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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical Note: A new global database of trace gases and aerosols from multiple sources of high vertical resolution measurements" *by* B. Hassler et al.

B. Hassler et al.

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Response to reviewers comments on 'Technical Note: A new global database of trace gases and aerosols from multiple sources of high vertical resolution measurements'.

First, we would like to thank the reviewers for taking the time to review our paper. This process has definitely improved the paper. Responses to the comments are detailed below. Reviewer comments are shown in bold font.

Reviewer #1

1 Summary

This technical note by Hassler et al. introduces a new ozone profile database

(BDBP), which promises several advantages over other existing profile compilations. The note describes the new concepts of the BDBP, outlines the advantages, and gives an overview over the database. Quality control procedures of the ingestion process are also described. Some of the current short-comings are indicated. I think it is very good that the BDBP is described in this way as an ACPD technical note. The BDBP is certainly interesting for many ACPD readers. In my opinion, this technical note deserves publication in ACPD/ACP. I have, however, several comments, that should be addressed before a publication in ACP.

2 Major comments

Although titled 'technical note' the manuscript contains very little technical information about the database. How many Gigabytes storage space are required for the BDBP? What are the system requirements (Windows, Unix)? What kind of access speed is provided, e.g., for single profiles? For monthly mean time series at a certain level/latitude/ longitude? What kind of user/ programming interface is/ will be provided? What programming language is used? Will the database be available to users? Over the web? To install locally? I realize that not all these questions might be relevant/easy to answer at this point, but certainly many of them should be answered in an additional section. After all, this is a 'technical note', so technical details are important. Please add a section on these technicalities.

The reviewer is correct and we have now added material to the end of section 2 providing this information. Furthermore, additional technical information is provided on a web page (`http://www.niwa.co.nz/rc/atmos/bdbp`) from which the data base files can be accessed. The access speed for extracting data from the data base will of course depend on the user's local computer. Monthly means are not provided in the BDBP, only single independent measurements are provided in the BDBP.

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Interactive Comment

Like reviewer 2, I also feel that the question of consistency/ systematic differences between different datasets is a very important one. This is mentioned a little bit (e.g. page 7680, lines 12 to 16), but it is really a very fundamental problem. It should be discussed in more detail throughout the manuscript.

We have added material to the manuscript where this issue was originally discussed. Specifically we have outlined the procedures currently in development for removing offsets and drifts between the different data sources. An example of one of the 'correction functions' for SAGE II and HALOE differences is shown in Figure 1 below. This approach is still very much in development and so we have not included this figure in the new version of the manuscript but decided to include it here to provide an indication of where we are going with this. It is beyond the scope of the current paper to fully develop and implement these procedures for removing offsets and drifts between the different data sources. In this first version of the BDBP, the data are provided as they come from the original data providers (subject to QA/QC screening).

Figure 1 see ftp://ftp.niwa.co.nz/incoming/hasslerb/ACPD_graph/Diff_SAGE2_HALOE.pdf.

I think the BDBP (version 2.0?) would become much more useful if it did include steps to remove systematic differences between datasets.

We fully agree and that is what we are currently working towards. The new material added to the paper provides additional information on how we are going about this.

I don't know how much work this is with the current BDBP, but 1 or 2 Figures showing systematic differences between SAGE and sondes, or between SAGE and HALOE (or the lack of such significant differences) would be a very important addition to the manuscript.

There are many papers out there in the literature that show and discuss SAGE-ozonesonde-HALOE etc. differences in detail and it is not our intention that this

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manuscript becomes a data validation/intercomparison paper. Therefore, rather than presenting data source differences in the paper, and adding figures to the paper (which is already quite long), we have shown in Figure 1 above, an example of one of our derived correction functions. This analysis of inter-data source differences is very much in its infancy and was never intended to be included in Version 1 of the BDBP. We will provide a much more detailed description of drift and offset corrections at the time of release of BDBP Version 2.

These results should be compared with published differences (see, e.g., the references given by reviewer 2). Such a mini-intercomparison would outline how this fundamental problem could be tackled in a version 2.0 of the BDBP (and how the BDBP 1.0 already makes it easy to do such intercomparisons?).

Such a mini-intercomparison would significantly extend the paper beyond its original scope and would not provide any new results that are not already available in the extant literature. Certainly the BDBP makes it very easy to conduct such intercomparisons, but this is not the intent of this paper. We have provided additional material in the manuscript outlining how we will derive correction functions in Version 2 of the BDBP and included Figure 1 above.

This would also improve the manuscript substantially.

We don't feel that it would improve the manuscript but rather extend it beyond a technical note, into a presentation of one specific application of the BDBP. As such, it would significantly lengthen the paper without providing any results that are not already available in the literature. Our aim is to keep this paper tight and focussed on a description of the BDBP.

