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Atmospheric Measurement Techniques Discussions

Interactive comment on "Validation of GOMOS ozone precision estimates in the stratosphere" *by* V. F. Sofieva et al.

Anonymous Referee #1

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General Comments This manuscript describes methods to validate estimated precisions for the ozone retrievals from GOMOS, which flew aboard ENVISAT between 2002 and 2012. There are not that many collocations for this data set using self-validation (closely collocated retrievals) or even outside checks using MIPAS, for example. A differential method is presented making use of different stars and the differences in sampled variances versus differences in precision variances. All results point to a good estimate of the precision by the theoretical estimates, at least for bright enough stars. Issues encountered with dim stars are supposedly understood and the GOMOS estimates relating to the dark current correction should be corrected in future data processing, and should lead to better precision estimates from dim stars also, in the future. Overall, especially for the brightest star results, this gives readers some confidence in

the precision estimates for ozone from GOMOS.

This methodology and discussion are generally well presented and the results appear to be robust enough. My comments are largely editorial in nature (see below), with only a few minor and non-trivial points (not dealing with English) mentioned in the "Specific Comments" below. Therefore, after some minor revisions to address these specific comments, and after corrections following the (editorial-type) detailed suggestions below, this work should be suitable for publication.

Specific Comments

In Table C1, it seems that even if the retrieval gets say 40 ppmv, this would be considered to be a good value for altitudes above 18 km at least. Is there not some other checks that would remove such obviously bad profiles? How often does this happen? A test of the Level 1 (flux) data could probably detect that there is not good enough closure for the forward model versus observed flux/radiance based on such a retrieved profile, no? This could allow for better screening – but maybe if such screening exists (and I missed this), please clarify or explain this better.

In Fig. 5, the vertical colored lines representing the uncertainties are too faint to see easily and should be made thicker.

In Fig. 6, the range of altitude (25-45 km) is chosen somewhat arbitrarily (for the stratosphere), and somewhat different numbers would be obtained for slightly different ranges. In part because of this, and just because this will also depend on the stars chosen, I would recommend not using so many significant digits in the resulting percentage variability numbers. If you use 5.8 instead of 5.78 and 5.7 instead of 5.68, this seems sufficient. Discussing the sensitivity to factors such as I mention here could be useful, but the main message probably does not change (i.e. MIPAS and GOMOS results agree quite well, and the curves show the results in more detail than the averages). At least, there is agreement within 1-2% over the whole range.

Also, the authors should indicate whether the expected future processing changes for dark current and dim stars will affect the precisions only, and not the ozone profile values themselves, as this may not be obvious. If more is currently known about this, it would make sense to expand upon this discussion (even slightly) in this manuscript; however, this could also be better described after a future reprocessing.

Finally, the methods and results described here can work especially for denser sampling measurements; in the case of GOMOS and for a large part of the stratosphere, results often lead to the belief that the theoretical estimates of precision (random uncertainty components) provide a good minimum value, although larger values are not always precluded (because of atmospheric variability). If indeed true, this could probably be mentioned more clearly; the (mathematical) steps taken to provide the theoretical estimates in the first place should be clearly detailed or referenced as well.

Minor Details and editorial comments

Page 2, Line 5, change “via” to “by”.

P2, L7, change “it is of” to “this is”; add “the” before “dependence”, and before “signal”.

P2, L8, add “the” before “small”.

P2, L9, I suggest rewording to something like “and the deteriorating uncertainties as a function of time because of the aging instrument.”

P2, L10-12, another better wording could be “The estimated ozone uncertainties are small in the stratosphere for bright star occultations, which complicates the characterisation of precision values, given the natural ozone variability.”

P2, L16, “comparisons of differences in sample variances with differences in. . .”

P2, L19, add “tangent” before “altitudes”.

P2, L20, add “the” before “stars”.

P2, L21, “Since this is observed. . . close to 1 for these . . .”

P2, L22, delete “can” and add “the” before “GOMOS”.

P2, L24, change “for” to “of”.

P3, L1, delete “the” before “data”.

P3, L5, change “uncertainty of measurements” to “measurement uncertainty”.

P3, L6-7, “which use retrievals of atmospheric parameters by solving inverse problems.” “The precision of remote. . .”

P3, L10, change “approximations used in retrievals” to “retrieval approximations”.

P3, L11, I suggest rewording to “”dedicated to the validation of stratospheric ozone precision estimates for the Global. . .”

P3, L16, change “Earth” to “Earth’s”.

P3, L21, delete “the” before “chemical”.

P3, L28, change “degrades significantly” to “significantly degrades”.

P4, L1-2, “with solar zenith angles larger than 107 at the tangent points”.

P4, L4-5, fix the references so they read “in Name et al. (YYYY), Name2 et al. (YYYY), Name3 et al. (YYYY), and Name4 et al. (YYYY).”

P4, L8, add “the” before “validation” and add “ozone” before “precision”.

P4, L9, simpler to just finish the sentence with “that allows for such validation in the stratosphere”.

P4, L11, add “the” before “GOMOS” and change “overview” to “review”.

P4, L14, change “estimate” to “estimates”.

P4, L17, change “is dominating” to “dominates”.

P4, L20, change “obeys” to “obey”.

P4, L24, change “ageing” to “aging”.

P4, L25, add “the” before “noise”.

P4, L26, add “the” before “attenuation”.

P5, L3, add “the” before “noise”.

P5, L5, add “a” before “random”.

