**Atmospheric
Measurement
Techniques
Discussions**

Interactive
Comment

Interactive comment on "Impact of temperature field inhomogeneities on the retrieval of atmospheric species from MIPAS IR limb emission spectra" *by* M. Kiefer et al.

Anonymous Referee #2

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General comments:

The authors compare results obtained from various different MIPAS/Envisat level-2 processors by focusing on differences in trace gas abundances retrieved from ascending and descending parts of the orbits. They find substantial differences in the retrieved traces gas fields of selected species. The differences are attributed to thermal gradients which are according to the authors insufficiently treated in the so-called 1-dimensional processing schemes. Best results were obtained for a full 2-dimensional retrieval model, whilst a method of retrieving horizontal gradients was proposed to improve otherwise insufficient 1-dimensional retrieval models.

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1) The authors highlight substantial differences in retrieved trace gas fields from ascending and descending parts of the orbits what in itself is very useful information for the user of MIPAS data as this information needs to be taken into account in the error budget of the different level-2 data products. Unfortunately, only some general recommendations are given and the manuscript doesn't provide a useful quantitative summary which would allow a data user to easily account for the identified errors. This should be improved for the selected target species and retrieval algorithms (level-2 data versions) under study.

2) The attribution of the ascending-descending orbit differences to regions with strong temperature gradients and further to short-comings in the employed 1-d retrieval schemes (with respect to representation of the temperature structure in these regions) needs however further clarification. Results in the manuscript are based on MIPAS data processed by considerably different algorithms and software. It can not simply be concluded that studied differences in trace gas fields are due to treatment of temperature gradients, as there are most likely various other differences in the employed forward models and retrieval schemes. The explanation presented in the manuscript is so far not very convincing as important aspects have not been discussed. Results for pressure and temperature retrieval are not shown at all, although one might expect a first order effect in these primary retrieved parameters. Other possible sources of ascending-descending differences should also be discussed. For example, are corresponding differences noticeable in the MIPAS level-1 spectral data, if ascending-descending orbit or day-night spectra are compared? In order to prove attribution to the treatment of temperature (and trace gas) gradients, a classical way of showing this is to perform 2-d retrieval simulations with real MIPAS and with synthetic 2-d input data, and compare to 1-d retrieval simulations obtained with the same retrieval model, thus avoiding differences between the models.

To conclude, I feel that further work is needed on the latter aspect (attribution to temperature gradients), along with some changes to the manuscript structure, before this

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work can be recommended for publication. Alternatively, the authors might want to shift the focus (and the paper title) rather on the analysis and description of the retrieval error owing to differences in ascending-descending orbits, which along with practical recommendations would provide very useful information for the user of MIPAS level-2 data.

Specific comments:

1708

Title

Inappropriate as long as the connection of ascending-descending orbit differences is not demonstrated in the manuscript.

Abstract

See general remarks. Specifically:

14-15 "This implies that inhomogeneities in the temperature field..." This conclusion can not simply be made as many other differences in the forward and retrieval algorithms may play a role.

23-26 It is not shown in the manuscript that the discussed ascending-descending orbit differences in the level-2 products are also seen in other sensors data. This can well be a MIPAS artifact.

Introduction

1710

22-23 " and on the different ... horizontal temperature gradients ..." Why? Explain in detail, as this "assumption" is a key point in the manuscript! Why were all other sources of error discarded?

1716

10-17 (on key species):

Results of the temperature should be shown in the manuscript as this is a key parameter.

An analysis for pressure - retrieved or assigned - would also be helpful in order to clarify attribution of day-night differences.

A short paragraph on the expected diurnal variation of the selected species in the here investigated altitude range is recommended, as the paper focuses on differences between measurements taken at different local times.

1721

1-2 "implies a connection of this anomaly to horizontal temperature gradients." This is speculation, this conclusion is not straight-forward. Any other differences between the algorithms might have caused this.

20-23 Correct statement, but temperature gradients are not necessarily the only effect which can cause the differences between the various retrieval algorithms. Again, retrieved temperature, pressure (pointing?) should be analysed. Moreover, from the information given in the manuscript it is difficult to attribute this to a retrieval problem, as the effect might already be present in the spectral measurements or other instrumental data (e.g. analyse day-night or ascending-descending effect in spectral domain).

1723

24 and following : Here the authors state themselves (correctly) that temperature field inhomogeneities are not the only cause for the effect under study, but all kind of other effects might cause a deviation of the retrieved from the "true" atmospheric state. This should be made consistent throughout the manuscript.

1725

Conclusions

Implications for MIPAS users: From results presented in the manuscript, a first conclusion could be that users are recommended to use data from the 2d-retrievals, instead of the 1-d processor data. Correct? I think this point needs some elaboration, in particular as the manuscript focuses only on a specific issue and doesn't compare overall error budgets of the different retrieval processors and data versions.

4 1) "In any worked it has to be checked whether the phenomenon ... has to be taken into account". This is a good point, please elaborate when this is the case and give recommendations, this would be very helpful for the user of MIPAS data.

