

## Comments on “A Critical Assessment of the Seeding of Convective Clouds for Rainfall Enhancement”

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**T**his commentary seeks clarification of the assertion by Silverman (2001, p. 919) that, “According to the proof-of-concept criteria, numerous investigations of the dynamic-mode seeding concept over the past 35 years have failed to provide either the statistical or physical evidence required to establish its credibility.” For ease of presentation, henceforth, Dr. Bernard A. Silverman and his assessment (Silverman 2001) will be referred to as BAS.

We agree with BAS that dynamic-mode seeding is not yet proven scientifically. We agree also that there are some deficiencies and inconsistencies in the results and concepts of dynamic-mode seeding experiments. We contend, however, that dynamic-mode seeding concepts continue to be worthy of pursuit, even though not yet proven. A careful reading of BAS suggests that he agrees. In addition, the official statement of the American Meteorological Society (AMS) on weather modification (AMS 1998a) and its background (AMS 1998b) calls for continued research into cloud seeding concepts, including dynamic-mode seeding.

With this as background, it is difficult for us to reconcile the call for more research into dynamic-mode seeding concepts from many quarters with the quoted passage from BAS. A cloud seeding concept that is lacking in scientific credibility, as we interpret the term “scientific credibility,” would hardly be worthy of continued pursuit.

We suspect, therefore, that our problem with BAS involves semantics. The first and most common definition of the word “credible” is plausible or believable. Thus, the assertion by BAS that dynamic-mode seeding lacks credibility is tantamount in our framework to saying that the concept itself is neither believable nor plausible and, therefore, lacks a scientific basis. Although this may not have been his intention, it is being perceived that way by the readers with whom we have had contact. Dynamic-mode seeding concepts have not yet been proven according to the proof-of-concept criteria, but their scientific basis certainly warrants their continued pursuit.

Overall, we are in agreement with BAS on the major issues raised in his paper. Besides agreeing that dynamic-mode seeding for rainfall enhancement has not yet been proven according to the proof-of-concept criteria, we are in agreement with BAS’s recommendation that operational cloud seeding programs should make provision for their evaluation. Such evaluations cannot, however, measure up to the assessments done in the context of randomized seeding experiments, nor should that be a requirement. Because unequivocal proof of seeding efficacy does not exist, all operational seeding programs were instituted after weighing the potential benefit of enhanced seeding-induced rainfall against the risk or cost involved. Therefore, the main function of various types of physical/statistical analyses done in the context of operational cloud seeding experiments should be to provide a risk–benefit assessment for having proceeded with the operational seeding. These might take the form of cell and area rainfall analyses and physical measurements made from aircraft and from space. Recent examples of the latter obtained in the context of the operational Texas seeding programs are the documentation of supercooled cloud water to near the point of homogeneous freezing (Rosenfeld and Woodley 2000) and the detection from space of glaciation signatures in clouds seeded by the operational programs (Woodley et al. 2000). Other credible methods of analysis are being sought by the Texas operational programs.

Finally, we are in strong agreement with BAS’s call for future research efforts in order to establish

proof of concept for both glaciogenic and hygroscopic seeding experiments. In this respect it should be noted that weather modification research is at its lowest ebb in years in the United States. Much of the research is now taking place abroad in such places as Mexico, Thailand, and the United Arab Emirates. At the same time operational cloud seeding programs continue to proliferate. This out-of-phase relationship between research and operations is neither helpful nor healthful for either sector. Although several important scientific findings have been made in the context of operational cloud seeding programs, it only scratches the surface of what might be accomplished in weather modification with a vigorous research effort.

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## REFERENCES

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