



WMO

World Meteorological Organization

Working together in weather, climate and water

## **WMO AMDAR Programme**

**Annual IAGOS-ERI Meeting 2010**

**September 29 - October 1, 2010**

Michael Berechree  
WMO AMDAR Technical Coordinator



# AMDAR System Background

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*AMDAR* = Aircraft Meteorological DAta Relay

- A fully automated upper air observing system
  - Collects high quality upper air observations of wind speed and direction, temperature, and can include turbulence and humidity;
  - Available from many existing commercial aircraft; and
  - In collaboration with national domestic and international airlines.
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# AMDAR System Background

**FITTED WITH EXISTING SENSORS**



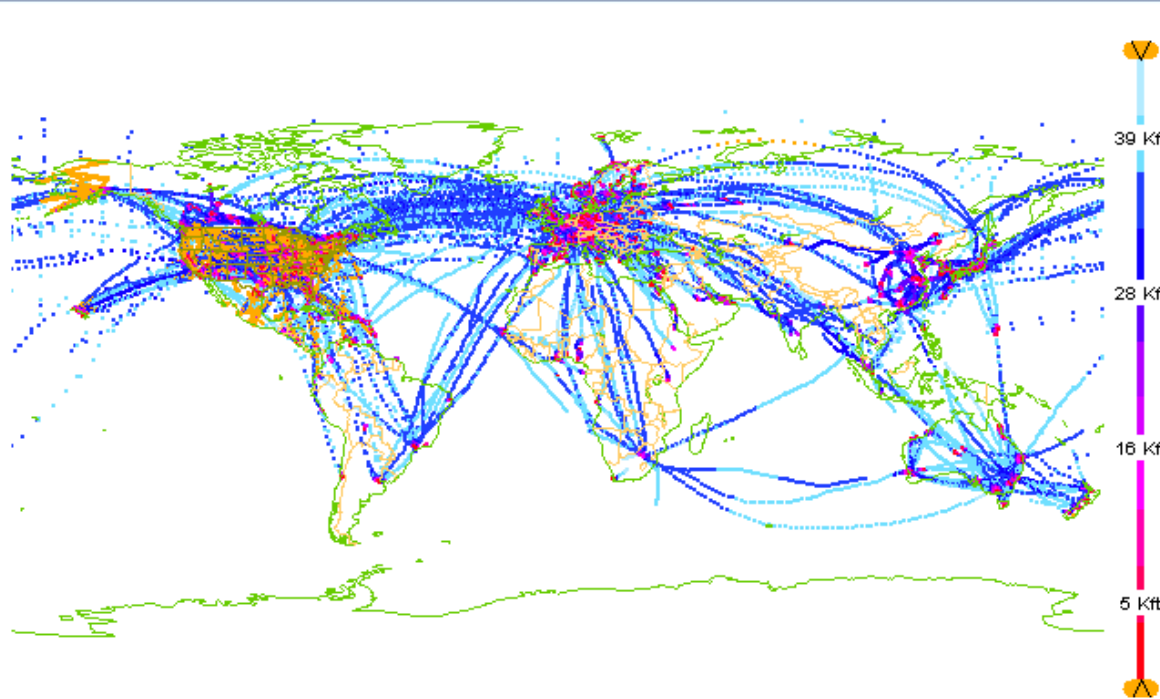
**+ Software**

**AMDAR uses existing aircraft and airline infrastructure:**

- Wind, temperature and turbulence plus height (pressure), time and position;
- Onboard avionics and communications hardware and software; and
- **Aircraft Communications And Reporting System (ACARS)**. Global services are provided by ARINC and SITA and others.



