

Topic: Air Masses and Weather Fronts

Title: Weather Analysis and Forecasting

Grade Level: Middle School (6, 7, 8)

Time Needed: 3 weeks - 80 minute blocks for 9 class periods (Classes meet on alternative days each week)

Standards:

MS-ESS2-5. Collect data to provide evidence for how the complex motions and interactions of air masses result in changes in weather conditions
MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Planning and Carrying Out Investigations Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.</p> <ul style="list-style-type: none"> Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. <p>Developing and Using Models Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> Develop and use a model to describe phenomena. 	<p>ESS2.C: The Roles of Water in Earth's Surface Processes</p> <ul style="list-style-type: none"> The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. <p>ESS2.D: Weather and Climate</p> <ul style="list-style-type: none"> Because these patterns are so complex, weather can only be predicted probabilistically. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems. <p>Systems and System Models</p> <ul style="list-style-type: none"> Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

Common Core State Standards Math:

- MP.2:** Reason abstractly and quantitatively
- 6.SP.B.5A:** Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
- 7.SP.B.4:** Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.
- 8.SP.A.2:** Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

Common Core State Standards ELA:

- SL.6.2:** Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.
- SL.8.5:** Integrate multimedia and visual displays into presentations to clarify information, strengthen

claims and evidence, and add interest.

RST.6-8-4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

ITEEA Technology: STEL-1E: New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.

STEL-3G: Explain how knowledge gained from other content areas affects the development of technological objects and systems

STEL-6C: Compare various technologies and how they have contributed to human progress

STEL-8L: Interpret the accuracy of information collected

Justification:

Students will be exploring data collected from a local weather station in the city of their choice to share as evidence of the weather conditions and exploring the different factors which effect weather such as air masses, air pressure, humidity, and fronts. They will use technology to explore the data collected and create visuals of the data as well as learning about the different types of tools used to collect the data and determining the accuracy of the data. Math will be integrated in the analysis of data when making interpretations of the data from the graphs and comparative inferences about the data they explore and the provided weather data. English Language Arts is integrated in the understanding of weather map symbols and related terms as well as interpreting different media, and integrating multimedia as evidence of weather information explored.

Objectives:

Students will be able to:

- Collect and record data using weather websites
- Construct graphs from data using sheets and appropriate titles, axis labels, and legends
- Read and interpret weather station model symbols and weather maps
- Create weather station models and weather maps from data
- Analyze data collected to compare temperatures, precipitation, humidity, barometric pressure, dew point
- Extension - Create a weather report for a city/country discussing the temperature, fronts (what will happen with the fronts), air pressure (how it is measured, what high and low mean), precipitation

Materials:

- Computer for each student and internet access
- TV or projector to display images/video for full class
- Science Notebooks
- Printable maps of country of chosen city
- Pencils, markers, colored pencils
- Additional materials listed within lesson activities

Data Integration: Data collected from Wunderground website (www.wunderground.com)

Differentiation: Options occur within the lesson for students to explore videos or written articles to further their understanding of the concepts presented. Students with additional challenges will be able to work in small groups with the teacher to review the concepts and the vocabulary being

discussed to further develop understanding. If students are requiring non-digital information, materials can be printed for them to continue the exploration of the activities in the unit.

Real-Life Connection: This lesson begins with a phenomenon of a weather report that is recent in South Africa and connects to current weather events occurring in this country and causing hardships for people in many areas related to flooding. Students also have the opportunity to explore a city that is meaningful to them as a past city where they resided or a city where family currently resides.

