Student's Name ____ Date ______________ Class ___________

Student Sheet 1.2: Where on Earth?

Directions: Think about where on Earth the events listed in Table 1 might occur most often. Also think about why this type of event might happen there. Then complete the table.

Table 1. What I Know About Weather and Climate Events

Type of Event	**Where Does This Event Happen?**	**Why Does It Happen There?** What Does It Tell About Earth?
Tornado		
Hurricane		
Flood		
Drought		
Ice melt		
Global warming		

Student's Name ____ Date _____________ Class ___________

Student Sheet 2.1: Testing the Warming and Cooling Rates of Soil and Water (page 1 of 2)

Directions: Answer the questions and then complete Table 1.

1. How will you make certain that your investigation of the warming and cooling of soil and water will be a fair test? ____

____

____

____

2. Which factors or variables are you changing? Which ones are you keeping the same? Record all the things that you will need to keep the same in both setups. (You may draw a picture here and label it.)

3. What do you think will happen to the temperature of the soil and the water when you turn on the lamp? Will there be differences? ____

____

____

____

4. What will happen to the temperatures when you turn off the lamp? Explain your reasoning.

____

____

____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 2.1: Testing the Warming and Cooling Rates of Soil and Water (page 2 of 2)

Table 1. Warming and Cooling Data

Warming			**Cooling**		
Time	**Soil Temperature (°C)**	**Water Temperature (°C)**	**Time**	**Soil Temperature (°C)**	**Water Temperature (°C)**
0:00			10:00		
1:00			11:00		
2:00			12:00		
3:00			13:00		
4:00			14:00		
5:00			15:00		
6:00			16:00		
7:00			17:00		
8:00			18:00		
9:00			19:00		
10:00			20:00		
Total Temperature Change			**Total Temperature Change**		

Student's Name ____ Date _____________ Class ___________

Student Sheet 2.2: Graph Paper

Student's Name ____ Date ______________ Class ___________

Student Sheet 3.GS: Interpreting a Data Table

Directions: Review the data in Table 1. Then answer the questions.

Table 1. Summer Temperatures Near Portland, Maine

Time	Portland Parklands (Temperature, °C)	Atlantic Ocean (Temperature, °C)
6:00 a.m.	14	18
8:00 a.m.	17	19
10:00 a.m.	18	19
Noon	23	19
2:00 p.m.	26.5	19
4:00 p.m.	27	20
6:00 p.m.	27	20
8:00 p.m.	20	20
10:00 p.m.	18	20
Midnight	16	20
2:00 a.m.	15	20
4:00 a.m.	14	19

1. What is the temperature of the Atlantic Ocean at 4:00 p.m.? ____________________________________

2. What is the temperature of Portland Parklands at noon? ____

3. At what time of day is the temperature of the land at Portland Parklands and the water in the Atlantic Ocean the same? ____

4. At 2:00 p.m., what is the difference in temperature between the land and the water? Which is warmer? What do you think is the reason for this difference? ___________________________________

____

5. During what season were these data collected? How do you know this? _________________________

____

6. What times on the data table do you think represent daytime?

____

Student's Name ____ Date _____________ Class ___________

Student Sheet 3.2: Modeling the Water Cycle

Day 1

	Mass (g)
Water + Small Cup	
Ice + Small Cup	
Total	

Observations:

____

____

____

____

____

____

Day 2

	Mass (g)
Small Cup 2 + Contents	
Small Cup 1 + Contents	
Water	
Total	

Observations:

____

____

____

____

____

____

Student's Name ____________________ Date __________ Class __________

Student Sheet 3.3: Investigating the Temperature of Air

Question I will try to answer: How does the temperature of Earth's surface affect the temperature of the air above it?

Directions: Answer the questions. Then complete Table 1 as you conduct the investigation.

1. How will you set up your equipment to ensure this is a fair test?

____

____

____

2. What will you keep the same? ______________________

____

____

3. What variable will you test? ______________________

____

____

4. Make a prediction. How do you think the temperature of a surface will affect the temperature of the air above it? ______________________

____

____

Table 1. Temperature Changes

	Cold Convection Tube		Hot Convection Tube	
	Container of Crushed Ice: Temperature (°C)		Container of Hot Water: Temperature (°C)	
Time (min)	**Temperature (°C) Thermometer A (top)**	**Temperature (°C) Thermometer B (bottom)**	**Temperature (°C) Thermometer A (top)**	**Temperature (°C) Thermometer B (bottom)**
0:00				
1:00				
2:00				
3:00				

Student's Name ______________________________ Date ____________ Class __________

Student Sheet 4.1: When Air Masses Meet

Directions: Fill in the boxes. Summarize your predictions in the "Predictions" column of Table 1. Then complete the table as you perform your investigation.

Question we will investigate: What happens when two of the same—and then different—air masses meet?	
Materials we will use:	**Procedures we will follow:**
What we will keep the same when comparing the three setups: **What we will change:**	

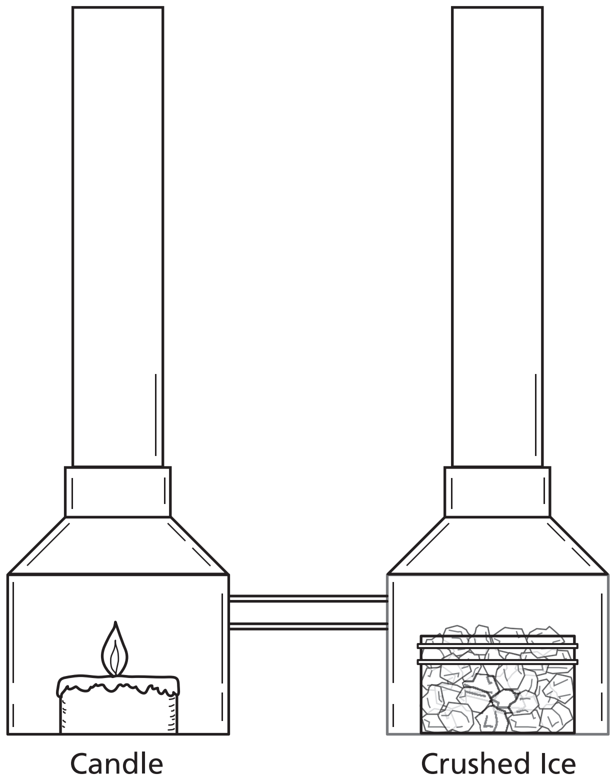
Table 1. Predictions and Observations

Setup of Convection Tubes	Predictions (What We Think Will Happen to the Air)	Observations (What Happened to the Air)
Crushed ice and crushed ice		
Hot water and hot water		
Tea candle and crushed ice		

Student's Name ______________________________ Date __________ Class _________

Student Sheet 4.R: Convection on Earth (page 1 of 2)

1. Think back to Investigation 4.1. Draw a punk stick, smoke, and arrows on the Convection Tubes™ to show the movement of air. Then, in the space below the illustration, explain why the air moves like this.



Explanation:

____

____

____

____

____

____

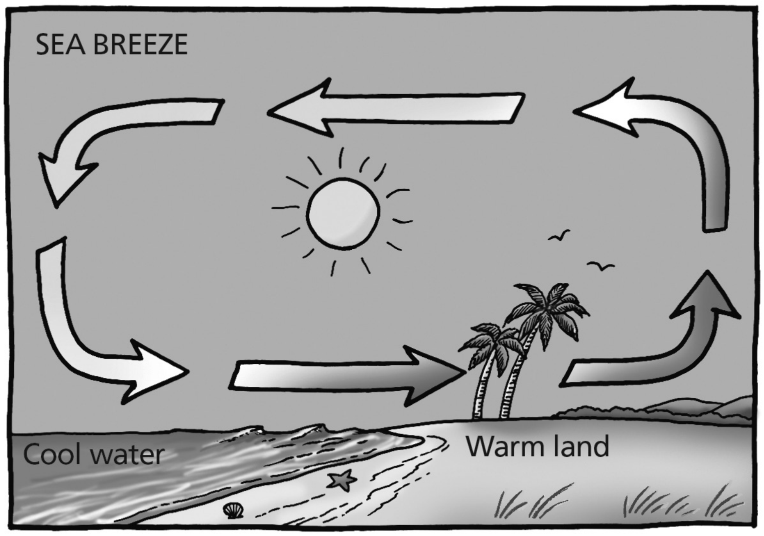
____

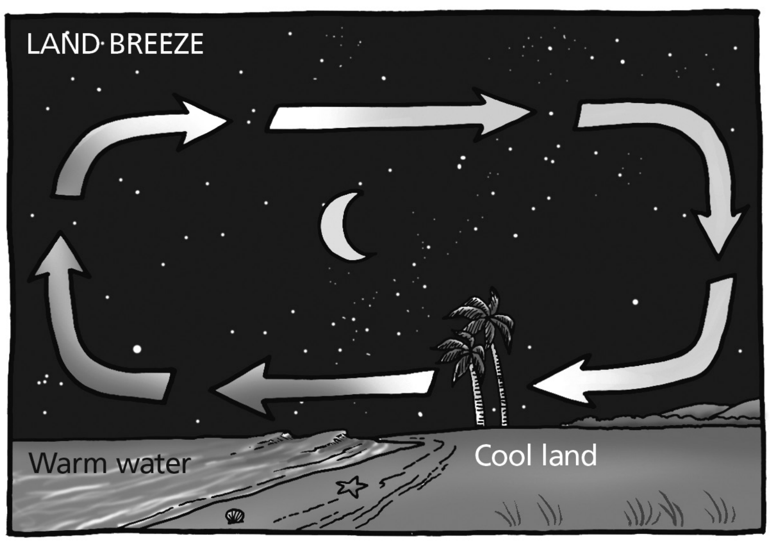
____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 4.R: Convection on Earth (page 2 of 2)

2. In the space below the illustrations, describe how uneven heating of land and water is responsible for sea breezes and land breezes.





Explanation:

____

____

____

____

____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 5.1: Investigating the Effect of Temperature on Ocean Currents

Directions: Complete all of the boxes as you work through the investigation.

Question we are trying to answer: How does the temperature of water affect the way water moves?	
Materials we will use:	**Procedures we will follow:**
What we will keep the same when comparing two setups:	
What we will look for and how we will know it is present: **What we will measure:**	
What happened: **Why we think it happened:**	

Student's Name ______________________________ Date ____________ Class __________

Student Sheet 6.R: Thunderstorms, Tornadoes, and Hurricanes

Directions: Read *That's a Fact: An Introduction to Thunderstorms, Tornadoes, and Hurricanes*. Answer the questions, and then complete Table 1.

1. Name two facts that you learned about thunderstorms.

____

____

2. What is a big, rotating wind and rainstorm called in different areas? Draw lines to match.

Atlantic Ocean and eastern Pacific Ocean	Typhoon
Western Pacific Ocean	Hurricane
Indian Ocean or off the coast of Australia	Cyclone

3. Complete Table 1.

Table 1. Compare and Contrast Tornadoes and Hurricanes

Question	Tornado	Hurricane
Where is it likely to form?		
What causes it to form?		
How big is it?		
How fast does it move?		
How fast do its winds rotate?		
With what scale can you measure its damage?		

Student's Name ______________________________ Date __________ Class ________

Student Sheet 7.2: Reading Weather Maps

Directions: Use the weather maps you have collected (or Figure 7.2) to complete Table 1. One row has been done for you as an example. Then answer questions 1–6 on this sheet.

Table 1. Weather Map Observations

Day	Weather System Observed (high or low pressure, warm or cold front, storm, or other)	Location	Direction System Is Moving	Associated Weather (precipitation, temperature, winds)
Sample	Low pressure, cold front	Phoenix, Denver, Rapid City	Southeast	Flurries becoming heavier, 4.4°C
1				
2				
3				

1. What kind of weather is associated with a high-pressure system? ______________________________

2. What kind of weather is associated with a low-pressure system? ______________________________

3. What symbol represents a cold front? ______________________________

4. What symbol represents a warm front? ______________________________

5. Pick one weather front on a map. What weather is associated with it? ______________________________

6. In what direction does air move across the United States? Why is this information important?

Student's Name ______________________________ Date ______________ Class ___________

Student Sheet 7.3: Graph Paper

Student's Name ______________________________ Date __________ Class ________

Student Sheet 8.1: Modeling Storm Surge

Background: The most dangerous part of a hurricane is the storm surge that forms on the water of the ocean or other body of water, such as a nearby lake. Low air pressure at the center of the hurricane draws water up into a hill that is higher than sea level, and hurricane winds push the hill of water forward, causing it to grow even taller. In other words, the size of the storm surge is determined mainly by wind speed but also by air pressure in the eye of the hurricane. The surge moves quickly across the ocean and may cause flooding when it contacts shorelines. Flooding produces higher casualties than any other aspect of a hurricane. The extent of flooding not only depends on the size of the storm surge but also on the shape of the shoreline.

Table 1. Storm Surge Data

	Model Landform with Cliffs		**Model Landform with Gentle Slope**	
	Water Height (cm)	**Shoreline Flooding (cm)**	**Water Height (cm)**	**Shoreline Flooding (cm)**
Non-hurricane conditions				
Hurricane conditions				
Wind Trial 1				
Wind Trial 2				
Wind Trial 3				
Average (hurricane conditions)				

Student's Name ______________________________ Date __________ Class ________

Student Sheet 8.2: Tracking Hurricane Katrina (page 1 of 3)

Background: When Hurricane Katrina struck the Gulf Coast in 2005, it was the most destructive hurricane ever to hit the continental United States. It was responsible for more deaths than any other hurricane in the previous century and was the costliest hurricane in recorded history. Hurricane Katrina was one of 28 North Atlantic hurricanes in 2005.

Step 1. Use Table 1 and a colored pencil to record the path of the hurricane on the hurricane tracking chart. Place a colored dot at each position listed in Table 1 using the latitude and longitude data. You may need to estimate. Make a prediction at each place indicated in the table. (Each dot on the chart represents the location of the hurricane's eye.)

Step 2. Answer questions 1–11.

1. Where did the tropical storm that eventually turned into Hurricane Katrina begin? ______________

   ____

2. Is this where tropical storms are usually born? ______________________________

3. At what point (longitude and latitude) did the tropical storm become a hurricane? ______________

   ____

4. In what direction did the storm move? ______________________________

5. What do you think caused Hurricane Katrina to move along this path? ______________________

   ____

6. Where did Hurricane Katrina lose its energy and turn back into a tropical storm? ______________

   ____

7. Why do you think it happened in that location? ______________________________

   ____

8. If you had been working at the National Hurricane Center when Hurricane Katrina was active, which cities or areas would you have evacuated? ______________________________

   ____

9. What day would you have recommended the evacuation? Why? ______________________

   ____

10. What happened to the wind speed and the barometric pressure over the eight-day period?

    ____

11. What data is missing that might explain the extensive damage caused on the Gulf Coast and New Orleans by Hurricane Katrina? ______________________________

    ____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 8.2: Tracking Hurricane Katrina (page 2 of 3)

Table 1. Path of Hurricane Katrina Over Eight Days

Date (Aug. 2005)	Time	Latitude	Longitude	Pressure (mb)	Wind Speed (kt/hr)	Storm Status Category
23	6 p.m.	23.10	−75.10	1008	30	Tropical depression
24	6 a.m.	23.80	−76.20	1007	30	Tropical depression
24	6 p.m.	25.40	−76.90	1003	40	Tropical storm
Based on the path of the storm, how far the storm has traveled, its pressure, and its wind speed, for which locations would you issue hurricane watches and warnings? A watch means hurricane conditions are likely for a location within 36 hours. A warning means the conditions are likely for a location within 24 hours.						
25	6 a.m.	26.10	−78.40	997	50	Tropical storm
25	6 p.m.	26.20	−79.60	988	60	Tropical storm
Based on the path of the storm, how far the storm has traveled, its pressure, and its wind speed, for which locations would you issue hurricane watches and warnings? A watch means hurricane conditions are likely for a location within 36 hours. A warning means the conditions are likely for a location within 24 hours.						
26	6 a.m.	25.40	−81.30	987	65	Hurricane
26	6 p.m.	24.90	−82.60	968	85	Hurricane
27	6 a.m.	24.40	−84.00	950	95	Hurricane
27	6 p.m.	24.50	−85.30	948	100	Hurricane
Based on the path of the storm, how far the storm has traveled, its pressure, and its wind speed, for which locations would you issue hurricane watches and warnings? A watch means hurricane conditions are likely for a location within 36 hours. A warning means the conditions are likely for a location within 24 hours.						
28	6 a.m.	25.20	−86.70	930	125	Hurricane
28	6 p.m.	26.30	−88.60	902	150	Hurricane
29	6 a.m.	28.20	−89.60	913	125	Hurricane
29	6 p.m.	31.10	−89.60	948	80	Hurricane
30	6 a.m.	34.10	−88.60	978	40	Tropical storm
30	6 p.m.	37.00	−87.00	990	30	Tropical depression
31	6 a.m.	40.10	−82.90	996	25	Extratropical depression

