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Climate of the Past Discussions

Interactive comment on "Response of regional climate and glacier ice proxies to El Niño-Southern Oscillation (ENSO) in the subtropical Andes" *by* E. Dietze et al.

Anonymous Referee #1

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General comments: This is a fascinating paper from a region where we still not very little about climate variability and history. The authors provide a comprehensive overview over the factors influencing winter and summer precipitation at a high altitude location in Mediterranean Chile along the border with Argentina and how they are related to ENSO. I fully support publication of this paper as it appears to provide significant new insight into the climate of this region for the last 50-100 years. I suggest only minor modifications, which include a more detailed discussion of the processes associated with summer precipitation in this region, as this appears to be one of the main results of this paper and a more cautious interpretation of results derived from gridded data over high-elevation, data-void terrain. I also believe that the ramifications from this pa-

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per may actually be more important than the authors realize. The coastal region of Chile where this study is located has seen a significant decline in precipitation during the 20th century (see Vuille and Milana, Geophys. Res. Lett., 2007; and Figure 3.13 in Trenberth, et al., 2007, In: Climate Change 2007: The Physical Science Basis. Contribution of WGI to IPCC AR4, Cambridge University Press). Since much of the fresh water in this region is derived from high altitude snowfall, the fact that high elevation precipitation may depend more strongly on tropical moisture, not affected by this downward trend, may be very welcome news.

Specific comments: -Page 177: When discussing the reasons for the significant impact of ENSO on winter precipitation in Mediterranean Chile, I think the authors missed one important aspect. The reason why the westerlies and the embedded jet-stream are displaced north is not solely due to a weaker SPA, but due to frequent blocking activity (high pressure of equivalent barotropic nature) in the Bellingshausen Sea (e.g. Karoly, J. Climate, 1989; Ruttlant and Fuenzalida, Int. J. Climatol., 1991). This blocking activity is the result of an upper tropospheric wave train emanating from the tropical Pacific linked to enhanced convective activity and related latent heat release over the warm pool area during El Niño events.

-Page 182, lines 18-20: I am not convinced that averaging ENSO-indices over three years wouldn't dampen the signal. ENSO has a strong biennial tendency rapidly switching from one phase to the other. Averaging over three years may suggest neutral conditions when in reality an El Nino was followed by a rapidly evolving La Nina event. Some of the strongest events of the last 50 years were of this biennial type (e.g. 1972-74, 1987-89, 1997-99) Averaging over these periods would suggest neutral conditions while in reality both a strong El Niño and a strong la Nina occurred.

-The authors mention that most studies in the Chile-Argentina border area are based on station data with poor coverage and short record length (page 177, bottom). This is true indeed, but there are in fact studies which use longer and high resolution records. Vuille and Keimig (J. Climate, 2004), for one, developed a high resolution gridded pre-

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cipitation data set from fractional cold cloud coverage using ISCCP-B3 data. The advantage of this data set is that it is based entirely on observations without the need for interpolation over high terrain due to lack of station data unlike the data set used here. Their results indicate that at 30S summer precipitation in the high Andes is not uncommon and related to an upper-air anticyclonic anomaly centered over southeastern South America, and associated easterly transport of humid air toward the subtropical Andes. Summer precipitation variability at this latitude is apparently no longer related to ENSO but rather a result of extratropical Rossby wave dispersion and modulation of the position of the Bolivian high. I think this study in many ways confirms the results by Dietsche et al and could be used to solidify their argument.

-Page 182, line 6-10: The fact that station data correlates well with the respective grid cell data is not really surprising since the gridded data represents a spatial interpolation from station data. The more interesting and unanswered question is whether the data set is also adequate over data-void regions at high elevations. While the answer may be yes for temperature I am less convinced that this is also the case for precipitation. Figure 3a shows little spatial variability in precipitation at higher elevations in either season, and even more disturbing, no east-west gradient across the Andes at all in summer precipitation. Hence I would be a bit more cautious when talking about 'high suitability' of this data set at high elevations. Falvey and Garreaud (J. Hydrometeorol., 2007) have shown that there are significant gradients across the Andes, albeit slightly further south, associated with (winter) precipitation, which appear to be completely absent in the data set used here. One way to gain some more insight into this issue would be to indicate which grid cells contain actual station input data (e.g. by marking them with a small dot in Figure 7) as compared to the ones based on interpolation from far-away locations.

-page 187-188: While the SE Pacific may have a strong influence on local temperature along coastal areas, I doubt that it is the cause of the large scale signal seen in this analysis. ENSO-related warming of the tropical/subtropical troposphere is circum-

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global and primarily driven by latent heat release in the tropical Pacific. (e.g. Chiang and Sobel, J. Climate, 2002; Chiang and Lintner, J. Climate, 2005). The related surface warming can also be traced back to the equatorial Pacific. Studies on surface temperature variability slightly further north in the Altiplano region for example indicate that temperature closely tracks SST anomalies in the central equatorial Pacific (Vuille et al., J.Geophys. Res., 2000), with no apparent connection to the SE Pacific.

-Page 190, Lines 18-21. I suggest being careful with statements about increased ENSO frequency associated with global warming. This is a subject of considerable uncertainty and most recent model assessments on this issue remain inconclusive (e.g. Collins, Geophys. Res. Lett, 2000; Cane, Earth Planet. Sci.Lett., 2005; Collins, Climate Dynamics, 2005).

Interactive comment on Clim. Past Discuss., 4, 173, 2008.