

# Forecasting the Weather

5E Integrated STEM Lesson Plan

By Daniel Lipin

Note: I used the headings in the lesson plan by Maureen Miller as the basis for my lesson plan.

Note: Still to be completed:

- Standards
- Optimization of learning objectives to target diverse levels of the depths of knowledge.
- Worksheets and Videos
- Rubrics

Grade: 6<sup>th</sup>

Teaching Time: 4 x 45 minute classes

## Learning Goals:

1. Students will analyze weather data and deduce the factors that affect weather patterns across the country.
2. Students will investigate the relationships between variables within this data to draw conclusions of the meanings of the various symbols of the national weather map.
3. Students will create a model that predicts future weather patterns across the country. They will defend their model by citing evidence from their previous investigation into the factors that contribute to weather patterns in the United States.

## NGSS Standards:

*MS-ESS2-5. Collect data to provide evidence for how the motions and complex 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.*

*MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.*

## Science and Engineering:

1. Developing and using models.
2. Planning and carrying out investigations.
3. Analyzing and interpreting data.
4. Constructing explanations and designing solutions.
5. Connection to Nature of Science – Scientific knowledge is open to revision in light of new evidence.

*Core Ideas:*

*ESS2.C: The Roles of Water in Earth's Surface Processes*

- 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.
- Global movements of water and its changes in form are propelled by sunlight and gravity.

*ESS2.D: Weather and Climate*

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.
- Because these patterns are so complex, weather can only be predicted probabilistically.
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

*PS1.A: Structure and Properties of Matter*

- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

*Crosscutting Concepts:*

1. Systems and system models.
2. Cause and effect.
3. Stability and change.

**CCSS Math Standards:**

CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them

CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.

CCSS.MATH.PRACTICE.MP4 Model with mathematics.

CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning.

**Driving Question:**

What will the weather be tomorrow?

**Justification:**

Weather is something that fascinates everyone, especially a middle school child. I have been a teacher long enough to have seen students amazed at the first snow of the year, or by the beauty of a summer's day or by the power of a storm. This driving question is one that I consistently get from students given that I am their science teacher, so I believe that it will not be challenging to convince them of the importance and usefulness of learning about the science and math they will need to answer this question.

This lesson seamlessly integrates skills and knowledge from each of the STEM disciplines. Students will discover and learn more about the complex movements of airflow that determine weather outcomes throughout the nation (and the world). They will improve their understanding of the core idea of matter being affected by changes in pressure and temperature, by looking at how warm and cool air masses interact with each other. They will also integrate previous learning of the water cycle into this current topic. They will also comprehend the limitations of current scientific understand with regard to weather forecasting, which reduces predictions to probabilities. This contributes to the student's understanding of the nature of science.

Analysis of the data will utilize math skills as students look for regularity and repetition in the in pressure, temperature, wind speed, cloud cover and precipitation values. Students will persevere to solve the challenge of finding these patterns. They will then use these patterns to construct a model to predict changes in these values over time. They will have to construct an explanation of their model.

Technology is used extensively in this lesson as students must navigate a variety of forecast maps and learn how to use additional software (Google Slides) to compare maps against each other or display several maps in sequence to show trends.

Finally, engineering skills are required for students to design a model for prediction of future weather patterns based on the knowledge that they have gained. This is not straightforward, as weather predictions can be made from a variety of factors. Students will be able to iteratively improve their prediction mechanism by comparing forecasts with actual data (which will be available on a day-to-day basis).

1. Developing and using models.
2. Planning and carrying out investigations.
3. Analyzing and interpreting data.
4. Constructing explanations and designing solutions.
5. Connection to Nature of Science – Scientific knowledge is open to revision in light of new evidence.

**Student Objectives:**

1. Navigate the *National Weather Service – National Forecast Maps website* (<https://www.weather.gov/forecastmaps>) to obtain weather forecast, temperature, precipitation, wind speed, surface pressure and upper air pressure maps.
2. Compare and contrast these maps to identify patterns between atmospheric variables (pressure – surface and upper air, temperature and wind speed) and forecast map symbols.
3. Identify forecast chart symbols that students need more assistance in comprehending their meanings. Research additional source material and combine this information with previous findings to summarize the purpose of each forecast map symbol.
4. Demonstrate these relationships by creating a weather forecast video.
5. Predict future weather patterns using a model that the students have created, defend predictions based on data investigation and compare predictions with actual data. If time, use comparison results to improve model.

