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Field-testing of Two Cloud-droplet Samplers

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Two cloud-droplet samplers, developed at the Indian Institute of Tropical Meteorology, Pime, for the measurement of the concentration of the size distribution of cloud-droplets, are field tested. The technical details of the two instruments and the sample data obtained from them are presented in the paper.

INTRODUCTION

Measurements on cloud-droplet size distribution are vital for research in cloud physics. For these measurements, two types of instruments are used by the scientists. The earlier instruments are based on simple mechanical techniques. With the advances in electronics, new optical automatic instruments have been developed. However, the former type of instruments are still widely used, inspite of the tedious and laborious data reduction procedures, for the reason that they provide the ground truth on the cloud-droplet populations. The automatic instruments are highly sophisticated and the technology requires perfection. The data obtained from them are subjected to errors.

Two mechanical cloud-droplet samplers have been developed at the Indian Institute of Tropical Meteorology (IITM), Pune, and they are field tested, during the aerial cloud-seeding experiments conducted by IITM, using a DC-3 aircraft. These instruments adopt the impaction technique for the collection of cloud-droplets and replicate these drops on glass slides, of these, one is based on a simple design and contains single-slide and the second is on the design of Clague[1] which contains eighteen slides.

Recently, Sharma[2] has developed a multi-slide coating gadget for coating glass slides with magnesium oxide smoke for measurement of cloud-droplets. Slides coated using this gadget is found to be more suitable than slides coated manually. The two instruments were flight tested during cloud-seeding experiments and found working satisfactorily. The details of the instruments and sample data obtained from them for the measurements of cloud-droplet size distribution are presented here under.

DESCRIPTION AND OPERATION

Single-slide Sampler

The droplet sampler contains a spring-loaded slide-holder (*Fig* 1). A glass slide of length 35 mm, breadth 7 mm and thickness 2 mm is fitted to one end of the holder. The glass slide is provided with a housing so that it is not exposed always to cloud-droplets. When the spring-loaded handle is released the glass slide travels in the vertical plane from the upper to lower position of its housing and is exposed to cloud-air. The time of exposure of the glass slide to coud-air is determined in the laboratory and is found to be 14.8 milli-seconds. The glass slide is coated with magnesium oxide smoke for obtaining the cloud-droplet replicas. The sampler is projected out of the aircraft window for collecting the cloud-droplet samples during aircraft penetrations through the clouds. The replicas of the cloud-droplets are thus obtained and their size distributions are measured under the optical microscope in the laboratory. The volume of cloud-air sampled is computed from the exposure time *ie* 14.8 milli-seconds; crusing speed of the aircraft which is 54 m/s; magnification used in optical microscope *ie* 150 × and the area of one field of view *ie* 0.006 cm². May[3] obtained a nearly constant ratio, 0.86, of water droplet to crater size in a magnesium oxide layer for droplets upto 200 μm diameter. He did not carry out callibration below 10 μm. May's callibration has been extensively used for studying the microphysics of fog and clouds. Hence the total concentration of cloud-droplets are obtained by applying May's callibration for differences in collection efficiency of the droplet sampler to different size cloud-droplets.

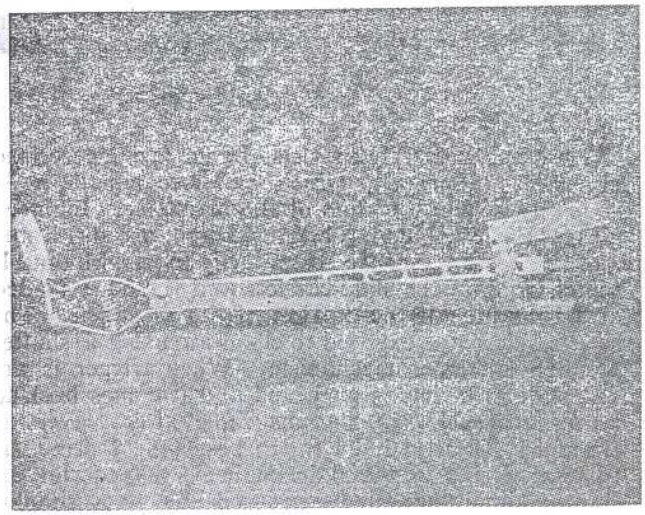

Fig 1 *Single-slide cloud-droplet sampler*

Multi-slide Cloud-droplet Sampler

The detailed mechanical drawing of the complete sampler is shown in *Fig 2*. Two photographic views of the sampler are given in *Figs 3 and 4*.

