DATA AND GRAPHING

Table of Contents

This series of lessons was developed by the Maine Mathematics & Science Alliance and a group of Maine, Massachusetts, and New Hampshire middle school science teachers with funding from NOAA Environmental Literacy Grant NA07SEC4690002. For more information about the Earth as a System is Essential: Seasons and the Seas (EaSiE) project, visit www.mmsa.org/easie

DATA AND GRAPHING

Overview: The overarching goal of *Earth as a System is Essential: Seasons and the Seas* (EaSiE) is to transform the traditional middle school study of terrestrial seasons and weather into an exploration of the dynamic interactions between Earth's land, water, atmosphere, and the living world. This is an introductory unit that guides students through the collection, graphing, and interpretation of weather data. The lesson series begins with students working with NOAA data that describes atmospheric temperatures over land. Students learn to organize data, draw the graph and interpret the data from the graph. This lays the foundation for lessons on graphing and interpreting atmospheric data from a GoMOOS buoy in the Gulf of Maine, culminating with an option for students to graph and interpret data that they collected during the EaSiE *Weather and Climate* unit.

These lessons are designed with several purposes in mind. The primary goal is to guide students through the process of working with and making meaning from real data. These lessons are also designed to introduce students to the types of data NOAA scientists collect and the variety of ways they collect it. Students will experience working with data generated from their own "backyard" using measurements, NOAA weather stations, buoys, and satellites.

It is anticipated that there will be a wide range of data and graphing understandings and abilities between Grades 5-8. Some scaffolding may be needed for certain groups, while more advanced groups may be able to work more quickly and independently. For this reason, extensions with resources for more practice and more advanced options are provided at the end of this unit.

A prerequisite lesson series, *Weather and Climate*, can be found at www.mmsa.org/easie

Ideas addressing trends, patterns, and predictions supported by data related to seasonality, climate change, and bioindicators of change in the Gulf of Maine region will be developed in a future series of EaSiE lessons that explore students' "bigger backyard". The interpretation of the data will also be linked to the EaSiE fundamental idea of Earth as a system.

Big Idea: Data can be collected, organized, represented, analyzed, interpreted, and explained using appropriate tools (including weather instruments, recording devices, computer hardware and software). The organized data can be used to answer questions about and make sense of natural phenomena such as local weather patterns. The data can also be used to guide the formation of new questions for exploration.

Related Goals from *Benchmarks for Science Literacy* (1993):

- Graphs can show a variety of possible relationships between two variables. As one variable increases uniformly, the other may do one of the following: increase or decrease steadily, increase or decrease faster and faster, get closer and closer to some limiting value, reach some intermediate maximum or minimum, alternately increase and decrease indefinitely, increase or decrease in steps, or do something different from any of these.
- The graphic display of numbers may help to show patterns such as trends, varying rate of change, gaps, or clusters. Such patterns sometimes can be used to make predictions about the phenomena being graphed.

Related Goals from the *National Science Education Standards* (1996):

- Mathematics is essential to asking and answering questions about the natural world. Mathematics can be used to ask questions; to gather, organize, and present data; and to structure convincing explanations.
- Science requires the use of mathematics in the collection and treatment of data and in the reasoning used to develop concepts, laws, and theories." Students gathering data in a science investigation should use tools of data analysis to organize these data and to formulate hypotheses for further testing.

Related Goals from the NCTM *Principles and Standards for School Mathematics* (2000):

- Instruction in statistics should focus on the active involvement of students in the entire process: formulating key questions; collecting and organizing data; representing the data using graphs, tables, frequency distributions, and summary statistics; analyzing the data; making conjectures; and communicating information in a convincing way. Students' understanding of statistics will also be enhanced by evaluating others' arguments.
- In studying data sets, questions like these should be raised: What appears most often in the data? Are there trends? Why are there outliers? How can we explain the data, and does our explanations allow a prediction of what further data would look like? What difficulties might arise when extending the explanation to similar problems? What additional data can we collect to try to verify the ideas developed from these data?
- The mean, median, and mode tell different things about the middle of a data set.
- Comparison of data from two groups should involve comparing both their middles and the spreads around them.

