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Climate of the Past Discussions

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Interactive Comment

Interactive comment on "Abrupt climate changes of the last deglaciation detected in a western Mediterranean forest record" *by* W. J. Fletcher et al.

W. J. Fletcher et al.

Received and published: 10 March 2010

Reply to Anonymous Referee 1

In response to specific comments:

1. COMMENT: *Title of the manuscript has to be modified because the paper data cover more than the Last Deglaciation. Then authors have to mention all the time period studied in this new title (ex: last 20,000 yr or add the Holocene). The title of the paper accurately reflects the interval on which the study is focused.*

RESPONSE: The interval between 20 and 6 cal ka BP corresponds to the main deglacial period of retreat of the northern hemisphere continental ice-sheets. During

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this period, the episodic influx of meltwater into the North Atlantic represents a likely contribution to rapid climate changes of both the Lateglacial and Early Holocene (Clark et al., 2001). In light of comments 1 and 5, we suspect that the referee considers the terms deglaciation and Lateglacial interchangeable and equivalent; we disagree with this.

2. COMMENT: *(A) The TMF curve cannot resume the consequences on vegetation of a precipitation decrease as Temperate and Mediterranean forest decrease are associated with other changes in vegetation. They are not shown here. (B) What are the differences between large decrease of H1 and YD climate episodes and Holocene events? I think that it will be good to present other pollen curve such as those of steppe vegetation in parallel to show that. This may explain that decreases in MAT parameters are very large during the first events (H1 and YD) and more slight during the onset of Holocene.*

RESPONSE: (A) In order to address the climatic significance of changes in the TMF curve, we add further information and discussion about the pollen record to the manuscript. Specifically, we have added a simple pollen diagram to illustrate the curves of all major taxa for the deglacial interval, and to illustrate the main components of the TMF curve. We also present two pollen-based indices based on the distribution of present-day regional vegetation types along temperature and precipitation gradients. The advantage of these indices is that each is effectively independent of fluctuations in other taxa and hence avoids the problem of interdependence in pollen percentages. One index describes the proportions of deciduous *Quercus* and semi-desert taxa, and primarily reflects moisture availability, while the second describes the proportions of evergreen *Quercus* and *Cedrus*+Cupressaceae, and primarily reflects temperature variability. The reviewer suggests that the conflation of temperate and Mediterranean vegetation elements within the TMF curve may prohibit the distinction of precipitation and temperature signals. The use of the two indices allows independent assessment of the temperate (deciduous *Quercus*) and Mediterranean (evergreen *Quercus*) elements in the pollen assemblage, and ultimately supports the interpretation of TMF declines as consistently dry episodes also generally associated with cooling. (B) In order to evaluate why large climatic anomalies are reconstructed for H1 and YD and weaker anomalies for Holocene events, we have added extended the discussion of the MAT results and evaluate the role of analogue locations and distances (dissimilarity).

3. COMMENT: *A remark about the Bølling/Allerød phase versus Greenland and other European records. Genty et al. have shown in 2006 that temperature vary in a different way from Bölling to Alleröd in north and south Europe with a decreasing trend in North (as in ice core records) that change progressively in increasing one in South. Results of MD 95-2043 show a parallelism with ice cores. It is in opposition with the first scheme developed by Genty et al. (2006) with a clear North to South gradient. Authors have to discuss about that.*

RESPONSE: We add a discussion of the BA trends. A stable BA trend is not present in the pollen record, suggesting more dynamic climate changes over the BA compared with, for example, the SST record from the same core, or certain palaeoclimatic records discussed by Genty et al. (2006). Warmest temperatures appear to have occurred at the end of the Bolling, with subsequent cooling; we draw attention to this pattern and highlight that it is at odds with the previously proposed pattern.

4. COMMENT: *Make attention to the ages of events, some of them have not the same age in different parts of the paper.*

RESPONSE: The consistency of ages has been checked throughout the paper.

