

**WORLD METEOROLOGICAL ORGANIZATION**

**COMMISSION FOR BASIC SYSTEMS  
OPAG ON INTEGRATED OBSERVING SYSTEMS**

**WMO REGIONAL WORKSHOP ON AMDAR**

Casablanca, Morocco, 3-4 December 2015



**FINAL REPORT**



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Chairperson, Publications Board  
World Meteorological Organization (WMO)  
7 bis, avenue de la Paix  
P.O. Box No. 2300  
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0)22 730 84 03  
Fax: +41 (0)22 730 80 40  
E-mail: [Publications@wmo.int](mailto:Publications@wmo.int)

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## EXECUTIVE SUMMARY

The Aircraft Meteorological DATA Relay (AMDAR) Regional Workshop, for the Northern and Western areas of WMO Region Association I (Africa) was held from 3 to 4 December 2015 in Casablanca, Morocco. This Workshop was organized and hosted by the Direction de la Météorologie Nationale (DMN) of Morocco (Maroc Météo) at the kind invitation of the Government of Morocco. Twenty three Participants, representing ten WMO Members, airlines, aircraft based observations related organizations and expert teams, actively participated in the Workshop.

The Workshop was part of the strategy that the WMO CBS/OPAG-IOS Expert-Team on Aircraft Based Observing Systems (ET-ABO) has developed, which includes support for the development of new ABO (including AMDAR) programmes and enhancement of existing ABO programmes at the WMO Regional level.

The Workshop was opened by the Deputy-Director of DMN, Mr Omar Chafki, the representative of WMO, Mr Luis Nunes and the Chairman of the ET-ABO, Mr Frank Grooters. Over the two days, the participants were given a thorough understanding of the many different aspects of an AMDAR Programme - the design and quality management considerations, the benefits and impacts of using AMDAR data in meteorological and aviation operations and the airline perspectives of AMDAR implementation. In particular attention was given to the benefits of AMDAR development to Morocco and neighboring countries.

Information was provided on the status of the developing AMDAR Programme in Kenya, as the result of the AMDAR regional workshop held in June in Nairobi, Kenya, the status of the development of an AMDAR Programme by ASECNA and benefits South African Weather Service (SAWS) and South African Airlines (SAA) have seen in their operations as the result of the use of AMDAR data. Presentations regarding the experiences gained in operational AMDAR programmes (the Australian AMDAR Programme, the European E-AMDAR Programme) were also made, as well as on the development of a water vapor measuring instrument (WVSS-II), specifically designed to complement the existing AMDAR parameters.

The Workshop ended with the discussions between the participants towards the development of a regionally oriented AMDAR Programme involving Royal Air Maroc (and possibly other North African Airlines), ASECNA and DMN. An agreement with EUMETNET for AMDAR data from airlines of the E-AMDAR program flying to Region I was also discussed.

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## GENERAL SUMMARY

### 1. INTRODUCTION

The WMO Regional Workshop on AMDAR, Casablanca, Morocco was held at the Palace d'Anfa Hotel from 3 to 4 December 2015 at the kind invitation of the Government of Morocco, hosted by the Moroccan National Meteorological Service, "Direction de la Météorologie Nationale" (DMN) and supported by the WMO Commission for Basic Systems and its Expert Team on Aircraft Based Observing Systems (ET-ABO). The Workshop was conducted in English and French, with simultaneous interpretation of both languages.

The participants consisted of those Region I WMO Members invited by WMO, having national airlines targeted for participation in the Aircraft Meteorological Data Relay (AMDAR) Programme and also other national Moroccan organizations invited by the host. The list of participants is provided in Appendix I of this document. The workshop program is provided in Appendix II.

This AMDAR workshop was the second of two expected workshops planned to be held in WMO Region I in 2015, the first one was held in June 2015 in Nairobi, Kenya and especially targeting but not limited to English-speaking Members.

The aims of the workshop were to provide participants with detailed knowledge about the establishment, requirements and operational and beneficial aspects of the WMO AMDAR Programme and to initiate and conduct discussions with and provide advice to participants on aspects of co-operation, leading to initiative to set up national or regional AMDAR programmes.

