# **Teaching Notes**

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#### **Course Information**

Department: Environmental Science

Level: Lower Undergraduate

Course type: Lab Students: Non-majors Number of Students:24

#### Module Information

*Original Module Name:* Global Temperature Change in the 21<sup>st</sup> Century *Link to Original:* 

- 1. http://tiee.esa.org/vol/v7/issues/data\_sets/taub/abstract.html
- 2. https://gubeshub.org/gubesresources/publications/263/1

Modified Module Name: Global Temperature Change in the 21<sup>st</sup> Century: An Introduction to Global Climate Models and Graphing in Excel (Non-Majors Redux) Files associated:

- Student Materials:
  - Revised Excel Data Files: Student\_redux\_DegF\_03182020.xls
  - Adapted Student Background Handout: Temperature Change in 21<sup>st</sup> Cen\_Background.pdf
  - Adapted Student Instructions: Temperature Change in the 21<sup>st</sup> Cen\_Student Instructions.docx
  - Adapted Student Assignment: student assignment Adapted.docx
  - o Post-lab Quiz: Temperature Changes Quiz.docx
  - Data File for Post-lab Quiz: Temperature Changes Quiz.xls
- Instructor Materials:

  - Excel file to be posted as a Collaborative spreadsheet for student regression results: January Regression Results Collaborative.xls
  - o Post-lab Quiz Answers:
    - Temperature Changes Quiz ANSWERS.xls
    - Temperature Changes Quiz ANSWERS.docx

#### Link to another source:

I used <a href="https://qubeshub.org/qubesresources/collections/post/1453">https://qubeshub.org/qubesresources/collections/post/1453</a> Linear Regression PPP by James Vance as a 20-minute introduction to simple linear regression

#### **Modification Learning Goals:**

- Provide opportunity for students to become familiar with using Excel to create graphs.
- Introduce global climate models (GCMs) and how they can be used to predict future climatic changes given various "What if" scenarios of human behavior.

• Introduce students to simple linear regression as a tool for examining relationships between two variables.

### **Teaching Notes**

(Think about what you would like to read about this activity if you came back to it in 2 years) Suggestions for this section (not all required, and extras always welcome):

## How was this activity Conducted?

- Materials were posted online a week in advance, and students were assigned to read the background document.
- o In lab, students were introduced to Global Climate Models and Linear Regression in a brief lecture followed by a class discussion.
  - Our discussion focused on the probable impacts that each of the human activities listed in Table 1 of the background would have on carbon emissions.
- Students were randomly assigned into 12 pairs (total of 24 students).
- o Each pair was assigned a single Latitude to analyze.
- o Students completed the analysis in lab using the instructions document.
- o The instructor worked with pairs of students as needed.
- Students were unable to complete the activity in a single night lab session, so we continued the work into the following lecture period.
- Students added their regression results to the collaborative Excel file as they completed their analyses
- We discussed their findings in a later lecture class.
  - Our discussion focused on which human behaviors seemed to have the largest impacts on temperature change and trends with latitude.
- o Students then wrote up their work as a lab report and submitted it online.
- Students were given the post-lab quiz the following lab period. This quiz was an "open-resources" quiz where students could ask the instructor for assistance. It was used as an opportunity to clarify some points of confusion.

#### What did you change and why?

- Temperature values were converted from Kelvin to Fahrenheit because most students in the U.S. are more familiar with Fahrenheit.
- Because a primary goal of the lab was to introduce students to new tools (Excel and simple linear regression), students worked in pairs during lab to look at a small subset of the original data.
- The reduced dataset included:
  - 1) January temperatures for every fifth year from 2001- 2100 (we did "Exercise 1" for the January and "Exercise 3" comparing the temperature change with Latitude from the original version);
  - 2) only compared three of the four original GCM scenarios (Committed, A2 and B1)
  - 3) pairs of students were assigned only 12 of the original Latitudes (one Latitude for each pair of students). This provided an opportunity for us to focus on skill acquisition while still examining the role that human behavior will play in Climate Change outcomes.
- I also created a collaborative summary spreadsheet that students used to combine the slopes and R<sup>2</sup> values for their regression models. The collaborative spreadsheet automatically generated a graph of change in temperature as a function of Latitude to help students visualize the Latitudinal trends in temperature change (i.e., polar latitudes will see larger temperature changes).