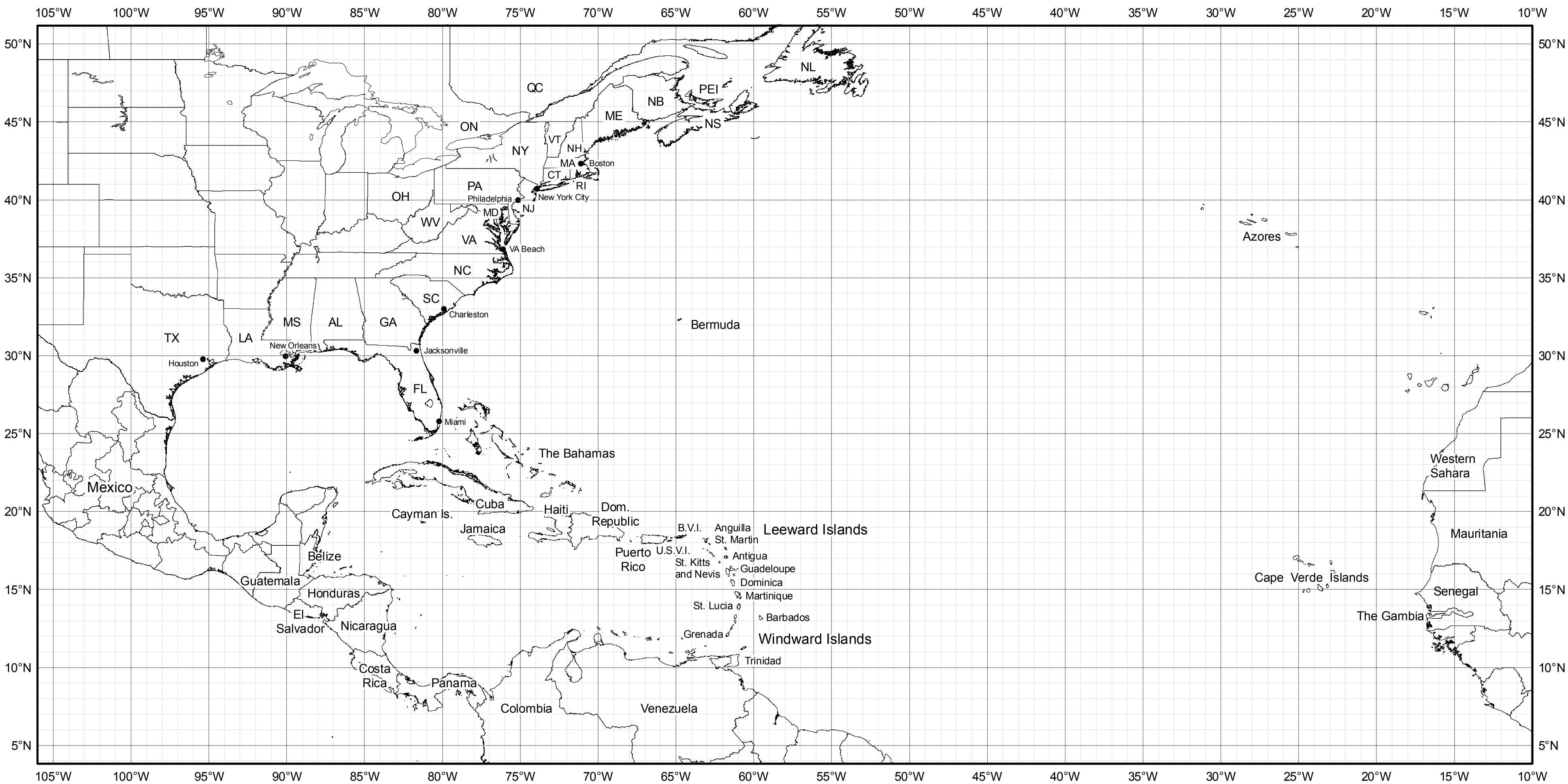
SOURCE: National Hurricane Center, NWS, NOAA

Student's Name ____________________ Date ____________ Class ________

Student Sheet 8.2: Tracking Hurricane Katrina (page 3 of 3)

Atlantic Basin Hurricane Tracking Chart

National Hurricane Center, Miami, Florida



SOURCE: National Hurricane Center, NWS, NOAA

Student's Name ______________________________ Date __________ Class ________

Student Sheet 8.3: Building Designs to Reduce Storm Surge

Directions: Research the following topics using the online resources provided. Include as many relevant details as possible that will help you draw your own building design.

Storm Impact

Flooding:

Winds:

Building Design

Garage Doors:

Shutters and Windows:

Hurricane Readiness: (Use this information to apply it to a new building design.)

Student's Name ______________________________ Date ____________ Class __________

Student Sheet 9.1: Graph Paper

Student's Name ______________________________ Date ____________ Class __________

Student Sheet Sheet 10.GS: Defining and Measuring the Temperature of an Area

1. Where will you take your measurements?

a. ____

____

b. ____

____

c. ____

____

2. What is the temperature at each location you chose? Explain how you took the temperature.

a. ____

____

b. ____

____

c. ____

____

3. What is the temperature of the area? ______________________________

4. How did you use your temperature readings to get that number?

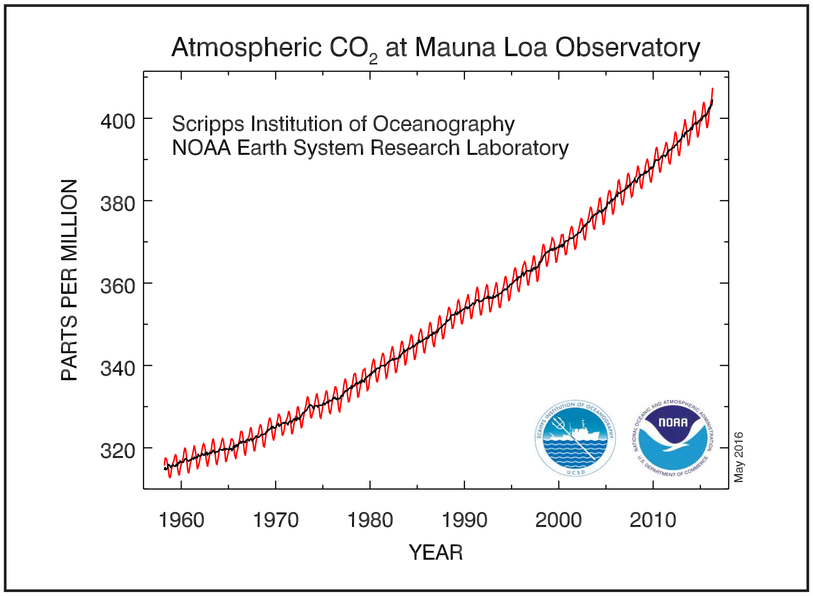
____

____

Student's Name ______________________________ Date __________ Class __________

Student Sheet 10.1: Climate Graph A (page 1 of 3)

Carbon Dioxide Concentration at Mauna Loa Observatory, 1960–2016



SOURCE: NOAA/Earth System Research Laboratory

Due Dates

__________: Selection of topics to address general research question

__________: Analysis of graph, including questions about the data

__________: Research on topics for general research question

__________: Bibliography

__________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

Independent variable: ______________________________

Dependent variable: ______________________________

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student's Name ____ Date _____________ Class ___________

Student Sheet 10.1: Climate Graph A (page 2 of 3)

3. Questions About the Data

a. What is the middle layer of the troposphere? What does measuring the CO_2 concentration there tell us?

b. How is it possible for scientists at the observatory to measure how much CO_2 gas there is in a layer of the atmosphere?

c. What does "parts per million" mean? What does "concentration" mean?

d. Does the CO_2 concentration remain constant throughout the year? Is this graph based on averages for an entire year?

e. Whose idea was it to take these measurements at Mauna Loa? What was that person's background, and why was recording CO_2 concentrations suggested?

f. The range for the CO_2 concentration is about 317–385 parts per million. Is this significant? At what concentration does atmospheric CO_2 become a problem, and why?

g. Additional question: ____

____

4. General Research Topic

Why is the level of atmospheric CO_2 important in studying climate change?

Possible research directions include:

- the history of monitoring atmospheric CO_2
- current debates about the importance of CO_2
- why CO_2 molecules trap heat
- efforts around the world to reduce the amount of CO_2 people release into the atmosphere
- how high levels of atmospheric CO_2 affect the ocean
- Other topic: ____

____

Student's Name ______________________________ Date __________ Class _________

Student Sheet 10.1: Climate Graph A (page 3 of 3)

5. Outline of Research Plan

i. ____

ii. ____

iii. ____

iv. ____

v. ____

vi. ____

vii. ____

viii. ____

6. Research Roles for Each Group Member

____________________: ____________________________

____________________: ____________________________

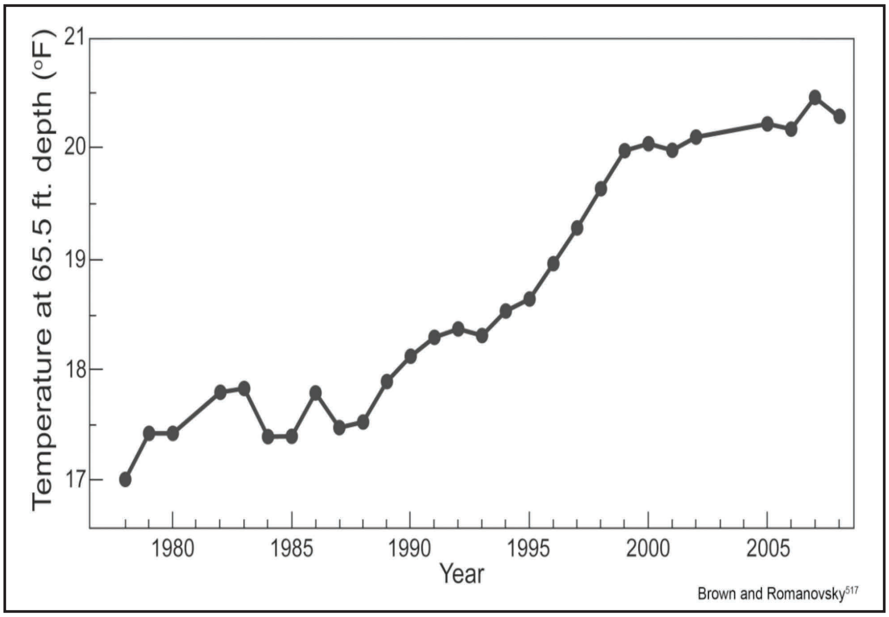
____________________: ____________________________

____________________: ____________________________

Student's Name ____ Date ______________ Class ___________

Student Sheet 10.1: Climate Graph B (page 1 of 3)

Permafrost Temperature at Deadhorse, Alaska, 1978–2008



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

Due Dates

_____________: Selection of topics to address general research question

_____________: Analysis of graph, including questions about the data

_____________: Research on topics for general research question

_____________: Bibliography

_____________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

   Independent variable: ____

   Dependent variable: ____

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student's Name ______________________________ Date __________ Class _________

Student Sheet 10.1: Climate Graph B (page 2 of 3)

3. Questions About the Data

a. Where is Deadhorse, AK? Find it on the map.

b. What is permafrost?

c. Why are the temperatures being taken at Deadhorse and why at a depth of 65.5 feet?

d. Whose idea was it to test here and why?

e. Is this the only location at which permafrost-layer temperatures are being monitored?

f. Additional question:____

____

4. General Research Topic

Why is permafrost important in climate change research?

Possible research directions include:

- how and when people noticed that the permafrost was thawing
- how people had lived on areas w ith permafrost, and how their lives have changed as permafrost has thawed
- the discovery that permafrost traps methane gas, and methane's importance as a greenhouse gas
- scientists' estimates of how much permafrost exists and where it is, and projections about how much may thaw
- Other topic: ____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph B (page 3 of 3)

5. Outline of Research Plan

i. ______________________________

ii. ______________________________

iii. ______________________________

iv. ______________________________

v. ______________________________

vi. ______________________________

vii. ______________________________

viii. ______________________________

6. Research Roles for Each Group Member

______________: ______________________________

______________: ______________________________

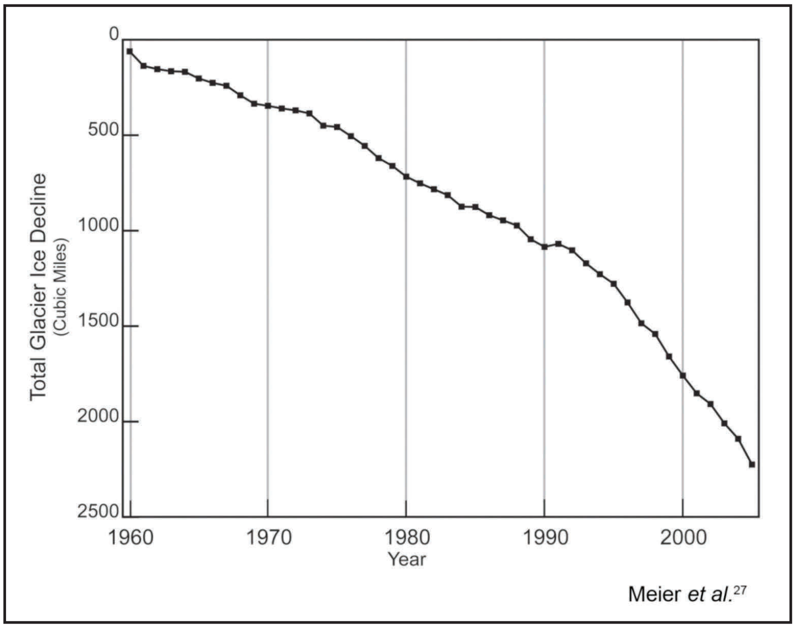
______________: ______________________________

______________: ______________________________

Student's Name ____ Date ______________ Class ___________

Student Sheet 10.1: Climate Graph C (page 1 of 3)

Volume of Glacier Ice, 1960–2005



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

Due Dates

_____________: Selection of topics to address general research question

_____________: Analysis of graph, including questions about the data

_____________: Research on topics for general research question

_____________: Bibliography

_____________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

   Independent variable: ____

   Dependent variable: ____

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student's Name ____ Date _____________ Class ___________

Student Sheet 10.1: Climate Graph C (page 2 of 3)

3. Questions About the Data

a. How big are glaciers?

b. How do glaciologists measure glaciers? How do they know whether a glacier is growing or shrinking?

c. This graph shows combined data for many glaciers. In fact, some glaciers are melting while others are holding steady, or melting at different rates. How could this be? If Earth is warming, wouldn't all glaciers melt at the same rate?

d. How much of the world's water is contained in glaciers?

e. Additional question: ____

____

4. General Research Topic

How are glaciers important in climate change?

Possible research directions include:

- how scientists estimate the amount of water trapped in glaciers, how much they estimate will be released as the climate changes, and what this might mean for sea and river levels
- paleoclimate research on how glaciers have advanced and retreated
- the extent of glaciers during the Little Ice Age, and the climate of Europe during that time
- the dynamics of how glaciers melt and move
- whether glacial melting is expected to affect (slow or hasten) global warming
- what the cryosphere is, and its effects on global climates
- Other topic: ____

____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph C (page 3 of 3)

5. Outline of Research Plan

i. ______________________________

ii. ______________________________

iii. ______________________________

iv. ______________________________

v. ______________________________

vi. ______________________________

vii. ______________________________

viii. ______________________________

6. Research Roles for Each Group Member

______________: ______________________________

______________: ______________________________

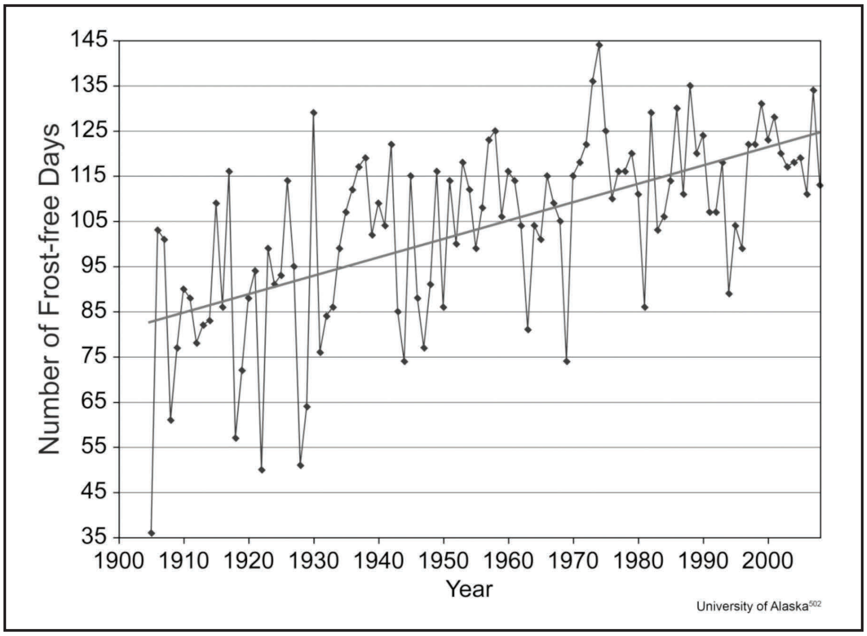
______________: ______________________________

______________: ______________________________

Student's Name ____ Date ______________ Class ___________

Student Sheet 10.1: Climate Graph D (page 1 of 3)

Frost-free Days in Fairbanks, Alaska, 1904–2008



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

Due Dates

_____________: Selection of topics to address general research question

_____________: Analysis of graph, including questions about the data

_____________: Research on topics for general research question

_____________: Bibliography

_____________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

Independent variable: ____

Dependent variable: ____

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student's Name ____ Date _____________ Class ___________

Student Sheet 10.1: Climate Graph D (page 2 of 3)

3. Questions About the Data

a. Why is the weather in Fairbanks, Alaska, important? Why would a climatologist use this graph rather than a graph of conditions in Montana or another cold place?

b. Why doesn't the graph show the number of frost-free days for 1900?

c. The number of frost-free days seems to jump around a lot from year to year, showing no steady pattern. Why would a climatologist be interested in a variable that changes so erratically?

d. The number of frost-free days in 1975 was unusual. What does the graph show?

e. Additional question: ____

____

4. General Research Topic

Are local climates changing?

