WEATHER AND CLIMATE

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WEATHER AND CLIMATE

Climate is what you expect;
Weather is what you get.
~ Mark Twain

Overview: The overarching goal of *Earth as a System is Essential: Seasons and the Seas* (EaSiE) is to transform the traditional middle school study of terrestrial seasons and weather into an exploration of the dynamic interactions between Earth's land, water, atmosphere, and the living world. This *Weather and Climate* lesson series allows student to explore how weather conditions are measured and to collect weather-related data over time in a particular area. This is used to distinguish climate from weather and leads to considering the weather in their backyard as a system with interacting components.

A prerequisite lesson series, *Systems*, can be found at www.mmsa.org/easie

A subsequent lesson series, *Data and Graphing*, examines weather data (temporal and spatial), and uses the data to investigate questions about weather patterns and trends.

Ideas related to seasons, climate change, and bioindicators of change in the Gulf of Maine region will be addressed in a future series of EaSiE lessons that explore students' "bigger backyard".

This lesson sets the stage for the big idea: Interactions among the air, land, and water play an important role in the weather conditions and climate in a particular location.

Note: This lesson series is intended to serve as a relevant context for the teaching and learning of weather-related ideas in middle school. It is not designed to replace a comprehensive curriculum, but rather enrich and integrate authentic Earth systems science content into instructional units using NOAA resources. It is suggested that teachers use the materials to supplement existing lessons about

- weather and the troposphere (e.g. factors that affect weather, including air temperature, air pressure, humidity);
- physical properties of atmospheric gases (e.g. factors that affect density, including pressure, temperature, factors that cause the rising and sinking of air, movements of air masses);
- water (e.g. the cycling of water through the atmosphere, factors that affect humidity and cloud formation); and
- energy transfer (e.g. sunlight, radiation, conduction, convection).

Related Goals from *Atlas of Science Literacy*, *Vol 2* (2007):

- The earth has a variety of climates, defined by average temperature, precipitation, humidity, air pressure, and wind, over time in a particular place (Weather and Climate, Grades 6-8).

Related Goals from *National Science Education Standards* (1996):

- Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground (Structure of the Earth System, Grades 5-8).
- Clouds, formed by the condensation of water vapor, affect weather and climate (Structure of the Earth System, Grades 5-8).
- Global patterns of atmospheric movement influence local weather (Structure of the Earth System, Grades 5-8).

Related Goals from *K-12 Science Literacy New Hampshire Curriculum Framework* (2006):

- Identify and describe the processes of the water cycle and explain their effects on climatic patterns (S:ESS1:8:1.1).
- Identify and describe the impact certain factors have on the Earth's climate, including changes in the ocean's temperature and composition of the atmosphere (S:ESS1:8:1.2).

Related Goals from *Maine Learning Results* (2007):

- Describe Earth Systems – biosphere, atmosphere, hydrosphere and lithosphere - and cycles and interactions within them (D2b).
- Give several reasons why the climate is different in different regions of the Earth (D2c).

Related Goals from *Massachusetts Science and Technology/Engineering Curriculum Framework* (2006):

- Differentiate between weather and climate (ESS).
- Explain the relationship among the energy provided by the sun, the global patterns of atmospheric movement, and the temperature differences among water, land, and atmosphere (ESS).

Starting with weather and climate in a student's "backyard" provides a foundation for developing an understanding of the *Ocean Literacy Essential Principles and Fundamental Concept*s (2006):

- The Earth has one big ocean with many features.
- The ocean is a major influence on weather and climate.
- The ocean supports a great diversity of life and ecosystems.
- The ocean and humans are inextricably interconnected.

This lesson also sets the stage for developing an understanding of the Essential Principles of Climate Science (2009). A link to the Climate Literacy Framework can be found at www.globalchange.gov.

Related Research on Student Learning from *Benchmarks for Science Literacy* (1993):

- Students understanding of conservation of matter, phase changes, clouds, and rain are interrelated and contribute to an understanding of the water cycle.
- Before having a firm understanding of evaporation (liquid water converted to an invisible form, water vapor gas) students may believe that when water evaporates it ceases to exist *or* that the water changes location but remains a liquid *or* that water is transformed into some other perceptible form such as fog, steam, or droplets.
- In order for students to understand that air is the final location of evaporating water they must first accept that air is a permanent substance.
- The mechanism of condensation is often not totally understood until early high school.

