Graphing Climate Change

Levels V-VI

Grades 9-12

Overview:

Students explore how increases in global temperature affect Arctic climate.

Objectives:

The student will:

- graph temperature normals;
- compare and contrast climate across Alaska; and
- debate the impact of a small increase in atmospheric temperature on Alaska's ecosystem.

GLEs Addressed:

Science

- [9] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [10-11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.
- [10-11] SD3.1 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by describing causes, effects, preventions, and mitigations of human impact on climate.
- [11] SC3.2 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by analyzing the potential impacts of changes (e.g., climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem.

Math

- [9] S&P-1 The student demonstrates an ability to classify and organize data by designing, collecting, organizing, displaying, or explaining the classification of data in real-world problems (e.g., science or humanities, peers, community, or careers), using information from tables or graphs that display two sets of data or with technology.
- [10] S&P-1 The student demonstrates an ability to classify and organize data by designing, collecting, organizing, displaying, or explaining the classification of data in real-world problems (e.g., science or humanities, peers, community, or careers), using information from tables or graphs that display two or more sets of data or with technology.

Materials:

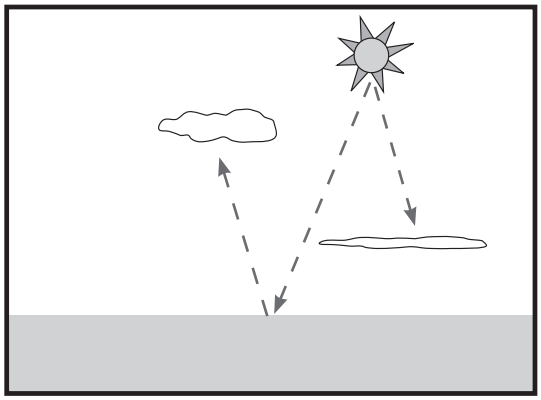
- *Global Climate* Interactive DVD
- OVERHEAD: "Ice Albedo Feedback Loop"
- STUDENT WORKSHEET: "Graphing Climate Change"

Activity Procedure:

1. Explain that scientists predict an approximate increase of the average global temperature of 2-3ºC (3.6 – 5.4ºF) by the end of this century. Ask students what this means to daily temperatures in the Arctic; will every day have a higher average temperature; will every month have a higher average temperature? List student ideas on the board.
2. Ask students how an increase in temperature, overall, will affect the local ecosystem; list student ideas on the board.

3. Ask students if the temperature changes will be consistent across all of Alaska. For example, will all temperatures increase, or will some regions see decreases in temperature? Why or why not?

4. As a class, review the "Earth's Systems," "Greenhouse Effect," and "Climate Change Impacts" units of the *Global Climate* Interactive DVD.



5. Explain that even a slight increase in atmospheric temperature can increase evaporation of water to the atmosphere. Since water vapor is a greenhouse gas, the increase of water vapor in the atmosphere results in further warming. However, water vapor also increases cloud cover, which contributes to an increase or decrease of atmospheric temperature depending upon the height and reflectivity of the clouds. Low clouds cool by blocking incoming solar radiation; high clouds warm by trapping outgoing radiation.

6. In the Arctic, temperature increases may be more dramatic than in the equatorial regions. This is due, in part, to the balance of Arctic temperatures, which fluctuate around freezing, and partly due to the large amount of snow and ice cover. Temperatures across Alaska are below freezing much of the year. A slight shift, pushing temperatures above freezing during more of the year, can result in less snow and ice cover.

7. As snow and ice cover decreases, the overall albedo, or reflectivity, of Alaska's land surface decreases, resulting in more absorption of solar energy. Also, as sea ice melts, open ocean is exposed, resulting in more heat absorption in Arctic waters. This heat in the ocean is released slowly, which may result in warmer coastal regions, creating a positive feedback loop that continues to melt the snow and ice.

8. Show OVERHEAD: "Ice Albedo Feedback Loop." Explain that a positive feedback loop is a reinforcing pattern. Ask students to write a paragraph explaining the feedback loop shown on the overhead. If necessary, explain that the ice albedo feedback loop shows how the warming of Earth results in less sea ice which reduces the albedo, or reflectivity, of the land surface, which results in a lower albedo. The lower albedo results in further warming and thus completes the loop.

Teacher's Note: There are many other feedback loops, both positive and negative. To reinforce this concept ask students to come up with their own example of a feedback loop. One common example is interest earned.

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9. Distribute the STUDENT WORKSHEET: "Graphing Climate Change." Remind students that a temperature normal is the average temperature over a period of 30 years or more. Scientists use normals to determine what is typical weather and climate, and what is a variation. Assist students as needed in completing the worksheet. (NOTE: This activity may also be completed in Excel.)

