Connecting Clouds with Weather and Climate Studies

by Ted Miracle, 2019 CTI Fellow
Devonshire Elementary

This curriculum unit is recommended for Fifth grade science

Keywords: clouds, climate, weather, elementary science, citizen science

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit

Synopsis: The key purpose of this curriculum unit is to teach information about clouds, cloud types, and weather associated with cloud types to upper elementary students. Understanding clouds and their connections to weather is an important element in understanding climate science. This curriculum unit will assist fifth grade students in developing knowledge about weather. This increased knowledge will have a direct impact on their understanding of North Carolina science standards. The curriculum unit will also spark interest in the natural world that will build towards a deeper future interest in climate science.

I plan to teach this unit in the coming year to 116 students in fifth grade.

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Introduction

Climate and weather are intertwined, but they are not the same thing. Climate is defined by Andrew Dessler as "a statistical description of the weather over a period of time, usually a few decades" while weather is "the actual state of the atmosphere at a particular time." Weather phenomenon such as precipitation and air temperature are short-term and easy to measure. Climate is a long-term proposition such as the average precipitation a place experiences in a certain timeframe. This makes it harder to measure than weather (1). It stands to reason if climate is harder to measure than weather, then climate will also be more difficult for elementary school students to understand than weather.

Climate and weather are related because the same factors that are associated with weather create climate when averaged statistically over a long period of time. Sometimes people make the error of associating short-term weather changes with climate. Dessler quotes Mark Twain's comparison of weather and climate. Twain said, "Climate is what you expect; weather is what you get" (1).

The National Oceanic and Atmospheric Administration (NOAA) has an excellent website that is useful for understanding the differences between climate and weather. NOAA says, "Weather is the mix of events that happens each day in our atmosphere." There are many factors that create weather. They include air pressure, temperature, humidity, wind speed, wind direction, and many others. These factors create weather conditions for a particular time in a particular place. NOAA says, "Climate describes what the weather is like over a long period of time in a specific area." NOAA says scientists might look at averages for precipitation, temperature, humidity, sunshine, wind, and other factors for a 30-year period to determine climate. NOAA uses the analogy that "weather tells you what to wear each day. Climate tells you what type of clothes to have in your closet." (2)

The title of the seminar course is Climate Science and Solution Strategies. It would be easy to assume that one would address climate change in a curriculum unit for a seminar course titled Climate Science and Solution Strategies. This is not necessarily the case. Students need a foundational understanding of key weather concepts as a step towards learning about climate and climate change.

Science educators advocate students learn about weather before learning about climate. Bruce Larson says weather is the entry point for developing the skills necessary for students to understand the complexity of climate. Larson suggests students in kindergarten and grade one observe seasons through weather, observe and name precipitation, discuss clothing choices, look at thermometers, and use correct weather vocabulary. He suggests students in grades two and three observe animal adaptations to seasonal change and local climate, discuss the importance of the sun to weather, record precipitation, record hours of daylight, and learn about sunrise and

sunset. Larson suggests students in grades four and five learn about protocols for standard weather measurement, record and/or report precipitation and/or cloud cover, learn about layers of the atmosphere, learn about extreme weather events and their impact on society, use and define intermediate weather vocabulary, and observe and record phenomena such as cloud types, temperature, wind speed, and relative humidity (3). It is notable that Larson suggests teaching about cloud types and precipitation in grade five. This curriculum unit does just that.

Larson recommends a climate learning progression. In this progression, students in kindergarten and grade one should observe seasons through weather events, become aware of the day and night cycle, and learn appropriate vocabulary. Students in grades two and three should observe animal adaptations in response to seasons and local climate, introduce the earth-moon-sun relationship, track hours of daylight and darkness, discuss why the sun is important to understanding climate, develop graphing skills, and use basic weather vocabulary. Students in grades four and five should be introduced to local climate data and graphs, learn about carbon dioxide data and global temperatures over longer time intervals, discuss how climate change affects other cultures and individuals, discuss ways humans can adapt and live with climate change, and use and identify climate vocabulary (3). Larson includes several suggested learning outcomes related to the study of climate for students in grades four and five.

Linda Froschauer wrote an editor's opinion piece about the study of climate for the National Science Teaching Association elementary science journal *Science and Children* in 2015. Froschauer believes schools have done a fairly good job of teaching basic information about weather and climate. Froschauer notes many students have heard about climate change and want to know more about it. Climate change is a complex topic. It may be hard for elementary students to build understanding of it (4). Froschauer discusses recommendations from the National Research Council's 2012 book, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. The *Framework* says climate change consists of "significant and persistent changes in an area's average or extreme weather conditions that can occur if any of Earth's systems change." The *Framework* advocates for teaching about climate change beginning in grade five (5).

