General Comments

This is a reasonably short paper, presenting phosgene retrievals from the MIPAS ESA version 8 processor. The manuscript presents the global distribution, trends and comparisons with ACE-FTS data. Overall, I would say this is an adequate study, without being particularly ground breaking. AMT seems a good match for publishing this manuscript, although firstly there are a number of points that need to be addressed.

There have been a number of previous studies utilising satellite-derived phosgene (mainly from the ACE-FTS). It isn't clear to me what the motivation is for this study, so the authors should explain in more detail what this study tells us that we didn't already know.

ANSWER: Thank you very much for your comments that, we believe, will contribute to improve our paper.

Specific Comments

After reading this manuscript I am left with a number of questions that aren't addressed.

The manuscript glosses over the derivation of the a priori, which comes from the so-called IG2 profiles. For phosgene, these are averages of ACE v3.5/3.6 data. However, as with all satellite datasets, these ACE measurements (and therefore the a priori) are subject to bias. In fact, the ACE retrievals use completely different phosgene spectroscopy, and are likely not consistent with MIPAS spectroscopy.

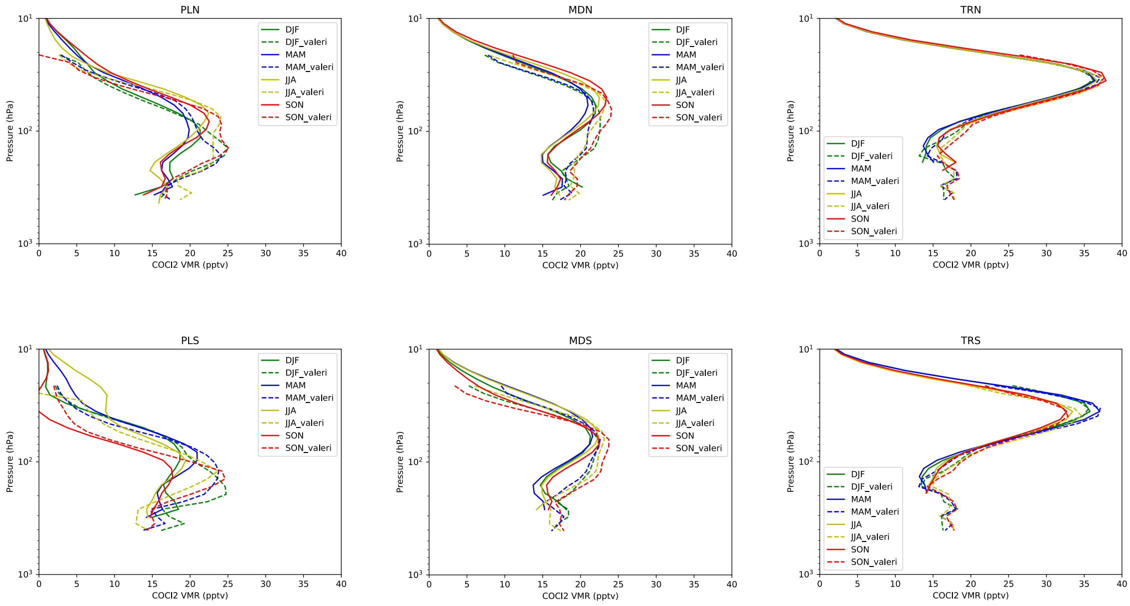
Additionally, using ACE data as the a priori also makes any MIPAS-ACE comparison appear rather circular.

I would like to see a more in depth discussion of the choice of a priori, and its contribution to the retrieved MIPAS mixing ratios at each level. How does this contribution change over the profile, if at all?

ANSWER: Actually, $COCl_2$ profiles included in the IG2 database stem from ACE data complemented with model data (in turn, the model has been tuned by comparisons with ACE data). While the IG2 database contains climatological profiles for 6 different latitude bands and 4 seasons, as a-priori we use a single profile, computed as a seasonal and latitudinal average of the IG2 tabulated profiles. In any individual retrieval this profile is then interpolated to the pressures corresponding to the altitudes of the vertical retrieval grid. Therefore, it is true that MIPAS v.8 products are not fully independent from ACE products, however we do not believe that such a weak dependency can invalidate the comparison with ACE measurements. The contribution of the a priori is different for each profile retrieval grid point and to quantify this contribution, we added to figure 2 a curve representing the information gain at each retrieval altitude. In the revised version of the paper the reader can evaluate the influence of the a-priori information and see that it becomes important at high altitudes, where the information gain decreases.

