

Interactive comment on “Volcanism and climate change as drivers in Holocene depositional dynamic of Laguna del Maule (Andes of central Chile – 36° S)” by Matías Frugone-Álvarez et al.

Anonymous Referee #3

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Frugone-Álvarez et al. characterized and discussed a very complex stratigraphy from Laguna del Maule in central Chile. Their reconstruction is supported by a wide range of sedimentological, geochemical and biological proxies. The integration of all these datasets is used to reconstruct the local volcanic history, as well as regional paleoclimate trends and potential mechanisms. This is a very comprehensive manuscript, with regional and hemispheric implications. Unfortunately, the chronology shows significant uncertainties, although the authors correctly considered them for their paleoenvironmental inferences. I think this study represent a genuine contribution to a better understanding of past volcanic and climate changes in South America, and consequently I recommend its publication in Climate of the Past after some modifications.

I can recognize only one major issue in this study, which is related to the interpretation of the pollen data. A significant number of minor corrections are outlined at the end of this review.

Interpretation of the pollen data In Line 383 the authors mention that the pollen data reveals “sparse vegetation and relatively high Ephedra/Poaceae ratio would suggest relatively humid conditions facilitating an upward shift of lower vegetation belts.” How can humid conditions facilitate an upward expansion of lowland vegetation? In most mountain regions humid conditions tend to promote downslope invasions of high-altitude taxa. This should be the case in the Laguna del Maule area, as rainfall increases with elevation (Supplementary Figure S4). In my opinion the authors should reconsider their vegetation-climate interpretations or, alternatively, provide supporting information.

In addition, is hard to understand how an upward expansion of lowland vegetation can be expressed by a rise in the Ephedra/Poaceae index of Figure 7. To my (rather limited) understanding of the flora of Chile, several species of the Poaceae family are commonly found in the high Andes, with their altitudinal distribution being, on average, higher than Ephedra. Can the authors state which are the relative climate affinities of Poaceae and Ephedra? I think this would clarify the interpretation of the index. There might be also a methodological problem in the actual index calculation. The pollen ratio in Figure 7 was calculated from the formula $(a-b)/(a+b)$; where “a” corresponds to Ephedra and “b” corresponds to Poaceae. Yet, in Figure S12 Poaceae shows higher abundance than Ephedra in almost all samples ($b>a$). If so, shouldn't the ratio be dominated by negative values? This issue makes the understanding of this index a bit confusing. For instance, the high values seen at the beginning of Phase 3 and during Phase 6 (Figure 7) are hard to reconcile considering that these phases are actually associated with rises in Poaceae and a drop in Ephedra (supplementary Figure S12). It would be great if the authors address this issue and ensure that the index is well calculated.

Finally, although I am not sure how was the index calculated; from my understanding of the regional vegetation and the pollen data of Figure S12, the index in Figure 7 could

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be directly proportional to regional humidity. In this case, high index values during pre-Holocene and the late Holocene time would indicate relative high precipitation, whilst low values during the early to mid-Holocene would reveal a drop in regional precipitation.

Minor corrections Line 6. “We produce an age model based...” Line 7. “According to this age mode, early Holocene...” An adjective for early Holocene is missing in this sentence. Line 12. “During the late Holocene, the tephra layers show...” Line 21. Consider change sentence to “. . .have documented major changes in the productivity of terrestrial ecosystems, atmospheric and oceanic circulation...” Line 22. “western slopes” Line 32. “. . ., does show that this is a regional hazard to central Chile.” Line 49. “. . .during known rapid climate changes...”. There is no need to create an acronym (RCC) if it is not going to be used again. Line 51. “70°30’W” Line 68. “CO2” Line 130. Please provide the country of the Keck Radicarbon Facility. Line 135. It seems that radiocarbon ages were not calibrated and simply reported as conventional 14C years. This might be problematic and inconsistent with Figures 5 and 7, which have their temporal axes in the calendar age scale. Please provide an explanation to this issue. Line 139. There is no explanation of how the Quizapú ash layer was identified in the methods section. There is a mention later (Line 310), but in my opinion it should be included here. Lines 169-171. There is something missing in the sentence starting with “The finer grain size of ...”. Please revise. Line 175. “Biogenic silica concentrations range from 5 to 26%...” Line 178. “Well-define peaks (throughs)...”. Not clear. Line 284. “ratios” Line 284. Please provide a climate interpretation for “an upward shift to lower vegetation belts”. Line 298. “the promulgations of the forest law in 1931 that had a large impact in deforestation. . .” How can a deforestation process be associated with a sharp increase in a tree (Pinus)? Line 300. “Unit 4” Line 307. “likely due to. . .” Line 338. “36Cl”. Line 352. Triggering process (3) does not follow the same grammatical structure than processes (1) and (2). Line 377. Unlike all the other variables, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ are not shown in Figure 7. Perhaps it will be useful to include them in order to facilitate comparisons. Line 382. “(Meyers and Teranes, 2002)” Line 395. “. . .settings),

reflecting..." Line 417. "...beginning of this phase followed by a decreasing..." Line 446. "...exhibits centennial-scale oscillations..." Line 473. "carbonate-producing" Line 494. In which way a strengthening of ENSO would lead to a southward shift of the ITCZ? Line 494. Define "ITCZ" Line 509. "...a progressive increase up to...". A progressive increase of what? Line 519. "...during the early-to-mid Holocene, with clear..." Line 530. "mid-latitude" Line 531. "Variation in the strength of the..." Line 542. "...favors a climate influence..." Line 555. "Both greater fluctuations in water levels..." Line 565. Define "LIA", both acronym and chronozone. Line 566. Provide chronozone for Medieval Climate Anomaly.

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