How Do Seasonal Temperature Patterns Vary Among Different Regions of the World?

Purpose

Students use GLOBE visualizations to display student data on maps and to learn about seasonal changes in regional and global temperature patterns.

Overview

Students use the GLOBE Student Data Archive and visualizations to display current temperatures on a map of the world. They explore the patterns in the temperature map, looking especially for differences between the Northern and Southern Hemispheres, and between equatorial regions and high latitudes. Then students zoom in for a closer look at a region which has a high density of student reporting stations (such as US and Europe). They examine temperature maps for the region, from four dates during the past year (the solstices and equinoxes). Students compare and contrast the patterns in these maps, looking for seasonal patterns. At the end of the activity, students discuss the relative merits of different types of data displays: data tables, graphs and maps.

Student Outcomes

Students will be able to:

- Summarize the effect of latitude, elevation, and geography on global temperature patterns;
- Explore local and regional seasonal variations.

Science Concepts

Physical Sciences

- Heat energy is transferred by conduction, convection and radiation.
- Heat moves from warmer to colder objects.
- Sun is a major source of energy for changes on the Earth's surface.

Earth and Space Sciences

- Weather changes from day to day and over the seasons.
- Seasons result from variations in solar insolation resulting from the tilt of the Earth's rotation axis.
- The sun is the major source of energy at Earth's surface.
- Solar insolation drives atmospheric and ocean circulation.

Life Sciences

- Sunlight is the major source of energy for ecosystems.

Scientific Inquiry Abilities

- Mapping data with the GLOBE Student Data Server to explore seasonal temperature patterns
- Comparing graphs, maps and data tables as tools for data analysis
- Develop explanations and predictions using evidence.
- Recognize and analyze alternative explanations.
- Communicate results and explanations.

Time

Approximately three 45-minute class periods

Level

Intermediate and Secondary

Materials and Tools

- Access to the GLOBE website
- A map of the world
- Acetate and markers (optional, so students won't mark directly on maps)

Preparation

- Make copies of local, regional, and national maps
- Post a large map of the world

Prerequisites

We recommend that students first do *What Are Some Factors That Affect Seasonal Patterns?*, which will give them experience using graphs to explore seasonal changes and basic understanding of factors affecting seasonal changes in temperature.

Crosswalks to Other GLOBE Learning Activities

See *Making a Contour Map Learning Activity* to prepare students for constructing their own regional or local temperature maps.

Your Regional to Global Connections in the *Earth as a System Investigation* to introduce the factors of wind patterns and ocean currents to you global analysis of temperature and seasonal changes.

Background

In this activity, your students use GLOBE's visualization tools to explore seasonal patterns in global and regional temperature data. This serves two purposes. First, students learn about seasons in a global context. Second, students learn how to use GLOBE's mapping tool to see global patterns in GLOBE student data.

For the time being, there are regions of the world (such as the United States and Europe) which have large numbers of schools reporting data, whereas other regions have fewer stations. Therefore, when you look at GLOBE visualizations, you will find some areas of the world with ample data for the types of analyses described here, whereas other areas may be too sparse for adequate analysis. Recognizing this temporary constraint, this activity includes both global studies (using the full scope of GLOBE reporting schools) and regional studies (which focus on areas with many reporting sites). Eventually, as GLOBE grows, your students will be able to do more and more global studies.

Mapping Data with the GLOBE Visualization Tool

Please refer to the color maps displayed in Figure AT-STP-1 through AT-STP-8. GLOBE's visualizations display student data in maps. These visualizations are especially powerful tools, and can be used to help students conduct a variety of investigations. In essence, you select the region that you want displayed, the type of data, and a date and time. Then the GLOBE software creates the requested map, and sends it to you over the Internet.

There are two types of maps that can be displayed: point maps and contour maps. Figure AT-STP-1 is a tpoint map. This shows each reporting school as a colored point. The color of each point corresponds to the value reported by the school. This type of map is best when you want to know where the reporting schools are located, and get a sense of the individual data values (as represented by the color).

Figure AT-STP-2 is a contour map. This map uses the raw data to create contours, such as the temperature bands in the example. This type of map is best when you want to explore patterns in the data. You can use the color key to find out what values are indicated by each band. Also, there may be regions of the map without contours. These are areas in which there are no reporting stations.

