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European Meteorological Society

First Annual Meeting of the European Meteorological Society

Budapest, 25-26 September 2001

Selected lectures from the symposium
The future of meteorology in Europe

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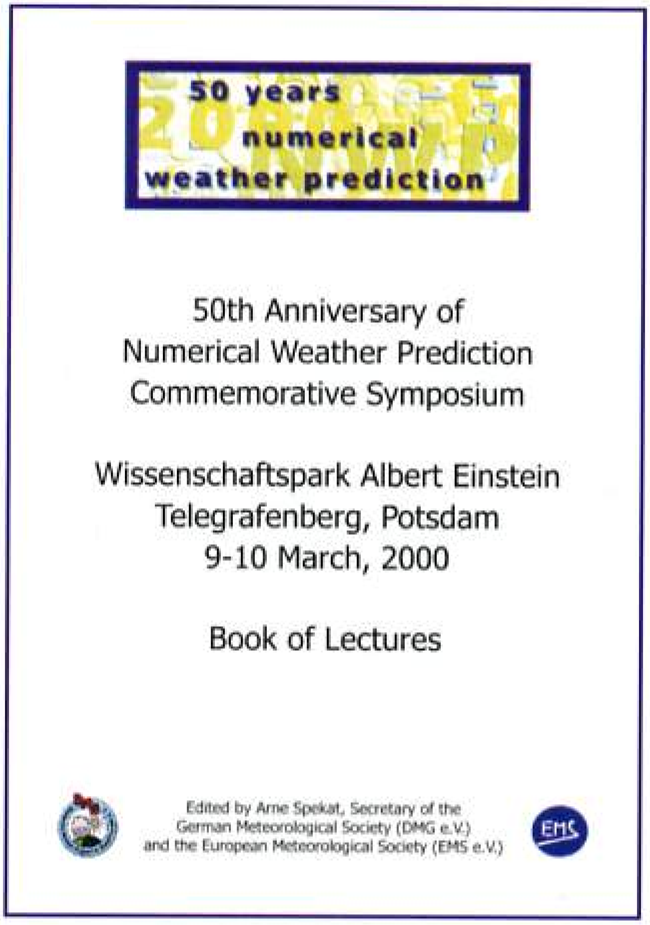

50th Anniversary of Numerical Weather Prediction
Book of Lectures
Contents

This publication of the Deutsche Meteorologische Gesellschaft and the European Meteorological Society summarises the proceedings from a symposium held 9-10 March, 2000 in Potsdam, Germany to commemorate the 50th anniversary of numerical weather prediction. A suitable reference point for this celebration is the paper by Charney, Fjortoft and von Neumann on the numerical integration of the barotropic vorticity equation published in 1950 in the Swedish journal Tellus.

The figure to the right is an assemblage of graphical objects, mostly from the Charney, Fjortoft and von Neumann article. The background is a rendering of their Figure 1, a finite-difference grid. Clockwise from top left: Partial differential equation for the change of height with respect to time needed to solve the vorticity equation in a form "well adapted to a variety of high-speed computing machines"; portrait of John von Neumann; their Figure 2c, forecast of January 5, 1949, 0300 GMT observed and computed 24-hour height change; equation to estimate the level of non-divergence, which lead to the use of the 500 hPa level in their computations, portrait of Ragnar Fjortoft (left) and Jule Charney (right).

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First Annual Meeting of the European Meteorological Society 25–26 September 2001, Budapest, Hungary

Selected lectures from the symposium: The future of meteorology in Europe

By René Morin[1] and Arne Spekat[2,*]

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Born in September 1999, the European Meteorological Society (EMS) has become an association of about 30 Meteorological Societies and more than 15 major organizations, weather services, manufacturers and service providers from all over Europe. They have set out to establish a permanent organization for their cooperation, particularly to deal with those aspects of meteorology which can be solved only on a Europe-wide basis or are best approached on that scale.

In order to meet its responsibilities and challenges, the EMS held its First Annual Meeting on 25 and 26 September, 2001 in conjunction with the 5th European Conference on Applications of Meteorology (ECAM) 2001 in Budapest, Hungary. The First Annual Meeting of EMS focused on a lively exchange of ideas on the future of meteorology in Europe. An array of high-calibre lecturers from WMO, European Organizations, National Meteorological and Hydrological Services and private companies presented views on and overviews of the problem.

Among the various aspects covered in the First Annual Meeting of EMS were the scientific, technical, industrial, economical and social sides of meteorology and their implications. The ECAM in Budapest was a very suitable environment in two respects: (i) ECAM conferences have been instrumental in bringing EMS to life and (ii) the host country exemplifies the fascinating way in which Europe is developing, in meteorology as in many other ways.

The Meeting programme included invited speakers on the following topics:

- The demands to meteorology: safety of life and property, quality of life, optimization of economic activities, climate change.
- The tools of meteorology: general views of the evolution of systems of observing, communicating, computing, forecasting, dissemination of information and products.
- The structures of meteorology: the European Meteorological Organizations, cooperation/coordination of National Meteorological Services, role of all actors public and private, relation between public and private entities, pricing of basic information.

In this volume which marks the launch of the EMS Publication Series, a number of lectures from the three topics of the First Annual Meeting of EMS are presented in extended form.

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Article

Demands on meteorology

JOHN ZILLMAN

Director of the Australian Bureau of Meteorology and President of the World Meteorological Organization

(Manuscript received February 15, 2002)

Abstract

The demands on meteorology for more, and more accurate and useful, data, scientific understanding and service provision are increasing at global, regional, national and local levels. The demands come from many sources, are determined by many influences and cover a wide range of products and services. The global interdependence of most meteorological activities and the public good properties (of non rivalry and non excludability) of much meteorological infrastructure and information means that the conventional market concepts of competitive demand and supply provide an inadequate framework for meteorology. Given the current near world-wide commitment to the use of competitive market models for an increasing range of traditionally non-market processes, there is an urgent need for a more comprehensive and more coherent economic framework for assessing and meeting the demands for meteorological services than has been found necessary in the past. Such a framework must be expected to encompass, at least, the source of the demand (the community at large, government, media, industry, educational institutions, environmental organisations, and the international community), the object of the demand (infrastructure, research, past present and future information, advice and investigation) the extent of the demand (including quantity, quality and timeliness) the multifaceted influences on the demand and assessment of the capability for meeting the demand. It must also, ultimately, address the social and economic basis for meeting the demand and the extent to which it should and can be met; as well as the scientific and public policy basis for management of unrealistic expectations.

No such coherent overall framework yet exists, but the present and foreseeable future demands on meteorology are such that pragmatic approaches involving both public sector National Meteorological Services (NMSs) and private sector service providers, and academic institutions, individually and in partnership, are evolving rapidly in individual country Members of the World Meteorological Organization. They include demands both for greatly enhanced public meteorological services in support of general community safety, convenience and economic and social wellbeing and for special services tailored to the needs of such major weather and climate sensitive industry sectors as aviation, shipping, agriculture, tourism, water supply, and financial services (including insurance and weather derivatives). The challenge for the coming decade will be to properly understand and quantify that demand and to provide the staff education and training, technical infrastructure, partnerships and overall framework of cooperation to ensure that it can be met in ways which result in the best use of the limited national and international resources and the largest ultimate benefits to the users and customers of meteorological and related science and services in all parts of the world.

1 Introduction

The human preoccupation with weather and climate and their impact on almost every aspect of our lives has placed the science of meteorology in a central and very demanding position in human affairs.

Our attitude to it, as citizens, seems to fall somewhere between:

- our attitude to religion where, if it fails to deliver what we seek of it, we have been taught to accept that the fault is probably our own and the failure is fair and just punishment for our lack of faith or for past wrong doing; and
- our attitude to modern technology where, if it fails, we assume someone is to blame for shoddy workmanship or criminal negligence, and the guilty party should be identified and punished; or, at the very least, we should get an apology and our money back.

It is, I believe, too little understood that the products of meteorology are fundamentally different from most other types of goods and services demanded and consumed by society in that:

- much, or even most, of what is demanded of meteorology is of the nature of public goods for which market models of demand and supply demonstrably fail; and
- a comprehensive international framework has been built up over time, which is based primarily on cooperative modes of interaction, rather than on competitive markets models, for meeting the demands.

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In fact, as a field of science and as a profession, meteorology has a long and proud history of enthusiastic and effective response to community needs and user demands.

But much more has always been demanded of it than it has been able to give. And, in seeking to meet the demand, its practitioners have always walked a tightrope between failing, for want of sufficient confidence in their science, to deliver benefits that are potentially deliverable to society, on the one hand; and, on the other, being pressured into providing products that lack integrity in a situation where the user cannot tell the difference and where it is easier, or more conducive to personal or institutional gain, to say yes than to say no.

This dilemma has been well recognised but not always well addressed over the past 150 years of rapid development of meteorology as a science and as a service. According to Sir Napier Shaw of the United Kingdom, writing in 1939 (Shaw, 1939) on 'the stress of public service':

From ... the course of development of the study of weather it will be clear that throughout the ages mankind has been demanding for its guidance more information than science has been able to give, just as in the science of medicine human needs have always asked for more assistance that the profession had at its disposal. It is not so with all the sciences. Astronomy, for example, is so efficient that by its aid a ship can ascertain its own position anywhere on the sea; with a little magnetism to help, it can start from any port in the world and find its way to any other port as directly as if it were on a line of rails provided that the weather does not interfere by fog or hurricane. The measurement of time has been carried to such a degree of perfection that by the aid of wireless and its own chronometers, a ship may know beforehand, wherever it may happen to be, the exact time of sunrise, noon and sunset.

Writing after L. F. Richardson (RICHARDSON, 1922), but before the concepts of chaos and the limits of predicability (LORENZ, 1993) had entered the meteorological lexicon, he went on:

Towards perfection of that kind meteorologists may perhaps look forward; but at present the cautious confine themselves to a 'further outlook' which occasionally reaches a few days ahead; they have to decline the demands of the daily press to know what kind of winter will follow a wet summer? Will fog be unusually frequent? What are the prospects for the summer holidays? Or the Christmas week? and a hundred of other questions that have been asked every year in the past and will be asked every year in the future.

But then he goes on further to assert:

The stress of service has hampered the progress of the science. Apart from the opportunity which it gives to what may be called rash speculation or imposture, it places the science in an awkward position. It is the habit of scientific folk who work in the seclusion of a laboratory to draw inferences from their experience and arrange experiments to test them; but to publish their inferences before they have been tested by experiment is, to say the lease, unusual. It is not done in the best scientific circles as it provokes remarks about meteorology not being an exact science, meaning that its predictions (like those of any other science) are not always correct. Yet that sort of premature announcement is what the forecaster has to make; the stress of necessity overrides the laws of conduct.

And he concludes, with only thinly disguised regret, that ... *In a properly regulated world (the meteorologist) might have continued the practice, adopted by the Meteorological Committee of the Royal Society from 1867 to 1879 and confined his attention to accounting for the recorded sequence of events ....*

The age old dilemma of the meteorologist, so eloquently captured by Sir Napier Shaw, took on a new dimension in the 1950's and 60's with the development of the numerical models for simulation of the atmosphere which, in the words of Professor Joe Smagorinsky (SMAGORINSKY, 1970), were soon forced into 'premature servitude' in the then rapidly advancing field of numerical weather prediction.

While having great sympathy with the concerns of Sir Napier Shaw and all those in our discipline who are committed to maintaining the integrity of the science, I believe it is true to say, in 2001, that the demands of service have greatly stimulated the progress of the science. There is little doubt, in my view, that, without the demands of the operational user communities of aviation, shipping and agriculture, in particular; without the pressing needs for advance warning of natural disasters; without the user pull of the World Weather Watch and the Intergovernmental Panel on Climate Change (IPCC) on GARP (Global Atmospheric Research Programme) and the World Climate Research Programme, we would not have made the enormous progress that has been achieved over the past half century, under the framework of international cooperation provided by the World Meteorological Organization (WMO).

At the beginning of the twenty-first century, the demands on meteorology are continuing to expand at a staggering pace; and it is incumbent on us to critically re-examine the framework for meeting these demands, which proved so successful through the twentieth century, to see if it is still adequate to respond to such difficult challenges as:

- our nearer approach to the inherent limits of predicability;
- the management of unrealistic expectations in a world of instant communication and insatiable demand;
- the substantial costs, in money terms, of continuing scientific progress; and
- the greater reliance on market mechanisms for the provision of public goods.

Against this background, and in line with the hints already given of the directions in which I am heading, I would like to provide a personal view of the demands on meteorology as a science, as a profession and as an institution over the next few decades. My analytical framework focuses in turn on:

- the forces that are shaping, or will shape, the demand; and
- the framework for meeting the demand.

I will then offer my brief thoughts on the priority needs of the next decade and some initial views on the most potent tools we have at our disposal for meeting those needs.

2 Forces shaping the demand

There are, of course, many different ways of viewing the various external and internal forces that will shape the demands on meteorology over the next few decades. However many, perhaps most, of the most important considerations emerge from the multi-dimensional perspective provided by examining, in turn:

- the source of the demand;
- the object of the demand;
- the extent of the demand;
- the influences on the demand; and
- the potential capability for meeting the demand.

I will deal with each of these, briefly, in this order.

2.1 Source of the demand

Because weather, climate and the state of the atmosphere (and, to a lesser extent, the state of the surface water and ocean) impact on virtually every person on the planet and because foreknowledge of their future behaviour can potentially improve a vast array of human decisions, the demands on meteorology come directly of indirectly, from almost every individual and every sector of society.

It is convenient to categorise and analyse the source of the demands on meteorology in terms of the needs and expectations of:

- the community at large. In virtually every country, over the past century, access to a basic level of essential day-to-day meteorological information has come to be seen as a community necessity and right for all civilised society and it has become clear that the general public have an almost insatiable appetite for weather information.

- Government. The efficient and effective discharge of many of the basic functions of government such as infrastructure and land use planning, natural disaster mitigation, transportation, safety regulation and environmental protection are heavily dependent on comprehensive and reliable meteorological information. Thus, in addition to whatever services are provided in response to the obligations which governments assume for ensuring direct provision of meteorological services to the community at large, we must consider governments' own demands on meteorology in support of a range of other planning, regulatory and service functions including, in some cases, the fulfilment of a range of formal international obligations.

- Media. Depending on national practice, the mass media may be viewed either as a partner of the meteorological profession and institutions in the delivery of an essential public service to the community at large or, alternatively, as a pre-eminent source of demand for the information and products they need to service their own end-user communities. In practice, in most countries, there are elements of both and, even in situations where the media are cast in a partnership role, they usually play a key part in identifying and defining the demand for meteorological information and services.

- Industry. There are very few industry sectors which do not have direct and substantial needs for meteorological science and information. In addition to the traditional user sectors of agriculture, aviation, construction, shipping and tourism, many new demands have emerged over recent decades from the energy and financial services sectors, in particular.

- Educational institutions. Weather and climate information and many of the basic tools of meteorology have, over recent decades, been in increasing demand for use in the educational sector. From basic general school education to the needs of highly specialised advanced education and research training in the universities, the education sector is now a major client group for meteorology.

- Environmental organisations. Increasingly, since the 1972 United Nations Conference on the Human Environment in Stockholm, the key role of meteorology as the core scientific discipline involved in understanding and addressing such global environmental problems as greenhouse warming, ozone layer depletion and acid rain has been recognised in the various international environmental fora and reflected in national programs and arrangements for assessing the state of the natural environment and addressing a wide range of environmental problems.

- International community. Many of the most pressing and important demands on meteorology come from the various sectors of the international community. Whether it be for meteorological services in support of the safety, efficiency, and regularity of civil aviation operating under the convention of ICAO (International Civil Aviation Organization), services required under the International Convention for Safety of Life at Sea (SOLAS) or input to international environmental negotiations and strategies under the Vienna Convention on the Ozone Layer, the Framework Convention on Climate Change or the UN Convention to Combat Desertification, the demands on meteorology from the international community are heavy and pervasive.

