This segment will have students continue to collect and analyze data to predict the weather for their local area, differentiate between weather and climate, and develop models of the various ways water cycles through evaporation, precipitation and condensation.

<table>
<thead>
<tr>
<th>Student Science Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade or course Fourth</td>
</tr>
<tr>
<td>Topic: Earth Science - Weather</td>
</tr>
</tbody>
</table>

**Performance Expectation for GSE:**

**S4E3. Obtain, evaluate, and communicate information to demonstrate the water cycle.**

- a. Plan and carry out investigations to observe the flow of energy in water as it changes states from solid (ice) to liquid (water) to gas (water vapor) and changes from gas to liquid to solid.
- b. Develop models to illustrate multiple pathways water may take during the water cycle (evaporation, condensation, and precipitation).
  
  *(Clarification statement: Students should understand that the water cycle does not follow a single pathway.)*

**S4E4. Obtain, evaluate, and communicate information to predict weather events and infer weather patterns using weather charts/maps and collected weather data.**

- a. Construct an explanation of how weather instruments (thermometer, rain gauge, barometer, wind vane, and anemometer) are used in gathering weather data and making forecasts.
- b. Interpret data from weather maps, including fronts (warm, cold, and stationary), temperature, pressure, and precipitation to make an informed prediction about tomorrow’s weather.
- c. Ask questions and use observations of cloud types (cirrus, stratus, and cumulus) and data of weather conditions to predict weather events.
- d. Construct an explanation based on research to communicate the difference between weather and climate.

**Performance Expectations for Instruction:**

Weather is an ongoing disciplinary core idea and is integrated throughout the year when “teachable moments” of weather events occur both locally and worldwide. The flow of energy in water and the patterns that aid in weather prediction provide opportunities for students to analyze and forecast the weather. Provide students with ample time to analyze and discuss these events.

Students will:

- collect, analyze, and predict the weather for their local area.
- differentiate between weather and climate.
- develop models of the water cycle that demonstrate multiple paths.
- plan and carry out investigations to observe the flow of energy in water.
- explain what instruments are necessary for weather collection and why it is necessary in forecasting.
- observe, chart, and record weather data using weather instruments, weather maps, cloud observations and knowledge of the water cycle to make an informed forecast for the local area.
- differentiate between weather and climate.
- explore weather instruments and their function.
- explore weather fronts and interpret them on a weather map.
- ask questions about cloud types and the water cycle to determine the types of weather associated with them.
- investigate the flow of energy as water changes states.
- collect data, analyze, and predict/forecast of tomorrow’s weather.
- engage in personal reflection on forecasting efforts via written and oral communication.
- practice predicting the weather using the local forecasts as a model for communication.
- discuss the water cycle as a factor in predicting the weather.

**Additional notes on student supports**

Georgia Department of Education
November 2019
Materials

Teacher Background Information

Water drop: smooth surface such as waxed paper or plastic plate, toothpicks, pipettes, water

States of Water: hot pot, thermometer, clear cups, warm water (85 degrees or less), ice cubes, plastic wrap

Thermometer Practice: thermometers, cups of warm, cold, and room temperature water.

Convection Currents: hot pot, thermometer, cups, clear graduated cylinder or container of the same shape, food coloring, room temperature water, ice, pipettes or droppers

Condensation: hot pot, can, water, ice (Teacher note: This is best done on a humid day.)

Unequal Heating: 3 cups, sand, soil, water, 3 thermometers, Recording Sheet

Weather Instruments, Charts, and Maps:

- Weather instruments for data collection including thermometer, rain gauge, wind vane anemometer, air pressure readings
- Access to computer for data collection
- Weather maps from local resources (news media) to analyze and blank weather maps for student data
- Presentation options: slides, Recording devices – (radio), Green screen App. – (TV), Other apps that are used for recording.
- Water Cycle Resource:

Exploring the Water Cycle Lesson Plans

Sample Weather Chart Organizer

- Information about Weather Charts and Maps:

Fronts, Storms, and Weather Prediction is a video that shows the information found on weather maps with explanations.

