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Climate of the Past Discussions

Interactive comment on "A millennial multi-proxy reconstruction of summer PDSI for Southern South America" *by* É. Boucher et al.

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The reconstruction of climate variations over the past centuries, and even the last millennium, is essential to establish whether the observed climate changes in recent decades in South America can be considered within the range of natural variability in the continent. In this context, the PDSI reconstructions in South America are particularly relevant considering that regional economies largely depend on natural resources, which in turn are severely affected by climate variations. Therefore, the study presented by Boucher et al., can be considered a good attempt to achieve these objectives. However, several points should be considered when attempting to reconstruct the spatial variations of climate in South America.

First, the quality and quantity of meteorological observations in South America are

far from the Northern Hemisphere standards, particularly those in Europe and North America. Most of the scarce meteorological records in South America are not homogeneous (changes in location of stations) and have significant periods of missing data. Consequently, in the development of climate grids, instrumental records should be examined very carefully and only include those records that safely passed the most rigorous studies of homogenization. This task is not usually conducted in most processes and it is assumed that the meteorological data in South America met, particularly in the first half of the twentieth century, the same standards of quality than in the northern hemisphere. This is not true for most records.

Another problem of using gridded climate data in South America is related to its changing geography, particularly close to the Andean region. In grids of 2.5 x 2.5 degrees, as those used in this study, a wide variety of environments with different climatic regimes are included, often with opposing trends in long-term variations in both temperature and precipitation. For example, if we consider the grids located in the Andes about 70 w (green dots in Figure 1), in the same grid are mixed totally different precipitation regimes. West of the Andes, precipitation is concentrated in winter and comes from the Pacific Ocean, whereas east of the Andes is mostly summer rainfall and from Atlantic origin. In addition, during the past 30-40 years trends on both sides of Andes have been opposite. The following figure, centered on the Andes at 33°S, clearly shows the seasonal differences in precipitation between the two sides of the Andes. Thus, all grids centered around 70°W results from averaging non-similar patterns on precipitation. Consequently, we should ask what climate information is represented in the grids along the Andes and what climate variations we intend to reconstruct.

The situation is similar, or even worse, for the proxy records. Although there is a large number of proxy records in South America (the largest concentration in the Southern Hemisphere), this is a huge territory, and the total number of proxy records is orders of magnitude smaller than in North America or Europe. In addition, the geographic distribution of those records is totally non-uniform across the continent. All tree-ring records, which represent the only source of High Frequency (HF) records used in this study, are located along the Andes. The same applies for three of the four ice cores, the remainder in Antarctica! Only the sedimentary record from Mar Chiquita is in the lowlands east of the Andes, but as the authors point out, strongly influenced by the water regime of the subtropical Andes. The only marine record used is that of the Cariaco basin, which although located in South America, is at 10°N in the Northern Hemisphere! We understand that through climatic teleconnections the proxy records from the Andes may contain relevant information about climate variations in remote regions, but reconstructing for 1000 years the climate of the Pampas without any single record in it (Mar Chiquita is only used to verify the results) is very difficult to explain. All records of high frequency, tree rings most of them, end in the 1970s, 1980s and 1990s. How we can be confident that the years 2002 and 2003 in the region of the Pampas (PM), where there is no proxy records, "were never equaled in magnitude over the last thousand years", as the authors state.

I am not familiar with the methods used by Boucher et al. to develop the reconstructions. However, I see in this methodology a very good alternative to the traditional methods used in dendroclimatology for past climate reconstructions. Indeed, I greatly appreciate the efforts made by Boucher et al., to reconstruct PDSI spatial variations in South America. I want to make clear that my concern is not with the methodology and the work done, but with the lack of "maturity" of the climatic gridded systems in South America, and in particular with the proxy records. These limitations can lead to invalid results even when using the best methodology to reconstruct past climates. In a recent assessment of the status of proxy records in South America published a special issue of PPP in October 2009, in the introductory paper, the authors identify these issues as the largest limitations for the advancement of paleoclimate studies in South America. "We have identified two major thrusts for the direction of future research: (i) A dedicated effort to build a comprehensive, quality-tested, and homogenized set of climate data during the (early) instrumental period would be of utmost value to calibrate proxy data series, to test and extend reanalysis data sets, and to explore the multi-decadal

variability of synoptic-scale atmospheric features, and (ii) expansion of the database of robust well-calibrated paleoclimate data series of adequate quality, temporal resolution and spatial representation; currently, this is the bottleneck for further improvements of the reconstructions." These limitations should be clearly acknowledged in the manuscript.

Additional comments (on version cpd-7-153-2011print.pdf) follow: Page 155, line 4. In their work, Garreaud et al (2009) did not refer to differences in precipitation trends for different sectors of South America.

Page 155, line 8. Long-term variations of rainfall in different sector of South America are not related to the presence of the Andes, as authors stated (point 1). It is clear that the Andes introduce significant precipitation gradients across the continent. However, the interannual variability in precipitation is not regulated by the mountains but by the changes in the atmospheric circulation around South America. Also, latitudinal, longitudinal and altitudinal gradients are not the drivers of interannual variability as indicated in point (2) but the changing influences of tropical (ENSO) and high-latitude (AAO) forcings of climate in South America (as indicated in point 3). Please, rephrase this paragraph to make clear this issue.

