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Climate of the Past Discussions

Interactive comment on "Synchronicity of the East Asian Summer Monsoon variability and Northern Hemisphere climate change since the last deglaciation" *by* T. Shinozaki et al.

T. Shinozaki et al.

shinozakit14@gmail.com

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We would like to thank the two anonymous referees for their helpful comments and suggestions for our manuscript.

Comment (1) The variation of δ13C in atmospheric CO2 is about 0.5‰ (Fig.3 e), which is too small compared with those in peat cellulose (about 8‰ in this study; Fig.3 d). The variability of δ13Catm is also incomparable with that of peat cellulose δ13C. Therefore, it is not necessary to calibrate the peat cellulose δ13C data with δ13Catm. In addition, how is the calibration done? From Fig.2, I note the δ13C' (after calibration) is ranged between -24 and -32‰ does this imply that the original data may vary between -30

and -40‰İf so, it seems to be quite negative for peat cellulose? Then it is important and necessary to provide the modern plants δ13C data around the study site. I note a work of Akagi et al. (Geochemical Journal, Vol. 38, pp. 299 to 306, 2004), in which the peat δ13C data seem to be more moderate (about -23‰ and -27‰İ therefore suggest the authors to check the experiments (e.g. the cellulose extraction, and δ13C measurements) and/or calibration method.

Answer (1) Certainly, the variation of δ13C in atmospheric CO2 is about 0.5‰İt is said that peat cellulose δ13C is also influenced by atmospheric CO2 variability (Akagi et al., 2004, Geochemical Journal). We would like to propose that atmospheric CO2 variability was not a major reason that restricts peat cellulose δ13C in the Tashiro Bog. To eliminate the variability of atmospheric CO2, even though its variability is small, we normalized the data. The baseline is the modern value (-8 ‰. We deducted the difference between the modern and the past value. These differences range between 1.0 to 1.8 ‰Therefore raw peat cellulose δ13C data ranges between -23 and -31‰

Comment (2) The lithology is helpful to constrain the climate pattern, it is better to describe the lithology in detail. Does the profile possibly contain some sections of lacustrine sediments? The authors mentioned two sand layers, this may be useful to understand the climates and to constrain the "peat δ13C - climate" response pattern at the study region. Are these two layers correctly marked in the lithology figure? The two layers are about 10cm and 20cm in depth, how to date there? By the way, the TOC data varied within a large range (0 to 50%; Fig.2 b). This possibly suggests notable changes in lithology. A high resolution TOC measurements or weight loss on ignition may be helpful to catch both the climatic trend and events.

Answer (2) We regard the two sand layers to originate from a temporal small stream flow and the mud layer from a paleo-pond. These sand/mud layers correspond to the warm periods. We picked up organic matter for 14C dating in sand/mud layers. Certainly, we might be able to understand the climate change events from the core column and TOC data.

Comment (3) About 6000-9000 is a traditionally generally warm/wet period. However, sedimentation rate during this period is slow (as shown in Fig.2), and the δ13C during this period is very negative. These two features are very similar with those in the Younger Dryas interval. What does this imply?

Answer (3) As you mentioned, we observe a low accumulation rate and relatively low peat cellulose δ13C values between 6000 and 9000 cal yr BP. It is possible that a global warming event during this period would not have influenced the climate around northeastern Japan. Also, even though peat cellulose δ13C shows relatively negative values, it gradually increases. Certainly, the accumulation rate is low during this period. However, because of few 14C data points over the interval between 6000 and 9000 cal yr BP, we might not assess the variability of the accumulation rate during that period. We will supplement data to assess this problem.

Comment (4) The Hani peat δ13C curve has been extended to about 14000 aBP (see Hong etral., 3P, 2010, 297: 214-222), I suggest the authors to compare their Tashiro Bog curve with the whole Hani peat δ13C curve. I note although these two curves show high synchronicity for millennial climatic events in the Holocene, they also show general anti-phase trends during about 15000âĹij10000 aBP. Does this imply different climatic dynamics or different "peat δ13CâĹijclimate" response pattern? Comparisons with more climatic records, especially those of nearby sites, like Lake Biwa, Lake Suigetsu, Maboroshi Cave, would therefore be helpful to constrain the "peat δ13C - climate" response pattern and the climatic dynamics.

Answer (4) Our δ13C curve might well be synchronized with the GISP2 ice core δ18O records, and our δ13C curve obviously indicates global climate change (such as the Younger Dryas) during the Holocene as well as the last deglaciation. Moreover, the different resolution of the age models of the two sites may render a comparison difficult. We think our proxy data should be compare with other proxy records of other sites such as Lake Biwa, Lake Suigetsu in the revised version of our manuscript.

