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Interactive comment on "The organic carbon pool of permafrost regions on the Qinghai–Xizang (Tibetan) Plateau" *by* C. Mu et al.

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Below are responses to reviewer's comments to manuscript TC-8-5015, The organic carbon pool of permafrost regions on the Qinghai-Xizang (Tibetan) Plateau.

This study provides the first comprehensive estimate of shallow and deep soil organic carbon (SOC) stocks in the Qinghai–Xizang (Tibetan) Plateau (QXP). The authors synthesize existing field data for near surface soils (0-1 m depth) and provides new field data for deeper deposits (1-25 m depth). This constitutes a timely contribution of data from a region that has previously been under-sampled. There are however aspects of the SOC upscaling which need more work and the dataset for deep SOC stocks needs to be more carefully described. I would also recommend that the manuscript is carefully proof-read and edited with regards to the English language.

Response: Thanks for your kind work for our manuscript. We have carefully performed SOC pools estimation upscaling and provided the dataset of deep SOC stocks in the supplement material.

I would strongly recommend that the authors calculate basic confidence intervals or uncertainty ranges for their estimates. Hugelius (2012, Global Biogeochemical Cycles) exemplifies how simple confidence intervals can be calculated. Note that it is likely not realistic to report the stock estimates with two decimals for a Pg given the uncertainties associated with estimates like this.

Response: The basic confidence intervals for their estimates were added in the revised version based on the method in Hugelius (2012). We took decimals off using rounding method and gave new numbers.

The authors have chosen to upscale point observations from soil pits and boreholes using a generalized vegetation map. It would be beneficial with some discussion and justification of this choice. How do the authors expect that the identified vegetation classes and their properties interact with the pedogenic processes that cause accumulation of SOC in soils?

Response: It was explained in the revised version as follows: Lines 76∼85: For the top layer, the important factors in the determination of SOC pools are vegetation type and climate (Jobbagy and Jackson, 2000). The vegetation type and climate conditions related closely to each other on the QXP (Wang et al., 2002). Thus it is possible to calculate the SOC pools at 0∼2 m depth according to the area of vegetation type (Chinese Academy of Sciences, 2001) in the permafrost regions (LIGG/CAS, 1988). For the deep layer, the geomorphology and lithological conditions play an important role in the distribution of SOC pools (Hugelius et al., 2013). Thus it is reasonable to estimate the SOC pools at 2∼25 m depth according to the area of quaternary geological stratification in the permafrost regions on the QXP.

A major strength of the paper is the new data from 11 deep boreholes which are used

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to estimate SOC stocks down to 25 m. Are all these 11 boreholes exactly 25 m deep? Looking at the data in Figure 2 it seems like ca. 5-6 sites has data extending below 10 m depth? This type of deep borehole data is very valuable and it would be very valuable of the authors provided more detail on individual boreholes, possibly as an online supplement? Data on C%, bulk density, ice-content and texture from such boreholes would be very valuable to the wider scientific community.

Response: Soil depth at several sampling sites was not exactly 25 m due to the situation of factual drilling work in field. Geographic location for the 11 boreholes, together with the active layer depth, sampling depth, vegetation type, quaternary geological stratigraphies, SOC contents, bulk density, water contents and texture were shown in the supplement in the revised version.

The authors have upscaled deep SOC stocks from eleven boreholes, mainly located along the railway, to the entire QXP. How likely is it that the entire non-forested section of the QXP is actually covered by 25 m thick unconsolidated sediments? If the authors maintain this claim, it needs to be justified with references to studies of Quaternary deposits in the region. I would expect that the deeper deposits only extend to some fraction of the QXP.

Response: Thanks a lot for the suggestion.

The area of geological stratification in permafrost regions was determined through overlaying the quaternary geological stratification map over the permafrost map of the QXP. Then we estimated the organic carbon pools in the three stratigraphies of quaternary, permian and triassic in permafrost regions, based on the geological stratification of 11 boreholes. There are 25 m thick unconsolidated sediments in the three stratigraphies of quaternary, permian and triassic, which was proved by the field drilling. The description in the present version was as follows:

Lines 80∼85: For the deep layer, the geomorphology and lithological conditions play an important role in the distribution of SOC pools (Hugelius et al., 2013). Thus it

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is reasonable to estimate the SOC pools at 2∼25 m depth according to the area of quaternary geological stratification in the permafrost regions on the QXP.

Lines 147∼151: The three geological stratigraphies had thick soil layer of about 25 m (Fang et al., 2002; 2003; Qiang et al., 2001). As for other geological stratigraphies, the poor soil development was reported and soil layer thickness was usually less than 3 m (Wu et al., 2012; Yang et al., 2008; Hu et al., 2014). Thus other stratigraphies were not considered in the estimation of deep organic carbon pool in the permafrost regions.

P5016 line 8-9: Note that this direct comparison of fraction SOC below 3 m is not applicable since the Tarnocai et al. (2009, Global Biogeochemical Cycles) estimate only includes selected deep deposits and makes no attempt to include deep deposits outside the yedoma region and deltas. Response: Thanks, the expression was replaced by that "The percentage of SOC storage in deep layer (3∼25 m) on the QXP (79.5%) was higher than that (38.8%) in the yedoma and thermokarst deposits in arctic region." (lines 23∼25).

