Dear Handling topical editor David Carlson,

Thank you so much for your work in handling with our manuscript “essd-2021-470”. We are very happy to hear the positive feedback on our datasets from community members (see the https://doi.org/10.5281/zenodo.7251283) and referees. We have carefully studied all comments and made corrections/changes as suggested.

Here, we briefly summarize the improvements to our dataset as well as the main changes in our revised manuscript considering the minor and moderate issues raised by the reviewers.

- Regarding the presentation of this manuscript, we have rewritten almost the entire manuscript and have tried to help the readers to better understand our study.
- We performed strict data quality control to eliminate any potentially problematic data points, and data version 2 is released as the final dataset for our manuscript that is under consideration for being published in ESSD.
- For water levels, we added six satellite altimeters (previsous version with four satellite altimeters) in this version and provided two modes, standard-measurement, and enhanced-measurement. For the enhanced-measurement product, we need to eliminate the systematic bias between satellites. The biases are removed using two methods, as detailed in comment R2C0, to address the main issue raised by Reviewer 2.
- For water area, we adopted a new monthly surface water area extent (SWA) from Landsat and Sentinel-2 images by using a new algorithm developed by Donchyts et al. (2022) and added a section to describe the accuracy assessment to evaluate our area dataset based on in situ water levels in 93 reservoirs, our generated altimetric water levels and cross validation against the other two existing area datasets to address the main issue raised by reviewers 2 and 3.
- For water storage variation, we added DEM-based estimates, so that we provide two types of storage variations, i.e., using satellite-based water levels and water area, and using satellite-based water area and DEM-based curves. The storage changes are validated against in situ storage changes for 93 reservoirs, addressing the main issue raised by reviewer 1 and 3 (Please note the major issue raised by reviewer 1 why we have negative values for storage variation dataset, because he incorrectly assumes that we provide storage data.)

Here, we would like to clarify the novelty of our data product again. In our revised manuscript, we generate (1) reservoir water level (WSE) from six satellite altimeters (Sentinel-3 A/B, CryoSat-2, SARAL/Altika, Jason-3, and ICESat-2), and provide two modes of WSE, standard measurement (single satellite) and enhanced measurement (i.e., merging measurements from multiple satellites for a specific reservoir if possible); (2) monthly surface water area extent (SWA) from Landsat and Sentinel-2 images by using a new algorithm developed by Donchyts et al. (2022); (3) monthly reservoir water storage change (RWSC) data and provide two types of RWSC (i.e., one type using satellite-based water levels and water area, and another type using satellite-based water area and DEM-based area-storage curves). Please note the following four points highlighting the novelty and value of our datasets: (a) in our revised data and manuscript, we performed strict data quality control to eliminate any potentially problematic data points, and performed a validation using 93 reservoirs with in situ water level and storage data, which is not done ever before for Chinese reservoirs; (b) although there are some similar databases covering partly reservoirs in our study, however, RWSC developed by Hou et al. (2022) are not publicly available, the methodology is also different, Hou et al. (2022) relied the GRSAD water area data and DEM (a geo-statistical approach) to calculate the storage change. Our datasets are publicly available and we provide two types of RWSC and validated their performance, which could be very valuable for relevant studies; through the literature review and our statistical metrics, the RWSC estimates from satellite WSE-SWA are more reliable than those from DEM-Area approach (c) we noted that there are several databases providing SWA such as GRSAD (Zhao and Gao, 2018), RealSAT (Khandelwal et al., 2022) and Donchyts et al. (2022), and WSE data; however, whether SWA/WSE time series from different databases have a good agreement with one another and gauged measurements is not systematically evaluated, which can be shown in this study; (d) moreover, a growing interest in using satellite altimetry data in hydrological cycle is expected, thus knowing the accuracy of satellite altimetry is a prerequisite, although previous studies assessed satellite altimeters in retrieving reservoir water levels (Shu et al., 2021), knowledge is still limited as to evaluations of different altimeters for a large sample of reservoirs, which can be shown in this study.

Hope the revised manuscript and data are to your satisfaction and meet the standard of ESSD journal.

Best,

Youjiang Shen.

Reviewer #1 Comment on essd-2021-470 (Stefano Galelli)

Dear Stefano Galelli,

Thank you for your time and efforts in reviewing our manuscript. We are very happy to hear your positive feedback on our datasets which provide strong support for many aspects. We are very happy about the agreement that the presented data set is an important contribution to the large-scale studies that will take place in the context of increasing activity in the reservoir and dam sector and are pleased to be able to contribute with this data set. Please find attached point-to-point responses regarding your comments (marked in purple) and made corresponding changes in the main manuscript (in red). We hope that the improved manuscript can help the readers to better understand our study.

Kind regards.

General comments

Manuscript essd-2021-470 describes a novel dataset providing water surface, level, and storage information for 338 reservoirs in China. In my opinion, this is a much-needed dataset that fills in an important gap, since data on water reservoirs are typically not available to the international community. I believe many studies and downstream applications will thus benefit from these data.

R1C0: Thank you for your positive comments identifying the strengths of our work.

Overall, both manuscript and dataset are well organized, although a few important probably deserve more attention. In particular:

1. I am not entirely convinced about the approach used to estimate the hypsometric relationships, which, if I understand correctly, are based on water level and surface data estimated from satellite data. In general, water level data are rather reliable, while it is always a challenge to get the right water surface data (a matter that explains the use of image enhancing techniques), a problem that might affect the quality of the curves. So, why not using a DEM to get the right curves? This could be done for many reservoirs. Estimating the hypsometric relationships from a DEM would also limit the need for water surface data.

R1C1: We added this DEM approach in the revised manuscript, thus, we provided two types of RWSC estimates, i.e., one is to use water level and water areas from satellite altimeters and images, while another one is to use imagery-based water areas and DEM (digital elevation model). The core of these two approaches is to construct the A–E relationships from the overlapping records of water level and areas or DEM. The performance of these two types of RWSC estimates are shown in Section 3.3. Here, we give the corresponding changes in the revised manuscript.

2.3 Reservoir storage variation estimation

Monthly reservoir storage variation estimation is based on two common approaches: one is to use water level and water areas from satellite altimeters and images, while another one is to use imagery-based water areas and DEM (digital elevation model). The core of these two approaches is to construct the A–E relationships from the overlapping records of water level and areas or DEM. Here, we assume that the A–E relationships can be described by five hypsometric relationships (i.e., linear, power, exponential, polynomial, and logarithmic relationships). Parameters of the relationships are derived by minimizing the residual sum of squares (RSS) using an ordinary least squares (OLS) regression. The curves were compared based on their R^2 values and the one with the best performance is served as the hypsometry relationship of the reservoir. For reservoirs with enough overlapping water level and area records from satellites, we performed the following procedures (Figure B2).

- The monthly WSE was estimated by directly averaging all measurements within each month.
- We generate the scatterplot of monthly area and water level data pairs and eliminating errors in the scatterplot.
- Generating the A–E relationship through OLS approaches.
- Applying the derived relationship to estimate WSE from SWA for periods when WSE is unavailable and inverse the function to estimate SWA from WSE for periods when SWA is unavailable (e.g., the month with large contamination ratio).
- Using Eq. (3), monthly RWSC estimation are determined during 2010–2021.

$$\Delta V_t = \frac{1}{2}(WSE_t - WSE_{t-1}) \times (SWA_t + SWA_{t-1}), \tag{3}$$

Regarding the DEM-based approached, we generated the water area-level-storage model based on SRTM-90m DEM and reservoir shapefile (Vu et al., 2022), and then calculated RWSC by combining imagery-based water areas and reconstructed area-level-storage model (Figure B2). After these steps, two types of reservoir storage variations are contained in our product. To assess the data quality, we use the RMSE, Pearson correlation coefficient (CC), and normalized root-mean-square error (NRMSE) as indicators of data quality. The generated RWSC were compared with in situ observation of 93 reservoirs.

3.3 Reservoir storage variation product

We provided monthly RWSC time series from 2010 to 2021 in two modes: one is to use WSE and SWA from satellite altimeters and images, while another one is to use satellite SWA and area-storage model developed by DEM. After excluding reservoirs without insufficient WSE-SWA data pairs to establish the A–E relationships and visual inspection of time series, we finally retained 337 reservoirs with RWSC time series, among which 335 reservoirs have RWSC estimates derived from the first type method while 266 reservoirs have RWSC estimates derived from the DEM-based method. To evaluate the data quality, we compared with in situ storage data of 91 reservoirs and calculated three error statistical metrics (i.e., RMSE, normalized root-mean-square error (NRMSE), and CC). The A–E curves derived from satellite WSE and SWA data are evaluated based on their R^2 values. We notice that 69% reservoirs of A–E curves could be better explained by a second-order polynomial function, while 13% and 16% reservoirs of A–E relationships are assumed to give a power and exponential function (Fig. 8 f, h). A total of 283 of 335 reservoirs (84%) have moderate R^2 values > 0.5, among which 107 reservoirs show very good agreement with R^2 values > 0.8. Nevertheless, 15% has relatively poor performance in terms of R^2 values. Overall, our A–E curves are reliable and lay the good foundation for RWSC estimates. Across gauge comparisons of RWSC, the median statistics of CC, NRMSE, and RMSE are 0.89, 11%, and 0.021 km^3. Around 91% reservoirs (83 of 91) show good data quality with a NRMSE value below 20% and a RMSE value ranging from 0.002 to 0.31 km3. The lowest NRMSE is 4%, from the Gangnan reservoir that displays high CC and low RMSE values. Regarding the DEM-based RWSC estimates, the results are getting worse, with the median statistics of CC, NRMSE, and RMSE are 0.56, 20%, and 0.03 km^3. The errors can be attributed to the inaccuracy of the area-storage model developed by DEM. It should be noted that this type of RWSC estimates is served as an alternative product. Figure 8 shows examples of RWSC for some selected small, medium, and large reservoirs located in different climate zones. Closer examination in Fig. 9 seems to indicate that almost all remotely sensed RWSC estimates show similar patterns to the observations, i.e., both positive or negative, despite of some large discrepancies when capturing peak values. Nonetheless, there are some differences. Some reservoirs with good NRMSE and RMSE values show poor performance in terms of CC value, e.g., the Baiguishan reservoir (CC: 0.38, NRMSE: 16%, RMSE 0.03 km^3) that experiences relatively significant surface water dynamics. Moderately poor performance of 20 reservoirs (7%) in terms of high NRMSE/RMSE and low CC values (CC < 0.4) is likely associated with their poor performances from the remotely sensed WSE and SWA. Overall, we used in-situ observations of 91 reservoirs as an important reference to validate RWSC dataset, thus bringing the good level of confidence in our data quality.

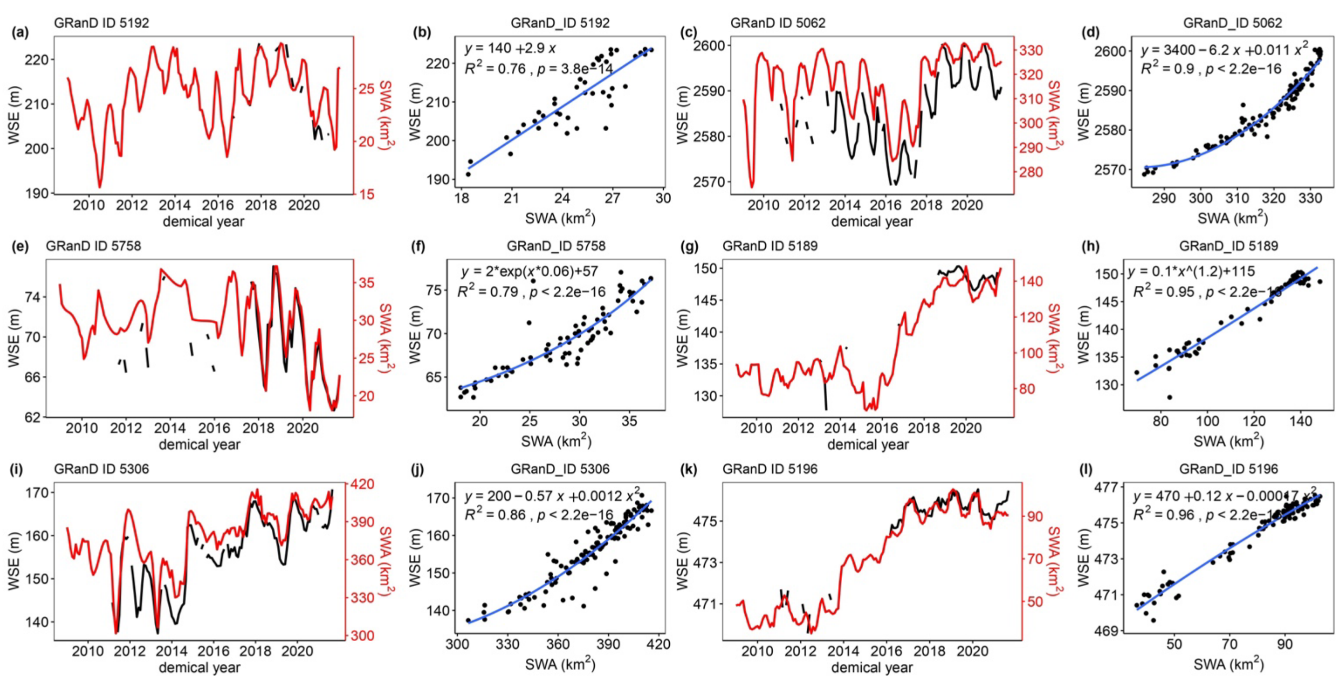

Figure 8: Illustration of A–E relationships constructed by satellite WSE and SWA and their associated time series at six reservoirs. (a)-(k) are the Panjiakou, Longyangxia, Baipenzhu, Miyun, Danjiangkou, and Guanting reservoir, respectively.

Note that: time series of WSE and SWA and associated established A–E relationships of the remaining reservoirs are available in our datasets.

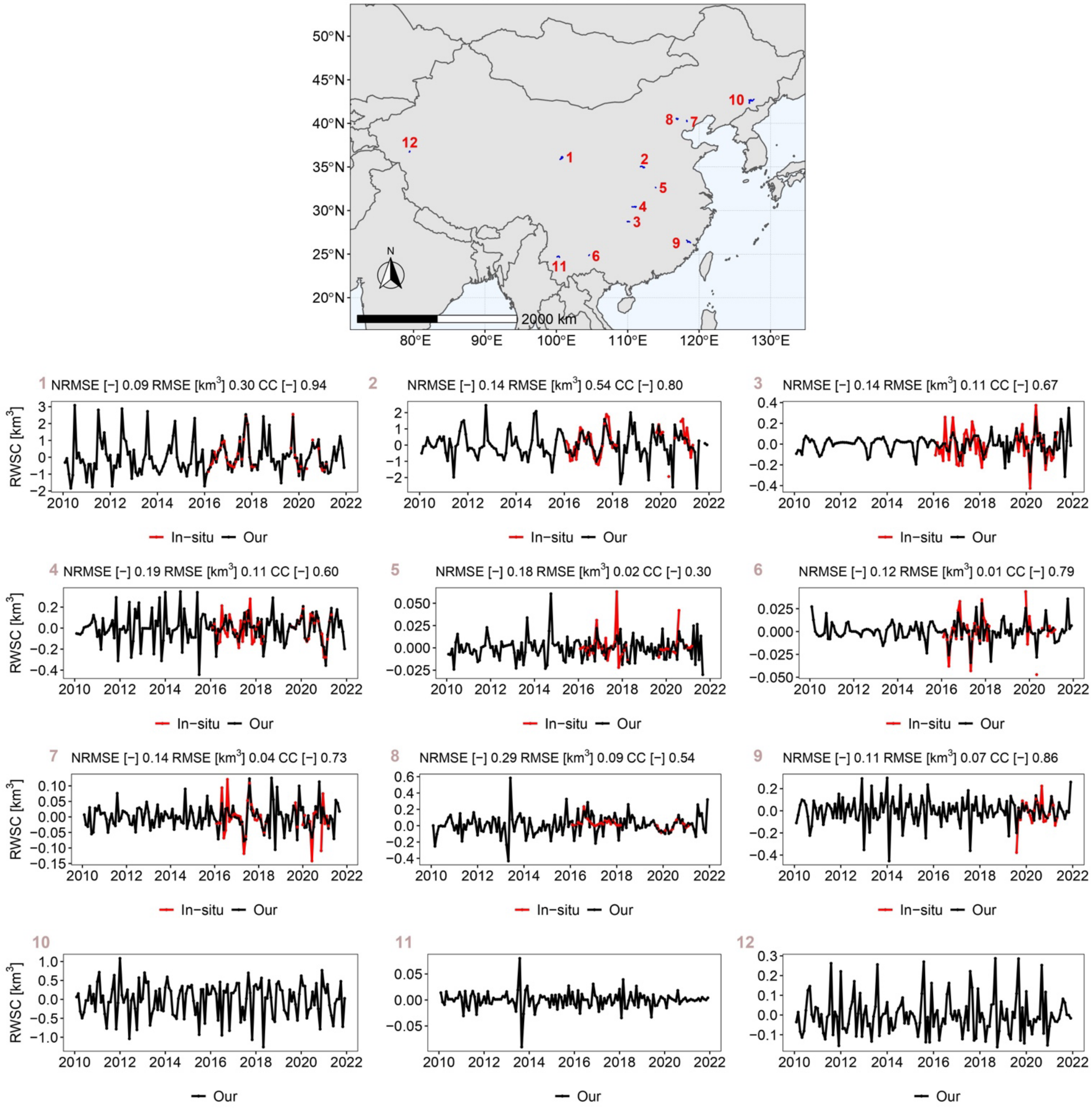

Figure 9: Illustration of time series of the remotely sensed RWSC of 12 reservoirs. NRMSE, RMSE (km^3), and CC values (if available) are given at the top of each subplot. Time series of the remotely sensed RWSC of the remaining reservoirs (validated or not validated) are available in our datasets.