- NASA Connect segment explaining how scientists use satellites to predict weather. The segment explores the Afternoon Constellation, or the collection of satellites known as the 'A' Train as well as weather balloons, weather stations and local weather observers: Predicting Weather

- There are several combinations of the three basic cloud types-- cirrus, cumulus, stratus, and nimbus. Students can use these to relate clouds to weather. Don’t try to learn all of the different combinations in fourth grade. Cloud Identification Chart

Students will continuously obtain, evaluate, and communicate information. This is not a linear process. Students will communicate through writing and discussions to allow for formative assessment. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.

Engaging Learners

Phenomenon

NOAA's GOES-16 Satellite Sends First Images from Space shows pictures of the Earth and its cloud cover. The infrared images show differences in clouds, smoke, and ash particles.

Obtaining

Have students compare how weather is similar and different on the other planets as compared to our weather on Earth.

Evaluating

How does the space forecast differ from the local forecast?

Students engage in a conversation with partners or in small groups about the similarities and differences between the space forecast and the local forecast.

Communicating

Engage students in a whole group comparison of the two forecasts.
Sample Driving Questions:

- Why is the space forecast so different from ours?
- How do we forecast the weather?

**Exploring**

*Obtaining*
Weather is the result of how air and water react when they are heated and cooled under different conditions. Have students work with the properties of water and air to have a better understanding of things like the water cycle.

**Air and Water Investigations for Weather**

**States of Water:** After students have a better understanding of the relationship between air and water in heating and cooling. Have students design a way to show how water evaporates, condenses and precipitates using basic materials. After the plan is sketched, labeled and explained, provide them with clear cups, warm water (85 degrees or less), ice cubes, and plastic wrap to test and revise their plan if necessary. Challenge the students to have an innovative design.

*Obtaining*
From the beginning of the year, students have used media resources to gather data about weather conditions so that they are familiar with the language and what the instruments do.

**Instructional Segment: Weather and Moon Phases** contains handouts for students to use in collecting weather data.

In this segment students will use weather instruments including thermometers, rain gauges, wind vane anemometers, and barometers, if available to collect and interpret their own weather data.

From the beginning of the year, students have collected cloud observation data and compared it to weather conditions.

Students will identify cloud types and explain the water cycle to aid in identifying weather patterns.

**Communicating**

**Sample Driving Questions:**

- How do weather instruments gather data that help us make weather predictions?
- How do fronts interact to produce different weather patterns?
- How do the fronts help with weather predictions/forecasting? How does the water cycle help with weather predictions/forecasting?
- What is the relationship between the water cycle and weather?
- What evidence exists that water is changing states?
- How do scientist use observations of cloud types in weather forecasting?
Weather Maps
Phenomenon: Fronts, Storms, and Weather Prediction

Provide students with weather maps for a 5-day range or have them view weather maps from news media for 5 days.
Have them note the movement of fronts, precipitation, temperature changes, etc. through the 5-day period. Ask them if they see a pattern in the direction the weather seems to move.

Divide the class into small groups and assign each group a day in consecutive order. Have them use a blank map to key in the data they collected for consecutive days of weather. Have them use colored pencils and symbols to input their data and share them maps with other groups.
Post each group’s work in order and have students make suggestions and ask questions on sticky notes to add to the maps. Allow time for groups to answer questions and make revisions to their maps.
Post the revised maps in order and have students note how the weather moved, the temperatures changed, and where the fronts between warm air and cold air appeared.

Map of Georgia
Blank Weather Map of U.S.

What is weather? What is climate? Compare and contrast weather and climate.

Explain: Climate is a summary of an average of weather conditions over a long period of time. It does not change from day to day the way weather does.

