We thank both reviewers for their comments and their constructive suggestions, which helped to significantly improve the manuscript. Since both reviewers particularly highlighted dating uncertainties of the archaeological settlements and the resulting difficulties in comparison to the flood record, we improved the discussion about the comparison of settling phases and floods periods by pointing out persistent dating uncertainties of the lake-dwellings at Lake Mondsee. In the following we give detailed point-by-point responses (normal fonts) to the individual comments (in italics). An accordingly revised manuscript is submitted.

***Anonymous Referee #1**:*

This manuscripts treats a very timely topic that is the interplay between human cultural evolution and climate change, thus the topic is very appropriate for 'Climate of the Past'. The study focuses on the Neolithic period and investigates the sedimentary record from Mondsee, a lake at the northern edge of the Alps in Austria, which is compared to the history of lake-shore settlements at the same site. In particular, the sediment record is investigated in terms of flood occurrence, so that regional-scale flood and debris flow deposits are compiled in a detailed runoff record reflecting Mid-Holocene precipitation events in the catchment. The study is also significant, as previous studies have linked the abandonment of lake-shore settlement to a single event, i.e. the impact wave caused by a major mass-movement that supposedly fell in the lake. The authors can disprove this theory, and instead, shed new lights into the potential influence of climate change (floods). The general outcome indicates that there is only little 'direct' connection between the flood history and human history. Floods occurred frequently at various magnitudes and certainly affected the settlements. However, no obvious trend or direct influence can be shown, as the abandonments do not match 1:1 with changes in flood activity. The authors show nicely, that flood activities varied substantially. The study is well written and documented. I do have some general comments followed by some detailed comments.

General comments:

In contrast to the lake sediments, the chronostratigraphic durations (and in particular the time of settlement and abandonment) of the settlements are not that well constrained - a correlation to multidecadal flood periods remains thus uncertain, but this is what the article is focused on. The lack of accurate dating of human occupation is a bit a surprise, because usually archaeologists date precisely such settlements in the Alpine realm with dendrochronology (these analyses may have not been performed for the Mondsee sites, despite them being archeologically famous). The 12 original radiocarbon samples cluster clearly around two radiocarbon windows, but it is not quite clear to me how long the settlement periods lasted really. Duration of these periods have been modelled, but on line 5902/27, the SP1 and SP2 phases are only given as <100 years windows, Fig. 3 shows them as ~500 year long period each. If they are only hundred years, then the uncertainty in age

dating on an absolute scale makes correlation to multidecadal flood periods thus highly speculative. Most of the flood periods are indeed in the multidecadal periods, a fact that is pushing a bit the dataset, as mean recurrence rates are reported to be 67 (regional floods) and 333 (debris flows) years. The identified enhanced flood periods last about 50 years. They are characterized in average by flood recurrence of ~10 years, which nevertheless makes them significant as they contrast to periods of flood quiescence. The longer-scale signal, with the flood maximum in the mid Holocene (5900-4500 BP), is certainly chronostratigraphically more robust, but this long window somehow comprises initiation and abandonment of human occupation and can thus not be used to more accurately evaluate climate control on settlement history.

We agree that the large chronological uncertainty of the archaeological findings prevents from a more precise comparison of settlement periods and decadal-scale flood episodes as inferred from the varved sediments of Lake Mondsee. Unfortunately, more precise ^{14}C dates from lake-dwellings at Lake Mondsee are still lacking so that an exact dating of the abandonment of the individual Neolithic settlements is still elusive (Ruttkay et al., 2004). Moreover, our intensive search for dendrochronological dating as suggested by the reviewer revealed that these attempts to constrain the chronology of the lake-dwellings were so far not successful because the discovered trees ring sequences were too short to enable robust wiggle matching. We added a respective reference from "grey literature" (Dworsky & Reitmaier 2004). However, the same publication provided three additional radiocarbon dates from the lake-dwellings, which allowed us to better constrain the settlement chronology (note the slightly different ages for the lake-dwellings given in the text). By using a state-of-the-art age modelling procedure for the settlement periods implemented in OxCal 4.1, we were able to reduce the uncertainty of the settlement periods (Note that we changed the term "settlement phases" into "settlement periods" to clarify that the settlements existed during this time interval; see also comment to Referee #2). We now state the modelled duration of the intervals during which the settlements existed (the mentioned time windows of <100 years did not include the modelled dating uncertainties) and focused our discussion on the comparison of settlement periods and flood occurrence on centennial time scales, showing that the uncertainty of the archaeological dating does not affect our main statement, i.e. that the abandonment of the settlement cannot be directly linked to a change in flooding frequency.

