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Climate of the Past Discussions

Interactive comment on "Climate warming and vegetation response at the end of Heinrich event 1 (16 700–16 000 cal yr BP) in Europe south of the Alps" *by* S. Samartin et al.

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We would like to thank all three referees and the editor for valuable comments on our article. Please find below our point-by-point replies to reviewer comments.

Referee 1

General remark: This is a very challenging paper which illustrates the great potential of Chironomid studies and explore a key period of transition between glacial and interglacial. Its structure is good.

Remark 1: Remark 1 is on the age model. I know how it is difïňĄcult, almost impossi-

ble to acquire 14C dates from sediments covering the last glaciation and the transition to LGI.the authors admit that the chronology of their sequence is not that robust but they claim that this chronology is sopported by similar evidences from other sites (continental, marine, speleothems). According to the available data, this assumtion and the correlation with HE1 remains still putative. The lack of a 14C at the limit between zones 1 and 2 is thus quite frustrative.

Response 1: Many thanks for the appreciation of our work, as mentioned in the paper the early warming at ca. 16,700-16,000 cal yr BP south of the Alps is chronologically not well constrained in the Origlio record. However, the biostratigraphical comparison (pollen and plant macrofossil records) with other well-dated lowland sites south of the Alps demonstrates that reforestation in the Origlio record, as indicated by pollen, is in agreement with other, well-dated lake records that document that afforestation processes started around 16,700-16,000 cal yr BP. In contrast to what is stated by the reviewer, we believe this unambiguously proves that our age-depth model is robust in the period around 16,000 cal yr BP (Vescovi et al., 2007). Also, because all dates were performed on terrestrial plant macrofossils, we consider our chronology potentially more reliable than paleo-environmental records from the marine sediments (reservoir effects) or bulk-dated sediment records from the continent. For instance at Balladrun, a close-by mire (19 km distant from Origlio), the expansion of Pinus cembra forests is dated to 16,700-16,000 cal yr BP (with a radiocarbon date on Pinus cembra macrofossils, 13,100 $\pm$ 100 yr 14C BP, Hofstetter et al., 2006) and this has been mentioned in our manuscript. Similarly, the early forest expansion at Lago di Annone in Northern Italy has been dated to 16,700-16,200 cal yr BP. This very good agreement with other well-dated pollen and plant macrofossil records in the study area makes the lack of 14C dates between 17,000-15,000 cal yr BP at Origlio less problematic. On the basis of our age-depth model and the independent biostratigraphic comparison with other sites we assume that the Origlio record has a chronological accuracy of about $\pm$500 years during the period 17,000-15,000 cal yr BP where radiocarbon dates are not available.

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Hofstetter, S., Tinner, W., Valsecchi, V., Carraro, G., and Conedera, M.: Lateglacial and Holocene vegetation history in the Insubrian Southern Alps - New indications from a small-scale site, Vegetation History and Archaeobotany, 15, 87–98, 2006. Vescovi, E., Ravazzi, C., Arpenti, E., Finsinger, W., Pini, R., Valsecchi, V., Wick, L., Ammann, B., and Tinner, W.: Interactions between climate and vegetation during the Lateglacial period as recorded by lake and mire sediment archives in Northern Italy and Southern Switzerland, Quaternary Science Reviews, 26, 1650–1669, 2007.

Remark 2: Remark 2 on the transition between zones 1 and 2: the Chironomids diagram in ïňĄg. 3 is in agreement with an "abrupt" change at the beginning of a local expression of the "Pre-Bolling", but this evidence (expressed in the text) is less convincing on ïňĄg.4 and 5 which suggests a progressive warming. How do the authors explain this discrepancy?

Response 2: The Origlio chironomid record in Figure 3 shows a quite abrupt increase in lowland taxa at the transition from ORE-1 to ORE-2, which coincides with an abrupt decline of alpine/subalpine taxa and results in an abrupt though moderate increase of ca. 2.5°C in chironomid-inferred July air temperatures at ca. 16,000 cal yr BP as seen in Figure 4b. The strongest temperature decrease in this part of the record happens between two samples at ca. 1350 cm depth. Although there is some variability in inferred temperatures between ca. 1330 and 1365 cm depth, we do not believe that the data provide clear evidence for a gradual temperature rise in this section of the core, with the first sample of zone ORE-2 actually recording higher temperatures than the last sample (Fig. 4b). Detrended correspondence analysis (DCA) as shown in Figure 4a also supports that shifts in chironomid assemblages were very rapid and largely took place between two individual samples. The compositional change recorded by DCA axis 1 is equivalent to 1.5 SD at the transition from ORE-1 to ORE-2, which suggests that many of the chironomids present in zone ORE-1 (the cold-loving alpine ones) are absent in zone ORE-2. Figure 5 displays the diagnostics statistics of the temperature reconstruction, not the reconstructions, and informs about the reliability of

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the reconstructed temperatures. We, therefore, do not believe that any of the figures document a gradual temperature increase in this section of the record. Instead, we attribute the variations in chironomid-inferred temperatures within ORE-2 to random and non-climatic processes affecting the chironomid record.

Remark 3: Remark 3 on the general understanding of the 18 000-14 500 interval. For me this transition is still difïňĄcult to understand and the authors could better underline the complexity of the question. For sure they insist on an altitudinal limit in the Alps: below 1000 m asl pollen data show faint evidences of reafforestation and nothing is observed above. But when looking at several pollen sites recording the period before the "Bolling", dated or not, they show different evidences. For instance, at Monticchio, a never glaciated site, in a region well known as a refugial zone for trees, a "progressive warming" since 16.000 BP could have allowed an early forest expansion. It is not at all the case, and this period is marked by amaximum in Juniperus and Artemisia suggestig a dry phase. Still in Italy, at Lago dell'Accesa, a zone centered on 15 500 BP by tephrostratigraphy marked by a decline of Juniperus and a maximum of Artemisia "suggests more continental" climate. Thus the discussion is still open and fascinating and this paper constitutes an important contribution and an incentive for a deeper exploration of this period.

Response 3: The main question of our article is whether large-scale afforestation processes south of the Alps, which occurred 1.5-2 millennia before the Bølling/Allerød warming, were triggered by increasing temperatures or not. We think that this main question is clearly addressed in our article. On the basis of the current knowledge there is no doubt about the observation that forests expanded at around 16,700-16,000 cal yr BP in the lowlands of southern Switzerland and Northern Italy. This interesting question has been addressed by many international articles since the 1990s and is not in the foreground here. In the conclusion section we further highlight the importance of moisture for forest growth (see p. 1634). The early warming between 16,700-16,000 cal yr BP together with sufficient moisture allowed the expansion of forests in South-

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ern Switzerland and Northern Italy but further south (e.g. Lago di Monticchio) forest expansion was delayed by several millennia due to lacking moisture availability (post-glacial afforestation gradient along the Italian peninsula and in Sicily). This interesting vegetational issue has been elucidated in former articles (for details see e.g. Tinner et al., 2009) including the presence of macro-fossil and pollen-inferred forests during the coldest periods of the LGM in Northern Italy.

Tinner, W., van Leeuwen, J. F. N., Colombaroli, D., Vescovi, E., van der Knaap, W. O., Henne, P. D., Pasta, S., D'Angelo, S., and La Mantia, T.: Holocene environmental and climatic changes at Gorgo Basso, a coastal lake in southern Sicily, Italy, Quaternary Science Reviews, 28, 2009.

Remark 4: On Fig.4 and 6 the legends identify image b as a, and a as b!

Response 4: This has been corrected, many thanks.

Interactive comment on Clim. Past Discuss., 8, 1615, 2012.