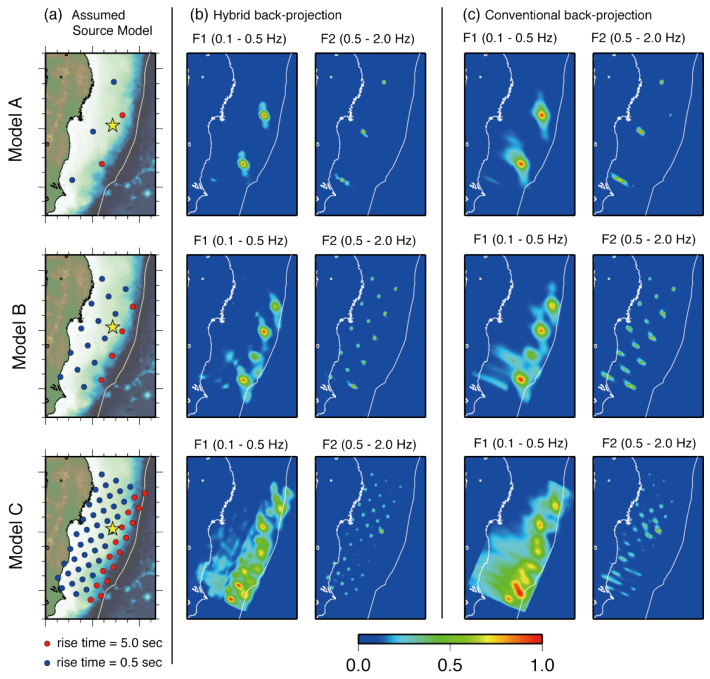
Seismic Source Imaging: Hybrid Back Projection

Yuji Yagi[a,1], Atsushi Nakao[b] Amato Kasahara[a],

[a]University of Tsukuba, Japan; [b] Tokyo Institute of Technology, Japan

Nominally continuous data in space and/or time is obtained in various observations in geophysics. Due to an enhanced technology of computers, we can now estimate seismic source process using such observed data with a very high sampling rate. We have been developing a new method to estimate the detailed and stable seismic source process. In this poster, we demonstrate a hybrid back-projection method that uses teleseismic P-waveforms to integrate the direct P-phase with reflected phases from structural discontinuities near the source. We projected a normalized cross-correlation of observed waveforms with corresponding Green's functions onto the seismic source region to obtain a high-resolution seismic source image. Applying this method to teleseismic P-waveform data of the 2011 Tohoku-oki earthquake, we obtained seismic source image for two frequency bands, a low-frequency dataset and a high-frequency dataset. We performed a synthetic test to compare the HBP method with the conventional BP method, focusing on the effect of source location and model resolution. The conventional BP method produced a more blurred image than the hybrid method for both frequency bands. The discrepancy between the input and estimated models tended to increase with distance from the hypocenter for both methods. Using the hybrid back-projection, we detected a large sub-event near the Japan Trench in the area of maximum slip, which was also the source area of the gigantic tsunami, when we used only the low-frequency dataset.



Results of synthetic test. (A) Source models A, B and C. Circles indicate point sources with rise time of 0.5 s (blue) and 5.0 s (red). The star indicates the epicenter determined by JMA. (B) Distribution of normalized total seismic energy release determined by the hybrid back-projection method for frequency bands F1 and F2 for models A, B and C. The color scale (normalized beam power) indicates the amount of seismic energy released (warmer colors indicate greater energy release). (C) As for panel (B) but the conventional back-projection method.