stantial increase in funds, but gives no real encouragement to the agency to conquer new worlds. Total new obligational authority for the agency would be $525 million in fiscal 1967, compared with $479.6 this year. If Congress complies, NSF would break the half-billion-dollar barrier which has seemed shatterproof to the agency for several years. Most of the roughly $48 million increase called for would go to expand activities in two major and familiar areas of NSF operations, support of basic research through project grants (up $25 million to bring the total to $180 million) and science education (up $14 million, for a total of $140 million). Project Mohole would get some $19 million next year, up slightly from $17.6 obligated in the current year. The science development program, which has provided funds for science programs in institutions with a potential for improvement, would get only $5 million more than in the current year, or a total of $45 million. Known as the "new centers of excellence" program, the science development program has been popular among universities not in the top 20, and among federal legislators who represent constituencies with institutions that have not received large amounts of federal money for research.

In comparing the new budget with last year's, the important difference is less one of money than of mood. The atmosphere in Washington has acquired a grimness clearly generated by the war in Vietnam and the difficulties of ending it. Perhaps portentously, more people here seem to be calling it the war in Southeast Asia.

Emphasis in the budget is specifically on the buildup in Vietnam and on support of Great Society legislation. The President has said that if more is needed he will ask for it, and the feeling is growing that the military situation is open-ended.

In nonmilitary sectors of the budget, including funds for R&D, the prospect seems to be one of slow growth or no growth in present programs and of high hurdles for new programs, or initiatives. Last year innovation was the watchword, and administration scouts were out looking for new ideas, cost notwithstanding. Phases come and go in Washington, and that one seems to be ended. This year, as one agency planner ruefully expressed it recently, "They might as well put a sign up over the door of the Bureau of the Budget, 'No new ideas wanted, even good ones.' "—JOHN WALSH

Weather Modification: Panels Want Greater Federal Effort

The lack of a scientific consensus on the value of cloud-seeding experiments has had a discouraging effect on proposals for greater government involvement in weather modification. The missing consensus may now be taking shape, however, as the result of a report issued last week by a prestigious panel appointed more than 2 years ago by the National Academy of Sciences.

The NAS panel,* chaired by Gordon J. F. MacDonald, professor in the Institute of Geophysics and Planetary Physics at the University of California, Los Angeles, has substantially revised its own previous views about cloud seeding. In a preliminary report issued in October 1964 the panel observed that many fundamental questions about atmospheric processes remained to be answered. "It is unlikely that these problems will be solved by the expansion of present efforts which emphasize the *a posteriori* evaluation of largely uncontrolled experiments," it said.

Now, after analysis of operational cloud-seeding projects and review of a number of recently completed experiments, the panel believes that available data, though inconclusive, indicate that seeding techniques are useful enough to be of immediate national concern. "Specifically, we find some evidence for precipitation increases of as much as 10 or even 20 percent over areas as large as 1000 square miles over periods ranging from weeks to years," the panel said.

It recommended the early establishment of "several carefully designed, randomized, seeding experiments, planned in such a way as to permit assessment of the seedability of a variety of storm types." Similar experiments should be conducted in both the western and eastern United States, the panel said. At a news conference, MacDonald estimated that the cost of each experiment would not exceed a few million dollars annually. Each would require a team of 20 to 30 people and several years to complete, the project in the East requiring a year or two more than the one in the West. Silver iodide would be used for seeding.

The NAS panel has worked closely with the Commission on Weather Modification (established by the National Science Foundation in June 1964), which also issued its report† last week. The commission left the scientific aspects of weather modification largely to MacDonald's group, while concentrating on the biological, social, economic, legal, and political aspects.

Except for the fact that the com-

* The Panel's report, *Weather and Climate Modification: Problems and Prospects* (in two volumes), Publication No. 1350, is available for $5 from the Printing and Publishing Office, National Academy of Sciences–National Research Council, Washington, D.C. 20418. The members of the panel are, in addition to MacDonald, Julian H. Bigelow, Institute for Advanced Study; Jule G. Charney, M.I.T.; Ralph E. Huschke, Rand Corporation; Francis S. Johnson, Southwest Center for Advanced Studies; Heinz H. Lettau, University of Wisconsin; Edward N. Lorenz, M.I.T.; James E. McDonald, University of Arizona; Joseph Smagorinsky, Environmental Science Services Administration (ESSA); Joanne Simpson, ESSA (through 1964); Verner E. Suomi, University of Wisconsin; Edward Teller, University of California, Livermore; H. K. Weickmann, ESSA; and E. J. Workman, University of Hawaii. Donald L. Gilman of ESSA and Edward P. Todd of NSF are liaison members.

