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SURFACE AND AIRBORNE CONDENSATION NUCLEI MEASURE-  
MENTS IN REMOTE AREAS

Laurence J. Budney

Army Electronics Command  
Fort Monmouth, New Jersey

March 1968

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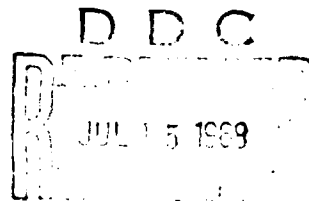
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**SURFACE AND AIRBORNE CONDENSATION NUCLEI  
MEASUREMENTS IN REMOTE AREAS**

by

**Laurence J. Budney**

**Techniques and Exploratory Development Technical Area  
Atmospheric Sciences Laboratory**

**March 1968**

**DA Task No. 1T0-14501B-53A-06-05**

**U. S. ARMY ELECTRONICS COMMAND  
FORT MONMOUTH, NEW JERSEY**

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## Abstract

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Condensation nuclei concentration measurements were made in the vicinity of Flagstaff, Arizona, during July 1966. The purpose of these measurements was to determine typical nuclei concentrations in the area and to correlate concentration with time of day, elevation, and weather conditions. The measurements were made both near the surface and from an aircraft.

From the aircraft measurements it was found that condensation nuclei concentrations decreased with elevation. There was no apparent difference between concentrations in clear air, clouds, or rain. The ground-level measurements, about one foot above the surface, indicated concentration of about 1000 to 1500 particles per cubic centimeter during sunrise and continuing for several hours thereafter. Sharp peaks in concentration occurred during the mid-day hours on each of the three days of ground-level measurements.

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## **SURFACE AND AIRBORNE CONDENSATION NUCLEI MEASUREMENTS IN REMOTE AREAS**

### **INTRODUCTION**

During July 1966, condensation nuclei concentration measurements were made with a one-expansion Aitken Counter in the vicinity of Flagstaff, Arizona. \* Ground-level measurements were made during 18, 19, and 22 July in an attempt to correlate nuclei concentrations with time of day and weather conditions. The elevation at ground level was about 7000 feet.

Measurements were also made with the same counter aboard a C-47 aircraft on 14 and 15 July. In the aircraft, a hose for the air samples was run from an opening on the outside of the fuselage directly to the nuclei counter inside the aircraft. The outside opening was located where there was no exhaust contamination from the engines. The purpose of these airborne measurements was twofold: 1) to relate nuclei concentration with respect to elevation, and 2) to compare concentrations in clear air, clouds, and areas of rain.

### **DISCUSSION**

Data were collected for three days on the ground at an elevation of approximately one foot. The data for the first two days of surface measurements (18 - 19 July) were collected in a remote pine forest a few miles west of Flagstaff; readings were taken in a large clearing in the shade of an isolated pine tree. The area was almost free of human contamination for several miles in all directions. However, there were cows and other wild life in the area. The only other known source of contamination in this area was from an occasional motor vehicle on the road by the test site. When vehicles did pass upwind, readings were temporarily discontinued.

The data for the third day, 22 July, were collected in another remote area about ten miles southeast of Flagstaff. This site was located near the

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\*The counter operates on the principle of a Wilson cloud chamber by growing water droplets on any nuclei available in the air sample being analyzed. In this particular counter, the degree of light extinction is believed to be proportional to the number of nuclei present.

