Vol. 7, No. 1

Royal Meteorological Society

METEOROLOGY - A WORLD ENDEAVOUR

R. C. Graham

CANADIAN BRANCH

25¢

Vol. 7 A Publication of the No. 1

Royal Meteorological Society, Canadian Branch

EXECUTIVE COMMITTEE 1956

Additional copies of this publication are available at a price of 25 cents each. All enquiries and correspondence concerning the Canadian Branch of the Royal Meteorological Society and its publications should be addressed to

The Secretary
Royal Meteorological Society, Canadian Branch
315 Bloor Street West
Toronto 5, Ontario

METEOROLOGY - A WORLD ENDEAVOUR

by

R. C. GRAHAM

Meteorological Services of Canada

Presidential address presented to the
Royal Meteorological Society, Canadian Branch
at Toronto on Thursday, February 2, 1956.

METEOROLOGY - A WORLD ENDEAVOUR

by R.C. GRAHAM

Science is proverbially stimulated by international co-operation. But to meteorology, such co-operation is not only stimulating, it is vital. To-night I propose to look at the background and current status of some international activities in meteorology, and contribute a few of my own comments.

The Role of International Co-operation in Meteorology

Meteorology stands in a position shared by few other sciences with regard to international co-operation. In meteorology, as in many fields of science, the growth of human knowledge is accelerated by exchanges of ideas between those practicing the science in different countries. But more than in most sciences, a large proportion of day-to-day meteorological activities are dependent on continuous international co-operation right at the operating level.

The Canadian Meteorologist and World Meteorology

The activities of the international meteorological world are becoming increasingly important to us in Canada. The leaders of Canadian meteorology have played an active part in world meteorological affairs. However, because of our geographical situation, the average Canadian meteorologist was at one time not as directly and deeply concerned with international meteorological matters as his colleagues in many other countries. This is rapidly changing. Meteorological techniques demand the use of data from wider and wider areas. The applications of meteorology require that we look farther and farther beyond our boundaries. At one Canadian forecast office, for example, meteorologists talk to pilots departing for Asia, Australia, South America and Europe. And at the other end of these routes, meteorologists talk to the same pilots, departing for Canada.

Organization

The importance of meteorology to mankind, and its international character, are attested by the recognition given it by United Nations. One specialized agency of United Nations, the World Meteorological Organization, is devoted entirely to meteorology. In the International Civil Aviation Organization, another specialized agency of United Nations, a Technical Division is devoted to meteorology. The two organizations work in close co-operation.

The first conference of meteorologists from different countries, to which I could find reference, took place over a century ago in Brussels in 1853, for the purpose of organizing meteorological observations from ships at sea. In 1872 a conference was held in Leipzig, attended by 52 Directors of Meteorological Institutes and other scientists, to settle among other things questions relating to observations made by land stations. Out of this latter conference came the idea of setting up a continuing organization responsible for international matters in meteorology, and led to the development of what became the International Meteorological Organization, transformed in 1951 into the World Meteorological Organization.

In WMO, technical matters of world-wide interest are dealt with, according to subject, in one or more of eight technical commissions. Matters of regional interest are dealt with in Regional Associations. The recommendations of these bodies are subject to adoption or disapproval by a Congress. Every Member of WMO is entitled to representation in these constituent bodies.

Between sessions of Congress, which take place every four years, the execution of Congress decisions is supervised by an Executive Committee of fifteen, meeting annually. The Executive Committee is composed in part of members elected by Congress, and in part of the elected officers of WMO and Regional Associations.

Last but by no means least, there is the Permanent Secretariat that does the day-to-day work and keeps the organization going.

One great attribute of WMO is that, as it is at present organized, Members have the fullest opportunity for expression of opinion. It is not subject to control by a bureaucracy or an entrenched minority. I hope that this attribute will be carefully guarded.

Sometimes WMO is criticized because of the time that it takes from the conception of an idea to its implementation. I believe that any difficulties that have been encountered in this respect were mainly because of the newness of the machinery, and can be largely rectified within the existing pattern, without running the risks attendant upon too great a concentration of authority. Moreover, in many matters of world meteorology, it is well to allow time for mature consideration.

