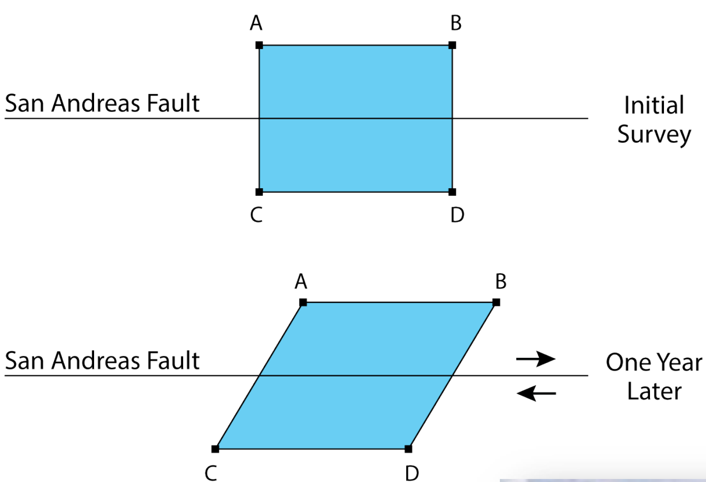
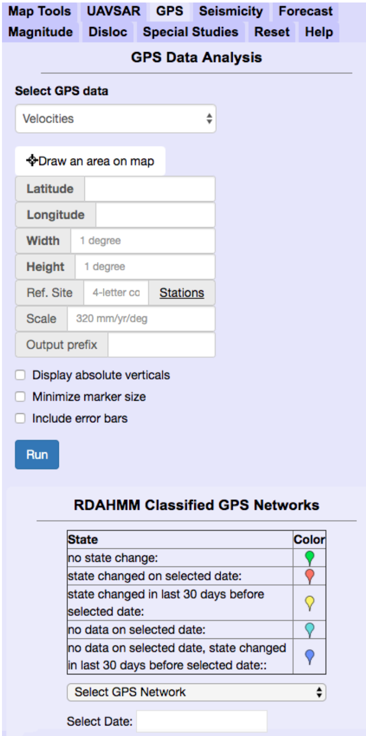
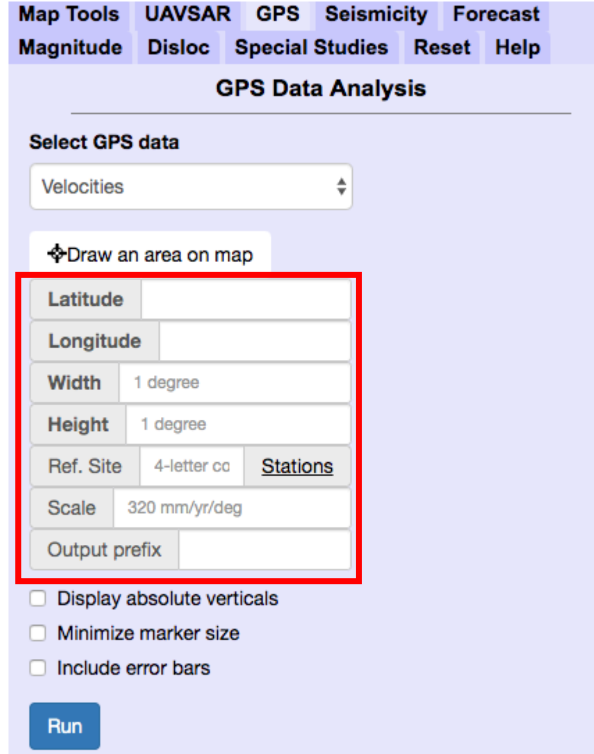
Global Positioning System (GPS)

Global Positioning System (GPS) measures geolocation and time. GPS stations measure crustal deformation and fault movement through the communication of satellites. GeoGateway's GPS tool can be used to measure plate motion and strain accumulation across faults.



The figure on the left shows how GPS stations around San Andreas Fault recorded data displaying measured movement of the fault within a time span of a year.





To define an area for analysis, fill in the parameters within the red box.

