NASA GLOBE Atmosphere Investigation

Student Science Research Journal

Student Name: _____

Date: _____

Week One—Observe Nature and Pose Questions About Clouds

Student Introduction: What, Why, and How

WHAT: Scientists are investigating the atmosphere; they want to understand and be able to predict the weather and climate for the different regions of the world. One of the questions that NASA scientists are currently studying is "How do clouds and surface temperature affect the Earth's Energy Budget?"

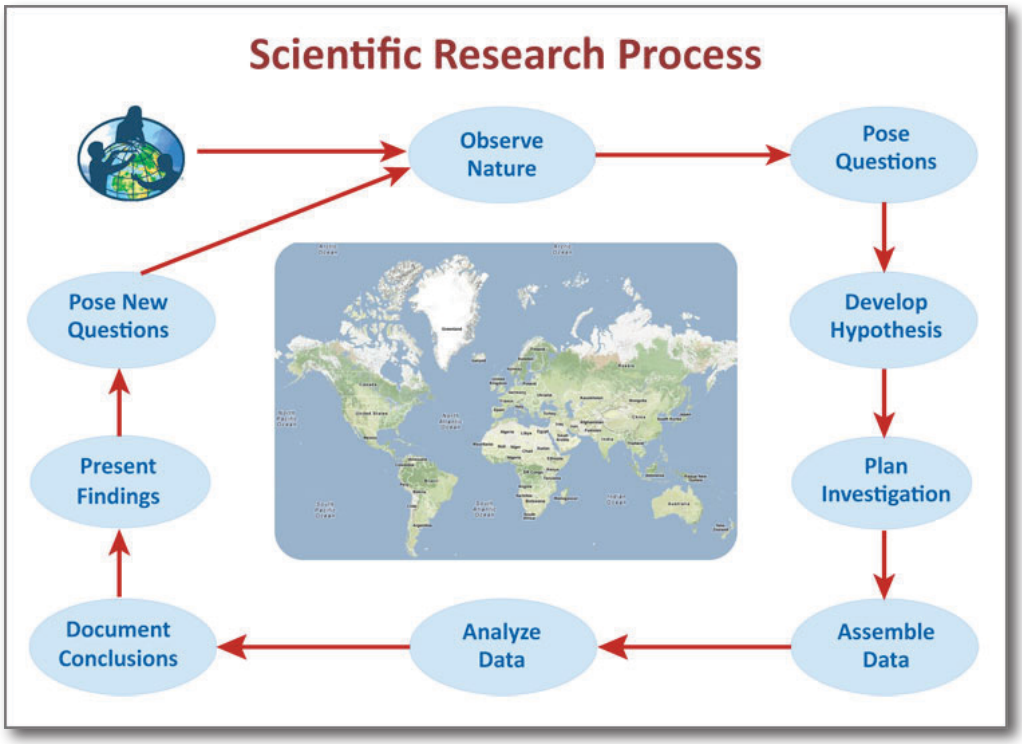
WHY: Each of the different characteristics of the atmosphere affects us and our environment. What we wear and what we can do outside today depend on the weather. Is it raining? Sunny? Cloudy? What is the temperature outside? How do clouds affect our temperature? Do different surfaces on Earth heat up differently? How we build our homes and schools, what crops we grow, what animals and plants naturally live around us depend on climate. All of these are questions that you will be exploring as you become a GLOBE scientist.

Your task as a GLOBE scientist is to explore the region around your school and determine how the energy coming from the Sun is being affected by clouds. You will be using the scientific research process as you conduct a series of investigations during which you will collect data to find the answer to your question.

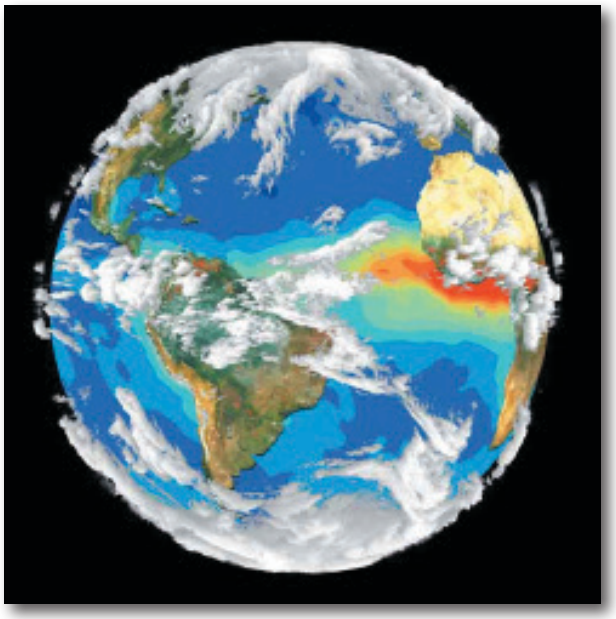
HOW: Collecting Data Using the Scientific Research Process

1. **What is the relationship between cloud cover and surface temperature in the area around your school?**
2. **How do clouds affect the Earth's Energy Budget?**

Make sure to record your observations and measurements as accurately as possible in your science journal.



Step 1: Project Introduction



Why are clouds so important?

_____

_____

_____

_____

_____

Who is studying the clouds?

_____

_____

_____

Step 2: What is GLOBE?

G : _____

L : _____

O : _____

B : _____

E : _____

The GLOBE Program

NASA Scientists NEED YOU!

Step 3: What Does a Scientist Do?

Draw a picture of a scientist in action. Consider the following: Where does your scientist work? What does your scientist do? What are some characteristics of your scientist? Write down any additional information regarding your scientist below.

Step 4: Observing, Describing, and Identifying Clouds

What do you already know about clouds?

Accurate weather forecasting starts with careful and consistent observations. The human eye represents one of the best weather instruments. Much of what we know about the weather is a result of human observation. Although being able to identify clouds is useful in itself, observing clouds on a regular basis and keeping track of the weather associated with certain kinds of clouds will enable you to make the connection between cloud types and weather. Recognizing cloud types can help you predict the kind of weather to expect in the near future.

Part 1: What do you see? Draw a picture of the clouds you see in the sky.

Draw a picture of the different types of clouds you see in the boxes below. Under each picture use words to describe the characteristics of each cloud.

Part 2: Compare Your Descriptions to the Official Descriptions Using the GLOBE Cloud Chart.

With a partner or small group use the GLOBE Cloud Chart to try to identify the different clouds that you sketched on the previous page.

Part 3: As a class, discuss the different types of clouds that you observed.

Based on your observations one person from your group should volunteer to draw one of your cloud sketches on the board and record the words your group used to describe the cloud.

As a class, work together to determine the "official" names for each of the different types of clouds that you observed.

Using the chart, determine what the four main types of clouds are and record those below. Write descriptive words for each of the different types.

Step 5: Cloud Observation

Clouds Measurement Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Sky conditions (check one):

- ❑ **Clear** *(no clouds visible)*
- ❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*
- ❑ **Obscured** *(More than 25% of the sky is not visible)*

Note: selecting ***Obscured*** will prevent data entry on clouds and contrails; therefore skip the cloud type and cover and the contrail type and cover sections and proceed to the Obscured section. If clouds and contrails are visible in non-obscured areas of the sky, these data can be entered in the Metadata field.

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

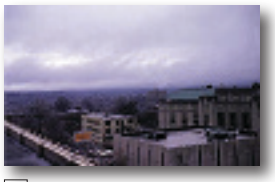
Low (in the sky):
(Check all types seen)

❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)



❑ Nimbostratus

❑ Cumulonimbus

GLOBE Atmosphere Investigations

Study Site: _____ *Date:* _____ *Time (UT):*_____

What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%

Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%

Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

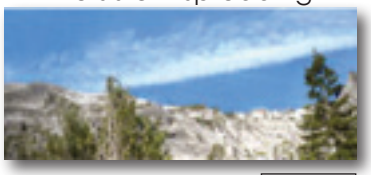
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading



Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Week One Science Journal Reflections

What have you learned?

What would you like to know more about?

Week Two—Observe Nature and Pose Questions About Clouds

Step 6: Heating Things Up Learning Activity

Imagine that you are at the beach and you are barefooted. What surfaces would you want to walk on and why? Why are some surfaces cool to your touch? Why are some hot to your touch? Where did the hot surfaces get their energy? Today you will investigate what happens to air and different Earth materials when they are exposed to the Sun.

Description of task:

Working in small groups you will explore the energy transfer of different Earth materials when they are heated up and cooled down. You will be recording your data in a chart which you will use to graph the changes in temperatures that occur over a 15-minute period of heating the Earth material up and a 15-minute period of the Earth material cooling down.

What to Do Part 1:

1. Make sure that each container has about the same amount of material. If it is a sunny day you will be completing the activity outside, but if not, desk lamps will be used to simulate the Sun's energy.
2. Once you have your containers set up, place a thermometer in each container.
3. For each Earth material, designate a recorder that will record the temperatures and a person that will measure the temperatures in degrees Celsius.
4. Record the beginning temperature of each material. Start the timer and the timekeeper should tell the student taking the measurements when they should measure the temperature with the Infrared Thermometer (IRT) or read the thermometers. If you are using one IRT, try to take the measurements as close together in time as possible.
5. Record the temperature of the Earth material in the Sun or under the light every 3 minutes for a total of 15 minutes. After 15 minutes, the Earth materials are shaded or the lights are turned off. Measure the temperature every 3 minutes for the next 15 minutes during the cooling down phase. Record your data in the Data Table Sheet that is provided on the next page.
6. Share your data with the class by having one person from your group record your data on the board or the piece of chart paper that is provided by your instructor.

