NOTES AND CORRESPONDENCE

Comments on "Ice-Phase Seeding Potential for Cumulus Cloud Modification in the Western United States"

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In his interesting and informative paper, Weinstein (1972) has shown how the results from a one-dimensional steady-state model of cumulus convection can be used to present a climatology of seeding potential over a wide area. Although Weinstein has painstakingly and quite properly couched the modeling results with qualifications as to their real-world applicability, I fear that the quantitative values displayed in his Fig. 4 may be construed too literally by some readers. These comments are intended to underscore the view that such "climatological" results need to be interpreted with a considerable degree of caution, particularly if the reader does not have first-hand knowledge and experience with the capabilities and limitations of Weinstein's numerical model.

It has been my experience from dynamical convective cloud modification programs carried out in Florida (Woodley *et al.*, 1971) and in Texas (Sax and Cress, 1971) that the modeling results from the 1200 GMT sounding data very often do not reflect the "seedability" conditions later in the day when actual operations are conducted. Also, it was found during the Texas project that same-time data from radiosonde stations separated in distance by only 100 km frequently resulted in completely different modeling predictions of seeding potential. Such indications of significant small-scale temporal and spatial variations in cumulus modification potential point out the possibility that a "climatology" based on afternoon (e.g., 2000 GMT) data from an upper-air network more dense than is currently available might yield a series of seeding-effect isopleths differing considerably from those obtained in the present study.

Predictions from one-dimensional steady-state cumulus models are notoriously sensitive to the base height assumed for the hypothetical cloud. In a study to be published, our Texas data are showing that changes of only 500 m in selected cloud base height can make substantial changes in model-predicted seedabilities. Although Weinstein has indicated that the use of his convective condensation level subroutine proved consistently accurate in predicting Arizona and Texas cloud bases to within about 300 m, our data from Texas has occasionally shown discrepancies of more than 500 m between computed and observed cloud bases. A scrutiny of our Texas data also confirms the well-known extreme sensitivity of one-dimensional cumulus models to such input parameters as cloud radius, entrainment coefficients, and method of water unloading.

I concur with Weinstein that a most important effect of ice-phase seeding, at least in regions where tropical maritime air provides copious moisture for the formation of broad, deep supercooled convective clouds, is the release of latent heat of fusion and the subsequent initiation of thermodynamic instability. I also agree that parameterized models such as those developed by Weinstein and Davis (1968) and Simpson and Wiggert (1971) show considerable skill in identifying the atmospheric conditions favoring thermodynamic instability release due to seeding. When combined with a working knowledge of localized meteorological and topographical factors influencing cloud formation, the cumulus model can be an invaluable tool in planning, guiding, interpreting and perfecting seeding techniques. However, because of the limitations inherent in these models, is it reasonable to assume that their results can constitute a basis for providing a valid climatology of ice-phase seeding potential over an area the size of the western United States? Admittedly, a study such as Weinstein's is the best that presently can be accomplished if a wide area seeding "climatology" is required, but I caution against its carte blanche acceptance as a valid basis for planning and conducting large-scale rain augmentation operations.

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