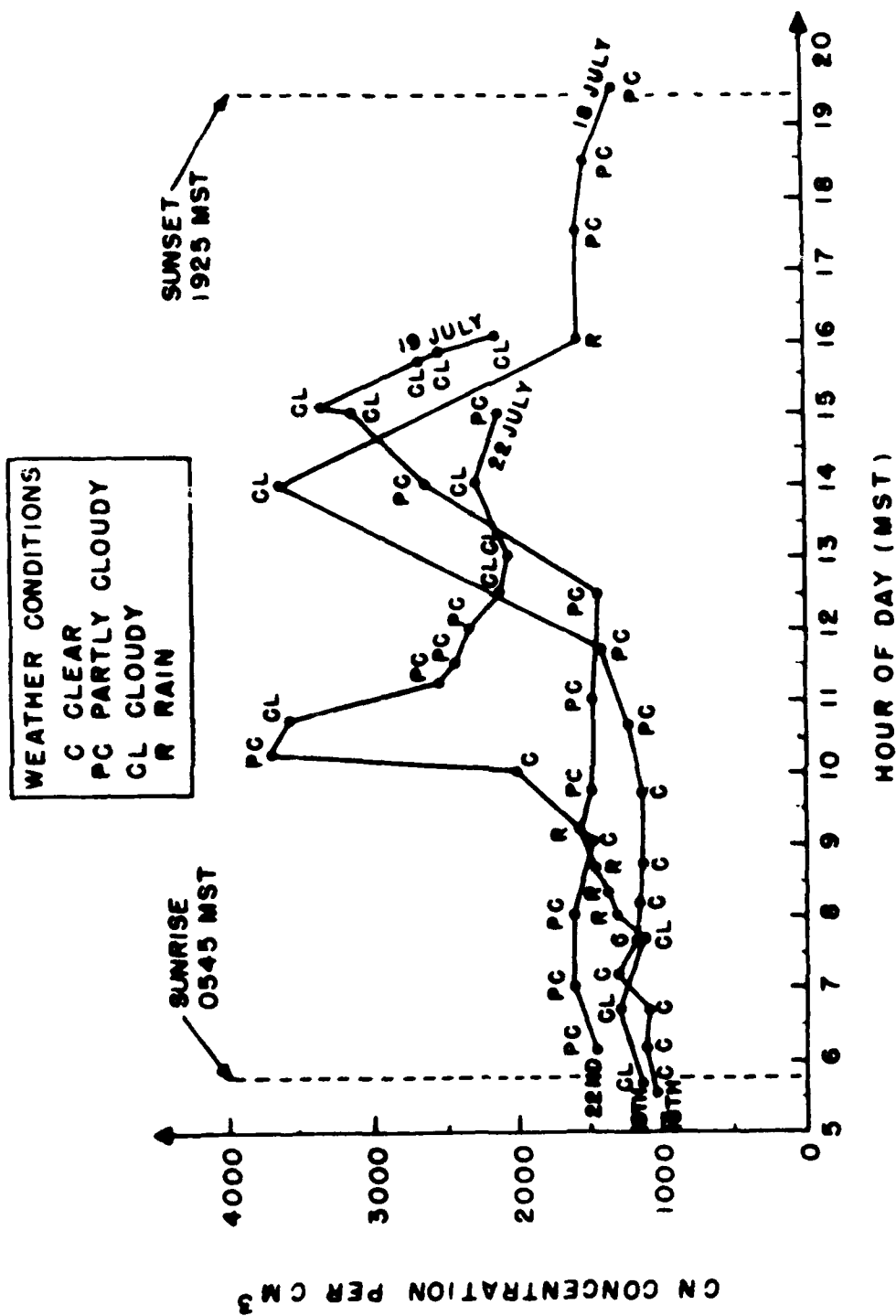


Figure 1. Condensation nuclei concentration versus time of day, 18, 19, and 22 July.

bottom of a valley in a hilly, forested area. Here there was a low level of contamination similar to that at the first site. Figure 1 shows the data from ground observations in graphical form.

#### Data - 18 July

On 18 July, the day began clear and calm. By 1100 Mountain Standard Time (MST) cumulus development was beginning in the area and wind gusts up to about five knots were occurring. At the 1400-hour reading, the sky was mostly obscured by clouds, wind gusts had picked up a little more, and a small shower was beginning directly overhead, but had not yet reached the ground. From 1400 to 1600 hours, intermittent moderate showers occurred. By 1600 hours the activity had deteriorated to a high overcast and gradually dissipating light showers throughout the area. By 1800 hours, the sky was mostly clear and the wind nearly calm again. In Figure 1, note the increase in nuclei count before the showers and a decrease of about the same amount after the showers.

#### Data - 19 July

On the morning of 19 July, the onset of very light rain did not seem to affect the nuclei concentration. However, the reason for this may be that the sky was overcast since sunrise, the winds were almost calm, and convective activity was at a minimum. By 0930 hours, the rain had ended and the sun was shining about half the time. A light, southerly breeze with gusts to about six knots had developed by 1400 hours, and an area of thundershowers was forming over the mountains a few miles north of the site. By 1500 hours, a moderate shower on the southern fringe of the activity was visible, reaching the ground within a mile north of the site. This shower never reached the site except for a few drops of rain. No other showers came closer to the site.

The site was in the southerly wind inflow into this shower area until approximately 1530 hours, when the wind suddenly shifted to the northeast. This appeared to be a downdraft from the shower area. The showers gradually deteriorated to a thin, inactive, altostratus overcast by 1730 hours. No nuclei data taken after 1605 hours were accepted because of motor vehicle traffic upwind of the site. On this day (19 July) once again, the nuclei count increased substantially preceding the showers which occurred nearby. The nuclei count decreased substantially once the downdraft air hit the site.

