

Interactive comment on “Estimation of the high-resolution variability of extreme wind speeds for a better management of wind damage risks to forest-based bioeconomy” by Ari K. Venäläinen et al.

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We would like to thank for the reviewer for the comments that help us to improve the manuscript.

The first comments is related to the Title “The title includes a bit more promises than actually addressed in the body of the manuscript – for risk management an assessment of potential future changes is necessary. Investigations about future scenarios are however not addressed in this study. Therefore I suggest to modify/correct the title for this missing part of the analysis.”

The Title is “Estimation of the high-resolution variability of extreme wind speeds for a better management of wind damage risks to forest-based bioeconomy”. If needed, we can shorten the title and make it more general e.g. “Estimation of the high spatial resolution variability of extreme wind speeds for forestry applications”

The next comment is related to Abstract. “The abstract is very extensive – At the end of the review the authors find a suggestion for a shortened version with focus on the very background and the most important findings.”

We thank for the good text and are happy to edit the Abstract.

Introduction The comment: “p1. l. 5: could you please add a few examples from the papers you cite which specific risks are impacting on the forests in Finland.”

The foreseen risks include increased wind throw risk due reduced soil frost period and depth. As well, drought may have negative impacts especially in southern Finland spruce forests. Related to drought, forest fire danger will increase. During winter season heavy snow loads will decrease in the southern but increase in the northern Finland. We will edit the text taking into account the comment.

Comment: “p2. l. 35ff: The authors should add one or two sentences on the drawbacks of reanalysis data sets when the network of stations used for assimilation changes in space and time affecting the temporal and spatial covariance patterns.”

Yes, we will add some text about the factors affecting the accuracy of re-analyzed data.

Comment: “p3. l. 1ff: In my opinion the authors could improve the intro by adding a short paragraph on their downscaling cascade from large to their localized scale. I guess that at least three levels of complexities are involved. An important issue in this context is that a consistent approach is desirable where the subsequent downscaling steps comprise over the at least as complex structure as the preceding. For instance, given the assimilated or GCM derived large-scale circulation shows too strong biases (e.g. blocking frequencies) also the following steps do not compensate this shortcom-

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ing but inherent the information from the boundaries. This should at least be kept in mind to consistently interpret results and according uncertainties. “

This again is a relevant comment and we will add the paragraph. There are many challenges when downscaling to this high resolution. The coarse resolution re-analyzed data contain inaccuracies. This is concrete especially if we are looking specific weather events. Fortunately the mean and as well, return levels are not as much dependent on imperfectly simulated cases as if we were making cases-studies of e.g. on some disastrous event. However, if the model contain systematic biases then the downscaling we have applied is not able to correct them. The importance of small scale spatial variation is demonstrated in our study; the coarse scale ERA Interim based spatial variation of e.g. 10-year return level of maximum wind speed for the area covering the whole Finland is less than the simulated high resolution spatial variation within the small test area.

Material and methods The next comment related to Material and methods chapter, 2.2 Estimation of return level for regional maximum wind speeds “p4 l. 1ff: I assume that also a seasonal component is into the variability of maximum wind speeds. The authors could add some information which processes drive maximum wind speed during different seasons (e.g. frontal based cyclonic maximum wind speed in cold fronts during winter half year vs. wind gusts originating from thunder storms that are operating during the summer seasons).”

Yes, we will add text about the reasons for the occurrence of high wind speeds.

Comment: “Another important information relates to the temporal basis. As much as I could infer authors use maximum monthly wind speeds. Using maximum daily wind data would provide a better statistical basis. However, in this case one also needs to account for the effect of serial correlated data. A third issue involved in the analysis of extremes relates to the procedure of averaging – Are the values used for comparisons based on 6(x)hourly means or are they related to certain reading hours,

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i.e. instantaneous measurements without any temporal averaging ? This could for instance explain already part of the differences between ERA40 and observations. Given the comparable short length of the observational basis with the high value of return period it might also be useful to calculate shorter term return period, i.e. two and five years.”

