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UCAR

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Office of the President

March 21, 1983

MEMORANDUM

TO: Members
National STORM Program Steering Committee

FROM: Robert M. White
President

With the publication of the three documents on STORM (Framework for a Plan, Scientific and Technological Bases, and A Call to Action), the major work of the steering committee is now accomplished. I want to express my personal appreciation and that of the UCAR Board of Trustees for the service you have rendered the nation and the scientific community. The campaign for STORM has just begun, but a great beginning has been made.

I would appreciate it if the Steering Committee would be on call until some of the anticipated positive steps described in the attached memorandum are accomplished. Also enclosed for your information is a copy of George Benton's Congressional testimony on STORM, presented on March 9, 1983; it was very well received.

If there is any aspect of the activities or status of STORM you wish to discuss at any time during George Benton's stay in China, please give me or Dave Johnson a ring.

Enclosures (2)

cc: UCAR Board of Trustees
W. Hess
D. Johnson
S. Ruttenberg
L. Romney
E. Wolff

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Office of the President

March 21, 1983

MEMORANDUM

TO: STORM Steering Committee

FROM: David S. Johnson *Dave Johnson*

SUBJECT: Status of STORM Activities

Release of "Call to Action" Report

The UCAR report, "The National STORM Program -- A Call to Action," was released on March 7 at a luncheon for the media in Washington. About a dozen media representatives participated. Special press packets were sent to 50 major newspapers, news magazines, and TV and radio outlets; about 300 copies of a news release were mailed to news outlets across the country.

The news of President Reagan's plans to transfer NOAA's weather satellites to private industry may have reduced media coverage on the "Call to Action" itslef. However, it appears that the satellite proposal is generating broad concern and inquiries regarding the nation's weather services and their potential for the future. As a result, there will be several opportunities to inform the Congress, the media and the public about how currently available scientific and technological capabilities can be harnessed to make fundamental improvements in the quality of weather services, including more effective handling of stormscale weather phenomena.

Action Within the Government

As George Benton described in his memo of 1 March, there have been informal interagency discussions about STORM. It appears likely that NOAA will become a focal point for continuing interagency communication; we do not know when a formal program office will be established. Since the Fiscal Year 1984 budget is now before Congress, it is likely that any "STORM" activities will have to be conducted within funds in that budget. It is too early to tell about FY 1985; we will have to see how the current debates and inquiries into the future of NOAA and the National Weather Service develop. Bob White has briefed the Office of Science and Technology Policy. George Benton has testified on STORM before the House Science and Technology Committee and Bob, George and I have briefed key Senate staffers.

Action at the National Academy

The Academy's Board on Atmospheric Sciences and Climate (BASC), under the chairmanship of Tom Malone, is proposing a panel to act as the scientific organizing committee called for in the STORM report. A proposal to fund this activity is being prepared by BASC for submission to the Federal agencies.

Future of the STORM Steering Committee

The Steering Committe should continue to be available until the government focal-point and the NAS/BASC Panel are established. At that time, it may no longer be needed.

cc: UCAR Board of Trustees
R. White
W. Hess
G. Benton
S. Ruttenberg
L. Romney
E. Wolff

March 9, 1983

WEATHER SERVICES AND SUPPORTING RESEARCH IN THE UNITED STATES: THE NEED FOR A NATIONAL STORM PROGRAM

Testimony by Dr. George S. Benton *
Professor of Meteorology, The Johns Hopkins University

It is a pleasure for me to appear before the Subcommittee on Natural Resources, Agriculture Research, and Environment to discuss weather services and supporting research in the United States.

I am appearing today in my role as chairman of a steering committee of outstanding scientists appointed by the University Corporation for Atmospheric Research (UCAR), a non-profit consortium of 50 universities in the United States which maintain graduate programs in meteorology or closely related disciplines. Over the last two years, our committee has evaluated the adequacy of existing weather services and supporting research, and has considered opportunities for economical and timely improvements.