Here is a summary if the climate of Georgia:

The climate of Georgia is typical of a humid subtropical climate with most of the state having mild winters and hot summers. The Atlantic Ocean on the east coast of Georgia and the hill country in the north impact the state’s climate. Also, the Chattahoochee River divides Georgia into separate climatic regions with the mountain region to the northwest being colder than the rest of the state, the average temperatures for that region in January and July being 39 °F (4 °C) and 78 °F (26 °C) respectively. Winter in Georgia is characterized by mild temperatures and little snowfall around the state, with colder, snowier, and icier weather more likely across northern and central Georgia. Summer daytime temperatures in Georgia often exceed 90 °F (32 °C). The state experiences widespread precipitation. Tornadoes and tropical cyclones are common.

Ask students how this is different from daily weather. Do we always have this kind of weather? No. There are exceptions. Let’s look at this year’s weather data we’ve collected and see if we can compare and contrast.

Have students look at how weather is a daily occurrence, but climate is a long-range summary of conditions.

Evaluating
Based on the results of the predictions and reflections, students can determine if their weather analysis and forecasting skills are improving. Continual observations and data collection of weather over a significant period of time (6 weeks +) will increase these skills.
<table>
<thead>
<tr>
<th><strong>Formative Assessment of Student Learning</strong></th>
</tr>
</thead>
</table>
| **Explaining**  
**Finalizing Model**  
Students should have multiple opportunities to interpret the data and make predictions about weather events. |
| **Obtaining**  
Students will determine how the weather data they collected is helpful in predicting the weather. Data collection with weather instruments is a vital experience as they make comparisons to their predictions and actual weather data. Have students use weather maps, observations of cloud types, knowledge of water cycle, along with their data, to make predictions on a daily basis.  
After ample time to collect, analyze, and forecast the weather, students will research climate and climate change paying close attention to how climate in a specific region differ from weather patterns in that region. |
| **Evaluating**  
Students continue reflecting on their weather predictions checking for accuracy and discrepancies. |
| **Communicating**  
Individuals keep a detailed journal about weather conditions, data analysis, and forecasts that will offer opportunities for reflection. The journal can include labeled drawings, detailed notes, photographs, and time and date of each entry.  
Students practice making a weather forecast, using the weather data collected, for peers.  
Sample Driving Questions:  
- How do scientist use weather data to make informed predictions?  
- How accurate are the predictions?  
- What are some of the improvements being made in the scientific community to improve weather predictions? |
| **Elaborating**  
**Applying Model to Solve a Problems**  
**Phenomenon**  
Why does weather change from day to day? Have students note differences in pressure, humidity, temperature, clouds, etc. |
| **Obtaining**  
Is forecasting scientific? Based on your data were your predictions as accurate as your local/regional forecast?  
Compare and contrast the collection methods. |
| **Evaluating**  
Students should practice reflecting on their prior predictions and make additional predictions checking for accuracy and discrepancies. Ask yourself, are your predictions correct? |
| **Communicating**  
Based on collected weather data, students will analyze, display, and choose how to communicate the predictions. |
| **Evaluation**  
**Assessment of Student Learning**  
Ongoing journal entries are complete and contain data, predictions, and reflections. The items in the sample weather data chart are used as a checklist for student completion.  
Weather forecast presentation contains details of data collection, analysis, and forecasting using weather maps, knowledge of the water cycle, cloud types, and fronts.  
Models detailing the multiple pathways water flows in the water cycle.  
Observe the flow of energy in water as it changes states.  
Students show a clear understanding of the difference between weather and climate. |

