Review: "A modelled multi-decadal hailday time series for Switzerland" by Lena Wilhelm, Cornelia Schwierz, Katharina Schröer, Mateusz Taszarek, and Olivia Martius

This is potentially a useful manuscript that could contribute to understanding the long-term trends in hail occurrence in Switzerland. The method laid out in this manuscript provides others with a way to perform a similar analysis for their own countries or regions.

There are a number of major issues that need addressing, along with a large number of other concerns. My other concerns are aimed at strengthening the text, employing consistency throughout the manuscript, ensuring that the authors fully explain themselves clearly and precisely to the readers, and adhering to common stylistic approaches in meteorological publications.

I support the eventual publication of this work, but not until these comments are addressed.

MAJOR COMMENTS:

1. Some of the indices used in this manuscript are quite outdated and have not been used in state-of-the-art meteorological research since the 1970s (e.g., LI, TT, BI, K index). [This list is just a partial list of the ones that are outdated.] These indices are combinations of other variables that are likely in the analysis anyway. (If not, they could easily be replaced with dewpoint at 850 hPa or air temperature at 700 hPa.) This manuscript cannot claim to be using modern methods with such outdated meteorological quantities. I recommend that the authors remove such outdated indices and perform the analysis again. Doing so will improve your paper and give you credibility. This is a potentially state-of-the-art paper, but other meteorologists who read this manuscript will struggle to accept it with such outdated metrics in it.

Doswell and Schultz (2006) have more on the history and inappropriateness of these indices.

Doswell, C. A. III, and D. M. Schultz, 2006: On the use of indices and parameters in forecasting severe storms. *Electronic J. Severe Storms Meteor.,* **1**(3), 1–22, https://ejssm.com/ojs/index.php/site/article/view/4.

2. The authors conflate the various indices, not properly understanding their original intent. For example, at lines 48–49, why "hailstorm"? These ingredients apply to any organized deep moist convective storm (Doswell et al. 1996). The ingredients for hail to be produced from organized deep convective storms are in addition to these. Please clarify. See also line 54.

Doswell, C. A., III, H. E. Brooks, and R. A. Maddox, 1996: Flash flood forecasting: An ingredients-based methodology. Wea. Forecasting, 11, 560– 581.

Furthermore, many of the indices used are not relevant to hail production in storms. Why include them if not relevant?

3. Line 290–291: OMEGA_vint is the vertical velocity on the scale of the ERA-5 (e.g., 25-km grid spacing). So, it cannot represent the vertical motion on the scale of the convective storms (Doswell and Bosart 2001). And, it is certainly not representing the ejection of hail embryos, as is implied in the manuscript.

Doswell, C.A., Bosart, L.F. (2001). Extratropical Synoptic-Scale Processes and Severe Convection. In: Doswell, C.A. (eds) Severe Convective Storms. Meteorological Monographs. American Meteorological Society, Boston, MA. https://doi.org/10.1007/978-1-935704-06-5_2

4. I have concerns about how the authors are using the various variables. I don't get a sense that there is an attempt to understand the physical justification for them or even appropriateness of them, as the previous comments have indicated. Instead, the paper is excessively couched in terms of statistics. It appears to be one of the reasons that these outdated convective indices are used in this paper.

As an example of this, I have the following comment regarding text at lines 562–564. If I understand the authors' argument here correctly, they are happy using outdated indices and not understanding why they work, as long as they get a time series they can work with. Do I understand that correctly?

5. There appears to be inconsistency in the messaging about how to interpret the trends. For example, line 618: If "it is not feasible to directly extrapolate our modelled trends into reality", then of what value is this study?

How is this statement consistent with your stated goal of building "a new multidecadal daily hail time series" (line 635)?

Or with, "With this time series we wanted to analyse long-term trends and changes in frequency, seasonality and the variability of model-derived Swiss hailstorms in the past decades." (Lines 640–642)?

Or with, "The final ensemble model reproduces the interannual variability and seasonality of the hail proxies well. The reconstructed time series shows a strong significant positive trend in the number of yearly haildays in both regions from 1959-2022. The trend is also significant and positive when looking at the period of 1979-2022." (Lines 643–645)?

How does the reader interpret the different messages from these different sentences?

6. The paper is in severe need of proofreading, as indicated by the large number of minor comments, grammatical errors, and inconsistencies noted throughout the manuscript. A note to the authors: Many of these issues could have been fixed with more care spent proofreading the manuscript, which I encourage the authors to do for this and subsequent submissions to journals. Peer reviewers should not have to identify these large numbers of issues to improve submissions. Authors should take their own responsibility for the quality and professionalism of their submissions.

OTHER COMMENTS:

1. Title: The authors may want to be more specific about what kind of "model" is used and what "multidecadal" means (i.e., what years were used).

2. Throughout the manuscript: Hyphenate "hail-day" when modifying another word (e.g., "hail-day time series", but "the number of hail days").

3. Line 7 and throughout: Use an en dash to separate two years, not a hyphen and spaces. See also lines 78, 149, 199, and 200, for example. Fix throughout. (Note that you do it correctly at line 79.)

