ANALYZING CONTINUOUS DATA – CLIMATE VARIABILITY

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In this activity, you will work in pairs to download, organize, and analyze historic climate data. In the process, you will:
- Explore the benefits and challenges of working with other people's data
- Learn new ways to use Excel and gain experience with those you already know
- Practice statistical techniques used to analyze continuous data
- Apply your presentation skills to a spreadsheet format
- Evaluate for yourself how the earth's climate has varied over the past 200 years

Your completed assignment should take the form of an Excel spreadsheet, which you will submit electronically. Your spreadsheet should be clearly organized and labeled so that it is easy to follow your analysis and reasoning. You should include the following components:
- A worksheet named Questions that includes answers to <u>all underlined questions</u> in this handout. Place the question numbers in column A (ex: B2) and your responses in column B.
- One original data worksheet for each data set, named GT-Orig, ZT-Orig, and WT-Orig.
- Data worksheets that show your analyses, named GT, ZT, and WT.
- Chart worksheets that show your graphs, named GT-F1, GT-F2, ZT-F1, and WT-F1.
- Worksheets labeled AE1 and AE2, containing your additional explorations.

Your score will reflect both the quality of your analysis and the clarity of your presentation.

Students in this course have a range of experience levels with Excel, statistics, and climate. As you work through the activity, you are encouraged to make use of your partner, classmates, the instructors, the Excel help file, and the internet to provide assistance and clarification as needed. You will find that while these analyses are challenging and time consuming at first, if you take the time to work through them carefully your comfort level and efficiency will increase rapidly. Please don't hesitate to ask for help if you are feeling confused or overwhelmed.

Part A – Exploring Your Data

The data we will be using for the lab is available online at http://data.giss.nasa.gov/. Scroll down to the section for temperature data and click on GISS Surface Air Temperature Analysis (GISTEMP). Before we analyze any data, it is important to understand where it comes from and how it is presented. Explore the website (and other sites if you like) and answer the following questions as best you can.

1) <u>Who collected this data?</u>
2) <u>What methods did they use?</u>
3) <u>Is this data raw or processed? If processed, what was done?</u>
4) <u>This data set is presented using temperature anomalies. What is a temperature anomaly? Why did these researchers choose to use anomalies rather than absolute temperatures?</u>
5) <u>What questions do you still have about this data?</u>
6) <u>Where could you search for answers to those questions?</u>

Part B – Setting Up Your Spreadsheet

Before you can analyze the data yourself, you will need to import it into a spreadsheet. Some data requires special programs to display it, but this data is a simple text file.

1) Scroll down to Table Data and find the section for Combined Land-Surface Air and Sea-Surface Water Temperature Anomalies (Land-Ocean Temperature Index, LOTI). <u>What is the advantage of using combined land and sea measurements rather than just land?</u>

2) Click on global-mean monthly, seasonal and annual. Look through the data and get a sense of the format. <u>How is the data organized? What information is provided in addition to the numbers? What do the numbers mean?</u>

3) Select the entire page, including the top and bottom info. Copy your selection and paste it into a blank Excel workbook. Rename this worksheet GT-Orig (global temp – original data). Make a copy of the entire worksheet and rename it GT. This is the worksheet you will be working with. <u>Why is it important to save a copy of the original data before you begin manipulating it?</u>

Now you have a worksheet with data (GT), but it's kind of a mess. Follow the instructions below to organize it. Organized worksheets are easier for you to work with, make errors much less likely, and are particularly important if you want to share your work with others.

4) You don't need the information above and below the data table for now, but you might want to look at it later. Select the rows containing all of the information above the table except for the first line. Right click and select hide to hide those rows. Do the same with all of the information below the table. Look at the row numbers on the left. The numbers skip to remind you that there are hidden rows, and you can unhide them later if you need them.

5) The data for 2011 only covers a single month, so our analysis will focus on the years 1800-2010. Delete the row containing 2011 data; remember that it is still in your original worksheet if you want to refer to it.

6) When you paste a text file into Excel, all of the data often goes into the first column. Before you can analyze it, you need each data point in its own box. To do that, select the first column of all of the data, including the header but not the top row of text information. Under the data tab at the top of the screen, click on Text to Columns. Check to make sure the default options are appropriate for your data and it is being separated in ways that make sense. When you are happy with how it is presented, click finish.

7) The data is divided into blocks of 20 years and the column header is repeated between each block. There are easier ways to view the headers, so you don't need those extra rows. Scroll down through your data and delete all the blank rows and header rows except the one at the top. The last column is a duplicate of the row header, so delete that as well.

8) Bold the headers that you have left (row and column) so that they are easier to see.

9) Headers provide useful information, so it would be nice if they stayed on the screen all the time. Click on the upper left box that contains data (-41). Under the view tab at the top of the screen, click on freeze panes. Freeze both the row and the column at the box you have chosen. Scroll through your worksheet – the headers should stay in place while you scroll.

Your data should now be fairly well organized and easy to work with. If there are any other changes you would like to make, now would be a good time to do so. Depending on what your original data looks like you might want to change the number format or font in cells, add color to key cells, add or remove spaces or lines between columns or rows of different data, etc.

