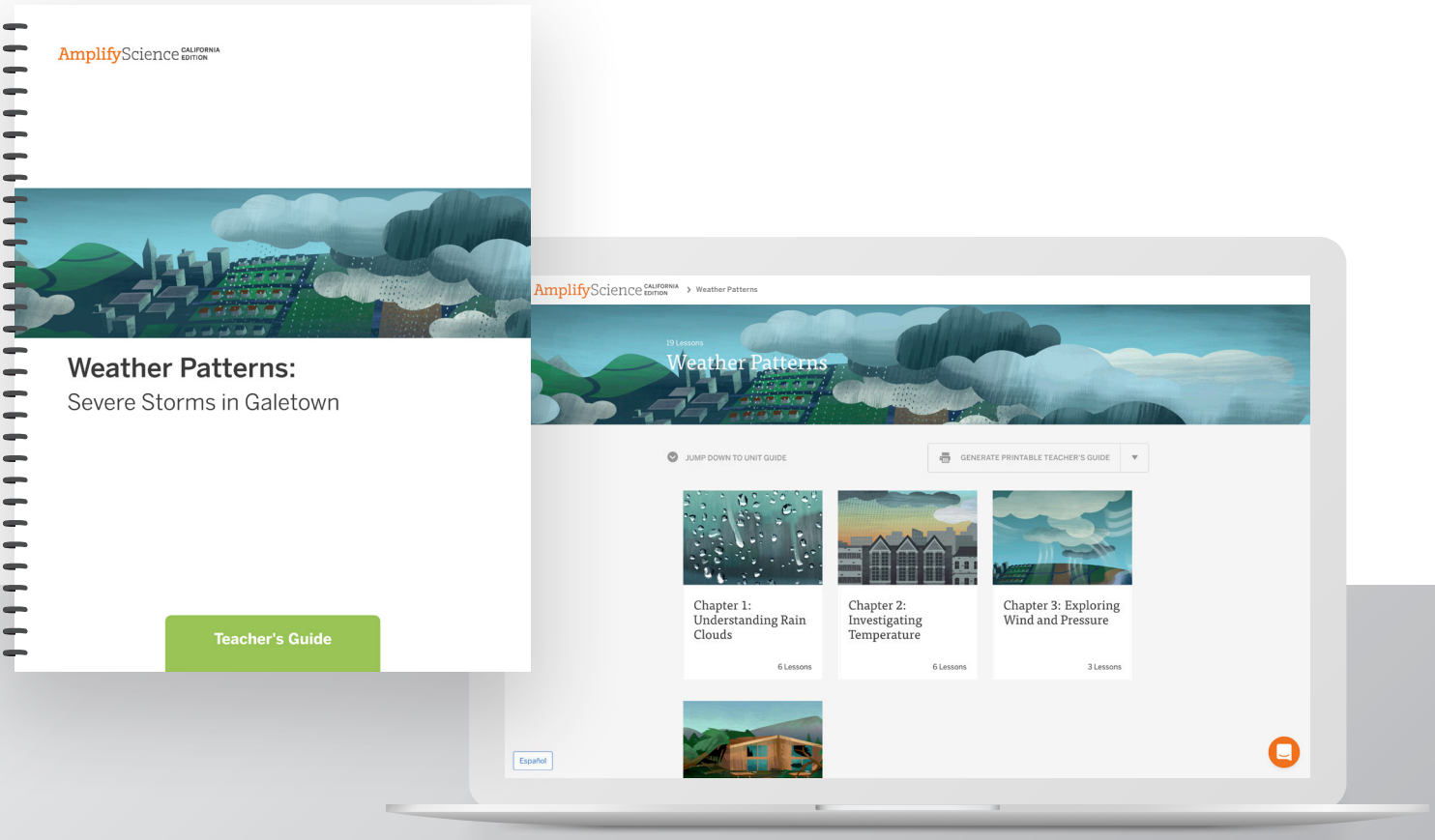
Amplify Science
CALIFORNIA

UNIT GUIDE

# Weather Patterns



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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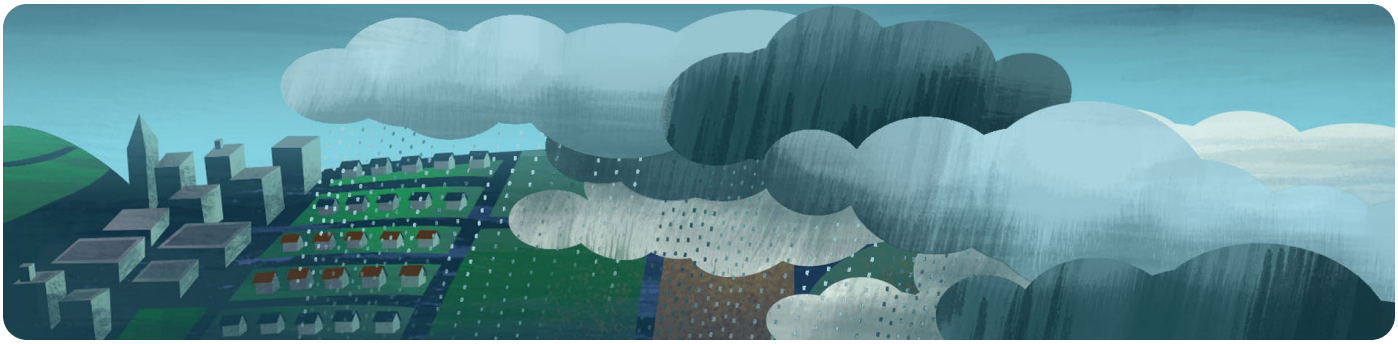


# Welcome to Weather Patterns

Rainstorms are complex weather events. When they are severe they can have a great impact on communities and livelihoods by causing flooding and other damage. Understanding the general components and mechanisms of the formation of rainstorms supports understandings of local, regional, and global weather phenomena. That said, many students have difficulty conceptualizing how rainstorms are generated. Often, they have a variety of alternate conceptions about energy transfer, cloud formation, and wind, which makes weather an important topic for students to investigate.

> Unlike a typical curriculum, Amplify Science California anchors learning by inviting students to take on the role of scientists and engineers.

In this unit, students take on the role of forensic meteorologists. Their job is to investigate the cause of severe rainstorms in a fictional town called Galetown. Working together, they build on their understanding of the sun, evaporation, and condensation, and investigate