

I was asked to review a revised version of this manuscript; I have now read a version called *cp-2017-92-manuscript-version-3.pdf*, on which my remarks are based.

It was apparently unclear to the reviewers of the original submission that the scope of the manuscript was limited to describing a new algorithm to address an inverse problem. In the revised manuscript, the authors have attempted to clarify this limitation, and to address further concerns that would need to be considered in order to apply it to real data.

Although the manuscript appears to have been significantly improved since the original submission, I still found the manuscript to be dense and difficult to read. The point of the manuscript is to introduce a method to infer past temperatures, but the description of the method is difficult to follow. I think the material is appropriate for publication in *Climate of the Past*, but the presentation of the material can still be improved to make it more accessible to a broader range of climate scientists. Reaching readers is, after all, a primary goal of publishing.

Here are issues that I had with Section 2:

- The authors want to describe a complicated procedure. The 4-point summary overview at the top of page 6 is a good start. However, in my view, too much detail is then provided before readers have been given a clear understanding of the whole process. Section 2.3 *Reconstruction Approach* actually contains many intermediate results, numerical values, and detailed discussion points, before the process is fully explained. When I see text like this, I really don't want to read it. I think the text would be easier to read if the authors were to restrict 2.3 to describing the fundamental concepts and assumptions of the approach. Then, e.g. in a subsequent *Discussion* section, they could explain how some of those results were developed or obtained, why they were needed, the numerical values that arose, and how they were used.
- Illustrations integrated with the description of the method could help readers to "see" and understand the procedure. For example, a flow chart could be very useful to help readers as they follow Section 2.3. However, there are no figures in the main text to help here; instead, the text depends heavily on figures and tables in the Supplement. If material is needed to explain the main points of a paper, then that material should be in the main body of the paper. A Supplement should be limited to material that is nice to have in order to *supplement* the primary material. It should not contain primary material that is essential in order for readers to understand the main text.

Reviewers of manuscripts are generally expected to identify two types of problems.

- The first is scientific failings, such as failure to correctly interpret and cite relevant background work, or omissions of key steps in descriptions or analysis, or errors in logical development of ideas or conclusions. I was pleased to see that many of the minor points raised by the two initial reviewers have been addressed.
- The second type of problem that reviewers are asked to identify is communication failings. Is a manuscript organized in a way that readers who are not closely connected with the work can easily understand the approach and grasp the aspects that are novel? If points were unclear to the reviewers, they will probably also be unclear to many other readers. So, I am a bit concerned that more effort appears to have gone into explaining how the initial two reviewers misunderstood the manuscript (15 pages), than has gone into making the manuscript clearer on those points to other readers. Section 4.3 is new in response, but it is only 3 pages long, i.e. only 20% of the length of the argument to the reviewers. I am concerned that the authors may not fully appreciate the challenges that outsiders can have in attempting to read their work.
- In most inverse problems, non-uniqueness of the inferred model parameters grows rapidly with increasing uncertainties in either the data or the model physics. Section 4.3 addresses the new uncertainties (suggested by Reviewer #2) that could be associated individually with each of the imperfectly known real-world data sets, and with unknowns in the model physics. However, it might be prudent to remind potential users of the procedure why a formal inverse approach is necessary.

Page 1, Line 16 –

Results may be reproducible, but are they correct?

Quite apart from uncertainties in the input data or in the model physics, are there biases built into the automated procedure? This was a question that Reviewer #2 posed, and it is unclear to me that it has been answered satisfactorily.

Page 9, Equation (8) –

Why is an L1 norm used instead of an L2 norm?

Page 9, Line 8 –

“If the mismatch decreases compared to the prior input, the new input is saved and used as new guess.”

I thought that in most Monte Carlo applications, there was also a probability that a result would *not* be accepted, even if it had a lower mismatch. Why is that not done here?

In their response to reviewers (page 13), the authors argue that their paper is appropriate for publication in *CP*, because another methods paper (Winstrup et al., 2012) was previously welcomed and published in *CP*. While the decision to publish

or not resides with the editors, I personally think that it is obvious that Winstrup et al. is a methods paper, and the Winstrup et al. paper is much clearer and more accessible to readers than this manuscript in its current form. The editors must also consider these factors.

