GLOBE Educator One-Week Pacing Guide: Cloud Types Featuring NASA GLOBE CLOUD GAZE

Phenomenon: Cloud Types **Grade Level:** 3-8	**Guiding Question:** What are the different types of clouds in Earth's atmosphere?	**Contact:** Reach out to the NASA GLOBE Clouds Team if you have questions.
Further Investigation: NASA GLOBE Clouds main website and The GLOBE Program's main website		
Optional: Become a GLOBE Trained Teacher: GLOBE Clouds Protocol Training		
Access GLOBE Pacing Guides: https://www.globe.gov/web/nasa-langley-research-center/home/resources		
Revision Date: 2-24-2022		

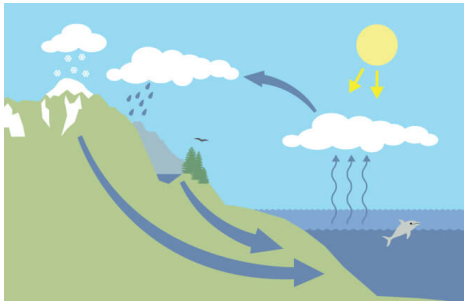
Standards - These standards are supported by the activities in this guide but not completely covered.		
Elementary	**Performance Expectations:** ● 3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. ● 3-ESS2-2 Obtain and combine information to describe climates in different regions of the world.	**Disciplinary Core Ideas:** ● ESS2D Weather and Climate
	Science and Engineering Practices: ● Analyzing and Interpreting Data ● Obtaining, Evaluating and Communicating Information	**Crosscutting Concept:** ● Patterns
Middle	**Performance Expectations:**	**Disciplinary Core Ideas:** ● ESS2.A Earth's Materials and systems

This work was supported by GLOBE Mission Earth, award No. NNX16AC54A, in collaboration with NASA Earth Science Education Collaborative.

	• MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives the process. • MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. • MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. • MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.	• ESS2.C The Roles of Water in Earth's Surface Processes • ESS2.D Weather and Climate
	Science and Engineering Practices: • Developing and Using Models • Planning and Carrying Out Investigations	**Crosscutting Concepts:** • Energy and Matter • Cause and Effect • Stability and Change • Systems and System Models

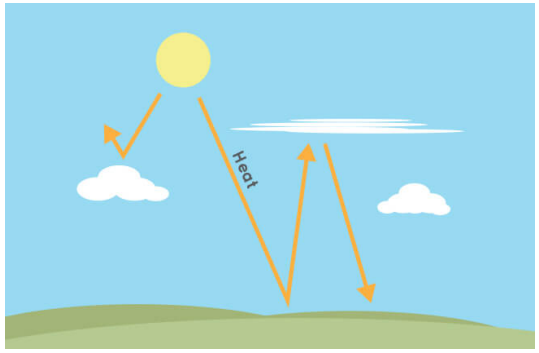
Background Information and NASA Connection

Clouds are a familiar part of our human environment. Clouds affect our daily plans, and even children pay attention to them from a young age because of the many shapes they can take. Clouds can change rapidly, and different types of clouds have different effects on local climates. Where lower, cumulus clouds tend to have a cooling effect on the Earth, cirrus clouds higher in the atmosphere warm the planet by reflecting more outgoing radiation back towards the ground. By observing clouds, we can get information about temperature, moisture, and wind conditions at different heights in the atmosphere. This information helps in predicting the weather.



Observations of clouds also help us know how much sunlight is reaching the ground and how easily heat from the ground and lower atmosphere can escape to space. Clouds play a central role in controlling the

exchange of heat in the atmosphere and changes in clouds over time can have significant climate impacts. To understand the impact of clouds over time, satellites observe the planet's clouds and energy from space. Data from multiple research and weather satellites have made and continue to make significant contributions to our understanding of clouds.



Specific cloud types can indicate a trend in the weather. Which types of clouds you see often depends on the weather conditions you are experiencing or will soon experience. Some clouds form only in fair weather, while others bring showers or thunderstorms. Clouds play a complex role in climate. They are the source of precipitation, affect the amount of energy from the Sun that reaches Earth's surface, and insulate Earth's surface and lower atmosphere.

While the satellites deployed by NASA and worldwide space agencies give us a big picture of climatic cloud effects, they struggle at times to provide a detailed analysis of what's happening in specific locations. That's why it's so crucial for researchers to have ground truth data gathered from the Earth's surface.

The GLOBE Program is NASA's largest and longest lasting citizen science program about the Earth. When you use the program's GLOBE Observer app, you can submit cloud reports and photographs of clouds and sky. After you submit your observations, the NASA GLOBE Clouds team at NASA Langley Research Center compares your observations with satellite data to determine key areas for further investigation. The results of these investigations are then sent to you via a NASA personalized email.

Your observations are very important because they provide scientists with a fuller perspective on how cloud cover affects our climate. Additionally, when you submit frequent observations over time, your data provides NASA with greater detail on how our climate is changing.