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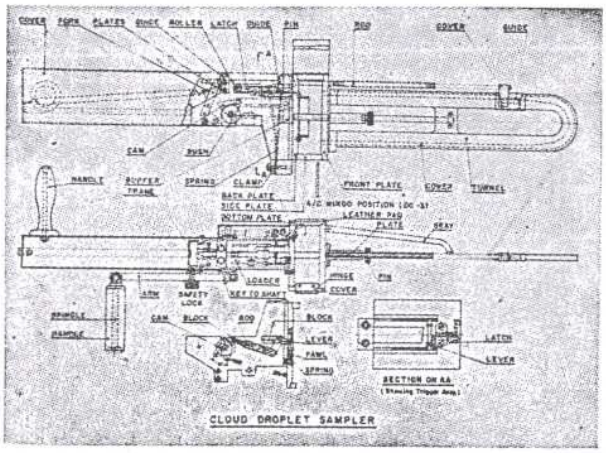

Fig 2 Detailed mechanical drawing of the multi-slide cloud-droplet sampler

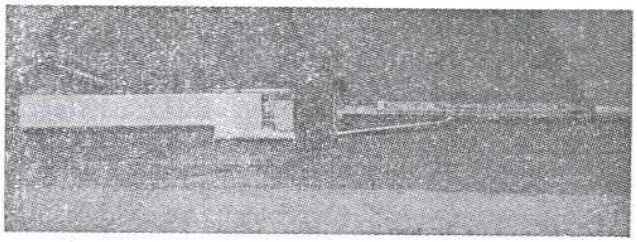

Fig 3 A view of the multi-slide cloud-droplet sampler

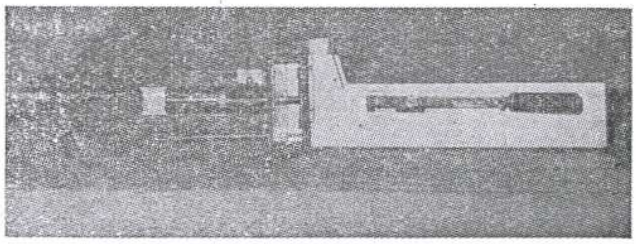

Fig 4 Another view of the multi-slide sampler

The sampler mainly consists of a magazine described elsewhere (Sharma[2]), which can accommodate 36 slides housed in the slots of the magazine. Eighteen glass slides each having length 25 mm, breadth 3 mm and thickness 1 mm are temporarily fixed with double scotch tape on the slide-carriers and these are loaded at a time in half the portion of the magazine. The slide-carriers are exposed to cloud-air using a shutter through a trigger mechanism. When trigger is on, one slide at a time is projected and it comes back to an opposite slot in the magazine after traversing through a U-shaped slot in the housing. During the traverse period of the slide in the U-shaped slot the shutter simultaneously opens and the glass slide is exposed to the cloud air. The shutter exposure time is 2.1 milliseconds. The replicas of the cloud-droplets were obtained by coating the glass slides with magnesium oxide. The total concentration and the size distributions are obtained as described in the case of the single-slide sampler.

SAMPLE DATA

The sample data obtained from the single and multi-slide samplers are given in *Figs 5* and *6*.

