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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.

The paper represents a great attempt to summarize all the past research on soil carbon stores and distribution in different ecosystems (cover types) of the Qinghai-Xizang Plateau (QXP). The authors have reviewed many published works/research done by the Chinese colleagues over the past several decades. It is timely and would contribute to our understanding of the relationships between carbon stores and vegetation covers. This paper has the potential being a monumental work if the authors can tie the physiography, soils, vegetation, permafrost to define the ecosystems of the QXP and how these ecosystem attributes affect the OC store on the QXP. But, there are some

shortcomings must ne addressed before being considered for publication. I would recommend the manuscript be accepted after major revision.

Response: Thank you very much for your valuable comments. We have carefully revised the manuscript according to your detailed suggestion.

I am confused if the objective of this paper is to estimate the organic carbon (OC) pools only of the permafrost regions of the Qinghai-Xizang Plateau (QXP) or the whole QXP. The authors calculated the total area of the permafrost regions of the QXP is 1.35×106 km2. But the total area of QXP is 2.5×106 km2. Therefore, 46% of the QXP are seasonal frozen grounds which also exist beyond the boundary of the QXP.

Response: Sorry for the previous confused expression. The permafrost area of different vegetation type was calculated again through overlaying the vegetation type map over the permafrost map in the present version. In the revised version, it was shown as "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." (lines 153∼155).

The authors estimated the total carbon stock of the QXP based on vegetation cover types; alpine desert, alpine steppe, and alpine meadow. The forest area in SE QXP was shown in the map but no carbon data was presented. To my understanding, except the forest area, each of the land cover types includes both permafrost and seasonal frozen ground. In general, the carbon contents in permafrost-affected sites are higher than those without permafrost (because of soil moisture contents). The authors claimed that the database relied on 706 profile sites distributed among these three cover types. I question if all these sites have permafrost within measurable depths? Except some broad basins, there are large areas with steppe and desert vegetation communities have very shallow soils due to the shallow depths of weathering. These sites cannot be called permafrost sites or permafrost soils. The carbon contents in wet

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meadows are generally much higher than those well-drained Kobrecia meadow soils.

Response: The sampling sites (190 sites) in permafrost regions on the QXP were collected though the permafrost map in the revised version. Lines 78∼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 gemorpholory 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. The 11 deep sampling sites were mainly located in the three vegetation types of alpine meadow, alpine stepper and alpine desert (Fig. 2), and three stratigraphies of quaternary, permian and triassic (Fig. 3). "permafrost sites or permafrost soils" were changed into "in deep soils of permafrost regions" in the revised version".

There has never before a comprehensive study or review of the carbon pools of the QXP. Because of this, it is crucial for the authors to scrutinize the dataset. In order to support the information in Table 1. The authors need to submit a supplement file that contains all the cited source of carbon data, site (pedon) by site as %C, bulk density, land cover type (meadow, steppe, desert, etc.), active layer depth, soil texture, sampling depth, elevation (asl) if these information is provided in the original source.

Response: We provided 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 in the supplement in the revised version. The data in the previous studies were available in the Yang et al., (2010), Liu et al., (2012), Wu et al„ (2012), and Mu et al., (2013), which are concluded in Table 1.

One of the coauthors, Dr. GD Cheng has studied the distribution of permafrost of the QXP for many years. Why not overlay the land cover type map over his permafrost map to separate the carbon pools in the permafrost and non-permafrost of the same cover type? This approach would improve the accuracy of the estimate. If this paper is to represent the whole QXP. Then the forest regions in SE QXP should be included. Professor Zhang Wan Ju of the Chinese Forest Sciences Academy studied forest soils including the LinZhi District in the 1970 to 1980 period and published the book Forest soils of China by Ministry of Forestry. Another reference is the Qinghai Province Soils by Bao Xingqui of the Xining Alpine Botany Institute.

