W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

COMMISSION FOR BASIC SYSTEMS

OPAG ON INTEGRATED OBSERVING SYSTEMS

&

COMMISSION FOR INSTRUMENTS

AND METHODS OF OBSERVATION

OPAG ON SITU TECHNOLOGIES AND INTERCOMPARISONS

CBS ET-ABO AND CIMO ET-AO JOINT MEETING

Casablanca, Morocco, 7-11 December 2015

FINAL REPORT

CONTENTS

AGENDA

EXECUTIVE SUMMARY

The Joint Meeting of the WMO Commission for Basic Systems Expert Team on Aircraft Based Observing Systems (ET-ABO) and the Commission for Instruments and Methods of Observation Expert Team on Aircraft-based Observations was opened by the Chair of the meeting, Mr Frank Grooters, the Netherlands, on 7 December 2015 at the headquarters of the Direction de la Météorologie Nationale (DMN) in Casablanca, Morocco. The session was addressed by the Deputy Director of DMN, Mr Omar Chafki who welcomed all participants to the Joint Meeting on behalf of DMN and also welcomed the opportunity provided by WMO to host the session in Casablanca, Morocco. Mr Etienne Charpentier, Chief of the Observing Systems Division of the WMO Secretariat also addressed the session, welcoming participants on behalf of WMO and the WMO Secretary General.

The Chairs of the two expert teams reported on the progress made on delivering their work plans over the past two years, of which some of the significant achievements included: continued expansion of the AMDAR programme and improved plans and increased interactions with WMO Regional Associations towards further collaborative development; increased deployment of AMDAR water vapour and turbulence measurement; progress on publishing and drafting new WMO guidance, standards and regulations on aircraft based observing systems; outreach activities including the publishing of newsletters, the holding of regional workshops on AMDAR and the development of an online COMET education and training module; successful and fruitful interaction with aviation transport industry forums and committees; improvements in data and data quality management processes and procedures; completion of a study on future technology and communications impacts on AMDAR; and new software developments and plans for further and future interaction with avionics vendors and developers towards wider availability of AMDAR software applications.

The session was informed about the progress being made in each WMO region in maintaining and developing existing and new AMDAR programmes and increasing the availability of aircraft based observations through the planning and implementation process in collaboration with WMO Regional Associations that has been established by ET-ABO and endorsed by CBS and Congress (Cg-17). The meeting was also informed about and discussed the WIGOS Pre-Operational Phase that was being undertaken over the coming inter-sessional period of Congress and the various aspects of WIGOS development that would impact upon aircraft based observations, including metadata development, required regulations and guidance and implications for quality management and monitoring.

Much of the session was devoted to recent technical developments in aircraft based observations and improving the planning and implementation process and documentation that had been put in place to ensure such developments were more widely implemented, including water vapour and turbulence measurement. Some of the issues associated with the potential for derivation of high resolution aircraft based observations from secondary surveillance radar systems were also addressed.

The teams devoted considerable time to review and revision of their respective work plans and reporting to WMO Technical Commissions and the relevant management and coordinating bodies.

Before the closure of the session, the meeting was addressed by the Director of DMN Morocco, Mr Abdalah Mokssit who thanked all the participants of the meeting. Mr Mokssit informed the session that he expected that the outcomes from the meeting would be of great benefit to Morocco and DMN and expressed confidence that there would be a strong and successful endeavour towards the development of an AMDAR programme in Morocco.

GENERAL SUMMARY

1 ORGANISATION OF THE SESSION

1.1 Opening of the Session

The Joint Meeting of the WMO Commission for Basic Systems Expert Team on Aircraft Based Observing Systems (ET-ABO) and the Commission for Instruments and Methods of Observation Expert Team on Aircraft-based Observations was opened by the Chair of the meeting, Mr Frank Grooters, the Netherlands, at 9:30am on 7 December 2015 at the headquarters of the Direction de la Météorologie Nationale (DMN) in Casablanca, Morocco.

Mr Grooters welcomed the members of both teams in attendance and thanked the hosts of DMN for the opportunity to hold the meeting in Morocco in series with the WMO Regional Workshop on AMDAR, which was held over 3-4 December at the Palace D'Anfa Hotel in Casablanca. Mr Grooters invited the Deputy Director of DMN, Mr Omar Chafki to address the meeting on behalf of the host organization. Mr Chafki welcomed all participants to the Joint Meeting on behalf of DMN and also welcomed the opportunity provided by WMO to host the session in Casablanca, Morocco. Mr Chafki suggested that the meeting and the preceding workshop came at an opportune time for promoting the commencement of the development of an AMDAR program for Morocco and outlined the various reasons that such development was important for both Africa and for the country, with particular emphasis on the requirement to improve the quality and availability of upper air observations in the region. While Morocco's mature Numerical Weather Prediction system and its various weather models already benefited from the availability of some aircraft based observations, a national programme with the participation of a national airline would likely provide significant benefits to NWP, aeronautical and other forecasting applications.

Mr Etienne Charpentier, Chief of the Observing Systems Division of the WMO Secretariat then addressed the session, welcoming participants on behalf of WMO and the WMO Secretary General and thanking the Permanent Representative of Morocco with the WMO, and third WMO vice-President, Mr Abdalah Mokssit, the Kingdom of Morocco, Mr Chafki, DMN and the DMN meeting organizing group for their kind welcome and hospitality and excellent organization of both the workshop and the Joint Meeting. Mr Charpentier recalled that the two teams, ET-ABO being essentially responsible for programmatic aspects and ET-AO being essentially responsible for the technical and standards related development of aircraft based observations, together form an important WMO programme that assists Members in the delivery of high quality upper air observations as a critical component of the WMO Integrated Global Observing System (WIGOS) and the World Weather Watch Programmes Global Observing System (GOS). Mr Charpentier outlined some of the key achievements of the programme over the past two years, including the development and publication of guidance, standards and educational materials, the publication of various studies and technical reports and also the maintenance and development of plans for programme expansion and enhancement. He recalled that the meeting was expected to make recommendations to the CBS and CIMO concerning the contribution of aircraft-based observations to the WIGOS pre-operational phase (2016-2019). It was also expected that the ET-ABO would report to CBS 16th Session later in 2016 through the CBS Implementation/Coordination Team on Integrated Observing Systems (ICT/IOS) at its 9th session in April 2016.

1.2 Adoption of the Agenda

The Chair proposed and the meeting agreed that the agenda as provided above should be adopted for the session.

1.3 Working Arrangements of the Session

It was agreed that the session would proceed predominantly in plenary with parts of agenda item 7 to be conducted within breakout groups during the latter stages of the meeting.

2 REPORTS OF THE CHAIRS

2.1 Report of the Chair of ET-ABO

The Chair of ET-ABO, Mr Frank Grooters, presented document 2.1, providing a report of the activities of ET-ABO since the previous session of the team. Mr Grooters informed the meeting that, since the first session of ET-ABO (September 2013) and the formation of the CIMO Task Team (2013), that late became the Expert Team on Aircraft-based Observations (July 2014), the chairs and vice-chairs of the teams and the WMO Scientific Officer on Aircraft-based and Remotely-sensed Observations (SO/ARO) had together coordinated the work plans and activities of the two teams and the budget for operation of the AMDAR Trust Fund in line with its terms of reference. This work was mostly carried out by correspondence (E-mail) and by remote conferencing (WebEx). At various times, ET-ABO members and its Sub-Group on Regulatory Material had met by WebEx to discuss and review the work plan and its various tasks and activities.

The meeting was informed that, at its 17th meeting, Congress adopted a resolution (Resolution 22 (Cg-17)), urging Members:

(4) to continue providing contributions to the AMDAR Trust Fund for the support of technical developments and capacity-building related to AMDAR.

The AMDAR Trust Fund therefore provided ongoing support for the activities of the Aircraft Based Observations Programme (ABOP) in line with the terms of reference of the fund.

Mr Grooters described the current status of the WMO AMDAR programme:

- More than 3500 aircraft of 40 airlines, under 11 national/regional programmes, produce currently around 700,000 observations (ascent, descent and en-route data) globally per day.

- 95% of Aircraft Based Observations were derived from the AMDAR observing system, supplemented by additional observations derived from ICAO aircraft observations (AIREPs, ADS-C).

- Most of the ABO observations were encoded in BUFR but FM42 (Character code) was still in use in some programmes.

- Water Vapour information was produced by more than 140 US and 8 European aircraft.

- Turbulence reporting (Eddy Dissipation Rate) was available from over 400 aircraft of 3 US airlines, while some programmes continued to report Derived Equivalent Vertical Gust measurements.

Mr Grooters then outlined the progress made on various activities of the work plan since the previous session, which would be elaborated on throughout the course of the session under the agenda, with plans for further work made and agreed under agenda item 7:

- Advancement had been made in the development of a framework for the establishment of ABO metadata under the WIGOS Metadata Standard and within the Observings Systems Capabilities, Analysis and Review (OSCAR) tool.

- ET-ABO had undertaken several activities towards the improvement of quality management of ABO data, with particular focus on data derived from the International Civil Aviation Organization (ICAO) aircraft observations via the Automatic Dependent Surveillance – Contract (ADS-C) system. This included the holding of a workshop with representatives of ICAO and the World Area Forecast Centers (WAFCs) in October 2015.

- While progress had been delayed, the expert teams in collaboration with E-AMDAR and Météo, had advanced the development of AMDAR Onboard Software for Boeing 777 aircraft in agreement with Air France, with an expectation that Air France B777 aircraft will be activated for reporting over late 2015 through the first quarter of 2016.

- The Mexico AMDAR Programme was implemented in October 2014 with support from the USA (NOAA/NWS) through a contract between WMO and ARINC. A funding scheme was agreed between the Mexico National Meteorological Sservice (SMN) and WMO in which SMN would cover the first operational year of communications costs and WMO would finance the implementation costs and the second year of communications costs, based on the funding provided by NOAA through a contribution to the AMDAR Trust Fund.

- Guidance material related to Requirements for the Implementation and Operation of an AMDAR Programme was published within WIGOS Technical Report No. 2014-02.

- Under an ET-ABO task to commission and publish papers on the Impact of AMDAR Data, WIGOS Technical Report No. 2015-01 has been produced and two related papers on AMDAR and Water Vapour Measurement (WVM)impact and benefits were expected to be published in the Bulletin of the AMS in 2016.

- The document, Benefits of AMDAR Data to Meteorology and Aviation was published within WIGOS Technical Report No. 2014-01.

- A WMO contract with a consultant had been completed resulting in the development of a report on the benefits of the AMDAR programme to the aviation industry. The report is expected to be published as a WIGOS technical report in the first quarter of 2016.

- ABOP representatives had attended meetings of the AEEC Data Link Users Forum, twice per year, by turns held in the USA and in Europe in 2014 and 2015, where AMDAR was promoted.

- A promotion and discussion paper on ABO and AMDAR was developed and submitted for discussion to the joint WMO/ICAO meeting (Montreal, July 2014).

- The ET-ABO Sub-group on Regulatory Material (SG-RM) had drafted an update on Aircraft Based Observations for the relevant sections in the Manual on the Global Observing System (WMO No.544) and the Guide on the GOS (WMO No. 488), expected to be later finalised and submitted to CBS for approval at its session in late 2016.

- In line with the ABOP Strategy and Implementation Plan (A-SIP), adopted at the first session of the ET-ABO in 2013, ET-ABO had been endeavouring to collaborate with each of the regional associations for the establishment of regional ABO work teams and the subsequent development, adoption and maintenance of six Aircraft Based Observations Programme Regional Implementation Plans (A-RIPs). This approach has been approved through the adoption by CBS of Recommendation 17 (CBS-Ext.(2014)). Significant progress had been made in the development of a number of the A-RIPs and interaction with the WMO Regional Associations (Ras) in some regions had been held, resulting in the formal adoption of various actions on regional AMDAR development within WMO Regional Assocations I, III and V.

- A Regional Workshop on AMDAR was organised for the Eastern, Central and Southern region of Africa in Nairobi, Kenya in June 2015, in cooperation with the Kenya Meteorological Service. A second Regional Workshop for the Western and Northern region was organised in Casablanca, Morocco, December 2015, in cooperation with the Direction de la Météorologie Nationale of Morocco.

- An on-line AMDAR Learning Module was developed in collaboration with COMET, a program under the US University Corporation for Atmospheric Research.

- In each of 2014 and 2015, two issues of the Newsletter had been published.

- Progress had been in the endeavour to find a suitable and willing organization to host the WMO Aircraft Based Observations Data Center. Requirements had been formulated and a possible candidate centre idendtified. See further below under item 5.5.

- An AMDAR Development Officer had been employed on a WMO Special Services Agreement over 2013 to early 2015, financed by the AMDAR Trust Fund. Given the successful outcomes of this arrangement, it was expected that this would be continued under a future initiative focusing on technical coordination for regional and global AMDAR programme development.

2.2 Report of the Chair of ET-AO

The Chair of ET-AO, Mr Stewart Taylor, United Kingdom of Great Britain and Northern Ireland, presented document 2.2, providing the Chair's report of the activities of ET-AO since it was re-formed from the previous Task Team on Aircraft-based Observations as a result of CIMO-16 in July 2014. The forebear to ET-AO, the Task Team on Aircraft-Based Observations, met once in Geneva over 18-20th February 2014 and was replaced by the expert team for the CIMO inter-sessional period, 2015-2018. ET-AO is therefore a component of the Aircraft Based Observations Programme (ABOP) in co-operation with the CBS ET-ABO.

The meeting was informed that the ET-AO sits within the CIMO Open Programme Area Group on In-situ Technologies and Intercomparisons (OPAG-ITI A.4) and that the ET-AO has an expectancy to meet every two years with the Work Plan activities and budget updated annually and presented for approval to the Chair of CIMO OPAG and the CIMO-MG. In line with the terms of reference for the team, consultation is carried out with ET-ABO to ensure that ABOP development activities are assigned appropriately and in harmony with the broad complementary areas of responsibility within the programme. The Work Plan of the ET had been reviewed and updated during the period as required in accordance with the ToR, with the latest version updated in January 2015

Mr Taylor provided the session with a brief description of the tasks of the work plan and their current status as summarized below:

- The work plan involved the coordination of activities and the organisation of team meetings, of which the current joint meeting with ET-ABO consituted the first session of ET-AO.

- Work had commenced on scientific investigation of the cause of the well known AMDAR air temperature bias issue.

- The team had undertaken the development of implementation plans for the wider and improved meaurement of water vapour and turbulence within the AMDAR system and the ABOP. These plans were to be presented to the current session with an

expectation to incorporate the agreed material in the ABOP Strategy and Implementation Plan.

- A consultant had been employed to undertake a Study on Current & Future Communications and Technology – the study had been completed and would soon be published, as reported under agenda item 5.5.

- The AMDAR Onboard Software Functional Requirements Specification (AOSFRS) had been updated and a new version 1.1 had been issued under the CIMO Instruments and Observing Methods (IOM) technical reports series in June 2014.

- The team had been developing strategy and making initial plans for collaborating with avionics vendors on the development of AMDAR Onbaord Software (AOS) applications as standard “catalogue” applications, with futher follow up planned for 2016.

- Under work plan Task 11 on Boeing B777 AMDAR Software Development, the team had worked with ET-ABO and in collaboration with partners, Air France, British Airways, E-AMDAR and Météo. It was expected that this initiative would lead to the rollout of AOS on the B777 fleets of these aircraft over late 2015 through early 2016.

- As part of the update to the Regulatory Material for ABO (to be incorporated into the Guide to GOS, WMO-No-488, 3.4 Aircraft Meteorological Stations), optimisation specifications had been included within Annex V – see below under agenda item 4.2.

- The team had continued to maintain watch on the various international efforts to assess the impacts and validate the performance of water vapour sensors for the WVSS-II and TAMDAR sensing systems. The E-AMDAR Programme was still awaiting the final reports on results from TAMDAR and WVSS-II comparisons on the FAAM aircraft. A study of the impact of TAMDAR data was carried out by both ECMWF and Deutscher Wetterdienst (DWD) and presented to EUMETNET Observations Scientific Expert Team (Obs-SET) – the reports from the studies were being collated and made available. The TAMDAR system continues to be rolled out on the Flybe and Icelandair fleets. Discussions were continuing with Panasonic regarding the use of the data. For more details, see below under agenda item 5.1.

- The work plan included a task on AMDAR and WVSS-II inter-comparison which was in the early stages of development.

- A draft report had been developed on the various tests and studies leading to scientific validation of the WVSS-II water vapour measurement sensor, expected to be published as an IOM report in 2016.

- The team had finalised the update of Part II, Chapter 3, Aircraft Observations of the WMO Guide to Meteorological Instruments and Methods of Observations, WMO-No. 8, which was approved for publication by CIMO-16.

- An update of the Meterological Report specification within AEEC ARINC620 Software Specification had been completed leading to the publication of version 6 within ARINC620 Supplement 8.

- The team had also developed a task on Study of Unmanned Ariel Vehicles (UAV) technologies. The Chair of ET-AO had attended the Commercial UAV Show (October 2014) and discussed meteorological applications with several vendors as well as British Antarctic Survey (BAS) who are active in the use of UAV. Further information is available under agenda item 5.5.

3 REGIONAL AND NATIONAL AMDAR & ABO PROGRAMME STATUS REPORTS

3.1 Region I

Mr Francis Mosetlho presented document 3.1, providing a summary of the current status and plans for development of ABO and AMDAR within WMO Region I.

The region was currently served by one operational programme only, the South Africa AMDAR programme, for which the participating airline, South African Airways provides AMDAR data from a fleet of 43 Airbus aircraft. The programme produces around 5000 observations per day and around 140 vertical profiles per day from 6 airport locations.

ASECNA Activities

Mr Goama Ilboudo, ASECNA, presented document 3.1(2) on the ASECNA AMDAR development project. Mr Ilboudo informed the meeting that the ASECNA project had originally been initiated in 2002 by ASECNA as the outcome of a joint workshop organized by WMO, ASECNA and the NMHS of Senegal. This workshop outlined the benefits of AMDAR data for Africa and led to a commitment from ASECNA to seek the provision of AMDAR for 24 international airports of the 17 African country members with potential for AMDAR participation. The project had been included as a component of the five-year investment plan of ASECNA. In 2014 after connection with ET-ABO and the appointment to the team of Mr Jean Ngamini, the project had been reinvigorated and Mr Ilboudo had been confirmed as the replacement of Mr Ngamini upon his retirement in late 2014.

ASECNA had identified several airlines that might participate in AMDAR including Air Côte d'Ivoire in Abidjan, Air Burkina in Burkina Faso, ASKY Airline in Togo, and Trans Air Congo in Congo, and have contacted these airlines requesting that they complete the WMO avionics survey form.

Mr Ilboudo informed the meeting that an International Aviation Conference would be held in April 2016 in Senegal and that this would be an opportunity to promote AMDAR development. The meeting agreed that ET-ABO should support this initiative.

ASECNA expects that its updated AMDAR development project for 2016-2019 would be approved by ASECNA in late 2015.

Development Activities

Through the activities of ET-ABO for regional development of ABO, a draft ABOP Regional Implementation Plan (A-RIP) for Region I had been developed and presented to Regional Association I (16th Session, February 2015) as an information document. A presentation on AMDAR was made to the Regional Conference (RECO) by the Secretariat and the RA agreed that a regional working body for AMDAR could take on the role of coordinating and overseeing the further development of the aircraft-based observing systems in the Region.

At the 3rd Session of the African Ministerial Conference on Meteorology (AMCOMET) (Cabo Verde, February 2015), AMDAR was adopted as a Flagship Programme within the adopted Implementation and Resource Mobilization Plan of AMCOMET.

A Regional Workshop on AMDAR was held in Nairobi, Kenya in June 2015 and a second in December 2015 in Casablanca, Morocco, preceding this joint meeting – see item 6.3 for more information.

