

## Reply to RC1

### Replies to the general comments:

According to your suggestions and new data in 2015 and 2015, the literature is sharpened to one page, the objective is re-expressed, monitoring period of all parameters is pictured and uniformed, the discussions are rewrote, the reciprocal action of hydrothermal effect are added, and the conclusions are promoted greatly.

### Replies to the specific comments and Technical corrections:

Line 13: Make transition smoother from first to second sentence;

**Please see the line 12 to 16.**

Line 15: Replace '.' by ':';

**Accepted. Please see the line 17.**

Line 17: An event cannot be thick → find correct formulation;

**Accepted. Please see the line 20 to 21.**

Line 19: Not clear; could it be like this: cooling of the active layer will be increased if the snow is removed all year round and even more if it is removed in winter, spring and autumn, but left in summer;

**Revised. Please see the line 21 to 27 and section 2.2.**

Line 21: Instead of 'maybe results' use 'may result';

**Revised. Please see the line 21 to 26.**

Line 21: Don't understand; was the snow removed only some weeks in autumn and then left? Above you wrote that the snow was removed the whole year or at least whole seasons;

**Revised. Please see the line 21 to 27.**

Lines 22, 87, : : :: I suggest either soil moisture or soil water content, but not soil moisture content;

**Accepted.**

Line 24: You already mentioned the decrease of the soil water content in the last sentence of (2);

**Revised.**

Line 25: Less compared to what?

**Revised.**

Lines 26-28: First mention that you observed lower soil temperatures and higher soil water contents at the NSS than at the SRS; then come up with your interpretation; another reason is the higher albedo of snow; look for literature on this topic;

**Revised. Please see the line 17 to 30.**

Line 36: Add space between 'Brown' and 'et', and 'Lemke' and 'et;'

**Accepted. Please see the line 36.**

Lines 36-37: Do all these authors in brackets give statements to all topics you mentioned in the sentence before? If not, please put each citation directly after the corresponding topic to make clear which content originates from which author/s;

**Accepted. Please see the line 36 to 39.**

Line 39: 'Alpine' is an adjective, but can not be used in addition as a noun as 'Arctic'

or 'Antarctic'; furthermore, 'Alpine' is usually related to the European Alps, while 'alpine' identifies an altitudinal belt in mountains;

Please see line 42.

Line 39: Do all these authors in brackets give statements to all topics you mentioned in the sentence before? If not, please put each citation directly after the corresponding topic to make clear which content originates from which author/s;

Please see the line 41 to 43.

Lines 47, 51: Avoid words like 'helpful' or 'help';

Accepted in the full text.

Line 47: Only for fresh snow; for old snow the albedo can drop below 80%;

It was revised.

Line 48: Why not simply 'snow surface'?

It was revised.

Line 50: Delays compared to what? To an imaginary lower value of the specific latent heat of fusion?

It was revised and deleted in the line 44 to 48.

Lines 49-50: 'specific latent heat of fusion at the transition from ice to liquid water' rather than 'latent heat' as the released energy is related to a given mass; where did you get the value 335 kJ/kg from?; in all physics books I know it is 334 kJ/kg;

Accepted in the full text.

Lines 47, 51: Avoid words like 'helpful' or 'help';

Accepted in the full text.

Line 52: A physical property can't be good or bad;

Yes. It was revise.

Line 53: The K has to be big as it means Kelvin but not thousand;

Yes. It was accepted.

Lines 53, 54: Only 'snow' instead of 'snow cover' because a cover has a thickness but here you refer to a material constant;

Yes. It was revised.

Line 55: Do you mean the European Alps? there are also other Alps like those e.g. in New Zealand;

It was revised and deleted in the line 44 to 48.

Line 55: I suggest '... that the daily rate of the increase in the thermal conductivity coefficient of snow is ...'; I guess this increase takes place during the melting period, but you have to tell the reader otherwise it is not clear.

It was revised and deleted in the line 44 to 48.

Line 56: K instead of k in the unit  $W/(m_K \cdot d)$ ;

It was revised and deleted in the line 44 to 48.

Line 59: Add a space after the fullstop;

Line 60: '... with a thick ...'

It was revised and deleted in the line 49 to 59

Line 61: '... with a temperature difference of 20 °C ...';

It was revised and deleted in the line 44 to 48.

Line 64: '... that a snow cover ...';

It was revised and deleted in the line 44 to 48.

Line 65: not 'will have' but 'has';

It was accepted in the line 53.

Line 65: '... a remarkable ...';

It was accepted in the line 53.

Line 67: Name the country where these mountains are;

It was deleted in the line 49-59.

Line 67: I am not a native speaker, but the English in this sentence doesn't seem to be correct to me; check with a native speaker, please;

It was deleted in the line 49-59.

Line 69: '..., the seasonal snow cover ...';

It was deleted in the line 49-59.

Line 69: Regarding 'temperature difference': as average over the whole winter season?

It was deleted in the line 49-59.

Line 71: Add space between 10 and \_C;

It was deleted in the line 49-59.

Line 71: Add space after fullstop;

It was deleted in the line 49-59.

Line 72: Why 'Pole'? Do you mean ....'in the arctic and subarctic regions'?

It was deleted in the line 49-59.

Line 74: Isn't it 'on the continent'? check with a native speaker, please;

It was accepted in the line 55.

