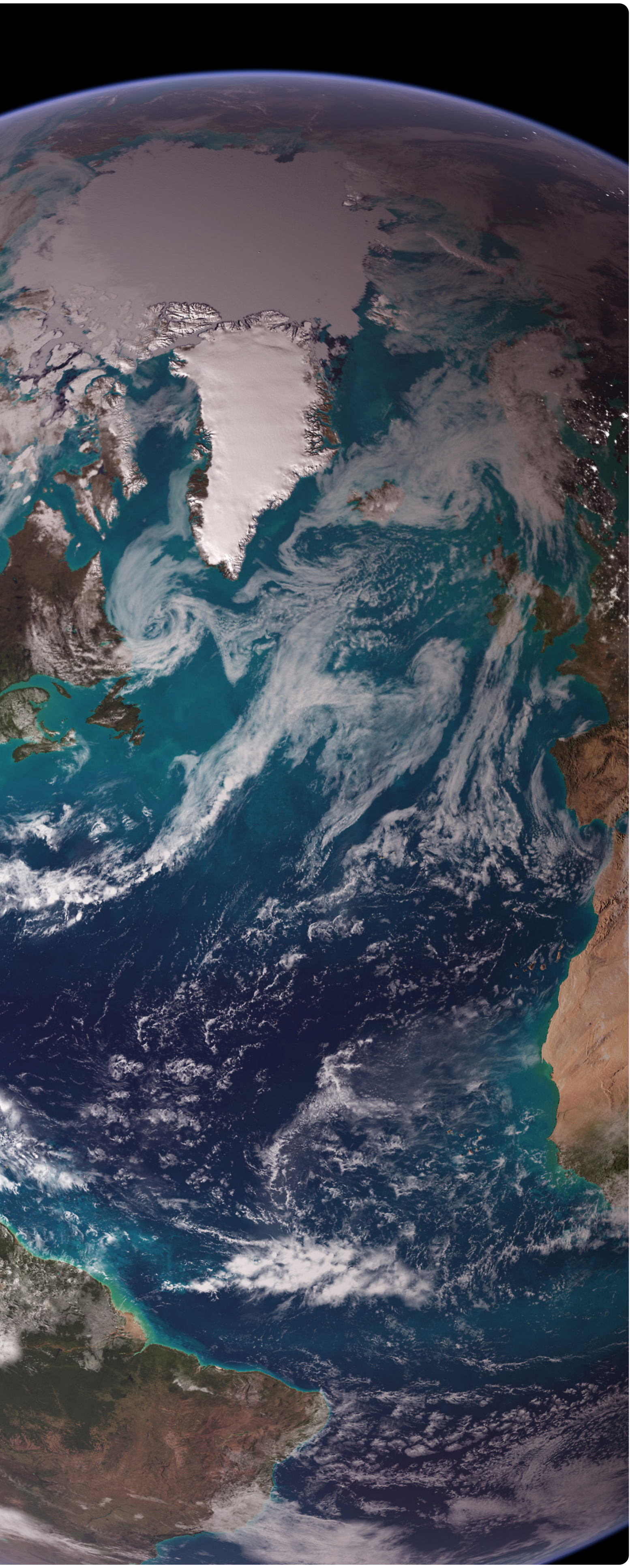
National Aeronautics and Space Administration

There's No Place Like Home

EARTH OBSERVATION CAMP EXPERIENCE

NASA Office of STEM Engagement Next Gen STEM

Featuring activities from the GLOBE Program



Welcome Earth Observers!

NASA Science is critical for understanding our home planet Earth. This set of hands-on activities, geared toward students in grades 3-5, introduces Earth observation, Earth science processes, and Earth's connection to the Sun. Intended for use in informal education settings such as after school programs, summer camps, STEM nights, and weekend workshops, this Earth Observation Camp Experience can also be easily adapted for use in formal settings, and will bring the excitement of NASA's Earth science and research missions to the next generation of explorers. While NASA is looking to the Moon and beyond with the future Artemis missions, the agency is also doing very important work in learning more about our own home planet – from studying surface water and land use to air quality and agriculture! Several of the activities in this guide are adapted from Elementary GLOBE. If you are interested in additional Earth Science activities and educator training, be sure to visit **The GLOBE program**.

Connections to the International Space Station

Throughout this guide, you will find connections to the role of the International Space Station in the study of Earth and its climate. Orbiting 250 miles above Earth, the station hosts a comprehensive suite of Earth-observing tools to enhance our understanding of our home planet. These tools include instruments mounted on the exterior of several of the station's modules and Earth-observing CubeSats regularly deployed from the station to study Earth's climate.

Visit **How Scientists Are Using the ISS to Study Earth** to learn more.

CAMP OVERVIEW

NASA is exploring Earth now more than ever! NASA's Earth System Observatory provides data on climate change, severe weather and other natural hazards, wildfires, and global food production. Developing programs for Earth-focused missions is the responsibility of NASA's Science Mission Directorate (SMD) Earth Science Division. These programs help us understand our planet's interconnected systems, from a global scale down to the smallest processes, and scientists from all over the world can use this data to learn more about the globe and their own communities. The activities in this guide highlight several key Earth Science focus areas, including aerosols and water quality, and allow participants to consider the connections between local observations and Earth science observation from air and space.

The activities open with an opportunity for discussion around why and how NASA observes Earth Systems with a brief video and icebreaker. The first activity, adapted from the Elementary GLOBE sundial resource, builds learner confidence in constructing local sensors and monitoring data over time. While practicing observation and environmental data acquisition skills, learners make connections to the Participants construct a sundial and use it to observe and record the movement of the Sun through the sky over the course of a day. They will revisit the site on a subsequent day to use their sundial and estimate the time of day.

The second activity allows participants to learn about air pollution and particulate matter. Since air pollution is caused by solid and liquid particles and certain gases that are suspended in the air, it can be difficult to see what is floating around. NASA uses satellites orbiting Earth and airborne remote sensing instruments to keep an eye on air pollution. Air quality forecasters use information about aerosols from a suite of NASA satellites, providing important health-related information to community members. The second investigation directs participants to work in groups to construct a simple adhesive aerosol sensor to observe airborne particles, collect data, and estimate the extent of aerosols present in their surrounding outdoor and indoor environments.