Critical Thinking Question: Debate Method. Stage a classroom debate regarding one of Questions 5-7 or 10 on the STUDENT WORKSHEET. Divide the class into two teams. Provide each team with approximately 15 minutes to discuss the argument they would like to present to prove their side of the issue. Give each student a chance to speak, with each side taking turns.

Answers:

1-3. See graph at top right.

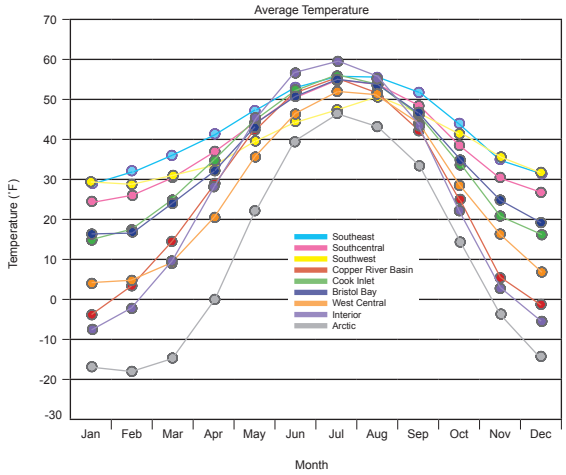
4. Answers will vary, however, students should identify the location of the climate region in respect to the ocean as a factor.

5. Yes, however, regions along the coast would experience less climate variability.

6. No, climate variability will be less as snow and ice cover is decreased; winters will be shorter and milder, and summers will only increase slightly.

7.

Month	Average
Jan	9.9
Feb	12.0
Mar	18.1
Apr	28.6
May	40.6
Jun	49.5
Jul	54.0
Aug	52.1
Sep	44.5
Oct	31.1
Nov	18.5
Dec	12.5

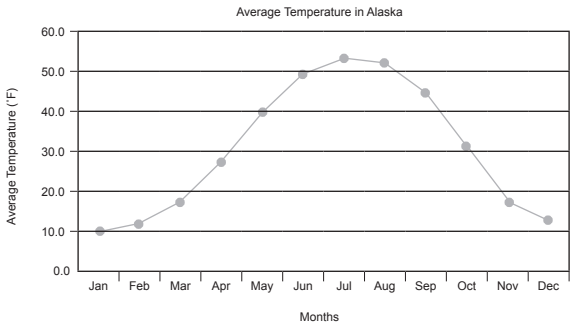


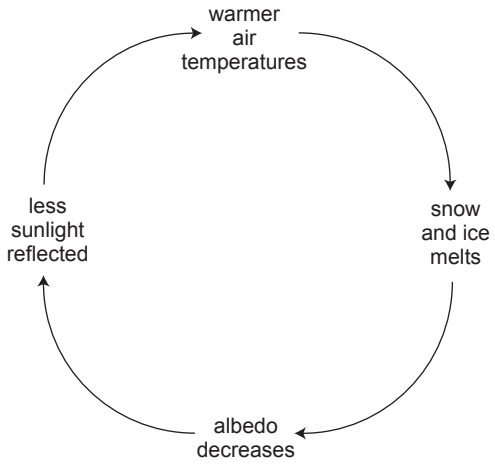
8. See graph at center right.