It is the conclusion of our committee that a major scientific and technological opportunity exists to achieve a breakthrough in our ability to understand and predict the occurrence of the small-scale weather events which dominate our local weather.

To this end, our committee has proposed the development of a national effort -- a National STORM Program. The primary purpose of the program will be to enable our weather services (public and private) to observe, predict, and disseminate timely forecasts of stormscale weather phenomena with the accuracy and reliability necessary to protect the public, serve the national economy, and meet defense requirements. The program will also develop the understanding of these phenomena required for the effective use of climate and weather information by government, industry, and agriculture.

Our committee has prepared a report which describes the program; explains why it is important and why it can succed; evaluates costs and benefits; and indicates what must be done to get the program underway. The benefits of the program so markedly outweigh the costs that we call our report The National STORM Program: A Call to Action.

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*To the Subcommittee on Natural Resources, Agricultural Research and Environment of the Committee on Science and Technology, U.S. House of Representatives

Mr. Chairman, you and each of the members of the Subcommittee have a copy of this report before you. I would like to enter the full report into the record, and I am prepared to present a very brief summary of its contents at the present time.

A BRIEF STATEMENT OF THE NATIONAL STORM PROGRAM

Weather comes in all sizes. The steady, soaking rains that cause floods on the Mississippi River may cover a dozen states and result from a large atmospheric disturbance many hundreds of miles in diameter. The snow blanketing New England in winter may come from a "northeaster" -- a large coastal storm which may extend from Cape Cod to Cape Hatteras.

Contrast the weather from these large-scale systems with a flood-producing thunderstorm or a violent tornado. A severe thunderstorm may affect an area of a few square miles; a "twister" may leave a wake of destruction only a hundred yards wide and a fraction of a mile in length.

Much of the weather that disrupts economic activity -- and affects the lives and property of citizens -- is caused by phenomena which are very limited in extent. The meteorologist uses the term mesoscale to describe these systems; we have chosen the more descriptive designation stormscale.

Stormscale phenomena include severe weather such as tornadoes or downbursts, violent squall lines and thunderstorms, rain-induced flash floods, or local heavy snows. They may also include nonviolent weather: freezing rain, dense ground fog, or low-lying clouds which disrupt ground or air traffic; persistent temperature inversions which cause extreme local air pollution; or strong nocturnal cooling which, combined with local air drainage, may produce killing frost.

Stormscale phenomena are closely related to large-scale weather. It is the distribution of large-scale cyclones and anticyclones -- low and high pressure areas -- that determines whether a broad region has predomenantly stormy or fair weather. But it is the occurrence of stormscale phenomena which determines the particular locality within the stormy region that experiences the devastating flash flood or the destructive windstorm. Stormscale phenomena are embedded within the large-scale weather patterns, and it is often the specific location and time of occurrence of the stormscale events that are of the greatest concern to our citizens.

If we are to forecast and then verify the occurrence of stormscale weather, we must first be able to observe it: to detect its genesis, development, and motion. Yet, until recently, our operational weather services -- civilian and military -- were designed to observe large-scale weather systems. Stations which take surface observations are spaced 50 to 100 miles apart; stations which measure winds and temperatures through the depth of the atmosphere are spaced even more widely -- 150 to 300 miles on the avarage. This netweork provides excellent information about large-scale atmospheric systems: the major cyclones and anticyclones, the air masses and weather fronts which cause our regional weather. It provides little or no information about the individual severe thunderstorm or tornado which occurs between observing stations, and insufficient information about the storm which affects a single station.

During the last two decades, radar and other ground-based remote sensing techniques, polar-orbiting and geostationary weather satellites, and dense, automated surface observing networks have begun to provide a way to observe stormscale weather. Yet progress is slow. We have not been making sufficient use of these new observational techniques -- and we have been slow to introduce powerful new technology such as Doppler radar, which renders many of the present operational observing systems obsolete.