The third activity in this guide focuses on water resources, with a particular focus on availability of clean water. NASA Earth Science Missions, like the **Surface Water and Ocean Topography (SWOT) mission,** will collect measurements from space that will help communities monitor and plan for changing water resources as well as the effects of sea level rise. The camp guide activity allows participants to graph data on Earth's global water supply and discuss the implications of the finite amount of consumable freshwater resources available to humans. Participants will observe macroinvertebrates from local freshwater resources as an indicator of water quality, making connections to their role as global stewards in protecting Earth's water sources.

The fourth activity invites participants to develop an "aerial" map of environmental data to inform local solutions. Participants will discover how NASA uses instruments aboard numerous satellites to learn more about our ever-changing planet and how our planet's systems work together. Using the data these satellites provide, scientists are able to make more informed decisions on the current and future state of our planet. In this final activity, participants will work in teams to collect data about an environmental issue that is affecting their local area, such as a nearby schoolyard or park. The teams will then compile their data into a single map of the area to visualize the environmental issue. Participants will draw conclusions and make recommendations on how to improve the environmental issue they are studying.

Learn more about NASA Earth Science research

Learn about additional ways NASA shares science with learners

CAMP OVERVIEW

There's No Place Like Home:

Earth Observation Camp Experience

Activities (Adapted from the **GLOBE Program**)

1. Making a Sundial
2. Aerosol Sensor
3. Water, A Journey Through Time
4. Mapping Local Solutions

Sample Camp Schedule (1 Day Camp Option)

8:00 to 8:10 a.m. .... Welcome – NASA's Earth Minute: **Why Does NASA Study Earth?**

8:10 to 8:30 a.m. .... Icebreaker – **Make a Stained Glass Earth**

8:30 to 9:30 a.m. .... Introduce Activity 1*

9:30 to 10:00 a.m. .... Break

10:00 to 11:00 a.m. ...... Introduce Activity 2**

11:00 to 12:00 p.m. ...... Lunch/Recess

12:00 to 1:00 p.m. .... Activity 3

1:00 to 1:15 p.m. .... Break

1:15 to 2:45 p.m. .... Activity 4

2:45 to 3:15 p.m. .... Wrap up

3:15 to 3:30 p.m. .... NASA's Earth Minute: **Mission to Earth**

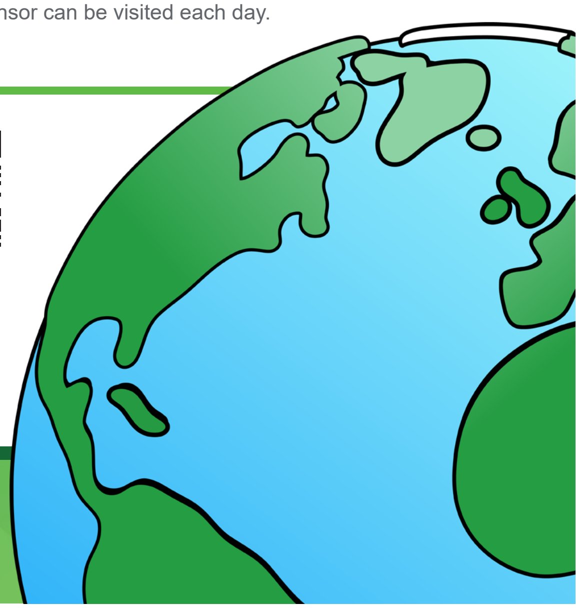
*Sundial will be constructed and visited several times the first day and if time allows, can be revisited on subsequent days for a multi-day camp event.

**For multi-day camp events, the aerosol sensor can be visited each day.

Video: Why Does NASA Study Earth?

Activity: Make a Stained Glass Earth

Video: Mission to Earth



Activity 1: Making a Sundial

Prep time: 10 min **Activity time:** Hourly measurements lasting 5 minutes during one sunny day; 15 minutes to revisit the sundial on subsequent days; time for discussion.

Summary: Participants learn the importance of our own star, the Sun. The Sun is important because it powers all the processes on the Earth and helps all the “spheres” of the planet work together. Participants construct their own sundial and observe the movement of the Sun through the sky. They will also learn what solar noon is and how to use their sundial to estimate the time of day. The sundial will be constructed on Day One and revisited on consecutive days.

Learning Objective: Participants will design and conduct a set of simple, quantitative observations to track the daily movement of the Sun across the sky. Participants will be able to describe the role of the Sun in driving the energy of Earth systems.

Outcome: Participants will construct and be able to use a simple sundial to estimate solar noon and the time of day.

Activity 2: Aerosol Sensor

Prep time: 20 min **Activity time:** 45 to 60 min

Summary: NASA uses satellites orbiting Earth to keep an eye on air pollution. Aerosols are tiny particles (e.g., dust, smoke, sea salt) suspended in the atmosphere that have great importance for the quality of the air we breathe. In this activity, participants will learn the basics of satellite remote sensing and will construct a ground-based aerosol sensor to help them understand that there are small particulates in the atmosphere.

Learning Objective: Participants will be able to assess data acquired through simple sensors and explain how NASA uses remote sensing tools to observe aerosols in Earth's atmosphere.

Outcome: Participants will work in teams to construct an aerosol sampler (sensor) with simple adhesives to collect data, analyze, and interpret data as they explore the amounts of aerosols present in the air around their learning environment. They will gather information regarding the weather conditions around their surroundings to determine how this affects the number of aerosols present and discuss observed relationships between aerosol measurements and environmental conditions.

Activity 3: Water: A Journey through Time

Prep Time: 30 min **Activity Time:** 60 min

Summary: Water is one of the most abundant and important substances on Earth. Water sustains plant and animal life, plays a key role in the formation of weather, and helps to shape the surface of the planet through erosion and other processes. It is important that we take care of our environment because pollution can leach into our fresh water. By observing the macroinvertebrates living in the fresh water in our community, we can learn about the ecology and health of the water body.

Learning Objective: Participants will observe fresh water from their community and the macroinvertebrates and flora living in the water and make connections to Earth Science Missions focused on water quality and security.

Outcome: Participants will make a plan for water conservation for themselves, their families, and their communities. In addition, they will make a plan to reduce water pollution for themselves, their families, and their communities.