Georgia Department of Education  
November 2019
<table>
<thead>
<tr>
<th><strong>SEP, CCC, DCI</strong></th>
<th><strong>Science Essentials</strong></th>
</tr>
</thead>
</table>
| Science and Engineering Practices | ● Ask questions and construct an explanation about weather instruments and function.  
● Analyzing and interpreting data from charts, maps, and weather instruments  
● Constructing explanations about weather, weather patterns, and climate.  
● Obtaining, evaluating, and communicating information to predict weather events and infer weather patterns  
● Developing and using models  
● Planning and carrying out investigations |
| Crosscutting Concepts | ● Patterns  
● Systems and System Models  
● Energy and Matter |
| Disciplinary Core Ideas | From *A Framework for K-12 Science Education*:  
● ESS2.A: EARTH MATERIALS AND SYSTEMS  
● ESS2.C: THE ROLES OF WATER IN EARTH’S SURFACE PROCESSES  
● PS1.A: STRUCTURE AND PROPERTIES OF MATTER  
● ESS2.D: WEATHER AND CLIMATE  
● PS3.B: CONSERVATION OF ENERGY AND ENERGY TRANSFER  
● ETS2.A: INTERDEPENDENCE OF SCIENCE, ENGINEERING, AND TECHNOLOGY |
Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student’s Individualized Education Program.

<table>
<thead>
<tr>
<th>General supports for the following categories:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading:</td>
</tr>
<tr>
<td>1. The teacher can have students match letters prior to reading to remind them of the alphabet.</td>
</tr>
<tr>
<td>2. The teacher can have students identify words that they know in the text as the class reads.</td>
</tr>
<tr>
<td>3. The teacher should remind students to use strategies when they are reading.</td>
</tr>
<tr>
<td>Writing:</td>
</tr>
<tr>
<td>1. The teacher can provide practice for students in the area of writing both in context and practicing just letters.</td>
</tr>
<tr>
<td>2. The teacher can provide a sentence starter for the students.</td>
</tr>
<tr>
<td>3. The teacher should continually give encouragement to the students.</td>
</tr>
<tr>
<td>4. The teacher can provide constructive positive feedback during the writing process to help students understand the expectations.</td>
</tr>
<tr>
<td>Math:</td>
</tr>
<tr>
<td>1. Provide students with opportunities to interact with numbers.</td>
</tr>
<tr>
<td>2. The teacher can provide manipulatives to allow the students to count and interact with materials.</td>
</tr>
</tbody>
</table>

Supports for this specific lesson if needed:

**Performance expectations for instruction:**

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.

**Engage:**

1. The teacher should consider showing images to students and have students make observations.
2. Then the teacher should consider having a class discussion about what the images show and what they mean.
3. The teacher should have clear and consistent guidelines for class discussion and group work. These guidelines should help students feel more comfortable participating.
4. The teacher should use intentional and flexible grouping to group students. Best practice is to use data to drive student grouping.
5. The teacher should consider providing sources for students to find out about weather on other planets.

**Exploring:**
1. The teacher should use intentional and flexible grouping. Best practice is to use data to drive student groupings.
2. The teacher should consider providing students with an organizer to record their research, observations and design.
3. The teacher should consider showing the materials to the students that they will be using to design their model.
4. The teacher should consider using guiding questions to assist students in their design process.
5. The teacher may need to explicitly teach students to use the weather instruments.
6. The teacher should consider a formative assessment of cloud types to determine the needs of students for re-teaching, reviewing or enriching.
7. The teacher should have clear and consistent guidelines for student discussions. These guidelines should help students feel more comfortable participating in the discussions.
8. The teacher should consider providing sources for students to find the 5-day weather forecast.
9. The teacher may need to remind students what patterns are and how to recognize them within science.
10. The teacher should have clear and consistent guidelines for students giving feedback to their peers. This should provide students with clear expectations and rules for the respectful ways to provide feedback to other students so that all students feel that they are getting the most out of getting and providing feedback.
11. The teacher should consider providing students with a Venn diagram for students to use to compare weather and climate.
12. Students may need additional time to complete their assignments.

**Explaining:**
1. The teacher should consider using guiding questions to assist students in with data collection and analyzation.
2. The teacher should consider providing students with resources to use in their research in climate and climate change.
3. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing, labeling images or designing a presentation.
4. Students may need additional time to complete their assignment.

