Clim. Past Discuss., 4, S610–S615, 2008
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Climate of the Past Discussions



# *Interactive comment on* "Holocene weak summer East Asian monsoon intervals in subtropical Taiwan and their global synchronicity" *by* K. Selvaraj et al.

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Received and published: 4 December 2008

We are very grateful to the anonymous referees for their constructive comments on the manuscript titled "Holocene weak summer East Asian monsoon intervals in subtropical Taiwan and their global synchronicity" (MS-NR: cpd-2008-0037). Indeed, we are very happy to explain the major differences between the one published in GRL in the year 2007 and the present paper we intend to publish in Climate of the Past.

Our previous time series of total organic carbon (TOC) and carbon to nitrogen (C/N) ratio were reconstructed by using only 84 data points with an average time resolution of around 45 years. Earlier, we published these coarse resolution time series of TOC content and C/N ratio in GRL. But by analyzing an other half of the same core

(only depth interval between 41 and 170 cm as the top 40 cm section of the core was distorted totally) preserved in the deep freezer, we increased the total number of data points to 201 with an average time resolution similar to 15-20 years, especially in sediments deposited during the Holocene optimum (ca. 8.6-4.5 kyr BP). By doing this, we enhanced the representation of number of data points, particularly for weak monsoon intervals. We thus produced combined time series records of these two measurements for TOC content and C/N ratio in Figure 3 of our manuscript in Climate of the Past Discussions. We then compared these relatively fine resolution time series of TOC content and C/N ratio with other well dated records **to exclusively show that the small oceanic islands can integrate/respond global climate signals synchronous to other larger climate-ocean interactive systems**. Actually, we go for a review like article because many reviews have been published so far on the Holocene East Asian monsoon changes in the region of monsoon Asia and arid central Asia (An et al., 2000; An et al., 2006, Feng et al., 2006; Herzschuh, 2006; Chen et al., 2008) but none of these reviews have not been considered/compared the monsoon records from Taiwan where the EAM exclusively makes (no influence of Indian monsoon as like Dongge cave in South China) its first landfall during every year8217;s summer. To fulfill this caveat, we compared our data with available major climate-ocean interactive time series.

In our GRL paper, the time series of TOC content and C/N ratio were not compared with delta $^{14}C$ residuals, a proxy for solar activity which is responsible for centennial-scale monsoon changes. In the present paper, we compared our records with delta $^{14}C$ residuals and explained that why only few weak monsoon intervals are correlated with solar activity and why others not. Similarly, we correlated the vegetation proxy records to Holocene atmospheric $CO_2$ and implied that long-term decrease in C3 plants was probably one of the causes for increased $CO_2$ in the atmosphere. Furthermore, in the present manuscript, we discussed the mechanisms involved during weak monsoon intervals, for example 5.4 kyr event and lake desiccation, in detail. Distinct representation of Holocene optimum climate and within that easily recognizable weak monsoon inter-



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val, for example 7, 6.2 and 5.4 kyr events, in Retreat Lake's records and their global synchronicity seem worth to publish in Climate of the Past.

Referee 3

Question 1: The chronology of various events does not match with those shown in Figure 3. The authors suggest that all these events are abrupt/major events, but looking at Figure 3, I find only 5 kyr event as a major event which is followed by a major hiatus.

Retreat Lake's records support a minor change associated similar to "8.2 kyr BP event". For instance, there is a trough in TOC time series between 8190 and 7990 cal yr BP. Within this interval, two data points at 8170 and 8100 cal yr BP respectively show low TOC contents (38.8 and 36.8 percent) when compared to above said points. These values are approximately 8 percent lower when compared to TOC values at 8190 and 7990 cal yr BP. This reveals a response of catchment vegetation to 8.2 kyr BP event but weaker when compared to their response to 5.4 kyr event where TOC shows 16-20 percent decrease. Reduction of 8 and 16 percent TOC in these intervals indicates decreased vegetation cover and thus a weaker summer EAM.

