Geophysical Research Abstracts
Vol. 17, EGU2015-8044, 2015
EGU General Assembly 2015

Detection of Rapid Events at Mantle Depth by Future Gravity Missions

Erik Ivins and Michael Watkins

JPL/Caltech, Science Division, Solid Earth Group, MS300-233, Pasadena, CA, United States (erik.r.ivins@jpl.nasa.gov)

The robust detection of gravity changes associated with relatively shallow subduction zone earthquakes (0-50 km depth co-seismic rupture) has been one of the success stories of the GRACE (e.g., Han et al. 2013, JGR-B, doi:10.1002/jgrb.50116) and GOCE (e.g., Fuchs et al., 2013, JGR-B, doi: 10.1002/jgrb.50381) missions. This surprise is a testament to the sensitivity of the measurement system, for the satellites must map the gravity potential field changes while flying at orbital altitudes exceeding 400 km (in the case of GRACE). It is clear that these observations contribute to advancing our understanding of large subduction zone earthquakes, if for no other reason than they allow comprehensive observation over the ocean covered solid Earth. The observations aid studies of both the mass transport associated with coseismic and post-seismic. Measurement capability for missions proposed to be flown after GRACE-2 are anticipated to be an order of magnitude, or greater, in accuracy and resolution (e.g., Wiese et al., 2012, J. Geodesy, doi: 10.1007/s00190-011-0493-8; Elsaka et al. 2014, J. Geodesy, doi: 10.1007/s00190-013-0665-9). Deep subduction zone earthquakes have not been detected, nor have any other non-seismic solid Earth deformations - with the exception of the glacial isostatic adjustment vertical response to the last glacial age. We examine the possibility that earthquakes occurring at, or near, the major transition zone in the mantle should be detected in the region where mantle phases become unstable and undergoes transition to a stable perovskite phase below 660 km depth. The Mw 8.2 1994 Bolivian Earthquake and the May 24, 2013 Mw 8.3 earthquake beneath the Sea of Okhotsk, Russia, are prototypes of events that can be studied with future gravity missions. Observation of gravity changes associated with deep subduction zone earthquakes could provide new clues on the enigmatic questions currently in debate over faulting mechanism (e.g., Zhan et al., 2014, Science, doi:10.1126/science.1252717). We also model the potential for detection of mantle plume motions in the upper mantle, and in both the deep and shallow parts of the lower mantle, by using simple parameterizations and forward models.