I wonder whether charcoal analysis of the well-dated sediment record could pinpoint more precisely the timing human occupation, as the settlements were certainly linked to fire and the distances of the shore to the coring site is small. There is for instance a recent study of Neolithic lake-dwelling settlement on the shores of Lake Lucerne (Thevenon and Anselmetti, 2007; QSR), which shows enhanced content of charcoal and fly-ash particles in a basinal lake-sediment succession related to Neolithic human activities. Maybe similar analyses are also available for the well-investigated Mondsee cores, which could verify a bit the timing of SP1 and SP2 settlement phases

We thank the reviewer for this correct comment on charcoal analysis but, unfortunately, such data are currently not available for the Lake Mondsee sediments. It definitely has a great potential and will be considered for future projects on Neolithic settlement history at this lake.

5909 7ff. An impact wave would mainly affect the shores and likely would have deposited a tsunami layer in coastal sediment succession, as was shown on various studies of tsunami deposits. Has this been investigated? Are shallow-water cores available, in which deposits of such a impact wave could have been recorded? As the contradiction to the single-event history of previous studies is also a major finding of this study, I would welcome a bit an extended discussion on this issue; currently, this is treated very briefly and not in-depth.

Although it has been shown that the imprint of a tsunami-like event should be also reflected in sediment cores from the lake profundal (we added respective references to the discussion) and we could not find any indication for such an event in the long master core, we agree that such an event should also have affected the shore areas and should be particularly present (if it occurred) in near-shore cores. Since we do not have sediment cores from the near-shore area, we investigated not only the master core presented in this paper but also a number of short cores from different parts of the lake basin (Swierczynski et al., 2009) for suspicious sediment structures in great detail with microscopic techniques. In none of the cores we could find any indication for a major tsunami event. Our rejection of such an event is further supported by professional diving expeditions in 2003 and 2004 that did not reveal any rock debris or unusual relief disturbances in the lake basin (Breitwieser, 2010). Even investigations on the settlement site "See" at the southeastern shoreline do not report a "tsunami horizon" or any abnormal stratification above the Neolithic cultural horizon (Schmidt et al., 1986). We agree that absence of evidence is not automatically evidence of absence but the combination of all available information makes us confident that a tsunami-like event during Neolithic times in Lake Mondsee can be excluded. We incorporated these additional information in the discussion according to the suggestion of the reviewer.

5899/10: It is not mentioned, why the authors opted for a coring site not really in the deepest area (= depocenter for underflows caused by flood events) but chose a coring site that lies 6 m above the deepest part of the lake. They also should indicate the site on Fig. 1, or is this the white spot (not indicated in Fig. caption)? This would indeed not be the deepest spot, so some underflow events might be missed. This should be discussed, maybe there were some reasons, but this location might affect the completeness of the flood record.

The main reason for selecting the site at 62 m water depth was the aim of the initial project to obtain an oxygen isotope record from ostracod valves (Lauterbach et al. 2011). Therefore, coring in the deepest part with the highest probability of oxygen deficiency has been avoided. However, we can exclude a lack of completeness of our core compared to the deepest part of the lake basin by detailed, thin section based comparison of short cores from both coring locations (Swierczynski et al., 2009). This information has been added in the text as well as

an indication of the meaning of the white spot in Fig. 1 in the caption.

This post 5000 BP dolomite signal (debris flow from south) is a bit hard to see on Fig. 5, I am not that convinced. On line 5908/26, the story is furthermore unclear or contradicting: it has been stated first that after 5000 BP the Mg increases, and that before the siliciclastic (Ti) content was high. Now they state here that there is a shift around 5000 BP to regional floods and an increase in siliciclastic material....., that is the opposite of the previous statement.....confuse, needs to be clarified!

