EUMETNET
The Network of European Meteorological Services

E-AMDAR (Aircraft Meteorological DAta Relay)

Wind Shear Conference, AEMET, Tenerife,
10 Junio 2016

Stewart Taylor, E-AMDAR Technical Coordinator

(on behalf of Steve Stringer, E-AMDAR Programme Manager)

Content of Presentation

- Overview of AMDAR and the E-AMDAR Programme.
- Why do we need aircraft observation data?
  - Impacts & benefits
- How do we get aircraft observations?
  - What is E-AMDAR?
- What airlines need to do to participate in E-AMDAR.
- Other ABO platforms
  - Mode-S EHS/MRAR data
  - Aireps/ADS-C data
  - AFIRS, TAMDAR
- ABO use in Wind Shear Forecasting
  - Some examples

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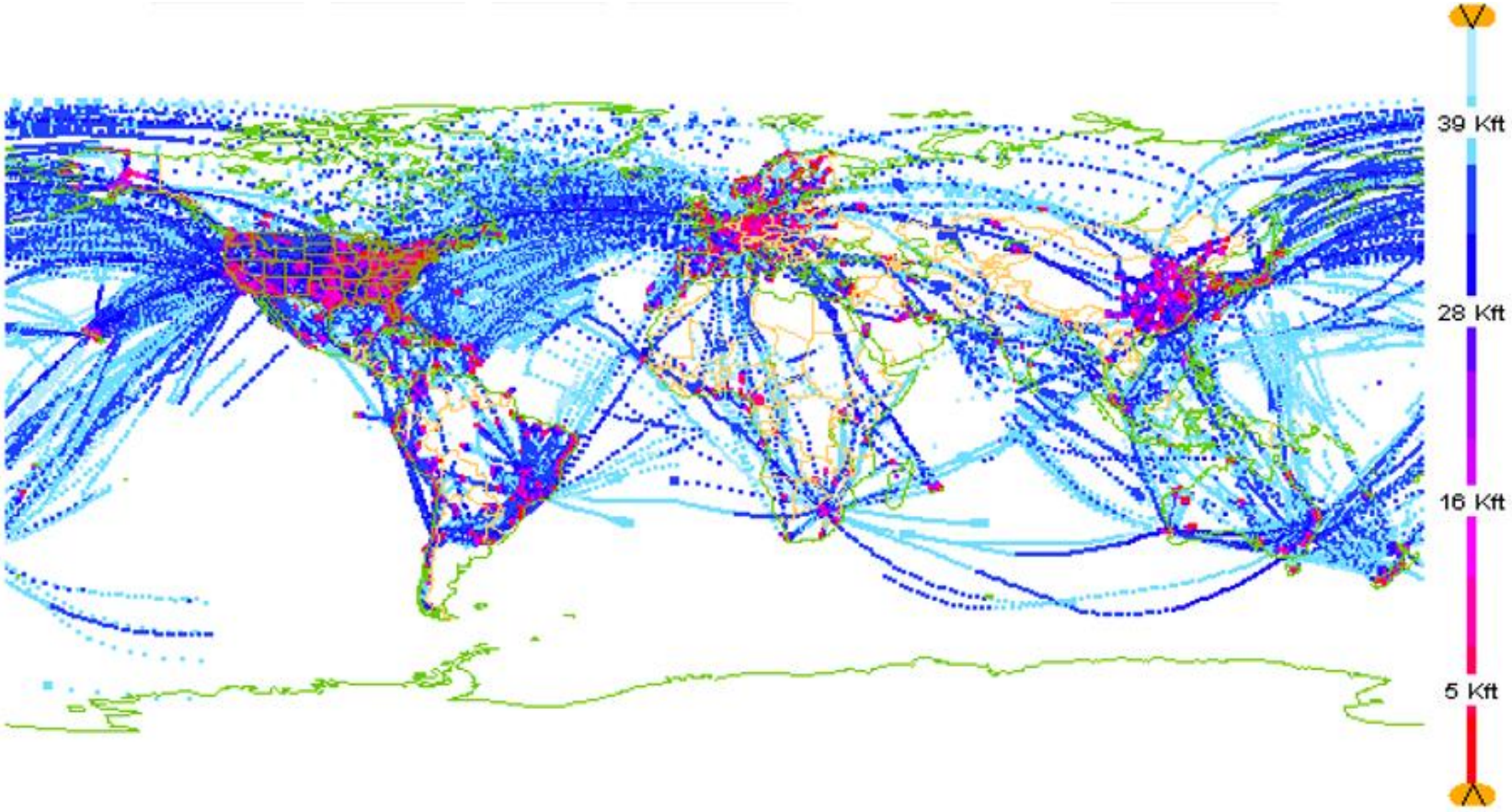
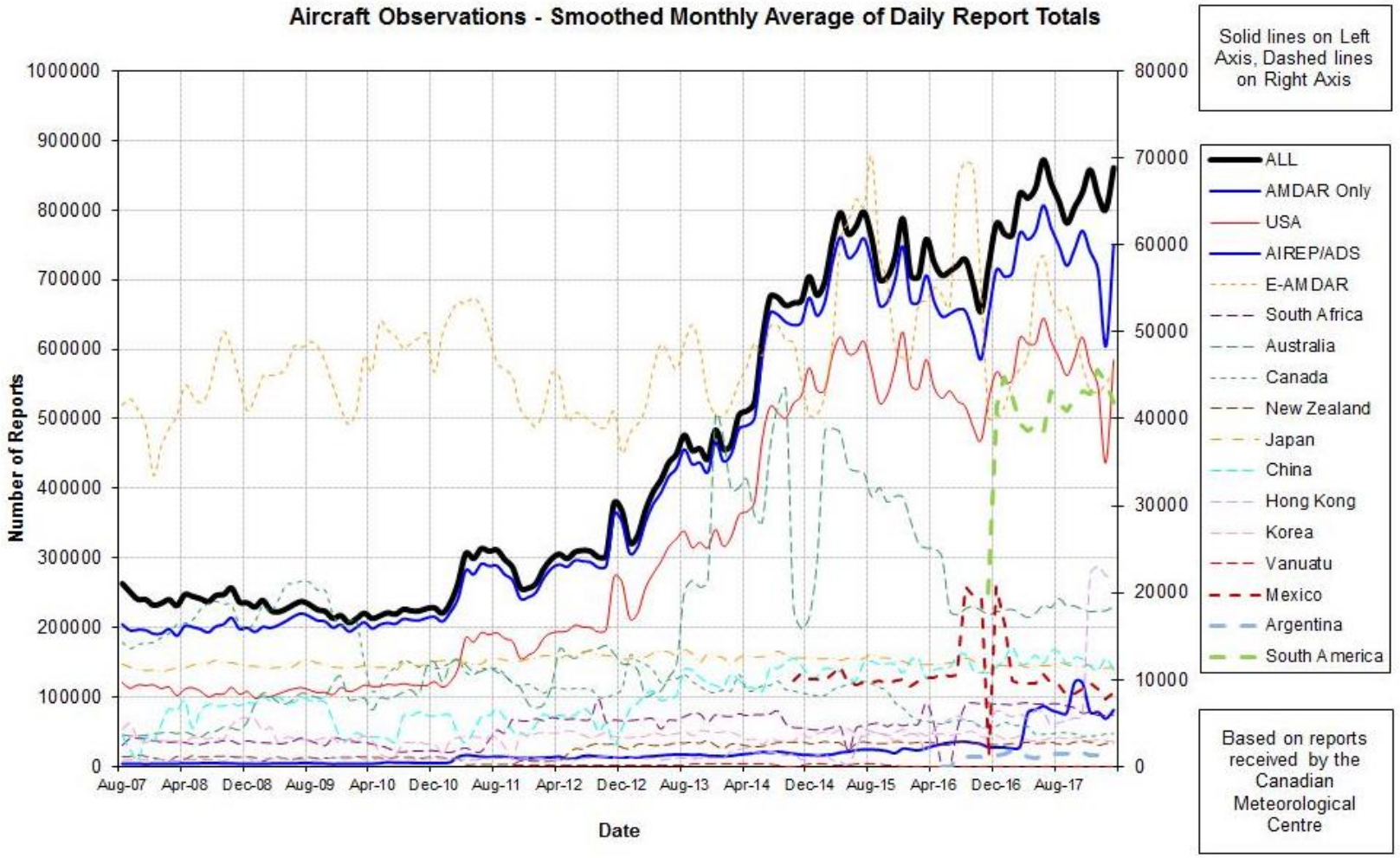
AMDAR: Network Coverage 1.