The three elementary grades with weather standards in North Carolina science are kindergarten, second grade, and fifth grade. The North Carolina Science Essential Standards do not mention the word climate in any of the standards or descriptions of content standards called Unpacked Standards for any elementary grade that studies weather (6). Not using the term climate in any fifth grade North Carolina science standard is questionable. The National Research Council includes climate change as a grade five topic in its framework for K-12 science education (5). Most grade five students can probably grasp the idea that climate is a long-term application of weather. Additionally, fifth graders study terrestrial ecosystems such as forests and grasslands and aquatic ecosystems such as lakes, ponds, estuaries, saltwater marshes, and oceans (6). It stands to reason climate is an important element in the types of life that exist in these ecosystems.

The rationale behind the topic addressed in this curriculum unit is that clouds are a fundamental element in weather. Learning about clouds and the weather associated with them is expressly a part of the North Carolina Science Essential Standards. As stated by Larson,

students need a fundamental understanding of weather before learning about climate (3). It is a good idea for grade five students to have a basic understanding of the connections of weather to climate and a basic understanding of weather and climate, and while this curriculum unit focus is on the study of clouds and the weather associated with cloud types, the Instructor should keep in mind that the Earth's average temperature (the global climate) itself is intensely regulated by cloud cover and variability. Clouds help students draw connections between weather and climate, even if the focus is on one or the other.

School/Student Demographics

Devonshire Elementary School is a K-5 Title I school in east Charlotte. Devonshire is a community school. Almost all of the students live within close proximity to the school. A small number of students who are considered homeless under the McKinney-Vento Act receive transportation to and from school and do not live nearby. Many of the students walk to and from school. The school has 630 students. The student body is about 59% Hispanic, 34% African-American, 4% Asian, 2% White, and 1% Other. Devonshire has a large English Learner (EL) population. The primary EL language is Spanish. Effectively teaching academic vocabulary is a need for all students, but especially at Devonshire due to the high percentage of students whose first language is not English.

Unit Goals

The primary goal of this curriculum unit is for fifth grade students to learn about common cloud formations and the weather that is associated with them. Weather topics such as temperature and precipitation will be part of the learning because they are weather factors that directly relate to clouds. This curriculum unit will lead to better student understanding of other weather topics such as weather patterns and the relationship of fronts to cloud formations.

I believe it is critical for students to understand their natural world. This includes weather. A Charlotte-Mecklenburg School teaching colleague of mine, Cynthia Dey, made a statement to me when I told her about this curriculum unit concept. Dey said, "Successful citizens knowing weather creates power as a citizen is like a pebble in a bucket of water." Later, she said the students will "understand pollution, acid rain, planning for storms, vegetation and erosion, community impact on ecosystems, global weather, and understand gas, liquid, and solids" (7). I agree with Dey's statement. Understanding weather will make students better citizens, and students will be more prepared to consider solutions to global warming and climate change if they have a deep understand of the weather forces that create climactic conditions. One of the important parts of weather is understanding clouds and the weather associated with them.

Cloudiness is a component of weather. The amount of types of clouds in a region will impact its climate over time. Learning about clouds and the weather associated with various types of clouds is an expectation in fifth grade science in North Carolina. For these reasons, this curriculum unit is about clouds and is designed for fifth grade students.

Background

The Charlotte-Mecklenburg Science Department has created a suggested pacing guide for elementary science topics. For the 2019-2020 school year, Charlotte-Mecklenburg Schools has suggested teachers devote thirty-five school days for teaching about weather. This is the equivalent of seven school weeks. This is by far the greatest number of days devoted to a particular science topic. The time ranges from November 4 to January 10. It does not include any review day(s) teachers might spend on weather during a suggested thirteen-day review for the fifth-grade science end-of-grade exam. The suggested review dates are May 4 to May 20. This information is included in the curriculum unit to illustrate there are a great number of weather concepts to teach. This curriculum unit will take place over a five-day period so that the timing allows for teachers to work on other weather concepts as well.

Charlotte-Mecklenburg teachers have access to online resources that many teachers across the state might not have and that Charlotte-Mecklenburg teachers might not have in the future depending on funding and curriculum decisions. In particular, Charlotte-Mecklenburg teachers have access to Science A-Z and Discovery Education. All lesson plans for this curriculum unit intentionally avoid Science A-Z and Discovery Education. The curriculum unit uses materials that are likely to remain available in the future. The purpose of this decision is to foster the long-term viability of the curriculum unit. A side benefit of not using material currently available to Charlotte-Mecklenburg teachers is this curriculum unit may give teachers information they can use in addition to Science A-Z and Discovery Education.