Related Goals from *K-12 Science Literacy New Hampshire Curriculum Framework* (2006):

- Use appropriate tools to gather data as part of an investigation (e.g., ruler, meter stick, thermometer, spring scale, graduated cylinder, calipers, balance, probes, microscopes). (S:SPS1:8:3.2)
- Use appropriate tools (including computer hardware and software) to collect, organize, represent, analyze and explain data. (S:SPS1:8:4.1)
- Evaluate whether the information and data collected allows an evaluation of the scientific idea under investigation. (S:SPS1:8:5.2)
- Determine what additional information would be helpful in answering the scientific question. (S:SPS1:8:5.3)

Related Goals from *Maine Learning Results* (2007):

- Students plan, conduct, analyze data from and communicate results of in-depth scientific investigations; and use a systematic process, tools, equipment, and a variety of materials to create a technological design and produce a solution or product to meet a specified need. (B)
- Use appropriate tools, metric units, and techniques to gather, analyze, and interpret data. (B1c)
- Use mathematics to gather, organize, and present data and structure convincing explanations. (B1d)
- Use logic, critical reasoning and evidence to develop description, explanations, predictions, and models. (B1e)

Related Goals from *Massachusetts Science and Technology/Engineering Curriculum Framework* (2006):

- Present and explain data and findings using multiple representations, including tables, graphs, mathematical and physical models, and demonstrations. (Skills of Inquiry)
- Draw conclusions based on data or evidence presented in tables or graphs, and make inferences based on patterns or trends in the data. (Skills of Inquiry)

The data and graphing understandings and abilities provide a foundation for exploring the *Ocean Literacy Essential Principles and Fundamental Concepts* (2006).

Related Research on Learning from *Benchmarks for Science Literacy* (1993):

- Two areas of confusion when using data have to do with the misunderstanding that averages are always highly representative of a population with little or no attention given to the range of variation around those averages. The other area of confusion has to do with the misdirected thinking that variables are always linked by cause and effect. The importance of guiding students to an understanding of what a correlation is and what it is not can't be overly stressed.

Teacher Background from Science for All Americans (1990):
http://www.project2061.org/publications/sfaa/online/ chap9.htm
Information is all around us—often in such great quantities that we are unable to make sense of it. A set of data can be represented by a few summary characteristics that may reveal or conceal important aspects of it. Statistics is a form of mathematics that develops useful ways for organizing and analyzing large amounts of data. To get an idea of what a set of data is like, for example, we can plot each case on a number line, and then inspect the plot to see where cases are piled up, where some are separate from the others, where the highest and lowest are, and so on. Alternatively, the data set can be characterized in a summary fashion by describing where its middle is and how much variation there is around that middle.

The most familiar statistic for summarizing a data distribution is the mean, or common average; but care must be taken in using or interpreting it. When data are discrete (such as number of children per family), the mean may not even be a possible value (for example, 2.2 children). When data are highly skewed toward one extreme, the mean may not even be close to a typical value. For example, a small fraction of people who have very large personal incomes can raise the mean considerably higher than the bulk of people piled at the lower end can lower it. The median, which divides the lower half of the data from the upper half, is more meaningful for many purposes. When there are only a few discrete values of a quantity, the most informative kind of average may be the mode, which is the most common single value—for example, the most common number of cars per U.S. family is 1.

More generally, averages by themselves neglect variation in the data and may imply more uniformity than exists. For example, the average temperature on the planet Mercury of about 15^{o} F does not sound too bad—until one considers that it swings from 300^{o} F above to almost 300^{o} F below zero. The neglect of variation can be particularly misleading when averages are compared. To interpret averages, therefore, it is important to have information about the variation within groups, such as the total range of data or the range covered by the middle 50 percent. A plot of all the data along a number line makes it possible to see how the data are spread out.