Global aircraft observations



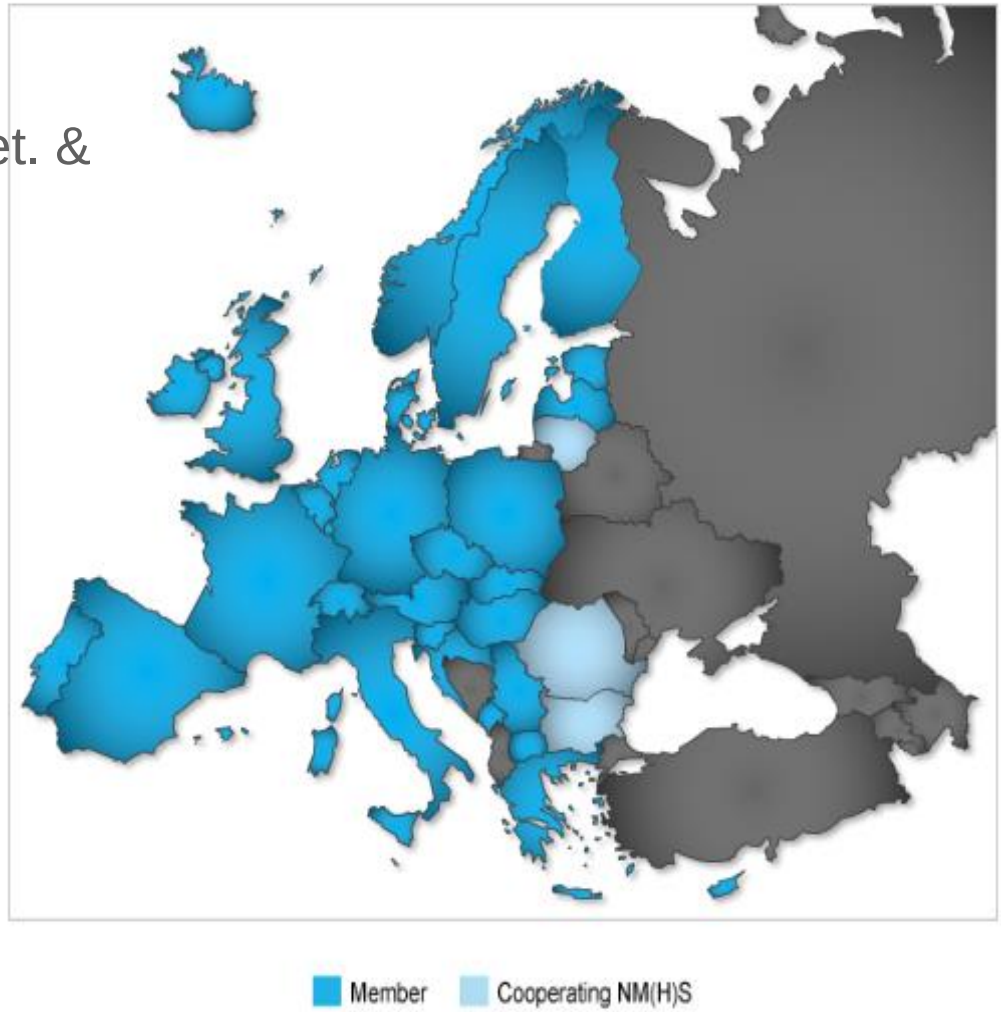
Further information: http://www.wmo.int/pages/prog/www/GOS/ABO/

Global Participating Airlines - by Programme

Programme	Number	Airlines
Australia	6	Qantas Airways, JetConnect (Qantas), Jetstar Airways, Jetstar Asia, SkyTraders, Air Vanuatu
Canada	2	Air Canada Jazz, NAV Canada
China	2	China Southern Airlines, Shandong Airlines
E-AMDAR	14	Air France, Austrian Airlines, KLM, Lufthansa Passage, Lufthansa CityLine, Lufthansa Cargo, British Airways, Finnair, Scandinavian Airlines, easyJet, Thomas Cook Scandinavia, GermanWings, Eurowings, Aer Lingus
Hong Kong China	1	Cathay Pacific
Japan	2	Air Nippon Airways, Japan Airlines
New Zealand	1	Air New Zealand
Korea	2	Korean Air, Asiana Airlines
South Africa	1	South African Airways
USA	9	Alaska Airlines, American Airlines, Continental, Delta Air Lines, Northwest Airlines, Federal Express, United Airlines, United Parcel Service (UPS), Southwest Airlines

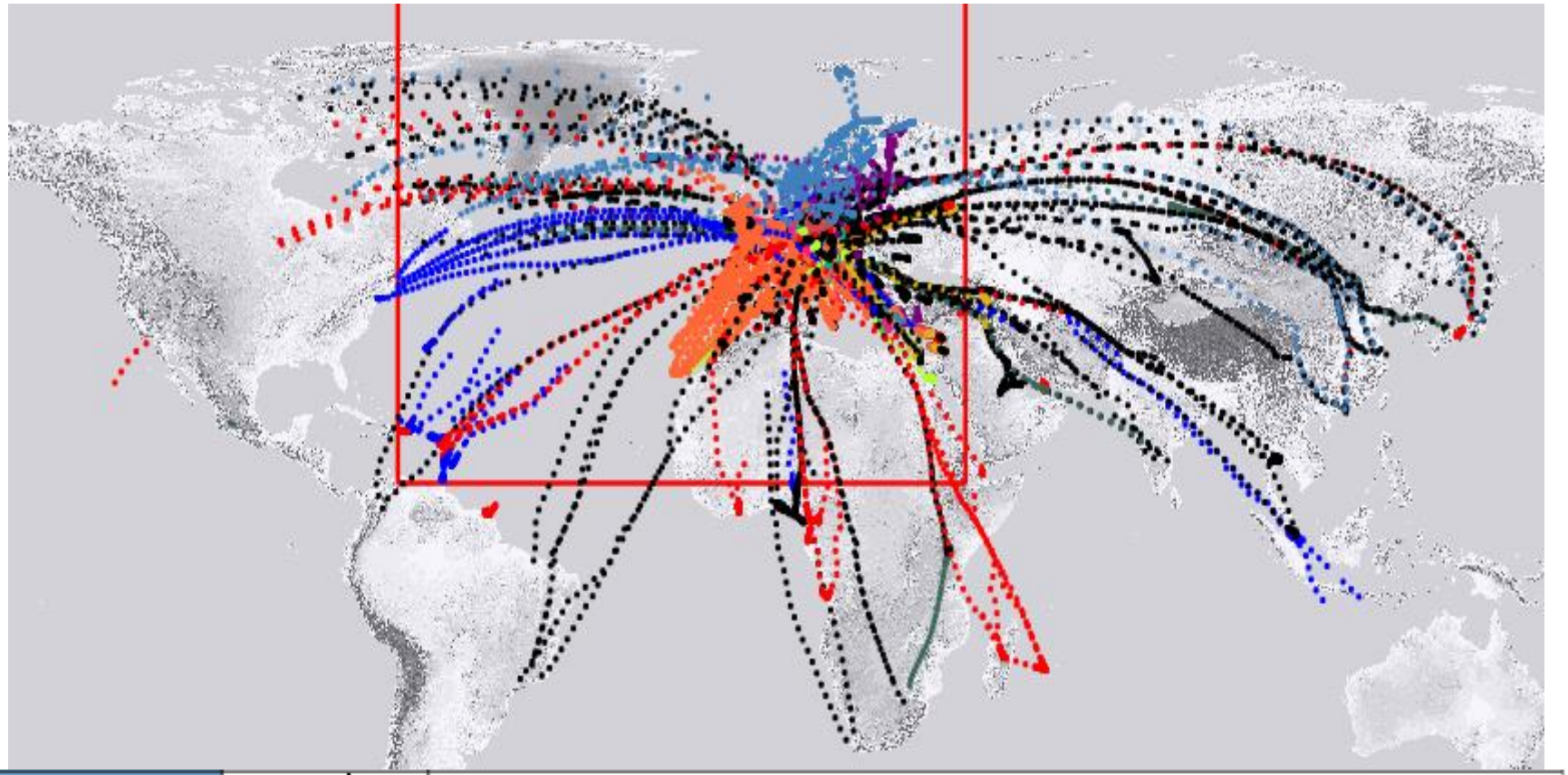
EUMETNET

- 31 Members: National Met. & Hydro. Services (NMHS)
- 3 Programmes
  - Observations
  - Forecasting
  - Climate
- Obs Programme
  - **E-AMDAR *(aircraft)***
  - E-ASAP *(ship Wx balloon)*
  - E-GVAP *(GNSS humidity)*
  - E-PROFILE *(+ lidar)*
  - E-SURFMAR *(ship, buoy)*
  - OPERA *(radar)*



