



Introduction to the GLOBE Atmosphere Protocols



The GLOBE Program



G Global
L Learning and
O Observations
B to Benefit the
E Environment



Welcome to GLOBE's Atmosphere Investigations!



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Overview and Objectives

This module:

- Introduces the GLOBE Atmosphere Investigation Area
- Introduces the GLOBE protocols associated with the atmosphere

After completing this module, you will be able to:

- Describe the structure and composition of the atmosphere
- Explain how differential heating of the Earth's surface generates winds
- Identify the components of the Earth system
- Explain the difference between weather and climate
- Be familiar with where and when to take atmosphere measurements
- Recognize various GLOBE atmosphere investigation protocols
- Identify the importance of atmospheric data

Estimated time to complete this module: 1.5 hours





1. What is the Atmosphere?

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

The Earth's atmosphere is an extremely thin sheet of air extending from the surface of the Earth to the edge of space. The Earth is a sphere with a roughly 8000-mile diameter; the thickness of the atmosphere is about 60 miles.

In this picture, taken from a spacecraft orbiting at 200 miles above the surface, we can see the atmosphere as the thin blue band between the surface and the blackness of space. **If the Earth were the size of a basketball, the thickness of the atmosphere could be modeled by a thin sheet of plastic wrapped around the ball!**



Image: NASA



The Atmosphere is Composed of a Mixture of Gases

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

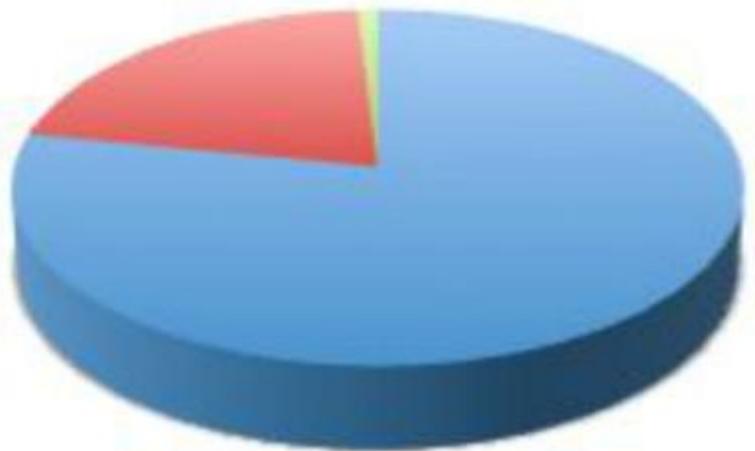
F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Air is composed of approximately 78% nitrogen, 21% oxygen, and small amounts of other gases.



Nitrogen

Oxygen

Other (Carbon Dioxide, Water Vapor, Aerosol Particles, Ozone)



The Atmosphere has Structure

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



Image Credit: NASA/JSC Gateway to Astronaut Photography of Earth

International Space Station astronauts captured this photo of Earth's atmospheric layers on July 31, 2011, revealing the troposphere (orange-red), stratosphere and above. Satellite instruments allow scientists to better understand the chemistry and dynamics occurring within and between these layers. Let's look at some of the layers of the atmosphere in the next slides.



At the Top of the Atmosphere: Exosphere and Ionosphere

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

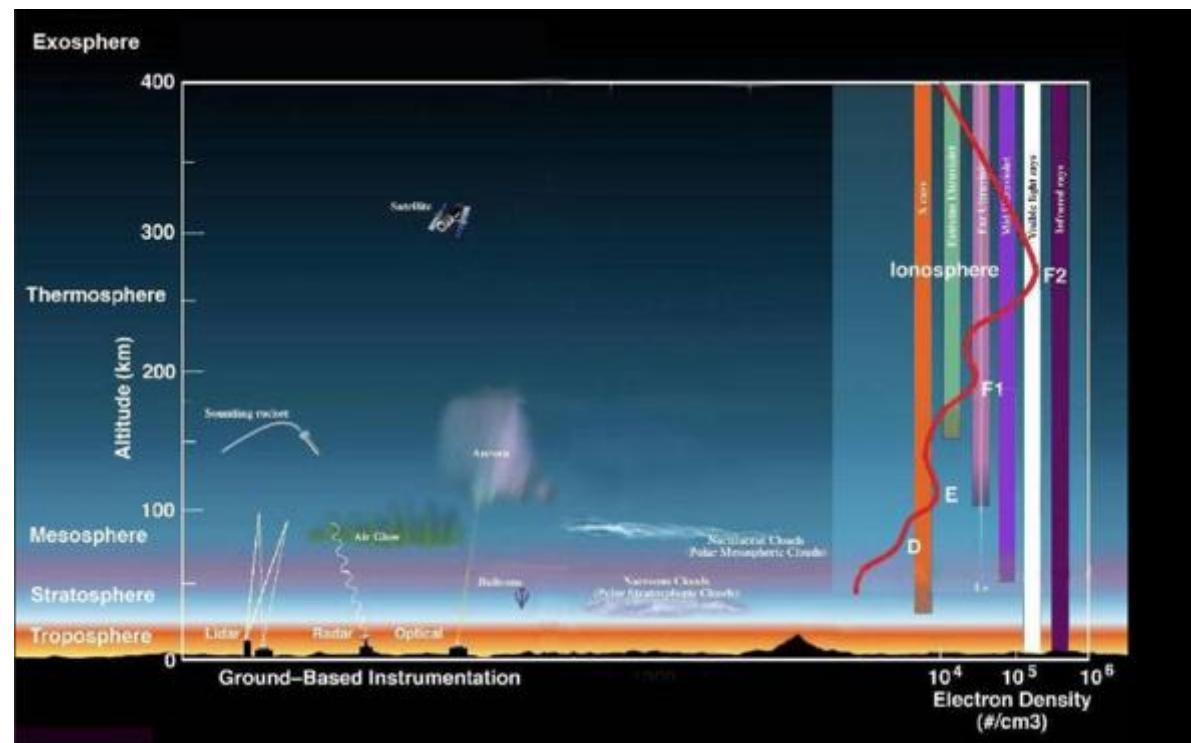


Image Credit: NASA Goddard

Exosphere: This is the upper limit of our atmosphere. It extends from the top of the thermosphere up to 10,000 km (6,200 mi). **Satellites orbit in this layer.**

Ionosphere: The ionosphere is an abundant layer of electrons and ionized atoms and molecules that stretches from about 48 kilometers (30 miles) above the surface to the edge of space at about 965 km (600 mi), overlapping into the mesosphere and thermosphere. This region is what makes radio communications possible.



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

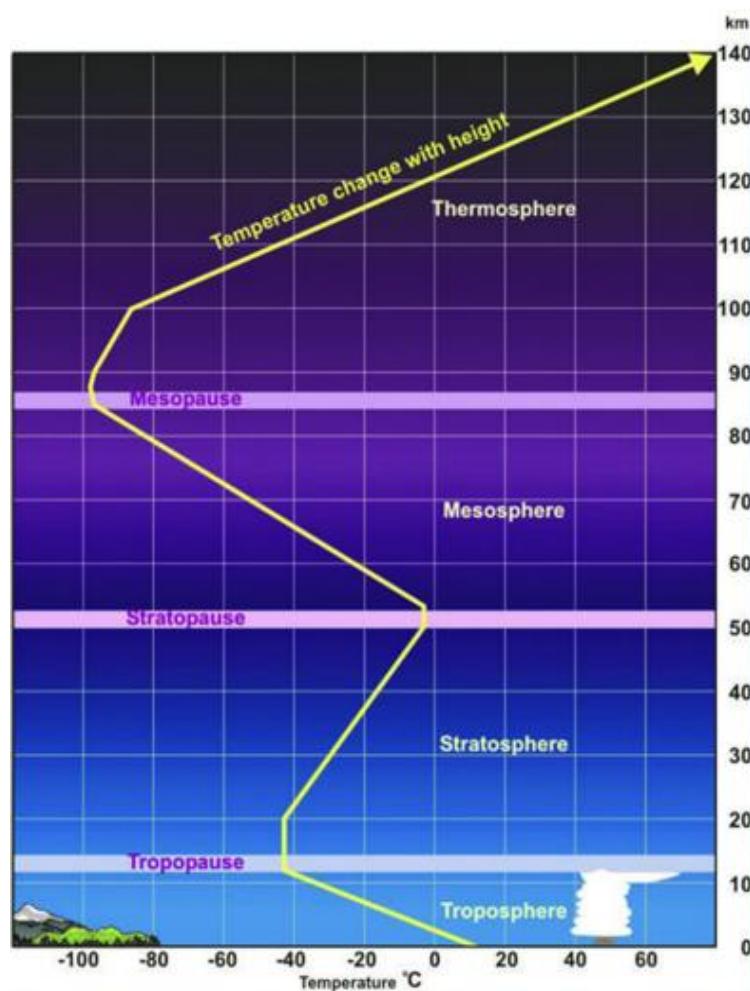
Below the Ionosphere: Thermosphere-Troposphere

Thermosphere: The thermosphere starts just above the mesosphere and extends to 600 kilometers (372 miles) high. **Aurora and some other satellites occur in this layer.**

Mesosphere: The mesosphere starts just above the stratosphere and extends to 85 kilometers (53 miles) high. Meteors burn up in this layer.

Stratosphere: The stratosphere starts just above the troposphere and extends to 50 kilometers (31 miles) high. **The ozone layer, which absorbs and scatters the solar ultraviolet radiation, is in this layer.**

Troposphere: The troposphere starts at the Earth's surface and extends 8 to 14.5 kilometers high (5 to 9 miles). This part of the atmosphere is the densest. **Almost all weather is in this region.**





Uneven Heating of the Earth Drives Air and Ocean Circulation

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

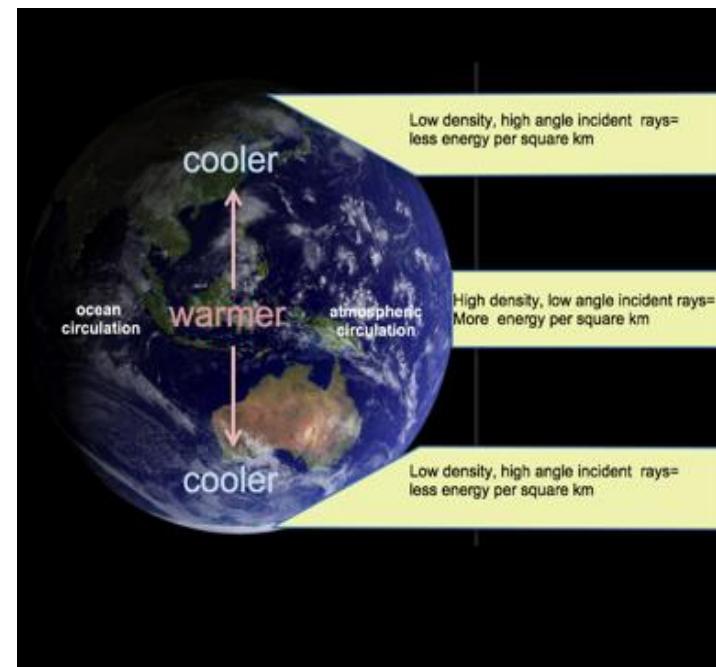
H. How to Report Data to GLOBE.

I. Further Resources and Review

The unequal heating of the Earth's surface drives air and ocean circulation and causes climate to vary by latitude.

Air and water circulation is initiated at the equator, where insolation is greatest. Masses of air and ocean transport heat energy from areas of high concentration to low concentration.