Line 77: Well, there is also an insulation effect below the given values, which rather refer to a (nearly) complete thermal insulation of the ground from the atmosphere by the snow cover;

It refers to a nearly complete thermal insulation. Below the snow cover with the thickness of  $\geq 0.8$  m, BTS depends on the ground temperature and thus the BTS is often used to judge the permafrost.

Line 78: Add a point after 'al';

It was deleted in the line 49-59.

Line 82: Isn't it written CoupModel?

It was deleted in the line 49-59.

Line 83: I suggest 'strongly' rather than 'deeply'; check with native speaker;

It was deleted in the line 49-59.

Line 83: Add space after (2001);

It was deleted in the line 49-59.

Line 84: 'at' instead of 'over';

It was deleted in the line 49-59.

Line 84: '... the European Alps ...';

It was deleted in the line 49-59.

Line 84: '... that a 5-15 cm thick snow cover ...';

It was deleted in the line 49-59.

Line 85: More than what?

It was deleted in the line 49-59.

Lines 22, 87, : : :: I suggest either soil moisture or soil water content, but not soil moisture

content;

Accepted in the line 61 and the full text.

Line 88: Instead of 'melted snow' I suggest 'snow melt water'; besides the melt water originating from ground ice

Accepted in line 62.

Line 89: 'the permafrost shell thickness of the surface layer' → I don't understand what you mean by this; please highlight;

It was revised in the line 63-65.

Line 92: Put the acronym 'SNOW-17' after 'snow cover energy ... model';

It was deleted in the line 49-59.

Lines 91-94: What is the main finding of this study related to your study?

It was deleted in the line 60-65.

Lines 95-96: You already explicated this statement in lines 43-59; avoid repetitions; you could start the sentence like: While previous studies investigated ..., in this study ...';

It was deleted in the line 66-74.

Line 98: Not 'mountain island permafrost' but 'patchy mountain permafrost';

It was revised in the line 66-74.

Line 100: Please explain these findings more detailed; Lines 101-109: Clearly tell the objectives or research questions of your study somewhere after the literature review and the gaps of knowledge;

It was deleted in the line 66-74.

Line 105: Do you mean '... down to a depth of ...?';

Yes. It was revised in the line 70-72.

Line 110: I suggest simply: '2. Methods';

Accepted.

Line 111: 'Description of' is dispensable, omit it;

Accepted.

Line 121: Label the figure parts using small letters (a, b, c), refer to them in the figure caption (below the figure) and give explanations only there;

Accepted. Please see the Figure 1.

Line 122 (Fig. 1a): Add a scale bar;

Accepted. Please see the Figure 1.

Line 122 (Fig. 1a): I recommend to use the color gradient for the elevation inversely: green for lowest and brown for highest altitudes (more common and intuitive);

Accepted. Please see the Figure 1.

Line 122 (Fig. 1a): Red points for cities are quite dominant compared to the landscape and especially the monitoring site; I recommend to make at least the monitoring site more visible (e.g. red frame);

Accepted. Please see the Figure 1.

Line 122 (Fig. 1a): The unit is usually given in [...]; would also do it like this here and throughout the manuscript (please check in all figures, tables and in the text where you give the unit after a numerical property);

Accepted. Please see the Figure 1.

Line 124 (Fig. 1b, Legend): 'Monitoring site' is exactly the same expression as for the whole

monitoring site you show in Fig. 1a - this is misleading; I suggest to use the word 'monitoring plot' for the areas you called NSS and SRS which then change to NSP and SRP;

Accepted in the full text.

Line 124 (Fig. 1b): Could you show the topographic map or an aerial photograph in the background to get a better impression of the soil surface coverage?

Accepted. Please see the Figure 1b.

Line 126 (Fig. 1d): Picture is slightly higher than that of Fig. 1c → adjust

Accepted. Please see the Figure 1c and d.

Line 127: Give meaning of all abbreviations; figures and tables (in combination with their caption) have to be understandable by its own; check for abbreviations in figures and tables throughout the manuscript;

Accepted in the full text.

Line 131: Why do you give a range for the average annual values but not for the minimum and maximum annual values?

I think the both expressions are all ok. Please see the section 3.1.

Lines 130-131: I suggest '..., the air temperature in the region ranged between minimum values of -33.9 °C and maximum values of 24.1 °C while the average annual value was ...';

Accepted. Please see the section 3.1.

Line 134: I suggest: 'mean annual gust speed (measured half-hourly)';

It was deleted in the revised paper.

Line 134: What is the name of the river? Also show it in Fig. 1 a, b;

This is a seasonal small stream, which can't be found in the local GIS database. It flows away in the northwest of the SRP and the shortest distance between the stream to the SRP is about 200 m. The stream does not appear in the google map (Figure 1b) due to the big distance.

Line 135: '... found (Figure 1d)';

Added.

Line 136: '... 20% (Figure 1c).';

Please see the line 89 in the section 2.1.

Line 139: '... at the snow site ...';

Please see the line 98-99..

Line 140: 'Mudstone occurs at a depth of 5.0 m for the NSS and 3.6 m for the SRS(Figure 2)';

Please see the line 100.

Line 144: '...-0.32 to -0.30 \_C...'; then use 'to' to indicate a range throughout the document;

It was deleted in the text.