P5016 line 18: This is an oversimplification. The previously frozen SOC becomes available for mineralization. Whether or not this leads to greenhouse gas release depends on multiple environmental factors. Response: Thanks for the corrections. It was replaced by "Climate warming will thaw permafrost, which can cause the previously frozen SOC become available for mineralization" (lines 33∼34).

P5017 line 21-22: I would not advise you to apply such a generalized statement for all deep permafrost deposits. The genesis and age of deep deposits is very different in different locations. Many deposits are epigenetic, which implies that they were permafrost-free for some time prior to permafrost aggradation. Response: Thanks, deleted.

P5018 line15: It is not essential that vegetation is used. It is one of several viable options for upscaling. Response: Deleted. We added the related contents in the introduction as follows: Lines 76∼83: For the top layer, the important factors in the

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determination of SOC pools are vegetation type and climate (Jobbagy and Jackson, 2000). The vegetation type and climate conditions related closely to each other on the QXP (Wang et al., 2002). Thus it is possible to calculate the SOC pools at 0∼2 m depth according to the area of vegetation type (Chinese Academy of Sciences, 2001) in the permafrost regions (LIGG/CAS, 1988). For the deep layer, the geomorphology and lithological conditions plays an important role in the distribution of SOC pools (Hugelius et al., 2013). Thus it is reasonable to estimate the SOC pools at 2∼25 m depth according to the area of quaternary geological stratification in the permafrost regions on the QXP.

P5020, equation 1: Note that if the BD was calculated based on initial frozen core volume, the ice content should not be subtracted again in the formula. It is already accounted for by the lower sample BD when ice melts and water evaporates in the drying of the sample. Response: Thanks very much for the corrections. We used the right formula in calculation, while this equation was wrongly created in a special tool. We have corrected the formula in the revised version (lines 130∼132).

P5021 line 6: Please report the standard deviations of these mean values. This applies whenever means are reported in the paper. Response: Changed. It was changed as follows: Lines 167∼174: According to the distribution of sampling sites at the geological stratigraphies, for the permian stratigraphy, average SOC contents at 2∼18 m depth were 1.1±0.3% at KXL. For the triassic stratigraphy, average SOC contents at 2∼25 m depth were 0.9±0.2%, 1.0±0.2%, 1.1±0.4%, 1.8±0.8%, 1.0±0.3% at HLH-1, HLH-2, KL150, KL300 and KL450. For the quaternary stratigraphy, average SOC contents from 2 m to 25 m in permafrost regions on the QXP were 1.1±0.3%, 0.1±0.03%, 1.1±0.8% at WDL, ZEH and XSH. In addition, SOC contents in permafrost regions in HHRB (Heihe-1, Heihe-2) were higher than those on the most QXP, with range of 0.8∼14.6% in depth of 19 m.

P5021 line13: “depth of 6 cm” This is likely a mistake and should be 6 m? Response: Changed. It should be 6 m.

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P5021 equation 2: The authors may consider is this function could be applicable to upscaling their deep SOC stocks (with uncertainty ranges) to those parts of the QXP where they expect deep deposits to occur. This may replace the simple thematic upscaling currently used. There is however the complicating factor that some individual cores show an increase with depth rather than a decrease. This may reflect different Quaternary deposits? Response: Thanks a lot. The discussion was changed in the revised version as follows: Lines 228∼238: There is a decreasing trend of the SOC along with the depth in the boreholes, which was in agreement with those reported in circum-Arctic regions (Strauss et al., 2013; Zimov et al., 2006). It could be explained by the dynamics of quaternary deposit and organic carbon formation in permafrost regions (Strauss et al., 2013). It was found that the organic carbon contents in some deep layers at the XSH, KL150 and KL300 were higher than those in the top layer (Fig. 4), which may be caused by the cryoturbation and sediment burying process (Ping et al., 2010), and quaternary deposits following the uplift of Tibetan Plateau (Li et al., 1994). Although the power equation may replace the present simple thematic upscaling, these are still complicating factors affecting the distribution of SOC contents with depth. Thus more effort in studying the distribution of deep organic carbon density in permafrost regions needs to be made in the future.

In addition, there are some revisions we made as follows:

Major revisions: The number of sampling sites was changed from 706 to 190, and the area of vegetation type was changed in the revised version. It was because that we overlaid the vegetation type map over the permafrost map to separate the sampling sites in the permafrost and non-permafrost of the same cover type. Thus, we selected the 190 sampling sites and used the organic carbon data to calculate the carbon storage at 0∼1 m depth. In addition, the permafrost area in the three vegetation types was calculated again using the same method, then the carbon storage at 1∼2 m depth was changed. The calculation method for the deep carbon pools at depth of 2∼3 m and 3∼25 m in the permafrost regions was changed according to the geomorphology

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and lithological conditions because they play important roles in the distribution of SOC pools for the deep layer. Thus it is reasonable to estimate the SOC pools at 2∼25 m depth according to the area of quaternary geological stratification in the permafrost regions on the QXP. We estimated the organic carbon pools in the three stratigraphies of quaternary, permian and triassic in permafrost regions, based on the geological stratification of 11 boreholes. Therefore, the storage of soil organic carbon at depth of 0∼2 m in permafrost regions on the QXP was recalculated and changed according to the area of vegetation type in permafrost regions. The deep organic carbon pools at different depth of 2∼25 m was recalculated according to the area of located quaternary geological stratigraphies. The previous total organic carbon pool in permafrost regions on the QXP was changed in the revised version. Other changes: Line 3: The order of author names was changed according to the contribution of this revised version. Dr. Bo Cao contributed to the geological data analysis.

