tion the surface temperature was between −15° and −21° F. He concluded that fog droplets were still liquid at such low temperatures—a fact which was not widely accepted at that time—since hoar frost formed on their garments. He further cited the theoretical work of Pernter [2] which predicts that droplets with a radius of 25μ produce a broad white bow with yellow outer and violet inner edges; the total extent is from 37 to 41 deg. of radius. Also a secondary bow should appear at a radius of about 35 deg. Consequently Simpson concluded that the fogbow he saw was composed of supercooled water droplets with radii smaller then 25μ, since both the radius and the coloring of a bow decreases with decreasing droplet size. (Apparently the same is true for the above observations since the maximum radius of the primary bow was only 38 deg.)

Subsequent observations have left no doubt that fogbows can be caused by supercooled water droplets (see, e.g., Brooks [3]). During the Norwegian-British-Swedish Antarctic Expedition of 1949–52, Liljequist [4] observed liquid-water fogbows at temperatures as low as −18° F.; the one measurement that he made of a fogbow revealed a mean radius of 37.5 deg.

A cursory check of literature on meteorological optics revealed no references to radii measurements of supernumerary bows. In fact, the only mention that I could find of more than one supernumerary bow stated that within the primary bow, "with a space between them, one or even two supernumerary bows are to be seen" [5].

Therefore, it appears that the second supernumerary is rarely observed and that the existence of the third one is virtually unknown; this latter fact is most likely due to the requirement that the elevation angle of the sun has to be less than 16 deg. before the bow can be seen. The measurements cited above should prove to be valuable in confirming theoretical studies of supernumerary fogbows caused by droplets with radii less than 25μ.

REFERENCES

1. G. C. Simpson, "Coronae and Iridescent Clouds," *Quarterly Journal of the Royal Meteorological Society*, vol. 38, No. 164, Oct. 1912, pp. 291–301.
2. J. M. Pernter, *Meteorologische Optik*, W. Braumüller, Vienna, vol. 3, 1910, p. 247.
3. C. F. Brooks, "Coronas and Iridescent Clouds," *Monthly Weather Review*, vol. 53, No. 2, Feb. 1925, pp. 49–58.
4. G. H. Liljequist, "Halo-Phenomena and Ice-Crystals (Maudheim, 71°03′ S., 10°56′ W.)," *Norwegian-British-Swedish Antarctic Expedition, 1949–52, Scientific Results*, Norsk Polarinstitutt, Oslo, vol. 2, Part 2, 1956, pp. 55–57.
5. M. Minnaert, *The Nature of Light and Color in the Open Air*, Dover Publications, Inc., New York, 1954, p. 183.

CORRESPONDENCE

Comments on "Weather Note: Rapid Intensification of Hurricane Cleo, August 1964"

DONALD ROSENFELD

Massachusetts Institute of Technology, Cambridge, Mass.

It is not exactly clear what Mr. Kraft [1] is suggesting in his recent note, but if he is saying that forecasters could predict intensification of tropical cyclones beforehand by the degree of angle associated with spiral bands I would be inclined to disagree. I feel that intensification occurs before the change in angle of spiral band curvature. This change of curvature, I believe, is caused by the increase of low-level inflow becoming more ageostrophic as the cyclone increases in intensity. This assumes that the basic inflow-outflow model is correct; i.e., intensity is primarily based on an increase in the outflow at very high levels resulting in an increase of inflow at low levels.

If a definite correlation can be found for curvature vs. storm intensity, the degree of curvature should prove useful as a research tool following the storm or during a time when a vortex is under radar observation only and intensity information is needed.

REFERENCE

1. R. H. Kraft, "Weather Note: Rapid Intensification of Hurricane Cleo, August 1964," *Monthly Weather Review*, vol. 93, No. 7, July 1965, p. 444.