The text in **BLACK color** is the **comments** from the reviewers, and the text in **BLUE color** is our **revisions and explanations**.

COMMENTS FROM EDITORS AND REVIEWERS:

Comments from Reviewers:

RC#2

The manuscript by TaoWang et al. presents the correlation analysis between the GNIP data in Siberia and Central Asia and the circulation patterns. This analysis is very important for the understanding of the precipitation isotopic composition formation as well as for the atmospheric circulation modeling. However, there are two major critical points that should be improved before the paper can be accepted for the publication.

We appreciated the reviewer for his/her recognition for the value of this study. We respect to every comments of the reviewer and revised the manuscript carefully. Please see our point to point response as follows.

Firstly, the dataset chosen for the analysis is rather poor. The datasets from the Siberian stations (Table 1) contain less than 30 points which is not enough for the proper correlation analysis. Many stations provide data for less than five years which is also not enough for the analysis of the seasonal cycle. Moreover, the datasets from the GNIP were not quality-checked. For instance, in the study of Butzin (Butzin et al., 2014) et al. (2014) several stations and data points were excluded from the analysis because of their unrealistic values.

Done

First of all, we agree with the reviewer that the data of GNIP site in the research area is scarce; we only found 15 sites within the research area defined in this paper. The scarcity of GNIP data in this region is a reality that cannot be changed at present. Secondly, we checked the data of Amderma Khanty-mansiysk, Olenek and Salekhard discarded by Butzin et al. (2014) as the reviewer mentioned. We agree with the reviewer and thanks for this great comments. There are some problems about the monthly mean temperature for Khanty-Mansiysk (K-M), Olenek and Salekhard. We revised our discussion about these stations, not discuss the relationship between precipitation isotopic compositions and questionable temperature values. Finally, we focused on the relationship between $\delta^{18}O_P$ and meteorological elements at monthly timescale, but not seasonal cycles.

We checked the GNIP data and found some problems as the reviewer mentioned. Please see the figures as follow.

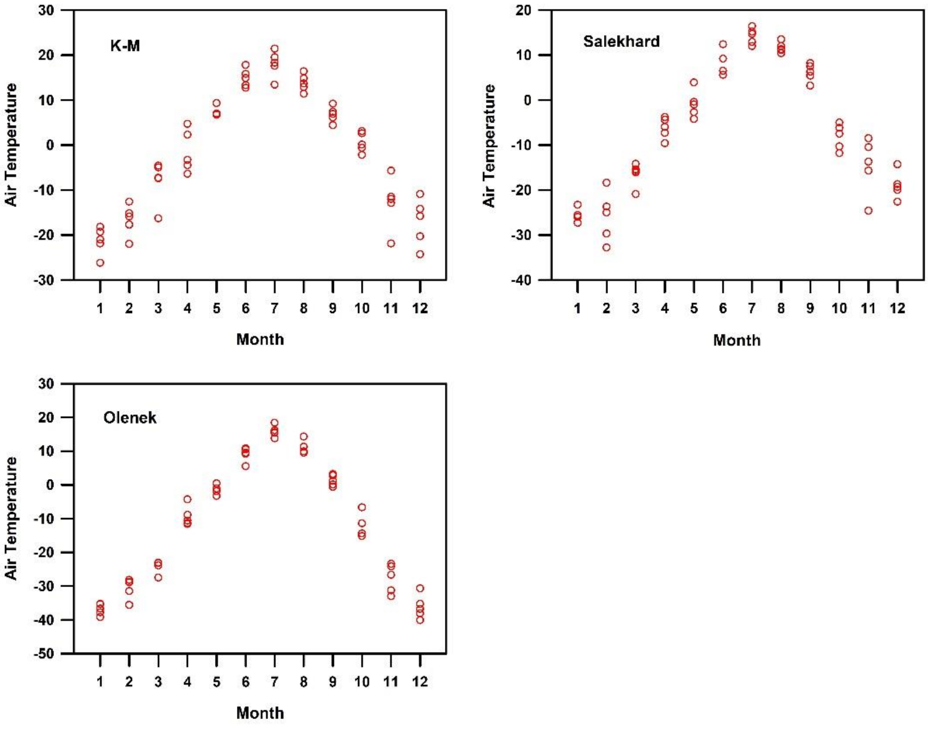

Fig. R2 Monthly mean temperatures of Khanty-Mansiysk (K-M), Olenek and Salekhard.

