

Dear anonymous referee #3,

We are grateful to you for reviewing our manuscript and objectively comments. Your comments encourage us to greatly improve the quality of manuscript. We have carefully considered all the comments. What follows are our point-by-point response to all your concerns.

This paper combines a very rich dataset of water isotopologues to provide conceptual models of the continental water cycle components in the different parts of the extensive, arid Qaidam basin in the Tibetan Plateau. The authors reach interesting conclusions on contrasting functioning of the sources and fates of water pathways and surface-groundwater exchanges in different part of the study area, with important implications for ongoing and future trajectories in a changing climate.

While this could be a significant contribution to the community and the topic fit wells in HESS readership, in my view the manuscript suffers from an inadapted structure that makes it hard to follow, and to fully assess the soundness of the proposed analyses and discussions. Due to this and other issues, I recommend a very substantial rewriting effort before this manuscript can be considered for publication. This would include a further effort on the level of written English as well; I tried to list some items in the technical comments, but this is not the role of a reviewer and a complete proof-reading, if possible, by a native speaker, will be needed.

General comments

The current structure of paper seems to be the biggest issue at this stage. On this matter I concur with the other comments, who notably summarized the main issues: lack of clear focus, difficult vocabulary and formulations (in the main text and some titles).

In particular, it seems the Discussion section is too long and essentially mixes a lot of additional results and discussion. I strongly advise the authors to rework this section in connexion with the Results section. Given the number of datasets and related analysis presented, special care should be given in crafting a more precise focus and red thread throughout these sections, in connexion with more clearly stated objectives and

research questions.

Reply: We apologize for the confusion caused by the disorganized structure and sloppy language. We have therefore summarized your and two other referees' relevant comments and made a major rewriting effort throughout the text. These enhancements focus on the study objectives and discussion chapters. Specific efforts included 1) the direction of the article's focus was clarified, 2) the logical framework was reorganized, 3) discussions of insignificant relevance to the main results were removed, and 4) the language and terminology were polished.

In the Introduction, we simplified the main research objectives into the following 3 points: 1) elucidating the distribution pattern of surface water and groundwater isotopes in this alpine arid basin at various spatial and seasonal scales; 2) identifying and quantifying the main components of the regional water cycle, their timing and spatial heterogeneity; and 3) revealing isotopic hydrological responses to climate change and predicting the trend in the changes of Qaidam Basin water resources.

Moreover, section 4.1 was streamlined and reorganized as 4.3; section 5.1 was reordered with paragraphs and subheadings to make it logical; section 5.3 was reorganized as 5.2.4; and section 5.4 was rewritten in 4 points. The revised text based on your comments is logically clear and progressive. The reformatted framework is as follows:

4.1 Spatial and seasonal characteristics of surface water $\delta^{18}\text{O}$ - δD

4.2 Spatial and seasonal characteristics of groundwater $\delta^{18}\text{O}$ - δD

4.3 Isotopic variations in different water bodies

5.1 Water cycle information indicated by surface water isotopes

5.1.1 Atmospheric moisture transport pattern

5.1.2 Isotopic records of surface water to precipitation

5.1.3 Climate impact on isotopic spatial and temporal variation

The embellishment of the above headings is based on summarizing the content of the paragraph and highlighting the main subject of the whole article, to strengthen the logic and readability of the article.

Specific comments

L20: "caused by climate warming" during which period?

Reply: It refers to current warming. Corrected.

L22: what are "structural channels"?

Reply: "structural channels" is ambiguous, and what we are trying to convey is that the favorable water conduits, such as faults and fissures.

L29-30: I disagree that an "in-depth study of the hydrological cycle is a prerequisite of water management"; Effective water management practice implementation may be hindered not by lack of knowledge but also geopolitical reasons, although it is a case-by-case matter. I understand the authors need to justify the significance of their study, so I'd recommend to be more balanced, for example rephrasing as follows "an in-depth study of the hydrological cycle processes is a prerequisite for accurate trend forecasting, and helps to design efficient water resource management strategies."

Reply: Thanks for the suggestion to modify it accordingly. Corrected.