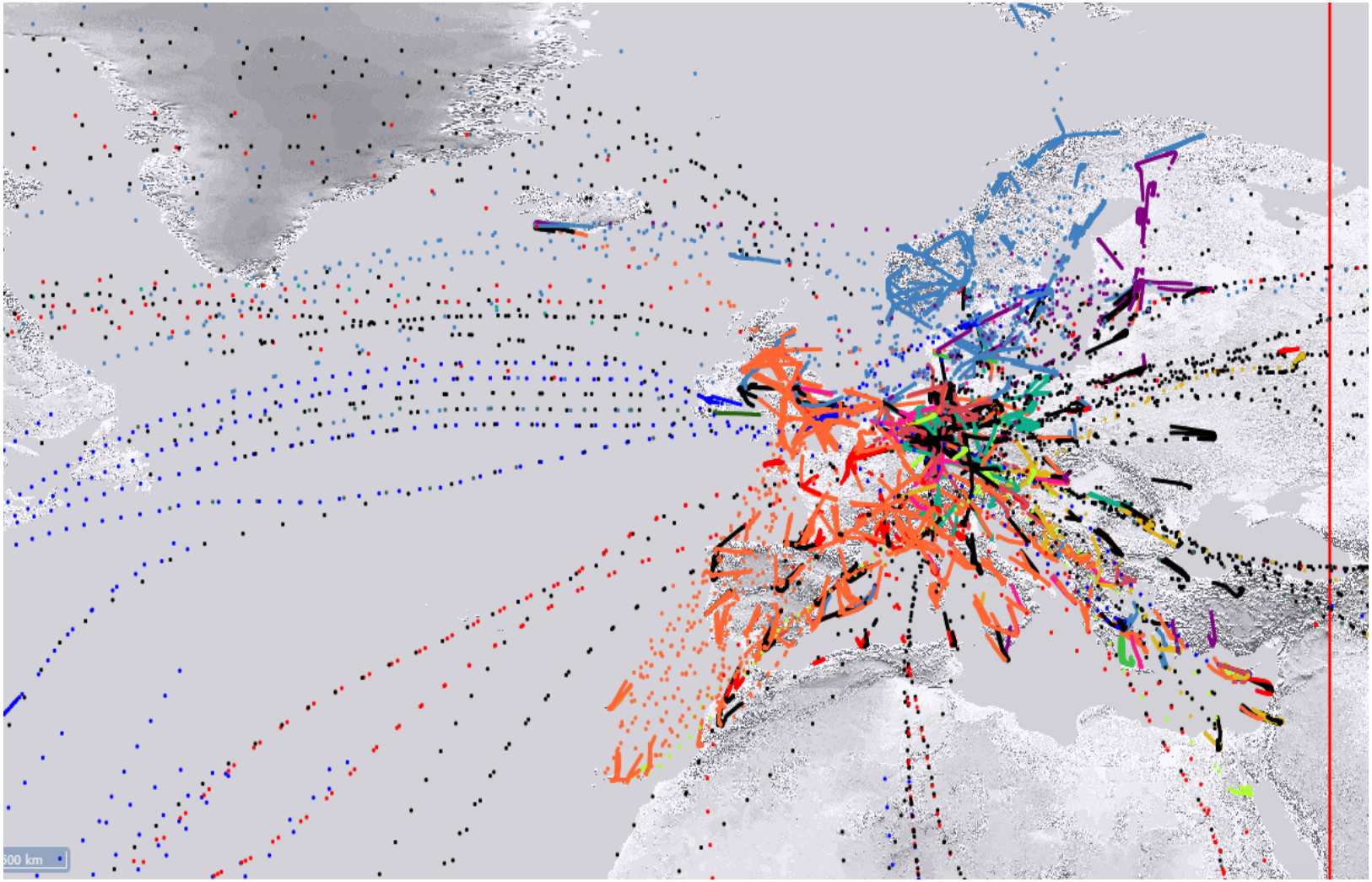
Economic Interest Grouping, EIG EUMETNET: provides a framework to organise co-operative programmes between its Members in the various fields of basic meteorological activities. www.eumetnet.eu

E-AMDAR: Network Coverage 1 - Global



E-AMDAR	14	Air France, Austrian Airlines, KLM, Lufthansa Passage, Lufthansa CityLine, Lufthansa Cargo, British Airways, Finnair, Scandinavian Airlines, easyJet, Thomas Cook Scandinavia, GermanWings, Eurowings, Aer Lingus

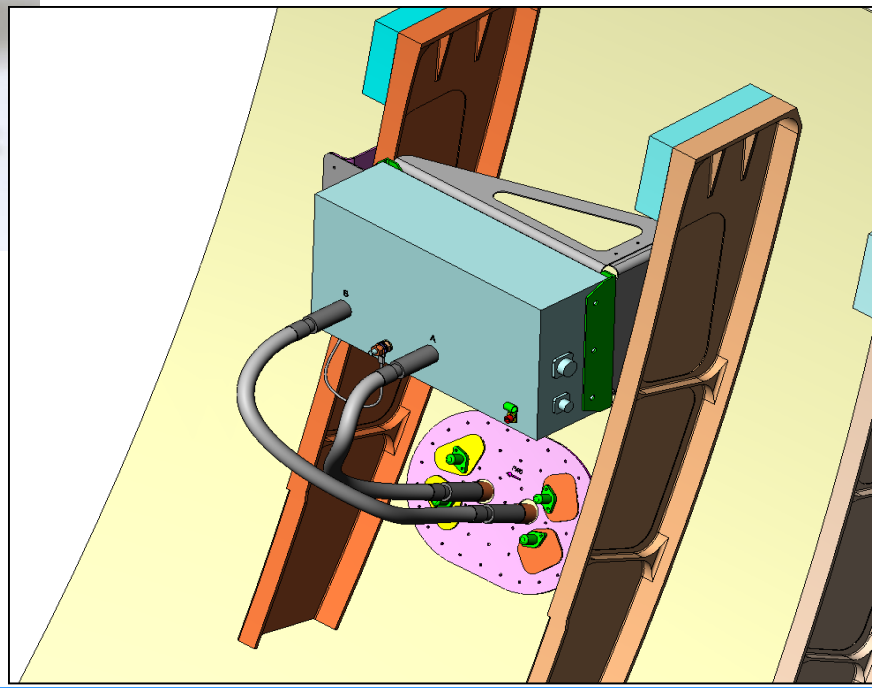
E-AMDAR: Network Coverage 2 - Europe



E-AMDAR - Why measure humidity?

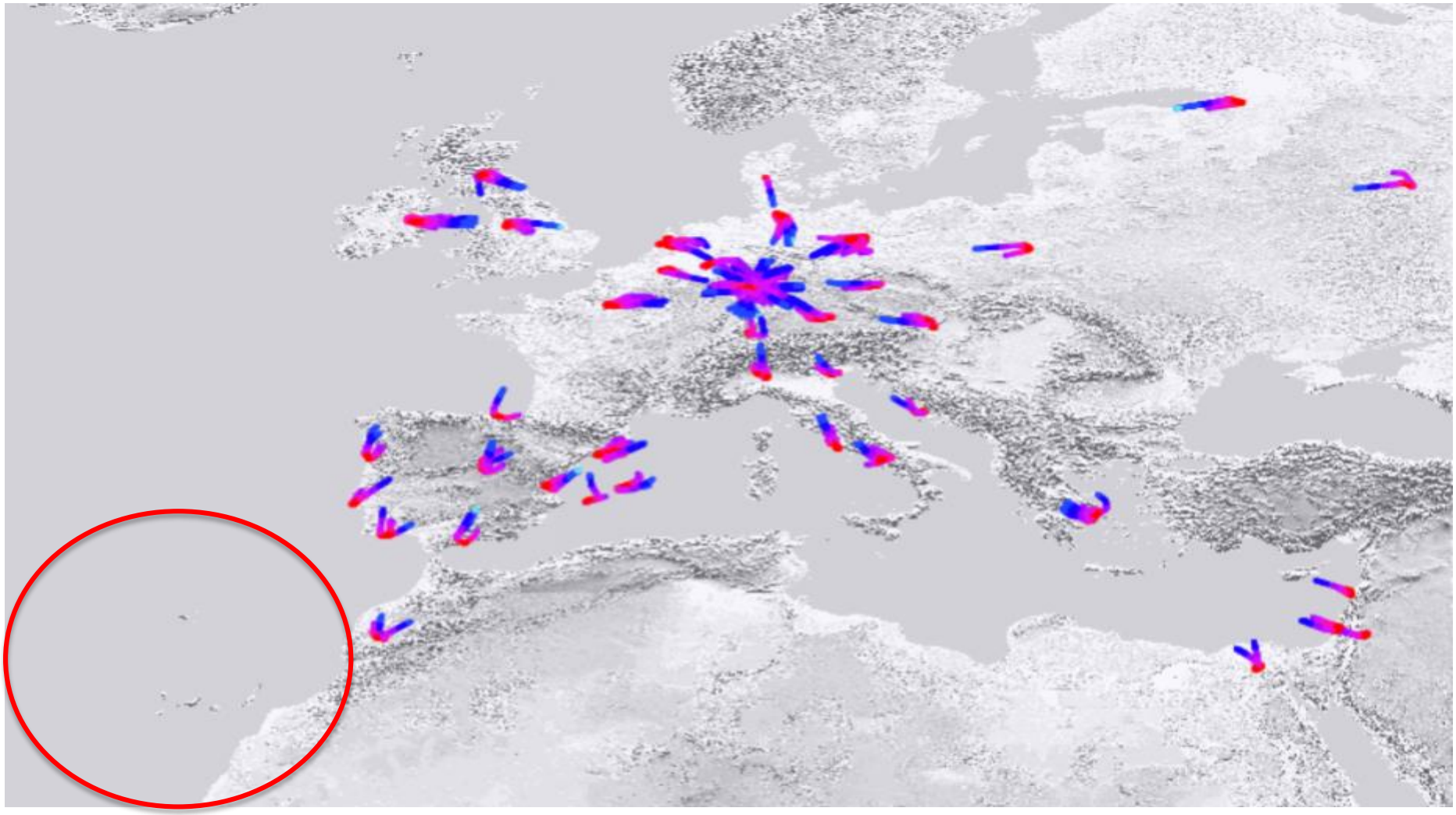
- Humidity – is one of the most significant parameters for weather evolution. Highly variable in time & space.
- Improvements to aviation meteorological products can be expected in the areas of:
  - Convection, precipitation and fog (forming/clearance) forecasts
  - Reliability of short and long term weather prognoses
  - Nowcasting procedures for fog and icing prognoses.
- The improvements to aviation meteorological products will have affects on:
  - Flight safety
  - Airport operations/flow control (optimisation of the start/landing frequency)

