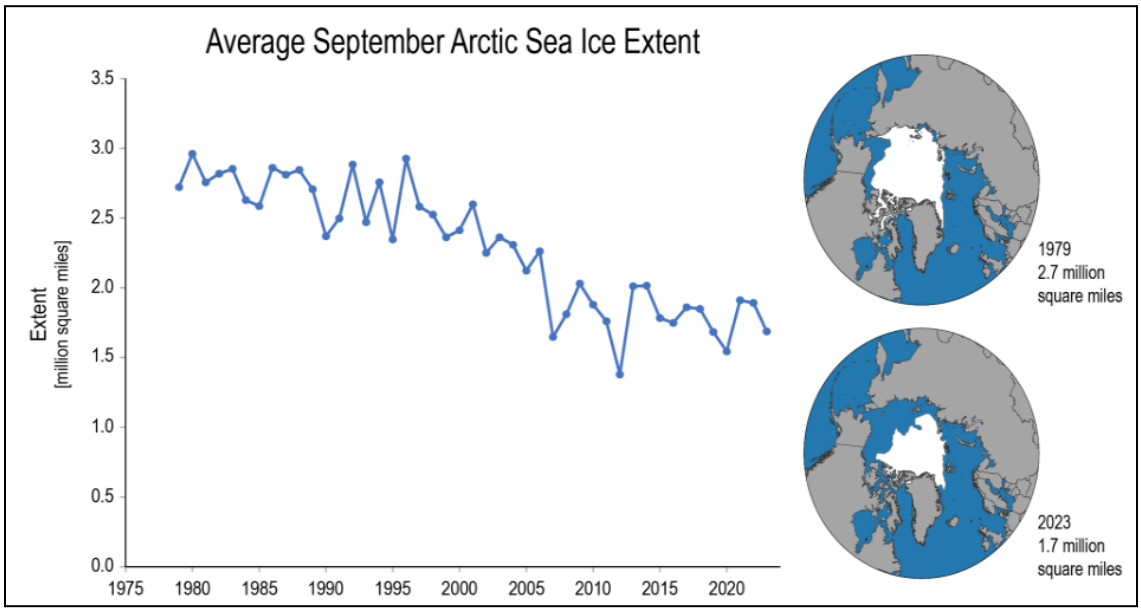
Part B: Exploring Arctic Climate Data - Teacher Guide

Setting the Stage

Students dig into the Arctic data using Excel to unravel some causes and effects of the melting of the snowpack. Students develop concept sketches of albedo.



Graph of Sea Ice Extent. Photo Credit: USGCRP

Lesson Overview

In this lesson sequence, students will plot and analyze Arctic data.

- ***Lesson 1*** *– (80 minutes) Understand and analyze data from the Eureka weather station*
  Students will plot data in Excel and answer questions that guide them to make sense of the data.
- ***Lesson 2*** *– (30 minutes) Create a concept sketch*
  Students will create a concept sketch

This project is funded by NSF, Award number 1107428

Instructional Overview	
Grade Level	Middle/High School
Instructional Time	80 minutes *(total time needed)*
Activity 3 Goals	• Calculate albedo from incoming and outgoing radiation data • Use known values to make sense of the calculated data • How to plot data and make sense of graphs. • Apply knowledge about albedo and the climate system to understanding Arctic change
Lesson Driving Question	• How do you make sense of data sets by using correlations? • How do you plot multiple datasets in Excel? • How do you evaluate the graphs?
Building Toward	NGSS: ESS2D, LS2C
NGSS Dimensions	Science and Engineering Practices: • Analyzing and Interpreting Data • Using Mathematics and Computational Thinking • Constructing Explanations and Designing Solutions • Engaging in Argument From Evidence Crosscutting Concepts: • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter: Flows Cycles & Conservation
Materials	❏ Student Worksheet ❏ Student Excel dataset
Material Preparation	❏ Print copy of Student Worksheet for each student ❏ Make sure all students have Excel installed on their computers
Instructional Strategies	**Excel data analysis**: Plotting data in Excel is an important way to guide students to make sense of data and learn important tools that are frequently used to analyze datasets. **Concept sketching:** A concept sketch is a simplified sketch illustrating the main aspects of a concept, annotated with concise but complete labels that (1) identify the features, (2) depict the processes that are occurring, and (3) characterize the relationships among features and processes.

Lesson 1: Understand and analyze data from the Eureka weather station *(80 minutes)*

Use Excel to plot data and analyze it

Now it is time to dig deeper into datasets that were collected at the Eureka weather station. Next, work with three datasets from Eureka.