Activity 4: Mapping Local Solutions

Prep time: 20 min **Activity time:** 90 min

Summary: Participants will mimic an Earth satellite mission by acting as remote sensors, collecting environmental data about a local outdoor space, and creating a visual map of the area using their data. Then, using their map, they will create a plan to improve the environmental quality of their area.

Learning Objective: Participants will apply skills in sensor development and data acquisition to collect local environmental data. Participants will create a map to visually represent observations in a fixed local area. Participants will design data-driven action plans to improve local conditions.

Outcome: Participants will create visual representations of collected data and make actionable plans based on conclusions drawn from their data.

MISSION BRIEFING

Activity: Making a Sundial (A GLOBE Activity)

Prep Time: 10 minutes

Activity Length: Minimum 30 minutes

Task: Participants will construct a sundial and use it follow the path of the Sun throughout the day, determine when solar noon is in their area, and estimate the time of day.

Safety Consideration: *Be mindful of sharp edges of objects used as shadow markers, especially if using staked flags.*

By the end of this activity participants will

gain an understanding of the daily movement of the Sun across the sky and experience conducting a set of simple quantitative observations.

Materials

- Wooden dowel or similar pole at least 50 cm (19.5 in) long
- Shadow markers (flags, rocks, sticks, etc.)
- Meter stick
- Level or plumb line (string with weight attached)
- Optional: protractor or compass

Preparation

1. Gather and prepare all listed supplies.
2. Group participants in teams of three to four.
3. Set up a spot in a clear area, free of shadows, for participants to leave their sundials. Consider roping off the area to prevent tampering with the sundials when they are not in use.
4. Review with the students how to read their rulers or meter sticks, if necessary.

Procedure

1. Select a day that will be sunny for a few hours.
2. Take student teams outside to a relatively flat spot that will be out the of the shadow of buildings and trees.
3. Place the pole in the ground, making certain that it is perpendicular to the ground using a plumb bob (a piece of string with a weight on it) or a level.
4. Measure and record the height from the ground to the top of the pole.
5. Have the participants put a #1 on the first object (rock, flag, etc.) they will use to mark the position of the

Activating Prior Knowledge

Participants may have noticed that when they arrive at school in the morning the Sun is shining on one side of the school and when they leave in the afternoon it is shining on the other side. This occurs because the Sun appears to travel across the sky each day. Before the invention of clocks, people used this motion of the Sun to determine the time by making sundials. Sundials are simple stationary vertical objects, such as a pole, placed on a flat surface. The pole is known as a gnomon (NOmon) and the flat surface as a dial. As the Sun travels through the sky, the length and position of the shadow cast on the dial by the gnomon change. The shadow is longest at sunrise and sunset and is shortest at local solar noon.

NASA Science Connections

NASA and other international space agencies monitor the Sun with a fleet of spacecraft, studying everything from its atmosphere to its surface, and even peering inside the Sun using special instruments. Some of these solar-orbiting spacecrafts include the Parker Solar Probe, the Solar Dynamics Observatory, and the Solar Terrestrial Relations Observatory (STEREO). NASA studies the Sun to better understand how its everchanging conditions can influence Earth, other worlds, and space itself. Its heat makes Earth warm enough to live on and without the light from the Sun, there wouldn't be plants or animals! We also study this star that we live with because it's the only star we can study up close!

MISSION GUIDANCE

GO

- Discuss the activity and the outcomes and expectations.
- Activity area should be flat with minimal shadows from buildings and trees.

MAYBE

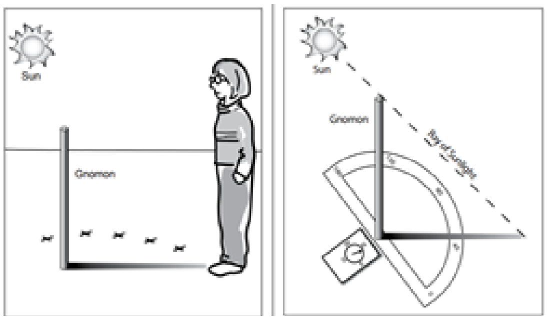
- Show the video describing NASA and the Sun.
- Where Does the Sun's Energy Come From? https://youtu.be/GAGFC8-wn1g

NO GO

- Do not remove the sundial between readings. It should remain in place for the duration of the activity.
- Do not look at watches prior to reading the sundial.

Video: Where Does the Sun's Energy Come From?

GLOBE Activity



shadows. Ask the participants to place the marker on the ground at the end of the shadow from the pole and record the time.

6. The participants should measure and record the distance from the base of the gnomon to the end of the shadow in the table provided. (Optional: Have participants measure the angle as well using a compass and a protractor).
7. Have the teams visit the gnomon at least once an hour for the remainder of your day with them. The participants should measure the length of the shadow (and the optional angle), place a new numbered marker at the end of the shadow, and record the time of day.
8. Ask the participants to use the table to determine which marker is closest to the pole. This is the time of the shortest shadow and is the observation closest to solar noon. If you have time, you could have the participants take more frequent measurements around the time of this observation on the following day to get a better estimate of solar noon.
9. Visit the sundial on another day in the same week. The student teams should bring their completed tables. Have the participants look at the shadow being cast by the pole and estimate from their tables what the time on their watches will be. Ask each student to write down their estimate. Have the participants look at their watches to find out how close their estimates were.

Challenge Questions

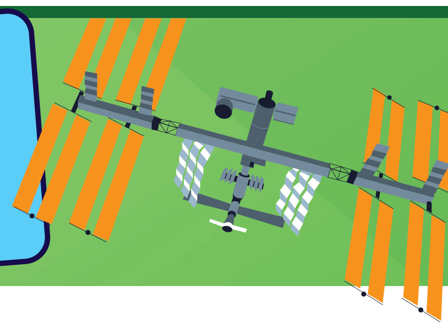
- What is the path of the Sun as it moves across the sky?
- Does the path of the Sun across the sky and the pattern of the shadows from the gnomon on the dial change during the year? (The answer could form the basis for a hypothesis that the participants could test experimentally.)

Extension

- Older participants can observe the changing angle of the Sun above the horizon. By measuring the height of the gnomon and the distance from the top of the pole to the end of the shadow (the hypotenuse of the triangle), participants can determine the angle of the Sun using simple geometry for similar triangles. Have the participants add a column to the table and fill in the solar elevation angle for each time they placed a marker. Observations of a flagpole and its shadow can also be tied into this type of observation.
  - When is the solar elevation the greatest? The smallest?
  - Could they have predicted this from the length of the shadows?
- Have students take temperature readings when checking their sundials. Does the temperature fluctuate between sunny and shady areas?

