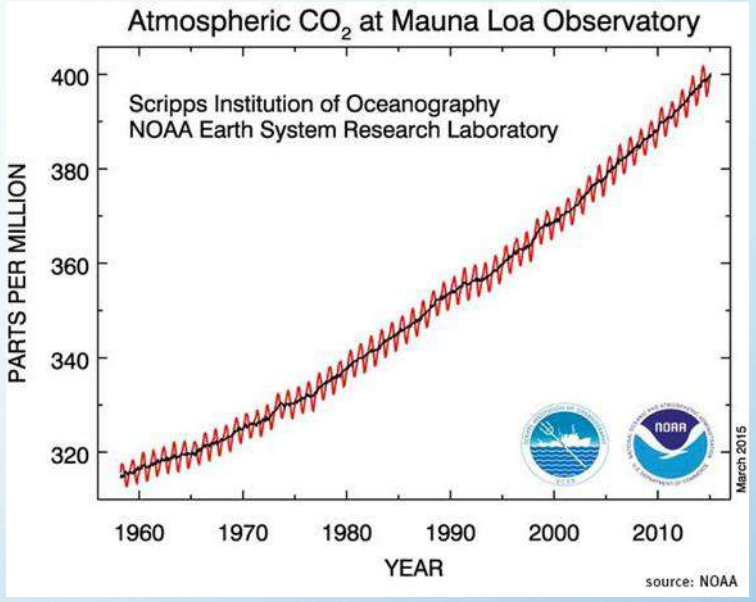
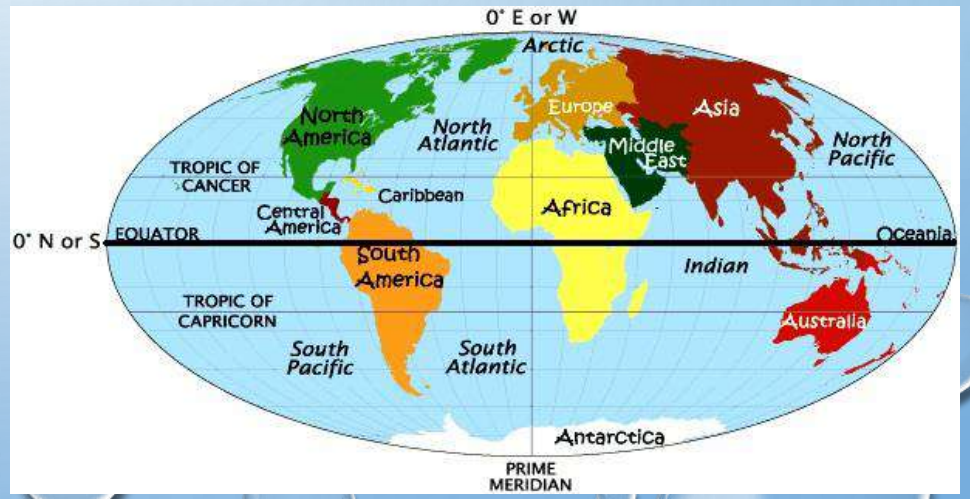
Greenhouse Effect Reasoning: In-Depth



