GeoGateway

EXERCISES

GeoGateway Exercises

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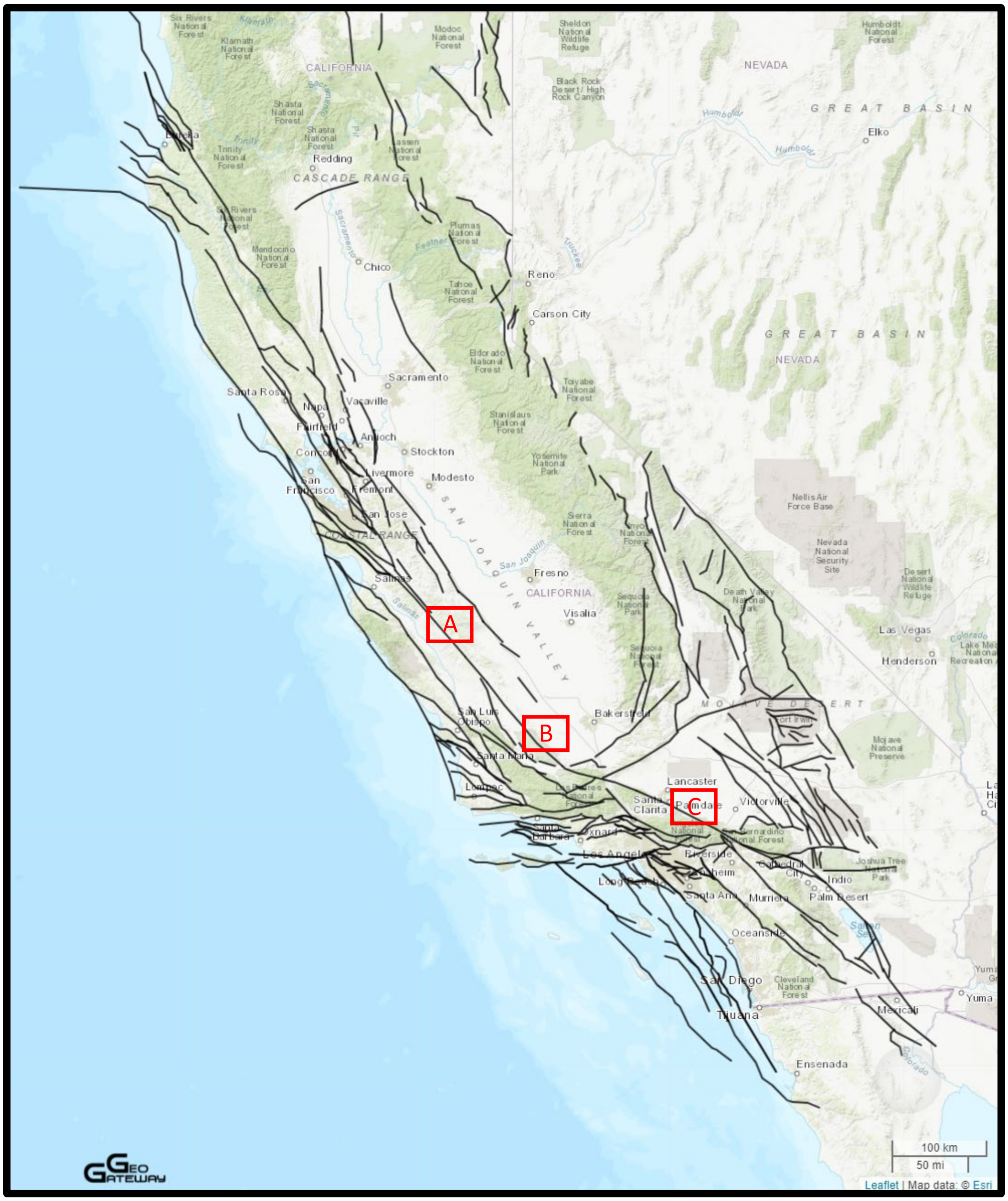
Exercise: San Andreas Fault and the Uniform California Earthquake Rupture Forecast v3 (UCERF3)

GeoGateway allows users to overlay layers such as faults, borders, and KMZ files onto the map. In this exercise, users will label 3 sections of the San Andreas fault used in UCERF3.

Step 1: Go to https://geo-gateway.org

Step 2: Click on the "**Maptools**" tab

Step 3: Check the box next to UCERF3 Faults. Note, clicking on the faults provides users with a popup description of the fault.



Step 4: Looking at the provided map, match the letters to the proper section of the San Andreas Fault.

A ____________________________

B ____________________________

C ____________________________

Carrizo Section
Mojave Section
Creeping Section

Answers:

A Creeping Section

B Carrizo Section

C Mojave Section

Exercise: Locating and Imaging Faults Using UAVSAR Interferograms

GeoGateway allows users to analyze UAVSAR interferograms. In this exercise, users will use UAVSAR interferograms to locate a creeping section of the San Andreas Fault.

Step 1: Go to https://geo-gateway.org

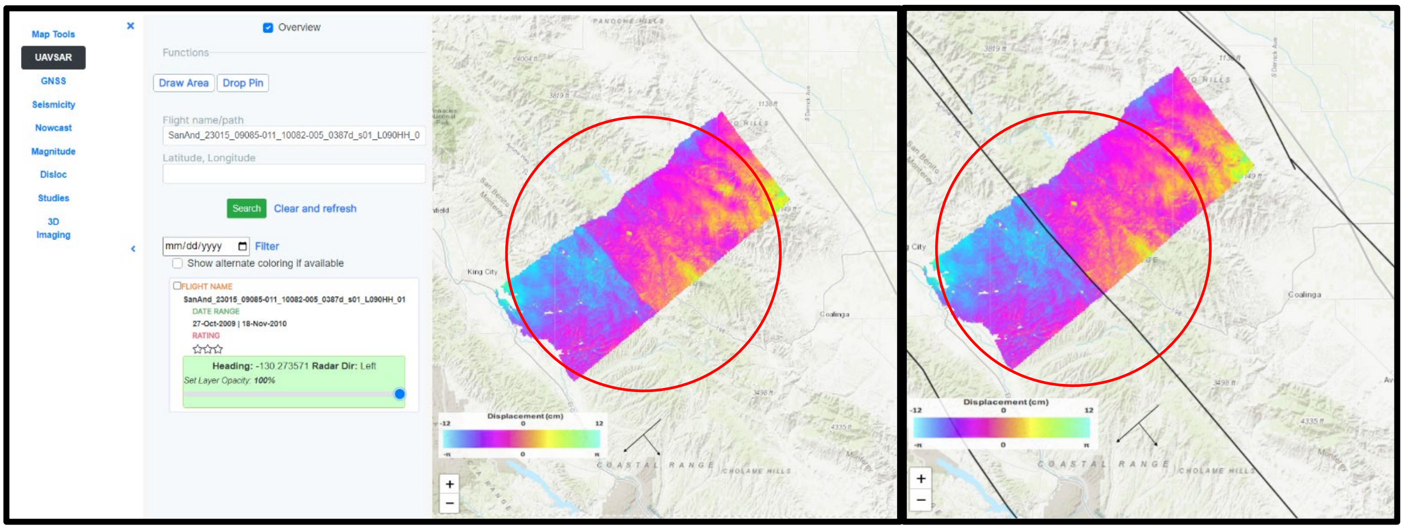
Step 2: Click on the "**UAVSAR**" tab

Step 3: In the box titled "Flight name/path", type the following

SanAnd_23015_09085-011_10082-005_0387d_s01_L090HH_01

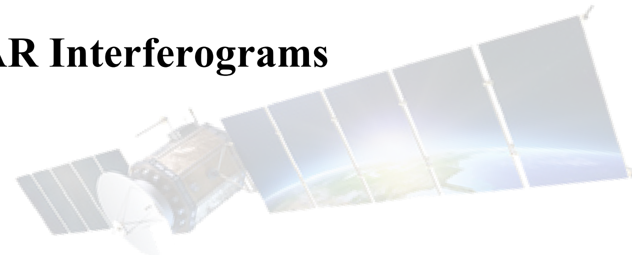
and click search.

Step 4: Check the interferogram displayed to view the interferogram on the map.



Looking at the image of the interferogram to the left, notice the line within the circle. This "creeping" section of the San Andreas Fault is moving at a slow, steady rate. Change in the ground surface due to creep causes a Line-of-Sight difference which is prominently imaged by the UAVSAR interferogram. The image to the right shows the Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3) faults plotted as black lines overlain on the UAVSAR interferogram.

Exercise: Explore and Analyze UAVSAR Interferograms



Step 1: Go to https://geo-gateway.org

Step 2: Click on the "**UAVSAR**" tab

There are two methods to search for a UAVSAR interferogram.

1. The "flight name/path" directly finds the flight name and path
2. The "latitude, longitude" option returns all flight paths crossing paths with the specified coordinates.

Step 3: For this exercise, enter Name is SanAnd_26501_09083-010_10028-000_0174d_s01_L090HH_C2 (flight name/path) in the search window and click Search.

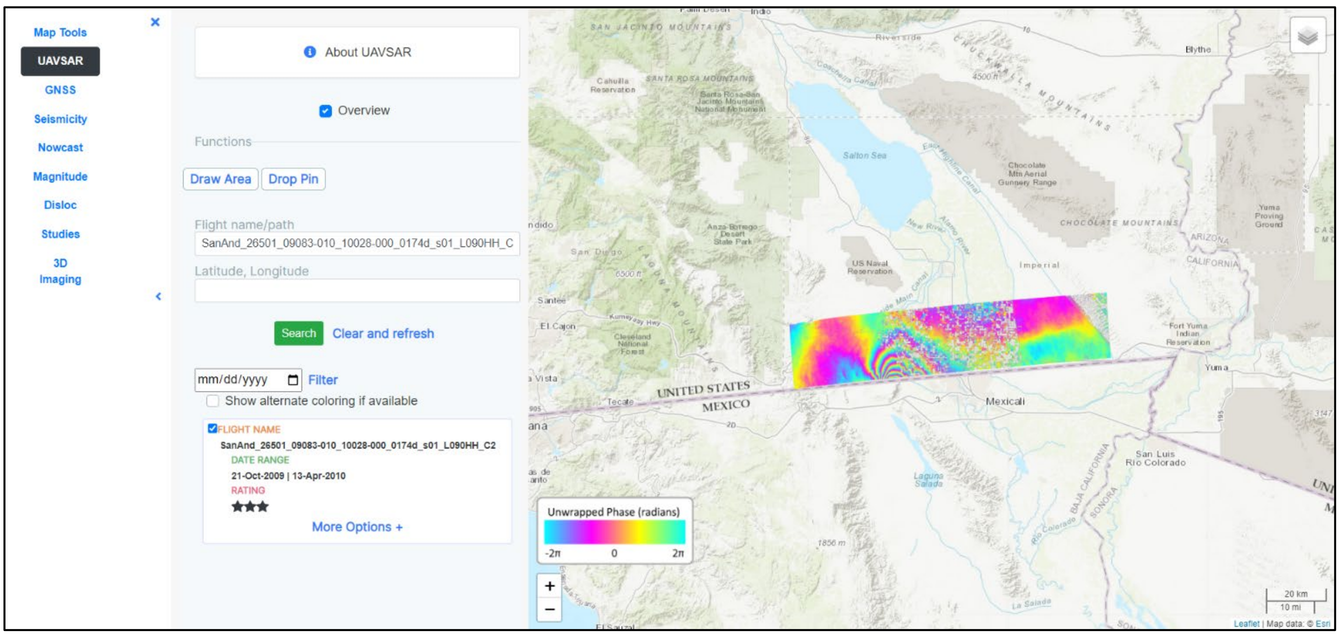
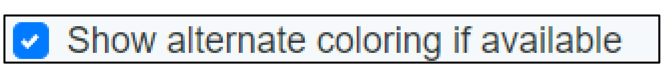


Figure 1 : Interferograms displayed after searching SanAnd_26501_09083-010_10028-000_0174d_s01_L090HH_C2flight name/path

Step 4: Check the box next to "Show Alternate Coloring" followed by clicking on "More Options +" on the interferogram



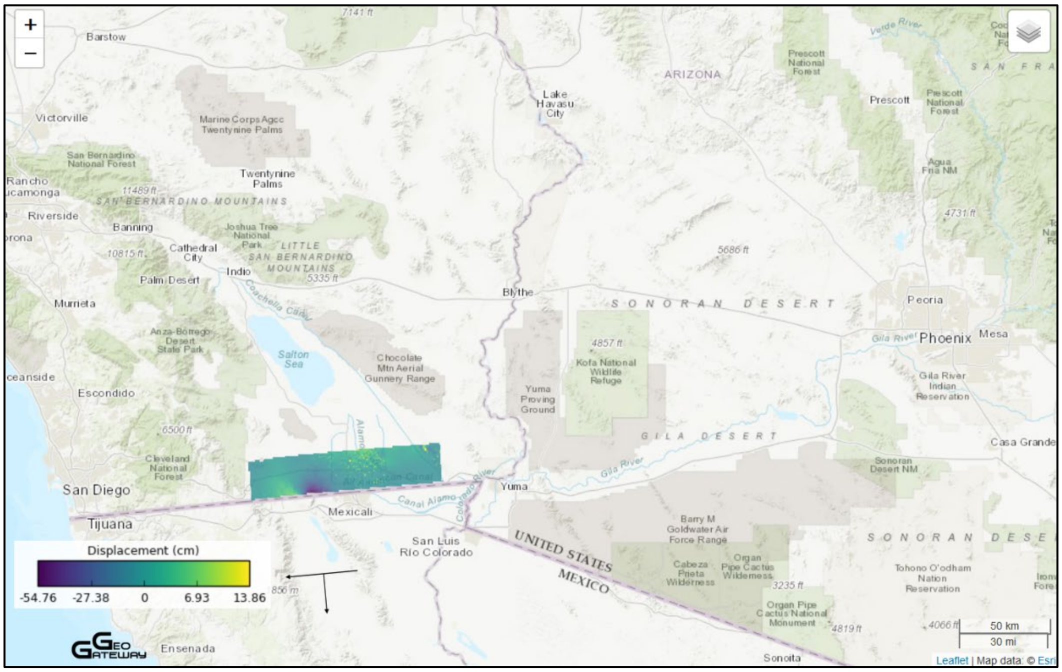


Figure 2: Interferogram displayed in units of displacement (cm)

Step 5: Zoom into the area of the two lobes that are green/yellow and purple.