Line 18: "of the permafrost regions" was replaced by "in the permafrost regions".

Line 19: "706 soil profiles" was changed into "190 soil profiles".

Lines 19∼21: The SOC pools at different depth were changed in the present version. We re-analyzed the data and realized that we made some mistakes in the previous version. We have checked the data of the present version.

Lines 21∼23: "The percentage of SOC storage in deep layer on the QXP was larger than that (38.8%) in the northern circumpolar permafrost region" was replaced by "The percentage of SOC storage in deep layer (3∼25 m) on the QXP (79.5%) was higher than that (38.8%) in the yedoma and thermokarst deposits in arctic regions".

Lines 23∼25: Changed.

Lines 25∼26: We added that "Total organic carbon pool in permafrost regions on the QXP was approximately 8.7% of that in northern circumpolar permafrost region."

Lines 26∼28: Changed.

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Line 32: “greenhouse content” was replaced by “greenhouse gas contents”.

Line 34: “releasing trapped carbon in permafrost affected soils into the atmosphere and further exacerbating global warming” was replaced by that “which can cause previously frozen SOC become available for mineralization”.

Line 35: “Schafer et al., 2011” was deleted.

Lines 35∼36: “Permafrost carbon has been potentially most significant carbon-climate feedbacks because of the size of carbon pools and intensity of climate forcing” was changed into “Permafrost has potentially most significant carbon-climate feedbacks not only due to the intensity of climate forcing, but also the size of carbon pools in permafrost regions”.

Lines 38∼39: “Recently, carbon stored in permafrost regions has created many concerns (Ping et al., 2008; Burke et al., 2012; Zimov et al., 2006; Michaelson et al., 2013; Hugelius et al., 2013).” was added.

Lines 53∼55: “It has been suggested that SOC in permafrost regions on the QXP was very sensitive to the global warming, due to the permafrost characteristics of high temperature (> –2.0âĎČ), thin thickness (< 100 m) and unstable thermal states (Li et al., 2008; Cheng and Wu, 2007)” was added.

Line 56: “During the past year” was added.

Line 57: “from 0.12âĎČ to 0.67âĎČ” was changed into “by a range of 0.12âĎČ to 0.67âĎČ”.

Line 58: “is” was changed into “was”.

Lines 59∼61: “In addition, the carbon stored in permafrost area was labile and a great part of the carbon was mineralizable (Mu et al., 2014; Wu, et al., 2014). Thus it is important to pay attention to organic matter in permafrost regions on the QXP.” was added.

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Lines 61∼62: “The studies have been conducted on . . .” was changed into “Some studies were conducted on . . .”.

Lines 62∼63: “Ohtsuka et al., 2008; Dorfer et al., 2013” were deleted and “Wu et al., 2012” was added.

Lines 63∼67: “The disagreement among the studies on the SOC pools was attributed to the limited sampling points and the quality of the SOC data gathered to date. Despite the importance of SOC in permafrost areas, there are still no reports to the SOC storage in the permafrost regions. So far, the global soil carbon database did not involve the SOC on the QXP (Tarnocai et al., 2009)” was added.

Line 67: “There are about 706 soil sites profiles were excavated in the permafrost regions on the QXP, which make it possible to calculate the SOC pools in this region” was deleted.

Line 69: “SOC in deep layer is usually earlier deposits and has been kept frozen, which has higher microbial decomposition (Waldrop et al., 2010)” was deleted.

Lines 72∼73: “The total yedoma region contains 211+160/-153 Gt C in deep soil deposits [Strauss et al., 2013]” was changed into “It was reported that the total yedoma region contains 211+160/–153 Pg C in deep soil deposits (Strauss et al., 2013).”.

Lines 73∼74: “deep permafrost organic carbon” was changed into “deep organic carbon in permafrost regions”.

Line 75: “permafrost” was removed in the “deep permafrost organic carbon”.

Lines 76∼77: “However, the distribution of permafrost organic carbon in the 0∼25 m depth on the QXP has been largely unknown.” was changed into “Therefore, it is essential to study the distribution of organic carbon contents in deep layer of permafrost regions”.

Lines 78∼85: “For the top layer, the important factors in the determination of SOC

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pools are vegetation type and climate (Jobbagy and Jackson, 2000). The vegetation type and climate conditions related closely to each other on the QXP (Wang et al., 2002). Thus it is possible to calculate the SOC pools at 0∼2 m depth according to the area of vegetation type (Chinese Academy of Sciences, 2001) in the permafrost regions (LIGG/CAS, 1988). For the deep layer, the geomorphology and lithological conditions plays an important role in the distribution of SOC pools (Hugelius et al., 2013). Thus it is reasonable to estimate the SOC pools at 2∼25 m depth according to the area of geological stratification in the permafrost regions on the QXP." was added.

Lines 86∼88: "In the present study, the SOC storages of the plateau were calculated using the data collected from 190 soil profiles (including 11 deep sampling sites) in combination with the vegetation map, permafrost map and geological stratigraphies map of the QXP (Fig. 1, 2, 3)." was added.

Line 89: "SOC pool" was changed into "SOC pools in permafrost regions".

