Response to Reviewer #1

The paper by Imfeld et al. presents several spring climatic and phenological indices for Switzerland with the aim to analyse their long-term changes since 1763 CE with particular attention to some selected warm, late frosts and cold springs. The paper has a potential to be published but the authors should consider my critical comments below.

We appreciate your careful review and detailed feedback. We hope that you find the following response satisfactory.

Major Comments

1) I understand that the paper concentrates on Switzerland, but I miss any broader Central European context, particularly in discussion of your results.

We will extend the discussion to a broader Central European context by adding a paragraph in the Discussion Section.

2) You are citing a lot of different places in Switzerland – it would be very useful for readers who are not so familiar with Swiss geography to see any map showing location of cited places or cantons.

We will add a new Figure 3 to get a better overview of where in Switzerland the described impacts happened. Also, the Figure will show the outlines of the Swiss plateau regions, for which the time series are shown in the current Figure 2.

3) Please consider to add some tables giving at least some characteristics (numbers) for the 30-years periods analysed which would be helpful to better follow your detail descriptions in Chapters 4.1 and 4.2.

We will add a table in the Appendix giving numbers about the 30-year periods analysed for the different indices.

4) Please check very carefully references – there is a lot of different errors in typos or in missing information needed for full citations.

We will correct the reference list carefully.

5) Please consider the information value of Figures 1 and B1 in which you have too many very small maps.

We will turn Figure 1 and B1 having the eight periods on the y axis and split the Figure according to temperature and precipitation-related indices. Thus, the maps can be increased in their size and will be better visible.

Minor Comments

Line 5: Please delete "for example" here.

We will delete it.

Line 18: What is it Bise? It is not explained here or in any other parts of the manuscript, where this term is used.

The Bise is a wind system occurring mainly in the Swiss plateau region between the Alps and the Jura mountains, and in some regions of eastern France. It is typically driven by a high-pressure system north or northwest of the Alps leading to cold northerly to easterly winds over the Swiss plateau. We will add a short explanation of this wind phenomenon in the manuscript based on Wanner and Furger (1990).

Line 20: . . . can destroy future harvest . . .

We will correct this.

Line 20: How spring snowfall may put trees in risk?

Due to higher temperatures, spring snow can be heavier and trees may have already developed leaves, making it easier for snow to accumulate on trees. This can increase the risk of a tree breaking a branch, for example.

Line 27: In connection with late spring frost it would be useful to involve also term "false spring".

Thank you for this suggestion. Since we do not further discuss "false springs", we prefer to mention only the term late spring frosts.

Line 28: Please add any other citations of other papers, e.g., 10.1007/s00704-023-04671-2.

Thank you. We will add more citations here.

Lines 29-30: Strange order of citations. Please check and present it correctly everywhere in the manuscript, where you have more than one citation (e.g., line 315).

We will correct the order of citations.

Line 35: "dataset" – please use it uniformly as dataset (you have it also as "data set" – e.g. lines 36, 53)

We will correct this throughout the manuscript.

Line 37: longer-term climate? Should be not long-term spring climate?

We will correct this.

Line 58: Not clear what you mean by "wet days" here – you define them later.

We will add the definition of wet days at an earlier stage in the manuscript.

Line 59: Which independent observations?

This sentence refers to an evaluation made in the article describing the data set (Imfeld et al., 2023). An evaluation with independent observations of precipitation occurrence showed that only up to 24% of the days were wrongly assigned to wet or dry days. Considering the daily time scale and the low availability of precipitation data, this is a good result. We will reformulate the sentence as follows to make it more clear that this refers to the article describing the data set:

"However, the number of monthly wet days compares well with independent observations, as shown by Imfeld et al. (2023), who compared the gridded reconstruction with an independent series from Bern."

Table 1: You define snowfall days by daily mean temperature and by precipitation total, not looking on kind of precipitation? How you can be sure, that it was really snow?

The two thresholds are based on the sensitivity analysis from Zubler et al. (2014) based on the 2km grid of Switzerland and they showed a good agreement between station data and grid cell snowfall days. We will recalculate the fresh snow day on our 1 km grid to evaluate the simple snow day estimate also for the higher resolved grid to determine how well this approach works. Further, we will add a sentence to stress that we look at potential fresh snow days based on these thresholds, and not at actual fresh snow days.

Table 1: Frost index – after which phenological phase?

We will add that we consider only the cherry full flowering.

Lines 90-91: Is correct the term "climatological period" – it should be rather as "30-years period used as standard in climatology" or anything similar.

We think it is adequate to talk about a climatological period in this context.

Line 92: I have serious doubts to speak about 1871–1900 as "pre-industrial" period. What be not better only "reference period"?

Thank you for your comment. The Swiss national weather service defined this period as their official pre-industrial reference period, also taking into account data availability and comparability to other periods and countries (Begert et al., 2019). They provide an evaluation of different reference periods and discuss the choice of 1871 to 1900, in the context of longer periods. We will state that this period is used by the Swiss national weather service as the pre-industrial reference period, but will subsequently remove the term "pre-industrial" from the manuscript.

Line 106: Not clear what you mean under "quality class of at least 3".

These are quality classes that have been assigned to the individual series by the study of Auchmann et al. (2018). We will add the following sentence to give a short explanation, but refer for details to the report by Auchmann et al. (2018).

"These quality classes were defined based on the length of records, the completeness (missing values and number of gaps longer than 5 years), reliability (number of quality flagged values), and number of inhomogeneities in the record. For further details on the quality classes see Auchmann et al. (2018)."

Line 108: Where or were?

We will correct this to "were".

Line 115: Please use 18,000.

We will correct this.

Figure 2: It would be useful to complement fluctuations in your characteristics by linear trends with their statistical significance.

Instead of a linear trend we will add a smoothing using a Gaussian filter to depict the decadal variability. Due to the discussed inhomogeneities in the reconstructed data set (Imfeld et al., 2023) we advise calculating linear trends only on the long observational series available e.g. Bern and Zurich (Brugnara et al., 2022).

Line 197: 10.1 °C instead of 10.09 °C.

We will correct this.

Line 215: Fig. 4d is not there, only 4a and 4b.

We will correct this in the text.

Line 247: Please use Table instead of Tab.

We will change Tab. to Table.

Line 250: Please consider replacing "from March to May" by "spring", i.e. here: "Their mean spring temperature in the Swiss plateau reached ..."

We will correct this occurrence, and also change "March to May" to "spring" in other occurrences where it is more appropriate.

Figure 9 – caption: 500 hPa geopotential ...

We will correct the caption.

Line 310: positive 500 hPa geopotential

We will correct this sentence.

Lines 371–372: Better formulation of the last sentence?

We will reformulate this sentence.

Appendix A: Variables Rg and n are not explained here.

We will add an explanation of these two variables and move the Appendix section to the main manuscript (phenological application) to expand the description of the phenological models as suggested by another reviewer.

Figure A1 – caption: c) and d) are the same as a) and b)

We will correct this caption.

Table 2: Ct. should be explained above.

We will add an explanation of Ct. (Canton) in the Table caption.

Figure C1 – caption: "absolute values (contours)" – I do not see any values there, only isolines.

The isolines represent the absolute values of the geopotential height field at 500 hPa. Indeed, the values of the isolines are not visible. We adjusted this in the revised figure (see below).

Line 425: The paper was not yet published, that you are citing Climate of the Past Discussion?

We will correct this reference.

Line 465: In review?

This is the data set corresponding to the herein presented manuscript. It is possible to evaluate it as well and it will be published alongside the manuscript. Currently, the DOI is not available. We will remove the "in review" and provide the correct DOI as soon as it is available.
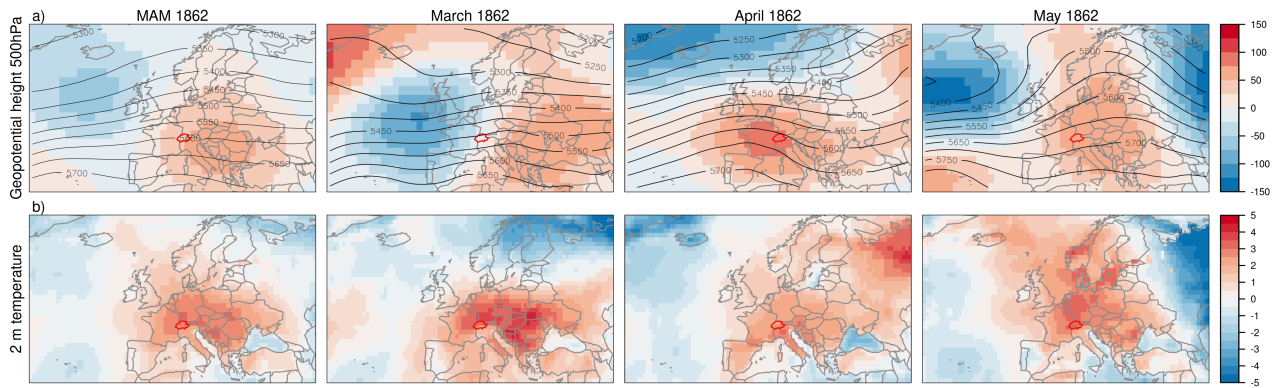
Figure 1: a) Geopotential height (m) anomalies (shading) and absolute values (contour) at the 500hPa level. b) 2 m temperature anomalies. Anomalies are calculated with respect to 1871 to 1900. The borders of Switzerland are marked in darkred. Data is from ModE-RA (Valler et al., in review).

References

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