CHICAGO BOTANIC GARDEN

2.4: Climate Change Around the World

Grades 10 – 12

Materials
- Student handouts
- Computer with internet access
- Pens or pencils
- Overhead projector (optional)
- Printer (optional)

Description: Up until now, students have focused on only on temperature when evaluating the effects of climate change. Now, through brainstorm and discussion, students will discuss and add other climatic factors to their analysis and investigate how changes in atmospheric carbon dioxide levels affect temperature, while also creating changes in regional precipitation and cloud cover. Students then use the MY NASA DATA website (http://mynasadata.larc.nasa.gov/las/getUI.do) to determine whether global patterns of climate change are directly reflected in their city and in cities around the world. They discuss why different locations around the world are impacted differently or to different degrees by changing climates.

Total Time: Two class periods

National Science Education Standards
A1.D Develop descriptions, explanations, predictions, and models using evidence.
A1.E Think critically and logically to connect the relationships between evidence and explanations.

AAAS Benchmarks
4B/M14: The Earth has a variety of climates, defined by average temperature, precipitation, humidity, air pressure, and wind over time in a particular place.
4B/H5: Climatic conditions result from latitude, altitude, and from the position of mountain ranges, oceans, and lakes. Dynamic processes such as cloud formation, ocean currents, and atmospheric circulation patterns influence climates as well.

Guiding Questions
- What variables make up climate, in addition to temperature?
- How are climate variables changing over time in individual cities?
- How do these variables compare across different cities throughout the world?
- How can we use NASA and NOAA climate data to represent changes in global and regional precipitation, temperature, and cloud cover?
- What are the changes in average temperatures, precipitation, and cloud cover over time in different regions around the world, and how do those change compare to those variables in our home city?
- Are global changes in climate variables (temperature, precipitation, and cloud cover) different across regions? What are the differences and similarities of the impacts of climate change on regions around the world?

Assessment(s)
- Graphs generated from MY NASA DATA
- Climate Change Around the World Worksheet

Pre-Activity:
- Familiarize yourself with the MY NASA DATA website. http://mynasadata.larc.nasa.gov/las/getUI.do
- Review the NOAA Paleoclimatology website to learn about weather events and climate trends over the past 100 years. http://www.ncdc.noaa.gov/paleo/ctl/100.html
- Following the activity plan and student handouts are additional graphs for your reference.

Procedure:
1. Review the conclusions of Activities 2-1 and 2-3. Discussion questions might include:
    - What did looking at past temperatures tell us about temperature over very long periods of time? (it changes slowly, naturally)
    - What was different about our graph of temperatures over the past 100 years from the rest of the historical temperature graphs that we looked at?
    - Have CO_2 levels changed? What conclusions might we draw from our temperature and CO_2 investigations?

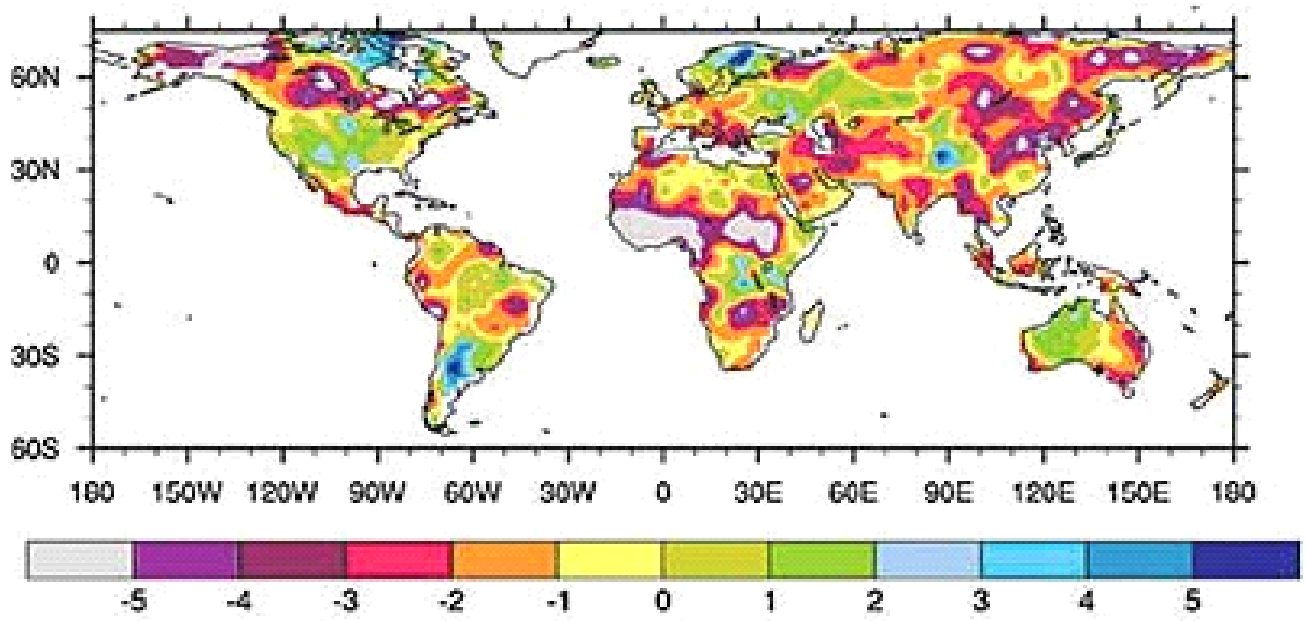
2. Transition the discussion to other aspects of climate. Write answers on the board, so students can refer to them during their investigation. Discussion questions might include:
    - We've looked only at temperature so far. What are other elements that make up climate? What did we find was a key factor in tree growth? (precipitation as well as temperature)
    - Do you think these elements of climate might change if the temperature changes? In what ways might they change? (more/less rain etc.)
    - Have they changed globally? What about in our city and in other cities around the world? Do you think the changes would be the same everywhere in the world?
    - What data would we need to find out whether precipitation and cloud cover have changed?

