

Searching for unidentified events using Earth's free oscillations

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Our detection method was based on that of Beroza & Jordan (1990), but we utilized a different test statistic and a numerical method for mode detection. The method was a two-step numerical hypothesis test: the first step was for testing excitation of fundamental spheroidal modes using the bootstrap method; the second step was for testing occurrence of an event using the Monte Carlo simulation. The test statistic for mode excitation was the difference of average powers in signal and noise frequency bands, and that for event occurrence was the number of detected modes.

It was inevitable for our method to detect ordinary earthquakes and Earth's background free oscillations as events, which were nuisances in detecting unknown events. Ability of event detection was controlled by significance level of the mode excitation test, ALPHA_MODE, so that we excluded the effect of Earth's background free oscillations by setting ALPHA_MODE = 5%. This value also gave us a proper detection ability for ordinary earthquakes. Significance level of the event occurrence test, ALPHA_EVENT, was also an arbitrary parameter in this method. We set ALPHA_EVENT = 0.1% in this study. These values made our method have the same detection ability for ordinary earthquakes as Beroza & Jordan (1990).

We analyzed continuous vertical records for a 10-year period from 1990 to 1999 at 30 quiet stations of IRIS GSN and GEOSCOPE networks and examined excitation of 27 fundamental spheroidal modes 0S17-0S43, which were in frequency range with the lowest background noise. We performed the test at time step of 3~hours. We made time variation plots for achieved significance level of the event occurrence test and visually inspected them. As a result we detected about 20 unknown events in seismically quiet intervals. We ascertained that these unknown events were not missed ordinary earthquakes. 75% of them occurred in the former half period of analysis. Beroza & Jordan (1990) reported detection of 27 unknown events in the period of 1978-79 from analyses of old IDA records at 10 stations. We require more analysis to determine whether the difference in event frequency among analysis periods is of significance or not.