There are also, of course, many major sub-categories of each of the above which assume particular importance and urgency from time to time in individual countries. And, of course, the methods used for identifying and articulating the nature of the demand range widely across the various sectors and the various political systems.

2.2 Object of the demand

The demands on meteorology can be categorised very broadly in terms of the user communities' requirements for infrastructure, research and services, broadly defined as:

- infrastructure: essentially the basic tools of operational, research and service meteorology, including the instruments, equipment and data processing, modelling and communication systems through which to measure, monitor and predict the state of the atmosphere;
- research: essentially the conduct of scientific study and investigation into aspects of the nature and behaviour of the earth's atmosphere, on local to global scales, according to the nature of the need for increased understanding; and in its most general sense, including also the development of systems, models and techniques for simulating and predicting the behaviour of the atmosphere on the full range of time and space scales; and
- services: the provision of meteorological information (including, of course, forecasts and warnings), advice or investigation to meet the needs of the diverse user communities. Services may be of a broad and general kind directed to the needs of major user sectors or they may be highly specialised and tailored to the specific needs of individual customers.

It is useful to broadly sub-categorise the objects of the demand for meteorological services into five broad groups (ZILLMAN, 1999) for, respectively:

- past (climatic) information: the provision of information on past conditions from the historical record.
- Current information: the provision of information on the current state of the atmosphere, ocean or surface water (where 'current' may be thought of in terms of instantaneous weather conditions, or the contemporary state of the global, regional or local climate).
- Future information: the provision of forecasts of future conditions, especially warnings of severe weather and climate events, including possible future human-induced climate change.
- Advice: the provision of advice on meteorological and related science and its application to community needs.
- Investigation: the conduct of investigations into specific scientific problems of the atmosphere, ocean or inland waters.

A further way of viewing the demand for meteorological services is also, of course, in terms of the traditional division between weather, climate and air quality services.

2.3 Extent of the demand

The extent of the demand for meteorological science and services can be measured in a number of ways, especially in terms of the quantity, quality and timeliness of services (information, forecasts, warnings etc) accessed and consumed by the user community; as well as in terms of the numbers of individuals, households and organisations who actively seek meteorological information of various kinds, even if that information is not readily accessible or not available. The demand may be assessed through standard community survey techniques and monitoring of routine service usage, as well as through consultative mechanisms specific to the various individual user sectors.

2.4 Influences on the demand

The demand for meteorological science and services is sensitive, to varying extent, to a wide range of influences at the national level, including, in particular:

- the nature of the climatic regime. In regions that are subject to many different high impact weather and climate events, the demand for services must be expected to be much higher than in generally benign climatic regimes.
- Geographic area. In general, the demand for public meteorological services can be expected to be more closely related to the size of the geographic area being serviced than to the size of the population inhabiting the area.
- State of development. While even the poorest communities will normally articulate a strong demand for basic meteorological information, the scale of the demand will normally depend strongly on the level of sophistication of the potential user community.
- Industry structure. Since some industries are far more weather sensitive than others (eg the rural industries will normally be much more in need of basic weather information than, say, city-based manufacturing), the nature and distribution of the major industry sectors must be expected to be significant determinants of the services that are likely to be provided.

- Community awareness. The extent of community education and awareness of meteorological process and services can be expected to significantly influence the nature and extent of the demand. In particular, community awareness of what is possible, in terms of both the services that are available elsewhere and the way that they may be advantageously used, can play a major part in shaping the demand. And, perhaps most significantly of all, the role of meteorological service providers in promoting and marketing the value of meteorological science and services can be expected to have a determining influence on user community expectations and demand.

2.5 Capability for meeting the demand

Ultimately, what is demanded of meteorology must be expected to be strongly influenced by knowledge of what is possible. And what is possible, in a particular country and at a particular time, will be largely determined by five main factors:

- the state of the science; both in the general sense of the international state of scientific knowledge and understanding of the meteorological processes or phenomena of relevance to the particular demand sector.
- Technological capability; whether this be the level of sophistication and capacity of the national and international meteorological infrastructure (data collection and communication systems, model development, information systems, ...) or a very specific technology related to a particular user need.
- The policy framework; including, in particular, the existence of established and accepted policies on the respective roles of the public and private sectors and the academic community in the total national meteorological enterprise.
- Prganisational structures; particularly in the sense of the legal, financial administrative skills and capacities required to design, operate and maintain the organisational infrastructure needed to undertake or deliver the research or service required; and
- the resources available; especially the level of funding and staffing available for maintenance and ongoing modernisation of the basic national meteorological infrastructure.

There is no doubt that, as a field of science, over the past century, meteorology has established an outstanding array of supporting technologies and organisational structures for responding to human needs (BOARD ON ATMOSPHERIC SCIENCES AND CLIMATE, 1998; BENGTSSON, 2001; CRUTZEN and RAMANATHAN, 2000; WMO, 2000; ANTHES et al., 2001; ASRAR et al., 2001; WHITE, 2001). There is no doubt also that community awareness of that capability will continue to play a major part in shaping the demands on meteorology over the decades ahead.

3 The framework for meeting the demand

More than for almost any other field of science, the present-day framework for meeting the demands on meteorology is a product of its long historical evolution and its inherently and uniquely international character (DAVIES, 1986). The great challenge facing early twenty-first century meteorology is that of perceiving sufficiently clearly the trends of future demand, capability and constraints to enable the meteorological practitioner community to build on the remarkably successful foundations set down in the twentieth century to provide an efficient, responsive and robust framework for the decade or so ahead (ZILLMAN, 2001). It is appropriate to reflect briefly on:

- the historical origins of the present framework;
- the role of the World Meteorological Organization (WMO);
- the forces for change; and
- the essential elements of a new framework.

3.1 Origins of the present framework

The national and international framework of meteorology which developed and evolved through the twentieth century was strongly influenced by the recognition that meteorology is fundamental to the fulfilment of four basic responsibilities of government in the modern-day nation state:

- protection of the safety and security of its citizens;
- the collection and protection of its national records for the use of future generations;
- the advancement of scientific knowledge and understanding of the natural world; and
- the fulfilment of its international obligations in the global community of nations.

Already in the second half of the nineteenth century, it was recognised that the impact of weather and climate on human affairs was such that, in the order to fulfil these four basic obligations, governments needed to establish and operate some form of official meteorological institute or service and that, to perform its functions effectively, the institute or service would have to cooperate closely with counterpart organisations in neighbouring countries in the collection and exchange of data, the tracking and forecasting of weather systems and the coordinated provision of information (including, especially, forecasts and warnings) in support of the safety of international travel.

From this basic insight and understanding, the concept of the official government funded and operated National Meteorological Service working within an international framework of voluntary cooperation and free exchange, emerged strongly in the second half of the nineteenth century and became accepted almost worldwide through the first half of the twentieth century (ZILLMAN, 1999).

3.2 The World Meteorological Organization

Although the international framework provided by the non-governmental International Meteorological Organization (IMO), which was established in 1873, provided an appropriate and efficient mechanism through which the individual governmental Meteorological Services could coordinate the necessary international data and information exchange for almost three quarters of a century, it had become clear by the 1930s that a more robust intergovernmental framework was needed. After some delays caused by the trauma of World War II, the Convention of the World Meteorological Organization (WMO) was signed in 1947 and WMO formally came into existence on 23 March 1950 (DAVIES, 1990).

The fundamental *raison d'être* of WMO is set out in the preamble to its Convention. It was established by its contracting States (now 179) *with a view to coordinating, standardising and improving world meteorological and related activities and to encouraging an efficient exchange of meteorological and related information between countries in the aid of human activities*.

One of the most important features of the WMO Convention and the framework for international meteorology that it has provided for more than fifty years was that, although its primary function was to provide the legal and operational basis for cooperation and data exchange between official government National Meteorological Services (NMSs), the Convention was not written as an agreement between NMSs but between nation states; and it specifically provided for the involvement of both the governmental and non-governmental meteorological communities within its Member States.

The key feature of the NMS and WMO framework as it relates to the demands on meteorology was the implicit assumption that Member governments, primarily if not exclusively through their NMSs, would provide whatever facilities had to be provided and do whatever had to be done to meet the reasonable demands of national communities and international shipping and aviation for the meteorological services they needed to ensure the desired levels of safety, security and general welfare. This provided an extraordinarily powerful and responsive framework for meeting the national and international demands on meteorology for most of the second half of the twentieth century. The rate of progress in the science and in its beneficial application which it made possible have been remarkable. To the extent that the capacity to meet the demand has been resource-limited, especially in the developing countries, this has been seen as unavoidable delay, rather than any form of permanent impediment to meeting the demand.

3.3 Forces for change

Notwithstanding the widely acknowledged social, economic and environmental benefits of this framework, the past fifteen years have seen the emergence of powerful forces for change to the established concept of operation of national and international meteorology so that it might accord more closely with the contemporary economic paradigms of the late twentieth century.

The forces for change are relentless and ubiquitous, if not always soundly based or well-directed. But they cannot be ignored (ZILLMAN, 2001) and it behooves those in the meteorological community who are committed to the future of meteorology as a science, as a profession and as a service to society to come to grips forcefully and quickly with the implications of the changing world. The most significant separate (but clearly related) influences which have called into question the established framework of national and international meteorology are:

- the late-twentieth century consensus on the ultimate benefits and inevitability of economic globalisation (STEGER, 2002);
- the associated necessity of, and belief in, the virtues of much greater reliance on market mechanisms for discharge of a wide range of functions formerly carried out by governments (KUTTNER, 1997);
- the resulting deterioration and near demise of the public sector in many countries (LANE, 2000).

The major direct impacts of these developments on the meteorological world have been:

- the pressure to change the national role of the NMS from that of tax-payer funded government service provider operating in the public interest to that of participant in an emerging national and international market for meteorological services;
- the need to either abandon the WMO model of international cooperation and free exchange of data and products in favour of the development of a regime of international trade in meteorological data and services; or find a way of harnessing both the virtues of international cooperation and the benefits of competition in a meteorological market place.

3.4 Towards a new framework

If one accepts that the historical public interest model for meeting the demand for meteorological science and services is no longer capable of doing so, the challenge we face is to devise a new framework which preserves as many as possible of the enormous benefits of what has operated in the past while refashioning meteorology to operate within the economic framework of the times.

Although the meteorological community have been exploring various aspects of the economics of meteorological service provision for several decades, no comprehensive economic framework for the operation of national or international meteorology yet exists. It is possible, however, to begin to build some elements of such a framework on an analysis of the economic characteristics of meteorological services (ZILLMAN and FREEBAIRN, 2001). The important points are:

- most basic meteorological infrastructure and public services possess the non-rival and non-excludable characteristics of economic public goods;
- there is also an important group of specialised meteorological services (such as those for energy utilities and other businesses) which are both rival in consumption and from which non-payers can be excluded and which thus possess the economic characteristics of private or market goods;
- there are still other services which are neither purely public good or private good in character.

In the case of public goods, markets demonstrably fail to provide the quality demanded by society and the traditional, and still accepted, role of government is to step in, in cases of market failure, to establish mechanisms for ensuring that the necessary services are provided (STIGLITZ, 2000; STIGLITZ and DRIFFILL, 2000). The mechanism can consist of a government funded service provider such as the traditional NMS or some form of legislated monopoly provider of user-pays services to legislatively bound user sectors.

In the case of private goods, the available models include complete reliance on market processes and a private meteorological sector, given access to a common base of public good information, or commercial supply by a NMS, or a mixture of both.

An economic model for the provision of meteorological services, including both public and private good services, can be established by analogy with the conventional market model of demand and supply as described in ZILLMAN and FREEBAIRN (2001). The socially optimal allocation of national resources to meteorological service provision corresponds to the point of intersection of the demand (marginal benefit) and supply (marginal cost) curves of the market model which is also the volume of service at which the difference between total benefits and total costs is greatest (ZILLMAN, 2002).

This model can be developed in various ways to provide a general economic framework for meeting both the public and special user demand for meteorological services (FREEBAIRN and ZILLMAN, 2002 a,b). There appears, in particular, to be a sound basis for regarding international meteorological cooperation as the example par excellence of global public goods (KAUL et al., 1999).

4 The priority needs of the next decade

Against this background, it is important to attempt to identify what will be the most important demands that will fall on meteorology, and on the meteorological community, over the next decade. I see these as being:

- An agreed policy framework for meteorology. It is essential that meteorology and the meteorological community work their way through the current period of severe turbulence as quickly as possible and establish a new policy framework at the national level in as many countries as possible. There is a serious risk that, if this is not soon achieved, new instabilities will develop in the three-way relationship between meteorology, government and the community leading to the loss of the expertise, professional standing and influence that have historically been so essential to the effectiveness of meteorology and to its perceived and actual value to the community.
- Robust national meteorological infrastructure. While the maintenance of the integrity of the national meteorological infrastructure is critically dependent on the existence of a sound policy framework and is a vital prerequisite for most of the downstream community benefit from meteorology, its achievement is dependent on an appropriate resource framework – both for one-off establishment and for ongoing operation. In a climate of continuing decline of taxpayer funding of government infrastructure, it will be extremely important that the special characteristics of meteorology and the requirements for meteorological infrastructure be understood and accepted by, and within, government in both developed and developing countries.
- High quality national climate records. There seems little doubt that the range and volume of requirements for continuous, reliable, homogenous climatic records will continue to increase. Major new areas of demand for high quality climate records are emerging in the areas of long term climate monitoring and in the financial services industries (especially weather derivatives), to mention just two.
- An efficient framework for international cooperation. It is almost inconceivable that nations would consciously forego the benefits that have flowed to each of them individually, as well as collectively, from the WMO framework of international cooperation through the second half of the twentieth century. But there are subtle feedbacks between the national and international arrangements and an essential element of stabilisation of the policy framework at the national level will be the emergence of a general consensus on the basic ingredients of a stable regime of international cooperation.

- An integrated global observing system. While impressive progress has been achieved over the past half century in the implementation of both domain specific observing systems, such as the World Weather Watch Global Observing System (GOS) and the Global Atmosphere Watch (GAW) for the atmosphere, and cross-cutting atmosphere-ocean-land surface observing systems, such as the Global Climate Observing System (GCOS), there is no doubt that the development of a robust integrated space and surface based global observing system must be viewed as an international imperative for the decade ahead.
- Improved understanding of the atmosphere. Despite the spectacular progress of atmospheric science through the second half of the twentieth century, it has become increasingly apparent that there is still much that is not understood and that the scientific and community benefits of increased understanding would be substantial and pervasive. This is as important to very short term warning of severe events as it is on the time scales of seasonal to interannual climate prediction.
- Increased integration with its sister sciences. The past decade has dramatically enhanced the level of awareness in the scientific community of the importance of a more integrated approach to the monitoring, research and modelling of the atmosphere, ocean and land surface and freshwater systems. The demand for more comprehensive environmental services and the expectation that ocean services will come in for much greater demand over the next decade have underscored the need for a much more integrated approach to environmental science service provision.
- Improved forecast quality. The enormous progress that has been achieved, over the past four decades, in the use of numerical models for forecasting on all time and space scales has, in turn, created even greater expectations and demands for still more sophisticated and consistently skilful forecast models and systems.
- Expanded service capability. The demands for improved weather and climate services come from almost every sector of society and it seems certain that community pressures for more and better services will continue to grow. Particularly strong demands must be expected for enhanced services:
  - for natural disaster reduction;
  - for urban community convenience and wellbeing
  - for the safety of transportation
  - for economic development of a range of industry sectors
  - to assist with strategies and operations for general environmental protection.
- Enhanced service delivery. In addition to improved quality of meteorological services, the demands for enhanced access and delivery systems must be expected to grow rapidly with users seeking easier, more timely, and more flexible methods of access to meteorological information at any location and at any hour of the day or night.
- Informed policy advice. Many of the major global environmental issues which will continue to demand the attention of governments and international organisations over the coming decades are meteorological in origin - greenhouse warming, ozone layer depletion, desertification, and long-range transport of air pollution. One of the most important roles of the meteorological community will be in the provision of informed and policy relevant scientific advice to governments through such mechanisms as the Intergovernmental Panel on Climate Change (IPCC).

