Reply to the RC1

In this file, the comments from RC1 are in **black font**; our replies below are in **blue font**.

In my opinion, the manuscript will be a great addition to the journal and be of interest to its readers. Mao et al targets the variations in time and in space of residence time and travel time at Lake Taihu, China, by processing and analyzing measurements of deuterium in the lake. Temporal scales in lakes have been correlated to water quality issues, therefore knowing how long a water parcel remains in the lake depending on the meteorological conditions will provide a clearer picture on how to better manage water quality in Taihu Lake. For example, their results show that depending on the inflow of water (through rivers and rain) the travel time can decrease by half.

Reply: We appreciate your acknowledgment of our manuscript's contribution to the journal. As you summarized, our manuscript aims to quantify the residence time, travel time, mixing, and storage release preferences of Lake Taihu, which are essential for investigating the eutrophication problem in this lake. Below are our point-by-point replies, which we hope will address your comments satisfactorily.

1. There have been publications mentioning Lake Taihu’s residence time. I am thinking for example of Xu et al 2009 (https://doi.org/10.4319/lo.2010.55.1.0420), Xu et al 2015 (https://doi.org/10.1021/es503744q) and Paerl et al 2014 (https://doi.org/10.1371/journal.pone.0113123). Interestingly the value of residence time is not consistent among these publications, but they remain below the 1 year mark. I think the manuscript would benefit by including a comparison and a possible explanation of the discrepancy between the publications.

Reply: We accept your valuable suggestions. Including a comparison and an explanation for the discrepancies between the publications is a good way to highlight our contribution. In our current manuscript, we only compare the scientific questions related to residence time addressed by our model with those addressed by Li et al. 2011 (https://doi.org/10.1016/j.ecoleng.2010.11.024) (see lines 74-79 in the manuscript which is being discussed), but, as you noted, there is more literature mentioned or estimated the residence time in Lake Taihu. Therefore, in the revised version, we will expand the literature review in the introduction section and compare our results with the time scales from other studies in the results section.

Here are our comparisons, which will be included in the future revised version：

（1） Firstly, in the literature on the study of Lake Taihu, the terms related to time scales vary widely. Some use "age", some use "retention time", and others use "residence time", each with different definitions, leading to varying numerical values in the literature. We will address the numerical differences caused by these terms in the following comparison.

（2） Secondly, the residence time and travel time of water in Lake Taihu are influenced by various factors, among which wet conditions (or lake water level), water flow path, and water flow velocity are the main factors discussed in our manuscript. These factors can lead to the differences in time scales among literature.

（3） In the study of Li et al. 2011 (https://doi.org/10.1016/j.ecoleng.2010.11.024), the spatial distribution of age in Lake Taihu was simulated. The term "age" in their study represents the locally averaged "residence time", influenced by the local mixing of water parcels with different residence times. This mixing can result from molecular diffusion between adjacent flow lines or the mixing of rainwater into the lake's surface with the local lake water. Consequently, the maximum age in the lake tends to be slightly smaller than the maximum residence time. Li et al. 2011 reported maximum ages of 120-150 days in July and 240-270 days in December. In our study, as shown in Fig. 9(b3) and lines 467-468, the maximum residence time is less than 9 months (varies between 4-5 months to 8-9 months), consistent with the results of Li et al. 2011.

（4） In the studies of Xu et al 2009 (https://doi.org/10.4319/lo.2010.55.1.0420), Xu et al 2015 (https://doi.org/10.1021/es503744q), the term "retention time" is used， which is similar to the definition of travel time, i.e., the time of water spends from inflow to outflow. Theoretically, travel time is not fixed at a specific moment, as some outflow rivers have shorter travel times while others have longer ones. Therefore, we quantify the travel time distribution in our study (Figs. 9 a(1)-a(3)). The temporal variation of mean travel time is calculated and shown in Fig 10. According to our findings, the travel time in outflow rivers varies between 2-4 months (high lake water level) and 7-9 months (low lake water level). In Fig. 10, the mean travel time in outflow rivers ranges from 4 to 8 months. However, retention times reported in the literature vary significantly, such as 284 days (Xu et al., 2009), 180 days (Xu et al., 2015), and 5 months (Qin et al., 2007). These retention times fall within the range of our calculated travel time distribution, which varies in time and space depending on lake water level, water flow paths, water flow velocities, etc.

（5） In the study by Paerl et al. (2014) (https://doi.org/10.1371/journal.pone.0113123), we did not find any information regarding water transport time scales.

Overall, there is currently a lack of unified and systematic understanding of the time scales of water transport in Lake Taihu. Utilizing travel time distribution theory and storage selection functions, we have conducted a comprehensive and systematic study on the time scales of water transport in Lake Taihu. We have quantified the travel time distribution, residence time distribution, mixing, and storage release preferences of lake water over time. This research is essential for future studies on the ecological and water quality issues of Lake Taihu.