different variables that contribute to a storm's severity. The unit concludes with a Science Seminar in which students use what they have learned to analyze evidence and participate in a discussion about whether one large rainstorm or several moderate-sized rainstorms are responsible for the damage done to the fictional Carson Wilderness Education Center.

**Unit Type:** Core

**Student Role:** Forensic Meteorologists

**Phenomenon:** In recent years, rainstorms in Galetown have been unusually severe.

**Core Concept:** Understanding why rain occurs and how different factors work together to create storms of varying severity

**Target Performance Expectations:**

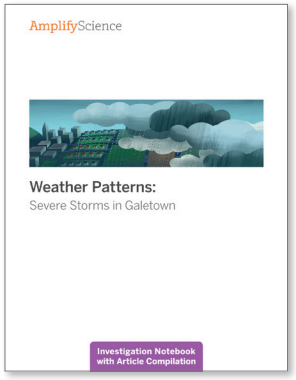
- ESS2-4: The Water Cycle
- ESS2-5: Air Masses

**Related Performance Expectations:**

- PS1-4: Phase Change
- PS3-3: Thermal Energy Transfer
- ESS2-1: Earth's Materials
- ESS2-6: Climate Patterns
- ESS3-2: Natural Hazards

# Students figure out the unit phenomenon through the use of a variety of resources.

## Student Investigation Notebook




## Hands-On Kit

## Videos


## Digital Tools


**About technology in this unit:**
All Amplify Science California lessons were designed with device sharing in mind, and never assume that every student has a separate device.