Latitude (see image below) in decimal degrees
Longitude (see image below) in decimal degrees

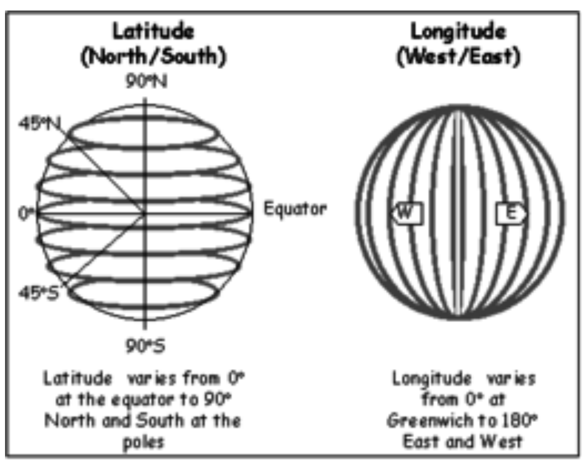


Figure adapted from (www.fedstats.gov)

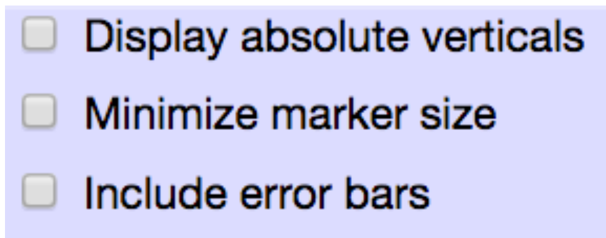
*Positive latitude is above the equator (N), and negative latitude is below the equator (S). Positive longitude is east of the prime meridian, while negative longitude is west of the prime meridian.)

Width and **Height** are measured in degrees, allowing the user to create a specified parameter.

Ref. Site is the GPS station site where the velocity vector data will be referenced to. A map with the sites can be located through the website below. Once a location is decided, type the 4-letter code in the box.

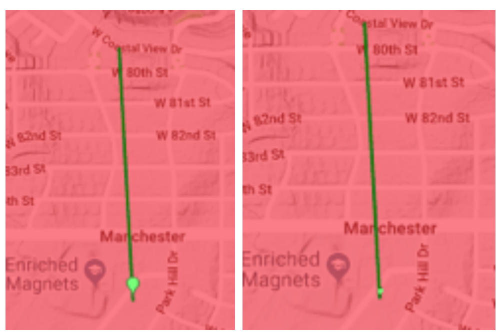
https://sideshow.jpl.nasa.gov/post/series.html

Scale allows the user to control the velocity vector length scaling.
Recommended to set at **320** mm/yr/deg.

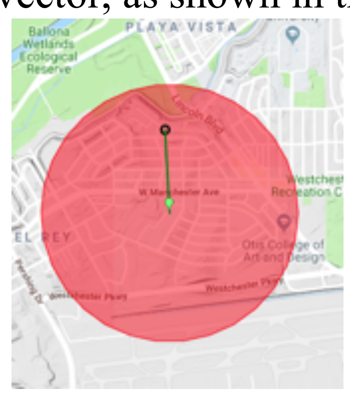


Click the box to “Display absolute verticals”.

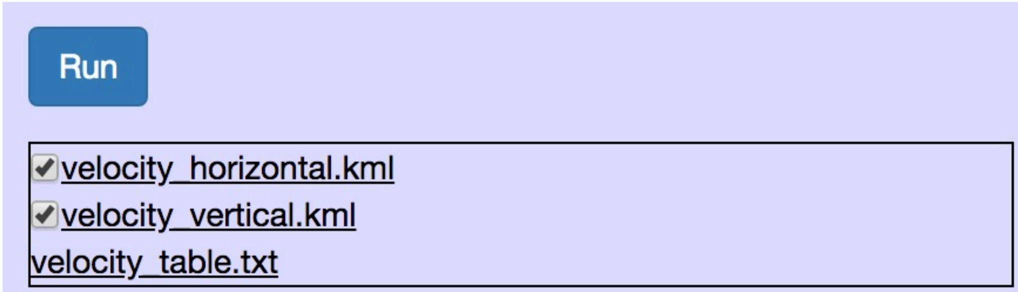
“Minimize marker size”  allows users to make GPS site markers smaller as shown in the image below.