The movement of these masses of air and ocean establish an equilibrium state of heat distribution which we determine the general climate bands, or zones that we see at different latitudes.



At the higher latitudes, solar energy reaches the Earth as Low density, high angle incident rays, so there is less energy reaching the Earth's surface per km², compared to the equator. Image: Blue Marble from NASA Earth Observatory



The Atmosphere is part of the Earth System

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

To summarize, atmospheric properties are not uniform; fluid properties are constantly changing with time and location. We call this change **the weather**.

The atmosphere's properties and the weather it generates affect all parts of the Earth, but at the same time, properties of the Earth's components- the hydrosphere (water), lithosphere (earth) and biosphere (life), affect the atmosphere. These interactions characterize the Earth system.

The Earth system behaves as a single, self-regulating *closed system* comprising physical, chemical, biological and human components.

The focus of Earth system science is understanding the interactions between the oceans and ice, atmosphere, life, geological processes and the land surface, and how those interactions impact each other and lead to changes on our planet.

The Earth system is also responsible for generating Earth's **climate**.

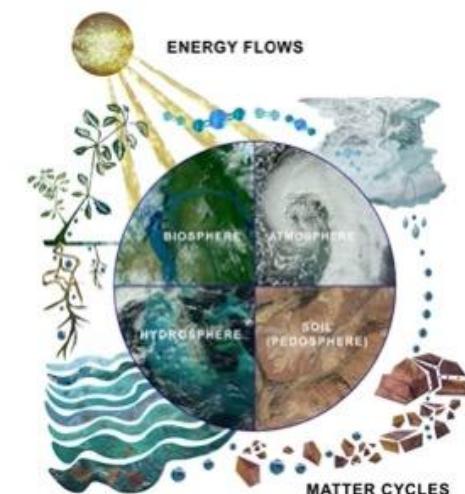


Image: GLOBE.gov



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

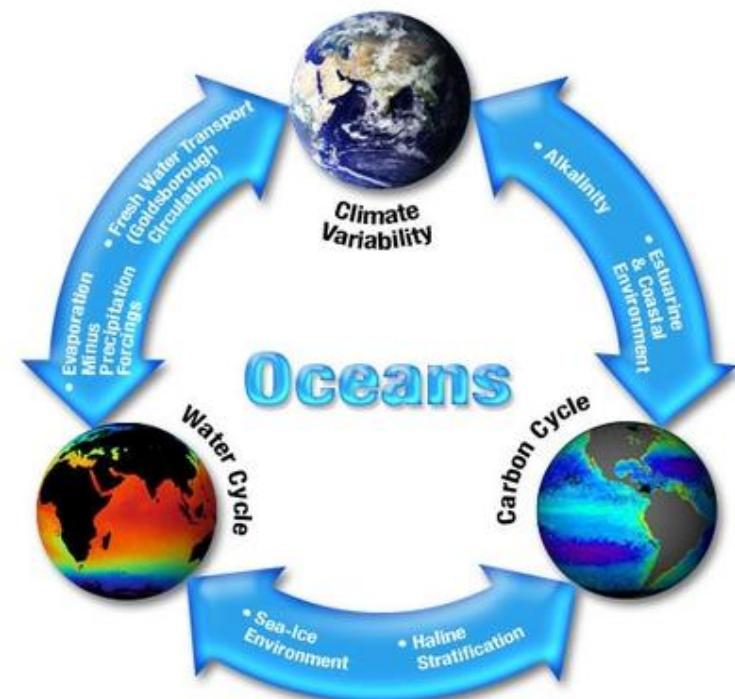
G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

In the Earth system, changes in one part of the system will affect the other parts.

This diagram shows some of the ways that elements of the Earth system affect other elements of the Earth system.



In the Earth system,
“Everything is connected to everything else.”

Image: NASA



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

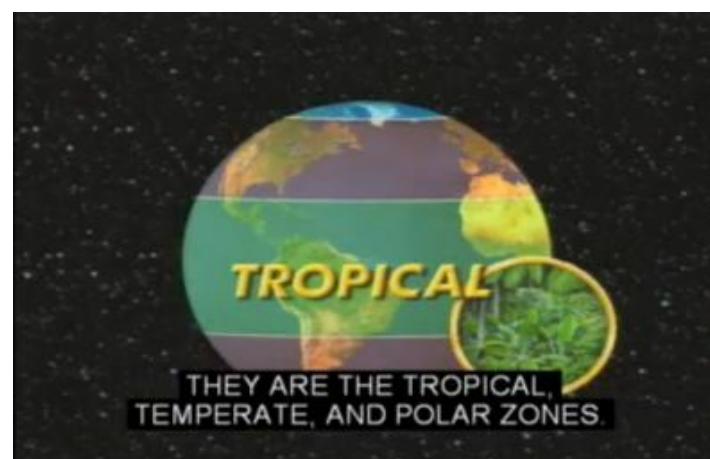
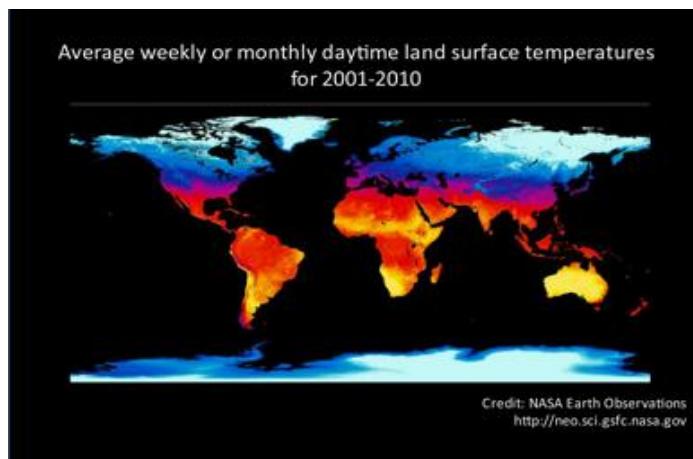
F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

The interactions of the Earth's system generate weather and climate.



Unequal heating of the Earth's surface by the Sun, and interactions between the atmosphere, biosphere, hydrosphere and lithosphere create the Earth's climate zones, which have characteristic weather conditions and life forms.



In the Earth system, changes in one part of the system will affect the other parts.

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

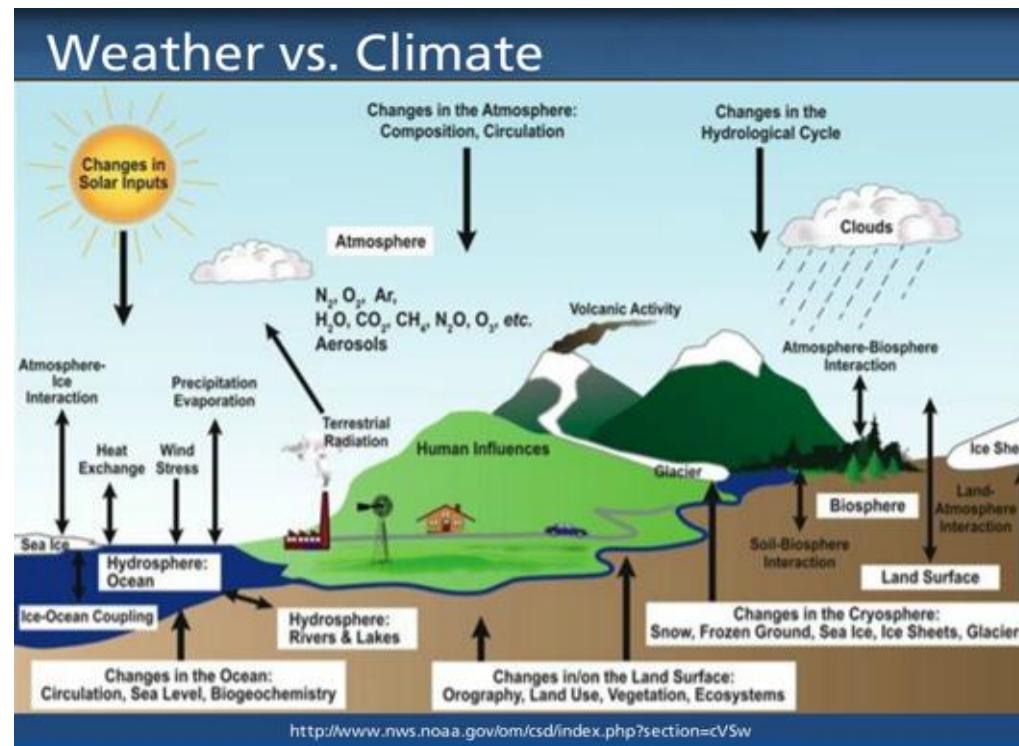
E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



This diagram summarizes some of the factors that influence weather and climate and are responsible for differentiation of climate zones. Don't worry about the details, but you should be aware that in the Earth system, **“Everything is connected to everything else.”** Note: Cryosphere is another term for the Earth's ice, and in GLOBE materials, the cryosphere is treated as part of the hydrosphere.



So, what is the difference between weather and climate?

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

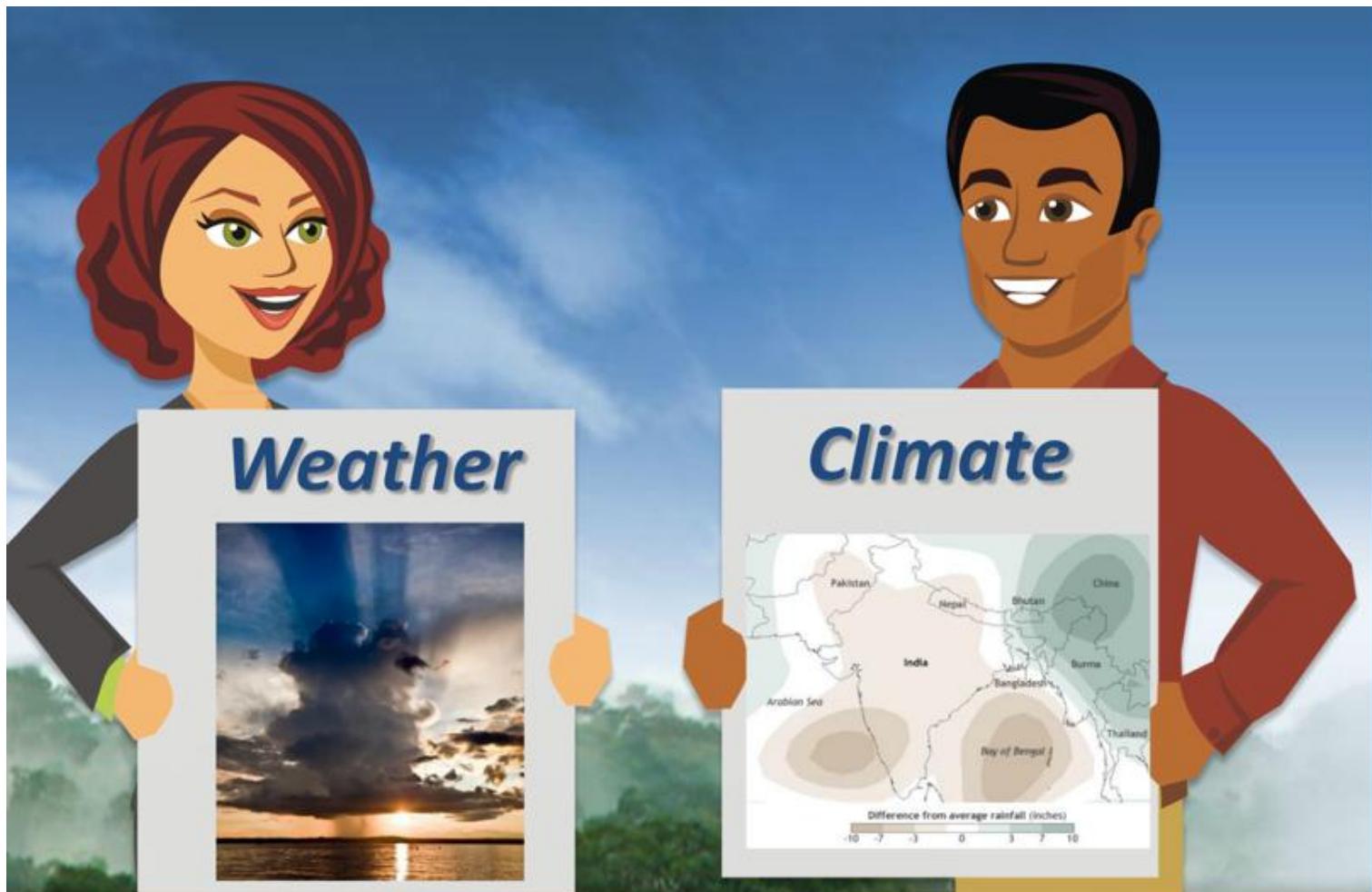
E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review





Weather and Climate Operate on Different Timescales

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



Image: NASA

Weather and climate are easily confused but they're not the same ... they operate on different timescales. **Weather describes how the atmosphere behaves over weeks or less. Climate describes the average behavior of weather over long timescales, typically 30 years or more.** So, climate refers to seasonal and longer periods, out to centuries and millennia.



