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ABSTRACT

This collection of activities is designed to show how TI-Interactive[TM] and Calculator-based Laboratories (CBL) can be used to explore topics in high school science. The activities address such topics as specific heat, Boyle's Law, Newton's Law of Cooling, and Antarctic Ozone Levels. Teaching notes and calculator instructions are included as are blackline masters. (MM)

Graphing Calculators, the CBL2™ And TI-Interactive™ In High School Science
16 Mar 01

at

T^3 International

Columbus, Ohio

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Light Meter and the Seasons of the Year

Introduction:

Life on Earth has evolved to be quite resilient. One of the reasons is that during the course of the year, the angle of the Sun's light reaching the Earth's surface changes, resulting in a variation in the amount of heat the biosphere absorbs. This causes the seasons. The reason the angle of incident light changes is because the Earth is tilted 23.5° from the vertical, relative to the orbital plane of the Earth around the Sun.

During the winter in the Northern Hemisphere the Earth is over a million miles closer to the Sun, yet our temperatures are quite a bit lower than in the summer. The Earth's axis tilt causes the angle of the Sun's rays to change from about 26° in the winter to about 74° from the horizontal in the summer at the latitude of New York City. This is about the same latitude as Philadelphia, Indianapolis, Denver and Salt Lake City.

In this exercise you will simulate the angle of the Sun using a protractor and an overhead projector. The Vernier Light Sensor will measure the intensity at various angles from 25° to 75°.

Materials:

Vernier Light Sensor	CBL2™	TI-83/83Plus™
Blackboard protractor	Meter stick	Overhead projector\\

Procedure:

1- Place an overhead projector on the seat of a student desk. Turn the adjusting prism down to near desk top level.
2- On another student desk, use a meter stick to position the protractor one meter from the lens of the projector. Set the base of the protractor so that it is perpendicular to the meter stick and line up the 90° mark in the center of the lens.
3- Connect the CBL2™ to the TI-83/83Plus™ with the short cable, making sure that it is pushed all the way into its port. Then connect the light sensor to the CBL2™ in channel 1.
4- Press the APPS key and select the DataMate™ program. The choose #1: setup. This will allow the CBL2™ to auto-identify the light sensor.
5- Use the cursor arrows to scroll down to MODE: and press ENTER. Select #2: events with entry and press ENTER. Select #1: OK. On the next window also press #1:OK.
6- Set the light probe on the protractor so that the length of the probe is parallel with, and laying on top of the 75° mark. The head of the probe should be even with the edge of the wood. When the reading is stable press ENTER and input the angle, 75°.
7- Move the probe to the 70° mark and repeat the procedure from step 6. Continue the same way all the way to 25°.
8- You are now ready to graph the data. The CBL2™ stores the data in List 1 and List 2 of the graphing calculator. Open the StatPlot window and turn on #1, select xyLine. Next make sure that L_1 and L_2 are selected, putting the angles on the X axis and the light readings on the Y axis. Then choose the type of mark you want the graph to plot with.
9- Open the WINDOW menu and adjust the minimum and maximum values to reflect your data. Now press GRAPH and the calculator will plot your data.

Specific Heat
With Two Temperature probes.

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Introduction:

Specific heat is the measure of a substances ability to change temperature. Some substances, such as air change temperature with the addition of very little energy and some need large amounts of energy to change its temperature. For this exercise we will use the calorie as the unit of heat. Another unit is the Joule. One calorie is equal to 4.18 Joules. One calorie is the heat energy needed to raise the temperature of one gram of water one degree Celsius. The specific heat is defined as the heat needed to change one gram of substance one degree Celsius. The more calories needed for each degree, the higher the specific heat. All substances have their own value for specific heat. For example iron has a value of 0.107cal/g °C. Many metals follow a general rule that their specific heat is approximately equal to 6.3/atomic weight. Ethanol has a value of 0.581 cal/g°C. It takes about five times more energy to change the temperature of one gram of ethanol compared to an equal mass of iron.

In this lab, you will determine the specific heat of a soil sample compared to water. This has many ramifications for us regarding our climate, both local and global.

Materials:

Two temperature probes	CBL	Light or heat source
Graphing calculator	2 petri dishes	Balance
Soil	Water	

Procedure:

1- Design a table of data after reading the instructions completely.

2- Record the mass of a petri dish and then add enough soil to fill it to the brim. Record the

3- mass again. The difference is the mass of the soil sample.

4- Record the mass of another petri dish and fill it with water and record the mass again. The difference is the mass of the water.

5- Plug one temperature probe into channel one the CBL2 and the other probe into channel two.

6- Connect the CBL2 to the graphing calculator with the link cable. Be sure to push the cable all the way in. Turn on the CBL2 and calculator.

7- Push the APPS button and then use the cursor to scroll down to the DataMate program and hit enter.

