

Correction of the manuscript entitled
“Vegetation and climate changes at the Early-Late Pliocene Transition around the Mediterranean Basin:
A case from the Burdur Basin in Southwestern Anatolia”
By Mary Robles et al.
January 2025

We thank the reviewers for their attentive reading and their accurate comments. As detailed in the point-by-point reply below, we have carefully addressed every point raised, added substantial new data and analyses and thoroughly revised the manuscript.

Responses to the comments of Reviewer 1

General comments:

“Your study presents a variety of analyses and methods, which is commendable. However, these methods do not appear to be well connected in the discussion section. Each method provides an independent evaluation, but a **cohesive overall conclusion** has not been clearly established. Strengthening the connections between the different analyses would enhance the clarity and impact of your findings.”

Response: We added a new figure comparing the climate reconstructions of Burdur with other palaeoclimatic records in the Mediterranean region and we will select, for Burdur, the BRT, MAT and CAM methods which provided the best R² and RMSE values.

Figure 9. Climate reconstructions from global and Mediterranean records for the Early-Late Pliocene transition (4.2–3.0 Ma), arranged west to east. Global records include the $\delta^{18}\text{O}$ stack (Lisiecki and Raymo, 2005) and the $\delta^{18}\text{O}$ dataset (Westerhold et al., 2020). Mediterranean records include the $\delta^{18}\text{O}$ Medstack (Wang et al., 2010), $\delta^{18}\text{O}_{\text{c}}$ from Teruel (Ezquerro et al., 2022), pollen-based climate reconstructions from Rio Maior, Andalucía, Nador, Tarragona, and Garraf using the Climatic Amplitude Method (CAM; Fauquette et al., 1999), alkenone-based sea surface temperatures (SSTs) from Italy (Herbert et al., 2015; Plancq et al., 2015) and Cyprus (Athanasίου et al., 2017), pollen-inferred climate reconstructions from Burdur (this study), using CAM, Modern Analogue Technique (MAT), and Boosted Regression Trees (BRT). MAAT: mean annual temperature. MTWA: mean temperature of the warmest month. MTCO: mean temperature of the coldest month. PANN: mean annual precipitation. Psummer: summer precipitation. Pwinter: winter precipitation.

Additionally, the palynological data from the Burdur area alone **can not fully represent the broader Eastern Mediterranean**. This statement appears in multiple parts of your manuscript and could benefit from some revision. In your study, you mention that Pliocene palynological studies in Anatolia are limited to the Ericek area. However, a **more detailed literature review may reveal additional studies**. To support this, I have included a few references that may be useful.

Response: We thank the reviewer for the references and have incorporated them into the manuscript.

After reviewing your manuscript, I would also recommend **reconsidering the title**. Your study focuses on the palynological, palaeoclimatic, and palaeovegetational data from a borehole in Burdur, with comparisons to European vegetation. Adjusting the title to better reflect this scope could improve clarity for readers.

Response: We have updated the title following your suggestion: “Vegetation and climate changes during the Early–Late Pliocene Transition (~3.6 Ma) in the Burdur Basin (Southwestern Anatolia): A comparison with the Mediterranean”

Moreover, while various methods were applied, they are not clearly interconnected in the discussion section. For example, **the relationship of the PCA analysis** to the overall study could be more explicitly addressed.

Response: The discussion has been revised to better integrate the PCA analysis with the rest of the study.

Finally, the manuscript currently lacks geological and sedimentological information regarding the drilling log. Clarifying where the samples were taken along the log and providing additional geological context would greatly strengthen the study.

Response: The log and its sedimentological information are included with comparison to the general stratigraphy of the basin in a new Figure 3.

Figure 3. The studied drill-log of BS-87 within the stratigraphy for the Burdur basin-fill succession (Sickenberg & Tobien 1971, Lefevre et al. 1983, Karaman 1986, Price & Scott 1991, Saraç 2003, Platevoet et al. 2008, Alçiçek et al. 2013a,b, Demirel & Mayda 2014, Alçiçek et al. 2017, Özkaptan et al. 2018, Alçiçek et al. 2019). The chronostratigraphic units stand on Hilgen et al. (2012).

In the **Material and methods** part, in the subsection “3.1 Coring, core conservation and stratigraphy”, we added the text “The stratigraphy of the BS-87 core from Lake Burdur has been previously described in several studies (Fig. 2; Sickenberg and Tobien, 1971; Lefevre et al., 1983; Karaman, 1986; Price and Scott, 1991; Saraç, 2003; Platevoet et al., 2008; Alçiçek et al., 2013a, b; Demirel and Mayda, 2014; Alçiçek et al., 2017; Özkaptan et al., 2018; Alçiçek et al., 2019). The core is primarily composed of alternating greenish-grey, yellow-brown, and beige marlstone and siltstone (Fig. 2). Scattered gastropod remains are present at the base of the core (360 m), and at depths of 275 m, 130 m, 80 m, and between 60–20 m. Organic-rich layers are concentrated in the lower part of the sequence, particularly between 325–300 m and 260–210 m. Five coal seams, ranging in colour from dark grey to black, are observed at approximately 177 m, 130 m, 110 m, 90 m, and 70 m. The top of the core consists of rounded to subrounded gravelstone composed of crystallized limestone.”

In the **Discussion** part, in the subsection 5.2 and the subpart “Dynamic of Lake Burdur”, the text has been completed to include the stratigraphy of the core: “The stratigraphy of the Lake Burdur sequence reveals an alternation between marlstone and siltstone units (Fig. 3), suggesting shifts between calm depositional phases and more dynamic episodes. Marlstone, composed of fine-grained, carbonate-rich deposits, typically forms under calm, shallow, or stagnant waters conditions. In contrast, siltstone reflects enhanced siliciclastic input, generally associated with increased runoff or erosion. This lithological alternation likely reflects cyclical climatic variations influencing the hydrodynamics of the basin.”

Alçiçek, M. C., Mayda, S., & Titov, V. V. (2013b.) Lower Pleistocene stratigraphy of the Burdur Basin of SW Anatolia. *Comptes Rendus Palevol*, 12, 1-11.

