- **RC1**: 'Comment on nhess-2022-276', Anonymous Referee #1, 16 Feb 2023

The paper nhess-2022-276 “Linking torrential events in the Northern French Alps to regional and local atmospheric conditions” shows several weakness points and in my opinion should be rejected.

=> We thank the Reviewer for his/her comprehensive review. From our perspective, most of the comments made can be easily addressed. They mostly result from misunderstandings due to a lack of explanations of the main objectives of this study.

First of all, the title is not appealing: torrential events are “naturally” linked to climatic conditions.

=> We thank you for this comment. We agree there has to be some “natural” link. However it is not obvious what this link is. In particular, it is still largely unknown which atmospheric variables are at the origin of torrential events. This is precisely the goal of this study (see the first sentence of the abstract). To make it clearer, we propose to precise the title as « Linking torrential events in the Northern French Alps to regional and local **driving** atmospheric conditions »

By reading the abstract I guess that the paper is strictly related to the study area. No general conclusions are present, nothing that could be useful in places other than the study area, and this is not in line with the requirements of an international journal. Here, the aim of the paper is not well focused. Even the quotation of climate change seems not strictly related to the analysis performed in the paper.

=> This is indeed a regional analysis. For this reason, the results are not directly generalizable : without further investigation on other regions, we cannot affirm that the discriminant variables found for the study region are also the most discriminating elsewhere in the Alps or anywhere else. We anticipate it depends on the climate, the atmospheric influences, the geographical features … However the methodology used here is generic and could be used anywhere. This is for sure something we should emphasize more. In particular, the abstract could finish with « Although the results are likely to be region-dependent, the methodology used in this article is generic and could be used elsewhere to find the most discriminating atmospheric variables – provided a list of flooding dates is available ».

The only quotation to « climate change » aims at saying that the difference in 20CR results before and after 1950 is probably related to data issues. We wanted to make clear that it is not possible to conclude from these differences that the atmospheric conditions at the origin of torrential events have changed due to climate change. To make it clearer, the sentence « this is likely more linked to 20CRv2c limitations over the remote past than a consequence of climate change » could be changed to « this is likely linked to 20CRv2c issues over the remote past ».

In the introduction the problem analyzed seems the forecast of torrential events, but at the end of the introduction it seems that the authors work in a simple descriptive way, without

finalize the work to something like a classification of severity levels of the effects according to the kind of conditions that triggered them or to something else.

=> We are sorry for the misunderstanding. Forecasting is actually out of the scope of this paper. It seems we didn't used this word but "prediction", which corresponds to the computation of probabilities of occurrence. The only reference to "prediction" in the introduction aims at motivating why it is important to know what are the driving atmospheric factors, and this is precisely the goal of this article. Note that computing probabilities of occurrence such as "Pr(event| p1>u1,p2>u2)" does actually belong to the field of "prediction". In particular Fig 10 shows the "predictive gain" of considering the discriminant atmospheric variables for predicting torrential event occurrence. This can can be useful for applications such as the development of warning systems. The "prediction part" of our work is an important added-value that was not emphasized enough in the first version of the article. We will work on that in the next version of the article.

We are not sure to know what is meant by « simple descriptive way » but let stress that our study is more a statistical analysis than an event-based analysis. Rather than considering a single event and trying to understand what happened, we consider all events and try to assess in general (i.e. statistically) what were the driving atmospheric conditions. To make it clearer, we could replace the sentence « We study the atmospheric conditions at the origin of damaging torrential events in the conurbation from 1851 to 2019, in order to isolate the most generating atmospheric scenarios. » that is a bit vague by « Using a discriminative index, we statistically assess what are the atmospheric conditions driving damaging torrential events in the conurbation from 1851 to 2019. ». The two other occurrences of « study » (« study the driving atmospheric conditions » and « study whether the atmospheric signature ») could also be replaced by « assess ».

The structure of the paper is not appropriate. In the sections DATA, the authors actually just describe us what they did, and not describe the kind of data required to perform the research. And in METHOD they describe their case study. Then the paper does not supply a clear vision of what someone needs to perform the same research in another geographical area

=> Let us clarify that three types of data are used in this study (all at daily scale):

- the dates of torrential events

- a classification of atmospheric circulation into weather types

- a bench of atmospheric variables.

These three types of data are described in Sections 2.2, 2.3 and 2.4 respectively. To make it clearer we propose to :

- rename Section 2 as « Study region and data »

- reorder Section 2 as : 2.1 Study region », 2.2 Data, 2.2.1 « Dates of torrential events », 2.2.2 « Weather type classification » , 2.2.3 « Atmospheric variables » .

Please note that Lamb weather type classification is very common, this is why we consider it as « data » rather than « results » since this is not a novely of this article.

Regarding the Method section, we are not sure to see why it looks like a description of the case study. Actually Section 3 introduces the discriminative (silhouette) index and how we use it to find the most discriminative atmospheric variables. Lines 179 to 230 are actually generic and could be used anywhere else replacing « French Alps » in lines 218-219 and « Grenoble conurbation » by the respective regions. But we understand your point of view and we propose to emphasize better in the next version of the article the generality of the method and its possible use on other study regions.

Moreover, there are no sections describing in a simple way the aim of the paper and the approach followed to reach it. Maybe a flow chart of DATA and STEPS of the METHODOLOGY could help to understand.

