Final author responses to referee comments

We thank all three reviewers for their constructive comments. We have revised the manuscript in response to the points raised below. The revision retains the methodological detail required to establish the reconstructions while expanding the climatological analysis and interpretation. In particular, we have added analysis of trend persistence, additional comparison with long-running UK precipitation series. We respond to each comment point by point below; our responses are shown in red.

Response to Reviewer 1

Reviewer summary

The manuscript presents several reconstructions of monthly and seasonal precipitation in two regions close to Dublin, covering the past few centuries. The reconstructions are based on observational data sets from a gridded, station-based long record from the Irish Weather Service, documentary-observational data from two statistical models that take long records of circulation and temperature indices from the Western North Atlantic and Western Europe, and finally, a time series of Delta O18 that is linearly translated to seasonal (mostly summer) precipitation.

Response

Thank you for this nice summary.

Reviewer recommendation

I have a very positive impression regarding the technical aspects of the manuscript, but I also have more critical suggestions regarding the target journal and the quality of the figures. Both critical remarks are related, and the way to address them depends on the objectives of the authors and the editor's opinion.

Response

We thank the reviewer for their positive assessment of our manuscript. We address each point below.

Main comments

Comment 1

1) The statistical and data-handling aspects are very good, and I wish to congratulate the authors for the thorough statistical analysis and the methodological descriptions. They are very clear and comprehensive. I do not have suggestions for any improvement in this regard, other than the minor point that the physical units of RMSE and MAE are missing in all tables.

Response

We thank the reviewer. Units have been added for RMSE and MAE in the relevant tables.

