Clim. Past Discuss.,
doi:10.5194/cp-2016-2-AC1, 2016

Climate of the Past Discussions

Interactive comment on "Modeling precipitation δ^{18}O pariability in East Asia since the Last Glacial Maximum: temperature and amount effects across different time scales" *by* X. Wen et al.

X. Wen et al.

xwen@pku.edu.cn

Received and published: 21 June 2016

We would like to appreciate the anonymous reviewer for his/her helpful suggestions. The original comment (Q) and our response (A) are as follows:

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Q: Specific corrections: Abstract Line 1: change "Water isotope in precipitation has played a key role" to "Water isotopes in precipitation have played a key role"

A: Done.

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Q: Abstract line 1: add references to support the first statement

A: Since it is not recommended to add reference in the abstract part for format reason, the references are included in the first statement of the main text.

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Q: Abstract line 5: Although I realise 'thru' is sometimes used for ranges esp. in American English, I would recommend changing "22ka thru 00ka using an isotope-enable AGCM" to "22 ka to 0 ka using an isotope-enabled atmospheric global circulation model (AGCM)".

A: Thanks. It is changed.

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Q: Abstract line 7: "Our study confirms the robustness of the temperature and amount effects on the seasonal cycle over China" – does this statement refer just to the present day? Please add to the text.

A: We have checked the two effects (temperature effect and amount effect) on seasonal cycle timescale in present day and the past slices in the model outputs. The supplementary Fig 1 shows an example for North China. We can see the conclusion based on the present day conditions does not change much in the past 22,000 years. But given lack of the observations at seasonal timescale for the past, we would prefer to make the conclusion, in this paper, just for the present day, as compared to the observed monthly data from GNIP. Thanks, we added "in the present climatic conditions" in the text to explicitly clarify this point.

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Q: Abstract line 8: "our analysis does not show significant temperature and amount effects over China on millennial and interannual timescales" – do you mean no significant change, or neither is significantly dominant?

A: The latter one. This sentence was changed to “our analysis shows that neither temperature nor amount effects is significantly dominant over China on millennial and interannual timescales”.

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Q: Introduction page 1 line 13: “Sturm et al., 2010; Noone, 2008” – add an ‘e.g.’ and perhaps reference to some of the older earlier pioneering papers on this

A: Thanks, it is changed. Also, we added some pioneering papers, such as Dansgaard1964, Grootes1993, Cuffey1995, and Salamatin1998.

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Q: Introduction page 1 line 15: ““local temperature effect”, whereas the d18O-precipitation relationship in the tropics and low latitudes tends to be associated with the “amount effect” – I would be keen to see a small amount of explanation of these terms for any readers who might be relatively new to the subject.

A: Thanks! Good point! We added “a positive correlation between d18O in precipitation and the temperature of ambient air (warmer air provide more energy to rain out 18O-rich water vapor)” to briefly describe the temperature effect, and added “a negative correlation between d18O in precipitation and the accumulated total rainfall at local and upstream regions (stronger tropical precipitation leave less d18O in vapors transported to the subtropics and low latitudes)” to briefly introduce the amount effect in the text.

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Q: Page 2 line 9 Change “East Asia locates at the transition zone” to “ East Asia is located at”

A: Done.

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Q: Page 2 line 10 “still remains as a great controversy” – delete “as”

A: Deleted.

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Q: Page 2 line 11 and all other instances of “isotope-enable GCM” change to “isotope enabled GCM”

A: Many thanks! We changed all the instances of “isotope-enable” in the text to “isotope-enabled”.

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Q: Page 2 line 20: delete “proxies”.

A: Deleted.

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Q: Page 2 line 26: “These experiments are forced by the realistic green house gases (GHGs) concentrations, orbital parameters, land ice sheet and land-ocean mask” – are these all the same boundary conditions as used in the Liu et al. papers, as well as the SSTs/sea-ice?

A: Yes, all the boundary conditions are the same as used in Liu et al. (2009).

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Q: Page 2 line 30: “1.6 permil (22ka) to 0.5 permil (0ka)” - please say/reference where you have derived the values from, which have then been linearly interpolated, if I understand right.