Two quantities are positively correlated if having more of one is associated with having more of the other. (A negative correlation means that having more of one is associated with having less of the other.) But even a strong correlation between two quantities does not mean that one is necessarily a cause of the other. Either one could possibly cause the other, or both could be the common result of some third factor.

Essential Questions:

- Are there patterns or trends in our weather?
- What types of questions can we ask when looking at data?

Knowledge and Skills:

1) Explain what data is.
2) Gather data.
3) Communicate data through the use of tables and graphs.
4) Interpret data.
5) Analyze data to answer questions.

Preparation:

Prepare copies of the following handouts

#1 Monthly Air Temperature Data
#2 Daylight Data (optional)
#3 Geostationary Satellite Worksheet
#4 GoMOOS Buoy Data
#5 Average Yearly Temperature, 3 Locations (optional)

Materials

- graph paper
- rulers
- pencils, colored pencils
- computers
- online or software graphing program (for upper middle grades)

NOAA-Related Data and Information Resources:

- National Weather Service: http://www.erh.noaa.gov/er/gyx/
- NOAA geostationary operational environmental (GOES) satellite information: http://www.oso.noaa.gov/goes/index.htm
- Gulf of Maine Ocean Observing System Buoy Information: http://gomoos.org
- Coastal Ocean Observing Center buoy, boat, and satellite data: http://www.cooa.unh.edu/data.jsp
- AIRMAP Air Quality and Climate Program: http://airmap.unh.edu/

Time Required

5 class periods

Teaching the Lesson:

Elicitation and Introduction to Data:

1. Ask:

a) " *What is data?* Students should know that data are observations. Use student responses to bridge to the idea that data stand for concrete events (Michaels et al., 2008).

For early middle grade students who have not had experience constructing data tables that stand for concrete events, consider providing a kinesthetic activity such as the "Human Birthday Graph" (Appendix A).

b) *"How can data such as air temperature be collected? How can it be used?"* Air temperature is collected using thermometers and the data can be used to monitor daily and monthly air temperature, to compare temperatures from year to year, and to help answer questions about the climate around us.

Ask students to review the weather observations they collected during the prior *Weather and Climate* lesson (www.mmsa.org/easie). One measurement they made each day was air temperature. If they collected the air temperature each day for a month, they could calculate the "average" monthly temperature.

Note: If students did not participate in the data collecting/recording activities, a month of daily air temperature measurements can be obtained from the National Weather Service. Students can be guided to calculate the average: http://www.erh.noaa.gov/er/gyx/

Tell students that NOAA and the National Weather Service collect air temperature information at weather stations around the country. Provide students with the Monthly Average Temperature data set (Handout #1) – or – create a data set of monthly average temperature from a National Weather Service station near your location.

Ask students, "What do you notice about this data?" Students should notice that the average monthly temperatures "go up" and then "go down" over the course of a year.

Have students tape the data set into their science notebooks on a left hand page (graphs will go on the adjacent right side page).

Optional: Comparing two sets of data is a skill that may be appropriate for upper middle grade students. If desired, distribute the Daylight Data (Handout #2). Ask students, "What's different about these two data sets?" (One is a measure of temperature, the other a measure of the length of daylight.) "Is there anything that seems to be similar?" (Both "go up" and "go down" in a similar way – with the highest numbers in June/July.)

Explore:
2. Constructing a Graph
Lead a discussion on ways data can be represented on paper. Explain how a graph makes a picture of data, and the graphic representation (picture) is easier to visualize – which helps scientists interpret the data.

If the class conducted the "Human Birthday Graph" (Appendix A), this data can be used as an introduction to graphing.

Graphing air temperature data:
Pair up the class. Explain that the data listed in their air temperature data table will now be translated into a "picture" so they can look for a pattern or trend. Distribute graph paper, rulers, and pencils (regular and colored). Guide (check with the math instructor) pairs as they work, discussing and deciding what graph format would be best to use. Have examples of weather-related graphs available for students to look at and model.