A workshop was held in Casablanca, Morocco over 3-4 December preceding the Joint Meeting. Based on feedback at this workshop, it was reported that the Kenya Meteorological

Department (KMD) had made good progress in negotiating the commencement of an AMDAR programme with Kenya Airways, however progress had become somewhat stalled in relation to programme development costs and the AOS development process. It was agreed that there was a need for ET-ABO to work with KMD to determine the most efficient means for AOS development and implementation.

Also based on the outcome of the Morocco workshop, the meeting was informed that a collaborative approach had been suggested between Morocco, Kenya and other countries on a possible regional approach to AMDAR development in northern and eastern Africa.

The meeting agreed that, while Mr Ilboudo had agreed to continue as the ET-ABO Lead on Region I, the WMO AMDAR Focal Points of Region I should continue to meet in 2016 seeking to establish a strong leadership group supporting the development of AMDAR through collaboration with RA I.

3.2 Region II

Mr Dean Lockett, the Secretariat, presented document 3.1, providing a summary of the current status and plans for development of ABO and AMDAR within WMO Region II.

There were currently four operational AMDAR programmes in Region II, operated by the countries and Regions of China, Hong Kong China, Japan and the Peoples Republic of Korea. The latest national reports for the China AMDAR programme and for the Hong Kong China programme were provided within document 3.2. Unfortunately, national status reports were not received for the other two programmes in Region II in time for the session.

Dragon Airlines was added to the Hong Kong China programme in July 2014 and based on the current report from China, two new airlines had been added to the China AMDAR programme over the past two years: Xiamen Airlines and China Eastern Airlines Jiangsu Limited.

Cathay Pacific had also been equipping newer B747-8F aircraft to replace the retiring existing B747-400 aircraft.

Development Activities

China was endeavouring to improve coverage over Western China through the future participation of Chengdu Airlines and was also working towards introduction of cargo airlines in order to take advantage of their night time flight operations, with first airline of interest, China Post Airlines.

Hong Kong Observatory and Cathay Pacific Airways were working together towards a large-scale expansion to include forty additional A330 and B777 aircraft.

Hong Kong China was also endeavouring to work with Cathay Pacific to implement turbulence monitoring as part of the AMDAR programme.

Of particular interest for Hong Kong China is the application of AMDAR data in support of low-level turbulence monitoring and prediction with the aim to introduce high resolution reporting below 2000ft in the future.

There were no known or imminent programme developments in Region II; however, as the table below from the AMDAR Coverage & Targeting for Future Airline Recruitment study indicates, there are many airlines of interest for the programme.

ET-ABO had been without a Region Lead for WMO Region II throughout most of the time since the first ET-ABO session, due to the previous core member for CMA, Mr Li Wei, having left the employ of CMA during that time. For this reason, no progress has been made in developing the ABOP Regional Implementation Plan for Region II. However, the Secretariat had been in contact with the ABO Focal Point for Hong Kong China, who is also the leader of the Expert Group on Aviation Meteorology within RA II and he was aware of the CBS and ET-ABO initiative to collaborate with each WMO Region on ABO.

Of interest and relevance from the China programme status report, the 4th International Training Course on Aeronautical MET service was held in Beijing from 8 to 19 June 2015, in which AMDAR and the China AMDAR programme were promoted.

The meeting was informed that RA II had adopted Resolution 16 (RA II-15) for the establishment of Pilot Project for RA-II to Develop Support for National Meteorological and Hydrological Services in the Collection and Application of Aircraft Meteorological Data Relay Data, due for completion in December 2016.

The meeting requested that Mr Zhao consider taking on the role of ET-ABO Lead for Region II and Mr Zhao agreed to consult with CMA regarding this request.

It was suggested that both the Middle East and central Asia were data-sparse areas that had great potential for AMDAR development and required particular focus over the coming two years as part of the ABOP development in Region II. In particular, India should be contacted by the Secretariat to seek the appointment of a Focal Point who might liaise with ET-ABO on AMDAR development.

While it was agreed that a possible AMMDAR workshop in Qatar should be a priority in 2016 and that the Secretariat should contact Qatar regarding this, if the workshop in Qatar failed to eventuate, a workshop in India might be an alternative option and should occur in 2017 otherwise.

It was agreed that ET-ABO would seek to engage further with RA II on AMDAR at its 16th Session in 2016.

3.3 Region III

The Secretariat was not able to make contact with the ET-ABO core member for Argentina who had taken on the role of Lead for Region III. A report on Region III activities was not received for the session. Previous contact with focal points in the region had indicated that plans were being implemented towards the development of new AMDAR programmes for Argentina and Brazil.

Development Activities

The Chair informed the meeting that some progress has been made on the development of a Region III A-RIP although a draft was not yet available. ET-ABO had been informed that AMDAR was presented at the RA-III Session in September 2014 and a rapporteur on AMDAR was appointed by the RA.

It was agreed that the Secretariat should contact the Lead and request the status of his role in the expert team.

3.4 Region IV

In the temporary absence from the meeting due to illness of Mr Gilles Fournier who prepared document 3.4, Mr Steven Pritchett, United States of America, presented the document, providing a summary of the current status and plans for development of ABO and AMDAR within WMO Region IV.

The Region IV ABO Programme comprised 3 national programmes, Canada, Mexico and the United States of America. 23 CRJ-200 aircraft from Jazz and NAVCANADA provide data to the Canadian Programme, 29 B737-700 aircraft from AeroMexico provide data to the Mexican Programme and a mixture of approximately 3000 aircraft models and types from 8 US air carriers (American, Alaska, Delta, FedEx, United, United Parcel Service, Air Wisconsin, and Southwest) provide data to the US Programme. The US Programme generates over 500,000 observations daily, including about 60,000 ascent or descent profiles a week.

In Canada, as Jazz is gradually retiring its CRJ-200 aircraft and acquiring DHC-8-Q400 aircraft, the Programme is not sustainable in the short term. Environment Canada is exploring options to sustain and eventually expand the Canadian AMDAR Programme, starting with Air Canada's interest with the intent to create an opportunity for follow-up, such as working with Air Canada to examine the possibilities and tailor a business case that would include the determination of operational benefits, and of cost and ability to add AMDAR reports to ACMS.

In Mexico, the aircraft data has been assimilated into a NWP regional model with a 3DVAR system (WRFDA) but quality control of AMDAR data and model verification of the forecast cycle are still part of the efforts to construct a viable operational forecasting system. The agreement that exists between SMN-CONAGUA and Aeromexico will be continued for two more years.

In the USA, 135 US aircraft are equipped with WVSS-II sensors producing about 2000 profiles daily. There is additional interest from the airlines for installing WVSS-II systems and budgets continue to be the limiting factor in expanding the WVSS-II network more rapidly.

The USA also continues to promote AMDAR at various events and venues, to seek new opportunities to promote AMDAR and to employ AMDAR data in the training developed for NWS forecasters. NOAA, the FAA, and private sector partners, including Rockwell Collins/ARINC, Panasonic Avionics, Spectra-Sensors Inc., participate in many national and international events each year.

Development Activities

NOAA and the FAA have been working with the airlines in developing standardized methods of reporting turbulence using Eddy Dissipation Rates (EDR) and experimenting with other techniques.

NOAA has recently awarded a contract for expanding aircraft observations into data sparse areas and through this contract is acquiring aircraft observations through the ADS-C downlinking processes.

NOAA is further utilizing the new ARINC contract in the development of processes for data thinning and data optimization.

In early 2016, with the concurrence of the participating providers, the AMDAR data associated with aircraft equipped by NOAA with WVSS-II sensors will be made publically available in real time for all to use.

For the future, the USA is taking steps to increase aircraft meteorological data coverage over data-sparse areas of the world. This most recent 3-year contract is meant to provide gap mitigation from delays in US satellite launches and will complement radiosonde soundings for global and regional weather prediction.

Currently no other members of RA IV have indicated a desire to develop or plan a national AMDAR Programme.

The 7th draft version of the AMDAR/ABO Implementation Plan for WMO Region IV has been out for review and consideration for further actions.

The USA has been planning a workshop for RA-III/RA-IV in 2016 from which a planning committee combining RA-III and RA-IV could emerge with the goal to finalize the implementation plan and develop a way forward. The workshop will have sessions with participants on the experiences of the US and other countries in integrating ABO for Numerical Weather Prediction, Forecast and Warning operations and the future impacts for turbulence and icing reporting, as well as radiosonde augmentation. This workshop will increase collaboration with international partners (airlines and other meteorological services), share knowledge, training methods and experience with ABO. The meeting agreed that ET-ABO and the WMO Secretariat should provide appropriate support for the proposed Region III/IV AMDAR workshop.

3.5 Region V

Mr Douglas Body, Australia, presented document 3.5, providing a summary of the current status and plans for development of ABO and AMDAR within WMO Region V.

RA V has 2 Operational National Programmes – Australia and New Zealand - and benefits also from data provided by other programmes, primarily US based carriers flying to Hawaii.

The New Zealand programme continues to provide approximately 3000 observations per day on the GTS from their fleet of 28 aircraft. The fleet configuration has changed slightly over recent years with the replacing of B737-800s by A320s within the Air New Zealand AMDAR fleet.

The Australian programme now provides approximately 13000 observations per day on the GTS from 88 AMDAR equipped aircraft from 4 airlines – Qantas, Jetconnect, Air Vanuatu and SkyTraders.

Development Activities

The session was informed that the Australian Bureau of Meteorology had initiated investigations into possible derivation of ABO through the Australia Mode-S system and that it was also working with Qantas towards equipping the Qantas A330 fleet with AMDAR and EDR reporting capability. The Bureau was also seeking to reactivate the development of a water vapour monitoring program as a component of the Qantas AMDAR program.

The sixteenth session of WMO Regional Association V (RA V-16, Jakarta, 1-7 May 2014) approved the formation of a Task Team on Aircraft Based Observations (TT-ABO) as part of the RA V Working Group on Infrastructure. This group is led by Mr Syamsul Huda (Indonesia). Terms of Reference have been established and the group is currently updating its information on the current status of ABO within the Region. A draft ABOP Regional Implementation for Region V has been developed by ET-ABO, which might be adopted by the RA task team.

It was agreed that the ET-ABO Lead for Region V should work with the RA task team towards expansion of the group and an update of the A-RIP in 2016.

It was agreed that ET-ABO should seek to hold a regional workshop on AMDAR in Region V, possibly in 2017 in Indonesia, targeting AMDAR participation by Indonesia and Malaysia.

3.6 Region VI

Mr Stewart Taylor made a presentation, providing a summary of the current status and plans for development of ABO and AMDAR within WMO Region VI.

The ABO Programme in Region VI was currently and predominantly associated with the EUMETNET E-AMDAR Program. There were 14 participating airlines with nearly 1000 aircraft providing around 50,000 observations per day on the GTS. In addition to providing coverage over the EUCOS designated observations area, E-AMDAR also made a contribution of up to 12% of its program to coverage outside this area, which provided some upper air coverage over Africa, South America, Eastern Europe, central and eastern Asia and some areas of the Atlantic.

The E-AMDAR program, supported by the E-AMDAR Data Optimisation System, endeavoured to provide 3-hourly vertical profiles over the EUCOS area at designated airport locations, with provision of higher temporal resolution profiles and provision of data in remote territories upon agreement with EUMETNET members. E-AMDAR also provides data for some countries through bilateral agreements, resulting in the provision of profiles over central, east and west Africa and for Singapore.

Eight aircraft within the Lufthansa fleet had now been equipped with WVSS-II sensor providing high resolution water vapour measurement observations over European airports. It was expected that the planned fleet of nine aircraft would be completed by early 2016. The E-AMDAR Expert Team is assisting EUMETNET with the development of a business case and plans for a possible future expanded AMDAR/WVSS-II programme with other airlines so as to optimize WVM coverage.

Development Activities

E-AMDAR continued to make improvements to the E-ADAS system which supports ground-based processing of AMDAR data.

In terms of its existing fleet, E-AMDAR expected:

- To work with Air France towards finalisation of B777 software development and roll out over late 2015 to early 2016;
- possible activation of the Finnair A340 fleet during 2016;

- integration of Eurowings aircraft into the programme;
- delay to the rollout of SAS CRJ fleet;
- rollout of British Airways A320 fleets, scheduled by end of 2015; and
- rollout of British Airways B777 fleet by early 2016.

Possible future development with new countries and airlines include Ireland (Aer Lingus), Turkey (Turkish Airlines), Portugal (SATA) and Spain (Vueling).

EUMETNET development related to Aircraft Derived Data (ADD) is covered under item 5.4.

A draft A-RIP for Region VI had been developed and the ET-ABO Lead for Region VI had corresponded with the President of RA VI regarding collaboration.

WMO has entered into a MoU with EUMETNET for collaboration on ABO in relation in particular to Region I and Region VI ABO and AMDAR development.

4 WIGOS DEVELOPMENT AND INTEGRATION OF AIRCRAFT BASED OBSERVATIONS

4.1 OSCAR Metadata Management

The meeting was informed by Mr Stewart Taylor on the development of the metadata framework for ABO under the WIGOS Metadata Standard (WMDS) and as a component of the Observing Systems Capability Analysis and Review (OSCAR) Surface-based Observing Systems Capabilities database.

Following the identification of the need for Aircraft Based Observations (ABO) Metadata initiated under the WIGOS Pilot Project on AMDAR several years ago, a metadata template was designed to meet the primary requirements for data Quality Control (QC) and asset tracking. Providing information on the aircraft and its instrumentation, software/hardware configuration, observation method/reporting frequency/resolution, this metadata template has been further developed in accordance with the WIGOS Metadata Standard (WMDS) being developed under WMO ICG-WIGOS and its Task Team on WIGOS Metadata.

The ABO metadata template would also seek to fulfill the requirements for OSCAR providing information on the capabilities of Aircraft Based Observations (ABO) observing systems.

There will be a future responsibility for ABO Programme Managers and WMO Focal Points on ABO to process and submit the metadata from their respective airlines. This would be able to be done by manual input on a small scale and/or by machine to machine interface protocols for larger metadata transactions.

As the ET-ABO Lead on metadata development, Mr Taylor was working with the ET-ABO Sub-group on Regulatory Material to develop initial guidance on the metadata framework for ABO. There would also be a requirement for ET-ABO to assist in the development of guidance on ABO metadata provision and the use of OSCAR for this purpose.

4.2 Regulatory & Guidance Material Development

Mr Frank Grooters presented document 4.2 on the development of ABO regulatory and guidance material. Following the first session of ET-ABO, the expert team had established a Sub-Group on Regulatory Material that has worked on draft guidance and regulatory material towards an update on Aircraft Based Observations within the relevant sections in the Manual on the Global Observing System (WMO No. 544) and the Guide to the GOS (WMO No. 488). Draft version 6 of the guidance material for the Guide to the GOS was submitted to the session as an information document and was to be reviewed during the session.

The Secretariat had developed a roadmap for the update of the regulatory materials culminating in their submission for review and adoption at CBS-16 in November 2016. The roadmap has the following key steps and milestones:

1. Provision to the IPET- WIFI/Subgroup on Regulatory Material of the “Zero Draft” of the proposed amendments to the Manual and Guide on the GOS by the end of January, 2016.

2. The IPET-WIFI/SG-RM would work on the Zero Draft until the end of March, 2016 and finalise the “First Draft”.

3. The Chair of the IPET-WIFI would submit the First Draft to the Implementation and Coordination Team on Integrated Observing Systems (ICT-IOS) for consideration at its next session in April 2016.

4. The Chair of IPET-WIFI and the Secretariat would prepare the First Draft for translation and internal approval within the Secretariat by May/June, 2016.

5. The First Draft would be made available to Members for review until August 2016.

6. Minor amendments taking in account comments received from Members and preparation of the final documents (Manual and Guide) for CBS-16 to be completed by end of September.

7. CBS to consider the proposed regulatory material for adoption at CBS-16 in November 2016.

The Session was informed that the draft ABO guidance material was considered by the ET-ABO subgroup to be in a mature state, with only the guidance on metadata yet to be included. However, the document still required at least one iteration of review and revision. While a draft of the updated ABO regulations for the Manual on the GOS was yet to be completed, it was expected that this would be produced by mid-January and would be based on the structure and the material in the draft guidance.

4.3 Quality Management

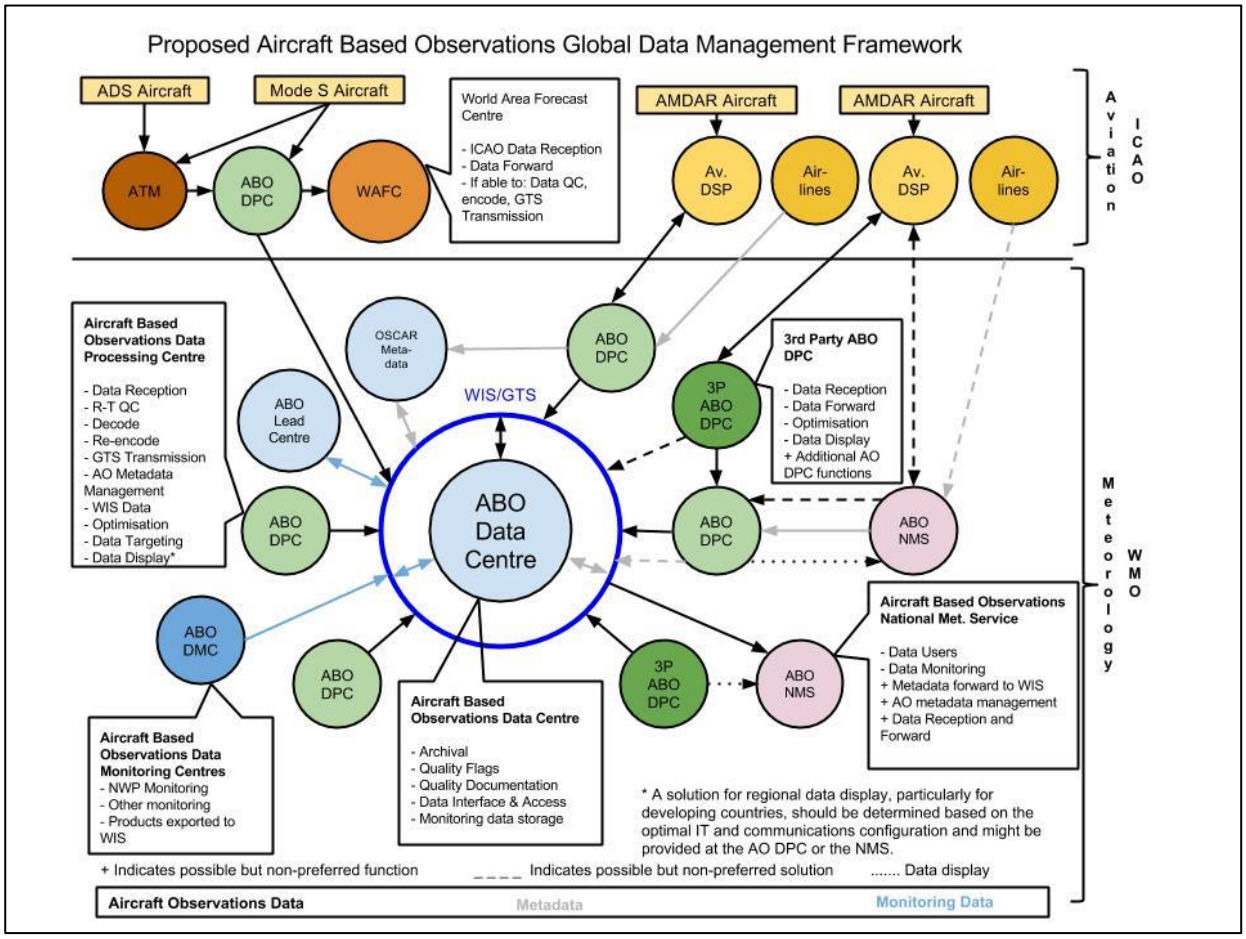
Mr Dean Lockett presented document 4.3 to the session, which provided background on the status of progress relating to development of procedures and guidance for quality control, monitoring and management of ABO.

