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COMMISSION FOR BASIC SYSTEMS

OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

Expert Team on Aircraft-Based Observing Systems

24 – 26 May, 2017

Jakarta, Indonesia

FINAL REPORT

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Annex V – Updated Work Plan for ET-ABO 1

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MEETING AGENDA

1. Opening

- 1.1. Adoption of agenda
- 1.2. Schedule

2. Report of the Chair

- 2.1. Status of the Work Plan
- 2.2. WIGOS and Technical Commissions Interaction and Issues
- 2.3. New Issues

3. Regional and National Reports

- 3.1. Region I
- 3.2. Region II
- 3.3. Region III
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4. ABO Program Development

- 4.1. Collaboration with IATA
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- 4.3. B777 Software Status and Development
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- 4.5. Turbulence monitoring
- 4.6. ADS Status and Development
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- 4.8. UAVs

5. Standards, Data and Quality Management

- 5.1. Technical regulations development
- 5.2. Data Quality Monitoring
- 5.3. Data Management

6. Outreach and Capacity Development

- 6.1. Regional Associations collaboration
- 6.2. Workshops
- 6.3. Aviation interaction
- 6.4. Newsletters, learning module, websites and social media

7. ET-ABO Work Plan Review

8. Any Other Business

9. Final Report

10. Close

EXECUTIVE SUMMARY

The third session of the Commission for Basic Systems (CBS), Expert Team on Aircraft-Based Observing Systems (ET-ABO), was held over the 24 to 26 May at the headquarters of the Agency for Meteorology, Climatology and Geophysics (BMKG) in Jakarta, Indonesia. The Director-General of BMKG, Dr Andi Eka Sakya welcomed the meeting participants to Indonesia and the BMKG and thanked WMO for the opportunity to host the meeting of ET-ABO, following on from the WMO Regional Workshop on AMDAR for Region V, which was held over 22-23 May at BMKG.

This third session of the ET-ABO was also the first meeting of the team for the new CBS inter-session period (2017 - 2020) and the first under the new leadership of the Chair, Mr Curtis Marshall, USA, and Vice-chair, Mr Abderrahim Mouhtadi, Morocco.

This meeting was a particularly important one for the expert team, being the first opportunity to openly and formally discuss the possible future collaboration between WMO and the International Air Transport Association (IATA) on the operation of the AMDAR programme. While the discussion raised a number of issues to be subsequently addressed, the team welcomed and fully endorsed the establishment of the IATA-WMO Working Arrangement that had been approved by the 69th session of the WMO Executive Council and agreed to undertake to work with IATA on the development of the proposed Concept of Operations under which the AMDAR programme might function.

Other important matters discussed and decided upon included, the steps to finalise the newly approved WMO Guide to Aircraft-Based Observations and to maintain it in the future, the development of the WIGOS, OSCAR/Surface interface and metadata repository for aircraft-based observations, the EC approval of the designation of the Global Data Centre for Aircraft-Based Observations and the required actions for it to commence operations, and the update of the WIGOS Data Quality Monitoring System for ABO.

The meeting also provided participants with the latest information relating to the development of the AMDAR observing system and aircraft-based observations at the national and regional levels and also on the various technical areas, including AMDAR software development, water vapour measurement, turbulence reporting and derivation of data from other sources such as the Automatic Dependent Surveillance (ADS) and Mode S systems.

The meeting also discussed in detail and updated the work plan of the expert team, agreeing on priorities in various tasks and activities including technical development, data management, aviation interaction and outreach and others.

The WMO Secretariat and the ET-ABO thank Dr Sakya and the staff of BMKG for kindly hosting the meeting, for providing such an excellent venue and for the professional organisation of logistics for both the regional workshop and the meeting of the ET-ABO.

GENERAL SUMMARY

1. Opening

- 1.1.1. The third session of the Commission for Basic Systems (CBS), Expert Team on Aircraft-Based Observing Systems (ET-ABO), was opened by the Director General of the Agency for Meteorology, Climatology and Geophysics (BMKG), Indonesia, Dr Andi Eka Sakya on 24 May 2017 at the BMKG Headquarters in Jakarta, Indonesia. Dr Sakya welcomed the meeting participants to Indonesia and the BMKG and thanked WMO for the opportunity to host the meeting of ET-ABO, following on from the WMO Regional Workshop on AMDAR for Region V, which was held over 22-23 May at BMKG. Dr Sakya informed the meeting of the interest of Indonesia in the AMDAR programme and agreed that the Workshop had been informative and encouraging, particularly given the interest shown by Indonesian airlines in the benefits to both meteorology and aviation. Dr Sakya presented some of the challenges and priorities within Region V, suggesting that the availability of both financial and human resources was a significant issue. While there was a priority to develop fundamental capabilities and enhancements related to the implementation of the WMO Information System (WIS) and WMO Integrated Global Observing System (WIGOS), there was also a need to develop systems and applications related to service provision, such as those related to the WMO Global Framework for Climate Services (GFCS) and to marine and aviation services. It was clear that the AMDAR programme could contribute to the enhancement and improvement of such capabilities and services in Region V.
- 1.1.2. Mr Dean Lockett, Scientific Officer, WMO Secretariat, addressed the meeting, also welcoming meeting participants and thanking Dr Sakya and the staff of BMKG for kindly hosting the meeting, for providing such an excellent venue and for its professional organisation. Mr Lockett provided the participants with background information on WMO, CBS, the Open Programme Area Group on Integrated Observing Systems and also on the organisation and structure of the Aircraft-Based Observations Programme (ABOP). Mr Lockett welcomed the new leadership of the ET-ABO for this CBS inter-sessional period, Mr Curtis Marshall, USA, as Chair and Mr Abderrahim Mouhtadi, Morocco, as Vice-chair.

1.2. Adoption of agenda

- 1.2.1. The Chair of the team, Mr Curtis Marshall, then addressed the team and outlined the provisional agenda that had been proposed for the meeting, with the meeting agreeing to adopt the agenda as proposed and as given above.

1.3. Schedule

- 1.3.1. The meeting agreed also to work in plenary according to the proposed schedule.

2. Report of the Chair

2.1. Status of the Work Plan

- 2.1.1. Mr Marshall presented his report to the meeting, summarising the high priority tasks and activities from the work plan that had been agreed to by CBS and the ICT-IOS. In particular, Mr Marshall highlighted the following:
 - The proposed collaboration of WMO with the International Air Transport Association (IATA) on AMDAR, noting that this would be a major focus for the meeting under agenda item 4.1;

- The establishment of the Global Data Centre on Aircraft-Based Observations in collaboration with USA and the National Oceanic and Atmospheric Administration (NOAA);
- Updating and upgrading the functions of the WMO Lead Centre on ABO and the role of WMO ABO monitoring centres in support of the WIGOS Data Quality Monitoring System for ABO (agenda item 5.2);
- The holding of regional workshops on AMDAR (agenda item 6.2);
- Access to Automatic Dependent Surveillance (ADS) aircraft-based observations (agenda item 4.6); and
- The contribution of the ABOP to the development of WIGOS in its Pre-operational Phase (agenda item 2.2).

2.1.2. Mr Marshall also informed the meeting that, in response to a number of these important issues and also to ensure a smooth transition to the new leadership of ET-ABO, a meeting of some of the leadership of the ABOP, former Chair, Mr Frank Grooters and the WMO Secretariat had been held over 14-16 February 2017 at NOAA, Silver Spring, USA. This meeting had also discussed the work plan of the team, the budget for the ABOP and made preparations for the Region V regional workshop on AMDAR and the 3rd session of the ET-ABO.

2.1.3. The meeting was reminded that, while these tasks and activities were indeed high priority, the routine and ongoing work of the ET-ABO in continuing to expand and develop the AMDAR programme and aircraft-based observing systems in collaboration with Members and partner airlines, was a primary focus of the team. This work would continue to be coordinated in partnership with WMO Regional Associations as endorsed by WMO Congress (Cg-17) and as established within the ABOP Strategy and Implementation Plan and the ABOP Regional Implementation Plans.

2.1.4. Mr Marshall also thanked the team members and leadership group of the ET-ABO for the work that the team had done in the previous CBS inter-sessional period, which, in addition to advancing those tasks and activities outlined above, also included:

- The holding of regional workshop in Kenya (2015), Morocco (2015), Panama (2016) and the United Arab Emirates (2016); and
- The development and approval of revised and new regulations in the Manual on the GOS on Aeronautical Meteorological Stations and the new WMO Guide to Aircraft-Based Observations, which are expected to be published in late 2017 or early 2018.

2.1.5. Both Mr Marshall and Mr Lockett referred to the WMO AMDAR Operating Fund and the continued generosity of WMO Members in supporting the work of the ABOP work programme with contributions to the fund that totalled around 146K CHF and 64K CHF in 2016 and 2015 respectively. The fund therefore had an estimated balance of around 845K CHF as at February 2017. The Aircraft-Based Observations Programme Budget for the 2017-2018 Work Plan and Projection to 2020 (Version: 2017.1A, Approved, February 2017)¹ would support the work plans of both ET-ABO and that of the WMO Commission for Instruments and Methods of Observations, Expert Team on Aircraft Observations (ET-AO). In particular, the fund would support several consultancies to advance ABOP activities in 2017 including:

- AMDAR Development Officer consultancy for technical coordination for global AMDAR programme development under the WMO/EUMETNET Memorandum of Understanding;

¹ See : http://www.wmo.int/pages/prog/www/GOS/ABO/documents/ABOP_Budget_2017-2018_Version_2017.1A.pdf

- Consultancy for development of several deliverables including: i) AMDAR Benefit to Climate and the Environment paper; ii) review and update or rewrite the 4-page flyer, Benefits of AMDAR to Aviation; iii) Develop draft and script for new COMET module on the use of AMDAR data by and for meteorological applications; iv) Flyer on the Use of AMDAR Data in Aviation Meteorological Applications;
- Consultancy for coordination and delivery of 2 regional workshops on AMDAR in 2017; and
- Consultancy for development of the Concept of Operations for the Operation and Development of the AMDAR Programme Under the IATA-WMO Collaboration.

2.2. WIGOS and Technical Commissions Interaction and Issues

- 2.2.1. Mr Dean Lockett, the Secretariat, presented document 2(2) to the meeting, which provided relevant information on the WMO WIGOS Pre-operational Phase and also highlighted the key outcomes from relevant WMO Technical Commissions, focusing in particular on the 16th session of CBS (CBS-16).
- 2.2.2. In relation to WIGOS, the meeting was reminded that Cg-17 had approved five priorities for WIGOS in the Pre-operational Phase (2016 – 2019): 1) National WIGOS implementation; 2) WIGOS Regulatory Material complemented with necessary guidance material to assist Members with the implementation of the WIGOS technical regulations; 3) Further development of the WIGOS Information Resource (WIR), with special emphasis on the operational deployment of the OSCAR databases; 4) Development and implementation of the WIGOS Data Quality Monitoring System (WDQMS); and 5) Concept development and initial establishment of Regional WIGOS Centres.
- 2.2.3. In relation to these priorities, the session agreed that the following activities of ET-ABO and the ABOP would contribute to the Plan for the WIGOS Pre-operational Phase (PWPP):
 - The incorporation of AMDAR-related technical regulations specified in the version of the Manual on the Global Observing System (WMO-No. 544) approved by EC-69 in the Manual on the WMO Integrated Global Observing System (WMO-No. 1160) and the reference to the Guide to Aircraft-Based Observations from the WMO Guide to WIGOS;
 - Assistance in the development of the Aircraft-Based Observing System (ABOS) component of OSCAR/Surface, including the incorporation and management of ABOS metadata;
 - The further development and enhancement of the ABO Data Quality Monitoring System under the framework of the WIGOS DQMS; and
 - The definition and establishment of Regional WIGOS Centres for ABO, likely including centres supporting the ABO WDQMS and the Global Data Centre for ABO.
- 2.2.4. Mr Lockett informed the meeting that, while several decisions of the WMO Executive Council 69th session (EC-69) had related to the work of the ABOP and would be addressed specifically during the meeting, another matter that would likely later effect the work of the ABOP and the team would be the expected future decisions by EC and Congress to reorganise the WMO constituent bodies, with an expected outcome to be a reduction in the number of WMO technical commissions and work groups. With this in mind, the team and the programme was requested to consider in the future how the ABOP might accommodate such an outcome, with an obvious consideration being the possibility to merge the ET-ABO and ET-AO into a single WMO work group on ABO.
- 2.2.5. Mr Anthony Rea, Chair of the Implementation Coordination Team on Integrated Observing System (ICT-IOS), the parent team of ET-ABO then addressed the meeting providing guidance from the leadership of CBS and ICT-IOS on its work plan and

activities. In particular, Mr Rea informed the meeting that CBS-MG had identified a number of strategic priorities for the commission, including:

- i. Evolution of WIGOS towards the 2040 Vision, with RBON implementation and consideration of bringing benefits of WIGOS implementation;
- ii. Information management, and the development and implementation of WIS 2.0 in support of the wide basic systems requirements, and its interoperability with other systems;
- iii. Emerging data issues and new technologies, opportunities and threats;
- iv. Governance with: (i) increased focus from research to operations, (ii) increased focus on service delivery and the required competency framework to support it, (iii) clarification of the role of the Regional Associations in the implementation of the CBS work programme, and (iv) enhanced partnerships and clarifying the role of the private sector for the Weather/Water/Climate Enterprise; v. Seamless GDPFS development with strong emphasis on implementing recent research developments and supporting technologies (e.g. WIS 2.0); vi. Capacity Development and continued work on identifying the socio economic benefits of NMHSs; and vii. Increased focus on quality management.

2.2.6. Mr Rea suggested to the team that it was already contributing to these priorities in many ways within its work plan tasks and activities and so was already strongly aligned with these CBS aims.

2.3. New Issues

2.3.1. In his report to the meeting, Mr Marshall suggested that the collaboration with IATA was the highest priority new issue that the team must contend with in the near future and that this activity was likely to be a key driver for the further development of the AMDAR programme, particularly in upper-air data-sparse regions of the globe.

3. Regional and National Reports

The ET-ABO Region Leads provided a summary presentation of the status and development reports on national and regional ABO and AMDAR programme development for each of the WMO Regions in collaboration with WMO Regional Associations (RA).

3.1. Region I

3.1.1. Mr Francis Moseitho, South Africa, presented the report on national and regional ABO programmes for WMO Region I.

National Programmes

South Africa

3.1.2. The South African Weather Service (SAWS) was managing the South Africa AMDAR programme by checking daily data and noting whether data transmission from registered aircrafts is received at the data reception centres for processing. Data transmission challenges experienced during 2016 January 24-25 where SA-AMDAR data could not be retrieved from the archives were addressed through existing collaboration between the SAA, SAWS and UK Met.