Strategies

Each lesson in the unit is scheduled to be forty-five minutes in length. This amount of time has been chosen because it is a common amount of time in Charlotte-Mecklenburg Schools for a science or social studies block. Teachers who have a shorter or longer amount of time for science instruction will need to make adjustments. One possibility may be to include some activities in art. One model of science instruction is STEAM rather than STEM. Some of the lessons in this curriculum unit have an art component.

The curriculum unit will apply concepts and tools developed for Next Generation Science Standards. The Next Generation Science Standards (NGSS) were developed by the National Research Council in 2011. Key collaborators in developing the Next Generation Science Standards were twenty-six lead state partners, the National Science Teaching Association, National Research Council, and the American Association for the Advancement of Science. North Carolina was one of the twenty-six lead state partners for developing the standards (8). Although North Carolina was one of the states that helped developed Next Generation Science Standards, the state has opted to develop North Carolina Essential Standards for science that do not mirror Next Generation Science Standards.

The Next Generation Science Standards developed a lesson plan format that has become widely used. It is the 5E model. The five E's are Engage, Explore, Explain, Elaborate, and Evaluate (8). Charlotte-Mecklenburg Schools promotes the use of the 5E model. One way it does so is through teacher access in grades K-8 to the Discovery Education Techbook web

resource. Discovery Education Techbook is set up along the 5E model for every science topic North Carolina requires for that grade level.

It is possible Charlotte-Mecklenburg Schools could choose to not use Discovery Education Techbook in the future. The connection to the 5E curriculum model and Discovery Education Techbook was mentioned in order to show the district's support of the 5E lesson plan model. This curriculum unit will utilize resources other than Discovery Education Techbook in order to ensure future access to those materials.

This curriculum unit will apply the 5E lesson planning model. Every part of the model will not be evident in every lesson in the curriculum unit, but all parts will be used to build student understanding about certain cloud formations and the weather that is associated with them.

The philosophy of the 5E model is teachers should avoid front-loading content at the beginning of studying a concept. Instead, students should be allowed to develop understanding through engagement and exploration. Starting with experiences will allow students to understand and define concepts before formal terms are introduced. Students can "discover" concepts on their own. They can then apply their learning to gain a deeper understanding of the topic. The basic tenets of each part of the 5E model will be explained by summarizing a description of each one.

The first E is Engage. In this portion of the model, students need to be mentally engaged with an activity or question. The question or activity needs to capture their interest and give them the opportunity to express what they know about the concept or skill being developed. It should also help students make connections between prior knowledge and new ideas.

The second E is Explore. This part of the model gives students hands-on activities for exploring the desired concept or skill. Students will deeply consider the phenomenon being studied and describe it in their own words. This part of the model allows students to acquire a common set of experiences to help them make sense of the concept they are studying.

The third E is Explain. The teacher provides content knowledge such as vocabulary terms and factual knowledge only after students have explored. The explanations will help students more deeply understand the phenomenon they have experienced. A significant attribute of this part of the lesson plan model is explanation follows experience.

The fourth E is Elaborate. Elaboration allows students to apply what they have learned to new situations. Students will develop a deeper understanding of the topic being studied. In this part of the model, it is important for students to discuss and compare their ideas with their peers.

The fifth E is Evaluate. This final part of the 5E model gives students the opportunity to review and reflect on the new learning and skills they have acquired. Students will produce evidence of their understandings, beliefs, and skills (8).

Curriculum Unit Lesson Plans

Day 1

The first lesson will use the Engage and Explore parts of the 5E lesson plan model. The teacher will not directly teach students the names of cloud types or the weather that is associated with them.

The first lesson activity for each day of the unit will start with nature journaling weather conditions, especially clouds conditions. Nature journaling gives students opportunities to observe and reflect on observations, feelings, and perceptions of the natural world (9). Students will take a journal outside. They will draw what they see in the sky and write any observations they have for the day. This will include drawing any clouds that are in the sky. There will be no expectations to identify any certain cloud types. Students simply observe, draw, and write. This should be a quiet time so that each student can focus. The amount of time for journaling will be about five minutes to journal and five minutes for students to review their observations with each other.

The next activity after nature journaling will be the creation of a K-W-L sheet. Each student will create a K-W-L. A K-W-L chart is a graphic organizer. The K part of the organizer stands for what the student already knows about the topic. In this case, the topic is clouds. Students will be instructed to write everything they already know about clouds. The W part of the graphic organizer is what the student wants to know about the topic. Students will complete the K and W parts of the K-W-L at the beginning of the unit. The L portion is for recording new information students learned. Students will add to the L part of the K-W-L at the end of each day in the unit.

A K-W-L graphic organizer elicits student prior knowledge. It can set a purpose for reading material. A final purpose is for students to monitor their learning. In the case of this unit, it will be used all week to document what students learn about clouds. This means the K-W-L chart will allow students to monitor their comprehension during the week. The students can monitor their own learning and the teacher can collect the K-W-L responses at the end of the unit as documentation of learning and an assessment piece for the student and the teacher's reflection on the quality of success of the unit.

K-W-L graphic organizers are often used to collect the ideas of small groups of students or a whole group of people. For this unit, it is suggested that each student keep their own K-W-L. In order to allow for a wide range of student learning modalities and achievement levels, students may draw and label pictures and not just write responses (10).

The next activity will be to look at time-lapse videos of cloud movement. Time-lapse videos of cloud movement are easy to find. This curriculum unit will use videos from the Cloud Appreciation Society. The Cloud Appreciation Society has a number of time-lapse cloud movement videos on its website. The teacher will introduce the videos. Students will then watch the videos. Students will be instructed to write their reactions to the videos in their nature journals. Although this activity is not being outdoors, it seems appropriate to add the notes to the

nature journal since the clouds in the video are a part of nature. Again, students will not be expected to give the name of any cloud types.

The teacher will then show still photographs of clouds. The Cloud Appreciation Society website will be used. It has a large gallery of cloud photos. Students will be asked to verbally describe the photos and their reactions to them.

The teacher will instruct students to write a brief reflection response on the L part of their K-W-L graphic organizer. Students will be asked to add to the L portion of the K-W-L as a concluding activity each day. This means the K-W-L sheets will need to stored safely so they can be reused each day and collected at the end of the unit.

Day 2

The second lesson in the unit will involve the first two E's in the 5E model, Engage and Explore. These parts of the lesson are designed to gain student interest. A hands-on activity relates to the Explore portion of the 5E model. The second part of the lesson will use the third E, Explain. In this part of the lesson, the teacher will begin explaining how clouds are formed and the weather related to clouds.

The second day of the unit will include a ten-minute observation of the clouds in the sky. Students will draw and write about what they are experiencing. Later in the week, students will compare how their journal responses show different things on different days.

The second activity in the lesson will be Cloud in a Bottle. There are many places to get directions for this activity. The directions used in this curriculum unit are from the NASA Climate Kids website. The teacher will post the directions while doing the activity because it gives step-by-step directions with excellent photographs.

The Cloud in a Bottle activity has to be a demonstration because fire is involved. A small amount of water is placed in the bottom of a bottle. A match is struck and is placed inside the bottle. The bottle is capped by an aluminum pie pan filled with ice. The cloud is formed as a result of condensation caused when the warmer water vapor comes into contact with the colder metal pan. The water droplets condense around the particles of smoke to form a cloud.

The teacher needs to explain this is related to how clouds form in the atmosphere. Warmer air rises from the surface of the Earth. The water vapor can cool when it contacts colder air. Water droplets form around particles of dust in the air. If the air is cold enough, the water droplets can form ice crystals. This means clouds are giant floating areas of water droplets or ice crystals. The water droplets won't form if the air in the atmosphere is at a very similar temperature.

In order to facilitate this explanation about how clouds form in the atmosphere, the teacher will use a webpage called *How Do Clouds Form?* The reading is from the website NASA Climate Kids. This explanation is intended to accompany the Cloud in a Bottle activity.

The teacher will use the webpage to provide illustrations and talking points. Students will be asked to read the information aloud to their peers.

Arbor Scientific has a cloud in a bottle activity titled *Cloud Machine*. This cloud in a bottle activity uses an individual pressure pump with a 20-ounce clear plastic bottle and a match. The pressure pump helps illustrate how lower air pressure impacts cloud formation.

The final activity will be to have students add to the L portion of their K-W-L graphic organizer. This will be the final activity during each day of the unit. Students will record things they learned in the lesson. They may respond with captioned drawings and/or writing.

Day 3

The students will start the lesson by exploring the appearance of the sky. They will draw and describe any clouds in the sky and note the weather. The teacher may ask the students if the clouds they see today are the same kinds they saw on the first two days of the unit.

The Explain portion of the 5E lesson model will be used again today. The teacher will use the book *Next Time You See a Cloud*. *Next Time You See a Cloud* was recognized as a National Science Teaching Association Outstanding Trade Book in 2017. It is a picture book with a Lexile reading level of 980 and a guided reading level of U. This reading level correlates with fifth grade. It is a 32-page book with engaging photos and clear descriptions of key cloud types.

Vocabulary in the text is highlighted in italics. This makes the book a good choice for students when they are searching for key vocabulary and concepts. Highlighted vocabulary terms in the book include evaporates, water vapor, condenses, cirrus, stratus, cumulus, cumulonimbus, and contrails. There are certainly many cloud types other than the ones described in this book, but it is an appropriate text for the unit because it promotes exploration before explanation, contains the key cloud types named in the North Carolina Essential Standards Unpacking Standards document (cirrus, cumulus, stratus), and contains extremely engaging.