Response: Thank you for your suggestion. We have overlaid the vegetation type map over the permafrost map to separate the carbon pools in the permafrost and non-permafrost of the same cover type. Thus, we can select the sampling sites and calculate the permafrost area in the three vegetation types again. The forest regions were not included in the present study because this paper focuses on the estimation of the organic carbon pool in permafrost regions not the whole QXP. Although the references (Zhang Wanju and Bao Xingqui) provided important data for the soils under the forest cover, we found it was very difficult to merge these data into our work partly because the permafrost cover was largely unknown in these forest regions.

Next, an important question is about the uncertainty or variations caused by different lab procedures. The OC of the 11 deep sampling sites were determined by high temperature combustion with pre-treatment to remove inorganic carbon. But most of the carbon contents data in published Chinese literatures were determined by wet oxidation (for example, dichromate oxidation) and or loss on ignition. There could be 10-18% difference among the 3 procedures. I have not seen any study in China dealing with the calibration among these three analytical procedures. But at least the methods used in each cited source of data point should be noted in the supplement

Response: The different analytical procedures indeed can cause uncertainly. The analytical methods used in each cited data has been noted in table 1. Thanks for the

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suggestion, which can make us pay more attention to the analytical methods of soil carbon in the future. Lines 214∼217: "In addition, the different analytical methods may also contribute to the differences of carbon contents (Table 1). It has been demonstrated that if taking the dry combustion method as standard, the recovery of organic carbon was 99% for wet combustion and 77% for Walkley-Black (Kalembasa and Jenkinson, 1973; Nelson and Sommers, 1996)" was added in the discussion of the revised version.

My next concern is the extrapolation of the deep OC stores (3-25 m). Please note even in the 2-3 m OC store estimation in the North Circumpolar Carbon Database, there is wide disparity and very high uncertainty. When Strauss, Schirrmeister and their collaborators studied the OC store in the yedoma deposit, they gave a definite geographic distribution base on geomorphology and lithological data (stratification) in that the yedoma OC store does not extrapolated to the whole Arctic Coastal Plain. Thus, I'd urge the authors be discretionary as how far (in area extent) can this deep OC data can be extrapolated. Geomorphic and or geological information would help such extrapolation. I'd strongly encourage the authors to go back to the cited dataset or data points and reorganize the data and consider the comments and synthesize all the previous work. Only after that the authors would be able to find the gaps in the previous work and pointing to the needs of future research.

Response: Thanks, we provided the distribution of sampling sites on the quaternary stratigraphies (supplement material). The 11 deep sampling sites were mainly located in the three stratigraphies of quaternary, permian and triassic (Fig. 3). Thus the estimated deep carbon pools in the present version were the carbon storages in quaternary, permian and triassic stratigraphies in permafrost regions on the QXP. Thus the carbon storage in deep layer was recalculated and discussed in the present version.

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

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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 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.

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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.

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.

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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.

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).”.

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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 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

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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)".

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

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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 stratigraphies.

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

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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."

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, aver-

age 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 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 ($R^2 = 0.36$, $p < 0.01$, $n = 362$) 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%

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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".

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.

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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.

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.

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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, 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.:

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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.

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.

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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/C2755/2014/tcd-8-C2755-2014-supplement.pdf

