**Reviewer #1:**

Literature

One of the co-authors (Peter Höller) has recently published an in-depth analysis of Austrian avalanche fatalities, with a particular emphasis on tourist avalanches (Höller, 2017). Höllers study covers essentially the same two categories backcountry and off-piste, and a very similar time period. Currently, Höller's study is not cited. From my perspective, the following results and statements made by Höller should be discussed, as they partly contradict the results and/or may influence the interpretations presented:
– frequency and influence of multi-fatality accidents - 32 accidents with more than 3 victims in the backcountry since 1981/82
– «Although in Austria a slight increase of fatalities in the off-piste area can be seen, this tendency is statistically not significant (p = 0.055).»(p. 6)
– «A trend towards more avalanche fatalities due to off-piste skiing cannot be identified at the moment. »(p. 7)

**Thank you for this advice! I did not know this paper. However, the data which are denoted by "tourist avalanches" (833 counts) in the paper are not comparable with our counts and as a reason of this they are not comparable with the results of the smaller counts in Pfeifer et al. (2013) (see at the end of page 5 of Höller 2017*).**

**I suppose you mean 12 accidents with more than 3 fatalities (see Table 4 of the paper); regarding the influence of "multi-fatalities", please see below.**

**In the case of off-piste fatalities (p=0.055) our data additionally include data from 1977/78 up to 1979/80 and as a result of this we observe different results**

**The Mann-Kendall test, which Techel and Höller employ in their papers, is only sensitive for MONOTONIC trend profiles. But our assumption is that the trend functions are possibly nonlinear and/or not monotonic. In general (and as a consequence of our paper), we think that it is necessary to take nonlinear functions into consideration.**

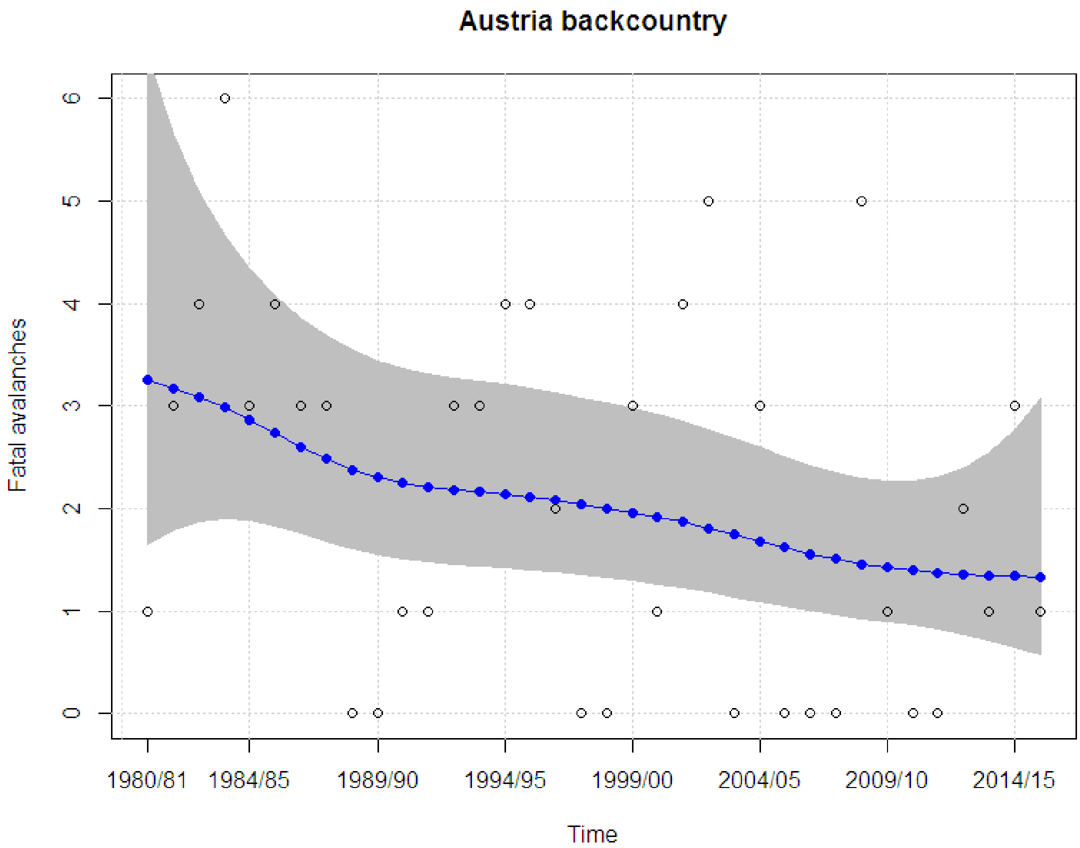
**Please see lines 278 ff. of the new version of the paper.**