Humidity Sensor hardware (WVSS-II)



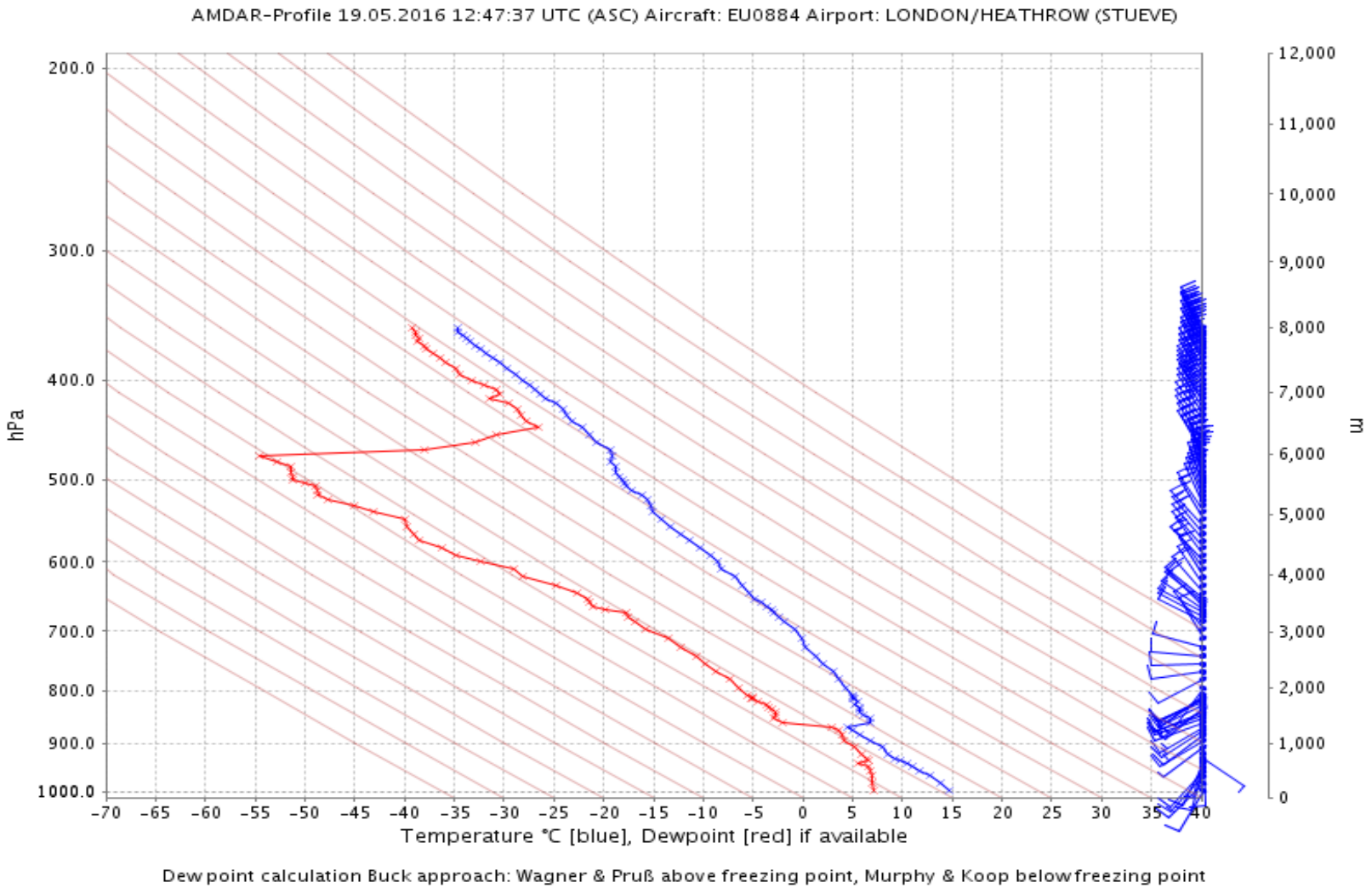
- **Near-Infrared Absorption Spectrometer based on Tunable Diode Laser**
- **Heated Inlet Hose**
- **Output: Water Vapor Mass Mixing Ratio**