ISS FUN FACT!

Did you know that the space station gets all of its power from the Sun? The station is currently undergoing solar array upgrades, providing more power to support cutting-edge research in Earth and Space science.



Date_______________

Description of Sundial Site____

____

____

Weather Conditions____

Height of gnomon (pole)_______________________

Marker #	Time	Length of shadow cast by the gnomon	Optional: Compass angle of the shadow
Estimated time of solar noon			

MISSION BRIEFING

Activity: Aerosol Sensor

Prep Time: 20 minutes

Activity Length: 45-60 minutes

Task: Participants will work in groups to make an aerosol sensor, a simple adhesive tool that allows them to collect data and estimate the extent of aerosols present in their surrounding outdoor and indoor environment.

By the end of this activity participants will

gain an understanding of data collection and interpretation as they explore and observe the amounts of aerosols present in the air around them.

Materials

- White paper plates or cardboard for each research team.
- Contact paper or alternative adhesive, petroleum jelly.
- Duct tape
- Wooden blocks/bricks
- Spoon or plastic knife to spread the petroleum jelly if using that method.
- Crayons or markers

Note: This activity is adapted from GLOBE's Up in the Air Activity. Contact paper with gridded backing is the recommended adhesive option for standardized data collection and clean set-up. Petroleum jelly is another adhesive option if more readily available.

Preparation

1. Read through the activity and related background information.
2. Gather and prepare all listed supplies.

Procedure

1. Divide participants into research teams of two to three.
   a. Older participants should be able to conduct the activity individually or with a partner.
   b. Younger members will need assistance in securing the aerosol sensors and ensuring proper, safe locations are selected.
2. Assign or have participants select four or more indoor and outdoor locations where they would like to place their aerosol sensors to test the atmosphere.
3. Individually label the back of each aerosol sensor (plate) from A-D and fill out the table below, leaving the last column blank for now.

Prior Knowledge:

Before beginning the lesson, ask participants the following questions and initiate a group discussion:

- What is an aerosol?
- What does it mean when we see haze outside?
- How do you and your family release aerosols into the atmosphere? Consider reading the elementary GLOBE resource **Exploring Colors in the Sky** with the participants to review topics like the atmosphere and aerosols.

NASA Science Connection

NASA observes Earth and other planetary bodies via satellite-, aircraft-, and spacecraft-borne sensors that detect and record reflected or emitted energy. One of the ways NASA uses satellites orbiting Earth is to keep an eye on air pollution. TEMPO (Tropospheric Emissions: Monitoring of Pollution) will measure air pollution hourly across the North American continent during daytime. Other satellites, like **Aqua**, **CALIPSO**, **Terra**, and **IceSAT-2**, specifically measure aerosols.

To learn more about TEMPO visit:
https://weather.ndc.nasa.gov/tempo/

MISSION GUIDANCE

GO

- Ensure participants have a background on air pollution and aerosols.
- Select a time period during which there is no rain or snow.
- Allow participants to draw the aerosols or particulate matter they observe.

MAYBE

- Show participants the Surprisingly STEM video about how NASA uses specialized technology to provide clean air to astronauts aboard the International Space Station.
- Allow participants to photograph the samplers before exposure to the test areas. This will allow participants to compare sensors before and after collection.

NO GO

- Do not allow participants to wander the premises.

Air Pollution Aerosols STEM Video

Aerosol Sensor	Location	Inside/Outside	Time Exposed	Rank (cleanest to dirtiest)
A				
B				
C				
D				

4. Create four sensors. Use the duct tape to securely attach a paper plate to a brick or other device to the test sensor.
    - Participants may have to anchor the sampler if the air is windy. Make sure the paper plate is firmly taped to the device anchoring or holding the sensor.
5. After the paper plate or cardboard is secured, do one of the following:
    a. Tape a piece of contact paper in the center of the plate or cardboard with the sticky side up, keeping the protective backing ON the contact paper.
    b. Use a spoon or plastic knife to coat the top of the paper plate with petroleum jelly.
6. Expose the sampler to the outside or indoor air for at least 2 hours, but for best results leave the sensors in the testing areas for up to 24 hours or multiple days.
7. After at least 2-24 hours, have research teams collect the samplers.
8. Have participants observe the aerosols or particulate matter that adhered to the plate and compare the aerosols collected from each group. Optional: Provide participants with magnifying glasses to see smaller particles.
9. Task research teams to rank the locations from cleanest (1) to dirtiest (4) in the table and answer the following questions.

Challenge Questions

- Can you see any particles in the petroleum jelly or contact paper?
- Did the indoor aerosol sensors have more or less particles than the outdoor ones?
- What types of weather conditions could cause the results to change? Why? (Conditions like wind, rain, snow, or extreme heat could cause a change in results. These conditions affect the amount of aerosols present in the air.)
- What other methods might your team use to collect data on atmospheric particulates? (Observe deposits of aerosols on objects, i.e., cars, glass, furniture.)

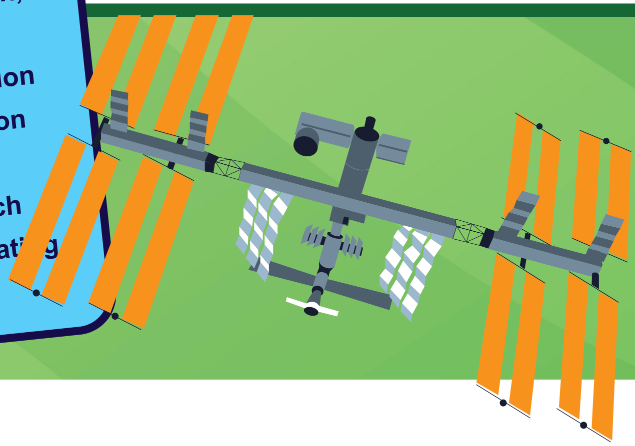
Extensions

- Experimental Design: After participants experience a basic concept of how their sensors can detect aerosols, they may design a contraption that reduces aerosols to improve air quality in their community. Designs can be planned out on paper, graphically or built using household or craft supplies.
- Compare Samples Across Multiple Days: Have participants prepare additional aerosol samplers to take outside each day. Remind them to record weather conditions each day the sampler is exposed to the open air. The participants can then compare the average aerosols to the weather conditions.
- GLOBE "**Up in the Air**" – Students can complete this extended version that includes random sampling.