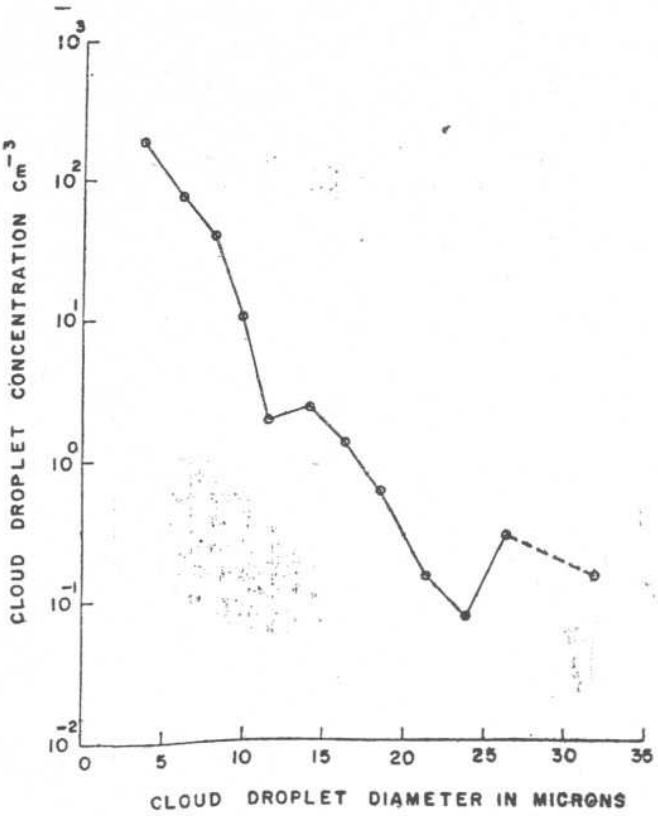

Fig 5 Size-distribution spectrum of the sample data obtained from single-slide sampler

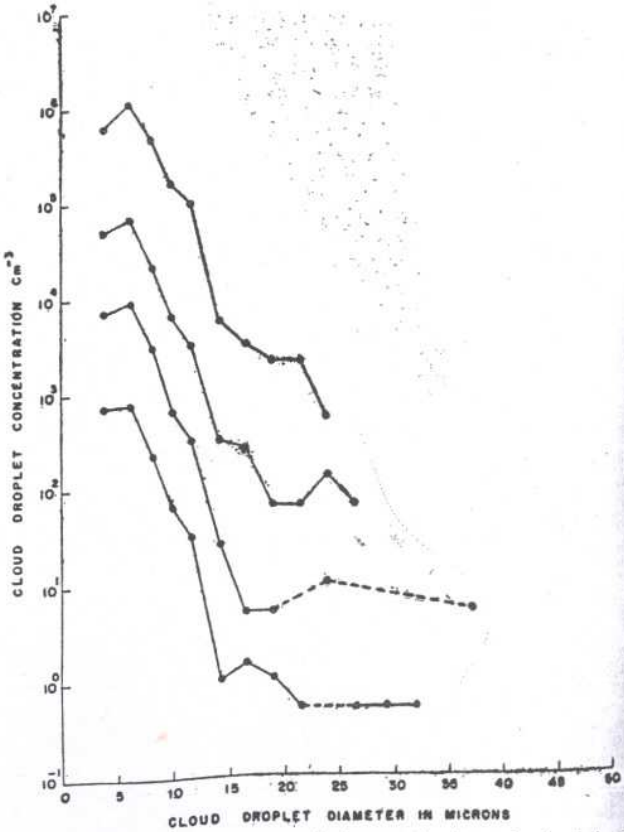

Fig 6 Size-distribution spectra of the sample data obtained from multi-slide sampler

Fig 5 relates to the size distribution obtained from a sample collected from a single cloud using single-slide sampler. The computed total concentration is 466.076 number/cm^3.

Fig 6 relates to the size distributions obtained from four samples collected from a single cloud using multi-slide sampler. The computed total concentrations obtained in this case are 2991.954, 3376.461, 2513.658 and 3523.122 number/cm^3 respectively. The extra-ordinary high values of concentrations can be attributed to the time of exposure of the multi-slide sampler.

The multi-slide sampler is more useful for getting more number of samples from a single cloud.

ACKNOWLEDGEMENT

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3. K R May. 'The Measurement of Airborne Droplets by the Magnesium Oxide Method'. *J of Scient Instrum*, Vol 27, p 128, 1950.