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Climate of the Past
Discussions

Interactive comment on "A 1500 yr warm-season temperature record from varved Lago Plomo, Northern Patagonia (47° S) and implications for the Pacific Decadal Oscillation (PDO)" *by* J. Elbert et al.

Anonymous Referee #3

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This paper presents a 1500-year long temperature reconstruction for the Northern Patagonia Icefield (NPI) based on a total brightness (TB) record from a sediment core from a proglacial lake (Lago Plomo). The paper builds on other previously described records: i) a precipitation reconstruction for Lago Plomo based on total Mass Accumulation Rate (MAR), ii) a temperature reconstruction from another regional lake core (Laguna Escondida, ∼140 km from Lago Plomo; both of these with the same lead author as this paper), and iii) the a multiproxy summer temperature reconstruction for northern Patagonia (Neukom et al. 2011), this latter record applicable for ∼1530 AD

forward only.

The age model for the core is based on varve counts and two 14C dates (at ∼140 and 1270 yrs BP). The core record is broken by an apparent slump at ∼1900 BP, leaving a floating chronology for the lower part of the varve record. Two 14C dates are used used to help verify the varve time scale in the upper portion of the record, and to constrain the age model for the floating chronology of the lower part of the core. A gravity core was also taken (going back to ∼300 yrs BP) and apparently yielded good replication for brightness after homogenization.

LOESS "trend removal" was applied to the total brightness (TB) record to remove multi-centennial and longer time scale variability. The removed low-frequency variability is believed to be due changes in glacier length driven by both precipitation and temperature, and is therefore not relevant to a temperature reconstruction; the same procedure was used for the earlier development of the MAR-based precipitation record

The TB record was calibrated over the period 1900-2009 using September-February (SONDJF) temperature data from the CRU 0.5 degree data (two adjacent grid squares were used). The correlation between the (detrened and smoothed) TB and the smoothed CRU is reasonably good (0.58), significant at the ∼95% level after accounting for autocorrelation; there is a substantial upward trend in both data sets (CRU and TB) over the calibration period. Because the TB data were LOESS-high-passed and later lopassed (5-year triangular filter) to remove higher frequency variability, the calibrated record is appropriate for centennial to sub-decadal time scales.

The calibrated TB-based SONDJF temperature record shows little clear association with the MAR-based precipitation record nor with the regional summer temperature reconstruction of Neukom et al. (2011). Comparison with the annual temperature reconstruction from Laguna Escondida (about 140 km from Lago Plomo) yields a correlation of 0.57. The lack of clear agreement between the TB-based record and the three other records (MAR-precipitation, Laguna Escondida precipitation and regional summer temperature) leaves the temperature reconstruction without strong support from other regional proxy records.

A main thrust of the paper evolves from the 20-year running correlations between the detrended and smoothed MAR-based precipitation reconstruction for Lago Plomo and the detrended and smoothed BT-based temperature reconstruction. These running correlations show decadal to multi-decadal periods of negative and positive values from 1530 AD forward, especially during the calibration period. It is suggested is these periods of in- and out-of-phase relationships might reflect variability in the PDO. For the calibration period, the proposed relationship appears to hold to a modest level, though this period of time holds only a few realizations, and the relationship is not especially clear. Broadly similar sorts of variability in MAR-BT running correlations are found for the period back to 1530 AD. Comparison of this record with the Mann et al. and MacDonald and Case PDO reconstructions, which themselves agree poorly, yields few convincing points of agreement.

This idea of PDO modulating the correlations between summer temperature and winter precipitation is explored further calculating the correlations using filtered gridded precipitation and temperature data sets (Legates and CRU). The Legates data results are shown and taken as at least consistent the proposed relationship (as they "sort of" do in the figure). Cluster analysis was applied to the Legates data (apparently) and the clusters were then segregated on the basis of PDO. This reviewer found the cluster analysis discussion difficult to follow. Apparently, the results support the proposed mechanism that the PDO modulates the meridional position of the winter westerlies (850 hPa winds are also used with the cluster analysis results) thereby causing the sign of the correlation between summer temperature and winter precipitation to change in concert with the PDO. This reviewer found the discussion of the cluster analysis and its results difficult to follow.