3 Minor Comments

page 7661, around line 1: What happened to longitude? Is it not a dimension anymore? Should this not be 4 dimensional?

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The longitude for each measurement set is stored. However, the measurement sets are grouped by latitude and altitude for ease of data extraction. Each measurement is indexed by latitude, longitude, altitude and time (i.e. 4D) but the measurement sets are stored in a 3D grid. This is shown in Figure 1 of the manuscript.

page 7662, around line 10: How are high resolution profiles (e.g. 5 second data from radiosondes) brought onto the 1 km grid? Interpolation might not be the best in this case (noise, fine structure), averaging might be better.

The reviewer is correct and we have now revised how we store the very high resolution data from the ozonesondes which, as the reviewer points out, will be noisier than the solar occultation measurements. We now have two different 'types' of ozone viz.: *ozone_highres* and *ozone_lowres* where the high resolution ozone is as we had before and the low resolution data are from the solar occultation instruments. Furthermore, we smooth the ozone profiles with a 1500m FWHM Gaussian filter to additionally provide *ozone_lowres* values from the ozonesondes. We have added this information to the end of Section 2 of the revised manuscript.

page 7662, line 26: replace 'measurements' by 'data', since e.g. NMC/NCEP pressure and temperature are not measured but analysed. (See also below).

We agree and have made that change.

page 7663, line 23: What season has sparse coverage? Probably summer. Be specific.

The data are sparse in winter and we have added that detail to the manuscript.

page 7666, line 22: What is meant by 'large absorption' (.... > 5%). Do you mean aerosol optical depth > 0.05? Or aerosol transmission < 95%. Is this line-of-sight or vertical? One way or two way? Please clarify.

We mean absorption larger than 5%, vertical and not line of sight and one way. We have added the Rind reference to the end of this sentence since it was from that paper

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that we obtained these details for the quality screening.

page 7667, section 3.2: HALOE ozone profiles sometimes have spikes in the ozone error estimates that appear unphysical. How did the authors treat such spikes? Were they screened/ removed.

No, these were neither screened nor removed as we had no references to published papers on these spikes. We did not make any judgements as to whether the stated error estimates were unphysical or not, and replicate them in the BDBP as they are provided by the HALOE retrieval team.

page 7669, section 3.4.1, and other parts of the paper: Is the 1 km grid of the BDBP for geometric altitude (SAGE, POAM?) or for geopotential altitude (sondes, NCEP analyses, HALOE)? How is geometric altitude converted to geopotential altitude (or the other way around)?

The reviewer raises a very good point and we have revised the entire database so that the altitude always refers to geopotential height for all data sources. Material has been added to the paper to explain that when geometric height is provided (e.g. for SAGE I, SAGE II and POAM II and POAM III) this is converted to geopotential height. We used coincident temperature and pressure profiles together with the hydrostatic balance equation to do this.

page 7669, 1st paragraph: I think Smit et al., (2007) would be a very good additional, and more recent, reference for ozone sondes (`http://www.agu.org/pubs/crossref/2007/2006JD007308.shtml`).

This reference has been added to the manuscript shortly after that paragraph.

page 7670, near line 25: For a first cut this is probably ok. However, for trend analyses it is probably not ok: Upper stratospheric ozone has declined by 15% or more from 1980 to about 1996 (e.g. Newchurch et al., 2003). So residual ozone has changed over time as well. Using a fixed climatology will, therefore,

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introduce spurious trends into the NFs.

Yes, it might induce small spurious trends into the NFs, but because NFs are never applied to the data, it will not introduce any biases in the database. The NFs are only used to screen the data. Furthermore, this method is only applied to ozonesonde flights that reach 30 hPa and so the residual added is relatively small.

Can you use residual ozone from the BDBP?

This is a good idea and yes, we could, but first the BDBP must be published and accepted as a valid database. Therefore, once this paper has been accepted, we will calculate a new set of transient residuals from Version 1 of the BDBP and use this when generating Version 2 of the BDBP.

Or from the SBUV zonal mean profile record (`http://code916.gsfc.nasa.gov/Data_services/merged/index.html`)?

We could use the SBUV zonal mean profile record but this is at rather coarse resolution (13 levels) and interpolation would be required. We feel that the first suggestion i.e. to use the BDBP itself, would be better and we will do that for Version 2 of the database.

page 7672, near line 20: Is pressure/height uncertainty translated into ozone uncertainty. Make this clear.

No, the pressure/height uncertainty is not translated into ozone uncertainty and this has now been clarified in the text.

Please also state the assumed temperature uncertainty.

