

Problems on Maintenance and Calibration of Weather Radars

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Abstract

Weather radar networks have been renewing and expanding around the world. Some networks have already been integrated with other networks and became a larger network like in Europe. The importance of requirements for calibration and maintenance of weather radars has been increasing accordingly. Because, regular maintenance and calibration of radar systems are critical aspects of operating a radar network properly and efficiently and maintaining availability of high quality data. On the other hand, weather radar is a complex instrument. The proper calibration of weather radars for accurate rainfall measurements has been a serious matter for many years due to its complexity. A weather radar survey of WMO (2009-2010) revealed that radar operators mainly perform receiver, transmitter and antenna calibrations. This is insufficient. Other calibrations carried out by operators are also inadequate. Preventive maintenance is another important issue to keep data quality at a specific level. Periods of periodic maintenances changes according to operators and capacity of the maintenance staff.

1. Preventive maintenance of weather radars

According to the survey, "Monthly" and "3 monthly" preventive maintenance periods are the most common regular maintenance periods carried out by the participants. (Figure 1) While some participants execute regular maintenance in fewer intervals like "6 monthly" or "yearly", on the other hand several participants carry out regular maintenance more frequently like "weekly" or "2 weekly". 23% of the radar operators (WMO members) don't carry out preventive maintenance. Approximately 10% of the participants execute preventive maintenance once a year.

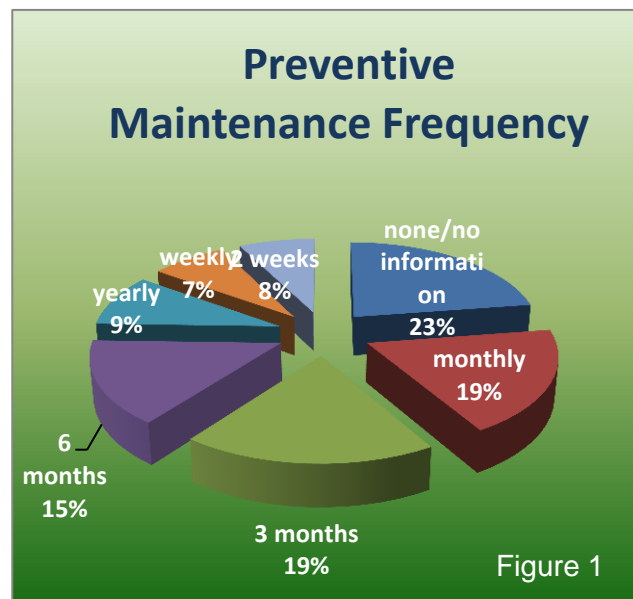


Figure 1

Approximately 60% of the operators have been carried of the maintenance themselves and 12% of the radar operators carry out maintenance partially. (Figure 2)

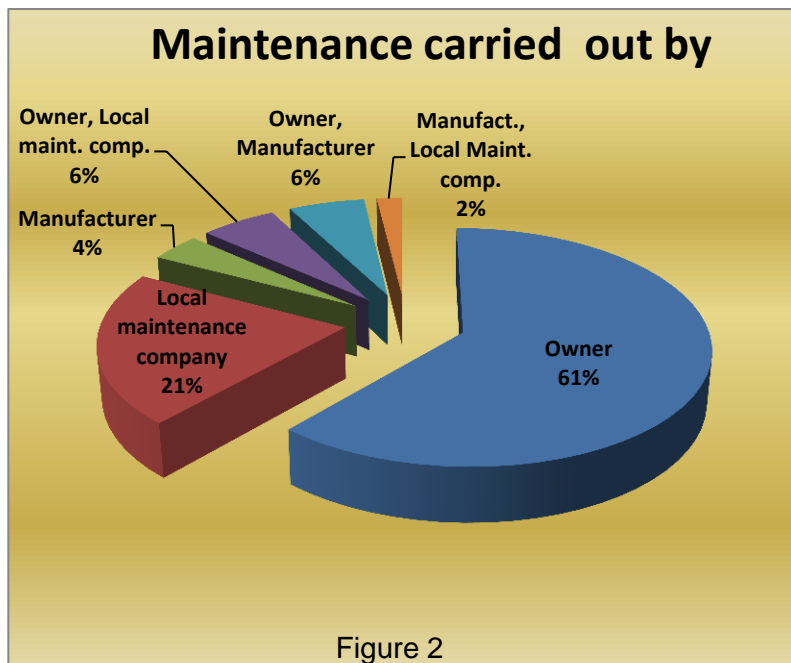


Figure 2

Maintenance activities of weather radars are carried out by "Owner" mainly in the sense that weather radars are so specific and expensive systems, they should run continuously and they should be maintained rapidly. Similarly in some countries "Local Maintenance Companies" maintains weather radars. "Manufacturers" carry out maintenance also, but not so widespread. So training is crucial for proper maintenance and calibration. Having adequate measurement tools is another key point.

