

## Weather, Climate & Water Cycling: Why does a lot of hail, rain, or snow fall at some times and not others? EQIP Rubric for Science Evaluation

**Developer/Curriculum:** OpenSciEd

**Unit Name:** Weather, Climate & Water Cycling: Why does a lot of hail, rain, or snow fall at some times and not others?

**Grade:** 6–8

**Date of Review:** February 2020

**Overall Rating (N, R, E/I, E):** E/I

[Category I: NGSS 3D Design Score \(0, 1, 2, 3\): 2](#)

[Category II: NGSS Instructional Supports Score \(0, 1, 2, 3\): 2](#)

[Category III: Monitoring NGSS Student Progress Score \(0, 1, 2, 3\): 3](#)

*Total Score (0–9): 7*

[Click here to see scoring guidelines](#)

This review was conducted by the [Achieve](#) Peer Review Panel using the [EQIP Rubric for Science](#).

| Category I Criteria Ratings                 |           | Category II Criteria Ratings            |            | Category III Criteria Ratings         |           |
|---|-----------|---|------------|---------------------------------------|-----------|
| A. Explaining Phenomena/Designing Solutions | Adequate  | A. Relevance and Authenticity           | Adequate   | A. Monitoring 3D Student Performances | Adequate  |
| B. Three Dimensions                         | Extensive | B. Student Ideas                        | Adequate   | B. Formative                          | Adequate  |
| C. Integrating the Three Dimensions         | Extensive | C. Building Progressions                | Adequate   | C. Scoring Guidance                   | Adequate  |
| D. Unit Coherence                           | Adequate  | D. Scientific Accuracy                  | Extensive  | D. Unbiased Tasks/Items               | Adequate  |
| E. Multiple Science Domains                 | Adequate  | E. Differentiated Instruction           | Adequate   | E. Coherence Assessment System        | Extensive |
| F. Math and ELA                             | Adequate  | F. Teacher Support for Unit Coherence   | Adequate   | F. Opportunity to Learn               | Adequate  |
|   |           | G. Scaffolded Differentiation Over Time | Inadequate |                                       |           |

### Summary Comments

Thank you for your commitment to students and their science education. Achieve is glad to partner with you in this continuous improvement process. The unit is strong in several areas, including integration of the three dimensions, scientific accuracy, and the inclusion of a teacher-friendly assessment system. All lessons provide a carefully crafted three-dimensional learning goal with broad and comprehensive content background for teachers. The Assessment System Overview provides teachers with a detailed, complete description of each type of assessment provided in the unit and lesson-by-lesson assessment guidance. Another strength of this unit is the “Elements of NGSS Dimensions” document that accompanies

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the teacher materials. This exhaustive document provides element-level SEPs and CCCs addressed in every lesson.

During revisions, the reviewers recommend paying close attention to the following areas:

- **Differentiated Instruction** – Consider providing opportunities for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.
- **Unit Coherence** - Opportunities for students to feel that their own questions are driving the learning could be more explicit and pervasive.
- **Student Ideas** - A variety of text, besides articles, could be provided to students throughout the unit.
- **Formative Assessment** - While there are multiple opportunities throughout the unit for formative assessment, consider adding clear guidance for teachers on how to interpret a range of student responses and change instruction based on varied student responses.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met and purple text is used as evidence that the criterion was not met.

### Category I. NGSS 3D Design

Score: 2

*3: At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C*

*2: At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C*

*1: Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C*

*0: Inadequate (or no) evidence to meet any criteria in Category I (A–F)*

**I.A. Explaining Phenomena/Designing Solutions:** Making sense of phenomena and/or designing solutions to a problem drive student learning.

Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.

The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.

When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

**Rating for Criterion I.A Explaining Phenomena/Designing Solutions: Adequate**  
(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that learning is driven by students making sense of phenomena because the materials in the first part of the unit (Lessons 1–13) are organized so that students figuring out a central phenomenon drives the learning across the unit. However, in the second half of the unit the

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phenomenon is connected to the learning but doesn't drive it as well as it could. The phenomenon is not referred to directly in the last four lessons.

The unit is mostly driven by phenomena that build upon student understanding. Some examples include:

- **Lesson 1** - Students observe, generate questions, and make predictions about mechanisms associated with weather (hail) events. Students develop initial models to explain the phenomenon of hail. At the end of Lesson 1, students create a poster of “Ideas for future investigations and Data We Need.”
- **Lesson 2** - Students examine photos of hailstones and analyze and interpret data from cases of hail events at different locations and times of year to notice patterns and identify relevant factors that might explain the formation of hail. “Give students 3–5 minutes to quietly update their Progress Tracker using words and drawings to show what they’ve learned so far about the conditions on days when it hails” (Teacher Edition, page 84).
- **Lesson 3** - Students analyze and interpret weather balloon data to figure out what happens to the temperature of the atmosphere as the distance from the Earth’s surface increases. At the end of the lesson during the Navigation section, teachers are prompted to say, “Remember, we are ultimately trying to explain how hailstorms form. We now know the air is colder higher up in the atmosphere than it is near the ground, which helps us understand where it might be cold enough for hailstones to form. Our next step is to figure out why the air up high is colder” (Teacher Edition, page 99).
- **Lesson 4** - Students plan an investigation to figure out what causes the air above different ground surfaces to be warmer than the air higher in the atmosphere. They measure the temperature of different ground surfaces and the air temperature above them, and also the amount of sunlight reaching and reflecting off them. During the navigation section, teachers are prompted, “Say, We are trying to figure out how a hailstorm can happen on a hot day, so tracking energy from the Sun to Earth’s surface could help explain what causes the temperature patterns we are noticing” (Teacher Edition, page 113).
- **Lesson 5** - Students conduct an investigation to explore how transferring thermal energy into and out of a parcel of air in a closed system (a bottle of air with a soap bubble film over the top) affects that air’s volume and behavior. They conduct a second investigation to explore how density changes in a parcel of air in another closed system (a balloon) cause it to float or sink in the surrounding air. They also develop a model to represent how the speed, spacing, and density of molecules that make up air are affected by temperature changes. At the end of the lesson, teachers are prompted, “Say, Now that we understand what happens to air when it is warmed up, let’s think about the anchoring phenomenon. How does rising and sinking air help us explain what is happening to the air outside on a day when it hails?” (Teacher Edition, page 142)

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- **Lesson 6** - Students examine photos and a video of clouds that tend to produce hail to look for patterns in the motion of air as clouds form. They construct an explanation using evidence for the path of air movement below, within, and at the top of a type of cloud that tends to form hail.
- **Lesson 7** - Students plan and carry out an investigation to determine where the water that's in the air comes from by measuring the humidity in the air over different samples of Earth surfaces. "Ask students to turn and talk about this question: How does what we just figured out help us explain what is happening in the clouds? Listen for ideas about how we are trying to explain how water gets into the clouds since we know that hailstorms have rain and frozen water" (Teacher Edition, page 170).
- **Lesson 10** - Students use the Gotta-Have-It Checklist to test and revise a thunderstorm simulation to produce larger and smaller storms. "Ask these questions: Did you notice how the storm clouds got really tall in the simulation when we made a big storm? How does that happen? Can we explain how hail forms yet?" (Teacher Edition, page 213)
- **Lesson 11** - Students try to lift or suspend different objects with air blown upward and record the weight of different objects and the amount of force that air blown toward or away from a digital scale registers on it. They develop a model to show how objects (like hail) might be lifted upward, fall downward, or remain suspended in the air, depending on the relative strength of two different forces acting on it.
- **Lesson 13** - Students create a final model to explain why some storms produce hail and others don't and answer other storm-related questions.
- **Lesson 14** - The second half of the unit has a new anchoring phenomenon. Students watch a video clip of a forecast and weather report for an upcoming snowstorm.
- **Lesson 16** - Students carry out an investigation using a tub and a divider between warm and cold fluids to explore what happens along a frontal boundary where warm air and cold air meet. "When students are ready, close the lesson by saying, we have figured out what happens when a warm air mass and a cold air mass interact and we have figured out why it happens. But I wonder...How do scientists know when a front is moving into an area? We can't see warm and cold air masses, so how do they know when a front is moving into an area and the weather is going to change? I think we need to figure out how scientists do this" (Teacher Edition, page 323).
- **Lesson 17** - Students analyze national pressure maps from around the time of the original forecast (phenomenon).
- **Lesson 18** - Students explore video and maps from three parts of a weather report and forecast from January 19th, 2019. This lesson refers directly to the anchoring phenomenon.
- **Lessons 19–22** - These lessons do not have a direct connection to the new phenomenon introduced in Lesson 14.

#### Suggestions for Improvement

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It would be helpful to determine a way to make the final lessons (14–22) more directly connected to the second anchoring phenomenon and to revisit the phenomenon each lesson. Alternatively, a different phenomenon could be chosen that could more easily be used to drive instruction through the entire series of lessons.

**I.B. Three Dimensions:** Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

Provides opportunities to *develop and use* specific elements of the SEP(s).

Provides opportunities to *develop and use* specific elements of the DCI(s).

Provides opportunities to *develop and use* specific elements of the CCC(s).

#### **Rating for Criterion I.B. Three Dimensions: Extensive** (None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions because students are using and developing elements of each of the three dimensions and those elements support students to make sense of the unit phenomena.

#### **Science and Engineering Practices (SEPs): Extensive**

The reviewers found extensive evidence that students have the opportunity to use or develop the SEPs in this unit because there is consistent use and development of a variety of Science and Engineering Practices at the appropriate grade’s element level. Students are provided with a large variety of opportunities to utilize and develop Science and Engineering Practices in service of making sense of phenomena. Some examples of the specific Science and Engineering Practice elements and how they are utilized and developed are found below:

#### **Developing and Using Models**

- In Lesson 1, “Cue students to create their initial models by first representing what type of changes they saw happening outside before, during, and after the precipitation event” (Teacher Edition, page 60).
  - Element - *Develop and/or use a model to predict and/or describe phenomena.*
- In Lesson 4, “Tell students to draw and write their ideas about the scenario and questions presented on the slide: Energy from the Sun enters Earth’s atmosphere. It travels to the surface of Earth, where it reaches the ground. What happens when the light reaches the surface? What happens to the temperature of the ground? Explain your thinking. What happens to the air in contact with the ground?” (Teacher Edition, page 113).

