Origin of WMO Data Exchange and Resolution 40

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Abstract

The World Meteorological Organization (WMO) system of data exchange is unique in the history of science and human affairs. It originated from the dual commitment of the 19th Century International Meteorological Organization (IMO) to the advancement of knowledge of atmospheric processes and to the delivery of practical benefits to society. It was reinforced through the mid-20th Century transformation of the non-governmental IMO into the intergovernmental WMO and by the geopolitical and technological circumstances and opportunities of the Cold War. It survived an existential crisis triggered by the late 20th Century commercialisation of public service meteorology in many countries. And it was institutionalised through Resolution 40 of the 1995 World Meteorological Congress which recognised broadening and enhancing the free and unrestricted international exchange of meteorological and related data and products as a fundamental principle of WMO. The IMO/WMO history provides both timely caution and reassuring encouragement for the development of a new and broader international framework for Earth system data and data exchange for the 21st Century.

Introduction

The 17th Century invention of the thermometer and the barometer transformed meteorology from philosophy to science and launched the long tradition of free and unrestricted data exchange as the defining principle of international cooperation in the science and practice of meteorology (Frisinger, 1977).

There is probably no other field of science or human endeavour that has been built so fundamentally on the collection and sharing of information amongst individuals, institutions and governments for the benefit of all (Zillman, 2018a).

It has not always been plain sailing but data and data exchange remain the lifeblood of 21st Century meteorology and the continuing raison d'etre for the World Meteorological Organization (WMO) (Zillman, 2018b).

The entire meteorological community can take pride in the WMO system of cooperation through which almost every person in the world benefits on a daily basis from WMO Members' collection and voluntary exchange of meteorological and related Earth system data for the common good (Davies, 1990).

It is clear that both the global weather and climate enterprise and the international data landscape are changing rapidly (WMO, 2019a). And that, as big data technologies reshape the information economy, the WMO system of data exchange must respond and advance with the times.

But, while the early 21st Century starting point is well defined by the WMO Convention and the oft referenced Resolutions 40, 25 and 60, I believe it important that the design and construction of a new more integrated and more robust Earth system data regime remain sensitive, also, to the history, philosophy and economics on which they, in their time, were built.

So I would like to identify briefly what I regard as the defining influences and events that shaped the development of international meteorological data exchange over the past 300 years.

The beginning

Historically, the vital role of observational data in meteorology's emergence as a global science goes back to the remarkable 18th Century German polymath Alexander von Humboldt. His extension of the Enlightenment concepts of truth and knowledge to the understanding of the natural world and his collection and use of meteorological data from different places to draw isolines of temperature and other meteorological variables provided a new scientific way of describing and explaining the nature of climate (Wulf, 2015).

But meteorology's development as a science was paralleled by its development as a service which was even more dependent on data exchange. The utilitarian perspective is usually traced back to the 1853 Brussels Conference agreement to collect and share meteorological data from ships' logs to improve marine navigation and help ensure the safety of life at sea (Dexter, 2020).

There were strong ethical and religious overtones to Matthew Fontaine Maury's account of what was agreed at Brussels in 1853: *This plan contemplates the cooperation of all the states of Christendom, at least so far as the form, method, subject of observations, time of making them and the interchange of results are concerned. I hope that my fellow citizens will not fail to second and cooperate in such a humane, wise and noble scheme* (Maury, 1855).

The International Meteorological Organization

The twin objectives of 'data for knowledge' and 'data for practical benefit' were brought together in the 1873 Vienna Congress which is generally regarded as marking the origin of the International Meteorological Organization (IMO), the predecessor of WMO (Daniel, 1973).

With its leadership for the next 75 years made up of both eminent research scientists and mostly government-appointed Directors of National Meteorological Institutes and Services, the IMO shaped the 20th Century development of meteorology as a model of international cooperation (Davies, 1986):

- As scientists, its members were committed to sharing their data, in the best Humboldtian tradition, for research to advance knowledge; and
- As Directors of government agencies they were reliant on data from their neighbouring countries to enable them to provide the forecast and other services that were, in many cases, the reason for their existence.