Data Table Sheet 1

	Temperatures °C				
Time	**Bare Soil**	**Grass**	**Gravel/Rocks**	**Sand**	**Water**
Beginning					
3 minutes					
6 minutes					
9 minutes					
12 minutes					
15 minutes					
	Shaded or turn off lights				
18 minutes					
21 minutes					
24 minutes					
27 minutes					
30 minutes					

Now look at the data and discuss the following questions within your group, record your answers below each question:

1. **Does each material in the containers start at the same temperature?**

2. **How can you compare them to see which one had the most change in temperature?**

3. **How would you describe the change that occurs over time?**

Part 2: As a class, fill in the changes in temperature in the data table below.

Data Table Sheet 2

	Change in Temperatures °C				
Time	**Bare Soil**	**Grass**	**Gravel/Rocks**	**Sand**	**Water**
Beginning					
3 minutes					
6 minutes					
9 minutes					
12 minutes					
15 minutes					
	Shaded or turn off lights				
18 minutes					
21 minutes					
24 minutes					
27 minutes					
30 minutes					

Going Further: One way scientists analyze their data is by graphing the data. In order to look at what is happening with each material, you will graph the data of all materials on one graph. Each material's data will be graphed in a different color. Use colored pencils to identify the different materials.

Using the graph that you have constructed, answer the following questions:

1. **Did all of the Earth materials heat up at the same rate? Explain the evidence you use to support your answer:**

2. **Did all of the Earth materials cool down at the same rate? Explain the evidence that you use to support your answer:**

3. **Which Earth material heated up the fastest? How do you know this?**

4. **Did each Earth material receive the same amount of energy? How do you know this?**

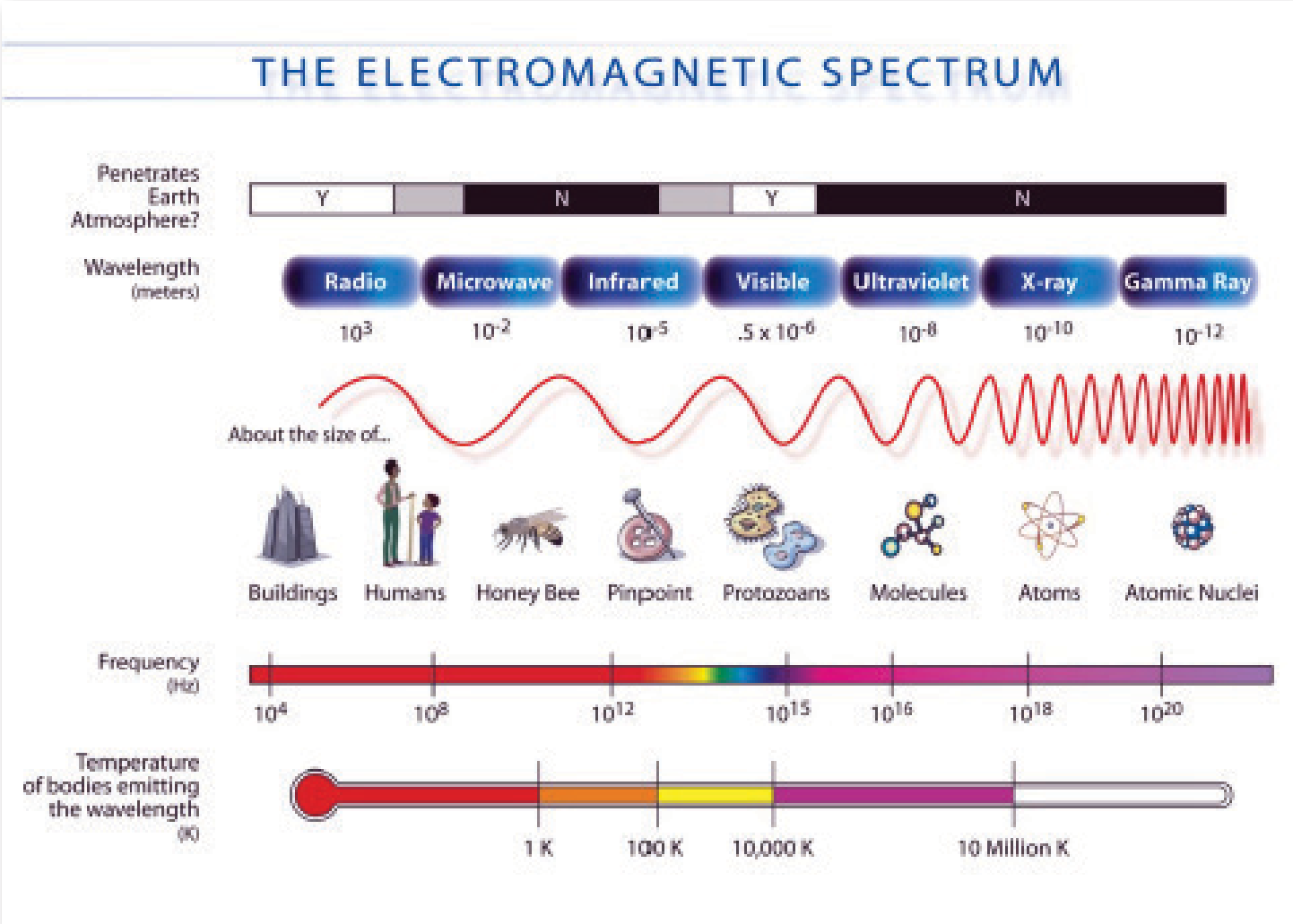
5. **Which Earth material cooled down the fastest? How do you know this?**

6. **Did each Earth material receive the same amount of energy? How do you know this?**

The Science Behind the Investigation

What you should find from this investigation is that water is the slowest to heat up and the slowest to cool down. All of the materials received the same amount of energy. So why do you think water increased so little? For water, it takes five times more heat energy to raise the temperature of an equal amount of dry soil or sand one degree. When the same amount of energy is absorbed equally by all of the Earth materials, the temperature of the solid Earth materials will increase faster and greater than water. In addition, water is a liquid that mixes. The energy for water is mixed throughout its volume while only the very surface of solids is heated.

The energy that comes from the Sun is radiant energy that travels in waves through space. This energy makes up the electromagnetic spectrum. Some waves that you may be familiar with are visible light (which we can see), radio waves (listening to radio stations in your car), and microwaves (like your microwave oven that can heat up things). When the energy hits a molecule or atom such as molecules of sand or water, the molecule gains energy. The gain in energy makes the molecule vibrate or move faster. We say the molecule absorbed the energy. This molecular movement is what we call heat. The more molecules move, the more heat is produced.



Step 7: Cloud Observation

Clouds Measurement Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Sky conditions (check one):

- ❑ **Clear** *(no clouds visible)*
- ❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*
- ❑ **Obscured** *(More than 25% of the sky is not visible)*

Note: selecting ***Obscured*** will prevent data entry on clouds and contrails; therefore skip the cloud type and cover and the contrail type and cover sections and proceed to the Obscured section. If clouds and contrails are visible in non-obscured areas of the sky, these data can be entered in the Metadata field.

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

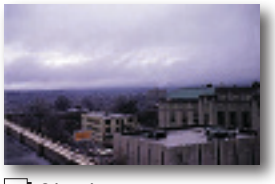
❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

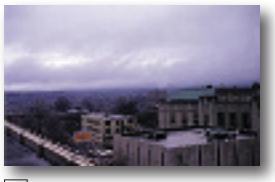


❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)



❑ Nimbostratus

❑ Cumulonimbus

GLOBE Atmosphere Investigations

Week Two

Study Site: _____ *Date:* _____ *Time (UT):*_____

What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%

Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%

Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

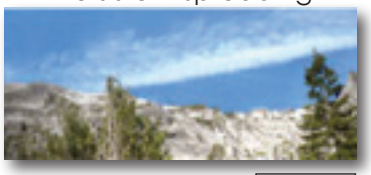
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading



Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Clouds Measurement Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Sky conditions (check one):

- ❑ **Clear** *(no clouds visible)*
- ❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*
- ❑ **Obscured** *(More than 25% of the sky is not visible)*

Note: selecting ***Obscured*** will prevent data entry on clouds and contrails; therefore skip the cloud type and cover and the contrail type and cover sections and proceed to the Obscured section. If clouds and contrails are visible in non-obscured areas of the sky, these data can be entered in the Metadata field.

