OVERVIEW

WEATHER AND WATER COURSE

WELCOME TO FOSS WEATHER AND WATER

The **FOSS Weather and Water Course** focuses on Earth's atmosphere, weather, and water. As part of their study, students delve into topics that may seem unrelated to weather, including a good dose of physics and a bit of chemistry. These scientific disciplines support many areas in the earth sciences. A good understanding of meteorology as an earth science isn't complete without an introduction to concepts that cross into the realm of physics and chemistry.

Understanding weather is more than reading a thermometer and recording air-pressure measurements. Students need to grapple with ideas about atoms and molecules, changes of state, and heat transfer before they can launch into the bigger ideas involving air masses and fronts, convection cells and winds, and the development of severe weather.

Earth's atmosphere is composed of a variety of gases, with nitrogen and oxygen the most abundant. But Earth wouldn't be the same if it weren't for one keystone gas, water vapor. When you look at the percentages, water vapor is a relatively minor and variable component of the atmosphere. But without water vapor and its liquid and solid forms, both on the surface and in the atmosphere, there would be no weather. There would be neither clouds nor precipitation. If precipitation didn't occur, we wouldn't have runoff to create the streams and rivers that erode mountains, deposit deltas, and replenish lakes and oceans. An atmosphere without water vapor would be an alien and hostile place. The importance of water on Earth is a major element of this course.

FOSS AND NATIONAL STANDARDS

The **Weather and Water Course** for grades 6–7 emphasizes the use of knowledge and evidence to construct explanations for the movement and change in air and water that result in weather on Earth. This course supports the following National Science Education Standards.

SCIENCE AS INQUIRY

Develop students' abilities to do and understand scientific inquiry.

- Design and conduct scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the connections between evidence and explanations.
- Communicate scientific procedures and explanations.
- Use mathematics in scientific inquiry.
- Understand that different kinds of questions suggest different kinds of scientific investigations; current knowledge guides scientific investigations; mathematics and technology are important scientific tools.
- Understand that scientific explanations emphasize evidence.

CONTENT: PHYSICAL SCIENCE

Develop students' understanding of the transfer of heat energy.

- Heat energy is transferred in many ways (radiation, conduction, convection).
- Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.
- The Sun is a major source of energy for changes on Earth's surface.

CONTENT: EARTH SCIENCE

Develop students' understanding of Earth's atmosphere.

- The atmosphere is a mixture of nitrogen, oxygen, and trace gases, including carbon dioxide and water vapor. The atmosphere has different properties at different locations.
- Clouds, formed by the condensation of water vapor, affect weather and climate.
- Global patterns of atmospheric movement include local weather. Oceans have a major effect on climate because water in the oceans holds a large amount of heat.
- Water circulates through Earth's crust, oceans, and atmosphere in the water cycle.

SCIENCE AND TECHNOLOGY

Develop students' understanding of science and technology.

- Science influences society through its knowledge and worldview.
- Scientists work in many different settings.

FOSS MIDDLE SCHOOL PROGRAM COMPONENTS

FOSS for Middle School is a general science curriculum for students and their teachers in grades 6–8. The curriculum is organized into topical courses in three strands: **Earth and Space Science, Life Science,** and **Physical Science and Technology.** Each course is an in-depth unit requiring 9–12 weeks to teach.

This course, designed for students in grades 6–7, includes the following five interconnected components:

- A detailed ***Weather and Water Teacher Guide*** in a three-ring binder, including overview, materials preparation, goals and objectives, at-a-glance investigation chart, science background, lesson plans, transparency masters, teacher answer sheets, assessments with masters and scoring guides, CD-ROM user guide, and references (books, multimedia, websites). Chapters of the teacher guide are separated by tabs for easy use. **Weather and Water** has nine investigations, each with two to five parts.
- **Kit of student laboratory equipment** packaged for multiple classes of 32 students each. The kit also contains class resource materials such as posters and videos. Each course is designed for one teacher working with five sections of students per day. The kit includes 34 transparencies for the investigations.
- ***FOSS Weather and Water Lab Notebook*** consisting of student sheets and organizers for students to use while they engage in the investigations. One copy comes in the kit. The lab notebook can be a consumable item if one is purchased for each student. The book is rendered in black and white and the sheets are perforated, so individual sheets can be used as duplication masters, adding flexibility to your use of the notebook.
- ***FOSS Weather and Water Resources*** is a book containing data and readings that are used throughout the course. Sixteen copies of the full-color resources book come in the kit. They are intended to be used as classroom resources, shared by all students, but additional copies can be purchased. We recommend that each student have a copy of the resources book.
- ***FOSS Weather and Water*** **CD-ROM** for use as a whole-class demonstration tool as well as an individual or small-group interactive instructional tool. The multimedia is woven into the instruction and is linked to each investigation.

	SYNOPSIS	SCIENCE CONCEPTS	THINKING PROCESSES
1	**What Is Weather? (2 sessions)** Students start their study of weather by watching a video of severe weather. Following small-group discussions, the class reaches a consensus on the factors that constitute weather. Students begin monitoring local weather conditions, using tools.	• Weather is the condition of Earth's atmosphere at a given time in a given place. • Severe weather occurs all over Earth. • Meteorology is the science of weather, and meteorologists are the people who study Earth's weather.	• Describe weather instruments and the weather factors that they measure. • Use weather instruments to measure temperature, atmospheric pressure, humidity, wind direction, and wind speed.
2	**Where's the Air? (3–4 sessions)** Students work with syringes and tubing to discover that air takes up space and is compressible. They work in small groups to design demonstrations to show that air has mass. They study the atmosphere, a mixture of gases, using diagrams, photos, and a reading.	• The atmosphere is the layers of gases surrounding Earth. • Weather happens in the troposphere. • The troposphere is a mixture of nitrogen, oxygen, and other gases, including water vapor. • Air has mass and can be compressed.	• Conduct experiments to determine that air has mass. • Explain how experimental results provide evidence that air has mass. • Use a molecular model to compare a gas at standard pressure and a gas under increased pressure.
3	**Seasons and Sun (5 sessions)** Students investigate how the shape of Earth and its relationship to the Sun affect the weather around the world. They use light sources and globes to model the length of the day throughout the year, which leads to an awareness of seasonal variations.	• Earth's axis of rotation tilts at an angle of 23.5º and always points at the North Star. • The angle at which light from the Sun strikes the surface of Earth is the solar angle.	• Graph monthly day-length data for a single location to look for a pattern. • Analyze sunlight data and consider explanations. • Use a Sun-Earth model to identify relationships involving the tilt of Earth's axis, Earth's rotation, and Earth's revolution around the Sun.
4	**Heat Transfer (5 sessions)** Students investigate energy transfer from the Sun to Earth's surface and the atmosphere. They learn the two mechanisms of heat transfer in solids, liquids, and gases: radiation and conduction.	• Heat is kinetic energy of atoms and molecules. • The Sun is the major source of energy that heats the atmosphere. • Energy moves from one material to another by radiation and conduction.	• Collect and analyze temperature data measuring the heating and cooling of different earth materials. • Describe heat transfer in terms of molecular activity. • Describe how the atmosphere is heated.
5	**Convection (5 sessions)** Students investigate density of fluids on their way to understanding convection as a process of mass movement of fluids and a mechanism for energy transfer. They observe interaction of liquids of different densities and gases of different densities.	• Density is the ratio of a mass and its volume. • As matter heats up, it expands, causing the matter to become less dense. • Convection is the circulation of fluid that results from energy transfer.	• Describe how materials of different densities interact. • Observe how heating and cooling of fluids moves air in a system. • Explain how energy transfer drives the process of convection.

