Response to comments by Reviewer #1 concerning our manuscript "Future Rime Ice Conditions for Energy Infrastructure over Fennoscandia Resolved with a High-Resolution Regional Climate Model" by Oskari Rockas et al.

We thank the reviewer for their positive and constructive comments, which have helped us to improve our manuscript. Below, we detail our responses to the received comments.

Major point

Please double check the absolute units/amount you get for ice masses. The values you show for instance in Figure 4a) and 4c), Table 2 and Figure A1 are very low compared to e.g. Iversen et al. 2023, considering that an ice load < 1kg would not be an issue I guess and that a max icing thickness of 70 mm is shown in Fig. 4d). Also, I think in Fig 4a) and 4c), the unit should be [kg/m] not [kg].

Reply: The units and amounts have been double-checked and, for example, in table A3 quite large maximum ice masses can be seen across all heights and models (more than 20 kg/m). The location there is partly in the Scandinavian mountains, which explains the large ice masses, but also illustrates that from HCLIM input, larger amounts can be produced. However, the major point you raised is also noted in the paper: "the absolute ice loads are smaller compared to the ensemble means in the study of Lutz et al. (2019) and thus may represent the lower end of the estimated ice distribution". We contribute this to uncertainty in liquid water content in HCLIM simulations, and LWC has been recognized as the largest source of uncertainty in icing frequency, for example by Lutz et al. (2019). In our response to Reviewer #2 (Aspect I), we have a wider answer to this point and how we plan to address it in the revised version of the article.

Abstract

l6: two twenty-year periods -> two *future* twenty-year periods

Reply: Very true, future should be highlighted in this case, and it will be fixed accordingly.

1. Introduction

l54: expense of small ensemble size. -> expense of *a* small ensemble size *and usually shorter time periods*.

Reply: Yes, these are good grammatical and substantive corrections, will be added to the text.

2.1 Rime ice model

l68: close to 1 for large particles (for which inertia dominates) and vice versa for small particles -> close to 1 for large particles (for which inertia dominates) and *close to 0 for small particles*.

Reply: Your suggestion is a clearer explanation so this will be fixed as suggested.

2.2 HARMONIE-Climate

l96: EC-EARTH shows a colder and drier response to climate change in northern Europe compared to GFDL-CM3. -> May be confusing or interpreted as EC-EARTH showing a cooling and drying. Maybe change to "EC-EARTH shows a more moderate warming and increasing humidity response to climate change in northern Europe than to GFDL-CM3."
l103: I would drop the "business as usual" remark for RCP85. It is a debated term, and it does not add any relevant information.
l104: A similar remark; whether "RCP 8.5 is considered to be increasingly unlikely" is also disputed, I'd say. I don't think there is a common agreement on this. Especially taking recent global developments into account. -> "Although RCP 8.5 may be considered to be increasingly unlikely ..."
l105: "it remains to be an useful tool for" -> "it remains *a useful tool* for"

Reply: For l96, true, this wording can be a bit confusing. It will be changed to something akin what you suggested. For l103, true, it doesn't add important information so it will be removed. For l104, that is a good correction so this will be changed according to your correction and the grammatical error in l105 will be fixed.

2.3 Processing of the ice model outputs

l109: 1) results calculated for 50 meters -> 1) results calculated for 50 meters *above ground*
l117: calculated from all heights -> calculated *for* all heights
l118: a maximum of all grid points -> *the maximum of all grid points*

Reply: For l109, yes, this correction makes sense and will be added to the final text. The grammatical corrections in l117 and l118 will be fixed as suggested.

3.1.1 Fennoscandia (50 m) -> Fennoscandia (50 m *height*)

l148: the GFDL-CM3 boundary model -> the GFDL-CM3 boundary *data*

Reply: This will be corrected as suggested as well as the header of the section.

3.1.2 Test areas 6–7: Power line perspective (50m)

l176-180: "In box plots ..." -> You may consider dropping the description of the figure (e.g. "solid lines" etc.) in the text and leave it to the caption of the figure.
l187: both model configurations show increase -> both model configurations show *an* increase
l192: "Yellow represents the historical period, red the mid-century, and black the end-of-century." -> Again, consider dropping the description of the figure in the text and leave it to the caption of the figure.

