

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Science serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

Editorial Board

1978: RICHARD E. BALZHISER, JAMES F. CROW, HANS LANDSBERG, EDWARD NEY, FRANK W. PUTNAM, MAXINE SINGER, PAUL E. WAGGONER, F. KARL WILLENBROCK

1979: E. PETER GEIDUSCHEK, WARD GOODENOUGH, N. BRUCE HANNAY, MARTIN J. KLEIN, FRANKLIN A. LONG, NEAL E. MILLER, JEFFREY J. WINE

Publisher

WILLIAM D. CAREY

Editor

PHILIP H. ABELSON

Editorial Staff

Managing Editor

ROBERT V. ORMES

Assistant Managing Editor

JOHN E. RINGLE

Business Manager

HANS NUSSBAUM

Production Editor

ELLEN E. MURPHY

News and Comment: BARBARA J. CULLITON, *Editor*; LUTHER J. CARTER, CONSTANCE HOLDEN, DEBORAH SHAPLEY, R. JEFFREY SMITH, NICHOLAS WADE, JOHN WALSH, *Editorial Assistant*, SCHERRAINE MACK

Research News: ALLEN L. HAMMOND, *Editor*; RICHARD A. KERR, GINA BARI KOLATA, JEAN L. MARX, THOMAS H. MAUGH II, WILLIAM D. METZ, ARTHUR L. ROBINSON, *Editorial Assistant*, FANNIE GROOM

Associate Editors: ELEANORE BUTZ, MARY DORFMAN, SYLVIA EBERHART, JUDITH GOTTLIEB

Assistant Editors: CAITILIN GORDON, RUTH KULSTAD, LOIS SCHMITT, DIANE TURKIN

Book Reviews: KATHERINE LIVINGSTON, *Editor*; LINDA HEISERMAN, JANET KEGG

Letters: CHRISTINE KARLIK

Copy Editors: ISABELLA BOULDIN, OLIVER HEATWOLE

Production: NANCY HARTNAGEL, JOHN BAKER; YA LI SWIGART, ELEANOR WARNER; JEAN ROCKWOOD, LEAH RYAN, SHARON RYAN

Covers, Reprints, and Permissions: GRAYCE FINGER, *Editor*; CORRINE HARRIS, MARGARET LLOYD

Guide to Scientific Instruments: RICHARD SOMMER

Assistant to the Editors: RICHARD SEMIKLOSE

Membership Recruitment: GWENDOLYN HUDDLE

Member and Subscription Records: ANN RAGLAND

EDITORIAL CORRESPONDENCE: 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Area code 202. General Editorial Office, 467-4350; Book Reviews, 467-4367; Guide to Scientific Instruments, 467-4480; News and Comment, 467-4430; Reprints and Permissions, 467-4483; Research News, 467-4321; Cable: *Advancesci*, Washington. For "Instructions for Contributors," write the editorial office or see page xi, *Science*, 30 June 1978.

BUSINESS CORRESPONDENCE: Area Code 202. Business Office, 467-4411; Circulation, 467-4417.

Advertising Representatives

Director: EARL J. SCHERAGO

Production Manager: MARGARET STERLING

Advertising Sales Manager: RICHARD L. CHARLES

Marketing Manager: HERBERT L. BURKLUND

Sales: NEW YORK, N.Y. 10036: Steve Hamburger, 1515 Broadway (212-730-1050); SCOTCH PLAINS, N.J. 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); CHICAGO, ILL. 60611: Jack Ryan, Room 2107, 919 N. Michigan Ave. (312-DE-7-4973); BEVERLY HILLS, CALIF. 90211: Winn Nance, 111 N. La Cienega Blvd. (213-657-2772); DORSET, VT. 05251: Fred W. Dieffenbach, Kent Hill Rd. (802-867-5581)

ADVERTISING CORRESPONDENCE: Tenth floor, 1515 Broadway, New York, N.Y. 10036. Phone: 212-730-1050.