Line 90: "Unlike those from previous assessment of SOC on the QXP" was deleted.

Lines 91∼93: "The result might update new estimation of surface organic carbon mass and deep permafrost carbon storage, which can provide new insights in permafrost carbon on the QXP." was changed into "The result might update new estimation of surface organic carbon mass and deep organic carbon storage in permafrost regions, which can provide new insights in permafrost carbon on the global scale.".

Line 96: "Soil carbon database on the QXP" was changed into "Soil carbon database in previous reports".

Line 97: "Permafrost regions in China are mainly on the QXP (LIGG/CAS, 1988), which occupied approximately 1.35×106 km2 of the QXP area [Ran et al., 2012]. Permafrost organic carbon was mainly distributed in the alpine meadow and alpine steppe, with the areas of 0.53×106 km2 and 0.72×106 km2, respectively [Yang et al., 2010]. In this paper, the remaining area of 0.092×106 km2 was considered as the alpine desert. For

the whole QTP with area of approximately 2.62×106 km2, it was estimated that the area of alpine meadow, alpine steppe, alpine desert and forest was 1.20×106 km2, 0.85×106 km2, 0.40×106 km2 and 0.17×106 km2, respectively, based on the China vegetation data [Chinese Academy of Sciences, 2001] (Fig. 1). The permafrost regions in the alpine meadow, alpine steppe and alpine desert are 0.53×106 km2, 0.72×106 km2 and 0.092×106 km2, respectively, total 1.35×106 km2." was deleted.

Line 97: "based on" was changed into "retrieved from".

Line 99: "Wang et al., 2002" was deleted.

Line 100: "Moreover, we complemented . . ." was deleted.

Line 101: "the" in "in the 0∼1 m depth" was deleted.

Line 102: "were calculated separately" was added.

Lines 102∼104: ". . ., since their study regions of western QXP, Shulehe river basin (SLRB) and Heihe river basin (HHRB) belonged to island permafrost and the climate conditions differed greatly with the continuous permafrost zones of the QXP" was added. Lines 104∼105: "The total permafrost carbon pool in the QTP was built up using 706 pedons, including 11 pedons in deep permafrost soils." was changed into "The total organic carbon pools in permafrost regions on the QXP were calculated using 190 profile sites.".

Line 106: "Deep Permafrost Carbon" was changed into "Field sampling".

Line 107: "In addition to the soil carbon in the 0∼1 m depth" was deleted.

Lines 107∼108: "we also reported deep permafrost carbon pools (0∼25 m) by nine sites in the QTP and two sites in the upper reach of the Heihe River basin by field machine-drill from 2009 to 2013 (Fig. 1)" was changed into "To calculate the deep carbon pools (2∼25 m) in permafrost regions, 11 boreholes on the QXP were drilled by field machine-drill from 2009 to 2013 (Fig. 1)".

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Lines 108∼111: “Geographic location for the 11 boreholes, together with the active layer depth, sampling depth, vegetation type, geological stratigraphies, SOC contents, bulk density, water contents and soil texture were shown in the supplement materials.” was added.

Line 113: “Five sites near the Qinghai Tibetan Highway were located in the Kaixinling basin (KXL), Honglianghe valley (HLH-1, HLH-2), Xiushuihe valley (XSH) and Wudaoliang basin (WDL), respectively.” was deleted.

Line 115: “The elevation ranged from 4525 m to 4779 m. Soil types were mainly Quaternary alluvial sand, silt and silty clay, under where were Tertiary mudstone and sandstone (Luo et al., 2012). Ice-rich permafrost was found at some areas in this region (Lin et al., 2010).” was deleted.

Line 117: “In addition, two deep permafrost sites in the Heihe river basin” was changed into “In addition, two sites in permafrost regions of the Heihe river basin”.

Lines 118∼119: “. . .were alpine meadow and rich in organic carbon. . .” was changed into “. . .with the vegetation type of alpine meadow were rich in organic carbon. . .”.

Lines 183∼123: “The deep sampling sites were mainly distributed in three geological stratigraphies of quaternary, permian and triassic (Fig. 3), of which ZEH, WDL, XSH, Heihe-1 and Heihe-2 were in quaternary stratigraphy, KL150, KL300, KL450, HLH-1 and HLH-2 were in triassic stratigraphy, and KXL was in permian stratigraphy.” was added.

Line 123: “The SOC densities reported in the previous studies were employed to calculated the SOC pools in the top 1 m layer. The SOC data of the 11 drilling holes were used for the calculation of SOC pools of the layers below 1 m” was moved into the Calculation of Soil Carbon Pools.

Lines 112∼123: The introduction of deep soil carbon in permafrost in 2.2 Field sampling was rewritten according to the located vegetation type and geological stratigra-

phies.

Line 134: “and/or ice content” was deleted.

Line 135: “0∼1 m” was added in the “the SSOC was calculated for the 0∼1m, 1∼2 m, 2∼3 m and 3∼25 m depth”.

Line 136: “by the area with different vegetation type” was replaced by “by the distribution area”.

