

## Responses for report referee # 1:

### General comments

This is a very nice paper with interesting results, providing valuable information about the performance of various total column ozone measuring instruments from ground and space. The results are now well presented by the graphs, which are in appropriate design after the corrections, proposed in the pre-reviews. Description of the data retrieval and instrumental properties is sufficiently detailed with a little too strong focus on the FTIR. Its description is somewhat too detailed compared with the other instruments. The publication of the paper is recommended.

Thank you for this positive comment.

### Special comments:

¶ 1 Introduction: The mention of the importance of vertical ozone transports implies, that the data measured by satellite-borne and ground-based instruments and which are compared in this paper are relevant for this issue. Investigations of the vertical transport, however, need mainly profile data, which are not examined here. Moreover, LIDAR and ozonesonde data are not mentioned as sources for profile data.

Yes, you are right, this paper is not dealing with vertical ozone profile data, that's why I propose to change the introduction as follow (line 40 to 44):

Actual text:

*“However, important vertical ozone transport events occur frequently and need to be quantified accurately to better understand radiative forcing and tropospheric chemistry. For this purpose, data from satellites and ground-based instruments are indispensable, in particular in combination with numerical models of atmospheric transport and chemistry.”*

Proposed text:

*“Nowadays, various types of competitive satellites and ground-based instruments are able to monitor atmospheric ozone data for which performances need to be evaluated continuously. They are indispensable, in particular in combination with numerical models of atmospheric transport and chemistry, to quantify accurately and better understand radiative forcing and atmospheric composition change.”*

¶ Chapter 2 (as already mentioned under general comments) is very detailed compared with the following sections describing Brewer and satellite data. More references to corresponding literature would be sufficient.

Descriptions of the FTIR are more detailed for two reasons:

- First, I am working in an IR spectroscopist group with whom I installed a FTIR observatory in Paris. Also, I collaborate with IMK-KIT team (i.e. Frank Hase, Matthias Schneider and Thomas Blumenstock) focused on ground-based FTIR measurements and I was in charge to measure, at Izaña, all the spectra showed in the paper and also performed ozone retrieval from them. The paper is then organized in the sense of the comparison of these ground-based measurements with all other sources of information on the total ozone column.

- Second, the FTIR instrument at Izaña is considered as a reference, in term of precision and quality of ozone measurements. This idea is based on literature [Schneider et al., 2005, 2008a, b; Schneider et Hase, 2008].

That's why emphasis was made on FTIR description and analysis since these parts represent my work. But still, I can reduce a little the text as follow (line 97 to 100):

Actual text:

*“All O<sub>3</sub> retrievals were made on a logarithmic scale in order to well reproduce the high variability of ozone around the tropopause (Hase et al., 2004; Deeter et al., 2007). Since major O<sub>3</sub> isotopologues have distinct absorption 5 lines, retrievals were performed for several individual O<sub>3</sub> isotopologues, i.e. <sup>48</sup>O<sub>3</sub>, asymmetric and symmetric <sup>50</sup>O<sub>3</sub> and <sup>49</sup>O<sub>3</sub>. In addition, temperature profiles have been retrieved simultaneously, which significantly improves the quality of the retrieved ozone data (Schneider and Hase, 2008)”.*

Proposed text:

*“All O<sub>3</sub> retrievals were made on a logarithmic scale, to well reproduce the high variability of ozone around the tropopause (Hase et al., 2004; Deeter et al., 2007) and include simultaneously O<sub>3</sub> isotopologues and temperature profiles retrievals to improve the quality of the retrieved ozone data (Schneider and Hase, 2008)”.*

Chapter 2.3: the wording from line 152 implies that the Brewers in general are double monochromators. This is not valid for the MK-II Brewers, which are single monochromators. The serial number of the used Brewer and the additional information, that this special instrument is a double monochromator would be helpful.

Here, a proposition to replace the phase would be (line 150 to 154):

On the text:

*“This double monochromator instrument (MK-III), known to widely reduce the impact of straylight on the measurements, works in a completely automatic way, and usually measures continuously during the whole day.”*

I suggest:

*“The reference triad of brewer of the RBCC-E, serial #157, #183 and the travelling instrument #185, are double monochromators (MK-III) known to widely reduce the impact of straylight on the measurements.,works in a completely automatic way, and usually measures continuously during the whole day. For this study data from the permanent reference #157 is used on the comparison.”*

Chapter 2.3: line 156: ozone cross-sections at a fixed effective temperature of the ozone layer of -45: : : : .would be better.