Lines 148 and 150 (Fig. 2a and 2b): To make it clearer I recommend to omit the vertical lines between a property and its value, e.g. Altitude: 4040 m;

Accepted in the Fig. 2a and 2b.

Lines 148 and 150 (Fig. 2a and 2b): Regarding column 'Notes' → To save space in the figure itself you could give this information in the caption;

Accepted in the Fig. 2a and 2b. Contents in the 'notes' are placed in the caption.

Lines 148 (Fig. 2a): Regarding second layer from top → I can hardly believe that the soil can be saturated at a water content of 2.6 % (at 2.1 m depth) within this layer which you generally call water saturated (equivalent for third layer from top in Fig. 2b);

Reply: Yes, a water content of 2.6 % shows that the soil is unsaturated. This W.C. value may

be connected with the water loss of the drill core. Water retention ability of sandy-gravelly soil, located in the second layer (Fig.2a), is very inferior. During the process of collecting the core in September 2009, the active layer was thawed and water flow could be seen along the core barrel. In the early plan, test pits were expected to be excavated in November 2009. Because the ground water was found at the depth of 0.6 m in the NSP and 0.8 m in the SRP, construction time of test pits were postponed to May 2010. So, the above mentioned soil layer was regarded as saturation in the both figures. To avoid misunderstanding, three W.C. values at the depths of 1.0 m, 1.5 m and 2.1 m, are all deleted in the Fig. 2a. Saturated water content of coarse sand is generally approximately 10.0% The W.C. values at the depths of 2.6 m in the Fig. 2a and 1.5 m in the fig. 2b are still retained in the both figures.

Lines 148 and 150 (Fig. 2a and 2b): Regarding ‘Column 1:100’ → On my screen (at a view size of 100%) 1 m is equivalent to 6 mm, so the scale 1:100 might be correct in the original figure but it was changed when implanting in this document;

Reply: The scale below the word ‘column’ in the figure is deleted because the scale changes when zoomed.

Lines 148 and 150 (Fig. 2a and 2b): ‘Total depth’ means what? Depth of the borehole, 6 m?

Reply: Yes, ‘Total depth’ means ‘depth of the borehole’. In practice, the borehole depths in the NSP and SRP are 15 m and 50 m, respectively. However, the depth of 6 m is enough for this paper because the maximum penetration of the active layer is less than 4 m. For the purpose of avoiding misunderstanding, the borehole depths are both changed to 6 m in Fig. 2.

Line 151: Mark figure parts either with a and b and refer to them in the caption or with NSS and SRS but not both;

Reply: The both figures are marked with a and b. They are referred to in the caption of Fig. 2.

Line 153 : : : You are describing the equipment here but the heading of 2.1 only refers to the monitoring site;

Here, the constructing process of snow site is described, including the climate, vegetation, geology. As a part of this site, installation process is also introduce here. Description of the equipment is provided in the section 2.2 and 2.3.

Line 153: September 2009?

Yes. Before the snow site is established, it is used to study the characteristic of permafrost.

Line 154: ‘... meteorological measurement equipment ...’

Deleted.

Line 154: November 2009?

Revised.

Line 155: ‘... monitored using the sensors ...’;

Revised.

Line 157: ‘: : : in May 2010 : : :’

Revised.

Line 157: Here you just refer to NSS and SRS. Explain your concept of investigating the effect of the snow cover by comparing one site with a natural snow cover with another one where you artificially removed the snow; this is essential for the understanding of the whole study; and describe it before you come to the measurement equipment;

Separation distance between the NSP and the SRP is approximately 300 m and thus ground surface and geological conditions can be regard as the same except snow cover. The

hydrothermal difference in the active layer between the NSP and SRP could be regarded as the result from seasonal snow cover.

Line 160: Ground temperature at which depth?

Please see the line 102.

Line 160-161: Do you mean: maximum duration of the snow season?

It was deleted here.

Line 160-161: Do you mean: maximum duration of the snow season?

It was deleted here.

Line 162: In line 153 you already mentioned a ground temperature equipment; how is it related to the probe you mention here?

Introduction of equipment is arranged in the section 2.3.

Line 162: ‘: : : in May 2010.’;

It is accepted in the line 132.

Lines 162-163: ‘A set of ... was installed ... of the two plots, NSS and SRS, respectively

It is revised in the line 132 to 135.

Line 167: Why did you measure the soil thermal flux only at the NSS, but not at the SRS?

It may be a mistake. There are soil thermal flux probes at the both plots.

Lines 165-168: ‘... were added at the NSS and the SRS, while an ultrasonic snow depth sensor and a sensor measuring the soil thermal flux at shallow depths were installed only at the NSS.’;

It is revised in the line 132 to 135.

Line 170 (Table 1): Use small letter at the beginning; also for soil temperature;

Reply: Accepted.

Line 170 (Table 1): Under the name ‘types’ you are mixing parameters (e.g. AT&H) and measuring instruments (e.g. barometer or rain gauge) → harmonize, please; use singular, e.g. ‘Type of probe’;

Reply: Accepted. Please see Table 1.

