Weather Note

AN APPARENT OBSERVATION OF ICE CRYSTAL HAZE BY RADAR

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1. RADAR OBSERVATIONS

During the period from 2200 EST March 4, until 0800 EST March 5, 1960, a rather unusual example of precipitation aloft was observed on the WSR–57 radar at Washington National Airport. Occurring predominantly to the north and east of the station, the echo appeared in all quadrants for much of the period. Often it formed a ring or "halo" about the center of the PPI scope, similar to the presentation associated with a layer of altostratus cloud, sometimes detectable on the WSR–57. This return, however, was brighter, and in appearance resembled that of light snow. See figures 1 and 2.

The RHI presentation (figs. 3–5) depicted two layers, identical in appearance to the return of layer clouds, or precipitation aloft, generally extending in all directions, and presumably over the station. The horizontal extent of the echo, at times 35 to 40 n. mi., gave further credence to the presence of precipitation aloft, as cloud returns are seldom detected beyond 15 or 20 n. mi.

Figure 3 taken at 0232 EST, shows a layer based at approximately 2,000 feet, with the top about 10,000, and a higher layer, based at roughly 11,000 feet, with the top at about 15,000. Until 0400 EST, with the exception of a single observation toward Baltimore, all the precipitation observed was aloft, requiring an elevation angle of 2 to 3 degrees for detection. From this time on, however, the echoes began to reach the ground at various points. At the same time, the tops seemed to average slightly higher, in some cases reaching an indicated height of 20,000 feet. Also, an apparent movement from the southwest was noted.

Figure 4, taken at 0650 EST, again indicates two layers, with the principal difference being the height of the top of the second layer, reaching to a little more than 18,000 feet. Figure 5, at 0730 EST, is about the same as figure 4, except that the horizontal extent of the lower layer is greater, and it appears to reach the ground (zero baseline) at a point in the vicinity of the 20-mile range marker. The RHI observations were not confined to a particular quadrant or azimuth, and the echo was detectable in all directions, with only slight variations in the heights of the bases and tops. (It should be noted that the zero level of the RHI scope was improperly aligned at this time, causing the sloping baseline visible in the photos, and a slight error in the height indications.)

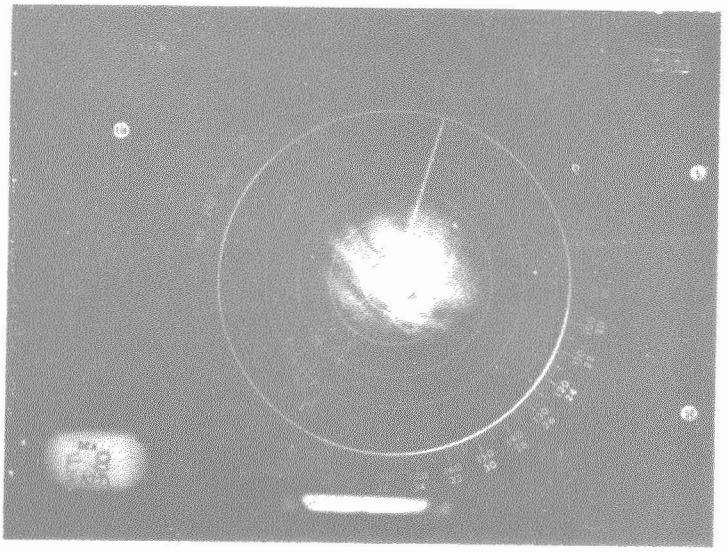

FIGURE 1.—PPI scope, 0146 EST, March 5, 1960. Settings: 50-mi. range; 3° elevation; normal gain; STC off.