While this short list is neither detailed nor exhaustive, I believe it captures the main elements of the demands likely to fall on the meteorological community over the next few decades. The challenge to the professional community will lie in the development of innovative approaches to meeting the demand.

5 Meeting the needs

While many different approaches will be adopted in different countries, there appears to be a set of strategies through which the meteorological community may be most likely to be able to satisfy the demands placed on them. These strategies centre around the increased use of partnership arrangements at the national level including, in particular:

- partnerships between the NMS community and the private sector (Pirone, 2001; White, 2001).
- Partnerships among countries, both under the framework of WMO and in response to direct bilaterally shared interests (WMO, 2000; Zillman, 2001);
- Partnership between the operational, research and service communities in carrying forward the level of understanding which is essential to progress in all other facets of meteorology (Board on Atmospheric Sciences and Climate, 1998).

Underpinning the effectiveness of all such partnerships will, of course, be the expertise of the people who will carry the baton for meteorology through the next few decades and the resources and facilities that they will have at their disposal. This leads in turn to the identification of two essential ingredients of a successful strategy for meeting the future demands on meteorology. They are:

- a focussed effort, worldwide, on attracting the best young minds into meteorology and providing them initially with a very high quality basic education in the field and the opportunities for much more investment in continuing education and training than is now possible in most NMSs or in the private sector. This means stronger promotion of both the intellectual challenges and the intellectual satisfaction to be derived from a career in meteorology and a very high priority for proper investment in the universities and training institutes of the Member countries of the WMO (WMO, 2002);
- a much higher level of awareness at the political and policy levels of individual governments of the social, economic and environmental benefits to national communities from an adequate investment in their national meteorological infrastructure (ZILLMAN, 2002).

Finally, I believe it will be essential that the characteristic feature of meteorology which make it one of the great success stories of twentieth century science – the deeply ingrained commitment to international cooperation in the interest of the entire global community – must be protected and further strengthened. I thus see an overwhelmingly important role for the World Meteorological Organization and its companion agencies, in both the intergovernmental and non-governmental domain, in fostering the international cooperation in data collection, research and service provision that have the potential to ensure that, within each individual country, the enormous potential demands on meteorology will be met to the satisfaction and benefit of national communities everywhere.

References

ANTHES, R., J. FELLOWS, B. HOOKE, R. MCPHERSON, 2001: AMS/UCAR Outreach to the Bush Administration and the 107th Congress. – Bull. Amer. Meteoro. Soc **82**, 987–994.

ASRAR, G., J.A. KEYE, P. MOREL, 2001: NASA research strategy for earth system science: climate component. – Bull. Amer. Meteoro. Soc **83**, 1309–1329.

BENGTSSON, L., 2001: The development of medium range forecasts. – In: 50th Anniversary of Numerical Weather Prediction Commemorative Symposium, Potsdam, 9–10 March 2000, Book of Lectures, SPEKAT, A. (Ed), Deutsche Meteorologische Gesellschaft, Berlin, 119–138.

BOARD ON ATMOSPHERIC SCIENCES AND CLIMATE, 1998: The Atmospheric Sciences Entering the Twenty First Century. – National Research Council, National Academy Press, Washington, DC, 364 pp.

BOARD ON SUSTAINABLE DEVELOPMENT, 1999: Our Common Journey – a Transition toward Sustainability. – National Research Council, National Academy Press, Washington, DC, 363 pp.

CRUTZEN, P.J., V. RAMANATHAN, 2000: The ascent of atmospheric sciences. – Science **290**, 299–304.

DAVIES, D.A., 1986: Meteorology - A model of International Cooperation. – WMO No **667**, WMO, Geneva, 30 pp.

DAVIES, D.A. (Ed), 1990: Forty Years of Progress and Achievement. A Historical Review of WMO. – WMO No **721**, Secretariat of the World Meteorological Organization, Geneva, 205 pp.

FREEBAIRN, J.W., J.W., ZILLMAN, 2002a: Economic benefits of meteorological services. – Meteorol. Appl. (in press).

—,— 2002b: Funding meteorological services. – Meteorol. Appl. (in press).

KAUL, I., I. GRUNBERG, M.A. STERN, 1999: Global Public Goods, International Cooperation in the 21st Century. – Oxford University Press, New York, Oxford, 546 pp.

KUTTNER, R., 1997: Everything for Sale. – Alfred A Knopf, New York, 410 pp.

LANE, J.E., 2000: New Public Management. – Routledge, London and New York, 242 pp.

LORENZ, E.N., 1993: The Essence of Chaos. – UCL Press, London, 223 pp.

PIRONE, M.A., 2001: Private sector role in service provision. – Proceedings, Commonwealth Conference of Meteorologists, 18–22 June, 2001, Reading, UK (in press).

RICHARDSON, L.F., 1922: Weather prediction by numerical processes. –Cambridge University Press, 236 pp. [also from Dover Publ. Inc., New York, 1965]

SHAW, N., 1939: The Drama of Weather. – Cambridge, 307 pp.

SMAGORINSKY, J., 1970: Numerical simulation of the global atmosphere, the Global Circulation of the Atmosphere. – In: Proceedings of conference of the global circulation of the atmosphere, London, England, August 1969, CORBY, G.A. (Ed.), 24–41.

STEGER, M.B., 2002: Globalisation – the New Market Ideology. – Rowina and Littlefield Publishers, Lanham, 195 pp.

STERN, P.C., W.E. EASTERLING (Ed.), 1999: Making Climate Forecasts Matter. – National Research Council, National Academy Press, Washington, DC, 175 pp.

STIGLITZ, J., 2000: Economics of the Public Sector, 3rd Edition. – Norton, New York, 823 pp.

STIGLITZ, J., J. DRIFFILL, 2000: Economics. – WW Norton and Company, New York, London, 756 pp.

WHITE, R.M., 2001: The evolving public-private meteorology partnership. – Bull, Amer. Meteoro. Soc. **82**, 1431–1437.

WMO, 2000: Fifth WMO Long-term Plan 2000–2009. – WMO No. **908**, World Meteorological Organization, Geneva, 88 pp.

— 2002: Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology, Fourth Edition. – WMO No. **258**, Secretariat of the World Meteorological Organization, Geneva (in press).

ZILLMAN, J.W., 1999: The National Meteorological Service. – WMO Bulletin **48**, 129–159.

— 2001: Meteorological service provision in changing times. – In: Proceedings Third Technical Conference on Management of Meteorological and Hydrological Services in RAV, Manila, Philippines, 23–27 April 2001, World Meteorological Organization, Geneva (in press).

— 2002: Benefits and costs of weather and climate services. – In: Preprints, Third Symposium on Environmental Applications, Amer. Meteoro. Soc, Boston.

ZILLMAN, J.W., J.W. FREEBAIRN, 2001: Economic framework for the provision of meteorological services. – WMO Bulletin **50**, 206–215.

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Article

Evolution to an integrated global (earth) observing system

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Abstract

The developments to be expected during the next ten to twenty years in observational techniques in both the in-situ and remote sensing components of the Global Observing System of WMO will lead to a fully integrated system for Meteorology which at the end will be part of a wider Integrated Global (Earth) Observing Systems. The evolution to such a system will be presented.

1 Comparison between the World Weather Watch Global Observing Systems 1967 and 2000

The purpose of the Global Observing System (GOS) is to provide, from all parts of the globe and from outer space, high-quality, standardized observations of the state of the atmosphere and ocean surface. GOS comprises observing facilities at stations on land and at sea, and on aircraft, meteorological satellites and other platforms. These facilities are owned and operated by the 185 Member countries of WMO. Since its launch, the Global Observing System has grown considerably. In 1967 its data base consisted of

- Synop. Stations 3338 (ca. 3020: 6 hrl.)
- Ships 4500, ca. 2500 obs. daily, 20 Ocean Weather Ships (N-Atlantic, N-Pacific)
- Upper-Air Stations 566 (556: 00, 12 z) ca. 1100 TEMPs daily
- Aireps, e.g., 250 daily over S-America and the S-Atlantic.

GOS' space-based component, in 1967, consisted of

- Polar Orbiting Satellites
  - ESSA-2 (09.00), APT, VIS, 1966, operational
  - ESSA-4 (15.00), APT, VIS, 1967, operational
- Geostationary Satellites
  - ATS-1, 150°W, SSCC, VIS, 1966, experimental
  - ATS-3, 150°W, SSCC, VIS, 1967, experimental.

In the subsequent thirty-three years, a number of data types were added, a growth in the number of surface station and ship reports and a rather constant density with respect to the upper-air stations emerged. Thus for the surface-based component there were in 2000

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- Synop. Stations 10602 (ca. 8000: 6 hrl., ca. 5000: hrl.) ca. 11600 obs. available daily on the GTS Ships 6900 (2800 obs. avail. daily)
- Buoys 800 (9500 obs. daily)
- Upper-Air Stations 595: 00, 12 z ca. 1050 TEMPs daily
- Aireps 4300 obs. daily
- ASDAR, ACARS, AMDAR 100000 obs. daily.

About 50% of the upper-air stations reported nearly all the time, 15% reported at least half of the time, a further 15% less than that and about 20% of the stations was silent.

Considerable progress can be seen in the number of space-based observations available

- Polar Orbiting Satellites
  - NOAA-15 (07.30)
  - NOAA-16 (14.00)
  - DMSP-F13 (05.40)
  - DMSP-F14 (08.40)
  - METEOR 2-21
  - METEOR 3-5
  - FY-IC (08.40)
- Geostationary Satellites
  - METEOSAT, 0°, 63°E
  - GOES-W, GOES-E (USA),75°W, 135°W
  - GMS (Japan), 140°E
  - FY-2 (China), 86°E, 105°E
  - INSAT (India), 74°E, 83°E

One of the products that could be produced was a global composite of images taken by geostationary satellites (cf. Fig. 4)

However there are source of data yet to be integrated in GOS, such as weather radars, wind profilers, Sodars/Lidars and lightning detection systems, among others.

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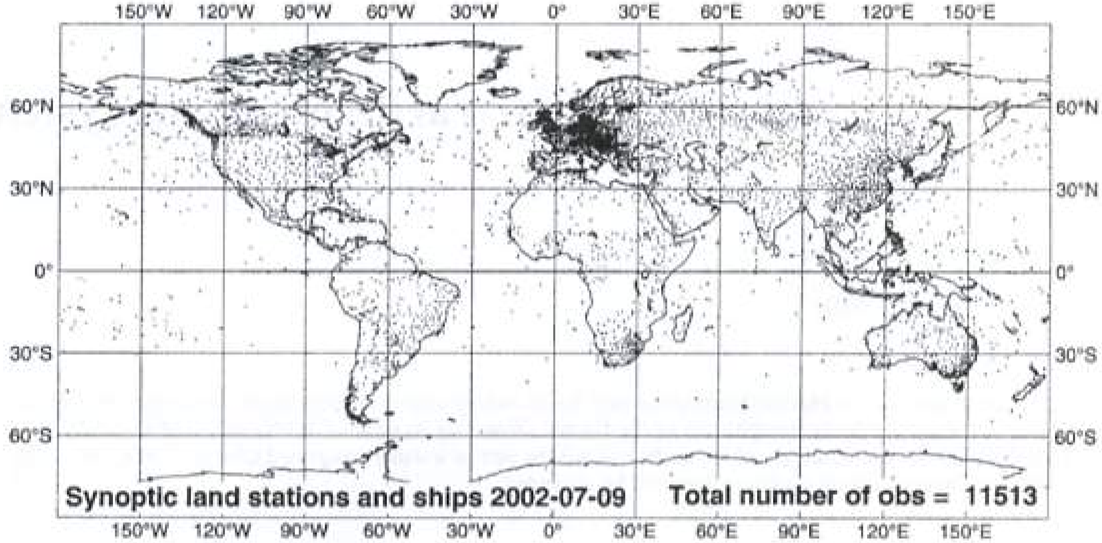

Figure 1: Coverage with land and ship synop stations on an arbitrarily picked day in 2002.

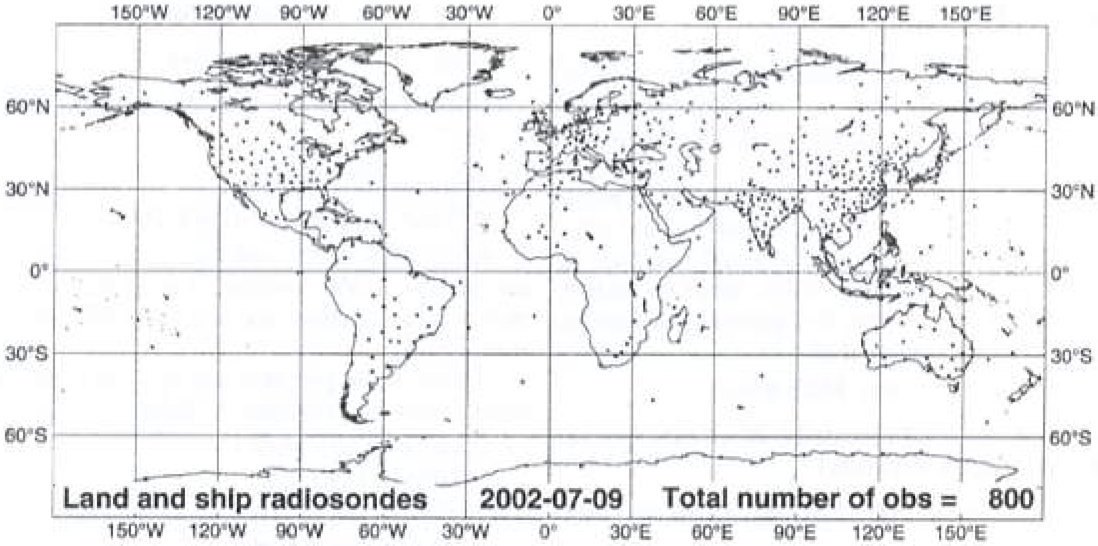

Figure 2: As in Fig. 1 but for land and ship radionsondes.

2 Technology trends in the surface-based component

In the last years, technological progress affected the measuring systems in a number of ways. Full automation and miniaturisation became prominent. Furthermore a high integration of the technical components, full quality control and remote monitoring of the stations was developed. This applies to automatic surface stations (Synop, Climate, Precipitation etc.) on land and on ships, as well as to automatic upper-air stations on land and on ships, automatic aircraft observation platforms and buoys (both, drifting and moored).

There were of course improvements resulting in a clearly increased usage of remote sensing equipment. Radar, for example, became fully automated and miniaturised, as well as remotely controlled and bi- to multistatic; Doppler-Radars, which look at polarisation, brought improvement in precipitation measurements, hail detection, etc. Lidar and Sodar equipment became fully automated and miniaturised, as well as remotely (RASS) controlled. Measurements could be made in additional frequencies. The introduction of Doppler-Lidar enabled to determine differential absorption and thus profiles of temperature, wind, water vapour, aerosols, ozone, etc., were improved. Last not least lightning detection systems were added to the toolbox.