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- Element - *Develop a model to describe unobservable mechanisms.*
- In Lesson 5, students create a model of what is happening to molecules inside a balloon immediately after it is heated.
  - Element - *Develop a model to describe unobservable mechanisms.*
- In Lesson 7, students individually develop models to explain how water gets into the air.
  - Element - *Develop and/or use a model to predict and/or describe phenomena.*
- In Lesson 10, “Pass out a copy of Blank Simulation to Revise Make a Thunderstorm and tell students they will work in partners to creatively revise the simulation to account for more of the ideas on the checklist. Give students the remaining time to work on their revisions. Students may use colored pencils or markers to mark up the blank version of the simulation” (Teachers Edition, page 212).
  - Element - ~~*Develop or modify a model— based on evidence—to match what happens if a variable or component of a system is changed.*~~
- In Lesson 11, students draw a model to represent what they think is going on when there are opposing forces acting on water droplets or crystals. The model represents the following three variables: when the forces are equal, when updraft forces are stronger, and when updraft forces are weaker. This model development is scaffolded through a whole class discussion transitioned to working with partners.
  - Element - ~~*Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.*~~
- In Lesson 12, “Pass out one copy of Air Movement in Different Conditions to each group and ask students to work with their group to map the results from the condition they tested. Remind them to show what would be different about the amount of lift in the air and the winds along the ground in each condition and what caused these differences. Give 5–7 minutes for groups to complete their visual. Encourage students to use their science notebook to jot down noticing and wonderings from the other groups’ results” (Teachers Edition, page 246).
  - Element - ~~*Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.*~~

#### Analyzing and Interpreting Data

- In Lesson 2, as students are reviewing weather data, “Ask pairs to identify one thing they notice about the time of day or conditions (temperature and humidity) when hail occurred” (Teacher Edition, page 80).
  - Element - *Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.*
- In Lesson 3, students “analyze and interpret weather balloon data to determine how the temperature of the air higher up compares to the temperature of the air closer to the ground” (Teacher Edition, page 88).

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- Element - *Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.*
- In Lesson 14, students look at forecast maps to identify patterns and relationships between what is happening in various locations.
  - Element - *Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.*
- In Lesson 15, students analyze temperature and humidity data before, during, and after storms and radar images showing “the intensity and type of precipitation (water) falling over an area” to figure out “Why would precipitation happen where two air masses meet?” (Teacher Edition, pages 283–290).
  - Element - *Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.*

#### Planning and Carrying out Investigations

- In Lesson 4, students plan an investigation to answer the question, “How could we study air close to the ground to see what is happening?” On the planning worksheet, students must identify the data they should collect and why, the tools they will use to collect the data, how they will use the tools, and what sites they will collect data from.
  - Element - *Plan an investigation individually and collaboratively, and in the design: ~~identify independent and dependent variables and controls~~, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.*
- In Lesson 5, students conduct two investigations. In the first investigation, they trap air in a bottle using a soap bubble film, creating a closed system. They cool and warm the bottle to observe the effects on the air inside the bottle. In the second, they observe the effects of warming a partially filled balloon on the helium inside the balloon and the balloon’s behavior. In both, students collect observational data to use as evidence to support their thinking.
  - Element - *Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.*
- In Lesson 7, students “Conduct an investigation in small groups to simulate environments where water may be coming from and collect data to see whether the humidity levels change” (Teacher Edition, page 160). As students are designing the investigation, they are asked, “What data should we collect? How will that help us answer our question? How could we use these materials to gather this data? What can we agree on for how to do the investigation and what data to collect?” (Teacher Edition, page 166).
  - Element - *Collect data to produce data to serve as the basis for evidence to answer scientific questions ~~or test design solutions under a range of conditions.~~*

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- In Lesson 8, “Let’s investigate these predictions by collecting some data. I have our same materials from yesterday available for us to use again for this investigation. That includes 2-L bottle covers from the last class that we could reuse again to trap some warm, humid air and cool it down so we could observe what happens to it more closely” (Teacher Edition page 184).
  - Element - *Collect data to produce data to serve as the basis for evidence to answer scientific questions ~~or test design solutions under a range of conditions.~~*
- In Lesson 12, “Say, in order to figure out what variables affect the amount and direction of the lift, you will get lab setups to test different conditions. Each group will get a different condition to test and share observations with the class. Let’s think about how to set up your investigations. Let’s use our demonstration setup to think through the design of our investigation” (Teacher Edition page 243).
  - Element - *Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, ~~and how many data are needed to support a claim. Evaluate the accuracy of various methods for collecting data.~~*

#### **Disciplinary Core Ideas (DCIs): Extensive**

The reviewers found extensive evidence that students have the opportunity to use or develop the DCIs in this unit because there are sufficient DCIs for the length of the materials, the claimed DCIs are evidenced in the unit, and there is a reasonable match between DCIs that are claimed and the evidence of DCIs developed and used in the materials. Below are DCI elements that are claimed and developed within the unit:

#### **ESS2.C: The Roles of Water in Earth's Surface Processes**

- *Water continually cycles among ~~land~~, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, ~~as well as downhill flows on land.~~ Global movements of water and its changes in form are propelled by sunlight and gravity.*
  - In Lesson 7, students conduct an investigation to determine where the water that is in the air comes from.
  - In Lesson 8, students conduct an investigation to determine what happens to water vapor in the air when it is cooled down. Students construct an explanation about how water droplets form.
  - In Lesson 9, students read about what clouds are made of and how they form.
  - In Lesson 11, students investigate why water droplets don’t always fall from clouds and take into consideration the role of gravity (and other forces).
  - In Lesson 17, “Say, Weather scientists have discovered similar patterns in the data from barometers in different parts of the world and at different times of year. Whenever the density of the air over a region decreases it typically corresponds to the air in that part of



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an air mass rising. And when there is sufficient humidity in that air, rising air tends to produce clouds, as the water vapor in it condenses as it is pushed higher up where it cools" (Teacher Edition page 334).

#### ESS2.C: The Roles of Water in Earth's Surface Processes

- *The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.*
  - In Lesson 12, students conduct an investigation to determine the factors that affect movement of air. Students fill out Air Movement in Different Conditions worksheet to demonstrate what they have learned about the factors that affect air movement.
  - In Lesson 15, students look at radar data to determine how air moves and how that affects the formation of precipitation and storms.
  - In Lesson 17, "Say, In order to figure out what was happening with the winter storm we've been investigating, we've developed some ways to visualize where the cold air and warm air was located before, during, and after it dumped precipitation on different parts of the country. Since we know that rising air corresponds should be detected as a drop in air pressure, and rising air lead to cloud formation, let's make some predictions about where we think barometers would have detected lower pressure air over the United States from the start of Jan 18th, 2019 to end of Jan 20th, 2019?" (Teacher Edition, page 335)

#### ESS2.D: Weather and Climate

- *Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.*
  - In Lesson 19, after viewing a one-week visualization of precipitation rates, "Ask students to share what they noticed and invite students to use the class' annotated map to help them articulate their observations. Use the students' questions from the navigation to guide this discussion. Partway through the discussion, transition students to start thinking about how the predictable air movement influences the kinds of air masses that move across the U.S. Suggested Prompts: Do you think this sort of pattern of air movement from west to east something that happens all the time? Which parts of the U.S. clearly have this air movement pattern? Does the air move east to west or north to south too? What do we think the air is like that comes up from the south, like the Gulf of Mexico? What is the air like that comes from the north? How do you think this could influence the precipitation in these places? Does a place need to be near the ocean to get a lot of precipitation?" (Teacher Edition, pages 361-362).

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- In Lesson 20, students look at ocean temperature data, read about ocean circulation, and analyze precipitation data to determine how oceans affect precipitation.

#### PS1.A Structure and Properties of Matter

- *Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.*
  - In Lesson 3, “We develop a consensus model for representing the motion of the molecules that make up air at different temperatures” (Teacher Edition, page 4).
  - In Lesson 5, “We conduct a second investigation to observe how density changes in a parcel of air (in a balloon) cause it to float or sink in the surrounding air. For each investigation, we develop a model to represent how the speed, spacing, and density of the molecules that make up air are affected by temperature changes” (Teacher Edition, page 5).
  - In Lesson 6, “students use particle-level explanation of changes in the speed, spacing, and density of molecules as temperature is changed, to predict and explain why parcels of air would rise or fall in surrounding air when it is heated or cooled” (Teacher Edition, page 239).
  - In Lesson 8, “We use magnetic marbles as a physical manipulative to develop a model for how temperature changes and mutual attraction between molecules can explain why water changes from states heated above or cooled below a certain temperature” (Teacher Edition, page 7).
  - In Lesson 12, “students extend that model of convection to explain the circulation of any fluid (gas or liquid), including how movement can change with the input of thermal energy” (Teacher Edition, page 239).

#### **Crosscutting Concepts (CCCs): Adequate**

The reviewers found extensive evidence that students have the opportunity to use or develop the CCCs in this unit because there are sufficient CCC elements for the length of materials and there is a reasonable match between CCCs that are claimed and the evidence of CCCs developed and used in the materials. Below are CCC elements that are claimed within the unit:

#### **Patterns**

- In Lesson 2, students examine photos of hailstones and analyze and interpret data from cases of hail events at different locations and times of year to notice patterns and identify relevant factors that might explain the formation of hail. “After students have worked on their own, spend about

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5 minutes as a class having them share out patterns they saw in the data” (Teacher Edition, page 78).