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

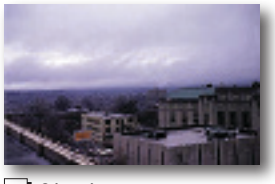
❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

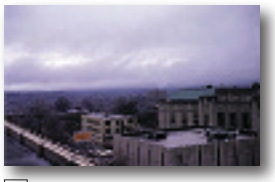


❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)



❑ Nimbostratus

❑ Cumulonimbus

GLOBE Atmosphere Investigations

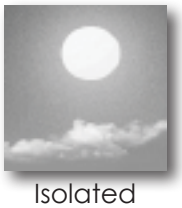
Week Two

Study Site: _____ *Date:* _____ *Time (UT):*_____

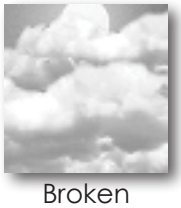
What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%


Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%


Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

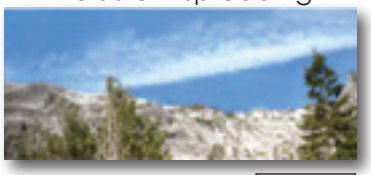
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading



Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Week Two Science Journal Reflections

What have you learned?

What would you like to know more about?

Week Three—Observe Nature and Pose Questions About Clouds and Surface Temperature

Step 8: Surface Temperature

Surface temperature is measured with a hand-held Infrared Thermometer (IRT). The instrument is pointed at the ground to take surface temperature readings.

With a partner, brainstorm answers to the following question thinking back to the activity you did with different Earth materials that heated and cooled at different rates.

How might the surface temperature of the different surfaces around the outside of your school be different?

Consider the following question as you and your classmates select four different surface areas for your surface temperature sites:

What factors do you need to consider as you select your sites to ensure that the only variable affecting the surface temperature being collected is the type of ground cover?

As a class identify four different surface areas outside of your school as surface temperature study sites remembering to consider what you have learned regarding heating and cooling of different Earth materials. Sketch the different site surfaces in the spaces provided on the next page and predict the order of surface temperatures from coolest to warmest.

Step 9: Surface Temperature Measurements and Cloud Observation Surface Temperature Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)

❑ Nimbostratus

❑ Cumulonimbus

GLOBE Atmosphere Investigations

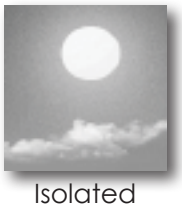
Week Three

Study Site: _____ *Date:* _____ *Time (UT):*_____

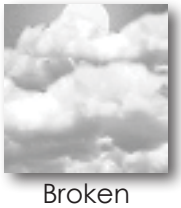
What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%


Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%


Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

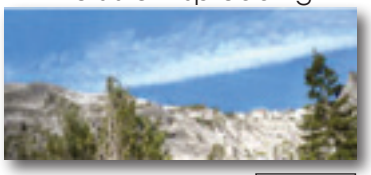
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading


Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Surface Temperature Measurements and Cloud Observation Surface Temperature Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)

❑ Nimbostratus

❑ Cumulonimbus

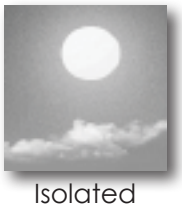
GLOBE Atmosphere Investigations

Study Site: _____ *Date:* _____ *Time (UT):*_____

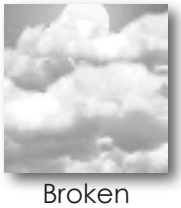
What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%


Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%


Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

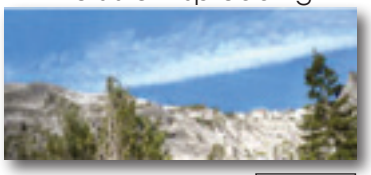
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading



Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Step 10: Cloudy vs Clear MY NASA DATA Activity

Description of task:

You will be examining a line plot using authentic NASA data to compare temperature on a cloudy vs clear day. You will practice drawing conclusions based on graphed data of cloudy vs. clear sky observations.

What to do:

1. **Cut out the two single-line plots and glue them in your foldable as demonstrated by your teacher**
2. **Identify the titles of the graphs. Is it easy to compare the two separate line plots?**

_____

_____

3. **Examine the double-line plot that your teacher gives you and glue it in your foldable. With a partner discuss similarities and differences between the single and double line plots, make a list of these on your foldable. Which one is easier to use to make a comparison between the cloudy and clear data?**

_____

4. **Identify 2 locations on the plot that are similar in cloudy and clear sky conditions.**

_____

5. **Find the month with the biggest difference in cloudy and clear sky conditions.**

_____

6. **Which line has the higher amount of energy from the sun throughout the year?**

_____ **Why?** _____

7. **What other things might affect how much of the Sun's energy reaches the Earth's surface?**

_____

8. **During what season is it most cloudy in China?** _____
9. **In the space below write a summary of how temperature is affected by clouds.**

_____

_____

_____

10. **On the front of your foldable, sketch a picture of a cloudy sky on the left fold and a clear sky on the right fold.**

Attach your foldable Cloudy vs Clear in the space below:

Week Three Science Journal Reflections

What have you learned?

What would you like to know more about?

Week Four—Observe Nature and Pose Questions About Clouds and Surface Temperature

Step 11: What's Visual Opacity? Activity

Clouds play an important role in maintaining the Earth's temperature.

Materials have lots of different properties. One is called *visual opacity*, which means how much light passes through the material. There are three different ways to describe visual opacity:

- ***Transparent:*** light passes through the material/object, things on the other side can be seen clearly (example: plastic wrap).
- ***Translucent:*** light passes through the materials/object; things on the other side can't be seen clearly (example: wax paper).
- ***Opaque:*** little or no light passes through the materials/object (example: paper bag).

Investigate

Come up with a way to test the visual opacity of different everyday items. Describe your test. You can draw your setup if you need.

Describe:

_____

_____

_____

_____

_____

_____

Draw:

Now test your materials and sort them based on your observations. List your results below.

Transparent	Translucent	Opaque

Predict

One of the ways they regulate the amount of light (energy) coming from the sun is their opacity. The terms transparent, translucent, and opaque describe how much light gets through a cloud and helps us understand why clouds make shadows.

How do you think an opaque cloud will impact surface temperature?

_____

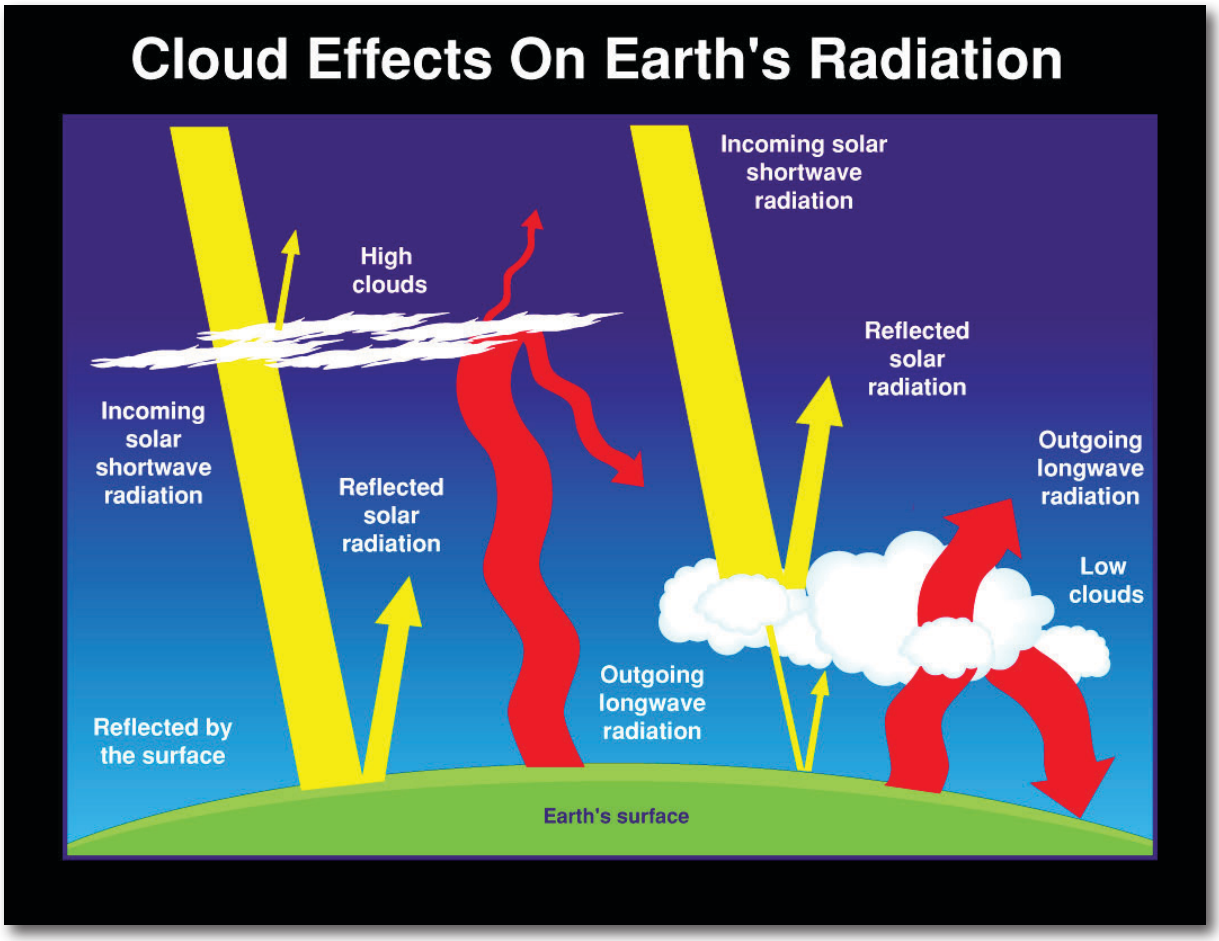
_____

How do you think a transparent cloud will impact surface temperature?