3 Technology trends in the space-based component

A vast number of breakthroughs and rapid developments occurred in satellite technology as well. Main improvements were in

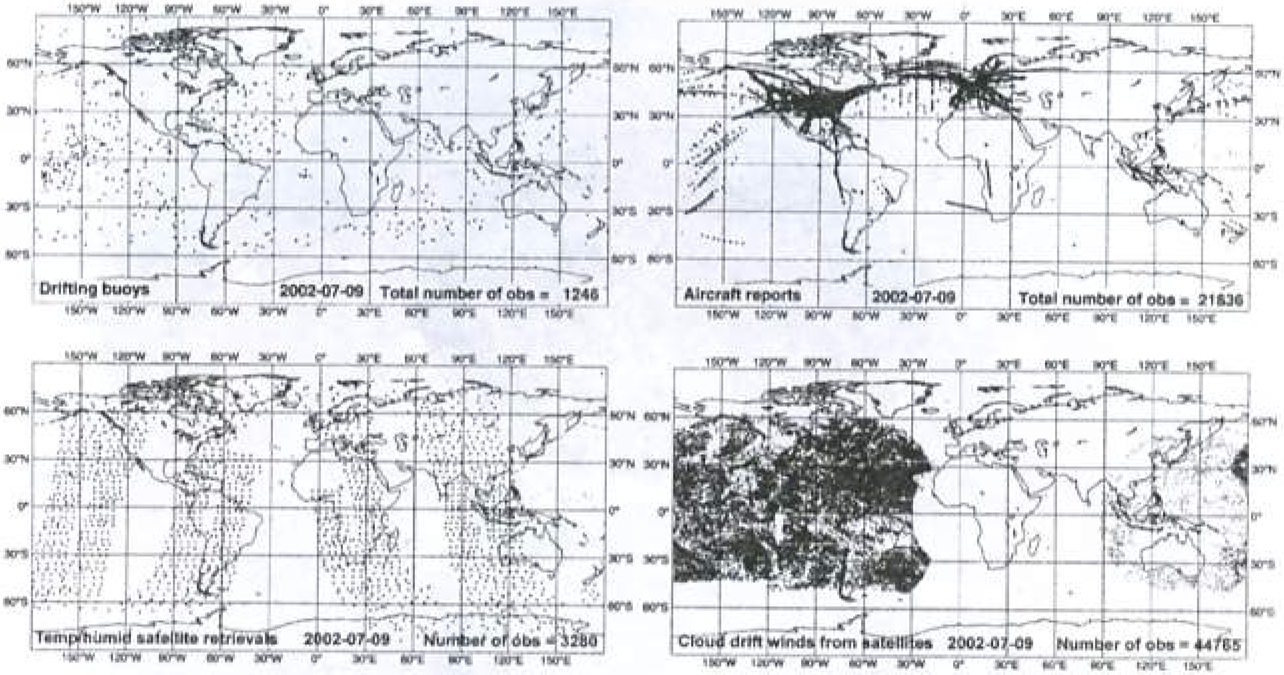

Figure 3: As in Fig. 1 but for drifting buoys (top left), aircraft reports (top right), temperature and humidity retrievals from satellites (bottom left) and cloud wind drift data from satellites (bottom right).

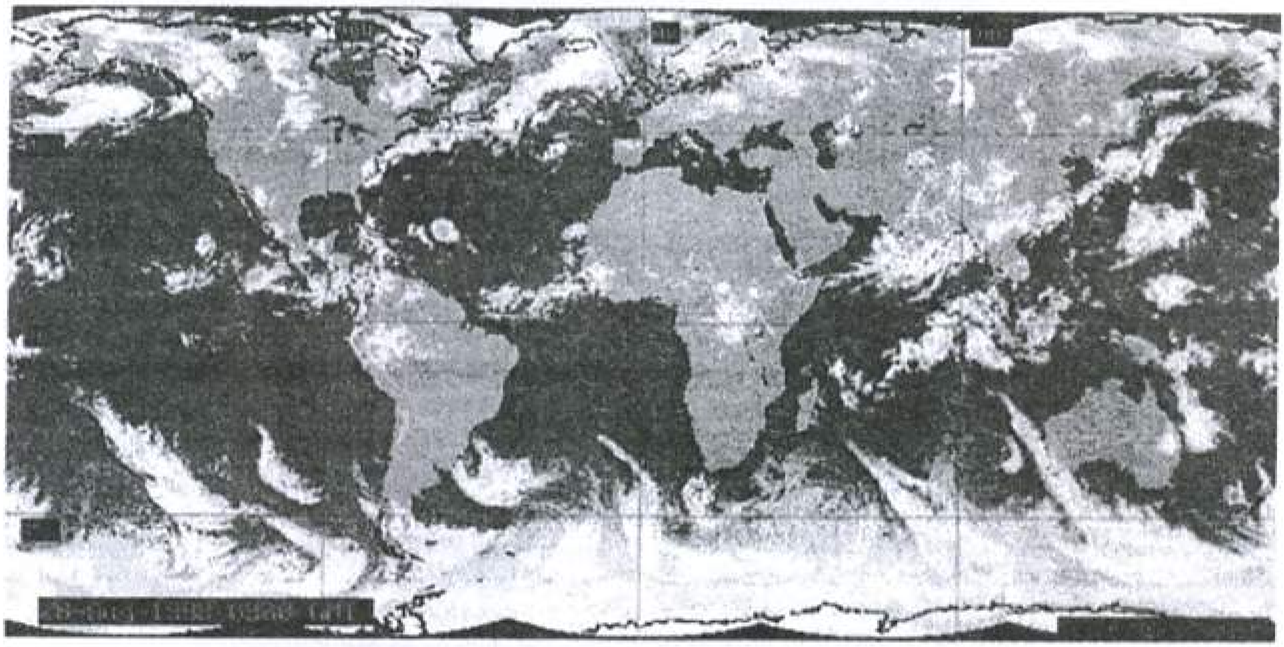

Figure 4: Global composite of satellite image from geostationary satellites.

- VIS/IR and Microwave imagers
- IR sounders (Interferometer)
- microwave sounders
- sounders based on occultation techniques
- scatterometers
- radar equipment (e.g. altimeter, cloud profiler)

Furthermore, lidar equipment had its space premiere.

With those technical improvements and the relevant data extraction methods the following parameters can be expected:

Vertical profiles:

- Temperature Δ x : 25 km Δ z : 1 km rms : 1°K
- Humidity Δ x : 25 km Δ z : 1 km rms : 0.3–0.005 g/kg (lower Troposph.–higher Stratosph.)
- Wind Δ x : 50 km Δ z : 1 km rms : 2 m/s, 10°

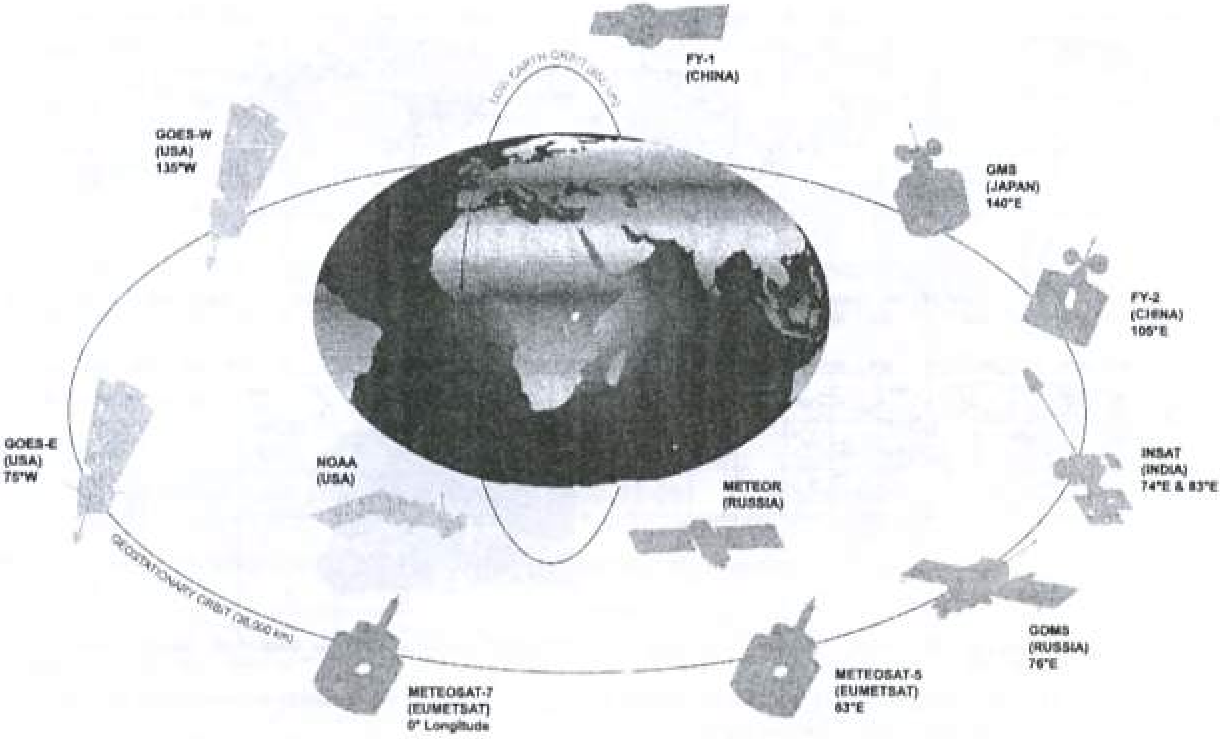

Figure 5: The global satellite system.

- Aerosols Δ x = 50 km Δ z = 1 km rms = 10%
- Ozone Δ x = 50 km Δ z = 1 km rms = 5%

Global determination of additional trace gases, such as CH_4, CO_2, CO, CFC-11, CFC-12, OH, NO, NO_2, N_2O, HNO_3, HCl, BrO, ClO, $ClONO_2$ etc. will be improved.
Cloud parameters will probably improve to

- Cloud Cover Δ x : 10 km rms : 5%
- Cloud Type Δ x : 10 km Classes : 8
- Cloud Top Temp. Δ x : 25 km rms : 0.5°K
- Cloud Top Height Δ x : 25 km rms : 0.5 km
- Cloud Base Height Δ x : 50 km (ATLID) rms : 0.5 km

Other cloud parameters, such as cloud water profile, preciptable water content, cloud drop size, cloud optical thickness, short-wave cloud reflectance, long-wave cloud emissivity, among other will benefit as well. Further satellite input consists of

- Surface Parameters
  - Ocean
    * Wind
    * Sea Surface Temperature
    * Precipitation Rate (liquid and solid)
    * Precipitation Index (daily cumulative)
    * Air Pressure
    * Signific. Wave Height
    * Wave Period and Direction
    * Sea-Ice Cover
    * Sea-Ice Type
    * Ocean Colour
  - Land
    * Surface Temperatures
    * Soil Moisture
    * Precipitation Rate
    * Precipitation Index
    * Snow and Ice Cover
    * Snow Melting Conditions
    * Snow Depth
    * Snow Water Equivalent
    * Land Cover
    * Land Use
    * Soil Composition
    * Fires
    * Volcanoes
  - Biomass
    * Vegetation Index
    * Leaf Area Index
    * Photosynthetically Active Radiation (PAR)
    * Fractional PAR
    * Vegetation Hydric Stress Index
    * Vegetation Type

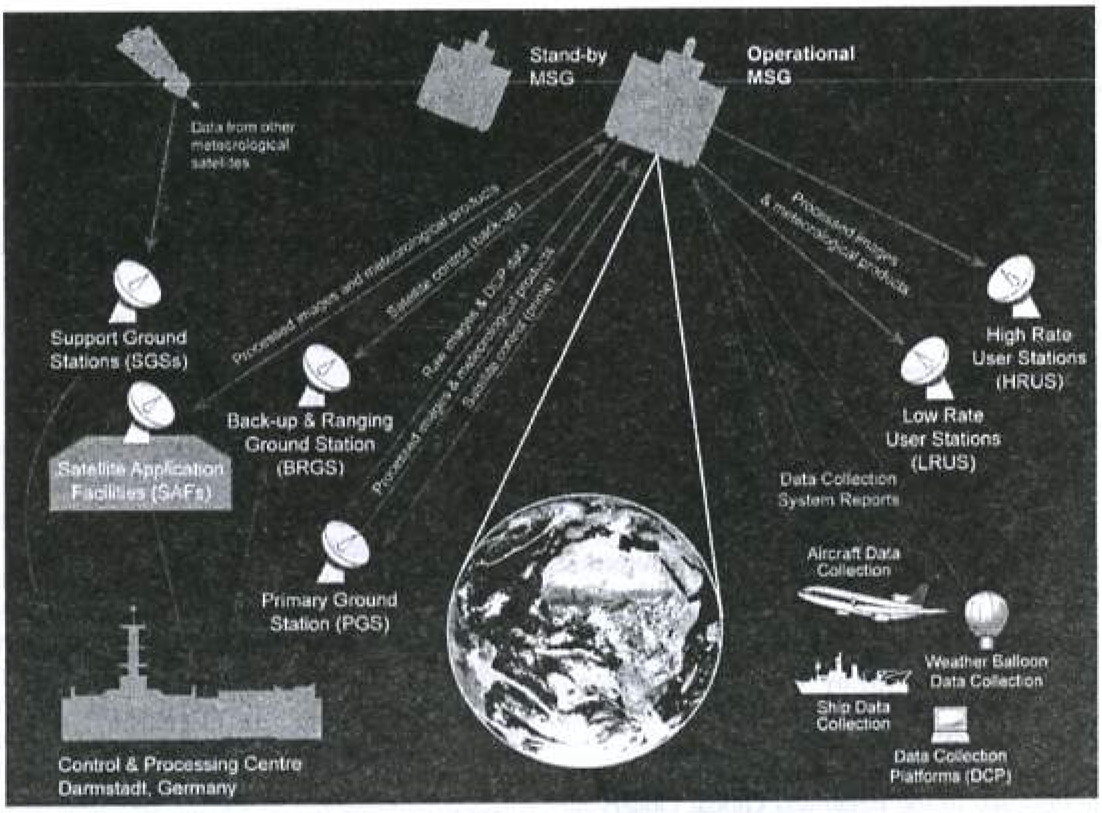

Figure 6: The global observing system.

Radiation data include

- At the top of the atmosphere
  - Solar irradiance
  - Shortwave outgoing radiation
  - Longwave outgoing radiation
- At the earth's surface
  - shortwave radiation
  - shortwave reflectance
  - longwave radiation
  - longwave emissivity

4 Integration of both observing system components

There is a need to recognise this as an objective which could be achieved by an ongoing process which should be based on the following steps:

- Review of observational requirements (including priorities) in regular intervals e.g. every 8 years by relevant bodies (Techn. Commissions of WMO, EUCOS of EUMETNET etc.).
- Studies on available/pot. available observing techniques to determine the most cost efficient techniques (in-situ vs remote sensing and/or surface based remote sensing vs space based) to derive the required observational data.
- Review of the design of the Global Observing System based on the results of the requirement reviews, the studies on Observing Techniques and Observing System Simulation Experiments to determine the optimum mix. The design should be fixed for a reasonable time frame e.g. 8 years to allow for a well planned implementation.
- If a new observing technique becomes operationally available during this time frame of 8 years a demonstration should be arranged and the effects on the system evaluated to allow, if possible, for an intermediate integration into the system.

5 Integration of the Global Observing Systems towards an Integrated Global (Earth) Observing System (IGOS)

A number of components have to be installed and harmonized until IGOS becomes reality. In 1967, the WMO launched World Weather Watch/Global Observing System. Twenty years later the Global Atmosphere Watch was launched by WMO as well. Both are operational. The International Oceanographic Commission's (IOC) Global Ocean Observing System (GOOS) is currently partly operational. A Global Terrestrial Observing System (GTOS) by the United Nation's Food and Agriculture Organization (FAO) is in the planning stage. The Global Climate Observing System (GCOS), jointly run by WMO, the International Council of Scientific Unions

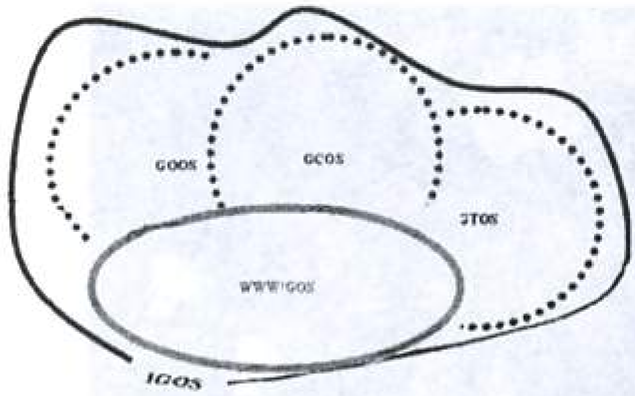

Figure 7: Components of the Integrated Global Observing Study (IGOS).