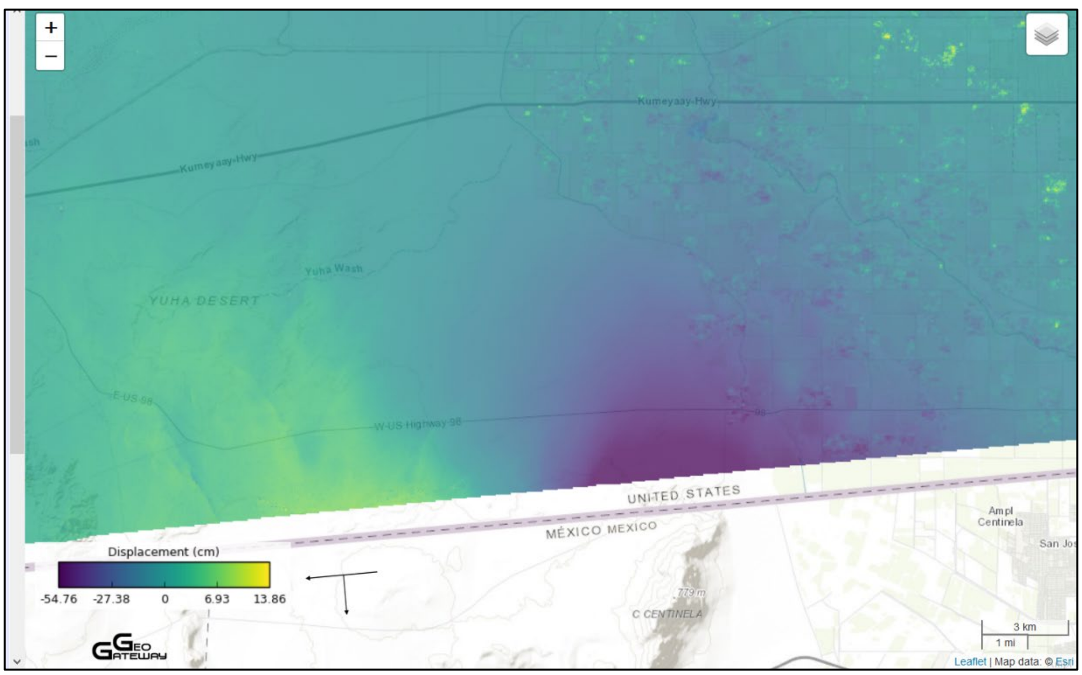


Figure 3: Interferogram shown zoomed into the two green/yellow and purple lobes. Yellow lobe shows more surface fracturing

Step 6: Activate the Line-Of-Sight (LOS) Tool by clicking on the map.

a. Adjust the endpoints of the profile to be on the product but parallel to the south end of the product through the largest color difference.

b. Mouse over the plot and read the maximum and minimum ground range change (GRC) from the upper right corner of the plot

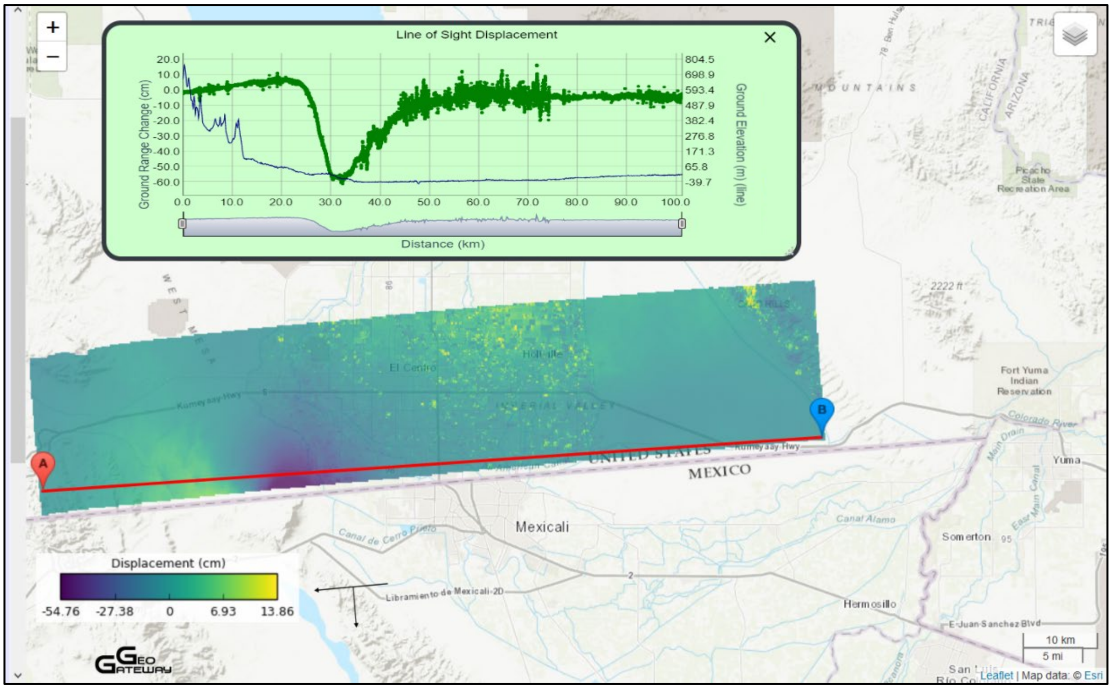


Figure 4: LOS Plot. Notice the ground range change that occurred across the two lobes.

The purple lobe moved away from the instrument on the aircraft. As shown on the legend, the negative (darker color) implies that the ground moved away from the instrument on the aircraft

Step 7: Visit the “Maptools” tab and select the “UCERF3 Faults.”

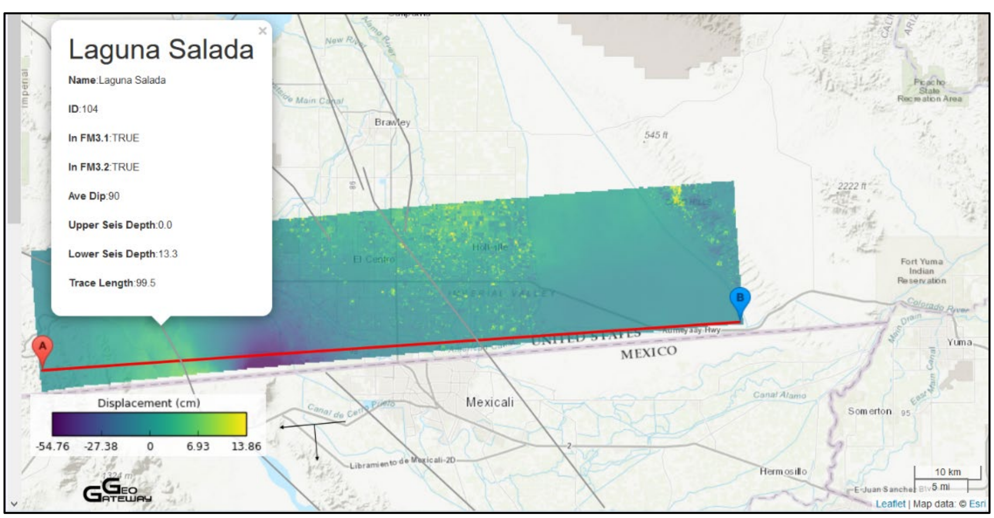


Figure 5: The mapped fault, Laguna Salada, ruptured in the 2010 El Mayor – Cucapah earthquake.

Step 8: Scroll down and find line SanAnd_26501_10028-000_10057-100_0079d_s01_L090HH_02 with dates 13-Apr-2010 17:49:59 UTC 1-Jul-2010 16:49:41 UTC

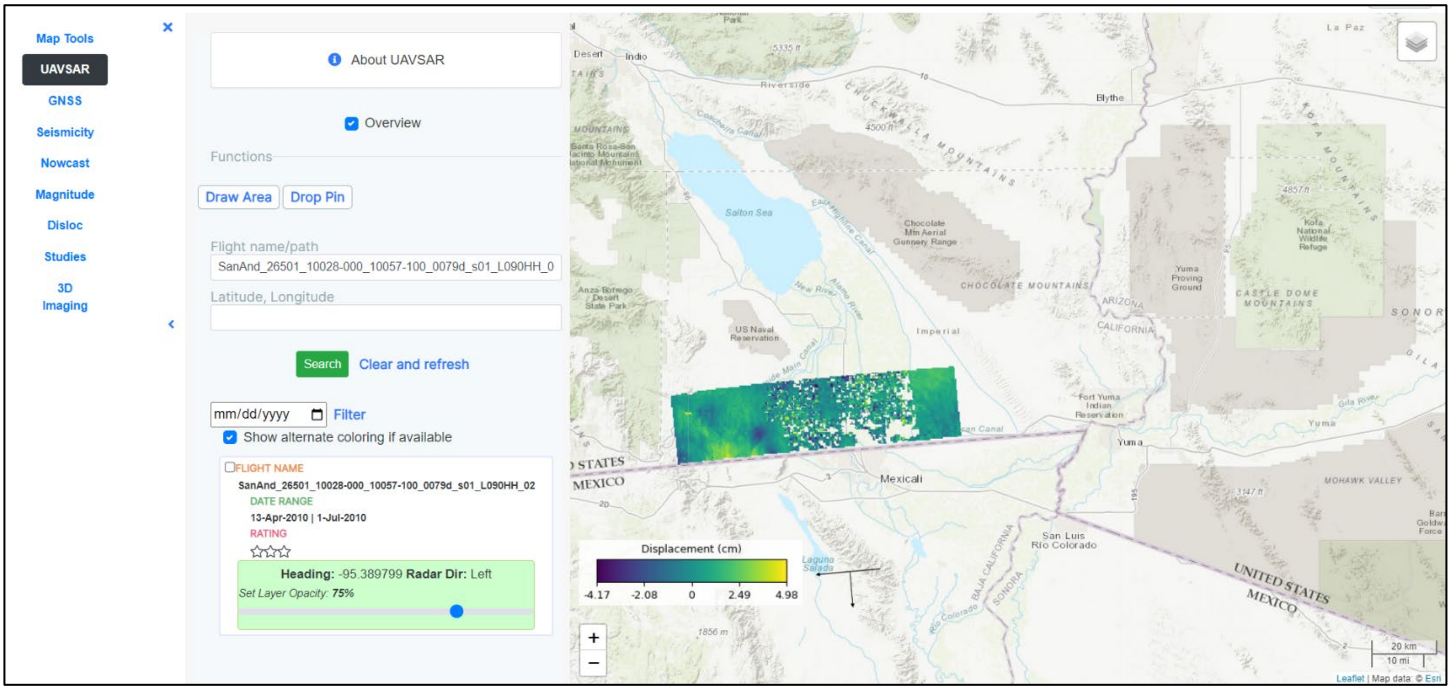


Figure 6: Notice the difference when selecting a different time frame. Also the signal is decorrelated in some areas, as shown by the absence in color.

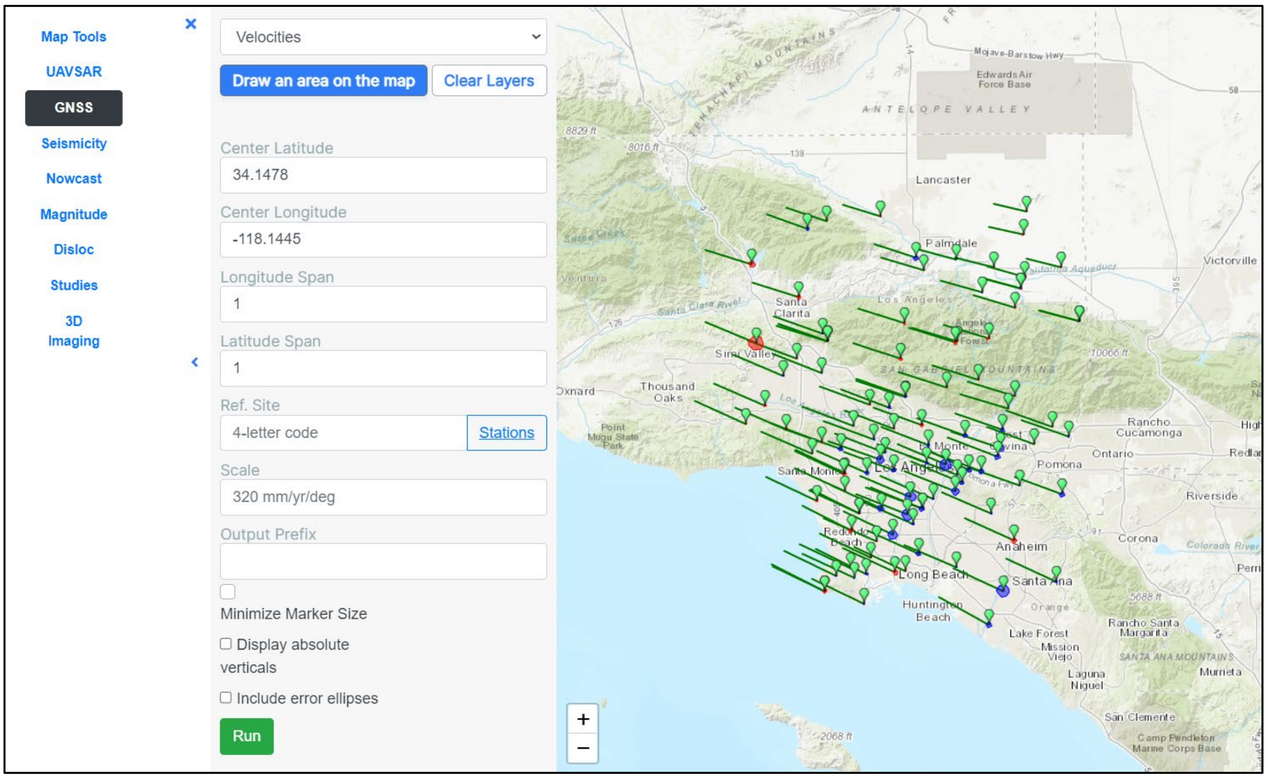
Exercise: Explore GNSS Velocities and Displacements

Step 1: Go to https://geo-gateway.org

Step 2: Click on the "**GNSS**" tab

Step 3: Construct a GNSS velocity map with no reference

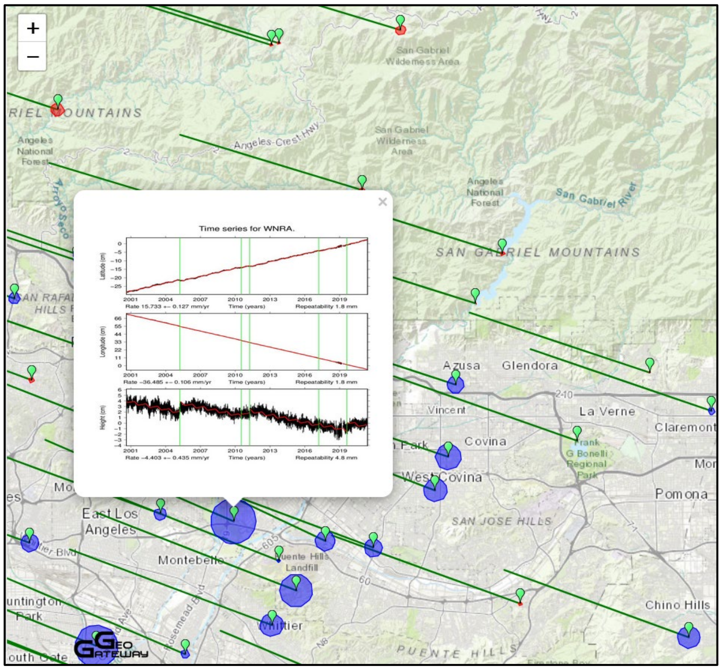
- **a.** Select center latitude and center longitude in decimal degrees
- **b.** Select longitude span and latitude span in degrees (try 1 degree)
- **c.** Leave reference site blank