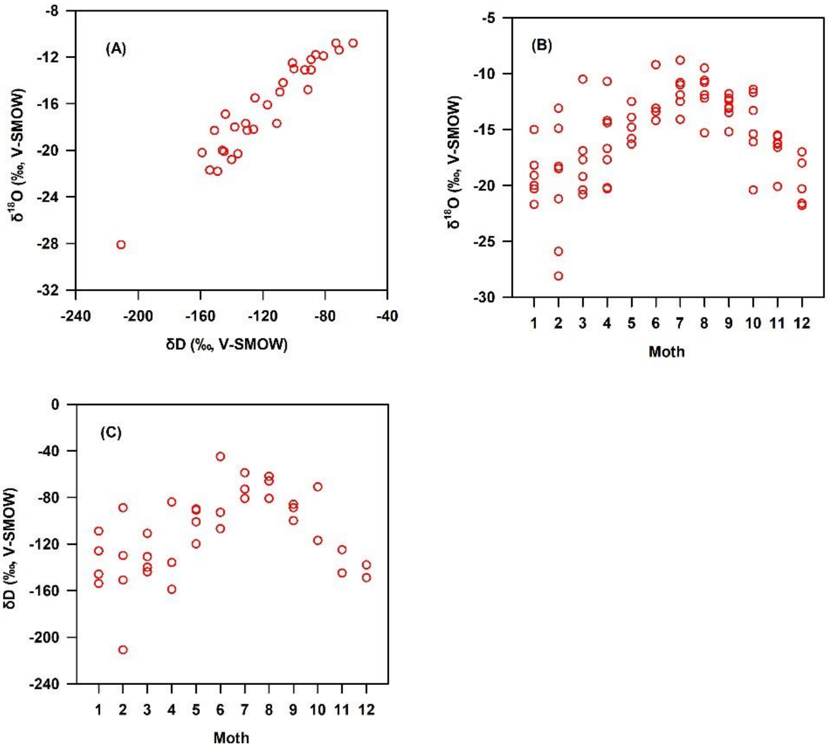

Fig. R3 Delta values of D and ^{18}O isotopes from Amderma. (A) $\delta^{18}O$ and δD values of precipitation (B) Annual variations in $\delta^{18}O$ (C) Annual variations in δD

Another point is the lack of new information in the study. Similar studies have already been conducted in Siberia and Central Asia. For example, Butzin et al. (2014) analyzed the GNIP data from the same monitoring sites combined with the ECHAM-wiso calculations and concluded that the precipitation isotopic composition depends mostly on the local temperature and on the NAO.

Done

First, the study area of Butzin et al. (2014) is mainly concentrated in Western Siberia (55–90° E and 55–70° N), and our study area covers a larger range (55–125° E and 40–70° N). Secondly, by analyzing the influence of NAO on $\delta^{18}O$, we believe that $\delta^{18}O$ is affected by not only the temperature but also the strength and path of westerly wind, and the change of moisture source, which is different from previous studies.

P19, L411-416:

The NAO influences the changes in both $\delta^{18}O_P$ and $\delta^{18}O_W$ by affecting the intensity and pathway of the westerly (Hurrell, 1995; Field, 2010; Langebroek et al., 2011). Therefore, we speculate that over mid- to high-latitude regions throughout Eurasia, $\delta^{18}O_W$ is affected by both the NAO and the temperature. This joint influence is the main reason for the absence of a temperature effect in the variability of $\delta^{18}O_W$ at the interannual time scale.

And in the third of forth in the section of conclusions, Lines 432-439:

(*3) The $\delta^{18}O_P$ values were negatively correlated with the EZCI at the monthly time scale. The zonal circulation results in changes in $\delta^{18}O_P$ throughout Eurasia by affecting the local temperature and water vapor source. The relationship among $\delta^{18}O_P$, the temperature and the EZCI varies seasonally and is influenced by changes in the source of water vapor in summer.*

(4) The $\delta^{18}O_P$ values in the study region and the NAOI exhibit opposing trends at the interannual timescale. The NAO affects the source of water vapor transport by changing the pathways of the westerly, leading to changes in both $\delta^{18}O_P$ and $\delta^{18}O_W$.