5. COMMENT: *I am not completely convinced by the interpretation about the two situations of blocking and non-blocking situations and by the explanation of the rapid climate events. In fact, I am not sure that the same mechanisms drive deglacial dry events and Holocene forest declines. Perhaps I have not understood what authors want to express in the 5.2 paragraph and, especially, I do not see the aim of the last section of the 5.2 paragraph about the anomalies (that are not presented in any figure). Anomalies per*

comparison with what? I suppose it is versus present day values!! Authors have to detailed their demonstration and interpretation and precise their conclusions.

RESPONSE: In this paper we consider that the underlying causes for dry events of the early Holocene may be similar to those for Lateglacial dry events (i.e. perturbation of Atlantic THC by meltwater pulses), despite ultimate differences in the magnitude of the various events. We also show a consistent pattern of opposed western Mediterranean dryness and increased central European humidity during both multi-centennial scale events of the Lateglacial (within the BA and YD) and early Holocene events. Although the magnitude of the different events may not be equal, the consistent sign and geographic pattern, not to mention the consistent association with N. Atlantic SST cooling (iceberg and meltwater discharges) suggest that similar atmospheric conditions may have been associated with both Lateglacial and early Holocene events. We recognise that an extensive literature and open-ended debate exists regarding the exact causes (e.g. oceanic, solar, volcanic) of Holocene cooling events, and agree that some mechanistic differences may exist between the different events discussed. However, in observance of Occam's Razor (never needlessly multiply entities), we present a single atmospheric mechanism that might explain or partially explain the pattern observed across the deglacial interval. Nevertheless, in response to the reviewer's doubts we have added sentences to this section so as to situate the specific mechanism of blocking episodes more tentatively within a more general interpretation of changes in the intensity of the zonal westerly flow. We have also rewritten the specific parts of section 5 dealing with the comparison with present-day precipitation anomalies associated with blocking episodes in order to make them clearer.

6. COMMENT: *I think that authors are too excessive with their considerations about age reservoir in Mediterranean. It seems too much exaggerate to use palynology (with only TMF curve) as a marker to evaluate the changes in age reservoir in the Mediterranean Sea. Siani et al, in 2000 show that the reservoir age was about 280 yrs in the western Alboran Sea although it reaches 555 yrs in the eastern part of this basin. So*

the 400yr correction that correspond to the mean value of Mediterranean does not be corrected of 200 yr according to one site on the basis on one specific curve.

RESPONSE: It appears that our intentions were perhaps not sufficiently clear in this section. In contrast to the reviewer's understanding of this section, we do not suggest that a reservoir age correction be applied to other sites on the basis of our observations, and we do not suggest that this exercise can replace the parallel dating of terrestrial and marine carbon from secure stratigraphic contexts as a means for improving regional reservoir age correction factors. Given the exceptional temporal resolution permitted in the study of Alboran Sea deglacial marine sediments, multiple AMS dates available on the MD95-2043 core, and the availability of a terrestrial tracer (in this case, pollen) which faithfully replicates Greenland climate variability, we feel strongly that this comparative exercise is both valuable and timely given current interests in improving the understanding of variability in reservoir ages and the comparability of timescales from different archives (ice, marine, terrestrial). In effect, this section represents a detailed examination of the core chronology in light of contextual information contained in the terrestrial pollen record. As such, we feel that it's inclusion represents a useful gesture of total transparency with respect to the available chronology and a logical examination of the implications of the identification of rapid climate variability in the pollen record. In light of the reviewer's criticism and comments from Reviewer 2, we have reworked and further qualified this section in order to make these intentions clear.

7. *Technical Corrections: In Figure 3, pollen events (forest decreases) are not reported and it is not easy to see clearly the correspondence between this figure plotted in depth and in figure 4 plotted in ages. It is not easy to read the MAT parameters curves in Figure 4 with only the error bars and the 3points smoothed curves. I do not know if the reason is the choice of colours or this presentation without the basic curve of each MAT parameter. Grey bars that marks forest decreases, are too light. Dashed line is too small to be well seen.*

RESPONSE: all figures have been carefully checked to ensure visibility of the critical

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details. Also, the key marine, pollen and MAT results are now presented in a single figure (Figure 5) for ease of interpretation.

Interactive comment on Clim. Past Discuss., 5, 203, 2009.