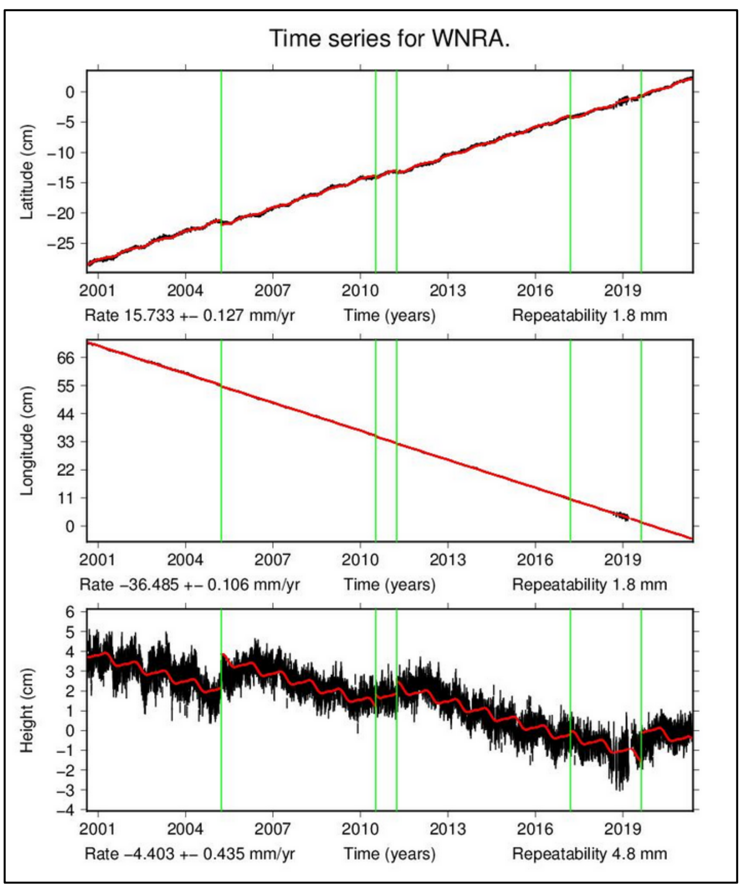
- **d.** Click on "Run"
- **e.** **Download the velocity table by clicking on "velocity_table.txt"**

Site	Lon	Lat	Delta E	Delta N	Delta V	Sigma E	Sigma N	Sigma V
AZU1	-117.896492	34.126020	-35.945000	11.890000	-1.635000	0.100000	0.110000	0.454000
BGIS	-118.159702	33.967120	-38.270000	15.292000	-4.142000	0.118000	0.136000	0.510000
BKMS	-118.094704	33.962260	-40.068000	17.099000	-0.828000	0.223000	0.264000	0.947000
BLSA	-118.028682	33.799545	-39.558000	16.391000	-0.786000	0.286000	0.333000	1.182000
BRAN	-118.277055	34.184896	-37.451000	13.931000	0.740000	0.099000	0.115000	0.483000
BTDM	-118.188231	34.292807	-35.552000	11.806000	1.226000	0.147000	0.153000	0.560000
CBHS	-118.629810	34.138563	-38.942000	17.629000	0.555000	0.051000	0.057000	0.218000
CCCO	-118.211202	33.876262	-37.277000	18.131000	-3.599000	0.203000	0.240000	0.859000
CCCS	-117.864947	33.862744	-36.802000	17.335000	1.927000	0.143000	0.170000	0.606000
CGDM	-117.964950	34.243994	-35.313000	10.754000	0.517000	0.050000	0.063000	0.221000
CHIL	-118.026004	34.333424	-34.415000	10.753000	0.259000	0.048000	0.056000	0.213000
CHMS	-117.827705	34.640463	-24.910000	5.466000	0.267000	0.094000	0.115000	0.391000
CIT1	-118.127290	34.136710	-36.874000	12.733000	-0.652000	0.105000	0.122000	0.429000
CJVG	-118.144233	34.530322	-30.862000	10.523000	-1.825000	0.205000	0.234000	0.825000
CLAR	-117.708814	34.109929	-35.101000	11.997000	-0.650000	0.097000	0.113000	0.403000
CMP9	-118.411429	34.353181	-36.487000	12.912000	-0.696000	0.099000	0.120000	0.412000
CRHS	-118.272771	33.823506	-39.009000	17.972000	0.312000	0.072000	0.084000	0.317000
CSDH	-118.256722	33.861479	-39.984000	17.710000	0.974000	0.059000	0.072000	0.245000
CSN1	-118.523817	34.253552	-37.876000	15.738000	-0.894000	0.092000	0.109000	0.382000
CTDM	-118.613215	34.516551	-35.061000	10.697000	0.916000	0.079000	0.095000	0.327000
CVHS	-117.901722	34.082013	-37.675000	12.633000	-2.493000	0.176000	0.208000	0.736000
DAM1	-118.397367	34.333997	-38.330000	11.540000	0.730000	0.366000	0.376000	1.601000
DAM2	-118.396869	34.334837	-36.844000	13.162000	0.735000	0.079000	0.081000	0.347000
DAM3	-118.397471	34.333992	-36.584000	12.826000	-0.056000	0.216000	0.210000	0.955000
DSHS	-118.348546	34.023934	-36.860000	17.245000	-0.390000	0.169000	0.196000	0.710000
DVPB	-117.860132	34.413414	-31.269000	9.248000	0.635000	0.045000	0.056000	0.194000

f. Click on a station to show the time series



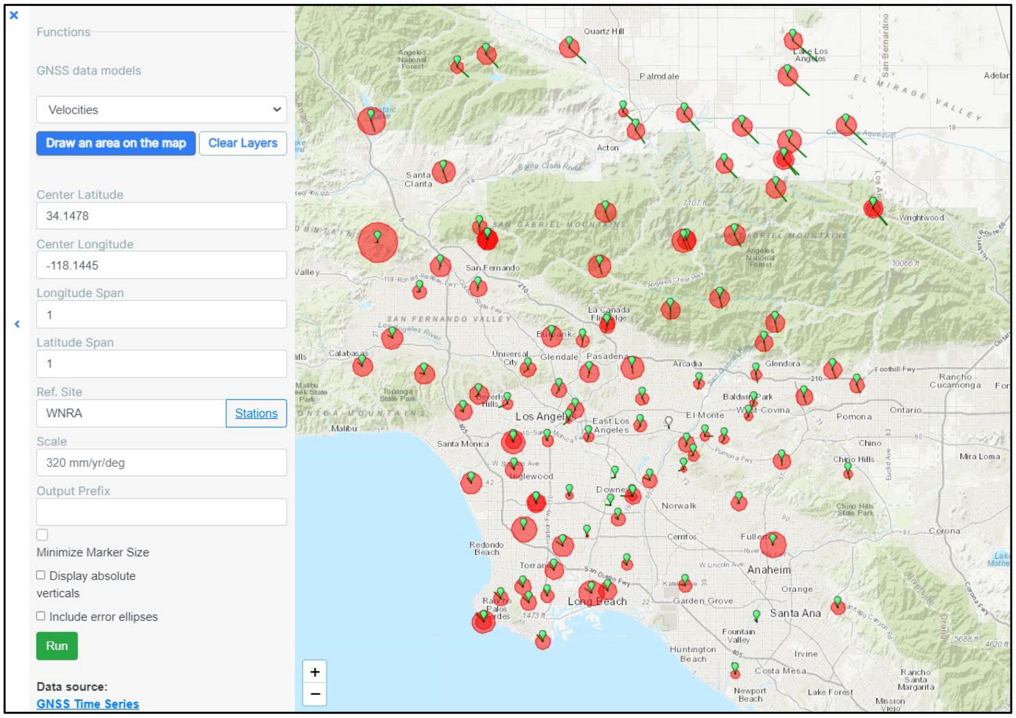
g. Click on the time series thumbnail to open the larger version of the graphs



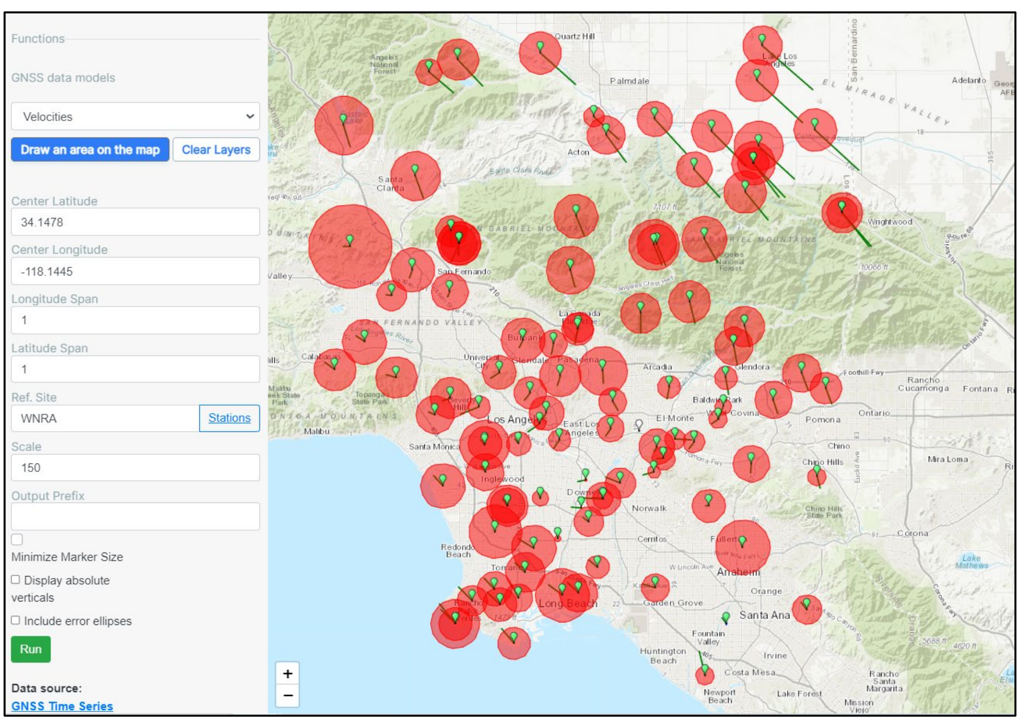
h. Download the KML file if you would like to save it. This can later be plotted using the "KML Uploader" on the Map Tools tab

Step 4: Now construct a GNSS velocity map with a reference site (WNRA)

a. Select center latitude and center longitude
b. Select longitude span and latitude span in degrees (1 degree is often good)
c. Select a reference site from the previous plot
d. Click on "Run"

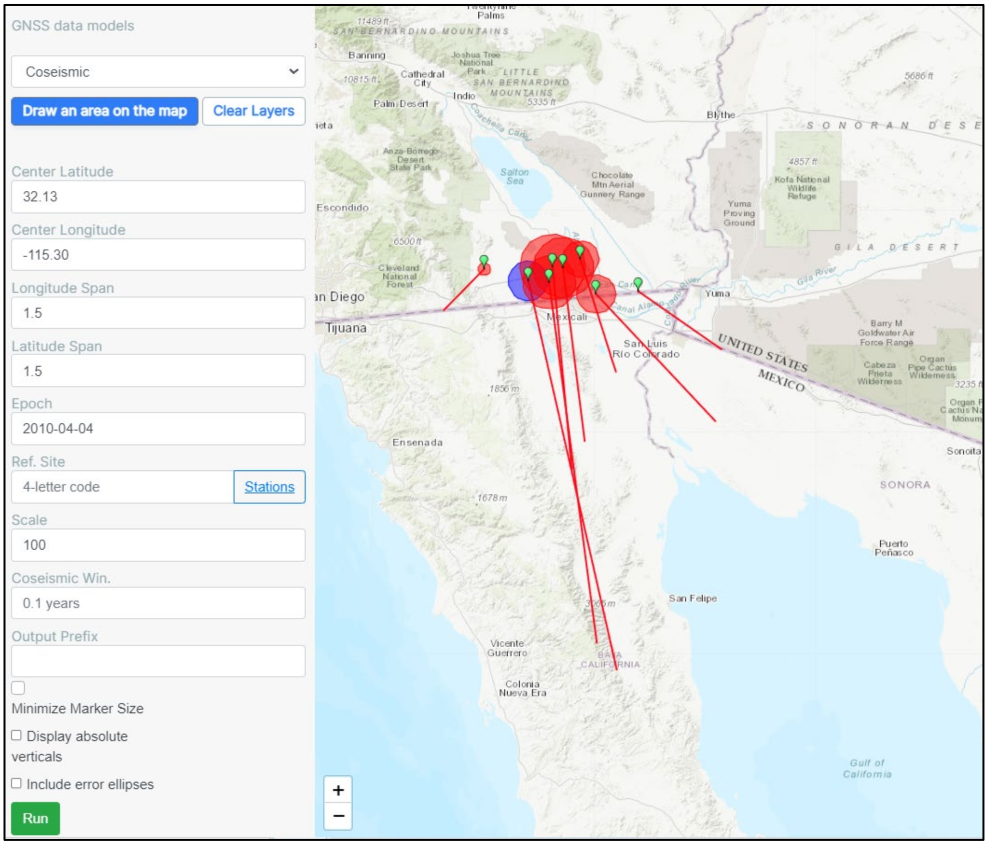


e. Vary the scale to see the result (hint – smaller number results in larger vectors).

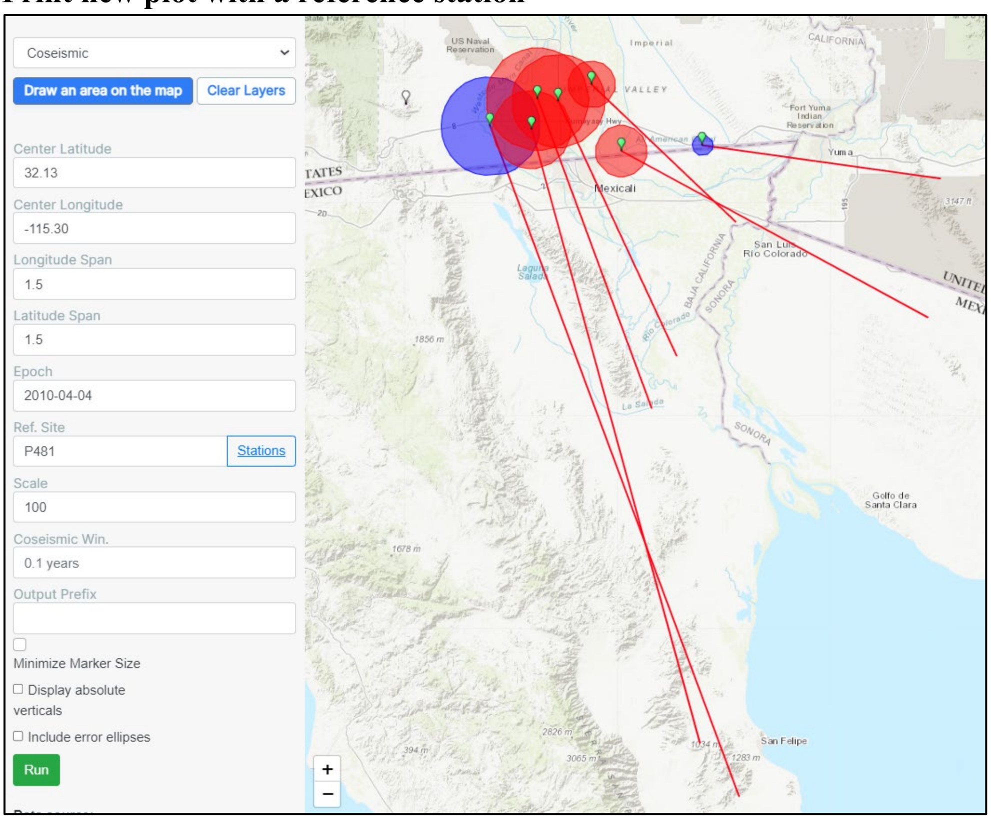


Step 5: Repeat for coseismic displacements. Choose Coseismic from dropdown box.

