Author comments to Anonymous Referee #1

We would like to thank Referee #1 for the very constructive comments provided on our manuscript "Clim. Past Discuss.10, 2595-2626, 2014 Annual proxy data from Lago Grande di Monticchio (southern Italy) contributing to chronological constraints and abrupt climatic oscillations between 76 and 112 ka".

We are pleased to accept all the suggestions, as they will improve our manuscript.

Regarding the major modifications and specific comments that the referee suggests:

1) Introduction has been rewritten. The revised introduction focuses on the study interval (76 to 112 ka) and provides information about the millennial-scale abrupt climate changes during early last glaciation and how this climate variability was recorded in the Greenland ice cores, as well as in other marine and terrestrial climate archives across the North Atlantic region and Western Europe. We have also showed the lack of knowledge of these abrupt climate changes in comparison to those occurring during the full glacial conditions, basically because a limited age control during the early last glaciation. We show detailed information about the most precise and highest resolved palaeoclimate archives recording the study time interval, so far (the NorthGRIP ice core record and the NALPS speleothem) and their main limitations of the chronologies. Thus, we have emphasized the importance of our record to the state-of-the-art, since it is the only independently dated, continuous, high-resolution paleoclimate archive in the central Mediterranean region through the early phase of the Last Glacial Period.
2) Age uncertainties: we provide a better description of the age uncertainties associated with the duration of the climate oscillations in the revised version of the manuscript. We have calculated error ranges along the study interval based on the comparison between two independent varve counts, the MON-07 which was partly published by Allen et al. 1999 and by Brauer et al. 2007, and the MON-2014 (this study). The correlation between both counts was established using 132 tephra layers as correlation markers. The detailed comparison between the MON-07 and the MON-2014 varve counts allows providing a better constrained and more precise error estimate for the study interval. And we applied this relative error as uncertainty range for the durations of the climate oscillations.
   Additionally we have provided two new figures following the referee's recommendations. Figure 6 zooms the climate oscillations described in the

Monticchio records in order to see clearly how the transitions were reflected by the pollen, varve thickness and geochemical (Ti) proxies. We have also indicated the resolution of the pollen samples. Figure 8 shows a direct comparison of the timing and duration of the stadials as displayed by the different chronologies discussed in the text (GICC05modelext, AICC2012, NALPS and MON-2014).

3) We have increased the vertical size of the Figure 3c (Figure 4 in the revised version) and Figure 5 (Figure 7 in the revised version) in order to allow an easier visualization of both the millennial-scale climate oscillations and the sub-millennial scale climate variability.
4) Discussion about different proxy response. According to the referee's suggestions, we have included previous publications that provide information about synchronicity/lead/lags during the Younger Dryas (Lane et al., 2013 and Rach et al., 2014). These studies show that regional differences in the abrupt climate response occurred in the range of decades. In the text, we mention that tracing possible leads and lags in the climate response of the different proxy records is not possible because of the discrepancies (several millennia) among the ice core chronologies and among those and the NALPS and the MON-2014 timescales during the study time interval is higher than decades. We agree Referee#1 that the differences observed between the different records may originate from different proxy response and we suggest this as a key issue for further investigations in the last paragraph of the conclusions.

Regarding the minor and technical corrections, we have accepted all of them, including the new title proposed by Referee#1.

Author comments to W. Fletcher Referee #2

We would like to thank Dr. Fletcher for his comments and suggestions on our manuscript "Clim. Past Discuss.10, 2595-2626, 2014 Annual proxy data from Lago Grande di Monticchio (southern Italy) contributing to chronological constraints and abrupt climatic oscillations between 76 and 112 ka".

Especially, the manuscript have highly benefited from his expert advises on the climatic interpretation of the Monticchio pollen record and their implications on the climatic discussion of the sedimentological and geochemical record presented in this study.

>> Climatic interpretation of the MON events. In his revision, Dr. Fletcher shows a list of published examples from the Monticchio pollen record and other pollen records in the Mediterranean region, where the correlative stadial periods in the Mediterranean are interpreted as episodes of cooler but also drier conditions with a very marked seasonality (cold winters and dry summers). Based on this evidence we have reconciled the interpretation of our sedimentological (microfacies and varve thickness) and geochemical (Ti counts) proxies with the appropriate climate interpretation of the MON pollen data. Thus, we interpret the interval of increased varve thickness and Ti counts, which coincide with the pollen-based Mediterranean stadial periods, as periods of increased soil erosion because of forest reduction. Dr. Fletcher asks for addressing the issue of the seasonality (T or P), but unfortunately our annual-proxy data do not show a straightforward climate-proxy relationship (see next paragraph). Based on the synchronicity of the changes in the sediments and in the vegetation, we take the climate interpretation given by the pollen data to explain changes in the sediments and we use the annual-proxy data as indicators of climate variability, which allow us to provide absolute (timing) and relative (duration and velocity of the change) dating of the climate oscillations (stadial periods) more accurately and precisely than with the lower-resolution pollen record.

>> Catchment dynamics. The heterogeneous nature of the sediments in the Monticchio varved record (i.e. organic varve sediments, reworked deposits and tephra layers) suggests multiple and very complex interactions among chemical elements. We found a strong parallels between the Ti and the varve thickness records and between those and the pollen record. As mentioned above, based on this good correlation we interpret our annual-proxy data as climate proxies but a more detailed reconstruction of the environmental and climate processes controlling these indicators is not fair. We agree Dr. Fletcher that the annual-proxy data shown in this study have the potential for a comprehensive discussion of the catchment dynamics, but we think this issue would deserve to be addressed in an additional manuscript. A well-supported study of the sedimentary processes operating on the lake Monticchio would imply further geochemical (e.g. TOC, TC, TN, Opal…) and isotopic analyses, as well as statistical treatment of the data. On the other hand, we would not expect that detailed reconstructions of the catchment dynamics have significant chronological implications, which do indeed be the main focus of our present study.

>> Introduction. The introduction has been rewritten in the revised version as suggested by both referees (see response to Referee#1).

Conclusion-Point 1. Proposing ideas about how and when millennial-scale variability emerges at the glacial inception, even being a very interesting challenge, is not within the scope of our study. In this study, we do not show annual-proxy data beyond 112 ka, so we cannot provide evidence for signs of millennial-scale variability coinciding with the DO 25 and the previous cooling episode GS 26.

Minor corrections and comments have been accepted.