_____

_____

Looking at the Science: The Earth's Radiation Budget is a concept used for understanding how much energy the Earth gets from the Sun and how much energy the Earth-system radiates back to outer space. It is this exchange of energy that powers and drives Earth's weather and climate systems. If the Earth system (earth surface, atmosphere, oceans and ice mass) retains more solar energy than it radiates back to space, the Earth will warm. If the Earth-system radiates more energy to space than it receives from the Sun, the Earth will cool. Scientists think of the *Radiation Budget* in terms of a see-saw or balance. If the Earth retains more energy from the Sun, the Earth warms and emits more infrared energy. This brings the Earth's Energy Budget into balance. If the Earth emits more of this energy than it absorbs, the Earth cools. As it cools, the Earth emits less energy. This change also brings the Energy/Radiation Budget back into balance.



1. Which type of clouds do you see represented in the diagram?

_____

_____

2. How do the low level clouds interact with the solar radiation that is coming from the Sun toward Earth's surface?

_____

_____

3. The high level clouds? _____

4. Based on the diagram, what affect do clouds have on the Earth's energy coming from the Sun?

_____

_____

5. What affect do clouds have on the energy that is being reflected from the Earth's surface back toward the atmosphere?

_____

_____

Step 12: NOVA Connection: *The Climate Wild Card*

After watching the NOVA Video: *The Climate Wild Card,* reflect on the questions below that NASA scientists are working hard to answer.

- **How will clouds respond as the planet warms?**

_____

- **Could we see an increase in reflecting clouds, which would help to slow the global warming trend?**

_____

- **Or will there be an increase in absorbing clouds, which could dramatically speed up the warming?**

_____

- **How would this warming affect the polar regions and in turn affect coastal areas?**

_____

As a class brainstorm how the polar regions and coastal areas might be affected if there is an increase in absorbing clouds. Fill in the chain of events below that might occur if the percentage of absorbing clouds increase.

Percentage of Absorbing Clouds Increase

↓

Warming of Atmosphere _____

↓

Ice at the Polar Regions _____

↓

Sea Level _____

↓

Coastal Areas _____

↓

This would result in the following impacts on humans:

_____

_____

Step 13: Surface Temperature Measurement and Cloud Observation Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

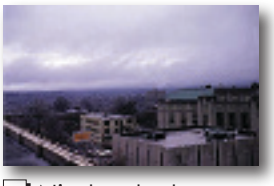
Low (in the sky):
(Check all types seen)

❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)



❑ Nimbostratus

❑ Cumulonimbus

GLOBE Atmosphere Investigations

Week Four

Study Site: _____ *Date:* _____ *Time (UT):*_____

What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%

Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%

Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

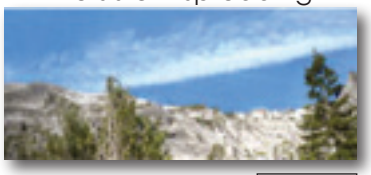
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading



Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Surface Temperature Measurement and Cloud Observation Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)

❑ Nimbostratus

❑ Cumulonimbus

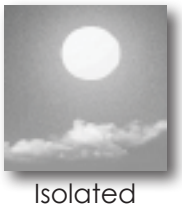
GLOBE Atmosphere Investigations

Study Site: _____ *Date:* _____ *Time (UT):*_____

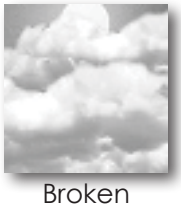
What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%


Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%


Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

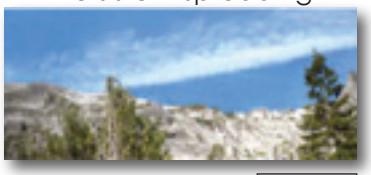
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading


Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Week Four Science Journal Reflections

What have you learned?

What would you like to know more about?

Week Five—Pose Research Question, Develop a Hypothesis and Identify the Data

Step 14: What Does a NASA Science Research Question Look Like?

As you can see from the previous activities, scientists asking questions and finding answers is extremely important to all of us. All factors of our daily lives are affected by the answers that NASA scientists are seeking. Everything we know about Earth and the world around us has been a result of someone, somewhere, asking a question and setting out to find an answer. It is natural human curiosity that has often resulted in the most important discoveries.

So what makes a "GOOD" science research question?

A good research question is a question that is worth answering. It poses a problem that can be answered through scientific investigation or the examination of data that has been collected. Simple yes or no questions may have important practical significance, but they do not make good research questions. A good science research question requires more than looking something up in a book or on the Internet. The answer does not simply depend on one or two missing facts. A good research question should force you to evaluate evidence and compare different possible answers.

Use the Research Question Characteristics Rubric below to identify which of the following questions are "GOOD" science research questions.

1. **Is there a relationship between today's clouds and tomorrow's weather?**
2. **How reliable is a prediction of tomorrow's weather based on today's cloud observations?**

Research Question Characteristics	Points (0 or 1)
The answer is not immediately obvious	
There could be more than one answer - the answer is not just yes or no	
Encourages a new or different view of phenomena	
Narrow in focus so that the necessary research can be done	
Clear enough for other people to understand	
Tests an accepted explanation	
Goes beyond existing explanations	
Possible to answer in the time available to you	
Possible to answer with measurement equipment and techniques available to you	
Any data required from others is available or can be obtained through collaboration	
Will sustain your interest for the time required to complete the research	
Tests your assumptions about the phenomena	
Completes or adapts an existing explanation	
Total Points	

Step 15: The Science Research Process In Action

The NASA big question: ***How do clouds affect the Earth's energy budget?***

Your* science research question:** ***How do clouds affect the surface temperature? OR ***What is the relationship between cloud cover and surface temperature in the area around your school?***

Reflect back on what you have learned through your investigations and respond to the following question.

What have you learned about the relationship between clouds and Earth's surface temperature?

Developing a Hypothesis: Science is about finding answers to our questions about the world around us. Part of finding the answer is to test a hypothesis. A hypothesis is a tentative statement that proposes a possible explanation to some phenomenon, event, or scientific problem that can be tested by further investigation. A useful hypothesis is a testable, measurable statement. Following the other steps in the scientific process helps us test to see if our hypothesis was correct or not. Over the next couple of weeks you will be compiling and analyzing the data that you have collected to find the answer to your science research question. What do you think will be the answer to your research question? That is your hypothesis.

Hypothesis:

Now that you have your hypothesis you need to assemble your data to be analyzed. Over the past several weeks you have been recording your GLOBE data, now it is time to put it all together so that you can begin to look for patterns and any cause-effect relationships that might exist. In the next activity, *Looking at Your GLOBE Data,* you will practice looking at data, graphic data and analyzing data.

Step 16: Looking at Your GLOBE Data Learning Activity

Part 1: Sketch, label, and describe the four surface areas that you have gathered data for during your investigation.

Location #1:

Location #2:

Location #3:

Location #4:

Describe how the four locations are similar.

Describe how the four locations are different.

Part 2: Copy the surface temperature data that you have collected over the past two weeks in the data chart below.

Surface Temperature/Sky Conditions Data

Sample Site	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Average
1											
2											
3											
4											
Sky Condition											N/A

Part 3: Describe how your predictions of the surface temperatures of these two locations compared with the observations and measurements that you collected.

Use the data chart to answer the following questions related to your data:

1. **Which location had the highest average surface temperature?**

_____

2. **What is the explanation for why that location had the highest average surface temperature?**

_____

_____

_____

3. **Do you think the average surface temperature for the four locations you selected would be different during a different season? _____ Why or why not?**

_____

_____

_____

_____

Step 17: Surface Temperature Measurement and Cloud Observation Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

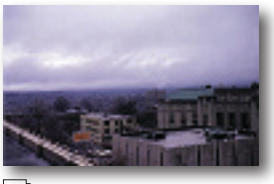
❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

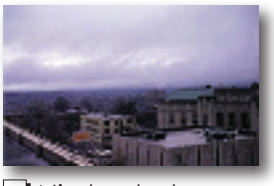


❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)



❑ Nimbostratus

❑ Cumulonimbus

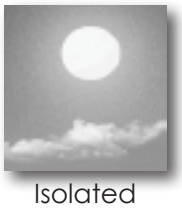
GLOBE Atmosphere Investigations

Study Site: _____ *Date:* _____ *Time (UT):*_____

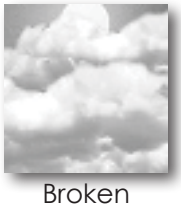
What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%


Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%


Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

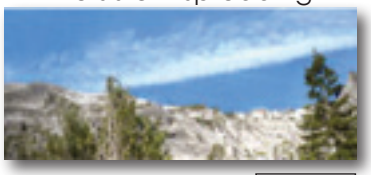
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading



Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Week Five Science Journal Reflections

