Calvet el al. (2015), www.soil-discuss.net/2/737/2015/

Impact of gravels and organic matter on the thermal properties of grassland soils in southern France

Response to Reviewer #1

(X. Xiao, xinhua.xiao@aamu.edu; xiaoxinhua2009@gmail.com**)**

The authors thank Dr. Xinhua Xiao (NC State University Soil Physics) for her review of the manuscript and for the fruitful comments.

1.1 [**Accuracy of predicative λ models highly depends on accurate estimation of λsat and q, which has been oversimplified as sand fraction. It is interesting and important to predict q and λsat in λ models using data of soil texture and gravel and SOM and to further examine their impacts on λ models. The methodology in this work to address the research question is appropriate. Discussion of model applicability is covered. The new pedotransfer functions for λsat and q derived from their original data will add good contribution to the literature. I however have major concerns about the presentation/organization of this paper that I feel in some sections focus is lacking and/or reorganization needed. Better justification of adopting some key empirical models and more relevant discussion are also desired**.]

RESPONSE 1.1

Many thanks for these positive comments. We will do our best to account for your remarks in a revised version of the manuscript.

1.2 [**On obtaining site/station specific λsat and q values. Equations 7-11 are the core functions for authors to enable retrieval of the site/station-specific λsat (and q value accordingly) by parameter fitting via reverse modeling. I think these equations/models (specifically Lu et al 2007 and Yang et al 2005) should to some extent be justified why they were chosen as opposed to other alternative equations in the literatures**.]

RESPONSE 1.2

Yes, two key equations are used for λ_{dry} and for K_e (Eqs. (7) and (9), respectively).

For λ_{dry} we used the Lu et al. (2007) parameterization. Figure R1.1 shows that this parameterization produces larger λ_{dry} values than the λ_{dry} estimates derived from Côté and Konrad (2005) for mineral soils. We checked that using Côté and Konrad (2005) instead of Lu et al. (2007) has a very limited impact on λ_{sat} and q retrievals (≤0.005 $Wm^{-1}K^{-1}$ and ≤0.01 $m^{-3}m^{-3}$, respectively).

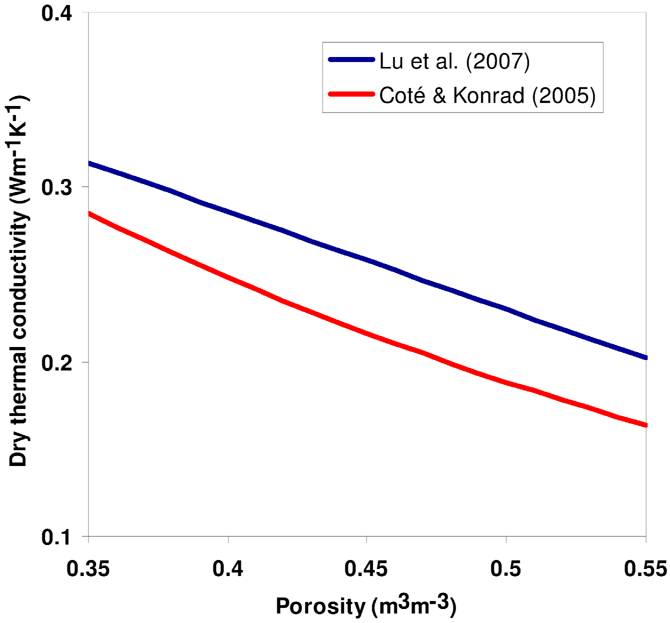

Figure R1.1 - Modelled λ_{dry} for the range of porosity values encountered in this study, using Lu et al. (2007) and Côté and Konrad (2005).