Pag. 155, last paragraph. This paragraph should be rewritten to clearly indicate that "spatial reconstructions" of temperature and precipitation are recent for South America. Reconstructions of temperature and precipitation in South America from tree rings date from the decades of 1970 (LaMarche 1974) and 1980 (Boninsegna 1988, Villalba et al., 1989) and they are much more numerous in the past 20 years (see Boninsegna et al., 2009 for a review). The work of Neukon et al (2010 a,b) represents the first "spatial reconstructions" across southern South America using high-resolution records. It should be well established that the reconstruction of "spatial patterns" is new, local or regional reconstructions have been developed since many years ago. Pag. 156, line 4-5. The sentence: "(summer precipitations increased since the Little Ice Age, while winter temperatures decreased)", should be (summer precipitations increased since the Little Ice Age, while winter precipitation decreased).

pag. 157, lines 22, It is not valid to assume that the climate is completely uniform across the four proposed regions. For example, Garreaud (2007) shows that the climate along the Patagonia (region PG) is regulated by westerly winds (as it is indicated in the paper). However, its effect on precipitation is opposite between the east and west of Patagonia. More intense westerly winds are associated with increased rainfall in the mountains but less rainfall on the Atlantic coast. See the figure (Fig. 2b in Garreaud, 2007) attached below. Based on Garreaud's observations, it would be desirable to reconstruct the PDSI for two regions across PG covering the eastern and western Patagonia, respectively.

Pag. 158, line 2. Climate variability in subtropical South America (region SP) is not directly related to variations in the ITCZ. Please see the following references for more details: Vuille, M. and Keimig, F.: Interannual variability of summertime convective cloudiness and precipitation in the central Andes derived from ISCCP-B3 data, J. Climate, 17, 3334–3348, 2004. Garreaud, R. The Andes climate and weather. Adv. Geosci., 7, 1–9, 2009.

Finally, given the importance for readers of the following issues, they should be commented or discussed in the contribution: 1. Why the reconstruction is limited to southern South America (south of 20°S)? 2. Why the PDSI was reconstructed for summer and not for other seasons? 3. For the reconstructions, the tree-ring and other records were truncated according to their signal strengths (replications)? 4. A brief comparison with local or regional reconstructions of precipitation previously developed for different regions in southern SA should be included.

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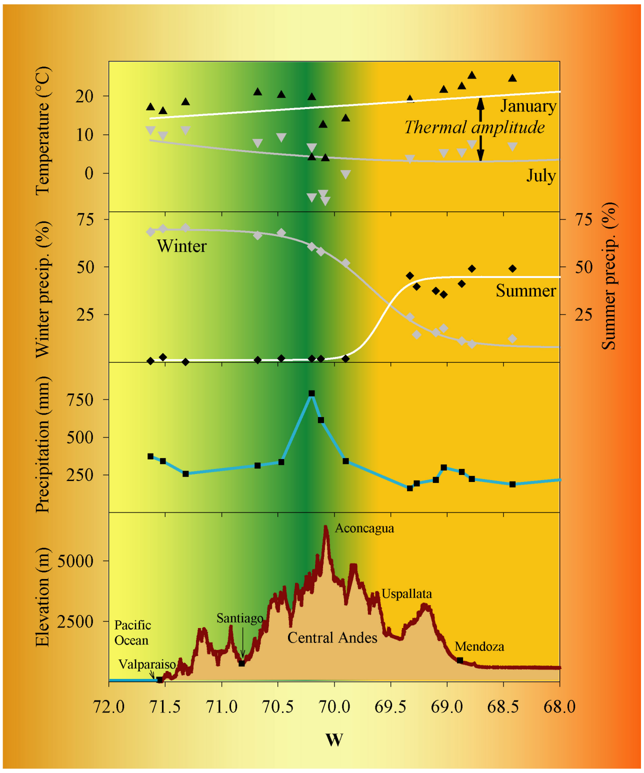

Fig. 1.

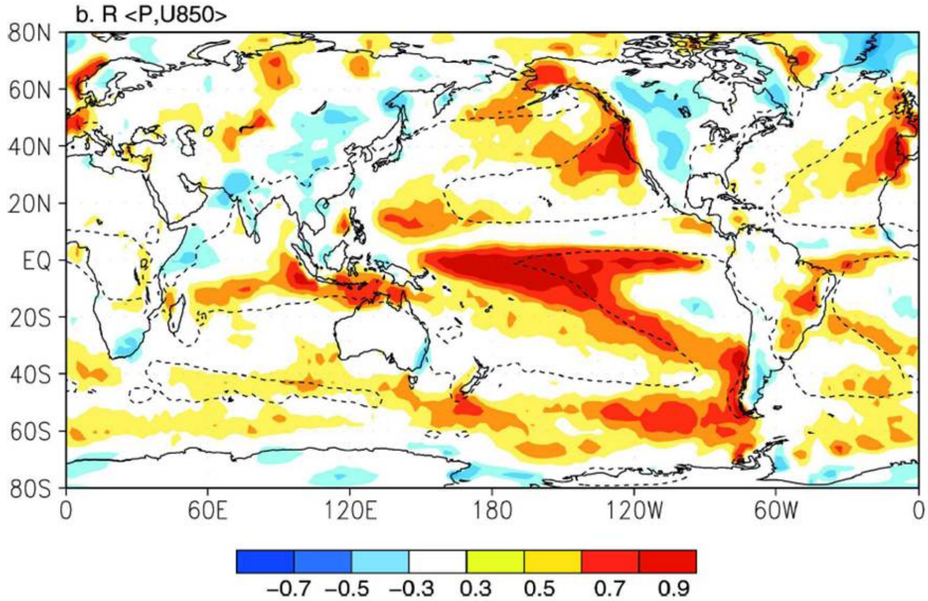

FIG. 2. (a) Map of local correlation between monthly anomalies of precipitation and 300-hPa zonal wind, scale at the bottom. Dashed lines outline regions where annual mean precipitation exceeds 1000 mm yr^{-1}. (b) Same as in (a) but for local correlation between monthly anomalies of precipitation and 850-hPa zonal wind.

Fig. 2.