Regional Development

3.1.3. The meeting was reminded that the draft Aircraft Based Observation Programme Regional Implementation Plan (A-RIP) for Region I had been presented to the 16th

session of RA-I (Cabo Verde, February 2015) as an information document and that the RA-I Regional Conference (RECO) held prior to the RA-I session had been informed about the regional approach to ABO development and implementation endorsed by CBS (and later by Congress, Cg-17). The RA session 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 (ABO) systems in the Region but did not complete the process by altering the structure of the RA to create a working group on ABO. At the 3rd Session of the African Ministerial Conference on Meteorology (AMCOMET), (Cabo Verde, February 2015), AMDAR was adopted as a Flagship Programme (3) within the adopted Implementation and Resource Mobilization Plan of AMCOMET.

- 3.1.4. Regional Workshops on AMDAR were held in Nairobi, Kenya in June 2015 and Casablanca, Morocco in December 2015.
- 3.1.5. Following on from these workshops, progress had been made in the plans for development of an AMDAR program with Kenya in cooperation with Kenya Airways, with WMO seeking support for the development with a grant from the Department for International Development (DFID) under its Weather and climate Information and SERvices for Africa (WISER) programme. It was expected that this development would now commence in the 4th quarter of 2017.
- 3.1.6. Following on from the workshop and the 2nd session of ET-ABO hosted by the (Direction de la Météorologie Nationale of Morocco (DNM), in Casablanca, Morocco (7-11 December 2015), DMN hosted a meeting with Royal Air Morocco (RAM), WMO and EUMETNET on 23 February 2017. At the meeting RAM agreed to cooperate with DMN and EUMETNET as an additional airline partner in the E-AMDAR programme. This development was expected to progress in the 2nd half of 2017 towards an operational programme by later 2017 or early 2018.
- 3.1.7. The Meeting also noted that Ms Gabo Khambule attended the Aviation Stakeholders Convention organised by the African Airlines Association (AFRAA) at the Medina Mediterranea in Yasmine Hammamet - Tunisia, from 7 - 9 May 2017. The ET-ABO and WMO wish to thank Ms Khambule for this and her previous commitments to promoting AMDAR in Africa.

3.2. Region II

- 3.2.1. Mr Yiu-fai Lee, Hong Kong China, presented the report on national and regional ABO programmes for WMO Region II.

National Programmes

- 3.2.2. There were currently four operational AMDAR programmes in RA-II, operated by (1) China, (2) Hong Kong, China, (3) Japan and (4) the Republic of Korea.
- 3.2.3. China indicated that the AMDAR report format on GTS would be changed from FM42 to BUFR in December 2017.
- 3.2.4. In Hong Kong, China, the previous way to receive AMDAR reports directly from aircraft through the ARINC air-ground and ground-ground links ceased. The AMDAR reports are now received by the participating airlines and then routed to the Hong Kong Observatory (HKO) via a Message Queue channel established over the internet. While there is no significant difference in terms of timeliness, the new communication method is considered financially more competitive.
- 3.2.5. Furthermore, Hong Kong, China is working along with Cathay Pacific Airways and Cathay Dragon to include additional A330 and B777 expanding the AMDAR fleet. As at

10 May 2017, the number of AMDAR aircraft in Hong Kong, China AMDAR Programme is expected to be increased to 36 when the data quality of 27 additional aircraft has been confirmed.

- 3.2.6. Hong Kong, China was going to adopt the recommended BUFR template in the "New Guide to Aircraft-based Observations".
- 3.2.7. Japan will introduce temperature bias correction method in the Meso-Scale Model and the Local Forecast Model data assimilation systems in order to bring positive impacts on the models. Meanwhile, the Japan Meteorological Agency (JMA) and Electronic Navigation Research Institute have conducted collaborative research to assimilate wind vector and temperature data derived from SSR mode-S. Recognizing the characteristic of the data bias, a data quality control technique is now being developed. Similar initiatives on retrieving aircraft-based observations through MODE-S surveillance were mentioned by Hong Kong, China and United Arab Emirates.

Regional Development

Potential AMDAR programme development in West Asia

- 3.2.8. A WMO WIGOS/AMDAR workshop for West Asia was held on 4 November 2016 in Abu Dhabi, United Arab Emirates (UAE). Invited participants from four Gulf countries have attended the workshop. From the final report of the workshop, Saudi Arabia undertook to lead the regional approach to AMDAR development in West Asia and to investigate the use of the Gulf Cooperation Council forum to promote the AMDAR programme.
- 3.2.9. Referring to the national ABO programme report submitted by UAE, National Centre of Meteorology & Seismology of UAE was investigating the implementation of AMDAR within UAE Flight Information Region and the possibility to transmit aircraft-based observations received from Etihad Airways on the GTS in BUFR format.
- 3.2.10. According to a news report, the technical director of Directorate General of Meteorology (DGM) of Oman revealed that DGM was considering discussing the matter with Oman Air on how they could take this (AMDAR) initiative forward.

Regional Coordination and Implementation Planning

- 3.2.11. In RA-II 16th session, the RA adopted draft resolution 5.2/8 "Pilot Project to Develop Support for National Meteorological and Hydrological Services in the Collection and Application of Aircraft Meteorological Data Relay data" and established a task team on Aircraft Based Observations under the Expert Group on WMO Integrated Global Observing System (EG-WIGOS). According to the terms of reference, the task team will "in collaboration with Regional Members and the CBS ET-ABO, develop a regional implementation plan for aircraft-based observations and AMDAR as a component of the Regional WIGOS Implementation Plan".

3.3. Region III

- 3.3.1. Mr Nicolas Rivaben, Argentina, presented the report on national and regional ABO programmes for WMO Region III.

National Programmes

Argentina

- 3.3.2. Currently the Argentina AMDAR program is operated in partnership with LATAM, with 5 Airbus A322 using an improved on-board software system and basic quality control. The programme became an operational programme in July 2016 and derives around 1000 messages daily and around 1600 soundings per month being processed by the Servicio Meteorológico Nacional (SMN). Data quality was being analysed by the Canadian Meteorological Centre (CMC) and the Met Office (UK).

- 3.3.3. By 2017-18, Argentina expected to expand its programme with the Aerolíneas Argentinas E190/195 fleet using their upgraded avionics and a suitable software application. This was expected to be accompanied by other initiatives, including the development of a data optimisation capability and assimilation of LATAM/Aerolíneas Argentinas data into the AR-WRF model.

LATAM Programme

- 3.3.4. The LATAM fleet began reporting in September 2016 and is currently providing data from around 166 aircraft, delivering around 40,000 observations per day. The development of this programme had been instigated and funded by NOAA until September 2017, with an expectation that this would be extended into 2018. The data from LATAM were being provided in essentially the same way as the USA MDCRS AMDAR data in collaboration with Rockwell Collins.
- 3.3.5. The meeting discussed the sustainability of the LATAM programme and agreed that there needed to be dialogue between relevant Members of Region III to ensure that continuation of the programme might be assured and resourced in the future and that this should be discussed at the next teleconference relating to the Region III A-RIP. It was also agreed that the Secretariat should write to NOAA to thank it for its support for the programme and to encourage continued support.
- 3.3.6. The meeting agreed that the development of the LATAM programme and its support by NOAA had led to a significant improvement in coverage over South America and that the impact on forecast skill, both regionally and globally was likely to be significant. It was expected that, while these data were not yet being assimilated into the US regional model, a study to measure the impact was likely to be undertaken by NCEP in collaboration with the University of Wisconsin. ET-ABO would report on the results of this and any other related studies.

Regional Development

Brazil

- 3.3.7. The Department of Airspace Control (DCEA), Brazil, provided input to the report regarding the status and development of the aircraft-based observations programme in Brazil. The Brazilian International OPMET was sending ADS-C data automatically to the World Area Forecast Centres, WAFC Washington (KWBCYYX) and London (EGRRYMYX) in accordance with Annex 3 of ICAO, with more than 40,000 messages being collected per month over the Atlantic Flight Information Region.
- 3.3.8. It was expected that a comprehensive SITA VHF datalink network over Brazil would be fully operational by the end of 2017.
- 3.3.9. There were 4 large airlines in Brazil with ACARS-equipped aircraft that might potentially contribute to the AMDAR programme in the future. The DCEA has been working with TAM Airlines (LATAM) and SITA on the development of an AMDAR programme using 7 A319 and 22 A320 aircraft and BUFR format exchange.
- 3.3.10. The meeting also discussed whether the availability of data over Region III was well known and whether it was being utilised. It was agreed that there might be benefit in developing a version of the NOAA AMDAR portal in Spanish.

3.4. Region IV

- 3.4.1. Mr Curtis Marshall, United States of America, presented the report on national and regional ABO programmes for WMO Region IV.

National Programmes

United States of America

- 3.4.2. The United States National Weather Service (NWS), in collaboration with the Federal Aviation Administration (FAA) and Rockwell Collins/ARINC (RC/A), continued to support the WMO Aircraft-Based Observations Programme (ABOP) through its contribution from the Meteorological Data Communications and Reporting System (MDCRS) and Water Vapor Sensing System (WVSS-II) programs.
- 3.4.3. The US was continuing to coordinate airline implementations within the network leading to growth in AMDAR/MDCRS coverage over the data sparse areas in the US and also expanding to Mexico, Latin America, and adjacent oceanic areas in the Pacific. In addition to AMDAR/MDCRS development, RC/A has also facilitated a recent expansion in availability and coverage from Automatic Dependent Surveillance Contract (ADS-C) data, which were now available for assimilation into NWS and international forecasting models.
- 3.4.4. These recent aircraft-based observations developments have had significant positive impact both on the regional and global coverage and on NWS weather forecasting skill and contribute to improvements in the accuracy of weather forecasts for aviation, all other applications and the general public.
- 3.4.5. Rockwell Collins/ARINC has completed updating its data processing and dissemination system so as to comply with the latest Binary Universal Form for the Representation of meteorological Data (BUFR) standard for provision of aircraft data on the WMO Global Telecommunications System (GTS). ABO data in BUFR v7 format was now being transmitted on the GTS and accepted by NWS's National Centers for Environmental Prediction (NCEP) for use in its forecasting models.
- 3.4.6. In collaboration with Boeing/Teledyne and Southwest Airlines (SWA), Rockwell Collins/ARINC also has successfully tested the new factory-released 737-MAX avionics software. Having this upgrade configured in the onboard software prior to delivery acceptance allows for a more streamlined configuration and reporting of the ABOP data.
- 3.4.7. From 2015, the US began procuring a limited subset of the TAMDAR aircraft-based observations of wind, temperature, and relative humidity from Panasonic, Inc. In 2017, this procurement was significantly expanded to include approximately 3500 soundings per day, from the surface to cruise level, with a vertical resolution of 20 mb. As of summer 2017, these data are operationally assimilated into NCEP's high resolution mesoscale and storm-scale numerical weather prediction systems, such as the High Resolution Rapid Refresh (HRRR) model. Based on previous research, it is expected that these data will lead to significant improvements in the forecast skill for these models, whose output is freely available to all WMO partners.
- 3.4.8. There were currently 142 WVSS-II equipped aircraft operating in the US MDCRS/AMDAR network. The airlines and aircraft on which these units were installed covered approximately 15 nations in WMO Region IV on a routine basis, with less frequent reports available from other regions. Thus, the US WVSS-II network is supporting international weather forecasting services in the region, resulting in improved forecast services and increased aviation safety globally.
- 3.4.9. At the recent American Meteorological Society (AMS) Annual Meeting in January 2017, multiple presentations covered current research into the benefits provided to forecast operations through the use of ABO data with Water Vapour Measurement (WVM). The meeting included presentations on topics such as "The Use of AMDAR Observations for Verifying Cloud Ceiling and Icing Forecasts" and "Geographic and Seasonal Variability of Accuracy in Water Vapor Measurements from WVSS-II." Other presentations discussed the benefits ABO WVM has provided to numerical weather prediction models, such as "Observation System Experiments with the Hourly-Updating Rapid Refresh (RAP) Model Using GSI Hybrid Ensemble/Variational Data Assimilation" and "RAP and HRRR Model/Assimilation System Improvements for Aviation Weather Applications: Latest Upgrades and Ongoing Work".

Canada

- 3.4.10. NAV CANADA and Jazz (operated under Air Canada Express) continue to be the only active AMDAR data contributors to the Canadian AMDAR Programme.
- 3.4.11. Jazz AMDAR CRJ-200 aircraft were being retired and partly replaced by DHC-8-Q400 (44 as of April 2017). Jazz also operates 26 DHC-8-300 and 16 DHC-8-100 aircraft which could potentially resume their contribution to the Canadian AMDAR Programme if Jazz decided to upgrade their Universal Unilink software to get rid of a mis-coded temperature data smoothing algorithm with the current version. Jazz upgraded their UL software on the DHC-8-Q400 but these are not fitted for AMDAR because of the temperature probe on all DHC-8 models.
- 3.4.12. NAV CANADA operates 2 AMDAR-capable CRJ-200 aircraft and 1 DHC-8-100 for unscheduled Flight Inspection at most Canadian airports (about 2 annual visits per Canadian airport).
- 3.4.13. AMDAR potential through major Canadian airlines engagement is being re-evaluated to identify potential options for establishing an expanded and sustainable Canadian AMDAR programme. This phase approach engagement is in progress while further developments were expected later in 2017.

Regional Development

Improved Coverage over South America

- 3.4.14. Over the last year, NWS has expanded into Latin America with LATAM Airlines providing much-needed upper-air wind and temperature data in that region. LATAM began reporting in September 2016 and currently was providing data from 166 aircraft, delivering approximately 50,000 additional observations daily. It was expected that the LATAM fleet would expand to more than 200 aircraft over the coming months.

3.5. Region V

- 3.5.1. Mr Douglas Body, Australia, presented the report on national and regional ABO programmes for WMO Region V.

National Programmes

- 3.5.2. AMDAR programmes in New Zealand and Australia provide approximately 10k AMDAR observations per day on the GTS from 118 AMDAR equipped aircraft. These programmes have remained stable since the previous ET-ABO session but key changes are expected to both over the next 6-12 months.
- 3.5.3. New Zealand will change its area of AMDAR data collection to 160E – 155W, 10S-50S which will allow profiles to be collected from Nadi, Niue, Rarotonga and Apia.
- 3.5.4. Australia has finished flight testing AMDAR software based on the AOSFRS specification for Qantas Airbus A330 aircraft, which will soon be rolled out to 23 Qantas A330-200 and A330-300 aircraft over the coming months. Initially, DEVG will be the turbulence metric reported but this will be updated to EDR when technical issues with implementing the algorithm on Airbus aircraft are resolved.