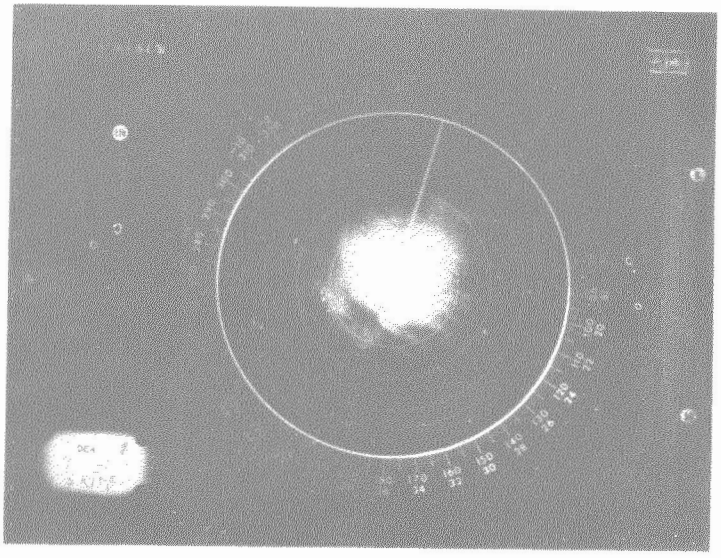

FIGURE 2.—PPI scope, 0232 EST, March 5, 1960. Settings: same as in figure 1.

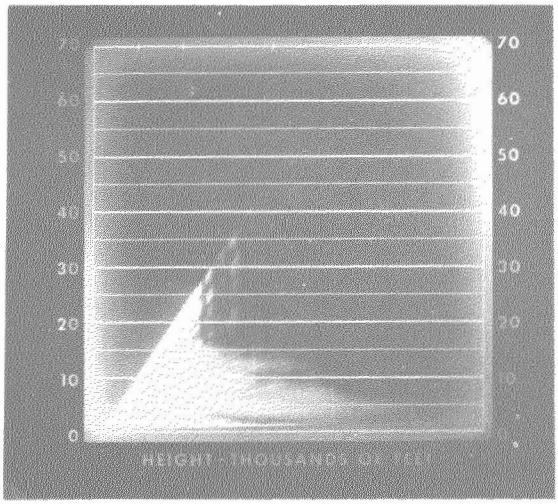

FIGURE 3.—RHI scope, 0232 EST, March 5, 1960. Settings: 25-mi. range; azimuth 117°; full gain; STC off.

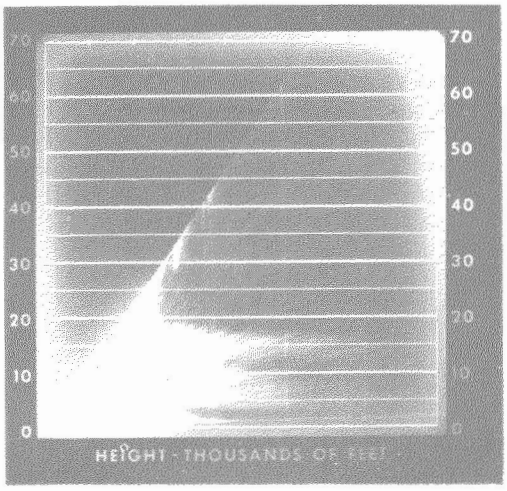

FIGURE 4.—RHI scope, 0650 EST, March 5, 1960. Settings: same as in figure 3.

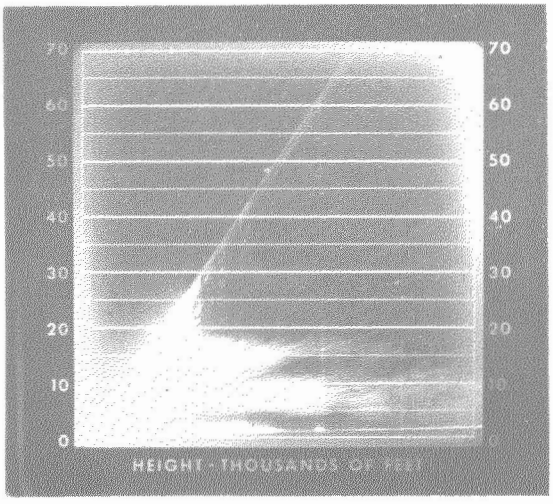

FIGURE 5.—RHI scope, 0730 EST, March 5, 1960. Settings: same as in figure 3 except azimuth 74°.