3. Tell students that they are going to use real data from NASA to find out whether other climate factors have changed, in addition to temperatures, in their city and in other cities around the world.

4. Assign or allow students to choose a city. **Make sure one group of students has the city in which your school is located**. The map below will help you find cities that will illustrate the contrast across regions. Some suggestions that provide interesting comparisons are:

Your School's City/State		
Alice Springs, Australia	Brisbane, Australia	Neuquen, Argentina
Gurupi, Brazil	Edmonton, Canada	Iriba, Chad
Beijing, China	Shanghi, China	Nzerekore, Guinea

New Delhi, India
Edmonton, Canada
Houston, Texas, USA
Noril'sk, Russia
Iriba, Chad
El Obeid, Sudan
Phoenix, Arizona, USA



This depiction of linear trends in the Palmer Drought Severity Index from 1948 to 2002 shows drying (reds and pinks) across much of Canada, Europe, Asia, and Africa and moistening (green) across parts of the United States, Argentina, Scandinavia, and western Australia. (Illustration courtesy Aiguo Dai and the American Meteorological Society.)

5. Hand out the Climate Change Around the World instructions and worksheet to students.

6. Break students into groups of two to three per computer and walk them through the creation of the first graph so they have the idea. Then have them complete the other graphs and their worksheets. Give students at least 30-40 minutes to generate their graphs.

7. Once students have created their graphs and done their analysis bring the class back together for the closing discussion.

8. Discuss the results of their graphing activity. Begin with the group that analyzed the data for your home city and state and have them report back their results and write them on the board. Have a full class discussion of the results for your home city and compare them with the data from other cities. Discussion questions might include:
    - Did you see trends in your data? (because the data is fairly short term, trends may not be immediately obvious)

- Are the trends from our city consistent with the U.S. data?
- Are trends from other locations consistent with U.S. data?
- Why might they be different?
- Are there any patterns in the trends?
- Are different climates, regions, or continents, reacting differently to the increase in global temperature?
- What might be some effects on the lives of the people who live in different areas of the world that have different trends? (e.g. people who live in places with less or more precipitation, on coasts, etc.)

9. Summarize by emphasizing that climate change is not simply temperature increase, but because all the Earth systems interact with each other, it affects other aspects of climate, precipitation, and cloud cover. Lab sheets may be collected as an assessment, and should be placed in student portfolios.

