WMO INITIATIVE FOR THE GLOBAL EXCHANGE OF RADAR DATA

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1. Introduction[1]

The conclusions and recommendations of the Fourth WMO Workshop on the impact of various observing systems on Numerical Weather Prediction identified the global exchange of Weather Radar radial winds and reflectivity data as a high priority. This need is also reflected in the new Evolution of the Global Observing System-Implementation Plan.

The WMO Commission on Basic Systems Expert Team on Surface-Based Observations (ET-SBO) conducted a workshop in Exeter, 24-26 April 2013 and brought together representatives of various Regions and experts to discuss how radar data exchange should be organized on a global basis. The success of OPERA to exchange data within EUMETNET was duly recognized by WMO and has the experiences and advancements that could be a basis for extension to the global scale. This contribution provides a review of the outcomes of the workshop.

2. Workshop Scope, Objectives and Deliverables

Noting the range of Weather Radar data types and products, the scope of the workshop was limited to the exchange of Doppler radial wind and reflectivity data types. The aims of the workshop were: (a) Define weather radar data to be exchanged at regional and global levels; (b) Propose formats and frequency of exchange of those data; and (c) Agree on the next steps needed to enable the regional and global exchange of these data.

The objectives were:

- Review the current and likely future requirements for regional and global weather radar data exchange, period of consideration 2012 to 2025;
- Review the current extent and operational status of regional and global data exchange being undertaken;
- Review the current regional and global data exchange models in operation;
- Review alternative regional and global data exchange models in operation in other observing system areas;
- Improve community understanding of the range of Weather Radar Network operators and their respective relationships with WMO Members;
- Identify current and likely future constraints on regional and global data exchange from Weather Radar Network operators. Areas of constraint could include: Data Ownership; Data Policy; Data Volumes; Data Quality;
- Recommend data model(s) for regional and global weather radar data exchange based on an improved understanding of requirements, capabilities and constraints;
- Recommend pilot study cases for regional and global weather radar data exchange using recommended data model(s) to demonstrate how constraints could be overcome.

The key drivers for the initiative and workshop originate from actions to improve the operation of the WMO Global Observing System and better meet user requirements and include: (1) Action G48 of the CBS Implementation Plan for Evolution of the GOS: “Define weather radar data to be exchanged at regional and global levels, propose frequency of exchange of those data and develop a weather radar data processing framework, in concert with development of products based on national, regional, global requirements.” (2) A lack of guidance within the Manual on the GOS in relation to requirements and practices for operation of weather radar systems and, in particular, the international exchange of weather radar data. (3) Evidence presented at WMO Workshops on Impacts of Various Observing Systems on NWP, for example: “The results of recent impact studies provide strong support for exchange of more observations between regions, and between countries within regions: e.g. ground-based GPS

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data, radar data, hourly surface observations and MODE-S data at airports"[2].

3. Requirements Analysis

Traditional weather requirements for radar data for convective severe weather hazards including that for flash flood warnings is a given. From a global perspective and in this context, exchange of radar data and products is considered a local problem and is addressed at the local level. Indeed, exchange of weather radar already exists through bi-lateral agreements.

Experts from Global and Regional NWP, climate and hydrology were invited to summarize raw radar data exchange requirements. This is summarized in Table 1. The use of composite radar products for the tracking of hurricanes sits between local and global radar data exchange requirements.

4. Current Status of Weather Radar data exchange

Various regional representatives provided a summary of the weather radar data exchanged. It relied on volunteered information and is incomplete. However, it is still an impressive response. See Table 2 for a summary.

Region I (Africa): A report for Regional Association I was not received. Participants agreed that requirements for global and regional exchange of radar data must take into account practical and technological challenges and limitations faced by developing countries and regions.

Region II (East Asia): Radar weather data is being exchanged within CMA through the China Integrated Meteorological Information Service System (CIMISS). Base data exchange between CMA and Hong Kong China is also occurring with a mosaic product being derived from 10 radar sites, including the HKC radar data.

