GPS Data and Earthquake Hazard

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Summary

Students learn to read GPS time series plots and apply that knowledge to evaluating the earthquake hazard in Cascadia. They observe that in the Pacific Northwest the western edge of the North American plate is moving northeastward compared to the interior of the North American continent. These observations support the hypothesis that the plate boundary is "locked" and building up strain that must eventually release in the next great Cascadia earthquake.

Context

Audience

Introductory undergraduate geoscience, geohazards, or environmental geology class.

Skills and concepts that students must have mastered

Students have already had introduction to plate tectonics.

How the activity is situated in the course

Most likely this activity would be done during the earthquakes section of the course. Could also work in conjunction with plate tectonics. It can be done as an ~20 minute small group activity during the flow of a "lecture" related to earthquakes or tectonics. Could also be adapted as a short homework exercise.

Goals

Content/concepts goals for this activity

Reading GPS time series plots; calculate measured horizontal velocities.

Higher order thinking skills goals for this activity

Students will be able to analyze GPS data, identify the regions of higher strain, and relate the findings to relative earthquake hazard.

Other goals for this activity

Practice applying quantitative skills of: estimating best-fit lines, calculating slope, and determining the length of a hypotenuse.

Activity Description and Teaching Materials

This activity can be done as a small-group break-out activity during the flow of a class or lab related to earthquakes or tectonics. The PPTX provided (gps-and-cascadia-earthquake-hazard-instructor.pptx) could be imbedded in a longer presentation. It includes background information that can be used to introduce students to what GPS stations are. It can be particularly compelling to try to evoke students' imagination of actually measuring how the ground is moving under their own feet at this very moment! After the instructor has worked through what high precision GPS

is, how it works, how to read the basic location data to determine rates of movement, and the Pacific Northwest GPS station map…stop the PPTX.

Divide the class into groups of 2-4. Use the files from cascadia-gps-time-series-handouts-student.pdf to give the students data to work with themselves. Each team should have data from two stations and two blank graph sheets. It works well if there are at least three different teams doing each station so that there is a check on answers obtained. Give the students time to work through calculating north, east, and total horizontal velocity and graphing the results. Then bring the attention of the class back to the main presentation and work through the rest of the PPTX gathering input from different teams as you step through the results from each station and finally achieve the final map which shows much greater movement near the coast than inland. Engage the class in a discussion about what this is and what it means.

You can follow this discussion with showing the animation what-can-gps-tell-about-future-earthquakes?.mp4 and then seeking student input on whether/how it has refined their understanding.

Teaching Notes and Tips

Students tend to find the stations with little movement to be quite confusing. If you have a class with students particularly challenged quantitatively, it can be best to only give them coastal and lowland stations for their own calculations. Once they have worked through the stations with more obvious movement themselves, you can show them the data from the far-inland stations and they seem to understand the very low movement results better.

Assessments

The instructor could: collect each team's graphed results and grade them or just do formative assessment during the class itself and then include a question related to reading and interpreting time series on a quiz or exam.

Extension

As part of assessment or to help students extend their understanding to another location, they could look at time series from another area such as California and investigate movement recorded on either side of the San Andreas fault. Alternatively ask them to analyze a time series with an actual earthquake in it to see if they can determine what it is.

Resources

Plate Boundary Observatory (PBO) data can be downloaded at http://pbo.unavco.org/data/gps.