Response to referee 1

We thank referee 1 for taking the time to assess our manuscript and providing valuable feedback. In this document, we have included said feedback along with our responses in blue.

Exploring extreme event attribution by using long-running meteorological observations

This paper assesses two methods of event attribution for two events in Sweden – a hot summer and an intense rainfall event. It is shown that the two different methods agree reasonably for the temperature event, but show more disagreement for rainfall.

I found the introduction and methods clearly written and enjoyable to read, with good background literature (although some perhaps less relevant to this particular study). The methods are clearly explained and the results from the second method well presented – but I struggled to identify the results from the first method, or a clear comparison between methods.

1 General comments

Clearly labelling the two methods from the outset would be useful – the header of 2.2 is misleading, as observations are also used in the first method. Something like 'GMST adjusted method' and 'using pre-industrial observations' would be more accurate.

This is a good point, and we agree that the header of 2.2 should be more specific, and including pre-industrial observations in the heading is a good suggestion.

In order to provide a comparison of the two methods a more thorough presentation of the results of the GMST adjusted method is needed. The GMST adjusted method could be applied to the same datasets as used in the pre-industrial observations data – I am not clear if it is.

This is a very important point. We will extend the presentation of the GMST adjusted results to better match the extent at which the results from the pre-industrial method are presented. In the revised version, we will also update figure A7 and A8 following comments from referee 2 and move these to the main results. These compare the results from the method using pre-industrial data and the results from applying GMST shifting/scaling to the current period data, for each station.

The study presents the use of pre-industrial data for attribution as a good alternative to the GMST adjusted method, without full discussion of possible problems with the method. Greater emphasis on possible downfall of the pre-industrial observational data would be useful. One major advantage of using a shorter observational record with GMST is that the data needed is available for more locations and variable globally. Although long observational records are available in Sweden, there are many parts of the world where this is not the case – this should be better highlighted.

This is absolutely correct. But we don't aim to present the use of pre-industrial data as a suitable alternative to the GMST adjusted method. This study is about comparing/evaluating the GMST method to only observations. But this is an indication that we should try to be more clear about this. We have one or two sentences regarding the shortcomings of relying solely on pre-industrial data in the conclusion, but we agree this is a bit short, so we will elaborate on this.

2 Specific comments

Title – doesn't capture the content, too vague
We will reconsider the title.

Abstract - 'analogue approach' this term is widely used for a different method using dynamical analogues (e.g. Climameter). Perhaps adding 'statistical' would make it more clear what you are doing (see also comment above about labelling the two methods).

This is a good suggestion. Both could be considered statistical, but as mentioned above, we will change the description of the methods to something more aligned with your suggestion of GMST adjusted method compare to pre-industrial observations.

Paragraph at line 40 could come sooner in the introduction (around line 23) as the two paragraphs either side flow better together (and have some repetition in the local-global responses).

Good suggestion, thanks.

Lines 25-30 perhaps irrelevant to this study as physical processes are not covered in this statistical assessment.

We have included this since we think it is valuable to give a brief overview of the different approaches to attribution.

Line 18 – what types of events?

We will expand this sentence to include the specific examples from the cited references.

Fig1 – I find this a little unclear, is p0 more likely hot than p1?

In this hypothetical case of heatwaves (as measured by days with Tmax $\geq 25^\circ$C), the probability p1 is larger than p0, so it is more likely to encounter a usually long heatwave

in the world of p1. However, we realise that the explanation of this figure could be more specific to make it clear what we want to show.

To include or not the event in question?
Not sure to what this comment refers. But in general, the question of including, or not, the event under investigation in an attribution study is relevant. We haven't touched upon this in the manuscript, but will add some sentences on this.

Why days greater than 25, not just Tmax?
The summer of 2018 in Sweden does not stand out when it comes to Tmax: there are plenty of years with a similar maximum temperature (this is just a single day after all). However, when it comes to the number of days exceeding 25°C, 2018 is essentially unprecedented. We will elaborate on this in the section about climate indicators.

Fig.3 caption typo in dates (1882-1992) - and fig 6
Thanks!

Fig.6 - no stations have at least one year missing 15% of days (none have the cross)? Is that correct?
This is correct, and we will remove the explanation of the cross to avoid confusion.

e.g. line 160, figA3, Interchanging use of historical and pre-industrial for the 1882-1911 period – I think it would be clearer to use pre-industrial throughout as historical could mean any past period (I think sometimes you use it to refer to the full historical/observational record).
Good catch. We agree and will make sure that we only use pre-industrial throughout the paper.

Paragraph at line 88 could be shortened, as the methods described are not those used in this study – perhaps it would be better to start with paragraph at line 97 stating what is done in this study, then mention that there are other methods used elsewhere.
We think that the information in this paragraph is valuable as it provides additional background as to why the GMST shifting/scaling is used. But since it is only background, we will condense it.

Line 112 – data for this study / event definition, a subheader would be useful here.
Good suggestion.

Header 2.2 - observations are used in the first method too
Agree, see reply for the general comment which also concerns this.

Section 2.3 - the climatic indicators have already been mentioned in the section above, maybe this should go into an event definition section – which perhaps could be section 2.1, before the two methods.

This is also a good suggestion.