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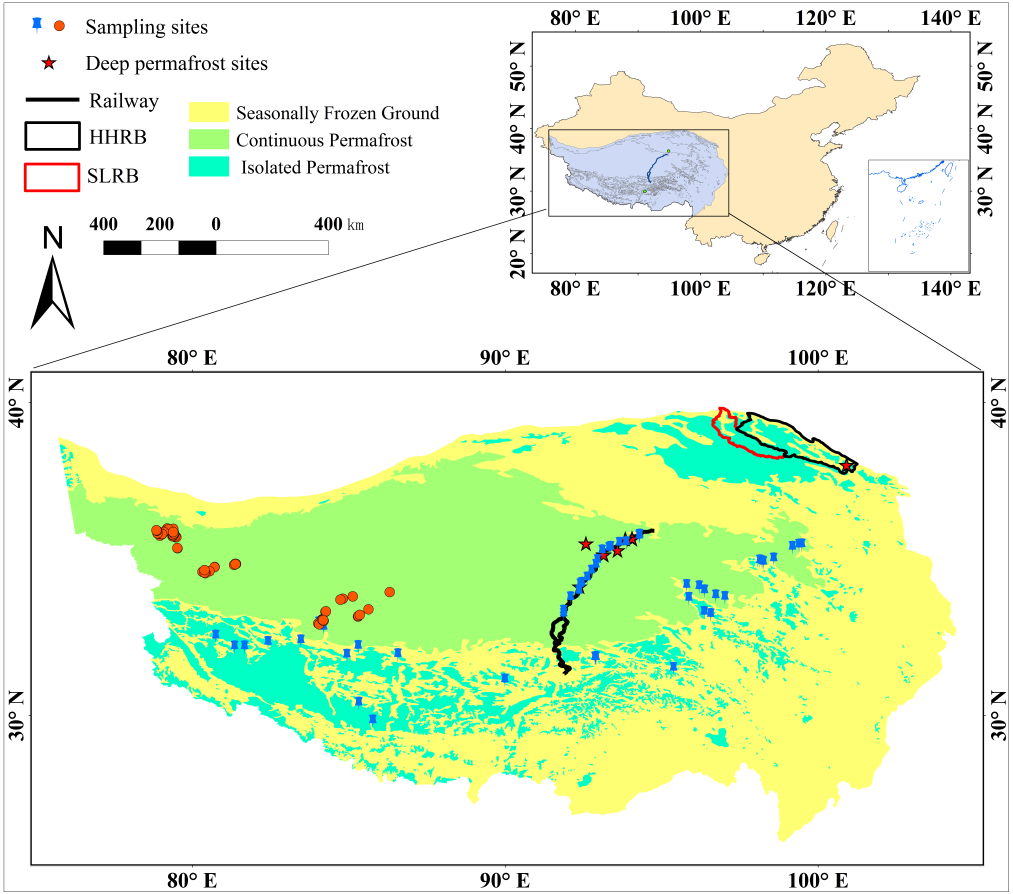

Fig. 1.

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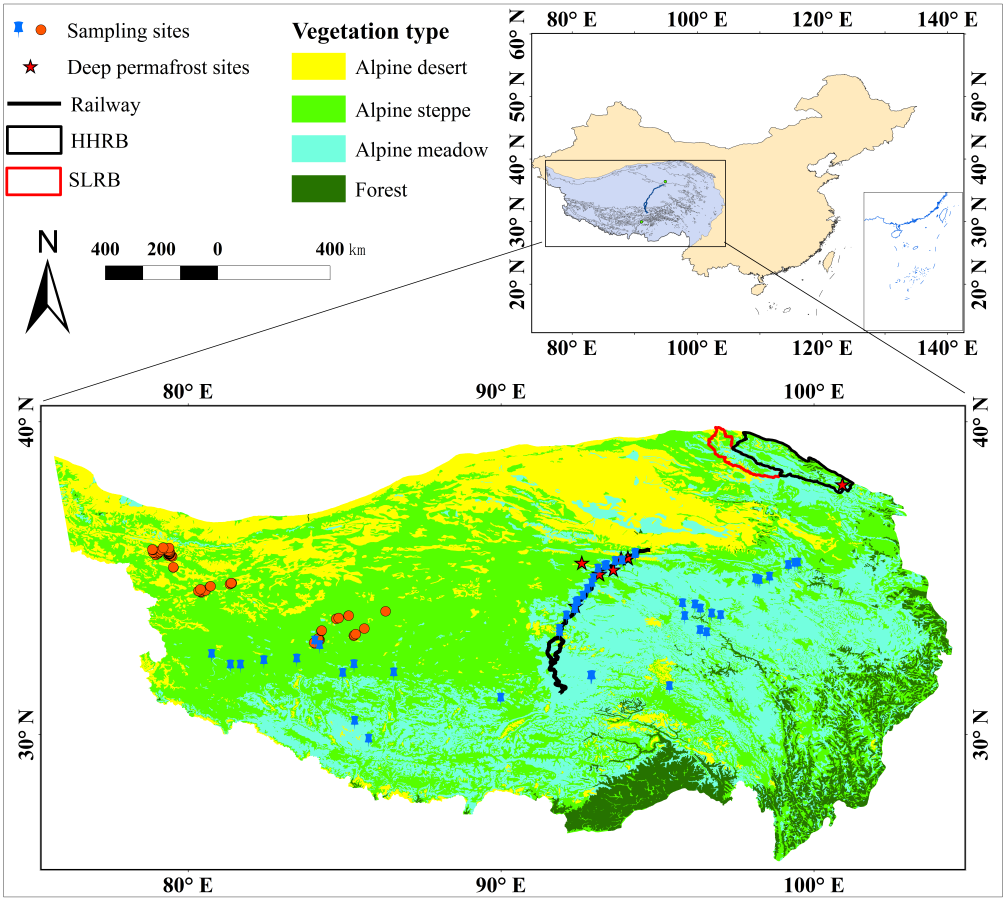