# AMDAR Global Coverage

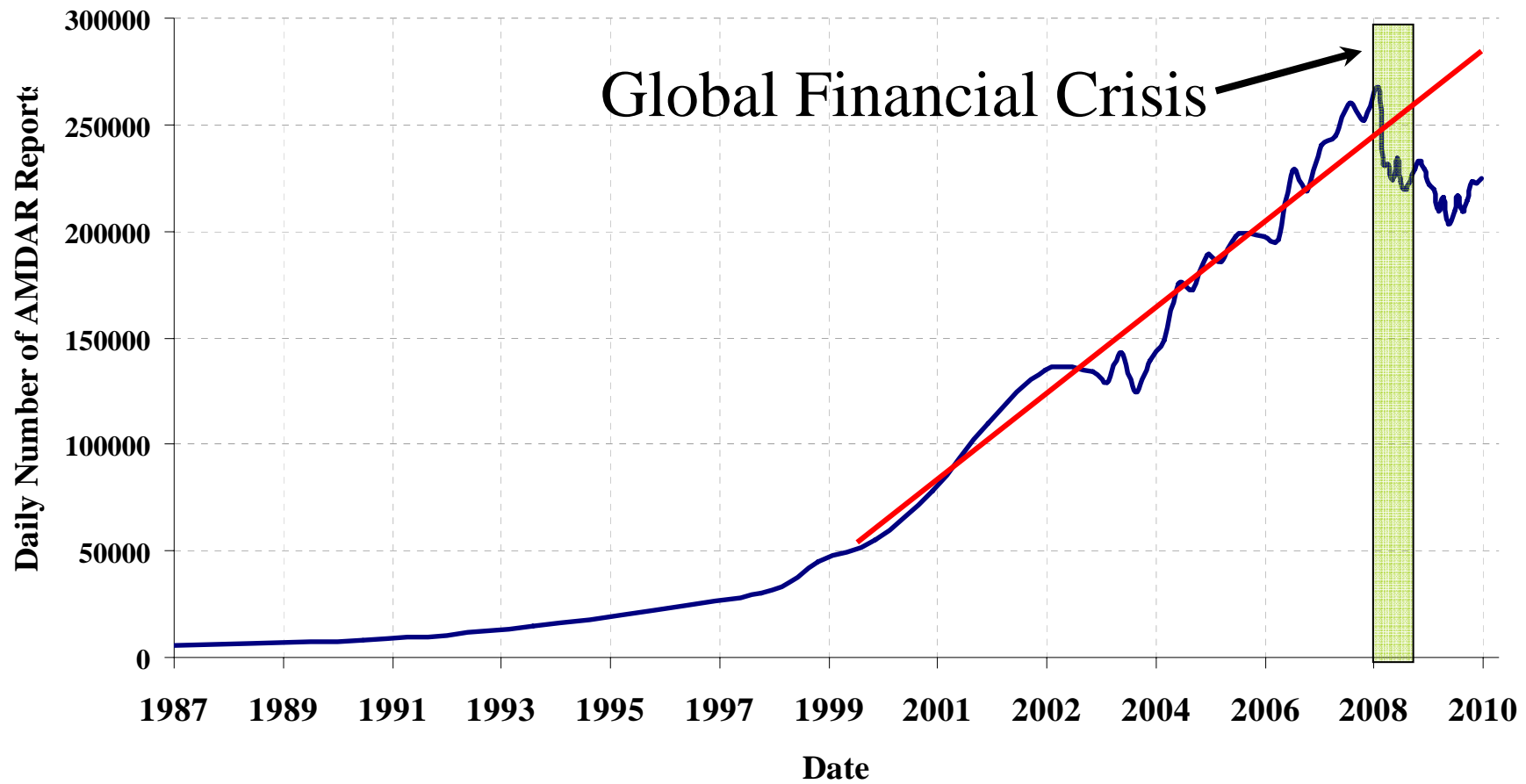


27-Sep-2010 12:00:00 -- 28-Sep-2010 12:09:34 (314385 obs loaded, 314376 in range, 18335 shown)

- 230K – 250K AMDAR reports per day disseminated on the GTS.
- 3000+ Reporting aircraft.
- Increased coverage in data sparse regions of Southern Africa, Eastern Europe, parts of the Russian Federation, South and East Asia and South America.