8- Go to set up probes, choice #1. Scroll down to Mode and press Enter. Choose #2, Time Graph

9- Now select the time intervals and number of seconds for the CBL2 to collect data. One is a good interval and 180 samples.

10- Press #1 OK and #1 OK again, if the screen says CH 1 and CH2 have the temp probes and Mode is Time Graph.

11- Place one probe in the soil sample and the other in the water. Make sure they are under the surface of each sample.

12- Place both samples under or on the heat source, make sure the probes are in the samples. Select #2,START to start recording data and plotting the data. Use the left and right scroll arrows to trace the data. The up and down arrow will switch you from one data set to the other.

Boyle's Law with the CBL2

1- Attach the CBL to the calculator in it's cradle. Be certain that the cable is fully inserted into each device.

2- Plug the connector from the Gas Pressure Sensor into Channel one of the CBL2.

3- Set the plunger on the syringe to 10mL and connect it to the sensor by pressing onto the white stem with a GENTLE ½ turn. The pressure inside the syringe is now equal to atmospheric pressure at the preset volume.

4- You are now set to run the experiment. Turn on the calculator, press the blue APPS button and select DataMate.

5- The DataMate program will automatically identify the Pressure Sensor and now you can select #1 Setup.

6- Use the cursor arrows to scroll up or down to Mode and press Enter.

7- In the Select Mode menu choose Events with Entry

8- Now select #1 OK to return to the main menu. You are now ready to start the experiment

9- Select #2 Start.. The screen will show the pressure. When the reading stabilizes, press Enter and type in the volume at the prompt and press Enter.

10- Reset the plunger on the syringe to another volume. Wait for the pressure to stabilize and repeat step #9.

11- Take readings at volumes larger and smaller than 10mL. Notice that the readings get plotted as you enter the data.

12- When you have collected all your data press the STO key to stop the data collecting. This will display the graph of your data. Press Enter to return to the main menu.

Newton's Law of Cooling

Introduction:

When you have a drink which is very hot, you probably notice that it quickly cools off to a temperature that you consider tolerable. Your drink then remains in a drinkable temperature range for quite a while until it eventually cools of too much as it approaches room temperature. Temperature variations for such cooling objects were first summarized by Newton. He stated that the rate at which a warm body cools is approximately proportional to the temperature difference between the temperature of the warm object and the temperature of the surroundings. This is an exponential variation.

In this exercise you will investigate temperature variations for a cooling object and attempt to verify the mathematically model developed by Newton.

Procedure:

1- Set up a beaker with about 250mL of water to boil. It will heat up while you make the other preparations.
2- Connect the temperature probe to the CBL2™ in channel 1. Also connect the calculator to the CBL2™. Make sure all the cables are firmly pushed into their ports.
3- Press the APPS key and select the DataMate program. Select #1: Setup.
4- DataMate should identify the temperature probe and display it in CH 1:
5- Use the cursor arrows to scroll down to MODE and press ENTER.
6- From the menu choose #2: Time Graph. This changes to the Settings screen.
7- select #2: Change time settings and input a 1 for time between samples and press ENTER. Then type in the number of readings you want the probe to record. A good first attempt would be 200. select #1:OK. Then select 231:OK again, if all looks good. You are now ready to start the experiment.
8- Determine the temperature of the room and record it.
9- Place the probe into the boiling water for a few minutes, until the temperature reaches equilibrium at 100°C.
10-When the temperature stabilizes at the boiling point, remove the probe and press #2:Start on the calculator. The probe should remain exposed to the air while the data is being collected. Avoid placing it on the table top and isolate it from drafts that could increase the evaporation rate.
11-After the data collecting stops, press ENTER and a scaled graph will appear. Pressing ENTER again brings you to the main menu. You can select #4: Analyze. Selecting #4 again allows you to define the portion of the graph you want to analyze. With the cursor arrow, move the cursor to the position you want the left edge of the graph to be and press

Using TI-Interactive to Analyze Data from the Internet

Introduction: One of the most powerful features of TI-Interactive™ is its ability to extract data from web pages for analysis.

Purpose: In this activity, you will be working with data from an EPA web site that relates ozone concentrations and areas of ozone holes over time. These techniques can be used to analyze data from any web page.