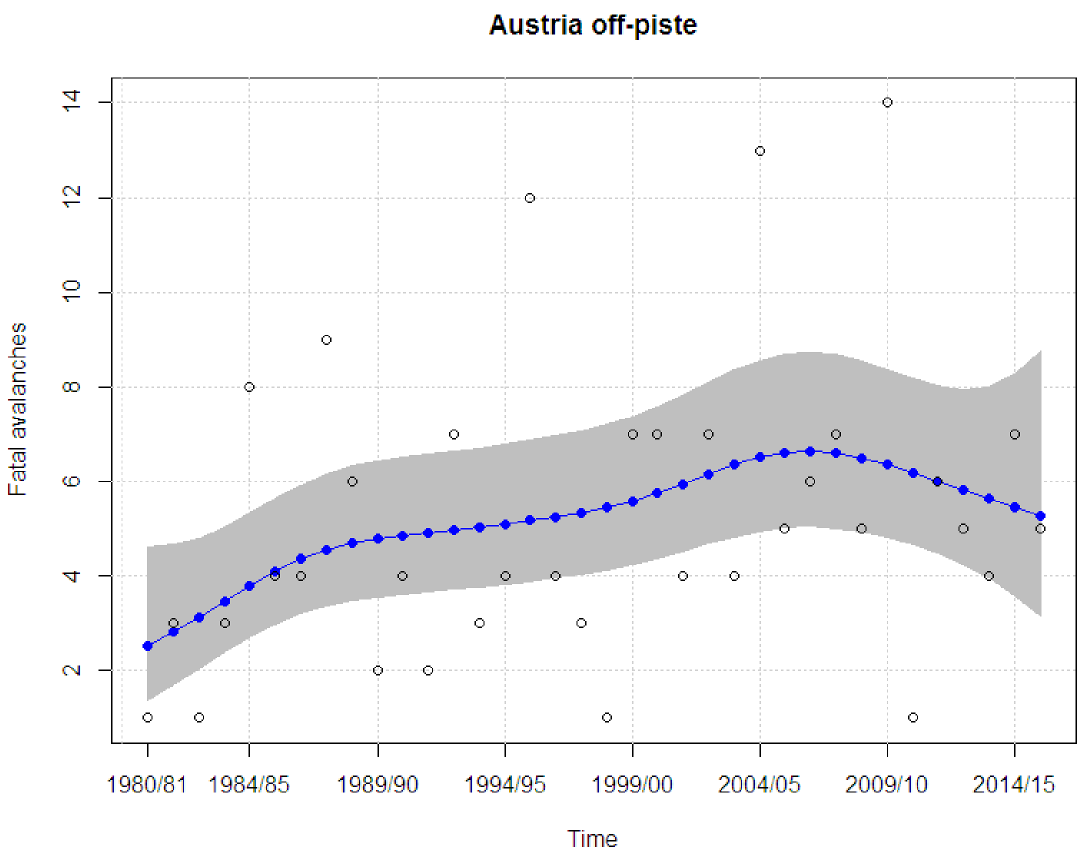
**Finally we agree with Höller (2017) that there is no increase of off-piste fatalities "at the moment". We rather observe a decrease of off-piste fatalities in the most recent years.**

