History of the Global Aircraft-Based Observations Programme (ABOP)

Friends and Partners of Aviation Weather (FPAW) Special Session, 11 Oct 2017
The NWS began regularly scheduled aircraft weather observations in 1919. Pilots flew unpressurized small aircraft into unknown weather conditions, making the task dangerous. They were not paid unless they reached an elevation of 13,500’, and received a bonus for each 1,000’ thereafter.
Aircraft Weather Observations 1919 ~ 1940

- 1919: Attaching a Meteograph to the Wing of a Bi-Plane
Weather Balloons Replace Aircraft in the Early 1940s

- Early 1940s: Aircraft soundings were discontinued with the advent of Weather Balloons with Radiosondes

Sensors are Reasonably:
- Accurate
- Reliable
- Available
- Low Unit Cost

But are:
- Manpower Intensive
- Single Use/Expendable
- Expensive Over Time
- A Hazard to Aviation
Weather Balloons with Radiosondes
1940s to Today

1940s – Today: Weather Balloons with Radiosondes are still considered the standard for In-Situ Upper Air Meteorological Observations

But Radiosonde Programs are:
- Low Spatial Resolution
- Low Temporal Sampling (00Z & 12Z)
- Expensive and Unsustainable
- Unreliable in many Regions
- Deteriorating with no signs of improving

Resulting in:
- Infrequent Reports in some Regions
- Low Availability of Quality Data
- Limits to Modern Forecasting
Interest in Aircraft Weather Observations Returns in the 1970s

- **1970s: Modern Navigation and Communication systems renewed the interest in Aircraft reporting of Meteorological Observations**

  Aircraft Sensors are:
  - Accurate
  - Very Reliable
  - Increasingly Available
  - Already Sampling
  - At Many Locations
  - With No Extra Equipment

  **But Require:**
  - Data Communications
  - New methods of Quality Monitoring
  - New Systems for Operations

1970s: Interest and Research in Aircraft Observations Returns
Aircraft to Satellite Data Relay (ASDAR)

Prototype-ASDAR

- 1978-1979: Automated Aircraft Weather Observations were first used in the Global Weather Experiment FGGE* to relay Wind and Temperature data
  - Prototype-ASDAR (USA)

- 17 Systems Installed
  - 16 commercial B747s
  - 1 US Air Force C-141
  - Later re-installed in commercial aircraft, outside USA (KLM, LH)

*FGGE = First Global GARP Experiment  
GARP = Global Atmospheric Research Programme
ASDAR (cont.)

Prototype-ASDAR

- **1978-1979: Prototype-ASDAR**
  - Large and Heavy Equipment
    - Thus additional cost for extra fuel consumption due to weight and antenna drag
  - Data communication via Geostationary Meteorological Satellites
    - Meteosat, GOES, GMS
    - From 80N to 80S
Aircraft to Satellite Data Relay 2nd Generation (ASDAR 2G)

ASDAR Second Generation

- 1982: ASDAR 2nd Generation
  - 10 WMO Member Nation Collaboration
- 1991: ASDAR 2G
  - Smaller and Lighter Equipment
    - Reducing added fuel consumption cost
  - Data communication still via Geostationary Meteorological Satellites
    - Meteosat, GOES, GMS
  - 23 Systems Installed Worldwide
    - 7 airlines
      - SAA, Air Mauritius, SAUDIA, Aerolineas Argentinas, KLM, LH, BA
  - Last ASDAR-2G decommissioned 2006
    - Air Mauritius B767-200ER
ASDAR 2G (cont.)

ASDAR 2G installation in KLM B747-200

ASDAR-2G Equipment in the E-Bay

Antenna on top of aircraft

Frank Grooters (KNMI)

Reviewing the Installation

Additional Cockpit Circuit Breakers
Aircraft Data Volume
1960 – 1995

1960 – 1995: 0 to ~20,000 Daily Obs (in 35 years)

Only Non-Automated AIREPs and PIREPs
Automated Reporting starts with FGGE

Note: All data volumes are approximate and based on limited available information, especially from the early years.

1960 – 1995: Early Years, Automated Reports start with FGGE
Aircraft Meteorological Data Relay (AMDAR)

AMDAR

- **1985: Early AMDAR Development**
  - **Software-only Solution**
    - Data acquisition from standard Aircraft Wx Sensors
    - Using Modern aircraft Flight Management Computer
  - **Based on Aviation and Meteorological Standards**
  - **ACARS Data Communications**
    - Global Coverage via HF, VHF, & SatComm
    - Network Providers: ARINC, SITA; with Cross-Network sharing
AMDAR 1985 - 2000

**Australia/SW Pacific**
(Australian Bureau of Meteorology)
- 1985 - ANSETT
- 1990 - Qantas

**North America**
(U.S. FAA, NOAA/NWS – MDCRS)
- 1990 – 1994: American, Delta, Northwest, United
- 1994 – 2000: UPS, Southwest

**Europe (E-AMDAR)**
- 1993 KLM, 1995 Air France
- 1998 British Airways, SAS
- 1999 Lufthansa
- 2000 Finland

**Asia**
- 1999 - China Southern
- 2000 - Japan Airlines

**Africa**
- 2000 - South African Airways

**South America**
- None


* Some Dates Approximate
Aircraft Data Volume
1986 – 2003

1986 – 2003: 5,000 to 140,000 Daily Obs
(+28x in 18 years)

Note: All data volumes are approximate and derived from limited available information, especially from the early years.
Aircraft-Based Observations Programme (ABOP)