- Element - *Graphs, charts, and images can be used to identify patterns in data.*
- In Lesson 3, students look for patterns in weather balloon data and relate this pattern to the movement of molecules in the air.
  - Element - *Macroscopic patterns are related to the nature of microscopic and atomic-level structure.*
- In Lesson 4, “Give students individual think time to notice any patterns across all the group measurements” (Teacher Edition, page 111).
  - Element - *Graphs, charts, and images can be used to identify patterns in data.*
- In Lesson 8, “Think about what you just saw a whole bunch of water molecules in liquid form do when they got close to another bunch of water molecules in liquid form. First, explain what might be happening between the water droplets that would make them do this. Then, imagine the same thing happening between any two water molecules when they get close to each other. How could you use these ideas to explain why liquid droplets appeared on the side of the bottle and grew larger as you decreased the temperature of the air with water vapor in it?” (Teacher Edition, page 186)
  - Element - *Macroscopic patterns are related to the nature of microscopic and atomic-level structure.*
- In Lesson 11, students explore the “role of opposing forces on changing an object” motion and position. In particular, students consider how opposing forces on water droplets or crystals can explain why they don’t immediately fall out of them when they first start forming and why precipitation occurs when it does (Teacher Edition, page 226).
  - Element - *Macroscopic patterns are related to the nature of microscopic and atomic-level structure.*
- In Lesson 14, students use a “Cloud Cover and Precipitation Map” to develop a model to show what students think will happen in the air over the United States at three points in time (Teacher Edition, page 274).
  - Element - *Graphs, charts, and images can be used to identify patterns in data.*
- In Lesson 16, “The purpose of this Building Understandings discussion is to find patterns in our observational data and generalize our descriptions of how warm and cold fluids interact. These generalized descriptions will help us begin to understand some of the weather changes that occur along warm and cold fronts” (Teacher Edition, page 313).
  - Element - *Graphs, charts, and images can be used to identify patterns in data.*

#### Cause and Effect

- In Lesson 5, students are asked to use the cause and effect relationship they previously investigated to predict answers to the questions: What do you think will happen to the air in the

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bottle when it is in contact with the cold water? Why? What do you think will happen to the air in the bottle when it is in contact with the hot water? Why?

- Element - *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
- In Lesson 10, following the use of a thunderstorm simulation “When students have had sufficient time to manipulate the conditions in the simulation, ask them which conditions produced stronger or larger storms and which conditions produced smaller storms” (Teacher Edition, page 215).
  - Element - *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
- In Lesson 10, students “construct an explanation to explain the relationship between the inputs in the simulation (i.e., temperature, humidity) and the output (storm formation), and why these inputs can only be used to predict when a storm might occur” (Teacher Edition, page 213).
  - Element - *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
- In Lesson 12, students “plan and carry out an investigation to determine what variables affect the amount of lift produced in a fluid. Students explain how the results of our investigation help us understand how differences between the air and ground temperatures can cause different amounts of lift and movement of the air.”
  - Element - *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
- In Lesson 13, students develop a model which explains why some storms produce hail using the cause and effect relationships they have developed throughout the unit.
  - Element - *Phenomena may have more than one cause, ~~and some cause and effect relationships in systems can only be described using probability.~~*
- In Lesson 20, students answer a variety of questions after analyzing ocean temperature maps. Questions include: How does the ocean affect an air mass? How could this affect the air above the ocean at the equator? How do you think this could affect the air above the ocean in these places? How does the ocean affect air or air masses? How does the ocean affect weather? Does the ocean cause these large storms? How do oceans affect whether a place gets a lot or a little precipitation? How do oceans relate to the air masses we’ve been investigating? “Examine students’ exit tickets to see if they are (1) making causal connections between ocean temperatures and air mass humidity, (2) using information from multiple sources, and (3) identifying important ideas about ocean circulation and temperature that would affect the chance of precipitation in a location” (Teacher Edition, page 374).
  - Element - *Relationships can be classified as causal or correlational, ~~and correlation does not necessarily imply causation.~~*

#### Systems and System Models

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- In Lesson 5, “When focusing on the crosscutting concept of Systems and System Models, students learn that models, whether built or drawn, are used to represent systems and their interactions, including inputs, processes, and outputs. They also come to understand that energy, matter, and information flow within and through systems. At this point in the lesson, you may want to spend a little time reminding students that matter cannot enter or leave a closed system. However, energy can enter and leave a closed system” (Teacher Edition, pages 124–125).
  - Element - *Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.*
- In Lesson 10, students are asked questions about a thunderstorm system simulation. “What does the simulation help us see that we already have in the checklist? What does it help us see that we did not have in the checklist? What is the simulation missing that we wished it had?” (Teacher Edition, page 210)
  - Element - *Models are limited in that they only represent certain aspects of a system under study.*

#### Matter & Energy

- In Lesson 3, the teacher asks, “What do we know about temperature and the kinetic energy of particles of matter?” and is looking for these sample student responses, “Light that is absorbed by matter transforms into thermal energy. The particles of matter move; so, the particles have kinetic energy. Temperature is the average kinetic energy of the particles in a substance. A particle’s speed is related to how much kinetic energy it has. The particles in a hot substance have more kinetic energy than the particles in a cold substance” (Teacher Edition, page 97).
  - Element - *Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion).*
- In Lesson 4, the class has a discussion “To generate a list of ideas related to how energy from the Sun can be absorbed by the ground, increasing its kinetic energy (and therefore temperature), and then how some of that energy transfers to the air above” (Teacher Edition, page 114).
  - Element - *The transfer of energy can be tracked as energy flows through a designed natural system.*

#### Suggestions for Improvement

SEPs

N/A

DCIs

N/A

CCCs

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Consider adding lessons or tasks where specific CCC elements are developed, not just used or mentioned in instruction.

**I.C. Integrating the Three Dimensions:** Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

#### **Rating for Criterion I.C. Integrating the Three Dimensions: Extensive** *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena or designing solutions to problems because there are numerous events where all students are expected to figure something out in a way that requires grade-appropriate elements of all three dimensions of the standards.

In the “What Students Will Do” section in the Teacher Edition for each lesson, at least one color-coded three-dimensional learning target is provided. For example:

- In Lesson 7, “**Plan and conduct an investigation using a model to gather data to serve as evidence to support a claim about from where water in the air originates (inputs)**” (Teacher Edition, page 159).
- In Lesson 19, “**Use visualized precipitation data from a large data set to identify spatial patterns in the direction of air masses movement that influences long-term weather patterns in predictable ways**” (Teacher Edition, page 355).

Some examples of how the three-dimensions are integrated can be found below:

- In Lesson 3, students analyze and interpret temperature profiles of the atmosphere collected from weather balloons at various altitudes at different locations during different times of the year and develop a consensus model for representing the motion of the molecules that make up air at different temperatures. This lesson combines grade appropriate elements of the SEP **Analyzing and Interpreting Data**, the CCC **Matter and Energy**, and a DCI for **Weather and Climate**.
- In Lesson 4, students plan an investigation to figure out what causes the air above different ground surfaces to be warmer than the air higher in the atmosphere. They measure the temperature of different ground surfaces and the air temperature above them, and also the amount of sunlight reaching and reflecting off them. These data help students figure out that different amounts of incoming and reflected sunlight are associated with different ground and surface air temperatures, and that ground temperatures are warmer than surface air temperatures. This lesson combines grade appropriate elements of the SEP **Planning and Carrying Out Investigations**, the CCC **Patterns**, and a DCI for **Weather and Climate**.

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- In Lesson 5, students carry out an investigation using a bottle of air with a soap bubble film as a system model to study the effects of heating and cooling air. Students then develop a model in which they track the flow of energy in and out of the system. This lesson combines grade appropriate elements of the SEP **Planning and Carrying Out Investigations**, the CCC **Systems and System Models**, and a DCI for **Weather and Climate**.
- In Lesson 17, students analyze pressure maps to identify patterns in order to develop an explanation how weather events in different parts of the country at different times can affect each other. This lesson combines grade appropriate elements of the SEP **Analyzing and Interpreting Data**, the CCC **Patterns**, and a DCI for **Weather and Climate**.

#### Suggestions for Improvement

N/A

**I.D. Unit Coherence:** Lessons fit together to target a set of performance expectations.

Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.

The lessons help students develop toward proficiency in a targeted set of performance expectations.

#### **Rating for Criterion I.D. Unit Coherence: Adequate**

*(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that lessons fit together coherently to target a set of performance expectations because each lesson builds on prior lessons by addressing questions raised in those lessons, and students are supported to develop toward proficiency in the targeted set of learning performances.

Examples of unit coherence can be found below:

This unit targets the following Performance Expectations: MS-PS1-4, MS-ESS2-4, MS-ESS2-5 and MS-ESS2-6. The ESS PE's are fully developed while only parts of MS-PS1-4 are developed. The teacher edition provides an explanation for this partial development. "Most parts of the next PE were addressed in the prior OpenSciEd unit 6.2. The remaining part of the PE that students have not addressed are underlined; these are addressed in this unit. MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed." (Teacher Edition, page 18).

Students revisit their original questions while also having the opportunity to develop new questions:

- The Unit phenomena are revisited in Lessons 2, 3, 4, 5, 6, 7, 10, 11, 13, 14, 16, 17, and 18.

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- This unit uses a Driving Question Board (DQB) to cultivate student questions. The DQB is used in Lessons 1, 6, 13, 14, 18, 19, and 22.

Navigation sections in each lesson in the Teacher’s Edition provide teacher guidance for how to connect lessons through student questions or phenomena.

- In Lesson 3, “Navigate from previous lessons. Tell students, In Lesson 1, we observed videos of hailstorms. They occurred in various locations and at different times of the year, but we noticed some similarities among the hailstorms. This led us to look at weather data for several sites where hailstorms occurred, and we noticed some patterns in the data. So, think back to the videos we observed in Lesson 1 and the data we analyzed in Lesson 2. What was the air like on a day when it hailed? Call on a few students to share their thinking” (Teacher Edition, page 91).
- In Lesson 4, “Summarize the investigation plan. Use slide H to remind students of the question we are trying to answer and how this investigation plan will help us answer it” (Teacher Edition, page 109).
- In Lesson 7, “Ask students to turn and talk about this question: How does what we just figured out help us explain what is happening in the clouds? Listen for ideas about how we are trying to explain how water gets into the clouds since we know that hailstorms have rain and frozen water” (Teacher Edition, page 170).
- In Lesson 8, “Say, But if we know water droplets can form in air that is cooled that has water vapor in it, then why aren’t water droplets always forming in the air above us outside? And if clouds are related to precipitation, then at what point exactly are droplets forming in the clouds? We have some ideas about how droplets might grow bigger, but why isn’t precipitation always falling from any clouds that pass over us? What exactly is a cloud, anyway? If we look back at our Driving Question Board, we can see that we had some questions about clouds and what is going on inside of them. Let’s start talking about these ideas, so we have some ideas about what we need to figure out next time” (Teacher Edition, page 191).