At the end of World War 2, two great problems confronted meteorologists. One was to restore meteorology in the war-ravaged areas; another was to provide meteorological services for fast-growing aviation. The International Civil Aviation Organization, newly formed to promote the orderly development of international aviation, and with the full force of aviation interests behind it, provided a forum in which rapid progress was made in meteorology in the immediate post-war years. In ICAO, agreements were reached not only on direct meteorological services to aviation, but on such supporting matters as observing networks, communications etc. Much of the present network of observations over the North Atlantic, and communications across the North Atlantic, stemmed from agreements reached in ICAO.

As WMO became organized and gathered headway, it became capable of assuming several of the responsibilities in meteorology that had been fulfilled by ICAO in the immediate postwar years, for example, basic synoptic and upper-air networks. A working arrangement between the two organizations has been developed, for the orderly allocation of responsibilities. Basically, division is between matters that primarily require co-ordination with aviation, and matters that primarily require co-ordination with other branches of meteorology. ICAO states the needs of aviation, WMO states the means of fulfilment. In ICAO, meteorology is one of the Air Navigation services; in WMO, aviation is one of the consumers of meteorological service. To ensure that technical matters of mutual concern get off to a good start in both organizations, it is customary for the ICAO Meteorological Division and the WMO Commission for Aeronautical Meteorology to hold their sessions jointly, with, in many cases, the same delegates representing countries in both organizations. WMO commonly delegates an observer to the Meteorological Committee of ICAO Regional Air Navigation Meetings, and ICAO sends an observer to WMO Regional Association sessions.

So much for the organizations. Now to look at some of the accomplishments in various fields.

Observation Networks

Meteorology rests upon a foundation of organized observations. And since few meteorologists can work satisfactorily with observations from within their respective countries alone, observing networks form a natural field for international co-ordination.

Regional Associations of WMO develop plans for networks in their regions with the objective of integrating the stations that each country can establish, into a network that will be to the best advantage of all. In addition, although basic networks are primarily a WMO responsibility, ICAO in its regional meetings makes recommendations on aviation requirements for networks.

In a later section I will speak about methods of financial aid to promote networks where they would not otherwise be adequate. However, it is appropriate to mention here that international financing has made possible observations from very important areas of the globe, that would otherwise have been lacking.

The ocean areas have presented a particular problem from the viewpoint of observations. The vast majority of observations from these areas come from merchant ships, observations made and transmitted on a voluntary basis in accordance with recommendations agreed upon in WMO. One cannot give too much credit to the ships' officers and men who make these observations possible.

Aircraft weather reports provide another valuable source of meteorological data over the ocean, especially on conditions aloft of direct importance to aviation. However, the trend toward smaller crews, faster aircraft, and greater congestion on the air-to-ground radio channels, makes it increasingly difficult to include in aircraft reports even the minimum meteorological information that is essential for the meteorological needs of aviation.

Perhaps, the most complete and reliable reports over the ocean areas come from the ocean weather stations and weather reconnaissance flights. However, valuable as they are, these are expensive and have been established only in some areas where the need is very great.

There are still large areas of the world where networks are inadequate. In some such areas, the deficiencies will be remedied as local needs for more meteorological service arise. However, this will not solve the problem in the unpopulated areas of the world. It may be that increasing demands for world meteorological networks will give rise to more requirements for international financing. Unfortunately, in much of the world, the maintenance of manned observing stations is extremely arduous and costly. There is room for a great contribution in the field of automatic weather stations.

One long standing question is: "What constitutes an adequate network?" Some forecasters might say that there is no such thing. Most of us can do little more than give a subjective opinion. Many professional man-hours have been devoted to debate on some objective means of defining an adequate network for various purposes. However, this question has yet to be resolved. If a formula, applicable worldwide, could be devised, it would meet a need in setting a target at which to aim.

Meteorological Communications

Communications are just as essential to meteorological services as are observation networks, WMO and IMO, and ICAO have all participated in development of meteorological communications. Under the present division of responsibility, WMO is primarily responsible for organizing exchanges of basic meteorological data, while ICAO is primarily responsible for organizing exchanges of aeronautical meteorological data.