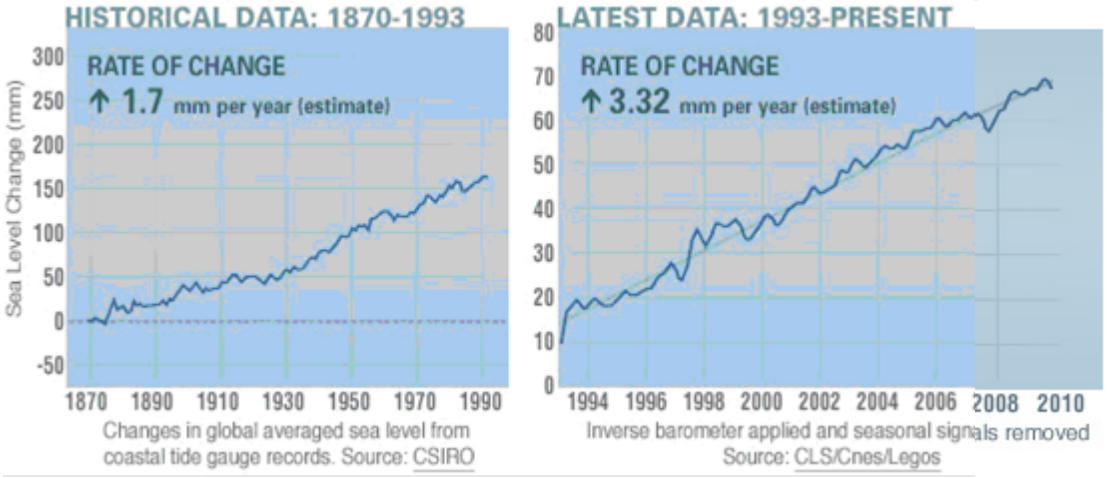
NOTE: If you do not have time to implement all four units of the curriculum, you may skip to the concluding activity Faces of Climate Change (Activity 4.2) to illustrate the impacts of changing climates on people around the world.

Useful Internet Resources:
http://www.nwsnorman.noaa.gov/severewx/safety.html (Severe Weather Safety)
http://www.txdirect.net/~msattler/ (Severe Weather!)
http://www.nssl.noaa.gov/ (National Severe Storms Laboratory)
http://weather.about.com/medianews/weather (About.com)
http://www.cwbol.com/ (Charles Boley's Weather Stuff Collection)
http://users.neca.com/jpcp32/svr.htm (Severe Weather Information)
http://www.weather.com/homepage.html (The Weather Channel)
http://data.giss.nasa.gov/precip_dai/ (NASA global precipitation data)

Additional Reference Graphs

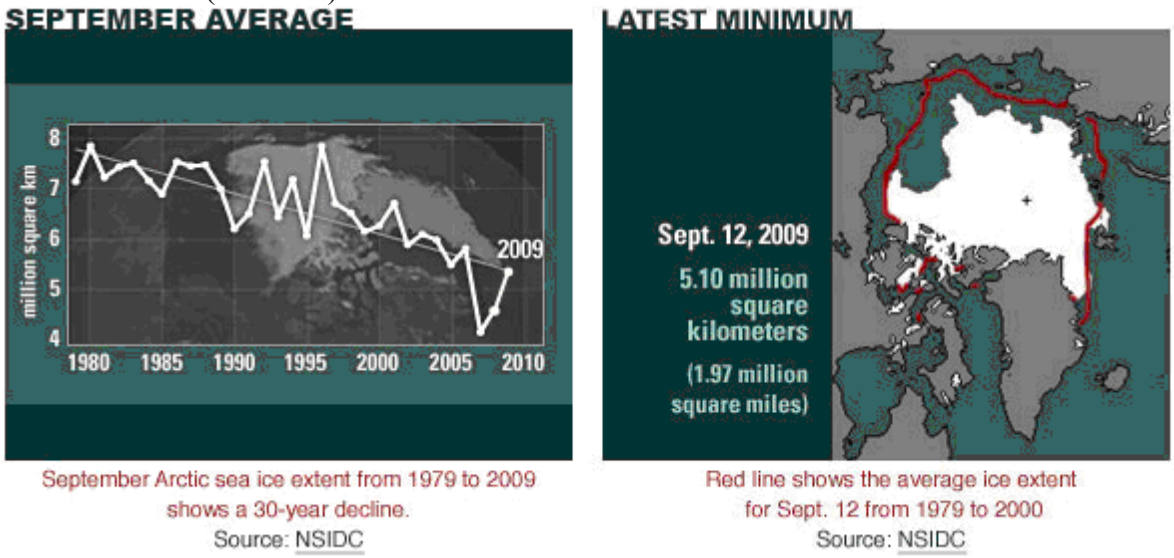
From NASA Global Climate Change: Key indicators, available:
http://climate.nasa.gov/keyIndicators/

Sea Level Data (12.01.09)