† *Weather and Climate Modification: Report of the Special Commission on Weather Modification*, may be obtained by persons with institutional certification, at no cost, from the National Science Foundation, 1800 G Street, NW, Washington, D.C. The supply is limited. Members of the commission are: A. R. Chamberlain, vice president of Colorado State University, chairman; John Bardeen, departments of physics and electrical engineering, University of Illinois; William G. Colman, Advisory Commission on Intergovernmental Relations; John C. Dreier, School of Advanced International Studies, Johns Hopkins; Leonid Hurwicz, economics department, University of Minnesota; Thomas F. Malone, research department, Travelers Insurance Company; Arthur W. Murphy, School of Law, Columbia; Sumner T. Pike, Lubec, Maine; William S. von Arx, M.I.T. and Woods Hole Oceanographic Institution; Gilbert F. White, geography department, University of Chicago; and Karl M. Wilbur, zoology department, Duke.

mission dealt with a broader range of questions, its recommendations and those of the NAS panel were similar. For example, both groups recommended substantially greater government support for weather modification and the assignment of primary responsibility in this field to a single agency.

Funds appropriated for weather modification for fiscal 1966 total $7.19 million. The MacDonald panel recommended increasing the appropriation to at least $30 million a year by 1970, with commensurate increases for the supporting atmospheric sciences and for supporting research facilities, such as new computers and observational networks for simulating atmospheric circulation. The increase proposed by the NSF commission was of the same order.

The commission suggested that the development and testing of weather modification techniques might be assigned to the Environmental Science Services Administration (ESSA) of the Department of Commerce or to a new agency organized for the purpose. It proposed that, by expanding its support of research in the atmospheric sciences and continuing to maintain the National Center for Atmospheric Research, NSF should help provide the scientific basis for weather modification. In the commission's view, other agencies should continue to conduct or support such basic and applied research as is required for their missions (for example, research on precipitation augmentation should be supported by the Bureau of Reclamation for its reservoir system, and military applications, by the Department of Defense).

The MacDonald panel said that the Interdepartmental Committee for Atmospheric Sciences (of the Federal Council for Science and Technology) aids in policy coordination, but it added that an important need for *operational* coordination remains unmet.

"We conclude that the administrative division of the environmental sciences, according to the diverse social purposes of different federal agencies, has been rendered obsolete by the increased interdependence among the various areas of environmental research and engineering," the panel said. "The present fragmentation of effort in weather modification research and development is unusual in that many of the fragments are below critical size or quality needed for effective work. We believe that major responsibility for weather modification should be centered in a single agency."

AIBS Records Damaged in Fire

The American Institute of Biological Sciences has announced that many of its records were damaged during a recent fire in the building which houses its headquarters. Although none of the papers were destroyed, there was extensive water damage, which is causing a delay in processing materials for the forthcoming annual meeting, in membership mailing efforts, and in compiling the National Register.

The panel said that it did not wish to propose a consolidation plan, but suggested that any group preparing such a proposal "should consider whether or not weather modification can sensibly be separated from the rest of the environmental sciences." Without actually saying so, both the MacDonald panel and the NSF commission seemed to favor ESSA as the appropriate agency to lead the weather modification program.

However, in mentioning handicaps of various agencies with respect to this assignment, the commission said the Weather Bureau (part of ESSA) lacks broad authority and experience in supporting basic research through grants and contracts. It added that the bureau's "in-house capability" has been improving and that its ties with outside researchers could be strengthened.

The commission dwelt at length on the need for federal regulation of weather modification. Commercial cloud seeding is carried on by 40 to 50 firms, whose activities may, in the absence of regulation, interfere with some of the experimental work sponsored or conducted by the federal government. Moreover, a baffling assortment of rules and jurisdictions is developing. Twenty-two states have enacted weather modification statutes, some of which impose licensing and qualification standards and demand proof of financial responsibility in the event damage claims arise.

A body of legal precedents, though still negligible, is developing. Rulings are likely to vary from jurisdiction to jurisdiction. According to the commission, five civil suits over weather modification have been litigated and decided. In two cases, relief was denied on the ground that no showing was made that flood conditions had been caused by weather modification practices. A third flooding case also was decided in favor of the weather modifier; the verdict meant that either no causal connection was established or no negligence was found.

Plaintiffs in the other two suits asserted property rights in the weather and asked the court to forbid weather modification practices. "In one, a suit by resort owners against the City of New York, the New York court held that the public interest in ending a prevailing drought outweighed the resort owners' interest in good weather," the commission said. "In another, the only decision against the weather modifiers, a Texas court granted an injunction against hail suppression activities carried on by farmers in favor of neighboring ranchers who wanted precipitation in any form, including hail."