4. Line 9: GAM is not defined.

5. Lines 13 and 15: Delete "we can see" and reword the sentence. Same with "we can now study".

6. Line 14: "however" cannot be used as a conjunction. See also line 87.

https://www.iup.edu/writingcenter/writing-resources/grammar/common-problems-with-however-therefore-and-similar-words.html

7. Line 21: "one of the most complicated meteorological phenomena": I'm not sure that this is appropriate. Please reword.

8. Lines 31–32: This sentence is a tautology: "With hail hotspots in Switzerland, the Alps are affect by hailstorms in Switzerland."

9. Line 47: Why "mesoscale"?

10. Line 51: I am uncomfortable with the word "driving" here. Synoptic and mesoscale conditions often set the stage for convective storms that may or may not produce hail. So, "associated" would be a more neutral and accurate word to use in this sentence.

11. Line 55: Why is "(or north)" in parentheses? Either delete the parentheses or delete the parenthetical. See also lines 61 and 249. Fix elsewhere in the manuscript.

12. Line 57: Air masses are transported, not advected. Quantities such as temperature can be advected. Write precisely.

13. Lines 68–71: Except for CAPE, these indices are outdated.

14. Lines 78–79. This sentence is poorly written and unclear. Delete the comma after "found".

15. Line 85: "Poisson" should be capitalized.

16. Line 106: Why is EchoTop capitalized? The "Z" in dBZ should be capitalized and italicized, as per convention.

17. Lines 108, 122, and 123: Change "resolution" to "grid spacing" because these two terms are not equivalent.

18. Line 114: I don't understand the phrase "area up to 140 km". Units are not consistent. Why up? Reword to be more clear.

19. Lines 114, 125, 179, and 202: Delete "see". It is unnecessary as the citation to the figure number is sufficient. Fix throughout.

20. Line 136 and throughout: Are colons used in UTC time? Generally not that I've seen. Delete the colons throughout.

21. Line 150: I don't know what "sereal" means. If you mean "serial", I still don't know what that means in the context of this sentence. Please reword.

22. Line 154: Delete "It is important to note that", which is unnecessary. The sentence is stronger without this phrase.

23. Line 161: There should be a brief introductory paragraph after section 3, but before section 3.1, describing what will be discussed in section 3. Give the reader some context for what follows. The same thing is true for section 4.

24. Line 173: I would argue that "mesoscale" should be replaced with "microscale".

25. Line 176: Is that 27.0 hail days? It should be consistent with the number of decimal places in the other number.

26. Line 182: No need for "as shown in". Just put the citation in parentheses at the end of the sentence.

27. Figure 1: There are stray characters "1e6" in the lower-right corner and top left. I don't understand why it is there. Make its purpose more clear or delete.

28. Line 216: Extra space between "hail days" and the period. Delete.

29. Line 245: Avoid sentences that start with "this <verb>". The reader often does not know what "this" refers to. Please rewrite to be more specific.

30. Line 248: Italicize p, as well as other variables throughout the manuscript.

31. Line 249: What is "insignificant". It is unclear. Avoid misplaced modifying phrases.

https://opentextbc.ca/advancedenglish/chapter/misplaced-and-dangling-modifiers/

32. Line 261: Similar problem with "this indicates".

33. Line 294: What is "3"?

34. Lines 294, 316: What does "this" refer to?

35. Line 296: Delete "already".

36. Line 297: Avoid one-sentence paragraphs.

https://warwick.ac.uk/fac/soc/al/globalpad-rip/openhouse/academicenglishskills/writing/paragraphing/

37. Line 311: Why is "recursive" capitalized?

38. Line 311: "e.g." is Latin for "for example". As such, there is no need for "etc.", too.

39. Line 313: Delete the two "see"s.

40. Lines 314, 330, and 359: "However" is used as a conjunction. Revise.

41. Table 1 caption: Avoid the construction with parentheses.

https://eos.org/opinions/parentheses-are-are-not-for-references-and-clarification-saving-space

42. Table 1: Italicize variables, such as z and v. Fix throughout.

43. Table 2 caption: Why are bias, precision, and accuracy capitalized?

44. Lines 328, 331, and 344: There is no need for the apostrophe in GAMs, as it is not possessive. Find all occurrences in the manuscript and fix.

45. Line 338: Be more specific. Most unstable CAPE determined over what depth?

46. Line 340: d2m is not a sensible abbreviation for dewpoint temperature. I suggest $T_{d,2m}$, which would also be consistent with w_{500}. Moreover, the authors use the typical Td in Table A2. Be consistent internally within your manuscript and with common notation in the meteorological literature.

47. Line 347: Why is "highly" in parentheses? Either delete the word or delete the parentheses.

48. Lines 347 and 571: Do you mean "variance" instead of "deviance"? Fix throughout the manuscript, if so.

49. Lines 349–350: Why is GAM being redefined again?

50. Figure 3 and 4 need individual panel letters, and these figure numbers and letters need to be referred to in the text for the ease of the understanding of the reader.