(ICSU), the United Nation Environmental Protection Agency (UNEP) and IOC is at the moment partly operational. The Global Environmental Monitoring System (GEMS) by UNEP, the World Hydrological Cycle Observing System (WHYCOS) by WMO and the World Bank and the Global Terrestrial Network Hydrology by WMO will need to be further developed.

International discussions and developments which started in 1995 led to the Integrated Global Observing Strategy (IGOS).

IGOS seeks to provide a comprehensive framework to harmonize the common interests of the major space-based and in-situ systems for global observation of the Earth. It is being developed as an over-arching strategy for conducting observations relating to climate and atmosphere, oceans and coasts, the land surface and the Earth's interior. IGOS furthermore strives to build upon the strategies of existing international global observing programs, and upon current achievements. It seeks to improve observing capacity and deliver observations in a cost-effective and timely fashion. Additional efforts will be directed to those areas where satisfactory international arrangements and structures do not currently exist. There is a joint website[1].

IGOS is a partnership of

- Sponsors of the Global Observing Systems (ICSU, FAO, UNEP, UNESCO-IOC, WMO).
- Global Observing Systems (GCOS, GOOS, GTOS) Program Offices.
- Committee on Earth Observation Satellites (CEOS; comprising member space agencies contributing to an IGOS).
- International Group of Funding Agencies (IGFA).
- International Geosphere-Biosphere Programme (IGBP) Program Office.
- World Climate Research Programme (WCRP) Program Office.

Other organisations prepared to contribute to an IGOS may be added as Partners.

Over the last 3 years a number of themes were agreed e.g. the Ocean theme, Carbon Cycle theme (Integrated Global Carbon Observation), Atmospheric Chemistry theme, Water Cycle theme etc. Relevant teams were established to develop the strategy for the individual theme. The Report on the ocean theme was agreed in Nov. 2000 and the proposed strategy is going to be implemented by the different groupings.

With respect to the space systems it is handled by the Strategy Implementation Team (SIT) of CEOS. In the case of EUMETSAT it will lead to the participation in the JASON-2 programme (altimetry).

6 Conclusions

First and foremost, the Global Observing System(s) will be composed of fully automatic observing system components. These components will have either in-situ measuring capabilities or will be based on remote sensing techniques. The remote sensing techniques, in turn, will be either surface or space based; the latter system will be the predominant one. Finally, the individual Global Observing Systems will be integrated into a Global Earth Observing System.

[1] http://www.igospartners.org

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Article

Possible futures for handling meteorological data, especially the dissemination of products to the consumer

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Abstract

The observing system, the collection of observations and their global distribution are expected to become increasingly satellite-based, and continued development of supercomputers is likely to dominate developments in weather forecasting. By contrast, the dissemination of products is likely to depend increasingly on mobile computing power in the hands of their potential consumers. Meteorology will be but one area of life which will be affected fundamentally by developments in this area and consequent changes in the patterns of consumer demand. Meteorologists should consider likely options for meeting the needs of society and for commercial opportunities which these changes may bring.

1 Introduction

This so-called information revolution is a technological phenomenon. But technological progress is, of course, a much older beast than the humble personal computer.

As is the study of meteorology. But with the information age has come a concentration on the end user, you and I, rather than the supplier in terms of why information is needed, why it is wanted, and for what purpose.

The rise and (relative) fall of the dotcom business gold rush told us a lot of things and nearly nothing. One thing that most business analysts and venture capitalists would agree on, if they are ever to agree on anything, is that consumers out there want to get digital services to the new devices they pay, to them, so much for. But very few companies have come up with the right kind of content to exploit this wish.

These money-making services that make consumers want to spend money, new money which isn't simply a transfer of existing spending from 'old-style' service providers, are often thrown in with the lumpent and somewhat meaningless phrase 'killer applications'. In the real world there have been very few killer applications and the phrase is now misused in its application to services, which are not applications at all.

Getting weather reports to mobile devices over current technologies, such as the short message service (SMS), otherwise known as text messaging, is seen as an application because it's interactive. It's seen to be a money-spinner because it's possible to charge users small amounts of money per SMS message (or on a subscription basis - using easily billed devices such as mobile phones or their successors means the type of charging is currently irrelevant as long as the correct tariffs are set). And users are willing to pay for them - at least enough users, for the moment.

The problem of the future of these services lies in their current limited scope and in the limited number of firms who are offering them. This will change, and when there are hordes of firms offering cheap, accessible weather product services to mobile devices, prices will either have to fall in line with traditional competition models, or aggregation will take place. Probably both – see the current nightmare being experienced by digital and analogue service providers such as NTL.

There are several ways to look at the possibilities that await, perhaps in the way a trap awaits the unwary bear, perhaps in the way an oasis awaits the thirsty traveller, those companies and organisations that put together meteorological products.

One of the things that the information revolution has so far revealed is that large organisations waited to throw their lot in with the small, admittedly agile innovating companies, many of which have sunk without trace. Large organisations, however, have more carefully applied themselves to the new way of doing things. A few have initially succeeded. Some have so far failed. Still more are directionless.

It's the task of the organisations who were present at the first annual meeting of the EMS to steer a careful path between these obstacles, if they wish to connect to the public directly with meteorological products or their derivatives. You're going to need help, and to help each other.

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2 It's vitally important to find something that fits with what you do

Some possible future applications and their concomitant devices will be described in the section to come, but it's important to remember that all of them are not necessarily what any organisation should do.

Why?

Because, in essence, following a bandwagon is not often the way to long- or even mid-term success. It's also highly unlikely that it will bring market leadership. These are, of course, generally accepted as being corporate strategy goals, not quango- or state-funded organisation goals. But they are important to consider if your organisation's goals include a commercialisation such as selling meteorological products to 'end-users'.

Currently some of the most successful weather-related services for consumers are those that are provided for 'free' or, more accurately, at a nearly invisible cost.

In precisely the same way that business users have services bundled or packaged in with contracts with meteorological service providers, consumers currently enjoy weather forecasts through consumer information service providers, such as radio, TV, internet portals and newspapers. In the UK, for example, there is only one way of obtaining any of this information for free, which is to use a radio. But no one directly pays for their weather when using these service – via a TV licence, metered or unmetered telephone costs, cover price of newspapers, etc.

Radio is, for now, extremely limited in its ability to provide what web-culture people would call 'rich content' – multimedia content comprising audio, video, a level of interactivity and, increasingly, personalisation and close localisation.

Digital TV is doing far better in some countries in Europe than in others. In the UK, traditionally a TV-watching nation more than her close neighbours, take-up looks promising but is slow and, according to at least one major consumers' group, not likely to hit government penetration targets even by 2010. Currently watchers get their weather reports packaged inside whatever they pay service providers.

There is a crucial difference to radio, for example, here and it's growing. The TV channels that are paying for the meteorological products from organisations such as yours do not, cannot charge directly for those products. This is because the networks that their signals are carried over are not generally owned by them. The BBC, as an example, might be a exception to this but across Europe the move to cable, satellite and digital terrestrial TV has engendered an almost total separation between content and service provider.

Newspapers, magazines and their ilk are now fully cognisant of the need to link their real-world print-based efforts to online content provision. Unfortunately virtually no one has any real idea of how to do this and make money from it. So far it is almost entirely the domain of niche market specialist magazines with expensive subscriptions and good profit margins that can charge for online content.

Some organisations have attempted to get around this obstacle by requiring users to register personal information with them in order to get content. This information is the used to 'leverage' advertising - in other words, this information is used to charge more for advertising based on the fact that reader demographics are very accurate.

It is a version of this 'information as currency' direction to which I will return later as being a serious possibility for meteorological service providers.

So what is the landscape as of now? Meteorological organisations are generally not private companies. They are making little mass-market advantage of their information base, primarily because there has, until recently, been almost no way of practically delivering those products to a mass audience with enough individual relevance. The companies which have been able to do this have not generally used weather products as primary selling points - although with advent of the US-style 'rolling news' radio and TV services this has changed to some extent.

There is, of course, another 'route to market'.

3 Why mobile and personalised devices and services will become so important

The devices of the future should allow for 'personalisation' on a previously unimaginable scale.

In the golden days of science fiction personalisation meant having your details stored in some vast all-powerful database (Isaac Asimov's Multivac springs to mind). This is still, in essence, true, perhaps more so than people in the '60s and '70s would ever have wanted.

But it is the devices that we use that make the world more personal, not the information about us. This sounds counter-intuitive, and certainly rubs up against current web wisdom, itself something of an oxymoron. But it is not. No matter how much information you have on someone, if you can't find them, communicate with them, learn how they change, your information is worth effectively nothing.

It's a well-polished truism that mobile phones are the most popular and rapidly accepted device ever. It is a truly personal object and has been phenomenally successful arguably because of that.

Most handheld 'connected devices' in circulation in Europe are capable of receiving data and displaying/conveying that information to their owners.

What follows is an hypothetical example of how services can be provided to mobile devices (predominantly mobile telephones at the moment), and a demonstration of the revenue potential inherent within this provision.

3.1 A demonstration of the revenue-generation power of SMS products

You will no doubt be aware of SMS, text messaging. In the short to medium term this method of content provision could prove to be the most effective revenue-generating route to take - perhaps even as a stopgap measure while a strategy is developed for more innovative services.

SMS currently traffic contributes 10 to 12 percent of European mobile revenues, with the highest usage in Scandinavia and the lowest in France. Almost certainly these figures will be terrifically out of date by the time you read this, but they serve well as an example.

In October 2001 alone the total number of chargeable text messages reached 1.2 billion in the UK. This compares to 105 million in September 1999. During 2000, 6.17 billion chargeable text messages were sent in the UK.

According to the most recent available data obtained by the Mobile Data Association[1]:

The total number of cellular data users in Western Europe will increase from 3.5 million in 1998 to 51 million in 2003. The proportion of all cellular users using data services (messaging, information services, or remote access applications) will increase from 4 percent to 25 percent over the period.

By 2003, Western European cellular data revenues are expected to reach $7.4 billion [Euros 8.36bn as at 27/12/01]. The proportion of total cellular revenue coming from data services will reach almost 6 percent by that time.

For both the European and US markets user adoption of basic messaging and text-based information services will outstrip demand for more advanced cellular data services such as corporate LAN access and internet browsing.

In Europe just 7 percent of cellular data users will be using these advanced services by 2003.

In other words, the corporate database and email access dreams of WAP service companies is peanuts compared to the potential number of people by 2003 using data services for other things. And, if the MDA's analyst is approximately right about a six percent share of revenue coming from data in 2003, in only a couple of years Europeans will be spending Euros 501.6 million per year on mobile data.

How can your organisation use delivery of information to personal mobile devices to gain a share of this?

By doing deals with mobile service providers, meteorological service providers could arrange to earn a percentage of the revenue gained from these message-based services:

A user base of one million subscribers in the UK all paying for one SMS alert at Euros 0.16 for weather per day based on their geographical location would earn around Euros 160,000 per day gross. If the meteorological service provider was to keep 20 percent of this revenue this would equate to a revenue to the meteorological organisation of around Euros 11.7 million per year.

So you can see that providing to a wide audience at a very small cost is still valuable.

From 1999 there was a general industry push to popularise the WAP system of using applications on mobile phones. Sadly for its proponents WAP has so far proved to be the Betamax of the mobile phone world, in that it might have been a technically better solution but it was cumbersome, badly marketed and ultimately unnecessary.

As far as I have been told the Met Office did try a WAP-based paid-for service over mobile phones that failed to garner revenue. Now the Met Office is running an SMS-based service of mobile text forecasts, available on two UK networks.

One firm that claims to have made a significant impact on its market is Meteoconsult. At the EMS's first annual meeting in 2001 I spoke with Harry Otten, head of Meteoconsult. He told me that Meteoconsult's SMS-based service was doing well and there is no immediate reason to doubt him.

Both the Met Office and Meteoconsult's service cost significantly more than the above example's Euros 0.16 per message, with the Met Office's service costing Euros 0.49 on Vodafone's system.

3.2 A possible complex future application of MSP-to-consumer business

In considering how possible MSP-to-consumer future applications could appear, you have to also consider the fact that all technological advances have resulted in unforeseen consequences. It is therefore likely that the most useful, or most prevalent, and these are by no means one and the same, applications may be almost impossible to predict. However, as an example:

The rise of the biotech industry will almost certainly have a cultural impact on the world at large. Knowledge and awareness of one's health is certain to become a yet more important element of living. Combined with the increasing need in certain parts of the world to gain more comprehensive privately funded health insurance (in countries such as the UK and 'developing' nations, for example), there is the potential to sell information products that are linked to one's health.

Though this example is a 'lite' one, it serves our purposes here.

The McDonald family go on holiday to a sunshine destination - let us use the south of France for an example. We can give the McDonalds a, still fairly prevalent but increasingly less so, nuclear family of three children and mother and father. The McDonald parents are concerned that their children do not receive any more exposure to the sun than their skin types will allow.

[1] www.mda-mobiledata.org

Normally this would result in reactive methods - judging as hours go on how much direct sunlight the children are exposed to on a beach on any day and mitigating it using sun cream and clothing.

But why not build an alarm system into this? On any given day the 'burn time', the amount of time the average person, unprotected, can remain in the sun without burning, will vary according to conditions. This is a predictive, however. As weather services update their forecasts throughout the day, it would be more than possible to provide an ongoing 'report' to the McDonald parents as to how much time they and their children can spend in the sun. The McDonalds could also contribute to highly localised weather measuring by reporting exactly where they are and whether the sun is occluded, for example. But, essentially, it could be possible to link a server-side database on health aspects of the McDonald family, such as individual skin types and previous conditions as well as possible future genetic information as predilection to melanomas, to an alert-style SMS (or future equivalent) system to tell the McDonalds when they should withdraw from the sun, which child should spend less time outside unprotected, on an hour by hour basis.

Once a family is involved in such a service, which obviously has limited use for many, it would then be possible to ask them if they would like to know on their mobile devices which local resort they could visit that would either have the most sun, the least sun, the shortest drive etc. Combined with automotive telematics[2], the use of communications technologies in motor vehicles, an MSP could have a large revenue stake in a holiday, bearing in mind that most holidays for those people in northern Europe, for example, depend almost entirely on the weather.

This kind of application is already being done in a limited way for skiing holidays - it is not at all hard to imagine a complex web of weather-related information products that could be applied to any holiday.

The subscription model and the charge-on-request model are revenue models that work, generally, now. But future models could be very different.

4 Using consumer information as a currency, and where to go next

But there are several other possibilities for sending chargeable information to mobile devices, and the state of the mobile communications industry and its debt will almost certainly mean that within the next three to five years there will be devices available at a reasonable cost that will be able to allow 'rich content' to be pumped to them.

There will also be significant consolidation in the mobile telecomms industry, with companies conglomerating to bring disparate chargeable services on to the same balance sheet and, ultimately, the same phone bill.

[2] http://www.telematicsupdate.com/

As I've said, SMS and its ilk are not the only possible future for revenue-generation for meteorological providers. Why try to make money directly from consumers at all?

Mobile providers and web content providers are crying out for content that will make their services more attractive. The 'portal' idea of providing information to 'channels' that work similarly to television, for example, is becoming established and would provide a more stable, if reduced compared to the above example, income.

Further into the future, it seems perfectly reasonable to propose cooperative systems where consumers 'add value', in other words information that could improve spot weather reports and possibly even eventually add to information added to models to improve skill, to meteorological providers.

This concept, and possible ways of living as consumers with some of the more bizarre devices that may come to pass, is what I shall spend the remainder of this piece discussing.

The peer to peer system of swapping files has been enormously successful. This notion that people want to share information because it has inherent value to them is nothing new, but in the digital age it can be easily and cheaply. By the same token, it's not hard to imagine people understanding the idea that information can work for them. People's personal information is extremely valuable – many a business model has been set up purely on the basis of it – and if used imaginatively will make them happy they gave it to you.