SEASONAL VARIATION CONT…

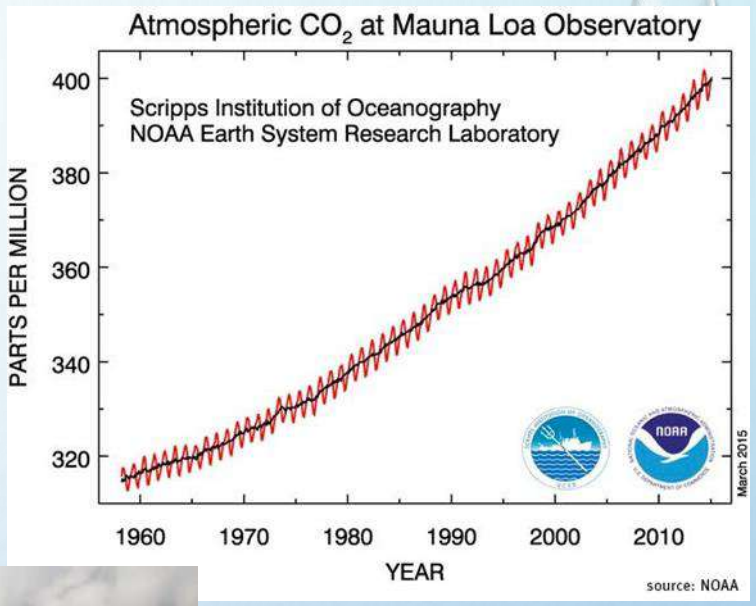
- THE PERIODIC ANNUAL FLUCTUATIONS IN THE GRAPH REFLECT SEASONAL CHANGES.
- THE NORTHERN HEMISPHERE HAS FAR MORE LAND AREA THAN THE SOUTHERN HEMISPHERE, AND MOST OF THE LAND AREA IN THE SOUTHERN HEMISPHERE IS DESERT.
- AS PLANTS IN THE NORTHERN HEMISPHERE GROW LEAVES EACH **SPRING AND SUMMER**, THEY REMOVE SOME CO_2 FROM THE AIR VIA PHOTOSYNTHESIS, CAUSING CO_2 LEVELS TO DROP.
  - THERE IS A LAG TIME FOR THIS EFFECT TO SHOW IN THE DATA, SO THE LOWEST ANNUAL CO_2 CONCENTRATIONS OCCUR IN THE FALL.
- DURING NORTHERN HEMISPHERE **FALL AND WINTER**, PLANTS LOSE THEIR LEAVES, AND THE DECREASE IN PHOTOSYNTHESIS CAUSES THE CO_2 LEVEL TO RISE.
  - THERE IS A LAG TIME FOR THIS CHANGE TO SHOW IN THE DATA AS WELL.
- THUS, HIGHEST CO_2 CONCENTRATIONS OCCUR IN MAY EACH YEAR. THIS SEASONAL FLUCTUATION IS THE NATURAL CYCLING OF CARBON FROM AN ATMOSPHERIC GAS TO SOLID PLANT MATERIAL AND BACK.



