# Response to Referee #3: Chunzhu Chen

We thank to Chunzhu Chen for their comments. We appreciate the acknowledgment of our work's contribution to understanding Holocene paleoclimate in the Eastern Mediterranean region. *Our specific responses are given below (in blue italic) and changes in wording are indicate in normal blue script.*

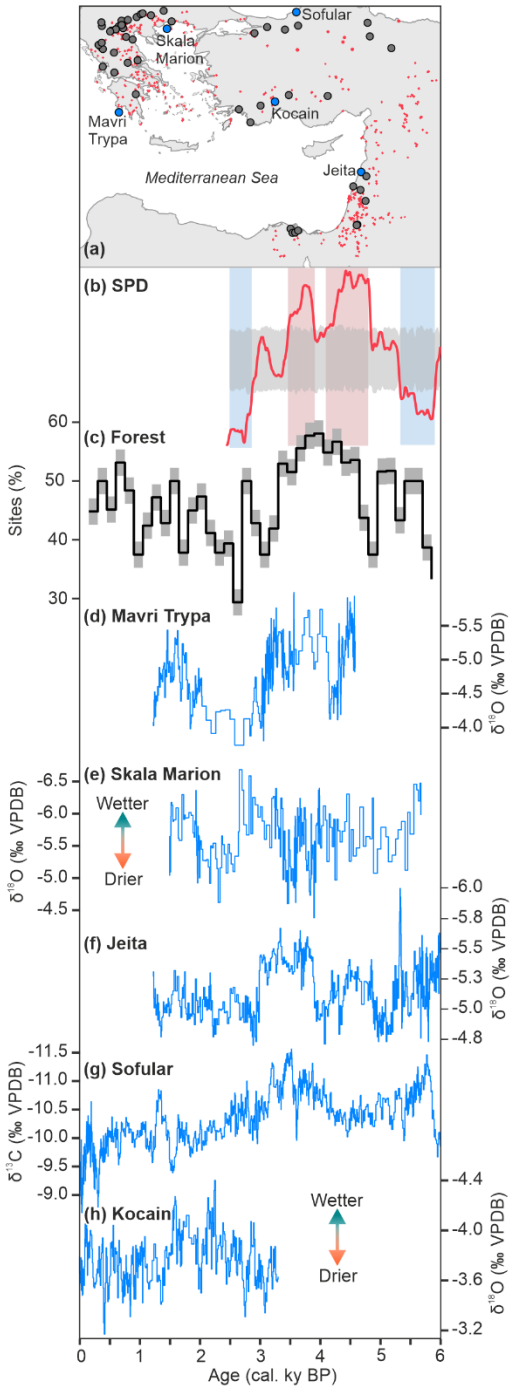
The manuscript presents a climate reconstruction spanning the Holocene period based on a collection of 71 pollen records from the Eastern Mediterranean region. It incorporates climate simulation results from multiple models to find out the forcings underlying climate variations. It makes an excellent contribution to our understanding of paleoclimate in the Eastern Mediterranean region. The region is fascinating because of its long human history, which has had a significant impact on vegetation and, as a result, the Holocene pollen records. While Cultural indicators have been removed from the fossil pollen dataset, pollen taxa that indicate both natural and anthropogenic impact pose a significant challenge in distinguishing the cause of vegetation changes. For instance, when humans clear forests for agriculture, we typically see a substantial decline in tree pollen and an increase in landscape openness, which can also be caused by cooling and/or drying. This has been observed since the middle Holocene, and may have occurred earlier in places such as Israel. The fossil pollen data used in this study more or less has human imprints, and many of these records open at ca. 5 ka. This is an important point to consider before using pollen records from the Eastern Mediterranean region to reconstruct Holocene climate variations. Aside from this, I believe the manuscript makes an important contribution, and minor revisions are required.