FOSS CD-ROM	FOSS READINGS	EXTENSIONS
• Links to On-Line Resources • Weather Chart Spreadsheet	• *Naming Hurricanes*	• Continue with the video. • Explore weather topics. • Track weather reports. • Consider weather lore. • Contact the National Weather Service. • Explore careers in meteorology. • Use a spreadsheet to look at weather data.
• Matter and Energy: Gas in a Syringe • Atmospheric Data: Elevator to Space	• *What's in the Air?* • *A Thin Blue Veil*	• Weigh the air in a soccer ball. • Draw atmosphere posters. • Find out about atmospheric research from space.
• Cycles: Seasons • Cycles: Pacific Coast Day Length • Cycles: Pacific Coast Sunsets	• *Wendy and Her Worldwide Weather Watchers* • *Seasons*	• Experiment with solar heating. • Compare variables for cities at different latitudes on the FOSS CD-ROM. • Change Earth's tilt on the FOSS CD-ROM. • Investigate day length and sunsets on the FOSS CD-ROM.
• Matter and Energy: Thermometer • Matter and Energy: Molecules in Solids, Liquids, and Gases • Matter and Energy: Heat and Energy • Video Resources: Conduction through Metals	• *Thermometer: A Device to Measure Temperature* • *Heating the Atmosphere*	• Test conduction through other materials. • Investigate heat capacity on the FOSS CD-ROM.
• Matter and Energy: Heat and Energy • Video Resources: Convection Chamber	• *Density* • *Convection*	• "Launching" solar balloons. • Practice calculating density.

	SYNOPSIS	SCIENCE CONCEPTS	THINKING PROCESSES
6	**Water in the Air (8 sessions)** Students explore the forms that water takes in the atmosphere. They investigate how water gets in the air and how it condenses out of air.	• Water changes from gas to liquid by condensation. • Water changes from liquid to gas by evaporation of water; requires heat from the surroundings.	• Infer that water vapor is part of the air by observing condensation on surfaces. • Determine dew point by observing at what temperature condensation occurs. • Predict cloud formation from dew point and temperature data.
7	**The Water Planet (4 sessions)** Students identify the elements of the water cycle and the distribution of water over Earth. Through a game and a multimedia simulation, they follow the path a water molecule might take as it travels in the water cycle.	• Most of Earth's water is in the oceans as salt water. • Earth's fresh water is found in many locations, including in the atmosphere, lakes, rivers, groundwater, and glaciers. • A water molecule might follow many different paths as it travels in the water cycle.	• Engage in simulations to follow the movement of a molecule of water through the water cycle. • Explain with words and drawings how evaporation, condensation, precipitation, and other processes produce many variations of the water cycle.
8	**Air Pressure and Wind (8 sessions)** Students investigate the relationship between changing air pressure and wind. They assemble and explore a pressure indicator and learn about barometers. Using knowledge developed in previous investigations, they come up with models of wind. They build an anemometer to measure local wind and use pressure maps to make weather predictions.	• Pressure exerted on a gas reduces its volume and increases its density. • Differential heating of Earth's surface by the Sun can create high- and low-pressure areas. • Wind is a movement of air from an area of high pressure to an area of low pressure. • Local winds, called sea breezes, land breezes, mountain breezes, and valley breezes, blow in predictable ways determined by local differential heating. • Wind speed is measured with an instrument called an anemometer. • Air pressure is represented on a map by contour lines called isobars.	• Apply pressure to a system and observe the compression of gas. • Build an anemometer and use it to gather data. • Interpret a pressure map. • Describe the relationship between changing air pressure and wind. • Explain how differential heating of Earth by the Sun creates local winds.
9	**Weather and Climate (6 sessions)** Students revisit severe weather and consider it in relation to air masses and fronts. Climate is introduced and climate regions are discussed. Students revisit the water-cycle multimedia simulation with the global-warming variation, in which Earth's average temperature has increased 2–5°C. They analyze the results.	• Air masses are large bodies of air that are uniform in temperature and humidity. • A front is a boundary that separates two air masses. • Weather conditions usually change as a front passes by. • Climate is the average weather over a long period of time in a region.	• Model and explain what happens when two air masses of different densities meet. • Explain how a global temperature increase could affect the water cycle and Earth's climate.