Comment (5) Continue from (4) : Climatic significance of peat cellulose δ13C P 2162, Line 7âĹij15, It is no need to cite so many peat-related but not directly relevant literatures here. Instead, more sentences about the climatic response pattern of grasses should largely improve the reliability of the proxy. How does the modern grass δ13C response to climate around the study region?

Answer (5) Your comment is very important for our study. We mentioned that the peat cellulose δ13C are mostly influenced by humid environment in summer when the plant grows. Plant δ13C varies due to the isotopic fractionation associated with carbon fixation during photosynthesis. This isotopic fractionation is largely influenced by the water availability during photosynthesis. Vascular plants such as shrubs respond to variations in water availability and relative humidity by regulating the opening or closing of leaf stomata. Thus, peat cellulose δ13C is used as a proxy indicator for evaluating precipitation and/or humidity. However, from ongoing analysis, it appear to correlate with summer temperature judging from a comparison between meteorological data in the study site and peat cellulose δ13C data from surface sediments (about between 0 and 50 cm depth). These detail data will discuss in revised manuscript. We need further study using surface sediments in Tashiro Bog to identify the variable factor of peat cellulose δ13C influence including other proxy data such as peat cellulose δ18O and biomarker δD. We will add these data in the revised manuscript.

Comment (6) Paleaoclimatic records covering the last deglaciation of East Asia are important to understand the nature of East Asian summer monsoon. However, the present literatures show very complex paleaoclimatic changes in Japan, e.g. the debates on YD-like and ACR-like (Antarctic Cold Reversal) patterns of Japanese paleaoclimatic records. Different proxy index may respond to different aspect of the climatic changes. Therefore, it is necessary to develop more indices with high resolution and robust dates. From this point of view, the Tashiro mire can provide ideal sediment to extract high resolution and well-dated paleaoclimatic information. The present work showed interesting result; however, much more work, both on the development of more proxy indices and on the interpretation of climatic significance, is necessary before deep discussion.

Answer (6) As mentioned in answer (5), we will perform more detailed analysis to identify the factors influencing peat cellulose δ13C in Tashiro Bog. In the future, we will conduct measurements such as peat cellulose δ18O and biomarker δD, and would like to discuss climate dynamics.

Comment (7) Some minor points (1) P 2184, Caption of table 1: ". . ...121114cm depth"? (2) P 2167, accumulation flux calculation, the units need to be checked. (3) P 2166, line 5, reference Shinozaki et al., 2011, is not appeared in the reference section. (4) P 2163, the geological location coordinates; change 144âŮę to 140âŮę? (5) P 2187, Figure 2, dencity to density? (6) I suggest marking the tephra dates in the AMS 14C dating curve. (7) P2169, line 5-10, the present sentence is hard to read through, need to be reorganized. (8) P 2190, Fig.5, the present caption is quite confused with some English writing error, needs to be rewritten.

Answer (7) Thank you for these comments. We will assess these points in the revised manuscript.

Comment (8) 2160 Abstract and throughout the entire paper - "peat sediment" is a confusing term, as bog and fen peat is formed in situ (peat deposits are mostly autochthonous, sedentary soils) although the archive may also include sediment from an ancient lake in the bottom of the core (allochthonous, sedimentary soils). There is a need to check the terminology.

Answer (8) Certainly, 'peat sediment' is the wrong word. We will use instead 'peat deposit'.

Comment (9) 2161, line 27 "vascular plants" – are peat samples used in this study only formed by vascular plants? Is it really so that all environments where peat forms (bogs, poor fens - rich fens) encourage growth of vascular plants? Which plants are

best preserved and contribute to the accumulation of peat, vascular or non-vascular plants (mosses)?

Answer (9) According to pollen analysis, herbs were dominant in Tashiro Bog during the last deglaciation and Holocene (Yoshida and Takeuti, 2009, JQS). In addition, there are a few non-vascular plant (moss) layers (Yoshida and Takeuti, 2009, JQS). Therefore, mainly herbs and few mosses contributed to peat accumulation in Tashiro Bog.

Comment (10) 2162, lines 1-4 "The balance between precipitation and evapotranspiration controls. . ." - it is true that it is a very important factor but the kind and abundance of bog plants also depends on several other circumstances that should be considered (temperature, nutrient status, pH, light availability, competitive advantages, etc.).

Answer (10) As we mentioned in answer (5), not only precipitation and/or humidity but also temperature seems to influence the peat cellulose δ13C value. We will add detailed discussion about variable factor of peat bulk cellulose δ13C.

Comment (11) 2163, line 2 – Geographyical, remove "y"

Answer (11) We will modify it in the revised manuscript.

Comment (12) 2163, line 9 – There is bit abrupt start of the description of vegetation in the study area, what are the plants that grow and die?

Answer (12) Truly, it is a little bit abrupt start. We will modify it. All vascular and non-vascular plants die by heavy snow.

