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Supporting Online Material for
Time-Variable Deformation in the New Madrid Seismic Zone

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Supporting online material

The GPS data were processed in daily batches with the Gamit software package using well-established procedures, described in detail elsewhere (e.g., 1). The new analysis adds three and a half years of data and three additional sites to the most recently published velocity estimates for the area that were based on 4 to 7 years of data. Velocity uncertainties decreased at least by a factor of two at all sites compared to earlier solutions (2). Residual velocities with respect to rigid North America are now less than 0.2 mm/yr and less than their uncertainty bounds at the 2-sigma level (95% confidence), indicating no significant site motions. Sites with the poorest quality position time series (most outliers, largest temporally correlated noise, large seasonal signals) such as RLAP and PIGT also have the largest velocity residuals.

To explore whether these residual velocities necessarily reflect real site motions, we computed synthetic time series for each GPS site's position assuming (1) zero long-term tectonic motion, (2) atmospheric and hydrological loading, two processes not corrected for in the GPS data processing, and (3) the sum of a Gaussian white noise and a random-walk colored noise with site-specific magnitudes estimated from each site's actual position time series. Surface displacements due to loading effects were computed by convolving Farrell's elastic Green's functions with the surface load. Water storage is taken from the Climate Prediction Center (CPC, www.cpc.noaa.gov) Merged Analysis of Precipitation (CMAP) and atmospheric pressure from the National Center for Environmental Prediction (NCEP, www.ncep.noaa.gov) reanalysis global pressure field. We obtained simulated time series for each site by summing the random-walk, white noise, and loading time series sampled at the dates of actual observations. Site velocities were computed from the least-squares fit of a straight line to the simulated position time series.

As expected, the presence of colored noise and loading effects in the simulated positions leads to apparent non-zero long-term velocities (Figure, top). The simulated velocity field is statistically equivalent to the observed one, even at the sites with the largest observed velocities, such as RLAP or PIGT. Simulated time series contain

fluctuations comparable to those observed in the data, in particular at site RLAP (Figure, bottom) where the apparent motion was previously interpreted as a tectonic effect (3). Hence even the largest apparent site velocities are both statistically insignificant and can be fully explained as non-tectonic artifacts. Therefore, GPS observations in the NMSZ do not require tectonic site motions different from zero.

References

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More information on the continuous GPS stations used in this work can be found at:

<http://www.ceri.memphis.edu/>

<http://www.fsl.noaa.gov/>

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Figure

Top. Comparison between observed velocities and a simulation that assumes zero long-term motion, with atmospheric and hydrological loading, white noise, and colored noise. To obtain these simulated velocities, we computed 1,000 times series per site, sampled them at the time of the actual observations, found the time series that best matches the observed one, and computed simulated velocities by fitting a straight line through the synthetic time series. Uncertainty is taken as the standard deviation of the ensemble of 1,000 simulated velocities. Bottom: Comparison between observed daily positions at site RLAP (North component) and simulated daily positions assuming zero secular motion plus atmospheric and hydrological loading, white noise, and colored noise. Dots in the background show the daily positions, thick red and blue lines are a sliding window average with a width of 30 days and forward step of one day. The simulation reproduces the offset in the observed time series around mid-2001 (no equipment or local environmental change where reported at the site at that time) and the overall slope of the time series (-0.9 mm/yr observed versus -0.8 mm/yr simulated).

