

1 **A catalog of high-impact windstorms**
2 **in Switzerland since 1859**

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10 **Response to Referee B. Gardiner**

11 **Main points**

12 1. Paper is well written and covers a topic of major importance for society and for
13 forestry.

14 2. The catalogue of storms will be of value to many researchers for many years
15 and the authors are to be congratulated for the effort in compiling the data from
16 such a complex set of sources.

17 **1. and 2.** Thank you for the careful and detailed comments. We appreciate your
18 confidence in our work.

19 3. In some places I found the discussion too cryptic and struggled to understand
20 how the analysis had been carried out. I have expanded on these concerns below in
21 the Specific Points and suggested where additional information could be helpful.

22 4. I found the use of the word “hazardous” for storms in contrast to “moderate”
23 confusing. Do you define “hazardous” as storms that are either “severe” or
24 “extreme”?

25 **3. and 4.** Yes, 'hazardous' in this context means the most damaging of the
26 windstorms classified as extreme and severe. We now explain it explicitly with the

1 terms 'extreme' and 'severe'.

2 We have put effort into clarifying the terminology in general. For instance,
3 scientific and technical terms from a range of disciplines (atmospheric science,
4 insurance, forestry, etc.) are used in this paper. Some of these terms are specific to
5 the German language or even to Switzerland only. Finding a correct and
6 comprehensive terminology and wording is challenging at times. Therefore, we
7 appreciate your suggestions, which we gladly adopt for the most part; e.g., 'total
8 losses' become 'total financial losses', 'movables' become 'movable property'.

9 5. There was very little discussion of the fact that most of the source data is
10 “secondary” and not “primary” data. You are basing your catalogue on data derived
11 by other people from different sources such as reports from local officials (who
12 may have actually measured or estimated the amount of damage). Therefore, there
13 is potential for errors to enter the system that cannot ever be checked because the
14 primary data don't exist. It is inevitable but I think this should be acknowledged. In
15 the end your methodology provides a robust way to deal with the problems caused
16 by such data sources.

17 5. This is a good point. It had been cut in the course of revisions, but is now
18 reintroduced in 3.2.4.

19 6. It is not clear to me what the value of the Decadal-scale Variability (Section
20 5.4) is to the paper. It appears to be an add-on at the end of the paper and the
21 statistical analysis is not fully presented. I would recommend leaving this section
22 out completely or adding more detail on the analysis undertaken.

23 6. Obviously, we have not been able to communicate the importance of this
24 paragraph from our perspective. In fact, this section is quite crucial for us in a range
25 of aspects.

26 We see the co-variation between the wind data (i.e., the hazard) and the damage
27 information (i.e., the impact) as a corroboration of our results. However, it is not
28 self-evident that temporal variations of windstorm activity can as well be found in
29 the damages from these windstorms due to issues regarding coverage and
30 concatenation of sources or normalization. Our statements are therefore quite
31 conservative at the cost of being perceived as rather vague.

32 Nevertheless, trends in windstorm activity over Switzerland / Europe have

1 repeatedly been postulated for and have been discussed controversially (e.g.,
2 Schiesser et al., 1997a; Wang et al., 2011, see Introduction). Here, we can show
3 once more that decadal-scale variations overrule long-term trends by far.
4 Of course, the catalog may be of use without this climatological context. In the first
5 place, however, it is intended to give a basis for further climatological and
6 atmospheric science studies. The damage-based approach was precisely chosen
7 because high-resolution wind data are not available. For instance, the windstorm
8 catalog and the found storminess variations might help establishing an extrapolation
9 of storminess over Switzerland into a future climate.
10 For these reasons, we opt for revising the paragraph, giving an additional Figure
11 (6c) and adding a reference for the Poisson point process.

12 **Specific Points**

13 1. Page 3822, line 1: What do you mean by “unanticipated”? Unanticipated by
14 whom?

15 1. The message should have been that the potential impacts of such events were
16 unanticipated / unforeseen by the (Swiss) society, authorities and economy.
17 Evidently, the meaning of the term 'unanticipated' is not clear without further
18 explanations. It is therefore replaced by 'unprecedented' for conciseness of the
19 abstract.

20 2. Page 3824, line 29: I think you need the Compo et al. (2011) reference here for
21 the global 20CR dataset. We don't get the reference until later.

22 2. The reference to Compo et al. (2011) is given on page 3824, line 14.

23 3. Page 3826, line 16: What do you mean by “total losses”? Total financial loss?

24 3. 'Total financial losses' is introduced for clarification. See also main point 3
25 regarding this and many more of your suggestions that are adopted in the following.