The paper is not well structured. The study region is not defined; the borders of Siberia and Central Asia assumed in the study are not described. The results from the previous studies in the region are not used (e.g. Ala-aho et al., 2018a, 2018b; Butzin et al., 2014; Opel et al., 2010). The description of the calculation methods is missing. How was the correlation calculated? How was the significance estimated? Finally, the English language should be improved by a native speaker.

Done

We define the range of Siberia and Central Asia at 55-125°E, 40-70°N, with borders of the Arctic Ocean, the Tien Shan Mountains, the Ural Mountains and the Verkhoyansk Mountains. Please see the details in Lines 156 - 162:

The study region, which is located in the northern part of Eurasia, includes inland Siberia and the northern part of Central Asia (40 °N – 70 °N, 55 °E – 125 °E) (Fig. 1). The region of interest herein is a typical mid- to high-latitude continental area, extending from the Ural Mountains in the west to the Stanovoy Range in the east, from the Arctic Ocean in the north to a series of mountain ranges toward the south, namely, the mountains in northern Kazakhstan to the southwest, Urumqi in the south, and Qiqihar (northeastern China) to the southeast (Fig. 1).

We read and cited the relevant literatures provided by the reviewer.

Please see that in P3, L56-60:

Siberian permafrost constitutes one of the most important forms of tundra in the world and acts as an indicator of temperature change; accordingly, the greenhouse gases released through the melting of permafrost have important impacts on global climate change and carbon cycle processes (Dobinski, 2011; Schuur et al., 2015; Ala-aho et al., 2018a, 2018b; Raudina et al., 2018).

Literatures (Butzin et al., 2014; Opel et al., 2010) have been cited in lines 82-85:

However, modern meteorological monitoring networks and paleoclimatic research are relatively scarce and controversial in Siberia and northern Central Asia in comparison with other regions worldwide (Aizen et al., 2005; Blyakharchuk et al., 2007; Butzin et al., 2014; Opel et al., 2010)

We calculated the Pearson correlation coefficient as follows:

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \overline{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \overline{y})^2}}$$

The sample values of the factor x and y are x_i and y_i (i=1, 2, ..., n), and r_{xy} is the correlation coefficient between the factor x and y. $\overline{x}$ and $\overline{y}$ represent the average of the two feature sample values, respectively.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \quad , \qquad \bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$$

We applied a Student's t test for the significance estimated.

To conclude, the paper at present cannot be published in ESD. I would recommend the editor rejects the manuscript.

Done

Thanks for the comments on our MS.

We have respected to each reviewer's comments and addressed the comments seriously. Thanks to the reviewers for their critical and constructive comments, which have improved the quality of the manuscript significantly. We will invite a professional person to improve the English of the MS in the coming days before re-submit to the journal.

Best regards

Ting-Yong Li and Tao Wang

21th, May 2019

Supplied References

Aizen, E.M., Aizen, V.B., Takeuchi, N., Mayewski, P.A., Grigholm, B., Joswiak, D.R., Nikitin, S.A., Fujita, K., Nakawo, M., Zapf, A., Schwikowski, M., Abrupt and moderate climate changes in the mid-latitudes of Asia during the Holocene, J. Glaciol., 62, 411-439, https://doi.org/10.1017/jog.2016.34, 2016.

Aizen, V.B., Aizen, E., Fujita, K., Nikitin, S.A., Kreutz, K.J., Takeuchi, L.N., Stable-isotope time series and precipitation origin from firn-core and snow samples, Altai glaciers, Siberia, J. Glaciol., 51, 637-654, 2005.

Ala-aho, P., Soulsby, C., Pokrovsky, O. S., Kirpotin, S. N., Karlsson, J., Serikova, S., Tetzlaff, D.: Using stable isotopes to assess surface water source dynamics and hydrological connectivity in a high-latitude wetland and permafrost influenced landscape. J. Hydrol. 556, https://doi.org/10.1016/j.jhydrol.2017.11.024, 2018a.

Ala-aho, P., Soulsby, C., Pokrovsky, O. S., Kirpotin, S. N., Karlsson, J., Serikova, S., Tetzlaff, D.: Permafrost and lakes control river isotope composition across a boreal Arctic transect in the Western Siberian lowlands. Environ. Res. Lett., 13(3), 34028, https://doi.org/10.1088/1748-9326/aaa4fe, 2018b.

Baker, J.L., Lachniet, M.S., Chervyatsova, O., Asmerom, Y., Polyak, V.J., Holocene warming in western continental Eurasia driven by glacial retreat and greenhouse forcing, Nat. Geosci., 10, 430-435, https://doi.org/10.1038/ngeo2953, 2017.

