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Interactive comment on "A parameterization of respiration in frozen soils based on substrate availability" *by* K. Schaefer and E. Jafarov

Anonymous Referee #2

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This paper uses numerical modeling to estimate the relationship between the size of the liquid water fraction and soil temperature, and uses this relationship to predict the substrate diffusion limitation on heterotrophic respiration at freezing temperatures. The modeling provides a clear hypothesis for why apparent Q10 is high at sub-zero temperatures.

Though this topic has been a point of discussion for some time (Burt & Williams, 1976, Eberling et al. 2003, Monson et al. 2006), this paper applies recent data and an interesting application by connecting the frozen bgc model to SiBCASA and is therefore appropriate for publication in Biogeosciences.

My main concern with the paper is that it is not clear how the VWC data are used to model heterotrophic respiration. Respiration is calculated from a linear relation-

ship with VWC (12042, line 4-5), but the agreement between observed and modeled respiration in Figure 6 suggests that respiration is more responsive to metabolic temperature effects than substrate limitation. Perhaps using an Arrhenius fit to this data that is moderated by VWC would provide a better fit to the data presented in Figures 5 and 6.

At any rate, I think it would be helpful to include a short discussion of how respiration is calculated by SiBCASA in the Methods section.

More minor suggestions and questions:

In Mikan et al. 2002, Figures 1&2 show CO2 efflux v. Temperature data that looks similar to the data presented in this paper (Figure 5), but when plotted as ln(CO2 efflux) v. Temperature, you can see a clear change in the slope of the line below 0 degC. Perhaps a figure such as this would help to convince the reader that there is in fact a change in slope near 0deg C.

How did you determine the values for phicrit and b (Table 1)?

p. 12034, line 22 "...ratio of organic matter density to the density of pure organic matter" I know what you mean, but a little confusing.

References:

Burt, T. P., and Peter John Williams. "Hydraulic conductivity in frozen soils." Earth Surface Processes 1.4 (1976): 349-360.

Elberling, Bo, and Kristian K. Brandt. "Uncoupling of microbial CO 2 production and release in frozen soil and its implications for field studies of arctic C cycling." Soil Biology and Biochemistry 35.2 (2003): 263-272.

Mikan, Carl J., Joshua P. Schimel, and Allen P. Doyle. "Temperature controls of microbial respiration in arctic tundra soils above and below freezing." Soil Biology and Biochemistry 34.11 (2002): 1785-1795.

Monson, Russell K., et al. "Winter forest soil respiration controlled by climate and microbial community composition." Nature 439.7077 (2006): 711-714.

Interactive comment on Biogeosciences Discuss., 12, 12027, 2015.