

Interactive comment on “Climate changes since the mid-Holocene in the Middle Atlas, Morocco” by M. Nourelbait et al.

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Response to reviewer #3:

Major comments:

- A detailed review of the available literature must be done. This will strongly improve the present manuscript which doesn't present the most relevant or recent studies from the western Mediterranean, Morocco and Middle Atlas: Reille 1976; Barker et al 1994, Lamb et al 1989, 1991, 1994, 1995, 1999; Cheddadi et al. 1998, 2009; Combourieu-Nebout et al., 2009 ; Detriche et al 2008, 2009, 2013; Rhoujjati et al. 2010; 2012; Amami et al. 2013; Fletcher et al., 2008 and 2013; Zapata et al., 2013; Reddad et al, 2013; Giraudi et al. 2013, Wassenburg et al., 2014; El Bait et al. 2014; Muller

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et al. 2015; Lebreton et al. 2015). Also see the synthesis presented in Fletcher and Zielhofer, 2013. While the actual review covers the Mediterranean area up to the Anatolian plateau, it should mention synthesis from Fletcher et al., 2013 and Magny et al., 2013 (and Joannin et al., 2014 if the authors still wish to go eastward). This comment is to be addressed both in introduction and in the discussion where one would like to see what the processes behind the observed environmental changes are.

== Thank you for this very constructive comment. We agree that a due review of available studies and a comparison with available data will certainly improve the manuscript. However, we prefer not to extend our discussion to the Anatolian plateau and/or the western part of the Mediterranean. A review restricted to the north-western part of Africa and the western Mediterranean area will be developed in the discussion.

- The MS failed to rigorously discuss the main data trend. Whether the Seasonal index trend is valuable, readers do not see much evidence. For instance, modern values of SI are not related to references

== All Pann values plotted in figure 7 stem from the worldclim data-set (Hijmans et al., 2005, cited in the manuscript) and we have computed the SI values from these modern data. The plotted Pann and SI do not stem from published work.

Hijmans, R. J., Cameron, S. E., Parra, J. L., Jones, P. G., and Jarvis, A.: Very high resolution interpolated climate surfaces for global land areas, *Int. J. Climatol.*, 25, 1965–1978, 2005.

- fig 7 does not show % as mentioned at p913 nor winter precipitation as mentioned p918.

== We guess that p913 is p 4105 of the manuscript set up by "Climate of the Past" but we couldn't relate p918 to any page and/or line in the manuscript. Having said this, figure 7 does not show percentages but frequencies.

- The whole discussion about SI is related to winter vs. summer precipitation and to

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the favoured evergreen oaks which are however not shown in the pollen diagram.

== Apologies for this misunderstanding. Actually, there is an oak curve plotted in the pollen diagram. However, in order to make our discussion about the evergreen oaks more clear, we will specify clearly "Quercus-evergreen" in the pollen diagram.

- The first part of the trend is based on a higher water level with an enhanced development of algae recorded in C/N and $\delta^{13}C$ values. The pollen diagram does not evidence this trend, and on contrary shows higher sub-aquatic plants (Cyperaceae) at first than after where Potamogetonaceae and Typha dominate. Can you please explain these opposite results? This part needs to be thoroughly revisited and discussed at the light of presented data together with other evidences available in the literature.

== Thank you for this remark. Actually, we haven't related any lake level change with the proportion of aquatic plants simply because plants are not directly indicative of lake level changes but rather of availability of water and very often during the summer season because many aquatic plants tend to flower and release their pollen between June and September. We have stated that "water persisted in the lake during the summer season" but one cannot infer any information about the lake level changes from such statement. $\delta^{13}C$ and C/N ratio provided us with information concerning the origin of the organic matter (in situ production versus input from the catchment area) but not on the lake level changes. Thus, higher $\delta^{13}C$ and/or C/N ratio with low presence of aquatic plants are not inconsistent in cases where there is a low terrestrial input (low C/N) during a period when aquatic plants may develop around the lake (high pollen production).

