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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.

L. R. Lait et al.

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Response to Referee #1

Although the PV-theta technique has been used for instrument comparisons in the past, this work compares its non-coincident results with coincident results and demonstrates the validity (and limitations) of the method. Thus, we believe that it has some additional benefit beyond spelling out the instrument biases.

Nevertheless, we agree that presenting the actual results of the comparisons is very important. We have therefore revised the results and conclusions sections to make the biases observed a little more concrete and to put somewhat more emphasis on them.

Most of the revisions requested have been made. Some comments pointed out state-

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ments which were confusing, and these have been revised for clarity. Most of the short paragraphs have been folded into larger ones.

The statement of biases at different altitudes have been mostly reconciled, although there remains a difference between the altitude range that applies to the coincident AROTAL/DIAL comparison, and that which applies to the non-coincident comparison, because the smaller error bars in the former expand the altitudes over which we can say the agreement is good or bad.

The missing reference to the Randall et al POAM/sonde comparison paper has been restored (it had been accidentally deleted from the original manuscript). However, we have been unable to find any systematic comparison (i.e., other than isolated anecdotal comparisons with single profiles) between AROTAL or DIAL with the ozonesonde measurements, so no prior work can be referenced for that.

The reviewer suggested that the plots be made in terms of percentages rather than absolute ozone concentrations. It is true that plotting the differences as percentages gives the reader context, indicating whether the difference is large or small relative to the ozone profile. But one problem with plotting percentages with this procedure is that the ozone profile in the denominator is itself an averaged profile that has its own uncertainties.

We feel strongly that the differences should be shown in terms of mixing ratios, since those are the quantities that are measured, and those are the quantities that the technique works with. Since both reviewers request percentage plots, we have revised the figures to show both profiles: the left panel in terms of mixing ratios, and the right panel in terms of percentages.

Also, early drafts of the figures had the number of profile observations being noted at each altitude, but the results were difficult to read. We agree that such information would be useful, but believe that implementing this suggestion would push these plots, with their multiple colored overlaid lines, over the threshold into crowded illegibility. The

ACPD

4, S2461–S2464, 2004

number of profiles can be estimated from information now given in the text.

Response to Referee #2

1. The main comment concerned estimating sources of instrument error individually. We have taken the approach of estimating the uncertainties in the method's results empirically rather than attempting to derive them from each individual source of error for two reasons:

First, quantifying each individual source of error would constitute a research project in its own right. In fact, much of the data in the mission archive files had no uncertainties attached. AROTAL and POAM had them, but DIAL and most of the sondes did not.

Moreover, errors in the meteorological analyses are notoriously difficult to quantify in a systematic and meaningful way. Comparisons with radiosonde observations will not suffice, because modern analyses tend to be assimilations which are constrained to match those observations (albeit at degraded vertical resolution). The true test is how well the analysis does in regions where the input observations are sparse. But of course these are precisely the regions where there is little opportunity for analysis/measurement comparisons. Data from aircraft missions such as SOLVE-2 help a little, but untangling atmospheric features from aircraft movements presents its own difficulties. Moreover, estimating uncertainties in PV requires estimating the uncertainties in horizontal gradients of winds and vertical gradients of potential temperature, and the approximately straight-line, level-altitude nature of most flight tracks makes this problematic.

Secondly, the uncertainties in the input data are not sufficient to predict the uncertainties in the output, even if they were completely specified. Our goal is to characterize the uncertainties in the inter-instrument differences, and that means determining variances about expected values. But only part of the variance is caused by instrument errors. A large part comes from the real fluctuations over smaller spatial scales than are resolved by the meteorological analysis, especially in the vertical. The inclusion of real

ACPD

4, S2461–S2464, 2004

geophysical variability with instrument error is both deliberate and desired, because both must be taken into account.

Therefore, we find it expedient, practical, and useful to estimate the uncertainties empirically and testing them through self-comparisons and by comparing coincident with non-coincident comparisons, instead of attempting to derive them from first principles. A brief explanation of this has been added to the text.

2. Why did we not use SAGE III data? All data were obtained from the SOLVE-2/VINTERSOL mission data archives. Originally, we had hoped to include SAGE III data in this analysis, but those data were not in the archives at the time the analysis was done.

3. All of the data were used for the self-comparisons – not just one flight. Similarly, the POAM-sonde differences include all measurements during the time period. Comparisons of single profiles or even profiles taken during a single DC-8 flight, would not have yielded enough measurements to obtain meaningful statistics. Roughly ten lidar profiles are used from each (8–10 hour) flight.

4. The right panel of Figure 1 was included to avoid having to plot the differences as percentages. It was hoped that showing an average profile would provide enough context to judge the significance/relative size of the average biases. This panel has now been removed, and all Figures now show the differences both in absolute terms in as percentages.

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

ACPD

4, S2461–S2464, 2004

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