WEATHER MODIFICATION

HEARINGS

BEFORE THE

SUBCOMMITTEE ON COMMUNICATIONS AND POWER

OF THE

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE HOUSE OF REPRESENTATIVES

NINETIETH CONGRESS

FIRST SESSION

ON

H.R. 9212

A BILL TO AUTHORIZE THE SECRETARY OF COMMERCE TO CARRY OUT A COMPREHENSIVE PROGRAM IN THE FIELD OF WEATHER MODIFICATION, AND FOR OTHER PURPOSES

H.J. Res. 688

TO PROVIDE FOR AN EXPANDED AND INTENSIFIED EFFORT TO INCREASE THE ACCURACY AND EXTEND THE TIME RANGE OF WEATHER PREDICTIONS AND TO REQUEST THE PRESIDENT TO TAKE ACTION SO THAT THE PEOPLES OF THE UNITED STATES DERIVE, AT THE EARLIEST POSSIBLE TIME, THE SOCIAL AND ECONOMIC BENEFITS THAT WOULD ACCRUE FROM ACHIEVEMENT OF THIS NEW LEVEL OF CAPABILITY IN WEATHER PREDICTIONS

OCTOBER 31 AND NOVEMBER 7, 1967

Serial No. 90–14

Printed for the use of the Committee on Interstate and Foreign Commerce

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1968

87-936

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Additional material supplied for the record by—

WEATHER MODIFICATION

TUESDAY, OCTOBER 31, 1967

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON COMMUNICATIONS AND POWER,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C.

The subcommittee met at 10 a.m., pursuant to notice, in room 2123, Rayburn House Office Building, Hon. Torbert H. Macdonald (chairman of the subcommittee) presiding.

Mr. MACDONALD. The hearing will come to order.

Today the Subcommittee on Communications and Power of the Committee on Interstate and Foreign Commerce commences hearings on H.R. 9212 and House Joint Resolution 688.

The first of these is a bill to identify and coordinate the present Federal and private efforts in weather modification. Up to this time I believe that it is fair to say that the numerous efforts which have been taking place in this very important field have been fragmented. Constructive gains have been achieved, but there is an obvious need for a comprehensive program in weather modification so that the various interests are not working at cross-purposes.

Some of the challenges which face us are the desirability of controlling severe storms; a need to augment our water resources; the desirability of determining ways to combat lightning and hail; the necessity to relieve pollution of our air; and the need to improve fog dispersal, perhaps particularly at airports.

The second and related legislation before the subcommittee this morning—House Joint Resolution 688—would declare it to be the policy of the United States to participate and fully support the world weather program. Briefly, the purposes of House Joint Resolution 688 are to develop the capability of the United States to make longer range weather predictions—for periods up to 2 weeks; to increase the accuracy of weather predictions; and to explore systematically the possibilities and limitations of large-scale weather and climate modifications.

(The bill, H.R. 9212, and departmental reports thereon, follow:)

[H.R. 9212, 90th Cong., first sess.]

A BILL To authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Weather Modification Act of 1967".

TITLE I—DECLARATION OF POLICY AND DEFINITIONS

DECLARATION OF POLICY

SEC. 101. (a) The Congress hereby declares that it is the policy of the United States to develop, encourage, and maintain a comprehensive and coordinated program in weather modification in order to contribute to—

(1) the protection of life and property.

(2) the maintenance of adequate water resources for the United States, and

(3) the enhancement of commerce, transportation, agriculture, natural resources, health, and security in the United States.

(b) In order to achieve the objectives of this Act, the weather modification activities of the United States shall be conducted with full consideration of:

(1) the development of the necessary scientific basis in a strong and balanced program in the atmospheric sciences;

(2) the mutual dependence of weather modification, weather forecasting, climatology, and other aspects of atmospheric sciences and meteorological services;

(3) the effective utilization of all applicable scientific and engineering resources of the Nation, including those in industrial, academic, and other public and private organizations, in all regions of the United States;

(4) the close cooperation of all agencies and organizations concerned in order to avoid waste or unnecessary duplication of effort, facilities, or equipment;

(5) the effective utilization of scientific and technical knowledge, instrumentation, equipment, and techniques in all scientific and engineerig disciplines applicable to weather modification;

(6) the advancement of education and training in the atmospheric sciences; and

(7) the cooperation of the United States with other nations and international organizations, whenever such cooperation is in the national interest, in order to facilitate the exchange of scientific and technical information and the peaceful and beneficial application of weather modification.

(c) Whenever the President deems any transfer of a function of any department or agency of the United States to any other Federal agency having responsibilities under this Act is necessary to carry out the provisions of this Act, he may accomplish such transfer under the provisions of the Reorganization Act of 1949.

DEFINITIONS

SEC. 102. As used in this Act—

(a) The term "weather modification" includes any intentional or inadvertent artificially produced changes in the composition, behavior, or dynamics of the atmosphere.

(b) The term "operational activities" means the construction and the systematic use of devices and systems for weather modification with intent to achieve a planned and continuing substantial result of social, economic, commercial, biological, or medical significance.

TITLE II—WEATHER MODIFICATION

FUNCTIONS OF FEDERAL AGENCIES

SEC. 201. In order to carry out the purposes of this Act—

(a) The Secretary of Commerce is authorized to—

(1) carry out a comprehensive program in the field of weather modification, which shall include a specific program designed to control or modify tornadoes, hurricanes, and other severe storms; and

(2) furnish technical assistance and information in the field of weather modification to any other Federal agency requesting such assistance or information.

(b) The Secretary of the Interior is authorized to carry out a program in such aspects of weather modification as relate to the augmentation and improvement of the usable water resources of the United States;

(c) The Secretary of Agriculture is authorized to carry out a program in such aspects of weather modification as relate to the control of lightning and hail, and to the protection of vegetation from the effects of other weather phenomena;

(d) The Secretary of Health, Education, and Welfare is authorized to carry out a program in such aspects of weather modification as relate to the control of air pollution and other similar deleterious effects of urbanization upon the composition of the atmosphere; and

(e) The Administrator of the Federal Aviation Agency is authorized to—

(1) carry out a program for the effective and beneficial dispersal of fog and cloud cover interfering with airport operations or air transportation in the United States; and

(2) conduct operational activities for such fog or cloud cover dispersal.

(f) The National Science Foundation is authorized to advance the state of knowledge in weather and climate modification through the initiation and support of basic and applied research, and programs of education and training, at universities, colleges and other appropriate institutions, in those sciences which relate to and underlie weather and climate modification technology.

ADMINISTRATIVE POWERS

SEC. 202. In order to carry out the provisions of this Act, the head of any Federal agency charged with responsibilities under section 201 is authorized to—

(1) adopt, amend, and repeal regulations governing the exercise of his duties under this Act;

(2) acquire by purchase, license, lease, donation, or otherwise such inventions, patents, patent applications, licenses, real property and interests therein as he deems necessary;

(3) accepts as a gift, money, material, or services and notwithstanding any other provisions of law, use of any such gift, if the donor so specifies, may be restricted or limited to certain projects or areas;

(4) enter into and perform such contracts, leases, cooperative agreements, or other transactions, including the making of grants, as may be necessary to carry out his duties under section 201 and on such terms as he may deem appropriate; and

(5) use, with their consent, the services, equipment, personnel, and facilities of other Federal agencies with or without reimbursement, and on a similar basis to cooperate with other public and private agencies and instrumentalities in the use of services, equipment, and facilities, and each department and agency of the Federal Government shall cooperate fully in making its services, equipment, personnel, and faciilties available to an agency charged with responsibilities under section 201 and, with the approval of the Director of the Bureau of the Budget, each department or agency is authorized, notwithstanding any other provision of law, to loan to such agency, without reimbursement, property, equipment, and facilities required for the performance of its duties under this Act.

HEARINGS

SEC. 203. (a) The head of any Federal agency charged with responsibilities under this Act or any employee of such agency designated by him, may for the purpose of performing his functions under this Act hold such hearings and sit and act at such times and places and take such testimony as he deems advisable. The head of any such Federal agency or any employee of such agency designated by him may administer oaths or affirmations to witnesses appearing before the head of such agency or such employee.

ACCESS TO INFORMATION

SEC. 204. Information contained in any statement, report, record, other document furnished pursuant to section 203, and information developed by any agency in the performance of its functions under this Act shall be made available at all reasonable times for public inspection except (1) information authorized or required by statute to be withheld and (2) information classified in accordance with law to protect the national security. Nothing in this subsection shall authorize or require the publication, divulging, or disclosure of any information described in section 1905 of title 18 of the United States Code, except that the head of any Federal agency charged with responsibilities under section 201 may disclose information described in such section 1905, furnished pursuant to section 203, whenever he determines that the withholding thereof would be contrary to the purposes of this Act.

NON-FEDERAL OPERATIONS

SEC. 205. (a) The Secretary of Commerce is authorized, after notice and opportunity for a hearing, to issue regulations governing the weather modification activities of any person or persons not engaging in such activities pursuant to contract, lease, cooperative agreement, grant, or other transaction with agencies of the Federal Government, which conflict with or impede any activities conducted under this Act and to encourage compliance with such regulations by such business concerns.

(b)(1) The Secretary of Commerce may obtain from any person or persons by regulation, subpena, or otherwise such information in the form of testimony, books, records, or other writings, may require the keeping of and furnishing such reports and records, and may make such inspections of the books, records, and other writings and premises or property of any person or persons as may be deemed necessary or appropriate by him to provide comprehensive data for the studies and investigations to be carried out under this Act, including data as to the nature and result of all weather modification activities (including research) carried out or intended to be carried out by such person or persons, but this authority shall not be exercised if adequate and authoritative data are available from any Federal agency. In case of contumacy by, or refusal to obey a subpena served upon, any person referred to in this subsection, the district court of the United States for any district in which such person is found or resides or transacts business, upon application by the Secretary, shall have jurisdiction to issue an order requiring such person to appear and give testimony or to appear and produce documents, or both; and any failure to obev such order of the court may be punished by such court as a contempt thereof.

(2) The production of a person's books, records, or other documentary evidence shall not be required at any place other than the place where such person usually keeps them, if, prior to the return date specified in the regulations, subpena, or other document issued with respect thereto, such person furnished the Secretary with a true copy of such books, records, or other documentary evidence (certified by such person under oath to be a true and correct copy) or enters into a stipulation with the Secretary as to the information contained in such books, records, or other documentary evidence. Witnesses shall be paid the same fees and mileage that are paid witnesses in the courts of the United States.

(c) Any person who willfully performs any act prohibited or willfully fails to perform any act required by subsection (b) above, or regulation issued thereunder, shall upon conviction be fined not more than $500.

(d) The Secretary of Commerce, in cooperation with the Secretary of State, the Secretary of Defense, and the heads of other Federal agencies charged with responsibilities under section 201, after consultation with the persons or persons concerned in weather modification activities or research, shall conduct a thorough study of the need for the regulation of weather modification research, development and operational activities, and report to Congress not later than one year after the enactment of this Act recommendations for additional legislation concerning such regulation including enforcement of such regulation.

TITLE III—FEDERAL COORDINATION AND PLANNING

THE PRESIDENT

SEC. 301. In order to achieve the objectives of his Act, the President is authorized to—

(1) direct the planning and supervision of the weather modification program authorized by this Act;

(2) establish the goals to be achieved by such program;

(3) establish priorities and resolve conflicts between agencies engaged in such program so that the activities of one agency conducted under this Act will not conflict with or impede activities of any other agency conducted under this Act;

(4) coordinate the activities of each agency engaged in such program in order to insure an effective and balanced effort and to avoid waste and duplication;

(5) consult with the National Academy of Sciences, the National Academy of Engineering, private scientific and educational organizations and individuals on scientific and technological developments and new opportunities for the beneficial application of weather modification; and

(6) conduct a thorough study and investigation, in cooperation with all Federal agencies engaged in such program, including the National Science Foundation, of the need for new national facilities for weather modification research, including a consideration of the adaptability of existing Federal facilities and shall include in the report under section 402 such recommendations for such additional legislation as he deems advisable.

INTERNATIONAL COOPERATION

SEC. 302. The Secretary of Commerce is authorized to cooperate in any international activities relating to weather modification consistent with the provisions of this Act. The authority to cooperate in international weather modification activities shall be exercised only with the approval of the Secretary of State to assure that such authority is exercised in a manner consistent with the foreign policy objectives of the United States. Subject to the provisions of this section, if negotiation with foreign countries or agencies thereof becomes necessary, such negotiations shall be carried on by the Secretary of State.

INVESTIGATIONS

SEC. 303. (a) The Secretary of Commerce, in cooperation with the Secretaries of Agriculture, Interior, and Health, Education, and Welfare, the Attorney General, and the National Science Foundation, shall conduct a thorough study and investigation to determine under what circumstances the United States and private parties should be liable for damages attributable to weather modification activities, including indemnification and insurance of contractors and grantees of the United States engaged in such activities, and report to the Congress not later than one year after the enactment of this Act recommendations for addiitonal legislation concerning such liability.

(b) The Secretary of Commerce, in cooperation with the Secretaries of Agriculture, Interior, Health, Education, and Welfare, and the National Science Foundation, shall conduct a thorough study and investigation into the social and economic effects, both deliberate and inadvertent, of weather modification activities and report the results of such study to the Congress not later than two years after the enactment of this Act.

(c) The Secretary of Commerce, in cooperation with the Secretaries of Agriculture, Interior, and Health, Education, and Welfare, and the National Science Foundation, shall conduct a thorough study and investigation of the biological and ecological effects of weather modification and report the results of such study to the Congress not later than two years after the enactment of this Act.

TITLE IV—GENERAL

AMENDMENTS TO NATIONAL SCIENCE FOUNDATION ACT OF 1950

SEC. 401. (a) Section 3(a)(2) of the National Science Foundation Act of 1950 (42 U.S.C. 1862 (a)(2)) is amended by adding "atmospheric," immediately after "engineering,".

(b) Section 3(a)(7) of such Act is amended by adding "and" after the semicolon at the end thereof.

(c) Section 3(a)(8) of such Act is amended by striking out the semicolon at the end thereof and inserting in lieu thereof a period.

(d) Section 3(a)(9) and section 14 of such Act are repealed.

REPORTS

SEC. 402. The President shall transmit to the Congress in January of each year a report which shall include (1) a comprehensive and detailed description of the activities and accomplishments of each Federal agency under the provisions of this Act during the preceding fiscal year; (2) an evalution of such activities and accomplishments in terms of obtaining the objectives of this Act; (3) an analysis of recommended expenditures for all weather modification activities authorized by this Act for the succeeding fiscal year; (4) a description of non-Federal weather modification activities; (5) a description of weather modification activities carried out by foreign countries; and (6) any recommendations for additional legislation which the President may consider necessary or desirable.

RECORDS AND AUDIT

SEC. 403. (a) Each recipient of a contract grant or party with whom a cooperative agreement is entered into under this Act shall keep such records as the head of the appropriate Federal agency shall prescribe, including records which fully disclose the amount and disposition of the funds received under the grant or cooperative agreement, the total cost of the project or undertaking in connection with which the contract or grant was made or cooperative agreement entered into, and the amount and nature of that portion of the cost of the project or undertaking supplied by other sources, and such other records as will facilitate an effective audit.

(b) The head of each Federal agency charged with responsibilities under section 201 and the Comptroller General of the United States, or any of their duly authorized representatives, shall have access for the purpose of audit and examination to any books, documents, papers, and records of the recipient of the grant or party of the cooperative agreement that are pertinent to the grant received or cooperative agreement entered into, under this Act.

APPROPRIATIONS

SEC. 404. There are hereby authorized to be appropriated such amounts as may be needed for the purposes of this Act.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., November 14, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This is in response to your request for the views of the Bureau of the Budget on H.R. 9212, a bill "To authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes."

The proposed legislation would declare it to be the policy of the United States to develop, encourage, and maintain a comprehensive and coordinated program in weather modification. The need for such a program has been recognized in studies by the National Science Foundation, the National Academy of Sciences, and others.

In his weather modification message of February 18, 1966, President Johnson stated that "Two sets of problems face us, and both are difficult. One consists of finding out how to modify the weather and climate. The second consists of determining how best to utilize this knowledge for the benefit of mankind once it is achieved." We believe that the programs and special studies authorized by H.R. 9212 will make a substantial contribution to the solution of both of these problems. Furthermore, as weather modification programs progress, it is important that the Congress and the public be fully informed of developments in this very significant scientific endeavor. This legislation will contribute to that end.

For these reasons the Bureau of the Budget strongly recommends the enactment of H.R. 9212.

Sincerely yours,

WILFRED H. ROMMEL,
Assistant Director for Legislative Reference.

GENERAL COUNSEL OF THE DEPARTMENT OF COMMERCE,
Washington, D.C., June 20, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This letter is in reply to your request for the views of this Department with respect to H.R. 9212, a bill "To authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes."

This bill would enable the United States to develop, encourage, and maintain a comprehensive and coordinated program in weather modification, fully con-

sidering the close relationship between weather modification, the atmospheric sciences, and the weather service. It authorizes the Department of Commerce and other designated Federal departments and agencies to carry out functions in the field of weather modification, and prescribes ancillary administrative powers and the power to hold hearings. The bill also authorizes the Secretary of Commerce to issue regulations on activities that conflict with Federal weather modification programs conducted under the bill, and transfers to him certain weather modification functions of the National Science Foundation. Additional provisions of the bill cover weather modification coordination, studies and planning, cooperation in international weather modification activities, and annual reports from the President to the Congress.

The Department strongly supports this bill and its recognition of weather modification as a new and highly important field in which we may be able to harness modern science and technology to bring new benefits to mankind. Successful modification of precipitation, and the moderation of damaging storms, would bring immense economic benefits to the Nation, as well as contributing importantly to the safety and well-being of the American people. Significant progress has occurred over the past two decades—the period of modern weather modification—but much more remains to be accomplished if our Nation is to realize the full benefits which now appear possible.

The Department of Commerce strongly believes that the time is at hand for the Nation to move vigorously ahead in weather modification and take full advantage of the opportunities now presented. The provisions of H.R. 9212 are a clear expression of this same view, and, if enacted, would provide strong impetus for the significant national program that is now warranted. For this reason the Department favors the bill's enactment.

The prospects for significant achievement if H.R. 9212 is enacted are quite encouraging. There has been an explosive growth in the technology needed to carry out necessary atmospheric measurements and analyses. Thus we now have technology for determining with precision the kinds of weather modification which are feasible, and the optimum techniques for achieving maximum benefits. The development of giant electronic computers enables the simulation of weather events on both worldwide and local scales, resulting in increased understanding of natural weather mechanisms. These computers will also furnish the means for carrying out simulated modification experiments in the laboratory, thus reducing the time required for field experiments. Weather satellites, advances in radar and other probing devices, and highly improved aircraft instruments, are other examples of the new tools now available for weather modification research and development. The Department of Commerce has developed competency in many of these technologies in carrying out its programs in weather forecasting, climatology, the atmospheric sciences, and meteorological services.

The Department is aware of the adverse consequences that could flow from indiscriminate use or misuse of weather modification techniques that have been developed under the legislation or otherwise. Uncoordinated or conflicting weather modification operations could lead to unforeseen and possibly destructive side effects. It seems likely that some form of regulation over private and public use of weather modification techniques will be needed to prevent the occurrence of adverse consequences and to provide for an appropriate decision-making process. However, at this time we have insufficient knowledge and understanding of the situation and are unable to make specific recommendations. H.R. 9212 would authorize a thorough study of the need for national and international regulation of weather modification activities, and would enable the executive branch to acquire the information needed for sound recommendations on this significant subject.

We wish to call particular attention to Sec. 201(a) of H.R. 9212 which authorizes the Secretary of Commerce to carry out a "comprehensive program" in the field of weather modification, and upon request, to furnish technical assistance and information in that field to other Federal departments and agencies. The Department views this subsection (a)(1) as authorizing the Secretary to mount a broad program to advance the science and technology of weather modification that is common to the various aspects in which other Federal departments and agencies are interested, such as dissipation of hurricanes and other severe storms, the augmentation and redistribution of precipitation, the suppression of hail, the suppression of lightning, and the dissipation of fog. This approach is consistent with Sec. 101(b)(2), which calls for the weather modification activities of the United States to be conducted with full consideration of "the mutual dependence

of weather modification, weather forecasting, climatology, and other aspects of atmospheric sciences and meteorological services."

We also wish to note that Sec. 201(d), which authorizes the Secretary of Health, Education, and Welfare to carry out a weather modification program relating to the control of air pollution and related similar problems, would not alter the traditional roles and relationships that now exist between the Departments of Commerce and Health, Education, and Welfare in this area.

We have been advised by the Bureau of the Budget that there would be no objection to the submission of our report to the Congress from the standpoint of the Administration's program.

Sincerely,

BURT W. ROPER
(For Robert E. Giles,
General Counsel).

DEPARTMENT OF AGRICULTURE,
Washington, D.C., June 15, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

DEAR MR. CHAIRMAN: In reply to your request of May 1, 1967, this is our report on H.R. 9212, to authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes.

This bill would declare the policy of Congress with respect to a weather modification program and the guidelines for weather modification activities. It would define the functions of several Federal agencies engaged in specific aspects of the program, including: Commerce; Interior; Agriculture; Health, Education and Welfare; Federal Aviation Agency; and National Science Foundation. The President would be authorized to direct Federal coordination and planning. Provisions for international cooperation and investigations of social and economic effects, including indemnification relevant to weather modification activities, would be enacted. Specific investigations are prescribed under leadership of Commerce, involving this Department with other agencies in a cooperative role.

Under Title II, the Secretary of Agriculture is authorized to carry out a research and development program in such aspects of weather modification as relate to the control of lightning and hail, and to the protection of vegetation from the effects of other weather phenomena. This provision seems entirely appropriate to our interests. The specific authorizations for other agencies included under this title seem apropos, if acceptable to them.

The provisions of Public Law 85-510 and Executive Order 10521 have provided a framework under which the National Science Foundation has given effective leadership and coordination to such research. The proposed H.R. 9212 would more specifically delineate the role of this and other executive agencies and could expedite the development of a coordinated weather modification program.

The Bureau of the Budget advises that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely yours,

ORVILLE L. FREEMAN, *Secretary.*

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D.C., October 30, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce, House of Representatives, Washington, D.C.

DEAR MR. STAGGERS: Your Committee has requested a report on H.R. 9212, a bill "To authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes."

We have no objection to the enactment of this bill if it is amended as herein recommended.

Title I of the bill establishes a general national policy that favors a comprehensive and coordinated program of weather modification, fully considering the interdependence of programs affecting management of this resource and the need for close cooperation with all agencies which are involved in it.

Title II of the bill establishes basic responsibilities in the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, including a specific program designed to control or modify tornadoes, hurricanes, and other severe storms. It also assigns certain responsibilities in weather modification to the heads of other departments, specifically the Secretaries of Interior, Agriculture, and Health, Education and Welfare, the Administrator of the Federal Aviation Agency, and the National Science Foundation. All of these agencies are given responsibilities for research and development allied with the basic missions of the agencies they represent, and are authorized to take appropriate actions to carry out their responsibilities. All Federal agencies which are assigned specific responsibilities in weather modification under the Act are authorized to hold hearings and to obtain testimony and documentation where appropriate to carry out the provisions of the Act. This portion of the bill also provides that any information developed under the program of weather modification shall be made available for public inspection, except information authorized or required by statute to be withheld and information classified by law in order to protect the national security. The bill also authorizes the Secretary of Commerce to issue regulations "governing the weather modification activities of any person or persons not engaging in such activities pursuant to contract, lease, cooperative agreement, grant, or other transaction with agencies of the Federal Government, [and] which conflict with or impede any activities conducted under the Act * * *". A succeeding clause within this portion of the Act authorizes the Secretary of Commerce to "encourage compliance with such regulations by such business concerns." With respect to non-Federal operations in the field of weather modification, the Act further grants broad investigatory powers to the Secretary of Commerce, including issuance of regulations and the power to require both personal testimony or production of documents through subpena. Recourse to U.S. District Courts for enforcement of these investigatory powers is provided for, with the exception that authority shall not be exercised where adequate and authoritative data is available from any Federal agency. Within 1 year after enactment of the Act the Secretary of Commerce, in cooperation with the Secretaries of State and Defense and other Federal agencies performing functions under the Act, is instructed to report back to the Congress on any need for additional legislation concerning regulatory functions and their enforcement.

Title III of the bill authorizes the President to direct the planning and supervision of the weather modification program contemplated by the Act, to coordinate activities, conduct consultations and studies, and establish goals for realization under the total program. The Secretary of Commerce is authorized to participate in any international activities relating to weather modification which are consistent with the provisions of the Act, subject to appropriate approval of the Secretary of State in order to assure consistency with general foreign policy objectives of the Nation. This portion of the Act also authorizes the Secretary of Commerce, in collaboration with other specified agencies, to engage in a study program to determine the extent to which the United States should be liable for damages attributable to weather modification programs, including indemnification of contractors and grantees, and requires a report to the Congress not later than 1 year from the date of enactment of the Act on any recommendations for additional legislation. The Secretary of Commerce is further instructed, in cooperation with other agencies, to conduct studies and investigations regarding the social, economic, biological and ecological effects, deliberate and inadvertent, of weather modification activities and to report on those studies to the Congress within 2 years following enactment of the Act.

Title IV amends the National Science Foundation Act by withdrawing from National Science Foundation certain responsibilities for research and development of weather modification techniques. It further provides that the President shall transmit annual reports to the Congress on Federal activities in connection with weather modification during each preceding year. The Presidential reports are to include proposals for future actions while describing what has already taken place during the preceding year. Presidential recommendations for additional legislation are to be included. The bill requires that each recipient of a contract or grant engaging in weather modification activities must maintain records of the costs of each such project, and must provide access to internal records and books of account to the Comptroller General or to any of the Federal agencies responsible for the program.

We feel that H.R. 9212 adequately recognizes and endorses the general principle that it is in the long-range national interest to authorize mission agencies of the Federal Government to continue and subsequently expand their respective activities in research, development, and operational programs in weather modification. In certain significant respects, however, we feel that the bill could be substantially improved. We therefore recommend the following amendments:

(1) Subsection 201(a)(2) authorizes the Secretary of Commerce to furnish technical assistance and information in the field of weather modification to any other Federal agency requesting such assistance or information. We feel that this subsection should be broadened to authorize all agencies that are assigned responsibilities by the Act to furnish technical assistance and information to each other. We therefore recommend that subsection 201(a)(2) be deleted and that the following new subsection (g) be inserted in its place:

"(g) Each Federal agency granted authorities by this section may furnish technical assistance and information in the field of weather modification to any other Federal agency requesting such assistance or information."

(2) Amend subsection 205(d) to provide that the Secretary of Commerce will submit his report to the President for transmission to the Congress. This seems appropriate since several Federal agencies will be involved in the study. An appropriate amendment would be:

On page 10, line 23, after "to" insert "the President for transmission to the".

(3) Amend subsection 302 to permit any Secretary or agency head engaged in weather modification activities, as authorized by section 201, to cooperate in appropriate international activities, with the concurrence of the Secretary of State. It seems appropriate to permit agencies which have developed specific expertise in any given area to participate as appropriate in international activities related to their separate missions. The following amendment is therefore recommended:

On page 12, line 12, delete "Secretary of Commerce" and substitute "head of any agency charged with responsibilities under section 201".

The Bureau of the Budget has advised that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely yours,

KENNETH HOLUM,
Assistant Secretary of the Interior.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
Washington, D.C., June 16, 1967.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This letter is in response to your request of May 1, 1967, for a report on H.R. 9212, a bill "To authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes."

The bill would authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, including a specific program for control or modification of tornadoes, hurricanes, and other severe storms, and to provide technical assistance to other agencies upon request. The Secretaries of Interior, Agriculture, and Health, Education, and Welfare, the Administrator of the Federal Aviation Agency, and the National Science Foundation would be authorized to carry out programs of weather modification relating to other matters within the spheres of competence of their respective agencies. This Department would be authorized to carry out a program in the aspects of weather modification relating to the control of air pollution and other similar deterious effects of urbanization upon the composition of the atmosphere. The President would have overall authority for coordination and planning of Federal Government weather modification activities.

The bill also would require the President to transmit a written report to the Congress in January of each year giving a description of each Federal Agency's activities and accomplishments in weather modification during the preceding fiscal year, an analysis of recommended expenditures for all authorized weather modification activities during the succeeding fiscal year, a description of non-Federal weather modification activities and those carried out by foreign coun-

tries, and any recommendations the President may have for additional legislation.

The bill would authorize the Secretary of Commerce to issue regulations governing non-Federal weather modification activities which conflict with or impede any Federal activities, and to encourage compliance with these regulations, but no sanctions would be provided for noncompliance.

However, the bill would provide for a study of the need for regulation of weather modification activities, and for a report to the Congress within a year after enactment of the bill giving recommendations for additional legislation concerning such regulation and its enforcement.

As far as this Department is concerned, we read this bill as not requiring any program of weather modification on our part except as it may become necessary or desirable in the context of our broad responsibilities in the prevention and control of air pollution under the Clean Air Act.

From the point of view of the Department, then, we would have no objection to enactment of this bill. On the other aspects of H.R. 9212, we defer to the judgment of those agencies more directly concerned.

We are advised by the Bureau of the Budget that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

WILBUR J. COHEN,
Under Secretary.

U.S. DEPARTMENT OF JUSTICE,
Washington, D.C., July 13, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, House Interstate and Foreign Commerce Committee,
U.S. House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This is in response to your request for the views of the Department of Justice on H.R. 9212 to be known as the "Weather Modification Act of 1967."

Based on a Congressional finding that it is the policy of the United States to develop, encourage, and maintain a comprehensive and coordinated program of weather modification, H.R. 9212 would authorize the Secretaries of Commerce, Interior, Agriculture, Health, Education, and Welfare, the Administrator of the Federal Aviation Agency and the National Science Foundation to conduct activities in the field of weather modification, including measures to control or modify tornadoes, hurricanes, and other severe storms. The President would be charged with direction and coordination of the program.

In nonfederal operations, the Secretary of Commerce would be vested with rule-making power. The Secretary would also be authorized to obtain information by regulation or subpoena, to require the keeping of records and furnishing reports, and to make inspection of writings and premises of any person he deems appropriate to carry out the studies and investigations authorized by the Act. Willful violators of these provisions would be subject to a fine up to $500. Court orders may be obtained to require the giving of testimony and the production of documents.

Authority to cooperate in international activities would be vested in the Secretary of Commerce with approval of the Secretary of State, and any negotiations with foreign countries would be the responsibility of the latter official. The President would be required to transmit to Congress a comprehensive and detailed description of the activities of Federal agencies under provisions of the Act in January of each year.

Section 204 of the bill provides for public access to information developed by an agency in the performance of its functions, except "(1) information authorized or required by statute to be withheld and (2) information classified in accordance with law to protect the national security." It is assumed that the language of phrase (1) would make applicable any relevant statute governing the release or withholding of official information, including the recently enacted Public Information provisions of section 552 of title 5, U.S.C. (Public Law 90–23; formerly Public Law 89–487). Section 552 of title 5 authorizes withholding certain kinds of information "specifically exempted from disclosure by statute" and information specifically required by Executive order to be kept secret in the interest of the "national defense or foreign policy." In addition, phrase (2) in section 204 would

except information classified to protect the national security, irrespective of whether it involves national defense or foreign policy secrets. Such provisions appear to be consistent with the Congressional policy expressed in the legislative history of section 552 of title 5.

Section 205(a) authorizes the Secretary of Commerce to issue regulations governing certain weather modification activities of "any person or persons not engaging in such activities pursuant to contract, lease, cooperative agreement, grant, or other transaction." Use of the word "not" confuses the meaning of the phrase. Also, the use of the words "such business concerns" at the end of the section should be changed to "such person or persons" to conform to the earlier usage in the section. We suggest rephrasing the section as follows:

> Section 205. (a) The Secretary of Commerce is authorized, after notice and opportunity for a hearing, to issue regulations governing the weather modification activities of any person or persons engaging in such activities *otherwise than* pursuant to contract, lease, cooperative agreement, grant, or other transaction with agencies of the Federal Government, which conflict with or impede any activities conducted under this Act and to encourage compliance by such *person or persons* with the regulations.

It may be noted that section 205(a) in conferring rulemaking authority upon the Secretary of Commerce requires "notice and opportunity for a hearing." This goes beyond the pertinent provisions of the Administrative Procedure Act, now contained among the provisions of sections 553(c) of title 5 U.S.C. which state that "After notice required by this section, the agency shall give interested persons an opportunity to participate in the rule making through submission of written data, views, or arguments with or without opportunity for oral presentation."

The Department of Justice has no objection to enactment of this legislation with the changes suggested, but defers on the policy considerations to the agencies charged with the implementation of the bill.

The Bureau of the Budget has advised that there is no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely,

RAMSEY CLARK,
Attorney General.

DEPARTMENT OF STATE,
Washington, D.C., July 17, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: The Department of State has reviewed H.R. 9212, the proposed "Weather Modification Act of 1967", which would establish a comprehensive program in the field of weather modification.

The Department is keenly interested in the field of weather modification as a possible area for fruitful international cooperation. Our comments are designed to make the bill a more effective vehicle in advancing those purposes. To this end, we would propose the following changes in the bill:

1. That a subsection (g) be added to section 201 of the bill so as to provide that "whenever the interests of foreign countries might be affected by any of the activities authorized by this act the Secretary of State shall be consulted before such activities are understaken". Such a provision in the bill is desirable so as to ensure that proper consideration is given to possible international aspects of domestic weather modification activities, particularly those conducted close to the borders of other countries.