The meeting was informed that much of this development was based on the outcomes and recommendations of the WMO AMDAR Panel Aircraft Observing System Data Management Workshop held in June 2012 in Geneva, Switzerland. Additionally, the outcomes of the work were being formulated as procedures and requirements that would be documented within the ABO regulatory and guidance material under work plan task 28 (see also agenda item 4.2).

In relation to international and global monitoring of ABO, the revision of the WMO Data Quality Monitoring System under the WIGOS Framework Implementation Plan should be taken into consideration. This WIGOS Key Activity and Congress designated priority task (Cg-17, 2015) was expected to lead to a revised framework and structure for quality monitoring of WIGOS observing systems and incorporate both more frequent and closer to real-time monitoring and also the establishment of international and regional practices associated with incident management. This approach was being adopted for ABO, for which detailed guidance and requirements for quality monitoring of ABO would be contained with Annex II of the ABO guidance material.

In relation to requirements for quality control, the draft ABO guidance material proposed to be included in the Guide to the GOS would contain a section with general guidance on quality management of ABO data with more specific and technical guidance provided in Annex I, Guidance on Quality Control of Aircraft-based Observational Data.

In relation to ABO Data Management, the proposed global data management framework as depicted in the following (updated) figure from the recent WMO/ICAO Workshop on Future Requirements for Meteorological Aircraft Observations (see agenda item 5.4), would be incorporated into the guidance material.



This Proposed ABO Global Data Management Framework depicts the following key aspects or elements:

- A possible future arrangement for the delegation by WAFCs of ABO Data Processing Centres to process ADS and Mode-S data prior to transmission on the GTS.
- The ABO Data Centre
- An ABO Lead Centre
- ABO Data Monitoring Centers
- The provision by Members, and the holding of ABO metadata within the OSCAR system.

A presentation was provided by Mr Jitze van der Meulen, demonstrating the very different behavior in timeliness of various sets of aircraft within the E-AMDAR programme. Data analyses demonstrated clearly that observations strategy and data processing causes this behavior. Significant impacts of these practices are found when requiring high performance rates for data, received within 15 minutes after observation. By stating a more realistic approach, e.g. based on the availability profiles up to 500 hPa, the 15 min timeliness requirement would be easily met.

5 AIRCRAFT BASED OBSERVATIONS TECHNICAL DEVELOPMENT

5.1 Water Vapour Measurement

Status report on WVM program in USA

Mr Steven Pritchett, United States of America, presented document 5.1(1) to the session providing a status report on recent development and current status of the USA AMDAR and ABO water vapour measurement (WVM) programme.

Over the last two years, the USA AMDAR/MDCRS programme had expanded its WVSS-II WVM programme to 135 reporting aircraft in cooperation with airlines UPS and Southwest Airlines.

Earlier results from an inter-comparison of the operational sensors with collocated radiosonde (Louisville Airport over 2005-2006) had shown that mean and standard deviations of differences of humidity pairs varied by around 5% to 10%, indicating that the sensors meet WMO uncertainty and operational performance requirements for upper air humidity measurement.

The meeting was informed that the USA expected to continue to expand the MDCRS/WVM programme over the coming years, possibly next in cooperation with airline FedEx.

Status report on WVM program in Europe

Mr Stewart Taylor, United Kingdom of Great Britain and Northern Ireland, presented document 5.1(2) to the session providing a status report on recent development and current status of the E-AMDAR WVM programme.

As part of the E-AMDAR Extended Humidity Trial (EHT) and subsequent EUMETNET Humidity Business Case (E-HBC), the E-AMDAR Programme has expanded the Water Vapour Sensor Systems (WVSS-II v3) to eight units, with a ninth and final unit expected to become operational in early 2016.

In addition to the WVSS-II units, there were also Panasonic TAMDAR sensor systems with WVM capability installed on aircraft from FlyBe and Icelandair. However the data from these aircraft were not currently available on the GTS and were being obtained by EUMETNET in Europe for research purposes only. Based on the assessment and impact results made so far, these data were shown to have similar quality to radiosonde and AMDAR WVM and, if the TAMDAR data became available, the two observing systems would together provide a complementary and valuable WVM network.

ABOP WVM Implementation Plan

Mr Axel Hoff, Germany, presented document 5.3(3), describing the work activity under the ET-AO work plan to develop an implementation plan for WVM within the AMDAR observing system.

The plan for implementation of WVM as a component of the AMDAR program is a component of the wider plan for development of the Aircraft-based Observation Programme (ABOP) and the AMDAR observing system, as outlined in the document “ABOP Strategy and Implementation Plan” (A-SIP).

The ABOP WVM Implementation Plan consists of two separate plans:

1) WVM Integration into Existing Avionics and Airframes.

2) WVM as Standard Accessory on Commercial Aircraft.

Plan 1) is concerned with the implementation of WVM within operational AMDAR fleets, while plan 2) is associated with the longer term aim to ensure that WVM becomes integrated into the future airframe manufacturing process and standard onboard systems and infrastructure. Both plans have a similar structure, consisting of sections with aims, stakeholders, scope, strategy and risks as well as a detailed list of tasks and activities to be managed.

WVM Integration into Existing Avionics and Airframes

The aim of retrofitting aircraft is to operationally validate and prove the technical and operational performance of the sensors and determine the impact and benefits. The WVM methods should be validated by inter-comparisons in laboratories and flight test campaigns. This includes comparisons with NWP as well as Observing System Experiments (OSEs) in cases where a large number of aircraft are equipped with WVM.

The plan also includes activities for validation of the technical and operational requirements of the sensors, including aspects such as size and power demand and maintenance cycles. Additionally, the WVM system has to be compatible and integrated with the AMDAR communications system, ACARS and the corresponding AMDAR on-board software (AOS) standard.

The plan relies on NMHSs and regional programs developing business cases and persuading airlines and other stakeholders to implement WVM (and AMDAR) on commercial aircraft fleets that are either currently participating in the AMDAR programme or those that will do so in the future. Entities such as ICAO and the International Air Transport Association (IATA)should be involved to support airlines for their engagement in AMDAR with WVM.

The retrofitting should be global in deployment so as to derive a global benefit and impact. Planning for retrofitting should be undertaken through an international collaborative approach to ensure maximum efficiency in terms of the attainment and widest applicability of airworthiness certificates for the sensors. Likely future developments in aviation, such as carbon fibre aircraft, will have to be incorporated.

WVM as Standard Accessory on Commercial Aircraft

The implementation plan for incorporation of WVM as Standard Accessory on Commercial Aircraft outlines a set of activities and tasks to be undertaken associated with various applications of WVM on commercial aircraft. These applications may not necessarily all be of direct interest to the NMHS but may have an impact and utility solely for aviation or aircraft operation. For example, WVM could be utilized as an input to aircraft icing warning and possibly the management of the de-icing process.

The strategy to incorporate WVM as a standard component of the aircraft infrastructure consists of three key, parallel approaches:

1. Airlines are encouraged to request airframe manufacturers that WVM be made available as an optional component of newly delivered aircraft, predominantly for weather related applications supporting more cost effective fleet operations;
2. The aircraft manufacturer incorporates the sensor into the aircraft as a standard optional accessory for weather related applications supporting more cost effective fleet operations; and,
3. The aircraft manufacturer incorporates WVM as a standard component that is integrated into aircraft operation for direct flight applications such as icing warning and de-icing control, in addition to weather related applications supporting more cost effective fleet operations.

The session agreed that:

- The two implementation plans should be incorporated into the ABOP Strategy and Implementation Plan; (Action: Secretariat to updated A-SIP.)
- ET-AO should undertake a new task to make an assessment of the utility and potential of WVM for icing prediction and management; (Action: ET-AO to update work plan accordingly.)
- ET-AO should undertake a new task specifically to investigate and undertake activities relating to interaction with airframe manufacturer (initially Boeing and Airbus) regarding standard integration of WVM on airframes. This activity might incorporate the strong encouragement of airline partners to require the addition of WVM as part of their source selection criteria for new aircraft acquisitions. (Action: ET-AO to update work plan accordingly.)

5.2 Turbulence Monitoring

Status of Turbulence Monitoring & Prediction in USA

Mr Steven Pritchett presented document 5.2(1) regarding the recent activities in the USA in the development and operational trial of turbulence monitoring and prediction.

The session was informed that there were currently three ABO programme contributing to the reporting of Eddy Dissipation Rate (EDR) in the USA:

1. The National Center for Atmospheric Research (NCAR) in collaboration with the USA Federal Aviation Administration (FAA) was coordinating an operational trial with four airlines and around 300 aircraft. This program generated around 18,000 observations of EDR per day and efforts were underway to expand the program globally incorporating airlines in China, Australia and Europe. FAA was collaborating with NCAR to develop an EDR Technical Transfer (EDR TT) package that would allow airlines to more readily implement stardardised EDR reporting. The EDR TT comprises both onboard data processing software and ground-based software to provide tuning and verification. Testing was being undertaken in collaboration with Delta Airlines and Boeing.

2. The TAMDAR system by Panasonic Avionics Corporation (PAC) also reported EDR from around 250 aircraft, with the fleet expected to increase in size by around 150 aircraft over the medium term, providing additional coverage over Central and South America, Asia and Europe.

3. WSI (recently merged with the Weather Company) also obtains EDR reports from a fleet of around 450 aircraft from multiple airlines operating over the USA.

Data from only the first programme above were being made available to NOAA.

The session was informed that while the 3 programmes were currently each using different algorithms for the reporting of EDR, the FAA was currently undertaking an activity to standardize EDR reporting in the USA through the activities of the Radio Technical Commission for Aeronautics (RTCA) Special Committee 206 (SC-206). This committee was expected to finalise its work by December 2017.

ABOP Turbulence Implementation Plans

Mr Greg Meymaris, United States of America, presented document 5.2(2) to the session, outlining the progress and status made on the ET-AO task to develop an implementation plan for EDR monitoring as a component of the AMDAR observing system.

The session was informed that, both in the USA and globally, unexpected turbulence encounters were a leading source of injuries sustained in aviation operations. Because turbulence was often invisible to pilots and remote sensing devices (e.g. radar), in situ aircraft observations were a critical piece of the turbulence mitigation puzzle. Reliable turbulence observations were essential for the development, operation, and verification of any turbulence nowcast and forecast product, or could be used like a pilot report (PIREP/AIREP) for situational awareness for tactical turbulence avoidance. While useful, there were significant problems with pilot generated turbulence reports. Under the sponsorship of the U.S. Federal Aviation Administration (FAA), the National Center for Atmospheric Research had developed an in situ turbulence reporting algorithm, which reported eddy dissipation rate (EDR), the ICAO standard metric for atmospheric turbulence. Under FAA sponsorship, NCAR was developing a software and documentation package to support implementers (e.g. avionics manufacturers, airlines, etc.) to integrate the NCAR in situ turbulence software into operations.

One of the goals of ET-AO was to pursue more widespread adoption of the reporting of atmospheric turbulence intensity, specifically EDR, within the AMDAR program, for which an initial task was to develop an implementation plan for EDR reporting (included as Annex I of document 5.2(2). This draft plan documents the aims, stakeholders, scope, strategy, and key tasks, as well as discussing risks. The key aspects of the implementation plan include:

- A pilot program is proposed to implement EDR reporting on a European airline to encourage adoption outside of the U.S.

- As part of the larger effort to pursue avionics vendors to develop an AMDAR package, avionics vendors would be approached to also include EDR reporting as an optional application.
- Strategies and materials would be developed for promotion and outreach for EDR reporting.

The following points were discussed in relation to the implementation plan:

- While EDR had been identified as the standard turbulence metric by ICAO and the preferred metric within the WMO AMDAR Onboard Software Functional Requirements Specification (AOSFRS), the reporting of Derived Equivalent Vertical Gust (DEVG) remained an option and there was currently no intention or directive to abandon reporting of DEVG within the AMDAR Programme. It was noted that Qantas (Australia) does not plan to replace the existing DEVG reporting with EDR but expects to report both metric in parallel for the foreseeable future. However, it was also noted that the aviation industry as a whole appeared to be moving towards the adoption of EDR as either the standard or preferred metric for turbulence applications.
- The meeting agreed that possible candidate airlines for turbulence monitoring pilot projects included Air France, Qantas, Lufthansa and British Airways.
- E-AMDAR was in the process of requesting participating AMDAR airlines to consider the implementation of EDR reporting.
- ET-AO should compile an inventory of aircraft models and avionics for which EDR applications existed. (Action: ET-AO to update work plan accordingly.)
- ET-AO should incorporate the development of EDR applications solutions as a component of the task to approach avionics vendors regarding AOS application development. (Action: ET-AO to update work plan accordingly.)

5.3 Data Representation & Codes

Transition to TDCF and the AMDAR BUFR Template

Mr Dean Lockett presented document 5.3(1) to the session, outlining the current status of the transition to Table-Driven Code Forms (TDCF) and the use of the AMDAR BUFR Template.

The meeting was informed that, at its extraordinary session in Asuncion, Paraguay in September 2014, the Commission for Basic Systems (CBS) had noted that the 2010 extraordinary session of CBS had confirmed the timetable for migration to Table-Driven Code Forms (TDCF) by November 2014 and that the plan included an end to parallel exchange of information in both Traditional Alphanumeric Codes (TAC) and TDCF, permitting only TDCF to be distributed from then on. A letter was recently sent (September 2015) to all Permanent Representatives to WMO that advised of and included a Status Report on Migration to Table-Driven Code Forms by the Inter-Programme Expert Team on Data Representation Maintenance and Monitoring (IPET-DRMM). Among other recommendations, the status report urged Members to cease parallel dissemination of TAC as soon as possible but only after having provided advance warning and ascertained that the TDCF provided equivalent of better quality data.

It was noted that, according to the Migration Matrix for Migration to Table-Driven Code Forms (MTDCF) as approved by CBS (2010) and provided in the Introduction to the letter, the MTDCF for AMDAR should have been completed by the start of November 2006. It is clear that this had not yet occurred fully and several programmes were still transmitting data in TAC format, FM 42.

It was also noted that, at the current time, only the E-AMDAR programme had migrated to using the AMDAR BUFR Template, 3 11 010. This template, which was developed under the WMO WIGOS Pilot Project for AMDAR and approved in May 2012, was intended to support the provision

of all aircraft-based observational level data and, in principle, should be the only format necessary to be utilised for transmission of ABO data on the GTS, including AMDAR, ADS-C and AIREPs.

The session was informed that, in accordance with the recommendations made in the IPET-DRMM status report, all ABO programmes should endeavour to transition to sole use of the AMDAR BUFR Template for transmission of AMDAR data on the GTS as soon as possible. In relation to this, the Secretariat should write to programme managers requesting details of their transition plan for MTDCF for AMDAR and use of the AMDAR BUFR Template, 3 11 010. (Action: Secretariat to write to AMDAR programme managers and document MTDCF plans.)

Requirements for Reporting of ADS Data

Mr Jitze van der Meulen, the Netherlands, presented document 5.3(2) to the session regarding the reporting of data derived from ICAO aircraft observations on the GTS.

At present about 2.5% of all ABO reports were routine aircraft reports, identified as AIREPs, generated automatically by applying Automatic Dependent Surveillance – Contract (ADS-C). Although in the past only manually generated aircraft reports (ARP) or special aircraft reports (ARS) were disseminated, currently an increase in automated AIREPs had been observed. All such aircraft reports should be derived following the practices as stated in WMO-No. 49 (Technical Regulations), Vol. II - which is identical to ICAO Annex 3.

However, while clearly stated in ICAO Doc. 8896 that only WAFCs should be responsible for collection and provision of ARP and ARS for dissemination over the WMO GTS, many Meteorological Watch Offices (MWO) are not complying with this directive and are disseminating these data on the GTS themselves. Moreover WAFCs may recompile the reports from the MWOs, so that reporting is duplicated. Also identical observations were being reported using both AMDAR and AIREP. It had also been found that, very often, these bulletins are not consistent and do not follow prescribed formatting principles, recommended by WMO or ICAO. Such inconsistent formatting leads to rejection of reports.

Because AIREPs are encoded in the obsolete Traditional Alphanumerical Code (TAC) format, whereas AMDAR is in BUFR, a transition from TAC to BUFR is strongly recommended. The present common sequence template for AMDAR single level reports (3 11 010) would be the best solution and it was confirmed that this template contains all required descriptors necessary for such a conversion. Additionally encoding software was already available or could be made available to Members.

A critical quality management issue for aircraft reports was the frequent lack of a unique aircraft identity, with reports most often containing only a flight identity.

The session agreed that:

- ET-ABO should undertake a task to plan and oversee the implementation of the use of BUFR for dissemination of ADS-C and AIREP data on the GTS, including the requirements for the provision of a unique aircraft identity. (Action ET-ABO to update work plan accordingly.)
- ET-AO should undertake a task to make assessment of whether there was a requirement for reporting of True Heading within the AMDAR BUFR Template. (Action: ET-AO to update work plan accordingly.)
- ET-ABO should consider and take action on any requirement for the development of a scheme for unique aircraft identification in OSCAR. (Action: ET-ABO to update work plan accordingly.)

5.4 Aircraft Derived Data

Developments in Aircraft Derived Data

Mr Siebren de Haan, the Netherlands, presented document 5.4(1) to the session regarding recent developments in the derivation of meteorological data from Automatic Dependent Surveillance – Broadcast (ADS-B) and Mode-S data sources.

Mr de Haan outlined the key elements of the recently published (October 2015) *Final report of the EUMETNET ADD FS ET on the feasibility to initiate a new EUMETNET activity for aircraft derived observations under the EUMETNET observation program*. The following summarises the important points and discussion by the session:

- While the study had investigated a range of surveillance message types that offered potential for the derivation of meteorological data, the table below summarises the outcome of the research and deliberation by the EUMETNET Expert Team.

Type	Sub-type	Direct meteorological information	Derived meteorological information	Remarks
Automatic Dependent Surveillance (ADS)	ADS-B	✗	✓	Only wind, small number and poor quality
	ADS-B ES	✗	✓	Small number, poor quality
	ADS-C	✓	✓	Only small portion of messages, good quality, data only via ATC or airlines and can have a data communication cost
Secondary Surveillance Radar (SSR) Mode-S	Mode-S EHS	✗	✓	Specific dynamic aircraft corrections and quality control required, good quality wind, lower quality of temperature
	Mode-S MRAR	✓	✗	Small number, good quality

ADS-B	Automatic Dependent Surveillance – Broadcast
ADS-B ES	ADS-B Extended Squitter
ADS-C	Automatic Dependent Surveillance – Contract
Mode-S EHS	Mode-S Enhanced Surveillance
Mode-S MRAR	Mode-S Meteorological Routine Air Report

- While ADS–B is of little use for meteorological purposes since meteorological information is not directly available, the ADS-B Extended Squitter contains significantly more information than ADS-B and has the potential to be expanded to include directly reported meteorological parameters.
- For ADS-C, the information transmitted from the aircraft to the ground systems contains at least its position, but not always data relevant for meteorology. A KNMI study showed that around 25% of ADS-C data received from KLM contained meteorological information. The quality of the wind direction, wind speed and temperature data, is good and is similar to the quality of AMDAR observations.
- Based upon the experience and studies undertaken by both the Netherlands and the MetOffice, meteorological data derived from Mode-S EHS information, including quality control and individual aircraft corrections has the following characteristics:

  - Provides very high frequency reporting over surveillance areas;
  - The quality of the derived wind direction and wind speed is good and is similar to the quality of AMDAR observations.
  - The quality of the derived temperature is significantly inferior to that of AMDAR.
- The quality of Mode-S MRAR wind and temperature is comparable to the quality of AMDAR for those aircraft that are suitable for AMDAR participation. However, it is important to note that only a small fraction of aircraft currently have the required reporting capability within Europe.