Outside of China, radar products are also being exchanged between countries. China and South Korea began to exchange radar in 2012 via the Global Telecommunications System, in the absence of regional governance protocols, resulting in improvement in the prediction of typhoon and other severe weather. China also provides a limited number of radar products to North Korea.

While an attempt was made to obtain information from other radar operators within Region II, there was no evidence found of any other data exchange arrangements or agreements. Of the 35 members of RA II, there was evidence of weather radar in 12 countries only

Region III (South America): In Brazil, there are many radars installed in the country but not part of a national network, representing local initiatives, with some of them selling products as a special service and therefore restricted from making the data available in real time as part of an open network. Due to the different interests of the radar owners, co-ordination to concentrate the actions in this area is still poor but the situation is changing. Throughout Region III, it appears that the situation is very similar to that of Brazil with very little in the way of even national coordination and collaboration on radar data and product exchange or integration, and the only evidence of international or regional radar data exchange is data from one radar in Paraguay composited together with Brazilian data.

Region IV (North America and Caribbean): Within Region IV (North America, Central America and the Caribbean), volume scan radar data is being exchanged between Canada and the US in native formats using the GTS (Canada to U.S.) or Local Data Manager (LDM, U.S. to Canada). Mosaics are being produced in research mode and just beginning to be used in operational NWP.

Within the Caribbean, there is an on-going project to exchange low level (zero degree) reflectivity every 15 minutes using BUFR or PNG format amongst Barbados, Belize, Dominican Republic, French Guyana, Guadeloupe, Guyana, Jamaica, Martinique and Trinidad-Tobago. The BUFR radar product is being processed and translated into a Mosaic by Météo-France in Martinique.

Telecommunications (push/pull) issues and information on status of data availability appear to be challenges (see CBS, Expert Team Meeting on Surface-Based Remotely-Sensed Observations, Session 2, Nov 2011).

Region V (Oceania/Australia): It was found that of the 22 Member countries of RA V, less than half of the members operate weather radar systems, with specific information on these able to be obtained only from Australia, Brunei Darussalam, Indonesia, Malaysia, New Zealand, Philippines, Singapore and Fiji. Australia and New Zealand currently have a bilateral agreement for exchange of both raw (commercial) and processed data (non-commercial).

Malaysia and Singapore have a bilateral agreement for exchange of radar data in BUFR format.

The Member countries of ASEAN (Association of South-East Asia Nations) are working towards collaboration on the exchange of radar data through the ASEAN Sub-Committee on Meteorology and Geophysics (SCMG).

[2] Final Report of the Fifth WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction)

Region VI (Europe, Middle East): The majority of the information presented related to those WMO members within Region VI who are also members of the EUMETNET OPERA programme. This accounts for 30 of the 50 WMO Members of the Region. Within the OPERA community the exchange of weather radar data is very mature and for more than 20 years there have been bilateral and regional exchange agreements between members (e.g. NORDRAD). In addition, for more than 7 years OPERA has operated centralised compositing (mosaic) capability, firstly with its Pilot Data Hub (PDH) and for the last 3 years the OPERA Data Centre (Odyssey).

Bilateral exchange between members is usually performed using Global Telecommunication System over the Regional Meteorological Data Communication Network but most input data to Odyssey is transmitted using the Internet. There is a desire to send data to Odyssey over RMDCN but there are concerns about GTS stability and topology. OPERA has just started a development activity to investigate the best transmission methods for radar data in Europe.

Data policy within Europe is generally managed by the European Commission, and in meteorology by ECOMET, European Interest Group. Through ECOMET the composite products of Odyssey will be made available for commercial exploitation. Bilateral agreements between members are still common.

It was noted that exchange between regions was also occurring. NCEP's stage IV surface rain composites over the US were being received by the ECMWF and assimilated into the ECMWF global model. The Caribbean Radar Project in RA IV includes radar data from French Guiana in RA III. Data exchange is also being pursued between regions II and IV under the umbrella of ASEAN.