The commitment to standardisation of instruments and sharing of data underpinned and permeated the work of all the IMO Technical Commissions. It found explicit expression in the IMO concept of the 'Reseau Mondial', the global network which the long-serving IMO President, Sir William Napier Shaw, eloquently described as the guiding principle of international cooperation between the world's meteorological establishments that *……countries…. should maintain the stations necessary for their own meteorological or economic purposes and exchange the information so acquired, by telegraph in the case of observations necessary for the construction of daily charts of weather of the respective countries , and by publication in an agreed form for the data of climatological stations '* (Shaw, 1926).

Under the IMO leadership of Napier Shaw and his successors, the centrality of data exchange found particular expression in the 1930s and 1940s:

- for scientific research purposes in the co-sponsorship, with the International Research Council, of the 1932-33 Second International Polar Year with its primary focus on collection of meteorological data for research into the physics of the polar regions; and
- for practical purposes in the huge growth in requirements for operational meteorological data in support of the safety and efficiency of civil aviation.

The Birth of WMO

It was, in fact, governments' responsibility for regulation of international civil aviation and the increasing governmental role in data exchange that convinced the 1940s leaders of the IMO that the time had come to turn the primarily non-governmental IMO into the fully intergovernmental (but still determinedly scientific) WMO (Daniel, 1973).

The 1947 WMO Convention identified the collection, exchange and application of meteorological and related geophysical data as the basic raison d'etre for international cooperation and for the existence and operation of WMO (Davies, 1990). The Commission for Climatology organised the mail collection of data for research. The Commission for Synoptic Meteorology (later Basic Systems) focussed on the collection and exchange of observations for real-time practical application.

The International Geophysical Year

With the WMO Convention and constituent bodies in place, the 1957-58 International Geophysical Year (IGY) reinforced and integrated the twin motives and channels for data collection and exchange: research data from special IGY observing networks quality controlled and published on WMO Micro-cards; operational data from the enhanced networks collected through telegraphic channels and used to support the real-time operation of the IGY Weather Central at Little America in Antarctica (Astapenko, 1960) as well as adding to the information flowing into forecasting offices in many countries.

But the IGY played an even more important role as the USSR launch of Sputnik-1 in 1957 and the US launch of the first weather satellite Tiros-1 in 1960 provided international meteorology with the credibility and the opportunity to use the geopolitics of the Cold War and the dawn of the space age to trigger the remarkable US-USSR cooperation that would give birth to the World Weather Watch and the Global Atmospheric Research Programme (GARP).

World Weather Watch and GARP

All of the accumulated experience and wisdom of the founding fathers of WMO and the successful implementation of the IGY was built into the September 1961 proposal from US President Kennedy to the United Nations that meteorology should lead the way in international global cooperation in the peaceful uses of outer space; in the responding General Assembly Resolution of December 1961 (Zillman, 2013); and especially in a remarkable March 1962 exchange of letters (Edwards, 2010) between President Kennedy and Soviet Premier Krushchev through which the US and USSR agreed to joint establishment of an operational weather satellite observation system to support the provision of meteorological services for all nations:

- Kennedy to Krushchev (7 March 1962) *Perhaps we could render no greater service to mankind through our space programs than by the joint establishment of an early operational weather satellite system. Such a system would be designed to provide global weather data for prompt use by any nation. To initiate this service, I propose that the United States and the Soviet Union each launch a satellite to photograph cloud cover and provide other agreed meteorological services for all nations.*

- Krushchev to Kennedy (21 March 1962) *It is difficult to overstate the benefit which could be brought to mankind by organising a world weather observation service with the aid of artificial earth satellites. Precise and timely weather forecasts will be another important step along the way to mans' conquering of nature, will help him still more successfully cope with natural calamities and open up new prospects for improving the well-being of mankind. Let us cooperate in this field, too.*