For these activities, we recommend contour maps because we are more interested in the patterns than in the actual values. Your students will focus primarily on the shape of the temperature bands (noting, for example, where a given band approaches the equator).

Your students may quickly learn how to work with contours, since these are the same types of temperature maps that appear in newspapers and on TV, and appear in science textbooks. If your students are confused, you might want to have them work with a point map to make their own contour map. First, use crayons to circle all the points in each temperature range (for example, use red to circle all points with a temperature of 20-29, blue for temperatures 30-35, etc.). Then have your students use crayons to draw bands connecting the points that are the same color.

Temperatures Vary from One Location to Another Around the World

Your students begin by displaying current temperatures, as reported by students around the world. For example Figure AT-STP-3 shows a map of student data from all currently reporting schools. In the activity, you will have students explore the map, looking for global patterns. In this example, notice that:

1. There are gaps in the data, because some parts of the world do not yet have GLOBE schools. The world coverage will improve over the years.
2. Since the data are from December, the Northern Hemisphere is generally cooler than the Southern Hemisphere
3. There are variations in the temperature patterns based on current weather and local climatology (e.g. France is warmer than Northeastern U.S., even though they are both at the same latitude)

Regional Maps Show Greater Detail in the Temperature Patterns

When you zoom in for a closer look at a region of the world, you can see more detail. This enables you to see regional patterns more clearly. In Figure AT-STP-5 through AT-STP-8, you can see the differences among four different views, each representing a different season. For example:

1. Temperatures are generally warmer in the summer than the winter.
2. Weather patterns are not constant throughout the year (for example, the curves in the temperature contour on June 21 is not the same as on September 21).

Your students can extend the investigation by looking at seasonal variations in other types of data, such as precipitation type and amount, soil moisture or water temperature. Your students can also explore how the local variations are affected by local geography and elevation.

Temperature Patterns Vary from One Season to the Next

When your students display temperature maps from four different days throughout the year, they are able to explore the seasonal variations in global temperatures, as shown in the above sample maps. (For more detailed analysis, your students could display data from each month of the year).

In these sample maps, Figures AT-STP-5 through AT-STP-8, notice that:

1. It is generally warmer in the summer and colder in the winter.
2. Fall and spring are similar in temperature.
3. Regardless of season, it is warmer the farther south you look.

What To Do and How To Do It

Note: These activities work best if students gather around the computer or take turns, so that they can work directly with the GLOBE visualizations. Or you can print the GLOBE maps and make copies for each student or for groups of students.

Step 1. Display a map of recent temperatures world-wide.

Use the GLOBE visualization tools to access recent temperature data (either minimums or maximums) from all student sites around the world, and display the data on two types of maps: point map and contour map. You might want to choose a date from one or more months to perhaps even a year ago as not all schools input their data immediately.

Step 2. Students explore the global temperature maps.

Begin with the point map. Have your students examine the map. First look for your own site. This shows the temperature data reported by your school. It is shown as a colored dot, with the color corresponding to the temperature. Next, look for other sites, and compare their location and temperature with your own. Find other schools with the same temperature (color) as your own. Find other schools in your own country. Find a school in each continent. Then find the absolute warmest location, and the absolute coldest location.

As noted in the background section, you will see that some areas have many GLOBE schools reporting data, and other areas have few or none. As more schools begin reporting data, your students will be better able to see global patterns. You can use this opportunity to help your students see the importance of having many schools world-wide and having each report their data every day.

Next, have your students look for global patterns in the temperature data. Your students might notice that:

1. Temperatures are warmer in equatorial regions, and colder as one moves further north or south.
2. The Northern Hemisphere is warmer than the Southern Hemisphere or vice-versa.

Step 3. Students zoom in for a local view, and explore regional seasonal variations.

Ask your students what they think the global temperature map will look like at different times of the year. This can be a useful discussion, helping students to think about global seasonal patterns, and to make their own predictions. It also helps you as teacher to find out what your students know and what misperceptions they might have.

Tell your students that they will now zoom in for a closer view of one or more regions of the world. Have them select areas of the world where there are many data points, and then request a contour map for that region. Make sure your students understand what the contour map shows (same data as in the data map, but presented as temperature bands). Ask them what shapes and patterns they see in the contour map.

