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Atmospheric Measurement Techniques Discussions

Interactive comment on "Vertical profile of tropospheric ozone derived from synergetic retrieval using three different wavelength ranges, UV, IR, and Microwave: sensitivity study for satellite observation" *by* Yasuko Kasai et al.

Anonymous Referee #2

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The paper by Kasai et al. presents an interesting simulation study of the potential of a synergetic retrieval using UV, IR and microwave (UV+IR+MW) spectra for retrieving tropospheric ozone vertical profiles. This multispectral approach could be implemented in future Japanese air-quality monitoring missions. Whereas the topic and relevance of the paper are suitable for a possible publication at AMT, the current manuscript needs substantial revision in order to add and complete with important information and correct some inconsistencies of the results. As described below, part of the calculations are needed to be done again (UV radiative transfer and error/averaging kernels

estimations) and many aspects should be more detailed (comparisons with previous multispectral methods, analysis of sensitivity as function of height, error estimations, etc.).

The major revisions needed for the manuscript are the following:

1) The choice of some of the parameters used in the simulation are neither clearly justified nor realistic: in page 3 lines 41-43, it is mentioned that a surface albedo of 90% and solar zenith angle of 0° are considered. These parameters are of course not realistic. Indeed, surface albedo at the UV is often from 5% to 15% and only greater than 30% for exceptionally bright surfaces. Solar zenith angles are also key parameters affecting UV spectra that greatly vary depending on overpass time and location of the measurement. Simulations of UV spectra and jacobians should be done again with realistic values of surface albedo and diverse solar zenith angles. The use of appropriate values is key for a proper estimation of the performance of the retrieval approach and they should be realistic for each scene observed.

2) Retrieval error estimations show extremely high levels (i.e. PCE from Figure 3). These values (around 65%) are too high for a proper retrieval. This is the case for all retrievals using diverse spectral domains (even for single band retrievals). We expect typical retrieval errors for tropospheric ozone around 20 to 30% (IR, UV, etc) and NOT 65%. Retrieval errors of diverse tropospheric ozone columns for most single band retrievals and even UV+IR approaches implemented to real data are indeed of 20-30%. This aspect should be revised in the simulations presented by Kasai et al.. For example, retrievals can be more constrained for obtaining lower errors and therefore will provide lower sensitivity. Sensitivity is then overestimated when accepting too high errors. Therefore, the retrieval approach used in the paper to estimate averaging kernels and errors in the results presented in the paper (Figures 3, 4 and 5) should be performed again.

3) Explicit comparison with other multispectral synergisms: The added value of the

method proposed in the paper should gain great clarity with an explicit comparison with previous work on multispectral retrieval of ozone. The performance of the UV+IR+MW synergism (sensitivity and probed height) and characteristics of the instruments (spectral resolution, signal-to-noise ratio) considered in the paper should be compared to previous multispectral approaches to retrieve ozone from space. This comparison should be done with the multispectral methods implemented with real measurements (OMI and TES, Fu et al., 2013 and GOME-2 and IASI, Cuesta et al. 2013) and also future approaches (e.g. UVNS and IASI-NG, Costantino et al., 2017).

4) Heights of maximum sensitivity for each partial column: in the paper, only the degrees of freedom for the retrieval of ozone partial column are used as diagnostic for sensitivity. However, averaging kernels explicitly provide information on the height of maximum sensitivity that varies for each retrieval method and measuring conditions. Therefore, I strongly recommend to provide the heights of maximum sensitivity for each ozone partial column retrieved from satellite spectra, and compare them explicitly for each spectral combination (UV, IR, MW, UV+IR+MW, etc)..

5) Additional terms for error estimations: for such a new multispectral retrieval, I strongly recommend to estimate the contribution of additional terms of errors such as cross errors from joint fit of surface albedo and emissivity and other systematic errors (atmospheric and surface temperature, water vapor, etc).

6) A better description of the atmospheric scenario is needed. How model and airborne data are combined? How the 20 cases are chosen? What is the main characteristic (time of the day, region, ozone load, surface and atmospheric properties) of each scenario? These aspects should be explicitly commented and described in the text of the paper.

7) Spectroscopy coherence should be mentioned as an important issue for real retrievals. There exist previous multispectral retrievals combining microwave spectra with other domains? Spectroscopic consistency has been analyzed as for UV and IR (e.g.

Gratien et al., 2010) ?

8) Aerosol in the UV: how are they accounted in simulations? Are aerosols jointly fitted or considered as perfectly known? The error of this assumption should be explicitly analysed and quantified.

9) In Fig. 3, why DFS for IR+MW are lower than for IR only at the LMT???? Please justify and verify calculations.

Additional corrections:

1) In page 2, lines 61-65: Here the performance of the combination of is done for that of OMI and TES. Similar characteristic should be provided for the synergism of IASI and GOME2 measurements, in terms of DFS, errors and altitude of maximum sensitivity.

2) Page 3: please provide the units for NESR.

3) Page 3: The UV domain <305 nm does provide useful information on stratospheric ozone. Please clarify why it is not used in the retrieval.

4) Page 3 : reference Boynard et al 2009 for IASI is not appropriate. Please use Clerbaux et al 2009 instead.

5) Page 7, lines 1-3 : Also Fu et al 2013 and Cuesta et al 2013, Landgraf et al 2007 showed the advantages of a combined UV+IR retrieval of ozone. Please add these references.

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