- **a.** Select center latitude and center longitude near a large event (e.g. El Mayor–Cucapah earthquake).
- **b.** Enter date of earthquake YYY-MM-DD
- **c. Print plot with no reference**



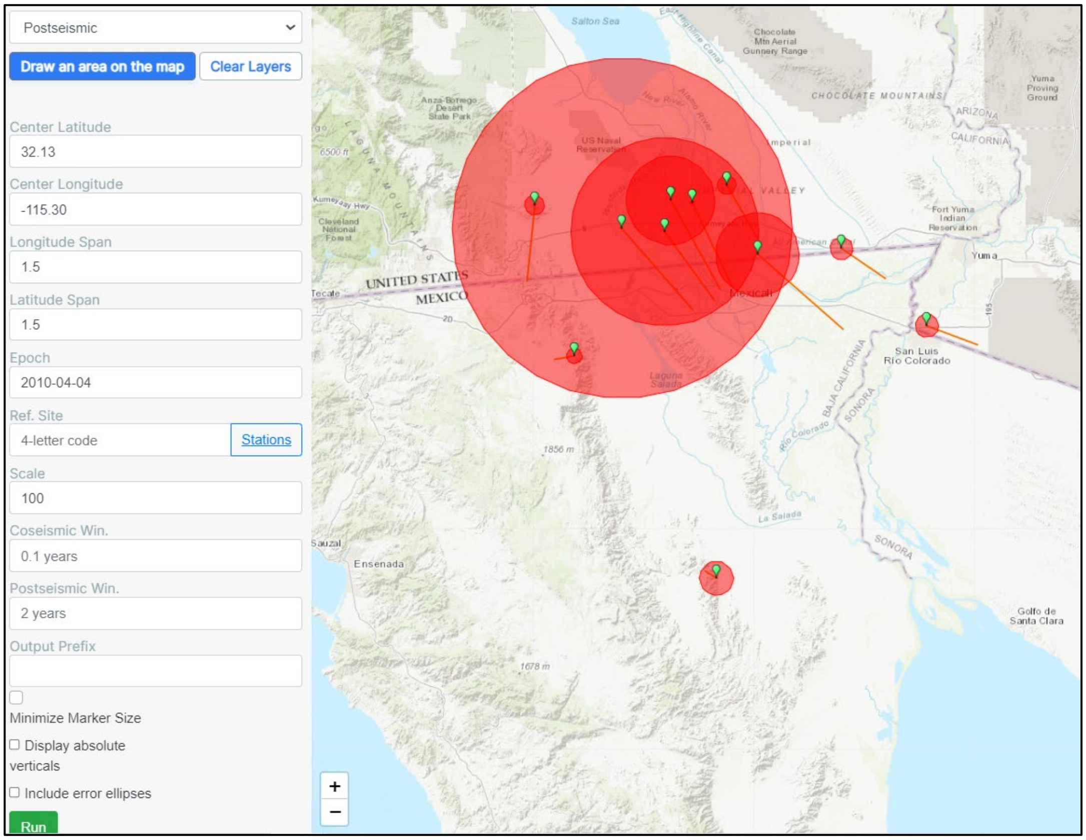
- **d. Print new plot with a reference station**



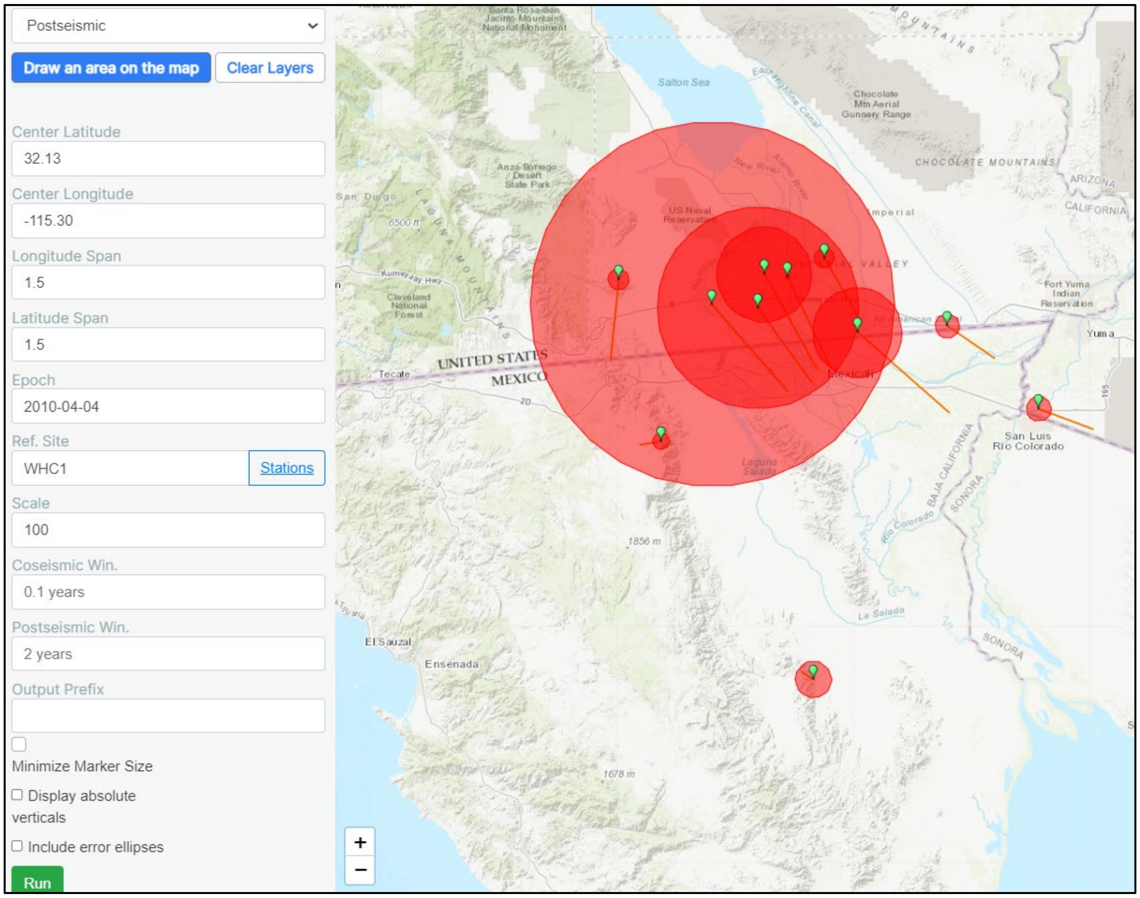
Step 6: Repeat for postseismic displacements. Select Postseismic dropdown.

- **a.** Select center latitude and center longitude of a large event (e.g. El Mayor–Cucapah earthquake)
- **b.** Enter date of earthquake, and postseismic time window in years
- **c.** Experiment with different postseismic windows

d. Print plot with no reference

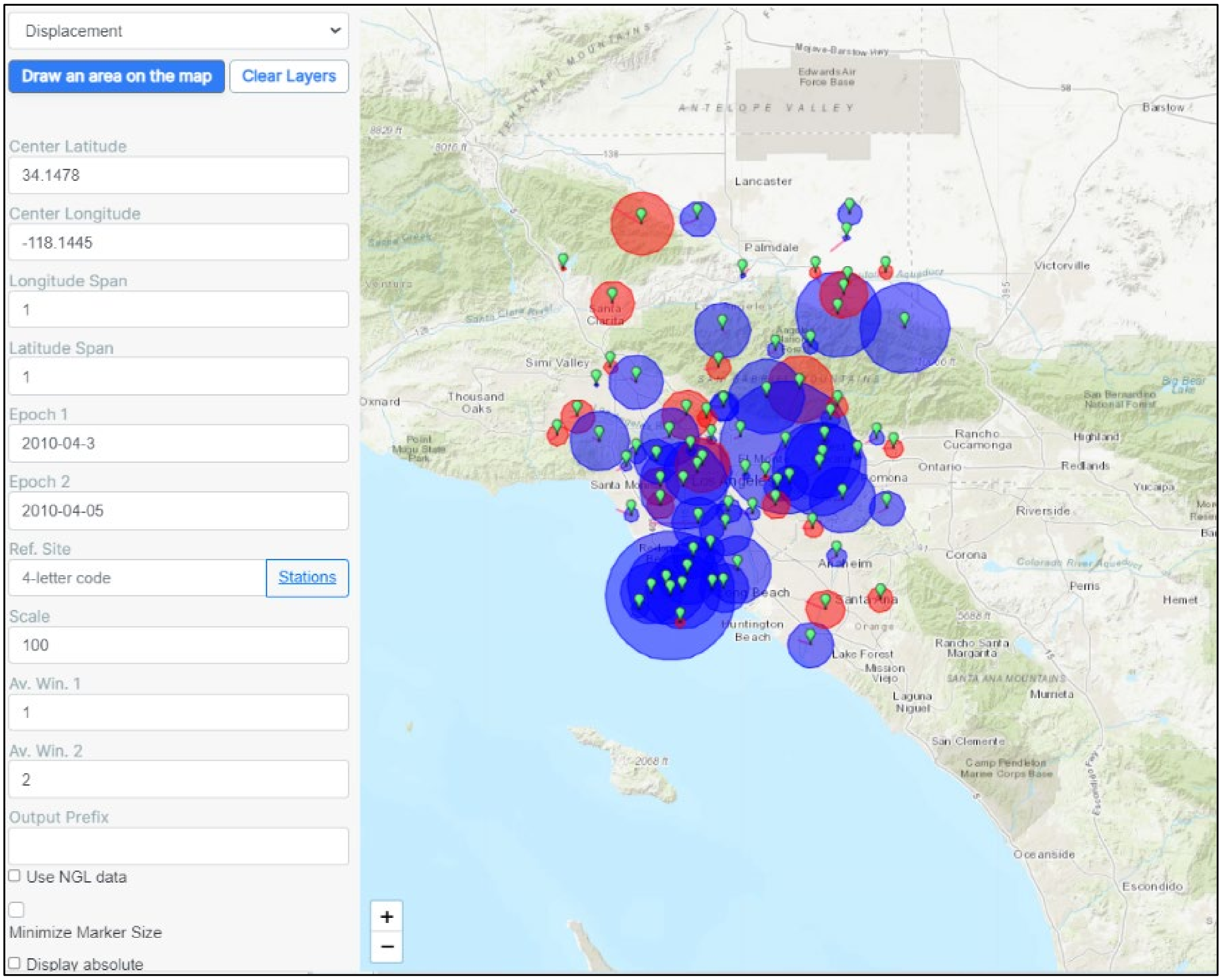


e. Print new plot with a reference station

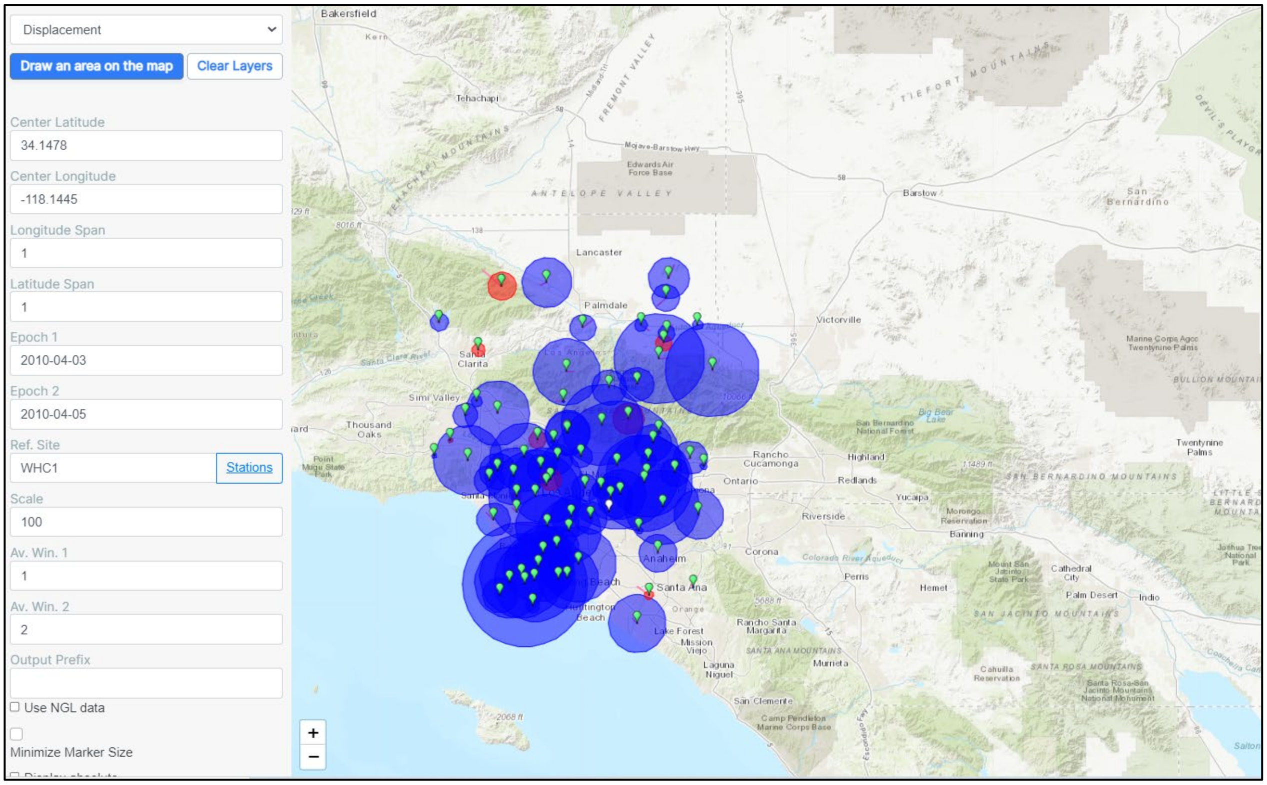


Step 7: Repeat for displacements. Select Displacement.

- **a.** Select center latitude and center longitude
- **b.** Enter two dates to calculate displacements between time 1 and time 2
- **c. Print plot with no reference**



