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Interactive comment on "Effect of ablation ring and soil temperature on 3-yr spring CO_2 efflux along the trans-Alaska pipeline, Alaska" *by* Y. Kim

Anonymous Referee #1

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This paper presents data on spring soil respiration rates along a latitudinal transect, from tundra to boreal forest, in the Alaskan arctic. The data show that respiration rates can generally be predicted from surface soil temperatures, but that the temperature response functions are substantially different from the summer growing season. This paper also shows that the presence of snow crusts and the formation of ablation rings produce high spatial variability in soil respiration rates. While the results are interesting and provide valuable insight to spring soil respiration rates in the arctic, about which little is understood, the paper is poorly organized and difficult to follow. There are a number of areas, which need substantial improvement before this paper can be published; these are listed below.

âĂć The paper does not really focus on ablation rings as the title implies, nor are the

other main objectives of the paper adequately addressed. One objective is to evaluate the environmental controls on spring respiration rates, but only soil temperature and snow depth are considered.

âĂć What is the temporal pattern of soil respiration and temperature and the timing of snowmelt and the formation of ablation rings. Do respiration rates at the different sites diverge after snowmelt or once the soils exceed 0C?

âĂć What accounts for the inter-annual differences in respiration patterns and rates? Why is 2010 much lower than other years?

âĂć Spring soil respiration is highly heterogeneous, how does this compare to heterogeneity in the summer?

âĂć The methods need to be substantially improved in order to understand how data was collected. Eg: o soil moisture measurements described in the methods are not reported

o replication of respiration measurements is unclear

o how many tree trunk or ablation ring areas were surveyed?

o P. 3622 line 2: this sentence is confusing, were bases only used in certain circumstances?

o P. 3624 line 1: soil CO2 flux was estimated with profile measurements? I thought all the measurements were chamber based

o there is no description of how respiration measurements were scaled to calculate a spring contribution to annual CO2 loss

o what does fig 7 show? Are these site averaged fluxes and soil temperatures?

o what were the ANOVA comparisons used for?

o What is the value of reporting CV?

o It is difficult to keep track of the sites based on the acronyms

âĂć The purpose of the temperature response functions is unclear. What do the different temperature response functions represent?

o If the temperature responses are dramatically different between sites (as Fig 3 suggests), then is it really appropriate to apply the same temperature response to all sites (as per Fig 7)?

o Does Fig 3 really represent intrinsically different temperature sensitivity? Or merely a different range of sample temperatures? While boreal forest sites have soil temperatures at 5C and 10C, tundra sites doe not exceed 2C. Are the temperature responses substantially different between -5C and 2C?

o Fig 4: shows that the temperature-flux relationship is driven by location around the tree – this is important as it creates large spatial heterogeneity. What additional value is derived from showing these two sites separately?

o What do the Q10 values mean? Mikan et al 2002, Soil Biology and Biochemistry 34, demonstrate that the transition from frozen to thawed soil produces very different Q10 values, but that these are not truly thermodynamic temperature responses. It is a valuable point of discussion that respiration rates change extremely rapidly during the transition from frozen to thawed, and that the temperature response does not follow predictions from the growing season.

âĂć The results contain too much discussion and unnecessary detail (see below for further details)

âĂć The relevance of some data is unclear, eg:

o Fig 6: shows that snow depth is important for flux at tundra sites and even at similar temperatures the presence of a snow crust suppressed flux rates. Is a comparison with and without snow-crust an accurate representation of the thawing process? Presumably the dynamics in a naturally thawed patch are different than in a patch where the

snow is removed between measurements. How does this data inform temperature and ablation ring dynamics?

o the presence of unidentified fungal communities (fig 5)

o the temperature differences between tussock tops and bottoms (fig 8&9). While very interesting, how does this relate to the rest of the data?

o In figure 9 it is confusing that doy counts incrementally from the beginning, rather than starting over at 1 in each year

âĂć The discussion needs to address the mechanisms which could be responsible for these differences

o Could the impact of snow depend on the time of year? In winter snow insulates, so respiration rates may depend on a combination of snow factors. On the one hand, greater snow cover in winter, which insulate from cold air temperatures. On the other, more rapid thaw, exposure to radiation and higher temperatures in spring, which enhance decomposition rates.

o How long before these high flux rates decline?

o What is the mechanism for such high fluxes? Microbial stress response? Turnover/community composition change of the microbial community? Depletion of labile C?

âĂć Discuss limitations of the study:

o The latitudinal gradient confounds the temporal component since spring in the tundra sites will be delayed relative to the boreal forests.

Specific points regarding the results section:

P. 3620: the site description here is very detailed and reads like results, either simplify and refer to tables, or include in results section

P. 3623 line 19 – paragraph end: discussion? Or reword to make a better connection to the results P. 3625 line 9 – section end: discussion

P. 3624 line 12, line 18: neither of these points is illustrated in Fig. 2

P. 3624 line 16: this statement is confusing, how does the flux data suggest a 10-17 day earlier melt? This conclusion must come from the photos and the flux data shows that timing of melt-out strongly impacts flux. Reword.

P. 3624 line 20: I would find this easier to follow if the data was organized either by magnitude or going around the compass rose, N, E, S, W

P. 3625 line 9 – these values are not a ten-fold increase?

P. 3625 line 25: Can this data be summarized into a descritption, eg: tundra sites tend to be colder than tundra sites. Is the level of detail important? How does it relate to information reported in figure 2?

P. 3626 line 22-paragraph end: this is extremely difficult to follow

P. 3628 lines 1-5: this is anecdotal information about unidentified fungi and it is not entirely clear how this relates to the rest of the paper

P. 3629 lines 1-4: does this really mean that microbial activity did not occur? Or are flux rates low because the soils are still very cold? What is meant by the 'elapsed spring season'? Why is this statement linked to figure 5? My interpretation of figure 6 is that snow-pack does influence soil CO2 efflux. For example 6b shows that at similar soil temperatures, removal of snow-crust results in much higher efflux rates.

P. 3630 lines 22-26: this in-text description does not match the figure caption. Also, how does the differences in tussock temperature relate to the flux measurements presented in this study? There is no data showing tussock and inter-tussock measurements.

P. 3631 line 6: where is this data?

Interactive comment on Biogeosciences Discuss., 11, 3615, 2014.