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2. Main problems encountered on weather radars

From the gathered information, clearly observed that most of the weather radars have been operated "24 hours a day".(Figure 3) Since weather radars are complex devices, failure probability is relatively high.

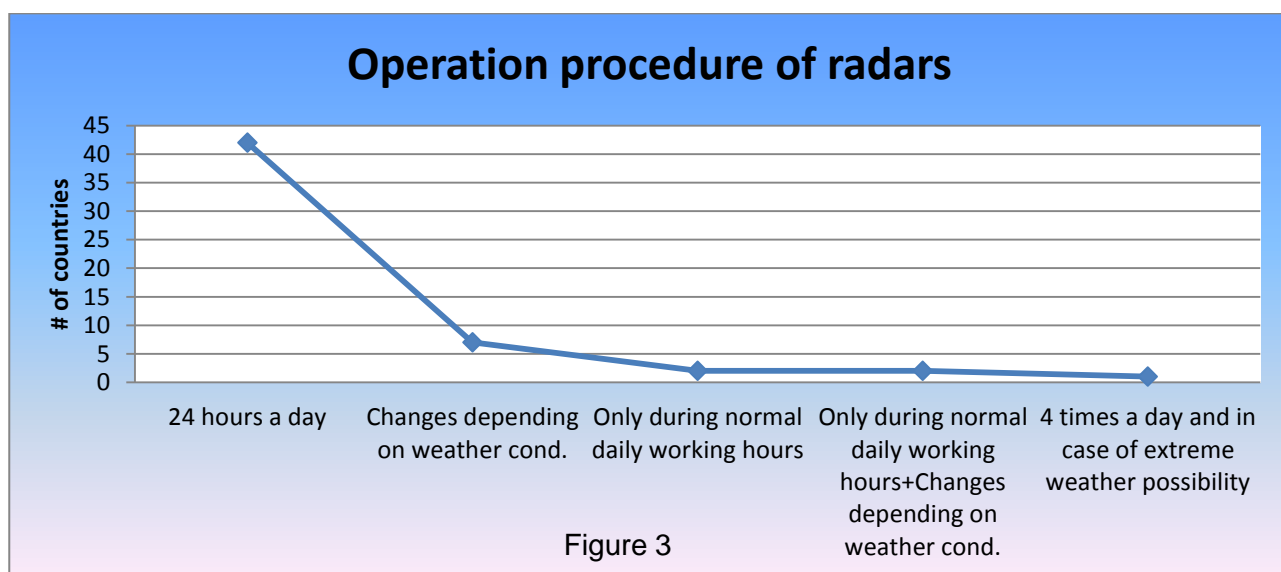


Figure 3

Main problems have been revealed on weather radars during operation in mentioned survey. Those are mechanical, electronic, communication, lightning, power cuts and so on. Precautions could be taken during procurements and planning phase against this type of problems like preventive maintenance, keeping spare parts, backing-up, increasing measures. Some other problems faced in radar systems are power cuts, HV parts, shortage of spare parts, software, air conditioning, outmoded facilities, interference and wind turbines. (Figure 4)

