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Climate of the Past Discussions



# *Interactive comment on* "Extreme warming rates affecting alpine areas in SW Europe deduced from algal lipids" *by* Antonio García-Alix et al.

**Anonymous Referee #2**

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García-Alix et al. studied long-chain diols extracted from sediments from 2 cores from Laguna de Rio Seco. Long chain diols are novel biomarkers in lacustrine environments that have not been used for paleo-reconstruction, but, from what is known from the marine realm, they could be a good paleo-thermometer. The authors used the LDI, which is the ratio of different long-chain diols, calculated following Rampen et al. (2012) and calibrated against air temperature from different instrumental stations from lower elevation corrected for altitude effect. From this calibration, based on the last 100 years of instrumental record, they extrapolate LDI temperature on the last 1500 years. From the diol distribution in LdRS the authors deduct a different source organism than though until then, i.e. freshwater eustigmatophytes.

Global comments: The study site is extremely interesting, as Mediterranean alpine en-



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Discussion paper

vironments are prone to rapid changes, and uncovering the causes of environmental changes in these high elevation sites would be helpful for understanding future climatic changes. Furthermore, long-chain diols are rarely used in lacustrine environments and developing a temperature calibration would be particularly interesting as long-chain diols are commonly found in lake sediments globally distributed (Rampen et al., 2014). However, Rampen et al., 2014 did a thorough study (n=62 lake sediments) of possible correlation of the LDI and diol fractional abundances with annual mean air temperatures and/or GDGT-reconstructed lake temperatures and concluded that LDI does not seem applicable in lake environments. As such, why is only LDI tested for temperature and not any other diol fractional abundances mentioned in Rampen et al. (2014)? In particular, as the C32 1,15-diol seems to have a positive relation with temperature in cultures (as in Rampen et al., 2014, Goniochloropsis) and the author's dataset, why not test for the C32:0 1,15 over the C32:1 1,15? Only one m/z has to be added to the SIM mode (m/z=339). More details on seasonal temperature calibration would be interesting to mention as diol are subject to seasonality (Smith et al., 2013; Lattaud et al., 2018). Furthermore, the conclusion on the organisms producing the diols lacks concrete evidence, as the LDI (a ratio) gives no indication of diol-producer abundances. It would be better to compare the concentration of diols in the sediment with the number of cysts. As the lake studied is so specific a thorough study of all diol present are needed (especially if any source organisms is hypothesized) and should be reported at least as results such as 1,14-diols, C32 1,16-diol, C34 1,17 etc.

L27: what do you define as extreme responses?

L29: Rather than "algal lipids" the study calibrated algal lipid proxies

L30: Rephrase "extending alpine temperatures backward 1500 years", I suggest: "extending alpine temperature reconstructions to 1500 years before present"

L60: Instead of "this is the case", "as it is the case"

L87: Willmott et al., 2010 would be a reference to mention in term of nutrient proxies

L182-183: In Table S7 21 samples are reported for the long core.

L197: How was the concentration evaluated as no internal/external standard is mentioned?

L215: spacing between “from 1965 to 2011” and “(Spanish National. . .”

L218-220: Is there any GDGT/alkenones detected? As they could provide another independent temperature for calibration.

L265: “(C28, C30 and C32 1,13- and 1,15-diols)” do you find the C32 1,13-diol? Furthermore, there is no significant difference between the diol distribution of the short and long core recent samples (last 200y) and what has been previously published, that should be stated in the manuscript or a statistical test should be provided if the authors think otherwise. Only the samples from the LIA seems to fall close to the marine sediment distribution and might point toward a shift in producer but could also be an adaptation to the cold from the same organism, a more detailed discussion is needed.

L273: due to their small size (<3 um), eustigmatophytes are usually overlooked during planktonic study that does not include DNA sequencing. DNA sequencing on the modern lake water would bring stronger evidence.

L275: quite a bold statement without explanation in the text, explain the method to obtain the figure S3 (cyst count and identification). As the diol distribution is not significantly different from the previously published distribution a more thorough discussion is needed on why Chromulina spp. are potential diol producers and not freshwater eustigmatophytes. The comparison on fig S3 between LDI and Chromulina cyst is not an evidence as LDI do not correlate with diol abundance (it is actually independent), nor with diol-producer biomass (Balzano et al., 2016). Are any long-chain alcohols present? Or Long-chain ketones? As they would give idea on the producers (Volkman et al., 1999) and the possible state of degradation of the sediments (Versteegh et al., 2000).

L298: In figure 3 there is a group of points (LDI between 0.23-0.27) that deviates from the general correlation, are they all from the same period? Such as the LIA? If so, the LIA seem to be significantly different from the rest of the core and need to be handled independently.

L304-306: doing an outlier test would provide significance to this statement on the 1973 samples.

L350: Fig4 should be inversed with Fig5 as Fig5 is discussed before in the manuscript.

L352: The argument is reverse, the tree ring record supports the LDI data as it is a more known and used proxy.

L352-354: Are the warming rate from Southern Europe/Spain also stabilizing?

L433: The LDI record does not have a sufficient resolution to recognize a 1 year-long event.

L437-438: The cooling in the LDI of 1450-1500 and 1690 CE could also be attributed to solar minima rather than volcanic eruption. What about the volcanic aerosol from 1200-1300 CE that do not seem to impact the LDI in LdRS?

L473: Precise the number of samples analyzed for the MCA. The MCA baseline seems to be only represented by one samples, the rest of the MCA samples are much cooler. An average temperature of all the MCA samples is a better representation of the MCA temperature and can be used as MCA baseline.

L477: Precise the number of samples analyzed for the LIA

L497-498: Provide a reference for the statement: “Future scenarios are not optimistic for Sierra Nevada alpine areas either as projected temperature may rise at least $\sim$1.4 $^{\circ}$C by the end of the 21st century”

L544: Is the temperature records mentioned from this study or from instrumental data, is there any precipitation reconstruction existing for this region?

Fig 2b: the dashed line is almost not visible, either change colors or thickness. Add the timing of LIA and MCA to the figure. Add the temperature records from the instrumental data to help comparison.

Fig S1: Correct “row” by “raw” in (a) (c) (e) (g) (i) and (k). Add unit for axis y

Fig S3: Please, add legend to the y axis. The authors use r and not r2 like in other figures, homogenize.

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