Atmos. Chem. Phys. Discuss., 15, C2323–C2328, 2015
www.atmos-chem-phys-discuss.net/15/C2323/2015/
© Author(s) 2015. This work is distributed under
the Creative Commons Attribute 3.0 License.

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Vertical profiling of aerosol hygroscopic properties in the planetary boundary layer during the PEGASOS campaigns" *by* B. Rosati et al.

Anonymous Referee #2

Received and published: 6 May 2015

General comments.

The manuscript presents a case study of aerosol properties in the atmospheric boundary layer measured from an airborne platform in two places for one day in each location. Suite of instruments onboard of the airship allowed measurement of hygroscopicity and chemical composition including estimate of equivalent black carbon mass concentration. The flights were performed in the vicinity of ground sites equipped to provide similar measurements. The authors discuss measured hygroscopic properties of 500 nm aerosols, results of composition-hygroscopicity closure studies as well as intercomparison with ground sites.

It should be noted that experimental data on hygroscopic properties of ambient aerosols are scarce, especially for the larger (few hundred nanometers) aerosols in the atmospheric boundary layer. Undoubtedly, the results of this work could be published in ACP, however only after the manuscript has undergone appropriate revision.

The manuscript needs to be re-arranged to separate description of the instrumentation and methods from the results and conclusions; it seems to be burdened with trivial statements and unsupported speculations, which should be avoided. Technical aspects of the current work may be presented in the Supplement to keep the main manuscript concise and focused. The authors are advised to secure help from a professional editor to improve readability of the manuscript.

Specific comments.

Please use generally accepted abbreviation for altitude in meters above ground: m a. g. l. or m AGL.

PP 9447-9448, Abstract: The abstract needs major revision to better reflect actual work done and substantiated conclusions reached; currently a reader gets an impression of much broader experimental data basis for the claimed conclusions. Also, it would be advisable to be more scrupulous in descriptions, for example "flown just after sunrise" looks like an exaggeration for the flight started 3 hours after sunrise.

P 9448, L 17: References to entire IPCC reports are not practical; please site the specific reference(s) in the IPCC 2013.

P 9450, L 12-14: There is at least one instrument for size resolved hygroscopicity measurements that was built and deployed earlier than DASH-SP, see: Hegg, D. A., Covert, D. S., Jonsson, H., and Covert, P. A., 2007: An instrument for measuring size-resolved hygroscopicity at both sub- and super-micron sizes, Aerosol Sci. Technol., 41, 873–883.

P 9452, L 5-13: Please describe state variables measurement (temperature, humidity,

wind speed, etc.) that has been made on board of the airship; including type of sensors, time response, averaging, etc.

Please provide a short description of inlets for the WHOPS, AMS, and aethalometer. Are they isokinetic? Any estimates of transmission efficiency?

P 9453, L 4-7 and 17-18: Please elaborate how the mixing layer depth was retrieved from the ceilometer data. Automated algorithms to retrieve atmospheric boundary layer height from ground based remote sensing measurements (lidar, sodar, ceilometer, radar wind profiler, etc.) are notoriously unreliable. Since the mixing layer depth is one of the key parameters in interpretation of the results, its retrieval procedure should be presented. Is there any radiosonde data from SPC meteo station or Hague Airport available for flight days? Radiosonde derived mixing layer depth could provide useful "hints" for interpretation of ceilometer data.

PP 9453âĂŤ9455, Section 2.3.1: The description of how the WHOPS works is not complete; please describe "wet" part. Also see comments to PP 9461âĂŤ9465 and P 9465 L 24-26.

P 9453, L 24-25: What is "dry" RH? Was it controlled/measured in any way?

P 9454, L 3-8: Please provide short description of measuring protocol (timing, averaging, size change and wet/dry sequences, etc.) for the WHOPS operation.

P 9454, L 16-19: Any DMA has a well-known artifact of "double sized, double charged" particles – any corrections for this artifact implemented in the WHOPS procedure?

P 9454, L 21-25: For absorbing aerosols the real part of the refraction index found via the presented technique is biased low; so, strictly speaking, this retrieved parameter is not the real part of refraction index.

P 9454, L 26âĂŤP 9455, L 11: This paragraph belongs to the Results and Discussion section. Figure 2 does not show "the temporal variability". Please try to correct the "effective" index of refraction for absorbing nature of the aerosols in both locations

when comparing to other measurements of the refractive index.