This situation can be changed. State-of-the-art technology places at our disposal powerful ways to observe stormscale meteorological events with substantially improved accuracy, to collect and process the data, and to disseminate information directly to the user -- all within a matter of minutes. Once this basic flow of information has been established, steady improvements will follow in our ability to forecast small-scale weather systems. The total process can be stimulated and accelerated by modern research techniques, which will provide insight into the basic physics of stormscale systems and will point the way toward the effective use of this understanding in forecasting and in a host of weather-related activities.

Two parallel efforts are required. The first is to plan and implement an operational program -- including the development of a STORM Warning System -- which will deploy the technology necessary to observe, analyze, forecast, and disseminate information concerning stormscale weather. The second is to plan and conduct a supporting research and technology development program -- a STORM Research Program -- to provide improved measurement and communication systems, to develop more effective forecasting methods, and to achieve a better understanding of stormscale phenomena.

Continuous interaction between these two programs is needed. Problems of operational weather forecasting must be formulated and communicated to the research scientist and engineer; advances in observational capability or in fundamental understanding must be translated into productive action.

The importance of stormscale weather has been known for many years. Why have meteorologists concluded that <u>today</u> this subject is ripe for attack? Why do scientists believe that within the next decade they can solve stormscale problems trhat have resisted solution for many generations?

Three basic ingredients for success are now in hand. The first is our vastly improved understanding of and ability to predict the large-scale motions of the atmosphere: the movements of the cyclones and anticyclcones, air mases and fronts which cause regional weather. These skills largely result from the effective use of numerical models and high speed digital computers, developed over the last several decades. They make it possible for us to describe accurately the physical background within which stormscale systems form, grow, and decay.

Second is state-of-the-art technology which makes it possible to plan and construct a system to observe, analyze, and disseminate stormscale weather information with a level of accuracy and timeliness which is substantially greater than would have been possible only ten years ago.

Third is the availability of improved computers -- and increased modeling capability -- which make it possible to extend to <u>stormscale</u> phenomena the techniques of numerical simulation now being used so effectively on the larger scales. The first significant steps in this direction have already been taken in research.

The stage has been set for a major assault on stormscale weather. The day is not far off when the user of weather information -- the urban dweller, the farmer, or a representative of government or industry -- can go to his television set and obtain, on demand, a map of his region showing the weather in his vicinity, including the location and extent of significant local weather systems such as thunderstorms or regions of snow or rainfall. He will also receive a forecast of changes in the weather, with computer-generated displays on the regional map to show the expected movement of stormscale weather systems over the next several hours. With such a modern weather system at his disposal, each individual can begin to use stormscale weather information efficiently and effectively.

Every indication is that the National STORM Program is timely, and can succeed. The outlines of the program -- the various steps that must be taken in operations and research -- are set forth in the Call to Action report.

WHO WILL BENEFIT FROM THE NATIONAL STORM PROGRAM?

The National STORM Program will benefit almost everyone: the general public, civil government at all levels, national defense, agriculture, and industry.

The general public will be one of the major beneficiaries of improved stormscale forecasting. Tens of millions of weather-related decisions are made daily. These range in nature from fairly trivial decisions . . . "Should I take an umbrella to work?" . . . to ones more important to the individual . . . "It's snowing; should I keep the children home today" . . . to those that are deadly serious . . . "The sirens are blowing and a tornado alert is on, should I take cover?"

There are many indicators that the public is intensely interested in weather.

- Each year approximately one billion calls are placed to local telephone companies to listen to transcribed weather reports. If the average cost of each call is assumed to be ten cents, the public is paying about $100 million annually for this information.

- Continuous weather reports are provided on dedicated channels through the NOAA Weather Radio Network. These reports can be received on special, single-purpose sets which can be purchased at prices ranging from $15 to $75. Approximately $100 million is spent annually to purchase these receivers.