Line 170 (Table 1): Here you list the measurement parameters wind speed, rel. air humidity, air pressure, precipitation, albedo in the methods but you don’t present them in the results or discussion; If you don’t need them for your paper delete them in Tab. 1;

Reply: Yes. Deleted measurement parameters are including air pressure, and albedo. Wind speed and direction and precipitation is mentioned in the discussion, RH is mentioned in the monitoring results.

Line 170 (Table 1): for the soil moisture probes you have to say if % refers to the gravimetric water content (as in Fig. 2) or the volumetric one;

Reply: Only in Figure 2 or content directly related with this figure, water content refer to gravimetric water content. In the other parts of this paper, water content and soil moisture both refer to volumetric water content. Description of water content has been noted in the caption of Figure 2.

Line 170 (Table 1): Why did you use different soil moisture and albedo probes at SRS and NSS? This makes it more difficult to compare the measured values;

Reply: Yes. It will be easier if the same sensors is used. But SRP and NSP are supported by different research projects. What’s more, donors of the two projects are different.

Line 170 (Table 1): Please tell the measuring interval(s) of the different parameters;

Reply: They have been added. See Table 1.

Line 170 (Table 1): To me the following order of columns from left to right would be understandable more intuitively: Type of probe, Number of probes (NSS [as reference first], SRS), Measuring range, Measuring accuracy, Brand, Model;

Reply: Accepted. See Table 1.

Line 170 (Table 1): As not all parameters were monitored for the same period of time it would be helpful to give the monitoring period for each parameter, either in this table or even more vivid in a figure;

Reply: Monitoring period for each parameter is added in Table 1.

Line 170 (Table 1): 'Measuring range' instead of 'Ranges';

Reply: Accepted. See Table 1.

Line 170 (Table 1): 'Number of probes' instead of 'Numbers';

Reply: Accepted. See Table 1.

Line 170 (Table 1): In order to save space you could use small superscript numbers directly after the probe type;

Reply: Accepted. See Table 1.

Line 175: Not clear. Do you mean you used the measured air temperature to correct the signal of the ultrasonic sensor measuring snow depth?

Yes. But the context is deleted.

Line 177: Add space: 6 cm;

It is deleted.

Line 178: '... are thus needed ...'; then you can omit: 'because ... rapidly';

It is revised in the line 146-147.

Line 180: All means all, so you don't need to list some probes;

Accepted. It is revised in the line 136-139.

Line 182: Specify the logger by the brand, at least;

They are listed in the Table 1.

Line 182: '... to the automatic data logger CR3000.';

It was revised in the line 138-139.

Line 183: instead of 'that ... when' use 'after';

It is revised in the line 148.

Line 184: '... station, data were often not recorded during night at the SRS.';

It is revised in the line 149-150.

Line 185: '... area differing between seasons.';

It is deleted.

Line 186: But I can see a fence around the SRS in Fig. 3b and c; so what do you mean by snow fence?

Yes. There are fences at the both plots, which are not snow fence and only used to keep the animal away from the plot.

Line 188: How could you guarantee that the SRS wasn't covered by snow again due to wind after snow removal?

The snow cover is removed manually again if there is snowdrift.

Line 191: Distance between the three pictures are slightly not the same as well as their height  
→ adjust;



Reply: They have been adjusted. See Figure 3.

Line 193 : : : A lot of information on the acquisition of soil temperature data was already given under 2.1; the information given here would fit to table 1; temperature measurement is a standard technique; why do you describe it here so extensively?

This part is revised in the section 2.4.

Line 193: 'soil temperature data acquisition' or 'soil temperature measurement';

Accepted in the section 2.4.

Line 205: See comments on the heading of 2.2 (Line 193) and transfer to 2.3;

See section 2.4.

Line 207: '... two parallel steel rods which are 300 mm long, 3.2 mm in diameter and separated by a distance of 32 mm.';

It is deleted.

Line 212-213: Did you dig the test pit and push the rods of the probes horizontally into a side wall or did you burry the probes in layers?

It is buried in layers due to the gravelly soil. This context is deleted.

Line 213: Not 'laid by drilling' but 'installed in a bore hole';

It was deleted.

Line 214: 'installed' instead of 'laid';

Accepted. See line 130.

Line 214: '... reaches its maximum thawing penetration.';

It is deleted.

Line 216: 'or' instead of 'and';

It is deleted.

Line 217: '... were thus due ...';

It is deleted.

Line 219: '... extended from the ground surface to 3.6 m depth?';

It is deleted.

Line 220: Not 'laid' but 'installed' (2 times in this line);

Accepted in the full text.

Line 222: Repetition, information already in Tab. 1;

They are deleted.

Line 223: What do you mean by hydrothermal probes? The soil temperature and moisture probes together? Did you have to dig into the active layer to install the mast onto which the ultrasonic snow depth sensors is mounted or why do you mention digging in connection with the snow depth measurements?

The soil temperature and moisture probes are separated. It was noted that the digging was carried out only in 2010, the influence of which on the active layer was very small. Installation of the mast did not involve digging in 2012.

Line 224: Not 'by' but 'in'

Accepted in the line 2.3.

Line 224: Instead of 'wouldn't' I would say 'shouldn't';

The part is deleted.

Line 226: '... water content in the thawed soil ...'?

Revised in the line 162-164.