P5, L13, “referred to (also in this paper) as. . .”

P5, L15-16, add “the” before “adequacy” and before “theoretical”, and before “correctness”. Also, change “for indication” to “as an indication”.

P5, L23, change “well the experimental data” to “the experimental data well”.

P6, L1, “can result”.

P6, L9, “In the laboratory” and delete “the” after “using”.

P6, L14, delete “the” before “variance”.

P7, top line, “rely on the variance of the difference. . .”

P7, L6, not sure why there is a period inside the “mean” bracket.

P7, L10, add a space after “precisions”.

P7, L11, add “the” before “uncertainty”.

P7, L13, I suggest “is readily obtained from the uncertainty. . .” instead of “is defined by the uncertainty. . .”

P7, L16, add “the” before “measurement”.

P7, L19, either say “Fioletov’s method” or “the Fioletov method”.

P7, L24, delete “as” before “collocated”.

P8, L7, change “via computing two-dimensional” to “by computing a two-dimensional”.

P8, L15, add “the” before “same orbit”.

P9, L1, “These features present some challenges for the validation of the GOMOS precision.”

P9, L8-9, add “the” before “GOMOS” and also before “natural”.

P9, L11, delete “the” before “effective”.

P9, L13, delete “the” before “method 3”.

P9, L14, change “is presented” to “are presented”.

P9, L17, “do not allow us to make definitive conclusions. . .”

P9, L21, add “an” before “experimental”.

P9, L22, change “occultation” to “occultations” and “the Fioletov method”.

P9, L24, delete “the” before “regions”.

P9, L27, change “Such an amount. . .” to “Such a number. . .”

P9, L28-29, add “the” before the instrument names (Michelson and Microwave).

P10, L2, “for MIPAS measurements using the ten brightest. . .”.

P10, L3, “the method of Fioletov et al. (2006) cannot. . .”

P10, L5, “A simple method that allows for the validation. . .”

P11, add “the” before “error” (L20), “tropics” (L23), “sampl” (L24), “difference” (L27).

P11, L24, change “in S134” to “for S134”.

P11, L25, change “in S4” to “for S4” and delete “variance” after “S4”. Also change “the

amount" to "an amount".

P13, L3, add "the" before "correctness".

P13, L5, change "even negative" to just "negative". Also ad "an" before "overestimation".

P13, L8, add "the" before "measurements".

P13, L9, delete "years".

P13, L11, change "these" to "those" and delete "year" before "2008".

P13, L20, add "the" before "quasi-biennial".

P13, L25, "The proposed differential method allows for testing of the precision. . .".

P14, L1, add "the" before "estimated" and also before "application".

Also, Page 14, Line 1, what is meant by "good accuracy" here? A small precision does not necessarily mean that there are no systematic effects, or large ones (so good accuracy which implies small systematic effects at least for some people may not be the best choice of words. . .). It is probably best to avoid that language here.

P14, L3, delete "the" before "errors".

P14, L4, change "the" to "this".

P14, L23-24, change "The careful" to "Careful".

P14, L27, add "the" before "retrievals".

P15, L6, change "reasons" to "reason".

P15, L12, change "Provided the" to "Provided" and I suggest "the method described here can also be applied".

P15, L14, change "The condition" to "Condition".

P15, L15, change "scattering" to "scatter".

P15, 4.4, add "the" before "natural and "tropics" (L24), and before "infrared" (L26).

P15, L25, change "of 7" to "for the 7".

P16, L8, add "the" before "7 brightest".

P16, L9, "and even the variations with altitude. . ."

P16, L17, add "the" before "dependence".

P16, L19-20, "and small ozone retrieval uncertainties in the case of bright stars."

P16, L22, "differences in sample variance with. . .".

P16, L23, change "the region" to "a region".

P16, L26, add "the" before "uncertainties".

P17, L1, add "of" before "the uncertainty".

P17, L2, delete "the" before "future".

P17, L5, change "hardly" to "not readily" and add "the" before "violation".

P17, L6. "An extension to the use of other instruments is . . ., as illustrated here with GOMOS and MIPAS measurements."

P17, L7, add "the" before "tropics".

P17, L8, add "using the" before "7 brightest stars". "thus, this provides additional confirmation of the correctness . . .".

Appendix A, either use "Fioletov's method" or "the Fioletov method".

P17, L14, change "measurements" to "measurement".

P18, eq. A3, the notation for s12 should have a comma between the 1 and 2 subscripts,

in order to be in accord with eq. A2.

P18, L11, there is a missing parenthesis in “by Eq. (2)”.

P18, L18, change “case” to “cases”.

P19, L4, add “the” before “North Pole” and also on L6 before “majority”, as well as before “North Pole” on lines 23 and 25, and also before “precision” on line 26.

P20, L8, change “difference” to “differences”.

P20, L14, change “is” to “are”.

P21, L2, change “A1” to “C1”.

P21, L4, change “Plank” to “Planck”.

P21, L7, add “the” before “ultraviolet”.

P21, L8, do you really not mean “or a valid altitude range smaller. . .”?

Table C1, change “maximal” to “maximum”.

Fig. 2, the x axis label at the far right says “01/01” but it probably should say “02/01” and be corrected.

Fig. 3, there is a typo for “January” in the caption.

Fig. 5, does “at altitudes 25-40 km” really mean for an average over the range 25-40 km? Please clarify. Also, “errorbars” should read “error bars”.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 2459, 2014.