#### Data - 22 July

July 22nd was a day of active cumulus development, but no showers occurred in the area. The nuclei count increased sharply around 1025 hours; this

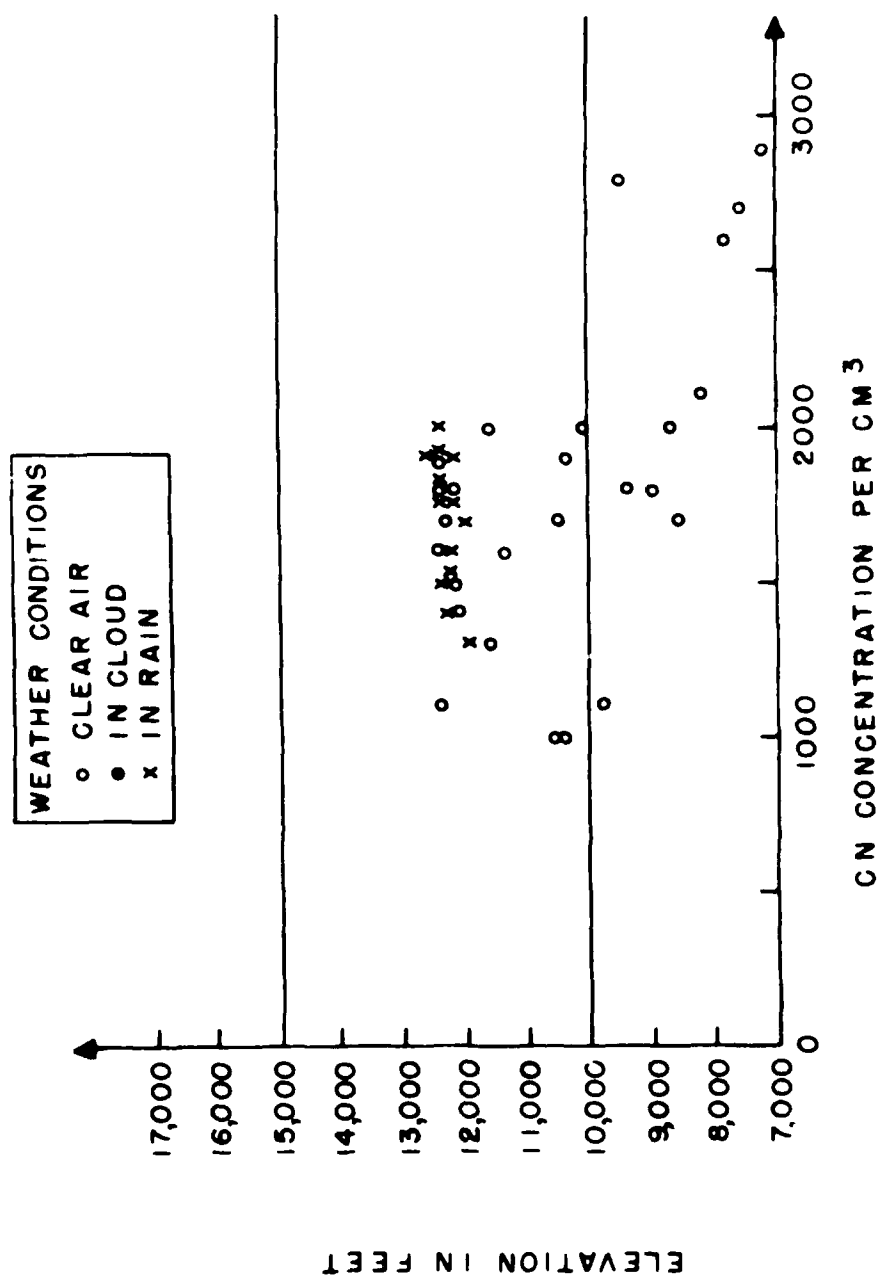


Figure 2. Condensation nuclei concentration versus elevation, 1700-1800 MST, 14 July.

