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Climate of the Past Discussions

Interactive comment on "Statistical framework for evaluation of climate model simulations by use of climate proxy data from the last millennium" *by* A. Hind et al.

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Dear editor,

firstly we would like to take this opportunity to thank all three reviewers for their many constructive suggestions and for reviewing our article so thoroughly. We are pleased to observe that all reviewers found our new framework and analysis to be of high quality and interest, however we recognize that several important questions and concerns have been raised.

It is clear that they all find the article too long, with Referee #1 and H. Yamazaki specifically suggesting that the pseudo-proxy section 9 could be shortened and clarified.

Whilst the referees have suggested the trimming of various sections, they would also like some additional discussion and clarification. H. Yamazaki even goes as far as to suggest that splitting the text into two complementary papers may be beneficial. We are in favour of such a solution, as we think it provides several advantages. However, because we submitted the work as a single paper, we would appreciate if the editor could advise us on whether the work should be split into two parts or not. If the editor recommends a splitting, then we are happy to submit a revised paper in two separate parts, where part 1 will deal with the theory (current sections 2-8) and part 2 with the pseudoproxy experiment (current section 9). Such a solution should make it easier to address several of the points of discussion raised by all referees, namely by having separate discussion sections in each of the two parts.

G. Hegerl wants us to discuss the similarities and differences between our framework and the optimal fingerprinting approach. We agree and we intend to do so in the revised paper, incorporating the motivation for the present framework. In fact, when we began to collaborate on how best to compare proxy and model data, the optimal fingerprinting framework was pursued, however due to difficulties regarding the inclusion of proxy error, with other reasons besides, we decided to address the problem of how to compare proxy and model data from scratch. We will try to clarify the strengths and weaknesses of our framework in the context of the established fingerprinting procedure in the revised article, even though several aspects may require additional empirical investigation.

G. Hegerl finds the assumption of white noise in the delta and eta of our framework to be too stringent an assumption, as both are likely to feature spatial and temporal correlations on a variety scales. Partially, however, this is due to a misunderstanding. We make no assumption at all of the temporal character of eta (the real unforced variability), which is allowed to have any type of temporal autocorrelation (as we mention on p 270, lines 14-15). Moreover, the spatial covariance of unforced climate variability at the different proxy locations is explicitly treated in our framework, in the formulation of the

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U_T and U_R measures (in sections 7 and 8). However, it is right to say we assume temporal white noise in the model's unforced variability and in the noise term of the proxy and instrumental records. This limitation is mentioned in our text, and we also mention that future versions of the method will consider more realistic noise representations. Our temporary solution to the problem (in the case of delta) is to conduct our pseudoproxy study on 30-year means, which we identified as possessing no significant auto-correlation for both global and individual location cases at this time resolution in the control simulations at hand (as shown in the supplementary material). However, we recognize that there are multi-decadal / centennial physical processes that contribute to the internal variability of the real climate system, and may very well do so in control simulations even if they cannot be detected in simulations of a finite length. As G. Hegerl points out, the optimal fingerprinting method makes use of both temporal and spatial covariances that are empirically determined from control simulations. Our approach uses control simulations only to estimate the spatial covariance, but not to account for the temporal autocorrelation. At the moment, we are not certain on how serious this restriction of ours is, but we intend to address the use of more realistic noise models in future research and we will extend the discussion of this issue in our revised paper.

H. Yamazaki, in one of his comments, claimed that we have assumed (near) linearity between climate forcing and response to the forcing. However, this appears to be a misunderstanding - possibly due to us not having sufficiently explained our statistical model 1. We have assumed that there is an approximate linearity between the real response to a real forcing and a simulated response to a forcing (of the same type as the real one in question) that is imposed upon a climate model. This linearity is explicitly represented in our statistical model 1 by the term xi in the true temperature and the corresponding term alpha*xi in the simulated temperature. In our view, this assumption of linearity between a true and simulated response to a forcing is conceptually very similar to an essential assumption made in optimal fingerprinting; namely that the true multiple-forced climate variability pattern can be expressed as a linear combination of a

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set of single-forced simulated climate patterns (signals) plus internal climate variability (see, e.g., IDAG, 2005, p. 1293).

All referees have asked for a more in-depth discussion of the proxy calibration procedure, with greater reference made to the literature regarding previous usage of 'classical calibration' or EIV methods. We will certainly clarify this aspect of our analysis and refer to previous examples where appropriate.

We consider the above suggestions as the most significant from the reviewers, however we will also address the more detailed comments and suggested revisions to the article as we revise it, in point-by-point detail. We thank the anonymous Referee #1 in particular, for their thoroughness in this regard.

Reference: IDAG (The International Ad Hoc Detection and Attribution Group). Detecting and attributing external influences on the climate system: A review of recent advances. J. Climate, 18, 1291-1314, 2005.

Interactive comment on Clim. Past Discuss., 8, 263, 2012.