Possible research directions include:

- the USDA's decision to redraw the nation's growing zones (These tell people which plants grow well in different areas.)
- how climatologists can tell that an area is warmer, cooler, wetter, or drier than it used to be
- people's beliefs about whether the climate is changing, as revealed by polls
- whether or not recent heat waves in the United States and Europe indicate climate change
- Other topic: ____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph D (page 3 of 3)

5. Outline of Research Plan

i. ____________________

ii. ____________________

iii. ____________________

iv. ____________________

v. ____________________

vi. ____________________

vii. ____________________

viii. ____________________

6. Research Roles for Each Group Member

____________: ____________________

____________: ____________________

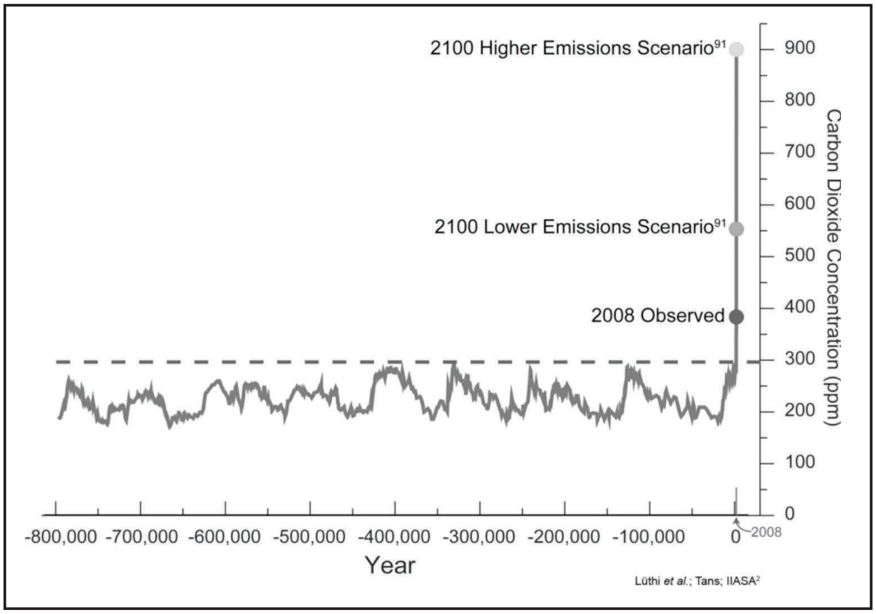
____________: ____________________

____________: ____________________

Student's Name ____ Date _____________ Class ___________

Student Sheet 10.1: Climate Graph E (page 1 of 3)

Changes in Carbon Dioxide Concentration in an Antarctic Ice Core Over 800,000 Years



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

Due Dates

_____________: Selection of topics to address general research question

_____________: Analysis of graph, including questions about the data

_____________: Research on topics for general research question

_____________: Bibliography

_____________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

Independent variable: ____

Dependent variable: ____

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student Sheet 10.1: Climate Graph E (page 2 of 3)

3. Questions About the Data

a. What does "ppm" mean? What does "scientists have drilled cores" mean? Is an ice sheet the same thing as a glacier?

b. How can ice say anything about how much CO_2 was in the atmosphere?

c. Was someone keeping records of CO_2 concentrations in ice 800,000 years ago? If not, what do the measurements mean, and how did we get them?

d. How are ice cores related to the atmosphere's temperature?

e. The point marked "0" on the x axis is also marked "2008." What does this mean?

f. The value plotted with the large, dark dot (2008 Observed) seems to be much different from the others. Could it be a mistake?

g. Additional question: ____

____

4. General Research Topic

Were ancient atmospheres different from ours?

Possible research directions include:

- how we reconstruct historical scenarios using "proxy data"
- how paleoclimatologists believe the composition of the atmosphere (what gases it is made of, and how much of each) has changed over time, and how that has affected climate and life on Earth
- why ice is a valuable source of climate data
- whether other planets' atmospheres change over time
- Other topic: ____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph E (page 3 of 3)

5. Outline of Research Plan

i. ____________________

ii. ____________________

iii. ____________________

iv. ____________________

v. ____________________

vi. ____________________

vii. ____________________

viii. ____________________

6. Research Roles for Each Group Member

__________: ____________________

__________: ____________________

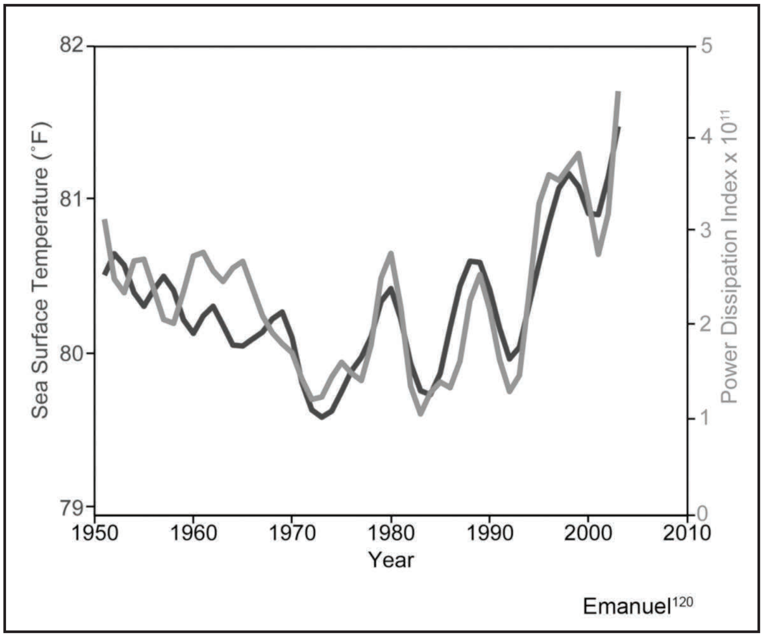
__________: ____________________

__________: ____________________

Student's Name ____ Date _____________ Class __________

Student Sheet 10.1: Climate Graph F (page 1 of 3)

Sea Surface Temperatures and Hurricane Power Dissipation in the North Atlantic Ocean



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

Due Dates

_____________: Selection of topics to address general research question

_____________: Analysis of graph, including questions about the data

_____________: Research on topics for general research question

_____________: Bibliography

_____________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

   Independent variable: ____

   Dependent variable: ____

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student's Name ____ Date _____________ Class ___________

Student Sheet 10.1: Climate Graph F (page 2 of 3)

3. Questions About the Data

a. What does "dissipate" mean?

b. Who invented the PDI, and what for?

c. Why does anyone want to know how much energy hurricanes give off? What is meant by "giving off energy"?

d. How is sea surface water temperature related to a hurricane's energy?

e. The last PDI value is higher than the rest. Is it likely to be a mistake? Why or why not?

f. Additional question: ____

____

4. General Research Topic

Are hurricanes getting stronger?

Possible research directions include:

- how we measure the amount of energy in storms and the intensity of storms
- coastal cities' preparation for strong hurricanes
- climate scientists' projections of what higher numbers of and stronger hurricanes might mean for coastal areas
- the number of Category 4 and 5 hurricanes in the last 50 years and whether there's been an increase
- how powerful hurricanes affect marine life
- Other topic: ____

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph F (page 3 of 3)

5. Outline of Research Plan

i. ______________________________

ii. ______________________________

iii. ______________________________

iv. ______________________________

v. ______________________________

vi. ______________________________

vii. ______________________________

viii. ______________________________

6. Research Roles for Each Group Member

______________: ______________________________

______________: ______________________________

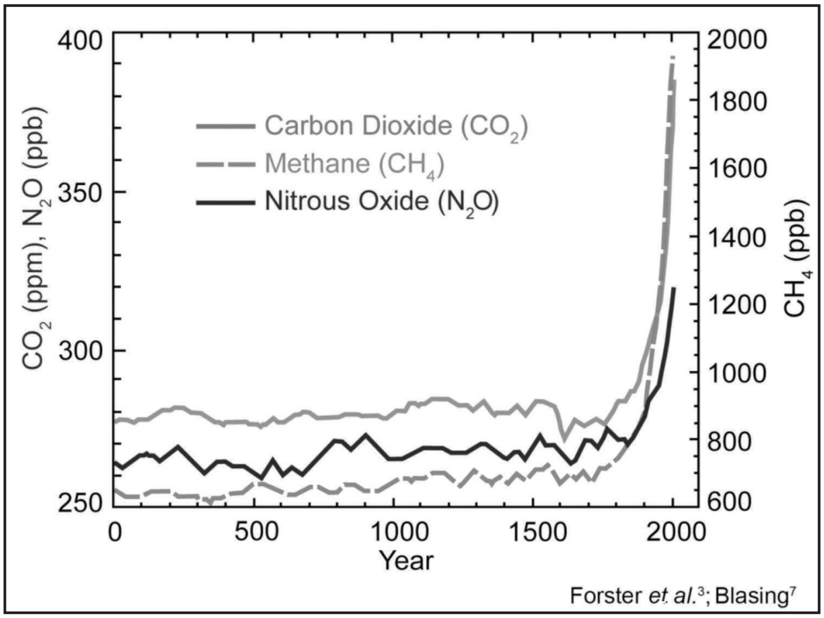
______________: ______________________________

______________: ______________________________

Student's Name ______________________________ Date __________ Class __________

Student Sheet 10.1: Climate Graph G (page 1 of 3)

Concentrations of Three Greenhouse Gases Over 2,000 Years



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

Due Dates

__________: Selection of topics to address general research question

__________: Analysis of graph, including questions about the data

__________: Research on topics for general research question

__________: Bibliography

__________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

   Independent variable: ______________________________

   Dependent variable: ______________________________

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph G (page 2 of 3)

3. Questions About the Data

a. What are greenhouse gases? Why are methane and nitrous oxide included in this graph?

b. What do "concentration," "ppm," and "ppb" mean?

c. In 1750, nobody knew that carbon dioxide, methane, and nitrous oxide existed. How can they have been measured from the years 0 CE to 1750 CE?

d. Does every place in the atmosphere have the same concentration of gases? If not, what do the concentrations in this graph mean? Where are they taken from?

e. This graph was taken from a report called "Changes in Atmospheric Constituents and in Radiative Forcing." (Atmospheric constituents are the things that constitute, or make up, the atmosphere.) What is radiative forcing, and how is it related to atmospheric constituents? In other words, what is this graph for? What point or argument was it supposed to support?

f. Additional question: ______________________________

____

4. General Research Topic

Why is there emphasis on carbon dioxide concentrations in the atmosphere, rather than on concentrations of another greenhouse gas?

Possible research directions include:

- how scientists determined that greenhouse gases are important in climate change
- how greenhouse gases trap heat
- whether all greenhouse gases trap heat equally well
- how much of each type of greenhouse gas on the graph humans release each year into the atmosphere
- where greenhouse gases come from
- national and international efforts to control the release of greenhouse gases
- research programs to monitor atmospheric CO_2 from space
- Other topic: ______________________________

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph G (page 3 of 3)

5. Outline of Research Plan

i. ____

ii. ____

iii. ____

iv. ____

v. ____

vi. ____

vii. ____

viii. ____

6. Research Roles for Each Group Member

____________________: ______________________________

____________________: ______________________________

____________________: ______________________________

____________________: ______________________________

Student's Name ______________________________ Date __________ Class __________

Student Sheet 10.1: Climate Graph H (page 1 of 3)

Arctic Sea Ice Extent, Annual Average, 1900–2008

Due Dates

__________: Selection of topics to address general research question

__________: Analysis of graph, including questions about the data

__________: Research on topics for general research question

__________: Bibliography

__________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

   Independent variable: ______________________________

   Dependent variable: ______________________________

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph H (page 2 of 3)

3. Questions About the Data

a. What is surface reflectivity?

b. This graph says that in 1900, sea ice covered over 5 million square miles. The Wright Brothers did not test their first glider until 1900, and of course, there were no satellites. How is it possible to know how much territory sea ice covered in 1900?

c. The part of the graph that shows sea ice cover before 1953 is shaded to show that scientists have less confidence in the data. What does "less confidence" mean?

d. Sea ice melts and forms with the seasons. Sea ice also breaks up at its edges and moves, making the borders of sea ice hard to find. How and when were the measurements in this graph taken? What problems might there be in interpreting this data if the measurements were taken at different times of year and by different methods?

e. Is every measurement on this graph as reliable as the others? If not, should we use it? Explain your answer.

f. Additional question: ______________________________

____

4. General Research Topic

Why does it matter how much of Earth is covered by sea ice?

Possible research directions include:

- what the National Snow and Ice Data Center is, and why it collects data on sea ice
- whether sea ice is more important to climate than land ice
- why snow and ice cores are valuable to climate scientists
- how global climates and/or sea levels might be affected if all the ice in the sea melted
- what could happen if more of Earth were covered by sea ice
- organisms that need sea ice in their habitats
- Other topic: ______________________________

Student's Name ____ Date ____________ Class __________

Student Sheet 10.1: Climate Graph H (page 3 of 3)

5. Outline of Research Plan

i. ____

ii. ____

iii. ____

iv. ____

v. ____

vi. ____

vii. ____

viii. ____

6. Research Roles for Each Group Member

__________________________: ____

__________________________: ____

__________________________: ____

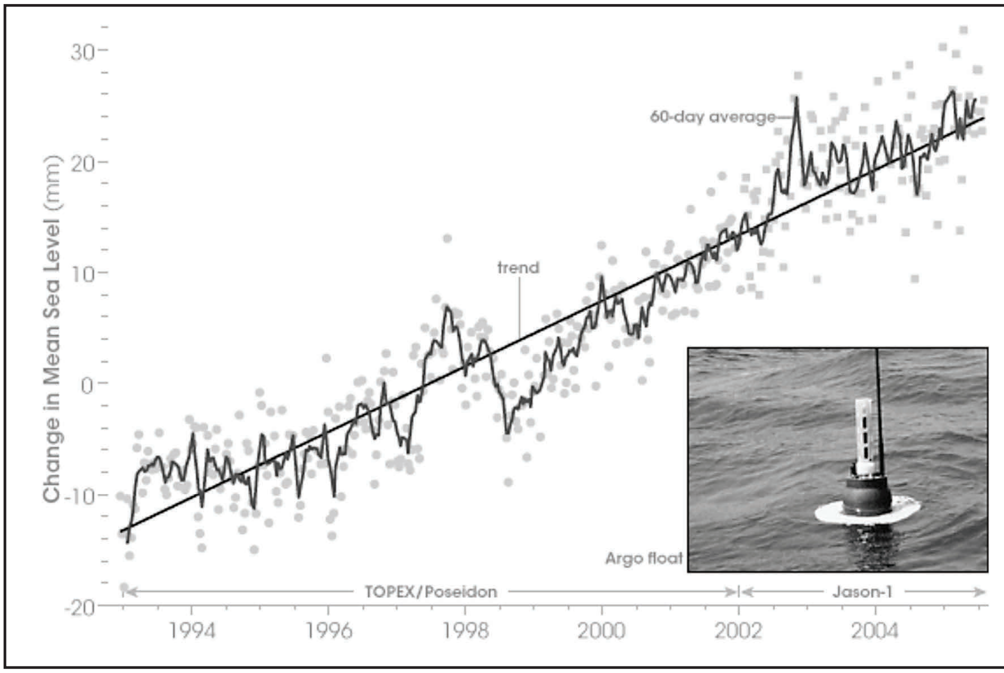
__________________________: ____

Student's Name ____ Date _____________ Class ___________

Student Sheet 10.1: Climate Graph I (page 1 of 3)

Change in Global Mean Sea Level, 1993–2005

Graph I



SOURCE: NASA Earth Observatory. Graph adapted by Robert Simmon from Leuliette, E., Nerem, R., and Mitchum, G. (2004). Calibration of TOPEX/Poseidon and Jason altimeter data to construct a continuous record of mean sea level change. Marine Geodesy, 27(1–2), 79–94.

Due Dates

_____________: Selection of topics to address general research question

_____________: Analysis of graph, including questions about the data

_____________: Research on topics for general research question

_____________: Bibliography

_____________: Oral presentation

1. List the independent variable and the dependent variable from the graph.

Independent variable: ____

Dependent variable: ____

2. Describe the apparent relationship between the variables. Is it direct? Indirect? Does there appear to be no relationship at all? Why do you think this?

Student's Name ______________________________ Date __________ Class ________

Student Sheet 10.1: Climate Graph I (page 2 of 3)

3. Questions About the Data

a. What does "global mean sea level" mean?

b. Is the sea level the same everywhere?

c. In total, according to Graph I, by how much have sea levels risen since 1993?

d. Is that a lot? How could we know?

e. Additional question: ____

____

4. General Research Topic

Why does it matter if sea levels rise?