With the growth of location-based services, a holy grail of revenue for mobile device service providers, people should start to see their location and the information about them as being connected and valuable to them. We are at a nascent stage in the popular understanding of the value of personal information. It will not be the case for long that people give away their personal information in return for an email newsletter or for a quick-fix service.

But people want to know about the weather. They would almost certainly be pleased to hand over personal information in return for weather products, as long as they trust the brand they are giving it to. It is not possible to overstate how important that element of trust is. However, it has a positive flipside: weather services often have well-established, renowned and respected brands. It may stick in the throat of some meteorologists to think in these corporate terms but it is essential to think in these terms when thinking about future revenue generation from meteorological products.

People can help you not only in terms of providing their personal information, which you can use (subject to consent and the law) to gain revenue from other providers in much the same way as described previously in this article for more immediately applicable services.

They can also, perhaps, help you gain meteorological information, or, more accurately, meteorological data.

If you want to know about the weather in a precise location that is not covered by a station, you could do worse than simply ask someone who is there. What if that person is regularly there? It appears that the standard way of gaining remote land-based information is by using automatic stations, but it seems reasonable to speculate that it would not be impossible in future to use a combination of eye-witness and small-scale technological measuring devices on a wide scale to 'add value' to future meteorological products.

If this sounds barking mad, think again. Aeroplanes and ships already do this for MSPs. This is because there is an in-built level of technological sophistication in these machines, which invariably can perform meteorological functions automatically. How difficult would it be to build limited versions of automatic stations into new houses? With the explosion of networking, connected homes and apartments, the flow of information to MSPs could be extremely valuable. In an increasingly competitive meteorological environment, this 'added value' could be, to create an unintended pun, invaluable. In the area of pollution tracking alone this appears to make financial sense.

Go out to people, ask them if they would do this. Talk to Nokia, to Ericsson, to construction firms, to governments about getting cooperative funding. There is no reason why you cannot at least ask.

The future is not necessarily based on the subscription, text-message oriented world of current mobile technologies. These services require people to go to lengths to ask, to request this information. Even on subscription, they still have simply 'raw data' from which to extrapolate their situation and decisions.

Imagine living in a home where the house and a personal robot, perhaps similar to Sony's Aibo or NEC's R100 [3] know your schedule. They 'know' what the weather will be like on an ongoing basis. You talk to them about what you're going to do today.

They tell you to hang the washing out this morning, because it's going to rain at lunchtime. They can set your shower to be the right temperature for the outside conditions – who wants a boiling hot shower in summer? – and they could even tell you what the night time conditions will be like if you're going out, or are an amateur astronomer. What shall I wear today? It isn't even necessarily the information itself that is the issue but the future ease by which it may be available.

It isn't hard to imagine because these technologies are already almost with us, in their infancy.[4]

The way to make them happen and be a part of what they will bring is to ask questions now, to speak to companies that making mobile technologies and the firms that run the networks for them and to make contacts at the companies that are looking to provide paid-for content over those networks.

Don't just listen to those who give you short-term revenue solutions. You will need to look further and think more laterally than that to make the most of future devices and of the opportunities to which they will give rise.

Good luck.

[3] http://www.incx.nec.co.jp/robot/english/version-e/ver03.htm

[4] http://www.incx.nec.co.jp/robot/english/version-e/ver01.htm

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Article

Evolution of linkages between public meteorological entities in Europe

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Abstract

Several portions of the European meteorological infrastructure are managed today as integrated or cooperative activities : medium range numerical prediction (ECMWF), meteorological satellites (EUMETSAT), regulation of commercial access to basic data (ECOMET), optimisation of ground based observing systems and other basic activities (EUMETNET). The status of these structures for collective management will be briefly reviewed.

Factors for potential inducement to change will be assessed. Such factors may be found in the fields of general policy (driven by the evolution of the political framework of the European Union), organisation (to develop a capability to serve users of European scale) or economics (to optimise the use of taxpayer funding).

In this context, and depending on the weight given to the various factors, several scenarios can be envisaged concerning the structural evolution of European meteorology, ranging from no change to the creation of a European Meteorological Service. An attempt will be made to assess the likelihood of these scenarios.

Today several frameworks, institutional or informal, provide a number of linkages between national meteorological services in Europe. This paper will review these linkages, analyse briefly the factors which could strengthen or weaken them and will try to provide a guess as to their future evolution. As the experience of the author has been mainly with the NMSs of the western part of Europe, the views and ideas presented here may not be valid for the whole sub-continent.

The European NMSs work together through the WMO Regional Association-VI, ECMWF, EUMETSAT, ICWED, ICCED, ECOMET and EUMETNET. A number of bilateral or multilateral sub-regional groupings or co-operations also exist. The most well known are probably the consortia organised for the purpose of developing and operating limited area models for short range numerical weather prediction (HIRLAM, ALADIN, COSMO).

The main purpose of WMO RA-VI is to adapt to the regional context the general principles and technical regulations adopted by the WMO. Symmetrically, in several occasions, technical developments have been experimented in RA-VI before being offered for generalisation. RA-VI has also pioneered new institutional arrangements as for the RMDCN (Regional Meteorological Data Communication Network), where under the leadership of ECMWF a framework contract at European scale allows each NMS to contract with the same operator for the provision of telecommunication links to build the RMDCN.

ECMWF (1973) and EUMETSAT (1983) are two very successful intergovernmental organisations. Both were born of the need to procure systems that were out of reach of individual countries : super-computers which were too expensive for a European NMS in the seventies in the case of ECMWF, satellites in the case of EUMETSAT. These two organisations are today of world standard. They act as collective extensions of the national meteorological infrastructures.

There are also informal groupings. The Heads of NMSs meet periodically in so called "Informal Conferences" for Western European and Central European Directors (ICWED, ICCED). These forums offer opportunities to debate complex issues and identify possible solutions to be then brought to the discussion in more formal intergovernmental frameworks, thus facilitating the decision making process.

The Economic Interest Grouping ECOMET (1993) was created more recently, at the time where the rapid development of commercial activities in meteorology induced strong tensions, almost crises. ECOMET embodies a mechanism to preserve the exchange of data and products between members NMS. This is necessary because the relevant provisions of the WMO Resolution 40 on data exchange cannot be applied between members of the European Economic Area. ECOMET also provides a fair playing field for commercial operators

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within the EU by ensuring equal access to the data for all operators.

EUMETNET (1996) is a network of eighteen NMSs, without legal personality. Its objective is to facilitate the exchange of know-how between Members and to optimise the use of collective resources for meteorological infrastructure. The current EUMETNET Programmes are in the fields of observing systems, data communications, climatological applications, training and support to research[1].

Some general conclusions can be drawn from the history of these linkages over the past decades.

Firstly, the permanent trend to more co-operations shows that strong technical interdependence, linked since the beginning of meteorology to the vital need to receive data from abroad, is part of the fabric of meteorological work. It induces a tradition of co-operation and a natural tendency to look collectively for solutions to problems (access to large computers or satellites, preservation of the technical infrastructure despite the pressure of commercial activities). The fear had been expressed in recent years that the development of commercial activities by the NMSs could lead to a breakdown of this traditional cooperative approach. So far, it does not seem to be the case. For instance the EUMETNET Programmes, some of them such as EUCOS representing rather dramatic cooperative achievements, have all been established in the past five years.

This strong tradition of cooperation does not however lead naturally to integration. Two European institutional frameworks – ECMWF and EUMETSAT – can be considered to represent "quantum jumps" in the nature of the linkages they establish : they are true collective (rather than cooperative) ventures, to some extent independent of their parent national bodies. These quantum jumps were possible only because of the very strong pressures existing at the time : there was no other solution to achieve vital objectives.

Let us now turn to a review of the possible factors for change in the current context, and start with those which are internal to the meteorological community of NMSs.

It seems improbable that motivations both technical and financial such as those which led to ECMWF or EUMETSAT will appear in the coming decade. There won't be any overwhelming necessity to create a new intergovernmental organisation to provide a basic tool to the European NMSs. However, less intense constraints or opportunities could justify changes for specific domains. The two domains which come immediately to mind are the synoptic scale observing system and short range (i.e. up to two days in advance) numerical weather prediction.

Both fairness (in sharing the financial burden) and efficiency (in optimising the system at European scale) speak in favour of a collective management of the synoptic scale observing system. This is what EUCOS is about. It is not certain that the EUMETNET framework, lacking a legal personality, will be sufficient in the long term to provide adequate continuity and efficient decision making to manage the evolving observing system. A stronger legal basis may become necessary. The case of short range NWP is somewhat different. It is the technical evolution - increase of the resolution of global models due to better computer performance on the one hand, increased relative importance of the data assimilation systems to provide the best initial state - which could render obsolete within fifteen years the use of limited area models. It could then make sense for the European NMSs to integrate their short range NWP as they did for the medium range with ECMWF.

Apart from technico-financial constraints, we have also to consider whether political or institutional changes within the meteorological community could have an influence on their linkages. Generally speaking – i.e., with possible local exceptions – no major change is expected in the definition of the mission and scope of NMSs. There will however be changes in emphasis and priorities concerning the missions of NMSs. The continuous societal drive for more safety will induce stronger pressure for warnings about meteorological risks, hence a very strong priority on nowcasting. The almost equally strong motivation for environmental protection will face the NMSs with the necessity to play the role which should be theirs in the monitoring and detection of climate change. Neither of these changes of emphasis is likely to induce institutional changes in the linkage of NMSs: nowcasting is essentially a local problem ; climate monitoring only requires stronger co-operations, in particular in the standardisation of access to databases, the premises of which exist already, for instance in the EUMETNET programmes ECSN and UNIDART.

A tentative conclusion at this stage is that there does not appear to be forces at work within the community of European NMSs that could induce dramatic changes in the evolution of their institutional linkages. But what about external pressures ? Could there be external factors for change?

The current mood within the EU at intergovernmental level is not one of integration. The current trend is for a strict preservation of national prerogatives, not for more European construction. This is of course reflected at the level of NMSs. There is currently no intention to build a European Weather Service. There is however a possibility, of very low probability, for a dramatic political move ; we will come back to this further down to describe an alternate scenario.

There is also no strong political trend to change drastically the role of NMSs, at least not generally speaking. There has been a change in the Netherlands, where KNMI had to relinquish its commercial branch. A similar move is contemplated in a few other European countries, but a landslide in this respect is not expected: in those countries where the NMS has successfully developed its commercial activities, this is too much of a good

[1] for more information see http://www.eumetnet.eu.org/

thing for the customers, the state budget and the NMS itself to lead to a reversal of the policy. Anyway, the example of KNMI has shown that such changes have no impact on the linkages between NMSs. This is simply because practically all the co-operations concern infrastructure tasks, not the provision of services.

Altogether, one is led by this review of possible factors of change to the conclusion that the most probable scenario is that there will be no dramatic change. We can thus probably base our forecast for the next decade on the time-honoured linear extrapolation of past trends. This high probability scenario is one of progressive strengthening of existing relations, including perhaps nevertheless the establishment of common subsidiaries of limited scope.

In this scenario, sub-regional or bilateral agreements (examples the Nordic co-operation, the Concorde agreement between Mto-France and Met Office, consortia for LAM NWP) will flourish because such selective co-operations between a small number of partners of equivalent capabilities are the most cost-effective. At a larger scale, one can expect the enlargement of ventures like EUMETNET (EUMETNET itself is bound by its founding Agreement to grow at least as fast as the European Union). The establishment of common "subsidiaries" of the NMSs will probably be considered, e.g. for management of the synoptic scale observing system or for short range (24–48 hours) numerical weather prediction

A much less likely scenario can be envisaged, including a breaking point, taking us to a quite different world. But after all, non-linearity is also familiar to meteorologists! This would be a scenario where a European Meteorological Agency would be created to manage the meteorological infrastructure of European scale, both space and ground based observing systems as well as global scale numerical weather prediction. Such an agency would provide basic data and products to all meteorological operators but would most probably not provide services to users. What would be the reason for the creation of such an Agency? Well, if perhaps the European governments decided to select a few "innocent" – i.e., less controversial – subjects to demonstrate their ability to progress a concrete construction of Europe, the integration of the meteorological infrastructure would certainly appear as one of the subjects which made sense…

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Article

The future of the national meteorological services in Europe within the next ten years

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I have been asked me to tell you about the future of meteorology in Europe. Future, indeed, is difficult to tell, even for us meteorologists! Still we can try to progress by having a look on some on-going strong trends in our area.

Here are some that we can observe and that should go on:
1. Scientific and technical progress are really fast. This is true in very different areas of concern for us. Nowcasting, mesoscale numerical weather prediction, seasonal forecasting are some examples. We now work at very local scales. These new tools are inducing important changes in our "corporate cultures". They also call for expensive application tools.
2. Thanks to these scientific and technical progress, meteorology has become more and more useful. Whenever we issue new kinds of products, new customers can get the specific information they need. Moreover it is now possible to tailor meteorological information to users' needs.
3. Some "related fields" are closer and closer. This is true for example for hydrology, oceanography or air quality studies. Some of these sciences are true neighbours of meteorology (oceanography and meteorology are sisters). Moreover it is a permanent responsibility of the meteorologists to ensure that full benefit is made of the state of the art in meteorological knowledge for ensuring the public safety. In many of these new areas the kind of international collaboration that has been organized by the meteorologists is a model. Many national meteorological services are involved or are being involved in these new sectors.
4. "Tele-meteorology" is now largely possible. Close, local contacts between the meteorologists and the customers are a "plus" but are not always fully necessary. It is possible to prepare products very far from the place where they will be used. This is due to progress in observation, modelling, etc. but above all, to the decreasing costs and the establishment of standards in telecommunications.
5. Automatisation in meteorology is progressing. And it is possible to tell which areas call for human expertise and which can be dealt with automatically with identical outputs and reduced costs. Still, contacts with users call for local meteorological structures. Even if we had a "pan-European meteorological service" we would need local branches. This is true as well for managing some parts of the infrastructure and maintenance systems.
6. The strong international collaboration established between the various European national meteorological services brings many scientific, technical ... and budget benefits. Clearly this is a win-win strategy: There is no reason to reinvent every wheel. Meteorologists are now used to these collaboration, not only in research or in the exchange of data but also in the development and use of many operational tools.
7. The private sector will play an increasing part in meteorology in Europe. Still, most national meteorological services will stay strong by ten years time. (a relatively short period in time). In fact, a large number of the NMSs are very dynamic and have shown large capacities to adapt, imagine and invent. Governments are also increasing the part of "official duties" of these NMS. The requests from the general public, linked to public safety, are also increasing (with new sociological and judiciary sides) and most European decision-makers will go on backing the idea of a large part of the meteorological activity directly paid for by the tax- payers.
8. The collaboration between the NMSs will increase and cover new areas In addition to what is already covered by Eumetsat, the ECMWF and Eumetnet/EUCOS new areas will emrge for multilateral cooperation. NMSs will also get closer to each other on various bilateral basis. Still, a large number of the NMSs will "survive" by ten years from now.

The above listed trends will go on in the future. It should be noted that today the national meteorological services face opposite strengths, some pushing towards integration and some against it. Scientific and

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technical progress (making telemeteorology possible) and some European Commission efforts and initiatives (eg: GMES) are among the first ones. There is also a very strong push for a European organisation of operational meteorology in some areas to resist an American (US) monopoly. This might be the case in aviation meteorology where national European efforts are spread. On the other hand, some facts plead against an integration: nowcasting, hydrology, air quality management are more "local" than many present applications. In some areas also, notably public safety, it can be argued that the role of the States actually increases. Getting closer to oceanography is an open question where the national meteorological services are now considering various options (not dealing with, joining efforts with other national agencies or joining efforts with other NMSs).

As far as it is concerned, METEO-FRANCE's strategy heavily relies on international collaboration. We perfectly realise how many scientific, technical and financial benefits can be derived from such international links. We are enthusiastically involved in many multilateral (eg: CEPMMT) or bilateral (eg: Concorde, with the UKMO) efforts. Still, for the time being, we think there is one limit: we do not want to be put in a situation where we would fully loose expertise, making impossible a road backward. We are willing to give up responsibilities but not to give up knowledge.

