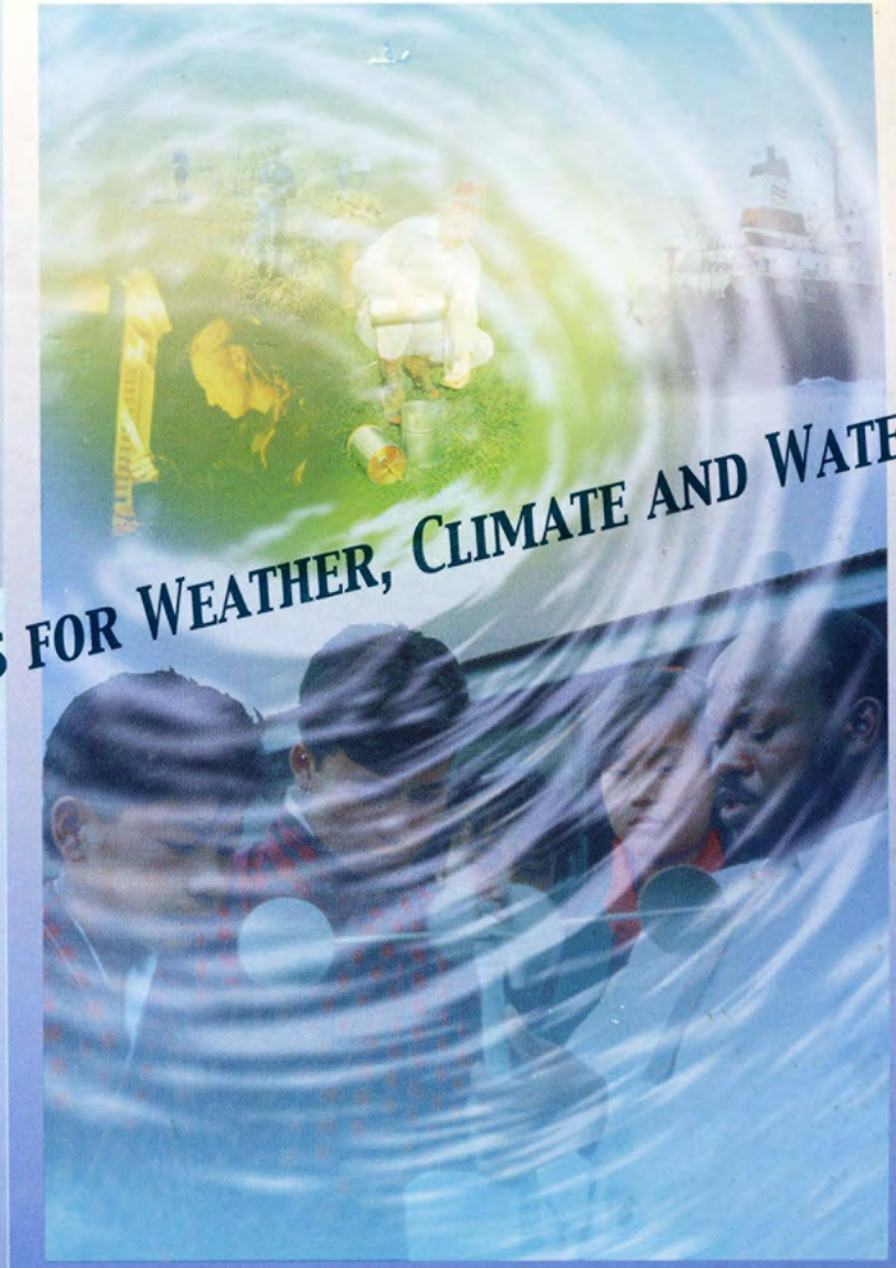
World
Meteorological
Organization



VOLUNTEERS FOR WEATHER, CLIMATE AND WATER

2001
International Year
of Volunteers

World Meteorological Organization

VOLUNTEERS FOR WEATHER, CLIMATE AND WATER

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2001 International Year of Volunteers

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NOTE

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CONTENTS

FOREWORD

Each year, World Meteorological Day is celebrated on 23 March to commemorate the coming into force of the Convention of the World Meteorological Organization (WMO) in 1950. For each anniversary, WMO selects a theme of topical interest to humanity. The United Nations having declared 2001 the International Year of Volunteers, WMO chose *Volunteers for weather, climate and water* as the theme for World Meteorological Day 2001, to give broader recognition and greater prominence to the contribution of volunteers to meteorology and hydrology.

Indeed, since the early days of these sciences, volunteers, including selfless individuals and institutions such as schools and religious groups, are known to have assisted meteorologists and hydrologists, especially in their operational work and in the promotion of the sciences. In this respect, volunteers are known for their perseverance and commitment and for sharing a fascination for meteorological and hydrological phenomena.

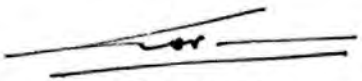
In some countries, especially in the event of natural disasters, volunteers are often called upon to take measurements and communicate near-real-time data, such as on precipitation, temperature and river levels, for use in early warnings to the populations under threat. Volunteer storm spotters provide on-the-scene and up-to-date information that often complements that provided by weather radars and satellites.