*As the reviewer acknowledges, we removed cultivation-related taxa from the training and the fossil data sets in order to minimise the impact of an anthropogenic signal in the records. We agree that human activities can also cause an increase in landscape openness, mimicking the impact of cooling and/or drying on the natural vegetation. However, we have examined the relationship between changes in forest cover, human population and climate changes in the Eastern Mediterranean region in a separate paper on the vegetation history of the region that is currently under review in Journal of Biogeography. This work shows (see figure below) that changes in forest cover from the mid-Holocene onwards are not closely related to the changes in population density, derived as summed probability distribution (SPD) of calibrated archaeological radiocarbon dates. They are, however, closely related to changes in moisture availability as indicated by oxygen isotope records from speleothems in the region. These findings suggest that the changes in forest cover during the late Holocene can be primarily attributed to climatic factors rather than human activities. This additional evidence provides confidence that our climate reconstructions are not substantially influenced by landscapes changes due to anthropogenic activities.*

*Archaeological evidence suggests that there is considerable variation in the timing of population changes in this region. It is widely accepted that the most significant population boom occurred during the Archaic-Classic and Roman periods, approximately 2,800 years ago (Palmisano et al., 2017; Stoddart et al., 2019) i.e. much later than the transition evident in our reconstructions at ca. 5ka. An independent assessment (Palmisano et al. 2021) of population density trends within subregions of the Eastern Mediterranean region shows that there was an overall increase in population across the whole region during the Late Pleistocene-Early Holocene ( 14 to 8.3 ky), but there were very different trends in different sub-regions during the Middle and Late Holocene (8.3 to 2.5 ky). These findings do not support a generalized population increase around ca. 5 ka, corresponding to the mid-Holocene transition evident in our climate reconstructions.*

*Finally, as we point out in the paper, our reconstructions of climate variables exhibit stronger congruence with climate model simulations driven by changes in external forcing during the late Holocene. Since these model simulations do not include changes in land use, this provides further*

*support for our interpretation that our climate reconstructions are robust and consistent with natural climatic forcings.*




*In response to this comment, we have revised the methods section to explain the purpose of removing cultivars more clearly as follows:*

Line 84: "The SMPDS pollen records have been taxonomically standardized, filtered to remove obligate aquatics, insectivorous species, introduced species, and taxa that only occur in cultivation. The removal of cultivars is designed to minimise the influence of anthropogenic signals on the reconstructions. We then grouped taxa with only sporadic occurrences into higher taxonomic levels

(genus, sub-family or family). Consequently, the data set provides relative abundance data for 247 pollen taxa (Supplementary Table 1).

Records from seas, such as the Black Sea, are excluded from the fossil pollen data. The seas are huge traps of pollen grains produced on land. Comparing to terrestrial pollen records, these records represent vegetation changes on a larger spatial scale and thus fit well with the manuscript's topic."

*We deliberately excluded marine records because they sample an extremely large area. In the case of the Black Sea, this could potentially be much of Europe and Russia, and thus inclusion of these records could potentially bias the reconstructions of Eastern Mediterranean climate. In fact, when we compare regional reconstructions made including the Black Sea records with those presented in the paper, the inclusion of marine records does not substantially alter the shape or magnitude of the reconstructed trends in climate. This indicates that, although from a pollen source theory point of view it makes sense to exclude marine records in making site-based climate reconstructions, the impact of this exclusion on our regional reconstructions appears to be limited.*

*The inclusion of records from the Black Sea was one of the methodological differences between our reconstructions and the Herzschuh et al reconstructions that we pointed out in our Discussion. Since inclusion of sites from the Black Sea does not affect our reconstructions substantially, we have modified this text as follows:*

Line 351: Specifically, Herzschuh et al. (2022) used (1) a unique calibration data set for each fossil site based on modern samples within a 2000 km radius of that site, rather than relying on a single training data set; (2) a limited set of 70 dominant taxa rather than the whole pollen assemblage; and (3) included marine records from e.g. the Black Sea, which were excluded in the other reconstructions because they sample an extremely large area and thus are unrepresentative of the local climate. However, inclusion of records from the Black Sea in our reconstructions does not have a substantial impact on either the magnitude or the trends in climate. Thus, it seems likely that the differences between these two reconstructions reflects the use of a unique calibration data set for each fossil site and the limited set of taxa included.