2. It looks like many reservoirs have a negative value of storage (Figure 7). What further confuses me is that the gauged data have also negative values. How do you explain

this matter (for both estimated and gauged data)? Shouldn't this problem be corrected? And wouldn't a more precise hypsometric relationship help?

R1C2: Thank you for the comment. We would like to clarify that we provide storage variations in our datasets, i.e., reservoir water storage change (RWSC), not the storage. Sorry for this misunderstanding and hope this can address your questions.

As already mentioned in the introduction, RWSC is an important variable that directly reflects the change of water stored in the reservoir and can be implemented into global hydrological/hydrodynamic models for better streamflow simulation. Our plan is to fill a data gap, i.e., the remotely sensed reservoir water level, area, and RWSC in China, which can be applied as constraints to calibrate models or directly used for reservoir analysis. We listed all previous studies producing these three types of datasets in Table 1. Furthermore, in sections 5, we demonstrated the blueprint applications of our datasets, taking the Ankang reservoir as a case study, to show the value of our RWSC data in estimating reservoir release. RWSC can also be used to develop a reservoir storage forecast system at 1- to 3-month lead that can be valuable for water resource management in China.

We also agree with that storage is also important, but out of the scope of this study. Anyway, we are willing to give some points to this. Firstly, previous studies (and our study) mainly focused on developing RWSC rather than storage (Table 1). This can be attributed to the fact that the state-of-the-art of estimating accurate storage data need the accurate reservoir bathymetry, which is difficult to obtained from satellites. Secondly, although some studies make a good attempt, for example, Li et al. (2020) developed a bathymetry dataset for ~400 global reservoirs, the application is limit to large reservoirs which are observed by ICESat-2 mission, that has a coarse spatial resolution! So, it is impossible for us to adopt their methodologies to produce the remotely sensed storage for a large number of reservoirs in China.

References:

Li, Y., Gao, H., Zhao, G., and Tseng, K. H.: A high-resolution bathymetry dataset for global reservoirs using multi-source satellite imagery and altimetry, Remote Sens. Environ., 244, 111831, doi: 10.1016/j.rse.2020.111831, 2020.

3. The quality of the presentation (including figures) could be enhanced. Please refer to my comments below.

R1C3: Thank you for the comment. The manuscript and figures are improved accordingly. Please find the responses below.

4. Are the water level and storage data retrieved from http://xxfb.mwr.cn/index.html available in the repository? Please correct me if I am wrong, but I couldn't find them. If

that's true, I would encourage to authors to share those—it is not possible to download them from the aforementioned website.

R1C4: Yes, you are right. The in-situ datasets are updated day-by-day, thus, not possible to download the historical time series. I apologize for not making our collected in-situ datasets publicly available on Zenodo as we have a federal grant that limits the sharing of in-situ dataset. Moreover, we have no right to make all of them publicly available, now. Anyway, we are happy to share some data for users to do some case studies, please feel free to contact the corresponding author.

General Comments:

- Line 60 ("It is obvious that ..."). This sentence is not clear. Are you referring to China? If yes, I would state it clearly.

Changed as:

Obviously, there is a data gap with regard to comprehensive reservoir information in China (Table A1).

- Line 61-62. I suggest being more precise here. What are the reservoirs for which data are already available? Are the data public? And, importantly, what type of data are available?

Changed as:

Records of a few Chinese reservoirs are available from these databases or previous studies (Table A1). Taking reservoir water level as an example, approximately 30 Chinese reservoirs are available from three datasets (i.e., Hydroweb, G-REALM and DAHITI).

See Table 1 and Table A1 below.

Table 1. Summary of recent studies and databases producing the remotely-sensed data on surface water area, water surface elevation, storage variation, and hypsometric curve of reservoirs.

Category	Product and reference	Source and remark
Water level	G-REALM, Birkett et al., 2011	https://ipad.fas.usda.gov/cropexplorer/global_reservoir, reservoirs and lakes
	Hydroweb, Crétaux et al., 2011	http://hydroweb.theia-land.fr/, for lakes and rivers
	Gao et al. 2012	34 global reservoirs, not publicly accessible
	DAHITI, Schwatke et al., 2015	https://dahiti.dgfi.tum.de, rivers, and lakes/reservoirs
	AltEx, Markert et al., 2019	https://altex.servirglobal.net, web application for exploring Jason and SARAL
	Tortini et al., 2020	https://doi.org/10.5067/UCLRS-GREV2, 347 lakes and reservoirs
	Water level On VITO, CGLS	https://land.copernicus.eu/global/products/wl, lakes (~210) and rivers
Water area	Hydroweb, Crétaux et al., 2011	http://hydroweb.theia-land.fr/, available for lakes
	Gao et al., 2012	34 global reservoirs, not publicly accessible
	Zhang et al., 2014	21 reservoirs, not publicly accessible
	DAHITI, Schwatke et al., 2015	https://dahiti.dgfi.tum.de, lakes/reservoirs
	Khandelwal et al., 2017	http://z.umn.edu/monitoringwaterRSE, 94 reservoirs
	GRASD, Zhao et al., 2018	https://doi.org/10.18738/T8/DF80WG, 7,246 global reservoirs
	Busker et al., 2019	137 lakes and reservoirs, not publicly accessible
	Yao et al., 2019	https://lakewatch.users.earthengine.app/view/glats, 205 reservoirs
	Liu et al., 2020	24 Chinese reservoirs, not publicly accessible
	Tortini et al., 2020	https://doi.org/10.5067/UCLRS-AREV2, 347 lakes and reservoirs
	Donchyts et al., 2022	https://doi.org/10.6084/m9.figshare.20359860, 71,208 lakes and reservoirs
	Khandelwal et al., 2022	https://doi.org/10.5281/zenodo.4118463, 681,137 lakes and reservoirs
	Bluedot Observatory	https://blue-dot-observatory.com, available for lakes/reservoirs
Storage variation	Gao et al., 2012	34 global reservoirs, not publicly accessible
	Zhang et al., 2014	21 reservoirs, not publicly accessible
	Busker et al., 2019	137 lakes and reservoirs, not publicly accessible
	DAHITI, Schwatke et al., 2020	https://dahiti.dgfi.tum.de, 62 lakes/reservoirs
	Liu et al., 2020	24 Chinese reservoirs, not publicly accessible
	Tortini et al., 2020	https://doi.org/10.5067/UCLRS-STOV2, 347 lakes and reservoirs
	Klein et al., 2021	1267 global reservoirs are analyzed, not publicly accessible
	Hou et al., 2022	6695 global reservoirs, not publicly accessible
	Vu et al., 2022	https://doi.org/10.5281/zenodo.6299041, 10 reservoirs
hypsometric curve	Gao et al., 2012	34 reservoirs, not publicly accessible
	Zhang et al., 2014	https://doi.org/10.1002/2014WR015829, 21 reservoirs
	Yigzaw et al., 2018	http://wowuoh.wixsite.com/home/models-data, 6,800 reservoirs
	Vu et al., 2022	https://doi.org/10.5281/zenodo.6299041, 10 reservoirs
Our study	https://doi.org/10.5281/zenodo.7251283, 338 reservoirs with water level, water area, storage variation and hypsometric curve during 2010-2021 in China	

* Last access: 15 October 2022. Abbreviations are as follow: Global reservoir and dam database (GRanD), Database for hydrological time series of inland waters (DAHITI), Global reservoirs and lakes monitor (G-REALM), Global reservoir surface area dataset (GRSAD).

Table A1. Providers of water level (light blue background), area (grey blackground), and storage variation (orange background) time series for Chinese reservoirs.

Data sources	No. of reservoirs	Time and temporal resolution	Download link
Hydroweb	32	1992–2021, 10–35 day	http://hydroweb.theia-land.fr/
DAHITI	8	2002–2021, 10–35 day	https://dahiti.dgfi.tum.de/en/
G-REALM	~30	1992–2021, 10–35 day	https://ipad.fas.usda.gov/cropexplorer/global_reservoir
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-GREV2
Shen et al. (2021)	338	2010–2021, monthly	https://doi.org/10.5281/zenodo.7251283
Bluedot	not clear	2016–2021, sub-monthly	https://blue-dot-observatory.com/
GRASD	923	1984-2018, monthly	https://doi.org/10.18738/T8/DF80WG
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-AREV2
RealSAT	85,522 (lakes and reservoirs)	1984–2015, monthly	https://doi.org/10.5281/zenodo.4118463
Donchyts et al. (2022)	9,418	1985–2021, monthly	https://doi.org/10.6084/m9.figshare.20359860
Yao et al. (2019)	~8	1992–2018, sub-monthly	https://lakewatch.users.earthengine.app/view/glats
Shen et al. (2021)	338	2010–2021, monthly	https://doi.org/10.5281/zenodo.7251283
Vu et al. (2022)	10	2008–2020, monthly	https://doi.org/10.5281/zenodo.6299041
Hou et al. (2022)	923	1984–2015, monthly	Not publicly accessible
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-STOV2
Shen et al. (2021)	337	2010–2021, monthly	https://doi.org/10.5281/zenodo.7251283

- Line 74. What do you mean with "difficult to be accessed"? Can they be accessed?

We have rephrased this sentence as:

Moreover, the remotely-sensed datasets (e.g., lake/reservoir storage variations by Busker et al., 2019 or RWSC by Avisse et al., 2017) are not publicly available.

- Line 64-85. Vu et al. (2022) has just released a water level, surface, and storage dataset for 10 reservoirs in the Lancang Basin, China, for the period 2008-2020. This dataset was created using satellite data and modelling techniques similar to the ones reported here, so this is why I'm mentioning that study. Please note I'm a co-author of that paper, so please feel free to discard my comment.

Sorry for missing this new reference, and much thanks for your work and contributions. We added this in our introduction, Table 1, Table A1. See above comments.

References:

Vu, D. T., Dang, T. D., Galelli, S., and Hossain, F.: Satellite observations reveal 13 years of reservoir filling strategies, operating rules, and hydrological alterations in the Upper Mekong River basin, Hydrol. Earth Syst. Sci., 26, 2345–2364, https://doi.org/10.5194/hess-26-2345-2022, 2022.

- Table 1 is very informative (and I would leave it as is); however, it somewhat mixes studies and datasets that have different geographical foci and intents (e.g., global v. regional). I would therefore suggest including another table specifically focussed on China. It will help readers understand what is currently available—and how this study complements the state-of-the-art.

We created Table A1 specifically focussed on Chinese reservoirs. See above response.

- Line 111. “Testbed”?

Changed.

- Line 112-113. This sentence is not clear.

This sentence has been removed from our revised version because it is not very relevant in this paragraph.

- Section 2.1. How about the Repeat cycle of SARAL/AltiKa?

We added this information Table 2 and main text.

Note that SARAL/AltiKa left its repetitive orbit with a repeat cycle of 35 days in July 2016 and switched to a drifting geodetic orbit with subcycles of 15-17 days with 1002 passes (Bonnefond et al., 2018).

- Equations (1) and (2). Which technique did you use to estimate the various corrections? Were these corrections applied uniformly to all reservoirs or were they site-specific?

The different re-tracking algorithms mentioned in Table 2 are used to correct the Rrange in Equation (1). While the remaining corrections in Equation (2) such as geophysical and atmospheric corrections are directly taken from the official altimetry products. We added this information in our main text. Following the official user-guideline, they are site-specific.

These corrections are taken from their products.

- Line 178. I would say a few words about the algorithm developed by Zhao and Gao (2018). Also, is the code available?

In the revised manuscript, we generated monthly surface water area extent (SWA) from Landsat and Sentinel-2 images by using a new algorithm developed by Donchyts et al. (2022), so please refer to the Section 2.2 and Result section 3.2 for more details about our area datasets.

References:

Donchyts, G., Winsemius, H., Baart, F., Dahm, R., Schellekens, J., Gorelick, N., Iceland, C., and Schmeier, S.: High-resolution surface water dynamics in Earth's small and medium-sized reservoirs, Sci. Rep., 12, 13776, https://doi.org/10.1038/s41598-022-17074-6, 2022.

- Figure 1. I suggest improving / re-drawing Figure 1. It's very hard to visualize the reservoirs (pink squares). Also, the colour-bar for the elevation is missing.

See the modified Figure 1 below.

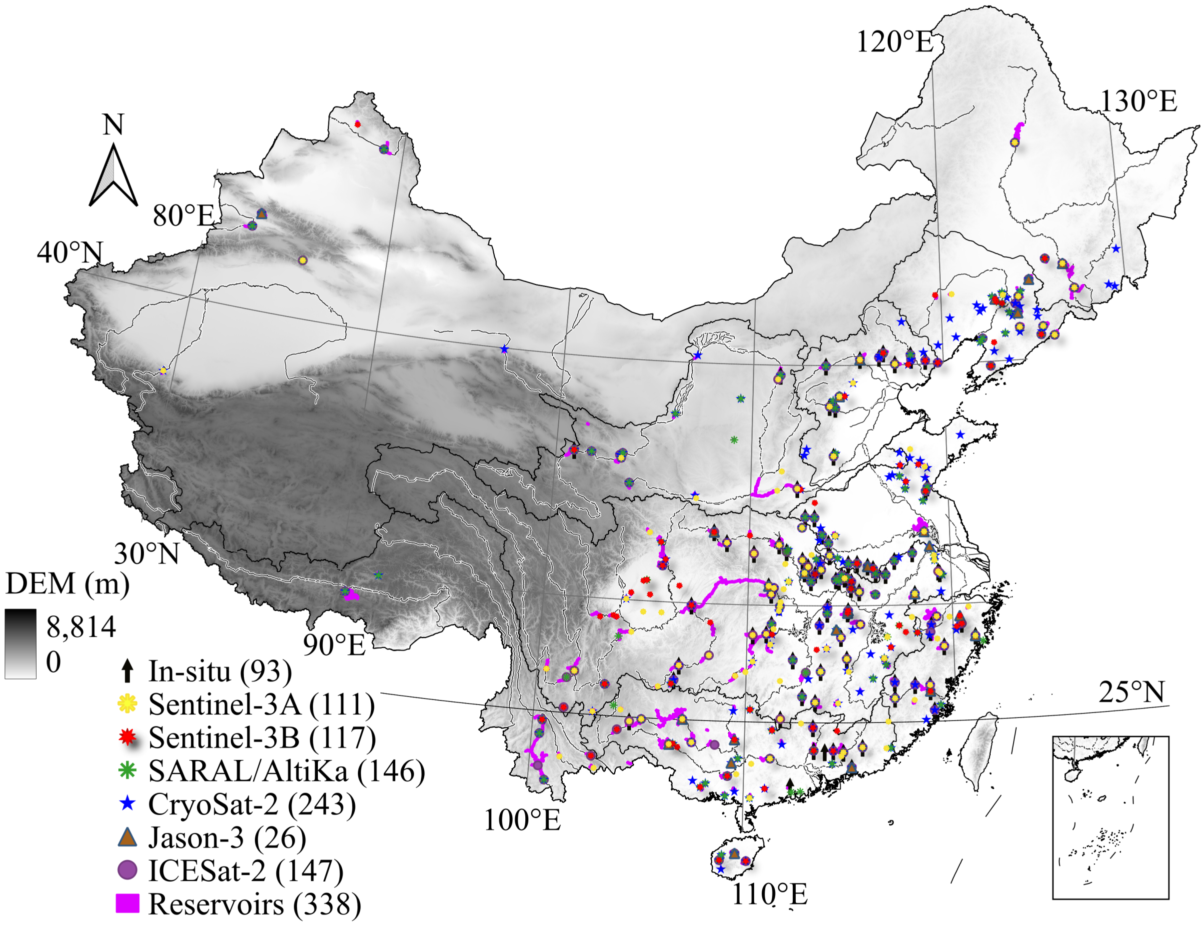

Figure 1: Map of reservoirs covered by multisource satellite altimeters and stages. 338 reservoirs are finally retained in our datasets. For more details, please refer to Sect. 3.