Baldini, L.M., McDermott, F., Foley, A.M., Baldini, J.U.L., Spatial variability in the European winter precipitationδ18O-NAO relationship: Implications for reconstructing NAO-mode climate variability in the Holocene, Geophys. Res Lett, 35, https://doi.org/10.1029/2007gl032027, 2008.

Blyakharchuk, T. A., Wright, H. E., Borodavko, P. S., Knaap, W. O. V. D., and Ammann, B.: Late Glacial and Holocene vegetational history of the Altai Mountains (southwestern Tuva Republic, Siberia), Palaeogeogr. Palaeocl., 245, 518-534, https://doi.org/10.1016/j.palaeo.2006.09.010, 2007.

Butzin, M., Werner, M., Masson-Delmotte, V., Risi, C., Frankenberg, C., Gribanov, K., Jouzel, J., Zakharov, V.I., Variations of oxygen-18 in West Siberian precipitation during the last 50 years, Atmos. Chem. Phys., 14, 5853-5869, https://doi.org/10.5194/acp-14-5853-2014, 2014.

Cai, Y., Chiang, J.C.H., Breitenbach, S.F.M., Tan, L., Cheng, H., Edwards, R.L., An, Z., Holocene moisture changes in western China, Central Asia, inferred from stalagmites, Quaternary. Sci. Rev., 158, 15-28, https://doi.org/10.1016/j.quascirev.2016.12.014, 2017.

Chen, F. L., Zhang, M. J., Wang, S. J., Ma, Q., Zhu, X. F., and Dong, L.: Relationship between sub-cloud secondary evaporation and stable isotopes in precipitation of Lanzhou and surrounding area, Quatern. Int., 380-381, 68-74, https://doi.org/10.1016/j.quaint.2014.12.051, 2015.

Chen, Y-S., Li, H-C., Yin, J-J., Mii, H-S., Blyakharchuk, T.A.; Shen,C-C., The Holocence climate in South Siberia and its linkage to Siberia High, Russia, EGU., poster, 2019

Cheng, H., Spotl, C., Breitenbach, S.F., Sinha, A., Wassenburg, J.A., Jochum, K.P., Scholz, D., Li, X., Yi, L., Peng, Y., Lv, Y., Zhang, P., Votintseva, A., Loginov, V., Ning, Y., Kathayat, G., Edwards, R.L., Climate variations of Central Asia on orbital to millennial timescales, Sci Rep, 5, 36975, https://doi.org/10.1038/srep36975, 2016.

Dansgaard, W., Stable isotopes in precipitation, Tellus, 16, 436-468, https://doi.org/10.3402/tellusa.v16i4.8993, 1964.

Field, R.D., Observed and modeled controls on precipitationδ18O over Europe: From local temperature to the Northern Annular Mode, J. Geophys. Res., 115, https://doi.org/10.1029/2009jd013370, 2010.

Henderson, K., Laube, A., Gäggeler, H.W., Olivier, S., Papina, T., Schwikowski, M., Temporal variations of accumulation and temperature during the past two centuries from Belukha ice core, Siberian Altai, J. Geophys. Res., 111, https://doi.org/10.1029/2005jd005819, 2006.

Hurrell, J.W., Decadal trends in the north atlantic oscillation: regional temperatures and precipitation, Science, 269, 676-679, https://doi.org/10.1126/science.269.5224.676, 1995.

Hurrell, J.W., Climate variability over the North Atlantic, Marine Ecosystems and Climate Variations, 2004.

Kurita, N., Relationship between the variation of isotopic ratios and the source of summer precipitation in eastern Siberia, J. Geophys. Res., 108, https://doi.org/10.1029/2001jd001359, 2003.

Kurita, N., Yoshida, N., Inoue, G., Chayanova, E.A., Modern isotope climatology of Russia: A first assessment, J. Geophys. Res - Atmos., 109, n/a-n/a, https://doi.org/10.1029/2003jd003404, 2004.

L. Clarke, M., M. Rendell, H., 2006. Effects of storminess, sand supply and the North Atlantic Oscillation on sand invasion and coastal dune accretion in Western Portugal.

Langebroek, P.M., Werner, M., Lohmann, G., Climate information imprinted in oxygen-isotopic composition of precipitation in Europe, Earth. Planet. Sc. Lett., 311, 144-154, https://doi.org/10.1016/j.epsl.2011.08.049, 2011.

