GPS Imaging of Solid Earth Flex and Flow From Vertical Motions Using EarthScope Networks

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We will present new results of imaging vertical motions of the Earth surface as measured by semi-continuous and continuous GPS networks including the EarthScope Plate Boundary Observatory (PBO). We show that by incorporating data in a mega-network approach, where data from numerous open access archives are obtained and analyzed uniformly, we can probe Earth's deep interior and better interpret the data in terms of geodynamic processes at work in the lithosphere. The method relies on new analysis innovations for estimating velocity fields using the non-parametric Theil-Sen median-based estimator to get vertical time series slope in a way that is highly robust with respect to unknown steps, outliers and seasonal deviations from time series linearity. We then apply a weighted median spatial filtering/despeckling algorithm and interpolation to the point estimates to create a vertical rate field.

The resulting geodetic images reveal geodynamically significant processes in the Earth's crust and mantle. Processes seen in the imagery include glacial isostatic adjustment across the North American continent, which reveals the contribution of vertical land motion to relative sea level rise with new scope and detail. We also see elastic rebound following the unburdening of the lithosphere owing to groundwater pumping in California's Central Valley, and viscoelastic flow from postseismic transient response to the largest recent earthquakes in Central Nevada and the Mojave Desert. In Fig. 1 the color indicates vertical rate for CA and NV where The MAGNET semi-continuous network is essential for providing the geographic coverage where PBO is sparse. Integrating InSAR, GPS, tide-gauge and leveling data in Southern California suggest that including constraints from InSAR provide even better control on vertical rates, making it possible to separate contributions from tectonic and hydrological forcing.