Line 228: Do you mean because of the calibration for unfrozen conditions by the manufacturer? How did you get the true value? By gravimetric water content measurements using soil probes? Or do you stress the fact that the probes measure the liquid water content but not the frozen water content? Not clear;

Yes. The soil moisture probes only measure the liquid water content but not the ice. In order to discuss the true water content and its annual variability, measurement results in the thawing period are analyzed in the process analysis. The interannual analysis only involves SM measured in October 1 with the maximum thawing penetration, which represents the water content of the whole active layer and can be called the characteristic soil moisture.

Line 237: Do you mean accumulated in total?

Yes. See the section 3.2.

Line 237: Why do you say 'surface snow cover' instead of simply 'snow cover'? As the snow cover is always deposited on the surface this word is dispensable;

It is deleted in the full text.

Line 239 (Fig. 4): Curves are too thick (only in pdf?); add horizontal lines as visual orientation;

Reply: The figure is deleted.

Line 245: I question if the snow depth can be determined with a resolution of 1 mm (surface hoar on the snow can be thicker than 1 mm);

The accuracy of SCT probe is 1 cm. But its resolution is 1 mm. What's more, artificial measurement is also carried out before every snow removal.

Lines 246, 248, 252: Use past tense because it occurred in 2014; check whole manuscript and use past tense for all events which were finished in the past;

Accepted. See section 3.2.

Line 246: Check with editor if this date format is ok; However, the date format should be the same throughout the document which is not the case, e.g. line 245 (December 2013) differs from line 240 (2012.12);

Accepted and revised in the full text.

Lines 251-252: '... snow cover remained 5 days at maximum in more than 90 % of the snowfall events, ...';

Revised in the section 3.2.

Line 253: In the same sentence you say that the snow cover would have been lasting not more than 5 days in general - this is a contradiction; instead of the words 'generally' and 'typically' try to quantify in the statements;

Revised in the section 3.2.

Line 260: Add space after fullstop;

Revised in the section 3.2.

Line 270 (Tab. 2): Data of air temperature and radiation averaged over the seasons would be helpful here as you argue in the text with these parameters;

Reply: Accepted. Averaged air temperatures and average solar radiation over the seasons are added. See Table 2 and table 4. See section 3.1, 3.3.

Line 272: As you define the depth negative in Fig. 7 the maximum depth would be 0; so either you can say something like 'the most negative depth' or you use a positive sign for depth values in Fig. 7;

A positive sign for depth values is accepted in Fig. 7.

Line: 277: 'Figure 7' but not 'figure 7';

Accepted. It is revised.

Line 277: I question if the ALT can be determined with a resolution of 1 mm;

The ALT is calculated based on the interpolation between temperature measurements of neighboring probes in space and time. Resolution of the ALT depends on the space of probes and frequencies of measurement. Below the depth of 3.0 m, separation distance of neighboring temperature probes is 1 m. Due to the difference of soil properties and unsteady temperature regime, distribution of temperature with the depth is often nonlinear. Therefore, accuracy of the ALT should be far more than 1 mm.

Additionally, the ALTs in the discussion manuscript are acquired by using 10 days step in the interpolation calculation. In this revised manuscript, time step is 1 day. As a result, there are some differences between the ALTs of this version and previous version. The maximum difference reaches 14 cm.

Line 280 (Fig. 7): Indicate at least one negative isotherm;

Reply: Accepted. See Figure 7.

Line 280 (Fig. 7): Mark figure parts either with a and b and refer to them in the caption or with NSS and SRS but not both;

Reply: Accepted. See Figure 7. a) natural snow plot, b) snow removal plot.

Line 286: Regarding 'at any depth' → the mean annual ground (rather than soil) temperature MAGT refers to the depth of the zero annual amplitude (see Wu and Zhang, 2008, caption of Table 2);

Yes. It was changed to "the mean annual soil temperature (MAST)".

Lines 284-288: This sentence needs to be related to the ground temperature measurements of this study;

It was introduced in the section 2.5.

Line 290: '... where the daily soil ...';

It was introduced in the section 2.5.

Line 291: Do you mean the extremes of daily air temperatures within a year? This must become more clear because the extremes of the air temperature within a day must not be excluded to estimate the daily geothermal propagation depth;

It was introduced in the section 2.5.

Line 293: Did you determine the daily geothermal propagation depth? If not, please cite the publication where you got this information from;

It was introduced in the section 2.5.

Line 294: It depends on the purpose; what do you want to say with these data?

It was introduced in the section 2.5.

Lines 293-296: I understand the sentence up to '... single time', but the words thereafter (several times, even partial time of each day) I can't logically relate to the rest of the sentence. Maybe 'or' is missing before 'even'?

It was introduced in the section 2.5.

Line 298: 'could' instead of 'can';

It was revised in the section 3.5.

Line 301: 'also' is dispensable;

It was revised in the section 3.5.