In this grade, student-facing technology includes Practice Tools and digital Simulations. When the use of a digital tool is called for in a lesson, teachers have several implementation options:

**If limited student devices are available**—teachers can have students do activities in pairs or small groups.

**If no student devices are available**—teachers can project the digital tool to the class and either "drive" the digital tool themself or invite students to "drive" by using their device.

**If internet access is unavailable**—teachers can "pre-load" the digital tool on their device for use offline.

# Chapter 1:
# The storyline begins

## What students investigate:

What causes rainfall in Galetown?

## What they figure out:

Rainfall is caused by motion of water and transfer of energy. When liquid water becomes warmer, it can evaporate and become water vapor in the air. All air contains water. When water vapor in an air parcel cools, it can condense into liquid water which can form a cloud and fall as rain. Energy transfers from warm air to cold air until the temperatures become equal. The more an air parcel loses energy and cools, the more rainfall can happen.

## How they figure it out:

- Analyzing data about ice cover, temperature, and several gases in the atmosphere
- Testing changes to the amounts of different gases in the atmosphere using the Sim
- Reading an article about what drives the movement of water on Earth
- Reading an article about famous meteorologists Dr. Joanne Simpson, who started studying clouds because she loved their shapes

KEY


CLASS


HANDS-ON


HOMEWORK


MODELING


READING


SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 1 | LESSON 1.1

### Pre-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

**Pre-Unit Assessment**

DAY 2 | LESSON 1.2

### Welcome to the Weather Patterns Unit

- Warm-Up (8 min)
- Introducing the Mystery of Galetown Storms (5 min)
- Discussing Galetown Storms (7 min)
- Exploring the Weather Patterns Simulation (25 min)
- Homework
- Family Homework Experience (Optional)

DAY 3 | LESSON 1.3

### Investigating Condensation

- Warm-Up (5 min)
- Investigating Condensation (10 min)
- Simulating Condensation (20 min)
- Observing and Reflecting on Condensation (10 min)
- Homework

DAY 4 | LESSON 1.4

### "What Are Clouds?"

- Warm-Up (5 min)
- Reading "What Are Clouds?" (25 min)
- Discussing Annotations (10 min)
- Explaining the Homework Assignment (5 min)
- Homework

**On-the-Fly Assessment**

DAY 5 | LESSON 1.5

### Investigating Why Clouds Produce Rain

- Warm-Up (5 min)
- Rereading "What Are Clouds?" (20 min)
- Making Different Weather Events (20 min)
- Homework

**On-the-Fly Assessment**

DAY 6 | LESSON 1.6

### Explaining Surface Water and Rain in Galetown

- Warm-Up (10 min)
- Word Relationships Routine (20 min)
- Modeling Galetown (15 min)
- Homework
- Self-Assessment (Optional)

**On-the-Fly Assessment**
**Self-Assessment**

# Chapter 2:
# The storyline builds

## What students investigate:

Why is the amount of rain in Galetown different from storm to storm?

## What they figure out:

The amount of rain is affected by air temperature. The troposphere is warmest at the surface and coldest at its highest point. If an air parcel is warmer than the surrounding air, it will rise. As an air parcel rises, energy transfers from the warm air parcel to the cold surrounding air until the temperatures become equal. When an air parcel starts with a higher temperature, it will rise higher and lose more energy, causing more rainfall. Systems go through periods of stability and periods of change.

## How they figure it out:

- Gathering evidence about stable and changing systems of energy flow from a physical model and using the Sim
- Reading an article about how air parcel temperature and height in the troposphere relate to rainfall
- Demonstrating their ideas using the unit's Modeling Tool

KEY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SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 7 | LESSON 2.1

### Air Parcels in the Troposphere

- Warm-Up (5 min)
- Cooling Air Parcels (25 min)
- Warm Air Parcel in the Classroom (15 min)
- Homework

**Optional Flextension: *Why Warm Air Rises***

DAY 8 | LESSON 2.2

### "Disaster in California!"

- Warm-Up (5 min)
- Reading "Disaster in California!" (30 min)
- Discussing Annotations (10 min)
- Homework

**On-the-Fly Assessment**

DAY 9 | LESSON 2.3

### Simulating a Large Storm

- Warm-Up (5 min)
- Rereading "Disaster in California!" (20 min)
- Simulating Rainstorms (20 min)
- Homework