GLOBE Up in the Air

ISS FUN FACT!

With three to ten astronauts living in such a tight, enclosed space, air management on station is critical! Life support systems on the space station must not only supply oxygen and remove carbon dioxide from the cabin's atmosphere, but also prevent gases like ammonia and acetone, which people emit in small quantities, from accumulating. Living in space isn't easy!



MISSION BRIEFING

Activity: Water, A Journey Through Time

Prep Time: 30 minutes

Activity Length: 60 minutes

Task: Participants observe data on Earth's water resources. They learn about how a macroinvertebrate assessment can be used to better understand fresh water ecology, making connections to availability of quality freshwater to their communities

By the end of this activity participants will

- Make a plan for water conservation for themselves, their families, and their community.
- Make a plan to reduce water pollution for themselves, their families, and their communities.

Materials

- Computers with internet capability
- Student handouts
- Writing utensils
- Crayons, markers, colored pencils
- Review GLOBE Water Wonders Activity and if planning to complete macroinvertebrate observations, prepare the following:
  - Aquarium with a lid or many large clear jars with lids
  - 5-10-gallon sample of fresh water from a local pond, stream, or lake. (If you do not have a body of water nearby, you can collect soil, non-poisonous plants, and harmless invertebrates.) The sample should include bottom debris, plant life from the water, water, and macroorganisms.
  - You may need a net to scoop bottom debris and skim through the water for macroorganisms (NO VERTEBRATES).
  - The water can be put into an aquarium or divided into a few large jars with lids so that it is easier for multiple people to observe.
  - Magnifying glass (optional)
  - Digital camera with magnifying option (optional)

Safety Consideration: *Teachers/facilitators should be responsible for acquisition of samples and return of samples. Be sure to comply with regulations in your local area about plant and animal collections. An alternative option is to order macroinvertebrates as described in "Water Wonders."*

Activating Prior Knowledge:

Ask participants:

- What is most of their body made of? (water)
- What makes Earth unique among all the other planets? (Water in all three states of matter)

NASA Science Connections

In Dec. 2022, NASA launched the Surface Water and Ocean Topography (SWOT) satellite into Earth's orbit to survey water on more than 90% of the planet's surface. SWOT will survey nearly all water on Earth's surface for the first time, helping to track how fresh and saltwater bodies change over time.

By providing us with a highly detailed 3D view of rivers, lakes, and oceans, SWOT promises to improve our understanding of Earth's water cycle and the role oceans play in climate change, as well as help us better respond to drought and flooding. SWOT will provide scientists with measurements of water volume change and movement to inform our understanding of freshwater availability, flood hazards, and the mechanisms of climate change.

MISSION GUIDANCE

GO

- Review introduction to Macroinvertebrates in Water Wonders activity.
- Follow local safety protocols if collecting samples in advance from local water sources.
- Encourage participants to learn more about water-focused missions, like SWOT.

MAYBE

- Have participants research and create an enclosed ecosystem, such as the aquarium activity in Water Wonders.

NO GO

- Do not use vertebrates in sample collection.
- For safety reasons, do not encourage students to collect their own samples.

Preparation

1. Gather and prepare all listed supplies.
2. Read the Elementary GLOBE storybook "**Discoveries at Willow Creek**" before the activity, either as a class or individually.
3. Be sure videos are downloaded and ready.
4. Review **Water Wonders** and if applicable, have freshwater sample ready at least 24 hours prior to the lesson, so that debris can settle.
5. Make sure students have a basic knowledge of percentages. For example, 80% means 80 parts out of 100, or 32% means 32 parts out of 100.

Procedure

1. Take a nice long drink of water (in a clear cup or bottle).
2. Ask participants some discussion questions.
    - What is water used for?
    - Where does it come from?
    - What are the parts of the water cycle?
3. Watch **The Water Cycle**
4. Have participants complete The Water Cycle graphic.
    - Word bank: Evaporation, Condensation, Runoff, Transpiration, Precipitation, Groundwater.
5. Regroup and discuss the graphic.
6. Ask the participants the following discussion questions.
    - If there is a water CYCLE, where did it start?
    - When we drink water, we drink FRESH water. What is FRESH water?
7. Let the participants know that "fresh" does not mean "new." There is a finite or limited amount of water on Earth. No water will be made or removed from Earth, but it could become polluted and unusable. The water that we drink is 3.8 BILLION years old. It was created as Earth began to cool.
8. Watch:
    - **Earth's Water Budget**
    - **KSNN: Did You Know NASA Astronauts Will Recycle Water In Space?**
9. Have participants complete the pie chart worksheet. You may want to play the video again and stop it in certain spots so that the participants can write in the percentages on the charts. For lower grades or students who are having difficulties, you may want to walk through this activity together.
10. Regroup and discuss the pie charts. Ask the participants what they have

Storybook: Discoveries at Willow Creek

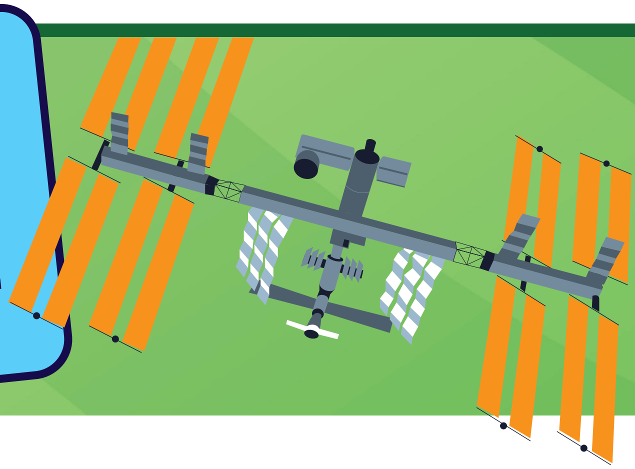
Video: The Water Cycle

Video: Earth's Water Budget

Video: Did You Know NASA Astronauts

ISS FUN FACT!