Regional Development

- 3.5.5. A RA V Task Team on Aircraft Based Observations operates under the RA V Working Group on Infrastructure. The full Working Group was meeting monthly by videoconference.
- 3.5.6. A very successful AMDAR Benefits Workshop was hosted by BMKG, Jakarta on 22-23rd May involving more 75 participants, and including representatives from airlines, RA V NMHS, members of the ET-ABO and Indonesian Air Safety and Navigation Authorities. Encouraging discussions were held with the Indonesian airlines with BMKG requesting

the further help of WMO and CBS in the establishment of an AMDAR programme in Indonesia. A report of the workshop will be made available from the WMO Aircraft-based Observations website.

3.6. Region VI

- 3.6.1. Mr Steven Stringer, United Kingdom, presented the report on national and regional ABO programmes for WMO Region VI.

National and Regional Programmes

E-AMDAR Programme

- 3.6.2. Since 1st January 2013, the Met Office has had responsibility for management of the E-AMDAR programme on behalf of the 31 members of EUMETNET. This responsibility includes a commitment to achieving the objectives for the programme, which includes:
- Continued, sustainable access to high quality upper air observations from commercial aircraft;
 - Delivery of the Extended Humidity Trial and a business case - setting out the investment options and related costs for an extension of capability to include humidity data;
 - Increased number of airports providing 3-hourly observations;
 - Increased horizontal coverage in data sparse areas; and
 - Flexibility to facilitate additional data required by individual NMHSs.
- 3.6.3. In addition to European area observations, E-AMDAR continues to contribute to ABO observations outside the European area towards data provision supporting the World Weather Watch Programme (WWW) and also based on contracted provision of data under bilateral arrangements.
- 3.6.4. Overall the performance has consistently been meeting and exceeding targets with the occasional in-month anomaly due to ad-hoc infrastructure issues. The majority of effort on operations has been taken by trying to balance the total number of observations purchased against increasing data costs (caused by continuing strong USD against the Euro). As such, for the first time in the current phase the total number of observations generated had reduced in 2016 from the previous year, 2015.
- 3.6.5. In 2016 the Boeing B777 long haul fleets for Air France and British Airways were implemented within the E-AMDAR programme in order to replace older fleets which are being superseded by these aircraft, such as B747s. The B777s have supported the recovery of the contribution to WMO WWW, which is now comfortably within required performance levels.
- 3.6.6. Network airline coverage remained fairly stable over the recent period, however 2 airlines have been removed from participation in E-AMDAR during 2016, namely Blue1 and Novair.
- 3.6.7. The planned installation of the Water Vapour Sensing System (WVSS-II) sensors for Lufthansa aircraft was completed with the final (9th) sensor being installed in May 2016. Data from all aircraft was now routinely being generated, monitored and provided to the GTS. While the majority of profiles are still being generated over Germany there are a significant number of profiles/observations produced other countries and across the entire EUCOS region. E-AMDAR was working with Lufthansa to find a solution to enable dynamic selection of where and when WVSS-II observations are made in order to reduce the over-reporting at German airport hubs.
- 3.6.8. The E-AMDAR Management Team, together with the E-AMDAR Expert Team, are actively trying to engage with some NMHSs to promote the WVM data availability and use and to obtain feedback on the benefits.

- 3.6.9. E-AMDAR was continuing to make and introduce developments based on efforts to maximise the number of observations and profiles generated within budget, including: improving coverage over data-sparse areas, such as Azores, Iceland, Baltic, East European and North African regions, engagement of new Airlines to cover above regions, reduction in coverage over data-dense areas, migration of AFR A320 and EZY fleets to E-ADOS for better data optimisation, strengthening of the business case for further investment in humidity observations, encouragement for airlines to report EDR (eddy dissipation rate) turbulence, discussions with Panasonic for access to their European TAMDAR (humidity) data and maintaining and developing the E-AMDAR portal which supports monitoring and accounting for the programme.
- 3.6.10. Additionally, a number of issues and objectives have been identified for the E-AMDAR programme that will drive future plans and related developments over the next few years, including: determining aircraft observing requirements for the next EUMETNET programme phase (2019-2023) taking into account expected developments to alternative forms of aircraft based observations, including Mode-S (EHS &MRAR), satellite ADS-B and ADS-C, and others, more timely delivery of aircraft data in support of Short Range NWP and cooperation with the In-service Aircraft for a Global Observing System (IAGOS) Project.

Regional Development

- 3.6.11. A short online questionnaire survey was drafted & finalised in early 2017 and passed to the RAVI regional office to be sent out to Members. Although only a few responses were received, these would be analysed and addressed accordingly over the coming months. Depending on feedback and the level of interest it might be advantageous to consider holding a regional workshop for Region VI later in 2017 or in early 2018.
- 3.6.12. The Israel Meteorological Service has previously approached WMO ABO and E-AMDAR regarding the possibility of commencing an AMDAR programme with the national airline, El AL, in cooperation with E-AMDAR.
- 3.6.13. The survey response from Russia indicated that a national AMDAR programme was currently under development although no details of the plans were provided. A direct approach would be made with the respondent to potentially provide assistance and cooperation.
- 3.6.14. The meeting agreed that the ET-ABO should aim to update the Region VI A-RIP in order to present it at the RA VI session in September 2017.

4. ABO Program Development

4.1. Collaboration with IATA

- 4.1.1. Mr Lockett informed the meeting about the recent approach of the International Air Transport Association (IATA) to WMO regarding the possibility to collaborate together on the future operation and development of the AMDAR programme and the progress that had been made over the past 6 months in this endeavour.
- 4.1.2. In late 2016 Members of the Secretariat of IATA contacted WMO to inform that, at the behest of its member airlines, it had undertaken a study on the operation of the WMO AMDAR programme, which had made the following recommendations:
- 1) IATA to work with the WMO to expand the AMDAR program across the globe and establish a more equitable cost-recovery mechanism for the participating airlines; and
 - 2) IATA to set up a global turbulence database with real-time data transmission to airlines during flight operations.

- 4.1.3. During an initial meeting between representatives of the secretariats of WMO and IATA, held in Geneva on 12 December 2016, it was agreed that there appeared to be significant advantages and mutual benefits to their respective members, if a formal collaboration on the future operation of the AMDAR programme were to be established.
- 4.1.4. Over 2017, the following actions in relation to the IATA-WMO collaboration had occurred:
- At the ET-ABO, Management Group Ad Hoc Meeting, Silver Spring, USA, 14 – 16 February, 2017, members of the ET met with representatives of IATA and discussed in detail the proposed collaboration and the implications. The ET-ABO-MG agreed that the possible collaboration was a great opportunity for the AMDAR programme and its future development in much closer consultation with the air transport industry and that members from the ET should continue to work together with the IATA representatives to further explore the opportunities and risks. It was also agreed that consultation should be made with the leadership of the Secretariat and the technical commissions and that an ET-ABO subgroup should begin work with IATA on the formulation of a Position Paper that might define the IATA-WMO collaboration and its aims and objectives for possible approval and endorsement by the two organisations under a suitable agreement.
 - In early April, the Position Paper was advanced to the point where it was passed for review to the respective executive managers and legal counsels of the organizations and, while the IATA LC agreed with the formulation, the WMO LC recommended that the arrangement should be established as a Working Arrangement based upon the content of the Position Paper.
 - Subsequently, the WMO Executive requested that the Working Arrangement would best be put into effect through the endorsement of the WMO EC (EC-69) in May 2017 and a document was prepared in which the EC decision was requested and subsequently approved - Document 12.2(2), Potential Future Collaboration of WMO and IATA on the Operation and Development of the AMDAR Programme.
- 4.1.5. The proposed decision of the Executive Council by EC-69 would establish a Working Arrangement under which the two organizations would work together to develop the terms of reference and concept of operations, based on which a future collaboration on AMDAR might be defined and later approved by a subsequent decision of the Executive Council. Importantly, the EC Decision also made clear that, while under WMO Resolution 40, AMDAR data is defined as essential data, WMO Members understand that there currently are, and would be in the future, restrictions for their use and distribution imposed by the partner airlines as the owners of the data.
- 4.1.6. Subsequent to the establishment of the Working Arrangement between WMO and IATA, the organisations would then work together on further describing the possible terms of reference and the concept of operations under which the AMDAR programme might function in the future under a potential IATA-WMO collaboration.

Concept of Operations for IATA-WMO Collaboration on AMDAR

- 4.1.7. Based upon initial discussions, the development of the collaboration and CONOPs would likely explore and elaborate on the following concepts and ideas:
- 1) The centralisation of contractual arrangements and accounting for the operation of the AMDAR programme under the management of IATA and WMO on behalf of their members.
 - 2) The establishment of a jointly-managed AMDAR Programme Expansion Fund (APEF) that would support the further expansion and enhancement of the AMDAR programme, including turbulence monitoring and water vapour measurement.

- 3) A simplified and centralised fee structure that would support both the operation of the programme and its expansion and enhancement via the APEF and the shared availability of AMDAR data in accordance with WMO Resolution 40.
 - 4) Mechanisms for funding further AMDAR expansion and development, particularly for least developed and developing countries through the APEF. For example, grants, revenue from data commercialization by IATA, etc.
 - 5) Agreement by WMO Members to securely manage AMDAR data so as to protect the airline's ownership of the data.
 - 6) Encouraging and facilitating participation in the AMDAR programme, by all airlines, with a focus on those operating in currently data-sparse areas.
 - 7) Working with the aviation industry, including equipment manufacturers and data service providers to encourage greater efficiencies and cost reductions in the development and deployment of AMDAR infrastructure and services, such as for example, AMDAR software and data communications.
 - 8) Expansion of turbulence monitoring and support by IATA for its enhanced utilisation by airlines operationally.
- 4.1.8. Based on the decision of the ET-ABO-MG, a subgroup of ET-ABO, hereafter referred to as the Sub-Group on IATA-WMO Collaboration (SG-IWC), had been working with IATA on the CONOP document. In April 2017, given the scope and urgency of the CONOP development, the SG-IWC identified the need to employ a consultant who might coordinate and assist on the CONOP development and compilation and, if possible, have the expertise to contribute to its content. The ET-ABO-MG sought the approval for funding for this proposed new consultancy under the Terms of Reference of the AMDAR Operating Fund, which was approved in early May. A consultant, Mr Stephen Lord, recently retired senior programme manager from the NWS, NOAA, has been selected to undertake this work.
- 4.1.9. Work on the CONOP had progressed to the point of developing a draft overview section of the CONOP. This overview section would provide the basis for the elaboration of the collaboration within the rest of the document.
- 4.1.10. A current draft of the Overview of a Revised AMDAR Programme Structure and Operations, was provided to the ET-ABO members attending the session, as Information Document 8.

Discussion, Recommendations and Actions

- 4.1.11. The meeting discussed at length the proposed collaboration with IATA on AMDAR and the concepts and issues related to the CONOP, with the following points made:
- It was agreed that the potential collaboration was overall a positive development for the AMDAR programme and that it should continue to be addressed as a high priority for the ABOP.
 - It was noted that the agreement between IATA and WMO was not exclusive, so there should be flexibility to allow extra data requirements in different AMDAR programmes to meet specific needs.
 - The CONOP should address the possibility that non-participating airlines might be levied for an annual contribution to the AMDAR development fund as an equalising measure, given that the participating airlines contribute, while the aviation industry as a whole derives a benefit through improved weather forecasts and more efficient operations.

- Once the CONOP was developed, the SG-IWC should also develop an implementation plan for the transition to the operational framework developed within the CONOP.
 - IATA should be requested to provide information to the ABOP on several aspects of the collaboration, including: 1) The process for, and the extent to which it was sharing the concept with its members; 2) How it would ascertain the level of support of its member airlines; and 3) The results of its investigation into the viability of the commercialisation of AMDAR and turbulence data.
 - The team agreed that, if possible, a copy of the report of the study undertaken by IATA might be made available to the ET-ABO.
 - The SG-IWC should be expanded to include Ms Tammy Farrar, FAA, USA and a team member from WMO Region II. *[Post meeting note: Invited by The Chair of the team, Mr Yiu-fai Lee of Hong Kong China accepted to join the SG-IWC as a team member from WMO Region II.]*
 - The CBS Management Group should be part of the review and approval process for the CONOP and the implementation plan.
- 4.1.12. The team agreed that the following steps and schedule should be followed in the development of the collaboration with IATA:
- 1) SG-IWC and Mr Lord to develop the CONOP, Implementation Plan and ToR with the aim to develop a mature draft of the Deliverables by the start of October 2017;
 - 2) Throughout 2017, IATA will continue the process of sharing the concept of the collaboration and the developing CONOP with its membership with a view to seeking formal endorsement of the proposed collaboration by the end of 2017.
 - 3) The Deliverables to be circulated for a first formal review to the ABOP, CBS-MG, WMO Executive and IATA Executive in October 2017.
 - 4) The Deliverables to be updated and circulated for a final formal review by the same reviewers (step 3) in November 2017.
 - 6) The CONOP, Implementation Plan and ToR should be submitted to ICT-IOS and the CBS-MG for consideration and a decision on proceeding in late-November 2017.
 - 7) If CBS-MG, WMO Executive and IATA agree to proceed, a draft agreement should be developed in December to January 2018 with a view to its submission to EC in May 2018 and its possible establishment around mid-2018.
- 4.1.13. The team also agreed that additional resources and funds should be requested as required to support the process as outlined above, including the holding of related meetings and consultancy to ensure the timely development of the Deliverables.

4.2. CIMO ET-AO Activities

- 4.2.1. Mr Stewart Taylor, United Kingdom provided an overview of the CIMO ET-AO structure and gave an update on the ET-AO Work plan 2016-2018.
- 4.2.2. Since ET-ABO-2 (Dec 2015) most of the Work Plan activities have been discussed and carried out by email, telephone and a series of WebEx Sessions with ET-AO Members. This culminated in the finalisation of the ET-AO Work Plan and associated budget in March 2017.