Possible Misconceptions:

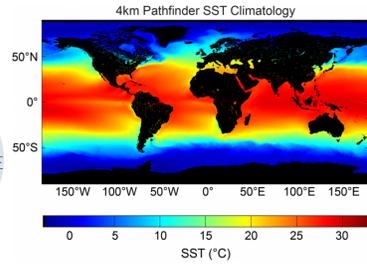
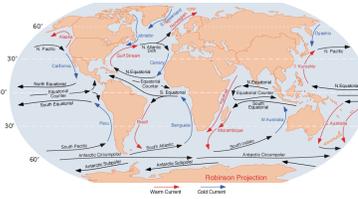
- Cold air produces windy weather
- Hot air weighs less than cold air
- Weather fronts are thin bands of air
- The sun is the only factor determining Earth's temperature
- The ocean has the same salinity levels throughout
- The ocean is not related to weather patterns

Teacher Background Information:

- Students have previously learned about how molecular movement changes when thermal energy is added and different forms of heat transfer including convection, conduction, and radiation. Students have previous knowledge of the water cycle and its involvement in Earth's weather. Students are also have previous knowledge of density. This lesson is adapted mostly from the following sources:
 - www.generationgenius.com
 - <https://middleschoolscience.com>
 - http://cimss.ssec.wisc.edu/satmet/modules/7_weather_forecast/wf-1.html
 - https://www.weather.gov/jetstream/ll_analyze

Procedure:

5E Model	5E Objectives
Engage	<p>Day 1: Introduction</p> <ol style="list-style-type: none"> 1. Watch a video of a recent weather report SA Weather on SABC 10 April 2022 (this report is in the midst of massive flooding in the Kwazulu Natal Province) 2. Teacher poses the following questions to the class: <ul style="list-style-type: none"> ● What important information is being shared to help people who live in areas that may be affected by the weather forecasted? ● What do you notice about the images in the weather report? ● How does this weather segment compare to other weather reports you have seen? 3. In table groups, provide students with the images in the slide show (Engage Weather Images) as seen below. (Images and questions from Generation Genius) <div style="display: flex; justify-content: space-around; align-items: center;">    </div>



4. In groups, students will make a KWL chart in their science notebooks and write what they know and what they wonder about the different images.
5. On chart paper (add images used above to each) have students respond to the following prompts from Generation Genius: What causes weather? What causes changes in the weather? How does cloudy weather come in to replace sunny weather? How does sunny weather replace rainy weather? Why is the temperature different in the ocean with all these currents? Why is the surface temperature of the water warmer nearer to the equator? Why are there so many warm currents beginning near the equator? What role do the sun and ocean play in our weather?

Show students the current weather conditions for Pretoria, South Africa using the wunderground website (wunderground.com) Explain to students that during this unit, they will be exploring weather conditions over a 2 week period of time for a city of their choice and comparing it to where we live.

Classwork/Homework:

1. Read through the following CK12 activities [11.1 Introduction to weather](#) and [11.14 Collecting Weather Data](#)
2. Choose a city from anywhere in the world that you would like to explore as you learn more about what causes different weather conditions and forecasting weather. Students can choose from these lists if they are stuck: [International Cities](#) or [US Cities](#)

Formative Assessment: Student KWL responses in science journals and chart paper responses

Explore

Day 2 - 3 Investigation Activities and Weather Maps

Each day students will complete a different lab activity in groups to further their understanding of unequal heating of the earth's surface and how differences in temperature affect currents.

Group Work - Activity One: Unequal Heating of Earth's Surface (Day 2)

Tell students many of us wondered what caused the air and the water to be so warm at the equator and we are going to investigate this. Students will work in groups of 3-4 to complete the investigation.

[Student Recording Sheets for Investigations](#)

Individual Classwork/Homework:

After the investigation, students will be able to begin finding and recording weather data about their city. Students can find a blank map of their country to print out using the site below: <https://worldmapblank.com/category/blank-map-of-world/>

1. They will plot their city on the map by making a dot and writing the name of the city

- next to it.
2. They will next explore the weather for the month by using the [wunderground](#) website. They can search the name of their city to find the current weather conditions.
 3. Record the weather data using the [spreadsheet](#) for each condition (Students can make their own copy to edit, or this can be assigned through an LMS). Students can look for the historical weather to complete the table - this can be done using the history tab or clicking on the weather station name and scrolling down to weather history.
 4. Watch the Brainpop video about [Humidity](#) or read [CK-12 11.2 Humidity](#)

Formative Assessment: Unequal Heating of the Earth Investigation Worksheet

Group Work - Activity Two: Changing Temperature and Fluid (Gas/Liquid) Movement (Day 3)

Tell students to recall some of what they learned in the Hot Matter/Water Cycle unit at the beginning of the year. Remember that when evaporation occurs it causes water molecules to heat up and they become a gas and rise into the atmosphere. Have them also recall what was discussed with convection and what happens to liquid in a pot of water that begins to boil. Explain that today they will do an investigation to see what happens with different temperatures of water; cold, hot, and room temperature. Ask students to predict what they think will happen as different temperatures of water are added to the same cup.

