

Where is that chunk of crust going?

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This project has been used in an introductory physical geology course that has no prerequisites, in the core course in structural geology, and in graduate courses in structure/tectonics. Students need to be able to navigate on the web and must be able to use a calculator or a spreadsheet to compute.



Introductory in-class session

I bring a hand-held GPS receiver into class, and present information about how the GPS receiver functions in coordination with the GPS satellites to define a position on Earth. I then talk about high-resolution GPS receivers, and introduce UNAVCO and the EarthScope Plate-Boundary Observatory. We visit the PBO website (pboweb.unavco.org) and find time-series data graphed for the motion of a given station (SBCC in Mission Viejo, California) relative to 3 orthogonal axes: north-south, east-west, and up-down. I hand-out paper copies of the data graphs, and we determine the slopes of the data to find the rate of change along each axis. We then use simple trigonometry to determine the length and direction of the 3-D velocity vector for that station. When we finish working on the first station's data together, we jointly write some rules for how to do the analysis. Then we use the rules to do a second analysis in class, working on data from a handout in groups of 2-3 students. The second station is BEMT in Twentynine Palms, California. The rules are refined as necessary and posted on the web. The results for SBCC and BEMT are then compared and discussed.

Homework portion

Students are required to find data for another PBO station and use the rules we developed to determine the velocity vector for that station. A report with the data and results of the analysis is due in the next class session. A sample report may be provided for their reference.

Classroom follow-up session

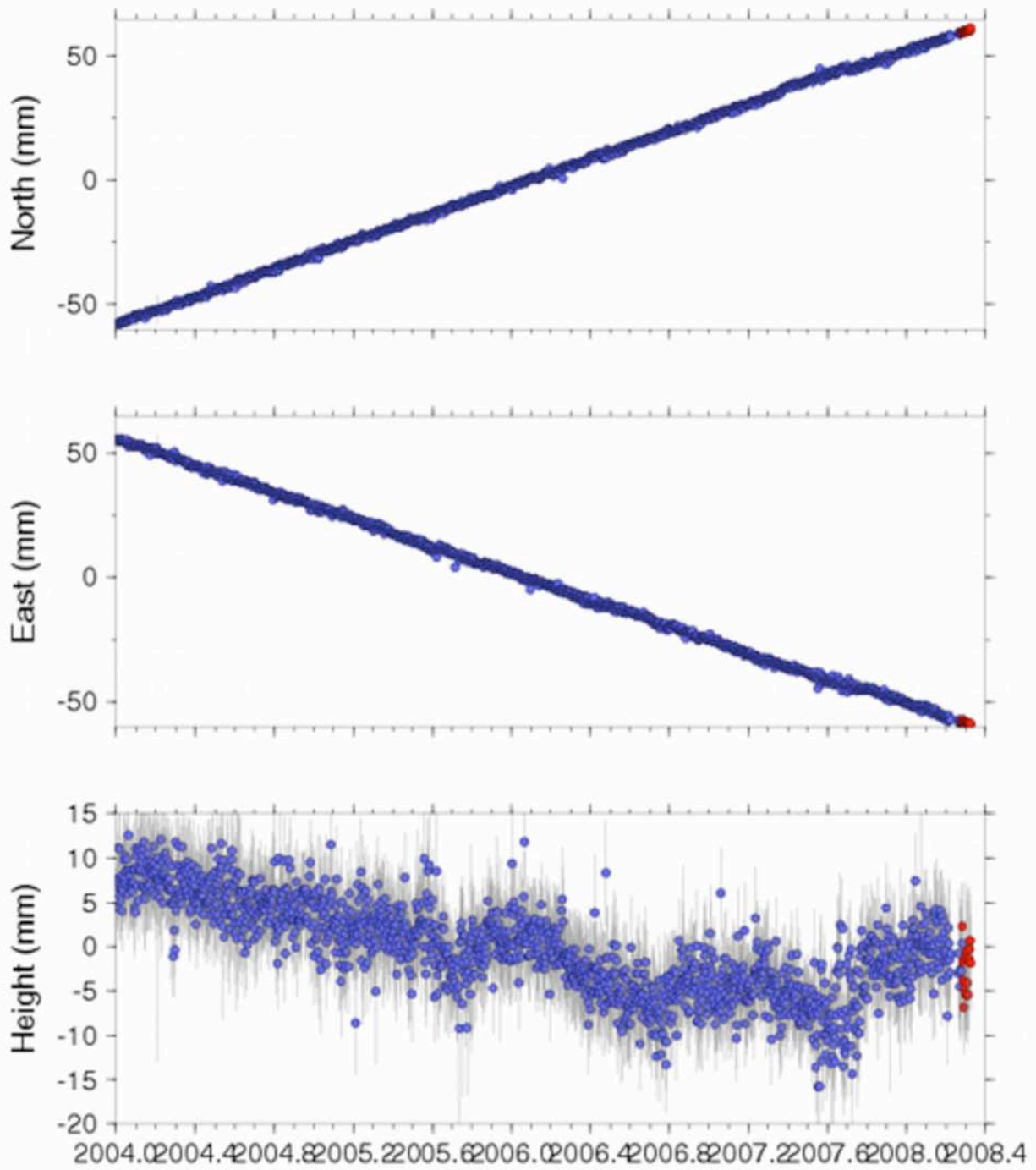
The results of the various analyses are compared, and questions generated about where various chunks of the lithosphere are going, how fast they are moving, and why they are moving. At the end, students are asked to write a few sentences describing what they would like to do next with the data -- what questions would they like to address through additional research work?

