**Supplemental material, "Ideas and Perspectives: Holocene thermokarst sediments of the Yedoma region do not increase the northern peatland carbon pool”**

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# 1. Methods

This sections contains a more detailed description of the methods concerning the properties of soils and deposits in Siberian Yedoma region alases. For a full reference list we refer to the main paper. Note that in this publication the term alas is used in a wide sense to describe former thermokarst lake basins. Following initial permafrost degradation and thermokarst, these basin have often been (partly) terrestrialized (e.g. through lake drainage or evaporation of lake water) and re-aggraded permafrost.

## 1.1 Geospatial analyses of peatland cover

All geospatial analyses and quantification of areal extents of classes were calculated in equal area projections using Geographical Information Systems (software ArcGIS 10.3, ESRI, Redlands, California, USA). The extent of the Siberian Yedoma region was digitised from Grosse et al. (2013) and, where applicable, snapped to correspond to the Arctic Ocean coastlines of the NCSCDv2 (Hugelius et al., 2013b). Soil and non-soil coverage within this region in the NCSCDv2 was extracted. To provide independent estimates of mapped coverage of peatlands and wetlands for the Siberian Yedoma region the following international geospatial datasets were used: Nilsson et al. (2002); Bartalev et al. (2003); Lehner and Döll (2004) and Arino et al. (2012). The thematic classes that corresponded to peatlands were identified and their respective coverage in the Siberian Yedoma region quantified. See section 1.1 below for the detailed coverage of different classes in the respective geospatial datasets.

## 1.2 Field surveys of soil properties

The independent field validation sites were classified and sampled using a transect-based semi-random approach during field campaigns in August (2010 and 2013). The starting point and direction of transects were chosen to cut across representative landscape types. After this, pedons (a pedon is a three-dimensional body of soil as sampled, described and classified in soil studies) were described and sampled at equidistant intervals. See Palmtag et al. (2015) and Siewert et al. (2015) for more detailed descriptions of sampling and soils. All sites used in this comparison were located in alases or thermoerosional gullies. In three out of nine sites, the bottom of deep peat deposits was not reached when sampling.

## 1.3 Calculations of OC stocks and overlap

Calculations of overlap in soil carbon stocks between different estimates and datasets are based on data on soil and/or sediment carbon stocks from Tarnocai et al. (2009), Hugelius et al. (2013a; 2013b; 2014) and Walter Anthony et al. (2014). By using the reported depth ranges and soil carbon densities of the different studies, the overlap between estimates has been calculated following the same methods used in the original studies. We assumed that all Histels in the NCSCDv2 within the Siberian Yedoma region where located in alases and the remaining soil area was subdivided between the Turbel and Orthel suborders of the Gelisol soil order. The calculations are made assuming 14% coverage of lakes/rivers in the Siberian Yedoma region (following Strauss et al., 2013). Tables 1 and 2 provide details of the calculations presented in figures 2a and 2b, respectively.

Table 1. Details of OC stock calculations for 0-3 m depth in the Siberian Yedoma region based on the NCSCDv2 (Hugelius et al., 2013b and 2014). The numbers correspond to those shown in figure 2a.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Soil type | Soil area NCSCD (km2) 1 | Percent of soil area | Mean SOC 0-3 m (kg C/m2) 2 | Pg OC |
| Histels | 102323 | 13% | 128.5 | 13.2 |
| Orthels | 147373 | 19% | 68.8 | 10.1 |
| Turbels | 546148 | 69% | 61.0 | 33.3 |
| sum | 795844 |  |  | 56.6 |

1. Calculated from shapefile clipped to the Siberian Yedoma region. Assuming, that 70% of the region is covered by alases with 14% lake cover and that all mapped Histels are within alases