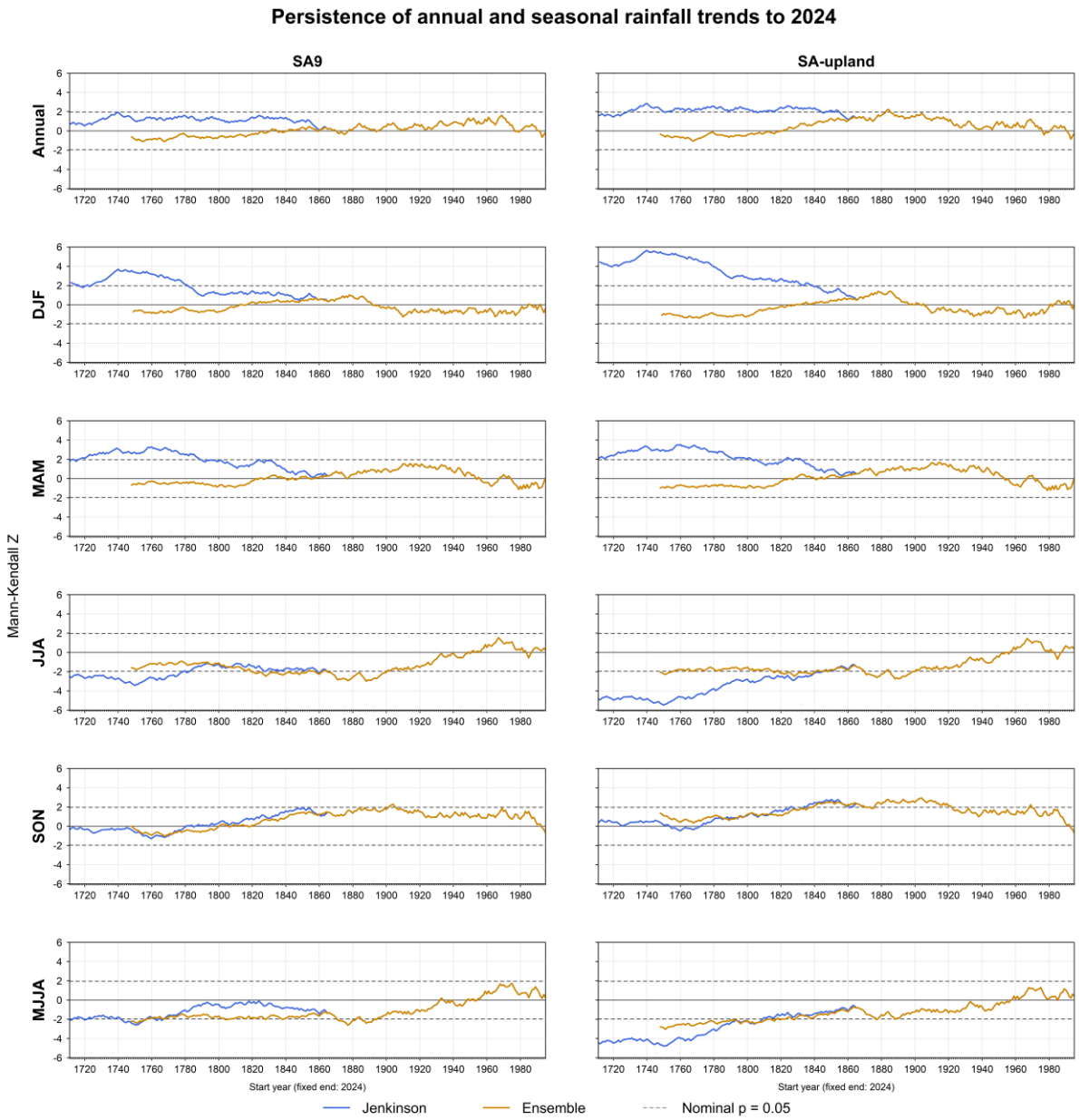
Comment 2

2) My critical comments are as follows: whereas the statistical and data aspects are flawless, the manuscript does not contain any discussion of physical drivers for rainfall variability or of possible imprint of volcanic eruptions or greenhouse gases (trends in the 20th century, sudden changes during the Krakatoa or Tambora eruptions?, Any connection to the Year of the Slaughter in Ireland 1739-1740 (Jones and Briffa, Climatic Change (2006) 79: 361-379? Any connection to the Central England temperature series? The study is silent about all these aspects, which leads me to my second critical comment.

Response

We thank the reviewer for these suggestions. We have expanded the Results and Discussion to provide greater climatological interpretation of the reconstructed series. The revised manuscript now examines the persistence of annual and seasonal rainfall trends using progressively later start years (Figure 14). We discuss the utility of the series for adding context to notable historical periods, including 1739-1741 and the 1765-1768 drought. We do not attempt formal attribution of individual rainfall anomalies to volcanic forcing, because doing so would require analyses beyond the scope of the present reconstruction study; we do mention this as a fruitful area for future work in the discussion. The revised discussion also considers the implications of snow and sleet undercatch for the early Jenkinson reconstruction. The trend-persistence analysis shows that agreement between the two reconstructions depends strongly on season and start year: differences are greatest in the colder seasons, particularly DJF and MAM and especially for SA-upland, whereas the

reconstructions show closer agreement in JJA, SON and MJJA. This provides additional climatological context while preserving the paper's principal focus on the development, evaluation and comparison of the reconstructions.



Persistence of annual and seasonal rainfall trends in the Jenkinson and Ensemble series for SA9 and SA-upland. Mann-Kendall Z statistics are calculated for progressively later start years with a fixed end year of 2024. Dashed lines denote the nominal significance threshold

(|Z| = 1.96). Both reconstructions are appended with the same observed rainfall series from 1865 onwards; consequently, persistence trajectories converge once the analysis windows contain only the common observational record.

Comment 3

3) Is Climate of the Past the correct target journal? Evaluating the present version of the manuscript, I would rather believe that it would be better hosted by ESSD, given that it is very data-centric and void of other climatological or dynamical elaborations. Depending on how this question is answered, the manuscript could go to ESSD with, in my opinion, rather minor revisions, or it may remain in Climate of the Past, but then a whole new section should be included, for example, focusing on the dynamical aspects that I mention in my point 2.

I do think that the reconstructions are very interesting, and they are definitely worth deeper exploration. I would welcome it if the authors wished to pursue the second path and expand the study. If not, however, I believe that the present version is a bit short of content for Climate of the Past. Alternatively, the authors may consider converting this manuscript to Part I of a two-part manuscript, with Part1 published in ESSD and Part 2 in Climate of the Past.

Response

We thank the reviewer for raising this question. We consider Climate of the Past the appropriate journal because the manuscript develops, evaluates and interprets multi-centennial historical precipitation reconstructions, rather than presenting a dataset alone. Comparable reconstruction studies include Murphy et al. (2018) and Herzschuh et al. (2026). In response to the reviewer, we have expanded the climatological analysis and interpretation of variability, trends and notable historical periods, while retaining the methodological detail needed to establish confidence in the reconstructions before they can be used in subsequent analysis.