6. The OPERA and BALTRAD Data Information and Exchange Models

There are four components to the concept "data exchange model". They include:

- File format – container for storing data in physical files.
- Data/information model – the way in which information is organized/represented, either in computer memory or files, independently of file format.
- Envelope – extra header announcing or describing the contents of the information being exchanged.
- Protocol – mechanisms for communication over a network.

There are several categories of data:

- Transmission – to facilitate data transfer from the radar to a central facility. This can be optimized for network load balancing, e.g. ray-by-ray.
- Production – contains all data and metadata required to derive higher-order outputs (e.g. quality-controlled data, products) from input data.
- Exchange – representation of data or product for sharing but not necessarily further processing, e.g. a radar composite or vertical profile.
- Archive – e.g. to represent data from many different observation systems for storage

Our focus is only the "exchange" format.

There are two main aspects of the actual exchange of data:

- Passive – Sender/recipient are aware of each other but transact indirectly, e.g. data is "pushed" and availability is determined by directory polling or file-system event monitoring. The GTS was given as an example of such a mechanism.
- Active – Sender/recipient are aware of each other and interact/transact directly. BALTRAD communications were given as an example.

To aid the exchange of data, OPERA has developed a data information model, known as ODIM (OPERA Data Information model). This model has been widely adopted by OPERA members to exchange data in two agreed formats, BUFR and HDF5. The adoption of ODIM has significantly improved the ability of members to receive, interpret and utilize each other's data. The ODIM data model description can be found on the OPERA web site. BALTRAD uses ODIM_H5.

As of February 2013, 17 of 20 countries provide their data to the Odyssey centres using ODIM_H5. Products generated by Odyssey are distributed to 19 recipients, ten using ODIM_H5 only and four in both ODIM_H5 and ODIM_BUFR. In identifying potential information models, the METCE model, "Modèle pour l'Échange de Temps, Climat et Eau" (Model for the Exchange of Weather, Climate and Water), or alternatively, the METeorological Community Exchange model, could potentially offer a vehicle for creating a truly orthodox information model that could then be used to create one or more representations using endorsed file formats. It was acknowledged that representing radar data involves a higher degree of complexity compared to aviation messages that have been addressed in METCE. A WMO Task Team will be established to investigate and implement a weather radar data model, and could consider elaboration of METCE to accommodate weather radar data and represent them using ODIM as a starting point.

Table 1: **Summary of Requirements for Radar Data & Radar Data Exchange**

Data User Area	Parameter/Field	Requirement Category	Requirement	Comment
NWP - Global	ECMWF currently assimilating GRIB precipitation composites but expect to require raw volumetric data in future	Horizontal resolution Cycle Latency	2 km^2 possibly later inc. to 1 km^2 15 min 15 to 30 min	Requirements may currently vary between NWP centers but there is an expectation that raw volumetric data will become the future standard requirement.
NWP – High resolution	raw volumetric data (Meteo-France	Horizontal resolution Cycle Latency	2 km^2 possibly later inc. to 1 km^2 1 hour 15 to 30 min	
Hydrology	Quantitative Precipitation Estimate	Horizontal resolution Cycle Latency		Access to long-term high quality archived precipitation data is critical to many hydrological applications.
Climate	Quantitative Precipitation Estimate	Horizontal resolution Cycle Latency	1 km^2 possibly later inc. to 0.250 km^2 1 hour possibly later inc. to 5 min. 48 hrs	Access to long-term high quality archived data is critical for climate applications.

7. Weather Radar Metadata held in the WMO Radar Database

Metadata is necessary to be able to track changes in the radar and to be able to re-analyze historical radar data. A global survey on weather radars was conducted by WMO to establish a "fully comprehensive up-to-date web-based metadata database" of the global use of weather radars between 2008 and 2010. In addition to establishing an initial radar metadata database, one of the additional aims was assisting and promoting the wider international exchange of radar data (Sireci et al, 2010). A link to the Weather Radar Database (WRD) is available from that page.