L62: H & O are not isotopes per sé. May an appropriate formulation would be "The isotopes of hydrogen and oxygen elements are useful tracers of the water cycle..."

Reply: Corrected.

L66-68: why talking only about stable isotopes (excluding ^3H), and then mentioning ^3H in the next sentence? Both stable and non-stable types are useful tracers in the applications cited.

Reply: These two have been modified. Both stable and non-stable isotopes are useful tracers in the text.

L70-71: an additional reference using stable isotopes and tritium may be Rodriguez et al.

(2019) and a recent paper on the topic (Benettin et al., 2022)

Reply: The most recent relevant literature on stable isotopes and tritium tracing of the water cycle like your issued has been cited in the corresponding position.

L81: I'm not sure to understand how tectonic patterns are caused by "hydrological, climatic and hydrogeological conditions". Isn't the other way around?

Reply: You're right. It was modified.

L91-95: objectives #1 to #2 seem somewhat vague and overlap. Also, perhaps the authors should consider having more focus objective than #3, e.g. instead of tracking "the entire water cycle" --> "identifying and quantifying the main components of the regional cycle, their timing and spatial heterogeneity" might be already quite ambitious and enough?

Reply: The objectives of the article in the Introduction have been simplified at your suggestion and that of other Referees to 3 points. The aims are 1) elucidating the distribution pattern of surface water and groundwater isotopes in this alpine arid basin at various spatial and seasonal scales; 2) identifying and quantifying the main components of the regional cycle, their timing and spatial heterogeneity; and 3) revealing isotopic hydrological responses to climate change and predicting the trend in the changes of Qaidam Basin water resources.

L96-100: This part is essentially a repetition of the above, please consider removing it.

Reply: Yes. This part was removed.

L159: is the sampling frequency or sampling period?

Reply: It is the sampling period.

L163-164: Providing a quick idea of the rain and snow(melt) sampling frequency would be useful.

Reply: Relevant information has been added.

L230: I guess mentioning "evaporative fractionation" instead of "evaporation" helps for

the analysis the plotting below the LMWL

Reply: You're right. It was modified.

L253: In this section, having a dual-isotopes plots per locations (possibly in the supplementary materials) would help the analysis; it seems this the current Fig. 7, but why does the latter comes much latter and is being only quickly mentioned in the main text (L357, L393) ?

Reply: We apologize for the confusion caused by inconsistent content. A new Figure corresponding to the characterization of the results section has been uploaded and its naming has been redefined from Figure 3 to Figure 5 in the text.

L285-288: I am not convinced that this assertion is supported by the data. Can the authors further develop and articulate this hypothesis?

Reply: It is really seemed to be very abrupt here. This has been rephrased and moved to be previous relevant expressions.

L337-340: This is interesting and should probably come earlier in the analysis, at least before general statements as those found e.g. L328-330?

Reply: Agreed. Under the new framework, it has been adjusted to the appropriate prominence.

L351-352: Is 3 permill (from 10 to 7) a substantial difference in d-excess?

Reply: Yes, this is a difference in mean d-values. Please refer to Table S1 for relevant data. Consistent with our results, previous works have shown that there is a substantial difference in the d value of water bodies originating on the north and south sides of the Tanggula Mountains in terms of their characteristics. This is caused by differences in moisture sources.

L400-519: In line with the general comments, it seems quite strange that the information content and results of tritium analysis only appears so late in the paper.

Reply: We agree with you and have resolved the confusion. The information content

and results of tritium analysis in surface water and groundwater have been added to the Results section.

L499: Typical tritium detection limit is around 0.05 TU or less, so this gives considerable range from "<3TU". Could the authors explain why they grouped all samples below 3TU and those "below detection limit"? And also provide their detection limit somewhere in the methods?

Reply: Yes, as you say, "less than 3 TU" and "below detection limit" at the same time are ambiguous. We are trying to convey low tritium concentration here. The ambiguity in the text was modified.

L578: what do the authors mean by "the cyclical nature of climate change"? The long-term glacial-interglacial dynamics? Please rephrase, as it reads it may be understood that current global warming is cyclical (against all evidence synthesized by the IPCC).

Reply: Rephrased.

