Investigating Weather with Google Earth Teacher Guide

In this activity, students will use Google Earth to explore some factors that affect weather. They will:
1. Determine how latitude, elevation, proximity to bodies of water, and mountain ranges affect a location's climate.
2. Explore, analyze, and interpret weather patterns in 7 different U.S. cities.

Implementation Suggestion: Some students may not be familiar with interpreting metric values for temperature (in Celsius) and precipitation (in cm) or interpreting climatographs. You may wish to present the **Weather and Climate** PowerPoint file (located on the Web site) to help students comprehend metric values. In addition, this PowerPoint file provides content background material for interpreting climatographs.

Model the following procedural instructions with your students. It is recommended that you display your computer image at the front of the classroom.

Step 1: Download data

a. Open your Web browser. Go to **https://eli.lehigh.edu/learners/climate-change**

b. Under Investigating Weather with Google Earth**,** click on **Google Earth file: investigatingweather.kmz**.

    The file is displayed in Google Earth.

    Note: If the file download does not automatically launch Google Earth, double-click on the downloaded file **investigatingweather.kmz** to launch Google Earth.

c. Click the arrow to the left of **"Investigating Weather"** in the left panel (see red arrow below).
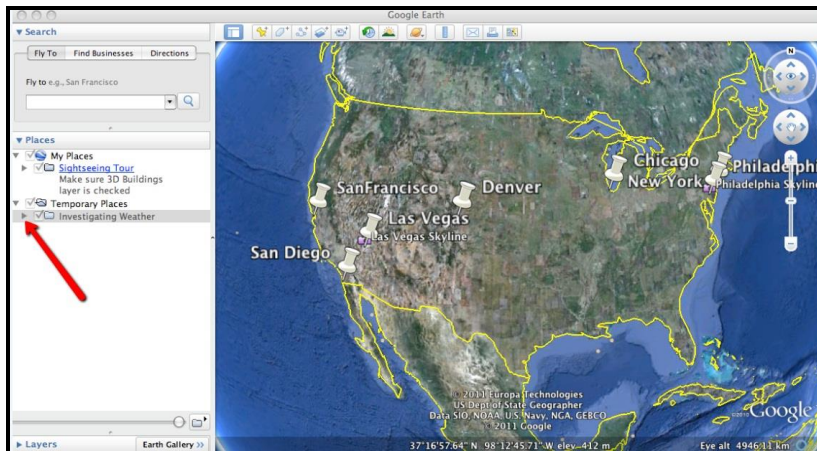
The "Investigating Weather" drop-down list will extend (see below). If you cannot see the whole list, scroll down.

 Step 2: Basic features of Google Earth

Note the following Google Earth features, tools, and navigation controls in the figure below.

1. **Search Panel** (arrow #1) – Type in the white box to find a location.

2. **3-dimensional (3D) Viewer** (arrow #2) – This window shows the Earth and its terrain.

3. **Navigation Controls** (arrow #3) – Use these controls to zoom, look, and move around. If the navigation controls are not visible click on View>Show Navigation>Always.
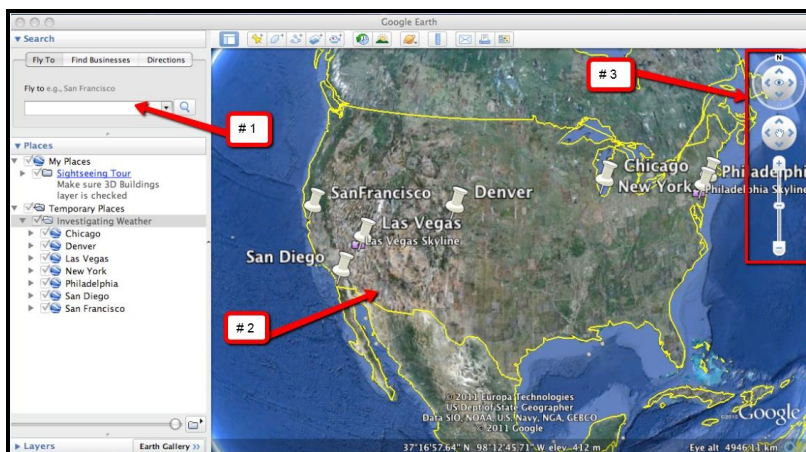

 Step 3: Interpreting climatographs

Your students will explore annual temperature patterns in 7 different U.S. cities using climatographs in Google Earth. Students will record data and answer analysis questions on their **Investigating Weather with Google Earth Student Exploration Sheet**.

