P波初動データを用いた応力空間パターン推定手法の開発：予備的な数値実験
Development of a method to estimate spatial stress pattern from P-wave first motion data: a preliminary numerical simulation

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A method of estimating spatial stress pattern from a centroid moment tensor (CMT) dataset has been developed by Terakawa and Matsu'ura [2008, GJI, 172, 674-685]. However, often the number of available CMT solutions is limited if our interest is the estimation for a small area. For such a case, it is difficult to apply this method because of the insufficiency of data. To meet this difficulty, this study proposes a method to estimate from P-wave first motion data, instead of CMT data. We assume that the direction of a pre-existing fault plane is random and that the direction of a seismic slip is parallel to that of the tangential component of the stress vector. Under these assumptions, we can compute the probability of the polarity (up/down) of a P-wave first motion if stress field at an hypocenter and the geometry between the hypocenter and seismic stations are given. Thus, on the basis of a likelihood function constructed from the computed probability and a prior distribution corresponding to a spatial smoothness constraint on the stress field, we can estimate the spatial stress pattern through a Bayesian approach.
The development of this method is currently at preliminary stage, and thus only a numerical simulation has been done. For the simplicity of the simulation, a case where hypocenters and seismic stations are located in a two-dimensional space (i.e., plane) is considered; one is horizontal and the other is vertical. Also, the direction of the intermediate principal stress (sigma2) and that of a fault plane of each earthquake are supposed to be vertical to the considered plane. The spatial variation of the plunge of the direction of the maximum principle stress (sigma1) is assumed to be follow a particular pattern (and consequently, the direction of the minimum principle stress sigma3 is also determined). Under these conditions and assumptions about the directions of a fault plane and seismic slip as described above, datasets of P-wave first motions are generated. Then, the proposed Bayesian approach is applied to these datasets. As a result, the estimated spatial pattern almost agrees with the one assumed in the generation of the simulation datasets, which suggests the validity of developing this Bayesian approach.

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