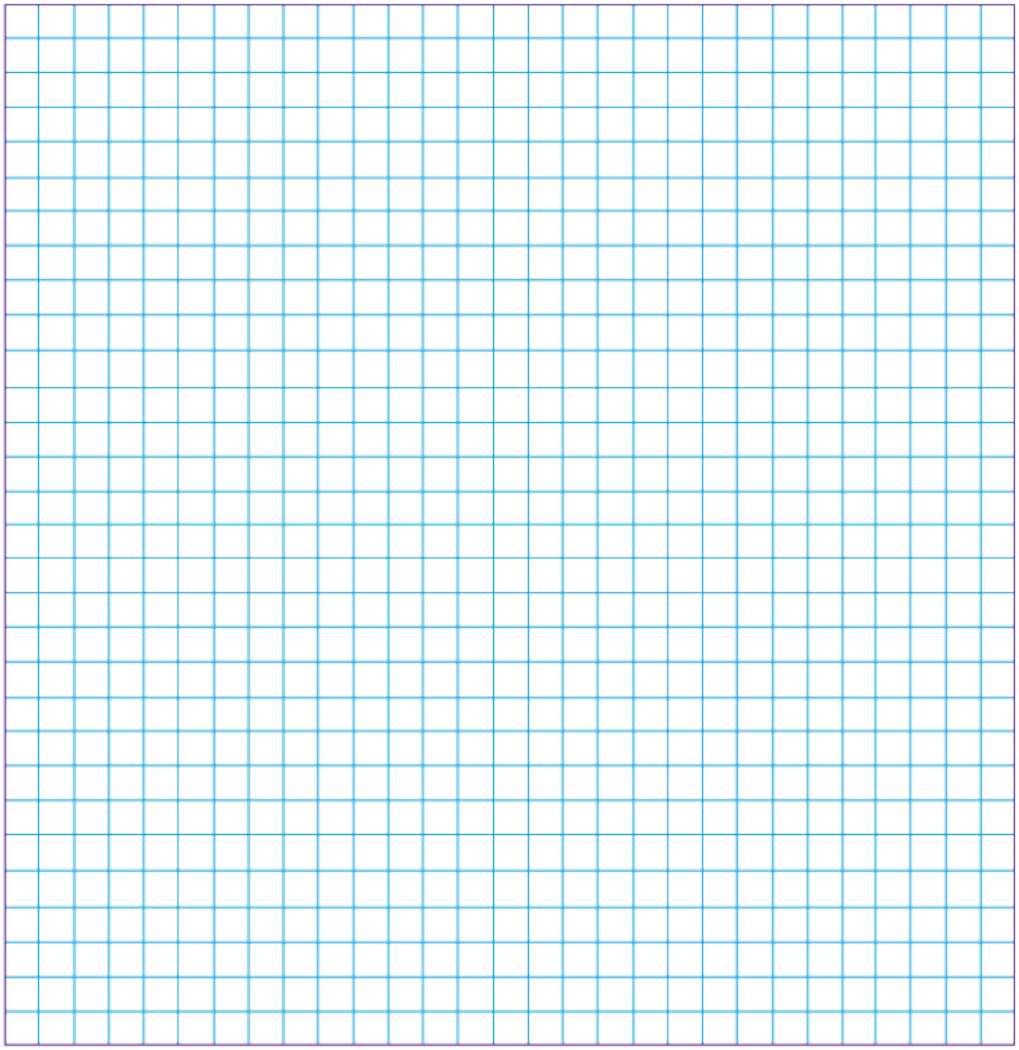
What have you learned?

What would you like to know more about?

Week Six—Planning the Investigation and Identify the Data

Step 18: Part 4: Graphing Your Data (Continue from Step 16)

Select the two locations from your data chart in **Part 2** that have the highest and lowest average surface temperatures and graph them on the grid below. You will use different colors to represent the different locations (purple for the highest surface temperature and green for the lowest surface temperature). Remember to provide appropriate labels/scales and a title for your graph. You should plot the ten days across the X-axis (horizontal) and the temperature in °C on the Y-axis (vertical).



Part 5: Use a blue colored pencil to circle the points on the graph for days with clear skies, an orange colored pencil to circle points on the graph for days with clouds visible and a red colored pencil to circle points on the graph for days with obscured skies. Based on the data does there appear to be a pattern/relationship between the surface temperature and clouds in the sky? _____

Explain:

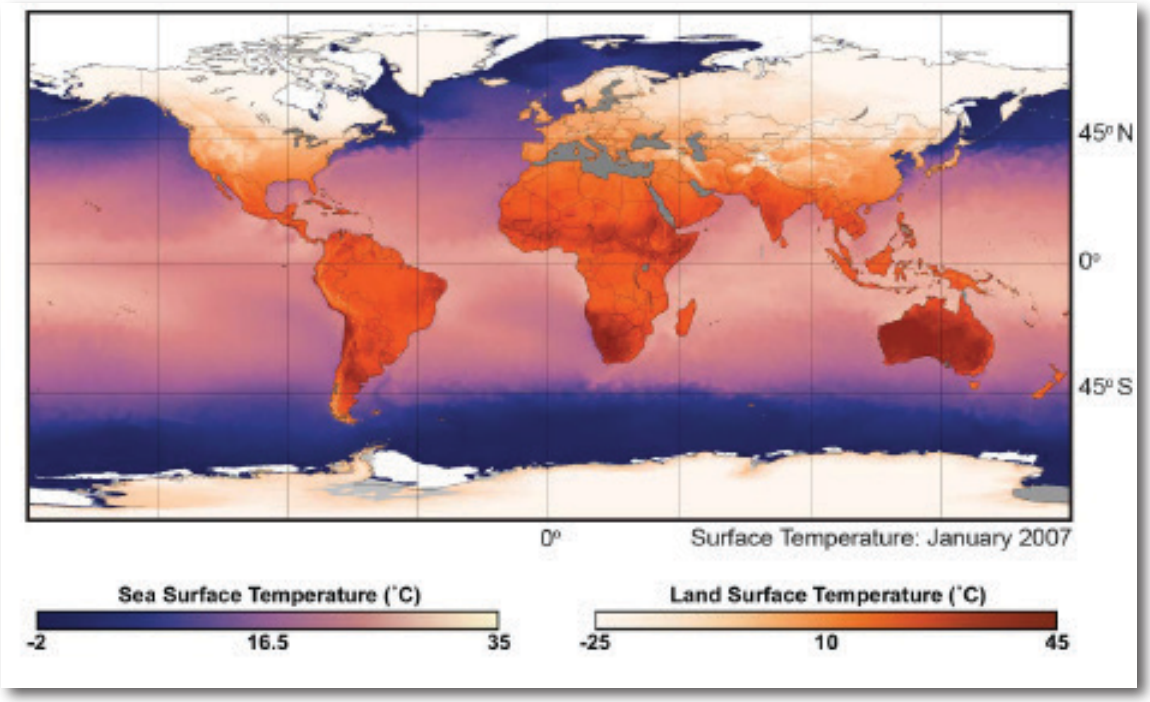
_____

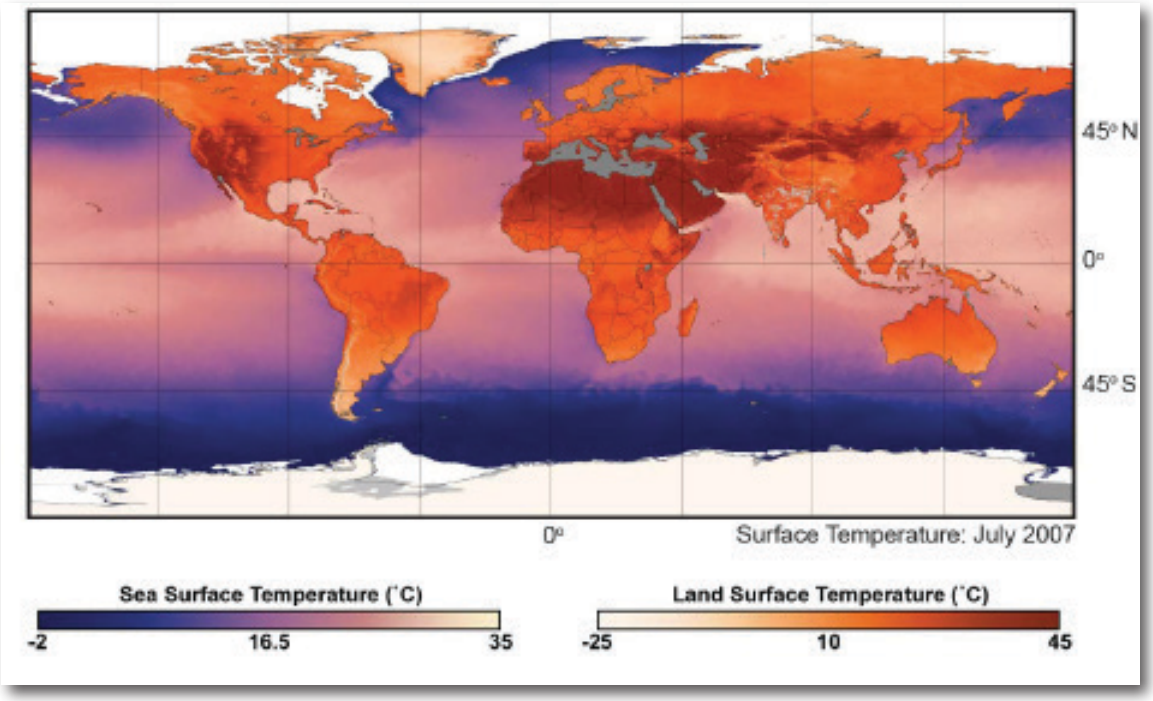
_____

_____

Part 6: Looking at GLOBE data

Work with a partner to examine the satellite images below to view surface temperature at a global scale. Pick a particular location in the first image and compare that to the surface temperature of the same point in the second image. Do this for three different locations and record your observations on the next page.





