Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-835-RC1, 2016

Atmospheric Chemistry and Physics Discussions
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Interactive comment on "Uptake of nitric acid, ammonia, and organics in orographic clouds: Mass spectrometric analyses of droplet residual and interstitial aerosol particles" *by* J. Schneider et al.

Anonymous Referee #1

Received and published: 28 September 2016

The study reports on a valuable dataset collected at the Schmucke mountain site in central Germany in September and October 2010. They collected aerosol composition data using a C-ToF-AMS downstream of a CVI inlet, which selectively samples droplets and rejects interstitial aerosol particles. The topic of the paper is of importance and of interest to readers of this journal. In general, measurements of this nature are difficult to make, especially at mountain sites, and thus the data are of importance to document in the literature. The analysis by the authors leads to a few interesting conclusions: (i) a significant fraction of submicron aerosol partitioned to the cloud liquid phase (85% on average); (ii) nitrate generally exhibited higher scavenging efficiencies as compared to ammonium, sulfate, and organics (black carbon was the lowest); (iii) nitrate and ammonium mass fractions were enhanced in droplet residual particles, with a speculation made about temperature playing a role in this finding; (iv) the oxidation state of organic matter in droplet residuals was also shown to have a potential temperature dependence. I found the analysis to be supportive of the conclusions reached. The figures can benefit in some parts from better aesthetic quality, including larger font size. Figure 3 in particular could use improvement. The title of the work is supportive of the contents of the paper. I recommend publication of this work after the authors address my suggested minor revisions below. Most of the specific comments relate to incorporating the work of others that may have gone overlooked but are highly relevant to the discussion topics of this paper.

Specific Comments: Page 2, Line 33-36: Other papers have also shown this that should be mentioned: Asa-Awuku et al. (2015). CCN properties of organic aerosol collected below and within marine stratocumulus clouds near Monterey California, Atmosphere, 6, 1590-1607, doi:10.3390/atmos6111590.

Page 4, Lines 5-19: How hot does the interior of the CVI inlet become? Provide temperature information for the heated counterflow stream. Also, what are the flow rates used for the various streams of the inlet?

Page 5, Lines 23-27: Doesn't the sampling efficiency depend on the droplet size distribution in ambient air? If the droplet distribution is not held fixed, it seems as though some sizes may have better or worse sampling efficiencies. Discussion about this issue is warranted here.

Table 1: clarify in caption what is meant by the various numbers of "+" and "-" in the last column.

Figure 1: clarify how far back the trajectories go in time, and what the final ending coordinates and altitude are for the trajectories.

Figure 3: It is unclear how to read the bars. Specifically, what are the two shadings indicative of on the bars labeled “int+res”? It is very difficult to analyze the results in this figure due to the inability to understand that important bar. Caption and figure should be improved.

Page 8, Line 6: change “that” to “than”

Section 3.2.1: The authors should also incorporate into the discussion the recent results of a paper focused on this very issue: Prabhakar et al. (2014). Sources of nitrate in stratocumulus cloud water: Airborne measurements during the 2011 E-PEACE and 2013 NiCE studies, Atmos. Environ., 97, 166-173, doi:10.1016/j.atmosenv.2014.08.019. General comment: was there any evidence of influence from biomass burning in this study?

Page 13: Line 24-26: The authors should update their references here because more studies than they have listed have examined cloud residues using an AMS, with results that could be relevant to interpretation of their own results. Below are a few examples that should be included:

Coggon et al. (2014). Observations of continental biogenic impacts on marine aerosol and clouds off the coast of California, J. Geophys. Res., 119, doi:10.1002/2013JD021228.

Sorooshian et al. (2013). Observations of sharp oxalate reductions in stratocumulus clouds at variable altitudes: organic acid and metal measurements during the 2011 E-PEACE campaign, Environ. Sci. Technol., 47, 7747–7756, doi:10.1021/es4012383.

Coggon et al. (2012). Ship impacts on the marine atmosphere: Insights into the contribution of shipping emissions to the properties of marine aerosol and clouds, Atmos. Chem. Phys., 12, 8439-8458.

Wonaschuetz et al. (2012). Aerosol and gas re-distribution by shallow cumulus clouds: an investigation using airborne measurements, J. Geophys. Res., 117, D17202,

doi:10.1029/2012JD018089.

Shingler et al. (2012). Characterisation and airborne deployment of a new counterflow virtual impactor inlet, Atmos. Meas. Tech., 5, 1259–1269.

Sorooshian et al. (2007). Particulate organic acids and overall water-soluble aerosol composition measurements from the 2006 Gulf of Mexico Atmospheric Composition and Climate Study (GoMACCS), J. Geophys. Res., 112, D13201, doi:10.1029/2007JD008537.

Section 3.2.4: it may be worth mentioning that in a recent study (Below), an organonitrate species was found only in cloud water as compared to CDR and out-of-cloud aerosol owing to the effect of heat kicking the species out of the aerosol phase. The results of this particular study are indeed interesting and warrant future investigation as to the effect of temperature on CDR composition.

Youn et al. (2015). Dimethylamine as a major alkyl amine species in particles and cloud water: observations in semi-arid and coastal regions, Atmos. Environ., 122, 250-258, doi:10.1016/j.atmosenv.2015.09.061.

General comment: What are the key sources of nitric acid, ammonia, and organics in the region? Also, what about organonitrates? Please add discussion about this.

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Discussion paper