

Interactive comment on “MIPAS IMK/IAA CFC-11 (CCl₃F) and CFC-12 (CCl₂F₂) measurements: accuracy, precision and long-term stability” by E. Eckert et al.

Anonymous Referee #1

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MIPAS IMK/IAA CFC-11 and CFC-12 measurements: accuracy, precision and long-term stability.

Eckert et al

REFEREE COMMENTS

SUMMARY

The paper contains a number of comparisons of profiles of CFC-11 and CFC-12 retrieved from the Envisat MIPAS instrument by the IMK/IAA L2 processor, with colocated profiles from other instruments as well as a ground-based network. From these results

C2788

the authors conclude that their CFC-11 values are 5-20% too high below 15km, but have a smaller (although unspecified) error above this. For the CFC-12 the accuracy is probably similar or better.

As regards precision, the conclusion is that the noise SD is probably an underestimate of the actual precision.

The CFC-11 data appear to have a negative drift of a few percent per decade, which is an order of magnitude smaller than the overall rate of decrease of atmospheric CFC-11. For CFC-12 the instrument drift is much larger (in the stratosphere) and of variable sign, and dominates the observed changes in MIPAS CFC-12 data.

MAJOR CONCERNS

1) STATED GOALS: Despite the title of the paper, the authors fail to provide any clear statement on either the accuracy or precision of their data (although I acknowledge that the long-term stability is explicitly, and convincingly, demonstrated). Instead, the authors provide is a list of comparisons with other datasets, from which one can discern relative biases; and measurements of SD of these differences, which contain a combination of precision of the two measurements and atmospheric variability.

Accuracy: I appreciate that absolute accuracy is hard to establish but there is little attempt to rate the correlative datasets according to probable absolute accuracy eg I would guess that the cryo-sampler would be top of the list, and ILAS bottom. If the aim is to give an overall picture of the level of agreement of different datasets, that's not reflected in the title of the paper. If the aim is to establish the absolute accuracy, only datasets known to be of comparable or better quality than MIPAS should be used. Either way it would have been useful to have a single summary plot of the biases (difference v. altitude) from the different comparison datasets. And there should be at least a clearly stated numerical value, in the abstract and the summary, for the upper limit of the estimated accuracy for the full profiles of both CFC-11 and CFC-12.

C2789

Precision: the only message seems to be that the nominal precision, ie propagation of noise into the profile retrieval, is probably too small, which (except in the case of particularly noisy measurements) is hardly surprising. There are a number of obvious self-consistency tests that could have been used to quantify the precision of a satellite dataset, eg RMS difference between successive profiles, orbit intersections, SD of the mean in dynamically quiescent atmospheric conditions, but none is used here. Similarly, 'atmospheric variability' is often cited as a probably contributing factor to the observed scatter, but with no attempt to quantify this (my guess is that this is negligible for CFCs, apart from disturbed vortex conditions). With so many of the other instruments measuring both CFC-11 and CFC-12, plotting the correlations between these two products might also have highlighted the different relative precisions of these instruments. Again at the minimum there should be a citable number for the estimated precision of the CFC-11 and CFC-12 products.

Ultimately the question a user might be wondering is: is a single profile from MIPAS better than using climatology for a particular time/location? What about a monthly zonal mean? Or an annual global mean? The paper should make some reference to the expected atmospheric variability which ultimately define whether or not the product is likely to be useful at various resolutions.

A related concern is that there is widespread use of terms such as 'excellent agreement' and 'very good agreement' but with little objective basis for these statements, which might lead a casual reader to conclude, for example, that since the overall agreement between MIPAS and HIRDLS is described as 'excellent' (P7610, L14) while ACE-FTS is merely 'good' (P7612, L9), the HIRDLS-MIPAS data must be a better match (ie more interchangeable) than ACE-MIPAS, while a comparison of the scatter in Figs 21 and 24 shows quite the opposite.

2) STRUCTURE Firstly, given the similarity of the FR/OR results (certainly more similarity between the two modes than between MIPAS and any of the other instruments) the paper could be shortened by combining the two datasets for comparisons.

C2790

Comparisons are not helped by different types of plots and analyses being used for each different instrument rather than, say, one set of plots for limited profiles (cryosampler, MIPAS-B, MIPAS-STR, Mark IV). At least for the HIRDLS and ACE-FTS comparisons similar plots are used.