In case of the re-analyzed coarse resolution data we have used 6-hourly data and the parameter was instantaneous 10-minute wind speed. When calculating the return levels we have applied the GEV approach that fits the extreme value distribution based on the annual maximum values. The same approach was used also for station data but now the parameter was the 3-hourly (synoptic) instantaneous 10-minute wind speed. In this sense the observational values are not exactly the same as reanalyzed data and this may create some systematic difference. However, when we finally use the annual maximum values as the bases for fitting the distribution this may reduce the bias. We can add discussion about this into the text. It is true that the estimation of e.g. 50-year return levels based on 30-years of data leads to large uncertainty in estimates. The shorter return periods like two and five years could be estimated more accurately but from the point of forestry planning activities the longer return periods are interesting and that is why we have demonstrated the applicability of the method with 10-year return level.

Discussion and conclusion

Comment: “How do other climate change studies (e.g. Barring et al. 2017) addressing other climatic variables compare to changes that are potentially controlled by changes in extreme wind speeds?”

Barring et al. (2017) examined climate change impacts on temperature and precipitation related indices relevant from the point of the Scots pine transfer functions. Their study is an interesting example on how climate change may influence on forestry. The importance of climate change impact studies is emphasized by the long rotation period

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of 50-100 years from forest cultivation to final harvesting in Scandinavia. Barring et al. (2017) found clear signal in temperature related indices but minor in precipitation and future climate is in that sense more favorable for forest growth. Barring et al. (2017) did not study possible changes in wind climate that might influence on wind throw risks. There are other studies like Nikulin et al. (2011); Pryor et al, 2012; Outten&Esau, 2013) that indicate no clear signal in the occurrence of extreme winds in Scandinavia. We are happy to add discussion and references to Barring et al. (2017) and other relevant literature into the manuscript.

References. Outten S.D. and Esau, I., 2013. Extreme winds over Europe in the ENSEMBLES regional climate models. *Atmos. Chem. Phys.*, 13, 5163–5172, 2013, www.atmos-chem-phys.net/13/5163/2013/, doi:10.5194/acp-13-5163-2013.

Nikulin G, KjellstroÁlm E, Hansson U, Strandberg G, Ullerstig A., (2010) Evaluation and future projections of temperature, precipitation and wind extremes over Europe in an ensemble of regional climate simulations. *Tellus Ser A Dyn Meteorol Oceanogr.* doi:10.1111/j.1600-0870.2010.00466.x.

Pryor et al., 2012. Analyses of possible changes in intense and extreme wind speeds over northern Europe under climate change scenarios. *Climate Dynamics*, Vol. 38, No. 1-2, 2012, p. 189-208.

Figure and Tables: Comment: “In general, on the small scale geographic information is missing at borders. It would also be helpful to include an inset covering the large scale surroundings. In addition, each map should have its own frame with lat/lon coordinates.”

There is information about the land use in Appendix, Figure A2. There exist detailed photos available e.g. in the Finnish National Surveys web service (<https://asiointi.maanmittauslaitos.fi/karttapaikka/?lang=en>) or Google Maps, we could add links to these services, however, we are hesitant to add these photos e.g. due to the copyright restrictions. We will add new information and the co-ordinates; this will

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improve the reading of manuscript.

Comment: “Table 1: Please include the length of the individual meteorological recordings to better visualize the robustness in the estimation of the 10yr return period. If the length between the ERA40 and the meteorological station varies then only the common overlap period should be used. Another question is whether the direction of strongest wind direction is the same for both, the ERA40 data set and the meteorological observations, respectively.”

We will include information about the length of observational data timeseries and also about the reliability of measurements.

Comment: “Appendix Figure 1: For the comparison a similar basis should be used. Obviously the ERA40 data are based on maximum monthly wind speed whereas the boxplot is based on 10min readings. Again, it would be important to know the averaging procedure, especially for the Era40 interim data set.”

ERA data is 6-hourly data and we can add a box plot that is drawn using that data.

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