Is it Weather or is it Climate?

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

In most places, weather can change from minute-to-minute, hour-to-hour, day-to-day, and season-to-season. Climate, however, is the average of weather over time and space. An easy way to remember the difference is that **climate is what you expect**, like a very hot summer, and **weather is what you get**, like a hot day with pop-up thunderstorms.



To see how climate has changed over time, explore NASA's Climate Time Machine.

[Link to the Climate Time Machine](#)



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Let's review our progress so far!



See if you can answer the following questions!



Review your Understanding! Question 1

Why is the atmosphere
warmest near Earth's surface?



- The surface absorbs sunlight.
- Clouds insulate the troposphere.
- Fires and volcanoes keep it warm.

What is your answer?



Answer to Question 1

- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Why is the atmosphere warmest near Earth's surface?



- The surface absorbs sunlight.
- Clouds insulate the troposphere.
- Fires and volcanoes keep it warm.

Were you correct? 😊



- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Review your Understanding! Question 2

What trace gas is most important in absorbing ultraviolet sunlight in the stratosphere?



- Water vapor
- Ozone
- Carbon dioxide

What is your answer?



- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Answer to Question 2

What trace gas is most important in absorbing ultraviolet sunlight in the stratosphere?



- Water vapor
- Ozone
- Carbon dioxide



Review your understanding! Quiz Question 3

- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Where are most clouds and aerosols found?



- Mesosphere
- Stratosphere
- Troposphere

What is your answer?



Answer to Quiz Question 3

- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Where are most clouds and aerosols found?



- Mesosphere
- Stratosphere
- Troposphere

Were you correct? 😊 If so, go to the next question!



- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Review your Understanding: Question 4

Which is It?



It's raining today.



Climate



Weather



- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Answer to Question 4

Which is It?

It's raining today.

Climate

Weather



Review your Understanding! Question 5

- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint**
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Which is It?



It's supposed to snow on Friday.

Climate

Weather

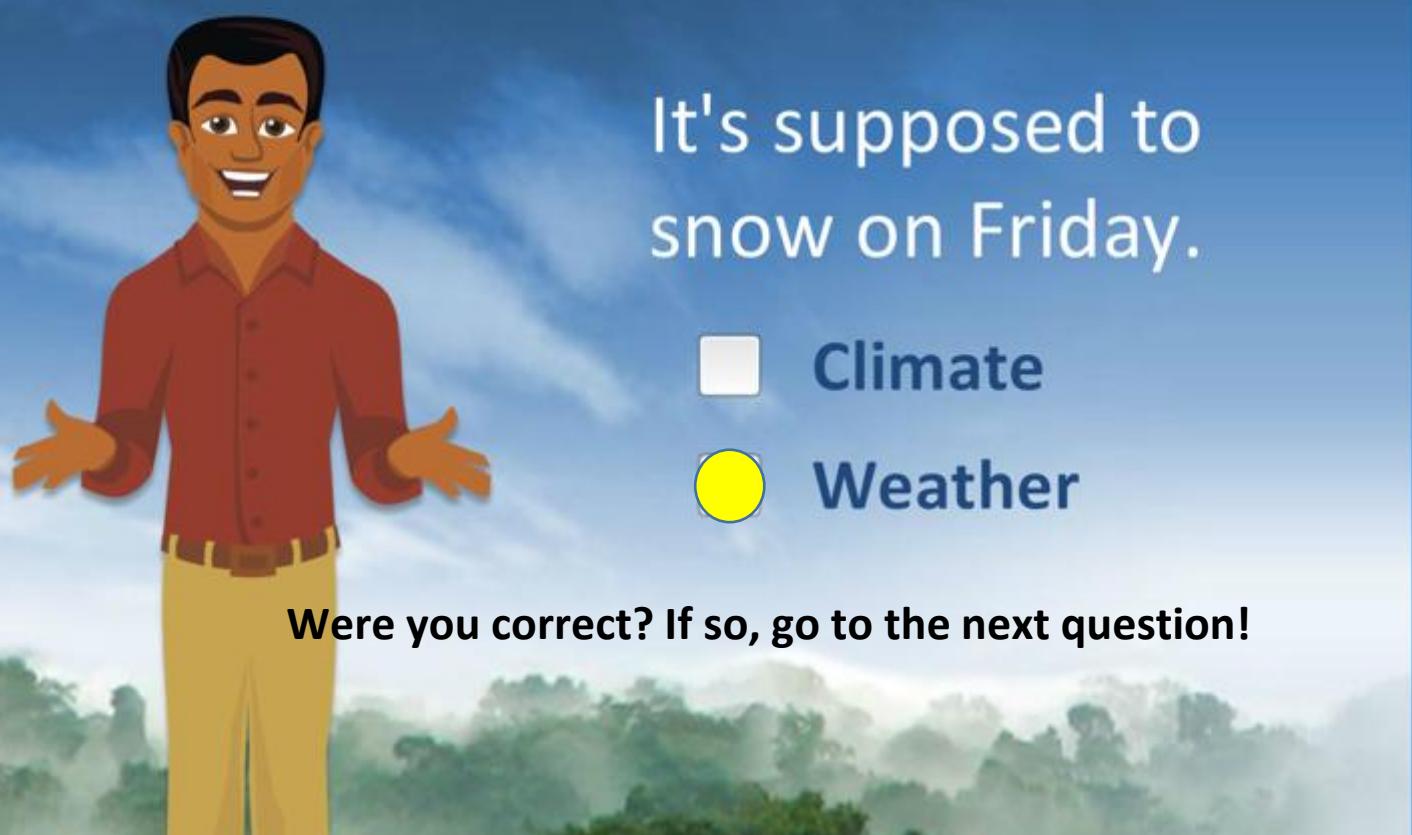
What is your answer?



- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Answer to Question 5

Which is It?



It's supposed to snow on Friday.

Climate

Weather

Were you correct? If so, go to the next question!

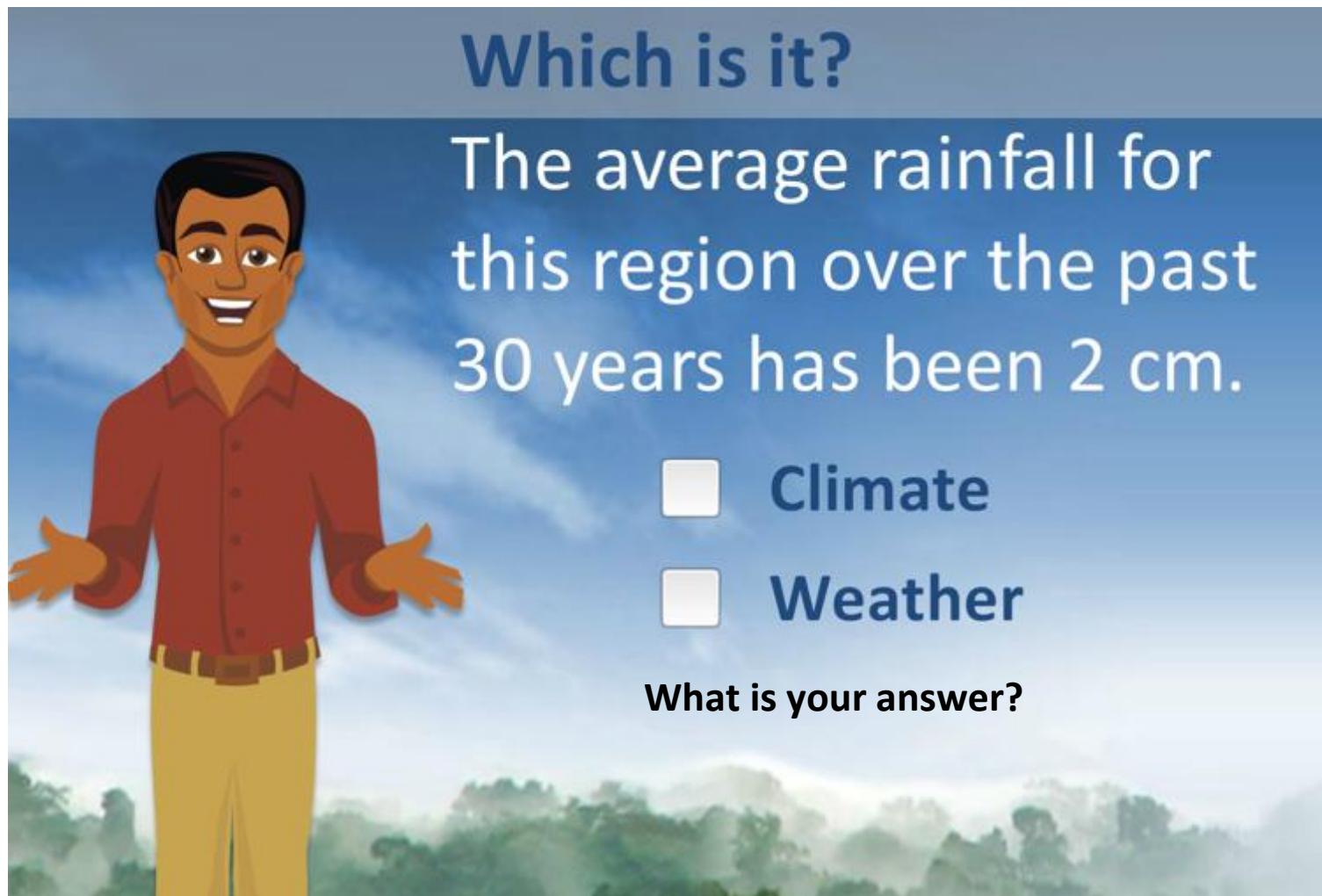


- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Review your Understanding! Question 6

Which is it?

The average rainfall for this region over the past 30 years has been 2 cm.



Climate

Weather

What is your answer?