Comment 4

4) Related to the previous point is the issue of the quality of the figures. They are all of low resolution, which in principle should not be a terrible problem. In this case, however, it does become an issue. I have been trying to discern by eye whether one can see an impact of volcanic eruptions in the series, or whether rainfall anomalies can be related to previously published temperature

reconstructions, but the low resolution does not allow me to really assess the timing of peaks in the time series. To be fair, the data have been made available, but an interested reader should be able to clearly see all details of the time series in the manuscript. As all plots include several time series, with different colours that are not well defined in the low-resolution figures either, this is not easy at all. The clear value of the reconstructions is somewhat diminished by the low figure resolution.

Response

We apologise for the poor figure resolution in the discussion manuscript. The figures in the revised manuscript have been replaced with high-resolution versions.

Minor comments

Comment 5

5) Figure 1, please include geographical coordinates.

Response

Geographical coordinates have been added to Figure 1.

Comment 6

6) 'We assess the consistency of the top 20 wettest and driest years between 1865 and 1977 across each reconstruction and observations using the Jaccard Similarity Coefficient...'

This suggestion is more a matter of taste but it would help the reader to add that the JI is related to the more usual F1-score by JI=F1/(2-F1). Or is JI in this case based on three (plus, neutral, minus) categories?

Response

We have clarified that the Jaccard index is calculated separately for the wet and dry extremes rather than across three categorical classes. We have also added its relationship to the F1 score, JI = F1/(2 - F1).

Comment 7

7) Table 2 ,3 4,5 , include units of RMSE, MAE and PBIAS

Response

Units have been added for RMSE (mm), MAE (mm) and PBIAS (%).

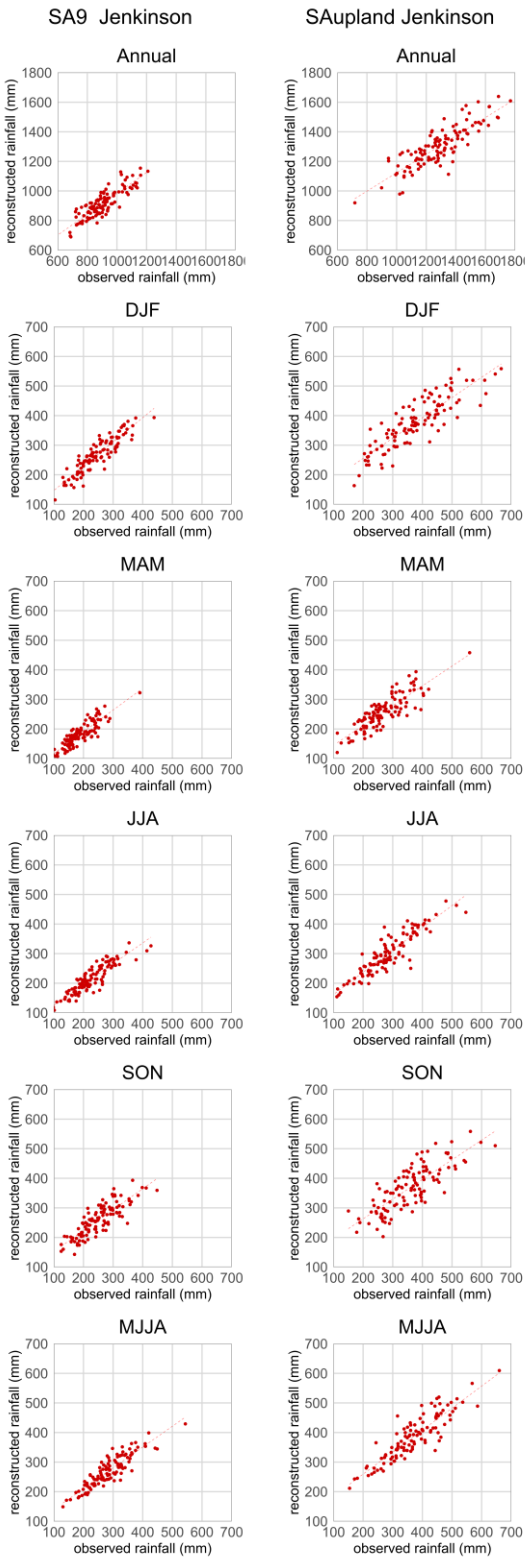
Comment 8

8) All reconstructions seem to underestimate the observed variability. For instance, in the scatter plots shown in Figures 4 and 5, the range of the x-axis (observations) is always larger than the y-axis (reconstructions). This difference in range can be misleading. The text does discuss the underestimation of extremes, but I do suggest redrawing the scatter plots using the same range for both axes.