Note:

- Students will need one full day of instruction on graphing to discuss three or four different types of graphs that they might use to display their data. A tutorial to help decide which type of graph to use can be found at: http://nces.ed.gov/nceskids/CreateAGraph/default.aspx (Summary, Appendix B).
- The "KLINT" approach can help students remember how to set up the framework of a graph (Appendix B).
- In order to provide a consistent approach to the construction of graphs, consult with colleagues in your mathematics program.
- Depending upon students' prior experience, you may choose to round the data to whole numbers.

Once students decide what type of graph they will create, have each student construct their own individual graph. Post examples on a wall. Talk about some of the components of various graphs, asking students to consider what helps to make the data understandable. Questions to ask could include, *"Which graph(s) help you see the data? Which graphs help you see relationships or patterns in the data? What claims can you make from the graphs/data? Why?"*

Optional: If you discussed the optional Daylight data set (Step 1), consider having half the class graph the Monthly Average Temperature (Handout #1) and the other half of the class graph the Daylight (Handout #2). Compare the monthly average temperature and daylight graphs. Students should notice that these two patterns approximately mirror each other (if working with upper middle grades, see "Extensions" regarding the "lag" in temperature).

When finished, have students tape their graphs into their science notebooks on the right side page adjacent to the corresponding data sets.

3. Create a graph using a computer
This application is intended for upper middle grades, once students have had multiple experiences constructing graphs using paper and pencil.

Revisit the air temperature graphs students created. Guide students through the process of creating a spreadsheet and graph using the computer and the same air temperature data.

Note: Decide if you want students working individually, in pairs, or small groups. Determine whether you want your students to save their work, mail it to you electronically, or post in a homework forum. Some computer software graphing options include *InspireData*, *Appleworks*, or *Excel*. An *Excel* tutorial is available at: http://www.ncsu.edu/labwrite/res/gt/gt-menu.html
Another option is to create graphs using an online graphing program such as: http://nces.ed.gov/nceskids/CreateAGraph/default.aspx

Explain:
4. How do scientists collect weather data?
There are many ways scientists collect data over land and also over bodies of water. The weather data may be collected using:

- Direct observation, such as types of clouds
- Direct measurement, such as air temperature using a thermometer or amount of rainfall using a rain gauge
- Instrumentation that can go places we can't, such as in deep water or up in the atmosphere

a) Buoy data:
Note that the data students graphed in steps 1 through 3 were sets of "terrestrial weather" – air temperatures measured above land. We can also measure air temperatures over bodies of water, such as the Gulf of Maine. The Gulf of Maine Ocean Observing System (GoMOOS) consists of a set of about ten buoys located around the Gulf of Maine. They are approximately two meters wide, solar powered, with instruments that fit inside a water-tight case. Sensors are used to measure air conditions: air temperature, wind speed and direction, visibility, and wave height. The buoys can also collect water measurements, including water temperature. The data is transmitted once an hour via cellular telephone to a GOES satellite (see below). This data is then checked by scientists and distributed by NOAA for public use.

b) Geostationary Operational Environmental Satellite (GOES) imagery: Scientists also collect weather data using geostationary satellite imagery. While buoys are useful in collecting data at a particular place in the Gulf of Maine, geostationary satellites can observe and measure weather across a large region – beyond "our backyard".

Show students the satellite images found at: http://www.goes.noaa.gov/

- Click on thumbnail images to enlarge them.
- Discuss what they think the pictures might be.
- Predominant features are the specific section of the Earth as well as cloud coverage.