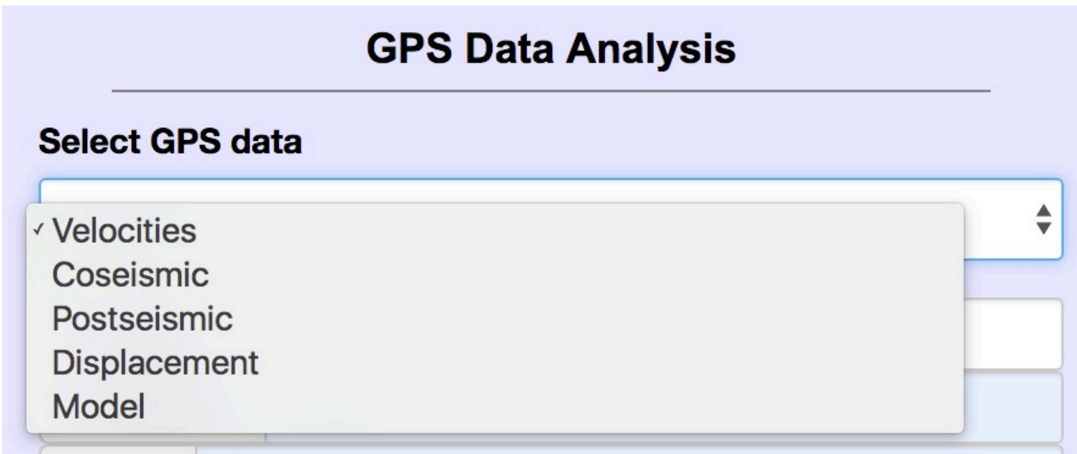
Error bars are a graphical tool used to illustrate the pair-wise correlation that exists between computed values (Error Ellipses). The error is represented by a black ellipse at the tip of the velocity vector, as shown in the image below.



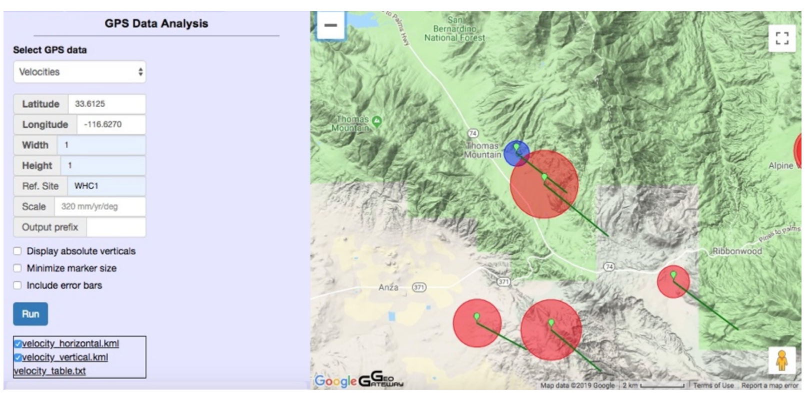
Once the steps to inputting data are complete, click on “Run”. There is an option to download kml and text files as shown below.



The GPS Data Analysis section allows users to select for Velocities, Coseismic, Postseismic, Displacement, and Model Analysis.



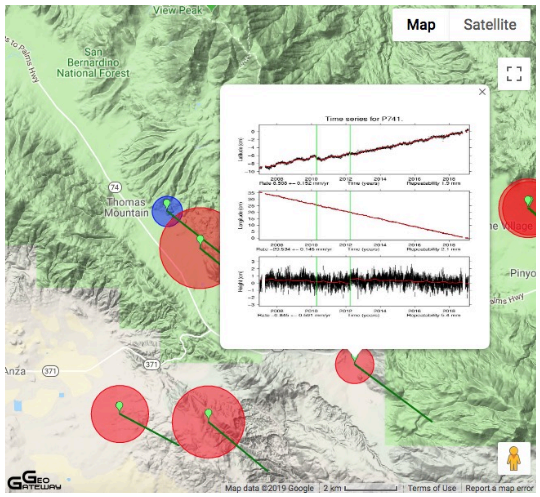
Selecting the “Velocities” option, the velocities of different GPS stations are seen relative to the reference frame.
As shown in the image below “WHC1” is set as the reference point.