Now select maps of the same region, from four different dates during the year. This will enable them to examine how the temperature patterns change over the year. Ask your students what four days would best represent the four seasons of the year. Discuss your students' suggestions. Either proceed with whatever dates they suggest, or guide the discussion to selecting the four seasonal transition points (June 21, Sept. 21, Dec 21, Mar 21). You might want to discuss the significance of these dates (solstices and equinoxes). Another approach is to select 12 dates, one per month. This will give your students more detail in the year-long variations.

Access, display (and if possible print and make copies of) the temperature map for each of the four days.

Now have your students study the maps. What similarities do they see from one season to the next? What differences? You want to promote student inquiry and investigation here, so don't simply tell them what the patterns are, but let your students explore the maps and discuss individually or in small groups.

Discuss what they found. They are likely to see:

1. One season tends to be warmer than another.
2. Regardless of season, it tends to be warmer as one moves closer to the equator.
3. Weather patterns are not constant throughout the year. The shape of the temperature bands will vary from one day to the next.
4. If you look at schools in the same latitude, you will find differences in their temperatures.

Ask your students why these patterns occur. For example, they may understand that the Northern and Southern Hemispheres have opposite seasons. Or they may comment that local weather conditions have an impact on the seasonal variations (coastal regions tend to have more stable temperatures throughout the year).

Step 4. Students compare and contrast data tables, maps and graphs. See Figure AT-STP-9 through AT-STP-11.

In this activity your students use GLOBE maps. In other activities, students use graphs and in others they use data tables. These three types of data displays enable your students to visualize, understand and interpret the data. At this point, it is worth exploring with your students the merits and applications of these three types of data displays.

Show your students these three types of data displays. Ask your students what type of information they see in each display. Then discuss with your students the advantages

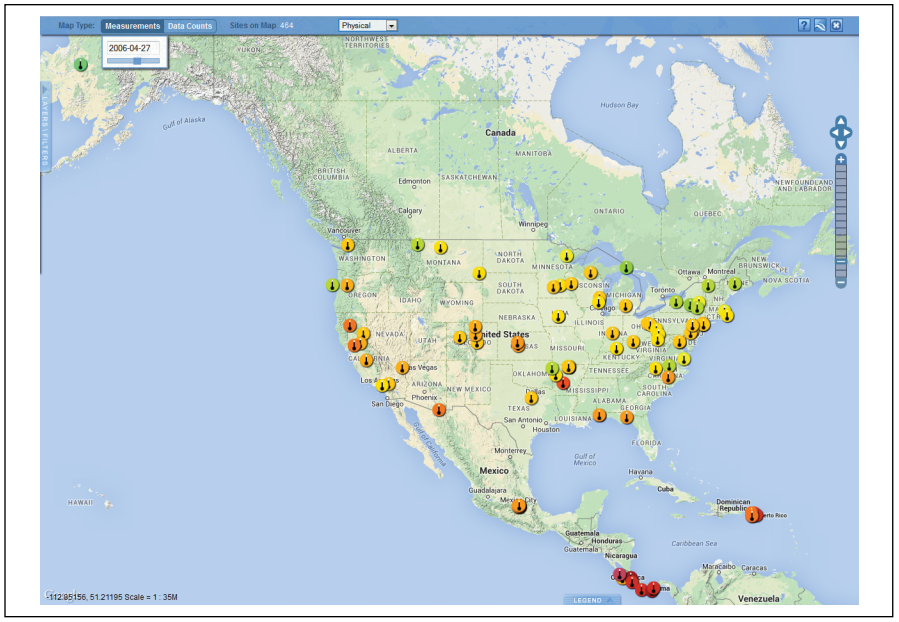

Figure AT-STP-1: Point Map of Maximum Temperatures in North America, on April 27, 2006.