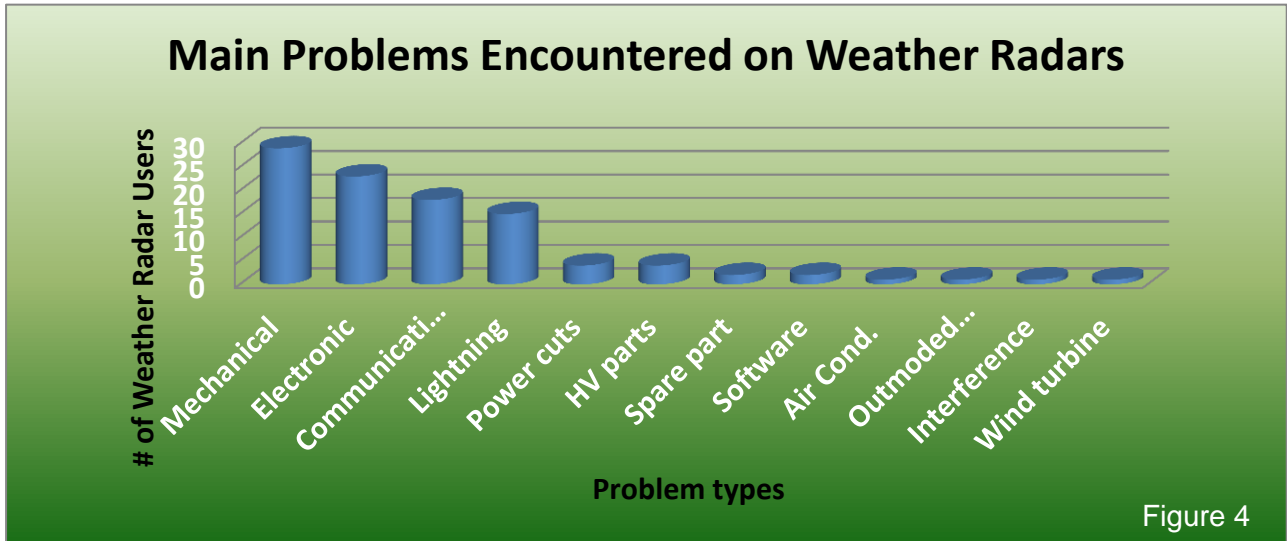


Figure 4

One of the major problems is lightning strike for weather radars. "A good grounding" and "lightning rods" are the most common measures against lightning strike damages. Advanced counter measures like "Surge protections" for data and power cables and "improving lightning protection like applying extra rods, decreasing grounding with more down conductors can be applied for extra protection. (Figure 5)