AMDAR Humidity Current Coverage



WVSS-II coverage over 7 day period with 9 sensors

AMDAR Humidity: Atmospheric Profiles



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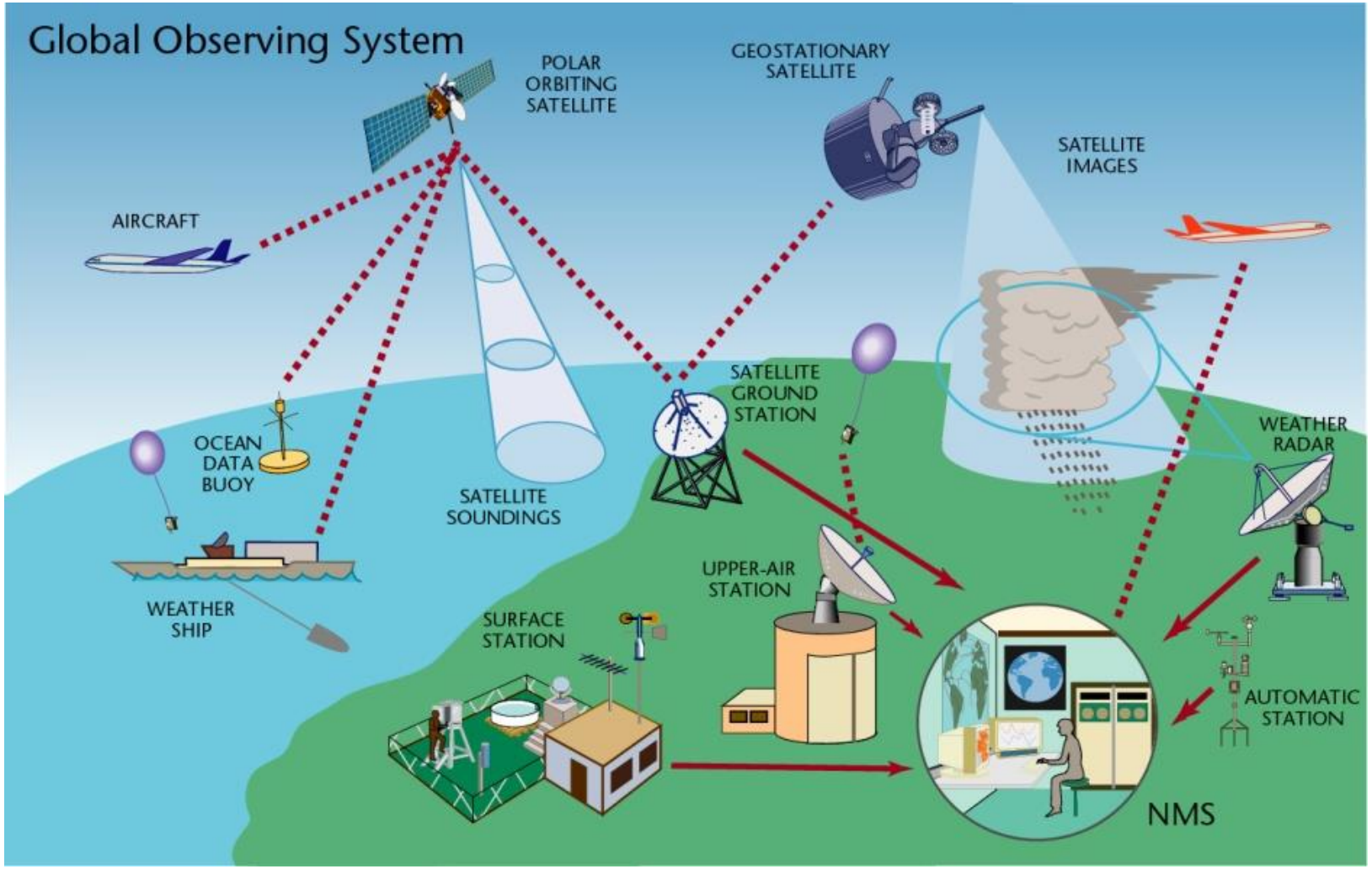
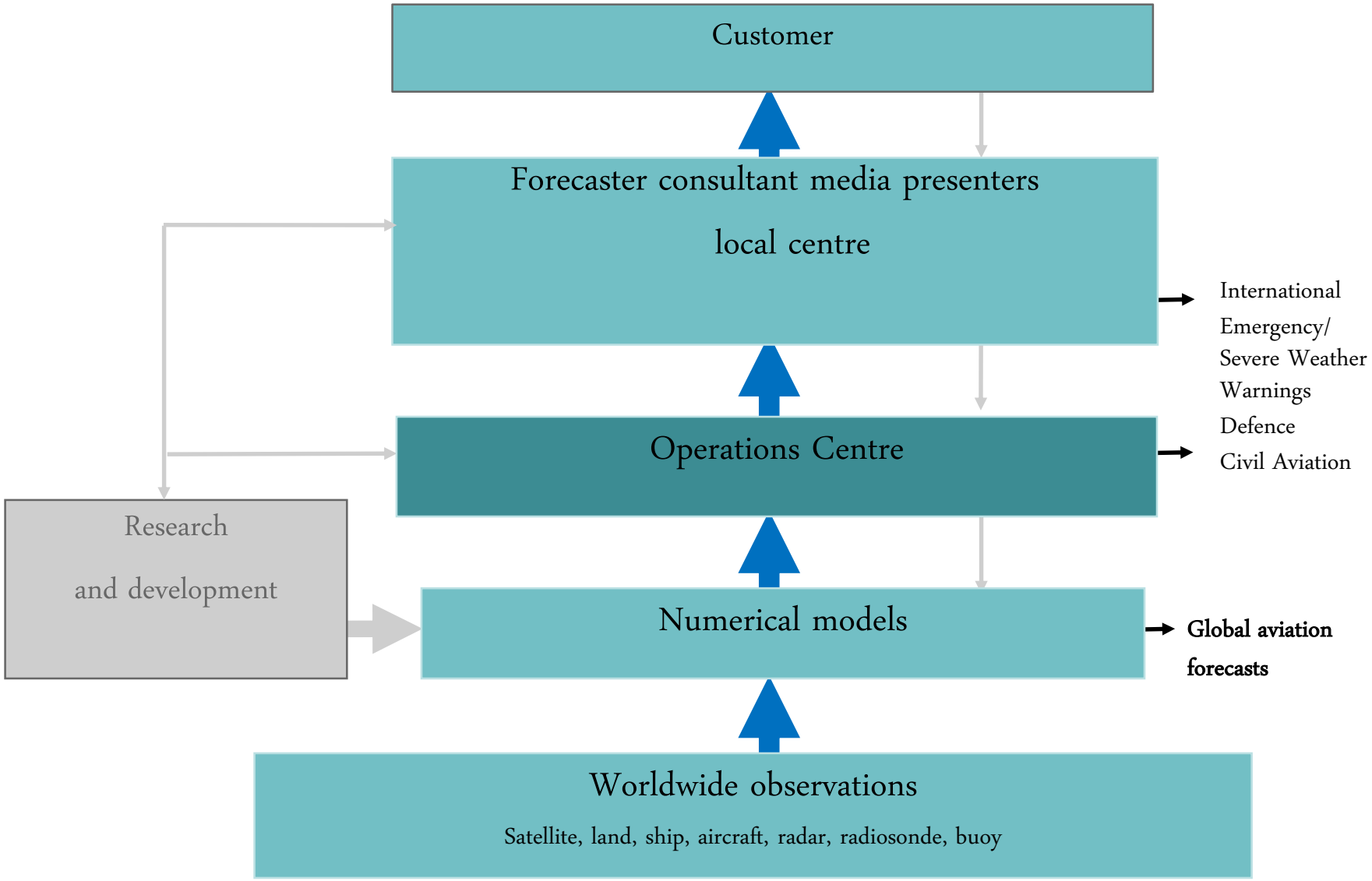
WMO Global Observing System



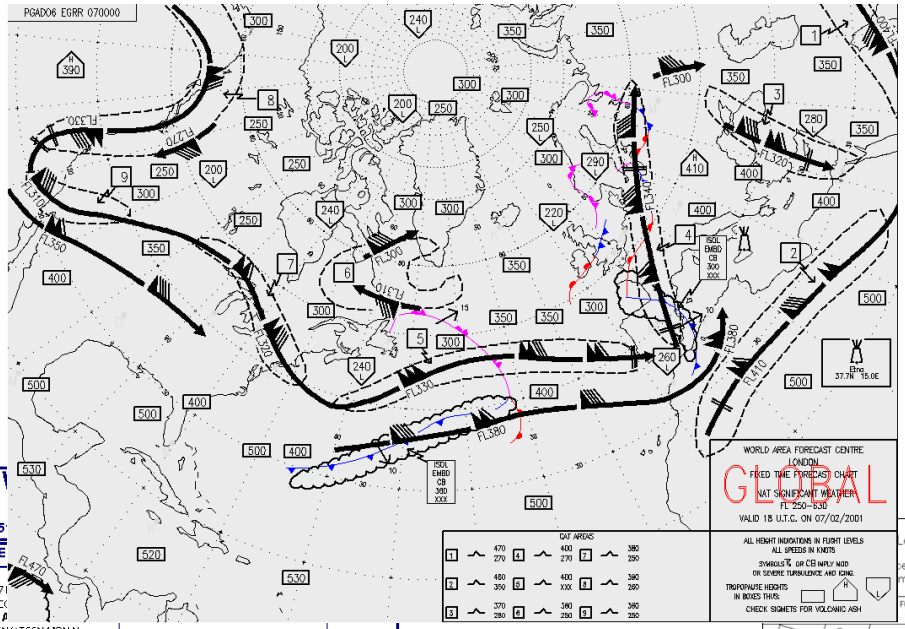
WMO – World Meteorological Organization (http://www.wmo.int)

