

Response to the review by Anonymous Referee #1 on the manuscript cp-2020-57
"Unlocking weather observations from the Societas Meteorologica Palatina (1781-1792)"
by Duncan Pappert et al.

We thank the reviewer for their effort in carefully reading and commenting on our manuscript. In the following, we reply to their comments point by point.

Review: *The database will undoubtedly be of importance to historical climatologists, and this manuscript could be useful to users of the database and to historical climatologists in general. However, as explained below, the article would be much more useful and impactful if the structure were revised for clarity. In particular, the authors should distinguish discussions and analysis of the original SMP observations from discussions and applications of the new database. Finally, the manuscript should address specific questions and concerns at the end of this review.*

First, *this structure can be confusing for the reader and makes it difficult to find and remember important content. Some topics are divided across multiple sections, while in other cases information has to be repeated. For example, sections 2.1 and 3.1 substantially overlap, and it's not clear why some information went in one section instead of the other. The fact that the original society reports contained much non-meteorological information and that this information was left out of the database seem like items that should have been discussed in "methods and data". On the other hand, much of the "methods and data" section consists of analysis or induction that I would normally expect in a "results" section (which is altogether missing from the article). These issues of clarity are problematic in an article such as this one, which is meant to serve as a guide to users.*

Second, *the structure does not allow the author to systematically address the project's context within, and contributions to, each field of research relevant to this study. These fields include:*

- *The history of meteorology and climatology;*
- *The study of early weather instruments and their measurements;*
- *Data rescue of early instrumental measurements;*
- *The creation of useful historical climatology databases; and*
- *High-resolution historical climate reconstruction.*

I wouldn't expect detailed discussion of each of these. However, simply keeping them in mind and addressing each specifically in the introduction and conclusion would help frame the article and ensure it does not neglect important context or applications.

Third, *the current structure blurs discussion and analysis of the methods and publications of the original SMP observation network and the usefulness of its measurements, on the one hand, with discussion and analysis of the methods and organization of the new database and its usefulness for climate reconstruction, on the other. Each of these is an interesting subject in its own right. As a researcher in historical climatology and potential user of the database, I would like to know (1) about the SMP, its background, and its activities; (2) about the new database and how it works; (3) what the database can tell us about the SMP, its coverage, and the quality of its observations; and (4) whether and how the database can help improve climate reconstructions. While that information is present in various places in the manuscript, it is currently all mixed together in ways that make it very hard to get at a good distinct explanation of each of these topics.*

As referee, I would not want to dictate the structure of the article. There are various ways the authors could revise or amend the current structure to address the three major issues outlined above. However, I suggest the following possible changes:

- The introduction could address the project's context within, and contributions to, the relevant research fields, as described above. The background and history of the SMP would fit better in the section on sources and methods.*
- The section on sources and methods could separate (1) the structure, methods, and publications of the SMP from (2) the structure of the database, its methods of compiling SMP data, the methods used to analyze the SMP network with the database, methods of correcting and homogenizing SMP measurements as they are put into the database, and how the database could be compared to other data or studies to examine its value for reconstruction.*
- There could be a "results" section presenting (1) the results of the analyses of SMP data for coverage, resolution, and consistency (currently in section 3.1); (2) results of analyses of tests for homogeneity and breakpoints (currently in section 2); (3) results of comparisons with other data or reconstructions (currently in section 4).*
- A "discussion" section could include much of the discussion in section 3.2 and the conclusion.*
- The conclusion could recap the article and address the project's contribution to the relevant fields of study presented in the introduction.*

Reply: The current structure of the paper was meant to reflect the dual goal of the study: 1) to create an inventory of meteorological observations carried out by the Palatina network ; 2) to digitize and correct the temperature and pressure observations, as well as demonstrate their potential usefulness. Perhaps the attempt to separate these two 'projects' has come at the expense of the more traditional 'methods-results-discussion' structure and resulted in a somewhat scattered and confused structure. The data rescue/processing part in the methods section was explained in detail and so were some of the identified issues which were addressed there and then to create cohesion and avoid mentioning these in a later part (e.g. in a 'results' section as suggested by the referee): this way, for instance, the 'why' 'what' and 'how' of homogenization is covered in one subchapter.

The 'Inventory' chapter is meant to be a results section dedicated to the first of the two study goals. The first part 'Summary' summarizes the main features and findings of this cataloguing exercise, and the second part 'Discussion' (perhaps a misleading name) discusses more or less point by point the features presented in the summary. This 'discussion' refers solely to a discussion of the Inventory, which necessitates more targeted explanations about the background of the Palatine Society; it is not meant as a discussion for the whole paper.

