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Mode cross coupling observations with a rotation sensor.

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The Earth's free oscillations induced by large earthquakes have been one of the most important ways to measure the Earth's internal structure and processes. They provide important large scale constraints on a variety of elastic parameters, attenuation and density of the Earth's deep interior. The potential of rotational seismic records for long period seismology was proven useful as a complement to traditional measurements in the study of the Earth's free oscillations (Igel et al. 2011). Thanks to the high resolution of the G-ring laser located at Geodetic Observatory Wettzell, Germany, we are now able to study the spectral energy generated by rotations in the low frequency range. On a SNREI Earth, a vertical component rotational sensor is primarily excited by horizontally polarised shear motions (SH waves, Love waves) with theoretically no sensitivity to compressional waves and conversions (P-SV) and Rayleigh waves. Consequently, in the context of the Earth's normal modes, this instrument detects mostly toroidal modes. Here, we present observations of spectral energy of both toroidal and spheroidal normal modes in the G-ring Laser records of two of the largest magnitude events recently recorded: Tohoku-Oki, Japan, 2011 and Maule, Chile, 2010. In an attempt to determine the mechanisms responsible for spheroidal energy in the vertical axes rotational spectra, we first rule out instrumental effects as well as the effect of local heterogeneity. Second, we carry out a simulation of an ideal rotational sensor taking into account the effects of the Earth's daily rotation, its hydrostatic ellipticity and structural heterogeneity, finding a good fit to the data. Simulations considering each effect separately are performed in order to evaluate the sensitivity of rotational motions to global effects with respect to traditional translation measurements.

Igel H, Nader MF, Kurrle D, Ferreira AM,Wassermann J, Schreiber KU (2011) "Observations of Earth's toroidal free oscillations with a rotation sensor: the 2011 magnitude 9.0 Tohoku-Oki earthquake." Geophys Res Lett. doi:10.1029/2011GL049045