d. With Reference

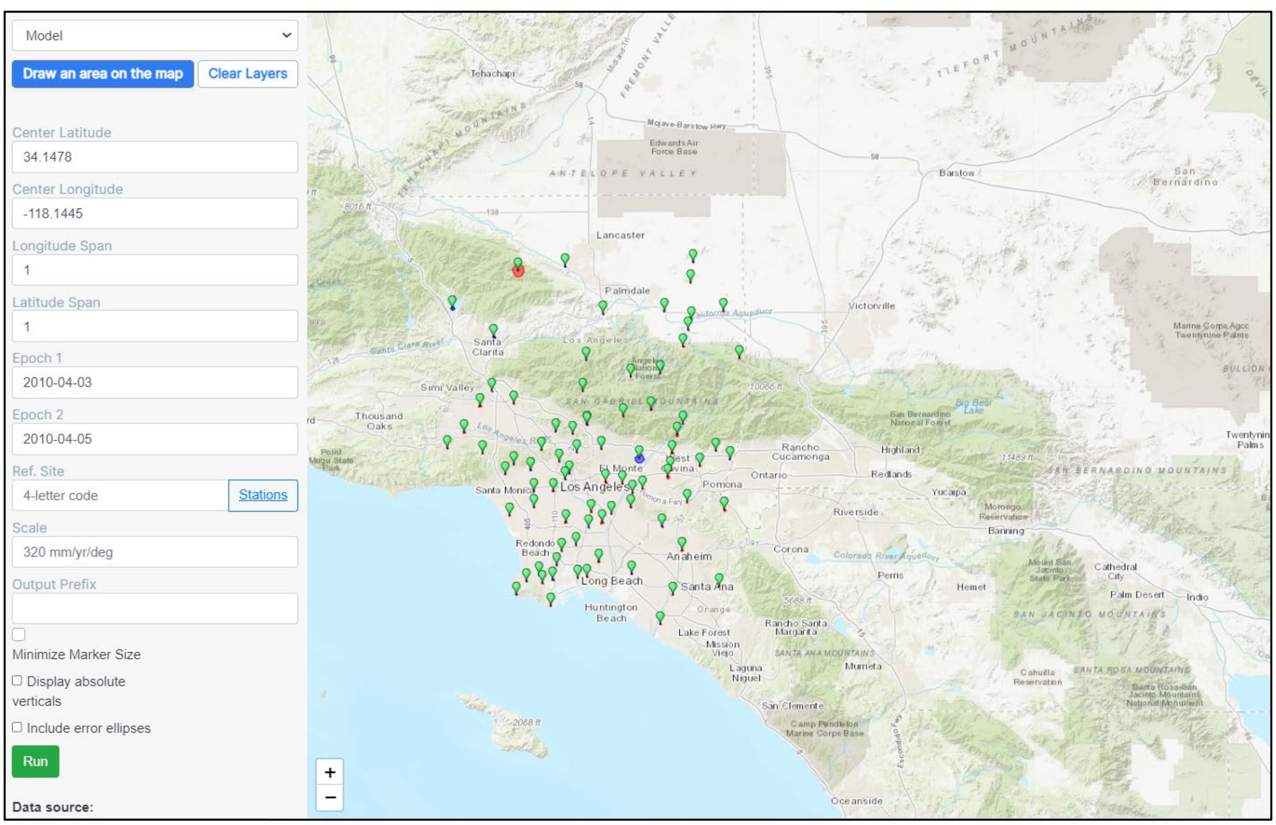


Step 8: Repeat for model. Select Model from dropdown menu

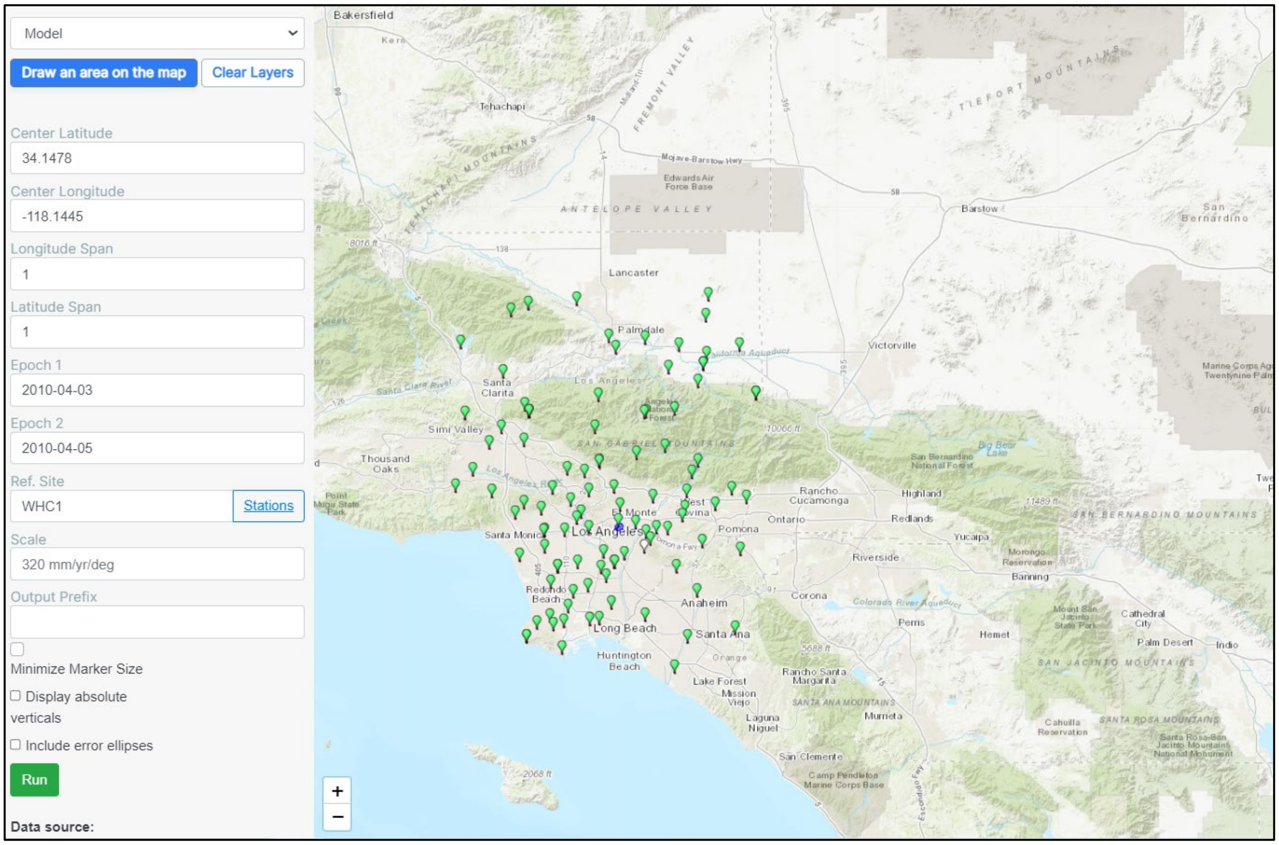
a. Select center latitude and center longitude

b. Enter two dates to calculate displacements between time 1 and time 2

c. Print plot with no reference



d. Print new plot with a reference station



Exercise: Calculating Moment Magnitude

GeoGateway allows users to calculate the magnitude of an earthquake based on rupture of a rectangular fault. In this example exercise, the result is a moment magnitude 6.0 earthquake.

Step 1: Go to https://geo-gateway.org
Step 2: Click on the "**Magnitude**" tab

Step 3: Enter parameters to create a moment magnitude 6.0 earthquake on a rectangular fault. Length is the rupture length. Rupture width is perpendicular to length. In this example we use a square fault with 2 m average slip.

a. Length (km): 4

b. Width (km): 4

c. Slip (m): 2

d. Shear Modulus (10^{11} dyne/cm^2): 4

e. Click Calculate

Results: The seismic moment and moment magnitude are

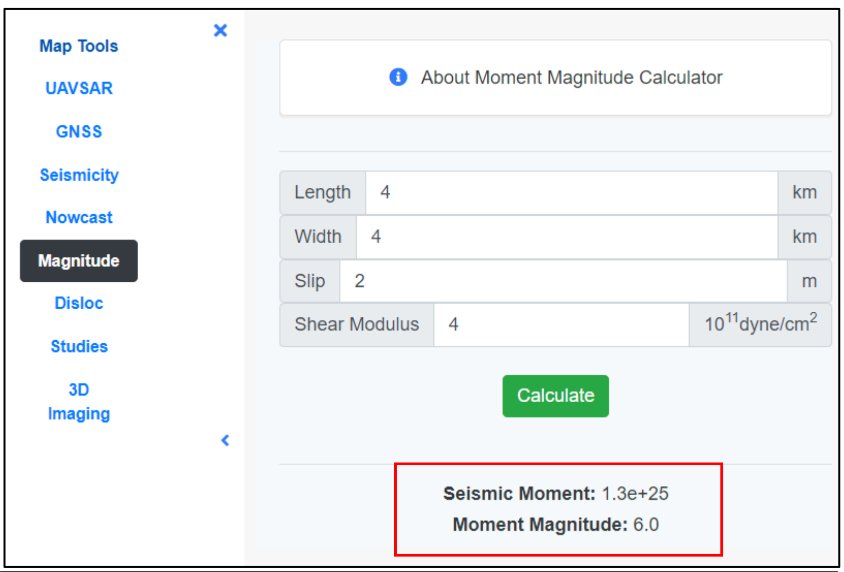
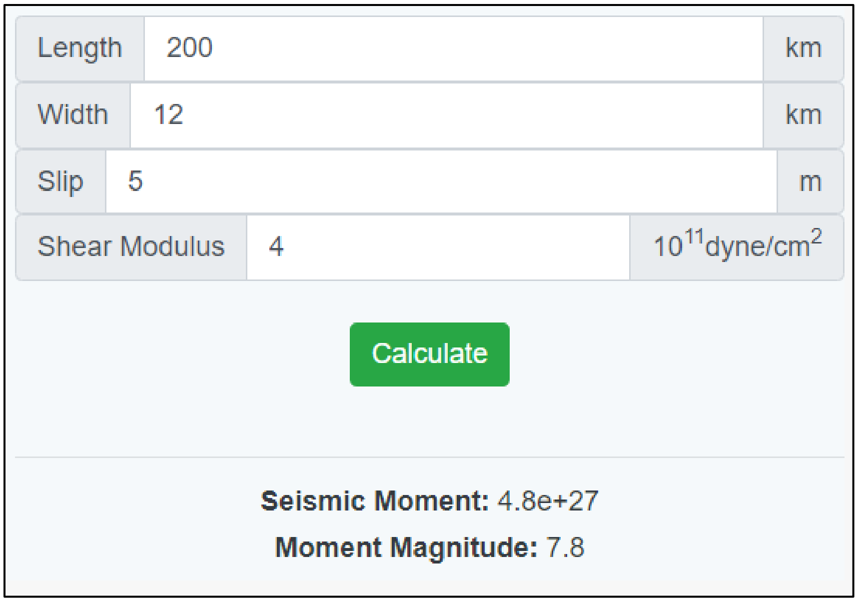


Figure: Results of seismic moment and moment magnitude generated by GeoGateway's Moment Magnitude Calculator.

Example Application:

Use GeoGateway's Moment Magnitude Calculator to estimate the magnitude of an earthquake that ruptured a 200-km section of the San Andreas fault with 5 m average slip. If we assume the rupture depth is 12 km, what is the magnitude?


Length
200
km
Width
12
km
Slip
5
m
Shear Modulus
4
10^11dyne/cm^2
Calculate
Seismic Moment: 4.8e+27
Moment Magnitude: 7.8

`Exercise: Understanding Seismicity

GeoGateway allows users to display earthquakes in a region over a specified period.

Step 1: Go to https://geo-gateway.org

Step 2: Click on "**Seismicity**" (scroll down page to find this option)

Step 3: Enter parameters to view earthquake(s) prior to the 2019 magnitude 6.4, and 7.1 earthquakes in Ridgecrest, California.

- **a.** Min Lat: 35.60
- **b.** Min Lon: -117.81
- **c.** Max Lat: 35.79
- **d.** Max Lon: -117.50
- **e.** Start Date: 06/01/2019
- **f.** Starting Time: 00:00:00
- **g.** Ending Date: 07/03/2019
- **h.** Ending Time: 00:00:00
- **i.** Minimum Magnitude: 1.0
- **j.** Maximum Magnitude: 7.5
- **k.** Icon Display Scale: 1

Step 4 (Answer questions based on results from data on map):

Question 1: Do you see any earthquake(s) displayed on the map? If yes, what is the magnitude? *Note: Click on the circle icons to obtain magnitude.*

Step 5: Enter parameters to view the quakes for a section of the sequence of the Ridgecrest, California earthquake. The dates include 07/04/2019 to 07/07/2019.

- **l.** Min Lat: 35.60
- **m.** Min Lon: -117.81
- **n.** Max Lat: 35.79
- **o.** Max Lon: -117.50
- **p.** Start Date: 07/04/2019
- **q.** Starting Time: 00:00:00
- **r.** Ending Date: 07/07/2019
- **s.** Ending Time: 00:00:00
- **t.** Minimum Magnitude: 4.0
- **u.** Maximum Magnitude: 7.5
- **v.** Icon Display Scale: 1

Step 6 (Answer questions based on results from data on map):

Question 2: What is a foreshock, mainshock, and aftershock?

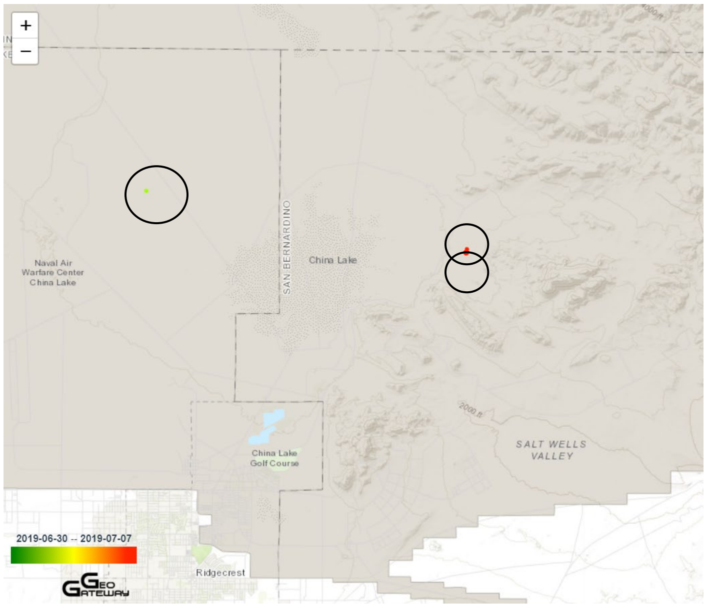
Question 3: Identify and take a screenshot of the magnitudes 6.4, and 7.1 earthquakes.

Question 4: Identify and take a screenshot of an aftershock following the events from question 3

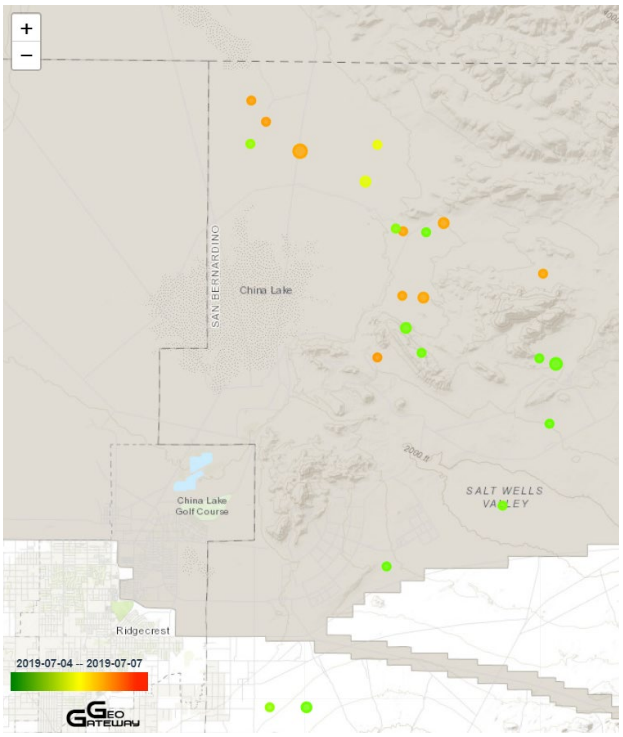
Question 5: What do the different coloring (green, red) within each datapoint represent?

Answers:

Question 1: Yes. Magnitudes 1.45, 1.54, and 1.47.