Sky photographs are one of the most requested portions of a GLOBE Clouds observation. This is because there is so much you can do with them. Photographs give scientists the opportunity to be right there with you. Details within a photograph can be used to compare with satellite data, confirm dust or haze observations, and give insight to unique cloud types like lenticular and noctilucent clouds over the polar regions.

GLOBE Educator One-Week Pacing Guide: Cloud Types Featuring NASA GLOBE CLOUD GAZE

<table>
<tr><th colspan="2">Activities</th><th>Assessment Options</th></tr>
<tr><td colspan="2">Day 1: Cloud Impacts of Earth’s Energy Budget

● Watch GLOBE Observer Cloud Science video with NASA scientist Jessica Taylor or Clouds and Earth’s Climate with Dr. Patrick Taylor.
● Walk through the My NASA Data Cloud Sort and complete the online activity. This can be done on computers or projected on an interactive white board.

Materials: online activity; links to video and activity.</td><td> 
</td><td>Formative Assessment: Completed cloud sort activity.

Connection to guiding question:
What are the three main cloud types?
Answer: cumulus, stratus, cirrus

Resources:
Clouds Effects On Earth’s Radiation Graphic
The GLOBE Program’s Cloud Chart</td></tr>
<tr><td colspan="2" rowspan="2">Day 2: NASA GLOBE CLOUD GAZE

● Go to NASA GLOBE CLOUD GAZE website.
● Scroll down the main page and select “Cloud Cover” under the “Get Started” section.
● As a group, discuss and select the total cloud cover option that best describes the photographs.
● Go back to the main page and select “What Do You See” under the “Get Started” section.
● As a group, discuss and select the cloud types you observe in the photographs.

Materials: online activity; link to Zooniverse project.</td><td rowspan="2"> 
</td><td>Student answers can not be assessed. They will identify cloud types and/or total cloud cover. Monitor for active participation.

Connection to guiding question:
How can you tell the different types of clouds apart from each other?
Answer: Cumulus-type clouds are all puffy, stratus-type clouds are all flat, and cirrus-type clouds are all thin or wispy.</td></tr>
<tr><td>Optional: Have students go to the NASA GLOBE CLOUD GAZE on their devices and make cloud cover and cloud type identifications on their own or in pairs.</td></tr>
</table>

GLOBE Educator One-Week Pacing Guide: Cloud Types Featuring NASA GLOBE CLOUD GAZE

<table>
<tr><th colspan="2">Activities</th><th>Assessment Options</th></tr>
<tr><td colspan="2">Day 3: Observe Clouds

Students use the GLOBE Observer App or GLOBE Clouds Data Sheet to record sky observations. If they use the GLOBE Clouds Data Sheet, remember to enter the data.

Materials: Recommendations found in Figure 3 of NSTA paper Making Science Come Alive with Clouds.

Only make observations if you can do so safely and legally.</td><td>  </td><td>Within groups, develop consensus on observations using evidence.

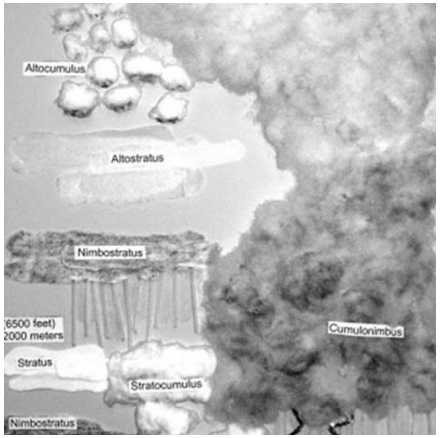
Submit observations.

Connection to guiding question:
Discuss the cloud observations based on the three main cloud types.

Optional Instructional Video: How to use the GLOBE Observer Clouds Tool</td></tr>
<tr><td colspan="2">Day 4: Choose one of the two activities below.

1. Create a cloudscape and properly identify the altitude of the different cloud types.
a. Original activity Cloudscape (Elementary/Middle)
b. Alternate tactile version of the activity Touching the Clouds: Activity Guide (globe.gov) (Middle/High)

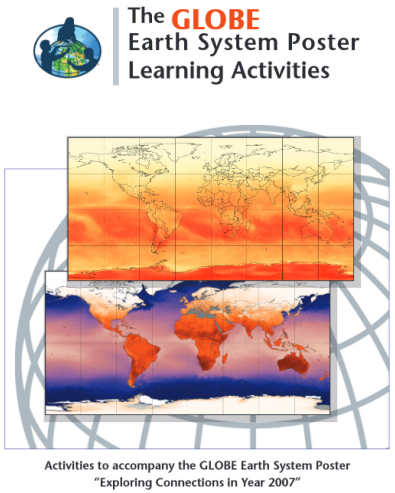
2. Make a Cloud in a Bottle as demonstrated in the video. (All grade levels)

Materials: material list found within activities.</td><td>  </td><td>1. Review the shape and altitude of different cloud types.
2. Discuss the texture of different cloud types and the relationship with their names and altitudes.
OR
3. Review ingredients necessary to create a cloud.