### 2. OPENING OF THE WORKSHOP

The workshop opening ceremony commenced at 9 am on 3<sup>rd</sup> December 2015 and was presided over by Mr Omar Chafki, Deputy-Director of DMN, who first welcomed the participants. Mr Frank Grooters (The Netherlands) also addressed the participants on behalf of CBS and Mr Luis Nunes on behalf of the WMO Secretariat.

Mr Chafki welcomed participants to Casablanca and to the workshop and expressed the interest of DMN in exploring the possibilities of collaborating for the implementation of an AMDAR programme in Morocco. He thanked WMO for the work in organizing this meeting.

Mr Grooters also welcomed participants and expressed his gratitude to the host and noted that this was the second WMO regional workshop on AMDAR in Africa. He briefly noted the changes in the governance of the Aircraft-Based Observations Programme and the new strategy focusing on a regional approach for the implementation of AMDAR programmes.

Mr Nunes thanked the host country and the DMN on behalf of WMO Secretary General and presented apologies from Mr Dean Lockett, the WMO Scientific Officer in charge of Aircraft and Remotely-sensed Observations, who was unable to attend the workshop. He briefly underlined the importance of the AMDAR Programme in the context of the WMO Integrated Global Observing System (WIGOS) and wished the workshop every success.

### 3. WORKSHOP PROCEEDINGS

#### 3.1. Day One

Following the workshop opening, Mr Grooters provided two presentations, the first on the history of aircraft-based observations dating back to the early twentieth century and the second on the development of the AMDAR observing system from the late 1980s as the successor to the WMO Aircraft to Satellite Data Relay (ASDAR) Programme.

Mr Grooters noted that there are six actions (G19 through to G24) of the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP) directly related to AMDAR. WMO is looking towards the extension of AMDAR into aviation standards and systems. Currently AMDAR is not an officially recognized system by the International Civil Aviation Organization (ICAO) - it is up to the

airline companies to join the WMO AMDAR Programme or not. WMO will continue working to promote AMDAR and to convince ICAO of the benefits of having AMDAR, preferably as an ICAO standard.

During discussions following the presentation, the quality of AMDAR data was mentioned to be compatible with the quality of radiosonde data. Also the desire that the airlines follow the WMO recommendations regarding the calibration of onboard sensors was noted. In following these recommendations, the quality of the aircraft-based data would be guaranteed to be within the boundaries required for optimal usage in meteorological and aviation related applications.

In the second session of day one, Mr Nunes gave a presentation, on behalf of and prepared by Mr Lockett, on the details relating to the design and implementation of national AMDAR programmes, including requirements for upper air data, infrastructure and ongoing programme costs, AMDAR software development and testing, systems and data management and data display and use.

Following the presentation, the costs of developing AMDAR Onboard Software (AOS) were discussed. In summary, much of the cost is dependent on whether AMDAR software has already been written for the avionics/airframe by another airline or NMHS. If it has, then the software cost is likely to be significantly less than if it is a new development.

Dr Douglas Body (Australia) then made a presentation on the technical aspects of AMDAR data quality control and monitoring. The need to maintain close contacts and good communication between the National Meteorological and Hydrological Service (NMHS) and the airline company was noted as a major contributor to the quality assurance of AMDAR data. The importance of a quality evaluation centre, to prevent the distribution of erroneous AMDAR data through the WMO Global Telecommunications Systems (GTS), was also mentioned. The case of the E-AMDAR (the EUMETNET AMDAR Programme in Europe) was mentioned as an example of regional collaboration and optimization.

In the third session Mr Grooters delivered a presentation focused on the benefits and impacts of the AMDAR Programme and the data provided to NMHSs and described the significant positive impacts that these data have on improving forecast skill and products for a range of meteorological application. He noted the economic and environmental benefits of AMDAR data for airline companies, such as more and better updated meteorological information that can be received onboard after departure, depending on the agreements between the airline and the NMHS for communications. He also mentioned that in addition to temperature and wind, some aircraft also report atmospheric water content (moisture) and turbulence data.

During discussions following the presentation, it was underlined that AMDAR system is complementary with radiosonde stations in terms of upper-air data, but should not be seen as a replacement; In some cases the observing network design may be optimized, but the radiosonde observations reach much higher altitude (~30 Km) compared to aircraft-based observations (~10 Km) and besides that, many radiosonde stations have relevant long term climate data series that should not be disrupted.