**Prior Knowledge:**

Students will have learned about pressure, density and temperature prior to this lesson. They will also have covered the water cycle.

**Materials:**

Each student will have a computer, which should have internet access and a camera for recording video. Weather maps for the weather forecast video can either be printed on paper, drawn on larger-sized paper or integrated into the video using a green screen (<https://www.makeuseof.com/tag/how-to-broadcast-live-with-a-green-screen/>).

**Engage:***Optional:*

Take students outside. If it is warm and there is a grassy/turf area, then have them lie down and look up at the sky. Ask students to describe what they see. If there are clouds, describe their shape and movement. Ask students to describe what they feel (snow/rain/humidity/temperature). Finish by asking students the driving question: What is the weather going to be tomorrow?

Split students into small groups (3-4) and give them two goals:

1. Declare to the rest of the class what they think tomorrow's weather will be (precipitation, wind and temperature).
2. Give a logical reason for their prediction.

*Required:*

Students will use their computers to login to the *National Weather Service – National Forecast Maps website* (<https://www.weather.gov/forecastmaps>) and open the national forecast chart (<https://www.wpc.ncep.noaa.gov//noaa/noaa.gif>). Groups of 3-4 students will complete worksheet 1, which challenges them to use the map to forecast tomorrow's weather AND assesses their current understanding of the map symbols and concepts behind them. Hold a class discussion so that the teacher can formatively assess current knowledge and any misconceptions regarding the weather forecast chart.

**Explore:**

Students will work in pairs to complete worksheet 2, which challenges them to compare weather forecast, temperature, precipitation, wind speed, surface pressure and upper air pressure maps. The goal of this comparison is to identify relationships between atmospheric variables (pressure – surface and upper air, temperature and wind speed) and forecast map symbols. They are free to look at future and archival forecast maps. A secondary goal of the comparison is to identify parts of the forecast map whose purposes are still unclear.

**Explain:**

Student pairs will record a simplified weather forecast video (no green screen, 2-3 minutes) where they will attempt to explain the weather around the country as described by the national forecast map. Watching these videos will allow the teacher to formatively assess student progress up to this point.

Students will watch a video explaining 'Weather Forecast Maps' for homework and take notes on it. This video will describe the concepts behind each of the symbols of the forecast map: high and low pressure systems and their effects on weather patterns, how to read surface pressure isobars on a forecast map, cold and warm air masses and their typical movement around the world, fronts between cold and warm air masses and their effects on weather patterns, how to read upper air pressure isobars on a forecast map to determine the location of cold and warm air masses.

I will plan to record a video of my own creation in the future.

There are existing videos that can be currently used:

General symbols on a weather chart: <https://www.youtube.com/watch?v=GkE3F5AuWBO>

What do cold and warm fronts mean: <https://www.youtube.com/watch?v=PJ4M6sERLM4>

**Elaborate/Extend:**

Student pairs will write and plan a more detailed weather forecast video. Several maps from a variety of weather scenarios will be available for students to use in their videos.

Student pairs will be given worksheet 3, which contains a blank national map. Students will be asked to predict the weather patterns for the country 4-5 days from that moment. They will have to describe the mechanism and reasoning that they used to make this prediction. There will be a space below their prediction map for the actual map to be pasted on for comparison purposes (when it becomes available 4-5 days later). Students will judge their own predictions, explain the reasons for any deviations and propose additional changes to their prediction mechanism to improve its effectiveness.

**Evaluate:**

Students will be assessed on their prior knowledge of weather maps during the engage phase. Students will be formatively assessed during the explore phase by periodic checking of each groups progress as they work through worksheet 1.

The simplified forecast video made at the start of the explain phase will provide the teacher with a good idea of the relationships that have been made (and not made) between the atmospheric variables and forecast map symbols. This will allow them to determine if the 'Weather Forecast Maps' video is enough to consolidate the student's understanding or if more discussion of the concepts is necessary after this video has been watched by the students.

Summative assessments will be made at the end of the lesson:

1. Students will be assessed on their final weather forecast video to see how well they explain what the forecast map tells the viewer about the nation's weather.
2. Students will be assessed on their weather prediction mechanism. They will not be judged on how well their prediction matches actual data. They will be assessed on how they use a variety of concepts that they have learned about to defend their prediction mechanism.