Alçiçek, M. C., Mayda, S., & Demirel, A. (2017). Discussion on “Neogene-Quaternary evolution of the Tefenni basin on the Fethiye-Burdur fault zone, SW Anatolia-Turkey. *Journal of African Earth Science* 118, 137-148 by R. Aksoy, S. Aksarı”. *Journal of African Earth Sciences*, 134, 794-799.

Demirel, A., & Mayda, S. (2014). A new Early Pleistocene mammalian fauna from Burdur Basin, SW Turkey. *Russian Journal of Theriology*, 13, 55-63.

Hilgen, F. J., Lourens, L. J., & Van Dam J. A. (2012). The Neogene period. In: F. M. Gradstein, J. G. Ogg, M., Schmitz, & G., Ogg. (Eds.), *The Geologic Time Scale 2012* (pp. 923-978). Oxford: Elsevier.

Karaman, E. (1986). Burdur dolayının genel stratigrafisi. *Akdeniz Üniversitesi Isparta Mühendislik Fakültesi Dergisi* 2, 23-36.

Lefevre, C., Bellon, H., & Poisson, A. (1983). Presence de leucitites dans le volcanisme Pliocene de la region d’Isparta (Taurus occidentales, Turquie). *Comptes Rendus de l’Académie des Sciences de Paris*, 297, 369-372.

Platevoet, B., Scaillet, S., Guillou, H., Blamart, D., Nomade, S., Massault, M., Poisson, A., Elitok, Ö., Özgür, N., Yağmurlu, F., & Yılmaz, K. (2008). Pleistocene eruptive chronology of the Gölcük volcano, Isparta Angle, Turkey. *Quaternaire*, 19, 147-156.

Saraç G. (2003). Vertebrate fossil localities of Turkey. Scientific Report No. 10609, Mineral Research and Exploration Directorate of Turkey (MTA), Ankara, pp. 208.

Sickenberg, O., Tobien, H. (1971). New Neogene and Lower Quaternary vertebrate faunas in Turkey. *Newsletters on Stratigraphy*, 1, 51-61

Specific comments:

Line 1: After reading your work, you need to reorganise your title. This study includes palynological, palaeoclimatic and palaeovegetational data of the Pliocene from the borehole taken from Burdur, and includes a comparison of these data with European vegetation. I can suggest a title like ‘Vegetation and

climate changes in the Early-Late Pliocene transition of the Burdur Basin in Southwestern Anatolia and comparison with the Mediterranean Basin'

Line 16: The title I suggested will be more coherent with your content and your focus

Response: We have updated the title based on your suggestion Vegetation and climate changes during the Early–Late Pliocene Transition (~3.6 Ma) in the Burdur Basin (Southwestern Anatolia): A comparison with the Mediterranean”

Line 38: “Following a climatic optimum in precipitation and temperature “Which one?

Response: We specified the time period in the text “Following a climatic optimum in precipitation and temperature during the Early Pliocene,”

Line 40: Your findings belong only to the Burdur area. You must reduce general explanations about the Mediterranean Basin. This is a local study. Focus on Burdur and its context.

Response: We have revised relevant sections to clarify that our findings are regional.

Line 44: Türkiye, The data set is not sufficient for a generalisation for the whole of Türkiye.

Response: We modified the statement to specify “Southwestern Türkiye,” ensuring that our interpretations are geographically appropriate.

Line 54: Here you are making a comparison within the Pliocene in geological time. Why didn't you compare it to pre-industrial era as in the next sentence? What is the result when you compare the early Pliocene with the pre-industrial era?

Response: We added contextual comparison with the pre-industrial era in the introduction to emphasize the relevance of the Pliocene to understanding future climate change:

“The Pliocene Epoch (5.33-2.58 Ma), which was warmer than the pre-industrial period, is particularly important for understanding future climate change due to its similarities with present-day conditions, including comparable climatic characteristics (Haywood et al., 2016) and atmospheric CO₂ concentrations (Masson-Delmotte et al., 2013).”

“Considering future climate change, Earth System Model (ESM) projections, based on CO₂ concentrations, ranging from about 400 p.p.m.v. to above 1100 p.p.m.v., indicate mass loss from the Greenland and Antarctic ice sheets, a projected sea-level rise of approximately 0.26 m to 0.92 m above present-day levels, and an increase in global air temperatures ranging from 1.4°C to 4.4°C depending on the scenario (IPCC, 2021, 2023).”

We also added sentences at the end of the conclusion:

“This study underscores the spatial heterogeneity and complexity of vegetation and climate responses across the Mediterranean during the Pliocene. It highlights the value of high-resolution, regionally focused records for refining global and regional climate models. Understanding the mechanisms and impacts of Pliocene climate variability offers critical insights into the potential trajectories and uneven regional consequences of current and future climate change.”

Line 54: “During warm periods of the Pliocene?” Which period? You mean my Early Pliocene.

Response: We modified the beginning of the sentences in the introduction: “During the mid-Pliocene Warm Period (mPWP; 3.264–3.025 Ma), atmospheric CO₂ concentration” and “During the mid-Pliocene Warm Period, General Circulation Model (GCM)” to be more precise.

Line 70: “The Early Pliocene was characterized by Mediterranean climate conditions (summer droughts and cool-wet winters) in the Mediterranean Basin” Eastern Mediterranean? or Western Mediterranean?

Response: We specified: “in the Western Mediterranean Basin”

Line 88: There are studies for Pliocene palynoflora in Anatolia other than these two papers. The use of the results of this DSDP drilling in the Euxine basin in the Western Black Sea for the eastern Mediterranean is questionable. However, I am attaching the references of a few studies published in the literature that will allow you to make comparisons. Comparison with these studies will eliminate your lack of data for SW Anatolia.

e.g.

Tagliasacchi, E., Kayseri Özer, M. S., & Altay, T., (2024). Environmental, vegetational and climatic investigations during the Plio-Pleistocene in SW-Anatolia: A case study from the fluvio-lacustrine deposits in Uşak-Karahallı area. *Palaeobiodiversity and Palaeoenvironments* , vol.104, no.1, 29-51.

