

Interactive comment on “Spatial consistency and bias in avalanche forecasts – a case study in the European Alps” by Frank Techel et al.

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REVIEW

The manuscript <https://doi.org/10.5194/nhess-2018-74> provides a significant contribution to the understanding of avalanche danger forecasting. It provides a thorough analysis of a large data set from the European Alps, and provides a method to compare the forecasted danger level within and between Avalanche Warning Services (AWS'). It is well written. The results and conclusions are relevant to the science community as well as the forecasting services. The results are presented and discussed in an adequate manner and the authors use a valid scientific approaches and methods. The manuscript is acceptable for publication in NHESS, when the recommends improve-

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ments are carried out.

GENERAL COMMENTS

The way the forecasting regions are reference to varies throughout the text. It will be easier for users to read the text if region names were used followed by the abbreviation in brackets. I recommend to use the following naming of region throughout the manuscript, example: “the regions Tirol (TIR) and Vorarlberg (VOR)”.

The four research questions are formulated on page 3 and 4. However, it is hard to follow how the analysis, discussion and conclusions address these four questions. I recommend that Chapter 2-7 explicitly states how each of the research questions are addressed. This could be done by adding text, such as “In order to test/answer/address research question 1, we analysed the following...” or it could be restructuring the Sub-Chapters or adding Section headings. The conclusions should definitively address each of the four research questions in turn.

The authors should check the manuscript for consistency wrt. the use of "AWS" versus "forecasting centre". The authors should also check for consistency in the use of "warning region" versus "forecasting region". For example, "warning regions" are used throughout the text, but not in Figs 6, 7 and 8, nor P3L23 or P8L11.

Please spell out names of countries, rather than use abbreviation in the text (e.g. P24L10).

The spelling should be consistent. British spelling is used for some words, such as “neighbour”, while US spelling is used for others, such as “center” and “color”. Please check and correct the spelling.

There is no reference to the material in the Appendix in the text, this should be added or the Appendix skipper.

SPECIFIC COMMENTS

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P1L7. Specify what is meant by “goodness”. Is spatial homogeneity equivalent to a good forecast? Probably not, as regions are defined based on, among other characteristics, spatial differences in avalanche conditions. Thus, danger levels are expected to be different from one region to another from time to time. Furthermore, country- or AWS-specific user may have developed strategies which account for potential differences between AWS’ (in other words are calibrated), and a bias may be only a problem for users who are not familiar with the different products. This could be discussed.

P2L26. Add a sentence about avalanche problems, such as “In 2017, EAWS introduced a set of five typical avalanche problems in order to both describe the avalanche hazard in more details and to provide better advice to the end users on how to manage these hazards.”

P2L27-28. Add a description of how the danger level is determined, and which factors are used to determine the danger level. Also specify how the level is determined, when the level varies with the spatial and temporal domain of the forecast (e.g., the forecasted avalanche danger is the highest expect level in the forecasting time period and geographical region). Furthermore, the authors should provide a short description of possible or actual differences in procedures or practices. For example, avalanche size is an important input factor when the AWS decided which avalanche danger to forecast for a region. The avalanche size may be set differently according to differences in terrain, snow cover, training, culture, etc, and the current definitions of size categories may allow differences in interpretation. These factors should be briefly mentioned in the introduction, and be further elaborate on in Chapters 2 and 5 or 6.

P2L22-P3L4. This part of the text should be improved, in order to explain specifically how this is interpreted and addressed in this study.

P3L7-10. These statements should be explained and substantiated in a better way.

P3L24-30. The main purpose or goal of the study should be more clearly stated. The current text (“This concept of consistency has in turn important implications for qual-

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ity and ergo value. In our work, we assume that the quality of forecasting is consistent across all forecast centres, and rather consider the implications for the value of the forecast, as consumed by its users, as a result of potential differences in consistency. We do so by quantifying bias between neighbouring forecast centres and regions in time and space.”) is complicated and somewhat hard to follow. What about something along these lines? “Biases in danger level between neighbouring warning regions and centres will decrease the value to users, unless biases are due to difference in avalanche conditions only. The main goal of this study is investigate if such spatial inconsistencies and biases exist, in order to improve the value provided by the European AWS”.

P8L11. Add a description of how the danger level is derived/determined by the different AWS’ and what are the contributing factors. For example, if one AWS systematically rate the avalanche size as 3 in cases where the neighbouring centre rates the size as 2, it will also systematically issue danger levels that are higher than its neighbour. Add this as a paragraph in Sub-Chapter 2.2 or as a Sub-Chapter on its own. This is important in order to understand why the danger levels may vary between regions or AWS’.

P10Fig3. This map shows region sizes. Region elevation is the other statistics being analysed, I suggest adding a map Fig 3b, showing colour coding according to region elevation, if the elevation differences are possible to display clearly on a map. In this way, the map in Fig 5 may be easier to interpret wrt. elevation as well as size.

P21. Justify why there is no Sub-Chapter on D=2.

P23L32. Describe the procedures/practices at the different AWS and discuss if this a factor that causes systematic differences.

P28L8. Consider to add “EAWS is also in the process of providing clear definitions of the key contributing factors, such as the distribution and likelihood.”.

P28L26. Discuss what could be the effects of some forecasters or forecasting centres

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issuing the highest level expected in the forecasting region/period, while others may issue the most probable or general level.

P29L12. Consider to add “and/or typical avalanche problems” after “regimes”.

P30L16-19. Consider to specify in more details the why, what, and how of such a study.

TECHNICAL COMMENTS

P1L4. Capitalise “avalanche danger scale”.

P2L3. Add “and forecasted” after “current”, as you are analysing forecasted danger levels and not nowcasts.

P2L13. Add “regional” before “avalanche”, if that is what you mean.

P3L17. What is meant by “situation”, please clarify.

P4L1. Replace “across” with “between”.

P5L8. The sentence is not complete. Please rephrase. Please specify what is meant by AWS and what is meant by a forecasting centre.

P7. “N” in the title of column 5 is also used to designate other properties in the manuscript (for example P18L13-14). I suggest change title to “Number of warning regions”.

P9L3. Replace “where” with “when”.

P9L9. Replace “correspond to” with “are larger than”.

P11Fig4. The Figure and caption should be improved. Use (a), (b) and (c) consistently in the figure and caption. Skip the words “hypothetical” and “Scenario” in the caption.

P11L1. Skip “(Dt1,Dt2)” in the title.

P11L3. Is this so? Please substantiate.

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P12L4. Skip “(De1,De2)” in the title.

P14L23. Use bold font only for “France”.

P15L18-25. Equations 1 and 2 are trivial. I recommend to skip these and rather explain the differencing in the text.

P16L23. State the number N used.

P20Fig6. The readability of the map and diagram should be improved. The boundaries are difficult to read, accuracy to the hundredth decimal is unnecessary in the legend and the length-proportion-days diagram should be rotated 90 degrees and enlarged. In the caption address (a) the map, (b) the diagram.

P21Fig7. Some of the same comments as above applies to this Figure. Use (a), (b) and (c) to denote the three subfigures and their caption text.

P21L1. Do you mean “D<1”?

P30L22. Replace “close to 500” with “477”.

FINAL COMMENT

I hope this comments and recommendations will be useful to improve the manuscript. If there are any questions, I remain available for discussion.

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