Hypocenter Determination Using 3-D Velocity Structure -Comparison with Temporal Observations-

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Nakamura (2004) reported hypocenters determined by 3-D velocity structure (3DHyp) of Nakamura et al. (2003). Then, he compared 3DHyp and JMA hypocenters (1DHyp) and showed that 3DHyp generally had smaller clusters and that 3DHyp were shallower than 1DHyp for deep events in the Pacific slab, suggesting that the Wadati-Benioff zones had actually lower dip angle than the conventional studies. Moreover, he pointed out that we could not improve the imprecise hypocenters in the sea area in principle.

In this presentation, I compared hypocenters determined by revised 3-D velocity structure of Nakamura et al. (2008), JMA hypocenters and hypocenters determined by temporal dense observations (TmpHyp). Nakamura et al. (2008) did not use hypocenter parameters and picked data obtained by the temporal observations to determine 3-D velocity structure. The temporal observations were for aftershocks of the following events; the Tokachi-oki Earthquake in 2003 (Shinohara et al., 2004), the Off Kii Hanto Earthquake in 2004 (Sakai et al., 2005), the Mid Niigata Prefecture Earthquake in 2004 (Kato et al., 2007), the West off Fukuoka Prefecture Earthquake in 2005 (Uehira et al., 2006) and the Noto Hanto Earthquake in 2007 (Sakai et al., 2008).

In the case of the Tokachi-oki Earthquake in 2003, 3DHyp had smaller clusters than 1DHyp in depth but TmpHyp were quite better than 3DHyp and 1DHyp. The closest pair was 3DHyp and 1DHyp for each event. We could not determine relative merits of 3DHyp and 1DHyp in horizontal direction judging from similarity with TmpHyp. In the case of the Off Kii Hanto Earthquake in 2004, 3DHyp were closer to TmpHyp than 1DHyp, especially in depth. In the case of the Mid Niigata Prefecture Earthquake in 2004, 3DHyp were closer to TmpHyp than 1DHyp in both depth and horizontal direction. However, the closest pair was 3DHyp and 1DHyp. In the case of the West off Fukuoka Prefecture Earthquake in 2005, 3DHyp were a little bit more distant from TmpHyp than 1DHyp in horizontal direction. On the other hand, 3DHyp were closer to TmpHyp than 1DHyp in depth. Moreover, the closest pair was 3DHyp and 1DHyp. In the case of the Noto Hanto Earthquake in 2007, 3DHyp had smallest clusters among three catalogues. The closest pair was 3DHyp and 1DHyp. Furthermore, we could not determine relative merits of 3DHyp and 1DHyp judging from similarity with TmpHyp.

We could summarize as follows; 3DHyp were generally better than 1DHyp, but it was not significant at all. 1DHyp were occasionally better than 3DHyp. The double difference relocation method was proposed to improve relative hypocenter precision dramatically (Waldhauser and Ellsworth, 2000). The important purpose of using 3-D velocity structure to determine hypocenter parameters would be improvement of absolute hypocenter precision as possible. To improve absolute hypocenter precision, we have only one way that is using the results of temporary observations aggressively when making 3-D velocity structure. Furthermore, those results showed effectiveness and superiority of temporary dense observations.

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References: Kato et al., 2007, EPS, 59, 923-928; Nakamura, 2004, Abstr. 2004 Japan Earth Planet. Sci. Joint Meeting, S045-001; Nakamura et al., 2003, Abstr. 2003 Japan Earth Planet. Sci. Joint Meeting, S053-P010; Nakamura et al., 2008, PEPI, 168, 49-70; Sakai et al., 2005, EPS, 57, 363-368; Sakai et al., 2008, EPS, 60, 83-88; Shinohara et al., 2004, EPS, 56, 295-300; Uehira et al., 2006, EPS, 58, 1605-1610; Waldhauser and Ellsworth, 2000, BSSA, 90, 1353-1368.