TUNCER, A., KARAYİĞİT, A. İ., OSKAY, R. G., TUNOĞLU, C., KAYSERİ ÖZER, M. S., GÜMÜŞ, B. A., ... Bulut, Y.(2023). A multi-proxy record of palaeoenvironmental and palaeoclimatic conditions during Plio-Pleistocene peat accumulation in the eastern flank of the Isparta Angle: A case study from the Şarkikaraağaç coalfield (Isparta, SW Central Anatolia). *International Journal of Coal Geology* , vol.265.

KAYSERİ ÖZER, M. S., Atalar, M., & Kovacova, M., (2019). Palaeovegetational evolution of the Cankiri-corum Basin during the Mio-Pliocene (Central Anatolia) based on the IPR analysis method. *PALAEODIVERSITY AND PALAEOENVIRONMENTS* , vol.99, no.4, 571-590.

KAYSERİ ÖZER, M. S., (2017). Cenozoic vegetation and climate change in Anatolia - A study based on the IPR-vegetation analysis. *PALAEOGEOGRAPHY PALAEOCLIMATOLOGY PALAEOECOLOGY* , vol.467, 37-68.

Yavuz-Işık, N., Saraç, G., Ünay, E., de Bruijn, H., 2011. Palynological analysis of Neogene mammal sites of Turkey — vegetational and climatic implications *Yerbilimleri* 32, 105–120.

Response: We thank the reviewer for pointing out additional references on the Pliocene palynoflora of Anatolia. We have reviewed the suggested literature and cited the relevant studies where appropriate in the revised manuscript. However, we note that the temporal constraints in most of these studies remain imprecise, and the limited number of analyzed samples significantly hinders direct comparison with our dataset. As such, while these works provide valuable regional context, they do not offer the resolution required for integration at the same interpretative level as the sites we have used.

We added a sentence in the introduction: “Additional pollen records from Anatolia exist, but many are limited by the low sample resolution and insufficient chronological control (Yavuk Işık et al., 2011; Kayseri-Özer et al., 2017; Tuncer et al., 2023; Tagliasacchi et al., 2024).”

We added sentences in the discussion in the 5.2 part and more precisely in “Vegetation changes around the Mediterranean Basin: “While other pollen records for Anatolia exist, their limited temporal resolution and imprecise chronologies preclude their inclusion in our comparison (Yavuk Işık et al., 2011; Kayseri-Özer et al., 2017; Tuncer et al., 2023; Tagliasacchi et al., 2024).” And “. Elsewhere in Anatolia, the poorly dated Çankırı-Çorum sequence from the central region, shows similarly open vegetation dominated by Poaceae, Amaranthaceae and Urticaceae, possibly representing a period earlier than 4 Ma (Kayseri-Özer et al., 2017).”

Line 92: The data for the Ericek region does not represent a large area such as the Anatolian plateau. Please limit your use of regional terms to the area they cover. Throughout the manuscript.

Response: We revised the text throughout the manuscript to ensure regional terms are used appropriately and specifically.

Line 112: The data for your study was obtained from only one point. It is difficult to make an interpretation covering the Eastern Mediterranean. In this sense, your findings will represent local and microclimatic conditions. Please reorganise your evaluations from this point of view.

Response: We revised our interpretations to clearly frame our findings as representing regional conditions around the Burdur area, avoiding overgeneralizations.

Line 130: The general geological features of the region in Figure 1 should be expanded. Maybe under one title, with a description of the borehole log.

Response: The geological map is now updated with more detailed geological features (Figure 1). A new figure (Figure 3) has been added, presenting a detailed description of the BS-87 borehole log. The borehole log has been described in “3.1 Coring, core conservation and stratigraphy” and integrated in the Discussion part, in the subsection “5.2 Vegetation changes and plant diversity around the Mediterranean Basin during the Early-Late Pliocene transition” and the subpart “Dynamic of Lake Burdur” (see above).

Figure 1. (A) Tectonic map of the eastern Mediterranean showing major tectonic structures (after Turkeyurt, 2003), (B) Geological maps of Acıgöl and Burdur Province and locations of selected cores and sections: Acıgöl C3 core (Andrieu-Ponel et al., 2021), Burdur Pmag section (Özkaptan et al., 2018) and Burdur BS-87 core (this study).

Line 145: “leading to a lake volume decrease of 39%” add with seasonal drought.

Response: We added in the text “with seasonal drought”.

Figure 1: A) Simplified tectonic map of Türkiye showing major neotectonic structures and neotectonic provinces. (Please added References). Please added the graben tectonic structure. Central Anatolian Province

Response: Figure 1 has been revised accordingly and the simplified tectonic map of Türkiye now includes references (Bozkurt, 2003) (see above).

Line 154: What was the palaeogeography and palaeotopography like in the Pliocene? Please add discussion (in the discussion sections of your manuscript), taking into account the fact that if the palaeogeography was close to the present day, your data may show unique local conditions, just like today.

Response: The present-day environment in the region includes a higher proportion of arboreal pollen taxa (Andrieu et al., 2021), mainly *Quercus*. However, the landscape does indeed resemble certain steppe regions found in the Middle East or the Caucasus (such as in Armenia), where similar modern analogues are observed and frequently selected in our climate reconstructions.

Line 209: “size, with *Pinus sylvestris* being smaller” You only distinguished by height? The type pollen of *Pinus sylvestris* has a different morphological appearance.