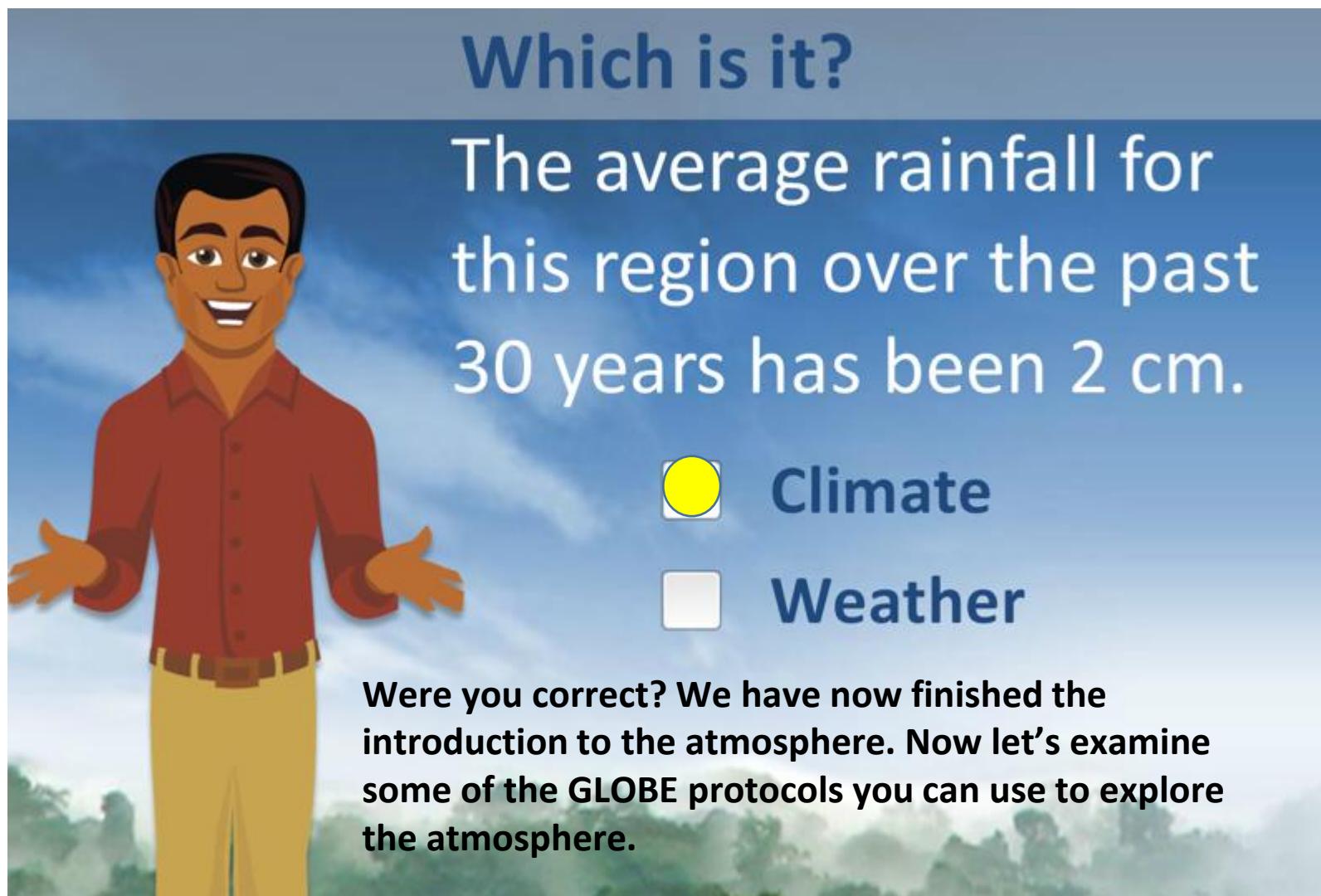


- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Answer to Question 6

Which is it?

The average rainfall for this region over the past 30 years has been 2 cm.



Climate

Weather

Were you correct? We have now finished the introduction to the atmosphere. Now let's examine some of the GLOBE protocols you can use to explore the atmosphere.



2. Overview of GLOBE Atmospheric Protocols

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Atmosphere Investigation
Site Definition Sheet

School Name: _____ Class or Group Name: _____

Name(s) of student(s) filling in Site Sheet: _____

Date: _____

Site name (give your site a unique name): _____

Location: Latitude: _____

Elevation: _____ meters

Source of Location Data (check all that apply):

Obstacles (Check one): (Obstacles are trees, buildings, etc.)

Description: _____

Buildings within 10 meters (describe below): _____

Description: _____

Other Site Data:

Steepest Slope: _____

Height of the top of the hill: _____

Height of the sensor: _____

Height of the clip in the air: _____

Surface Cover under 10 meters: Short grass (< 10 cm) Other (describe): _____

Description: _____

GPS Investigation
Data Sheet

Data Recorded By: _____

Date Recorded: Year: _____ Month: _____ Day: _____

Circle Site type: School Atmosphere Hydrology
Soil Land Cover Phenology
Other: _____

Site Name: _____

School Name: _____

School Address: _____

Do not begin recording data until your GPS receiver has "locked in." Wait at least one minute between recording each observation. Record the following data from the appropriate screens on your GPS unit.

OBS	Latitude Decimal Degrees (N/S)	Longitude Decimal Degrees (E/W)	Elevation Meters	Time H M S UTC	# Sats Satellites	Messages Circle if shown
1						2D 3D
2						2D 3D
3						2D 3D
4						2D 3D
5						2D 3D



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

If you are a teacher, here are some things you should know about GLOBE's Atmosphere Investigations

- **Grade Level:** Some measurements, such as cloud and contrail type can be conducted by all students, including those in the youngest grades. When combined with concepts such as parts per billion or relative humidity, these measurements are also very appropriate for older students.
- [Link to GLOBE Toolkit](#)



GLOBE Measurements and Their Instruments

GLOBE environmental measurements are in four study areas: Atmosphere, Biosphere (including Land Cover and Phenology), Hydrophere, and Soil (Pedosphere). The following table summarizes measurements, associated GLOBE protocols, instruments for data collection, skill level, and how to access listed equipment (purchase, build or download).

Measurement(s)	Protocol	Instrument(s)	Skill Level	Access
GPS Latitude, longitude, elevation	GPS Protocol	GPS receiver	All	Purchase
Atmosphere				
Aerosols	Aerosols Protocol	Sun photometer (digital instrument); Sun photometer for solar instrument	Middle, Secondary	Purchase or build
Air Temperature	Digital Multi-Day Maximum/Minimum Current Air and Soil Temperature Protocol	Digital multi-day maximum/minimum thermometer; calibration thermometer; soil thermometer; spacers, tape, and ruler	All	Build/make; spacers (can purchase or build or purchase); Build/make or purchase; instrument shelter; Purchase all others
	Maximum/Minimum Air Temperature Protocol	Maximum/minimum thermometer; calibration thermometer; instrument shelter	All	Build/make or purchase; instrument shelter; Purchase all others
Barometric Pressure	Barometric Pressure Protocol	Aneroid barometer or altimeter or digital barometer	All	Purchase
Cloud and contrail type	Cloud Protocols	Cloud chart, contrail chart	All	Download or purchase



Where to find out about the instruments you need

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Instrumentation: Some instruments are available on the GLOBE website, such as the Cloud Chart. Others you may already have, such as thermometers and meter sticks. There are instruments that can be made, such as instrument shelters for temperature measurements and snow boards. All instruments are available for purchase, including automated weather stations, that provide an optional way to collect atmosphere data.

To find the specifications for instruments you need, you can consult the GLOBE Toolkit.



Protocols

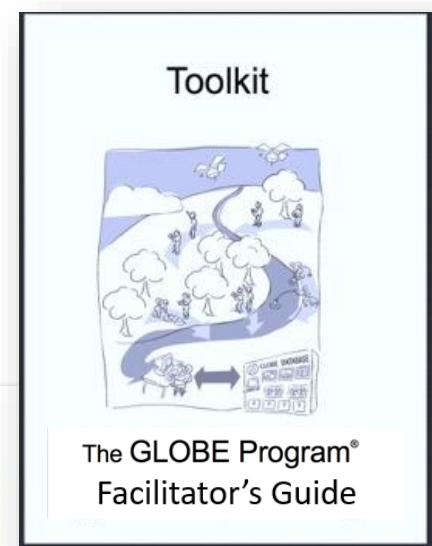
Selecting and Documenting Your Atmosphere Study Site
Instructions on how to select the best site for making atmospheric observations, setting up and documenting your atmosphere study site.

Instrument Construction: Instrument Shelter
Instructions for building an atmosphere instrument shelter.

Instrument Construction: Snowboard
Instructions for making a snowboard for measuring solid precipitation.

Instrument Construction: Surface Ozone
Instructions for making an ozone measurement station and wind direction instrument.

Cloud Protocols
Students estimate the amount of cloud and contrail cover, observe which types of clouds are visible, and count the number of each type of contrail.





A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

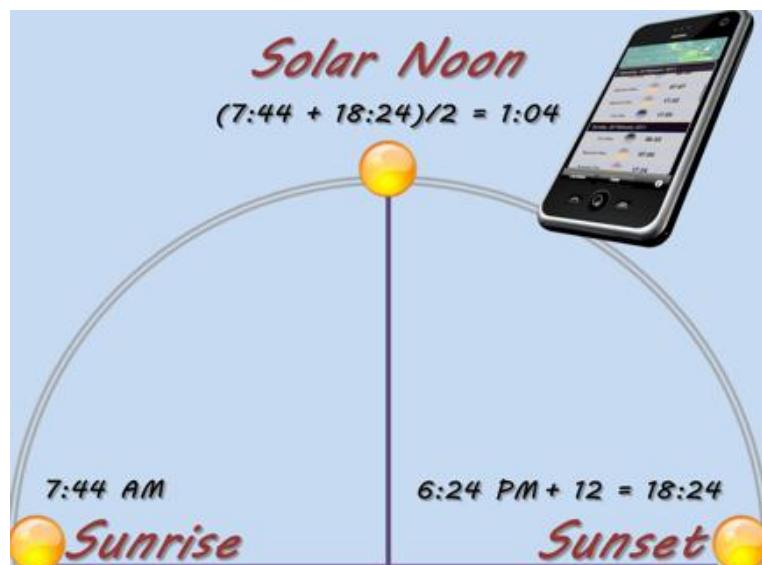
G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Many of your measurements should be taken at **local solar noon**