**Elaborating:**
1. The teacher should consider facilitating a discussion about the weather and differences from day to day.
2. The teacher should use guiding questions to assist in evaluating their predictions.
3. The teacher should have clear and consistent guidelines for students giving feedback to their peers. This should provide students with clear expectations and rules for the respectful ways to provide feedback to other students so that all students feel that they are getting the most out of getting and providing feedback.
4. Students may need additional time to complete their assignment.
Evaluating:
1. Students may need additional time to complete their assignment.
2. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.
Teacher Background Information

Water Cycle

Earth’s water is always on the move. It changes from solid to liquid to gas and back again. Solid water is defined as ice, liquid water takes the shape of its container and can be poured from one container to another, and gas can be water vapor or steam when heated. Each of these changes is a part of the water cycle. The cycle contains different stages. Evaporation, condensation, precipitation, and collection are all parts of the water cycle.

The temperature of water changes as it travels through the water cycle. Water freezes (becomes a solid) at 32 degrees Fahrenheit and 0 degrees Celsius. Water changes to a gas (water vapor) when it reaches a temperature of 212 degrees Fahrenheit and 100 degrees Celsius.

Energy from the sun is an important factor in the process of the water cycle. Heat from the sun provides energy for evaporation. Water evaporates from the oceans, lakes, and streams to form water vapor. Plants and animals are also a part of the water cycle. Both add water vapor to the air.

Water vapor rises into the air. It cools as it rises. Cooling causes it to condense. Condensation changes water vapor to liquid droplets. These droplets combine to form precipitation and falls to the ground as rain, sleet, snow, hail, etc. It is then collected in oceans, rivers, lakes, and streams and the cycle starts over again.

Clouds

Water falls to the ground in different forms of precipitation. The temperature of the air determines the form of precipitation. Different types of clouds give an indication of the type of precipitation that will occur. Clouds form when warm, moist air rises and cools.

**Stratus clouds** are low to the ground and cover all the sky. Stratus clouds produce rain or snow depending on the surface temperature.

**Fog** is a stratus cloud that is close to the ground.

**Cumulus clouds** are dense and look like fluffy cotton balls. Cumulus clouds may change their shape. Scattered, puffy cumulus clouds can be seen during nice weather. Low, dark gray cumulus clouds can bring rain showers.

**Cirrus clouds** are thin, white clouds that appear high in the sky. They have fuzzy edges and look like feathers. Cirrus clouds can be seen during fair weather.

**Altostratus clouds** may indicate upcoming rain, but the rain dissipates before reaching the ground.
Nimbus linked to a cloud type depicts a dark rain cloud.

**Weather Data and Instruments**

**Weather** is what is happening in the atmosphere at a certain place. Temperature, wind, and precipitation are all parts of the weather.

**Anemometers** measure wind speed.

**Barometers** measure atmospheric pressure. A change in air pressure will indicate a change in the weather. A rising air pressure indicates dry weather and a drop in the air pressure indicates precipitation is coming.

**Climate** is the average weather of a particular location over an extended period of time.

**Meteorologists** are scientists who study the weather and the atmosphere. They measure and record changes in the air. These changes help them to predict the daily weather. A variety of instruments are used to forecast the weather. Thermometers, anemometers, barometers, rain gauges, and wind vanes.

**Rain gauges** measure the amount of precipitation.

**Thermometers** indicate temperature. There are a variety of thermometers available for use. Fahrenheit and Celsius should be used.

**Wind vanes** wind direction.
Unequal Heating Recording Sheet

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Soil</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning Temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After 10 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After 20 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After 30 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference from Beginning Temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Turn off the heat source and measure cooling temperatures for another 30 minutes.

