Relationship between the subducting plate boundary and fault geometry of the 2016 Mw7.8 Kaikoura Earthquake, New Zealand, based on high precision aftershock distribution

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On November 14, 2016, the Kaikoura earthquake (Mw. 7.8) occurred in northeastern South Island, New Zealand. The main characteristic of this earthquake is that the co-seismic rupture process of the main shock was composed of slip on many faults. Clark et al. (2017) pointed out that the aftershocks of both strike-slip and reverse fault types frequently occurred and more than 20 faults were ruptured during the main shock. Moreover, Cesca et al. (2017) proposed a simple model that the complex rupture proceeded on three major faults in the northern, central and southern areas based on the aftershock distribution, focal mechanisms, geodetic and seismic waveform inversion. Two previous studies have relocated aftershocks using double-difference techniques (Mouslopoulou et al., 2019; Lanza et al., 2019). However, in these studies, it was difficult to determine the fault geometry in detail because of the sparse seismic station density within about 50 km. In this research, we added phase data from seismic stations that we deployed before the main shock in order to improve the accuracy of hypocenter location. Furthermore, we apply the double-difference earthquake relocation algorithm (Waldhauser and Ellsworth, 2000) and time-domain waveform cross-correlation (Poupinet et al., 1984), which further enhance the precision of the hypocenter locations.

As a result, the variance of the hypocenter distribution is reduced and the depth is also concentrated to 15 km or less. There are 10-kilometer long clusters that mainly show a north-south-southwest orientation. Nine fault planes were found from the relocated aftershock distribution through a principal component analysis and bootstrap resampling method. The bottom of the aftershock distribution reveals a curved surface deepening in the southwest direction, which is parallel to the slab determined by Williams et al. (2013).