2. Mean values calculated from the pedon dataset presented in Hugelius et al., 2013b

Table 2. Details of OC stock calculations for the Siberian Yedoma region from Walter Anthony et al. (2014). The numbers correspond to those shown in figure 2b.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Total | terrestrial (76%\*) | subaqueous (14%\*) |
| Holocene >3 m | 89\* | 76.5 | 12.5 |
| Holocene <3 m | 70\* | 60.2 | 9.8 |
| Sum Holocene | 159\* | 136.7 | 22.3 |
| Pleistocene 0-10 m | 155\* | 117.8 | 21.7 |

\*numbers extracted directly from Walter Anthony et al. (2014)

## 1.4 Analyses of peatland cover in the Siberian Yedoma region

This section contains more detailed material on the analyses of Siberian Yedoma region peatland extent. Figure S1 shows coverage of peatlands in the independent geospatial datasets (ESA Globcover, GLC2000, GLWD and Land Resources of Russia) as well as in the NCSCDv2. Following this the detailed coverage of land cover types from the four geospatial datasets within the Siberian Yedoma region is provided in tables, including comments on which thematic classes were considered to correspond to peatlands/organic soils.

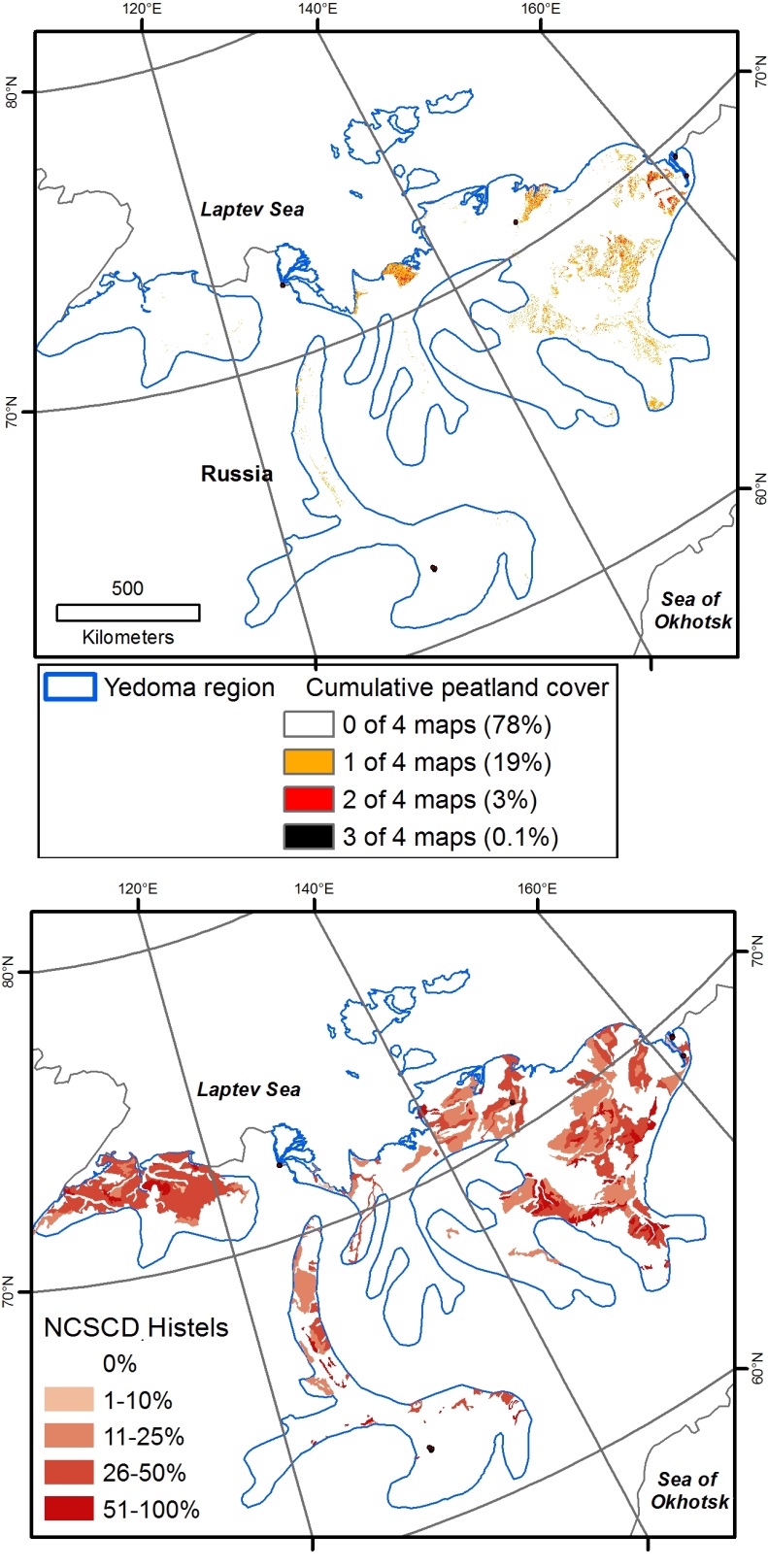


Figure S1. Upper panel shows map Siberian Yedoma region extent with cumulative coverage of peatland classes in the four independent geospatial datasets used in analyses. The lower panel map shows the extent of mapped Histels in the NCSCDv2 within the same region. Small black dots in both panels show exact locations of validation sites.

