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Automatic Hypocenter Determination using Particle Filter Method

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Quick estimation of spatial and temporal hypocenter distributions in aftershocks is essential for taking a measure to mitigate earthquake disaster. The automatic hypocenter determination method is important to grasp seismic activities in real time, especially after the 2011 off the Pacific coast of Tohoku Earthquake. However, it is difficult to determine aftershocks due to a high trigger level and wrong phase pickings.

To solve above problems, Liu, Yamada (2011) proposed a particle filter method for detecting earthquakes that occurred at the same time. This method can estimate the most probable event parameter values (t,lat,lon,dep,mag). They formulated a likelihood function using the amplitude.

In this study, I proposed a new likelihood function using the amplitude and pickings. I defined the likelihood function as follows,

$lik(x|m,s)$=Product$_{i=1}^{N}[f(t_i^{obs}|m,s_i)*g(M_i^{obs}|m,s_M)]$,

where f is the likelihood function for variance of pickings, g is for variance of magnitudes, m is the particle (t,lat,lon,dep).

In addition, I considered the territory method and the hypocenter distribution of the past in the first probability density function.

I applied this method for some aftershock activities. This method can determine 90% or more hypocenters automatically compared with JMA catalog (Inland, M>=1.0).

Keywords: automatic hypocenter determination, particle filter