Possible research directions include:

- effects of rising sea levels on coastal areas
- how rising sea levels affect ecosystems in estuaries
- how much sea levels are expected to rise in the next hundred years
- the percentage of the human population that lives along coastlines and the percentage of human industry that takes place along coastlines
- Other topic: ____

Student's Name ______________________________ Date ___________ Class __________

Student Sheet 10.1: Climate Graph I (page 3 of 3)

5. Outline of Research Plan

i. ______________________________

ii. ______________________________

iii. ______________________________

iv. ______________________________

v. ______________________________

vi. ______________________________

vii. ______________________________

viii. ______________________________

6. Research Roles for Each Group Member

______________: ______________________________

______________: ______________________________

______________: ______________________________

______________: ______________________________

Student's Name ____ Date _____________ Class ___________

Student Sheet 11.2: Investigating the Impact of Climate Change on Wetlands

Scientists at the Smithsonian Environmental Research Center, such as Pat Megonigal, are simulating a "marsh of the future." They are injecting extra CO_2 into the air around the marsh and adding extra nitrogen to the soil to study the potential effects of climate change on wetlands. Listen closely to the video to gather the information you need to answer the questions.

1. Why is it important to study wetlands? ____

2. How did researchers determine the simulated conditions used in the study?

3. How did researchers simulate increased levels of CO_2 in the wetlands and monitor its effects?

4. How did the plants respond to increased levels of CO_2? ____________________________________

5. Why are researchers concerned about the impact of increased CO_2 on wetland plant growth?

6. What happens if CO_2 and nitrogen increase together? ____________________________________

7. What are the implications of this in terms of the impact of sea level rise on wetlands?

8. What happened when the researchers simulated sea level rise? ______________________________

9. How could increased CO_2 and nitrogen levels impact the types of plants that grow in the wetland?

10. Why is climate change difficult to study? ____

Student's Name ______________________________ Date ____________ Class __________

Student Sheet WA.2: *Weather and Climate Systems* Written Assessment Answer Sheet
(page 1 of 2)

Multiple Choice

1. ________ **4.** ________

2. ________ **5.** ________

3. ________ **6.** ________

Short Answer

7. ____

____

____

8. ____

____

____

9. ____

____

____

10. ____

____

____

11. ____

____

____

12. ____

____

____

Student's Name ______________________________ Date __________ Class ________

Student Sheet WA.2: *Weather and Climate Systems* Written Assessment Answer Sheet
(page 2 of 2)

13. ______________________________

____

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14. ______________________________

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15. ______________________________

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16. ______________________________

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17. ______________________________

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18. ______________________________

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19. ______________________________

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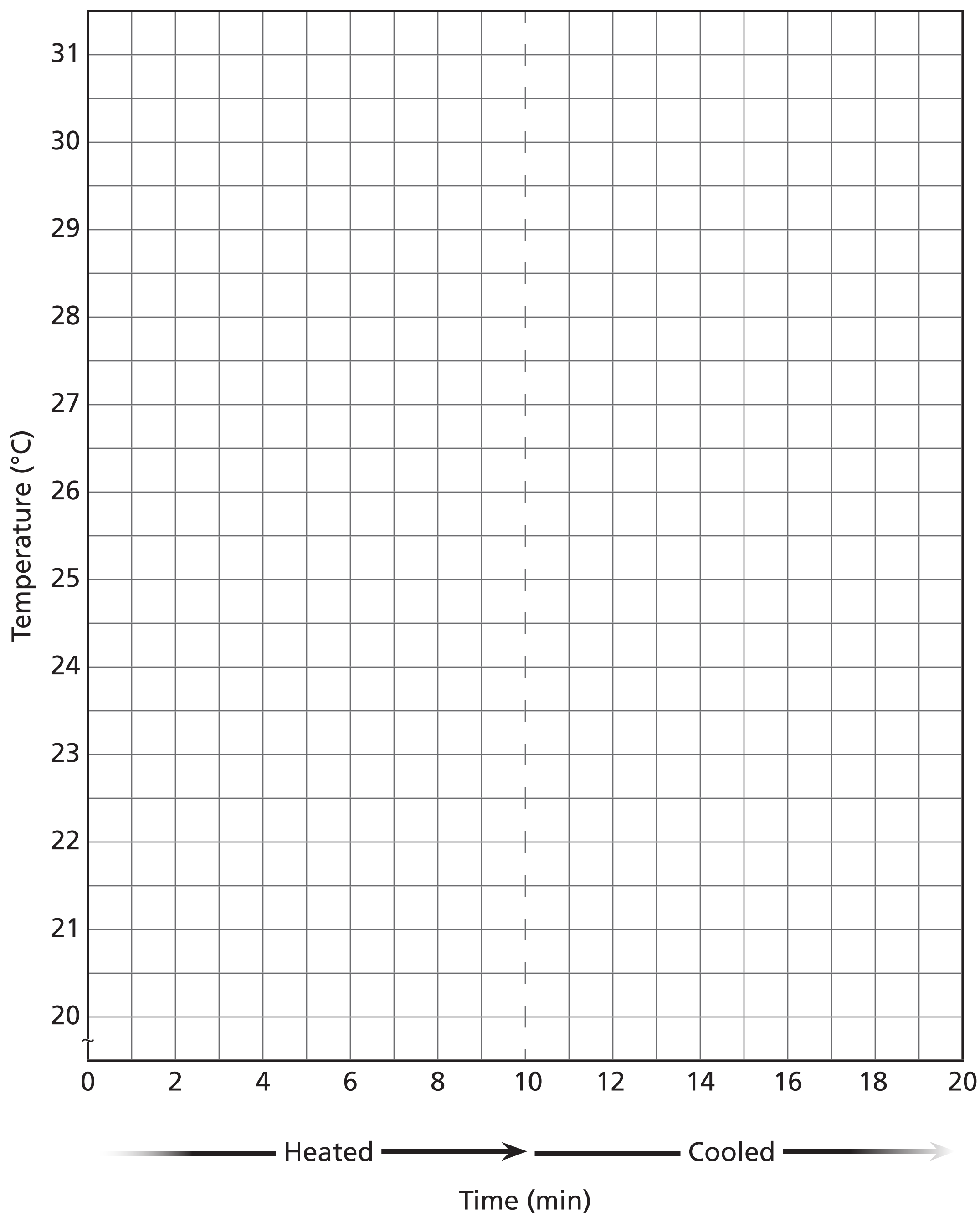
20. ______________________________

Lesson Master 2.2a: Suggestions for Making a Graph

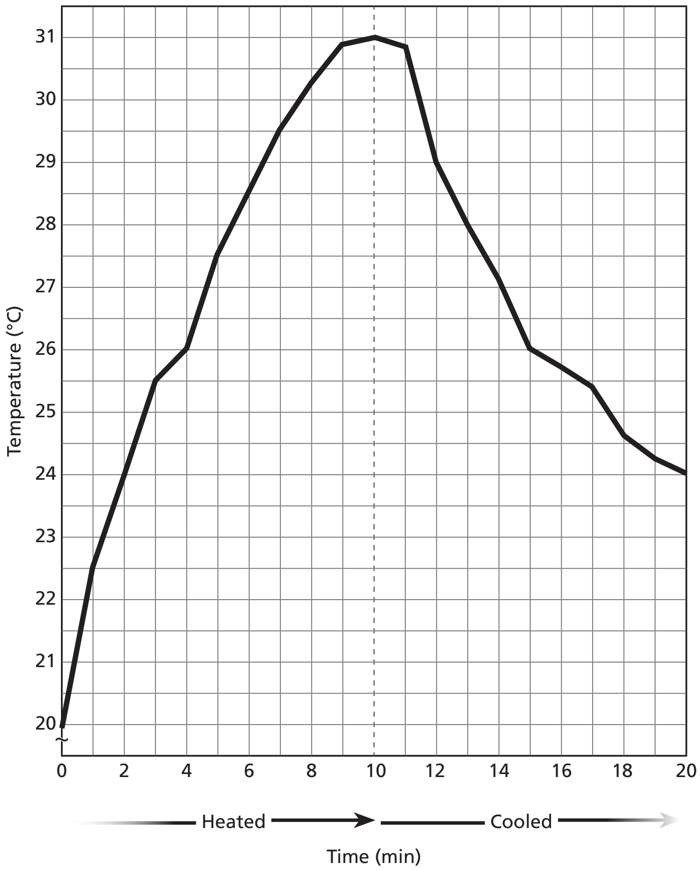
1. Give each graph a title that describes the data it displays.
2. Cover as much space on the graph as possible with plotted data. Leave enough space along the axes for labels, even scale divisions, and units of measure.
3. Label horizontal and vertical axes with a description of the data being plotted and the units of measure.
4. Plot the independent variable (the data being controlled) on the horizontal, or x axis, and the dependent variable on the vertical, or y axis.
5. Set the scale for each axis with even divisions, letting the highest measured value in the data fit on the axis.
6. Make sure all spaces on the x- and y-axis scales are equal, even if they are not marked in the same intervals.
7. Make scaling of the axes start from zero at the intersection of the axes (called the origin) and increase in value, moving right on the x-axis and upward on the y axis.
8. Plot the location of each data point on the graph with a small dot.

Lesson Master 2.2b: Plotting Soil and Water Data (page 1 of 4)

Graph A



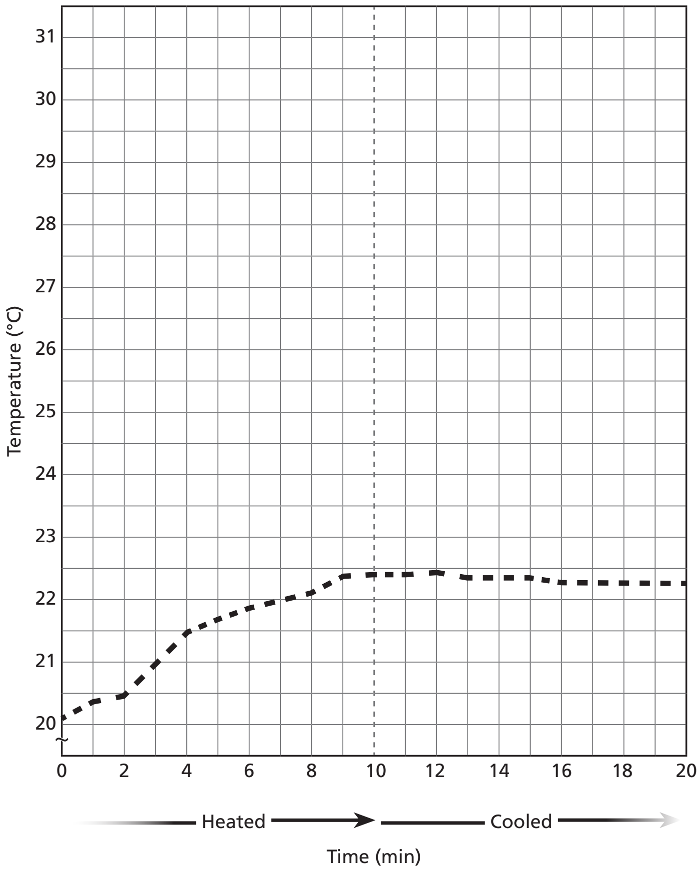
Graph B Soil Data



Soil Data

Time (mins)	<Heating> Soil Temperature (°C)	Time (mins)	Cooling Soil Temperature (°C)
Start	20.0	Start	31.0
1	22.5	11	30.8
2	24.0	12	28.9
3	25.5	13	28.1
4	26.0	14	27.2
5	27.5	15	26.0
6	28.5	16	25.7
7	29.5	17	25.4
8	30.3	18	24.6
9	30.8	19	24.3
10	31.0	20	24.0

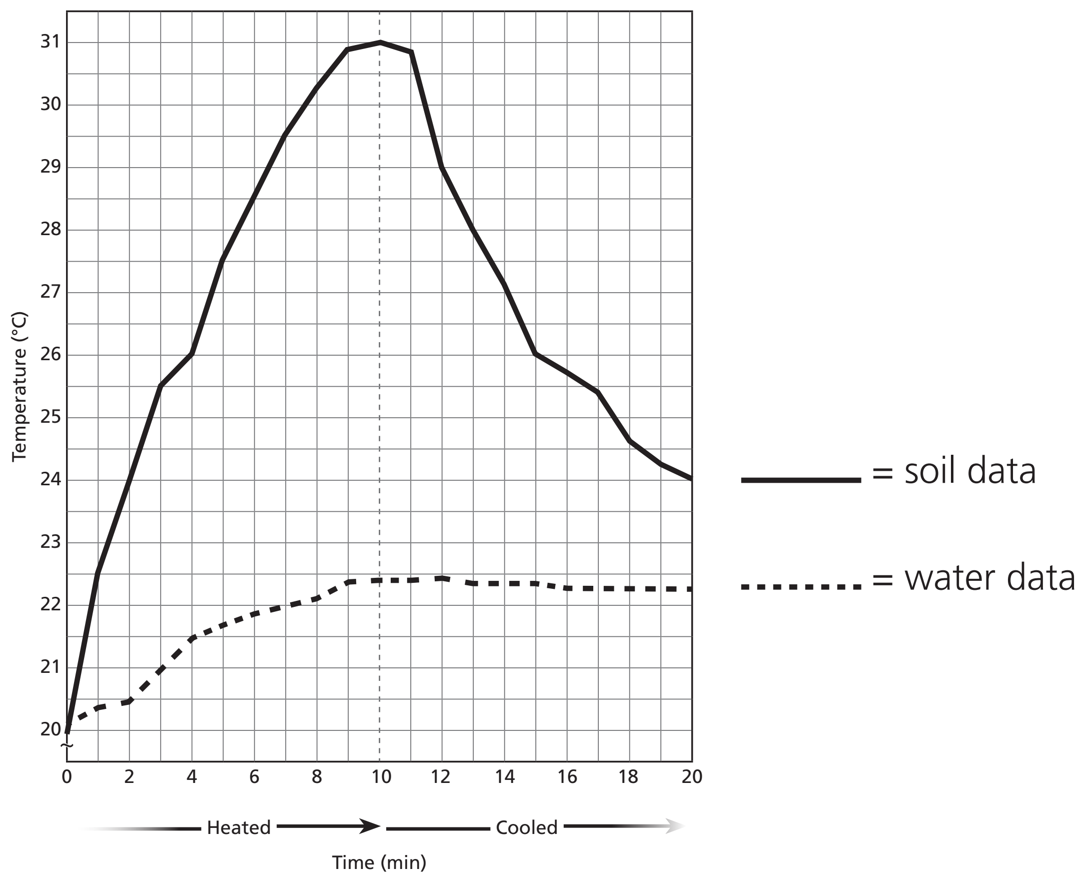
Graph C Water Data



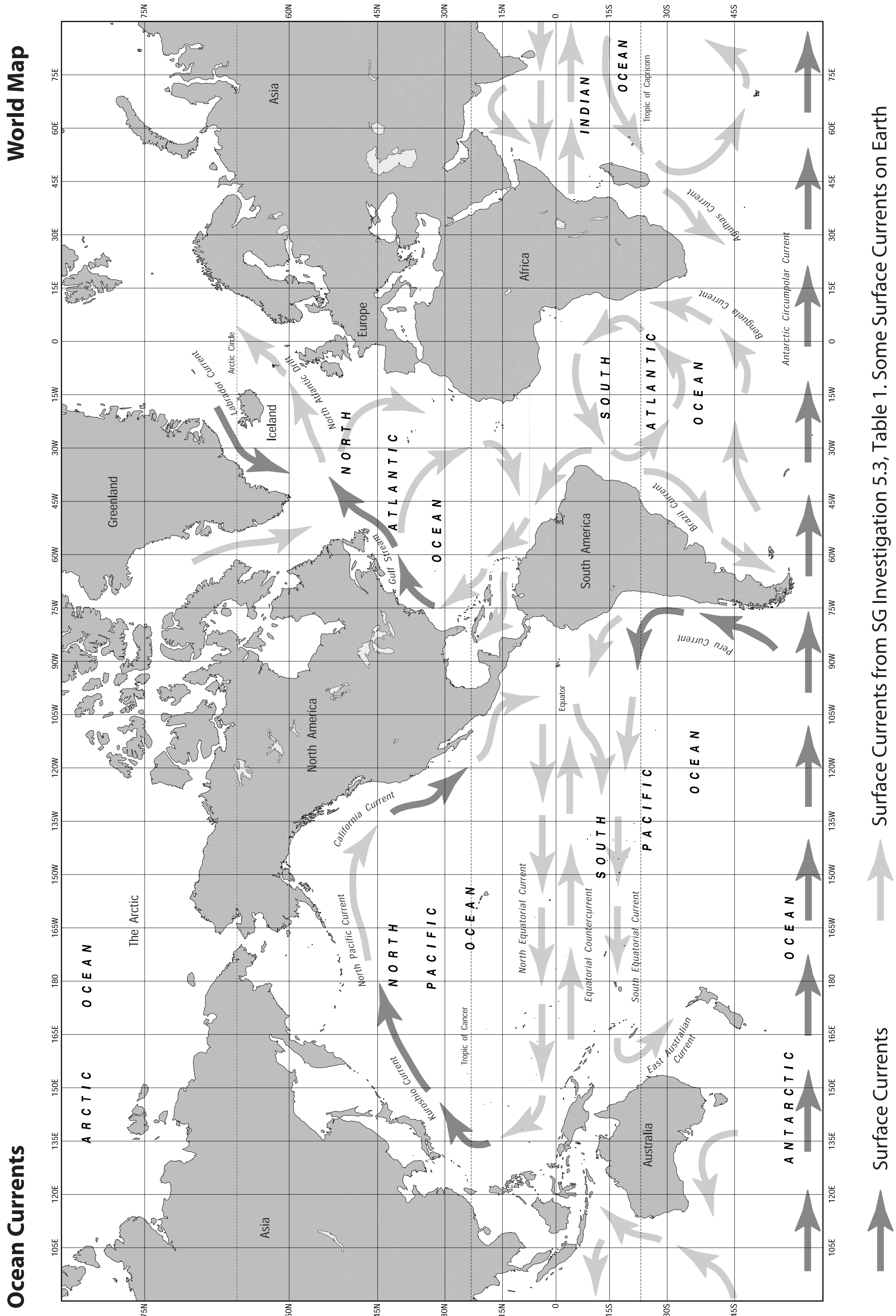
Water Data

Time (mins)	<Heating> Water Temperature (°C)	Time (mins)	Cooling Water Temperature (°C)
Start	20.1	Start	22.3
1	20.3	11	22.3
2	20.5	12	22.4
3	21.0	13	22.3
4	21.5	14	22.3
5	21.7	15	22.3
6	21.8	16	22.2
7	22.0	17	22.2
8	22.1	18	22.2
9	22.3	19	22.2
10	22.3	20	22.2

