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Interactive comment

Interactive comment on "Characterizing Sampling and Quality Screening Biases in Infrared and Microwave Limb Sounding" *by* Luis F. Millán et al.

Anonymous Referee #1

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This paper discusses the impact of non-uniform sampling of the MIPAS and MLS instruments on resulting zonally averaged data with particular emphasis on how data quality screening exacerbates biases. The authors describe how MIPAS and MLS have similar sampling biases but how MIPAS data is detrimentally affected by screening through the use of running MIPAS and MLS sampling through the CMAM30-SD CCM. While the methodology applied has some use and accurate in its basic conclusions, some of the more meaningful conclusions (e.g., impacts on ability to derive trends from different instruments in the UTLS) are not supported by analysis and thus speculative. Furthermore, the scope of this work is severely limited and the tone of the paper is seemingly self-serving. As such, I would recommend this work for publication only after additional work and major revision.

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Discussion paper

Major Comments:

Pg. 02, Line 29: “We emphasize that the results of this study refer only to the representativeness of the respective data, not to their intrinsic quality.”

This statement greatly detracts from the value of this work. This work makes very clear remarks regarding the impact of sampling biases on the ability to use certain kinds of data sets for trend analysis in the UTLS and how sampling biases will require longer data sets because of the added noise. However, the quality of the data sets that are used is a critical component to those kinds of analyses. Recent work in the 2014 Ozone Assessment or the SI2N effort (https://www.atmos-chem-phys.net/special_issue284.html) have shown that sampling biases, while present in trend analyses, are not necessarily the greatest driver of trend uncertainty as data quality issues and instrument drifts are also present. Incorporating data quality into the calculation is necessary, as it is still possible for higher precision data with sampling biases to be more robust for trending work than lower precision data, though it ultimately depends on what those precisions and sampling impacts are.

Pg. 06, Line 32 and Pg. 07, Line 25: “These poor metrics imply that any trends derived at these pressure levels will also be impacted by quality screening induced biases: the magnitude of the trends will be affected because of the change in the slope, and the number of years of observations required to conclusively detect trends will considerably increase due to the noise associated with the worsening of the coefficients of determination (e.g., Millán et al., 2016).”

Biases and trends can be completely independent and the slopes that are referred to here are not trend slopes but correlation slopes. For example, a seasonally dependent dry bias in H2O as shown in Fig. 5 does not guarantee an induced bias in the trend values and so the impact of these sampling biases on trends is not directly addressed by this work. Furthermore, while it is true that increased noise in the data can result in requiring longer duration data records to determine significant trends, neither this study nor Millan et al. (2016) considers the attribution between data quality and non-uniform sampling. Without additional work to address the impacts of each of these factors, this entire statement is only speculative.

In general, the scope of this work is severely limited. The statement that an instrument's inability to see through clouds will result in less data is obvious while comparing two data sets to ascertain the impact on trends without considering data quality is neglectful. As it stands, this study has limited to no scientific value. However, the underlying concept of this work could be expanded albeit with simulated sampling and uncertainties. For example, the authors could simulate different sampling patterns from different orbit types and sampling frequencies for an expected limb sounder. Running these through model data would allow for comparisons of the impact of different potential sampling patterns. To further test potential data quality screening, utilizing model cloud fields or retrieval limitations of different observation techniques would create another variable to test rather than using the data quality screening of a specific instrument. Lastly, the authors could simulate differing data precisions or vertical resolutions from all of these sensitivity tests and incorporate the resulting uncertainties into trending analyses to determine the impact of all of these variables on the derived trends. This would provide a large solution space to test the impacts of potential measurement systems on their ability to be used for trending analyses in the UTLS region. While these suggestions are extensive and perhaps more comprehensive, some aspect(s) would be necessary to incorporate actual data quality into the authors' data quality screening to back up the claims regarding the impact on trend detection.

Perhaps what is most troubling is the tone of the paper. It seems that the purpose of this paper is to act as a published reference for why a future MLS instrument must be used to ascertain long-term trends of trace gas species in the UTLS. The authors appear to go to great lengths to phrase the message as to assert the “superiority” of MLS measurements over MIPAS at every turn (i.e., pointing out all potential deficiencies in MIPAS data without mentioning any for MLS), and even go as far as attempting to undermine the usefulness of other current or future measurement systems as evidenced by the last two sentences in the paper. While this type of rhetoric is expected in a proposal, it is not suited for a scientific publication.

Minor Comments:

Pg. 01, Line 23: “Further, satellite missions such as . . . have records that span more than a decade.” This statement is phrased in such a way as to suggest that no ground station data have records that long. I would suggest revising.

Pg. 02, Line 09: “They concluded that coarse non-uniform sampling leads to non-negligible biases . . .” Biases in what? Is that data biased from the sampling or are the analysis methods not conducive to using data with non-uniform sampling?

Pg. 02, Line 13: “They found that coarse non-uniform sampling patterns can induce significant errors in the magnitudes of inferred trends . . .” Again, is this a flaw in the data or the analysis method?

Pg. 04, Line 12: “MLS measures around 3500 vertical scans daily, providing near-global (82S to 82N) observations.” Please also include the geospatial sampling characteristics of the MIPAS instrument in its description.

Pg. 04, Line 20: “Further, we used the vertical grid of the CMAM30-SD fields; that is, we assume that MIPAS and MLS vertical resolution is good enough to resolve these model fields, at least in the upper troposphere / lower stratosphere (UTLS).” What are the vertical resolutions of the model and instruments in the UTLS?

Pg. 06, Line 31 and Pg. 07, Line 24: “The biases for O3 and HNO3 oscillate between -10

Figure 5: It would be better to change the X-axis label interval on the time-series plot to every 5 years.

Figures 6 and 7: There is a lot of unnecessary white space in some of these plots, though given the desire to maintain consistent axes ranges between the two I can see why Figure 6 has so much white space. That having been said, I still think some reductions can be made to make the results easier to see. Additionally, for whatever reason the line thicknesses appear the same between Figs. 6 and 7 when zoomed out but are much thinner in Fig. 6 when zoomed in. Lastly, what is the bottommost pressure level on the Y-axis?

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