

Interactive comment on “Thermal signal propagation in soils in Romania: conductive and non-conductive processes” by C. Demetrescu et al.

Anonymous Referee #2

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General comments

The paper is aimed to contribute to the knowledge of the SAT-GST relations and the assessment of the character of the heat transfer process in the subsurface. It presents a set of meteorological data and temperature time series at different depth levels recorded within the uppermost meter of soil at several stations in Romania in the period 2003-2004. These data are analyzed with a relatively simple straightforward procedure. Although the methods of analysis do not seem innovative, their detailed description, the application to real data and the data quality by itself can be of help for fellow scientists addressed to this topic and satisfy, in my opinion, CP standards. In

summary, I have no major objections to the publication of this paper, but only a number of technical points and language corrections, which should improve the paper in clarity and readability.

p.469, Abstract

- row 5: the sentence "at 0, 5, 10, 20, 50 and 100cm below soil surface as well as precipitation and snow thickness have been monitored..." should be instead (/) "...at 0, 5, 10, 20, 50 and 100cm below the surface as well as rain fall and snow cover thickness have been monitored..."

- rows7-9: "First order modeling confirm that at certain locations and for certain time intervals soil temperatures track air temperature variations and consequently the heat transfer is by conduction, while at others, processes" / "Preliminary analytical modeling shows that soil temperatures track air temperature variations at certain locations and, consequently, the heat transfer is by conduction, while at other stations processes..."

- row 10: solar radiation and heat flux balance are mentioned, but I did not find any discussion in the text.

- row 12: "...first meter of soil is through conduction; the effective thermal diffusivity for 8 stations..." / "...uppermost one meter of soil is mainly by conduction; the inferred thermal diffusivity for 8 stations..."

- row 13: there is certainly a mistake in the exponent, 10-7 instead of 10-6.

p.470

- rows 19-20: it is not clear what the "variable standards found in meteorological and proxy data" are. I would be more explicit.

- row 23: the paper is focused on SAT-GST relation. I think that a more explicit definition for GST should be given, especially for readers not so familiar with the climatic reconstructions from geothermal data. Moreover in other sections of the paper ground

surface temperature and soil surface temperature are used with the same significance and acronym (GST). This might be misleading. I would clarify this point.

-row 26: “The setting up of a new automatic weather station network in Romania in the last few years is likely...” / “In the last few years, the setting up of a new automatic weather station network in Romania is likely...”

p. 471

- row 2-3: “...characterized by lateral climatic variability (Tistea et al. al., 1979; Boroneantȳ et al. al., 2004) that can be used in clarifying some...” / “...characterized by lateral climatic variability (Tistea et al. al., 1979; Boroneantȳ et al. al., 2004). This dataset can be used in clarifying some...”

- row 4: “In the present paper we analyze the soil heat transfer for 10 stations from Romania using daily air and soil temperature data recorded continuously for two years.” / “In the present paper we analyze the heat transfer in the uppermost meter of soil using air and soil data temperature recorded daily at 10 stations from Romania during a two year period”...

-row 12: “investigations of the basic assumptions (i.e. the ground is a perfectly conductive medium) underlying the theory of borehole inversions (Pollack and Smerdon Smerdon, 2004;...” / “investigations on the basic assumptions of the geothermal method, i.e. that of a purely conductive regime (Pollack and Smerdon Smerdon, 2004;...”

- rows 17-18: “...logs come, on this subject (Beltrami and Kellman, 2003;..” / “...logs come (Beltrami and Kellman, 2003;...”

- rows 18-19: “...role of snow cover fall rate, onset time and duration, the role of its physical properties and their variation throughout the year...” / “...role of snow cover, its onset time and duration and its physical properties variation throughout the year...”

- rows 26-27: “...by the presence of snow cover and the freezing and melting of the soil water. Mainly in open field areas, processes arising from precipitation fall, water

movement or...” / “...by the presence of snow cover and by the freezing and melting of the soil water. Mainly in open field areas, processes arising from precipitation, water movement or...