Qin, B., Xu, P., Wu, Q., Luo, L., & Zhang, Y. (2007). Environmental issues of lake Taihu, China. Eutrophication of shallow lakes with special reference to Lake Taihu, China, 3-14.

2. There are portions of paragraph in Section 5 that appear contradictory to the results described in the abstract. For example, at the end of Section 5.2.1, lines 477-478, Mao et al states that "older water parcels may have greater chances leaving the system than younger water parcels". However, in the abstract it is stated that "the release preference shifts toward younger water when lake volume is large". A reorganization of the subsections would help to make things clearer.

Reply: We apologize for the confusion caused by the sentences in section 5 and the abstract. We will revise the abstract sentence as follows: "The release preference shifts toward younger old water when the lake volume is large", which means the release preference is still old water, but the age of these old water becomes a little bit younger when lake volume is large. (see lines 544-546 in the discussed manuscript). This is primarily due to two reasons: (1) the mean travel time and residence time decrease with larger lake volume and flow velocity; (2) there are shorter flow paths in the lake when lake volume is large. We will carefully review all sentences in section 5 to prevent similar issues in the future.

3. In the introduction, lines 51-52, the authors mention that only Smith et al. 2018 applied the travel time distribution theory to a lake. Unless the authors were implicitly focusing on the usage of isotopic compound, I disagree with the authors. Temporal scales have been addressed in previous work in lakes. For example, Rueda and Cohen, 2005 (https://doi.org/10.4319/lo.2005.50.5.1638) looked at variation in space and time of residence time in an embayment of Lake Ontario, Canada.

Reply: We accept this comment. In 51-52, our intention was to say that currently only Smith et al. (2018) have applied travel time distribution theory and storage selection functions to two lakes to quantify the ages and storage release preferences of the lakes. However, in the study by Rueda and Cohen (2005), the TTD theory was at an early stage, and recent development in TTD theory, such as storage selection functions and age master equations put forward in the 2010s, are very helpful to characterize not only RTD but also the mixing and storage release preference of lakes. Moreover, in our study, as described in lines 52-61, we further developed the TTD model to quantify the mixing of rainwater and river water in Lake Taihu.

Therefore, we will revise this sentence as: "To the best knowledge of the authors, while there is study (Rueda and Cohen, 2005) estimating RTD in lakes, there is only one study (Smith et al. 2018) applied the time-variant TTD theory developed in 2010s and storage selection function to quantify the age, mixing and storage release preference of the lake".

4. The authors mention the spatio-temporal variations of the time scales are controlled by horizontal velocities on several occasions (in the abstract and in the conclusion), they did not discuss past work identifying the flow field at Lake Taihu. The manuscript would benefit from including comparisons with past work on average flow field in Lake Taihu Liu et al. 2018 (doi:10.3390/w10060792) shows for example a rather complex average flow field, which would definitely hinder the flow of water from inflow to outflow.

Reply: We accept this suggestion. In section 5.4.2, we will add a comparison of past works in literature on average flow fields as supplementary information to illustrate the implications of spatio-temporal variations in isotope data on the flow field, and to discuss the relationship between the flow field and time scales.

Firstly, the overall water flow direction in Lake Taihu has been reported in many studies, such as Qin et al, 2007, Xiao et al. 2016 (https://doi.org/10.1080/10256016.2016.1147442), indicating a generally flow direction from northwest to southeast. This pattern is generally consistent with the spatial distribution of isotopes shown in Fig. 14.

As for the temporal variation of flow paths, the isotope data indicate that the water transfer project in Wangyu River plays a significant role in controlling water flow paths. This is confirmed by Liu et al. 2018 (doi:10.3390/w10060792), who investigated the influence of water transfer project on the water circulation patterns. Their study found that when Wangyu River is an inflow river, it significantly obstructs the northwest-to-southeast water flow direction, thereby prolonging the travel time from inflow to outflow zones (as we discussed in lines 624-626). Conversely, in June 2014, when Wangyu River became an outflow river, this obstruction ceased, explaining the shift in storage release preference towards younger old water during that month.

5. I noticed a couple of typos in the text:

Figure 2: There is no sampling point 2. I assume it is supposed to be where sampling point 32 is.

Reply: After examining our dataset, we confirmed that there is indeed no sampling point 2 here. Although the figures are numbered up to 32, as mentioned in line 114, there are only a total of 29 sampling points for isotope data. Isotope data at points 2, 9, and 15 are not available. You can find our isotope data for these 29 sampling points in the supplementary file. Additionally, the original data in xlsx format is available for download from the following DOI link: https://doi.org/10.5281/zenodo.10156422.

Line 304: If I understand properly, s_rain(t,tau) is the volume of rain water aged tau, and not s(t,tau).

Reply: Yes, it should be s_rain(t,tau), we will revise it in the manuscript.

Line 499: please replace “board range” with “broad range”.

Reply: Thanks for pointing out this typo, we will correct it in the manuscript.

Line 505: please replace “Lake” with “lake”.

Reply: Thanks for pointing out this typo, we will correct it in the manuscript.