The tables below show the properties of clipped sections of four geospatial datasets (ESA Globcover, GLC2000, GLWD and Land Resources of Russia) within the Siberian Yedoma region. The classes which were identified as being thematically similar to peatlands are highlighted and sometimes a comment on the reasoning behind the choice is given.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ESA Globcover** | |  |  |  |
| Reference: | Arino, O., Ramos Perez, J. J., Kalogirou, V., Bontemps, S., Defourny, P., and Van Bogaert, E. Global Land Cover Map for 2009 (GlobCover 2009). European Space Agency (ESA) & Université catholique de Louvain (UCL), doi:10.1594/PANGAEA.787668, 2012. | | | |
| **Properties within the Siberian Yedoma region** | | | |  |
| Pixel Value | Pixel Count | Percent cover | Class description | Comment |
| 50 | 184 | 0.0% | Closed (>40%) broadleaved deciduous forest (>5m) |  |
| 90 | 490096 | 40.8% | Open (15-40%) needleleaved deciduous or evergreen forest (>5m) |  |
| 100 | 6661 | 0.6% | Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m) |  |
| 110 | 72821 | 6.1% | Mosaic forest or shrubland (50-70%) / grassland (20-50%) |  |
| 120 | 115856 | 9.6% | Mosaic grassland (50-70%) / forest or shrubland (20-50%) |  |
| 130 | 731 | 0.1% | Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m) |  |
| 140 | 1994 | 0.2% | Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses) |  |
| 150 | 339463 | 28.2% | Sparse (<15%) vegetation |  |
| 180 | 52965 | **4.4%** | **Closed to open (>15%) grassland or woody vegetation on regularly flooded or waterlogged soil - Fresh, brackish or saline water** | Included as peatland, since the thematic resolution of the product does not allow separation of wetlands and peatlands |
| 190 | 70 | 0.0% | Artificial surfaces and associated areas (Urban areas >50%) |  |
| 200 | 59627 | 5.0% | Bare areas |  |
| 210 | 42594 | 3.5% | Water bodies |  |
| 220 | 18648 | 1.6% | Permanent snow and ice |  |
| 230 | 26 | 0.0% | No data (burnt areas, clouds,…) |  |
|  |  |  |  |  |
|  |  |  |  |  |
| **GLC2000** |  |  |  |  |
| Reference: | Bartalev, S., Erchov, D., Isaev, A. and Belward, A. A new SPOT4-Vegetation derived land cover map of Northern Eurasia. Int. J. Remote Sensing, 24, 9, 1977-1982, 2003. | | | |
| **Properties within the Siberian Yedoma region** | | | |  |
| Pixel Value | Pixel Count | Percent cover | Class description |  |
| 0 | 115214 | 9.8% | Unclassified |  |
| 1 | 14714 | 1.3% | Evergreen Needle-leaf Forest |  |
| 3 | 6378 | 0.5% | Deciduous Broadleaf Forest |  |
| 4 | 2054 | 0.2% | Needle-leaf/Broadleaf Forest |  |
