Geophysical Research Abstracts
Vol. 13, EGU2011-8552-1, 2011
EGU General Assembly 2011

Observations of Earth's Free Oscillation with Long-Period Rotational Ground Motion Records.Â

Maria Nader (1), Heiner Igel (1), Dieter Kurrle (1), Ana Ferreira (2), Joachim Wassermann (1), and Ulrich Schreiber (3)

(1) Earth Sciences, Ludwig-Maximilians-Universität, Munich, Germany ({maria.nader,igel,kurrle,jowa}@geophysik.uni-muenchen.de), (2) Environmental Sciences, UEA, Norwich, United Kingdom (A.Ferreira@uea.ac.uk), (3) Geodesy, TUM, Munich, Germany (schreiber@fs.wettzell.de)

Rotational seismology is a recent and promising field in active development that focuses on the study of all aspects concerning rotational ground motions induced by earthquakes, explosions, and ambient vibrations. The understanding of rotational ground motions is relevant to several disciplines: seismology (strong-motion studies, seismic instrumentation), earthquake engineering, exploration geophysics, and even the decoupling of sensitive structures from ground motions (e.g., gravitational wave detection). In this study we explore the potential of measuring Earth's free oscillations using ring laser rotational measurements.

Many different instruments have been developed to measure the rotational contribution in seismic events. So far the most successful results have been achieved using Ring Laser technology based on the Sagnac effect. In 2009, a marked improvement of the signal-to-noise ratio for the broad-band frequency range of seismic observations could be achieved after some technical improvements to the ring laser system, located at the Geodetic Observatory Wettzell (Germany), measuring the vertical component of rotation rate. This led to the first direct observation of rotational ground motions induced by toroidal free oscillations of the Earth, following the Mw=8.1 Samoa earthquake on September 29, 2009 and the Mw=8.8 Chile earthquake on February 27, 2010. Observations are compared with synthetic seismograms computed by summing normal modes. Amplitude spectra of real and synthetic data are analyzed to interpret the observations. We show that several toroidal modes can be detected in the ring laser data and that our observations are in reasonable agreement with the synthetic spectra.

A systematic analysis of rotational records of the most recent large Earthquakes shows that is necessary to have Mw > 7.8 seismic event as well as a time window between 16 and 32 hours in order to detect the toroidal modes with this instrument. In comparison with the transverse acceleration spectra acquired in a broadband seismometer at the same location, the rotation spectra exhibit a difference in the energy distribution along normal mode frequencies. Such a difference can be explained by the relationship between rotational and translational ground motions in the case of a standing wave field. This indicates that long-period seismology studies can benefit from rotational ground motion measurements using ring lasers in the future.