- Temperature
- Snow depth
- Albedo

[Note - this is a continuation from Part A and therefore continues with numbering to match student worksheet]

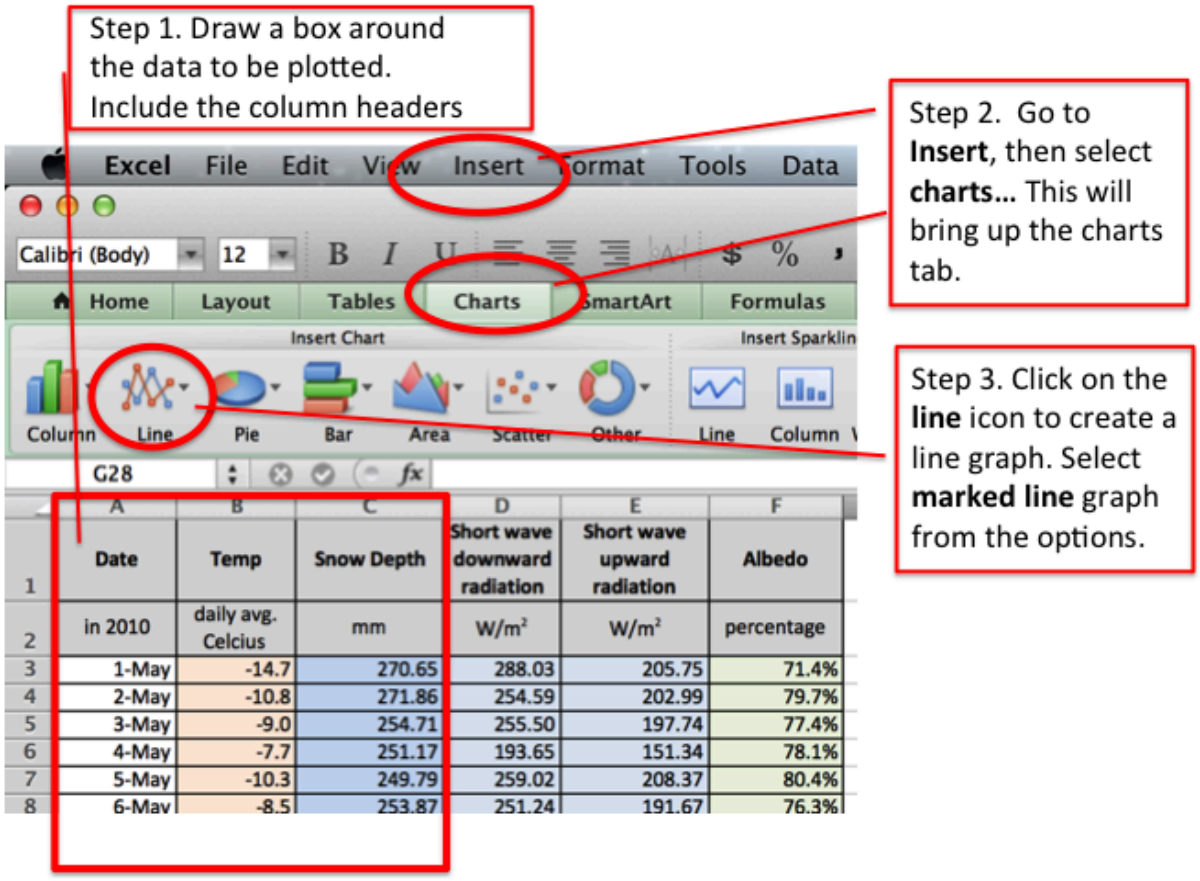
8. Of these three graphs, where do you see a strong *correlation*? In other words, find a point where the data on one graph seems to be similar, or strongly related to data on another graph.

Let's explore that correlation more closely. To do that, we'll want to zoom in on what's going on during the time when the snowpack is melting.

- Go to the Excel Student file. Download the dataset and save the file under your name by clicking *File > Save as…* and then adding your last name to the file name (such as Eureka_Smith.xlsx)
- Click on the tab called 'student datasets'. (The first tab contains all the same data, but remains there in case you make a mistake while working with the data.)
- That tab contains data for the entire year, but we only want to look at the spring and early summer, from May 1 through July 1.
- So you'll want to delete the rows that are before and after spring and summer.
- Keep the column headings, but delete rows from January 1 through April 30.
    - Highlight the rows, then right-click, then select 'delete.'
- Repeat this for July 2 – December 31
- Now you should just have data for May 1 through July 1.

