Interactive comment on "Permafrost temperature and active-layer thickness of Yakutia with 0.5 degree spatial resolution for model evaluation" by C. Beer et al.

Anonymous Referee #1

Received and published: 21 June 2013

The manuscript by Beer et al uses a map of landscape and permafrost conditions in Yakutia from 1991 to derive active layer thickness and permafrost temperatures in order to produce a validation data set for climate and associated land surface model results with a resolution of 0.5 deg. It is clear that independent data sets for variables related to permafrost are of high importance, and at present the IPA map by Brown et al is mostly used, but has clear restrictions. This means the objectives of the manuscript are important and relevant. However, the discussion paper has some major problem.

We thank the referee for careful reading and useful comments which helped to improve the revised paper.

1. The Russian map is only referred to, but not shown. This is important for a reader to see the map to assess the validity of the data set produced. E.g. p. 156, l. 8 refers to layer 4 and 5, and I do not know what those layers are.

We fully agree with the referee here. The full information content provided by the original Russian Yakutsk map can be best understand when looking at the map itself. Therefore, we attach a high-resolution pdf file showing the original map as supplemental material. This way, you can zoom in and read all the information given in the legend, and you can see the level of spatial detail.

Several features of the map have been digitized into GIS layers. For the purpose of this paper, we are overlapping two layers, (i) surface deposit and (ii) vegetation and permafrost type. Surface deposit is displayed in hachures (rows in the legend) and vegetation and permafrost type is shown in colors (columns in the legend). Then, ALT and permafrost temperature ranges can be read from the legend for each combination of these layers. We also explained in detail in the methods section how these values have been used to derive distributions for each fine and each coarse scale grid cell.

In the discussion paper we used a wrong translation of the GIS layers (soil type and permafrost type). This is now corrected in the revised version.

We improved and extended the respective first paragraph in the methods section as follows:

"For deriving permafrost temperature and active-layer thickness (ALT), the two layers describing (i) surface deposit, and (ii) describing vegetation and permafrost type are used. The surface deposit layer is displayed in hachures in the original map (see original map including the legend in supplemental material). In the original legend, surface deposit information is given by rows. The layer describing vegetation and permafrost type is represented by color (columns in the legend) in the original map. These layers have been digitized individually and the respective polygons were further rasterized with 0.001 degree spatial resolution. Visual comparison with the vector data has proven an accurate and full representation of all polygons using such high resolution. Then, these two types of information were combined for assigning permafrost temperature and ALT according to the map legend at the full 0.001 degree

spatial resolution. For each represented combination of the GIS layers ranges of permafrost temperature and active-layer thickness are given in the legend (cf. supplemental material).”

2. It is not given any indication of how the map info is transferred into ALT and permafrost temperatures based on the landscape classes. It is not given how the map is compiled, which again makes it difficult for the user to evaluate the data set.

We hope that all methods on how permafrost temperature and active-layer thickness were derived and scaled become more clear with the improved and extended new methods section (see point 1 above) and the additionally presented original map in the supplemental material. Point 1 from referee 2 and our response to it give also more information.

3. It is not given what you mean with permafrost temperatures here. For which depth is the temperature given?

Thanks a lot for this hint. We include into the introduction section:

“Permafrost temperature is defined as the soil temperature in the depth where temperature fluctuations are negligible, usually 10-20 m. Active-layer thickness (ALT) stands for the maximum thawing depth at the end of the thawing season.”

4. What do you mean with “isolated permafrost zone”? In convention we distinguish between
continuous (>90%), discontinuous (50-90%), and sporadic permafrost (< 50%).
The IPA map in addition refers to areas with “isolated patches” (< 10% I think) of permafrost.
You never use the term “sporadic” here, see p. 157, l 11 ff.

Thanks for clarifying this translation error. We have corrected the term to “sporadic permafrost” in the whole revised version.

5. The original Russian map is certainly highly detailed, but if you quantify based on a qualitative analogue product, it should be somehow be validated in the first place. As the map has a high resolution, comparison with e.g. CALM sites should be shown for ALT and GTN-P sites for ground temperatures to document the quantitative value of the map.

Indeed, validation and cross-comparison is always a very important aspect when presenting a new data product. In the discussion paper we have not included any comparison to independent data because we are not aware of any useful datasets. GTN-P and CALM are very important databases. However, MAGT and ALT are usually reported for years later than 1995. In contrast, the Yakutsk map is based on data from 1960-1987. The time period is more important for active-layer thickness since this quantity is more dependent on atmospheric conditions and hence fluctuate a lot from one year to another. A comparison of permafrost temperature seems to be still useful. The other issue with such comparison to station data is the spatial scale. Latitude and longitude information in GTN-P and CALM are given at the second most decimal place, which is far too uncertain for a comparison of the high-resolution map (0.001 degree pixel size).