A: They came from other’s work. References added: Schrag et al. (1996) for 22ka and Hoffmann et al. (1998) for 0ka.

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Q: Page 3 line 1: add reference for the GNIP data

A: Reference added: Schotterer and Oldfield (1996).

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Q: Page 3 line 3: change “This dataset has sufficient spatial coverage. But majority of” to “This dataset has sufficient spatial coverage but the majority of”

A: Done.

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Q: Page 3 line 4: change “there is only12 stations” to “there are only12 stations”

A: Done.

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Q: Page 3 line 4: change ‘showing’ to ‘shown’

A: Done.

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Q: Page 3 line 18: “For each region, the modeled seasonal cycle are derived from” change to “For each region, the modeled seasonal cycle is derived from”

A: Done.

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Q: Figure 2: I know the names of the GNIP stations used are included in the plot, but is it also possible to add in the number that corresponds to the number of the site in figure 1.

A: Do you suggest us to add a table for 31 GNIP stations? Great idea! We collected their basic information and would like to add a table in the revised manuscript, as shown

in the attached file.

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Q: Figure 2: The comparison of the left and right hand graphs is slightly improved as the y-axes have different limits. While I see that this is to maximize the details, it would be easier to make comparisons if the scales were the same. – Actually I realize this is mentioned on page 4 in the penultimate paragraph.

A: Many many thanks! Good point! The left and right columns share the same y-scale in the revised version. You may check this in supplementary Figure 2 in advance.

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Q: Page 3 line 20: why only use the ‘GNIP station that has the longest records in that region’ in the comparison in figure 2. Have you checked whether there is good correspondence between the one record chosen for each region and the other shorter records in the region? I.e. is each particular record indicative of the overall pattern in the region? Otherwise it seems insufficient reason to choose a particular record based on its length, or say why a longer record is better – e.g. to reduce the impact of interannual variability? Related to this – page 4 paragraph around line 25 – states that the d18O values have somewhat different magnitudes although the phase is a good match with the data, however, there are similar differences in precip and temperature between model and data (as I’d imagine with most models), which might be worth also pointing out in this paragraph.

A: Yes, we did so to reduce the uncertainty of interannual variability. Given the feature of GNIP data’s discontinuity (A. many missing within a year; B. observed years is so short, commonly no more than 10 years from 1985 to 1993), as shown in Fig 1(b), the longer records one station has, the better quality in representing reliable seasonal cycle of d18O/temperature/precipitation. The supplementary Figure 3 shows an example for NE China: QIQIHAR station, the one used in our study that has longest records among

the 4 stations in this region, gives a highly consistent seasonal cycle as the mean. We checked this point for other regions and the same thing happened.

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Q: Page 4 line 8: discusses that the d18O signal from the model in southern China doesn't replicate the seasonal pattern in the data and suggests a resemblance to the 'third mode' as discussed in the following paragraph. However, no mention is made of the fact that the seasonality of precipitation isn't quite right over S China either and how this could influence the mismatch between the model and data d18O.

A: Thanks for this helpful comment. We rewrite the sentence like this: "Instead, the modeled d18O in southern China exhibits a double maximum in spring and fall partly due to the incorrect seasonality of precipitation with its maximum occurred near May-June. The model cannot well reproduce the climatology in this region as it slightly resembles the third mode to be discussed next."

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Q: Page 4 line 18: change 'implications to the interpretation' to 'implications for the interpretation'.

A: Done.

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Q: Page 4 line 20: 'Thus, we would suggest that one should NOT interpret the d18O records around this region simply as the monsoon rainfall amount.' One could also suggest that the boundaries between these different regions could change significantly over time (through glacial-interglacial cycles fro example). It would be useful if the authors could say something regarding this uncertainty and the implications for interpretation of palaeo-isotopic records.

A: Thanks! The changes of Asian monsoon advancing/retreating during glacial-

interglacial cycle are much smaller than the amplitude of seasonal cycle of d18O/T/P. Thus, the position of this transition region is robust across glacial-interglacial cycle and change little. We made the supplementary Figure 4, which shows the model results from other time slices than 00ka (Fig 3a and b). We can see the model suggests a robust and almost stationary "blank region" over the central China.