Web Resources

<http://pboweb.unavco.org>
http://www.unavco.org/edu_outreach/data/SBCC.html
http://www.unavco.org/edu_outreach/data/BEMT.html
http://www.unavco.org/edu_outreach/data.html
http://facility.unavco.org/data/gnss/perm_sta.php

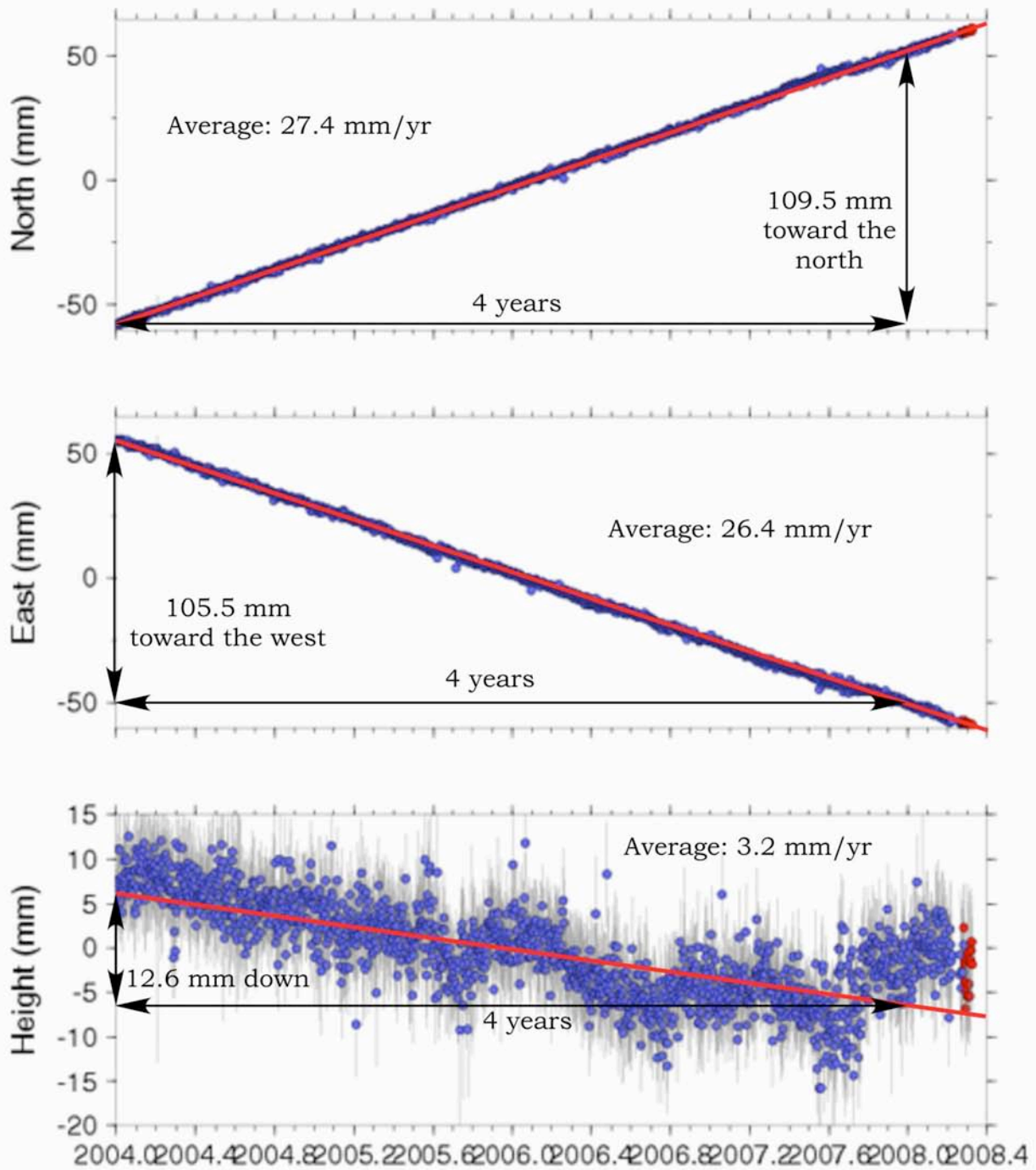
First Data Handout (from http://www.unavco.org/edu_outreach/data/SBCC.html)