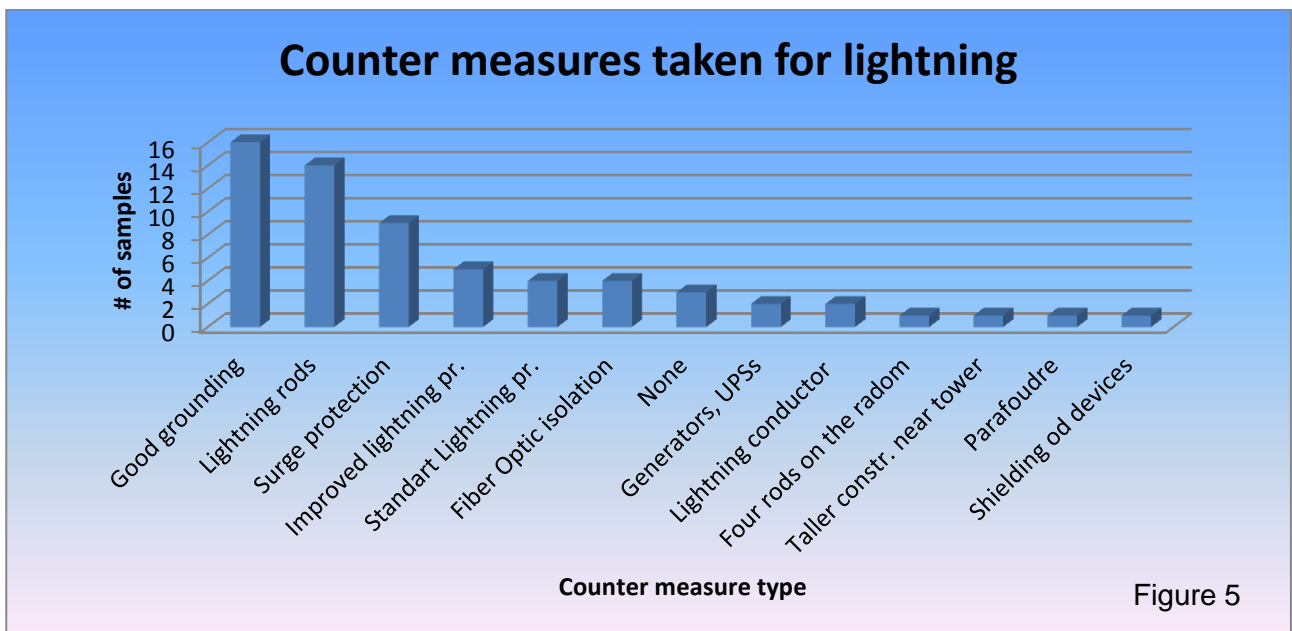


Figure 5

Weather radar systems are upgradable systems and some upgrades could be applied in parallel with new developments in time. (Figure 6) "Doppler" and other "Signal/Control Processor" upgrades have been applied to the systems according to the replies most commonly. Significant number of upgrades on "Analogue to Digital Receiver", "Dual Polarization" and "Software" has been implemented. Some of the participants "completely changed" the systems corresponding to the improvements. Several upgrades have been executed on "Solid State Modulators", "ACU/LCU Units" and "communication protocols like ethernet" with respect to the gathered information.

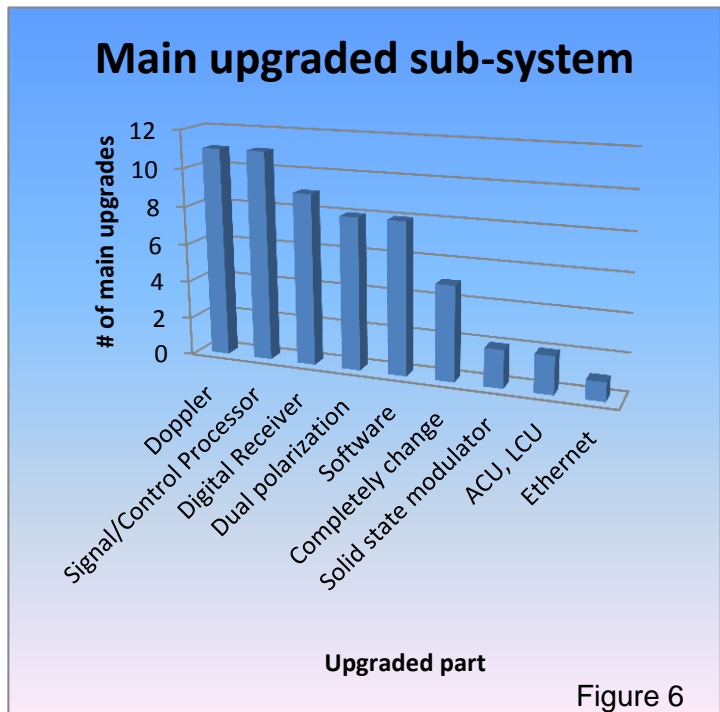


Figure 6

3. Calibration of weather radars

Most of the participants to the survey have been stated that they are carrying out calibrations on weather radars. (Figure 7) On the other hand, weather radars have different complex calibrations like reflectivity, velocity, dual polarization products (ZDR, LDR, etc), antenna calibrations for different products and main parts.

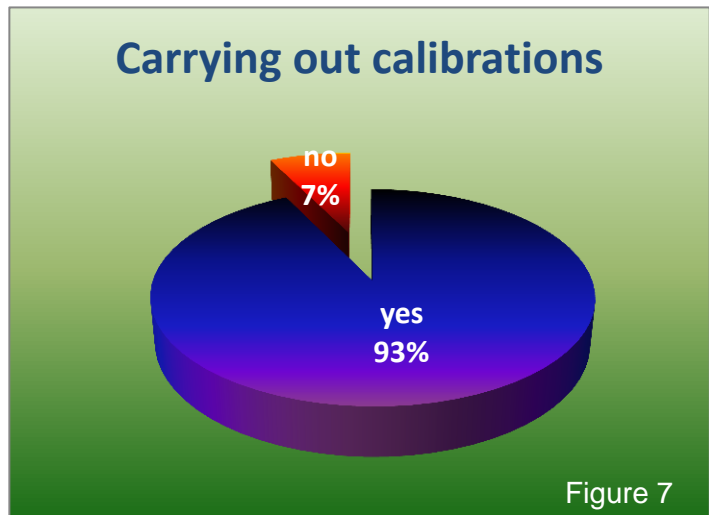


Figure 7

Mainly receiver, Transmitter and antenna calibrations have been carried out by weather radar users. (Figure 8) Other calibrations like dual polarization have been executed relatively insufficient.

