

## ***Interactive comment on “First detection of ammonia (NH<sub>3</sub>) in the Asian monsoon upper troposphere” by M. Höpfner et al.***

**M. Santee (Referee)**

michelle.l.santee@jpl.nasa.gov

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This manuscript presents the first unequivocal detection of enhanced NH<sub>3</sub> in the UTLS. Retrievals of NH<sub>3</sub> from seasonally averaged MIPAS spectra in 10 deg x 10 deg bins are described and their errors estimated through systematic uncertainty analysis. Enhanced UTLS NH<sub>3</sub> is found only within the Asian summer monsoon anticyclone. The implications of these enhancements for the ATAL are discussed.

I am not an expert on the sources and sinks controlling atmospheric NH<sub>3</sub>, so I cannot critically evaluate much of the background information presented here, but the authors appear to have done a very diligent job of documenting the previous literature and placing their new measurements into context. In general I think that the analysis is sound, and the results are well presented. I have only a few very minor substantive

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comments for the authors to consider, all of which should be quite easy to address. In addition, because the manuscript is generally well written, I have made the effort to correct a few typos, and I also added a number of suggestions for other small wording changes that I feel would further enhance the quality of the paper – in truth, I would not have bothered making most of these suggestions had the manuscript not been so polished already!

Specific substantive comments:

– 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).

– L142-143: Shouldn't the total error be the RSS of the individual sources of uncertainty? That is, shouldn't the error components being summed be squared?

– Figure 4 shows the seasonal distributions of NH<sub>3</sub> 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.

– When I first read through Section 4, I thought that although there may not be any correlative measurements of UTLS NH<sub>3</sub> 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 distribution. It turns out that model results (or the lack thereof) are discussed at length in Section 5, but it might

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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.

– It is stated (L177-178) that: “the maximum concentrations of NH<sub>3</sub> 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.

– It is noted (L181) that in the western portion of the monsoon region enhanced NH<sub>3</sub> “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.

– L196-197: Nor could random errors account for the enhancements appearing only in one season.

– L250-254: The point about the differences in the altitudes of the peaks in the NH<sub>3</sub> 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.

– 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.

Typos and other minor wording and grammar corrections / suggestions:

– L8: “aersol”

– L14: “bulk” would be better than “wealth”

– L15: “by use” → “the use”

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- L16: delete comma after “and”
- L20: add a comma after “(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>”
- L24-25: “also cirrus clouds might be affected” → “cirrus clouds might also be affected”
- L27: “respect of” → “respect to”
- L33: “prospects for”
- L39: add a comma after “Beer et al. (2008)”
- L49: “the ground”
- L53: “vast” is not quite the right word. I suggest either replacing it with “severe” or simply deleting it.
- The paragraph in L55-58 is all one sentence, and it is followed by another short paragraph in L59-61. It seems to me that these two short paragraphs could be combined into one.
- L61: I found the last part of this sentence confusing and had to read it twice to understand the meaning. I suggest rewording as: “. . . restricted NH<sub>3</sub> concentrations to the sub-pptv range at altitudes between 8 and 10 km”.
- L62: “In the case”. Also add a comma after “instruments”
- L66: add a comma after “NH<sub>3</sub>”
- L67: “like” → “such as”
- L74 & 76: add commas after “(period 1)” and “(period 2)”
- L75: “UTLS” should be spelled out the first time it is used; also “in the case”
- L78: “in the horizontal”

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- L83: “on the basis”
- L86: “those investigations” would be clearer
- L87: add a comma after “intervals”
- L89-90: (1) “the meridional”, (2) add a comma after “direction”, (3) “To obtain at least a reduction of the spectral noise of at least” → “To reduce the spectral noise by at least”
- L93: “As cloud” → “For the cloud”
- L96: where → “whereby”
- L102: “oder”
- L106: add a comma after “970 cm-1”
- L108: “simultaneously to” → “simultaneously with”
- L110: delete “subsequent”
- L117: add a comma after “retrieval”
- L118: delete “two”
- L123: “both” → “the two”
- L125: “like” → “such as”
- L128: it would be good to add “(orange curves)” after “ammonia lines”
- L128-129: move “are” from before “fitted” to after “account” and delete the comma there
- L144: add “, right panels” after “70-80%”
- L154: add a comma after “20 km”

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- L173: “parts”
- L174-175: “curves show the NH<sub>3</sub> mean profiles for all years”
- L178: “vmr” is not used elsewhere in the text, and I don’t think it should be used here either.
- L183: “always located”
- L186: add a comma after “5 pptv”
- L187: “in the case”; also “indicated by”
- L198: delete “the” before “15 ppbv”
- L202: “which amounts up to” → “that reaches”
- L203: “both” → “the two”
- L208: “has been” → “was”
- L210: “in good agreement with” may be too strong in this case (given the uncertainty in the NH<sub>3</sub> data); “consistent with” may be more appropriate
- L214: “overestimated” would be better than “over-”
- L218: “In contrast to the results of”
- L223: “both” → “the two”; also add a comma after “visible”
- L224: “albeit” → “although”; also “given” would be better than “compared to” and “conclusively” would be better than “clearly”
- L231: “clouds by which” → “clouds, such that”
- L237: move the comma after “(TTL)” to after “ammonium”
- L241: “first evidence for” → “the first evidence of”

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- L243: “three-monthly” → “three-month”
- L244: delete the comma after “thus”; also “at the ground”
- L248-254: No need to capitalize “Western” and “Eastern”, or “West” and “East”
- L249: “transport to areas far from”
- L254: “ongoing”
- L258-259: (1) “ones”, (2) either delete the comma after “aircraft” or add one after “observations” (i.e., the part of the sentence from “like” to “aircraft” should be set off by two commas or none, not one); (3) I suggest saying “would” rather than “will”
- L260: delete the hyphen after “time”
- Fig 2 caption: “vmr” is not used elsewhere in the figure captions, and I don’t think it should be used here either
- Fig 5 caption: “seasonal mean spectra for several years during the Asian monsoon period” would be better as “seasonal mean spectra during the Asian monsoon period for several years”
- Fig 6 caption: “westerly” → “western”; “easterly” → “eastern”

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