In the first version of this work, we used the Kersten number calculation used by Yang et al. (2005). Figure R1.2 shows the resulting K_e value, together the K_e value obtained using the Lu et al. (2007) model for fine and coarse soils. It can be seen that most differences between these models occur for S_d values < 0.4. Since we only use λ retrievals for S_d values > 0.4, the impact of the uncertainties in the determination of K_e is limited. However, using Lu et al. (2007) instead of Yang et al. (2005) tends to produce smaller values of λ_{sat} and q retrievals, as shown by Figs. R1.3 and R1.4. The impact of the Kersten number calculation will be discussed in the final version of this work.

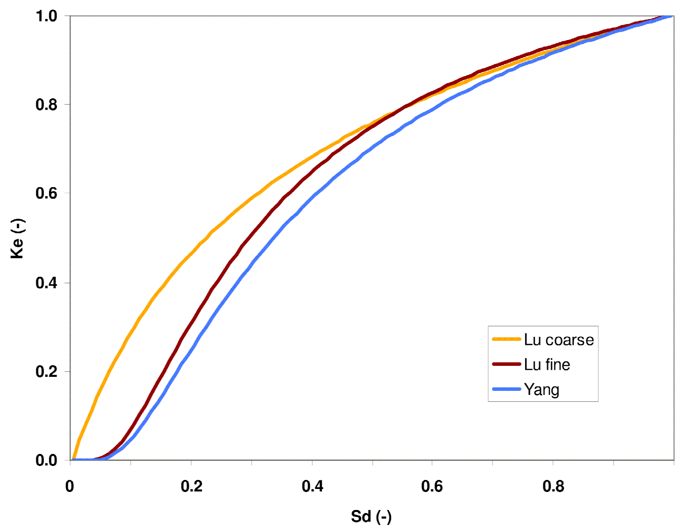

Figure R1.2 - Kersten number vs. degree of saturation as modelled by Lu et al. (2007) for coarse and fine soils, and as modelled by Yang et al. (2005).

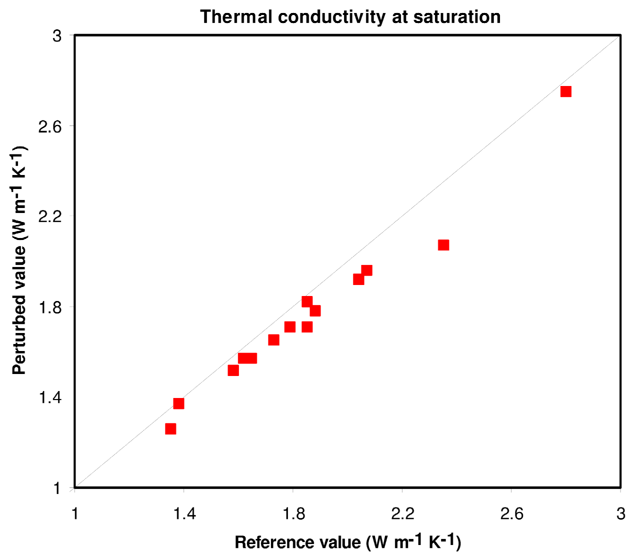

Figure R1.3 - λ_{sat} retrievals using the Kersten number as modelled by Lu et al. (2007) vs. those using the Kersten number as modelled by Yang et al. (2005).