- rows 28-29: “...all seasons of the year, leading to a non-conductive heat...” / “...all season. This leads to a non-conductive heat...”

p. 472

- row 3: check subsurface; perhaps soil or ground is less generic.

- rows 3-10: This paragraph is too long and unclear. I suggest authors to shorten it, synthesizing it without details of the analysis that at this point cannot be fully understood and that are better explained in the following sections.

- row 18: more details are needed from the QTM 107 system.

- row 23: “...2003 and 2004, have been used.” / “...2003 and 2004, were used.”

- row 26: It should be specified that 2003-2004 data are given in Table 1 as average values. It is stated on p. 472 row 3, but it is better to specify it before.

p. 473

- row 3: remove “the annual averages from”

- row 5: GST = ground surface temperature; soil surface temperature = GST. A standard definition should be adopted for the acronym.

- rows 8-10: Simplicity does not seem a good reason to explain the analysis only for one station. I suggest a more convincing explanation “The analysis was performed for each of the ten stations, but in the following we show results only for Bistritÿ because it has continuous records available.”

- rows 10-11: “The daily-averaged temperatures...” / “The daily average temperatures...”

-row 13: isopleths of temperature; this term seems not properly used. Isopleths means “lines with same value”. In case of T, the proper term does exist: isotherm.

-rows 16-17: “...as well as the heat valve effect (in summer the heat flows downwards, while in...” / “...as well as the “heat-valve” effect (heat flows downwards in summer, while in winter it flows towards...”

- row 18: “...(Beltrami, 2001) and the zero-curtain...” / “...(Beltrami, 2001). Moreover, the zero-curtain...”

-rows 19-20: “Massive data missing” instead of “massive missing data”; “can be noticed for Adamclisi” instead of “can be noticed in case of E” The same at row 20

pp. 473-476

Titles of sections and subsections appear long and inappropriate. I suggest only one section 3 entitled “Heat transfer regime”. The first part (from “In Fig. 5...” to “...(see Fig. 7).” is the qualitative introduction to the problem tackled in the paper. Section 4 and 4.1 could be merged into a single sub-section “3.2 Daily variation” and, subsequently, “3.3 Annual variations”.

p. 473

- rows 24-30: I suggest to modify as it follows “Figure shows a comparison of the air temperatures measured daily at Bistrit in 2003 with the soil temperatures recorded at various levels in the uppermost meter. Figure 6 presents a plot of the soil temperatures at 10 cm to the temperature series at larger depths. In ideal conductive conditions the plots should be ellipses. The major axes should become shorter with the increase of the depth of the soil temperature measurement, because of the attenuation with depth of the annual signal amplitude, and minor axes should extend, due to phase the difference between temperatures recorded at different levels Beltrami Beltrami, 1996 1996).”

- rows 9-10: eliminate “between 10 cm and 20, 50 and 100 cm respectively”.

- rows 14-15: "...of melting and freezing of the liquid present within soil pores do not appear anymore to be superimposed on the process of heat transfer through conduction." change as "...of melting and freezing of the liquid present within soil pores do not occur."

- row 17: eliminate "the"

- row 18 eliminate "to the underground"

p. 474

- rows 22-24: change as "In a 1-D case and a purely conductive medium, variations of subsurface temperature T propagate into the ground according to the equation:.." The citation of Carslaw and Jaeger does not seem appropriate here.

p. 475

- row 1: eliminate " T is temperature " and add " z is depth taken positive downwards

- row 2: eliminate "soil"; Greek symbol for thermal diffusivity is too similar to K used for the number of the temperature step changes as well as for Kelvin. I suggest the classic " n " to avoid confusion

- row 4: eliminate $T_t(z, t)$; Mention also Carslaw and Jaeger for the solution of eq. 1

- row 5, eq 2: the subscript " t " of T does not seem necessary

- rows 8-10: change as "Modelling temperature variations with Eq.(2) and comparing them with the recorded temperatures can show deviations of the transfer of heat from a purely conductive regime. Taking..."

- row 12: "day of data (January 26th 2003)" change as "recorded temperature (January 26th 2003)"

- rows 12-13: " ...variation assuming different values for the soil thermal diffusivity..." / "...variation for thermal diffusivity..."