2. That the first clause of the third sentence of section 302 which reads "subject to the provisions of this section, if negotiation with foreign countries or agencies thereof becomes necessary, such negotiation shall be carried on by the Secretary of State", be deleted. Inasmuch as section 302 does not seem to impose any limits on the authority of the Secretary of State to carry out the Government's negotiations with foreign countries or agencies, the clause "subject to the provisions of this section" is confusing and unnecessary.

With respect to section 302, which authorizes the Secretary of Commerce to cooperate in international activities relating to weather modification with the approval of the Secretary of State, the Department of State assumes that this grant of authority is not meant to exclude those agencies of the Government which have primary responsibility in the field of foreign affairs from undertak-

ing and continuing cooperative international activities relating to weather modification. We have in mind, particularly, assistance which the Agency for International Development might render other countries in dealing with weather problems, and international guidelines concerning weather modification activities that the Department of State might wish to cooperate in establishing. Such activities would, of course, be carried on with full consultation with all interested agencies.

Subject to the above, the Department of State is pleased to support the proposed bill.

The Bureau of the Budget advises that from the standpoint of the Administration's program, there is no objection to the submission of this report.

Sincerely yours,

WILLIAM B. MACOMBER, Jr.,
Assistant Secretary for Congressional Relations.

DEPARTMENT OF THE AIR FORCE,
OFFICE OF THE SECRETARY,
Washington, D.C., June 19, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

DEAR MR. CHAIRMAN: Reference is made to your request to the Secretary of Defense for the views of the Department of Defense with respect to H.R. 9212, 90th Congress, a bill to provide for a weather modification program to be carried out by the Secretary of Commerce. The Department of the Air Force has been designated to express the views of the Department of Defense.

The proposed legislation would authorize the Secretary of Commerce to carry out a comprehensive program in weather modification and to furnish technical assistance and information in weather modification to any other Federal agency requesting such. It would also authorize the Secretary of Agriculture, the Secretary of Interior, the Secretary of Health, Education, and Welfare, and the Administrator of the Federal Aviation Administration to carry out research and development programs in weather modification related to their functional areas. It would permit the Federal Aviation Administration to conduct operational activities related to its own research and development program and would authorize the National Science Foundation to initiate and support basic and applied research and programs of education and training in those sciences related to weather and climate modification. Further, the bill would provide for Federal planning, coordinating, reporting, regulating, and international cooperation concerning certain weather modification activities.

In establishing Federal agency responsibility for carrying out the various programs of weather modification, the proposed legislation does not specifically allocate a particular program to the Department of Defense. However, H.R. 9212 recognizes the Department's programs in weather modification developments since it provides for the Secretary of Defense's participation in a study to determine the need for the regulation of commercial weather modification programs. The Department of Defense, therefore, interprets H.R. 9212 as containing no restrictions on its responsibilities and functions in weather modification research, development, and operational activities, subject only to the coordination process of section 301 to avoid duplication of efforts.

It is noted that in providing for various "Administrative Powers" section 202(5) of H.R. 9212 enables the agencies covered to utilize the services, equipment, personnel, and facilities of other Federal agencies. Although the bill states such utilization will be on a consent basis, it goes on to state that "each department and agency of the Federal Government *shall* cooperate fully in making its services, equipment, personnel, and facilities available . . ." (Emphasis supplied.) The Department of Defense intends to cooperate fully with the agencies designated to carry out their respective programs, but must emphasize that such cooperation should be on a consent basis so as to insure the availability of resources and facilities within the Department to meet its primary responsibilities.

Subject to the above, the Department of Defense defers to the Federal agencies primarily concerned with H.R. 9212.

This report has been coordinated within the Department of Defense in accordance with procedures prescribed by the Secretary of Defense.

The Bureau of the Budget advises that, from the standpoint of the Administration's program, there is no objection to the presentation of this report for the consideration of the Committee.

Sincerely,

ALEXANDER H. FLAX,
Assistant Secretary, Research and Development.

OFFICE OF THE SECRETARY OF TRANSPORTATION,
Washington, D.C., October 30, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: We would like to volunteer views on H.R. 9212, a bill "To authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes."

The bill establishes general policy with respect to the development of a comprehensive program in weather modification and authorizes various Federal departments and agencies to carry out weather modification activities in specific areas. In the case of the Federal Aviation Agency (now Administration), the bill authorizes the conduct of a program for the effective dispersal of fog and cloud cover interfering with airport operations or air transportation in the United States. The Department has no objection to enactment of this legislation, if amended as set forth below.

The authority to conduct research and development in fog and cloud dispersal, which section 201(e)(1) of H.R. 9212 would assign to the FAA, involves the areas of weather modification that currently hold the most promise for some benefit to aviation safety. Since fog and other weather conditions can adversely affect the safe and efficient use of ground and water transportation fully as much as it does air transportation, we recommend that the authority under section 201(e) be vested in the Secretary of Transportation. We think that limiting DOT to fog and cloud dispersal activities, as section 201(e) would do, is too restrictive. Because of the broader implications of weather on transportation, we would recommend that section 201(e) be amended to read:

"The Secretary of Transportation is authorized to—

"(1) carry out a program for the effective and beneficial dispersal of fog and cloud cover interfering with air, ground, or water transportation.

"(2) conduct operational weather modification activities that the Secretary considers desirable in the interest of safety in transportation."

DOT would, of course, not attempt to undertake any far reaching weather modification without full and proper coordination within the executive branch as provided in Title III of the bill, or any weather modification that is not directly related to transportation safety.

We also recommend deletion of the reference to the United States in section 201(e)(1). Particularly if that term were interpreted to include only the fifty states, we believe that section 201(e)(1) would be too restrictive.

We have been advised by the Bureau of the Budget that there would be no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely,

JOHN L. SWEENEY,
Assistant Secretary for Public Affairs.

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, D.C., May 5, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

DEAR MR. CHAIRMAN: By letter dated May 1, 1967, you requested our report on H.R. 9212, 90th Congress.

The bill would assign responsibility for specific aspects of weather modification activities to the Secretary of Commerce; the Secretary of the Interior; the Secretary of Agriculture; the Secretary of Health, Education, and Welfare; the

Administrator of the Federal Aviation Agency; and the National Science Foundation. Overall responsibility for directing the planning and coordinating the activities of the various agencies would be vested with the President.

While the desirability of the proposed legislation involves a matter of policy for determination by the Congress, and we therefore make no recommendation as to its merits, we are pleased to note that section 403 of H.R. 9212 includes a records and audits provision relating to recipients of Federal funds under grants and cooperative agreements.

Sincerely yours,

FRANK H. WEITZEL,
Assistant Comptroller General of the United States.

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D.C., August 9, 1967.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This is in further reply to your request of May 1, 1967 for comments on H.R. 9212, a Bill "to authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes."

The Foundation endorses H.R. 9212 and urges its swift enactment. Its provisions for a Federal Government approach to weather modification should improve the overall effort and create a situation in which the Foundation can continue to contribute to the field. We believe that the proposed transfer of the basic Federal authority in weather modification from the National Science Foundation to the Commerce Department is desirable and is satisfactorily accomplished by the Bill.

We regard H.R. 9212 as an improvement over other previous and contemporary versions of the Bill. In particular, set out below, are comparisons with S. 373, which we believe is less adequate than H.R. 9212:

1. H.R. 9212 differs from S. 373 in several respects. The title of Section 205 has been changed from "Commercial Operations" to "Non-Federal Operations.' This is a desirable change since it now covers State and Municipal projects which may not have been covered under the old title.

2. The text of Section 205 has been expanded by two additional parts, (b) and (c). Part 205(b) provides authority to the Secretary of Commerce to obtain records, testimony, etc., from field operators in the same context as the National Science Foundation is now authorized to do under the National Science Foundation Act of 1950 as amended. This authority is necessary if the Secretary of Commerce is to assume the National Science Foundation's role of maintaining cognizance and records of all current weather modification activities. It will enable Commerce to issue a regulation on reporting similar to the present National Science Foundation regulation 45 CFR 635. 1–635.7. Part 205(c) of H.R. 9212 provides a $500 penalty for failure to report or provide information. This penalty was missing from S. 373, and constituted a weakness of the Senate Bill which has now been rectified. We wonder, however, whether Section 205(a) should not be strengthened; at present it only permits the Secretary of Commerce to *encourage* compliance with regulations promulgated under 205(a). A penalty for noncompliance would serve to make such regulations really effective.

3. Part 302(b) of S. 373 under the title "International Cooperation" has been deleted in H.R. 9212. This removes the blanket authority for the Secretary of Commerce to represent the U.S.A. in international meetings involving weather or climate modification. This change seems desirable in that it increases flexibility in this area, without loss of any necessary authorizations to participate in international activities.

4. The entire Section 303 "Conduct of Federal Operational Activities" of the original S. 373 has been deleted in H.R. 9212. This is a great improvement, since the old Section 303 would inhibit any research affecting the atmosphere beyond 150 miles (eliminating severe storm research) and would require that a public law be enacted each time an agency desired to put a weather modification technique into operational practice. This section was objectionable to most agencies who discussed it at the Eighth Interagency Conference on Weather Modification in October 1966 at Big Meadows.

5. The last change to be noted here is the deletion in Section 404 of H.R. 9212 ("Appropriations") of any target appropriation figures such as appeared in S. 373. In our view, this deletion is preferable since it is hoped that the Bill, if enacted into law, will be in effect beyond FY 1969.

As a final comment we question whether the definition of "operational activities" should be retained in Section 102(b) of H.R. 9212, since it now apepars to refer only to fog or cloud cover dispersal activities conducted by the Administrator of the FAA as they appear in Section 201(e)(2). In other versions of the Bill "operational activities" was used more widely and there were doubtless desirable reasons for a formal definition. With the elimination of these other uses of the phrase, the continued presence of the definition becomes confusing. In this connection, we see no reason why Section 201(e)(2) could not be eliminated since it seems merely duplicative of Section 201(e)(1).

The Bureau of the Budget has advised us that it has no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely yours,

LELAND J. HAWORTH, *Director.*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., June 19, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This replies further to your request for the comments of the National Aeronautics and Space Administration on the bill H.R. 9212, "To authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes."

The bill contains a declaration of policy that the United States should develop a comprehensive and coordinated program in weather modification in order to better protect life and property, maintain adequate water resources and enhance commerce, transportation, agriculture and other particular concerns. To achieve these objectives it would direct that full consideration be given to a strong program in the atmospheric sciences, to the relationship of weather modification to weather forecasting and other areas of meteorological science, to the full utilization of applicable scientific and engineering resources, to the effective cooperation and coordination of all agencies and organizations involved, to the full exploitation of all scientific and engineering disciplines that can contribute to weather modification, to the production of trained manpower to participate in this effort, and to the international cooperation by the United States. The President would have authority to transfer functions within the Executive Branch to carry out the provisions of the bill, such transfer to be carried out under the provisions of the Reorganization Act of 1949.

Section 201 would provide for programs of weather modification to be conducted by the Secretaries of Commerce, Interior, Agriculture, Health, Education and Welfare, and the Administrator of the Federal Aviation Agency. Only the Administrator of the Federal Aviation Agency would be permitted to engage in operational activities in weather modification. The National Science Foundation would be authorized to engage in and support research and education in the weather modification field.

Section 203 would authorize the head of any agency charged with responsibilities under the bill to hold hearings and administer oaths or affirmations for the purpose of performing his functions under the bill.

Section 205(a) would authorize the Secretary of Commerce to issue non-binding regulations governing the weather modification activities of persons not engaging in such activities pursuant to contract, lease, cooperative agreement, grant, or other transaction with agencies of the Federal Government, which interfere with activities which would be authorized by the bill. Section 205(b) would authorize the Secretary of Commerce to obtain appropriate information by subpena, inspect records, and to apply to any appropriate district court of the United States, where necessary, for an order requiring testimony or the production of documents. Section 205(c) would provide criminal penalties for failure to perform any required act or performance of any prohibited act under subsection 205(b).

The President would be authorized to maintain overall control of the program, establish goals and priorities, coordinate activities, consult with the National

Academy of Sciences and other similar organizations and conduct a study of the need for new facilities for weather modification research. He would report to Congress annually any recommendations for new legislation.

The Secretary of Commerce, in cooperation with certain designated agencies, would be authorized to conduct a study to determine under what circumstances the United States and private parties should be liable for damages attributable to weather modification activities, and to study the social and economic effects and the biological and ecological effects of weather modification.

The authority of the National Science Foundation would be adjusted by repealing Sections 3(a)(9) and 14 of the National Science Foundation Act of 1950, which would have the effect of removing the present detailed authority of the Foundation in this area. However, the bill would retain NSF's authority to initiate and support basic research in the atmospheric sciences.

NASA has in the past cooperated with the National Science Foundation, the Department of Commerce, and other agencies engaged in weather research. NASA would expect to continue to cooperate with responsible Federal agencies working in this field.

This legislation would not affect NASA's authority to engage in weather modification research and development utilizing space technology; therefore, the National Aeronautics and Space Administration interposes no objection to its enactment.

The Bureau of the Budget has advised that, from the standpoint of the Administration's program, there is no objection to the submission of this report to the Congress.

Sincerely yours,

ROBERT F. ALLNUTT,
Assistant Administrator for Legislative Affairs.

(The bill, H.J. Res. 688, and departmental reports thereon, follow:)

[H.J. Res. 688, 90th Cong., first sess.]

JOINT RESOLUTION To provide for an expanded and intensified effort to increase the accuracy and extend the time range of weather predictions and to request the President to take action so that the peoples of the United States derive, at the earliest possible time, the social and economic benefits that would accrue from achievement of this new level of capability in weather predictions

Whereas the Congress finds that unprecedented scientific opportunities and technological possibilities exist to improve the weather services for the United States by increasing the accuracy and extending the time range of weather prediction:

Whereas substantial improvements in the weather services of the United States would enhance the protection of life and property against severe storms and other hazards, would further the safety and efficiency of air and marine transportation, and would assist the growth of agriculture, commerce, and industry, thereby yielding social and economic benefits of great magnitude to the peoples of the United States;

Whereas the increased capability in weather prediction and weather services to the people of the United States will require the development and operation of a system for the acquisition, communication, and processing of weather data from over the entire globe, and the conduct of a systematic program of research to broaden the scientific understanding of global atmospheric processes;

Whereas the global weather system and the research program—the world weather program—can be more effectively and economically carried out through a cooperative effort by the nations of the world which have already demonstrated in international forums a genuine interest and desire to cooperate and participate in the required effort;

Whereas the World Meteorological Organization has taken action on an initial implementation program for the World Weather Watch System and the International Council of Scientific Unions in concert with the World Meteorological Organization has begun to move forward with the planning of the research programs:

Resolved by the Senate and the House of Representatives of the United States of America in Congress assembled, That it is the policy of the United States to participate in and give full support to the world weather program which includes (1) a world weather watch—the development and operation of an international system for the observation of the global atmosphere and the rapid and efficient communication, processing, and analysis of worldwide weather data, and (2) the

conduct of a comprehensive program of research for the development of a capability in long-range weather prediction and for the theoretical study and evaluation of inadvertent climate modifications and the feasibility of intentional climate modification;

SEC. 2. That in furtherance of this policy the Congress requests the President to cooperate with other nations in (1) a program, utilizing proven technology, procedures, and techniques, for the immediate improvement of the capability of the existing international weather system to observe the global atmosphere and to communicate, process, and analyze worldwide weather data; (2) a program to develop new technology, procedures, and techniques for the observation of the global atmosphere and for the communication, processing, and analysis of worldwide weather data, so that the needs of operational weather forecasting may be adequately served; (3) a program of research on the global wind systems of the atmosphere and on the interactions between the atmosphere and the underlying earth and oceans, including the collection of the data that may be required for these research activities; (4) a program for the training and education of scientists, engineers, and technical personnel for the development, operation, and conduct of any system or program in which the President is authorized to participate by this subsection; and (5) a program to provide appropriate technical and training assistance and facilities to other nations and to international organizations so that they may effectively participate in an international system for the observation of the global atmosphere and the rapid and efficient communication, processing, and analysis of worldwide weather data and so that they may fully utilize the data, charts, analyses, and other information provided by such a system.

SEC. 3. That on or before March 1 of each year, the President shall transmit to the Congress a plan setting forth the proposed participation of the United States for the next fiscal year in international programs in meteorology. The plan shall contain a statement of the activities to be conducted and shall specify the department or agency of the Government which shall conduct the activity and which shall seek appropriations therefor.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., August 17, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This is in response to your request of July 10, 1967, for the views of the Bureau of the Budget on H.J. Res. 688, regarding United States participation in, and support for, the world weather program.

The Bureau of the Budget recommends favorable consideration of that resolution, enactment of which would be consistent with the Administration's objectives.

Sincerely yours,

WILFRED H. ROMMEL,
Assistant Director for Legislative Reference.

GENERAL COUNSEL OF THE DEPARTMENT OF COMMERCE,
Washington, D.C., August 23, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This is in response to your letter requesting the views of the Department of Commerce on H.J. Res. 688, a joint resolution "To provide for an expanded and intensified effort to increase the accuracy and extend the time range of weather predictions and to request the President to take action so that the peoples of the United States derive, at the earliest possible time, the social and economic benefits that would accrue from achievement of this new level of capability in weather predictions."

This joint resolution declares it to be the policy of the United States to participate in and give full support to the World Weather Program, a cooperative international program designed to provide for: monitoring the global atmos-

phere; collecting, analyzing and disseminating worldwide weather information; developing a long-range weather prediction capability; and studying and evaluating the causes and effects of inadvertent climate modification and the feasibility of international climate modification.

In furtherance of the above policy, the resolution requests the President to cooperate with other nations in specific programs aimed at: immediate improvement of the existing international weather system through optimum application of present technology; development of new technology; research on the global wind systems and the interaction of the atmosphere with the land and sea; training of personnel; and provision of technical and training assistance and facilities to other nations and international organizations. The resolution also directs the President to transmit to Congress annually a plan showing proposed United States participation in the World Weather Program for the next fiscal year.

The Department of Commerce strongly urges that this Joint Resolution be acted upon favorably.

Successful execution of the World Weather Program is of great importance to the United States. The United States needs to develop the capability to make long-range weather predictions, to improve the accuracy of predictions, and to determine the feasibility of modifying major weather patterns. It can do so only through this program.

It is propitious to undertake this program now. As a result of the progress that has been made in the last decade in furthering our understanding of the physics of the atmosphere, we now have a firm basis, for the first time, for intensive development of methods of predicting weather for extended periods of up to two weeks. The largest obstacle at this time is the lack of global weather data. But, technologically it appears possible to obtain these global data with further development of new tools such as the meteorological satellite.

Development of the ability to make long-range and more accurate forecasts would have a profound impact on our economy and society. It would permit us to provide greater protection of life and property from the ravages of storms and floods. It would increase the safety and efficiency of air and marine transportation. It would allow us to utilize our national fuel and energy resources more efficiently. It would permit more effective planning of construction and other industrial activities. It also would allow our farmers to receive vital guidance for the planning of such activities as planting, spraying, irrigation, harvesting, storing, and marketing.

The resolution would have a significant impact on the Department's Environmental Science Services Administration (ESSA) which was designated by President Johnson—in his statement on the occasion of World Meteorological Day, March 23, 1966,—as the focal point for coordinating this nation's efforts in the World Weather Program. In addition to the coordinating and planning functions as reflected above, ESSA has a large share of implementing the U.S. portion of the World Weather Program plan. The total plan was recently approved by the World Meteorological Organization Congress V.

Within the U.S. effort on the World Weather Program, ESSA is charged with implementing those aspects of the global observing system, the global communications system and the global processing system for which the United States will have responsibility, with conducting basic research on the dynamics of global wind systems and the interactions between the atmosphere and the land and sea, and with cooperating with the National Aeronautics and Space Administration in the development, testing, and operation of environmental satellite technology.

The direct dollar benefits to Agriculture, Commerce, and Industry and the increased protection of life and property that will accrue to the peoples of the United States are factors that weigh heavily in favor of this joint resolution. The United States has been a leader in developing the concept of the World Weather Program, and the other nations look to the United States for continued leadership. H. J. Res. 688, if enacted, would provide the other nations of the world with a clear statement of the United States' intent to participate and cooperate in this mutually advantageous program.

We have been advised by the Bureau of the Budget that there would be no objection to the submission of this report and that enactment of this legislation would be consistent with the Administration's objectives.

Sincerely,

JAMES L. PARRIS,
Acting General Counsel.

DEPARTMENT OF AGRICULTURE,
Washington, D.C., August 17, 1967.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

DEAR MR. CHAIRMAN: This is in reply to your request of July 10, 1967, for a report on H.J. Res. 688, to provide for an expanded and intensified effort to increase the accuracy and extend the time range of weather predictions and to request the President to take action so that the peoples of the United States derive, at the earliest possible time, the social and economic benefits that would accrue from achievement of this new level of capability in weather predictions.

This joint resolution would declare the policy of the United States to participate in and give full support to the world weather program which includes (1) a world weather watch for observation of the global atmosphere and communication of weather data, and (2) a comprehensive program of research relating to long-range weather prediction and climate modification. It would request the President to cooperate with other nations with respect to five programs: international weather observation and data exchange; development of new procedures for weather forcasting; research on wind systems and interactions between atmosphere and earth; training of scientists and engineers for authorized programs; and technical assistance to other nations and international organizations. To implement these provisions, the President would transmit a plan to Congress each year setting forth programs and activities to be conducted, and designating agencies to conduct the activities and seek appropriations thereof.

The interests of agriculture are implicit to the objectives of this resolution. We would be most vitally concerned with the program of research on the interactions between the atmosphere and the underlying earth, including the collection of the date that may be required for these research activities. We would be equally concerned with the program for the training and education of scientists, engineers, and technical personnel for the development, operation, and conduct of any system or program interrelating weather with the growth and production of crops, forests, and livestock or the social and economic implications to rural areas in general.

Our research programs and those of the cooperating land-grant colleges and State agricultural experiment stations include significant effort in the field of meteorology. The experiment stations and their branches have a long history of weather data collection and analysis with relation to plant growth and development. Regional and interregional cooperation has been effected and networks of sites for phenological observations to aid in studying the response of plants to the environment have been established in cooperation with the Weather Bureau.

The National Program of Research for Agriculture recognizes the need for research to manage air and climate as essential elements in conserving and using our soil, land, water, timber, range and recreation resources. The proposed H.J. Res. 688 could expedite research in agriculture directed to weather effects, probabilities and agricultural decision making, and enhance agriculture and forestry here as well as abroad.

The Bureau of the Budget advises that there is no objection to the presentation of this report in that enactment of this legislation would be consistent with the Administration's objectives.

Sincerely yours,

JOHN A. SCHNITTKER,
Acting Secretary.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D.C., October 30, 1967.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. STAGGERS: Your Committee has requested a report on H.J. Res. 688, a joint resolution "To provide for an expanded and intensified effort to increase the accuracy and extend the time range of weather predictions and to request the President to take action so that the peoples of the United States derive, at

the earliest possible time, the social and economic benefits that would accrue from achievement of this new level of capability in weather predictions."

We recommend that the resolution be enacted.

H.J. Res. 688 would provide for support of a worldwide system of observation, communication, processing, and analysis of weather data, and a research program utilizing these data for the development of a capability in long-range weather prediction. It would also provide for studies and evaluation of inadvertent climate modification and the feasibility of intentional climate modification. It would provide for the training and education of scientists, engineers, and technical personnel for the development, operation, and conduct of any system in which the President is authorized to participate. It would provide for technical and training assistance and facilities to other nations or to international organizations in order to assure their effective participation in such a program. Under provisions of the resolution the President is to submit a plan to the Congress before March 1 of each year setting forth the proposed participation of the United States for the next fiscal year, a statement of the activities to be conducted, and the department or agency which is to conduct the activities and which shall seek appropriations therefor.

Enactment of the resolution would promote a significant improvement in long-range forecasting, which in turn would result in material benefit to this Department's reclamation program generally, and to the Atmospheric Water Resources Program in particular. The broad language of the resolution does not permit any estimate of the cost of support and participation in the proposed program. The costs would be determined by the kind and number of observations, which in turn would be determined to a great extent by the application and results of data obtained from prior observations. The implementation of the program would necessarily demand a strict review of the data requirements of each participant to avoid duplication, and also to assure that all participants have the benefit of results obtained from all studies.

The results gained from the worldwide program would be of material value in advancing our Atmospheric Water Resources Research Program. With more detailed and reliable short-range and long-range weather predictions, we would be able to conduct field operations and experiments with a greater degree of accuracy. Furthermore, the results of such operations and experiments could be determined more precisely.

The Bureau of the Budget has advised that there is no objection to the presentation of this report from the standpoint of the Administration's program, and that enactment of this legislation would be consistent with the Administration's objectives.

Sincerely yours,

KENNETH HOLUM,
Assistant Secretary of the Interior.

OFFICE OF THE SECRETARY OF TRANSPORTATION,
Washington, D.C., September 25, 1967.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. STAGGERS: This letter is in reply to your request of July 11, 1967, for the views of this Department with respect to H.J. Res. 688, a joint resolution "To provide for an expanded and intensified effort to increase the accuracy and entend the time range of weather predictions and to request the President to take action so that the people of the United States derive, at the earliest possible time, the social and economic benefits that would accrue from achievement of this new level of capability in weather predictions."

The joint resolution would declare it to be the policy of the United States to participate in and give full support to the World Weather Program. Additionally, the joint resolution would request the President to cooperate with other nations in specific programs implementing the overall World Weather Program. The Department recommends adoption of such a national policy.

Cooperation with other nations in the overall World Weather Program would include a program to communicate, process, and analyze world-wide weather data; a program to develop new technology procedures and techniques for the

observation of global atmosphere; a program of research on global wind systems; a program for the training and education of appropriate personnel to participate in the World Weather Program; and a program to provide appropriate technical and training assistance and facilities to other nations and to international organizations to enable their participation in the overall program.

The emphasis indicated, particularly with regard to collection of weather data, would undoubtedly create impact on some current Coast Guard missions and operations. The need for ocean-station vessels would be reinforced. Development of national and international data buoy networks would probably be accelerated.

Obvious benefits would accrue to transportation systems, particularly air and marine transportation. The World Weather Program is a forward-looking plan which should contribute greatly to the social and economic benefit of all nations.

The Bureau of the Budget advises that from the standpoint of the Administration's program there is no objection to the submission of this report for the consideration of the Committee in that enactment of this legislation would be consistent with Administration objectives.

Sincerely,

JOHN L. SWEENEY,
Assistant Secretary for Public Affairs.

DEPARTMENT OF THE AIR FORCE,
OFFICE OF THE SECRETARY,
Washington, D.C., September 20, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

DEAR MR. CHAIRMAN: Reference is made to your request to the Secretary of Defense for the views of the Department of Defense with respect to H.J. Res. 688, 90th Congress, to provide for expanded and intensified effort to increase the accuracy and extend the time range of weather predictions and for other purposes. The Department of the Air Force has been designated to express the views of the Department of Defense.

H.J. Res. 688 would establish that it is the policy of the United States to participate in and give full support to certain world weather programs. In furtherance of this policy the Congress would request the President to cooperate with other nations in weather programs. Additionally, the resolution would require that the President transmit to the Congress before March 1 of each year a plan setting forth the proposed participation of the United States for the next fiscal year in international programs in meteorology.

Any international program which contributes to more complete and efficient observation, communication, processing and analysis of world-wide weather data and which may lead to the development of capabilities for long-range weather prediction or large-scale climate modification would obviously be of interest and benefit to the Department of Defense. In fact, this Department is constantly seeking, through research and development and day-to-day operations, to improve the understanding of the general circulation of the atmosphere as well as to extend and improve its forecast capability. These efforts, although undertaken in response to the specialized needs of the Department of Defense, can make an effective contribution to a world weather program. For example, the Automated Weather Network; the Military Rocketsonde Network; the Aerial Weather Reconnaissance Program; and the Solar Observing and Forecasting Network, to mention but a few, are programs pioneered by the Department of Defense which might complement a world weather program. Likewise, new equipments developed by the Department of Defense to meet rigid technical requirements may be effective in accomplishing future improvements in a world weather watch system, as has frequently been the case in the past with civilian weather services.

However, because of the specialized nature of Department of Defense meteorological requirements, and because a proposed world weather program is a wholly civil undertaking, it is not considered desirable that any of these purely military programs become an integral part of an international system; nor can the Department of Defense become dependent upon an international civil cooperative program in fulfilling its meteorological requirements. The Department of Defense, therefore, interprets H.J. Res. 688 as containing no restrictions on its responsi-

bilities and functions in meteorological research, development, and operational activities.

In view of the above, the Department of Defense defers to those Federal agencies primarily concerned with such a program.

This report has been coordinated within the Department of Defense in accordance with procedures prescribed by the Secretary of Defense.

The Bureau of the Budget advises that, from the standpoint of the Administration's program, there is no objection to the presentation of this report for the consideration of the Committee, and that enactment of this legislation would be consistent with Administration objectives.

Sincerely,

ALEXANDER H. FLAX,
Assistant Secretary, Research and Development.

DEPARTMENT OF STATE,
Washington, D.C., August 21, 1967.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

DEAR MR. CHAIRMAN: The Secretary has asked me to reply to your letter of July 10, 1967, enclosing for comment a copy of House Joint Resolution 688 which calls for United States participation in expanded world weather programs which include a world weather watch and a comprehensive program of research for the development of a capability in long-range weather prediction and the study and evaluation of climate modification programs.

In the opinion of the Department of State active United States participation in these programs is in the interest of the United States. The World Weather Watch will provide an expanded international system for the observation of the atmosphere over the entire globe and for the rapid communication and processing of global weather data. The proposed research program will provide a better scientific understanding of the physical processes of the atmosphere essential to developing a capability for long-range weather prediction.

The 128 Members of the World Meteorological Organization are joining together in the cooperative implementation of these expanded world weather programs

The United States is in the forefront of scientific and technological advances in this field. The other 127 Members of the World Meteorological Organization will be looking to us for continued leadership. With our leadership and active participation in these programs, the other Members of the Organization are much more likely to contribute significantly to the success of these programs. The United States will benefit substantially by their participation in these programs because we need their input for a meaningful weather program in this country.

The programs of the World Meteorological Organization are an extraordinary example of international cooperation substantially benefiting every one of the 128 Members of the Organization. The global atmosphere is an indivisible whole. The principal obstacles to long-range weather prediction and a determination of the feasibility of large-scale weather modification are the lack of adequate global data and an understanding of the physical processes of the atmosphere.

Expanded United States participation in these programs will contribute significantly to meeting these obstacles.

The Department of State accordingly supports the approval of House Joint Resolution 688.

The Bureau of the Budget has advised that there is no objection to the submission of this report and that enactment of this legislation would be consistent with the Administration's objectives.

Sincerely,

WILLIAM B. MACOMBER, Jr.,
Assistant Secretary for Congressional Relations.

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D.C., October 27, 1967.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This is in further reply to your request of August 2, 1967 for comments on H.J. Res. 688, "To provide for an expanded and intensified effort to increase the accuracy and extend the time range of weather predictions and to request the President to take action so that the peoples of the United States derive, at the earliest possible time, the social and economic benefits that would accrue from achievement of this new level of capability in weather predictions."

The National Science Foundation strongly endorses H.J. Res. 688 and hopes that the Congress will act favorably upon it.

The world weather program is a truly cooperative project coordinated domestically by the National Academy of Sciences and interagency committees, and internationally by the International Council of Scientific Unions and the World Meteorological Organization. The National Science Foundation has participated in the design of the program.

We feel that not only will the world weather program aid in the development of long-range weather prediction, but also that the associated theoretical studies will provide the necessary tools to evaluate the phenomenon of inadvertent climate modification and the feasibility of intentional climate modification. Adoption of H.J. Res. 688 will aid in the realization of these goals, and the plan to be submitted annually to the Congress under Section 3 should provide useful information.

The Bureau of the Budget has advised us that it has no objection to the submission of this report and that enactment of this legislation would be consistent with the Administration's objectives.

Sincerely yours,

LELAND J. HAWORTH,
Director.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., August 21, 1967.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives,
Washington, D.C.

DEAR MR. CHAIRMAN: This is in further reply to your letter of July 10, 1967, requesting comments from the National Aeronautics and Space Administration on H.J. Res. 688, "To provide for an expanded and intensified effort to increase the accuracy and extend the time range of weather predictions and to request the President to take action so that the peoples of the United States derive, at the earliest possible time, the social and economic benefits that would accrue from achievement of this new level of capability in weather predictions."

H.J. Res. 688 would declare it to be the policy of the United States to participate in and give full support to the world weather program. It would request the President to cooperate with other nations in programs for (1) improving the existing international weather system; (2) developing new technology, procedures and techniques for observing and communicating world-wide weather information; (3) cooperating in research on global wind systems and the interaction between atmosphere and earth and oceans; (4) training scientists, engineers and technicians in weather technology; and (5) providing technical training and assistance to other nations and to international organizations so that they can effectively participate in the international system. The bill would require the President, or or before March 1st of each year, to transmit to the Congress plans setting forth the participation of the United States for the next fiscal year in international programs on meteorology.

The Interagency Committee on International Meteorological Programs, which is chaired by the Assistant Secretary of Commerce and in which NASA and other agencies of the Federal Government with interests in the meteorological programs have representation, has reviewed the bill in the light of pending programs and has concluded that it represents an appropriate recognition of the role that should be played by the United States in meteorological research and

operations. The proposal would support current and planned National Aeronautics and Space Administration programs in the meteorological area.

