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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Validation of satellite formaldehyde (HCHO) retrievals using observations from 12 aircraft campaigns" *by* Lei Zhu et al.

Anonymous Referee #1

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In this paper, Zhu et al. evaluated OMI HCHO retrievals using in situ measurements from 12 airborne field campaigns (mostly over the U.S.) and the GEOS-Chem chemical transport model. They first compared GEOS-Chem simulated HCHO with aircraft measurements and used a constant scaling factor for each field campaign to correct the biases in GEOS-Chem simulations. The bias-corrected GEOS-Chem HCHO vertical column densities (VCDs) were then compared with OMI retrievals. It was found that OMI retrievals were generally biased high for low-HCHO conditions and had relatively small biases for high-HCHO cases. Potential reasons for the biases in OMI retrievals were also discussed. Overall, this is a useful study for understanding the quality and uncertainty in OMI HCHO retrievals. The authors expanded upon their previous study

using the same approach (Zhu et al., 2016) to different locations and seasons. The advantage of the approach is that by using GEOS-Chem as a transfer standard, data from different field campaigns (often involving different instruments) can be used in a more consistent way for satellite validation. The paper is generally well written. There are, however, several points that need to be clarified. I would recommend that the paper be accepted for publication after the following comments have been addressed.

Specific Comments:

González Abad et al. (2015) showed that there were fairly large changes in OMI HCHO retrievals over remote background areas between the beginning of OMI (2004-2005) and more recent years (2012 and later). All the field campaigns discussed in this study took place after 2013. Have the authors looked into data from earlier field campaigns to check , for example, whether OMI retrieval biases under low-HCHO conditions were smaller in earlier years?

Given the positive biases over low-HCHO areas and (smaller but mostly negative) biases over high HCHO areas in GEOS-Chem simulations, using a fixed scaling factor may not be appropriate for some of the field campaigns. For example, as shown in Figure 4, the mean HCHO VCD can range from ∼3*10ˆ15 molecules/cmˆ2 to over 10ˆ16 molecules/cmˆ2 and it is possible that GEOS-Chem overestimates HCHO over relatively clean areas in the southwest corner of the domain, and at the meantime underestimates HCHO over the southeast corner of the domain. Also by changing the domain slightly (for example, expand the domain to the west), the comparisons between OMI and bias-corrected GEOS-Chem can probably yield somewhat different results.

The authors proposed the validation method as a "global validation platform". Since the field campaigns discussed in this paper had no coverage outside of North America and Asia Pacific region, this is hardly "global". Also for the method to be a "platform", there should be some utilities or applications that facilitate the validation of not just

NASA OMI HCHO retrievals, but also retrievals from other satellite sensors/algorithms. Maybe there should also be functionality to ingest additional field campaign data and/or CTM simulations to be used in validation. I wonder if the authors can discuss these aspects of the validation platform (probably as an appendix).

Technical Comments:

Figure 3 is discussed quite extensively in two parts: lines 119-125 and lines 155-161. Maybe the authors can re-organize and consolidate the two parts?

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