

Observations of Normal Modes Excited by The Great Sumatra-Andaman Islands Earthquake

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The Great Sumatra-Andaman Islands Earthquake of 26 December 2004 caused one of the most severe natural disaster in human history. This earthquake and accompanying tsunami devastated south Asian countries and other circum-Indian Ocean countries, social and economical impact of which would be unprecedented.

Scientifically, this was the largest event in the last half century, and the first Mw 9 class event occurred in the era of modern digital recordings. Preliminary analysis of this event reveals that this earthquake radiated rich low frequency energy as elastic waves, and seismic records of this event would be an indispensable resource for us to improve our knowledge on large scale Earth structure and source process of large interplate earthquake.

We investigate properties of low-frequency normal mode of the Earth using recordings at Japanese observatories. In addition to broadband seismic recordings, we use various geodetic recordings such as strainmeters and extensometers. Signal-to-noise ratio of these recordings are remarkably high as a result of large excitation of low frequency modes at the source.

We employ conventional spectral analysis methods as well as 'kyosin' (resonance) method [Morii, Journal of Geodetic Society Japan, 2001] to detect isolated spectral peaks of modes. The latter method is based on the principle of phase sensitive detector (PSD) or lock-in amplifier, and is a noise-resistant robust detector for spectral peaks. We are able to detect fundamental spheroidal modes to OS36 as distinct peak with this method from good vertical-component recordings at Japanese broadband stations. We also detect other exotic modes.

Splitting of the lowest frequency spheroidal mode, OS2 (at 0.31 mHz), is observable with the strainmeter recordings as well as broadband seismometer recordings, for which we use as long as approximately 25 days time series. Five splitted peaks of OS2 have temporal and spatial variation in their amplitudes. Spatially, their amplitudes have dependence on epicentral distance, as the mode amplitude diminishes near its node. Temporally, additional excitation by large aftershocks appears to be the cause and such variation could bias estimates of seismic moments of the mainshock and amplitude and width (Q) of mode peaks if ignored.