

## Develop and evaluate modified envelope correlation method for deep tremor

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Since the discovery of the deep tremor in southwest Japan [Obara, 2002], the tremor has been studied by many researchers. For base of these studies, the hypocenter determination of the deep tremor is necessary and the envelope correlation method [Obara, 2002] have been widely used. As an alternative, Wech and Creager (2008) proposed a method to maximize the sum of cross-correlation functions. The present study develops a new code based on Wech and Creager (2008), to improve the precision of hypocenter location and the detection completeness.

In the conventional envelope correlation method, hypocenter is determined to minimize the difference of relative arrival times. The new code determines the hypocenter to maximize the sum of the cross-correlations similarly to Wech and Creager (2008), except for their weighing scheme. This is equivalent to minimize the sum of the square of the difference of the normalized envelope functions. We optimize the objective function using the gradient method started from a preliminary solution calculated by the grid search.

Here, we apply this code to Hi-Net data in southwest Japan and detected tremors. The error of hypocenter location is estimated to be about 1 km in horizontal and vertical directions by the bootstrap method. This is smaller than the reported precision of the envelope correlation method (e.g.; Ide, 2010). The conventional envelope correlation method is able to detect only one tremor or earthquake for one time window. However, by the proposed technique, it is confirmed that each tremor and earthquake appears as a local maximum when some tremors and earthquakes occurred in one time window.

Keywords: Deep tremor, Hypocenter determination, Envelope correlation method