Still, the MAGT reported by GTN-P could be compared to the final product presented in this paper with a pixel size of 0.5 degree. The spatial scale mismatch remains problematic for such comparison. However, we have included this comparison as a new figure 2 into the revised version of the paper. GTN-P measurements are usually within the mean +/- standard deviation reported by the map (extracted from Fig. 1b). There is a general overestimation of very cold temperatures (<-10 °C) and an underestimation of warm temperatures higher than zero °C. We attribute a spatial scale mismatch between site measurements and 0.5 degree statistics to such differences. For example, in an arbitrary chosen grid cell with mean temperature of -0.3 degrees C and standard deviation of 1.7 degrees C, a GTN-P site within the grid cell reported 2.8 degrees C. However, the range of values for the vector from the high-resolution map is from -9 to 2 degrees C. In addition to the scatter plot (Fig. 2) a respective paragraph (#3) is added to 'Results and discussion' presenting and interpreting the comparison.

In conclusion, I understand the absolute need of independent and more quantitative validation data sets. And I see of course that maps like those produced for Yakutia contain surely more detailed information than the global IPA product. However, the step from analogue map information to quantitative data sets requires a careful documentation
of the base map in addition to a careful description how the information
is transformed into a digital data set. Here, the discussion paper should be improved under a possible revision process.

Interactive comment on Earth Syst. Sci. Data Discuss., 6, 153, 2013.

Interactive comment on "Permafrost temperature and active-layer thickness of Yakutia with 0.5 degree spatial resolution for model evaluation" by C. Beer et al.

Anonymous Referee #2

Received and published: 22 July 2013
Journal: Earth System Science Data Title: Permafrost temperature and active-layer thickness of Yakutia with 0.5 degree spatial resolution for model evaluation Author(s): C. Beer et al. MS No.: essd-2013-4
Overall evaluation: Acceptable with minor revision
Comments
In this paper the authors introduce an original approach to convert a published in the 1990s detailed permafrost landscape map of Yakutia, Russia into a permafrost temperature
and active layer thickness maps with 0.5 degree spatial resolution. The new maps developed in this study are very suitable for different models validation and for different types of spatial analysis of permafrost distribution and permafrost and active layer characteristics in the permafrost zone of East Siberia. It is a good paper and the publication of this kind of paper will be timely and beneficial for researchers working in the field of climate change including those involved in permafrost research. The paper in review could be published in "Earth System Science Data" after a minor revision.

We thank the referee for the detailed and very useful comments which helped to improve the manuscript.

My suggestions for the improvement of this paper are:

1. The methodology and the sources of specific permafrost information that were used to develop the original permafrost landscape map should be discussed in details. For example, it is obvious that there is not enough information on measured permafrost temperatures and active layer thickness for the development of such a detailed map. Because of that some sort of modeling was used to create this original map. It is very important to describe the specific model(s) that were used for this purpose.

The basic idea is to overlap geological-geomorphological and biohydroclimatological parameters for estimating the permafrost temperature and ALT spatial distributions. The landscape classification units shown on the map are terrain types and types of landscapes. Terrain types were correlated with geological genetic complexes of deposits (alluvium, eluvium, diluvium etc.), and types of landscapes were allocated on a basis of biohydrological parameters at ecoregion level (tundra, northern taiga, middle taiga, mountains tundra, mountains bush zone etc.). Overlapping of these parameters resulted in spatial distributions of permafrost temperature and ALT. For illustration, we present the kind of data used in a small subset of the original data in the following table. In total, more than 1000 temperature profiles in different landscape units are the basis for the permafrost temperature and ALT ranges presented in the original map. Permafrost temperature was measured by thermometer until 1970th, after that by thermo resistors. ALT has been measured by all methods (ground temperature, steel stick, frost tubes). For some landscape units with small areas data is lacking, for example fluvioglacial and glacial in middle taiga and tundra. In these cases, also no data values are reported in the map legend.