- 4.2.3. A summary of some of the Work Plan Tasks was presented with emphasis on AMDAR Water Vapour measurement (WVM) – reported on by Dr Axel Hoff under Item 4.4. below – Turbulence (EDR) development and implementation along with AMDAR Software development with avionics vendors.
- 4.2.4. This year is the last in the current inter-sessional period and as such, CIMO Management Group (MG) will be encouraging Expert Teams to achieve goals as outlined in the relevant Work Plan. A CIMO MG (Strategic Management) Meeting is planned for June 2017 and the CIMO 17th Session will be held mid-2018. Chair of ET-AO will be responsible for the provision of a report on Work Plan activities and Status during Q1/2018.

4.3. B777 Software Status and Development

- 4.3.1. During January 2016, the B777 fleets of Air France (AFR) were configured for reporting of AMDAR data (55 of 67 aircraft available 29th January). Initially the aircraft were configured with reporting “geographical boxes” while awaiting the upgrade to the E-AMDAR data optimisation system (E-ADOS). The migration of the AFR B777 to E-ADOS was realised by mid 2016. This software development was a co-funded collaboration with WMO ET-ABOP, MeteoFrance and E-AMDAR and the software is available for other airlines operating B777 fleets.
- 4.3.2. Since May 2015, British Airways (BAW) B777 fleets have been providing data and rollout to all aircraft was completed with the 58th aircraft becoming operational February 2016. The development of the BAW software was initiated by E-AMDAR to supplement the loss of BAW data from other long haul fleets that were being phased out (e.g. B747 and B767).
- 4.3.3. The global coverage of both AFR and BAW B777 fleets is shown in Document 4.3 to this meeting. As mentioned above, the AFR software is available to other airlines and this will be incorporated to the Regional Association Implementation Plans (A-RIP) where identified airlines operate B777 fleets. [*POST MEETING NOTE: Focal Point for RA II informs that Hong Kong Observatory have received request from Cathay Pacific with regards to implementing AMDAR on the B777 fleets.*]

4.4. Water Vapour Measurement

- 4.4.1. Mr Axel Hoff, Germany, presented the status and progress made in relation to water vapour measurement since the last session of the team.
- 4.4.2. There are two different kinds of water vapour measurement (WVM) systems in use. Nearly 160 aircraft of the worldwide AMDAR fleets are been equipped with the instrument type WVSS-II, which is a laser based Water Vapour Sensing System. The system’s output is fed into the aircraft avionics data infrastructure and then, via the Aircraft Communications Addressing and Reporting System (ACARS) communications, the measurements are sent directly to the ground-based data processing system, where the data can be transmitted on the WMO WIS/GTS. The densest coverage derived from 142 Boeing aircraft is over the continental USA, while 9 Airbus A320 units provide vertical profile of water vapour measurement, mainly over Western Europe under the EUMETNET/E-AMDAR programme. Installations of WVSS-II for research applications also continue to increase, with 21 units now in such use around the world. Quality assessment results have shown that WVSS-II biases in reference to the first guess fields of numerical models are consistently in the range of a few percent of relative humidity.
- 4.4.3. The other primary source of aircraft WVM can be derived from the TAMDAR system operated on a commercial basis by Panasonic Aviation Corporation (PAC). The TAMDAR system uses capacitive relative humidity sensors with communications for data relay via a satellite connection (IRIDIUM or Ku-band of other communication

satellites). The WVM observations and other meteorological information derived from the TAMDAR system are relayed to the central data management hub of Panasonic, which on-forwards quality-controlled data to contracted recipients and data users.

- 4.4.4. No further progress has been reported in relation to the testing of the WVSS-II units that have been installed on the UK Facility for Airborne Atmospheric Measurements (FAAM) aircraft.
- 4.4.5. Aircraft-based observations with WVM used in NWP systems are improving humidity and precipitation forecasts, with demonstrated positive impact particularly evident over the first 24-hour forecast period. Prediction of both the timing and location of precipitation events is enhanced. Apparent super saturation output of WVSS-II are likely related to measurements made within particles of clouds and precipitation. While such information is usually removed from vertical profile display systems by capping display of humidity at 100%, this signal behaviour may prove to be useful as an indicator of liquid or total water content.
- 4.4.6. The meeting was also informed that Deustcher Wetterdienst (DWD) and Lufthansa Technik (LHT) were expecting to soon begin collaborating on a project to make an assessment of the possibility to use onboard humidity measurement as a component of an in-situ icing warning system and possibly for derivation of efficiencies in economising the de-icing process. The project outcomes, including consideration of the benefits to NWP and other forecast applications, would be expected to contribute to the justification and business case for future investment by the airline in WVM expansion and enhancement. The meeting was supportive of this endeavour and recommended that DWD might consider if WMO support could assist the project process.
- 4.4.7. The ABOP has developed plans within the ABOP Strategy and Implementation Plan (A-SIP) for the further integration of WVSS-II within the AMDAR programme, while recognising that the current primary focus of retrofitting aircraft for WVM makes such an endeavour difficult. Therefore, important aspects of the planning are to develop the business case for airline support for wider implementation and also for implementation and integration of WVM (WVSS-II) at the aircraft production stage.
- 4.4.8. It was recognised by the meeting that WVM integration and expansion would be greatly assisted by the IATA-WMO collaboration and the team endorsed the move to ensure this aspect is developed within the CONOP.

4.5. Turbulence Monitoring

- 4.5.1. Mr Stewart Taylor, United Kingdom, provided the meeting with a report on Turbulence Monitoring focusing on USA and European Programme activities.
- 4.5.2. While there is no government-coordinated program for reporting and providing turbulence information to users in the United States, there are three known systems that are producing Eddy Dissipation Rate (EDR);
 - 1) The collaborative work between National Center for Atmospheric research (NCAR) and the USA Federal Aviation Administration (FAA) is now co-ordinating Eddy Dissipation Rate (EDR) implementation on US airlines with expansion plans in China, Australia and Europe. Development of a technical transfer package (TTP) will provide information on onboard and ground data processing allowing the airlines to more readily implement standardised EDR reporting;
 - 2) The TAMDAR system by Panasonic Avionics Corporation (PAC) also reports EDR from their equipped fleets; fleet size is expected to rise to ~400 aircraft in the medium term expanding into areas such as South America, Asia and Europe; and

3) The Weather Company (merged with WSI) obtain EDR reports from around 450 aircraft from multiple aircraft operating over the USA.

- 4.5.3. These three programmes use different algorithms for reporting of EDR. In an effort to "standardise" EDR reporting, FAA through the activities of the Radio Technical Commission for Aeronautics (RTCA) Special Committee 206 (SC-206), have produced a document "FAA EDR Performance Standards". This document is awaiting RTCA approval to be released for public comment, sometime June/July 2017.
- 4.5.4. An operational trial with Delta Airlines (DAL) has resulted in >10,000 pilots utilizing the EDR data via tablets in the cockpit.
- 4.5.5. In Europe there are currently no airlines reporting EDR. Through the E-AMDAR programme, airlines are being canvassed about implementation of EDR and the associated benefits to operations. Air France (AFR) is awaiting the release of the NCAR TTP to progress their EDR developments.
- 4.5.6. The ET-AO Work Plan contains a task to co-ordinate and develop EDR as the preferred metric within the AMDAR Onboard Software Functional Requirements Specification (AOSFRS)

4.6. ADS Status and Development

- 4.6.1. Mr Christopher Hill, USA, provided the meeting with a report on the recent activities in the USA related to the derivation of global aircraft-based observations from the Automatic Dependent Surveillance – Contract (ADS-C) system.
- 4.6.2. The meeting was informed that the US National Weather Service had recently begun obtaining and evaluating ADS-C observations via contract with Rockwell Collins/ARINC. Out of 5000 airframes providing wind and temperature observations every 14 minutes en-route, approximately 3000 are providing good quality observations and their utility to NWP was currently being assessed. It was expected that these ADS-C data would result in the provision of more than 20K additional good quality observations per day on the GTS of temperature and wind.
- 4.6.3. The NWS ABO program is considering options for continuing to procure these data, keeping in mind related policy issues such as the provisions within ICAO Annex 3 that, in theory, allows access to these data by WMO members via the ICAO World Area Forecast Centres.
- 4.6.4. Several issues relating to the management of ADS-C data were also discussed under item 5.3.

4.7. Mode S Status and Development

- 4.7.1. Mr Stewart Taylor, United Kingdom, provided the meeting an update on developments with Mode-S. Since ET-ABO-2 (Dec 2015), ET-ABO Members have progressed in areas of receiving, processing and in some cases assimilating of Mode-S data.
- 4.7.2. In Europe, several NMHSs have made progress in deriving meteorological data from Mode-S data, including:
 - KNMI in the Netherlands has begun a SESAR PCP deployment (jointly with the Met Office, United Kingdom) with the goal of setting up an operational Data Processing Centre (DPC) which will gather Mode-S data from as many radars as possible over the next three years. This DPC will transition to EUMETNET under the EUMETNET Aircraft Derived Data (E-ADD) Programme.
 - AEMET, Spain have encountered resource issues internally and have had to postpone further work on Mode-S development. It is hoped to restart work later in 2017.

- Met Office, United Kingdom now have six Mode-S receivers collecting Mode-S EHS and ADS-B data – which allows for derivation of wind and temperature data. This data has been used in initial Data Assimilation (DA) trials and a project is underway to operationalise the Mode-S receiver network with a completion date of September 2017 – this will allow operational assimilation in the UKV NWP model early in 2018.
- DMI, Denmark currently receiving Mode-S data from ATC but no updated information received for this meeting.
- SEA, Slovenia are using Mode-S MRAR data (meteorological wind and temperature) operationally from two Slovenian ATC radars. This data is used in a wide range of applications including wind shear detection, data assimilation in the ALADIN model and in some instances general forecasting.
- Bureau of Meteorology, Australia carried out a trial of capturing Mode-S and ADS-B data in 2014 and subsequently presented the results to CIMO TECO 2016. The Bureau continues investigations into the use of Mode-S data.

4.8. UAVs

- 4.8.1. Mr Stewart Taylor, United Kingdom provided an update on the ET-AO Work Plan activities with regards to Unmanned Aerial Vehicles (UAVs). The ET-AO Task is looking at several areas of UAV legislation that may allow the use of UAVs to supplement existing ABO platforms with more meteorological information.
- 4.8.2. Several legislative bodies have produced documentation with regards to UAVs and their integration to non-segregated airspace to assess air traffic management requirements for shared usage with commercial manned aircraft.
- 1) Single European Sky ATM Research (SESAR) introduced a Joint Undertaking (JU) in 2012 following the rapid development with UAVs and a recent paper “European Drones Outlook Study” was published November 2016. SESAR is also investing heavily in R&D developments relating to UAVs under SESAR 2020 (Industrial Research).
 - 2) Several documents have been published under the International Civil Aviation Organisation (ICAO) Safety Programme. In 2016, ICAO issued “UAS Tool Kit” providing information to UAV users on Operations, Rules & Guidelines and Authorisation procedures. A Remotely Piloted Aircraft System (RPAS) Symposium was held in 2015 with the next one planned for Nigeria in July 2017 focusing on Africa and Indian Ocean which will allow States and organisations the opportunity to share experiences and address issues with relevant legislative authorities.
 - 3) The Federal Aviation Administration (FAA) have been exploring the possible design of the infrastructure for a UAV Traffic Management System (UTM). This project, in collaboration with the National Aeronautics and Space Administration, is looking at the concept to enable multiple “beyond visual line of sight” (BVLOS) UAV operations at low altitudes where current FAA air traffic services are not provided.
- 4.8.3. Several NMHSs are either using UAVs operationally or are developing the use of UAVs in meteorological research.
- 1) In the United States, NOAA has a UAS Programme for Polar monitoring and high impact weather monitoring.
 - 2) Canada use UAVs in the study of atmospheric and boundary layer processes.
 - 3) Antarctica, the British Antarctic Survey (BAS) have four UAVs mainly used for ice shelf monitoring and the UAVs also have a meteorological sensor package.

These UAVs are fully robotic and fly out of sight with data logged for post-flight analysis.

- 4) In Europe, Met Office, Deutscher Wetterdienst (DWD) and Meteo-France have all used UAVs in boundary layer process research.
- 4.8.4. In addition to the meteorological communities, there are several private companies utilising UAVs for research purposes.
- 4.8.5. Issues with regards to Security and Cyber resilience is a priority area to mitigate risk of UAV operations being subjected to malicious or accidental takeover of data-link control.
- 4.8.6. In addition, data communications are critical to BVLOS and long endurance flights and this has to be managed by the allocation (and protection) of the necessary spectrum. It is this area that we need to keep abreast of developments to ensure we can be involved in the down-linking of meteorological data in "near-real time".

5. Standards, Data and Quality Management

5.1. Technical Regulations Development

Revision of Manual and Guide to GOS on Aircraft Meteorological Stations

- 5.1.1. Following the discussion at the Joint Meeting of ET-ABO and ET-AO (Casablanca, Morocco, December 2015) on the draft revision of the sections of the Manual on the GOS (WMO No. 544) and the Guide to the GOS (WMO No. 488), under the heading "Aircraft Meteorological Stations", the ET-ABO Subgroup on Regular Material (SG-RM) continued work on these materials, aiming at submission for their adoption at CBS-16 (Guangzhou, China, November 2016).
- 5.1.2. The SG-RM cooperated with the IPET-WIFI Subgroup on Regulatory Material on an initial review of the materials, which resulted in a recommendation to ICT-IOS at its 9th Session in April 2016 that the regulatory materials, after further review and revision, should be recommended for adoption by CBS-16. ICT-IOS agreed with the recommendation, also deciding that the guidance material should be changed so that the bulk of the material should be extracted and published as a stand-alone, WMO numbered Guide to Aircraft-Based Observations. With that decision, the text in the Guide to the GOS reduced to a short text referencing the new Guide to ABO.
- 5.1.3. In collaboration with IPET-WIFI the ET-ABO Subgroup continued to further update and improve the regulatory materials throughout 2016 in preparation for their submission to CBS-16 through ICT-IOS. The proposed draft sections were submitted to CBS-16 and adopted subject to their approval by the Executive Council (EC-69) in May 2017, based on the CBS Recommendation 3.2(1))/1 Revised Manual on the GOS and the Guide to the GOS.

Guide to Aircraft-Based Observations

- 5.1.4. The Guide to ABO provides extensive guidance on aircraft-based observations and the AMDAR observing system as a component of the World Weather Watch Programme, WIGOS and the GOS and will be referenced as guidance on regulatory material by both the Manual on the GOS and the Guide to the GOS.
- 5.1.5. Draft version 10 of the Guide to ABO was submitted to CBS-16, with CBS adopting the guide, recommending its approval for publication by EC at its 69th session and requesting comments and feedback from WMO Members.
- 5.1.6. EC-69 (Geneva, 10-17 May 2017) approved the CBS recommendation to adopt the regulatory materials including the Guide to the GOS and the Guide to ABO.