The Plan for the World Weather Watch, which was agreed in principle in 1963 and formally adopted in 1967 (WMO, 1967), was thus based fundamentally on the concept of global cooperation in the collection and distribution of data as a public good. The early planning for WWW was supported by economic studies of the national benefits of the cooperative mode of data collection and service provision (WMO, 1968). The WWW concept was eloquently summarised by Academician Federov of the USSR (Federov, 1966) as:

- *National Services will combine their efforts in four main fields, namely observations, the collection and dissemination of information , the processing and analysis of information and ….scientific research;*
- *This cooperation is ……voluntary and is based on the principle that each Service will provide all that it can to, and obtain all that it requires from, the common fund; and*
- *This cooperation is …..possible only under peaceful conditions and …. It should be planned and established exclusively on (that) basis.*

The Plan envisaged the progressive convergence of data collection and exchange for weather and climate. The historical distinction between operational and research data gradually faded as the WMO-ICSU GARP emerged as the research support for the WMO World Weather Watch and the GARP Global Weather Experiment became the prototype for the future operational World Weather Watch (Zillman, 1977).

The 1979 Global Weather Experiment was a great success (Bengtsson, 1983; Zillman, 1983) and it provided the basis for the 'Integrated Systems Study' that guided the re-design the World Weather Watch in the mid-1980s. I have argued (Zillman, 2013) that the World Weather Watch is the most successful international system yet devised for sustained global cooperation in science or in any other field. Certainly, in the WMO community by the mid-1980s, there was an immense sense of satisfaction that we now had a global framework which would provide all sectors of meteorology with the basic data needed to support:

- Public weather services provided by National Meteorological Services (NMSs) through their national mass media;
- Value-added services provided by both NMSs and the private sector; and
- Meteorological research by the academic, public and private sectors.

As we wrote our ten-year plan 1988-1997 (WMO, 1987), the main remaining challenge for international meteorology seemed to be that of progressively extending to all countries the capabilities and quality of service that was then becoming possible in the advanced countries.

Commercialisation

It was in this climate of satisfaction, pride and optimism that WMO suddenly found itself confronted with what soon turned out to be an existential threat to the system of free and unrestricted international exchange of data, products and scientific knowledge that we had all taken for granted through the early years of the World Weather Watch and GARP.

We were caught largely unprepared by the extension to meteorology of the market fundamentalism of the 1980s (Self, 1993). The problem was not so much from the increasing commercialisation of meteorological service provision which was already well established through public-private partnership in the US and some other countries (White, 2001) and was entirely consistent with the free exchange of basic data as a public good. Rather, it was from commercialisation and privatisation of the formerly publicly funded NMSs themselves in ways that forced them to look for what they could sell in order to be able to fund their continuing basic operations. And, for most of them, in both developed and developing countries, this was their precious national observational data.

The WMO Executive Council tried to help Members address what was initially referred to as 'the commercialisation issue' through the introduction of clearer distinction between what had recently been defined as 'basic' and 'specialised' services. But, as NMSs withheld from exchange through World Weather Watch the data that they needed to sell, it soon became clear that the real problem was becoming that of loss of data from the common pool. The issue escalated rapidly and the WMO language changed from 'the commercialisation issue' to 'the data exchange issue.'

Belatedly, the 1987and 1991 WMO Congresses committed Members to a policy of maintenance of free and unrestricted data exchange but it was too late. Over the next few years, the community split between those who felt we must retain 'free and unrestricted exchange' at all costs and those who had concluded that, without knowing how a commercial data world would work, we probably had no choice but to accept that 'free exchange' of meteorological data would become an inevitable casualty of ideological and economic change in the wider world far beyond our control.

With NMSs withholding previously freely exchanged data from the WMO Global Telecommunications System, their neighbouring Services saw little choice but to retaliate. The long-standing WMO tradition of mutual support and trust among NMSs was giving way to competition and mutual distrust. Tensions and even legal action erupted between NMSs, between members of the WMO Executive Council and between WMO Member governments (WMO, 2019b).

As the 1995 WMO Congress approached, there was widespread speculation that we were facing the end of the established system of international cooperation in meteorology and were on the verge of a global meteorological data war.