Related to this point, it seems to me, just by eyeballing, that these scatter plots indicate a non-linear link between observations and reconstructions. Even with the unequal axis ranges, it seems that the data cloud is 'bent' . This, of course, may be related to the underestimation of extremes, or perhaps a deeper issue throughout the whole range of the reconstructions.

Response

The scatter plots have been redrawn using identical ranges on both axes and now include a 1:1 line. The revised presentation more clearly shows that the apparent curvature is primarily associated with compression at high rainfall totals rather than with an obvious systematic non-linear relationship. The underestimation of high rainfall totals is now discussed more clearly. A redrawing of Figure 4 is shown below



Observed versus reconstructed SA9 (left) and SA-upland (right) rainfall for the Jenkinson-based reconstructions over 1865-1977 at annual and seasonal timescales (DJF, MAM, JJA, SON, and MJJA).

References cited in the responses

Herzschuh, U., Böhmer, T., Jia, W., and Lisovski, S.: Quantitative climate reconstruction from sedimentary ancient DNA: framework, validation and application, *Clim. Past*, 22, 1159-1180, https://doi.org/10.5194/cp-22-1159-2026, 2026.

Murphy, C., Broderick, C., Burt, T. P., Curley, M., Duffy, C., Hall, J., Harrigan, S., Matthews, T. K. R., Macdonald, N., McCarthy, G., McCarthy, M. P., Mullan, D., Noone, S., Osborn, T. J., Ryan, C., Sweeney, J., Thorne, P. W., Walsh, S., and Wilby, R. L.: A 305-year continuous monthly rainfall series for the island of Ireland (1711-2016), *Clim. Past*, 14, 413-440, https://doi.org/10.5194/cp-14-413-2018, 2018.

Response to Reviewer 2

Reviewer summary

In the temperate climate zone, precipitation is the meteorological variable characterised by the greatest temporal and spatial variability. It is also one of the most important meteorological variables, second only to air temperature. Therefore, reconstructing precipitation patterns over the longest possible period, particularly over the last millennium, is both important and scientifically valuable.

In the manuscript under review, the authors undertook this task for Dublin and the surrounding area. They presented three reconstructions of precipitation totals that differ in their estimated values, with each providing specific insights into the long-term variability of precipitation. The manuscript focuses primarily on the methodology used to reconstruct precipitation series from both instrumental and proxy data.

Each reconstructed precipitation series was calibrated and verified against instrumental observations using appropriate statistical methods. In conclusion, I believe that the authors have demonstrated in considerable detail that their reconstructed series are reliable and suitable for a variety of applications.

Response

We thank Reviewer 2 for this positive summation and for their constructive comments.

Main comments

Comment 1

The main weakness of the manuscript is the limited scope of the climatological analysis. The authors provide only lists of the 20 wettest and 20 driest years. It would also be valuable to identify the wettest and driest multi-year periods and to attempt to explain their possible causes. Beyond the statistical reconstruction itself, the authors could investigate the atmospheric circulation patterns or other factors responsible for these periods.

Response

We thank the reviewer for this suggestion. We agree that the manuscript benefits from greater climatological interpretation, and we have expanded this aspect of the revision. The revised manuscript now includes a trend-persistence analysis of annual and seasonal rainfall (Figure 14), expanded comparison with long-running UK precipitation series, and in the discussion we note the insights that can be afforded to understanding notable historical periods, including 1739-1741 and the 1765-1768 drought. The ranked-extreme analyses have also been extended in the Supplement for the appended long-term series. We have not added a separate systematic attribution analysis of the wettest and driest multi-year periods. Robust attribution of individual historical hydroclimatic episodes to atmospheric circulation or external forcing would require additional analyses beyond the scope of a paper already focused on developing, evaluating and comparing several multi-centennial reconstructions. We therefore provide the additional climatological context supported by the present analyses while identifying formal attribution as an important avenue for future work.