Still the road ahead is clear. We will reach a point where instead of choosing the (some) areas where we will collaborate, we will choose the (some) areas where we will not!

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Article

Overview of the evolution of linkage between the Hungarian Meteorological Service and other national meteorological services in Europe

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(Manuscript received January 29, 2002)

Abstract

In the last decade fantastic political, economic and social changes occurred in Europe, first of all in its eastern part. At the same time in the structure and co-operation of the meteorological services there have not been significant changes. What can be the reasons for it? Is it because of the nature of the NMSs or is this transformation that seems to be balanced only illusory? Is there probably at the bottom of the processes a factor causing sudden, unexpected changes?

I would like to follow these two scenarios, the slow and the explosion-like change in the field of co-operation between the NMSs. In the course of the analysis I would like to extrapolate the past to the next decade based on Hungarian and European data on the one hand and to examine the effects of supposed sudden changes of some critical points in the near future on the other hand.

Mr. Chairman, Ladies and Gentlemen,

In order to be able to present the development and the future of relations between the Hungarian Meteorological Service and other European meteorological services, I think it is necessary to sum up the tasks and strategies of HMS in the past, first of all in the near past. Taking this information as a basis, we can see better the changes and tendencies and evaluate their results or failures. I consider the vision for the future especially important, as this is what we may still influence positively.

I do not intend to evaluate here the operation of the NMSs in the 19th century, I would like to mention only as a fact that our profession was that time really on the level of Europe also in the Carpathian basin. The most important tasks was the harmonization of measurements and analyzes, and the organization of data exchange. Our relations developed well in this respect, and not only with the neighbouring countries.

Between the two World Wars the above tasks remained in essence but the stresses were shifted. Beside surface observations also upper-air measurements became regular, and weather forecasting was an operative task. The research and development of present sense have also started. The regular and effective relations that could contribute to realizing the above aims were on low level at least at the beginning of the period...

When the 2nd World War was over, the earlier differences in technical conditions were equalized due to the destruction, but it was not the case in the field of knowledge, experiences and political system.

The development or better to say the transformation in Eastern part of Central Europe differed essentially from the tendencies in Western Europe. The orientation and determination of this region turned towards the East, first it was forced into then it accepted a completely different attitude. The working moral, the results and the values gained new dimension. Let's mention some examples:

The fact that the voluntary observer network became resulted that the voluntary network, the background of committed non-experts interested in meteorology weakened. It is true that in return the reliability of observations became better but in the situation of the cold war the use and exchange of these advanced data was limited.

The open usage of meteorological information under the circumstances of general secretiveness resulted interesting aspects (e.g. for the 1st of May good weather had to be always predicted). On the other hand, the exaggerated application has also appeared, e.g. there was an increased pressure to influence the weather actively.

We turned towards East also in the field of techniques. The lack of instruments and the usage of not really adequate instruments was typical.

The copying of successful instruments without permission appeared as well (e.g. the illegal production of Vaisala radiosondes in the middle of the fifties).

Even in the eighties, the extensive development was considered important, it was intended to compensate the

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out-of-date techniques this way. For example, instead of using developed technique, a lot of people were employed without ensuring adequate conditions for successful work.

Beside the negative sides, there was also one positive fact. The level of education became better and the ideology could not cause much damage in the field of natural sciences. Thus we had many well-educated experts, some of them having really considerable professional knowledge. The utilization and exploitation of their knowledge was regretfully on a low level, so to say it was wasted.

Because of political and ideological reasons, the Russian language was preferred, the relations were forced in this direction.

Let's examine how the Hungarian National Service was operating in the middle of the seventies.

- It was a meteorological service. In contrast to the services of other socialist countries, it was not dealing with operational hydrology.
- From he nearly 580 employees 190 were graduated of university.
- An important part of its activities – nearly the half – served the purpose of research.
- The sale of data and information on business basis has appeared, it amounted to about 10 per cent of the budget.
- The weather prediction profile was essential but far not of crucial importance.
- The elements of the observing network were instrumented and operated according to the WMO recommendations. 24 stations reporting every hour, two sounding stations, about 100 climate stations and 700 rain-gauges were operating.
- The international relation had four directions: the so-called COMECON co-operation that comprised the entire field of meteorology but was more or less formal in professional aspects. In a political sense, it was successful, we can still remember the elections and debates in WMO. It is true that the uniform but in number small socialist block could force its ideas several times to the less uniform majority.

The other organization, named INTERKOSMOS, concentrated to satellite meteorology. Its characteristics were the same as in the former case. The results of this co-operation, taking up plenty of time and energy, were moderate.

A co-operation covering the entire field of our profession existed also between academic institutes but it was even more formal.

The two "great achievements" of that time were the automation of protocol writing and the so-called "bez valjutnüj" travel exchange. The protocol was prepared usually in a form determined in advance, and mostly based on ready materials on the first day of the meeting. The only problem was the shortage of typewriters with Cyrillic letters. The exchange without currency meant that the partners covered the daily allowance of the visitors that was agreed in advance but only for the days that were fixed in a barter-like agreement.

The bilateral co-operations appeared also in embryo. As a matter of fact they were tolerated but not supported relations, as the possibility of Soviet control was here not ensured. The first relation of our Service towards the West after the war was established with Austria. It is strange to say that the essence of these relations was to establish human relations. This aim was achieved successfully, thus establishing a basis also for the professional co-operation at a later stage.

In the eighties the position of our Service was more or less unchanged. At the same time some phenomena strengthened such as the increase in the rate of own income. The staff number was nearly one thousand. We built up and operated a hail suppression rocket system. The maintenance of the relations with the East became more difficult, sometimes we had to persuade colleagues who were ready to travel to the Soviet Union.

A completely different situation characterized the slowly developing co-operations with the West. On the occasion of entering into official relations with the USA for the first time, the lucky participants who were envied by everyone, handled this possibility as a conspiracy while they nearly ruined their health by overwork in order to achieve success in the co-operation.

Despite our difficulties, most of our experts had several important ideas:

- We believed that our profession is important for the public.
- We believed that this work could be accomplished the best by the national meteorological service.
- We were sure that our tasks could be fulfilled the best with the support of international co-operations and we alone were not enough to achieve success in our work.
- We were missing the intensive relations with the West.
- We felt that this deficiency was limiting our results.
- We accepted the noble conception of free and unrestricted exchange of data and we endeavoured to realize this idea sometimes even with trickery.
- We hoped that the exchange of knowledge and methods were hindered only by political obstacles.
- We did what we had to do, as we loved our profession.
- We considered it a mission and not a gainful employment.

- We thought that the deviation from these principles was the fault of the given system and it could be improved.

After the transition in the nineties and the collapse of systems based on communist ideology, the political changes in Hungary were radical. A few years were enough to destroy the earlier structure and to liquidate almost totally the former political system. The economic change showed interesting duality. The foreign capital flew to the newly freed market and changed the situation completely in its own field. In case of the not negligible minority of still Hungarian properties, the economic change happened not so dramatically. Sometimes only the form has changed, the persons and the content remained the same. As a consequence, the transition is still going on in some fields.

As I see, the change in the most important field, that is in the way of thinking and attitude of the people is very slow. The past ten years seem to be not enough even to understand and accept the essence of the changes.

Without entering into particulars, I would like to emphasize that the political transition in the nineties took the Hungarian Meteorological Service unprepared. I do not think I am wrong if I suppose that the situation was the same in the other NMSs of the region. Because of this unpreparedness we had opportunity only to follow the changes and not to influence them. This situation must be considered crucial as the position of HMS that was not very strong and illustrious in the state apparatus anyway, continued to weaken.

How did all these reflect in the structure, operation and strategy in HMS? First, we came to an ethic, then to a governing and finally to an economic crisis. The transition did not happen in an instant. The premonitory signs of the changes could be felt, but the management and the colleagues of the Service were uncertain. On the one hand, they did not bear to leave the political position they were used to during the past decades, and on the other hand, they had no strength or intention to preserve it. Some of them did not even recognize the changes of course. A moral crisis has developed indeed. In the first place, we were not occupied in our profession but in our personal past and future. The concomitant of this situation was of course that the management became uncertain and the aims were not clarified or they were even missing. In the meantime, the shocking of the state budget came also to light, thus it was not a surprise that the Service bankrupted.

An enormous reduction of staff (70%), the entire replacement of the management and economic restrictions followed. The peaceful situation of a research institute was terminated and the disappointment in some earlier ideas also occurred.

We were in trouble. We asked for international, Western-European help and trusted in the support. Apart from some isolated actions, we were left alone. We had to understand that we could count only with ourselves first of all. We realized that possessing data and information had advantages. We learnt that the love of our profession was not enough, we should sell our working capacity for our subsistence.

Thus we remained much less with much less commitment but with rational thoughts and a lot of experiences about international co-operation. I may say that we tried to grow up under the burden.

How are all these demonstrated in the examples listed earlier? The observing network was entirely transformed for the second time within fifty years. We automated and reduced. We did not return to the network based on voluntary observers but it did not depend on us. The elements of the observing network were instrumented and operated according to the WMO recommendations. (29 stations reporting every hour, two sounding stations, nearly 60 climate stations and 500 rain-gauges, three radars, lightning localization system satellite receivers are now operating.)

After our enthusiasm at the beginning of the nineties in the field data exchange that made everything free and remained unreturned, the former situation was restored by now. However the reason of the limited data exchange is nowadays not the secretiveness of the cold war but the economic interests.

There are no more exaggerated demands for applications. We are gladly at the disposal of our partners but based on mutual interest. The pressure to influence weather actively ended, now we consider it only an expensive error.

In the field of techniques we turned to the West. The instruments are better but the significant difference between promises and reality is still not rare. Even now there is lack of instruments, the reason of it is now the lack of resources.

The extensive development has come to an end, the obstacle to the increased intensive development is now only the lack of adequately educated experts. The international co-operation is free, but now we have gone to the other extreme, i.e. by now everybody has forgotten even the Russian language.

Let's see how the Hungarian Meteorological Service is operating in the present days. It is a pure meteorological service with a few activities in the field of environmental protection. Among the nearly 300 employees, 120 are graduated of university, 70 of them have diploma in meteorology.

A significant part of the activities of HMS – about two-third – is connected with operational weather forecasting. The research and development activities come to one-fifth of the total capacity. The business activities are providing nearly the half of the total budgetary income. The weather prediction profile is essential and of crucial importance. The elements of the observing network are instrumented and operated according to the WMO recommendations. Beside WMO, we have international relations almost exclusively with European international organizations, NMSs and with their multilateral co-operations. The former orientation towards East has completely changed, and now it is directed essentially to the West, and to a smaller degree to Central Europe. With establishing and maintaining these relations, our aims are were as follows:

- to adopt and exchange important and useful professional information,
- to participate in the development of new methods and procedures,
- to harmonize, represent commonly and protect our interests.

Knowing the stage of development and economic capacity of our country and the historical background, we did not expect that our application will be welcomed by all of our new partners, and we will be drawn immediately into the co-operations that were established with much effort and attention. We found that the mistrust of the Western part in the earlier enemy is natural, but we must confess that we did not count with such difficulties. Sometimes we felt that we were in vacuum.

Nowadays our main endeavour is to achieve – as a reliable and useful partner – the full membership status in all of the significant Western-European meteorological co-operations and to develop a well operating Central European partner relation. Now we are in the phase of confidence-building, and I hope we will be successful.

I would like to list herewith our existing co-operations:

- we are a co-operating state of ECMWF and EUMETSAT,
- full membership in ECOMET and participation in some EUMETNET programmes,
- membership in the LACE co-operation of the Central European countries, in ICCED and in the ALADIN project,
- numerous smaller or larger bilateral co-operations.

A neglected field of our international relations is the co-operation - based on mutual advantages - with the concurrent private companies and university or academic institutes. All our attempts in this respect ended in failure.

Probably we did not manage to understand the main principles of operation of these organizations and/or our offer was not really attractive. Thus we are rather competing. In view of the future the co-operation with the private sector may be advantageous, so it seems to be desirable for us.

The above detailed analysis of conditions means a background for me to examine the alternatives of future co-operations from this special, Central European point of view. For a Central European NMS, the great questions, problems to be solved and dilemmas of the future seem to be the followings:

- Is Europe becoming unified and/or more divided to regions?
- Concentration and/or sovereignty on the level of NMSs?
- Co-operation and/or competition between NMSs?
- A significant role of the state and/or preferring individual initiatives from the part of the government?

I think that there are no simple answers of universal validity to these questions. The age of cold war with its black or white formula is over. Concepts that were in contradiction with each other earlier, are and will be co-existing and exerting influence.

In my opinion, it is likely that on a long view beside the reduction of useless over-capacity meteorological activities will be realized through regional co-operations. A tight relation among the 49 sovereign NMSs with different culture and stage of development could be operated hardly or not in the least, so the co-operation of our continent can be attained through the co-operation of smaller groups and regions. It seems to be a contrasting process that the former socialist countries endeavour to build up their Western European relations separately. They lay usually even more stress on these relations than on the Central European co-operations. Thus it seems to be likely that the two endeavours will be existing simultaneously. If we fail to create a Europe of regions – what cannot be precluded – different interest groups will be established within the unified organization and the regions will be acting as separate factions.

The meteorological activities on an adequate level require capital and resources, the progress and the solution of the emerged problems can be realized only with the help of significant resources. It is unlikely that the different governments will be ready to spend more money on this purpose. The solution of this contradiction can be the concentration of capital and resources. If the different NMSs and groups of NMSs give up sovereignty and cancel parallel activities, the necessary concentration of resources can be realized. The organizations dislike giving up sovereignty, but it seems that this principle of "keep through stopping it" is the only good solution.

We could experience in the last years that the competition is good but tiring. Apparently it is easier to agree and cartelize than to struggle, but I think we have to choose competition for the sake of development. The competition helps us in finding the better solution and in the concentration of capital, but it makes the exchange of data and information more difficult, and the weak and inexperienced partners impossible. We have to learn from the large multinational companies in this respect. They are not in frontal competition with each other, but form communities of interest in order to realize some common tasks. If the competitor becomes weakened, it will be bought up at most. It will not be liquidated but its values will be built in the own system of the purchaser.

I would not trust that on a longer view the role of the states may remain on the same level. In competitions, the role of a state is not advantageous, it is slow, circumstantial and burdened by too many regulations. This is not the case in the private sector and ventures. Thus I believe that the private ventures will gain ground in the future.

What kind of strategic ideas do we have in the field of co-operation here in the Central European region based on the facts outlined above?

We accept as a fact that we alone are not able to achieve essential professional development and in some fields even to keep the level.

We intend to become full member of the Western European international meteorological organizations.

At the same time, we would like to strengthen the regional co-operation not precluding the competition but maintaining the unrestricted exchange of data.

We do not think it likely that beside the political unification of Europe, the present structure of NMSs can be maintained, that is the own meteorological service of each small country can cover the complete sphere of meteorological activities.

In our opinion, there is only a little chance that the role of the states will remain on the present level. But this loss might be compensated by the co-operation and the market.

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Article

The structure of linkages between providers of meteorological products, advice and data – a perspective from existing National Meteorological and Hydrological Services

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(Manuscript received October 31, 2001)

Abstract

The existing principles regarding data policy will survive and ECOMET will remain as a useful tool for taking care of the relations between the NMHS's and the Private Sector. The Commercial Units of the NMHS's will be organised more like independent Service Providers (SP).

Some of the NMHS's will be active on the whole European market, sometimes in co-operation with private companies. There will be more of a segmentation of the market with service providers being specialised on certain marketshares. There will be a differentiation of SP's regarding the size of the company – a few large ones and many small companies.

Prices for data will be reduced quite substantially and the means for transmitting data will be developed. "Simple forecasts" will be available free of charge on the Internet and the business concept for larger companies, including the NMHS's – will be an ambition to add more and more value to their services, including coupling of meteorology to hydrology and oceanography. There will be a lot of possibilities to get more and more tailor-made forecasts like "weather-on-demand".