Инв. №№	№№ по источ-	Местоположение	Широта	Долгота	Рельеф	Отложения	Растительность	грунтов			Дата замера	Источник
								10м	15м	20м		
357F	10	Бассейн р.Вилюй, близ г.Вилюйска, район пос.Хатырык-Хомо	63.92	122.87	Высокая пойма р.Вилюй	пески(3м), пыль известковая (3-8м), ниже пески	Гарь по лиственничному лесу	-3,4			21.08.61	Данилова Н.С., Заболотник С.И., Слепцова А.Д. Геокриологическая характеристика нижнего течения р.Вилюя. Якутск, 1962. (Фонды ИМЗ 730)
358F	8-а	Низовье р.Вилюй, участок Собо-Хая, левый берег р.Вилюй	64.28	126.39	Высокая пойма р.Вилюй	Пески	Елово-лиственничный лес с примесью березы с густым подлеском	-4,6	-3,9	-3,8		Данилова Н.С., Заболотник С.И., Слепцова А.Д. Геокриологическая характеристика нижнего течения р.Вилюя. Якутск, 1962. (Фонды ИМЗ 730)
359F	13-к	Низовье р.Вилюй, участок Собо-Хая, левый берег р.Вилюй	64.28	126.37	Надпойменная терраса р.Вилюй	торф с илом (1м), суглинки (1-2,5м), супеси (2,5-4), пески (4-8м), суглинки (8-10), пески (10-17), ниже песчаник	Поросль березы по гари	-4,7	-4,4	-4,4	14.04.61	Данилова Н.С., Заболотник С.И., Слепцова А.Д. Геокриологическая характеристика нижнего течения р.Вилюя. Якутск, 1962. (Фонды ИМЗ 730)
360F	53-к	Средняя Лена, высокая пойма р.Лена выше устья р.Лунха	64.03	126.95	Высокая пойма	пески (4,1м), суглинки (9,2м), пески (10,8м), ниже песчаник	Гарь по лиственнично-березовому сырому лесу	-2,1	-1,8	-1,6	9.04.61	Данилова Н.С., Заболотник С.И., Слепцова А.Д. Геокриологическая характеристика нижнего течения р.Вилюя. Якутск, 1962. (Фонды ИМЗ 730)
361F	59-к	Средняя Лена, низкая пойма р.Лена 20 км выше пос.Тас-Тумус	64.07	126.02	Низкая пойма, песчаная коса	пески (13м), ниже песчаник	нет	-2,8	-1,7	-1,6	12.04.61	Данилова Н.С., Заболотник С.И., Слепцова А.Д. Геокриологическая характеристика нижнего течения р.Вилюя. Якутск, 1962. (Фонды ИМЗ 730)
362F	23	Центральная Якутия, окрестности с.Кобяй	63.57	126.65	1-я надпойменная терраса р. Хатынг-Юрях	Пески с прослоями суглинков	Лиственничный лес брусничный	-1,9			25.07.61	Катасонова Е.Г., Мозжухина А.С., Толстов А.Н. Геокриологическая характеристика междуречья рр. Берге-Тюгене-Вилюй. -
363F	9	Центральная Якутия, окрестности с.Кобяй	63.60	126.59	1-я надпойменная терраса р. Лунха, грива	Пески (6,6м), суглинки (6,6-8,8м), ниже пески	Боровая тайга	0,0			25.08.61	Катасонова Е.Г., Мозжухина А.С., Толстов А.Н. Геокриологическая характеристика междуречья рр. Берге-Тюгене-Вилюй. -
364F	10	Низовье р.Вилюй, окрестности с.Кобяй, мтф Кубятка	63.63	126.11	1-я надпойменная терраса р. Лунха, межгривное понижение	Пески с прослоем суглинки (3,7-5,1 м)	Сфагновое (?) болото с кассандрой, с отдельными лиственницами	-1,4			31.07.61	Катасонова Е.Г., Мозжухина А.С., Толстов А.Н. Геокриологическая характеристика междуречья рр. Берге-Тюгене-Вилюй. - Якутск, 1962. (Фонды ИМЗ 628)
365F	13	Низовье р.Вилюй, Хотугу-Улахан-Тукулан	63.62	125.47	Межгрядовая ложбина	Пески	разреженная травянистая растительность	-1,0	-0,7		6.07.61	Катасонова Е.Г., Мозжухина А.С., Толстов А.Н. Геокриологическая характеристика междуречья рр. Берге-Тюгене-Вилюй. - Якутск, 1962. (Фонды ИМЗ 628)
366F	14	Низовье р.Вилюй, Хотугу-Улахан-Тукулан	63.62	125.47	Песчаная гряда высотой 8 м	Пески	кедровый стланик и лишайники Cetraria, сухостой	0,0			6.07.61	Катасонова Е.Г., Мозжухина А.С., Толстов А.Н. Геокриологическая характеристика междуречья рр. Берге-Тюгене-Вилюй. - Якутск, 1962. (Фонды ИМЗ 628)
367F	17	Центральная Якутия, Кобяй, низовье р.Берге-Тюгене	63.92	126.59	Эрозионно-термокарстовое понижение оз.Мандыйа	торф (2,2м), супеси оторфяненные (2,2-4,3м), ниже пески до 10,2 м	марь, полигональное болото	-3,6			20.08.60	Катасонова Е.Г., Мозжухина А.С., Толстов А.Н. Геокриологическая характеристика междуречья рр. Берге-Тюгене-Вилюй. - Якутск, 1962. (Фонды ИМЗ 628)
368F	20	Центральная Якутия, Кобяй, низовье р.Берге-Тюгене	63.92	127,03	Высокая пойма р.Берге-Тюгене	супеси (0,4м), ПЖЛ (0,4-6м), ниже песок	Елово-лиственничный лес	-5,3			27.08.60	Катасонова Е.Г., Мозжухина А.С., Толстов А.Н. Геокриологическая характеристика междуречья рр. Берге-Тюгене-Вилюй. - Якутск, 1962. (Фонды ИМЗ 628)
369F	38	Центральная Якутия, окрестности с.Кобяй	63.52	126.29	4-я надпойменная терраса	суглинки (10,7 м), ниже пески	-	-2,5			21.12.61	Катасонова Е.Г., Мозжухина А.С., Толстов А.Н. Геокриологическая характеристика междуречья рр. Берге-Тюгене-Вилюй. - Якутск, 1962. (Фонды ИМЗ 628)
370F	19	Низовье р.Вилюй, Тукулан Махатта, верховье руч. Мугур-Тарын	64.00	122.32	высокая терраса	пески?	-	-0,3	-	-0,4	31.08.73	Бойцов А.В. Гидрорежимные исследования массива переевваемых песков Махатта на левобережье нижнего течения р.Вилюй. - Якутск, 1974. - 153 с. (Фонды ИМЗ 1322).