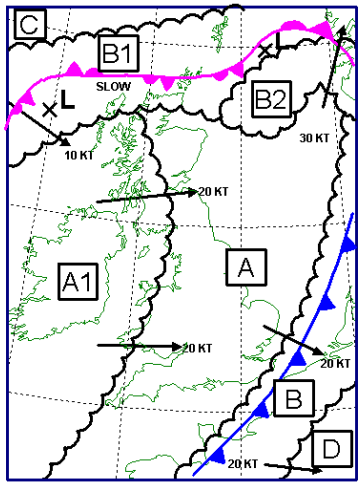
Forecasting the weather

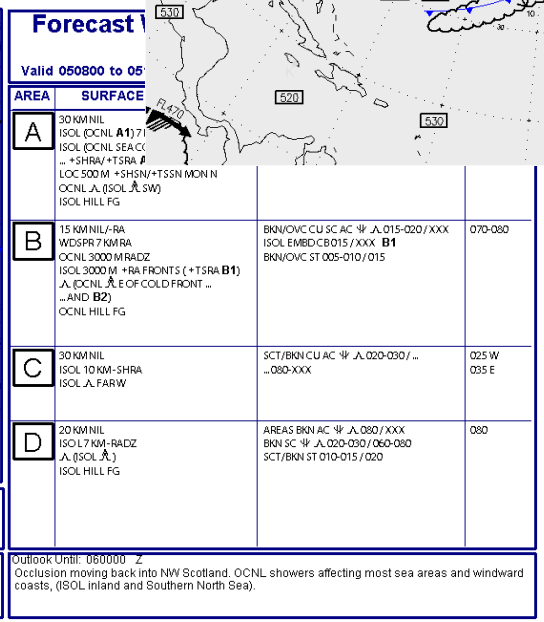


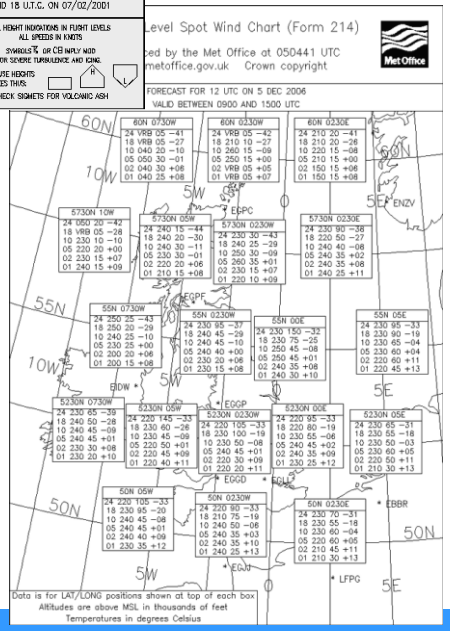
Forecasting the weather

Ops Centre



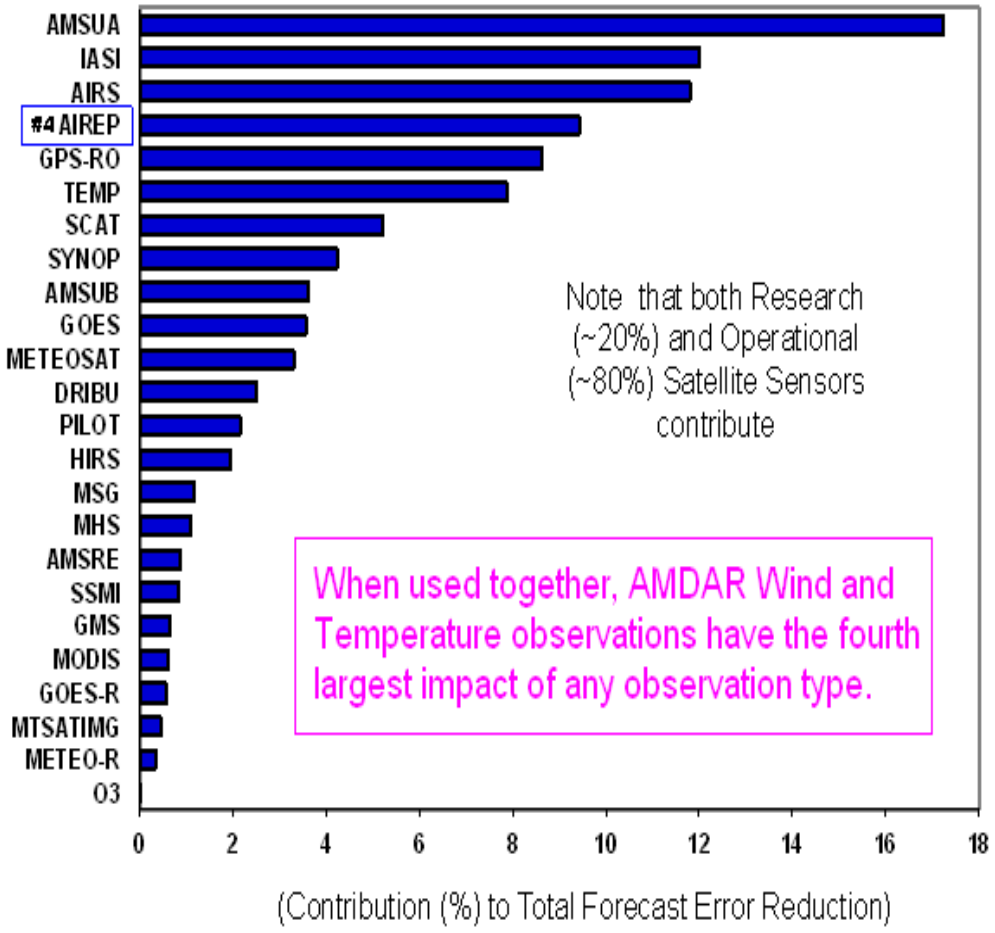






AMDAR Impact on Weather Prediction(NWP)

- Provides both better accuracy than satellites
- and higher temporal coverage than radiosondes
- With improved horizontal coverage and water vapour – Impacts will be even greater.



ABO Impact on Weather Prediction

There are 3 elements of the Aircraft observing system which make it especially valuable:

- wind and temperature data are similar in data quality to radiosondes;
- can provide fine detailed structure within the vertical profiles;
- profiles can be produced every 3-hours (or much less) at many airports.

Forecasters use the data to improve forecasts of:

- Surface and upper air forecasts of wind and temperature;
- Thunderstorm genesis, location and severity;
- Wind shear location and intensity;
- Low cloud formation, location and duration;
- Fog formation, location and duration;
- Precipitation amounts and rates.

Benefits of Aircraft Data (to Meteorology and to the Aviation Industry)

Data Use

- Use in Numerical Weather Prediction Models
- Use in Forecast Applications
- Use in Climate Applications
- Use in Verification of Forecast Products

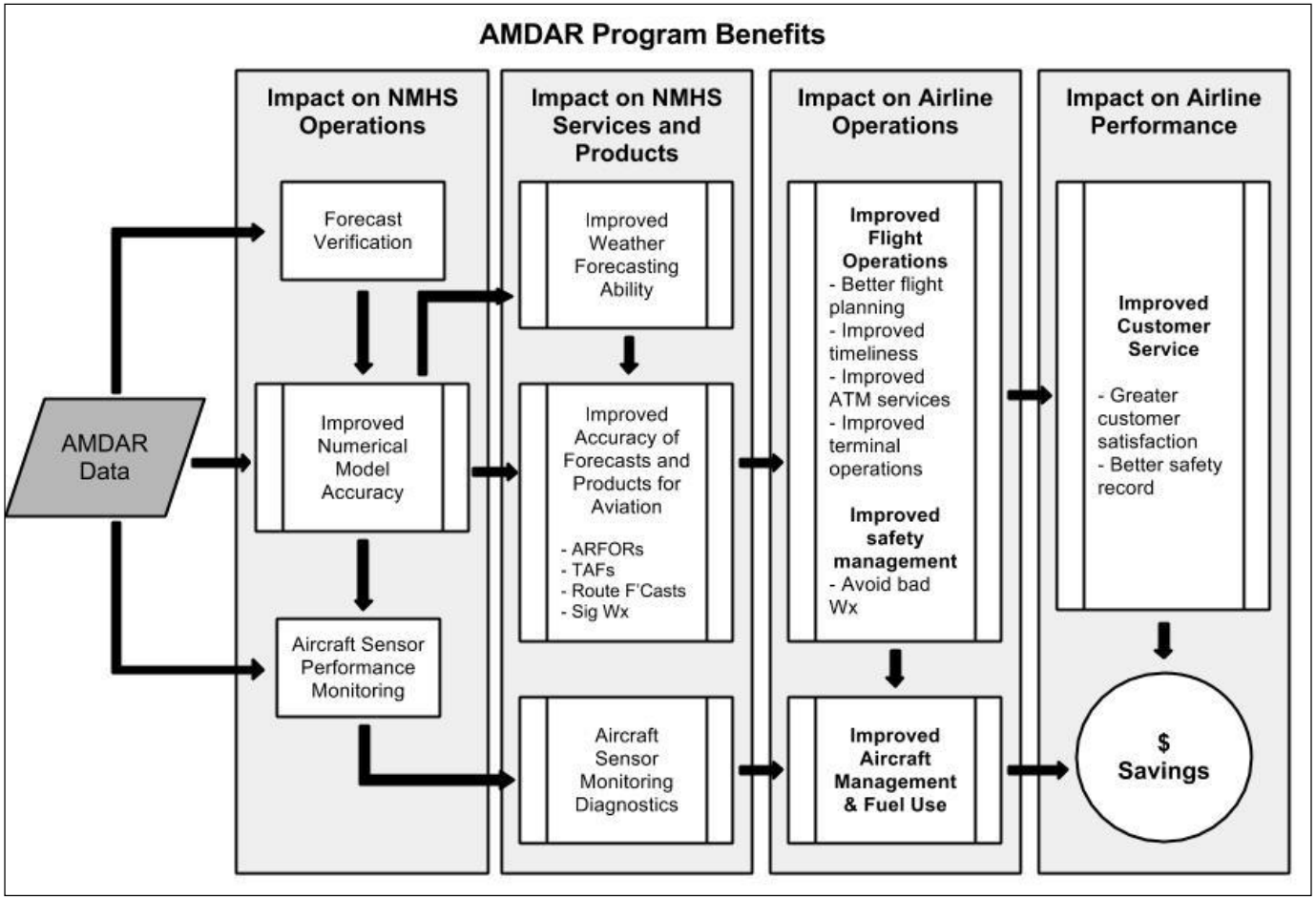
Benefit to Airline Operations

- Impact of Improved Weather Forecast Skill on Airline Operations
- Improved Flight Operations*
- Improved Safety
- Operational Cost Savings*
- Aircraft Sensor and System Monitoring

**South African Airways example will be provided.*

Benefits to Aviation

(http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/publications/Benefit_of_AMDAR_Data_to_Meteorology_and_Aviation.pdf)



- **Improved and more accurate weather forecasts, products and diagnostics and aircraft sensor performance monitoring for the aviation industry ultimately lead to significant cost savings to airlines and safer flight operations.**