Response: We thank the reviewer for this relevant comment. We have clarified the distinction made between *Pinus* types in the manuscript. In our study, we use a size-based classification to differentiate *Pinus sylvestris*-type pollen from Mediterranean *Pinus*-type pollen, based on the maximum grain length (L). This classification was developed from observations of modern *Pinus* pollen slides in the IMBE reference collection by Valérie Andrieu. The size differences are also supported by the illustrations in Reille’s pollen atlases (Reille, 1998). Both the reference and fossil pollen are mounted in glycerine between slide and coverslip, allowing direct comparison. Our observations led us to define two morphometric groups:

- *Pinus sylvestris*-type: $L < 66 \mu\text{m}$ (typically found on the northern slopes of the Mediterranean and in mid- to high-altitude regions),
- Mediterranean *Pinus*-type: $L > 66 \mu\text{m}$

The measurements established by V. Andrieu for modern *Pinus* species are as follows:

- *P. sylvestris*: $62 < L < 66 \mu\text{m}$
- *P. brutia*: $72 < L < 96 \mu\text{m}$
- *P. pinea*: $86 < L < 94 \mu\text{m}$
- *P. maritima* and *P. pinaster*: $84 < L < 100 \mu\text{m}$
- *P. halepensis*: $88 < L < 108 \mu\text{m}$

We doubt that *P. sylvestris* pollen can be reliably identified at the species level using morphological criteria, particularly in the case of the 3-million-year-old pollen from Burdur, which is in some instances quite degraded. However, species-level identification may be possible when 1) the pollen is well preserved, and 2) sufficient time is dedicated to detailed palynological analysis.

Following the reviewer’s suggestion, we have revised the manuscript text to replace *Pinus sylvestris* with “*Pinus sylvestris*-type”, and we updated the Materials and Methods section as follows: “Pollen of *Pinus sylvestris*-type and *Pinus mediterranean*-type have been differentiated based on their size, with *Pinus sylvestris*-type $< 66 \mu\text{m}$ and *Pinus mediterranean*-type $> 66 \mu\text{m}$ (Reille, 1998).”

Line 212: “Aquatic taxa, fern spores, and NPPs (algae and fungal spores) were counted alongside pollen.” How did you evaluate these counts in your manuscript. Please include the methodology.

Response: We explained that we calculated and used the percentages for aquatic taxa, fern spores, and NPPs. We based the counts on a minimum of 300 terrestrial pollen grains to ensure a representative pollen signal.

Line 227: Please add other references to support your sentence.

Response: We added the references: (Robles et al., 2023; d'Oliveira et al., 2023; Sassoon et al., 2025).

Line 271: In this section, a photograph and/or digital drawing of the drilling log you sampled, sample locations and sedimentological and lithological characteristics should be added.

under the 4.1 or 4.2 title

Response: A new figure (Figure 3) has been added, presenting a detailed description of the BS-87 borehole log. The borehole log has been described in the Results part in a new subsection "4.2 Stratigraphy" and integrated in the Discussion part, in the subsection "5.2 Vegetation changes and plant diversity around the Mediterranean Basin during the Early-Late Pliocene transition" and the subpart "Dynamic of Lake Burdur" (see above).

Line 271: Why do you compare with Özkaplan et al. 2018?

Response: as Özkaplan et al. (2018) produced a magnetostratigraphy of the Burdur lacustrine sequence over 200 m, sampled about 20 km north of our drill core, it was necessary compare their results and ours to match the two sequences (see Discussion part, the subsection "5.1 Age-depth model") and to build a more robust interpretation of the age constraints.

Figure 3: How did you distinguish between Amaranthaceae and Chenopodiaceae? Should they be written together? Poaceae is not steppic. Please move it in other herb. please added NAP. The values you interpret in the figure are not understood. It would be good to give counts as supplementary data.

Response: According to the APG IV (Angiosperm Phylogeny Group IV), the correct family name is now Amaranthaceae (The Angiosperm Phylogeny Group et al., 2016). The term Chenopodiaceae was previously used in older classifications (e.g., APG III and earlier), but it is now included within Amaranthaceae.

The Angiosperm Phylogeny Group, Chase, M. W., Christenhusz, M. J. M., Fay, M. F., Byng, J. W., Judd, W. S., Soltis, D. E., Mabberley, D. J., Sennikov, A. N., Soltis, P. S., and Stevens, P. F.: An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV, Botanical Journal of the Linnean Society, 181, 1–20, <https://doi.org/10.1111/boj.12385>, 2016.

Line 366: "A total of 53 samples were analyzed" Repetition. This sentence can be written as 46 samples were determined to contain sufficient palynomorphs for palaeoclimatic and palaeovegetational assessment. To remove repetition.

Response: The sentence has been simplified: "In the 53 samples analyzed from the Burdur Basin, 46 samples were polliniferous and 7 samples were sterile"

Line 372: "from PAZ 4 to 7, where the percentage of arboreal pollen is lower" There is an increase in *Pinus* in PAZ 7.

Response: We adapted the text: "from PAZ 4 to 6, where the percentage of arboreal pollen is lower (ca. 10%)"

Line 376: "PAZ 1 (247-184 m) records an open steppic vegetation dominated by Amaranthaceae (ca. 28%), *Artemisia* (ca. 23%), and Poaceae (ca. 16%)," The values you interpret in the figure 3a are not understood.

Response: The mean value for each PAZ was calculated and described in the text to support the figure.

Figure 4. Please italicise species names. Why did you make this analysis. You have not analysed it at all in the discussion section.

Response: We italicize species names of the figure 4

Figure 4: Principal component analysis (PCA) on selected terrestrial pollen taxa from the lacustrine succession of the Burdur Basin-fill (Türkiye). Sample map was coloured according to the PAZ (presented in Fig. 3).

Line 433: Please provide examples from the areas that do not fit the description you have mentioned.

Response: We completed the sentence: “, except for two samples in PAZ 5 (at depths of 69.6 m and 65.85 m), where arboreal pollen taxa are more abundant. On the contrary,”

Figure 5. In this study, in which you go into the detail of *Cerealia* pollen, it is necessary to put the sheet in the *Cerealia* extract.

Response: We added the measurements of large pollen grains of Poaceae in supplementary data.

Supplementary Table S2. Measurements of diameter of pollen grains, annulus and pores of large pollen grains of Poaceae from the core BS-87 Burdur against core depth.

Line 491: Please added the plate including Poaceae types.

Response: We used the distinction between Poaceae and *Cerealia*-type as established by Beug (2004). Since the focus of the manuscript is primarily on climate reconstruction, we believe that including a pollen plate is not essential. Even in studies centered on vegetation changes based on pollen, it is not common practice to include such plates.

Figure 6. please mark the early-late Pliocene boundary, even if possible. reorganise from old to young. Or if it is, it's not clear.