- Line 179. What do you exactly mean with "reservoir shapefiles"? - Line 180-186. I found this part to be not that clear.

As explained above, in the revised manuscript, we generated monthly surface water area extent (SWA) from Landsat and Sentinel-2 images by using a new algorithm developed by Donchyts et al. (2022), so please refer to the Section 2.2 and Result section 3.3 for more details about our area datasets. The original part of water area are removed.

- Line 190-203. I'm a bit confused by this approach: why not estimating the hypsometric relationships from the DEM? The SRTM mission, for instance, was carried out in 2000, so the SRTM-DEM could provide detailed hypsometric relationships for all reservoirs built after the year 2000.

Hope the above responses (R1C1) addressed your question. We have added the DEM-approach for estimating RWSC.

- Line 2010-211 (“especially the regions where the reservoir storage are dynamic”). What does this mean?

Changed:

Different levels of data are provided in an easily readable file format (Wikipedia contributors, FAIR data, 2021), showing that our remotely sensed datasets have clear patterns and can capture seasonal filling and emptying of reservoirs very well.

- Line 231-239. I have nothing against qualitative assessments (and in fact think it’s useful in this case), but I suggest being precise about how the letter grades were assigned. Ideally, the assessment should be reproducible.

Thank you for your comments. The qualitative assessment has been removed in consideration of the comments of other referrers.

- Figure 4. Please consider the option of using the same symbol (with different size or different colour) to provide information about RMSE. I found the combination of symbols and colours to be confusing.

Changed. We used the same color with different symbol for better visualization. See modified Figure (in our revised manuscript, this figure is named Figure 3) below.

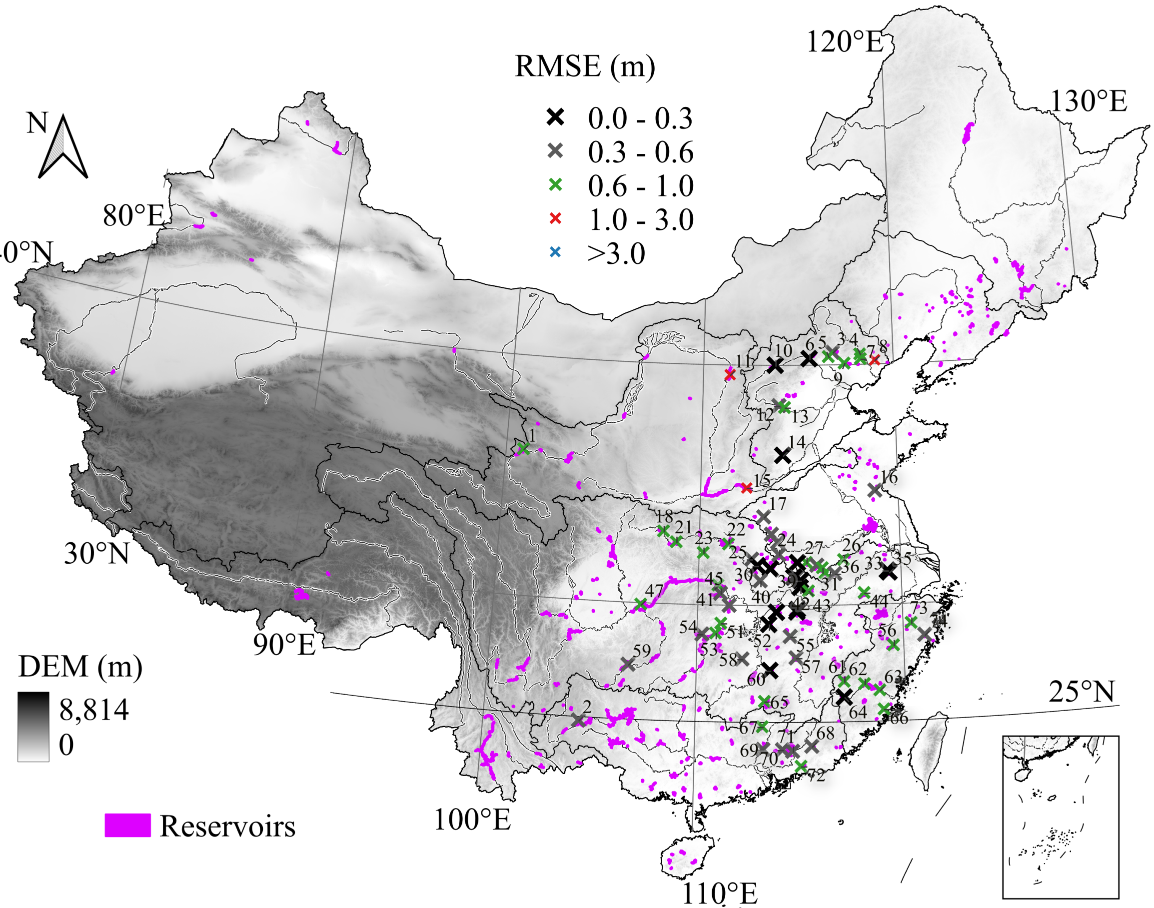

Figure 3: Performance of the enhanced measurement products in terms of RMSE of 74 reservoirs. For validated RESERVOIR ID, please refers to the Supplementary.

- Figure 6. What do the different colours (red, blue) represent?

Sorry for this confusion, we added color legend in this figure.

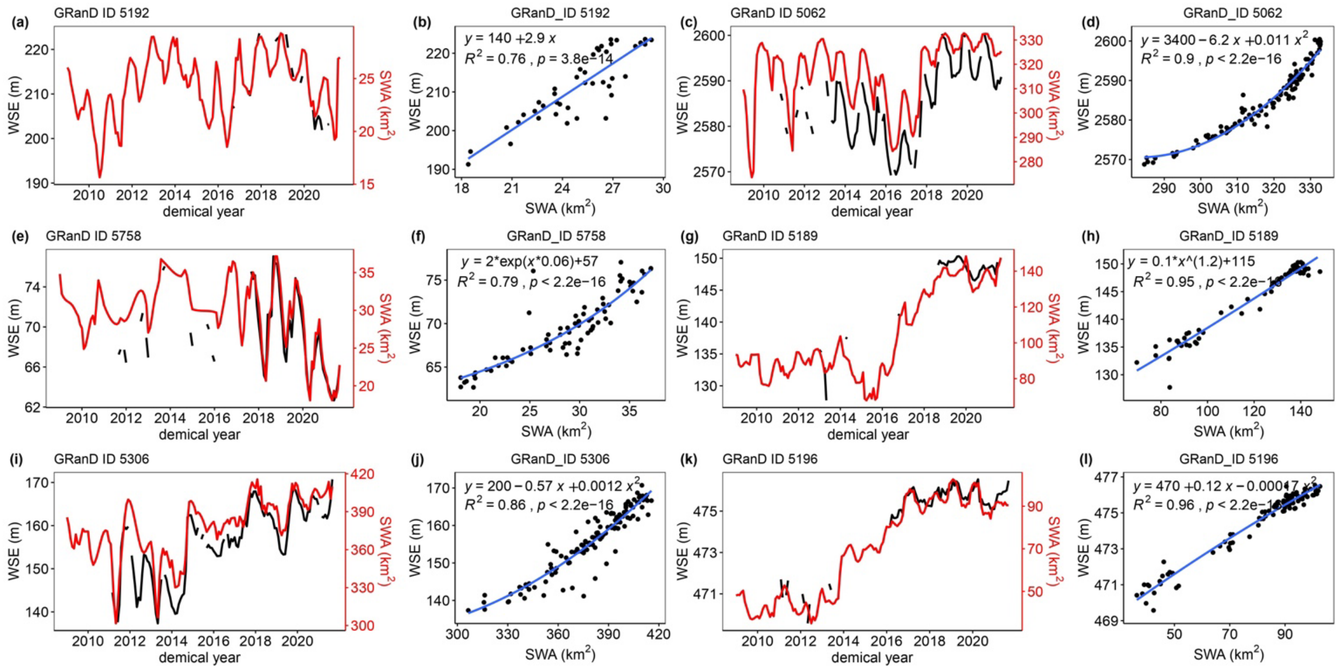

Figure 8: Illustration of A─E relationships constructed by satellite WSE and SWA and their associated time series at six reservoirs. Note that: time series of WSE and SWA and associated established A─E relationships of the remaining reservoirs are available in our datasets.

- Line 295. Do you mean Figure 6?

Corrected it.

- Line 301. Do you mean Figure 7?

Corrected it.

- Figure 7. Shouldn't you correct for negative values?

We apologize for the confusion. Hope the above responses addressed your question. Reservoir water storage change is provided in our datasets, not the storage values.

- Section 3.3. The content of this sub-section does not qualify as Result (Section 3). Why not placing it in a stand-alone section? Perhaps, it could be moved to the repository.

According to the normal practice in ESSD paper, we need such a data description in main text, we have placed in stand-alone section.

- Line 390-394. Not clear.

Sorry for the confusion. We would like to clarify this paragraph demonstrated that our datasets can be applied as constraints to calibrate models or directly used for reservoir studies. Specifically, we describe the flowchart of combining the hydrological models with our remotely sensed RWSC datasets to estimate reservoir outflow at national scale (blueprint application). Taking the Ankang reservoir as a case study, we argue that our datasets could help achieve this blueprint application by introducing the key components (e.g., RWSC) of reservoirs at national scale. We have rephrased the texts.

The simulated releases show good agreements to the observations, with KGE exceeding 0.90 and NRMSE below 0.04. We compare reservoir inflow and release simulations and notice that flow regimes at the Ankang reservoir have been substantially altered (Fig. 11 f). In conclusion, our RWSC dataset can be applied to reservoir release simulation, achieving satisfactory streamflow simulations. However, some limitations can be seen in our case study. Firstly, reservoir evaporation and precipitation are neglected for the tested reservoir with humid climate conditions. We suggest that these variables should be considered using high quality satellite datasets such as ET products or model simulations. Secondly, the case study cannot provide a big picture of reservoir regulations on streamflow at national scale. Similar studies should be done at the remaining reservoirs to achieve this goal. Acknowledging such limitations, we argue that the datasets could help achieve the blueprint application by introducing the key components (e.g., RWSC) of reservoirs at national scale.

Reviewer #2 Comment on essd-2021-470 (Xingguo Mo)

Dear Xingguo Mo,

Thank you for your time and efforts in reviewing our manuscript. Please find attached point-to-point responses regarding your comments (marked in purple) and made corresponding changes in the main manuscript (in red). We hope that the improved manuscript can help the readers to better understand our study.

Kind regards.

General comments

This study constructed the monthly water level and storage variation datasets for 338 reservoirs in China using multi-source satellites, and also validated the results by massive in-situ datasets. The workload of this article is impressive, and the dataset is complete and consistent with the article. However, there are also many issues unsolved (see details below). Therefore, I could not be more positive in this regard unless the following comments have been addressed with more convincing results presented in this manuscript. Moderate to major issues:

R2C0: All issues are clarified and solved, please see detailed responses below.

Moderate to major issues:

1. Line 165-168: It's unreasonable that you put all reservoirs with different baseline together to talk about their performance under the same metric. According to the reason you select Sentinel-3 as the first baseline, do you think CryoSat-2 has a higher temporal resolution than SARAL/AltiKa? How did you calculate the systematic biases of the reservoirs with no overlap period of different altimeters (such as GRAND_ID 5405 and 5861)?

R2C1: systematic biases of satellite altimetry-derived water level. Please note we provide two modes of satellite water level, standard rate (single satellite) and high rate (multiple satellites). For High rate, we need to remove systematic biases among satellites. The biases are removed using two approaches, (1) directly removing the mean differences for those with enough overlapping periods. (2) for those without overlapping periods, remotely sensed surface area time series are used to act as an anchor of biased time series, allowing for estimation of the relevant biases. Here, a 2-D cost function in surface-area–water-level coordinates is minimized within a Gauss–Helmert adjustment scheme. See the attached texts and figure in the revised manuscript.

To cope with the limitation of the opposing spatial sampling and temporal resolution of single altimeter and obtain an enhanced resolution water level product, we merged single-satellite SM products from multisource (i.e., CryoSat-2, S3A, S3B, SARAL/AltiKa, ICESat-2, and Jason-3) for a reservoir if available and generated enhanced measurement (EM) reservoir water level time series products. Notably, we select the SM products from each satellite with the best retracking algorithm in terms of root-mean-square error (RMSE) compared to in situ water level or the default retracking algorithm time series to densify time series. To remove inter-satellite systematic biases, two approaches are used: the first one is applied to satellites with enough overlapping periods by directly removing their mean water level differences, and the second one is to use the remotely sensed reservoir area time series as an anchor of biased time series to estimate the inter-satellite relevant bias. We used the Gauss–Helmert adjustment scheme to minimize the 2-D cost function in surface-area–water-level coordinates (Figure B1).

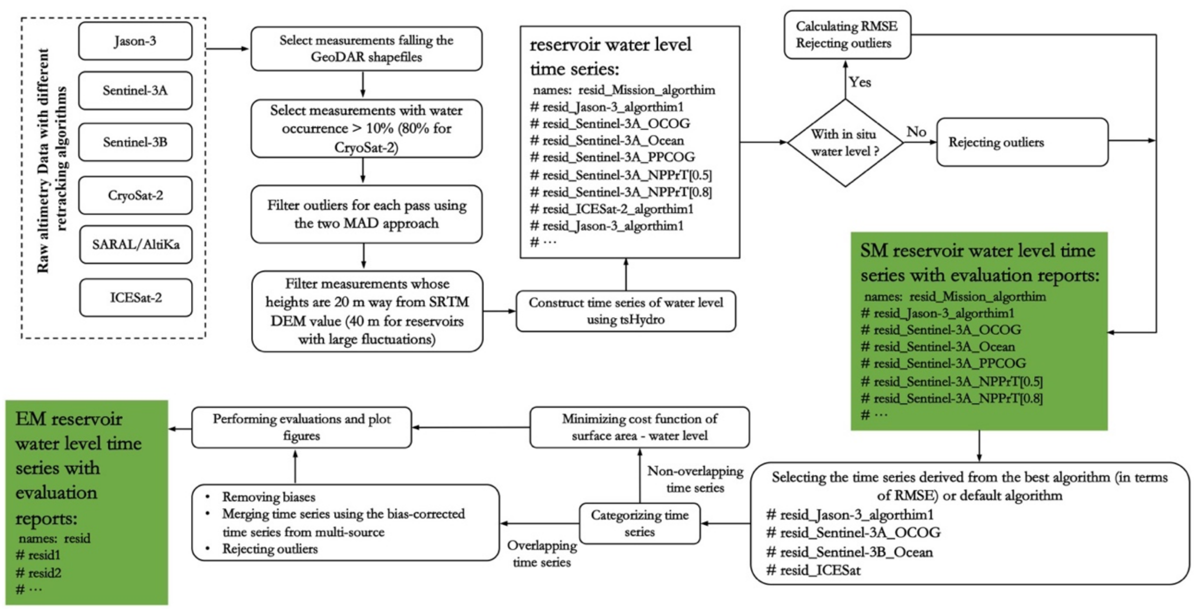

Figure B1. Flowchart of obtaining SM (standard measurement) and EM (enhanced measurement) altimetric water level time series over reservoirs.

2. Line 173-175: Did you consider that the reservoir might freeze in winter when you derive the WSE with algorithm for water surface from altimeters?

R2C2: No, we acknowledge this issue and thank you for your comments. This will lead to a slightly overestimation of water level. But only part of these reservoirs freezes, and the ice cover is usually shallow. This issue has minor influences on our derived water level considering the locations and climates of our provided reservoirs.

3. Line 233-234: Please show the quantitative metrics for different grades.

R2C3: We have removed the quantitative metrics considering comments from other referees.

4. Line 288-289: The validation for SWA is not convincing enough. Try to illustrate the accuracy of the SWA using high-resolution images, such as Sentinel-2.

R2C4: In our revised manuscript, we generated monthly surface water area extent (SWA) from Landsat and Sentinel-2 images by using a new algorithm developed by Donchyts et al. (2022), so please refer to the section 2.2 and result 3.3 for more details about our area datasets. Section 2.2 describes the methodology of generating water area while result 3.3 details the performance of our generated area datasets.