- row 17-18: "...and, respectively, evapotranspirative cooling and convection." / "...and, evapotranspirative cooling, respectively."

- row 24: "...variation at 100 cm for the year 2003, using different values for thermal diffusivity, and..." / "...variation at 100 cm for 2003, using different values for thermal diffusivity. Figure 9 shows a comparison of the modeled..." Eliminate Fig. 9 in brackets.

- row 27: Eliminate "The figure shows"

p. 476

- row 4: substitute "variable " with "which varies"

- row 5: "fit worsens precisely" / " misfit increases"

- rows 6-7: eliminate " precipitation, possibly responsible for increasing the water content of soil in the 50-100 cm depth range."

- row 11: "The above example..." / "This example..."

- row 14: eliminate "in the first meter of soil"

- rows 15-16: "...and previously applied on data from North America by Smerdon et al. (2003)." / "...and applied by Smerdon et al. (2003) to data from North America. "

- row 17: " On a certain scale, if the air..."

- row 18: eliminate "soil"

- row 23: put citation after "by"

p. 477

-row 10: "...parameters are the initial temperature y_0 , the amplitude $b...$ " and so on

- row 13 "...that are present in SAT (upper panel); at one meter (lower panel) the measured signal..." / "...that are present in SAT. At one meter depth, the measured signal..." moreover put r_2 at the end of the sentence.

- rows 16-17: eliminate “upper panel”, “lower panel” and put Fig 12 in brackets.

From row 21 to row 5 (p. 478), the text is unclear and should be reformulated. I suggest: “...thermal diffusivity, k_a and k_f , respectively, for the uppermost one meter of soil. The results for 8 stations are presented in Table 2. Because of missing data, Roman and Resita stations could not be used for this analysis. There is a good correlation between the values of diffusivity ($r^2=0.843$) obtained with the two regression curves, but diffusivities computed from $\ln A$ curve are generally larger (Fig. 13). The difference to their mean value is less than $\pm 10\%$, except for Adamclisi and Satu Mare stations ($\pm 13\%$ and $\pm 17\%$, respectively). A 10% variation of k_a implies an rms difference in the annual temperature signal propagating into the uppermost one meter of soil of less than 0.2 K. This difference is negligible...”

p. 478

- row 6: $^{\circ}\text{C}$ is missing

- row 7: modify as “ At Adamclisi, the larger difference...”

- row 11: “...by other non-conductive processes.”

- I would simplify the title of section 5. “Non-conductive processes” is enough

-rows 14-15 “ heat transfer at shallow depths. During...”

- rows 17-21: This part should be reformulated like in the examples given above.

- rows 25-28. the definition for zero-curtain should be given before, for example on page 473. This could help readers not familiar with the physics and climatic effects in the soils.

p. 479

- row 16: “In contrast, in periods without snow cover, ...”

- rows 20-23: should be reformulated (see foregoing examples)

p.480

- row 3: “ Romanian weather network shows that:...”
- row 4: "The heat transfer down to one meter depth is influenced..."
- rows 5-7: this sentence does not contain any conclusion
- row 8: “At the daily time-scale...”
- row 11: “...in the uppermost 50 cm. Simple...”
- row 25: “ ...at present consist of four temperature records per day.”

Table 1 “...climatic conditions in the 2003-2004 period at the...” Rain fall instead of precip., snow fall instead of snow

Table 2 Give more explanations. For example: “...amplitude of annual surface temperature variation A (in $^{\circ}\text{C}$) and thermal diffusivity k_a and k_f (in $\text{m}^2 \text{s}^{-1} \times 10^{-6}$). k is the average value of thermal diffusivity (half-difference in brackets)?

Figures The paper shows a huge number of figures compared to the text length. Can they be reduced some more? Fig. 3-4: I suggest for example to show only data from the complete time series (3 stations) and make only one figure In fig. 3 I think that the term isopleths is incorrect. Better isotherms. Fig. 13 presents a comparison between results of thermal diffusivity, but they are already given in Table 2. I do not think this figure necessary.

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