The traditional method of communication recommended by IMO - WMO is a system of wireless-telegraphy broadcasts. The plan calls for national communication centres from which data is collected at sub-continental broadcasting centres, and then in turn collected at continental broadcasting centres which are supposed to have sufficient power to be capable of world-wide interception. To some of us accustomed to landline or point-to-point radioteletype, wireless telegraphy broadcast seems slow, unreliable, and costly in manpower. However, it requires less costly

equipment than more modern methods, and so, despite the trend toward higher speed methods, wireless-telegraphy broadcast is still extensively used.

In ICAO, the means of meeting requirements for meteorological exchanges has generally been by the aeronautical fixed telecommunication network - essentially a point-to-point network. On the ordinary AFTN circuits, carrying all types of aeronautical communications, meteorological traffic, like other traffic, goes as addressed messages with assigned priorities. This has two disadvantages: if the number of recipients is large, as is the case with much meteorological traffic, the addressed message procedure can be very cumbersome. Moreover, the priority system prevents handling the traffic on a scheduled basis. In recent ICAO Regional Meetings, it has been recommended that 40% traffic loading be considered about the maximum on this type of circuit, whereas one can run a circuit at almost 100% loading if it is handling scheduled traffic.

Fortunately, some international point-to-point circuits have been assigned for exclusively meteorological purposes. One can then take advantages of scheduling, pre-determined routing instead of addresses, high speed transmission methods, and in general use procedures particularly adapted to meteorological traffic. Fortunately the trend seems to be in this direction.

The use of aircraft of longer range and higher speed, and techniques of meteorological analysis calling for data from wider and wider areas, are creating more and more demands upon international meteorological communications. There is a limit to available radio frequencies. We are going to have to rely more and more on exchanges of processed rather than raw data, or on technical means of multiplying the capacity of circuits.

World developments in facsimile are just in the embryo stage. We have been able to advance fairly rapidly in Canada because, with our large area, we gain advantages and escape some problems, that would exist in other parts of the world. One international problem is the standardization of equipment, so that international facsimile exchanges will be possible, without freezing technical improvements. Happily, several countries are using equipment of sufficiently similar characteristics to permit exchanges of transmissions. The potential advantages of facsimile are so great that it seems inevitable that the difficulties will be overcome and large-scale facsimile exchanges will take place.

There is a good chance that numerical prediction methods will create requirements for new methods and procedures to facilitate the direct feeding of data from communications to the machines.

Codes

Having stations to take observations and a means to communicate them, the meteorological world must have a language in which to communicate. Meteorological codes form what is probably one of the nearest approaches to an international language.

In 1943, Canada began using the international synoptic code. Now most of our meteorological data is transmitted in WMO codes, except for domestic aviation weather reports and forecasts.

Meteorological codes usually give rise to considerable controversy when they come up in conferences, because they affect many different interests - the synoptician, the research worker, the communicator, the map plotter, etc. Also, there are wide differences in requirements from country to country. It was a major achievement, crowning years of effort, when in 1952 the Commission for Synoptic Meteorology developed a synoptic code that is used by all Members of WMO.

When we are tempted to criticize any international code we must remember that any of us could easily devise a set of codes that would be best for his purposes, but it is an entirely different matter to devise a code that will be acceptable to more than 80 meteorological services. Moreover, any change in code is a costly and disrupting occurrence and there are very strong reasons to adhere to existing codes until there are compelling reasons to change.

Scientific Development

The average meteorologist sees the results of the activities of WMO and ICAO mainly in the form of day-to-day tools such as weather reports, and symbols on weather maps. However, since the beginning of organized international cooperation to meteorology there has been a keen interest in the use of international organizations to advance the meteorological knowledge of the world. One of the objectives stated in the convention of WMO is: to encourage research and training in meteorology and to assist in coordinating the international aspects of such research and training.

Among the many ways in which IMO and WMO have promoted the advancement of meteorological knowledge may be listed in the following: Organization of the International Polar Years of 1882 and 1932 and the International Aerological Day programs; current collaboration in organizing the International Geophysical Year program for 1957; standardization of physical functions and constants for use in meteorology; recommendations for subjects requiring study; recommendations to promote the publishing of data needed for research in such a way as to be readily available internationally.