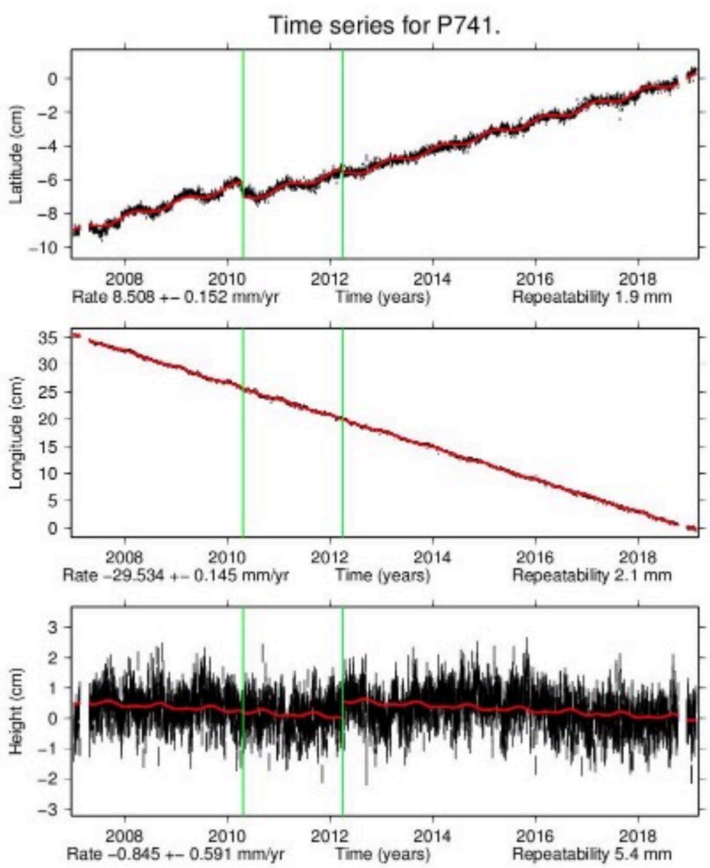


Each vector shows the velocity of a single GPS station as the Earth moves. The tail of the vector is pinned at the GPS station, and the length of the vector shows how fast the GPS station is moving. The other end of the line, away from the marker, is the direction the GPS station is moving.

Vertical displacements are shown by red (uplift) or blue (subsidence) circles. The larger the circle, the more displacement.

