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Three-dimensional (3D) coseismic deformation map produced by the 2014 South Napa Earthquake estimated and modeled by SAR and GPS data integration

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In this work we present a 3D map of coseismic displacements due to the 2014 Mw 6.0 South Napa earthquake, California, obtained by integrating displacement information data from SAR Interferometry (InSAR), Multiple Aperture Interferometry (MAI), Pixel Offset Tracking (POT) and GPS data acquired by both permanent stations and campaigns sites.
This seismic event produced significant surface deformation along the 3D components causing several damages to vineyards, roads and houses.
The remote sensing results, i.e. InSAR, MAI and POT, were obtained from the pair of SAR images provided by the Sentinel-1 satellite, launched on April 3rd, 2014. They were acquired on August 7th and 31st along descending orbits with an incidence angle of about 23°.
The GPS dataset includes measurements from 32 stations belonging to the Bay Area Regional Deformation Network (BARDN), 301 continuous stations available from the UNAVCO and the CDDIS archives, and 13 additional campaign sites from Barnhart et al, 2014 [1]. These data constrain the horizontal and vertical displacement components proving to be helpful for the adopted integration method.
We exploit the Bayes theory to search for the 3D coseismic displacement components. In particular, for each point, we construct an energy function and solve the problem to find a global minimum.
Experimental results are consistent with a strike-slip fault mechanism with an approximately NW-SE fault plane. Indeed, the 3D displacement map shows a strong North-South (NS) component, peaking at about 15 cm, a few kilometers far from the epicenter. The East-West (EW) displacement component reaches its maximum (∼10 cm) south of the city of Napa, whereas the vertical one (UP) is smaller, although a subsidence in the order of 8 cm on the east side of the fault can be observed.
A source modelling was performed by inverting the estimated displacement components. The best fitting model is given by a ∼N330° E-oriented and ∼70° dipping fault with a prevailing right-lateral motion. Both NS and UP components are well constrained while the residuals for the EW component are higher. Further analysis will be mainly focused on model improvements.

References

[1] Barnhart W.D., Murray J.R., Yun S. H., Svarc J. L., Samsonov S. V., Fielding E. J., Brooks B. A., Milillo P. (2015) - Geodetic Constraints on the 2014 M 6.0 South Napa Earthquake. Seismological Research Letters, vol. 86, pp. 335-343, doi: http://dx.doi.org/10.1785/0220140210.