# Extreme Weather In Western Pennsylvania: A Google Earth Exercise

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Grade 12 Science and Geography

3 Class Periods

## I. Objectives

This lesson will allow students to understand local meteorological phenomena through Google Earth. Students will learn basic Google Earth Skills and concepts that can be used for other assignments and applications. These include uploading data, searching for locations, and finding distances. They will also learn how to access Earth Science Data that is made available through Google Earth. Basic skills for this program, such as navigation and zooming, should be taught prior to this lesson. Students will also learn about the dangers associated with common weather hazards in western PA, including heavy snow and severe thunderstorms. After this lesson, students will be able to understand how these weather dangers are impacted by natural systems. This lesson will allow them to look at these hazards from a spatial perspective, so that they can understand how they are impacted by geographic variables. Overall, this lesson should give students a greater understanding of Western Pennsylvania weather patterns.

## II. State Standards

**Geography:**

**7.1.12.A:** Use geographic tools to analyze information about the interaction between people, places, and the environment.

**7.2.12.A:** Analyze the physical characteristics of places and regions, including the interrelationships among the components of Earth's physical systems.

**Science:**

**3.3.12.A7:** MODELS Interpret and analyze a combination of ground-based observations, satellite data, and computer models to demonstrate Earth systems and their interconnections. CONSTANCY/CHANGE Infer how human activities may impact the natural course of Earth's cycles. PATTERNS Summarize the use of data in understanding seismic events, meteorology, and geologic time.

III. Methods

The Google Earth lesson should be administered by teachers using the following process.

1. The teacher should look over the content of the assessment and background information to be sure that their students have enough background knowledge to successfully complete the lesson. If they do not, the teacher should lecture or demonstrate any prior information needed.
2. The teacher must insure that the students have access to computers that run Google Earth.
3. Each student should be put onto a computer with the necessary software and files for the lesson.

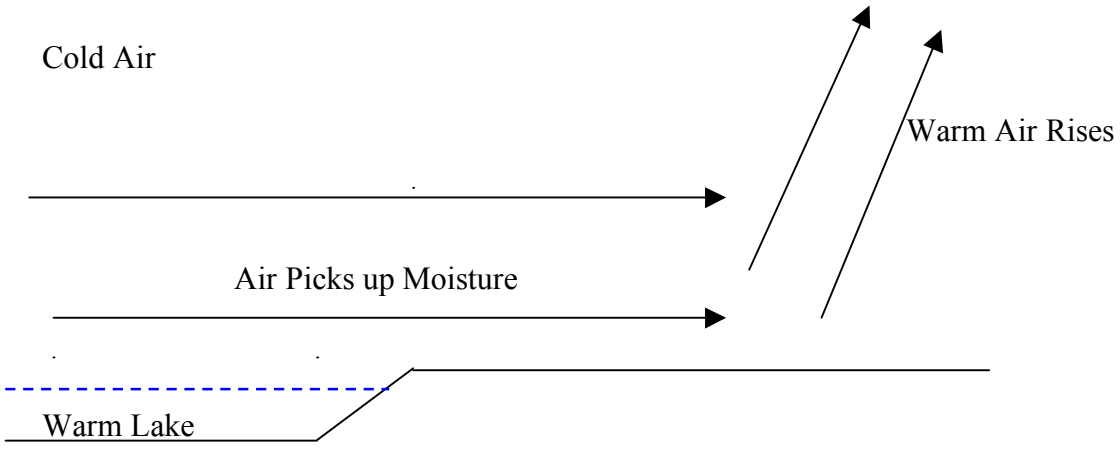
4. The teacher will demonstrate Part 1 of the lesson to the students in the lab. This will give them the scientific and technological background they need to complete the assessment. This will likely take one class period. Part I content is listed below.
5. The students should be given the assessment (Part II) with access to the computer technology. This will take at least two more class periods.

The following materials are content needed for the teacher to follow the above procedure.

**Prior to the lesson, students should be familiar with the following scientific concepts:**

1. Lake-effect snow, with a basic idea of how it forms
    a. This local weather phenomenon forms from cold air picking up moisture and heat energy over the great lakes. This forces the air to rise, which causes precipitation.