Estimated Latitude/Longitude of the Locations Selected:

Location #1: _____

Northern or Southern Hemisphere: _____

Location #2: _____

Northern or Southern Hemisphere: _____

Location #3: _____

Northern or Southern Hemisphere: _____

What similarities and or differences did you observe between the three locations that you selected on the two images for the months of January and July?

Similarities:

_____

_____

_____

Differences:

_____

_____

_____

On the next page you will observe two satellite images that show cloud fraction (the fraction of sky hidden by visible clouds) for the months of January and July in 2007. Compare the images of cloud fraction with the images of surface temperature for these same two months. Examine the same three locations that you selected previously and see how the percentage of cloud cover compares to the surface temperature.

Describe what you observe:

Location #1: _____

_____

Location #2: _____

_____

Location #3: _____

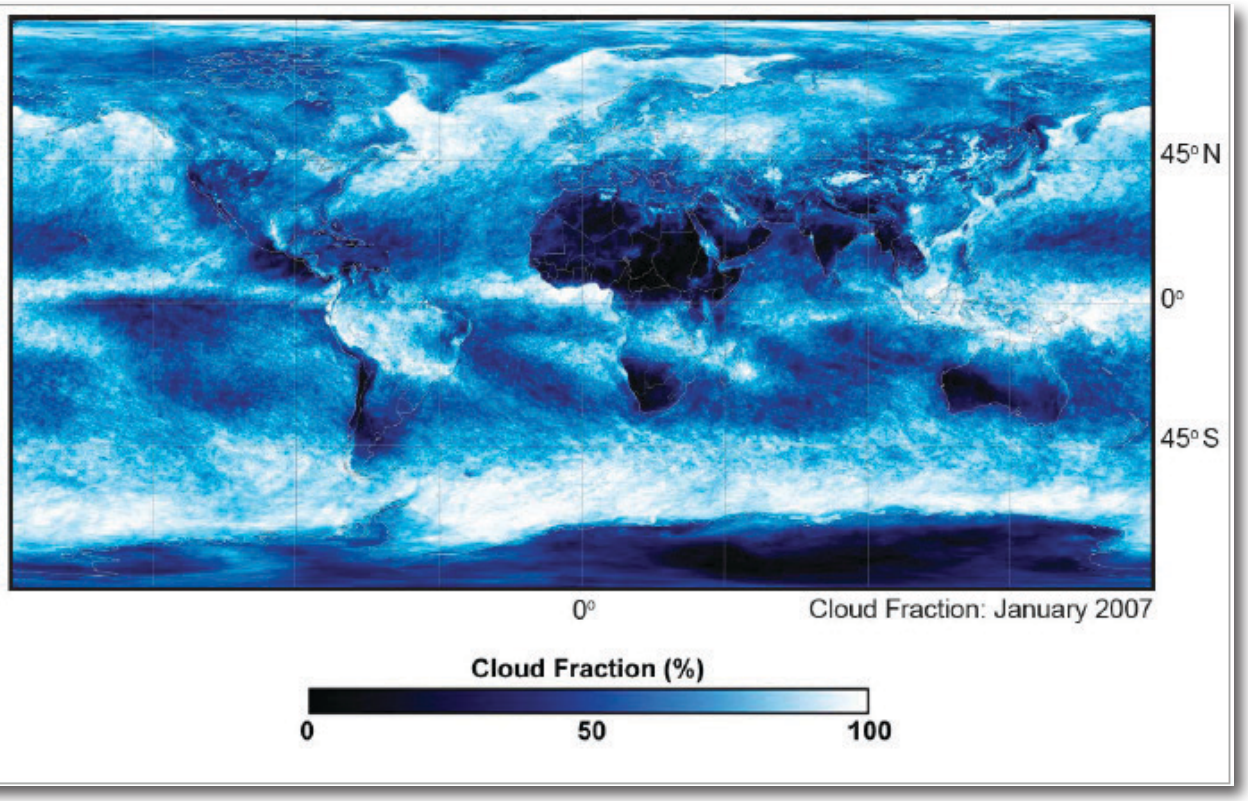
_____

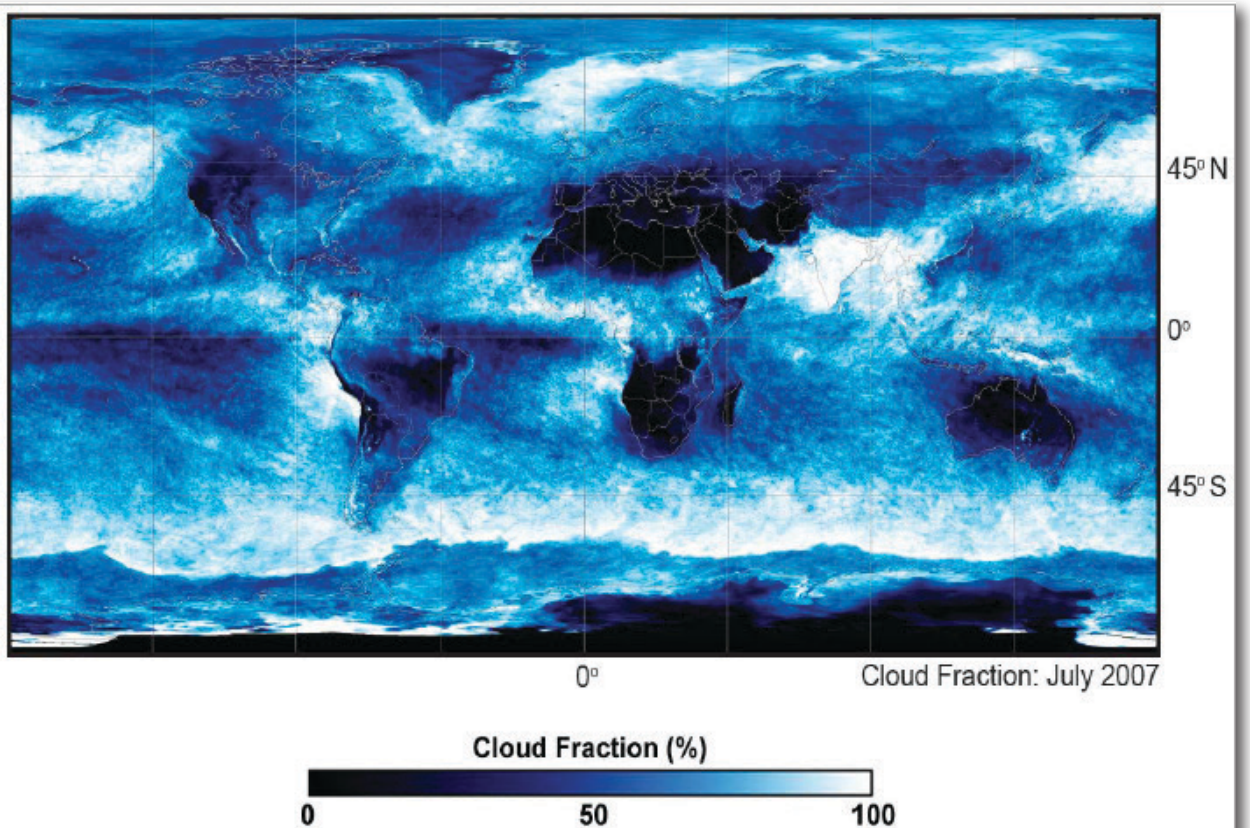
Does there appear to be a relationship between the surface temperature and the cloud fraction for the months of January and July, 2007? Why or why not?

_____

_____

_____


45° N
0°
45° S
0°
Cloud Fraction: January 2007
Cloud Fraction (%)
0
50
100


45° N
0°
45° S
0°
Cloud Fraction: July 2007
Cloud Fraction (%)
0
50
100

Step 19: Selecting Your Culminating Project

Choice 1: Science Project Poster

With a partner or a small group:

- Identify the research question
- Develop a title for your project
- Use steps of the science research process to guide the components of your poster
- Identify visuals and the data you will include on the poster
- Draft content to be included on the poster
- Present the draft to your instructor
- Make necessary edits to the draft
- Create graphic components
- Write a conclusion from analysis of the data
- Show a rough draft of the poster to the instructor for feedback
- Construct the poster
- Present the final poster to peers for a critique
- Optional: present final poster at Culminating Project Community Night

Choice 2: Public Service Announcement

With a partner or in a small group:

- Identify the research question
- Develop a Public Service Announcement (PSA) message
- Identify visuals and sounds to use in the PSA
- Draft a storyboard and script
- Present the PSA draft to the instructor for review
- Make necessary edits to the draft
- Film and edit the PSA
- Show a rough cut to teacher for feedback
- Present final PSA to peers for a critique
- Optional: present final PSA at Culminating Project Community Night

Choice 3: PowerPoint

With a partner or a small group:

- Identify the research question
- Use steps of the science research process to guide the components of your PowerPoint
- Develop an outline for the PowerPoint
- Identify images and data to be included
- Draft content to accompany images
- Present the PowerPoint draft to the instructor
- Make necessary edits to the draft
- Show the edited PowerPoint to the instructor for feedback
- Present the final PowerPoint to peers
- Optional: present the final PowerPoint at Culminating Project Community Night.

