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# *Interactive comment on* "Densified multi-mission observations by developed optical water levels show marked increases in lake water storage and overflow floods on the Tibetan Plateau" *by* Xingdong Li et al.

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Comment: This is a valuable and interesting manuscript. The authors have exploited multisource remote sensing (i.e., multiple altimetric missions and Landsat archives) to create dense time series of lake water level and storage changes across 52 large lakes on the Tibetan Plateau. There are some previous studies focusing on changes in water level and storage on the Tibetan Plateau; however, these studies just got relatively lower temporal sampling and little altimetric information was used. It may limit the accuracy of trends in lake water level/storage in some cases and short-term monitoring



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Discussion paper

of lake overflow flood. Therefore, I am firmly convinced that the densified water-level dataset derived by the authors can have tremendous practical value in studying water storage changes and regional hydrological processes on the Tibetan Plateau.

Response: We thank Dr. Wu for these encouraging and constructive comments. As Dr. Wu's indicated, this work aims to provide improved lake water level and storage change estimates in terms of temporal resolution as well as accuracy. We appreciate all these comments from the community. Our responses to these comments are given as follows.

Comment: As far as I am concerned, deriving altimetry water levels through multiple altimetry missions (including Jason-1/2/3, ENVISAT, ICESat-1, and CryoSat-2) is the key component. I think the manuscript needs a more detailed description of this methodology in section 3.1.

Response: Thanks for this comment. It is indeed important to clarify the method we used and developed to derive lake water levels from altimetry data. The waveform retracking methods in this section could be the most important part regarding technical details. Here we provided a general equation (Eq 1) for surface height calculation mainly because different sensors have different correction items, e.g., the saturation correction for ICESat (laser altimeter) was not applicable to radar altimeters.

As for waveform retracking correction, which is crucial to radar altimeters, we performed existing algorithms (e.g., the NTTP method for Croysat-2) or used a default method provided by the altimetry product (e.g., the ICE-1 retracking method). These methods have been widely tested and recommended based on in situ measurements. However, there can be a paradox when several studies suggested different methods for the same altimeter. If so, we can only apply the rule of thumb to choose those that balance the robustness, computational cost, and accuracy (e.g., the Improved Threshold Method for Jason-1/2/3).

In fact, the original idea of the NTTP, ICE-1, and Improved Threshold Method is quite similar. All of them adopt a threshold defined as the percentage of waveform peak to determine the retracking gate, and then transfer the difference between the retracking gate and the nominal gate into range correction by multiplying the gate range ($c\Delta t/2$, where c is the speed of light and $\Delta t$ is the time duration of a gate). The differences lie in the choice of thresholds as well as the calculation of waveform peaks. Therefore, we think it would be more suitable to provide some general information in the manuscript about threshold retracking schemes and to clarify the similarities and differences among the retracking methods we used.

This part will be modified in the revised manuscript.

Comment: To validate the derived optical water levels, the authors used pressure type water level sensors to measure water pressure and converted them into water depths. How to convert the water depths into the actual water level and unify to the same reference datum with optical water levels? It should be clarified

Response: Thanks for this comment. The water level measured by the pressure type sensor is the water depth (~20 m) of the installed location, while the water level acquired from optical images/satellite altimeters is the surface height with respect to EGM96 which generally has a value ~4000 m. To make them comparable, we calculated water level anomalies for the both time series. This part will be illustrated in detail in the revised manuscript.

Comment: Pg.1, Line 14 "(>100km2) " should be " (>150km2) "?

Response: Thanks for this comment. We do have investigated almost all Tibetan lakes larger than 150 km2 (except for one or two lakes with too limited altimetry/optical data) and several lakes between 100-150 km2 (e.g., Lake Salt). This part will be modified in the revised manuscript to avoid confusion.

Comment: The legend of Figure 11 should be revised (add unit and scale).

Response: Thanks for this comment. It will be corrected in the revised manuscript.

Comment: Figure 16, miss unit in y axis

Response: Thanks for this comment. It will be corrected in the revised manuscript.

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