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Atmospheric Chemistry and Physics Discussions

Interactive comment on "4D-Var Assimilation of MIPAS chemical observations: ozone and nitrogen dioxide analyses" *by* Q. Errera et al.

Anonymous Referee #2

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General Comments

The paper describes the global analyses of stratospheric ozone and nitrogen dioxide obtained by BASCOE and it evaluates the quality of the analysis against assimilated MIPAS data and independent HALOE and POAM-III data.

The authors show the benefit of the assimilation for ozone in lower stratosphere and ozone hole conditions and for nitrogen dioxide in stratosphere. They also use the assimilation technique to confirm the validation of MIPAS data.

However, I have four general, although not major, criticisms, which I would like the authors to address before publishing it.

1) I am unconvinced by the use of the MIPAS data to assess the quality of the analyses,

since MIPAS data are assimilated to produce the analyses. I would think this is more a consistency check than an evaluation of the quality of the analyses. It is also not clear what information we gain out of comparing the analyses with "assimilated MIPAS" or "all MIPAS" data. I would like the authors to clarify this point.

2) The error analysis is a little rushed. I understand that the authors have made an effort to determine the reasonable estimate of total error for MIPAS data, but I am quite surprised that MIPAS data are not well characterised. As far as I know, a full error characterisation was performed in order to select the MIPAS spectral regions for retrieving the target species. This was done at the beginning of the mission. I would like the authors to acknowledge it when they explain MIPAS total error and compare their estimated total error for each species with the one estimated by the MIPAS team (e.g. www.atm.ox.ac.uk/group/mipas/err/). About the background error covariance, there is no explanation about how it has been characterised and why spatial and species to species error correlations are negligible. I would like the authors to address this point.

3) I have found the paper a bit long with a lot of descriptions and not much interpretation of the results. It would be more easy to read if the results, that are already shown in the figures, are summarised in tables and give more space to the reasons or possible causes of disagreement.

4) Finally, although the dataset produced takes into account a larger variety of atmospheric conditions than the MIPAS dataset, the paper does not make it clear what are the benefits of using this dataset instead of the MIPAS dataset itself, when for example it confirms the quality of the MIPAS data but it omits some scientific data (e.g. NO2 data during periods of Solar Proton Events or Energetic Particles Precipitation events). It would be useful to mention also who are the possible users or customers for this dataset.

Specific Comments

p8011, line 8: One of the goals of assimilation systems based on chemical transport

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models is the validation of satellite data. I imagine though it is not the main goal. Additional examples of the goals of DA systems based on CTMs might help in understanding the usefulness of your specific work.

p8011,line 23: It would be useful to mention here which of the MIPAS Level-2 products are assimilated and in which altitude range.

p8012, line 9-11: Could you describe a bit more the monitoring procedure?

p8017, line 3: What do you mean by MIPAS observation space? Radiance space?

p8018, line 7: Are the ozone error values estimates of precision or accuracy?

p8018, line 17-18: This sentence is not clear to me, could you explain what is the error at the terminator?

p8019, line 20: What is the observation space of the instruments? radiances?

p8020, line 15-18: How do you characterise the background error covariance? Could you give an explanation on the 20% setting for all species? Explain also why neglecting the off-diagonal elements of the background error covariance is a reasonable approximation or give the reasons for choosing this simplification.

p8020, line 21-25: See general comment about MIPAS error characterisation and if possible add a reference to the error analysis done by the MIPAS team.

p8020, line 25-27: This sentence is a bit confusing, could you please explain it better?

p8021, line 26 - p8022, line 4: As I mentioned in the general comment, I do not understand well the difference of these tests and how useful they could be since you have used MIPAS data in the assimilation system to get the analysis. I see these tests more as consistency checks instead of tests for assessing the quality of the analyses. I think that comparisons with independent measurements or MIPAS data that have not been assimilated is a better validation tool.

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p8022, line 16-28: I do not clearly understand the meaning of this bias and standard deviations since as I said before the paper uses the MIPAS data in the assimilation system. It seems an incestuous comparison. This paragraph would be more clear if instead of describing the results that are visible in the Figure, you explain if these results are expected and possible reasons for disagreement (same for p8023, line 4-15).

p8021-p8024: It would be helpful to add a table summarising the results and where possible reduce the text.

p8024, line 21-24: There is a repetition of what already said in paragraph 3.3. Maybe this information could be repeated in Table 1 instead.

p8025, line 28 - p8026, line 1 and p8026, line 10-12: It would be helpful to have a figure showing the absolute difference instead of numbers in the text, maybe you could add another panel in Figure 6.

p8027, line 4-7: I am slightly confused about using MIPAS data to validate the analyses (as you describe in section 5.1) and now using the analyses, where MIPAS data have been assimilated, to validate MIPAS data. Is it not using the same information twice? Could you clarify this point?

section 6.1, 6.2 and 6.3: Similar comments as section 5.1, 5.2 and 5.3

p8042: The table caption is not that clear: are you reporting biases with standard deviations or estimated uncertainties with their errors? In the table it is not clear which column reports HALOE and which POAM-III comparisons.

p8043: Same comment as for Table 1 caption.

p8045: Why are there zero observations for high altitudes? It would be helpful to add a comment about it in the caption or in the text.

p8049: Is it maybe clearer to say "at POAM-III locations" and to add what the red dots are?

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p8053: Same comment as Fig. 2 (p8045).

Technical Corrections

p8017, line 16-21: In summarising Cortesi et al results, it would be useful to report bias and precision/accuracy for the same altitude ranges and use consistently pressure (hPa) or altitudes (km) to describe the vertical range.

p8018, line 15: Again the vertical range is expressed in km although before pressure ranges have been used.

p8019, line 16: Spelling wrong for "version".

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 8009, 2008.