26 4. Page 3827, line 7: What do you mean by “movables”?

27 4. 'Movables' is replaced by 'movable property' here and in Table 1.

1 5. Page 3827, line 14: What do you mean by “tempest storms” and how are they
2 different from winter storms. Tempest just means storm. Do you mean
3 “thunderstorms”?

4 5. According to information from Munich Re NatCatSERVICE, 'tempests' can be
5 replaced by 'convective storms'.

6 6. Page 3828, line 2: I would prefer this sentence to read “These three sources are
7 used for validation of the previous data discussed in Sections 2.1.1 to 2.1.4.”

8 6. The sentence now reads 'used for validation of the obtained results (see Sect. 5).'

9 7. Page 3828, line 8: Suggest you change “larger damages” to “major damage”.

10 7. 'Larger' is replaced by 'major'.

11 8. Page 3830, line 17: What do you mean by “field field-means”?

12 8. This is a typo; 'field means' is correct.

13 9. Page 3831, line 24: How is duration implicitly included? You could have an
14 intense and short-lived (1 hour) or an intense and long-lived storm (several hours).
15 Please explain better what you mean here.

16 9. Unfortunately, we could not find a concise definition for the term 'intensity' in
17 the field of natural hazards.

18 The term 'intensity' seems to be widely used in a rather informal way and in the
19 sense of 'strong' or 'with great damage'. Closer to physical reasoning, 'intensity'
20 means 'amount of force per unit'. Then, the 'magnitude' of the damage from a
21 natural event would be a function of 'intensity' and 'duration'.

22 Our historical damages are virtually all described with respect to the informal
23 meaning of intensity. No report explicitly describes a specific influence of 'duration'
24 on the damage patterns (e.g., from cladding or fatigue loads), but implicitly, the
25 effects of the storm 'duration' are included in the descriptions of the storm 'intensity'
26 (i.e., 'magnitude').

27 However, such specifications would be rather lengthy and are not relevant for
28 understanding the method. Therefore, the text in parenthesis is removed.

1 10. Page 3833, Section 3.2.1, last paragraph: I do not think there is enough
2 information provided to understand how normalization was carried out. More detail
3 please.

4 **10.** The normalization ratio is introduced.

5 11. Page 3835, line 5: Got a little confused here. Does “<-35%” mean a reduction
6 of with a magnitude of more than 35%?

7 **11.** This is rephrased to 'from a reduction of >35 % to an increase of >250 %'.

8 12. Page 3835, line 16: What is “Klafter”?

9 **12.** An explanation is added: 'a solid measure for piled wood'.

10 13. Page 3835, lines 18-20: More detailed required on conversion from number of
11 trees to volume. This is too cryptic.

12 **13.** This procedure was applied to little data, and a detailed explanation would put
13 too much weight on it compared to more relevant procedures. A compromise
14 between conciseness and clarity is maybe found in that interim results are given and
15 calculation is referenced.

16 14. Page 3835, line 23-25: After the initial damage there can be additional damage
17 due to bark-beetle attacks, which is why the estimates can be different if they just
18 discuss damaged timber. This possibility is not mentioned.

19 **14.** 'Such as bark-beetle attacks' is added as an example.

20 15. Page 3837, line 1: Suggest you remove “exemplarily”.

21 **15.** 'Exemplarily' is removed.

22 16. Page 3837, line 2: What do you mean by the statement “this assures identical
23 distribution”. I cannot understand how you can make this statement.

24 **16.** The sentence is completed as follows: '(i.e., the probability distributions are
25 approximately identical, see Coles, 2001)'. Note that we also added 'independent
26 and identically distributed values ' on page 3837, line 7.

27 17. Page 3837, line 5: Suggest you replace “exceeding” with “exceedance”.

28 **17.** 'Exceedance values' is the correct term.

1 18. Page 3837, Section 3.2.7: Are the return periods for the whole of Switzerland?

2 **18.** The return periods are with regard to accrued losses, number of affected
3 buildings, and volume of windfall timber (see first sentence of Section 3.2.7). Only
4 damage information from Switzerland was considered.

5 19. Page 3837, line 23: What is meant by “reflect the societal notion”? Where do
6 you obtain the idea that six extreme windstorms reflect the societal notion of
7 memorable storms?

8 **19.** This sentence was intended to explain the subjective threshold choice of 30
9 years, but the phrasing is admittedly confusing. We rephrased such that we can give
10 a reference for the used term.

