

Interactive comment on “The 2010–2015 mega drought in Central Chile: Impacts on regional hydroclimate and vegetation” by René Garreaud et al.

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Original comments in quotes "..."

Reviewer 1 (Dr. Trigo) Recommendation: Minor Revisions Summary

"This manuscript focus on the prolonged and intense Drought episode that struck Chile between 2010 and 2015. The authors provide a comprehensive characterization of this so called Mega-Drought event from various perspectives (meteorological, hydrological, anomalous climate dynamics, vegetation dynamics) but also considering the long-term context (last millennium), and finally providing some framing within regional warming

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background. The work is very interesting to read, with plenty of informative figures. The major problems I see are related with the level of novelty of this manuscript taking into account the contents of two other papers by the authors with some overlap in contents. I'm also particularly concerned with the amateurish attitude of the authors in relation to citations with so many missing and wrong references. Thus, I believe the paper can be accepted if the authors improve the manuscript taking into consideration the following clarifications listed below"

R. Thanks for your overall assessment of our work. We plan to fully address your major and specific comments in order improve the quality and readability of our manuscript. Major issues

"1. Level of originality Despite the overall good quality of the work presented here I must confess that an interested reader cannot be entirely sure on the level of originality of the contents included in the manuscript, particularly taking into account the two sister publications carry out by these authors, and covering (at least in part) the same Mega-drought event (Boisier et al., 2016 and Garreaud et al., submitted). While I can understand perfectly well that such a major event can be characterized from multiple perspectives, it is not entirely clear the level of superposition (if any) among these three manuscripts. Please provide a clarification on this important issue."

R. Thanks for pointing this out. The paper by Boisier et al. (2016), published in GRL, focuses on the rainfall trends in this region from the late 70's onward and attributes these trends to both natural variability (ENSO+PDO) and anthropogenic forcing. Of course, the current mega-drought contributed to the existence of this trend, and an attribution exercise was done, but the actual mechanism behind the protracted dry condition was not unveiled. We plan to investigate those mechanism in a paper cited in the HESS manuscript as Garreaud et al. submitted. It turns out that such paper was rejected and we are currently working in a new version including some long numerical simulations. In any case, the soon-to-be manuscript (intended for J. of Climate) only addressed the large-scale atmospheric forcing of the central Chile mega drought (here

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is the problem...we know that a major part of the drought was ocean-forced, but we don't know yet which part of the ocean was most influential...at least not the tropical Pacific). In the new version of our HESS manuscript we also plan to cite a handful of published papers on previous droughts in central Chile. None of those past events persisted for more than 3-years. This is precisely a novel aspect of the current event... its very long duration (7 years now).

In sum, the new version will explicitly state that our manuscript is the only scientific work addressing the physical, regional aspects of the central Chile mega drought, an event that is unprecedented in itself.

"2. References The authors were extremely careless with the references. It is unacceptable that you have so many missing and wrong references, including papers by the authors (?). This is quite distracting when a reader is trying to put the scientific questions in context of previous literature."

R. We deeply apologize for this mistake (my mistake!). We pasted an old version of the reference section in the submitted version...this explains the numerous omissions. Of course, the revised version will include a full, updated list of references. We also will take the opportunity to correct several typographical, spelling and usage errors.

"Minor suggestions 1. (Introduction, 2nd parag) The authors introduce several major droughts that have occurred around the world in the last two decades. Taking into account the amount of people affected and the outstanding implications I would like to suggest to add the Middle East (or Fertile Crescent) drought between 2007-2012 (Trigo et al., 2010; Kelly et al., 2005)"

R. References to these analogs will be added. Thanks for pointing them out.

"2. (Page 5, lines 22-23) This statement that winter precipitation corresponds to >75 needs a reference to support it. More importantly, this is not consistent with Fig. 1b where winter precipitation for regions south of 33°S represents less than 75%. Please

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rewrite sentence, adapting to the large N-S gradient of winter precipitation contribution"

R. Good point, the 75% winter accumulation is only a reference (this is why we include Fig. 1b) and text will be rephrased.

