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Theoretical gravitogram and gravito-gradiogram associated with seismic sources

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Seismic waves radiated from diverse source processes accompany density perturbations, which give rise to transient gravity perturbations. Here we present analytical expressions for theoretical gravitogram and gravito-gradiogram associated with seismic radiations from a single force or a seismic moment tensor in an infinite homogeneous elastic medium. Our expressions include whole time series from the instantaneous onset of gravity change to the static state. These formulae will functionally give template waveforms for the use of finding transient gravity changes in time-series data. As quantitative examples, we synthesize theoretical waveforms induced by the 2011 Tohoku-Oki earthquake (moment tensor) and by the 1980 St. Helens volcanic eruptions (single force), and examine their spatiotemporal characteristics. Other seismic sources, such as tensile cracking or CLVD (compensated linear vector dipole) in seismology are also within our scope though the corresponding prompt gravity signals are expected to be very small compared with the background seismic noise. In future the detection of the prompt gravity signals induced by earthquakes would become possible with high-sensitive measurements, which would give an earthquake and tsunami early-warning faster than the existing system based on the P-wave detection.