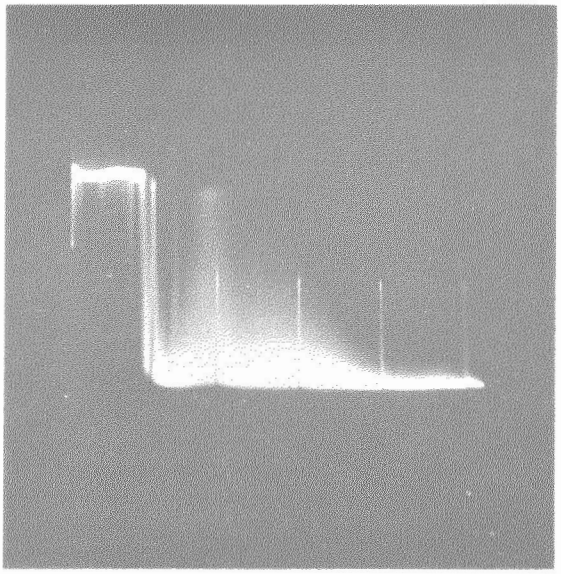

FIGURE 6.—"A" scope, 0240 EST, March 5, 1960. Settings: 25-mi. range; azimuth 117°; lin receiver; gain way down, STC off.

In addition to the similarities of the observed echoes to those of light snow, as presented on the PPI and RHI displays, there was the further parallel of the "A" scope presentation (fig. 6), where the rapidly fluctuating, incoherent nature of the display definitely suggested a precipitation target, being of a greater amplitude than would have been associated with a cloud return.

2. WEATHER OBSERVATIONS

Observations taken during this interval, however, of ceiling and sky conditions failed to substantiate the radar return, or at least not in the manner which might have been expected. The stars overhead were visible for much of the time, and the only detectable clouds formed a high overcast, apparently cirrostratus, at an altitude well above that of the echoes represented on the RHI scope. The observer did detect a slight "haze-like" layer at approximately 8,000 feet early in the period, and a pilot flying in the area covered by the target reported a kind of "haze" with the ground visible through it from an altitude of 8,000 feet.

The airways observation, made at 0230 EST, reported a thin broken layer at 8,000 feet, and a higher overcast. The lower layer, however, was based on a clinometer observation by the observer, in which he noticed a thin "haze" at approximately 8,000 feet, while the upper layer was judged to be quite high, in the vicinity of 20,000 feet. The 0700 EST observation, taken after sunrise, disclosed a broken layer at approximately 17,000 feet, with a higher overcast above that. The 0730 EST observation was much the same as the one at 0700 EST. It should be noted that although the radar was still indicating a lower layer, there was nothing visually observed below 17,000 feet, not even the "haze" layer mentioned earlier.

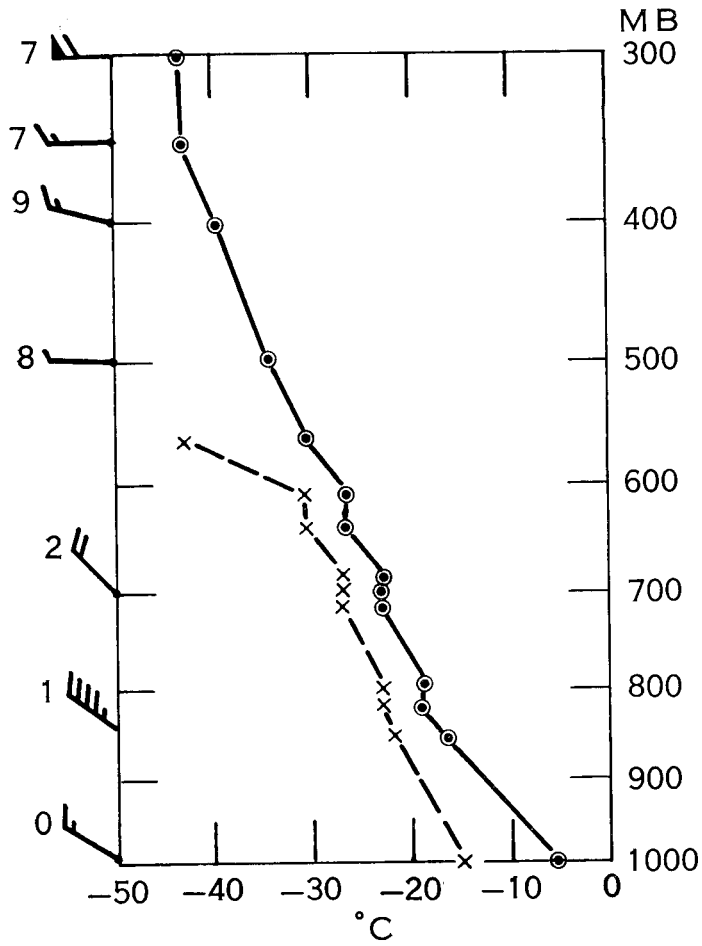

FIGURE 7.—Upper air sounding, 1900 EST, March 4, 1960.