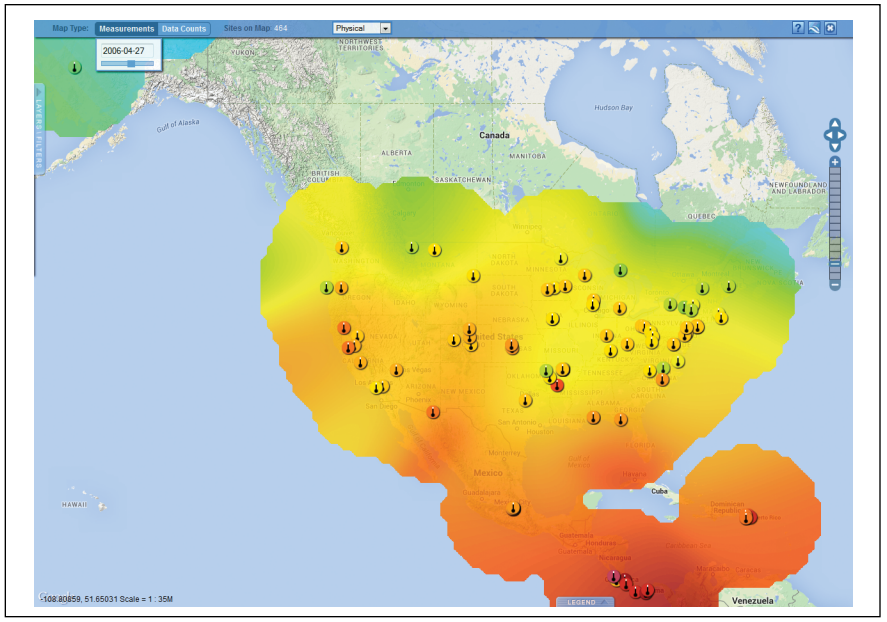

Figure AT-STP-2: Contour Map of Maximum Temperatures in North America, on April 27, 2006.

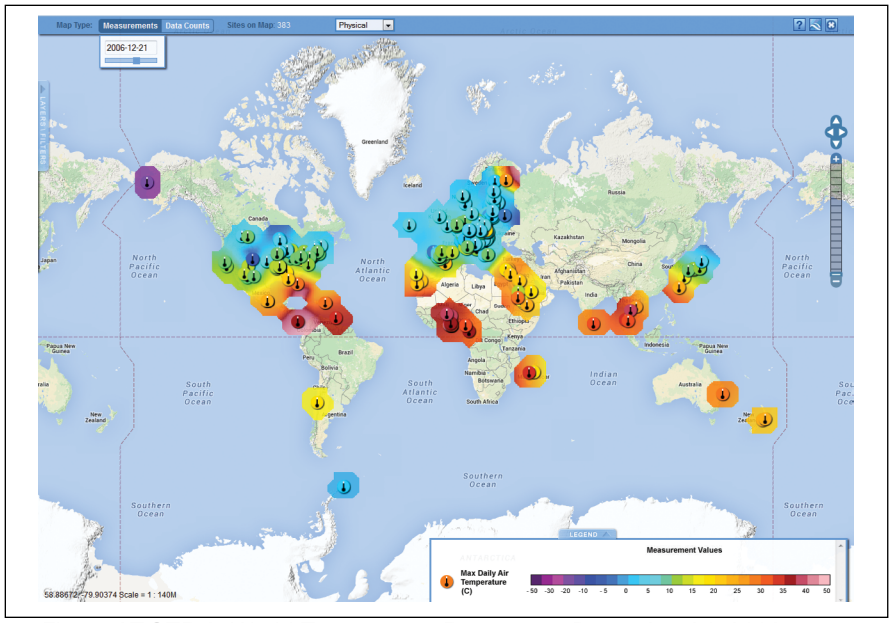

Figure AT-STP-3: World Temperature Patterns on December 21, 2006.

