A Contribution to the Measurement of Raindrop Spectra with Airborne Foil Impactors

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19 March 1973

1. Introduction

Among the more dependable instruments for sampling raindrop spectra from aircraft are foil impactors such as those described by Brown (1961) and Spyers-Duran (1968) using lead foil, and those described by Duncan (1966) and Schecter and Russ (1970) using aluminum foil. At the National Hurricane Research Laboratory (NHRL) we have been photographing samples from our aluminum foil unit and processing the photographs, thereby reducing the risk of damage to the original data. The use of polarized light photography also permits selective image enhancement of the imprints with respect to wrinkles and corrosion. The purpose of this note is to describe the way we produce the image-enhanced pictures.

2. The system

The system consists of a collimated light source with a polarizing filter and a 35-mm camera with a similar filter. Fig. 1 shows our equipment. The source is a 120 W spotlight followed by a tube 5 inches in diameter by 34 inches long containing baffles every 6 inches which pass a rectangular beam roughly 1 inch by 4 inches. The beam illuminates the foil at an angle of 23°, producing a nearly rectangular field 3 inches by 4 inches. The source polarizer A is placed after the collimater so that no unpolarized scattered light is emitted. The camera is placed above the sample high enough that the illuminated foil fills one frame on the film. A single-lens reflex type is used to simplify the adjustment and focusing of the optics. A small mirror is used to reflect light almost vertically onto a $\frac{1}{4}$ inch strip at the edge of the foil so that notations placed on the foil will show on the photographs.

With no filter on the camera, a piece of exposed foil is viewed under a thin piece of glass and "A" is rotated until the background corrosion and wrinkles on the sample have minimum brightness in the camera's viewfinder. Rotating "A" seems to have little effect on the brightness of the droplet impressions. Without disturbing "A", the camera filter is installed and rotated until the impressions show maximum brightness in the viewfinder. The pictures are taken in this configuration using Kodak Plus-X film.[1] The most effective exposure seems to be $\frac{1}{4}$ sec at $f/5.6$ for maximum signal-to-noise ratio without losing too many of the smaller droplet impressions.

[1] The mention of a commercial product does not constitute an endorsement of it.

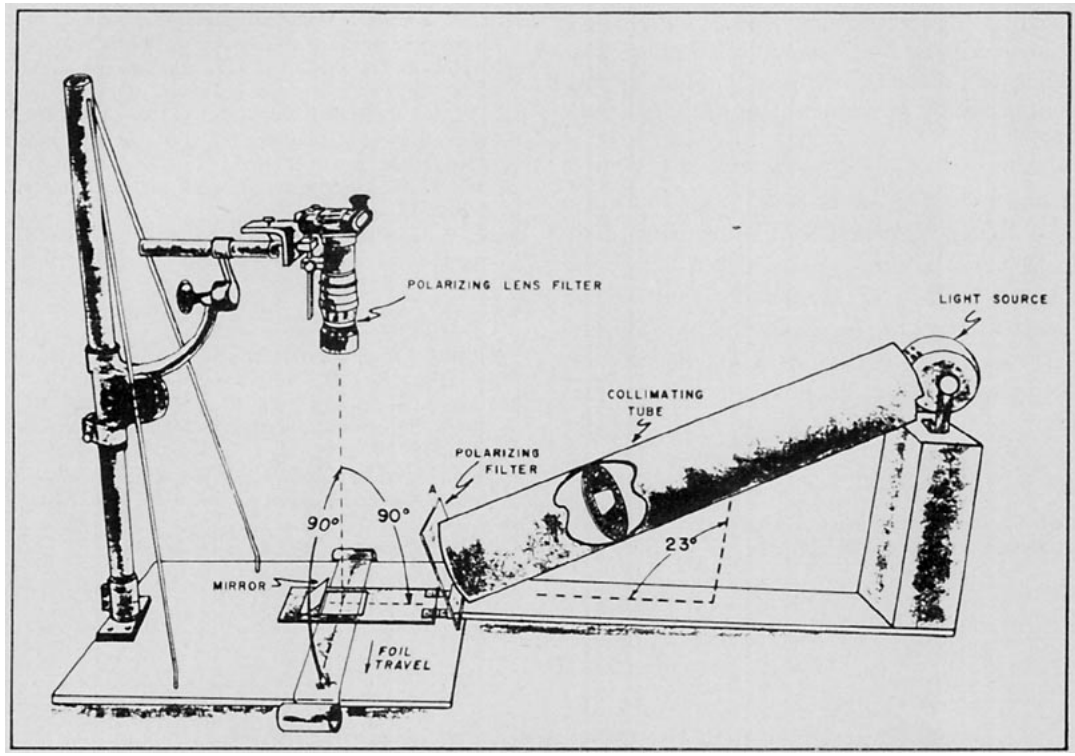

FIG. 1. The foil photography system.

3. The results

Figs. 2 and 3 present pictures taken, respectively, without and with polarization on a heavily corroded piece of foil: the improvement in signal-to-noise ratio with polarization is apparent.