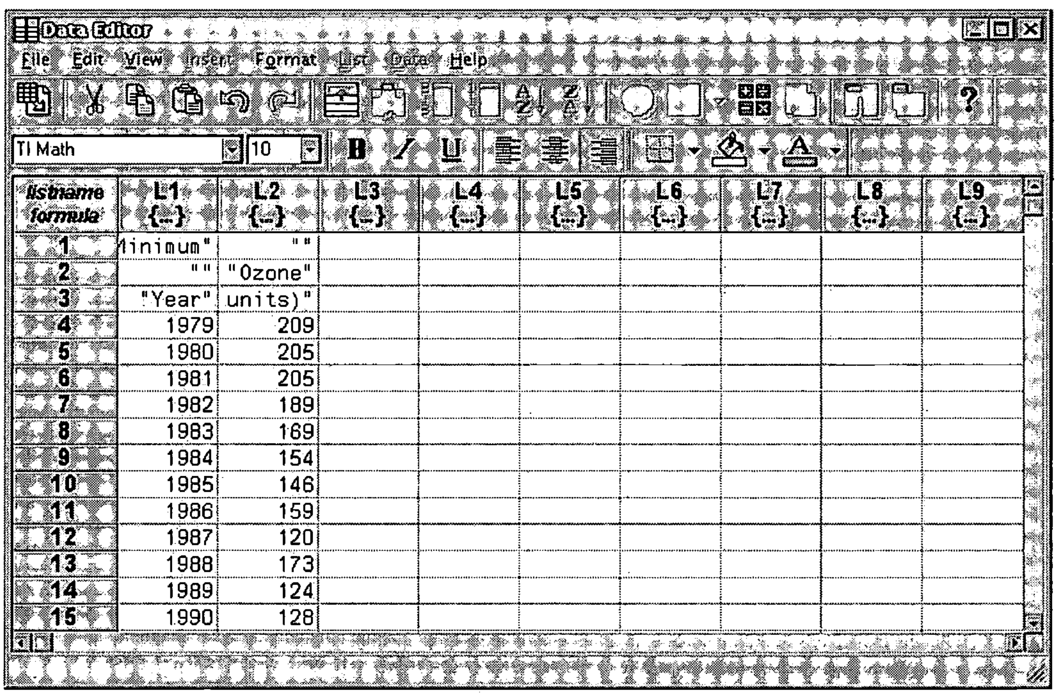
Procedure: Extracting data from a web page

1- Click on the small globe icon to open the TI-Interactive ® web browser.

2- Type in the URL (http://www.epa.gov/docs/ozone/science/hole/sizedata.html) for the web page that contains the data you want to analyze and click on GO.

3- When the web page comes up, highlight the data you want and press Extract.

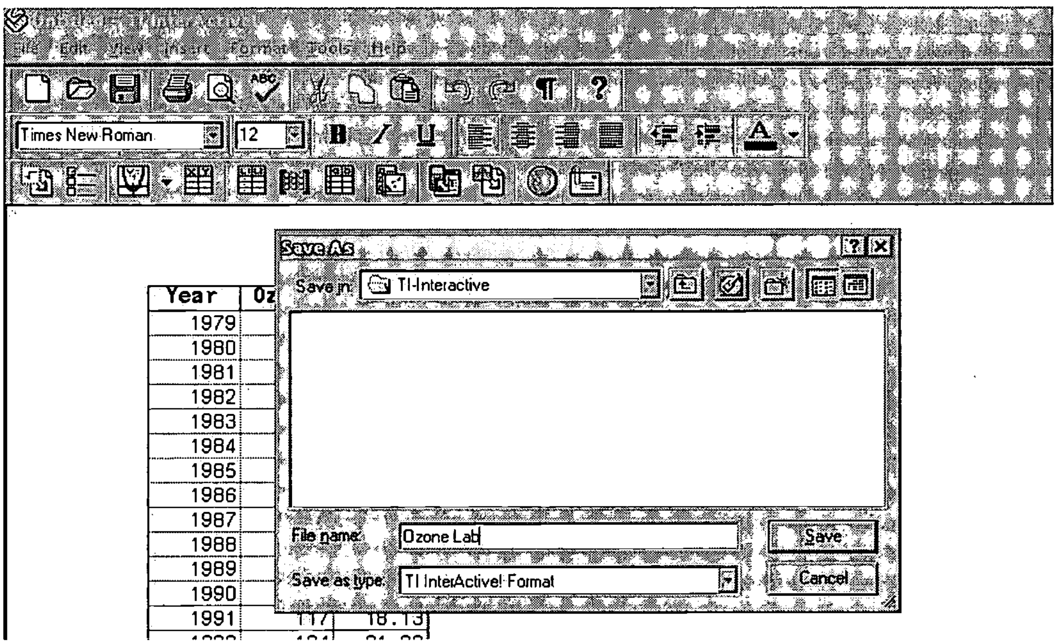
The Data Editor is displayed with the data added to Lists. The data will probably will have to be edited.



