

Reply on RC2

Mariano S. Morales et al.

Author comment on "Drought increase since the mid-20th century in the northern South American Altiplano revealed by a 389-year precipitation record" by Mariano S. Morales et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2022-37-AC2>, 2022

We thank the reviewer for their thoughtful critiques and his time and consideration.

General comments

"The authors often cite the issue of water stress and how this can inform management - and this is alluded to in the text at several points. It could be useful for the authors to articulate exactly how their study can be used in management. It would provide context, but as written can not inform management of water supplies. Perhaps more articulation (in a few sentences) could be included in the discussion section of this paper. Overall the quality of the science and the manuscript is very high. There are a few areas where sentences are a little long, and need to be shortened and/or rephrased to make sure the information is not lost. I attach an annotated manuscript with corrections / edits for the authors to undertake."

To be more specific about the importance of paleoclimatic records as a source of information potentially useful for decision-makers, we rephrase the following paragraph in the Discussion section:

Droughts are of particular relevance in climate variability for this semi-arid region of the Andes. Therefore, the information provided by this study allows us to understand that mean dry condition dominates the instrumental period and the frequency of occurrence of extreme drought events in the present has no precedent in the past. Under a global warming context, the Altiplano's water resources are fundamental for biodiversity conservation and socioeconomic activities. The projected increase in evapotranspiration as a result of global warming, together with a wide range of variability among the precipitation models projected for the 21st century, may lead to growing demand for water in a region already under water stress. Knowing the long-term hydroclimatic variability in this region, we need to consider whether the current configuration of social and organizational structures are sufficient to provide the resilience and adaptation to successfully address current and future hydroclimatic changes. A better understanding of the future of Altiplano's water resources should be listed as priority for stakeholders and decision-makers to avoid social conflicts at both the local and regional levels. Under this complex political, social and environmental scenario, the results from our study are relevant to plan and implement adaptive strategies to reduce these vulnerabilities in the face of future water shortages.

Specific comments

Line 24. "There are several very long sentences in this abstract. I have tried to split some where possible. Please check that sentences are a little bit shorter - it makes it easier to read."

The abstract and manuscript were revised in order to shorten, where possible, very long sentences.

Line 29. "CLARIFY - this would need rephrasing - it doesn't quite make sense. What gap? Temporal? Spatial? In our knowledge of hydroclimatic change?"

To be clearer, we rephrase the following sentence:

However, in the northern sector of the Peruvian and Chilean Altiplano (16°-19° S) still exist a gap of hydroclimatic tree-ring records.

By

However, in the northern sector of the Peruvian and Chilean Altiplano (16°-19° S) still exist a gap in our knowledge of high-resolution hydroclimatic change based on tree-ring records.

Line 99 – 102. Do you mean >85% of the rainfall occurs from December to March? If so, you need to clarify this. If not, then it will need to be clarified as I'm not sure I understand. "Can you give actual numbers here - this isn't the best phrasing and has also appeared immediately before"

Thanks for the comment. We rephrase and split the sentence to be shorter and clearer.

The climate is semi-arid with dry-cold winters and rainy-warm summers, with a total annual precipitation that ranges between 290-400 mm. More than 85% of the total annual precipitation occurs during summer (December to March).

Line 300-302. "This description doesn't make sense. Can you rephrase"

To be clearer, we rephrase the following sentence:

Strong correlations ($r > -0.42$) were recorded centered in the periods 1885-1900, 1940-1955, 1965-1975, while sharp decreases in correlations were found centered in the periods 1910-1935, 1978-2000 (Fig. 6c).

by

Strong negative correlations were recorded centered in the periods 1885-1900, 1940-1955, 1965-1975, while a lost in the relationships was found centered in the periods 1910-1935, 1978-2000 (Fig. 6c).

Line 303-307. "Not sure this makes sense. What explains the high percentage. Need to split sentence into 2 and clarify."

The following sentence was rephrased:

Both, reconstructed precipitation and SSTs_N3 recorded dominant oscillations modes at decadal (Fig. 6d) and inter-annual (Fig. 6e,f) frequencies explaining high percentage of their variability. A correlation analyses among the main dominant oscillatory modes at

decadal 10.2 year (Fig. 6d) and inter-annual frequencies 6.2 year (Fig. 6e) and 3.5 year (Fig. 6f) of the precipitation reconstruction and the SSTs_N3 with 12.7 year, 5.6 year and 3.6 year, respectively, showed in the three cases significant negative correlations.

By

High percentage of the variability in the recorded precipitation reconstruction and the SSTs_N3 is dominated by oscillations modes at decadal (Fig. 6d) and inter-annual (Fig. 6e,f) frequencies. Correlation analyses among the main dominant oscillatory modes of the precipitation reconstruction and the SSTs_N3 at decadal (Fig. 6d) and inter-annual (Fig. 6e,f) frequencies, showed significant negative correlations. These results highlight the occurrence of common waveforms and demonstrate the ENSO signal in the precipitation reconstruction from the northern South American Altiplano.

Line 367-371. "The phrasing of this doesn't make sense. please clarify"

Original text: The wettest year recorded in our reconstruction is 1876, which is associated with the occurrence of a prolonged cool phase of the central tropical Pacific during 1870–1876 period (La Niña conditions), being the year 1876 the coldest SST record (Singh et al., 2018). This cool La Niña phase conditions reversed to a warm SSTs during the strong 1876/1877 El Niño event (Singh et al., 2018), which is registered in our precipitation reconstruction as an extreme dry year in 1877.

There was a dating error. The Niño event occurred during calendar years 1877/78 (Singh et al. 2018) and not in 1876/77 as stated in the original text. Therefore, the occurrence of the 1877/78 Niño event coincides with the occurrence of an extreme drought event recorded in the 1877 year of our reconstruction. The year 1877 of our reconstruction represents the months corresponding to November and December 1877 and January 1878.

We have changed the date in the new version of the manuscript

Line 380-383. "Can you give actual numbers here - this isn't the best phrasing and has also appeared immediately before".

The following sentence was rephrased for clarity:

It is important to place this increase in aridity conditions since the late 20th century -beginning 21st century observed in our northern record in the long-term context and the great spatial coherence and synchrony shown by all the other proxies records across the southern tropical Andes (Fig. 7 and Fig. S2), suggesting largescale common atmospheric and ocean forcings over this Andean region

By

In the context of the last four centuries of hydroclimatic variability provided by our reconstruction, the severe aridity conditions since the late 20th century are unprecedented. Due to its large spatial extent and temporal synchronicity, this extraordinary dry event across the Altiplano appears to be modulated by the action of large-scale atmospheric and oceanic forcings common to the entire region

Line 419-422. "Sentence too long and too complex. Please rephrase and clarify."

Segura et al. (2020) based on instrumental-satellite precipitation data for the southern region of the tropical Andes (12°-20° S; 60°-80° W), evaluate the common pattern of summer rainfall variation for this region during the period 1982-2018, identifying a

positive trend specially based in positive anomalies after 2010 that would be influenced by upward motion over the western Amazon.

To be clearer and shorter, we split the sentence as follow:

Segura et al. (2020) based on instrumental-satellite precipitation data for the southern region of the tropical Andes (12° - 20° S; 60° - 80° W), evaluate the common pattern of summer rainfall variation for this region during the period 1982-2018. They identified a positive trend especially after 2010, which would be influenced by upward motion over the western Amazon.

All typos have been corrected in the new version of our manuscript.