Now, we obtained a very high resolution (1 mm) data of Relative Grey Index (RGI; an indicator of proportion of dark (organic) to light (minerogenic) sedimentary materials in lake sediments) with a time resolution of 4 years in core R. The time series of RGI between 7.5 kyr BP to the core end shows a relatively high RGI values between 8230 and 8070 cal yr BP with the highest value of 56 at ca. 8130 cal yr BP. This indicates reduced influx of organic matter and increased input of minerogenic sediments from the catchment. Comparison of RGI record with *Globigerina bulloides* abundance data from the Arabian Sea (Gupta et al., 2005) shows coherent fluctuations, including a drastic monsoon shift at ca. 8.6 kyr BP and a weak monsoon at 8.2 kyr event as well as increased monsoon at ca. 9.6 kyr BP (this increase is missing in the TOC content and C/N ratio records and the reason is given in the manuscript (see page 7, lines 13-16). This further supports that we can resolve a signal similar to 8.2 kyr BP event from



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Retreat Lake's records. Furthermore, 8.2 kyr BP monsoon event is weakly represented in both Retreat Lake and the Arabian Sea records likely because it falls in the interval of intense monsoon but decreasing monsoon trend between 8.6 and 7.7 kyr BP in East and South Asia. This might be the reason why many records did not respond to 8.2 kyr cold spell properly. Based on these points, we argue that chronology of weak monsoon events mentioned in the manuscript corresponds well with similar events resolved in other well dated records and drastic shift in TOC content and C/N ratio associated with ca. 8.6 kyr BP (rapid accumulation of organic sediment) was not an artifact of dating.

Total nitrogen (TN) record shows decreased sedimentary nitrogen between 8.28 and 8.01 kyr BP (1.60 and 1.54 percent TN, respectively) with the lowest TN content of 1.15 percent is centered at 8.10 kyr BP. When compared to this, we observed a larger TN trough between 7.97 and 7.38 kyr BP (1.54 and 1.53 percent TN, respectively) due essentially to wood materials present in this interval where C/N ratios indicate extremely high values, mostly of above 40. All these positive attributes aside, some records, for instance C/N ratio in core R and water content data in core Rd, does not support "8.2 kyr" weak EAM event in the study area. Therefore, we were not included 8.2 kyr BP weak monsoon event and related discussion in the revised version.

Question 2: The authors have related changes in the Retreat Lake with almost every component of the climate-ocean system and with regions ranging from the tropics to the Northern Hemisphere. These changes in the Retreat Lake have been related to ENSO, Hadley circulation, West Pacific Warm Pool, Tibetan Plateau ice accumulation, Siberian Highs, North Atlantic Deep Water circulation, Global Conveyor, Indonesian Throughflow, $CO_2$ variability, methane production, African aridification, sea level changes, cold spells in the North Atlantic, ITCZ and solar insolation, changes in North American and Caribbean climates, etc. I have failed to understand as what is the purpose of relating Retreat Lake changes with so many events and forcing factors without any conclusions.

It is very important to remember that PAGES has started a "Global Monsoon" working group just a year ago with an aim to study the global monsoon variability and its climate



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and environmental changes as well as their synchronous link with other climate forces during the late Quaternary. We expect that the working group will go for a synthesis of global monsoon and climate forcing records similar to what we have done in the present manuscript but for the longer time scale of entire late Quaternary in the near future. Anyhow, we have reduced a larger part of text dealing with these relationships in the revised version.

Question 3: 8.2 ka event is weakly present in the Retreat Lake record compared to 5.4 ka event 8211; any thought? The latter coincides with the aridification of Africa, a major weakening of the South Asian monsoon that may have led to the demise of civilizations in the South Asian region.

We agree that 8.2 kyr BP event is weakly represented in records of Retreat Lake when compared to 5.4 kyr BP weak EAM event. More details are given in our reply to Question 1.

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