In addition to individuals, the concept of volunteerism could also be extended to include relevant activities by governmental institutions, civil societies and the private sector. In this regard, National Meteorological and Hydrological Services (NMHSs) provide a wide range of voluntary contributions such as expertise and infrastructure in support of WMO scientific and technical programmes, regional associations and technical commissions. The NMHSs also arrange for voluntary observations from aircraft and ships. For example, over 6 700 ships participate in the WMO Voluntary Observing Ships (VOS) Programme. The real-time data collected from these ships and from aircraft are vital for weather forecasts that contribute, *inter alia*, to the safety and efficiency of air and maritime transport. The data are also useful for other activities such as studies on ocean-atmosphere interaction, prediction of the El Niño phenomenon and climate change.

A number of other mechanisms that assist in ensuring important voluntary contributions include the operation by several WMO Member countries of regional training centres as well as meteorological centres which freely provide weather and climate forecasts, and advisories related to natural disasters such as tropical cyclones, floods and droughts. Within the context of the WMO/United Nations Environment Programme (UNEP) Intergovernmental Panel on Climate Change, Member countries provide the services of over 3 000 scientists and experts for the preparation of assessment reports which form the basis of humanity's actions in relation to climate change. The WMO Voluntary Cooperation Programme fosters global cooperation whereby Member countries volunteer to assist each other in the implementation of WMO Programmes and

activities. Within the UN system, WMO collaborates with the United Nations Volunteer Programme that offers expertise for the implementation of a wide range of development projects.

The volunteer services of individuals, nations and international organizations therefore need greater recognition for their valuable contributions to meteorology and hydrology and indeed to socio-economic development in general. Even as socio-economic and technological factors change the pattern of meteorological and hydrological networking around the world, it is my hope that volunteer work — be it provided by individuals, civil societies or governments — will continue to make an indispensable contribution to the advancement of meteorology, hydrology and related geophysical sciences and their applications to the sustainable development of nations in the 21st century.



(G.O.P. Obasi)
Secretary-General

"It is appropriate, at the beginning of the new millennium and following the celebration of the 50th anniversary of WMO in the year 2000, for WMO to join the world community in paying tribute to the volunteers who have been making significant contributions to meteorology, hydrology and the related geophysical sciences"

G.O.P. Obasi, Secretary-General,
World Meteorological Organization

THE CONTRIBUTION OF VOLUNTEERS TO NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES

Weather and climate know no national boundaries. International cooperation on a global scale is therefore essential for the development of meteorology and operational hydrology, as well as for reaping the benefits from their application. Networks of weather and climate observers, and international cooperation in the field of meteorology, developed concurrently in the 19th century and have grown and gained momentum ever since. The contribution of volunteers has been invaluable in this process.

National Meteorological and Hydrological Services (NMHSs) around the world have traditionally relied on thousands of volunteers to gather data on climate and weather. The sets of data normally gathered by volunteers include climate data such as daily temperatures and precipitation; extreme weather phenomena, such as tropical cyclones or tornadoes; or hydrological information on river flows. Most of the raw data or 'readings' obtained by these networks of volunteers and cooperative observers are transmitted to national weather and hydrological centres, which merge these data, as appropriate, with other synoptic data to produce weather forecasts or other products.

A long dry spell... volunteer rainfall observer Rick Grocke checks the rain gauge at Tanami Downs cattle station in the Northern Territory of Australia (Australian Bureau of Meteorology)

Local weather observations made by volunteers are valuable to a wide range of users such as farmers, utility planners, businesses and local governments. Planners and decision makers use these observations, and others obtained from NMHSs, to plan the socio-economic development of a place or region. These are also used to prepare in advance for impending hazardous weather conditions (hurricanes, floods, etc.) at the local, regional and national levels, as well as contributing data to the regional and global weather picture. The information gathered helps NMHSs in their continuing study of the weather and climatic fluctuations that affect both economic activity and everyday life, thereby making a valuable contribution toward a greater understanding of the climate and its effect on the environment.

Why are volunteers needed?

Automatic weather observations are not only possible, but are in common use, and fully automatic data reporting from weather or

climate stations gives users more frequent access to information. However, this does not diminish the value of the work of volunteers. On the contrary, observational networks would be compromised without the active participation of volunteer observers. Ground-, air- and sea-based voluntary observations continue to be useful because they:

- Provide essential inputs to operational weather forecasting;
- Add to the growing knowledge of ocean climates;
- Increase understanding of the links between the oceans and the atmosphere;
- Contribute to the development of important historical databases.

Nowadays, meteorologists use sophisticated equipment and models in the preparation of weather forecasts. In addition to the measurement of basic meteorological variables, they use modern remote sensing and observing systems such as weather satellites, Doppler radars and other advanced technology to develop increasingly accurate forecasts. Modern weather forecasting also relies heavily on computerized numerical weather prediction (NWP) models. The accuracy of the initial conditions used in the model forecasts affects their accuracy, that is, *in situ* observations and local information can contribute to the accuracy of forecasts.

The network of meteorological, hydrological and climate stations has been designed to obtain data from all regions of the globe. The fact that some data are collected by volunteers partly relieves the financial burden on NMHSs.

