Response to the comments of Anonymous Referee #1

We would like to thank Referee **#1** for the thoughtful comments. The following is our response.

This article describes the temporal evolution of the spread of temperature in a randomly heterogeneous porous media. The article is well written and organized but I am afraid that has no scientific contribution. The theoretical analysis is based on a well-establish analogy between the advection-dispersion equation of solutes and the heat equation. Once this analogy is presented, the authors basically reproduce the stochastic analysis of solute dispersion in aquifers conducted by Gelhar, Dagan and many others. The analogy is well known and therefore there is no adding value in presenting this. The implications of this analogy are also obvious, i.e., it reduces the problem to basically solve exactly the same stochastic partial differential equation as Gelhar did a long time ago. For all of this, I am afraid to have to suggest the rejection of this paper.

Reply

(1) Most existing stochastic studies of transient solute transport in heterogeneous porous media have built on the Lagrangian methodology (e.g., Rubin, 2003). Within the Lagrangian framework, the transient effective dispersion coefficient is determined by half the rate of change of the particle displacement variance. On the other hand, the stochastic analysis of the field-scale temporal heat advection in heterogeneous aquifers presented in this paper is however developed based on the Eulerian point of view. The dispersion coefficient subject to transient effect is obtained by quantifying the correlation between the velocity fields and concentration fluctuations (macro-dispersive heat flux).

(2) Gelhar and Axness (1983) provided a stochastic analytical methodology for quantifying field-scale solute transport processes in heterogeneous porous media within the Eulerian framework. Their focus was placed on the prediction of macrodispersion under the steady-state condition (i.e. asymptotic macrodispersion) in heterogeneous aquifers. The paper extends their concept to deal with the transient problems such as uncertainty associated with the heat transport in heterogeneous aquifers.

(3) To the best of our knowledge, the closed-form expression for the field-scale temporal dispersion has so far not been reported in regard to the application of the methodology of Gelhar and Axness (or Eulerian concept). This paper presents the closed-form expression for the field-scale temporal heat advection which might be

the first article to provide a theoretical basis for the analysis of field-scale heat transport processes.

(4) The body of literature on stochastic analysis of heat transport is relatively sparse although the basic theory of heat flow applied to ground water problems is analogous to that of describing transport of solutes in groundwater. We hoped that the present study may stimulate further studies in this area.

References

Gelhar, L. W. and Axness, C. L.: Three-dimensional stochastic analysis of macrodispersion in aquifers, Water Resour. Res.,19(1), 161-180, 1983.

Rubin, Y.: *Applied Stochastic Hydrogeology*. New York: Oxford University Press, 2003.