The Management of Weather Resources

"The history of our time is sprinkled with instances of new technologies running ahead of the social, economic, environmental, international, and institutional thinking that should accompany them. Precisely because the science and technology of weather resources management are still at such an early stage, there is an excellent chance in this field to do things right—that is, for policy to be made and institutions to be built in parallel with the scientific discoveries and technological innovations."

The comment above is part of the reply* by the 17 members of the Weather Modification Advisory Board to the question posed by Congress in the National Weather Modification Policy Act of 1976: in effect, What should the federal government be doing about changing the weather?

What can be done? The euphoric predictions of a generation ago, when cloud seeding was first invented, have not been borne out, but significant results have been obtained. The Advisory Board concludes that a more vigorous and better focused research and development effort can yield regional increases in mountain snowpack in the 1980's, increase the rainfall in areas such as the High Plains and the Midwest by late 1980's, reduce hurricane winds and hail damage by the 1990's, and very soon poke holes in the clouds over cities to let the sun shine through. The changes expected would be 10 to 30 percent increases for snow and rain; 10 to 20 percent reductions for some hurricane winds (with much greater reductions in wind damage); and up to 60 percent reduction for hail in some kinds of storms.

Should it be done? The case for managing local weather is very strong. The economic benefits of delivering more water in the right places—for irrigation, hydroelectric power, and municipal and industrial use—far outweigh the costs. Population growth and migration to sunny coastal areas are multiplying the number of people at risk from hurricanes and other severe storms.

To achieve a better grasp of these problems will take 10 to 20 years of concentrated R & D. At present, physicists cannot follow with assurance the chain of cause and effect through a cloud; we are still too heavily dependent on statistical inference. Yet people in 74 countries with interests at stake have bet good money on operational cloud seeding without the kind of semicertainty that would pass muster in a scientific journal. In the United States last year, clouds were seeded in 88 projects in 23 states, covering 260,000 square miles or 7 percent of our land area.

How should it be done? The air and clouds are a public good, belonging to no one. So we must make sure people intervene with prudence in the great envelope around the globe. The Advisory Board feels that we should resist the temptation to place a heavy regulatory hand on an industry still struggling to be born. But it does propose that the federal government license weather modifiers, just as pilots are federally licensed.

Managing the weather to serve human needs is in itself an environmental impact. Those who experiment in the sky need to go beyond guessing the outcome ahead of time; they should monitor during and assess afterward the ecological changes they may provoke. Deliberate changes in the atmosphere should also be designed in open consultation with the people likely to be affected, not all of whom are Americans.

As things stand, no one is in charge of the future of weather resources management. We are still tackling a 20-year problem with 5-year projects staffed by short-term contracts and funded by 1-year appropriations. It is not nearly good enough. The Advisory Board recommends putting the federal government's weather modification R & D in one consolidated action program (not a "lead agency"), and giving it a clear mandate to produce a kit of useful tools with which to make the best of the only environment we have. If we start now, there is a chance to do things right, for a change.—HARLAN CLEVELAND, *Aspen Institute for Humanistic Studies, Chairman, Weather Modification Advisory Board, Washington, D.C. 20230*

**The Management of Weather Resources*, vol. 1, *Proposals for a National Policy and Program* (Department of Commerce, Washington, D.C., July 1978).

Science

The Management of Weather Resources

HARLAN CLEVELAND

Science **201** (4354), 399.

DOI: 10.1126/science.201.4354.399

ARTICLE TOOLS

<http://science.sciencemag.org/content/201/4354/399.citation>

PERMISSIONS

<http://www.sciencemag.org/help/reprints-and-permissions>

Use of this article is subject to the [Terms of Service](#)

Science (print ISSN 0036-8075; online ISSN 1095-9203) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. 2017 © The Authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original U.S. Government Works. The title *Science* is a registered trademark of AAAS.