Lines 137∼151: We added “For the organic carbon storage in 0∼1 m depth, the reported SOC densities data of 190 sampling sites were collected through their distribution in permafrost regions (Fig. 1). The area of alpine meadow, alpine steppe and alpine desert in permafrost regions was calculated through overlaying the vegetation map over the QXP permafrost regions (Fig. 2). For the organic carbon storage in 1∼2 m depth, the organic carbon densities of 11 boreholes were multiplied by the located vegetation type area. For the organic carbon storage in 2∼25 m depth, the area of permafrost regions in the quaternary, permian and triassic stratigraphies on the QXP was calculated through overlaying the distribution of geological stratigraphies over the permafrost map (Fig. 3). The organic carbon pool of 2∼25 m depth was estimated through deep organic carbon densities multiplied by the area of geological stratigraphies. The three geological stratigraphies had thick soil layer of about 25 m (Fang et al., 2002; 2003; Qiang et al., 2001). As for other geological stratigraphies, the poor soil development was reported and soil layer thickness was usually less than 3 m (Wu et al., 2012; Yang et al., 2008; Hu et al., 2014). Thus other stratigraphies were not considered in the estimation of deep organic carbon pool in permafrost regions.”.

Lines 155∼157: We added “Based on the China vegetation data in permafrost regions on the QXP (Fig. 1, 2), the area of permafrost regions in the alpine meadow, alpine steppe and alpine desert are 0.302×106 km2, 0.772×106 km2 and 0.175×106 km2 respectively, total approximately 1.25×106 km2.”

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Line 158: “On the QXP, organic carbon storage of the permafrost regions in the 0∼1 m depth was. . .” was replaced by that “Organic carbon storage of the permafrost regions in the 0∼1 m depth on the QXP. . .”

Lines 158∼160: The organic carbon stocks and storages with three vegetation types in the 0∼1 m depth were changed in the present version.

Line 161: “was much variation. . .” was changed into “were great variations among the sites under alpine meadow area”.

Lines 162∼165: It was replaced by “SOC contents in the HHRB (39.0±17.5 kg m-2) were much higher than those of most sites in the continuous permafrost zome on the QXP (5.46∼13.7 kg m-2). In contrast, the SOC contents showed little variations over the sites from the alpine steppe and alpine desert area, with the ranges of 1.67∼10.91 kg m-2 and 1.76∼5.10 kg m-2, respectively”.

Line 166: “deep permafrost organic carbon” was replaced by “Distribution of deep organic carbon contents”.

Lines 167∼174: The paragraph was replaced by that “According to the distribution of sampling sites at the geological stratigraphies, for the permian stratigraphy, average SOC contents at 2∼18 m depth were 1.1±0.3% at KXL. For the triassic stratigraphy, average SOC contents at 2∼25 m depth were 0.9±0.2%, 1.0±0.2%, 1.1±0.4%, 1.8±0.8%, 1.0±0.3% at HLH-1, HLH-2, KL150, KL300 and KL450. For the quaternary stratigraphy, average SOC contents from 2 m to 25 m in permafrost regions on the QXP were 1.1±0.3%, 0.1±0.03%, 1.1±0.8% at WDL, ZEH and XSH. As for the permafrost regions in HHRB, SOC contents in HHRB (Heihe-1, Heihe-2) were higher than those of the continuous permafrost zone on the QXP, with a range of 5.1±3.7% and 2.7±2.4% in depth of 19 m”.

Lines 174∼176: “SOC contents decreased with depth at the KXL, HLH-1 and HLH-2. While SOC contents in deeper depth were higher than those in the top layer at the

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XSH, WDL and KL300." was changed into "SOC contents decreased with depth at most deep boreholes, while SOC contents in deeper depth were higher than those in the top layer at the XSH, KL150 and KL300 (Fig. 4)".

Line 177: "deep permafrost soil data" was replaced by "With the deep soil data".

Line 178: "in deep permafrost soils" was replaced by "in deep soils of permafrost regions".

Line 178: "Fig. 2" was changed into "Fig. 4" because two figures were added in the present version.

Line 179: The equation was changed into SOC% = 4.285h-0.45 (R2 = 0.36, $p < 0.01$, n = 362) according to the data collected in the permafrost regions on the QXP.

Line 180: "Deep permafrost organic carbon pools" was changed into "Deep organic carbon pools in permafrost regions".

Lines 181∼184: We added "Based on the China quarternary stratigraphies data in permafrost regions on the QXP (Fig. 3), the area of permafrost regions in the quaternary, permian and triassic stratigraphies are 0.194×106 km2, 0.135×106 km2 and 0.238×106 km2 respectively, with a total area of approximately 0.567×106 km2 (45.4% of the permafrost regions on the QXP)."

Line 185: "organic carbon storage" was changed into "Organic carbon storages in permafrost regions".

Lines 185∼187: The organic carbon pools in 1∼2 m, 2∼3 m, and 3∼25 m were changed in the revised version.

Line 187: "The organic carbon storage in the 0∼1 m depth was approximately twice that in the 1∼3 m depth." was deleted.

Lines 191∼192: It was replaced by that "According to this depth, the organic carbon storage in permafrost layer was approximately five times of that in the active layer".

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Lines 193∼195: “SOC storages in the alpine meadow, alpine steppe and alpine desert were 32.39 Pg, 38.79 Pg and 0.82 Pg, of which 17.73 Pg (54.7%), 29.64 Pg (76.4%) and 0.32 Pg (39.0%) stored in permafrost-affected soils, respectively. Among the three vegetation types, more organic carbon is stored in deep permafrost soils in the alpine steppe.” was changed into SOC storages in the quaternary, triassic and Permian stratigraphies.