Step 20: Following the Steps of the Scientific Research Process

Atmospheric GLOBE Investigation Culminating Project

As you work to complete your culminating project complete the following:

Scientific Research Question: _____

_____

_____

_____

Hypothesis: _____

_____

_____

_____

Summarize the steps of your investigation (*what did you do to find the answer to your question?*):

_____

_____

_____

_____

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_____

Step 21: Surface Temperature Measurement and Cloud Observation Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

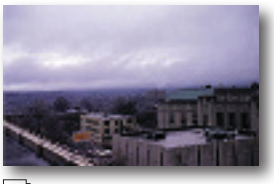
❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

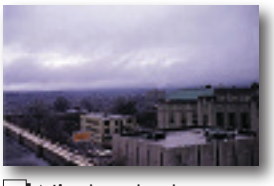


❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)



❑ Nimbostratus

❑ Cumulonimbus

GLOBE Atmosphere Investigations

Week Six

Study Site: _____ *Date:* _____ *Time (UT):*_____

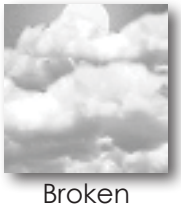
What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%

Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%


Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

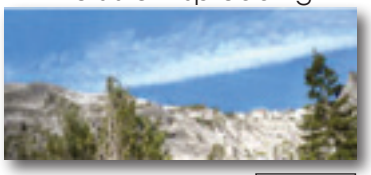
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading


Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Week Six Science Journal Reflections

What have you learned?

What would you like to know more about?

Week Seven—Assemble and Analyze the Data, Document, and Conclusion

Step 22: Assemble Your Data

(Continuing the development of your science research project)

Describe the data you will use to show the results of your investigation:

_____

_____

_____

_____

_____

_____

_____

_____

_____

Components to consider for your graph: *(Depending on the data you have selected to use for your project, consider the following components and fill in the information that you will use to complete your graph.)*

Title:_____

What variable will you plot on the X-Axis? _____

_____

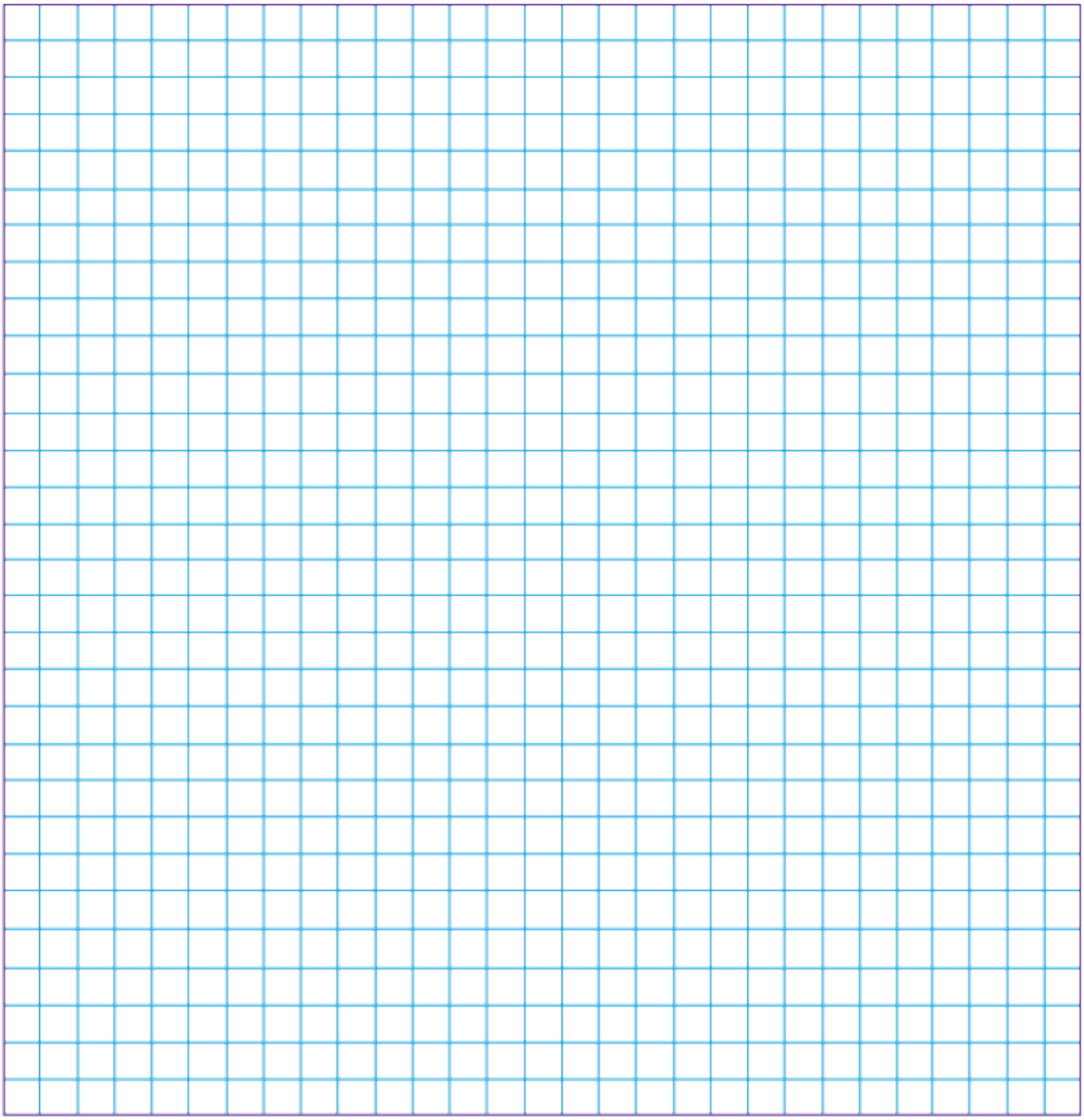
Range of numbers needed:_____

_____

Scale:_____

Units of measurement: _____

Use the grid below to create a rough draft of the graph of your data:



Step 23: Analyze Your Data

In conclusion: As you develop your conclusion refer back to your hypothesis as it relates to your research question and state whether or not it was supported by your data. You should also include any new questions that you might have as a result of your findings.

Questions for further research:

Step 24: Surface Temperature Measurement and Cloud Observation Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)

❑ Nimbostratus

❑ Cumulonimbus

GLOBE Atmosphere Investigations

Week Seven

Study Site: _____ *Date:* _____ *Time (UT):*_____

What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%

Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%

Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

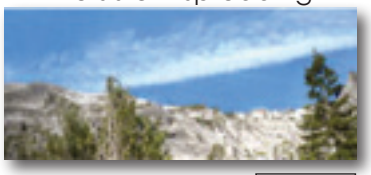
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading



Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Week Seven Science Journal Reflections

What have you learned?

What would you like to know more about?

Week Eight—Present Findings and Pose New Questions

Step 25: Surface Temperature Measurement and Cloud Observation Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

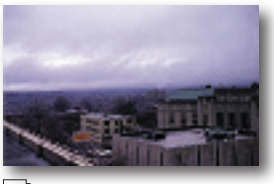
❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

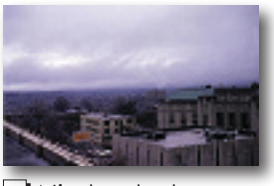


❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)