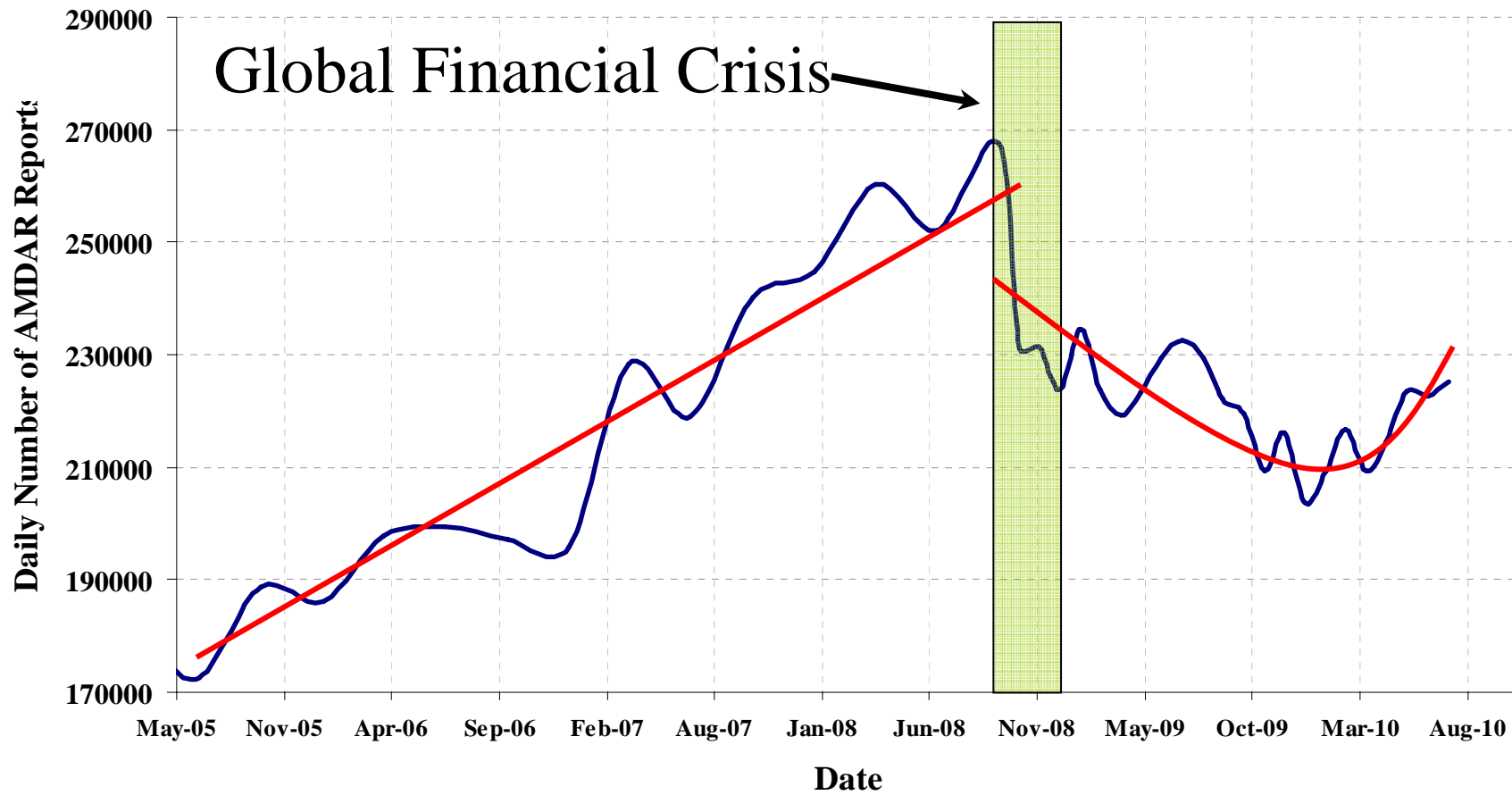


# AMDAR Global Coverage





# AMDAR Global Coverage







# Importance of AMDAR

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Real time high quality vertical profiles of AMDAR temperature and wind have proven to contribute significantly to the improvement in short to medium-term forecasting applications. AMDAR is particularly useful for now-casting situations where conditions are changing rapidly and are therefore of special use to the aviation industry. Such applications include:

- Surface and upper air forecasts of wind and temperature;
  - Thunderstorm genesis, location and severity;
  - Wind-shear location and intensity e.g. dangerous low-level jets;
  - Low cloud and fog formation, location and duration;
  - Turbulence location and intensity; and
  - Jet-stream location and intensity.
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# Importance of AMDAR

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**The AMDAR Panel together with the WMO can help NMHSs organize regional and/or national AMDAR Programs by:**

- Working with NMHSs and airlines to evaluate the potential for developing a national AMDAR programme;
  - Assisting with technical support and training;
    - Regional AMDAR workshops are planned for a combined Central and Southern America, Eastern and Northern Africa.
  - Providing technical material and manuals needed to establish a National AMDAR Programme; and
  - Working with NMHSs and the airlines to create the necessary documents and infrastructure agreements.
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# Integration of AMDAR into WIGOS

