Reply to Carla Mateus in blue

Review of 'Historical climate extremes in Europe and the connection between spring precipitation and summer heat' submitted to Climate of the Past.

The manuscript is well written and clear, and the scientific significance of its content and outputs fits the scope of Climate of the Past. The topic is of paramount concern and importance. The methodology is adequate and explained to ensure traceability and reproducibility. The figures and supplementary materials are of adequate quality and quantity.

Minor comments and suggestions are provided below:

1. Introduction

The authors give proper credit to related work and clearly indicate their own contributions by citing prior studies to support their arguments. However, further information is required for clarity to inform an international and/or non-expert readership of the manuscript:

1. Why is this study important?
2. Mention compound events and why they are important.
3. It would be great to provide references on long-term trends and projections of spring & summer precipitation and summer heat waves; linking past and future.
4. Expand why you have selected these specific historical extremes as case studies (e.g. what makes them stand out in the long record).

Thanks for the comment. We will rephrase the introduction by first referring to this current summer in the second sentence ("The latest example is 2026, when numerous hear records were broken across Europe after a very dry March-April period.") and later point more to the relevance of the study, including compound events ("Studying this connection is relevant for understanding climate variability and change, but also for seasonal forecasting. Often compound heat and drought events develop as the summer starts from an already low water balance.").

We will also add information in the trend in projected future precipitation from EURO-CORDEX, but we add this to the discussion rather than the introduction ("For the future, according to the EURO-CORDEX simulations, precipitation will likely increase in the north and decrease in the south of Europe with the zero line shifting north from winter to summer. Southeastern Europe, which was identified as a key area, is likely to see an increase in precipitation in winter and spring (e.g., Ivušić et al. 2024), whereas Europe south of ca. 50° N will suffer from a decrease in summer precipitation.", with the reference to Ivušić, S., Güttler, I. & Horvath, K. Overview of mean and extreme precipitation climate changes across the Dinaric Alps in the latest EURO-CORDEX ensemble. *Clim Dyn* **62**, 10785–10815 (2024). https://doi.org/10.1007/s00382-024-07476-9)

As to the selection of cases for the Appendix, this included outstanding events that are well documented.

2.2. Documentary data

Lines 110 – 111: “In the English countryside, spring was perceived as an event rather than a season.” Why? Expand and provide references.

The reference is at the end of this section: Pribyl and Cornes (2020).
Pribyl, K. and Cornes, R.C. , 2020: Droughts in medieval and early modern England, part 1: The evidence. Weather, 75: 168-172. https://doi.org/10.1002/wea.3599 (10th Aug 2026)

2.3. Methods

Line 124: Rephrase as ‘Atlas of European climate extremes since 1421’.

We will do that.

2.3.2 Seasonal precipitation and temperature

Justify and/or present references for why you have chosen precipitation anomalies below the 10th percentile and temperature anomalies above the 90th percentile (e.g., the significance of the impacts of these extremes).

A threshold of 10 percent means we are selecting a one-in-ten year event. This is an often-used threshold, including in the IPCC report. It corresponds very roughly to a 1.5 °C warmer summer or a winter-spring season with 30% less precipitation. These are relevant anomalies, while at the same time the sample is large and reconstruction quality good. (This text will be added to the method section)

2.3.3 Atmospheric circulation

Provide references for the data used.

We add the reference to Valler et al. (2024) – it is the same data set as the precipitation and temperature analysis described in the previous section.

It would be great to have a brief explanation of the importance of the NAO, the East Atlantic pattern, the Scandinavian pattern, and the three indices of the jet stream over the Atlantic-European sector.

We will add a sentence with references on why the NAO, the East Atlantic pattern, the Scandinavian pattern are important (“These patterns have been shown to be relevant both for winter-spring precipitation and summer drought in Europe (e.g., Wang et al., 2011, Halifa-Marín et al., 2025”). As to the jet indices, we refer to our previous paper from which we took the jet indices, where we found a strong relation between jet latitude and drought. We will add the remark “especially jet latitude was shown to be strongly associated with summer drought”.