Student questions drive each lesson to build an understanding of core ideas and concepts and guidance/instruction is provided to support the cultivation of new questions arising from related phenomena or prior experiences. For example:

- In Lesson 1, “Give students sticky notes and at least 4 minutes to generate questions” (Teacher Edition, page 66).
- In Lesson 4, “Give students an opportunity, through discussion, to come to an agreement about the evidence and generate a list of the ideas we have figured out now” (Teacher Edition, page 114).
- In Lesson 6, “Say, Let’s revisit our DQB and see which questions we have made progress on, and then next time we can see if there are any questions we need to refine or want to pursue in upcoming lessons” (Teacher Edition, page 151).



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- In Lesson 11, “The local observations that students are making in this weather log provides additional opportunities for students to connect their learning to events in their lives by asking them to connect to their own experiences and generate questions based upon their real-life experiences” (Teacher Edition, page 233).
- In Lesson 14, “Give students 4 minutes to generate their questions on sticky notes” (Teacher Edition, page 276).
- In Lesson 18, “Each remaining activity the class does will be aimed at trying to help students identify new areas of curiosity, uncertainty, or gaps in understanding in order to help them generate new questions” (Teacher Edition, page 350).

Questions that drive learning in the next lesson are often driven by the teacher. For example:

- Lesson Four: “This may or may not have already come up while discussing predictions. Ask, Why is the air near the ground warmer than the air higher up? Write this question in a public space to refer to it throughout the lesson. Importantly, follow up with, How could we investigate this question?” (Teacher Edition, page 105)
- Lesson 16: “Navigate to the next lesson. Before closing the lesson, direct students to tape Relative Humidity Data into their notebooks. When students are ready, close the lesson by saying, We have figured out what happens when a warm air mass and a cold air mass interact and we have figured out why it happens. But I wonder...How do scientists know when a front is moving into an area? We can’t see warm and cold air masses, so how do they know when a front is moving into an area and the weather is going to change? I think we need to figure out how scientists do this” (Teacher Edition, page 323).

#### Suggestions for Improvement

- Consider providing additional guidance as to how to get students to pose lesson-level questions rather than having the teacher introduce them.
- Consider having the students revisit the DQB on a more regular basis throughout the unit.

**I.E. Multiple Science Domains:** When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

Disciplinary core ideas from different disciplines are used together to explain phenomena.

The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted

**Rating for Criterion I.E. Multiple Science Domains: Adequate**

*(None, Inadequate, Adequate, Extensive)*

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### EQulP Rubric for Science Evaluation

The reviewers found adequate evidence that links are made across the science domains when appropriate because the unit focuses on core ideas from two or more disciplines and it clearly conveys how ideas from different domains together are required to explain the phenomenon.

This unit combines elements from a Physical Science performance expectation (PE) and three Earth Science PEs to develop an explanation of the phenomenon of hail and weather and climate. The unit also uses the Developing and Using Models SEP across the disciplines in this unit with the use of the Progress Tracker. Students conduct investigations that require knowledge in both of these science domains in order to make sense of the phenomenon.

Some examples of lessons that combine both Physical Science and Earth Space Science domains are found below:

- In Lesson 5, students “develop and use a model to track and describe how transferring thermal energy to and from a fixed amount of air (matter) in a closed system affects its volume and density due to unobservable mechanisms (causes), including changes in the speed and spacing of the molecules that make up that air” (Teacher Edition, page 117).
- In Lesson 6, students “obtain information by reading scientific texts adapted for classroom use and summarize key ideas to determine that the air is a mixture of different types of gases (matter), including water vapor, and that relative humidity is a measure of a small proportion of molecules of water vapor in the air” (Teacher Edition, page 143).
- In Lesson 8, students “develop and use a model to describe unobservable mechanisms that explain why a decrease in the speed of water molecules and their mutual attraction both contribute to what causes them to condense (effect) when water reaches a low enough temperature (condensation/melting point)” (Teacher Edition, page 177).
- In Lesson 11, “This lesson introduces students to balanced and unbalanced forces in the context of different objects suspended by an upward current of air. In the case of an object suspended in the air from a hair dryer or a water droplet in a cloud, you are helping students see that these objects have at least two opposing forces acting on them, but they add to give zero net force on the object when the object is suspended in the air, which causes the object to neither fall nor rise. And in the case of an object that starts falling or rising in a stream of upward-moving air, the forces must not sum to zero, which is an example of where non-zero net forces cause changes in the object’s speed or direction of motion” (Teacher Edition, page 110).

#### Suggestions for Improvement

Consider using crosscutting concepts intentionally and explicitly to make connections across the Earth and Physical science domains.

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**I.F. Math and ELA:** Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

#### **Rating for Criterion I.F. Math and ELA: Adequate** *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide grade-appropriate connections to mathematics, English language arts (ELA), history, social studies, or technical standards because students use math and ELA skills frequently throughout the unit in service of understanding and explaining the science content.

Grade-appropriate mathematics and ELA-Literacy concepts are purposefully incorporated into lessons with teacher support to help students make these connections.

- In the Additional Teacher Guidance sections of the Teacher’s Guide, connections are made to ELA-Literacy standards in Lessons 1, 3, 6, 7, 9, 10, 12, 13, 14, 17, 18, and 20.
- In the Additional Teacher Guidance sections of the Teacher’s Guide, connections are made to Mathematics standards in Lessons 2, 4, 11, 12, 15, and 16.

Reading materials do not go beyond articles. This unit does not include news articles, journal articles, infographics, or websites of scientific entities.

- In Lesson 6, students “use the close reading strategy to read about the composition of air, including the amount of water in the air and how it is measured” (Teacher Edition, page 144).
- In Lesson 9, students read an article, “What are Clouds?”
- In Lesson 13, students read an article, “Tracing paths of Hailstones.”
- In Lesson 20, students read an article, “How the ocean changes our weather.”

Writing assignments are varied in structure and purpose and are rigorous.

- In the Lesson 6 assessment, Explaining the Movement of Air in a Hail Storm Cloud, students write short answers to several prompts.
- In the Lesson 13 assessment, students write short answers to several prompts and a longer writing explaining a phenomenon.
- In the Lesson 22 assessment, students write several longer explanations of phenomena.

Students have multiple opportunities for high level verbal discourse in a variety of formats and scenarios (partners, small group, formal presentations, [technology-enhanced](#)).

- Students participate in Scientists Circles (Consensus Discussion) in Lessons 1, 2, 3, 4, 5, 6, 7, 11, 12, 13, 14, 15, 19, 20, 21, and 22.
- There are several instances where students turn and talk with a partner. Some examples are:

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- In Lesson 3, “Give students a few moments to individually think about the questions, then have them turn and talk with a partner. After a few minutes, ask students to share their thinking with the class” (Teacher Edition, page 91).
- In Lesson 5, “Say, If we want to figure out what happens to air near the ground when it is warmed up, then we need to trap some air that is in contact with a warm surface to observe what happens to it. How can we do this? Turn and talk with a partner” (Teacher Edition, page 123).
- In Lesson 9, “Say, When we finish our reading, we will come back to the setup and lift up the gel pack. Do you think we will see anything on the surface of the gel pack that is facing the water? If so, what? Turn and talk to a partner to share your prediction” (Teacher Edition, page 198).

Teacher guidance is provided for additional opportunities for students to engage in reading, writing, and speaking and listening tasks.

- In Lesson 1, “Strategies for Consensus Discussion: There are two goals of this discussion: (1) to continue to help students build the habit of sharing their initial ideas publicly and (2) to generate a variety of initial ideas about what is causing these precipitation events. As such, it is important to accept all student responses and encourage students to share their ideas. Further, it is important to highlight any areas of disagreement and help students clearly explicate their thinking. Be careful not to favorably respond to any one idea over others so as not to “give away” what might be going on” (Teacher Edition, page 63).
- In Lesson 6, CONDUCT A CLOSE READING ON COMPOSITION OF AIR AND HUMIDITY section provides teachers with guidance as to how to introduce and model the close reading activity.

#### Suggestions for Improvement

Consider inclusion of reading materials beyond textbook-style articles.

### **Overall Category I Score (0, 1, 2, 3): 2**

#### **Unit Scoring Guide – Category I**

##### **Criteria A–F**

**3:** At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C

**2:** At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C

**1:** Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C

**0:** Inadequate (or no) evidence to meet any criteria in Category I (A–F)

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## EQuIP Rubric for Science Evaluation

### Category II. NGSS Instructional Supports

Score: 2

#### Criteria A-G:

3: At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria

2: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A

1: Adequate evidence for at least three criteria in the category

0: Adequate evidence for no more than two criteria in the category

**II.A. Relevance and Authenticity:** Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

Students experience phenomena or design problems as directly as possible (firsthand or through media representations).

Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.

Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

#### **Rating for Criterion II.A. Relevance and Authenticity: Adequate** (None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because students are all exposed to the phenomenon through videos, and opportunities are provided for students to connect their own questions and prior experiences to the targeted learning. However, the materials were not structured in a way that values the funds of knowledge students bring to school from their homes and communities.

Engagement is created by engaging in the hail phenomenon as directly as possible by showing videos of three hail storms. For example:

- “Say, I have some videos that show a kind of perplexing phenomenon occurring outdoors that I want to explore together. Some of you may have experienced this phenomenon before” (Teacher Edition, page 57).
- “To make this type of phenomenon even more locally relevant, you could search the internet for videos of hail in your state or region” (Teacher Edition, page 58).