If there seems to be a tendency in WMO and ICAO to place emphasis on the operational rather than the research side of meteorology, it is not with any intent to subordinate the importance of research, but rather because cooperation between research workers in different countries takes place in many ways other than through the medium of these particular organizations.

Standardization and Uniformity

In international meetings dealing with meteorology, the objectives of uniformity and standardization are sometimes quoted as the strongest possible arguments in support of a proposal. A large part of the working time of international bodies in meteorology has been devoted to these ends. Without a large measure of uniformity in international meteorology, meteorologists would indeed be in difficulty.

Many of us who practice meteorology in Canada have to stop and think for a minute to appreciate the viewpoint of our colleagues in many other parts of the world on the subject of uniformity. For reasons of geography, we were for many years not as dependent as some on international uniformity of procedures. However, despite our fortunate position in this respect, the record of meteorology in Canada shows a keen interest in international standardization. The trends in meteorological techniques and applications make this increasingly essential to meteorologists in Canada as in the rest of the world. We live in the age of hemispheric charts and 6,000-mile aircraft.

We Canadian meteorologists have a stake greater than most in ensuring that world standard procedures are the best that can be devised. With our vast network of observing stations and communications, and vast area of responsibility for meteorological services, inefficiency in a procedure can be prohibitive. If the Canadian meteorologist takes a long and careful look at a proposal for a procedure before he accepts it, it is with good reason.

Uniformity is a means to an end and not an end in itself. It is usually impossible to devise a uniform procedure that is ideal for everyone. On the long road from chaos to complete uniformity, a point may be reached where the advantages of further uniformity would not justify the sacrifices that would have to be made to obtain it. If sometimes an international meeting leaves room for regional or national options in a world procedure, it may be not an admission of failure but a wise recognition of the optimum degree of uniformity.

I would not be surprised if we have reached nearly the maximum degree of uniformity in meteorological procedures and practices that the world can hope to obtain, because as uniformity is obtained in mature techniques and procedures, new ideas come forward that require an experimental approach, and would be hampered by early standardization.

To those who deplore lack of complete uniformity in meteorology, my answer is; look away from the few aspects where there is not uniformity and look at the tremendous degree of uniformity that already exists. I have been fortunate in being able to visit meteorological offices in several countries. Language and even alphabet might be quite unknown to me. But I could read the weather maps. We can exchange reports and forecasts. The degree of uniformity that exists is amazing. If in some respects there is not complete uniformity, it is a healthy sign; it means that our science is still growing.

INTERNATIONAL FINANCIAL ASSISTANCE

The thought of international cooperation in meteorology leads naturally to the idea of financing by international contributions, projects that would be beyond the resources of individual countries. The first reference I found to this idea was in a proposal made by Professor Buys-Ballot to the International Meteorological Committee in Vienna in 1873, and presented by that Committee to the Rome Congress in 1879. The proposal was for the establishment of an international fund to be maintained by contributions of States and used to finance joint research work and collective undertakings such as setting up meteorological stations on islands and in remote areas. The Congress rejected the proposal, but the general idea has recurred many times. Today it finds expression mainly in two forms, Joint Support and Technical Assistance.

Joint Support in meteorology is simply an arrangement whereby nations cooperate in financing meteorological facilities where they are needed and would not otherwise exist. The contracting states agree in detail on the meteorological services to be provided and on the means of paying for them, and the plan is put into effect. There is no altruistic motive - it is a business arrangement. Perhaps, this is one reason why it has worked so well. Examples of this type of arrangement are the Joint Support Agreements administered by ICAO for meteorological services in Greenland and Iceland, and the North Atlantic Ocean Weather Station agreement.

Technical Assistance programs, as operated under the United Nations, are somewhat different. The full title gives the idea behind Technical Assistance: The United Nations Expanded Program for Technical Assistance for Economic Development of Under-developed Countires. The idea is, speaking of technical assistance in meteorology, to assistance countries to develop meteorological services to meet their domestic needs and enable them to take their place in the meteorological world.

Examples of Technical Assistance are: WMO may arrange for a Technical Mission to conduct a survey and provide advice to a country on how to start a meteorological service or raise the level of existing services; or arrangements may be made for experience personnel to provide supervision and training in a country being aided, until their own people can take over; or scholarships may be provided to enable nationals of a country seeking assistance, to be trained in meteorology.