The session agreed with the following recommendations:

- WMO and ET-ABO should approach ICAO regarding the possibility to extend the ADS-B ES message to include directly reported meteorological data. (Action: ET-ABO to update work plan accordingly.)
- WMO and ET-ABO should take action to ensure that all Members endevaour to collaborate with their national civil aviation authorities to ensure all sources of ADS-C and Mode-S EHS/MRAR meteorological data are made available to WAFCs and subsequently provided on the GTS. (Action: ET-ABO to update work plan accordingly.)
- ET-AO should investigate any additional metadata requirements to support heading derivation for ADD. (Action: ET-AO to update work plan accordingly.)

WMO/ICAO Workshop on Future Requirements for Aircraft Observations

Mr Dean Lockett presented document 5.4(2), providing the session with a report on the outcomes of the WMO/ICAO Workshop on Future Requirements for Aircraft Observations that was held at the WMO Secretariat, Geneva, Switzerland over 28-29 October 2015.

The workshop, which was coordinated by the Secretariat as an activity of ET-ABO, had the following purposes:

1. Present the current status of meteorological aircraft observations, including both the WMO Aircraft Meteorological DAta Relay (AMDAR) program and ICAO aircraft observations;
2. Present and discuss the potential for and benefits of wider and improved future access to ICAO aircraft observations by World Area Forecast Centers (WAFCs) and WMO Members; and
3. Initiate high level discussion with ICAO and other stakeholders towards a more coordinated approach to the derivation of meteorological data from ICAO aircraft observations in support of improved weather services.

The participants included several representatives of the ABOP, a representative of ICAO, Mr Neil Halsey, and representatives of the Washington and London ICAO World Area Forecast Centres.

The following were the important outcomes/actions from the workshop:

- It was agreed that Mr Strahan, WAFC Washington, and Mr Tyson, WAFC London, would review the current AeM SoG in order to assess the document's relevance to WAFC operations and, in collaboration with ICAO, report back to ET-ABO.
- Mr Strahan and Mr Tyson agreed to review the needs of WAFCs for Aircraft Observations, in consultation with WAFC colleagues and report back to WMO ET-ABO accordingly.

- Mr Halsey agreed to investigate possible ICAO forums and means for addressing the issue of lack of compliance with existing ICAO Annex 3 in relation to provision of aircraft observations and report back to ET-ABO on any progress made. It was agreed that ET-ABO should consult with IATA contacts regarding possible collaboration with IATA and their Members on this issue.

- ET-ABO would investigate further the possibility to put in place and regulate a WMO data processing centre to be associated with each WAFC and to provide QC functionality for meteorological data derived from ICAO Aircraft Observations as provided by the WAFCs.

- Mr Strahan and Mr Tyson would investigate whether there might be a benefit for WAFCs to receive quality controlled meteorological data derived from ICAO Aircraft Observations.

- The workshop participants agreed that a remote conference meeting of workshop participants should be held around March 2016, arranged by the WMO Secretariat, so as to discuss progress on the above agreed actions from the workshop.

- The workshop participants unanimously agreed that the workshop had been very beneficial, both to the participants and to the organizations represented and that such a face to face meeting or workshop should be considered again in the future to discuss progress and issues related to ABO.

The session agreed that:

1. ET-ABO should investigate further the possibility to put in place and regulate a WMO data processing centre to be associated with each WAFC and responsible for quality control of aircraft observations prior to dissemination on the GTS. (Action: ET-ABO to update work plan accordingly.)
2. ET-ABO should develop plans to ensure WMO Members comply with ICAO requirements for provision of ICAO aircraft observations on the GTS. (Action: ET-ABO to update work plan accordingly.)
3. ET-ABO should continue to monitor progress on the various outcomes and agreed actions from the workshop and provide assistance and input where required. (Action: ET-ABO to update work plan accordingly.)
4. The Secretariat and ET-ABO should arrange a follow up meeting in March 2016. (Action: ET-ABO to update work plan accordingly.)
5. ET-ABO should collaobrate with IATA regarding support for WMO ABO activities, possibly through the Flight Operations Support Task Force (FOSTF) IATA forum. (Action: ET-ABO to update work plan accordingly.)

5.5 Other Technical Issues & Developments

Study on Future Technologies Impacting on AMDAR

Mr Stewart Taylor presented document 5.5(1) to the session providing a report on the ET-AO work to commission a study on The Future Communications and Technologies Impact on AMDAR. The study provides an insight on current and future developments that may have an impact on Aircraft Based Observations (ABO) by advances in areas of communication and technology within the aviation industries. The Study document contains a general overview, informs the reader about Aircraft Communications and Avionics Systems evolutions with regards to all current ABO platforms. The Study includes a summary of current ABO and possible alternatives for data transmission (e.g. cabin systems and broadband) are included in the document

recommendations. The study is expected to be published as a CIMO IOM technical report in the first quarter of 2016.

ABO Data Center

Mr Frank Grooters presented document 5.5(2) to the session outlining the progress that had been made in the ET-ABO activity to establish an international data centre for aircraft based observations (ABO-DC).

The meeting was informed that a high level functional specification for an ABO-DC was developed and sent to four international data centres and organisations with a request to respond through an Expression of Interest (EoI) by October 2013. Subsequently, through contact with the National Climatic Data Center – NOAA (NCDC) the NOAA Meteorological Assimilated Data Ingest System (MADIS) was identified as a strong candidate for this role. When assessed against a detailed specification of requirements for the ABO-DC developed by ET-ABO, it was clear that the MADIS system was readily able to comply with a majority of the requirements with little or no development required. Following discussion and clarification in a (WebEx) meeting in March 2015 with NOAA representatives (including Mr Steven Pritchett), it was clear that MADIS could meet the majority of the requirements and those requirements that were not currently able to be met were either not mandatory or could be met with a small amount of development. Mr Pritchett informed the ET-ABO management group and reiterated to the session that NOAA was very amenable to the proposition to take on this role using the MADIS system as a platform for the WMO ABO-DC.

Mr Steven Pritchett made a presentation to the joint meeting regarding the operational functions of MADIS and its capabilities and it was agreed that ET-ABO should work with NOAA towards formalization of the role of MADIS as the ABO-DC.

The session discussed the next steps to complete the process. It was agreed that a formal offer might be made by NOAA to WMO via a letter to the WMO Secretary General, with a decision by CBS based on a recommendation made by ICT-IOS to formally complete the designation. The following steps were agreed:

1. Upon establishment of the AMDAR display system within MADIS Mr Pritchett would seek final agreement and confirmation within NOAA to undertake to fulfil the role of WMO Aircraft Based Obesrvations Data Centre. (Action: S. Pritchett, Feb. 2016)

2. If NOAA agrees, Mr Pritchett would facilitate the compilation of a letter from NOAA to WMO formally offering to taken on the role of provision and maintenance of the WMO ABO-DC. (Action: S. Pritchett, Mar. 2016)

3. ET-ABO would draft a recommendation (containing the terms of reference for operation of the centre) to CBS through ICT-IOS that NOAA should be delegated to establish and maintain the WMO ABO-DC. (Action: Chair/ET-ABO, Apr. 2016).

4. Upon designation of the role by CBS (Nov 2016), the Secretariat and ET-ABO should establish an agreement between WMO and NOAA for operation of the ABO-DC. (Action: Secretariat, ET-ABO, 2nd quarter 2017.)

Benefits & Impacts of AMDAR Data

Mr Dean Lockett presented document 5.5(3) to the session, providing an outline of the ET-ABO work that had been undertaken on various documents and reports relating to the benefits and impacts of ABO and AMDAR data.

Under the ET-ABO Work Plan Tasks 18, Papers on Impact of AMDAR Data and 19, AMDAR Impacts and Benefits Documentation, both involve activities on the impacts and benefits of Aircraft-Based Observations (ABO). Progress with these two work plan tasks were described along with an activity coordinated by the Secretariat for the development of a series of business

case materials for the AMDAR programme that were developed under consultancy with the Dalberg company.

The joint meeting was informed that, in accordance with the ET-ABO work plan, the commissioning of two scientific papers that summarise and document the impacts of AMDAR and AMDAR water vapour measurement (WVM) on meteorological applications had been completed. This work had resulted in the provision to WMO of the drafts of two papers by consultant Dr Ralph Petersen of the University of Wisconsin, which had been submitted to the Bulletin of the American Meteorological Society (BAMS) for publication in October 2014:

- Paper 1: On the current impact and future benefits of AMDAR observations in operational forecasting - Part 1: A review of the impact of automated aircraft wind and temperature reports

- Paper 2: On the current impact and future benefits of AMDAR observations in operational forecasting - Part 2: Water Vapour Observations

While Paper 1 has been fully revised and accepted for publication, the review process for Paper 2 was still underway and the two papers were expected to be published together in BAMS in 2016.

In July 2015 and, given the delay in the BAMS publication process, Dr Petersen consolidated the two papers into a single document: *A Report to the World Meteorological Organization on the Impact and Benefits of AMDAR Temperature, Wind and Moisture Observations in Operational Weather Forecasting, Ralph Alvin Petersen, Lee Cronce, Richard Mamrosh and Randy Baker*, that was published in the University of Wisconsin-Madison, Space Science and Engineering Center library. Under agreement with the University of Wisconsin, WMO has also published the document as WIGOS Technical Report 2015-1 - available from the WMO Library.

The meeting was further informed that, also under the ET-ABO work plan, considerable progress had been made in the development of documentation of AMDAR benefits and impact by ET-ABO. In particular, *WIGOS Technical Report 2014-1, The Benefits of AMDAR to Meteorology and Aviation* was published in January 2014 and is available from the WMO library. This report has been printed by WMO and made available to participants at WMO AMDAR workshops and at various other AMDAR and aviation related events, including the AMDAR Side Event at WMO Congress, June, 2015. Additionally, and with the assistance of the WMO AMDAR Development Officer, Mr Stig Carlberg, work was completed on the WMO published flyer, *The WMO AMDAR Observing System - Benefits to Airlines and Aviation* in August, 2014, which can also be obtained from the WMO library and the WMO AMDAR resources website. The flyer is a foldout of 4 pages that briefly explains the benefits of the AMDAR observing system to airlines and, more generally, to the aviation industry. The brochure may be printed and distributed by Members and others in the interests of AMDAR programme development and promotion. Mr Carlberg had also made a draft of two additional flyers that might in the future be further refined and published.

AMDAR Business Case Material Development

The ABOP management group and the Secretariat had held discussion over 2014 regarding the possibility of developing a "project framework" for the actions of the CBS EGOS-IP related to expansion of aircraft-based observations and AMDAR. In consultation with the Development and Regional Activities Branch, the Secretariat investigated the possibility of seeking consultancy to undertake and support such a project development. This led to the production of a specification of work and, through the WMO procurement process, a request for proposals and quotations for consultancy associated with a Statement of Work for developing the “AMDAR Marketing Strategy”.

The chief outcomes/deliverables from this work were to be:

1. A Roadmap and Funding Proposal - describing and supporting the AMDAR program expansion project.

2. A business case and suite of business case materials tailored for the range of AMDAR stakeholders.

3. A communications strategy for effectively pitching the expansion project to stakeholders (WMO members and aviation).

The work was tendered by WMO in April 2014 and three proposals and quotations were received and were assessed by the DRA and OBS departments. In September 2014, the Dalberg company was awarded the contract at a cost of 49,050 CHF. Over September 2014 to April 2015, SO/ARO and members of ET-ABO collaborated with Dalberg on the development and revision of the above deliverables. The Roadmap and Funding Proposal Communications Strategy were provided as Information Documents to the joint meeting document plan and the Business Case Templates are available at the WMO AMDAR Resources website.

AMDAR Onboard Software Development

Mr Axel Hoff presented document 5.5(4), providing a brief overview of the general guidance being developed by the ET-ABO Sub-Group on Regulatory Material on the requirements and process to develop and implement AMDAR onboard software (AOS) on commercial aircraft fleets The draft guidance has been integrated into the new draft material for the Guide to the GOS on Aircraft Meteorological Stations. The guidance material consists of an overview of the various aircraft and avionics (aviation electronics) platforms and AMDAR applications solutions and a simple road map for the process of AMDAR onboard software development and implementation. The document also contains an appendix listing the AOS versions and platforms being used in the WMO AMDAR programme.

Application of UAVs for Meteorological Observations

Mr Stewart Taylor presented document 5.5(5), outlining the investigations into the possibility of using UAVs for reporting of meteorological parameters as part of the ET-AO Work Plan. Mr Taylor had attended the Commercial UAV Show in London in October 2014 and was subsequently invited to present on AMDAR at the 2015 event, however, a change to WMO Meeting dates had prevented his attendance.

There are several NMHS and research organisations currently employing UAVs in their programmes e.g. boundary layer research and storm genesis. Most data from UAVs is gathered in research mode, meaning that it is usually analysed post-flight whereas the current ABO data is disseminated in “near-real time”.

ET-AO expected to continue this work with the aim of monitoring progress and determining if the use of UAV systems for obtaining ABO might in the future move or be moved into the operational domain.

TAMDAR Developments

Mr Neil Jacobs, USA, Panasonic Avionic Corporation (PAC), made a presentation to the session on the current status and recent developments of the PAC TAMDAR system and the benefits of this upper air meteorological monitoring network for aviation and meteorological applications.

The meeting was informed that PAC had recently been contracted by NOAA to provide TAMDAR data within the boundary layer over the USA region as part of funding available to support nowcasting activities in the US. These data would become available in the near future but would be available publicly only after 48 hours subsequent to real-time generation.

Of considerable interest to the meeting was that PAC had entered into contracts with several airlines to provide customer in-flight internet services over the Iridium satellite communications system. This allows PAC access to the in-flight entertainment systems of these airlines and also the stream of meteorological data that supports the passenger flight information application. Mr Jacobs expected that, under appropriate agreements between PAC, participating airlines and WMO Members, it would be potentially possible to stream these data through the PAC operational center and make them available for meteorological purposes at relatively low cost. It

was agreed that ET-ABO should explore this possibility further in collaboration with PAC. (Action: ET-AO to update work plan accordingly and commence a dialogue with PAC.)

Additionally PAC satellite communications also offered the possibility for the download of aircraft radar, camera and GPS radio occultation data at high resolution and frequency for small cost.

6 OUTREACH ACTIVITIES

6.1 WMO Website & Newsletters

Mr Dean Lockett provided the meeting with a brief overview of the status and future likely changes to and developments of the WMO AMDAR website.

In early 2013, the Secretariat (SO/ARO) completed a major revision of the WMO ABO and AMDAR websites to reflect the new programmatic structure subsequent to the AMDAR Panel cessation and to include a range of new materials and information. The site was also re-structured to better reflect the concept of the AMDAR observing system as a sub-system of the GOS and as a subset of the wider possible range of aircraft-based observing systems. The information available on the AMDAR observing system itself and on data and data quality was expanded and enhanced.

In addition to the public website, the Secretariat has developed and maintained the Aircraft Based Observations & AMDAR Projects and Collaboration, Google Group wiki that hosts a range of other information more specific to the work plan of the WMO technical commission expert teams and focal points.

The meeting was informed that, over the past year, WMO has been working towards a major upgrade and update of its internet services and presence. In the final quarter of 2015 or early in 2016 WMO expected to release its new public website. In addition to the new public layer for the WMO website, WMO will also develop a new Extranet which will be focused on the provision of information to, and interaction with, WMO Members and NMHS. It was expected that much of the material on the WMO ABO/AMDAR websites and the wiki would be migrated to the Extranet, with only a minimal informational and promotional layer maintained in the public layer of the WMO website. It is not clear yet whether the Aircraft Observations & AMDAR News and Events website would require migration to the new WMO website.

The expert team members agreed that the Secretariat should ensure that the ABOP and AMDAR observing system were well promoted on the new WMO public website and that the current ABO website and the Google Sites wiki were migrated to the new WMO Extranet as appropriate.

Mr Carl Weiss, USA, AMDAR Newsletter Editor, provided a report to the meeting on the WMO AMDAR Observing System Newsletter which, since its premier publication in February 2012, has become an important source of aircraft observation-related news and information. With the October 2015 edition, a significant milestone has been reached - the newsletter's tenth volume.

A wide variety of topics have been featured throughout the history of the publication. These including, regular updates of the global AMDAR system, status of established programs, e.g., Australia, China, United States and E-AMDAR, developments in newer programs, e.g., Mexico, Latin America and Hong Kong China, and advancements in technical matters, e.g., turbulence detection, data reporting formats and onboard software. An important area also chronicled has been the development and expansion of water vapour measurement.

The data's impact on both weather forecasting and the aviation industry has also been a major component of the newsletter's content. Articles have demonstrated the importance of AMDAR observations to both NWP and the issuance of weather watches, warnings and daily forecasts. Recent findings of tangible benefits to the airlines from AMDAR data have been summarized in newsletter articles.

Since statistics on AMDAR website usage began in August 2012, the newsletter has been viewed on approximately 5000 occasions by more than 3000 readers. Direct linking to the WMO

AMDAR page has been the main vehicle for viewing with nearly one-third of the users gaining access in this manner.

Future plans include having a larger newsletter presence on social media, perhaps creating a newsletter Facebook page.

The meeting agreed that ABOP would continue to publish the WMO AMDAR Observing System Newsletter on a twice-yearly basis.

COMET AMDAR Learning Module

A collaborative effort between the World Meteorological Organization (WMO), the U.S. National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) and The COMET Program had produced an informational module entitled "Introduction to Aircraft Meteorological Data Relay (AMDAR)." The primary aims of the module are to outline the business case for the various partners' participation in the AMDAR program and to explain the benefits and positive impact of AMDAR data to the meteorological and aviation communities.

Since its release in January of this year, the AMDAR module has had more than 1000 viewing sessions and has given the meteorological and aviation communities an unprecedented opportunity to learn about the WMO aircraft-based observations program (ABOP). The module has enjoyed a wide viewing audience from the education and private sectors as well as international and U.S. government agencies.

The AMDAR module is available from the WMO AMDAR website and on COMET's MetEd web page.

6.2 Membership and Interaction with Aviation Forums

Mr Stewart Taylor presented document 6.2 to the meeting, describing the activities of both ET-ABO and ET-AO in interacting with the aviation community and its various forums that related to or impact upon operation of the AMDAR programme.

The AMDAR Panel and the successor WMO ABO programme has interacted with and developed a working and collaborative relationship with several aviation industry forums that have been critical in the endevaours to promote and integrate ABO within the aviation industry. In particular over the past few years, the ABOP has ensured representation and collaboration with the Airlines Electronic Engineering Committee (AEEC) through several key working groups and committees:

- Data Link Users Forum (DLUF) – Co-chaired by British Airways and Southwest Airlines. The DLUF meets twice a year – in Europe and the USA. DLUF met in Feb 2015 in Panama City and again in Sep 2015 in Toulouse. The next meeting will be Feb 2-3 2016 in Florida.
- Data Link Systems Sub-Committee – chaired by American Airlines. This sub-committee maintains and approves the ARINC 620 data links specifications which contains the Meteorolgoical Report supporting AMDAR onboard software development by avionics developers.
- ABOP has been invited to the AEEC Aeronautical Operational Control Sub-committee (AOC).
- ABOP was invited to, and was represented at the AEEC/AMC General Session April 2015, Prague.

The ABOP also had attended meetings and symposiums organised by aviation data service providers, Rockwell Collins (formerly ARINC) and SITA. ABOP is also represented at the USA Friends and Partners in Aviation Weather (FPAW). This is an informal group of aviation weather related participants led by National Centre for Atmospheric research (NCAR)

The meeting agreed that:

- ET-AO should undertake an assessment of aviation forums and determine which should have representation by ABOP and should include consideration of at least AEEC, RTCA and SESAR forums. (Action: ET-AO to update its work plan accordingly.)
- ET-ABO should seek to ensure ABOP representation at the following forums: the appropriate AMS forums/events, the ICAO Meteorology Panel and the IATA Flight Operations Support Task Force (FOSTF) forum. (Action: ET-ABO to update its work plan accordingly.)