Students periodically add questions to the Driving Question Board and determine if any of the questions have been answered:

- In Lesson 6, “Problematize what we don’t yet know regarding where all the water that forms hail comes from. Add any new questions to the DQB” (Teacher Edition, page 144).
- In Lesson 13, “We revisit the DQB and discuss the questions that we have now answered” (Teacher Edition, page 10).

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- In Lesson 14, “We develop questions for our Driving Question Board (DQB). We brainstorm ways we could investigate these questions” (Teacher Edition, page 11).
- In Lesson 18, “We develop new questions for our Driving Question Board (DQB) and brainstorm ways we could investigate these questions” (Teacher Edition, page 14).

Students are provided with opportunities to bring their knowledge and ideas into the investigations. For example:

- In Lesson 1, students brainstorm related phenomena. During this process, students are provided with an opportunity to relate the phenomenon to their previous experiences by answering these questions provided in the Lesson 1 presentation:
  - “Describe some times when you’ve seen a lot of precipitation fall in one place in a relatively short time (minutes).”
  - “Describe some times when you’ve seen a lot of precipitation fall continuously in one place over a much longer time.”
- In Lesson 1, student ideas for possible investigations are collected: “Say something like, To make sure we have your ideas up here, I will pass a marker to the first person on the edge of the circle. That student should share one idea. I will write it up and number it. Once I’ve almost finished writing it, that student should pass the marker to the student next to them. The second student then shares an idea. If that idea is on the poster already, the student should say which idea it is and how it is similar. I will put a tally mark next to it. The marker is then passed and we continue until we have heard once from everyone in the class. If you have additional ideas that don’t end up on the poster, feel free to raise your hand after the marker makes it all the way around the circle. If we run out of time, we’ll pick up here in the next class. And if you think of new ideas as we go, feel free to jot them down. We should always be thinking of ways we can add to this list” (Teacher Edition, page 69).
- In Lesson 14, after developing an explanation for hail events, students revisit the list of related phenomena they brainstormed in Lesson 1 and answer the question: “What were some other types of precipitation events that occur on a larger scale that we also wanted to explain?” (Lesson 14, Slide Presentation)

Throughout the unit, limited opportunities are provided for students to connect the funds of knowledge that they bring to school from their homes and communities to the phenomenon.

- In Lesson 1, an alternate activity is provided to make the phenomenon more relevant to students: “To make this type of phenomenon even more locally relevant, you could search the internet for videos of hail in your state or region. It is recommended to only use video that foregrounds the falling of hail rather than the damage or impact after the event. The latter will generate questions that are better raised and addressed in the later OpenSciEd Unit 6.5” (Teacher Edition, page 57).

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- In Lesson 6, “One way to help students connect their learning to events in their own lives is to support local outdoor observations of clouds and storms. Consider doing an outdoor cloud observation as a class as well as assigning a project or home learning activity in which students record a time-lapse video of clouds and then make observations from their video” (Teacher Edition, page 153).

#### Suggestions for Improvement

Consider structuring the materials in a way that explicitly values the fund of knowledge that students bring to school from their homes and communities as a launching point for learning, balanced with common (firsthand) opportunities to experience the phenomenon in the classroom.

**II.B. Student Ideas:** Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.

#### Rating for Criterion II.B. Student Ideas: Adequate (None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas because there are appropriate ways for students to make their thinking explicit and also feedback loops (from the teacher and peers as appropriate) to help them to improve their understanding in this unit.

Throughout the unit, students are provided with a large number of opportunities to express their current thinking and engage in collaborative discussions to share their reasoning and refine their ideas. These opportunities allow students to gather feedback on their current thoughts and gather new ideas from their peers through discussion which are facilitated by the teacher. **There are limited opportunities for students to formally use the feedback provided to adjust their thinking or revise their models.**

- Guidance is given for teachers to periodically provide time for self-assessment. “The student self-assessment discussion rubric can be used any time after a discussion to help students reflect on their participation in the class that day. Choose to use this at least once a week or once every other week” (Teacher Edition, page 30).
- In Lesson 1, “Brainstorm ideas for future investigations and useful data sets. Present slide O. Read the slide aloud. Give students 3 minutes to talk with a shoulder partner to generate ideas” (Teacher Edition, page 69).
- In Lesson 1, “While students construct their models, walk around the room and quietly ask probing questions of students who have no written labels or descriptions on their models, to help

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them represent their thinking more clearly and elaborate upon their ideas” (Teacher Edition, page 60).

- In Lesson 3, “Tell students, In Lesson 1, we observed videos of hailstorms. They occurred in various locations and at different times of the year, but we noticed some similarities among the hailstorms. This led us to look at weather data for several sites where hail storms occurred, and we noticed some patterns in the data. So, think back to the videos we observed in Lesson 1 and the data we analyzed in Lesson 2. What was the air like on a day when it hailed? Call on a few students to share their thinking” (Teacher Edition, page 91).
- In Lesson 3, “Conduct a Building Understandings Discussion. During this discussion, have students share how they analyzed their assigned data. Keep in mind that you want students to share patterns they noticed in data sets for a particular location and across sites (e.g., several dates at a single site or a single date at several sites). Use the following prompts to guide the discussion. Make sure numerous students share their observations” (Teacher Edition, page 95).
- In Lesson 4, “Give students time to share their ideas about what data they want to collect. Students will likely say they could go outside and measure the temperature of the air and the ground. Some may consider collecting sunlight data, especially after previously discussing the difference between weather balloon data from midnight and noon, and some might suggest recording the time of day; if they do not, ask, Do you think it would matter what time we collect the data? Would it matter if it is cloudy or sunny, or dark or light outside? What if we are in the shade?” (Teacher Edition, page 106).
- In Lesson 6, Revise Our Initial Class Consensus Model includes suggestions for providing feedback for revising the class consensus model “It seems like we have figured out some parts of what happens in the air when a hailstorm forms, and we may have begun to answer some of the questions we had on our initial consensus model. Let’s work together to represent our thinking now by revising that model based on what we have figured out so far (Teacher Edition, page 149).
- In Lesson 7, students “Provide and receive feedback about their individual models with a partner” and “use feedback to make any revisions to their individual models before coming to the Scientists Circle” (Teacher Edition, page 160).
- In Lesson 10, “Give students time to view one another’s work. During the gallery walk, they should observe how others represented the same ideas but in different ways. Students should consider how different ways of representing ideas from the Gotta-Have-It Checklist help answer the lesson question. Students should mark in their notebook what about each revision helped push their thinking forward or helped to clarify an idea for them” (Teacher Edition, page 212).
- In Lesson 17, “For all students who are missing at least one old or new mechanism, leave written feedback on Q3” (Teacher Edition, page 29).
- Students engage in a Scientists Circle numerous times throughout the unit. A Scientists Circle includes these important features: students sitting so they face one another to build a sense of shared mission and a community of learners working together; celebrating progress toward



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answering students' questions and developing more complete explanations of phenomena; focusing on where students need to go next and how they might go about the next steps in their work" (Teacher Edition, page 63).

#### Suggestions for Improvement

Consider providing additional opportunities for students to revise their thinking based on feedback and to explain why they chose to incorporate new ideas.

**II.C. Building Progressions:** Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

- Explicitly identifying prior student learning expected for all three dimensions
- Clearly explaining how the prior learning will be built upon.

#### Rating for Criterion II.C. Building Progressions: Adequate

*(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions because materials make clear the expected level of proficiency students should have with all three dimensions for the core learning in the unit and provide learning progressions for how the three dimensions build throughout the unit. **However, the teacher materials do not provide suggestions for adaptation if students are above or below this level.**

Guidance is provided in all three dimensions for the expected prior understanding needed for success with this unit.

- "Related Disciplinary Core Ideas (DCIs) that students should know from earlier grades
  - "DCIs from Kindergarten
    - *Sunlight warms Earth's surface.*
    - *Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.*
  - "DCIs from Grade 3:
    - *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.*
    - *Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over the years."* (Teacher Edition, page 18)
- "While this unit engages students in multiple SEPs across the lesson level performance expectations for all the lessons in the unit, there are three focal practices that this unit targets to

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support students' development in a learning progression across 6th grade year for the SEPs. These are:

1. Developing and Using Models,
2. Planning and Carrying Out Investigations
3. Analyzing and Interpreting Data

"The sections below describe the learning progressions for each of these practices leading to this unit and through this unit" (Teacher Edition, page 19).

- "What are some common ideas that students might have?"
  - Students may come to this unit with prior knowledge that air tends to be cooler the higher up they travel, based on experiences related to mountains and air travel. Some may think that the air should get warmer higher up because it is closer to the sun.
  - Students may think that a cloud is all gas, rather than a combination of gas and droplets or crystals. Alternatively, they may think of a cloud as something similar to a sponge - a solid that can absorb only so much water before it becomes saturated and starts overflowing with water, leading to precipitation (Teacher Edition, Page 24)"
- "The sections below describe the learning progressions for each of these CCCs leading to this unit and through this unit" (Teacher Edition, Page 20).

#### Suggestions for Improvement

Consider providing suggestions for adaptations if students are above or below expected level proficiency for each of the three dimensions.

**II.D. Scientific Accuracy:** Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

#### Rating for Criterion II.D. Scientific Accuracy: **Extensive** (None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials use scientifically accurate and grade appropriate scientific information because all science ideas included in the materials are accurate and there is strong support for teachers to clarify potential alternate conceptions that they (or their students) may have.