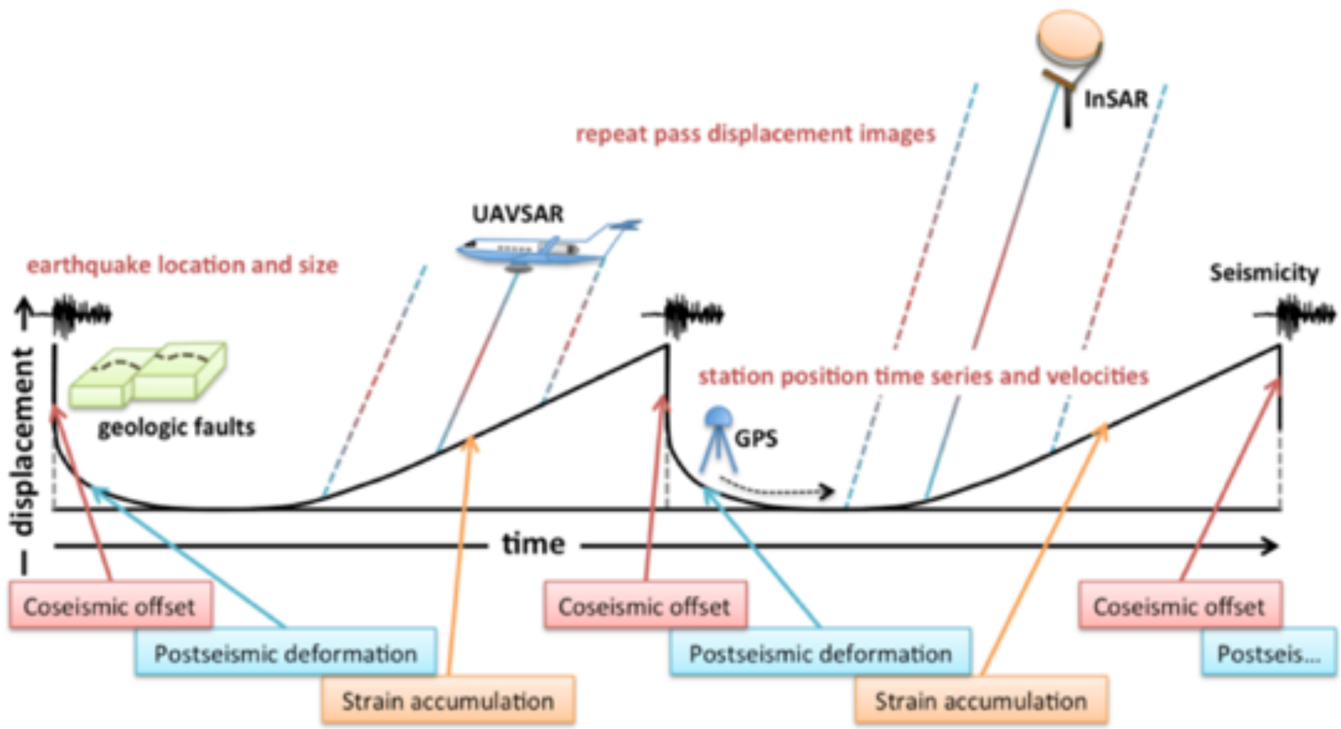
Clicking on a GPS station, three time series graphs appear.





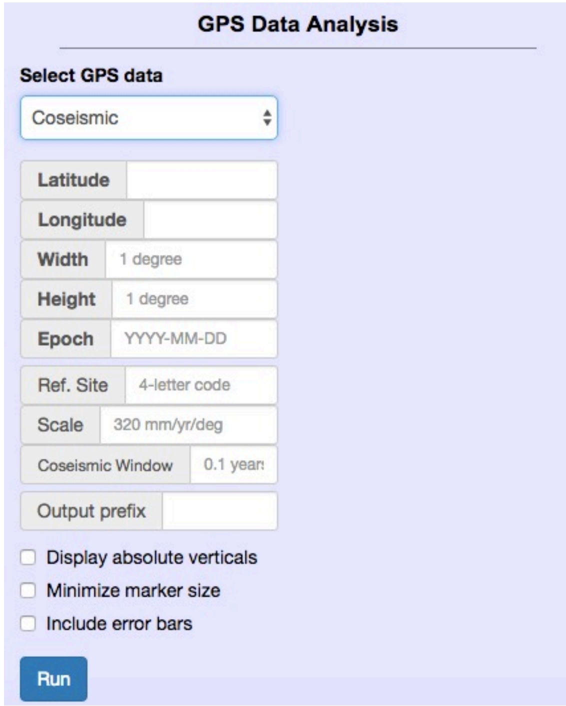
The time series shows how far the station has moved. The top graph shows latitude (cm) versus time (years). The black dots are the data points and the red line is the best fit line to the entire dataset. In this example, we see as time goes by the station moves closer to the North. For the longitude versus time graph (middle graph) we see that the GPS station is moving to the West. The bottom graph shows the vertical height versus time which is relatively constant. The green lines that intersect vertically on the graph are locations where there are jumps in the data.

Coseismic and postseismic data can be selected by specifying a time period during or after an earthquake which a user wants to focus on.