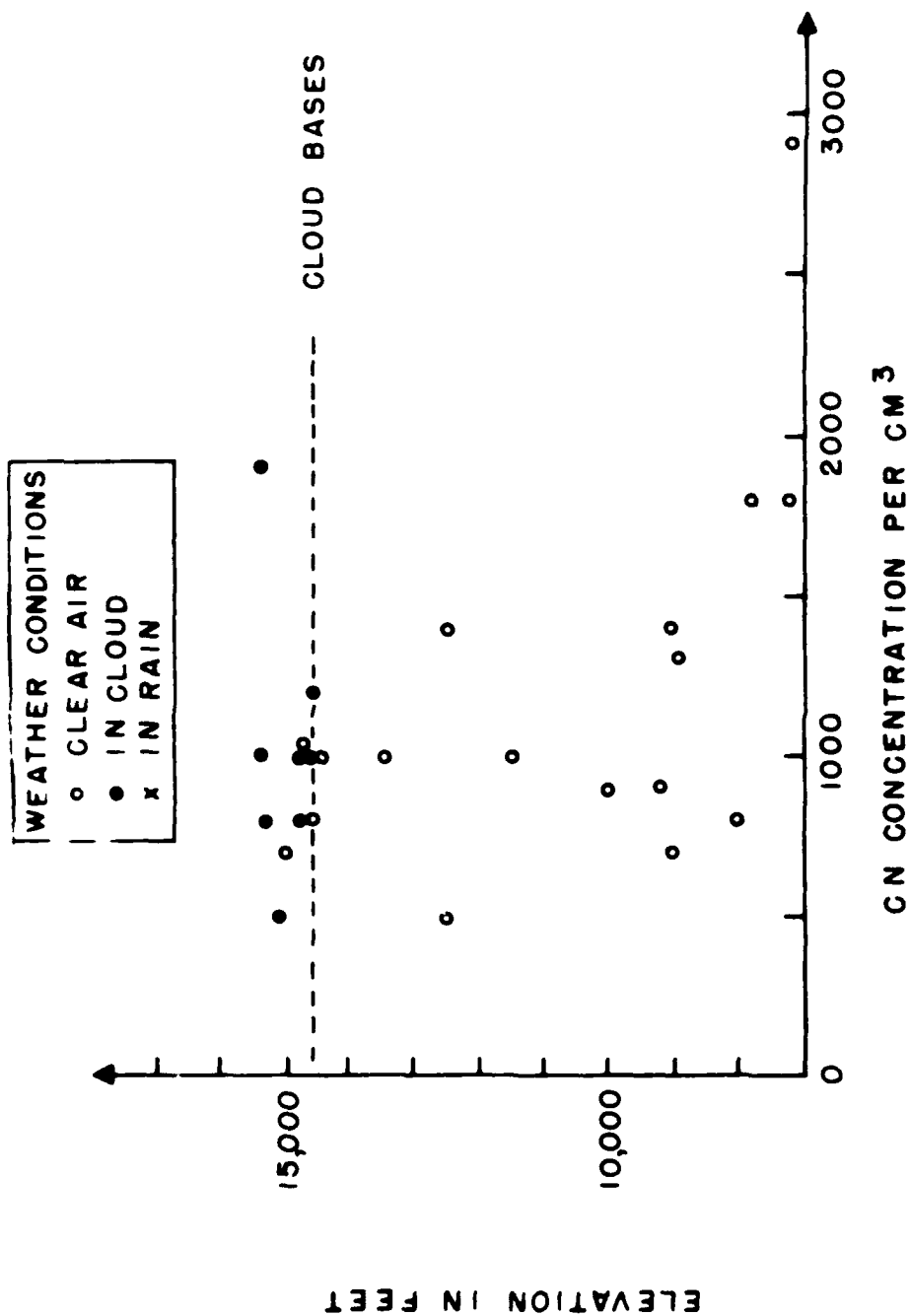


Figure 3. Condensation nuclei concentration versus elevation, 1100-1200 MST, 15 July.

may have been associated with a large cumulus developing overhead. Surface winds were very light throughout the time of high nuclei readings. Since this site was beneath a forest canopy, the winds could have been considerably stronger above the trees. After 1100 hours, the sun was shining about one-third of the time. Cumulus gradually dissipated later in the afternoon.

The possibility of the atmosphere being contaminated must always be kept in mind during surface measurements. Logging trucks were being operated within a mile of the July 22nd site and might have been operating near the first site as well, although none were seen. Also, variable winds could have carried contamination from the person operating the counter or from his own vehicle. Attempts were made to confine sources of contamination to positions downwind of the nuclei counter.

#### Data (Airborne) 14 - 15 July

Condensation nuclei concentration measurements were made aboard a C-47 aircraft during one flight on 14 July and two flights on 15 July. Figures 2, 3, and 4 show the concentration versus elevation on these flights. The data in the figures are segregated into clear air, "in-cloud," and rain area measurements. It is difficult to determine a difference between concentrations during each of these three weather conditions. However, the graphs do show a definite decrease of concentration with elevation.

Comparing the distribution of points on each of the graphs for 15 July, it appears that the convective updrafts distributed the higher surface concentration as much as 6000 feet above the surface by mid-afternoon.

#### **CONCLUSIONS**

Measurements about one foot above the surface indicated condensation nuclei concentrations of about 1000 to 1500 particles per cubic centimeter during sunrise and continuing for several hours thereafter. Sharp increases in concentration occurred during the mid-day hours on each of the three days (18, 19, 22 July) during which surface data were taken. The increases in concentration occurred during active cumulus development overhead and preceding the onset of showers. Towards evening, concentrations decreased towards their early morning values.

At any particular elevation, there is no apparent differences between clear air, "in-cloud," and rain area nuclei concentrations. However, concentrations do decrease with elevation. On the average, concentrations at the surface were roughly twice the concentration at elevations 6000 to 8000 feet above the surface.



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