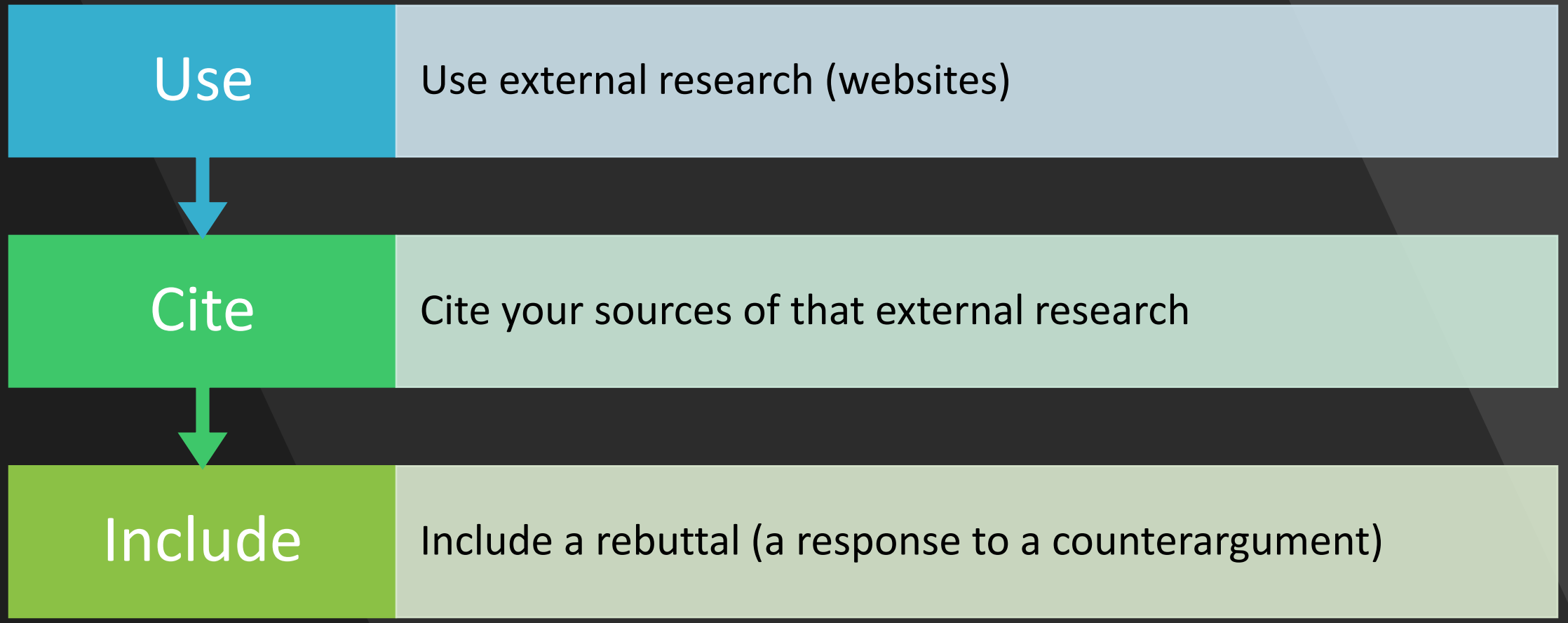


SEASONAL VARIATION CONT…

- WHEN YOU VIEW MULTIPLE YEARS OF DATA TOGETHER, THE OBVIOUS UPWARD TREND IS NOT PART OF THE NATURAL CYCLING OF CARBON BETWEEN THE ATMOSPHERE AND THE BIOSPHERE.
- **HUMAN ACTIVITIES ARE ALTERING THE CARBON CYCLE** — BOTH BY ADDING MORE CO_2 TO THE ATMOSPHERE AND, THROUGH LAND USE CHANGES SUCH AS DEFORESTATION, INFLUENCING THE ABILITY OF NATURAL SINKS, LIKE FORESTS, TO REMOVE CO_2 FROM THE ATMOSPHERE.
- WHILE CO_2 EMISSIONS COME FROM A VARIETY OF NATURAL SOURCES, HUMAN-RELATED EMISSIONS ARE RESPONSIBLE FOR THE INCREASE THAT HAS OCCURRED IN THE ATMOSPHERE SINCE THE INDUSTRIAL REVOLUTION (1760 - 1840).
- UNTIL THAT TIME, ATMOSPHERIC CO_2 HAD NOT BEEN HIGHER THAN 280 PPM. DIRECT MEASUREMENTS OF GAS BUBBLES IN ICE CORES FROM ANTARCTICA SHOW THAT ATMOSPHERIC CO_2 LEVELS DID NOT EXCEED 280 PPM DURING THE PREVIOUS 800,000 YEARS.
- THE MAIN HUMAN ACTIVITY THAT EMITS CO_2 IS THE COMBUSTION OF FOSSIL FUELS (COAL, NATURAL GAS, AND OIL) FOR ENERGY AND TRANSPORTATION, ALTHOUGH CERTAIN INDUSTRIAL PROCESSES AND LAND-USE CHANGES ALSO EMIT CO_2.



How to Exceed Expectations



Extra Credit

- Include in your explanation a discussion of how we know that the increased atmospheric carbon dioxide is caused by human burning fossil fuel instead of other natural sources.
- Possible sources:
  - https://www.esrl.noaa.gov/gmd/outreach/isotopes/mixing.html
  - https://www.yaleclimateconnections.org/2018/11/isotopes-point-to-the-culprit-behind-climate-change/
  - https://cdiac.ess-dive.lbl.gov/trends/co2/modern_isotopes.html

Exit Ticket

1) What topic or ideas are you most unsure of and want to review before the test?

2) How do you want to review that topic?