- Discussion of the 5.5kyr event: Both Abstract, Introduction and discussion highlight a 5.5kyr event which is insufficiently discussed with no references at all. For example, you should rigorously present all data and highlight that this corresponds to the sand level deposit, which in turn certainly affects the pollen diagram. Clays develop at that time, but do you have any idea of which clay type it is so that you can maybe relate

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this event with stronger saharian winds (summer?) (Bout-Remazaille et al 2007). This would be worth a try but to read other NA papers showing this event and relate/match your record to their interpretation in terms of climate process. For example, in the Jefara, the second Saharan humid period is divided into two parts by a dry spell that occurred around 5.5–5.4 ka BP (Giraudi et al., 2013).

== thank you for this interesting comment. Indeed, there are references that should be brought up in the discussion and we will develop this topic in the discussion. Concerning the proportion of sandy fraction in the sediment (see figure below), it is rather very low between 5 and 5.5 ka. In effect, the ratio sand/silt in figure 3 shows rather a strong depletion of the sandy fraction. We haven't provided the absolute sand proportion in figure 3 but rather the "sand/silt" ratio because it may provide some information about the erosion strength. Here below are the proportions of the sandy fraction. Concerning the clay composition, we, unfortunately, analysed only the size fraction of the bulk sediment but not the composition and therefore we cannot locate the origin of clay particles.

[Figure 1]

Age-model:

- No information on what is dated;

== The material dated is bulk for this coring. We have reported this information in table 1.

- you should use the 2sigma error calibrated with intercal13 and an appropriate program to plot and calculate the ages of samples.

== Thank you for this remark. The ^{14}C ages provided in table 1 were already calibrated using 2sigma error and the calibration data-set used was intercal13. Concerning the age/depth model we have recomputed it using BACON (Blaauw & Christen, 2011). Figure 2 in the manuscript will be replaced accordingly.

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- Then is artificially added an age at 0cm which is not correct. In the end, data stop at 250 years cal BP without any explanation! Does it suggest a possible water reservoir effect? Can you please detail?

== As stated in the section "Materials and methods", the coring length is 250cm that is why the age/depth model covers 250 cm. We have unconstrained the age of the core top and extrapolated the age using BACON software. Indeed there is a difference of a few hundred years. We compared the obtained age/depth model using Bacon with our age/depth model and we found very minor differences between the two because the four ^{14}C ages show a linear distribution. However, all data will be re-plotted using the new age/depth model.

Methods:

- methods are listed but the reader does not know which process the authors expect them to highlight. For example, C/N threshold is not argued so that the reader has no clue whether it is a good interpretation. It is mentioned a depth resolution of 5 cm for all proxies so that the study should be based on $250\text{cm}/5\text{cm}=50$ samples. This is clearly not the case: 46 samples for $\delta^{13}\text{C}$, TOC. . . 30 samples for pollen and climate variables. Can you please detail?

== Thank for this remark. Indeed, we have stated that the coring was sub-sampled every 5 cm (p. 4101, l. 15) which is wrong. We will provide in the manuscript the exact number of analysed samples for each proxy.

Results:

- the results coming from the pollen data are not insufficiently presented.

== Thank you for this remark. In order to make an efficient and useful presentation of our data, we now provide a detailed description in a new table. This makes the main features of the pollen diagram easily accessible to the reader without overwhelming the manuscript with unnecessary details.

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- We do not know the lower limit of pollen sum counted by samples.

== We have added the pollen sum for each sample in figure 4 (pollen diagram). Just for your information, the minimum and maximum pollen counts are 202 and 1323 pollen grains.

- Results on vegetation are not presented in the text and the figures are not explained. For what use is the pollen zonation?

== We set up pollen zones (using a cluster analysis) to describe periods of time during which the vegetation shows minor changes and to depict more important changes from one period of time to another (or from one zone to another). Indeed, these pollen zones have not been used in the discussion because our aim is to carry a discussion on the overall trends rather than comparing time periods or vegetation zones over the last 6000 years.

- What means the red line in figure 4?

== Apologies for this unnecessary line in figure 3 which has been removed.

- TN is not shown but presented in results. Should be shown or not presented in the text.

== TOC and TN are highly correlated ($r^2=0.99$). However, it will be included in figure 3 of the submitted manuscript.

