**Climate
of the Past
Discussions**

Interactive comment on "A novel approach to climate reconstructions using Ensemble Kalman Filtering" *by* J. Bhend et al.

J. Bhend et al.

jonas.bhend@csiro.au

We thank Reviewer 3 for very valuable comments to the manuscript. The responses to the specific comments follow below. Paragraphs from the original review are marked with '$$'; our comments follow immediately after the respective paragraphs.

$$ Major points

$$ Readers not familiar with the basics of EnKF have stopped reading after the first few paragraphs of section 2.2, and that is a pity. Please be a little more expansive on the concept of EnKF. This allows a more gentle introduction of the covariance matrices Pa and Pb and the gain matrix K. Preceding the mathematical explanation of EnSRF, a conceptual explanation would be nice and would guide the reader through the math-

ematics. An small example that the authors are not kind to the reader is on line 14 of page 2842. Why not explain that 1342 is related to 2*694+4 (temp. and precip. at 694 locations plus 4 indices).

We will expand the introduction on the EnKF and improve the readability of the technical paragraphs.

$$ In section 3 we read on the first line about the 'covariance localization' which presumably relates to equation 5. Unfortunately, the terminology is not introduced at eq. 5. Given the importance of localization to the results of this study, a less terse and more informative introduction seems to be in place.

The section about the covariance localisation will be expanded to better introduce the rationale and necessity for covariance localisation. Additionally we discuss the dependence of skill and analysis variance on different cut-off lengths for the covariance localisation.

$$ Other points to look into

$$ The pseudo-proxies used are of inter-annual resolution. The timestep of the model is much smaller than this timescale as well as the typical timescale of synoptic systems. At every timestep of the simulation, the EnSRF method takes the simulation to the pseudo proxies. The authors show that this leads to a reproduction of the pseudo-proxies in the simulations, but what does it do to the variability of the model on the timescales of the synoptic systems? The authors rightly claim that EnSRF has been successfully applied to a reanalysis study, where 6-hourly data are assimilated - no problem there in any suppression of internal variability. The authors should discuss the effects of their method on the level of synoptic scale variability in their data-assimilated simulations (like the activity/position of the storm tracks).

We do not feed the analysis back as initial conditions for the next analysis cycle (see below), thus the data assimilation has a negligible effect on the short-term variabil-

ity. Even when cycling the procedure, we do not expect a strong effect on day-to-day variability, as the adjustment (the update from the unconstrained simulation to the analysis) would still be carried out on seasonal (semi-annual) averages and very likely be small compared to daily variability. However, the procedure introduces artificial step changes at the boundary of adjacent seasons due to the update being different for different seasons. Nevertheless, the discrepancy between assimilation frequency and characteristic time scales of the atmosphere indeed deserves further attention when moving to a system with cycling.

$$ page 2838/2839: I don't really understand the reasoning why the corrected states need not be fed back into the system to give the next simulation. I see that the timescale of the pseudo proxy is much larger than the typical timescale of atmospheric processed, but the AGCM surely has a land surface model, with soil moisture and snow cover, and a swamp ocean as boundary conditions that introduce long timescales in the model. This also relates to the discussion on page 2849, lines 5 and 6.

We have chosen the present setup as we cannot afford to test a recursive data assimilation in a paleoclimatological context with a full-fledged AGCM (simulations with an ensemble of 10+ members and for several decades would be necessary). By using an atmosphere-only climate model, we expect very little long-term memory and therefore, there is no need to use the computationally more intensive and less flexible data assimilation with analyses providing new initial conditions. Furthermore, SST, sea-ice, and land-cover are prescribed in the AGCM used here. Soil moisture and snow cover might introduce long-term memory. In the case of snow cover only small areas in the high latitudes with snow cover by the end of April (northern hemisphere) or October (southern hemisphere) are affected. Whether there is significant long-term memory introduced through soil-moisture, we do not know at the moment. We expand the discussion of the initial condition ensemble used here to clarify these issues.

Interactive comment on Clim. Past Discuss., 7, 2835, 2011.