In the "Where are we going (and not going)," "What Students will Figure Out," "What are Some Common Ideas Students May Have?" and the "Key Ideas" sections of the Teacher Guide, guidance is given to ensure teachers have adequate and accurate scientific background along with potential misconceptions or misunderstanding by students. For example:

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- Where are we going (and not going): “Hailstorms are relatively short in duration and isolated in impact. The weather data examined in this lesson are gathered from weather stations in the vicinity of the hailstorm. Because of a hailstorm’s relatively small area, we are often limited to analyzing data in the vicinity of a hailstorm rather than under the center of it” (Teacher Guide, page 75).
- What Students will Figure Out (Teacher Edition, page 71):
  - Hailstones are made of ice, often in layers.
  - Hailstorms are more common in the central United States, with fewer events in the west.
  - The days that have hail also have relatively warm air temperatures (mostly in the 50–90°F range, which is above the melting/freezing point of water) and relative humidity in the range of 37–96 percent.
    - Hail happens later in the day in the spring, summer, and fall.
    - Hailstorms impact a small area (20–60 square miles).
    - There are changes in the wind when it hails.
  - What are Some Common Ideas Students May Have?: “Students may come to this unit with prior knowledge that air tends to be cooler the higher up they travel, based on experiences related to mountains and air travel. Some may think that the air should get warmer higher up because it is closer to the sun” (Teacher Edition, page 24).
  - Key Ideas (Teacher Edition, page 61):
    - Listen for these ideas:
      - The particles in a gas, like air, are spread far apart, and the particles in a solid and a liquid are packed close together.
      - Energy can be transferred through collisions between neighboring particles (conduction).
      - Energy can enter a system when matter absorbs light shining on it (radiation).
      - The particles of a substance move faster, on average, at higher temperatures and slower, on average, at lower temperatures.

#### Suggestions for Improvement

N/A

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**II.E. Differentiated Instruction:** Provides guidance for teachers to support differentiated instruction by including:

Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level.

Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.

Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

### **Rating for Criterion II.E. Differentiated Instruction: Adequate** (None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction because materials include a variety of differentiation strategies with examples and guidance for use that supports the reading, writing, listening, and speaking that are integral in sense-making. Extra support is provided for students who are struggling to meet performance expectations. *However, there are no extensions for students who are motivated and ready to move beyond.*

Opportunities for differentiation can be found in the “Attending to Equity” sections in the Teacher Edition:

- In Lesson 2, “As an opportunity for differentiation, you can provide these cases to students who may benefit from the extra challenge” (Teacher Edition, page 81).
- In Lesson 3, “It is important to organize activities in ways that create opportunities for students to engage in meaningful, accountable talk by emphasizing socially safe activity structures (e.g., small-group or partner work before a whole-class discussion). This is especially beneficial to multilingual students. For this reason, partner talk or small-group talk should precede whole-class discussion whenever possible to give students an opportunity to share their ideas with one or two peers before “going public” (Teacher Edition, page 94).
- In Lesson 3, “Some or all of your students may need support writing claims supported by evidence and reasoning. Support can be provided in a number of ways...” (Teacher Edition, page 95).
- In Lesson 6, “Some students may benefit from using other modalities, such as drawing, to show their thinking for any or all of the questions on this assessment. Consider allowing some students to present their answers verbally as another student scribes their thinking on paper; this would allow students to also use gestures to help articulate their understanding about how the air behaves and rises in a cloud. Encouraging students to use other modalities to show their thinking creates an equitable pathway for all students to demonstrate proficiency” (Teacher Edition, pages 148–149).
- In Lesson 13, “This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far through multiple different modalities, including writing to

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explain and drawing models. Some students may benefit from using multiple modalities to show their thinking for any or all of the questions on this assessment. You may consider allowing some students to present their answers verbally with you or another student acting as a scribe to record their thinking on paper. Other students may benefit from using gestures rather than images to describe parts of their models. Some students might also benefit from using manipulatives to represent parts of the model and to support a written or verbal explanation of what’s happening in each part of the model. In each case, encouraging students to use multiple modalities to show their thinking creates a clear, accessible, equitable pathway for all students to demonstrate proficiency” (Teacher Edition, page 259).

- In Lesson 15, “Supporting emergent multilinguals: Before students engage in whole-class discussions, it can be helpful to first provide them with the opportunity to work with others--either in pairs, triads, or small groups--on ideas related to their reasoning. These smaller group structures can be especially helpful for emerging multilingual students because they offer students a chance to engage in sensemaking with their peers and also the space to use their linguistic and nonlinguistic resources to express their ideas (and learn from other students’ uses of these resources too)” (Teacher Edition, page 286).
- In Lesson 15, “Supporting emergent multilinguals: Teachers can support all students, particularly emerging multilingual students, in forming a deeper understanding of newly “earned” vocabulary by representing the new term in multiple ways. For example, students can (1) write the term, (2) draw a representation of the term, (3) use their own words to write an explanation for what the term means, and (4) use the new term in a sentence” (Teacher Edition, page 286).
- In Lesson 20, “Check in with students who need additional reading support every couple of paragraphs. Ask them to practice summarizing the main idea from a single paragraph and to jot this idea down in the margins of their reading” (Teacher Edition, page 373).
- In Lesson 20, “For emergent multilingual learners (EMLLs), partner these students with a reading buddy and cue the reading buddies to pause each paragraph to discuss the main point of the paragraph and to write notes in the margin of their reading. Allow EMLLs to write discuss and write notes in the language they prefer most to process the text” (Teacher Edition, page 373).

#### Suggestions for Improvement

Consider adding extension activities that extend students’ understanding of all three dimensions for students who have already met the performance expectations or who are already proficient in any one of the three dimensions.

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**II.F. Teacher Support for Unit Coherence:** Supports teachers in facilitating coherent student learning experiences over time by:

Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).

Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

### **Rating for Criterion II.F. Teacher Support for Unit Coherence: Adequate** (None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials support teachers in facilitating coherent student learning experiences over time because students have an opportunity to engage in asking questions about phenomena and the phenomena and questions drive student learning.

The unit is driven by the phenomena listed in Lessons 1 and 14. The lessons are sequenced so that the ideas in the previous lesson drive the learning of subsequent lessons. Some examples of how this is accomplished are found below:

- Teacher Materials include a “Where We Are Going and NOT Going” section. This section includes information such as “Students should come to this unit with prior knowledge from the Cup Design Unit related to these two NGSS performance expectations”, “Relevant ideas from previous work include...”, “Students may come to this unit with prior knowledge that...” (Teacher Edition, page. 56).
- Each unit begins with the “Navigation,” which reviews the previous lesson and connects it with what is going to happen next.
  - In Lesson 2, “Present slide A and remind students, In the last lesson, we observed and tried to explain a hailstorm and other long-term and short-term precipitation events. We had a lot of questions about what hail is like and what the conditions are like during a hailstorm. We also came up with some ideas for investigating some of those questions” (Teacher Edition, page 75).
  - In Lesson 3, “Tell students, In Lesson 1, we observed videos of hailstorms. They occurred in various locations and at different times of the year, but we noticed some similarities among the hailstorms. This led us to look at weather data for several sites where hailstorms occurred, and we noticed some patterns in the data. So, think back to the videos we observed in Lesson 1 and the data we analyzed in Lesson 2. What was the air like on a day when it hailed? Call on a few students to share their thinking” (Teacher Edition, page 91).
  - In Lesson 5, “Show slide A and say, In the last lesson, we measured the air temperature 1 inch and 4 feet above the ground, and we looked for patterns in our data. What did we

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learn that would help us understand how the air above the ground warmed up? Give students a few minutes to work with a partner to review their data and conclusions from Lesson 4, then ask a few to share their responses to the first question with the class. Listen for the following responses” (Teacher Edition, page 123).

- The Driving Question Board is used periodically throughout the unit. This provides a structure for the teacher to cultivate student questions and to refer to questions answered as the learning progresses.
  - In Lesson 5, “plan to revisit question generation and take additional time to have students add new questions to the DQB about other types of precipitation events they’ve experienced. These other precipitation event related questions help motivate the third and fourth lesson sets of the unit” (Teacher Edition, page 26).
  - In Lesson 13, “We revisit the DQB and discuss the questions that we have now answered” (Teacher Edition, page 10).
  - In Lesson 18, “revisit the DQB again at the start of the next lesson and ask students to brainstorm places in our country that they think might get more or less water than where we live and develop a short explanation why. Have them share their ideas with a partner and write new questions based on what this led them to wonder” (Teacher Edition, page 48).

#### Suggestions for Improvement

Consider adding additional opportunities for students to ask questions at the end of lessons and for teachers to be supported to use these questions to drive the next lesson.

**II.G. Scaffolded differentiation over time:** Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

#### **Rating for Criterion II.G. Scaffolded Differentiation Over Time: Inadequate** *(None, Inadequate, Adequate, Extensive)*

The reviewers found inadequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjusts supports over time. The instructional materials create learning experiences that allow all students to engage in SEPs in ways that build student understanding and proficiency in the SEPs over time **however, although there is an abundance of scaffolding provided in the teacher edition, there is no evidence that the amount of scaffolding decreases over the course of the unit.**

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Throughout the unit, sections are included labeled “Supporting Students in...” an SEP. This gives teachers explicit directions for building understanding of the SEPs over time. For example:

- In Lesson 1, “SUPPORTING STUDENTS IN ENGAGING IN ASKING QUESTIONS AND DEFINING PROBLEMS. If students forget to explain how or why their questions are linked to someone else’s question, press them to try to talk through their own thinking. This is a key way to emphasize the importance of listening to and building off each other’s ideas, and to help scaffold student thinking” (Teacher Edition, page 68).
- In Lesson 5, “SUPPORTING STUDENTS IN DEVELOPING AND USING SYSTEMS AND SYSTEM MODELS. When focusing on the crosscutting concept of Systems and System Models, students learn that models, whether built or drawn, are used to represent systems and their interactions, including inputs, processes, and outputs. They also come to understand that energy, matter, and information flow within and through systems. At this point in the lesson, you may want to spend a little time reminding students that matter cannot enter or leave a closed system. However, energy can enter and leave a closed system” (Teacher Edition, pages 124–125).
- In Lesson 7, SUPPORTING STUDENTS IN ENGAGING IN PLANNING AND CARRYING OUT INVESTIGATIONS. Having students describe the purpose of each of the materials to be used in the investigation is a helpful way to engage students in thinking about what tools are needed to gather the data in order to answer the question that is motivating the investigation. As the discussion continues, push students to think about what data would be most helpful to report on the class data table in order to answer this question. In this case, reporting the change in humidity from start to finish rather than (or in addition to) the beginning and ending humidity levels is the most relevant data for answering our question” (Teacher Edition, pages 165–166).
- In addition to these sections, additional guidance is provided throughout the lesson for teachers to scaffold the development of the practices:
  - In Lesson 7, “Lead a class discussion about how to design the investigation. Record the decisions on a whiteboard or chart paper as you plan together” (Teacher Edition, page 166).
  - In Lesson 12, “Each group will get a different condition to test and share observations with the class. Let’s think about how to set up your investigations. Let’s use our demonstration setup to think through the design of our investigation” (Teacher Edition, page 243).