 Instruct students to turn on the Google Earth Gridlines if they are not activated.
Select "View" and then "Grid" as shown below.
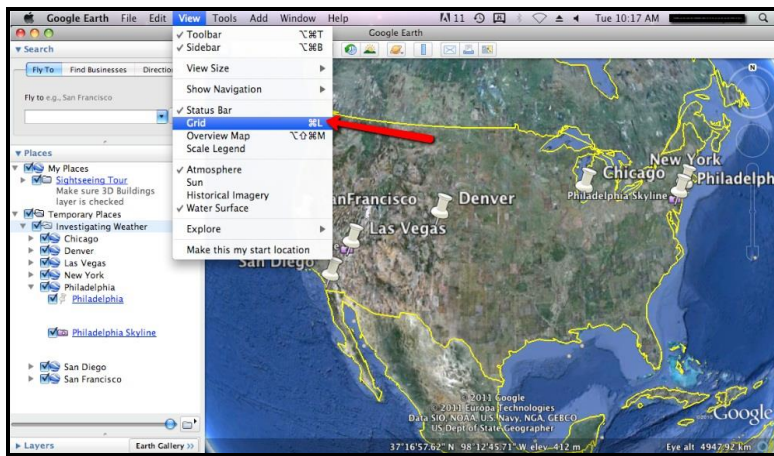
Walk students through the following example to examine annual weather data from a **Philadelphia climatograph**.

a. **Double-click** on **Philadelphia** in the **Places** window. Google Earth will zoom in to the city of Philadelphia.

b. **Click** on the underlined word **Philadelphia** in the Places window (as shown below) or **click** on the **Push-Pin** in the 3D viewer to view the Philadelphia climatograph.
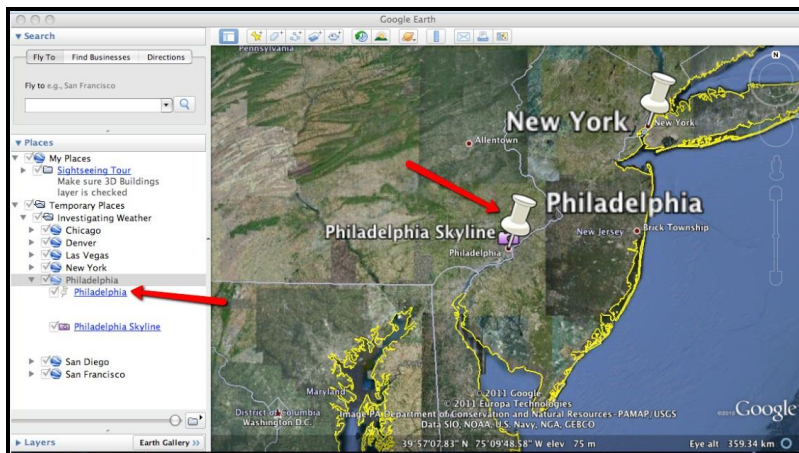
Show the students how to read and interpret a climatograph using Philadelphia as an example. Note that "months" are located on the x-axis, "temperature in degrees Celsius" is located on the right y-axis, and "precipitation in centimeters" is listed on the left y-axis. The average monthly **temperature** is noted by the **red** points on the graph. The average monthly **precipitation** is noted by the **blue** bars on the graph.
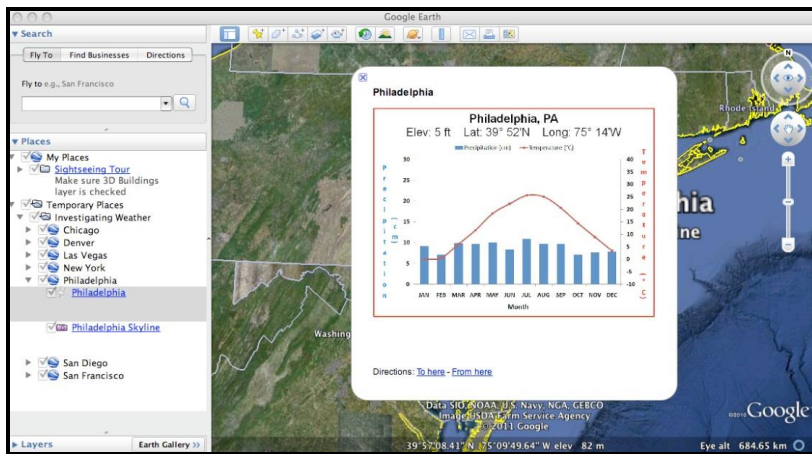
Ask students what pattern they observe in the climatograph's temperature data. The climatograph displays a seasonal pattern with lower temperatures during the winter months and higher temperatures during the summer months. Average annual temperatures increase during the spring months and decrease during the fall months. There is a 26 degree Celsius (46 degree Fahrenheit) temperature difference between Philadelphia's lowest and highest average monthly temperatures. This is reflected in the bell shape of the graph with the top of the bell at the temperature peak.