In view of the foregoing, the National Aeronautics and space Administration interposes no objection to the enactment of H.J. Res. 688.

The Bureau of the Budget has advised that there is no objection to the submission of this report to the Congress, and that enactment of the legislation would be consistent with the Administration's objectives.

Sincerely yours,

ROBERT F. ALLNUTT,
Assistant Administrator for Legislative Affairs.

Mr. MACDONALD. I understand that the experts and spokesmen from the concerned executive departments and agencies are with us this morning. We look forward with interest to receiving their testimony on this important matter and our first witness will be Dr. Robert M. White, Administrator, the Environmental Science Services Administration, Department of Commerce.

STATEMENT OF ROBERT M. WHITE, ADMINISTRATOR, ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, DEPARTMENT OF COMMERCE; ACCOMPANIED BY ROBERT B. ELLERT, ASSISTANT GENERAL COUNSEL; W. FERGUSON HALL, STAFF SCIENTIST, OFFICE OF PLANS AND PROGRAMS; AND DR. RICHARD HALLGREN, DIRECTOR, OFFICE OF WORLD WEATHER SYSTEMS

Dr. WHITE. Mr. Chairman, before I begin, I would like to introduce my colleagues. This is Mr. Ferguson Hall of our Office of Plans and Programs; Mr. Robert Ellert, from our General Counsel's Office; and Dr. Richard Hallgren.

It is a particular pleasure for me to testify before this committee which has shown longstanding and continuing interest in weather modification.

The committee's early interest in weather modification was demonstrated in March 1948, when less than 2 years after Dr. Irving Langmuir and Dr. Vincent J. Schaefer made the first successful demonstration of cloud modification, the committee was considering legislation to authorize the Weather Bureau to conduct experiments in cloud seeding. In April of this year, almost two decades later, Mr. Staggers, the chairman of this committee, introduced H.R. 9212, a bill on which we are commenting today.

I believe that the committee's demonstrated interest in weather modification follows naturally from its deep and long-term concern with weather prediction and the activities of the Weather Bureau. In my opinion, weather prediction and weather modification are reciprocal in many ways.

The committee was also responsible for the enactment of the first law relating specifically to weather modification. This was Public Law 83–256 of August 13, 1953, which created the Advisory Committee on Weather Control. The purpose of this law was to make a complete study and evaluation of public and private experiments in weather modification.

Significant progress in weather modification has been made in the past 20 years. Today I am here to present the views of the Department of Commerce on weather modification and to voice our strong support

of H.R. 9212, a bill to establish a comprehensive weather modification program.

H.R. 9212 authorizes a broad national program in weather modification. The bill recognizes the importance and relationship of weather modification to the missions of various Federal agencies. For example, the Department of Commerce is authorized to conduct a comprehensive program in weather modification including control of severe storms; the Department of the Interior, to conduct a program aimed to augmenting our water resources; the Department of Agriculture, to explore means for combating lightning and hail; the Department of Health, Education, and Welfare, to adapt weather modification to relieve pollution of our air; and the Federal Aviation Administration, to expand programs in fog dispersal at airports. In addition, the National Science Foundation would continue to support basic research in the atmospheric sciences, including research that will aid in the understanding of weather modification. The past work of the Foundation has proved to be invaluable in increasing our understanding in this area.

The bill would also provide administrative authority necessary to the accomplishment of the function in weather modification which it authorizes. In addition, the bill looks beyond delegation of functions and administrative authority and provides for consideration of the various types of problems that could arise in the conduct of a large Federal weather modification program. Thus, interagency studies of social, economic, ecological, biological, legal, and regulatory questions in the field of weather modification would be authorized, and the results of these studies would be reported to the Congress.

The bill would also authorize the development of limited regulations to protect federally sponsored weather modification activities from contamination by other weather modification activities, although compliance with these regulations would be voluntary. The bill also authorizes coordination of the agencies' activities in weather modification by the President and contains adequate authority for the international cooperation which the President has recommended.

This bill will enable the United States to accomplish the objectives which President Johnson recently set forth in transmitting the annual weather modification report to the Congress:

> To develop the full potential of weather modification, we must continue our research and experimentation. We must bring to the effort our best skills and our most advanced technologies. We must better organize our efforts in this area.
>
> And we must join with other nations in the search for solutions, for the weather respects no national boundary.

This bill is also responsive to the recommendations of two recent reports on weather modification which call for an expanded, integrated national program. The first report summarizes 2 years' work of a National Academy of Sciences Panel on Weather Modification. The second report is the result of an inquiry by a Special Commission on Weather Modification of the National Science Foundation.

In its summary of these reports to the President and Congress, the National Science Foundation said that they "mark a milestone in the history of weather modification. Assessing the progress of the atmospheric sciences and of weather modification over the past 20 years, they state that for the first time there is a scientific basis for cau-

tious optimism about the future of weather modification." This "cautious optimism" is based on the many recent advances that have been occurring in our understanding of the weather.

We have developed knowledge of the fundamental mechanics of weather. We have made considerable progress in the use of computers to study and simulate hemispheric weather patterns. Satellites have been launched to make weather observations on a global basis. The world weather program, which I will discuss in detail in a separate statement, will provide us with an additional wealth of information on the earth's pattern of weather.

Both the NAS and NSF reports point out that the United States presently lacks a broad, systematic, and comprehensive program to extend and exploit available scientific knowledge. In the past, our efforts have been fragmentary and subcritical—far below the size and quality needed for effective work.

The reports urge prompt and thorough study of ways and means of improving the U.S. efforts in weather modification, and the Department of Commerce agrees that these efforts must be improved and extended, so that we may take full advantage of our capabilities to make significant scientific and technical advances. The task we must begin is to organize the necessary scientific and technical resources to learn what can be done and how best to do it and to assess the consequences. We believe that H.R. 9212 will provide the comprehensive program needed if the United States is to make a significant breakthrough in weather modification.

We must not delay in seeking the advantages of weather modification. The potential benefits to our country and mankind in general are enormous. Control of severe storms alone could save our country hundreds of lives and billions of dollars annually. Positive control of precipitation would benefit agriculture and the economy immensely.

In seeking the enormous benefits that can flow from weather modification, we must not lose sight of its relation to weather prediction. Modification and prediction of the weather use similar data and equipment, including satellites, radar, ocean and land observations, and balloon soundings. Furthermore, to determine the effect of a particular modification technique, we must be able to predict what would happen under given conditions if the technique were not used.

In short, we face inefficiency in the use of facilities and possible ineffectiveness in research if we attempt to divorce weather modification from the balance of meteorological science. The Environmental Science Services Administration is, of course, the Nation's principal agency in meteorological science, and is at the forefront of weather prediction and the gaining of new understanding and insight into weather processes. On the basis of this broad experience in meteorology ESSA is already engaged in an active research program in weather modification.

Present ESSA facilities provide a valuable nucleus for expanding our Nation's program. ESSA's Atmospheric Physics and Chemistry Laboratory at Boulder, Colo., is equipped for laboratory studies and field experiments. Other specialized laboratories of the Institutes for Enviromental Research participate in weather modification studies and experiments. These include the National Hurricane Research Laboratory at Miami, Fla.; the National Severe Storms Laboratory

at Norman, Okla.; the Geophysical Fluid Dynamics Laboratory here in Washington, D.C.; and the Air Resources Laboratory, also in Washington. Flight support is provided by the ESSA Research Flight Facility based in Miami.

ESSA will continue to place strong emphasis on cloud and storm exploration, field experimentation, and simulation of weather on electronic computers. Advances in the design and statistical evaluation of tests will be sought. The study of the possibility of inadvertent weather modification, now underway, will be intensified. Supporting laboratory research into cloud and precipitation physics will be strengthened. Ground and aircraft facilities, adequately instrumented, will be provided for both our own program and those carried out in collaboration with other agencies and research groups.

We wish to call particular attention to section 201(a) of H.R. 9212 which authorizes the Secretary of Commerce to carry out a "comprehensive program" in the field of weather modification, and upon request, to furnish technical assistance and information in that field to other Federal departments and agencies.

The Department views this subsection (a)(1) as authorizing the Secretary to mount a broad program to advance the science and technology of weather modification that supports the various aspects in which other Federal departments and agencies are interested, such as the augmentation and redistribution of precipitation, the suppression of hail, the suppression of lightning, and the dissipation of fog.

This approach is consistent with section 101(b)(2), which calls for the weather modification activities of the United States to be conducted with full consideration of "the mutual dependence of weather modification, weather forecasting, climatology, and other aspects of atmospheric sciences and meteorological services."

I would now like to review briefly a number of our current activities and our plans for the future.

PRECIPITATION MODIFICATION

First of all, I would like to discuss precipitation modification. In broader perspective this includes the ability to increase, decrease, or redistribute rain and snowfall. Success in this area remains one of the high-priority goals of weather modification. It would provide significant benefits today in view of our dwindling water resources, and would be of even greater benefit in the future when water supply may become critical. Although we must not expect rain-increasing projects to solve all problems—since we still must depend upon nature to supply the clouds—nevertheless, modification techniques could become an important factor in our overall water resources development effort.

The current situation in rainfall stimulation is confused. It appears that weather modification efforts could result in increases in snowpack on our western mountain ranges, although further tests are necessary. Several commercial projects appear to have been successful in other parts of the Nation. Carefully conducted projects in Israel and India seem to have defintely established success in those areas. Similar success has been reported in Australia.

On the other side of the ledger, however, a number of well-designed experiments, including some carried out in our own country and in

Canada, have shown no effects. One of the first tasks to be undertaken must be to reconcile these conflicting results, and determine when, where, and how increased rainfall can be produced.

Two basic steps are required: First, we must make detailed explorations of the internal structure of clouds under differing climatic and regional regimes, to assess the efficiency of natural precipitation mechanisms, and the extent to which artificial intervention is possible.

Second, we must determine the proper seeding techniques to employ in each situation. Differences, both in cloud structure and seeding methods, may have accounted for the variable success so far achieved. Further, we must determine the effects of modifying precipitation on the intensity and circulation of storm systems, to make certain that unwanted changes do not occur.

Some of ESSA's current projects in this field include:

The Great Lakes project, a study of the possibility of moderating the severe snowstorms occurring in early winter along the southern shores of Lake Erie and Lake Ontario. Cornell Aeronautical Laboratory, Pennsylvania State University, and the State University of New York are the participating research groups.

The Northeast project, aimed to determining precipitation modification potential in the full spectrum of cloud and storm systems occurring in that area. Detailed design of the experimental approach is being prepared by New York University.

The cumulus precipitation project, to be carried out in southern Florida, now in the planning phase. Seeding of maritime cumulus clouds over the ocean by the U.S. Navy and ESSA appears to have caused substantial buildup of the clouds. These experiments will now be repeated over land, where the effects on precipitation can be measured.

Incidentally, behind this chart, Mr. Chairman, I have "before and after" pictures of one of these seeding attempts, if you care to see them.

These experiments were conducted jointly with the Navy over the ocean. The objective was to determine the effect of seeding on certain kinds of cumulus clouds. This is an actual photograph of what happened in a seeding attempt. We call this the "explosive" growth of a cloud.

You see the cloud before seeding on the left and the difference after seeding on the right. It seems rather clearly related to the actual seeding operations that were conducted.

Computer modeling of precipitation processes, now being carried out by Allied Research Associates, Inc., will permit initial experimentation on the computer, and will assist greatly in analyzing the results of field experiments.

Future plans include expansion of the field program to other parts of the Nation, including our Norman, Okla., site, and locations in the Midwest and west coast.

HURRICANES

The possibility of artificially moderating the destructive aspects of tropical storms and hurricanes remains a major goal of ESSA's weather modification program. Experiments begun in 1961 are being continued through Project Stormfury, a joint project of the U.S. Navy

and ESSA, with Air Force assistance, which employs specially instrumented aircraft for carrying out cloud-seeding experiments and collecting research data.

The project involves the massive seeding of supercooled clouds, near the storm's "eye wall"—and I have a chart here which will show the "eye wall" to you, Mr. Chairman.

When you get into the eye of the hurricane, the wall of white clouds you see there is called the "eye wall." We introduce silver iodide in the eye wall of the hurricane, thereby releasing heat, and affecting the storm's heat balance.

The project also involves seeding in the "rain bands" which spiral toward the eye. Unseeded storms are monitored to provide data for comparison with the experimental hurricanes.

Two experiments carried out thus far are encouraging, since changes in eye wall structure and reduction of wind speeds followed the seeding. However, many additional tests will be required to verify whether the seeding was, in fact, the causative factor.

Paralleling this experimental activity, expanded programs of hurricane exploration and computer simulation will be conducted under the sponsorship of the National Hurricane Research Laboratory. The highly successful photography from the NASA ATS–B synchronous satellite opens up new approaches to hurricane observation.

In addition, however, it will be necessary to view the hurricane much more extensively from within and from below. This will require upgrading of the aircraft of our research flight facility. And I believe I have a photo of one of our aircraft. This is a heavy aircraft flight facility designed specifically to explore hurricanes and severe storms. The aircraft are instrumented and designed specifically for this purpose.

Increased measurements of the interaction between the air and sea surface in hurricanes are required, calling for radically new measuring techniques.

The new data thus acquired will provide the input necessary for the construction of more realistic mathematical models of hurricane circulation for use with high-speed computers to permit simulated experiments to be carried out in the laboratory.

THUNDERSTORMS, TORNADOES, HAIL, LIGHTNING

The spring and summer thunderstorms occurring over much of the Nation are prime sources of moisture for agriculture, and thus constitute an important national asset. On the other hand, when overdeveloped they bring tornadoes, damaging hail, and severe lightning storms to many areas. A very important area of weather modification will be a search for ways to moderate the severity of these storms and still preserve their indispensable precipitation.

Our National Severe Storms Laboratory is expanding its investigations into the causes and nature of tornadoes and other severe local storms. Possibilities are being sought for reducing the energy input to these storms, or dissipating the energy in less harmful paths. We believe that continued exploration and analysis, theoretical modeling and simulation with computers, and future field experiments will contribute to the fuller understanding of these storm and lead the way to their successful modification.

Hail suppression appears to be one of the more tractable of the several modification possibilities associated with severe local storms. A national hail modification research plan, now being formulated by an interagency group, will provide a focus for a major effort in this area. A broad attack will be necessary, involving theoretical, numerical, and laboratory studies, as well as field exploration and preliminary experiments, before we will be ready for a full-scale field project. It is encouraging, however, that many of the tools for storm analysis and storm seeding are in sight. These include specialized radar, infrared and microwave sensors, improved seeding techniques, and the capability for analysis of storms from airborne measurements.

Favorable results in the reduction of hail damage by heavily seeding incipient storms at critical stages in their development have been reported in the Soviet Union. These reports are being carefully studied, and should lead to a repetition of the experiments here.

ESSA and the U.S. Army are conducting a joint experiment to moderate lightning near Flagstaff, Ariz., by distributing chaff—metalized threads—in thunderstorms in an effort to "short circuit" the electrical charges before they reach lightning intensity. Results will be compared with those of experiments conducted by the U.S. Forest Service near Missoula, Mont., using another technique.

Future research will emphasize isolation of the cause of thunderstorm electricity, and means for preventing its development. Effects of lightning suppression on precipitation will be carefully evaluated.

In case of fog and low stratus clouds, these create hazards to aviation, and in the case of fog, to other transportation. Marked success has been achieved in clearing airport approach zones and runways in cases where the fog or cloud is supercooled, and the technique has become operational at a number of airports. The dispersal of "warm" fog represents different problems. Several possible approaches are being considered by ESSA and by other Federal agencies.

Fog and cloud dispersal may have important application for highways and harbors, for relieving air pollution, and for local climate control. Interagency plans for further research and engineering are in preparation, and will assist in the development of an expanded national program in this area.

Turning now to quite a different aspect of weather modification—that of the effects we may be producing inadvertently through air pollution—the first requisite is a network of "benchmark" stations for measuring changes in the chemical content of the atmosphere taking place over the years. This is now being done at our observatory on Mauna Loa, Hawaii.

I have a picture of this observatory. It is interesting from the following point of view, Mr. Chairman. Here is the only long-term record that we have in the world of the increasing content of carbon dioxide in the atmosphere, and there is a need for other such stations.

A second station will soon be in operation near Boulder, Colo. In addition, we look toward a global network, initially involving a sampling line from the Arctic to the South Pole along the Americas, and later including other continents. First, attention will be given to the concentration of carbon dioxide resulting from the burning of coal and oil, which may be affecting the atmosphere's radiation balance.

The possibility of deliberate changes in climate is also receiving attention, although the chances for success seem remote at present. Drought relief is one aspect of great interest, but major relief would require interference with hemispheric flow patterns—a step not within our reach at present.

All aspects of large-scale climate modification must of necessity be studied theoretically through the development of a comprehensive theory of atmospheric circulation, and through complete simulation by computer of the effects of possible human intervention. This work is advancing at ESSA's Geophysical Fluid Dynamics Laboratory and at a number of university centers.

Many other important aspects of weather modification will receive increasing attention and will support the full achievement of weather modification potentialities. In the interest of brevity, I will merely outline several of these research areas:

Physics and chemistry of precipitation: To overcome our present rudimentary knowledge in this field, and establish a firm scientific basis for precipitation modification.

Cloud nucleation studies: To resolve recent questions regarding the effectiveness of present seeding methods, and establish sound standards.

Numerical modeling: To capitalize on present ability to predict cloud-seeding effects, and extend such techniques to other forms of weather modification.

Temporary inhibition of precipitation: To shift precipitation to areas where it can be better utilized.

Boundary layer effects: To further investigate sea-air and land-air interactions, and the possibilities for deliberate alteration.

Radiation control: To consider techniques and effects of altering the atmosphere's heat balance, as a weather modification tool.

Water and energy budgets: To analyze the overall air-sea-earth system in terms of the budgets of storms and cloud systems.

Instrument and system development: To improve present instrumentation and search for advanced methods. To seek new approaches in modification delivery systems. To consider future operational deployment systems.

In addition to the foregoing will, of course, be the social, economic, ecological, and legal studies, as specified in H.R. 9212, to be carried out in cooperation with other agencies.

Carrying out a program of this size and complexity will require additional resources of some magnitude. The most immediate need is for modern aircraft with improved performance and greater economy of operation. The success of most of the work described above will depend upon adequate aerial support. Provision must also be made for equipping the several field experimental sites with adequate facilities. In addition, improved laboratory and cloud-simulation equipment will be needed.

Weather is an international phenomenon and knows no boundary lines, and I wish to point out the importance of international cooperation in the field of weather modification. The recent successes in Israel, Australia, India, and the Soviet Union illustrate the impact that foreign research could have on our own program of weather modification. H.R. 9212 recognizes the importance of international cooperation, and provides sufficient authority for our present needs.

Gentlemen, recent studies have indicated that we are at a turning point in the history of weather modification. We have before us the opportunity to make significant advances toward modification, and ultimately control of one of our most significant and largely untapped resources, the atmosphere. H.R. 9212 would authorize a major program in the field of weather modification.

The Department of Commerce strongly supports this legislation and the program which it would authorize. The benefits which could come to the United States and to this world from the program are almost limitless. We must not fail to seek them.

Mr. Chairman, I would be happy to answer any questions on H.R. 9212, or, if you desire, I can give my statement on the joint resolution on the world weather program and answer any questions later.

Mr. MACDONALD. Mr. White, we certainly appreciate your testimony. I know that members of the committee will have some questions. I was wondering if you could submit your statement in support of the world weather program for the record, where it will appear as read, and sort of summarize it for us, and perhaps we can ask you questions and cover both.

Mr. WHITE. I would be glad to.

The world weather program, Mr. Chairman, is, in my view, as the person responsible for the weather services of this Nation, one of the most important activities which this country can undertake.

Every nation needs every other nation's weather data. Today we receive weather data from all of the nations of the world, routinely and regularly. Our major obstacle in seeking to improve the accuracy and extend the time range of our weather forecasts, which would have enormous economic consequences, is that today we only have upper-air weather observations from about 20 percent of the world.

Our scientists now tell us, based upon theoretical calculations that if we could acquire the additional observations it would be possible for us to extend our weather forecasts for 2 weeks.

To obtain the required observations it is necessary for us to work cooperatively with other nations of the world in establishing the proper kinds of global observation networks, global communications systems, and global data-processing systems.

At the last Congress of the World Meteorological Organization, a specialized agency of the United Nations, which is responsible for the coordination of international weather matters, the countries of the world reached firm decisions on movinig ahead with this program.

The attitudes of the other nations of the world were almost unanimous in identifying the world weather program as the most important weather activity, not only in the interests of each individual nation, but for the globe as a whole.

The various nations of the world indicated at the World Meteorological Organization Congress and subsequently that they are prepared to move ahead with their own resources to put in the necessary observations for which they would be responsible, and to put in the necessary communications systems for which they would be responsible. It is important that this country also move ahead with them, because the economic benefits to this country will be very, very significant.

A second part of this program deals with the research that would be required to achieve a capability to make long-range weather forecasts. This is called the global atmospheric research program.

This program visualizes a series of field experiments in which successively we would begin to bring various parts of the atmosphere under observation using the new technology which is now available to us.

One thing that now makes this world weather program feasible and timely is the development of the satellite, which now places us in a position to acquire weather observations over the entire world.

When this is wedded to our communications and high-speed computers, we are now in a position, if we can solve some of the technological problems so that we can get the required observations, to move ahead in the research area and develop the techniques which will yield us the kind of long-range forecasting capability we need.

If we are ever to consider in any serious way the possibility of modifying weather and climate on a large scale, it will be necessary for us to have a rational basis on which to make decisions. We will have to understand the consequences of what we propose to do. The only way in which we will be able to do this will be to have the capability to forecast for longer periods in advance than presently. Hence the world weather program is vital for two reasons.

One, to generate a capability for long-range weather forecasts, up to about 2 weeks, with its own economic benefits, and second, to establish a basis where we can rationally think about the problem of large-scale climate and weather control.

This is a brief summary of my statement, and I will submit it for the record.

Mr. MACDONALD. Without objection, your entire statement will be put in the record.

(Mr. White's prepared statement on H.J. Res. 688 follows:)

STATEMENT OF ROBERT M. WHITE, ADMINISTRATOR, ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, DEPARTMENT OF COMMERCE, ON H.J. RES. 688

Mr. Chairman and members of the subcommittee, I am pleased also to have the opportunity to present the views of the Department of Commerce on House Joint Resolution 688 and to strongly recommend its enactment.

This joint resolution declares it to be the policy of the United States to participate in and give full support to the World Weather Program, a cooperative international program which includes (1) a World Weather Watch—the development and operation of a global weather observing, communication, and processing system and (2) the Global Atmospheric Research Program—a comprehensive program of research on the global wind systems of the atmosphere.

In furtherance of the above policy, the resolution requests the President to cooperate with other nations' efforts to: make immediate improvement in the existing international weather system; develop new technology; carry out research directed toward improved methods of predicting atmospheric conditions including the collection of additional data that may be required; train personnel; and provide technical and training assistance and facilities to other nations and international organizations. The resolution also directs the President to transmit to Congress annually a plan showing proposed United States participation in the World Weather Program for the next fiscal year.

On April 3 of this year President Johnson stressed the need for the World Weather Program when he said, "For centuries man's inability to predict weather far enough ahead has caused incalculable human suffering. . . . The proposed system will, through international cooperation, lead to improved weather forecasting and protection of life and property, and deserves the wholehearted support of the American people."

The United States has been a leader in the preparation of the plans for the World Weather Program. It was a speech on the peaceful uses of outer space by President Kennedy, before the United Nations in 1961, which stirred the international activity that has led to the World Weather Program. The United Nations passed resolutions in 1961 and 1962 calling upon the nations of the world and the appropriate international institutions to develop a plan to capture the unparalleled opportunities which then could be foreseen for improving the weather services of all nations of the world. This call has been heeded.

The Congress of the World Meteorological Organization held its fifth quadrennial meeting in April of this year. President Johnson instructed the United States representatives to that meeting to "pledge the full and continuing participation of the United States in this important endeavor." At this meeting, the World Meteorological Organization Congress delineated specific activities to be pursued by the nations of the world over the next four years, recognizing that it would take at least a decade to establish the World Weather Program fully. The World Meteorological Organization plan is in accord with United States views.

The World Weather Program is of great importance to the people of the United States. It is only through this program that we can develop the capability to make useful long-range weather predictions for periods of up to two weeks, to increase the accuracy of weather predictions significantly, and to explore systematically the possibilities and limitations of large-scale weather modification and climate modification.

The United States can achieve substantial economic benefits from successful execution of the World Weather Program. These benefits would flow from positive use of long-range weather forecasts in the planning of weather-sensitive activities, as opposed to our present mere defensive reaction to the weather in the conduct of these activities. As an example, consider agriculture. Farmers would be able to schedule irrigation, spraying, planting, and harvesting more efficiently and economically if long-range forecasts were available. Or, consider the construction industry. Through appropriate scheduling far enough in advance, builders would be able to avoid much of the materiel spoilage which now frequently results from unexpected adverse weather and permit more efficient use of the labor force. The fuel industry could program the distribution of fuels more efficiently. Transportation could become more efficient and safer. Other activities which will be profoundly affected are merchandising, recreation, commercial fishing, and water management. Although quantitative estimates of the benefits that might result to each of these areas are not available, I believe that the return to our nation will far exceed the investment required.

The World Weather Program can ameliorate substantially the enormous toll annually of lives and property in the United States and throughout the world caused by weather hazards such as hurricanes, floods, tornadoes and snow storms. In 1966 for example, the United States lost approximately a thousand lives and over one billion dollars from property damage due to weather hazards and catastrophes.

If through the data provided by the World Weather Program large-scale weather modification is found to be practicable, signicantly greater benefits could accrue to the United States. Slight but systematic increases in total rainfall or small changes in average temperatures for certain areas of the United States would make agriculture possible where none exists now. But I want to emphasize that, at this time, we do not know whether large-scale weather modification is feasible as opposed to the smaller scale modification which I have previously discussed. We do know that with the World Weather Program we can carry out a sound and reliable appraisal of its theoretical feasibility.

We cannot derive these benefits, however, by ourselves. An international program is required. Weather is a global phenomenon, not local or only national. Atmospheric disturbances do not respect political boundaries. Changes occurring in any one place have an effect on the entire face of our planet, in a matter of days. Therefore, no single nation can deal with the world's weather alone, or even predict its own weather for any extended period of time without the cooperation of other nations.

Accurate prediction of United States weather one or two days in advance requires observed weather data from North America and most of the Pacific and Atlantic Oceans; predictions for three or four days in advance require at least hemispheric data; predictions for a week or more in advance require data from the entire globe. Today we obtain adequate observations from only 20 percent

of the world. And many of these are so delayed or garbled in transmission that they are of little value in producing forecasts. Yet these data are essential if we are to produce accurate long-range forecasts for this country.

It is clear that now is the time to join with the nations of the world in seeking the benefits that will flow from a successful World Weather Program. Internationally, the nations of the world have expressed a genuine interest in moving forward with the World Weather Program. Scientifically and technologically, we are now in a position to carry out the World Weather Program effectively, thanks to recent developments in many diverse fields from computers to observational technology. The theoretical basis for modern weather forecasting was well established prior to the second World War. By the late 1940's, means were available to enable scientists to tackle a part of the problem, such as solving simplified mathematical equations for describing the atmosphere and the processes that collectively make our weather. But at that time the technology required for taking adequate global observations was not even on the horizon, nor were computers fast enough to carry out more sophisticated simulations of the global atmosphere. Today, the computers are fast and large enough to allow us to begin such simulations, and we have working atmospheric models. Today, the meteorological satellite is obtaining global cloud cover data and has the potential of obtaining many of the other required global observations more efficiently and economically. Our experience with ESSA's operational meteorological satellite system—the world's first operational satellite system—leads us to the conclusion that with further development the future global weather observation system will center around such satellite systems. Thus, scientifically, technologically, and internationally, recently established capabilities give us the opportunity to move forward to vastly improved weather services.

Now, I would like to turn to a more detailed description of the major elements of the World Weather Program. As I pointed out earlier, the program consists of two major lines of effort.

The first major line is to design and implement the World Weather Watch, a new international system combining routine observation of the atmosphere over the entire globe with rapid and efficient communication, processing, and analysis of the resulting worldwide weather data. The World Weather Watch during the period 1968–1971 deals with three broad areas.

First, the international plan identifies 131 upper air observing land stations which will be either newly established or upgraded to obtain the full range of data required. The responsibility for the implementation of three of these stations would fall to the United States. The others would be implemented by other nations. Over the oceans, the plan is to equip 100 merchant ships to take both surface and upper air observations. Thirty-two of these ships are projected for implementation by the United States. In addition, the current meteorological satellite systems of the United States and the Soviet Union are to be continued and improved.

Second, the plan deals with analysis and processing of meteorological data. The World Meteorological Organization plan calls for expanding the scope of the analyses and extending the use of high-speed computers at the three existing World Meteorological Centers—one at Washington, one at Moscow, and one at Melbourne. These centers prepare large-scale atmospheric and global charts, analyses and forecasts for use by the various National Meteorological Centers throughout the world.

Third, the plan includes the installation of an effective global communications network which, as I said earlier, is also of vital importance to the United States weather services. The United States and the Federal Republic of Germany have already implemented a communications link between Washington and Offenbach. The cost is shared by the two countries. Similarly, we are negotiating for the installation of links between Washington and Brasilia and between Washington and Tokyo. Other links, such as Moscow to Offenbach, Moscow to New Delhi to Melbourne, and Tokyo to Melbourne—are either in use, or are in the advanced planning stages.

To the maximum extent possible, the improvements called for in the three areas set out above will be carried out by the individual nations. However, the developing nations will most likely need technological and financial assistance to implement some of the facilities which are called for in the plan, and which are essential to the success of the World Weather Watch. This assistance will be provided, as far as possible, by the United Nations Development Fund. In addition, the World Meteorological Organization has established a Voluntary

Assistance Program, through which the advanced nations may extend assistance for selected World Weather Watch projects in the developing nations.

Now, let me turn to the second major line of effort of the World Weather Program which is the comprehensive Global Atmospheric Research Program—or GARP, as it is becoming known in this day of acronyms. GARP is designed to give us the basic scientific understanding of the atmosphere's global wind systems that we also need, if we are to improve the accuracy and extend the time range of weather predictions.

An important step in the planning of GARP was taken in Stockholm early this summer. At that time, atmospheric scientists from around the world, under the joint auspices of the International Council of Scientific Unions and the World Meterological Organization, met and developed the general plan of the research program. The program will consist of two parts.

The first part will focus on the development of the mathematical models of the atmosphere required for long-range weather predictions. These mathematical models are used with electronic computers to predict atmospheric processes. A great deal of progress has been made in the last decade, so that today, computer programs based on such models are used routinely by over a dozen nations to produce weather forecasts for one to three days into the future. Some recent experiments, using complex and sophisticated research models, have demonstrated that useful predictions for at least a week in advance can be made. In other experiments it has been shown that the basic character of the atmosphere is such that, in principle, useful predictions should be possible for periods of up to two weeks in advance if given a complete set of global data. However, there are still major improvements that must be made in the atmospheric models. For example, we must incorporate, among other things, the tropical circulation of which little is known, and the manner in which energy is put into and taken out of the atmosphere by the sea and land surfaces.

The second part of GARP is a series of field experiments to provide the data needed for the improvement of the mathematical models. Three kinds of data gathering experiments were recommended at the GARP conference in Stockholm for furnishing these supplemental data.

First are those of a localized nature, including ocean-atmosphere and land-atmosphere interaction studies. A number of nations—United Kingdom, Soviet Union, Japan, and the United States—are individually planning such experiments in various regions of the world. The United States' experiment is called the Barbados Oceanographic and Meteorological Experiment. It is scheduled for the summer of 1969. Its planning on an interagency basis has been in process for a number of years. It is responsive to recommendations for area studies by the National Academy of Sciences. Within ESSA, as the lead agency on behalf of the government a project office has been established to provide a central focus for the coordination of the overall project.

The second type of experiment recommended is regional in nature, such as the Tropical Meteorological Experiment. This experiment is being planned for the period 1972–73 and is designed to provide a physical description of tropical circulations.

The third type of experiment recommended deals with the enitre globe. This experiment would provide a complete set of global data for use in the research on improving the mathematical models of the atmosphere.

To achieve global observational capability for the World Weather Watch and GARP within reasonable costs, new observational tools will have to be developed. Much of this development will center on the environmental satellite. The satellite is a unique platform for remote sensing of the atmosphere, for collection of data from other observing platforms, and for rapid communication of weather data over global distances.

Remote sensors, to be mounted on a satellite, can be developed for observing the atmosphere's vertical structure of temperature and humidity. Development of such sensors is underway in this country, in the United Kingdom, and in the Soviet Union.

The satellite also provides a unique means of locating and collecting meteorological data from a variety of platforms scattered over the globe; there are several such systems now under development in this country and France. Instrumented balloons which will float at fixed levels, ocean buoys, automatic land stations, and merchant ships are among the platforms which can work in conjunction with a satellite data location and collection system.

The development of these and other new observation techniques will be the work of many years. But this work is important. It is important for the near

future so that the World Weather Watch and large-scale data gathering experiments may proceed more effectively and economically. And it is certainly important for the more distant future, when we have a fully implemented World Weather Program.