Fig. 2.

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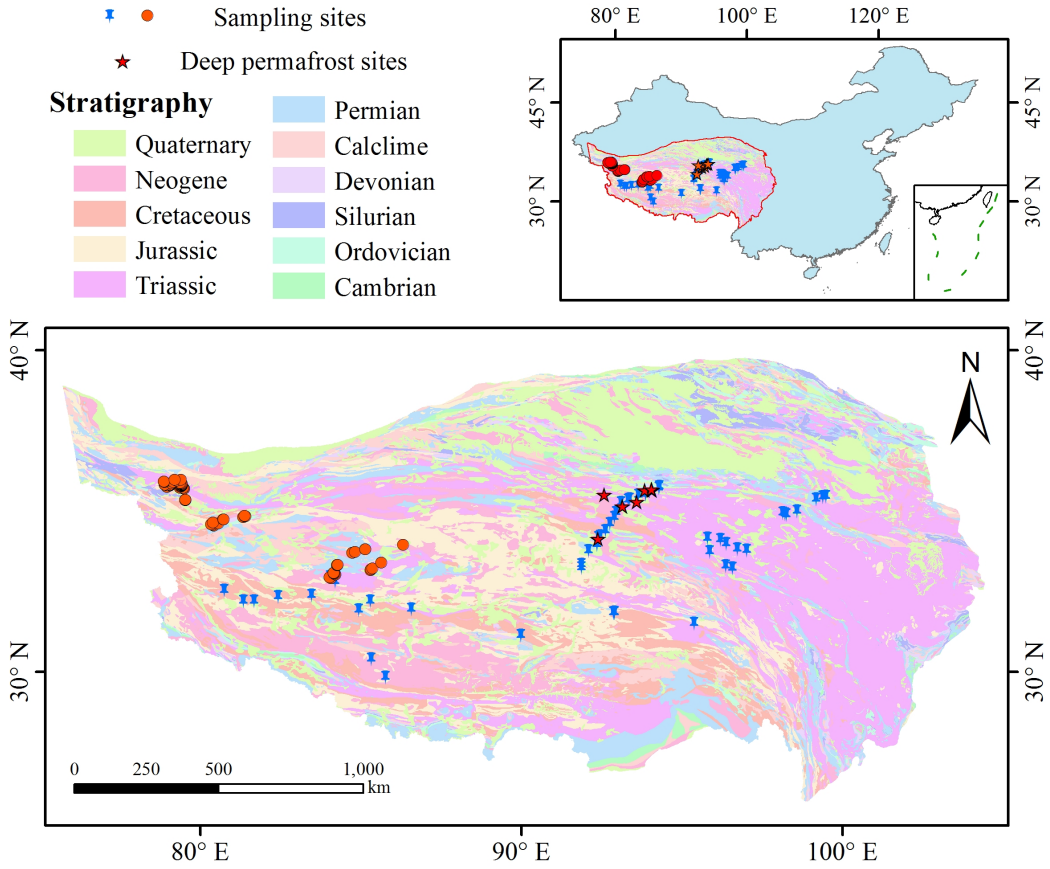

Fig. 3.

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