SBCC (SBCC_SCGN_CS1999)



Graphical Solution for First Station

SBCC (SBCC_SCGN_CS1999)



We know three components of the total velocity vector:

27.4 mm/yr north

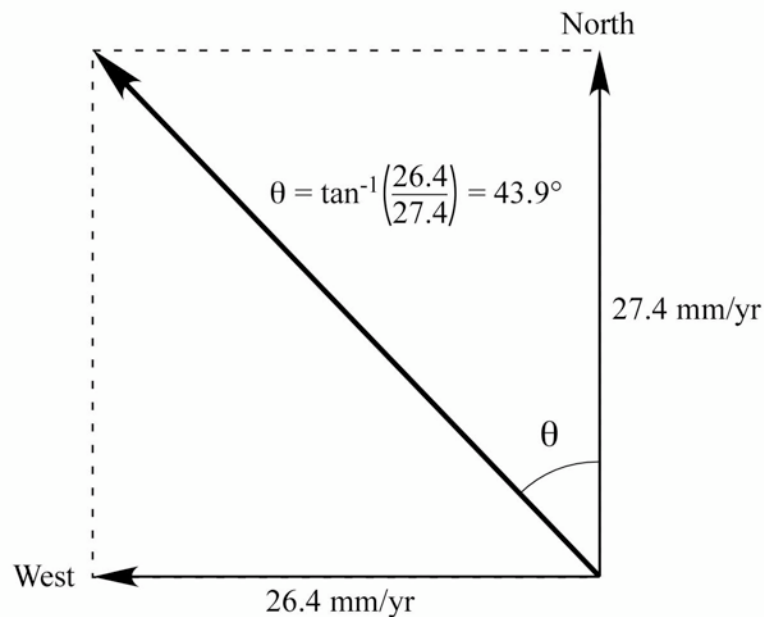
26.4 mm/yr west

3.2 mm/yr down

What is the length (magnitude) of the total velocity vector? By the Pythagorean Theorem, the length of the total velocity vector (V) is