The reading strategy called close reading will be used with the book *Next Time You See a Cloud*. Close reading provides a thoughtful, careful analysis of a text. Close reading involves rereading text as needed. Close reading can be done with small groups of students or the teacher can read the text to the whole class. Students often use a turn-and-talk strategy where the teacher instructs students to talk to a classmate about key points in the material. Students read with a pencil so they can take notes about key text points (11).

In order to heighten student interest, the teacher can preview the text by posting and reviewing questions the book will address. The questions come from a page at the beginning of the book titled *A Note to Parents and Teachers*. They include the following:

What colors are the clouds?
Why do you think they are those colors?
What do the clouds look like?
What do you think the clouds are made from?
Why do the clouds float?
Where did the clouds come from?
Where are the clouds going?
What direction are the clouds going?

The book will be read aloud by the teacher to the whole class. There are questions in the book. The teacher should ask students those questions. After reading the book, the teacher will ask students to identify the main gist of the book. Students will then need to reread the book in small groups. Students will need to have their pencils readily available in order to add to the L portion of the notes they are taking for the week.

There are some other topics the teacher could use while reading the book. One is to ask students is how the clouds they have seen on their nature walks compare to the clouds described in the book. Ask students if they saw cirrus, cumulus, stratus, contrails, or cumulonimbus clouds. Another is to ask students to connect their lessons about the water cycle to this discussion. The water cycle is taught during the weather unit, but it is also a topic many teachers review during the unit on heat transfer. If students have had previous lessons about the water cycle and its relationship to heat transfer in the atmosphere, the connection between the water cycle and clouds could be explored.

The teacher will walk around the room to monitor the quality of student notetaking. Students will be instructed to write down key facts about clouds in the L portion of their K-W-L chart. Key concepts will include clouds are made of water droplets and ice crystals that attach to tiny particles in the air (page 8), clouds form from evaporation of water into water vapor and condensation of that water (page 11), how students make their own clouds on a cold day (page 12), why clouds are white (page 15), cirrus clouds are wispy clouds made of ice crystals and are high in the sky (page 16), stratus clouds are like thick blankets and sometimes bring steady rain or snow (page 17), cumulus clouds are big and puffy and usually mean the weather is not rainy (page 18), cumulonimbus clouds are tall and are associated with thunderstorms (page 19), contrails are left by jets (page 20), clouds are heavy (page 21), clouds float because the water droplets and ice crystals are so tiny (22), and fog is a cloud (page 25).

The teacher will need to read the book in advance and prepare to support students with navigating the key aspects of the text. The teacher should also record key student notes about what they learned on a chart or dry erase board. Students will be encouraged to copy facts they did not put in their L portion of the K-W-L from the class record.

There are other children's books and online resources that could be used for teaching students about clouds. One children's book that could be used is *The Cloud Book* by Tomie De Paola. This book might be a good choice if this curriculum unit is applied to second graders or if the fifth-grade students are struggling readers. It covers much of the same material as *Next Time You See a Cloud*, but it is an easier text to navigate than *Next Time You See a Cloud*.

Day 4 and Day 5

Day 4 and Day 5 are together because the main activity will take two days to complete. The lesson will fulfill the fourth E in the 5E model, Elaborate, and the fifth E in the model, Evaluate.

The third E in the 5E model is Elaborate. Students will apply what they have learned to a new situation. Doing so will help students develop a deeper understanding of the topic. Students will discuss and compare ideas. The fifth E is Evaluate. The Evaluate phase gives students an opportunity to review and reflect on their new learning and new understandings. It is also will provide the teacher with evidence of those new learnings and understandings. The quality of student work on a cloud project as well as K-W-L notes and daily nature journal entries will be used to evaluate student progress.

Students will begin day four and day five by observing the clouds in the sky and the weather. They will record this information in their nature journals. The activity will be built upon by asking students to label the types of clouds they have seen so far this week. For this part of the activity, students will look at all of their cloud drawings and descriptions of the cloud and the weather. A cloud chart from NASA will be made available for students to reference to assist them in correctly labeling the cloud type. They will attempt to determine what type of clouds they observed, label the cloud with its cloud type name, and make associations between the cloud type and what type of precipitation occurred on that day.

The main activity for this lesson will be a NASA GLOBE activity called Cloudscape. NASA GLOBE is a program devoted to students conducting citizen science. There is a component called Elementary GLOBE that targets students in grades K-4. The program has student reading books and activities for teachers to use with classes. Teachers can also complete GLOBE training and have their students record observations as citizen scientists. These observations can be sent to NASA to be a part of data bases of information.