## • How did the activity go?

Overall, the pairs of students worked well together. The three-hour lab period was
insufficient for them to complete the activity and write-up, so I gave them an
additional 1.15 lecture period to complete their work. Things definitely could have
gone better, but I had one student report that they have since used linear
regression in their job based on what they learned during this lab.

## What went well and why?

- By the end of the activity, students were beginning to feel comfortable working in Excel. I was able to work with students in pairs, which was necessary for helping students learn Excel. If this activity is to be conducted online, I suggest adding Excel resource and tutorial links to the activity. You may want to write out step-by-step instructions for the version of Excel that you students have available (my college provides web-based Office365 to our students, so I will be writing instructions for that version for this Fall 2020).
- We had a good class discussion about the various climate change scenarios in which we talked through Table 1 on pg 4 of the student handout. As a class, we predicted how we thought each of the "Scenario Characteristics" listed in the table would affect carbon emissions and thus Global Temperatures.

#### • What went wrong and why?

- Some of my students still did not fully understand how linear regression should be used. I think that this was due primarily to my inadequate introduction of the topic. I think that working as a class to analyze and interpret a smaller data set prior to starting the lab would have helped. Even this reduced dataset was a bit overwhelming for some students.
- I used the provided "Student Assignment," which has students write a
  short lab report. I had the pairs of students submit a single report as a
  pair. Scientific writing is not something that we emphasize in our
  Environmental Science Courses, so students needed a lot of guidance
  and there was a huge variability in their final products. Next time I teach
  this, I will create a worksheet for them to complete or just discuss our
  results as a class.
- I also could have done a better job of introducing the GCMs. I think a video explaining how these models are constructed would be helpful.

#### What was the prep like?

- How much time went into prep? If using prepared materials and not modifying
  the dataset, the prep time is very small. Primarily, working through the activity and
  uploading the student materials into your LMS. I estimate three hours.
- Did you have to do any prep (i.e. grow cultures, grow seeds, order supplies) ahead of implementation?
  - Most of my prep time was spent revising the dataset. In hindsight, I should have prepared more of a presentation for them and a practice dataset to start with.

#### Would you do this activity again? Yes

- What would you change in the future?
  - By way of an introduction to GCMs I will start with a video introduction to GCMs, followed by a class discussion about what we would need to know if we're going to build a GCM from scratch. This will probably be a

- group in-class pre-lab or lecture assignment. These are links to some videos that I am considering for next time. (<a href="https://www.youtube.com/watch?v=SuZHnqxltKo">https://www.youtube.com/watch?v=i9EyFghlt5o</a>). (https://www.youtube.com/watch?v=i9EyFghlt5o).
- I will walk the students through the analysis of a smaller dataset as an example after using the Linear Regression PPT introduction listed above.
- What do you wish you'd known before you ran the activity?
   I should have had my students self-assess their Excel skills ahead of time and paired them according to those skills.
- How does this activity fit in your overall course curriculum?

  In the first part of the second semester of Environmental Science, we focus on developing sustainable societies. We discuss fossil fuel use and how societies can transition to renewable energy sources and the reasons why doing so is absolutely necessary: 1) climate change mitigation and 2) Fossil Fuel resources are limited and likely to be exhausted in the next few decades. As a part of that discussion, we examine the role that human behavior plays in possible outcomes. This activity fits well with that discussion because it allows students to link human behavior in the various climate change scenarios to predicted temperature changes at both local (their assigned Latitude) and global (Latitudinal trends) scales.
- In what ways, if any, did you modify your teaching practice with this activity? I did not modify my teaching practice greatly. I was focused on making this lab more "comfortable" for students by decreasing the amount of data they had to work with and converting temperature values into a unit that is more familiar to most of them. My goal was to get them past that initial "OMG, what a lot of numbers!!!," reaction so that they could have some fun and see that they can make graphs and analyze data!