New Guidance Material for OSCAR/Surface and Provision of Metadata

- 5.1.7. The development of the Aircraft-Based Observations component of OSCAR/Surface is still underway but is expected to be completed in 2017. Given the unique nature of the ABO observing systems interface and metadata requirements, it will be important that ET-ABO oversees or, at least contributes to, the development of related guidance within the Guide to WIGOS. The meeting agreed that SG-RM should actively take responsibility for this task with a view to ensuring any draft guidance materials are completed by 2nd quarter of 2018.

Further Development of the Manual on WIGOS and the Guide to WIGOS

- 5.1.8. Given the requirements related to the integration of GOS regulatory material under WIGOS by 2019 (Cg-18), it was recommended that the ET-ABO should give some consideration to planning and required adaptation of regulations and guidance, in consultation with the WIGOS Editorial Board.

Actions and Recommendations

- 5.1.9. The Meeting noted the information provided with regard to the progress in the development of the ABO Technical regulations for WIGOS and agreed with the following actions:

- 1) Noting the draft Guide on ABO (Version 10), ET-ABO members to review and provide guidance for further improvement (comments, revision, contribution) of the Guide to ABO (deadline 15 June 2017).
- 2) the Guide to ABO should be finalised according to the following schedule:
 - i. A possible drafting meeting of the SG-RM to be held over 2-3 days in June 2017;
 - ii. Possible additional material on OSCAR/Surface to be added during July 2017, subject to progress on development of the OSCAR/Surface, ABO component;
 - iii. SG-RM to complete final revision of the Guide to ABO by end-July 2017 and published in the WMO Library by the end of December 2017;
- 3) the ET-ABO and its SG-RM continue to maintain and develop the Guide to ABO in accordance with ongoing requirements and the development of the Guide to WIGOS and OSCAR/Surface.
- 4) given the requirements related to the integration of regulatory material under WIGOS by 2019 (Cg-18), the ET-ABO and its SG-RM should make an assessment and plan for the required adaptation of regulations and guidance in consultation with the WIGOS Editorial Board.

5.2. Data Quality Monitoring

WMO Lead Centre for ABO Operations and Development

- 5.2.1. Mr Chris Hill provided a report to the meeting on the status and the work of the US National Centers for Environmental Prediction (NCEP), functioning on behalf of the World Meteorological Center of Washington as the WMO Lead Centre (LC) for Aircraft Observations. This function of the provision of monitoring and quality evaluation (QM/QE) of aircraft-based observations has been manifested primarily in the provision of monthly reports, as defined in section 5 of Attachment II of the Manual on the GDPS, since 1992.
- 5.2.2. The meeting was informed that, within the Guide to Aircraft-Based Observations, Annex II, "Guidance on Quality Monitoring of Aircraft-Based Observations" has been developed by the Expert Team to specify in detail the proposed revised and updated requirements for QM/QE activities of the Monitoring Centres and Lead Centre, which would form the Data Quality Monitoring System (DQMS) for aircraft-based observations. Mr Hill had undertaken to review the annex on behalf of the LC so as to

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Approved by Fernando Belda Esplugues, Tue Aug 15 10:17:07 UTC 2017

provide the team with feedback on the requirements and the various issues and options associated with their possible implementation by NOAA. Within his review Mr Hill suggested that:

- MADIS, the Global Data Centre for Aircraft Observations (GDC-AO), will be instrumental in facilitating the reception, process, and archival of monitoring reports.
 - The incident management system should facilitate the communication of issues identified in reports and a ticketing system might be developed to fulfil this requirement, initially to take the form of managed email exchange before any dedicated computing system might be employed.
 - Commentary of quality issues has been provided with each of the Lead Centre monthly reports. As monthly reports become more automated in nature, separate and more interactive correspondence through an incident management system would become necessary to more effectively address and rectify quality issues. The development of more frequent reports will prove useful in quickly identifying quality issues.
 - Additional development would be needed to more fully realize the online facilities requirements of Attachment III to Annex II.
 - Within the Lead Centre there is an existing method to counting AMDAR messages for which a three-day running count of AMDAR messages and a monthly average of these hourly counts are each updated on an hourly basis. This counting methodology is regularly applied to each observation system within NCEP. These hourly counts can be readily concatenated to produce a daily count, which may serve as a first step toward providing a daily report of AMDAR data availability as recommended in Annex II.
 - Following its review, a few recommended revisions have been recommended for the draft of Annex II.
 - With no specific criteria having existed for relative humidity (RH) data, to date, the basis of suspect criteria added in Attachment II to Annex II stems from a review of March 2017 statistics computed for US-based MDCRS aircraft. Unlike other observation fields, defined gross errors are found to be more common with humidity data, and a sample gross error tolerance of 10% is recommended in place of 2%. Mean difference (or bias) criteria of $\pm 5\%$ and $\pm 10\%$ were similarly developed and recommended. With a typical range of only 8-15%, no suspect criteria are recommended for the RMS of relative humidity. The sample table of statistics can be considered as a partial prototype for future monthly reports that could be similarly applied toward daily and 10-day reports.
 - A standard definition for wind vector difference, regularly used for Lead Centre monthly reporting, is added with Attachment II.
- 5.2.3. Pending any additional recommendation for addition revision or amendment by the Expert Team, and pending discussion with – and any necessary approvals by – internal management of NWS/NCEP, it is intended that the guidance contained within the most recent iteration of Annex II could be implemented at the Lead Centre for Aircraft Observations.
- 5.2.4. As present QM/QE activities of the Lead Centre are primarily maintained by one staff member of NCEP, it is believed that significant implementation of the Annex II guidance at the Lead Centre may require some integration of existing computing resources within NOAA, as well as exploration of other, potential resources. It is estimated that significant implementation of Annex II may take place over the course of approximately 24 months.
- 5.2.5. The team agreed that the ET-ABO budget should be updated to include resourcing of 50K CHF to be allocated to updating the functionality of the Lead Centre operations

within NCEP. It was also agreed that an WMO email address should be made available to support incident management communications with AMDAR programme operators.

Data Quality Issues

- 5.2.6. While a document, 5.2(2), Data Quality Issues, was submitted to the meeting document plan by Mr Van Der Meulen, the team deferred discussion of the issues raised in the document until Mr Van Der Meulen was able to present them to the ET-ABO management group.

5.3. Data Management

- 5.3.1. Mr Lockett presented document 5.3 to the meeting, providing information on a number of high priority issues relating to ABO data management.

Designation of the WMO Global Data Centre for Aircraft-Based Observations

- 5.3.2. Since the previous session of ET-ABO, much progress has been made in relation to the establishment of a WMO Global Centre for Aircraft-Based Observations (GDC-ABO) and, based on EC-69 Resolution 5.1(2)/6, Establishment and Designation of the WMO Global Data Centre for Aircraft-Based Observations, the USA, NOAA, Meteorological Assimilated Data Ingest System (MADIS) has now been designated to fulfil that role.
- 5.3.3. This outcome is the result of several steps that have been undertaken over 2016 and 2017 including:
- 1) At the 9th session of the CBS Implementation-Coordination Team on Integrated Observing Systems (ICT-IOS) 9th Session in Geneva, Switzerland (April 2017), the ICT-IOS considered this matter and agreed to recommend to CBS that the NOAA/MADIS system should be designated as the WMO GDC-ABO, subject to suitable Terms of Reference (ToR) developed by ET-ABO and agreed to by NOAA.
 - 2) Subsequently, the ET-ABO Management Group, Mr Pritchett and the Secretariat together developed draft Terms of Reference for the operation of the GDC-ABO, which are based upon the more detailed specification of requirements for the GDC that had previously been developed by ET-ABO. The ToR are provided within [Annex III](#). Based on these ToR, NOAA agreed in principle to the possibility that MADIS could be designated as the GDC-ABO.
 - 3) In July 2016, a letter to NOAA was sent to the USA Permanent Representative with WMO from the WMO Secretary General requesting a formal response to undertake the role, subject to approval of the designation by CBS and EC. WMO subsequently received an affirmative response, which was confirmed officially in writing prior to EC-69.
- 5.3.4. The resolution of EC-69, 5.1(2)/6², was contained within EC-69 document 5.1(2) and approved by the EC without a change request intervention and with the confirmed support of the USA. The resolution :
- Requests** the Secretary-General, in collaboration with CBS, to establish an agreement with the United States of America, designating and authorizing its National Oceanic and Atmospheric Administration to operate the WMO GDC-ABO under the Terms of Reference defined by CBS, and to make every effort to ensure that such agreement comes into effect as soon as possible.
- 5.3.5. It was agreed that the ET-ABO should ensure that the agreement between WMO and NOAA is established as soon as possible based on the ToR and additional agreed operational requirements.

² See : [http://meetings.wmo.int/EC-69/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-69/English/2.%20PROVISIONAL%20REPORT%20\(Approved%20documents\)/EC-69-d05-1\(2\)-WIGOS-RESOLUTIONS-approved_en.docx&action=default](http://meetings.wmo.int/EC-69/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-69/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/EC-69-d05-1(2)-WIGOS-RESOLUTIONS-approved_en.docx&action=default)

5.3.6. Based on the discussion on the GDC-ABO at the ET-ABO management group meeting and by the session (Feb, 2017), the following further steps and actions were agreed in order to operationally establish the centre:

- 1) ET-ABO to draft a document that outlines the required functions of the GDC-ABO, in particular focussing on:
 - a. Requirements and restrictions for access based on ABO data policy; and
 - b. A process for validation and approval of access to the GDC upon application by users.
- 2) ET-ABO to work with MADIS management on the development of the interface to the GDC-ABO on the MADIS website.
- 3) ET-ABO to undertake a review of the MADIS system functionality and identify any changes required either prior to or subsequent to its activation as the GDC.
- 4) ET-ABO to formally launch the GDC-ABO in consultation with NOAA.

5.3.7. The team also agreed that:

- A Sub-Group of the ET should be formed to undertake these steps in collaboration with MADIS and other team members as required. The Sub-Group on the GGC (SG-GDC) would consist of: Mr Curtis Marshall, Mr Steve Stringer and Ms Tammy Farrar.
- 50K CHF should be allocated in the budget of 2018 to support the required update of the MADIS functionality for GDC-ABO operation.

Management of ADS-C Data

5.3.8. The meeting discussed the management and quality of Automatic Dependent Surveillance Contract (ADS-C) data, taking into account the contribution of the USA as outlined in agenda item 4.6 and relating to Task 14 of the ET work plan, Liaise with ICAO on data management of ICAO aircraft observations, including input to the ICAO Met. Panel. This task had the following sub-tasks:

- 1) Establishment of WAFC authorised regional ABO data processing centres.
- 2) Improved QC of AIREP and ADS-C aircraft observations.
- 3) Ensure input through ICAO Meteorological Panel (METP) and its relevant collaborating groups.
- 4) Develop plans to ensure WMO Members comply with ICAO requirements for provision of ICAO ABO on GTS.

5.3.9. At the current time, while little formal progress has been made in relation to item 1, there had been significant progress in the availability of ADS-C data on the GTS, with NOAA having in 2014 contracted Rockwell Collins/ARINC (ARINC) to obtain ADS-C messages and provide the derived meteorological data in BUFR (AMDAR Version 7) on the GTS.

5.3.10. The meeting agreed that the process that NOAA had put in place with Rockwell Collins was in line with the aims of ET-ABO under Task 14 and that it might serve as a model for expanding the availability of ADS-C derived meteorological data on the GTS. It was agreed that a similar arrangement with SITA, the other major aviation data service provider (DSP), might be sought. The issue of funding this arrangement was discussed and it was agreed that the ET should seek to encourage DSPs to make provision of these data at minimal cost, given that the data air-ground transmissions of these data

were effectively already paid for by airlines and that WMO had a right to access these data under the provisions within ICAO Annex 3.

5.3.11. The meeting agreed on the following actions in relation to ADS-C data management:

- 1) Mr Steve Stringer and Mr Dean Lockett should arrange to meet with SITA as soon as possible to discuss the possibility of SITA assisting with the provision of ADS-C data; and
- 2) Mr Steve Stringer to investigate whether the E-ADAS system might be utilised to process ADS-C data derived from such an arrangement.

5.3.12. It was agreed that, once the aim to establish 1 or 2 global data centres for provision of ADS-C data on the GTS had been accomplished, Members should be informed that this should be the sole means for provision of such data and they should support the global data centre activities to ensure such data from their region was processed and made available. The ET-ABO/SG-RM should also ensure that the Guide to ABO was later updated to ensure compliance with this practice.

WIGOS WDQMS

5.3.13. The meeting was informed regarding progress on the development of the WIGOS Data Quality Monitoring System (WDQMS) and the activities of the team in developing plans and specifications to update and upgrade the functionality of the ABO DQMS.

5.3.14. The meeting was reminded that, while the Lead Centre on Aircraft Observations (LC-AO) and the requirements for monitoring by the National Monitoring Centres of the Global Data Processing and Forecast System (GDPFS) of aircraft observation on the GTS were defined on the WMO website, the requirements of Lead Centres has not been formally defined and established as a role under CBS. Up until recently, the LC-AO had undertaken monthly monitoring only based on the Manual on the GDPFS, Attachment II, Procedures and Formats for the Exchange of Monitoring Results, Chapter 5, Aircraft Data.

5.3.15. In the development of the Guide to Aircraft-Based Observations, Annex II, Guidance on Quality Monitoring of Aircraft-Based Observations, the ET-ABO has effectively been developing the concepts and requirements for the WDQMS of the aircraft-based observing system. Within this guidance, it is proposed that the Lead Centre and Monitoring Centre roles and requirements are defined separately and more concisely. The Lead Centre would be responsible for receiving and processing the monitoring data from Monitoring Centre(s) and then undertaking the required quality evaluation functions. The Lead Centre would also be responsible for the incident management functions, which would ensure feedbacks to and from the relevant member operations focal points. The Lead Centre would be responsible for the development and maintenance of the processing and distribution of monitoring reports, which would be increased in resolution to daily reporting. The Lead Centre would also be responsible for developing and maintaining monitoring information along with a suite of online tools to facilitate quality evaluation by both the Lead Centre and programme operators. Under this enhanced DQMS, Monitoring Centres would be required to provide standardised monitoring reports to the Lead Centre for processing and analysis. Such reports would enable the provision of both daily and monthly reporting and alerting for both ABO data availability and quality.