The data collected methodically by volunteers from conventional equipment such as Stevenson screens have contributed to knowledge of the human and natural processes affecting the atmosphere, land and oceans. The understanding of climate change and variability is likewise based on climate observations

Volunteer measuring the rate of evaporation of water using a Piche evaporimeter; behind is a traditional "Stevenson screen" instrument housing

Economic benefits

The important contributions that volunteers make are often overlooked in both developed and developing countries. Indeed, most countries do not take their services into account when calculating national output. In the few countries where they have been measured, it is estimated that volunteer activities make up between 8 and 14 per cent of the Gross Domestic Product. In the United States, for instance, the volunteer workforce represents the equivalent of over 9 million full-time employees, at an annual value of $225 billion. In Canada, one third of the population does voluntary work, providing over 1 billion hours of their time to the service of others every year [estimated at 16 billion dollars per year, or 8 per cent of GDP]. And in the United Kingdom, the same applies to nearly half the population.

United Nations, Press Release of 28 November 2000

"I have a passion for the weather volunteer observers. In many ways, they are like the explorers of Canada. I mean very modest people, very ordinary kinds of Canadians, but they all share a passion for watching the sky and looking at the texture of clouds and taking weather observations."

Quote from Phillip Graham, volunteer weather observer, from a transcript of a Canadian Broadcasting Corporation television show *Nature of things* (telecast on 27 March 2000)

Storm spotters

Volunteer storm spotters track severe storms (such as tornadoes, shown at right) for the National Weather Service (NWS), USA. Meteorologists are able to identify and issue warnings for 90 to 95 per cent of the severe storms that blow through the central part of Texas. The improvement is due in part to Doppler radar but also to the storm spotters who track the storms. These trained spotters are indispensable, as they provide on-the-scene, up-to-date information that backs up other NWS technologies such as radar and satellite. This information is reported to meteorologists through a network of amateur radio operators. The concerted effort and solidarity that are so often seen in extreme weather events or in natural disasters are, in many respects, reinforced by the fact that critical functions, from those of amateur radio operators to fire fighters, are carried out by volunteers.

spanning more than a century and, in some places, even longer. In conjunction with other data such as from tree rings, these observations have enabled scientists to test the accuracy of complex computer models used to simulate the climate of the recent past and to make projections of the future state of the climate.

In short, the more observations the better. At times, the success of crucial forecasts during extreme weather events depends on the availability of critical ground-based observations. For example, if a Doppler radar in a Meteorological Service shows the beginnings of a dangerous weather event like a tornado, a trained volunteer on the ground can quickly confirm that a storm is under way. Every detail, such as the size of hail or the strength of the wind, received by meteorological and emergency services is important and helps them take appropriate measures. An example of this is when weather reports received from a lighthouse during a yacht race alerted forecasters to the strength of the wind and enabled them to issue the necessary storm warnings.

Why do people volunteer their services?

Voluntary observers making weather, climate or hydrological observations provide clear benefits for the well-being and security of their communities. Farmers have a strong interest in weather and climate and are especially keen to know the positive and negative impacts of weather on their livelihood — agriculture. In Mauritius, if the sugarcane crop is damaged or

destroyed following cyclones, droughts or excessive rainfalls, the loss assessment for insurance purposes is based on meteorological data that include those of the country's network of volunteer observers.

In Israel, most of the volunteers are traditionally from the agricultural sector, be they from agricultural schools or farmers from rural settlements and cooperatives.

Volunteers living close to rivers are well aware of the need for timely flood warnings and can be proud to be associated with an effective and efficient flood forecasting and warning service that exists to protect the safety, economy and welfare of their communities. Those ships or aircraft participating in voluntary schemes are providing meteorological data needed for the weather forecasts which will serve to guide a safe passage to their destination.

Volunteers need not, however, have a direct professional interest in the weather and its effects. For many, it is a hobby and an object of study and interest. Others are fascinated by weather phenomena. In different parts of the world, people of all ages and from different backgrounds become volunteers, including students, schoolteachers, retirees, farmers, civil servants, home-business owners, retired military personnel, missionaries, civil engineers, lighthouse keepers, and park and forest rangers, to name but a few.

Cape Agulhas lighthouse and weather station

Dangerous seas, unpredictable currents, dense fog and frequent gales have caused numerous shipwrecks through the years. Established in 1849 on a desolate and rocky stretch of coastline at the southernmost tip of Africa at 34 50S, 20 01E, the lighthouse at Cape Agulhas is South Africa's second oldest. The limestone structure gradually became unsafe but was refurbished and the lighthouse officially recommissioned as a navigation aid in 1988 and designated a national monument. The lighthouse also serves as a fascinating museum, the first of its kind on the African continent, and the surrounding area was declared a nature reserve. Its closest neighbour is a small fishing community and from the lighthouse one looks down upon the "Southernmost Point in Africa", a popular tourist site. Meteorological observations at the lighthouse, made voluntarily through the years by lighthouse keepers, commenced in 1855 and have continued in various forms ever since. The synoptic station (68920) is now a WMO reference station, augmented by a nearby automatic weather station.