#### Suggestions for Improvement

- Consider providing additional learning supports that use a variety of approaches to develop the SEPs.
- Consider adding teacher guidance to decrease the level of support and scaffolding over time. Provide ways for teachers to scale back as the unit progresses.



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- It would be helpful to ensure that instructional materials provide specific guidance to create learning experiences targeting students with diverse needs and abilities so they can connect to and make progress over time toward common learning goals of engaging in the practices and making sense of phenomena.

### **Overall Category II Score (0, 1, 2, 3): 2**

#### **Unit Scoring Guide – Category II**

##### **Criteria A-G:**

**3:** At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria

**2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A

**1:** Adequate evidence for at least three criteria in the category

**0:** Adequate evidence for no more than two criteria in the category

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### Category III. Monitoring NGSS Student Progress

Score: 3

#### Criteria A–F:

**3:** At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion

**2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A

**1:** Adequate evidence for at least three criteria in the category

**0:** Adequate evidence for no more than two criteria in the category

**III.A. Monitoring 3D student performances:** Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

**Rating for Criterion III.A. Monitoring 3D Student Performances: Adequate**  
(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena or design solutions because the core of the grade-appropriate SEP, CCC, and DCI elements that students are required to demonstrate are in service of students making sense of phenomena.

There are several structures in this unit that allow teachers to monitor three-dimensional student performances as students progress toward understanding of the unit phenomenon. For example:

- An “Assessment System Overview” is provided on pages 25 through 51. Guidance is provided on the type of assessment, the purpose of the assessment, what to look/listen for, including specific guidance for assessing the CCC and SEP from the lesson objective.
- Three formal individual assessments are included in the materials:
  - In Lesson 6, students use an image of cloud data from Salem Oregon and land surface temperature data from NASA to explain the movement of air in a hailstorm cloud. Students use the SEPs of Analyzing and Interpreting Data and Constructing Explanations, and elements of the DCIs addressed up to this point in the unit. **While no CCC is explicitly stated in the lesson**, elements of cause and effect and patterns **could be utilized** by students when addressing the questions on the assessment.
  - In Lesson 13, students are asked to use information provided (which includes text, data, and models) to develop an explanation for Hurricane formation. This makes use of the SEPs of Developing and Using Models, Analyzing and Interpreting Data, and Constructing Explanations and the DCI elements addressed in the unit up to this point. **While no CCCs are explicitly mentioned in the assessment**, students utilize thinking around the element of Energy and Matter when answering the questions.

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- In Lesson 22, students use the DCI elements addressed in the unit and are provided maps to predict locations of other tropical rainforests and predict which oceans have the most effect on air temperature. Students are explicitly asked to use the CCC of Energy and Matter.
- There are multiple three-dimensional formative assessment opportunities embedded throughout the unit. For example:
  - Lesson Three: “After working in small groups, students write a claim using evidence from the data and their observations (slide G). This is another opportunity to formatively assess students’ understanding of the data and patterns, and also to see how well they can write evidence-based claims” (Teacher Edition, page 33).
  - In Lesson 17, “Students record the patterns they notice at the start of the lesson and in their responses to the first two questions Monitor students’ analysis of the data in the first map they are assigned. Monitor their work on the first two questions, as this is the most effective time to step in to help break down what these questions are asking, if needed. What to look for/listen for: The low pressure center moves from west to east over time. The movement and location of warm and cold fronts appear to be connected to this low pressure center. Precipitation tends to fall along the line of the cold front and warm front and behind the low pressure center” (Teacher Edition, page 29).

#### Suggestions for Improvement

Add assessments that make student use of the CCCs more visible and obvious. Provide teacher guidance to evaluate the CCCs students would be expected to use in assessment items.

**III.B. Formative:** Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

#### Rating for Criterion III.B. Formative: **Adequate**

*(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because the materials include explicit, frequent, and varied supports for formative assessment processes.

Examples of formative assessment guidance are below:

- An “Assessment System Overview” is provided on Pages 25 through 51. Guidance is provided on the embedded opportunities for Formative Assessment.
- The unit uses the Progress Tracker as an ongoing formative assessment tool. “The Progress Tracker is a thinking tool that was designed to help students keep track of important discoveries

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that the class makes while investigating phenomena and figure out how to prioritize and use those discoveries to develop a model to explain phenomena. It is important that what the students write in the Progress Tracker reflects their own thinking at that particular moment in time. In this way, the Progress Tracker can be used to formatively assess individual student progress or for students to assess their own understanding throughout the unit. Because the Progress Tracker is meant to be a thinking tool for kids, we strongly suggest it is not collected for a summative “grade” other than for completion” (Teacher Edition, page 30).

- Within individual lessons, guidance is also provided for formative assessment.
  - In Lesson 5, “After students have had a few minutes to talk, call on a few to share their thinking. Remember, the goal is to help students figure out that changes in the density of the gas in the balloon are causing it to float and sink. If they struggle, use additional questions to help them think about the relationship between the unchanging amount of helium in the closed balloon system, the changes in volume as the balloon warms up and cools down, and the density of the helium” (Teacher Edition, page 138).
  - In Lesson 5, "Reviewing students' responses in the two-column Progress Tracker provides an opportunity to formatively assess students' understanding of the lesson-level performance expectations. Responses should not be graded; rather, use what you learn to inform next steps for moving students' thinking forward. Examples of next steps include documenting feedback in students' notebooks, such as additional probing questions, suggestions for improvement, or a request for additional evidence or reasoning; revisiting, reteaching, or reinforcing ideas from the lesson to help students fill in gaps in their learning; using examples of actual student work to prompt discussion about what we have and haven't figured out up to this point in the unit; and asking additional questions at the beginning of the next lesson to probe students' thinking and help them make connections and build understandings" (Teacher Edition, page 141).
  - In Lesson 7, "Students have had multiple opportunities throughout the unit to develop models that represent unobservable mechanisms including how thermal energy drives the cycling of matter. This activity provides a great opportunity to formatively assess their ability to represent what is happening at the molecule level as thermal energy is added to the bottle system. If students are struggling to show what is happening at a molecular level, ask them to look back in their Progress Trackers for how we have represented these ideas earlier in the unit" (Teacher Edition, page 168).
  - In Lesson 8, “This assessment opportunity gives teachers the chance to formatively assess students' understanding of the interactions that occur between energy and matter that lead to the formation of clouds. Though the explanation that students are writing in response to each prompt is relatively brief and doesn't focus on citing sources of evidence from previous experiments, it does require them to draw on the scientific principles and

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models that they constructed from those experiments as well as some of the new ideas introduced in the reading” (Teacher Edition, page 200).

- In Lesson 9, “This assessment opportunity gives teachers the chance to formatively assess students’ understanding of the interactions that occur between energy and matter that lead to the formation of clouds” (Teacher Edition, page 200).
- In Lesson 10, “Use this activity and discussion as a formative assessment to determine whether students understand how changing the inputs (i.e., temperature and humidity) in a system model (i.e., the Make a Thunderstorm simulation) will change the outputs in the system (i.e., the size of the resulting storm). You can use Data Table for Make a Thunderstorm to assess students’ understanding of why certain outputs occurred based on the inputs” (Teacher Edition, page 210).
- In Lesson 18, “Listen in on small group discussions particularly where can you listen to particular students. Focus on groups that have students that struggled to articulate connections to any new or old science ideas in explanations you collected and reviewed before this lesson. Pose questions such as: Did you hear anything from Student X explanation that you didn't have but think you might want to include?” (Teacher Edition, page 344).
- In Lesson 19, “As students share their thinking, listen for students to identify (1) the pattern of air movement at different latitudes but specifically from west to east across the U.S, (2) cold air from the north or northwest moving to the east and colliding with warm air from the south/southeast (i.e., Gulf of Mexico), (3) places with a lot of precipitation as likely locations where warm and cold air masses interact or collide, and (4) predictable winds bringing cold or warm air as one way for us to predict a location’s long-term precipitation pattern. If students struggle with identifying the ideas above, revisit the first visualization of one week of precipitation rates in the United States. Pause the visualization at a moment with a large storm. Label the flow of a cold air mass from the north and a warm air mass from the south that resulted in the storm. Unpause the simulation and pause again at a second storm. Have your students describe how they would label the cold air mass (from the north or northwest) and the warm air mass (from the south or southwest) that resulted in the storm” (Teacher Edition, page 365).
- In Lesson 20, “The Exit Ticket will provide you valuable formative assessment information to help you tailor the Consensus Discussion on day 2” (Teacher Edition, page 373).

#### Suggestions for Improvement

It would be helpful to ensure that formative assessment opportunities are accompanied by clear guidance to teachers for how to interpret a range of student responses and change instruction based on varied student responses.

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**III.C. Scoring guidance:** Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

### **Rating for Criterion III.C. Scoring Guidance: Adequate** (None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions because clear guidance is provided for teachers to interpret student progress in relation to both the instructional materials as well as the targeted standards/dimensions/parts of dimensions/learning performance.