Step 5's figure:

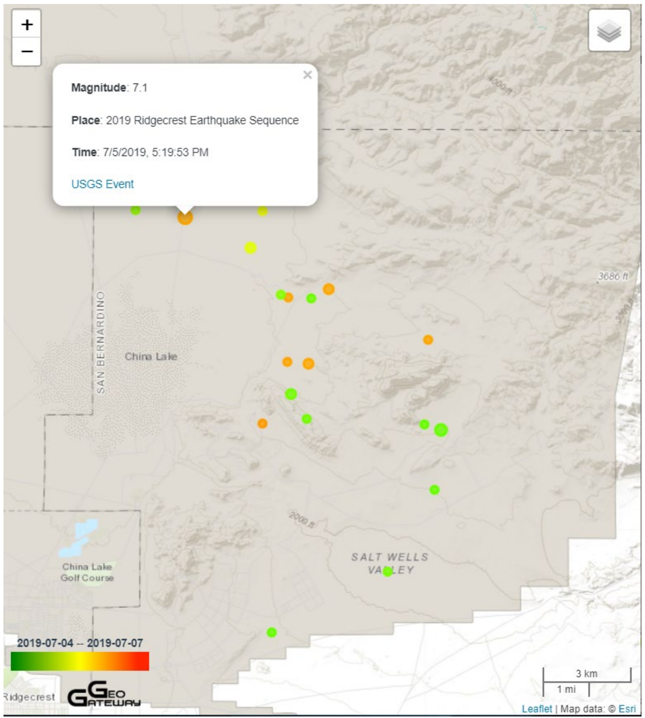


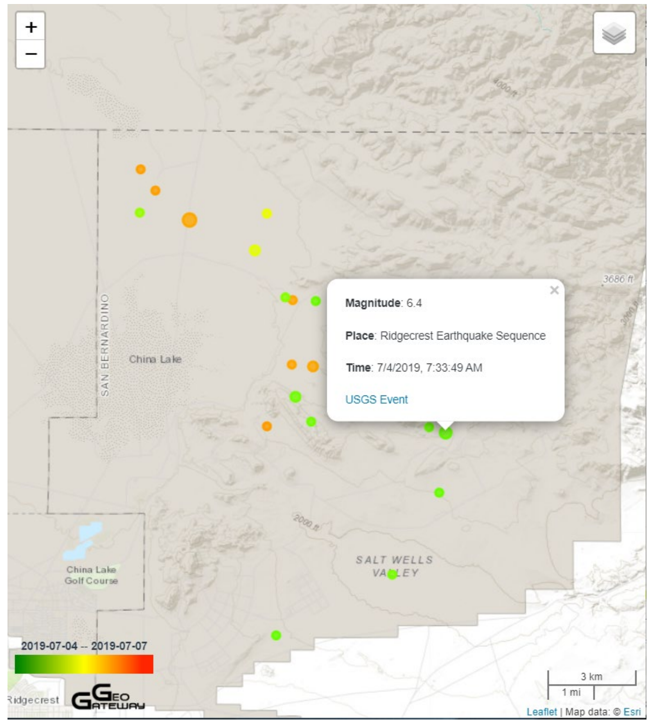
Question 2:

<u>Foreshocks</u> are earthquakes that lead up to the largest earthquake in a series, the <u>mainshock</u>.

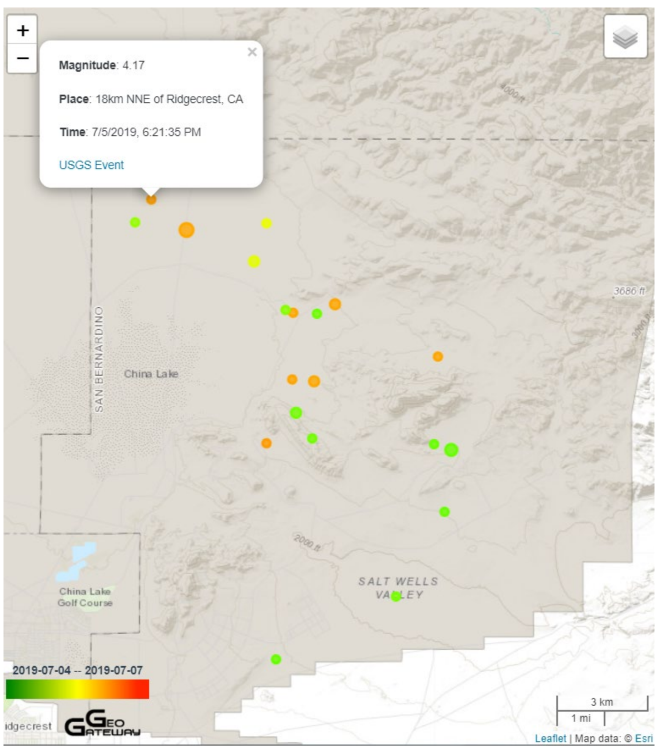
<u>Aftershocks</u> are earthquakes that follow the largest earthquake sequence.

Question 3:





Question 4:



Question 5:

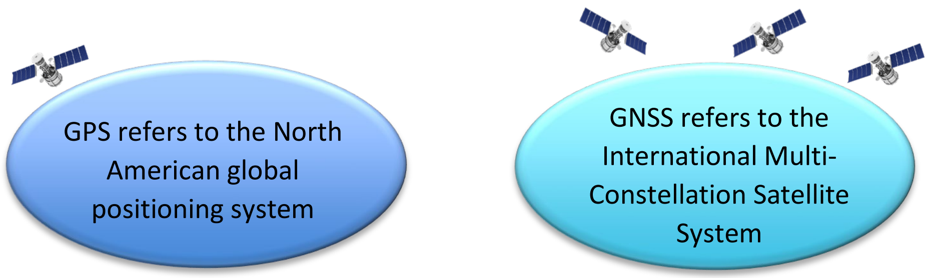
The green data point represents a date and time closer to the specified “Start Date” and “Starting Time” while the red data points represent a date and time closer to the specified “Ending Date” and “Ending Time.”

Exercise: Using GNSS to Understand Movement of the Earth

Adapted from GETSI (https://serc.carleton.edu/getsi/index.html).

Kortz, K and Smay, J. (2007) Unit 1: Collecting GPS Data. Retrieved May 05, 2022, from https://serc.carleton.edu/getsi/teaching_materials/measure_earth/unit1.html.

The concepts of the GETSI exercises were modified so that users can complete the exercises using GeoGateway's datasets. The purpose of this exercise is to use GNSS data to understand Earth's movement. Note that GETSI uses GPS data while GeoGateway uses GNSS data. GNSS includes the United States-owned Global Positioning System (GPS).



To learn more about GNSS/GPS

↓

Download the GeoGateway User Guide by visiting Geo-Gateway.org

↓

Refer to Unit 1: Collecting GPS Data on the GETSI website

Step 1: Go to https://geo-gateway.org

Step 2: Click on "**GNSS**" (scroll down page to find the option "GNSS")

Step 3: Enter "**37**" for Center Latitude

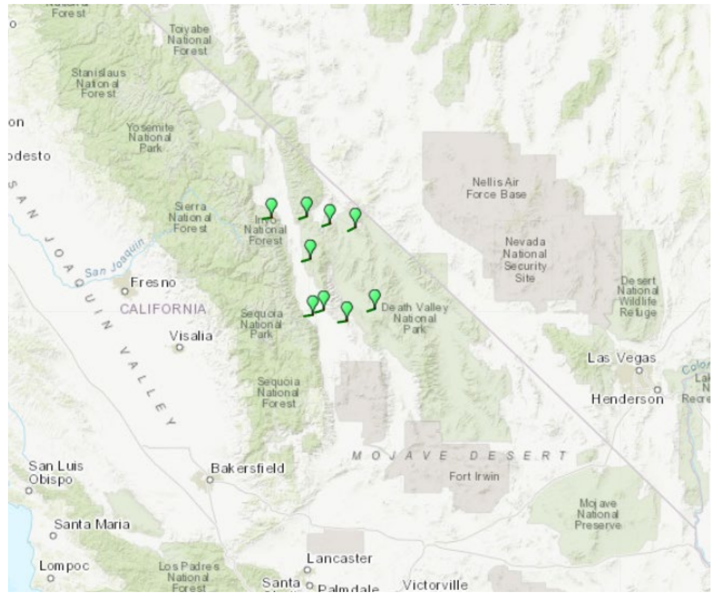
Step 4: Enter "**-118**" for Center Longitude

Step 5: Enter "**1**" for Longitude Span

Step 6: Enter "**1**" for Latitude Span

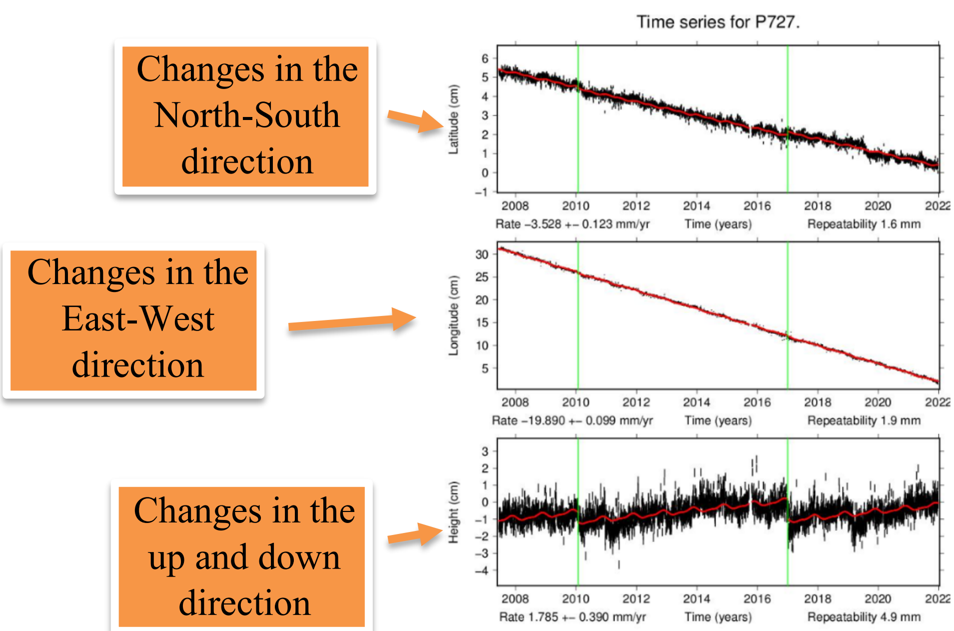
Step 7: Click on "**Run**"

The map should display the following GNSS stations as shown in the figure to the right.



Step 8: Select the GNSS station "**P727**"

Step 9: Click on the time series' graphs to open an enlarged image of the graphs as shown in the figure below



Questions: (Prior to answering questions, please refer to the PowerPoint Presentation Introduction to GPS).

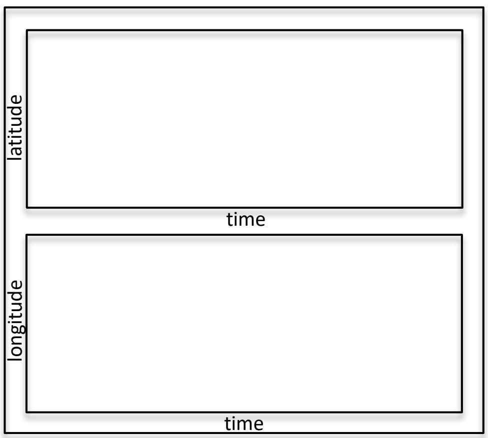
1. **In what direction does the GNSS station P727 move in the North-South (changes in latitude) time series graph?**

   ____

2. **In what direction does the GNSS station P727 move in the East-West (changes in longitude) time series graph?**

   ____

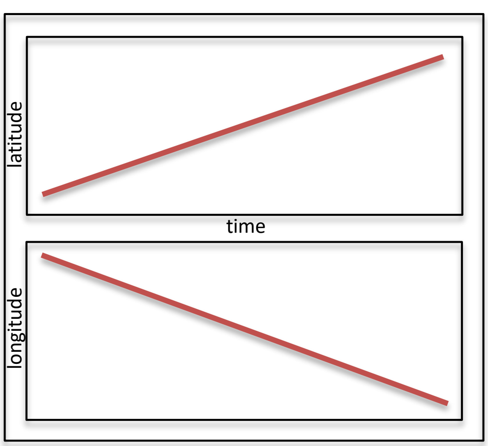
3. **Draw the latitude and longitude graphs if the figures were moving Northwest.**



Answers:

1. South
2. West

3.



Exercise: Using GNSS to Understand the Velocity of the GNSS stations

Adapted from GETSI (https://serc.carleton.edu/getsi/index.html).

Kortz, K and Smay, J. (2007) Unit 1: Collecting GPS Data. Retrieved May 05, 2022, from https://serc.carleton.edu/getsi/teaching_materials/measure_earth/unit1.html.

The concepts of the GETSI exercises were modified so that users can complete the exercises using GeoGateway's datasets. The purpose of this exercise is to understand the movement of each GNSS station. Note that GETSI uses GPS data while GeoGateway uses GNSS data. GNSS includes the United States-owned Global Positioning System (GPS).

Step 1: Go to https://geo-gateway.org

Step 2: Click on "**GNSS**" (scroll down to find GNSS)

Step 3: Enter "**33**" for Center Latitude

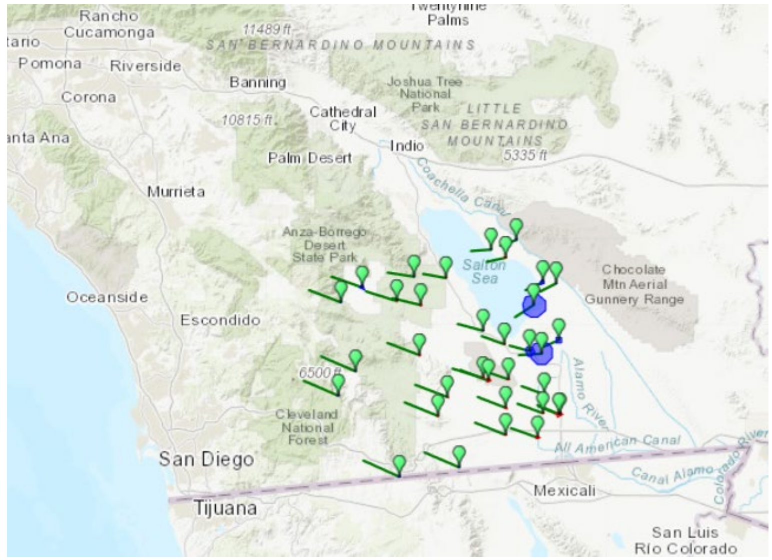
Step 4: Enter "**-116**" for Center Longitude

Step 5: Enter "**1**" for Longitude Span

Step 6: Enter "**1**" for Latitude Span

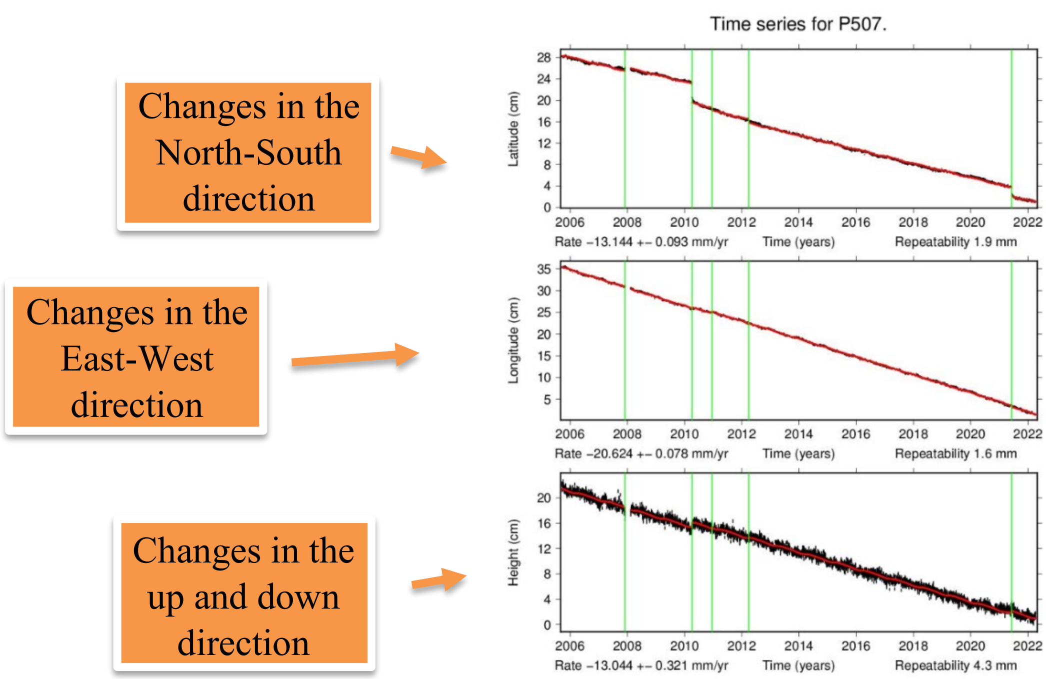
Step 7: Click on "**Run**"

The map should display the following GNSS stations as shown in the figure to the right.



