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Interactive comment on "Glacier equilibrium line altitude variations during the "Little Ice Age" in the Mediterranean Andes (30°–37° S)" *by* Álvaro González-Reyes et al.

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We greatly appreciate your comments and suggestions in order to improve our manuscript. Many thanks. In order to check our modeled annual ELA for the 1979 – 2015 period, we contrast it with ELA information at annual resolution, obtained from Landsat images for five glaciers located across the Mediterranean Andes region (Juncal Norte, Olivares Gamma, Cipreses, Cortaderal and Universidad). Landsat images (MSS, TM, ETM+, OLI) have been widely used to obtain snowlines on glaciers (Rabatel et al., 2012, 2013; Wastlhuber et al., 2017; Rastner et al., 2019). The free access to images and the high acquisition frequency allows us to count with a long-time coverage of many glaciers worldwide. To contrast our modeled ELA with observations, we used ten years for comparison within the 1986 – 2014 period due to availability of images by this Andean region. In the results section, we comment that our ELA model presents similitudes with the ELA values from Landsat images (Figure 1). Our results show a good ELA representation for Juncal Norte and Olivares Gamma glacier (Figure 1a), which are located around of 33°00'S and 70°10'W within the MA region. Our modeled annual median ELA shows congruence with annual ELA values derived from Landsat images within 1979 – 2015. In this location of the MA region, our modeled ELA reproduces well the annual average ELA condition. In the case of satellite-derived ELAs from Universidad, Cortaderal, and Cipreses glaciers, our model shows an overestimation (Figure 1b). We think that differences between hydroclimatic patterns over the MA region (i.e., annual precipitation distribution and spatio-temporal variability) are essential to explain these differences in both locations of MA. A previous study carried out by González-Reyes et al. 2017 exposes spatio-temporal hydroclimatic differences in the MA region. We think that such previously documented temporal ELA differences are associated with interannual variability due to ENSO in the northern portion of MA (30° - 33°S), while from 34°S southward, the multidecadal hydroclimate variability, e.g. precipitation, is associated with the Interdecadal Pacific Oscillation (IPO). In the new version of our manuscript, we added a full description on the annual ELA estimation methodology using Landsat images. In addition, we added a new table (see table 2) that summarizes the specific values of annual ELAs calculated for each glacier, along with the associated total error.

Technical specifications

Line 475. Include the chapter tittle in the Kinnard et al 2018 reference. This is a key reference and only the book tittle is given.

We included the chapter title of Christoph Kinnard and coauthors 2018 in the manuscript. Thanks.

Figure 2. Please indicate what the boxes, dashed lines and circles indicate (percentile confidence intervals?). Include this information in the other box plots of the manuscript (Figs A1 and A2).

We added a full description of the dashed lines and circles. Thanks.

Figure 3. According to recent inventories, modern medium elevation (climatic ELA proxy) for all debris free ice masses of MA is close to 4300 m asl, ranging from over 2400 to over 6500 m asl. This figure does not accurately represent the present value or the large variability of probable modern ELA.

This Figure shows the ELA results for each GCM used as input for our mass balance model. As the Reviewer noted, the resolution of each GCM does not allow to identify local ELAs, which also depend on local factors. The range of values mentioned by the Reviewer is related to these local factors. Hence, it refers to a spatial variability within the MA during a very specific time (year of the inventory), while our Figure shows a time series. As we mentioned in Page 6, Line 145, we used the concept of "Regional ELA" with the aim to identify the generalized response of the glaciers within the MA.

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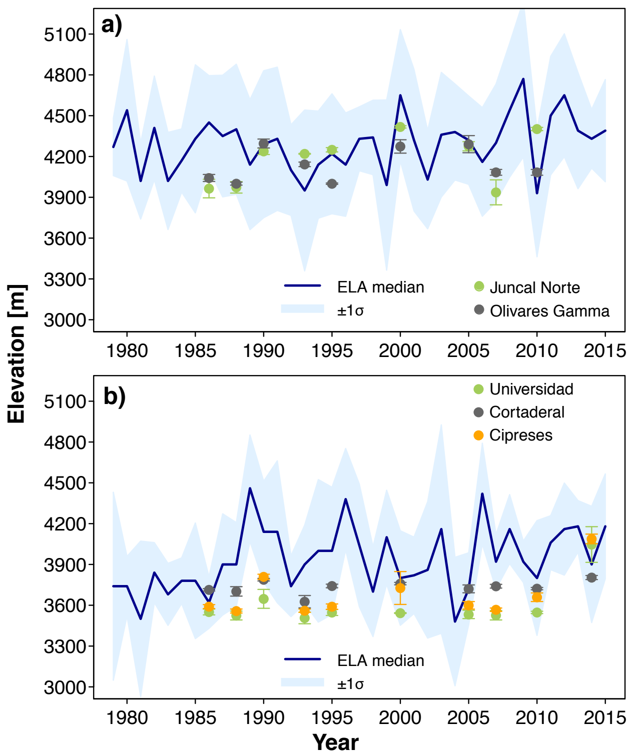

a)
b)
Elevation [m]
5100
4800
4500
4200
3900
3600
3300
3000
1980
1985
1990
1995
2000
2005
2010
2015
Year
ELA median
±1σ
Juncal Norte
Olivares Gamma
Universidad
Cortaderal
Cipreses

Fig. 1.