2.2 Surface area datasets

In this study, we applied the new algorithm developed by Donchyts et al. (2022) to leverage freely accessible Landsat and Sentinel-2 images to generate reservoir water area time series. The GEE code for this water mapping algorithm is available at https://github.com/global-water-watch/research-reservoir-water-dynamics and was applied individually to each reservoir and every satellite image intersecting a given reservoir to map accurate reservoir water. This algorithm can efficiently address several challenges associated with optical Landsat satellites, such as contamination from clouds and limitations of previous algorithms that reclassify contaminated pixels as water. Donchyts et al. (2022) demonstrated the algorithm's good performance in mapping reservoir water areas by comparing the areas with in situ water level/storage in 768 reservoirs of varying size and geographic regions. Here, we detail how this algorithm addresses the challenges from optical images and generates water area time series. First, we selected the cloudy satellite images that intersect with a given reservoir shapefile. Second, we used the global cloud frequency dataset (Wilson, 2016) to identify the cloudiest images that are fully covered by clouds and corrected the remaining images using the following steps. Third, we computed the NDWI (normalized difference water index) spectral water index. Fourth, we detected land/water edges based on the Canny edge detector algorithm (Donchyts et al., 2016) and defined sampling areas for pixels around the land/water edges. Fifth, we determined the optimal threshold based on the Otsu thresholding algorithm (Markert et al., 2020) using a sample of NDWI spectral index values within the region determined in the previous step to obtain a water mask. Next, we eliminated incorrectly detected water (water pixels detected as non-water) by sampling surface water occurrence along water edges and obtained the final gap-filled water mask by clipping surface water occurrence at a given occurrence value and combining it with the water mask. Lastly, reservoir water area time series from the final gap-filled water mask are filtered with a quantile-based temporal outlier filtering algorithm to remove the remaining errors. Detailed procedures and flowcharts can be found in Donchyts et al. (2022).

After these steps, we generated monthly reservoir water area time series for 338 reservoirs. To analyze the performance of our products, reservoir time series are compared with the in situ water level time series, the altimetric water level time series (SM and EM product, see Section 2.1), and two similar existing products from GRSAD (Global reservoir surface area dataset, Zhao and Gao, 2018) and RealSAT (Khandelwal et al., 2022, Table 1). The CC, rRMSE (relative RMSE), and rBIAS (relative bias) are used as indicators of data quality.

3.2 Reservoir water area product

Monthly reservoir SWA time series are provided for 338 reservoirs during 2010-2021 and are compared with water level time series (in situ and altimetric measurements) and two other similar areal datasets water level. The SWA time series show good agreements with in situ water level observations in 93 reservoirs, approximately 80% have good CC values exceeding 0.5, among which 48 reservoirs show very good agreement with a CC > 0.8. Comparing to our altimetric standard measurements, we found that reservoir SWA and altimetric products generally show a good agreement with CC values higher than 0.5 for 70% of 323 validated reservoirs, among which 139 reservoirs have very good agreement with a CC value > 0.8. Comparing to our altimetric enhanced measurements, reservoir SWA and altimetric products also show a good agreement with CC values higher than 0.5 for 73% of 196 validated reservoirs, among which 62 reservoirs show very good agreement with a CC value > 0.8. In addition, two similar areal datasets (Table 1), i.e., GRSAD (Zhao and Gao, 2018) and RealSAT (Khandelwal et al., 2022), were used for cross validation. GRSAD provides monthly SWA values for global 7,246 reservoirs during 1984-2020 (updated version 3) extracted from the Landsat-based images (Pekel et al., 2016) and correction of contaminations from terrain shadows, clouds, and cloud shadows. The datasets were validated over 9 reservoirs with in situ water level/storage observations and compared with the synthetic data from cloud-clear Landsat images, showing a good performance of the algorithm to repair contaminated optical images for more reliable SWA estimates. RealSAT used a machine-learning method (i.e., ordering based information transfer) to process optical images for generating monthly SWA values over 681,137 global lakes/reservoirs from 1984 to 2015. It should be noted that GRSAD used the existing reservoir shapefiles from GRanD database to generate SWA values, while RealSAT generated new lake polygons from surface water occurrence data. Based on all compared reservoirs available, we found that our SWA time series show good agreements to values in GRSAD (median CC value of 0.64, rBIAS = -9%, rRMSE = 26%, n = 338) and RealSAT (median CC value = 0.68, rBIAS = -10%, rRMSE = 22%, n = 47) datasets. Overall, these comparisons (Fig. 7) above suggest a good level of trustworthiness in our SWA time series.

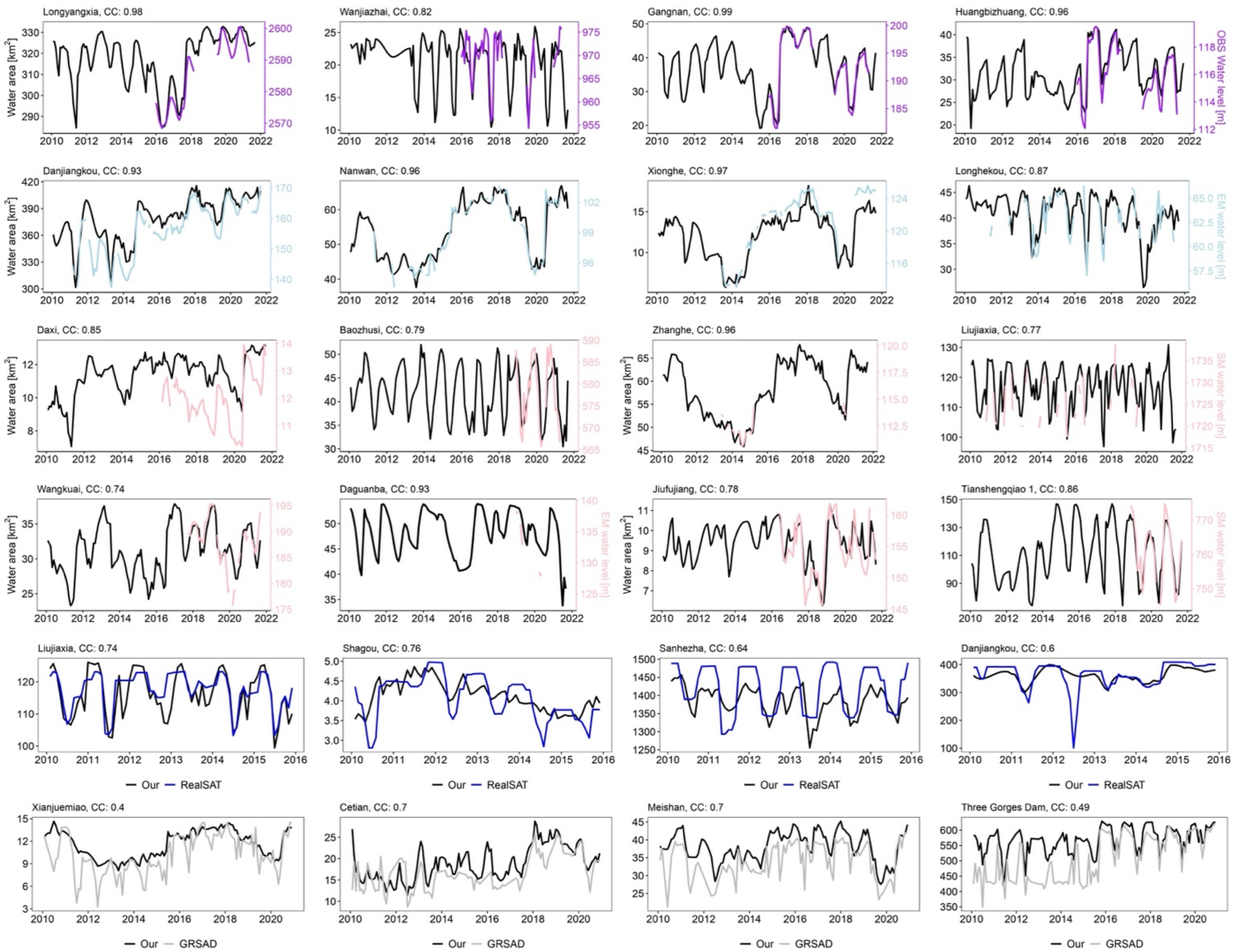

Figure 7: Illustration of reservoir water area time series against in situ water level, altimetric water level from standard measurement and enhanced measurement, as well as GRSAD and RealSAT area time series at a selected sample of reservoirs with varying area size. Time series for other reservoirs are all available in the datasets.

5. Line 295-296: In my opinion, a reliable A–E curve is a prerequisite for calculating the RWSC of the reservoirs, so I don't think it makes any sense to calculate the RWSC of the reservoirs with poor R2 values.

R2C5: In our revised manuscript, we performed strict data quality control to eliminate any potentially problematic data points, and data version 2 is released as the final dataset.

For water levels, we added six satellite altimeters (previous one with four satellite altimeters) in this version and provided two modes, standard rate and high rate. For the high rate, we need to eliminate the systematic bias between satellites. The biases are removed using two methods, as detailed in reponse R2C1, to address the issues raised by Reviewer 2.

For water area, we added a section to describe the accuracy assessment to evaluate our area dataset based on in situ water levels in 93 reservoirs and our generated altimetric water levels (standard rate and high rate) to address the issue raised by reviewer 2.

For water storage variation, we added DEM-based estimates, so that we provide two types of storage change, i.e., using satellite-based water levels and water area, and using satellite-based water area and DEM-based curves. The storage changes are validated against in situ storage changes for 93 reservoirs.

In the section 3.3, the performance of RWSC is evaluated. From our new dataset, we can see that many reservoirs have reliable A–E curves, and compared to in situ data, bringing the good level of confidence in our data quality. Please see attached texts.

3.3 Reservoir storage variation product

We provided monthly RWSC time series from 2010 to 2021 in two modes: one is to use WSE and SWA from satellite altimeters and images, while another one is to use satellite SWA and area-storage model developed by DEM. After excluding reservoirs without insufficient WSE-SWA data pairs to establish the A–E relationships and visual inspection of time series, we finally retained 337 reservoirs with RWSC time series, among which 335 reservoirs have RWSC estimates derived from the first type method while 266 reservoirs have RWSC estimates derived from the DEM-based method. To evaluate the data quality, we compared with in situ storage data of 91 reservoirs and calculated three error statistical metrics (i.e., RMSE, normalized root-mean-square error (NRMSE), and CC). The A–E curves derived from satellite WSE and SWA data are evaluated based on their R^2 values. We notice that 69% reservoirs of A–E curves could be better explained by a second-order polynomial function, while 13% and 16% reservoirs of A–E relationships are assumed to give a power and exponential function (Fig. 8 f, h). A total of 283 of 335 reservoirs (84%) have moderate R^2 values > 0.5, among which 107 reservoirs show very good agreement with R^2 values > 0.8. Nevertheless, 15% has relatively poor performance in terms of R^2 values. Overall, our A–E curves are reliable and lay the good foundation for RWSC estimates. Across gauge comparisons of RWSC, the median statistics of CC, NRMSE, and RMSE are 0.89, 11%, and 0.021 km^3. Around 91% reservoirs (83 of 91) show good data quality with a NRMSE value below 20% and a RMSE value ranging from 0.002 to 0.31 km3. The lowest NRMSE is 4%, from the Gangnan reservoir that displays high CC and low RMSE values. Regarding the DEM-based RWSC estimates, the results are getting worse, with the median statistics of CC, NRMSE, and RMSE are 0.56, 20%, and 0.03 km^3. The errors can be attributed to the inaccuracy of the area-storage model developed by DEM. It should be noted that this type of RWSC estimates is served as an alternative product. Figure 8 shows examples of RWSC for some selected small, medium, and large reservoirs located in different climate zones. Closer examination in Fig. 9 seems to indicate that almost all remotely sensed RWSC estimates show similar patterns to the observations, i.e., both positive or negative, despite of some large discrepancies when capturing peak values. Nonetheless, there are some differences. Some reservoirs with good NRMSE and RMSE values show poor performance in terms of CC value, e.g., the Baiguishan reservoir (CC: 0.38, NRMSE: 16%, RMSE 0.03 km^3) that experiences relatively significant surface water dynamics. Moderately poor performance of 20 reservoirs (7%) in terms of high NRMSE/RMSE and low CC values (CC < 0.4) is likely associated with their poor performances from the remotely sensed WSE and SWA. Overall, we used in-situ observations of 91 reservoirs as an important reference to validate RWSC dataset, thus bringing the good level of confidence in our data quality.

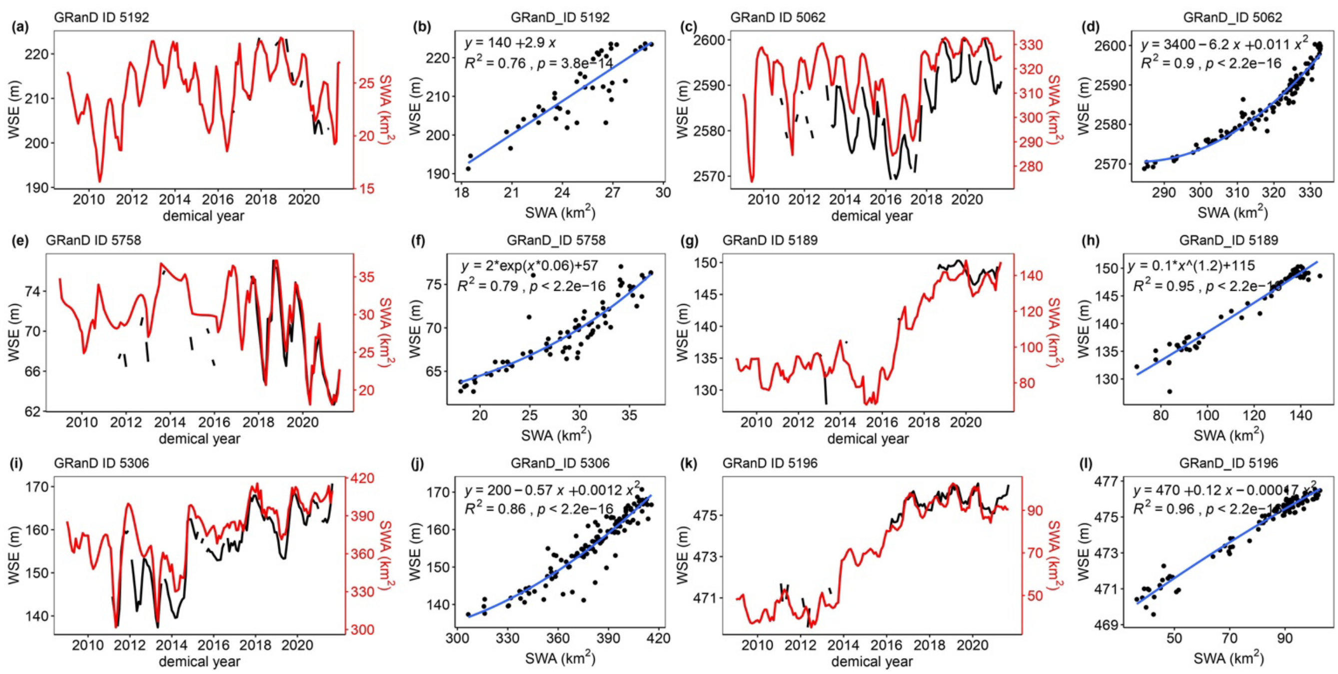

Figure 8: Illustration of A–E relationships constructed by satellite WSE and SWA and their associated time series at six reservoirs. (a)-(k) are the Panjiakou, Longyangxia, Baipenzhu, Miyun, Danjiangkou, and Guanting reservoir, respectively. Note that: time series of WSE and SWA and associated established A–E relationships of the remaining reservoirs are available in our datasets.

