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Reply on RC1

Shengli Tao et al.

Author comment on "A global long-term, high-resolution satellite radar backscatter data record (1992–2022+): merging C-band ERS/ASCAT and Ku-band QSCAT" by Shengli Tao et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2022-264-AC1, 2022

This work developed a monthly global long-term satellite radar C-band backscatter data set (CScat) by fusion of ERS-1(C-band), QSCAT (Ku-band) and ASCAT(C-band) observations using a new rescaling method. Maybe the CScat data set has useful in analysis and understanding of some global surface parameters (e.g., vegetation and soil moisture). But the temporal resolution is little low. And, there are some main problems of this manuscript:

Response: We thank Referee #1 for reviewing our manuscript. All the received comments have been carefully considered. The review is overall beneficial for improving our research, and we very much appreciate this chance to discuss with Referee #1 on some potentially unclear parts of our manuscript. Below please find a point-by-point reply. A full revision will be available once comments from all referees are received.

1) The signals of Ku-band (13.4GHz) and C-band (5.3GHz) microwave is different. Theoretically, comparing the Ku-band, the X-band and C-band have more similar frequency. Authors choose the Ku-band to fill up the six-year gap of the C-band scatterometer, not choose the X-band, L-band. It is no reasonable explanation here. In addition, authors did not choose data of the same C-band satellite radar data for fusion. It is better using same C-band radar data for fusion. For example, ERS-1/2, ASCAT, Sentinel-1 and GF-3 et al. The results of microwave data merging using the same microwave C-band have greater application significance compared with different microwave bands.

Response: Thanks. We fully agree that Ku-band and C-band signal dynamics are different, but we believe this is exactly why our research is potentially valuable: we successfully developed an approach to adjust the Ku-band signals into C-band signal dynamics.

Referee #1 asked why X-band or C-band data were not used for filling the six-year (2001-2007) data gap between ERS and ASCAT. We appreciate that this point might have not been made clear enough in the manuscript, thus will address it in full during revision.

The answer to Referee #1's question is: as far as we know, there is no such data at the global scale. Referee #1 first mentioned X-band data. However, the only X-band sensor covering the entire period of 2001-2007 is TRMM TMI. Unfortunately, TMI is only available for tropical regions. Since we aimed at producing a global dataset, TMI was not used.

Referee #1 then mentioned C-band Sentinel-1 and GF-3. However, Sentinel-1 and GF-3 are available since 2014 and 2016, respectively, thus cannot be used to bridge the data gap of 2001-2007.

2) For the developed new rescaling method, the comparison analysis in Figure 3 is not enough with CDF method in only two sites. And, Is the new rescaling method developed by authors only applicable to Ku-band correction? Can X-band and L-band data also be fused with C-band using this new rescaling method☐

Response: Indeed, we showed only two examples in Fig. 3. We will provide more examples during revision to address this concern. Meanwhile, we emphasize that we have placed an utmost emphasis on transparency, including making all the results fully available for anyone to inspect the merged signals.

The new scaling method relied only on the mean and the std of the overlapping observations between two microwave sensors. It's therefore theoretically applicable to other microwave sensors as long as overlapping observations are presented. Because our research deals with C-band and Ku-band signals, we tested the new scaling method on these two kinds of signals. Referee #1 mentioned X-band and L-band data but didn't specify the name of such data. We will be glad to test further our method if Referee #1 could provide more details here.

3) I think the validation of CScat data set is not sufficient if authors only used ERS-2 data as validation data for CScat. I suggested that the authors consider using the C-band observation data of airborne or other satellite/sensor different ERS-1/2 as comparison data. And, I doubt the reliability of the validation results of CScat data set. Authors used the ERS-1 observation radar signals to correct the Ku-band signals of QSCAT, and used the ERS-2 signals to validate the corrected Ku-band data. Because the satellite parameters and sensor parameters of ERS-1 and ERS-2 are the quite same, the observation radar signals of ERS-1 and ERS-2 are very similar at the same place and time. This may be the reason for the very high correlation coefficient in Figure 9.