EUMETNET
European Meteorological Services Network

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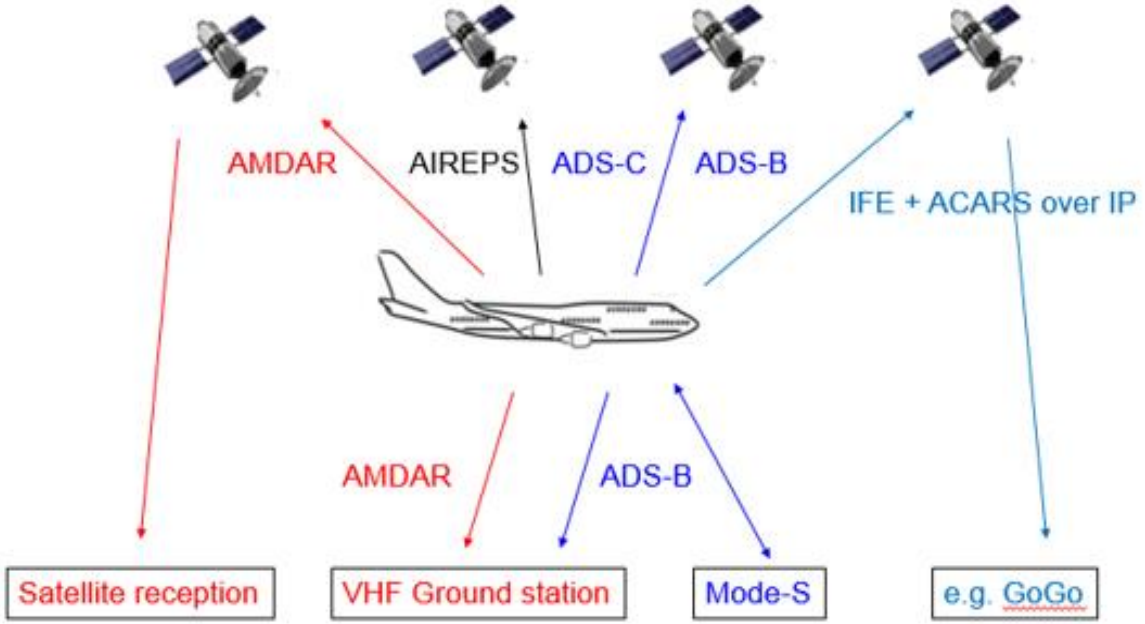
Aircraft Based Observations

Current & planned utilisation from as many aircraft data sources as possible

…including:

- AMDAR
- Mode-S
  (EHS & MRAR)
- ADS-C
  (via RC & SITA)
- Satellite ADS-B
- 3rd Party data
  (TAMDAR/AFIRS/others)
- Satellite IP data

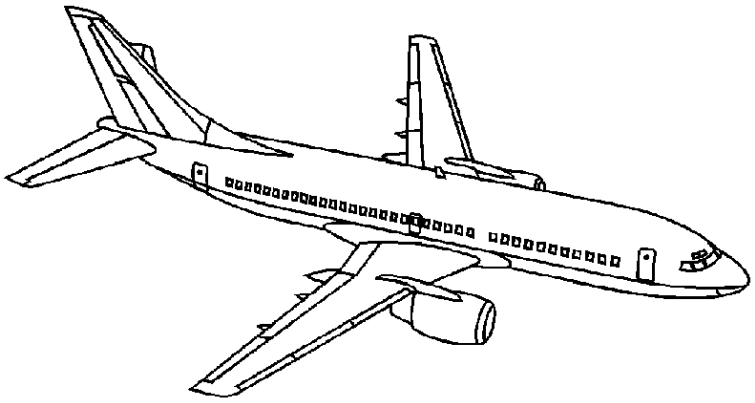


What is AMDAR ?

AMDAR (**A**ircraft **M**eteorological **DA**ta **R**elay)

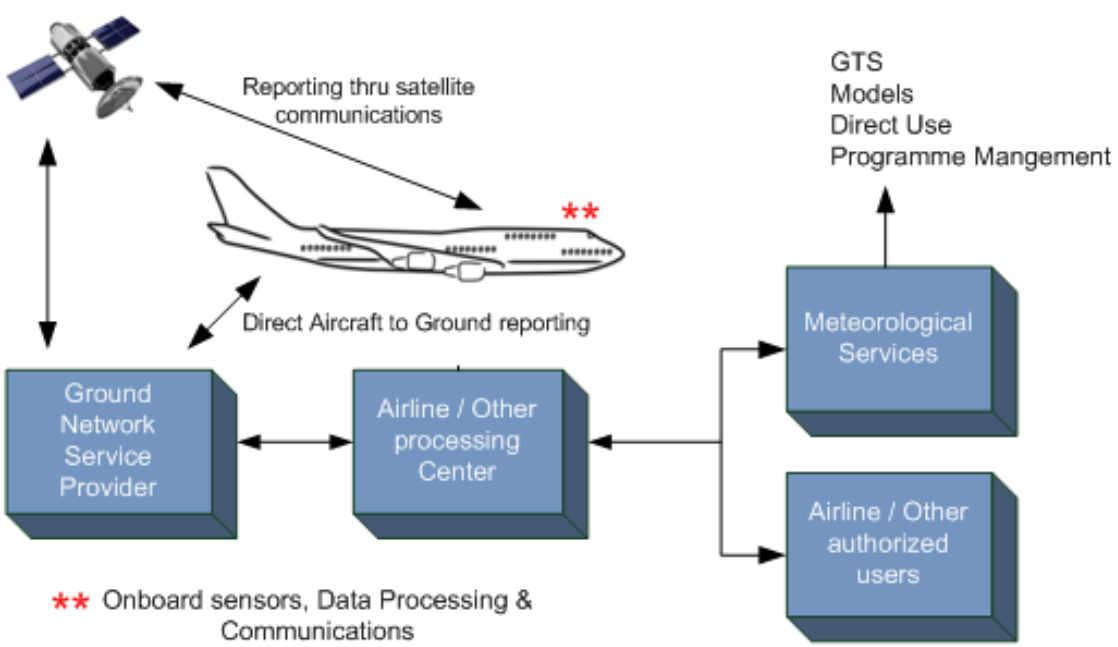
- Automated collection and transmission of various parameters using existing aircraft sensors and airline infrastructure:
  - Height (pressure derived)
  - Temperature
  - Wind speed
  - Wind direction

Additional parameters potential
  - Turbulence
  - Icing
  - Humidity



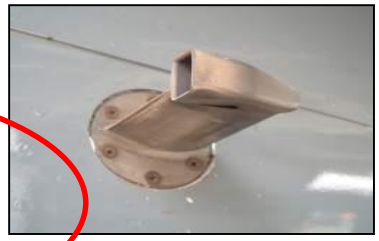
AMDAR observations

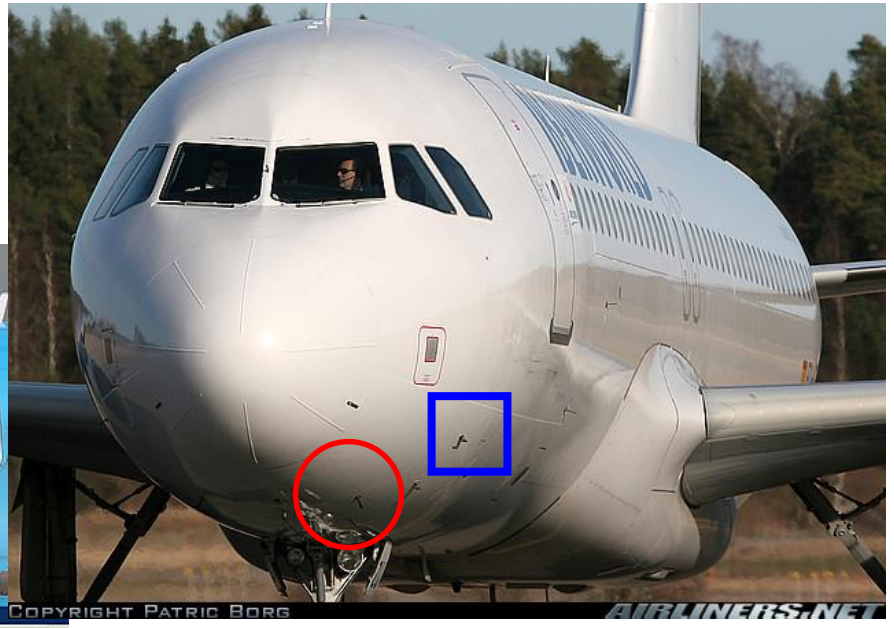
- AMDAR is a collaborative programme between Airlines and National Meteorological Services
- From aircraft systems, meteorological parameters are provided in real time via ACARS (**A**ircraft **C**ommunications **A**ddressing and **R**eporting **S**ystem):



AMDAR observations

- TAT probes (temperature)