Comment (13) 2163, line 11 "lower" – than what?

Answer (13) We will change 'lower' to 'low'.

Comment (14) 2163, line 12 "more intact" – than what?

Answer (14) We will change 'more intact' to 'intact'

Comment (15) 2163, line 12-14 – here it is stated that Tashiro Bog is a raised bog by hydrology, the “swamp water” originates from precipitation and the peat layer was not disturbed. Has it been so through the whole peat sequence or is it possible that in earlier stages there has been also ground water input? This could be seen e.g. in changes in stratigraphy and/or plant assemblages. What about other causes for disturbance in peat accumulation, such as hiatuses caused by dry periods/erosion?

Answer (15) Judging from the existence of sand/mud layers, it seems to be large water input. From the 14C consecutive data, there is no hiatus and sedimentation reversal. We measured 14C of organic matter in the sand/mud layers.

Comment (16) 2164, lines 9-10 “a mixture consisting of . . .“ - only tree species of “different species of C3 plants” are exemplified here. Even though there can be remains of trees in peat, the major constituent of peat in a 880 long sequence ought to be mosses (Bryophytes, non-vascular C3 plants) together with herbs/sedges/shrubs (other vascular C3 plants than trees)? The primary productivity of peatlands is commonly dominated by bryophytes.

Answer (16) As we mentioned in answer (9), herbs and a few non-vascular plants (moss) were dominant in Tashiro Bog during the last deglaciation and Holocene judging from pollen analysis (Yoshida and Takeuti, 2009, JQS). Therefore, mainly herbs and few mosses contributed to peat accumulation in Tashiro Bog.

Comment (17) 2164, lines 10-13 - because (Sphagnum) mosses do not possess stomata, a discussion about different pathways for the mixed bulk samples could be relevant.

Answer (17) Certainly, mosses do not possess stomata. However, the existence of water around hyaline cells affects the isotopic fractionation. As already mentioned in Answer (9) and (16), the vegetation in Tashiro Bog consists mainly of herbs. The influence of moss is low.

Comment (18) 2164, lines 20-21 “the smaller the water reservoir surrounding the chloroplast, the lower the δ13C cellulose”. How does this statement match with the

one in p. 2162 lines 14- 16: “the amount of rainfall is negatively correlated to plant δ13C value; the larger the amount of rainfall, the smaller the value”?

Answer (18) 2164, lines 20-21 “the smaller the water reservoir surrounding the chloroplast, the lower the δ13C cellulose” was a mistake. We changed ‘the smaller’ to ‘the larger’. When sufficient amount of water surrounds hyaline cells, the plant can open stomata, because it will not become dry. Hyaline cells fix mainly 13CO2 because metabolic activity prefers 13C than 12C. For this reason, when hyaline cells are surrounded by enough amount of water, carbon isotopic fractionation becomes large.

Comment (19) 2465, lines 1-2 “the standard method is not used for peat sediments but for tree-rings” – the standard method by Green (1963) has been modified slightly in some studies (Daley et al., 2010; Kaislahti Tillman et al., 2010) to suit small moss samples but it is still used.

Answer (19) We modified the extraction method for ‘peat bulk deposit’. Daley et al. (2010) and Tillman et al. (2010)’s methods are applied for ‘moss’ extracted from peat bulk deposits. A new extraction method applied for peat bulk deposit is needed.

Comment (20) 2165, line 5 “Acid-Alkali-Acid procedure” – are the parameters concentration, temperature and time “respectively” used for both acid and alkali solutions? Which solutions were they? How were reagents removed? Was cellulose homogenized before freeze-drying?

Answer (20) The cellulose was freeze-dried before homogenizing. The ‘Acid-Alkali-Acid procedure’ is as follows: First, carbonate is removed by incubating the samples in 10 ml HCl (5 %) for 2 h at 60 °C. After three times washing with milli-Q water, 10ml NaOH solution (5 %) is added to the samples, and the mixture is again incubated for 2 h at 60 °C to remove lipids, tannins, and resins. Then, after three times washing with milli-Q water, 10 ml HCl (5 %) is again added and the samples are incubated for 2 h at 60 °C. After acid treatment, samples are repeatedly washed with milli-Q water.

Comment (21) 2165, line 14 "the overall precision was estimated" - estimated or calculated?

Answer (21) We changed 'estimated' to 'calculated'

Comment (22) 2165, line 18 "bulk sediment" – once more, do the authors mean bulk peat? If the samples include roots, is there not a risk for too young ages? Why was not any plant macrofossils selected? It could be worth to discuss somewhere the choice of bulk samples for isotope analyses and radiocarbon dates.