The paper is fairly well written, though the presentation jumps around quite a bit and this is distracting [for example, the running correlations are first discussed briefly in

Section 4 and then revisited in Section 5. It would be useful to help the reader along by stating in the Section 4 discussion that this topic (running correlations / PDO) will be revisited later]. The presentation of the calibration results needs to be more complete – the reader is only shown the comparison between the calibration and proxy data over a small part of one graphic – a more focused graphic for the calibration period and a scatter plot would be useful. In general, presentation needs a good bit smoothing and some reorganization to help the reader along. Introduce all abbreviations, methods (LOESS, cluster analysis etc.) and data used in Section 2 – for example, the Neukom et al. 2011,2012 and Laguna Escondida are not introduced until the results section and yet figure importantly in the analyses.

One major difficulty withe the paper is that no significance test results are presented concerning the running correlation / PDO analyses. Relatively large amount of low frequency variability the the MAR and TB records, especially 5-year low-pass smoothing, caution is advised in interpreting these results. The reviewer performed a simple analysis using two random [uniform(0,1)] time series smoothed so they have variability similar to the MAR-based precipitation and TB-based temperature in Fig. 5a-b. These random data sets produced a record of 20-year running correlations much like that in Fig. 5c. While this may not be a fully appropriate comparison, the point that it is relatively easy to obtain high running cross-correlations from smoothed random series. In this case, a 20-year segment of data smoothed with at triangular 5-year filter has at most a few degrees of freedom – high running correlations are bound to occur.

The paper would be improved with a more complete presentation of the calibration results– the only direct comparison between the the calibration and proxy data is shown in one small part of one graphic – a more focused discussion of the calibration and a couple of graphics for the calibration period (time series and a scatter plot) would be useful.

Minor Points

1) The discussion of sedimentation rate in the first 3 paragraphs of Section 4 would better be placed in the Section 3.

2) As noted above, introduce all method (LOESS, smoothing, clusters, etc), data (MAR and MAR-based reconstruction, Neukom 2011 and Laguna Escondida, and statistical measures (RE etc) in the methods and data section.

3) The records of Bertrand et al. 2012 (Clim. Past.) and Lamy et al. 2001 (EPSL) may have some use for comparison, but perhaps they have insufficient temporal resolution.

4) Make "up-welling" on P. 1776 "coastal upwelling".

5) Describe how the LOESS smoothing was done and show the response of the original data to the LOESS high pass filtering with span=0.85 (why was that large value used?). Show what has the LOESS done to the original data?

6) Would it be worthwhile to look at the PDO – temp/precip correlation question using results from long CGCM simulations?

7) It was difficult to follow the discussion of the cluster analysis method (beyond it was done) or the presentation of those results. This includes the legend for Fig. 6.

8) Color bars on Figs. 1 and 5 are hard are to read. Lettering on Fig. 3 is pretty small (or is it my eyes?). Why color the Neukom et al records and not the Lago Plomo results in Fig. 3?

9) The discussion of Fig. 6 and its legend were confusing.

10) (noted above) More complete presentation of the calibration results (e.g. a scatter plot and a figure showing the two time series over the calibration period only would improve the paper.

11) There is no discussion of the possible impacts of reservoir age on the 14C dates for this lake [though the use of terrestrial material should reduce possible issues (e.g. Geyh et al. 1998)], nor is much information given about the development of the age-

depth curve, nor the lack of an established age for the core top. A gravity core was also taken (going back to ∼300 yrs BP) and apparently yielded good replication for brightness after homogenization.

12) On the comparison between the Laguna Escondida record and the Lago Plomo TB-based temperature record It is not apparent by visual comparison that the records agree as well as a correlation of 0.57 might suggest, except for specific points noted in the presentation, and there are points of clear disagreement in the records. That the records agree at all provides the only external proxy support of TB record, so it is an important point to emphasize. Plotting the records on top of one another and/or a scatter plot would help bolster this result

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Interactive comment on Clim. Past Discuss., 9, 1771, 2013.