Criteria for Evaluating Alternative Hypocentres

R J Willemann

Many seismic network operators are implementing new algorithms and travel time models for computing earthquake hypocentres. Their objective is more accurate hypocentres and hypocentral uncertainties, which are required for rapid response to disasters, studies of earthquake physics and earth structure, and monitoring the comprehensive test ban treaty. It is preferable to evaluate different hypocentres by comparing them with "ground truth", but very accurate locations are often unknown or perhaps undependable. Alternatively, we could compare differences between residuals arrival times for differently computed hypocentres, since more accurate locations should fit the data better. Difficulty arises in evaluating the statistical significance of residual statistics, however, since the population distribution is not known and the samples are likely to include outliers. Where two sets of hypocentres are computed using the same method and data but different travel time models, they optimise the same norm of the residuals. Variance of the residuals is a familiar norm, even though an unmodified variance is rarely used in practice because of its sensitivity to outliers. We show how two complete sets of residual norms can be compared, so that the statistical significance of their differences can be evaluated without making assumptions about their distribution. We give examples from recent work at the ISC using travel times from three-dimensional earth models. When two sets of hypocentres are computed using different location algorithms or with different data, however, the residual norms are generally not comparable. This case is of interest to the ISC in evaluating use of later phase arrival times, and we discuss the utility of robust measures of scale to compare residuals directly, rather than the norms for each set of hypocentres.

Slides presented at the meeting