Nationally, a great deal of planning has been carried out both within and outside the government. Our National Academy of Sciences has recommended that the United States move ahead vigorously with the World Weather Program. The White House Conference on International Cooperation also recommended that the United States support this program fully and exercise a role of leadership in its execution. Within the Executive Branch, the formulation of the United States portion of the World Weather Program has been carried out on a multiagency basis. The agencies with primary responsibilities in the World Weather Program are the Department of State, the National Science Foundation, the National Aeronautics and Space Administration, and the Department of Commerce.

The Department of State is responsible for coordinating relations with international meteorological organizations; assisting the less developed nations in improving their national weather services, and developing the appropriate bilateral and multilateral arrangements required for the World Weather Program.

The National Science Foundation is responsible for stimulating and intensifying research related to GARP and for the education and training of scientists. This is an extremely important activity. Achievements of the objectives of the program can only be accomplished with the full participation of the scientists at our universities.

The National Aeronautics and Space Administration, in relation to its responsibilities under existing authority, is responsible for the development of the space technology required for an economical global weather system. Much has been accomplished to date by NASA through the TIROS and NIMBUS satellites. As I mentioned earlier, this is vital work for the World Weather Program. We have just begun to tap the potential of the meteorological satellite. The developments underway in NASA for remotely sensing the atmosphere and for the collection of meteorological data from surface platforms and balloons in the atomsphere will form key elements in the full World Weather Program.

The Department of Commerce has been given responsibility by the President for coordinating the United States' effort on the program. In addition, the Department of Commerce, through the Environmental Science Services Administration, is responsible for implementing the United States' portion of the World Weather Watch, for pursuing the development of new technology within its existing authority, and for supporting GARP activities.

Within this framework, we plan to implement the initial World Weather Watch improvements mentioned earlier as United States responsibilities in the world meteorological plan. We are planning to continue the development of improved equipment for merchant ships, of horizontal sounding balloons and of ocean buoys as required by the World Weather Program. In addition, ESSA will continue to cooperate with NASA in the development of technology for remote sensing from a satellite and for satellite interrogation-location of the observation platforms. We plan to accelerate and expand our research in atmospheric modeling. Finally, we plan to participate in the air-sea interaction project planned for 1969 in the vicinity of Barbados.

This, then, is the World Weather Program—its purposes, its plans, its management structure, its hopes, and its problems. To the meteorologist it is an absolute necessity if he is to perform his job substantially better in the future. To the people of the United States it will mean enormous benefits—socially and economically—and if I may go beyond, I believe that this program can do much in furthering understanding between nations and make a substantial contribution to our highest goal—peace among nations.

Again, I want to urge enactment of this resolution. I believe it is essential for a program of such importance, of such scope, and of such complexity that the intent of Congress be indicated. It would provide the Congress with an annual report which describes the specific contributions of the Federal agencies involved in the program, thereby permitting decisions which will maintain the coherency of the effort. It would give positive assurance to the other participating nations that the people of this country will support this program which our representatives started and helped develop, and which cannot be accomplished without their assistance. It would mean that within the next decade the people of the United States would enjoy a vastly improved weather service.

I thank you.

Mr. MACDONALD. Sir, some years ago, some of us went to Antarctica. As a matter of fact, the late Dr. Harry Wexler, I think, was representing the National Science Foundation, and it opened up a whole new world to me that I didn't comprehend before.

At that time, there were five or six countries which had several stations down in Antarctica: the Russians, Australians, New Zealanders, the Japanese, I believe, and of course ourselves.

We were told at that time, if I recall correctly, and I think I do, that because of those stations, this so-called long-range weather prophecy could be made because most of the world's weather is made up down there, which is something I didn't know before.

In your statements, I have seen no mention of that. I was wondering, were they wrong at that time, because they easily could have been back in 1957, and, of course, things have changed a good deal. But they placed great emphasis on the fact of what was being done during the Geophysical Year, and I thought it was very important, and I see no mention of it in either one of your statements. I was wondering if you would care to comment on it?

Mr. WHITE. I think the statement made to you by Dr. Wexler is correct. I haven't mentioned Antarctica specifically, but I have mentioned the fact that only 20 percent of the world's surface is covered with adequate upper air observations.

One of the greatest areas of deficiency is in the Southern Hemisphere. We have found that weather systems propagate over vast areas rapidly.

That means, if you were going to forecast for the United States, the North Atlantic and the North Pacific for 4 days in advance, you need data from the entire Northern Hemisphere. To extend the predictions beyond 4 days, you need weather data from the entire globe.

Therefore, the data we receive from Antarctica is extremely critical. What we now know, based upon our calculations since 1957, is that we are going to need the observations from the remaining 80 percent of the earth, including the oceans.

Mr. MACDONALD. Do I understand that you think it is important we maintain our stations in Antarctica?

Mr. WHITE. I think it is essential, sir, from a weather point of view.

Mr. MACDONALD. My second question deals with the satellite. When you talk about a satellite, are you talking about an international or domestic satellite?

Mr. WHITE. I am talking meteorological satellites. One such satellite, the NASA ATS–1, is presently stationed over the Pacific. I have a photograph here showing the kind of weather information that one can gain from such a synchronous satellite.

From a single satellite, we can get weather information covering the entire Pacific area.

Mr. MACDONALD. A synchronous satellite—we are all laymen here—merely means that it keeps pace with the earth's orbit?

Mr. WHITE. That is correct.

Mr. MACDONALD. Where is it again?

Mr. WHITE. It is over the Pacific at the present time. It is an experimental NASA satellite.

Mr. MACDONALD. We have Telstar and Early Bird.

Mr. WHITE. Those are communications satellites.

Mr. MACDONALD. I would think this satellite would have to be a communications one, too, or else you wouldn't get any information from it, would you?

Mr. WHITE. This satellite is a general-purpose test bed. NASA is conducting communications experiments with the satellite, in addition to meteorological experiments, at the present time.

This, however, is a research and development activity at the present time. As you know, we have an operational weather satellite system which is operated by the Department of Commerce to serve all national interests, which now gives us complete global cloud cover on a routine basis.

Mr. MACDONALD. Could you expand on that point just a little more?

Mr. WHITE. The earth-orbiting satellite gives you a platform which is unique for weather purposes. One could conceive of a variety of different kinds of weather satellites. At present, we have brought to operational utility a polar-orbiting satellite which essentially takes photographs of the world's cloud cover once each day. This is now an operational system being used routinely in our daily weather forecasting activities.

Mr. MACDONALD. Is it used just by the United States, or by all other countries as well?

Mr. WHITE. The present satellite is used by all countries of the world. It has on board what is called an automatic picture transmission system, which enables any country to receive, very inexpensively, the pictures from the satellite. There are over 250 of these installations in various countries of the world today.

Mr. MACDONALD. So it is put up by us?

Mr. WHITE. That is correct, sir.

Mr. MACDONALD. Put up by the U.S. Government, but it is being used by all the countries of the world?

Mr. WHITE. It is being used by all the countries of the world today. The free exchange of weather information has been a tradition in meteorology.

Mr. MACDONALD. It is a great concept. I am not knocking it. I am just curious. Is there any other country that has a similar satellite up?

Mr. WHITE. Yes. The Soviet Union has a weather satellite system in being, and we exchange satellite information with the Soviet Union on a routine basis each day. They send us their weather satellite data, and we send them ours.

Mr. MACDONALD. There is no cold war going on in the weather field, I take it.

Mr. WHITE. The weather business has a very, very traditional cooperative spirit internationally, because everybody literally needs everybody else.

Mr. MACDONALD. If the committee will indulge me just one more question for my own information: What is the difference between warm fog and cold fog?

Mr. WHITE. Mr. Chairman, a cold fog is a fog which is below freezing, and a warm fog is one where the droplets are above freezing.

Mr. MACDONALD. At what point do you gage the temperature of the fog?

Mr. WHITE. It is the temperature of the water droplets. When the water droplets are supercooled, we can use techniques like seeding to dissipate the fog. When the temperature of the fog droplets is above freezing, these techniques do not work.

Mr. MACDONALD. Thank you.

Mr. Broyhill?

Mr. BROYHILL. H.R. 9212 contains what we call an open-end authorization. Do you have any information that you could provide to the committee on the amount of money that would be requested in the next 3 to 5 years on this program?

Mr. WHITE. I can merely give you at the present time, Mr. Congressman, information of a very general nature, because, of course, the amount of money that would be devoted to the program would depend on the budgetary situation each year.

However, the Commission of the National Science Foundation and the Panel of the National Academy of Sciences have recommended an increase to the order of about $20 to $30 million annually over the next 5 years.

Mr. BROYHILL. What you are going to do is to provide the committee with the amount of authorization that you would request for the next 3 years; is that correct?

Mr. WHITE. I was going to provide the committee with the recommended level of expenditure for the weather modification program which would be carried out by all the agencies of the Government as recommended by the National Academy of Sciences and by the Commission of the National Science Foundation, where they have assessed the present state of our weather modification program, and have made recommendations as to the level of magnitude of the program they think would be necessary.

(The following information was subsequently submitted:)

DEPARTMENT OF COMMERCE,
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION,
Rockville, Md., November 16, 1967.

HON. TORBERT H. MACDONALD,
Chairman, Subcommittee on Communications and Power, Committee on Interstate and Foreign Commerce, House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: In response to the request of your subcommittee during the hearings on H.R. 9212 relating to weather modification, and on H.J.R. 688 relating to the World Weather Program, held on October 31, 1967, I am happy to submit the attached statement on current and projected funding levels for several of the Federal agencies involved in weather modification research. As mentioned in the statement, the figures for fiscal years 1969 and 1970 have been prepared for planning purposes only, and do not represent a commitment by the Executive Branch.

Sincerely yours,

ROBERT M. WHITE, *Administrator.*

The following table provides an estimate of weather modification research and development funding for the current fiscal year, and the level of funding required during fiscal years 1968–70 to support the programs of most of the interested agencies. The 1969–70 figures have been prepared by the agencies for planning use, and do not represent commitments by the Administration. All such funding would necessarily be developed in the course of the regular budgetary process of the Executive Branch.

FEDERAL WEATHER MODIFICATION RESEARCH AND DEVELOPMENT PROGRAMS—ESTIMATED FUNDING LEVELS, FISCAL YEARS 1968–70

[In millions of dollars]

Agency	Fiscal years		
	1968	1969	1970
Department of Agriculture	0.18	(1)	(1)
Department of Commerce	1.5	2.5	5.0
Department of the Interior	5.1	10.0	15.0
National Science Foundation	3.5	3.5	5.0
Federal Aviation Administration	.030	.4	1.25
National Aeronautics and Space Administration	.24	.25	.25
Total	10.55	16.65	26.50

[1] The weather modification program of the Department of Agriculture and proposed funding levels for fiscal years 1969–70 are currently being reviewed in the Department and are not yet available.

NOTES

The interest of the Department of Health, Education, and Welfare lies primarily in pollution abatement, including that required to prevent unwanted modification of weather and climate. Funding for weather modification is not separately identified.

Department of Defense funding in weather modification, currently at a level of $2,000,000 and expected to rise to about $3,000,000 by fiscal year 1972, is omitted from the table, since the Department's program is not included under H.R. 9212

DEPARTMENT OF COMMERCE,
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION,
Rockville, Md., November 16, 1697.

HON. TORBERT H. MACDONALD,
Chairman, Subcommittee on Communication and Power, Committee on Interstate and Foreign Commerce, House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: In response to a further request from your subcommittee, estimates of the number of new positions in grades GS–16 and above that would be required by the interested agencies in carrying out weather modification programs under H.R. 9212 are presented in the following table. As in the case of funding, Department of Agriculture estimates for 1969 and 1970 are deferred pending completion of its program review.

FEDERAL WEATHER MODIFICATION RESEARCH AND DEVELOPMENT PROGRAMS—ESTIMATED NEW POSITIONS, GS–16 AND ABOVE, FISCAL YEARS 1968–70

Agency	1968	1969	1970
Department of Agriculture	0	----------	----------
Department of Commerce	0	0	2
Department of the Interior	0	2	3
National Science Foundation	0	0	1
Federal Aviation Administration	0	0	1
National Aeronautics and Space Administration	0	0	0
Total	0	2	7

Please let me know if we can assist in any further way.
Sincerely yours,

ROBERT M. WHITE, *Administrator.*

Mr. BROYHILL. Does H.R. 9212 give the Secretary of Commerce or any other agency of the U.S. Government any legislative authority that it does not have at present?

Mr. WHITE. Yes, it does. It provides certain legislative authority to the Department of Commerce which it does not presently have. The present legislative authority which runs to the National Science Foundation would, as a result of this bill, in certain ways be transferred to the Department of Commerce.

Mr. BROYHILL. In other words, the legislative authority in this field at present is being exercised by the National Science Foundation?

Mr. WHITE. Certain aspects of the authority in this bill are presently being exercised by the National Science Foundation.

Mr. BROYHILL. The reason I asked that question is that you want to do more of this work, and I was wondering if the bill really gave you any additional or broader authority than you have now.

Mr. WHITE. It does in certain ways. There are provisions for certain studies, legislative authority for holding certain kinds of hearings that the Department of Commerce does not presently have.

Mr. BROYHILL. What about the Secretary of Agriculture? He has legislative authority already to conduct certain experiments. Is this not correct?

Mr. WHITE. The various departments of the Federal Government have legislative authority to carry out R. & D. work in support of their particular missions as they presently stand, and so the agencies are conducting weather modification activities in conformity with their authorizations.

Mr. BROTZMAN. Will the gentleman yield?

Mr. BROYHILL. I will be glad to yield.

Mr. BROTZMAN. It is my understanding, Dr. White, that there is a coordinating agency among the various governmental agencies concerned with weather?

Mr. WHITE. Yes, it is coordinated by the Interdepartmental Committee for Atmospheric Sciences at the present time.

Mr. BROTZMAN. So that these efforts are coordinated under one heading, though there might be different authorities granted to the various agencies?

Mr. WHITE. That is correct.

Mr. BROYHILL. It is brought to my attention that S. 2916, which came out of the Senate committee last year in the 89th Congress, authorized certain figures for the fiscal years 1967, 1968, and 1969.

Are these figures similar to those you will be asking for in the next 3 fiscal years?

Mr. WHITE. I believe the levels will be somewhat lower. This would have to be coordinated among the agencies, and, of course, checked with the Bureau of the Budget. It is not possible at this time to make an exact projection of the authorization that we would seek in subsequent budgetary years.

Mr. BROYHILL. Does House Joint Resolution 688 give the President any additional authority that he does not have at the present time? As I understood your testimony on House Joint Resolution 688, the President is already cooperating with other countries in exchange of weather information. Does this bill give the President any additional authority that he does not have at the present time?

Mr. WHITE. No; it does not, Mr. Congressman. The resolution endorses a program which is going to take place over a period of the next 10 years and is going to require extensive international collaboration. Various countries of the world have signified their intention to participate in and support this program.

Mr. BROYHILL. If the President already has this authority, what is the purpose of the passage of this joint resolution?

Mr. WHITE. We feel it is very important to indicate to the other nations of the world the importance which this country attaches to the program, and the fact that the Nation is planning to move ahead with the other nations in furthering it.

Mr. BROYHILL. In House Joint Resolution 688, section 3, the President will be transmitting a plan to the Congress, it says, which will set forth the proposed participation of the United States for the next fiscal year in any international program.

It also states that the plans will give a statement of activities conducted, and specify the agency or department of Government which shall conduct the activity, and which departments shall seek appropriations therefor.

Can you also furnish the committee figures on how much these agencies will be requiring for the next 3 years to carry out this program?

Mr. WHITE. We can attempt to do this, Mr. Congressman. This will take some time, sir.

(The information requested follows:)

DEPARTMENT OF COMMERCE,
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION,
Rockville, Md., November 8, 1967.

Hon. TORBERT MACDONALD,
Chairman, Subcommittee on Communications and Power, Committee on Interstate and Foreign Commerce, House of Representatives, Washington, D.C.

DEAR MR. MACDONALD: Pursuant to your request of October 31, 1967, I am submitting herewith an estimate of the funds that would be required during the next three years for United States participation in this World Weather Program referred to in House Joint Resolution 688.

Sincerely yours,

WERNER A. BAUM
(For Robert M. White, Administrator).

ESTIMATED U.S. COSTS OF THE WORLD WEATHER PROGRAM FOR FY 1968–70

At the hearing on October 31, 1967, of the Subcommittee on Communications and Power of the Committee on Interstate and Foreign Commerce on H. J. Resolution 688, the Chairman of the Subcommittee requested additional information with respect to the costs of the United States participation in the World Weather Program for the next three fiscal years. It should be noted that H. J. Resolution 688 does not contain an authorization for appropriations. The following costs, furnished in response to the request, are estimates and are not to be considered approved or authorized by the Administration for the period beyond FY 68. Funds for FY 68 have been authorized through the regular budgetary process. All funds for this program for the period beyond FY 68 are subject to the normal appropriation processes of the Executive Branch, including Bureau of the Budget review. These estimated costs reflect the amount required for United States participation in the World Weather Program in accordance with the plans and schedules that have been developed internationally.

The primary objectives of the World Weather Program (WWP) are to increase the accuracy and extend the time range of weather forecasts. These objectives are the same as the objectives of the United States agencies concerned with meteorological activities. The advantage, however, in the WWP is that targets are established which call for accelerated efforts on the part of all nations in achieving our, as well as their goals. Thus, in effect, the accelerated effort of the United States is multiplied through corresponding actions of many nations. The estimated costs identified below are those additional costs required by the United States to meet the internationally established schedules.

As indicated in the testimony of Dr. Robert M. White on H. J. Resolution 688, the three largest activities during the initial three year period on the WWP are (1) the World Weather Watch, (2) the Global Atmospheric Research Program, and (3) development of new technology.

In FY 1968 the United States plans to initiate implementation of its share of the improvements to be made in the World Weather Watch (WWW) in accordance with the internationally agreed plan, developed and approved by the members of the World Meteorological Organization, a specialized agency of the United Nations. Under this plan the United States is to implement communications links (Washington to Germany, Washington to Japan, Washington to Brasilia) through joint sharing of costs with the country at the other end of the link. The United States is responsible for implementing three upper air observing stations in the Pacific Trust Territories, the upgrading of 15 merchant ships and the equipping of 17 additional merchant ships to take upper air observations. The United States will contribute to the Voluntary Assistance Program established by the World Meteorological Organization. In addition, the United States will develop detailed plans and designs for further implementation of its portion of the WWW. Costs of these activities during the next three fiscal years are shown in the table below.

Within the Global Atmospheric Research Program (GARP) during the next three years, the United States plans to expand its research on long range weather prediction techniques, and to carry out a significant field experiment concerning the interactions between the ocean and the atmosphere which is required for long range weather predictions. We plan also to move forward with the design of experiments planned beyond the period 1970. These costs are also shown in the table below.

Development of new technology is necessary to meet the requirements of the WWW and the GARP data-gathering experiments. The United States already has a sizeable research and development effort in this area, much of which focuses around the meteorological satellite. In addition, further acceleration is required in the development of horizontal sounding balloons, buoys, and automatic land and merchant ship equipment. The cost of the buoy development has not been included in the following table because these developments are proceeding under our U.S. marine activities programs.

SUMMARY OF ESTIMATED U.S. COSTS FOR WORLD WEATHER PROGRAM FOR PERIOD FISCAL YEAR 1968-70

[In thousands of dollars]

	Fiscal year 1968	Fiscal year 1969	Fiscal year 1970
WWW implementation:			
U.S. national:			
Observing	----------	----------	700
Communications	200	475	500
Processing	200	200	600
Systems design	0	100	400
Voluntary assistance program	0	2,000	2,000
GARP:			
Research on weather prediction techniques	315	1,215	2,215
Ocean-atmosphere field experiment	725	1,790	1,100
Planning tropical and global experiments	110	260	1,000
Technology development: [1]			
Horizontal sounding balloons	0	300	800
Automatic observing equipment	0	70	500
Annual total	1,550	6,410	9,815

[1] If the technology development progresses rapidly, additional funding will be required for the procurement of a satellite and launch vehicle for GARP. The funding required is estimated to be $4,000,000 in fiscal year 1970.

Mr. MACDONALD. I just have one question before I recognize Mr. Harvey, and that deals also with a money matter that was brought up by Mr. Broyhill.

In this seeding—say that a hurricane is headed toward the United States. We don't want it, obviously, and we seed it and it goes off somewhere else, and hits, say, Haiti, or Santo Domingo or some place in the Caribbean and does a good deal of damage to those countries.

Are we internationally liable for the cost that the people of those countries are put to because the hurricane was diverted their way? I should say, should we be?

Mr. WHITE. I can ask Mr. Ellert to answer this question, but I believe the bill requires a study of the legal problems that are going to be encountered. The work we are going to be doing on hurricanes is basic research.

Before one would want to go operational with a technique for modifying hurricanes, the question you raise would have to be resolved.

Mr. ELLERT. In the program we have now, we are very careful about picking a hurricane which we seed. We have certain very rigid restrictions. We pick one which would not go close to land as far as we can determine.

However, to answer your question, Mr. Chairman, certainly I think that if it were proven that there was a causal relationship between our seeding a hurricane and the movement of this hurricane over a foreign land, and the foreign government of that land could show that the hurricane would not have come there except for the act of the United States in seeding the hurricane, we would be subject to an international claim for damages.

However, the state of the art at this time is not so developed, we think, that the causal connection could be proven. This is something we are still trying to find out, how to modify the hurricane. In conducting our experiments, we choose one that is out of the shiplanes and away from land, as near as we can determine.

Mr. MACDONALD. But isn't that a grave danger as far as monetary considerations are concerned? Mr. Broyhill was asking about the cost of the bill, but I was thinking, as he asked the question, of not just the initial cost of the program, but how about any ensuing costs?

Mr. ELLERT. Actually the restrictions are very rigid. For instance, during this past hurricane season, my recollection is that we didn't have any we could seed—that met our criteria.

Would that be right, Mr. White?

Mr. WHITE. That is right. What we are presently doing in hurricane modification is basic research. It is our strong belief that nothing we are presently doing in a hurricane could cause any significant long-term change in the direction or intensity of the hurricane.

Mr. MACDONALD. Then why bother to spend the money to seed it?

Mr. WHITE. Because we wish to test to see whether we can bring about at the present time certain kinds of changes in the hurricane.

The kinds of changes we are seeking now are small-scale changes. If one is able to achieve small-scale changes in the hurricane, one can then ask what one might do about larger scale effects.

Before one would operationally attempt to modify hurricanes, there would be a host of problems that would have to be solved.

Mr. MACDONALD. Mr. Harvey?

Mr. HARVEY. I didn't get the conclusion to Mr. Broyhill's question on cost.

Is it correct that with regard to House Joint Resolution 688 that the requested authorization for that would be unknown until the President comes in and requests whatever will be necessary, or will you come back and resubmit figures on that, or what is the status?

Mr. WHITE. I am going to attempt to get some estimates of what the program might entail over the next few years.

Mr. HARVEY. With regard to weather modification programs gen-

erally that you testified on, are the costs of that comparable to the cost in S. 2916?

Mr. WHITE. I think the costs listed in S. 2916 are close to the costs recommended by the National Science Foundation——

Mr. HARVEY. That wasn't my question. Are the authorizations you are requesting comparable to those? Do you wish to change those at this time, or are you going to submit additional figures?

Mr. WHITE. We will attempt to submit additional figures.

Mr. HARVEY. In conclusion, you cannot tell the committee what the cost is at this time?

Mr. WHITE. We can give you information about what we are presently spending and what our agency would want to get in future years. We cannot, of course, give you figures for the other agencies.

Mr. HARVEY. I think we have to have that. This is one of the functions of this committee.

Mr. WHITE. We will attempt to secure the information.

(See letter dated Nov. 8, 1967, p. 44.)

Mr. HARVEY. House Joint Resolution 688 envisages a certain amount of cooperation between the Communist world and our world, which I think most Americans would look on with a great deal of favor.

There are a lot of questions which I don't know the answers on, and perhaps you would have the information.

What information do we presently get from the Soviet Union, or Communist Cuba?

Mr. WHITE. We receive extensive information from Russia, Cuba, and other nations of the world.

In fact, the weather data today we are receiving from the Soviet Union is very much greater than that we transmit to them, because they cover so much more territory than we do.

Mr. HARVEY. How is that exchanged?

Mr. WHITE. We have an international agreement. The data is exchanged every 6 hours.

Mr. HARVEY. Where do you send your information?

Mr. WHITE. Our information goes two ways. The first way is a direct line which we have between Washington and Moscow, and the second way is by transmission of data from here to West Germany, from which point it is transmitted to the Soviet Union.

Mr. HARVEY. Is there any lack of cooperation at any time? Are you completely satisfied?

Mr. WHITE. The cooperation with the Soviet Union in weather matters has been very good.

Mr. HARVEY. I am anticipating questions that might well come up on the floor.

Is there any chance of our ever being misled by information furnished to us in this regard?

Mr. WHITE. I rather doubt it, Mr. Congressman, because it is possible to detect erroneous data by comparing it with other nearby data.

Mr. KORNEGAY. Will the gentleman yield?

Mr. HARVEY. Yes.

Mr. KORNEGAY. In regard to the information the Soviet Union sends out and makes available to us and other nations of the free world, is it all weather information relative to the Soviet Union—that is,

over the entire area of the Soviet Union—or is it only about the conditions over areas that can affect our weather?

Would they make us aware of all information, or would they transmit only that information which would have some bearing on our weather?

Mr. WHITE. They transmit all weather information. There is an agreed-upon international network, and all nations transmit information from this network.

Mr. KORNEGAY. I assume we do the same thing. The conditions over Kansas, the movement of air masses and so forth, that goes out?

Mr. WHITE. Yes, sir.

Mr. HARVEY. I assume the military concurs in this joint resolution?

Mr. WHITE. I believe they do.

Mr. HARVEY. Are they called upon to approve it in advance of your coming here?

Mr. WHITE. I believe there is no question about the fact that the Department of Defense supports this. We have an interagency committee which deals with international meteorological programs in which the Department of Defense has been represented, and they have been fully participating with us.

Mr. HARVEY. Can you tell us without qualification that they do approve it?

Mr. WHITE. I believe I can tell you that without qualification they do approve it.

Mr. HARVEY. In section 2 of the resolution, it is said, "That in furtherance of this policy the Congress requests the President to cooperate with other nations," and then one is in programs utilizing procedures and techniques for the immediate improvement of the capability of the existing facilities in international weather systems.

How do we go about determining how much of our technology we give, and how much the Soviets give?

Mr. WHITE. There is an agreed-upon international plan, which was agreed to in the World Meteorological Organization, which sets forth what the various nations should do on this weather program.

Secondly, we are familiar with the technological activities of the Soviet Union, as they are of ours, from normal scientific meetings and exchange of information.

We feel we are getting a very good exchange in the technological developments.

Mr. HARVEY. You have no qualms about the sharing of our technology with the Soviets?

Mr. WHITE. I have no qualms about sharing the kind of technology we are talking about in this program.

Mr. HARVEY. Down in the paragraph of that same section 2, it provides for—

> * * * a program for the training and education of scientists, engineers, and technical personnel for the development, operation, and conduct of any system or program in which the President is authorized to participate by this subsection; and (5) a program to provide appropriate technical and training assistance and facilities to other nations and to international organizations so that they may effectively participate in an international system for the observation of the global atmosphere and the rapid and efficient communication, processing, and analysis of worldwide weather data and so that they may fully utilize the data, charts, analyses, and other information provided by such a system.

Does that mean we will have some of the Soviet personnel over here, and some of ours over there?

Mr. WHITE. There are a number of aspects of the program. If we are going to obtain the global observations, we are going to have to get them from countries that are underdeveloped.

There are training schools for technicians, not only in this country, but other countries also, where people from the underdeveloped countries come for training. We have trained a number and other countries train them also.

There is also provided by the World Meteorological Organization facilities for training people from these countries.

(The following information was subsequently submitted:)

DEPARTMENT OF COMMERCE STATEMENT ON U.S. PARTICIPATION IN THE WORLD METEOROLOGICAL ORGANIZATION'S VOLUNTARY ASSISTANCE PROGRAM

The Voluntary Assistance Program for the World Weather Program was developed and approved at the Fifth World Meteorological Organization Congress in April 1967. At this Congress, it was recognized that the less developed countries would require assistance in carrying out their part of the World Weather Watch implementation plan. In general, this assistance would be for weather observation and communication equipment, and training of personnel. The less developed countries would provide, on a continuing basis, the other facilities required and the personnel to operate the equipment.

In view of the direct United States need to obtain data from the World Weather Watch, the United States plans to participate fully and effectively in the Voluntary Assistance Program.

The rules which govern the Voluntary Assistance Program require that all projects be a part of the approved World Meteorological Organization's World Weather Watch plan. Each country providing equipment and services can select those projects for which the assistance will be utilized. Therefore, the United States can select those projects which will result in the maximum benefit to itself.

The assistance provided by the United States will be through the World Meteorological Organization, a specialized agency of the United Nations. Budgeting and securing of funds for the United States contribution to this activity is the responsibility of the Department of State.

Mr. HARVEY. Does the World Meteorological Organization have offices anywhere?

Mr. WHITE. It has offices in Geneva, which is its headquarters. It is the agency whereby various training facilities are established in various parts of the world as part of the United Nations development program.

It also coordinates the training activities internationally. If there are people from Africa or South America who wish to be trained in other countries, it provides the coordination of that.

Mr. HARVEY. Thank you.

Mr. MACDONALD. I would like to add that I was very amazed in 1957, when the relationships between the Soviets and ourselves were not at an alltime high as far as friendship was concerned, that in the Antarctic there were two Russians working directly with our scientists, and we had two American working over at the Russian base, and, frankly, I never quite understood it. But it was the fact.

I would like to ask you this question. You have mentioned Cuba and the Soviet Union giving us weather information. How about China?

Mr. WHITE. We receive weather information from mainland China through international communications channels. It is relayed to Tokyo. The Japanese pick it up from radio broadcasts.

Mr. MACDONALD. In other words, our people in South Vietnam and Guam who are about to bomb the coast near China can depend on Chinese weather information?

Mr. WHITE. I believe the Department of Defense also uses the data received through international channels.

Mr. MACDONALD. That wasn't my question. My question is, Do the Chinese give us the kind of information on what the weather is going to be like on their border in North Vietnam that we are about to bomb? That really stretches my imagination.

Mr. WHITE. These weather data are broadcast internationally, and we receive them, and on the basis of this data we make forecasts.

Mr. MACDONALD. Then China actually helps us formulate plans for bombing, or whether not to bomb, close to their border?

Mr. WHITE. I would not put it that way, Mr. Chairman.

Mr. MACDONALD. Well, I am putting it that way.

Mr. WHITE. They are broadcasting weather information from their weather stations, which is picked up, and we receive it. We use them to make weather forecasts.

Mr. MACDONALD. Thank you.

Mr. Ottinger?

Mr. OTTINGER. I have no questions.

Mr. MACDONALD. Mr. Kornegay?

Mr. KORNEGAY. No questions.

Mr. MACDONALD. Mr. Brotzman?

Mr. BROTZMAN. Thank you, Mr. Chairman.

I would like to welcome you to the committee, Dr. White, and your colleagues also.

As I said at the outset, some of these concepts are staggering to the imagination. Since we have the ESSA facilities in Boulder, I have had an opportunity to witness some of the work that you are doing. I don't know if it is exactly my prerogative at this point, but I certainly believe—and I think I expressed this thought to you, and I will express it to the rest of the members of the subcommittee—I think it would be a very beneficial thing for all of us to share some of this scientific information.

I think it is important for Members of Congress, and I will add, particularly the members of this subcommittee, because this is under our jurisdiction, to know as much as we possibly can about what I consider to be a tremendously important subject.

I would hope, Mr. Chairman, that at some time in the not-too-distant future, that particularly the members of this subcommittee would have an opportunity to visit the installation at Boulder, Colo., or some of the others, because it has certainly helped me a great deal.

It seems to me that there is need for higher and better coordination of the whole weather modification programs that the Government is engaged in, and if I understand correctly, you, among other agencies, come before us because you want us to be advised of what you are doing. Would that be a fair statement?

Mr. WHITE. That is correct, Mr. Congressman.

Mr. BROTZMAN. I listened to your testimony and your examination by my colleague from North Carolina. It wasn't too clear that the main reason you are coming here is that you want to advise us of what you are doing, because you know that we share the responsibility with you. Is that correct?

Mr. WHITE. That is correct, Mr. Congressman.

Mr. BROTZMAN. Do I understand you are talking about a 10-year program right now, Doctor?

Mr. WHITE. The world weather program is visualized as a program extending at least 10 years, and possibly 15.

Mr. BROTZMAN. It is probably going to be in perpetuity, I would think.

Mr. WHITE. Yes, once we have the system established.

Mr. BROTZMAN. What we are talking about now, though, is something 10 years in the future?

Mr. WHITE. That is correct.

Mr. BROTZMAN. You know, this is a very big thing. Of course, out in Colorado and a lot of places we have an unusual weather formation out there. We like those Rocky Mountains, but it also produced floods, and I was out there last weekend to participate in the start of a dam to prevent the recurrence of something like what we had in 1965. We lost many lives and a lot of dollars.

But I understand that within your scientific spectrum, you would believe at some time you might be able to predict the occurrence of a tremendous thunderstorm, and possibly even do something about it to stop that from occurring. That is what I understand the thrust of your testimony to be.

Mr. WHITE. That is correct.

Mr. BROTZMAN. How far away are we?

Mr. WHITE. When you speak about a thunderstorm, Mr. Congressman, you are talking about a relatively small scale phenomenon. We require additional observations on a small scale. We need improved radar facilities for this kind of thing.