This statement is indeed wrong and we apologize for the confusion. Firstly, a shift occurred from enhanced Ti input to Mg-input and not vice versa. Secondly, the shift took place around 4900 vyrs BP and not at 5000 vyrs. This has been corrected in the revised manuscript. However, we have cancelled the discussion of a shift from regional flooding to local debris flows based on interpretation of the µXRF data from the revised manuscript since the broad-scale trend in the µXRF data reflects changes in detrital background influx but not single events like the event layer record, which is well-constrained and thus the basis of our argumentation.

Detailed comments:

Repetitive use of 'varve year BP', could be abbreviate to vBP or similar

The abbreviation "vyrs BP" has been introduced.

The term 'Lake Mondsee' sounds a bit weird, as 'See' means 'lake'. Maybe one can just use 'Mondsee' and indicate in the beginning that it is a lake.

Although we are aware that the term 'Lake Mondsee' might sound a bit strange we prefer to keep it in order to avoid confusion with the 'Mondsee Culture' and the town of Mondsee. Moreover, the term has already been introduced in the literature (Lauterbach et al., 2011; Swierczynski et al., 2012a) and thus should not be changed.

5896/20 The lake's morphology does not support the definition of two basins, as there is only one basin and thus one sink for detrital underflows. Two basins would need to be separated by a sill, this does not seem to be the case.

We did not say that there are two distinct basins but rather that the "basin can be divided into a shallower northern and a deeper southern part". Indeed, both parts of the basin are separated by a small sill and reveal small limno-physical differences (Jagsch and Megay, 1982). We added this information.

5897/15: These lakes usually are not Alpine lakes, but perialpine, or prealpine. Mondsee is

somehow an exception as it lies within the Alpine naps, but all the other quoted ones are outside the Alps. s. str.

We changed the formulation in the manuscript into "pre-Alpine and Alpine lakes" because, in addition to Lake Mondsee, also Lake Keutschacher See in Carinthia with its prominent lake-dwellings lies within the Alps sensu stricto (Gurktaler Alpen).

5901: 13-18 should be deleted, plain repetition to method chapter just above.

This has been changed accordingly.

5902: Rejected 14C age should also be displayed graphically on the plot of the age- depth models.

The rejected radiocarbon date (KIA32795, 873 cm composite depth, Table 2) is outside the depth range shown in Fig. 2 (550–850 cm composite depth) and therefore cannot be displayed in the figure.

Figs. 4 and 5: What is the bar between 24 and 32 mm on the axis of the debris flow layer thickness?

The bars were thought to indicate a break in the scaling between the lower part (0-5 mm thick) and the upper part (32 mm thick) because there are no thickness values in between. The figures have been redrawn for clarity.

5906: 1 ff. The age errors are in the range of plus minus 100 years, the correlation to these cold spells to some of the flood periods are thus a bit speculative.

It is correct that due to the dating uncertainty of the Rotmoos cold spells the comparison with single decadal-scale flood episodes is a bit speculative. Therefore, we focus the discussion on centennial-scale comparisons but also keep the statement of a likely correlation also at decadal scales since a similar relationship has been shown for the younger time interval of the last 1600 years (Swierczynski et al., 2012a). We added this information to the manuscript.

5903/0-10: This is a bit a weird statement: the timber dates indicate construction and abandonment?

We agree that this formulation is ambiguous and re-phrased this section for clarification and moved it into the discussion chapter.

5907/15: the Flysch-containing layer lies below the cultural layer!? But why should this then cause/coincide abandonment, as settling occurs afterwards? Unclear argumentation! Related

to this: How do the Flysch particles come to the outlet area, if the three Flysch-dominated inflows feed the northern 'basin'? Over and interflows instead of underflows?

We have taken this information from "grey literature" (Schmidt et al. 1986) and were indeed not critical enough concerning this statement. The arguments for a lake-level transgression revealed from the observations in the cited paper are indeed not strong enough. Therefore, we cancelled the detailed discussion on the layer reported by Schmidt et al. (1986) and only mention that we cannot exclude that lake level changes have affected the Neolithic settlements.

Fig. 1 Label names of archaeological sites on Fig. 1, as numbers are not labeled.