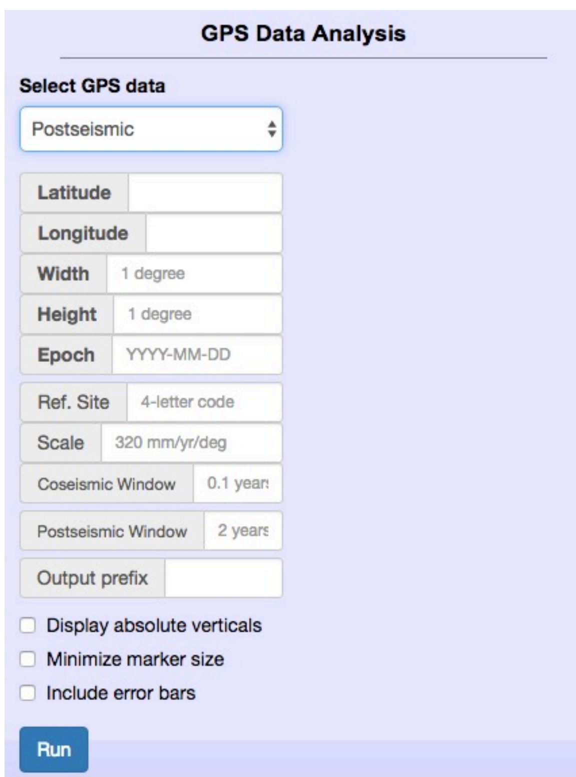


The image above illustrates the earthquake cycle, and typical rates of deformation in the coseismic and postseismic periods.

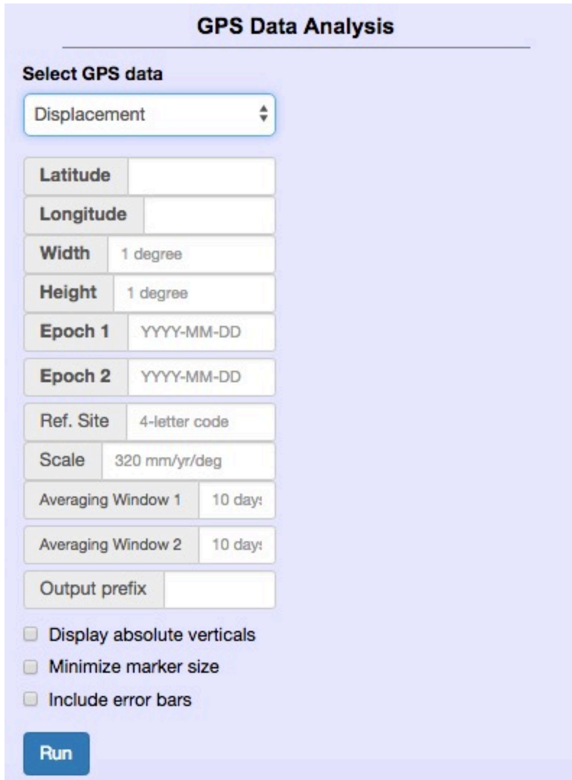
Coseismic offset refers to the time during an earthquake until a rupture ends.



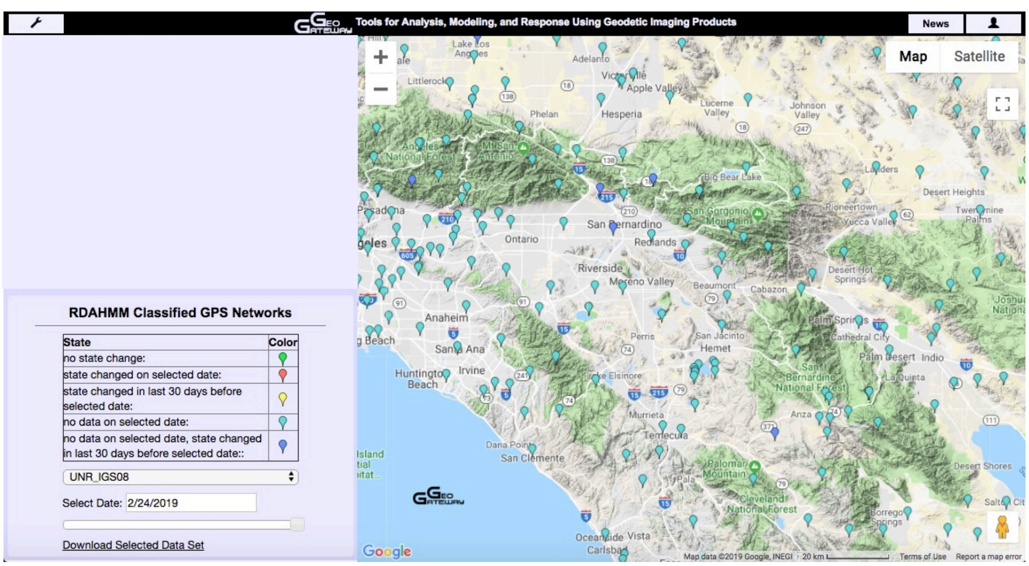
Postseismic deformation refers to the time after a large earthquake when deformation occurs.