Have students read the Geostationary Satellite Imagery worksheet (Handout #3): Students work with a partner, taking turns reading sections. At the end of each section, students discuss and write their ideas.
Note: Introducing Geostationary Satellite Imagery is adapted from the NOAA Earth Systems Research Laboratory Hurricane lesson:
http://www.fsl.noaa.gov/outreach/education/poet/

NOAA's Geostationary Satellites are used to monitor storm development and track their movements. GOES satellite imagery is also used to estimate rainfall during the thunderstorms and hurricanes for flash flood warnings, as well as estimates snowfall accumulations and overall extent of snow cover. Such data help meteorologists issue winter storm warnings and spring snow melt advisories.
For more information on NOAA's Geostationary Satellites:
http://noaasis.noaa.gov/NOAASIS/ml/genlsatl.html

5. Interpreting Buoy Data:

Show students where the "B1" buoy is located using the Gulf of Maine map: http://gomoos.org/data/recent.html. Distribute the B1 buoy data sheet (Handout #4). Have students continue working in their pair/share groupings as they look at and discuss the B1 buoy air temperature and wind speed data table and then create a graph representing the data – either using paper and pencil, or a computer. If your students struggle with two data sets, have them create two separate graphs, one for the air temperature and one for the wind speed.

As a class or in small groups have students refer to their data tables and graphs as they discuss the following:

- What do this data and the graphs tell you?
- Are there any trends in the air temperature data from this buoy located in the Gulf of Maine?

- What about the wind speed data – is there a pattern here?
- Are the air temperature and wind speed patterns similar or different? (Students will notice that as one "goes up", the other "goes down".)
- How can you explain the data – what might be the reason for the patterns?
- Does your explanation allow for you to predict what future data might look like?
- What additional data would be helpful in explaining your ideas that you've gained from this data?
- What other questions would you like to ask?

Encourage and guide students to ask questions as they look at data. Post their questions so they can refer back to them.

Evaluate:

6. Constructing and Interpreting Data Tables and Graphs:

Working with the data from Average Yearly Temperatures for 3 Different Locations (Handout #5), have students construct:

- a single data table that lists the average monthly temperatures for Boston MA, Houlton ME, and Mt. Washington NH.
- a graph of the data.
  Note: You may choose to simplify the handout by removing the additional information (latitude, longitude, elevation, yearly average).

Ask students to respond to the following prompts:

- What do this data and graph tell you?
- Compare the three sets of data and graph, and identify at least one trend or pattern that is similar.
- How can you explain the data – what might be the reason for the similar pattern?
- Compare the three sets of data, and identify at least one difference.
- How can you explain the data – what might be the reason for this difference?
- What additional information would be helpful in explaining the ideas that you've gained from this data?
- What is one other question that you would you like to ask?

Suggestions and Extensions

Some suggestions:

- Depending on students' familiarity with using data and their ability to analyze data, you may want to dig deeper into any of the data sets or you may want to focus on the fundamental skills. The amount of time you have available may also play a role in your decision.
- Spend time describing data before interpreting.
- Have students collect measurement data directly before using online data sources.
- Simplify online data sets; too much data can be overwhelming to students.
- It is important to consider the use of data and graphing in an inquiry approach. Use the process to not only build the skills of creating and interpreting graphs, but to also guide the formation of new questions to be explored.
- Data can be used to build understandings of patterns and trends from a temporal or spatial perspective. It can also be used to examine interactions and relationships between different kinds of weather parameters, supporting a systems thinking approach.

Possible extensions include:

- **Have students independently create a graph** of the air temperature data they collected during the *Weather and Climate* lesson, Step 9. Ask them to write a description of that the graph explains:
  - What does this graph represent?
  - What does it tell you? Are there any patterns in the air temperature data from this time period?
  - How can you explain the data? What might be the reason for the patterns (or for having no patterns)?
  - What additional data would be helpful in explaining the ideas that you've gained from this data?
  - What other questions would you like to ask?

- **Use National Weather Service "Current Conditions" and "Climate" data:** http://www.erh.noaa.gov/er/gyx/
  - Obtain current weather conditions from multiple sites to develop an awareness of spatial variation.
  - Build upon prior definition of climate that was descriptive in nature (see *Weather and Climate* lesson, Step 12) to include a data perspective.
  - Use local temporal data to examine typical weather conditions for the months of January, April, July, and October.
  - Expand the understanding of geographic differences in climate by comparing multiple locations.