Graph D Soil and Water Data



Lesson Master 5.3: Mapping Ocean Surface Currents



Lesson Master 7.3: Grading Rubrics for Patterns and Relationships in Weather Data Project

Table 1. Weather Data Collection Rubric

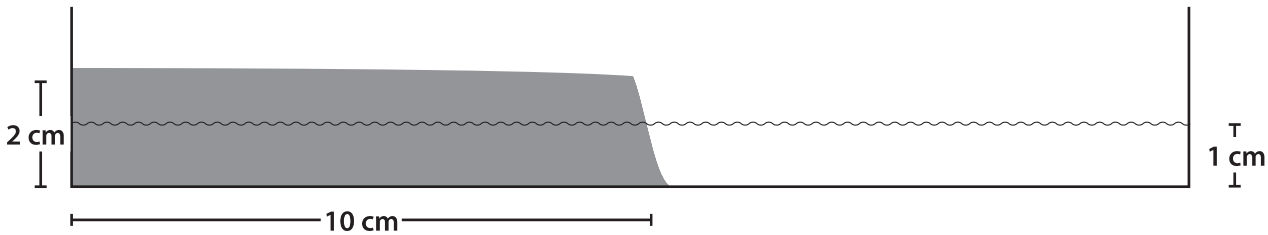
Components	Day 1		Day 2		Day 3		Day 4		Day 5	
High/Low Temperature (°C)	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Relative Humidity (%)	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Barometric pressure (mb), 6 a.m.	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Barometric Pressure (mb), 6 p.m.	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Peak Wind Speed (km/hr)	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Total Precipitation (cm)	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Clouds (accurate drawing and label of kind)	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Other	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Total Points/Day	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned	Points Possible	Points Earned
Total Points Earned / Total Points Possible ________ / ________										

Table 2. Weather Correlations and Predictions Rubric

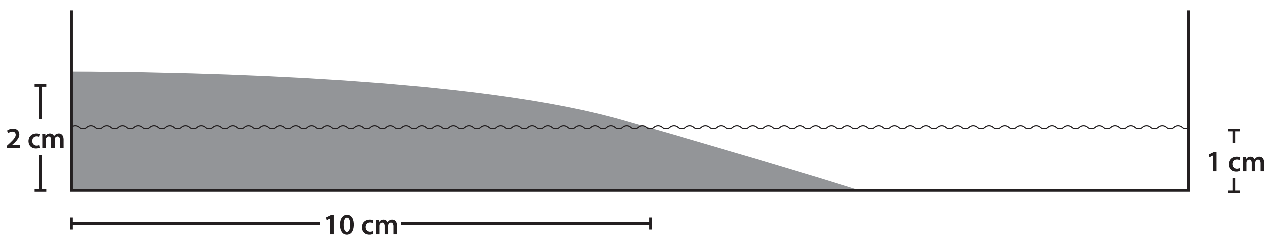
	Points Possible
No correlations attempted	0
Correlations attempted, but not supported	1
Correlations attempted and supported	2
Correlations attempted and supported, and predictions made	3
Correlations attempted and supported, predictions made, and predictions were accurate	4

Lesson Master 8.1: Coastal Landforms

Landform with Steep Cliffs



Landform with Gentle Slope



Lesson Master 9.1: Using Data to Determine Climate (page 1 of 2)

Directions: Analyze and interpret the data in the following tables. This data represents average values for each measurement. Use the data and the information in Building Your Knowledge: *Climate Classification System* to classify each locations' climate.

Location: City A												
Coordinates: 32.7150° N, 117.1625° W												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
High Temperature (°F)	65	65	66	68	69	71	75	76	76	73	69	65
Low Temperature (°F)	49	51	53	56	59	62	65	67	65	61	54	48
Inches of Precipitation	1.97	2.28	1.81	0.79	0.12	0.08	0.04	0.04	0.16	0.55	1.02	1.54
Number of Days with Precipitation	7	7	7	5	2	1	0	0	1	3	4	6

Location: City B												
Coordinates: 33.4500° N, 112.0667° W												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
High Temperature (°F)	67	71	77	85	95	104	106	104	100	89	76	66
Low Temperature (°F)	46	49	53	60	69	78	83	83	77	65	53	45
Inches of Precipitation	0.91	0.91	0.98	0.28	0.12	0.04	1.06	0.98	0.63	0.59	0.67	0.87
Number of Days with Precipitation	4	4	3	2	1	1	4	5	3	3	2	4

Location: City C												
Coordinates: 33.7550° N, 84.3900° W												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
High Temperature (°F)	51	54	62	71	79	86	87	86	82	72	61	52
Low Temperature (°F)	35	37	43	51	60	67	70	69	64	54	43	37
Inches of Precipitation	4.45	4.53	5.35	4.49	3.15	3.82	4.72	3.58	3.27	2.44	2.95	4.37
Number of Days with Precipitation	11	10	12	10	9	10	12	10	7	7	8	11

Location: City D												
Coordinates: 32.7833° N, 79.9333° W												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
High Temperature (°F)	59	63	70	76	83	88	91	89	85	77	70	62
Low Temperature (°F)	38	41	47	53	62	70	73	72	67	57	47	40
Inches of Precipitation	3.7	2.95	3.7	2.91	3.03	5.67	6.54	7.17	6.1	3.74	2.44	3.11
Number of Days with Precipitation	9	9	11	8	14	10	15	12	10	6	7	8

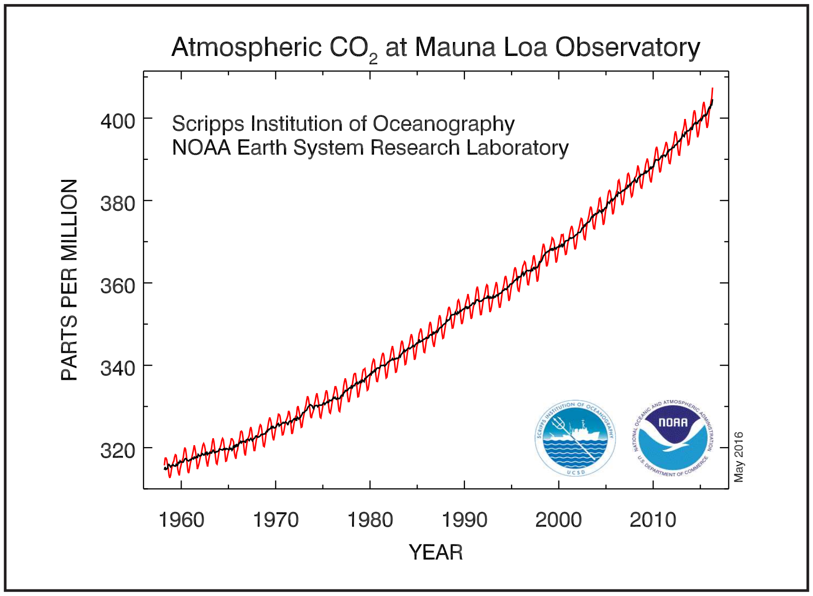
Location: City E												
Coordinates: 32.8969° N, 97.0381° W												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
High Temperature (°F)	57	61	69	77	84	92	96	96	89	78	67	58
Low Temperature (°F)	37	41	49	56	65	73	77	77	69	58	48	38
Inches of Precipitation	2.05	2.6	3.5	3.07	4.92	4.09	2.2	1.85	2.83	4.8	2.87	2.76
Number of Days with Precipitation	7	8	8	9	9	6	5	6	5	6	6	6

Lesson Master 10.1: Climate Graph A

Carbon Dioxide Concentration at Mauna Loa Observatory, 1960–2016

Introduction: The data on carbon dioxide concentration in the graph below was collected over a 50-year period at the Mauna Loa Observatory in Hawaii. This observatory, located on the side of the Mauna Loa volcano on the Big Island of Hawaii, is one of many run by the National Oceanographic and Atmospheric Administration (NOAA). The Mauna Loa record is considered by scientists to be a precise and reliable indicator of carbon dioxide (CO_2) in the middle layer of the troposphere.

Graph A



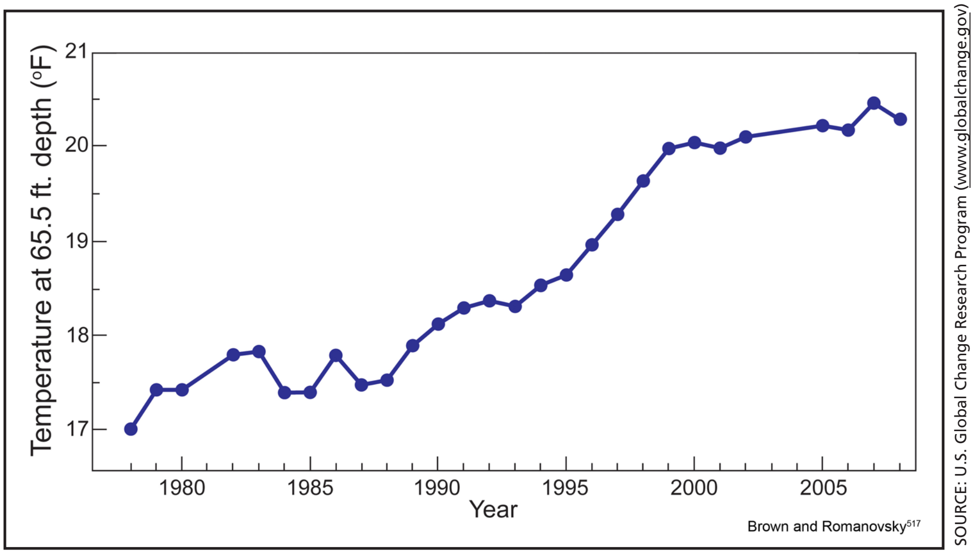
SOURCE: NOAA/Earth System Research Laboratory

Lesson Master 10.1: Climate Graph B

Permafrost Temperature at Deadhorse, Alaska, 1978–2008

Introduction: The graph below shows the temperature at a depth of 65.5 feet (20 meters) into the permafrost layer at Deadhorse, Alaska, over a 30-year period. Permafrost thawing can result in the sinking of the land (subsidence), which has led to dramatic instances of roads buckling and utility poles falling over. A major concern with permafrost thawing is the potential release of large amounts of methane (CH_4), a greenhouse gas, trapped in the soil by the permafrost.

Graph B



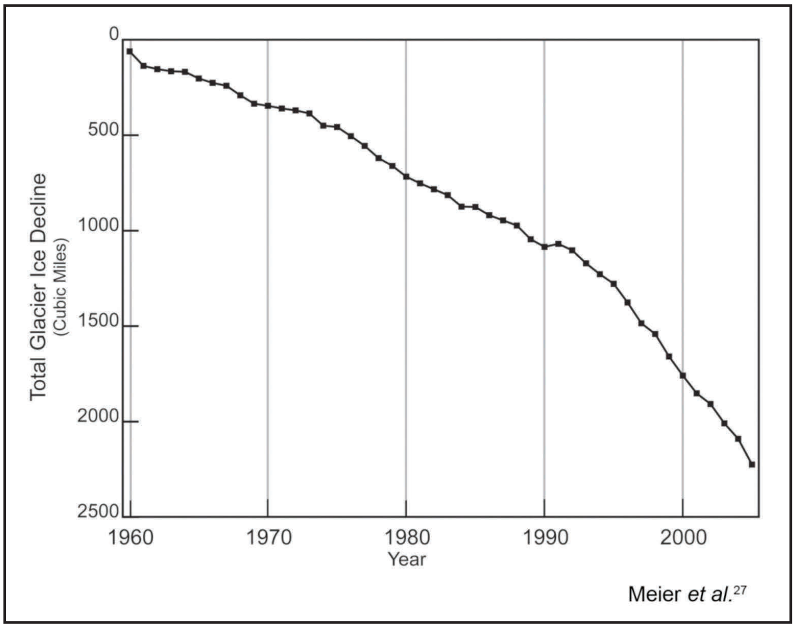
Permafrost temperatures have risen throughout Alaska, with the largest increases in the northern part of the state.

Lesson Master 10.1: Climate Graph C

Volume of Glacier Ice, 1960–2005

Introduction: Glaciers change: they grow as snow falls on them and melt as they warm. When melting is exactly balanced by snow accumulation, the glacier does not change in size. Glaciologists call this a static glacier, or one that hasn't changed in the amount of water it contains. The graph below shows the total volume of glacier ice worldwide over a 45-year period.

Graph C



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

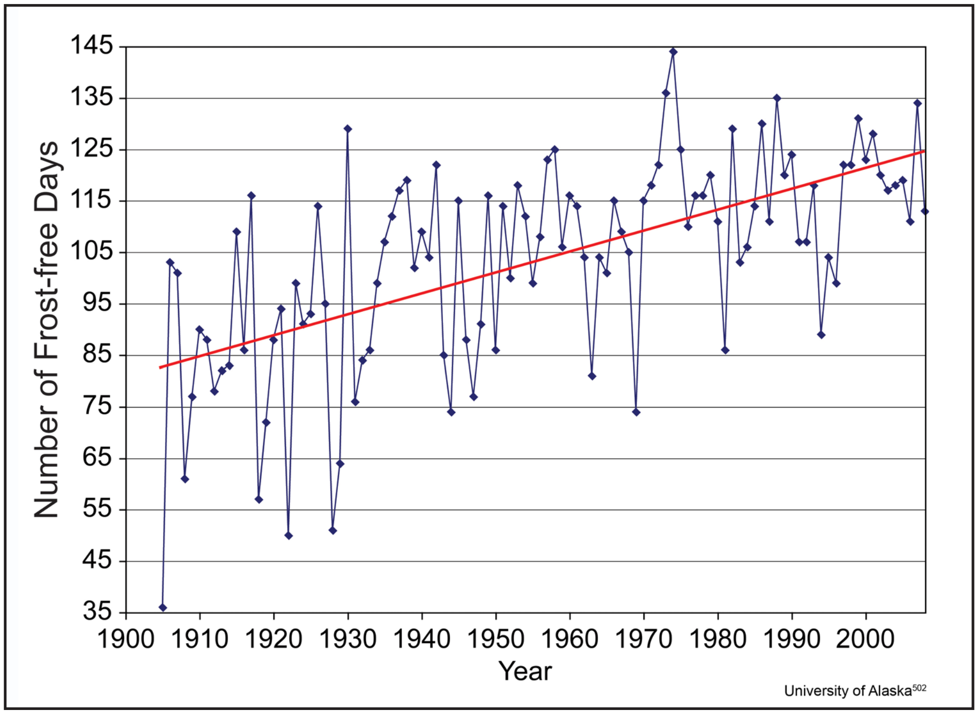
As temperatures have risen, glaciers around the world have shrunk. The graph shows the cumulative decline in glacier ice worldwide.

Lesson Master 10.1: Climate Graph D

Frost-free Days in Fairbanks, Alaska, 1904–2008

Introduction: Graph D shows the number of frost-free days in Fairbanks, Alaska, for more than 100 years. Fairbanks lies in the middle of Alaska and experiences long winters, generally lasting from late September through early May, when the snowpack disappears. Winter temperatures can fall as low as −15°C to −25°C (5°F to −13°F).

Graph D



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

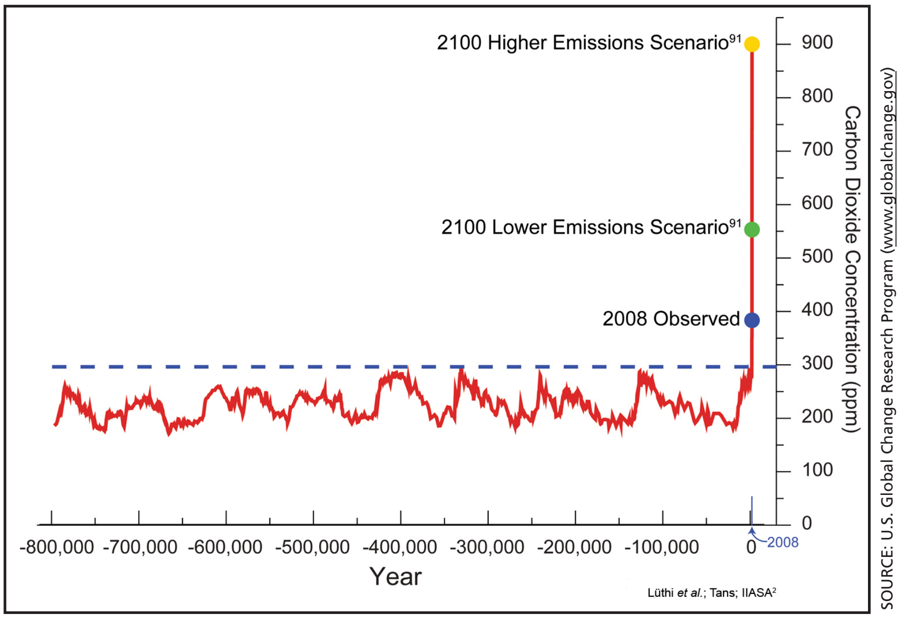
Over the past 100 years, the length of the frost-free season in Fairbanks, Alaska, has increased by 50 percent. The trend toward a longer frost-free season is projected to produce benefits in some sectors and detriments in others.