In the following presentation Mr Francis Moseitho (South Africa), provided the workshop with information on the South African AMDAR programme, describing the benefits that the South African Weather Service (SAWS) derives from its national programme and also the experience of South African Airways (SAA) as the partner airline. SAA has provided testimony that it has quantified a significant benefit in terms of savings on fuel costs through improved and dynamic use of weather information that is enhanced with its own contribution of data received from the AMDAR programme. SAA calculates savings of the order of several million US dollars per annum through the use of more accurate and current wind information in pre-flight fuel-loading and both pre-flight and in-flight route planning. Therefore, there are immediate economic benefits for the partner airline, and also for the whole area where AMDAR equipped aircraft fly.

In the next presentation, made by Mr Hassan Haddouch (DMN), the workshop was informed about the structure, operations and activities of DMN and the expectations they have in benefiting from and making use of AMDAR data that might be made available through the implementation of an AMDAR programme in partnership with Royal Air Maroc (RAM) and/or other airlines operating in north-west Africa. Mr Haddouch mentioned that a relevant benefit of an immediate implementation

of AMDAR in the country would be the development of a climate AMDAR database that could be of great value to provide the airlines with much better and higher resolution upper-air information, e.g. wind regime in and around the region.

The final presentation of the day (fourth session) was provided by Mr Grooters who discussed some important technical considerations and aspects of AMDAR development in Africa, in particular the key airlines targeted for participation, the required communications infrastructure and issues and the benefits of regional international collaboration on programmatic activities such as data processing and sharing.

### **3.2. Day Two**

The first session of day two started with a presentation submitted by Mr Goama Ilboudo, representative of the Agency for Aerial Navigation Safety in Africa and Madagascar (ASECNA) outlining the development of AMDAR as a project and component of the ASECNA five-year planning cycle, in collaboration with WMO and CBS. He underlined the need for assistance for the ASECNA project especially regarding the ground systems for data receiving and processing and he raised the challenge of engaging other African airlines in the AMDAR Programme.

Mr Grooters suggested ASECNA and RAM conduct discussions looking for the common interests in order to define the best approach for the development of a first AMDAR Programme in the Morocco/North-West Africa area. He also suggested that such a programme would not need an optimization system due its likely size. The first step should be to use the AMDAR "Compatible Systems Survey" which provides a list of onboard avionics systems of the airline fleet that are known or expected to be capable of hosting AMDAR onboard software applications:

[http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/resources/AMDAR\\_Programme\\_Development.html](http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/resources/AMDAR_Programme_Development.html).

Mr Grooters added that cost savings are expected if a regional AMDAR Programme is developed in cooperation, e.g. through ASECNA. The Tunisia representative, Mr Rafik Chahed expressed interest of the National Institute of Meteorology (INM) in participating in the ASECNA project as well as with the E-AMDAR Programme.

The next presentation was made by Mr Elijah Bukachi (Kenya), who informed the workshop about the operations of the Kenya Meteorological Department (KMD) and the benefits that KMD expects, such as improvements to meteorological services and forecast products as a result of the availability of AMDAR data over the Kenya region. This would in turn lead to benefits to the aviation industry, to the operations of the airlines and the airports.

During discussions following the presentation, the challenge of convincing a national airline to become a partner of the NMHS in sharing costs of an AMDAR Programme was raised. The answer from KMD pointed to the need to demonstrate the benefits such as the availability of vertical profiles observed exactly over the airports – as opposed to radiosonde stations away from airports – reminding that, for example, the condensation level is critical for fog forecast, the occurrence of which has huge impacts in operations and thus negative economic consequences. Following this discussion the importance of humidity measurements was noted and the case of a package delivery company that has installed water vapor sensors onboard its aircraft was mentioned, because of their early morning flights from USA to Europe. The DMN representatives agreed with the relevance of AMDAR data for the fog forecast both directly by forecasters, as well as by the hi-resolution numerical weather prediction (NWP) models.