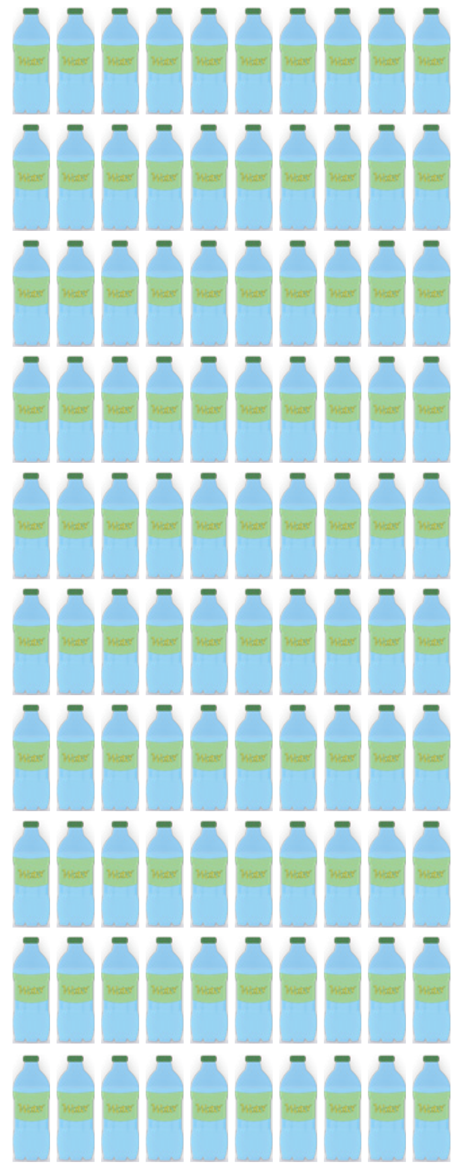
Did you know that more than 93% of the water on the space station is recycled? The water the astronauts drink is recycled from their sweat, breath, and even urine! Technologies that were developed to filter and recycle water on station now benefit life here on Earth!



learned about the amount of fresh water available.
- To help them understand, use the visual aid "if all the world's water were to equal 100 liters."
- Ask why it is important to protect and keep the water free from pollution.
- With whom do we share our water?

11. Conduct Part 1 of the GLOBE Activity **Water Wonders** to provide an introduction to macroinvertebrates and what participants can learn from them about their local water sources.
12. If water samples have been safely collected from local sources, complete this step: Let the participants take a look at the water samples from the local area.
    - They may need to use magnifying glasses or a digital camera with the magnification increased.
    - Have participants fill out the My First Macroinvertebrate worksheet.
    - Participants can use the Water Wonders activity to identify macroinvertebrates they might see.
13. In small groups, have participants make plans, slogans, posters, or information pamphlets about:
    - Conserving water as an:
      - Individual
      - Family
      - Community
    - Reducing water pollution as an:
      - Individual
      - Family
      - Community

Water Wonders



If all the world's water were to equal 100 liters (26 gallons).....
The amount of drinkable fresh water would = .003 of a liter (1/2 teaspoon).

Challenge Questions

- Macroinvertebrates can tell us a lot about the conditions within a water body. What does the presence of these critters tell you about the water quality?
- What do you think the macroinvertebrates eat?
- What can you do to help limit water pollution in your community?

Extensions

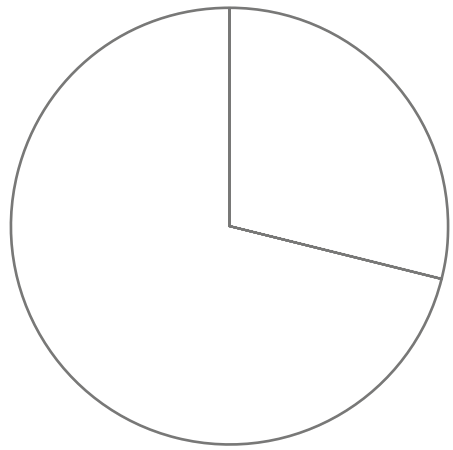
- Have participants use the computer to make their own pie charts.
- Have students try to identify the plant material in their sample.
- Observe the water sample over time; record and discuss the changes.
- Do not give participants a word bank for the water cycle worksheet.
- Have participants research and share about one of the macroorganisms.
- Other optional **GLOBE activities**

GLOBE Activities

After reading the background information, activity summary, and watching **Earth's Water Budget**, fill in the percentages and finish the pie charts.

