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ERRATA

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Methods for Regression Analysis of Strong-Motion Data

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We have discovered errors in our recent article describing one- and two-stage maximum likelihood methods for regression analysis of strong-motion data. The corrections, fortunately, are simple and are described below.

In the first stage of the two-stage method, the parameters controlling the distance dependence are determined along with a set of amplitude factors, one for each earthquake. In the second stage, the amplitude factors are regressed against magnitude to determine the magnitude dependence. As described in the article, the second stage is a generalized least-squares problem (Searle, 1971, p. 87) with a weighting matrix equal to the inverse of the variance-covariance matrix of the residuals. The variance-covariance matrix of the residuals, given by equation (28) of the article, has off-diagonal terms and consequently the weighing matrix has off-diagonal terms. The off-diagonal terms reflect the fact that the amplitude factors are mutually correlated because they were determined in the first-stage regression along with the parameters controlling distance dependence and are coupled through possible errors in the distance parameters.

The use of the full weighting matrix, including the off-diagonal terms, in the second stage is a logical error. By using that matrix we are in effect asking, what are the best estimates of the magnitude coefficients independent of the values of the distance parameters determined in the first stage? What we should be asking is what are the best estimates of the magnitude coefficients for use with the distance parameters determined in the first stage, or, in other words, what are the best estimates of the magnitude coefficients conditional on the values of the distance parameters obtained in the first stage? If we fix the distance parameters, the variance-covariance matrix for the residuals of the second-stage regression is diagonal, and its inverse is the diagonal weighting matrix given in equation (34) of the article. Equation (34) gives the rigorously correct weighting ma-

Corrected Table 4
Monte Carlo Comparison of One-Stage and Two-Stage Methods for Peak Velocity

Parameter*	Assumed Value	One-Stage Mean of Simulations	Standard Deviation of Simulations	Assumed Value	Two-Stage** Mean of Simulations	Standard Deviation of Simulations
a	2.123	2.144	0.064	2.191	2.224	0.096
b	0.439	0.436	0.065	0.487	0.483	0.102
c	−0.00098	−0.00115	0.00132	−0.00256	−0.00277	0.00155
h	3.71	4.04	1.27	4.00	4.37	1.37
s	0.238	0.222	0.061	0.167	0.152	0.063
Parameter*	**Assumed Value**	**Median of Simulations**	**16–84 Percentile of Simulations**	**Assumed Value**	**Median of Simulations**	**16–84 Percentile of Simulations**
$\hat{\sigma}_r$	0.214	0.213	0.192–0.230	0.199	0.199	0.178–0.219
$\hat{\sigma}_e$	0.0	0.0	0.0–0.0	0.181	0.174	0.112–0.251
Magnitude and Distance	**Log Velocity Calculated from Assumed Values**	**Mean Log Velocity Calculated from Output Parameters**	**Standard Deviation of Log Velocity Calculated from Ouput Parameters**	**Log Velocity Calculated from Assumed Values**	**Mean Log Velocity Calculated from Output Parameters**	**Standard Deviation of Log Velocity Calculated from Output Parameters**
$M = 7.5, d = 0$ km	2.446	2.431	0.133	2.476	2.470	0.188
$M = 6.5, d = 0$ km	2.007	1.995	0.112	1.989	1.987	0.141
$M = 7.5, d = 25$ km	1.592	1.587	0.083	1.620	1.625	0.139
$M = 6.5, d = 25$ km	1.153	1.151	0.038	1.133	1.141	0.078

*Parameter values correspond to the use of logarithms to the base 10 in equation (1).
**Weighting in the second stage as given by equation (34).

trix for the second-stage regression rather than an approximation, as indicated in the article. We discovered the error when we applied the method to response spectra and, in some cases, found that the output of the second regression did not fit the data very well. When we changed to the weighting given in equation (34), the output fit the data, and the results of the two-stage method agreed with those of the one-stage method.

We recomputed the results given in Tables 3, 4, 5, and A1 of the article using the weighting of equation (34) for the second stage of the two-stage computation in place of the weighting originally used. In the case of Tables 3, 5, and A1, the numbers shifted, in some cases, by amounts comparable to the differences shown in Table 2 between the results for the two weighting methods (columns 1 and 4). The shifts in the case of Table 4 were larger, reflecting the effect of the smaller data set. The recomputed values, however, demonstrate that the conclusions drawn in the article from Tables 3, 4, 5, and A1 apply also when the weighting of equation (34) is used. To save space we do not give the recomputed results for Tables 3, 5, and A1. In the corrected Table 4, given here for other reasons as discussed below, the two-stage computations were done with the weighting of equation (34).

A second, less serious problem was encountered in applying the two-stage method to response spectral data. The second stage of the two-stage method requires the solution of equation (33) of the article for σ_e, the earthquake-to-earthquake component of ground-motion variance. In some cases equation (33) had no solution for real σ_e. A satisfactory alternative is simply to minimize the square of the difference between the left- and right-hand side of equation (33).

Two computer programming errors were also discovered. One affects the numerical results only in the least significant digit, and to save space we do not give corrected results. The other error affects only Table 4 of the article. A corrected Table 4 is presented with this note. The changes do not affect the original conclusions of the article.

References

Searle, S. R. (1971). *Linear Models*, Wiley, New York, 532 pp.