Related Research on Learning from *Making Sense of Secondary Science* (1994):

- In order for children to understand the water cycle they need an understanding of evaporation and condensation and that water vapor and drops of water have weight and undergo free-fall.
- Students, ages 9-10, often believe that clouds are made of water evaporated from puddles.
- Older students, ages 11-15, often think that clouds are created when vapor becomes cold.

Teacher Background from *Science for All Americans* (1990):
http://www.project2061.org/publications/sfaa/online/chap4.htm#6
The gravitational pull of the planet's mass is sufficient to hold onto an atmosphere. This thin envelope of gases evolved as a result of changing physical conditions on the earth's surface and the evolution of plant life, and it is an integral part of the global ecosystem. Altering the concentration of its natural component gases of the atmosphere, or adding new ones, can have serious consequences for the earth's life systems.

The distance of the earth from the sun ensures that energy reaches the planet at a rate sufficient to sustain life, and yet not so fast that water would boil away or that molecules necessary to life would not form. Water exists on the earth in liquid, solid, and gaseous forms—a rarity among the planets (the others are either closer to the sun and too hot or farther from the sun and too cold).

The motion of the earth and its position with regard to the sun and the moon have noticeable effects. The earth's one-year revolution around the sun, because of the tilt of the earth's axis, changes how directly sunlight falls on one part or another of the earth. This difference in heating different parts of the earth's surface produces seasonal variations in climate.

The earth has a variety of climatic patterns, which consist of different conditions of temperature, precipitation, humidity, wind, air pressure, and other atmospheric phenomena. These patterns result from an interplay of many factors. The basic energy source is the heating of land, ocean, and air by solar radiation. Transfer of heat energy at the interfaces of the atmosphere with the land and oceans produces layers at different temperatures in both the air and the oceans. These layers rise or sink or mix, giving rise to winds and ocean currents that carry heat energy between warm and cool regions. The earth's rotation curves the flow of winds and ocean currents, which are further deflected by the shape of the land.

The cycling of water in and out of the atmosphere plays an important part in determining climatic patterns—evaporating from the surface, rising and cooling, condensing into clouds and then into snow or rain, and falling again to the surface, where it collects in rivers, lakes, and porous layers of rock. There are also large areas on the earth's surface covered by thick ice (such as Antarctica), which interacts with the atmosphere and oceans in affecting worldwide variations in climate.

Additional weather and climate background information can be found at
AIRMAP's "A Climate Primer for New England":
http://airmap.unh.edu/background/ClimatePrimer.html

Essential Question: Is the weather and climate in our backyard a system?

Knowledge and skills:

1. Observe and measure weather conditions.
2. Distinguish between weather and climate.
3. Explain weather as a system of interactions.

Preparation

Prepare copies of handouts:

Weather concept cards, 1 set for each group of 3-4 students (Handout #1; make copies on colored paper and cut into cards)

Questions about Systems (found at end of the EaSiE Systems unit; mmsa.org/easie)

Materials:

Paper, markers, glue or tape for concept card maps

Air thermometers

Materials for Build Your Own Weather Station (optional NOAA resource)

NOAA Resources (Optional):

The following resources are available on the *Discover Your World with NOAA* CD in the *Understand the Earth* section. These resources are also available online at:
http://celebrating200years.noaa.gov/edufun/book/welcome.html#book

a) Build Your Own Weather Station – how to make an anemometer to measure wind speed, weather vane to measure wind direction, barometer to measure atmospheric pressure, screened thermometer to measure air temperature, hygrometer to measure humidity, and a rain gauge to measure rainfall.

b) Be a Citizen Weather Reporter – how to set up a weather journal and record ongoing weather measurements

Time Required

Steps 1 through 4: one to two class periods.

Step 5: A minimum of two weeks of weather measurements are collected. This will take a few minutes each day.
If the optional Measuring Weather Extension is selected (Appendix A), depending on the grade level and experience with instruments, it will take a minimum of 4-6 class periods to conduct the activity.

Steps 6 through 10: three to four class periods.

Vocabulary

Weather	Forecast
Climate	Anemometer
Atmosphere	Barometer
Water cycle	Hygrometer
Meteorology	Rain gauge

Teaching the Lesson:

Elicit/Engage

1. Ask: How does weather affect us - and our lives? (Some ideas that students may share may be that we dress according to weather, we plan recreational activities and meal choices based on weather. We alter our homes' heating and cooling abilities based on weather.)

