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Atmospheric Chemistry and Physics Discussions

Interactive comment on "NDACC UV-visible total ozone measurements: improved retrieval and comparison with correlative satellite and ground-based observations" *by* F. Hendrick et al.

Anonymous Referee #3

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1 Introduction

This paper reports on a standardisation of groundbased DOAS retrievals of total ozone within NDACC. This is a very important and relevant topic since so far very different approaches are used to derive total ozone from DOAS type measurements which makes them less suitable for long-term trend assessment than the more conventional Brewer/Dobson network (with highly standardized retrievals) and the suite of satellite measurements. The ground DOAS retrieval is a two step procedure with slant column derived in a first step from spectral inversion and conversion to vertical column amounts using radiative transfer models and a priori knowledge of atmospheric profiles, in par-

ticular ozone, in a second step. This paper focuses more on the use of a standardized air mass factor (amf) tables for the slant column conversion to total ozone, which is believed to be the largest source of errors in the DOAS retrieval so far.

For satellite retrievals the use of a seasonal and meridional dependent ozone profile climatology (used in the AMF caluclation) is very common and has been here specified for the ground DOAS retrievals within NDACC as well. Significant improvements are obtained with the new AMF tables reducing seasonal variations with respect to other correlative data. This paper investigates in details the various error sources in the new retrieval version. Comparisons with other data show that still some seasonal variations remain in the differences and possible sources for this are discussed in detail. This paper is very well written and suitable for publication in AMT after clarifying some issues as raised below.

2 Major issues

p. 20409, l. 27: The authors should make it more clear that SAOZ is part of the world wide DOAS network, which in parts is also part of NDACC. I do not think that every DOAS station is within NDACC. It would be also very helpful for the reader to know more about what is the distinction of SAOZ from other DOAS stations apart form the oraganisation. Are their instrumental differences? For instance, some SAOZ instruments are not temperature stabilized which could lead to different type of errors.

p. 20416, l. 18: Regarding the neglect of seasonal and longitude dependence of tropospheric ozone in the ozone profile climatology, one should remind the reader that the TV8 climatology is per definition a stratospheric climatology. I would rather say here that tropospheric ozone changes are "not accounted for" rather than "not implemented" here. It would be tricky to combine total ozone and tropospheric ozone classification, although from the work by Lamsal et al. (2004) it is evident that there is some link-

age between stratospheric and tropospheric ozone variation revealed in a total ozone classified profile climatology. A zonal mean monthly mean climatology may be better suited to represent seasonal variation in tropospheric ozone. For this reason the WF-DOAS approach described by Coldewey-Egbers et al. (2005) uses the McPeters et al. zonal mean climatology to determine the ghost column to be added to the retrieved satllite columns. However, a zonal mean climatology will still neglect the longitude dependence (e.g. wave-1 pattern).

p. 20418, l. 22: Here the authors claim that there are little differences in the AMFs when using different ozone profile climatologies (TV8, IUP, and Fortuin and Kelder climatologiues). If the use of Fortuin Kelder (1998) does not make a large difference then a total ozone classified climatology would be not needed, since FK is a zonal mean monthly mean climatology. My impression was that a total ozone classified climatology is important like TV8 or Lamsal et al. (2004). Please discuss this. In Lamsal et al. (2004, 2007) the impact of different O3 climatologies on satellite retrievals were investigated and at large solar zenith angles it has an impact on satellite retrievals. Please discuss this.

p. 20419, l. 11: Here the V1 of SAOZ retrieval is mentioned. Are the AMF changes the only modfication in the new version 2. Please clarify.

p. 20424, l. 19: The correlation of total ozone with analysis temperatures is in my opinion not a true temperature correction, since the seasonal variation is a superposition of the seasonalities of many errors, of which stratospheric T (or cross-sections) is one of them. In a sense the ECMWF/NCEP temperature are used more like a proxy for seasonally varying errors. Even though the temperature corrections derived from Dobson coparisons seem to agree with the inferred numbers from Komhyr et al. (1993), but sometimes the seasonal variations are even larger (e.g. OMI-DOAS). Although SAOZ has no temperature dependence due to the use of Chappuis ozone bands, they may have still a seasonal dependent error source. It should be more stressed in the conclusion that seasonal varying errors in many of the auxiliary parameters used can

cause seasonal depoendence in the comparisons between data sets that are beyond the stratospheric temperature issue.

