Atmos. Chem. Phys. Discuss., 5, S13–S16, 2005
www.atmos-chem-phys.org/acpd/5/S13/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Retrieval of ozone column content from airborne Sun photometer measurements during SOLVE II: comparison with coincident satellite and aircraft measurements" *by* J. M. Livingston et al.

Anonymous Referee #2

Received and published: 28 January 2005

Reviewer comments on, "Retrieval of ozone column content from airborne Sun photometer measurements during SOLVE II: comparison with coincident satellite and aircraft measurements" by Livingston et al., Atmos. Chem. Phys. Discuss., 5, 243-286, 2005, www.atmos-chem-phys.org/acpd/5/243/ SRef-ID: 1680-7375/acpd/2005-5-243 European Geosciences Union.

This paper provides the details of deriving clear-sky columnar ozone amounts from spectral solar extinction measurements with a specific application to aircraft-based measurements at large solar zenith angles. The method employed involves separating the characteristic shape of ozone extinction in the Chappis band from the expected smoothly varying aerosol and Rayleigh attenuation as well as other known gaseous absorption over the band. The spectral measurements extend beyond the Chappis band in both directions to permit determination of supporting spectral aerosol optical depths in ozone absorption-free regions. The field measurement and much of the data reduction methodologies closely follow those required for the determination of aerosol optical depth, for which the lead authors are particularly well known and extremely competent. The ozone retrieval methodology follows an inversion procedure developed three decades ago but which is known to have limited accuracy relative to other remote sensing methods such as those applied with in situ sampling or Brewer spectrometers and Dobson spectrographs. The field data were collected from a series of Arctic aircraft flights in an exercise to validate spaceborne instrumentation also retrieving ozone amounts. The measurements were obtained at various locations and altitudes. The authors do a remarkably detailed job in data reduction and inversion in attempting to account for vertical and horizontal inhomogeneities in various atmospheric constituents, which additionally limit the accuracy of the retrievals. The large solar zenith angles experienced at nearly all measurement times exacerbate the inhomogeneity problems but benefit the authors in the reduced uncertainty from Sun photometer calibration uncertainty, which is divided by the large relative air masses existing at the large zenith angles. In the opinion of this reviewer, the ozone values presented in the paper are the best attainable using the Chapppis band technique and under the conditions encountered. This paper could become a classic example of how upward looking spectral extinction measurements at extreme large zenith angles should be processed. A question that goes unanswered and distracts from the usefulness of this paper is, “ Just how good do ozone validation measurements need to be to useful in this validation exercise?” The differences between the Sun photometer and other methods are given for several different times but without discussion of the meaningfulness of the comparison. After each comparison the reader is left asking

“So?” In the conclusions section, there is a summary of conditions under which the authors claim that their methodology does produce data useful for validations, but it is not readily apparent when those conditions were met, or when and to what extent the data to be validated were within those bounds. The reader might be left with the impression that the satellite measurements were used to validate the Sun photometer measurements. Some sort of table or graphic showing validation comparisons at times the Sun photometer was producing its best results would be very helpful and a logical result from this work, as would be some indication of the stated accuracy of the satellite and other data ozone. The paper comes up against a common limitation of the unknown spatial and temporal inhomogeneities that exist in the atmosphere and the inability to make precisely collocated measurements of a fixed atmospheric quantity. In this case the authors are dealing with spatial separations of tens of kilometers and temporal differences up to almost an hour. The authors adequately identify these sources of uncertainty but again do not suggest what sort of agreement under even ideal conditions is necessary to advance the involved methodology. In summary, this paper is technically detailed and exemplary but lacks the insight to provide the reader with an understanding of what as been accomplished or what the other measurement teams can take away for this. Perhaps the authors are unaware of what the requirements are for validation of the other platforms.

Specific questions/comments to authors:

1. What is the filter blocking in the out-of-band rejection regions? At the extreme zenith angles and shortest of your wavelengths it would need to be nearly 10ˆ-7, which is difficult to achieve and verify. 2. At about line 1 on page 254 you state that the eigenanalysis approach gave better results than King and Byrne but then go on to use King an Byrne without further explanation. Would be good to fill the missing justification. 3. At line 25 page 258, retrieval errors of up to 30 DU are mentioned for smaller zenith angles. Is this result in agreement with earlier applications of the King and Byrne method? References? 4. Item 1. in the conclusions (line 11, page 268) - How was this 0.04 limit

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determined? There isn't a discussion of this limit in the body of the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 243, 2005.

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