**On-the-Fly Assessment**

DAY 10 | LESSON 2.4

### Analyzing New Data About Galetown

- Warm-Up (5 min)
- Word Relationships Routine (15 min)
- Modeling Galetown (20 min)
- Homework

**On-the-Fly Assessment**

DAY 11 | LESSON 2.5

### Critical Juncture Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

**Critical Juncture Assessment**

DAY 12 | LESSON 2.6

### Reviewing Key Ideas About Weather

- Warm-Up (5 min)
- Preparing for the Lesson (3 min)
- Playing the Weather Patterns Card Games (20 min)
- Reflection (5 min)
- Self-Assessment (Optional)

**Self-Assessment**

**Optional Flextension: *Modeling Rain Formation***

# Chapter 3:
# The storyline goes deeper

## What students investigate:

Why did the most recent storm in Galetown have the greatest amount of rain?

## What they figure out:

The amount of rain is also affected by air pressure. Air moving from areas of high pressure to areas of low pressure is wind. Air parcels can be pushed up into the troposphere by wind (moving air).

## How they figure it out:

- Analyzing data about human activity
- Testing changes to human activities using the Sim
- Reading an article about two other types of rainfall: orographic rain and frontal rain
- Demonstrating their understanding with the Modeling Tool
- Reading an article about meteorology and how meteorologists predict weather using computer models

KEY


CLASS


HANDS-ON


HOMEWORK


MODELING


READING


SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 13 | LESSON 3.1

### Investigating Wind

- Warm-Up (10 min)
- Exploring Wind (10 min)
- Modeling Wind and Air Parcels (5 min)
- Wind and Air Parcels (20 min)
- Homework

DAY 14 | LESSON 3.2

### Analyzing Data About Storms

- Warm-Up (5 min)
- Evaluating Sources with the Evidence Gradient (20 min)
- Analyzing Data from Severe Storms (20 min)
- Homework

**On-the-Fly Assessment**

DAY 15 | LESSON 3.3

### Creating a Report for Galetown

- Warm-Up (5 min)
- Modeling Severe Rainstorms in Galetown (25 min)
- Discussing Models of Galetown (15 min)
- Homework
- Self-Assessment (Optional)

**Self-Assessment**

# Chapter 4:
# Application to a new storyline

## What students investigate:

The Carson Wilderness Education Center, located in a deep wilderness area, was damaged by rain during a season when few people were around to observe what happened. So, there remains the question: Was the damage to the building due to one large severe storm or a series of more moderate storms?

## What they figure out:

Scientists must communicate how their claims and evidence are supported with reasoning in a convincing scientific argument. A written scientific argument needs to state a claim, describe specific evidence, and explain how the evidence supports the claim to convince its reader. A claim can sometimes be supported more effectively if you consider the combination of several different pieces of evidence.

## How they figure it out:

- Analyzing and sorting evidence, mostly from one large volcanic eruption (Pinatubo in 1991)
- Considering the factors that cause warming versus those that cause cooling
- Reading an article about different types of precipitation
- Reviewing available evidence to make an argument
- Engaging in oral argumentation in a student-led discourse routine called a Science Seminar
- Writing final arguments

KEY


CLASS


HANDS-ON


HOMEWORK


MODELING


READING


SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 16 | LESSON 4.1

### Evaluating Evidence from the Center

- Warm-Up (5 min)
- Introducing the Carson Mystery (15 min)
- Sorting Evidence from the Center (15 min)
- Discussing Reliable Evidence (10 min)
- Homework

DAY 17 | LESSON 4.2

### Considering Evidence from the Center

- Warm-Up (5 min)
- Examining Evidence About the Center (25 min)
- Discussing and Organizing Evidence (15 min)

**On-the-Fly Assessment**

DAY 18 | LESSON 4.3

### Science Seminar

- Warm-Up (15 min)
- Introducing the Science Seminar (5 min)
- Participating in the Science Seminar (20 min)
- Introducing the Homework (5 min)
- Homework
- Self-Assessment (Optional)

**On-the-Fly Assessment**
**Self-Assessment**

DAY 19 | LESSON 4.4

### End-of-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

**End-of-Unit Assessment**

# All students. All standards.

Rather than treating the standards simply as a list of topics to cover, we designed Amplify Science California to allow for truly in-depth and integrated coverage of the disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). Unlike other programs, however, ours makes the NGSS' vision of "all students, all standards" a reality by creating a unit-specific learning progression for every unit called a Progress Build.

