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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosols in the tropical and subtropical UT/LS: in-situ measurements of submicron particle abundance and volatility" *by* S. Borrmann et al.

Anonymous Referee #1

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Summary: This manuscript presents unique and valuable data regarding particle properties in an undersampled and climatically important region of the atmosphere. While the data should be published, substantial revision of the paper should be done to improve clarity and to place the observations more clearly in the context of transport processes.

1. Does the paper address relevant scientific questions within the scope of ACP? Yes, the subject of aerosol sources in the upper troposphere/lower stratosphere (UT/LS), and tropical transition layer (TTL) is relevant for a number of reasons, including heterogeneous chemistry, cloud nucleation, and climate forcing.

2. Does the paper present novel concepts, ideas, tools, or data? The UT/LS and the TTL are data-sparse regions, and customized instruments have been developed that are capable of measuring in this high-altitude environment. The data collected cover a broad range of latitudes and altitudes and were measured from two primary platforms during three field projects. Thus these data are unique, and should be published to add to the limited information available.

3. Are substantial conclusions reached? The manuscript is primarily descriptive in nature. It presents latitudinal and altitudinal profiles of particle number mixing ratio and of the fraction of non-volatile (refractory) particles. The data are not generalized to a more comprehensive understanding; they are evidently intended to be used by others to improve modeling of particle properties in this region of the atmosphere. It is disappointing that, with this broad set of measurements, a more general evaluation was not included. For example, the profiles are grouped by geographic location, rather than into classifications (midlatitude, tropical) based upon meteorological and/or chemical measurements. Such grouping would allow more direct comparison with literature values and models. Profiles over Brazil were taken in the subtropical transition zone, and more careful delineation of the data into a tropical or midlatitude classification would allow them to be understood in the context of the other profiles. Similarly, profiles made during the transit flights are not always clearly identified as to their airmass classification. Once properly classified, the profiles can be better understood in the concept of production and transport–both vertical and horizontal–of particles in the UT/LS. In addition to the lack of careful classification, the data are not compared with available gas-phase measurements. For example, N2O was evidently measured on the Geophysica aircraft. Nitrous oxide is an extremely useful proxy for the age of stratospheric air, and correlations between particle concentration and N2O would allow a better understanding of the evolution of particle concentration as a function of stratospheric age. This type of correlation is particularly useful for constraining conceptual and numerical models of aerosol sources and sinks in the stratosphere. In sum, except for the identification of a volcanic influence on profiles over Africa, substantial conclusions are not

reached; the data are simply presented. The data are unique and valuable, and should be published, but it is disappointing that a more thorough analysis was not done.

4. Are the scientific methods and assumptions valid and clearly outlined? Yes, the methodologies and uncertainties are adequately described.

5. Are the results sufficient to support the interpretations and conclusions? Yes. Especially the evidence for aerosol perturbations due to a modest tropical volcanic eruption is well presented and confirmed.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Yes.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes, the observational literature is well cited and the results are put in the context of previous observations. However, the literature regarding modeling of sources and sinks of stratospheric aerosol is not discussed much, and these models–constrained by limited observations–are essential to understanding the stratospheric aerosol life cycle.

8. Does the title clearly reflect the contents of the paper? Yes.

9. Does the abstract provide a concise and complete summary? No. The abstract is quite wordy. There is too much description of the platforms and methodologies. It could be condensed by a factor of two.

10. Is the overall presentation well structured and clear? Yes, the general structure is clear. The experimental section is too long, especially the description of the COPAS. A simple reference to the Weigel et al. (2009) could replace much of lines 1-15 on page 24596.The last paragraph of Section 1, which begins the description of the methodology, should be moved into Section 2. On p. 24598, lines10-14, this sentence belongs in the appropriate figure caption, not in the text. Also, I don't understand what is meant by the sentence from lines 22-25 on p. 24598. Please clarify. The discussion of "lowest

fractions, f, of non-volatile particle mixing ratios. . ." on p. 24606 is confusing. The lowest values of f approach 5% for all the profiles. There is a minimum in the median values, however–is this what the authors refer to? The first paragraph of p. 24607 essentially repeats information in the previous page. This whole section, which describes three profiles, is a bit disjointed and hard to follow.

11. Is the language fluent and precise? The language could be improved. There are grammatical errors (especially involving definite and indefinite articles), as well as typographical errors that suggest the authors did not thoroughly review the manuscript before submission. I recommend a native-English-speaking author carefully edit the manuscript.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Yes. However, the nonvolatile fraction, f, is repetitively defined. Once is enough.

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? Yes. I am confused about the switches between mixing ratio (number of particles per mg of air), which is conserved during transport, and number concentration (number of particles per cubic centimeter of air). There is no rationale given for the switch, and perhaps figures 2 and 8 could be eliminated or their content combined with other figures. There are a lot of profiles presented, and having two figures using different units just confuses the reader.

The figures could be improved. In particular, I think it would be very helpful to have a schematic diagram of altitude (or potential temperature) vs. latitude, with indications of the TTL, the midlatitude tropopause, the subtropical jet, convective zones, and the regions of rapid horizontal transport and gradual vertical transport. Then perhaps figure 3 and some of the profiles (Fig. 4, 7, and 8?) could be replaced by plots of altitude vs. latitude, color coded by particle mixing ratio. Then one would see the altitude of the measurement, the latitude, and the variation in mixing ratio with both of these param-

eters. This type of presentation also make comparison with the conceptual schematic easy, and place the observations in the context of transport processes. As it stands, the reader is presented with numerous profiles from different geographical regions, and it is very hard to place them in the context of production and transport processes.

Finally, the profiles should be classified into different regimes (tropical, transitional-subtropical, and midlatitude), and an average profile produced for each for comparison with literature values. Only then can a claim be made that there has been no substantial change in the aerosol number profile since the 1987 (disregarding Pinatubo).

14. Are the number and quality of references appropriate? Yes.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 24587, 2009.