Line 303 (Fig. 8f): How do you interpret that the MAGT-curves are bent towards lower temperatures above 1.5 m? Compare to Fig. 3 in Smith & Riseborough (2002): Climate and the limits of permafrost;

Reply: Generally, MAGT-curves should be similar with that in Fig.3 in Smith & Riseborough (2002): Climate and the limits of permafrost if the ground thermal is stable and water content is high in the active layer. However, owing to the variation of MAAT, earth surface conditions and soil moisture in the active layer, the MAGT-curves often behave different shapes. Taking an example of permafrost along the Qinghai-Tibet highway, there are three typical shapes of MAGT-curves (Jin et al., 2006. Thermal regimes and degradation modes of permafrost along the Qinghai-Tibet highway. Science in China Series D: Earth Sciences. DOI: 10.1007/s11430-006-2003-z ). The mean annual air temperature, water content in the active layer and the snow cover changed a lot in the snow monitoring site since 2011. The MAAT fluctuated between -4.5 °C and -2.8 °C during the period of 2010-2016. Snow cover is removed since the December, 2012. Changes of surface conditions caused that the 5cm-MAGT in the SRP is about 0.2 to 0.8 °C lower than that in the NSP. Additionally, volumetric water content above the depth of 0.8 m has been nearly always lower than 12% in the SRP from 2012 to 2015 (Figure 10). So, thermal offset in this soil layer can be neglected. Drop of MAAT and 5 cm-MAGT, and the shallow soil layer with less water content, may be the main reason that the MAGT-curves are bent towards lower temperatures.

Line 303 (Fig. 8f): I recommend not to choose blue and red lines in Fig. 8d as these colors are used in a different meaning in Fig. 8a - 8e;

Reply: Accepted. See Fig.8f.

Line 303 (Fig. 8): The colors in Fig. 8 should be harmonized with those in Fig. 10 regarding their meaning;

Reply: The colors are modified according to the year. Blue, 2012; red, 2013; black, 2014; purple, 2015; orange, 2016. See the detail in Fig.8 and Fig.10.

Lines 304-307: In line 304 you say 'annual' for the entire Fig. 8, but later you say that the temperature profiles are averaged over seasons!

Reply: It has been revised. See the caption of Fig.8 and 9.

Lines 309-311: This should additionally be described in methods;

Reply: It was revised in the section 2.5.

Line 323: 'In terms of yearly temperature,' is dispensable;

It was revised in the section 3.5.

Lines 323-325: As first sentence of this paragraph I suggest: 'The mean annual soil temperature at 0.5 m depth was 0.8 °C higher for the NSS than the SRS while the temperature difference between the two sites decreased with depth being approximately zero below 2 m depth.';

It was revised in the section 3.5.

Lines 325-326: According to Figure 8e they are approximately the same compared to the layer above 1.6 m!

It was revised in the section 3.5.

Line 327: What do you mean by 'generally' here? Average difference over the whole depth profile or only below 1.6 m? Not clear;

It was revised in the section 3.5.

Lines 328-329: This sentence in the present form belongs to methods but not to results; don't

repeat methods in results;

**It was revised in the section 3.5.**

Lines 329-330: '... removal, the mean annual ground temperature at 0.5 m and 2.0 m depth increased by 0.3 \_C and 0.2 \_C, respectively.';

**It was revised in the section 3.5.**

Lines 323-333: Not clear! I suggest: 'The MAAT in Yashatu was -4.5 \_C, -3.4 \_C, and -3.9 \_C in 2012, 2013 and 2014, respectively, indicating ...';

**It was revised in the section 3.5.**

Line 333: Where did you get the value for 2012 from? According to Fig. 4 you only measured the air temperature since December 2012; you have to cite the source if it is not your own measurement;

**It was revised in the section 3.5.**

Line 334: No comma after 'namely';

**It was revised in the section 3.5.**

Lines 338-339: This sentence is only valid for NSS, tell the reader;

**It was revised in the section 3.6.**

Lines 340-341: Regarding '..., there is ...' → Where? Do you mean at the SRS? So you have to tell it the reader. However, I see something different in Fig. 9: besides the small L-shaped area at SRS with a water content above 40 % in 2013 the water contents at NSS are higher throughout the depth profile and throughout the monitoring period;

**It was revised in the section 3.6.**

Line 342: 'based on CS616' does not belong to results but to methods and shouldn't be repeated;

**It was introduced in the section 2.4.**

Line 342: It can, but does it or does it not?

**It was introduced in the section 2.4.**

Lines 343-345: There appeared strong changes during redistribution, but if you directly compare the water content profile at NSS in Oct. 2013 and Oct. 2014 I roughly agree although I can see an increase from 30 to 40% between about 1.1 m and 1.7 m depth → has to be described more clearly;

**It was revised in the section 3.6.**

Line 345: Is the class with the highest water content from 40 to 70%? Please indicate in the color bar in Fig. 9. However, a vol. water content of 70% in gravel (as stated in Fig. 2) is very unlikely to me even for saturation (maybe in clay it would be possible); Line 349: Just to describe what you can see anyway in Fig. 10 doesn't give an additional benefit; add information in the text you can't directly see in a Fig. itself;

**It was revised in the section 3.6.**

Line 349: Don't make a new paragraph after only 1 sentence (minimum after 2);

**It was revised in the section 3.6.**

Lines 350-351: 'At a depth of 0-50 cm soil moisture sites varies no more than 4 % between the years 2012-2014 at each of the two sites.';

**It was revised in the section 3.6.**

Line 351: 'soil moisture decreases with time, and' → not needed, delete;

**It was accepted in the section 3.6.**

Line 354: 'Between 80 cm and 120 cm depth, soil ...';

It was revised in the section 3.6.

Lines 354-355: Sentence is too complicated to express the facts;

It was revised in the section 3.6.

