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Interactive comment on “Brief Communication: Future avenues for permafrost science from the perspective of early career researchers” by M. Fritz et al.

M. Fritz et al.

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Reply to Anonymous Referee No.1

We are grateful for the review and acknowledge your comments and suggestions. You will find all replies and changes that have been made below. Reviewer comments are cited in italic font.

Best regards,
Michael Fritz

(on behalf of the co-authors)

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The paper by Fritz et al. reports on the outcomes of an Early Career Researcher forum aimed at identifying permafrost research priorities. This paper is submitted as a brief communication for the The Cryosphere, which can include reports or discussions of matters of policy and perspective or information on topical events. The paper would therefore fall within the scope for communications and be suitable for publication in the journal. The paper however is rather long with many references and may not fall within the length requirements for a brief communication.

The manuscript is one of the rare contributions that deal with research priorities and science policy issues. Because of its rather unusual scope and structure it might appear slightly longer than normal brief communication manuscripts. However, we have undertaken efforts to remove redundancies and to shorten where possible without losing content or message.

The paper gives a good overview of the objectives of the project, methodology and the results of the survey. A number of comments are however offered for the authors' consideration that will improve the paper.

The effort to identify permafrost research priorities, described in this paper is not occurring in isolation. The paper mentions (in the Introduction) that the International Permafrost Association (IPA) highlighted the need to identify research priorities in 2012 but the authors do not mention that the IPA is also leading a project to identify permafrost research priorities which contributes to the ICARP III process. The final outcome will be based on input from both the ECR and IPA processes. The authors should place their activity and its outcomes in the context of the larger effort to identify permafrost research priorities.

We agree that future research priorities for permafrost science under the umbrella of ICARP III will not appear in isolation. We have partnered with the IPA and CliC, who are leading a similar project called 'Permafrost Research Priorities' to use a similar approach to involve the community. In doing so, we achieve comparable results. Nevertheless, this manuscript is a stand-alone product issued by the community of early

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career researchers (ECRs). The purpose is to extract the ERCs' perspective. It is not absolutely clear yet how IASC will bring together the numerous and different kinds of activities that have taken place during the ICARP III process.

In the last part of the introductory chapter it is mentioned that our initiative has worked in close collaboration with the IPA. The synthesis chapter clearly mentions that “we need to ... ii) contribute our insights into larger efforts of the community such as the Permafrost Research Priorities initiative by the Climate and Cryosphere (CliC) Project together with the IPA (<http://www.climate-cryosphere.org/activities/targeted/permafrost-research-priorities>)”.

In the Supplement, a very good summary of the results is provided including a list of all questions submitted, results of voting and ranking of questions. However, the highlighted questions presented in section 4 do not match exactly any of the original questions submitted. It is assumed that questions that were similar may have been combined or grouped according to theme and reworded. The authors could briefly mention in the text (section 3 or 4) any grouping/modification of questions that was done prior to the voting.

It is correct that none of the highlighted research questions match exactly with the originally submitted questions. Figure 1 mentions it several times that for example ‘Reviewing, refining and grouping the questions’ took place and that ‘... the general question structure was corrected’. After the voting process it is said that ‘the five top questions were selected for further development and supplementation with information from the scientific literature.’ Also the caption of table S4 mentions that the top five priority research questions after the voting process were developed further.

If this exercise is largely a contribution to ICARP which focuses on the arctic, then perhaps some of the text in section 4 should focus more on arctic issues. This might also make these sections a bit shorter.

This product is a contribution to ICARP III but not under a mandate of any Arctic ini-

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tative. Permafrost is a phenomenon of both polar areas, alpine regions and high plateaus. The same applies to the scientific background of the authors. The exercise behind the manuscript took place during a Permafrost science workshop, and so reflects the interests and expertise of ECRs present at that workshop. As opposed to excluding parts of the community we wanted to be as comprehensive as possible and include all communities and perspectives.

The authors' should consider reducing the paper length especially if it exceeds the requirements for a brief communication. Reduction of background information and some editorial revisions might help. Some suggestions are provided in the specific comments below.

We have reduced the length of the core part of the manuscript (abstract to acknowledgements) by 140 words.

Specific Comments Abstract Page 1211, line 7-8: *"spatial analysis of permafrost types" Do you mean characterizing the distribution of permafrost (or ground ice)?*

Changed to: "spatial distribution of ground ice"

Introduction Pg 1211, line 13: *suggested revision ". . .the cryosphere underlying 24 %....." (Permafrost underlies the surface rather than occupying it)*

The phrasing was modified according to the suggestion.

Pg 1212, line 12: *Shouldn't reference be made to PYRN here as this was a permafrost event.* This event was not PYRN-specific, but was organised and included ECRs from multiple organisations/projects (APECS, ADAPT, PYRN, PAGE21).

Section 2 Page 1212 line 25 to page 1213 line 6: *Is all this information necessary? To reduce length you could focus on what is required to define the process of generating and voting on questions with additional information on workshop provided in the supplement.*

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We removed:

- a) “It was proceeded by breakout sessions hosted by senior scientist from IASC, the IPA and other organizations.”
- b) “This activity format was selected due to its flexibility, prior positive experiences of workshop organizers, and highly collaborative nature.”

New shortened part: “For this activity, participants were provided with instructions (Supplement S3) and worked with more than 20 different members of the ECR permafrost research community, and viewed a variety of research topics, many of which were outside their own field of expertise.”

Section 3 Page 1213, line 14-20: *Be careful with use of the term “trend”. This might imply that an analysis of research topics over time has been done especially when referring to carbon research being a younger trend.*

The word “trend” was removed, and the paragraph was re-written.

line 14: removed “trending”

line 16: changed into “fields”

line 19: “...a more recent research interest”

This highlights the current changing nature of the terrestrial cryosphere environment and is directly linked to research topics on thermokarst, active-layer monitoring and drivers of change. Tied for second were keywords “ground ice” and “carbon”, which are linked to two distinct fields in permafrost research. Ground ice research hints at a more classical, geocryological approach to permafrost science and is concerned mostly with distribution, formation and sensitivity at thaw, while carbon research, a more recent research interest, links permafrost dynamics to carbon cycling by investigating its abundance, distribution and vulnerability.

Finally, we added the reference ‘Hubberten, H.-W., Lewkowicz, A. G., Christiansen, H. H., Drozdov, D. S., Ma, W., Romanovsky, V. E., and Lantuit, H.: Report from the international permafrost association: A new strategy and structure for the international per-

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mafrost association, Permafrost and Periglacial Processes, 22, 195-197, 2011.’ They show the clear trend in the increasing number of permafrost-related publications between 1970 and 2010.

Page 1213, line 20-23: *These topics are not really independent of the other ones mentioned, i.e. there are linkages between them (eg. links between ground ice and hydrology or process)*

Changed to ‘Inter-related research topics...’

Section 4.1: *This section is fairly long and could perhaps be made shorter.*

Section 4.1 has been shortened so that each subchapter in section 4 is almost equally long.

Page 1214, line 24: *should this be “at the ground surface”*

The phrasing was modified according to the reviewer’s suggestion.

Section 4.2 Page 1215, line 13: *suggested revision “. . .effect on the environment and human. . .” or “. . .effect on environmental process and. . .”*

The phrasing was modified according to the reviewer’s suggestion: “...effect on the environment and human...”.

Page 1215, line 19: *suggest you delete “presently”*

The phrasing was modified according to the reviewer’s suggestion.

Page 1215, line 23-28: *Isn’t one of the key issues here the lack of adequate information on ground conditions (i.e. soil properties, ground ice etc.)*

It is indeed, and we address this issue when we say “Hereby, a main problem is the availability of forcing data sets at such scales, which requires permafrost modeling in conjunction with downscaling approaches”. Later in the paragraph we mention the same challenges the reviewer raised: “vegetation, snow cover, soil moisture, ...”.

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Page 1215, line 25-26: *Suggested revision – delete “Hereby” and just say “In particular, the thermal evolution. . .” (I assume you are referring to the thermal evolution here)*

The phrasing was modified according to the reviewer’s suggestion.

Section 4.3 Page 1216, line 19-20: *Revision suggested – “The description of environmental processes by the non-scientific community, including indigenous people, often differs from that by the scientific community.”*

The phrasing was modified according to the reviewer’s suggestion.

Section 4.4 Q4: *Do you mean amount of ice rather than types. Perhaps you should just say “spatial distribution of ground ice”.*

The question of ice type can affect permafrost dynamics in a way that is not covered by only looking at total ice content. For example, micro-lenticular cryostructures can contain as much ice on a local scale as ice wedges or massive ice bodies, yet degradation of an ice wedge does not affect the landscape in the same way as micro-lenticular ice does. Carbon contents in permafrost are also influenced by the type of ice and its formation process. The type of permafrost and of ice therefore can tell a greater story than the sole ice content, and this is what the question is addressing.

Page 1217, line 18-19: *Revision suggested – “The presence of excess ice, including massive ice, is a key factor affecting the thaw sensitivity of permafrost to warmer temperatures and mechanical disturbance as ice melt can result in thermokarst topography (subsidence and collapse)”*

The phrasing was modified according to the reviewer’s suggestion.

Page 1217, Line 25: *Suggest you use “ice-bearing permafrost” (i.e. delete “ground”)*

The phrasing was modified according to the reviewer’s suggestion.

Page 1218, Line 1-3: *Researchers can submit databases to the Frozen Ground*

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Database so it isn't clear what the issue is here. Note that this is also more of a data rescue issue as this information probably exists in less available forms such as engineering reports etc.

The Frozen Ground Data Center (or Database) does not really exist anymore. We argue for a single database for this type of information, which could become GTN-P, instead of the many different portals and reports that exist.