Response: We believe there is a misunderstanding of our method here, thus respectfully disagree. Referee #1's statement, "Authors used the ERS-1 observation radar signals to correct the Ku-band signals of QSCAT", is unfortunately incorrect: we did not use ERS-1 to correct the Ku-band signals.

Instead, we used C-band ERS-2 (1996-2001) and ASCAT (2007-2020) to adjust the Ku-band QSCAT (1999-2009) into C-band signal dynamics, based on overlapping observations in the years of 1999-2001 (between ERS-2 and QSCAT) and 2007-2009 (between ASCAT and QSCAT).

To check whether Ku-band QSCAT signals have been well adjusted into C-band dynamics, the best validation data should be a continuous C-band time series extending through our study period---This is exactly what we did with Fig. 9:

although ERS-2 stopped working in full mode after 2001, observations are occasionally available for a subset of global pixels until 2011. Comparing our merged radar signal against this long-term but spatially incomplete ERS-2 dataset is the strictest validation we can perform.

Referee #1 suggested "…the authors consider using the C-band observation data of airborne or other satellite/sensor different ERS-1/2 as comparison data". Again, we will be glad to perform the validation if Referee #1 can specify where to obtain such validation data.

4) The English language of manuscript needs to be polished. The abstract of this manuscript is too long. For the introduction of this manuscript, the research background for active microwave fusion or rescaling study is not sufficient. In 110 lines, is there any other studies that show that the Ku-band QSCAT signal can be adjusted to the ERS observations except the author's own research (i.e., Tao et al.,2002b)? I suggest that the abstract and introduction of this manuscript need to be rewritten.

Response: Thank you. Regarding English writing, we would appreciate if Referee #1 can point out directly which sentences are unclear. We will address them during revision.

Referee #1 pointed out that the abstract is too long. Indeed, the abstract is longer than requested by other journals. However, before submitting our paper, we double-checked the submission guideline of ESSD, and found no limitation on the length of the abstract. We therefore choose to write a relatively long abstract to make our methods and results as clear as possible. Per suggestion of Referee #1, we will try to shorten the abstract.

Regarding the Introduction, we appreciate the suggestion that more background for fusing active microwave data is needed, and we will revise accordingly. We would also like to mention that, as far as we know, our research is the first to merge active microwave signals at the global scale. We have successfully merged signals from the same sensors (ERS, QSCAT, and ASCAT) for global tropics (Tao et al. 2020b). Referee #1 questioned *"is there any other studies that show that the Ku-band QSCAT signal can be adjusted to the ERS observations except the author's own research (i.e., Tao et al.,2002b)? "* **We appreciate this question, the answer to which is yes: recently, Frolking et al. (2022a & b) have been published which merged signals from exactly the same sensors but for global metropolis. Their research therefore confirms that QSCAT is one of the best options for gap-filling the six-year data between the ERS and ASCAT. We will revise our manuscript to make sure Frolking et al. (2022 a & b) are referred.**

Frolking, S., Milliman, T., Mahtta, R., Paget, A., Long, D. G., & Seto, K. C. (2022a). A global urban microwave backscatter time series data set for 1993–2020 using ERS, QuikSCAT, and ASCAT data. Scientific Data, 9(1), 1-12.

Frolking, S., Mahtta, R., Milliman, T., & Seto, K. C. (2022b). Three decades of global trends in urban microwave backscatter, building volume and city GDP. Remote Sensing of Environment, 281, 113225.

Above-mentioned, I am in a difficult position to reject the manuscript for publication

Response: Once again, we thank Referee #1 for commenting on our manuscript. We hope our reply have clarified the unclear points of our manuscript, as well as the potential misunderstandings. Hopefully, we will have the chance to prepare a fully revised manuscript to further exchange with Referee #1.