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The Cryosphere Discussions



# *Interactive comment on* "Evaluation of the ground surface Enthalpy balance from bedrock shallow borehole temperatures (Livingston Island, Maritime Antarctic)" *by* M. Ramos and G. Vieira

**M. Ramos and G. Vieira**

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Dear Professor Zhang,

We have revised the paper entitled (Evaluation of the ground surface Enthalpy balance from bedrock shallow borehole temperatures); considering the suggestions of the reviewers.

We have calculated the surface energy exchange by mean of the classical method based in the (Fourrier); equation and we have analyzed the propagation error due to the additive solution and the instrumental devices. We can see that this solution has an error so big to consider the estimating values, we present this in the new version.

We have not focus our paper in the quasi-stationary sinusoidal heat transfer propagation in a semi infinite medium; we focus it in a thermodynamical discussion of the Enthalpy change around the annual period, considering two thermodynamical equilibrium points in the ground just in the time when the soil gradient was zero (starts of summer and winter). This simple method will permit us to control the seasonal exchange of energy across the surface of the ground. This method is applicable only with restrictive hypothesis that are commons in the polar areas where we do our scientific works.

We have used the solutions proposed by Kudryavtsev, 1974 and the other one proposed by Smith and Riseborough,1996 to calculate the temperature of the permafrost table considering the statistical values of the air and ground temperatures collected in our experiences, with the adequate restrictions. Theses solutions are according with the hypostasis of thermal equilibrium at phase change water temperature in normal conditions (0žC) in the deepest zone of the ground and we propose the semi infinite hypostasis to apply the thermodynamical arguments to study the Enthalpy exchange.

In the figure 4 we divide the seasons in periods where the ground is loosing energy (for example frost season) in this case the thermal distribution in different depths has a negative temporal trend. This cooling period is follow by a warming one that attains the equilibrium temperature at 0žC with the final of this season and the start of the thaw season. Each season has a cooling and warming periods. Enthalpy is a thermodynamical state function and its variation depend only of the initial an final states, in this sense the loosing energy in the cooling season is between the isothermal state at the start time of the frost season and the minimum energy ,that correspond with the state with minimum temperature during this season. In analogue form with the thaw season but in this case the final state corresponds to the maximum values of the temperatures in the ground for this season.

Finally, the terminology problem in permafrost is really open in discussion in several forums. For example (Brown et al, 2008) (written literally): (By the time the IPA was established, it was clear that the major terminological problem associated with permafrost, as defined in North America, Russia and China, arose from the fact that ground at or below 0C may, or may not, be frozen). In this case where there is not water content but the temperatures in depth are below zero we suggest that the terminology is more appropriate taking into account that in the study area there are other ground typologies where the processes of freezing and thawing are related with the presence of water.

We sincerely thank you and all referees your contribution and suggestions in the process and we hope that the paper will be considered for a possible publication in The Cryosphere.

Brown, T (former president of IPA),The International Permafrost Association 1983-2008. Ninth International Conference on Permafrost. Fairbanks (2008). Pp.- 199-204.

Kudryavtsev, V. A., Gaagulya, L. S., Kondratýeva, K. A., Melamed, V. G.: Fundamentals of frost forecasting in geological engineering investigations. Cold Regions Research and Engineering Laboratory: Hanover, NH, 1974.

Smith, M. W., Riseborough, D. W.: Ground temperature monitoring and detection of climate change. Permafrost and Periglacial Processes, vol. 7 nž 4, pp- 301-310. DOI:10.1002/(SICI) 1099-1530 (199610) 7:4<301:AID-PPP231>3.O.CO;2-R.1996.

Interactive comment on The Cryosphere Discuss., 2, 153, 2008.