Step 8: Select the station "**P507**"

Step 9: Click on the time series' graphs to open an enlarged image of the graphs as shown in the figure below



Question 1:

In the time series graphs what do the x-axis and y-axis represent?

____

The information provided within the time series graphs allows users to understand the speed of the GNSS stations. In this exercise, a 4-year time period will be analyzed (2008 to 2012). Begin by measuring the distance (y-axis), next calculate the rate.

Question 2:

	North-South	East-West
Distance (mm)	______	______
Time (years)	4	4
Rate (mm/year)	______	______

Question 3:

Calculate the overall rate of the GNSS station for the specified 4-year time period from Question 1?

Step 1: Square the North-South rate

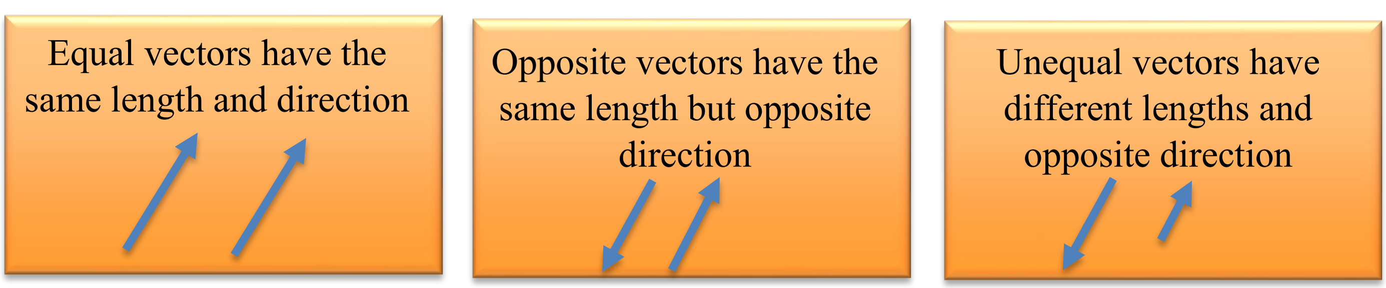
Step 2: Square the East-West rate

Step 3: Add the two values from step 1 and step 2 together

Step 4: Take the square root of the sum

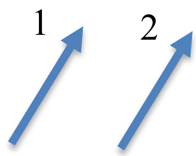
____

Now it is time to understand what the vector's represent. Note that direction of the vector represents the direction of movement, and the length of the vector represents the rate of the movement.

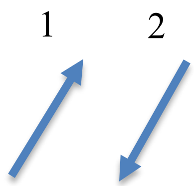


Answer true or false to the following questions regarding the velocity of a station (vector 1) compared to another station (vector 2).

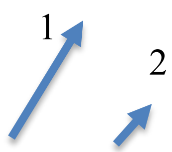
Question 4: **Station 1 has the same rate and is moving in the same direction (northwest) from station 2 [TRUE or FALSE]**



Question 5: **Station 1 has the same rate and is moving in the opposite direction from station 2 [TRUE or FALSE]**



Question 6: **Station 1 has the same rate and is moving in the same direction as station 2 [TRUE or FALSE]**



Answers:

Question 1

x-axis indicates time

y-axis indicates position

Question 2

	North-South	East-West
Distance (mm)	~10	~8
Time (years)	4	4
Rate (mm/year)	~2.5	~2

Question 3

~3.2 mm/year

Question 4

True

Question 5

True

Question 6

False

Exercise: Using GNSS to Understand the Isostatic Adjustment of Bedrock

Adapted from GETSI (https://serc.carleton.edu/getsi/index.html).

Kortz, K and Smay, J. (2007) Unit 3: Glaciers, GPS, and Sea Level Rise. Retrieved May 07, 2022, from https://serc.carleton.edu/getsi/teaching_materials/measure_earth/unit3.html.

The concepts of the GETSI exercises were modified so that users can complete the exercises using GeoGateway's datasets. The purpose of this exercise is to understand the isostatic adjustment of bedrock due to changes in glacier size. Note that GETSI uses GPS data while GeoGateway uses GNSS data. GNSS includes the United States-owned Global Positioning System (GPS).

To learn more about how to measure glaciers using GNSS/GPS

↓

Refer to Unit 3: Glaciers, GPS, and Sea Level Rise on the GETSI website

Step 1: Go to https://geo-gateway.org

Step 2: Click on "**GNSS**" (scroll down page to locate GNSS)

Step 3: Click on "**Draw an area on map**"

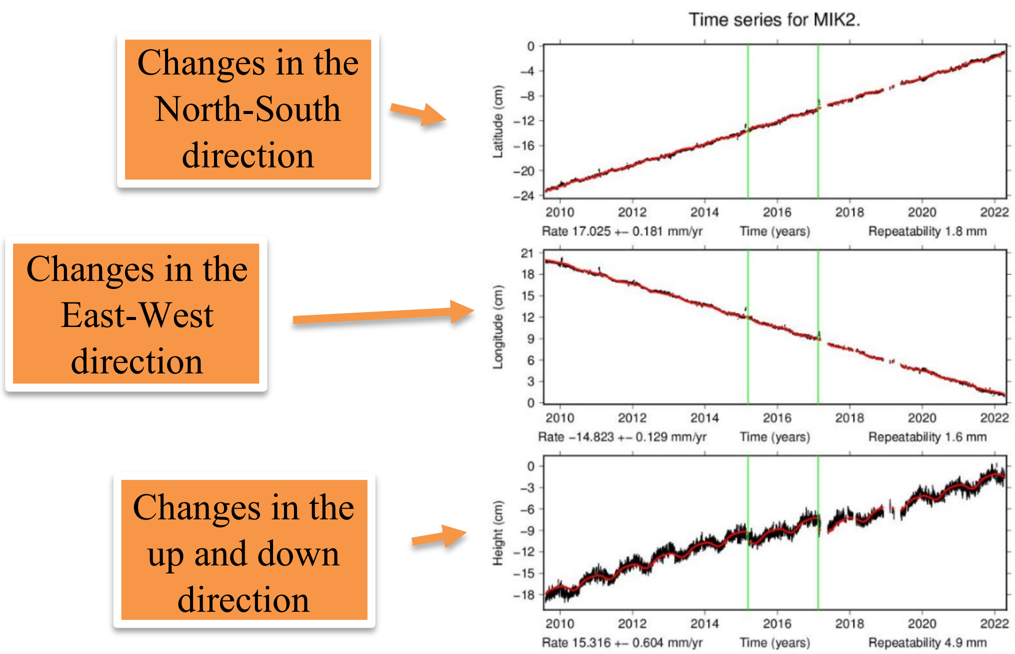
Step 4: Draw an area around Greenland

Step 5: Click on "**Run**"

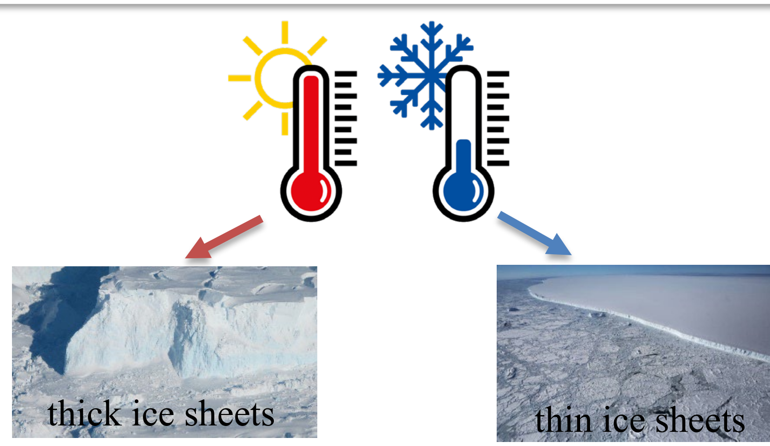
The map should display the following GNSS stations as shown in the figure to the right.

Step 6: Select the GNSS station "**MIK2**" located on the southeastern end of Greenland (shown in circle from figure above)

Step 7: Click on the time series' graphs to open an enlarged image of the graphs as shown on the next page



Isostatic adjustment occurs when ice mass is added or removed. During the winter months, thick ice causes bedrock to dip down, causing the GNSS station to show a decrease in height. During the summer months, ice melts causing bedrock to rise, resulting in GNSS stations to show an increase in height.



Question 1:

Does the time series for the station MIK2 show an increasing and decreasing trend for the height (y-axis) each year? If yes, what might be the cause of this increase and decrease in height?

Question 2:

There is an increasing trend in the overall height for the time series. What is causing the increase and what might be the reason for this result?

Answers:

Question 1

Yes, seasonal (summer and winter) changes. As the area heats during the summer months, the ice melts, and the bedrock rises causing an increase in height for the GNSS station. As the area cools during the winter months, the ice thickens and the bedrock lowers causing a decrease in height for the GNSS station.

Question 2

The overall increase in trend can be due to the increase in global temperatures causing the ice sheets to thin as they melt.

Exercise: Using UAVSAR and GNSS to Understand Volcanos

Adapted from GETSI (https://serc.carleton.edu/getsi/index.html).
Funning, G and Douglas, B. Imaging Active Tectonics with InSAR and Lidar. Retrieved May 05, 2022, from https://serc.carleton.edu/getsi/teaching_materials/imaging_active_tectonics/index.html.
The concepts of the GETSI exercises were modified so that users can complete the exercises using GeoGateway's datasets. The purpose of this exercise is to use GNSS and UAVSAR data to understand volcanic activity. Note that GETSI uses GPS data while GeoGateway uses GNSS data. GNSS includes the United States-owned Global Positioning System (GPS).

To learn more about SAR

↓

Download the GeoGateway User Guide by visiting Geo-Gateway.org

↓

Refer to Imaging Active Tectonics with InSAR and Lidar on the GETSI website

Questions:

1. What does UAVSAR stand for?

2. Take a screenshot of the interferogram (use steps below) "BigIsl_05901_10003-004_11022-011_0484d_s01_L090HH_01."

- **Examining the interferogram of Kilauea in Hawaii**

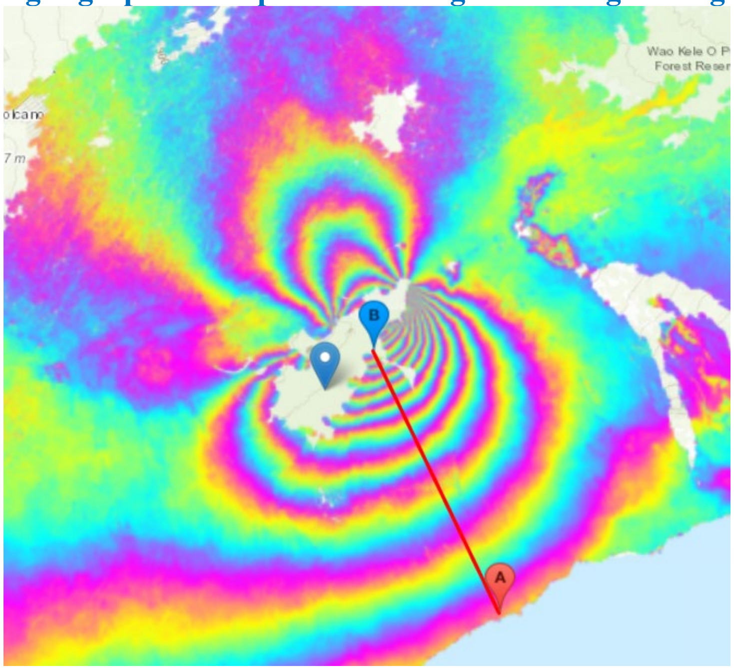
Step 1: Go to https://geo-gateway.org

Step 2: Click on the "**UAVSAR**" tab

Step 3: Locate the interferogram "BigIsl_05901_10003-004_11022-011_0484d_s01_L090HH_01" by either copy and pasting "BigIsl_05901_10003-004_11022-011_0484d_s01_L090HH_01" into "flight name/path," or inserting the latitude 19.32919 and longitude -155.12994 in the "latitude/longitude" section and then clicking "search."

Step 4: Look for the interferogram "BigIsl_05901_10003-004_11022-011_0484d_s01_L090HH_01" if multiple interferograms appear.

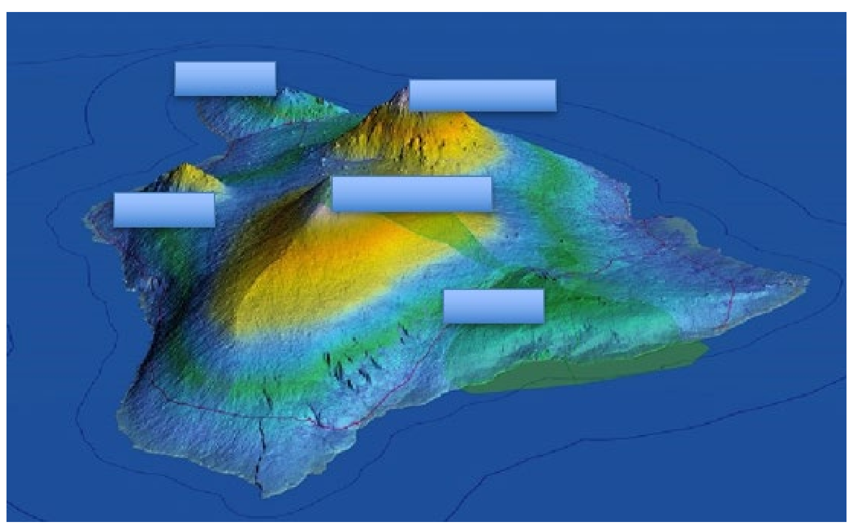
3. Click on the interferogram selection box then click on the interferogram right after to activate the line-of-sight tool. Mark the A and B point similar to the image shown below. Take a screenshot of the line-of-sight graph and explain how the ground range changes as the distance increases.



4. Notice the fringes get closer together from point A to B, what does that represent? Is there deflation or inflation?

5. When a volcano erupts, magma moves in or out of the volcano. By looking at UAVSAR interferograms, scientists can get a better understanding of how much________is inside the volcano.

Understanding Elevation Change



Step 1: Go to https://geo-gateway.org

Step 2: Click on the "**UAVSAR**" tab

Step 3: Zoom into Hawaii's Big Island

Step 4: Type in the names of the 5 major volcanos in the figure to the right (Q6).

Step 5: Change the map style to "ArcGIS World Imagery" by clicking on the hamburger symbol on the right side of the GeoGateway map. **Take a screenshot (Q7).**

Step 6: Locate the interferogram "BigIsl_14905_10004-012_10005-013_0001d_s01_L090HH_01."

Step 7: Draw the line for the interferogram from top (A) to bottom (B).

Question 8. Take a screenshot. Identify one of the five major volcanos on the Big Island that can be identified from the line-of-sight. Record the elevation at the highest point recorded from the line-of-sight.

Examining a GNSS station within Kilauea

Step 1: Go to https://geo-gateway.org

Step 2: Click on the "**GNSS**" tab

Step 3: Inserting the center latitude 19.32919 and center longitude -155.12994 in the "center latitude" and "center longitude" section.

Step 4: Insert 1 for both "longitude spam" and "latitude spam."

Step 5: Click on "search."