Dr Body and Mr Grooters delivered presentations on operational regional and national AMDAR programmes. Dr Body mentioned that the Australian AMDAR Programme, which includes an optimization system, collects data all the way to the destinations in the long-haul flights of the airlines involved, because they recognize the lack of data over oceanic areas and its importance for the global NWP. Mr Grooters informed that there is an activity in the AMDAR Expert Teams to develop generic specifications for the optimization systems, however the specifications of the E-AMDAR and the Australian optimization systems can be provided to interested WMO Members. He also described the modular infrastructure, including a data acquisition and processing system, an optimization system, a quality evaluation center and a data display and presentation system, of the E-AMDAR programme and explained the default requirements for the EUCOS (EUMETNET

Composite Observing System) area of observations, based on the requirements of the European NWP systems. However, 12% of E-AMDAR data comes from outside this EUCOS area as the EUMETNET contribution to the WMO Global Observing System.

The last presentation was done by Mr Bryce Ford (USA) representing the Association of the Hydro-Meteorological Equipment Industry (HMEI) who introduced the water vapour sensing system that is produced by SpectraSensors Incorporated (USA) and has been installed on aircraft of several airlines, mostly in USA and some in Europe. He mentioned that his company is looking into the future inclusion of water vapour sensors as standard equipment on commercial aircraft.

#### **4. FINAL DISCUSSION, PARTICIPANTS FEEDBACK AND PLANS**

As the final component of the formal part of the workshop, Mr Grooters led a session of discussion among all participants on the AMDAR Programme and its potential for development in northern Africa and in particular within those countries represented at the workshop. A summary of the key points is provided below:

**Royal Air Maroc:** After several presentations delivering a large set of information on various aspects of the AMDAR Programme they felt there was a need for a concise and short presentation about AMDAR and its benefits to be shown to CEOs and other senior officials, to allow them to quickly understand and help them to make decisions whether to join AMDAR.

**Kenya Airways:** As regards to funding, talks with national governments are essential, and the first step should be to obtain seed funding that allows an AMDAR implementation project to be started. The AMDAR Trust Fund and other Members of WMO through the relevant VCPs could be approached to avail funds to jump-start the programme since waiting for the Government's support might take a long time. AMCOMET Secretariat could support AMDAR initiatives through awareness and its benefits and encourage more Member States to participate. They look forward for feedback of the AMDAR Concept Note (developed by Dalberg Company) from a development partner for potential funding.

**ASECNA:** They think that the following three levels of AMDAR implementation should be considered: initial; in progress; advanced. They expressed concerns regarding the use of AMDAR data by the NMHS of the region, since this programme implies a new higher level of products to be developed and made operational in order to extract effective benefits of the programme. Therefore, they propose that future workshops to be organized should include a specific module to discuss this topic.

**NMHS of Tunisia:** The INM is considering and will study the future participation in the AMDAR Programme. They suggested that WMO should involve the national civil aviation authorities in the development and implementation of AMDAR projects.

**NMHS of Morocco:** The DMN recognizes AMDAR as a major and relevant WMO programme that needs to be supported and implemented as soon as possible, not only in the country but also in other regions of Africa.

A side-meeting was arranged right after the closure of the Workshop involving the two main parties of a future AMDAR Programme in Morocco, RAM and DMN, but also other relevant players in the region, such as ASECNA and the Tunisia-INM. They exchanged contacts information and agreed to collaborate in the future, the starting point of negotiations to be taken by RAM and DMN in the short term.

#### **5. CLOSURE OF THE WORKSHOP**

In the afternoon of day two the closing ceremony took place. On behalf of WMO Secretary General Mr Nunes thanked the Workshop host and organizers, the participants and the experts for their various contributions to the discussions, especially the Chair Mr Grooters for his excellent job.

The Workshop was closed by Mr Grooters, who thanked the DMN for hosting the Workshop and for the excellent choice of the venue and the logistics provided, including the translation and audio facilities. He noted that ET-ABO looks forward to seeing the next steps taken in this region towards a successful development of a (Regional) AMDAR Programme and offered any support needed to accomplish such a programme.