The 'Examples' chapter stands as a results for the second goal and is meant to showcase the measurement series themselves. Understandably, this is confusing, as some of the 'results' of the measurements were addressed in the methods section.

As the structure is a concern raised by the second Referee as well, the revised draft of the manuscript will clearly need some rewriting as well as a reshuffling of the structure. This will be done following some of the advised suggestion listed above. The context of the paper and its contribution to different fields of research will be addressed better in both the introduction and conclusion.

Content pertaining to either Methods, Results and Discussion will be more clearly divided into these groups.

Review: *Is the database compatible with those of other early instrumental data rescue projects such as ACRE? Are the results being incorporated into ACRE or another such project?*

Reply: Two of the co-authors were directly involved in the establishment of the Copernicus Data Rescue Service, which is tightly related with ACRE, and collaborate regularly with ACRE members. The data format complies with the best practices recommended by Copernicus (https://climate.copernicus.eu/sites/default/files/2021-05/C3S_DC3S311a_Lot1.3.4.2_2020_BestPracticeGuidelines_Part2.pdf). The data will be eventually submitted to the Copernicus database (GLAMOD).

Review: *Have any of the original instruments from the SMP (or other examples of the same manufacture) survived? If so, have they been analyzed for any particular errors or biases, particularly those that would require non-linear corrections at high or low temperatures (in addition to the data processing already discussed in section 2.3)?*

Reply: We do not know of any instrument that survived, although certainly some must have. We visited the astronomical observatories in Geneva and Bologna (i.e., the two Palatina stations closest to Bern) but did not find any instrument from the Palatina in their collections. In any case, the instruments reflected the standard for the time and were already rather accurate (see, e.g., the literature from the IMPROVE project – Camuffo and Jones, 2002). In fact, reliable international calibration standards were already in place (Cavendish, 1777). The main instrumental error source that we are aware of is the contraction of the glass, and that is accounted for in our corrections. Another known problem of the Palatina thermometer is that it was only graduated until -16°Ré, which makes lower temperatures somewhat less accurate (we will add this information to the manuscript).

Larger, non-linear errors are probably related to the exposure of the thermometer, but they are hard to estimate and out of the scope of this paper, as they affect pretty much any temperature measurement up until at least the early 20th century.

Review: *The case study in section 4.1 compares information in the new database with the reconstructions of Kington 1988. However, as described in the introduction (line 55-56), Kington 1988's reconstruction is also based on SMP measurements. Therefore, the comparison does not justify the conclusion that "This brief example demonstrates the reliability of the processed pressure data as well as its usefulness when paired with documentary sources" (lines 426-427). For tests of reliability, the processed SMP data should be compared with other early instrumental series or high-resolution reconstructions based on reliable phenological observations. In fact, if there were differences between Kington 1988 and the new database, then that would actually underline the importance of the correction and homogenization applied to the SMP data. Instead, this example seems to illustrate relative ease of producing and visualizing data with the new database (as opposed to the laborious hand-drawn maps of Kington). Similarly, in section 4.2, can the authors confirm that the EKF400v2 reanalysis (line 431) did not itself use SMP measurements?*

Reply: Yes, 'reliability' may be the wrong choice of words as it implies a validation against high-quality independent observations. This is not strictly the case here as both Kington's hand-drawn maps and EKF400 used SMP data (although in the latter case, only a handful of series were used). The examples in the study are meant to showcase the usefulness of the recovered series, their agreement with each other, and how they fit with and complement existing work done on this

period. Combined with information from historical databases, the potential of these measurements could be further uncovered.

As the main added value of this database in comparison with existing products is its daily resolution, there are no independent, high-quality measurements with that resolution that we can validate against.

Review: *The manuscript is generally well written but contains occasional minor issues of English usage (for example, in line 30 “spurn” should be “spur”).*

Reply: Will be corrected and the manuscript will be scanned for more such mistakes.

Camuffo D., Jones P. (eds), 2002, Improved Understanding of Past Climatic Variability from Early Daily European Instrumental Sources. Springer, Dordrecht. https://doi.org/10.1007/978-94-010-0371-1_1.

Cavendish, H., Heberden, Alex-Aubert, Deluc, Maskelyne, Horsley, Planta, 1777, The report of the Committee of the Royal Society to consider of the Best Method of Adjusting the Fixed Points of Thermometers; and the Precautions Necessary to be Used in Making Experiments with these Instruments, Philosophical Transactions 67, 816–857 .