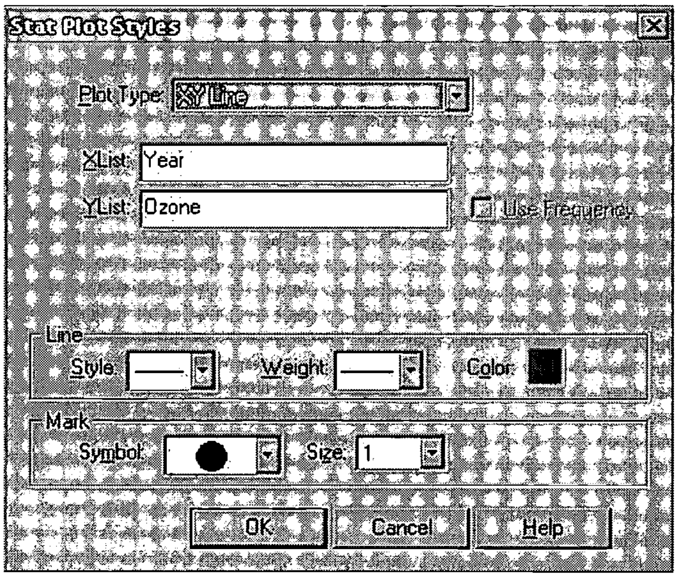
Part 2 – Graphing and Analyzing the Data

Now that the data has been extracted and cleaned up, it can be graphed and analyzed.

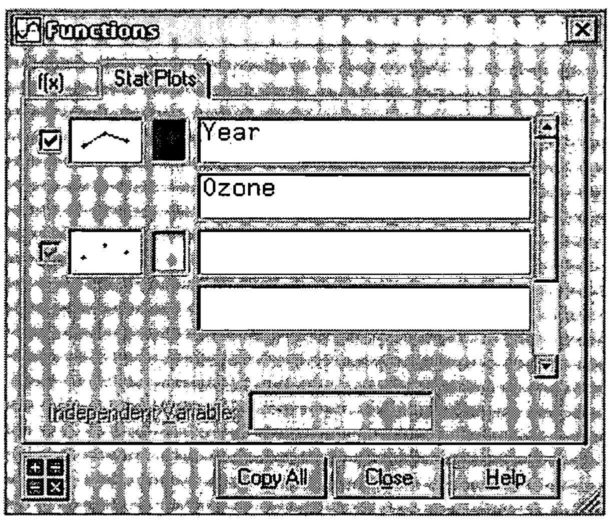
1- Before you go on, it would be wise to save your work. Go to the File menu in the upper left hand corner and select Save As. A dialog box will appear asking you to name your work and assign it a location in your computer. Call it whatever you want, but I will call it Ozone Lab and save it to a folder for TI-Interactive™ in My Documents.



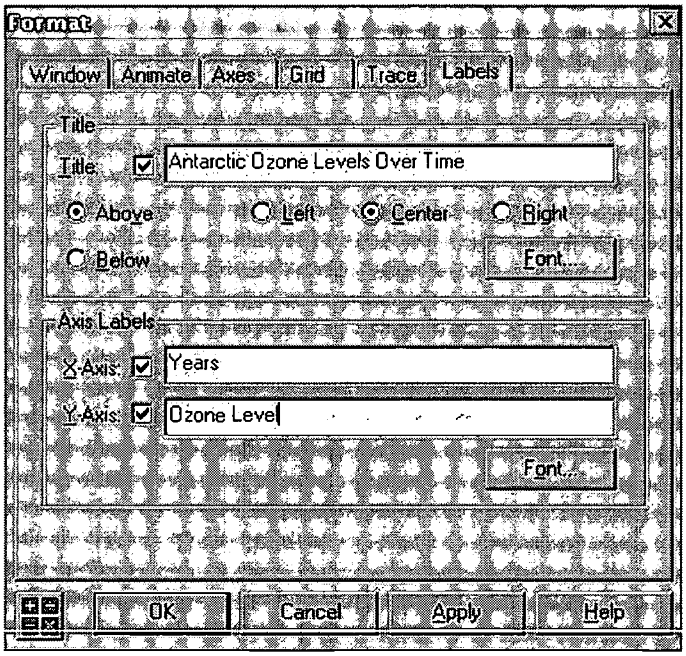
4- Select XY line from the pull-down menu for Plot Type, and type in Year and Ozone for the X and Y axes. Click OK.