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## LIST OF PARTICIPANTS

Name	Country, Organization	Invited By	Role
Douglas Body	Australia	WMO	Presenter
Frank Grooters	Netherlands, ET-ABO	WMO	Presenter
Goama Ilboudo	ASECNA	WMO	Presenter
Francis Moseelho	South Africa, SAWS	WMO	Presenter
Bryce Ford	USA, HMEI	WMO	Presenter
Luis Nunes	Switzerland, WMO	WMO	Presenter
Jemima Mwebia	Kenya, Kenya Airways	WMO	Participant
Nassim Akretche	Algeria	WMO	Participant
Rafik Chahed	Tunisia	WMO	Participant
Elijah Bukachi	Kenya	WMO	Presenter
Abderrahim Mouhtadi	Morocco	Morocco	Participant
Brahim El Messaoudi	Morocco meteorological service	Morocco	Participant
Hassan Haddouch	Morocco meteorological service	Morocco	Presenter
Siham Sbi	Morocco meteorological service	Morocco	Participant
Moulay Driss El Hachimi	Morocco meteorological service	Morocco	Participant
Abdelaziz ESSTRI	Morocco meteorological service	Morocco	Participant
Sara Touil	Civil Aviation Authority of Morocco	Morocco	Participant
Rihana Drissi	Civil Aviation Authority of Morocco	Morocco	Participant
El Majdi Rachid	Royal Air Maroc	Morocco	Participant
Lounis Hasni	Morocco (Air Arabia)	Morocco	Participant
Lakhdar Hassan	Morocco (Air Arabia)	Morocco	Participant
Ikram Benali	Royal Air Force	Morocco	Participant



WMO, Regional Workshop on AMDAR,  
Casablanca, Morocco  
3 - 4 December 2015

Appendix II

Workshop programme

Day 1, 3 December			
Session	Time	Topic or Item	Presenter/Chair
Day 1 Session 1	0830	Workshop Registration	
	0900	Workshop Opening	1. Mr Omar Chafki, Deputy-Director Maroc Météo 2. Mr Luis Nunes, WMO 3. Mr Frank Grooters, Chairman CBS ET-ABO
	0930	Workshop Working & Practical Arrangements	Chair, Host
	0940	History of aircraft-based observations including AMDAR	Mr Frank Grooters
	1000	The AMDAR Observing System	
Break	1030	Coffee/Tea Break	
Day 1 Session 2	1050	Design and Implementation of an AMDAR Programme	Mr Luis Nunes (WMO)
	1150	Data Quality Monitoring and Control	Dr Douglas Body (Australian Bureau of Meteorology)
	1210	Discussion of the morning presentations	Mr Frank Grooters
Break	1230	Lunch break	
Day 1 Session 3	1330	Benefits and Impacts of AMDAR Data	Mr Frank Grooters
	1400	Meteorological Services Use of AMDAR Data	Mr Francis Moseelho (SAWS)
	1430	Airline Perspective of AMDAR Implementation	
	1500	Expected Benefits of AMDAR Development in Morocco	Mr Hassan Haddouch (Maroc Météo)
Break	1540	Coffee/Tea Break	
Day 1 Session 4	1600	ABO Requirements, Capabilities and other Considerations for Region I and its Countries	Mr Frank Grooters
	1645	Panel discussion and feedback from participants	Mr Frank Grooters, WMO, Participants
	1730	End Day 1	

<b>Day 2, 4 December</b>			
<b>Session</b>	<b>Time</b>	<b>Topic or Item</b>	<b>Presenter/Chair</b>
<b>Day 2 Session 1</b>	0900	ASECNA AMDAR Development Project	Mr Goama Ilboudo (ASECNA)
	0930	Kenya AMDAR Programme Development	Mr Elijah Bukachi (Kenya Meteorological Service)
	1000	Operational Regional and National Programs: Australian AMDAR Programme E-AMDAR	Dr Douglas Body Mr Frank Grooters
<b>Break</b>	1030	Coffee/Tea Break	
	1050	Water Vapour Measurement	Mr Bryce Ford (HMEI)
	1130	Region I AMDAR Development and Technical Aspects of Programme Implementation	Mr Frank Grooters & Feedback from Participants
<b>Lunch</b>	1230	Lunch Break	
<b>Day 2 Session 3</b>	1400	Final Panel discussion and feedback from participants	ET-ABO Chairman, Mr Luis Nunes, Dr Douglas Body, Participants
	1445	Closing Ceremony	
<b>Day 2 Session 4</b>	1500	Workshop Close	
	1500 to 1700	For meetings & discussion among meteorological service representatives and national airline representatives. Conference venue will be available.	