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Atmospheric Chemistry and Physics Discussions

Interactive comment on "MIPAS measurements of upper tropospheric C_2H_6 and O_3 during the Southern hemispheric biomass burning season in 2003" *by* T. von Clarmann et al.

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Overview

This paper describes the analysis of upper tropospheric C2H6 and ozone distributions observed in the Southern Hemispheric biomass burning pollution belt by the MIPAS/ENVISAT satellite instrument in October-November 2003.
The authors use C2H6 measurements as a tracer of pollution transport, attributed to biomass burning in South America and Africa. They study the C2H6 and ozone mixing ratios within the identified pollution belt, using the MIPAS CFC-11 measurements to discriminate tropospheric from stratospheric contributions to ozone enhancements.

They show that the MIPAS measurements highlight different ozone production mechanisms within the pollution belt; with larger ozone/ethane values in the pollution plume transported from savanna burning in Africa than in the plume transported from South America.
Their analysis is based on forward trajectory calculations started from the burning regions, which are used to determine the origin of the polluted air observed by the instrument. My main concern regarding the method used is that the authors do not discuss the uncertainty of the trajectory calculations and the possible mixing of plumes from different origins (see general comments).
Nevertheless, this paper presents new data from the MIPAS instrument and shows through the analysis of the Southern Hemispheric biomass burning pollution belt that these data contribute to the improvement of our understanding of the long range transport of pollution and chemistry in the upper troposphere. Furthermore, this paper is well written and the methods and data used are clearly described. I therefore recommend its publication in ACP, with the following general and specific comments addressed.

General comments:

The authors refer to the biomass burning "plume" or "plume-like pollution belt" throughout the paper. A plume usually refers to a transport event of pollution from a specific source. Here the authors discuss the transport from different source regions, mixing into a pollution belt. It would clarify the paper to explain from the beginning what is meant by "plume" in the analysis.
In the trajectory calculation of the origin of C2H6 enhancements, the possible mixing of pollution from different origins is not clearly addressed, although one could assume that it will be an important factor for ozone production, especially above the Indian Ocean and downwind. The authors then discuss the differences between Amazonian and African plumes. What is the confidence that there is no South American contribution to the "African plume"? Are they always well separated (not clear from Figure 9)?
It would also be interesting to give a quantitative idea of the strength of biomass burning

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emissions compared to other sources in the Southern Hemisphere.

It would add to the scientific interest of the paper to explain how MIPAS upper tropospheric measurements are complementary with respect to ACE (which also provides C2H6) and MOPITT CO. What is the main advantage? Why would people want to use these MIPAS data? What are the complementarities between C2H6 and CO?

Specific comments:

Introduction:
Since MOPITT provides well validated measurements of CO. It would be good to explain better why C2H6 is interesting for the analysis of biomass burning transport (sources, lifetime, etc.), as already mentioned in the general comments, and compare C2H6 to CO in particular.
An introduction of what the authors mean by "plume" would clarify the following discussion.
P. 12068, L.21: MOPITT observed "enhanced tropospheric CO during the 2003 Southern hemispheric biomass burning season". Was 2003 particularly high? Why?
P. 12069, L.4: This statement is too strong, as ACE also provides measurements in the tropics, but with a lower coverage.

Section 2:
It would be interesting to give an idea of the MIPAS coverage and horizontal (how many days for a global coverage?)
What motivated the choice of the 21/10-14/11 2003 time period?

Section 2.1:
P. 12071, L.2: It is not clear what is meant by the analysis of "relative distributions"...
P. 12071, L.18: The uncertainty is in fact larger if the uncertainty on the spectroscopic parameters is taken into account. Does this number correspond to the retrieval error?

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P. 12071, L.25-26: Was the fire season in 1992 higher than in 2003? Should we expect 2003 to give lower values or can we conclude that MIPAS is biased low compared to other measurements?

Section 2.2:
P. 12072, L.5: The typical retrieval error is estimated to 50%: is it only the retrieval error or the uncertainty deduced from the validation exercise?
The last sentence of this section is not clear...

Section 3:
Section 3.1:
The authors chose to run forward trajectories instead of back-trajectories started at the altitude range where the enhancement was found (which is the method usually used in this kind of analysis). However, only biomass burning sources are considered using satellite fire counts. A discussion of the importance and location of other sources would be useful for the discussion and to justify why BB is considered to be the major contribution here.
How was the 12 days limit chosen?
The authors should provide a short discussion of the trajectory uncertainty.

Section 3.2:
How was the avg + 2sigma criterion chosen?
The possible mixing of plumes from different origins needs to be discussed here. Can a specific enhancement of C2H6 be attributed to only one source region? Is there no mixing above South Africa and downwind? Did the authors choose to analyze only specific parts which are clearly dominated by specific source regions? Can the authors associate a percent confidence to the plume origin?

Section 3.3:

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The second sentence may be confusing as ozone is generated by photochemical reaction with two main precursors: VOCs (mainly longer lived species - CO and CH4 - in the remote atmosphere) and NOx, although it depends critically on the level of NOx (NOx-limited and NOx-satured regimes).
In section 3.3 and 3.4, and in the following discussion, the authors refer to Amazonian and African plumes. Again, the question of mixing in the pollution belt should be addressed.

Section 3.5:
Considerations on injection heights could be moved to section 3.1
The emission ratios could also help understanding the difference in O3/C2H6? According to Andreae and Merlet [2001], C2H6 emission factor is 0.32$\pm$0.16 for savanna/grassland and 0.5-1.9 for Tropical forest (usually higher VOCs EF for tropical forests), and NOx emission factor is 3.9$\pm$2.4 for savanna/grassland and 1.6$\pm$0.7 for Tropical forest. Could O3 production also be more efficient for savanna/grassland?
Do the altitudes of trajectories show differences in altitude reflecting different residence time in the lower troposphere? Or is it something that would be missed by the trajectories?

Conclusion:
The authors could state more precisely how the MIPAS and MOPITT data are complementary.
P. 12079, L.10: small scale convective processes are needed but also chemistry. The authors could mention need of chemistry-transport model calculations for further analysis of ozone production within the plume.

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