Each Progress Build defines several levels of understanding of the unit's anchoring phenomenon, with each level integrating and building upon the knowledge and skills from lower levels. In this way, each Progress Build provides a clear roadmap for how students' understanding of the phenomenon is expected to deepen and develop with each successive chapter and lesson.

What's more, the program's system of assessments is also tied to these Progress Builds. This carefully crafted integration provides teachers with credible, actionable, and timely diagnostic information about student progress toward the unit's learning goals and grade-level performance expectations. Armed with this powerful data, teachers have the ultimate flexibility to decide when to move on and when to slow down and dive deeper.

## Weather Patterns Progress Build

The Progress Build in this unit consists of three levels of understanding. At each level, students add new ideas and integrate them into a progressively deeper understanding of what causes severe rainfall, and why some rainstorms have more rain than others.



**Progress Build Level 1:**

Rain can happen when an air parcel cools and loses energy. The loss of energy causes water vapor in the air parcel to condense and fall as rain.

**Progress Build Level 2:**

A warmer air parcel has more energy, so it can rise higher into the troposphere and lose more energy, which can result in a greater amount of rain.

**Progress Build Level 3:**

Wind can push an air parcel higher into the troposphere causing the air parcel to lose more energy, which can result in a greater amount of rain.

## Examples of differentiation in this unit

In addition to providing unit-specific Progress Builds that break learning goals into smaller, more achievable levels of understanding, Amplify Science California makes learning accessible for all students through a variety of scaffolds, supports, and differentiation strategies for every lesson. **For a complete list of strategies, see the Differentiation section of every Lesson Brief**.

Below are a few examples of strategies embedded in this unit.

**For English learners:**

**More practice making deeper connections during reading (Example from Lesson 1.4)**

In Activity 2, students practice making deeper connections as they read. Students may have very personal connections that they would like to make, and some English learners may feel more confident making these connections in their primary languages. Encourage students to write their annotations in their primary languages, as needed, in order to support a more engaged and personal experience during today's reading activity.

**For students needing more support:**

**Extra teacher modeling when exploring the Simulation (Example from Lesson 1.3)**

Students will be working with the Sim many times in this unit. If needed, take time in this lesson to develop students' proficiency by stopping and modeling how to carefully explore the Sim. Ask, "I wonder what happens if I change _____ but keep _____ the same?" Or, "I wonder how this graph relates to what I just observed in live view. What do you think?"

**For students ready for a challenge:**

**Create additional models (Example from Lesson 3.3)**

Students who need more challenge can use the Modeling Tool as a guide to create an additional model scenario of a storm in which there are very high temperatures, high water vapor, and strong wind but low surface water. This additional model would challenge students to think through how high temperatures and strong wind might affect the town in the absence of the man-made lake. Students could then use this information to support their arguments about the continuation of the severe storms in Galetown.

# 3-D Statements

In order to help teachers recognize the three-dimensional structure of every unit, chapter, and lesson, each unit contains a 3-D Statement document that makes the integration clear.

Making the 3-D statement document all the more effective, the three dimensions are color-coded for easy recognition.

## Weather Patterns 3-D Coverage

**SEPs**
Science and Engineering Practices

**DCIs**
Disciplinary Core Ideas

**CCCs**
Cross-Cutting Concepts

### Unit Level

Students use digital and physical models, hands-on activities, data, and science texts to investigate how changes in weather conditions result from interactions between sunlight, surface water, and air (stability and change, energy and matter).