Totally 812 weather radars have been included in WRD so far. Currently there are 707 radars of 86 NMHS and 105 radars of other owners. For displaying the radar metadata, the WRD has a range of features including basic search; search based on countries, parameters of individual radars and materials; statistics with graphs and a Virtual Earth mapping application. The WRD is maintained by Member Focal Points for Weather Radar Metadata, with each FP provided with a login to the User Interface to the database. The metadata within the WRD is also accessible to the WMO Information System (WIS) through an automated routinely accessed interface mechanism. Although the number of radars in the WRD has been increasing rapidly, there are still a lot of gaps in the information: new parameters and statistics can be added to the database to assist radar data exchange.

8. Current Weather Radar Exchange Models

The Centralised Model – OPERA/Odyssey: Odyssey is a EUMETNET initiative jointly hosted by the UK Met Office and Météo France and operational since January 2011. Twin data centres running in Exeter and Toulouse receive polar (TYPE II) ODIM compliant data from about 120 European radars and produce directly, using the same software, 2 km resolution Europe wide composites of rainfall intensity, maximum reflectivity and hourly accumulation every 15 minutes. Only one centre disseminates products at any given time and routine (quarterly) switch of operational node is planned for upgrade and maintenance of the nodes as illustrated in Fig. 1. As a result the resilience of the system is very high.

Table 2a: Summary of Regional Radar Data Exchange

Region	*Countries*	*Polar*	*Products*	*Format*	*Comms*	*Agreement*
I	BW, MZ, ZA	Z in	Regional composites	TITAN	TITAN	MoU
						Centralized
II	CN – HK	Z, V, W	Composite	Polar: WSR-88D	WIS using “MSTP special line”	Bilateral Guangdong – HK.
				Composite: ?		Centralized compositing.
II	CN – MO					
II	CN – KR		5 products	GIF	Special ”GTS” line	Bilateral
II	CN –> KP		“several”			Bilateral, one-way
II	CN – TW		Composites			To be considered
III	N/A					
IV	CA – US			“native”	GTS	Bilateral
				CA: IRIS	FTP – pull	
				US: L2, L3, L4		
IV	AN – SX			AN: IRIS		
IV	CU – US		Composite	US L4	Push	To NWS (Hurricane Center)
IV	BB, BZ, GF, TT (more?)			BUFR	Planned	EC Caribbean radar project – multilateral MoU
IV	BS, CU, PR ?		(On BS website)			
IV	CA – US			“native”	GTS	Bilateral
				CA: IRIS	FTP – pull	
				US: L2, L3, L4		
IV	AN – SX			AN: IRIS		
IV	CU – US		Composite	US L4	Push	To NWS (Hurricane Center)
IV	BB, BZ, GF, TT (more?)			BUFR	Planned	EC Caribbean radar project – multilateral MoU
IV	BS, CU, PR ?		(On BS website)			

Table 2b: Summary of Regional Radar Data Exchange

Region	*Countries*	*Polar*	*Products*	*Format*	*Comms*	*Agreement*
V	AU – NZ	yes	yes	"raw"		Bilateral
				"graphics"		
V	MY – SG			BUFR		Bilateral
VI	BE, CZ, DE, DK, EE, ES, FI, FR, HR, IE, IS, NL, NO, PL, PT, RO, RS, SE, SI, SK, UK …	Corrected Reflectivity (Z), Radial Velocity (V)	Z composite	ODIM_H5	FTP	EUMETNET
			R composite	ODIM_BUFR	GTS	OPERA – centralized through "Odyssey"
			RR-1hr composite			
VI	AT, CH, CZ, DE, HR, PL, SI, SK		Z CAPPIs in	BUFR	GTS	CERAD – centralized
			Z composites out			
VI			Vertical wind profiles	BUFR	GTS	EUMETNET CWINDE
VI	DK, EE, FI, LV, NO, SE		Z Pseudo-CAPPI	HDF5 –	NORDRAD –	NORDRAD Cooperation Agreement: multilateral, decentralized
			Vertical wind profiles	COST 717 model	"persistent HTTP", XML headers,	
					"notify-pull"	
VI	BY, DK, DE, EE, FI, LT, LV, NO, PL, SE, UA	Total Reflectivity (T), Z, V and Spectral Width (W)		ODIM_H5	BALTRAD – HTTP, own HTML headers,	BALTRAD Cooperation Agreement: multilateral, decentralized
		Dual-pol moments			"subscribe-push",	
					WIS connectivity	