Some of the smaller impressions on the foil do not appear on the photographs in either case, and in each case a few larger droplets appear undersized by one corrogation (250 μm). On heavily corroded foils some impressions become nearly invisible if covered by the

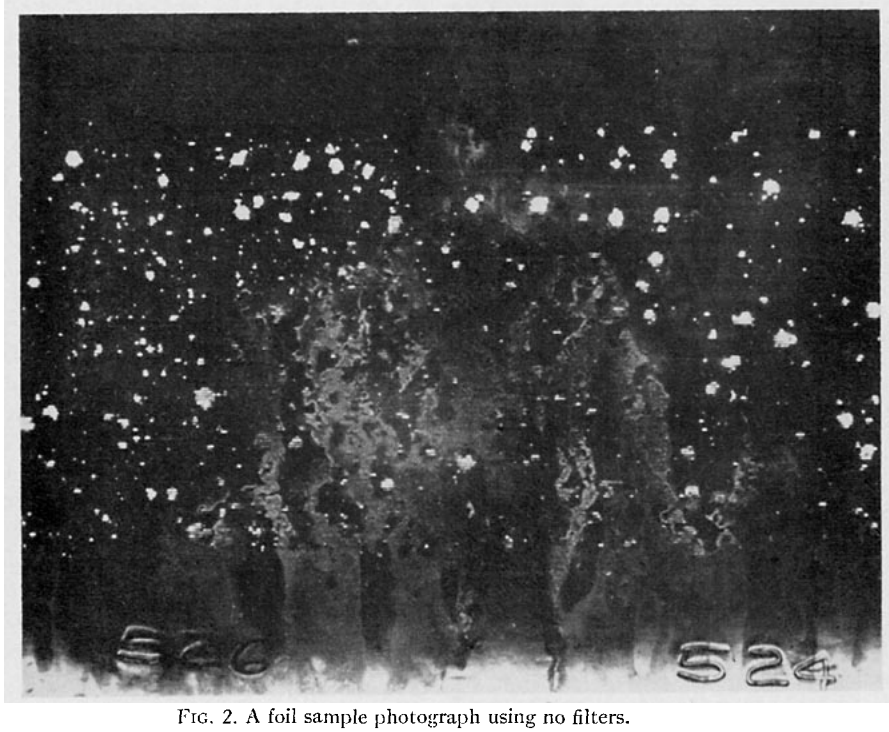

FIG. 2. A foil sample photograph using no filters.

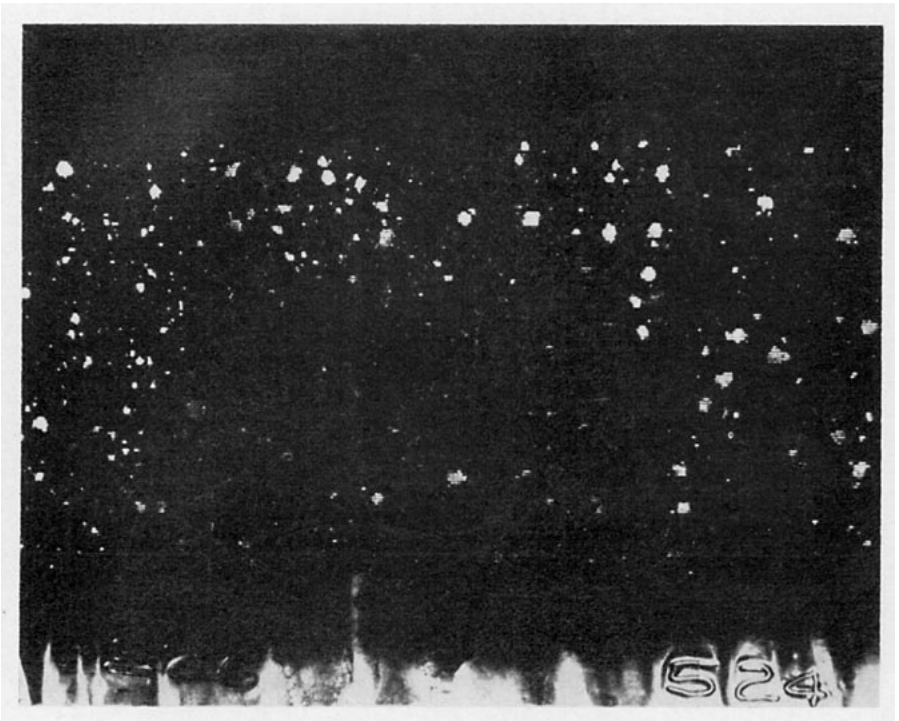

Fig. 3. A foil sample photograph using polarizing filters.

corrosion. The use of the polaroid filters increases the number of impressions omitted or undersized slightly, but the difference between the techniques seems to have no measurable effect in computing spectral distributions by least-squares techniques and causes a decrease in the computed liquid water content of less than 5% on clean foils having a high initial signal-to-noise ratio. On wrinkled or corroded foils such as those used for these figures, the methods are equally accurate for manual data reduction and the enhanced images are considerably easier to read.

Limited experiments with an optical scanning device, a Bausch and Lomb model QMS belonging to the Experimental Meteorology Laboratory, NOAA, Miami, Fla., indicate the enhanced films are better inputs for such devices than the unenhanced ones.

4. Conclusion

The use of polarizing filters with a photographic system in an optimum geometric configuration results in both mechanical protection of the foil and significant improvement in the signal-to-noise ratio for data from impactor-type, airborne raindrop spectrometers.

Acknowledgments. The author is grateful to Alan H. Miller and the Experimental Meteorology Laboratory for the use of the QMS analyzer.

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