

Reviewer #2

Thank you very much for reviewing our manuscript and your helpful comments.

1) Reviewer comment: The authors provide an overview of (1) the meteorological phenomenon wind (2) its processes in interacting with the surface from a physical as well as an impact perspective and (3) a large collection of indices that are structured based on five environments: forests, urban, transport, agriculture, and wind-based energy production. These environments represent different communities in scientific literature as well as different sectors of socio-economic impacts. The authors provide a synthesis, an outlook and discuss open research questions.

Our response:

Thank you for your kind remarks.

2) Reviewer comment: The manuscript would greatly benefit, if the different environments could be more synthesized in the outlook sections. Many open research questions seem similar in the different communities and could be tackled synergistically in the future. Additionally more explicitly spelling out some generalized conclusions about the different indices in the different environments before the outlook would increase the usefulness of this review.

Our response:

That is a good suggestion. We added several specific research points to the outlook section.

See lines 1194-1275.

3) Reviewer comment: This manuscript features damage, impact and risk throughout the manuscript, but it mentions the socio-economic literature community (especially regarding exposure and vulnerability) mainly when such elements are used in indices in section 4. Maybe it would be beneficial to more often link to this body of research also in other sections:

Our response:

We tried to do this, we added some more references to the introduction, but the most appropriate place for the socio-economic literature is in section 4. So some imbalance is unavoidable.

See lines 85, 340 and 1149 where we added some socio-economic literature.

4) Reviewer comment: General introduction: How does this review position itself compared to reviews over different sectors in the impact modelling community (e.g. Merz et al. 2020 for windstorms and severe convective storms)?

Our response:

The focus of our review paper is quite different than Merz et al. 2020, which focusses on the forecasting of impacts related with many natural hazards, and not only wind(storms). They also consider only a few indices, where we discuss many more. We have added a sentence in the introduction to specify the different focus of Merz et al.

See lines 78-80.

5) Reviewer comment: L867ff/L1009ff How do the non-climatic drivers related to vulnerability and exposure mentioned in Zscheischler et al. (2018) play into the development of compounded indices?

Our response:

To our best knowledge non-climate drivers (like the mentioned vulnerability and exposure) can be considered for the development of compound indices. However, this is not typically the case. We state now that an important challenge is the inclusion of non-climate drivers in the indices. See lines 1003-1011.

6) Reviewer comment: L1: is the word “damage” broad enough? The manuscripts also mentions positive or indirect effects of wind. Why not mention the word “indices” in the title?

Our response:

We added “indices” to the title and define “damage” in the first paragraph of the introduction to ensure that its meaning is broad enough. See lines 61-62.

7) Reviewer comment: L39: “Fortunately, simple indices and thresholds are as effective as complex mechanistic models for many applications.” The “complex mechanistic models” are only mentioned in comparison with indexes but never fully defined, This term should be defined somewhere in the manuscript (e.g. in section 3).

Our response:

We added the last paragraph in “3.1. The physics of fine scale interactions between surfaces and wind”. See lines 448-457.

8) Reviewer comment: L40: “Nonetheless, the multitude of indices and thresholds available requires a careful selection process according to the target environment”. This “careful selection process” could be taken up and expanded upon with useful suggestions at the end of the manuscript e.g. after L1001.

Our response:

We followed the request of the reviewer and added the text in the suggested location. See lines 1169-1193.

9) Reviewer comment: L78: It would be important if the manuscript would include information about the applied methodology that lead to this manuscript, here is just one possible location in the text: From the acknowledgement, I assume that a group of experts formed in the project ClimXtreme. The selection of the papers and their categorization in this review is an outcome of many discussions or workshops within this group and of individual expert knowledge. If this is not the case: how where the studied papers selected? Where there any relevant decisions what overlapping/neighboring fields of literature to include or exclude (e.g. other types of indices, other environments)?

Our response:

We added the text as requested. Lines 109-117.

10) Reviewer comment: L623: shouldn't Koks and Haer (2020, already in References) also be mentioned here as an example of loss models

Our response:

We added the citation.

11) Reviewer comment: L940: National meteorological services do not only indicate the possible consequences, but take the consequences and the probabilities of these consequences as input into their warning decision (e.g. Neal et al. 2014) or they plan to do so in the future (Kaltenberger et al. 2020).

Our response:

Thank you for the advice. This is a helpful addition and we have added it to the manuscript. See lines 1086-1092.

12) Reviewer comment: L942ff: This paragraph could be structured and phrased more clearly. It would also be helpful to include the references for the thresholds of the different environments in the main text and not only in the supplementary material.

Our response:

We add line breaks and some of the references from the supplementary material. See lines 1094-1117.

13) Reviewer comment: L946: It is unclear how reaching a critical warning threshold in wind speed is related to the spatial extent. Mainly, it is unclear if the threshold is applied to each location (as it

normally is for warnings) or once per weather phenomena (e.g. for the maximum wind speed over the whole affected area of an event similar to a storm severity index). If it is applied to each location, can't a larger area (e.g. national area) have reached WL2? If it is about a localized damage having consequences for society on a larger spatial scale, then this needs to be said more clearly.

Our response:

The damage localization belongs to the consequences for society. Therefore we name the category National "Impact". We add the word "impact" to regional and local as well, to clear this up. See lines 1101-1117.

14) Reviewer comment: L961: The names of the different threshold ranges (e.g. local, regional, cut-in speed, cut- out speed) are only understandable using the supplementary material (S2). It would be better if these names would be explained in the caption or at least the previous paragraph of the main text.

Our response:

We add short explanation of the threshold ranges in the figure caption.

15) Reviewer comment: L1001: "Such a methodology needs to be developed on a large spatial scale to evaluate in which regions certain groups of indices are useful." It would be nice if this sentence would be expanded so its meaning is made clearer. Also what else is needed to allow such evaluations on a large spatial scale? Could the "careful selection process" mentioned in the abstract be expanded on here?

Our response:

We expanded and clarified this section as requested. Furthermore, the statement "careful selection process" is explained now here. See lines 1169-1193.

16) Reviewer comment: L1002ff: Data on "given metrics" are often scarcely available, if the "given metric" is related to a socio-economic impact. This should be mentioned.

Our response:

We changed the text as requested. See lines 1169-1193.

17) Reviewer comment: L1002ff: what about other possible solutions? E.g. the inclusion of user preference or expert knowledge in the development of indices using co-design (e.g. Gebhardt et al. 2019 cited in Merz et al. 2020)

Our response:

We thank the reviewer for the suggestion, and we incorporated it in the text. See lines 1174-1184.

18) Reviewer comment: L1016-1039: It would increase the usefulness of the manuscript if outlook and open research questions could be unified over the five environments. Would it be possible to combine these two paragraphs or to the split according to common questions? Surely, not only the forest setting is lacking damage data etc.

Our response:

We significantly extended the outlook section, devoting a sub-section for each of the sectors. See lines 1194-1279.

19) Reviewer comment: L1021-1030 and L1034-1038: In my understanding, better knowledge of the spatial variability of the environments (e.g. forests or urban) is important for two reasons: (1) it has an effect on the small-scale interactions of the wind field with the surface (2) it informs difference in vulnerability and spatial distribution (e.g. of the value) of the impacted entity (e.g. trees and buildings). These two reasons could be more clearly distinguished in this paragraph but also in the section 4.

Our response:

We added these key aspects in all sections of the outlook and especially for forest, urban and agriculture sectors.