- **Use GoMOOS data to spark interest in students' "bigger backyard":** Have students "adopt" a buoy and monitor the weather conditions at their location on a daily or weekly basis. Compare data (air temp, water temp, wind speed, wave height) across buoys. The *Adopt-a-Buoy* lesson can be found at mmsa.org/easie

- **Partner with other schools:** Share and discuss data similarities, differences in local weather data.

- **Use the AIRMAP site to create temporal datasets** that students can ask questions about and graph (e.g. air temp or precipitation) at a particular location, look for patterns, trends: http://airmap.unh.edu/

- **Use the AIRMAP site to create spatial datasets** that students can ask questions about and graph (e.g. air temp or precipitation) comparing two or more locations, look for patterns, trends: http://airmap.unh.edu/

- **Use NOAA daily data to graph high and low temperatures.** Compare this with daily outdoor high and low temperature measurements at your school. Use this as a discussion point for talking about weather and climate.

- **Use data to show how weather components are related.** Use classroom-collected, GoMOOS buoy, and other data projects the class is involved in (e.g. Global Sun, Journey North projects) to consider how two types of data might be related. Construct a data table and graph demonstrating the relationship, discuss what the results show, what questions this leads to, and what other data might be useful to answer your question. Examine these interactions and develop the questions through the lens of "systems thinking" from the earlier *Systems* and *Weather and Climate* lesson series (www.mmsa.org/easie).

- **If both air temperature and hours of daylight were graphed in Step 2,** discuss the possible reasons for the maximum hours of daylight happening in June and the maximum air temperature happening in July. What causes this "lag"?

- **Build upon the connection between air temperature and photoperiods.** Sunrise/sunset data available at www.erh.noaa.gov/box/sunmoon.shtml

- **Expand the weather ideas to a global perspective.** World air temperature data available at: http://www.ncdc.noaa.gov/oa/mpp/

- **A good source of Northeast climate data:** http://www.northeastclimatedata.org/

- **Compare GOES satellite imagery with Google Earth.** What are the similarities and differences? Why might you use one instead of the other?

- **For more information about Doppler Radar**, visit NOAA's online tutorial: http://www.srh.noaa.gov/srh/jetstream/doppler/doppler_intro.htm

References:

American Association for the Advancement of Science (AAAS). (1993). *Benchmarks for science literacy*. New York: Oxford University Press.

American Association for the Advancement of Science (AAAS). (1990). *Science for all Americans*. New York: Oxford University Press.

Maine Department of Education. (2007). *Maine learning results: Parameters for essential instruction*. Augusta ME: Maine Department of Education.

Massachusetts Department of Education. (2006). *Massachusetts science and technology/engineering curriculum framework*. Malden MA: Massachusetts Department of Education.

Michaels, S., A.W. Shouse, and H.A. Schweingruber. (2008). *Ready, set, science: Putting research to work in K-8 science classrooms. Chapter 6: Making thinking visible – modeling and representations*. Washington DC: National Academies Press.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Geographic Society. (2006). *Ocean literacy: The essential principles of ocean sciences, K-12*. Washington DC: National Geographic.

National Research Council (NRC). (1996). *National science education standards*. Washington DC: National Academy Press.

New Hampshire Department of Education. (2006). *New Hampshire curriculum framework*. Concord NH: New Hampshire Department of Education.