11 20. Page 3838, line 7-8: How do you deal with the boundaries between
12 classifications? Not every severe storm is one order of magnitude lower in losses
13 than every extreme storm. Are you talking about means here?

14 **20.** The sentence is slightly rephrased and completed.

15 21. Page 3839, lines 9-10: “Hence, winter storms tend to be more numerous and
16 more destructive than summer storms as a general rule”. Don’t forget that you
17 believe you underestimate summer storm numbers.

18 **21.** This is a description of the first results, i.e., before validation. However, the
19 sentence could be misleadingly interpreted as being contradictory to our final
20 findings. Therefore, it is discarded here.

21 22. Page 3840, line 25: Suggest replacing “well” with “very”.

22 **22.** 'Well' is replaced by 'very'.

23 23. Page 3841, Section 5.1.2: Did the 11 storms you refer to in Gardiner et al.
24 (2010) come from Appendix 1 of that publication or from the online database at
25 <http://www.efiatlantic.efi.int/portal/databases/forestorms/>? If from the database you
26 need to acknowledge it (might be nice anyway to reference as a resource for
27 people). I also think it would be helpful to mark the 11 storms in the catalogue in
28 the Appendix in a similar way to how you marked “multiple storms in 4 days”.

29 **23.** The link to your online database is added in the text.

30 In the Supplement, the 'multiple storms in 4 days' are marked for a different reason.

1 Our declustering required one storm-free day between two windstorm events (see
2 Sect. 3.2.5 and the Supplement). The yellow mark is intended to transparently
3 communicate that there are a few windstorm events in the catalog that are close to
4 clustering as we define it. For conciseness, we would like not to additionally mark
5 the validation sources.

6 24. Page 3842, line 17: “This is due to topographical and meteorological
7 particularities”. This sounds rather vague and uncertain. Are you saying that
8 actually you don’t know why there are differences?

9 25. Page 3842, lines 14-21: I am not totally clear what you are trying to say here.
10 Are you trying to say that a storm as identified in Switzerland may not provide very
11 much information about the impact in neighbouring countries?

12 **24. and 25.** The paragraph is slightly revised and further explanations are given for
13 more clarity.

14 26. Page 3844, lines 9-11: How do you make this inference? You only had
15 coincidence for half of the top 30 high wind days.

16 27. Page 3845, line 11: This is an example of the word “hazardous” that seems to
17 only cover “severe” and “extreme” storms and not “moderate” ones. Would prefer
18 to not use “hazardous” and spell out more clearly what type of storms you are
19 referring to.

20 **26. and 27.** We added that nine out of the top ten events are the same and defined
21 'most hazardous' by use of the classification terms. Note that page 3845 line 11 and
22 page 3847 line 22 have been adapted accordingly.

23 28. Page 3845, line 16: Why not misses of “severe” storms because you say
24 “although the wind series feature some moderate to severe winter storms”.

25 **28.** This is a correct objection. Consequently, the sentence is slightly rephrased.
26 Note that accordingly, page 3847, line 22 is also slightly changed to 'all extreme
27 and virtually all severe winter storms'.

28 29. Page 3845, line 28: Why did you not include all storms to show when CAT
29 DAM and CAT Wind agree?

30 **29.** Hopefully, the answer is given on page 3846, lines 6 to 8.

1 30. Page 3846, line 1: Why do you mark OBS Zurich as USB in the catalogue when
2 everywhere else in the paper you use OBS Zurich?

3 **30.** This is indeed an inconsistency. USB is replaced by OBS in the Supplement,
4 and the abbreviation OBS is now explained in the Supplement as well.

5 31. Page 3846, line 8: Suggest replace “largest” with “most extreme”.

6 **31.** 'Largest' is certainly wrong here, but 'extreme' is reserved for the classes. It is
7 substituted by 'the most extraordinary high-wind days'.

8 32. Page 3846, line 10: I think it would be better to replace “not shown” with a
9 reference.

10 **32.** This is an elegant suggestion.

11 33. Page 3846, Section 5.4: I find this section weak. The statistical analysis is not
12 shown and I don't see how it fits into the rest of the paper in a sensible way. I
13 would recommend leaving out.

14 **33.** See the reply to main point 6. Some reasoning is introduced in the paragraph.

15 34. Page 3847, lines 16-17: Suggest you remove “applied to”.

16 **34.** We would like to leave the parenthesis as is. It adds the purposes, e.g., that
17 extreme value analysis was applied to windfall timber.

18 35. Page 3848, line 3: Suggest you leave out “particularly”.

19 **35.** 'Particularly' is discarded.