Section 2.2 discusses at length the various other instruments used in the comparisons, however it does seem like a collection of separate contributions (possibly from the various co-authors) without much attempt to harmonise or compare the information presented, or even to avoid repetition of previously-defined acronyms (MIPAS, KOPRA). In any case much of the information is more concisely (and clearly) summarised in Table 1, so this section could be considerably shortened by avoiding repetition of the same information and restriction to relevant details (eg I don't really need to know that the BONBON inlet has a gold pipe, when MIPAS-B made its maiden flight, the details of the cut-off criteria for ACE-FTS profiles, the location of the launch site of ADEOS).

On the other hand it would have been useful to include (in Table 1) the spectral resolution or sampling of the different interferometers, and flight altitude of the non-satellite measurements. Perhaps I missed it, but I couldn't find any reference to Table 1 in the main text either.

MINOR COMMENTS

a) The MIPAS-QWG 'recommends' that the term 'Optimised Resolution' (OR) is used instead of 'Reduced Resolution' (RR). Just mentioning it, that's all.

b) Given the repeated reference to 'MIPAS Envisat' in this paper, I would suggest shortening to just 'MIPAS', with MIPAS-B and MIPAS-STR being used to distinguish the balloon and airborne versions.

c) The authors frequently use 'comp.' followed by some reference. I don't know what this means. 'Compared with' suggests some contradictory opinion, but its use seems to be to cite supporting opinion.

C2791

d) Eg '685 and 2410cm⁻¹ (4.1 and 14.6µm)' (and several other places) - to me it seems better to keep the wavelength values in the same order as the preceding wavenumber values, so '(14.6 and 4.1µm)'. But that's just my opinion.

e) It would be useful to have a plot showing the CFC-11 emission spectrum (or at least the 850cm⁻¹ band) with, superimposed, the various spectral regions used by the other instruments. Certainly much clearer than trying to describe these in the body of the text.

f) There is little reference to the source of spectroscopic data used by the different instrument teams. Could different spectroscopic data account for some of the observed differences?

g) Comparing mean profiles (or mean differences) can sometimes be misleading since one dataset or the other may not be symmetrically distributed about its mean. It would be better also to include the median differences on such plots.

h) Mark IV comparisons: Could these just be due to a 1-2km altitude offset between the profiles? Are opposite biases seen for profiles of quantities which increase with height through the stratosphere, such as temperature or HNO₃?

i) For the figures, it would be helpful to have a clear title showing which instrument is being compared, or else add more detail in the caption, not just 'same as fig ... but for CFC-12'. Also, where relevant, list the latitude for the comparisons as well as the date.

j) Caution may need to be applied when taking the mean of HIRDLS data. Some time ago - I don't know if this is still true - part of the radiometric calibration involved correcting the radiances to match the expected values from climatological profiles so naturally the mean values would agree with climatology but would not constitute an independent bias validation.

k) With the HATS comparisons it wasn't clear whether the HATS data have been averaged to produce a true global mean, or if there is some latitude-weighting representing

C2792

the locations of the stations. It seems that the oscillations in MIPAS CFC-11 are well-correlated with those of CFC-12 and exhibit an annual cycle (min around March, max around September), which is worth mentioning. Also, I would have liked to have seen the FR time period included in these plots rather than as separate plots.

l) I don't understand why the ESA CFC-11 and CFC-12 MIPAS products have been omitted from the intercomparison - they would have no colocation error. Indeed there is not even any mention of the existence of these products.

SPECIFIC COMMENTS

P7576, L9: for clarity, I suggest adding that these CFC-11 drifts are superimposed on an overall, larger, decreasing trend in atmospheric CFC-11.

P7579, L8: 0.035 and 0.0625 cm⁻¹. The instrument spectral sampling for the FR/OR modes is 0.025 and 0.0625cm⁻¹, so I would expect the actual unapodized spectral resolution to be larger than 0.0625cm⁻¹ for the OR mode.

P7580, L5-20: This information on altitude range, vertical resolution, sampling, precision would be much clearer if presented on a diagram.

P7580, L8,L12: Altitude coverage down to 5km is claimed, but on P7579 L17 the lowest observation altitude is 7km.

P7582, L8: 'equivalent to the satellite version'. Presumably in FR mode?

P7590, L19: The 1km grid is not actually the 'MIPAS Envisat grid', which implies some fundamental link to the instrument itself, but simply the grid chosen for the IMK/IAA profile retrievals.

P7590, Eqs 4 and 5: would be simpler, and clearer, if Eq 5 came first and the standard error could simply be defined as SD/sqrt(n).