### Chapter Level

#### Chapter 1: Understanding Rain Clouds

Students investigate evaporation, condensation, and energy transfer (energy and matter) by using the simulation, a hands-on investigation, and an article. They construct explanations and visual models showing how an increased amount of surface water can cause the amount of rainfall to increase (cause and effect).

#### Chapter 2: Investigating Temperature

Students obtain information from the Simulation, an article, and a demonstration to investigate how higher temperatures can affect the amount of rain (cause and effect). They construct visual models showing how warmer air parcels rise higher in the troposphere, losing energy until they reach the same temperature as the surrounding air (stability and change) and that the greater energy loss leads to more rainfall.

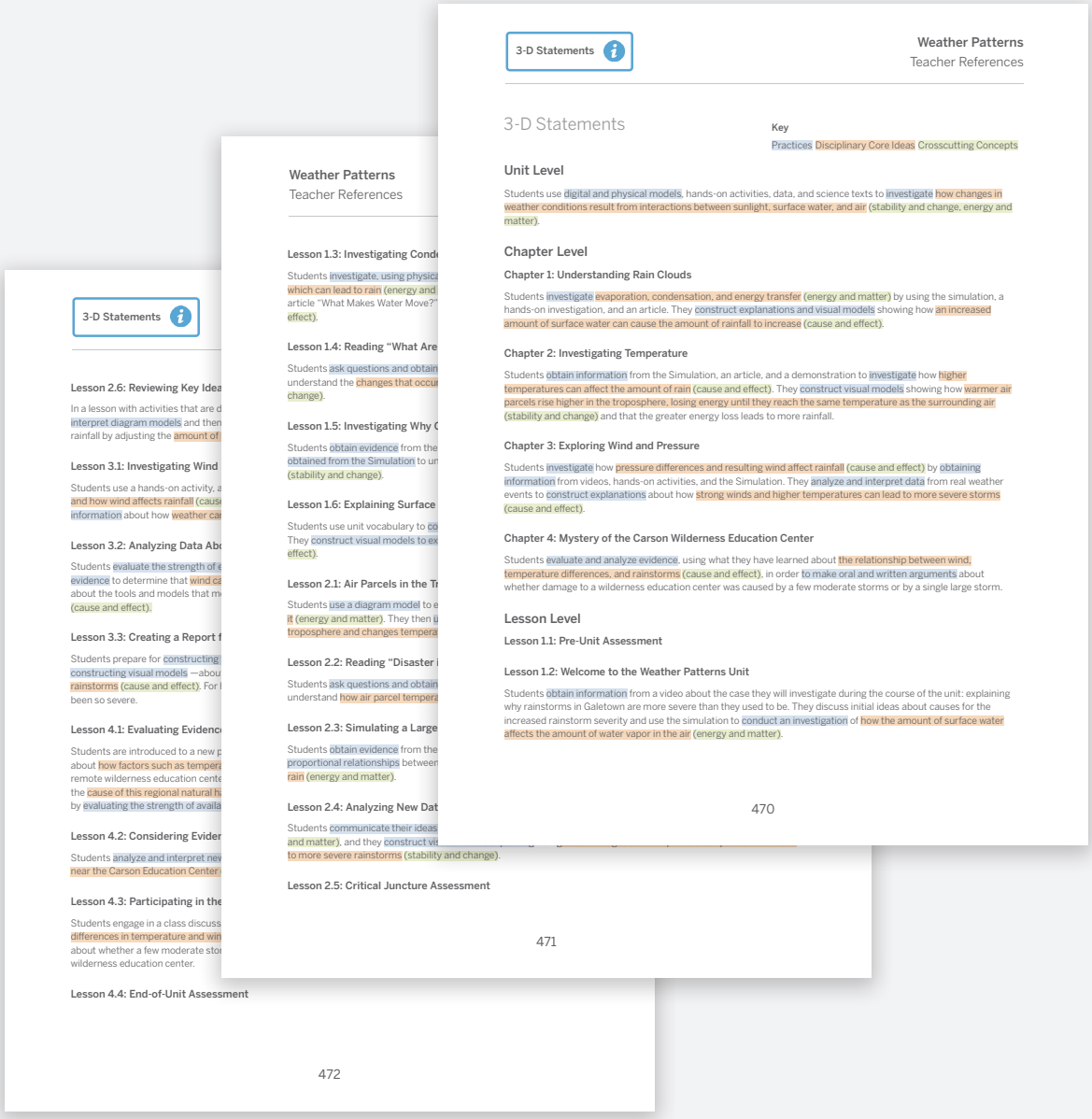
#### Chapter 3: Exploring Wind and Pressure