- The total spent each year to distribute weather information by telephone, radio, and television is about $1.7 billion -- more than three times the cost of civil weather services in the Federal government and about seven times the budget of the National Weather Service.

The dissemination to the public of up-to-the-minute local weather information and very short-term forecasts is an essential part of the National STORM Program. Forecasts of severe weather will help the public avoid hazards to life and property; forecasts of more normal weather will help the citizen make better choices, improve the quality of his life, and avoid petty frustrations. All of the evidence indicates that the public wants this information, believes it needs this information, and is willing to pay for it.

Government -- Federal, state, and local -- will benefit from the National STORM Program. In government, many programs are weather-related. Agriculture, commerce, energy, environmental quality, transportation, public health and safety -- the government's business is dependent on today's weather.

A few examples will suffice. When the President officially designates a disaster area, the chances are better than eight to one that the problem is weather-induced. Blizzards, flash floods, hurricanes, tornadoes -- the roster of stormscale catastrophes is long. Disasters caused by severe weather place urgent demands on local and state police, and on health and public assistance agencies. At the Federal level, agencies such as the Federal Emergency Management Administration are directly involved. The consequences of many weather disasters can be reduced by adequate warnings.

Systems of transportation are weather dependent. Municipal traffic and transit systems are severely affected by snowstorms, freezing rain, or fog. State and interstate highway systems can be crippled by a severe flood or by a winter blizzard. The design and efficiency of air traffic control systems -- the responsibility of the Federal Aviation Administration -- depend crucially on our ability to observe and forecast severe or otherwise disruptive weather.

Systems of water management are weather dependent. Schedules of water use for irrigation and the management of flood control structures can be improved by timely and accurate forecasts of precipitation. The Bureau of Reclamation, the Corps of Engineers, and other agencies such as the Tennessee Valley Authority -- all are involved in management problems of this type.

Better stormscale forecasts can readily be translated into increased efficiency of civil government at the local, state, and Federal level.

National defense is even more dependent on the weather. High performance aircraft in the Air Force or the Navy may be required to operate with comparatively small margins of safety. The severe thunderstorm which forces a commercial airfield to close down for 30 minutes may cause traffic delays and inconvenience passengers; the same storm unexpectedly occurring over a military airfield or an aircraft carrier could cause disaster. Similar problems may result from high winds, low clouds, or fog.

Problems of battlefield environment have become increasingly important as weapon systems have become more sophisticated. High-technology electromagnetic sensors, operating at a variety of wavelengths, are affected by the temperature and moisture structure of the atmosphere. These special areas of stormscale weather forecasting can be dramatically improved by techniques developed as part of a National STORM Program.

In agriculture virtually every activity is weather-dependent, and major costs are associated with short-term decisions. Irrigation schedules can be adjusted to take advantage of local rainstorms; crop-dusting operations can be timed to avoid high winds or precipitation; harvesting can be advanced or delayed to minimize crop loss. Agriculture in the United States depends on information sources such as the NOAA Weather Radio Network to obtain its local forecasts. The National STORM Program can dramatically improve both the timeliness and the accuracy of the weather information provided to the farmer.

But perhaps the broadest application of stormscale forecasting will involve industry: including transportation, construction, energy, retail sales, and recreation. Consider, for example, general aviation -- a rapidly growing industry which is highly weather dependent. There are more than 200,000 privately owned aircraft in the United States, and about 360,000 operators with private licenses. The planes have lower performance characteristics and are more sensitive to bad weather than commercial or military aircraft; the operators are often comparatively inexperienced.

Most aircraft in general aviation operate in and out of small airfields at which no weather observations are taken. When the large-scale weather patterns are hazardous, general aviation usually receives adequate notice and appropriate adjustments are made in flight schedules. All too often, however, the aircraft are severely affected by stormscale weather that has little impact on commercial or general aviation. Weather-related events in general aviation annually cause the loss of about $50 million and 800 lives.