Mr. BROTZMAN. Right there I am going to ask you this question: Do you have a radar now that would pick up a thunderstorm?

Mr. WHITE. It will pick up the thunderstorm once it starts precipitating.

Mr. BROTZMAN. On aircraft, is the development in the state of the art to a point where the pilot can pick up a thunderstorm in advance?

Mr. WHITE. Not at the present time, to my knowledge. The radar return is reflected from the raindrops, that is how we detect a thunderstorm.

Mr. BROTZMAN. I interrupted your answer. How long would it take to develop these techniques?

Mr. WHITE. As far as the long-range forecasting techniques are concerned, we believe in 15 years, if we can acquire the global observations, we will have a good chance of doing it.

Mr. BROTZMAN. I have had an opportunity to read this bill in its entirety, but just so I understand the distribution of information that would be developed, would you provide information to the Federal aviation authorities?

Mr. WHITE. As we do now. Yes, sir, we provide the weather services for the air traffic control system, and for all general aviation.

Mr. BROTZMAN. Some questions were asked relative to the matters of defense. You were talking generally, I think, about a peaceful approach to this. We can't overlook the military significance of the weather data.

Do you provide information to the Department of Defense?

Mr. WHITE. Yes; the weather service of the United States is a completely integrated service. By this, I mean all the observations taken by the civilian agencies and the military agencies are available to all. So it is a completely integrated weather service, and this is coordinated on a routine basis through the Federal Coordinator for Meteorological Services.

Mr. BROTZMAN. When you talk about money, and this is our responsibility and also yours, do I understand that the attempt you are going to make on a monetary projection will include all of the various agencies that are coordinated under this particular bill?

Mr. WHITE. We will make an attempt to get information as to what the projection would be for incremental costs of the program over and above those we have today for the next 3 or 4 years.

Mr. BROTZMAN. Would there be a greatly increased expenditure necessary in, say, the first year?

Mr. WHITE. There is going to be an initial requirement for some increase in funding. It will be relatively modest, and I believe the program will grow by relatively small increments over the period of years.

Mr. BROTZMAN. Since we have an acute budgetary problem right now—and I guess that will be the understatement of the morning—but I understand from your statement that the costs will not be dramatic, and that we will have continuing information presented to us and an opportunity for continuing review as the program is projected on down through the various years as you envisage it?

I know we have the power, but that is your idea?

Mr. WHITE. That is how we envisage it, Mr. Congressman.

Mr. BROTZMAN. So we could continue to look at it and to add to it or take away from it as we thought was in the national interest?

Mr. WHITE. That is correct, Mr. Congressman.

Mr. BROTZMAN. As I said, we are very happy to have you here, and I do hope, and I told you this already, but I hope the opportunity might present itself for all of us to see some of the things you are doing. I think it is much more meaningful than just to listen to it, to see it in operation.

Mr. WHITE. We would welcome the opportunity to have the committee visit any of our facilities. We would be pleased to extend the invitation to them.

Mr. MACDONALD. Mr. Kornegay?

Mr. KORNEGAY. Thank you, Mr. Chairman.

Dr. White, I am sorry I was not here to hear your statement. I attended another committee meeting this morning.

I don't know that this question has been asked, but I do feel that it ought to be in the record if it has not been asked, and if it has, stop me.

Under the present state of the art in weather forecasting, what is the length of time that you can reliably and accurately predict what the weather conditions will be?

Mr. WHITE. We believe our weather forecasts are reasonably accurate for a period on the order of 48 hours. We consider them useful—it is a vague term, admittedly—for periods of about 3 to 4 days.

After that, our accuracy on day-to-day predictions becomes quite marginal, although it is possible to provide useful information on average conditions over a period of a week and, in some cases, over a period of a month.

Mr. KORNEGAY. In the program that you recommended under the House bill and under the Joint Resolution 688, if it were implemented and were to go into effect, what would be the length of prediction, say, at the end of 10 years?

Mr. WHITE. If we are successful in the program of obtaining the observations that I have spoken about, at the end of 10 years, as it stands now, in principle we should be able to make the same kinds of forecasts that we presently make for 48 hours for a period out beyond 1 week.

Mr. KORNEGAY. In other words, that would be a substantial advance in the state of the art.

Mr. WHITE. It would, Mr. Congressman. It would have tremendous economic implications.

Mr. KORNEGAY. Let me ask you one other thing. On page 3 of your statement, you talk about, as a result of the scientific discoveries and advances, that you are cautiously optimistic about the future of weather modification.

By the term "weather modification," do you mean the ability of man to affect the weather conditions, or cause changes in weather conditions by actions that man might take?

Mr. WHITE. Yes, sir.

Mr. KORNEGAY. Do you feel that we will so progress at any time in the future that we will possess knowledge on how to divert a hurricane and that type of thing?

Mr. WHITE. I think ultimately we will attain that type of ability. I do not believe that practical hurricane modification is something we are going to find in the near future.

On the other hand, there are other kinds of weather modifications that are now with us. There is no question any longer than we can successfully clear cold fogs from airport runways. There is also growing evidence that one can modify precipitation from certain kinds of cloud systems.

Mr. KORNEGAY. When you say "modify precipitation," do you mean stop rain, or make it start to rain?

Mr. WHITE. Most experiments have been directed at increasing the rainfall, especially in arid regions and other regions that become arid for a time, as in the recent Northeast drought.

Mr. MACDONALD. Would the gentleman yield?

Mr. KORNEGAY. Yes.

Mr. MACDONALD. What happens if there is going to be a rainstorm, say, in Iowa, and yet it falls in Kansas and Iowa doesn't get any?

How about those farmers in Iowa? Who is going to reimburse them for the rain they were going to get?

Mr. WHITE. Mr. Chairman, you raised the $64 question. This is a question to which nobody at the present time has the answer. One of the purposes behind this bill is to foster the necessary legal studies so that we can come up with some recommendations as to what might be done.

Mr. OTTINGER. Would the gentleman yield?

Mr. KORNEGAY. Yes.

Mr. OTTINGER. Something that has fascinated me is the accuracy of the Farmers Almanac in predicting a year ahead the amount of rainfall or snowfall in a particular season of the year. Do they consult with you on that, or do they have a special divining rod?

Mr. WHITE. No; they don't consult with us, and I hate to make any adverse comment on the Farmers Almanac, because I enjoy it so much——

Mr. KORNEGAY. Let me ask this. Do you consult the almanac? [Laughter.]

Mr. WHITE. At times, I feel like doing just that.

Mr. OTTINGER. You don't know what systems they use?

Mr. WHITE. No, I don't.

Mr. KORNEGAY. Just this one final question, Mr. Chairman.

Dr. White gave us the information on the improvement in the art of weather prediction. You say it will be improved over the years under the provisions of House Joint Resolution 688. Related to that is the question of weather modification.

Do you feel that within that 10-year period substantial progress will be made in weather modification?

Mr. WHITE. Yes, if we judge by the progress that has been made in the past 10 years in weather modification, I think we will see significant improvements in our capabilities in that area in the next 10 years.

Mr. KORNEGAY. That is all, thank you.

Mr. MACDONALD. Mr. Brown?

Mr. BROWN. Mr. White, are House Joint Resolution 688 and H.R. 9212 related to the extent that one of them involves areas of activity that would be helpful in the economic accomplishment of objectives of the other?

Mr. WHITE. Yes, very definitely so. House Joint Resolution 688, which calls for this international program of observations, is going to be very vital in any attempts that we make with regard to large-scale weather and climate modification, whether it be a conscious modification we might attempt or inadvertent modification such as might result from air pollution.

It would provide a scientific basis on which we could judge the consequences of any artificial interference with large-scale weather.

Mr. BROWN. Let me question you on the point that has been raised by a couple of colleagues. They have started down this road but I am not sure they have really finished it up. The total cost of 9212 as it sits now is what, $50 million?

Mr. WHITE. There is no specific fund authorization in 9212 as it now stands.

Mr. BROWN. Is there an estimate of the costs?

Mr. WHITE. I have agreed to attempt to provide the committee with an estimate of the kinds of funds that might be required over the next 3 or 4 years. I have also indicated that we do have recommendations as to what the total scope of the national program should be from two bodies which have studied the problem, the National Academy of Science Panel and the Commission of the National Science Foundation.

And I have further indicated that I believe the amounts of money that were authorized in S. 2916, which passed the Senate last year, roughly correspond to the amounts of money envisioned in those reports.

Mr. BROWN. What amount is that?

Mr. WHITE. It authorized $30 million in 1968 and $40 million in 1969.

Mr. BROWN. Are you talking about 9212?

Mr. WHITE. Yes, 9212.

Mr. BROWN. What about 688?

Mr. WHITE. On 688, I have not given any figures at all. I will attempt to provide such figures.

Mr. BROWN. And if you could, I think a 5-year projection is a legitimate request of you, although by the fifth year hence you would be guessing pretty widely perhaps.

Is the undertaking of both of these budgeted by the Bureau of the Budget?

Mr. WHITE. The undertaking of the activities in fiscal year 1968 was approved by the Bureau of the Budget and submitted to the Congress for appropriations this year; yes.

Mr. BROWN. I am sorry that I haven't had a chance to study the legislation in detail, but is there any provision for the assessment of the results of these two undertakings—the effectiveness of the expenditure of this money?

Mr. WHITE. Yes. House Joint Resolution 688 provides for an annual report by the President to the Congress summarizing the program, its plans, and its accomplishments, and there is a provision for a report on the other bill also by the President to the Congress.

Mr. BROWN. On an annual basis?

Mr. WHITE. On an annual basis.

Mr. BROWN. One thing I have noticed lacking in your first testimony, is any reference to ocean currents. Is it presumed in 9212 that you will get into that area?

Mr. WHITE. Under 9212, when we talk about the modification of hurricanes, since the hurricanes are a creature of the oceans, their energy comes from the moisture of the ocean, it becomes very important to understand the interaction between the atmosphere and the ocean.

With regard to House Joint Resolution 688, we will have to get into ocean activities for the following reason: The ocean is a sort of a boiler for the atmosphere. Unless we know the rate that moisture and energy are imparted from the ocean to the atmosphere, we will not be able to make the kind of forecast I have talked about.

Therefore, the world weather program does provide for the oceanographic information required for this purpose.

Mr. BROWN. I recall during World War II in the Sunday supplements, we were going to dam up the Gulf Stream and freeze out the

Germans on their way to Moscow, a la the War of 1812, and I gathered from what I see here that you have read some of that stuff, too. But I presume that all of these other contributing forces, such as the accumulation of data on the polar icecap are the kinds of things, the effects of which you intend to study.

Mr. WHITE. They would have to be. For example, in our computer simulations, we have already arrived at a point where we can model the global atmosphere. One can see what will happen if one changed the temperature of the ocean a few degrees. One can also change the amount of carbon dioxide in the atmosphere in the mathematical model and ask what the consequences will be.

This is the principal way of approaching this climate modification problem. Our feeling is that you must understand the consequences before anybody attempts experiments.

As for these grandiose schemes proposed for modifying climate, at the present time they are speculative. One would have to have a model to judge what the results would be.

Mr. BROWN. Will your studies go in depth into the effects of air pollution and to what extent is provision made for the sharing or working with other departments of the Federal Government so that you are not duplicating efforts already being made by somebody else in this field, or coming up with significant information which then doesn't become available to somebody else in the Federal Government who needs it?

The problem of exchanging information with the Soviet Union is duck soup compared with the problem of getting information from one branch of the U.S. Federal Government to the other, from my experience on this committee and others.

Mr. WHITE. I am pleased to report, Mr. Congressman, that we have close contacts with the Department of Health, Education, and Welfare about air pollution problems.

We work very closely with them at the Air Pollution Control Center in Cincinnati, where we have our own people.

We also—with regard to the measurements——

Mr. BROWN. May I interrupt you at that point to ask if you are beginning to feel any significant information may develop out of it?

Mr. WHITE. Well, quite a bit of information has developed out of this. Indeed, in forecasting, as contrasted with weather modification, we have already developed techniques for forecasting air pollution potential, which are distributed routinely through the Nation to alert air pollution people on the dilution capacity of the atmosphere.

Mr. BROWN. Reverse that, and give us the effects of pollution on the modification of the weather.

Mr. WHITE. It is quite clear there are effects. One is increased carbon dioxide in the atmosphere.

There are indications that the amount of carbon dioxide in the air seem to be increasing. Since carbon dioxide is an important absorber, and provides a greenhouse effect in the atmosphere, it is critical for us to know whether it is going to continue to increase and, if so, what the consequences are going to be.

Mr. BROWN. If I may, are you suggesting that the temperature and humidity of the surface of the earth may be increasing because of the increase in pollution?

Mr. WHITE. We don't know what the consequences will be. That is the point. We don't know whether it will bring about an increase or decrease in the precipitation or the temperature, because the processes in the atmosphere are complicated. But we know it will have an effect.

Similarly with the dust content in the atmosphere. This cuts down the amount of sunshine received at the surface of the earth, and we are looking at what the consequences will be of continuing to increase dust content of the atmosphere through monitoring networks.

Mr. BROWN. With relation to the international implications not only of 9212, but of 688, have you given, or has the Department of Commerce given any consideration to the possibility of an international weather year on a regular basis such as the International Geophysical Year that we had a couple of years ago? Or is it necessary?

Mr. WHITE. It is desirable.

One of the proposals which we hope to follow through with on the research phases of House Joint Resolution 688 deals with what we call the global observational experiment, Glomex, which proposes at a point some 10 years hence to place the atmosphere under complete surveillance for a period of from 3 to 4 months to a year, using all the facilities we have. So exactly the kind of thing you are proposing, but perhaps on a somewhat grander scale, is envisioned.

Mr. BROWN. Thank you very much.

Mr. MACDONALD. Thank you very much.

Before we close, Mr. Harvey has a question.

Mr. HARVEY. Just one question, Dr. White. In looking at the bill here, are we duplicating our effort in H.R. 9212, in the way we have provided here, on having functions of weather modification carried out by several departments?

This is frightening, dividing up the earth.

Mr. WHITE. I don't believe we are. I think weather modification has to be regarded as a technology, like atomic energy, which is going to be useful to many agencies. It becomes natural, therefore, that the particular agency which has a task to do should be able to use this technology to do the job.

The key problem is the need for a comprehensive program in which the entire technology is being explored, and this is provided for by the bill.

Then you need an adequate coordinating mechanism which makes sure the program hangs together as a well-integrated national program.

Mr. HARVEY. We hear about the need of another Hoover Commission to eliminate overlapping. We are looking at section 201 and what we are attempting to do, it looks like we are taking a job and dividing it up into six different pieces and giving it out to six different agencies to possibly duplicate.

Thank you, Mr. Chairman. That is all I have.

Mr. MACDONALD. Mr. Brown?

Mr. BROWN. I should like to ask one other question. We have talked about all the possibilities of use of this pollution control in defense and agriculture and everything else.

Other than the purely local ramifications, are there broader dangers inherent in the modification of weather? I think it is wonderful if you

try to eliminate hurricanes and thunderstorms and all that, but are we also then creating some worldwide problems, or do we know?

Mr. WHITE. At the present time we don't know. And the bill does provide for studies in which we would attempt to come to grips with the problems.

I think these are questions the answer to which we don't know.

Mr. MACDONALD. Thank you very much, Dr. White, and your associates. We appreciate your testimony.

The next witness will be Dr. Milner B. Schaefer, science adviser to the Secretary of the Department of the Interior.

STATEMENT OF DR. MILNER B. SCHAEFER, SCIENCE ADVISER TO THE SECRETARY, DEPARTMENT OF THE INTERIOR; ACCOMPANIED BY DR. ARCHIE M. KAHAN, CHIEF, OFFICE OF ATMOSPHERIC WATER RESOURCES, BUREAU OF RECLAMATION, DENVER, COLO.

Dr. SCHAEFER. Mr. Chairman, it is a pleasure to appear before you to testify on these bills. I would like to introduce my colleague, Dr. Archie M. Kahan, who is Chief of the Office of Atmospheric Water Resources, Bureau of Reclamation, Denver, Colo. He happens to be here in the city, and it is fortunate to have him with us.

Mr. MACDONALD. You are both very welcome.

Dr. SCHAEFER. We have brief statements on both House Joint Resolution 688 and H.R. 9212. Would you like us to take 688 first?

Mr. MACDONALD. Why don't you submit the statements, and perhaps you can summarize them. I think time is running out.

Dr. KAHAN. I will speak first to 9212.

Mr. MACDONALD. Without objection, the statements will appear in the record.

(Dr. Schaefer's prepared statements on H.R. 9212 and H. J. Res. 688 follow:)

STATEMENT OF DR. MILNER B. SCHAEFER, SCIENCE ADVISER TO THE SECRETARY OF THE DEPARTMENT OF THE INTERIOR, ON H.R. 9212.

Mr. Chairman, I appear before you today in behalf of the Department of the Interior to testify on H.R. 9212, a bill "To authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes." The views of the Department were outlined in the report we submitted to your committee.

We would not object to enactment of this bill, if it is amended in accordance with our suggestions.

Mr. Chairman, as was indicated when we testified last year in relation to the Senate version of this bill (S. 2916), we strongly believe that the importance and complexity of the total problem of weather modification require that a national program designed to make optimum use of our atmospheric water resources should draw on the coordinated strength of several agencies, each doing the job it knows best. There were adopted several amendments that, in our view, strengthened it in this respect, which are included in H.R. 9212. We believe that you will wish further to strengthen the opportunities for full utilization of the capabilities of all agencies concerned with weather modification.

H.R. 9212 would place a major responsibility for weather modification in the Department of Commerce; it would also include authorization for programs in various aspects of weather modification in the Departments of Interior, Agriculture; Health, Education and Welfare; and the Federal Aviation Agency; it would restrict the National Science Foundation to support of basic and applied research and programs of education and training, in the sciences which relate to and underlie weather and climate modification technology.

We believe that *all* agencies concerned with weather modification, enumerated in Sec. 201 should be authorized to furnish technical assistance and information to each other. We have suggested a specific amendment of Sec. 201(a)(2) to that effect.

Regulation of weather modification research, development, and operational activities is a very complex matter, and legislation concerning it will almost certainly require modification after careful study. This is wisely provided for in Sec. 205(d). However, inasmuch as several Federal agencies would be involved in this study, we believe that the final product should be coordinated by the President. We recommend, therefore, that the report called for be made to the President who would submit it to the Congress with his recommendations.

Many aspects of weather modification, including those specifically authorized to be undertaken by the agencies enumerated in Sec. 201, require international cooperation for their effective pursuit. This is true both because of the global, international nature of the atmospheric circulation, and also because of the need for extensive cooperation in development and applications of methodologies. It is, therefore, essential that the heads of all agencies concerned, not just the Secretary of Commerce, have authority for international cooperative activities. We have, therefore, suggested a specific amendment to Sec. 302 to this effect.

Mr. Chairman, the total problem of weather modification, its application and its potential effects, both planned and inadvertent, is extremely complex. It requires, we believe, to be developed cooperatively by the several Federal agencies, each designing its program in accordance with its assigned mission and responsibilities. It is in the Nation's interest to encourage the orderly development of such weather modification activities.

As you know, the Department of the Interior (through our Bureau of Reclamation) has been conducting a limited, but highly promising study of atmospheric water resources since 1961. On January 9, 1967, we released a report on a "Plan to Develop Technology for Increasing Water Yield from Atmospheric Sources." This report outlines a plan for the orderly development of operational systems to enhance precipitation in some parts of the country by 1972 and for achieving a general national capability to enhance or redistribute precipitation by 1985.

We are already conducting studies on the legal, social, economic, biological and ecological effects of weather modification. The Secretary of Interior has established an Office of Ecology, one of the primary responsibilities of which is a study of biological and ecological effects of weather modification.

It is logical that this expanded national program for the utilization of atmospheric water resources should be the responsibility of the Department of the Interior. As the government's department of natural resources, we already have many and varied responsibilities in relation to water. The Department collects basic data on the quantity and quality of the Nation's surface and underground waters. It provides water for irrigation, hydroelectric power, and municipal and industrial uses from a vast system of storage reservoirs and canals. It manages public lands as watersheds, and fish and wildlife refuges. Its responsibilities for promoting outdoor recreation and conservation are intimately concerned with water. In recent years, we have been assigned added responsibilities for developing desalination techniques, encouraging water resources research, and controlling pollution. And finally, beginning in 1962, the Congress authorized us to undertake a modest program of research into developing the water resources of the atmosphere through our Bureau of Reclamation. Weather modification activities are completely harmonious with the basic mission of the Department of the Interior—the conservation, development, and use of natural resources.

Our scientific and engineering efforts to develop techniques for increasing the yield of water from the atmosphere have accelerated during the last five years. The present work being done by the Bureau of Reclamation brings to bear some of the best scientific and engineering talents available in the Department of the Interior, in other government agencies, such as the Forest Service and the Weather Bureau, and in many universities and private meteorological institutions. We are receiving strong encouragement from the National Academy of Sciences and the National Science Foundation.

In conclusion, Mr. Chairman, while we are strongly in favor of an enhanced national program in weather modification, we consider that H.R. 9212 requires further revision in order most effectively to serve the Nation's needs.

STATEMENT OF DR. MILNER B. SCHAEFER, SCIENCE ADVISER TO THE SECRETARY OF THE DEPARTMENT OF THE INTERIOR, ON H.J. RES. 688

Mr. Chairman, I am pleased to appear before you today on behalf of the Department of the Interior in support of H.J. Res. 688, "To provide for an expanded and intensified effort to increase the accuracy and extend the time range of weather predictions and to request the President to take action so that the peoples of the United States derive, at the earliest possible time, the social and economic benefits that would accrue from achievement of this new level of capability in weather predictions." The views of the Department were outlined in the report we submitted to your committee.

H.J. Res. 688 would provide for support for United States' participation in a worldwide system of observation, communication, processing, and analysis of weather data, and for the conduct of a comprehensive research program, utilizing these data, for the development of a capability in long-range weather prediction. It would also provide for studies and evaluation of inadvertent climate modification, as well as the feasibility of intentional climate modification. Additionally, it would provide for the training and education of scientists, engineers, and technical personnel for the development, operation, and conduct of any system in which the President is authorized to participate, and for the provision of appropriate technical and training assistance and facilities to other nations, and to international organizations, to assure their effective participation in the global program. Under provisions of the proposed legislation the President is to submit a plan to the Congress before March 1 of each year setting forth the proposed participation of the United States for the next fiscal year, a statement of the activities to be conducted, and indicating the department or agency which is to conduct the activities and seek appropriations therefor.

The program contemplated by H.J. Res. 688 would not supersede or take precedence over our Atmospheric Water Resources Research Program. On the other hand, the results gained from the worldwide program would be of material value in advancing our Atmospheric Water Resources Program. With more detailed and reliable short- and long-range weather predictions, we would be able to conduct with a greater degree of accuracy field operations and experiments under this program. Furthermore, the results of such operations and experiments could be determined more precisely.

This program would also greatly assist the Department of the Interior's program of fisheries forecasting. The observational net for improved weather prediction requires increased data acquisition over and in the sea, and the research program requires, as specifically mentioned in the bill, study of the interactions between the atmosphere and the oceans. These observations and studies will enable improved long-term predictions of currents, temperature structure, and other ocean phenomena that determine the location of abundant fish concentrations.

For the above reasons, we recommend that H.J. Res. 688 be enacted. The Bureau of the Budget has advised that enactment of this legislation would be consistent with the Administration's objectives.

Dr. SCHAEFER. We have outlined our views on both of these bills in letters written to the committee.

Our position on 9212 is that we would not object to the enactment of this bill if it is amended in accordance with some of our suggestions.

In reporting on the Senate version of this bill, which was S. 2916, we indicated that we believe very strongly that the importance and complexity of the total problem of weather modification requires a national program, designed to make optimum use of our atmospheric water resources. This activity draws on the coordinated strengths of the several agencies of the Federal Government, each doing the job that it knows best.

At the time S. 2916 was considered, we submitted several suggested amendments, and a number of these were adopted. We believe that you may wish further to strengthen the opportunities for full utilization of the capabilities of all of the agencies concerned by considering additional amendments.

We believe that all of the agencies concerned with weather modification enumerated in section 201 should be authorized to furnish technical assistance and information to each other on a reciprocal basis, rather than just having Commerce act as the advisory agency, and we have suggested a specific amendment in this regard.

We also consider that regulation of weather modification research, development and operations is an an extremely complex matter, and legislation that concerns it will almost certainly require modification after very careful study, and section 205, paragraph (d) of the bill very wisely provides for this.

However, several Federal agencies would obviously be involved in this study. We believe, therefore, that the final product should be coordinated by the President. We recommend that the report called for be made to the President, who will submit it to the Congress with his recommendations.

We also note that a great many aspects of weather modification that were discussed by Dr. White, including those that are specifically authorized to be undertaken by the agencies enumerated in section 201, require international cooperation.

This is true both because of the global nature of the atmosphere that Dr. White described, and also because of the need for extensive cooperation in the development of methodologies among nations.

We, therefore, believe it is essential that the heads of all agencies concerned, and not just the Secretary of Commerce, take part in international cooperative activities. Again, we have suggested a specific amendment in that regard.

Mr. Chairman, the message I would like to carry is that the total problem of weather modification, its applications and its potential effects, both planned and inadvertent, is very complex. We believe that it requires, therefore, to be attacked cooperatively by the several Federal agencies, each designing its programs in accordance with its assigned responsibilities.

It is in the Nation's interest to encourage the orderly development of these activities.

As you probably know, our Department has been conducting limited, but highly promising studies, of atmospheric water resources since 1961. In January of this year, Interior Secretary Udall released a report entitled "Plan To Develop Technology for Increasing Water Yield From Atmospheric Sources." It outlines a plan for the development of an operational system to enhance precipitation in some parts of the country by 1972, and for achieving a general national capability to redistribute precipitation by 1975.

Mr. MACDONALD. Sir, could I interrupt you at that point?

Does the experiment which you refer to include the one at Sonora in Mexico?

Dr. KAHAN. No, sir. That is being conducted by the Mexican Government, and is not part of our program.

Mr. MACDONALD. No, it was being conducted by Sonora University in conjunction with Arizona University.

Dr. KAHAN. It is not part of the Bureau of Reclamation programs.

Mr. MACDONALD. How about the one that is going on in California now, in which both water and power are being considered?

Dr. KAHAN. We do have a program in California, the so-called Southern Sierra program.

Mr. MACDONALD. There is another bigger one farther down south.

Dr. SCHAEFER. I think I can answer the question, sir. It is a nuclear reactor to produce power and desalinate sea water. I would be very glad to speak to this. It isn't part of the atmospheric program. It is part of our total water program.

Mr. MACDONALD. Thank you.

Dr. SCHAEFER. The work in Sonora may be a program of the National Science Foundation. Again, this illustrates that these are complex programs, and this is all part of the total picture.

Mr. BROWN. If the gentleman would yield, it also points up one of the other problems to which you alluded in your testimony, and to which I alluded in my questions, and that is the failure of keeping everybody advised of studies being made. This encourages duplication.

Dr. SCHAEFER. I think we are aware of the programs at Sonora and the University of Arizona. The only question was who was funding that particular study. You see, many of the university contractors that are at work in this area receive support from several agencies. That is a very good thing, because we get the best brains in universities, and even in private companies, to bear on these problems.

Mr. BROWN. It is also not bad sometimes for the people who are getting the funds.

Dr. SCHAEFER. I would like to point out, sir, in relation——

Mr. BROTZMAN. Would the gentleman yield for one more question at this point?

I have been led to believe that all of the agencies in weather modification were presently exchanging information. Is that correct? Do you know that those studies are, in fact, going on, and what A, B, C, and D are doing?

Dr. SCHAEFER. Yes, sir. One of the major mechanisms is through the Federal Council on Science and Technology: There is an Interagency Committee on Atmospheric Sciences. There is quite good interchange of information and plans.

Mr. BROTZMAN. Taking your first section on page 2 here relative to a proposed amendment, you say that under section 201 all agencies "should be authorized to furnish technical assistance and information to each other."

Is the addition there the technical assistance? Presently you are furnishing information to each other, as you just stated.

Dr. SCHAEFER. As the bill reads, it authorizes the Secretary of Commerce to furnish technical assistance and information to any other Federal agency requesting assistance.

We believe that, if the bill were passed, it would be desirable to make it so that it authorizes the heads of all of these agencies to provide technical assistance and information to each other.

Mr. BROTZMAN. Thank you.

Thank you, Mr. Chairman.

Dr. SCHAEFER. I think the second significant matter is that we have anticipated some of the legal, social, economic, biological, and ecological effects, of weather modification. We already have started some studies in the legal aspects and the economic and ecological aspects.

The Secretary of Interior has established an Office of Ecology.

Obviously, one of its very important responsibilities is a system for the study of the biological and ecological effects of weather modification.

We believe that it is quite logical that this expanded national program in atmospheric water resources should be a responsibility of our Department, because we already have a great many responsibilities in relation to water. The chairman already mentioned the desalinisation effort that is advancing in southern California.

We collect basic data on the quantity and quality of all the Nation's surface and underground waters. We are in the business of providing water for irrigation, hydroelectric power, and municipal and industrial uses from reservoir systems. We manage the Nation's public lands and watersheds, and fish and wildlife refuges, and so on.

Without going into all the details given in my statement, it is quite obvious that weather modification activities are completely harmonious with the basic mission of the Department of Interior. That is, conservation and development of the Nation's natural resources, of which water resources are a part.

In the conduct of our own program, we are attempting to mobilize the best scientific and engineering efforts to develop the techniques for increasing the yield of water from the atmosphere. This program has been accelerated in the last 5 years.

Presently the work done by our Bureau of Reclamation is bringing to bear some of the best engineering and scientific talent available in our Department, and other agencies and universities and private meteorological institutions. We have been encouraged in this area by the National Academy of Sciences and the National Science Foundation.

Our conclusion is that while we are strongly in favor of this program, we consider that H.R. 9212 requires some further revision in order most effectively to serve the Nation's needs.

Mr. MACDONALD. Thank you, sir. I just have one question, and that is when you say you have been "encouraged by the National Science Foundation," in what way do you mean? Just by conversation, or monetarily, or exchange of information, or what?

Dr. SCHAEFER. There are the two reports that Dr. White referred to, one by the National Science Foundation and the other by a committee of the National Academy of Sciences that recommended strong support for the further development of these weather modification activities. Our people remain in quite close touch with these groups.

Perhaps Dr. Kahan would like to speak to this.

Dr. KAHAN. The reports recognized the need for further experimentation in the field. Our program, already underway in field experiments, recognizes that it is a complex matter that requires engineers, and social scientists—this is compatible with our program, and we feel the reports advocate the kind of program we have been trying to mount.

Mr. MACDONALD. Mr. Ottinger?

Mr. OTTINGER. Thank you, Mr. Chairman.

One of the questions that your testimony raises is the relationship between our efforts to clear up water pollution and air pollution. I suppose all these efforts are interrelated, the supplies of water and the quality of water.

What is the justification of separating out the air pollution program and having that in Health, Education, and Welfare, rather than in the Department of Interior?

Dr. SCHAEFER. Again, sir, it is one of these problems where certain aspects are being handled by the Department of Commerce, as Dr. White indicated—that is, certain weather aspects.

The Department of Health, Education, and Welfare has a large part of this program. At Interior, we are doing work particularly with respect to the problem of sulfur dioxide that is largely generated by fuel, that is, by coal and petroleum, which again is our responsibility. So, in cooperation with Health, Education, and Welfare, we have an extensive program in our Bureau of Mines looking toward either attempting to eliminate the sulfur from the fuel, or to process stack emissions to get rid of it.

Here, again, I think it is one of the things that relate to the missions of several agencies.

Mr. OTTINGER. Excuse me. On water pollution, is there consideration given to interstate bodies created to handle water pollution, to also handle air pollution in the same areas where the airshed may correspond roughly with the watershed?

Dr. SCHAEFER. I am sorry, sir. I am not able to answer that question.

Mr. OTTINGER. We are getting into an area that concerns me, where we are duplicating a lot of these regional arrangements.

Thank you, Mr. Chairman.

Mr. MACDONALD. Mr. Broyhill?

Mr. BROYHILL. Dr. Schaefer, I note from your testimony that the Department of Interior has already undertaken a number of projects and is involved in this area of weather modification. What does H.R. 9212 do? What extra power does this give you that you do not already have?

Dr. SCHAEFER. As far as I am aware, sir, it doesn't give us any new authority that we don't have. In fact, we would like to make sure it doesn't subtract any authority we have, among other things.

I believe that the only possibility of new authority is in relation to the matter of international cooperation. I think we probably already have authority for international cooperation, but if we don't, the amendment suggested would give us the requisite authority.

We certainly have authority in certain aspects of international cooperation. We may have it for all. We would not like to see it implied that we don't have authority for things we need to do as part of our own program.

Mr. BROYHILL. Are you hopeful of getting additional appropriations as a result of this legislation?

Dr. SCHAEFER. Our position on the legislation, sir, is that with these amendments we would not object to its passage, but we are not necessarily testifying in support of it. We have authority for our developing program now, and we believe that this is coming along in moderately good fashion.

Mr. MACDONALD. If the gentleman would yield.

Mr. BROYHILL. I would be glad to.

Mr. MACDONALD. Do I understand that there is going to be a hassle in the tradition of Washington between the various departments now about this bill?

Dr. SCHAEFER. No.

Mr. MACDONALD. I thought the bill was agreed upon. I thought that everyone agreed that this bill was necessary and needed, and that you were testifying in support of it.

If I understood what you just said to Mr. Broyhill, you said you weren't testifying in support of it.

