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A Unified Approach to Modeling the Effects of Earthquakes on the Three Pillars of Geodesy

R. S. Gross (1) and B. F. Chao (2)

(1) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA, (2) NASA/Goddard Space Flight Center, Space Geodesy Laboratory, Greenbelt, MD, USA; also at College of Earth Sciences, National Central University, Chungli, Taiwan, ROC (Richard.Gross@jpl.nasa.gov; phone:1-818-354-4010; fax:1-818-393-4965)

Besides generating seismic waves, which eventually dissipate, an earthquake also generates a static displacement field everywhere within the Earth, causing the geometrical shape of both the Earth's outer surface and of internal boundaries such as the core-mantle boundary to change. By rearranging the Earth's mass, earthquakes also cause the Earth's rotation and gravitational field to change. Earthquakes therefore affect all three pillars of geodesy, namely, the Earth's geometrical shape, rotation, and gravity. These effects of earthquakes are usually modeled separately, with flat Earth models typically being used to compute earthquake-induced site displacements and spherical Earth models being used to compute the Earth rotation and gravitational field variations. Here, a unified approach to computing changes in geometrical shape, rotation, and gravity based upon using normal modes as basis functions for the displacement field is described. By computing the normal modes for a realistic Earth model such as PREM this approach automatically accounts for the effects of sphericity, layering, and self-gravitation. The result of applying this approach to selected recent earthquakes will be shown.