51. Line 352: Italicize the y.

52. Line 353: Change "trough" to "through".

53. Line 354: There are long sections of text without paragraph breaks. This paragraph is just one example that needs fixed. But, this problem exists elsewhere, too.

54. Line 361: What curve is being referred to? There are no figure and panel-letter citations in the sentences as far as I can see. Each reference to an interpretation of a figure needs to be cited so that the reader knows what they are looking at (e.g., Fig. 2a).

55. Line 370: Change "layer" to "level".

56. Line 371: This text repeats earlier text. It also indicates a profound lack of understanding of what scales vertical motion acts, as discussed previously.

57. At this point, I am frustrated by the lack of proofreading, so I will not repeat comments that I have made before beyond line 372. The previous comments should be applied throughout the manuscript during extensive proofreading.

58. Lines 388–389: What are the citations for this information?

59. Line 392: Delete "We also need to mention that", and revise the sentence.

60. Section 4.2: I am finding the manuscript tedious, particularly in this section. Is there anything the authors can do to improve the readability of this manuscript? Options could include shortening the text, putting more content into appendices or supplemental files, and improving interpretation of the results.

61. Lines 461–462: Are two decimal places needed?

62. Line 466: Why is "e" raised to a power rather than "10"?

63. Line 472: No period at the end of this sentence.

64. Line 473: Insert "the" after "Using".

65. Figure 10 caption: "Modelled" needs to be capitalized. "linse" is misspelled.

66. Figures 10, 11, and 12: Why the unusual color bar? There is an abrupt color transition between red and blue in the middle of the bar. Why? The color scheme should have a smooth transition. Moreover, one could ask why a color scheme is needed in the first place? Is the value of the point not sufficient to indicate its value? Why does the dot need a color associated with it?

67. Line 487: Delete "it is important to mention that". It is unnecessary.

68. Lines 525–549 is one long paragraph. It needs to be broken up. In fact, given the number of times that I have flagged paragraphs as being too short or too long, the authors should revisit the rules of writing paragraphs.

https://warwick.ac.uk/fac/soc/al/globalpad-rip/openhouse/academicenglishskills/writing/paragraphing/

I also suggest reading Gopen and Swan (1990) "The Science of Scientific Writing" (https://www.americanscientist.org/blog/the-long-view/the-science-of-scientific-writing) to gain further insight into better structuring your writing, particularly the use of topic and stress positions in sentences and paragraphs. Please indicate in your response that you have read this article and have implemented its guidance in the revised manuscript.

69. Line 531: I don't understand "shear replacement". Please explain.

70. Line 538: Markowski and Richardson (2010) is a book. As they are not presenting original results, it would be inappropriate to write that they "showed" something.

71. Moreover, when citing a book, you should also cite the specific page number to which you are referring to. Otherwise, the reader will not be able to source your information from the entire book easily.

72. Line 539: When you say "significant fraction", please say what the specific number is.

73. Lines 534–543: This text is poorly organized. It is not a systematic description of the literature that advances your argument.

74. Line 544: What is "Alpine pumping"? Provide a citation and explain the result to nonspecialists. Or, delete.

75. Line 545: What is "orographic enhancement" (note correct term), and how does it create higher shear? Provide a citation and explain this mechanism to nonspecialists.

76. Line 562: This is the first occurrence of "5D". It is not defined, and the authors use it twice on this page. Define and use throughout, or delete.

77. Line 564: Can you please provide an argument for this assumption that "models learn how to best deal with limitations of the datasets"?

78. Lines 564–568: This text seems like just a list of random thoughts put here, without context, without evidence and without organization.

79. Line 575: Why is the BI only defined here, even though it has been used throughout the manuscript? Define upon first usage.

80. Line 590: Why is b before a? Put citations in alphabetical order.

81. Lines 610–611: Why not provide what the increase is? Can you normalize all the different studies to a percentage increase by year, as they all use different time periods?

82. Lines 618–619: Why is a more extensive period of observational data required? You are already using a decadal-length time series of data from different datasets.

83. Line 661–662: The author should make this code freely available via a public repository.

84. Line 669: AIC, BIC, and VIF are not defined here.

85. Line numbers are missing after line 665.

86. After equations for AIC and VIF: The comma should be on the same line as the equation.

87. Table A1 caption: Are TP, FP, FN, and TN needed? If not delete. If so, why not express the equations under "Explanation" in terms of these variables?

88. Table A2: Why is deg01 used as an abbreviation for the height of the zero-degree isotherm? Why not use a more understandable expression, consistent with others? For example, $z_{\{0°C\}}$?

89. I am also similarly concerned about a number of other abbreviations that are not standard: FF, lfc (this and many others should be capitalized), mn2t, msl_mean, OMEGA (why all capitals?), etc. These inconsistencies should be made consistent, and standard abbreviations/variables used. Fix throughout the manuscript.

90. If Taszarek is a coauthor, then he should not be listed in the acknowledgements as providing data, but in the Author Contributions in terms of data curation.

91. Also, Taszarek's data should be made available through the Code and data availability section.

https://www.natural-hazards-and-earth-system-sciences.net/policies/data_policy.html