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Atmospheric Chemistry and Physics Discussions

ACPD
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Interactive Comment

Interactive comment on "Characterization of particle cloud droplet activity and composition in the free troposphere and the boundary layer during INTEX-B" *by* G. C. Roberts et al.

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Response to Reviewer #2:

We thank the reviewer for his/her comments and suggestions that helped us improve the quality of the manuscript. We have revised the manuscript accordingly to address his/her specific comments as detailed below.

In the present work authors have presented air borne measurements of cloud condensation nuclei (CCN), aerosol size distributions, and submicron aerosol composition taken during INTEX-B campaign by focusing on three distinct air masses; free troposphere (FT), the marine boundary layer (MBL), and polluted continental boundary *layer over the Californian central valley (CCV). Further, they have estimated the values of kappa for the understanding of CCN activity of aerosol particles of different chemical composition (organics and inorganic). The manuscript is carefully prepared and well written considering the size of the data set reported. The data appear to be of high quality and of high relevance for atmospheric science studies and manuscript is within the scope of Atmospheric Chemistry and Physics (ACP). I recommend publication in ACP after the following points have been addressed.*

Specific comments/suggestions
1) Introduction
1.1) Page 3503, line 6 and 7: Authors could consider citing recently published paper by Cooper et al., 2010, about spring pollution plumes originating in Asia and ending up across the Pacific.

The sentence was expanded to include references to this and other work (Stith et al., JGR, 2001) on long-range transport from Asia.

2) Experimental methods
2.1) Page 3512: Authors may consider showing a general plot of back trajectories for the ease of visualization for the readers.

We agree that figures facilitate visualization for the readers and had included figures of back-trajectories in earlier versions of the manuscript. However, we decided to describe the trajectories in the text in broad terms to avoid the association of specific trajectories with the three main categories of air masses. Trajectories from the California Central Valley are not necessary as the measurements are dominated by local sources and trajectories from the Marine Boundary Layer originate exclusively from the Pacific Ocean, which for the purpose of our study is treated as a uniform source. Nonetheless, we do include a link to the source of the back trajectories in the manuscript (http://fuelberg.met.fsu.edu/research/intexb/).

3) Results

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3.1) Page 3513, line 18: Can authors please explain why did they choose geometric mean over arithmetic mean for representing the kappa value for each separate air-mass? On the other hand, I thought, geometric mean was the appropriate choice to represent the overall average kappa value (averaged over all three airmasses; overall arithmetic mean 0.48 and overall geometric mean 0.37) which authors have not included.

We have restrained from using arithmetic means because of the large range of kappas and the subsequent bias caused by outliers. We report the arithmetic and geometric means as well as median values for each airmass below. The median values are very very similar to the geometric mean values reported in Table 3.

kappa geomean $\pm$ geoSTD - FT: 0.98 $\pm$ 2.39
kappa geomean $\pm$ geoSTD - MBL: 0.21 $\pm$ 1.97
kappa geomean $\pm$ geoSTD - CBL: 0.25 $\pm$ 1.25

kappa arithmean $\pm$ arithSTD - FT: 1.52 $\pm$ 1.72
kappa arithmean $\pm$ arithSTD - MBL: 0.29 $\pm$ 0.27
kappa arithmean $\pm$ arithSTD - CBL: 0.26 $\pm$ 0.06

kappa median - FT: 0.94
kappa median - MBL: 0.21
kappa median - CBL: 0.24

3.2) Do authors have any explanation for such a high kappa value (0.98) observed in free tropospheric air mass in-spite of the fact that bulk sub-micron mass concentration was not highly variable in all three air masses? It seems that uncertainties in the supersaturation level in the CCN counter may be an explanation (Rose et al., 2008).

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As we note in our response to Reviewer #1, calculations of kappa are influenced by not only the CCN instruments, but also the measurements of size distributions. Systematic biases are nearly impossible to uncover, especially when CCN and size distribution instruments are not calibrated as a single unit. As this reviewer noted in the next comment, H-TDMA systems showed significant variability in a recent inter-comparison (Duplissy et al., 2009) – such variability between DMA systems will obviously propagate to biases in kappa quantification.

3.3) Page 3522, Section 4.2: I echo point raised by Referee #1 about HTDMA measurements. Please add some details about HTDMA measurement technique in section 2 of the manuscript (Experimental method section). Was the HTDMA set up identical to the one used by Shinozuka et al., 2009? According to recent studies different HTDMA systems can yield substantially different results (Good et al., 2010; Duplissy et al., 2009).

Yes, the HTDMA measurements were performed by the same system used by Shinozuka et al., 2009. We thank both reviewers for pointing out this omission and have added a brief description of the H-TDMA measurements with the following text:

"Size-resolved particle hygroscopicity was measured with a humidfied tandem differential mobility analyzer (H-TDMA) of Texas A&M University (Gasparini et al., 2004; Tomlinson et al., 2007). Dry classified particles (RH $<$ 5%) of 50, 100, 200 and 300 nm diameter were exposed to an elevated RH at 84%; a second DMA measured the hygroscopic growth of the particles. The resulting hygroscopic growth factors are used to determine H-TMDA-derived kappas, which are compared to CCN-derived kappas in Section 4 (Discussion)."

References to the studies of different H-TDMA systems and comparisons to CCN measurements are included in the conclusions:

"As highlighted by recent measurements of CCN and aerosol size distributions (Good et al., 2010 and Duplissy et al., 2009), the discrepancy between H-TDMA and CCN-

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derived methods warrants further investigation, particularly under the challenging conditions present in aircraft platform sampling."

3.4) Page 3524, line 12: . . ...concentration (and assumed densities). Please specify if the values of Tab. 2 were used or what else was assumed.

Reference to Table 2 included in sentence.

3.5) Fig 6: According to Petters and Kreidenweis, 2007 kappa should depend (near) linearly on chemical composition (mass or volume fractions), as observed by Gunthe et al. (2009) and Dusek et al. (2010). Hence it might be worthwhile to compare/plot/present Fig. 6 and fit parameters on linear scale.

Kappa does show a nearly linear relationship with mass (and volume) fractions; however, we plotted kappa on log-scale because of the large range of kappas observed during the experiment.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 3499, 2010.