**Instructions:** Please, read the *Temperature Change in the 21st Century Background* document before coming to lab. We will work together in pairs to complete the exercises below. After completing the exercises below, pairs of students will write and submit a short report using the guidelines provided in the *Temperature Change Student Assignment* handout.

**Exercises:** In this lab we will address two questions: 1) *How will human behavior impact future carbon emissions?* and 2) *Will temperature changes be similar across Latitudes in the Northern Hemisphere (or will temperature changes be the same from the tropics to the poles)?* We will address the first question by comparing GCM model outcomes from three different Emissions Scenarios (see Table 1 in *Temperature Change Background*) that vary with regards to human population growth and other human activities that influence human-generated carbon emissions. We will address the second question by comparing predicted temperature changes for 12 different latitudes across North America. Each lab pair will analyze predicted temperature changes at a single latitude, and then we will pool our results as a class into a collaborative Excel file in order to compare predicted temperature change from the Polar Regions to the Equator.

**Exercise 1: Comparison of temperature trends among emissions scenarios**

1. Examine the data contained in the Excel file entitled *students\_redux\_DegF\_03182020*. Notice the variables that are included, how the data is organized, and the time period it spans.
2. Make a graph showing how winter (January) temperature varies across the 100 years of this study. Begin with the Committed scenario. Only graph the data for your assigned latitude. You will want Year to be the x axis of the graph and Temp to be the y axis. Use the graphing tools of Excel to create a scatterplot with these values; choose the plot that includes only data points and no connecting lines.
3. Label the axes appropriately, including units. Give the figure an appropriate, detailed title. Since you and the class will be creating a number of different figures, it will be important to have a title that distinguishes among them, including the range of years depicted, the dependent variable, the latitude, and which scenario was used.
4. Insert a trend line (linear regression), including the equation and the R2 value. You can do this by clicking on one of the data points in the figure. This should select the entire series of data points. You can then choose add trend line from the Chart menu (the location of this command may vary with the version of Excel).
5. Note the slope from the trend line equation. Based on this analysis, how much did January temperature changed per year over the time period analyzed.
6. Now, graph the remaining two scenarios for your specific latitude, and add the trend lines to each graph (you will have four total). Note the slope for each equation.
7. Change the scale for the x and y axes for each of your figures. You can do this by clicking on the axis in the finished figure, and then changing the scale values. Set the range of X and Y values for all figures so that they are the same for each figure. This allows for visual comparison of the regression lines.
8. With your partner, discuss how temperature has changed in each scenario.
9. Come together as a class so each group can briefly share its findings.
   1. Are there any patterns as to which scenarios show changes in temperature across the century, or show the greatest change?
   2. What might the differences in projected climate change under these scenarios be due to?
   3. What might the differences in human population growth and activities among the carbon emission scenarios indicate about future climate change?

**Exercise 2: Latitudinal Comparisons**

1. Enter your results from your linear regression analyses (slopes and R2 for each of the three scenarios) into the collaborative Excel file entitled "January Regression Results" (available on OneDive via Canvas).
2. Once everyone has access to all of the results, each pair should examine the graph showing temperature change (the slopes of your regression trendlines) as a function of Latitude.
3. What is the geographic pattern of temperature change?
   1. Were the predicted temperature changes at some latitudes greater than those at others?
   2. Did it differ between arctic and tropical regions?
4. Discuss these findings as a class.
   1. What implications might latitudinal patterns of climate change have for the impacts (social, ecological, medical, etc.) of future climate change?