**Lesson Materials:**

Worksheet 1 – Initial Forecast Map Analysis

Worksheet 2 – Explore the Forecast Map

Worksheet 3 – Weather Prediction

**Rubrics:**

## Formative Assessment – Explain the Forecast Map – Simplified weather forecast video

<i>Assessment</i>	<i>4</i>	<i>3</i>	<i>2</i>	<i>1</i>
Weather symbols	0 mistakes during definition of weather chart symbols	1-2 mistakes during definition of weather chart symbols	3-4 mistakes during definition of weather chart symbols	No weather chart symbols were defined
Patterns between symbols and variables	Identification of patterns between 3 or more symbols and atmospheric variables	Identification of patterns between 2 symbols and atmospheric variables	Identification of patterns between 1 symbol and atmospheric variables	No identification of patterns between symbols and atmospheric variables
Explanations are clear and concise	Video is easy to follow and understand	Video is mostly easy to follow, with a few contradictory sentences or confusing sections	Video is challenging to follow, with many contradictory sentences or confusing sections	Video is not submitted.

Summative Assessment – Explain the Forecast Map – Final weather forecast video

<i>Assessment</i>	<i>4</i>	<i>3</i>	<i>2</i>	<i>1</i>
Weather symbols	0 mistakes during definition of weather chart symbols	1-2 mistakes during definition of weather chart symbols	3-4 mistakes during definition of weather chart symbols	No weather chart symbols were defined
Identification of weather patterns within the United States	Identification of 3 weather patterns in the United States	Identification of 2 weather patterns in the United States	Identification of 1 weather pattern in the United States	Identification of no weather patterns in the United States
Interactions between air masses	Explain how weather patterns are caused by the interaction between air masses, including discussion of pressure and temperature	Explain how weather patterns are caused by the interaction between air masses, not including discussion of pressure and temperature		No explanation of how weather patterns are caused by the interaction between air masses.
Explanations are clear and concise	Video is easy to follow and understand	Video is mostly easy to follow, with a few contradictory sentences or confusing sections	Video is challenging to follow, with many contradictory sentences or confusing sections	Video is not submitted.

Summative Assessment – Weather Prediction – What will the weather be like in 4 days?

<i>Assessment</i>	<i>4</i>	<i>3</i>	<i>2</i>	<i>1</i>
Weather forecast chart	Completed with all symbols, pressure bars, fronts and precipitation bands	Completed with all but one of: symbols, pressure bars, fronts and precipitation bands	Completed with all but two of: symbols, pressure bars, fronts and precipitation bands	No weather chart is submitted
Defense of weather forecast chart	Shows strong grounding in concepts of air masses and how they interact to create weather patterns	Shows basic understanding of concepts of air masses and how they interact to create weather patterns	Shows partial understanding of concepts of air masses and how they interact to create weather patterns	Not completed

**Resources:**

NGA Center/CCSSO. (2018). Standards for Mathematical Practice. Retrieved from <http://www.corestandards.org/Math/Practice/>

NGSS Lead States. (2013). Next generation science standards. for states, by states. Washington, D.C.: National Academies Press.

Science Explorer: Earth Science. (2006). Boston, MA: Pearson Prentice Hall.

## Put in WORK

**Assignment Name:** TXD1 National Weather Map Introduction

**Name:**

**Date:**

**Section:**

**Materials:** Chromebook.

**Challenge:** Predict tomorrow's weather in Tarrytown, NY using a national forecast map.

*What you should NOT do:*

1. ANYTHING other than what this worksheet asks you to do.
2. Do not CHEAT by just going to another website and checking the forecast chart. Try to solve this puzzle, I just know that you will find it interesting and challenging.

### **Instructions:**

1. Use your computer to login to the *National Weather Service – National Forecast Maps website* (<https://www.weather.gov/forecastmaps>).
2. Open the national forecast chart (high resolution image): (<https://www.wpc.ncep.noaa.gov//noaa/noaa.gif>).
3. NOTE: DO NOT open any other images on the site.
4. NOTE: DO NOT look up the answers to the following questions online.
5. Work in groups of 3-4 to answer the following questions as best as you can.

