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Comment on "An Application of Hygroscopic Flares – A Single Case Study", by Henderson, Wood and Newsom

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In a short paper (accompanied by a cover photo with explanation) describing a single case study, Henderson, et al. (1997; hereafter HWN) raised the spectre of hail production as a consequence of seeding a cumulus cloud with flare-produced hygroscopic salts. We have read that article with great interest and arrive at a radically different conclusion. Though it is not possible to prove anything with a single case study, we could argue that the described case is a heuristic demonstration of the effectiveness of the hygroscopic flares in reducing damaging hail.

The principal hypothesis under which most hail prevention cloud seeding has been performed, over many years, has involved the generation, usually by seeding with ice-forming nuclei such as silver iodide, of large concentrations of graupel and small hail, to create a condition of "beneficial competition". This is expected to limit the growth of the individual hailstones to less than about one cm in diameter, so that they will melt before reaching the ground (see, for example, Ludlam, 1958, or Sulakvelidze, 1966). Hail of the sizes (5 to 7 mm diameter) reported in the article by HWN to have fallen on high ground will melt before falling to elevations of a few hundred meters above sea level. On many thunderstorm days in northern Italy, small hail and graupel (often in large amounts) are reported from the mountain weather stations in the Alps, though hail does not fall from thunderstorms in the lower, agricultural areas on most such days. The same is true over the Pyrenees and the adjacent plains.

HWN could only give qualitative descriptions of concentrations, such as "a substantial amount" of snow pellets and hail, or the ground being "white with hail." We infer from the descriptions given that the seeding successfully created large concentrations of ice particles in the cloud. This could be taken as confirming the observation by Mather (personal communication), based on flights with an instrumented Learjet in flare-seeded clouds, in South Africa, of (unexpected) high concentrations of ice particles, far beyond what have been experienced there in unseeded clouds, at the -10°C level. It further might confirm the observation of one of us (JFB), in France, of the generation of ice needles in clear air at -2°C and 95% relative humidity following seeding with a flare. These observations have not been explained, but have played a role in our decisions to pursue research into the effect of hygroscopic flare seeding on hailstorms. The report by HWN further encourages us in that.

The reported rate of seeding in the HWN case study was rather low compared to what has been used in the hail prevention project which was carried out by one of us (JFB) near Agen, France, using hygroscopic flares to seed warm-based (>O°C) thunderstorm clouds (the primary objective of the seeding is to accelerate the coalescence process). The observations of HWN may shed some light on the practical question of seeding rates with hygroscopic materials, in that a spectacular effect was possibly produced with a small amount of material. In the French hail prevention trials, two 1000g (similar to those used in South Africa and in Mexico for rain enhancement) are used, every four minutes, flying in the laminar inflow of a storm, a region about two to three km wide. The flare used produces most of its particles in the 0.3 to 10 micrometer diameter range. The posi-

tion of the seeding, the quantity and the dimensions of the salt particles are crucial to producing a change in the microphysical properties of the warm part of the cloud, and surely also in the supercooled part.

The non-randomized trials of hygroscopic flare seeding for hail prevention in the vicinity of Agen, France, have not yet been fully analyzed, but preliminary results suggest a strong positive effect for hail suppression. It is planned, for the summer of 1999, to make cloud-physical measurements in flare-seeded clouds in northeastern Italy, and perhaps confirm the existence of the effects reported by HWN.

References

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