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Interactive Comment

Interactive comment on "Long term validation of ESA operational retrieval (version 6.0) of MIPAS Envisat vertical profiles of methane, nitrous oxides, CFC-11 and CFC-12 using balloon borne observations and trajectory matching" *by* A. Engel et al.

Anonymous Referee #2

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This paper provides an important evaluation/validation for key trace gas products from the MIPAS-E satellite measurements, specifically the operational ESA retrieval version ML2PP/6.0. It is essentially a comparison study of data from BONBON, a balloon-borne cryosampler instrument, and the MIPAS-E operational retrieval products CH4, N2O, CFC-12, and CFC-11. The comparison makes use of a trajectory matching technique to increase the number of coincidences between the balloon and satellite data.

A total 7 balloon flights are used for comparison.

The BONBON data are of high quality and can be considered a useful standard for validation of the satellite data. Thus, the paper represents an important contribution to the scientific community that uses MIPAS data in their analyses. This paper may be suitable for publication in AMT, provided that the major comments below are adequately addressed.

Major Comments

1. There are a number possible uncertainties that can creep in when comparing in situ and satellite vertical profiles. First, even in the case of a direct satellite overpass, one usually has to consider the impact of vertical averaging kernels in comparing satellite and balloon vertical profiles. This is particularly important for species with large vertical gradients, such as CFC-11. There is no discussion of the effect of MIPAS averaging kernels on the comparison. Second, the impact of trajectory errors on the comparison should be explored. These may turn out be small, but they should be quantified. For example, even at 1.25 degrees , it is unlikely that the initialization point exactly lines up with the balloon location, so how do the results differ if one chooses the next-nearest ECMWF gridpoint for initializing the back- and forward-trajectories? In the vertical, it is possible that using climatological heating rates could lead to under- or over-estimation of vertical displacements. Although the manuscript states that these deviations are small, for gases such as CFC-11 with large vertical gradients, even small vertical displacements could have a large impact on the matched CFC-11. Finally, the choice of 500 km for spatial coincidence should be justified. Presumably, it is a compromise between the quantity of matches and trying to sample the same airmass. The paper should discuss what kind of results were obtained using other coincidence criteria (e.g. 250 km, 1,000 km, etc.) to give an indication of how that impacted the number of matches and whether or not that changed the mean differences.

2. The paper does a good job at separating the comparison between the high spectral

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resolution, “older” dataset, and the lower resolution “younger” dataset. But given the differences in latitude of the 7 balloon flights, and the fact that the two tropical flights (B42 and B43) occurred during the younger MIPAS phase, it is possible that some of the changes seen between the older and younger data comparisons may in fact be due to latitude effects. The analysis of B42-B46 could be split into low- latitude and high-latitude comparisons. It may not be necessary to show results in a figure, but it would allow the authors to comment on any differences with respect to latitude, which could be significant given the very large contrast between low- and high-latitude vertical profiles.

3. Units for differences: The significant differences between MIPAS and BONBON are reported in mixing ratios (ppb or ppt), but since all of these gases have steep vertical gradients, it would also be useful to report any significant differences in percent values such as (MIPAS-BONBON)/BONBONx100%. Presumably the mean % differences could be calculated in a straightforward way. It may not be necessary to include additional figures, but the major points in the conclusion ought to include percentages. For example, the underestimation of N2O by 20 ppb around 15 km and of CFC-12 by 50 ppt at 10 km in the younger MIPAS data should also be reported as mean % differences. Also for CFC- 11, it would be good to note how the percent difference grow rapidly from 10-20% around 15 km to a few hundred percent or larger at 25 km.

4. Comparison to other retrieval algorithms: As noted in the manuscript, there are a number of different analysis algorithms for retrieving CH4, N2O, and the two major CFCs from MIPAS data. This can lead to confusion and uncertainty in applying MIPAS products to science investigations. If there has been an intercomparison study between retrieved products, then it would be good to include a reference and make some general statements about the implications of the results in this paper to the other retrievals. For CFC-11 in particular, since this study does not recommend its use in scientific studies, it would be useful to know whether that applies to the other retrievals as well.

Minor comments

1. section 2.3, line 16: “where” should be “were”

2. section 2.3, line 25: “winter” should be “winter/spring” for 9 march and 1 april

3. section 2.4, lines 17-20: The sentence is unclear. Should the “matched altitude interval of the satellite data be *less* than 1.5 km?

4. section 3, line 27: “...in the in situ *data* is sufficiently small...”

5. section 3.4, lines 27-28: It appears from Figure 14 that that for the younger data, the CFC-11 differences below 20 km can be explained with the measurement uncertainty, so this statement seems to be too general.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 7455, 2015.