

## ***Interactive comment on “Assessing global water mass transfers from continents to oceans over the period 1948–2016” by Denise Cáceres et al.***

**Anonymous Referee #1**

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Caceres et al introduce a new version of the WaterGAP global hydrological model that is able to simulate total continental water storage anomalies (TWSA) by integrating a global glacier model (Marzeion et al., 2012). They reach important calculations of continental water storage anomalies and of their implications for ocean mass change. They also quantify (again, and new estimates) TWSA due to groundwater mass abstractions and impoundment in reservoirs. These calculations are worth publication, due to their urgent need with rising sea water levels and decreasing terrestrial water availability. Although I am aware of the big effort beyond this study (an accumulated effort with the ongoing improvement of WaterGap), it is not ready for publication and I recommend a major revision.

The knowledge gap or research questions addressed by this manuscript are not clear.

C1

I also think that the manuscript is too long, giving too much information on all models and related details, and limited in the discussion and comparison with other studies. Also, the authors need to put their results in the context of the urgency to understand TWSA and OMC that precisely requires these results. I find also some issues with structure, that again, break the main thread and hide the really important results.

First, the question is what is the real aim of the manuscript? I think that the authors should state more clearly the research question or hypothesis driving this study, than just focusing it as a new version or integration of WaterGAP. Which is the real aim of the study: 1) to quantify (or rather update or give other versions of) glacier and non-glacier contributions to sea level, with more emphasis on glacier or non-glacier?, 2) to validate TWSA from WaterGap with GRACE, to update WaterGap with the glacier module integration? It is not clear at all. I recommend a main focus, with appropriate redistributed weight across the manuscript.

The introduction should be restructured to really focus on the research question addressed, the identification of knowledge gaps and objectives specifically the knowledge gaps. Glaciers, water use, sea, ocean mass change. I know that combining all of these concepts together and reducing the state of the art to an introduction or discussion is not easy, but I think it is worth the effort. There are many efforts attempting to do similar objectives, with completely different methods, that should be mentioned (for glacier melt contributions, impoundment and withdrawals of water, etc). If GRACE is not the main objective, I suggest reducing considerably the emphasis on it in the introduction. Also, missing important references, see next paragraph.

And again, the discussion, a comparison with other works is necessary, and to put the results of the study in context. Some of the references I here mention could help, as many others. Discussion is completely missing. For instance, can these estimates be compared in some way with others? Anomalies related to water storage and/or consumption by irrigation and reservoir impoundment (Chao et al., 2008; Hoekstra and Mekonnen, 2012; Jaramillo and Destouni, 2015; Stefanie Rost et al., 2008), glacier

C2

contributions to oceans (Braithwaite and Raper, 2002; Giesen and Oerlemans, 2013; Huss and Hock, 2015; Jacob et al., 2012; Meier, 1984; Radić and Hock, 2014).

I have a feeling that Section 6.2 does not belong there, and it is also containing much information that it is not important and dilutes the main message of the manuscript, from my perspective. But again, I may be wrong, depending on the main aim of the article. Can much of it be moved to Supplementary information. Instead, a good discussion of the results and comparison with other studies could fill that gap.

The methods section is very hard to read, or in other words, very hard to focus while reading it. I assume it starts in L. 120 and finishes in L. 330? This should be explicit. There are so many acronyms, too many, I would just use the most important ones. For example what is the purpose of OMC, it is not a variable. The information on models and data sets is important and should be generally included in a methods section, but in this case, due to the massive amount of information due to the complexity of the study, I suggest just leaving the most important methods and sending the details to supplementary information. Also, because now the red thread is completely lost by the end of the methods, and since the objectives are not very clear in the introduction.

The results... where do they start by the way, in Model evaluation? Also, are they focused on the comparison with GRACE? That is why I ask if that is the main aim of the article.

For figure 4 and 5, can I recommend an additional simple barplot figure showing the TWSA with and without the accounting of glacier melt, with uncertainty ranges?

Another suggestion, a brief explanation somewhere how the term "anomaly" on land and change of mass in the ocean are related.

The conclusions should also pinpoint the main objectives of the introduction, and focus in what is really important.

The y-axis of Fig. 4 and 5 mean different things but have the same level or no level at

C3

all. The level is missing, only units, and complicates the understanding of the results.

L. 466 The word "contribution" is not appropriate here, I would delete it. In general, the use of the word "contribution" is very subjective, can you be more direct in its real meaning. What is a "contribution to ocean mass change" really, increase or decrease in ocean mass? Why is it an addition to the continents?

Just mentioning that the result of Figure 6 is very interesting, illustrative and explains many questions that I had before regarding Global mean annual human-driven LWSA.

On the other hand, Table 5 is too complicated due to the amount of numbers and acronyms and the lack of explanations, maybe a Figure could be more illustrative? Many of the components have not been introduced before. Same for Figure 7.

With losses, do you mean just negative anomalies?

L. 22-25 What do these results have to do with the main aim of the article?

L. 31 – Missing reference (Chao, 2008)

L. 34-35 I don't see the purpose of this sentence.

I think there are too many acronyms, I would only use the most important ones.

L138-140 So why are you using them then?

References

Braithwaite, R.J., Raper, S.C.B., 2002. Glaciers and their contribution to sea level change. *Phys. Chem. Earth Parts ABC* 27, 1445–1454. [https://doi.org/10.1016/S1474-7065\(02\)00089-X](https://doi.org/10.1016/S1474-7065(02)00089-X)

Chao, B.F., Wu, Y.H., Li, Y.S., 2008. Impact of Artificial Reservoir Water Impoundment on Global Sea Level. *Science* 320, 212–214. <https://doi.org/10.1126/science.1154580>

Giesen, R.H., Oerlemans, J., 2013. Climate-model induced differences in the 21st century global and regional glacier contributions to sea-level rise. *Clim. Dyn.* 41,

C4

3283–3300. <https://doi.org/10.1007/s00382-013-1743-7>

Jacob, T., Wahr, J., Pfeffer, W.T., Swenson, S., 2012. Recent contributions of glaciers and ice caps to sea level rise. *Nature* 482, 514–518. <https://doi.org/10.1038/nature10847>

Jaramillo, F., Destouni, G., 2015. Local flow regulation and irrigation raise global human water consumption and footprint. *Science* 350, 1248–1251. <https://doi.org/10.1126/science.aad1010> Meier, M.F., 1984. Contribution of Small Glaciers to Global Sea Level. *Science* 226, 1418–1421. <https://doi.org/10.1126/science.226.4681.1418>

Radić, V., Hock, R., 2014. Glaciers in the Earth's Hydrological Cycle: Assessments of Glacier Mass and Runoff Changes on Global and Regional Scales. *Surv. Geophys.* 35, 813–837. <https://doi.org/10.1007/s10712-013-9262-y>

Rost, Stefanie, Gerten, D., Bondeau, A., Lucht, W., Rohwer, J., Schaphoff, S., 2008. Agricultural green and blue water consumption and its influence on the global water system. *Water Resour. Res.* 44, W09405. <https://doi.org/10.1029/2007WR006331>

Rost, S., Gerten, D., Heyder, U., 2008. Human alterations of the terrestrial water cycle through land management. *Adv Geosci* 18, 43–50. <https://doi.org/10.5194/adgeo-18-43-2008>

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