South African Weather Bureau

Volunteers on every continent have been providing valuable service to their communities for hundreds of years [left: measuring rainfall (Meteorological Service of Canada); *centre: changing an autographic chart at a nature Education Centre* (Hong Kong Observatory); *right: reading an automatic rain gauge in Cape Verde* (Food and Agriculture Organization of the United Nations)]

Perseverance and commitment are two of the most common personal characteristics of volunteers. It is not uncommon to come across volunteers with 50 years of service, or individuals forming part of the second or third generation of volunteers, for example the Hawker family in South Australia who has been recording rainfall on a daily basis since 1860. In many countries, certificates and awards are presented to individuals and families who have reached milestones of long-time continuous service as volunteer climate observers. The ceremonies are often timed to coincide with World Meteorological Day or held during special national events, such as National Volunteer Week in the United States. In 1999, the Irish Meteorological Service presented an award for long service to a 93-year-old man who had faithfully measured the rainfall daily for an unbroken period of 56 years. New generations of volunteers are ready to take up the challenge. In 1999, more than 600 Argentinians offered their services after the *Servicio Meteorológico Nacional* appealed for volunteers to participate in a denser network of rainfall stations.

Extending a long tradition of amateur science, certain activities undertaken by some of the volunteers are highly professional. Some volunteers use sophisticated meteorological equipment, and publish annual summaries and descriptive climatological studies. In Mauritius, the strongest gusts ever recorded in the South-West Indian Ocean were traced on a volunteer's anemogram in 1968. In Israel, volunteer observers, under the guidance of professionals, have issued publications on their regional climate, based on their long-term systematic observations.

In some countries, training seminars and lectures are regularly given to voluntary weather observers on general developments in meteorology and related disciplines. These are designed to help them master the intricacies of operating and maintaining equipment; handling instrument standards and calibration procedures; subtleties of the standard meteorological codes for exchanging observations; new observation systems; and the variety of computer systems for entering data on-site.

Historical development of volunteer observing networks

In different countries and continents, networks have mushroomed. In Mauritius, systematic meteorological observations began in 1774 and by the mid-20th century the island counted

a network of 250 rainfall stations, 10 climatological and 25 agrometeorological stations, 90 per cent of which are managed by volunteers. In Israel, several thousand volunteers have provided vital meteorological data by carrying out rainfall observations and taking responsibility for entire synoptic, climatological or agrometeorological stations for many years. Rainfall being an important meteorological element affecting its economy, the Kenya Meteorological Department established a dense network of 2 000 rainfall stations around the country. In 1904, the Station Master of Kipkelio's railway station was the country's first volunteer observer — a tradition that has been upheld by subsequent stations masters, as well as by farmers and foresters throughout the country. The use of volunteers at the Spanish *Instituto Nacional de Meteorología* (INM) dates back to the early part of the 20th century. In 1913, the INM had around 400 volunteers who worked in 400 stations, principally measuring temperature and precipitation. There are now 4 000 such stations throughout Spain.

In Australia, volunteer and cooperative observer networks have existed for a century and a half. These have not only provided the country with data to describe and understand its highly variable climate, but also prepared the foundations for climatologists to develop useful seasonal predictions. By the late 1880s, more than 6 000 sites had already been established. Most of the observations focused on rainfall, because of Australia's reliance on agriculture, and were taken for no payment — a service that continues today. Australia has a history of extreme floods, thus measurements of rainfall and river level are vital elements in the development of forecasting and warning services. The operation of rainfall and river-level data collection networks was originally totally reliant on the services of volunteer observers. Automated equipment is now used at most sites, but volunteer observers continue to provide a valuable service.

In the United States, there has been a vast network of cooperative observers reporting weather findings such as temperature and precipitation to the National Weather Service on a daily basis since the 1890s. These volunteer observations became part of the country's weather annals and, through daily measurements, have helped meteorologists and climatologists shape their understanding of the relationship between weather, water and climate. Many of the 11 700 volunteer weather observers across the United States have taken weather records for decades, passing down the tradition from one generation to the next. In some cases, these records have been collected at the same locations for more than 100 years.

Since about 1840, the Meteorological Service of Canada has relied on a network of several thousand volunteers across the

National meteorological and hydrological societies

Volunteer activity also takes place within national meteorological and hydrological societies. A number of countries have national societies. At the regional level, societies such as the African Meteorological Society and the European Meteorological Society have been established. While many societies comprise a few dedicated staff, they all benefit from the participation of dedicated, altruistic and experienced scientists in activities related to the science of meteorology and its applications at the national level. These involve, for example, developing and disseminating knowledge of meteorology and related sciences; promoting and advancing the professional application of meteorology; promoting among the public an understanding of weather and an appreciation of the value of meteorology and its applications by means of popular lectures and short meteorology courses; and organizing seminars lead by academic researchers, practising meteorologists and eminent visiting scientists.

Field visits by students to weather stations, such as in the Seychelles, above, are at the same time informative and a means of encouraging their participation in voluntary weather observing projects

country. The National Climate Archive in Downsview, Ontario, houses more than seven billion observations collected throughout Canada over the past century and a half. A large number of these observations have come from a network of more than 3 000 volunteer climate observers from every province and territory in the country.

The first scientific meteorological observations by South African volunteers date back almost 150 years. Various official data collecting agencies relied heavily on volunteer observers as a source of meteorological information. In 1860 there were 11 volunteer observers and by 1898 the observations network had grown to 90 temperature and 451 rainfall observing stations. By the late 1940s, there were 350 climate stations, 80 of which were synoptic stations, and 4 500 rainfall stations were in operation — all operated by volunteer observers.