The figure caption has been changed, accordingly. Numbers and names of the three settlements are stated now.

Anonymous Referee #2:

Referring to palaeohydrological events reconstructed from sedimentological studies of a deep core in Lake Mondsee (Austria), the paper by Swierczynski et al. attempts to document the ongoing debate whether the abandonment of Late Neolithic lake- dwellings at Lake Mondsee was caused by (1) unfavourable climatic conditions, (2) a single catastrophic event linked to a tsunami provoked by a rock fall, or (3) cultural factors. Taken as a whole, the paper presents an interesting contribution to the debate, and it is well structured. The chronology of the sediment sequence offers on a robust time scale based on both varve counting and radiocarbon dates, while sedimentological analyses offer a precise environmental context from sediment microfacies and XRF studies. The climatic conditions reconstructed from the Lake Mondsee deep core appear to be in general agreement with other palaeoenvironmental and palaeoclimatic records established in the Alps for the time window 7000-4000 cal BP.

However, the main difficulties in the section Discussion arise when comparing the environmental/climatic data collected from a deep core in Lake Mondsee with archaeological data collected from littoral archaeological sites. While the first ones are well-dated by a combination of varve counting and radiocarbon dates (uncertainty equivalent to ± 50 yr), the second ones are only dated by radiocarbon dates with considerable uncertainties. Thus, phase SPI began at 5594 ± 167 cal BP (i.e. 5761-5427 cal BP) and ended at ca 5369 ± 147 cal BP (i.e. 5516-5222 cal BP), while phase SPII began at ca 5167 ± 244 cal BP (i.e. 5411-4923 cal BP) and ended at ca 5003 ± 351 cal BP (i.e. 5354-4652 cal BP).
In addition, on the basis of radiocarbon dates, the authors seem to assume a continuous multi-centennial long occupation during phases SPI and SPII. However, archaeological data collected on the Swiss Plateau and in eastern France and well-dated by tree-ring dates suggest that occupations of Neolithic villages correspond to relatively short decadal-scale time intervals, generally no more than one century (see for instance Die Schweiz from Paläolithikum bis zum Mittelalter, Vol. 2, 1995, Verlag SGU Basel). What about possible interesting observations of stratigraphic sections examined in the littoral archaeological sites? Do they show several archaeological layers suggesting distinct successive occupations? Consequently, the section Discussion should be seriously revised (minor/major revision) to take into account the considerable uncertainties in the chronology of archaeological data which prevent from a precise and direct comparison between environmental/climatic and archaeological data.

We agree to the reviewer's comment that a direct comparison of decadal-scale floods with centennial scale settling phases is difficult and that we cannot make clear statements on the duration of the settling periods. Therefore, we calculated the maximum length of the periods during which the settlements must have existed, taking into account the error ranges of the archaeological ^{14}C dating. Accordingly, we introduced the term "settling periods" instead of "settling phase" in order to avoid any misunderstanding in archaeological context of the exact duration of the settlements (settlement phase). At the same time we clearly state that the time

interval when the settlements existed (settlement phase) might well have been much shorter. Furthermore, we now focus our comparison to the centennial-scale flood trends as we already stated before (see response to Reviewer #1). We also clearly point out that our interpretation about multi-decadal scale flood episodes and Neolithic settlements is limited due to the present availability of ^{14}C datings.

Additional remarks

Text Dates for periods defined or discussed in the text should be continuously expressed in the text by indication of first the oldest and then the youngest ages (for instance: 5600-5300 cal BP, instead of 5300-5600 cal BP).

This has been changed accordingly.

Introduction: page 3, line 13-14: please, indicate the approximative chronology of the Mondsee culture.

We added the dating range for the Mondsee Culture from published literature (5050-5650 cal. yr BP, Ruttkay et al., 2004).

Section 3: Page 5, line 22; please, add approximative dates for the Young to Final Neolithic ages Line 23: idem for Mondsee culture Page 6, Line 17: idem for Early to Middle Bronze ages

Dates have been added.

Section 5: page 12, line 12: Swierczynski et al 2012: a or b? (see reference list).

This has been changed to "Swierczynski et al., 2012a".

