An Improved Device for Obtaining Cloud Droplet Samples

L. F. CLAGUE

Radiophysics Laboratory, CSIRO, Sydney, Australia

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1. Introduction

There is as yet no thoroughly satisfactory instrument for observing, from an aircraft, the spectrum of cloud drop sizes in the free air. Attempts to make a device capable of giving a continuous record of the droplets impinging on it have not been entirely successful. Most results have been obtained by taking, at intervals, small samples of the cloud traversed by the aircraft. The drops or the traces which they leave on the sampling surface are examined microscopically. Typical instruments using this principle are described by Bigg and Abel (1953), Brown and Willet (1955), Frith (1951), Owens (1957) and Squires and Gillespie (1952).

The instrument described in this paper uses the sampling technique of Squires and Gillespie (1952) in which droplets impinge on a soot coated glass slide, leaving holes whose size is related by laboratory calibration to that of the droplets. Since the slide coating technique is identical to that used by these authors their calibration figures will be used.

The advantages of the device described here are shorter sampling time, which enables samples to be obtained in very wet clouds, smaller time interval between successive slide exposures, and a greater number of slides available in each magazine. The last two features allow better appreciation to be obtained of the variation of droplet spectrum along the aircraft path.

2. Description and operation

This instrument is in the form of a gun (Figs. 1 and 2) and is intended to be operated from an aircraft through the co-pilot’s (starboard) window.

The instrument is held at an angle to the airstream, determined from the aircraft speed and the velocity of the slides, such that the impinging droplets produce circular impressions on the sampling surface. This assists in the accurate determination of drop sizes.

Eighteen slide and holder assemblies (Fig. 3) are stored in adjacent slots in the magazine. Each slide is rubber cemented to the stainless steel holder, the cement acting as a shock absorber to prevent damage to the slide on firing. At the desired intervals each slide assembly can be projected past an opening in the “barrel” (A and B, Fig. 2) where the slide is exposed to the cloud. It is then returned to the magazine (Fig. 4) by way of a U-shaped extension to the barrel. A plunger powered by a leaf spring (C, Fig. 2) drives the slide assembly into the barrel. The leaf spring is loaded by a manually operated cocking lever (D, Fig. 2). Operation of the lever also cocks a shutter (E, Fig. 2) which covers the opening in the barrel. On its return stroke (spring energized) the lever rotates the magazine 10°, positioning a fresh slide ready for exposure. An index number shows through a window in the magazine housing, indicating the number of the next slide to be exposed.

When the sampler is cocked both leaf and shutter springs are held by latches (F and G, Fig. 2), the shutter is kept closed by a trigger (H, Fig. 2), and a torch bulb lights to indicate that the instrument is ready to sample.

When the trigger is depressed the shutter flies open and trips the leaf spring. The shutter is closed by a return spring after the slide has been exposed; the cycle may then be repeated.

Magazines can be changed in less than one minute; this must be done with the instrument cocked.

It is not known what effect the airstream has on slide velocities but as a first attempt to avoid such effects the barrel opening has been angled in the manner described by Owens (1957). Both laboratory and flight trials show the simplicity of operation of the droplet sampler. In flight trials, an interval between slide exposures of approximately one second was readily attained.
Fig. 1. A general view of the cloud droplet sampler.

Fig. 2. Diagram of the mechanical arrangement of the sampler.

Fig. 3. The slide holder with slide in place. The inset shows a photomicrograph of an area 1 mm in diameter, which has been exposed in cloud.

The effective exposure time of the slides was found in the laboratory to be 2.5 milliseconds with a random variation from slide to slide of the order of 0.25 millisecond. Even when the same slide was fired repeatedly from the one magazine slot a similar variation in exposure time was experienced. With the above exposure time the sampled volume is approximately 20 cm$^3$ at an aircraft speed of 70 m sec$^{-1}$. Operation of the sampler in cloud showed no evidence of splashing of water from the barrel onto the slide. Even in an extreme case when exposure was made immediately after emerging from a large wet cloud, no splashing was observed.
The slides exposed in cloud showed clear impressions with sufficient separation between holes to ensure reliable droplet counting and size evaluation. Insufficient measurements have yet been made to comment on the meteorological significance of the observations.

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REFERENCES