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## **Introduction:**

- Within the WMO Integrated Global Observing System (WIGOS) is the WIGOS Pilot Project for AMDAR, initiated with participation from the EUMETNET and USA AMDAR Programs;
- The WIGOS Pilot Project for AMDAR was designed to focus on the practices impacting AMDAR data collection, processing, archiving and disseminating;





# Integration of AMDAR into WIGOS

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## Governance Issues and Technical Issues:

- **Transfer of AMDAR Technical Coordinator's responsibility to WMO**
  - **Creation of Aircraft Observation Unit (OBS/OSD/AIR)**
- **CBS/OPAG-IOS/ICT-IOS-5 (15-18 Sept. 2008)**
  - **Rec. 7.2.4: CBS-XIV to consider establishment of an ET on Airborne Observations (AIR) assisting the integration of AMDAR into WWW programme and CBS working structure (“anchoring WMO AMDAR Panel to CBS”) [*The proposal was approved at Panel-11 (17-21 Nov. 2008, Malaysia) and the first joint meeting was held with the AMDAR Panel in Toulouse, France, November 2009*]**





# Integration of AMDAR into WIGOS

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## **Governance Issues and Technical Issues (continue):**

- **Several key components require immediate attention by WIGOS PP for AMDAR (AMDAR Panel Management Group, May 2008)**
  - **Standardization AMDAR BUFR code, essential updates to Reference Manual, standardization AMDAR software**
- **Ad-hoc Steering Group (July 2008) discussed issues relevant to the three levels of WIGOS integration**
  - **Standardization AMDAR BUFR template, standardization QC/QA requirements, standardized specification for instruments, standardized generation of data from all types of aircraft**
  - **▶ 6 Pilot Project Aims and Objectives (Sub-projects)**





# WIGOS Pilot Project for AMDAR

## Short-Long Term Aims

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1. Development of a standardised BUFR Template for AMDAR;
2. Update of the AMDAR Reference Manual WMO-No.958;
3. Development standardised procedure for Quality Management of AMDAR data;
4. Application of WMO Metadata relevant to AMDAR;
5. Specification of the framework for the development of generic software for AMDAR;
6. Validation and preparation for intercomparison of available Water Vapour Sensor performance.





# Standardised Aircraft Measurements

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- **The development of a standardised AMDAR software solution will require:**
  - Update to the AMDAR Reference Manual to include new observation parameters and identified problem areas;
  - Update the current software specification under ARINC 620 version 4, based on the updated Reference Manual;
  - Certification of the specification with ARINC (1-3 year time frame);
  - Software development (expensive).





# Standardised Aircraft Measurements

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## **Steps required to update/upgrade ARINC SPECIFICATION 620 Meteorological Report Messages - Ascent Weather Report Format:**

- 1. The E-AMDAR Programme and WMO have held discussions with the ARINC Standards Committee on the future requirements for the ARINC620 Standard.**
- 2. WMO hosted a short meeting with key E-AMDAR Programme personnel to draft the initial upgraded ARINC620 Standard taking into account:**
  - a. The new AMDAR BUFR Template; and**
  - b. IAGOS requirements.**
- 3. Proposed new ARINC620 Standard changes to be reviewed by the AMDAR Panel Science and Technology Sub-Group and IAGOS.**
- 4. Pass proposed changes onto the ARINC Standard Committee for review.**





# Standardised Aircraft Measurements

## Ascent Weather Report Format (Example changes)

Character Number	# of Char	Character Content	Format <sup>[w1]</sup>	Notes
1-10	10	Standard Message Header		
<u>28-29</u>	<u>2</u>	<u>Parameter configuration</u>	<u>nn</u> <sup>[w2]</sup>	
<b>Initial report:</b>				
	<u>76</u>	Latitude	ADDMM <u>ss</u> <sup>†</sup>	3
	<u>87</u>	<u>Longitude</u>	ADDDMM <sup>†</sup> <u>ss</u>	4 <sup>[w3]</sup>
	<u>64</u>	Time of Observation	hhmm <u>ss</u>	5
	<u>4</u>	<u>GNSS Altitude</u>	<u>nnnn</u> <sup>[w4]</sup>	
	<u>84</u>	<u>WV Mixing Ratio</u>	<u>nnnnQ</u>	9 <sup>[w5]</sup>