You may need to explicitly state to your students which months correspond to a particular season.
Winter = December, January, and February
Spring = March, April, and May
Summer = June, July, and August
Fall = September, October, and November

Next, ask students what pattern they observe in the climatograph's precipitation data. In the Philadelphia climatograph, the precipitation is about the same throughout the year. Philadelphia receives an average of 107 cm of annual precipitation or about 9 cm a month, the approximate height of the monthly bar graphs.

Implementation Suggestion: Before proceeding with the exploration tasks, some students may need you to model how to compare climatographs from different geographical areas. You may wish to show students the San Diego climatograph and compare its weather patterns to those of Philadelphia. Ask students what pattern they observe in the San Diego climatograph's temperature data. The climatograph displays a gradual increase in temperature from January to a peak temperature in August. The temperature decreases from August to January. There is only a 7 degree Celsius (14 degree Fahrenheit) temperature difference between San Diego's lowest and highest average monthly temperatures.
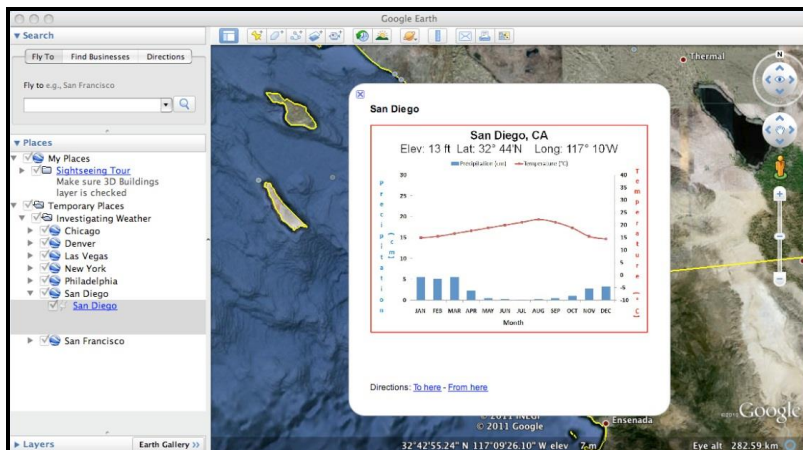
Next, ask students what pattern they observe in the climatograph's precipitation data. Overall, there is very little annual precipitation in San Diego (less than 27.3 cm). San Diego receives almost no precipitation between May and September. Most precipitation occurs between October and April.

Distribute the **Investigating Weather with Google Earth Student Exploration Sheet** to each student. Tell students that they will analyze climatographs from 7 different U.S. cities in order to complete a series of data tables and answer analysis questions. For each city, they will record weather (both temperature and precipitation) patterns based on a seasonal cycle. They will also note the season(s) in which temperature and precipitation peaks occur.

Instruct students to analyze the climatographs from the other cities as described below to complete the corresponding data tables and analysis questions. The students can navigate from one city to the next by selecting the cities from the drop-down menu in the Places window or by using the Google Earth navigational tools.

Note: If you are zoomed out far enough to view the push-pins for more than one city in the 3D Viewer, you can view the climatographs by selecting the push-pins.

Step 4: Exploring weather patterns in San Diego and San Francisco

In this step, students will use Google Earth to understand the effects of **latitude** on weather patterns.

Instruct students to navigate to the cities of **San Diego** and **San Francisco** with Google Earth. Have students examine the weather patterns in these climatographs.

Students should complete the data table and answer analysis questions # **1-3** on their **Investigating Weather with Google Earth Student Exploration Sheet**. Prompt students to focus on seasonal patterns in the climatographs and the shapes of the graphs. If needed, prompt students to look for periods of cold and warm temperatures and high and low periods of precipitation.

Implementation Suggestion: Some students, especially those that are low-ability level students, students with disabilities, and language learners, may require additional support for completing this learning task. You may wish to walk your students through each city one at a time as an entire class using guided questions to analyze each city's climatograph. This instructional strategy is effective using one computer in the classroom that displays the image to the front of the room.

