Reply

JEAN DESSENS

Université de Clermont II, Centre de Recherches Atmosphériques, 65300 Lannemezan, France

31 January 1987

Some people in France claim that the ANELFA hail prevention project with AgI ground generators is not at all a benefit to agriculture, and that stopping it would save money. Dr. Mezeix is currently the leader of this movement; he is the director of GNEFA, a nonprofit organization which has the same structure as ANELFA, but which refuses to practice any operational seeding. I was pleased to read that Mezeix (1987) has no convincing argument against the fact that the project in southwestern France leads to a significant decrease of the hail damage in this region.

On the contrary, more proof of a beneficial seeding effect was presented by Dr. Mezeix: comparing the hail losses in the seeded area with those in a part of southeastern France, he finds a significant change after the year 1973. This change, a 43% decrease in the damage in the seeded area, is very similar to the 41% decrease in my paper. We must, however, carefully consider the meaning of this finding.

The area proposed for control by Mezeix is the Rhodanian region (C_0) instead of all of France except Aquitaine (C). This area consists of five regions: Ardèche, Drôme, Gard, Isère, and Loire. The loss-to-risk ratios, R_{C_0}, are given by Moreau (1983); they are reported in Table 1, together with the ratios in the target area (R_T).

The choice of this new control area has two advantages:

- The control and target areas do not border on each other.
- The insured values in C_0 and T are highly correlated: $r = 0.996$.

The choice of new control also has two disadvantages:

- The superficies of C_0 is half the superficies of T, and the insured values in C_0 are one-third of the insured values in T. This situation is particularly unfavorable for the use of the bivariate test where the control series must be a regional series assumed to be homogeneous.
- The loss-to-risk ratios in C_0 and T are poorly correlated ($r = 0.32$), probably for two reasons: 1) the Rhodanian region is less affected by summer cold fronts than the Aquitaine and the rest of France; 2) the distributions of crop types are different (Ginouvès, 1978).

We can draw (Fig. 1) the double-mass curve between C_0 and T, and compare it with the "control-target" curve of Fig. 4 in Dessens (1986); a break in the slope is observed on the two curves nearly at the same time. The exact year of the change in the curve C_0/T is 1963, and 1964 or 1965 in the curve C/T; this difference is due to the exceptional hail year of 1963 in C_0, and the two curves are in no way in physical contradiction. The double ratio calculation with the R values in C_0 and T gives a value of 54% for the decrease of the damage in T since the year 1963.

Surprisingly enough, the bivariate test with C_0, presented by Mezeix (1987), does not show a significant change after the year 1963. This result is obviously not in opposition to the possibility of a seeding effect in T, but it does suggest that it is more difficult to reach a given significance level for a change in T when using C_0 instead of C as the control area. One reason for this is probably that the hail data have more chance to be nonhomogeneous in a small region.

However, the bivariate test with C_0 indicates a significant change after the year 1973. What is remarkable is that this change is also observed with nearly the same significance in the illustration of the test, with the rest of France as control area (second peak on Fig. 5 in Dessens, 1986). This change corresponds to a further hail decrease in the seeded area; such an amelioration is logical, considering the continuous increase in the number of generators, and the introduction in 1974 of a new forecasting method.

A slightly different evaluation of the hail decrease in T also suggests a probable amelioration around 1974; it is possible to compare R_T with the total amount of rain during the seeding months (mean value of several stations in the target area). The result of the bivariate test with this new type of regional series is the same as the result with the R_{C_0} series: there is a change, significant at the 0.05 level, after the year 1973. This change is a hail decrease in T amounting to 51% (rain: +12%, hail: −45%).

TABLE 1. Loss-to-risk ratios R (%) in the Rhodanian region (C_0) and in the target area (T).