1 Introduction

SMHI, the Swedish Meteorological and Hydrological Institute, is an authority with extensive service and business operations, active in the areas of meteorology, hydrology and oceanography. The products and services, including consulting assignments, are frequently used by authorities and by Swedish and international trade and industry. Fig. 1 shows SMHI's structure.

2 Development of tasks

Grown over the years, the present tasks will be the same in the future:

- Responsibility for the infrastructure.
- Commercial services.
- Co-operation with other governmental authorities.

3 What constitutes the infrastructure?

The infrastructure of SMHI is not unlike that of other National Meteorological and Hydrological Services (NMHS); it chiefly consists of

- General forecasts, warnings and co-operation with civil protection authorities;
- climate databases;
- observations;
- exchange of data within WMO;
- responsible for ECOMET-undertakings
- distribution of data for research and education according to WMO Resolution 40.

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4 Commercialization

4.1 Why commercialization?

First and foremost, the need to commercialize is a political decision by European governments. Basically the cost of taxpayers' money spent on the infrastructure is to be recovered at a target of 3%. In Europe the cost for infrastructure amounted to 1.4 billion US-Dollars in 1997. This requires that more resources are allocated to the NMHS's for research, computers, observation etc. Cost-recovery as a principle is not unique for NMHS, it also applies for State Agencies dealing, e.g, with statistics or maps.

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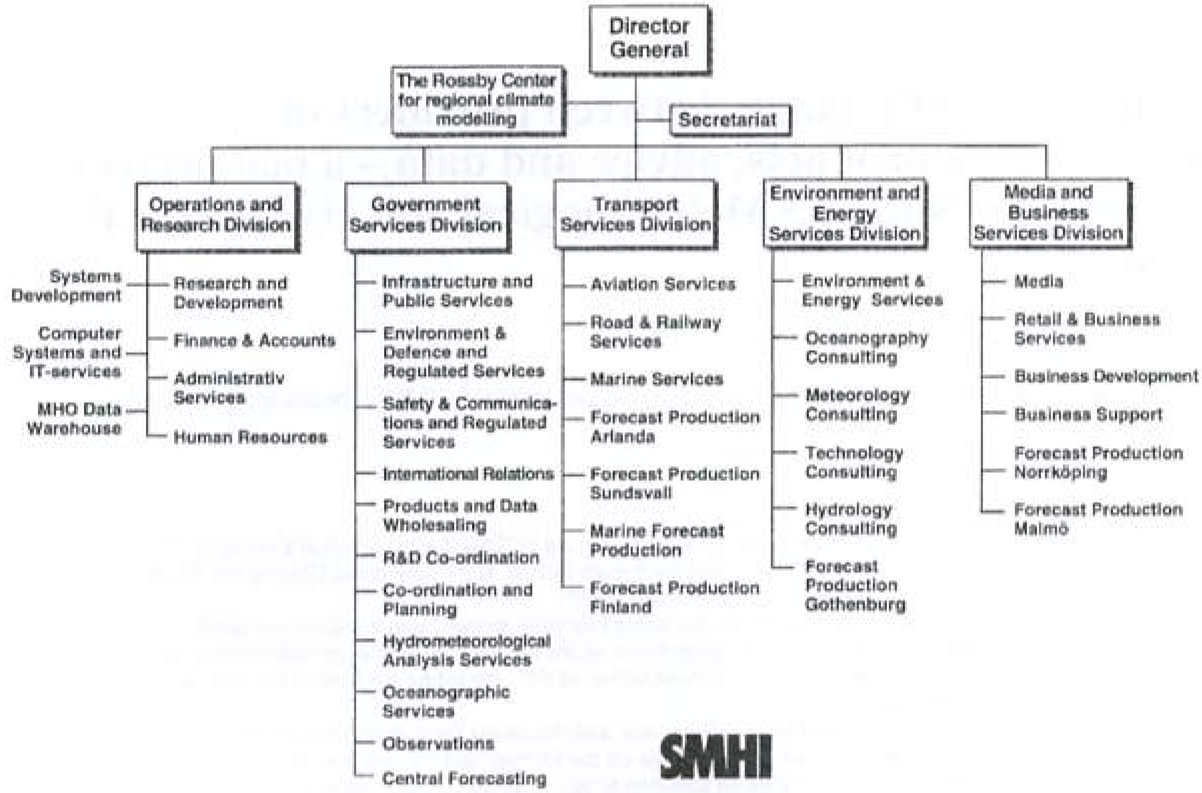

Figure 1: The SMHI structure.

Table 1: The SMHI business concept.

For whom?	*Doing what?*	*How?*	*Why?*
Government	Infrastructure	With efficiency	Protect life and property
Government Authorities	Basis for decisions	Cost recovery	Support society
Market	Satisfy the demand	With profit	Earn money

In the process, positive impact on the NMHS results from continuous contacts and feedback with their customers. Furthermore, in market terms, commercialization is necessary to defend the NMHS against the threat from private companies.

4.2 The SMHI business concept

SMHI is doing business based on a concept given in Tab. 1.

4.3 ECOMET

The business concept suggests that ECOMET will develop from its present form, but will still guarantee a framework for the exchange of data and for free competition. The commercial parts of NMHS's will, more and more, come to be treated as other, private sector, service providers. This implies the creation of a distinct border between infrastructure and business within NMHS's. One other "forecast" is that prices for weather data will become much lower than they are today.

4.4 The NMS's and their commercial activities in different parts of the world

There are a variety of models of operation regarding NMHS's and their commercial activities in different parts of the world. In the US and Japan, the NMHS is only responsibility for the Infrastructure – this arrangement is not without its problems. In European countries – except the Netherlands – commercial activities form a part of the responsibility of the NMHS. In many countries the consequent income forms a substantial part of their turnover, and in almost all countries this is a growing part. In the rest of the world – mainly in Africa and Latin-America, but also in Singapore – NMHS's have begun to act on the commercial market. SMHI has been active in sharing its experiences. New Zealand is a special case in that it has everything in a (government-owned) company.

The effects of external competition on European NMHSs can already be seen. Prices for weather data and for "Value Added Services" have dropped. A wider range of products is now available than heretofore. Their is a better focus on the needs of users. The creation of more efficiency through the generation of a "business-culture" represents a benefit for the taxpayers.

4.5 How is the development of the commercial sections of NMHS's in Europe likely to proceed over the next decade?

A few NMHS's will only provide services in response to demands; these are likely to generate income to about 5–10% of their turnover. Some more will be proactive in search of business, but only in their own country; these are likely to generate income to about 20–30% of their turnover. A few European NMHS's will be very active on the European – and perhaps the global – market, generating income representing more than 50% of their turnover. Some NMHS's may co-operate with private companies or have subsidiaries.

4.6 Development of the private sector

There will probably be a few Europe-based globally acting companies, owned by US or Japanese parents. There will be one or two European companies doing business in several countries. There will probably be many small companies operating only in their own country or region.

5 Future roles

5.1 A vision for a NMS in the future

The NMHS's should aim to provide a useful resource for climate and environmental activities in Europe. There will be an increasing focus on user-needs. This will encompass the provision of services that help customers provide efficiency and security in their operations. NMHS's should aim to provide the best possible forecast on all timescales. They need to develop effective production process from observations to forecasts to end users. They should operate to a high scientific level, and develop close co-operation with other researchers. They will need either to become integrated with or develop close co-operation with the sister disciplines of hydrology and oceanography.

5.2 The future weather market

Delivery will be based more and more on Internet technologies, encompassing WAP, 3G etc. There will tend to be fewer problems with the use of different languages. Forecasts for the energy and environment sectors will prove increasingly important; and there will be a need generally to add more value to the forecasts. There will be an increase in the number and range of free forecasts that are available, as we move towards a concept of "Weather-on-demand".

There are mutual problems that are shared between public and private sectors. The dissemination of consistent warnings is one such issue, while forecast quality concerns us all. Delivery of data is still a difficulty, as are complaints to competition authorities about alleged unfair practices. Both public and private sectors need to develop a deeper knowledge of the European market for weather forecasts and related products and services.

6 A wish-list for the future

To finish, a wish-list for the future, in which we all must live and work together. There should be a mutual respect for the different tasks of the public and private sectors, and a constructive dialogue to address the difficulties which still divide us.

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Private and public sector meteorology

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The organizers of the First EMS Annual Meeting invited me to Budapest to represent one of the major weather companies in Europe though compared to some national weather services we are still small. In this text I want to outline a short history of private weather services, the response to the private initiatives from the state services and the current situation. I want to show to the reader where the market is now and where the chances are. Of course you will want to know from me how the future might look like and at the end I will also fly some ideas how we could turn meteorology into a more efficient science.

I want to start with a quote.*There is a feeling among many Weather Bureau employees that encouragement of private meteorology is incompatible with growth of the national weather service. This is not in accordance with the American philosophy of private enterprise and competition. We believe the progress of one is indissoluble bound to that of the other. This concept should be stressed at all levels.* This quote was made by the Department of Commerce Advisory Committee on Weather Services in the year I was born: 1948.

The European version of this quote might run like this: *There is a feeling among many employees of national weather services that encouragement of private meteorology is incompatible with the growth or even maintaining their much too large service and their importance. This is in accordance with short sighted views of governments and the European Commission. Despite and much in contrary to the basis of the EU, the Treaty of Rome, they therefore founded an institution called ECOMET that has as one and only task to make life of the private sector as difficult as possible.*

Talking about the European Commission, I would like to say that I'm very disappointed that the EU representative did not come and without valid arguments as the organisers told me. It shows the disdain of the EU with respect to meteorology and I would like to suggest to Rene Morin to send a letter to the EU expressing the great disappointment of the participants in this conference that no representative showed up.

Where have the different views I just expressed taken us? I can show it simply in the numbers: the private meteorology sector in the United States has grown into a $500M sector whereas the private sector in Europe is not much larger than $30M. This may be partly due to the fact that the private sector in the USA emerged 20–25 years before that in Europe but it does not account for all of the difference.

A report by PIRA commissioned by the European Commission's Directorate General on Information Society gave numbers on the total turnover reached with public sector information. With public sector information I mean data that has been paid already by you and me through the tax system. Free available data leads to enormous markets. In the European community the present annual turnover with public sector information is approximately 68 billion Euro whereas this market in the United States is around 750 billion Euro. The difference may account for the substantial difference in the number of jobless people at both sides of the Ocean. Substantial number of jobs could be generated when, like in the US, public sector information is more freely available.

Despite almost everything the private meteorology sector has emerged in Europe as well and is growing. Meteo Consult has offices now in the Netherlands, the UK, Belgium, Germany, Spain and the United States employing all in total some 135 persons. From within some National Met. Services we hear doubts about the quality of the services we provide and that we are just repackaging the data we obtain from the observational networks and the computer models. Are national weather services better because they have such greater budgets and data available to them or can the private sector compete with them? Let me just give you two examples. In the Netherlands the private sector is responsible for Winter Road Maintenance. The winter of 2000-2001 was one with quite a number of days with ice and snow. Forecasts and warnings by the private sector resulted in a minimal number of fatal accidents. In the entire winter 17 people were killed in fatal accidents due to slippery roads. In the same period the numbers of deaths in Germany was 400. Another example comes from a company that is active in Weather Derivatives. By the way a market that in 2000 had a contract value of 7.3 billion $ in the USA compared to 120M in Europe. Our forecasts for a large number of locations in Europe were compared to those of the UK Met.Office and to those available from the BBC. The results are shown in Fig. 1. More or less on the longer term we are about two days better than the Met. Office. We recently found out that our ideas of interactive meteorological databases that we have oper-

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ational in our offices are about five years ahead of the national weather service implementations.

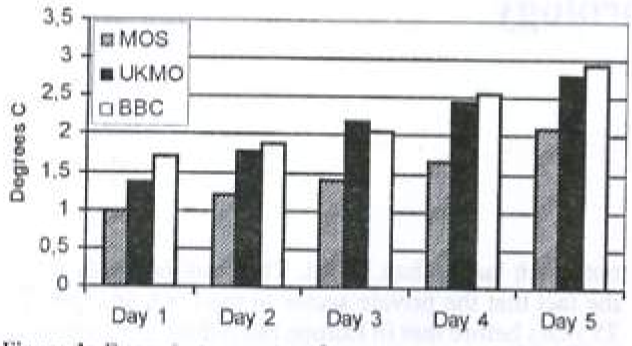

Figure 1: Errors in temperature forecase; sources: MOS, UKMO and BBC.

What is the big difference between the public and the private sector? Many people have asked me this over the past years. Is our quality better? Yes, but not always. Are we faster to respond? In most cases yes. Do we listen better to our customers? Yes, almost always. But I can define the big difference in five words: we work with **real** money. Or to say it differently: even yesterday I was told that we are just taken the raisins out of the bread. The amazing thing is that even if we did so, the number of raisins in the bread of the public sector would not change. The private sector opened up completely new markets and we do our fair share of research. For instance: MOS development, models for Winter Road Maintenance and Traffic Management, radiation forecasts for greenhouses – shown in an ECAM poster presentation – and interactive graphical meteorological databases. We spend at least 10% of our budget in research and development.

The point I very strongly want to make in this presentation is that the private sector offers services that are at least comparable in quality to those of the national weather services so quality is not an issue. This calls for a much more liberal data policy in Europe. States should not compete with their citizens and instead of trying to get money from the private sector directly, the revenue should come from the increased payments in taxes and social security. In my view the private sector in Europe could grow to a 200M Euro business in the next five to ten years. This will yield some 100M Euro in taxes and social security payments. Compared to the direct payment to ECOMET this is a large multiple.

Fortunately there is light at the horizon. In a number of countries the philosophy about the availability of data is changing rapidly. The Netherlands has the intention to declare all of its meteorological data WMO essential shortly. This means that all data is available to everybody at just the cost of dissemination and can be multiplied freely. In the UK synoptic data was declared WMO essential from January 2001. In Finland after a shameful period of tampering with data, the government will put the commercial department away from the National Weather Service in a split up. A logical step there would be to declare all data WMO essential. In Sweden the State is investigating the position of SMHI. It might well lead to the conclusion that there should be more room for competition and that data should be free. In Germany the new law on the weather service is not working and an evaluation might lead to completely different conclusions and even in France there is some movement towards a more liberalised data policy. Ultimately WMO 40 should be turned into a resolution declaring all meteorological data free. We should eclipse ECOMET as rapidly as possible and we will be rewarded by beautiful phenomena. It is my strong belief that the next generation of Meteosat satellites should not be encrypted and that the current encryption should end as rapidly as possible. The costs to do this are far larger than the direct revenues from it and business would grow so much faster without encryption.

With this in mind I expect the private sector to grow considerably though it may take quite a while to reach USA levels. We are very grateful to our American counterparts, the National Weather Service and the private sector to lead the discussion in Europe in a favourable direction. We sincerely hope that the European Meteorological Society will play a leading role in the European environment. The seniority of most of its leading members might play an important role. The private sector wants an excellent relation with the National Met. Offices. Each in our own role we can bring meteorology so much further to the benefit of all people paying for meteorological data through taxes.

I would like to conclude with some ideas for the future of meteorology. My background is in nuclear physics and the scene there is so much faster than in meteorology. New articles and ideas appear on the web the day they have emerged. In meteorology it normally takes more than a year before new ideas come into print. The EMS could help to organise a web environment for the exchange of scientific ideas and papers. I also see a much more active role for the World Meteorological Organisation. Many countries have different practises for coding their data. WMO should see it as one of its important tasks to make decoding programs available that can handle all the different formats used in the entire world. It would have great value for all organisations active in meteorology. And ECMWF: a splendid initiative that needs to go beyond its current borders. ECMWF should not only be a centre for medium and long range weather forecasts but also for the very short term. The centre has the computers and the knowledge to be a centre of excellence for short-term forecasts as well.

In the end it is our goal to find the ideal public private partnership. We can than serve the entire community so much better and take meteorology to a much higher level. Rene Morin, with the EMS you have taken an excellent initiative to bring all these people together in this conference. I hope that many conferences are to follow in our common goal of achieving excellence in meteorology.