2. Create a 'working definition' of weather by asking students to respond to the following prompt in their science notebooks, "What is weather?" After a few minutes, have students pair up and share their responses with each other. Chart students' ideas, and keep the ideas posted. This is a brief elicitation, providing them an opportunity to begin thinking about this topic. The definition will be refined as the unit progresses; it is not necessary at this point to "correct" student responses.

Exploration of Weather: Local Observation and Measurement

3. Observe the latest weather forecast, available online through NOAA and the National Weather Service at http://www.nws.noaa.gov (click on "Local Forecasts", find your region, and the "Forecast at a Glance" will show the predicted air temperature, wind speed, and precipitation).
   A video source of the New England area forecast can be found at http://wbztv.com/weathernews/weathervideo

4. **Introduce weather observing and measurement -**
   Weather observing methods discussion: Have students consider the weather forecast they watched. Post and ask students,"*How is weather observed?"*
   Have students record their ideas in their science notebook. When they have finished recording, lead a whole class discussion in answering this question by referring to what they observed while watching the weather reporting clip, other weather shows they may have seen on TV, or maps they may have seen in newspapers. Chart student ideas during the discussion. (They may know that weather is observed using instruments, and that measurements include temperature, humidity, wind speed, air pressure, and precipitation. They might also know satellites can be used to collect some of the data.)

5. **Local area weather recording** - Post a large chart paper to use for recording the local daily weather conditions.
   Measure outdoor air temperature (either at the same time each day, or minimum/maximum temps) for at least two weeks.

Note: With older students, it is preferable to have 1-2 months of temperature data. This can be obtained by having students take turns measuring the temperature each day.

Also have the teacher or students obtain daily humidity, wind speed, barometric pressure, precipitation in your local area for that same time span using the NOAA National Weather Service online site, http://www.nws.noaa.gov.

If desired, see NOAA *Discover your World* CD for information on setting up a weather recording journal.

Before proceeding to Step 6, show photographs or display actual weather measuring instruments that can be used to directly measure humidity (hygrometer), wind speed (anemometer), air pressure (barometer), and precipitation (rain gauge) "in your backyard". You may also want to display cloud charts that are used to determine cloud type. Collection of weather data via NOAA satellites will be explored in the subsequent "Data & Graphing" lesson series.

If you want to incorporate a more detailed weather component into your curriculum, Appendix A: Measuring Weather provides directions for constructing "backyard" weather instruments. The purpose of building the instruments is to show how weather measurements are made, but should not be relied upon for accuracy.

Explanation of weather and climate

6. Using classroom weather data to make a weather/climate connection

Reminder: For this step, a minimum of two weeks of local weather data is needed.

Measuring daily weather will allow students the opportunity to study weather patterns they find over time - in a particular place. The finding should also demonstrate that weather is always changing and can be described in measurable quantities such as air temperature, wind direction and speed, and precipitation. These observations and the discussions that will accompany them will aid in their future understanding that large masses of air with certain properties move across the surface of the earth and that the movement and interaction of these air masses is used to forecast the weather.

a) Place the weather chart that students have been using to record local weather measurements where all students can see it (or provide sheets of this local weather data for each group of students).

b) Have students work in groups of 3-4 to decipher/discuss the information on the charts. Students with less experience in collecting and interpreting data will need a guided discussion that includes:

i. What do these numbers (and the units) represent?
ii. How were these numbers obtained/generated? What tools were used?
iii. Do you notice any patterns in the weather data (e.g. is there a temperature trend)?
Note: Subsequent EaSiE lessons will go into greater detail on data interpretation and graphing.

c) After students look over the charts ask the class, *"As you look at this weather data, how does this relate to what we call climate?"*
Depending upon students' prior knowledge, they may not know how climate differs from weather. You may need to introduce the idea of climate and its connection to weather, which should lead to a definition of weather as the conditions in the atmosphere at a given time, and climate as the average temperature, precipitation, humidity, air pressure, wind speed over a particular time span in a particular place. Discuss your local climate, pointing out that in New England, we live in a climate where we typically have warm summers and cold winters.

An easy way to remember this difference is to post and discuss the meaning of the statement,

"Weather is what you wear each day,
and climate is what's in your closet!"

Note: Climate-related ideas will be explored further in subsequent lessons on Climate & Climate Change.