Odyssey plans to apply consistent pre-processing to the input data and generating uniform pixel level quality flags for all incoming data. OPERA has just started a new development phase which will see the development of pre-processing modules and related quality information added to the incoming data. Given the different radar software to identify ground clutters from the European radars, OPERA will require common incoming raw metadata, in order to be able to produce such pre-processing modules and quality information. This last information is crucial for NWP applications, but potentially also for improving the rules of rain rate compositing. These incoming data (unchanged) plus the centrally generated quality flags will be redistributed to NWP centres in Europe. Currently only reflectivity and radial wind data are supplied to Odyssey but dual-polarisation products will follow.

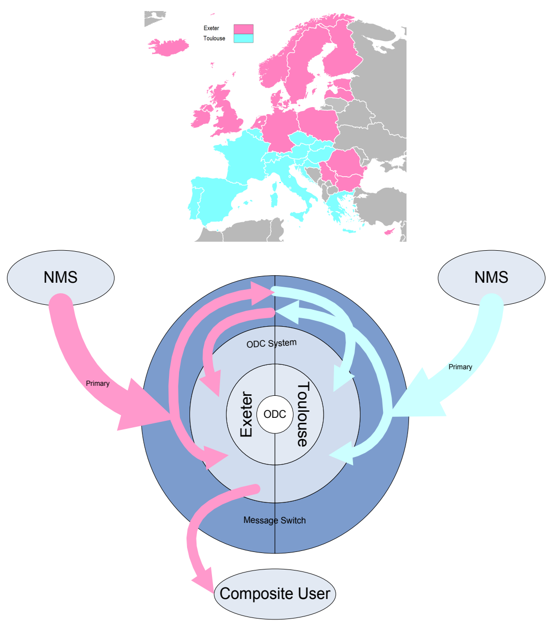

Figure 1: The OPERA/Odyssey Centralized Exchange Model

The Distributed or Peer to Peer Model – BALTRAD: The BALTRAD partnership is currently developing and operationally deploying the latest generation software system designed to exchange and process weather radar data. The partnership contains 14 partners in 11 countries. BALTRAD software is Open Source and is deployed in a decentralized way, allowing partners to exchange data on equal terms and process them according to local requirements using a common set of data processing algorithms. The system exchanges data, manages them locally, and optionally processes them. This concept is generally illustrated in Fig. 2 (left).

When a partner deploys its BALTRAD node, it establishes peer-to-peer network connections with other nodes (Fig. 2, right). Each partner decides which data it lets other nodes subscribe to. Other nodes select from the data it is allowed to subscribe to, and then these data are pushed from producing node to subscribing node. Only authorized nodes are allowed to interact. The producer decides which data other nodes are allowed to subscribe to. Only data that the subscriber has requested are accepted. Exchange is thereby secure.

The optional data processing is performed using the BALTRAD toolbox, which can be run stand-alone without the other node components. Partners can tailor their use of the tools to suit their local purposes. The partnership, along with interested members of the community, contributes its tools to the toolbox and documents them using the wiki-based online BALTRAD Cookbook. This advanced data processing software is now used operationally by EUMETNET OPERA's Odyssey to quality control all input polar data.

