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Climate of the Past Discussions

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.

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Reply to Anonymous Referee 2

In response to specific points:

1. COMMENT: *In the paragraph "Data and Methods"; the authors present the Modern Analogue Technique (MAT) to estimate past temperature and precipitation based on pollen data. Reliability of temperature and precipitation reconstructions are in general assessed using a square chord distance test (dissimilarity coefficient) representing the mean degree of similarity between the sample and the best modern analogues issued from the database. When the dissimilarity coefficient is lower than 0.25, the reconstruction is considered to be of good quality (see Overpeck et al., 1985). The authors*

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did not present the dissimilarity coefficient values neither the geographic origin and the number of modern analogs used in this study. These data should be provided to facilitate the interpretation of results. Finally, how is significant to present Temperature and Precipitation record by MAT instead of TMF record taking into account the error bars on the estimations?

RESPONSE: In order to address these shortcomings we have added the curve for the dissimilarity coefficient and Monte-Carlo simulation threshold for reliable analogues to the MAT figure. In the results section, we have added a section to discuss the location of analogues and the possible influence of changes in dissimilarity coefficient between different core sections. The number of analogues is (and was) stated in the methods section (10 best analogues). Furthermore, the addition of two pollen-based climatic indices providing the best possible non-quantitative inference of precipitation and temperature signals in the pollen record provides a further basis for assessment of the sensitivity and reliability of the MAT reconstructions.

2. COMMENT: *Results from MAT reconstructions and TMF record clearly indicate a good correlation with SSTs alkenone record from Cacho et al. 1999, especially during the main climatic transitions since the last deglaciation. On contrary short term climatic changes are only recorded by TMF record indicating a series of dry intervals characterised by reduced forest development throughout the Late glacial to the Early Holocene. For the events dated at 12.4 ka, 11.4 ka, 11.1 ka, 10.7 ka, 10.1 ka and 6.9 ka, TMF variability is lower than 5-10 percent. May these events be considered realistic especially when compared to Alkenone SSTs record? Can we consider AC3 AC4 AC5 and AC6 events reliable taking into account the error bars on the alkenone measurement? Finally, how can be explained the absence of the Younger Dryas cold event in the temperature and precipitation record?*

RESPONSE: The question of the statistical significance of anomalies in the different records is important, and challenging to address. In order to be more cautious, we no longer describe the lowest frequency oscillations in TMF at 12.4, 11.4, 11.1 and 6.9 cal

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ka BP as forest declines, but consider other changes of 5 percent or more in TMF as meaningful (supported by calculations of uncertainty in the pollen record presented in Fletcher and Sanchez Goñi, 2008. The presentation of the TMF curve with a running mean is also done with the aim of, at least visually, reducing the effect of noise in the dataset. The "absence" of the Younger Dryas event in the MAT reconstructions may relate to greater analogue distances in this core section, and also to a lack of good vegetation analogues for transitional forest-steppe vegetation of the Lateglacial: we add discussion of these points to the MAT results section.

3. COMMENT: *The Authors suggest an increase of sea surface 14C reservoir age in the Alboran Sea by about 200 years during the Late glacial/interglacial transition by comparing calibrated radiocarbon and ice core ages. From my point of view this approach is a little bit simplistic as it is not based on a quantitative measure of the offset between the 14C activity of the atmosphere and that of the contemporaneous oceanic carbon reservoir. This approach was indeed adopted in Mediterranean Sea (Siani et al., 2001) as well in the North Atlantic Ocean (Bard et al., 1994, Austin et al., 1995; Bondevik et al., 2006; Cao et al., 2007 among the others). Concerning the present study, I believe that the best way to give a more realistic estimation of the sea-surface reservoir 14C age in the Alboran Sea is to compare the SST record in Siani et al., (2001) with TMF record in core MD95-2043 by using for both series the conventional radiocarbon measures as age model. Such correlation displays a good match between the Adriatic and Alboran sea records showing a quite synchronous Glacial-Interglacial transition. Therefore, by taking into account that no changes in the Mediterranean circulation occurred during this time interval, it could be suggested that the reservoir age offset estimated in the Alboran Sea is probably the same than the Adriatic one and consequently older than present day global mean age of 400 yrs. Finally, I recommend to add in paragraph 5.3 the following references, Bard et al., (1994), Austin et al., (1995) and Bondevik et al., (2006) when the authors introduce the term reservoir 14C ages in North Atlantic Ocean taking into account that their estimations are based on reliable results and not from correlations with ice cores chronologies.*

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RESPONSE: (See also response to comment 6 of Reviewer 1) We recognise that the exercise undertaken here cannot have the same significance as estimates based on paired dating of marine and terrestrial material, and have modified the text so as to make this clear. We also add a statement explaining why the direct AMS dating of pollen in this core is, at present, not practically feasible. It is true that a good match between the Alboran and Adriatic sea records is evident when they are compared directly on a conventional radiocarbon age-scale, supporting the suggestions we make in this section. However, we argue that virtual synchroneity between TMF changes (which reflect atmospheric conditions) and Greenland climate is more likely reliable in light of recent evidence for evidence for extremely rapid atmospheric reorganisation at abrupt climate transitions (Steffensen et al., 2008) than synchroneity between TMF changes and Adriatic SSTs, although both may ultimately reflect responses to similar atmospheric forcing. Moreover, the specific climate transitions of interest are well-defined in the ice core records and their ages and age uncertainties on the GICC05 timescale have been previously published, while the much lower resolution of the Adriatic SST record does not permit their identification. For these reasons we do not make the technical change suggested. The additional references suggested have been added to this section.

4. COMMENT: The authors state that HE1 is the equivalent of the Oldest Dryas in southern Europe terrestrial pollen sequences. It is not clear for the reader which are the de64257;nitions of Older Dryas (OD) and Heinrich event (HE). In general, the OD is considered like a cold and dry period spanning a time interval between 15 ka to 17 ka and corresponding to the GS-2a event following INTIMATE recommendations (Lowe et al., 2008). On contrary, HE is a rapid event characterised by short surge episodes associated to iceberg meltings. In conclusion, it is not realistic consider HE 1 as a climatic period but rather as one or more short events occurred during the Oldest Dryas period.

RESPONSE: We agree that the term "Heinrich event" should be used to refer to the

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iceberg discharge events. We alter the terminology to "Heinrich stadial" as proposed in Sanchez Goñi and Harrison (Millennial-scale climate variability and vegetation changes during the Last Glacial: Concepts and terminology, QSR, in press) to indicate a stadial interval associated with iceberg discharge events in the North Atlantic. As demonstrated in several Iberian margin marine records containing terrestrial tracers (pollen), the interval marked by IRD deposition, SST cooling and increases in polar foraminifera known as Heinrich stadial 1 corresponds closely with indications of cold and dry conditions on land recognised in terrestrial sequences as the Oldest Dryas (not Older).

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