Details

When acronyms are well established in the broad scientific literature, it is fine to use them. However, very little space is saved when authors introduce new acronyms for phrases that are relatively short and which are used relatively infrequently. Writing the phrase in full for clarity whenever it is used makes reading more efficient and produces happier readers, who don't need to search back through dense text to find the meaning. For example, is using "cop" for "cut-off period" really necessary?

I think the manuscript would benefit from a table of variables (and acronyms). If readers are going to need to frequently look up meanings of variables and acronyms, it would at least make it easier for them if there was one clearly identified place to go for that information.

Hyphens

The manuscript is nearly devoid of hyphens, although in many instances, correctly used hyphens would eliminate minor textual stumbling blocks that can slow readers' grasp of the material. For example –

- Page 3, line 1 – "... argon-isotope-based temperature reconstructions."
Or better,
"... temperature reconstructions based on argon isotopes."
- Page 3, line 24 – "... Holocene-like data"
- Page 6, line 19 – "low-pass filtered:"
- Page 8, line 30 – "first-guess temperature"
- Page 6, line 21 - "... accumulation-rate data ..."
- Page 16, line 14 – "gas-isotope-based temperature reconstructions ...",
or better, "temperature reconstructions based on gas isotopes ...",

Data are plural

- Page 6, line 21 - "... data **are** linearly interpolated ..."
- Page 6, line 24 - "... data **were** linearly indeed reconstructed ..."
- Page 8, line 2 – "... data **are** filtered ..."
- Page 17, line 5 – "... gas-isotope data **are** calculated ..."
- Page 18, line 11 – "... data **are** used to run ..."

Page 1, line 26 –

"This is shown by high quality fitting of NGRIP $\delta^{15}\text{N}$ data for two Dansgaard-Oeschger events using the presented approach, leading to results comparable to other studies."

“High quality” is wordy and can appear to be an attempt to prejudice how readers will view the results. It can often be more convincing to simply state that results were comparable, and let readers decide for themselves whether or not the fit was “high quality”. If the authors want to retain “high-quality fitting”, then it needs a hyphen.

Page 17, line 23 – The distance between GRIP and GISP3 is ~30 km, it is not “a few km”. The authors are correct that more cores closer together could be very useful.

Clarity

- Page 1, line 15 – “... parameter tuning leading to ...” I think there should be a comma after “tuning. Without a comma it is unclear whether the phrase “leading to reproducible temperature estimates” refers to the new automated approach or to the old manual approach. I think the former, but some readers may stumble on this point.
- Page 1, line 16 –
“... other ice core based temperature reconstruction methods ...”.
Please try to avoid long strings of adjectives especially if you don’t use hyphens to help readers understand the groupings.
Better, with hyphens, “... other ice-core-based temperature-reconstruction methods ...”
Or better yet, unpacked,
“... other temperature-reconstruction methods based on ice cores ...”.
- Page 2, line 3 - What is intended by “partly even centennial ... variations”? This is not a English expression that I understand.
- Page 2, line 14 – There is no “Cuffey et al. (1997)” reference. The correct reference is “Cuffey and Clow (1997)”.
- Page 4 – “g is the acceleration constant.” I think it is standard practice to mention “gravity” in this context.
- Page 8, line 8 – “...which serve later **on** as ...” Delete “on”.
- Page 8, line 31 – “... of **about** -29.6°C”. Did you use -29.6°C, or did you use something different? Why not just say “... **of -29.6°C**”?

Tables

In Table 01, I don’t see the point of saying that calculations ran over a weekend. Surely the days of the week are unimportant (are Saturdays really better than Wednesdays?). If the point is the execution time, then state “48 hours” or “N cpu cycles”, or whatever is the appropriate number.

References

- Guillevic (2013). PhD thesis. More information would be helpful – title, university, accessibility.
- Schwander et al. (1997) should have a hanging indent, not be fully indented.
- Severinghaus et al. (1998) should have hanging indent. “Sowers” and “Alley” are mis-spelled.
- Spahni (2003) Check how “CH 4” is presented in *GRL*.
- Steig et al. (1994). Only the first word in the title (“Seasonal”) should be capitalized.
- Werner et al. (2001) Missing space in “... present and ...”