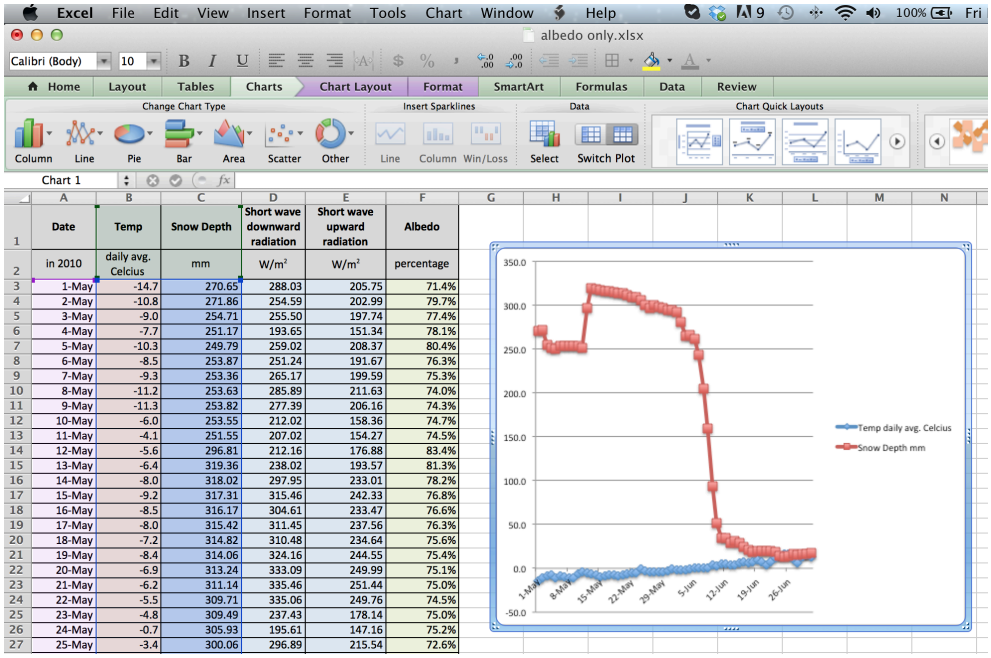
Next, create a marked line graph that plots temperature and snow depth over time.

- Starting with cell A1, drag the mouse to draw a box around columns A, B, and C, then drag your box down to surround all of the data. (It should go from A1 to C64.)
- In the uppermost menu, click on **insert** and select **chart…**
- This brings up the 'charts' tab. (Note – this may vary depending on your version of Excel.)
- From the types of charts, select **line** and then from the types of line graphs, select **marked line graph**.



	A	B	C	D	E	F
1	Date	Temp	Snow Depth	Short wave downward radiation	Short wave upward radiation	Albedo
2	in 2010	daily avg. Celcius	mm	W/m²	W/m²	percentage
3	1-May	-14.7	270.65	288.03	205.75	71.4%
4	2-May	-10.8	271.86	254.59	202.99	79.7%
5	3-May	-9.0	254.71	255.50	197.74	77.4%
6	4-May	-7.7	251.17	193.65	151.34	78.1%
7	5-May	-10.3	249.79	259.02	208.37	80.4%
8	6-May	-8.5	253.87	251.24	191.67	76.3%

A chart will appear somewhere on your screen. Drag it to a location where it does not overlap the data, and then click and drag the corners to make it larger and more legible.



