P1.6 **IN SITU MEASUREMENTS OF CHARGE ON CLOUD DROPS**

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1. ABSTRACT

A unique instrument has been developed to measure the average charge on cloud drops. The charge per unit time on the stream of residue from evaporated cloud drops is captured by a filter in our instrument and used along with the concentration of the particles to determine the average charge on the particles and thus the cloud drops. The stream of cloud drop residues is produced by a Cloud-drop Virtual Impactor (CVI). The average cloud drop charge as a function of time was measured during C130 flights in the ICE-L field program. Almost all clouds contained drops with significant charge. Important potential consequences of the charge observed on cloud drops are presented.

2. INSTRUMENTATION

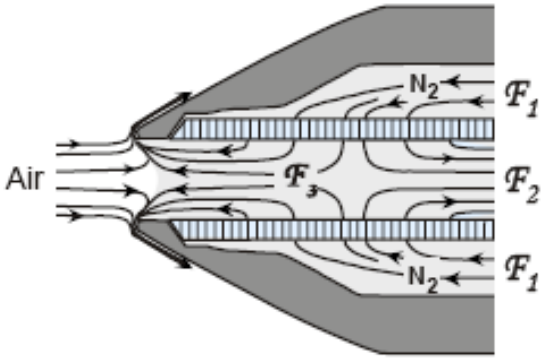

Figure 1. Counter flow Virtual Impactor (CVI) inlet.

A schematic of the flow pattern in the CVI inlet is shown in figure 1. Dry Nitrogen under pressure (F_1) prevents air and aerosol from entering the counter flow virtual impactor (CVI). Cloud drops above a cutoff size enter the CVI and pass the flow reversal point (F_3) and flow into the aircraft (F_2)

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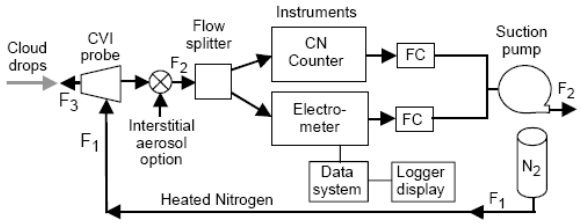

Figure 2. CVI flow diagram with the Atmospheric Physics Associates Electrometer.

The flow diagram in figure 2 shows the CVI CN counter that provides the concentration of the cloud droplets that penetrate the flow reversal (F_3 in figure 1) and enter the CVI. The electrometer measures the current resulting from the charge originally on the cloud droplets that enter the CVI. The electrometer is a TSI Model 3068 Aerosol Electrometer that has been modified to improve the instrument response time.

MEASUREMENTS

The data presented here come from flights using the NCAR C130 shown in figure 3.

Figure 3. NCAR C130 flying above a layer cloud observed in ICE-L Research Flight 5.

During ICE-L Research Flight 5 the C130 skimmed the top of the layer cloud shown in figure 3. A twenty minute segment of electrometer current (femtoamps) (figure 4) and cloud drop residue concentration (cm^{-3}) (figure 5) are shown.

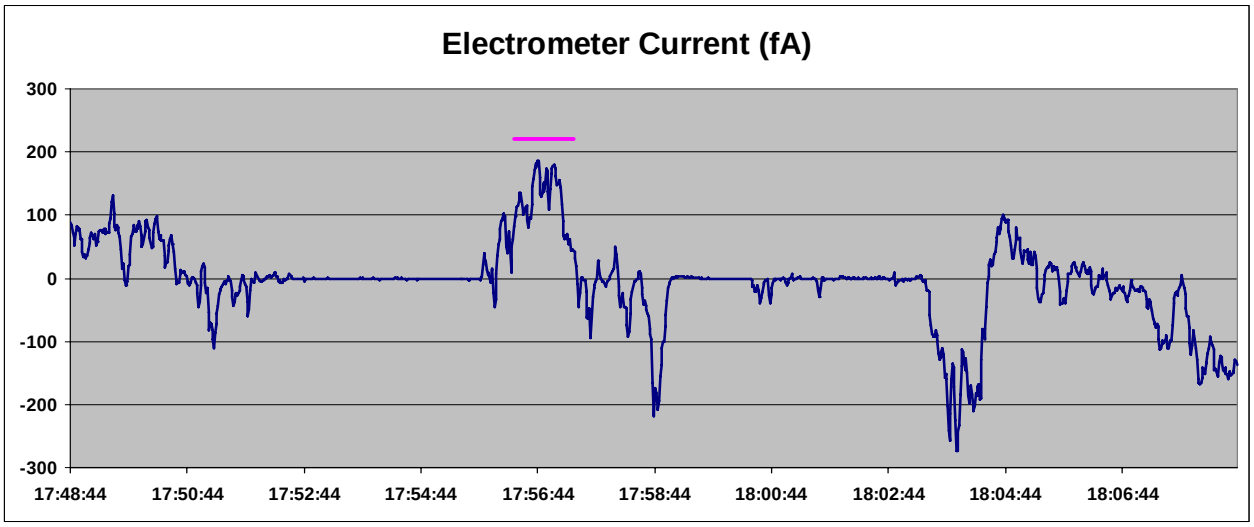

Figure 4. Electrometer current in femtoamps.

