We thank the referee for their positive comments about the value of this paper, and particularly the application of a correction for the physiological effects of low CO2 and the use of a more robust technique and expanded training data set for the reconstructions.

In response to the specific comments (Original comments are in **bold**, our response in *italics*, with suggested changes in the text in normal script):

Age control and stratigraphy – the referee suggests that we could discuss further, and help the reader to assess, the chronological uncertainties and consider the stratigraphical complexity of this very dynamic environmental setting which must also bear on the uncertainty of the age-model, and that comments about very specific D-O events (e.g. lines 331-334, line 404) should be checked and revised to reflect realistic caution about the attributions.
We agree that the quality of the age model is very important. We cite the paper describing the age model in detail in the text (Valero-Garcés et al.) – this paper is accepted for publication and we expect this to be published in the next few weeks. However, we intend to include a new figure with the Bayesian age model for this record and some explanation in the Supplementary Information, so that the readers can make an assessment of the reliability. We identified the D-O events based on the known age of these events in the Greenland ice core, and we made no adjustment to our age model. The fact that pronounced changes occur at the appropriate age may, of course, be by chance but this seems unlikely. However, we can modify the text to make it clear that these were identified purely based on their ages (line 331 onward) as follows:
Some of these (Supplementary Fig. 4) clearly occur at times that correspond to D-O events, including D-O 20 (72.28-70.28 cal ka) and D-O 19 (76.4-74 cal ka) in MIS5a and D-O 9 (40.11-39.81 cal ka) and D-O 8 (38.17-36.57 cal ka) in MIS3. Heinrich Stadial 2 (26.45-24.25 cal ka) also clearly corresponds to an interval of year-round cooling in our reconstructions. Gaps in the pollen record, and poor dating resolution in some parts of the record, preclude identification of all of the D-O and Heinrich events. However, where abrupt events that appear to correspond to D-O events are registered, they were characterized by a marked increase in seasonality – this explains the apparently anomalous high seasonality recorded during some parts of the glacial (Fig. 5).
We will also modify the text at line 404 to be more specific, as follows:
Orbital forcing was not the only cause of enhanced seasonality at Villarquemado, since we also see enhanced seasonality associated with intervals of abrupt warming that appear to correlate with D-O events (e.g. D-O 9).

Given that forest development in dry sectors of the Mediterranean is generally considered to be limited by moisture availability, the authors should comment on why the lowest moisture availability is reconstructed for the interval with highest Mediterranean taxa and why the vegetation transition from xerophytic grassland steppe to forest development would imply reduced moisture availability.
The highest levels of MI occur in the late glacial when the abundance of Mediterranean taxa are low, but this probably reflects the impact of CO2 on tree growth. Relatively high lake levels, and higher moisture availability during the Lateglacial than the first part of the Holocene, have been recorded in other regional lacustrine sequences (i.e., Valero-Garcés et al., 2000, 2004; González-Sampériz et al., 2006, 2017; Morellón et al., 2009). Low MI around 10ka corresponds to an interval when steppe is prominent (increase in Artemisia and Chenopodiaceae:

Aranbarri et al., 2014) and there is a marked decrease in Pinus diploxylon (and Cyperaceae). These arid and/or still cool conditions for the beginning of the Holocene have been identified in different lacustrine sequences from inner Iberia and related to intense evapotranspiration due to high summer insolation and extreme warm temperatures (Morellón et al., 2018). There is a slight increase in MI during the middle Holocene when seasonality is reduced and therefore, evapotranspiration too; this appears to correspond to an increase in Mediterranean taxa (mainly evergreen Quercus) (Aranbarri et al., 2014). In addition MI is a ratio of annual precipitation to evapotranspiation; our Mediterranean assemblage includes trees and shrubs that are tolerant to increasing evapotranspiration (Quercus rotundifolia, Oleaceae, Rhamnus, Helianthemum) which would be a likely scenario during the Lateglacial-Early Holocene with increasing temperature. Such situation with increasing temperature, and evapotranspiration under increasing CO_2 *is fully compatible with the development of woody Mediterranean vegetation.*

- Aranbarri, J., González-Sampériz, P., Valero-Garcés, B., Moreno, A., Gil-Romera, G., Sevilla-Callejo, M., García-Prieto, E., Di Rita, F., Mata, M. P., Morellón, M., Magri, D., Rodríguez-Lazaro, J., and Carrion, J. S.: Rapid climatic changes and resilient vegetation during the Lateglacial and Holocene in a continental region of south-western Europe, Global Planet. Change, 114, 50-65,

- González-Sampériz, P., Valero-Garcés, B.L., Moreno, A., Morellón, M., Navas, A., Machín, J., Delgado-Huertas, A., 2008. Vegetation changes and hydrological fluctuations in the Central Ebro Basin (NE Spain) since the Late Glacial period: Saline lake records. Palaeogeogr. Palaeoclimatol. Palaeoecol. 259, 157–181.