9. Answers will vary, but reasoning should explain the line and the logic for its positioning.

10. Answers will vary.

11. See diagram at bottom right.





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Graphing Climate Change

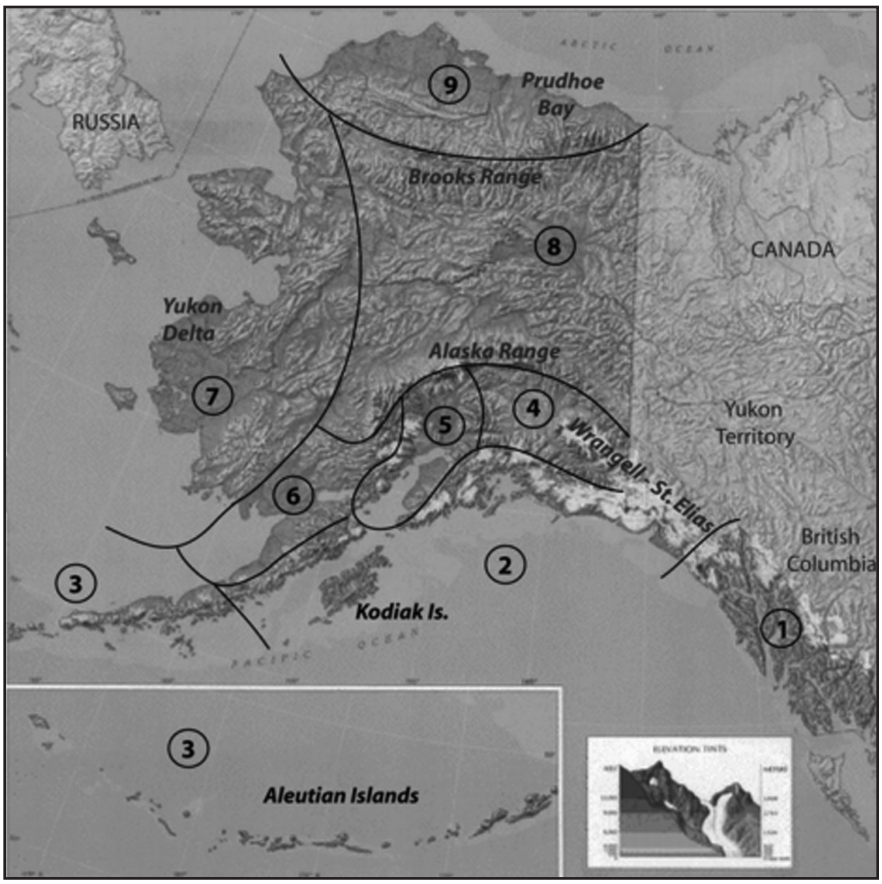
Student Worksheet (page 1 of 3)

Levels V-VI

Directions: Use the following data table and map to complete the questions and procedures on the following pages.

	Southeast	Southcentral	Southwest	Copper River Basin	Cook Inlet	Bristol Bay	West Central	Interior	Arctic	Average
Jan	29.1	24.8	29.6	-4.4	14.3	16.7	4.2	-8.4	-16.7	
Feb	31.9	26.3	29.4	3.1	17.7	16.8	4.4	-3.2	-18.4	
Mar	35.7	30.5	30.9	14.3	24.6	23.3	9.1	9.7	-14.9	
April	41.5	37.0	34.0	29.3	34.8	32.4	20.2	28.0	-0.1	
May	47.7	44.1	39.1	42.3	45.0	42.7	36.2	45.5	22.4	
June	53.3	50.9	44.3	51.8	52.8	50.6	46.5	56.5	39.2	
Jul	56.7	55.2	48.8	55.7	56.7	55.2	52.4	59.6	46.0	
Aug	56.2	54.6	50.6	51.7	54.5	54.2	50.7	54.0	42.7	
Sep	51.0	48.3	47.4	41.7	46.4	47.4	43.0	42.5	32.6	
Oct	43.6	38.7	41.1	25.3	33.0	34.4	28.7	21.9	13.6	
Nov	35.3	30.3	35.8	5.6	20.7	24.9	16.5	2.5	-4.7	
Dec	31.4	26.8	31.9	-1.4	16.2	19.0	7.3	-5.0	-13.6	
Avg.	42.8	39.0	38.6	26.3	34.7	34.8	26.6	25.3	10.7	

Map of Climate Divisions



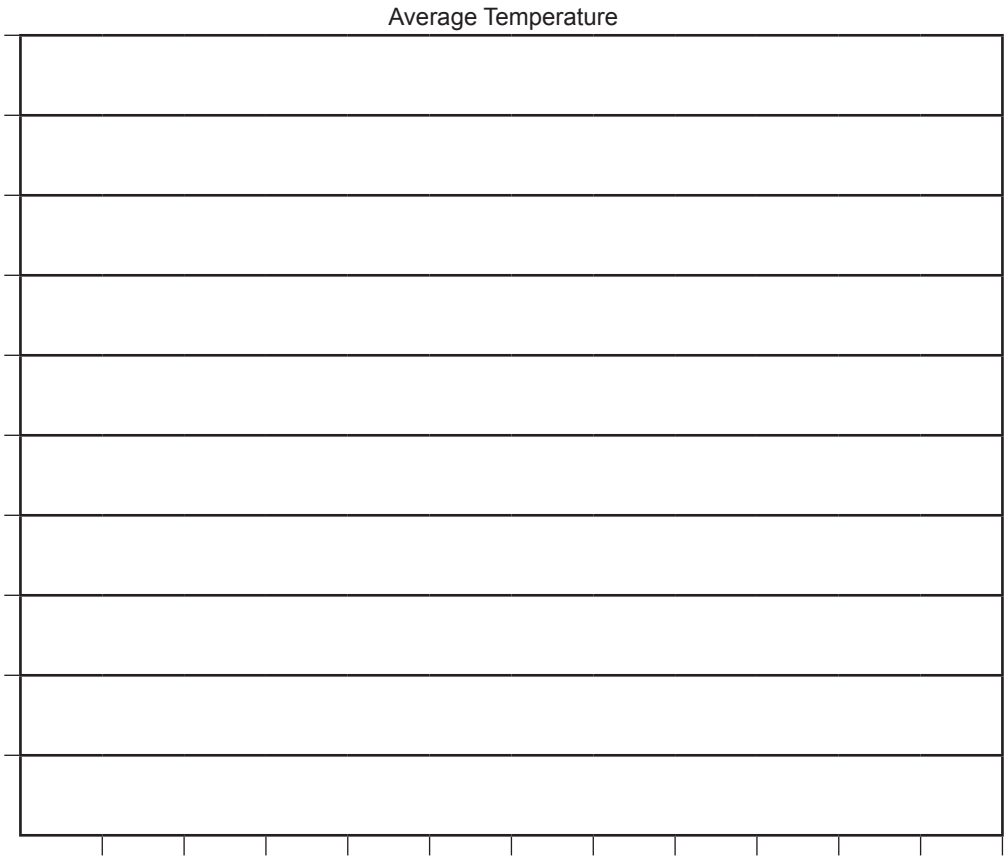
Map courtesy Alaska Climate Research Center: http://climate.gi.alaska.edu/Climate/Normals/Div_Map.jpg