Comment 2

Since several UK precipitation datasets were used in the reconstruction, the manuscript would also benefit from a brief comparison of precipitation conditions in the UK and the Dublin area, with particular emphasis on their similarities and differences. Simply stating that circulation patterns are similar in both regions is not entirely sufficient, as substantial differences may be expected, particularly in summer, as is also the case in continental Europe.

Response

Figure 12 in the manuscript compares the reconstructions with long-running UK precipitation series at seasonal and May-August scales using 10-year averages. It shows broad agreement but also two important differences: low Jenkinson winter totals before 1800 and high Jenkinson summer totals during parts of 1740-1800. The UK series suggest that the Jenkinson reconstruction may be too dry in winter, potentially because of snow undercatch and its reliance on Rutty's weather diary. At the same time, the elevated summer totals may reflect either documentary-source uncertainty or genuine regional hydroclimatic heterogeneity. These similarities and differences are now explained more clearly in the Results and Discussion.

Comment 3

The area referred to as "SA upland" should also be described more precisely in terms of elevation range, topography, and exposure to incoming air masses, all of which may significantly affect precipitation totals.

Response

Thank you. We have expanded the study-area description to include the elevation range, topography, orographic rainfall gradients and exposure of SA-upland to moisture-bearing Atlantic air masses.

Comment 4

Given the manuscript's predominantly technical focus, particularly its extensive presentation of the statistical methods used to calibrate and verify the reconstructed precipitation series and to quantify their uncertainty, it may be better suited to a data-oriented journal such as Earth System Science Data or Scientific Data. One possible solution would be to move a substantial proportion of the statistical analyses to the Supplementary Material and to place greater emphasis in the main text on the climatological interpretation of the reconstructed precipitation series, including long-term variability, trends, and related aspects.

Response

We appreciate this suggestion, but, as stated above, we consider Climate of the Past the most appropriate journal because the manuscript develops, evaluates and interprets historical precipitation reconstructions. We have retained the methodological detail required for transparency, robustness and replication, while expanding the climatological analysis of variability, trends and extremes. Additional supporting analyses, including the reconstruction-minus-observation difference series and ranked extremes for the appended reconstructions, are provided in the Supplement. We believe this revised balance between reconstruction methodology and climatological interpretation is appropriate for Climate of the Past.

Minor comments

Minor comment 1

Line 41 - Replace "climatic variability" with the more natural expression "natural climate variability".

Response

The wording has been changed to 'natural climate variability'.

Minor comment 2

Line 44 - Add the missing full stop after "(Murphy, 2019)".

Response

The missing full stop has been added.

Minor comment 3

Lines 115-117 - I suggest providing information on the elevation range and topography of the study area.

Response

The study-area description now includes the elevation range and topography.

Minor comment 4

Figure 1 - The colour used for the urban area differs between the legend and the map; please correct this inconsistency. I also suggest using a topographic map that shows the relief and elevation. Please add geographical coordinates as well.

Response

The urban-area colour has been corrected, topographic information has been added, and geographical coordinates are now shown.

Minor comment 5

Line 134 - It would be useful to provide information on the number of precipitation stations located within the GDA, their exact locations, and their correspondence with the nearest grid cells in the dataset. The relevant grid cells should also be shown on the map.

Response

The observed target is a 1 km gridded Met Éireann dataset constructed from all available stations, with station availability and continuity varying through time. The revised text clarifies the composition and limitations of this gridded dataset, and Figure S1 shows the Met Éireann 1 km grid cells, contributing station locations and the spatial domains used in the analysis. The main text now explicitly directs readers to Figure S1.

Minor comment 6

Line 160 - Add a full stop after "al": "et al" should be changed to "et al."

Response

The full stop has been added to 'et al.'.

Minor comment 7

Lines 169-175 - It is unclear which specific data from the series described above, and for which corresponding periods, were used to construct the final precipitation series. When referring to the late twentieth century, please specify the exact year.

Response

We have expanded this section to clarify the changing source material used in the Jenkinson series and the periods over which the different sources contribute. These inputs were compiled in the original Jenkinson reconstruction rather than selected in the present study.

Minor comment 8

Line 196 - Add a space: "to1994" should be changed to "to 1994".

Response

The missing space has been added.

Minor comment 9

Table 1 - Please add information on the time period covered by each predictor.