Elementary GLOBE is about the study of Earth science. Many of the Elementary GLOBE modules are about weather and climate. Elementary GLOBE topics include air quality, climate, clouds, earth system, seasons, soil, and water. The activity selected for inclusion in this unit is about clouds called Cloudscape.

The Cloudscape activity takes two 30-minute sessions to complete. The activity will be split into two parts. The basic concept behind the activity is for students to create cloud art that correctly identifies the cloud type. The activity will be modified to have students add details such as the type of precipitation associated with the cloud type and facts about the cloud. These facts can include whether the clouds are made of ice crystals or water droplets and the altitude of the cloud type. If other weather concepts have been previously taught, such as air pressure and fronts, the teacher can ask students to add those facts to the information labels about each cloud type. If they have not been taught, the teacher should have students add that information when those associations can be made.

Students will have access to text and photos to assist them with completing the activity. The texts can include *Next Time You See a Cloud*, *The Cloud Book*, NASA cloud charts, and any other cloud photo resources the teacher wishes to provide.

Students can make their own individual cloudscape. Students will need a piece of sturdy construction paper or card stock that is a light blue color to mimic the sky. A silhouette of a city skyline needs to be placed at the bottom. An interesting addition would be to download and use a Charlotte skyline. There are several Charlotte silhouette skylines available online. Elevation in the sky for low, middle, and high clouds should be on the left edge of the paper.

This unit may have students make a large cloudscape as a class project. The teacher will place blue bulletin board paper on a bulletin board or the wall for students to use as a model of the sky. A silhouette of a Charlotte skyline will be placed at the bottom of the paper to provide a visual perspective. Altitude numbers will be placed on the side of the bulletin board so students can accurately place cloud types in the "sky."

A variety of art materials will be given to students. They will include cloud making material such as cotton balls, cotton quilt batting, wax paper, white fabric, white bedsheets, pipe cleaners. Art supplies for making the clouds will include glue, craft feathers, glue sticks, scissors, gray markers, and rulers. Colored construction paper will be provided for writing facts about the clouds. These facts will be placed next to the cloud type.

Students will work in small groups to complete the tasks of creating clouds, putting them on the bulletin board in a correct location, and labeling the clouds. Cloud types students will be asked to create will include cirrus, stratus, cumulus, contrails, and cumulonimbus. Students may create other clouds types if they finish early on day five.

Creating the cloudscape is likely to take more than thirty minutes. That is why the activity is spread over day four and day five. It is entirely possible a group or multiple groups could finish before time is up on day five. If this happens, the teacher needs to have alternate activities related to clouds ready to use as extension activities.

One extension activity suggested by the Cloudscape lesson plan is to write poetry about clouds. The poem will need to teach others about clouds. One adaptation to this activity is for students to write lyrics to a familiar children's tune. This idea is from a book called *Deep in the Desert* from Arbordale Publishing. The book adapts familiar songs to teach students about desert flora and fauna, but the concept can be applied to any topic.

The final activity on day four and day five will be to add the L part of the K-W-L. Students will be instructed to review how much they have learned about clouds and the precipitation associated with them. If it has been studied already, the associations of air pressure and fronts to cloud type can also be explored to see if students can connect those concepts. If air pressure and fronts have not been studied yet, the associations to clouds, precipitation, and air pressure will need to be explored in the future.

On day five, students will be asked to rate the five-day unit on a Likert scale of 1-5 with 1 being boring and 5 being fun. Students will be asked to explain their reason(s) for their score with a detailed answer. The teacher will use this information to assess student response to the unit.

Teaching About Climate Change as an Extension Activity

It is quite possible an elementary school student will be curious about climate change because it is such a major topic in the news. I would suggest a teacher capitalize on this curiosity by being prepared with high level teaching materials on the subject of climate change and allow such students to extend their knowledge with those materials. At the planetary scale, cloud cover regulates how much sunlight reaches the Earth's surface and acts to determine global climate. Climate change is expected to change the type of clouds that form most often, and the characteristics of the clouds, so the connection this curriculum unit makes between the clouds we see every day and that change every moment could be drawn towards the question of how climate change might affect what we see and, more generally, the weather. One of the many resources describing clouds and climate is at NOAA https://www.esrl.noaa.gov/psd/outreach/education/science/clouds_and_climate.html.

There are several children's books that address the topic of climate change. They explain the key differences in weather versus climate, explain climate change, and discuss what people can do to mitigate the effects of climate change. These trade books are worth considering for teachers who want to give interested students access to good information about climate change.