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Q: Page 4 line 31: 'This distinctively different three regions' change to 'These three distinctively different regions'

A: Done.

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Q: Page 5, line 10-15 These lines contain a suggestion of why south Asia and East Asia show different correlations between d18O and temp/precip on interannual timescales, but not enough detail to understand the mechanisms for this beyond them having different moisture sources. I suggest a clearer and more detailed explanation is necessary here.

A: Thanks. This point is also closely related to the penultimate question about the relationship between Chinese d18O and Indian monsoon. Please find our response and associated reference in that part together. We will add more words to discuss their relationship in the revised text.

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Q: Page 5 line 20: 'using the last 40 years of model output' do you mean where each of the 23 year time slices provides one time point that is the average of the last 40 model years of that simulation. Text could be a bit clearer.

A: Thanks. This sentence is changed to "The millennial climatology is derived from each time slice by averaging the last 40 years out of 50-year raw results."

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Q: Page 5 line 25 onwards: it is an interesting result that millennial-scale variability in d18O doesn't reflect high significance in correlation with local temperature or precip. In line with other studies, the authors suggest that d18O over East Asia could be influenced by upstream moisture transport from the Indian monsoon region (similar to Pausata et al). However, they do not investigate this any further in their model so we do not learn as much as we could about what mechanisms are important factors here. The authors have all the data at their disposal and so could look at e.g. correlation at the millennial time-scale of Indian monsoon temp/precip/d18O with d18O over China, and variability in the southerly monsoon winds etc. I would like to see the authors examine what is driving their millennial scale variation further.

A: Thanks for great suggestion! In another paper (Liu and Wen, 2014) with focus on the summer monsoon dynamics, we investigated the variability of d18O on orbital timescale over China, and its relations to Indian precipitation as well as the southerly monsoon winds. Basically, Chinese d18O highly correlated with Indian d18O and precipitation, suggesting a reliable dynamic link between Indian precipitation and Chinese isotope records through amount effect. On the other hand, East Asian monsoon is also influenced by the western North Pacific and South China Sea rather than just the Indian Ocean. The complex circulation determines China's nature having multiple modes of precipitation and d18O. We will add more discussion for this part.

Reference: Liu, Z and X Wen et al., 2014: Chinese cave d18O records representing East Asia summer monsoon, Quan. Sci. Rev., 83, 115-128.

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Q: Page 5: line 25: Related to the above point, does the seasonality of precipitation/ temperature/d18O change much in the different locations in these 23 time slices? Do the seasonal correlations, interpreted as d18O being affected by the temperature effect in the north and the precipitation effect in the south still hold for the same locations or

do the boundaries change from glacial to interglacial time slices?

A: Similarly, please take a look at the supplementary Figure 4 for the spatial distribution of temperature/amount effects on seasonal timescale across 20ka, 15ka, 10ka, 5ka, and 0ka. It is shown that the pattern, temperature dominating north and precipitation dominating south, does not change much in the last 20,000 years. You may also check the supplementary Figure 1 for the details of d18O/T/P seasonal cycle over North China, as an example, across the last 22,000 years.

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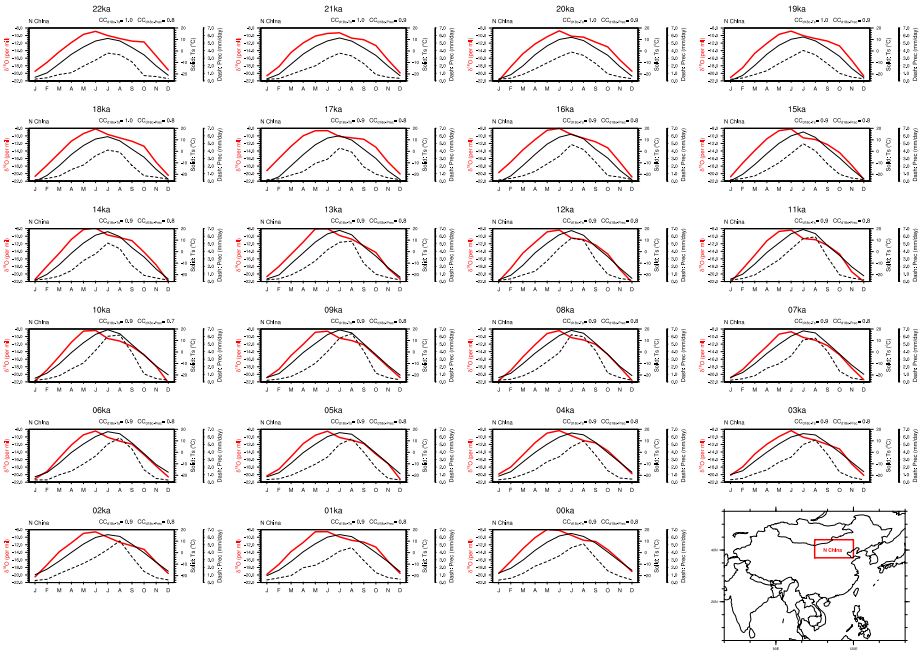