Answer (22) We used bulk peat deposit for 14C dating. Firstly, fine roots were removed under microscope. In sand layers, we picked up and measured organic matter. On the other hand, we are trying to establish a new age model using cellulose extracted from peat bulk deposit, not peat bulk deposit. Cellulose is not contained in roots. From the result of a small dataset (N = 15) of peat bulk deposit and peat bulk cellulose from the same layers, we found that peat bulk cellulose is younger than peat bulk deposit (about 100 to 200 years). We consider that peat bulk deposit might contain old carbon transported from lower sediment layers by a rising water table. This result is submitted in NIMB Proceeding (the title is 'Radiocarbon chronology using various organic matters in peat sediments: case study using a 9m-long core from the Tashiro Bog, northeast Japan'; authors: Tetsuya Shinozaki, Masao Uchida, Koji Minoura, Miyuki Kondo and Yasuyuki Shibata).

Comment (23) 2166, lines 8-14 - are the tephra layers used in age models? Without geochemical analysis, tephra layer ages are assumed from radiocarbon dates. Are there any other possible volcanic eruptions during the time span?

Answer (23) We did not use tephra age. The absolute ages of each tephra are known, however, these age data were measured many years ago, so these error is too large (more than 100 yr). Therefore, we measured 14C of the upper and lower parts of each tephra layer.

Comment (24) 2166, line 19 "DBD" – explain! Dry bulk density is mentioned in Fig. 2 but not in the text here.

Answer (24) We missed it. We will explain the meaning of DBD.

Comment (25) 2166, lines 21-22 "sand and/or mud layers" – what is the possible origin of these layers, wind or water deposited? These sediments may tell something about altered hydrology, precipitation was not the only source of water then? See p. 2163 lines 12-14 comment.

Answer (25) As mentioned in answer (2), we regard the two sand layers to origin from small stream flows and the mud layer from a paleo-pond. Currently, there is no river and pond around the core site. However, large amounts of water supply might have changed the ground form.

Comment (26) 2167, lines 3-8 "peat accumulation fluxes" – is it meant to be carbon accumulation fluxes according to the unit? The flux unit does not match with the given partial units that are used in the calculation.

Answer (26) Yes, we mean carbon accumulation fluxes. To normalize the carbon input, we calculated it.

Comment (27) 2167, lines 8-14 "the influence of atmospheric δ13C variability. . ." – It is of interest that authors have investigated a possible effect of variability to the whole long record since peat started to accumulate in the Tashiro Bog. Could that effect be illustrated in the Fig. 3 showing the heavy stable carbon isotope record? There could be both δ13C and δ13C' records for comparison. From around AD 1850 until today the depletion is about 2‰ adding of differences during the industrial time to recorded values is appro- priate (e.g. McCarrol and Loader, Quaternary Science Reviews (2004) 23, 771-801; Leuenberger, Terrestrial Ecology (2007) 1, 211-233).

Answer (27) Certainly, from around AD 1850 to today, there is 2 ‰ atmospheric δ13C depletion. However, our discussion covers mainly the Holocene and the last deglaciation. The recent 100 yr records are negligible for discussion.

Comment (28) 2168, line 3-4 “accumulation rates are high only during warm periods” – if there is a dry and warm period, are accumulation rates due to photosynthesis/decay always higher than in cooler and moisture periods? Is the statement valid for all plant communities (vascular and non-vascular plants)? Compare also with p.2162 lines 1-3 where the authors discuss the importance of moisture conditions.

Answer (28) Our results indicate large deposition during warm periods. In general, plant production is larger during warm periods than cold periods. In addition, the degree of precipitation and/or humidity is important for plant humification. Plants humify better in dry conditions than wet conditions.

Comments (29) 2170, lines 12-15 – “the influence of an increased relative contribution of Sphagnum species in peat sediments in Hani Bog on peat cellulose δ13C seems to be negligible. . .” – it is difficult to draw conclusions about the relative contribution in Tashiro Bog in comparison with results from Hani Bog, because the authors do not include a macrofossil analysis in their study. According to several other studies (e.g. Loader et al., 2007; Loisel et al.,2009; Moschen et al.,2009) there are differences in isotope values between species and between plant fractions, which also may have different decay rates in peat and therefore risk to bias the bulk peat record.

Answer (29) Certainly, in Hani’s record δ13C is based on one species, while our δ13C record is based on peat bulk cellulose, therefore there is a risk of bias in the peat bulk celluloserecord. Although there is a large difference in the absolute value between Tashiro Bog and Hani Bog, the variability pattern is correlative during the Holocene.

Comments (30) 2176, line4 “Bond, G.,. . . muscheler, R. . ..” change m to a capital letter M. 2182, line 17 “in Pleurozium and Sphagnum” – missing space before “and”.

Answer (30) We will modify these points in the revised manuscript.

Comment (31) 2191, Fig.6 - abbreviations should be explained

Answer (31) We will explain them in the revised manuscript.

Interactive comment on Clim. Past Discuss., 7, 2159, 2011.