General Remarks for *Stucki and Pfister et al.*

In this study, the authors test the ability of the WRF model to simulate a cold spell over the European Alps during the Year Without Summer (1816). For this purpose, the authors employ two different configurations of the model: a simulation including 3DVAR data assimilation and another one without. Results show that even if the simulation including data assimilation consumes more computational resources and needs a more careful set-up (the available stations must be carefully selected first), it improves the results compared to the simple WRF simulation. Both simulations can simulate the observed general weather conditions, but only the one including data assimilation is closer to observations in terms of temperature and pressure. Thus, the authors highlight the improvements obtained due to the data assimilation only, and the novel opportunities provided by the digitalization of early records to study previous weather events.

The manuscript follows a logical structure, and it fits into the scope of Climate of the Past. However, some major comments need to be addressed by the authors before the manuscript is ready for publication.

Major comments:

Introduction.
I think that a sentence about the possibility of learning from past extreme events should be added to the paragraph about the objectives of the study. It was briefly mentioned in the abstract, but I think that it should be added reaffirmed here.

Section 2.1 Observations:
This section is difficult to follow, and it should be straightforward for the reader. Thus, I suggest clarifying some points from it:

(1) Are the three stations assimilated in 20CR included in WRFDA again? In Table 1, Geneva, Turin and Hohenpeissenberg are listed, but it is unclear if those are the same as those from 20CR.
(2) In line 131 is stated that "Eight out of the 70 records (at 40 locations) cover the region of interest", but this information is not included in the tables. I think Tables 1 and 2 should provide specific details about the assimilated observations in WRFDA (total number of records, dates, etc). In the current state, the tables provide general information about the records (digitized period, source, etc.), but not the specific details that could facilitate understanding the DA assimilation in the model.
(3) Some information about Table 1 is missing: what are the implications of "irregular readings" in the Remarks column? Why some hours of the Readings column are between brackets (e.g., Zurich and Zurich*)?

Section 2.3 Regional circulation model:
Some comments about this section:

(1) I think that the authors should include a figure in which the set-up of the three nested domains is included. I thought that the set-up was that from Figure 2, but then I realized that Figure 2a is a plot from 20CR reanalysis, so I was wondering if

that is still the original parent domain of the WRF simulations. I think that it would be easier if the authors could include a new figure with the three-domain set-up (even in the supplementary).

(2) The spin-up of the simulation is approximately 24 hours. Have the authors checked if that is enough to let the model reach the equilibrium (particularly for the land/soil)?

Section 2.4 Data Assimilation System:

Some critical information about the DA is missing in this section:

(1) Were the observations assimilated in all three domains, or only in the bigger domain (D1)?

(2) What method was followed to create the background error covariance matrix?

Section 3.1 The meteorological situation in June 1816:

Lines 287-296: This paragraph explains the atmospheric conditions that led to the cold-air outbreak over the Alps in June 1816. However, all the plots from 20CR data that could facilitate the understanding of the event are missing in the manuscript. I think the authors should include a summary of the atmospheric dynamics that triggered the event using the 20CR data, including different panels for different time steps and linking each of them to different lines of the paragraph. This would allow the readers to have in mind an idea of the development of the cold outbreak, and what should they expect from WRF.

Section 3.2 The cold period 5-11 June 1816 in the WRF NODA and DA simulations:

Line 320: This is linked to a precious comment for section 2.3 (1). Why domain 1 of WRF is not shown in Figure 2? Wouldn't it be better to include it along the plot for the 20CR input data, so that the reader can see already the improvements in spatial resolution made by WRF (from ~75km to 27 km)?

Section 3.3 Verification of NODA simulations with systematic observations:

(1) Lines 378-379: I think that a link to section 2.4 (where the correction methods are explained) should be included here.

(2) Figure 5: I think that a lot of information is included in the same figure, and due to its current resolution, not everything is visible even if you zoom in on the different panels. Thus, I would suggest the authors split it into two figures (Two variables for each station in one figure and the other two variables in another for example to match the structure of the text). Additionally, some labels are not visible (e.g., only one value is visible in the Y-axis of wind and precipitation) or omitted (e.g., labels for relative humidity). Also, it is difficult to differentiate the SW values (orange lines) and the clouds (grey lines) for both WRF simulations.

(3) Figure 6: There is a mismatch between the labels in the plots and the labels in the captions. At the end of the caption, labels e, f, g and h are mentioned, but in the figure, only a-d are marked. Additionally, I think that some corrected values for the assimilated station for Zurich (in black) are not plotted in the Figure (from 06-05 to 06-07).

Minor comments:

- References should be listed in chronological order throughout the introduction and the rest of the manuscript (e.g., lines 37-38, 40-41, etc)
- Lines 84-86: the sentence is long and tricky to understand. I would suggest reducing it or splitting it into two different sentences.
- Figure S1: I would add a white background for the legend included in the figure, as it is difficult to read the way it is now. Also, would it not be better to use red and blue dots directly instead of red dots and blue circles over the dots? In the end, all dots are assimilated at some point, right?
- Line 126-127: I think the sentence should be separated into two sentences.
- Line 186: A full stop after the references is missing.
- Line 373: “independent of the simulation”. Could it be that it should be independent of the assimilation?
- Line 423: “in the simulation..” Remove one of the full stops.
- Line 480: (Fig. 7A-b). A shouldn’t be capitalised.
- Line 488: “and Turin”. However, in Fig.7, it is called Torino (also in Fig. S2). Please, agree on a way of calling the stations and keep it throughout the entire paper.
- Line 515: 3D-VAR assimilation.
- Line 529: Be more accurate and specific instead of “old land use scheme”
- Line 534: Be more specific about the comparison of modelled precipitation against observations.