Part C – Global Climate Variability

Now that your data is organized, let's begin by looking at how the temperature is changing with time. The data is presented by month, and the annual mean (January to December) is already calculated in one of the columns.

1) Make a graph of annual mean temperature anomaly by year and place it in its own worksheet. Label this worksheet GT-F1 (global temp – figure 1). <u>What kind of graph is most appropriate for this data? Why?</u> You can change the chart type by right clicking on your graph; try out a few different possibilities to see how they look and decide what works best. Your graph should be neat, easy to read, and clearly labeled. Don't just accept the Excel defaults; use your best figure making skills.

2) Before you delve into statistical analyses, it is important to be familiar with your data so that you know what tests to run and whether your results make sense. Examine your graph. <u>What observations can you make just by looking at your data?</u>

3) Add a linear trendline to your graph (right click on the data series) and display the equation and r^2 value on the chart. You should now have three numbers on your graph. <u>Write down your three numbers and explain in words what each of them is telling you about your data.</u> Since your chart now includes two lines, make sure it also includes a legend so we can tell what each of the lines represents.

4) Go back into worksheet GT. Numbers on your graph are easy to read, but if they were in cells in the spreadsheet they would be easier to manipulate. Scroll to the bottom of your chart. In the empty space below your data, use the SLOPE, INTERCEPT, and RSQ functions to calculate those parameters for your data. Make sure to label your results clearly within the spreadsheet. <u>Do your results correspond to the numbers on your graph?</u>

5) Although extrapolating past your data is risky, sometimes it is still useful. Use your results from C4 to predict what the temperature anomaly will be in the year 2100, both manually and using FORECAST; <u>confirm that these give you the same answer.</u>

6) Make a copy of worksheet GT-F1 and label the duplicate GT-F2. Select the trendline, right click and click format trendline. Select moving average and experiment with changing the period. Move the trendline window to the side so that you can watch the graph change underneath. <u>How does the trendline change as you change the period?</u>

7) Set the period to 5, corresponding to a 5 year moving average. Examine your new trendline and compare it to the one in GT-F1. <u>What exactly is a moving average? What does this new line tell you? What doesn't it tell you? For what purposes is each type of line preferable?</u>

Part D – Zonal Climate Variability

Go back to the original website, scroll down to the LOTI data, and click on zonal annual means. Copy the data into a new worksheet in your workbook and label it ZT-Orig. Create a duplicate worksheet named ZT and organize it just as you did the global data in part B.

1) Graph the zonal temperature anomaly over time for a zone that includes Kenosha. Place your graph in a new worksheet labeled ZT-F1. Create a trendline for your graph and estimate the temperature anomaly in the year 2100. <u>Explain in words what the data is telling you. How do your data, trendlines, and prediction compare to the one from Part C? Suggest one or more explanations for the differences.</u>

Part E – Wisconsin Climate Variability

The Wisconsin State Climatology Office gathers data on our local climate. Go to their website at http://www.aos.wisc.edu/~sco/. On the left side of the screen, select Past Wisconsin Climate and then Statewide. Scroll down to the section for long-term variability of annual climate and click on the statewide annual temperature in tabular form.

1) Look through this new data set. <u>What data is reported and how is it organized? In what ways is it similar to the global data set? In what ways is it different?</u>
2) Copy the data into a new worksheet in your workbook and label it WT-Orig. Create a duplicate worksheet named WT and organize it in whatever way makes most sense to you.
3) Graph the Wisconsin data over time and place it in a worksheet named WT-F1. Create a trendline for your graph and estimate the temperature anomaly in the year 2100. <u>Explain in words what the data is telling you. How do your data, trendlines, and prediction compare to the ones from Part C and D? Suggest one or more explanations for the differences.</u>

Part F – Additional Explorations

Choose two additional questions related to climate variability and use the data to evaluate them. You can also download additional data from both websites, including land-surface temperature anomalies and Wisconsin precipitation and snowfall. Be sure to:

1) Choose a specific scientific question and state it clearly.
2) Explain how you are going to address your question and why.
3) Present your analyses so that they are easy for someone else to follow.
4) State your findings and explain what they mean.

Create a new worksheet in your workbook for each exploration and label them AE1 and AE2. Each worksheet should include your answers to questions 1,2, and 4 for that analysis, as well as any additional information you think a reader should know in order to follow your analysis and reasoning. You may want to create additional worksheets containing graphs, data, or other work. Label these in whatever manner makes sense to you, and include a list of any additional related worksheets on AE1 and AE2.

You are welcome to choose any questions you like that relate to these data sets, but the following general questions might give you ideas for some more specific possibilities.
- How does the rate of climate change vary with time?
- How much change is there for a particular month or season? How do two compare?
- Is there more change in the Northern Hemisphere or the Southern Hemisphere?
- Is there more change in some zones than others?

Part G – Regression Significance (Optional)

Use the regression function in the Analysis ToolPak to evaluate the significance of one or more of your regression lines. Some computers may not be able to access this ToolPak. To install and use the ToolPak, go to the main Excel file menu and click on Excel options. Click on Add-Ins. At the bottom of the screen where it says Manage Excel Add-Ins, click Go. Check the box next to Analysis ToolPak and click ok. You should now be able to access the ToolPak by going to the data table and clicking data analysis, then scrolling down and clicking Regression.