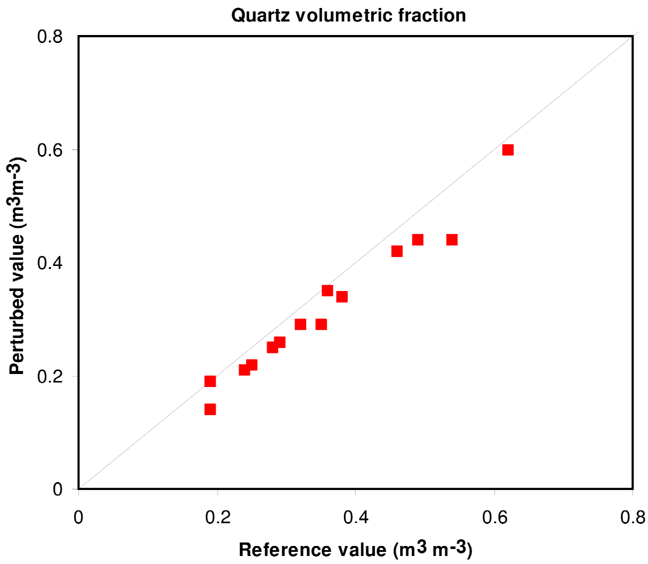

Figure R1.4 - As in Fig. R1.3, except for *q* retrievals.

1.3 [**On discussion. First, the pedotransfer function for q (and thus λsat) was evaluated with 11 stations/sites in this study but not tested. One alternative to be discussed is to divide the 11 stations that some are used for model development and others for testing its predictive/generalization power**.]

RESPONSE 1.3

Yes, this is a very good point. In order to address this issue, we have used a simple bootstrapping resampling technique consisting in calculating a new estimate of *q* for each soil using the pedotransfer function obtained without using this specific soil. Gathering these new *q* estimates, one can calculate new scores with respect to the retrieved *q* values. Also, this method provides a range of possible values of the coefficients of the pedotransfer function and permits assessing the influence of a given *q* retrieval on the final result.

These additional scores will be published in the final version of this work.

1.4 [**Second, the impact of q on λ prediction actually has been studied in Tarnawski et al 2009, in which q was shown mostly linearly dependent on coarse fraction including sand and gravel. Authors recognized that work in this paper yet need to perform enough comparisons with that work and/or other related previous work in the literatures**.]

RESPONSE 1.4

Yes. It is interesting to test the statistical relationships we get between *q* retrievals and soil characteristics using the independent data from Lu et al. (2007) and Tarnawski et al. (2009). We checked that the pedotransfer function(s) we get from our observations produce λ_{sat} values close to those observed for the fine-textured Lu soils. For coarse-textured soils, our pedotransfer function(s) tend(s) to overestimate λ_{sat} values. Note that Lu et al. (2007) obtained a similar result with their model, which assumes that $q=m_{SAND}$. It must be noted that most of these soils contain very little organic matter and consisted of reassembled sieved soil samples, while our data concern undisturbed soils.

REFERENCES :

Lu, S., Ren, T., Gong, Y., and Horton, R.: An improved model for predicting soil thermal conductivity from water content at room temperature, Soil Sci. Soc. Am. J., 71, 8–14, doi:10.2136/sssaj2006.0041, 2007.

Tarnawski V. R., T. Momose , W. H. Leong, 2009: Assessing the impact of quartz content on the prediction of soil thermal conductivity. Géotechnique 59 (4), 331-338, doi:10.1680/geot.2009.59.4.331.

1.5 [**Focus. I believe the pedotransfer function and its evaluation constitute the main contribution of this work. The derivation of soil thermal properties from soil temperature profile, the soil temperature resolution (0.1 C) and its impact on the model applicability can be concise. To me Figure 3 seems dispensable. The Conclusion section also needs revision with a concise description concerning these**.]

RESPONSE 1.5

Yes. In the revised version of this work, we will use a slightly more sophisticated *q* retrieval technique able to cope with soil heterogeneities (see the response to Reviewer 2). The details will be described in a supplement, making the main text more concise.

1.6 [**Organization. Section 4.1 is about evaluating impact of gravel and SOM with sensitivity analysis. I suggest it be included/appended following the pedotransfer functions in the Results section. Indeed authors intended doing so (in Page 740 Line 6 “in Sect 3 a sensitivity analysis of λsat to SOM and gravel fractions”)**.]

RESPONSE 1.6

We agree. Sect 4.1 will be moved to Sect. 3.

1.7 [**On Abstract. Authors should do better job in these sections. In Abstract the last three sentences are key results and conclusions of this work and need a great expansion with details; conversely the remaining should be more concise. Please rewrite it and include question, significance, methodology, results, conclusion and this work's impact**.]