FOSS CD-ROM	FOSS READINGS	EXTENSIONS
• Video Resources: Cloud in a Bottle • Atmospheric Data: Weather-Balloon Launch	• *Dragon's Breath* • *Observing Clouds* • *Weather Balloons and Upper-Air Soundings*	• Investigate transpiration. • Observe a weather-balloon launch. • Take a second look at the pressure/temperature relationship. • Explore evaporation. • Collect local radiosonde data.
• Cycles: Water Cycle	• *Earth: The Water Planet*	• Play the inflatable globe game. • Take a field trip.
• Climate Factors: Local Wind • Matter and Energy: Gas in a Syringe • Atmospheric Data: Weather-Balloon Launch • Atmospheric Data: Elevator to Space	• *What Is Air Pressure?* • *Where the Wild Wind Blows* • *Laura's Big Day*	• Write a poem about wind. • Build a wind sock. • Build a wind vane. • Make airplane or mountain-climbing observations. • Reduce pressure in a bottle.
• Video Resources: Solar Balloon • Video Resources: Weather Satellite • Climate Factors: Weather and Landforms • Climate Factors: Climate Regions • Cycles: Water Cycle	• *Severe Weather* • *Is Earth Getting Warmer?*	• Use the weather-satellite on the CD-ROM. • Check out local water. • Do an urban heat island project.

FOSS TEACHER GUIDE

The ***Weather and Water Teacher Guide*** is just that—a guide. It is designed to be an information and planning tool to help you understand and enjoy your introduction to weather, much like an interpretive brochure might guide your visit to historic Williamsburg. A good guide will suggest the best path to follow, and will enrich your visit with history, facts, and lore as you proceed. Like any good guide it will also point out places to rest, where to stop for refreshments. You should feel comfortable and confident that you know what you are doing as you go along.

Like a good guide it may be pressed into service less as you become more and more familiar with the territory. On your third visit to Williamsburg you might head straight for the main street, passing by some of the introductory exhibits, and you might visit your favorite spots in a slightly different order than you did before. You might even leave the trail here and there to drink in some of the historical ambiance in a way quite different from that intended by the preparer of the guide brochure.

The first time you visit the **FOSS Weather and Water Course,** we hope you will follow our suggested sequence to get the lay of the land. The guide is filled with information to help you have an excellent first use of the course. It may seem overwhelming at first, but in a short time you will discover how to use it effectively. Here's what we suggest.

Look at the **Table of Contents** to see how the teacher guide is assembled. You'll notice that the guide is subdivided into 18 chapters. Turn each tab to see how much information there is in each section.

Next read the **Overview** chapter completely. This describes the scope of the course content and discusses issues of instruction, assessment, management, and safety.

Now turn all the pages in the guide, pausing to read the **Goal and Objectives** of each investigation carefully. In this way you will be able to get a very good sense of the curriculum.

Finally digest Investigation 1, *What Is Weather?* thoroughly. Read the science background carefully and study the **at-a-glance chart** to see how the investigation is subdivided. The chart also provides a dissected overview of the several days of classroom actions, including the use of media (CD-ROM, video, and readings) and the assessments. Project the actions you read about into your classroom. Visualize students grappling with the issues and working with materials in small groups. If you have the kit at hand, bring out the materials as you read, and do the investigations. Discover where you are in the atmosphere. Then read Investigation 2 carefully, then 3, 4, 5, and so forth. Keep the *Weather and Water Teacher Guide* close at hand (even in hand) during your first excursion out into the weather to ensure a safe and productive adventure.