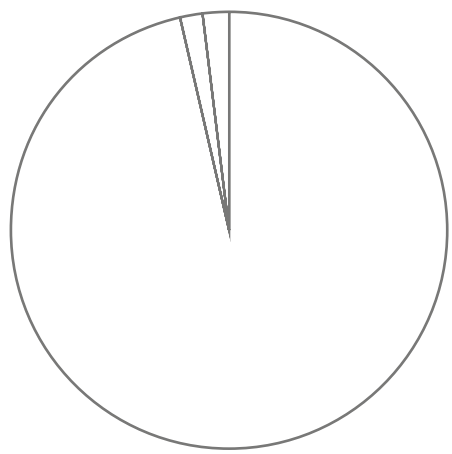
Video: Earth's Water Budget

Earth



- Land_______%
- Water_______%

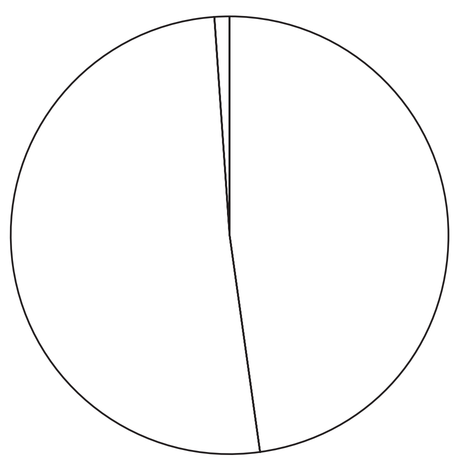
Earth's Water



- Oceans_______%
- Ice Caps_______%
- Groundwater_______%
- Other_______%

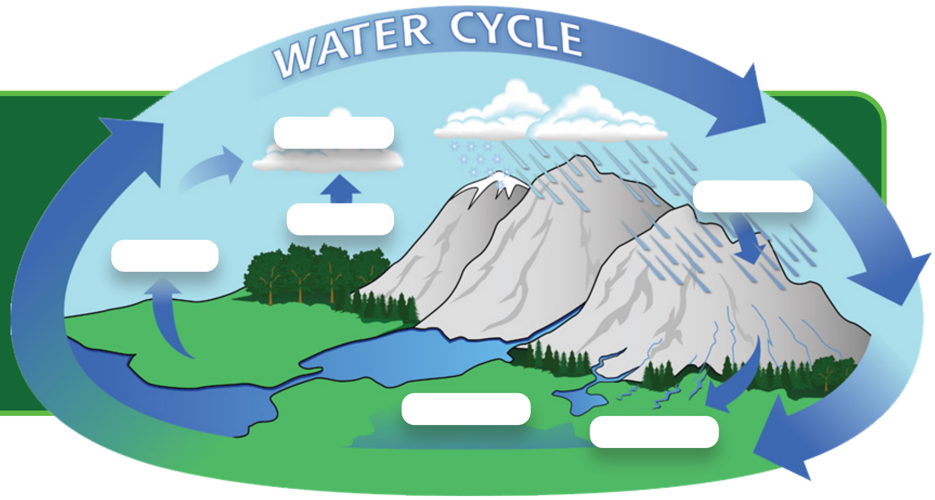
Why is there no section to color for "other"?

Freshwater



- Ice Caps_______%
- Groundwater_______%
- Other_______%

After watching The Water Cycle **https://gpm.nasa.gov/education/videos/water-cycle-featuring-molecule-man** fill in the blanks in the diagram.



Name______________________

My First Macroinvertebrate

Its name is____

Here's a drawing of what it looks like.

This is where I think it lives:_________________________________

____

This is how I think it moves:__________________________________

____

MISSION BRIEFING

Activity: Mapping Local Solutions

Prep Time: 20 minutes

Activity Length: 90 minutes

Task: Participants will collect data about a specific environmental condition in a local outdoor area and use that data to create a visual map. They will then use their map to inform a plan to improve that environmental condition.

Note: This activity requires participants to make observations and collect data outdoors for the first 30 minutes. Be mindful of weather conditions and participant safety while they are outdoors.

Safety Consideration: *Be cautious of selection of location for data collection, ensuring proper safety protocols and guidance are provided to students. Be mindful of data collection near water, streams, and open areas.*

By the end of this activity participants will

be able to visually represent observations in an "aerial" map, making connections to data visualizations constructed using NASA Earth-observing satellite data. Participants will design data-driven action plans to improve local conditions.

Materials

- An outdoor area, such as a campus, park, or playground
- Pencils
- Paper
- Clipboards
- Poster Paper
- Markers

Preparation

1. Gather and prepare all listed supplies.
2. Ensure chosen outdoor space is safe for participants to explore/record data.
3. Choose type of environmental data participants are going to study. This can vary from location to location based on local conditions, but here are some ideas:
   a. Where litter is located within the chosen area.
   b. Surface erosion or runoff within the chosen area.
   c. Areas where grass will not grow within the chosen area.

Activating Prior Knowledge:

Have you ever seen an image of Earth with information about weather conditions, sea levels, vegetation levels, drought conditions? How do you think satellites were able to get this information from space and make it into a map or image? How does having these images or models of our Earth affect us in our lives? Do we change our daily routines, the decisions we make, or the way we do business? How?

NASA Science Connections

Remote sensing is a valuable tool that NASA uses to monitor Earth from space. Remote sensing allows mapping of vegetation, climate, and atmospheric composition over large regions and lets us repeat the measurements consistently over many years. In this way remote sensing provides planetary-scale measurements of our entire Earth system, which helps us develop and validate new theories and solutions to large scale issues. The first Earth-observing satellite explicitly designed to study planet Earth was NASA's Landsat program. The program began in 1972, and it is still collecting data today! Over the years, the program has collected data on the forests, farms, urban areas, and fresh water of our home planet. Scientists across the globe use Landsat data to better understand environmental change, manage agricultural practices, allocate scarce water resources, respond to natural disasters, and more. Learn more about Landsat with engaging activities here: Camp Landsat - Landsat Science (nasa.gov)

MISSION GUIDANCE

GO

- Discuss ahead of time the boundaries of each participant's assigned region for data collection and create a larger map that participants will be adding their data to.
- Chosen outdoor area should be small enough for all participants to explore/map within 20-30 minutes, but the environmental issue being studied should be prevalent enough for all participants to be able to find and map data.

MAYBE

- Create and print maps ahead of time for each group to help younger participants.

NO GO

- Do not allow participants to collect data in an unsafe manner (handling potential hazardous litter or going to unsafe areas).
- Do not allow participants to be unsupervised.

d. Invasive plant species within the chosen area.
e. Standing water/poor drainage within the chosen area.

Procedure

1. Introduce the activity to the participants and tell them that they will be acting as analogs to remote sensors, collecting environmental data about the chosen area just like a satellite would. Explain to them the type of environmental data they will be collecting and that they will record that data by placing a dot on a map at each place where they find evidence that the chosen environmental issue occurs.
2. Divide the participants into groups of two or three and assign each group a specific region of the chosen area to explore and collect data.
3. Each group should make their own map of their assigned search region. To assist participants in making their maps, see the **Making a Map** activity from The Globe Program at **Land Cover Activities - GLOBE Observer - GLOBE.gov**.

Note that the examples assume use of open/natural areas. Urban and developed areas also provide important environmental data, and the steps in this procedure can be adapted to include observations based on where participants are.

4. Have groups search their assigned regions for 20-30 minutes, collecting data on their maps.
5. Have the groups come back together to compile their data. Each group will transfer their collected data from their individual maps of their assigned search region to create a larger map of the entire chosen area.
6. Discuss with participants what they can learn from having all the data together in one model. Ask them what kind of conclusions they can draw from looking at the model.
7. Divide the participants back into their groups and discuss, based on the model, what they think is causing the environmental issue within the chosen area.
8. Have each group create a basic Environmental Improvement Plan for the chosen area. It should include the following:

Making a Map

Land Cover Activities - GLOBE Observer - GLOBE.gov

a. What is the environmental issue?
b. What is the negative impact of the environmental issue?
c. How was data collected to make a model of the environmental issue?
d. What conclusions were you able to draw from your model?
e. What steps do you recommend to improve the environmental issue?
f. Who should be responsible for taking these steps?
g. Why is it important to improve the environmental issue?
h. What are the expected results from improving the environmental issue?