How does the new retrieval compare with the previous one in the study of Valeri et al? I understand there are some spectroscopy differences which should be considered here.

ANSWER: In the following plots we can see both COCl2 profiles of Valeri et al. (dotted lines) and ORM v.8 COCl2 profiles used for the study presented in this paper (solid lines). Plotted profiles are averages obtained exactly as in Valeri et al. (same days of data, same latitudinal bands and same seasons). The main differences occur below 100 hPa in polar and mid-latitude regions where negative differences between MIPAS v8 data and Valeri's profiles are visible. We used the same COCl2 spectroscopic database that is reported in Valeri article. However, Valeri et al. performed their analysis using version 7 of MIPAS level 1 data. That have a different correction of the time dependent nonlinearity of the detectors (see Kleinert et al, 2019). This and the different Micro-Windows (MWs) used for the retrievals and the different retrieval strategy can be responsible for the observed differences. Indeed, Valeri, differently from us, performed a simultaneous retrieval of COCl2 and CFC-11 because of their spectral interference occurring in his MWs.

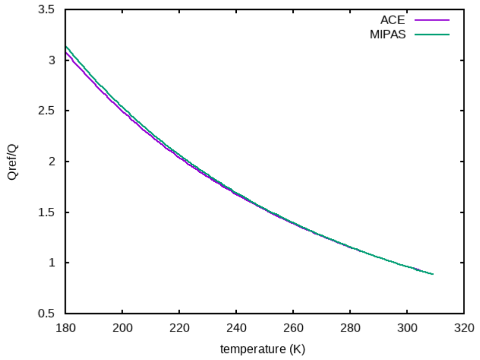


3. Figure 9 indicates to me that the retrieval is far from perfect. There is a large offset/bias between OR and FR, which unfortunately casts doubt on the quality of the phosgene retrievals. What causes this? Is it linked to differences in the vertical resolution between OR and FR?

ANSWER: This offset is a well-known problem, present in most of the MIPAS products. We know that it exists, and we take it into account in the trend computation. It is mainly due to the different Micro-Windows (MWs) used for the retrieval in the FR and OR periods. Minor contributions are also due to the different vertical resolution and vertical sampling in the two mission periods.

4. There is no detailed discussion of the difference in spectroscopy between MIPAS and ACE. Figure 7 provides a plot of differences for just MIPAS. However, differences can also arise from the use of partition functions, which I suspect are handled differently for the older ACE linelist used in v3.5/3.6.

ANSWER: The difference in spectroscopy was already discussed in Valeri et al. Concerning the different partition functions, we have asked the ACE team for the partition function used in their analyses. In the plot below, we have plotted the correction that was applied to the line strength (the ratio between the reference partition function at 296 K and the partition function at a given temperature) as a function of temperature. The green line represents the one used for MIPAS and the purple one for ACE. The plot shows that the differences are almost negligible, especially in the temperature range where phosgene contribution is maximum and, as a consequence, they don't influence results presented in the paper.



5. Comparisons of MIPAS trends with ACE-FTS are rather qualitative. For example, there is no attempt to recalculate ACE trends over the same time interval as the MIPAS data. The ACE trend is simply taken from a previous publication.

ANSWER: The main purpose of this paper is to estimate the COCl2 trend from MIPAS measurements. We compare our results to data found in literature, as it is commonly done and accepted.

6. How good is the retrieved MIPAS pressure and temperature and have these been validated? These are crucial in producing good quality phosgene trends.

ANSWER: Yes, they have been validated and all information about it can be found in the Product Quality Readme File (https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.1_20210916.pdf). For the altitude scale, the bias found in the comparison against radiosonde is less than 20 m at low altitudes, increasing to a maximum of 100 m at an altitude of 10 hPa. No significant latitudinal dependencies are present. MIPAS temperatures are systematically colder than radiosonde and lidar data. The bias is less than 1 K in the stratosphere and it becomes about 2 K in the lower mesosphere. Also in this case, no significant latitudinal dependencies are present. Moreover, comparisons with radiosonde and lidar data show also a positive drift of about 0.4 K/decade in the differences between MIPAS and correlative temperature measurements. Note that such a drift in the MIPAS retrieved temperatures can't be directly translated into an error in the VMR trend. The temperature itself, which is retrieved from the same set of measurements, may actually compensate some instrumental / calibration drift which would otherwise affect the retrieved VMR.

Technical corrections:

line 31: photolysis

line 85: Fourier

line 335: resemble

Technical corrections were implemented in the revised paper.