| 5 | 10210 | 0.9% | Mixed Forest |  |
| 6 | 1229 | 0.1% | Broadleaf/Needle-leaf Forest |  |
| 7 | 388907 | 33.2% | Deciduous Needle-leaf Forest |  |
| 8 | 1312 | 0.1% | Broadleaf deciduous shrubs |  |
| 9 | 15646 | 1.3% | Needle-leaf evergreen shrubs |  |
| 10 | 2233 | 0.2% | Humid grasslands |  |
| 11 | 532 | 0.0% | Steppe |  |
| 12 | 29174 | **2.5%** | **Bogs and marshes** |  |
| 13 | 31861 | **2.7%** | **Palsa bogs** |  |
| 14 | 4584 | **0.4%** | **Riparian vegetation** |  |
| 15 | 29480 | 2.5% | Barren tundra |  |
| 16 | 63485 | 5.4% | Prostrate shrub tundra |  |
| 17 | 127891 | 10.9% | Sedge tundra |  |
| 18 | 152075 | 13.0% | Shrub tundra |  |
| 19 | 9644 | 0.8% | Recent burns |  |
| 20 | 5 | 0.0% | Croplands |  |
| 21 | 52072 | 4.5% | Forest - Natural Vegetation complexes |  |
| 22 | 20 | 0.0% | Forest - Cropland complexes |  |
| 23 | 31 | 0.0% | Cropland - Grassland complexes |  |
| 24 | 54791 | 4.7% | Bare soil and rock |  |
| 25 | 2 | 0.0% | Permanent snow/ice |  |
| 26 | 53917 | 4.6% | Water bodies |  |
| 27 | 75 | 0.0% | Urban |  |
| 28 | 2276 | **0.2%** | **Salt-marsh** |  |
| 29 | 289 | 0.0% | Burns of year 2000 |  |
|  |  |  |  |  |
|  |  |  |  |  |
| **GLWD** |  |  |  |  |
| Reference: | Lehner, B. and Döll, P.: Development and validation of a global database of lakes, reservoirs and wetlands. Journal of Hydrology 296, 1-4, 1-22, 2004. | | | |
| **Properties within the Siberian Yedoma region** | | | |  |
| Pixel Value | Pixel Count | Percent cover | Class description |  |
| 1 | 38917 | 3.4% | Lake |  |
| 3 | 18635 | 1.6% | River |  |
| 4 | 21284 | 1.9% | Freshwater marsh |  |
| 6 | 5876 | 0.5% | Coastal wetland |  |
| 8 | 64491 | **5.7%** | **Bog , fen, Mire (peatland)** |  |
|  |  |  |  |  |
|  |  |  |  |  |
| **Land Resources of Russia** |  |  |  |  |
| Reference: | Nilsson S., Stolbovoi V., & A. Shvidenko: Land cover, Land Resources of Russia CD-ROM version 1.1, copyright IIASA and Russian Academy of Sciences, available at: http://webarchive.iiasa.ac.at/Research/FOR/russia\_cd/download.htm, 2002. | | | |
| **Properties within the Siberian Yedoma region** | | | |  |
| Pixel Value | Pixel Count | Percent cover | Class description |  |
| 0 | 18742 | 2% | unknown |  |
| 2 | 22254 | 2% | pastures |  |
| 3 | 286521 | 24% | forest |  |
| 4 | 38884 | **3%** | **bogs** |  |
| 5 | 233244 | 19% | swamps (mainly mineral wetlands) | not included as peatlands, overlay with Stolbovoi (2002) shows that these are primarily mineral wetland soils |
| 6 | 597575 | 50% | non-forest vegetation |  |
| 7 | 4516 | 0% | unvegetated |  |