9. Have each group present their "Environmental Improvement Plan" to the rest of the participants.

Challenge Questions

Why was it important for different groups to look at different areas at the same time?

- Satellites only have a limited field of view for their sensors, so they can only see a small area at any given time. They orbit the Earth to look at different areas and compile the data together. Sometimes multiple satellites work together to collect all the data for large areas.

Why was the data collected put on a map instead of just written down?

- Visual images such as graphs and models make it easier for us to understand data. We are able to see the data represented all at the same time, making it easier to draw conclusions from it.

If you could design a satellite-based Earth mission, what type of data would you want your satellite to be able to observe?

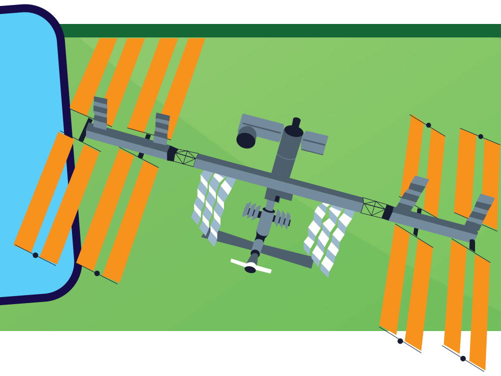
- Answers will vary by participant.

Extensions

- Allow participants to research NASA satellite-based Earth Science missions and find one that closely matches the type of environmental issue they are studying in this activity.
- Compile different aspects of each group's Environmental Improvement Plan into a single proposal and have the participants present it to a local authority (principal, organization director, city official, etc.) of your chosen area.

ISS FUN FACT!

Did you know that astronauts have captured more than one million images of Earth? Astronauts can record phenomena such as storms on Earth in real time, observe and collect images of natural events such as hurricanes, and share their thoughts and observations with scientists on the ground.



Culturally Responsive Education (CRE) Strategies Tip Sheet

Section Title (page #)	CRE Strategy	CRE Tips
Mission Briefing Activating Prior Knowledge pg. 6, 9, 11, 16	Making Cultural Connections	• Pose questions to activate prior knowledge and/or make connections to real-life applications.
Preparation pg. 6, 9, 12, 16	Power and Participation	• This activity provides the opportunity for active participation of all students. • Sharing responses in small groups and with the entire class. • Team roles can be assigned to encourage all students to participate.
Mission Briefing Activating Prior Knowledge pg. 6, 9, 11, 16	Language and Communications	• Activate prior knowledge on terms used in the lesson and have students offer a definition or understanding of the terms. (gnomon) (air pollution, aerosols, remote sensing) (water cycle, freshwater, evaporation, condensation, runoff, transpiration, precipitation, groundwater) (satellites)
Challenge Questions pg. 7, 10, 13, 18	Power and Participation	• Students will participate in a think/pair share to answer Challenge Questions
Procedure pg. 6	High Expectations	• Students will use inquiry and critical thinking to collaborate in groups to make quantitative observations of the Sun
Connection to NASA pg. 6, 9, 11, 16	High Expectations	• Students will learn about connection to NASA and determine how it relates to their lives

For more, join our community of educators, NASA CONNECTS!

https://stemgateway.nasa.gov/connects/s

Making a Map

Getting Started

When you think of a map, you might think of different elements, like a grid, a compass, a scale, a key, symbols, and labels that show how different things relate to each other. However, the most important part of a map is its purpose. The purpose of a map drives choices such as the scale and what information to include.

Use this page to plan your map and then draw it on the back.

Purpose

How will your map be used?

It might help to start with one of these verbs:

find navigate study document teach

____

____

____

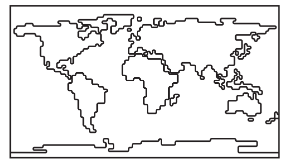
____

Extent and Scale

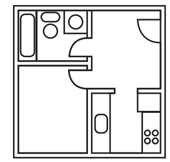
Map extent is the area that your map shows, and that area must be scaled to the size of your map.

What will the extent of your map be? ______________________________

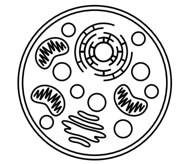
World Map



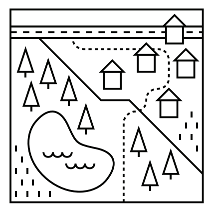
Floor Plan

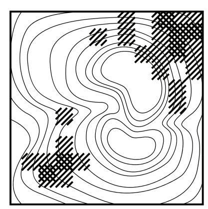


Cell Diagram



Scale describes the size that real-life objects appear on a map. It is often written as a ratio, but can also be descriptive—like *one square equals a city block*.





Map Data

Map data is the information that your map includes, like points of interest, boundaries, physical features, and statistics.

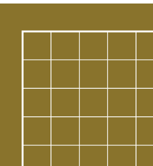
What information will you include in your map?

____

____

____

Want to do more? Place a piece of clear plastic over your map and assign a color to each type of surface. Now try coloring the squares of the grid with just one color each. These squares are similar to the pixels that make up satellite imagery.



observer.globe.gov

Title and Description

Creator

Date

SCALE

=

KEY

CAMP GLOSSARY

- **Aerosols** - Aerosols are tiny particles found in the atmosphere. Natural sources of aerosols include pollen, sea salt, desert dust, ash from volcanic eruptions, and smoke from forest fires. Aerosols that come from human activities include exhaust from burning fossil fuels, manufacturing chemicals from factories, and land use.
- **Air quality** - The measurement of the pollutants in the air. Good air quality means that the air is fresh and clean, and this air is easy for people to breathe. Polluted air is harder for people to breathe and can cause problems for some people.
- **Analog** - A person or thing that is comparable to or a representation of another person or thing.
- **Gnomon (No-mon)** - The pole on a sundial that shows the time by the position of its shadow.
- **Remote sensing** - Acquiring information from a distance

NOTES:

National Aeronautics and Space Administration

NASA Headquarters
300 E Street SW
Washington, DC 20546
www.nasa.gov/centers/hq

www.nasa.gov