Reply: For l176-180: Yes, we agree that the description of the image can be taken out of the main text and so it will be corrected as suggested. The grammatical error in l187 will be fixed

as suggested. For l192: The same applies here as in the previous comment about image descriptions in the text, it will be corrected as suggested.

3.1.3 Test areas 1-5: Wind power perspective (50-400m)

l209: The mean value is highlighted with a diamond symbol. -> Again, consider dropping the description of the figure in the text and leave it to the caption of the figure.

Reply: Yes, the description will be removed from the main text.

3.2.1 Temperature

l249: In Fig. A3 -> In case you have not reached a figure limit, move this to the main text. It seems relevant information for the main text to me.

Reply: The figure can be moved to the main text, we have not reached a figure limit.

3.2.2 Liquid water content

l265: "LWC only included the cloud liquid water content (CLWC) because cloud rain water content (CRWC) was not available in the pre-calculated HCLIM data. Thus, the modeled atmospheric ice type is primarily rime ice." -> I don't entirely understand what you refer to with cloud rain water content (CRWC) and how it relates to total LWC. Please explain in more details (maybe refering to relevant literature) and maybe move this part to section 2.

We agree that this notion was not opened enough in the preprint version of the article and will be reworked and clarified in the revised version. A better explanation, and which can be taken to section 2 as suggested, is that liquid water content in an atmospheric layer can be divided into cloud liquid water content (CLWC) and rain liquid water content (RLWC), so into nonprecipitating cloud droplets and rain droplets (Tian et al. 2019, Ellis and Vivekanandan 2011). HCLIM model bases its cloud microphysics in an ICE3-OCND2-scheme which separates between cloud water and rain (Lind et al. 2020, Bengtsson et al. 2017), however, the simulations we used as input data in our research only included the cloud liquid water content (CLWC) and not the rain liquid water content (RLWC).

3.2.3 Wind speed

l275: where the possible ice forms. -> "where ice may form." or "where it may turn into ice."

These are better suggestions, it will most probably be changed to “where ice may form” as suggested.

4 Conclusions

l333: "is a business-as-usual scenario" -> (maybe) consider changing it to a more neutral term, e.g. "is a high emission scenario"

Reply: Yes, as already discussed, the “business-as-usual” can be avoided, and, in this case, be changed into “is a high emission scenario” as suggested.

Table 1: the domains to which -> the domains *for* which

Reply: This will be corrected as suggested.

Table 2 and A1- A4: Please add the units of IM, IE and IH to the table. Either in the table or the caption.

Reply: The units will be added.

Bengtsson, L., Andrae, U., Aspelien, T., Batrak, Y., Calvo, J., de Rooy, W., Gleeson, E., Hansen-Sass, B., Homleid, M., Hortal, M., et al.: The HARMONIE-AROME model configuration in the ALADIN-HIRLAM NWP system, Monthly Weather Review, 145, 1919-1935, 2017.

Ellis, Scott M., and Jothiram Vivekanandan. "Liquid water content estimates using simultaneous S and K a band radar measurements." *Radio Science* 46.02 (2011): 1-15.

Lind, P., Belušic, D., Christensen, O. B., Dobler, A., Kjellstrom, E., Landgren, O., Lindstedt, D., Matte, D., Pedersen, R. A., Toivonen,E., and Wang, F.: Benefits and added value of convection-permitting climate modeling over Fenno-Scandinavia, Climate Dynamics, 55,1893-1912, https://doi.org/10.1007/s00382-020-05359-3, 2020.

Lutz, J., Dobler, A., Nygaard, B. E., Mc Innes, H., and Haugen, J. E.: Future projections of icing on power lines over Norway, in: Proceedings of the International Workshop on Atmospheric Icing of Structures IWAIS, 2019.

Tian, Jingjing, et al. "Estimation of liquid water path below the melting layer in stratiform precipitation systems using radar measurements during MC3E." *Atmospheric Measurement Techniques* 12.7 (2019): 3743-3759.