Monthly Average High Temperature
Portland, Maine
2008

Month	Air Temperature
January	1.8 °C
February	1.2 °C
March	4.1 °C
April	12.8 °C
May	18.2 °C
June	22.9 °C
July	26.7 °C
August	23.6 °C
September	20.8 °C
October	14.9 °C
November	8.6 °C
December	3.1 °C

Data source: National Weather Service http://www.erh.noaa.gov/er/gyx/

(Handout #1)

Monthly Average Daylight
Portland, Maine
2008

Month	Daylight
January	9.3 hours
February	10.5 hours
March	11.9 hours
April	13.5 hours
May	14.7 hours
June	15.4 hours
July	15.1 hours
August	14.0 hours
September	12.5 hours
October	11.0 hours
November	9.7 hours
December	9.0 hours

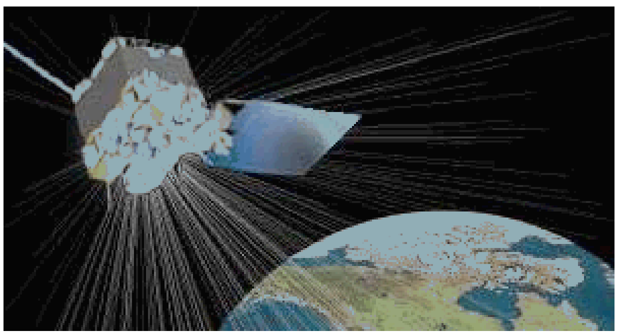
Data source: U.S. Naval Observatory Astronomical Applications
http://aa.usno.navy.mil/

(Handout #2)

Introducing Geostationary Satellite Imagery

Procedure - Read the paragraph and examine the diagrams below. Summarize your readings and observations by completing the "Weather Forecasting Goes Satellite!" sheet. Use a "two column note taking" method: Fill the right hand column with information that describes the topic in the left hand column.

Cloud images and other data that are seen on daily weather forecasts come from satellites that orbit the Earth. **Geostationary** (**geo = Earth** and **stationary = does not move**) satellites provide data for a variety of uses including weather observing and forecasting.



Special satellites called ***geostationary satellites*** collect data used in weather forecasts, climate research and prediction, volcano monitoring, forest fire detection, and search and rescue operations.

Geostationary satellites circle the Earth in a way that makes them always appear to be at the same location to an observer on Earth.

A geostationary satellite collects and distributes data.

- **Geostationary** means that the satellite is always above the same location on the Earth.
- **Satellite** is an object that orbits the Earth. In this case the geostationary satellites are human made satellites. Can you think of a natural satellite that orbits Earth?

Source: NOAA Earth Systems Research Laboratory:
http://www.fsl.noaa.gov/outreach/education/poet/

(Handout #3)

Weather Forecasting Goes Satellite!

In your own words, explain what satellites are.	
What does “geo” mean?	
What does “stationary” mean?	
In your own words explain what “geostationary” means.	
What are the data collected by geostationary satellites used for?	

(Handout #3)

Gulf of Maine Ocean Observing System (GoMOOS)

Buoy: B01 - Western Maine Shelf

Monthly Average

Month	Air Temperature	Wind Speed
Aug 2007	17.6 °C	13 kph
Sep 2007	15.9 °C	15 kph
Oct 2007	12.7 °C	18 kph
Nov 2007	5.5 °C	25 kph
Dec 2007	1.2 °C	26 kph
Jan 2008	0.0 °C	25 kph
Feb 2008	1.0 °C	24 kph
Mar 2008	1.1 °C	25 kph
Apr 2008	6.5 °C	17 kph
May 2008	10.0 °C	17 kph
Jun 2008	15.2 °C	13 kph
Jul 2008	18.5 °C	14 kph
Aug 2008	18.6 °C	15 kph

Data source: GoMOOS http://www.gomoos.org/gnd/

(Handout #4)

Average Yearly Temperatures for 3 Different Locations

Boston Massachusetts
Elevation: 20 feet   Latitude: 42.22 ° N   Longitude: 71.02 ° W
Yearly Average   52 °F

January	30 °F
February	31 °F
March	38 °F
April	49 °F
May	59 °F
June	68 °F
July	74 °F
August	72 °F
September	65 °F
October	55 °F
November	45 °F
December	34 °F

Houlton, Maine
Elevation: 493 feet   Latitude: 46.08 ° N   Longitude: 67.48 ° W
Yearly Average   40 °F