We fully agree with the referee that a kind of modeling is required to produce such map. We hope to make clear the basic ideas. The aim of this paper was not to explain all details of methods and data leading to the original map of landscapes and permafrost conditions (Fedorov et al., 1991) which is presented in Fedorov et al. (1989). This paper focuses on how the high-resolution information presented by the original map (Fedorov et al., 1991) can be made available to the community (and in particular the modeling community) with much lower resolution.

2. A combined big vector for each 0.5 degree grid sell will include parameter values that typically will have not normal statistical distribution but probably will have multi-modal distribution. It needs to be explained how the mean and the standard deviation of this parameter will be calculated in this case for each 0.5 degree grid sell. Even more difficult task is how to derive a meaningful mean and standard deviation in case of a discontinuous or sporadic permafrost distribution within such a grid sell.

This is a very good point. Indeed, distributions at 0.5 degree grid cell size do not need to be normal. Skewed and multi-model distributions can be expected from merging normal

distributions which represent different landscape types. However, the mean and standard deviation have been used because one major aim of the resulting maps is their comparison to other spatial datasets, in particular process-oriented one-dimensional model results. Such models usually assume average environmental properties, such as climate and soil properties for the whole large grid cell. The resulting temperature is then also assumed to represent the arithmetic mean.

We agree with the referee that for specific other objectives, it could be useful to also obtain the median and median absolute deviation, or 2-3 modes per grid cell. This is an interesting follow-up which can be done in case of requests form the scientific community. We include this point into the discussion section as follows:

"This paper presents mean and standard deviation of subsoil temperature and ALT Fig. 1 and Fig. 3). In doing so, our assumptions are compatible with assumption of other approaches for estimating coarse-scale patterns of permafrost temperature and ALT, such as process-oriented 1-D models. Therefore, model results can be directly compared to the maps presented in Fig. 1 and Fig. 3. However, the distribution of the quantities within each coarse-scale grid cell does not need to be normal. Skewed or multi-modal distributions can be expected from merging fine-scale results representing distinct landscape classes. Therefore, median and median absolute deviation as well as modes will be also computed for specific requests from the scientific community."

3. There are several places in the text where the wording needs to be changed to make it more understandable. These places are the last three paragraphs in Section 2 "Methods" and the first paragraph in Section 3.

We have changed wording in these paragraphs to increase their understandability.

My other comments are:
The letter "B" is missing in the very first sentence.

Thanks.

"Isolated permafrost zone" is not correct term

Changed to "sporadic permafrost", cf. comment 4 of referee one.