Students investigate how pressure differences and resulting wind affect rainfall (cause and effect) by obtaining information from videos, hands-on activities, and the Simulation. They analyze and interpret data from real weather events to construct explanations about how strong winds and higher temperatures can lead to more severe storms (cause and effect).

#### Chapter 4: Mystery of the Carson Wilderness Education Center

Students evaluate and analyze evidence, using what they have learned about the relationship between wind, temperature differences, and rainstorms (cause and effect), in order to make oral and written arguments about whether damage to a wilderness education center was caused by a few moderate storms or by a single large storm.

## To review the 3-D Statements at the lesson level, see the Lesson Brief section of every lesson.



3-D Statements

Lesson 2.6: Reviewing Key Idea

In a lesson with activities that are d
interpret diagram models and then
rainfall by adjusting the amount of

Lesson 3.1: Investigating Wind

Students use a hands-on activity, a
and how wind affects rainfall (caus
information about how weather ca

Lesson 3.2: Analyzing Data Abo

Students evaluate the strength of e
evidence to determine that wind ca
about the tools and models that m
(cause and effect).

Lesson 3.3: Creating a Report f

Students prepare for constructing
constructing visual models —abou
rainstorms (cause and effect). For
been so severe.

Lesson 4.1: Evaluating Evidenc

Students are introduced to a new p
about how factors such as tempera
remote wilderness education cente
the cause of this regional natural h
by evaluating the strength of availa

Lesson 4.2: Considering Evider

Students analyze and interpret new
near the Carson Education Center

Lesson 4.3: Participating in the

Students engage in a class discuss
differences in temperature and win
about whether a few moderate sto
wilderness education center.

Lesson 4.4: End-of-Unit Assessment

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Weather Patterns
Teacher References

Lesson 1.3: Investigating Cond

Students investigate, using physica
which can lead to rain (energy and
article "What Makes Water Move?"
effect).

Lesson 1.4: Reading "What Are

Students ask questions and obtain
understand the changes that occu
change).

Lesson 1.5: Investigating Why C

Students obtain evidence from the
obtained from the Simulation to un
(stability and change).

Lesson 1.6: Explaining Surface

Students use unit vocabulary to co
They construct visual models to ex
effect).

Lesson 2.1: Air Parcels in the Tr

Students use a diagram model to e
it (energy and matter). They then u
troposphere and changes tempera

Lesson 2.2: Reading "Disaster

Students ask questions and obtain
understand how air parcel tempera

Lesson 2.3: Simulating a Large

Students obtain evidence from the
proportional relationships between
rain (energy and matter).

Lesson 2.4: Analyzing New Dat

Students communicate their ideas
and matter), and they construct vis
to more severe rainstorms (stability and change).

Lesson 2.5: Critical Juncture Assessment

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3-D Statements

Weather Patterns
Teacher References

3-D Statements

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

### Unit Level

Students use digital and physical models, hands-on activities, data, and science texts to investigate how changes in weather conditions result from interactions between sunlight, surface water, and air (stability and change, energy and matter).

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### Lesson Level

**Lesson 1.1: Pre-Unit Assessment**

**Lesson 1.2: Welcome to the Weather Patterns Unit**

Students obtain information from a video about the case they will investigate during the course of the unit: explaining why rainstorms in Galetown are more severe than they used to be. They discuss initial ideas about causes for the increased rainstorm severity and use the simulation to conduct an investigation of how the amount of surface water affects the amount of water vapor in the air (energy and matter).

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# Notes

# Notes

For more information on Amplify Science, visit **amplify.com/science/california**.

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