Lines 198∼261: The six paragraphs in the Discussion were rewritten according the revised results and revisers’ suggestion in the present version.

Lines 264∼265: “deep permafrost” was replaced by “deep boreholes in permafrost regions”.

Line 265: “permafrost organic carbon storage” was changed into “the organic carbon storages in permafrost regions”.

Line 266: “. . .were approximately . . .” was changed into “. . . were estimated to approximately. . .”.

Line 267: “. . .larger than that in previous analyses” was deleted.

Line 269: “It contained approximately 24.02 Pg SOC in the surface 0∼3 m depth, with an additional 43.19 Pg carbon locked in deep layers (3∼25 m) of alpine steppe (27.76 Pg), alpine meadow (15.43 Pg) and alpine desert (0.23 Pg).” was deleted.

Line 269: Changed.

Lines 275∼276: The order of supported project was changed into “National Key Scientific Research Project (Grant 2013CBA01802), National Natural Science Foundation of China (Grants 41330634, 91325202).”

Line 284: The reference “Burke, E. J., Hartley, I. P., and Jones, C. D.: Uncertainties in the global temperature change caused by carbon release from permafrost thawing. The Cryosphere, 2012, 6(5), 1063–1076.” was added.

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Line 298: The reference “Don, A., Schumacher J., Scherer-Lorenzen, M., Scholten, T., and Schulze, E.D.: Spatial and vertical variation of soil carbon at two grassland sites âĂŤ Implications for measuring soil carbon stocks, Geoderma, 141, 272–282, 2007.” was added.

Line 301: The reference “Fang, X. M., Lu, L. Q., Mason, J. A., Yang, S. L., An, Z. S., Li, J. J., and Guo, Z. L.: Pedogenic response to millennial summer monsoon enhancements on the Tibetan Plateau, Quaternary International, 106–107, 79–88, 2003.” was added.

Line 304: The reference “Fang, X. M., Lu, L. Q., Yang, S. L., Li, J. J., An, Z. S., Jiang, P.A., and Chen, X.L.: Loess in Kunlun Mountains and its implications on desert development and Tibetan Plateau uplift in west China, Science in China, 45, 291–298, 2002.” was added.

Line 311: The reference “Hu, G. L., Fang, H. B., Liu, G. M., Zhao, L., Wu, T. H., Li, R., and Wu, X. D.: Soil carbon and nitrogen in the active layers of the permafrost regions in the Three Rivers’ Headstream, Environ. Earth. Sci., 72, 5113–5122, 2014.” was added.

Line 317: The reference “Hugelius, G., Strauss, J., Zubrzycki, S., Harden, J. W., Schuur, E. A. G., Ping, C. L., Schirrmeister, L., Grosse, G., Michaelson, G. J., Koven, C. D., O’Donnell, J. A., Elberling, B., Mishra, U., Camill, P., Yu, Z., Palmtag, J., Kuhry, P.: Estimated stocks of circumpolar permafrost carbon with quantified uncertainty ranges and identified data gaps, Biogeosciences, 11, 6573–6593, 2014.” was added.

Line 324: The reference “Kalembasa, S. J., and Jenkinson, D. D.: A comparative study of titrimetric and gravimetric methods for the determination of organic carbon in soil, Journal of the Science of Food and Agriculture, 24, 1085–1090, 1973.” was added.

Line 336: The reference “Li, J. J., Zhang, Q. S., and Li, B. Y.: Main processes of geomorphology in China in the past fifteen years, Acta Geographical Sinica, 1997, 49,

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642–648." was added.

Line 341: The reference "Lin, Z. J., F. J. Niu, Z. Y. Xu, J. Xu, and Wang, P.: Thermal Regime of a Thermokarst Lake and its Influence on Permafrost, Beiluhe Basin, Qinghai-Tibet Plateau, Permafrost and Periglac. Process., 2010, 21, 315–324." was deleted.

Line 346: The reference "Luo, J., F. J. Niu, Z. J. Lin, and Lu, J. H.: Permafrost Features around a Representative Thermokarst Lake in Beiluhe on the Tibetan Plateau, Journal of Glaciology and Geocryology, 2012, 34(5), 1112–1117." was deleted.

Line 358: The reference "Nelson, D. E., and Sommers, L. E.: Total carbon, organic carbon, and organic matter, Methods of soil analysis, Part 3 - chemical methods, 961–1010, 1996." was added.

Line 371: The reference "Qiang, X. K., Li, Z. X., Powell, C. McA., and Zheng, H.B.: Magnetostratigraphic record of the Late Miocene onset of the East Asian monsoon, and Pliocene uplift of northern Tibet, Earth and Planetary Science Letters, 187, 83–93, 2001." was added.

Line 377: The reference "Schaefer, K., T. Zhang, L. Bruhwiler, and Barrett, A. P.: Amount and timing of permafrost carbon release in response to climate warming, Tellus B, 2011, 63, 165–180." was deleted.

Line 403: The reference "Wu, X.D., Fang, H.B., Zhao, L., Wu, T.H., Li, Ren., Ren, Z.W., Pang, Q.Q., and Ding, Y.J.: Mineralization and Fractions Changes in Soil Organic Matter in Soils of Permafrost Region in Qinghai-Tibet Plateau. Permafrost and Periglacial Processes., DOI:10.1002/ppp.1796,2014." was added.

