Atmos. Chem. Phys. Discuss., 11, C1902–C1904, 2011
www.atmos-chem-phys-discuss.net/11/C1902/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Scavenging of biomass burning refractory black carbon and ice nuclei in a Western Pacific extratropical storm" *by* J. L. Stith et al.

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Received and published: 16 April 2011

We thank this referee for his helpful suggestions and agree with his general comment that the agreement between measured Ice Nuclei concentrations and ice crystal measurements is an interesting highlight of our paper. Our responses to his comments are:

1. With respect to the work using other Counterflow Virtual Impactors (CVI) by Ström and colleagues, their CVI is of a somewhat different design and the shattering char-

acteristics are not necessarily the same as our CVI. See our Response to the 2nd Referee under the section "Shattering effects on IN concentrations" for more information. We hope our paper will encourage others to consider this issue of particle breakup in future studies using CVI instruments for studying the residuals from evaporated hydrometeors including the ice phase. As recommended by this referee, we include in the abstract and in Section 2 a mention of the potential for multiple residuals from the CVI.

2. With regard to the issue of shattering artifacts in the 2DC measurements (which was also raised by referee #2), we have followed this referee's suggestion to look for the presence of large particles that might affect the 2DC concentrations through their shattering on the tips of the 2DC. The first half of the major sampling leg did contain significant amounts of larger ice crystals, including aggregates of single crystals, and these larger particles were significantly less abundant in the second half of the leg. The first half of this leg also exhibited higher ice content observed by the satellite measurements than did the second half of this leg, which is consistent with the observations of larger particles from the 2DC in the first leg. Thus, it is useful to examine these two regions of the warm sector cloud separately. We focus on the two time periods 5:22 to 5:41 and 5:42 to 5:54, since these time periods represent data taken when the temperature in the CFDC chamber was within about 2 degrees of ambient. As suggested by this referee, we include size distributions from each of these two regions.

Since large particles were present in this cloud, to account for the problem of shattering on the tips of the 2DC, we have reprocessed these data using the correction method discussed by Field et al. (2006), based upon particle interarrival times, to correct the concentrations for shattering artifacts. As expected, these corrections reduced the 2DC concentrations somewhat, resulting in slightly better agreement with IN concentrations during the second half of the sampling leg and somewhat worse agreement with IN in the first half of the leg, where more IN were present per ice particle sampled by the 2DC. We have examined images during the period when there are more IN per 2DC particles present and found that aggregates of multiple single ice crystals are present. These images are included in the revised paper.

Thus, after correcting the 2DC data for the effects of probe tip shattering, the data still support the hypothesis that heterogeneous freezing on observed IN can explain the concentration of ice in areas where heterogeneous freezing is likely to occur, with additional evidence suggesting that the residuals from aggregate ice particles (which contain multiple single crystals) contains multiple IN per ice aggregate. This observation is consistent with the heterogeneous freezing hypothesis.

3. We include a discussion of the chemical analysis of IN in the abstract as suggested.

Technical corrections: We include these corrections in the revised manuscript. We also correct two errors in the figure captions for Fig. 7 ("for the same time period" should read "for the warm sector cloud 5:22 to 5:50 UT") and Fig. 8 ("number concentration" should read "mass concentration"; we use number concentration in the revised manuscript).

References.

Field, P. R., Heymsfield, A. J, and Bansemer, A.: Shattering and Particle Interarrival Times Measured by Optical Array Probes in Ice Clouds. J. Atmos. Oceanic Technol., 23, 1357–1371. 2006

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 567, 2011.