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Interactive comment on "Thermal energy in dry snow avalanches" *by* W. Steinkogler et al.

Anonymous Referee #2

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GENERAL COMMENTS:

The paper address an important issue in avalanche dynamics, as, how the authors state, recent investigation showed that the temperature of the moving snow is one of the most important factors controlling the mobility of the flow. Starting form an experimental approach, collecting data on real avalanche events, the authors propose then a method to calculate the thermal balanche in the avalanches, from release to deposition, identifying two main sources of thermal energy: friction and entrainment. They also discuss the application of the IRT tecnique to investigate the thermal properties of the avalanches.

The paper is well written and structured and the reader can easily follow all the story, from data to results, with good figures. The discussion section is a bit unbalanced towards the applicability of the IRT technique, while from the abstract and the rest of

the paper, it seems that the main aim is the evalution of the thermal energy of an avalanche (p. 5796, ll. 9-11).

As I agree with the detailed revision of the other reviewer, I will not write in the following again the same points, but just expand some concepts and add some more specific comments. In particular, I think the main point which need to be discussed better is the identification of the contributions to the thermal energy increase from friction and entrainment, which the authors identify as separate ones.

Finally, I think that the paper is ready for publication after major revisions.

SPECIFIC COMMENTS:

p. 5793, ll. 13-19 (and later in the manuscript): how can you state this? Can you really separate the two contributions? The statement related to the importance of the elevation drop for the warming due to friction is too much general. Starting from only three avalanches on the same slope I would not generalize the results. I would present the results in a less general way. It is already a good result the presentation of what you could measure with field work and IRT technique. The attempt of explaining the thermal energy increase in a general way is ambitious and valuable but I think it needs more work (and data).

p. 5796, l. 9-13: Here you describe the aim, where the emphasis is put on the quantification of the thermal energy in avalanches. As in the discussion you then put more emphasis in the IRT stuff, I would here write something like “A secondary aim is to evaluate the application of the IRT technique to get deep insights into the thermal state of an avalanche”. The last sentence (ll. 12-13) is not an aim. I would keep this last paragraph of the Introduction only to clear state the aims of the study.

p. 5797, ll. 19-22: which is the spatial resolution of the measurements? Fig. 8 shows continuous values, which are an interpolation of the measurements. The grid should be presented or at least this information given. And, is the profile georeferenced and

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matched with the laser scan measurements? In general, how did you match the point data, the profile data and the grid data of IRT and TLS?

p. 5798, ll. 25-27: here you state that laser scan was used for the determination of the release and erosion depths along the track, and later (p. 5800, l. 21 and p. 5801, l. 11) you report values for the deposition masses. In general, keep in mind that laser scan can only give information on the net volume difference between erosion and deposition. It is not the topic of this paper, but I would discuss this, as you need the mass for your calculation. I would also give the value of the density of the deposit, which I guess you used, together with the deposition volume from laser scan, to calculate the deposition mass.

p. 5802, Section 4.1.1: you write about avalanche #1 and #2 and not #3? Is there a reason? For completeness I would describe also the third avalanche.

p. 5082, ll. 22-25: I would not state that lateral IRT profile allowed to differentiate between undisturbed snow cover, dense core and the deposits of the fluidized layer. The limits are not so clear. I would say that comparing the IRT data with field observations you could identify the three zones where surface snow temperature are different. Otherwise, as it is written now, it seems that in general the IRT technique could be used to identify the deposit of different parts of an avalanche (dense and fluidized layers). More avalanches should be analysed to be able to propose a generalized methodology suitable to this aim.

p. 5805, ll. 4-5: I think that you cannot drop the mass m in eq. (3), as you yourself in the previous section (4.2.2) wrote that entrainment is happening. . .

p.5804, ll. 23-24: explain better how you can say that the profile temperature can give information related to the type of avalanche regime (plug-like flow).

Table 1. Which density value you used to calculate the mass? I would add this info in the caption.

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Figure 2. In the legend Avalanche #4 should be #3 I guess.

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