Dr. SCHAEFER. I am sorry if I made a misstatement, sir. We would be in favor of it with the suggested amendments.

Mr. BROYHILL. Your statement says that you would not object.

Mr. MACDONALD. There is a good deal of difference between not objecting to something and supporting something. I would like to have it on record whether you support it, or you just don't object to it.

Dr. SCHAEFER. Well, the statement that our Department wishes to make formally is that we don't object to its passage with these amendments, and this was the same statement, I believe, that was provided in relation to the bill on the Senate side.

Mr. MACDONALD. Then you are not supporting the bill, is that correct?

Dr. SCHAEFER. I think as far as I could go, sir, is to say that we won't object to its passage, with these amendments.

Mr. MACDONALD. I will ask you a question that is not contained in your statement. Do you, as scientific adviser to Mr. Udall—you have some authority in these matters. I will ask you a direct question. Does the Department of Interior support this bill, or not?

Dr. SCHAEFER. It is my belief that we do not urge the passage of the bill.

Mr. MACDONALD. I will try again. You don't object to it, and you don't urge the passage of this. You support it?

Dr. SCHAEFER. With these amendments, we would support it.

Mr. BROWN. I think that you have come very close to saying what you really think about this bill in the last sentence at the top of page 5, in which you say:

> Weather modification activities are completely harmonious with the basic mission of the Department of the Interior.

I would assume the bill would be a great deal more palatable if the authority for the functioning of the bill were put under the head of the Department of Interior. Is that a fair statement?

Dr. SCHAEFER. I don't think so, sir. Our position is that we believe that the various aspects are harmonious with our functions.

In section 201, still other departments have capabilities. We would like to see a fully coordinated program without one of the agencies necessarily being the chosen one.

Mr. BROWN. If the chairman will continue to yield further, it still strikes me that perhaps the lack of enthusiasm on the part of the Department of Interior on this bill may be truly in the tradition of Washington in that it may boil down to who is going to sign the pay checks for this effort.

Mr. MACDONALD. Mr. Brotzman?

Mr. BROTZMAN. Thank you, Mr. Chairman. I would like to welcome you, Dr. Schaefer, and also your colleague, Dr. Kahan, whom we all know out in the West, for appearing this morning.

One technical thing that I think you probably would like to correct: According to copies of your statement that I have, which you sub-

mitted for the record, it shows you are appearing before the Subcommittee on Transportation and Aeronautics, and I say this so that it doesn't show up incorrectly in the report, that you would rather have that show that you are appearing before the Communications and Power Subcommittee.

Dr. SCHAEFER. I certainly would, sir.

Mr. MACDONALD. Without objection, it is so ordered.

Mr. BROTZMAN. I think most of this has been covered by my colleagues here, but I was going to ask this. The reluctance, I would assume, on your part—maybe it is as stated by my colleague from Ohio, that you just don't know what this bill does. Is that what is troubling you?

Dr. SCHAEFER. Well, the review of the legislation indicated that it does give certain authorities to Commerce that, without these amendments, might value the authority that we have.

For example, we are involved in the water for peace program——

Mr. BROTZMAN. The water for peace?

Dr. SCHAEFER. Yes, which is an international activity. This is one of the programs the Secretary of Interior is involved in. We would be very reluctant to see this bill passed in a form that would imply that international cooperation activities were authorized only to the Department of Commerce and not to Interior and the other agencies stipulated in section 201.

Mr. BROTZMAN. This is what I was really sort of leading up to, because you know your particular programs and projects. I wondered if, from your study of 9212 as it is constituted, in conjunction with House Joint Resolution 688, that you feel it will preclude you from doing something you are presently doing, that you have been working on, or pointing toward?

Dr. SCHAEFER. No, I believe it would not; and particularly with the amendments suggested, it would not preclude anything we are doing.

I might also say in relation to the international business, that, when we come to it, we very strongly support House Joint Resolution 688. Here, again, we are involved in our Department in certain of the air-sea interaction aspects of House Joint Resolution 688, which involves international cooperation.

Mr. BROTZMAN. Most of your testimony related to 9212, but you do support 688 as written, or do you feel that there are amendments needed to it?

Dr. SCHAEFER. No, we support that as drafted, from two aspects. In the first place, as indicated in more detail in my prepared statement this bill would provide for studies and evaluation of inadvertent climate modification, and would also provide for the training and education of scientists and technical personnel, and many other things that are necessary as part of this general international cooperative program.

Specifically, with relation to our own programs, while it would not take precedence over our atmospheric water resources program, the results from this worldwide program would be of very great value in helping our predictions in relation to weather modification.

Secondly, we have another responsibility in fisheries forecasting in the ocean. This observational net for improved weather predictions is required to acquire data both in the sea and in the atmosphere over

the ocean, as Dr. White explained, and the research program to go with it.

This same program will enable long-term forecasts of the ocean conditions that determine the location of fish concentrations. An interesting fact is that, due to the sluggishness of the ocean, a day in the air is about like a week in the ocean. So, if one can attain the capability for forecasting the air for 2 weeks, much of the same data will enable us to forecast in the ocean for 2 or 3 months.

We would strongly support it, and in fact the Bureau of the Budget has advised us that enactment of this legislation would be in line with the administration's objectives.

Mr. MACDONALD. Would the gentleman yield?

Mr. BROTZMAN. Yes.

Mr. MACDONALD. What do you forecast in the ocean?

Dr. SCHAEFER. The distribution of the temperature, and currents in the ocean, both their horizontal movements and vertical movements.

Mr. MACDONALD. You mean the drop of the tides?

Dr. SCHAEFER. No. There is an upper mixed layer of the ocean, separated from a deeper colder layer by a density change called the thermocline.

The upper layer receives radiation from the sun, and it returns heat and moisture to the atmosphere. One has to look at the upper ocean and atmosphere as part of the same system. We have to have the measurements in the top part of the ocean to predict what will happen in the atmosphere and, conversely, we have to know what is happening in the atmosphere to predict what will happen in the ocean.

So, this world weather watch will advance the forecasting in the atmosphere, and will also advance the forecasting of the temperature and currents of the top part of the ocean——

Mr. MACDONALD. Who really cares about the temperature of the ocean?

Dr. SCHAEFER. Well, fishermen——

Mr. MACDONALD. I come from a State where we are right alongside the ocean, and I have been on the ocean a lot of times, and I never stay awake nights wondering whether or not the temperature of the ocean is going to change.

Dr. SCHAFER. Tuna fishermen operating out of Massachusetts would be much interested—also those on the west coast and Florida, pursuing the pelagic fisheries. The temperature distribution determines where different kinds of fish are concentrated. Many of the sports fishermen along the Atlantic are also interested in this.

Of course, the ocean currents are of great interest not only with respect to fisheries forecasting, but also with respect to transportation, and military operations, and quite a lot of things.

Mr. MACDONALD. I would just like to finish with one comment, which really has nothing to do with the record, about if we had been doing that sort of forecasting—2 years ago, we had a tuna sport fishing contest off the Massachusetts coast, and they had to call it off after 3 days. They hadn't caught one tunafish. So the forecast didn't seem to be terribly accurate, or else they didn't call on your services.

Dr. SCHAEFER. Fisheries forecasting, like weather forecasting, requires improvements, sir, and this is one of the reasons we are en-

thusiastic about the world weather watch, because it will give us the basis for improved forecasts.

Mr. BROTZMAN. I yield to the gentleman.

Mr. BROYHILL. Is this a prime responsibility of the Department of Interior, or does any other agency or department of the Government get into it?

Dr. SCHAEFER. Well, in the Department of Interior, through the Bureau of Commercial Fisheries, we are responsible for the encouragement, development, and conservation of the fisheries of the United States. There are other departments, including the Department of Commerce, which are responsible for other aspects of the ocean environment.

Also the Department of Defense, which needs the same data, obviously, as part of their submarine and antisubmarine programs.

Mr. BROTZMAN. I have one simple question now. If we report this particular measure, and I am referring to 9212, with the amendments suggested, do you think that it might be helpful to you in accomplishing your weather objectives and missions? What would your opinion be?

Dr. SCHAEFER. I would like to bow to Dr. Kahan from the technical side. I cannot say that it would give us additional new authority. As to whether the coordination would in any way enhance our technical capability, I would rather have Dr. Kahan answer that.

Dr. KAHAN. In my opinion, sir, the need is for sufficient funds to mount the scale of attack, rather than legislation. If this legislation makes available funds, then we would be benefited from it.

So far as carrying out our program, we don't see an immediate need for this legislation.

Mr. BROTZMAN. All right.

Mr. BROYHILL. I have one more question Mr. Chairman.

You have referred to proposed amendments in section 201 and also section 302. Are these amendments before the committee in legislative language?

Dr. SCHAEFER. Yes. There was a letter written to you by our legislative counsel that contains the specific language.

Mr. MACDONALD. It might have got misplaced and gone to the Committee on Aeronautics and Transportation. I can see why it would, because it seems the Department of Interior on this particular issue is up in the air anyway, so I can see why it might have got misplaced.

Dr. SCHAEFER. I wanted to say that a copy of that was addressed to the correct place.

Mr. MACDONALD. I have one last question—have you finished, Mr. Brown?

Mr. BROWN. No.

Mr. MACDONALD. Go ahead.

Mr. BROWN. Dr. Schaefer, in your testimony on 688, all of which I was unable to hear you deliver but which I have gone ahead and read, in the paragraph in the middle of page 2, it says:

> The program contemplated by House Joint Resolution 688 would not supersede or take precedence over our atmospheric water resources research program.

That further leads me to the feeling that the thrust of your testimony here is to explore a possible jurisdictional dispute between Interior and

Commerce over whose authority is going to be modified and to what degree by these two pieces of legislation.

I would like to ask Dr. Kahan, in view of his comment in response to the previous questions, do you think that the $50 milllion figure estimated by Mr. White is about right? Is it too modest, is it too high?

Dr. KAHAN. I think it is too modest, sir. I think to really do the investigations that are required, it is going to require a commitment in excess of $50 million a year.

Mr. BROWN. Would you care to say how much in excess, or to cite some kind of a figure that would give us a better idea of where we might be heading financially?

Dr. KAHAN. I think a comprehensive national program——

Mr. BROWN. Are you underscoring national rather than worldwide?

Dr. KAHAN. Yes, sir. I have no way now of estimating the cost of the world weather watch program. I doubt that anybody has a good way of doing it now, because instrumentation is not yet fully developed and priced out, and that is envisioned as part of observational facilities.

I think it may help understand it to make some comments about the term. The term "weather modification" has become a Mother Hubbard-type term, which covers the subject and reveals no details.

It ranges from the scale of the microclimate of plants to the circulation of planets, and while it has, throughout its range, involvement with the atmosphere, there are so many activities involved that it is difficult to be sensible about the cost of a weather modification program.

In just developing the technology that will be required to use this matter of cloud seeding for water resource purposes, I can see a need for in excess of $50 million a year, and this is completely apart from whether or not you are going to understand the total circulation of the atmosphere.

Mr. BROWN. Your comments have made me more nervous, but I haven't yet decided how nervous they make me.

How much in excess of $50 million?

Dr. KAHAN. In our planning, we have gotten an outlook of getting up around $57 million as a peak value.

Mr. BROWN. But just for a domestic program in this area, not related to the international weather watch?

Dr. KAHAN. That is correct.

Dr. SCHAEFER. Mr. Congressman, I think there may be a bit of confusion about this $50 million, if this is the correct figure. I believe the figure Dr. White was referring to was the quantity that was recommended by these study committees for only the next few years.

Mr. MACDONALD. Three years.

Dr. SCHAEFER. The number Dr. Kahan is talking about is beyond that.

Mr. MACDONALD. The Senate bill covers 3 years, and it is $50 million for 3 years.

Mr. Brown is nervous, and I understand why he should be.

Dr. KAHAN. I am talking about what I see is required to solve the problems, and not just in the next 3 years. There have been recommendations, a report that has not been mentioned here, which was an ICAS report, prepared by Dr. Newell, which looks to this point.

It recommends in 1970 a $35 million program for the Bureau of Reclamation, Department of Interior program alone.

Mr. BROWN. What is this ICAS? What does ICAS stand for?

Dr. KAHAN. It is the Interdepartmental Committee on Atmospheric Sciences, and brings all the agencies together with an interest in atmospheric sciences.

Mr. BROWN. Do 9212 and 688 really only begin on this? Is it an iceberg that we are just beginning to see? If you are talking about $35 million for one portion of what the Department of Interior is now doing, this $50 million that was mentioned for 3 years doesn't seem to me to be too appropriate to our thinking. It is only the top of the problem.

Dr. KAHAN. I think in all these things, a start needs to be made. When you try to estimate the total cost, this calls for crystal balling of a nature that I don't know who is really qualified to speak authoritatively on it. To some extent, you are talking about employing things that are now only concepts, and to try to estimate the total cost, I don't know how to do it.

I think——

Mr. BROWN. Somebody has got to do that crystal balling, though, because the fiscal problem is the one we face right now, where this money is going to come from, and how much the taxpayer is going to sit still for—perhaps I should say lie down for—in terms of where we get this money that goes into these programs.

This is all wonderful stuff, and I am enthusiastic about them. As I said earlier, they are visions of the Sunday supplements turned real, and I begin to get all excited about that. But that is the whole problem we are now having, somebody gets us all excited about what we ought to be doing, how we should control our atmosphere, but nobody tells us how much it is going to cost.

Dr. KAHAN. It is a difficult thing, because it involves several different agencies which may not yet have the basis for specifying what they see as their role in the global research program.

Mr. BROWN. I wonder if it would be appropriate, Mr. Chairman, to ask the Interior Department, which indicates it has a certain amount of interest, and present jurisdiction and expertise in this area, to give us its estimates of costs in this regard as relates to 688 and 9212, and to give us reference to other independent estimates which may have been made, such as the ICAS survey or report.

Dr. SCHAEFER. Mr. Congressman, we would be very glad to provide you with such estimates as we have on our program, and to give you references to estimates that have been made.

I believe with regard to 688 that it would be better for us to cooperate with Dr. White.

Mr. BROWN. I would almost prefer that you didn't. I would like to compare what you come up with separately.

Dr. SCHAEFER. Actually, sir, I believe, on this particular program, it would not be possible for us to come up with a separate estimate because the work to be done under 688 is going to involve cooperation of several agencies and the World Meteorological Organization. It involves the State Department, and so forth, and any useful estimate has to be a coordinated estimate.

(The following information was subsequently submitted:)

The Department of the Interior submitted the following cost estimates for the atmospheric water resources program of the Bureau of Reclamation:

Fiscal year:	
1969	$10,000,000
1970	15,000,000
1971	27,000,000
1972	39,000,000

These represent estimates only—not approved budget programs. The cost estimates for an optimum program would be higher by about $5 million each year, if current budgetary considerations were relaxed. The nationwide plan contemplates expenditures approximating $57 million a year in the mid-1970's.

Estimates for various Federal weather modification programs may be found in ICAS report No. 10a, "A Recommended National Program in Weather Modification," by Dr. Homer E. Newell, dated November 1966.

Dr. SCHAEFER. I will also, if I might, sir, answer your original question with regard to paragraph 2 on page 2 of my statement. We did not mean this to represent any jurisdictional dispute. We simply meant that in regard to priorities, if funds were short, we would not like to see the world weather watch displace the work we are doing on the atmospheric water research program. We would like to see the world weather watch undertaken because it would help out that program and others.

There is no jurisdictional dispute intended, sir.

Mr. BROWN. If I could go back to this tuna fish derby, you might get a copy of the Old Fisherman's Almanac, if there is one in existence. If there isn't, there should be.

Mr. MACDONALD. Thank you very much. We appreciate your testimony.

The House is now in session, and there is a quorum call. We had two more witnesses scheduled—Mr. Barrows of the Forest Service, Department of Agriculture; and Mr. Malone of the Travelers Insurance Co.

Obviously we have just run out of time. We have already scheduled, or there has been scheduled for the subcommittee a hearing tomorrow and the next day, so I would think that the best possible thing, and I hate to discommode Mr. Malone, who came from Hartford, I am sure, to give testimony—unless either of the gentlemen want to submit their statements for the record now. Otherwise, I think the best thing that we can do is recess until Tuesday of next week at 10 o'clock. So whichever you want to do, Mr. Barrows or Mr. Malone——

Mr. BARROWS. Tuesday of next week would be fine, sir.

Mr. MACDONALD. We are adjourned until Tuesday of next week.

(Whereupon, at 12:30 p.m., the subcommittee adjourned, to reconvene at 10 a.m. Tuesday, November 7, 1967.)

WEATHER MODIFICATION

TUESDAY, NOVEMBER 7, 1967

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON COMMUNICATIONS AND POWER,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C.

The subcommittee met at 10 a.m., pursuant to notice, in room 2123, Rayburn House Office Building, Hon. Torbert H. Macdonald (chairman of the subcommittee) presiding.

Mr. MACDONALD. The hearing will be in order.

The first witness to be heard today is Mr. Jack S. Barrows of the Forest Service, Department of Agriculture.

STATEMENT OF JACK S. BARROWS, DIRECTOR, FOREST FIRE RESEARCH, FOREST SERVICE, DEPARTMENT OF AGRICULTURE; ACCOMPANIED BY DR. BRUCE F. BEACHER AND DR. ARNAUD LOUSTALOT, COOPERATIVE STATE RESEARCH SERVICE

Mr. BARROWS. Mr. Chairman, I am Jack Barrows, Director of Forest Fire Research of the Forest Service in the Department of Agriculture. With me is Dr. Bruce Beacher, of the Cooperative State Research Service, and Dr. Arnaud Loustalot, of the Cooperative State Research Service of the Department.

We are pleased to have this opportunity to meet with the committee. We do not have a formal statement to present.

The Department of Agriculture's position on H.R. 9212 and House Joint Resolution 688 are as stated in the respective Department reports of June 15 and August 17, 1967. We are here to answer questions and we would be glad to respond to your questions and provide you with all the information we can on plans, current programs, capabilities, and general activities of the Department of Agriculture in weather modification.

Mr. MACDONALD. Thank you very much for coming here this morning. We have had a couple of hearings in between times so we lost a little continuity in so doing, but as I recall the last question being asked of the witness was whether or not all departments concerned with this matter are really for the bill.

As I recall, one of the departments said they don't oppose it, with certain amendments, if the amendments were reported out, but do you actively support the bill?

Mr. BARROWS. Yes; we do, and you are speaking I assume first for H.R. 9212 and also for House Joint Resolution 688.

Mr. MACDONALD. I don't think the latter bill is in any trouble at all. I think that is fine. I am talking about the first bill.

Mr. BARROWS. I would like to add to this statement. In our view this bill does not provide the Department of Agriculture any authority that we do not have at the present time. As we view it, it delineates the total area of weather modification to show the specific major responsibilities of each of the several departments. We are in agreement with the language of this bill as it pertains to the mission of the Department of Agriculture in weather modification research.

Mr. MACDONALD. Right. And my last question is, you know, it seems a little farfetched to me to have the Department of Agriculture in the weather picture, anyway, and if you could explain what you are doing in the weather picture I would be edified.

Mr. BARROWS. Thank you. We would be glad to. Weather modification presents an enormous opportunity to agriculture and forestry. During the last 20 years man has been gradually learning that various techniques can be used to modify atmospheric behavior. The resulting knowledge and technology, though only in preliminary stages of development, show great potential benefits to agriculture and forestry.

The possible consequences of weather modification can affect nearly every program for the management of agriculture and forest resources. Agriculture production may be increased. Damage to agricultural crops and resources may be decreased. The kinds of crops grown in various areas may be changed.

Forests may be better protected from lightning-caused fires and disastrous conflagrations. Agricultural and forest water resources may be improved.

I think these indicate some of the reasons why Agriculture is so vitally interested and concerned in weather modification.

Mr. MACDONALD. Right, sir. I asked one of the witnesses last week or the week before, whenever it was, what are the legal ramifications of rain heading toward Iowa and somebody seeds it so it drops in North Dakota or, you know, I am not familiar with the Midwest, but another State. Do you follow my question?

Mr. BARROWS. Yes. This is a question that has been raised many times from the beginning of the programs in weather modification. I think it is a question that is only going to be satisfactorily answered through the kinds of research programs that are now being planned and carried out, and that this is really the only way we are going to get at the answers of what are the downstream effects of weather modification.

Mr. MACDONALD. Well, I don't really know what you mean by downstream effects.

Mr. BARROWS. By downstream effects I mean that if clouds are seeded in Montana what are the possible effects downstream in North Dakota, if there are, in fact, any effects downstream?

Mr. MACDONALD Well, do you have any answers, or are you as curious as I am about it?

Mr. BARROWS. I am sure I am as curious as you are. Within our own weather modification programs in Agriculture we have not been dealing with this specific problem because our work has been aimed to date entirely upon lightning storms and the modification of these storms for fire prevention purposes. We have been dealing strictly with local and mountain-type thunderstorms.

When we look at downstream effects I think we are visualizing the

possible effects from large-scale weather systems that may be affected at some distance from the point of seeding. I am sure that these answers are not yet adequately available. I think they will be available through the kinds of programs that are being planned by the various Government agencies.

Mr. MACDONALD. If Mr. Broyhill will indulge me, that is one of the things that has been bothering me. It seems from the testimony that about four, five, or maybe six different departments are carrying on experiments in this field.

Don't you think there should be just one—either department or commission or something—to do this?

Mr. BARROWS. No sir; I do not think that would be the way to get at these answers. I think the activities of the several Federal agencies that are working in weather modification are, in fact, being very well coordinated.

A good example of this is just 2 weeks ago all of us in Government weather modification research met for the ninth consecutive year at Big Meadows in Shenandoah National Park, which is the scene of the annual National Science Foundation Weather Modification Conference.

Every Federal weather modification activity was reported at that meeting and ideas exchanged on them, and in my view we have good coordination in the weather modification field as a result of the activities of the National Science Foundation performing these kinds of conferences and also as a result of the activities of ICAS. I believe this activity is reasonably well coordinated.

Mr. MACDONALD. What is the ICAS?

Mr. BARROWS. Interdepartmental Committee on Atmospheric Sciences.

Mr. MACDONALD. Mr. Broyhill.

Mr. BROYHILL. Thank you, Mr. Chairman. Mr. Barrows, it is good to see you here today. You state that you already have authority in this field and that you are presently conducting experiments of weather modification as it applies to the control of lightning and hail, is that correct?

Mr. BARROWS. It is correct, sir, for lightning. The hail suppression research program that is being planned has not yet been activated.

Mr. BROYHILL. And this authority comes to you in specific terms, or in general terms in other legislation?

Mr. BARROWS. It comes in general terms through the research authority to the Department of Agriculture.

Mr. BROYHILL. How long have you been conducting experiments of this type?

Mr. BARROWS. The only active experimental weather modification program in the Department is lightning suppression. This research was originated in 1953 and has been carried on continuously from that time. I believe it is now perhaps the oldest continuous weather modification research project in the United States.

Mr. BROYHILL. Can you tell the committee approximately how much money is being spent in this program for the current fiscal year?

Mr. BARROWS. Yes. This is a modest program. It is a cooperative affort with the National Science Foundation. The Forest Service is expending $180,000 for Forest Service fire research funds. There is

approximately $70,000 this fiscal year of National Science Foundation funds, a total of $250,000 for this project.

We have additional assistance, however, from numerous other sources. For example, the Weather Bureau cooperates in this program; it provides some of the radar observations and the special weather forecasting that is necessary for the project.

In addition, we utilize existing facilities of the Forest Service that are in place for fire protection purposes to help this project. This includes a network of 38 lookout stations that are scattered over the northern Rockies and the Northwest that provide special cloud and lightning observations for the project. We train these lookout observers in cloud and lightning observation. Their services are valuable to us but are not included in the cost figures I have just given you.

Mr. BROYHILL. Your Department is the coordinating agency for this particular specific program; is that correct? What I am asking relates to your organization structure. To whom do you report this information? With whom do you exchange information? How is it coordinated?

Mr. BARROWS. Sir, I wouldn't regard us as a coordinating agency. It is true that we have perhaps been the lead agency in lightning suppression research.

Our results are first of all reported to the scientific community through normal channels—scientific publications. We make periodic reports to the National Science Foundation as well and, of course, periodic reports to the Secretary of Agriculture.

Mr. BROYHILL. Mr. Chairman, one question which perhaps can't be answered or perhaps it can be, is what has been accomplished with these programs, not only in the Department of Agriculture, the Forest Service, but the other departments as well. What are the results of these programs?

Can you point to really meaningful results?

Mr. BARROWS. Yes, sir. We are quite encouraged by the weather modification results from Project Skyfire and I would be glad to cite some of them.

In doing this I would like to back up, if I may, to look at the kind of a problem that we are dealing with in lightning suppression research. Lightning causes some 10,000 to 15,000 forest fires annually. In the Western United States lightning is the greatest single cause of forest fires. These fires cause tremendous damage to timber, watershed, and outdoor recreation resources.

Fire suppression costs alone on lightning fires amount to some $50 million annually. The 1967 fire season in the Rockies and the Northwest is a vivid example of the seriousness of the lightning fire problem. In August of 1967 dry lightning storms which were preceded by a summer-long period of critically hot and dry weather ignited thousands of fires. Some 4,000 fires occurred in a 3-week period.

On the national forests alone 46 of these fires spread to sizes of 100 to more than 50,000 acres. We believe that fire prevention is the best method for reducing such losses and costs.

Weather modification provides the best possibility for the prevention of lightning fires. Project Skyfire is performing research on this possibility. The research performed to date includes the following results: First, the development of an electronic sensing system for the measurement of lightning discharges. We are operating this electronic

sensing system in a specially instrumented experimental area near Missoula, Mont. It provides vital information needed for the evaluation of weather modification experiments.

Second, we believe that we have identified the special type of lightning discharge that is most apt to start forest fires. There is a wide variation in the kinds of cloud-to-ground discharges that occur from thunderstorms.

The discharge that we believe is most apt to ignite fires is a discharge that has a long continuing surge of current involved in it. In time scale it lasts considerably longer than a normal lightning discharge.

Third, we have developed special equipment and technology for the massive seeding of mountain thunderstorms. This equipment includes a highly efficient airborne generator using a ramjet principle that we are using in seeding experiments.

Fourth, we have performed over the past 5 years a pilot experiment in lightning suppression. The results from this experiment show one-third less cloud-to-ground lightning from seeded storms. We are most curious as a result of these experiments as to whether or not we are, in fact, also reducing the occurrence of the kind of discharges that start fires and this will be the target of concentrated work that we are planning for the period ahead.

We are now ready on the basis of this pilot experiment to conduct a larger scale experiment which is essential if we are going to get results from this field.

I would like to add one other thing with regard to our results from Project Skyfire. We believe that this is providing some of the scientific basis that has been badly needed for the planning of hail suppression experiments. The experience that we are getting with massive seeding aimed at lightning prevention is the same general approach that may be most useful in hail suppression.

Perhaps I could cite an example of this. With these high output generators that we are using on Project Skyfire we have recently found that we can get nearly total glaciation of supercooled clouds at temperatures as warm as $-7°$ C. This is the first time to our knowledge that this has been found or reported.

We have penetrated these clouds with specially instrumented aircraft, sampling both seeded and unseeded clouds, to get these results. We believe this provides part of the basis to now go ahead and plan similar massive type seeding aimed at hail suppression.

Mr. BROYHILL. I would like to ask one more question, Mr. Chairman.

This bill, H.R. 9212, provides what we call open end appropriation authority. How much is the Department of Agriculture looking to receive from this legislation for the next 3 fiscal years?

Mr. BARROWS. The Secretary of Agriculture has appointed a weather modification research task force to develop a long-range weather modification program for agriculture and forestry and this task force is currently at work to develop the specific kind of figures that you are requesting.

Our work is not yet completed. We expect to have these figures available within the next month to 6 weeks. I might mention that this task force consists of 18 members, including representatives from

each of the other departments that would have a hand in a cooperative program involving agriculture and forestry. We have representatives from the Department of the Interior, from ESSA, and from the National Science Foundation on our task force.

Now to respond still further to your question on funding, as you may recall, last year the Federal Council for Science and Technology issued the so-called Newell report which is ICA's Report No. 10A. This report contains recommended levels of funding for all agencies for fiscal year 1970.

Agriculture agrees with the recommended level of funding for the kind of programs that we are interested in as contained in this report for that year.

Mr. BROYHILL. What are those figures?

Mr. BARROWS. For the Department of Agriculture this recommends a program of $7 million in fiscal year 1970.

Mr. BROYHILL. And you are presently spending $180,000?

Mr. BARROWS. This is correct.

Mr. BROYHILL. Thank you.

Mr. MACDONALD. Mr. Van Deerlin? Mr. Brotzman?

Mr. BROTZMAN. Thank you, Mr. Chairman.

Will the passage of H.R. 9212 and House Joint Resolution 688 help you to accomplish your objectives in this particular area, or will it retard you in your opinion?

Mr. BARROWS. H.R. 9212 does not add to the Department of Agriculture any authority that we don't have at the present time. House Joint Resolution 688 we regard as an excellent piece of legislation that will certainly give emphasis to the worldwide weather program.

We think everyone will benefit from this increased effort through the worldwide weather program and we are very much in favor of it. I am sure we will benefit from the results of the worldwide activities.

Mr. BROTZMAN. To pursue your answer, will H.R. 9212 detract from the powers that you have, or, as I asked the question before, retard your effort?

Mr. BARROWS. We do not feel that it will retard our effort.

Mr. BROTZMAN. That is all, Mr. Chairman.

Mr. MACDONALD. The only question I have is, if you are spending $180,000 now and you are requesting $7 million, you know, that is quite a jump and what would that money be used for?

I am not one of these so-called economy men so I ask just for my own information.

Mr. BARROWS. Sir, first of all when these figures were developed in 1966 it was assumed then that the level of funding in 1967 and 1968 would be much larger than has actually occurred, so we need to look at it from that standpoint first.

However, looking at how the fund will be used, these funds first of all will be used to establish large-scale experiments in both lightning suppression and hail suppression. The scientific basis for such experiments has been established.

Installing these experiments will be fairly expensive because of the equipment that will be required for good large-scale experimentation, also from the standpoint of expenses of the aircraft that will be flown. Things of this type are fairly expensive for this kind of experimentation.

Mr. MACDONALD. You want to get the aircraft from the Air Force, for a concrete example? The thing that bothers me, and I think it bothers most Congressmen, is the total fiefdom that each Department sets up. They never seem to me to get very close together. It seems to me if they got closer together I would think expenses per se would go down.

Mr. BARROWS. Perhaps, sir, I could give you an example of how two departments recently did get together, aiming at the very thing I think you are questioning. The cloud penetration experiments that we made last year on Project Skyfire utilized an aircraft belonging to a private meteorological concern in California. This aircraft had been specially instrumented under the auspices of the Department of the Interior program. This made it quite a unique aircraft. It could do some of the things the Department of Interior was interested in as well as the Department of Agriculture.

Therefore, the two agencies cooperated on this matter. We made a contract with this private concern to make these cloud penetrations for us just as Interior would. We wouldn't have been able to do this if the two agencies hadn't been willing to pool their resources. I think there are numerous examples of this kind of cooperation.

The type of aircraft that we are using in our lightning suppression experiments are light aircraft that do not belong to the Government. We contract for these aircraft.

However, one of our requirements is to upgrade the aircraft from the standpoint of safety. In the kinds of work we will need to do in large-scale experiments we are going to need much better and much safer aircraft.

Mr. MACDONALD. Mr. Kornegay.

Mr. KORNEGAY. No questions.

Mr. MACDONALD. Thank you very much.

Mr. BARROWS. Thank you.

Mr. MACDONALD. The next witness is Mr. Thomas F. Malone, research department, Travelers Insurance Co., Hartford, Conn.

We welcome you here, Mr. Malone, and I would like to point out before you go into your statement, I know you work for the Hartford Insurance Co.—of the insurance company in Hartford—but that you are Chairman of the Committee on Atmospheric Sciences of the National Academy of Sciences and past president of the American Meteorological Society and of the American Geophysical Union, and therefore your background is obviously much more than that of a consultant to an insurance company.

Because this is a rather peculiar day for us—we reported out the educational TV bill and we have been asked to go to the White House for the signing of it and I think we are supposed to leave at 11, but that, of course, is not as important as hearing witnesses on this subject and I for one will stay if it takes that long—I was wondering if you could submit your statement for the record and then summarize and answer questions from the committee as they might arise.

STATEMENT OF THOMAS F. MALONE, VICE PRESIDENT, AND HEAD OF RESEARCH DEPARTMENT, THE TRAVELERS INSURANCE COS., HARTFORD, CONN.

Mr. MALONE. Mr. Chairman, I would be pleased to do that. I think I could summarize it in about 5 minutes.

Mr. MACDONALD. Without objection the written statement of Mr. Malone will be inserted in the record at this point.

(Mr. Malone's prepared statement follows:)

STATEMENT OF THOMAS F. MALONE,[1] VICE PRESIDENT, AND HEAD OF RESEARCH DEPARTMENT, THE TRAVELERS INSURANCE COS., HARTFORD, CONN.

Mr. Chairman, I am pleased at this opportunity to appear before your committee and convey the enthusiasm of the scientific community in this country and in the world at large over the program of international cooperation in meteorology described in Joint Resolution 688 together with some remarks on the reasons—as I see them—for this enthusiasm. I am pleased, also, to comment on H.R. 9212. My remarks on this latter bill will be rather brief inasmuch as I am submitting for the record a copy of an article which appeared over my name in Science magazine earlier this year, summarizing in considerable detail my views on the matter of weather modification.

