

GPS scavenger hunt
Due April 25

Global Positioning Satellites (GPS)

GPS works by receiving signals from a set of 24 (or more) satellites orbiting the earth. The most commonly used satellites were constructed by the US Department of Defense, although there is also a Russian set of nine satellites and the Europeans are planning one. These satellites constantly transmit a signal with precise timing information. The handheld unit receives this signal and calculates the exact distance to each satellite. At least three satellites must be visible for the longitude and latitude to be determined, and four satellites for longitude, latitude, and elevation. In general, the more satellites that are visible (line-of-sight) to the unit, the better the location. If trees, tall buildings, or cliffs block the signal, the accuracy will be reduced.

The accuracy of handheld GPS units is roughly 15 m under normal circumstances. More precise measurements can be determined by using differential GPS, which compares the signal received by several units. Finally, more expensive equipment and special processing can yield measurements accurate to within mm, which has been used to measure plate motion vectors.

The errors are generally due to several causes. As mentioned above, blocked or reflected (multipath) signals are most common. The geometry of the signals paths is also a factor, as the best location is from widely separated satellites. Variations in the amount of atmospheric water vapor or changes in the ionosphere can slightly alter the velocity of the radio waves, which also creates errors. Finally, the U.S. Department of Defense can add changes (dithering) to the signal which will decrease accuracy for non-military receivers.



Waypoints

It's nice to know where you are, but it is also good to know where you have been. The Garmin GPS does this with waypoints. A waypoint is a map position. A series of waypoints are kept in a route. Multiple routes may be defined. The Garmin GPS holds up to 500 waypoints. Use the center button to move around menus, enter to select, quit to exit, and page to go to the next page. Mark makes a waypoint.

Exercise 1.) Position. Pick a point outside, with as clear a view of the sky as you can get (no nearby trees, buildings, etc). How many satellites do you see? Clear all waypoints, and routes (go to main menu, waypoint list, delete wpts and main menu routes, clr).

Create a route. Walk to a point on main campus a few minutes away. Mark your waypoints every 100 feet or when you turn (use a different symbol than a house). Save as route number 1.

Exercise 2.) Now go to these points. Write in your lab what you see and the coordinates of your nearest point. What is the elevation?

- A) N 32 46.531 W 117 04.258
- B) N 32 46.558 W 117 04.315
- C) N 32 46.450 W 117 04.314
- D) N 32 46.416 W 117 04.200

Downloading points.

Now we want to demonstrate how to download the waypoint data to a PC. We use a shareware version which can only handle a limited number of points. You should watch this done at least once but you are not required to do it yourself as it is installed on only one computer. Turn the GPS on and go to the main menu. Select *system* on the setup menu and then *interface*. We will use a program named GPS utility. Hook up the GPS using the cable to comm port 1

PC: Start the GPS utility, go to GPS, download all.

GPS: go to *main menu, system, interface*.

This should download the data from the GPS.

PC: A list of points should appear on the screen. These can be saved as *.shp files for later import into arcview.

Plotting plate motion vectors.

Here we will download a file of crustal deformation vectors showing the relative motion between North American and the Pacific Plate. Download the compressed file (gps.zip) from the website and then uncompress in some directory. You should see a set of files: sccoast.dbf, sccoast.shp, sccoast.shx, scfaults.dbx, scfaults.shp, scfaults.shx, and gps.dbx. sccoast and scfaults are shapefiles (actually three separate files that need to be together) and gps.dbx is a table (originally created with excel and saved as dbase IV file).

Click on the view and then go to view, add theme and go to that directory. You should see sccoast and scfaults show up as shapefiles. Load into arcview and then display in the window. You may have to zoom in to see it clearly. Now click on the other window with the little icons of Tables, Charts, Layouts, etc. You should see a “project” menu item appear at the top. Go to project, add table and click on gps.dbx. You should see table appears with longitude and latitude. Now click on the view again, and go to view, add event theme. Add the table gps.dbf with the x field being “Lon” and the y field “Lat”. Hit okay, and a cloud of dots should appear on your map. These are the location of the highly accurate GPS units. Click on the GPS symbol on the left side of the view window and the legend editor should appear. Double click the symbol in the legend editor and change it to an arrow (hit apply). Click on “advanced” in the legend editor and set the rotation field to “angle”. Go to Legend type and change to “Graduated symbol” and use “vmag”. You may have to redo the symbol type and angle. “vmag” is the displacement (in mm per year) of each point relative to the North American plate. The arrow shows the direction.

You may want to change the size of the symbol to make it more visible. If you click on the little “T” icon at the top left and then on a symbol, it should give you more information about that point. Click on the symbol nearest San Diego.

How fast (in mm per year) is San Diego moving to the northwest? Click on some of the symbols east of the Salton Sea. How fast are they moving? Suppose a large earthquake occurred along the San Andreas – what would the motion vectors look like afterwards? Include an image of your final result and write a paragraph on plate motions and earthquakes in Southern California.