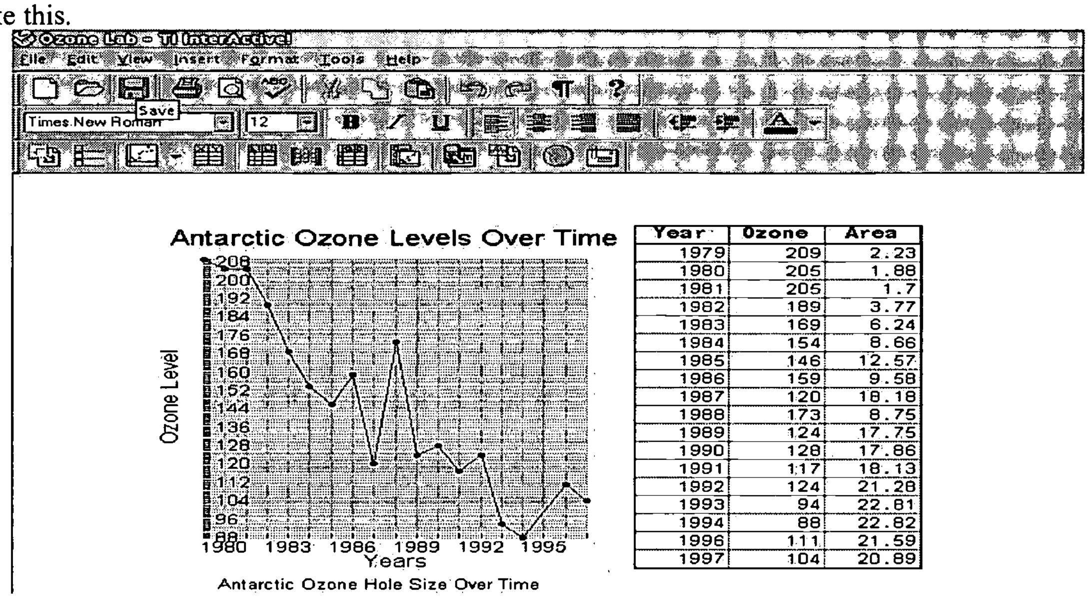
5- The Function box appears and you should click on the small white check box in the far upper left to make a check mark appear, if it is not already there.



7- Next, click on the Format button and select the Labels tabs in the Graph Format box. Complete the Title and Axes labels and make sure the check marks appear in the small white boxes next to your typed labels.

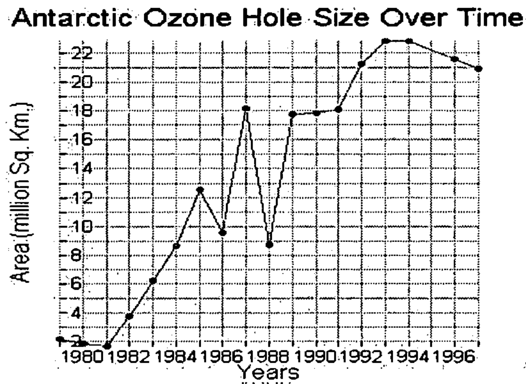


8- Now click the Apply button on the bottom of the dialog box. Your graph should look like this.

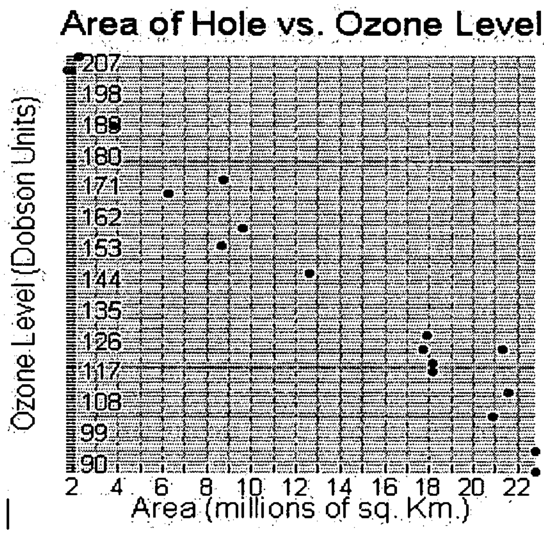


Year	Ozone	Area
1979	209	2.23
1980	205	1.88
1981	205	1.7
1982	189	3.77
1983	169	6.24
1984	154	8.66
1985	146	12.57
1986	159	9.58
1987	120	18.18
1988	173	8.75
1989	124	17.75
1990	128	17.86
1991	117	18.13
1992	124	21.28
1993	94	22.81
1994	88	22.82
1996	111	21.59
1997	104	20.89