Fig. 1. Seasonal cycle of d18O/temperature/precipitation over North China across the past 22,000 years.

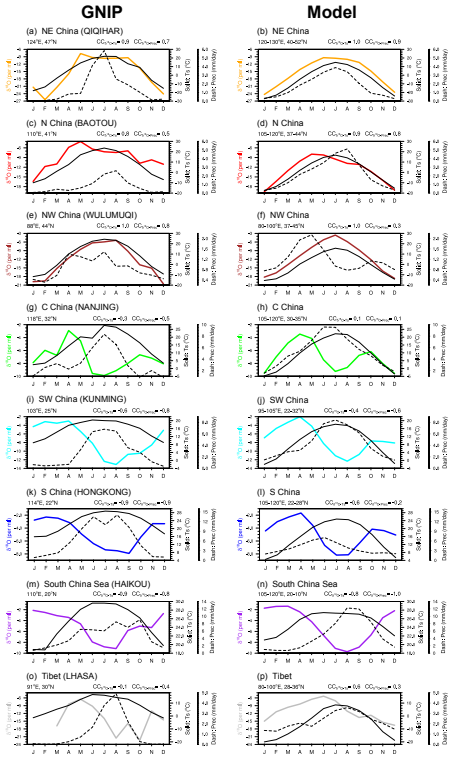

Fig. 2. Revised Figure 2 with unified y-axis for model-observation comparison.

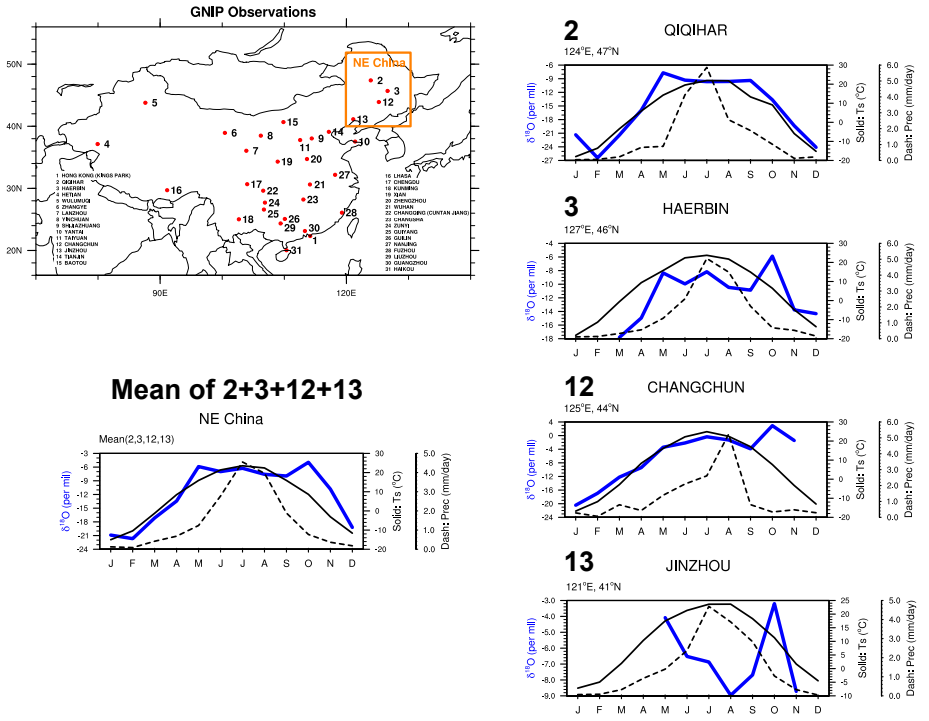

Fig. 3. The usefulness of selection of the station with longest records in representing regional features of d18O/temperature/precipitation, taken Northeast China as an example.