Volunteers in schools

There are numerous projects around the world aimed at giving children and adult weather enthusiasts an opportunity to learn about weather, while providing scientists with valuable data. Typically, volunteers measure rain and hail from their homes or schools and report their findings to a local weather office or other schools using the Internet. In the United Kingdom, Metlink International is a collaborative schools' weather project sponsored by the Royal Meteorological Society and the UK Met Office that aims at encouraging an appreciation and understanding of weather from both scientific and geographical standpoints. The project, which began in 1998, is open to students of all ages worldwide and includes schools not only in the UK, but in Africa, Asia, Australia, Europe and North America.

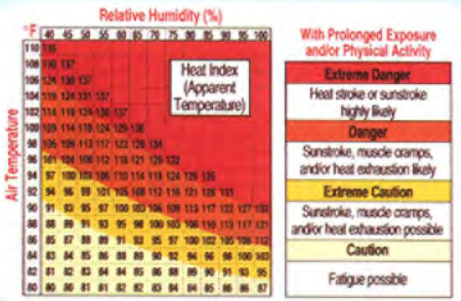
Community early warning systems

In response to emergencies such as Hurricane *Mitch* in 1998, which showed that volunteers are ready to provide observations and operate warning dissemination systems to reduce the risk of a natural disaster, a number of Central American countries have adopted an approach based on risk reduction rather than disaster response. When risk levels increase, volunteer observers are asked to measure rainfall and report the results every hour to the forecasting centre. Once rainfall exceeds a critical level in the space of one to three hours, the levels of the river and its tributaries are measured. When the river surpasses its critical flooding level, the forecasting centre notifies the local emergency committee which issues a public warning and activates an emergency plan. These community early warning systems have the advantage of being very simple to operate in raising the awareness of rural communities to the risk of natural disasters.

Use of volunteers in heatwave emergencies

Some volunteers are active in helping vulnerable persons during heatwave emergencies. In Philadelphia, USA, volunteers are used whenever the city's Health Commissioner declares a heatwave emergency. When this occurs, the media are contacted and asked to inform the public that heat illnesses could follow. The media then broadcast steps that should be taken to lessen the likelihood of a heat problem, such as staying in air-conditioned premises if possible, drinking plenty of fluids and taking a cool bath. The intervention system also foresees a "buddy system", whereby a volunteer assigned to each street makes a door-to-door check on the elderly and infirm, providing support and advice, or calling an ambulance or arranging for other assistance, as necessary.

Following the success of the Philadelphia project, WMO is working with China's meteorological and health authorities in Shanghai to pioneer a similar heat emergency intervention plan. This showcase project is based on proven climate applications that correlate historical climate and mortality data with dangerous air masses. When a heat emergency is declared, city dwellers will be given information to mitigate the life-threatening effects of extreme heatwaves.



This Heat Index card was produced as part of a joint WMO/National Oceanic and Atmospheric Administration (NOAA, USA) project for distribution to participants and visitors at the 1996 Olympic Games in Atlanta, to make them aware of the risks associated with heat illnesses

INTERNATIONAL COOPERATION IN METEOROLOGY AND HYDROLOGY

International voluntary cooperation in meteorology and hydrology has existed since the mid-19th century, when weather kites were used to take recording instruments to high levels; see page 17 for up-to-date observational methods

Meteorological observations have been made since antiquity. Records of the earliest civilizations contain innumerable references to weather and climate. The first network of observation stations is thought to be that created by Ferdinand II of Tuscany in 1654. The development of instrumentation, such as the air thermometer in 1600 by Galileo, the rain gauge in 1639 by Castelli, the barometer in 1644 by Torricelli and an anemometer by Hooke in 1664, enabled scientists in the 1700s and 1800s to make considerable progress in determining the basic physical laws which underpin the understanding of meteorological phenomena. The discoveries include those of Hadley (1735) on trade winds and the rotation of the Earth, Franklin (1752) on atmospheric electricity, and Lavoisier (1783) and Dalton (1800) on the nature, condition and composition of the mixture of gases that make up the atmosphere.

(National Oceanic and Atmospheric Administration, USA)

By the 1800s, meteorological observing stations and networks grew rapidly in different parts of the world as technological developments made it possible to gather, analyse and transmit data. With the invention of the electric telegraph, developed by Samuel Morse in the 1830s, weather stations could transmit their observations, and weather maps, incorporating data measured simultaneously from remote places, could be produced. This information was valuable to the rapidly growing industrial, commercial and agricultural sectors.

International voluntary cooperation in meteorology was first achieved in the field of marine observations when a conference was convened in Brussels in August 1853. The organizer of the event, US Navy Lieutenant Maury, suggested that the navies of all the maritime nations of the world should work toward standardizing meteorological observations. The momentum generated by this conference, and the widely-felt need for concerted international efforts to deal with meteorological problems common to the international community, eventually led to the establishment of the International Meteorological Organization in 1873 and to its successor, the World Meteorological Organization, in 1950.

Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change was established by WMO and the United Nations Environment Programme (UNEP) in 1988. WMO hosts its Secretariat. There are currently more than 3 000 scientists and other experts from around the world providing expertise, research and voluntary service in drafting, reviewing and finalizing the IPCC reports on various aspects of climate change. These highly-qualified scientists and experts cover a large number of disciplines, such as climatology, hydrology, agriculture, forestry, and other issues such as sea-level rise projections, sustainable development, equity issues and costing methodologies. The level of participation by scientists and other experts from developing countries or those with economies in transition has increased steadily in IPCC over recent years. The current mandate of IPCC is to assess the science, the impacts and the economics of climate change and the mitigation/adaptation options available to address climate change. It also provides scientific, technical and socio-economic advice to the United Nations Framework Convention on Climate Change (UNFCCC) bodies. Since its inception, IPCC has produced a series of Assessment Reports, Special Reports, Technical Papers, methodologies and other products that have become standard works of reference, widely used by policymakers, scientists and other experts in all parts of the world. Some of these can be viewed at http://www.ipcc.ch.

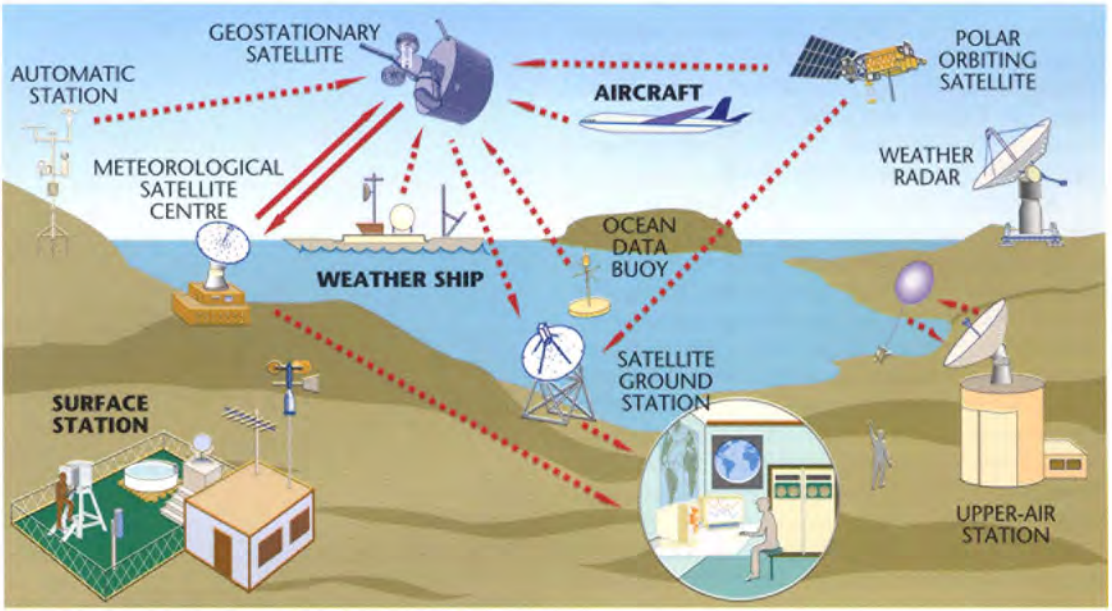
International cooperation in scientific experiments

One of the unique aspects of meteorology is that the volunteer principle of mutual aid is also extended to the exchange of data between nations and their NMHSs, with the result that local information is aggregated to national, regional, and then, via WMO's World Weather Watch, to global levels.

As stated above, systematic observations of the weather extend back for centuries, but mechanisms for their distribution and exchange are more recent. WMO has been responsible for some of the best examples of international cooperation in scientific experiments, exchange of data and expertise, and provision of services. Its pioneering role in the global coordination of geophysical and meteorological experiments has contributed to remarkable advancements in weather forecasting and the geophysical sciences; these include the International

During the International Geophysical Year, an increased programme of weather observations in the higher atmosphere was implemented world-wide; shown is a sun observation on an ice shelf in Antarctica for precise positioning
(US Navy)

Meteorology depends on complex technological interactions; even so, ground-, air- and sea-based voluntary observations provide essential inputs to operational weather forecasts and warnings



Exchange of meteorological and hydrological data and products

Recognizing the interdependency of all countries in the face of natural and human-induced disasters and that weather forecasting could only be effective if seen as a global activity, WMO formalized the free exchange of meteorological data and products between its Members in 1995, through its Resolution 40 of Twelfth Congress, and that on hydrological data and products in 1999, through its Resolution 25 of Thirteenth Congress. These two resolutions provide a unique framework for the free and unrestricted exchange of meteorological and hydrological data and products among Members to sustain their programmes and activities in support of the protection of life and property and the well-being of nations, and to fulfil obligations under international conventions.

WMO has published two brochures on the subject: *Exchanging meteorological data — Guidelines on relationships in commercial meteorological activities — WMO policy and practice* (WMO-No. 837) and *Exchanging hydrological data and information — WMO policy and practice* (WMO-No. 925).

Geophysical Year (1957/1958), Global Weather Experiment (1978/1979), Alpine Experiment (1982), and the Coupled Ocean-Atmosphere Response Experiment (1992/1993) within the Tropical Ocean and Global Atmosphere (TOGA) programme (1985/1994).

Scientific data gathering has a long history, as data constitute the raw material of scientific understanding. On completion of the International Geophysical Year in 1958, Sir Arthur Davies, then Secretary-General of WMO, paid a special tribute to the thousands of meteorological observers throughout the world for having made the required observations with accuracy and enthusiasm: "The collection of data" he said, "constitutes a unique contribution to future development in the science of meteorology".

