Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-244-RC2, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol arriving on the Caribbean island of Barbados: Physical properties and origin" *by* Heike Wex et al.

Anonymous Referee #2

Received and published: 10 June 2016

The authors present measurements of aerosol size distributions, total and cloud condensation nuclei (CCN) number concentrations, and derived hygroscopicities conducted during November 2010 and April 2011 during the CARRIBA field campaign. Aerosol size distributions show distinct Aitken and accumulation modes, which are used to classify the aerosol into one of three types: 1) marine-type (both modes of same order), 2) Aitken-type (both modes present but with a pronounced Aitken mode), 3) accumulation-type (both modes present but with a pronounced accumulation mode). Ten-day air mass backtrajectories are used infer the origins of these aerosol types and show that the accumulation-type aerosols are transported via easterly flow across the Atlantic from Africa, while the Aitken-type aerosols follow more northerly trajectories (hailing sometimes from North America or the N. Atlantic). The origins of marine-type aerosol are indeterminate with transport via both easterly and northeasterly flows.

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Discussion paper

Comparisons of ground-based and airborne CCN number concentrations show excellent agreement and that assuming a constant aerosol hygroscopity of 0.66 combined with Kohler theory and the measured dry particle size distributions is generally sufficient to predict CCN number concentrations to within 0-15% uncertainty. In general, the manuscript is well written and the results should be of interest to the readers of ACP. I recommend publication after the following comments are satisfactorily addressed:

1) It is stated on Line 19 (and elsewhere in the manuscript, e.g., Pg. 17, Line 10) that sea spray does not contribute noticeably to Ntotal or NCCN. This strong conclusion seems to be based on a bulk average hygroscopicity of 0.66 that is lower than that for pure sodium chloride and more consistent with that for sulfate aerosols, as well as a lack of correlation between the aerosol number concentrations and local wind speeds measured 17 m above the tops of the Barbados cliffs. This does not seem to me to be strong evidence on which to base this conclusion.

Recently, Modini et al., examined similar-looking marine size distributions to those shown in Figure 1 that were measured in the Eastern Pacific during the EPEACE campaign. Their distributions also possessed the distinct Aitken and accumulation modes seen in this study with a long tail out to larger than 1um in diameter. They carried out a three-lognormal-mode fit to apportion the influence of primary marine aerosol versus the smaller size modes of likely secondary origin. Looking at the lower panels in Figure 1 of the present paper, a hump is clearly visible with a peak between 300-400 nm diameter. It is suggested in Appendix 3 that this hump may be an artifact caused by the SMPS-OPC splicing at 230-250 nm diameters. Alternatively, it could be the real manifestation of the primary marine aerosol mode. The authors should examine this further and, either way, employ the canonical size distribution fitting procedure of Modini et al. in order to quantify the likely contribution of primary marine aerosol, rather than just saying that it is negligible. It may also be worth bringing in the PDI size distributions to further constrain the supermicron tail of the dry aerosol distribution in Figure 1.

2) I don't understand the relevance of Figure 8 and the discussion related to wind

speeds measured at the tops of the Barbados cliffs. Presumably the surface wind speeds over the ocean and along the air mass backtrajectories are more relevant for aerosol production via whitecapping and bubble bursting. I suggest that this figure and discussion be removed.

3) What is the height of the Ragged Point aerosol inlet above sea level? How does this compare to the heights of the SCL sampled by ACTOS (reported as between 100-400 m)? If cloud base is at 500 m, do the ACTOS measurements indicate that the aerosol concentrations at 100 m are just as representative of the SCL as those at 400 m (i.e, the marine boundary layer is always well mixed)?

4) On Page 16, Lines 6-7, it is suggested that sea spray particles are found predominantly in the super-micron size range, which suggests a distinct mode being measured by the PDI rather than just the tail of the distribution; however, no data between 500-1000 nm are presented nor are the actual PDI size distributions shown. Please include a figure showing the ACTOS OPC distributions out to 2.5 um and the supermicron PDI distributions for each aerosol type or add them to Figure 1. This additional data should be very useful for carrying out the 3-mode fit requested in Point #1 above.

5) Figure 7 is quite nice for showing the origins of the air masses arriving at the measurement station, but is lacking any vertical context that would distinguish between free tropospheric transport of, e.g., SAL-influenced air versus more low-level transport that could be influenced by primary marine emissions and wet deposition. Please add some panels giving the altitude vs. time history of the trajectories for each aerosol type.

6) On Pg. 18, Lines 1-3, reference is drawn to both mineral dust and biomass burning particles. Is this suggesting that either of these aerosol types contribute to those sampled during CARRIBA? Until this brief discussion, I was under the impression that this was mainly a sulfate story with perhaps a minor contribution from primary marine aerosols. Please clarify.

Minor Comments:

a) What do the dotted lines (versus solid lines) in Figure 7 represent?

b) Pg. 2, Line 29: Do you mean “sea spray” rather than “sea salt”?

c) Pg. 7, Line 9: Strike redundant “the”

d) Pg. 7, Line 20: Remove comma between “both, heights”

e) Pg. 11, Line 9, 10: Change “extend” to “extent”

f) Pg. 12, Line 10: “discusses” to “discussed”

g) Pg. 13, Line 1: cmˆ3 to cmˆ-3

h) Pg. 14, Line 5: “weather” to “whether”

i) Pg. 14, Lines 10-12: Strike sentences “No correlation. . .from sea-spray”

j) Pg. 15, Line 9: “with the PDI were found in”

k) Pg. 16, Line 6: strike “and were found predominantly in the super-micron size range”. This statement is unsupported as the PDI only measures in the supermicron size range.

l) Pg. 17, Line 10: Strike “A correlation. . .significantly to Ntotal”

m) Pg. 17, Line 32: Replace “towards” with “versus”

n) Pg. 18, Line 5: What is meant by “found temporarily and fragmented”? Please clarify/reword.

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