$$V = \sqrt{(27.4)^2 + (26.4)^2 + (3.2)^2} = 38.2 \text{ mm/yr}$$

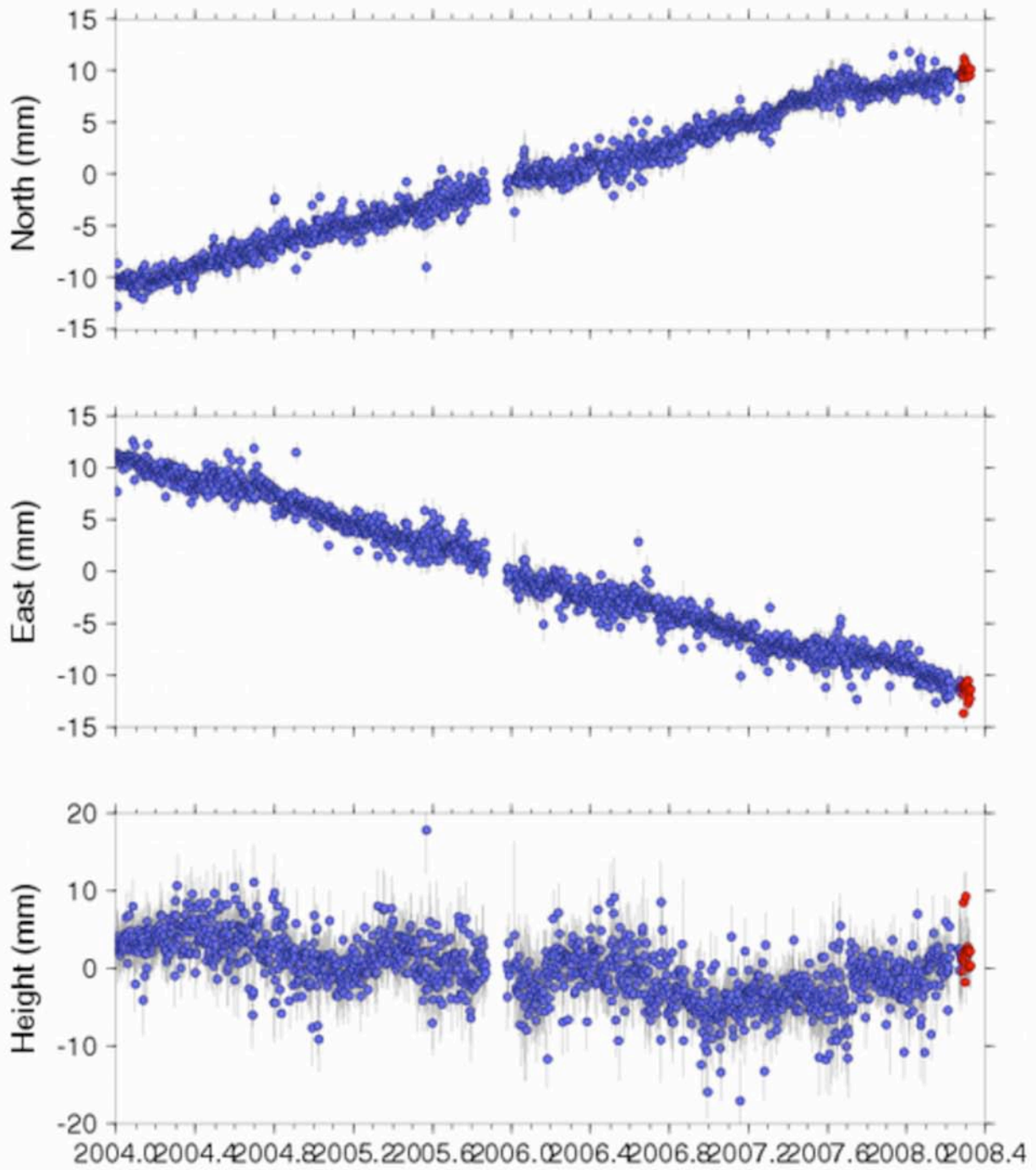
What azimuth is that vector directed toward? We plot the two horizontal vectors and use them to define the horizontal projection of the total velocity vector. We can then either measure the angle between the total velocity vector and a north-south line, or we can solve a trigonometric equation to find the angle.



In this case, the station is moving 43.9° to the west of north, or toward an azimuth of $(360^\circ - 43.9^\circ) = 316.1^\circ$.

Second data handout (from http://www.unavco.org/edu_outreach/data/BEMT.html)

BEMT (BEMT_SCGN_CS2001)



Graphical Solution for Second Station

BEMT (BEMT_SCGN_CS2001)

