

Dear Dr Dooley and co-authors

As you can see from the comments of the two expert reviewers, they find your manuscript well improved, but that it still lacks some information/analyses for it to be ready for publication. I realize that another major revision is not what you expected, but I'm confident that the suggested improvements will make your work even more relevant for a wider public. I agree with both reviewers that you should further attempt to set your study in a wider context, and I also suggest that you carefully consider the recommendations of reviewer #1 regarding the additional analyses (850 hPa temperature maps). While it may require a bit of extra work, it will give more weight to your results.

Good luck with the revision

Hans Linderholm, Editor

Thanks for your feedback and also for the extension granted owing to covid infection and illness of critical authors. Responses are given in italics and this blue text throughout. Please note that owing to a hardware failure we had to manually reinsert the prior resubmission from pdf into the template. This may have led to some slight differences in the format of the paper but should have had no effect upon the contents.

Report #1

We thank the reviewer for the time taken to review our manuscript and their very useful feedback and helpful suggestions. We respond to specific points as they arise below and will of course attempt to improve the aspects of the presentation mentioned above (and below).

Key Remarks

I have two main sets of remarks. Firstly, the authors have responded to the Editor and Reviewer 2 to place the paper better in a general context. However, I think they could go further. First, an improved title could reflect this change of emphasis. A suggested title, which might be improved, would be “Reassessing hottest temperature records using Ireland as an example.” Secondly the Abstract could be modestly reconfigured, without making it significantly longer, by placing this work in the general context in the first few sentences rather than just at the end.

We have modified the title (although it may now be too long) and moved up the final abstract sentence and reconfigured it to address this suggestion which we agree provides a better context to a generalist CP journal audience..

My second comment would need more work. The authors have responded to my key comment and included 850hPa temperature maps. These data are clearly promising for aiding the arguments of this paper but are only used qualitatively. It is unclear whether the maps shown are one day averages or the 1500 GMT temperatures I recommended. This is not stated in the text and should be. 1500 GMT would correspond approximately to the time of maximum temperature in Ireland. It would take a little experimentation to see how much

difference these two alternative ways (daily average versus 1500GMT) of treating the 850hPa temperature data make.

The maps are all for 1500 UTC (GMT) and this has been clarified accordingly in the text and figure captions.

But the authors should make a more quantitative use of the 850hPa temperature data anyway. Quantitative use of 850hPa temperatures for a position above a given station could cast greater light on the relative likelihoods of the various high surface temperatures. One way is to adiabatically reduce the 850hPa temperatures to station heights (approximately when these are only known within a range of heights using local geography). These reduced values can then be plotted in one or more diagrams. The quasi-surface temperatures so created would only be approximate, but their relative values are likely to significantly aid judgement as to which which surface record to choose as being really the hottest.

The issue here is one of a scale mismatch between the 20CRv3 product (available as a 1 degree resolution product) and the point nature and spatial density of the station networks being considered. To do this would require some approach to spatial interpolation to differentiate data at different locations which may or may not be a valid application to 20CRv3 and would compound the uncertainty associated with an assumption of adiabatic relaxation from 850 hPa (top of the boundary layer) down to the surface. In unpublished aspects of Ian Gillespie's PhD thesis under the supervision of co-author Peter Thorne on the use of 20CRv3 to homogenise surface temperatures the use of temperatures at greater heights than 2m was considered and shown to be a worse predictor of station level temperature timeseries than use of 20CRv3 2m temperatures. For these reasons while we see the methodological merit in the suggestion the available data at our disposal and our understanding of the relationship in 20CRV3 between surface temperatures at point locations and temperatures at various heights aloft suggest the uncertainty would be considerable.

A slightly less good but simpler alternative would be to plot the set of 850hPa temperatures without reduction to a surface value and compare these. This may still reflect the relative levels of surface temperature adequately given the likely modest elevation differences between Irish stations. However, I am not sure about this. Such a methodology could be useful for studying hottest surface regional temperatures more generally, at least in the extra-tropics.

We agree that 850hPa temperatures are informative and that is why we included them in the plots. For the two cases where the temporal evolution is considered we have added a set of maps at finer resolution as additional figures. We have also added discussion of 850hPa temperatures usefulness when introducing the first such map.

Detailed remarks

1. Table 2 should include the approximate heights of each station where not known exactly or a perhaps a range of likely heights based on local geography.

We have revisited and improved the location metadata in this table and its consistency

2. Figure 2. Kilkenny station should be marked particularly clearly on this map, e.g. as a purple dot with a black ring around it like Figure 3. The Figure would be even clearer if a paler green was used.

Figure 2 has been reedited to reflect these changes. The Kilkenny marker is now a red dot with a black marker around it, while the island colour is now a pale green to better denote the stations.

3. Lines 185 onward. It should be made clear whether a daily average of the reanalyses is used or even better the 1500GMT (or nearest available) value as both reanalyses are available every three hours. Presumably the ensemble reanalysis mean is used – this should be clarified, mentioning ensemble size.

Thank you. This research paper gathered data at 1500GMT using the ensemble mean. This has been clarified in both the text and the revised figure captions.

4. Figure 4 and similar figures. The mapped variation of 850hPa temperature over Ireland would be even clearer if a somewhat reduced numerical scale range of colours (currently 0-25oC) was used. This will give even better differentiation of 850hPa temperature colours over Ireland. This might be helped for the map as a whole by reducing the geographical area covered to some extent. Again, arguably 1500 GMT (or similar) temperatures and PMSL would be better.

We thank the reviewer for this feedback the larger geographical domain of interest was selected as we feel this provides a better synoptic picture of which air masses were most influential on the dates of interest. We have also added two figures with a zoom in to aid the reader to contextualise the 2 19th century candidates from Kilkenny Castle and Phoenix Park.

From the authors comment in the body of text “Adiabatically reduce the 850hPa temperatures to station heights (approximately when these are only known within a range of heights using local geography”:

We thank you for your comment. See response above to the main comment to the same effect.

5. About line 200. There needs to be an explicit discussion of what the maps of 850Pha temperatures show. This seems to be missing.

Added with thanks.

6. Figure 6. Needs labelling a-f for clarity. There is no mention in the caption of the last sub figure (nominally Fig.6f) or even a discussion of it in the text. But I think this sub figure should be kept.

Figure has been amended as requested and reference has been given to 6f in the text.

7. Line 262. “Recency” will not be understood by some non-native English speakers and should be replaced.

Noted and so clarified.

8. Line 272. The UK Met Office was founded in 1854 and so this statement is not true of the 1856 RCS Dublin record.

Text has been edited to reflect this information.

9. Lines 284-293. This discussion is not quite complete. Depending on geography, it is possible to have a very high temperature at a coastal station given a long a long upstream land passage of the air combined with an offshore wind. This should be clarified.

Thank you, re-edited to include this.

10. Table 3 and discussion. It would help to add a map of these stations when discussing the Boora record with the warmest record (currently Boora) shown more prominently as suggested for Fig 2.

Added with thanks.

Chris Folland 24 March 2022

Report #2

The broader implications of the work may be further explored in the context of global and regional warming, or of long-term extreme temperature change detection, in addition to the potential applicability of the method to surface air temperature records in other regions.

We thank reviewer 2 for the time taken to review our revised manuscript and the positive response provided. We have tried to strengthen the final concluding paragraph to reflect their suggestion which is where we felt it best placed to add this valuable additional context.