One great attraction of Technical Assistance is that the benefits do not stop when the supply of supporting funds is discontinued.

Both Technical Assitance and Joint Support present administrative problems. Such problems are almost inevitable when the expenditure of funds is so far removed from those who originally provide them. However, through the devoted and unselfish efforts of those responsible for those administering these projects, great benefits have been derived from them.

METEOROLOGICAL SERVICE TO CONSUMER INTEREST

Meteorology is above all an applied science. The data necessary for the study of meteorology as a pure science would simply not be available if they were not needed for application of meteorology in services for mankind.

Three of the eight Commissions of WMO are devoted to the application of meteorology with specific purposes - Agriculture, Marine Navigation, and Aviation. The Meteorological Division of ICAO exists entirely for the purpose of relating meteorology to aviation requirements.

Meteorological serivce to Aviation attracts particular attention internationally because, along with meteorology for shipping, services in this field are rendered for international use to a greater extent than is the case with most other consumer interests. Meteorology can provide service in many fields of application, without the service going beyond national borders. But service for aviation involves, on a world-wide basis, detailed coordination between meteorological offices, and provision of services to flag carriers of many countries. Weather service for aviation is, therefore, particularly international in character.

I could spend an evening very easily discussing current activities in the field of meteorological service for international aviation, but I would earn the accusation of devoting too much time to aviation. So I will leave it with the remark that procedures in this field have by no means settled down. The tremendous expansion of aviation is placing great demands on meteorological services, and in my opinion these demands cannot be met by procedures in which the amount of work is more or less in direct proportion to the number of aircraft. There must be an evolution toward mass production methods to an increasing extent.

Sometimes there is a tendency to regard aviation as being in competition with other consumer interests for meteorological services. I consider it more correct to regard aviation along with other users, as helping to provide the incentive that leads to better meteorological services for all. Fortunately, it is generally only in the final stages of preparation that meteorological information is tailored to the particular consumer interest, and when meteorological resources are increased to serve aviation or any other user, the capacity for service to all is increased. There are exceptions to this, but in general I am sure that all users of meteorological service have benefitted because of the requirements of aviation.

If one does not hear as much about Maritime Meteorology as Aviation Meteorology it is only because Marine Navigation is in a more mature and settled state than Aviation, and its requirements are more stable. However, in the field of Marine Meteorology, a well-organized worldwide shheme for obtaining reports and issuing forecasts has been devised, and has been going along quietly and efficiently for years.

It must be rememberedthat prior to Aviation, Marine requirements gave great impetus to meteorology in general. It seems that when a man tkaes it upon himself to leave his home and travel about the face of the earth, he becomes more vulnerable to weather, and therefore transportation in its various forms has provided valuable incentive to the provision of weather services.

It is in the field of Agriculture that meteorology can be of probably more importance to man than in any other field. The immediate safety aspect is not evident as it is in aviation, but the development of agriculture in a new area without due regard for the information that meteorology can provide, can lead to human suffering perhaps greater than the crash of an aircraft. Even a small increase in the efficiency of agricultural practices, can be potentially of economic value far in excess of all aviation. Agricultural meteorology can easily be neglected because agriculture is not a new activity and does not have the spectacular appeal of some other activities. However, considering the magnitude of the food production in the world today, agricultural meteorology is, perhaps the most important branch of meteorology in the future.

I have touched on only a few applications of meteorology that received international attention, and I have not mentioned the various files into which meteorological science is commonly divided - Climatology, Research, Forecasting, etc. I would like to go back and make one more remark about the spirit of WMO. WMO is primarily an organization to facilitate accomplishments by national meteorological services, rather than an organization to take over such functions. It operates on a budget remarkably small as international organizations go, considering its accomplishments. This is because of the tremendous spirit of cooperation put forward by its members.

Much has been achieved and we are, I believe, on the eve of new problems. The potential demands for meteorological services are so great that they cannot be met simply by adding to the number of meteorologist who work by present methods. Ways have to be found of increasing the productivity of meteorologists. These will present new problems and new opportunities for international cooperation in meteorology.