As already pointed out in one of the initial reviews, the influence of multi-fatality accidents on the absolute annual number of fatalities and on the trend function should be discussed. This may be particularly relevant, as the dataset is split into two categories, with low counts for the off-piste category. Although (Höller, 2017) noted no trend in the number of accidents with many fatalities, single events claiming many lives occurred repeatedly (for instance a backcountry accident in 1982 claimed 12 lives).

**As said in a previous reply to the reviews, we do not think that single extreme events have an effect on the (nonlinear) estimates because of their robustness (is the case only for a "cluster" of larger Austrian total fatality counts in the mid 80s).**

**The number of accidents with more than one fatalities is rather decreasing (in case of backcountry significantly linear decreasing; see figure below and AIC/BIC values in the paper)!**


Austria backcountry
Fatal avalanches
0
1
2
3
4
5
6
1980/81
1984/85
1989/90
1994/95
1999/00
2004/05
2009/10
2014/15
Time


Austria off-piste
Fatal avalanches
2
4
6
8
10
12
14
1980/81
1984/85
1989/90
1994/95
1999/00
2004/05
2009/10
2014/15
Time

Therefore, I suggest to additionally explore the trend for the period 1980/81 until 2015/16 using just the counts of fatal accidents in Austria (in this case, multi-fatality accidents have no influence on annual fatality numbers).

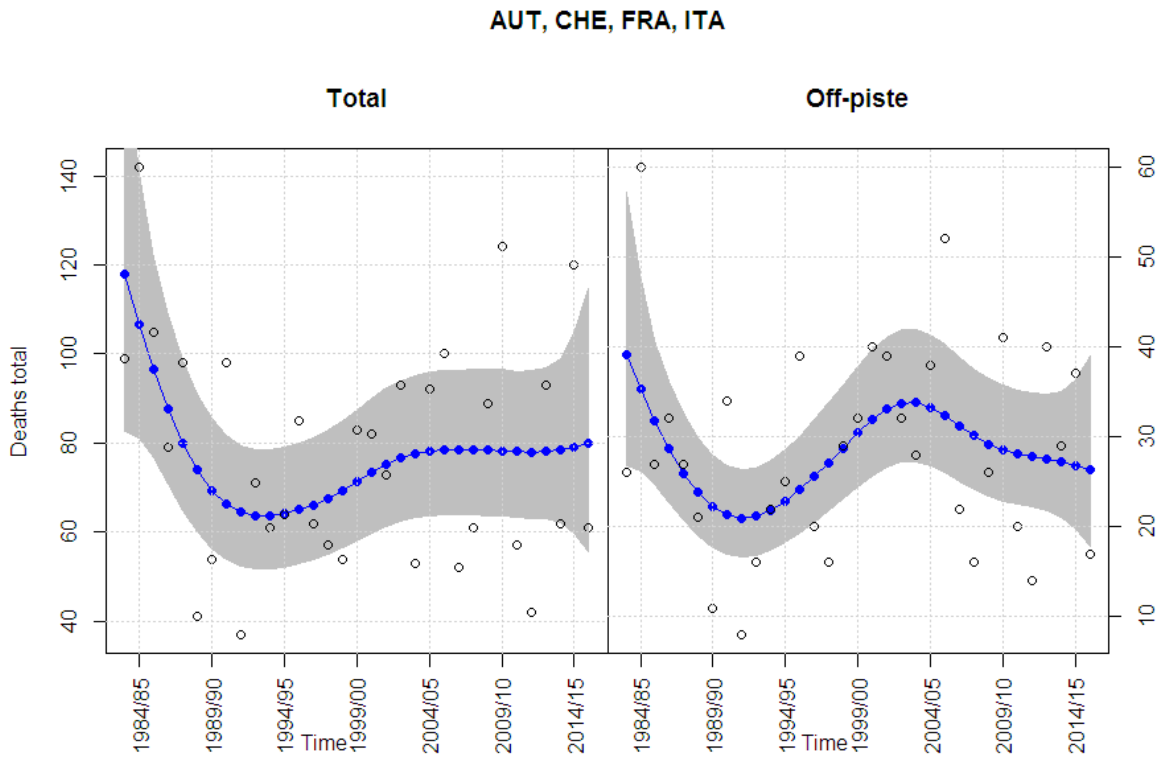
**In case of total fatalities (Fig. 1 of the paper) we are not able to gather the number of avalanches with fatalities beginning from 1967/68 for our purposes (only the number of fatalities).**
**In case of off-piste fatal avalanches we are able to report the number of fatalities beginning from 1980/81 (the first 3 years missing). As you can see the shape of the estimated function is similar (or even more significant because of the decrease of multi-fatal avalanches, see figure above).**