*“Ozone absorption cross-sections at fixed temperature of -45 °C”*

will be changed to (line 156-157)

*“ozone cross-sections at a fixed effective temperature of the ozone layer of -45 °C”*

°u Chapter 4.2, line 292 ff: much better description of the FTIR-Brewer difference than in the first version. The mention of the intended introduction of new cross-sections after DMB could also be helpful (in the following sections comparing the ground based instruments with satellite borne too).

I propose to add at the end of this section:

at line 302-303:

*“New DMB UV-cross-sections have to be introduced in Brewer algorithm for deriving ozone data.”*

and line 360:

*“The introduction of the new DMB cross-section in Brewer algorithm is relevant for future investigations”*

°u Chapter 4.3, line 319 ff: it is true that IASI op is lower than FTIR, it, however, agrees better with the Brewer than the IASI analytical.(1) In addition, the evident trend in the difference IASI op to FTIR and Brewer is not mentioned.(2) Reason for this trend, which cannot be seen in the IASI analytical comparison? (3)

(1) Considering, in the comparison between IASI-op and Brewer, the high value of the standard deviation (of 2.5) higher than the mean (0.9); and also the significant number of days involved in this comparison (77), we cannot conclude that IASI-op obviously agrees with Brewer measurements. It is important to note that only for the operational IASI retrieval, the difference exceeds the estimated uncertainty.

(2) I propose to change, in line 318-319, instead of *“However, the operational IASI O<sub>3</sub> total columns seem to be lower than the FTIR ones”*, *“However, negative sign appearing in the DMR suggest that IASI operational algorithm underestimate O<sub>3</sub> total columns compared to Brewer and FTIR data”*

(3) I don't have the final response but I suggest that this trend is not seen in the IASI-an because a completely different algorithm is used for the O<sub>3</sub> total column related to IASI-op. Indeed, a neuronal network for IASI-op that really depends on the training data set (using HITRAN 1996) and a line by line retrieval for IASI-an using (HITRAN 2004) are used. As the trend seems to be a function of season, the reason then may be in the neuronal network training set that is not representing some seasonal variations of the total ozone column.

°u Chapter 4.4: a little bit short compared with the previous chapters.

I propose to add sentences in this section (line 361-368):

*“To conclude, ozone data derived from space instruments of OMI and GOME-2 are in a good agreement compared to ground-based measurements derived from Brewer and FTIR. However, negative signs of mean relative differences, appearing in the comparison between FTIR and UV satellite instruments (GOME-2 and OMI), suggest that the IR ground-based measurements over-estimate the O<sub>3</sub> total column. This trend confirms the systematic difference between IR and UV measurements, already seen between Brewer and FTIR comparison.”*

### Technical corrections:

° Chapter 2.1, line 66: Meteorological Sate Agency of Spain Service? State Agency of Meteorology of Spain as better proposal and correction for Sate.

I changed at line 66

° Chapter 3.1.2, line 203: regularization or regularisation

I changed at line 200

° References: there are two references not mentioned in the text ( Höpfner and Malicet); Balis et al 2007 and Bhartia and Wellemeyer 2002 are not unambiguous., in addition Balis et al 2007, Rothman et al 1998 and 2005 and Van Roozendael (should be dael) et al is O.K. in the text, but not here under references; please name all authors.

The reference to Höpfner can be deleted, this name was mentioned in the Acknowledgements. The reference to Malicet can be deleted too.

Line 242 and 246, I add “and Wellemeyer 2002”

For GOME-2 validation (line 226) I add “a” and a reference at line 425:

Balis D., Lambert, J.-C., Van Roozendael, M., Spurr, R., Loyola, D., Livschitz, Y., Valks, P., Amiridis, V., Gerard, P., Granville, J., and Zehner, C.: *Ten years of GOME/ERS2 total ozone data the new GOME data processor (GDP) version 4.2: Ground-based validation and comparisons with TOMS V7/V8*, J. Geophys. Res., 112, D07307, doi:10.1029/2005JD006376, 2007a.

For OMI validation (line 247) I add “b” and a reference at line 430:

Balis, D., Kroon, M., Koukouli, M. E., Brinksma, E. J., Labow, G., Veefkind, J. P., and McPeters, R. D.: *Validation of Ozone Monitoring Instrument total ozone column measurements using Brewer and Dobson spectrophotometer ground-based observations*, J. Geophys. Res., 112, D24S46, doi:10.1029/2007JD008796, 2007b.

I named authors for Rothman references and Roozendael (lines 555, 562 and 604)

° Graphs 4, 5 and 7: Brewer data as purple squares?, may be my printer is not O.K., I see dark blue squares.

Your printer is o.k., I changed to “dark blue” at lines 685, 659 and 649.