Lesson Master 10.1: Climate Graph E

Changes in Carbon Dioxide Concentration in an Antarctic Ice Core Over 800,000 Years

Introduction: Scientists have drilled cores in ice sheets and glaciers in different parts of the world, dated them, and analyzed their contents to determine the temperature and the amount of carbon dioxide (CO_2) in the atmosphere when the ice was formed. This graph shows the calculated concentration of carbon dioxide in an Antarctic ice core over a period of 800,000 years.

Graph E



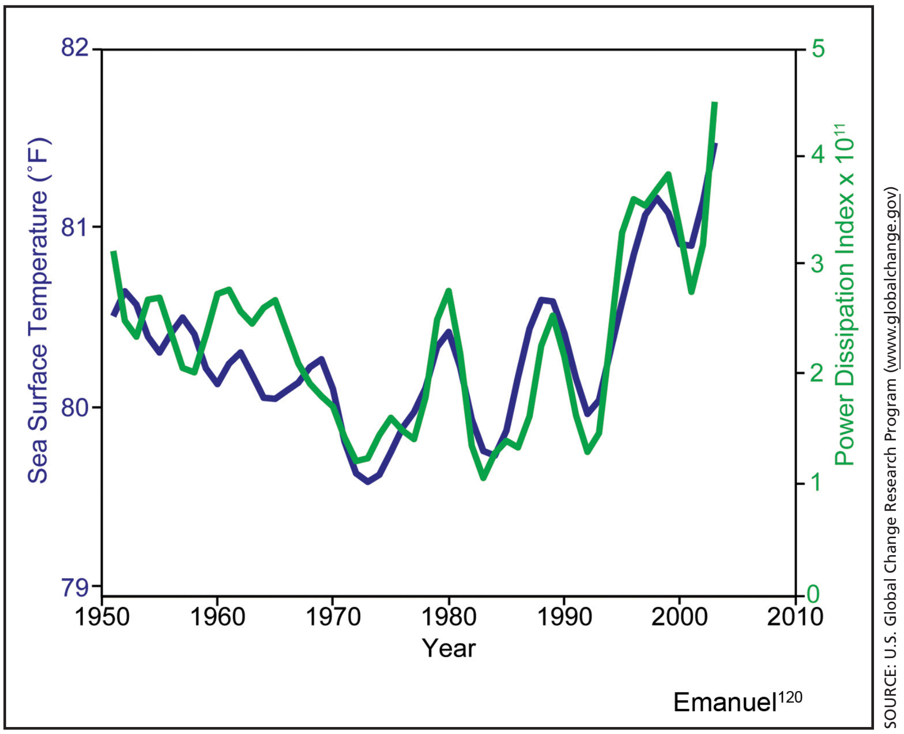
Analysis of air bubbles trapped in an Antarctic ice core extending back 600,000 years documents Earth's changing carbon dioxide concentration. Over this long period, natural factors have caused the atmospheric carbon dioxide concentration to vary within a range of about 170 to 300 parts per million (ppm). Temperature-related data make clear that these variations have played a central role in determining the global climate. As a result of human activities, the present carbon dioxide concentration of about 385 ppm is about 30 percent above its highest level over at least the last 800,000 years. In the absence of strong control measures, emissions projected for this century would result in the carbon dioxide concentration increasing to a level that is roughly 2 to 3 times the highest level occurring over the glacial-interglacial era that spans the last 800,000 or more years.

Lesson Master 10.1: Climate Graph F

Sea Surface Temperatures and Hurricane Power Dissipation in the North Atlantic Ocean

Introduction: The graph below shows 85 years of sea surface temperatures in areas of the North Atlantic in which hurricanes have formed and traveled. The Power Dissipation Index (PDI) of hurricanes is a scale that quantifies how much energy the storms give off. PDI is calculated by sampling hurricanes' top wind speeds the entire time they are tropical-storm-strength or stronger. The higher the number, the more powerful the storm.

Graph F



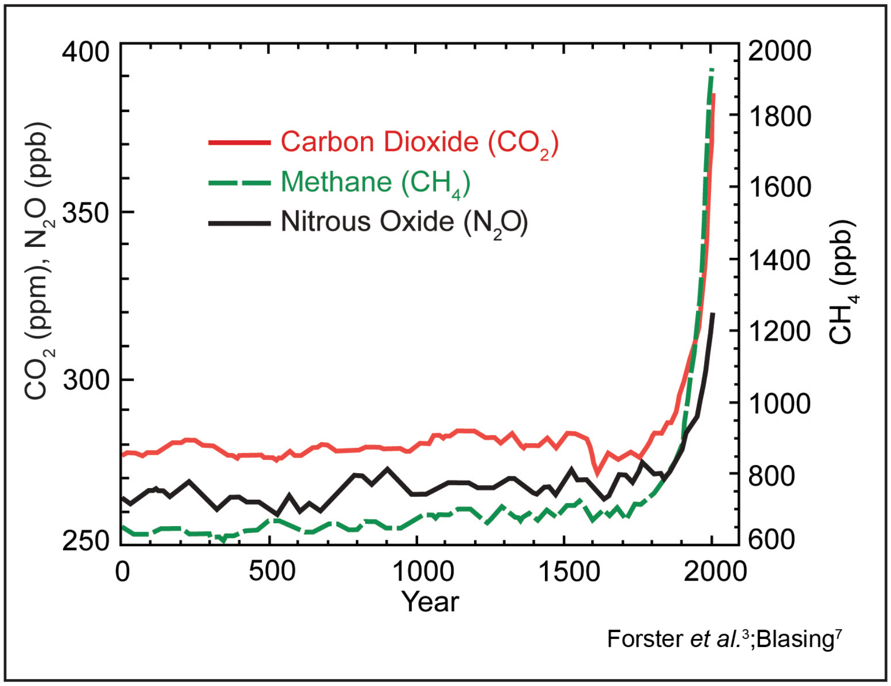
Observed sea surface temperature (blue) and the Power Dissipation Index (green), which combine frequency, intensity, and duration for North Atlantic hurricanes. Hurricane rainfall and wind speeds are likely to increase in response to human-caused warming. Analyses of model simulations suggest that for each 1.8°F increase in tropical sea surface temperatures, rainfall rates will increase by 6 to 18 percent.

Lesson Master 10.1: Climate Graph G

Concentrations of Three Greenhouse Gases over 2,000 Years

Introduction: Graph G shows the concentration of three greenhouse gases in the atmosphere over 2,000 years. In addition to carbon dioxide, it shows the concentrations of methane and nitrous oxide gas.

Graph G



SOURCE: U.S. Global Change Research Program (www.globalchange.gov)

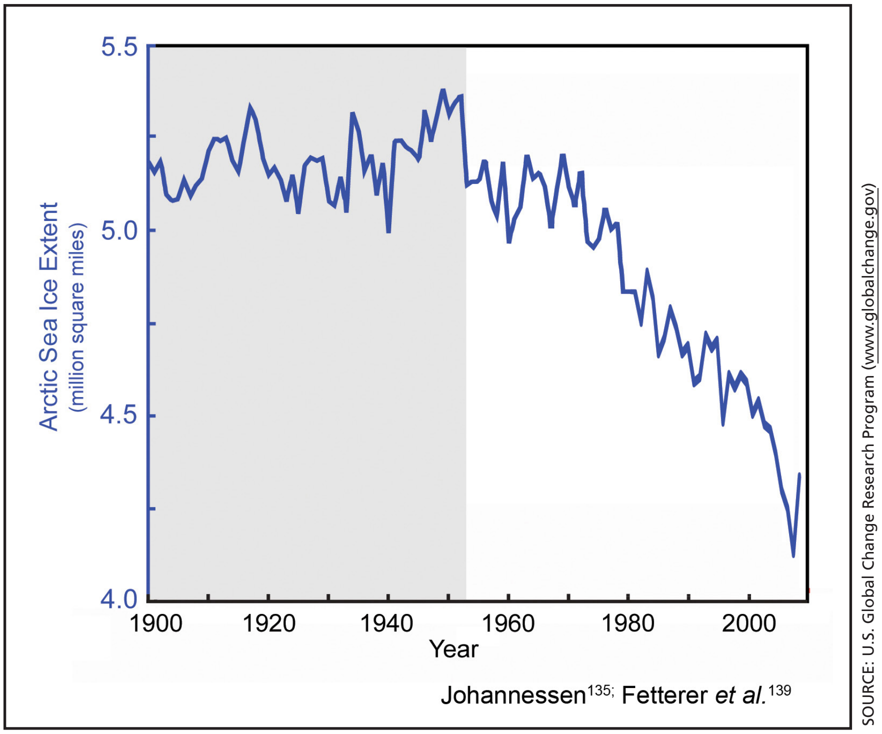
Increases in concentrations of these gases since 1750 are due to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion molecules of air.

Lesson Master 10.1: Climate Graph H

Arctic Sea Ice Extent, Annual Average, 1900–2008

Introduction: Sea ice is an important part of the climate system. It affects surface reflectivity, ocean currents, cloudiness, humidity, and the exchange of heat and moisture at the ocean's surface. Satellites have provided the best record for sea ice cover since the 1970s; before that, information came from aircraft, ship, and coastal observations. The graph below provides information from 1900 through 2008.

Graph H



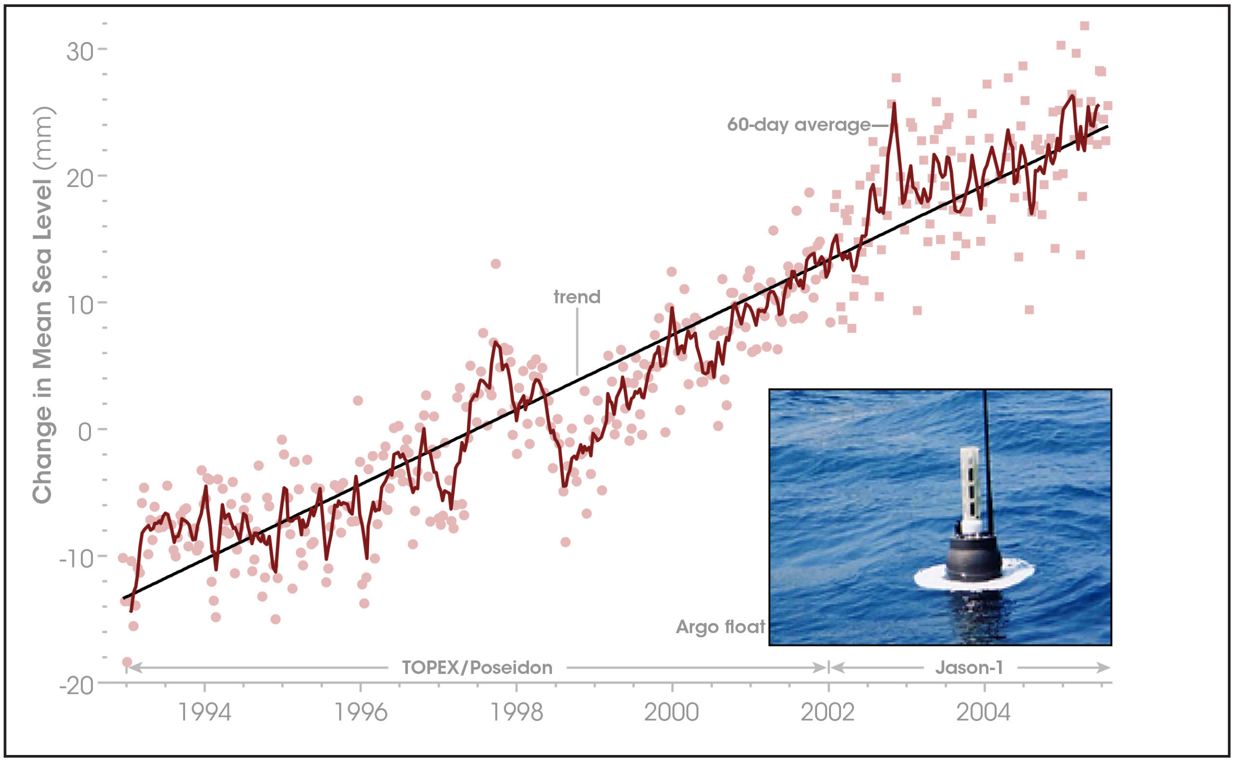
Observations of annual average arctic sea ice extent for the period 1900 to 2008. The gray shading indicates less confidence in the data before 1953.

Lesson Master 10.1: Climate Graph I

Change in Global Mean Sea Level, 1993–2005

Introduction: One way that scientists have measured sea levels is with tide gauges, which hang in the ocean near land, and allow scientists to compare the level of the water's surface with the height of a marker on shore. A major problem with this method is that land also moves. If the sea level and the land marker are both moving, it's difficult to say (for instance) whether seas are rising or the land is sinking. Fortunately, sea levels are now also measured using satellites. Using radar, satellites can measure the sea surface's distance from Earth, a point that doesn't change. This graph combines measurements of sea surface height from multiple satellites and an ocean float to track mean sea level from 1993 to 2005.

Graph I



SOURCE: NASA Earth Observatory. Graph adapted by Robert Simmon from Leuliette, E., Nerem, R., and Mitchum, G. (2004). Calibration of TOPEX/Poseidon and Jason altimeter data to construct a continuous record of mean sea level change. Marine Geodesy, 27(1–2), 79–94.

Lesson Master 10.2: Climate Change Research Scoring Rubric

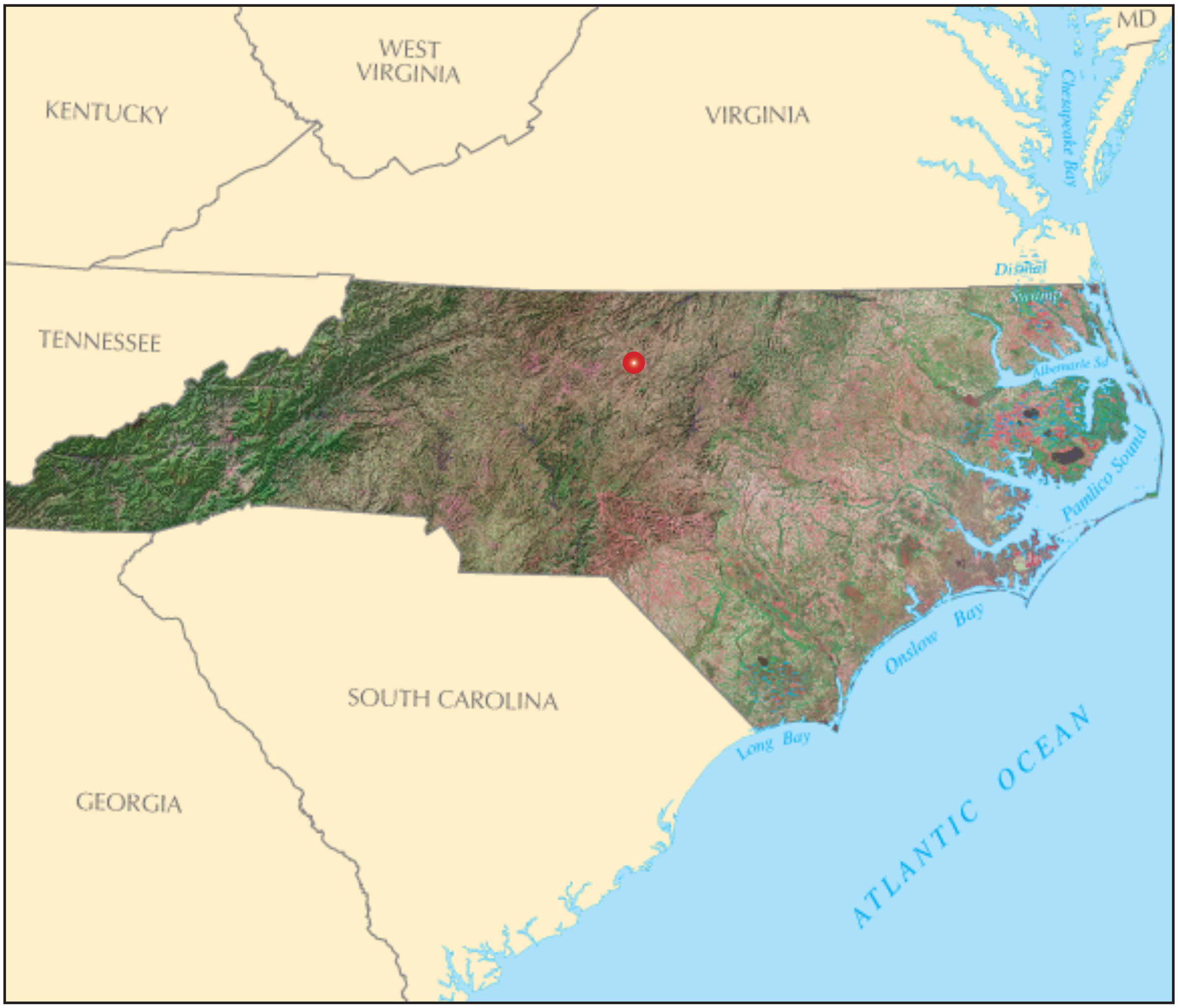
Group Members ____

____

	Presentation Components	Possible Points	Points Earned
Content	• Correctly explained the relationship between the independent and dependent variables shown in the graph • Listed and answered all the questions about the graphed data on student sheet • Addressed the broader research topic(s) based on the question(s) on student sheet • Overall, showed an understanding of the significance of the data in the context of climate change research		
Presentation	• Presentation was well organized and informative • Student(s) spoke loudly and clearly • Visual materials enhanced the presentation		
Visual Aid	• Layout and design were effective for the presentation of information • Diagrams, tables, and photos were relevant • Labeling and description were informative and complete		
Bibliography	• Included at least five complete references • References were relevant • References were reputable		
Total			