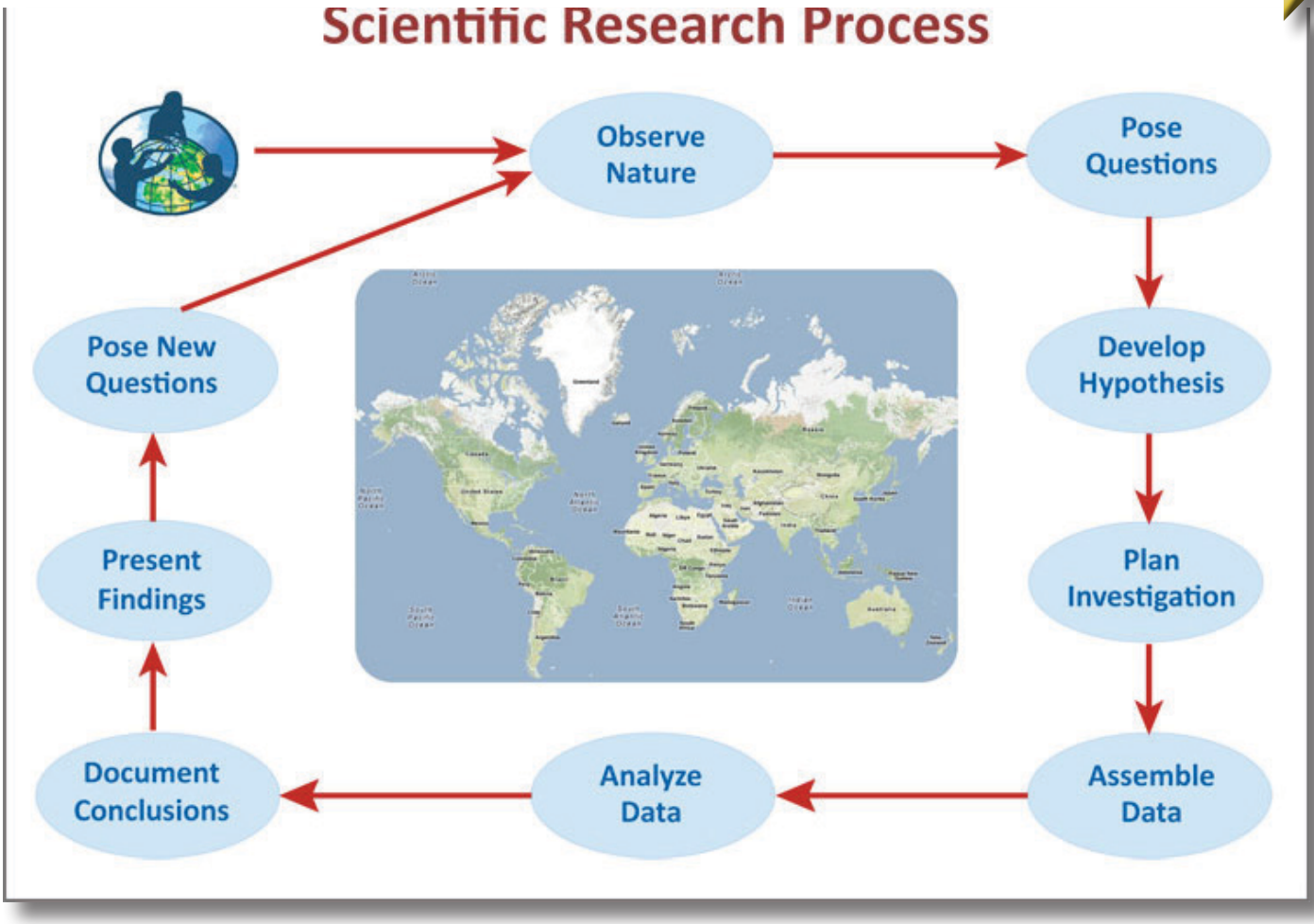


❑ Nimbostratus

❑ Cumulonimbus

Step 26: Finalizing the Culminating Project

Putting the final touches on your culminating project is very important. You want to make sure that it provides the audience with a clear visualization of your investigation and the data that you collected. As you finalize your project refer back to the Science Research Process as a guide and use the Culminating Project Rubric to ensure that you include all of the key components.



GLOBE Atmosphere Investigation Culminating Project Rubric

Category	Exemplary 5 points	Proficient 3 points	Novice 1 point	Not Included 0 points
Research Question	Clearly stated a research question that could be answered using data collected during the process of the atmosphere investigation.	Provided a research question from the atmosphere investigation that related to the data that was collected.	Referred to a question that was not necessarily answerable with the data that was collected.	Did not provide a research question for the investigation.
Hypothesis Developed	Fully developed the hypothesis proposing a possible explanation of the research question in a format that is testable and measurable.	Provided a hypothesis as a possible explanation of the research question that was not clearly testable or measurable.	Developed a hypothesis that did not provide an explanation of a possible answer for the research question and was not testable or measurable.	Did not provide a hypothesis for the atmosphere investigation.
Detailed Procedure	Clearly summarized and detailed the steps of the investigation process providing enough detail that the atmosphere investigation could be replicated.	Provided steps for the investigation that could be followed but would not allow for accurate replication of the atmosphere investigation.	Steps given were unclear and contained gaps that would not allow for the atmosphere investigation to be replicated.	Did not provide a procedure for the atmosphere investigation.
Data Assembled	Data was selected and assembled in a graphical visualization that could be used as evidence to answer the research question.	Data was selected that could be used to provide an answer to the research question, but was not provided in a graphical format.	Data was selected but could not be used to provide an answer to the research question.	Did not assemble data from the atmosphere investigation.
Data Analyzed	Data was analyzed as evidence to support a clear explanation/ argument of the answer to the research question.	Data was analyzed providing an answer to the research question that was not clearly evident from the data.	Data was examined but was not related to the research question as a possible explanation.	Did not analyze data from the atmosphere investigation.
Conclusion Summarized	Results of the atmosphere investigation were summarized with supporting evidence from data collected during the investigation as it related to the hypothesis and new questions were provided for further investigation.	Results of the investigation were summarized with supporting evidence from the data that was collected during the investigation but no reference to the hypothesis was given and questions for further investigation were not provided.	Results of the investigation were summarized but not supported by evidence from the data collected during the investigation, no reference to the hypothesis was given and questions for further investigation were not provided.	Did not provide a conclusion for the atmosphere investigation.

Step 27: Present Culminating Project

You will have the opportunity to present your project to your peers and possibly to other members of your community. Below you will see a list of items to remember when making a presentation.

Points to Remember When Presenting:

- Make eye contact
- Speak clearly
- Smile
- Discuss your project rather than read it
- Identify your main points
- Refer to your graph for visualization
- Have your science research journal available
- Feel proud of what you have accomplished

You might also consider sharing your project with members of the GLOBE Community through submission to the Virtual Science Symposia. (http://www.globe.gov/news-events/globe-events/virtual-conferences)

GLOBE Atmosphere Investigations

Study Site: _____ *Date:* _____ *Time (UT):*_____

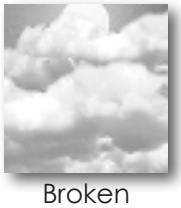
What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%

Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%


Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

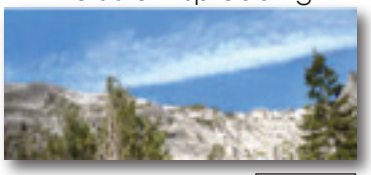
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading


Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Surface Temperature Measurement and Cloud Observation Data Sheet

School Name: _____ *Study Site:* _____

Observer Names: _____

Date: Year _____ *Month* _____ *Day* _____ *Universal Time (hour:min):* _____

Surface Temperature:

Site's overall surface condition (Check one): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature (°C)	Snow Depth (mm)
1		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
2		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
3		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm
4		❑ Zero Trace ❑ (<10 mm) ❑ Measurable ❑ (>10 mm) _____ mm

Sky conditions (check one):

❑ **Clear** *(no clouds visible)*

❑ **Clouds visible** *(1% to 100% covered by clouds or contrails)*

❑ **Obscured** *(More than 25% of the sky is not visible)*

Sketch the sky below:

Comments:

_____

_____

_____

_____

_____

_____

_____

Study Site: _____ *Date:* _____ *Time (UT):*_____

If clouds are visible select all cloud types seen:

High (in the sky):
(Check all types seen)

❑ Cirrus

❑ Cirrocumulus

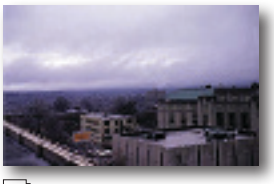
❑ Cirrostratus

Middle (of the sky):
(Check all types seen)

❑ Altostratus

❑ Altocumulus

Low (in the sky):
(Check all types seen)

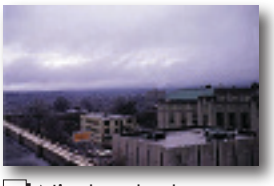


❑ Stratus

❑ Stratocumulus

❑ Cumulus

Rain or snow producing clouds:
(Check all types seen)



❑ Nimbostratus

❑ Cumulonimbus

GLOBE Atmosphere Investigations

Study Site: _____ *Date:* _____ *Time (UT):*_____

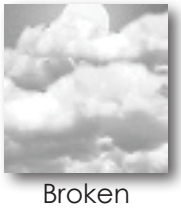
What percent of the sky is covered by clouds? (Check one): Three-quarters or More of the Sky is Visible: Cloud Cover (Check one)

No Clouds
❑ 0%

Clear
❑ >0 to 10%

Isolated
❑ 10 to 25%

Scattered
❑ 25 to 50%


Broken
❑ 50 to 90%

Overcast
❑ >90%

Are there contrails in the sky? (Check one): ❑ **No contrails** ❑ **Contrails are visible**

If contrails are visible, record the number of each type seen:

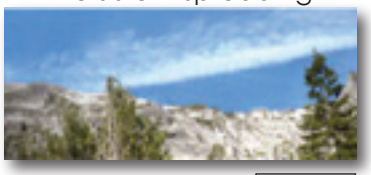
Short-lived

Number observed ☐

Persistent non-spreading

Number observed ☐

Persistent spreading



Number observed ☐

What percent of the sky is covered by contrails? (Check one):

❑ 0 to 10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

If you selected "obscured" (>25% of the sky is not visible) (check all that apply):

❑ Blowing snow

❑ Heavy snow

❑ Heavy rain

❑ Fog

❑ Sand

❑ Spray

❑ Volcanic ash

❑ Smoke

❑ Dust

❑ Haze

Comments:

_____

_____

_____

Week Eight Science Journal Reflections

What have you learned?

What would you like to know more about?