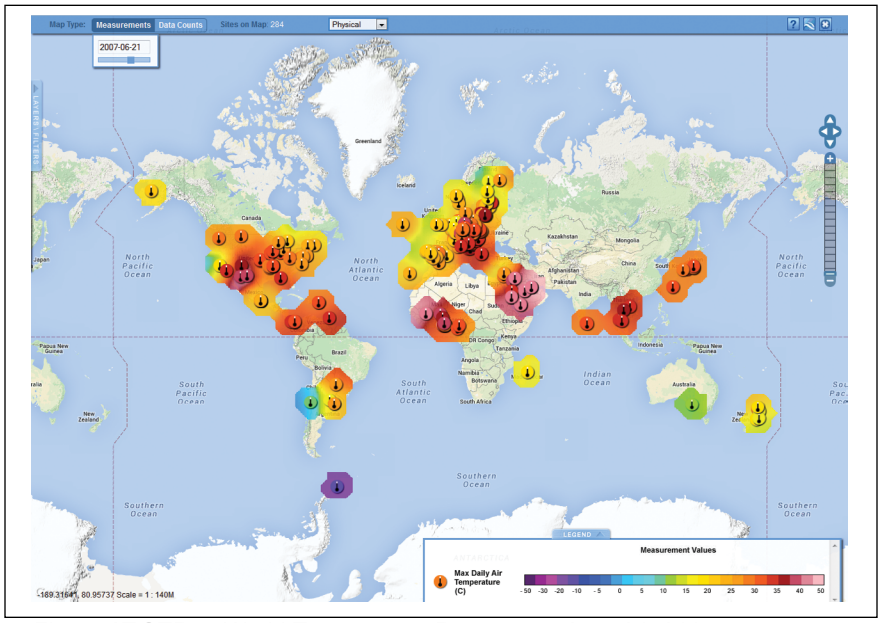

Figure AT-STP-4: World Temperature Patterns on June 21, 2007.

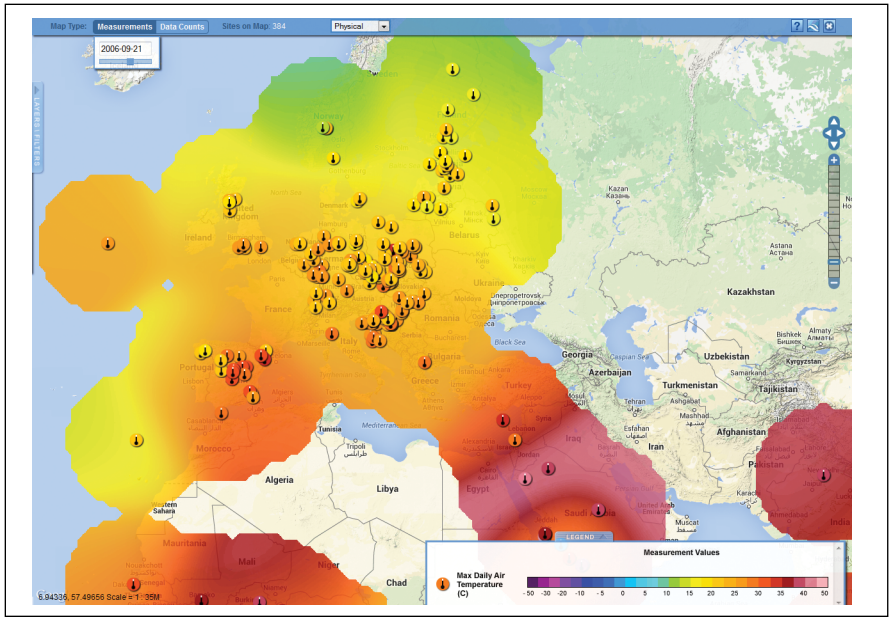

Figure AT-STP-5: Europe Temperatures - September 21, 2006.

