Clim. Past Discuss., 5, C739–C746, 2009
www.clim-past-discuss.net/5/C739/2009/

Climate of the Past Discussions

Interactive comment on "Using data assimilation to study extratropical Northern Hemisphere climate over the last millennium" *by* M. Widmann et al.

Anonymous Referee #2

Received and published: 5 October 2009

Review of the paper

'Using data assimilation to study extratropical Northern Hemisphere climate over the last millennium' by

M. Widmann, H. Goosse, G. van der Schrier, R. Schnur, and J. Barkmeijer

The manuscript presents and critically discusses three methods potentially suited for data assimilation for reconstructing the climate of the past with model simulations. I think the manuscript fits well into the scope of CP because it provides sound information on concepts that will become more and more important for the paleoclimate community.

General:

The manuscript is well written. It presents new information to the body of knowledge to the paleoclimate community. The methodological concepts are outlined in great detail. The authors also discuss the pros and cons of data assimilation concepts to be used in paleoclimatology. The only shortcoming I face is the overall length of the manuscript. Here it might be helpful to concentrate on selected problems – this would also help to increase the readability of the paper.

I recommend publication of the manuscript when the minor changes listed below are addressed.

Specific comments:

Introduction:

2nd paragraph: I think it would be usefull to briefly describe the main differences between EMICS and GCMs related to internal climate variability by a few words

3rd paragraph: Could you say sth about the errors included in the reconstruction of climate indices based on proxy data – are the numerical simulations carried out with GCMs and EMICS forced with changes in external forcings are really independent [i.e. thinking about the reconstruction of the solar and volcanic activity ?]

4th paragraph: You state that the NAO/NAM are dominant modes of natural variability. Does this imply that under externally forced factors these modes are not dominant anymore ? Maybe it would be more appropriate to formulate dominant modes of atmospheric variability

Compared to the total length of the paper the introduction is quite short. Maybe the authors could include at least one paragraph about the main climatological characteristics of Scandinavia and related work [i.e. climate reconstructions already carried out, the impact of the north Atlantic drift in that region]

2 Dynamical models and data assimilation – the standard framework

This paragraph is in my opinion very helpful as it introduces the main ideas in a formal and way.

3 Data assimilation in paleoclimatology

3.1 Differences between weather and forecasting and palaeoproblems

4th paragraph: The authors should mention that not only the spatial and temporal resolution is limited in proxy data, but they also contain large errors related to the reduction of variability induced by many reconstruction methods, i.e. linear methods such as regression or canonical correlation.

What do the authors conclude about the variational techniques ? Is the 'standard approach' as for example used in NWP appropriate to address paleoclimatic issues or does – based on a pragmatic point of view – the [proper] estimation of the model and observational errors preclude the usage of the established terminology of data assimilation when used on paleoclimatic problems.

I also would suggest to shorten the whole section, for example the discussion of the NCEP/NCAR reanalysis.

3.2 Ensemble member selection

Proxy Data over Scandinavia: Could you just mention that the number of degrees of freedom is strongly reduced when decadal filters are applied – this then also would explain part of the high correlations, especially in Fig. 1c. Moreover the model is constrained to the proxy data and therefore a-priori knowledge about the state of the system is included in the modeled time series [as you mention in the following paragraph]. Therefore it should not be a surprise to attain the high correlations. I think more important in this respect would be what we learn about the large-scale state of the system, i.e. which states of the atmosphere and/or ocean control the evolution of the local proxy time series [as you state in the last paragraph in this section].

I think for the reader that is not so deeply involved in the topic it would be very helpful to make this points really clear: High correlations between modeled and proxy time series should not be regarded as specific virtue of DA – the real added value of DA is instead to get information about local climatic conditions where no proxies are available and the large scale climatic state in terms of atmospheric and also oceanic circulation – the latter might be especially important for Scandinavia because of the pronounced influence of the North Atlantic drift. One could therefore also hypothesis on the stability of the atmospheric circulation-climate connection under changed oceanic lower boundary conditions.

3.3 Upscaling and control of large-scale circulation

I would suggest to shorten the introduction to the main ideas because a lot of information contained in this section will be discussed in the following subsection and therefore this section includes somewhat redundant information.

