Low-Frequency Acoustic-Gravity Waves from Tectonic Deformation Associated with the 2004 Sumatra-Andaman Earthquake

Takeshi Mikumo[1]; Takuo Shibutani[2]; Takahiro Tsuyuki[3]; Shingo Watada[4]; Wataru Morii[5]

[1] Kyoto Univ.; [2] DPRI, Kyoto Univ.; [3] Matsushiro Seismological Observatory, JMA; [4] Earthquake Research Insititute, U. of Tokyo; [5] RCEP, DPRI, Kyoto-Univ.

1. Observed Data

Atmospheric pressure disturbances have been observed by sensitive microbarographs at several global stations after the 2004 Sumatra-Andaman earthquake (Mw=9.2). Among these observations, very low-frequency acoustic-gravity waves (0.0016 - 0.0027 Hz) with a group velocity around 305 - 315 m/s and amplitudes ranging between 1 - 9 Pa can be clearly identified through data processing at 4 stations on the Japanese Islands and also at 4 IMS stations around the Indian Ocean. The recorded waves may have been generated by large-scale tectonic uplift and subsidence of the sea-bottom due to this great thrust earthquake and hence by swelling and depression of the sea surface over the source region extending for 1500 km.

2. Waveform Modeling Related to Tectonic Deformation

We attempt to model synthetic barograms appropriate to some of these stations, on the basis of dynamic response of the lower atmosphere with realistic thermal structure up to an altitude of 220 km, assuming several seismic source parameters. For this forward modeling, we incorporate the source dimensions in different zones, the spreading velocity of the source region, the vertical displacements of uplift and subsidence, and their time constants. Some of various combinations of these source parameters provide the synthetic waveforms well consistent with the general features of the observed low-frequency records.

3. Results

The results suggest that the uplift in the south-central zone of the Andaman-Nicobar regions may be at least a few times larger than that in the other zones, and that the northern half of the entire region appears to contribute only a small portion to the generation of the observed acoustic-gravity waves. The time constant of the tectonic deformation may be of the order of 1 - 1.5 min, which is the time shortly before generating tsunami waves. These features are found to be similar to the case of the 1964 Alaskan earthquake (Mw=9.0) that also accompanied large tectonic deformations and generated low-frequency atmospheric pressure waves.

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