# Major earthquakes resulting in gravity changes detected by GRACE

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The twin-satellite mission - Gravity Recovery and Climate Experiment (GRACE) launched in 2002 measure the time-variable gravity (TVG) field. We analyze the GRACE data to study the TVG due to earthquake faulting and the associated mass dislocations in the Earth. Most GRACE TVG signals are directly related to changes in surface processes, primarily the water cycle. So we first strive to remove the terrestrial water signal using the Global Land Data Assimilation System model outputs and the seasonal (annual and semi-annual) signals by the least-squares estimation. Then we apply the method of Empirical Orthogonal Function (EOF) analysis to extract the earthquake-induced TVG signals in the epicentral region in terms of change pattern and time evolution. Our EOF results corroborate past findings of the GRACE TVG signals caused by the greatest recent earthquakes not only for co-seismic but also post-seismic behavior. We do so notably for the 2004 Sumatra-Andaman (Mw 9.1), 2010 Chile (Mw 8.9), and 2011 Tohoku (Mw 9.0) events, as well as somewhat smaller earthquakes including the 2005 Nias (Mw 8.5) event otherwise largely masked by the 2004 Sumatra-Andaman signals, the 2007 Sumatra (Mw 8.5) event, the 2012 Sumatra (double event of Mw 8.2 and 8.6 in one day) event which is largely strike-slip, and even possibly the 2013 deep-focused Okhotsk (Mw 8.3) event. We also conduct least-squares fitting with a co-seismic step function representing the earthquake for every grid point in the considered region, to augment to and confirm the EOF results. Furthermore, assuming a point-source double-couple dislocation and a spherically symmetrical Earth, the earthquake-induced displacement field is expanded by spherical harmonics where components of order greater than 2 vanish. We transform the epicenter to the North Pole in the canonical coordinates and could duplicate the whole TVG signal by spherical harmonics up to degree 60 but only order 2, which accentuates the EOF and least-squares fitting results that are approximated by co-seismic double-couple phenomena.

Keywords: earthquake, gravity change, Gravity Recovery and Climate Experiment (GRACE), Empirical Orthogonal Function (EOF)

 