# Standardised Aircraft Measurements

## Ascent Weather Report Format (Example changes)

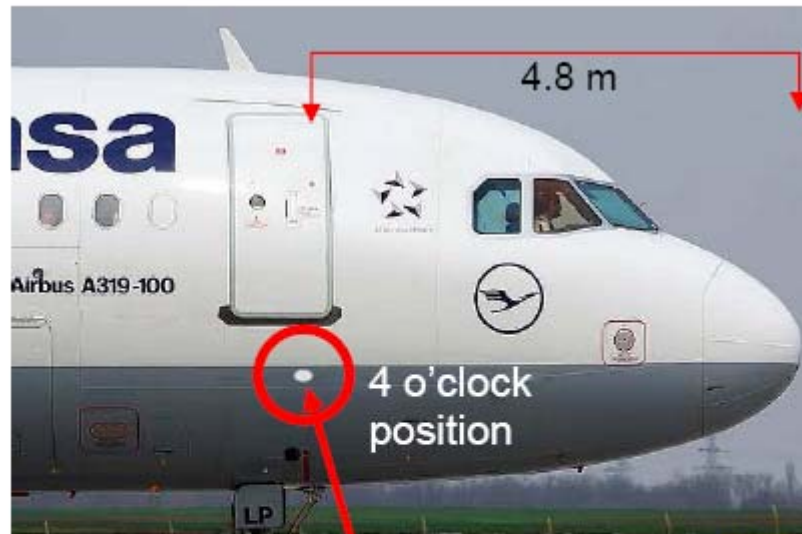
Character Number	# of Char	Character Content	Format <sup>[w6]</sup>	Notes
Series #1				
	<u>4</u>	<u>GNSS</u>	<u>nnnn</u>	
	<u>5</u> 4	WV Mixing Ratio	<u>nnnnQ</u>	9
	<u>4</u>	<u>True air speed vector</u>	<u>nnnn</u>	<u>[w7]</u>
	<u>4</u>	<u>True heading</u>	<u>nnnn</u>	<u>[w8]</u>
	<u>1</u>	<u>De-icing</u>	<u>n</u>	<u>[w9]</u>
	<u>[</u>	<u>Aircraft configuration</u>	<u>n][w10][w11</u>	
	<u>6</u> 2	<u>Aerosols (Volcanic Ash)</u>	<u>Base 36][w12]</u>	
	<u>4</u>	<u>Aerosols (Weather)</u>	<u>Base 36</u>	
	<u>10</u>	<u>Clouds (Weather Forecast)</u>	<u>Base 36</u>	
	<u>14</u>	<u>Airborne Chemistry</u>	<u>Base 36</u>	