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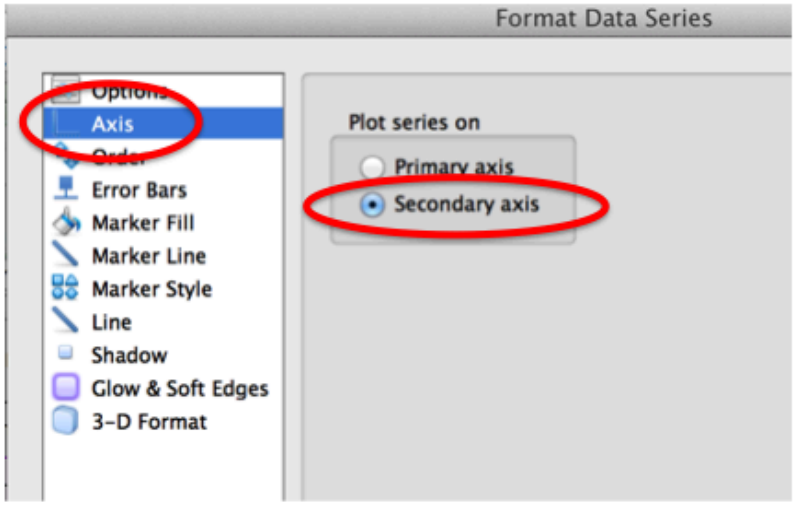
1-May	-14.7	270.65	288.03	205.75	71.4%
2-May	-10.8	271.86	254.59	202.99	79.7%
3-May	-9.0	254.71	255.50	197.74	77.4%
4-May	-7.7	251.17	193.65	151.34	78.1%
5-May	-10.3	249.79	259.02	208.37	80.4%
6-May	-8.5	253.87	251.24	191.67	76.3%
7-May	-9.3	253.36	265.17	199.59	75.3%
8-May	-11.2	253.63	285.89	211.63	74.0%
9-May	-11.3	253.82	277.39	206.16	74.3%
10-May	-6.0	253.55	212.02	158.36	74.7%
11-May	-4.1	251.55	207.02	154.27	74.5%
12-May	-5.6	296.81	212.16	176.88	83.4%
13-May	-6.4	319.36	238.02	193.57	81.3%
14-May	-8.0	318.02	297.95	233.01	78.2%
15-May	-9.2	317.31	315.46	242.33	76.8%
16-May	-8.5	316.17	304.61	233.47	76.6%
17-May	-8.0	315.42	311.45	237.56	76.3%
18-May	-7.2	314.82	310.48	234.64	75.6%
19-May	-8.4	314.06	324.16	244.55	75.4%
20-May	-6.9	313.24	333.09	249.99	75.1%
21-May	-6.2	311.14	335.46	251.44	75.0%
22-May	-5.5	309.71	335.06	249.76	74.5%
23-May	-4.8	309.49	237.43	178.14	75.0%
24-May	-0.7	305.93	195.61	147.16	75.2%
25-May	-3.4	300.06	296.89	215.54	72.6%

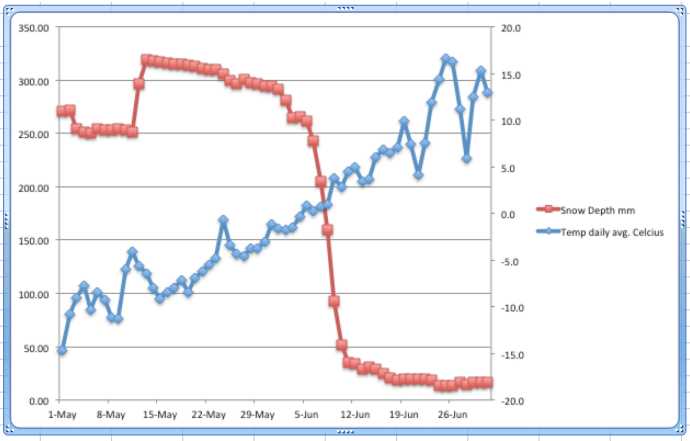
You are plotting two variables (snow depth and albedo) vs time. So there will be two y-axes, one for snow depth and one for albedo. Put snow depth on the y-axis on the left side. Put temperature on the y-axis on the right side.

To do that:

- Click the line on the graph that shows temperature.
- On the **Format** menu, click **Selected Data Series**.
- On the **Axis** tab, click **Secondary axis**.



Your graph should now look something like this:



Following the same steps as above, create another graph that plots snow depth and albedo on the same graph.

- Note – One way to make this plot is to draw a box around Columns A, B, C, and D (even though you don't want Column B). Then create a marked line graph. On the graph, click on the line that represents that column and delete that data series.

- Put snow depth on the y-axis on the left side. Put albedo on the y-axis on the right side.

Looking at snow depth vs. albedo:

9. What are some reasons that albedo could vary while there is snow covering the ground?

10. Can you come up with an explanation for the sharp increase in albedo on May 12?

Looking at snow depth, temperature, and albedo:

11. What causes the initial drop in snow depth?

12. On what date does the snow depth begin to rapidly decrease?

13. What happens to the temperature around that same time?

14. What other effects can you see in the data that are closely linked with melting?

15. How does that, in turn, affect snow depth?

Lesson 2: Concept sketching and short reflection essay *(30 minutes)*

Explain the processes that you learned about in a concept sketch and a short essay

Graphics are powerful tools for explaining complex concepts. How would you summarize albedo graphically? Sketch, label, and describe what albedo is. Identify the key features you decide to include. Explain the processes that happen. Indicate how the features and processes are related. Use clear, complete sentences and leaders.

Then, write a short essay (2 - 4 paragraphs) that leads the reader through the concept of albedo and the related processes and features you used in your concept sketch. Use complete sentences and proper writing mechanics.

Find more curriculum here:
https://ceee.colorado.edu/resources/arctic-climate-connections