City	Seasonal Temperature Pattern *How much does the temperature change during the year? What pattern do you observe?*	Seasonal Precipitation Pattern *Is the seasonal precipitation the same or different throughout the year? What pattern do you observe?*
San Diego **Elevation:** 13 Feet **Latitude:** 32° 44' N	*High temp: Low temp:* *Change:* *Pattern:*	*Amount:* *Pattern:*
San Francisco **Elevation:** 8 Feet **Latitude:** 37° 37' N	*High temp: Low temp:* *Change:* *Pattern:*	*Amount:* *Pattern:*

Analysis Questions:

1. For each city, which month has the highest temperature?

   San Diego:

   San Francisco:

2. Look at the climatographs. Which city has a colder overall temperature pattern and a greater amount of precipitation?

3. Why do think there is a difference between the temperature patterns for each city?

Step 5: Exploring Weather Patterns in Denver and San Francisco

In this next section, students will use Google Earth to understand the effects of **Elevation** on weather patterns. This part of the exploration will utilize the cities of **Denver** and **San Francisco**. Students should navigate to those cities and then observe the respective climatographs. Students should record seasonal temperature and precipitation pattern information in the table below and answer analysis questions # **4-5**.

City	Seasonal Temperature Pattern *How much does the temperature change during the year? What pattern do you observe?*	Seasonal Precipitation Pattern *Is the seasonal precipitation the same or different throughout the year? What pattern do you observe?*
Denver **Elevation:** 5286 Feet **Latitude:** 39° 46' N	*High temp:* *Low temp:* *Change:* *Pattern:*	*Amount:* *Pattern:*
San Francisco **Elevation:** 8 Feet **Latitude:** 37° 37' N	*High temp:* *Low temp:* *Change:* *Pattern:*	*Amount:* *Pattern:*

Analysis Questions:

4. For each city, which month has the highest temperature?

Denver:

San Francisco:

5. Look closely at the climatographs. Why do you think the patterns of these two cities are different from each other?

Step 6: Exploring Weather Patterns in New York, Chicago, and San Francisco

In this next section, students will use Google Earth to understand how proximity to **Bodies of Water** affects a city's weather pattern. This part of the exploration will utilize only the cities of **New York, Chicago,** and **San Francisco**. Students should navigate to those cities and then observe the respective climatographs. Students should record the seasonal temperature and precipitation pattern information in the table below and answer analysis question # **6**.

City	Seasonal Temperature Pattern *How much does the temperature change during the year? What pattern do you observe?*		Seasonal Precipitation Pattern *Is the seasonal precipitation the same or different throughout the year? What pattern do you observe?*
New York **Elevation:** 11 Feet **Latitude:** 40° 47' N	*High temp:* *Change:* *Pattern:*	*Low temp:*	*Amount:* *Pattern:*
Chicago **Elevation:** 658 Feet **Latitude:** 41° 59' N	*High temp:* *Change:* *Pattern:*	*Low temp:*	*Amount:* *Pattern:*
San Francisco **Elevation:** 8 Feet **Latitude:** 37° 37' N	*High temp:* *Change:* *Pattern:*	*Low temp:*	*Amount:* *Pattern:*

Analysis Questions:

6. These three cities have similar latitudes. What other factor might account for the differences in the weather patterns at these locations?
    Hint: Note other physical features near these cities.

Step 7: Exploring Weather Patterns in Las Vegas and Philadelphia

   In this next section, students will use Google Earth to understand the effects of **Mountain Ranges** on weather patterns. This part of the exploration will utilize only the cities of **Las Vegas** and **Philadelphia**. Students should navigate to those cities and then observe the respective climatographs. Students should click on the camera icon at both locations to observe the skyline pictures associated with these 2 cities. This will help them with their analysis.

Students should record seasonal temperature and precipitation pattern information in the table below and answer the analysis question # **7**.

City	Seasonal Temperature Pattern *How much does the temperature change during the year? What pattern do you observe?*	Seasonal Precipitation Pattern *Is the seasonal precipitation the same or different throughout the year? What pattern do you observe?*	Mountain Range (Y/N)
Las Vegas **Elevation:** 2127 Feet **Latitude:** 36° 05' N	*High temp:* *Low temp:* *Change:* *Pattern:*	*Amount:* *Pattern:*	
Philadelphia **Elevation:** 5 Feet **Latitude:** 39° 52' N	*High temp:* *Low temp:* *Change:* *Pattern:*	*Amount:* *Pattern:*	

Analysis Questions:

   7.   How do mountain ranges affect precipitation?