# WVSS-II Water Vapour Sensor

## Lufthansa Configuration



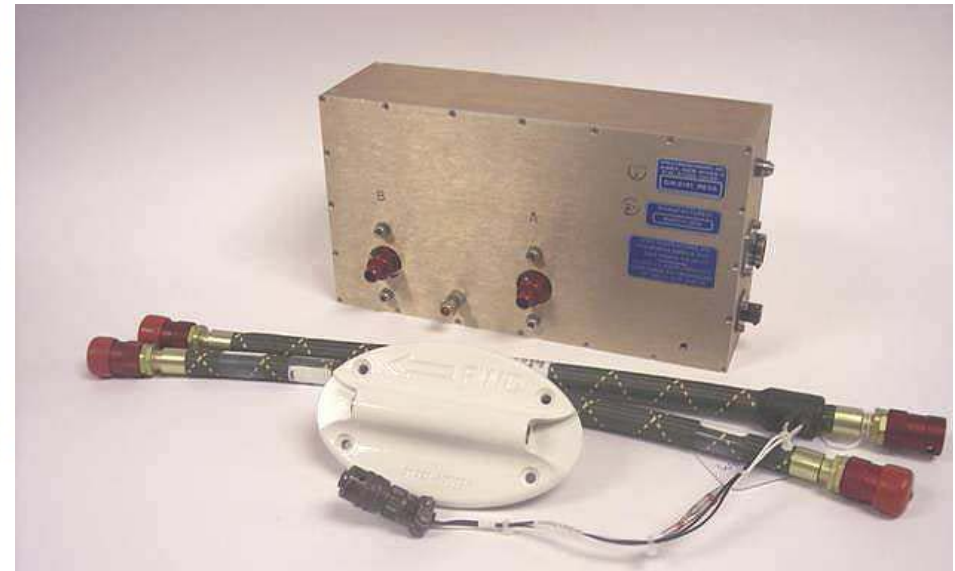
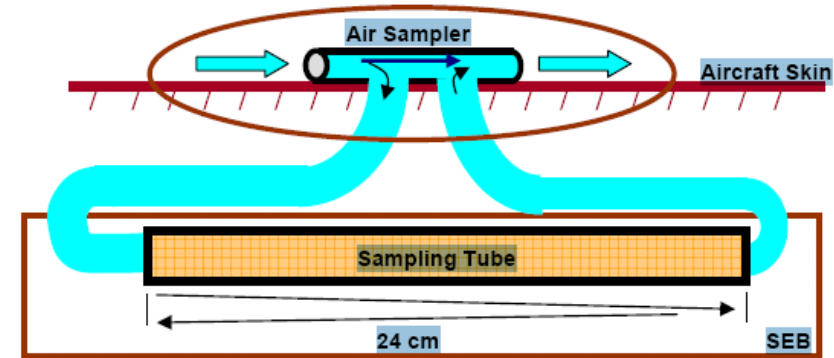
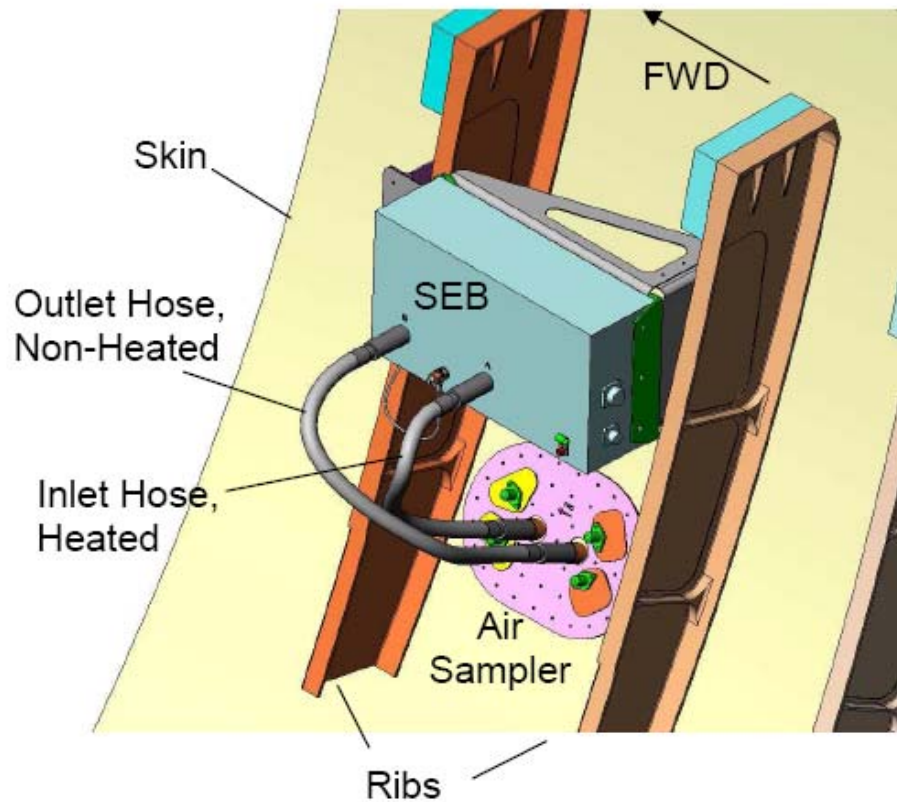
Air Sampler





# WVSS-II Water Vapour Sensor

## Lufthansa Configuration





# WVSS-II Water Vapour Sensor

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- Based on the results from testing in the USA and Europe and experiences gained with in flight and climate chamber tests made up until 2008, the sensor system was re-engineered.
  - This re-engineered version has already been subject to climate chamber testing at NOAA / NWS (USA) and DWD as well at the Research Centre Juelich (Germany).
  - Upgrades to existing USA fleet of 25 UPS units (Boeing B 757) aircraft installations are in progress and new units are being installed on 30 Southwest Airlines units (Boeing B 737).
  - In Europe up to 15 units are planned to be installed on a number of E-AMDAR participating aircraft.
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# WVSS-II Water Vapour Sensor

- It has been proposed that an extra flight test programme be implemented on a European based research aircraft (FAAM, the BAe 146 platform), currently being used by the British Met Office and the NERC.
- A trial of this nature would allow access to high quality reference humidity measurements performed by precision aircraft mounted scientific equipment as well as to the WVSS-II's raw signal as well as high frequency metadata.







