

Interactive comment on “First detection of ammonia (NH₃) in the Asian monsoon upper troposphere” by M. Höpfner et al.

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We would like to thank Michelle Santee (referee 1) for her valuable comments and corrections all of them leading to an improvement of our manuscript. Comments and questions of the referee are marked in bold face and manuscript changes in italics.

Just to avoid any potential for ambiguity (since there is also an Asian winter monsoon), I suggest that the word “summer” be inserted before “monsoon” in a few more places in the manuscript, for example: the title of the article, the Abstract (L3), the Discussion section (L193), and the Conclusions (L243).

We agree and have inserted “summer” at the suggested locations.

L142-143: Shouldn't the total error be the RSS of the individual sources of un-

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certainty? That is, shouldn't the error components being summed be squared?

Right, this is an error in the text (not in the Figure). We have corrected the text accordingly by inserting “squared” before “error components”.

Figure 4 shows the seasonal distributions of NH₃ during MIPAS period 1. But I am not sure that it is necessary to show all 7 seasons in that interval, especially given that the first panel covers only July and August 2002 and is thus not completely comparable to the 3-month averages depicted in the other panels. Perhaps the information could be conveyed with just one row of 4 maps, starting with MAM 2003, then JJA 2003, SON 2003, and ending with DJF 2003/2004. Then the fact that the other seasons from period 1 show similar results could simply be stated in words. For completeness, such a statement about the other seasons in period 2 should be made in any case, as should a statement about other altitudes in period 1.

The text has been changed according to the reviewer's suggestions:

From: “*During all other seasons and outside the region influenced by the Asian monsoon, no similarly high concentrations of NH₃ can be found.*”

To: “*During all other seasons of the two MIPAS periods and outside the region influenced by the Asian monsoon, no similarly high concentrations of NH₃ can be found within the entire altitude region covered by our measurements.*”

Regarding the proposed update of Figure 4, we tend not to change it in order, (a) to demonstrate that also in Jul/Aug 2002 there have been enhancements of NH₃ in the Asian monsoon region, and, (b) to cover one period of the MIPAS observations entirely.

When I first read through Section 4, I thought that although there may not be any correlative measurements of UTLS NH₃ to validate the MIPAS retrievals against, there surely must be some model simulations that could provide a zeroth-order “sanity check” on the morphology if not the magnitude of the retrieved distribu-

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tion. It turns out that model results (or the lack thereof) are discussed at length in Section 5, but it might be useful to add a sentence in this section that points forward to that discussion, so that readers do not assume at this point that opportunities for validation have been overlooked.

We agree and have added some text at the end of Section 4:

“Due to the lack of ammonia observations in the upper troposphere, we cannot validate our dataset with correlative measurements. However, in the next section we discuss its plausibility by comparing with the few previous observations and atmospheric model results.”

It is stated (L177–178) that: “the maximum concentrations of NH₃ are always larger within the eastern part of the Asian monsoon”. However, this statement is only true at certain altitudes; it is not the case above 13 km in 2008 or above 15 km in 2010.

This wording might be misleading. What we meant here relates to the maximum values over the whole altitude range of the profile. We have tried to make it clearer by changing the sentence to:

“The profiles in the region of the Asian monsoon reveal that the maximum concentrations over the whole altitude range within one year are always larger within the eastern part of the Asian monsoon compared to the western part. Maximum concentrations of NH₃ in the eastern part reach about 10–22 pptv at 11–13 km altitude.”

It is noted (L181) that in the western portion of the monsoon region enhanced NH₃ “can only be observed during the years 2003, 2008, and 2010”. As written, this makes such enhancements sound like a rare occurrence. But that sample includes half of the years observed.

Agreed: we have skipped the word “only”.

L196–197: Nor could random errors account for the enhancements appearing

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only in one season.

Thanks for pointing to this argument. We have added it by changing the sentence to: *“However, random errors cannot explain why the enhancements should appear in a contiguous geographical pattern nor could they account for the enhancements appearing only in one season.”*

L250–254: The point about the differences in the altitudes of the peaks in the NH₃ profiles in the eastern and western parts of the monsoon region being consistent with the “general view” has not been made previously in the manuscript, and it seems to me that it would be more appropriate to make such a point for the first time in the Discussion section (or in Section 4 where the differences in the two regions are initially discussed) and not the Conclusions. Moreover, a reference or two should be provided for the description of the “general view” of the monsoon system.

In the revised version we have (1) moved this part to Section 4, as suggested by the referee, and, (2) weakened the statement on the “general view”, since we could not support it clearly on basis of published material.

Text added after line 184 of the original manuscript:

“The position of the NH₃ maximum at higher altitudes in the western compared to the eastern part of the monsoon system might be due to convective uplift of boundary layer air in the east followed by upper tropospheric transport and further uplift towards the west. Such an uplift of air from east to west is indicated in Vogel et al. (2014, Fig. 10) by trajectory calculations, however mainly located at the border of the anticyclone.

Fig 1: The orange lines are helpful but somewhat hard to see. It might be better to use solid or dashed rather than dotted lines.

OK, we have changed them to dashed style and used a thicker line width.

Typos and other minor wording and grammar corrections / suggestions:

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Thanks for the list of technical corrections! We have implemented all of them as suggested.

New references

Vogel, B., Günther, G., Müller, R., Groß, J.-U., Hoor, P., Krämer, M., Müller, S., Zahn, A., and Riese, M.: Fast transport from Southeast Asia boundary layer sources to northern Europe: rapid uplift in typhoons and eastward eddy shedding of the Asian monsoon anticyclone, *Atmos. Chem. Phys.*, 14, 12 745–12 762, 600 doi:10.5194/acp-14-12745-2014, <http://www.atmos-chem-phys.net/14/12745/2014/>, 2014.

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