16-19 Reformulate or remove. Which data/instruments are meant? Do these data sets show such differences? If not, the attribution of differences in MIPAS ascending-descending orbit data to temperature gradients would be incorrect. A comparison with level-2 data from other instruments might indeed help to clarify the issue raised in the manuscript.

Technical corrections:

Introduction

1709

7 shares "in"?

24 LOS -> "line of sight": for better readability it is recommended to avoid unnecessary abbreviations or acronyms. Suggest to correct this throughout the manuscript.

1710

8 due to "day/night conditions"? Please explain / reformulate.

11 "in/out" vortex

13 was -> were

20 Which version precisely?

Section 2

1711

4 "near"?

11 ...,produced with...models,...

1712

Sec 2.3 The section appears to be incomplete. I would suggest to rewrite parts of this section with focus first on the common features and then of the major differences between the different processors. Which spectral ranges are used for the here relevant temperature and species retrievals?

7 Short explanation of global fit approach would be useful (e.g compared to optimal estimation which is detailed below).

16 Short summary of basic features of this processor should be given.

20 the "Optimal Estimation Method" is a regularised least-squares fit method.

22 "...at the risk of introducing a bias..."? Please explain.

1713

1 "at the expense of increased CPU time"? Explain why (or remove).

23 Are these the latest versions? Also provide versions for other processors, for completeness.

28 Short explanation of "retrieval of temperature gradients", compared to ordinary temperature retrieval, would be helpful.

1714

19 Does MIPAS always observe in the plane defined by the orbit track?

24 Please explain/reformulate "when the starting sequence ... at the end of the orbit"

1715

5 MTR -> multi-target retrieval

5-8 Badly retrieved temperature and pressure will still lead to systematic errors, doesn't really matter whether simultaneously retrieved or sequentially. Please reformulate. Is this really relevant here?

Section 3

21 remove "in log pressure"

22 Finally,

1716

5 altitude - vertical (level)

6-8 Other latitudes are discussed in the text. Actually, also latitude-time plots are provided, so that this statement is not entirely correct.

15 a gas of

21-22 "Unless ... anomaly". Suggest to reformulate or remove.

1717

27 75S-30S -> rather 30S-90S. Please check!

29 somewhat weaker? -> smaller magnitude of the annual variation of the differences?

1718

6 Instead of presenting here results for HNO3, I would rather be interested to see results (as for CFC-11) for temperature and pressure as those are key parameters in the retrieval.

8 "conspicuous" ?

15 profile peak value

20 Concerning Fig 4: Why not interpolation onto the same pressure levels?

21 compared to CFC-11

1719

13-15 "The cross-section ... correlates partly with HNO3 ... but is not very clear" Is this relevant? Suggest to remove or reformulate.

20hPa pressure level

Sect 3.2.4 Could be written in a more compact way (option to shorten the paper).

17 were processed

1720

Section 4

17 Reformulate, e.g. "The majority of the analysed retrieved species show ... with distinct annual cycle ..."

1721

7 "on" -> during ?

8 60S

9 "to" -> on?

11 "along LOS" -> along the line of sight

13 respectively,

11-15 reformulate?

17 along a constant latitude

19 Isn't there a phase shift of the annual pattern towards lower pressures?

1722

1-3 Several errors, please reformulate.

4- p1723 This case study on improvement of 1-d algorithms deserves certainly an own paragraph as it suggests an option for future 1-d data processing. Why is this only done for a few orbits and with the IMK 1-d model?

11 were then?

24 values of differences? high?

26 at altitudes -> pressures

27 difference of ... are found

1723

2-10 Results could be compared to Figures 3 (and following), for consistency.

11 condensed?

12 all four orbits -> the four test orbits

13 conspicuous impact of the modification of the IMK processor??? Suggest to reformulate.

1724

Conclusions

6-10: Also analysis for temperature (and possibly pressure) should be discussed.

11-14: Conclusion 3) - this has not been demonstrated in this paper. Simulation with synthetic data are one way to do this.

21: 1) "Passive approach..." Is this future work? Why passive?

1725

9 2) ... but the bias is part of the level-2 data. I don't understand this point. Suggest to remove or reformulate.

11 remove "then. The latter ... performed" Isn't the number of data of the ascending and descending parts of the orbits roughly the same?

13 of a certain extent?

All Figures: All labels need to be considerably larger to be readable! (printer friendly version)

Fig 1,2, ...: average values? Longitude bin? Are mixing ratios or number densities shown?

Fig 5: Scales (labels) can't be recognised on any of the Figures. ESA-1d?

Fig8: Period is 2002-2009? LOS? Averaged over all longitudes? Can't this be directly compared to the retrieved temperatures?

Fig 9: Same comments as for Fig 8, temperature fields could be shown for clarity and a comparison to retrieved temperatures could be shown. Check caption (wording).

Fig10: "inclination"?

Fig11: Can't read labels and can't see any plus or diamond signs (figures are simply too small in printed version).

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 1707, 2010.