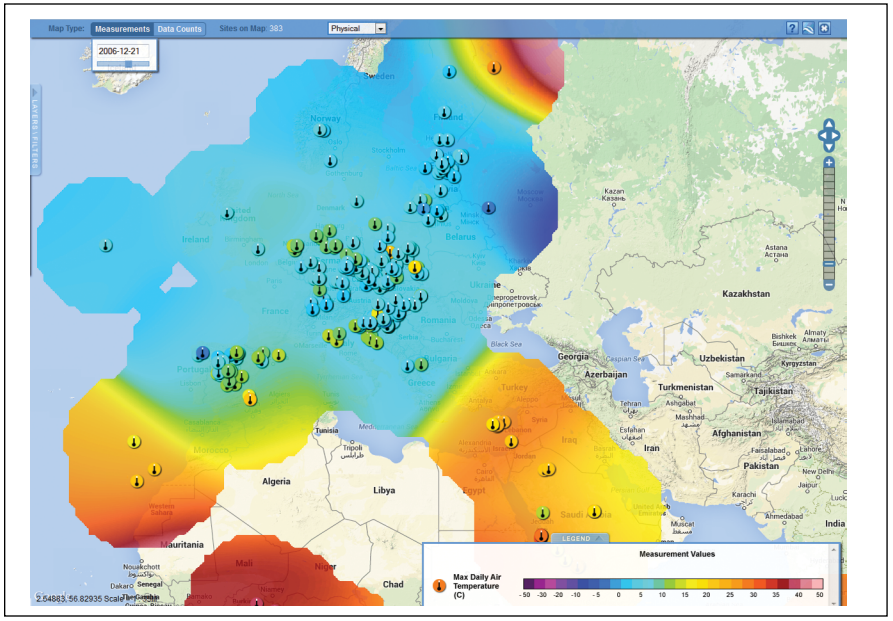

Figure AT-STP-6: Europe Temperatures - December 21, 2006.

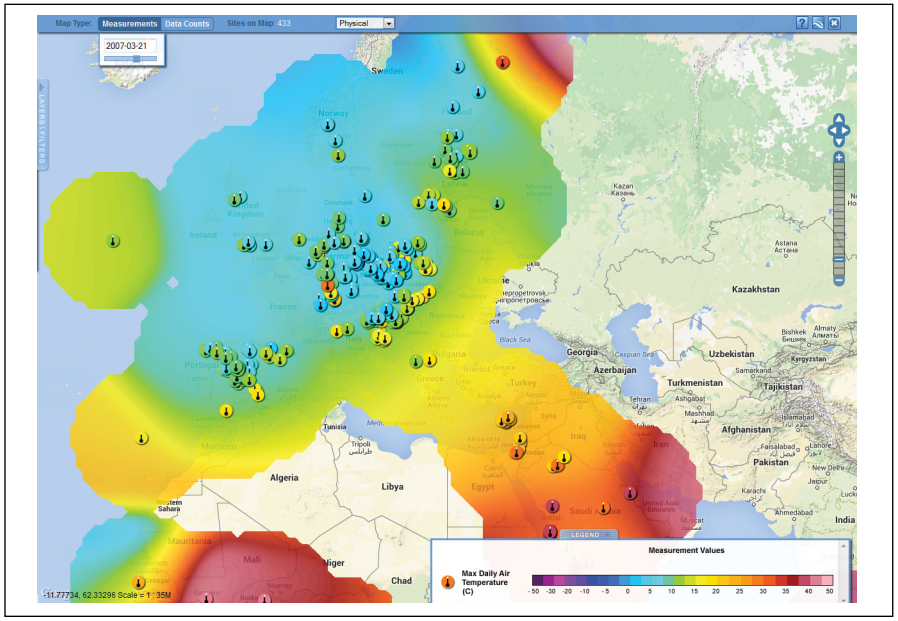

Figure AT-STP-7: Europe Temperatures - March 21, 2007.

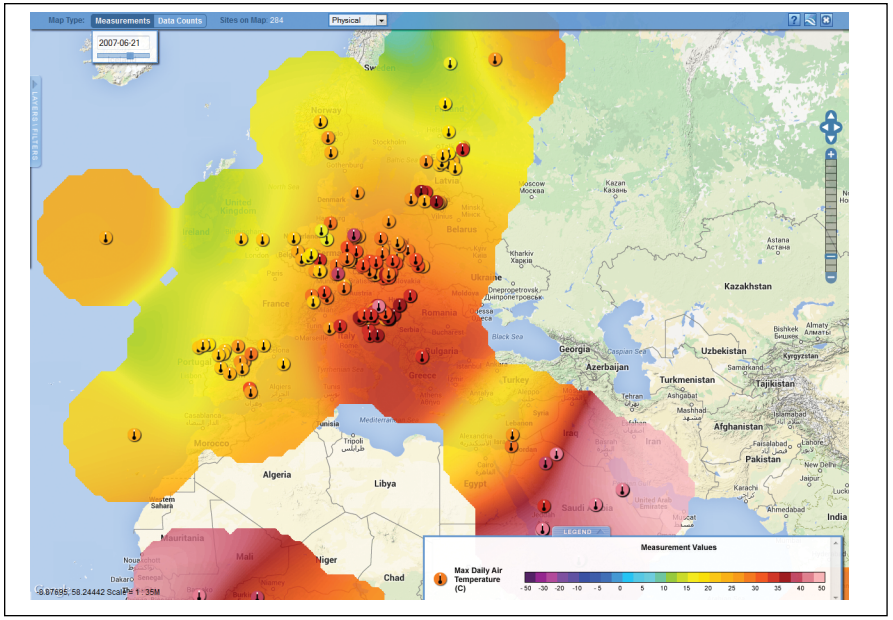

Figure AT-STP-8: Europe Temperatures - June 21, 2007.