Line 356: Give a depth range as in Fig. 10;

It was revised in the section 3.6.

Line 358: 'first' and 'then' means from 2012-2013 and from 2013-2014, respectively; express it more clearly;

It was revised in the section 3.6.

Line 360 (Fig. 9, caption): In Table 1 you say that soil moisture at NSS was measured using a probe called SM300 but not CS616;

Reply: It has been revised. See the caption of Fig.10.

Line 360 (Fig. 9, caption): ... 'based on CS616' is an information regarding the methods and must not be repeated here;

Reply: It has been revised. See the caption of Fig. 10.

Line 359 (Fig. 9): How do you explain the pronounced steps in the water content profiles, especially in 2013?

Reply: In the Fig. 10, 0 °C isotherm is added. It can be seen from the figure that there are often big steps in the water content near the 0 °C isotherm. It can be explained that the dielectric constant of water is much less than that of ice. In the thawed area, water-content step also can be found. It be resulted from the downward infiltration and upward migration of soil water.

Line 359 (Fig. 9): What is the upper limit of the highest class above 40 %? Please indicate on the color bar.

Reply: The maximum of water content of the active layer in the snow site is 59.7%. It was added on the color bar.

Lines 364-369: Too complicate; just say that you linearly interpolate between the point measurements using the soil moisture probes;

A good suggestion. Accepted. See line 324 to 328.

Line 372: '... at 0-5 cm depth is assumed to be the same as ...';

Accepted in line 330.

Lines 364-379: This information would be more adequate in the methods;

I think this is a reprocessing of field data. It may be coherent with the context. See line 326 to 333.

Line 379: A range is from a minimum to a maximum value; here you mean the difference;

It was replaced by new analysis in section 3.6. See line 334-343.

Line 382: Not 'in 2013 and 2014' but 'from 2012 to 2013 and from 2013 to 2014';

It was revised in the section 3.6.

Line 385: Mark figure parts either with a and b and refer to them in the caption or with NSS and SRS but not both;

It was accepted in the Figure 11.

Line 390: Add space after Alps;

Accepted in line 348.

Line 391: Don't use first names for the citations in the text (only initials of first names in bibliography);

Accepted in line 349.

Line 394: See comment on line 47 and 51;

Accepted in line 351-352.

Line 397: Cite these studies;

The part is deleted.

Line 399: It did in case of ASR-1, but not for ASR-2;

The part is deleted.

Line 401: A comma or 'and' is missing after 'snow removal';

The part is deleted.

Line 402: To see the effect of the snow cover at the SRS by comparing the 3 years 2012, 2013 and 2014 (i.e. BSR, ASR-1, ASR-2) is hardly possible as you have 3 samples (years) only, but 2 factors (air temperature and snow cover);

The part is deleted.

Lines 400-403: You cannot directly compare ASR-2 (i.e. SRS 2 years after snow removal) with NSS because the observation period of ASR-2 was 2013.12-2014.11 (line 311) while it was 2014.3.1-2015.2.28 (line 300) for NSS; however, you can compare SRS and NSS in the same period of monitoring as shown in Fig. 8e. Maybe you meant this, but it is not clear;

The part is deleted.

Line 405: '... heat dissipation from the active layer to the atmosphere in winter (...).';

Accepted in line 360.

Line 407: Omit 'the';

The part is deleted.

Line 407: Are these results yours? If not, cite the publication in the same sentence;

The part is deleted.

Line 409: This finding means that the ground cooling effect due to the change of the albedo by the first snow cover in autumn is less effective than the cooling due to the stronger heat dissipation without snow; finally, the thermal insulation (and during this season warming) effect of the snow cover overbalanced the cooling effect due to the higher albedo of snow in this study;

Yes. Monitoring result in 2015 and 2016 also verified this findings.

Line 411: In addition to Fig. 6, also refer to Table 2;

Accepted.

Lines 414-415: '... when the ground temperature is higher than the air temperature'?

Accepted in line 371 and 372.

Line 418 (Table 3, caption): The table is obviously not at the right place but should be positioned later;

It is deleted.

Line 418 (Table 3, caption): This is again another period of time than for the collection of the other data (soil temperature, air temperature, water content); so it is difficult to relate them to each other;

The part is replaced by new analysis. Please see line 380-410.

Line 418: Table 3 shows results and should thus be presented in chapter 3, but not only in the discussion;

It is deleted.

Line 421: '... since the snow ...';

The part is deleted.

Line 423: '... of the active layer.';

The part is replaced by new analysis. Please see line 384-395.

Line 424: Which areas?

The part is replaced by new analysis. Please see line 384-395.

Line 426: not correct: latent heat is released by freezing and by condensation, but not by a decrease in the water content; if the soil water content in autumn is less than the year before, also the latent heat released during freezing will be less; is it this point you wanted to make? Then make it clearer, please

The part is replaced by new analysis. Please see line 384-395.

Line 427: See comment on line 50;

Corrected.

Line 429: But at 4000 m a.s.l. altitude the pressure is much lower → adapt the following calculations to a realistic atmospheric pressure at 4000 m a.s.l.;

The part is replaced by new analysis. Please see line 384-395.

Line 429: '... heat for water stored in a 1 m<sup>3</sup> soil body at a volumetric water content (VWC) of 1 % is 3350 kJ ...';

The part is deleted.