The temperature uncertainty is not a single value and the profiles of the uncertainties are shown in Bodeker et al. (1998) which is cited. We did not feel it appropriate to repeat this figure in this paper.

How do the stated uncertainties in temperature, pressure and relative humidity compare with manufacturers specifications (e.g. from www.vaisala.com)?

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Please state if your numbers are consistent with manufacturer specifications, or with what is commonly known.

In many cases we have used the manufacturers specifications (for pressure and humidity) as detailed in the paper. For temperature this depends on whether the temperature sensor is screened or not and therefore whether the Vaisala radiation correction is applied. All of this is detailed in Bodeker et al. (1998) and we felt it would be unnecessary to repeat this in detail here.

page 7673, line 6. Before about 1985 most stations were flying non-Vaisala radiosondes. Please make some statement about the errors of those older sondes (and maybe try to account for them in a future version?).

We added some information about VIZ radiosondes and their errors to the manuscript. But since the errors of VIZ and Vaisala sondes are similar, and because in most ozonesonde data files no information about radiosonde types is given, in the BDBP we keep the error values for temperature and pressure which are derived from radiosondes as we have stated them in the manuscript.

page 7674, line 24: What is required to compute a monthly mean? Is one profile enough, or do you require several profiles? How many? Please describe.

This is described in Section 5 of the paper i.e. 'but with the requirement that there had to be at least 6 values available at the given latitude and altitude for the monthly mean to be valid'. The same requirement was applied in the calculation of the B-factors and this has been clarified in the revised manuscript.

page 7675, line 1: If I understand it correctly, to go from a B factor of 50% (half of all grid-cells have a monthly mean for half of the time) to a B factor of 100% (all grid-cells have a monthly mean all the time) I need to increase the number of monthly means by a factor of 4. So the B-factor goes up with the square root of the number of available monthly means. Do I understand this correctly? Maybe

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this should be explained.

This is not strictly true since the number of valid monthly means could increase without causing any increase in the B-factor e.g. if the spatial coverage is not extended. So it would not be correct to conclude that the B-factor goes up with the square root of the number of available monthly means.

page 7676, line 13: I guess you mean latitude bins and altitude bins? Please state/repeat how wide these bins were.

We have made this correction.

page 7678, line 21: As indicated in my major comment, this statement needs to be backed up by an additional section giving technical details about the BDBP.

Additional material added to the end of Section 2 provides the requested technical details.

Table 1, row 'Temperature': SAGE I and II do not measure temperature at all, HALOE only measures temperature at levels above 4 hPa. I don't know about POAM, but would suspect about the same. All these temperatures and pressures are not measured but come from operational NMC/ NCEP analyses (with possible jumps etc.). Please make that very clear!

We have added a footnote to the entry in Table 1 to clarify this.

This should also be made clear in sections 2 and 3 of the text.

We changed the text where the origin of the temperature data was not clear enough (section 3). In addition, we removed references to temperature as a main target measurement (section 2).

You also need p and T to convert between pressure and altitude vertical coordinates. This should also be clarified in the text.

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We mention already in section 3.1.1 (SAGE data) and section 3.3 (POAM data) that we store pressure and temperature values although they are derived from reanalyses because they are necessary to determine the levels at which the data were inserted in Grid II and Grid III. We have now included a short comment on that in section 3.2 (HALOE data) as well to clarify this fact some more.

Also: should pressure or air density not also be a variable? Otherwise how do you convert to/ from mixing ratio?

One of our goals in creating the BDBP was to make the database as compact as possible. So we tried to avoid storing unnecessary entries. In each grid either altitude or pressure is stored if that is not one of the dimensions of that grid. Since a temperature value is stored in each grid, it is possible to convert or recalculate different ozone units or values out of the stored species.

Table 3: Same as with table 1: SAGE and HALOE (and probably POAM as well) do not measure temperature over all of this altitude range. Instead most of it is taken from NMC/ NCEP operational analyses, (with the indicated potential problems). Please make that clear.

We have added a footnote to the temperature entry in Table 3 to clarify this.

Table A1: A very useful additional column would be to give the (average) number of soundings per year for each station.

We agree and we added an additional column about the average number of soundings per year for each station.

Fig. 4: In panel a.) I think it would be good to also plot the B factor for the 1965 to 2006 time period / and or the 1965 to 1979 time period and/or the B factor from sondes alone.

It is mentioned in the text that the coverage of the ozonesondes is not very dense in the early years (section 3.4.1. last paragraph) so that the B-factors for the period

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from 1965 to 1979 are expected to be small. In fact, for the mentioned period the B-factors are only slightly bigger than 21. An additional graph would only show that the coverage is far from being globally dense and equal. To emphasize the importance for the coverage of adding the ozonesondes to the BDBP we plotted the contributions of each data source for the time period 1979 to 2006 (Fig. 4, panel b.) where satellite observations started.