7. Group concept maps – Divide the class into groups of 3-4 students. Pass out large sheets of paper, markers, and glue or tape. Explain that students are to work together to create a group concept map about weather. Distribute the weather concept cards (Handout #1), and have them talk about and arrange the cards as a connected web of ideas. Groups should continue rearranging the cards until they are able to draw lines and write linkage words between the cards – words that describe the relationship between the concepts. Glue or tape the cards on paper. Do not accept any maps unless the connections are justified with linking words.

8. Sharing concept maps - Post the group maps so all can view. Have students compare the maps and discuss the similarities and differences. As you discuss their maps, point out the connections between the water cycle, humidity, clouds, and precipitation, placing an emphasis on the

the interactions and how the components of air, land, and hydrosphere respond to each other.
After the class discussion, provide time for groups to add to, clarify, or revise their maps.
Note: Unless explicitly discussed, many students will not see the connection between weather and the water cycle. Developing an understanding of the interactions in the water cycle (lithosphere, hydrosphere, and atmosphere – both gaseous water vapor and liquid water in the form of clouds) is a critical component to understanding factors that affect weather.
See "Possible Extensions" for resources that support learning of key ideas related to the water cycle.

9. Revisit original ideas and working definitions of weather. Continue with the question: *"What is the difference between weather and climate?"*
What do we now know that we didn't consider in our original working definition? Revise the definitions and have students record these in their science notebooks. Use guiding questions and the "clothes in the closet" analogy to bring students to a scientific definition of weather and climate if needed (weather being the actual atmospheric conditions at a particular moment, climate being the average over time in a particular place).

Ask students to now add their working definition of climate to their science notebooks. This should be based upon the local perspective – climate in your area. For now, the emphasis can focus on a descriptive rather than a data approach. This will be extended during the "Data & Graphing" lesson series.

Elaboration of Systems:

10. Weather as a System – Remind students of the "Systems" lessons they experienced, where they first looked at a bicycle, then another manufactured object, and finally something found in nature as a system (lesson available at www.mmsa.org/easie). Ask students to refer back to their science notebooks, where they wrote about, what makes something a system? What were the characteristics that all systems have in common, whether they are living or nonliving? (Responses should have included that systems have components that interact. They also may have identified some of the "things coming in" and "things going out.")

Explain that you are now going to use this same kind of "systems thinking" to think about weather. Use the *Questions about Systems* handout from the "Systems" lessons for pairs of students to discuss, "Is weather a system?" The subsequent group discussion should focus on the components that highlight interactions among the air, land, and water,

and how this plays an important role in the weather conditions and climate in a particular location. Weather indeed fits our definition of a system.

To incorporate a more detailed discussion of systems thinking into your lesson, see Appendix B: Thinking About Weather as a System.

Possible Extensions

This lesson series is intended to build essential understandings about weather so students can proceed to the EaSiE "Data and Graphing" series of lessons, examine weather data (temporal or spatial), and use the data to investigate questions about the patterns and trends. If you would like to expand on this core set of lessons, you might consider some of the following options that the EaSiE Project Teachers have incorporated into their classroom instruction.

Weather:

- Bring in local weather reports from the local daily newspaper. Discuss the terms and symbols of TV and newspaper weather reports.
- Make a daily weather map of your region; update daily. Keep in the classroom or the entryway of your school or library. Consider including universal weather symbols.
- Have a daily weather announcement over your school's audio system.
- Keep an updated weather page on your school's webpage.
- USA weather recording – During step 5, post a large map of the United States and a piece of chart paper to use as a data table. Use these to post the daily forecast in a variety of areas around the country. This information can be found at the NOAA National Weather Service site, http://www.nws.noaa.gov/

  Include areas that have different climates such as Florida, Arizona, California, Washington state, South Dakota, as well as your New England state. Refer to this at the end of the weather exploration to guide a geographically expanded discussion about "weather vs. climate".
- Other weather-related resources can be found on the NOAA Education website: www.education.noaa.gov

New England Weather and Climate:

- Use the lessons about local weather and climate to build up to a more regional perspective, serving as a foundation for lessons about:
    - What factors influence New England weather – why is weather so variable in New England?
    - New England climate, climagraphs
    - Use this as a precursor to units related to seasons, daylight, energy, energy transfer

- Use Gulf of Maine Ocean Observing System (www.gomoos.org/) and other online NOAA data to compare local weather with Gulf of Maine weather - and to bring the Gulf of Maine into students' thinking of their "big backyard".