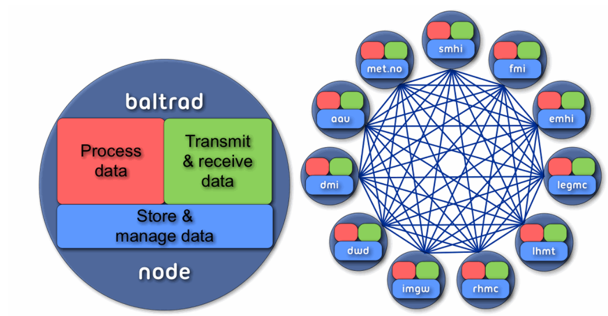

Figure 2: BALTRAD node modularity (left). Decentralized networking concept with several BALTRAD nodes. The nodes illustrated here are those operated by partners in the BALTRAD+ project (right).

9. Review of constraints to increased Weather Radar data exchange

The regional reports provided to the Workshop were analyzed to identify potential barriers and potential solutions. None of the constraints are considered insurmountable, although the most challenging and most likely to prevent progress was considered to be that of data policy. However, the WMO has a long-standing Resolution (40) pertaining to the exchange of weather data that might be emphasized, enhanced or extended to alleviate concerns and mitigate the associated risk. It was agreed that the other barriers could be overcome through application of the following strategies or approaches:

1. The vision, aims and objectives for weather radar data exchange should be clearly articulated;

2. The telecommunications barrier is mainly and most significantly a resource and cost issue, which, while presenting difficulties in some instances, particularly for those Members from developing countries, does not constitute a technical obstacle. While satellite communications technology may be expensive, it does at least provide a potential global solution. Costs can also be alleviated through the use of alternative communications strategies, such as that of data providers making data available to

be "pulled" to data users at their costs rather than "pushed" at the cost of the provider;

3. In line with the proposed mitigation in point 1, it is expected that an internationally standardized exchange format would be widely and internationally recognised and adopted in the fullness of time, as manufacturers will be requested to provide the WMO format as part of radar system procurements. This will promote consistency and efficiency. However, exchange of native formats should not be discouraged if members cannot produce the WMO standard, even though exchange in the WMO data format would be much preferred;

4. The data policy issue may be mitigated through potential strengthening or extension of WMO Resolution 40 combined with negotiation, mutual benefit and sponsorship but it must be recognized as a significant issue

5. Use of WMO authority and standardization mechanisms to ensure development, adoption and support by WMO Members and radar operators of the appropriate data model. It was also highly recommended by the Workshop that WMO should be willing to consider the adoption and standardization of modern alternative data formats (e.g. HDF5 and netCDF) in addition or alternatively to BUFR to promote the research use and development of the global radar data.

6. A related issue to successful exchange of data and satisfying the requirements of data users for provision of a reliable and continuous data product is the operations and maintenance of the radars in the network. This necessarily includes other critical aspects such as the monitoring of the systems and the reliable management of critical radar parts.

A critical issue is the emerging dual-polarization technology and its exchange, and the need for quality information in the data model. It is recognized that there will be requirements for additional data. A change mechanism and technical support is critically important otherwise other formats will proliferate and make the WMO format obsolete. (Such changes are anticipated with ODIM.)

10. Proposed Radar Data Exchange Model

Examples of the computing and telecommunications (ICT) strategies of several scientific organizations were considered. In all cases, a compromise had been reached between making all possible information available to all users and the cost and technical feasibility of the ICT systems needed to deliver and process the data. CERN, for example, processes data as they are generated by the particle colliders so that only a reduced data stream is sent to the central computers for storage and further processing. Even this reduced set of data is processed further before being distributed to users, although it is archived so that it can be used for more detailed studies.

The Workshop acknowledged that there may be some cases where it is not possible to follow a standard pattern for exchanging data, but that the group should work on the assumption of the following design for global exchange of radar data.

- Information from individual radars should be collected and processed by the operators of the radar network (usually national centres) to create an agreed set of outputs (data in exchange format plus products – in a format to be determined, note some products are already defined in WMO BUFR format).
- Collated data from several radar networks should then be further processed by a collection centre (usually responsible for a geographical area) to form a consistent set of information.
- The output (data in exchange format and products) from these collection centres would then be exchanged globally.

