

Interactive comment on “Palynological evidence for gradual vegetation and climate changes during the “African Humid Period” termination at 13° N from a Mega-Lake Chad sedimentary sequence” by P. G. C. Amaral et al.

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General comments

This paper uses pollen data from a newly recovered sediment sequence from within the present-day Lake Chad as well as a regional calibration of pollen-vegetation-rainfall relationships to reconstruct past vegetation and inferred annual rainfall for a brief mid-Holocene period supposedly covering the termination of the African Humid Period (AHP). The results presented are important and to be recommended for publication in

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ClimPast, firstly because temporally well-constrained Holocene paleovegetation data from the drier parts of North Africa are scarce, and because the methods employed by the authors are thorough and state-of-the-art.

The main drawback of this study, which qualifies its potential impact, is the short period covered by the sediment sequence, at 1700 years scarcely more than a single time slice of Holocene history. The authors somewhat easily state (Introduction, 3/13) that their 95-cm long sequence, dated by 5 fairly evenly spaced bulk-carbon dates to between 6700 and 5000 cal yr BP, covers the principal phase of the Holocene desiccation of the Sahara, since it straddles the period 6000-5500 cal yr BP commonly cited as the end of the AHP. But the studied record is really too short to tell whether or not the drying trend it documents is a representative fragment of a longer period of progressive, gradual landscape drying.

Particularly, CA1 axis scores of the pollen assemblage (Fig. 4), reconstructed rainfall estimates (Fig. 9) and even some of the biome attributions (Fig. 6) for the base of the sequence suggest relatively dry conditions ~6600-6700 cal yr BP and possibly immediately before the covered period, such that the period 6500-6100 cal yrs BP may have been unusually wet rather than representing the implied 'typical' AHP climate. Allowing some dating mismatch, several other pollen records from the present-day Sahel (Kajamorum, Kuluwu, Tilla; p.20/15-16) already suggested that the period ~6800-6000 cal yr BP may have been wetter than much of the early Holocene, and Schuster et al. (2005) suggest Megalake Chad stood at its highest Holocene level at that time. More generally, the prominent century-scale climate variability which is superimposed on the longer-term mid-Holocene drying trend, also evident in the Lake Yoa record (Kröpelin et al. 2008), adds to the already large uncertainty range in the authors' past rainfall estimates, and deserves more elaborate discussion in this paper.

The second issue requiring attention in a revised paper is the authors' much too convenient assumption that "during the period covered by the LT1 sequence, the height [surface elevation] and extent [surface area] of paleolake Chad very likely remained

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quite constant and near its maximal Holocene extent”. (p.17, 13-15). This is quite certainly not the case when comparing the periods before and after 6000 cal yr BP. The water budget of (Mega)Lake Chad is extremely sensitive to precipitation variability at all timescales; a significant reduction in mean annual rainfall as inferred from the pollen data simply must have been translated into major reductions in surface area and depth. This is already evident in the authors’ own pollen data, from the more-than-doubling of % Cyperaceae grains. It is also shown by the lithological gradient towards less organic (and more carbonate-rich? Please add info on basic sediment composition) muds in the upper half of the core. Absence of clear unconformities and of abrupt facies changes within the cored sediment sequence (except the top 5 cm) supports the authors’ claim that sedimentation has been continuous at the core location throughout the studied 1700-year period, in other words the lake didn’t dry out and was (in all likelihood) always larger than it is today. But it is a big (and in my opinion, unjustified) leap to suggest that “sedimentation [actually, pollen influx] at the location of core LT1 was not affected by variation in the distance of fluvial [pollen] sources during that period (p.17, 22-23)”. I would like the authors to construct a more robust argument about why changes through time in the relative importance of river-borne pollen, which certainly must have occurred, do not affect the LT1 pollen record to such extent that it jeopardizes the authors’ principal inferences about regional vegetation change and rainfall trends.

Specific comments and text corrections

Abstract.

2/3: ‘endorheic’.

2/4-7: “However, until now, no continuous archive from Lake Chad covering the Holocene has been studied. In this paper, we present pollen data from the first Holocene sedimentary sequence collected in Lake Chad”. This formulation suggests that we will be presented with a continuous record covering the entire Holocene. Un-

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derstandably, the next sentence is somewhat disappointing.

2/8-9: “Vegetational reconstructions are based on standard analyses of the pollen diagrams”. Please scan the entire paper and delete redundant uses of the definite article ‘the’; I found about 20 cases.

2/15-16: “thrived in the vicinity and/or the extra-local environment of the Mega-Lake Chad in place of the modern steppe, dry woodland and desert vegetation observed today”. ‘Modern’ duplicates ‘observed today’.

2/18-20, “This vegetation distribution is supported. . .”; 2/28-3/2, “This is also evidenced by. . .”: Not so, since you are in fact deriving the biome reconstructions and estimates of past precipitation from the vegetation distributions as revealed by the pollen data.

Introduction.

3/24: delete ‘present’, it duplicates ‘currently’.

4/16: “oceanic records suggest that this transition may have started as early as ca. 5.5 kyr ago and was completed within a few hundred years (deMenocal et al., 2000; Kuhlmann et al., 2004)”.