- NOAA online interactive climate map of the US: http://www.cdc.noaa.gov/USclimate/states.fast.html

Global Weather and Climate:

- NOAA climate resources, including links to climate observations and the Education Division of the Climate Program Office, can be found at http://www.noaa.gov/climate

- World climate maps of air temperature and precipitation: http://www.climate-charts.com/World-Climate-Maps.html

History of Weather, Extreme Weather:

- During Step 5, include historical information on weather collecting and weather instruments.

- Create a historical time line of weather inventions/discoveries. Have students research the science and technology, as well as the historical context.

- Historical stories and photographs of weather instruments and events can be found at: http://www.photolib.noaa.gov/nws/

- Research extreme weather. Interview someone who has experienced extreme phenomena such as blizzards, hurricanes.

- Interactive NOAA weather hazard quizzes for kids: http://www.ngdc.noaa.gov/hazard/kqStart.shtml

Weather and the Water Cycle:

- Continue exploring the water cycle ideas, which are essential to understanding weather and climate conditions. The NOAA Water Cycle Game has students assume the role of a water molecule and travel through a series of components to the water cycle. By being an active participant in a representation of the water cycle, students gain a better understanding for the true complexity of the movement of water. A review of this resource and link to the activity can be found by typing the term "NOAA" into the search box on the PRISMS website: prisms.mmsa.org

- Show the NOAA "Water Cycle" and "Global Impact of the Water Cycle on Climate" videos http://www.montereyinstitute.org/noaa/lesson07.html This resource is also reviewed as part of the PRISMS collection found at prisms.mmsa.org. Pause the resources after each transition in the water cycle, and have students discuss the connection between each stage to weather and climate.

- Other online resources related to the water cycle can be found in the "Earth" section of the PRISMS collection: prisms.mmsa.org

- Use the "Wet Jeans" probe from *Uncovering Students Ideas in Science, Vol. 1* (2005) to elicit student ideas about evaporation and the water cycle prior to teaching this lesson.

References:

American Association for the Advancement of Science (AAAS). (2007). *Atlas of science literacy. Volume 2.* Washington DC: Author, and Arlington, VA: National Science Teachers Association.

American Association for the Advancement of Science (AAAS). (1993). *Benchmarks for science literacy.* New York: Oxford University Press.

American Association for the Advancement of Science (AAAS). (1990). *Science for all Americans.* New York: Oxford University Press.

Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994). *Making sense of secondary science: Research into children's ideas.* London: Routledge-Falmer.

Keeley, P., Eberle, F., and Farrin, L. (2005). *Uncovering student ideas in science: 25 formative assessment probes Vol. 1.* Arlington VA: NSTA Press.

Maine Department of Education. (2007). *Maine learning results: Parameters for essential instruction.* Augusta ME: Maine Department of Education.

Massachusetts Department of Education. (2006). *Massachusetts science and technology/engineering curriculum framework.* Malden MA: Massachusetts Department of Education.

National Geographic Society. (2006). *Ocean literacy: The essential principles of ocean sciences, K-12.* Washington DC: Author.

National Research Council (NRC). (1996). *National science education standards.* Washington DC: National Academy Press.

New Hampshire Department of Education. (2006). *New Hampshire curriculum framework.* Concord NH: New Hampshire Department of Education.

Smith, M.J., Southard, J.B., and Mably, C. (2002). *Investigating Earth Systems: Investigating Climate and Weather.* Armonk NY: It's About Time.

U.S. Global Change Research Program/Climate Change Science Program. (2009). *Climate literacy: The essential principles of climate science, a guide for individuals and communities.* Washington DC: Author.

Weather	**Temperature**	**Precipitation**
Humidity	**Air pressure**	**Wind Speed**
Clouds	**Earth**	**Wind Direction**
Air	**Land**	**Water**
Water Cycle	**Sun**	**Climate**

Handout #1: Cards for concept map

Appendix A
Measuring Weather: Build Your Own Weather Station

Note: This optional activity is based upon *Investigating Earth Systems: Climate and Weather*, "Observing Weather" (AGI 2002; NSF grant no. 9353035).

I. Introduction

A) Explain to students that they will work in groups to research the science and technology behind a weather instrument and to take weather measurements using that instrument. Each group will have one weather instrument/observation for which they will be responsible. Their job will include:

- Researching the science behind this weather observation, including relationship to water cycle or moving air masses and fronts.
- Learning the technique for making this observation.
- Studying the instrument that will be used for this observation.
- Making the weather observation.
- Writing a protocol for making this weather observation.
- Setting up a center for classmates to learn about this weather observation.