<table>
<thead>
<tr>
<th></th>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference from Beginning Temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What material heated the most? ________________________________________
Heated the least? ____________________________________________________
What material cooled the most? ________________________________________
Cooled the least? ____________________________________________________
Conclusion:___________________________________________________________

__________________________________________________________________________________________

Return to Instructional Segment
Sample Weather Chart:

<table>
<thead>
<tr>
<th>Date</th>
<th>Temperature</th>
<th>Rain fall</th>
<th>Barometric Pressure</th>
<th>Wind direction</th>
<th>Wind speed</th>
<th>Fronts</th>
<th>Cloud type</th>
<th>Cloud coverage</th>
<th>Prediction</th>
<th>Right or Wrong?</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/28/17</td>
<td>79 F</td>
<td>0”</td>
<td>29.9 inHg</td>
<td>NE</td>
<td>9 mph</td>
<td>Stationary</td>
<td>cirrus</td>
<td>Partly Cloudy</td>
<td>Similar weather to today</td>
<td>Correct</td>
</tr>
<tr>
<td>8/29/17</td>
<td>82 F</td>
<td>0”</td>
<td>29.9 inHg</td>
<td>NE</td>
<td>5 mph</td>
<td>Stationary</td>
<td>Cumulus nimbus</td>
<td>Partly Cloudy</td>
<td>Fair tomorrow with possibility of rain</td>
<td>Wrong</td>
</tr>
<tr>
<td>8/30/17</td>
<td>71 F</td>
<td>0.5in</td>
<td>30 inHg</td>
<td>E</td>
<td>3 mph</td>
<td>Low Pressure moving North</td>
<td>Nimbus</td>
<td>Cloudy</td>
<td>Cloudy with possibility of rain</td>
<td>Right: morning</td>
</tr>
<tr>
<td>8/31/17</td>
<td>79 F</td>
<td>.3in</td>
<td>29.9 inHg</td>
<td>SE</td>
<td>6 mph</td>
<td>Warm air High Pressure</td>
<td>Cumulus</td>
<td>Mostly Sunny</td>
<td>Mostly sunny with a slight rise in temperature</td>
<td>Afternoon cleared and sunny</td>
</tr>
</tbody>
</table>

Right or Wrong? Correct Wrong: Rain not fair at all Right: morning Afternoon cleared and sunny
NOAA’s GOES-16 satellite sends first images of Earth

Higher-resolution details will lead to more accurate forecasts

January 23, 2017

Since the GOES-16 satellite lifted off from Cape Canaveral on November 19, scientists, meteorologists and ordinary weather enthusiasts have anxiously waited for the first photos from NOAA’s newest weather satellite, GOES-16, formerly GOES-R.

The release of the first images today is the latest step in a new age of weather satellites. It will be like high definition from the heavens.
This 16-panel image shows the continental United States in the two visible, four near-infrared and 10 infrared channels on the Advanced Baseline Imager (ABI). These channels help forecasters distinguish between differences in the atmosphere like clouds, water vapor, smoke, ice and volcanic ash. (NOAA/NASA)

Download Image

The pictures from its Advanced Baseline Imager (ABI) instrument, built by Harris Corporation, show a full-disc view of the Western Hemisphere in high detail — at four times the image resolution of existing GOES spacecraft. The higher resolution will allow forecasters to pinpoint the location of severe weather with greater accuracy. GOES-16 can provide a full image of Earth every 15 minutes and one of the continental U.S. every five minutes and scans the Earth at five times the speed of NOAA’s current GOES imagers.

NOAA’s GOES-16, situated in geostationary orbit 22,300 miles above Earth, will boost the nation’s weather observation network and NOAA’s prediction capabilities, leading to more accurate and timely forecasts, watches and warnings.

“This is such an exciting day for NOAA! One of our GOES-16 scientists compared this to seeing a newborn baby’s first pictures — it’s that exciting for us,” said Stephen Volz Ph.D. director of NOAA’s Satellite and Information Service. “These images come from the most sophisticated technology ever flown in space to predict severe weather on Earth. The fantastically rich images provide us with our first glimpse of the impact GOES-16 will have on developing life-saving forecasts.”
GOES-16 captured this view of the moon as it looked across the surface of the Earth on January 15. Like earlier GOES satellites, GOES-16 will use the moon for calibration. (NOAA/NASA)

Download Image

In May, NOAA will announce the planned location for GOES-16. By November 2017, GOES-16 will be operational as either GOES-East or GOES-West. Once operational, NOAA will use the satellite’s six new instruments to generate new or improved meteorological, solar, and space weather products.