Meyer, H., Opel, T., Laepple, T., Dereviagin, A.Y., Hoffmann, K., Werner, M., Long-term winter warming trend in the Siberian Arctic during the mid- to late Holocene, Nat. Geosci., 8, 122, https://doi.org/10.1038/ngeo2349

Numaguti, A., Origin and recycling processes of precipitating water over the Eurasian continent: Experiments using an atmospheric general circulation model, J. Geophys. Res - Atmos., 104, 1957-1972, https://doi.org/10.1029/1998jd200026, 1999.

Opel T., A.Yu. Dereviagin, H.Meyer, L. Schirrmeister, S.: Palaeoclimatic Information from StableWater Isotopes of Holocene IceWedges on the Dmitrii Laptev Strait, Northeast Siberia, Russia. Permafrost and Periglac. Process., https://doi.org/10.1002/ppp.667, 2010.

Pang, Z. H., Kong, Y. L., Froehlich, K., Huang, T. M., Yuan, L. J., Li, Z. Q., and Wang, F. T.: Processes affecting isotopes in precipitation of an arid region, Tellus. B., 63, 352-359, https://doi.org/10.1111/j.1600-0889.2011.00532.x, 2011.

Peng, H.-D., Mayer, B., Norman, A.-L., and Krouse, H. R.: Modelling of hydrogen and oxygen isotope compositions for local precipitation, Tellus. B., 57, 273-282, https://doi.org/10.3402/tellusb.v57i4.16545, 2005.

Rao, Z., Huang, C., Xie, L., Shi, F., Zhao, Y., Cao, J., Gou, X., Chen, J., Chen, F., Long-term summer warming trend during the Holocene in central Asia indicated by alpine peat α-cellulose δ13C record, Quaternary. Sci. Rev., 203, 56-67, https://doi.org/https://doi.org/10.1016/j.quascirev.2018.11.010, 2019a.

Rao, Z.G., Wu, D.D., Shi, F.X., Guo, H.C., Cao, J.T., Chen, F.H., Reconciling the 'westerlies' and 'monsoon' models: A new hypothesis for the Holocene moisture evolution of the Xinjiang region, NW China, Earth-Sci. Rev, 191, 263-272, https://doi.org/10.1016/j.earscirev.2019.03.002, 2019b.

Stewart, M. K.: Stable isotope fractionation due to evaporation and isotopic exchange of falling waterdrops: Applications to atmospheric processes and evaporation of lakes, J. Geophys. Res., 80, 1133-1146, https://doi.org/10.1029/JC080i009p01133, 1975.

Sidorova, O.V., Siegwolf, R.T.W., Saurer, M., Naurzbaev, M.M., Shashkin, A.V., Vaganov, E.A., Spatial patterns of climatic changes in the Eurasian north reflected in Siberian larch tree-ring parameters and stable isotopes, Global. Change. Biol., 16, 1003-1018, https://doi.org/10.1111/j.1365-2486.2009.02008.x, 2010.

Wassenburg, J.A., Dietrich, S., Fietzke, J., Fohlmeister, J., Jochum, K.P., Scholz, D., Richter, D.K., Sabaoui, A., Spötl, C., Lohmann, G., Andreae, Meinrat O., Immenhauser, A., Reorganization of the North Atlantic Oscillation during early Holocene deglaciation, Nat. Geosci., 9, 602-605, https://doi.org/10.1038/ngeo2767, 2016.

Wolff, C., Plessen, B., Dudashvilli, A.S., Breitenbach, S.F.M., Cheng, H., Edwards, L.R., Strecker, M.R., Precipitation evolution of Central Asia during the last 5000 years, The Holocene, 27, 142-154, https://doi.org/10.1177/0959683616652711, 2016.

Yamanaka, T., Tsujimura, M., Oyunbaatar, D., Davaa, G., Isotopic variation of precipitation over eastern Mongolia and its implication for the atmospheric water cycle, J. Hydrol., 333, 21-34, https://doi.org/10.1016/j.jhydrol.2006.07.022, 2007.

Ye, Y-S., Li, H-C., Mii, H-S., Blyakharchuk, T.A.; Shen,C-C.; Tsai, H-S., High resolution climate record in South Siberia during MIS3 from a stalagmite in the Altai Mountain area, Russia, EGU., poster, 2019