Name:_____

Graphing Climate Change

Student Worksheet (page 2 of 3)

1. On the graph below, label the x and y-axis, and set the scale and interval for the y-axis.
2. Create a key that identifies each climate division, you may use different symbols for each climate, or various colors of pencil/pen.
3. Graph the values that are in the data chart.



4. What are some possible reasons for the variation in climate among each climatic region? (HINT: Examine the map of climate divisions.)

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5. Would a 1ºF rise in average global temperature result in all communities in Alaska having higher monthly temperatures? Why or why not?

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Name:_____

Graphing Climate Change

Student Worksheet (page 3 of 3)

6. Would a 1ºF rise in average global temperature result in more drastic differences in climate (high variability throughout the year)? Why or why not?

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7. Complete the last column of the data table on the first page of this worksheet by calculating the average normal temperature for the state as a whole. For example, for January, add the January value for each region, then divide by the total number of regions.
8. On the blank graph below, graph the average normal temperature for all of Alaska. (HINT: See the last column of the data table.) Be sure to label the x and y-axis and provide a key.
9. Add another line to the graph that represents your prediction for how Alaska's temperature will change if the annual average global temperature increases 1ºF. Explain your reasoning.

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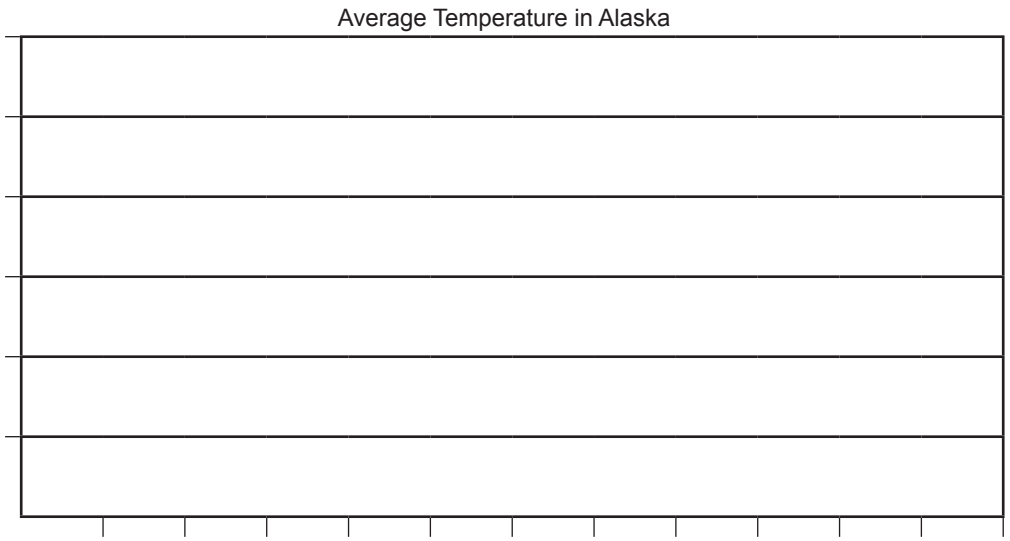

10. How might a 1ºF increase in annual average temperature affect Alaska's ecosystem?

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11. Draw the ice albedo feedback loop.

Ice Albedo Feedback Loop

Overhead