The Following Diagram shows this concept:




2. The Storm Prediction Center's definition of a severe thunderstorm. Such a storm may contain:

    a. A tornado
    b. Quarter-Sized Hail (> 1.00 in.) (UPDATED BY THE STORM PREDICTION CENTER, JANUARY 2010)
    c. High Winds (> 58 mph)
3. The effects of elevation on precipitation (also known as orographic lift)
    a. When horizontally moving air moves over mountains, it tends to rise due to the elevation change.
    b. Rising air is connected with greater precipitation amounts, as described in relation to the formation of lake effect snow.
    c. During a winter storm, this increases snow amounts. Students will see an example of this when they look at local snow cover maps.
4. Students will go over some basic earth science topics so they can be introduced to the software. While these topics are not the main focus of the lesson, students should be familiar with them. These topics include:
    a. Geologic time, in relation to how mountain ranges and other geologic features change over time
    b. Earthquakes, in relation to how depth of an earth quake's focus impacts the intensity of ground shaking

**Google Earth Content for Part I of the lesson:**

1. Simple Google Earth Tools; the instructor should introduce students to all of these tools, as they will be needed to complete the lesson:
    a. Distance (Measuring) Tool

b. Zoom Tool

c. “Fly To” Tool

d. Layers Box- students should know how to turn on and turn off specific layers.

e. Places Box- students will need this layer to access weather data.

2. Instructors help their students to load the tutorial data into Google Earth. The .kmz files should be made available to the students prior to the lesson. Help the students load the files using the following steps:

    a. Go to File > Open.

    b. Navigate to the folder containing the Google Earth data. Select the desired file.

    c. Click Open

    d. The file will be saved into Temporary Places. If it is not moved, the data will be lost when the application is closed. Right click the file, and choose “Save to My Places”

    e. Repeat for the same process for the remaining files.

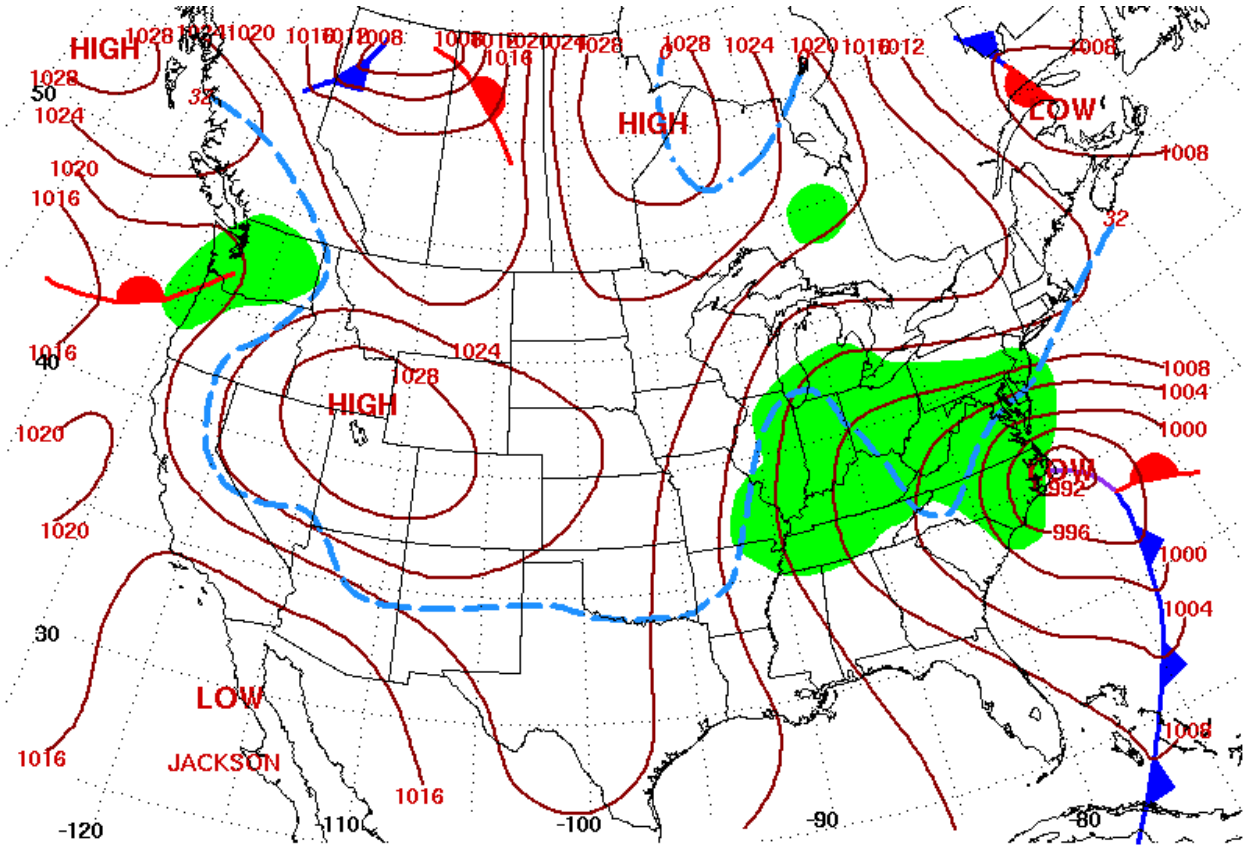
3. The instructor should show students how to interpret the snowfall data. Direct the students to the “Storm2Depth” file. The following concepts should be discussed:

    a. Students should first be directed to the legend at the top of the map that shows snow amounts.

    b. The greatest amount of snow fell to the South East of Pittsburgh. Zoom out, and the large area of precipitation that fell over Virginia can be seen.

    c. The Low Pressure system in this system passed just off the east Coast. This illustrates that most snow falls on the Northwest side of a low-pressure system.

    d. This topic is VERY important later on in the lesson, so make sure your students understand it. This image of the weather system may be helpful:



Surface Weather Map at 7:00 A.M. E.S.T.

**PART II: See Assessment Section.**

IV. Materials Needed

- Computer with Google Earth 5.1 or later*
- Google Earth data (provided)*
- Assessment worksheets*
- Calculator*
- Writing Utensil*
- Answer Key
- Content for instructor (provided)

- Computer with an overhead projector (for demonstration)

*Needed for each student

V. Assessment

Students should complete the assessment on the below pages. The answer key is at the end of this document.

SEE NEXT PAGE

## Using Google Earth to Understand Local Weather

Name_____ Date_____

Point Total _____/36

I. Once you are logged into your computer, launch the Google Earth Application. This will vary by operating system, so your teacher should direct you through this step

II. Google Earth comes with a lot of basic earth science data. One example of this is earthquake data.

   a. In the layers tab, expand the "Primary Database" if it does not already show several layers. After this is open, expand "Gallery," and turn on "Earthquakes"

   b. In 1994, a major earthquake impacted much of southern California. In the Search Box, make sure "Fly To" is selected, and type in "Northridge, CA". Click the Begin Search button that looks like a magnifying glass.

   c. Google Earth will move the user to the location in the search box. Look for earthquake symbols here, and find the one that reads "M 6.7, Greater Los Angeles area, California". Click on the symbol to get more information about the earthquake.

   d. The data for this earthquake includes depth. What was the depth of this event?

      **(1)**_____ How do you think depth can effect the intensity of earthquake shaking?

      **(2)**_____

      _____

      _____

III. Another Useful tool in Google Earth is the elevation data. At the bottom of the Google Earth window, look for "elev". The elevation data should be listed in feet to the right of this label. This data is related to some of the geologic history in the US. Look at the elevation data for some distinct mountains to compare their heights.

a. Go to "Somerset, PA". Use your mouse to hover over the town and find its elevation. What is Somerset's elevation? **(3)**_____

b. Next, go to "Alamosa, CO". What is its elevation? **(4)**_____

c. Somerset is part of the Appalachian Mountain Range, while Alamosa is part of the Rockies. With your knowledge of geologic time and the elevation data that you found on Google Earth, which mountain range do you thinks is older? Explain why.

**(5)**_____

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_____

IV. Another feature that is part of Google Earth is its current weather data.

a. Zoom out from Alamosa so that you can see the entire US. You can use navigation tools to adjust your perspective.

b. Expand the weather tab, and turn on "Clouds." This may take a few moments to load.

c. You can also upload radar data through Google Earth. Turn on "Radar".

d. The "Clouds" data represents a satellite picture of the earth's cloud cover. Radar represents precipitation. (Note that Snow appears in white and gray shades, sleet or ice appears in pink shades, and rain appears in green shades.)

e. Based on this radar and cloud cover data, describe any relationships you see between these two observations.

**(6)**_____

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V. With knowledge of Google Earth's capabilities, you can now use this program to analyze local weather. You should now turn off the radar and cloud data.

a. Yesterday, you uploaded a file that contains Severe Thunderstorm Warnings that were issued for Western Pennsylvania on June 28, 2008. This file is in My Places, and it is called "20080628.kmz". Turn on the layer.

b. This data has a timeline with slider bars. Drag these as far as left and right as they will go. This makes all of the warnings that were issued during the day appear.

c. Zoom to "Latrobe, PA" with the Fly To function. Click on the warning that covers the entire area, and a text box will appear.

d. For what hazard was the Severe Thunderstorm Warning issued for?