The meeting was also informed that an Avionics Vendors conference would be held in conjunction with the AEEC DLUF to be held in Europe in 2016 and that this event might provide an opportunity to hold a 1-day seminar on AMDAR and AO, sponsored by WMO in collaboration with AEEC and inviting all DLUF attendees and avionics vendors in particular to participate. The expert team members agreed that this activity should be added to the ET-AO work plan with a budget of 10K CHF and that Mr Pritchett would be asked to promote and make this request at the next DLUF meeting to be held in February 2016 in Florida. (Action: ET-AO to update work plan accordingly; S. Pritchett to be supported to attend DLUF, Florida 2016; S. Pritchett to discuss and promote this activity at DLUF, Florida 2016.)

6.3 Other Activities

AMDAR Benefits to Aviation

Mr Frank Grooters presented document 6.3(1) to the session, providing a report on the ET-ABO task to produce a technical document on the benefits of ABO and AMDAR to the aviation industry.

In mid-2013 ET-ABO drafted a Description of Work (DoW) for a “Study and Document on the Benefits of AMDAR to the Airline Industry.” The DoW was circulated to a limited number of potential candidates with established contacts in the airline industry. After assessing the responses, a contract for the study was awarded to Mr. Frédéric Falise, a Swiss independent consultant, who has a background in the aviation industry from his earlier work with SITA. Mr Falise started the study in early 2014 and the results of his work form the basis for the report *AMDAR Benefits to the Air Transport Industry*, have been submitted and the contract completed in October 2015.

The study focuses on the benefits of AMDAR to the four main sectors in the air transport industry: commercial airlines, airline operators, air traffic management and control and aircraft and engine manufacturers. While the report relies predominantly on the derived benefits to the aviation industry that follow from improvements to weather forecasting capability and for which most benefits are described in subjective terms, the work did undertake an analysis of the benefits of improved wind forecast accuracy to aircraft flight operations and for which a quantified benefit to airlines is derived through fuel cost savings.

The study is expected to be finalized and published as a WIGOS technical report in early 2016.

Regional Workshops on AMDAR

Mr Franks Grooters presented document 6.3(2), providing a report to the session on the two regional workshops on AMDAR that were conducted by ET-ABO and the Secretariat in 2015.

The first Regional Workshop on AMDAR was held in collaboration with the Kenya Meteorological Department (KMD) over 25-26 June 2015 in Nairobi. Over the 2 days, 45 persons were registered as participants in the workshop. The 2-day program included the presentation of a range of technical details and aspects on the AMDAR program, focusing on the operational requirements of both national meteorological and hydrological services and airlines for participation in the program and various related topics which included: data processing, quality control and monitoring, data access and applications and other aircraft-based observing systems. The workshop concluded with a series of discussion sessions between several meteorological agencies

and their respective national airline representatives, to talk about possible next steps in advancing the development of AMDAR programs in their countries. The final report of the workshop was available from the WMO AMDAR website.

A second Regional Workshop on AMDAR was held at Casablanca over 3-4 December 2015, at the Palace d'Anfa Hotel, Casablanca prior to the joint meeting. This event brought together WMO Member experts and airline representatives of the northern Africa region to learn about the AMDAR programme and the requirements and responsibilities for national development and participation in it. Mr Grooters and several other members of ET-ABO and participants at the joint meeting attended and presented at the workshop and agreed that the workshop had been very successful with great potential for at least one new airline to join the AMDAR programme. Discussions were held with Royal Air Maroc during the workshop and also during the joint meeting and there was great interest shown by the airline in further collaboration with DMN Morocco, ET-ABO and E-AMDAR. The final report of the workshop will be available on the WMO AMDAR website.

A Regional Workshop on AMDAR was planned to be held in support to the Middle East region (probably in Qatar), but was postponed until 2016.

The joint meeting agreed that, over the coming 3 to 5 years, the ABOP should endeavour to hold two regional workshops on AMDAR annually, particularly focusing on data sparse regions and host countries that had firm prospects for AMDAR programme development.

It was also agreed that ET-ABO should seek to collaborate with the WMO Education and Training division to determine if AMDAR workshop activities might be better coordinated in consultation with the division.

7 FUTURE ACTIVITIES AND PLANNING

Over the 4th and part of the 5th day of the meeting the participants worked in two parallel breakout groups to review and revise the various strategy and planning documents that the ABOP maintained.

Group 1 undertook a revision and review of the two implementation plans for water vapour measurement and the implementation plan for turbulence (agenda items 5.1 and 5.2), while Group 2 reviewed the draft guidance material developed by the ET-ABO SG-RM and the ABOP Strategy and Implementation Plan (A-SIP).

Review of WVM Implementation Plans

Breakout Group 1 reviewed the latest versions of the WVM Implementation Plan documents that have been developed under the work plan of ET-AO. The Group provided input which resulted in updates to the plan tasks and details of the discussion and decisions are given in Annex V.

Review of Turbulence Implementation Plan

Breakout Group 1 reviewed the latest version of the Turbulence (EDR) Implementation Plan that had been developed under the work plan of ET-AO. The Group provided input which provided resulted in updates to the plan tasks and details of the discussion and decisions are given in Annex V.

During the breakout sessions, there was an opportunity to meet with Royal Air Maroc (RAM) and DNM representatives to discuss implementation of AMDAR on the RAM fleets. The discussions were positive and actions were placed on E-AMDAR and RAM to progress the development. It was agreed that a webex discussion should be arranged early in 2016 – software implementation, data processing and possible optimization – to advance this development in RA I.

Revision of Draft Regulatory Material

Breakout Group 2 reviewed the draft regulatory material developed by the ET-ABO Sub-Group on Regulatory Material (SG-RM) and submitted to the session as an information document under item 4.2. The group agreed strongly on the general structure of the document and several issues were raised and documented for the SG-RM to take into consideration for its next review iteration.

The meeting also separated into expert teams to revise and update their respective work plans. Further details on the outcomes of these sessions are provided below.

7.1 ABOP Strategy & Implementation Plan

Breakout Group 2 undertook a review of the ABOP Strategy and Implementation Plan that had been submitted to the session as an information document with proposals to update the plan for the period 2016 to 2020.

The group agreed on the majority of the proposed changes and that the WVM and turbulence implementation plans should be integrated into the A-SIP.

The session agreed that the ABOP management group and the Secretariat should finalise the changes to the A-SIP in early 2016 with a view to seeking approval of the updated plan through the CBS/ICT-IOS session in April 2016.

Status of the AMDAR Trust Fund

Mr Dean Lockett presented document 7.1(2) to the session, providing a summary of the status and budgetary information relating to use of the WMO AMDAR Trust Fund by the ABOP.

The income from member contributions over 2014 and 2015 was 105,352.40 CHF and 33,773.86 CHF respectively, taking into account the 10,000 CHF contributions made each year by Environment Canada, which are held against a 5-year, pledge made in 2011. The meeting expressed some concern at the fall in contributions in 2015 but it was pointed out that there was a likelihood that late contributions from Germany and Norway were still to be made.

The expenditures over 2014 and 2015 were 185,067.9 CHF and 172,408.83 CHF respectively. A table providing a summary of information on the expenditures made over 2014 and 2015 was presented to the meeting.

As at 24 November 2015, the balance of the AMDAR Trust fund was 849,857.96 CHF.

The joint meeting was pleased to be informed of the following extract from WMO-No. 1157, the Cg-XVII Abridged Final Report With Resolutions:

Resolution 22 (Cg-17)

GLOBAL OBSERVING SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

...

Urges Members:

...

(4) To continue providing contributions to the AMDAR Trust Fund for the support of technical developments and capacity-building related to AMDAR;

The meeting agreed that this resolution by Cg should be recalled within the annual letter to members requesting contribution to the AMDAR Trust Fund.

7.2 ABOP Regional Implementation Plans

The session discussed in plenary the work that had been undertaken and the progress made on the development of the ABOP Regional Implementation Plans (A-RIPs) and interaction with the WMO Regional Associations since the first session of ABOP.

It was clear that, while good progress had been made for Regions I, IV, V and VI, work had not progressed so well for Regions II and III, although, for both of these regions, some activities had taken place in relation to ABO and AMDAR as described in Items 3.2 and 3.3 above.

The session agreed that a strong ET-ABO leadership role was required to progress development on A-RIPs and, in addition to endeavouring to reinvigorate this ET-ABO leadership for some regions, it was also very important that regional working groups were formed and met on

a regular basis to stimulate activity, collaboration and ideas. If such work groups could not be formed under the respective RAs, then ET-ABO Region Leads should endeavour to form groups until such time as the RAs took on this role. The members of ET-ABO agreed that ET-ABO should endeavour to hold meetings with regional focal points and ABOP/RA working groups at least 4 times annually – a total of 24 meetings per year. (Action: ET-ABO to update work plan accordingly.)

7.3 Expert Team Work Plans

The meeting separated into expert teams to revise and update their respective work plans. The plans were updated based on the progress made prior to the session and also the new actions and activities identified during the session.

It was agreed that the management groups of both expert teams should further refine these work plans early in 2016 so as to facilitate the production of the budget for use of the AMDAR Trust Fund and its approval for 2016-17.

The draft updated work plan of ET-ABO is provided within Annex II.

The draft updated work plan of ET-AO is provided within Annex III.

7.4 Aircraft-Based Observations Programme Structure

The session discussed the WMO ABO programmatic structure and the utility and functionality of the arrangement with an ABO related team in each of the CBS and CIMO Technical Commissions. It was agreed that this structure worked well and there was no reason to contemplate recommending any change for at least the duration of the next CBS inter-sessional period.

7.5 Reporting to CBS and CIMO

The session discussed the requirements for reporting to CBS and CIMO by the expert teams, with ET-ABO in particular having a more urgent need to report to the next session of the CBS Implementation and Coordination Team on Integrated Observing Systems (ICT-IOS) in April 2016, prior to the upcoming session of CBS in November 2016.

While it was agreed that the work plan of ET-ABO would not be expected to diverge significantly in the future from that which had been discussed and planned during the session, it was acknowledged that the terms of reference for the team should be updated to better reflect the programmatic structure in which CIMO/ET-AO was responsible for the scientific, technical and standards aspects of the programme. In particular the following changes were required:

1. Clause (c) - Change scientific and technical development to operation.

2. Clause (a) - Change to reflect collaboration with ET-AO (consistent with ET-AO)

3. Clause (f) - contribute to the CBS contribution to the WIGOS pre-operational phase.

It was agreed that the Chair of ET-ABO should draft updated ToR and make a recommendation at the upcoming ICT-IOS session. (Action: Chair ET-ABO, Apr. 2016).

The meeting also discussed the current key ABO issues that were expected to require deliberation and decisions by CBS and agreed to identify the designation of NOAA/MADIS as the ABO Data Centre and the need to request wider and better support for ABO from organizations such as ICAO and IATA and also the promotion of its use and impact for aviation forecasting and other applications. The draft text to be finalized for submission to CBS via ICT-IOS is provided within Annex IV.

It was agreed that the ET-ABO management group should refine and finalise this text prior to submission to CBS via ICT-IOS. (Action: Chair ET-ABO.)

8 REPORT OF THE SESSION

It was agreed that the Secretariat should compile a draft Final Report of the session based on the outcomes of the session and that the meeting participants should be given the opportunity to review the report prior to its submission for approval and publication by WMO.

Future Meetings

It was agreed that there would be no formal face to face meetings of either expert team in 2016 and that the ABOP management group would later develop plans for a meeting of one of perhaps both teams in 2017.

9 SESSION CLOSURE

Prior to the closure of the session, the meeting was addressed by the Director of DMN Morocco, Mr Abdalah Mokssit, who thanked all the participants of the meeting and WMO for the opportunity to host both the Joint Expert Team Meeting and the workshop. Mr Mokssit expected that the outcomes from the meeting would be of great benefit to Morocco and DMN and was confident that it would lead to a strong and successful endeavour towards the development of an AMDAR programme in Morocco. Mr Etienne Charpentier and Mr Frank Grooters each responded, thanking Mr Mokssit and DMN for their kindness, generosity and professionalism in the hosting of the meeting and workshop and for contributing to the success of both events.

The session was closed by the Chair of ET-ABO at around 3:30pm on 11 December 2015.

ANNEX I

LIST OF PARTICIPANTS

Frank GROOTERS **(Chair ET-ABO)** **Proposed by: Netherlands**	Consultant Prunuslaan 17 NL-3723 WC Bilthoven Netherlands Tel: +31 30 2293250 Mobile: +31 6 11225867 Email: fgrooters@gmail.com
Gilles FOURNIER **(Vice-chair)** **Proposed by: Canada**	Meteorological Service of Canada Place Vincent Massey 351 Boulevard Saint Joseph, étage 7 K1A 0H3 Gatineau Québec Canada Fax: +1-819-205-6455 Tel: +1-819-934-4449 Email: gilles.fournier@canada.ca
Stewart TAYLOR **(Chair ET-AO, Associate Member ET-ABO)** **Proposed by: United Kingdom**	Met Office Unit 3 Holland Business Park, Spa Lane L40 6LN Lathom LANCASHIRE United Kingdom of Great Britain and Northern Ireland Fax: +44 1392 885 681 Tel: +44 1695 729 742 Mobile: +44 775 388 0518 Email: stewart.taylor@metoffice.gov.uk
Douglas BODY **(Vice-chair ET-AO, Core Member ET-ABO)** **Proposed by: Australia**	Bureau of Meteorology 700 Collins Street 3008 Docklands VICTORIA Australia Tel: +61 3 9616 8344 Email: d.body@bom.gov.au
Goama ILBOUDO **(Core member ET-ABO)** **Proposed by: ASECNA**	Direction de l'Exploitation de l'ASECNA 32-38 Av. Jean Jaures BP 3144 DAKAR Senegal Fax: +221 33 820 7528 Tel: +221 33 869 5705 Email: ilboudogoa@asecna.org

Peitao ZHAO
(Core member ET-ABO)
Proposed by: China

China Meteorological Administration
46 Zhongguancun Nandajie
100081 BEIJING
China
Email: peitaozhao@163.com

Domnick ARODI
(Member ET-AO)
Proposed by: Kenya

Kenya Meteorological Service
Tower Road 19021
00501 Nairobi
Kenya
Tel: +254 734 878 178
Email: arodioginga@yahoo.com

Jianliang XU
(Member ET-AO)
Proposed by: China

Air Traffic Management Bureau, CAAC
P.O. Box 2272
100122 Beijing
Shilihe, Chaoyang District
China
Fax: +86 10 8792 2183
Tel: +86 10 8792 2084
Email: xujl@atmb.net.cn

Siebren DE HAAN
(Member ET-AO)
Proposed by: Netherlands

Royal Netherlands Meteorological Institute
Utrechtseweg 297
NL-3731 GK DE BILT
Netherlands
Fax: +31 30 2210 407
Tel: +31 30 2206 745
Email: siebren.de.haan@knmi.nl

Gregory MEYMARIS
(Member ET-AO)
Proposed by: United States

University Corporation for Atmospheric Research (UCAR)
P.O. Box 3000
80307-300 Boulder
Colorado
United States of America
Fax: +1 303 497 8401
Tel: +1 303 497 2828
Email: meymaris@ucar.edu

Abderrahim MOUHTADI
(Invited member)
Proposed by: Morocco

Abderrahim MOUHTADI
Direction de la météorologie nationale, CNP/SMAé
B.P. 8106 en face de la prefecture Hay Hassani
CASABLANCA
Morocco
Fax: +(212) 522913698
Tel: +212-0-22654910, +212 6472338
Email: abderrahim.mouhtadi@gmail.com

Florence BESSON
(Associate member ET-ABO)
Proposed by: France

Météo-France
42, avenue Gaspard Coriolis
31057 TOULOUSE CEDEX
France
Fax: +33 56 107 9559
Tel: +33 56 107 95 50
Email: florence.besson@meteo.fr

Axel HOFF
(Associate member ET-ABO, member ET-AO)
Proposed by: Germany

Deutscher Wetterdienst (DWD)
Frankfurter Strasse 135
D-63067 OFFENBACH AM MAIN
Germany
Fax: +49 69 8062 3827
Tel: +49 69 8062 2852
Email: axel.hoff@dwd.de

Bryce FORD
(Associate member ET-ABO, member ET-AO)
Proposed by: HMEI

SpectraSensors Inc.
Suite 100
4333 W Sam Houston Pkwy N
TX 77043 Houston
United States of America
Mobile: +1 202 549 3477
Email: bford@spectrasensors.com

Hans-Rudi SONNABEND
(Associate member ET-ABO)
Proposed by: IATA

Head of Meteorological Services
Lufthansa Systems GmbH & Co KG
Lido Product Management, FRA AF/L-P
Am Prime Parc 2
D-65479 Raunheim
Tel: +49 69 696 90362
Mobile: +49 151 589 22475
Fax: +49 69 696 94736
email: hans-rudi.sonnabend@lhsystems.com
or met.services@lhsystems.com

Jitze VAN DER MEULEN
(Associate member ET-ABO)
Proposed by: Netherlands

Royal Netherlands Meteorological Institute
Utrechtseweg 297
NL-3731 GK DE BILT
Netherlands
Fax: +(31 30) 2210 407
Tel: +(31 30) 2206 432
Email: jitze.van.der.meulen@knmi.nl

Gaobotse Francis MOSETLHO
(Associate member ET-ABO)
Proposed by: South Africa

South African Weather Service
Bloemfontein Weather Office
Private Bag x20562
Bloemfontein
South Africa
Fax: +27 51 433 2477
Tel: +27 51 433 2301
Mobile: +27 83 341 4540
Email: francis.mosetlho@weathersa.co.za

Neil JACOBS
(Associate member ET-ABO)
Proposed by: HMEI

Panasonic Avionics Corporation
1100 Perimeter Park Dr., Suite 104
NC 27560 Morrisville
North Carolina
United States of America
Tel: +1 919 653 4358
Email: neil.jacobs@panasonic.aero

Steven PRITCHETT
(Associate member ET-ABO)
Proposed by: United States

NOAA - National Weather Service
1325 East-West Highway
SILVER SPRING
MD 20910
United States of America
Fax: +1 301 713-0173
Tel: +1 301 427-9121
Email: steven.pritchett@noaa.gov

Carl WEISS
(Associate member ET-ABO)
Proposed by: CBS

94 Concession Oak Drive
Bluffton, SC, USA 29909-5082
Tel: 843-707-1430
Email: ceweiss1949@gmail.com

Dean LOCKETT
(Coordinator)
Proposed by: WMO Secretariat

World Meteorological Organization
7 bis, avenue de la Paix
Case postale No. 2300
CH-1211 2 GENEVA
Switzerland
Fax: +41-22-7308021
Tel: +41-22-7308323
Email: dlockett@wmo.int

Etienne Charpentier
Proposed by: WMO Secretariat

World Meteorological Organization
7 bis, avenue de la Paix
Case postale No. 2300
CH-1211 2 GENEVA
Switzerland
Fax: +41-22-7308021
Tel: +41-22-7308223
Email: echarpentier@wmo.int

ANNEX II - CBS Expert Team on Aircraft-Based Observing systems Work Plan, 2016-2017 (2016.1D3, Draft, December 2015)