"3 (Page 6, lines 32-33) The marked West-East gradient in precipitation is not so clear at all latitudes as it happens mostly in the central section of Chile. North of 33°S and South of 38°S it appears to be negligible."

R. The map in Fig. 1b has not enough data to portrait the zonal gradient (and actually, there is no much data in the high Andes). Text clarified.

"4 (Page 7, lines 23) I believe this low-order correlation refers to the autocorrelation coefficient? If so please clarify it."

R. Yes, autocorrelation. Corrected.

"5 (Page 8, lines 2-3) If you have continuous precipitation data from 1960 until 2015 why restricting the historical comparison period to the 1961-2000 (40 years) instead of considering 1960-2009 (50 years)?"

R. The auto calibration model to obtain the SPI only needs 40 years, but we have expanded the reference period and results don't change significantly. Commented in the new version.

"6 (Page 8, lines 3,5,9) Although there are no standard procedures, the SPI acronym is usually employed as such, the temporal scales should be added as indices (or brackets). Please consider adapting the cumbersome SPI-12D to SPI12D or even SPI12"

R. Done, we will use SPI12D

"7 (Page 11, lines 27-28) Can you provide some additional information or literature for the Andes regarding the separation of the role played by diminishing precipitation and increasing temperatures in terms of reduced snow pack."

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R. We wish we could, but to our knowledge such comparison hasn't been done for the Andes. It will be commented.

"8 (Page 12, line 11) Please check if Fig.8 should be Fig.9 here." R. It actually refer to Fig. 8d. Changed.

"9 (Page 13, line 5) Please check if Fig.9b should be Fig.10b here." R. Thanks for pointing this out...we changed to Fig. 10b

"10 (Page 13, lines 18-22) This increment of DTR is consistent with the remaining of South America? Until the AR4 IPCC report in 2007 the DTR was diminishing in most areas of the world, but that has changed in the last decade. Can you provide a little bit more of regional (remaining S. America) and temporal (changes in DTR trend signal) context."

R. This is an interesting point. Along Chile are the warming trend is very marked in the maximum (daytime) temperatures but much smaller in the minimum (nighttime) temperatures. As you pointed out, this is contrary to most of continental land masses. Right now we only can note and hypothesize on this: during daytime there is entrainment of the free tropospheric air into the mixed layer that otherwise is not warming due to the ocean influence. This will be commented in the new version.

"11 (Page 13, line 25) Please check if Fig.10b should be Fig.11b here." R. Thanks for pointing this out...we changed to Fig. 11b

"12 (Page 13) Please check carefully all Figure numbers. Some appear to be lagging by one (e.g. Figure10c means Figure11c, Figure12b means Figure13b)." Yes, there was a problem with the figure numbers. Problem fixed.

"Figures Fig.1d The scale used is a bit misleading. Every station appears with the same reddish color and it is very difficult to distinguish regions. What is the point of presenting the range of possible values between -1 and 1? Please compress the possible values to the range [0 1] or even [0.5 1]. That will provide a much more informative plot."

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R. We modified the color scale (distributed between +0.5 and +1 in new version).

"Fig.5a and Fig.5b. Can you explain how come a few stations present a positive rainfall trend (Fig.5a) or streamflow trend (Fig.5b) in the midst of strong negative trends everywhere else?"

R. We only can speculate in problems with the data. We are doing an extra quality control for them.

Fig.9 Please provide a clear link between each subpanel letter (a,b,c,d,e) and the corresponding section in the figure caption. R. Caption corrected.

"Fig.10. Please provide the meaning of the regression dashed lines in the figure caption." R. Caption corrected.

"Fig.12. If you describe first Fig.12b and then Fig.12a why not provide the information in the logical reverse order, i.e. place the map on the left (becoming Fig.12a) and the scatter plot on the right (becoming Fig.12b)?"

R. Order altered following your advice.

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