**(7)**_____

e. Reading the warning, you can find that the storm was located in Harrison City, PA. Find this town on the map with a Fly To search, and use the measuring tool to find its distance from Latrobe. **(8)**_____

f. Latrobe is almost directly east of Harrison City, the same direction as the motion of the storm. How fast is the storm moving, according to the warning?

**(9)**_____

g. Using the equation, Time = Distance/Speed, how long does the city of Latrobe have to prepare for this storm. Assume that the warning is issued at the same time the storm is over Harrison City. Convert your answer to minutes. Show your work on the next page:

Answer: **(10)**_____

VI. We will now analyze Winter Storm Data

a. Turn on the map that contains the Snow Depth for January 11, 2009. This is named Storm1Depth. Turn off the Severe Thunderstorm data.

b. Fly to California, PA. Estimate the snow depth in this town, based on the legend that appears near the top of the screen. Your answer can be a range.

**(11)**_____

c. Fly to Butler, PA. What is the range of its snow depth? **(12)**_____

d. Zoom out so that all of Pennsylvania, and some of its surrounding states are visible. Now turn off the "Storm1Depth" layer, and turn on the "Storm1Non-Snow" layer. This data shows rainfall that occurred during the storm. Given the large amount of rain that fell near Pittsburgh, and to its south, where do you think

the low-pressure system passed? Support your answer using what you learned in your instructor's demonstration of the December 2009 storm.

**(13)**_____

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VII. Lake-effect snow produces large amounts of snow in parts of Western Pennsylvania. Turn off the "Storm1Non-Snow" layer, and turn on the "LakeEffectDepth" layer. This shows snow depth during a recent lake effect snow event.

a. Zoom in so that all of Western Pennsylvania can be seen. Describe how the depth of the snow changes with respect to the distance from lake Erie. If global climate change caused the water in lake Erie to warm, how might snow amounts be effected? (Assume surface temperatures are still cold enough for snow.)

**(14)**_____

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_____

b. Find California, PA and Somerset, PA. How much snow fell in these locations?

**(15)**_____

c. Which location has the higher elevation? Describe, using your knowledge of terrain on precipitation, how elevation will effect snow amounts at these two locations?

**(16)**_____

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ANSWER KEY:

1. 18.40 km OR 11.43 miles (answers with both units are acceptable) (1 point)

2. Increased depth generally makes ground shaking less severe. There are many other factors that can impact intensity of shaking. (3 points)

3. Approximately 2190 ft (answers close to this are acceptable) (1 point)

4. Approximately 7543 ft (answers close to this are acceptable) (1 point)

5. Older mountain ranges have been eroded for longer time periods. This means that they have a lower elevation. The Appalachian Mountains are not as tall as the Rocky mountains, so they are much older. (4 points)

6. Answers may vary. Students should notice that areas of heavy precipitation can be found in areas of greater cloud cover. (3 points)

7. Damaging Winds (1 point)

8. 14.5 miles (1 point)

9. 50 miles per hour (1 Point)

10. Time = (14.5 mi)/(50 mi/hr), Time = 0.29 hours

    UNIT CONVERSION: (0.29 hours)*(60min.)/(1 hour) = 17.4 min.

    ROUND TO **17 min.** (5 points)

11. Near Zero (1 point)

12. 10-25 cm OR 3.94- 9.84 in.(1 point)

13. In most cases, more snow falls on the Northwest side of a low-pressure system. Given that much of the area north of Pittsburgh got snow, it is likely that the low passed right through or just to the north of Pittsburgh. (4 points)

14. It can be seen by the data that snow depth decreases with respect to distance from the lake. A warmer lake surface will increase the moisture content of the air that passes over the lake, and warm the air. This will cause the air to rise more, and it will lead to higher precipitation amounts. (4 points)

Note: Other atmospheric variables could effect this phenomenon as well; however, increased lake surface temperatures should enhance precipitation amounts.

15. California: 1-5 cm OR .394-.97 in. Somerset: 10-25 cm OR 3.94- 9.84 in. (1 point)

16. Somerset has a higher elevation than California, PA. Because mountains cause air to rise as they pass over them, precipitation amounts increase. Somerset's greater elevation increases its snow amounts. (4 points)