

Activity: exploring temperature data

Name _____

Alaska lies in the high latitudes, mostly between $\sim 60^\circ\text{N}$ and the pole (90°N). The climate at high latitudes may behave differently than at lower latitudes (the tropics, subtropics, or mid-latitudes). To investigate that possibility, we are going to plot weather station data from the last 100 years. Talkeetna Airport started recording weather data in 1918, so we are going to use that record.

1. Looking at the data

Let's start by plotting data from Alaska to see how temperature has or has not changed over the past 100 years. We are going to make a scatter plot, which plots points that have an X and a Y value. In this case the x-value is the time and the y-value is the average (mean) temperature for a particular month. Plotting those data up will show us how temperature has changed through time.

Open the Excel file containing the climate data. We want to plot the year (X) versus temperature (Y), so highlight the columns with the years and the temperature. Holding Ctrl will allow you to select two different areas that are not adjacent. (Leave out the top row, or it will cause problems.)

From the Insert Pane, select Scatter and choose the top left option, which has only markers for points. A plot will appear. Let's make it larger and not covering our data: right-click the plot, select Move Chart, and then choose to make it a New Sheet. Now you have a plot you can work with, but before it you can share it with someone else, it needs some work. From the Layout pane, you can add Axis Titles so that other people know what the X and Y axes represent. If you want, you can add/remove lines, change the shape/size/color of the data points, and other things to make your plot look beautiful and easy to understand, mostly from the Layout Pane and by right-clicking on a particular plot element and then Format XXXX, where XXXX is that element. In particular, you might adjust the range of the axes so that the data fill the plot instead of leaving spans of time with no data at either end. Remember, you are going to save this plot to turn in, so make it look like an assignment.

Using your plot, how has the temperature changed since 1918? Has Talkeetna warmed? Cooled? Stayed the same? By how much?

2. Comparison

We want to know how temperature change in Alaska compares to temperature change at lower latitudes. Add data from St. Louis to your existing plot. St. Louis is at a similar elevation to Talkeetna, but obviously is located at a much lower latitude ($\sim 39^\circ\text{N}$ versus $\sim 62^\circ\text{N}$).

To add new data, right-click the plot and choose Select Data. In the dialog box, choose to Add a legend entry (series). This asks you to tell it where the X and Y data are. Clicking the button with the red arrow at the right side of each box allows you to pick the X (time) and Y (temperature) data separately. Ask if you need help with this. When you are finished, click OK, OK and the new data should appear.

Compare the St. Louis temperature data with Talkeetna. St. Louis is obviously warmer than Alaska, but did the temperature in St. Louis change in a similar direction as Talkeetna? Which changed more?

3. Measuring the difference

While we can get a feeling just with our eye for the direction and amount of change in temperature at Talkeetna and St. Louis (a qualitative observation), it would be nice to express this numerically (as a quantitative observation). To do this, let's calculate the difference between the temperature at these two weather stations and then plot it to see how it changes.

Because we want to calculate the difference in temperature between the two sites for each year, we are going to make Excel do the math for us with a formula (this is one of the reasons spreadsheets are useful tools). Title a new column "St. Louis minus Talkeetna" or something like that. Go down that column to the first year that has data from both stations (1939). Click in that cell and type a formula, which starts with the equals sign. We want to subtract the Talkeetna temperature from the St. Louis temperature (we could do it in reverse and get the same answer, but this way we keep the numbers positive), so type "=", click on the cell with the 1939 St. Louis temperature (which will make a colored cell reference appear), type "-" (minus), and then click on the 1939 Talkeetna temperature. Your formula should look something like "=G3-C3", although the exact cells might differ. Hit enter and Excel does the math. Now, the black box surrounding the cell with your formula has a black spot in the lower right corner. Grab that spot and drag it down the column to 2017. This will fill your formula down, changing it to refer to the temperatures in each successive row (each year). This is one of the powerful things about spreadsheets – you can perform lots of calculations easily.

To see how the difference between the two sites has changed, make a new scatter plot with the year versus the difference (you're getting good at this now, but ask if you need help).

Did the temperature difference generally get larger or smaller? Given the direction of change in both sites, what does the changing size of the difference tell you about which site changed faster?

Finally, use Excel to quantify the rate of change in the difference over time. Click on any data point, choose the Layout pane, and select Trendline > Linear Trendline. This will calculate and add a best-fit line. Right-click and Format the trendline and select Display Equation. This shows the equation describing the best-fit line. Pay attention to the slope of the line, which is the number next to the x in the equation (remember from math that a line is expressed as $y = Mx + b$). Slope = y/x , or how many units y changes for each 1 unit (years in this case) that x changes. A negative slope indicates that y decreases by that much for each 1 year that x increases.

Quantify your earlier observation: for each year that passes, how much (on average) did the difference change by? Are St. Louis and Talkeetna more or less similar in their temperature today than they were in 1939?