Resolution 40

The 1995 Congress negotiations that led to the unanimous adoption of Resolution 40 make a fascinating story (WMO, 2019b; Zillman, 2019) which there is no time to tell here. Suffice it to say that, notwithstanding the various qualifications and caveats built into the text of the Resolution and its four annexes, the Congress committed WMO to continued free and unrestricted international exchange of data and products as '**a fundamental principle of WMO'**.

The adoption of Resolution 40 was not a foregone conclusion:

- Until the President of WMO brought down the gavel on the afternoon of 21 June 1995, it was touch and go and the fragile consensus could have collapsed at any moment.
- Its adoption was more a product of deep-seated belief in the goodness of international cooperation in meteorology than of any particular line of legal or economic argument.
- Few of those who rose in standing ovation at its adoption knew how we were going to make it work.

The follow-up and implementation of Resolution 40 over the next eight years was extremely challenging but, as far as I am aware, no-one in the WMO community ever had second thoughts

about its adoption. We extended it to hydrology through Resolution 25 of the 1999 Congress and subsequently to oceanography through the close WMO partnership with the Intergovernmental Oceanographic Commission (IOC). We built its basic principle into the Global Climate Observing System (GCOS) and the United Nations Framework Convention on Climate Change (UNFCCC). And I think it is fair to say that it significantly influenced the Group on Earth Observations (GEO) adoption of free exchange as the data policy for the Global Earth Observation System of Systems (GEOSS).

Building on Resolution 40

It is my impression that the economic and policy foundation for free exchange has been significantly strengthened since 1995. Public forecast and warning services have long been cited as the text-book example of an economic public good (Heilbroner and Thurow, 1994) but there is now a much clearer picture of how the non-rival and non-excludability properties of most basic meteorological infrastructure and data make their provision to societally acceptable levels a fundamental responsibility of government (Zillman and Freebairn, 2001). In 1999, the Nobel Prize-winning economist Amartya Sen identified inequality and the provision of public goods as the two great challenges confronting capitalism (Sen, 1999) while, in 2000, another Nobel Prize economist, Joe Stiglitz, provided strong support, on economic grounds, for the government provision of essential public forecast and warning services in the digital age (Stiglitz, Orsag and Orsag, 2000). And, on the basis of their service to most people in most countries and to future as well as present generations, the theory of global public goods (Kaul et al, 1999) provides a compelling case for identifying internationally exchanged meteorological data as the example par excellance of a global public good (Gunasekera and Zillman, 2004). But more work is needed to build a robust economic framework for the complementary roles of the public, private and academic sectors in global infrastructure operation and service provision.

There were discussions in the wake of Resolution 40, including with some who were present at the birth of the WMO Convention (Gibbs, 1994), as to why the founding fathers of WMO did not include 'free and unrestricted exchange' explicitly in the text of the Convention. The dominant conclusion was that, in those days, in the euphoria of the end of World War II and creation of the United Nations, it seemed so self-evidently the right thing for the whole world that it would have been almost inappropriate to imply that there could be any other possibility than free exchange.

We also discussed whether, with the crisis passed, we could improve Resolution 40. But it soon became clear that the Resolution 40 generation were so traumatised by the experience of having nearly lost free exchange completely that we were not willing to see the issues and the conflict reopened in the hope of building a better and more robust framework. And we were not even brave enough to risk their reopening through an attempt to incorporate free and unrestricted exchange explicitly into the text of the Convention.

Conclusion

So, to conclude on a note of reassurance and optimism, I stress that Resolution 40 of the 1995 WMO Congress was a solution to a hopefully once-only existential crisis in international meteorology. But it was neither a perfect nor a permanent solution and international meteorology has changed greatly in the past 25 years. It is clearly time to design a better and more robust framework for the exchange of the much larger quantities of more diverse data now available on the Earth system. I wish the WMO community great success in building a new and better framework without first having to go through a crisis of the kind that my generation went through to get us to Resolution 40.

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