Section 6: page 17, line 20: Regarding the rock fall event and the possible associated tsunami, the authors should cite the paper by Girardclos et al. (2012, Nature Geoscience, about a well-dated and quantified tsunami at Lake Geneva provoked by a rock fall).

We added the respective reference (Kremer et al., 2012) where Girardclos is co-author.

Figures Figure 1: please, indicate the names of sites shown by points 2 and 3.

The figure caption has been changed accordingly.

Figure 5 (caption): FE 10 to FE 17, as defined by Swierczynski et al. 2012 b, QSR?

FE 10 to 17 are defined in the present manuscript (see chapter 5.3 “Flood and debris flow deposition”). FE 1 to 6 for the period 0-1600 cal. yrs BP are defined in Swierczynski et al. (2012) while FE 7 to 9 during the period 1600-4000 cal. yrs BP are defined in Swierczynski et al., 2012b (manuscript submitted to QSR).

Figure 6: The tree-line data from Nicolussi et al. 2005 are not shown. Revise panels D, E and F and caption accordingly. Please, the beginning and the end of boxes corresponding to phases SPI and SPII should be represented not by vertical but by oblique lines to better (precisely) give evidence of the chronological uncertainties.

We revised the figure and the caption accordingly and added uncertainty ranges for the oldest and youngest dates for every settlement period. Oblique lines would have been confusing.

References:

Breitwieser, R., 2010. Der "Mondsee-Tsunami"- Fakt oder Mediengang? in: Nachrichtenblatt, Arbeitskreis, Unterwasserarchäologi, ed. Kommission für Unterwasserarchäologie im verband der Landesarchäologen in der Bundesrepublik Deutschland 16.

Dworsky, C., and Reitmaier, T.: Moment, da war doch noch was! Neues zur Pfahlbauarchäologie im Mond- und Attersee - 1854-2004: 150 Jahre Entdeckung der Pfahlbauten, Archäologie Österreichs, 15/2, 4-15, 2004.

Jagsch, A., Megay, K., 1982. Seenreinhaltung in Österreich. Wasserwirtschaft 6, 155-163.

Kremer, K., Simpson, G., and Girardclos, S.: Giant Lake Geneva tsunami in AD 563, Nat. Geosci., 5, 756-757, 2012.

Lauterbach, S., Brauer, A., Andersen, N., Danielopol, D.L., Dulski, P., Hüls, M., Milecka, K., Namiotko, T., Obremska, M., Von Grafenstein, U., Declakes, P., 2011. Environmental responses to Lateglacial climatic fluctuations recorded in the sediments of pre-Alpine Lake Mondsee (northeastern Alps). Journal of Quaternary Science 26, 253-267.

Ruttkay, E., Cichocki, O., Pernika, E., Pucher, E., 2004. Prehistoric lacustrine villages on the Austrian Lakes- Past and recent research developments. In Living on the Lake in Prehistoric Europe: 150 years of lake-dwellings research, edited by Francesco Menotti.

Schmidt, R.: Palynologie, Stratigraphie und Großreste von Profilen der neolithischen Station See am Mondsee, Oberösterreich, Archaeologia Austriaca, 70, 227-235, 1986.

Swierczynski, T., Brauer, A., Lauterbach, S., Martín-Puertas, C., Dulski, P., Grafenstein, U.v., Rohr, C., 2012a. A 1600 yr seasonally resolved record of decadal-scale flood variability from the Austrian Pre-Alps. Geology.

Swierczynski, T., Lauterbach, S., Dulski, P., Delgado, J., Merz, B., and Brauer, A.: Late Holocene flood frequency changes in the northeastern Alps recorded in varved sediments of Lake Mondsee (Upper Austria), submitted to Quaternary Sci. Rev., submitted, 2012b.

Swierczynski, T., Lauterbach, S., Dulski, P., and Brauer, A.: Die Sedimentablagerungen des Mondsees (Oberösterreich) als ein Archiv extremer Abflussereignisse der letzten 100 Jahre, in: Klimawandel in Österreich - Die letzten 20.000 Jahre ... und ein Blick voraus, edited by: Schmidt, R., Matulla, C., and Psenner, R., Alpine space - man & environment, 6, Innsbruck University Press, Innsbruck, 115–126, 2009.