[Student Recording Sheets for Investigations](#)

After completing the investigation and questions, students can continue to explore weather phenomenon in their groups:

1. Watch the video about [Condensations and it's different forms](#)
2. In your notebooks, respond to the following questions:
 - a. What is condensation?
 - b. Why does dew form?
 - c. What is the dew point?
 - d. Why does fog form and where does it happen?
 - e. Why does frost form and where does it happen?
 - f. Why does mist form and where does it happen?
 - g. What is the difference between fog and mist?
3. Watch the video about [atmospheric pressure](#)
4. In your notebooks, respond to the following questions:
 - a. Draw a picture of what you saw in the demonstration
 - b. What happened when the balloon was placed on top of the jar with the burning paper?
 - c. Why can't you pull the balloon out of the jar?
 - d. How did he get the balloon out of the jar? Why did that work?

Individual Classwork/Homework:

Go to the [Wunderground](#) website and record the day's weather in your [spreadsheet](#)

Formative Assessment: Changing Temperature and Fluid Movement Investigation Worksheet and notebook responses to videos

Explain

Day 4-5 Making Connections and Explaining Observations

Day 4 - Unequal Heating of the Earth

1. Have students share our their data and observations from the Unequal Heating of Earth's Surface Investigation

2. Watch the [Generation Genius Climate Zones and Ocean Currents Video](#) and review the discussion questions as a class.
3. Have students return to their KWL chart from day one and add anything that they have learned.
4. Explore [Wundermaps](#) zoom out to find your country/city and then zoom back in to view their city. On the menu bar on the right side of the screen, scroll down to atmospheric conditions and explore what conditions are in their city (they may need to move out to country to gain a better picture) Click on Fronts, Satellite, Radar, and Windstream each separately at first to explore current conditions. Then they can have more than one measurement selected. What do you notice about the satellite, radar, and windstream imagery? How does this connect to what they just learned about? Take out their country map from day two and plot the following:
 - a. Today's date
 - b. Color in where there is precipitation on your map
 - c. Shade in any cloud cover
 - d. Draw in the windstream lines as seen in the animation
 - e. Compare your map to peers - Discuss the similarities and differences. What about the location do they think affects the weather based on what we have learned about unequal heating of the Earth's surface?
 - f. Select only fronts and add any fronts and pressure systems that they see (they will need to zoom out) - we will discuss these in depth in our next class. (Students will use this in their final weather report)

Individual Classwork/Homework:

Explore the vocabulary introduced in the video and add this to your notebook
Go to the [Wunderground](#) website and record the day's weather in your [spreadsheet](#)
Make sure that the graphs are edited to include the information for your city.

Formative Assessment: Student responses to discussion questions and the L in their KWL chart. Also review with students their weather map based on data from Wundermaps

Day 5 - Changing Temperatures and Fluid Movement

1. Have students share out their data and observations from the Changing Temperatures and Fluid Movement Investigation
2. Watch the Generation Genius Air Masses and Weather Fronts Video and use the [Air Masses](#) worksheet to begin to record the different definitions of air masses and types of air masses. Also view the [image of air masses](#) here as they further develop the understanding of air masses in both South Africa and their city's country. Review the discussion questions together.
3. Read CK12 [11.6 Air Masses](#) and complete the air masses worksheet
4. Read CK12 [11.7 Fronts](#) and draw and define each type of front in your notebook, use the [NOAA website](#) to assist you
5. Have students return to their KWL chart from day one and add anything that they have learned.