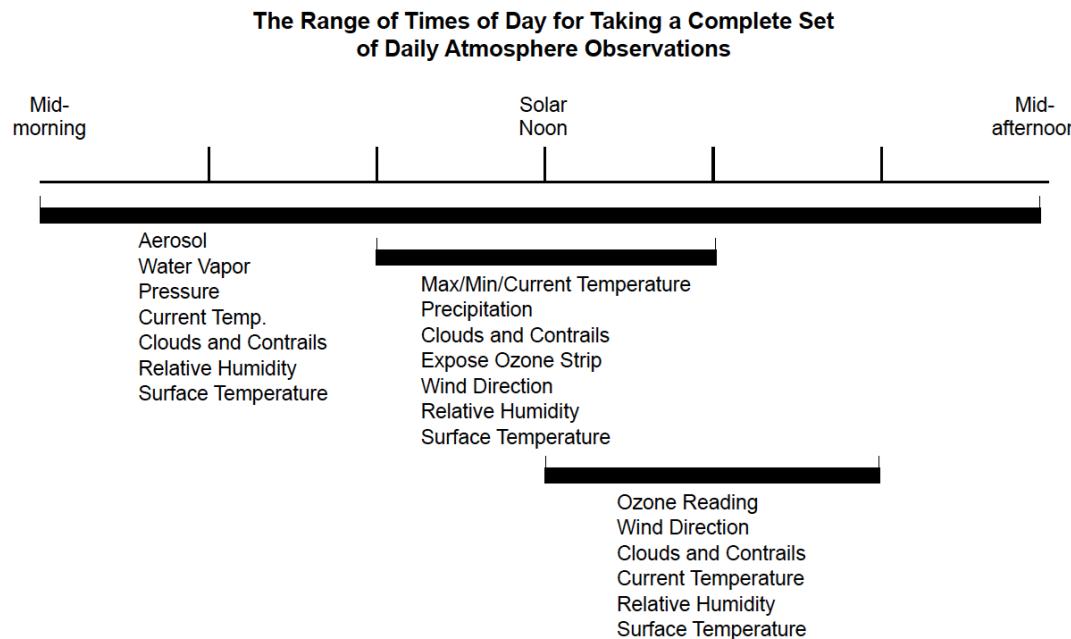
To ensure comparability of measurements worldwide, it's best to take your atmospheric measurements at your **local solar noon**. This time is usually not 12 pm on your local clock. You can look up the real time for local solar noon, or calculate it by finding the average time between the published sunrise and sunset for your area. You will report your time as UTC, or Coordinated Universal Time. This is calculated automatically for you when you input your data to GLOBE. *Note: if it is not possible to take your measurements at local solar noon, it is OK to take them at another time.*





- A. Overview**
 - B. What is the Atmosphere?**
 - C. Weather and Climate**
 - D. Progress Checkpoint**
 - E. Overview of GLOBE Atmospheric Protocols**
 - F. Quiz Yourself!**
 - G. How to Collect Your Data.**
 - H. How to Report Data to GLOBE.**
 - I. Further Resources and Review**

Most of the GLOBE atmosphere measurements should be taken during a two hour window surrounding your local solar noon, *if possible*.



Remember, you don't have to do all the measurements! You can select the measurements that fit with the times that work with your schedule.



Atmospheric Protocols: When to take your measurements, and how long you will need to take them

Time: Most of the measurements take just a few minutes and can be collected at about the same time every day, within a two-hour window, one hour before or after **local, solar noon** (*if possible, but OK to take measurements at another time*). However, other data can be taken at any time of day, such as clouds or relative humidity.

Which measurements you collect may be restricted due to the time available at the atmosphere study site.

Measurement	Taken within one hour of local solar noon	Other times measurements may be taken
Cloud Cover and Type Contrail Cover and Type	Yes	Required in support of aerosols, water vapor, surface temperature, ozone, and water transparency measurements; additional times are acceptable
Aerosols Water Vapor	Variable. Ideal time varies with location and season	When the sun is at least 30° above the horizon or at local solar noon when the sun doesn't reach 30° above the horizon; additional times are acceptable
Relative Humidity	Yes for the psychrometer; the digital hygrometer reading may be reported up to one hour later at the same time as the ozone measurement	Additional times are acceptable. Required in support of aerosols, water vapor, and ozone.
Precipitation	Yes	No
Current Temperature	Yes	Required for comparison with soil temperature measurements and in support of aerosols, water vapor, ozone, and relative humidity measurements; additional times are acceptable
Surface Temperature	Not required	Important for comparisons with soil and current temperature measurements
Maximum and Minimum Temperature	Yes	No
Barometric Pressure	Not required	Within one hour of aerosols and water vapor measurements if they are taken; otherwise as convenient
Ozone	The observation is started at this time and completed one hour later	Other one-hour periods are acceptable in addition to the near-noon measurement

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



Atmospheric Protocols: How long measurements take

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Most of the measurements take just a few minutes. Which measurements you collect may be restricted due to the time available at the atmosphere study site.

Measurement	Approximate Time required (in minutes)
Cloud and contrail cover and type	10
Aerosols including supporting measurements	15 - 30
Water Vapor including supporting measurements	15 - 30
Aerosols and water vapor combined including supporting measurements	20 - 40
Relative Humidity	5 - 10
Precipitation	5 - 10
Precipitation pH using meter including calibration	10
Handling of snow samples in the classroom for snow or snow pack water equivalent	5
Snow water equivalent once the snow has melted	5

1-day maximum, minimum, and current temperature	5
Multi-day max/min/current air and soil temperature	5 - 10
Surface temperature including supporting measurements	10 - 20
Ozone deploying the strip and taking supporting measurements	10
Ozone reading the strip and taking supporting measurements	10 - 15
Entire set of local solar noon measurements: clouds and contrails, relative humidity, precipitation amount and pH, max/min/current temperature, surface temperature, and deploying the ozone strip*	15 - 25



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of
GLOBE
Atmospheric
Protocols

F. Quiz
Yourself!

G. How to
Collect Your
Data.

H. How to
Report Data to
GLOBE.

I. Further
Resources
and Review



Atmospheric Pressure

Use either a barometer or an altimeter to measure atmospheric/barometric pressure.

Skill Level: All

Time Required 15-25 minutes



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



Clouds

Use a cloud and/or contrail chart or the GLOBE Observer app to identify types of clouds and contrails.

Skill Level: All

Time Required: 10 minutes



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

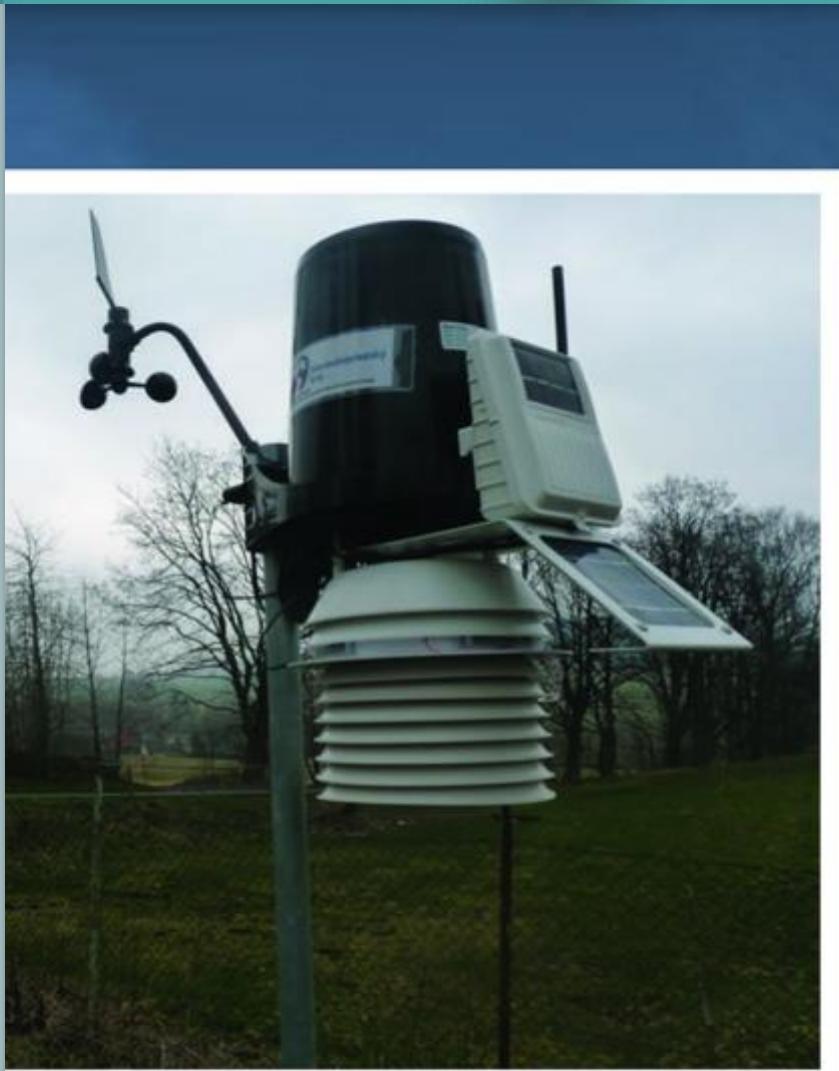
E. Overview of
GLOBE
Atmospheric
Protocols

F. Quiz
Yourself!

G. How to
Collect Your
Data.

H. How to
Report Data to
GLOBE.

I. Further
Resources
and Review



Automatic Weather Station

Collect various atmospheric measurements using an automatic weather station.

Skill Level: All

Time Required: 10 minutes





A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of
GLOBE
Atmospheric
Protocols

F. Quiz
Yourself!

G. How to
Collect Your
Data.

H. How to
Report Data to
GLOBE.

I. Further
Resources
and Review



Surface Temperature

Use a handheld infrared thermometer (IRT) to measure the temperature of the ground at nine widely-spaced places at the measurement site.

Skill Level: All

Time Required: 10-15 minutes



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of
GLOBE
Atmospheric
Protocols

F. Quiz
Yourself!

G. How to
Collect Your
Data.

H. How to
Report Data to
GLOBE.

I. Further
Resources
and Review



Air Temperature

Use a thermometer to measure minimum and maximum air temperature over a 24-hour period. The thermometer is housed in an instrument shelter.

Skill Level: All

Time required: 5 minutes



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



Aerosols

Use a sun photometer (and in some cases a voltmeter) to measure aerosol optical thickness.

Skill Level: Intermediate (Middle, Secondary grades)

Time Required: 15-30 minutes



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



Precipitation (Solid)

Use a snow board and a metric ruler to measure snowfall and snowpack. You can also measure pH.

Skill Level: All

Time Required: 10 minutes



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of
GLOBE
Atmospheric
Protocols

F. Quiz
Yourself!

G. How to
Collect Your
Data.

H. How to
Report Data to
GLOBE.

I. Further
Resources
and Review



Relative Humidity

Use either a sling psychrometer or a digital hygrometer to measure relative humidity.

Skill Level: All

Time Required: 5-10 minutes



- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols**
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review



Precipitation (Liquid)

Use a rain gauge to measure rainfall. You can also measure pH.

Skill Level: All

Time Required: 5-10 minutes



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

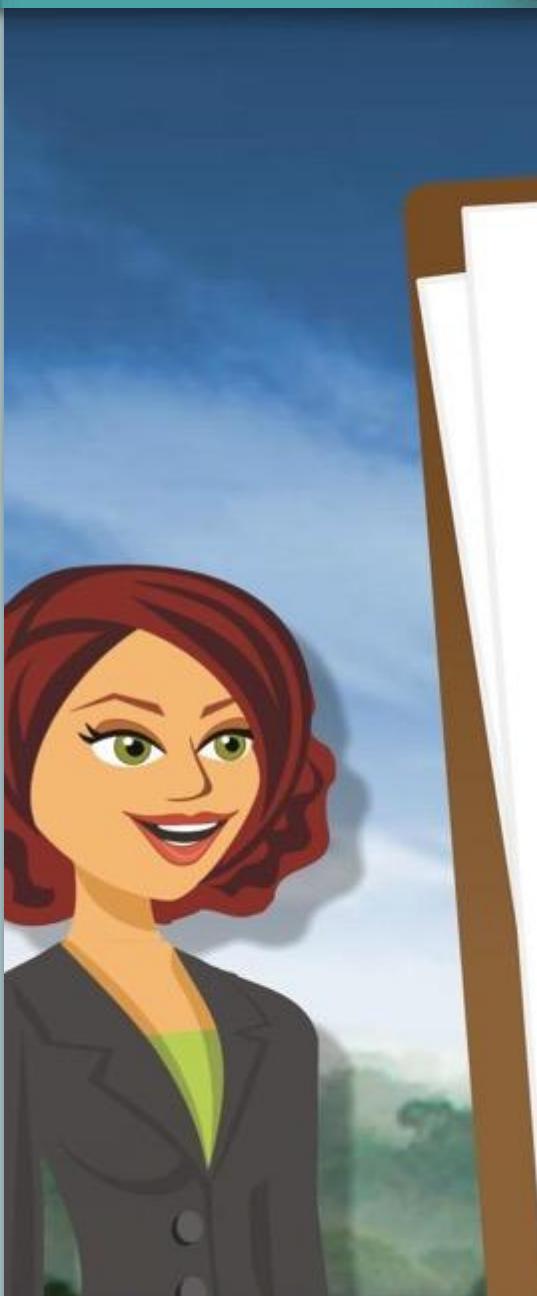
E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

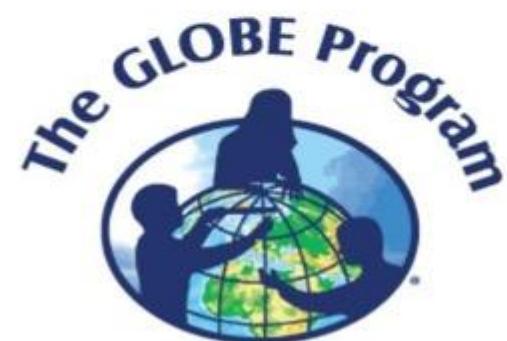


Review your Knowledge! Question 7

Which of the following protocols requires no purchased equipment?

