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Viewing the Earth as a Rotating, Deforming Polyhedron, Using the Global Positioning System

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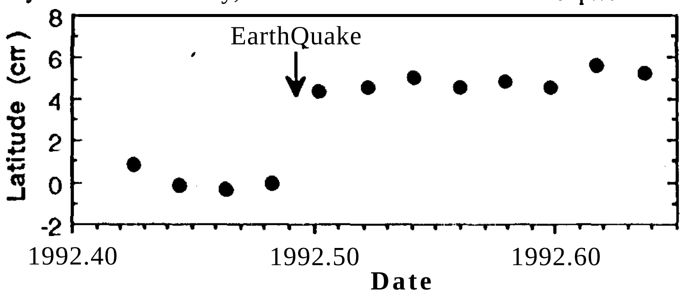
Geodesists have a new way of looking at (he Earth, using a global network of receivers that track radio signals from the satellites of the U.S. DOD's Global Positioning System (GPS). Every day since mid-1 992, various GPS analysis groups have been est imat ing the location of the Earth's pole of rotation, spin rate, center of mass, and the coordinates of-30 permanent stations around the globe. Distances between stations can be estimated with a precision of a few parts per billion (1 cm over several thousand kilometers). Each daily (or weekly) solution of the global network can be considered a snapshot of a deforming polyhedron, with stations at the vertices. The geocentric coordinates of these vertices are defined to be consistent with the distance between all stations and the distance of each station to the Earth center of mass. (The coordinate frame origin is at the Earth's center of mass, and the polyhedron's orientation is set to agree on average with international convention.)

We are no longer required to characterize station motion in terms of changes in baselines (i.e., vectors between stations). Rather, the presence of many simultaneously observing stations allows us to estimate a time-series of geocentric coordinates. Currently, in the northern hemisphere, weekly estimates of station latitude and longitude have a precision of 4 mm (and 8 mm for station height). Recently, these concepts were used to measure co-seismic displacements in California caused by the 28 June 1992, Landers earthquake sequence, Using this absolute technique, we do not have to assume symmetric slip about the fault plane. The following example shows weekly estimates of the latitude (minus a nominal value) of Pinyon Flat Observatory, about 50 km south of the main rupture:[1,2]



Observing how the global polyhedron evolves in time will allow us to measure global-scale phenomena, for example, the rebound of the Earth's crust in response to the unloading of melting ice due to Pleistocene deglaciation. It aiso provides a very precise reference frame with which to observe global sea-level change and sea-surface. topography (e.g., Topex/Poseidon mission). Such a reference frame is also important to support regional *GPS* experiments, so that all networks can be tied into one consistent kinematic description.

[1]Blewitt, G., et al., *Nature 361,* pp. 340-342, 1993.
[2]Bock, Y., et al., *Nature, 361,* pp. 338-340, 1993.

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