Grade: 3rd grade	Topic: The Atmosphere	Number of lessons: 9-11
Brief Lesson Description:		
This series of lessons and investigations will be part of a 3rd grade Earth and Space Science unit exploring Earth's Atmosphere. The phenomenon used to introduce and engage students will be various cloud observations and images collected from NASA satellites. Students will have already explored different types of weather and will have practiced recording daily observations of temperature, precipitation, and cloud coverage - they will be introduced to the troposphere as the level of the atmosphere where weather happens. Students will be challenged to use cloud observations and temperatures to make predictions about future weather. Through a series of exploration labs, students should gain an understanding of weather versus climate and patterns in both. Students will be asked to think about how scientists collect authentic and accurate data and will be challenged to make their own detailed observations to submit to NASA through the GLOBE program.		
Performance Expectations and Goals:		
Students should develop an understanding of the following: 1. The atmosphere has different layers. 2. Weather happens in the troposphere. 3. How clouds are formed and the characteristics of cloud types. 4. Cloud types can be used to predict weather. 5. Weather and climate are different. 6. Patterns in weather and climate help scientists make predictions about future conditions. 7. Data collected from satellites and probes can provide invaluable data and understanding about short- and long-term changes in the atmosphere and can be used to predict these patterns of change.		
Disciplinary Core Ideas: **3-ESS2-1** Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. **3-ESS2-2** Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.	**Science & Engineering Practices:** Students **carry out an investigation** by **using a model** to observe evaporation. They **engage in argument from evidence** using observations from their investigation to explain what clouds are. Students **obtain and communicate information** about different cloud types and **engage in argument from evidence** to determine if a storm will occur and why. Students **organize and analyze data** to decide on the best location for a snow festival. Students **obtain and evaluate**	**Cross Cutting Concepts:** Patterns Students explore patterns of changing clouds as a way to predict weather. Students explore temperature patterns of the past to predict temperatures and weather conditions that will occur. Students recognize climate across the world as an observable pattern. Cause and Effect Mechanisms and Prediction

	information about multiple location's weather. They **communicate the information** through collaborative maps and **analyze and interpret the data** to determine climate patterns.	Students consider the cause-and-effect relationship between heated liquid water and the evaporation of gas water that forms clouds. Energy and Matter: Flows, cycles, and conservations Students will explore the water cycle and how water can exist in 3 states of matter.

Background Information and skills already introduced:

Prior to beginning this unit, students have been recording daily observations of weather conditions. More data is better, but students should have at least 2 weeks of daily observations.

Students have spent time talking about and exploring scientific patterns and using observable data from patterns to support claims. Students have worked collaboratively to collect data and share observations. Students have been introduced to using evidence to support claims and arguing from evidence.

Resources Used:

NASA:
My NASA data: https://mynasadata.larc.nasa.gov/
NASA Climate Kids: https://climatekids.nasa.gov/menu/atmosphere/
Earth Systems Data Explorer: https://mynasadata.larc.nasa.gov/EarthSystemLAS/UI.vm
NASA GLOBE program: https://www.globe.gov/
Other:
Mystery Science: mysteryscience.com
BrainPop: https://www.brainpop.com/teacher

Lesson Plan:

ENGAGE: 1-2 class periods
Objective: To introduce students to the atmosphere, specifically the troposphere where weather happens. To look for patterns in cloud type and coverage and to think about how daily/yearly patterns in weather can help to make predictions about future weather.

1. Ask students to observe different NASA images of cloud coverage. Images will be shown in a slide show and printed and placed around the room for students to move between and observe. The last slide will be copied and glued into their lab books.

2. Ask students to share in small groups - What do they notice? What do they wonder? The teacher will facilitate discussions and guide students to look for similarities/differences in the images. The teacher will also reinforce that these images are real photographs taken at different locations and different times.
3. Lead a class discussion about how these images are all images of cloud coverage and that students will begin a unit exploring how clouds are formed, how patterns in clouds can predict future weather, and how climate relates to weather. Remind students that they have already been working to collect real time authentic data in their daily weather charts.
4. Students will observe actual cloud coverage data through the completion of a cloud coverage flip book.
   "NASA visualizers take data – numbers, codes – and turn them into animations people can see and quickly understand. Students can become a data visualizer by creating their own flipbook animations using maps of science variables that NASA scientists commonly study to better understand the Earth System. "
5. This visualization should help students see that cloud type and coverage is dynamic and changing. Ask students to share what they have observed, what they think, and what they still wonder about clouds and weather.

EXPLORE: 5-7 class periods
Students will complete a modified Mystery Science unit called Stormy Skies. In this unit, students investigate and make predictions about the weather through careful observation of the clouds and wind. Students also learn to differentiate between weather and climate and use models to reveal global climate patterns.

1. Lesson #1: Water Cycle & Phases of Matter - Where do clouds come from?
   Pre-lesson questions for students to think about: What do you think a cloud would feel like? Why?
   a. Clouds may look like white, fluffy, cotton, but they are actually made of water! When liquid water is heated it turns into gas water. This process is called evaporation. Some liquid water from Earth's surface (like oceans and lakes) is heated and turns into invisible water gas. It rises up into the atmosphere and becomes trapped! These trapped water droplets make clouds.
   b. In this lesson, students examine clues about how clouds look and feel to discover what they're made of and how they form. In the activity, Gas Trap, students add hot water to clear cups to observe evaporation firsthand. They observe the condensation of the water vapor on the sides of the cup. They use this model to understand how clouds are formed. Plastic cups with lids are needed.
   c. Students write the definitions of CONDENSATION and EVAPORATION in their lab books. They also write that water can be a solid, liquid, or a gas.