**We did these examinations earlier too, but we decided to take only the number of fatalities which are common in literature. However we are not able to do this in case of other countries (and partly in case of Austria if we consider total fatal avalanches).**

**We will address this in the discussion!**

**(In a former version of the paper we had a map with numbers of fatal off-piste avalanches, but we skipped this because of lack of space)**

Additionally, the authors could show trend curves and statistics combining the annual backcountry fatalities for the four Alpine countries Austria, France, Italy, Switzerland. From my perspective, these two approaches would considerably strengthen the analysis, allow a more robust interpretation of the results (particularly if trends are confirmed using the different datasets), and would allow a more in-depth-discussion of the advantages and limitations of the statistical model.




**Please see Figure 7 in the new version of the article.**

Furthermore, Höller (2017) provides an extensive overview of publications concerning trends and statistics of avalanche fatalities (Switzerland, USA, Italy, France), some of which might be suitable references when discussing trends.

**Thank you for this advice; we will add the references Pfeifer et. al. (2013) and Höller (2017). However, some other references relating to Switzerland,...,USA are not suitable because of the different data bases, see e.g. (*) above.**

Data and Methods
As you analyze fatality counts only, you could remove line 83 (number of persons involved).

**If we put Figure 1 of this reply (fatal avalanches with fatal.>1) into the paper, we propose not to delete this line.**

Results - Section 3.1 and 3.2
These two sections introduce the figures and tables, but not the results themselves (this was already pointed out in one of the first reviews). Results are presented and discussed in Section 4 (Discussion) only.
I find this a rather unusual approach. I recommend to introduce the figures together with the results they show.

**The results are introduced or presented in the "Results" section and discussed in the "Discussion" section, please see discussion in a former reply (however, we are open for changes if requested by the editor).**

