

Interactive comment on “Assimilating monthly precipitation data in a paleoclimate data assimilation framework” by V. Valler et al.

Anonymous Referee #1

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General comments

This paper discusses a new method for creating a monthly paleoclimate reconstruction by assimilating precipitation data in the form of monthly precipitation accumulation or number of wet days per month. Experiments are performed over a 55-year time period. Performance is judged relative to a separate gridded reconstruction, and results are compared with a model-only simulation and with a reconstruction created by assimilating only the conventional observations of temperature and pressure. While there are some mixed results, the overall conclusion is that this method would be worthwhile to continue pursuing. I am particularly interested in one of the final statements in the conclusions regarding limiting the effects of precipitation on assimilation, presumably to decrease the influence of precipitation when sea level pressure or temperature ob-

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servations are dense, with an asymmetric localization function. Overall, the paper is clear and concise. The methods are explained well and the results are shown clearly. I have only minor scientific and technical comments.

Specific comments

1. Lines 40-43: Could you give some quantification of what a “dense network” is in this context?
2. Line 50: A short discussion of the necessary density of proxies for successful reconstruction here would help to link with the previous paragraph.
3. Line 157-158: Why did you choose this order to assimilate observations (temperature, then pressure, then precipitation)?
4. End of sections 4.1 and/or 5.1: It might be worthwhile to discuss the tradeoffs in more detail. When precipitation is assimilated, is the improvement in precipitation skill worth the loss of skill in SLP and temperature?
5. Section 4.2 and related figures: It may be useful to add the observation locations from 20CRv3 to Figure 7 so that the reader has an idea of what the observational network looks like in 1842 over Europe. In addition, it would be useful to mention that the 20CRv3 analysis is an ensemble mean, and thus comes with an ensemble spread that can provide an idea of the confidence in the reanalysis at any time and location. It could be useful to add maps showing this spread, or at least add the observation locations to Fig 7 along with a few sentences noting that the reanalysis will be less reliable in locations with no observations, than in regions of dense observations. Finally, Figures 7 and S7 might be clearer if difference fields are shown. As it is, the reader is left to judge by eye which of the experiments matches the reanalysis or reconstruction best.

Technical corrections

1. Line 34: “fist” should be “first”

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2. Line 48: change to "...based on the covariances between the observed and unobserved variables."
3. Line 50: "such as" should be "in the form of"
4. Line 57: "other" should be "others"
5. line 87: "change to ...with a correlation function that decreases as distance increases"
6. line 104: maybe replace "rains" with "drizzles", since light precipitation is overestimated.
7. Line 117: replace "considered as a wet day" with "considered wet days")
8. Line 126: change to "...using the following procedure for both precipitation amounts and wet days:"
9. Line 129: replace "precipitation and wet days" with "station"
10. Line 139 should be "If more than one station is available. . ."
11. Line 149: "A set of experiments was conducted. . ."
12. Line 170: Please add: "In 20CRv3 only pressure measurements are assimilated into a model with prescribed sea surface temperatures, sea ice concentrations, and radiative forcings." Also, could you expand on what "globally 39 observations data" means? Are there 39 distinct observation locations in 1842, or are there 39 instantaneous pressure reports within all of 1842?
13. Line 172: please replace "besides" with "In addition,"
14. Line 181: Is CRU TS3.10 completely independent from the experiments or does it use some of the same data?
15. Line 183 to 185: maybe change to "In Section 4.1, we show the differences between the correlations calculated from. . ."

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16. Line 186: change “skills” to “skill”
17. Line 189-190: change to “on the anomalies from the . . .”
18. Line 197: remove “season”
19. Line 229-230: Change “increased localization” to “increased localization distance” or “decreased localization”, since localization itself usually refers to the method of limiting spurious correlations.
20. Lines 240-242 are unclear as written; maybe change to “The regions over central South America and South Africa that were negatively affected in the exp_W experiment show worsening skill in the exp_W_2L experiment (Fig. S4).”
21. Line 245: remove “as it should be done in the real application of the method in the future”, or describe what you mean by “real application”.
22. Line 249: change “besides not assimilating” to “except that it does not assimilate”
23. Line 251: add “. . .the skill of the exp_TPR and exp_TPW analyses are compared. . .”
24. Line 296: change “weather forecast” to “weather forecasting”
25. Line 298: change “in some data assimilation methods” to “for many data assimilation methods”
26. Line 299: change “normality” to “Gaussian”.
27. Line 303: add a reference for the Shapiro Wilk test. Which ensemble was this test performed on?
28. Line 307: Add “The hypothesis of normality in the number of wet days. . .”
29. Line 310: maybe add “. . .to be assimilated successfully.”?
30. Line 322: change “for example” to “such as”

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31. Line 327: change “using the number. . .” to “assimilating the number. . .”
32. Line 335: change to “Assimilating precipitation amount or the number of wet days has a small impact. . .”
33. Line 343: add “assimilating precipitation amounts. . .performs worse than assimilating wet days. . .”
34. Figures S.1-S.2: Are the columns different months? Please label.

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