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
1	(a)	Compile ET-ABO work plan and budget.	1. 2016 WP & Budget 2. 2017 WP & Budget		Ch/ET-ABO	Q4 2013	Ongoing	2	Work Plan, Ann. Budget 2016,2017	• Plan & Budget 2015 approved.			
2	(a)	Meetings of ET-ABO		Hold a meeting, 2nd half of 2015. Requirements: • Agenda (Ch-ET-ABO); • Meeting Form (SO/ARO) • Meeting Q4 2017	Ch/ET-ABO	Q1 2015	Ongoing	1	Agenda, Meeting Form, Meeting	• ET-ABO-1 held in Sep 2013 • ET-ABO-2 in progress, Dec 2015			
3	(b)	Establishment of ABO Metadata (national, international)	Finalise Imp. Plan		S.Taylor, SO/ARO	Q3 2013	Q4 2013	2	AMDAR Metadata IP	This task is now incorporated in OSCAR development			
			Incorporate metadata specification into draft Reg. Material		S.Taylor, SO/ARO	Q2 2013	Q4 2015	1	Metadata definition incorporated into WIGOS Reg. Mat.	This task will be incorporated into Task 28.			
			Establish Metadata Pilot Project	Pilot project to test the exchange of metadata. Will need a recipient data centre (e.g. CMC or the AO Data Centre?) Funding possibly required for software development	S.Taylor, SO/ARO	Q4 2013	Q1 2014	0	Pilot project in place.	This task has been overtaken by activities related to OSCAR OSC development. Expect ABO metadata will be incorporated within OSCAR.			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
			ABO metadata management in OSCAR	• Assist in and contribute to the establishment of a system for ABO metadata management in OSCAR. • Contribute to documentation/guidance of OSCAR	S.Taylor, SO/ARO	Q2 2014	Q4 2016	1	ABO global metadata management system in OSCAR	• Requirements for ABO metadata management and capabilities have been provided.	0 (30)	57	
4	(b)	Establish AO Data Centre	1. Write to pros. Centres; 2. Define requirements of AO DC 3. Finalise agreement with NOAA/MADIS 4. Submit proposal to ICT-IOS, CBS	Prospective centres: • NCEP • CMC • NOAA NCDC • EUMETNET • Panasonic Aviation May require both establishment and ongoing funding support.	Ch/ET-ABO, SO/ARO	Q1 2013	Q4 2016	2	AO Data Centre	• Initial approaches made to prospective centers (Q3 2013) • Set of requirements finalized • Discussions & meetings with NOAA re MADIS over 2015.	0 (25)		
5	(b)	Document ABO QMS		Include: • Recomm. from Workshop on DM	J.v.d.Meulen, ET-ABO	2012	Q4 2014	1	ABO QM Documented in WMO Reg. Mat.	This task will be incorporated into Task 28.			
6	(b)	Revise and update AOP Data QC and QM procedures		Include: • Relevant recomm. From Workshop on DM • Use of flags • Policy on ICAO data QM • Spec. of QC by DPCs/NMSHSs • Reqs for NWP • Radiosonde comparison	J.v.d.Meulen, D.Body	Q4 2013	Q4 2014	0	QC Procedures updated in WIGOS Reg. Mat.	This task will be incorporated into Task 28.			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
		Improve QC and management of ADS Data	1. Provide requirements to ICAO 2. Liaise with WAFC toward solution to ADS-C QC establishment. 3. Meet with ICAO and WAFC reps in 2015 to finalise arrangements 4. Meet with ICAO and WAFC reps in March 2016 5. Develop plan for ADS-C migration to BUFR 6. Develop plan for ADS-C data processing by WAFC center delegates 7. Develop guidance on QC		1. SO/ARO 2. SO/ARO 3. SO/ARO 4. SO/ARO 5. JvdM 6. C Tyson, M Strahan 7. S. Taylor; C Tyson	Q4 2013	Q4 2016	1	1. Requirements developed & provided to ICAO 2. ADS-C Implemented.	• WAFC representatives to ET-ABO identified, added as assoc. members. • Workshop held with representatives of ICAO and WAFCs in October 2015			
7	(c)	Coordinate with CIMO ET-AO on Scientific & Technical Matters	1. Coord. Finalization of 2016-17 WP.		Ch-ET-ABO, SO/ARO	2012	Ongoing	2	Harmonised Work Plan & Budget for the ABO Program.	• Ch-ET-AO attended ET-ABO-1 • Vc-ET-ABO attended ET-AO-1 as member • Joint meeting of ET-ABO/ET-AO Dec 2015			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
8	(c)	B777 Software Dev.	1. Finalise negotiations with AFR and KLM in consult. with E-AMDAR & Meteo-France. 2. Finalise agreement with stakeholders on final costs. 3. Finalise implentation and software roll out.	1. Combined action with ET-AO	Ch/ET-ABO, SO/ARO, Ch-ET-AO, S.Stringer (E-AMDAR PM)	2012	Q2 20165	2	B777 AMDAR Software application	• Activity delayed in 2013 due to neg. with AFR and KLM. • Agreement signed with AFR for S/W development Dec 2014 • S/W developed by Air France Q3 2015. • QC of operational data by E-AMDAR ongoing		In ET-AO Budget	
9	(d)	Study on Data Coverage and Airline Capabilities	Complete study & publish		SO/ARO	Q1 2012	Q1 2013	4	Published study	Study completed and published. COMPLETED			
10	(d)	Mexico Prog Implement.	1. Finalise ARINC Contract 2. Monitor contract & data 3. Seek extension of contract for 2017-18 funded by SMN Mexico		SO/ARO	2012	Q4 2016	2	Contract	• Contract with ARINC delayed • WMO approval for contract provided in Nov 2013 • Program operational in Oct 2014 • SMN to pay 1st year of data costs – WMO to pay 2nd year. • ARINC Contract est. July 2014 • Est. contract paid Jan 2015 • Monthly billing comm. from Jan 2015.	*19 (24)	24 (SMN Mexico via Trust)	24 (SMN Mexico via Trust)

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
11	(d)	Employ AMDAR Dev. Officer (ADO)	1. Negotiate with EUMETNET for 0.5 persons working with E-AMDAR for WMO ABO.		SO/ARO, Ch/ET-ABO, GF	Q1 2013	Q4 2016	2	Job Description, ADO employed.	• Mr Stig Carlberg was employed as ADO over period July 2013 through January 2015. • Mr Carlberg completed contract in Jan 2015. • Expectation is that a continuing arrangement will be made with a technical consultant to provide technical support for international AMDAR development.	0(30)	40	60
12	(d)	Develop Global & Regional ABOP Imp. Plans	ABOP Strategy & Implementation Plan (A-SIP)	This may incorporate the following: • WVSS Implementation • Letter to airlines based on consideration of Data Coverage & Airline Targeting study; • Letter to PRs of relevant countries based on consideration of Data Coverage & Airline Targeting study; • Letter to RAs. • Update A-SIP to version 2016.	SO/ARO, Ch/ET-ABO, Vc/ET-ABO	Q1 2013	Q4 2016	4	1. A-SIP Completed and published; 2. Draft A-RIP Template completed. 3. A-SIP ver. 2016	Ver. 2015.1 COMPLETED			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
			Development of Region I ABOP Regional Implementation Plan	• Possible that these plans can be developed in coordination with RA sessions. • Attend RA I session in Feb 2015 and present A-RIP • Work with RA I on: 1) A-RIP in WIGOS-IP, 2) Form RA I work group. • Meet with AMCOMET Project Officer • Quarterly meetings of Region I work group. • Participate in Int. Aviation Conf. April 2016. • Maintain A-RIP	SO/ARO, G.Ilboudo, F.Mosetlho	Q2 2013	Q4 2016	2	1. Region I A-RIP 2. Participation at RA I session in Feb 2015	• Mature draft A-RIP has been produced. • Item on RA I RECO on AMDAR has was presented by SO/ARO (Feb 2015). • AMDAR adopted as AMCOMET Project.	0		
			RA I AMDAR Workshops	• Schedule first in 1st half of 2015, likely to be held in Kenya in April. • Possible 2nd workshop to be held in Morocco in 2nd half of 2015 possibly in conjunction with joint meeting of ETs.	ET-ABO, SO/ARO, J.Ngamini, RA I FPs	Q2 2013	Q4 2015		• AMDAR Workshop held in Kenya • AMDAR Workshop held in Morocco	• Requests to host workshops have been received from KMS and Morocco MS. • Negotiations with KMS have commenced to hold workshop in April 2015. • Workshop held in June 2015 • Workshop held in Morocco, Dec 2015	22 (Ken.) *16 (Mor.)		

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
			AFIRS Trial in RA I	Investigate and, if feasible, implement a trial of AFIRS data provision within RA I.	G Ilboudo, ET-ABO, SO/ARO	Q1 2014	Q4 2016	1	1. Data from trial obtained and analysed. 2. Report to ET-ABO and CBS.	• Consulted with FlyHt and obtained quotation – expect to go ahead in 2015. • Activity included in draft A-RIP.	0 (17)	?	?
			E-AMDAR Data Provision Trial Region I	• Investigate and if feasible request E-AMDAR to provide all possible AMDAR data over Region I for a one year period. • Ensure all Region I Members are aware of the trial. • Ensure an impact assessment is undertaken • Seek collaboration with Region I Members for continuation of data provision beyond the trial. • Extend scope to include data from B777s.	ET-ABO, SO/ARO	Q4 2014	Q4 2016	1	1. E-AMDAR AMDAR data made available for one year. 2. Region I Members reports on impact of data. 3. (NWP) Impact assessment on supplementary data.	• Costing has been provided by E-AMDAR (4K per annum) • Activity has been included in the draft A-RIP • E-AMDAR have provided est. costs for existing fleets exc. B777s	0(2)	?	?
			Development of Region II ABOP Regional Implementation Plan		ADO, SO/ARO, ?	Q2 2013	Q4 2016	2	Region II A-RIP	• No significant progress			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
			Development of Region III ABOP Regional Implementation Plan		ADO, SO/ARO, J.Horler	Q2 2013	Q4 2016	2	Region III A-RIP	• No significant progress on A-RIP • AMDAR was presented at RA III session in Sep 2014 – rapporteur on AMDAR was appointed.			
			Development of Region IV ABOP Regional Implementation Plan		ADO, SO/ARO, G.Fournier	Q2 2013	Q4 2016	2	Region IV A-RIP	• Draft A-RIP has been developed. • RA has been contacted and request for review of A-RIP made.			
			Development of Region V ABOP Regional Implementation Plan		ADO, SO/ARO, D. Body	Q2 2013	Q4 2016	2	Region V A-RIP	• Draft A-RIP has been developed. • R. Stringer (Lead WG on Infrastructure) presented ET-ABO coordination plans to the RA Session in May 2014 – A WG on AMDAR would be established if enough Members nominated experts.			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
			Development of Region VI ABOP Regional Implementation Plan		ADO, SO/ARO, S.Stringer	Q2 2013	Q4 2016	2	Region VI A-RIP	• Draft A-RIP has been developed. • RA has been contacted and request for review of A-RIP made. • WMO and EUMETNET have agreed on collaboration on AMDAR international regional development under their MoU.			
			Request collaboration with RAs	Collaborate with RAs towards adoption of A-RIPs.	ET-ABO Region Leads, SO/ARO	Q4 2013	Q4 2016	2	• Correspondence to Pres. RAs compiled and sent.	• ET-ABO Regional Leads have corresponded with relevant working group leaders and other members of RAs.			
			Request collaboration with NMHSs	1. List of target NMHSs (based on target airlines) to be compiled; 2. Ch-ET-ABO to write to PRs of NMHS to request collaboration on programme development 3. Letter to 10 target NMHS in 2016	Ch-ET-ABO, SO/ARO	Q4 2013	Q1 2014	4	Letters to target NMHSs compiled and sent.	• Letter was sent to all PRs in Q1 2014 • CBS approved RA collaborative process (ext-2014)			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
			RA V Air Niuguini FlyHt/AFIRS Project	Objective is to implement (3) Air Niugini aircraft and fund data for 1 year and ensuring future continutation. 1. Investigate options for equipping Air Niugine aircraft for reporting. 2. Determine requirements and means for data processing for GTS trans. 3. Implement project. 4. Investigate options for future funding.	D.Body	Q1 2015	Q4 2016	1	ABO Data for SW Pacific	• Initial investigations have been made. • Offer provided by FlyHt • Proposal has been prepared by ADO. • Initiative has been delayed until 2016 due to excessive cost of software.	0(17)	15	5
			Consultancy for AMDAR expansion & enhancement project	Project initiated during 2014 in consultation with WMODevelopment and Regional Activities to formulate business case materials and comms strategy for AMDAR program development. 1. Develop statement of work. 2. Undertake tendering process in WMO Sec. 3. Contract consultant and provide subject matter expertise.	SO/ARO, ET-ABO	Q2 2014	Q1 2015	4	1. Roadmap and Funding proposal. 2. Business cases. 3. Communications Strategy	• Sub-tasks 1 and 2 completed. • Consultancy firm Dalberg has been contracted. • Roadmap and Funding proposal has been delivered. • Draft Comms strategy and business cases have been delivered. COMPLETED	50 (49)		

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
13	(d)	Polar ABO	Report on the availability of observations over polar regions		Ch-ET-ABO	Q3 2013	Q4 2013	4	Ch-ET-ABO to report to EC-PORS (24-28 Feb. 2014)	COMPLETED			
			Investigate and report on possible airlines/aircraft to enhance polar ABO coverage	1. G.Fournier to follow up with Panasonic re Arctic coverage.	ET-ABO, N.Jacobs	Q3 2013	Q4 2013	4	Provide input to Ch-ET-ABO for report to EC-PORS	COMPLETED			
			Seek proposal from PAC for sat comm. ABO data provision for 1 year	G. Fournier								?	?
14	(d)	Establish ASECNA requirements for Supplementary AMDAR Data			SO/ARO, J.Ngamini	Q2 2013	Q2 2014	4	Data Agreement with EUMETNET/E-AMDAR	• ASECNA approached and declined. • This activity is now being taken up under the Region I A-RIP. COMPLETED			
15	(d)	Optimise Existing Program Coverage	• Determine existing potential coverage, capacity to provide the additional potential data & cost of doing so.	AMDAR Program Managers to provide potential vertical profile coverage. SO/ARO to make request.	ET-ABO, Operational Program FPs	Q1 2013	Q2 2015	2	Report to ET-ABO	• E-AMDAR have identified potential to provide supplementary data. This will be incorporated in Region I A-RIP under task 12			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
			• Investigate WMO ability to admin. MoUs between NMHSs • WMO Sec. to establish MoU system and Trust budget line for sup. Data provision		SO/ARO	Q2 2013	Q4 2016	2	Report to ET-ABO				
			• Fund supplementary agreed data provision activities	Region I, B777, PAC								50	50
16	(d)	Develop guidelines for AMDAR Program Dev.	1. provide revised draft to ET-ABO 2. Guidelines to be published in Man. or Guide on WIGOS	Publish in relevant guide.	1. Ch-ET-ABO, S.Taylor 2. Review group, Task 28	Q3 2013	Q1 2014	4	Guidelines for AMDAR Prog. Dev. Published in Reg. Material.	• Guidance published as WIGOS TR 2014-2 COMPLETED.			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
17	(d)	Attend meetings of relevance to global AMDAR dev.	• Establish collaboration with ICAO Met Panel, IATA FOSTF, AMS	This may include: • 2 E-AMDAR TAG meetings per annum; • Participation in ICAO/ASECNA meeting RA I (Aug 2014) • Others.	SO/ARO, ET/ABO	Q2 2013	Q4 2016	2	Meetings attended. Reports produced for ET-ABO and Secretariat	• Ch-ET-ABO attended IPET-OSDE, Feb 2014 (1.9K) • Ch-ET-ABO attended ICT-IOS-8, Mar 2014 (2.2K) • ET-ABO Chair attended meetings 23, 24 (2014) (3.3K) • D.Lockett attended NOAA Workshop on ABO, April 2014 (5.7K) • G.Fournier participated in the ICAO/ASECNA meeting in Aug. 2014 (1.9K) • S.Carlberg attended ET-ABO/SG-RM Meeting (2.1K) • S.Pritchett attended DLUF Feb. 2015 • S.Taylor attended AEEC GA, Apr. 2015 • D.Lockett attended E-AMDAR ET, Nov 2015	4 (15)	15	15

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
18	(e)	Papers on Impact of AMDAR Data	1. Publish 2 papers on AMDAR data impact 2. Prepare and present paper at ATRS Conf, Bordeaux, July 2014 (SSA ext.)	1. Draft papers received 2. Papers reviewed 3. Papers published	SO/ARO, ET-ABO Review Team	2012	Q4 2014	4	Published papers	• Drafts received and reviewed Q3 2014 • Final versions of submitted papers received. • R.Petersen attended ATRS meeting, Bordeaux, June 2014 (6K) • Papers will be published in BAMS in Q1 2015. • Papers merged and published as WIGOS TR (July 2015) COMPLETED			
19	(e)	AMDAR Impacts and Benefits Documentation	Benefits for Aviation Document	1. Revise & Finalise Statement of Work 2. Seek EoIs from consultants and commence and complete SSA 3. Publish report as WIGOS TR	Ch/ET-ABO, SO/ARO	Q1 2013	Q1 2016	2	1. SoW 2. SSA with selected Consultant and delivery of benefits document	• Kick-off meeting held 9 December 2013 • 1s draft has been provided and reviewed • SSA Appointed Feb 2014 completion has been delayed due to complexity • SSA Extended to include provision of modeling study on fuel burn. • SSA completed (Sep 2015).	34(24)		

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
			ABO Benefits to Meteorology & Aviation Document	Work collaboratively with ABO Focal Points to compile a general ABO benefits document.	Ch/ET-ABO, SO/ARO, FPs Op. Programmes	Q3 2013	Q1 2014	4	ABO Benefits Document completed & published online.	• Document published as WIGOS Tech. Report 2014-1 COMPLETED			
			Publish Flyers on AMDAR Program Benefits	Develop 3 new short flyers on AMDAR benefits to/from: 1. Aviation 2. Meteorology 3. Water vapour measurement	ET-ABO, ADO, SO/ARO	Q1 2014	Q4 2016	1	Flyers published	• Flyer on AMDAR benefits to aviation has been completed and published • Drafts of flyers 2 and 3 have been completed by ADO. • Flyer 1 pub. Aug 2014.			
20	(e)	AMDAR Training Module	Develop SoW for Training Module	• Present SoW to ET/ABO for assessment; • As per AMDAR-15, funding to be sought as ring-fenced item in TF.	Lead AMDAR Training & Outreach (C.Weiss)	Q3 2013	Q4 2013	4	SoW	COMPLETED			
			Investigate possible joint NOAA/WMO project to fund COMET to develop module.	1. C.Weiss to investigate possibility within NOAA 2. SO/ARO to investigate possibility within WMO 3. If all ok, proceed to having funding approved 4. Develop project in collaboration between NOAA, ET-ABO & COMET	C.Weiss, SO/ARO, Ch-ET-ABO, Vc-ET-ABO, Ch-ET-AO	Q1 2014	Q3 2014	4	Contract secured with COMET.	• Kick-off meeting held 29 November 2013 • Module has been completed and will be released in Q1 2015. (+30K from NOAA) COMPLETED			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
21	(e)	Attend Relevant Aviation Meetings	Attend AEEC Data Link Users Forum, 2012-2016	• S.Prtichett to represent ET-ABO at AEEC DLUF meeting in Panama, Feb 2015	ET-ABORep, SO/ARO, Ch-ET-ABO.	Q4 2013	Q4 2016	2	Attend meetings; report to ET-ABO;	• C.Weiss, S.Taylor attended USA, Europe meeting in 2013; Reports produced. • S. Taylor attended DLUF meeting in Brussels, Sep 2014; Report produced.	2 (2)		
			Promote AMDAR & ABO at WMO/ICAO Joint Meeting, July 2014, Montreal	This may also potentially be used as the venue to launch a WMO/ICAO joint project on ABO development.	SO/ARO, Ch-ET-ABO	Q4 2013	Q3 2014	4	Report to ET-ABO on promotion activities.	• Submitted discussion paper to joint meeting. Funding from Item 17 COMPLETED			
22	(e)	WMO AMDAR Newsletter	Produce Newsletter Vol 5		ET-ABO, AMDAR FPs, SO/ARO	Q2 2013	Q2 2013	4	Newsletter Vol 5	COMPLETED			
			Produce Newsletter Vol 6		ET-ABO, AMDAR FPs, SO/ARO	Q4 2013	Q4 2013	4	Newsletter Vol 6	COMPLETED			
			• Produce NewslettersVols 9 &10 (2015) • Produce NewslettersVols 11 &12 (2016)		ET-ABO, AMDAR FPs, SO/ARO	Q1 2014	Ongoing	2	• Newsletter Vol 7 & Vol 8; • Newsletter Vol 9 & Vol10 • Newsletter Vol 11 & Vol12	• Vol 7 and Vol 8 published (2014).			
23	(e)	Global AMDAR Program Development Workshops and Seminars	1. Workshop in Region II, Mid-east. 2. Workshop in ?		ET-ABO	Q2 2013	Q4 2016	2	1. Region II Workshop	• Workshop postponed until 2015 • Middle-East Workshop postponed until 2016	0 (20)	40	40