Second satellite in GOES series already in development

Following on the heels of GOES-R will be, GOES-S, the second of four spacecraft in the series. GOES-S is undergoing environmental testing at Lockheed Martin’s Corporation facility in Littleton, Colorado, where it was built. A full set of environmental, mechanical and electromagnetic testing will take about one year to complete. The GOES-S satellite will be moved into the other operational position as GOES-17 immediately after launch and initial checkout of the satellite, approximately nine months after GOES-16.
Air and Water Investigations for Weather

**Water Drop:** Explain that water sticks to itself (cohesive) and to other objects (adhesive). Allow students to use a toothpick to manipulate a drop of water on waxed paper or plastic plate. The water drop will stick to the toothpick and students can move the drop around the surface. Have them use more than one drop and watch what happens when one drop gets close to another drop.

Explain: Clouds form when a tiny water drops (water vapor) meets another tiny water drop or other tiny particle (smoke, dust, ash) in the atmosphere. When enough collect together, they form a cloud.

**Water is adhesive and cohesive:**

- Do this over a container just in case!
- Fill half a glass with water.
- Place a piece of cardboard or playing card on the top of the glass.
- Hold the cardboard in place and invert the glass.
- Carefully move away the hand holding the card.
- Do this over a container just in case!
- Fill half a glass with water.
- Place a piece of screen on the top of the glass and hold it with a rubber band.
- Place the palm of your hand over the glass and invert the glass.
- Carefully move away the hand holding the screen.

**Clingy water**

- Tie one end of a string to the handle of a measuring cup.
- Run the string over the spout and hold the other end in a bowl.
- Stretch the string until it is tight.
- Hold the measuring cup above the bowl.
- Pour the water out slowly.
- The water clings to the string and can be poured at an angle.

**Full of pennies or clips**

- Place a glass filled with water on paper towels.
- Carefully slip one penny or paper clip at a time into the water being careful not to touch the edge of the glass with the penny or paper clip.
- Continue to add pennies or clips to the water.
- The water will bulge at the top of the glass. This bulge is called a meniscus.
- The water molecules attach to other water molecules to cause cohesion.
- A 5-ounce cup of water will hold over 200 paper clips on a dry day.

**Communicating:** Have students explain how knowing about the properties of water help explain cloud formation.
Thermometer Practice: Provide pairs of students with the opportunity to measure the temperature of warm water, cold water, and room temperature water. Have them practice not touching the thermometer as they collect the data. Explain that they should check each other’s data to see if it is the same.

Teacher Notes: Make sure students know how to read the different scales on the thermometers since different thermometers could differ in Fahrenheit, Celsius, graduated by ones, twos, or fives.

Convection Currents:

1. Use food coloring to color the warm water (85 degrees F or less) and a different color for the cold water (ice in the water).
2. Have students measure out room temperature water into a graduated cylinder.
3. Have them add 5 drops of the colored cold water into the room temperature water and observe. (The cold water will sink to the bottom and show a trail of color as it goes down.)
4. Have students add 5 drops of the colored hot water into the cylinder of water and observe. (The hot water will form a layer at the top of the cylinder.)
5. Let the cylinder sit and observe what happens as the water temperatures equalize.
6. Have them sketch their observations and write what they found out about how water behaves at different temperatures.

Condensation: Demonstrate how water condenses by pouring very warm water in a can and watch as water droplets form on the inside rim. Put cold water in a can and watch as water droplets form on the outside of the can. Have students explain why this happens.

Teacher Notes: Water freezes at 32 degrees F or 0 degrees C but can evaporate at any temperature. The temperature that the water vapor condenses is known as the dew point. This is best done on a humid day.

Air Expands and Contracts

- Wet a dime and the mouth of an empty soft drink bottle.
- Place the dime on the mouth of the bottle.
- Hold the bottle with both hands.
- The heat from your hands warms the air in the bottle.
- The warm air expands, pushing the dime up.