The commission indicated that eventually federal law and regulation may have to preempt the field in order that weather modifiers won't be enshrouded by a legal fog. No federal regulation now exists except for a new requirement that NSF be given 30 days' notice of weather modification activities and that certain records be kept. The commission said the regulatory and the research and development functions should be kept separate, but that assigning them to different agencies within one department would be acceptable.

Since weather modification is still largely an undeveloped art, federal regulation should be limited to what is needed to permit federal programs to proceed without interference, the commission suggested. Activities in actual or potential conflict with federal programs should be stopped or delayed, and federal grantees or contractors should be indemnified against damage claims, it said.

"As the art develops, and as weather and climate modification activities increase, comprehensive regulation seems inevitable," the commission added. "Such regulation will probably require the setting of minimum standards of competence, and perhaps financial responsibility, for all operators and the establishing of some authority for deciding between competing claims for priority."

Noting that weather modification is

of international concern, the commission called for the enunciation of a national policy embodying two points: (i) the United States, with due regard for its own basic interests, will pursue its weather modification efforts for peaceful ends and for the constructive improvement of conditions of human life throughout the world; (ii) the U.S. welcomes and solicits the cooperation, directly and through international organizations, of other nations.

Weather modification ultimately will affect the interests of everyone because the problems involved extend over a vast range of human concerns—posing the possibility of change, not always for the good, in social habits and ways of livelihood, and of destabilizing delicate biological and ecological balances. The commission said that, in weather modification research, none of these problems should be neglected.

"Although man may seek to modify weather in order to benefit the quality of his life, the result is rarely a simple relation between an atmospheric circulation and human activity," it said. "Atmospheric circulation, the hydrologic cycle, biological ecosystems, and human production are interlocked."

In its review of the scientific aspects of weather modification, the MacDonald panel identified a need for a number of studies and experiments in addition to cloud seeding. Among the projects and investigations recommended were a comprehensive exploration of hurricane energetics, leading to the development of a theoretical hurricane model and, subsequently, to hypotheses for hurricane modification; a comprehensive investigation of hailstorms; measurement of the dynamics and water budgets of a variety of precipitating storm types; development of theoretical models of condensation and precipitation mechanisms; and studies of the meteorological effects of atmospheric pollution and urbanization. The panel said that faster computers are required for simulation of atmospheric processes.

Computers, the formulation of increasingly elaborate theories and mathematical models, and better observation of the atmosphere through the use of aircraft, radar, and satellite—all have enhanced the long-term prospects for weather modification, the panel said. An earlier era of speculation has been superseded by a period in which "rational and systematic exploration of modification potentialities has become possible," it stated.

By encouraging a more widespread belief that useful techniques for changing the weather are within reach, the reports of the MacDonald panel and the NSF commission may promote greater political acceptance of proposals to give weather modification increased government support. In any event, the political base on which the program rests seems to be broadening.

Members of Congress from arid regions of the West have, in the past, appealed for more ambitious efforts to increase rain and snow, without arousing much interest among colleagues from regions where water has been taken for granted. But now, drought conditions in the East are likely to assure the Westerners of enthusiastic new allies. Some measure of the extent of the new interest may be obtainable when the Senate Commerce Committee, which at times has been suspected of indifference to weather modification, holds hearings on the subject later this year (none are yet scheduled).

Funds budgeted for weather modification for fiscal 1967 represent an increase of only a few million dollars over the fiscal 1966 appropriation. Sooner or later, however, funds will be increased substantially if the demand for a broader, more intensive program develops.

In September Secretary of Commerce John T. Connor, in a message to President Johnson after hurricane Betsy, said, "A vigorous national program to explore the possibility of weather modification should now be mounted. I in-

India's AEC Head Dies in Crash

Homi J. Bhabha, chairman of India's Atomic Energy Commission, was among 117 persons killed Monday when a jet-liner crashed into Mont Blanc. Bhabha, 57, was en route to Vienna to attend a meeting of the International Atomic Energy Agency. He was a member of the group's Scientific Advisory Committee.

A theoretical physicist and key figure in the development of India's atomic energy industry, Bhabha was his country's representative to many international organizations and had close professional and personal relations with scientists throughout the world.

Frederick Seitz, president of the National Academy of Sciences, and head of this country's delegation to the General Assembly of the International Council of Scientific Unions that met earlier this month in Bombay, issued the following statement upon hearing of Bhabha's death.

"Bhabha has occupied an entirely unique position in the developing science of India during the past two decades. He has not only created a center, the Tata Institute, at which outstanding science, as judged by the best international standards, is carried out, and has not only developed the activities of the International Atomic Energy Agency to a point that they are essentially self sustaining but has also devoted himself and all of the resources available to him to the service to India without reservation.

"As a young man he must have been tempted to follow an academic career abroad where he would have been welcome permanently as a major figure in any country, but he preferred to commit his career to his homeland. There he stood for quality in science and engineering in a developing environment in which standards of quality can have an unusually great effect on the course of progress.