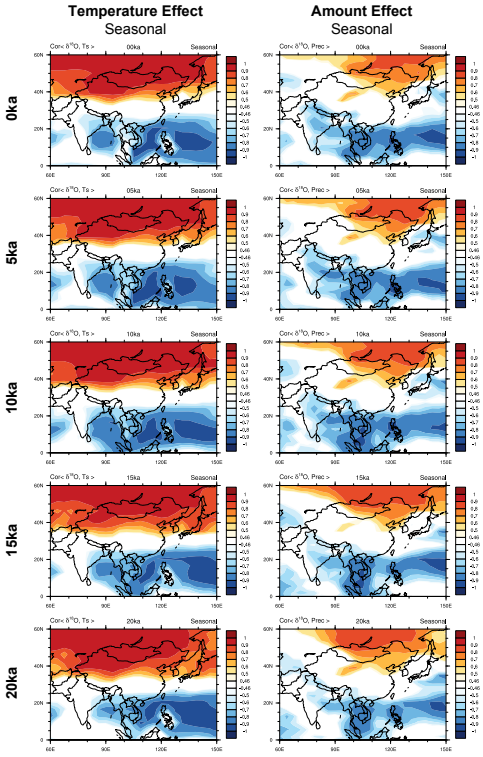

Fig. 4. The spatial distribution of temperature/amount effects on seasonal timescale across 20ka, 15ka, 10ka, 5ka, and 0ka.

Table 1. Basic information of 31 GNIP stations in China

No.	Station Name	WMO ID	Longitude (°E)	Latitude (°N)	Altitude (m)
1	HONG KONG (KINGS PARK)	4500400	114.2	22.3	66
2	QIQIHAR	5074500	123.9	47.4	147
3	HAERBIN	5095300	126.6	45.7	172
4	HETIAN	5182800	79.9	37.1	1375
5	WULUMUQI	5182801	87.6	43.8	918
6	ZHANGYE	5265200	100.4	38.9	1483
7	LANZHOU	5288900	103.9	36.1	1517
8	YINCHUAN	5361400	106.2	38.5	1112
9	SHIJIAZHUANG	5369800	114.4	38.0	80
10	YANTAI	5369801	121.4	37.5	47
11	TAIYUAN	5377200	112.6	37.8	778
12	CHANGCHUN	5416101	125.2	43.9	237
13	JINZHOU	5433700	121.1	41.1	66
14	TIANJIN	5452700	117.2	39.1	3
15	BAOTOU	5452701	109.9	40.7	1067
16	LHASA	5559100	91.1	29.7	3649
17	CHENGDU	5629400	104.0	30.7	506
18	KUNMING	5677800	102.7	25.0	1892
19	XIAN	5703600	108.9	34.3	397
20	ZHENGZHOU	5708300	113.7	34.7	110
21	WUHAN	5749400	114.1	30.6	23
22	CHANGQING (CUNTAN JIANG)	5751600	106.6	29.6	192
23	CHANGSHA	5767900	113.1	28.2	37
24	ZUNYI	5771300	106.9	27.7	844
25	GUIYANG	5781600	106.7	26.6	1071
26	GUILIN	5795700	110.1	25.1	170
27	NANJING	5823800	118.2	32.2	26
28	FUZHOU	5884700	119.3	26.1	16
29	LIUZHOU	5904600	109.4	24.4	97
30	GUANGZHOU	5928700	113.3	23.1	7
31	HAIKOU	5975800	110.4	20.0	15

Fig. 5. Basic information for 35 GNIP stations in China.