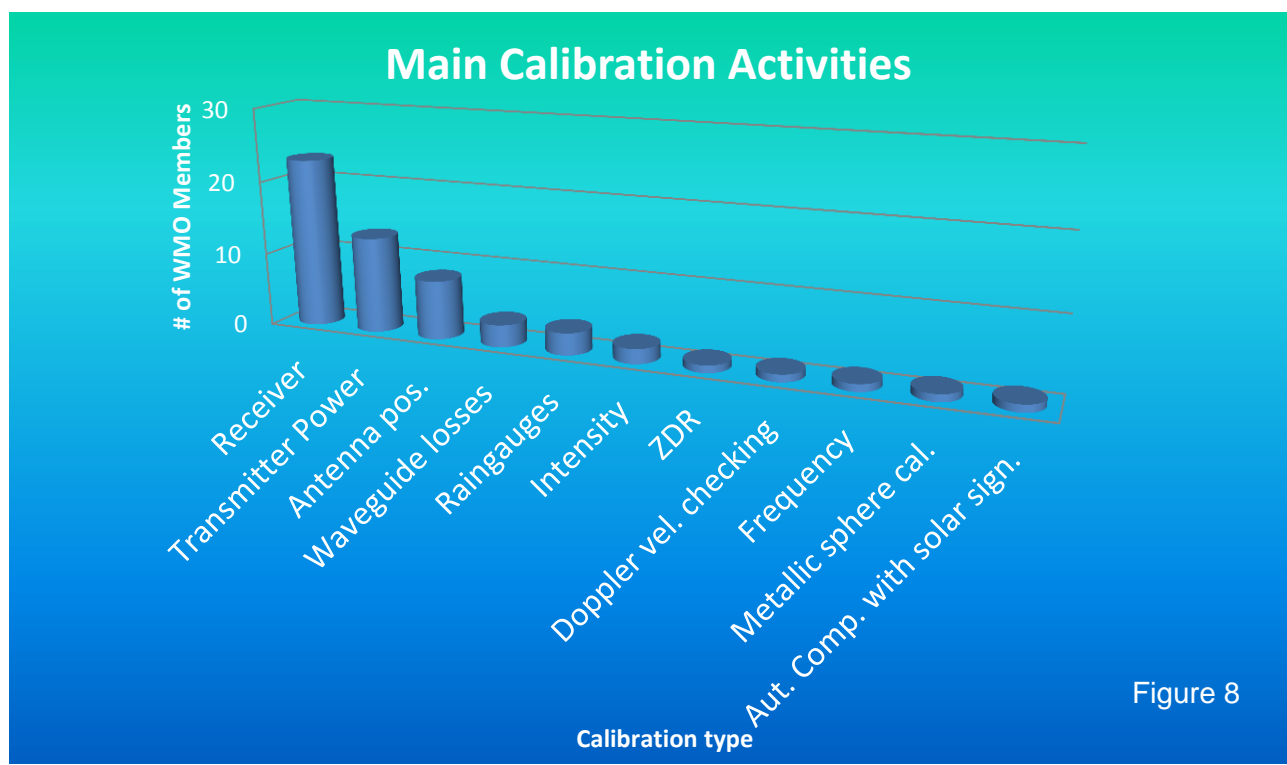


Figure 8

Besides, for accurate precipitation estimation site-specific studies should be carried out by using rain gauges or distrometers. Approximately 79% of the participants of the mentioned survey have been using standard Marshall Palmer's ZR relation. (Figure 9)

