Responses to RC1:

The stable isotope composition of water is a very useful tracer to elucidate its formation history and cycle. The precipitation is an essential input for the hydrological cycle but it is very difficult to obtain continuous temporal and spatial variations of precipitation isotopes. This paper provides a high-resolution precipitation oxygen distribution in China based on IAEA long-term data and other datasets. These results will be of significant interest to the scientific community, particularly in hydrology. Overall, this review paper is scientifically robust given the available datasets. It is also reasonably written and well organized. I think the paper suits the reader of this journal and can be accepted for publication. I have some major comments and several minor comments for the authors to consider.

Re: We thank the reviewer for the positive evaluation and valuable comments. We think all comments can be addressed in the revised manuscript. Our responses to each comment are presented as follows.

Major:

- *The topic of this paper is very interesting, in my opinion, it upgrades the data from a sparse point scale to a continuous regional area scale. I suggest that authors highlight this in the introduction section, and be more explicit about the meaning of the paper, which will help arouse the reader's interest and facilitate its further spread.*

Re: Thanks for the suggestion. We agree with the reviewer that this paper upgrades the data from a sparse point scale to a continuous regional area scale. To improve our understanding of the precipitation and hydrological processes, it is necessary to have a long-term, temporally consistent and high-quality precipitation isoscape. Making full use of the advantages of observations and iGCM simulations, the built isoscape overcomes the deficiencies of the sparse and discontinuous distribution of observed data and reduces the uncertainty of iGCMs simulated data. We will modify the introduction to highlight the motivation of our study in the revised manuscript.

- *As we know, isotopic composition in precipitation also varies dramatically over time. Therefore, I think the temporal resolution is also important. What do you think about this? I think authors should state or discuss clearly the time resolution.*

Re: We agree with the reviewer that the temporal resolution is very important for isoscape. The temporal resolution of isoscape provided in this study is at the monthly scale. In other words, twelve values are provided each year for each grid. The monthly temporal resolution was the most commonly used in scientific research for precipitation isotope composition, especially at the large spatial scale. Some observed event precipitation isotope data are also available, but they are

relatively short in duration and spatial scale. Thus, they were not considered in this study. The temporal resolution of isoscape will be clearly stated in the revised manuscript.

Minor:

Line 25: investigated —> shown?

Re: We will replace that.

Line 40 add reference: IAEA/WMO (2022). Global Network of Isotopes in Precipitation. The GNIP Database. Accessible at: https://nucleus.iaea.org/wiser

Re: We will add the reference.

Line 63 watershed —> catchment

Re: We will modify that.

Figure 1 the unit (m) should be added to the legend.

Re: The unit will be added in the figure.

IAEA also provided long-term data in Haikou, why isn't it being used in your paper?

Re: This is because the LMDZ4 zoomed data we obtained does not include Haikou. We will discuss this in the revised manuscript.

Line 96 There are many types of averages, are you using a monthly precipitation amount weighted average here?

Re: In most cases, we just use the monthly data provided by GNIP and CHNIP for our calculations. For a few references providing event isotope data, monthly precipitation weighted data are used. This will be clarified in the revised manuscript.

Line 102 What is surface condition ¼Ÿ would you like to give more information?

Re: Yes. The free-running simulations were performed following the Atmospheric Model Intercomparison Project (AMIP) protocol, using prescribed sea surface temperatures (SST) and sea ice. We will clarified this and add the following references in the revised manuscript.

Risi, C., Bony, S., Vimeux, F., and Jouzel, J.: Water-stable isotopes in the LMDZ4 general circulation model: Model evaluation for present-day and past climates and applications to climatic interpretations of tropical isotopic records, Journal of Geophysical Research, 115, D12118, https://doi.org/10.1029/2009jd013255, 2010.

Yoshimura, K., Kanamitsu, M., Noone, D., and Oki, T.: Historical isotope simulation using Reanalysis atmospheric data, Journal of Geophysical Research, 113, D19108, https://doi.org/10.1029/2008jd010074, 2008.