The book *How We Know What We Know About Our Changing Climate* by Lynne Cherry and Gary Braasch is designed for grades 5-8. This book would be a good choice for fifth graders with a strong interest in climate change. Book sections include clues in the world about climate change, putting the clues together, and what scientists and regular citizens can do about climate change. Topics in section one include clues about climate change found in flowers, butterflies, birds, tree rings, penguins, polar bears, coastlines, ice cores, ice caps, glaciers, and the tundra. Topics in section two include Earth's web of life and a 1000-year temperature chart. Topics in section three include observing and recording climate, carbon footprints, and what kids and people in a community can do about climate change.

The National Geographic book *Earth in the Hot Seat: Bulletins from a Warming World* has text, colorful photographs and brief highlight sections. The National Geographic book is written in an engaging style that many readers will readily recognize. It has lots of fantastically colorful photographs that include excellent captions. There are many brief stories, facts, maps, and diagrams mixed with longer narratives. There are five sections. They are The Big Thaw: Signs of a Warming World, The Big Picture: The Science of Climate Change, Feeling the Heat: Life in a Warmer World, Keeping Our Cool: Solutions to Global Warming, and What You Do Counts: Protecting Our Planet.

The Seymour Simon book *Global Warming* discusses the causes of global warming, its results, and changes people can make to address it. Simon's book is designed for children ages 8-11 and is a fifth-grade reading Lexile level of 980 (8). *Global Warming* was named an

Outstanding Science Trade Book by the National Science Teaching Association in 2011. the NSTA review says, “In the brilliant Seymour Simon format, this book is a photo essay examining global warming and the devastating facts regarding this enormous world issue. The lesson, that this problem affects each and every one of us, is powerfully conveyed through text and photos (10)”

Earth: Feeling the Heat by Brenda Z. Guiberson is designed for students ages 4-8 and describes the impact of global warming on animals around the world. Book topics include polar bears, puffins, filefish, penguin, butterfly, zebra, orangutan, long-nosed fly, frog, caribou, pika, and tiger. Each section has a full-illustration on the left and a one-page story on the right side of the page. The National Science Teaching Association named *Earth: Feeling the Heat* as one its Outstanding Science Trade Books in 2011. The NSTA said Guiberson’s book is “Elegantly illustrated and providing a rich display of animals, this book reveals the devastation that global warming has on these critters in different biomes throughout the world. Each page asks readers, ‘Who can help?’”.

National Geographic has an online resource library for educators. One of the entries is entitled *Weather*. The entry is for grades 5-12. National Geographic identifies six parts to weather. They are temperature, atmospheric pressure, wind, humidity, precipitation, and cloudiness. Understanding these components is vital for understanding weather. The National Geographic online resource library provides a wealth of information to teachers for the topics of weather and climate.

Conclusion

Understanding the elements of weather is crucial to understanding climate. Clouds are one of the fundamental elements of weather. Identifying cirrus, stratus, and cumulus clouds and the weather associated with them is part of the weather standards for the North Carolina Essential Standards. Those are all reasons why the study of clouds is the focus of this curriculum unit.

Appendix 1: Implementing Teaching Standards

North Carolina Fifth Grade Science Essential Standards
5.E.1 Understand weather patterns and phenomena, making connections to the weather in a particular place and time.
5.E.1.2 Predict upcoming weather events from weather data collected through observation and measurements.
North Carolina Science Essential Standards: Grade 5 Science Unpacked Content
5.E.1.2 Students know that one can collect and compare weather data in order to predict the likelihood of a particular weather condition occurring. Students know how to read basic weather instruments: thermometer, barometer, anemometer, wind vane, and rain gauge. ***Students also can identify atmospheric conditions (presence and type of clouds [stratus, cirrus, cumulous], fronts) that are associated with predictable weather patterns***. Students can make basic weather predictions using these skills. (bold italics added for emphasis)

Teacher Resources

Arbor Scientific. Individual Pressure Pumper. https://www.arborsci.com/products/individual-pressure-pumper
This individual pressure pumper can be used with clear two-liter plastic bottles and temperature strips to demonstrate air has mass, the effects of air pressure, and for creating clouds in a bottle. The individual pressure pumper is also called a fizz keeper. A set of 15 costs $89.

Arbor Scientific. *Cloud Machine*. https://asc-mag-media.s3.amazonaws.com/datasheet/P1-2060_DS.pdf
This activity from Arbor Scientific explains how to use an individual pressure pumper, a match, and a 20-ounce clear plastic bottle to make a cloud in a bottle. The Cloud Machine activity is at the end of a set of lesson plans for the individual pressure pumper.

Cherry, Lynne and Gary Braasch. *How We Know What We Know About Our Changing Climate*. Nevada City, CA: Dawn Publications (2008). Book sections include clues in the world about climate change, putting the clues together, and what scientists and regular citizens can do about climate change.