January	14 °F
February	15 °F
March	25 °F
April	39 °F
May	51 °F
June	60 °F
July	66 °F
August	63 °F
September	55 °F
October	44 °F
November	33 °F
December	18 °F

Data source: AIRMAP http://airmap.unh.edu/

(Handout #5)

Mount Washington, New Hampshire

Elevation: 6262 feet   Latitude: 44.16° N Longitude: 71.18° W

Yearly Average 27 °F

January	6 °F
February	6 °F
March	13 °F
April	23 °F
May	35 °F
June	45 °F
July	49 °F
August	48 °F
September	41 °F
October	31 °F
November	21 °F
December	10 °F

Data source: AIRMAP http://airmap.unh.edu/

(Handout #5)

Appendix A
Human Birthday Graph

To introduce the idea of collecting and communicating data in a kinesthetic and visual manner, start with data to which students can relate:

Line up according to birthdates (optional challenge – try lining up without talking!). Then divide the students into groups by birthday month. Have a volunteer record the data (number of students' birthdays by month) on chart paper. Check to be sure the data is being recorded correctly and in a way that the other students will be able to follow.

While the volunteer is recording the data and with students still in place, guide a discussion introducing the term "data":

What is data? How can it be collected? How can it be used?

Ask what information this birthday data tells them about their classmates' birthdays. Lead a discussion on ways this "data" can be represented on paper. Once the volunteer has recorded the information, post it so it's visible to all students. Have students return to their desks and record the information in a data table in their science notebooks.
If unfamiliar to students, guide the creation of their data table.

Appendix B

Constructing a graph:
Students may need help with how to set up the skeleton of a graph prior to inserting the data. Filling in the title, labels and axes may need to be reviewed. Consider using the "***KLINT***" approach with students. Post KLINT somewhere for all to see and reference:

K *= key*
L *= labels*
I *= intervals and scale*
N *= neatness*
T *= title*

Note that the **"I"** in **KLINT** refers to **intervals and scale**:

Intervals are how far apart the numbers are on the dependent, vertical (y) axis. For example; 0,2,4,6,8, has an interval of 2, and 0,5,10,15,20, has an interval of 5.
Intervals are also applied to the independent, horizontal (x) axis. If graphing precipitation by month, the month would be on the x axis. The months should be equally spaced out from left to right.
Intervals set the tone for how people see the graph. By changing intervals you can change the way people see things. For example, if students were graphing local precipitation with an interval of one and the highest month had 15 inches of precipitation and the lowest had 0, visually there would be a large difference. If they changed the interval to 5, it would appear that there isn't that great of a difference from month to month. Keep in mind that students often don't pay attention to intervals when they look at a graph. They often react to what they see in the graph.

Scale is the range of numbers you are using for your dependent variable (y axis), For example, precipitation may go from 0 to 15 inches.

How to Choose Which Type of Graph to Use?
When to Use . . .

. . . a Line graph- Line graphs are used to track changes over short and long periods of time. When smaller changes exist, line graphs are better to use than bar graphs. Line graphs can also be sued to compare changes over the same period of time for more than one group.

. . . a Pie Chart- Pie charts are best to use when you are trying to compare parts of a whole. They do not show changes over time.

. . . a Bar Graph- Bar graphs are used to compare things between different groups or to track changes over time. However, when trying to measure change over time, bar graphs are best when the changes are larger.

. . . an Area Graph- Area graphs are very similar to line graphs. They can be used to track changes over time for one or more groups. Area graphs are good to use when you are tracking the changes in two or more related groups that make up one whole category (for example public and private groups).

. . . an X-Y Plot- X-Y plots are used to determine relationships between the two different things. The x-axis is used to measure one event (or variable) and the y-axis is used to measure the other. If both variables increase at the same time, they have a positive relationship. If one variable decreases while the other increases, they have a negative relationship. Sometimes the variables don't follow any pattern and have no relationship.

Source: http://nces.ed.gov/nceskids/CreateAGraph/default.aspx