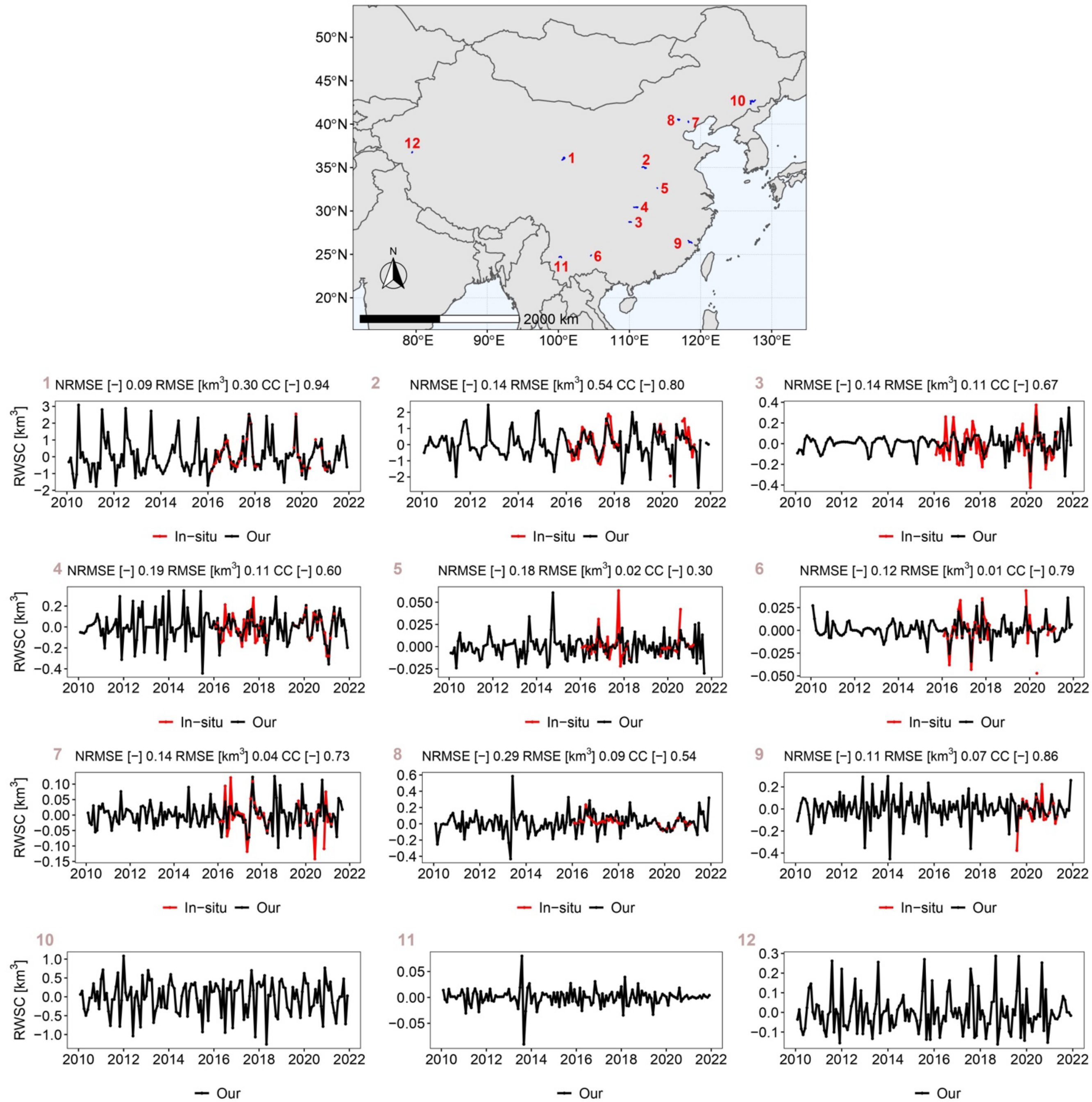

Figure 9: Illustration of time series of the remotely sensed RWSC of 12 reservoirs. NRMSE, RMSE (km^3), and CC values (if available) are given at the top of each subplot. Time series of the remotely sensed RWSC of the remaining reservoirs (validated or not validated) are available in our datasets.

6. Line 370: This part should not be included in this article because it's off topic.

R2C6: This part is changed to Section 5 following the normal practice of ESSD journal, showing the values of our datasets by an example application.

Minor comments:

- Line 20: Write the full name on the first occurrence of the abbreviation.

We have added the full name of the abbreviation:

Across gauge comparisons of RWSC, the median statistics of Pearson correlation coefficient (CC), normalized root-mean-square error (NRMSE), and root-mean-square error (RMSE) are 0.89, 11%, and 0.021 km^3, with a total of 91% validated reservoirs (83 of 91) having good RMSE from 0.002 to 0.31 km^3 and NRMSE values smaller than 20%.

Line 71-72: Where is the problem? You also did this in section 3.2.2.

We have rephrased this paragraph as:

Altimetric water level time series from 94 reservoirs were used to validate their area datasets due to the lack of in situ measurements

Line 90-92: The word "highest" is too strong here. Why the novelty of datasets can be illustrated by validation data?

We have rephrased this paragraph as:

To validate the remotely-sensed results, the in-situ observations of 93 reservoirs are used for evaluations, thereby bringing the good level of confidence on the quality of datasets.

Line 138-139: Please add relevant references.

It is the first altimeter measuring in SAR radar altimeter at global scale with an open-loop tracking system (Biancamaria et al., 2018).

References:

Biancamaria, S., Schaedele, T., Blumstein, D., Frappart, F., Boy, F., Desjonquères, J.D., Pottier, C., Blarel, F., Niño, F., 2018. Validation of Jason-3 tracking modes over French rivers. Remote Sens. Environ. 209, 77–89. https://doi.org/10.1016/j.rse.2018.02.037

Line 144: Why didn't you show the repeat cycle of SARAL/AltiKa?

We added this information Table 2. The SARAL/AltiKa satellite flew on the same repeat orbit as ENVISAT with a 35-day repeat cycle until July 2016, and was then switched to drifting orbit mode with subcycles of 15-17 days with 1002 passes.

Line 182-184: This sentence is not clear.

As explained above, in the revised manuscript, we generated monthly surface water area extent (SWA) from Landsat and Sentinel-2 images by using a new algorithm developed by Donchyts et al. (2022), so please refer to the section 2.2 and result 3.3 for more details about our area datasets. The original parts of water area are removed.

Line 190-191: Monthly fluctuations of reservoir SWA and WSE can be quite large. This processing may introduce errors because SWA and WSA do not correspond in time.

Yes, partly agree. Currently, it is the normal practice to generate monthly reservoir water storage change using satellite WSE and SWA considering their limitations of relatively coarse temporal resolution, see some references adopted the same methodologies below.

References:

Busker, T., de Roo, A., Gelati, E., Schwatke, C., Adamovic, M., Bisselink, B., Pekel, J.-F., and Cottam, A.: A global lake and reservoir volume analysis using a surface water dataset and satellite altimetry, Hydrol. Earth Syst. Sci., 23, 669–690, doi: 10.5194/hess-23-669-2019, 2019.

Gao, H., Birkett, C., and Lettenmaier, D. P.: Global monitoring of large reservoir storage from satellite remote sensing, Water Resour. Res., 48, W09504, doi: 10.1029/2012WR012063, 2012.

Liu, J., Jiang, L., Zhang, X., Druce, D., Kittel, C. M. M., Tøttrup, C., and Bauer-Gottwein, P.: Impacts of water resources management on land water storage in the North China Plain: Insights from multi-mission earth observations, J. Hydrol., 603, 126933, doi: 10.1016/j.jhydrol.2021.126933, 2021.

Bonnema, M., and Hossain, F.: Assessing the potential of the Surface Water and Ocean Topography Mission for reservoir monitoring in the Mekong River basin, Water Resour. Res., 55, 444–461, doi: 10.1029/2018WR023743, 2019.

Bonnema, M., Sikder, S., Miao, Y., Chen, X., Hossain, F., Pervin, I. A., Mahbubur Rahman, S. M., and Lee, H.: Understanding satellite-based monthly-to-seasonal reservoir outflow estimation as a function of hydrologic controls, Water Resour. Res., 52, 4095–4115, doi: 10.1002/2015WR017830, 2016.

Line 280: Please add the legend for surface water extent.

Added.

Line 317-319: This sentence is not clear.

We have removed the quantitative metrics considering comments from other referees.

Datasets: Please name the GRAND_ID of the reservoirs according to certain rules.

Corrected.

Reviewer #3 Comment on essd-2021-470 (Anonymous Referee)

Dear Anonymous Referee,

Thank you for your time and efforts in reviewing our manuscript. Please find attached point-to-point responses regarding your comments (marked in purple) and made corresponding changes in the main manuscript (in red). We hope that the improved manuscript can help the readers to better understand our study.

Kind regards.

General comments:

The authors used altimetry data and Landsat-derived water extent product to estimate water storage changes between 2010-2020 for hundreds of reservoirs in China. They validated satellite-derived water level and storage time series against in situ data. I think the authors did great work validating altimetry data while the extent and storage validation parts are relatively weak. As some recent studies on reservoir water dynamics have already covered the same reservoirs in this study, I would not suggest this dataset can be valuable in this research area. In addition, I have several major concerns about this study. Please see my comments below.

R3C0: We greatly appreciate the time and effort the reviewer had put in reviewing our manuscript! And thank you for recognizing the importance and "weakness" of our work. We have made substantial changes in the revised manuscript. By addressing the comments you raised up, we feel the manuscript has been much improved. In addition to our point-to-point response for each of the comments, we have summarized/clarified the major points in R3C1, please take a look at this part and corresponding revised manuscript.

Major Comments:

Monthly surface water extent and storage time series have been estimated for nearly all reservoirs from the GRanD in Zhao and Gao (2018) and Hou et al. (2022). As these global studies have covered the same Chinese reservoirs in this study, I was wondering what it is the novelty of this data product. I think it may be worthwhile if you could extend to more Chinese reservoirs, e.g., delineated by Song et al (2022). It provides nearly 100 000 reservoir polygons in China, which has not yet been achieved in the GRanD. You will find more overlapped altimetry data for these reservoirs.

R3C1: Thank for your comments. Here, we would like to clarify the novelty of our data product firstly. In our revised manuscript, we generate (1) reservoir water level (WSE) from six satellite altimeters (Sentinel-3 A/B, CryoSat-2, SARAL/Altika, Jason-3, and

ICESat-2), and provide two modes of WSE, standard measurement (single satellite) and enhanced measurement (i.e., merging measurements from multiple satellites for a specific reservoir if possible); (2) monthly surface water area extent (SWA) from Landsat and Sentinel-2 images by using a new algorithm developed by Donchyts et al. (2022); (3) monthly reservoir water storage change (RWSC) data and provide two types of RWSC (i.e., one type using satellite-based water levels and water area, and another type using satellite-based water area and DEM-based area-storage curves). Please note the following four points highlighting the novelty and value of our datasets: (a) in our revised data and manuscript, we performed strict data quality control to eliminate any potentially problematic data points, and performed a validation using 93 reservoirs with in situ water level and storage data, which is not done ever before for Chinese reservoirs; (b) although there are some similar databases covering partly reservoirs in our study, however, RWSC developed by Hou et al. (2022) are not publicly available, the methodology is also different, Hou et al. (2022) relied the GRSAD water area data and DEM (a geo-statistical approach) to calculate the storage change. Our datasets are publicly available and we provide two types of RWSC and validated their performance, which could be very valuable for relevant studies; through the literature review and our statistical metrics, the RWSC estimates from satellite WSE-SWA are more reliable than those from DEM-Area approach (c) we noted that there are several databases providing SWA such as GRSAD (Zhao and Gao, 2018), RealSAT (Khandelwal et al., 2022) and Donchyts et al. (2022), and WSE data, however, whether SWA/WSE time series from different databases have a good agreement with one another and gauged measurements is not systematically evaluated, which can be shown in this study; (d) moreover, a growing interest in using satellite altimetry data in hydrological cycle is expected, thus knowing the accuracy of satellite altimetry is a prerequisite, although previous studies assessed satellite altimeters in retrieving reservoir water levels (Shu et al., 2021), knowledge is still limited as to evaluations of different altimeters for a large sample of reservoirs, which can be shown in this study.

For your last suggestion to extend our dataset with the new reservoir shapefiles developed by Song et al. (2022), it is a good suggestion, and we will embed this issue in the discussion and future version of the data as we will continue to update our data. As you can see, during the last four months of the review process we have revised our datasets, added new satellite altimeters, and updated the SWA datasets. In any case, we have taken your suggestion into account and have given some arguments below. Firstly, we note that there are two other similar ESSD papers that produced reservoir shapefiles, namely the GeoDAR dataset (Wang Jida et al., 2022) and Large reservoirs and lakes in China (Wang et al., 2022). Through our literature review and comparison of these studies, there is no doubt that the reservoir shapefiles of Song et al. (2022) cover most of Chinese reservoirs, still Wang et al. (2022) can contribute to the large reservoirs and lakes that were produced using Landsat images from 2019. We found that most of these newer shapefiles have their own limitations, and we chose GRanD because of its popularity in hydrological modeling and reservoir studies. We believe that the current dataset we presented is very valuable for relevant studies in China (See community comments and dataset download times), which is also recognized by the previous two referees. This proposal should be our ongoing work for this publication to further include a growing number of reservoirs. However, we need to be aware that the satellite altimetry ground track is rather sparse. The majority of these reservoirs are not crossed by the ground tracks. Therefore, no altimetry is available

References:

Zhao, G., and Gao, H.: Automatic Correction of Contaminated Images for Assessment of Reservoir Surface Area Dynamics, Geophys. Res. Letters, 45, 6092–6099, doi: 10.1029/2018GL078343, 2018.

Wang, J., Walter, B. A., Yao, F., Song, C., Ding, M., Maroof, A. S., Zhu, J., Fan, C., McAlister, J. M., Sikder, S., Sheng, Y., Allen, G. H., Crétaux, J.-F., and Wada, Y.: GeoDAR: georeferenced global dams and reservoirs dataset for bridging attributes and geolocations, Earth Syst. Sci. Data, 14, 1869–1899, https://doi.org/10.5194/essd-14-1869-2022, 2022.

Song, C., Fan, C., Zhu, J., Wang, J., Sheng, Y., Liu, K., Chen, T., Zhan, P., Luo, S., Yuan, C., and Ke, L.: A comprehensive geospatial database of nearly 100 000 reservoirs in China, Earth Syst. Sci. Data, 14, 4017–4034, https://doi.org/10.5194/essd-14-4017-2022, 2022.

Wang, X., Xiao, X., Qin, Y., Dong, J., Wu, J., and Li, B.: Improved maps of surface water bodies, large dams, reservoirs, and lakes in China, Earth Syst. Sci. Data, 14, 3757–3771, https://doi.org/10.5194/essd-14-3757-2022, 2022.

Donchyts, G., Winsemius, H., Baart, F., Dahm, R., Schellekens, J., Gorelick, N., Iceland, C., and Schmeier, S.: High-resolution surface water dynamics in Earth's small and medium-sized reservoirs, Sci. Rep., 12, 13776, https://doi.org/10.1038/s41598-022-17074-6, 2022.

Khandelwal, A., Karpatne, A., Ravirathinam, P. Ghosh, R., Wei. Z., Dugan, H. A., Hanson, P. C., and Kumar, V.: ReaLSAT, a global dataset of reservoir and lake surface area variations, Sci. Data, 9, 356, https://doi.org/10.1038/s41597-022-01449-5, 2022.

Shu, S., Liu, H., Beck, R. A., Frappart, F., Korhonen, J., Lan, M., Xu, M., Yang, B., and Huang, Y.: Evaluation of historic and operational satellite radar altimetry missions for constructing consistent long-term lake water level records, Hydrol. Earth Syst. Sci., 25, 1643–1670, doi: 10.5194/hess-25-1643-2021, 2021.

I do not think you can estimate reservoir storage when the correlation between elevation and extent is poor. Please refer to Busker et al. (2019). Therefore, the total number of reservoirs whose storage can be estimated using remote sensing should be lower than 338. Could you also provide statistics on the robustness of the elevation-extent relationships for all reservoirs you analyzed?

R3C2: Yes, we provided statistics of constructed A-E curves in our revised manuscript (Section 3.1 and 3.3). Please see it in our revised manuscript or the attached texts.

3.1 Data set description

In this study, we generated the remotely sensed reservoir datasets for 338 Chinese reservoirs, with a total of 470.6 km^3 storage capacity (50% reservoir water capacity in China). The geographical distributions of these reservoirs are represented in Fig. 1 and a summarized information on the components of the datasets are shown in Table 3. By synthesizing information from various data sources, the remotely sensed datasets (WSE, SWA, and RWSC) of 338 Chinese reservoirs were calculated during 2010–2021 and are publicly available at https://doi.org/10.5281/zenodo.7251283 (Shen et al., 2021). The files provided are: (i) the reservoir shapefiles, (ii) the time series of SWA, WSE and RWSC, and (iii) a readme file. In the directory of 01_res_loc, we provide two ESRI shapefiles (the location of 338 reservoirs and 93 reservoirs with in-situ observations for validation) and one Excel file of their associated attributes. In the directory of 02_res_wse, we provide the time series of reservoir water surface elevation in two modes (i.e., standard-Measurement and enhanced-Measurement), with their comprehensive evaluation reports and figures in PDF and Excel files. The standard-Measurement (SM) products are individual measurements from each satellite altimeter with different retracking algorithms, while the enhanced-Measurement (EM) products are the densified water level observations from multisource if available. In the directory of 03_res_swa, we provide reservoir monthly area time series. In the directory of 04_res_rwsc, we provide the time series of RWSC in two modes (i.e., DEM-based, and water area and water level from satellites) and A–E curves, with their comprehensive evaluation reports, regression statistics, and figures in PDFs and Excels. Different levels of data are provided in an easily readable file format, showing that our remotely sensed datasets have clear patterns and can capture seasonal filling and emptying of reservoirs very well. For more details, please refer to the following sections and supplementary materials.

Table 3. Summary of the data provided in this study.

Category		**Number of reservoirs**	**Description**
01 res_loc		338	Two shapefiles (338 reservoirs and dams, and 93 validated reservoirs) and one excel files associated with reservoir attributes
02 res_wse	Standard Measurements (In total: 338 reservoirs)	111	From Sentinel-3A mission, 27-days, 2016-2021, with 5 retracking algorithms
		117	From Sentinel-3B mission, 27-days, 2018-2021, with 5 retracking algorithms
		146	From SARAL/AltiKa mission, 35-days, 2016-2021, with 5 retracking algorithms
		243	From CryoSat-2 mission, 369-days, 2010-2021, with 3 retracking algorithms
		26	From Jason-3 mission, 10-days, 2016-2021, with 3 retracking algorithms
		147	From ICESat-2 mission, 90-days, 2019-2021, with 1 retracking algorithm
	Enhanced Measurements	196	Enhanced measurements (EM) product by merging SM products, from 2010-2021, sub-monthly or monthly
03 res_swa		338	Monthly from 2010-2021
04 res_rwsc	Satellite water level-area based	335	Monthly storage variation from 2010-2021
	DEM-based	266	Monthly storage variation from 2010-2021
Readme file			A detailed description of the generated products and references

3.3 Reservoir storage variation product

We provided monthly RWSC time series from 2010 to 2021 in two modes: one is to use WSE and SWA from satellite altimeters and images, while another one is to use satellite SWA and area-storage model developed by DEM. After excluding reservoirs without insufficient WSE-SWA data pairs to establish the A–E relationships and visual inspection of time series, we finally retained 337 reservoirs with RWSC time series, among which 335 reservoirs have RWSC estimates derived from the first type method while 266 reservoirs have RWSC estimates derived from the DEM-based method. To evaluate the data quality, we compared with in situ storage data of 91 reservoirs and calculated three error statistical metrics (i.e., RMSE, normalized root-mean-square error (NRMSE), and CC). The A–E curves derived from satellite WSE and SWA data are evaluated based on their R^2 values. We notice that 69% reservoirs of A–E curves could be better explained by a second-order polynomial function, while 13% and 16% reservoirs of A–E relationships are assumed to give a power and exponential function (Fig. 8 f, h). A total of 283 of 335 reservoirs (84%) have moderate R^2 values > 0.5, among which 107 reservoirs show very good agreement with R^2 values > 0.8. Nevertheless, 15% has relatively poor performance in terms of R^2 values. Overall, our A–E curves are reliable and lay the good foundation for RWSC estimates. Across gauge comparisons of RWSC, the median statistics of CC, NRMSE, and RMSE are 0.89, 11%, and 0.021 km^3. Around 91% reservoirs (83 of 91) show good data quality with a NRMSE value below 20% and a RMSE value ranging from 0.002 to 0.31 km3. The lowest NRMSE is 4%, from the Gangnan reservoir that displays high CC and low RMSE values. Regarding the DEM-based RWSC estimates, the results are getting worse, with the median statistics of CC, NRMSE, and RMSE are 0.56, 20%, and 0.03 km^3. The errors can be attributed to the inaccuracy of the area-storage model developed by DEM. It should be noted that this type of RWSC estimates is served as an alternative product. Figure 8 shows examples of RWSC for some selected small, medium, and large reservoirs located in different climate zones. Closer examination in Fig. 9 seems to indicate that almost all remotely sensed RWSC estimates show similar patterns to the observations, i.e., both positive or negative, despite of some large discrepancies when capturing peak values. Nonetheless, there are some differences. Some reservoirs with good NRMSE and RMSE values show poor performance in terms of CC value, e.g., the Baiguishan reservoir (CC: 0.38, NRMSE: 16%, RMSE 0.03 km^3) that experiences relatively significant surface water dynamics. Moderately poor performance of 20 reservoirs (7%) in terms of high NRMSE/RMSE and low CC values (CC < 0.4) is likely associated with their poor performances from the remotely sensed WSE and SWA. Overall, we used in-situ observations of 91 reservoirs as an important reference to validate RWSC dataset, thus bringing the good level of confidence in our data quality.

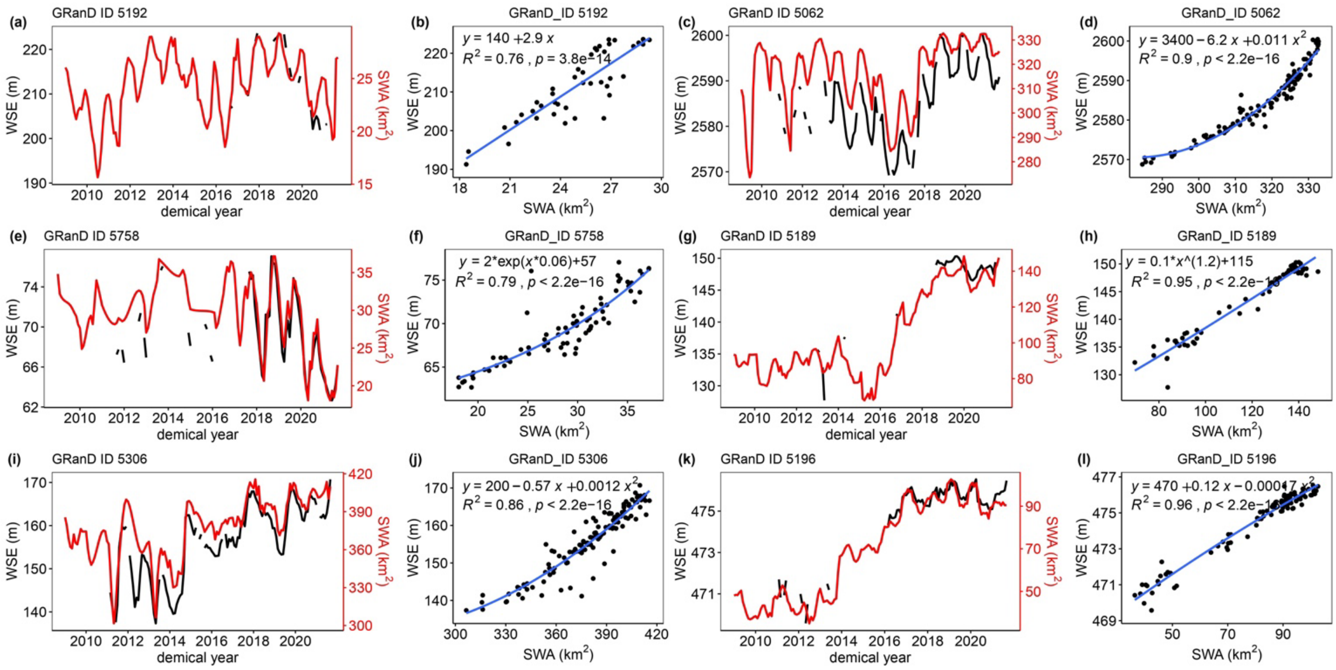

Figure 8: Illustration of A–E relationships constructed by satellite WSE and SWA and their associated time series at six reservoirs. (a)-(k) are the Panjiakou, Longyangxia, Baipenzhu, Miyun, Danjiangkou, and Guanting reservoir, respectively. Note that: time series of WSE and SWA and associated established A–E relationships of the remaining reservoirs are available in our datasets.

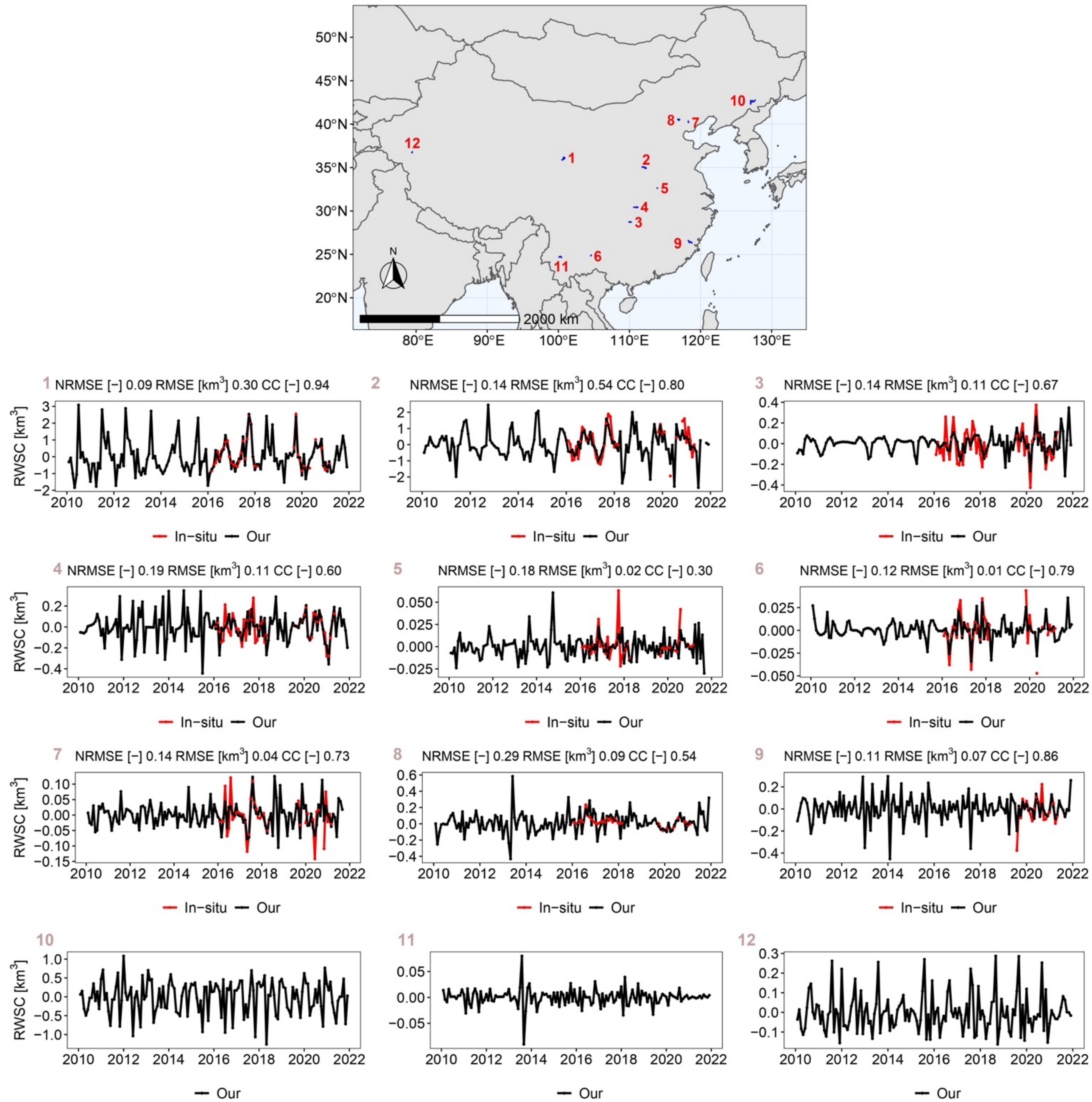

Figure 9: Illustration of time series of the remotely sensed RWSC of 12 reservoirs. NRMSE, RMSE (km^3), and CC values (if available) are given at the top of each subplot. Time series of the remotely sensed RWSC of the remaining reservoirs (validated or not validated) are available in our datasets.

Jason 1/2/3 and Topex/Poseidon together provide higher temporal (10-day) surface water elevation observations over the past three decades. Why did the authors choose low-frequency SARAL/AltiKa, Sentinel-3 A and B, and CroySat-2? Especially CroySat-2 has only one observation per year. And Sentinel-3 and SARAL/AltiKa do not fully cover your study period (2010-2022).

R3C3: Very good suggestion, and we have added Jason-3 and ICESat-2 in our revised manuscript. We will continually update our datasets to expand its utility and popularity, as we can see many people have comments and downloaded our dataset. Hope that R3C0 addressed your concern at this stage.

The structure of the Data and Methods section is very poor. It is very difficult to distinguish the methods you developed for your study from the methods embedded in the published dataset you used. I would recommend separating data and method description. And include another subsection to describe in-situ data that you highlight in the introduction. I think you also need to introduce more about JRC-GSWD data, which is one of the main datasets you used for your study.

R3C4: Considering the structure and flow of the paper, we have greatly improved the presentation of the manuscript, but still combine data and methods. In section 2, we first describe the reservoir covered in our study area and the in-situ data available for further validation so that the reader can directly understand the spatial coverage of our dataset and the validation of the in situ data (we have added an excel file and graphs to show basic information about the validated reservoirs as you suggested). Then, in each section, such as water levels, we describe the data and methods, as well as the validation methods. It still has a very clear logical sequence and we have improved the presentation considerably. In Section 3, we first give a description of the data (some text and tables) to describe the coverage and type of data. Then, in each section, such as water levels, we describe the results of the assessment and give a description of the time series for a selected sample of reservoirs. We have completely revised the article to significantly improve the presentation of data sources, methods and results, and hope that it meets your standard.

Zhao and Gao (2018) have produced monthly surface water extent time series for all reservoirs from the GRanD using JRC-GSWD. Why do you need to use their method again to derive reservoir water extents using the same input data source JRC-GSWD? It does not make sense to me. The reservoir monthly time series can be accessed via https://dataverse.tdl.org/dataset.xhtml?persistentId=doi:10.18738/T8/DF80WG. I did not find any validation on your reservoir water extent data. As there are many published satellite-derived surface water extent products, I think you can compare yours against some of them.

R3C5: Hope response “R3C1” addressed your concern. As explained earlier, we used a new algorithm to generate reservoir area time series, which have been validated against in situ water level, our Standard Measurement altimetric water level, our Enhanced Measurement altimetric water level, and two other existing datasets (GRSAD dataset and RealSAT data). Please find the corresponding changes in the Section 3.2 of the revised manuscript, which are given below.

2.2 Surface area datasets

In this study, we applied the new algorithm developed by Donchyts et al. (2022) to leverage freely accessible Landsat and Sentinel-2 images to generate reservoir water area time series. The GEE code for this water mapping algorithm is available at https://github.com/global-water-watch/research-reservoir-water-dynamics and was applied individually to each reservoir and every satellite image intersecting a given reservoir to map accurate reservoir water. This algorithm can efficiently address several challenges associated with optical Landsat satellites, such as contamination from clouds and limitations of previous algorithms that reclassify contaminated pixels as water. Donchyts et al. (2022) demonstrated the algorithm's good performance in mapping reservoir water areas by comparing the areas with in situ water level/storage in 768 reservoirs of varying size and geographic regions. Here, we detail how this algorithm addresses the challenges from optical images and generates water area time series. First, we selected the cloudy satellite images that intersect with a given reservoir shapefile. Second, we used the global cloud frequency dataset (Wilson, 2016) to identify the cloudiest images that are fully covered by clouds and corrected the remaining images using the following steps. Third, we computed the NDWI (normalized difference water index) spectral water index. Fourth, we detected land/water edges based on the Canny edge detector algorithm (Donchyts et al., 2016) and defined sampling areas for pixels around the land/water edges. Fifth, we determined the optimal threshold based on the Otsu thresholding algorithm (Markert et al., 2020) using a sample of NDWI spectral index values within the region determined in the previous step to obtain a water mask. Next, we eliminated incorrectly detected water (water pixels detected as non-water) by sampling surface water occurrence along water edges and obtained the final gap-filled water mask by clipping surface water occurrence at a given occurrence value and combining it with the water mask. Lastly, reservoir water area time series from the final gap-filled water mask are filtered with a quantile-based temporal outlier filtering algorithm to remove the remaining errors. Detailed procedures and flowcharts can be found in Donchyts et al. (2022).

After these steps, we generated monthly reservoir water area time series for 338 reservoirs. To analyze the performance of our products, reservoir time series are compared with the in situ water level time series, the altimetric water level time series (SM and EM product, see Section 2.1), and two similar existing products from GRSAD (Global reservoir surface area dataset, Zhao and Gao, 2018) and RealSAT (Khandelwal et al., 2022, Table 1). The CC, rRMSE (relative RMSE), and rBIAS (relative bias) are used as indicators of data quality.