P9455, L 12-23: Please provide short description of measuring protocol (timing, averaging) used on ground site HTDMA's.

P 9456, L 28âĂŤP 9457, L 6: Please provide short description of measuring protocol (timing, averaging) for AE42 aethalometer.

P 9458, L 8: Looks like unfinished sentence?

P 9459, L 18-19: Please provide a short description of the flight pattern (linear, box, spiral or ramp ascend/descend, etc.) and a distance from the ground site during measurements, if in excess of a few kilometers.

P 9459, L 23-25: Figure 3 shows time trace of Th and RH, rather than vertical profile. It might be beneficial to present vertical profiles of Th and RH measured on descent (minimal influence of the airship body?) to help the readers get another (independent) pattern of the mixing layer depth evolution (see also comment P 9453, L 4-7 and 17-18).

PP 9460âĂŤ9461: Section 4.1.1 needs to be revised. It is not clear why IHP3 has been excluded from discussion – it seems to be in line with general pattern of growing ML. It might be beneficial to present values for all flight legs separately in Table 2; please include also averaging time, mean RH and Th (or T) for each leg. It would be interesting to see GF (corrected to 95%) measured at the ground site for each leg as well.

The "upper" leg of IHP4 seems to be "odd" in sense that airship altitude was not kept constant, at the same time the airship was in the vicinity of the ML top; it is quite possible that part of the leg was within the ML or the entrainment layer. For this reason, IHP4 should not be classified/averaged as flown in "fully developed ML" here and in subsequent sections of the manuscript.

The hypothesis of an aerosol _layer_ with special properties at 100 m AGL in presumably convective boundary layer around 12:45 seems to be far-fetched; it should be

corroborated by measurements, if any available, like significant change in total aerosol concentration, scattering, extinction, etc.

PP 9461âĂŤ9465: Section 4.1.2 needs to be revised. Description of how aerosol mixing state could be inferred from the WHOPS measurements should be moved to Section 2.3.1. It is not clear what "kind" of PDF is shown in Fig. 5: total sum/area of a PDF should come to 1.0 (or 100%), neither seems to be the case with all presented GF-PDFs. Non-hygroscopic mode that is present in all and every GF-PDFs measured by the WHOPS is really surprising; it looks rather like an artifact of the instrument. Ambiguity of relationship between the "wet" scattering cross section and GF is a major limitation of the WHOPS (as it is discussed in WHOPS introductory paper, Rosati et al, 2015). It is assumed, that the WHOPS is operated within certain "safe" limits of dry sizes, effective refractive indices, and growth factors where "sigma"-GF relationship is unambiguous. The problem is that these "safe" limits were found under approximation of non-absorbing aerosol; for absorbing aerosol these "safe" limits should be different, possibly not including the whole range of effective refraction indices observed in the current work. Detailed study of this problem is obviously beyond the scope of the current work, but it should be discussed in Section 2.3.1.

P 9464 L 29âĂŤP 9465 L 2: "Influence of Saharan dust intrusion... can be expected for the day of the Zeppelin flight" – so what is exactly HYSPLIT show? This is the only ground for a rather far-reaching conclusion of dust presence and its effect on aerosol hygroscopicity.

P 9465 L 19-21: Direct comparison of the airborne measurements with MTC ground site seems to be not very relevant here due to (a) horizontal separation of 100 km (over 5 hours travel time with 5 m/s winds), (b) "MTC is situated at a much higher elevation than the Zeppelin NT was flying", and (c) ground site measurements are always affected by local ground layer/sources (e. g. see current manuscript P 9660 L 26-28).

P 9465 L 24-26: This limitation of the WHOPS should be described earlier, in Section 2.3.1 and reflected in the abstract.

P 9467, L 4-6: Please elaborate how "differences ... are influenced by data inversion algorithms".

P 9471, L 17-21: It might be beneficial to present vertical profiles of Th and RH; see comment to P 9459, L 23-25. Trace for Th in Figure 10 looks like the time series was smoothed or filtered, if so, please explain why, and, if possible, present un-filtered version.

P 9471, L 21-24: see also comment to P 9453, L 4-6 and 17-18.

P 9472, L 22-24: "GF-PDFs between a GF of 0.9 up to 3.2 are visible ..." – please change wording in this and subsequent phrases.

PP 9475-9477, Conclusion: the Conclusion needs to be revised in a similar manner as the Abstract (see comment to PP 9447-9448).

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 9445, 2015.