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
24	(e)	Maintain & Develop WMO ABO and AMDAR Websites	Operational programmes to produce a technical description of their programmes for the website	1. SO/ARO to develop a template 2. Operational programme managers to provide the input.	SO/ARO, Op. Programme Managers	Q4 2013	Q4 2016	2	AMDAR Programme Technical Descriptions published online.	• Template developed. • E-AMDAR implemented new template (December 2014).			
			Investigate Cross-promotion from Av. Org. Websites	1. SO/ARO to contact N.Halsey to investigate possibilities for ICAO website X-promotion; 2. SO/ARO to contact H-R Sonnabend to investigate possibilities for IATA website X-promotion	SO/ARO	Q4 2013	Q4 2016	1	X-promotion on ICAO and IATA websites	• No progress due to other priorities			
25	(f)	Provide input to ICG-WIGOS/TT-WMD	Attend TT-WMD Meetings		S.Taylor, SO/ARO	Q1 2013	Ongoing	2	Determine req. for input to TT-WMD	• Commenced • S.Taylor attended TT-WMD meeting, December 2014 • S.Taylor attended TT-WMD-4, Oct 2015			
26	(f)	Provide input to ICG-WIGOS/TT-WRM	Attend TT-WRM Meetings		J.v.d.Meulen	Q1 2012	Ongoing	2	Determine req. for input to TT-WRM	• J.v.d. Meulen attended TT-WRM meetings, June and November 2013.			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/ Activities	Progress	2015 Budget Expend	2016 Budget Estimate	2017 Budget Estimate
27	(f)	Contribute to the WMO/CBS RRR Process	• WAFCs to review AeM SoG.	Continuous process	SO/ARO, ET-ABO	2012	Ongoing	2	Input in RRR Database SoR Document/ input in RRR OSC Database	• SO/ARO and S.Taylor provided requirement specification for determination of aircraft systems capabilities.			
28	(f)	Revision of AMDAR Regulatory Material in WIGOS context	1. Revise current status. 2. Develop plan for update process. 3. Meeting of SG-RM (Dec 2014) 4. Consolidation of draft material for ET-ABO-2	1. Develop new ABO input to the Manual on the GOS and Guide to the GOS 2. Finalise input through the CBS process.	ADO; J.v.d.Meulen, Ch-ET-ABO, A.Hoff, D.Body SO/ARO to form review team on Reg. Mat.	Q3 2013	Q4 2016	2	1. Plan for integration of AMDAR RM into WIGOS RM. 2. Commence and complete update of Reg. Mat. in Man. on WIGOS and Man. on GOS	• Review team met as Sub-Group on Regulatory Material in December 2014 – produced initial draft of ABO content for Manual on GOS and Guide to GOS.			

ANNEX III - CIMO ET-AO Work Plan, 2015-2018, Budget 2016-2017 (Version 2016.1D2, Draft, December 2015)

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
1	1)	Coordinate with CBS ET-ABO on Work Plan & Budget	Ch-ET-AO, SO/ARO	1. Representative of ET to attend ET-ABO-2 (2015); 2. Work Plan & Budget to be compiled & approved on at least an annual basis. 3. Regular Work Plan WebEx sessions to be held. 4.	Harmonised Work Plan & Budget for the ABO Program. Report to ET-AO	Q4 2014	Ongoing	N/A	• Chair attended ET-ABO-1 • ET-AO-1 held jointly with ET-ABO-2 Dec 2015	2.3k		
2	2)	Meeting of ET-AO	Ch-ET-AO, SO/ARO	Meeting of ET-AO, Q4 2015 Meeting of ET-AO, 2017, prior to CIMO Session	1. Work Program advanced; 2. Report to CIMO 3. Report to CIMO Q1 2016 ahead of CIMO MG Meeting Apr 2016	Q4 2014	Q1 2018	0	• Meeting of TT-AO-1 held 18-20 Feb 2014. • ET-AO-1 held Dec 2015	15k (WMO RB)		
3	3)	Investigate AMDAR Temperature Bias	S.d.Haan	1. Review of relevant reference material 2. Consultation with avionics/sensor experts	1. Report to ET-AO and CIMO 2. CIMO IOM Report 3. Meeting to be arranged with avionics vendors 2016	Q1 2014	Q3 20165	25	May require funding to complete a study on onboard issues, such as deicing. Ref: WMO AMDAR Panel Aircraft Observing System Data Management Workshop, Section 5.1,	1k		

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
4	3)	AMDAR and water vapor measurement (WVM) integration into existing avionics and airframes	A.Hoff, G.Meymaris, S.Stringer, B.Ford, SO/ARO	1. Drafting and review of plan. 2. Finalise plan as part of the ABOP Strategy & Implementation Plan (A-SIP)	Strategic Plan	2012	Q1 2015	95	This needs to be harmonized with the the A-SIP. Ref: WMO AMDAR Panel Session 15 Fin. Rep. 4.2.1. Incorporate: • Ownership of STCs • Collaboration on STC costs • Integration into airframes AMDAR Software requirements. Some elements of the IP will be delivered during 2016 – thus delaying completion of deliverable			
5	3)	AMDAR and water vapor measurement (WVM) as standard accessory on commercial aircraft	A.Hoff, G.Meymaris, S.Stringer, B.Ford, SO/ARO	1. Drafting and review of plan. 2. Finalise plan as part of the ABOP Strategy & Implementation Plan (A-SiP)	Strategic Plan	2012	Q1 2015	50	Incorporate: • Formulation of IP into WMO Project, perhaps in collaboration with ICAO. Ref: WMO AMDAR Panel Session 15 Fin. Rep 4.2.1. Some elements of the IP will be delivered during 2016 – thus delaying completion of deliverable			

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
6	3)	Turbulence (EDR) Implementation in AMDAR - Develop IP for EDR	G Meymaris, S.Taylor, T.Farrar, SO/ARO	1. Drafting and review of plan. 2. Teleconferencing of collaborators. Liaise with NCAR on software requirements; 3. Identify possible airline partner for trial.	EDR IP	Q3 2013	Q1 2015	50	Possibly include: • A trial program with a European airline (the E-AMDAR Team discussing possibility with Air France). Delay in discussing with airline. • Development of AFR B777 also includes implementation of EDR – airline /Boeing will collaborate to achieve during 2016. • Lufthansa and DWD (TeFiS Project) are collaborating on installing EDR on ~30 aircraft (all fleet types). Ref: WMO AMDAR Panel Session 15 Fin. Rep 4.2.2.			
7	3)	Turbulence (EDR) Implementation	G Meymaris	1. In collaboration with ET-ABO, undertake activities as required to facilitate AMDAR EDR monitoring program.	• EDR monitoring program operational	Q2 2015	Q4 2018	0	This Task will follow on from Task 6.			

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
8	3)	Study on Current & Future Comms & Technology Impact on AMDAR	SO/ARO, S.Taylor, D. Arodi.	1. Write Statement of Work 2. Identify consultants 3. SSA in place Monitor progress 4. Study to be published as a IOM report.	1. Kick off webex with consultant (Sep 2014). 2. Study and recommendations produced. Two sections to cover Executive Summary and Technical terminology.	Q3 2013	Q1 2015	95	• Monthly status reports received. • Regular Webex sessions held with consultant during 2014. • Webex held Jan 2015. • SSA consultancy completed. • IOM with WMO Publications for Final approval	24K (24)		
9	(4)	Update and maintain the AOSFRS	ET-AO	1.	AOSFRS Maintained	Q4 2014	Q4 2018	0	• No current requirement for updates identified • Version 1.1 issued. Record of amendments included in document.			
10	4)	AMDAR Software Development & Availability	S.Taylor, SO/ARO	1. Approach Teledyne Controls re AOSFRS implementation; 2. Approach other avionics vendors	Integration of AMDAR into avionics systems.	Q3 2013	N/A	Ongoing	Work towards availability of AMDAR software as a catalogue item of delivery for avionics systems. ET-AO agreed on more proactive approach possibly involving face to face meetings necessitating travel of Members.			

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
			ET-AO, SO/ARO	Development of Generic AMDAR Onboard Software Modules: 1. Determine viability of project. 2. Develop Description of Work and requirements. 3. WMO Tender for job. 4. Initiate contact with Avionics Vendors on this topic.	Suite of generic AOSFRS-compliant modules for deployment with participating airlines and avionics vendors.	Q3 2014	Q4 2016	10	• Initial discussions with vendors. • Honeywell and Teledyne contacted. • Other vendors and aircraft manufacturers to be contacted (Q1 2015). • Promotion of concept at aviation meetings (e.g. AEEC DLUF Q1 2016)	0 (50)	?	?
11	4)	Boeing 777 AMDR Software Dev.	Ch-ET-AO, Ch/ET-ABO, SO/ARO,	1. Finalise negotiations with AFR and KLM in consult. with E-AMDAR & Meteo-France 2. Review quotation; 3. Provide advice on specifications and requirements. 4. Finalise agreement with stakeholders on costs. 5. Finalise implentation and software roll out.	B777 AMDAR Software application	2012	Q4 2016	95	2. Combined action with ET-ABO 3. Agreement signed with AFR for S/W develop. Dec 2014 4. AFR, LSY and E-AMDAR coord. Integ. of B777 to optimizer Jan 2015. 5. Project imp. delayed – expect completion in 2016 6. AFR data available wef 1st Feb 2016. Ref: WMO AMDAR Panel Session 15 Fin. Rep 4.4.7.	0 (20K)	20K	

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
12	4)	Develop and specify standard for AMDAR Data Optimisation System	D.Body	1. Determine requirements (consult with FPs); 2. Draft specification; 3. Conduct review; 4. Publish spec.	Addition to WMO guidance material.	Q4 2014	Q4 2016	95	• Develop a functional specification that can be included in the Manual on WIGOS or in CIMO Guide. • Guidance has been developed. • Will be added to the Guide to GOS.			
13	5)	Monitor & Review reports from WVSS testing	A.Hoff	1. Review reports. 2. Report to TT-AO-1 3. Provide summary report on DENCHAR test results. 4. Provide ET-AO and ET-ABO with updates.	1. Report to CIMO. 2. Updates to ETs.	Q3 2013	Ongoing	N/A.	Ref: WMO AMDAR Panel Session 15 Fin. Rep 4.2.1.			
14	5)	Monitor & report on impact assessment results of TAMDAR humidity & other parameters by MetOffice	ET-AO	1. Review reports and analyse results. 2. Report to ET-AO-1. 3. Provide updates to ET	Report to CIMO	Q3 2013	Q2 2015	40	• Delay to installation of TAMDAR on FAAM aircraft, now scheduled for Oct 2014. • TAMDAR sensor installed and Panasonic completing onboard calib. Data will be collected from campaigns from March 2015. • Awaiting results from Met Office			

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
15	3)	Develop & Implement plans for AMDAR & WVSS inter-comparison	S.d.Haan	1. Determine requirements; 2. Analyse options; 3. Draft Plan; 4. Implement & report (IOM).	AMDAR & WVSS Inter-comparisons Plan	Q4 2013	Q2 2016	30	This task was delayed whilst awaiting WVSS installation on DLH aircraft. All 9 aircraft will be operational Q1 2016.			
16	6)	Prepare a paper on the status of WVSS-II validation	B. Ford & Collaborators	1. Prepare outline and scope 2. Identify contributors 3. Research and draft 4. Review 5. Publish	IOM Report	Q3 2013	Q4 2014	70	• Provide a summary on all scientific and operational aspects of the WVSS-II sensor and prepare a paper to be published as an IOM report. • Upon review by CIMO requires some changes and additional material. • After further iteration, document will be reviewed by ET-AO Q1 2016			
17	6)	Review & Update Aircraft-based Obs Reg. Mat. In CIMO Guide	ET-AO	1. Review current status of material and identify requirements for update; 2. Coordinate & undertake update; 3. Review and complete; 4. Provide to CIMO Editorial Board.	CIMO Guide on Aircraft-based Observations updated.	Q1 2014	Q4 2018	0				

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
18	7)	Attend meetings of relevance to AMDAR Technical Dev.	ET-AO, SO/ARO	1. Develop list of aviation committees and reps on P&C wiki. 2. Membership of RTCA	Meetings attended. Reports produced for CIMO and Secretariat	Q2 2013	Ongoing	N/A	This may include: • Meeting with avionics vendors; • SO/ARO & S.Taylor met with A.Hoff in Dec 2013 in Offenbach for Task 19.	0 (10K)	10K	10K
19	4)	Maintenance of AEEC ARINC 620 Specification	S.Taylor, SO/ARO, A. Hoff	1. As necessary, work with AEEC DataLink Systems Sub-Committee to maintain the Met. Report in the ARINC 620 standard.	Met. Report V6 defined in the AEEC ARINC 620 spec.	Q4 2013	Q4 2014	100	• Will require travel support for work team and to attend AEEC meetings • D.Lockett attended AEEC DLK SSC, June 2014 (1.2K) • Met Rep. v6 incorp. into ARINC620-8 (published Dec 2014).	1.2K		
20	4)	Interaction with AEEC AOC	ET-AO, SO/ARO	1. Review existing documents and reports to determine requirements for ET-AO 2. Seek membership of AOC and attend meetings	Liaison with Aviation Industries. Report to ETs where appropriate.	Q2 2014	Ongoing	N/A	• SSC and AOC are trying to harmonize requirements for data link in A633 and A620. • ET-AO should determine any implications for AMDAR. • This Task is related to Task 18 and any funding is captured there.			

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Comm.	Deadline for Delivery	Status (%)	Comments	2015 Budget Expend.	2016 Budget Estimate	2017 Budget Estimate
21	3)	Study of UAV technologies.	Ch-ET-AO	1. Investigate possible applications of UAV/UAS developments for reporting of meteorological parameters. 2. Attend meetings of relevance	1. Reports to ET-AO and CIMO. 2. Mission Report from UAV Conference (Oct 2014).	Q3 2014	Ongoing	N/A	• Ch-ET-AO attended UAV Conference Oct 2014. (1.4K) • UK Met Office are investigating UAV technology for meteorological research. • Ch-ET-AO invited to visit UAV vendors – to be arranged during first half of 2015. • Visit to UAV vendors delayed to 2016 • UAV meeting identified (Brussels March)	1.4K	2K	

Annex IV – Draft Recommendations to CBS

The WMO AMDAR observing system, the primary component of the Aircraft Based Observing System, is considered to be a critical source of upper-air observations in support of the Global Observing System. The data provided is of excellent quality and is recognised as being of great benefit to the meteorological and aviation communities and related operational application areas. Numerous studies and scientific papers attest to the quality and positive impact of such data. While the benefits of aircraft based observations and AMDAR data are widely appreciated by the weather forecasting and aviation services communities, they are often not as well appreciated or understood by the Air Transport Industry and, therefore, perhaps not as well promoted and utilized as might be the case. Additionally, the expansion and enhancement of aircraft based observations, that is expected to provide even greater benefit, is not progressing as well or as rapidly as anticipated.

In order to address these issues, the CBS ET-ABO recommends two important initiatives by WMO and CBS. Firstly, that an international Data Centre for aircraft based observations is established so as to provide the centralized and secure archival and availability of these observations for provisional use by the aviation and meteorological communities. ET-ABO has developed a set of requirements for such an Aircraft Based Observations Global Data Centre and determined that the NOAA Meteorological Assimilation Data Ingest System (MADIS) platform can currently best meet these requirements. NOAA has agreed in principle to such an undertaking. Secondly, it is recommended that WMO and its technical commissions seeks a greater cooperation with key aviation organisations to more actively and widely promote the availability and use of aircraft based observations and participation in the AMDAR observing system.

Therefore, in order to increase the appreciation for, and the awareness of the WMO AMDAR observing system and to ensure greater use of aircraft based observations by the Air Transport Industry and other application areas, CBS is requested to:

1) approve the designation of the NOAA Meteorological Assimilation Data Ingest System (MADIS) as the WMO Aircraft Based Observations Global Data Centre; and

2) collaborate with the Commission for Aeronautical Meteorology in seeking the strong support and promotion by ICAO and IATA of the WMO ABO Global Data Center, participation in the WMO AMDAR programme and the provision of aircraft based observations by the Air Transport Industry.

Annex V – Report of Group I Breakout Sessions

Break out session – WVM Plan

DISCUSSION TEAM

Lead: A Hoff

Participants: S Taylor, B Ford, F Besson, G Meymaris, D Arodi, J Xu, D Body A Mouhtadi.

Brief

Review WVM plans and add details and update to activities and tasks – which will feed into the update to ET-AO Work Plan.

Group discussion

A Hoff introduced the Tasks in the Work Plan and provided an overview for the team.

The meeting starting by reviewing documentation relating to Task 4.

- The summary content was accepted. Request for plenary to review section 3 Stakeholders to ensure capture of relevant stakeholders.
- Subtasks;
    - Sensor Validation Process – listed priorities to the subtasks
        - Reports on test flight campaigns – FAAM aircraft still requires the swap over of the two sensors – this is still awaited. DENCHAR results available. **Task completed**.
        - Intake and outlet gadgets – Need to confirm dataset from 3 years ago would be comparative to swap-over data on WVSS sensors. FAAM aircraft now has WVSS flush and Rosemount along with TAMDAR. Again awaiting information from Met Office. **A Hoff assigned** to start Q1 2017
        - Gaps in current testing – sensor reporting is seen as being met for the full spectrum of atmospheric conditions. The issue of calibration was discussed and WVSS provided information on process in the dual chamber testing (sensor and SEB). **A Hoff assigned** to start Q1 2017
        - Impact Studies – there are many positive studies available and these should be collated and referenced in an article in the WMO Newsletter and any other document that needs to meet WMO standards. **S Taylor assigned** to start Q3 2016.
        - Produce paper summarising validation status – WVSS validation paper produced by **B Ford and now awaiting re-compilation**. TAMDAR validation to be **assigned to Panasonic, N Jacobs**.
        - Compliance with CIMO Guide – WVSS (and TAMDAR) data are being assimilated and meeting parameter criteria. The credibility of the data quality has been proved. **Assigned to DWD, NOAA and EUMETNET**
        - Initiate OSEs – this was not seen as a high priority and ET-AO should monitor any OSEs carried out by other NWP centres. **S Taylor assigned**
        - Alternate measurement principles - with references to DENCHAR it was suggested that we could perhaps **enrol the assistance from a research facility (e.g. Juelich)** as they have experience in studying humidity? **A Hoff assigned**.
        - Validation of WVM methods – no issues with WVSS weight, power or robustness. Maintenance periods as per manufacturer specification and users have not indicated any issues. **B Ford assigned**.