20 36. Page 3855, Table 2: I think many of the definitions are vague and should be
21 expanded. Here are some things I was not sure about:

22 a. What are your definitions of “local”, “regional” and “national”.

23 b. Why are “stables” particularly identified? Are they prone to wind damage? Do
24 these indices come from some meteorological guidelines?

25 c. What is meant by “numerous places”?

26 d. Do you really mean “Entire forests”? I have never heard of entire forests being
27 blown down. You always have some surviving stands.

28 e. What does “(eq. 2010)” mean? Equivalent to 2010?

1 f. The numbers in the last row should be between limits, e.g. a moderate storm
2 should be between 10000 and 41000 m³.

3 g. What does the “Usbeck: 500000” refer to at the bottom right?

4 **36.** We would like to restrain from going too much into details here, which could
5 overload the table. Typesetting and layout of this table was already rather
6 complicated for NHESS and a few changes had to be made.

7 Moreover, the rather vague terms and attributes listed here are often seen in
8 indexing / historical climatology due to the lack of exact information. In Sect. 3.1,
9 we explain the concept referring to its scientific background, our sources and
10 adaptations, we give key words for each class, and we give a short example. In
11 addition, three examples are provided in the Supplement, where readers can re-
12 enact how the conceptual guideline was applied in concrete cases. We added the
13 sources below Table 2 again so that interested readers can find answers to questions
14 such as in your review.

15 Nevertheless, we appreciate your suggestions and have modified some text for a bit
16 more clarity.

17 a) The regional extent is adopted from a visual guideline in BAFU (2008): This
18 reference should be added here. In addition, an approximate number of affected
19 Cantons are given.

20 b) Yes. Stables used to be built much less solidly than residential houses. The
21 guidelines are adapted from several sources indicated below the table.

22 c) This is another example of a vague indication. It gives a guideline for how to
23 weight the term 'numerous' or equivalent terms found in descriptions. Therefore, we
24 cannot give an exact number.

25 d) It is not necessarily a total breakdown, but the devastation of entire forests, like
26 from Lothar. 'Devastated' is added.

27 e) 'Equivalent' is spelled out.

28 f) Ranges instead of thresholds are given.

29 g) This refers to Usbeck et al. (2010) as indicated below the table.

30 **37.** Page 3856, Figure 1a: Can you put some sort of monetary figure or volume of
31 timber on the y-axis and a size in kms on the x-axis?

1 **37.** For the reasons given in 36, we would like to leave the text without
2 modifications.

3 **38.** Page 3856, Figure 1b: Can you label y-axis here as well. And the x-axis must
4 be years. Is the Correlation between Return Period and Categories (3 years is
5 division between moderate and severe and 30 years division between severe and
6 extreme deliberate? Could the dates of the 3 extreme storms be put right against the
7 relevant dots?

8 **38.** The labels are added as suggested. We are not sure about the first question. If
9 you ask whether the thresholds are subjectively chosen, we can refer to Sect. 3.2.7.
10 The date labels are related to the specific points.

11 **39.** Page 3859, Figure 4: What does Return Level on the y-axis indicate? Are we
12 really talking moderate (1), severe (2), and extreme (3)?

13 **39.** The y-axis is complemented with 'Return level (weighted means)' for
14 clarification.

15 **40.** Page 3860, Figure 5a: What do you mean by “adjusted” damage. Adjusted to
16 2010? X-axis is a log scale and would be better plotted as one, i.e. 105, 106, 107
17 and the units given as m3. Bit confusing at the moment. I also presume that this is
18 damage only for Switzerland (that is why indicating these storms in the catalogue
19 would help). I also thought the 1962 storm was on 8 Nov 1962 but maybe I am
20 wrong.

21 **40.** This needs indeed some clarification. The term 'adjusted' is replaced by
22 'normalized' to keep consistency with the introduced terminology, the tick labels on
23 the x-axis are modified as suggested, and 'Swiss forests' is indicated. In our
24 database, both 7 and 8 November 1962 are mentioned; see the Supplement.

25 **Further changes to the manuscript**

26 **Page 3833, Line 1.** 'large' instead of 'dramatic'

27 **Page 3843, Section 5.2.1.** 'range' replaces 'spread', as the latter could be
28 misunderstood as 'standard deviation'. 'extraordinary wind speeds' is replaced by
29 'extreme wind speeds' to be consistent with 'resulted in extreme values at' further
30 below. We also added 'for the 1919 case' in the reference.

1 **Page 3846, Line 3.** We added 'The same declustering as for CAT-DAM was
2 applied'.