5.3.16. Under item 5.2, the current Lead Centre (NOAA/NCEP), via Mr Chris Hill, provided a review of the proposed requirements for the ABO DQMS. While agreeing that the requirements specified in the Guide to ABO were reasonable and could feasibly be implemented by NOAA, the resources required to implement the system would be significant and would likely require funding input. The team agreed that a funding allocation of 50K CHF to support upgrading of the Lead Centre functionality should be sought from the AMDAR Operational Fund within the 2018 budget.

5.3.17. The meeting also agreed that a WMO email group should be established for communications relating to incident management pertaining to ABO.

Metadata Management and OSCAR/Surface

5.3.18. Under the development of the framework for WIGOS over the last Congress inter-session period and under the WIGOS Pre-Operational Phase during the current period, WMO has been developing the WMO Observing System Capability Analysis and Review (OSCAR) tool, which includes the OSCAR/Surface system and metadata database to support WIGOS observing systems. Incorporated within OSCAR/Surface would be the functionality to hold all observational metadata defined under the WIGOS Metadata Standard (WMDS).

5.3.19. The ABOP contribution to the WMDS had been developed within the Guide to ABO within Annex IV, *Guidance on Aircraft-Based Observations Metadata Maintenance and Provision*. Under item 2, the meeting had been informed that work on the ABO component of OSCAR/Surface was underway and it was expected that the ABO metadata component and ABO interface would be completed by the end of 2017.

5.3.20. Under Task 2 of the ET-ABO work plan, the contribution of the team to development of ABO metadata management and OSCAR/Surface implementation had 2 sub-tasks:

- 1) Contribute to development and testing of the ABO component of OSCAR/Surface
- 2) Assist in establishment and maintenance of ABO metadata

5.3.21. The meeting agreed on the need to establish a Sub-Group on ABO Metadata (SG-AMD) within the ET to coordinate and undertake the tasks and activities of Task 2 of the work plan. The subgroup would consist of Mr Stewart Taylor, Mr Doug Body and Mr Curtis Marshall and Mr Yiu-fai Lee. It was agreed that the subgroup should undertake/coordinate the following activities:

- 1) OSCAR/Surface ABO metadata interface testing and verification;
- 2) Instigate a pilot project to populate OSCAR/Surface with metadata for one or more national programs to test its functionality;
- 3) Make plans for implementation of ABOP metadata within OSCAR/Surface; and
- 4) Develop guidance material supporting ABO metadata maintenance within OSCAR/Surface in collaboration with SG-RM.

6. Outreach and Capacity Development

6.1. Regional Associations collaboration

6.1.1. Mr Lockett provided the meeting with a summary of the status of ET-ABO collaboration with the WMO Regional Associations. The summary is provided within [Annex II](#).

6.1.2. The meeting was reminded that, since its commencement as an Expert Team within CBS, the Expert Team on Aircraft-Based Observing Systems has been endeavouring to work closer with WMO Regional Associations so as to establish an international framework for planning and implementation of aircraft-based observations based on national and regional requirements. This strategy is outlined and developed within the ABOP Strategy and Implementation Plan (A-SIP). The strategy has been endorsed by CBS and Congress through Resolution 24(Cg-17).

6.1.3. The team agreed on the need to continue to make efforts to engage with the RAs, particularly in light of the development of the IATA-WMO collaboration and the

expected requirement for RAs to be engaged in the future establishment of requirements for ABO.

- 6.1.4. The meeting also agreed that the first priority should be to ensure the coordination of input to the 17th session of RA VI, which would be held over 18-22 September 2017.
- 6.1.5. The following additional actions were agreed:
 - 1) Chair-ET-ABO to address the issue of the possibility to develop a combined RA III and RA IV A-RIP for these WMO Regions; and
 - 2) The Secretariat to compile a letter to NOAA outlining the benefits and support of WMO in NOAA continuing to fund the provision of ADS-C and LATAM data. (July 2017).

6.2. Workshops

AMDAR Workshops in 2016

- 6.2.1. The ABO Work Plan, in line with the ABOP Strategy and Implementation Plan (A-SIP), budget and allow for the holding of two regional AMDAR workshops per year.
- 6.2.2. A Regional Workshop on AMDAR was organised for Central and South America in Panama City, Panama, 17-18 August 2016, in cooperation with the Dirección de Hidrometeorología (DDH) of Panama. This workshop was co-sponsored by NOAA.
- 6.2.3. As part of the WMO Region II WIGOS Workshop for West Asia, a Regional AMDAR Workshop was organised in Abu Dhabi, United Arab Emirates, on the 4th of November 2016. The workshop was organised in cooperation with the UAE National Centre for Meteorology and Seismology (NCMS).

AMDAR Workshops in 2017

- 6.2.4. A Workshop on AMDAR for the South-West Pacific Region (WMO Region V) was held prior to the 3rd Meeting of the CBS ET-ABO, in cooperation with the Agency for Meteorology, Climatology and Geophysics of Indonesia (Badan Meteorologi, Klimatologi, dan Geofisika, BMKG). The Meeting was informed about the outcome of this workshop. A Workshop Report will be made available in due course on the ABO website.
- 6.2.5. At the CBS/ET-ABO Management Group Ad Hoc Meeting (Silver Spring, USA, 14-16 February 2017) it was proposed that the 2nd workshop for 2017 might be targeted for Central Asia, either in India or in Thailand (or perhaps both). India covers a vast, data sparse territory and offers a great potential (regarding aircraft type opportunities) for the establishment of a national AMDAR programme. WMO consultant, Mr Frank Grooters, had made initial inquiries with the Permanent Representative to WMO with Thailand but a response and decision has not yet been received.

AMDAR Workshops in 2018

- 6.2.6. The Management Group further discussed 2018 objectives for ABOP workshops agreeing to recommend to ET-ABO the following future possibilities:
 - i. A workshop on AMDAR for Eastern Europe, in collaboration with E-AMDAR;
 - ii. A workshop on AMDAR for ASECNA countries, in collaboration with ASECNA;
 - iii. A workshop on AMDAR Data Use.
- 6.2.7. The Meeting decided that only 1 workshop should be considered for Central Asia with Thailand the preferred location with a requirement to ensure planning allowed for invitations to be sent at least 3 months in advance to all members in the region. It was also agreed that several Members that were not able to be represented at the Region V workshop should be considered for invitation to the Region II workshop.

- 6.2.8. The meeting also discussed the format and content of the workshops, noting that this had not changed much since the workshops were started under the AMDAR Panel. In particular, it was agreed that consideration should be given to inviting representatives from air traffic management and civil aviation authorities. The team also agreed to establish a Subgroup on Workshop (SG-WS) with the task to review and revise the workshop format and harmonize presentations and material. The membership of the subgroup would initially consist of Mr Steven Stringer, Mr Dean Lockett and Mr Frank Grooters.
- 6.2.9. The meeting agreed with the proposal to organise one special workshop on the use of AMDAR data. This would be an exceptional event since the ET-ABO had decided that AMDAR workshops only should focus on the AMDAR system, development and implementation, and its benefits to the WMO Regions and the Aviation Industry.

Actions and recommendations

- 6.2.10. The Meeting agreed with the following actions related to workshops:
- 1) To contact, through the AMDAR Focal Point, the PR of Thailand with WMO investigating the possibility of holding a Regional AMDAR Workshop for the southern part of Region II (Asia);
 - 2) To prepare for holding 2 workshops in 2018, for Eastern Europe (RA VI) in the first half of 2018, and for ASECNA in the second half of 2018;
 - 3) To prepare for holding 2 workshops in 2019, for AMDAR Data Use and for the avionics providers respectively;
 - 4) The ET-ABO, through the SO/ARO, to consult with the WMO Education and Training Division to determine if AMDAR workshop activities might be better coordinated in collaboration with the division; and
 - 5) Following the positive results of the WIGOS AMDAR Workshop for West Asia, held in Abu Dhabi, United Arab Emirates, the ET-ABO should try to coordinate AMDAR workshops with WIGOS activities, if deemed appropriate and advantageous.

6.3. Aviation interaction

- 6.3.1. Mr Stewart Taylor, United Kingdom, provided a short status report on meetings and activities within the Aviation communities that have an interest for both ET-ABO and ET-AO.
- 6.3.2. The Airlines Electronic Engineering Committee (AEEC) has many sub-committees and working groups developing standards in avionics.
- 6.3.2.1. Both ET-ABO and ET-AO are represented at the AEEC DataLink Users Forum (DLUF) which is held twice a year (US and Europe). The AMDAR community have been involved with DLUF for several years and assists with the co-ordination between airlines, avionics and aviation industries and the meteorological community.
 - 6.3.2.2. ET-AO also attend the AEEC DataLink Systems Sub-Committee (DLK SSC) which has the responsibility for the ARINC standards for transfer of data between aircraft and the ground. Input to the Standards Committee with regards to ARINC620 and other standards that have an impact on AMDAR data downlinking.
 - 6.3.2.3. Also attend and input to AEEC Aeronautical Operational Control Sub-Committee (AOC SC) which is responsible for the development of new data link applications.
- 6.3.3. Other aviation activities include discussions with ICAO on the receipt and processing of ADS-C messages, IATA and WMO collaboration (discussed under Item 4.1 of

this meeting) and RTCA Sub Committee (SC-206) discussing the Aeronautical Information (AI) and MET data link services required to meet current and future needs of aviation and meteorological communities.

6.4. Newsletters, learning module, websites and social media

6.4.1. Mr Carl Weiss, USA, AMDAR Newsletter Editor and Training and Outreach Coordinator, provided a report to the meeting on activities and progress since the last joint ET-ABO/E-AO meeting in December 2015 relating to the WMO AMDAR Observing System Newsletter, ABOP outreach and the AMDAR COMET module.

WMO AMDAR Observing System Newsletter

6.4.2. Since the last meeting, three newsletter editions have been published covering a wide variety of ABOP-related topics. These include:

- regular updates of the global AMDAR system, including WVSS-II developments and turbulence detection,
- status of established programs, e.g., Canada, United States and E-AMDAR,
- developments in newer programs, e.g., Mexico, Argentina, Brazil, Africa/Kenya, Morocco and Ethiopia, and
- the first two instalments of a three-part series covering the impact of AMDAR water vapour data on NWP performance.

6.4.3. Additionally, articles illustrating the data's impact on the issuance of weather watches, warnings and daily forecasts as well as benefits to the airlines and air traffic management have been featured.

6.4.4. The WMO AMDAR page has been the main vehicle for viewing with nearly one-third of the users gaining access in this manner. However, newsletter availability has been enhanced through distribution and promotion via other outlets, such as:

- the WMO Google Group, Aircraft Observations News, where subscribers are sent an e-mail version of each newsletter edition upon publication, and
- various aviation and meteorological group forums on the professional "social" media site, LinkedIn.

6.4.5. Since statistics on AMDAR website usage began in August 2012, the newsletter has been accessed on approximately 8000 occasions.

6.4.6. The newsletter is available on the WMO AMDAR News and Events web page at

<https://sites.google.com/a/wmo.int/amdar-news-and-events/newsletters/>

ABOP Outreach Activities

6.4.7. The ABO community has been active in promoting the benefits of aircraft-based observations and seeking new opportunities for airline participation. These activities include presentations and discussions as well as written articles and workshops. Some of these activities including:

- WMO meetings and workshops,
- meetings of professional associations such as the American Meteorological Society,
- articles in professional aviation and meteorological journals,
- meetings with NMHSs and airlines,
- press releases, and many more.

The AMDAR COMET Module

- 6.4.8. A collaborative effort between the 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.
- 6.4.9. Since its release in January 2015, the AMDAR module has had almost 1400 viewing sessions and has given the meteorological and aviation communities a unique opportunity to learn about WMO 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 current AMDAR module has been extremely successful in informing both the meteorological and aviation communities about ABOP.
- 6.4.10. The AMDAR module is available on COMET's MetEd web page at:
https://www.meted.ucar.edu/training_module.php?id=1114
- 6.4.11. It has been suggested that the next step is possibly to develop a new module, or an extension to the current module that demonstrates the utility and value of AMDAR data in both meteorological and aviation operational situations. Additionally, examples showing benefits to air quality, climate and agriculture might be included. Mr Ercument Avsar, on secondment to WMO, has drafted an outline of such a module, which would later be considered by the team as a basis for proceeding with the extension of the existing module or the development of a new one.
- 6.4.12. The meeting also discussed alternative outreach activities and media and agreed that the team should consider the possibility to develop video media for education and outreach purposes. It was agreed that the Secretariat would investigate the capacity for such a development to be undertaken based on experiences in other areas, including the Education and Training Division of WMO.

7. ET-ABO Work Plan Review

- 7.1. The team reviewed in plenary the work plan of the ET-ABO in light of the outcomes and proposed actions from the meeting. It was agreed that the ET-ABO management group and the Secretariat would compile and update of the work plan based on these outcomes and actions and the discussions and decisions during the agenda item, with the updated version to be reviewed by the team as part of the final report of the meeting.

ABOP Strategy and Implementation Plan

- 7.2. The meeting also discussed the status of the ABOP Strategy and Implementation Plan (A-SIP) that had been submitted to the meeting as Information Document 7. The team was informed that the A-SIP had been updated by the ET-ABO over 2016, subsequent to the changes that had been endorsed by the ET-ABO 3rd Session (ET-ABO-3) and including the addition of the implementation plans for WVM and turbulence. The meeting agreed that this document should be approved and adopted as the ongoing basis for the work of the ABOP over the coming 5 years. Although it was agreed that the document might need to be revised in the near future in light of the development of the IATA-WMO collaboration on AMDAR.

Contribution to Executive Council panel of experts on Polar and High Mountain Observations, Research, and Services (EC-PHORS)

- 7.3. The meeting noted the submission of Information Document 11 concerning the work of the Executive Council panel of experts on Polar and High Mountain Observations, Research, and Services (EC-PHORS) and the request for ET-ABO to continue to consider how the aircraft-based observations might be extended over polar regions. In

particular the team was asked to report back to EC-PHORS on the progress made and provide input to the 8th session of the Panel, in March 2018. The meeting agreed that Mr Frank Grooters would address this request and report to the EC-PHORS session on behalf of the ET.

- 7.4. The updated work plan is provided within Annex IV.

8. Any Other Business

- 8.1. No other business was raised.

9. Final Report

- 9.1. The meeting agreed that the final report of the session would be compiled by the Secretariat and reviewed and finalised subsequently to the meeting by team members.