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- Morellón, M., Valero-Garcés, B., Vegas-Vilarrúbia, T., González-Sampériz, P., Romero, Ó., Delgado-Huertas, A., Mata, P., Moreno, A., Rico, M., Corella, J.P., 2009. Lateglacial and Holocene palaeohydrology in the western Mediterranean region: the Lake Estanya record (NE Spain). Quat. Sci. Rev. 28, 2582–2599.

- Morellón, M., Aranbarri J, Moreno A González-Sampériz, P., Valero-Garcés, B.L. 2018. Early Holocene humidity patterns in the Iberian Peninsula reconstructed from lake, pollen and speleothem records. Quaternary Science Reviews 18: 1-18.

- Valero-Garcés, B.L., González-Sampériz, P., Delgado-Huertas, A., Navas, A., Machín, J., Kelts, K., 2000b. Lateglacial and Late Holocene environmental and vegetational change in Salada Mediana, central Ebro Basin, Spain. Quat. Int. 73–74, 29–46.

- Valero-Garcés, B.L., González-Sampériz, P., Navas, A., Machín, J., Delgado-Huertas, A., Peña-Monné, J.L., Sancho-Marcén, C., Stevenson, T., Davis, B., 2004. Paleohydrological fluctuations and steppe vegetation during the last glacial maximum in the central Ebro valley (NE Spain). Quat. Int. 122, 43–55.

Supplementary Figure 3 showing the impact of moisture index correction for CO2 against time is one of the major findings of the study, and could usefully be incorporated in the main paper.

We agree that this is an interesting figure and we will move it into the main text.

Minor comments:

Line 61. The record cannot really be described as "continuous" in light of several intervals with poor pollen preservation and hence no reported pollen spectra (e.g. lines 207-208).
We agree that there are gaps in the pollen record, and will take out the word continuous.

Line 197. Is the local evergreen oak Q. ilex subsp ilex or Q. ilex subsp rotundifolia?
The local evergreen oak today is Q. ilex subsp rotundifolia. Unfortunately, it is not possible to distinguish these sub-species in the pollen record. However it is highly unlikely that Q. ilex subsp ilex was present in the area as this taxon would not tolerate the extreme temperatures that occurred in Villarquemado throughout the whole sequence because of its continentality.

Line 197. Q. faginea is generally classed as a deciduous (or marcescent) species, rather than evergreen.
It is somewhat difficult to know whether to classify marcescent species, such as Q. faginea, as deciduous or evergreen. For our reconstructions (see Supplement) we divide the Quercus taxa into the three groups, strictly evergreen, strictly deciduous and an intermediate class which includes marcescent species. We will modify the text to read:
….. by evergreen or marcescent trees

Line 207-208. Round ages to nearest 10 or 100 years.
We agree that we were being over-precise here and will round these ages to the nearest 100 years. The revised text will read:
There are intervals with poor pollen preservation between ca 16 000 and 22 300, 31 200 and 37 500, 43 100 and 50 100, and 87 900 and 93 800 cal yr BP.

Line 423-424. This statement seems a bit too strong – the recent work at Padul provides a pollen record that is arguably more complete (i.e. not containing pollen hiatuses), and could ultimately provide a valuable comparison data set for climate reconstruction
We cite the earlier Camuera et al. (2018) paper (lines 69) but had not seen the later paper (or its corrigendum). The Padul record may be more complete and have no hiatuses, but we still feel (as we said in the original text, lines 70-72) that the age model is less well-constrained than that of Villarquemado. Specifically, although the upper 30 m is very well-dated using 42 AMS dates, the lower part of the core is only dated by linear extrapolation of sedimentation rates. Nevertheless, we agree that this is a good record and that it would be worthwhile to try and reconstruct the climate at this site for comparison with Villarquemada as soon as the pollen data are made public. We will add the newer Camuera et al references to the text (line 69) and we will modify our statement at lines 423-424 to read:
provides a relatively complete and well-dated record from continental Iberia

Camuera, J., Jiménez-Moreno, G., Ramos-Román, M.J., García-Alix, A., Toney, J.L., Anderson, R.S., Jiménez-Espejo, F., Bright, J., Webster, C., Yanes, Y. and Carrión, J.S., 2019. Vegetation and climate changes during the last two glacial-interglacial cycles in the western Mediterranean: A new long pollen record from Padul (southern Iberian Peninsula). Quaternary Science Reviews, 205, pp.86-105.