	Year												
Region	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
R_{C_0}	2.45	2.91	2.60	4.01	1.00	0.56	2.66	2.49	1.07	0.49	1.08	4.69	1.72
R_T	4.63	3.80	1.90	1.16	2.12	1.98	4.20	3.15	3.73	2.67	1.06	3.96	2.68
	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
R_{C_0}	3.02	3.46	1.92	1.82	1.57	0.99	9.09	2.69	2.83	2.32	3.95	0.76	1.76
R_T	3.55	3.41	1.71	2.16	1.85	1.26	3.55	2.14	1.23	1.34	2.18	2.31	2.68
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
R_{C_0}	2.61	5.65	2.18	1.59	0.99	3.55	1.89	1.52	1.85	2.01	1.99	0.81	6.49
R_T	1.41	5.60	1.20	3.06	0.74	1.63	1.12	1.90	0.41	0.43	2.83	1.87	1.38

Finally, the use of the Rhodanian region as the control area gives a good confirmation of a large hail decrease in the seeded area since around 1964, but it also strongly suggests that better efficiency was obtained 10 yr later. When the rest of France is taken as the control area, this amelioration could be more apparent if a 10% deductible was not applied to the losses since 1972 only in this area (see section 4b.3 in Dessens, 1986).

The other comments given by Mezeix are probably of lesser importance, but they prove that this author has carefully examined all the potential arguments against my results. I simply want to raise again the question of the amount of seeding material released by the ANELFA network. Assuming a uniform mixing ratio over the 1 km depth of the network, 4×10^{-13} g of AgI per g of air are accumulated in the boundary layer over a 3-h period in the most protected parts of the target area. This ratio of seeding material is considered as negligible by Mezeix. However, the same ratio is used by Farley and Orville (1986) for their numerical simulation of ground seeding experiments applied to an Alberta hailstorm, and they find that such seeding induces changes in both cloud dynamics and precipitation development.

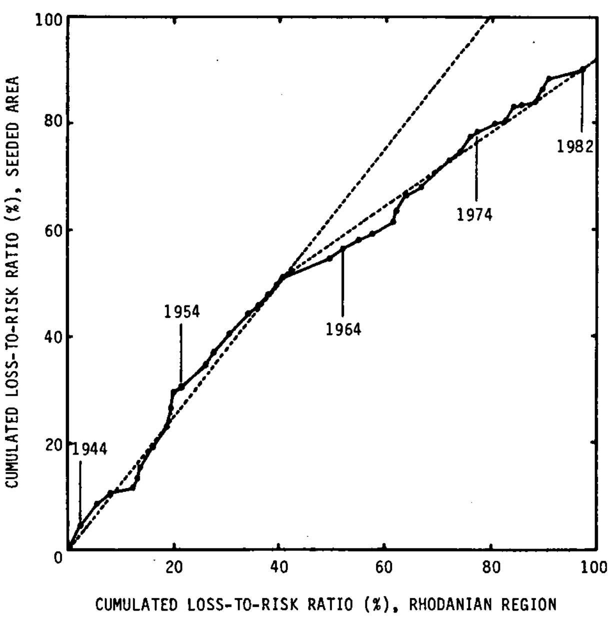

FIG. 1. Double-mass curve of the loss-to-risk ratios in the target area and in the new control area as recommended by Mezeix. The break in the slope corresponds to a 54% decrease of the hail damage since 1963 in the seeded area. Compare with Fig. 4 in Dessens (1986), where the break is observed two years later.

In conclusion, this discussion with Dr. Mezeix was very profitable. Indeed, it shows that the hail decrease in the seeded area is also observed when using a secondary control area which is probably less suitable than the one I proposed. However, it has the advantage of not being my choice.

REFERENCES

Dessens, J., 1986: Hail in southwestern France. Part II: Results of a 30-year hail prevention project with silver iodide seeding from the ground. *J. Climate Appl. Meteor.*, **25**, 48–58.

Farley, R. D., and H. D. Orville, 1986: Numerical simulation of cloud seeding experiments applied to an Alberta hailstorm. Rep. SDSMT/IAS/R-86/06, Institute of Atmospheric Sciences, South Dakota School of Mines and Technology, 61 pp.

Ginouvès, J., 1978: Peut-on utiliser les données des assurances grêle en France pour évaluer les résultats d'une opération de suppression de ce fléau? *Atm. Ocean*, **16**, 120–128.

Mezeix, J. F., 1987: Comments on "Hail in southwestern France. Part II: Results of a 30-year hail prevention project with silver iodide seeding from the ground." *J. Climate Appl. Meteor.*, **26**, 1779–1780.

Moreau, J., 1983: La lutte contre la grêle. *Dix-septième Congrès de l'Assoc. Internationale des Assureurs contre la Grêle,* Sorrento, 35 pp.