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Interactive comment on "Continuous and discontinuous variation in ecosystem carbon stocks with elevation across a treeline ecotone" *by* J. D. M. Speed et al.

Anonymous Referee #1

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The study of Speed et al. investigates how carbon stocks in different vegetation and soil pools vary across a ca. 300m altitudinal gradient in southern Norway. They find little effect of grazing intensity, twelve years after grazing levels were manipulated. Their main conclusion is that there is continuous variation in soil organic matter stocks, with soil stocks increasing linearly with altitude, while there is a clear 'breakpoint' at the treeline for vegetation carbon stocks. The implications of these contrasting patterns are discussed in the context of ecosystem carbon stocks.

This is an interesting paper, but I do not find the conclusion that soil organic matter stocks are linearly related to altitude to be convincing. It appears that there is the same change as has been observed in previous studies (Sjögersten Wookey 2009; Hartley

et al. 2012), albeit slightly less pronounced. The tundra system investigated in the current study is more grass-dominated than in these previous studies, which may help explain some of the differences. However, the key issue is that the data presented in Figure 3 does appear to show a change in organic matter contents and C stocks in the organic horizon at the treeline. All the organic horizon C contents are lower in the forest. There is one thick organic horizon within the forest zone (Fig A4), but the organic horizon C stocks in all other forest sites are substantially lower than the mean for the tundra. The analysis does not find a significant relationship between organic matter carbon stocks and altitude within the forest or tundra zones, and therefore it appears that the overall relationship with altitude is driven, in large part, by a change between the two ecosystem types.

In the supplementary methods of the study of Hartley et al. 2012, data were presented comparing tundra-heath and birch forest at the same altitude within the ecotone, observing the same pattern of changes in soil carbon storage as when comparing sites above and below the treeline. Again, it may be that the more grass-dominated tundra in the current study explains the reduced magnitude of the differences in organic horizon C stocks above and below the treeline, but the data do not appear to support the conclusion that there is continuous variation in soil stocks with altitude, or that there is no threshold change around the treeline.

There is still very valuable information in this paper, especially in terms of how ecosystem C stocks change with altitude, with the relative importance of changes in above versus below ground stocks being presented clearly. I would suggest the study not claim there is no threshold change in soil carbon stocks around the treeline, but rather place the relatively small threshold change in soil stocks observed for this ecotone into the context of substantial increases in tree biomass. It would also be worth emphasising the differences between the vegetation communities (grass versus shrub-dominated tundra) being investigated in the current study versus those in much of the literature which has been cited.

Specific comments:

Page 15441 line 5: This is the first time that the type of tundra being studied is really described. It would be useful to include more details in the introduction regarding the type of ecotone being studied and how it differs from some of the previous studies which have been cited.

Page 15443 line 3: A fuller justification of the number of points required to detect breakpoints would be useful. There are only nine forest plots and since the hypotheses are about continuous versus discontinuous changes, is this really enough to be able to detect relatively small magnitude threshold effects?

Page 15445 line 14: I am slightly confused about the definition of the organic horizon. With some of the soils having carbon contents as low as 10

Page 15448 lines 9-13: There seems to be an argument here that increases in carbon storage in plant biomass takes place more slowly than losses of carbon from soils. This is an interesting suggestion and perhaps one that could be discussed in more detail, in terms of trajectories of change in ecosystem carbon storage as the treeline shifts.

Interactive comment on Biogeosciences Discuss., 11, 15435, 2014.