3 Minor issues

Abstract/Section 4.1: Why did the authors did not use SCIAMACHY-OL3 which has about the same data version as GOME-GDO4 for comparisons to SAOZ? this would highlight how different satellite algorithms impact differences to SAOZ.

p. 20409, l. 2: spell out acronym NDSC

p. 20409, l. 2: "However, despite", better start sentence with "Despite" only

p. 20411, l. 12: "provision of homogeneous tools for calculating appropriate latitude and seasonal dependent AMFs". "Homogenous tools" sounds a bit awkward, I suggest to say "provision of an standardized AMF data base that accounts for latitude and seasonal dependence of the climatological ozone profiles"

p. 20412, l. 16: "average all available measurements between 86deg and 91deg SZA". To make it less ambigous, say "average of all retrieved vertical ozone columns" to distinguish this from averaging spectral data.

p. 20412, l. 25: The McPeters et al (2007) paper describes a monlthly mean zoal mean climatology which is different from the total ozone classified (TV8) used in the OMI-TOMS retrieval. The same profile data pool was apparently used in both climatologies. This should be clarified here.

p. 20413, l. 7: "for the eighteen TV8 latitude bands" –> for eighteen zonal bands"

p. 20413, l. 21: "the Pinatubo" –> "Mt. Pinatubo"

p. 20413, l. 25: "global monthly climatology" –> "global monthly mean climatology"

p. 20414, l. 3: Please add a reference which describes the SAOZ AMFs as used in the V1 retrieval.

p. 20416, l. 2: "Lidar" –> "lidar"

p. 20416, l. 12: "in average" –> "on average"

p. 20416, l. 16: "here is of -1%" –> "here is -1%" (omit "of")

p. 20416, l. 18: "that the zonal dependence of the tropospheric ozone seasonality is not implemented in the TV8 climatology" –> "that the tropospheric ozone seasonality is not accounted for in the TV8 climatology." (omit: "the zonal dependence of", change "implemented" to "accounted for", see also discussion above)

p. 20417, l. 7: "is of 0.6%" –> "is 0.6

p. 20417, l. 26: I would stress by adding a sentence that in the new AMF tables for DOAS ground retrieval clouds are not accounted for.

p. 20418, l. 20: "the University of Bremen atmospheric model for trace gases". Is this the same as the Lamsal et al. (2004) ozone profile climatology, called "IUP" in SCIATRAN settings for ozone profiles, then please add the reference here! All other trace gases are from the Bremen CTM. Please clarify.

p. 20420, l. 22 (Table 6): What is the explanation that OMI-DOAS shows a larger seasonal cycle in the differences to SAOZ V2 than V1. Almost all satellite retrievals so far I know account for stratospheric temperature changes. From this is clar that the seasonal dependence in total ozone retrieval differences must have other origins than ozone tempoerature issues. This should be discussed here in some more details.

p. 20421, l. 10: "the average bias of each station is normalize to zero at 210 K". A bias cannot be normalised, better to say: the bias of each station is set to zero at 210 K"

p. 20422, l. better: "Since these features are not present with all satellites, they can not be attributed to the SAOZ retrievals alone". (remove "hardly" and add "alone") I think

that the issue here is that many of the auxillary data (albedo, cloud, O3 climatology and associated errors) as well as stratospheric temperature (or error in cross-sections) have a distinct seasonal pattern and this varies among all retrievals (see earlier discussion).

p. 20423, l. 12. "zonal profile climatology" –> "zonal mean profile climatology"

p. 20425, l. 25: "although an underestimation of the temperature sensitivity of the Dobson AD pair cannot be ruled-out" If this point is not discussed further in the paper, I suggest to remove this subphrase.

p. 20428, l. 13: "mean zonal profile climatology" –> "zonal mean profile climatology"

Table 1: I suggest to add in Table 1 references to the solar atlases (Kurucz and/or Chance, is there a preference?) als use a reference to the Chance paper for the Ring effect (remove "NDACC source(?)")

Table 2: Spell out the climatology TV8, i.e. "TOMS V8 climatology (TV8, Bhartia et al., 2004)". Is a representative AMF wavelength or several wavelengths are used for slant column conversion into VCD. No details are given here nor in the main text. Please do so.

Fig. 5: Mention "OHP" in figure caption.

4 References

L.N. Lamsal, M. Weber, S. Tellmann, and J. P. Burrows, Ozone column classified climatology of ozone and temperature profiles based on ozonesonde and satellite data, J. Geophys. Res., 109, D20304, doi:10.1029/2004JD004680, 2004.

L.N. Lamsal, M. Weber, G. Labow, and J.P. Burrows, Influence of ozone and temperature climatology on the accuracy of satellite total ozone retrieval, J. Geophys. Res.,112,

D02302, doi:10.1029/2005JD006865, 2007.

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