Figure AT-STP-9: Maps

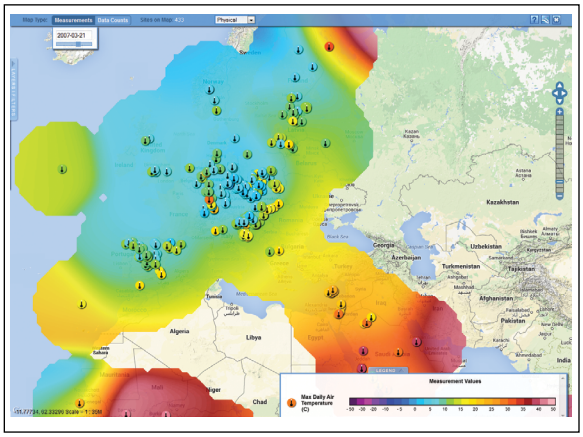

Figure AT-STP-10: Graphs

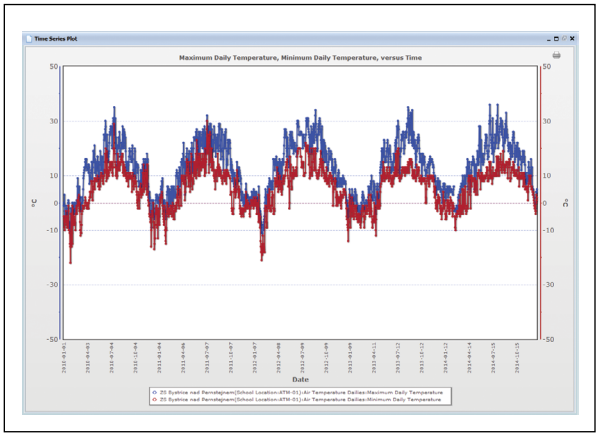

Figure AT-STP-11: Data Table

School Name	Latitude	Longitude	Elevation	Measured Value
Wilhelm-August-Lay-Schule	48.083	7.683	160.8	22.5
Foerderzentrum Erding	48.2977	11.8943	468	26
Stredni Odborne Uciliste Lesnicke a Rybarsk / SOUL a R/	48.9345	17.2934	147.9	23
Zakladni skola Josefa Bublika, Banov	48.9908	17.7203	250	22
ZS a MS Domamil	49	15	495	20
Zakladni skola T.G.Masaryka	49	15	465	23
ZS Brumov Bylnice	49.0818	18.0198	286.9	21.3
Gymnazium Slavicin	49.0905	17.88	363	21
ZS Otrokovice	49.2179	17.5115	135.8	23
Volksschule Petersaurach	49.3117	10.7448	445	21.2
Staatliche Realschule	49.32613	11.01033	301	23
ZS Bystrice nad Pernstejnem	49.519	16.26	570	21
Gymnazium Dr. A. Hrdlicky	49.542	15.3537	518	22.4
Wilhelm-Erb-Gymnasium	49.5673	7.8502	268	22.8
Gimnazjum No 2 in Żywiec	49.6833	19.2002	353	18.3
ZS Pomezi	49.7148	16.3003	565	29.5
Gymnasium an der Heinzenwies	49.7213	7.3092	341	22
Zakladni Skola Opavska	49.7597	17.7845	401	20.7
ZS Golcuv Jenikov	49.8224	15.4836	395	25.1
Darmstadt Elementary School	49.8457	8.6412	217.1	17
VOS a SOST Litomysl	49.8724	16.3041	299.6	19
Offene Schule Babenhausen	49.9	8.84	37	21.6
Gymnazium (CZCZMA4W)	49.9042	16.4432	350	24
ZS Borovskeho Karvina	49.9088	18.4522	279	27
ZS Vrane nad Vltavou	49.9368	14.3792	240	26
Offene Schule Babenhausen	49.96	8.95	37	21
Complex of Schools in Jaroslaw	50.0033	22.6786	212.2	22.6
Gymnazium Voderadska	50.0673	14.4977	185	24
Complex of Schools in Rudna Wielka	50.0874	21.954	174.5	22.5
Gimnazjum No 7 Jana III Sobieskiego in Rzeszów	50.1466	22.1738	179.1	23
Zakladni Skola (CZCZAHJA)	50.2057	16.2367	438	25
DDM	50.2066	15.8347	233.2	26
4. Zakladni Skola - Ekolog. Praktikum	50.4387	15.3523	868	22.2
Mittelschule Elsterberg	50.4433	12.5057	643.5	19.1
Gimnazium in Toszek	50.4514	18.5163	209.1	19
Complex of Schools J. Kilinskiego in Krapkowice	50.4842	17.9581	200	21
Goethe Schule	50.5412	8.522	260	26.3

