Slip Distributions of the 2004 Sumatra-Andaman and 2005 Nias Earthquakes
–Re-examination of Tsunami Data Inversions using Phase-corrected Green's Functions –

*Yushiro Fujii[1], Kenji Satake[2], Shingo Watada[2], Tungcheng Ho[2]

1. International Institute of Seismology and Earthquake Enginnering, Building Research Institute, 2. Earthquake Research Institute, The University of Tokyo

We re-estimated slip distributions on faults of the 2004 Sumatra-Andaman (Mw9.1) and 2005 Nias (Mw8.6) earthquakes by the inversion of tsunami data with phase-corrected Green’s functions (GF). The phase correction method by Watada et al. (2014, JGR) was applied to linear long waves calculated at observation data points. This correction includes the effects of elasticity of solid earth, compressibility of sea waver and gravitational potential variation to reproduce the delayed arrival and phase reversal of the first tsunami waves. Recently, this correction method was applied to the 2010 Maule earthquake (Yoshimoto et al., 2016, GRL) and the 2011 Tohoku earthquake (Ho et al., 2017, JGR).
For tsunami data inversions of the 2004 and 2005 earthquakes, we used the digital data at tide gauges (TG) in and around the Indian Ocean. Most of TG data were downloaded from the University of Hawaii, Sea-Level Center, and some of them were digitized from analog marigrams shown in Tsuji et al. (2005, EPS) and Aydan et al. (2005, JSMST). We also used the sea surface height (SSH) data from satellite altimetry measurements for inversions of the 2004 earthquake. The SSH tsunami signals were well extracted from background ocean noise by Hayashi (2008, JGR:O).
As the fault models, we used the 22-subfault model of Fujii and Satake (2007, BSSA) for the 2004 earthquake, and newly set eight-subfault model for the 2005 earthquake covering the shallower to deeper areas along the plate boundary. Each subfault has a size of 100 km length and 100 km width. We perform tsunami data inversions of the SSH and TG data using linear long wave GFs with or without the phase corrections, and changing assumed rupture velocities (Vr). We also calculate the far-field tsunami waveforms from the estimated slip distributions to compare with the observed records at ocean bottom pressure gauges (OBPG) located at Drake Passage, a DART off Chile, and Syowa station in Antarctica.
The inversion results show that the reproducibility of tsunami waveforms at TGs and spatiotemporal SSH data are improved, although the phase-correction effects are not so significant for stations or data points within the Indian Ocean. For the 2004 earthquake using the phase-corrected GFs and Vr = 1.5 km/s, the slip distribution inverted from the SSH data shows large slips of 17 - 22 m off Sumatra, moderate slips of 5 - 7 m off Nicobar Islands, and small slips less than 5 m in Andaman Islands. This slip model well reproduces the SSH data and explains the OBPG tsunami waveforms at the far-field stations more than 13,000 km, while the slip distribution inferred only from TG data does not well reproduce the SSH data.
For the 2005 earthquake, a deeper slip of 7 m was revealed from the TG data inversion. The far-field synthetic tsunami waveform approximately matches with the observed OBPG data at the Syowa station.

Keywords: 2004 Sumatra-Andaman earthquake, 2005 Nias earthquake, Slip distribution, Tsunami data inversion, Phase-corrected Green’s function