4/25-27: please add Kröpelin et al. (2008b), i.e. our response to the technical comment by Brovkin & Claussen (2008) to your reference list.

5/3: “presently driest northern part”.

6/1: “In the central Sahel region. . .”.

6/9: “Here we present palynological data from the first. . .” or “Here we present the results of a palynological study on the first. . .”.

Study area.

6/15-16: “Lake Chad (ca. 13_ N, ca. 14_ E) is located in the Sahel region of North-Central Africa, . . .”.

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6/17: delete 'considered'.

6/24: the Komadugu River enters the northwestern part of the present-day lake, and drains the southwestern part of the LCB; which area exactly?

7/1-3: "Today, due to increased aridification, Lake Chad has a surface area of only ca. 2500 km² and a mean depth comprised between 3 and 5 m". In a long-term perspective of the past few centuries, the present lowstand is just part of significant natural fluctuation.

7/24: 27°C is high for mean annual temperature; you mean the annual mean of daytime maxima? Please specify.

Material and Methods.

8/15ff: which type of coring equipment was used, and was the core recovered from a boat or anchored platform? Given that no unsupported 210Pb was found at the core top, which technique was used to recover and preserve the sediment-water interface? If it has indeed been recovered intact, complete lack of unsupported 210Pb implies that the coring site is at present located in a non-depositional environment; this cannot be explained only by deflation during the 1970s drought. But if instead the used field techniques failed to recover the true sed-water interface and soft mud deposited since the 1970s, please say so. Also, does the 3-cm thick layer of sloped sediment at the top represent in situ sediment reworking, or just slumping during transport and storage?

8/20: "linear interpolation between adjacent dates".

9/22: "plant life-form and habitat of each identified pollen taxon". See also 9/25, 10/15 etc.

10/10: "with which it has the greatest affinity". Maximum is 100%, which would imply the pollen spectrum to uniquely fit into one particular biome.

11/18: "Error bars for each sample are defined. . .".

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Results.

11/25: "...CA results that reveal the main variation in pollen assemblage".

14/8: "where the reconstructed contributions of all [regional] biomes. . .".

15/4-5: "are presented in Fig. 9 and Table S2. They show a general decreasing trend. . .".

15/18: "seem to determine the selection of the best analogue".

15/29: "modern lake-side vegetation".

Interpretation and discussion.

16/10-12: "which indicate that rivers such as the Logone-Chari river system play a primary role in pollen transport over long distances, . . .".

16/28: Lake Chad is situated above sea level (a.s.l.)!

17/2-3: "During the Holocene, the hydrological budget might have also changed, leading to changes in the paleolake surface elevation that, due to the flat regional topography, would have resulted in large fluctuations of the paleolake size and its shoreline configuration through time. However, robust chronological constraints on paleolake Chad elevation and surface-area variation through the Holocene remain scarce (see review in Leblanc et al., 2006)". Leblanc et al. 2006a or 2006b?

17/29-18/1: This numerical selection is supported by our quantitative climate reconstructions. . .".

18/6-7, "but which have been closer to the Mega-Lake during the Holocene": your inference based on the new data, or referring to other data (in which case a reference must be cited)?

18/12: "mean combined frequencies".

19/8: "during the mid-Holocene".

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19/17-18, “In the Holocene pollen sequence of Tjéri, located about 200 km north-east of the LT1 sequence in the present Sahel zone, and at a probably similar distance to the influence of the Chari-Logone river system”: I strongly doubt this to be the case: LT1 is directly in front of the river outflow, whereas Tjéri is far to the northeast.

20/2: “maxima”; 20/15: “maximum” or “highest” or “peak”.

21/6-7: “local and regional floristic changes in vegetation would have occurred, linked to a northward migration of more humid plant species during the AHP.”

21/12-13: “immigration”, not introduction; 22/11: “(re-)appearance”, not reintroduction.

22/3: “was not complete by ca. 5000 cal yr BP”.

23/1: “Today the Olea populations closest to Lake Chad...”.

23/10-11: In the Tjéri sequence (Chad), Olea was found between ca. 9400 and ca. 8500 cal yr BP with frequencies close to those found in the LT1 record (1 to 2.3 %). ”.

23/17-19: “Olea is relatively well represented (maximum pollen frequencies of 14 %), but only between ca. 11 500 and ca. 9300 cal yr BP after which it largely decreases to very low values by 8000 cal yr BP, and persists until ca. 4000 cal yr BP (Fig. 11)”.

24/2: “(Vincens et al., 2010)”.

24/5: “trend observed at Mbalang from ca. 6100 cal yr BP...”.

Conclusions.

24/25: “this vegetation would have included more humid tree plants such as...”.

25/22-25: “As previously pointed out by Brovkin and Claussen (2008), one has to be cautious in interpreting these dust records as unequivocally reflecting a decrease in vegetation cover. The abrupt change in the dust flux may also reflect a spread of the source area of the dust caused by lake desiccations.” To my knowledge, this caution was in fact expressed by Jonathan Holmes (2008: Science 320, 752-753) in

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his Perspective on the Kröpelin et al. (2008) paper.

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