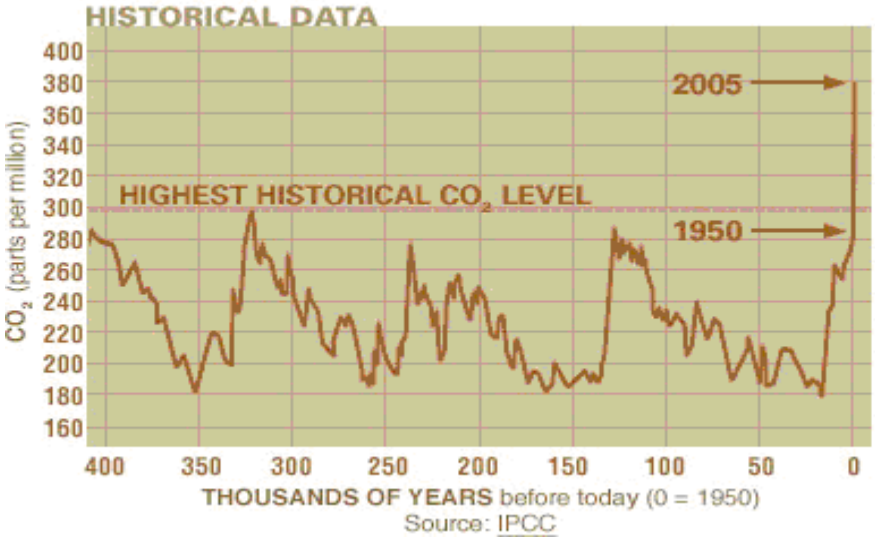
The two charts show historical and current data for sea level rise. Values for the Historical Data graph were obtained from coastal tide gauge records. Values for the Latest Data graph are from global satellite measurements. Sea-level rise is caused by thermal expansion of water, and melting of land ice, both caused by increasing temperatures.

Arctic Sea Ice Data (02.25.10)



The September Average graph shows that the area of Artic sea ice has declined from 1979 to 2009. (Arctic sea ice area is lowest in September, relative to the rest of the year). The Latest Minimum graph shows the area covered by ice in September 2009 (white) as compared to 1979 (red outline)

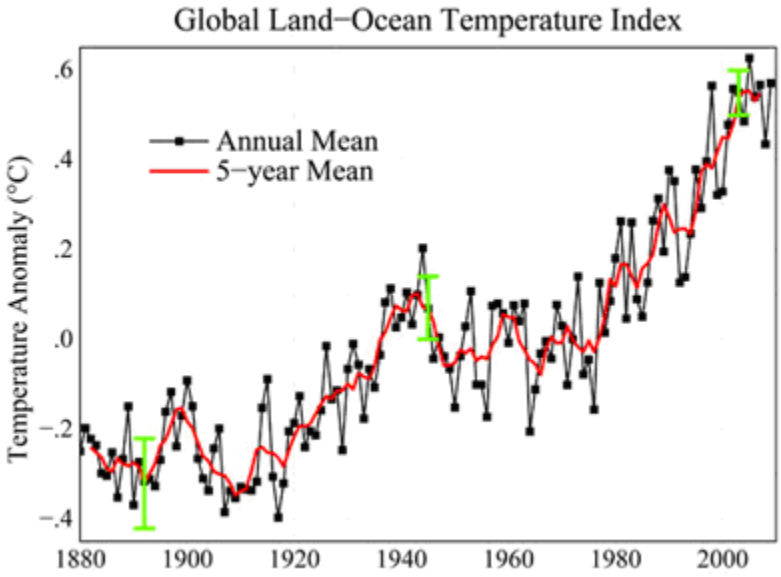
Carbon Dioxide Concentration (updated 02.11.10)



Carbon dioxide (CO_2) is released through natural processes such as respiration and volcanic eruptions and through human activities such as deforestation and burning fossil fuels. The Historical Data graph shows carbon dioxide levels over the past 400,000 years, as collected from ice cores.

Global Surface Temperature Data (updated 02.10.10)

The Global Land-Ocean Temperature Index graph shows the difference between the temperature at each given year, and the mean temperature between 1951 and 1980. When the temperature of any given year is lower than the mean, the value is negative, when the temperature is higher than the mean, the value is positive.



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Directions: Climate change around the world

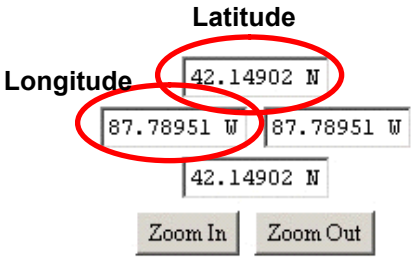
Use NASA data to make the same type of graph for your location.