### **Questions:**

1. Weather prediction:
  - a. Using no more than 6 words, describe what the weather will be like tomorrow in Tarrytown, NY:
  
  
  
  
  
  
  
  
  
  
  - b. Use TWO sentences to explain why you have made this prediction:
2. What do you think the 'L' and 'H' symbols mean on the chart?
  
  
  
  
  
  
  
  
  
  
3. What do you think the BLUE half-circle and RED half diamond symbols mean on the chart?
  
  
  
  
  
  
  
  
  
  
4. Which general direction will weather phenomena (rain, wind, snow, sunshine) move across the country: Circle one: North to South, East to West, South to North or West to East.

## Put in WORK

**Assignment Name:** TXD2 National Weather Map Analysis

**Name:**

**Date:**

**Section:**

**Materials:** Chromebook.

**Challenge:** Detect patterns and relationships between the national forecast map symbols and the atmospheric variables (temperature/pressure/precipitation). Use this knowledge to more accurately predict tomorrow's weather.

*What you should NOT do:*

1. ANYTHING other than what this worksheet asks you to do.
2. Do not CHEAT by just going to another website and checking the forecast chart. Try to solve this puzzle, I just know that you will find it interesting and challenging.

### Google Slides Instructions:

1. Login to Google Drive and open a new Google Slides presentation.
2. Rename this presentation: 'LASTNAME-SECTION-WEATHERMAP' and share it with your teacher ([dlipin@hackleyschool.org](mailto:dlipin@hackleyschool.org)).
3. To paste an image into your Google Slides presentation, select 'Insert/Image/By URL'. Copy the URL of the image and paste it in the box. Click 'Insert'.
4. To make the picture TRANSPARENT:
  - a. Click on the picture.
  - b. Select 'Format Options' and 'Adjustments'.
  - c. Scroll the 'Transparency' bar left and right.

### Challenge Instructions

1. Work in groups of 2 for this part of the unit.
2. Use your computer to login to the *National Weather Service – National Forecast Maps website* (<https://www.weather.gov/forecastmaps>).
3. Open the national forecast chart (high resolution image): (<https://www.wpc.ncep.noaa.gov//noaa/noaa.gif>).
4. Copy this image into your Google Slides presentation (see above).
5. Navigate throughout the rest of the website to look at the following maps:
  - a. Temperature.
  - b. Surface Pressure.
  - c. Upper air Pressure (500 mb).
  - d. Precipitation.
  - e. Sky cover.
  - f. Wind speed and direction.
6. Copy these images into your Google Slides presentation and resize them so that they are the same size as the national weather forecast chart.
7. Try to find patterns and relationships to get a better understanding of what the symbols mean.

**Observations: Note any patterns that you observe**

1. Temperature.
2. Surface Pressure.
3. Upper air Pressure (500 mb).
4. Precipitation.
5. Sky cover.
6. Wind speed and direction.

**Challenge:**

1. Use no more than 6 words to predict what will the weather be like tomorrow?
2. Explain your answer to the above question.

**First Weather Forecast Video Challenge:**

1. Fill a Google Slide with the national weather forecast chart.
2. Use VIDEO SOFTWARE (to be determined) to record a video with your partner (maximum 2 minutes).
3. Your video should identify what you think ALL symbols on the chart mean based on what you have learned from your investigation.
4. Share the video with your teacher.

**Put in WORK**

**Assignment Name: TXD3 National Weather Map Prediction**

**Name:**

**Date:**

**Section:**

**Materials:** Chromebook, color pencils

**Challenge:** Use your knowledge to create a model that predicts the weather 4 days from now for the continental United States (excluding Hawaii and Alaska). Create a forecast chart that shows this prediction and defend it using concepts that you have learned. Check your model's accuracy in 4 day's time.

**Plot your forecast map:**

Today's Date:

Forecast Date (4 days from now):

**Forecast Map:**



Include in your map: H, L, Fronts (cold/warm), Precipitation

BONUS: Include areas of high winds

Use your understanding of weather concepts that you have learned over the past few days to defend your prediction. You should write 3-4 sentences:

Weather chart in 4 day's time (past it here):

What did you get right?

What did you get wrong?

Why is it still impossible to predict weather with 100% accuracy?

If you could create this model again to predict the weather in 4 days time, describe ONE thing that you would do differently: