

## ***Interactive comment on “Permafrost distribution in the European Alps: calculation and evaluation of an index map and summary statistics” by L. Boeckli et al.***

**Anonymous Referee #1**

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### General comments

The study by Boeckli et al. is a follow-up of the already published paper “A statistical approach to modelling permafrost ...” in The Cryosphere 6, 125-140 (from hereon named B1). While the first paper describes the basics for the statistical modelling approach (“APMOD”), this study follows up with an application for the Alps and the generation of an Alpine Permafrost Index Map (“APIM”). Some general comments first:

The approach presented in both papers are interesting and of high relevance. Permafrost as a sub-surface and non-visible phenomenon is extremely difficult to model in space in highly heterogeneous terrain like alpine mountain chains. While in more ho-

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mogenous terrain like the Arctic lowland, permafrost models explicitly calculate ground temperatures with reasonable success, statistical-empirical approaches still are necessary for rough terrain. Within this respect the study is of interest, as here a large set of observations are put together into a statistical modelling approach, leading to a “permafrost index”. The principles of the approach has been used in other studies before, and uses a sort of more or less objective multi-criteria analysis known from other permafrost studies like BTS-based logistic regression, index maps (China, Mongolia) or in e.g. geohazard assessments.

For evaluating this study, I had to read the B1-paper, and it is clear that this study is an application of the B1-concept to the Alps. And I wondered, why these two papers were not combined, as the second would nicely underpin the validity of the first. As this did not happen, and this study already was cited as “in prep” in the B1-paper (which one absolutely should avoid in recognised scientific journals), some problems arose, as much of the info from B1 is repeated in this study. As an application this study tries to predict permafrost for the entire Alps, and this would be the first unifying approach for the Alps with such a high spatial resolution (30 m). However, it is difficult to follow this study without reading B1 first.

Well, based on these considerations I would recommend publication after some minor and partly major revisions. I understand, there is a lot of work related to this study, and the results are valuable, however its presentation is not always as intuitive. First, the paper is lengthy, and much of the APMOD description in METHODS can be omitted, or partly moved to the DISCUSSION. Further, the validation to observations not used in the ALPMOD scheme is ok, but I would like to see how the model performs in relation to the already published modelling approaches, e.g. for the Corvatch area where much information is available. Then, I think the paper would improve with a defined RESULT chapter. Finally, I would suggest to provide an alpine-wide map showing that your approach is unifying, or a couple of higher-resolution examples from different regions in the Alps, maybe both regions containing validation and regions which are not that

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much investigated.

Detailed comments and suggestions:

p. 850, abstract: Delete last sentence, put in ACKNOWLEDGEMENT

INTRODUCTION: Is not very good and “jumpy”. Give first a background for the study, and then Objectives and Aims or Hypothesis, and how you address these with your approach. P. 852, l. 1 ff. can be moved into the discussion, or use parts early in the Introduction. Last paragraph of Introduction should be part of the Discussion. What is the advantage of your study in relation to the cited studies?

Paragraph 2.1.: This is a discussion of APMOD, move to discussion or delete

Paragraph 2.2.: Also much Discussion, only say what you have done and discuss later.

DATA chapter: Most of the Data chapter are METHODS, where you want to show how you translate the APMOD outcome into the permafrost index. I would strongly suggest that you make on “DATA and METHODS” chapter, explicitly showing how you translate from APMOD to APIM. Give a flow chart if you want, this is often beneficial for other readers to understand your thinking here. Move the “Validation” from 2.2. to the end here or as an own part in 6.

Ch. 3.1. What is from the B1 paper and what from this study, if from B1, remove.

p. 857 l. 2: “In agreement with ...”, this sounds like a total different paper, but it is your work. Again, what is this study and what B1?

Evaluation data: I had difficulties to understand this section in terms of how you justify your weighting here. Try to make it a bit clearer, I understand that this is an important part, and therefore it should be easy to understand.

p. 859, l. 15 ff. Remove the whole first paragraph, we do not need a summary of the following section.

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p. 860, l. 1 ff: Same as “evaluation”, I do not really follow the argumentation. Maybe it is more pedagogic if you start with the equation, and then explain why and what the different components are.

l. 12: What is “optimistic” here? And what is then “Pessimistic”?

p. 861, 1st paragr. This is a Discussion again, move.

Chapter 5: Remove the whole paragraph and the figure in the appendix. This is an own story, and would be a nice contribution to e.g. the Journal of Maps. Public authorities normally do not read scientific journals, so I guess if you want them to use your maps, you must make a report and guidance how to use your map, and there you can write these things.

Chapter 6: This is a validation. DELETE the first sentence! DELETE the last paragraph of the chapter or move this to an earlier place. The AUROC presentation is nice, but as mentioned above, how is the performance in relation to earlier models? Consider at least an inter-comparison, this is often valuable as the earlier published models serve as a sort of state of the art, and you want to improve that. I understand that your approach is based on a much better data basis; however, often this does not necessarily mean that the model performs better.

Chapter 7: This is a RESULT, move.

DISCUSSION: I would suggest a restructuring of the discussion. I have suggested that many earlier paragraphs should be moved into the discussion, and at present there seems to be some redundancies. In the discussion you should discuss first the uncertainties and model advantages (in relation to older approaches) and limitations, then the obtained permafrost distribution for the Alps and finally some sentences about what your new findings mean for mountain permafrost science and possible practical applications such as planning etc. This is a suggestion, at present the discussion could be improved, and there is no scientific discussion in relation to comparable approaches

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elsewhere.

CONCLUSIONS:

p. 867, l. 22: "A high index value ...": You never showed that high APIM means "permafrost in very cold condition" What is "Very cold"? Then you should show a scatter of e.g. borehole temperatures against APIM-values.

Bullet point 3: 1-6%? This is a large range, what is "relative area of permafrost occurrence"? In relation to country? Or in relation to the APIM?

And: Nobody expects to calculate "Exact" extents, or nobody can. You can remove that sentence. Remove the last sentence, too (l. 15 ff.).

DATA AVAILABILITY: Delete or remove to Acknowledgement. In 30 years your paper will still be available and citable; will the exact link for data download also survive 30 years at your Department? Therefore it is maybe better to have this type of info other places than in the main paper text.

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Interactive comment on The Cryosphere Discuss., 6, 849, 2012.