1. **Find the latitude and longitude of the city you will be researching and record it on your worksheet.**
   1. Go to the Project BudBurst Geocoder at http://neoninc.org/budburst/geocoder.php
   2. Type the city, and country into the text box above the map
   3. Click the **GEOCODE** button
   4. The latitude and longitude of you city will be displayed above the map
   5. Write the latitude and longitude, including the direction (north/south for latitude and east/west for longitude)

2. **Generate your graphs**

Part A – Temperature

1. Open your web browser and go to the MY NASA DATA website. Either type in the following address http://mynasadata.larc.nasa.gov/las/getUI.do, or click on the desktop link your teacher has created.
2. The **DATASETS** window will open automatically
3. Click on the **+** sign next to Land Surface
4. Click on the **+** sign next to Surface Conditions
5. Select **Monthly Surface Clear-sky Temperature (ISCCP)**
6. Select **Time Series** under the **Line Plots** header
7. Select the full time range available
8. Enter your latitude in the **top** text box and the longitude in the **left** text box to the right of the map



9. Click the checkbox on the **UPDATE PLOT** button on the far left of the top menu bar. This will update your graph and make sure that your graphs update as you make selections for precipitation, cloud cover and carbon dioxide.
10. Your graph will update on the right side of the web page
11. Click on the **PRINT** button on the far right of the top menu bar, and this will show your graph in a separate window
12. Print or save your graph

<u>To PRINT your graph</u>

a. Select **File** then **Print** from the top menu on your web browser
b. A print options box will open
c. Your teacher will give you instructions on what printer and options to select

<u>To SAVE your graph</u>

a. Select **File** then **Save As** from the top menu on your web browser
b. Select **Desktop** from the Save in drop-down menu

c. Type the name of your graph in the **File Name** text box. Name your graph so that you will know what is in the file
   - Begin the file name with your name or your initials, so you know it is your file
   - Leave a space
   - Then type the climate variable the graph represents (Temperature, Precipitation, Cloud Cover, or CO_2)

   Example: JSB Temperature

d. Select the file type: WEB ARCHIVE, SINGLE FILE (*.mht)
e. Click **SAVE**
f. The file will appear on your desktop

Part B – Cloud Cover

1. Click the **CHOOSE DATASET** button on the far left of the top menu bar.
2. Click on the ✚ sign next to Atmosphere
3. Click on the ✚ sign next to Clouds
4. Click on the ✚ sign next to Cloud Coverage
5. Select **Monthly Cloud Coverage (ISCCP)**
6. Select the full time range available

Follow steps 9-12 to print or save your graph

Part C – Precipitation

1. Click the **CHOOSE DATASET** button on the far left of the top menu bar.
2. Click on the ✚ sign next to Atmosphere
3. Click on the ✚ sign next to Precipitation
4. Select **Monthly Precipitation (GPCP)**
5. Select the full time range available

Follow steps 9-12 to print or save your graph

Part D – Carbon Dioxide

1. Click the **CHOOSE DATASET** button on the far left of the top menu bar.
2. Click on the ✚ sign next to Atmosphere
3. Click on the ✚ sign next to Air Quality
4. Select **Monthly Carbon Dioxide in Troposphere (ARIS on AQUA)**
5. Select the full time range available

Follow steps 9-12 to print or save your graph

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Name:_____ **Date:**_____ **Room:**_____

Expanding the Climate Model

Answer questions 1 – 5 as a group using the graphs you generate. Answer questions 6 –11 from the following whole class discussion.

Part 1: Researching your city

1. Write the name of the city and country that you are researching, and their latitude and longitude below

   City, Country: _____

   Latitude:_____ Longitude: _____

2. From your graphs, can you determine any trends in temperature, precipitation and cloud cover in the city you are researching? Discuss each graph separately.

   Temperature Trends:

   Precipitation Trends:

   Cloud Cover Trends:

3. What can you determine from the graph of CO_2 in the atmosphere?

4. How do your CO_2 and climate variable graphs compare? What conclusions can you draw, if any? Use your data to support these conclusions.

5. Based on your data, what do you predict will happen to the climate in your city in the future?

Part 2: Comparing across cities

6. Compare your city's graphs with at least one other group of students. Note their city, and describe how your temperature, precipitation, and cloud cover graphs compare to theirs. Use the data to explain your answers.

   Comparison City and Country: _____

   Temperature Comparison:

   Precipitation Comparison:

   Cloud Cover Comparison:

7. Is the climate changing in the same way in both your cities? What does your data tell you about how climate is changing globally?

Part 3: Global Comparisons

Answer the following questions as you discuss the results of your data analysis as a class.

8. Based on the data that you and your classmates have analyzed, describe the similarities and differences in trends in temperature, precipitation, cloud cover and around the world. Support your answer with examples from your discussion.

9. Based on the data that you and your classmates have analyzed, describe the similarities and differences in trends in carbon dioxide around the world. What conclusions can you draw?

10. You've heard the term Global Warming to describe changing climates. Explain why Climate Change is a more accurate way of describing what is happening to climate today.

11. What might be some impacts on the lives of the people who live in different areas of the world that have different trends?