Lines 425∼428: "Supplement: Dataset of the geographic location for 11 boreholes on the Qinghai-Xizang (Tibetan) Plateau, together with the active layer depth, sampling depth, vegetation type, geological stratigraphies, soil organic carbon (SOC) contents, bulk density, water contents and soil texture." was added.

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Line 431: The caption of table 1 was changed into “Organic carbon pools in the 0∼1 m depth with different vegetation type on the QXP”.

Lines 435∼438: Figure 1 was changed into “Location of sampling sites on the QXP, shown on the background of QXP permafrost distribution (blue points were sampling sites in Yang et al., (2010); orange points were in Wu et al., (2012); red box was Shule river basin (SLRB) in Liu et al., (2012); black box was Heihe river basin (HHRB) in Mu et al., (2013))”. Lines 439∼441: The previous figure 1 was changed into figure 2.

Lines 442∼444: Figure 3 (Location of sampling sites on the QXP, shown on the background of QXP quaternary geological map) was added in the present version.

Lines 436∼437: The figure 4 caption was changed into “Distributions of soil organic carbon contents in deep soils in permafrost regions on the QXP.”

Line 447: “Ecosystem” was changed into “Vegetation types”, and “Soil content” was changed into “Soil stock” in table 1. In addition, “Analytical methods” was added in table 1.

Line 448: The SOC pools in vegetation types were expressed as those in the geological stratification in table 2.

Please also note the supplement to this comment:
http://www.the-cryosphere-discuss.net/8/C2733/2014/tcd-8-C2733-2014-supplement.pdf

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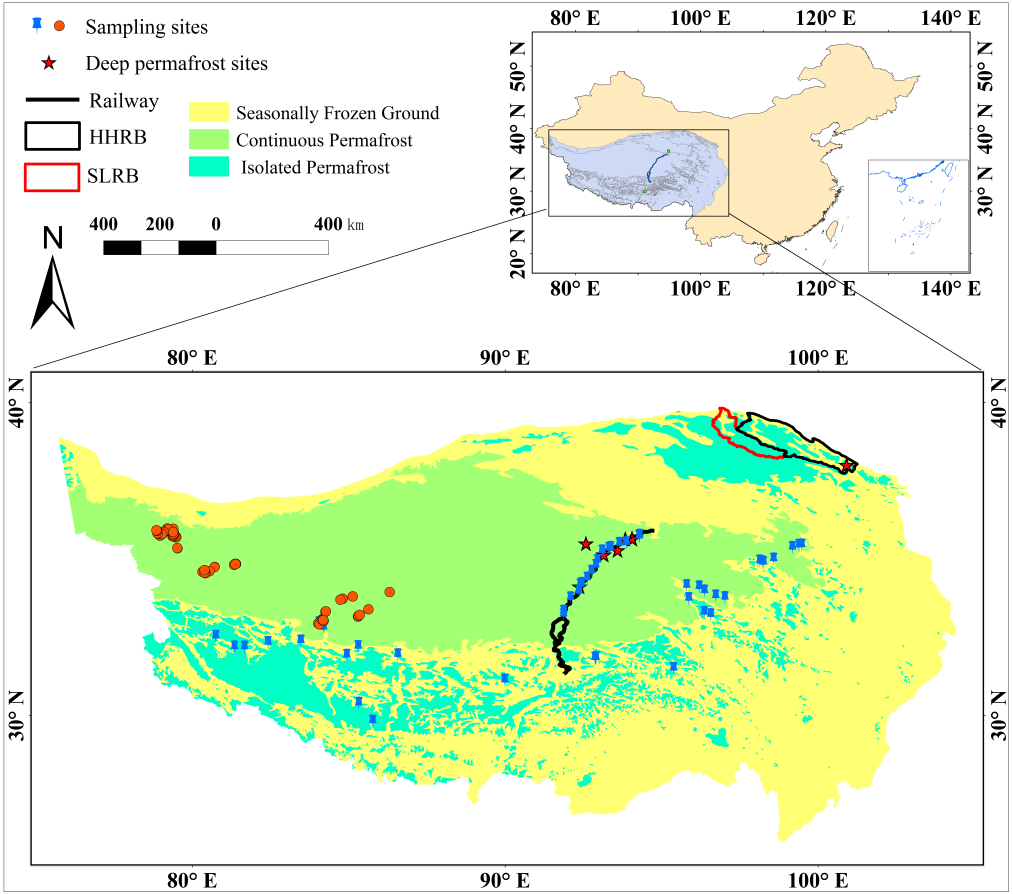

Fig. 1.

