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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Non-coincident inter-instrument comparisons of ozone measurementsusing quasi-conservative coordinates" *by* L. R. Lait et al.

Anonymous Referee #1

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General Comments

This paper describes comparisons between aircraft-based lidar, satellite-based occultation, and balloon-based sonde measurements of ozone profiles during the 2002-2003 Arctic winter. To increase the comparison statistics, the authors have employed a PV-theta mapping technique. The authors show the utility of this technique for comparing measurements from different instruments when few near-coincident measurements exist. From a technical standpoint, I believe that the analysis is executed appropriately and is explained well. As noted in the paper, this is not a new application of the PV-theta mapping technique - thus the main value of this paper is in the specific results obtained. In my opinion, the description of these results should be expanded, and conclusions

regarding the relative accuracy of the different instruments should be drawn.

Specific Comments

p. 4386, line 25: The Randall et al. 2002 reference described mapping of measurements onto a 3-d field, and validation of the PV-theta mapping method - it was not used as an inter-instrument comparison like the Manney et al. and Redaelli et al. references. Thus, this reference should be moved up to the first sentence in the paragraph.

p. 4388, lines 1-4. Instead of simply listing the sonde stations, the paper would be improved if these could be presented in a table that includes the dates (or range of dates) of the sonde launches, the number of sonde launches, and the lat/lon of each station.

Section 4. Overall: This section should refer to previous evaluations of the different measurements, describing any known biases or errors, and should compare the results here to the results shown elsewhere. Have the differences between the DIAL and AROTAL measurements been seen before, or were the relative biases unique to the 2002-2003 winter? Has either instrument been compared to sondes before? The authors do note that the POAM-AROTAL comparisons are similar to those described by Lumpe et al (2003). What about the POAM-Sonde differences? How do they compare to the results in Randall et al. (2003, Validation of POAM III ozone, in J. Geophys. Res.)?

p. 4391, lines 29-30. Referring to Figure 7, the paper states that DIAL matches the sondes well at the lower altitudes, but is higher than the sondes above 25 km. This statement should probably be accompanied by a caveat - the apparent high DIAL bias is inferred from what looks like a single altitude that has very few measurements and a large error bar. As the authors have emphasized, results from the mapping technique cannot be trusted without good statistics, so it is not clear that the differences above 25 km are significant.

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p. 4392, line 7. Referring to Figure 9, the paper states that the POAM-DIAL differences at the uppermost DIAL altitudes are of different sign from those in Lumpe et al. (2003). The authors should further note that the differences seen in Figure 9 (at 25 km) are consistent with the sonde comparisons shown in this paper. That is, POAM agrees well with sondes at 25 km (Figure 10), and DIAL appears to be higher than sondes at 25 km (Figure 7, although there are large uncertainties). This all points to a high bias in the DIAL measurements near 25 km, consistent with the DIAL/AROTAL comparisons in Figure 2. But then one must question why different results were seen by Lumpe et al., and I believe the authors should comment on this.

p. 4392, line 13. The authors should name the other meteorological analyses that were used.

Section 5. Overall: I think this section should have two purposes - summarizing the relative measurement biases that can be inferred from the comparisons, and summarizing the validity of the technique. The latter is done in the last paragraph of the paper. The former is only partially addressed, in the second paragraph of this section. After reading this paper, the reader still does not have a good feeling for the presence or magnitude of measurement biases in any of the instruments. Thus, many of the following comments regard improvements to this paragraph. I believe the authors should explicitly discuss whether their results suggest any biases in one or more instruments.

p. 4393, lines 1-2 and 5-6. The paper states that AROTAL and DIAL agree “fairly well” from 18-24 km - within 0.25 ppmv or 10%. Yet on p. 4391 the authors emphasize that DIAL is systematically higher than AROTAL above 20 km. And a few lines down the authors state that DIAL values were higher than AROTAL by 0.3 ppmv or more above 22 km. These inconsistencies should be cleaned up. Since Figure 2 indicates that the average differences between AROTAL and DIAL are around 0.3 ppmv or slightly larger at 24 km (not within 0.25 ppmv), and these coincident comparisons have much smaller uncertainties than the reconstruction results, it seems appropriate to cite them when describing the final conclusions. It could then be stated that the reconstructions

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are consistent with this conclusion. Also, I recommend that the qualifier “fairly well” be dropped - I believe that the state of the art is for different measurements of ozone to be within about 5% at these altitudes (statisticallyĚnot for individual measurements). I would certainly expect that of two lidars on the same aircraft. In my opinion, the observation that they only agree to within 10% indicates a serious problem with one or both measurements. Finally, I think the authors should be consistent in what they emphasize - based on all of the comparisons (including sondes and POAM), is there a statistically significant systematic DIAL high bias above 20 km or not?

p. 4393, lines 2-4. The paper cites the AROTAL/DIAL and AROTAL/sonde comparisons, from which the reader can infer a probable high bias in the AROTAL data below 16 km. Why not just state this outright? And at the same time, why not bring in the POAM comparisons as well? In my opinion it would be much clearer to simply state that the comparisons between AROTAL and the DIAL lidar, ozonesondes and POAM are all consistent in indicating a systematic high bias in the AROTAL measurements below about 16 km.

p. 4393, lines 6-7. The authors state that the sondes and POAM III agree well, except for a possible bias near 22 km. First, Figure 10 indicates that this should probably be 21 or 20 km. Second, this conclusion should be checked against the near-coincident POAM/sonde comparisons in Randall et al. (2003); if consistent, this should be stated. If not, an explanation is in order.

Figures: For all of the comparisons shown, it would be very helpful if the # observations being plotted was listed explicitly. Perhaps the best way to do this, assuming the number varies with altitude, is to simply list the number of comparisons at each altitude on the right vertical axis of the plots.

Figures: Because it is often common to think in % when comparing different instruments, I recommend that all of the difference profiles be shown as both mixing ratio and %. It is often very difficult to ascertain the significance of the differences when

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only presented as mixing ratios. And while the text occasionally states both, it would be easier for the reader if both were shown in the figures.

Technical Corrections and Editorial Comments

General: There are many very short paragraphs (e.g., 1-3 sentences) that probably should not stand as separate paragraphs.

p. 4385, line 19. Define FASTOZ (FAST response OZone instrument).

p. 4385, line 20: "Gas and Aerosol Measurement System" should be "Gas and Aerosol Measurement Sensor" (although note that the Langley web page differs from the SOLVE-2 web page with regard to this). Also, LAABS is the "Langley Airborne A-Band Spectrometer", not the "Langley Airborne Measurement Spectrometer".

p. 4385, line 20: "GAMES" should be "GAMS".

p. 4385, line 24: Please replace solar "extinction" instrument with solar "occultation" instrument. Both are technically accurate, but occultation is more commonly used.

p. 4386, line 7. It does not make sense to write "Other approaches" when you have not described any approach yet.

p. 4387, line 5 and line 16. It would be helpful to specify XeCl excimer laser and Nd:YAG laser.

p. 4388, line 9. The POAM instrument measures 14 profiles in each hemisphere each day, not just 14 profiles each day, as currently stated.

p. 4388, line 26. Reverse the words, "the all".

p. 4390, line 2. Remove the comma before the period.

p. 4390, line 18. Is "mixedness" a word?

p. 4392, line 4. "The POAM-AROTAL areĚ" Perhaps add the word "biases" after "AROTAL"?

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p. 4392, line 11. Fix “the the”.

p. 4394, line 1. Please replace “Between about 18 to 24 km” with “Between about 18 and 24 km” or “From about 18 to 24 km”.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 4383, 2004.