**EARTH 103 LABORATORY WORKBOOK**

**Global Carbon Cycling**

**Module Lab 5 Submission**

This lab is the same format as the lab for Module 4. Answer the questions in this worksheet then when you are ready, go to Canvas where you will answer them in a timed environment. Make sure you have the model ready to run while you are in Canvas, as we will be asking additional questions as indicated below.

**STEP 1.**

To begin with, we will use [this model](http://forio.com/simulate/dmb53/global-clim-carb-f15/simulation/) of the carbon cycle (which is coupled to the same climate model we used in Module 3) to learn a few basic things about how the model responds to different scenarios of carbon emissions from fossil fuel burning (FFB). Note, the A2 scenario is also known as “Business-as-Usual” (BAU) in which we make no efforts to limit carbon emissions. Be sure to watch the video that introduces this model and explains how to use the switches to change the FFB scenarios. To get the right answers it is imperative that you have switches in the correct positions. If in doubt, try reloading the model (reloading the web page) and restoring all devices.

Before running the model, try to guess what will happen to global temperature change under the two reduced emissions scenarios — in one of them (the leveling off scenario) the emissions are held constant after 2010, and in the other (the halt scenario) they drop to zero after 2010.

1. Will the global temperature change level off by 2100 if the emissions level off?  
   a. Yes  
   b. No
2. Will the global temperature change drop to 0 by 2100 if the emissions drop to 0?  
   a. Yes  
   b. No

Now run all three emissions scenarios (keep the land use switch in the **on** position) in the following sequence: A2 (BAU), then FFB Leveling Off, followed by FFB Halt.

1. Focus on the second scenario — what happens to the global temperature change when the FFB emissions level off (leveling off begins in 2010)?

a. Temperature does not level off — it just increases more slowly

b. Temperature levels off right away

c. Temperature levels off after 20 years

1. Now turn to the FFB Halt scenario — what happens to the global temperature change when the FFB emissions halt (the halt begins in 2010)?

a. Temperature drops off right away and goes to 0

b. Temperature drops off shortly after 2010, but does not return to 0

c. Temperature levels off right away

1. QUESTION IN CANVAS ONLY.

**STEP 2.**

Now we turn to a [version of the model](https://forio.com/simulate/dmb53/global-clim-carb-ipcc/simulation/) that has three emissions scenarios from the IPCC. Again the A2 scenario is also known as “Business-as-Usual” in which we make no efforts to limit carbon emissions; the A1B scenario is one of modest reductions in emissions; the B1 scenario is one of more drastic reductions. Run all three emission scenarios (A2, A1B and B1) with the permafrost switch **off** and the land use switch **on**, then answer the following questions.

Temperature (Page 1of the graph pad)

1. Which scenario produces the largest warming in 2100?
2. Which scenario produces the smallest warming in 2100?
3. What is the temperature difference between the highest and lowest emission scenario? (answer to 2.d.p)
4. QUESTION IN CANVAS ONLY.

Atmospheric CO2 (pCO2 atm on Page 2 of the graph pad)

1. Which emission scenario has the largest impact on drawing down CO2?
2. When does that decrease begin?
3. When does the rate of CO2 increase in A1B start to decrease?
4. QUESTION IN CANVAS ONLY.

pH (Page 3 of the graph pad)

1. pH is a measure of the acidity of the ocean — it is related to the amount of CO2 dissolved in the oceans. More CO2 in the oceans lowers the pH, which means the water is more acidic (a phenomenon known as Ocean Acidification). We will see in Module 7 that the key variable controlling the precipitation of reefs and other organisms that make shells of CaCO3 is a variable called saturation, which is indirectly related to the pH. Let’s assume for the next four questions that coral framework precipitation in a species of coral declines at a pH of 8.0 and that it can no longer form any below a pH of 7.8 (again this is hypothetical since saturation is key).

List the emission scenarios that result in a slow-down in shell precipitation at any time during the model run (i.e., pH drops below 8.0).

1. Which of the scenarios will stop the growth of coral reefs?
2. What year does your answer from the previous question happen?
3. QUESTION IN CANVAS ONLY.

**STEP 3.**

Now, we will see what impact permafrost melting might have on the carbon cycle and climate. First hit the “refresh” button on the browser to return the model to its original state. Run the A2 scenario with the PF switch in the off position, and then run it again with the PF switch turned on.

1. How much additional warming is caused by 2100 in the A2 scenario by the permafrost melting?
2. How much does the pCO2 atm increase by 2100 as a result of the permafrost melting?

Hit the refresh button again, and then run the B1 scenario (the one with the more drastic reductions) with the PF switch off, then run it again with the PF switch on.

1. How much additional warming is caused by 2100 in the B1 scenario by the permafrost melting?
2. How much does the pCO2 atm increase by 2100 as a result of the permafrost melting?

This result might be a surprise to you, but remember how CO2 affects the climate — an increase of something like 100 ppm is much more important at lower concentrations than higher concentrations. So going from 200 ppm to 300 ppm causes more warming than going from 700 ppm to 800 ppm.