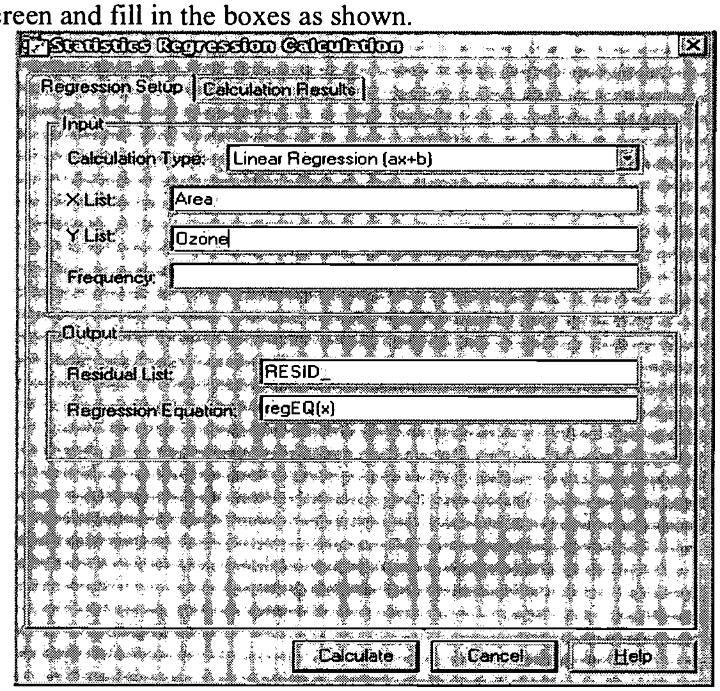
11- Now repeat what you learned in this exercise to plot the data for Years vs. Area of Ozone holes and compare them to the graph you already plotted. The graph be added to the above page, but will look like this.



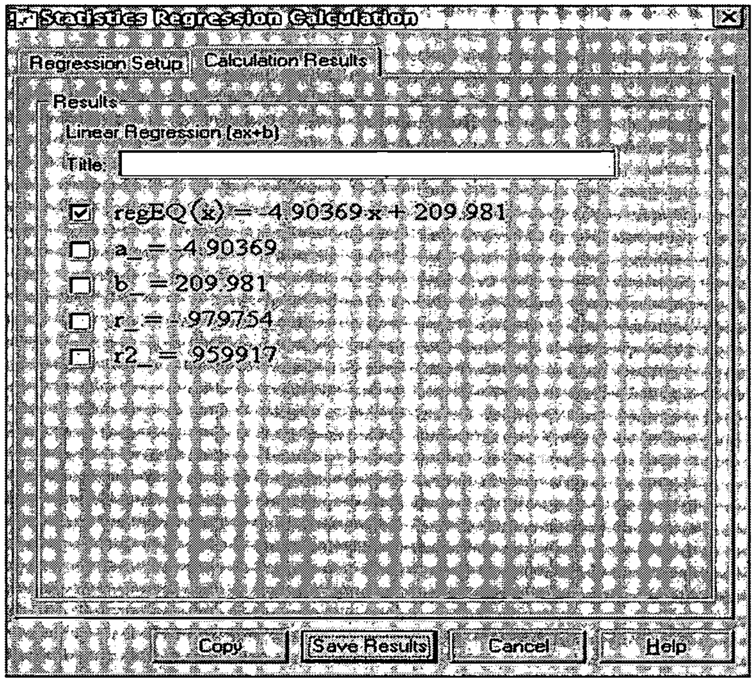
12- There seems to be a relationship between the levels of ozone and the area of the Ozone Hole. To test this you can plot the level of ozone each year to the size of the hole. Just follow the same instructions from step 2., except that the order of the year doesn't matter here. In the Stat Plot Styles box select XY Scatter. The graph will also be added to the other two, but will look like this.



13- To see if there is an actual relationship between these measurements, we can use the Stat Calculation Tool. Click on the fifth button in from the right on the bottom row to get this screen and fill in the boxes as shown.



14- Now select the Calculation Results tab to see the regression statistics.



15- This analysis seems to show that the relationship is quite reliable, with a "r" value of almost 0.98. There seems to be a strong linear relationship between the area of the ozone hole and the level of ozone.

Extension:

Part A:

Sending data from TI-Interactive™ Data Editor to the TI-83Plus™ graphing calculator to do regression calculations.

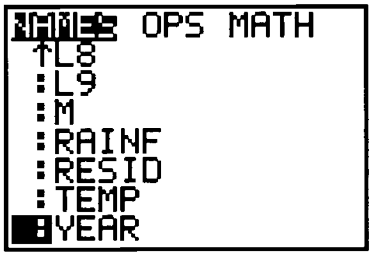
1- Download data from the web to TI-Interactive™. I used temperature data for New Jersey for the years 1895 to 1999. TI-Interactive™ can graph this and do the regressions, using the Math box. See next section for how to do this.

2- In the Data Editor, go to File and scroll down to Export and select TI calculator

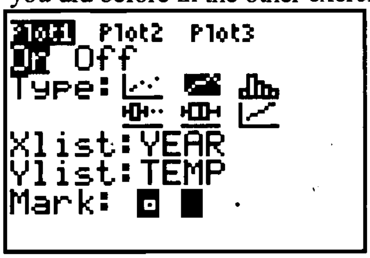
3- Name the lists to be exported. The calculator can only handle 5 characters, so your names may be truncated. Set the screen for the type of calculator you have, the cable and communication port. Firmly inset the calculator end of the GraphLink™ cable into the bottom of your calculator.