A National STORM Program could have a profound impact on major sectors of society: the public, government at all levels, national defense, agriculture, and industry. Would such a program also be cost-effective?

THE COSTS AND BENEFITS OF THE NATIONAL STORM PROGRAM

It is impossible at this time to prepare detailed estimates of the cost of the National STORM Program. Neither plans nor preliminary designs are available for the required operational systems or the supporting research effort, and the boundaries of the program are not yet precise. Nevertheless, some rough estimates can be made. Our committee has estimated that over the next decade, as a result of the STORM program, incremental costs above existing out-year plans would be in the range of $60 to $120 million per year in fiscal 1982 dollars. Since Federal expenditures for the atmospheric sciences -- civil and military, operations and research -- are about $1.3 billion annually, this would represent an increment of about five to ten percent.

Quantitative benefits will accrue in four ways. First, weather-related property damage will be reduced. Each year our nation pays a frightful toll to nature (as the recent floods on the Mississippi and the storms in California have so clearly illustrated). The total of all weather-related losses probably exceeds $20 billion a year. And a substantial part of the total is attributable to stormscale weather.

How much damage could be avoided if better stormscale warnings were available? The potential value of a forecast is primarily a function of its timeliness and accuracy. Its actual value depends on whether the user receives the forecast promptly, and on whether it stimulates him to take appropriate action. Whether or not the forecast is effective is strongly influenced by the user's level of familiarity with the specific weather phenomenon, on his perception of the probable accuracy of the forecast, and on his ability to take protective measures. One of the strengths of the National STORM Program will be that the regular dissemination of stormscale forecasts will rapidly increase the public level of understanding with regard to severe weather events. This educational process will, in the long run, contribute substantially to reduced loss.

Our committee has estimated that a modern STORM Warning System can, within the next decade, reduce property damage due to weather-related events by at least five percent. This would correspond to a saving of $1.0 billion per year -- an amount roughly ten times the total cost of the program. Reducing property damage by even one percent ($200 million per year) would provide savings substantially greater than the incremental cost of the STORM program. And all will benefit: the general public; Federal, state, and local government; agriculture; and industry.

A second major benefit will accrue from improving the efficiency of agriculture and industry. Many examples could be cited:

- An accurate stormscale forecast of an afternoon thunderstorm may cause a farmer to postpone irrigating his fields. This could save thousands of dollars.

- A stormscale forecast of cloudy skies, with temperatures rising above the freezing level, may lead a construction firm to go ahead with a concrete pour, thus completing a contract on time.

- A stormscale forecast of a local snowstorm may allow a municipal transit authority to call up snow removal crews two hours earlier (or later) than would otherwise have been possible. This will improve the effectiveness and reduce the cost of snow removal.

- A forecast of low clouds and high winds may cause an oil company to dispatch a helicopter to an off-shore platform two hours ahead of schedule. This may permit the company to rotate personnel on schedule.

As these simple examples illustrate, better weather information can be used to improve efficiency. And increased efficiency can immediately be translated into higher profits and a sounder economy.

Meteorologists in the private sector will play a crucial role in helping agriculture and industry learn how to use stormscale information to best advantage. This process is already underway. In the last two decades, many large corporations have added weather experts to their staffs; smaller companies have generally chosen to rely on the services of a private meteorological consulting firm.

The growth of private meteorology in the service of agriculture and industry has been rapid. In future years, as our ability to prepare accurate stormscale forecasts increases, even more rapid growth can be anticipated.

A third benefit of the National STORM Program is the value of public interest forecasts. Accurate stormscale weather information will enhance the public's ability to make effective decisions in everyday living.