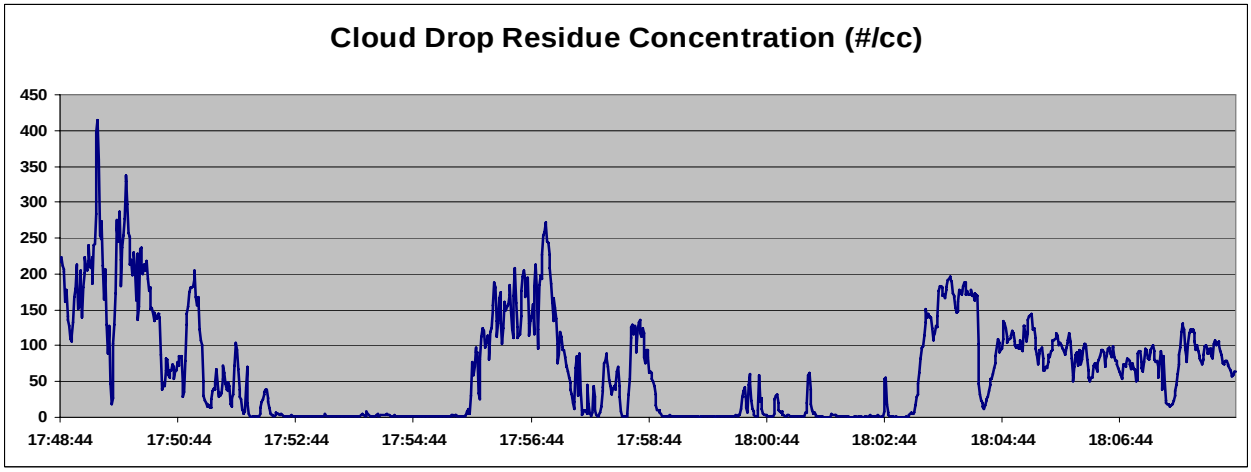

Figure 5. Cloud drop residue concentration (cm^{-3}).

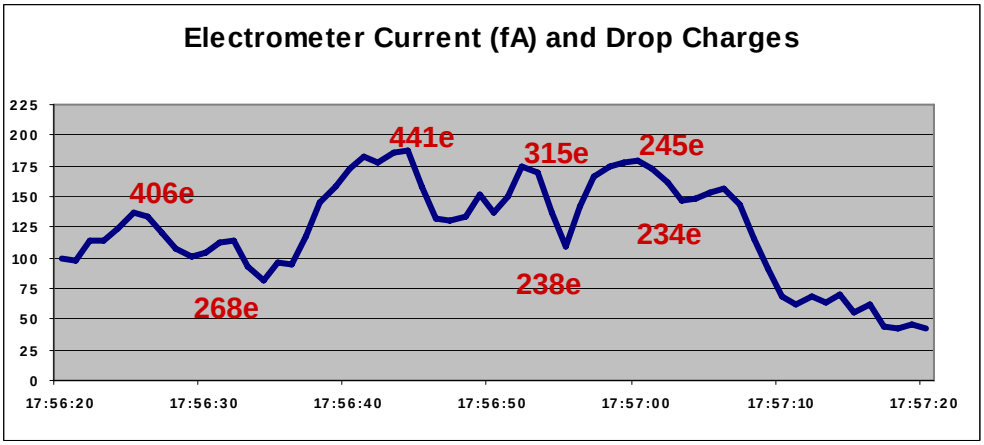

Figure 6. Electrometer current in femtoamps and drop charge in electrons.

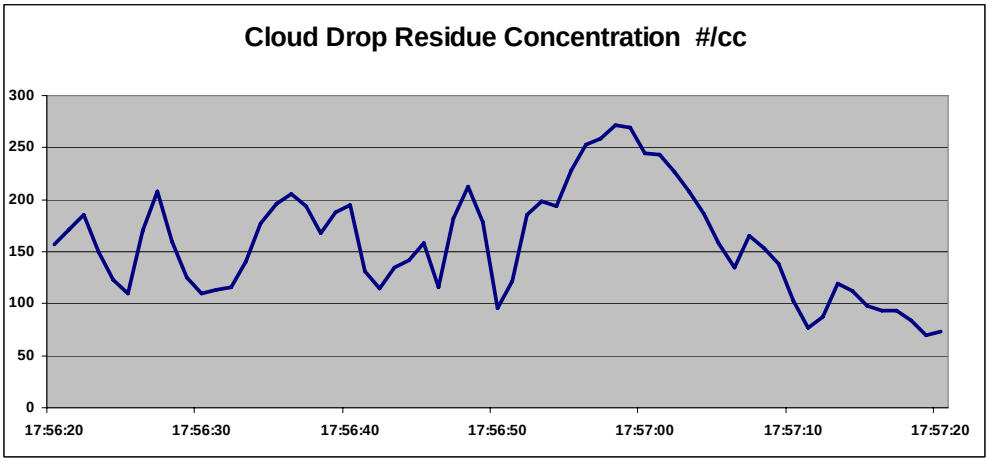

Figure 7. Cloud drop residue concentration (cm^{-3}).

Figures 6 and 7 show expanded plots of one minute of data for the time period delineated by the pink horizontal line in the upper center of figure 4. The numbers in red are the calculated average drop charges in numbers of electrons at several peaks and valleys in the electrometer current plot.

There are several potential implications of drop charge. First, scavenging efficiencies for aerosol can be increased. Also, coalescence efficiency can be enhanced. Finally, ice nucleation can may be enhanced. Ice nucleation may be enhanced because evaporation of droplets at cloud edge can result in fresh aerosol that may be effective contact ice nuclei but calculations of collection efficiencies for these aerosol are very small. However calculations of collection efficiencies for charged aerosol show dramatic increases in collection efficiencies.

The measured average droplet charges at the upper edge of a layer cloud studied in ICE-L are consistent with an excess or deficit of several hundred electrons. The CVI evaporates these cloud drops and the Atmospheric Physics Associates Electrometer measures the current produced by the flow of the charged drop residue. Calculated collision efficiencies for aerosol with the observed charges and cloud drops indicate efficiencies in the range of 40%. Charges similar to those presented here were observed in all layer clouds measured during ICE-L. Thus evaporated cloud drops may be an important source of contact ice nuclei.

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