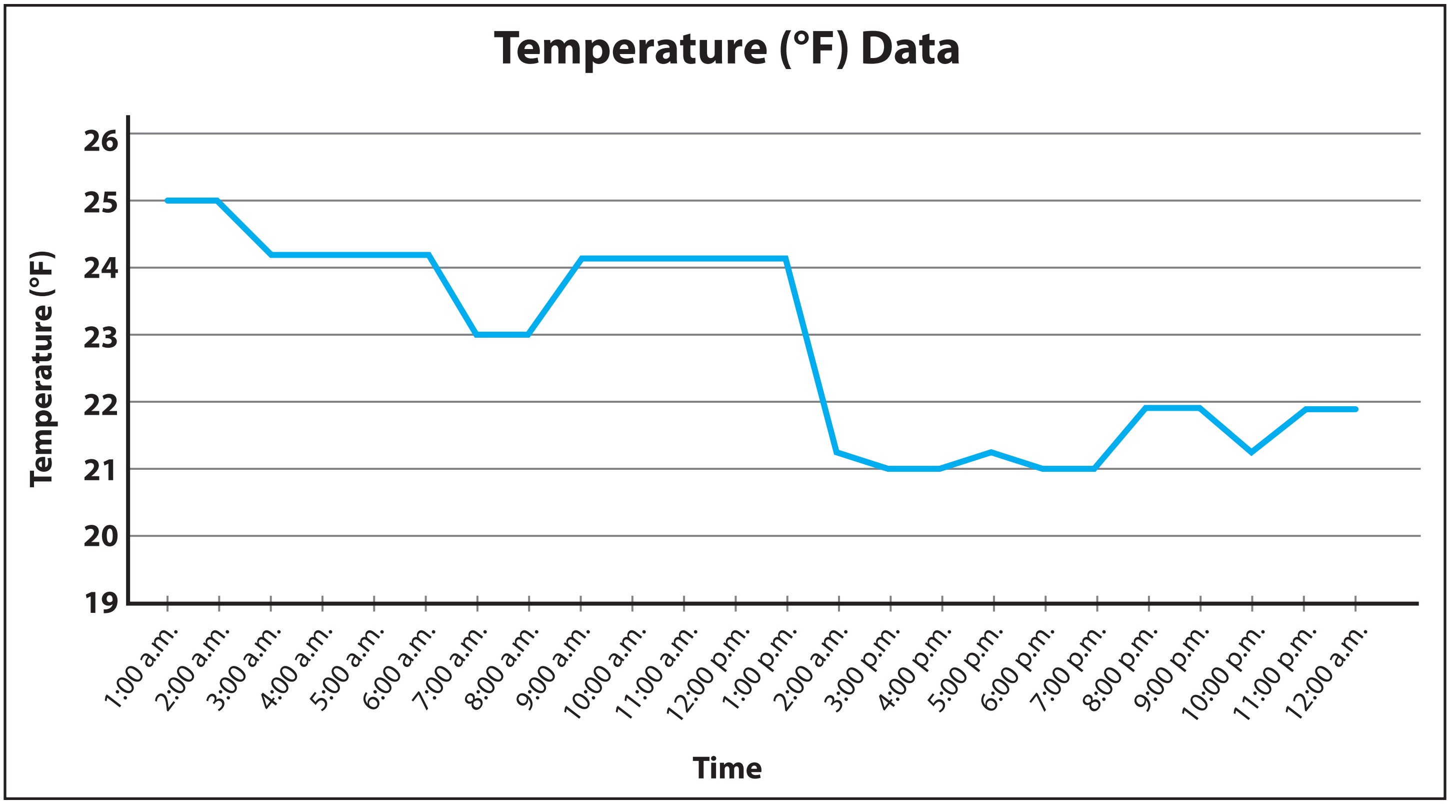
Lesson Master 12.1a: Weather Data (page 1 of 6)

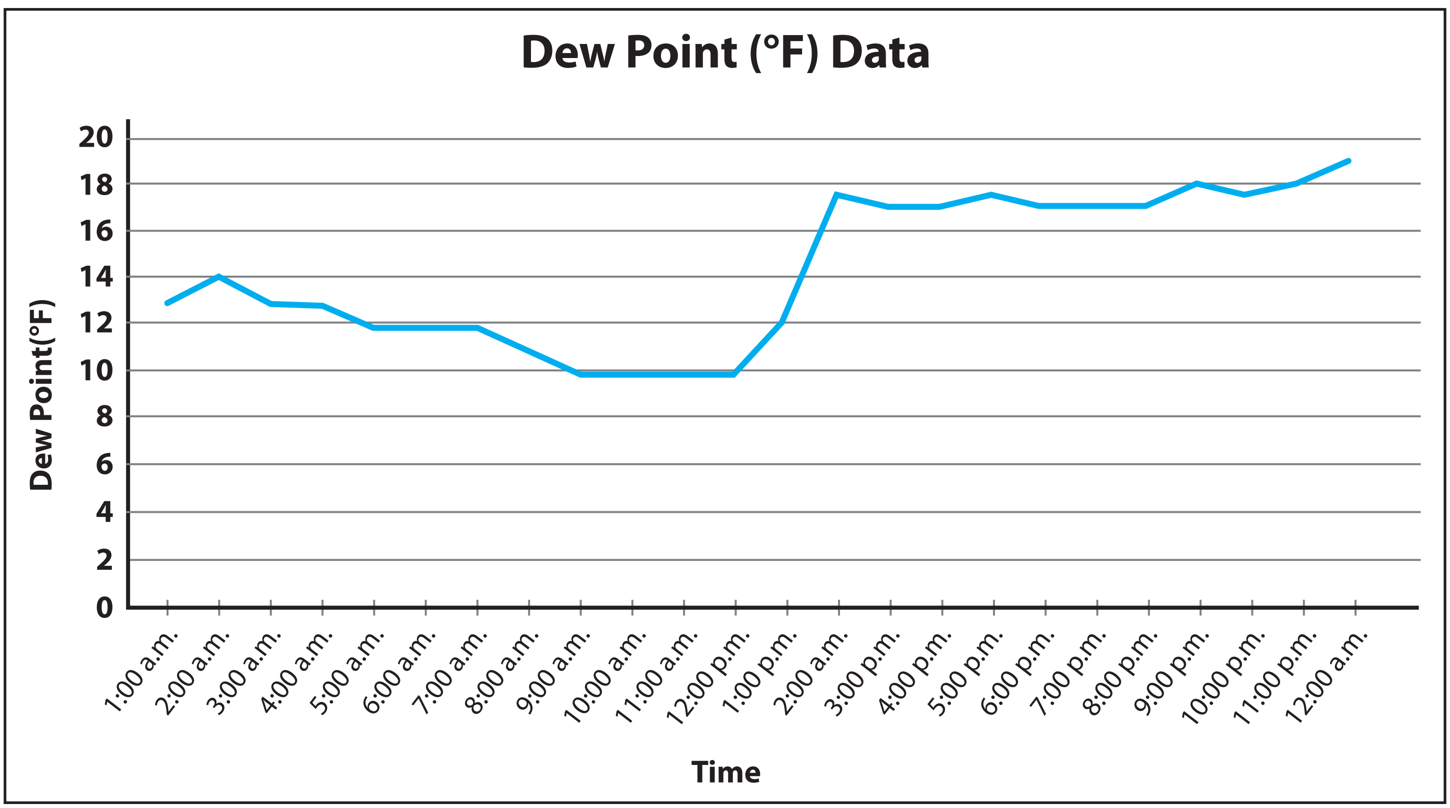
Location of Burlington, North Carolina



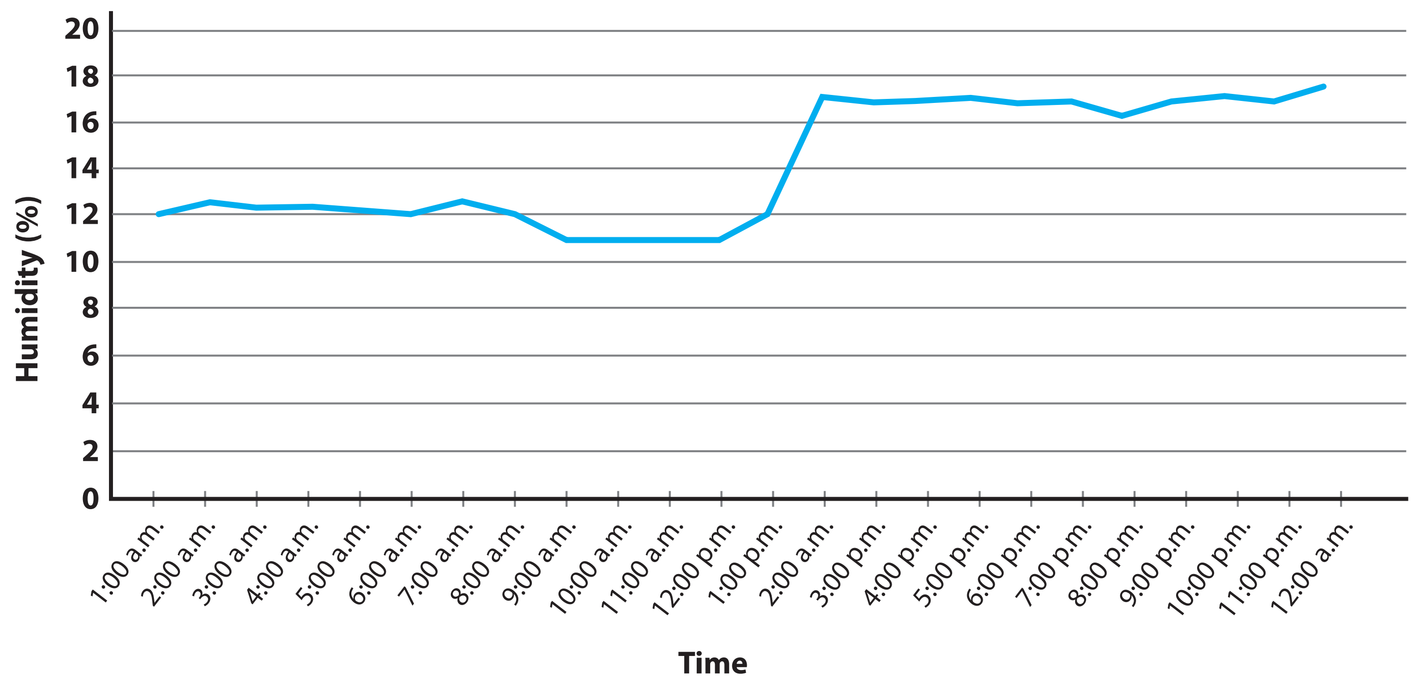
SOURCE:

Weather Data	
Mean Temperature	23°F
Max Temperature	25°F
Min Temperature	21°F
Dew Point	14°F
Average Humidity	71%
Precipitation	0.53 in
Barometric Pressure	30.23 in
Wind Speed	12 mph (NE)

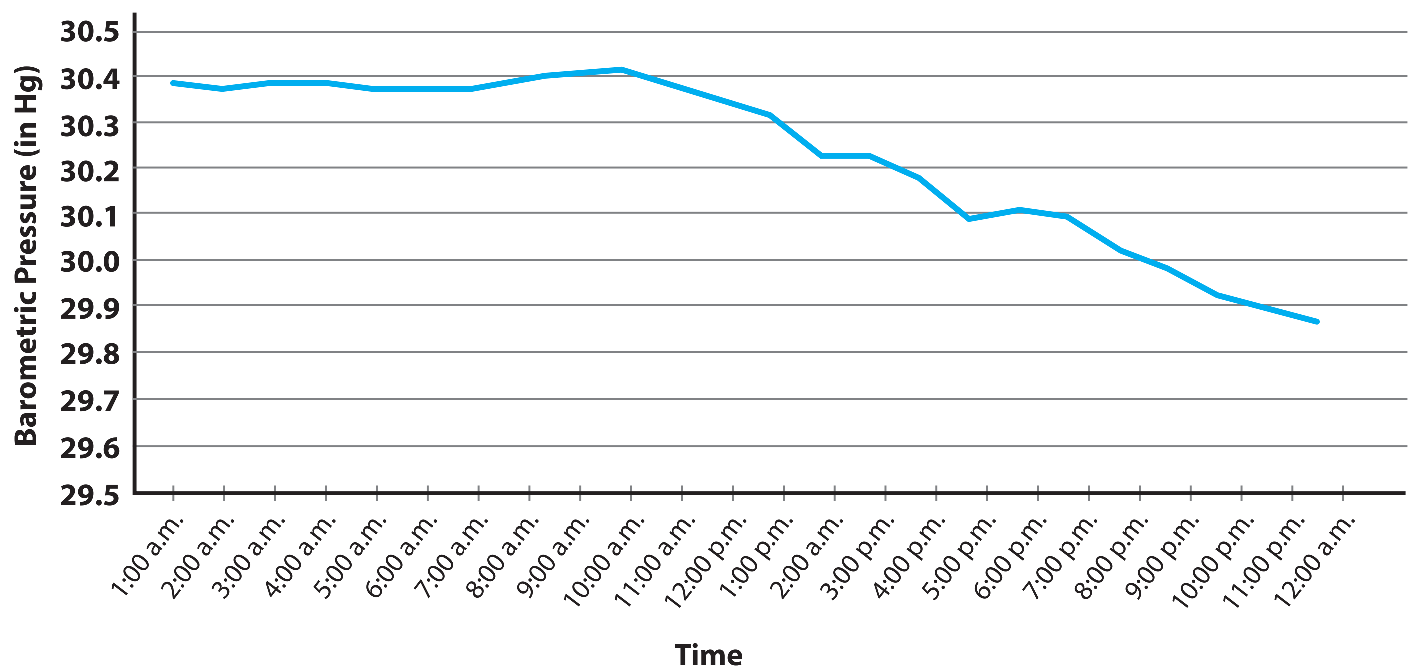

Temperature (°F) Data
Temperature (°F)
26
25
24
23
22
21
20
19
1:00 a.m.
2:00 a.m.
3:00 a.m.
4:00 a.m.
5:00 a.m.
6:00 a.m.
7:00 a.m.
8:00 a.m.
9:00 a.m.
10:00 a.m.
11:00 a.m.
12:00 p.m.
1:00 p.m.
2:00 a.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
6:00 p.m.
7:00 p.m.
8:00 p.m.
9:00 p.m.
10:00 p.m.
11:00 p.m.
12:00 a.m.
Time