Response: Thank you for the suggestion. In paleoclimatology, it is standard practice to display data in this manner, with the choice of direction often depending on disciplinary conventions. However, we will clarify the Early–Late Pliocene boundary to improve readability.

Figure 6: Lake Burdur pollen-inferred climate reconstruction based on five methods against depth: CAM (Climatic Amplitude Method), MAT (Modern Analogue Technique), WA-PLS (Weighted Averaging Partial Least Squares regression), BRT (Boosted Regression Trees) and RF (Random Forest). Large lines correspond to loess smoothed curves and shaded areas to the 95 % confidence interval. Black dashed lines correspond to modern climate values of Burdur. Grey dashed lines correspond to Pollen Assemblage Zones (Fig. 3A). MAAT: mean annual air temperature. MTWA: mean temperature of the warmest month. MTCO: mean temperature of the coldest month. PANN: mean annual precipitation. Psummer: summer precipitation. Pwinter: winter precipitation.

Line 541: Your sampling frequency is 1 metre apart and some of your samples were steril. This resolution is useful to consider when making an environmental assessment. The increase or decrease of some of your palynomorphs should be taken into consideration. Since you do not know the percentage of these palynomorphs at levels where you cannot sample, you should be careful in interpretation.

Response: Thank you for your remark. We acknowledge the limitations related to our sampling resolution and the presence of sterile samples. In our interpretation, we have been careful to consider these aspects and avoid overinterpreting the data.

Line 542: “by two peaks of the planktonic colonial green” three

Response: We have applied the correction by replacing 'two' with 'three'.

Line 746: “and the wide climatic range of taxa like Poaceae prevent full constraint of the climate reconstruction amplitude.” Poaceae wide climatic range and also in different environments. Cosmopolitan

Response: We thank the reviewer for the comment. We agree that Poaceae is a highly cosmopolitan family, present across a wide range of climatic and ecological conditions. Precisely because of this ecological diversity, it was challenging to constrain the climate reconstruction amplitude when Poaceae dominated the pollen assemblages.

Line 774: “to the results for Burdur using CAM. However, this trend is not reflected by the other methods (Fig. 6).” Why? Please explained.

Response: We added sentences to explain the differences between the methods: “During the final part of the Early Pliocene (Zanclean period, 4–3.6 Ma), CAM-based reconstructions indicate warmer-than-present conditions at sites including Rio Maior, Andalucía, Nador, Tarragona, and Garraf (Fauquette et al., 1998a, 1999, 2007). These results are consistent with the temperature trends reconstructed at Burdur using CAM, while other methods (except for MTWA with MAT and WA-PLS) do not replicate this warming signal (Fig. 8). Other proxies also support a global climatic context warmer than today for this

period. The LR04 benthic oxygen isotope stack (Lisiecki and Raymo, 2005) and the Global Reference benthic foraminifer oxygen isotope dataset (Westerhold et al., 2020) show lower $\delta^{18}\text{O}$ values than today, reflecting elevated global temperatures and reduced ice volume prior to the intensification of the Northern Hemisphere glaciation (Maslin et al., 1998). Around the Mediterranean Basin, sea surface temperature (SST) reconstructions based on alkenones from Cyprus similarly indicate warmer-than-modern conditions during the Zanclean (Athanasίου et al., 2017), although a transient cooling event at ~ 3.91 Ma is recorded and corresponds to the global MIS Gi16 (Athanasίου et al., 2017). Further temperature reconstructions from the Teruel (Spain), based on lacustrine $\delta^{18}\text{O}$ (Ezquerro et al., 2022), and on planktonic $\delta^{18}\text{O}$ records from Cyprus and Italy (Medstack; Wang et al., 2010; Colleoni et al., 2012) also indicate generally warm climatic conditions. The temperature reconstructions for Burdur using CAM are consistent with these regional and global datasets. Additionally, MTWA values reconstructed using MAT, agree with alkenone-based SST reconstructions from the Eastern Mediterranean (Athanasίου et al., 2017), likely reflecting summer temperatures.”

Westerhold, T., Marwan, N., Drury A.J., Liebrand D., et al., 2020. An astronomically dated record of Earth’s climate and its predictability over the last 66 million years. *Science*, 369, 1383-1387.

<https://doi.org/10.1126/science.aba6853>

Maslin, M.A., Li, X.S., Loutre, M.-F., Berger, A., 1998. The contribution of orbital forcing to the progressive intensification of Northern Hemisphere glaciation. *Quaternary Science Reviews*, 17, 4-5, 411-426. [https://doi.org/10.1016/S0277-3791\(97\)00047-4](https://doi.org/10.1016/S0277-3791(97)00047-4)

Line 811: “whereas Tükyie” Please check the spelling of the name “Türkiye” throughout your manuscript.

Response: The spelling of Türkiye has been systematically corrected throughout the manuscript.

Figure 8: Please, could you please add data for Burdur area in the Supplementary file in mm.month-1 scale. In order to see the data showing that there is no change in the amount of precipitation.

Does this simulation map cover your time range?. In Figure 2, your youngest age is $>3.33\text{Ma}$?

So I don’t understand which of your examples in your Supplementary file you are using the precipitation amount against?

Spore and pollen data? For a precise comparison you should use plant data for point 14, since all your other points belong to the plant.

Response: We added a section in the Methods for the simulations part in the text and included the following sentence: “Despite the Burdur sequence terminating at 3.33 Ma, slightly older than the mPWP interval, it is included due to the scarcity of high-resolution records and limited regional model coverage.” Unchanged conditions for the most recent period of the Burdur record are attributed in comparison to modern conditions.

Line 861: “Burdur shows a low proportion of coprophilous spores” Please added the name and plate.

Response: The pollen and NPP have been already described in the references cited.

Line 863: “However, these two sites do not cover the same time period and are associated with different environmental and climatic contexts.” While even these two close basins reflect a different environment from each other, the data only from the Burdur area do not allow a climatic and vegetational generalisation to cover the entire Eastern Mediterranean basin. Please reorganise your interpretations accordingly.

Response: We have incorporated the suggested references and revised the text to avoid extrapolating regional environmental interpretations.