A variety of supports for scoring are provided in the unit. For example:

- Sample student responses are provided for every suggested prompt.
- Examples of possible student models are provided via photographs.
- In the “Assessment System Overview” guidance is provided on expected learning in all dimensions identified in the lesson objective. This guidance includes:
  - When to Check for Understanding
  - What to Look/Listen For
  - What to Do
- Answer keys are provided for the three major formal assessments in the unit after Lessons 6, 13, and 22.
- Sample rubrics for modeling and argument were found for different units in the Teacher Handbook, however, *no specific rubrics for this unit were included.*

### Suggestions for Improvement

- Consider providing a three-dimensional rubric for summative assessments specific to this unit.
- Consider providing examples of a range of student responses in addition to expected responses.
- Consider providing guidance to teachers and students about how to address gaps and misconceptions through future instructional experience and other assessment opportunities (explicit coherence in terms of interpreting student progress).

**III.D. Unbiased tasks/items:** Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

### **Rating for Criterion III.D. Unbiased Task/Items: Adequate** (None, Inadequate, Adequate, Extensive)

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The reviewers found adequate evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples because vocabulary and text are appropriate for middle school and are frequently accompanied by other ways (visual representations, graphs, video, etc.) of communicating the expectations of student performance. Representations or scenarios are culturally neutral and there are a variety of ways for students to convey their answers.

Some examples are below:

- Grade appropriate vocabulary is used throughout the unit, including on the formal assessments provided for Lessons 6, 13, and 22.
- Students are provided with the appropriate background needed for completing all tasks through readings, investigations, or videos when appropriate.
  - In Lesson 1, students watch videos of hail events, allowing all students to have firsthand experience with the phenomenon.
  - A thunderstorm simulation is used to provide a uniform experience for all students.
  - In addition to articles, students review graphs, tables, videos, diagrams, and maps throughout the unit.
  - Students are provided with an opportunity to watch weather forecast videos to introduce the large storm phenomenon in Lesson 14.
  - Throughout the unit, students are provided with opportunities to engage in firsthand investigations of weather-related phenomena. For example:
    - Lesson 5: Students conduct an investigation using soap bubbles in a bottle to determine the effects of increasing temperature.
    - Lesson 7: Students measure the humidity in the air over different surfaces.
- Assessment occurs in multiple modalities a few times in the unit to ensure students are provided with opportunities to express their ideas and reasoning in a variety of ways. Some examples are found below:
  - In Lesson 1, students are provided with a handout that allows them to sketch their initial model.
  - In Lesson 6, “This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far by scaffolding the construction of a written explanation. Some students may benefit from using other modalities, such as drawing, to show their thinking for any or all of the questions on this assessment. Consider allowing some students to present their answers verbally as another student scribes their thinking on paper; this would allow students to also use gestures to help articulate their understanding about how the air behaves and rises in a cloud. Encouraging students to use other modalities to show their thinking creates an equitable pathway for all students to demonstrate proficiency” (Teacher Edition, pages 148–149). This guidance is also provided for formal assessments in Lesson 13.

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### Suggestions for Improvement

Consider including a significant task that provides all students with a choice of responses across multiple modalities.

**III.E. Coherent Assessment system:** Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

### Rating for Criterion III.E. Coherent Assessment System: **Extensive** *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning because materials include assessments that are consistently designed to connect to learning goals and require students to apply appropriate elements of the three dimensions to make sense of the phenomenon.

Evidence for the coherence of the assessment system is provided below:

- An “Assessment System Overview” is provided on pages 25 through 51. Guidance is provided on the type of assessment, the purpose of the assessment, what to look/listen for, including specific guidance for assessing the elements of the DCIs, CCCs, and SEPs from the lesson objective.
  - “The table below summarizes opportunities in each lesson for assessing every lesson-level performance expectation (LLPE). Examples of these opportunities include student handouts, home learning assignments, progress trackers, or student discussions. Most LLPEs are recommended as potential formative assessments. Assessing every LLPE listed can be logistically difficult. Strategically picking which LLPEs to assess and how to provide timely and informative feedback to students on their progress toward meeting these is left to the teacher's discretion” (Teacher Edition, page 30).
- In the “Assessment System Overview” guidance is provided on expected learning in all dimensions identified in the lesson objective. This guidance includes:
  - When to Check for Understanding
  - What to Look/Listen For
  - What to Do
- All four of the assessment types mentioned in the criterion are present in this unit. Some examples are as follows:
  - “Pre-Assessment. The student work in Lesson 1 should be considered a pre-assessment. It is an opportunity to learn where students are coming in and what ideas they have” (Teacher Edition, page 25).



## Weather, Climate & Water Cycling: Why does a lot of hail, rain, or snow fall at some times and not others?

### EQuIP Rubric for Science Evaluation

- In Lesson 14, “The student work in Lesson 14 should be considered a pre-assessment. It is an opportunity to learn what ideas students are coming in and what ideas they have that you can build on in this second half of the unit, grounded in a much larger scale weather phenomena than the first half of the unit. Specifically, look for students’ initial understandings of analyzing data, developing patterns, scale, systems and systems models, and matter and energy. Students will be looking for spatial and temporal patterns in data on maps at this scale throughout the remaining lessons of the unit and in the next unit (OpenSciEd Unit 6.4 - the Everest Unit), so this also is a good opportunity to gauge their initial literacy with analyzing such data sources” (Teacher Edition, page 33).
- In Lesson 6, “This lesson is a “putting the pieces together” lesson. It includes a midpoint assessment along with a scoring guide. But, because it is still relatively early in the unit, this is considered a formative assessment. This midpoint assessment is important formatively to make sure the class has made progress and is ready to move forward in the unit. At this point, students should be comfortable with making the following claims...” (Teacher Edition, page 26).
- In Lesson 9, “This assessment opportunity gives teachers the chance to formatively assess students’ understanding of the interactions that occur between energy and matter that lead to the formation of clouds” (Teacher Edition, page 200).
- Summative assessments are provided in Lessons 13 and 22.
- Guidance is provided for student self-assessments. “The student self-assessment discussion rubric can be used any time after a discussion to help students reflect on their participation in the class that day. Choose to use this at least once a week or once every other week” (Teacher Edition, page 30).
- “The Progress Tracker is a thinking tool that was designed to help students keep track of important discoveries that the class makes while investigating phenomena and figure out how to prioritize and use those discoveries to develop a model to explain phenomena. It is important that what the students write in the Progress Tracker reflects their own thinking at that particular moment in time. In this way, the Progress Tracker can be used to formatively assess individual student progress or for students to assess their own understanding throughout the unit. Because the Progress Tracker is meant to be a thinking tool for kids, we strongly suggest it is not collected for a summative “grade” other than for completion” (Teacher Edition, page 29).
- Students are assessed in this unit in multiple ways including through discussion, the creation and revision of models, constructed response questions, and through peer feedback.

#### Suggestions for Improvement

N/A

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**III.F. Opportunity to learn:** Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback

### **Rating for Criterion III.F. Opportunity to learn: Adequate** (None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of core ideas and crosscutting concepts because there are some interconnected opportunities over time for students to demonstrate understanding supported by multi-modal feedback loops.

For key, claimed learning in the unit, there are multiple, linked student performances that provide students with several opportunities to demonstrate understanding. For example:

- In Lesson 6, students complete a summative assessment including written responses.
- Throughout the unit, students demonstrate knowledge through whole-class discussions and partner discussions. Guidance is given to the teacher to listen for appropriate responses.
- Students analyze maps and data in several lessons and create several different models of their thinking.
- Students complete a Progress Tracker throughout the unit to demonstrate their on-going accumulation of understanding.

Students utilize multi-modal feedback across a series of student performances to demonstrate new thinking based on peer and teacher feedback and personal reflection.

- Students are provided with both teacher and peer feedback in this unit.
  - In Lesson 5, teachers document written feedback in student notebooks.
  - Students are provided with formal written feedback after written assessments in Lessons 6, 13, and 22.
  - In Lesson 7, students receive peer feedback and revise their models based on that feedback.
  - Verbal feedback is provided by the teacher throughout the unit. For example: “While students construct their models, walk around the room and quietly ask probing questions of students who have no written labels or descriptions on their models, to help them represent their thinking more clearly and elaborate upon their ideas” (Teacher Edition, page 60).

### Suggestions for Improvement

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### EQIP Rubric for Science Evaluation

- Consider integrating more opportunities for feedback loops where students revise their models/thinking based on peer or teacher feedback.
- Consider incorporating other ways students could demonstrate understanding.

### Overall Category III Score (0, 1, 2, 3): 3

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| <p><b>Unit Scoring Guide – Category III</b></p> <p><b>Criteria A–F:</b></p> <p><b>3:</b> At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion</p> <p><b>2:</b> Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A</p> <p><b>1:</b> Adequate evidence for at least three criteria in the category</p> <p><b>0:</b> Adequate evidence for no more than two criteria in the category</p> |
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## Overall Score

**Category I: NGSS 3D Design Score (0, 1, 2, 3): 2**

**Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 2**

**Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 3**

**Total Score: 7**

**Overall Score (E, E/I, R, N): E/I**

| Scoring Guides for Each Category  |
|---|
| <p><b>Unit Scoring Guide</b></p> <p><b>Category I (Criteria A–F):</b></p> <p><b>3:</b> At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C</p> <p><b>2:</b> At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C</p> <p><b>1:</b> Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C</p> <p><b>0:</b> Inadequate (or no) evidence to meet any criteria in Category I (A–F)</p> <p><b>Category II (Criteria A–G):</b></p> <p><b>3:</b> At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria</p> <p><b>2:</b> Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A</p> <p><b>1:</b> Adequate evidence for at least three criteria in the category</p> <p><b>0:</b> Adequate evidence for no more than two criteria in the category</p> <p><b>Category III (Criteria A–F):</b></p> <p><b>3:</b> At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion</p> <p><b>2:</b> Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A</p> <p><b>1:</b> Adequate evidence for at least three criteria in the category</p> <p><b>0:</b> Adequate evidence for no more than two criteria in the category</p> |

| Overall Scoring Guide   |
|---|
| <p><b>E: Example of high quality NGSS design</b>—High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, &amp; III of the rubric. (total score ~8–9)</p> |

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**E/I: Example of high quality NGSS design if Improved**—Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)

**R: Revision needed**—Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)

**N: Not ready to review**—Not designed for the NGSS; does not meet criteria (total 0–2)