2008 SCEC Annual Report

Rapid and continuous assessment of holes in campaign GPS density

Rowena Lohman
Department of Earth and Atmospheric Sciences
Cornell University, Ithaca, NY 14850
Ph: 607 255-6929;
email: rbl62@cornell.edu

Amount of requested funding: $10,017
        SCEC internship matching funds + travel for PI+interns

Proposal Categories:
Category A. Data Gathering and Products
Category E. SCEC/SURE intern project
        proposal includes funding for undergraduate research
Category F. Workshop Participation
        This is an abbreviated proposal (with few references) because the only requested
        costs are workshop participation for two participants and a SCEC internship. The
        requested funds can be adjusted if a SCEC internship is granted.

Science Priority Objectives:
C: Improve and develop community products (data or descriptions) that can be used in
system-level models for the forecasting of seismic hazard. Proposals for such activities
should show how they would significantly contribute to one or more of the numbered
goals in A or B.
        A2. Investigate implications of geodetic/geologic rate discrepancies
        A3. Develop a system-level deformation and stress-evolution model

Start date: Feb. 1, 2008
End date: Jan. 31, 2009

Overview:
Throughout much of Southern California, high-precision Global Positioning System
(GPS) stations have been erected to monitor ground motion resulting from elastic
deformation around the plate boundary. These stations come in two flavors: continuous
and campaign. Continuous GPS stations automatically collect data and lots of it, so their
errors are relatively small. Campaign GPS stations, on the other hand, require manual
resurveying, but cover a much broader area. The costs associated with placing new
continuous stations and resurveying old campaign stations are rather high – thousands of
dollars per site.

The GPS network in Southern California constitutes about 200 continuous GPS stations
and several hundred more campaign sites, each with its own data and time series. We
explored varying levels of spatial smoothing to determine shear strain and dilation, and

performed Monte Carlo tests to determine the expected variance on these values. Extending the temporal span of GPS observations for individual stations will decrease model errors and result in better estimates on strain or other model parameters. Other factors, such as distance from faults, also affect stations' contributions to models. Using computer programs, such as Matlab, to artificially extend stations' time series data, we can determine the effect a resurveyed site has on the model and infer which sites would most benefit the model if resurveyed. This in turn shows the optimal distribution of resources to improve model estimates.

The other challenge is then to present improvement data in an efficient manner. For this purpose, we created a public website and Google Earth™ tour. The combination of these tools allow for easy distribution, and visualization in the interactive environment of Google Earth. The next step will be to compare the models resulting from this research to updated models from Crustal Motion Map version 4 to determine the accuracy of these estimated error improvements.

Progress:
The students achieved the following over the course of the summer:
1. Created web page detailing their results, at http://home.comcast.net/~nrwhawk/scec/index.htm
2. Learned the basics of inverse theory and strain analysis, as well as the use of GMT and the Matlab mapping toolbox, as well as how to import their results into Google Earth.
3. Set up codes that could perform Monte Carlo analyses of strain inversions for various parameters, and then compared the error estimates on these parameters before and after the addition of new campaign GPS observations.
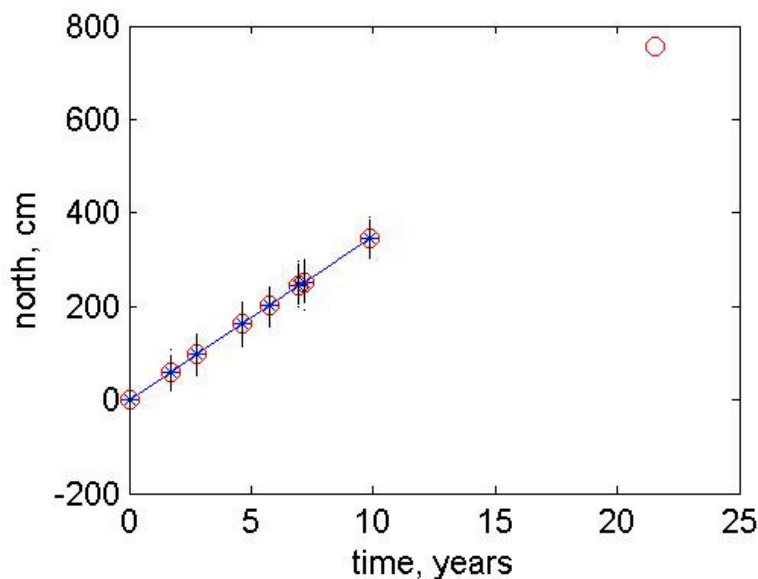

Figure 1: Typical time series for one of the sets of campaign GPS observations, with a hypothetical "new" observation. The students then examined the sensitivity of the inferred rate at this site to the addition of the new observation, as well as other types of inversion results.

The students were unable to add in data from the CMM 4.0 crustal motion map, because it was not released during the course of this project.