10. Close

- 10.1. The meeting was closed on the afternoon of the 26 May 2017 at around 3pm.
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ANNEX I – LIST OF PARTICIPANTS

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(Chair)

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ANNEX II – ET-ABO STATUS OF COLLABORATION WITH REGIONAL ASSOCIATIONS

Region I

Working Structure: https://www.wmo.int/cpdb/regions/africa/working_structure

- Mature Draft Region I A-RIP has been developed and provided to the RA I 16th Session, Cabo Verde (February 2015) as an information document.
- Presentation was made by WMO SO-ARO at the RA I 16th Session, Regional Conference (RECO) in February 2015, Cabo Verde.
- The RA I 16th Session *suggested 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 (Cabo Verde, February 2015), AMDAR was adopted as a Flagship Programme (3) within the adopted Implementation and Resource Mobilization Plan of AMCOMET.
- A Regional Workshop on AMDAR was held in Nairobi, Kenya in June 2015.
- A Regional Workshop on AMDAR was held in Casablanca, Morocco in December 2016.
- WMO is seeking to establish a funded project for development of the Kenya AMDAR Programme with Kenya Airways under the UK Department for International Development, Weather and climate Information and Services for Africa (WISER) programme. Expected this will commence late Q2 2017 or Q3 2017.
- Morocco is collaborating with E-AMDAR on development of an AMDAR programme with Royal Air Maroc.

Region II

Working Structure: https://www.wmo.int/cpdb/regions/asia/working_structure

- As a result of SO/ARO input to the RA-II Management Group meeting ahead of the RA-II 16th session held in Abu Dhabi, United Arab Emirates from 12 to 16 February 2017, the RA:
 - Adopted draft Resolution 5.2/8 — Pilot Project to Develop Support for National Meteorological and Hydrological Services in the Collection and Application of Aircraft Meteorological Data Relay (AMDAR) data;
 - Established a task team on Aircraft Based Observations under the Expert Group on WMO Integrated Global Observing System (EG-WIGOS).
- Regional Workshop on AMDAR for RA II (West Asia) was held 4 November 2016, in Abu Dhabi, United Arab Emirates.
- Regional workshop on AMDAR for Central Asia expected to be held in Q4 2017.

Region III

Working Structure: https://www.wmo.int/cpdb/regions/south-america/working_structure

- Some progress has been made on the development of a Region III A-RIP in Spanish but it has not been continued.
- AMDAR was presented at the RA-III Session in September 2014 - A rapporteur on AMDAR was appointed.
- Argentina started its operational AMDAR program in July 2016.
- Brazil made tests on AMDAR data with ADS-C reports during 2016.
- Regional workshop on AMDAR for Regions III and IV was held in Panama City, Panama in August 2016.
- NOAA initiated an AMDAR programme with LATAM/ DMC (Chile) in 2016 and expects to extend the contract in 2017.

Region IV

Working Structure: https://www.wmo.int/cpdb/regions/north-america-central-america-and-the-caribbean/working_structure

- A draft A-RIP has been developed.
- SO/ARO provided input to the RA IV Management Group meeting ahead of the RA-IV 17th session held in San José, Costa Rica from 27 to 31 March 2017 but the RA elected not to establish any work group on ABO.

Region V

Working Structure: https://www.wmo.int/cpdb/regions/south-west-pacific/working_structure

- A draft A-RIP has been developed.
- Mr R. Stringer (Lead Working Group on Infrastructure) presented ET-ABO Coordination plans to the RA-V Session in May 2014.
- The Session concluded that a Working Group on AMDAR would be established if enough Members should nominate the required experts.
- Chair of Task Team on Aircraft Based Observations from BMKG has retired. A new Chair is being sought.
- Regional workshop on AMDAR was held in May 2017.

Region VI

Working Structure: https://www.wmo.int/cpdb/regions/europe/working_structure

- A draft A-RIP for Region VI has been developed.
 - The ET-ABO Region Lead has corresponded with the President of RA VI regarding collaboration.
 - WMO has entered into a MoU with EUMETNET for collaboration on ABO in relation I in particular to Region VI and Region I ABO development.
 - A survey of targeted Region VI members was conducted in May 2017.
 - The RA-VI 17th session will be held over 18-22 September 2017.
-

ANNEX III - TERMS OF REFERENCE OF THE WMO GLOBAL DATA CENTRE FOR AIRCRAFT-BASED OBSERVATIONS (GDC-ABO)

The WMO Global Data Centre for Aircraft-Based Observations (GDC-ABO) shall:

- (1) Liaise as necessary and come to agreement with designated CBS expert teams on the detailed operation and functions of the GDC-ABO;
- (2) Receive, quality control and maintain a database archive of all aircraft-based observations (ABO) transmitted on the WMO Information System (WIS), along with the required metadata;
- (3) Make provision of archived ABO data and metadata to WMO Members and approved and registered data users in accordance with the data policy of data providers;
- (4) Develop and maintain a record of data quality issues associated with ABO data, taking into account quality monitoring and quality assessment reports from designated WMO monitoring and lead centres;
- (5) To the extent possible, retrieve and backfill the GDC-ABO database with available historical global ABO data; and
- (6) Report to CBS on an annual basis on actions taken, progress achieved, concerns and recommendations.

ANNEX IV – LIST OF ACTIONS ARISING FROM THE MEETING

No.	Agenda Item	Action	Who	Expected Completion
1	3.1	Report on timeline for South Africa AMDAR programme to migrate to transmission in BUFR.	F. Moseitlho	Q3 2017
1	3.3	Monitor data impact results from OSEs related to LATAM development	ET-ABO Lead Region III	ET-ABO-4
2	3.3	Ensure national representatives discuss future of LATAM resourcing at next Region III teleconference.	ET-ABO Lead Region III	Q4 2017
3	3.3	The Secretariat to write to NOAA regarding its support for the LATAM AMDAR programme.	SO/ARO	July 2017
4	3.3	Investigate the possibility to develop a Spanish AMDAR portal and define requirements for resources to be available in Spanish.	ET-ABO Lead Region III	Q4 2017
5	3.5	Lead to seek to expand the membership of the RA-V TT-ABO including the addition of a member from Indonesia and workshop participants.	ET-ABO Lead Region V	Q4 2017
6	3.6	Lead to report to ET-ABO on outcomes of impact studies on humidity.	ET-ABO Lead Region VI	ET-ABO-4
7	3.6	Lead to investigate possibility to hold a regional workshop on AMDAR for Region VI in next 12 months.	ET-ABO Lead Region VI	Q2 2018
8	3.6	Update A-RIP-VI ready for submission to the RA-VI Management Group session in Q4 2017.	ET-ABO Lead Region VI	Q4 2017
9	4.1	<p>Actions on IATA-WMO Collaboration:</p> <ul style="list-style-type: none"> • SG-IWC to seek additional information from IATA on various aspects of collaboration • SG-IWC to include T. Farrar and a team member of ET-ABO from WMO Region II • SG-IWC to continue to develop CONOP, ToR and Implementation Plan 	ET-ABO/SG-IWC	Q4 2017

No.	Agenda Item	Action	Who	Expected Completion
10	4.3, 4.5	Consultancy should be put in place to update the Study on target airlines for AMDAR recruitment with an additional emphasis on possibilities to expand B777 reporting and to recruit aircraft for turbulence reporting from existing and new fleets. (40K CHF)	Secretariat	Q4 2017 (study completed by Q1 2018)
11	4.5	ET-AO to provide Hong Kong China with contacts to provide assistance on implementation of turbulence (EDR or DEVG) in Cathay Pacific.	Chair ET-AO	Q3 2017
12	4.6	ET-AO to develop guidance on the process and requirements for deriving data from Mode S information.	ET-AO	Q2 2018 (Consult CIMO Ed. Board on timeline)
13	4.8	ET-ABO to support ET-AO in holding of a workshop on UAV capabilities.	ET-AO	Q3 2018
14	5.1	ET to complete final editorials to Guide to ABO before end of July 2017	ET-ABO/SG-RM	July 2017
15	5.1	ET-ABO/SG-RM to make plans and work on required regulations and guidance relating to integration of Man. and Guide to GOS into WIGOS regulatory material in consultation with WIGOS Ed.B.	ET-ABO/SG-RM	Q4 2018
16	5.1	ET-ABO to maintain the Guide to ABO with first consideration given to: <ul style="list-style-type: none"> development of guidance on use of OSCAR/Surface for provision of metadata. Guidance on practices relating to ADS-C derived data. 	ET-ABO/SG-RM	Q4 2018
17	5.2	50K CHF to be allocated to updating of the Lead Centre functions for requirements in Guide to ABO	Ch/ET-ABO, SO/ARO	Q4 2017
18	5.2	Follow up on data quality issues with J.v.d.Meulen	Ch/ET-ABO, SO/ARO	Q4 2017
19	5.3	Sub-Group GDC (SG-GDC) to be formed and to commence work on agreed actions relating to implementation of the GDC-ABO	C. Marshall, S. Stringer, T. Farrar	Q1 2018
20	5.3	ET-ABO to ensure that the agreement between WMO and NOAA is established as soon as possible based on the ToR and additional agreed operational requirements.	SG-GDC, SO/ARO	Q4 2017
21	5.3	50K CHF to be allocated to resourcing updated functionality of GDC if required.	Ch/ET-ABO, SO/ARO	Q4 2018

No.	Agenda Item	Action	Who	Expected Completion
22	5.3	Team to contact SITA regarding provision of ADS-C data	S. Stringer, SO/ARO	Q3 2017
23	5.3	Investigate possibility for E-AMDAR/E-ADAS system to process ADS-C data.	S. Stringer	Q3 2017
24	5.3	Sub-Group on metadata to be formed (SG-AMD) and begin work on testing, verification, implementation of ABOP metadata within OSCAR/Surface.	S. Taylor, D. Body, C. Marshall	Q2 2018
24	6.1	Investigate option to develop a joint RA-III & RA-VI A-RIP	C. Marshall, N. Rivaben	Q4 2017
26	6.2	Sub-group on workshops to be formed (SG-WS) and begin planning for future workshops and reviewing the workshop format and materials: <ul style="list-style-type: none"> • Region II or Region VI, Q4 2017 • Region II or Region VI, Q1 2018 • Africa/ASECNA Q4 2018 • Workshop on Data Use in 2019 • Workshop for Avionics Providers in 2019 	F. Grooters, S. Stringer, SO/ARO, ADO	Ongoing
27	6.2	Investigate whether: <ol style="list-style-type: none"> 1. WMO/ETR can assist in organisation and holding of workshops. 2. Workshops can be held with WIGOS events. 	SO/ARO	Ongoing
28	6.3	Letter of thanks to be written to SAWS to thank G. Khambule for promotion of AMDAR in Region I	SO/ARO	Q3 2017
29	6.4	ET-ABO to assess the need for additional outreach material on AMDAR Data Use based on work of consultant Mr Asvar.	ET-ABO-MG, SO/ARO	Q3 2017
30	6.4	ET-ABO to assess the possibilities to develop video material for AMDAR and ABO outreach.	ET-ABO, SO/ARO	Q4 2017
31	7	Report to EC-PHORS on the progress made on the extension of aircraft-based observations over the polar regions and provide input to the 8th session of the Panel in March 2018.	F. Grooters	Q1 2018
32	7	A-SIP to be published on the WMO website.	SO/ARO	Q3 2017
33	7	Update the work plan based on outcomes of ET-ABO-3.	Ch/ET-ABO	July 2017

ANNEX V – UPDATED WORK PLAN FOR ET-ABO

(Version 2017.2D, May 2017)

No.	ToR	Task	Sub-tasks	Description	Responsible	Commencement	Completion	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
1	(a)	Provide representation to relevant ICG-WIGOS working groups, including the TT-WMD, TT-WEDB and TT-DQMS	Develop and document the ABO WDQMS	Representing relevant aspects of ABOP at meetings	Ch/ET-ABO. SO/ARO, ADO	Q4 2016	Ongoing	2	Input at meetings	<ul style="list-style-type: none"> • Representative in TT-WMD available. • Representatives in TT-WEDB and TT-DQMS to be identified 			
2	(a)	Contribute to OSCAR/Surface development & implementation	<ol style="list-style-type: none"> 1. Contribute to development and testing of the ABO component of OSCAR/Surface 2. Assist in establishment and maintenance of ABO metadata 3. Contribute to development of guidance on use of OSCAR/Surface/ABO 	<ul style="list-style-type: none"> • Previously budgeted for OSCAR/Surface development costs which were absorbed by WIGOS funding. • Budget 6K per annum as contribution to OSCAR maintenance as requested by D/OBS. 	<ol style="list-style-type: none"> 1. S. Taylor, C. Marshall, D. Body, Y. Fai 2. ET-ABO 3. SG-RM 	Q2 2016	Ongoing	2		Compiling ABO relevant metadata for implementation in OSCAR	0 (57)	6	6

Ref: 307/56/2017-13-085-WIGOS
 Approved by Fernando Belda Esplugaes, Tue Aug 15 10:17:07 UTC 2017

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
3	(a)	Contribute to WIGOS ABO regulatory and guidance development	<ol style="list-style-type: none"> 1. Finalise approval and publication of the Guide to ABO. 2. Develop guidance for use of the OSCAR/Surface ABO interface. 3. Updated guidance on the GDC-ABO 4. Review and approve other guidance, reports 	<ul style="list-style-type: none"> • Updating GOS manual and guide for including into WIGOS regulatory material • Will require 1 or more sub-group meetings or teleconferences. 	SG-RM	Q2 2016	Ongoing	2	<ol style="list-style-type: none"> 1. Publication and maintenance Guide on ABO 2. Guidance on ABO OSCAR/Surface 3. Guidance on GDC-ABO 	Draft GOS Manual and Guide and ABO Guide for review			
4	(b)	Plan and hold meetings of ET-ABO	<ol style="list-style-type: none"> 1. 4th Session ET-ABO, Q4 2019 	Plan for next meeting of ET-ABO in order to conclude work plan of intersessional period and to report to CBS through ICT-IO.	Ch/ET-ABO, SO/ARO	Q1 2017	Q4 2019	1	<ul style="list-style-type: none"> • Agenda, Meeting Form, Session • Meeting Reports 	<ul style="list-style-type: none"> • ET-ABO-1 held in Sep 2013 • ET-ABO-2 held jointly with ET-AO in Dec 2015 • Meeting of ET-ABO leadership was held Feb 2017, Silver Spring, USA. (15) • ET-ABO-3 was held in Jakarta, Indonesia, May 2017. 		15 (35)	