L587-589: I did not understand how the authors can predict a large-scale decrease after the increase in water resources, please clarify.

Reply: This issue has not been well clarified due to confusing logic. In the revised version, some literature data was added to support this conclusion. We rewrite this paragraph in order to convince it to be accepted by readers.

L592-593: does this involve regional evaporation recycling mechanisms? AS it stands, little of this is directly discuss in the paper, yet it seems like an important piece of the puzzle.

Reply: The evaporation recycling mechanism is actually existent here, especially in these watersheds where precipitation is sparser. Corresponding mechanisms are added here to couple other hydrometeorological elements. We would like to state that in this extremely arid basin, intense evaporation is one of the most dominant climatic features. Therefore, this premise is present by default, although there seem to be regional differences between the watersheds. Limited by the paper's length, we did not develop

a detailed discussion of evaporation recycling mechanism. It is clear that these proposals point the way we forward. The modifications in the text are as follows:

3) In the central basin (Nomhon, Golmud, and Yuka Rivers), there is long-term large-scale groundwater mining during the agriculture and industry development, accompanied by strong local evaporation. The sparse precipitation in the source area led to a melt dependence, although the surface water and groundwater recharge here is relatively stable.

L637: similar comment as for L578 ("cyclical nature of climate change")

Reply: Rephrased.

Technical comments

L8: "climate warming" reads odd to me. maybe "climate change" or "global warming" instead? It is found several times in the manuscript

Reply: These ambiguities have been modified in the whole text.

L13: heavy isotopes do not enrich, more correctly stated "the water is enriched in heavy isotopes"

Reply: Modified.

L18: "regulated" reads strange; "controlled", maybe?

Reply: Modified.

L22: what is the "impending climate change process"? Perhaps "In the face of ongoing environmental changes, ..."

Reply: Modified.

L47: replace "and a substantial steep...globally" by "with a steep rise in temperature overall".

Reply: Modified.

L49: "0.53°C per decade"?

Reply: Yes, you are right. It was corrected as suggest.

L77: please define a "confined regional unit scale" or rephrase.

Reply: Rephrased.

L84: "to study the entire process of the water cycle" --> "to get a comprehensive view of the water cycle"?

Reply: Modified.

L85: "isotopic composition" rather than "isotopes"

Reply: Modified.

L92: "in this alpine arid basin"

Reply: Modified.

L131: "extensive" instead of "expansive"?

Reply: Modified.

L162: I am not sure what "phrenic" means here; is it "phreatic"?

Reply: Modified.

L245: by "positively skewed" I guess the authors mean that it is more enriched ; I find the latter expression more correct and self-explanatory.

Reply: Terminology on isotope changes throughout the text has been checked and modified

L29 - Fig. 3: the figure is very small and symbols are hard to tease out ; consider using a larger, vertically stacked figure (with higher DPI / less compression as well, it is quite pixelized at present)

Reply: An updated Figure consistent with the main text has been uploaded and now it looks clear a lot.

L313: what do the authors mean by "an augmentation in the continental characteristics

of water vapor"? Please clarify and/or rephrase.

[Reply: Rephrased. Again, we apologize for the confusion.](#)

L457 - Fig. 8: The scale is hard to read; I suggest the authors remove the color from the background (with a simplified map) and use a color scale to isotopic ratios and $3H$. I would also suggest to duplicate the panels to clearly separate surface and groundwater, as surface is here only shown for tritium.

[Reply: Thank you for your suggestions, we have modified Figure 8 based on them, the new graphic is more aesthetically pleasing and helps to directly present our findings.](#)

References

Benettin, P., Rodriguez, N. B., Sprenger, M., Kim, M., Klaus, J., Harman, C. J., ... & McDonnell, J. J. (2022). Transit time estimation in catchments: Recent developments and future directions. *Water Resources Research*, 58(11), e2022WR033096.

Rodriguez, N. B., Pfister, L., Zehe, E., & Klaus, J. (2021). A comparison of catchment travel times and storage deduced from deuterium and tritium tracers using StorAge Selection functions. *Hydrology and Earth System Sciences*, 25(1), 401-428.