Halifa-Marín, A., M. A. Torres-Vázquez, R. Trigo, et al. 2025. “ Beyond the NAO: The East Atlantic Pattern's Role in Early 20th-Century Meteorological Droughts in Western Europe.” *International Journal of Climatology* 45, no. 13: e70045. https://doi.org/10.1002/joc.70045.

Line 171: “We then used a regression approach to predict JJA 2 m temperature from spring predictors.” Provide references (e.g., a statistical textbook) to ensure reproducibility for other researchers.

Thanks, we will add a reference to Wilks, D. S. (2020) Statistical Methods in the Atmospheric Sciences, Fourth Edition. Elsevier.

Line 177: Same comment as above; please provide a reference.

We will add the same reference also there.

Further results suggestion:

It would be interesting to reference the Little Ice Age to see how the frequency and characteristics of events have changed over time and to link this to the ‘Appendix: Documentary data for hot summers that followed dry springs’.

Reviewer 1 had a similar comment. We do not think that there is a relation to the Little Ice Age. However, we will add some information on this to the discussion.

“No direct connection to the LIA is seen. Extreme summer droughts can be traced back to 1252, i.e. before the start of the LIA around 1350. However, the LIA was also a period with more frequent volcanic eruptions, which cause cool summers due to direct forcing unrelated to winter-spring precipitation. This could make the composite statistics worse, but is included in the regression model. The NAO showed a cluster with negative values in the second half of the 17$^{th}$ century, but overall does not exhibit a particular behaviour during the LIA, neither do EA or SCA (Brönnimann et al., 2024) or the jet indices (Brönnimann et al. 2025).”

Brönnimann, S., Filipiak, J., Chen, S., and Pfister, L.: The weather of 1740, the coldest year in central Europe in 600 years, Clim. Past, 20, 2219–2235, https://doi.org/10.5194/cp-20-2219-2024, 2024.

It would be interesting to include a figure that illustrates or presents original documentary data to highlight the impacts associated with one of the historical case studies (e.g., a painting, illustration, manuscript, or newspaper).

With pleasure. The vine-grower Hans Stolz in Guebwiller (Alsace, France) provides a detailed report about the severe drought and its impacts in 1540.
Stolz, W., Die Hans Stolzsche Gebweilet Chronik. Zeugenbericht über den Bauernkrieg am Oberrhein. Stolz, Freiburg 1979. [no ISBN available].
We will add a figure with a clipping to the Appendix.

1. Discussion and conclusion

This section must be expanded. What is the importance of these findings?

Thanks. We will come back to the relevance statements made in the Introduction and take them up again. Furthermore, we refer to the possible future changes in precipitation. In addition to the discussion of the LIA (see above), we will add the text: “Establishing the relation between a winter-spring precipitation

deficit and summer heat is relevant for understanding climate variability and change, as the most recent summer of 2026 has demonstrated. In this case, as in most others, the summer heat is accompanied by a lack of rainfall, thus exacerbating the already low water balance and leading to sever compound heat and drought. For the future, according to the EURO-CORDEX simulations, precipitation will likely increase in the north and decrease in the south of Europe with the zero line shifting north from winter to summer. Southeastern Europe, which was identified as a key area, is likely to see an increase in precipitation in winter and spring (e.g., Ivušić et al. 2024), whereas Europe south of ca. 50° N will suffer from a decrease in summer precipitation."

Furthermore, the section is also expanded due to the comments of Reviewer 1.

Lines 382-383: "We find a link between dry springs and warm summers in climate reconstructions, consistent with other studies." Provide examples of previous studies/references.

We will add references: (e.g., Vautard et al., 2007; Fischer et al., 2007; Seneviratne et al., 2010; Rousi et al., 2023; Böhnisch et al., 2024, Padro et al., 2024).