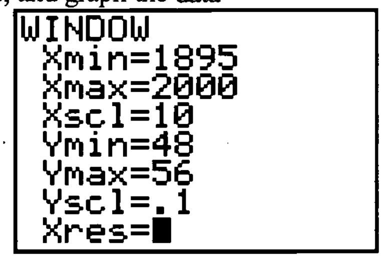
4- On your TI-83Plus™, go to second Link, use the cursor arrow to select receive, and press enter. Now click on Export to send the data.

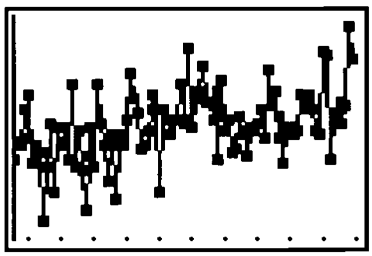
5- On your calculator you can view the lists by pressing second List and scrolling though to Year and Temp.



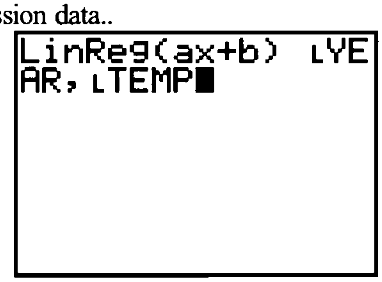
6- To graph the data, go to STAT PLOT and enter the proper settings, set the window the way you did before in the other exercises, and graph the data

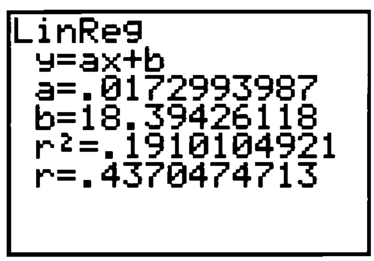






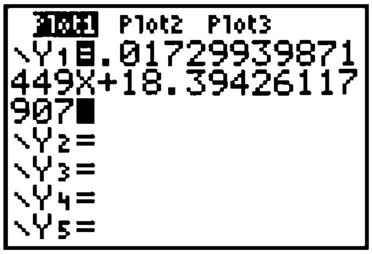
7- To get the regression line, go to STAT CALC and scroll down to LinReg(ax+b) and press ENTER. The selection of lists in different from your other exercises, because they now have names instead of just L_1, L_2 etc. To select Year and Temp, go to second LIST and scroll down to Year and press ENTER. LYEAR should appear after LinReg(ax+b). Type in a comma and again go to second LIST and now select Temp. The screen should look like the left picture. Press ENTER and get the regression data..

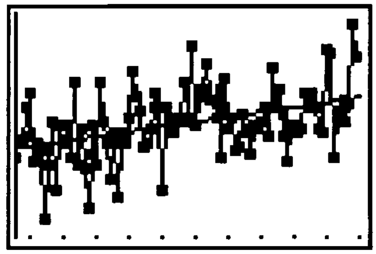




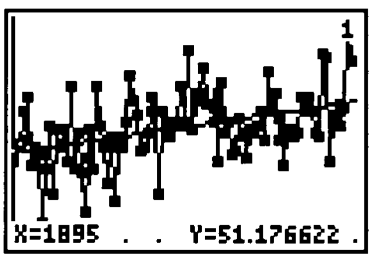
Notice the "r" value is very low. This is because of the variability of the data. The trend is still linear.

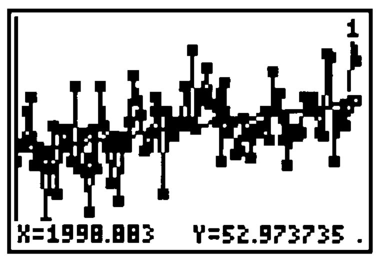
8- Now you will get the regression line the same way you always did. Press Y= and the VARS. Select #5 Statistics and the use the cursor arrow to select EQ #1 RegEQ, press ENTER. This pastes the regression equation into the Y= and allows you to graph the line of best fit over your data graph. Press GRAPH to see it.



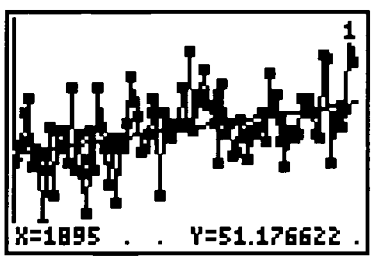


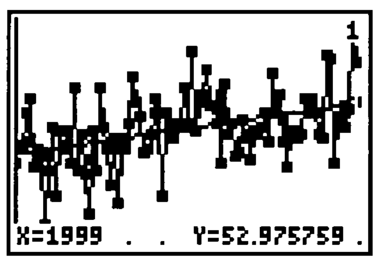
9- Now you can use the TRACE to see how the temperature has changed of the last 104 years in New Jersey. The TRACE key puts the cursor on your data. If you want the regression data to be traced, press either the up or down cursor arrow. What is the temperature in 1895? 1999? How much did it change, on the average in New Jersey?