RESPONSE 1.7

We agree. The Abstract will be rewritten.

1.8 [**Page 738 Line 11. "there is no map of q"? Reword to clarify**.]

RESPONSE 1.8

We mean that today, *q* estimates are not given in global digital soil maps. Therefore, land surface modellers need to use a pedotransfer function for *q*.

1.9 [**Page 745 Line 9. How/why is 0.4 chosen/set as cutoff of saturation degree?**]

RESPONSE 1.9

In dry conditions, conduction is not the only mechanism for heat exchange in soils, as the convective water vapour flux may become significant (Schelde et al., 1998, Parlange et al. 1998). Also, the K_e functions found in the literature display more variability in dry conditions (see Fig. R1.2). Therefore, this threshold value of S_d = 0.4 results from a compromise between the need of limiting the influence of convection, of the shape of the K_e function on the retrieved values of λ_{sat}, and of using as many observations as possible in the retrieval process. For example, if we had taken a threshold of 0.6, we would not have been able to retrieve λ_{sat} for SBR, SVN, LZC, PRD, LGC, BRN, and CBR.

REFERENCES :

Schelde, K., A. Thomsen, T. Heidmann, P. Schjonning and P.-E. Jansson: Diurnal fluctuations of water and heat flows in a bare soil, Water Resour. Res., 34, 11, 2919-2929, 1998.

Parlange, M.B., A.T. Cahill, D.R. Nielsen, J.W. Hopmans, O. Wendroth: Review of heat and water movement in field soils, Soil & Tillage Research, 47, 5-10, 1998.

1.10 [**Page 745 Lines 15-17. I suggest an explicit specifying that the three "contrasting retrieved values of λsat" are for high, medium and low levels of λsat values respectively**.]

RESPONSE 1.10

Agreed.

1.11 [**Page 746 Eq 13. I suggest relating this θsatMOD equation to Eq. 12 for quartz pedotransfer function and further to λsat**.]

RESPONSE 1.11

Yes, the use of Eq. (13) in determining a pedotransfer function will be discussed.

1.12 [**Page 747 Lines 1-4 about Eq 14. I do not see how dMOD is related to λsat here. I do not see dMOD is mentioned elsewhere. This dMOD is distracting/interruptive to the θsatMOD and can be deleted**.]

RESPONSE 1.12

Eq. (14) is equivalent to Eq. (1). The impact of using Eqs. (13)-(14) in the sensitivity study (current Sect. 4.1) will be shown and discussed.

1.13 [**Page 756 Table 2. The 6 stations with no eligible observations (n = 0), filtered by saturation degree of 0.4, can be simply omitted since they are not informative**.]

RESPONSE 1.13

Agreed.

1.14 [**Page 762 Figure 4 legend. These three stations were chosen as examples to illustrate contrasting levels of λsat values. I suggest specifying this in legend**.]

RESPONSE 1.14

Agreed.

1.15 [**Page 764 Figure 6. I may have missed, but I do not see the top and middle plots mentioned in the text**.]

RESPONSE 1.15

Yes. The Figure is insufficiently discussed in the text. More emphasis will be put on the use of pedotranfer function(s) for quartz in the revised version of this paper.

1.16 [**Page 739 Line 15-16. "hydrom-eteorology" should be properly hyphenated as "hydro-meteorology"**.]

RESPONSE 1.16

Yes. This typo will be corrected.

1.17 [**Page 751 Line 16. To be more accurate, change "proposed for quartz" to "proposed for volumetric fraction of quartz"**.]

RESPONSE 1.17

Agreed.

1.18 [**Page 760 and page 761. Figure 2 and Figure 3 are misplaced and with wrong legend; the figures should be swapped if they are to be included**.]

RESPONSE 1.18

Agreed.

========================END ========================