Connection to guiding question:
What information does a cloud name give you?
Answer: The name of a cloud gives you the altitude (low, mid, high) and how they look (puffy = cumulus, flat = stratus, wispy = cirrus).

Connection to guiding question:
Do clouds have water vapor in them? Answer: No, clouds are made up of water droplets or ice crystals. Some clouds are a mix of water droplets and ice crystals.</td></tr>
</table>

GLOBE Educator One-Week Pacing Guide: Cloud Types Featuring NASA GLOBE CLOUD GAZE

Activities		Assessment Options
Day 5: Earth system poster cards Use the digital Earth System Cards for the following variables: cloud cover and precipitation. Start by looking at just cloud cover data. Compare the first two months presented in the slides (January 2019 and May 2019). Note that the whiter the map, the more cloud cover there is in that region. 1. Look in the region you are located in and compare the values between the two months. 2. Discuss how the values compare with the observations taken in Day 3. 3. Choosing one month, look for regions that have no cloud cover. Discuss similarities and differences with this and your region. 4. Repeat steps 1-3 and do the same with precipitation. 5. Discuss the following question: *Do regions with the most cloud cover have the most precipitation?* **Materials:** online; link to activity and cards. ***Optional***: Use other variables available.		Use the guiding questions suggested within the "GLOBE Digital Earth System Poster: Implementing the NGSS" for different grade levels. You may find the implementation suggestions under "Document Resources" at the bottom of the page. Exit tickets or Claim Evidence Reasoning statements can be used for assessment. ***Connection to guiding question:*** *Why is it important to study clouds?* ***Answer****: Clouds play a complex role in climate. They are the source of precipitation, affect the amount of energy from the Sun that reaches Earth's surface, and insulate Earth's surface and lower atmosphere.* ***Connection to NASA:*** *Why does NASA study clouds?* ***Answer:*** *Clouds have an impact on weather and climate. Different cloud types have different effects on weather and Earth's energy budget.*

Activities		Assessment Options
Day 5: Earth system poster cards Continued		***Extension:*** *Project the NASA GLOBE Clouds Satellite Match Table received from making cloud observations on Day 3. Point out which satellite(s) matched the observation. Discuss if total cloud cover observed matches the total cloud cover reported by satellite(s).* ***Resource****: The Science of Clouds Video: How to Read Your Satellite Matches? explains how to read the satellite match table and highlights situations when observations might not match.*

GLOBE Educator One-Week Pacing Guide: Cloud Types Featuring NASA GLOBE CLOUD GAZE

Additional Resources		
Online Activities	Audience	Description
Interactive Weather Observations	Elementary Daily observations	Students track weather over time and create an online bar chart to track their data. English and Spanish versions of the interactive slides are now available.
Modeling Cloud Cover	Upper Elementary through High School	Using the Interactive Google Slides, select a percentage as a multiple of 10% (or fraction) of cloud cover to approximate and estimate percent cloud cover of a particular area.
Hands-On Activities	Audience	Description
Elementary GLOBE Clouds Module	Elementary Storybook	This module includes a story book on cloud types, activities, and coloring sheets. The book is available as a PDF and eBook. Students will be able to classify clouds based on their shape, determine what kind of weather is associated with each cloud, and identify the three different types of contrails.
Estimating Cloud Cover	Upper Elementary through High School Individual, group and large group settings	Students use construction paper to simulate cloud cover. They estimate the percentage of cloud cover represented by torn pieces of paper on a contrasting background and assign a cloud cover classification to the simulations created by their classmates.
Weather Adds up to Climate	Elementary Multi-day classroom activity	This activity consists of five parts that occur over the course of a school year. In Part 1 of this activity, students are introduced to different ways to describe weather. In Part 2, students record weather observations each day in bar graphs made out of interlocking plastic cubes. In Part 3, at the end of each month, students summarize the information in bar graphs. In Part 4, at the end of the school year, students use the data they collected to describe the patterns of weather through the year. In Part 5, students compare regions with different patterns of weather (climate).

Additional Resources (continued)		
Videos and Reading	Audience	Description
Science of Clouds Videos	Ages 9-adult	Join different NASA scientists and learn how to look at clouds with a new perspective. Follow along with a GLOBE educator on how to do a cloud related activity. Topics include: *what is citizen science?, How to read your satellite matches?, Your Cloud observations in Research, Clouds & Weather, Clouds & Earth's Climate,* and *Clouds & Aerosols.*
EOKids From School to NASA Earth Scientist	Ages 9-14	NASA EO (Earth Observatory) Kids is written for audiences aged 9 to 14. In this issue, find out what three NASA scientists wanted to be when they were young and discover what they do now. Then, be a scientist yourself! Learn how to use the GLOBE Observer app to collect your own scientific observations.
EO Kids Clouds or Snow	Ages 9-14	NASA EO (Earth Observatory) Kids is written for audiences aged 9 to 14. In this issue, EO Kids is investigating how similar snow and clouds look from space. Discover how satellites measure light to help scientists know which is which.

This work was supported by GLOBE Mission Earth, award No. NNX16AC54A, in collaboration with NASA Earth Science Education Collaborative.