Name: Date:
Weather to Climate Investigation: Snow
**These are example answers using the Durham, NH dataset. Answers from students using Boise and Little Rock datasets will differ.

Guiding Questions:

• What are the historical and current weather patterns or events for a location in the United States?

• What are the long-term weather (i.e. climate) patterns for this location?

Definitions:

• ***Weather*** *is the mix of events (precipitation, humidity, temperature, etc.) that happen over a short period of time (minutes to months) in a specific location.*
• ***Climate*** *is the long-term pattern of weather in a particular area. This is often measured as the average weather over a period of time.*
• ***Snow Water Equivalent*** *is the amount of water in the snowpack. Essentially, the volume of water that would result if you melted the entire snowpack instantaneously.*

Conduct the Investigation:

1) Open the Excel Spreadsheet on your computer.
2) In the table below, record your location name, latitude, and longitude from the INTRODUCTION tab on the spreadsheet.

Location	Latitude	Longitude
Durham, NH	*43.13*	*-70.93*

3) Click on the **DAILY** tab at the bottom of the spreadsheet. The columns contain data for the Date, Maximum Temperature, Minimum Temperature, Snow Water Equivalent, and Precipitation (*Use the INTRO tab to understand what these variables mean*). Begin by making a graph of one year of snow data:
    a. Highlight one year of the DATE column, A1 to A366, by clicking on A1 and dragging the mouse down.
    b. While holding down the Ctrl (PC) or command (Mac) button, highlight one year of the SWE column, D1 to D366.
    c. Click on the CHARTS tab at the top of the spreadsheet, and click the X Y (Scatter) button.
    d. Choose a chart that connects the points with lines. The chart will now appear on the spreadsheet.
    e. In the Formatting Palette, under Chart Options, add in an appropriate Chart Title.
    f. Click on the dropdown menu to change 'Chart Title' to 'Horizontal Axis' and add an appropriate title for the x-axis.
    g. Repeat the same steps for the y-axis.

4) In your location, in 1980, which month had the maximum daily snow water equivalent? Make an estimate of the highest snow water equivalent in 1980.

January, February, and December had the highest snow water equivalents. The value was 12 kg/m2.

5) When was the final spring snowmelt? Make an estimate of which the month has the last snow of 1980.

It looks like the spring snowmelt happened in late April. I can tell because that is when the snow water equivalent drops to 0 kg/m2 for the summer.

6) How would you describe the overall snow water equivalent pattern for 1980?

The overall pattern has three peaks. The snow water equivalent is high in January, goes back to zero, and then peaks again in February. It then drops back down to zero in late March, where it remains until the following December.

7) Make a prediction: do you think the overall snow water equivalent pattern is similar or different from year to year? (i.e. will the snow in 1981 look the same as the snow in 1980?).

I think that each year, the snow will follow the same pattern, but the values for the highest point and when the snow melts in the spring might be different.

8) Find out by making a graph of 3 years of snow depth data, following the same steps as above, but highlighting more data.
    a. Highlight three years of the DATE column, A1 to A1096, by clicking on A1 and dragging the mouse down.
    b. While holding down the Ctrl (PC) or command (Mac) button, highlight three years of the SWE column, D1 to D1096.
    c. Click on the CHARTS tab at the top of the spreadsheet, and click the X Y (Scatter) button.
    d. Choose a chart that connects the points with lines. The chart will now appear on the spreadsheet.
    e. In the Formatting Palette, under Chart Options, add in an appropriate Chart Title.

Student Climate Data. University of New Hampshire. 2014

f. Click on the dropdown menu to change 'Chart Title' to 'Horizontal Axis' and add an appropriate title for the x-axis.

g. Repeat the same steps for the y-axis.

9) Do the data support your prediction? Explain using data from the graph.

The data did not support my prediction. Although 1980 has three distinct peaks, 1981 and 1982 have only one large peak. Moreover, the highs and lows each year are very different. For example, the highest snow water equivalent is in 1982, at 115 kg/m2, much higher than the 12 kg/m2 in 1980.

10) Will these weather patterns remain the same over time? One way to find out is to display the yearly averages (the daily weather data averaged over each year), which illustrates how the climate in an area may be changing over time. By averaging the daily weather data, an entire year's worth of daily weather data is summarized with a single number. Click on the **YEARLY_AVERAGES** tab at the bottom of the spreadsheet.

11) To make it easier to see the trend, make a graph of average yearly snow water equivalent from 1980 to 2013, following the same steps as before, but highlighting the **entire DATE** and **AVE_SWE** columns.

12) What is the range of yearly average snow water equivalent from 1980 to 2013?

The average snow depth ranges from about 1 km/m2 to 41 km/m2.

13) Add a trend line to the graph to see the overall pattern.
   a. Right click on the data points of the graph.
   b. Choose 'Add Trendline..' (*A **trendline** is a line showing the general direction of the data*).
   c. Under options, click 'Display equation on chart' and 'Display R-squared value on chart.' (*The **R-squared** value describes the goodness of fit of the line to the individual data points*).
   d. Click Okay.

14) Using the trendline to help you, do you observe a trend in snow water equivalent over time? Is it increasing, decreasing or remaining the same? Support your response with specific evidence displayed in the graph.

The snow water equivalent is increasing over time. I can tell because the slope of the line is positive, with a value of 0.462 (R^2 = 0.317).

15) Make a prediction: Do you expect this trend to continue over time? How might the climate change in this area in 100 years? Provide some evidence that supports your prediction.

I think that the trend will continue for a while, and then it will become too warm to get much snow, so it will begin to decrease. I expect that by the end of the century, the snow water equivalent will have decreased because of increasing greenhouse gas levels in the atmosphere. In 100 years, the average yearly snow depth might still change year to year, but it might be mostly below 10 km/m2.

16) Ask a question: What questions do you have about weather and/or climate following an initial exploration of one site?

Will the average snow depth begin to decrease over time with climate change?

Examples of the three graphs students will produce:

Daily Snow Water Equivalent for 1980: Durham, NH

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Yearly Snow Water Equivalent for Durham, NH

Trendline Equation
$y = 0.462x - 906.9$
$R^2 = 0.137$

Y-axis: **Average Snow Water Equivalent (kg/m2)**

X-axis: **Year**