Velocity maps

Student Worksheet

Research-grade GPS units measure horizontal motion precisely—they can detect millimeters of motion per year. Data from the UNAVCO Velocity Viewer and other sources is available at no cost. (Search for "UNAVCO Velocity Viewer") From plots of position over time, the average velocity in the north-south, east-west, and vertical directions is calculated for you, along with error in the measurements.

In this activity, you will analyze vectors that show crustal motion at three GPS stations. You will derive these vectors from time-series data.

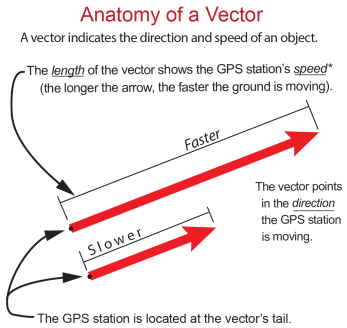
Velocity vectors

1. Carefully draw the N - S and E - W velocity vectors associated with each of the three GPS sites shown as green dots on the accompanying map. A negative north component is a vector pointing south, and a negative east component is a vector pointing west. The graphs are scaled in units of millimeters per year.

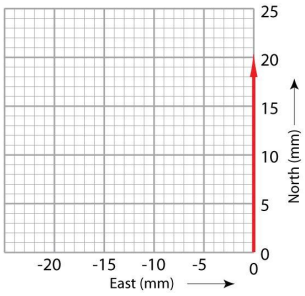
What is a vector?

A vector is a special type of arrow that shows velocity and the direction of motion. We can draw a vector to show the north motion and another vector to show the east (or west) motion. By adding them together we can show the total horizontal motion!

The **vector's tail** is the location of the GPS monument.
The **direction the vector points** is the direction the GPS station is moving.
The **length of the vector** represents the velocity the GPS monument and the land beneath it is moving.

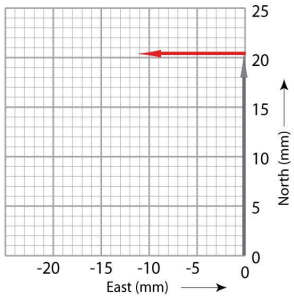


Adding vectors: Step 1.



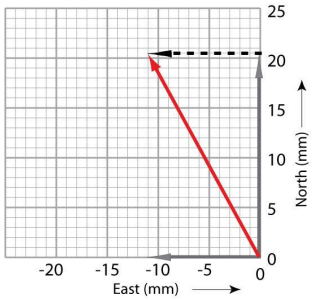
Start at the origin (0,0) draw a light arrow along the north axis the length equal to the north velocity (e.g. one block is 1 mm/yr.)

Step 2.



Draw the east vector from the end of the north vector's arrowhead.
(A vector moving west is drawn to the west.)

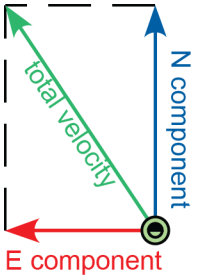
Step 3.



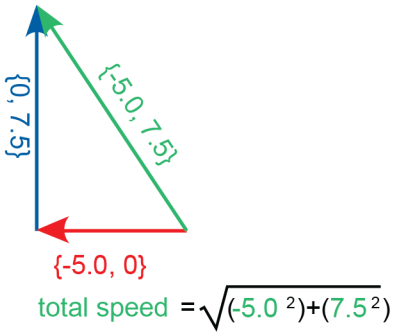
Draw a diagonal arrow from (0,0) to the arrowhead of the east vector.
This new vector is the sum of the north and east vectors.

2. Now draw the total horizontal velocity vector for each site, and determine the horizontal speed (that is, the length of the total horizontal velocity vector) of each site. You can do this at least three ways.

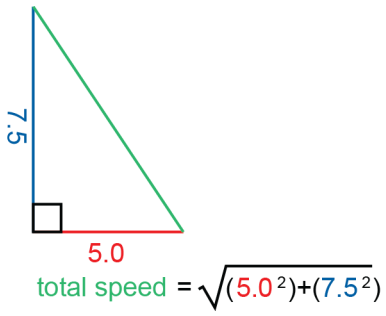
You can add the vectors graphically and use the scale to measure the length of the velocity vector.



Or, you can use the Pythagorean theorem, either by adding vectors and solving for the length of the velocity vector (a) or by treating the east and north components as two sides of a triangle and calculating the hypotenuse (b).



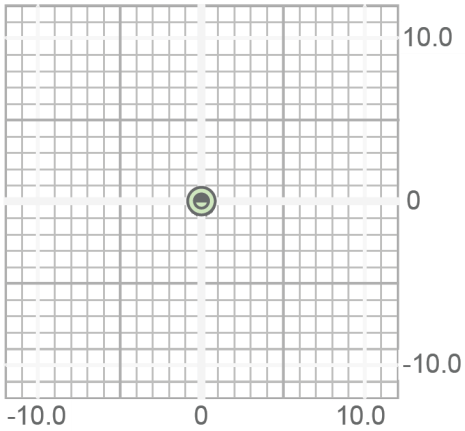
(a)



(b)

Velocity map **Name(s):_____**

[Instructors: Insert map with grids centered on each GPS station in this space.]



Total horizontal speeds: XXXX_____mm/yr; XXXX_____mm/yr; XXXX_____mm/yr.

Optional: Distances among stations: