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Discussions

Interactive comment on "A global lake and reservoir volume analysis using a surface water dataset and satellite altimetry" *by* Tim Busker et al.

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Thank you for your time and interesting comments about our paper.

It is an interesting paper that promotes the use of remote sensing data. It is also well written and well organised. The authors claim that their study can be useful in the assessment of changes in water availability due to climate change. However, I cannot see how the latter can be achieved based on the material presented. The authors are asked to expand on that thought. In addition, I am not sure how this publication might contribute to the enhancement of knowledge on the physical processes involved. In other words, a link is missing between the paper's main contribution – a new lake and reservoir volume dataset - and the possible applications.

This paper's main aim is to develop an automatic methodology to calculate volume variations with remote sensing, that improves on current monitoring techniques. However, we realized that a more detailed and explicit explanation on the possible applications of the dataset will indeed improve the paper.

Proposed correction: Therefore, we added a much more detailed explanation of the possible applications that will replace the former 'explanation' on line 5-10, page 17:

'The lake and reservoir volume dataset developed here will help to better understand the behaviour and operations of lakes and reservoirs. As the number of reservoirs is still increasing because of growing energy demands, it is crucial to include their effects in (continental and global scale) hydrological models. Zajac et al. (2017) found that the exclusion of lakes and reservoirs often leads to inaccurate downstream discharge estimates. Furthermore, lake or reservoir storage change combined with modelled or observed inflow allows for a better estimation of the outflow (e.g. Muala et al., 2014). These outflow estimates can be used to calibrate hydrological models or estimate hydropower production in areas where in situ observations are lacking. However, due to a lack of storage observations and their availability – often because of commercial reasons -, the parametrization and the representation of lakes and reservoirs in many hydrological models – if at all present - is still highly simplified. Our global lake and reservoir volume dataset over 32 years will be very beneficial to calibrate and validate their parameterisation to mimic their operational behaviour. This will improve our current understanding of lakes and reservoirs, improve their simulations and consequently the simulations in the rest of the river basin. In addition, a better understanding of reservoirs will also likely improve water and energy production projections of these reservoirs under climate change, or under different management scenarios (e.g. changing downstream water requirements, flow legislation, changing inflow due to other activities upstream). Moreover, the area time series developed in this study can be included in models to improve on (often fixed) current area estimates and can furthermore improve estimates of open water evaporation.'

The authors mention that some lakes showed poor regression between h and A, with one of the reasons being lake size. What are the limits of detection of h(A) relationship from the satellite data (what is the minimum lake area detectable)?

One of the reasons for poor regressions between h and A is indeed lake size. However, as also explained in AC1 and in the discussion section, many other factors induce uncertainty in the regression (e.g. topography around the lakes, lake shape, position of the altimeter track, wave height, ice coverage, time difference between level and area observation, amount of no data in the GSW dataset). Therefore, we did not found a clear relationship between lake size and the R^2 of the regression. A hard limit on the minimum lake size for which the regressions are accurate is hard to give, as it thus depends on many other factors. However, we observed two lakes with an area $< 10km^2$ (Barragem do Caia and Encoro de Salas) that still showed accurate regressions. For these lakes the surrounding conditions were ideal and above mentioned uncertainties had a limited influence.

Proposed correction: We will add the following sentences in line 18, page 17: 'However, many other factors than the size of the water body determine the accuracy of the measurement; also surrounding topography, surface waves, winter ice coverage, the shape of the water body and the position of the altimeter track determine the measurement error. This could explain why no clear relationship between lake size and regression accuracy (R^2) was observed. Although most lakes with an area < 10 km^2 showed poor regression results, some of these small lakes still returned an accurate regression (e.g. Barragem do Caia and Encoro de Salas). '

From the satellite altimetry data description we learn that the accuracy of water level time series varies with the lake size, from 4-5 cm for large lakes up to over a meter (several decimetres) for small lakes and rivers. Can this variable error variance be included in the calculation of volume variations?

The satellite altimetry data description indeed states that the accuracy for large lakes

can potentially be higher than for small lakes. However, as described above and in comment 2 of AC1, the accuracy depends on many other factors. Therefore, we cannot find a relationship between lake size and altimeter accuracy that is clear enough to include the altimetry error in the volume variation estimation.

References

Muala, E., Mohamed, Y. A., Duan, Z. and van der Zaag, P.: Estimation of reservoir discharges from Lake Nasser and Roseires Reservoir in the Nile Basin using satellite altimetry and imagery data, Remote Sens., 6(8), 7522–7545, doi:10.3390/rs6087522, 2014.

Zajac, Z., Revilla-Romero, B., Salamon, P., Burek, P., Hirpa, F. and Beck, H.: The impact of lake and reservoir parameterization on global streamflow simulation, J. Hydrol., 548, 552–568, doi:10.1016/j.jhydrol.2017.03.022, 2017.

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