10- It looks like the temperature went up 1.80° F in that time period. You also could have used the second TRACE and selected #1 Value and type 1985. Repeat for 1999.





Part B:

Using TI-Interactive™ to get the line of best fit.

1- Click on the Stat Calculator button, which is fifth in from the right of the Tool bar. The Statistics Regression Calculation tool is displayed. Type in the axes names and frequency of one. Calculation type should be Linear Regression(ax+b). Click on Calculate in the bottom of the box. Click on Save Results and TI-Interactive™ displays the results in your document.

2- With the cursor displayed at the end of the regression results, press ENTER. Type Graphed Regression Equation: and press ENTER again.

3- On the TI-Interactive™ tool bar, click on the Graph button and select STAT PLOTS.

4- Type in Year and Temp in the first and second boxes. Press ENTER.

5- Select the tab labeled f(x) and in the uppermost box type regEQ(x). Press ENTER.

6- In the Graph window go to Zoom and select Statistics. This will draw the line of best fit.

7- You can now use the TRACE to find the 1895 and 1999 temperatures.

8- You can also use the Calculate button on the Graph window. Click on Calculate and scroll down to Minimum. In the Guess window type 1895 and click on Calculate. The answer is found in the Results window, (1895., 51.1766). Repeat to find the maximum, (1999., 52.9758).

Pop 1950-2050.tii

T^3 Data Sets for TI - Interactive

Official TI – Interactive Data Site
http://www.ti.com/calc/docs/interactive/docs/datasites/datasitecategories.html

Tree Ring Data for North NJ
http://picasso.ngdc.noaa.gov/cgi-bin/paleo/idlpdsi.pl?maptype=tree&Latitude=41&Longitude=74.5

US Tree Ring Data
http://www.ngdc.noaa.gov/paleo/usclient2.html

Lots of Drought Data

http://enso.unl.edu/ndmc/climate/climate.htm

USGS Data
http://ask.usgs.gov/education.html

Environmental Data sets
http://www.erin.gov.au/edd/owa/edd_search2.category_list

CO_2 Emissions From Fossil Duel Sources
http://cdiac.esd.ornl.gov/ftp/ndp030/global97.ems

Population and Ecology Data List
http://www.ento.vt.edu/~sharov/popechome/refernce.html#data

Sun or Moon rise and setting data for the year
http://aa.usno.navy.mil/data/docs/RS_OneYear.html

tides do 31 days for data
http://co-ops.nos.noaa.gov/data_retrieve.shtml?input_code=000111111vwl&station=8531680+Sandy+Hook,+NJ

Data to graph – Tides and water levels
http://co-ops.nos.noaa.gov

Moon phases 2000
http://aa.usno.navy.mil/AA/data/docs/MoonPhase.html#y2000

Lots of data
http://www.erin.gov.au/edd/owa/edd_search2.category_list

Environmental Data Sets
http://www.csuohio.edu/cestp/dataproj/dataproj.htm

CO_2 and climate plot
http://www.athena.ivv.nasa.gov/curric/land/global/plotco2.html

Tree ring and weather
http://www.athena.ivv.nasa.gov/curric/land/global/trdata.html

Water Use: National and Local

1- From the data table of Total Water Use in the US, Calculate the per capita use of water for each state. Be careful of the units. What are the top ten water users and the ten states that use the least amount of water per capita? Use data from the following web site.
http://wwwga.usgs.gov/edu/tables/dltotal.html

2- What patterns do you observe about water use? Why are some of the states in your above list ranked where they are? What does this tell you about water use and consumption in various parts of the country?

3- What states use more ground water than surface water? Are there states in the drier parts of the USA that use more surface water? Where does it come from?

4- For New Jersey, how does our water use match our water supply?
NJ Reservoir levels to date:
http://www.state.nj.us/dep/watersupply/admin.htm#Combined%20Northeast%20Reservoirs
Summary of hydrologic conditions in NJ to date:
http://nj.usgs.gov/monthly_summary/index.html

5- Evaluate the average rainfall in New Jersey with the 1895-1999 rainfall patterns. How are we doing this year, so far? How does the data relate to the average temperature? Is there a relationship? How does the pattern of El Nino and La Nina fit?
To data this year:
http://climate.rutgers.edu/stateclim/njclimatewatch.html
Long term data:
http://climate.rutgers.edu/stateclim/data/njhistprecip.html

6- On topographic maps of our region, draw our watershed. Where does the water come from? How does it get to the reservoirs? What terrain does the water pass thru and what are some of the threats to the safety of the water? What about development in our watershed?

7- How is the water treated for public use? How is it distributed?

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