Comments to Anonymous Referee #2 of "Permafrost-Affected Soils of the Russian Arctic and their Carbon Pools"

by S. Zubrzycki et al.

Referee #2, general comment

This paper presents organic content data from permafrost soils of the Russian North. Examples are highlighted from around the Lena Delta. Values are presented defining soil organic matter contents from those soils along with literature values from other northern permafrost soils. A possible positive feedback is discussed in the way that thawing tundra soil in a warming Arctic could release more greenhouse gases, which would boost even greater warming. Knowledge gaps and possible future works are addressed. The paper is well written, nicely illustrated and likely useful to the growing community of soil and modelling scientists dealing with landscape change in the north. I have realized that there was already a peer review done in the past and I appreciate that some updates have been inserted since then. I recommend the paper for publication to make it accessible to the growing permafrost community within the earth sciences.

We thank the referee for his positive feedback and his helpful specific comments to improve the manuscript.

Referee #2, specific comments:

Meanwhile there might be an overlap with the Hugelius papers from 2013a and 2013b, where also organic carbon figures are listed. To overcome this to some extent results from Hugelius et al., 2013a and 2013b should be incorporated into Table 1. This would make the table more useful (e.g. for modellers). By the way, 2013b is a final article now, not a discussion paper anymore.

We thank the referee for this comment and the recommendation to incorporate data from both papers by Hugelius et al. 2013 into Table 1, as well as for his attentive reading of the reference list. We updated the list using the final and revised version of the manuscript published by Hugelius et al. 2013b.

Hugelius and co-authors have other objectives in both addressed papers. The authors want to provide a spatial overview of SOC pools to 1 m and 3 m depth, respectively. To achieve this, methods for data gap filling were used such as extrapolations and estimations based on default values. Furthermore, Hugelius et al. extrapolated the gathered data across spatial polygons, originally derived from regional soil maps with scales ranging from 1:250,000 for the well investigated regions of contiguous USA and Alaska to 1:7,500,000 for Greenland. Spatial soil data for the area of our interest, Russia, were derived from a map with a scale of 1:2,500,000. For their objectives, Hugelius at al. have chosen right methods. However, these methods introduce uncertainties, well described by Hugelius et al. in both papers.

Our objective is to provide an overview of measured point data and we do not try to address these data to any spatial extent. Therefore, we suggest neither including the data of Hugelius et al. 2013a nor Hugelius et al. 2013b into Table 1. Nevertheless, these data are discussed in the running text of our paper.

Apart from the fact that no definite example from earth history is known to me, where soil dynamics have driven climate dynamics, the authors point out that the carbon pool database is "still fraught with great uncertainties at the present time". This uncertainty should inspire the authors to temper their certain tone in assigning permafrost regions with their distinctive soils an important tipping point. (For example the supposed increased release of climate-relevant trace gases into the atmosphere could be balanced hypothetically by shrub and tree growth at the same time.)

The carbon pools database is still fraught with great uncertainties and the general knowledge of carbon pools in permafrost-affected regions needs to be improved. This is right. However, the evaluation of carbon pool data over the last years has shown, that each update, based on an increased number of samples providing more robust estimates, resulted in an increased total carbon mass, e.g. Post et al., 1982: 192 Pg SOC, Tarnocai et al., 2003: 268 Pg SOC, Tarnocai et al., 2009: 496 Pg SOC (all data for the depth of 1 m).

The enormous storage of still frozen organic matter within the top 3 m of permafrost-affected soils is that high, exceeding the carbon mass of the present atmosphere and the carbon mass of the global vegetation together, that it might be considered as one tipping points for the future climate. Taking into account the observed progressive climate change and the projected polar amplification as well as up-to date models estimating the permafrost extent and the active

layer thickness, large amounts of the still frozen organic matter will be available for decomposition processes and are likely to liberate climate relevant trace gases to the atmosphere in future. The vegetation is likely to adapt to changed environmental conditions and with the increased available CO_2 higher biomass production is likely to be possible. The response of liberation of trace gases from thawing permafrost to the environment as well SOC pool size have to be exhaustively studied to provide robust answers of the future of northern permafrost regions.

Since the present knowledge about the addressed issues is afflicted with huge uncertainties, we will follow the reviewer's recommendation and will "temper our tone in assigning permafrost regions with their distinctive soils an important tipping point".

There are many multinational programs at present, which focus on northern soil dynamics. I would find it useful mentioning or discussing them e.g. in chapter 4. Even though the programs themselves may be outdated after some years references to available landmark papers from those programs could be given. I am aware of the following active platforms working on permafrost carbon dynamics, there might be more though (e.g. GRENE-TEA):
Vulnerability of Permafrost Carbon - Research Coordination Network (RCN)
http://www.biology.ufl.edu/permafrostcarbon/
DEFROST Scandinavian Research Initiative (http://www.ncoe-defrost.org/home)
CRAICC - Cryosphere-atmosphere interactions in a changing Arctic climate – Finish Research (http://www.atm.helsinki.fi/craicc/)
CAPP project (http://www.geowiss.uni-hamburg.de/i-boden/capp/index.html)
Next-Generation Ecosystem Experiments (NGEE Arctic) (http://ngee-arctic.ornl.gov/)
U.S. North American Carbon Program (http://www.nacarbon.org/nacp/)
The CryoCARB Project - Long-term Carbon Storage in Cryoturbated Arctic Soils
http://www.univie.ac.at/cryocarb/the-cryocarb-project/

Following the response to the previous comment, we state that investigations of SOC in permafrost-affected soils as well as the response of the environment to the changed climatic conditions need to be studied. We thank the referee for suggesting to include programs, which focus on these important topics. We will include the proposed programs and will extend the list for the revised version of our manuscript.

Referee #2, technical corrections:

p. 620, l. 5: delete "most" p. 620, l. 25: define "special" p. 629, l. 9: delete "special"

p. 620, l. 5: "most" was deleted

p. 620, l. 5: "special" was deleted, and not defined as requested by the referee. We decided to delete the word, since it is redundant in this version of the manuscript. In a preliminary version we used the wording " ... on special pedogenetic processes.." and in the next sentence we explained the speciality, namely the presence of ice and general Temperatures below 0° C. In the given version of the manuscript we speak about "cryopedogenetic processes".

p. 629, l. 9: "special" was deleted

New/updated references:

Hugelius, G., Bockheim, J. G., Camill, P., Elberling, B., Grosse, G., Harden, J. W., Johnson, K., Jorgenson, T., Koven, C. D., Kuhry, P., Michaelson, G., Mishra, U., Palmtag, J., Ping, C.-L., O'Donnell, J., Schirrmeister, L., Schuur, E. A. G., Sheng, Y., Smith, L. C., Strauss, J., and Yu, Z.: A new data set for estimating organic carbon storage to 3 m depth in soils of the northern circumpolar permafrost region, Earth Syst. Sci. Data, 5, 393-402, doi:10.5194/essd-5-393-2013, 2013.