Page 1218, Line 3-5: Note that the objective of GTN-P is to monitor ECVs (permafrost thermal state and active layer). It is not meant to be an archive of all permafrost information. Within site descriptions (metadata) information is provided on soil conditions including ground ice. More appropriate references for GTN-P would be Burgess et al. (2000) or Smith and Brown (2009). Smith, S.L., and Brown, J. 2009. T7 Permafrost: Permafrost and seasonally frozen ground. Global Terrestrial Observing System, GTOS 62, Rome 2009, 19 pp. Burgess, M.M., Smith, S.L., Brown, J., Romanovsky, V., and Hinkel, K. 2000. Global Terrestrial Network for Permafrost (GTNet-P): permafrost monitoring contributing to global climate observations. Geological Survey of Canada Current Research 2000-E14 (<http://geoscan.nrcan.gc.ca/starweb/geoscan/servlet.starweb?path=geoscan/download.websearch1=R=211621>)

We replaced the URL with the following latest publication:

Biskaborn, B. K., Lanckman, J. P., Lantuit, H., Elger, K., Streletskiy, D. A., Cable, W. L., and Romanovsky, V. E.: The Global Terrestrial Network for Permafrost Database: metadata statistics and prospective analysis on future permafrost temperature and active layer depth monitoring site distribution, Earth Syst. Sci. Data Discuss., 8, 279-315, 2015. doi: 10.5194/essdd-8-279-2015

Section 4.5 Page 1218, line 16: Revision suggested – “. . .transportation systems often rely on the. . .” (whether infrastructure relies on frozen conditions will depend on its design).

The phrasing was modified according to the reviewer's suggestion.

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Page 1218, line 22: *McGregor et al 2010 should probably be referenced as Transportation Association of Canada 2010. (this is the correct citation for Transportation Association of Canada documents). There was also a similar document for community infrastructure by Canadian Standards Association (CSA): Canadian Standards Association 2010. Technical Guide - Infrastructure in permafrost: a guideline for climate change adaptation, Report Plus 4011-10.*

We removed:

McGregor, R. V., Hayley, D., Wilkins, G., Hoeve, E., Grozic, E., Roujanski, V., Jansen, A., and Doré, G.: Guidelines for development and management of transportation infrastructure in permafrost regions, Transportation Association of Canada, Ottawa, 2010.

Changed to:

Transportation Association of Canada: Guidelines for development and management of transportation infrastructure in permafrost regions, Ottawa, Canada, 177 p., 2010.

We added:

Canadian Standards Association: Technical Guide - Infrastructure in permafrost: a guideline for climate change adaptation, Special Publication PLUS 4011-10, Canadian Standards Association, Mississauga, Canada, 112 p., 2010.

Page 1218, line 25-26: *There is integration already as engineers do conduct terrain mapping and also sensitivity mapping for major projects.*

Changed into: “future research needs to **systematically** integrate permafrost engineering with earth sciences.”

Page 1219, line 1-5: *More recent papers could be referred to here such as Lepage et al. (2010, 2012) for the Beaver Creek test section and overview by Burgess et al. (2010) for Norman Wells Pipeline. The 2012 AMAP update of ACIA would probably better to use than the ACIA report.*

We replaced Instanes et al. (2005) with: Callaghan, T.V., Johansson, M., Anisimov, O.,

Christiansen, H.H., Instanes, A., Romanovsky, V., and Smith, S.: Changing permafrost and its impacts. In: AMAP. Snow, Water, Ice and Permafrost in the Arctic (SWIPA): Climate Change and the Cryosphere, Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway, pp. 62, 2011.

We added: Malenfant-Lepage et al. (2012) which presents the latest results from the Beaver Creek test section:

Malenfant-Lepage, J., Doré, G., and Fortier, F.: Thermal effectiveness of the mitigation techniques tested at Beaver Creek Experimental road site based on a heat balance analysis (Yukon, Canada), 15th International Conference on Cold Regions Engineering, Quebec, Canada, 42-51, 2012.

We added: Burgess, M.M., Oswell, J., and Smith, S.L.: Government-industry collaborative monitoring of a pipeline in permafrost – the Norman Wells Pipeline experience, Canada, In: GEO2010, 63rd Canadian Geotechnical Conference and 6th Canadian Conference on Permafrost, Calgary, Canada, 579- 586, 2010.

Section 5 Page 1219, line 10-19: *The key thing here is the interactions which makes it difficult to categorize the questions. Q1 and Q2 deal directly with the permafrost aspects of determining the carbon fluxes so perhaps are the relevant permafrost questions. For carbon there are permafrost and non permafrost aspects.*

We agree.

Page 1220, line 3: *APECS and PYRN need to be defined.*

These have now been defined.

Page 1220, line 9: *replace “identifying” with “identify”*

The phrasing was modified according to the reviewer’s suggestion.

References Page 1223, line 4: *Define IPCC*

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It is explained in the title of the reference.

Page 1223, line 3: *see earlier comment re McGregor et al. (should refer to Transportation Association of Canada as author)*

The phrasing was modified according to the reviewer's suggestion. See above.

Interactive comment on The Cryosphere Discuss., 9, 1209, 2015.

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