"Bhabha was a hospitable man. Any scientist who visited Bombay received a warm and sophisticated welcome from an individual who was steeped not only in his many professional interests but also in the history and culture of his homeland. His last major opportunity to serve as host occurred at the General Assembly of the International Council of Scientific Unions in the first half of January this year. Those of us who were in Bombay will carry a treasured memory of a great man at the peak of his valuable career."

tend to have the Environmental Science Services Administration take a leading role in this program." Johnson's reply has not been made public, but it is understood to have been one of encouragement.

Last week Robert M. White, administrator of ESSA, confirmed the report that his agency plans cloud-seeding experiments in the Northeast next summer. These would be a step toward larger experiments of the kind recommended by the MacDonald panel.

The reports by the panel and the NSF commission were prepared partly at the request of the Interdepartmental Committee for Atmospheric Sciences (ICAS), which is chaired by Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology. Hollomon, a prime mover in the establishment of ESSA last summer, can be expected to use the reports in order to push harder for a larger weather modification effort. NSF director Leland J. Haworth, to whom the commission reported, agrees generally with the reports' objectives, although his views as to precisely what should be done have not been disclosed.

All in all, chances of the weather modification program's gathering momentum seem good. Contrary to the old saw, a decade hence people may be doing more to the weather than just talking about it.—LUTHER J. CARTER

LBJ and Hornig: Close Ties Exist as Science Adviser Starts Third Year

Two years ago this week, Donald F. Hornig, on leave from the chairmanship of the Princeton chemistry department, became director of the Office of Science and Technology (OST) and science adviser to President Johnson. How has he been doing?

The answer is difficult to determine with any precision, since the advisory role involves a confidential relationship with the President, and OST, though subject to congressional scrutiny and public inquiry, tends to operate out of sight. But it is at least clear that President Johnson, a notoriously difficult boss, is well pleased with the man who advises him on science and technology. Hornig is to stay on for at least another year, and it is said that the President wants him to regard the position in even longer-range terms. The science post is physically and politically outside the inner sanctum of the White House (Hornig and his staff are in the Executive Office Building, adjacent to the White House). But it is still very close to the center of power, especially since Johnson enthusiastically regards science and technology as potent tools for his social and economic designs. And one measure of his regard for his personal counselor in this area is that, in length of service, Hornig is now one of the most senior men in the President's official family.

Increasingly, on a variety of matters, including some that might not conform to the popular vision of what science advisers do, the President has turned to Hornig. Last November, when the great Northeast power failure occurred, Hornig was one of the first officials called by the President, who was then in Texas. Johnson wanted a quick assessment of what had gone wrong, and of how steps to correct it were proceeding. Hornig spent the night on the telephone, collecting information and channeling it to the Texas White House.

In another area, physical protection of the President, the White House requested Hornig's office to make a study and produce recommendations. With the several security agencies scrapping among themselves, OST was regarded as a capable and disinterested source of advice. Hornig has also become a sort of internationally roving presidential emissary for science and technology. The President has great faith in the use of science and technology to encourage international cooperation, and in the course of his service Hornig has repeatedly gone abroad, to the Soviet Union, Western Europe, Korea, and elsewhere.

Hornig's performance is often compared to that of his predecessor, Jerome B. Wiesner, who served under Kennedy. But Hornig isn't Wiesner, and Johnson isn't Kennedy, and comparisons don't have very much validity. Wiesner, who was informally associated with Kennedy before 1961, seemed to have a zest for the capital's political atmosphere, and, furthermore, worked for a President who wasn't jealous about sharing the public limelight. Hornig, on the other hand, was appointed by Kennedy when Wiesner decided to return to M.I.T. and took office amid the great uncertainty that surrounded all presidential affairs during the period after the assassination. Hornig is not a "political type," and the President he serves tends to favor an official family that stays off center stage.

During the first 6 or so months of Hornig's term, it appears, the President and the White House inner circle had an unclear notion of how they might employ OST, and there were some matters involving science and technology where the politicos were acting without talking to OST. Such a case occurred when Johnson dedicated the new National Geographic Society headquarters building, and proclaimed—to the astonishment of OST and the horror of the Society—that the Society should become the coordinator for a great international program of scientific cooperation. Nothing further has been heard of the idea.

In those early days of the Johnson administration, some of the science staff members complained that they were bored, and that OST was underemployed or involved with trivia. But a transition has taken place, and as Hornig begins his third year of service, OST and its surrounding bodies—the President's Science Advisory Committee and the Federal Council for Science and Technology—are heavily involved in policy formulation, coordination of the technical aspects of the Great Society programs, and troubleshooting in a variety of areas.—D.S.G.