This hybrid approach (mix of centralised and distributed) limits the volume of information to be exchanged globally (that is, the data is optionally exchanged), and also reduces the complexity of the processing required by the users of global information.

11. Information Systems Approach

In the context of the WMO Information System, the creation of consistent data for a network would be the task of a National Centre. The collection centres would be Data Collection or Product Centres, and these would pass the data and products to the GISCs to manage the global exchange.

Successful global exchange of radar information depends on clear definitions of what information (data, metadata or product) has to be exchanged. The information content is described through a "data model," and it is the data model that specifies which physical parameters have to be contained and the supporting information (observation metadata) that is needed to allow them (the data and products) to be interpreted correctly. Provided that the correct data model is used, it is possible to exchange the same information in different formats (for example BUFR, GRIB and HDF5) for different application areas – and to convert between formats.

Defining a standard data model for exchange of radar information (data, metadata and products) between collection centres is considered as a high priority task.

13. Pilot Projects

Radar data exchange is expected to be a complex initiative and pilot studies are envisioned. There is already both a requirement and solutions in place for supporting real-time radar data exchange among countries (e.g. OPERA and BALTRAD). Establishment of new regional radar data exchange centres was proposed to test the transferability of existing technology but also the hybrid exchange model.

14. Recommendations

1. CBS (via ET-SBO) should investigate the possibility of forming a body for weather radar observations similar to EUMETSAT CAF or SAF's that should also explore the climatological uses of radar data and elaborate further recommendations to that end. These should encompass:

    - Quality control indicators should be developed and be an integral part of the radar data, particularly precipitation products
    - Development of consistent radar precipitation databases for use in hydro-climatological studies
    - It was recommended that WMO organize experts to develop standardised quality control and calibration schemes that are able to take into account the different radar systems in operation in different countries.

2. Standardised exchange models for weather radar data will need to take into account now-casting and other applications with different stringent requirements on transmission frequency, latency and processing requirements.

3. With additional data requirements anticipated, an efficient change management system should be implemented.

4. Envisaging that data policy issues may be a significant limiting factor and that some agreements may initially allow the exchange of radar products only, consideration should be given to the comprehensive exchange of these product format and quality standards.

5. The inclusion and maintenance of associated metadata is critical and several recommendations to update the WMO Radar Database were proposed. The radar exchange information (see Table 2) needs to be updated periodically when new data exchange is initiated somewhere.

6. It is recommended that WMO and CBS give consideration to the possible requirement for adoption of ODIM_H5 as a WMO standard for representation of radar data.

7. It was recommended that a Task Team is formed, under the direction of CBS ET-SBO and charged with the responsibility of addressing a requirement for the development of global standard for representing weather radar data in support of global data exchange

    - The task team should investigate and implement a weather radar data model, should consider elaboration of METCE to accommodate weather radar data and represent them using ODIM as a starting point.
    - The task team should recognize and take into consideration the considerable progress achieved by EUMETNET OPERA in harmonizing operationally exchanged real-time weather radar data with the OPERA Data Information Model (ODIM) and it is recommended that the Task Team should utilize this data model as the basis and starting point for the development and finalization of a WMO standard for global radar data exchange.
    - The task team should contain appropriate representatives from Regional Associations, weather radar experts, communications experts, and data model experts. Participation of representatives from other WMO bodies, such as ET-CTS and IPEG-DRMM, is also desirable. WMO and CBS should also ensure that relevant observing systems operators, manufacturers and applications and data user communities are informed of the task team's role and outputs.

8. It was proposed that pilot projects should be established to work towards the definition and implementation of data exchange protocols between various regions of the globe. Region II (TMS) and Region VI (ODYSSEY) will first test the concept with the exchange of composite products. This project should be overseen by the CBS ET-SBO. An exchange of weather radar data among ASEAN members would be under the ASEAN ASMB. It is also recommended that Brazil and other countries in Region III establish a pilot project and that this is considered and progressed through coordination by CBS/ET-SBO.