- a. Aerosols
- b. Cloud
- c. Relative humidity
- d. Water vapor

What is your answer?





Answer to Quiz Question 7



Answer to Question 7

which of the following protocols requires no purchased equipment?

- a. Aerosols
- b. Cloud- ☺ correct!**
- c. Relative humidity
- d. Water vapor

Were you correct?





A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Review your Knowledge!

Question 8 (For educators)



Most Atmosphere Protocols can be conducted by student of all ages. Which is one of the protocols that may be more appropriate for older students?

- a. Precipitation
- b. Cloud
- c. Air Temperature
- d. Water vapor

What is your answer?





A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



Review your Knowledge! Question 9

Most of the GLOBE atmosphere measurements should be taken (*if possible*) during a two hour window around

- a. noon local time
- b. local solar noon
- c. dawn or sunset
- d. Noon UTC (coordinated universal time)

What is your answer?





- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

Answer to Quiz Question 9



Most of the GLOBE atmosphere measurements should be taken during a two hour window around

- a. noon local time
- b. local solar noon ☺ Correct!**
- c. dawn or sunset
- d. Noon UTC (coordinated universal time)

Were you correct?





3. Setting up your Atmosphere Study Site

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

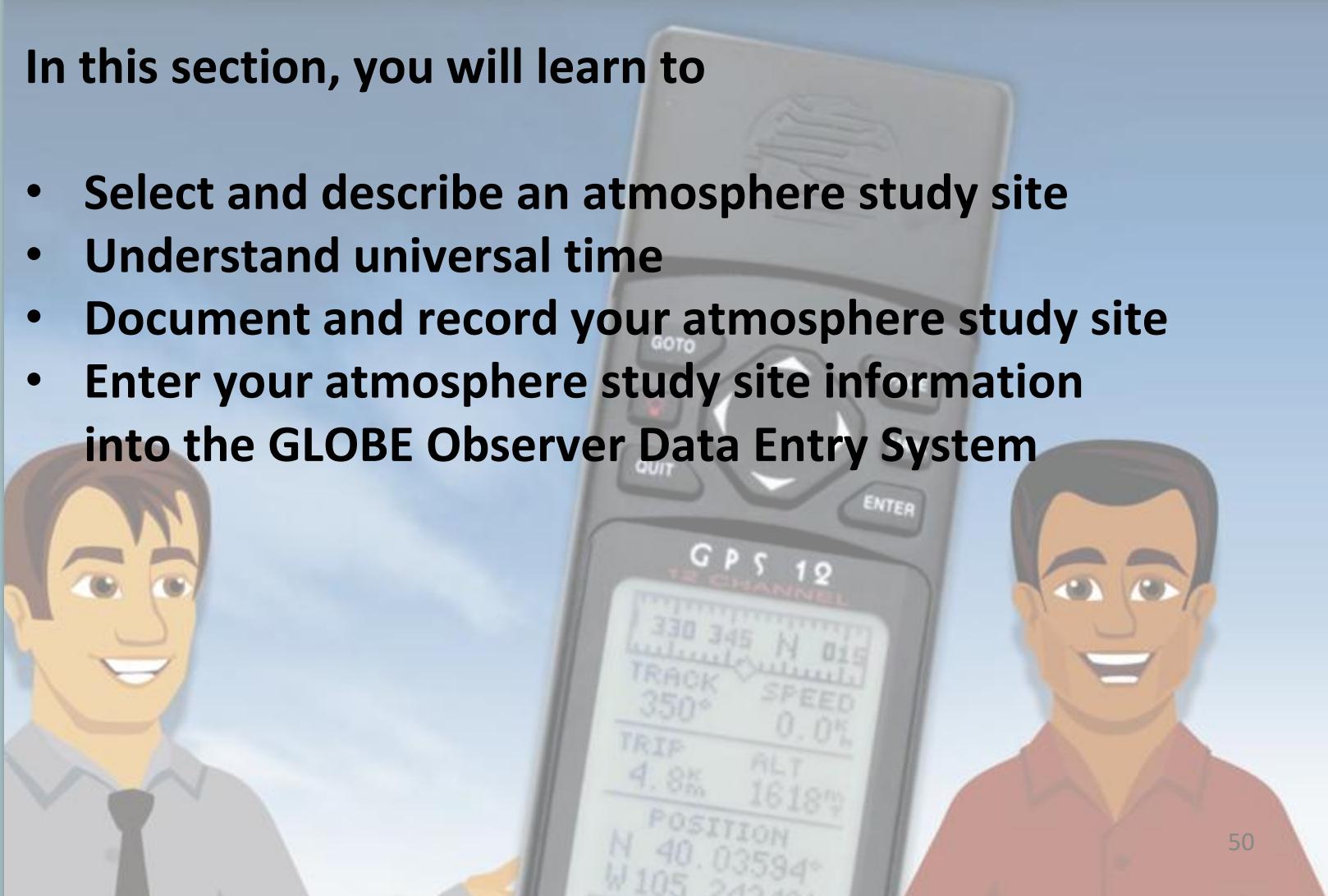
G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

In this section, you will learn to

- Select and describe an atmosphere study site
- Understand universal time
- Document and record your atmosphere study site
- Enter your atmosphere study site information into the GLOBE Observer Data Entry System





Documenting your Atmosphere Study Site

A. Overview**B. What is the Atmosphere?****C. Weather and Climate****D. Progress Checkpoint****E. Overview of GLOBE Atmospheric Protocols****F. Quiz Yourself!****G. How to Collect Your Data.****H. How to Report Data to GLOBE.****I. Further Resources and Review**

Let's go through the steps in the next slides...

Use a GPS

Evaluate your observing site and identify any obstacles to the sky

Ensure no building is within 10 m

Use compass to determine the slope

Site Definition Sheet * Required Field

School Name: _____ Site Name: _____
Choose a unique name based on location, e.g. "Grassy area - Front of School"

Names of students completing Site Definition Sheet: _____

Date: Year _____ Month _____ Day _____ Check one: New Site Metadata Update

*Coordinates: Latitude: _____ * N or S Longitude: _____ * E or W
Elevation: _____ meters

*Source of Location Data (check one): GPS Other _____

Comments: _____

Site Type (select all that apply based on intended measurements, then complete the necessary fields below): Atmosphere Surface Temperature Hydrology Land Cover
 Greening Soil Characteristics Soil Moisture and Temperature

Atmosphere
List any obstacles (Check one): No obstacles Obstacles (describe below)
(Obstacles are trees, buildings, etc. that appear above 14' elevation when viewed from the site)
Description: _____

Buildings within 10 meters of instrument shelter (Check one):
 No buildings Buildings (describe below)
Description: _____

Other Site Data:
Steepest Slope: _____ Compass Angle (facing up slope): _____
Rain Gauge Height _____ cm Ozone Clip Height _____ cm Thermometer Height _____ cm

*Thermometer Type (Check one):
 Other, Soil or Air
 Liquid-filled Max/Min (U-tube)
 Liquid-filled, Current Temperature Only
 Digital Single-Day Min/Max
 Digital Multi-Day Min/Max
 Reset Digital Multi-Day Min/Max Thermometer

Note: reset is required before data collection and entry, when batteries are changed or every 6 months.

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

Was this reset due to a battery change? Yes No

AWS WeatherBug Station (Automated Station ID _____)
 Davis Instrument (Davis Thermometer Type _____)
 Data Logger (HOBO)
 Rainwise
 WeatherHawk
 No Thermometer



Equipment you need to document your Atmosphere Study Site

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

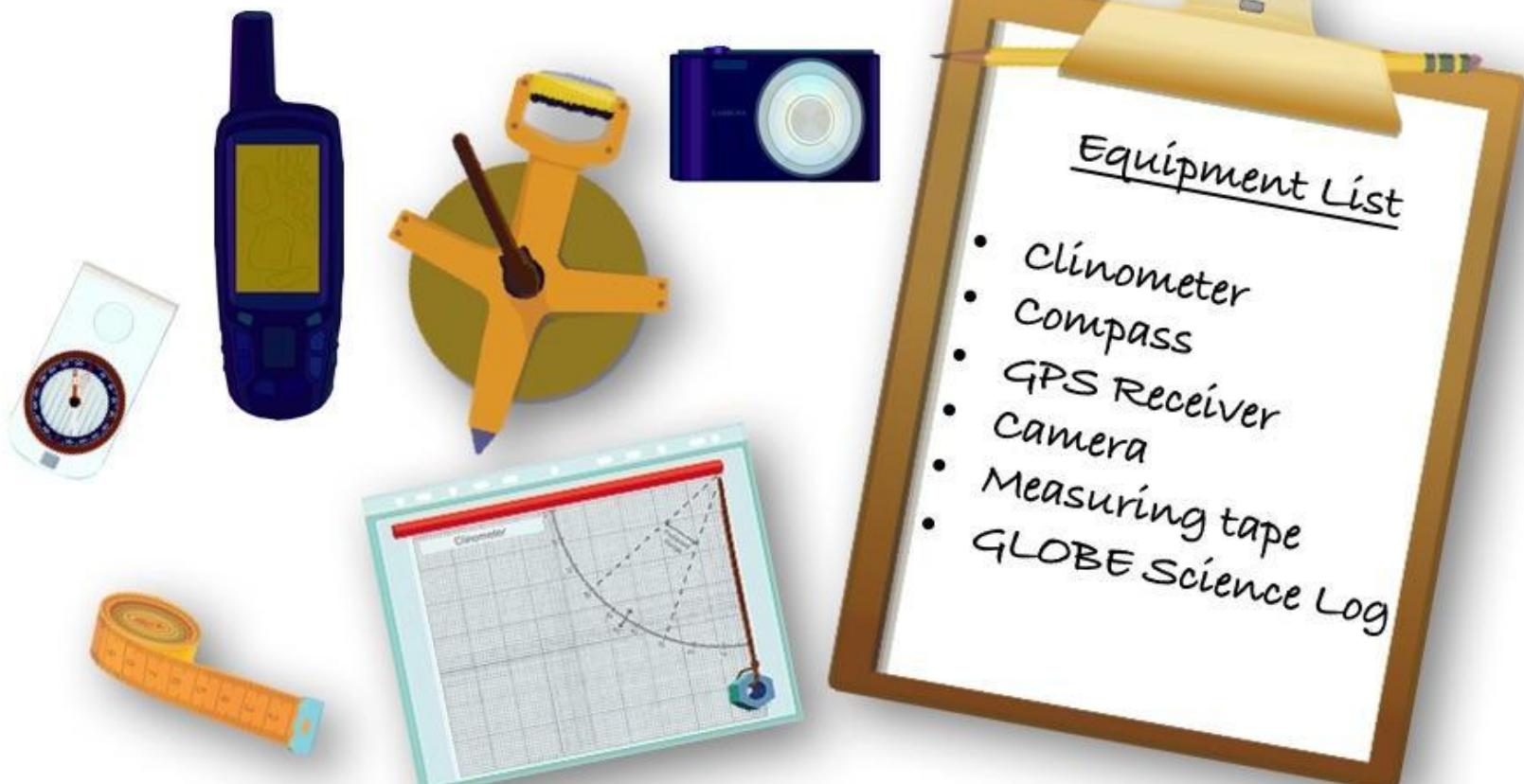
E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review





Where is a good place to locate the Atmosphere Study Site?