and disadvantages of each type of display.

For example, your students might notice that:

Maps show how data varies from one location to another. You can see world-wide or regional patterns such as the warmer temperatures in the equatorial regions of the world.

Graphs show how data changes over time. You can see annual patterns such as the warmer temperatures in summer and the colder temperatures in winter.

Data tables show lots of data values in a grid. You can quickly find any type of data for any location, such as the temperature and precipitation amount for a given city.

Post a copy of the map, graph and data table on a bulletin board, and have your students write under each type of display some interesting observations that they see in that display. For example, under the graph they might write the coldest day of the year. Under the map, they might write the coldest location in the world. Then have them write some questions that could be answered with that type of display.

You may need to revisit this comparison of different types of data displays, as students plan their own investigations, such as in step 5 below. Students need to be sure that they're using the most appropriate display for their data analysis.

Step 5. Students use an inquiry-based approach to extend the investigations.

There are several ways that you and your students can extend the investigations. For example:

- Print out maps from two consecutive days (such as June 21 and June 22). Using these two maps, students can explore short term variations versus long-term seasonal changes. For example, they might see minor changes in the shapes of the temperature bands from one day to the next, and larger changes in the overall temperatures from one season to the next.
- Pick two locations for more detailed comparison. For example, your students might find that a town on the Mediterranean coast has less variation between winter and summer than a place in central Canada. This might be because the water of the Mediterranean has a moderating effect on temperature variations. If so, do other coastal locations have similarly moderated temperature variations?
- Display other data on the maps, such as precipitation amount. Students might compare patterns of snowfall in the winter versus the summer and compare Northern Hemisphere vs. Southern Hemisphere.

In each of these extensions, be sure your students use an inquiry-based approach, in which students:

1. Begin by exploring the displays to see what patterns and questions emerge.
2. Select a question that seems especially interesting.
3. Decide what resources can help students investigate the question. Especially focus on use of GLOBE data (each of the examples above uses GLOBE data).
4. Conduct the investigation, either individually or in teams.
5. Share the findings with other students.
6. Think about what new questions emerged that could lead to further investigations.

For these investigations to succeed, they need to be genuinely engaging for the students, the student(s) should really care about the answer. One goal of the activities in this seasons module is to stimulate such interests. In that sense, these activities not only have their own intrinsic value, but also serve as launching pads for further investigations.

Assessment

In this activity, your students have learned about seasonal patterns in global temperature data. They also have learned about GLOBE's map visualization tools. To assess student learning, use the following two steps:

1. Ask your students to use the GLOBE data server to create a contour map of student temperature data from July 15 and January 15 (these dates are near the peaks of summer and winter, and are different from the maps they've already used). Check to make sure each student is able do this activity correctly. You might have a student who knows how to do this help you by observing the other students as they go through the steps, to see who knows how to do this, and who has what kinds of problems.
2. If possible print out the July 15 and January 15 maps from the previous step, and make copies for your students. If you can't do this, then use the sample Dec 21 and June 21 temperature maps that appear in the background section. Then have your students indicate which is summer and which is winter. If you wanted to extend the assessment further, you might print out a 6 month sequence from July 15 to January 15 (one map from each month), cut out or cover over the date on each display, and then ask your students to sort them into the proper sequence. Then ask them to write down what evidence they used to put them in this sequence.