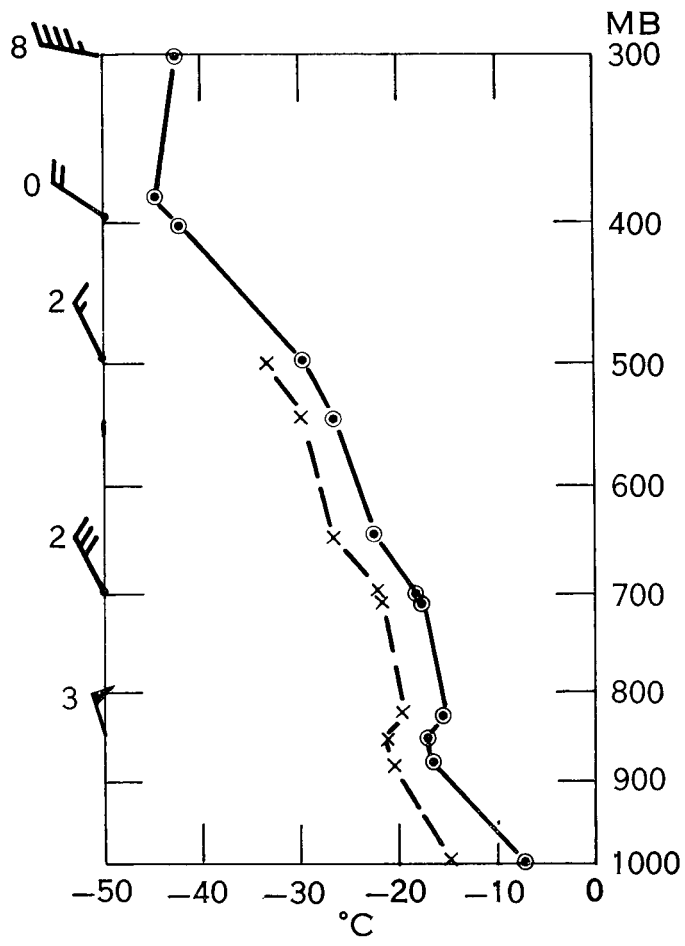

FIGURE 8.—Upper air sounding, 0700 EST, March 5, 1960.

At 0205 EST a pilot report relayed to the observer stated: "Descending from Riverdale—indefinite haze layer—contact with ground from 8,000 feet." Riverdale, a radio navigational aid site, is located about 6 n. mi. northeast of the airport, and at this time was in the area covered by the target, as presented on the PPI scope. This report, coupled with the apparent lack of observable clouds or precipitation over the station, at the heights indicated by the radar, would seem to indicate something other than the presence of snow aloft, at least snow associated with a deck of stratus clouds, as would appear to have been indicated by the RHI presentations.

At 0300 EST Baltimore reported very light snow showers in their airways observation, and in their 0700 EST synoptic report recorded a trace for the 6-hour precipitation amount. At that time the echo was located principally to the northeast of the Washington National Airport, and extended in the general direction of Baltimore. A check of the RHI scope revealed that precipitation was apparently reaching the ground at a distance of approximately 20 n. mi. to the northeast. This echo, incidentally, also included Riverdale, mentioned earlier in the pilot report. If this was snow, it was apparently very light and fine, and, as stated before, apparently not locally associated with any cloud layers at the heights indicated on the radar, or else they would have been visible to the pilot, and to our observer at the airport. Baltimore, however, was reporting low clouds, with one deck at 1500 feet, broken, and a higher overcast at 5,000 feet. Prior to this observation, however, they had been reporting only a high overcast. Snow was reported during much of the period from stations farther north and northwest as, for example, Wilmington, Del., Philadelphia, Philipsburg, and Pittsburgh, Pa.; snow showers were reported in West Virginia and southwestern Virginia.