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
5	(b)	Harmonize annual work plan and budget for ET-ABO with ET-AO annual work plan and budget	<ol style="list-style-type: none"> Maintain ET work plan Coordinate with CIMO ET-AO on harmonization of work plans and finalization of budgets 	2018-19 Budget to include new budget items approved during ET-ABO-3.	Ch/ET-ABO	Q4 2016	Ongoing	2	Revision of Work Plans, Annual Budgets	Plan and budget for 2017 approved			
6	(b)	Maintain the ABOP Strategy and Implementation Plan (A-SIP)	Review and finalise A-SIP version 2017		Ch/ET-ABO	Q3 2016	Q2 2017	2	ABOP A-SIP Version 2017.1	Finalized A-SIP Version 2017 1D4 to be reviewed and approved by Ch/OPAG-IOS			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commenc e	Comple t e	Statu s	Deliverables/ Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estim at e
7	(d)	Assist in the development, coordination and maintenance of regional and national ABO programmes	<ol style="list-style-type: none"> 1. Develop ABOP Regional Implementation Plans. 2. Establish RA ABO work groups. 3. Assist in coordination of regional activities and development. 4. Regular teleconferences with each Region. 5. Attend E-AMDAR Meetings 6. Update study on target airlines for AMDAR with additional element on B777 and EDR reporting (40K) 	<ul style="list-style-type: none"> • Provide input on ABO to RA sessions. • Develop and maintain A-RIPs. • ABO in RA II meeting (Feb. 2017), RA IV meeting (March 2017), RA VI meeting (Feb. 2018). • Ch-ET-ABO to ensure ongoing funding of LATA programme in collaboration with RA III. • Collaborate and meet with RA work groups. • Attendance at E-AMDAR meetings – supports the collaboration between WMO and EUMETNET. 	<p>CH/ET-ABO, SO.ARO, ADO</p> <p>TT Leaders for A-RIP Development:</p> <ul style="list-style-type: none"> • RA I Abderrahim Mouhtadi • RA II Yiu-fai Lee • RA III Nicolas Rivaben • RA IV Curtis Marshall • RA V Douglas Body • RA VI Steve Stringer 	Q4 2013	ongoing	2	<ol style="list-style-type: none"> 1. Maintained A-RIPs 2. RA work groups established 3. Meetings of 	<ul style="list-style-type: none"> • Mature drafts have been produced for RA I, RA IV, RA V, RA VI. • A-RIPs presented at sessions RA II, RA III, RA V, RA VI. • ABO Trials projected for RA I and RA V. • BAW and AFR B777 ABO expansion realized over RA I (2016) • SO/ARO attended E-AMDAR ET-8 meeting (Nov, 2016) • G.Khambule attended AFRAA conf. (May 2016 and 2017). 	3 (15)	45	5

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
8	(c)	Undertake regional workshops on ABO/AMDAR	<ol style="list-style-type: none"> 1. Second regional workshop in 2017 2. Two regional workshops in 2018 3. Tentative plan to hold a data user workshop and an ATI-related workshop in 2019 	<ul style="list-style-type: none"> • Workshops planned in 2017: <ul style="list-style-type: none"> - RA V (Indonesia), - RA II (Thailand) or RA VI (Eastern Europe) – (40K) • 2018: Region II (Thailand) or Region VI (Eastern Europe), NW Africa (ASECNA) • SG-WS to review workshop format and content. • Workshops to include input of IATA. • Consultancy for organising workshops (15K) 	SG-WS (F. Grooter, S. Stringer, SO/ARO), Ch-ET-ABO	2012	Ongoing	2	<ul style="list-style-type: none"> • ABO/AMDAR Workshop held, • Workshop Reports. 	<ul style="list-style-type: none"> • Workshops held in Kenya (2015), Morocco (2015), Panama (2016), UAE (2016), Indonesia (2017) • US contributed 75K for workshops and AMDAR development in Region III-IV. 	40 (40)	55	55

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
9	(d)	Contribute to national and regional ABO & AMDAR development projects	<ol style="list-style-type: none"> 1. Assist in establishment of AMDAR programmes in Kenya, Ethiopia and Morocco. 2. Extend ABO through wider availability of meteorological data from ICAO aircraft reports and observations from commercial data service providers. 3. Expanded operational use of WMO AOS for B777 	<ul style="list-style-type: none"> • Kenya (WISER funding by DFID – Fund travel of staff to Nairobi for kick off meeting; (10K) fund development of software for Embraer aircraft (15K) • Funding source for Ethiopia being sought. (10K) • Morocco through E-AMDAR collaboration. – SO/ARO to attend meeting in Feb 2017 (5K) • Two projects with FLYHT for trial of the AFIRS system in regions I and V. (80K) • Identify further B777 fleets, initially operated by participating airlines. 	Ch/ET-ABO, RA-I Lead, SO/ARO, ADO, S.Stringer (E-AMDAR PM)	2015	Q4 2018	2	<ol style="list-style-type: none"> 1. Quality controlled ABO data distributed on WIS 	<ul style="list-style-type: none"> • Funding for Kenya programme agreed; SO/ARO attended kick-off meeting (Nairobi, 2016) • Negotiations on Morocco programme progressing. • ADO to follow up on FLYHT progress and kick-start the projects through A-RIPs for Regions I and V. 	7 (30)	80	60

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
10	(d)	Under the WMO/EUMETNET MoU, collaborate with E-AMDAR on regional and global development of AMDAR	<ol style="list-style-type: none"> Employ part-time ABOP Development Officer under E-AMDAR Program. Consultancy for project work. 	<ul style="list-style-type: none"> ADO to support SO/ARO managing the ABOP workplan – S. Taylor (60K) Consultancy to review/Summary benefits to Aviation; Benefits to environment; COMET module extension - E. Avsar (30K) 	SO/ARO	Q4 2016	Q4 2017	2	<ol style="list-style-type: none"> Appointment of ADO. Contract with consultant; contract & deliverables as agreed. 	<ul style="list-style-type: none"> Mr Stewart Taylor employed as ADO at half-time under WMO appointment from Oct. 2016 (15K) 	15 (40)	90	60
11	(c)	Promote ABO and AMDAR to relevant aviation bodies	Attendance at and reports from AEEC Data-Link User Forum meetings	AEEC DLUF meets twice per year, by turn held in the USA and in Europe.	SO/ARO, Ch/ET-ABO, ADO, FP USA	Q4 2013	ongoing	2	<ul style="list-style-type: none"> Attend meetings. Report to ET-ABO 1-Day workshop Workshop report 		0 (4)	10	10
12	(c)	Promote ABO and AMDAR through the AMDAR newsletter	<ul style="list-style-type: none"> Two volumes annually of the WMO AMDAR Observing System Newsletter. Maintain the WMO ABO and AMDAR websites 	.	ET-ABO, SO/ARO, Carl Weiss, AMDAR FPs	Q1 2012	ongoing	2	<ul style="list-style-type: none"> Newsletter Volumes. #13 and #14, Newsletter Volumes #15 and #16 	Volumes #11 and #12 published in 2016 and accessible on the AMDAR web site			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
13	(c)	Maintain and enhance the COMET AMDAR Learning module	Possible update of the COMET AMDAR Learning Module focussing on data use.	<ul style="list-style-type: none"> Mr Avsar to produce an outline script for the module. ET-ABO to assess requirement for updating the module and means for funding. 	ET-ABO, SO/ARO, ADO	Q1 2017	Q4 2018	0	Updated or 2 nd AMDAR Learning Module	Mr Ercument Avsar has been contracted to WMO to work on this and other ET-ABO projects (see item 10).			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commenc e	Comple t e	Statu s	Deliverables/ Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estim at e
14	(c)	Liaise with ICAO on data management of ICAO aircraft observations, including input to the ICAO Met. Panel.	<ol style="list-style-type: none"> 1. Establishment of WAFC authorised regional ABO data processing centres. 2. Improved QC of AIREP and ADS-C aircraft observations. 3. Ensure input through ICAO Meteorological Panel (METP) and its relevant collaborating groups 4. Develop plans to ensure WMO Members comply with ICAO requirements for provision of ICAO ABO on GTS 	<ul style="list-style-type: none"> • Starting with WAFG Washington, followed by WAFC London • Continue to monitor progress on ICAO/WMO workshop outcomes and actions, and assist where required. <ul style="list-style-type: none"> ○ Follow up meeting with ICAO and WAFC reps in 2017 ○ WAFC reps to revise WMO RRR SoG on Aeronautical Meteorology • Contact SITA regarding possible collaboration on provision of ADS-C data (S. Stringer, C. Marshall, SO/ARO). 	ET-ABO, SO/ARO, ADO	Q2 2015	ongoing	2	Report to ET-ABO	<ul style="list-style-type: none"> • WMO/ICAO workshop held in Geneva, June 2015 • Follow up meeting via WebEx in 2016 • Next meetings planned in 2017 			

No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
15	(c)	Establish collaboration with IATA in ABOP	<p>Collaboration with IATA in extension and wider global coverage of ABO/AMDAR observing network and increase in the use of ABO data</p> <ol style="list-style-type: none"> Develop the proposed Concept of Operations, Terms of Reference and Implementation Plan Put in place consultancy for assistance on 1 (20K) 	<p>Focus on:</p> <ul style="list-style-type: none"> Benefits to ATI Provision of ABO data for use by airlines <p>Collaborate with IATA FOSTF in support of WMO ABO activities</p>	SG-IWC (C. Marshall, S. Stringer, S. Taylor, F. Grooters, A. Mouthadi, T. Farrar, Y. Lee) SO/ARO	Q4 2016	Ongoing	2	<ul style="list-style-type: none"> Cooperation agreement WMO-IATA Representation at FOSTF meetings 	<ul style="list-style-type: none"> Initial meeting WMO-IATA in December 2016 IATA-WMO Working Arrangement established Consultant S. Lord contracted. Work on CONOP commenced. 		20	

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No.	ToR	Task	Sub-tasks	Description	Responsible	Commence	Complete	Status	Deliverables/Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estimate
16	(d)	Work with national and regional programmes to optimise ABO reporting and coverage	<ol style="list-style-type: none"> 1. Ongoing supplementary AMDAR data provision, particularly focused on Region I (50K) 2. Seek to obtain report on impact assessment (ECMWF); 3. Ensure continuation of the LATAM program in Region III and the Mexico programme (through the Secretariat) in Region IV 	<ul style="list-style-type: none"> • Continue to support data provision over Region I in 2017 • Investigation of (further) provision of supplementary ABO data from E-AMDAR and MDCRS/US AMDAR programmes • Investigate (in collaboration with IATA) opportunities for increase (globally) implementation of water vapour turbulence and measurement and the development of icing detection <p>24K to support Mexico programme (funded by Mexico within the Trust); 50K to support item 1.</p>	ET-ABO, ET-AO, SO/ARO. ADO	2015	ongoing	2	<ul style="list-style-type: none"> • Funding and data delivery agreements • New implementation arrangements, including funding 	<ul style="list-style-type: none"> • 100+ Aircraft in the US AMDAR programme providing turbulence (EDR) information • 125+ Aircraft in the US AMDAR programme and 9 aircraft in the E-AMDAR programme providing water vapour data – 2016 expenditure on data for Region I = 19K 	43 (74)	75	75

No.	ToR	Task	Sub-tasks	Description	Responsible	Commenc e	Comple t e	Statu s	Deliverables/ Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estim at e
17	(e)	Establish the ABO Global Data Center (GDC-ABO)	<ol style="list-style-type: none"> 1. Review functionality of MADIS and agree on any required changes 2. Meeting with GDC-ABO Operator in Q1 2017 3. SG-GDC to work with MADIS on making the GDC operational and establishing the MoU (50K). 	<ul style="list-style-type: none"> • Additional functional establishment/development/enhancement and ongoing funding may be needed. • Coordination with Lead Center for ABO – SO/ARO and F.Grooters to meet with NOAA/MADIS managers. 	SG-GDC (C. Marshall, S. Stringer, T. Farrar), SO/ARO,	Q1 2013	Q4 2018	2	<ol style="list-style-type: none"> 1. Additional functions of the Operational ABO Global Data Center 2. Meeting with 	<ul style="list-style-type: none"> • Recommendation and draft requirements discussed and endorsed by ICT-IOS and CBS-XVI • EC-69 Approved designation of MADIS as GDC. 			50

No.	ToR	Task	Sub-tasks	Description	Responsible	Commenc e	Comple t e	Statu s	Deliverables/ Activities	Progress	2016 Budget Expend	2017 Budget Estimate	2018 Budget Estim at e
18	(e)	Enhance data monitoring and QC in collaboration with monitoring and Lead Center	<ol style="list-style-type: none"> 1. Revise both the monitoring and Lead Center requirements and role with respect to the Guide to ABO (Annex II) and plan for implementation. (50K) 2. Develop plans to ensure WMO Members comply with ICAO requirements for provision of ICAO ABO on GTS 	<ul style="list-style-type: none"> • Collaborate with the ABO Lead Centre – meet with managers in Q1 2017. • Develop plan for processing, QC and migration to BUFR of ADS-C and AIREP data 	Ch/ET-ABO, SO/ARO, Chris Hill	Q1 2017	Q4 2018	1	Revised operational Lead Center requirements, monitoring activities and QC guidance	<ul style="list-style-type: none"> • Meeting held with NOAA Feb. 2017 • C. Hill reviewed requirements of the ABO QMS in the Guide to ABO (ET-ABO-3) • ET-ABO agreed to go ahead with updating LC and QM centre functionalities. 			50

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19	(f)	Represent ABO and contribute to the activities of CBS/IPET-OSDE.	<ol style="list-style-type: none"> 1. Report to IPET-OSDE on ABO status and developments 2. Contribute to the development of the "Vision for WIGOS Surface-based Observing Components in 2040" 	F. Grooters, Ch/ET-ABO	ET-ABO, SO-ARO	Q4 2012	Ongoing	2	<ul style="list-style-type: none"> • Attend meetings • Report on meeting outcome to ET-ABO 	<ul style="list-style-type: none"> • Ch/ET-ABO attended ICT-IOS and IPET-OSND (4K) 	4 (0)	5	10
20	(g)	Report to sessions of ICT-IOS	Representative of ET-ABO to attend and provide report to ICT-IOS sessions	Report on work plan tasks and outcomes	Ch/ET-ABO	Q4 2012	Ongoing	2	<ul style="list-style-type: none"> • Attend meetings • Report to ICT-IOS • Input to report to CBS • Report on meeting outcome to ET-ABO 				