Line 219: Figure 3. I think the NW result is bad too. It should be discussed in detail.

Re: We agree with the reviewer that the NW result is bad too. This is because, On the one hand, the sparse coverage of stations coupled with complex topography over northwest China cannot well represent the full range of precipitation isotope conditions. This can lead to biases in the distribution of observations. On the other hand, the arid northwest region is one of the most sensitive regions to climate change due to its fragile ecosystem, which affects sub-cloud evaporation and local moisture cycle, leading to the large uncertainty in isotope simulation between different iGCMs. This will be clarified in the revised manuscript.

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

Wang, S., Zhang, M., Chen, F., Che, Y., Du, M., and Liu, Y.: Comparison of GCM-simulated isotopic compositions of precipitation in arid central Asia, Journal of Geographical Sciences, 25, 771-783, https://doi.org/10.1007/s11442-015-1201-z, 2015.

Figure 5 – 8 What are SPR, SUM, AUT, and WIN? Jan- Mar is SPR? Authors should clearly indicate the months covered by each season. Table 2 also should be clearly mentioned.

Re: SPR, SUM, AUT, and WIN are respectively defined as March – May (MAM), June – August (JJA), September – November (SON), and December – February (DJF). We will replace them with accurate definitions and add descriptions accordingly.

Line 315-319. Author should add some references to prove your point.

Re: The following references will be added in the revised manuscript.

Peng, D., and Zhou, T.: Why was the arid and semiarid northwest China getting wetter in the recent decades?, Journal of Geophysical Research: Atmospheres, 122, 9060-9075, https://doi.org/10.1002/2016JD026424, 2017.

Ren, G. Y., Yuan, Y. J., Liu, Y. J., Ren, Y. Y., Wang, T., and Ren, X. Y.: Changes in precipitation over Northwest China. Arid Zone Research, 33, 1-19, https://doi.org/10.13866/j.azr.2016.01.01, 2016.

Sun, C., Li, X., Chen, Y., Li, W., Stotler, R. L., and Zhang, Y.: Spatial and temporal characteristics of stable isotopes in the Tarim River Basin. Isotopes in Environmental and Health Studies, 52, 281-297, https://doi.org/10.1080/10256016.2016.1125350, 2016.

Yao, J., Chen, Y., Zhao, Y., Guan, X., Mao, W., and Yang, L.: Climatic and associated atmospheric water cycle changes over the Xinjiang, China, Journal of Hydrology, 585, 124823, https://doi.org/10.1016/j.jhydrol.2020.124823, 2020.

Line338-40: You discussed TP again, why not move to Line302?

Re: This is because in the first part (line 288-319), the spatial distribution of oxygen isotope in precipitation is analyzed, and after line 320, the seasonal variation of the isotope is analyzed.

Line346: It's better to start a new paragraph so that it can be read more clearly.

Re: Agree. We will modify the paragraph structure.

Line 352-354: It's hard to see a significant trend.

Re: This is because the trend of precipitation isotope in NW sub-region is not obvious. We have performed the Mann-Kendall test, which shows that δ18Op in NW increased significantly from the 1920s to the 1970s at the P=0.1 level. However, from the 1980s to the 2000s, the δ18Op shows an insignificant upward trend. This will be clarified in the revised manuscript.

Figure 9 Need to add y-axis labels.

Re: We will add the labels.

Figure 10 I think it's very unclear to discuss why it is divided into these stages according to Figure 10. Based on methods? Or data? Authors should state it clearly.

Re: This division is mainly based on the time period of iGCM data and performance of different fusion and bias correction methods. According to Section 4.1, CNN performs the best over all other fusion methods and bias correction methods, and the participation of more iGCMs in the CNN fusion further improve its performance. Therefore, when generating the isoscape, the CNN fusion was used in priority with the number of iGCM simulations being more than two. Considering that iGCMs have different time periods, we divide the whole period into various stages. CNN method was used in stages with sufficient iGCMs, and the bias correction method was used in other stages. This will be clarified in the revised manuscript.