

***Interactive comment on “Comparison of
ground-based Brewer and FTIR total
O₃ monitoring techniques” by M. Schneider et al.***

Anonymous Referee #3

Received and published: 22 February 2008

General Comments

The paper provides an interesting report about the advantages/ disadvantages of the Brewer and FTIR measurement techniques for total ozone - with a good comparison between both. Although much of the information is well known in the

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Brewer and FTIR communities separately, the fact of putting them together in a comparative way gives some added value and is of interest for both communities. In addition to what the title evokes, the paper makes an important statement regarding the precision of the ozone measurements achieved with both techniques. Personally, I would have chosen a title that highlights also this aspect. The concluding statement (in the abstract) that 'both Brewer and FTIR are able to continuously monitor total O₃ amounts with a precision of better than 0.4%' is maybe a bit too strong. As is well illustrated throughout the paper, this achievement holds under very specific conditions; it is the best performance that one can obtain if all instrumental and atmospheric state conditions are well under control, but it is far from evident that this

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achievement can be obtained 'continuously. As is clearly indicated in the Conclusions: one cannot draw the same conclusions in conditions that are different from the almost ideal stable atmosphere conditions at Izana; in particular, it probably does not hold true at large solar zenith angles. Also, it requires the today's most performant hard- and software for the FTIR experiment which is not yet generally available in the FTIR community. The term 'continuously' makes me think about a long-term performance; however we see in the paper that it is difficult to obtain enough stability in the Brewer and FTIR experiments to achieve this performance on the long term. A nice thing of the paper is that it clearly shows what can be achieved under the best conditions, but also that it shows how hard the requirements are and therefore, the limitations to achieve this optimal

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performance on a long-term basis.

Specific questions/comments

Pg. 289 line 4: ETC is not well defined here (1st occurrence) and so for a non-specialist in Brewer algorithms it becomes clear only on pg. 291 what ETC refers to. A clear definition of ETC at its 1st occurrence would be welcome.

Pg. 289 line 26: the spectral windows for the O3 retrieval are given nowhere in this paper: one has to go back to (Schneider and Hase, 2007) to find them. I would have appreciated that they were repeated here.

Pg. 292, line 14: I don't understand why the errors caused by the assumptions (simplifications) made in the Brewer algorithm are called systematic? For example the fact that the ozone profile is assumed to have an effective height of 22 km is a

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simplification of a varying O₃ profile; the effective height will vary from one time to another as the ozone profile changes. So it is a systematic error in the sense that this same assumption is made for all spectra - therefore affecting all observations; on the other hand, the error that it induces will vary randomly as the ozone profile changes. So maybe this should be categorized as a systematic error with random variability ?

Section 2.3 is a good summary of the previous sections but to a large extent redundant: the authors should consider whether the Table (Table 1) is not sufficient on its own.

Pg. 296, lines 20-23: the statements about the IZANA FTIR also being a TCCON instrument are not relevant here.

Pg. 303, line 4: the temporal coincidence criterium

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adopted is 30'. Depending on the solar zenith angle (time of the day, and season), a 30' time difference implies a solar zenith angle and azimuth difference up to 5 degrees and therefore a significant airmass difference. Depending on the inhomogeneity of the ozone field, this may affect the comparisons differently. Wouldn't it have been better to define the coincidence criterium in terms of a maximum difference in solar position (as both instruments have the same observation geometry)? One may wonder whether the outlier on March 2, 2006 could be explained by a mismatch of the compared airmasses ?

Pg. 304, last paragraph, and following sections: The authors might consult and refer to Picquet-Varrault, B., et al., J. Phys. Chem. A, 109, 1008-1014, 2005, and Dufour, G., et al., J. Phys. Chem. A, 109, 8760-8764, 2005, to better discuss

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possible discrepancies between the IR and UV spectroscopies used in the FTIR and Brewer experiments, resp.

Apart from the spectroscopic uncertainties, there are systematic errors due to the uncertainty in the ETC and other assumptions adopted in the retrievals, as explained on pg 292 for the Brewer instrument. Can the authors give a better analysis of the magnitude of these errors, as compared to the observed 4.7% systematic difference between the FTIR and Brewer measurements ? In the following paragraphs, it is shown that this systematic difference changes with time (e.g., larger in 2005 than in 2006): this points indeed towards sources of systematic error that are not of spectroscopic nature but rather of instrumental nature. Moreover, from the following sections, it becomes clear that the offset also depends on the

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slant column amounts. Can the authors give some suggestions as to which instrumental uncertainties can explain such a behaviour ?

Conclusions 1) I agree with the authors that they have been able to show a very high precision of the Brewer and FTIR instruments at Izana, better than 0.5%. However, I am less convinced about the statement 'over several years' and therefore, about the compliance with the requirements for trend monitoring - as stated in the introduction. The figures and discussions (covering 2 years and a half) clearly show that the precision and accuracy (offset between Brewer and FTIR) are dependent on time and O₃ slant column amounts. So how do you derive a reliable trend in such a case? I understand that the time dependence is due to instrument alignment and calibration uncertainties: the question is to what extent this

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can be better controlled than is already the case now ? The authors do not really give an explanation for the dependence on slant column amounts - so they don't give a clue as to whether this dependence can be minimized ? Moreover, if we know that Izana is a most optimal situation from the geophysical point of view and that the instruments are among the most reliable ones in the world, one may wonder to what extent the results from this study can be extended to other sites/instruments of the same type.

2) The authors state 'Brewer spectrometers...measure O₃ throughout the day and during the whole year'. Is this a general statement or does it hold only for the case of Izana? For example, is this true also at high latitude when the SZA may become very high ?

Technical corrections

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The paper is not consistent in its spelling of dependency and (in)dependent(ly) : sometimes it is written as above, sometimes with an 'a' instead of an 'e' like dependancy => choose 1 consistent spelling throughout the paper.

Pg. 291, line 17: reference to (Bernhard et al., 2005) should be between brackets.

Pg. 292, line 14: hight instead of height (the 'e' is missing)

Pg. 295, line 16: times instead of time

Pg. 296 line 15: spectrometer instead of spectrometers.

Pg. 297 line 6: 'Further gaps in the time series of Brewer data are...': add the word 'series'

Pg. 299 line 8: '...the site standard Brewer #157...' instead of '...the standard size Brewer #157...'

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Pg. 301 line 7: the authors mean slant column amounts below 400 DU instead of above 400 DU ? !

Pg. 302 line 15: modifications instead of modification

Pg. 304, line 11: '...precisions of the Brewer and FTIR instruments' : 'of' is missing, instruments instead of instrument

Pg. 308, line 28: 'TCCON aims at a precision of 0.1%' instead of 'aims on'

Pg. 312, line 12-13: should be deleted

Pg. 313, Table 1: the angle theta is not defined

Pg. 314, Fig. 1 caption: 'Brewer site standard Brewer ': first occurrence of Brewer should be deleted.

Pg. 318, Fig. 5: last line should probably read 'the red line is the linear regression line of the least

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squares fit’.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 285, 2008.

ACPD

8, S290–S301, 2008

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