Individual Classwork/Homework:

Explore the vocabulary introduced in the video and add this to your notebook
Go to the [Wunderground](#) website and record the day's weather in your [spreadsheet](#)
Read the information in CK12 [11.16 Weather Maps](#) to prepare for the next lesson.

Formative Assessment: Student responses to discussion questions and the L in their KWL chart.

Elaborate**Days 6-7 Information on Weather Station Maps and Drawing Conclusions****Day 6: Drawing Conclusions - Isobars and Isotherms, Air Pressure and Fronts**

1. Students will explore the activities in [Module 7 - Satellite Meteorology](#) slides 1-4
2. Students can view the video explaining [how to read weather maps](#)
3. Students will also the [Synoptic Meteorology Drawing Conclusions](#) (teacher overview) in groups of 2-3. They can also use the [MetService](#) website on how to read weather maps for further background information.

Print out copies of the maps for each student below:

[Drawing Conclusions Maps](#)

4. In groups of 2-3 students will follow along with the Drawing Conclusions objective, procedure, and analysis activities to explore: (Note: advise students to work through the activities first and then use the self checking features. Students can move ahead through the four activities using the next tab at the bottom of the screen)
 - a. [Surface Air Pressure](#)
 - b. [Air Temperature](#)
 - c. [Dew Point Temperature](#)
 - d. [Air Pressure Change](#)

Individual Classwork/Homework:

1. Students go to the [Wunderground](#) website and record the day's weather in their [spreadsheet](#)
2. Make a second copy of their country map:
<https://worldmapblank.com/category/blank-map-of-world/>
3. Add and label their city and now go back to [Wundermaps](#) and record the data that they see for the current weather in their city's region.
4. Students can also explore [mountainforecast.com](#) and look at the weather map to observe current conditions and see isobar data and add this information to their country map for today. (Students will use this in their final weather report)

Formative Assessment: Review the maps that students created from the drawing conclusions activity.

Day 7: Weather Station Maps

1. Students will explore weather station symbols and data to create the weather station maps for different cities. Students can work in groups of 2-3 for the activities
2. Explore slide 5 of [Module 7- Satellite Meteorology](#) and work through at least 3 exercises with your group. Use this [website](#) to review weather station symbols to assist in analyzing the data in the activities.
3. Explore the [practice data sheet](#) to record the weather map symbols for the areas listed
4. Check with the teacher to ensure that you are on the right track

Individual Classwork/Homework:

1. Students go to the [Wunderground](#) website and record the day's weather in their [spreadsheet](#)
2. Pick 2 dates from your data to share the weather station map data for your city (Students will use this in their final weather report)
3. Read CK12 [11.15 Predicting Weather](#) and consider: What are the different tools used to detect weather data? How has the collection of data for weather changed over time? How do engineering and technology affect the type of information we are able to collect about weather? What are new tools that are being used to help us understand and predict weather.
4. Explore the [ARGO](#) site and [GOES](#) site to see how weather data is collected

Formative Assessment: practice data sheet on weather map symbols

Evaluate/Extend**Day 8-9 - Weather Report and Forecast****Day 8 - Weather Report**

1. Use the data that you have collected and create a weather report for your city. This can be in a format of your choice: Google Slides, Google Docs, Sildeshare, Beautiful.ai, etc.
2. Use the [Weather Report Guidelines](#) to create your Weather Report
3. Your Weather Report should also include the weather maps created through the course of activities in this unit (two Weather maps, and two Weather station maps)

Day 9 - Weather Forecast

1. Use the data that you have collected over the last few weeks of class and the information that you have learned about weather forecasting to create a 3 Day forecast for your city. This can be shared in Flipgrid as either a video or an audio file. In your forecast you need to meet the expectations shared here: [Weather Forecast Presentation](#). There are also examples of images to include in a forecast using images from [wundermaps](#). Students can make use of the green screen at school and create a video using the [pixlr template](#) and images captured from Wundermaps.

Extension: Students can continue to explore the weather satellite information provided in the [Module 7- Satellite Meteorology](#) to further their understanding of how weather is forecasted.

Students can also continue with weather exploration by exploring natural disasters with storms (This is explored in Grade 7 at my school)

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