3. SYNOPTIC CONDITIONS

The surface analysis for 0100 EST, March 5, 1960, showed a deep Low in the Atlantic, south of Nova Scotia, and a large high cell centered near the Missouri–Iowa border. Under the influence of these pressure systems, cold, unstable air flowed strongly into the Washington area from the snow areas to the northwest. During the period under discussion the surface conditions showed little or no change.

The 500-mb. analysis for 1900 EST March 4 showed a closed Low near the Ohio–Pennsylvania border, with a trough extending eastward to another closed Low over the

Atlantic, associated with the surface depression in that region. By 0700 EST March 5, the first Low, and the associated shallow trough, had moved past the Washington area and were located over the Atlantic, off the Maryland coastline. The passage of this upper Low may explain the apparent movement of the radar echo from the southwest during this period. Later (0800–1500 EST) the direction of movement was very definitely from the northwest.

4. UPPER AIR SOUNDINGS

The stratification of the atmosphere, as shown by upper air soundings for Washington at 1900 EST March 4 (fig. 7) and 0700 EST March 5 (fig. 8), seemed to be closely related to the layers shown by radar. Both soundings indicate cold air aloft and at the surface, and high moisture content of the lower layers. In both soundings the lower layers are conditionally unstable and both show inversions and isothermal layers through the vertical extent of the radar echoes. To illustrate how closely the radar presentations and the soundings agree, a comparison of the 0700 EST raob (fig. 8), and the RHI photo taken at 0730 EST (fig. 5) may be made. The raob shows the base of an abrupt change in the lapse rate at approximately 4,000 feet, with the top of this more-or-less isothermal layer indicated at about 10,000 feet. The RHI photo shows a layer based (near the station) at approximately 4,000–5,000 feet, with the top roughly 10,000–11,000 feet. The raob, again, shows another such layer based just above 12,000 feet, with the top indicated at a little more than 18,000 feet. The photograph depicts a second layer based between 12,000 and 13,000 feet, with a top at roughly 18,000 feet. The 0650 EST photo (fig. 4) shows about the same degree of correlation. The other photo, taken about 0230 EST (fig. 3), though not close to either sounding in time, compares favorably if the gradual vertical extension of the isothermal layers in both directions during the interval between soundings is taken into consideration.

5. CONCLUSIONS

(1) The echoes in question, at least locally, appear to have been from frozen precipitation particles, presumably ice crystals, suspended in layers, and independent of accompanying clouds. Such a phenomenon fits pretty well the definition of "ice crystal haze," a form of ice fog, as given in [1]: "A type of very light ice fog composed only of ice crystals . . . and at times observable to altitudes as great as 20,000 feet. It usually is associated with precipitation of ice crystals. Observed from the ground, ice-crystal haze may be dense enough to hinder observation of celestial bodies. . . . Looking down from the air, however, the ground is usually visible and the horizon only blurred." The pilot report discussed earlier would appear to support this assumption.

Another point, the precipitation of ice crystals, which could explain some of the observations of precipitation reaching the ground, also seems to fit. Ice crystals are defined in [1] as "A type of precipitation composed of slowly falling, very small, unbranched crystals of ice which often seem to float in the air. It may fall from a cloud, or from a cloudless sky. It is visible only in direct sunlight or in an artificial light beam, and does not appreciably reduce visibility."

Whether Baltimore's reported snow shower comes under this category is questionable considering their reported cloud heights. Since Baltimore was closer to the upper-level depression it would have been in an area of an earlier stage of the evolutionary precipitation process.

(2) The intensity of the return was due to the hydrometeoric nature of the particles, as well as to their relatively larger size, as compared to cloud droplets. Though these reflectivity factors enhanced their detection by radar, their rather low concentration per unit area, compared to that of a cloud, made visual detection relatively poorer, resembling as they did a very thin cirrostratus cloud layer.

(3) The observed phenomenon was probably a dissipated stage of the snow showers farther north, associated with the upper low system. The radar layers, then, would have represented those frozen particles which remained—lacking sufficient weight to precipitate.

REFERENCE

1. R. E. Huschke (Ed.), *Glossary of Meteorology*, American Meteorological Society, Boston, 1959, (p. 295).