- Define physical and aeronautical rules for WVM
  - Draft set of rules – position of sensor and air sampler type
  - Approval from flight test experts – contact identified experts.
  - Approval from flight operations experts – contact airlines and aviation engineering group. Implement comments in draft of rules.
    - These three subtasks **assigned to A Hoff and will be assisted by B Ford**. Completion date revised for a Q2 2017 completion.
- Standards for retrofit of WVM
  - Ask STC holders for sharing or offering access to STCs held. A list of STCs is available. The STC is specific to the aircraft type – if an airline procures a WVSS for B737 installation all documentation will be provided by SSI. In the case of an Airbus airline procuring WVSS, they will be directed to Lufthansa as STC holder. **A Hoff and B Ford assigned**.
  - Attaining new STC – need to discuss with AMDAR Programme and NMHS (if at national level). Suggest that the use of existing STC be used for expansion. **A Hoff and B Ford assigned**. Also look to WMO AMDAR webpage Resources documentation on WVSS STC and add list of STCs.
  - Commercial owners of STC – WVSS for Boeing is only valid in the USA – this would need some development and cost for EASA certification. **WMO**.
  - Cross agency recognition of STC. **WMO**.
  - Funding is an issue for STC development. Need to define programme requirement e.g. E-AMDAR looking at STC on A340. If only for national requirement, funded by NMHS. Suggestion of WMO AMDAR to facilitate a consortium of interested NMHSs and if requirements meet more than one NMHS look at shared funding. **Assigned to NMHS/Regional Programme. If seen as part of A-RIP also include ET-ABO**.
  - Maintain on-board software standards. AOSFRS etc, contact with aviation groups. **S Taylor assigned**.
  - Potential airline fleets. **S Taylor for Europe and D Lockett to co-ordinate other Global programmes**.
  - Maintain WVM systems compatible with data communications. Utilise existing aircraft infrastructure (429 interface). Look at data transmission methods from aircraft to ground e.g. IP. **Assigned to ET-AO to collaborate with Instrument Manufacturer**.
  - Funding for shared ACARS software development is recognised and need to be discussed further. **Assigned to D Lockett (WMO Trust Fund)**
- Motivation of airlines to operate WVM
  - Advertise AMDAR + WVM. **Ask WMO (CBS/ABOP) to contact existing airlines**. Investigate whether WMO PR department could assist?
  - Compile advantages for aviation. It was seen that ABOP should be a facilitator and promoter of all materials to assist NMHS in starting up AMDAR/WVM. **Assigned ET-AO (with assistance from ET-ABO)**.
  - Newsletter. WVSS articles informing readers of any advances and updated information. **ET-ABO**
  - Business case. Discussion on the different aspects of the business case for an airline as well as NMHS. Contact to be made with WVM operators who have convinced airlines to install WVSS – **assigned to**

F Besson and HR Sonnabend (E-HBC and DLH). Also assigned to NMHS – with an interest in WVM – to formulate business case from meteorological point of view and ET-AO to facilitate business case with airlines and ATM with emphasis on cost savings with addition of WVM.
        - Encourage airlines to advertise their use of AMDAR and WVM. **Assigned to A Hoff and E-AMDAR ET**. Suggest airlines promote AMDAR on their websites.
    - Implement measurement network
        - Meet requirements for WVM network and look at implementing data in QMS. **Assigned to JvM** to utilise his knowledge on QM issues.
        - Sensor supply and maintenance capability. **NMHS**
        - Acquire WVM global coverage by identifying aircraft types, fleet equipage and airline coverage. **NMHS/WMO**
    - Motivate NMHSs to join AMDAR with WVM
        - Convince NMHS by demonstrating advantages. **Assigned to WMO and Regional Associations**.
    - Consider future aircraft types
        - Identify aircraft types of new aircraft both short/medium and long haul. **B Ford tasked**.
        - Modification of new technology airframes e.g. carbon fibre. It was agreed that this should be a task for the sensor manufacturer and airlines keeping ABOP informed. There could be issues with aircraft manufacturer requesting reiteration of sensor. **Assigned to B Ford**.
        - Engagement of experts on carbon fibre aircraft to provide information on effort and cost estimation. **Assigned to B Ford**
    - Applications beyond retrofitting to existing aircraft
        - Identify future commercial airframes e.g. UAV. **Assigned to S Taylor**.

The meeting then reviewed documentation relating to Task 5.

Tasks were discussed and edited;

Subtasks;

- Aircraft prepared for retrofit installation of AMDAR and WVM.
    - Ask NMHSs to consider WVM capable aircraft within their AMDAR Programme. **Regional ABOP**.
    - Preparation of virgin aircraft. **Regional ABOP**.
        - Contact different airlines asking them to contact aircraft manufacturer about WVM
        - Look at airlines placing orders for the same aircraft type
        - Affordable financing models.
        - Enhancement to more aircraft types
    - **Assigned to regional ABOP**.
- WVM standard accessory in manufacturers catalogue.
    - Sensor to become a delivery item,
    - **Assigned to Regional ABOP and WMO**.
- WVM intrinsic to Flight Operations. **Assigned to WMO and ICAO**.
    - Involvement with aviation industry projects with improvement to safety regards icing.
        - SESAR and NEXTGEN

- Liaise with ICAO on necessity to include WVM in data flow and promote benefits and safety element of WVM and temperature.
- De-icing management and the economic benefits of using WVM as a form of icing warning system.
- Pricing negotiations. **WMO**

Task	Sub-task/Activity	Description	Responsible	Start	Complete
Sensor Validation Process	Produce reports on test flight campaigns	• Trace the continuation of WVSS-II tests on the BAe 146 of FAAM • Compile DENCHAR results			Completed
	Effects of intake and outlet gadgets	• Analyse WVSS-II tests on the BAe 146 of FAAM with regard to the thermodynamic and aerodynamic effects of different intake and outlet units	AH	Q1 2017	
	Determine Gaps in current testing	• Find out the physical ranges in the space of temperature, altitude and humidity having been missed up to now • Find out the instrument's resolution limits in the time scale	AH	Q1 2017	
	Impact studies	• Finalise and publish the impact paper (Petersen) • Investigate req. for new OSE's on WVM impact.	ST	Q3 2016	

Task	Sub-task/Activity	Description	Responsible	Start	Complete
	Produce paper summarising validation status	• Summarising validation of WVSS-II • Summarising validation of TAMDAR	BF NJ	Q2 2016	
	WVM principle to comply with CIMO guide requirements	• Check measurements against first guess background of numerical models	DWD, NOAA, EUMETNET,	Ongoing	
	Initiate OSEs	• Assess current and medium term requirements for OSEs • Work with IPET-OSDE to request OSEs to be performed	ST	Ongoing	
	Watch for alternate measurement principles	• Compile DENCHAR results with regard to instruments having been used besides of WVSS-II • Evaluate TAMDAR tests on Flybe fleet	AH, H. Smit	Q2 2016	
	Validation of the WVM methods with regard to the technical and operational requirements	• Minimize the sensor system's weight and power consumption • Test and if necessary increase the instruments robustness, stability and durability against the typical frame conditions of aircraft operation • Keep the measurement system's maintenance requirements in compliance with those for the aircraft	BF		
		•			
Define the physical and aeronautical rules for WVM integration on aircraft	Draft a set of rules	• Write a draft about the set of physical and aeronautical rules	AH	Q1 2016	By Q2 2017
	Obtain approvals from flight test experts	• Contact entities like DLR, FAAM, NCAR for revision of the draft • Compile the revisions for the rule book	AH	Q1 2016	By Q2 2017
	Obtain approvals from flight operation experts	• Contact airlines for revision of the draft • Contact aviation engineering entities for revision of the draft • Compile the revisions for the rule book	AH	Q1 2016	By Q2 2017
Standards for retrofit of	Ask NMHSs / AMDAR programs for sharing or offering the access to	• Establish and maintain directories of existing STCs • Negotiate with NMHSs and / or regional AMDAR	AH, BF		

Task	Sub-task/Activity	Description	Responsible	Start	Complete
WVM on AMDAR aircraft	existing STCs	programs and suppliers for sharing technical information from existing STCs. Negotiate with NMHSs and/or regional AMDAR programs for sharing the cost of getting existing STCs recognized in their nations/regions			
	Ask NMHSs / AMDAR programs for attaining STCs	• Consult NMHSs and / or regional AMDAR programs in attaining new STCs that will result in a significant implementation of WVM technologies. • Negotiate with NMHSs and/or regional AMDAR programs for sharing the cost of new STCs	AH, BF		
	Ask commercial owners of existing STCs (like the instrument manufacturers, airlines) for sharing or offering the access to	• Establish and maintain directories of existing STCs • Negotiate with the corresponding owners for sharing technical information from STCs that will allow airlines to consider installation	WMO		
	Ask commercial partners (like the instrument manufacturers, system integration providers or airlines) for attaining STCs	• Encourage the partners for attaining an STC for the WVM integration. • Develop a process for streamlining initiation of STCs • Achieve grants given by national/regional aviation regulatory authorities: CASA, EASA, FAA, JCAB,... • Develop an understanding of the processes for cross agency recognition of STC by aviation regulatory authorities; e.g. EASA recognition of an FAA STC. The system integration partners need access to the most practical ways to achieve STCs.	WMO		
	Funding	• Require a funded plan for STC attainment	NMHS/ Regional Program / ET-ABO		

Task	Sub-task/Activity	Description	Responsible	Start	Complete
Standards for retrofit of WVM on AMDAR aircraft	Maintain on-board software standards by initiation of corrections or amendments	• AOSFRS and ARINC 620 Keep in contact with AEEC • RTCA documents Keep in contact with RTCA • Keep in contact with DLUF • CIMO Guide and other WMO documents considering AMDAR including WVM	ST	Ongoing	
	Identify potential airline fleets	• The ground software either at the communication network provider or at the airline data management base has to be able to handle WVM data to transmit them to the NMHS or regional AMDAR program centre. Standards for this data transfer have to be drawn up in cooperation with ARINC and SITA	DL (global) ST (Euroope)	Ongoing	
	Keep WVM system compatible with communication units. In cooperation with RTCA, AEEC formulate a standard for interfacing between added systems and communication units	• The WVM output interface shall be compatible with the input part of the corresponding communication system. I.e. ACARS and ACMS have ARINC 429 interfaces. • The WVM output data stream shall be readable by the operational AMDAR software. Only the technical work of the installation should be necessary to implement WVM measurement within an AMDAR programme. • WVM installation on AMDAR aircraft should be able to be accomplished with a standard configuration of the WVM system and not require redesign for each airline implementation. The output data interface of the WVM system shall be compatible with the input interface of aircraft communication systems like ACARS or ACMS.	Instrument Manufacturers		
	Obtain fundings for the elements of the plan being relevant to costs.	• ACARS software complying with AOSFRS, ARINC 620, AAA • STCs for the WVM instrumentation of AMDAR aircraft	DL		

Task	Sub-task/Activity	Description	Responsible	Start	Complete
		• Adaptation of the infrastructure of the communication providers and the airlines to achieve measurement data supply for NMHS or regional AMDAR projects.			

Task	Sub-task/Activity	Description	Responsible	Start	Complete
Motivate airlines to operate AMDAR plus WVM	Advertise the idea of AMDAR plus WVM towards the appropriate airlines	• Write generic letter from WMO/CBS to existing AMDAR airlines to request participation in the WVM project. • Prefer large airlines in the advertising activities	WMO PR Department		
	Compile material about advantages generally for the aviation	• Compile arguments • Refer to WMO reports like The Benefits of AMDAR Data to Meteorology and Aviation, WMO Technical Report No. 2014-01 • Compile material about internal justification of advantages used by the participating airlines - Refer to justifications used by UPS - Refer to justifications used by SWA - Refer to justifications used by DLH	ET-ABO / ET-AO		
	Article on WVM in each AMDAR Newsletter produced.	• Compile all articles	ET-ABO	Ongoing	
	Build the Business Case	• List the amount of savings being achievable in the flight operation by a more immediate and more precise awareness against fog, winter weather, convective weather, or other severe weather occurrences • Develop a true financial Business Case model for WVM that an airline can adapt to their operations, with standard financial metrics that will appeal to airline executive management • Decide about the commercial structure of purchasing the service of AMDAR plus WVM. The question is, if a NMHS or a regional AMDAR program directly approaches the airlines and WVM manufacturers or if it gives the complete coordination job to a separate institution like a communication service provider or another System Integration partner with	HRS/ FB NMHS/ Airports	Q1 2016	

Task	Sub-task/Activity	Description	Responsible	Start	Complete
		the appropriate know how in the aviation and meteorological communities.			
	Encourage airlines to advertise with their meteorological activities.	• Suggest to the airlines several possibilities for advertising in cooperation with the corresponding NMHS and / or WMO • Logo sharing of WMO and national/regional NMHS • Reference public material about advantages realized by the participating airlines - Refer to media published by UPS - Refer to media published by SWA • Factor the value of media relations into the WVM Business Case model.	E-AMDAR/ AH	Q2 2016	
Implementation of a sustainable measurement network that meets user requirements	Meet WMO requirements (OSCAR Rolling Review of Requirements) for upper air WVM	• Quality Management System	JvM		
	Assured sensor supply and maintenance capability	• enable sufficient implementations to ensure a viable business case for sensor suppliers • The maintenance capability shall be transferable to each NMHS or regional AMDAR programme. Dependencies on one single laboratory of the instrument's manufacturer have to be avoided.	NMHS		
	Get WVM global coverage at required spatial and temporal distribution by 2025	• Introduce widespread optimising systems • Select AMDAR fleets regarding - aircraft types - features of fleet size and equipment - airline's coverage and persistence	NMHS/ WMO		
Motivate NMHSs to join AMDAR plus WVM	Convince other NMHSs by demonstrating the advantages	• Address other NMHSs - actually not participating in AMDAR and - whose national area is sparsely covered by other AMDAR fleets	WMO	Q1 2016	

Task	Sub-task/Activity	Description	Responsible	Start	Complete
Consider future aircraft types	Identify applicable models of new aircraft	• Determine the current and upcoming new aircraft models for which obtaining an STC is strategically desirable	BF		
	Identify institutions with an expertise about modification of airframes such as carbon fibre, composite materials, etc.	• Investigate the community of parts suppliers and developers. • Compile the appropriate institutions and companies.	BF		
	Engage experts for cost estimates about modifications of carbon fibre airframes	• The scenario of WVM integration in existing carbon fibre airframes has to be drafted. • The effort and corresponding costs have to be estimated.	BF		
Future applications beyond the frame of retrofitting to existing commercial aircraft	Identify institutions with an expertise in future commercial airframe designs such as supersonic aircraft, sub-orbital aircraft, Unmanned Vehicles	•	ST	Ongoing	
	Series adaption to WVM This part of the strategy is described under Task No. 5 “AMDAR and Water Vapour Measurement as Standard Accessory on Commercial Aircraft”	• Collaborate with partner airlines to request that WVM capabilities be included in the requirements for new aircraft acquisitions, or at least as an optional item. • Encourage aircraft manufacturers to implement a reliable Water Vapour measurement system as standard equipment on new aircraft. As standard equipment the collection of WVM data would be dramatically simplified, and be comparable to the standard AMDAR implementation.			

Break out session – Turbulence Plan

DISCUSSION TEAM

Lead: G Meymaris

Participants: S Taylor, A Hoff, F Besson, D Body, S de Haan, G Ilboudo , B Ford, J Xu, A Mouhtadi

Brief

Review Turbulence IP and add details and update to activities and tasks – and provide update to ET-AO Work Plan

Group discussion

Sub tasks;

Identify airlines.

The Task be changed to “Develop Pilot Projects”

- Interaction with AMDAR Programme Managers.
  - Discussion regarding E-AMDAR mandate from EUMETNET
- Facilitate EDR reporting integration.
  - **Assigned to G Meymaris**.

Integration of EDR

- Updating of documentation.
  - **Assigned to ABOP and D Body**

Pursue to include EDR as avionics package.

- Dialogue with avionics vendors etc.
  - **ABOP**

Determining EDR requirements.

- Engagement with FAA etc.
  - **G Meymaris and ABOP representation on relevant committees**

Develop strategies and materials for promotion of EDR

- Compile list of aircraft avionics.
  - **Assigned to Regional Programme managers**.
- Develop online project space. Assume this means WMO web?
  - **WMO AMDAR System?**
- Outreach.
  - Business case – focus on airlines. Regional programme managers to canvas respective airlines. If there is a requirement, business case can then be drafted to meet requirements of airlines and downstream for WAFC, NMHS and other data users. **ABOP?**
  - ABO Newsletter. **G Meymaris**.

Task	Sub-task/Activity	Description	Responsible	Start	Complete
Develop pilot project(s) including E-AMDAR	Identify airline(s)	• Interact with AMDAR programme managers to encourage dialogue with respective airlines and their met. services regarding promotion of future availability of EDR and possibilities for use. • Meet with E-AMDAR and other regions and prospective airlines regarding participation in pilot projects. • Identify potential airlines based on interest, available aircraft type and avionics to target for EDR pilot project.	GM,ST,DB,others?	Q1 2016	
	Facilitate EDR reporting integration	• Provide EDR reporting software package • Participate in telecons to facilitate integration of EDR reporting software package into ACMS • If necessary, assist with tuning/validation • Assist in data flow and determining path of operational use	GM	Ongoing	
Integration of EDR reporting into AMDAR software	Update Documentations as necessary	• Update documents such as the ARINC620 specification and AOSFRS	ABOP,DB,GM,DL	Ongoing	

Task	Sub-task/Activity	Description	Responsible	Start	Complete

Pursue to include EDR as avionics package (likely as part of an AMDAR package)		• Continue dialog with avionics manufacturers, including:
		  • Boeing
		  • Teledyne
		  • Honeywell
		  • Others?
		• Discuss potential benefits of inclusion
		• Provide EDR reporting software package
		• Participate in telecons to facilitate integration of EDR reporting software package into ACMS
		• If necessary, assist with tuning/validation
			GM,DL	Ongoing	

Determining EDR Requirements		• Engage with other organizations, committees, agencies (such as FAA, RTCA 206 SG4) that are actively engaged in requirement for application/data use and data flow (including decoding, quality control, and dissemination) • Incorporate the relevant objectives and outcomes of the FAA EDR Technical Transfer and FAA EDR Standards projects. • Engage with other data users as necessary	GM,ST and DL (as Members of RTCA 206-SG4)	Q1 2016	

Task	Sub-task/Activity	Description	Responsible	Start	Complete
Develop strategies and materials for promotion	Compile a general list of aircraft/avionics combinations from interested airlines	• EDR software/initialization parameters generally needs to be integrated and tuned separately for each aircraft type (sometimes family) and avionics combination. Targeting combinations that are advantageous (geographic distribution, numbers of potential aircraft) will be critical. • Reach out to different participating airlines to compile lists.	regional program managers	Ongoing	
	Develop online project space (incorporate with ABO/AMDAR development project).	•	DL		
	Outreach	• Regional program managers contact airlines and discuss impacts of turbulence on their operations • Develop airline business case materials. • Article in ABO Newsletter.	GM, CW, regional program managers	Q1 2016	

The group discussed the list of stakeholders. The matter of whether ATM would directly use EDR data was discussed.

Also to expand airlines to mention pilots and meteorological services.

STAKEHOLDERS

9.1 Data Users

- Airlines (pilots, dispatchers, met. dept.)
- Turbulence Forecasting/Nowcasting tools (NWP).
- Wake Vortex entities
- Aviation meteorology (National met. services)
- Air Traffic Management?

9.2 Contributors/Commercial Service Providers

- EDR Algorithm/software developers
- Airlines
- Data Service Providers
- Communications service providers
- Avionics manufacturers

9.3 Aviation standards entities

- ICAO
- RTCA
- DLUF

9.4 Contributors

- Airlines
- Government Agencies/Regulators (e.g. FAA)
- Avionics vendors and applications developers

9.5 Beneficiaries

- Air Traffic Management
- Flight management entities (e.g. weather display)
- Air navigation authorities/organizations
- NWP and other data user and applications entities (e.g. wake vortex community)
- Research communities (e.g. universities)