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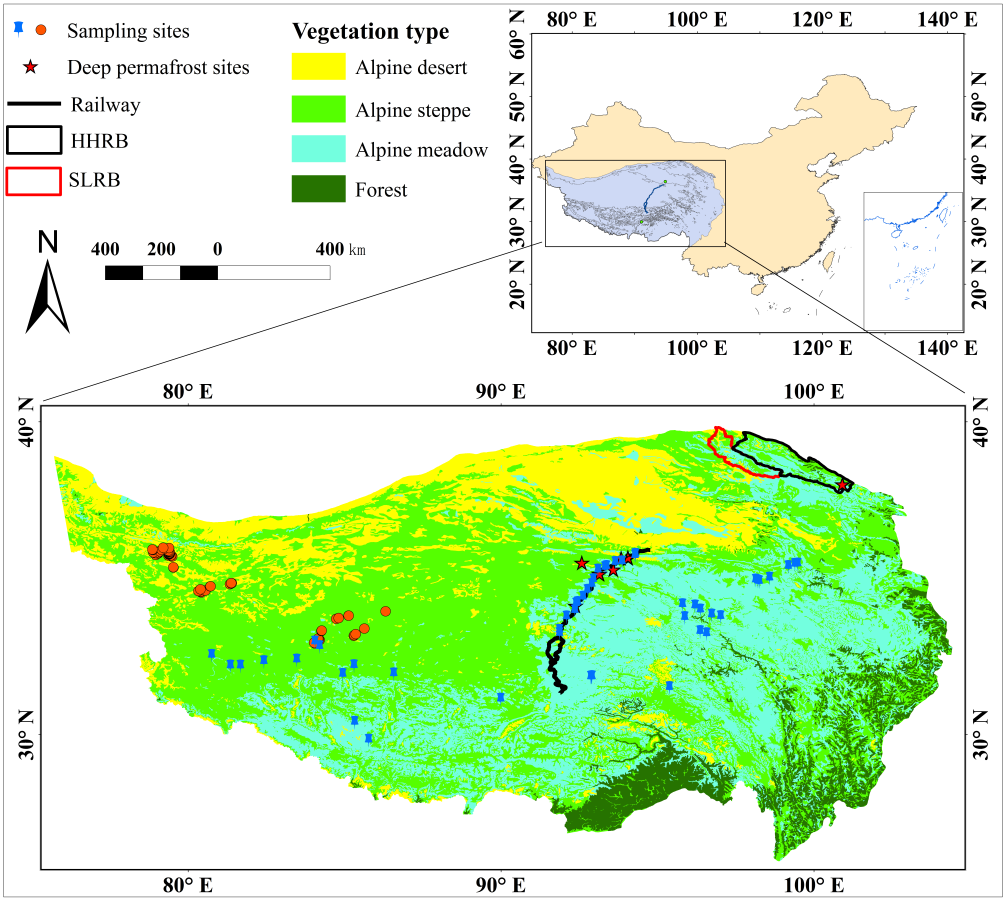

Fig. 2.

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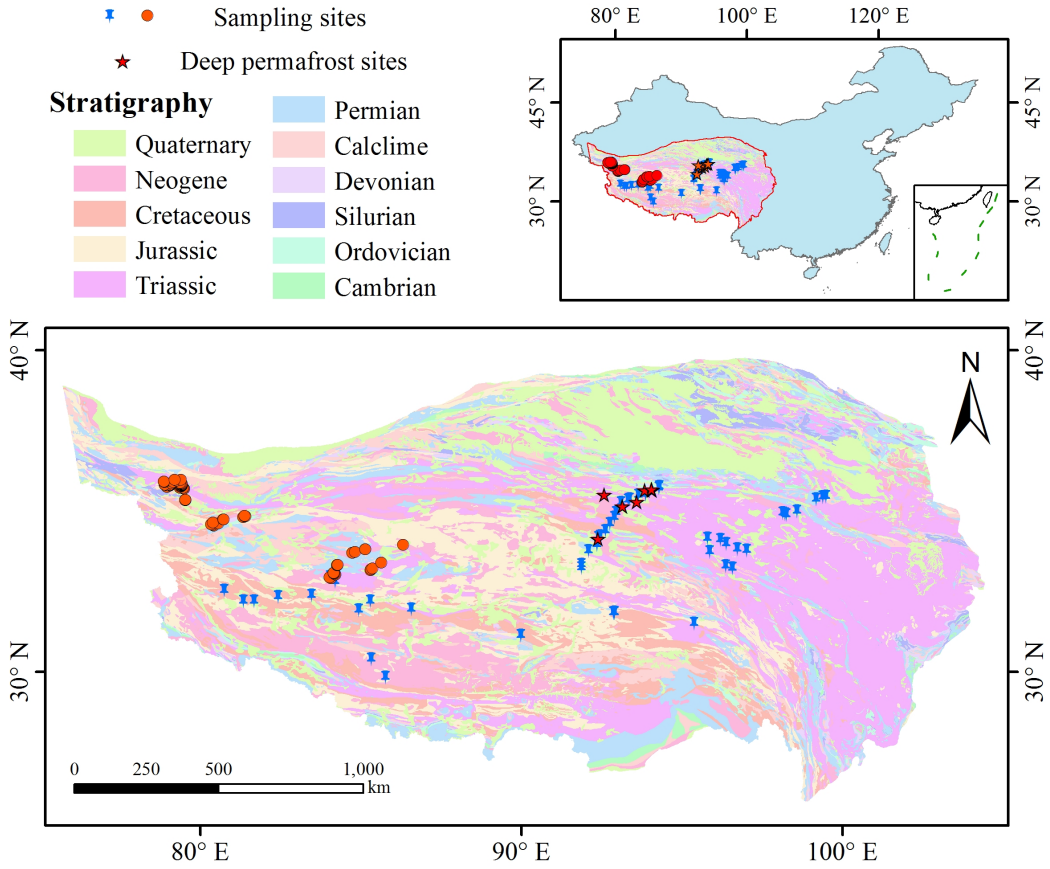

Fig. 3.

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