WMO's role and participation in the voluntary scientific collaboration and data exchange on a global scale are unique. Numerous examples of this spirit of collaboration exist, such as the WMO World Data Centres (WDCs) which operate under the umbrella of the Global Atmosphere Watch (GAW). These centres collect and archive data on the background chemical composition and related physical characteristics of the atmosphere from all parts of the globe and then distribute the derived data, products and information. Currently, there are WDCs collecting data on ozone and ultraviolet radiation in Canada; greenhouse gases in Japan; aerosols in Italy; solar radiation in the Russian Federation; precipitation chemistry in the United States; surface ozone in Norway; and a Global Runoff Data Centre in Germany.

National weather and climate data and information are exchanged on a regular basis between nations, through the World Weather Watch Programme.

The World Weather Watch

The World Weather Watch, a unique voluntary global operational system for the collection, exchange, analysis and forecasting of weather and other environmental information, makes an invaluable contribution to international cooperation. Fundamental to the success of the World Weather Watch are the clear guidelines developed by WMO to ensure that the millions of observations from ground-based weather stations, ships, satellites, balloons and ocean buoys are consistent and compatible. These data make it possible to run sophisticated computer models of the state of the world's oceans and atmosphere and for national weather centres to issue timely forecasts and warnings on weather-related natural disasters to ensure, as far as possible, the safety of life and property. The data also provide a standardized high-quality database on weather, water and climate for research and applications.

INTERNATIONAL VOLUNTARY COOPERATION AND VOLUNTARY WORK

The NMHSs of WMO's 185 Members have also collectively contributed voluntarily to the scientific and operational work of the Organization by sharing observations, encouraging standardization, and exchanging data. The World Weather Watch and several other WMO Programmes, such as the Hydrology and Water Resources Programme through its World Hydrological Cycle Observing System, ensure that each meteorological or hydrological centre is connected as an equal with others in terms of access to information and expertise.

Voluntary observing ships recording and transmitting meteorological observations are a vital component of the World Weather Watch

Voluntary Observing Ships (VOS)

As early as 1853, leading seafaring nations organized the first formal international meteorological meeting to voluntarily coordinate weather observing at sea. Since that time, ships' meteorological observations have provided essential inputs to progressively more accurate weather forecasts and warnings. Today, WMO's World Weather Watch coordinates around-the-clock monitoring to take the pulse of the weather over the oceans and the continents, drawing on meteorological observations from ships, drifting and moored buoys, oil rigs and satellites, as well as from inland observing sites.

The WMO Voluntary Observing Ships (VOS) Programme, under which ships are recruited by NMHSs to record and transmit meteorological observations (the most critical being air pressure, air temperature, sea-surface temperature, wind and sea-state), is an essential component of the World Weather Watch. Meteorological observations from VOS make a vital contribution to marine safety and efficiency, providing both real-time reports needed for weather forecasting and historical data needed for planning and design. They contribute substantially to increasing the understanding of atmosphere-ocean linkages, and are essential in addressing the issue of global warming and for the development of accurate long-range weather forecasts.

In early 2000, there were just over 6 700 vessels from 52 countries participating in the VOS Programme. The observations, made by officers on board vessels in the Programme, are

Hydrology in Africa

In many African countries, volunteers are often instrumental in enabling National Hydrological Services to play a more effective role in the socio-economic development of their countries. The Hydrometeorological Survey for the Equatorial Lakes in East Africa was a most successful WMO/United Nations Development Programme (UNDP) project, to which volunteers made a considerable contribution. The first phase, launched in 1967, consisted of a basin-wide network for hydrological and meteorological data collection in the Nile Basin and aimed to provide data as input for a mathematical model developed for water resources management of the Nile Basin during the second phase. One of the important criteria for selecting the hydrological station included both the location and the presence of people who could volunteer to read the rain gauges, installed in easy-to-reach locations such as in schools, government offices, public areas or by the banks of rivers and lakes.

A volunteer (right) learns to use a staff gauge; his readings can be compared with those from the automatic water level recorder in the foreground (P. Mosley)

recorded in meteorological logbooks and coded in a standardized format for immediate transmission to shore. These observations are then routed around the world on WMO's Global Telecommunication System (GTS) for use by meteorologists, ship-routing services, radio and television broadcasters and other clients. The Programme operates at no direct cost to participating ships, as no communications charges are levied for the transmission of these meteorological observations.

Recent technological advances have made it possible for volunteer observers to carry out complex observational tasks previously performed by meteorological and oceanographic specialists. As a result, voluntary shipboard observing programmes have expanded to include observations of the upper atmosphere and subsurface oceanographic measurements from a relatively small number of specially selected ships.

Aircraft observations

From the early days of aviation, meteorological information was considered to be vital for the safe conduct of flights. Despite the remarkable progress made in weather observations and

Airline companies benefit directly from meteorological observations made by aircraft, as 40 per cent of fatal aircraft accidents involve weather factors (S. Béliveau)
Inset: external ASDAR antenna on a Boeing 747 (British Airways)

forecasting, more than a one-third of aircraft accidents are weather-related and 40 per cent of fatal accidents involve weather factors. Even with the increased horizontal and vertical resolution of the numerical weather prediction models, more accurate and high-resolution data are needed — even in countries with extensive radiosonde networks.