3.2 Reservoir water area product

Monthly reservoir SWA time series are provided for 338 reservoirs during 2010-2021 and are compared with water level time series (in situ and altimetric measurements) and two other similar areal datasets water level. The SWA time series show good agreements with in situ water level observations in 93 reservoirs, approximately 80% have good CC values exceeding 0.5, among which 48 reservoirs show very good agreement with a CC > 0.8. Comparing to our altimetric standard measurements, we found that reservoir SWA and altimetric products generally show a good agreement with CC values higher than 0.5 for 70% of 323 validated reservoirs, among which 139 reservoirs have very good agreement with a CC value > 0.8. Comparing to our altimetric enhanced measurements, reservoir SWA and altimetric products also show a good agreement with CC values higher than 0.5 for 73% of 196 validated reservoirs, among which 62 reservoirs show very good agreement with a CC value > 0.8. In addition, two similar areal datasets (Table 1), i.e., GRSAD (Zhao and Gao, 2018) and RealSAT (Khandelwal et al., 2022), were used for cross validation. GRSAD provides monthly SWA values for global 7,246 reservoirs during 1984-2020 (updated version 3) extracted from the Landsat-based images (Pekel et al., 2016) and correction of contaminations from terrain shadows, clouds, and cloud shadows. The datasets were validated over 9 reservoirs with in situ water level/storage observations and compared with the synthetic data from cloud-clear Landsat images, showing a good performance of the algorithm to repair contaminated optical images for more reliable SWA estimates. RealSAT used a machine-learning method (i.e., ordering based information transfer) to process optical images for generating monthly SWA values over 681,137 global lakes/reservoirs from 1984 to 2015. It should be noted that GRSAD used the existing reservoir shapefiles from GRanD database to generate SWA values, while RealSAT generated new lake polygons from surface water occurrence data. Based on all compared reservoirs available, we found that our SWA time series show good agreements to values in GRSAD (median CC value of 0.64, rBIAS = -9%, rRMSE = 26%, n = 338) and RealSAT (median CC value = 0.68, rBIAS = -10%, rRMSE = 22%, n = 47) datasets. Overall, these comparisons (Fig. 7) above suggest a good level of trustworthiness in our SWA time series.

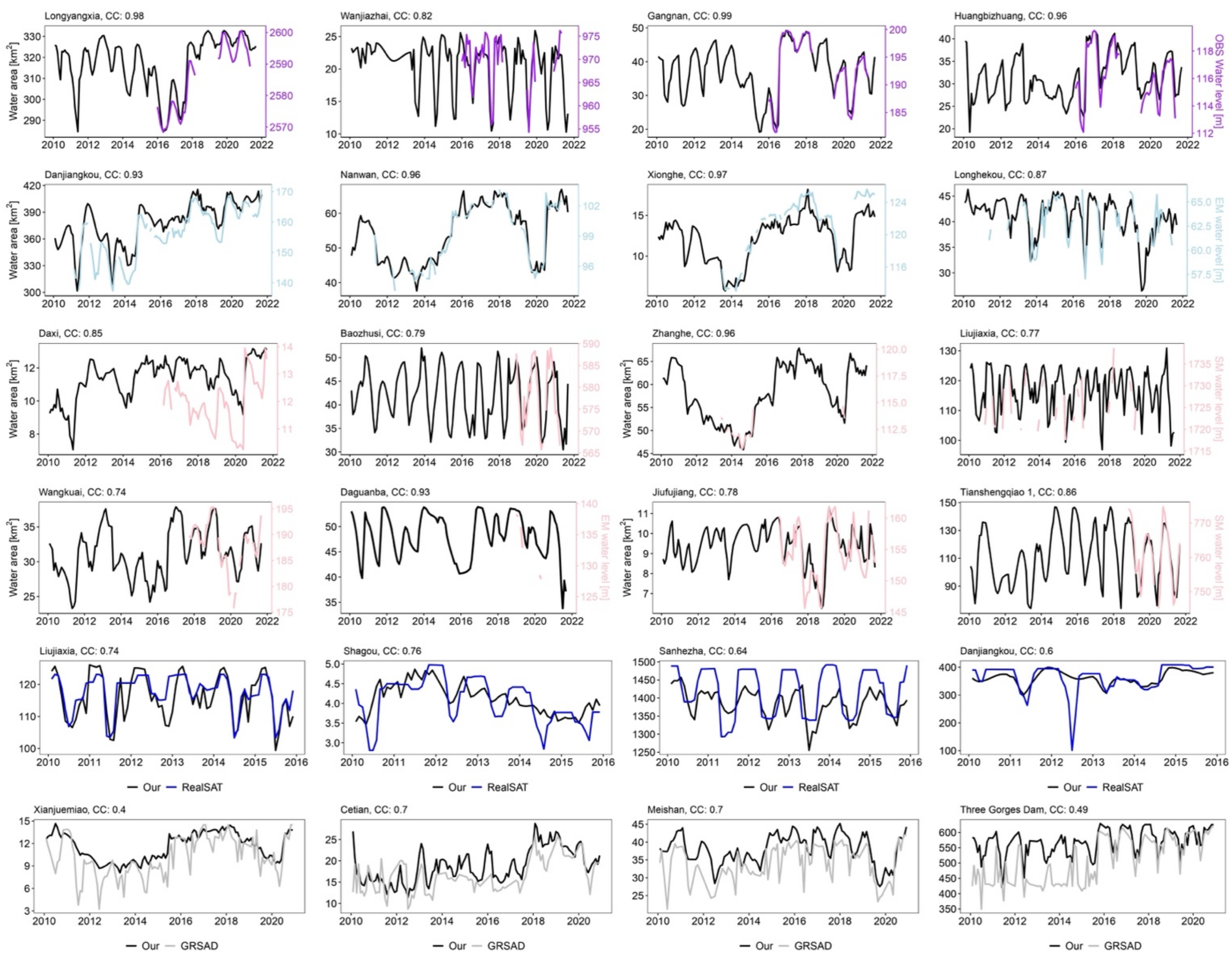

Figure 7: Illustration of reservoir water area time series against in situ water level, altimetric water level from standard measurement and enhanced measurement, as well as GRSAD and RealSAT area time series at a selected sample of reservoirs with varying area size. Time series for other reservoirs are all available in the datasets.

References:

Zhao, G., and Gao, H.: Automatic Correction of Contaminated Images for Assessment of Reservoir Surface Area Dynamics, Geophys. Res. Letters, 45, 6092–6099, doi: 10.1029/2018GL078343, 2018.

Donchyts, G., Winsemius, H., Baart, F., Dahm, R., Schellekens, J., Gorelick, N., Iceland, C., and Schmeier, S.: High-resolution surface water dynamics in Earth's small and medium-sized reservoirs, Sci. Rep., 12, 13776, https://doi.org/10.1038/s41598-022-17074-6, 2022.

Khandelwal, A., Karpatne, A., Ravirathinam, P. Ghosh, R., Wei. Z., Dugan, H. A., Hanson, P. C., and Kumar, V.: ReaLSAT, a global dataset of reservoir and lake surface area variations, Sci. Data, 9, 356, https://doi.org/10.1038/s41597-022-01449-5, 2022.

Wilson, A. M., and Jetz, W.: Remotely sensed high-resolution global cloud dynamics for predicting ecosystem and biodiversity distributions, PLoS biology, 14(3), e1002415, https://doi.org/10.1371/journal.pbio.1002415, 2016.

Markert, K. N., Markert, A. M., Mayer, T., Nauman, C., Haag, A., Poortinga, A., Bhandari, B., Thwal, N. S., Kunlamai, T., Chishtie, F., Kwant, M., Phongsapan, K., Clinton, N., Towashiraporn, P., and Saah, D.: Comparing sentinel-1 surface water mapping algorithms and radiometric terrain correction processing in southeast asia utilizing google earth engine, Remote Sens., 12(15), 2469, https://doi.org/10.3390/rs12152469, 2020.

Pekel, J, F., Cottam, A., Gorelick, N., Belward, A. S.: High-resolution mapping of global surface water and its long-term changes, Nature, 540, 418–422, https://doi.org/10.1038/nature20584, 2016.

Please include the reservoir name for all your analysis, which would be very important information in this m/s. For example, you only show GRanD ID in Figure 5 but I am keen to know which reservoir it is in China.

R3C6: The name of reservoirs is added in all figures, meanwhile a .csv file is also provided in our datasets illustrating GRanD_ID and its name and other attributes.

As you mentioned that the accuracy of altimetry data is poor in some large reservoirs (P12L255-256), you should provide more analysis on the influence of reservoir size on the accuracy of altimetry data.

R3C7: Agree with your ideas, although previous studies suggested that there is no relationship between reservoir size and the performance of altimetric data (see Zhang et al., 2020; Jiang et al., 2020; Biancamaria et al., 2017; Bonnema et al., 2016; 2019). Here we added the figures in the supplementary files to support this idea. See the attached figures below.

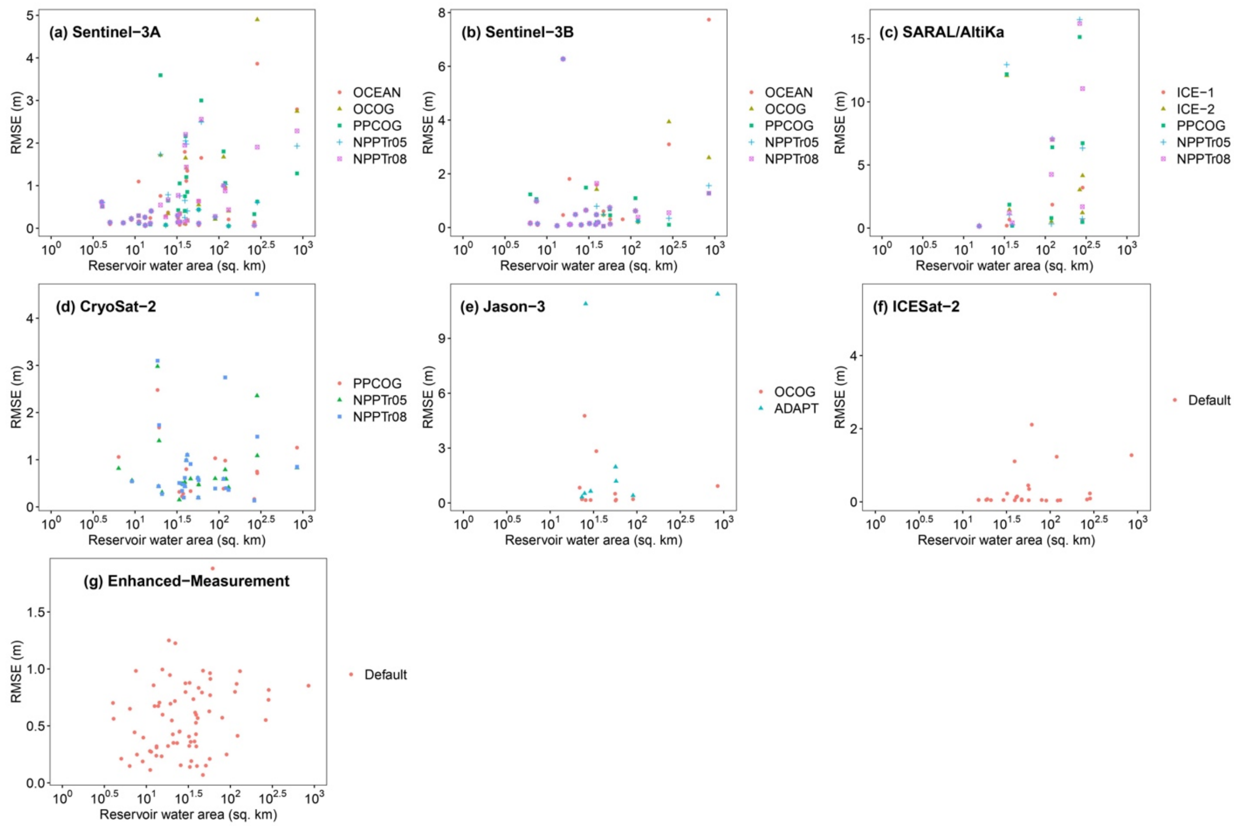

Figure S2. Comparison of the performance of altimetric water level against reservoir water area. Logarithmic scales are used for X-axis. Please note we have five retracking algorithms for Sentinel-3A, Sentinel-3B and SARAL/AltiKA, and three retracking algorithms for Cryosat-2, two retracking algorithms Jason-3, and one for ICESat-2, and one for our enhanced-measurements.

References:

Biancamaria, S., Frappart, F., Leleu, A.-S., Marieu, V., Blumstein, D., Desjonquères, J.-D., Boy, F., Sottolichio, A., Valle-Levinson, A., 2017. Satellite radar altimetry water elevations performance over a 200m wide river: Evaluation over the Garonne River. Adv. Sp. Res. 59, 128–146. https://doi.org/10.1016/j.asr.2016.10.008

Jiang, L., Nielsen, K., Dinardo, S., Andersen, O. B., and Bauer-Gottwein, P.: Evaluation of Sentinel-3 SRAL SAR altimetry over Chinese rivers, Remote Sens. Environ., 237, 111546, doi: 10.1016/j.rse.2019.111546, 2020.

Bonnema, M., and Hossain, F.: Assessing the potential of the Surface Water and Ocean Topography Mission for reservoir monitoring in the Mekong River basin, Water Resour. Res., 55, 444–461, doi: 10.1029/2018WR023743, 2019.

Bonnema, M., Sikder, S., Miao, Y., Chen, X., Hossain, F., Pervin, I. A., Mahbubur Rahman, S. M., and Lee, H.: Understanding satellite-based monthly-to-seasonal reservoir outflow estimation as a function of hydrologic controls, Water Resour. Res., 52, 4095–4115, doi: 10.1002/2015WR017830, 2016.

Zhang, X., Jiang, L., Kittel, C. M. M., Yao, Z., Nielsen, K., Liu, Z., Wang, R., Liu, J., Andersen, O. B., Bauer-Gottwein, P.: On the performance of Sentinel-3 altimetry over new reservoirs: Approaches to determine onboard a priori elevation, Geophys. Res. Letters, 47, e2020GL088770, doi: 10.1029/2020GL088770, 2020.

Specific Comments:

P2L54-56: The hypsometry relationship is developed by the overlapped measurements of elevation and extent. Are these two steps to calculate storage or two approaches? Please clarify.

Thank you for your suggestion, we have rephrased this sentence:

RWSC can be calculated by two methods: one is using WSE and SWA from satellite altimeters and images, and the other one is using imagery-based SWA and digital elevation model (DEM). The core of these two methods is to construct the hypsometry relationships, i.e., Area-Elevation curves (A–E) from the overlapping records of WSE and SWA or DEM (Bonnema et al., 2016; Vu et al., 2022).

P2L61-P3L1: Can you provide any references about the limited number (approx. 30) of available Chinese reservoir data from Hydroweb, G-REALM and DAHITI?

Nope, we manually checked the websites from Hydroweb, G-REALM and DAHITI, and searched the region "China" and sum up the available numbers of reservoirs in China. Here, we give their websites below (also listed in Table 1).

Hydroweb, http://hydroweb.theia-land.fr/

DAHITI, https://dahiti.dgfi.tum.de

G-REALM, https://ipad.fas.usda.gov/cropexplorer/global_reservoir

P3L68: Please clarify "large observations"

We have rephrased this sentence:

The remotely-sensed products had often not been extensively validated by ground observed data, which are usually not publicly available, with the exception of a few studies with scare in-situ observations (Bonnema and Hossain, 2019).

P3L78: Can you introduce the Hydrostat as well and add a reference to it?

Here is the website of Hydrosat (http://hydrosat.gis.uni-stuttgart.de/php/index.php), Hydrosat provided water level, area, discharge, and GRACE data globally. Please note that water area is directly using the JRC-images or MODIS data, that have limitations as demonstrated in GRSAD datasets (Zhao and Gao, 2018). Regarding to water level, it is mainly generated for rivers, and we could not find many results for Chinese reservoirs except only one reservoir on its website. In this sense, we do not include this reference in our revised manuscript to avoid any misunderstanding because we focus on reservoir' datasets.

References:

Tourian, M. J., Elmi, O., Shafaghi, Y., Behnia, S., Saemian, P., Schlesinger, R., and Sneeuw, N.: HydroSat: geometric quantities of the global water cycle from geodetic satellites, Earth Syst. Sci. Data, 14, 2463–2486, https://doi.org/10.5194/essd-14-2463-2022, 2022.

Table1: It was a great work to summarize relevant studies in Table 1 but it looks quite messy. I would suggest to simply this summary, highlight important points and divide information (e.g., time, temporal resolution, altimetry data, validation data, etc.) into a few more columns. Does "/" mean unknown or not applicable? Please name satellite sources for altimetry data rather than say "online databases".

