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Solid Earth Discussions

Interactive comment on "The stochastic quantization method and its application to the numerical simulation of volcanic conduit dynamics under random conditions" *by* E. Peruzzo et al.

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We thank referee $\#1$ for his comments. We answer to the two specific comments.

1. For the minimization of the function $h(\mathbf{x}^{(1)}, \ldots, \mathbf{x}^{(N)})$, we used a standard minimization algorithm for functions of several variables, the Powell's method. This method requires the assignment of an initial point and of an initial set of search directions, which is usually chosen to be the set of unit vectors in the coordinate directions. The algorithm consists in successive minimizations of h along the

search directions: the results of these one-dimensional minimizations are used to identify the directions of steepest descent of the function, which are progressively included in the set of search directions. See (Powell, 1964) and (Press et al. , 2001) for an exhaustive explanation of the method.

   However, the use of Powell's method is not critical: other multidimensional minimization techniques could be used, provided they are sufficiently robust as the number of variables increases. h is a function of N points in a d-dimensional space, so it depends on Nd variables; as Nd increases, the risk of finding only a local minimum becomes very high. In order to overcome this risk, for each value of N we performed 10 minimizations with the Powell's method, starting from 10 different initial points chosen at random, and we selected the lowest among the 10 calculated minima. The use of a stochastic minimization algorithm could be another possibility (see, for instance, (Pagès, 1997)).

   In order to improve the clarity of the manuscript, we have now included the following succinct description of the method at page 56 of the manuscript, just after line 5:

   The minimization is performed using the Powell's method (Powell, 1964; Press et al. , 2001), which moves the points $\mathbf{x}^{(1)}, \ldots, \mathbf{x}^{(N)}$, starting from an initial guess; for each new choice of $\mathbf{x}^{(1)}, \ldots, \mathbf{x}^{(N)}$, the algorithm evaluates $h\left(\mathbf{x}^{(1)}, \ldots, \mathbf{x}^{(N)}\right)$ going through the steps 1-4 above. The set of points which produces the minimum value of h is just the optimal set of points we are searching for. In order to minimize the risk of finding local minima, the minimization is repeated 10 times, varying the initial guesses, and the lowest minimum is taken as the best estimate of the true minimum.

2. We have now limited the number of decimal digits to two; this is justified by the central limit theorem, at least for the mean value; the other values are rounded based on the same criterion.

References

Pagès, G.: A space quantization method for numerical integration, J. Comput. Appl. Math, 89, 1-38, 1997.

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Press, W. H., Teukolsky, S. A., Vetterling, W. T., Flannery, B. P.: Numerical Recipes in Fortran 77, Cambridge University Press, Cambridge, 2001.