Effects of 3-D Variations in Fault Geometry and Elastic Structure on Geodetic Velocities, Ventura Basin Region, California

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Geodetic observations of interseismic elastic strain accumulation and coseismic strain release are sensitive to the heterogeneous rheology of the lithosphere. Even though models assuming simple rheology might fit observed geodetic velocities well, conclusions about fault behavior could be biased if lateral and vertical variations of the lithosphere's mechanical properties are not accounted for. We are developing 3-D Crustal Deformation Models (CDM) of southern California using the Finite Element Method (FEM), accounting for realistic fault geometries provided by the SCEC Community Fault Model (CFM) and 3-D variable elastic properties provided by the SCEC Community Velocity Models (CVM). We are using the mesh generation package LaGriT [meshing.lanl.gov] to create the meshes. To perform the modeling itself, we are using PyLith [*Aagaard et al.*, 2008]. The model we present here encompasses the region around the Ventura Basin, including the San Cayetano, Oak Ridge and Santa Susana faults.

We perform three different calculations of coseismic displacements of the Ventura Basin model: 1) analytic models using the rectangular dislocation based (CFM-R) fault geometry assuming homogeneous elastic properties [*Meade and Hager*, 2005]; 2) FEM models using our meshing of the T-surf based CFM assuming homogeneous elastic properties; 3) FEM models using our meshing of the CFM including elastic structure from the latest CVM-H. We also explore different boundary conditions by assuming a) fixed, b) free and c) displacements computed from analytical models. By comparing model results, we find that both realistic fault geometry and inhomogeneous elastic structure have significant effects on the surface displacements. The effects of differing fault geometry can reach surprisingly far from the faults in certain places; the CFM-R fault model does not always provide a good representation of the CFM. The effects of the inhomogeneous elastic structure on surface displacements are substantial in a much broader region and the inhomogeneous model shows more concentrated deformation across the basin. Incorporating the variations of elastic properties and fault geometry, coseismic displacements can differ on the order of 30~40% in the near field, and the azimuth can differ by as much as 90 degrees. We conclude that ignoring realistic variations in fault geometry by using rectangular dislocations and ignoring 3-D elastic structure can lead to large errors in calculations of coseismic and interseismic displacements.

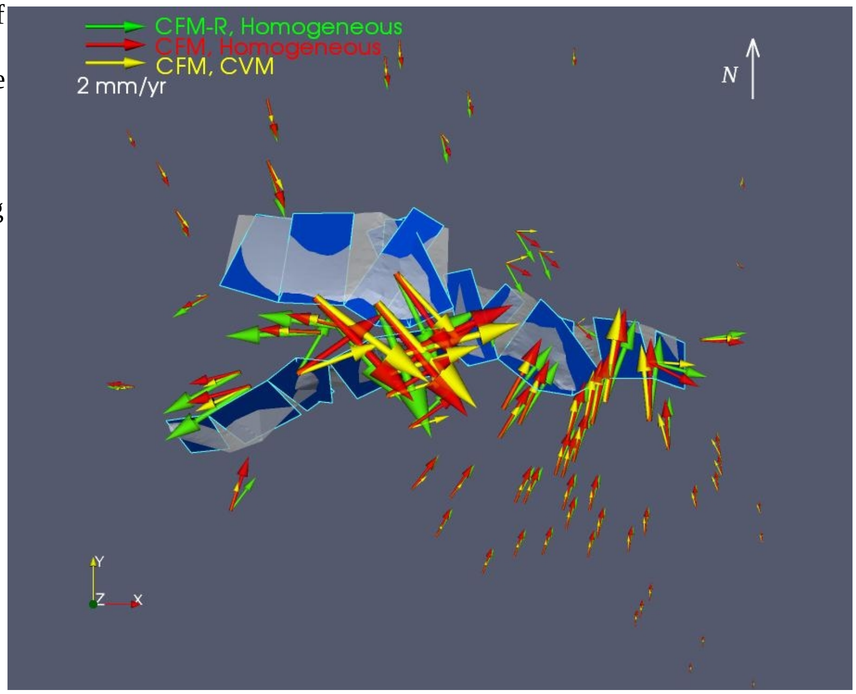

Figure. Map view of Comparison of coseismic surface displacements from models assuming different versions of fault geometry and elastic structure. Green: simplified rectangular fault geometriy (CFM-R) and homogeneous elastic structure; Red: realistic fault geometry (CFM) and homogeneous elastic structure ; Yellow: realistic fault geometry (CFM) and elastic structure with 3-D variations (CVM).

References

Aagaard, B., S. Kientz, M. Knepley, L. Strand, and C. Williams, Pylith User Manual, Version 1.3.1, Computational Infrastructure for Geodynamics, 2008.

Meade, B. J., and B. H. Hager, Block models of crustal motion in southern California constrained by GPS measurements, *J. Geophys, Res.*, 110, B03403, doi:10.1029/2004JB003209, 2005.