This would show the coverage from the sondes, and the increase of coverage gained by the satellites. Panel B. does not give much information about the coverage from the sondes. It only shows that they are the main instruments providing tropospheric information.

One of the main reasons to add the ozonesonde profiles to the BDBP was to get a better coverage for ozone in the troposphere. In showing the B-factors for the different sources (Fig. 4, panel b.) the contribution to the coverage from each data source can be seen (cumulative effect). Since soundings from ozonesondes routinely reach altitudes of about 30 km, it can be seen in Fig. 4, (panel b.) that the highest contribution from the ozonesondes to the B-factors is in fact in the troposphere and that it gets smaller with increasing height. We might not have been clear enough in the figure caption of Fig. 4 but panel b.) shows the accumulated effects of the different data sources on the coverage. So with every added satellite instrument the temporal and spatial coverage gets better and adding the ozonesondes result in a B-factor>80 in the lower stratosphere for the time period 1979-2006, and coverage at all in the troposphere. We changed the figure caption of Fig. 4 to clarify the meaning of panel b.). Measurements from ozonesondes alone result in a B-factor over 70 up to about 30 km altitude.

4 Conclusion

A worthwhile and informative technical note on a database with large potential. Please give more technical details, and let us know when, where, and how it will be available.

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We are glad that the reviewer thinks our technical note is worthwhile and informative. We added more technical details to the manuscript as well as some information about a webpage from which the BDBP can be downloaded.

Reviewer #2

GENERAL COMMENTS:

This paper describes a new database (BDBP) that combines ozonesonde and solar occultation data into a single database such that all of the data can be accessed from a computer program in a uniform manner. In this regard, the BDBP goes further than simply gathering the data into a common location or data format site such at the NILU database, the NASA Aura Validation Data Center, or the French ETHER website. The paper nicely details the data sets and quality control algorithms used. Nevertheless, a user of the database should still become familiar with each of the instrument types and data quality issues. Some of the nice features of the BDBP include the ability to access the data on both altitude and pressure grids, and a lower resolution equivalent latitude/theta grid based on the consistent potential vorticity from the NCEP/NCAR reanalysis. The BDBP may be a useful tool for atmospheric scientists and is an appropriate subject for an ACP technical note. The level of detail is sufficient for understanding the database, although specific information about to obtain the database and any example programs for reading the data is absent.

We added some additional technical details and a link to the BDBP website to the manuscript. Examples of how to read data from the BDBP data files are given on the mentioned website.

The suggested applications for the BDBP include trend analysis and process studies. For these applications the BDBP has one major problem that has not been addressed. There can be significant biases in the lower stratospheric ozone profiles between different solar occultation instruments and relative to

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ozonesondes (see example references below). Differences as large as 5% are not uncommon for altitudes below 25 km. Combining measurements from SAGE, POAM, HALOE, and ozonesondes in a trend analysis or process study cannot be done without accounting for the biases between these instruments. The same is true for other trace gases and aerosols. I would suggest that this issue be discussed in the technical note.

We have added some material to the comments for reviewer 1 and to the paper that describes how data offsets and drifts will be dealt with in future version of the BDBP.

A few example references regarding ozone profile biases: Randall, C. E., et al., Validation of POAM III ozone: Comparisons with ozonesonde and satellite data, J. Geophys. Res., 108(D12), 4367, doi:10.1029/2002JD002944, 2003. McPeters, R. D., et al. (1999), Results from the 1995 Stratospheric Ozone Profile Intercomparison at Mauna Loa, J. Geophys. Res., 104(D23), 30,505-30,514. Nazaryan, H., M. P. McCormick, and J. M. Russell III (2005), New studies of SAGE II and HALOE ozone profile and long-term change comparisons, J. Geophys. Res., 110, D09305, doi:10.1029/2004JD005425.

We have added the mentioned references to our manuscript (as far as they were not already cited) in the section where offsets and drifts between data sources are discussed.

SPECIFIC COMMENTS:

1) Table 3 should add a note for those instruments where the temperature is not measured, but simply taken from a standard meteorological analysis.

We have added a footnote to Table 3 to make it clear that temperature is only a measured variable for ozonesondes.

2) Are the ozonesonde profiles subsampled or averaged to 1 km resolution? I did not see this detail in the text. Averaging would make the profiles more easily

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compared with the satellite profiles.

We agree that the treatment and description of how we obtained the ozone values from the sondes was not sufficient. We have changed the methods to account for the different resolutions between ozonesonde and satellite measurements (see comment for reviewer 1). We have added this new information to the end of Section 2 of the revised manuscript.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 7657, 2008.