Line 876: “Climate reconstructions indicate a climatic optimum of precipitation and temperature before the Early–Late Pliocene transition,” You said it was very cold compared to *Botryococcus*.

Response: We did not interpret *Botryococcus* as a climatic indicator, but rather as a proxy for trophic conditions within the lake. Therefore, its occurrence does not contradict our climate reconstruction, which suggests a climatic optimum in terms of precipitation and temperature before the Early–Late Pliocene transition.

Line 886: for Burdur. Türkiye is a large region

Response: We modified the text “while southwestern Türkiye”.

Responses to the comments of Reviewer 2

General comments:

- The topic of **protocereals** seems well introduced to me, it is also well documented, and, in my opinion, it should be moved everywhere at the end of the **sections on vegetation**, whether in the objectives listed in the introduction or in the discussion, which is already the case in the sections on methods and results. It is more natural.

Response: We thank the reviewer for this suggestion. Following the recommendation, the section on large Poaceae (protocereals) has been repositioned in the vegetation section of the discussion.

- I agree with the authors on the application of climate reconstruction methods in the conditions in which they are carried out here, i.e. without relict taxa and after the comparison showing that the west-east gradient is also marked for the study period. It is quite surprising how close the reconstructed values, regardless of the method used, are to current values, but it ultimately makes sense in view of the reconstructed pollen assemblages, or even the previous conclusions of the work carried out by Suc. I would have liked a comparison with external data in a graphical form. This is discussed in the section "**Climate changes around the Mediterranean basin**" but would in my opinion deserve a **figure**. For example, SST, isotopes on foraminifera in the eastern Mediterranean. This seems possible since the authors are confident in the ages assigned to the sequence studied.

Response: We thank the reviewer for the suggestion. We added a new figure comparing the climate reconstructions of Burdur with other palaeoclimatic records in the Mediterranean region.

Figure 9. Climate reconstructions from global and Mediterranean records for the Early-Late Pliocene transition (4.2–3.0 Ma), arranged west to east. Global records include the $\delta^{18}\text{O}$ stack (Lisiecki and Raymo, 2005) and the $\delta^{18}\text{O}$ dataset (Westerhold et al., 2020). Mediterranean records include the $\delta^{18}\text{O}$ Medstack (Wang et al., 2010), $\delta^{18}\text{O}$ from Teruel (Ezquerro et al., 2022), pollen-based climate reconstructions from Rio Maior, Andalucía, Nador, Tarragona, and Garraf using the Climatic Amplitude Method (CAM; Fauquette et al., 1999), alkenone-based sea surface temperatures (SSTs) from Italy (Herbert et al., 2015; Plancq et al., 2015) and Cyprus (Athanasίου et al., 2017), pollen-inferred climate reconstructions from Burdur (this study), using CAM, Modern Analogue Technique (MAT), and Boosted Regression Trees (BRT). MAAT: mean annual temperature. MTWA: mean temperature of the warmest month. MTCO: mean temperature of the coldest month. PANN: mean annual precipitation. Psummer: summer precipitation. Pwinter: winter precipitation.

- I find that the **model-data comparison** section is **under-exploited** and could be further emphasized to justify the ambition displayed by the title and the targeted journal. This comparison must be present in the abstract, listed in the objectives of the introduction, its methodology rigorously explained and a separate section (therefore with a title) devoted to it in the discussion.

Response: We thank the reviewer for this constructive comment. We revised the manuscript to emphasize the model-data comparison more clearly and consistently. Specifically:

We added a sentence on model-data comparison in the **Abstract**: A weak Atlantic Meridional Overturning Circulation (AMOC) is identified in Europe during the Late Pliocene, leading to cooler and wetter conditions primarily in the Northwestern Mediterranean. While model simulations of PlioMIP2 show warmer conditions and a latitudinally contrasted precipitation pattern, with wetter conditions in Northern Europe and drier conditions in the south during the mid-Pliocene Warm Period (3.264–3.025 Ma)."

We added a sentence on model data comparison in the **Conclusion**: "PlioMIP2 simulations for the mid-Pliocene Warm Period (3.264–3.025 Ma) indicate a generally warmer climate and a latitudinal precipitation gradient, wetter in Northern Europe, drier in the southern. While these simulations align with some proxy records, they fail to fully capture the spatial complexity of the Eastern Mediterranean climate, where the Burdur record supports drier or near-modern conditions, in contrast to wetter conditions inferred from other nearby regions."

This objective is now explicitly listed in the **Introduction**: Our specific aims are to:

- 1) Reconstruct lake dynamics using pollen and Non-Pollen Palynomorphs (NPPs),
- 2) Reconstruct regional vegetation dynamics based on pollen,
- 3) Morphologically characterize large pollen grains of Poaceae (Cerealia-type),

4) Quantitatively reconstruct climate changes using a multi-method approach, including the Modern Analogue Technique (MAT; Guiot, 1990), Weighted Averaging Partial Least Squares regression (WA-PLS; ter Braak and van Dam, 1989; ter Braak and Juggins, 1993), Random Forest (RF; Prasad et al., 2006), and Boosted Regression Trees (BRT; Salonen et al., 2012) and Climatic Amplitude Method (Fauquette et al., 1998a),

5) Gain a better understanding of regional-scale changes by comparing our results with existing climate reconstructions derived from proxy data and model simulations (PlioMIP2) for the Mediterranean Basin.”

We clarified the methodology for the model-data comparison in the **Discussion** section: The Pliocene Model Intercomparison Project Phase 2 (PlioMIP2) includes results from 13 coupled atmosphere-ocean global climate models (GCMs) simulating climate during the mid-Pliocene Warm Period (mPWP; 3.264–3.025 Ma), using boundary conditions based on the PRISM4 data set (Feng et al., 2022). These conditions incorporate land-sea distribution, topography, bathymetry, vegetation, soils, lakes, and land ice cover, with atmospheric pCO₂ set at 400 ppmv. A compilation of 62 global proxy records, including sedimentological indicators, palynological, floral or faunal, offshore marine records, and stable isotope analyses of organic and inorganic materials were assembled by Feng et al. (2022). Each record was classified as indicating wetter, drier, or unchanged conditions compared to late Quaternary or modern climates. In the present study, we focus on the Mediterranean Basin, including 18 proxy records from Feng et al. (2022) and the Burdur record (this study) as an additional point (Fig. 10). Despite the Burdur sequence terminating at 3.33 Ma, slightly older than the mPWP interval, it is included due to the scarcity of high-resolution records and limited regional model coverage.”