- Same for sand.

== We have added the sand proportions in figure 3.

Discussion:

- p8 l2-10. Why this paragraph on human and climate relationship when the present study doesn't deal with this? To be deleted.

== Thank for this remark. In fact, our intention is not to deal with the human impact but

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to state that human populations have settled and expanded around the Mediterranean very probably because climate allowed them to do so. Areas with extreme or unstable climate tend to be less populated and/or with discontinuous human occupation. We prefer to keep this 2 or 3 sentences.

- P6 I1. What is your conclusion about the SI?

== Our conclusions are that (1) it increases steadily after 5 ka, (2) it becomes 2 to 3 times higher today than at 6ka and (3) it corresponds to the observed contrasted Mediterranean climate.

- P11 I15-17. I don't understand on what is based this statement. Please argue. TOC is only mentioned in the discussion but not discussed. Why is it used for?

== Apologies, we couldn't relate this comment to any page of the manuscript. Please could you refer to the pages set up in the PDF generated by CP. Thank you.

Minor comments

- The abstract has to be reshaped and carefully corrected to make it easily readable. The sentence "Holocene climate is known to be rather stable. . ." in spite of not being new is not a good way to introduce the time window of your study. Why the authors focus on the last 6000 yrs? Is it of particular interest?

== Thank for this remark. The abstract will be re-written indeed.

1. Introduction: p4 I13-19: this paragraph is of any use? Repetition of the abstract! What is studied, a lake?

== Apologies here again, we couldn't relate this comment to any page of the manuscript. Please could you refer to the pages set up in the PDF generated by CP. Thank you. In section 2 "Study area" pages 4100 and 4101 we state that "... the studied site, Dayet (lake) Hachlaf. This small water body is located ...".

2. Study area:

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- where does the climate data come from?

== In the study area (we state that "Available meteorological data (1980–2008) at Ifrane station . . .". The climate data are from Ifrane meteorological station.

- During which season or month the lake level is the higher?

== Presently, it is during the late spring.

- Is there any river inflows?

== No, there is no river inflow.

- The figure 1 does not show well the lake, nor the scale and nor the coring site.

== The scale and the coring site have been added to figure 1 and will be submitted with the manuscript.

- Oaks are differentiated in the text not in figure 1c.

== Figure 1c does not provide any detail concerning the plant species but rather the dominating taxa (mainly Cedrus and Quercus) in the main ecosystem types (steppe, matorral ..). Moreover, we do not use oak species in our interpretations. We now mention "Oak forest" instead of "Oak" in figure 1c.

3. Materials and Methods:

- a presentation of the coring itself is necessary. Are they twin cores?

== A detailed lithological description is provided in figure 2a. No, we haven't made a twin coring.

Interactive comment on Clim. Past Discuss., 11, 4097, 2015.

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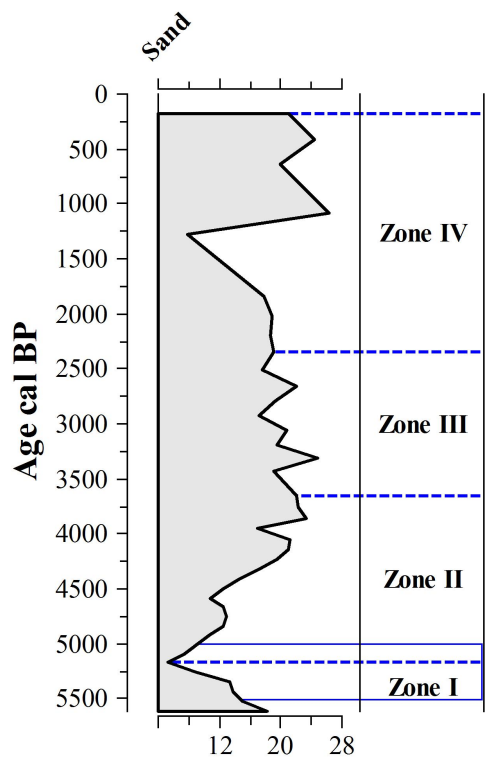


Fig. 1.

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