3.3.1 Forcing singular vectors

Figure 3: You state that there is a 'strong qualitative similarity' between the target pattern and the difference pattern. I would suggest to leave out 'strong' – simply because the positive geopotential height anomaly is deflected to the east in the difference pattern and therefore the well established and enclosed negative geopotential height anomaly over central eastern Europe is not fully established – this should also lead to changes in the resulting air flow being would be more zonal in the data assimilated simulation. This could potentially also be seen in the temperature patterns in DJF because temperature anomalies over central eastern Europe do not show the significantly reduced temperatures as indicated in the reconstructed Luterbacher data.

3.3.2 Pattern nudging

2nd paragraph: the application of the ECH-G model should could be shortened because it does not present direct information for data assimilation.

The paper Widmann et al. 2009 (in preparation) is cited a few times. I am not quite sure how to deal with this issure because the interested reader will not be able to consult the paper.

4 Summary and conclusions:

I think a short paragraph emphasizing the real added value of data assimilation specifically it's main skill should be included. For example, DA is not a tool simply increasing the correlation between results based on observations/reconstructions and model simulations. This can be seen in most cases, because a-priory knowledge about the evolution of the local scale or large scale climate is included in the model simulation via DA. I think the point where DA can really be used is to understand potential dynamical processes controlling the local scale variables. This information about dynamical considerations should be highlighted as a virtue of Data assimilation into paleocliamtological simulations

Figures:

General:

- The [physical] units should be given under or nearby the color bars of spatial plots and y-axes of time series plots.

- The numbering of the different plots in the figures should be carried out in the same way [i.e. characters a,b,c,. . . in the upper left or lower left corner with same font

- I would suggest a stereographic map projection for the plots showing the North Atlantic region because the high latitude areas are over-represented with the present [Mercator] projection. Also the compatibility with Figures 7 and 8 would be easier.

- The colorbars – and colors in the plot – should be generated symmetrically around zero

Specific:

Fig. 1: The figure seems to be deflected in the y-direction. For a better readability it would be desirable to rescale the Figure.

Fig. 4: I think it should be 5% level instead of 95% [95 usually refers to the confidence interval]

Fig. 6: The numbers below the color bar are not readable.

Figs. 7 and 8: Please provide a frame around the plots.

References:

Corrections to be done are in italics:

- Compo et al. 2006: [. . .] of a 100 Year reanalysis [. . .]

- Groll et al. 2005: [. . .] Kaspar, F [. . .]

- Last reference index term should be written in one line

CP evaluation form

In the full review and interactive discussion the referees and other interested members of the scientific community are asked to take into account all of the following aspects:

1. Does the paper address relevant scientific questions within the scope of CP?

Yes – it addresses and introduces concepts of a field [namely data assimilation into paleoclimatic models] that will become more important in paleoclimate research

2. Does the paper present novel concepts, ideas, tools, or data?

Yes - Established concepts used in meteorology are introduced and discussed for their application in paleoclimatic framework

3. Are substantial conclusions reached?

Yes – the authors present a variety of examples highlighting the usefulness of data

assimilation in paleoclimatology

4. Are the scientific methods and assumptions valid and clearly outlined?

Yes – the methods are presented in a formal way and the reader could for example derive own programs or applications based on the formal introduction of the concepts

5. Are the results sufficient to support the interpretations and conclusions?

Yes – Results presented are based on the concepts introduced and discussed in each section

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

Yes – as already mentions the concepts are outlined in great detail and therefore it should be possible to reproduce the results/conclusions presented in the paper.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

Yes – The manuscript often shows a review or textbook character. In the reference list recent and fundamental papers are listed and discussed in the different sections of the paper

8. Does the title clearly reflect the contents of the paper?

Yes

9. Does the abstract provide a concise and complete summary?

Yes – The abstract is written clearly and concise and summarizes the main ideas presented in the body of the text

10. Is the overall presentation well structured and clear?

Partly – I would suggest to shorten and focus the manuscript [see specific comments

] in some parts.

11. Is the language fluent and precise?

Yes

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

Yes

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

Partly – I listed some suggestions for improving the quality and readability of the figures in the specific comments.

14. Are the number and quality of references appropriate?

Yes

15. Is the amount and quality of supplementary material appropriate?

Interactive comment on Clim. Past Discuss., 5, 2115, 2009.