Step 6: Select the GNSS station JCUZ

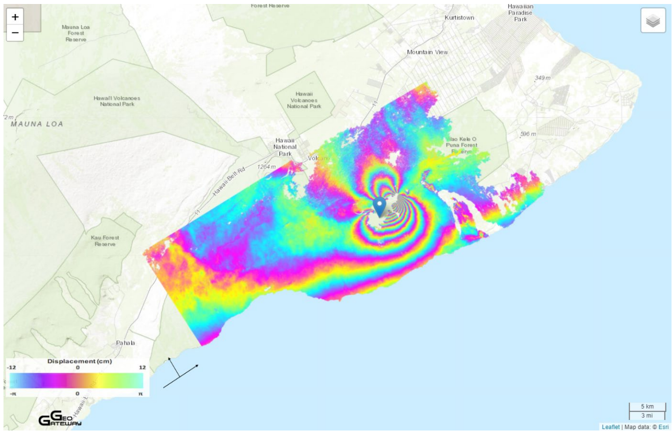
Step 6: Click on the time-series graph

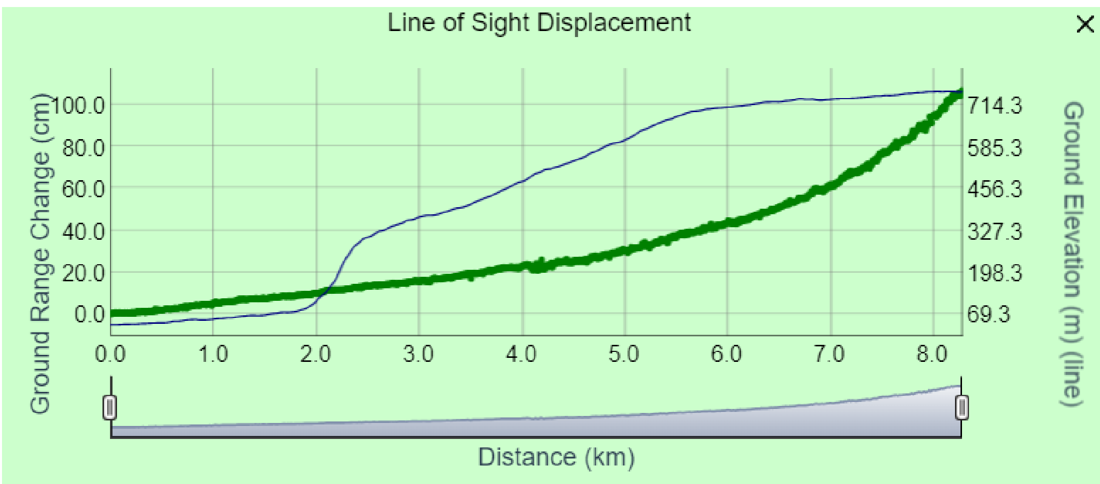
9. By looking at the time series graph, when do you believe there was seismic activity?

Answers:

1. Uninhabited Aerial Vehicle Synthetic Aperture Radar

2.



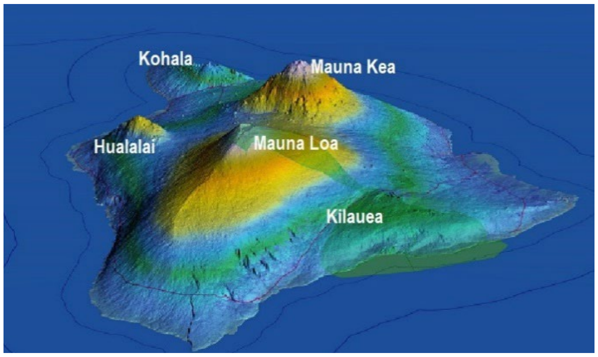


3.
The ground range change increases with distance.

4. The closer the fringes are together the greater deformation on the ground.
Inflation

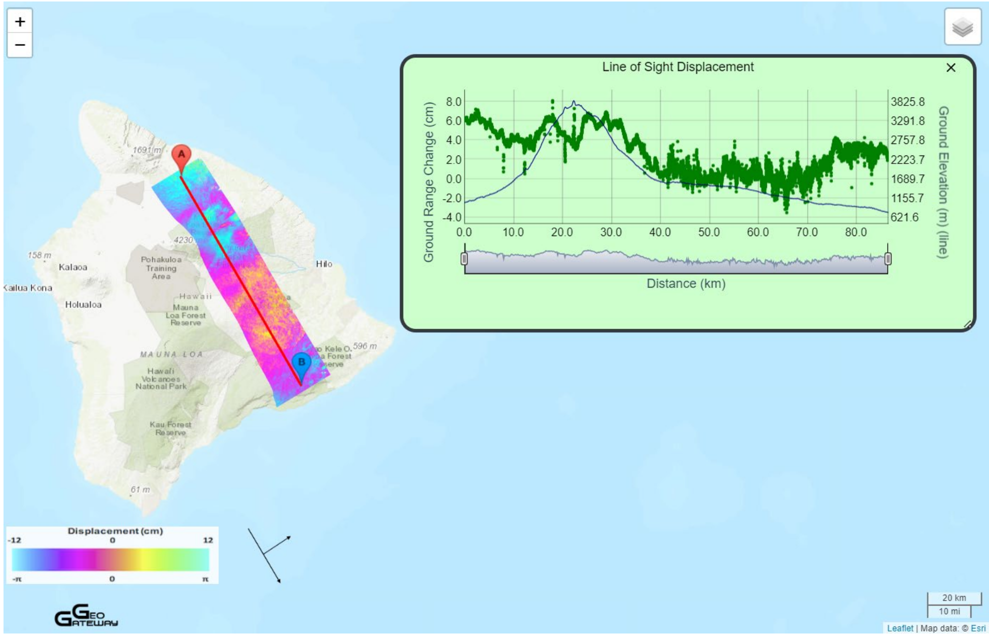
5. magma

6. 5 major volcanos on the Big Island of Hawaii

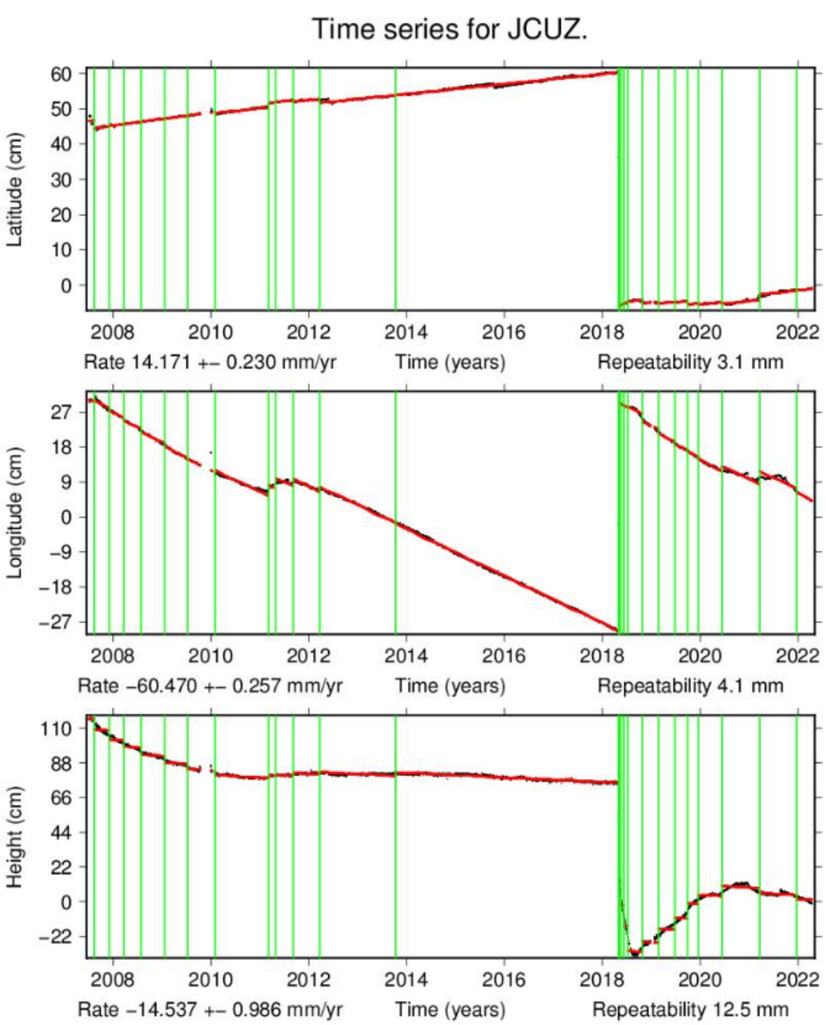


7. ArcGIS World Imagery map view

8. Manau Kea; elevation answers may vary ~4,000 m - 3,000 m


Line of Sight Displacement
Ground Range Change (cm)
Ground Elevation (m) (line)
Distance (km)
Displacement (cm)
Hilo
Kalaoa
Kailua Kona
Holualoa
Pohakuloa Training Area
Mauna Loa Forest Reserve
MAUNA LOA
Hawaii Volcanoes National Park
Kau Forest Reserve
20 km
10 mi
Leaflet | Map data: © Esri

9. 2018


Time series for JCUZ.
Latitude (cm)
Rate 14.171 +– 0.230 mm/yr
Time (years)
Repeatability 3.1 mm
Longitude (cm)
Rate −60.470 +– 0.257 mm/yr
Time (years)
Repeatability 4.1 mm
Height (cm)
Rate −14.537 +– 0.986 mm/yr
Time (years)
Repeatability 12.5 mm

Exercise: Using GNSS to Understand Aquifer Depletion

Adapted from GETSI (https://serc.carleton.edu/getsi/index.html).

Kortz, K and Smay, J. (2018, 2019) Unit 4: Groundwater, GPS, and Water Resources. Retrieved May 05, 2022, from https://serc.carleton.edu/getsi/teaching_materials/measure_earth/unit4.html.

The concepts of the GETSI exercises were modified so that users can complete the exercises using GeoGateway's datasets. The purpose of this exercise is to use GNSS data to understand aquifer depletion. Note that GETSI uses GPS data while GeoGateway uses GNSS data. GNSS includes the United States-owned Global Positioning System.

To learn more about GPS/GNSS applications for hydrology

↓

Refer to the UNAVCO website

↓

Refer to Unit 4: Groundwater, GPS, and Water Resources on the GETSI website

Figure adapted from Manteca and Ripon Bulletin

The figure to the left demonstrates the effects of pumping for irrigation in the San Joaquin Valley. Significant subsidence is evident in the region.

Step 1: Go to https://geo-gateway.org

Step 2: Click on the “**GNSS**” tab

Step 3: Enter “**35.84**” for Center Latitude

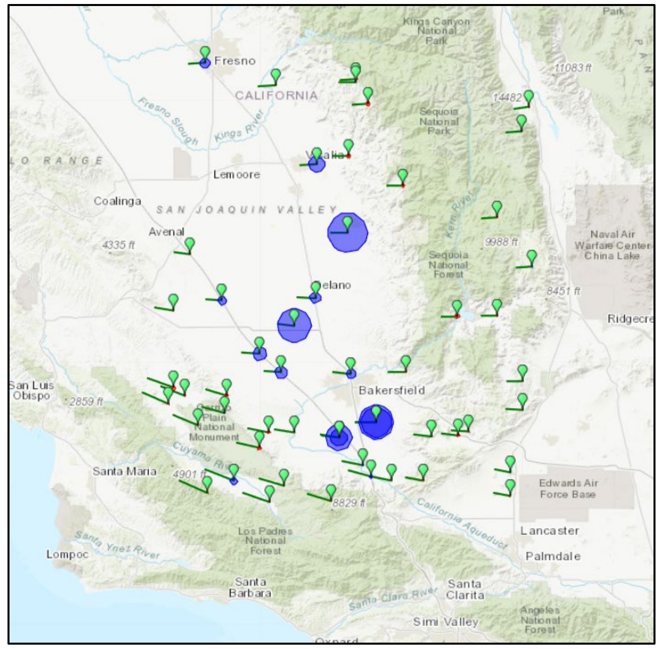
Step 4: Enter “**-119.03**” for Center Longitude

Step 5: Enter “**2**” for Longitude Span

Step 6: Enter “**2**” for Latitude Span

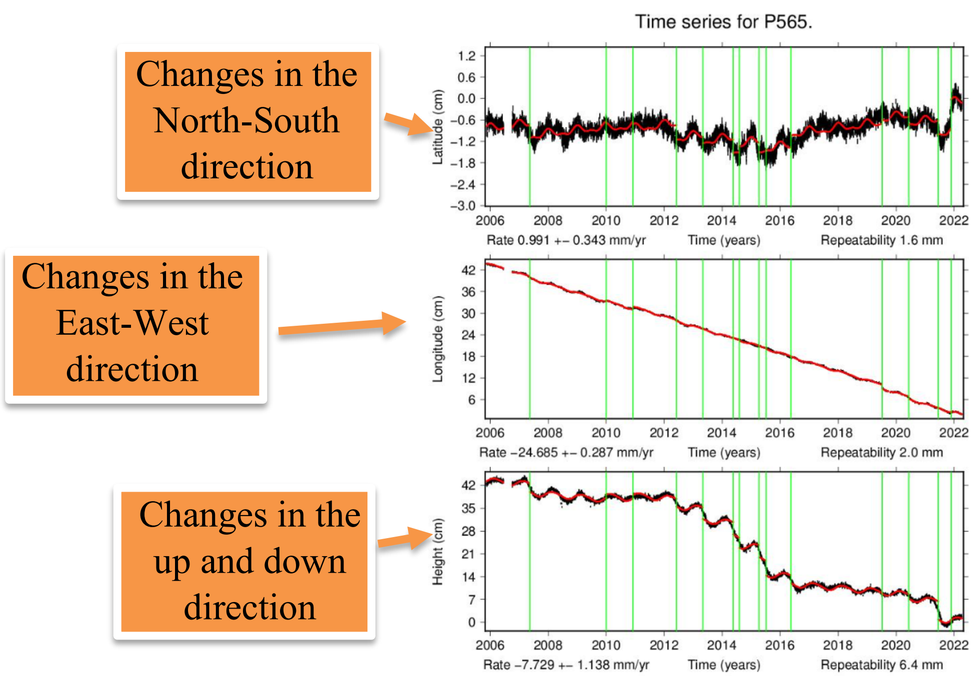
Step 7: Click on “**Run**”

The map should display the following GNSS stations as shown in the figure to the right.



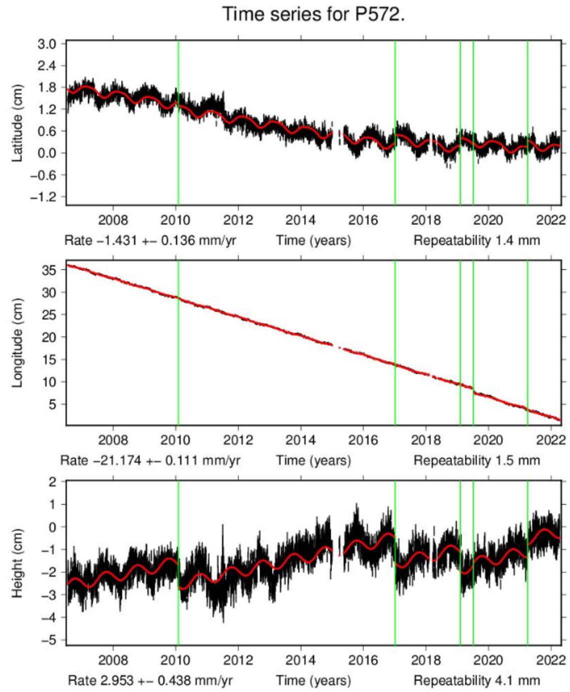
Step 8: Select the GNSS station “**P565**” near Delano, CA

Step 9: Click on the time series’ graphs to open an enlarged image of the graphs as shown in the figure below



Step 10: Now select the GNSS station “**P572**” near Sequoia National Park

Step 11: Click on the time series’ graphs to open an enlarged image of the graphs as shown in the next page



Question:

1. **The two GNSS sites are less than 100 km apart, yet have different trends in height. What might be the cause of the declining height in the GNSS station for P565?**

Answers:

1. Land subsidence when aquifers are depleted due to the pumping of water.