When considering coseismic and postseismic data, the user must consider "Epoch" and "Coseismic Window" and "Postseismic Window". The Epoch is the time of the event and the window is any time period of choice.
Looking at displacement data, we must choose a time period for analysis.

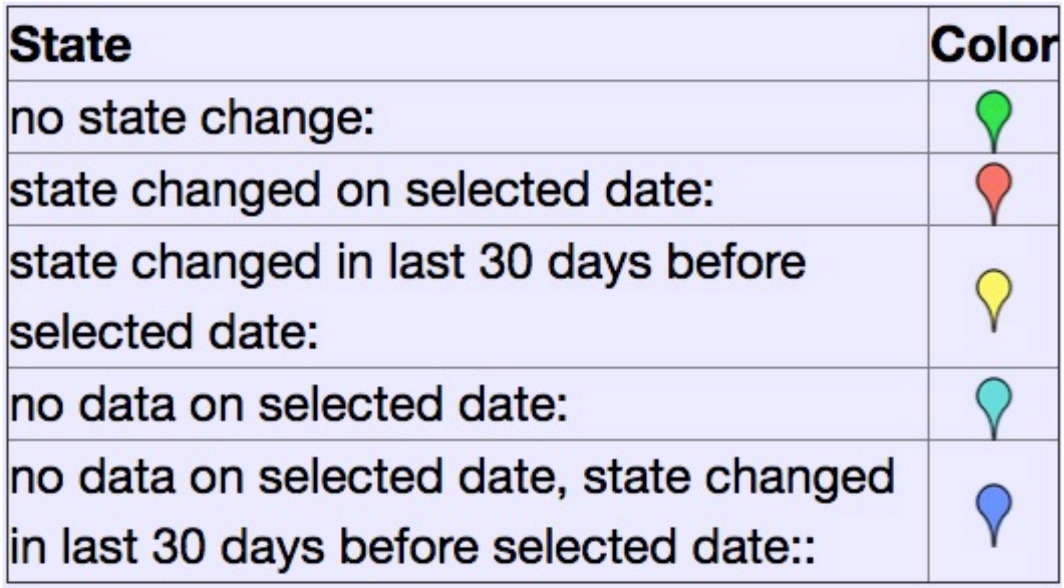


Below "GPS Data analysis" is the "RDAHMM Classified GPS Networks", allowing one to choose different GPS Networks and a specific date.