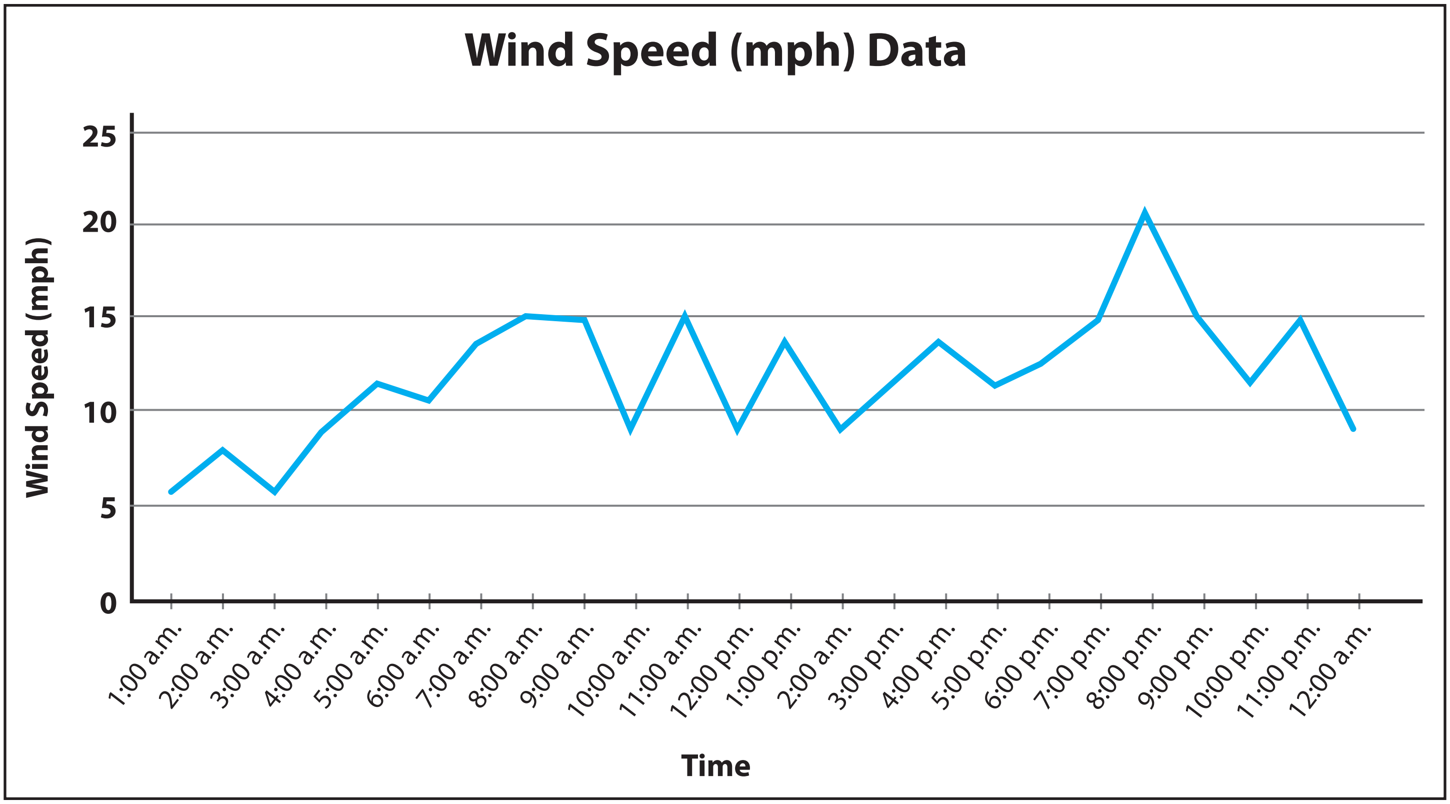

Dew Point (°F) Data
Dew Point(°F)
20
18
16
14
12
10
8
6
4
2
0
1:00 a.m.
2:00 a.m.
3:00 a.m.
4:00 a.m.
5:00 a.m.
6:00 a.m.
7:00 a.m.
8:00 a.m.
9:00 a.m.
10:00 a.m.
11:00 a.m.
12:00 p.m.
1:00 p.m.
2:00 a.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
6:00 p.m.
7:00 p.m.
8:00 p.m.
9:00 p.m.
10:00 p.m.
11:00 p.m.
12:00 a.m.
Time

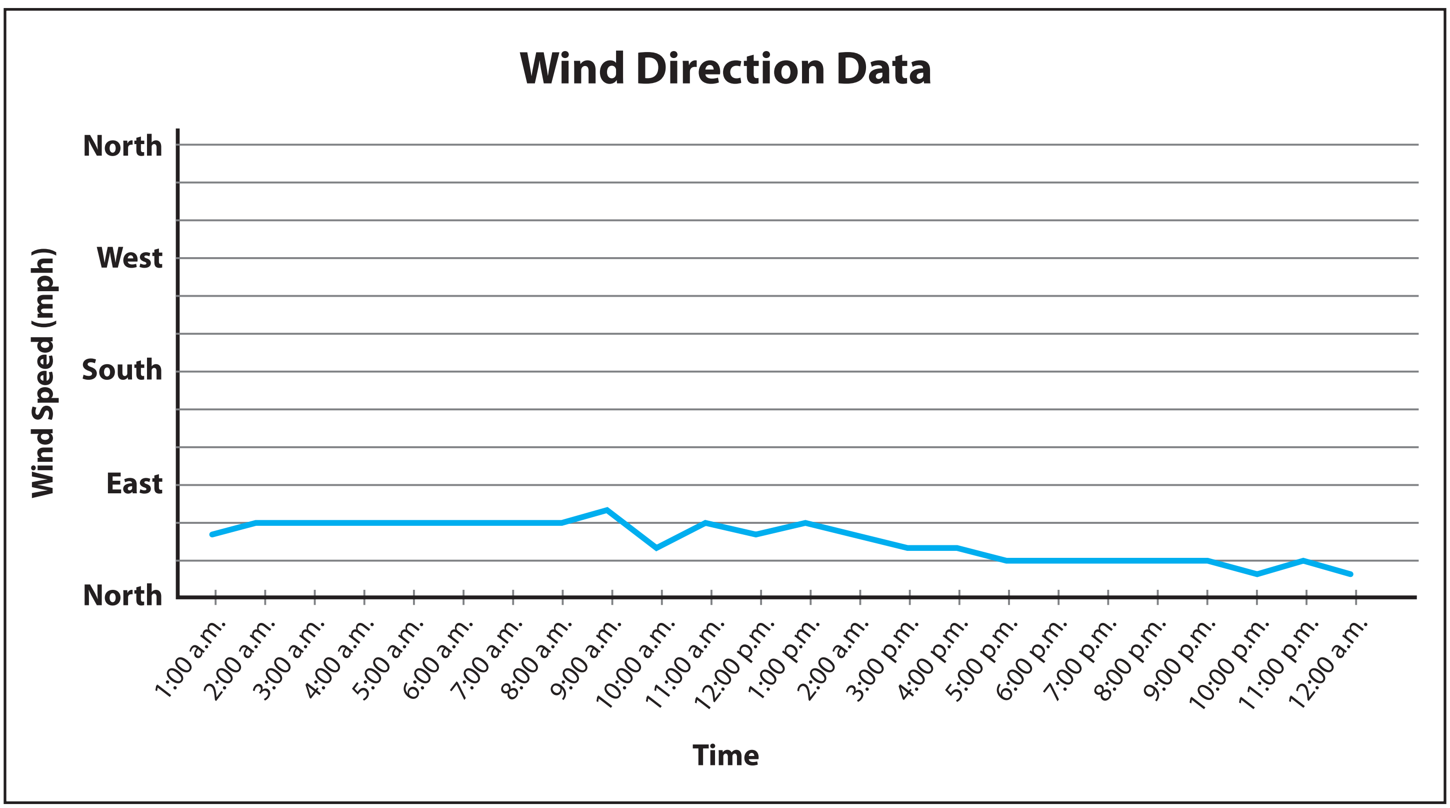
Humidity (%) Data

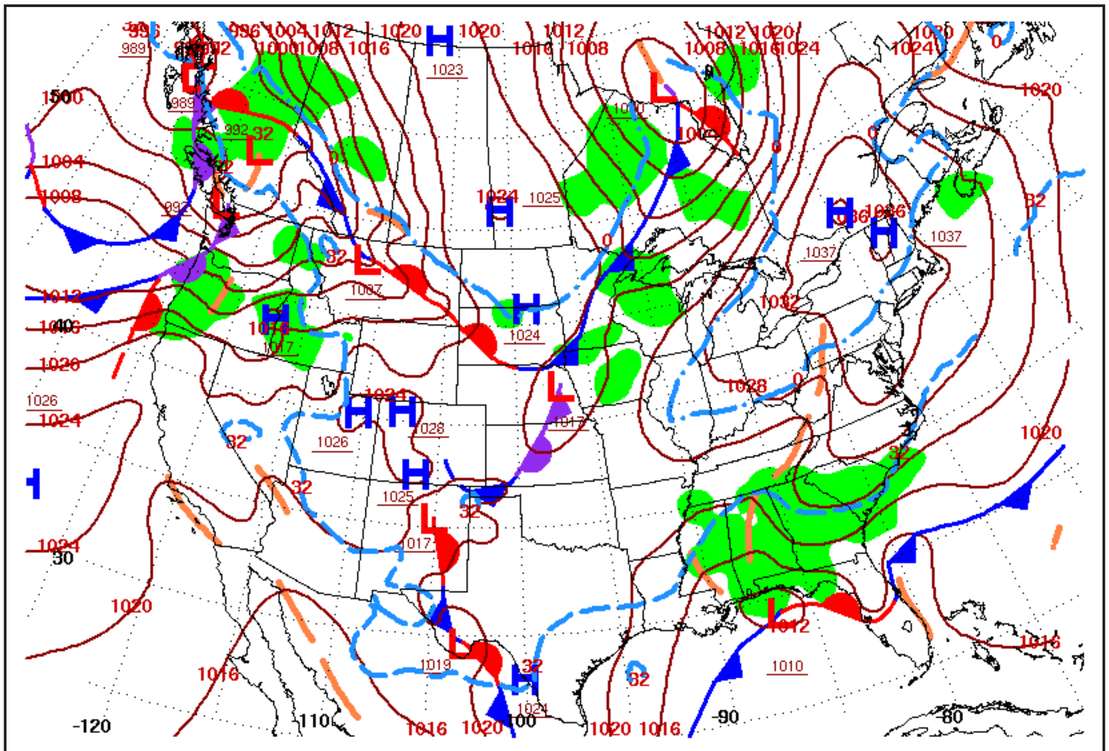


Barometric Pressure (in Hg) Data



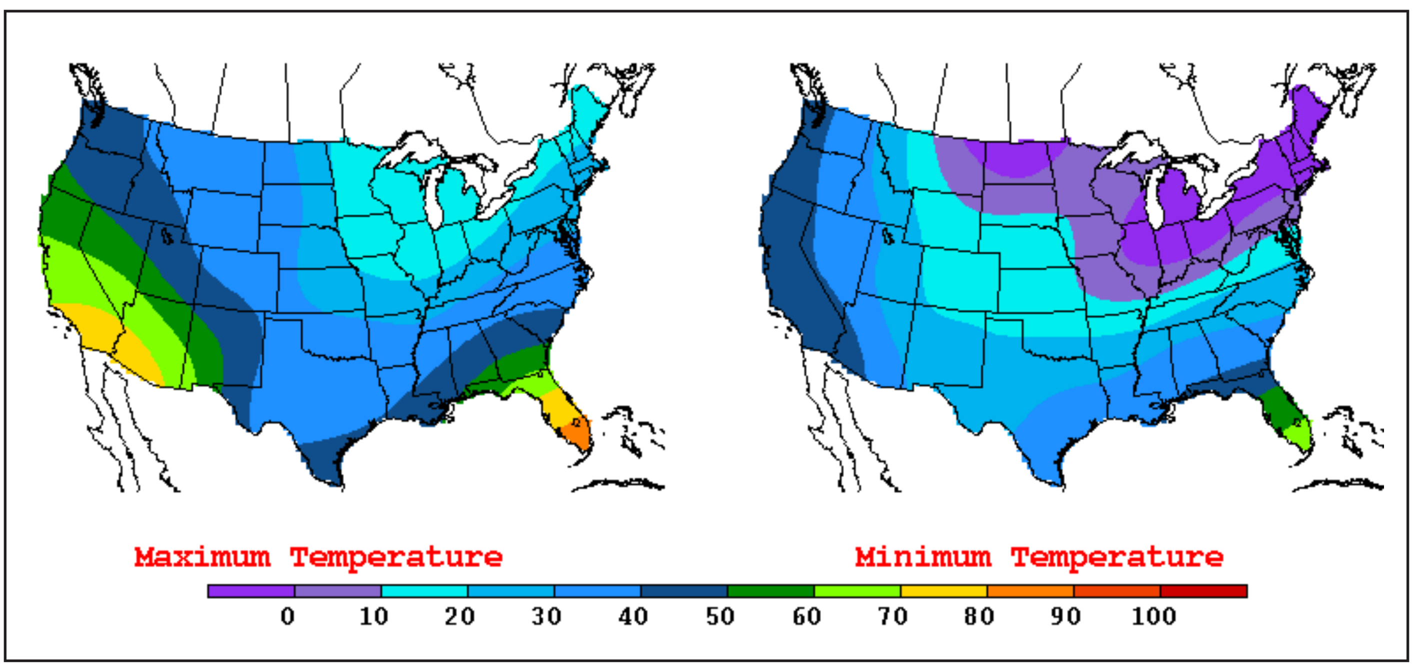

Wind Speed (mph) Data
Wind Speed (mph)
25
20
15
10
5
0
1:00 a.m.
2:00 a.m.
3:00 a.m.
4:00 a.m.
5:00 a.m.
6:00 a.m.
7:00 a.m.
8:00 a.m.
9:00 a.m.
10:00 a.m.
11:00 a.m.
12:00 p.m.
1:00 p.m.
2:00 a.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
6:00 p.m.
7:00 p.m.
8:00 p.m.
9:00 p.m.
10:00 p.m.
11:00 p.m.
12:00 a.m.
Time


Wind Direction Data
Wind Speed (mph)
North
West
South
East
North
1:00 a.m.
2:00 a.m.
3:00 a.m.
4:00 a.m.
5:00 a.m.
6:00 a.m.
7:00 a.m.
8:00 a.m.
9:00 a.m.
10:00 a.m.
11:00 a.m.
12:00 p.m.
1:00 p.m.
2:00 a.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
6:00 p.m.
7:00 p.m.
8:00 p.m.
9:00 p.m.
10:00 p.m.
11:00 p.m.
12:00 a.m.
Time

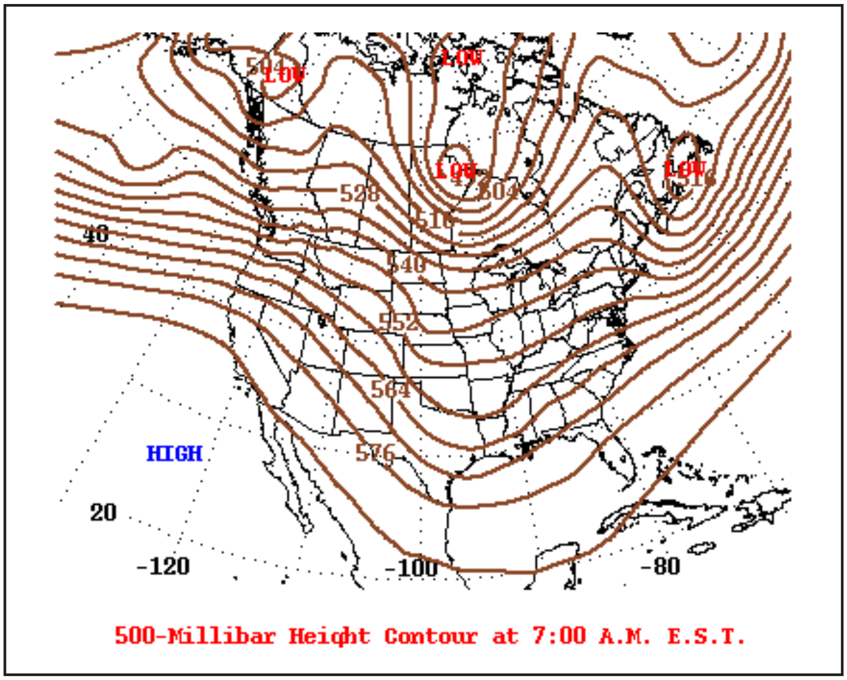


Surface Weather Map at 7:00 A.M. E.S.T.

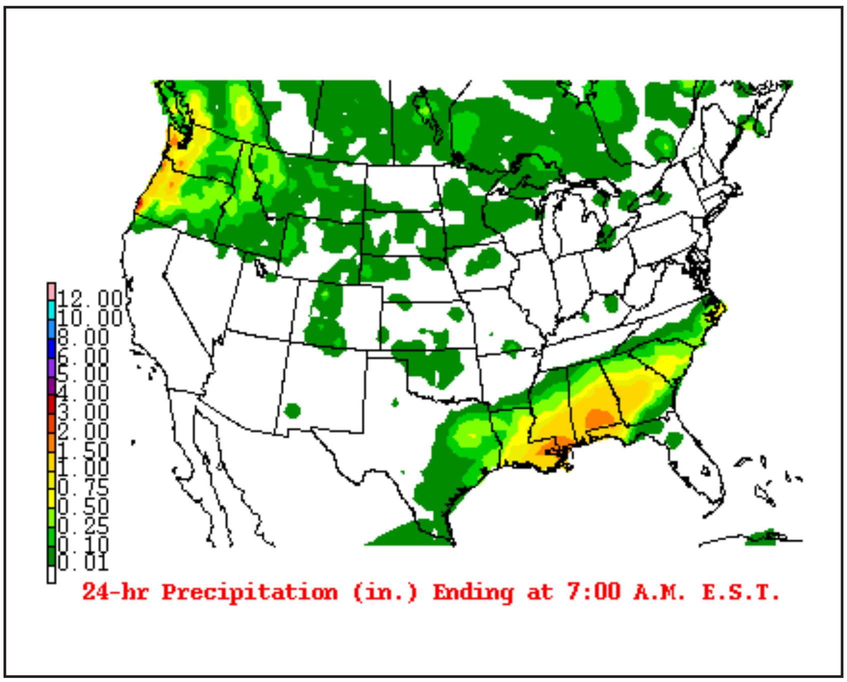
SOURCE: NOAA



SOURCE: NOAA



SOURCE: NOAA



SOURCE: NOAA

Lesson Master 12.1b: Poster Scoring Rubric

	Presentation Components	Possible Points	Points Earned
Content	• The student explained whether or not school should be closed. • The student explained whether or not it was likely to snow the next day. • The student supported their position using the provided data. • The student clearly explained the data. • The student used at least three pieces of data to support their position. • The student correctly interpreted the presented information.		
Poster	• The layout and design were effective for the presentation of information. • The information was shown in a clear and concise manner. • The information could be understood without a presentation. • The visual aids were relevant and useful.		
Presentation	• The information on poster was well explained. • The students spoke clearly. • The presentation enhanced the information on the poster.		