P1592, L14: It seems a bit too strong a claim to say that such deviations can be 'reliably' detected on the basis of a single example. To be convinced I would have liked to have

C2793

seen the comparisons with the cryosampler shown as deviations about, say, the MIPAS monthly zonal mean to verify whether or not individual MIPAS profiles really do agree with the cryosampler in picking out deviations.

P7595, L28: the 'slight bump' in the HIRDLS data is not evident to me. Nevertheless, the MIPAS 150pptv peak at 23 km is curious - is this associated with MIPAS data from a particular latitude?

P7602, comparisons with ILAS: I think the only point worth making here is that the ILAS data is clearly wrong, so no need to dwell on the details.

P7604, long-term stability: a couple of points worth making here are that the MIPAS detector non-linearity, translated as a radiometric gain error, would be partly compensated by the temperature retrieval so the residual effect on the CFC-11 retrieval is even smaller. Secondly, any such drift with time would not be expected to be latitude dependent and, as a percentage error, probably also altitude-independent, which is consistent with the uniformity shown on the left panel in Fig 16.

P7606, L2: I'm not convinced that these deviations represent 'proof' of large natural variability outside the winter polar vortex - as with the CFC-11 plots I would like to have seen comparisons of deviations from the zonal mean before being convinced that these aren't just random variations in the MIPAS profiles.

P7606, & Fig 18: here the MIPAS CFC-12 profiles extend to 50km but Table 1 lists the maximum altitude as 40km. In any case, the MIPAS oscillations are probably comparable with the vertical resolution of the retrieval at these altitudes so should not be interpreted as representing real atmospheric features.

P7608, L18: The suggestion here seems to be that the consistency between the CFC-11 and CFC-12 profiles measured by MIPAS, and those measured by MIPAS-STR, is evidence that both are retrieving the correct profiles but targeting different airmasses. Perhaps you could include some neighbouring MIPAS profiles as in the cryosampler

C2794

comparisons to show that such local variability is indeed present?

P7648, L21: Again, I struggle to see these multiple peaks in the HIRDLS data.

P7612, L29: so is most of the trend visible in the right plot of Fig 32 due to the change in non-linearity correction shown in the left hand plot? (see also comment below on the Fig 16/32). If so, why not show what happens if the non-linearity trend is subtracted?

Figs 6, 9, 22 & 25: a minor point, but these might be clearer if the outline of the comparison histogram was superimposed on the MIPAS data rather than as separate plots in the bottom row. Perhaps also mark mean and median.

Figs 16 and 32: it is not clear whether the plots on the right are the absolute trend in MIPAS data or if the effect of the changing non-linearity correction has been included.

GRAMMATICAL/TYPOGRAPHICAL

P7575, L3: 'abord' should be 'aboard'

P7578, L4: extra space after 'Organisation'

P7578, L12: 'deteriorated' suggested some inevitable and progressive worsening in instrument resolution, whereas in fact it was a deliberate, and instantaneous, change in the way the instrument was operated.

P7578, L17: 'A concluding summary is closing the paper' - clumsy wording - suggest 'The paper concludes with a summary'.

P7578, L23: 'Guyana', with a 'y' is a (different) country, formerly known as 'British Guiana'. Here it should be 'Guiana Space Centre' and 'French Guiana'.

P7579, L1: Suggest '10:00' and '22:00' local time as more conventional time notation.

P7579, L4: 'emission AT the limb' - suggest 'from the limb', the measurement was AT an altitude of 790km.

P7579, L10: 'In correspondence' - suggest: 'In consequence'

C2795

P7579, L26: 'was retrieved' should, pedantically, be 'were retrived'.

P7580, L9: 'is 3 up to' and 'about 7 at' - I assume the units are km?

P7587, L2: 'edition' - How does one 'edit' a satellite?

P7587, L4: I assume 'Nakajima et al' is the appropriate reference rather than part of the name of the satellite.

P7592, L18: 'excessive' - perhaps 'excess' is better.

P7593, L19: 'good' should be 'well' (adverb rather than adjective required)

P7597, L24: 'similar as for' - suggest 'similarly to'

P7599, L18: 'spectroscopical' - should be 'spectroscopic'

P7600, L5: should this be 'Sect 4.3' for details? (also P7612 L25).

P7604, L26: presumably 'right panel' for the MIPAS trends.

P7608, L18: 'due to the fact, that' - remove comma after 'fact'.

P7613, L1: 'extend' should be 'extent'.

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