Balloon on heated bottle

- Fill the bottom of a soda bottle with water and put a balloon over the top of the bottle.
- Heat the bottle by placing it in a pan of water.
- Heat the water and observe the heated air expanding into the balloon.
- Remove the bottle with oven mittens and allow the bottle to cool.
- Observe the balloon as the air cools.
Unequal Heating:

Materials: 3 cups, sand, soil, water, 3 thermometers, recording sheet

1. Put sand in a cup. Put the same amount of soil in another cup, and the same amount of water in a third cup.
2. Put a thermometer in the middle of each cup.
3. After 1 minute, have students record the beginning temperature of each material.
4. Place the three cups under the heat source.
5. Have students record the heating temperature every 10 minutes for half an hour.
6. Turn off the heat source and after 1 minute, have students record the beginning temperature of each material.
7. Have them record the cooling temperature every 10 minutes for half an hour.
8. Have them report and discuss findings of the material that heated most, heated least, cooled most, cooled least.

Explain: The unequal heating of the land and water causes weather. As evident from the other investigations, students can relate that this unequal heating can cause air and water movement, clouds, and fronts.

Warm and Cold Fronts (Demo)

- Get two identical jars with small mouths.
- Fill one jar with cold water and a small amount of blue food coloring.
- Fill the other one with heated water colored light red.
- Sprinkle a small amount of pepper on each. The pepper simulates precipitation.
- Explain that the red heated water simulates a warm day. The ground and air above it are warm.
- Explain that the blue cold water simulates a cold front moving in.
- Put an index or playing card over the cold-water jar, invert and place it exactly over the mouth of the heated water jar.
- The card is the leading edge of the cold front.
- Carefully slide the card from between the two jars.
- The heated water will rise; the cold water will sink creating a demonstration of turbulence.
- Put a piece of white paper behind the jars to show the swirling pepper.

When a cold front moves in, we usually have storms, wind, and rain.

- If you reverse the process, put the cold-water jar on the bottom and the hot water jar on top.
- There will only be a drizzling pepper in the jars.

When a warm front moves into an area, we usually have foggy, cloudy, drizzly weather.
Unequal Air Pressure

- Put a small amount of water in an empty soda can.
- Heat to boiling. Heating water to form steam causes it to expand as much as 1000 times.
- When the steam has driven out much of the air, invert the can in cold water. The can will implode.
- As the heated water vapor expands, it increases the pressure on the inside of the can.
- When the can is cooled suddenly, the vapor condenses back to its original state creating a sort of vacuum or low pressure in the can.

OR

- Use a peeled hardboiled egg or a small water balloon.
  - **Safety issues**: Have water handy. Make sure the paper easily fits into the opening. Fire burns up, so when you place the paper in the bottle, the flame burns toward your hand unless you tilt the bottle.
- Heat the inside of a small-mouthed bottle with a flaming twisted paper towel or strip of newspaper. (Heated air increases pressure. It expands.)
- Quickly place a balloon or egg so it covers the opening.
- The flame will smother due to excess carbon dioxide and lack of oxygen.
- When the flame is extinguished, the temperature of the inside of the bottle becomes cooler. (Cooler air decreases pressure. It contracts.)
- The lower pressure inside the bottle pulls the egg into the bottle.

More Heating and Cooling

- Stick a candle to the bottom of a small clear bowl or Petri dish.
- Add some colored water to the dish.
- Light the candle and cover it with a vial or jar.
- Heat causes the air around the flame to expand.
- The candle will go out because the oxygen has been replaced with carbon dioxide.
- The air will cool, causing the air to contract and create a partial vacuum.
- The water will rise in the jar.

Cloud in a Bottle

- Put 15 milliliters of water in a two-liter bottle and swish it all around.
- Light three matches one at a time and drop them into the bottle.
- Put the lid back on the bottle.
- Squeeze the sides of the bottle.
- Low pressure—clouds
- High pressure—fair
Map of Georgia

Observe the movement of the weather from different directions.
Weather Map