Whether an individual citizen decides to carry an umbrella when going out on an errand -- or whether he or she closes the windows when leaving home, in expectation of a thunderstorm -- is not a momentous decision. The economy of the nation is not seriously affected by the result. In fact, one could argue that the neighborhood dry cleaner -- or the local home improvement contractor -- benefits from the unexpected wind and rainstorm which soaks the unwary shopper or damages the finish of the living room floor. But to the individual, the result is unpleasant: time is wasted, and scarce resources are spent in unproductive ways.

What is the value of timely, accurate stormscale forecasts to the general public? There is no easy answer to this question. One approach is to make a speculative, back-of-the-envelope computation. Let us assume that the average citizen makes only one stormscale weather-related decision each week -- 50 per year. If the average value of each decision is only 25 cents, the total value of the ensemble of decisions is $2.5 billion annually.

The enormity of this figure helps explain why (as we have already noted) our society spends $1.7 billion annually to disseminate weather information to the general public. After all, if the back-of-the-envelope computation has any validity, it must somehow be related to the willingness of the public to pay for the information it requires. In these terms, the $100 million spent annually for special-purpose radios permanently tuned to NOAA weather broadcasts -- or the one billion telephone calls made each year to hear automatic recordings of current weather conditions -- take on more significance.

The <u>fourth</u> benefit of the National STORM Program will be reduction in loss of life and injury. Each year many thousands of people are killed and injured as a result of weather-related events. Stormscale systems are responsible for most of these casualties. The largest loss of life comes from the impact of weather on transportation: for example, about 800 persons are killed annually in general aviation as a result of weather-related accidents. Flash floods result in a death toll of over 200 per year.

Our committee has estimated that over a period of 20 years, loss of life due to severe stormscale weather can be reduced by a factor of two. This corresponds to a saving of well over a thousand lives annually. Much larger reductions will occur in the number of personal injuries.

<u>Will the National STORM Program be cost-effective?</u> Our committee made no effort to derive a numerical benefit-cost ratio for ther program. Too often such numbers are self-serving and difficult to justify. In the last analysis, a decision to support or not to support a program involves not

only economic considerations, but also subjective judgments implicitly related to issues of public policy.

We have shown that substantial benefits will accrue from the National STORM Program in four different areas: reduction of property damage; improvement of the efficiency of government, agriculture, and industry; enhanced flow of information which is in the public interest; and reduction of loss of life and personal injury. Any one of these benefits alone could be used to justify the STORM program.

HOW CAN WE GET STARTED?

The National STORM Program will be a complex effort, involving the expenditure of substantial resources. The diverse participating agencies will include a number of government agencies, as well as universities and industry. The program itself will be a long-term effort, national in scope. It will involve both operations and research, with the customary difficulties of coordination. Oversight responsibility will be required at a number of levels: within the scientific community, for technical validity; within the Executive Branch, for managerial effectiveness.

Finally, Congress must become involved in the program. The National STORM Program will benefit broad sectors of our society, including the general public. Fundamental issues of public policy are involved. The welfare and safety of the public will be enhanced, as well as the efficiency and well-being of agriculture and industry. The support of the Congress in making available the necessary appropriations, and the involvement of Congress in the oversight process, are essential to the success of the effort.

Some suggestions with regard to an organizational framework for the National STORM Program are included in the Call to Action report. But the primary issue is not the organization -- or even the oversight -- of the program.

This country has developed, at substantial cost, new technology for remote sensing of weather information. We have pioneered in the operational deployment of weather satellites -- and in the use of high speed digital computers for data analysis and weather prediction. We have led the world in communication technology. The primary issue is whether these capabilities and technologies will be put to use to provide the American people with the kind of modern weather service they need to meet the demands of our complex society. The alternative is to export the technology, and allow other developed countries to lead the way.

Mr. Chairman and members of the Subcommittee, we believe the National STORM Program is a concept ready to be implemented. The scientific and technical community in the United States, within and external to the government, awaits the opportunity to launch a major attack on the losses and inefficiencies which result from inclement weather. Government at all levels, national defense, the general public, agriculture and industry -- each will benefit.

NOW is the time to begin.