B) Assign groups - Decide what weather observations you would like the class to measure, and how many students you would like working in each group. Possible instruments and measurements include:

- Anemometer – wind speed
- Weather vane – wind direction
- Barometer – atmospheric pressure
- Screened thermometer – air temperature
- Hygrometer – humidity
- Rain gauge – rainfall
- Cloud type can be analyzed using the cloud chart found at: www.weather.gov/os/brochures/cloudchart.pdf

Instructions and a list of materials needed for building the weather measuring instruments can be found at *Discover Your World with NOAA*: Understand the Earth; Build your own weather station: http://celebrating200years.noaa.gov/edufun/book/welcome.html#book

You may want a "wind" group to measure wind speed and direction, an "air" group to measure pressure and temperature, a "water" group to measure humidity and rainfall, and a "cloud" group to observe and measure cloud type and cover. Or, depending on the number of groups and the types of observations you want included, you may arrange in other ways.

II. Conduct research and build weather instruments

Once students are divided into groups they should begin dividing up the research options. They can follow the jobs as assigned by the teachers, or devise a plan that works well for them. Jobs include:

A) Researching the science behind their weather observation – this should be brief (1/2 – 1 page).
B) Learning the techniques for making their observations (1/2 page write up).
C) Study the instrument they will be using for their measurements/ observations – (1/2 page write up and sketches)
D) Constructing the instrument.
E) Write a protocol for making their weather observations (students who are not familiar with their instrument should be able to follow this procedure).
F) Practice making their weather observations.
G) Keeping a weather log of measurements in their science notebooks.

After each group divides up the tasks, they should have their plans approved by the teacher before starting work.

III. Set up weather measurement stations

As students are conducting research, building, and testing weather instruments they can also begin setting up the weather center that their peers will visit (this will most likely be a group endeavor; see the NOAA *Discover your World* CD for instructions).
Begin the station design work with sketches in science notebooks. Have students show the teacher design ideas/sketches and get approval before moving forward with their weather station.

Weather stations should address:

- What does this weather observation tell you about the weather picture for a particular day?
- How does this weather instrument work?
- In thinking about the protocol, what sorts of things could affect the accuracy of the weather data?
- Is there any other information that will help others understand the measurements and the information the measurements tell? This may include connections to the water cycle, moving air masses and weather fronts.

Allow one class period for students to visit the weather stations.

Appendix B
Thinking About Weather as a System (contd.)

Use the *Questions about Systems* handout from the *Systems* lesson (www.mmsa.org/easie) for pairs of students to discuss, "Is weather a system?" The subsequent group discussion should focus on the components that highlight interactions among the air, land, and water, and how this plays an important role in the weather conditions and climate in a specific location. Weather indeed fits our systems definition.

Emphasize that in order to examine these interactions, we have placed some artificial boundaries on our system. Meteorologists – scientists who study weather – do the same thing. They often define the weather system in our region by geographic boundaries – sometimes as small as your local area. Once these boundaries are defined, this helps a meteorologist forecast (predict) weather conditions for the upcoming days.
Ask students to discuss in pairs, what's "coming in" and "going out" of your area that makes changes in the weather? (Students may mention wind or air, clouds or water, sun or heat). These are called "inputs" and "outputs", and it is the interactions that influence our weather.

If students have had prior learning experiences pertaining to matter and energy, this discussion of inputs, outputs, and interactions can make a connection to matter and energy ideas (e.g. gases and water in the air, radiation from the Sun) coming in and out of our local area that influences our weather.

Sometimes meteorologists forecast weather on a larger geographic scale, such as your entire state. Discuss how this makes a difference in what a meteorologist will forecast (predict), because sometimes it might be warm and cloud-free in your town, while it is cooler, cloudy, and raining on the other side of your state. Changing the boundaries of the system you are thinking about influences how specific you can be in studying the inputs, outputs, and interactions within the system.

If we want to further our understanding of why the weather in New England is so variable, we would also need to expand our boundaries to include the geographic regions to our North, South, East, and West (e.g. the interactions between the mountains, Gulf of Maine, ocean, etc. We would need to include not only the flow of air over land masses, but also the energy inputs and outputs (e.g. energy transfer, the role of the Sun).

It's OK to establish different boundaries as we learn about something – scientists do this, too. But as scientists research something, and as they share their ideas with others, they make sure that they communicate what they used as their boundaries in their thinking.