With respect to the World Weather Watch and its closely associated Global Atmospheric Research Program (GARP), I am pleased to report that two and one-half years devoted to the development of a global atmospheric research program by the Committee on Atmospheric Sciences of the International Council of Scientific Unions culminated in an intensive Study Conference of two weeks duration in Stockholm, Sweden this past summer at which approximately fifty distinguished scientists from thirteen countries reached essentially unanimous agreement on—

(a) The basic scientific problems that require attention;

(b) The preparatory numerical experiments that seem most important;

(c) The observational requirements both for the preparatory studies and a global experiment;

(d) The feasibility of necessary observational systems in view of today's technology and the expected developments over the next few years.

The deliberations of this Study Conference were summarized in a 325 page report which was considered in some detail at the 14th General Assembly of the International Union of Geodesy and Geophysics in Switzerland last month. The IUGG endorsed unanimously the GARP program as an appropriate and imaginative response to the United Nations Resolution and urged that "the nations of the world, acting singly and in concert, ICSU and its constituent bodies, adhering academies and research councils provide strong and sustained support for this important program." This Resolution was received and acted upon unanimously by the Executive Committee of the International Council of Scientific Unions at its meeting in Rome on October 10. A joint committee with the World Meteorological Organization has been established to develop and to keep under review the global atmospheric research program including—

Determination of scientific objectives and content of the general program and its sub-programs:

Design of observational and logistical systems; and

Implementation of the program, including data acquisition and processing analysis.

This joint committee will provide administrative direction and preclude wasteful duplication of effort. This prompt and enthusiastic response of IUGG and

[1] Dr. Malone is Chairman of the Committee on Atmospheric Sciences of the National Academy of Sciences and Past President of the American Meteorological Society and of the American Geophysical Union. In addition, he has served as Secretary-General of the Committee on Atmospheric Sciences established by the International Council of Scientific Unions and the International Union of Geodesy and Geophysics to develop a global atmospheric research program in response to Resolution 1802 (XVII) of the United Nations. He has also served as Chairman of the Committee on Metereology for the International Cooperation Year. Dr. Malone was a member of the Special Commission on Weather Modification established by the National Science Foundation in 1963 to develop recommendations to NSF.

ICSU should, I believe, be reassuring to you as an indication of the importance and timeliness of this program in the eyes of scientists all over the world.

You have heard from Dr. Robert M. White concerning the overall plans for the World Weather Watch and GARP at the national level. I would simply extend that discussion to indicate that the National Academy of Sciences has agreed to establish a United States Committee for GARP under the chairmanship of Professor Jule G. Charney, of the Massachusetts Institute of Technology, to be concerned with—

Development of the scientific objectives of GARP, specification of the observational requirements, initial technological feasibility evaluations for each project; and to

Provide appropriate advice and review concerning the detailed project design, operational logistic planning, and field work.

It has been my privilege to discuss this program with the Board of Trustees of the University Corporation for Atmospheric Research and with the Council of the American Meteorological Society during the past month. In both instances, the reaction was positive and enthusiastic.

I recite these developments of the past few months as an indication of the widespread support among scientists of this country as well as scientists from other countries for the program described in Joint Resolution 688. Perhaps some thoughts on the reasons for this support may be of interest to your committee. Basically, in my view, there are three:

Intrinsic scientific interest and timeliness of the program are suggested by the following three developments:

Theories on physical processes governing atmospheric motion have advanced to the state at which moderately realistic mathematical models can be constructed to simulate a variety of atmospheric systems ranging in scale from individual clouds to the global wind systems. Although still in a relatively rudimentary stage, these models constitute a point of departure for replacing empiricism with physically meaningful weather prediction techniques.

Our ability to measure quantitatively the variables that determine the state of the atmosphere has increased rapidly in recent decades. Radiosondes, meteorological radar, and a host of both direct and indirect sensing methods have been augmented in dramatic fashion by the development of the meteorological satellite which, for the first time, offers promise of bringing the global atmosphere under observational surveillance in a real-time data system.

The advent of high-speed electronic computers which has hastened the promise of being able to integrate the nonlinear, partial, differential equations governing atmospheric motions by numerical methods. Computers, in turn, provided a powerful new tool for the growing number of investigators seeking to understand atmospheric processes by means of analysis of the relevant mathematical equations and anxious to perfect the power of these methods in numerical weather prediction.

The practical benefits that can reasonably be anticipated from these prospects that large-scale features of the atmospheric circulation can be predicted quantitatively for periods up to two weeks or more. While this prospective capability will not provide the "ultimate" solution to the weather forecast problem, it is clear that the advantages to agriculture, commerce, transportation, and industry are potentially very large.

The commonality of interest among all nations is precisely the kind of base upon which successful international cooperation has been built in the past and, hopefully, will constitute a small but significant brick in the institutional edifice which one day will help to contain world conflict within a framework of law and order.

Now a few words concerning H.R. 9212 having to do with a comprehensive program in the field of weather modification. Since your committee has already heard testimony on this bill and since my views have been set forth in extensive form in the reprint that I am submitting to you, I will restrict my comments to two aspects and then be prepared to answer questions, if that is your pleasure.

My first comment has to do with the appropriateness of legislative action on this matter at this time. Four developments have made this legislation timely:

Recognition that the problem of weather modification is passing from an era of intellectually undisciplined speculation and more or less opportunistic

field experimentation into an era of rational, organized inquiry in which a set of meaningful scientific questions can be explored analytically and by means of coordinated and carefully designed field experimentation.

Increasing but still somewhat ambiguous statistical evidence that precipitation from some types of clouds and storm systems can be modestly increased or redistributed by seeding techniques.

Recognition that the implications and issues involved in weather modification transcend the boundaries of the physical sciences and embrace important questions in the social and the life sciences, in international relations, in law and governmental regulation, and in the decision-making structure of the federal government by which it legislates, appropriates, manages, and coordinates national programs that cut across scientific disciplines and departmental missions.

Recognition of a deeper appreciation of the international implications of any success in weather modification as exemplified by these words of a panel of the National Academy of Sciences:

"It is clear that a long-range program of weather control and climate modification can have a direct bearing upon relations between nations. It can aid the economic and social advancement of the less-developed countries, many of which face problems associated with hostile climates and serious imbalances in soil and water resources. And, quite importantly, it can serve to develop common interests among all nations and thus be a stimulus for new patterns of international cooperation."

Mr. MALONE. I could speak first, sir, for about 2 minutes on House Joint Resolution 688, and I think perhaps the most important thing I could do would be simply to convey to you the widespread interest within the scientific community of the United States and in other nations over this international cooperative program.

Two and a half years ago the International Council of Scientific Unions established a committee to look at this. The activities of that Committee culminated in a 2-week intensive study conference in Stockholm this year out of which emerged a 300-page report setting forth the character of the program; what it should do.

This report was reviewed by the scientists and geophysicists and meteorologists assembled in Switzerland at a general assembly. They passed this unanimously to the Executive Committee of the International Council, which is established, together with the World Meteorological Organization; that is, the intergovernmental apparatus, a joint committee.

What I really want to convey to you is the remarkable unanimity among all these peoples that this program is timely and worthwhile doing.

Scientifically it promises useful benefits from improved and extended forecasts and as an act of international cooperation it is useful in establishing a commonality of purpose among the nations of the world.

I think this is why it has such widespread support. Within the United States it has been my privilege to talk to the board of trustees of the University Corp. for Atmospheric Research which operates the laboratory out in Colorado. It is a consort of about 15 or 20 universities. Their response was very warming and positive.

I discussed this with the Council of the American Meterological Society, again a very enthusiastic response. Within the National Academy a special committee to look after this program over the next 10 years is now in the process of being established and it is attracting some of the very best minds in our field.

So on both the international and the national scene I want you to know that I am impressed by what to me as one who has worked in these societies is truly a remarkable degree of unanimity.

Now if I might turn to the weather modification program, I would make two comments on this. First, I think it is appropriate; and second, I think the legislation before you is responsive to the thinking of both the scientists and the National Science Foundation's Commission which looked into this.

I had the privilege of sitting on the Commission. With regard to the timeliness, I would emphasize, Mr. Chairman, this point above all others: That rather than a dramatic turning point, something very subtle has taken place in weather modification within the past few years, and it is this: That the whole effort has passed from a sort of intellectually undisciplined era of speculation and more or less opportunistic field experiments—by that I mean conjecture about what happens if you melt the icecap, going out and seeding hopefully above ranchers' land with expectation there will be an increase—it has passed from that into a period when you can analyze this problem.

You can design meaningful field experimentation and it is really now becoming a rational field of inquiry. Along with that it is going to expand. That is why I think the legislative provisions here are useful. That is why this is a good bill at this time.

Other developments attesting to the timeliness is the encouraging evidence that rainfall can be increased; the recognition that the problem goes beyond just a physical science problem, because it embraces questions in the life sciences, law, government regulation, and so on; and again the international implications.

We know that if you can do something meaningful in the atmosphere in one portion of the earth it is very likely to affect it somewhere else. It is rather important that we get our links established now before we are confronted with a problem which has gotten out of hand.

A formidable scientific problem has yet to be solved, but when that is solved—and I believe it will be solved—a far more difficult problem in political science will emerge.

Mr. Chairman, those are my prinicpal thoughts and perhaps it could be most helpful if I tried to respond to questions.

Mr. MACDONALD. I have one which I have asked other people, but I think you are uniquely equipped to answer it and that goes to the liability if this bill is adopted and the seeding of clouds does occur and one State was about to get some rain and the farmers there would prosper.

If this were to be diverted by mechanical means who would be liable? I ask you this not just as a scientist, but as a representative of an insurance company.

Mr. MALONE. This is one of the perplexing problems that you cannot, I don't believe, state a priori who is responsible. This will eventually be settled by a series of court decisions, but we must not wait for this to be thrown in the courts and right now there is considerable activity going on analyzing the legislative and indemnity aspects of this.

Southern Methodist University is holding a symposium on December 7 and 8 at which they are gathering lawyers, scientists, some insurance people—2 days to look at precisely the problems that you are

identifying. There are as yet no answers, but you have put your finger on a very crucial aspect of this, one which is just as difficult as the scientific problem.

Mr. MACDONALD. My last question. Isn't it asking the Congress to do quite a good deal to go into a field in which there are no answers and put the long finger of the Federal Government into an area in which the legal aspects have not been decided or at least even legal opinions haven't been reached.

It would seem to me that the original cost as outlined in the bill would be important, of course, but the aftereffects of the liability, to use an insurance term, might be fantastic, and isn't it asking a good deal of the Congress to go ahead with a program like this before there are any answers in the field?

Mr. MALONE. Mr. Chairman, I think there are two mitigating circumstances here. One is that the Congress will have the opportunity to amend and revise this legislation as we walk down this road.

Second, it is my observation that here is one area in particular where a strong case can be made for Federal regulation as contrasted with State regulation. We have already seen instances where States erect barriers to activities within a State and between States.

In Connecticut, for example, we have a State weather control commission and we have taken a position that we would prefer to see this handled at the Federal level because the atmosphere does not recognize any State boundaries.

I am afraid I haven't answered your question.

Mr. MACDONALD. If you have, I haven't quite understood it, sir, but I won't pursue it because I know it is a difficult one.

However, it just also offers difficulties to us who have to pass on this type of legislation to go ahead into a field that is really as uncharted as the Atlantic Ocean was when Columbus took off.

Mr. MALONE. You may be aware that a couple of years ago there was rather bad summer weather in the Province of Quebec in Canada and there were 80,000 signatures affixed to a petition requesting the Government authorities in Canada to do something about the people down in New York State who were seeding the clouds and allegedly causing the bad weather over the bay.

This, you see, is a problem that perhaps only can be handled by the national governments and not by the Province of Quebec and the State of New York. I would encourage you to go into this even though the waters are uncharted.

Mr. MACDONALD. Thank you, sir. Mr. Kornegay?

Mr. KORNEGAY. Thank you. You put your finger on one thought which occurred to me: that is, it is not only national, but international, because weather conditions, of course, do not respect States lines nor national boundaries.

I have no further questions to ask.

Mr. MALONE. May I respond, sir, that I did leave with your committee for the record, a reprint of an article that I published in Science magazine a few months ago and much of that article is addressed to precisely this question of international implications.

I did not go into detail because of the time, but if the topic intrigues you, you will find at least my thinking laid out in that article.

(The article referred to follows:)

[Reprinted from Science, May 19, 1967]

Weather Modification: Implications of the New Horizons in Research

Thomas F. Malone [1]

For tens of millions of years the development of man and his ancestral stock has been profoundly influenced by the nature of his physical environment. As the species evolved, multiplied, spread over the face of the earth, and achieved mastery of matter and energy, man began to transform the environment in which he was formed and in which he had learned to function. Some transformations are deliberate; others, inadvertent. Some are deemed to be good; others, undesirable. My present concern is with one special way in which ubiquitous man is tinkering with one aspect of his physical environment: with artificially produced changes—deliberate or inadvertent, transient or permanent—in the composition and behavior of the atmosphere.

It is not altogether inappropriate that we turn to this topic at this time. The past year has been an eventful one in the long—and not always happy—history of weather modification, but not because of great scientific or technologic breakthroughs; if any were achieved, they have, I am sorry to say, passed relatively unnoticed as yet. True, it is the 20th anniversary of Schaefer's path-breaking demonstration that super-cooled water clouds could be transformed into ice crystals, with some yield of precipitation (*1*).[2] By contrast, the characteristics that made 1966 eventful were cumulative and subtle rather than discontinuous and dramatic; they were nevertheless profound and portentous.

Four developments are worthy of special mention: First, there was general agreement (*2*) that the problem of weather modification was passing from an era of intellectually undisciplined speculation and more or less opportunistic field experimentation into an era of rational, organized inquiry in which a set of meaningful scientific questions could be explored analytically and by means of coordinated and carefully designed field experimentation. The importance of this transformation, and of the fact that it has been identified even as it is underway, cannot be overstated. I am confident that its significance will be even more apparent 100 years from now than it is today.

Second, there was clarification of the efficacy of cloud-seeding intended to augment natural rain or snow. Although couched in the typically—and properly—cautious and carefully chosen words of the panel of the National Academy of Sciences, "There is increasing but still somewhat ambiguous statistical evidence that precipitation from some types of clouds and storm systems can be modestly increased or redistributed by seeding techniques," this conclusion has clearly added new dimensions of practical interest to a problem that was beginning to attract considerably intellectual interest. Keenly aware of the significance of its findings, the panel went on to say, "The implications are manifold and of immediate national concern." Thus the preliminary findings of the Advisory Committee on Weather Control (*3*) of nearly a decade ago have been vindicated, and the controversy in which no one can take a great deal of pride may now be replaced by the positive steps that have been proposed to reduce further the remaining ambiguity.

Third, there was forthright recognition that the implications and issues involved in weather modification transcend the boundaries of the physical sciences and embrace important questions in the social and the life sciences, in international relations, in law and governmental regulation, and in the decision-making structure of the federal government by which it legislates, appropriates, manages, and coordinates national programs that cut across scientific disciplines and departmental missions. These considerations were treated in some detail by a Special Commission of the National Science Foundation (*4*), which clearly stressed the urgent need for detailed analyses of the consequences *before* we are confronted with the task of coping with them.

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[1] The author is vice president and director of research of the Travelers Insurance Company, 1 Tower Square, Hartford, Connecticut; and chairman of the Committee on Atmospheric Sciences, National Academy of Sciences. The article is adapted from an address to the AAAS, Washington, D.C., 28 December 1966.

[2] Italic numerals in parentheses denote references to bibliography at end of article.

Fourth, there was the unanimity among the scientific community, the executive branch of the government, and the Congress that a drastically increased research effort (fivefold growth by 1970) in weather modification is required. The speed with which the 89th Congress moved on hearings, studies, and legislation (*5*) leaves little doubt but that the 90th Congress will take definitive action.

Deep issues of science and public policy are involved and it is timely that the dialogue be widened. I welcome this opportunity to widen it; it was the AAAS Committee on Science in the Promotion of Human Welfare that remarked less than 6 years ago (*6*):

"For nearly two decades scientists have viewed with growing concern the troublesome events that have been evoked by the interaction between scientific progress and public affairs. With each increment of power, the problem of directing its use toward beneficial ends becomes more complex, the consequences of failure more disastrous, and the time for decisions more brief. The problem is not new either in the history of human affairs or of science. What is without parallel is its urgency."

I am quite persuaded that these thoughtful words apply today with particular force to the scientific exploration of weather modification. The potential increment in mastery over nature, the ever-present hazard that this power may be used as a tool of conflict rather than for the benefit of mankind, and the responsibility to preclude inadvertent initiation of massive irreversible processes that are not in the interests of human life confront our civilization with a complex set of decisions that will be taken—consciously or unconsciously—during the next few decades. Whether the "time for decision" is adequate or inadequate may be debated. That debate, I submit, is irrelevant; the point is that time remains for reflective thought, for setting objectives, and for weighing alternative courses of action—in short, for acting responsibly.

With that thought as a point of departure, let us: (i) examine the scientific problem and the developments that are currently transforming it, (ii) briefly summarize the state of the art, (iii) review the issues, and (iv) close with some of the implications that transcend science.

With respect to the scientific problem, we may think of the atmosphere as a complex physical system in which movement of air, changes in temperature, and transformation of water among the liquid, solid, and gaseous phases are all of considerable practical interest, all taking place in response to certain forces or through particular processes. Although the atmosphere is far from being a tidy little deterministic system, in principle (by altering the forces or interfering with the processes) we can influence the motion of air, changes in temperature, and the phase transformations of water. In this sense, the matter of weather modification is a meaningful scientific problem.

It is, however, a complicated problem. The earth's atmosphere may be viewed as an envelope rotating with the earth as well as relative to it. The relative motion arises because of the forces associated with the rotation of the earth, and forces associated with the sources and sinks of energy that are variable in number, location, and strength. These sources and sinks of energy depend on the distribution of shortwave solar radiation, the flux of outgoing longwave radiation, the latent heat involved in the change in phase of water, the transfer of sensible heat between the atmosphere and the underlying surface, and finally the air motion itself. The kinetic energy of air motion exists in an array of scale sizes that extend from planetary wave systems down to monecular movement. There is continuous exchange of kinetic energy from one scale to another, and the kinetic energy is continually being exchanged with other forms of energy in the atmosphere.

The quantities of energy involved in weather systems and processes occurring naturally in the atmosphere exceed substantially the quantities of energy under the control of man. For example, the energy required for increase of the rainfall by 0.1 inch (2.5 millimeters) over an area 100 miles (160 kilometers) square is equivalent to the sum of the total output of electrical energy in the United States for about 6 days. Thus, even though it is clear that the scientific problem of weather modification is solvable in principle, the outlook would be pessimistic within the foreseeable future were it not for two characteristics of the atmosphere: (i) an intrinsic tendency toward certain instabilities; and (ii) the key role of the processes at the interface between the atmosphere and the underlying surface in determining the energy inputs into the atmosphere.

The attribute of instability is readily apparent, from everyday experience, in the tendency for the amplitude of atmospheric disturbances to increase with

time. For example, a small puffy-type cloud may grow to a towering thunderstorm in a matter of hours; a gentle zephyr in tropical latitudes may develop into a "killer" hurricane in a matter of days; and a small low-pressure center may grow to a vigorous extratropical cyclone within a single day.

We are just beginning to understand: (i) the instability of supercooled water droplets which, when released, provide a local source of sensible energy; (ii) the convective instability of a rising current of air within which water vapor is condensing into liquid, thus affecting the vertical distributon of sensble energy; and (iii) the so-called baroclinic instability of the large-scale, planetary atmospheric waves, which when released can profoundly alter the nature of the great global system of winds.

Should it turn out that the upward progression of energy through the size spectrum of instabilities that I cite is a process of considerable significance, an avenue may be opened up by which great effects may be produced from relatively modest but highly selective human interventions. We could, then, break the eggs rather than slay the dragons! Similarly, the sensitivity of the atmosphere to the interplay of the variables that determine the flux of energy, between the atmosphere and the underlying land or water, is beginning to yield to numerical analyses and field measurement. The influence of changing surface parameters such as roughness, reflecting power, and transfer of water across the interface is becoming known, and the posibilities that the effects range beyond a local area are being explored.

Some support for the line of reasoning that links small causes with large effects is found in the results of an examination of fluctuations in the climate that have been either observed or reconstructed from historical or geologic evidence. There is reason to believe that these fluctuations—some of which would be disastrous to modern civilization—may have been caused by the triggering of instabilities by natural processes, through which a given climatic regime was transformed into a radically different one.

There in barest outline is the nature of the scientific problem and the general direction in which it is likely to proceed. The new horizons of research that are suggested by the title of this article arise from four scientific and technological developments:

(1) Understanding of the physical processes occurring in the atmosphere has now progressed to the point at which they can be expressed in equations that constitute mathematical models. These models permit simulation of natural processes or—of particular relevance to our topic—assessment of the consequences of human intervention in these natural processes. Although crude and oversimplified relative to the processes they are intended to simulate, useful models have been constructed of atmospheric phenomena that range in size from a single cloud to circulation of air over an entire hemisphere. There is almost unlimited potential for extension and refinement.

(2) Development of the modern high-speed computer (which was encouraged initially by the computational needs of meteorological models) has proceeded simultaneously with the growth in sophistication of these atmospheric models, and brings within the realm of reality experimentation by simulation that has hitherto been only a gleam in the eye of the meteorologist. Some of the more difficult problems of nonlinear instability will soon be within reach as the speed and capacity of computers both increase.

(3) The third development concerns the expanding capabilities of making the observations and measurements that specify the initial and final atmospheric conditions that must be reconciled by the computerized atmospheric models if they are to be meaningful. These emerging capabilities range from the use of meteorologic satellites on a global scale to intricate measurements of the relevant physical characteristics of a single cloud.

(4) There have been significant advances in the refinement and the power of modern statistical procedures for resolving questions of cause-and-effect relation, in field experimentation, by establishing appropriate "design criteria" for both research and operational projects. The interaction between individuals skilled in these procedures and experimental meteorologists is really only getting underway, but it already promises important contributions to the reduction of ambiguity in the interpretation of weather-modification activities.

Taken together, these four advances set the stage for the rational inquiry into weather modification to which I have referred. Quite clearly, within the next decade or so it will become possible to explore, through simulation techniques, an al-

most unlimited array of deliberate interventions in natural atmospheric processes, and to assess possibilities and limitations. These studies will inevitably lead to specific requirements for meteorological measurements that will deepen our understanding of natural processes. As an example, mathematical models of the atmosphere have already been used in a preliminary way to assess the consequences of the inadvertent intervention associated with the increase of atmospheric carbon dioxide. Models may yet be used to define the tolerable limits to this large-scale geophysical experiment that mankind is undertaking; or, alternatively, to determine desirable countervailing measures.

As I have already indicated, these scientific considerations take on new dimensions when viewed in the context of the present state of the art. At the risk of oversimplification, this state may be summarized in the following way:

(1) Field results have demonstrated unequivocally that several cubic kilometers of clouds, consisting of supercooled water droplets, can be transformed into ice-crystal clouds by seeding with appropriate chemicals.

(2) Supercooled ground fog can be cleared from large areas by the same techniques.

(3) Persuasive although not conclusive evidence suggests that rainfall can be increased by from 5 to 20 percent (say 10 percent), depending upon the conditions.

(4) There are indications that Soviet scientists have succeeded in suppressing hail by introducing silver iodide directly into susceptible parts of hail-producing clouds.

(5) Physically reasonable approaches to the suppression of lightning have been tried with mixed but, on balance, promising results.

(6) Cloud-seeding techniques that are of sufficient merit to warrant field experimentation have been advanced for the modification of hurricanes, but the limited tests have not yet yielded even preliminary conclusions.

(7) No technique for influencing large-scale weather patterns in a deliberate and predictable manner yet exists.

(8) With respect to inadvertent weather modification, calculations suggest that the 10- to 15-percent increase since 1900 in the minute amount of carbon dioxide in the atmosphere has caused surface temperatures to rise 0.2°C, while temperatures in the stratosphere may have decreased ten times as much. Air pollution—particularly the ejection of submicroscopic particles of lead from automobile exhaust—may have already extended its influence beyond the urban domain (7). Contamination of the upper atmosphere by rocket exhaust may become a problem of practical importance sooner than we realize. Finally, agricultural cultivation and urbranization are transforming the nature of the surface underlying the atmosphere, with possibly important consequences that we hope soon to be able to assess.

Against this brief background of scientific problem and opportunity, and practical accomplishment as well as frustration, it is appropriate to review the issues now confronting us. To my mind there are two major ones. I stress the fact that each is a very live issue today because the crucial legislative decisions that commit us to a particular course of action have not yet been made.

The first issue is our domestic program—its character, its size, its rate of growth, and its management. Since the character of the domestic program is singly the most important part of this issue, let us examine it. the character of the program should be responsive to the elements involved in the solution of the problem, which include, first, basic research of the kind we designate "little" science: fundamental studies in (i) the physical sciences, engineering, and statistical design theory—nucleation, the physics of precipitation, energy-exchange processes, instability in the atmosphere, sensors and sensing systems, and decision-making in the face of uncertainty; (ii) the life sciences—the ecologic effects of transient or permanent modification of the physical environment of natural biologic communities; biologists warn us that the biologic outcome of modification of the weather is apt to be a "mixed bag" of good and bad effects on man's artificial ecosystems; and (iii) the social sciences—the human effects, including the impact of weather on the individual and on human activity, the "right" of the individual to the weather provided by nature, the gains and losses to different sectors of society that would follow in the wake of atmospheric alterations, assessment of benefits in relation to costs, the likelihood of conflict, and the institutions that may have to be created or transformed to resolve those conflicts.

Second, the elements include applied research of a kind having a specific aim—in which the mission is to develop capability of modifying the weather. This

element has all the attributes of "big" science: giant computers simulating atmospheric processes, simulating biologic adaptation to variable ecosystems, and simulating economic input-output models—instrumentation laboratories; extensive field measurement programs and experimental research. This element would close the most conspicuous gap in our present national effort and would give the effort of coherence by complementing the current fragmentation that has certain positive attributes.

The third element would be operational application of proven techniques as soon as their efficacy and desirability are established.

The fourth and final element is the regulation that may be required to protect the interests of the public, and the rights, responsibilities, and opportunities of the private sector, as well as to prevent the contamination of field-research projects.

The Weather Modification Act of 1966, passed by the United States Senate last October, goes a surprisingly long way toward development of a domestic program compatible with the elements we have just discussed. Since there was no concurrent action by the House, the entire matter must be reopened for discussion during 1967 if definitive action is to result.

The second issue is concerned with the manner in which our domestic program interacts with the vigorous national programs in other countries. Basic to this issue is the knowledge that the atmosphere is a single, indivisible, physical system: a large-scale disturbance over one part of the world is reflected in different disturbances over other parts.

Resolution of this issue demands perception and awareness that we are no longer in the 19th century but moving rapidly toward a 21st century in which science and technology will have so transformed society that it will be scarcely recognizable, with science and technology creating new imperatives for foreign policy. Even now the demands on imaginative innovation are so great that they are equaled only by the concomitant opportunities. The international issue demands that we forthrightly recognize the atmosphere, and the benefits it brings, as a resource shared by all nations; recognize that the terrors it holds and the suffering it can cause are adversaries that nations can overcome only through a partnership of effort. If one day we may be able to divert the rivers of rain that course through the skies, let that diversion be for the common good and not for narrow national aggrandizement. The Academy panel stated the case succinctly in these words:

"It is clear that a long-range program of weather control and climate modification can have a direct bearing upon relations between nations. It can aid the economic and social advancement of the less-developed countries, many of which face problems associated wth hostile climates and serious imbalances in soil and water resources. And, quite importantly, it can serve to develop common interests among all nations and thus be a stimulus for new patterns of international cooperation."

The NSF commission presented the opportunity in this way:

"Rarely has a more inviting opportunity been offered for advanced thinking and planning regarding the impact of a technological development upon international relations."

The bill passed by the Senate in 1966 included a policy declaration supporting international cooperation and "peaceful and beneficial applications of weather modification."

Now is the time to carry out this policy declaration—while weather modification is still a research problem and *before* there are dramatic demonstrations of capability of large-scale modification. *Now* is the time to take that "long sequence of small, correct decisions" that John von Neumann told us a decade ago would be superior to a "novel cure-all" as a method of resolving the problems attendant on a development that would "merge each nation's affairs with those of every other, more thoroughly than the threat of nuclear war or any other war may have done" (*8*).

The description of plans for the World Weather Watch, discussed at the 1966 meeting of the AAAS, set forth—I hope—one such "small, correct decision." The warm response from our colleagues in other countries stimulates us to rise to the challenge offered by the occasion.

The actions taken by Maryland, in making any form of weather modification a crime, and Pennsylvania, in giving each county the option to outlaw weather modification (*9*), are unmistakable signs of political complication sent out by

an "early warning" system to those who would note them. The public concern and indignation in Canada (manifested by 60,000 signatures on a petition requesting governmental intervention), over the *possible* relation between abnormal weather in the Province of Quebec and alleged rain-making activities in the Province of Ontario and in New York State, contain a mild hint of the international complications that could arise (*10*).

In closing let me select, from among the many implications of these new horizons of research in weather modification, three that seem to me to have special significance:

(1) There is the suggestion, implicit in what I have said, that the undertaking now just getting started is at such an early stage that it may well be carefully documented as it proceeds and be treated as a case study by scholars concerned with the interaction of science and public policy. All the essential ingredients appear to be present, including: (i) an intrinsically interesting scientific problem, with the outcome uncertain; (ii) a potential for great practical benefits for mankind and an equally great potential for exacerbating man's proclivity for conflict—with moral judgments and the aplication of ethics likely to determine that outcome; (iii) clear indications of the need for a substantial, specifically aimed program of applied research, with the opportunity to shed some light on the controversial conclusions of the Defense Department's Project Hindsight (*11*) (quite clearly the hazard of inhibiting the emerging and flourishing, undirected, basic research in the atmospheric sciences at several first-rate universities should be avoided); (iv) intricate problems of interdisciplinary interaction among the physical, life, and social sciences; (v) complex interagency coordination and collaboration, with the opportunity for innovation in governmental organization; (vi) involved legal and regulatory questions, as well as issues concerning the role of the private sector; and (vii) an opportunity to integrate emerging scientific and technological elements into imaginative foreign policy. During the decades ahead we must deepen and perfect our understanding of the interaction of science and public policy. The gathering of data on an experiment as it proceeds would be a good start.

(2) There is the implication that current and prospective advances in weather modification are placing in our hands what Harlan Cleveland (*12*) refers to as "the technological imperatives" to create or strengthen the institutions for international cooperation that are required to serve the national inerests of ourselves and other peoples while simultaneously advancing the welfare of all mankind. Much more than the parochial promotion of a specialized area of science is at stake. Cleveland quotes President Kennedy as remarking that a manageable, worthwhile system of world order will be based "not on a sudden revolution of human nature, but on a gradual evolution in human institutions—on a series of concrete actions and effective agreements which are in the interest of all concerned." If the exploration of weather modification adds one more small brick to the edifice that restrains world conflict and supports world order, science will have served a noble purpose by enriching human life. The burden of responsibility for seeing that this happens is, I believe, on scientists. Long ago Heisenberg underscored the unique role of science in contributing to the solution of one of the great problems of our time with these words (*13*):

"It is especially one feature of science which makes it more than anything else suited for establishing the first strong connection between different cultural traditions. This is the fact that the ultimate decisions about the value of a special scientific work, about what is correct or wrong in the work, do not depend on any human authority. It may sometimes take many years before one knows the solution of a problem, before one can distinguish between truth and error; but finally the questions will be decided, and the decisions are made not by any group of scientists but by nature itself."

(3) Finally there is the implication of an opportunity—nay, necessity—to turn our attention to the structure and the foundations of the moral and ethical framework within which we seek assistance in deciding *why* we must do those things that science tells us *how* to do. What an unparalleled opportunity to synthesize advances toward an understanding of our physical universe with advances in our understanding of man's role in this universe! For, as Teilhard de Chardin has suggested with such simple eloquence in *The Phenomenon of Man*:

"How can one fail to recognize this revealing association of technical mastery over environment and inward spiritual concentration as the work of the same great force—the very force that brought us into being."

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Mr. MACDONALD. Mr. Harvey.

Mr. HARVEY. I just want to congratulate Mr. Malone on a very fine statement and ask a very naive question. What is the connection or relationship between this weather modification legislation and the insurance industry that retains you in this particular field?

Mr. MALONE. The insurance industry pays out roughly $300 million a year on the average for weather-caused damage to property of one kind or another. That is how I got into it in the first place. We made an assessment of the potential savings to the insurance industry and to the purchasers therefor of insurance if you could achieve a rather modest degree of influence over the weather and it comes out to be—the figure is not perhaps precise as the number sounds—$182 million a year.

This is for a very modest tinkering or modification of the weather.

Mr. HARVEY. What do you call modest? Do you mean being able to slow down a hurricane a little bit?

Mr. MALONE. Yes; decreasing the incidence of hurricanes by, say, 10 percent over a 10-year period, not wiping them out completely, but moving one out of 10 away from the coast, preventing hailstorms, preventing the kinds of high wind damage that are insured, the damage of hail to cars, the damage of hail to crops.

Mr. HARVEY. But through these minor modifications you feel you can effect a saving of as much as $182 million a year.

Mr. MALONE. Yes, sir.

Mr. HARVEY. That is all. Thank you.

Mr. MACDONALD. Mr. Van Deerlin?

