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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Australian bush fires of February 2009: MIPAS observations and GEM-AQ model results" *by* N. Glatthor et al.

Anonymous Referee #1

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General Comments:

This paper presents some very interesting data from MIPAS that captured the plumes from the very large Australian "Black Saturday" fires of February 2009. The MIPAS measurements support previously published evidence of the penetration of the plume into the stratosphere, including a lofting of the plume some days after the initial firestorm. The measurements provide an insight into the chemical composition of the smoke plume with measurements of C2H2, HCN, C2H6, PAN, HCOOH, provided.

These measurements are important because:

1. They can help to characterise the chemical composition of emissions from these very large fires.

2. They provide additional evidence of the injection of significant parts of the plume into the stratosphere.

3. They might be able to provide information about the chemical aging of the plume.

4. They can be used to help test the ability of models to predict the plumes dispersion and in particular to assess the likely injection height of smoke during the firestorm on the 7th February 2009.

The subject matter is relevant to ACP and the data are certainly worthy of publication, however the choice of exactly what to present and how the data was presented seemed strange to me so I have some suggestions for alterations to the paper that the authors might like to consider.

From one point of view the list above is given in descending order of importance. Other than as a mechanism for providing evidence for the initial injection height of the plume and supporting previously published evidence of unusually large stratospheric injections, the exact details of the plume dispersion do not seem to me to be the most scientifically interesting aspect of these measurements and yet a large part of the paper is dedicated to this subject. In fact the dispersion of the plume is discussed separately for the three gases considered. It was not clear to me why this was done when the authors state that 10 days after the fires on the 17th February 2009 MIPAS measures very similar profiles for HCN, C2H2 and HCOOH. I would expect that (to the first order at least) the dispersion of the plume would be the same regardless of which gas you used to track it, although the HCOOH has a short enough atmospheric lifetime that you would expect it to be decreasing in the plume more rapidly that the other gases.

I suggest that the authors either combine the sections discussing the plume dispersion into a single section that uses evidence from all of the trace gas retrievals or that they add a sentence or two explaining to the reader why they have presented them separately.

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A similar comment should be added explaining why the authors have chosen to present the CO, C2H2, HCN, C2H6, PAN, HCOOH concentrations at 3 different altitudes 15km, 18km and 21 km despite the resolution being described as $\sim$ 5km at these altitudes. Why not combine the data into a partial column?

It would also be really interesting for the authors to use partial column amounts from the MIPAS retrievals to determine ratios of the trace gases C2H2, HCN, C2H6, PAN, HCOOH to CO and determine how these enhancement ratios (otherwise known as normalised excess mixing ratios) change as the plume ages. This has been attempted previously by Young & Paton-Walsh, 2011, for the Black Saturday fires but without access to retrievals of trace gases like HCOOH with intermediate atmospheric lifetimes. In a similar manner Alvarado et al, 2011 inferred emission ratios from trace gas enhancements of CO, HCOOH, PAN, NH3 and C2H4 detected in smoke plumes from Canadian fires by TES.

It would be very interesting to monitor the changing composition of the plume as it ages and to see if the lofting to extreme high altitudes has a significant effect on the chemical aging of the plume. I encourage the authors to consider adding an exploration of these changing ratios to their paper.

Specific Comments:

On page 15012, line 1 the authors state that the total area burned in the fires was about 3000km2. This is in disagreement with the figure of about 4300 km2 given in the Royal Commissions final report, [Teague & Pascoe, 2009]. Please change or add your reference and mention that it differs from the administrative estimates.

On page 15014, line 24-25 - Explain why the distributions use C2H2, HCN and HCOOH but only the profiles of the other gases are presented (C2H6, PAN and CO).

On page 15017 lines 26,27 " The GEM-AQ has been validated by comparison with spaceborne, airborne and ballonborne observations." - Please provide references.

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On page 15018, lines 1 & 2 " The model run was focused on the largest of the Victorian fires, the Kilmore East fire on 7 February 85km north of Melbourne." Does this mean that the model only simulated this fire? If so explain the reasoning behind this. Also if this means that the main plumes that penetrated to the stratosphere have been identified by your modelling as originating from this particular fire then this should be stated clearly and added to your conclusions. The authors might like to compare to the findings of [Raffuse et al., 2012].

On page 15018, lines 3 -13 the authors describe calculated total emissions for different gases from the fires. The authors should clarify whether these emissions calculations are for just the Kilmore East fire, for all fires or for the whole region but only on the 7th February 2009. Comparing to the values predicted for all February by GFED3 and FINNv1 [Wiedinmyer et al., 2011] these values represent just less than a third of the GFED3 numbers for total carbon emissions from all the fires for the whole month. The authors might like to compare their estimates for the total emissions of HCOOH, HCN and C2H2 to those provided for these fires by other methods (see [Paton-Walsh et al., 2012].)

Page 15018, lines 23-24 " The column injection was switched on at 15:00 UT on 7 February and maintained for 9 h." Please explain why these times were chosen.

Page 15018-19 "Except for the altitude distribution, the initial plume release details appear to be of secondary importance." Please elaborate - which other release details are unimportant?

Page 15023, line 5-6: and Page 15024, lines 10-12" Practically all enhanced MIPAS HCN values are at exactly the same geolocations as the elevated measured C2H2 data." and " Nearly all model features are well covered by elevated MIPAS HCOOH values, and the locations of elevated MIPAS HCOOH are largely congruent with those of enhanced C2H2 and HCN." So why bother with separate discussions of the dispersion?

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Conclusions: This section is long and although it reiterates some of the points made in the paper it fails to summarise the major conclusions of the paper .The authors should consider whether they can make a briefer summary of the major conclusions of the paper.

References

Alvarado, M. J., K. E. Cady-Pereira, Y. Xiao, D. B. Millet, and V. H. Payne (2011), Emission Ratios for Ammonia and Formic Acid and Observations of Peroxy Acetyl Nitrate (PAN) and Ethylene in Biomass Burning Smoke as Seen by the Tropospheric Emission Spectrometer (TES), Atmosphere, 2(4), 633-654.

Paton-Walsh, C., L. K. Emmons, and C. Wiedinmyer (2012), Australia's Black Saturday fires - comparison of techniques for estimating emissions from vegetation fires, Atmospheric Environment (http://dx.doi.org/10.1016/j.atmosenv.2012.06.066)

Raffuse, S. M., K. J. Craig, N. K. Larkin, T. T. Strand, D. C. Sullivan, N. J. M. Wheeler, and R. Solomon (2012), An Evaluation of Modeled Plume Injection Height with Satellite-Derived Observed Plume Height, Atmosphere, 3(1), 103-123

Teague, B., McLeod, D., and Pascoe, S.: 2009 Victorian Bushfires Royal Commission – Final Report, Tech. rep., http://www.royalcommission.vic.gov.au/Commission-Reports/Final-Report, 2010.

Wiedinmyer, C., S. K. Akagi, R. J. Yokelson, L. K. Emmons, J. A. Al-Saadi, J. J. Orlando, and A. J. Soja (2011), The Fire INventory from NCAR (FINN): a high resolution global model to estimate the emissions from open burning, Geosci. Model Dev., 4(3), 625-641

Young, E.; Paton-Walsh, C. Emission Ratios of the Tropospheric Ozone Precursors Nitrogen Dioxide and Formaldehyde from Australia's Black Saturday Fires. Atmosphere 2011, 2, 617-632 http://www.mdpi.com/2073-4433/2/4/617

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 15009, 2012.