

The differences between focal mechanisms by the initial motions and moment tensors by the waveforms in and around Japan

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1. Introduction

Japan Meteorological Agency (JMA) has determined the P-wave initial motion focal mechanisms (hereafter called IM) for the local earthquakes occurred in and around Japan. On the other hand, National Research Institute for Earth Science and Disaster Prevention (NIED) has routinely calculated the moment tensor solutions (hereafter called MT) for local events by F-net broadband seismograms since January 1997 [Fukuyama et al., 1998]. Both of IMs and MTs are published, and they are useful in understanding the surrounding of the earthquake occurrence. Agreement of two catalogues is good as a whole. However, large difference is observed for a considerable number of events, as well as Hori (2002) appointed the disagreement between the F-net MT and the NIED IM for the earthquakes occurred beneath the Kanto-Tokai district. In this study, we report the statistical nature and regional feature of the differences for the events occurred in all over Japan.

2. Data and Method

We compare the JMA IMs with the F-net MTs for the period from October 1997 to May 2009. There are about 3,100 earthquakes, which are included in both catalogues. The mean number of polarities for IM is 155, and the minimum is 22. The mean score is 96%, and the minimum is 77%. We don't use some MTs, the number of used station for is less than 3 or the variance reduction of is less than 70%. In order to evaluate the difference between IM and best DC solution of MT, we use the 3-D rotation angle (hereafter called K angle) [Kagan, 1991].

3. Result

The mean of K angles is 26 degree, and the median is 20 degree. The number of the events which have less K than 30 and 45 degree is 71% and 87%, respectively. Though the number of disagreement in this study is smaller than that Hori (2002) described, we cannot ignore the difference.

In terms of focal depth, the mean K for shallower events than 20km is significant large, and deeper events tend to have smaller K. The mean K for the events of larger absolute value of eps, which means the amount of the non-DC component, tends to be large. The mean K for larger events tends to be small.

We describe the regional features of disagreement for shallower events than 90km. We divide all over Japan into 269 sub-regions, and calculate the ratio of the events which have the larger K angle than 30 degree at each sub-region. The ratios in the regions; near Miyakejima and far off Ibaraki, where Hori (2002) indicated the ratios are high, are 60% or more in this study, too. In addition to these, we find the following regions, where the ratios of the disagreements are 45% or more: southern Yamagata, off Miyagi, northern Tochigi, east off Izu peninsula, far southern off Boso peninsula, around Noto peninsula, western Fukui and eastern Tottori.

4. Discussion and Summary

Hori (2002) described that the cause of the disagreement is for the difference between the mechanisms of initial and main rupture in well-fractured area. In this study, the large differences in the swarm areas and the relation of eps with the mean K seem to support his hypothesis.

However, Aoki (2007) indicated that JMA IMs imply 10 degree or more uncertainty. Flohlich & Davis (1999) regarded ϵ_{ps} as the index of reliability of MT. Therefore, it is fair to say that one of the causes is for the uncertainty of the mechanism. The relation of M_w with the mean K seems to support our view because the mechanisms of larger events are generally determined with better accuracy. We must examine the dependence of uncertainties of both IM and MT on the focal area, depth and so on, in order to compare them exactly.

Finally, the consistency number of polarity data with MT became, on an average, only 11% worse than that with IM in this study. We can get the polarities before determining MT. We have to use polarities as a constraint or criteria to improve the accuracy for the real-time estimation of MT. Thus it is very important whether MT is essentially different from IM.

Keywords: Focal mechanism determined by the initial motions, Moment tensor solution, Uncertainty of focal mechanisms