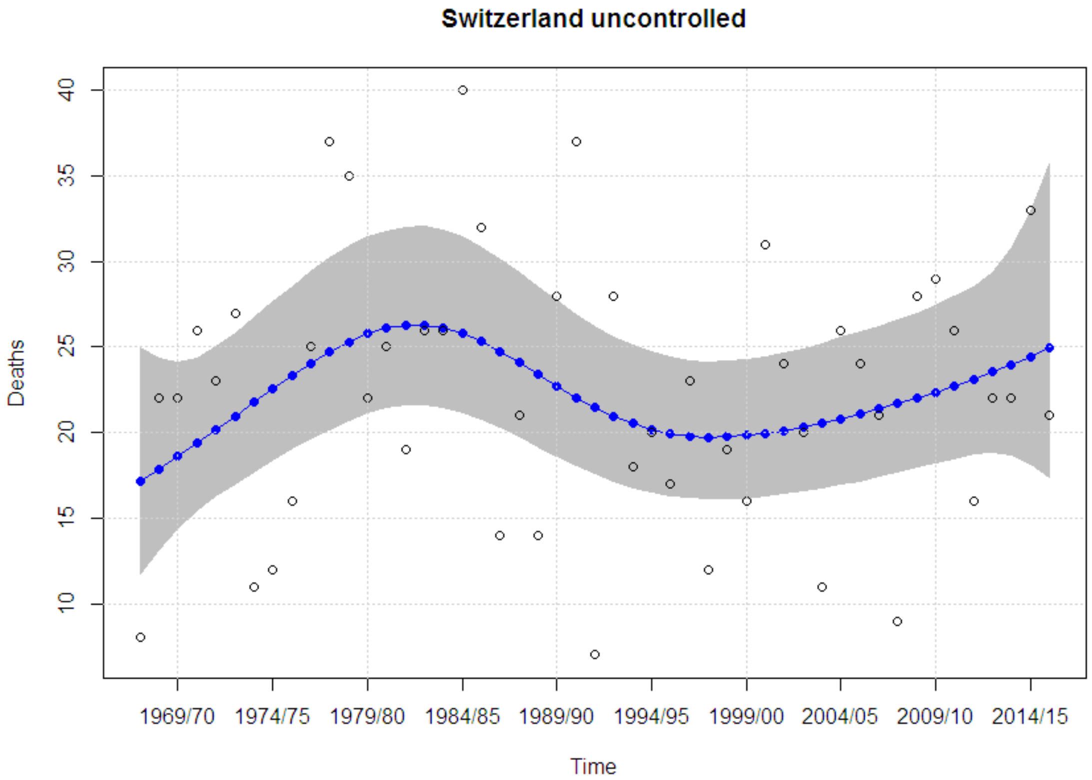
Discussion - Section 4.1
lines 214 to 219: You discuss the increased number of fatalities in the 1980's and mention increased snowfall (in Austria, I assume) but cite two sources which explored Swiss snowfall trends (Abegg, 1998; Laternser and Schneebeli, 2003). Furthermore, you note no peak of off- piste fatalities in the 1980's. As already outlined in one of the initial reviews, these two statements seem contradictory.

**This is literature referring to snow fall trends in the ALPS. In a former version of the article we had a time series plot with snow fall in the St. Anton cluster, see Fig (Solid precipitation during wintertime around St. Anton a. Arlberg within 1900 and 2003 based on precipitation data of the 'Zentralanstalt für Meteorologie und Geodynamik' (ZAMG)):**


**As pointed out in a former reply we have no idea where there is no peak in the off-piste case. (We will address this contradiction in the paper more clearly; an explanation could be: higher frequencies of "multi-fatality" accidents in the case of backcountry skiers).**

lines 264-267: As you point out, AIC/BIC statistics indicate that the curves are non-linear in most cases. Maybe you could formulate more clearly whether this result confirms or contradicts the cited study by Techel et al. (2016) (this did not become clear to me reading these lines).

**As mentioned in a previous reply the data where the results of Techel et. al (2016) are based on (uncontrolled terrain), are different from ours.**
**In Switzerland we notice a decrease in the 1990s and slight increase in the 2000s - see figure 1 (a), Techel et al 2016 and figure 2 (b,d) in case of Switzerland, Austria and Slovenia - which is similar to our case.**
**Unfortunately, there is some variation because of Techel's running mean approach. Here you see our GAM estimate of uncontrolled fatalities in Switzerland (source: data we kindly received from F. Techel, before 1983/84 taken from Figure 1(a), Techel et al 2016):**




Discussion - Section 4.2
I could not find any information whether, and to what extent, the spatial simulation matches the actual observed number of fatalities (the maps show this, but they are hard to interpret - printed numbers vs. background colors). Please show the correlation between observations and simulations, or some other measure of similarity.

**Rsquare adjusted: total 0.972, off-piste 0.954**
**or**
**Deviance explained: total 91.2% off-piste 87.1%**
**see lines 203,204 in the paper.**

Similarly, you could present the statistical correlation between the fatality numbers at municipal level with the proportion of Alpine terrain or overnight tourists. This would facilitate the interpretation for the reader.