# Integration of AMDAR into WMO

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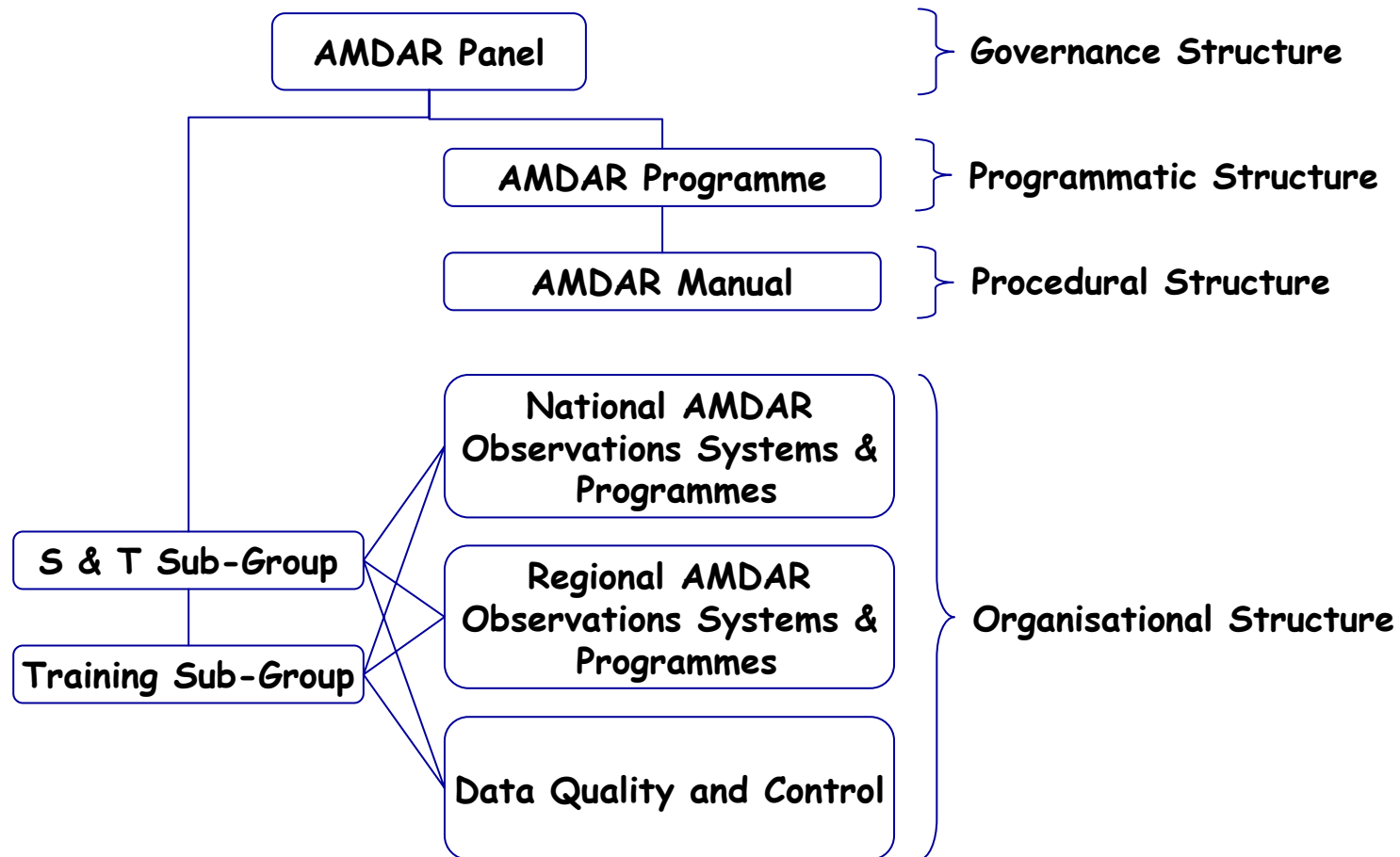
In order to achieve the full integration of AMDAR/Aircraft Observations into WIGOS, with AMDAR regarded as a cost-effective upper-air system for a worldwide composite network the following steps must be achieved:

1. Move the responsibility for AMDAR from the CAeM to the CBS. *(Completed)*
  2. Creation of a new Aircraft Observation Unit (AIR) within the WMO. With the newly created AMDAR Technical Co-ordinator position in the WMO Secretariat as the lead for AIR. *(Completed)*
  3. Establish a new Expert Team on (ET-AIR). *(Completed)*
  4. Inclusion of AMDAR experts in CIMO *(Completed)*
  5. The provision in the WMO Secretariat's regular budget for the AMDAR Technical Coordinator (2012 – 2015). *(Underway)*
  6. Full support for AMDAR activities from the WMO regular budget. *(pending Cg-XVI decision)*
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# Integration of AMDAR into WMO

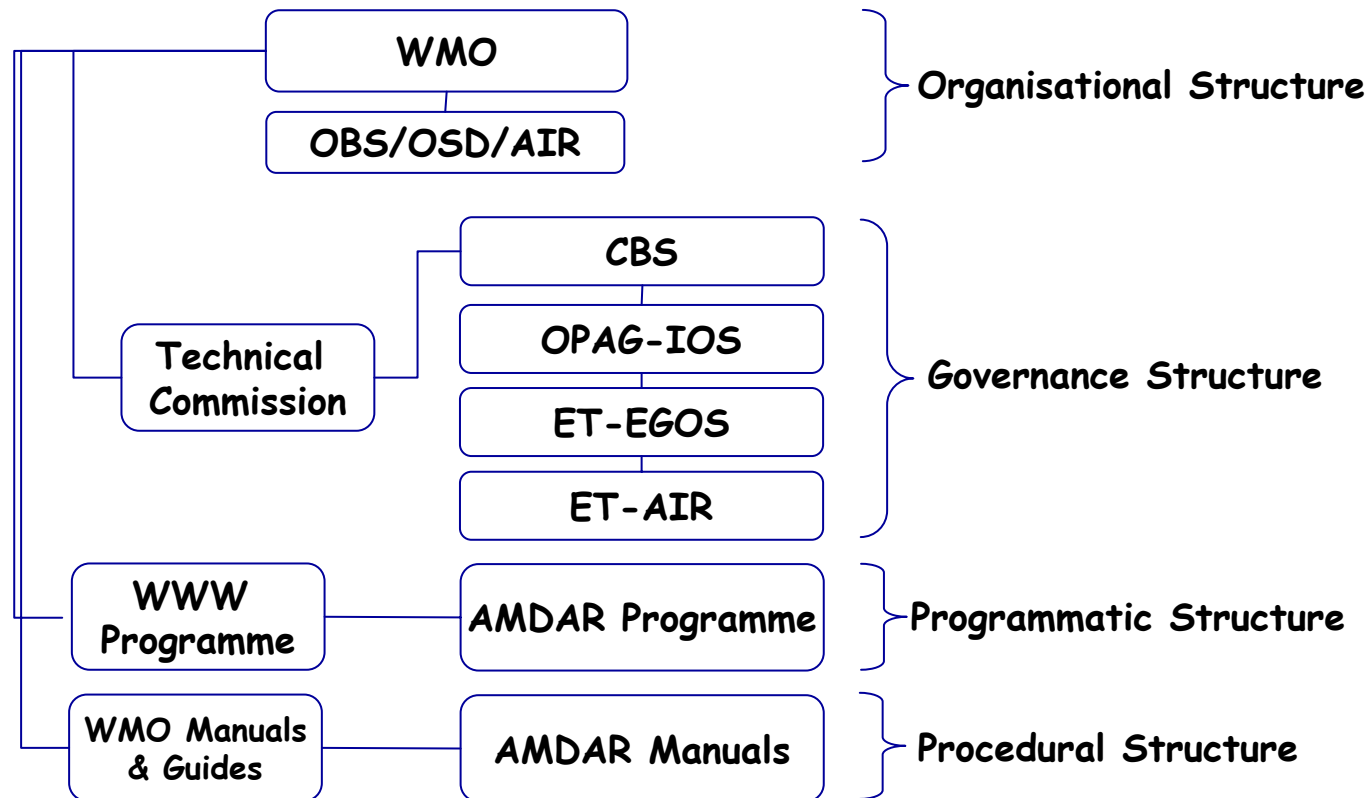
## Past Programmatic Structure





# Integration of AMDAR into WMO

## Future Programmatic Structure





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# Questions

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