Evaluation of Variation in Source Parameters of Repeating Characeristic Subduction
Earthquakes in Case of Characteristic Earthquakes off Kesennuma, northeast Japan

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After the experience of the 2011 Tohoku earthquake, scenario-based strong motion prediction is
strongly required quantitatively to show its variation or uncertainty. In this presentation, we
focus on the variation or uncertainty of source parameters such as area and stress drop of strong
motion generation area (SMGA). In the strong motion prediction recipe, outer and inner source
parameters are given by the empirical scaling relationships (e.g., Murotani *et al.*, 2008). Each
empirical scaling relationship has its standard deviation. However, such standard deviation is
combination of variation due to difference in source characteristics among many different source
regions and one due to the deviation among repeating events in a specific source region. In order
to develop more sophisticated strong motion prediction, we would like to separate these two factors
of variations from each other to obtain reasonable probabilistic distributions of source parameters
by analyzing repeating characteristic earthquakes occurring in a same source region. Nagai *et al.*
(2001) and Yamanaka and Kikuchi (2004) are pioneering studies for such objectives, however, what
aspect of SMGA will be preserved and deviated is need to be investigated for advancing strong
motion prediction framework. Particularly in northeast Japan, repeating characteristic subduction
earthquakes have been observed during the history of strong motion observation. For example,
Takiguchi *et al.* (2011) analyzed SMGAs for the 1982 and 2008 off Ibaraki earthquakes (both events
are M_J7.0), and they concluded that the size of SMGA is same for two events, but the stress drop of
SMGA for the 1982 event is 1.5 times larger than that of 2008 event.
In this study, repeating characteristic subduction earthquakes occurring off Kesennuma, northeast
Japan, are analyzed. The latest event occurred on May 13, 2015 (M_J6.8). According to Hasegawa *et
al.* (2005) and Takasai *et al.* (2014), M6-class events repeatedly occurred in 1940, 1954, 1973,
1986, and 2002. They showed that the average repeating period is 15.5 years and the average JMA
magnitude is 6.3. Two events occurring in 2002 and 2015 are densely observed by K-NET and KiK-net
operated by NIED. PARI continues strong motion observation in many ports over 50 years, and four
events (1974, 1986, 2002, and 2015) were observed by their network. The figure below shows
comparison of the EW components of observed velocities in 0.2–2 Hz at Ofunato-Bochi station of
PARI. The pulse length of the direct S-wave is almost same for these four events, but the maximum
amplitude of the 2015 event is largest among the four events. From above comparison, the size of
SMGA for these four events might be almost equivalent to each other, and the difference in the
waveforms reflects the difference in stress drop of SMGA. We will further discuss on the variation
in stress drop based on the spectral ratio method and waveform modeling.

Keywords: Repeating characteristic earthquakes, Source characteristics, Strong motion generation
          area