=> This is a good idea and yes, we could provide a figure describing the different steps to make it easier to follow.

Some of the data used are actually NOT described. "20CRv2c (in short 20CR, Compo et al., 2011) covers the period 1851-2014 with a spatial resolution of 2∘. In this article, we use the mean member but results with members 1 and 2 (arbitrarily tested as they are independent) are very similar (not shown). In addition, in order to study the impact of the spatial resolution, the ERA5 reanalysis". This is simple and clear for you but not for readers that never used this kind of data and could be interested in doing. If I would like to apply the same "approach" in another study area I don't know what data I need and were could I find them!

=> 20CRv2c and ERA5 are actually common data so we had in mind that a brief description such as the previous sentence was enough: « two atmospheric reanalyses which are spatial and temporal interpolations of past meteorological measurements using data assimilation techniques and a meteorological model » (see lines 117-119). However regarding 20CRv2c members, we agree it was not clear and we propose to add after the first cited sentence : « 20CR is composed of 56 individual members that are equiprobable as well as a mean member ».

Even the information that are obtained from the analysis are sparse all around the sections and it is difficult to identify what can be useful in the practical management of torrential events.

=> Maybe the misunderstanding is that in the Data section we also give some "results":

- we give numbers about the seasonality of the torrential events (lines 99 to 104).

- we show maps of the average sea level pressure (lines 142 to 147 and Fig 2) of each class and we give numbers about the repartition of the events within the classes (lines 149 to 162 and Tables 2 and 3, Fig 3).

Regarding the first point, please note that this is more a description of the data than results *per se*, given that study of the torrential events has already been published in Creutin et al 2022 (there is nothing new here).

Regarding the second point, we agree that these are borderline between « data » and « results ». To make it clearer, we propose to move lines 142 to 162 and the cited tables/figures into a new subsection of the Result section. Section 4 would then contain 2 subsections : 4.1 « Weather types generating torrential events » and 4.2 « The atmospheric conditions driving torrential events ». In Section 4.1 we could also add a Table showing the probability of experiencing an event for a sequence in a given weather type, i.e. Pr(event) of Line 308. Thus Fig 10 would show the added discriminative power of the atmospheric variables compared to the mere classification into weather types.

Maybe something like a table of the main findings could be useful.

=> Note that the main results are given:

- in Fig 6 showing which atmospheric variables are the most discriminating for the identification of torrential flooding events and

- in Fig 10 showing how more likely it is to experience torrential flooding when the discriminant atmospheric variables are extreme.

These results are described in the text but unfortunately we don't think they can be easily described in a simple table. A summary of the discriminative atmospheric variables is provided lines 291 to 298 (« In conclusion ... »). A second summary of the results of Fig 10 would definitively be useful (after line 319). It could rephrase the last sentence of the conclusion : « In total, depending on the class, torrential events are 4 to 14 times more likely when the respective discriminant variables are extreme ».

I think that the paper must be completely re-written, putting light more on the scientific question that the paper aims to face and less on the study area (that currently is the focus of the paper). As is the paper does not show interest for an international audience.

Conclusions lack to finalize the results of the research, because not give to the reader the explanation of how these results will help in the management of torrential events or in some other framework.

=> We think there are three main contributions to our work:

- we propose a generic method to distinguish the discriminant atmospheric variables. This method could be used in other regions.

- we are able to distinguish what are the driving factors for torrential events in the Northern French Alps

- we assess what is the predictive gain provided by the discriminant atmospheric variables. This can be useful for application such as the development of warning system.

We think these points are of interest for the scientific community and suitable for NHESS. However we realize from the two Reviewers' comments that we did not emphasize these

contributions enough in the first version of the paper. We will in particular partly rewrite the abstract and the conclusion to better highlight our contribution.

Further elements in the following:

1. Figure 1 could represent something everywhere. I imagine that the authors know very well their study area but why the reader should? Geographical maps in scientific journal must have a national map inside, depicting the country where it is located, and almost the north arrow…Moreover, in the caption, RTM are quoted, but the definition of this acronym is in the next page so the reader doesn't know, at this page, what is the meaning.
   => Thanks, we will fix these points (please note that the location of the catchment within France is also shown in Fig 2, as already stated line 60)
2. Tab 1 and 2: there are no headings on the columns
   => Actually Table 1 is kind of a list : it lists the Lamb classes of each class. Table 2 seems to show heading of the columns (the classes).
3. Table A1 should be placed after Appendix A
   => This is actually automatically placed with Latex so we let the editing to the journal.
4. The majority of formulas are not numbered
   => That's true. Our strategy was to number only the equations that are referenced to in the text but this can be easily fixed if needed.
5. It is unclear how the torrential events are identified and selected
   => This is explained lines 82 to 97 but a figure showing the different steps could be helpful.
6. L 216: actually, these are not 4 DB, but instead 2 DB split in two according to the period

   => ok, this will be modified.

7. L 223: 20CR-1 e 20CR-2 have different length but can be compared because in the period 1930-1940 no events were recorded. Could they be comparable even if some events had occurred?

   => Actually in line 223 we note that using two equal lengths (i.e. extending 20CR-2 back to the 1920s) does not change the results because it adds very few events (see Fig 3), so at the end the same discriminative atmospheric variables are found (we could show the results if needed). But please note that any period is comparable since the same methodology can be used – the question whether all periods give the same results (i.e. the same discriminative variables) is another question.