Line 431: How did you determine this heat capacity? Please show that it is realistic using the content of mineral material, ice and water;

See line 389-390.

Line 430-433: Has to be explained more clearly. Just by reducing the water content the temperature won't decrease! However, the heat to be extracted from 1 m<sup>3</sup> of soil to freeze the water equivalent to a VWC = 1% is 3350 kJ. If the same heat would be extracted from the same body of soil without freezing (i.e. if already all the water is frozen or all the water remains liquid) a temperature decrease of 1.5 °C would occur. For the heat of vaporization the argumentation is equivalent;

Please see line 384-395.

Line 435 : : : I can't see that you used the thermal flux data to verify 'this phenomenon' explained above. I would just argue that at higher water contents more heat has to be extracted for freezing than in drier soils. The atmosphere can take up only a given amount of heat under given meteorological conditions. After freezing, in drier soils more heat that can be dissipated is left for ground cooling resulting in lower temperatures;

The part is deleted.

Line 437: Add a space before 'According';

Corrected.

Line 438: To make these four stages more visible I suggest a diagram rather than a table;

The part is deleted.

Line 444: It should be like this, but Table 3 shows the opposite! You argued for all other months. I would say the higher/lower values in February/June at the NSS than at SRS is just natural variability;

The part is deleted.

Line 446: Even greater than in Table 3? And why should the heat exchange be different at NSS and SRS if there is no snow? Because of the higher water content at NSS than at SRS? Then



you need to argue which processes lead to the assumed result; however, it has to be consistent with your other findings;

The part is deleted.

Line 456: Instead of the grain size distribution it is rather the pore size distribution;

Accepted. See line 428.

Line 457: Why and how? I would say the pore size distribution, the porosity and thus the bulk density are changed by digging, but not the grain size distribution;

I agree with you. See line 427-430.

Line 462: Is it possible that the digging lead to preferential flow paths in the ground? However, you dug at both sites in the same way, right?

I agree with you.

Line 464: 1 space before 'therefore' is enough;

Accepted.

Line 469: '...), resulting in a snow water equivalent (SWE) of ...';

It is revised. See line 440-441.

Lines 471-473: Does the annual rainfall of Delingha originate from 1960? Or was it only published then and is a long term mean, i.e. even older? It could have changed a lot since then! So you can't compare it with today's values of Yashatu;

It is revised. See line 415-416.

Lines 480-481: Is half a page really necessary to come to this explanation?

It is revised. See section 4.2.

Lines 483: Repetition of line 469 → delete;

It is revised. See section 4.2.

Line 483: 'the melt water equivalent to the SWE' instead of 'this result';

It is revised. See section 4.2.

Line 484: '... content between 0-2.5 m depth in the active layer ...';

It is revised. See section 4.2.

Line 483: '... could have increased ... by only 4.4 % ...';

It is revised. See section 4.2.

Line 493: Only in summer, when the evaporation is highest, the NSS was cooler than the SRS at 0.5 m depth (Fig. 8). However, then there was nearly no snow (Table 2). So I don't think that this effect contributed to the lower water content at SRS, otherwise the near surface temperatures (0.5 m depth) should have been higher at SRS than at NSS also in spring, winter and autumn which was not the case;

Before 2014, the temperature of topsoil above the depth of 0.5m was not acquired due the acquisition frequency of one time per day. According to the data in 2015 and 2016, the seasonal and annual topsoil temperature at the SRP is lower than at the NSP except for the autumn (Figure 8 and 9).

Line 497: But according to Tab. 2 there was nearly no snow in summer at your site;

It is revised.

Lines 498-499: But in Fig. 8 you have shown that the mean winter temperature is lower at the snow free SRS than at the snow covered NSS!

It is revised. See section 4.2.

Line 504: Also this sounds logical but should have resulted in lower near surface temperatures

at NSS than at SRS, also in winter, spring and autumn. Or do you think this was the case, but you couldn't show it as no data could be gained above 0.5 m depth? Then you have to say it

**It is a wrong conclusion. New analysis is displayed in the 4.2. See line 453-463.**

Line 507: Which range do you mean - within a year? Then during the first year the VWC ranged between 0 and the highest class (40 - ?%), in the second year between 0 and the second highest class (30% - 40%). So what do the 50 % decrease mean?

**The part is replaced by new analysis. Please see line 453-463.**

Line 508: Add a space after the fullstop;

**Corrected.**

Line 515: The mean surface?

**It is revised. New conclusions were drawn according the field data in 2015 and 2016.**

Lines 523-525: The topic of your paper are the effects of the seasonal snow cover on the hydrothermal conditions of the active layer; so here you should conclude that the snow removal at SRS lead to lower water contents which can be derived from the comparison with the NSS where the measurements took place at the same period of time facing the same (dry) meteorological conditions. So far (in point 3 of the conclusions) you argue only by the temporal sequence of 3 years;

**I agree with you. New conclusions were drawn according the field data in 2015 and 2016.**

Line 524: '... SRS can be attributed to the removal of ...';

**It was replaced by other conclusions.**

Line 628: Check that the authors' family names and the initials are always separated by commas in the bibliography (which is not the case e.g. in line 628 and 630)

**It was replaced in line 631.**