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

A location near you for quick and easy access.





- [A. Overview](#)
- [B. What is the Atmosphere?](#)
- [C. Weather and Climate](#)
- [D. Progress Checkpoint](#)
- [E. Overview of GLOBE Atmospheric Protocols](#)
- [F. Quiz Yourself!](#)
- [G. How to Collect Your Data.](#)
- [H. How to Report Data to GLOBE.](#)
- [I. Further Resources and Review](#)

An open grass-covered area is optimal.





- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

It is best to be in an open area away from buildings. An open area will prevent the blocking of precipitation.





Don't worry if you don't have the perfect sampling site

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review





Method to determine location if using a GPS Receiver

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review





The GLOBE Facilitator's Guide tells you how to use a compass and determine the slope

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Investigation Instruments: Compass

Using a Compass

A compass is useful for many applications. In the case of GLOBE field investigations the compass will be used to set up field sites that can be measured and returned to every year. In addition, a compass is used to help orientate soil temperature and moisture sites, ensure that the door to the Atmosphere Instrument Shelter is facing away from the Equator, and in noting direction on all site maps (e.g., Hydrosphere).

Investigating a Compass

1. Review the parts of the compass.
 - A. Base Plate
 - B. Housing and Degree Dial
 - C. Cardinal Direction Indicators (N, S, E, W)
 - D. Direction of Travel Arrow
 - E. Orienting Arrow
 - F. Magnetic Needle
2. Examine the degrees noted on the housing of your compass. Degrees are typically in increments of 2° or 5°.
3. Hold the compass flat in the palm of your hand with the direction of travel arrow pointed away from you.
4. Practice turning the housing.
5. The red part of the magnetic needle points toward Earth's magnetic north pole.
6. Move slowly around the area or in a circle; watch how the needle always points the same direction. If the needle doesn't always point in the same direction look around to see if there are any metal objects around (e.g., jacket zippers, keys, clipboards, field tools, desks, etc.).

Magnetic Declination

As you may know, there are two North Poles on Earth. Magnetic North – where the compass points – is an area of highly magnetic rock under central Canada. True North is geographically at the top of the Earth (90° N) – maps are based on True North. Declination is the angle between the two. The size and angle depends your location. Declination is important to navigating correctly and can also be important in orienting your sample site to satellite images. Compasses have either a mechanism to set the declination so it is accounted for in your compass reading or a scale to make the calculation yourself. (To find your local declination, see GPS Investigation: [Identify Magnetic Declination Map](#))

Note: it is extremely important to ensure that your compass is level when reading it. Make sure that the needle is not dragging or rubbing against the top or bottom of the needle capsule.

GLOBE® 2014
Investigation Instruments: Compass - 1
Biosphere

Welcome
Introduction
Protocols
Learning Activities
Appendix



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Entering Atmosphere Study Site Information in the GLOBE Observer Data Entry System

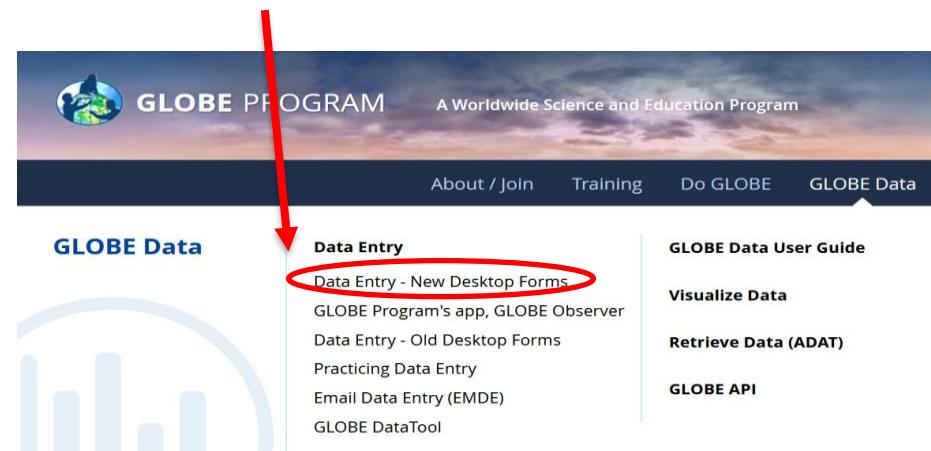
REMINDER: Complete the Atmosphere Section of the Site Definition Sheet before entering data in the GLOBE Observer Data Entry system. Remember to select a study site in an open area, away from obstacles (if possible).

Two Options for Uploading Data:

1a) Download the GLOBE Observer app from the [App Store](#).



1b) Data Entry: Visit [globe.gov](#), click on the “GLOBE Data” tab, then underneath “Data Entry” click on “Data Entry – New Desktop Forms”.





A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

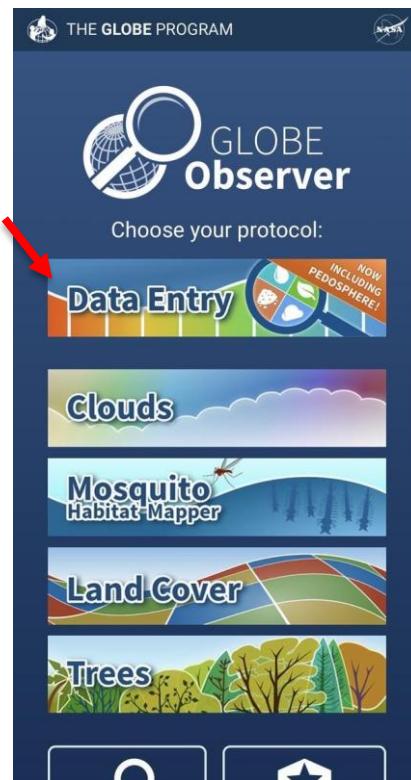
H. How to Report Data to GLOBE.

I. Further Resources and Review

Entering Atmosphere Study Site Information in the GLOBE Observer Data Entry System – Step 1 & 2

The steps below will walk you through entering your Atmosphere Study Site Information in the GLOBE Observer App, which you can access using your GLOBE or GLOBE Observer login.

1. Click "Data Entry"



2. Click "Create/Edit My Sites"





A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Entering Atmosphere Study Site Information in the GLOBE Observer Data Entry System – Step 3 & 4

The steps below will walk you through entering your Atmosphere Study Site Information in the GLOBE Observer App, which you can access using your GLOBE or GLOBE Observer login.

3. Choose a site from your list of existing sites or click "Add Site +" to enter a New Site name.



4. Enter any Site Specific Comments in the space below the map.

Site Location

New Site

Name: *

(use coordinates or move/zoom map)

Latitude:

Longitude:

Elevation: *

Use 2 fingers to move map



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

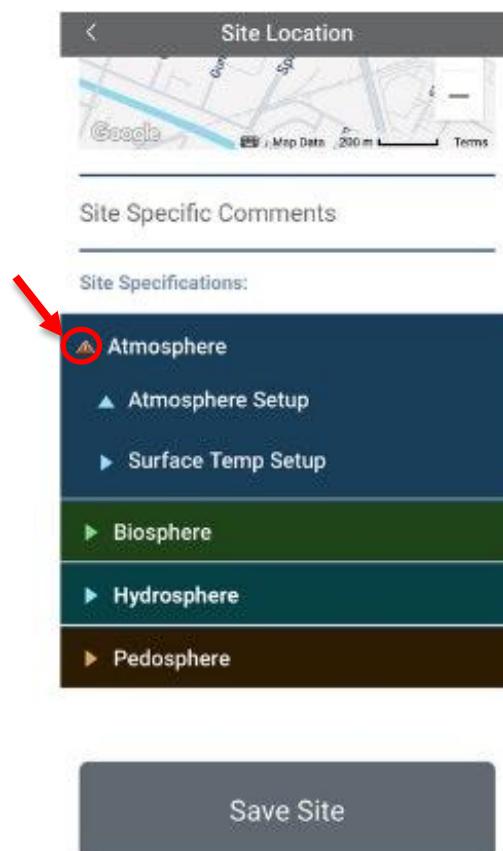
G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Entering Atmosphere Study Site Information in the GLOBE Observer Data Entry System – Step 5

5. Click on the arrow next to "Atmosphere" and select "Atmosphere Setup."





A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Entering Atmosphere Study Site Information in the GLOBE Observer Data Entry System – Step 6 & 7

6. Select the Thermometer Type from the dropdown list, enter the Thermometer Height (cm), and enter notes about Obstacles or Buildings nearby.

Site Specific Comments

Site Specifications:

Atmosphere

Atmosphere Setup

Thermometer Type:

Thermometer Height (cm):

Obstacles:

Buildings:

Other; Soil or Air

Liquid-Filled, Current Temp Only

Digital Single-Day Max/Min

Digital Multi-Day Max/Min

Earth Observation Station

7. Select the Surface Cover type from the dropdown list. Click "Save Site" at the bottom of the screen.

Thermometer Type: Liquid-Filled, Current Temp Only

Thermometer Height (cm):

Obstacles:

Buildings:

Surface Cover:

Surface Temp Setup

Biosphere

Artificial Turf

Asphalt

Concrete

Dry bare ground

Soil surface



NASA Campaigns and Missions

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

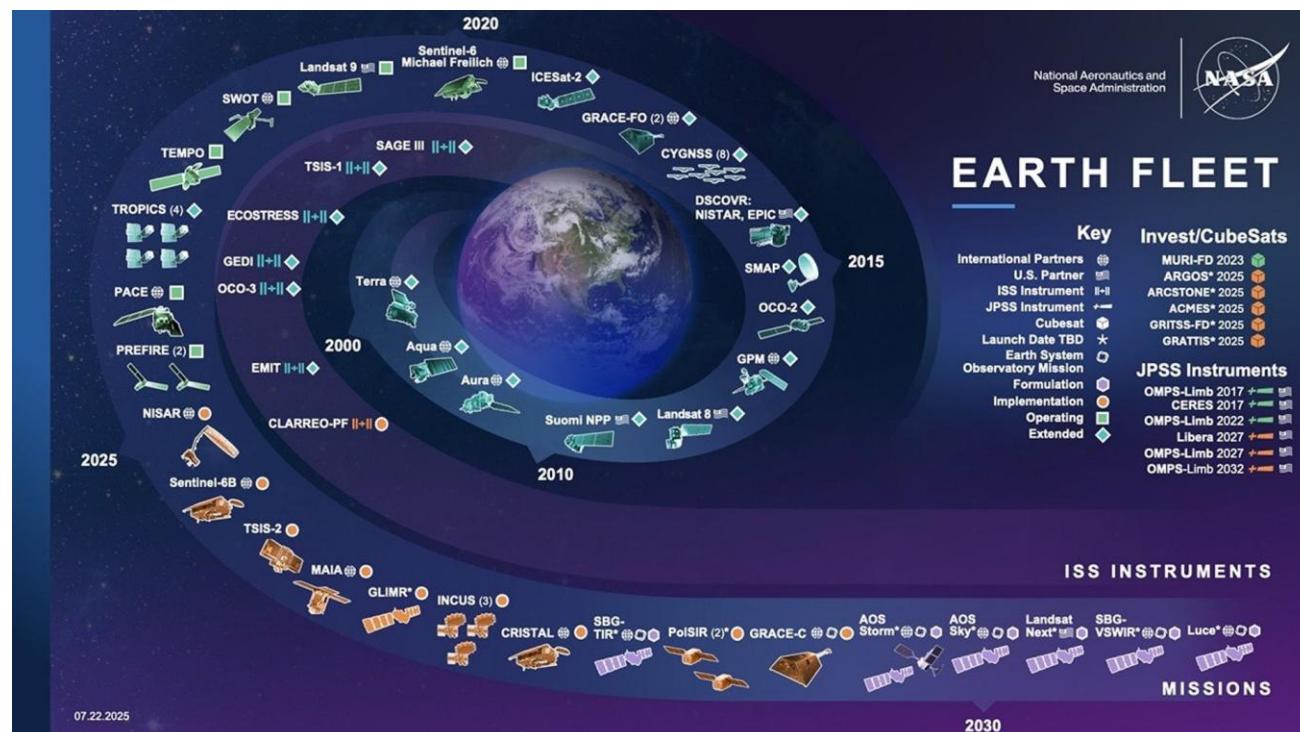
G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

NASA monitors Earth's vital signs from land, air and space with a fleet of satellites and ground-based observation campaigns.

One of the ground-based observation campaigns is GLOBE.



Learn more about NASA Earth Science Missions here:
<https://science.nasa.gov/earth-science/missions/>



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

These are some of the important ideas we have covered!



Important Concepts

- Mixture of gases in the atmosphere
- The four layers of the atmosphere
- Weather and climate
- GLOBE's Atmosphere Protocols
- Latitude, longitude, and elevation
- The location of an atmosphere study site
- Solar noon and Universal Time
- The GLOBE Atmosphere Site Definition Sheet.



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

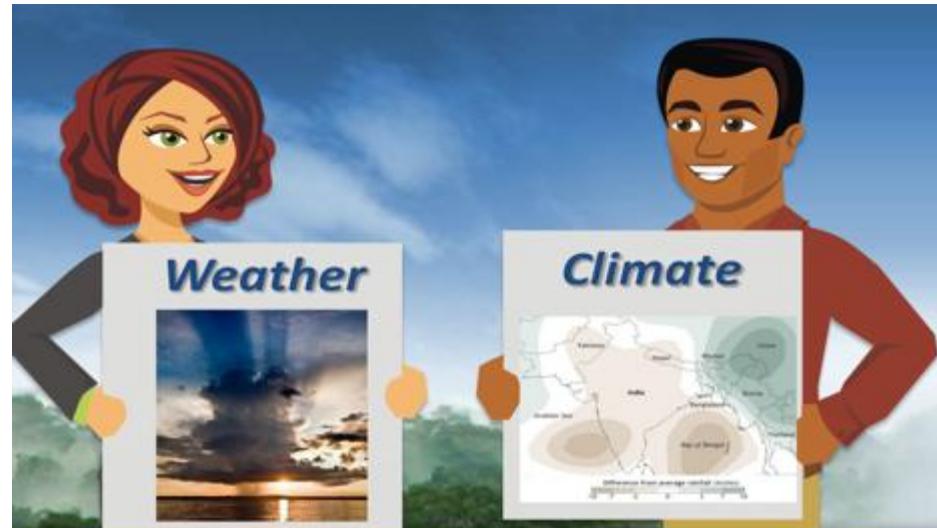
H. How to Report Data to GLOBE.

I. Further Resources and Review



Before you end this session, review your knowledge of these important concepts!

1. What is the difference between weather and climate?



(Find the Answer: slides 14-15)



Before you end this session, review your Knowledge of these important concepts!

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



(Find the Answer: Slides 4-8)



Before you end this session, review your knowledge of these important concepts!

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

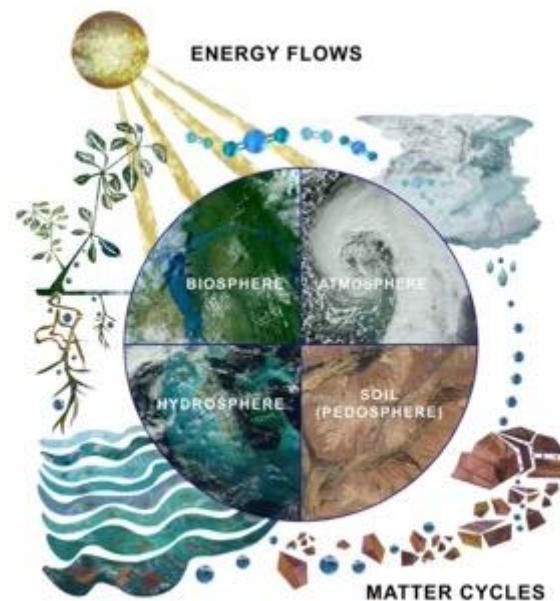
F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

3. What do we mean when we say that in the Earth system, “Everything is connected to everything else?”



(Find the Answer: Slides 10-13)



Before you end this session, review your knowledge of these important concepts!

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

4. What are some of the measurement protocols used in GLOBE Atmosphere investigation?



(Find the Answer: slides 36-46)



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review



Before you end this session, review your knowledge of these important concepts!

5. What should you consider when determining placement of an Atmosphere Study Site?



(Find the Answer: Slides 56-59)



Before you end this session, review your knowledge of these important concepts!

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

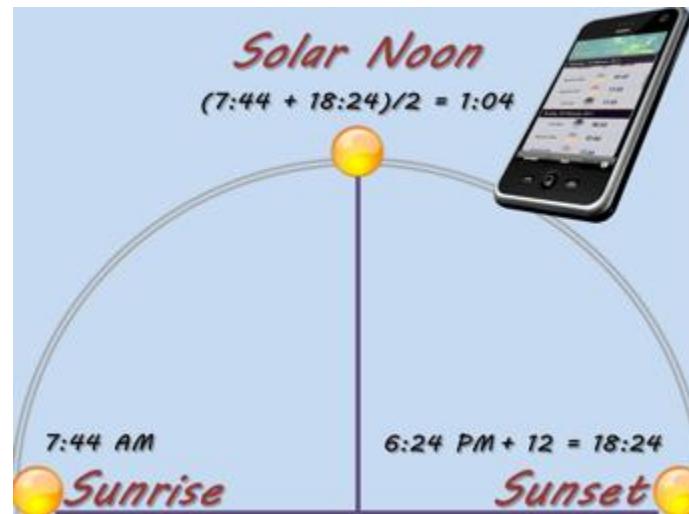
F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

6. When do you *preferably* take measurements?



(Find the Answer: Slides 32-33)



Before you end this session, review your knowledge of these important concepts!

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

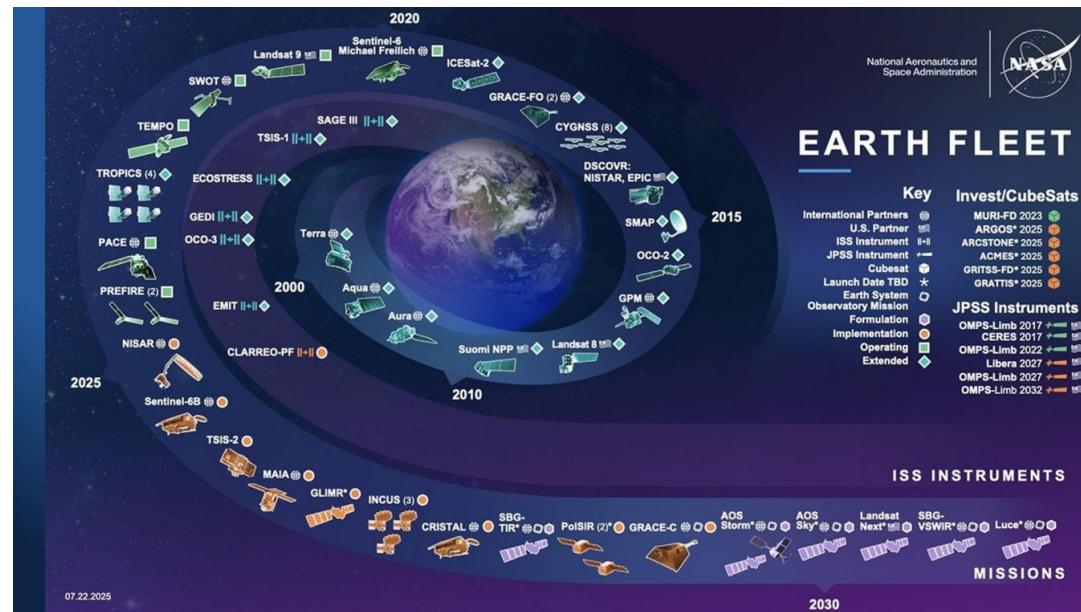
F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

7. What is the relationship between NASA satellite measurements and GLOBE?



(Find the Answer: slide 64)



Moving On...

A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

If you feel you are ready to take the Introduction to Atmosphere Quiz, you will see a link next to where you found this module.



Introduction to Atmosphere

This module provides an overview of the protocols of the GLOBE Atmosphere Investigation. It also explains how to find the best locations for an atmosphere study site and instrument shelter. After completing it, you will be prepared to learn any atmosphere measurement protocols.

Download Module

Assessment Test





Welcome to GLOBE's Atmosphere Investigations!

- A. Overview
- B. What is the Atmosphere?
- C. Weather and Climate
- D. Progress Checkpoint
- E. Overview of GLOBE Atmospheric Protocols
- F. Quiz Yourself!
- G. How to Collect Your Data.
- H. How to Report Data to GLOBE.
- I. Further Resources and Review

The GLOBE Program

G Global

L Learning and

O Observations

B to Benefit the

E Environment

Do you have Questions?
[Link to the GLOBE Program](#)



A. Overview

B. What is the Atmosphere?

C. Weather and Climate

D. Progress Checkpoint

E. Overview of GLOBE Atmospheric Protocols

F. Quiz Yourself!

G. How to Collect Your Data.

H. How to Report Data to GLOBE.

I. Further Resources and Review

Please provide us with feedback about this module. This is a community project and we welcome your comments, suggestions and edits! Comment here: [eTraining Feedback](#)

Questions about this module? Contact help@nasaglobe.org

For More Information:

[The GLOBE Program](#)

[NASA Wavelength](#) NASA's Digital Library of K-16 Earth and Space Educational Resources

[NASA Global Climate Change: Vital Signs of the Planet](#)

The GLOBE Program is sponsored by these organizations:



Version 11/12/25. If you edit and modify this slide set for use for educational purposes, please note "modified by (and your name and date)" on this page. Thank you.