**Corr off-piste: 0.66; total: 0.62, see lines 215, 216 in the paper**

**(Alpine terrain: off-piste: 0.27; total: 0.42)**

From my perspective, you should also discuss the benefits and limits of the chosen Markov Random Fields method used for the spatial analysis.

**In a further step a temporal and spatial modeling en bloc (spatio-temporal model) would be nice from a statistical point of view.**

Lines 209 - 215, Figure 1
I personally would interpret Figure 1 as a considerable increase between 1969/70 and 1985/86 (probably significant), with only minor changes afterwards (slight increase until 2005, but 90% confidence interval is large in comparison). This interpretation would correspond quite closely to Höller's results and conclusions, and would also agree quite closely with the trends shown for Switzerland (study you already cite (Techel et al., 2016)). I suggest to show whether fatality counts in the years surrounding 1985 and 2005 differ significantly.

**We would describe it as an increase up to the mid 2000s with a peak in the 1980s (possibly due to increased snowfall in the 80s).**

Figures - 7, 8, 9
The color of the individual polygons in Figures 7 and 8 (simulated number of fatalities) show different information than in Figure 9 (Proportion Alpine terrain). This is not fully intuitive. Therefore, I suggest using different color schemes.

**We changed the colors, see the new version of the article.**

The figure captions (Fig. 7 and 8) miss the information what the background color shows and what the numbers are. This information, currently in the text section 3.2, should be added (or moved) to the caption.

**Thank you for this advice, see modified Figures 9 and 10 in the new paper.**

Please indicate the clusters CL1 and CL2 on the maps in Fig. 7 and Fig. 8 (you refer to them in the text, but non- Austrians will likely not know which location is which).

**We tried this in an earlier version, but we did not find it very nice (such as the borders of the federal states). You should be able to identify the clusters with the accident numbers in the text (I admit: This is a rather tedious task).**

**Reviewer #2:**

Specific comments
Reference 3 (Brugger H, Durrer B, et al. 2001) is outdated. Please use instead "Resuscitation of avalanche victims: Evidence-based guidelines of the international commission for mountain emergency medicine (ICAR MEDCOM): intended for physicians and other advanced life support personnel. Brugger H, Durrer B, Elsensohn F, Paal P, Strapazzon G, Winterberger E, Zafren K, Boyd J; ICAR MEDCOM. Resuscitation. 2013 May;84(5):539-46. doi:10.1016/j.resuscitation.2012.10.020."

**Unfortunately, this article does not refer to the trend of avalanche fatalities over time (such as Brugger et al. 2001).**

**Editor:**

Comments to the Author:
Dear Authors,

Finally, I received two out of three referee reports, and in order not to further delay the publication I made my decisions based on these two reviews. As you can see, referee #2 has no concern about your manuscript, which is fine.
Referee #1, in contrast, raised some additional questions which are worth to be discussed a bit deeper:
- One of the co-authors, Peter Höller, recently published an analysis of Austrian avalanche fatalities in “Cold Regions Science and Technology” entitled “Avalanche accidents and fatalities in Austria since 1946/47 with special regard to tourist avalanches in the period 1981/82 to 2015/16”. I am wondering why this study is not referred to in your work, in particular since there are some similarities between the data sets used.

- Furthermore, I particularly would like to see a discussion on the items discussed by referee #2, in particular the contradictions between your data and Höller’s published work, as (and here I entirely agree with the referee) discussed in the review.
- More information is given in the extensive comments of reviewer #1.
Please proceed accordingly, and provide a step-by-step answer to the referees’ comments when re-submitting your work.

**Please see our statements to Reviewer #1 (I hope you mean “referee #1” instead of “referee #2” in the last paragraph).**

**Last but not least, I would like to thank the reviewers for their helpful comments which helped us to improve our paper considerably!**