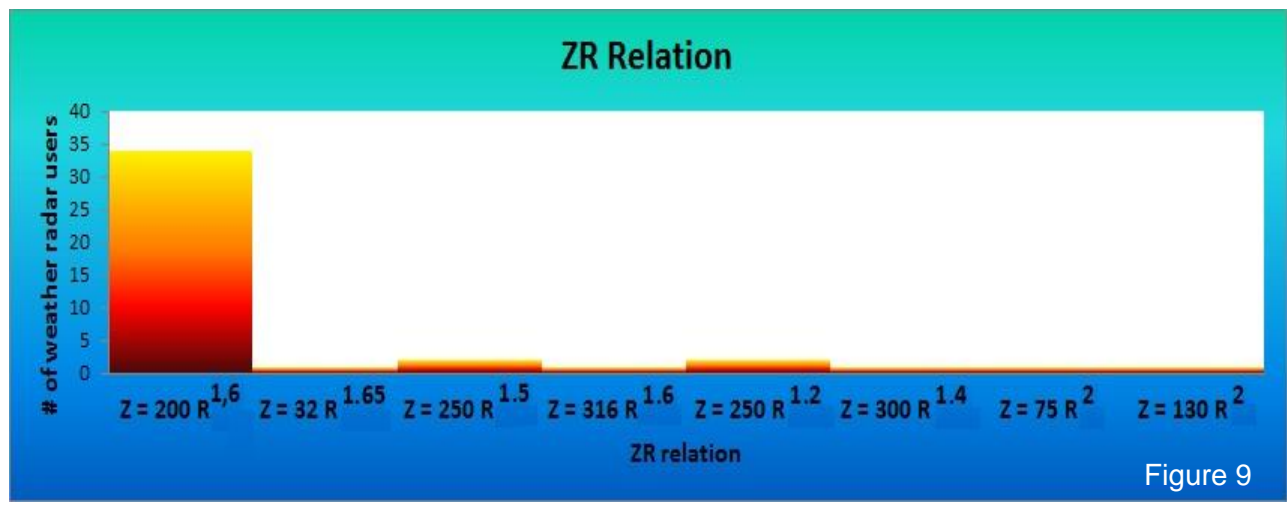
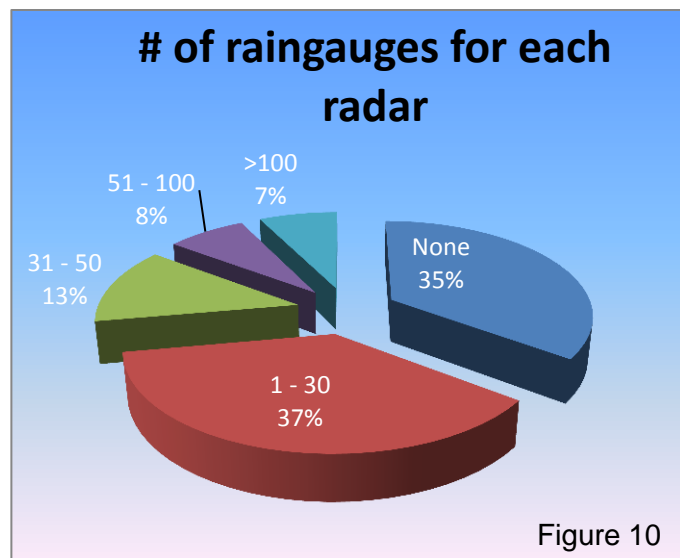


Figure 9

Significant number of participants doesn't have rain gauges interestingly. (Figure 10) Again, most of the participants who are operating rain gauges have 1-30 rain gauges in the coverage of each weather radar. The rest of the participants which compose minority have a rich number of rain gauges for each radar. These participants have mainly 30-50 rain gauges, but in some cases have rain gauges reaching 400s for each radar.



4. Conclusion

Weather radars operated by National Meteorological and Hydrological Services are operated as 7/24 in general. Since they are complex devices which have parts like high voltage, mechanical, electronics and processors and runs at the top of mountains having severe weather environment in some countries, the risk for failure is relatively high. On the other hand, weather radars have different complex calibrations like reflectivity, velocity, dual polarization products (ZDR, LDR, etc), antenna calibrations for different products and main parts. Unfortunately, there is not a standard full calibration procedure for users. So each part and product should be calibrated by well trained staff.

In this scope, opinions from survey participants regarding with training issue are important. "Continuous and frequent training", "Training of junior staff", "Training by Manufacturers", "Carrying out on the job trainings", "Trainings, workshops carried out by WMO regarding with weather radars", "E-learning and distance learning systems" subjects have been emphasized by the participants.

During the evaluation of mentioned survey, a weather radar database has been developed and a web page (<http://wrd.mgm.gov.tr>) has been prepared for sharing radar features and experiences, radar network planning information and resource allocation for all members, assisting a wide spread international exchange of radar data, gathering radar information to protect radio-frequency spectrum allocation, presenting common issues/problems and potential solutions. Encouragement for joint studies and sharing experiences of weather radar users are also important for data quality of products.

Reference: "Evaluation of CIMO/WMO Weather Radars Survey and Web-Based Weather Radar Database" 2011 - Oguzhan Sireci