Response

Collation of potential predictors was performed to ensure that all predictors had data ranging from 1748 to 1994, which is the period of our reconstructions. We have added clarity to the text and table caption for this end.

Minor comment 10

Line 219 - Delete "May-August", as it is repeated.

Response

The repeated wording has been removed.

Minor comment 11

Lines 245-249 - The grid cells should be shown in Figure 1.

Response

To avoid overloading the main study-area map, the detailed gridded spatial information is provided in Figure S1. Figure S1 shows the Met Éireann 1 km grid cells, contributing station locations and the spatial domains used in the analysis, and the main text now explicitly refers readers to this figure.

Minor comment 12

Figures 6 and 7 - Difficult to read. I suggest also showing, for a common period, the differences between the statistical and Jenkinson reconstructions and the observations.

Response

We have added annual and seasonal reconstruction-minus-observation difference series for the common period 1865-1977 as Figures S3 and S4, respectively, and refer to them in the captions of Figures 6 and 7.

Minor comment 13

Figure 8 - Too many variables are presented in a single figure, making the differences difficult to discern.

Response

The intention in Figure 8 is to show a comparison of the oxygen isotope reconstructions with observations and our other reconstructions for the period of overlap and for the full duration of the isotope reconstructions back to 1200. The objective is not to see individual years but to visualise the broad pattern, which is achieved in this figure. Nevertheless, Figure 8 has been reformatted from a 2 x 2 to a 4 x 1 arrangement, providing greater horizontal space for each panel and improving legibility.

Minor comment 14

Figure 12 – There are far too many lines or curves in a single figure, making it largely illegible.

Response

We appreciate the reviewer's concern. Figure 12 is intended to show decadal variability in our reconstructions and available UK stations to add confidence or highlight differences with our reconstructions, which are highlighted in bold red (Jenkinson) and blue (Statistical Ensemble). The UK stations are in lighter colours. The intent is to show where the latter fall in relation to the period of uncertainty we draw attention to. The figure is successful at this task, highlighting the very low

Jenkinson series in the winters of the 1700s and the very high summer totals in the mid-1700s. It is only necessary that the reader can see periods of agreement/disagreement from this figure to support our results and interpretation.

Minor comment 15

Figure 13 - The figure should show the differences relative to the observations more clearly. In its current form, it is difficult to read.

Response

Thank you for this suggestion. The intent of this figure is not to show differences from observations but to show the broad agreement of the Pauling et al. reconstructions relative to our own. In particular, the figure makes it clear that the Pauling reconstructions agree more closely with our statistical ensemble than with the Jenkinson reconstruction, which adds weight to our findings and supports our conclusions regarding the early winter and summer totals in the Jenkinson reconstruction. In our figures, we focus on providing the necessary supporting information rather than being able to visualise all information, which is very difficult for multiple multi-century series.

Response to Reviewer 3

Comment 1

This study reconstructs monthly precipitation for two water resource domain in the Greater Dublin Area for the period 1711 to 1977 using a combination of four different statistical approaches. For each domain and calendar month, two regression approaches are applied. The statistical methodology is accessible only to specialists. The title should be shortened and refocused to reflect the study's primary objective and key result. The abstract should indicate the available evidence and objective of the analysis. It should be intelligible to the general reader without reference to the text. This objective is not met.

Response

We thank the reviewer for their comments. We have shortened and refocused the title and revised the abstract to ensure it clearly states the motivation and objective, identifies the documentary, instrumental, circulation-based and tree-ring evidence used, and highlights the main findings. We have also clarified that the study evaluates three reconstruction products: the documentary-instrumental Jenkinson reconstruction, a circulation-informed statistical ensemble combining Lasso and Random Forest models, and a tree-ring $\delta^{18}O$ reconstruction of May-August precipitation.

Comment 2

Results: The reconstruction of rainfall from documentary records (Jenkinson) performs best relative to observations across nearly all temporal aggregations and in both spatial domains. At the seasonal scale the Jenkinson reconstruction again outperforms the weighted ensemble across nearly all seasons and in both domains.

Response

We thank the reviewer for highlighting this key result. The revised abstract now states that the Jenkinson reconstruction generally shows the strongest agreement with observations across monthly, seasonal, annual and event-based evaluations in both domains. We also note that this stronger performance is partly expected because the Jenkinson series incorporates early instrumental observations and is therefore not fully independent of the observational dataset used for evaluation.