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Interactive comment on "The role of radiation penetration in the energy budget of the snowpack at Summit, Greenland" *by* P. Kuipers Munneke et al.

M. Pelto

mauri.pelto@nichols.edu

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Kuipers Munneke et al., (2009) provides a compelling analysis of the importance of shortwave radiation penetration to the energy balance at the Greenland summit. The paper provides a useful model of the energy balance in a non-ablating sector of the Greenland Ice Sheet. The following comments are focused entirely on the need for an additional figure and further analysis of Figure 3.

Colbeck (1989) observes that the amount of solar radiation absorbed beneath the surface of the snowcover can exceed the ability of the snowcover to conduct the energy away. This will result in an increase both in the temperature of the snowcover and of the temperature gradient. It is further pointed out that 88% of the radiation is absorbed in the upper 0.5 m of the snowpack (Colbeck, 1989). In the current study a series of thermistors were emplaced at 0.20 m, 0.3 m and 0.5 m, 0.75 m and 1.0 m below the surface and, as I read it, thermocouples at 0.02m intervals for the first 0.10 m below the surface. A figure similar to Fig. 8 from van den Broeke et. al., (2008) should be included of temperature versus depth at a couple of different times, maybe showing the diurnal temperature range versus depth as well. This figure should illustrate the temperature signature of the radiation penetration supporting the idea that most of the penetrated radiation is absorbed within 0.5 m of the snowpack surface.

Figure 3a indicates the success of the model in replicating the observed temperature record, which suggests the energy balance model is reflecting reality. This figure warrants further consideration, in particular there is no discussion of the lag time between the observed temperature peaks and troughs, at the surface and at 0.5 and 0.75 m depth. The lag suggests that the diffusion argument is correct, and that the model is replicating this process well. Further the lag time between the two models in Fig. 3a and 3b needs to be contrasted as radiation penetration is not the only possible energy source that could be diffused. The model results for Fig 3a versus Fig. 3b at 0.5 m and 0.75 m depth respectively indicate a suppressed snow temperature response to the three periods of decreased snow surface temperature. What is the magnitude of this difference between the models? Why does the radiation penetration model temperatures remain more elevated and why does diffusion provide the best explanation for this response? Comparing the temperature difference from the surface to 0.75 m in Fig. 3a indicates a comparatively consistent variation, suggesting no substantial increase in the temperature gradient. Or am I looking for too big a change? Colbeck (1989) suggested the temperature gradient should increase in the presence of radiation penetration. How much did the mean multi-day temperature gradient vary from the start to the end of the study? Is this change what is expected for the radiation penetration concept? Figure 3a can provide a stronger corroboration of the proposed model if more detail analysis of the figure is completed.

Colbeck, S. C.: Snow-crystal growth with varying surface temperatures and radiation penetration, J. Glaciol., 35, 23–29, 1989. 279

van den Broeke, M., Smeets, P., Ettema, J., van der Veen, C., van de Wal, R., and Oerlemans, J.: Partitioning 5 of melt energy and meltwater fluxes in the ablation zone of the west Greenland ice sheet, Cryosphere, 2, 179–189, 2008, http://www.the-cryosphere-discuss.net/2/179/2008/.

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