We have revised Table 1 and added Table A1, combining comments from yours and referee 1.

Table 1. Summary of recent studies and databases producing the remotely-sensed data on surface water area, water surface elevation, storage variation, and hypsometric curve of reservoirs.

Category	Product and reference	Source and remark
Water level	G-REALM, Birkett et al., 2011	https://ipad.fas.usda.gov/cropexplorer/global_reservoir, reservoirs and lakes
	Hydroweb, Crétaux et al., 2011	http://hydroweb.theia-land.fr/, for lakes and rivers
	Gao et al. 2012	34 global reservoirs, not publicly accessible
	DAHITI, Schwatke et al., 2015	https://dahiti.dgfi.tum.de, rivers, and lakes/reservoirs
	AltEx, Markert et al., 2019	https://altex.servirglobal.net, web application for exploring Jason and SARAL
	Tortini et al., 2020	https://doi.org/10.5067/UCLRS-GREV2, 347 lakes and reservoirs
	Water level On VITO, CGLS	https://land.copernicus.eu/global/products/wl, lakes (~210) and rivers
Water area	Hydroweb, Crétaux et al., 2011	http://hydroweb.theia-land.fr/, available for lakes
	Gao et al., 2012	34 global reservoirs, not publicly accessible
	Zhang et al., 2014	21 reservoirs, not publicly accessible
	DAHITI, Schwatke et al., 2015	https://dahiti.dgfi.tum.de, lakes/reservoirs
	Khandelwal et al., 2017	http://z.umn.edu/monitoringwaterRSE, 94 reservoirs
	GRASD, Zhao et al., 2018	https://doi.org/10.18738/T8/DF80WG, 7,246 global reservoirs
	Busker et al., 2019	137 lakes and reservoirs, not publicly accessible
	Yao et al., 2019	https://lakewatch.users.earthengine.app/view/glats, 205 reservoirs
	Liu et al., 2020	24 Chinese reservoirs, not publicly accessible
	Tortini et al., 2020	https://doi.org/10.5067/UCLRS-AREV2, 347 lakes and reservoirs
	Donchyts et al., 2022	https://doi.org/10.6084/m9.figshare.20359860, 71,208 lakes and reservoirs
	Khandelwal et al., 2022	https://doi.org/10.5281/zenodo.4118463, 681,137 lakes and reservoirs
	Bluedot Observatory	https://blue-dot-observatory.com, available for lakes/reservoirs
Storage variation	Gao et al., 2012	34 global reservoirs, not publicly accessible
	Zhang et al., 2014	21 reservoirs, not publicly accessible
	Busker et al., 2019	137 lakes and reservoirs, not publicly accessible
	DAHITI, Schwatke et al., 2020	https://dahiti.dgfi.tum.de, 62 lakes/reservoirs
	Liu et al., 2020	24 Chinese reservoirs, not publicly accessible
	Tortini et al., 2020	https://doi.org/10.5067/UCLRS-STOV2, 347 lakes and reservoirs
	Klein et al., 2021	1267 global reservoirs are analyzed, not publicly accessible
	Hou et al., 2022	6695 global reservoirs, not publicly accessible
	Vu et al., 2022	https://doi.org/10.5281/zenodo.6299041, 10 reservoirs
hypsometric curve	Gao et al., 2012	34 reservoirs, not publicly accessible
	Zhang et al., 2014	https://doi.org/10.1002/2014WR015829, 21 reservoirs
	Yigzaw et al., 2018	http://wowuoh.wixsite.com/home/models-data, 6,800 reservoirs

	Vu et al., 2022	https://doi.org/10.5281/zenodo.6299041, 10 reservoirs
Our study	https://doi.org/10.5281/zenodo.7251283, 338 reservoirs with water level, water area, storage variation and hypsometric curve during 2010-2021 in China	

* Last access: 15 October 2022. Abbreviations are as follow: Global reservoir and dam database (GRanD), Database for hydrological time series of inland waters (DAHITI), Global reservoirs and lakes monitor (G-REALM), Global reservoir surface area dataset (GRSAD).

Table A1. Providers of water level (light blue background), area (grey blackground), and storage variation (orange background) time series for Chinese reservoirs.

Data sources	No. of reservoirs	Time and temporal resolution	Download link
Hydroweb	32	1992–2021, 10–35 day	http://hydroweb.theia-land.fr/
DAHITI	8	2002–2021, 10–35 day	https://dahiti.dgfi.tum.de/en/
G-REALM	~30	1992–2021, 10–35 day	https://ipad.fas.usda.gov/cropexplorer/global_reservoir
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-GREV2
Shen et al. (2021)	338	2010–2021, monthly	https://doi.org/10.5281/zenodo.7251283
Bluedot	not clear	2016–2021, sub-monthly	https://blue-dot-observatory.com/
GRASD	923	1984-2018, monthly	https://doi.org/10.18738/T8/DF80WG
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-AREV2
RealSAT	85,522 (lakes and reservoirs)	1984–2015, monthly	https://doi.org/10.5281/zenodo.4118463
Donchyts et al. (2022)	9,418	1985–2021, monthly	https://doi.org/10.6084/m9.figshare.20359860
Yao et al. (2019)	~8	1992–2018, sub-monthly	https://lakewatch.users.earthengine.app/view/glats
Shen et al. (2021)	338	2010–2021, monthly	https://doi.org/10.5281/zenodo.7251283
Vu et al. (2022)	10	2008–2020, monthly	https://doi.org/10.5281/zenodo.6299041
Hou et al. (2022)	923	1984–2015, monthly	Not publicly accessible
Tortini et al. (2020)	<10	1992–2018, sub-monthly	https://doi.org/10.5067/UCLRS-STOV2
Shen et al. (2021)	337	2010–2021, monthly	https://doi.org/10.5281/zenodo.7251283

P6L112: “these missions” is not relevant to the context here.

We have removed this sentence as you suggested.

P6L112-113: Please explain why altimetry data show highest values in ungauged or poorly gauged areas?

We have removed this sentence considering your previous comment “P6L112” to make our text easily understood.

P6L116-119: It is not clear here. Please put the cover period and capacity information into a table.

In previous version, we included this this information in the datasets, see the reservoir_attributes.xlsx file, containing all attributes of reservoirs including the capacity information. Here, we added a figure to show its capacity in the supplementary. Regarding to the cover period, the main text has an illustration, and we can further find it in the plots of each reservoir in our datasets.

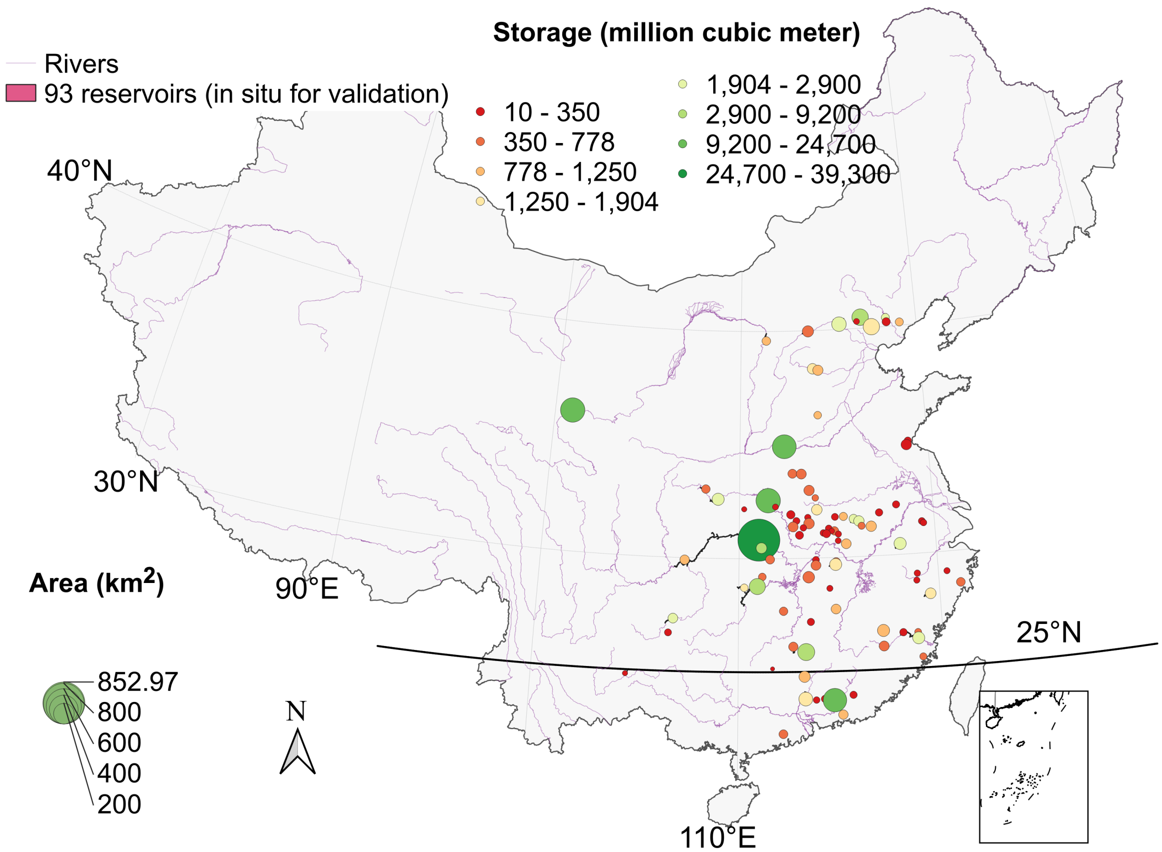

Figure S1: Illustration of 93 reservoir with in situ data for validation in this study, other reservoir attributes can be found in the Reservoir_attribute.xlsx in our datasets.

Section 2.1: Please carefully check this section about the description of different satellite instruments. I am not 100% sure if all the information here is correct or not. For example, “Hz” or “GHz”; Sentinel-3 SRAL have Ku-band and C-band with different frequencies, two radar modes and two tracking modes, I am not sure which mode or band do you refer to.

Yes, we carefully checked this section. If here refers to the 20 Hz measurements, it is correct. We only use Ku-band SAR measurements with open-loop tracking mode.

We only used Ku-band SAR measurements with open-loop tracking mode (Jiang et al., 2020) and downloaded Level 2 “Enhanced measurements” datasets from https://scihub.copernicus.eu/dhus/.

References:

Jiang, L., Nielsen, K., Dinardo, S., Andersen, O. B., and Bauer-Gottwein, P.: Evaluation of Sentinel-3 SRAL SAR altimetry over Chinese rivers, Remote Sens. Environ., 237, 111546, doi: 10.1016/j.rse.2019.111546, 2020.

P7L133: please clarify “higher data availability” and why Ka-band leads to that?

Since the Ka-band (35.75 GHz) is used, the antenna beamwidth is smaller and leads to a reduced radar footprint (4 km in radius). Moreover, the pulse repetition frequency is higher (~3700 Hz), resulting 40 Hz measurements spacing at c.a. 170 m instead of 300 m.

We added a reference to support this.

References:

CNES, SARAL/AltiKa Products Handbook, available at: https://www.aviso.altimetry.fr/fileadmin/documents/data/tools/SARAL_Altika_products_handbook.pdf, (last access: 17 December 2021), 2016.

P8L175-177: Did you do the analysis on counting no-valid data between Jan and Dec by yourself or cited from previous studies?

I did the analysis by myself for these Chinese reservoirs. However, in the revised manuscript, this section is completely changed, please see the above responses, since we used a new algorithm for processing reservoir water area dataset.

P8L177-178: what do you refer to by “over 12% of contamination pixels”? Do you mean all JRC-GSWD data or in Zhao and Gao (2018) study? P8L180-181: Please check. I am not sure if this statement is correct or not. As far as I know, the GRanD reservoir polygon is derived not only from SRTM Water Body Database, but also from Global Lakes and Wetlands Database and some other studies. P9L187-188: What does this sentence try to explain?

In the revised manuscript, this section is completely changed, please see the above responses, since we used a new algorithm for processing reservoir water area dataset.

Figure 2: All these evaluation metrics should be mentioned and explained in the data and method sections.

Yes, we included these evaluation metrics in each section (2.1-2.3).

P11L245-248: Please explain the criteria to filter out any reservoir in the method section.

As described in the main texts, most reservoirs are removed due to the insufficient altimetry data points rather than other reasons. For example, for 923 reservoirs recorded in GRanD database, we found that Sentinel-3A can cover 194 reservoirs by overlapping their ground tracks with reservoir shapefiles. However, please note that not every reservoir has valid measurements (nan records from the original data source), which is the primary reason to filter out reservoir in our final datasets. And after removing outliers (see steps in section 2.1),

- We removed outliers for each pass (i.e., 2 deviations away from the median value) using the median of absolute deviation (Jiang et al., 2019).
- Outliers are identified and discarded by comparing with SRTM DEM, i.e., 20 m away from DEM (set 40 m for reservoirs with large fluctuations).

only 111 reservoirs have enough data from Sentinel-3A to construct water level time series. Hope these answers addressed your questions.

Figure 7: It is difficult to see observed variations (red line) in the figure.

We have re-draw the figures.

Sections 4.1 and 4.2 are all your results (data comparison and application in modelling). Please move these to the Results section.

We have removed the Section 4.2 into a separated section (potential application in modeling) and removed the section 4.1 in the Results section 3.2 (water level comparison).

References:

[1] Busker, T., de Roo, A., Gelati, E., Schwatke, C., Adamovic, M., Bisselink, B., ... & Cottam, A. (2019). A global lake and reservoir volume analysis using a surface water dataset and satellite altimetry. Hydrology and Earth System Sciences, 23(2), 669-690.

[2] Hou, J., van Dijk, A. I., Beck, H. E., Renzullo, L. J., & Wada, Y. (2022). Remotely sensed reservoir water storage dynamics (1984–2015) and the influence of climate variability and management at a global scale. Hydrology and Earth System Sciences, 26(14), 3785-3803.

[3] Song, C., Fan, C., Zhu, J., Wang, J., Sheng, Y., Liu, K., ... & Ke, L. (2022). A comprehensive geospatial database of nearly 100 000 reservoirs in China. Earth System Science Data, 14(9), 4017-4034.

[4] Zhao, G., & Gao, H. (2018). Automatic correction of contaminated images for assessment of reservoir surface area dynamics. Geophysical Research Letters, 45(12), 6092-6099.

Community comment from Zhaokai Wang

Dear authors, thank you for submitting such an interesting paper which is likely to provide a very valuable data source for water resources studies in China. As a potential end user of this dataset, I have a suggestion for the authors to help further improve the quality of the dataset. The figure below depicts the RWSC of GranD ID 5062, 5267 and 5410 provided by the authors in Zenodo and the in-situ RWSC collected by myself. While the authors' data generally match with the observations, several abnormal spikes (outliners) exist for these dams, for example in mid-2011 and mid-2012 for GRanD 5062, and mid-2010 and late 2013 for GRanD 5410. These spikes could lead to an overestimation of CC reported by the authors, because these spikes seem to occur less in late 2010s where the validation is performed. From my point of view, this may be a result of contaminated data points from either altimetric satellites or remote sensing images. Therefore, I would like to encourage authors to conduct a rigorous data quality control to remove any possible problematic data points before publishing the final dataset.

Dear Zhaokai Wang,

We appreciate positive feedback on our work. We checked these three reservoirs you mentioned, the statistical metrics on water level and RWSC can be found in our datasets, including time-series and error reports for all reservoirs (e.g., time-series of rwsc 93/232res.pdfs). Please note that you collected in-situ data before 2016, are not available from our side. We obtained daily water level and storage data spanning 2015–May 2021 for 93 reservoirs in this study.

We performed strict data quality control to eliminate any potentially problematic data points, and data version 2 is released as the final dataset.

Here, we briefly summarize the improvements to our dataset, taking into account the minor and moderate issues raised by the reviewers.

For water levels, we added six satellite altimeters (previsous one with four satellite altimeters) in this version and provided two modes, standard rate and high rate. For the high rate, we need to eliminate the systematic bias between satellites. The biases are removed using two methods, as detailed in comment AC3, to address the issues raised by Reviewer 2.

For water area, we added a section to describe the accuracy assessment to evaluate our area dataset based on in situ water levels in 93 reservoirs and our generated altimetric water levels (standard rate and high rate) to address the issue raised by reviewer 2.

For water storage variation, we added DEM-based estimates, so that we provide two types of storage change, i.e., using satellite-based water levels and water area, and using satellite-based water area and DEM-based curves. The storage changes are validated against in situ storage changes for 93 reservoirs, addressing the issues raised by reviewer 1.