Name _____ Teacher _____ Date _____

4.5: Grading Seasons and Oceans Worksheet

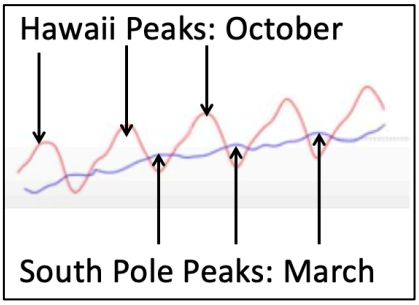
*This tool has "grading" in the title because at this point, students can be held accountable for correct answers. Level 4 (correct) responses to the questions are in **blue bold italics** below. There are also comments about common Level 2 and Level 3 responses to help you with grading and making decisions about what to emphasize in future lessons.*

Red italics suggest ways to grade student responses by giving them points for correct or partially correct answers. There are 6 points total on this worksheet.

A. Explaining why CO_2 concentrations in Hawaii are different from CO_2 concentrations at the South Pole

Start by viewing videos that show some important patterns that you will need for your explanation:

- The NOAA "pumphandle" video: https://www.esrl.noaa.gov/gmd/ccgg/trends/history.html Note how the changes each year are different in the Northern and Southern hemispheres.
- Comparing the annual cycle in Hawaii vs. the South Pole: https://www.youtube.com/watch?v=UatUDnFmNTY&feature=youtu.be Note when CO2 concentrations reach their peak in each location.
- Movie showing rates of photosynthesis at different times of the year: on the PowerPoint presentation Activity 4.5 How Seasons and Oceans Affect Atmospheric CO_2. Note how summer and winter are different in the Northern and Southern hemispheres.



Now try using the Large-scale Four Questions and checklist to write your explanation:

Setting the stage: Describe the pattern in CO_2 concentrations that you are explaining.

Both the overall trajectories of the CO_2 concentrations in Hawaii and the South Pole are increasing, however, they differ in their annual cycle, or seasonal fluctuation. Hawaii seems to go up around October down around May, while the South Pole has smaller fluctuations, but remains as more of a straight line overall. This overall upward trajectory is due to fossil fuel combustion, which results in the release of CO_2 into the atmosphere at rates too fast and too high to be fully sequestered in the environment.

1 point for correct answer

Carbon Pools Question: Which carbon pools are changing?

The atmospheric carbon pool is changing as it goes up and down seasonally in Hawaii but is rising overall for both Hawaii and the South pole.

1 point for correct answer

Carbon Cycling Question: Which carbon flux changes with the seasons? *Photosynthesis*

1 point for correct answer

Energy Flow Question: What form of energy changes with the seasons *Chemical*

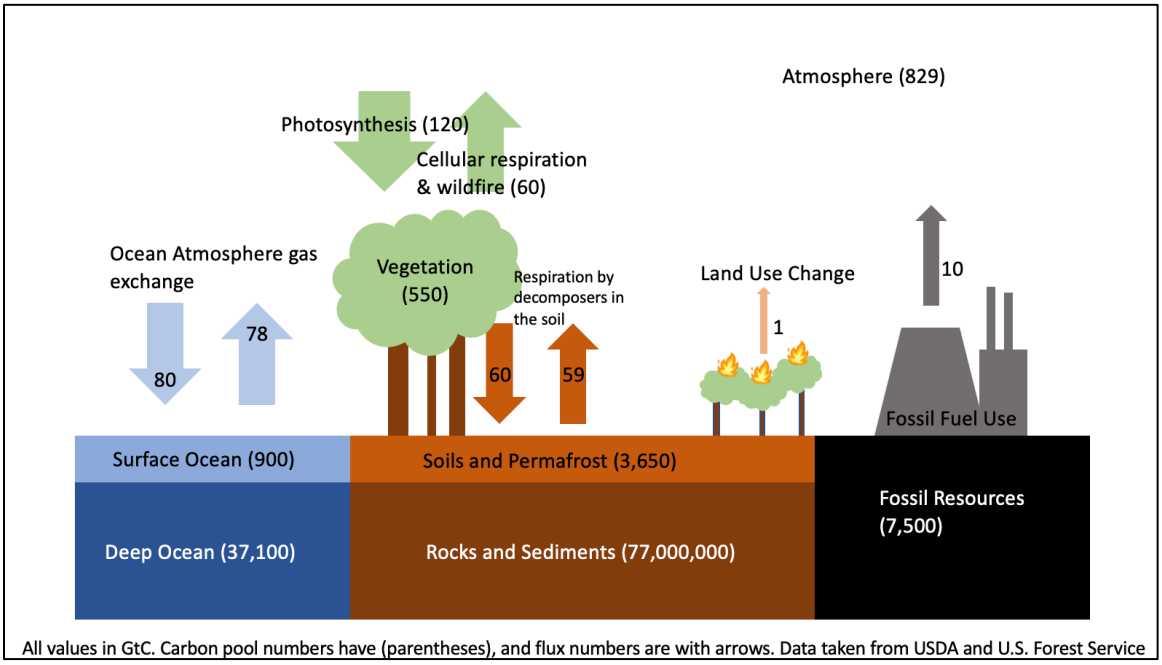
1 point for correct answer

Stability and Change Question: Now try putting all these ideas together. Why are the annual cycles of CO_2 concentrations different for Hawaii and the South Pole?

The reason we see this annual cycle in Hawaii and not in the South Pole has to do with photosynthesis. As plants begin to photosynthesize in the spring and summer, they take in more CO_2 from the atmosphere, which causes the decrease in the CO_2 levels each May. Since the South Pole does not have any vegetation to perform photosynthesis, we do not see this annual cycle and instead just see a steady increase in atmospheric CO_2 because the process of cellular respiration is only happening in the South Pole (exhalation of CO_2) and not photosynthesis.

1 point for correct answer

B. Using a global carbon cycling diagram to predict the effects of cutting fossil fuel emissions in half.



All values in GtC. Carbon pool numbers have (parentheses), and flux numbers are with arrows. Data taken from USDA and U.S. Forest Service

Try using this diagram to make a prediction of what would happen if humans cut emissions from fossil fuel use in half, but all the other pools and fluxes stayed the same. Show your calculations below.

Currently, the natural CO_2 exchange between the ocean, vegetation, soil and gas is about even. This means that the fluxes into and out of each pool keep each other quite balanced. Now, with the current 10 GtC of CO_2 being released into the environment, it makes the flux to the atmosphere outweigh the flux into the ocean, soil, plants, etc. If we were to cut this in half to 5 GtC, there would still be an unbalanced flux into the atmosphere, meaning the CO_2 concentrations in the air would still go up, but slower.

1 point for correct answer