Cloud Appreciation Society. https://cloudappreciationsociety.
This website has lots of photos and videos of clouds.

Clouds module from NASA Elementary GLOBE. https://www.globe.gov/web/elementary-globe/overview/clouds

Cloudscape lesson plan from NASA Elementary GLOBE program.
https://www.globe.gov/documents/348830/55942511/Cloudscape_27July2018_FINAL.pdf/46ba0b3a-3831-476c-bedc-c8e24bfe675d

Delano, Marfe Ferguson. *Earth in the Hot Seat*. Washington, DC: National Geographic (2009).
This book combines outstanding pictures, maps, graphs, and short, colorful feature stories with more detailed information about climate change its causes, and potential solutions.

de Paola, Tomie. *The Cloud Book*. New York: Holiday House (1975).
This classic picture book is designed for younger children. It teaches students about ten cloud types. They are altocumulus, altostratus, cirrocumulus, cirrostratus, cirrus, cumulonimbus, cumulus, nimbostratus, stratocumulus, and stratus. It includes information about how clouds are formed, the history of how people in the past thought clouds were formed, weather sayings, and shapes people see in the clouds.

Donald, Rhonda Lucas. *Deep in the Desert*. Mt. Pleasant, SC:Arbordale Publishing (2011).
This book sets information about desert ecosystems to children's songs. This concept could be applied to having students write lyrics about clouds to familiar children's songs.

Guiberson, Brenda Z. *Earth: Feeling the Heat*. New York: Henry Holt and Company (2010).

This book contains two-page stories about how climate change is impacting certain animals in the world. Each two-page section has a full-page illustration on the left and text on the right. The book is designed for students ages 4-8.

Hatheway, Becca, Kerry Zarlengo, and Peggy Lemone. *Do You Know that Clouds Have Names*? NASA Elementary GLOBE book (2018). This book is available in print form from Amazon. It is the book that accompanies the NASA Elementary GLOBE cloud lessons.

Leslie, Clare Walker and Charles E. Roth. *Keeping a Nature Journal*. North Adams, MA: Storey Publishing (2003). This is an excellent resource for teachers who want to implement nature journaling in their classroom lessons.

Lowery, Lawrence F. *Clouds, Rain, Clouds Again*. Arlington, VA: National Science Teaching Association (2013). This book is part of an NSTA series called I Wonder Why? It is a picture book with basic information about cirrus, cumulus, and stratus clouds. The back page has activities for observing evaporation, making a water cycle model, how clouds are formed, and measuring the size of raindrops.

Morgan, Emily. *Next Time You See a Cloud*. Arlington, VA: National Science Teaching Association (2016). This book has excellent photographs. It describes cirrus, stratus, cumulus, and cumulonimbus clouds as well as contrails. The book explains how clouds are formed. The last page has several resources listed.

NASA. *The GLOBE Program: Cloud Identification Chart*. Retrieved November 18, 2019. https://www.globe.gov/documents/348614/24331082/GLOBE+Cloud+Chart
This is a printable cloud chart from NASA. It was created to accompany cloud lessons from NASA Elementary GLOBE.

National Geographic. *Weather*.
https://www.nationalgeographic.org/encyclopedia/weather/#targetText=However%2C%20several%20thousand%20years%20ago,Sahara%E2%80%9D%20experienced%20frequent%20rainy%20weather.&targetText=There%20are%20six%20main%20components,humidity%2C%20precipitation%2C%20and%20cloudiness.
This website has information about weather. It is designed for students in grades five through twelve.

North Carolina Department of Public Instruction. *Essential Standards for Science*.
http://www.dpi.state.nc.us/curriculum/science/scos/support-tools/

Rockwell, Anne. *Clouds*. New York: HarperCollins (2008). This book says it is designed for students ages 3-6. However, vocabulary in the book includes cirrus clouds, cirrostratus clouds, cirrocumulus clouds, cumulus clouds, altostratus clouds, stratus clouds, stratocumulus clouds, and nimbostratus clouds. The vocabulary and accompanying illustrations make it a potentially useful book.

Simon, Seymour. *Global Warming*. New York: HarperCollins (2010).

This 2011 NSTA Outstanding Science Trade Book was written in cooperation with the Smithsonian Institute. It is designed for upper elementary students. It gives examples of the impact of global warming and suggestions for what can be done about it.

Sky Watcher chart from NOAA and NASA. www.nws.noaa.gov/om/brochures/cloudchart.pdf
This is a free, downloadable cloud chart.

Wonderopolis Wonder of the Day #1413: How Do Clouds Form?
http://wonderopolis.org/wonder/how-do-clouds-form
This website contains information for how clouds are formed.

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