A new subsection titled “Model–data comparison for the Mediterranean Basin” has been included in the **Discussion** and the text has been developed: “Several factors may explain the differences between proxy records and the PlioMIP2 simulations. Firstly, many proxy datasets represent average or time-integrated climate signals due to coarse temporal resolution and dating uncertainties, while models simulate a narrow time window using fixed orbital parameters (Haywood et al., 2020; Feng et al., 2022). Secondly, regional topography and land-sea contrasts, which are critical to local climate dynamics, may be insufficiently resolved in GCMs. Third, vegetation and ice sheet feedbacks, important long-term components of Earth system, are not fully incorporated into many model configurations (Feng et al., 2022). Additionally, while model ensembles agree over some regions (e.g., Sahel and East Asia), they show divergent spatial signals elsewhere, especially in mid-latitudes (Feng et al., 2022).

Despite these limitations, both proxy data and model simulations, support the hypothesis of a weakened AMOC during 3.8 and 3 Ma, resulting in cooler and wetter conditions, particularly in the Northwestern Mediterranean. However, PlioMIP2 simulations suggest this wetter zone is located farther north on the Iberian Peninsula compared to proxy evidence. In the Eastern Mediterranean, strong regional variability inferred from proxy data is not captured by model outputs. Nevertheless, the Burdur site shows drier or near-modern conditions during the mPWP, aligning with model simulations and contributing value regional insight to the mid-Pliocene climatic mosaic.”

Minor remarks:

Here are a few minor remarks:

- Part 5.2 Wetland dynamic

How does the dynamic observed from pollen and NPP adjust with sediment and the presence of shells stated in Figure 2? I would like a few lines explaining it.

Response: We completed the text in the subsection 5.2 and in the subpart “Dynamic of Lake Burdur”: “The presence of mollusk shells in this interval (Fig. 3) further supports the interpretation of improved trophic conditions, typically associated with such nutrient levels.” for the Early Pliocene and “The occurrence of mollusk shells (Fig. 4B) further supports an interpretation of oligotrophic to mesotrophic conditions during these phases.” for the Late Pliocene.

- Part 5.3

I suggest to retitle this part “Vegetation change and plant diversity around the Mediterranean Basin” and add a table S4 with the list of all taxa determined in your study in order to understand how this site compare with others and the discussion and table S3.

Response: The title has been modified: “Vegetation and climate changes during the Early–Late Pliocene Transition (~3.6 Ma) in the Burdur Basin (Southwestern Anatolia): A comparison with the Mediterranean”

Below I detail the minor changes:

Line 67-69: It is not stated why relevant for your study. Do they characterized the Pliocene Transition? : “Moreover, two major cooling events characterized the Early-Late Pliocene transition, the MIS MG12 at ~3.58 Ma and the MIS M2 at ~3.3 Ma (Lisiecki and Raymo, 2005; De Schepper et al., 2014).”

Response: We thank the reviewer for this comment. In the revised manuscript, we defined the Early-Late Pliocene transition. In the text, we included the events of MIS MG12 (~3.58 Ma) and MIS M2 (~3.3 Ma) as they represent globally recognized climatic events of the Pliocene. Although they are important markers of global climate variability, our age model does not allow for a detailed assessment of their expression in the Burdur record.

Line 75: ...region is poorly documented.

Response: the verb of the sentence has been changed

Line 91: Despite the fragmentary character of the information available, it seems that, prior to ...

Response: The sentence has been modified

Line 138: there and below, can you please better explain when talking about modern lake Burdur or paleolake Burdur in Burdur Basin.

Response: We have revised the manuscript to clarify the distinction between the modern Lake Burdur and the inferred paleolake phases within the Burdur Basin.

Figure 1: add a scale.

Response: A scale has been added on Figure 1.

Line 177: in part 2.1, it is said sediment is “alluvialfan, fluvial and lacustrine deposits” which slightly different here. Can you please homogenise here or in part 2.1 and elsewhere (part 3.1 for example...)?

Response: the text has been homogenized.

Line 212: were the measurements done on all Poaceae grains or in all samples where there is Poaceae grains?

Response: The measurements were carried out on all large Poaceae grains (*Cerealia*-type) in all samples where such grains were identified. We added the measurements of large Poaceae grains in supplementary data (see above).

Line 245 or 251: Check and correct reference(s) from Dugerdil.

Response: References have been checked.

Figure 2: A log presenting the sediment itself is needed here or in figure 3.

Response: The log and its sedimentological information are included with comparison to the general stratigraphy of the basin in a new Figure 3.

Figure 3. The studied drill-log of BS-87 within the stratigraphy for the Burdur basin-fill succession (Sickenberg & Tobien 1971, Lefevre et al. 1983, Karaman 1986, Price & Scott 1991, Saraç 2003, Platevoet et al. 2008, Alçiçek et al. 2013a,b, Demirel & Mayda 2014, Alçiçek et al. 2017, Özkaptan et al. 2018, Alçiçek et al. 2019). The chronostratigraphic units stand on Hilgen et al. (2012).

In the **Material and methods** part, in the subsection “3.1 Coring, core conservation and stratigraphy”, we added the text “The stratigraphy of the BS-87 core from Lake Burdur has been previously described in several studies (Fig. 2; Sickenberg and Tobien, 1971; Lefevre et al., 1983; Karaman, 1986; Price and Scott, 1991; Saraç, 2003; Platevoet et al., 2008; Alçiçek et al., 2013a, b;

Demirel and Mayda, 2014; Alçiçek et al., 2017; Özkaptan et al., 2018; Alçiçek et al., 2019). The core is primarily composed of alternating greenish-grey, yellow-brown, and beige marlstone and siltstone (Fig. 2). Scattered gastropod remains are present at the base of the core (360 m), and at depths of 275 m, 130 m, 80 m, and between 60–20 m. Organic-rich layers are concentrated in the lower part of the sequence, particularly between 325–300 m and 260–210 m. Five coal seams, ranging in colour from dark grey to black, are observed at approximately 177 m, 130 m, 110 m, 90 m, and 70 m. The top of the core consists of rounded to subrounded gravelstone composed of crystallized limestone.”