2. Lesson #2: Local Weather Patterns & Weather Prediction - How can we predict when

it's going to storm?

Pre-lesson question for students to think about: What clues would you look for to see if a thunderstorm was coming your way?

a. There are many different types of clouds! Knowing what types of clouds bring stormy weather (and the wind's direction) can help you prepare for a rainstorm. Understanding these patterns help scientists, and you, predict what kind of weather might happen next!
b. In this lesson, students learn how to make predictions about the weather by observing clouds and their changes. In the activity, Storm Spotter's Guide, students create a small book to record their notes, identify different types of clouds, and think about wind direction to figure out if a storm is heading their way.

3. Lesson #3: Seasonal Weather Patterns - Where's the best place to build a snow fort?

Pre-lesson questions for students to think about: How do you know it's winter where you live? What clues do you look for? What changes do you notice?

a. Weather changes from day to day and from season to season, but examining patterns of weather in the past can help predict future weather. Looking at regional temperature patterns during one season can inform what weather we might expect in future years during that season.
b. In this lesson, students explore seasonal weather conditions across different regions. They investigate how weather patterns can be used to make predictions about future weather. In the activity, Snow Fort Weather, students organize daily temperature data from three snowy towns into a table so that they can compare weather conditions and predict which town is most likely to have the best weather for a snow fort festival next year.

4. Lesson #4: Climate, Geography & Global Weather Patterns - Why are some places always hot?

Pre-lesson question for students to think about: What's the climate like where we live?

a. Weather conditions that are predictable and occur over long periods of time are called climates. There are 5 climates--tropical, polar, temperate, mild, and desert. Each climate occurs in a specific part of the world, depending on how much sunlight and rain it gets throughout the year.
b. In this lesson, students are introduced to the concept of "climate" and explore the world's five major climates. In the activity, Climate Decoder, students color one part of a world map to figure out the different climates of that region. Students then combine maps and search for global climate patterns.
c. Students should write the definition of climate and weather in their lab books.

EXPLAIN: 1-2 class periods
-BrainPop video about clouds - the quiz at the end will be completed as a class. The video cannot be viewed without a membership - here is the transcript.
-My cloud sort activity to be completed in small groups as the teacher moves around and facilitates discussions and collaboration.
-My cloud sort answer key should be shared in a large group discussion. Time should be spent on the last 5 slides as there will probably be different answers and ideas about what possible cloud types are present.
-Here is a great interactive resource from NASA to help students understand the atmosphere and to use while working on the cloud sort activity.
-All the content presented in the explain section should be a review of the information students discovered through their investigations.

ELABORATE: 1-2 class periods
Authentic real data, like cloud type and coverage, can be used to explain and predict patterns on earth like future weather. Remind students how they just used cloud images from satellites and from earth to predict if storms are approaching and how they used yearly winter temperatures and weather data to predict future winter weather patterns. Explain that they will now be the scientists collecting the data and sharing their observations with NASA scientists who will compare their ground observations with satellite images.

1. Use the cloud identification chart to review cloud types, cloud coverage, and contrails. Introduce cloud opacity, sky visibility, and sky color.
2. Students should work in teams, outside, to collect data on their Atmosphere Investigation: Cloud Protocol Data Sheet. Students should use the Sky window to help them make accurate observations. The sky window should be copied on cardstock (double sided) with the center cut out for students to view the sky through.
3. Using the iPad and the NASA Globe Observer app (clouds protocol) - students should submit the data collected on the cloud protocol data sheet. Explain to the students that their ground data will be used in conjunction with satellite data taken from above the clouds. More information about why this satellite matching data is important and how it is used can be found here. The app is easily downloaded to an iPad and is very student friendly.

Here is a Cloud cover interactive activity that students might find helpful before collecting data.

EVALUATE:
Students will be evaluated throughout the lessons on:
- Class/small group discussion participation
- Completion of lab sheets/storm spotters guide for the 4 Mystery Science modified lessons - completed as a lab group
- Accurate collaborative climate map - completed as a team

- Mystery Science lesson assessment - completed individually
- Exit ticket for Lesson #1, #2, and #4 - completed individually
- Completion of cloud protocol data sheet - completed as a team
- Students would pick one cloud image and make a claim about what cloud type they think it is, providing at least one piece of evidence to support their claim. The images will be printed with the cloud type covered - completed individually

Mathematics Standards

Mathematics: Grade 3 PA Core Standards

Measurement, Data and Probability

Represent and interpret data using various displays.

Solve problems involving measurement and estimation of temperature

Construct viable arguments and critique the reasoning of others.

Mathematics Common Core Standards - Grade 3

Measurement and Data

Represent and interpret data.

Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories.

Mathematical Practices

Make sense of problems and persevere in solving them.

Reason abstractly and quantitatively.

Construct viable arguments and critique the reasoning of others.

Look for and express regularity in repeated reasoning and patterns.

Using a thermometer – comparing different units of measurement.