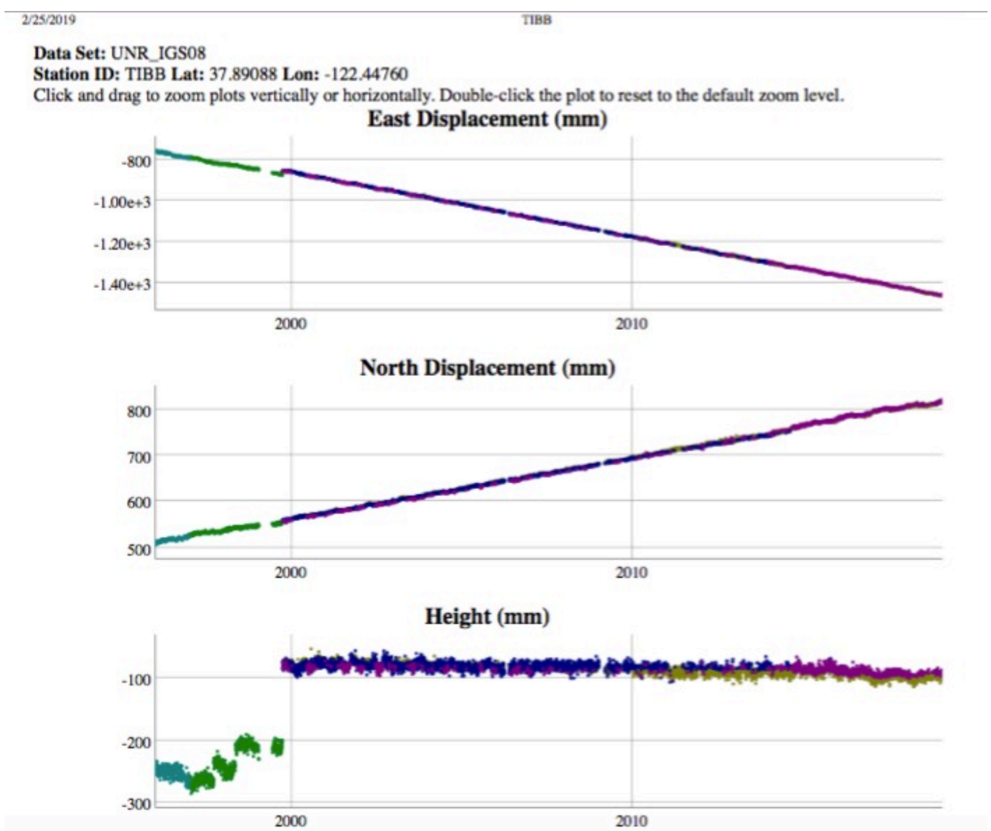
As shown in the image above, the GPS station markers have different colors unlike the "GPS Data analysis" section. The colors indicate change of state.

The representation of the colors is seen in the box below.



State	Color
no state change:	
state changed on selected date:	
state changed in last 30 days before selected date:	
no data on selected date:	
no data on selected date, state changed in last 30 days before selected date::	

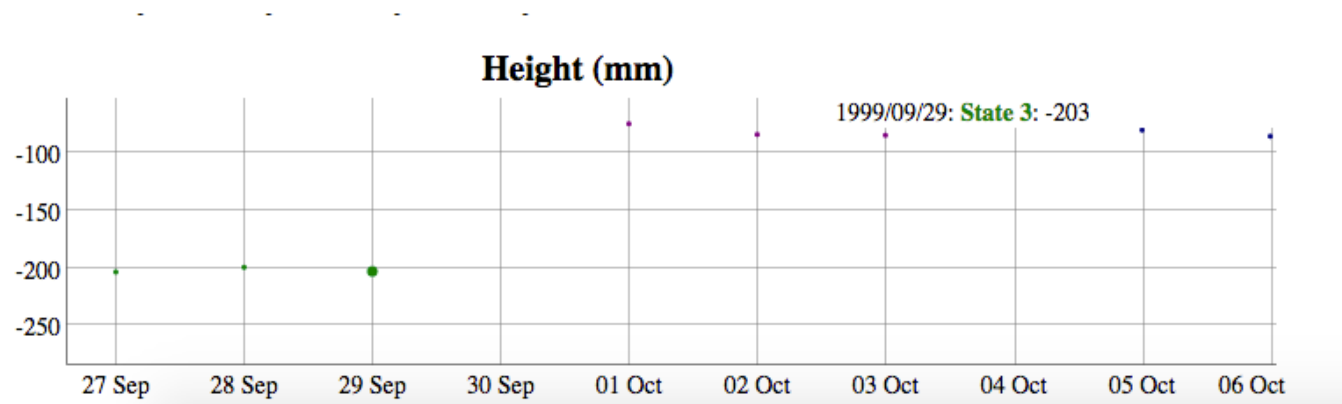
Clicking on a GPS station, will open three graphs that show displacement (mm) with time.



The longitudinal coordinate system exemplifies the **east-west** displacement, while the latitudinal coordinates exemplifies the **north-south** displacement.

To zoom into a specific time frame, pick a start point and drag the mouse to an end point.

After zooming in, the state changes are better noticed. The color change as shown in the image below, shows state change of the GPS station.



The paper by Donnellan et al. (2018a), referenced in the citations section, displays observations of the **Global Positioning System** (GPS) time series encompassing the region reveal a northward migrating pattern of deformation following the 04 April 2010 Mw7.2 El Mayor-Cucapah (EMC) earthquake.