Mr. VAN DEERLIN. That is $182 million out of approximately $300 million?

Mr. MALONE. Yes. The $300 million is in a normal situation. As you may recall, in the hurricane that hit New Orleans I believe the insurance losses that year ran to over $700 million.

Mr. VAN DEERLIN. I should imagine this would lead to a promising reduction in insurance rates, and I can only hope that after success in this field you might transfer your attention to the automotive insurance field.

Mr. MALONE. Touché.

Mr. MACDONALD. On that point, is it still true that you can't get insurance against high tides, hurricanes, so-called?

Mr. MALONE. You can get wave wash insurance and in any instance—this is a technicality—where the wind causes the damage first, that is, the wind making entrance in the building and then water comes in, then that is ascribed to the wind component and you are fully insured under what they call the extended coverage.

Mr. MACDONALD. Yes, sir; but doesn't the wind cause the waves in the first place?

Mr. MALONE. Yes; it does.

Mr. MACDONALD. I have a house in Maine and I can't get insured. I don't know why. They just won't give you insurance, and it is one thing that I think the insurance companies or somebody should fix up.

Mr. MALONE. I am glad to hear you say that, sir, because some of the people who work for me have spent a lot of hours the last year in trying to develop the actuarial base for not only flood insurance on streams, but for high water insurance on coastal areas.

There is, as you know, a bill before Congress, was hotly debated last week, in which an attempt is being made to develop a cooperative plan between the private sector and the Government with the reinsurance clause to provide precisely the kind of coverage that you have difficulty in getting now.

Mr. MACDONALD. I remember the bill, but I don't remember any section that would cover the situation such as I have personal knowledge of.

Mr. MALONE. Well, my participation stopped. We generated about 1,000 years of flood experience, both on coastal areas and on streams, and that was intended to provide the actuarial base for HUD's study in response to the directive from Congress.

Mr. MACDONALD. Thank you, sir. Mr. Brotzman?

Mr. BROTZMAN. Thank you, Mr. Chairman. Mr. Malone, are you speaking just for your particular company, or are most of the casualty insurance companies across the Nation pointed in the same direction as you have indicated here on behalf of your company?

Mr. MALONE. Well, really, of course, I speak for myself here, but I like to think our company is unique. We are the only one that has a staff of this size.

Mr. BROTZMAN. Working in this particular area, is that right?

Mr. MALONE. Yes, sir.

Mr. BROTZMAN. That is all. Thank you.

Mr. MACDONALD. Mr. Chairman, do you have any questions?

Mr. STAGGERS. I have no questions, but I would like to thank Mr. Malone for coming and giving us the benefit of your views. You have been very helpful. I am sorry I didn't get to hear all of it.

Mr. MACDONALD. Thank you, Mr. Chairman. Mr. Brown?

Mr. BROWN. Mr. Malone, I am sorry that I didn't get to hear all of your statement, thanks to a little delay in the airline this morning, but may I ask one question which you may not be in position to answer?

How does the $182 million savings—which you suggested could be anticipated by modest weather modification—relate to the potential cost of the program into which we are entering?

When you speak of modest weather modification, are you talking about technology we now have, or technology which will be developed by this program, and at what annual cost would that technology be developed? Do you have any idea?

Mr. MALONE. We are talking about an annual cost which will probably grow with an accelerated effort in this area at the rate of, say, 30 percent per year—it will be constrained by the manpower limitations—grow to something of the order of $50 million a year.

I think that is a measure of the kind of benefit-to-cost possibility. This is just one sector of the economy.

The Soviets, for example, in agriculture in their hail prevention get benefit-to-cost ratios of something like 30 to 1, so in round terms we are talking about a program which will probably grow to $50 to $80 million a year. I don't know. This will have to be determined, but that is the kind of ball park. We are certainly not talking about a $500 million a year program at this stage.

Mr. BROWN. This would be $50 to $80 million in a new program and is the $50 to $80 million cost to which you are relating the $182 million savings potential?

Mr. MALONE. Yes, sir.

Mr. BROWN. In the utilization of the $50 to $80 million Federal program?

Mr. MALONE. Yes, sir. Actually $50 to $80 million is probably the level this program would be at in the early seventies. That will be the total program, which would grow from its present value of somewhere around $7 or $9 million. I am not too sure of the exact status of it, but it is in that ball park.

Mr. BROWN. Perhaps something a little less speculative: do you know to what degree savings have been realized by the insurance companies and those who pay insurance premiums based on the past improvement in weather prediction and such efforts as have been made previously in weather modification?

Mr. MALONE. I would say that the improvements of prediction have probably yielded a savings. These were all wiped out in one stroke with Betsy, I believe, that struck New Orleans.

But over a period of time I am satisfied in my own mind that improved predictions will yield a saving. I can't give you a hard estimate of what that might be.

Mr. BROWN. No study has been done on what those savings are? What I am really asking is, if we can anticipate $182 million savings on the basis of a $50 to $80 million Federal expenditure, if that can be so precisely predicted or even so generally predicted, I wonder why it would be impossible or why we can't come up with some figures to indicate the savings which have been realized by past expenditures. I would think both of these would be known quantities.

Mr. MALONE. I think it would be possible to do that, sir.

Mr. BROWN. But none exists of which you are aware.

Mr. MALONE. No; not to my knowledge.

Mr. BROWN. Thank you.

Mr. MACDONALD. Thank you, Mr. Brown, Thank you very much, Mr. Malone.

With this testimony the hearings are now closed.

Mr. MALONE. Thank you, sir.

87-936—68——7

(The following material was submitted for the record:)

STATEMENT OF E. WENDELL HEWSON, PROFESSOR OF METEOROLGY, UNIVERSITY OF MICHIGAN, ON H.R. 9212

The establishment of a comprehensive program in weather modification by the United States has my full support, the writer being Dr. E. Wendell Hewson, Professor of Meteorology at the University of Michigan since 1954. I wish to express my support for the whole program, and in particular for that portion relating to air pollution, a field of research in which I have engaged actively since 1938.

My statement is presented in three sections: the influence of air pollution on weather and climate; the influence of weather and climate on air pollution; and the pros and cons of weather modification in general.

INFLUENCE OF AIR POLLUTION ON WEATHER AND CLIMATE

There are two areas of concern here: inadvertent changes in city weather and climate resulting from air pollution; and inadvertent changes in global weather and climate resulting from air pollution.

We already know that air pollution may affect city climate in a number of ways: by reducing the amount of ultraviolet sunlight reaching the ground; by lowering visibility; by increasing the occurrence and duration of fogs; by increasing rainfall, if only by small amounts; and in other ways. Most of these are adverse effects on the quality of city life.

Air pollution may be changing our global weather and climate in more serious ways. The concentration of carbon dioxide in the atmosphere has been growing since the beginning of the century in step with our increased burning of fossil fuels. Increasing temperatures in the northern hemisphere for the same period may be due to the "greenhouse effect" of this higher concentration of atmospheric carbon dioxide. There is evidence that this temperature trend may have reversed itself during the past ten years or so, a period when the growing pall of industrial smoke over the continent may have become sufficiently dense to reflect back to space a significant fraction of the sun's radiation falling on it. Major changes in global patterns of weather and climate could have catastrophic effects, not only on this continent but on the whole world. Even if there is only one chance in a thousand that major climatic shifts might occur unintentionally because of our industrial and other practices, the magnitude of the possible disaster which might ensue is sufficiently great to warrant making a major effort to assess and evaluate the danger. The proposed legislation would at least permit a modest beginning in the type of effort required.

INFLUENCE OF WEATHER AND CLIMATE ON AIR POLLUTION

Up to the present time the main method of attack on the air pollution problem has been to remove contaminants at the source. Disposal of such collected wastes presents a major difficulty: they tend to become either water pollution or land pollution or both. The possibilities of modifying weather to permit atmospheric dispersal of pollutants over wider areas and in insignificant concentrations have received relatively little attention. But until such time as industrial processes can be developed to the point where they are so efficient that they produce little or no wastes—and that time may never arrive—efficient atmospheric dispersal developed with suitable weather modification techniques offers a possible means of partial relief from air pollution. The proposed program in weather modification would permit a serious search for effective methods of reducing concentrations of air pollutants by such means.

WEATHER MODIFICATION IN GENERAL

Although effective means of weather modification will bring many problems, the benefits are likely to be so great as to outweigh the disadvantages. The hazards can be minimized by conducting limited experiments on a small scale. As physical understanding of weather modification processes grows, the experiments can develop in complexity and size in an orderly way. The present space program affords an excellent example of how scientific and engineering skills can be organized to move from modest beginnings to major accomplishments. Costs would be less because expensive hardware is unlikely to be needed and

practical benefits would probably be greater. The key to success is greatly increased knowledge of weather modfication processes. If such knowledge is gained, as it must be, before large scale experiments are undertaken, there is little danger of adverse results. It is appropriate that the first requirement listed in the proposed legislation calls for "the development of the necessary scientific basis * * *."

In conclusion, let me emphasize that I support fully the whole program in weather modification. My concentration on the air pollution aspects merely reflects my greater experience and competence in that particular area.

STATEMENT OF NATIONAL ASSOCIATION OF GOVERNMENT EMPLOYEES BY MICHAEL SCARPA, NATIONAL REPRESENTATIVE FOR WEATHER BUREAU AFFAIRS

The U.S. Weather Bureau is one of the Federal Government's most important agencies. It is essentially a service agency charged with the task of probing and measuring meteorological phenomena within our atmosphere to provide weather forecasts to the public on a routine basis and timely warnings of extreme weather conditions as they develop.

It is not fulfilling this critical mission. Serious operational deficiencies have been created by mismanagement and shortsightedness over the past 30 years. Faults developed over this period are being perpetuated today by the present policy of reorganization upon reorganization which has done nothing to improve the national weather service.

The net effect of these reorganizations has been to assign higher priorities to administrative and non-operational programs, at the expense of operations. The latest change, the consolidation of various scientific agencies of the U.S. Department of Commerce into one superagency—the Evironmental Science Services Administration—has resulted in a serious deterioration of our national weather service.

The fact is that in many situations a breakdown in Weather Bureau services is primarily due to an inefficient system rather than the scientific limitations of the profession. We feel certain that, given the facts, the taxpayer will understand the latter; it is doubtful that he will long tolerate the former.

At the tender age of two, ESSA has evolved into a bureaucratic monster which is rapidly outgrowing one featherbed after another. Here are some of the results:

Empire-building and inefficiency take precedence over vital public services.

Proliferation of positions and pay grades at the administrative and staff levels is taking place at the expense of positions and pay grades at the operational field level.

A large influx of retired military officers and other personnel from particular sectors of private industry and their assignment to high-paying, non-operational positions is strongly suggestive of the infamous "Buddy System" practiced in Defense Department civilian employment. This practice has had a devastating effect on the morale of career employees.

A too subjective promotion policy emphasizes favoritism, rather than ability and experience.

Seriously inadequate servicing of weather forecasting and warning needs of many metropolitan areas across the country exists.

The use of propaganda and exaggerated claims as a means of winning Congressional approval of the ESSA budget—a foolish and dangerous precedent.

In private enterprise, there is a very real test of the efficiency of a corporation. The annual report gives the stockholders the answer to how well the company is being managed; and woe to the company president who comes up with unsatisfactory earnings reports year after year. Although the same standard of comparison does not exist in government, the following efficiency tests might be applied to ESSA:

1. Ratio of non-operational to operational personnel prior to reorganization and at the present time.
2. The number of new GS–12 and higher grades created in nonoperational and operational positions under the current administration.
3. The number of positions downgraded, left vacant or filled at a lower grade in Weather Bureau field offices.
4. Duplication of programs at the national, regional and local levels.

Today, the weather forecasting service provided by the Federal Government is so cumbersome and centralized that the storm warning and forecast needs (aviation, public, marine, and agricultural) of many important areas across the country are not being met.

For example, let us examine the procedures involved in the preparation of a weather forecast for a large metropolitan area such as Rochester, N.Y. (1960 population of 786,000). A small team of meteorologists in the Washington area supplies basic and general guidance meteorological material to a forecaster at Cleveland, Ohio, who in turn issues the weather forecast for an area comprising Ohio, Western Pennsylvania and Western New York. Then another forecaster at the Weather Bureau Office in Buffalo, N.Y., re-issues a similar forecast for the western half of New York State.

At the Weather Bureau Office in Rochester, a single employee is on duty and his tasks and responsibilities increase as weather conditions become more critical. He, therefore, must assume the responsibility of providing a weather forecast or warning for Rochester and vicinity. This system is fantastically inefficient, but more importantly, it does not provide a true forecast service to an area such as Rochester. So-called refinements and local details to make a general weather forecast suitable for local use are performed by successively lowergrade employees as the forecast echelon proceeds downward from Washington to Cleveland to Buffalo to Rochester.

Curiously enough, at Rochester the employee already performing a staggering amount of work under difficult conditions is classified as a Meteorological Technician whose prime responsibility is the recording of weather observations and the dissemination of weather information and forecast together with technical briefings. Officially, the Weather Bureau refuses to consider him a professional employee and he is, as a matter of fact, ineligible for promotion to a higher grade according to current Weather Bureau grade standards. However, this very individual is charged with the professional task of issuing weather forecast and warnings for a large metropolitan area. This is a gross inconsistency and injustice, since the employer claims that the employee isn't professionally qualified, yet he is assigned professional duties.

Even if the question of professionalism versus skilled technician were resolved, the problem would not be solved. The very real problem is the inadequate staffing at most Weather Bureau offices which makes effective service during periods of severe weather an impossible achievement. The heavy snows of last winter and more recent experience this past September when hurricane "Doria" threatened the East Coast are examples of poor service to the public.

It must be made clear that Rochester, N.Y. is not the only major city confronted with this problem of inadequate weather service. Following is a list of metropolitan areas in the eastern part of the nation where similar conditions prevail. The 1960 population is provided in parentheses.

1. Akron, O. (634,000)
2. Allentown, Pa. (492,168)
3. Asheville, N.C. (130,074)
4. Atlantic City, N.J. (160,880)
5. Binghamton, N.Y. (283,600)
6. Canton, O. (340,345)
7. Charleston, S.C. (254,578)
8. Charleston, W. Va. (252,925)
9. Charlotte, N.C. (316,781)
10. Columbus, O. (828,000)
11. Dayton, O. (778,000)
12. Erie, Pa. (250,682)
13. Greensboro, N.C. (246,520)
14. Greenville, S.C. (255,806)
15. Huntington, W. Va. (254,780)
16. Lancaster, Pa. (278,359)
17. Mansfield, O. (117,761)
18. New Haven, Conn. (320,836)
19. Norfolk, Va. (578,507)
20. Portland, Me. (139,122)
21. Providence, R.I. (735,000)
22. Reading, Pa. (275,414)
23. Richmond, Va. (436,044)
24. Roanoke, Va. (158,803)
25. Scranton, Pa. (234,531)
26. Syracuse, N.Y. (563,781)
27. Toledo, O. (630,647)
28. Trenton, N.J. (266,392)
29. Williamsport, Pa. (109,367)
30. Wilmington, Del. (414,565)
31. Worcester, Mass. (328,898)
32. Youngstown, O. (511,000)
33. York, Pa. (290,242)
34. Johnstown, Pa. (280,733)
35. Lorraine-Elyria, O. (217,500)
36. Lynchburg, Va. (110,701)
37. New London-Groton, Conn. (170,981)
38. Columbia, S.C. (260,828)

Weather Bureau management over the years has readily admitted that their field offices are "staffed only for fair weather." This is a startling revelation when one considers that the government agency responsible for issuing severe

weather warnings for the protection of life and property is admitting that services during critical weather cannot be provided. This is tantamount to having firemen on duty only when there are no fires! Similarly, if the Weather Bureau cannot plan its operations and assure proper staffing to guarantee meaningful public service during the 10–20% of the time when weather plays a major role in the fate of mankind, can there be any real justification for its existence when weather conditions are normal?

Obviously, this very same question must have been in the minds of members of Congress, especially those of the Appropriations Committee, judging from their actions during the last session of Congress when millions of dollars were cut from the ESSA budget.

The Congress and the American taxpayers have been hearing and reading many glowing reports and promises of some near-term weather forecasting capabilities during the past few years. These stories have included such promises as monthly, seasonal, and annual detailed and highly accurate weather forecasts. The role of electronic computers and weather satellites has been so grossly exaggerated that there are many people today who hold the illusion that weather satellites and electronic computers actually are 21st Century oracles spewing forth the latest and most accurate weather forecasts.

The public and the Congress have not been told that the computer and the satellite only provide the most basic and raw material needed before a weather forecast can be prepared. It is man's ingenuity and innate ability that continue to be the most important ingredients in the preparation of today's weather forecast.

Devastating and sad indeed have been the consequences of this foolish and amateurish use of propaganda and public relations. Can a Member of Congress or any taxpayer be expected to understand how, in the light of all these marvelous promises, the Weather Bureau not only doesn't come through on a monthly or yearly basis with weather predictions, but has fallen on its face in merely providing hourly or daily predictions and warnings.

Perhaps, if the planners with ESSA would forget the glamorous, "win-over" sales talk and present their case forthrightly and honestly by pointing to the real needs of their organization as well as the limitations in solving the current problems, they would find a more understanding and sympathetic audience.

NATIONAL ASSOCIATION OF GOVERNMENT EMPLOYEES,
South Plainfield, N.J., November 15, 1967.

SUBCOMMITTEE ON TRANSPORTATION AND AERONAUTICS,
Rayburn House Office Building, Congress of the United States, House of Representatives, Washington, D.C.

GENTLEMEN: I have received a request from Representative Florence P. Dwyer to submit written testimony regarding the Weather Bureau facility at Newark Airport. The National Association of Government Employees has considerable data that I have sent them during the past several months. I spoke to Mr. Lyons, the National President of the NAGE today. He will submit the requested information to the subcommittee.

Enclosed are copies of newspaper articles that have appeared in the local press recently. They bring out some of the deficiencies that exist at the Newark Airport facility.

A program should be developed having as its primary objective the raising of safety standards at government facilities at airports. The FAA and the Weather Bureau can contribute toward safe operations at airports provided they are supported by appropriate legislation enacted by the subcommittee.

Obsolete equipment should be replaced by up-to-date equipment at this station. Sufficient personnel should be provided so that the demands of the public for weather information can be satisfied, especially during stormy weather.

Thank you for your consideration in this matter.

Very sincerely,

JULIUS A. RUDY,
President, NAGE Local R2–48.

[From the Newark Evening News, Nov. 1, 1967]

Union Head Hits Weather Station at Newark Airport

(By Albert M. Skea)

The Weather Bureau station at Newark Airport is poorly equipped and inadequately staffed, a union representative charged today.

Julius A. Rudy of South Plainfield, president of the Newark local of the National Association of Government Employees, said he was making public the complaint in the interest of flight safety.

Rudy has been a meteorological technician at the airport for 15 of his 19 years with the bureau.

His major complaint is that with only one man assigned to a shift, the task of keeping up with observations during poor flying weather leaves little or no time for briefing pilots or answering telephone calls from other airports in the state.

ONLY ONE CEILOMETER

As for equipment, he said the station has only one instrument for measuring cloud height, one of the factors in determining whether flight operations can continue. He said the station formerly had two ceilometers but one of the measuring devices has been removed.

He added that the remaining rotating beam ceilometer "has some bugs."

While airline pilots generally are expected to stop at the station before a flight, airlines maintain their own meteorology staffs and make use of computers to select the most desirable flight plan.

These resources are not available to general aviation, meaning private and business planes, which account for about a third of the landings and departures at the airport.

PRIVATE SERVICE AVAILABLE

However, a privately operated weather forecasting service is available at the Newark Air Service building, which caters to general aviation.

According to Rudy, the Weather Bureau staff at the airport has been reduced from nine in 1949 to six today. Landings and takeoffs, meantime, have increased from 93,000 in 1949 to 211,000 last year.

Weather observations, Rudy said, must be made twice an hour. These measurements include temperature, precipitation, cloud height, visibility, wind direction and velocity, and barometric pressure.

More frequent reports, however, are required when the weather approaches the minimums for continued operation of the airport. For example, when soupy weather prevails, every 100-foot change in the height of the fog or clouds must be reported, so pilots can determine whether the airport is open or closed.

WAGING CAMPAIGN

While Rudy spoke only of conditions at Newark Airport, as he sees it, the national organization to which he belongs has been waging a campaign against the Weather Bureau as operated by the Environmental Science Services Administration (ESSA).

The charge is that ESSA, since its formation two years ago, has "evolved into a bureaucratic monster" by vastly expanding its administrative staff while neglecting field stations, such as the one here.

At least one private pilot has written to ESSA complaining about the weather service.

The letter, in part, said:

"The service offered at the Newark Weather Bureau is progressing from bad to worse * * *.

"It appears to me that economizing on such an important factor as weather service is in the worst possible interests of safe flying, which, I am sure, your agency is trying to improve."

[From the Star-Ledger, Nov. 2]

Storm Raised Over Airport Weather Watch

A meteorologist charged yesterday that the U.S. Weather Bureau at Newark Airport is poorly equipped and inadequately staffed.

Julius A. Rudy of South Plainfield, a meteorological technician at the airport, issued the statement in his capacity as president of the Newark local of the National Association of Government Employes.

He said that with only one man assigned to a shift, the task of keeping up with observations during poor flying weather leaves little or no time for briefing pilots or answering telephone calls from other airports in the state.

CUTS FIGURES

While the staff at the bureau has been reduced from nine in 1949 to six today, Rudy charged, landings and takeoffs have increased from 93,000 to 211,000 a year over the same period.

He also said that the bureau has only one instrument for measuring cloud height, one of the factors in determining if flights can take off in bad weather. He said that the bureau formerly had two of these devices, but one has been removed.

Airlines using the airport maintain their own meterology staffs.

[From the Daily News, Nov. 2, 1967]

RIPS NEWARK AIRPORT OVER WEATHER UNIT

The president of the Newark local of the National Association of Government Employes charged yesterday that Newark Airport's Weather Bureau is poorly equipped and understaffed.

The association's president, Julius A. Rudy of South Plainfield, N.J., himself a meteorologist, said that only one man is on duty during each shift, making it impossible for the man to answer telephone calls or brief pilots during poor weather. All his time is taken up in making observations, Rudy said.

TELLS OF STAFF CUT

Since 1949, Rudy said, the number of takeoffs and landings at the airport has risen by as many as 210,000 per year. However, he said, in the same period the Weather Bureau's staff at the airport has been cut from nine to six.

Airlines using the airport maintain their own meteorology staffs, it was said. Private planes, which make up one-third of the airport's traffic, however, are forced to make use of a privately operated weather forecasting service, it was said.

[From the New York Times, Oct. 26, 1967]

FOUR FORECASTERS CALL NEW AGENCY "MONSTER"

WASHINGTON, D.C., October 25.—Four Government weathermen charged today that there was a breakdown in the nation's weather forecasting system caused by inefficiency and a lack of manpower.

The four charged at a news conference that the new Environmental Science Services Administration had evolved into a "bureaucratic monster." They said they spoke as officers of the National Association of Government Employes and not as forecasters.

The four are: Michael J. Scarpa, district forecaster in New York City; Harvey S. Sands, aviation meteorologist at Kennedy International Airport; Stanley J. Krowka, a forecaster in the international aviation unit at Kennedy, and Julius A. Rudy, forecaster at Newark, N.J.

AIR TRANSPORT ASSOCIATION,
Washington, D.C., November 7, 1967.

Re H.R. 9212.

HON. TORBERT H. MACDONALD,
Chairman, Subcommittee on Communications and Power, Committee on Interstate and Foreign Commerce, House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: The Air Transport Association of America on behalf of its members, the scheduled U.S. airlines, supports the broad purposes of H.R. 9212, a bill "to authorize the Secretary of Commerce to carry out a comprehensive program in the field of weather modification, and for other purposes."

While the airlines are interested in, and support the general objectives of a comprehensive weather modification program, our comments are directed par-

ticularly to the problems of fog and cloud dispersal as they relate to airport and air transport operations (Sec. 201(e)).

The Air Transport Association and its members have had an interest in weather modification, particularly fog dispersal, going back many years. A member carrier has developed a successful technique for abating supercooled fog (fog colder than 32° F.), utilizing dry ice dispensed by a light aircraft. In the last several years, the airlines have made arrangements for fog dispersal services at 17 airports in the U.S. with a high exposure to supercooled fog.

Supercooled fog accounts for only 5% of all fogs. Warm fog (fog warmer than 32° F.) accounts for the other 95%. To date, efforts to modify warm fog have not been completely practical and effective.

Several techniques for abating warm fog have been explored by the airlines since the end of World War II. The FIDO system, which involved the burning of fuel along the edges of runways, was rejected as too costly and hazardous. In 1950–1951, United Air Lines funded a project which was conducted at Arcata, Calif. and Medford, Ore. Using the contractor's aircraft, a heated brine solution was sprayed into fog banks with good clearing effects in many cases. When similar equipment was installed in a United aircraft, results were poor and the project was dropped. Nevertheless, cloud physicists regard this as a technique worth further examination.

Not under 1966 did the airlines fund another warm fog seeding experiment. Six airlines put up a modest sum to try dispensing carbides at Houston, Texas. After five tests with no conclusive results, the fog period ended. With some money remaining, one test was made with a new polyelectrolytic chemical prepared by the Dow Chemical Company in the spring of 1967. Clearing resulted, permitting aircraft operations.

On the strength of this test, the ATA member airlines have put up $100,000 to explore further the efficacy of this chemical in a more prolonged test. This project will commence November 15, 1967, at Sacramento Metropolitan Field, Sacramento, California. It will conclude February 29, 1968. A second chemical, prepared by Procter and Gamble, will be tried as well.

Sacramento was selected because of its high exposure to warm fog during the time period of the contract. Seeding will be done, using the contractor's aircraft. It is also hoped to use powerful ground sprayers to evaluate their usefulness.

These limited tests of two techniques by no means exhausts the possibilities. We are aware of three other approaches that deserve investigation and testing.

In September of 1966, the Air Transport Association urged the Federal Aviation Administration to support a research program to explore the more promising recommendations for warm fog suppression that had come to our attention. Although FAA was interested, support was not received.

Under Sec. 312 (c) of the Federal Aviation Act of 1958, entitled "Research and Development", the Administrator is empowered to "develop, modify, test and evaluate systems, procedures, facilities, and devices, * * * to meet the needs for *safe and efficient navigation and traffic control.*" Surely, any procedure to abate warm fog and open an airport to flight operations that would otherwise be closed is a proper task for FAA.

In our view, the ability to economically abate warm fog to permit resumption of flight operations will do much to enhance the regularity of air transportation. The objective of H.R. 9212 of bringing the Federal Aviation Administration into the weather modification program to aid the safety and efficiency of air transportation is sound.

It is our recommendation that the bill be modified slightly to assure that the Department of Transportation is fully informed of all federal weather modification programs.

We suggest that Sec. 303 (a), (b), and (c) be amended to include the Secretary of Transportation as a participant in the three areas outlined. The Federal Aviation Administration which would conduct weather modification research, is a part of that Department.

In addition, the Department of Transportation should be interested in fog dispersal and weather modification techniques that may have application to other modes of transportation and, therefore, should participate in these plans and programs.

Cordially,

STUART G. TIPTON, *President.*

AIR TRANSPORT ASSOCIATION,
Washington, D.C., November 7, 1967.

Re H.J. Res. 688.

Hon. TORBERT H. MACDONALD,
Chairman, Subcommittee on Communications and Power, Committee on Interstate and Foreign Commerce, House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: The Air Transport Association of America, trade and service organization for virtually all the U.S. scheduled, certificated air carriers, supports H.J. Res. 688.

Knowledge of the earth's atmosphere is greatest in the northern hemisphere, particularly over the populated land masses. Since most of the globe consists of water areas, much of it untraveled, weather data from these areas is sparse. Even the land masses of the southern hemisphere are not covered with a dense surface observation network, and upper air observations come from but a handful of stations.

To truly understand and to better predict the behavior of the weather on this planet, knowledge of the weather everywhere must be obtained through cooperative international efforts. The relationship of tropical weather on future behavior of northern hemispheric weather no doubt directly bears on long range weather forecasting.

The airlines are particularly aware of this in the evaluation of computer forecasts used in long over-water flights. We have found that the accuracy and completeness of forecasts over the Pacific would be improved if more adequate data below 25° North latitude were available. Were it not for the high volume of aircraft on the Pacific routes and pilot reports of enroute weather, it is doubtful that satisfactory forecasts in this area would be possible. As it is, forecasts for these services are based 95% on pilot observations of weather.

With greater knowledge of the equatorial weather, more accurate and longer range forecasts of U.S. weather would become possible. It is well known that the Pacific Ocean is the "heat engine" most responsible for our weather conditions. Hence, greater knowledge of the Pacific equatorial areas with respect to weather and sea temperatures could enhance long range forecasts of air routes further north. This is an objective of the World Weather Watch.

Special measures must be taken to obtain needed weather data, through periodic reporting over a time span of a year or two from those areas for which weather reporting is now inadequate. These data will then enable forecasters, through computer techniques, to understand the interplay of the weather developments in one part of the globe on those developments in another part. Such a data bank is possible under the World Weather Watch program of the World Meteorological Organization.

The Air Transport Association urges full support of the World Weather Watch and participation by the Environmental Science Services Administration in this vital program as envisaged in H.J. Res. 688. The benefits to be derived should improve weather forecasts for the air transport industry throughout the globe.

Cordially,

STUART G. TIPTON, *President.*

THE UNIVERSITY OF MICHIGAN,
COLLEGE OF ENGINEERING,
Ann Arbor, Mich., November 6, 1967.

Hon. TORBERT H. MACDONALD,
Chairman, Subcommittee on Communications and Power, Committee on Interstate and Foreign Commerce, House of Representatives.

DEAR SIR: It is a pleasure to react to Congressman Marvin L. Esch's invitation to comment on H.J. Res. 688 which is under consideration in your subcommittee at the present time. I am honored to submit the following statement for the record.

During the last two decades there has been a significant increase in our ability to understand atmospheric processes and to forecast the weather using modern computer technology. The forecasts prepared operationally by the Environmental Science Service Administration, the U.S. Air Force and the U.S. Navy for period of 1 to 3 days have shown increased accuracy. The simulation of the atmospheric

general circulation on computers has added to our understanding of atmospheric development over periods of weeks and months.

However, it is becoming increasingly evident that if we want to extend our forecasts beyond a couple of days we need to obtain more detailed information concerning the physical state of the atmosphere. We require mainly an increase in meteorological observations from regions of the earth from which we have little or no information in the observational network which exists today. It seems that the most crucial regions are the oceanic regions of the world, the tropics and the southern hemisphere.

It is obvious that the world weather program can be carried out only as a truly international effort, and that it is of the greatest importance that we participate freely in a cooperative effort by the nations of the world to implement the World Weather Watch System and thereby obtain increased capability in weather prediction and weather service to the people of the United States.

I am happy to add my endorsement of the complete H.J. Res. 688. It is of particular importance to recognize that such an undertaking will be successful only if it is accompanied by an intensive research program as outlined in the so-called Global Atmospheric Research Program, and if support is obtained to provide for the training and education of atmospheric scientists and engineers.

It is indeed encouraging to observe the diligent efforts of your committee in critically examining the great potential which the World Weather Program may offer. H.J. Res. 688 should make a significant contribution to a broad national effort to increase our ability to understand and predict the atmospheric circulations over longer time periods than we are able to handle today. I hope that you may see fit to consider these comments favorably.

Sincerely yours,

A. WIIN-NIELSEN,
Chairman, Department of Meteorology and Oceanography.

THE UNIVERSITY OF MICHIGAN,
COLLEGE OF ENGINEERING,
DEPARTMENT OF METEOROLOGY AND OCEANOGRAPHY,
Ann Arbor, Mich., November 6, 1967.

Hon. MARVIN L. ESCH,
Longworth Building,
Washington, D.C.

Dear MARVIN: I am writing in regard to H.J. Resolution 688; S.J. Resolution 116 to urge your strongest possible support of this measure and of the program to which it pertains. I understand that you have already been in correspondence with Professor Wiin-Nielsen on this matter, but I thought I would add my own comments anyway.

When I was in Washington several years ago as a consultant in the Department of Commerce, I became involved in the early planning and deliberations that have evolved into the present concept of a World Weather Watch and the related Global Atmospheric Research Project. The people who have continued these efforts are some of the finest atmospheric scientists we have.

As a meteorologist I am sure that I have always had some prejudices in favor of the concept of such a program, but I think I have been most impressed by the way in which such a program is suitable. All nations, large and small, developed and undeveloped, would be able to contribute, each in its own way, and to benefit, each according to its own problems.

From the point of view of our own national self-interest, I believe that these programs, if we could undertake them ourselves, would be fully worth the cost and the effort. But we are not able, nor should we try to do these things ourselves, because the entire world stands to benefit along with us. From the beginning those who have been concerned with the global weather program have tried to assure that it is neither unilateral nor bilateral, but a truly multilateral program, involving the underdeveloped nations as well as the great powers. Now, with the favorable actions of the World Meterological Organization this is assured. We can have a program of real cooperation with all contributing and all benefiting.

From the scientific point of view, too, the proposed program is sound. I have met personally many of the prospective international leaders who will plan and direct these programs, and they are very competent people of high integrity.

If there are any specific questions with regard to this program to which you would like answers, I would be happy to help in any way I could.

Sincerely yours,

Ed

EDWARD S. EPSTEIN,
Associate Professor of Meteorology.

(Whereupon, at 10:58 a.m., the subcommittee was adjourned.)

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