Voluntary observations from commercial aircraft are playing an increasingly important role in the provision of timely and accurate upper-air observations, and as such are becoming an important part of the upper-air observing network. The future requirement will be met by a combination of many types of data where wind and humidity observations are more important for local or regional forecast models. Future activities will involve the combination of aircraft, satellite and other observational data to form a composite observing system. Targeted observations may be used to improve the forecast of extreme weather situations.

The improved availability of basic meteorological data and satellite high-quality imagery from the World Weather Watch has contributed largely to improved accuracy and timeliness of operational aeronautical meteorological information. It is expected that the increased availability of high-quality and timely automated meteorological reports from aircraft — from 3 500 AMDAR (aircraft meteorological data relay) reports per day a few years ago to today's level of 78 000 reports per day — and the continued installation of automated observing systems at airports will contribute to improved quality of weather forecasts that will subsequently benefit aviation. The progressive global implementation of the new communication, navigation, surveillance and air traffic management system to accommodate the needs of aviation for the 21st century is expected to increase demands for higher standards in weather observing, forecasting and reporting for aviation.

WMO Voluntary Cooperation Programme

The WMO Voluntary Cooperation Programme (VCP) focuses on global cooperation among National Meteorological and Hydrological Services within the WMO community. Member countries volunteer to assist each other to enhance capabilities in the implementation of WMO's scientific and technical programmes. The Programme complements the range of

other implementation activities carried out under national, bilateral or multilateral programmes and the United Nations Development Programme (UNDP). The Voluntary Cooperation Programme's success is largely due to the high degree of cooperation between NMHSs, as well as the collaborative efforts and commitments of those countries that provide equipment, fellowships, expertise and financing through the Programme, and the recipient countries that have ensured their effective use by providing considerable counterpart contributions from national resources, such as the provision of the required local infrastructure, staffing and operational costs.

To ensure that weather centres in developing countries can provide better meteorological and hydrological services, VCP coordinates the support provided by countries with more developed NMHSs. Coordinated efforts are being made through various measures, including:

- The implementation of the World Weather Watch;
- Granting short-term and long-term fellowships;
- Support to meteorological applications activities;
- Support for the activities of the Hydrology and Water Resources Programme;
- Establishment of observing and data-processing facilities necessary for the World Climate Programme;
- Establishment and maintenance of the Global Atmosphere Watch stations; and
- Support for meteorological and hydrological activities related to environmental protection.

United Nations Volunteers

United Nations Volunteers (UNVs) with key professional skills have been regularly assigned to WMO projects throughout the world for many years. Close to 40 UNV specialists have contributed a wide range of expertise to projects implemented by WMO in developing countries. The UNVs assigned to WMO have worked in fields as varied as agrometeorology, hydrology and training. At various times during the past decade, hydrologists, hydrogeologists, oceanographers, water ecologists, meteorologists, agrometeorologists, aeronautical forecasters, telecommunications experts and energy technicians from countries in Africa, Asia and the South Pacific have volunteered their services.

On one UNV project, the task of a volunteer aeronautical forecaster consisted of

The training of volunteers for weather, climate and water takes many forms, from highly organized to the grass-roots level, and from one-on-one to group participation
(Centre: ACMAD)

Basil Tibanyendera of Uganda, a UNV meteorological specialist, demonstrates meteorological instruments in Bhutan (F. Pommaret)

analysing surface and upper-air charts and preparing 24-hour public weather forecasts and flight documentation for aircraft on a daily basis. "When I arrived here, about 30 flight documents a month were being prepared. Within two years we were preparing a minimum of 100 documents a month and, during the peak season, about 160", he said. A key aspect of his work involved training local counterparts in aeronautical forecasting techniques. The aim of the project was to train at least ten local forecasters to WMO standards so they could continue preparing forecasts and flight documentation after the departure of the UNVs.

Another project consisted of seven UNV specialists assigned over five years to help the country's government efforts to develop a more comprehensive and effective weather-forecasting system. The aim was to provide an accurate forecasting service for farmers to improve food security in the drought-prone country, where water is a much valued resource. With support from WMO, UNDP and UNV, the National Meteorological Service established a wider network of climatological stations throughout the country, the computerization of databanks and the repair and calibration of meteorological equipment.

CONCLUSION

Volunteer observers historically have been — and remain to this day — a constituent part of National Meteorological and Hydrological Services around the world. Their continuing involvement is a symbol of the cooperation and collaboration that exist between individuals working at the local level, on the one hand, and regional, national and global services and organizations on the other. Their continued participation in providing weather and climate observations and expertise is proof, if proof were needed, that weather has a direct impact on daily life and professional activities.

Major environmental issues of global concern have begun to place new and unprecedented demands on National Meteorological and Hydrological Services and WMO for the application of meteorology and hydrology. Therefore, as the world moves forward into the new millennium, the volunteers for weather, climate and water will need to extend and reinforce their collaboration with the NMHSs and WMO in contributing to the protection of life and property against natural disasters, in safeguarding the environment and in enhancing the economic and social well-being of all sectors of society. It is also an opportunity for governments, civil societies, the private sector, the general public and the media to appreciate the important contributions that volunteers make to society in general and to sciences such as meteorology and hydrology, in particular. WMO will continue to enhance such collaboration and encourage the relevant individuals and institutions to further develop such voluntary work for the benefit of future generations.

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