In the **Discussion** part, in the subsection “5.2 Vegetation changes and plant diversity around the Mediterranean Basin during the Early-Late Pliocene transition” and the subpart “Dynamic of Lake Burdur”, the text has been completed to include the stratigraphy of the core: “The stratigraphy of the Lake Burdur sequence reveals an alternation between marlstone and siltstone units (Fig. 3), suggesting shifts between calm depositional phases and more dynamic episodes. Marlstone, composed of fine-grained, carbonate-rich deposits, typically forms under calm, shallow, or stagnant waters conditions. In contrast, siltstone reflects enhanced siliciclastic input, generally associated with increased runoff or erosion. This lithological alternation likely reflects cyclical climatic variations influencing the hydrodynamics of the basin.”

Alçiçek, M. C., Mayda, S., & Titov, V. V. (2013b.) Lower Pleistocene stratigraphy of the Burdur Basin of SW Anatolia. *Comptes Rendus Palevol*, 12, 1-11.

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Demirel, A., & Mayda, S. (2014). A new Early Pleistocene mammalian fauna from Burdur Basin, SW Turkey. *Russian Journal of Theriology*, 13, 55-63.

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Karaman, E. (1986). Burdur dolayının genel stratigrafisi. *Akdeniz Üniversitesi Isparta Mühendislik Fakültesi Dergisi* 2, 23-36.

Platevoet, B., Scaillet, S., Guillou, H., Blamart, D., Nomade, S., Massault, M., Poisson, A., Elitok, Ö., Özgür, N., Yağmurlu, F., & Yılmaz, K. (2008). Pleistocene eruptive chronology of the Gölcük volcano, Isparta Angle, Turkey. *Quaternaire*, 19, 147-156.

Saraç G. (2003). Vertebrate fossil localities of Turkey. Scientific Report No. 10609, Mineral Research and Exploration Directorate of Turkey (MTA), Ankara, pp. 208.

Sickenberg, O., Tobien, H. (1971). New Neogene and Lower Quaternary vertebrate faunas in Turkey. *Newsletters on Stratigraphy*, 1, 51-61

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Line 351: Change Türkiye

Response: The spelling of the name Türkiye has been verified.

Line 360: Precise in the caption that AP is here an average for the PAZ

Response: A sentence has been added: “Values represent the mean percentages for each PAZ.”

Line 488: A large grain diameter is not necessarily associated with a large annulus or a large pore. Replace by “The size of grain diameter is not correlated with annulus and pore sizes” and add correlation values to assert this information.

Response: We added a correlation matrix in the supplementary data and we completed the text: “. Correlation analysis indicates a weak but statistically significant positive relationship between grain diameter and annulus diameter ($r = 0.22$; $p \leq 0.05$), while no significant correlation was found between pollen grain diameter and pore size (Supplementary Figure S3).”

Supplementary Figure S3. Pearson's correlation matrix showing significant correlations ($p \leq 0.05$), with a color gradient denoting the Pearson correlation coefficient. The analysis was applied between (A) selected pollen taxa and (B) measurements performed on *Cerealia*-type pollen grains.

Figure 6: grey dashed lines (PAZ) are not easy to see, reinforce their color.

Response: We modified the figure to reinforce the grey color.

Figure 6: Lake Burdur pollen-inferred climate reconstruction based on five methods against depth: CAM (Climatic Amplitude Method), MAT (Modern Analogue Technique), WA-PLS (Weighted Averaging Partial Least Squares regression), BRT (Boosted Regression Trees) and RF (Random Forest). Large lines correspond to loess smoothed curves and shaded areas to the 95 % confidence interval. Black dashed lines correspond to modern climate values of Burdur. Grey dashed lines correspond to Pollen Assemblage Zones (Fig. 3A). MAAT: mean annual air temperature. MTWA: mean temperature of the warmest month. MTCO: mean temperature of the coldest month. PANN: mean annual precipitation. Psummer: summer precipitation. Pwinter: winter precipitation.

Line 535: Our pollen sampling?

Response: "Our" has been replaced by "the".

Line 536: I don't understand this sentence stating that cyclicities and magnetic. Rephrase it.

Response: We thank the reviewer for this comment. Our sampling interval corresponds to a temporal resolution of approximately 2–4 ka between samples. As a result, identifying cyclicities of around 20 ka in parameters such as magnetic susceptibility is not feasible, as this would provide only about 5 to 10 data points per cycle. For this reason, we did not attempt to interpret or search for such cyclicities in the magnetic susceptibility record. We have changed the sentence in the manuscript accordingly to improve clarity: "This resolution is insufficient for resolving short-term environmental cyclicities of ~20 ka, such as those detected in the magnetic susceptibility record, which would require 5 to 10 samples per cycle for reliable analysis."

Line 546 and 566: salinity is usually expressed in ‰.

Response: the correction has been done.

Line 613: rephrase this "steppe vegetation is dominated by Poaceae, Amaranthaceae, *Artemisia*, is recorded"

Response: the sentence has been modified with the suggestion.

Line 702: Cupressaceae? Do you mean Taxodiaceae? Cf Table S3

Response: We modified the text.

Line 854: suppress)

Response: the correction has been done.

Line 855: There is an error here because Fig 5 or S2 are not presenting correlation values. But it is a good idea to actually give the correlation values.

Response: We added a correlation matrix in the supplementary data (see above) and we completed the text: "Statistical analysis reveals that high proportions of large Poaceae pollen are significantly positively correlated with *Cedrus* ($r = 0.60$, $p \leq 0.05$) and negatively correlated with Amaranthaceae ($r = -0.41$, $p \leq 0.05$) (Fig. 6; Supplementary Figure S3)."