Aircraft-Based Observations Programme 2000 - 2017

- 2004: Global AMDAR Programme Grows
  - AMDAR Panel Strengthening Global Collaboration
  - WMO Central Support and Coordination Increasing

- 2007: WMO Restructuring benefits AMDAR
  - WMO Headquarters Appoints AMDAR Technical Coordinator
  - Transfers AMDAR from WMO Commission for Aeronautical Meteorology to WMO Commission for Basic Systems (CBS)
  - Becomes Expert Team on Aircraft Based Observations (ET-AIR)
  - ET-AIR and AMDAR Panel meet Jointly
  - Harmonisation/Standardisation under WWW => WIGOS/WIS

- 2009: WMO Declares AMDAR “Mature” Programme
  - Temp and Wind Data Quality Suitable for Operational Applications

Growth in ABOP Data
2003 – 2010

2003 – 2010: 140,000 to 210,000 Daily Obs
(+1.5x in 7 years)

Note: From approximately 2003 the current WMO ABOP system for measuring data volumes has been used.
Aircraft-Based Observations Programme (ABOP)

Aircraft-Based Observations Programme 2000 - 2017

- 2012: ABOP Fully Integrated into WMO Structure
  - Transitions to “Aircraft-Based Observations” (ABO)
    - ABO includes AMDAR, ADS-B/C, Mode-S, & all forms of Aircraft Obs
  - ABO formally becomes a WMO Observation “Programme” (ABOP)
    - With responsibilities split between CBS and CIMO
  - WMO CBS Expert Team on Aircraft-Based Observing Systems (ET-ABO)
    - Regional Implementation Strategy, Outreach, Publications, Education, Training
  - WMO CIMO Expert Team on Aircraft-based Observations (ET-AO)
    - Technical Development, Tech Evaluations, Tech Standards, and Tech Support

ABOP Today

ABOP in 2017

● A Growing Global ABO Infrastructure
  ● 1 ABO Global Data Centre (USA)
  ● 1 ABO Data Quality Evaluation Center (Europe)
  ● 2 ABO Optimization Systems (Europe, Australia)
  ● ABOP Focal Points in many WMO Member Nations
  ● Contributing to WMO Integrated Global Observing System (WIGOS)

● 14 National/Regional Operational Programs
  ● 40 Airlines providing daily ABO data
  ● 10,200+ Aircraft and growing
  ● 870,000 Observations/Day to WIGOS

● Programs Adding New Data Types and Sources
  ● Water Vapour Sensors and Turbulence Reporting
  ● Partnerships for new ABO Sources

2017: ABOP Globally Organized and Growing Rapidly
ABOP in 2017

- **Australia/SW Pacific**
  - 4 Airlines reporting
- **North America**
  - 11 Airlines reporting
- **Europe (E-AMDAR)**
  - 14 Airlines reporting
- **Asia**
  - 8 Airlines reporting
- **Africa**
  - 1 Airline reporting
- **South America**
  - 2 Airlines reporting

2017: 40 Airlines and 10,200 Aircraft over Six Continents
Growth in Number of Aircraft Reporting into ABOP

2012 – 2017: Dramatic Growth in Aircraft Reporting (+3.4x in 5 years)

ABOP/AMDAR Monthly Number of Reporting Aircraft

2012 – 2017: 3,000 growing to 10,200+ Aircraft

Based on reports received by the Canadian Meteorological Centre

2012 – 2017: Dramatic Growth in Aircraft Reporting
Growth in ABOP Data
2010 – 2017

2010 – 2017: 210,000 to 870,000 Daily Obs
(+4.4x in 7 years)

Aircraft Observations - Smoothed Monthly Average of Daily Report Totals

Date:

2010 – 2017: Dramatic Growth in ABOP Data
24 Hours of ABOP Data

Note: Only 2.9% of the ABOP Data is shown in the Graphic

01-Aug-2017 00:00:00 -- 01-Aug-2017 23:59:59 (819004 obs loaded, 755150 in range, 23443 shown)

NOAA / ESRL / GSD  Altitude: -1000 ft. to 45000 ft.

Graphics Courtesy of NOAA/ESRL/GSD
Growing Number of ABOP Aircraft Reporting Water Vapour Measurements

2012 – 2017: 50 to 145 Aircraft (+2.9x in 5 years)

ABOP Reporting of High Quality Water Vapour Measurements

Note: Only 3.6% of the ABOP WVM Data is shown in the Graphic

01-Aug-2017 00:00:00 -- 01-Aug-2017 23:59:59 (66315 obs loaded, 66218 in range, 2375 shown)

NOAA / ESRL / GSD  Altitude: -1000 ft. to 45000 ft.  Good w and T vapor

Graphics Courtesy of NOAA/ESRL/GSD
Growth in ABOP Data
1960 – 2017

1960 – 2017: ABO Data is Getting Bigger Every Day
ABOP
2018 and Beyond

Aircraft-Based Observations Programme 2018+

● Greater Expansion into Developing Nations/Regions
  ● South America, Africa, Southern Asia
  ● With Greater Regional Collaboration

● Greater Integration of New Technologies
  ● Water Vapour Measurement and Turbulence Reporting
  ● ADS-C, ADS-B Wx, Mode-S, Broadband SatComm
  ● Aircraft Wx Radar

● Greater Use of Public Private Partnerships
  ● Airlines/WMO/Rockwell Collins
  ● Airlines/WMO/Panasonic
  ● IATA/WMO
  ● Other New PPPs

● Continuously Increasing Data Volume and Quality

2018+: Strong ABO PPPs Benefitting Aviation
Thank You for your attention!
Questions?

http://www.wmo.int/pages/prog/www/GOS/ABO/AMDar/