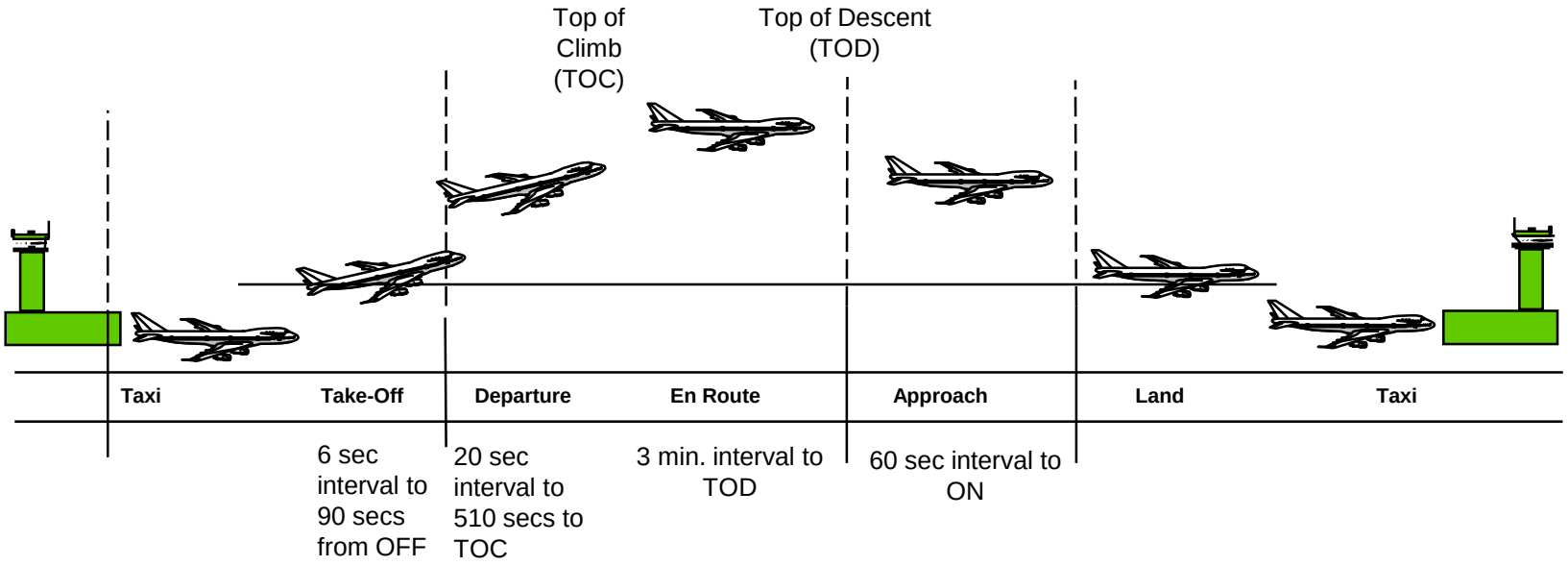




- Pitot-static tubes (pressure)

AMDAR observations

- AMDAR data can be reported in all phases of flight - series of observations at a height, latitude and longitude forming a profile, similar to a radiosonde



- AMDAR reporting can be triggered by time or pressure – dependant on software/avionics platforms installed on the airlines

- Reported observation resolution can be configured to meet specific requirements (i.e. cost saving or **C**ontinuous **D**escent **A**pproach)

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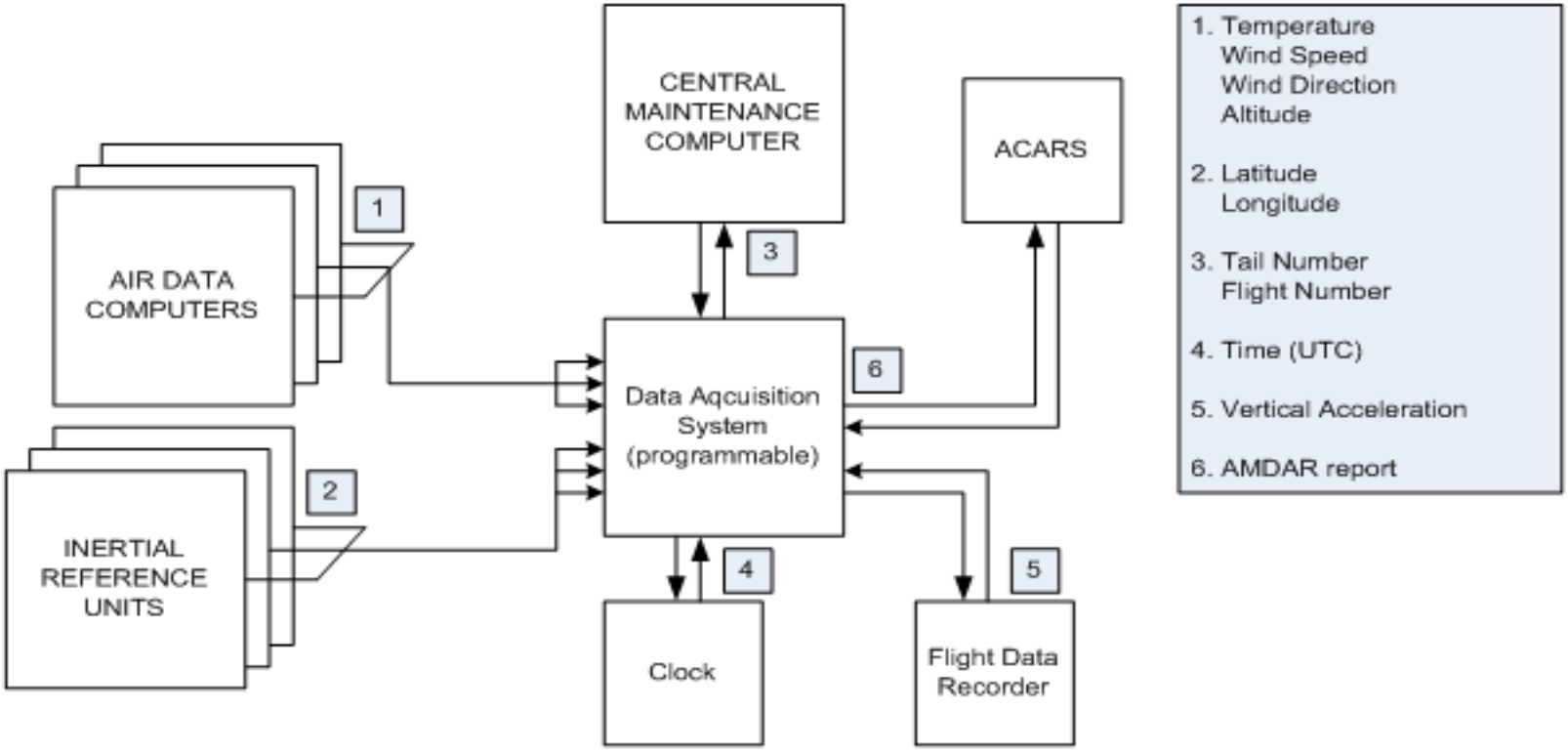
1. AMDAR Software

An example of a typical Onboard AMDAR System is depicted in the figure below.



In reality, the Onboard AMDAR System is a combination of existing sensors and systems on the aircraft, combined with the AMDAR Onboard Software or AMDAR software application.

1. AMDAR Software

How do we* know if you have the right software?

- Once airline identified for AMDAR integration, we initiate discussions with airline and NMHS representatives,
- An avionics questionnaire is given to airline.
- This provides information on whether airlines are AMDAR capable and level of development that may be required.

* WMO, NMHS or regional collaboration

1. AMDAR Software

http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/resources/AMDAR_Programme_Development.html

Airlines AMDAR Compatible Systems Survey	*AMDAR/ARINC620-Compatible Hardware and Software Request for Details* This document was developed in consultation with avionics specialists and provides a list of onboard avionics systems that are known or expected to be capable of hosting AMDAR onboard software applications. It is recommended that prospective AMDAR Programme developers provide this document to airlines to complete and return it to the Secretariat for further advice.

Example of Honeywell AMDAR compatible hardware/AOC

Product name	HW part number	Core software PN	AOC/application PN
ACARS	965-0728-xxx	Note 1	998-1375-508 or newer Note 2
CMU	965-0758-xxx	Note 1	998-2141-509 or newer Notes 3, 4
ATSU	Any HPS compatible with the AOC is acceptable	Note 5	998-2459-505 or 998-2794-501 or newer Note 4

1. AMDAR Software

http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/resources/AMDAR_Standards.html

Standard	Description & Comments
NEW AMDAR Onboard Software Functional Requirements Specification (AOSFRS), Version 1.1 (CIMO, IOM Report No. 115) This document is also available from the WMO FTP Website here.	This specification provides the primary WMO meteorological-based specification for AMDAR onboard software. The AOSFRS defines the recommended formats for AMDAR data uplink and downlink for ACARS applications of AMDAR onboard software. This specification will be consistent with and provide the functional requirements for the AEEC 620-8 Meteorological Report Version 6. AOSFRS Version 1.1 is an update of version 1.0 and has the following primary elements and additions: ▪ Contains several additional recommended downlink and uplink formats (see Appendix A) that will provide consistency with the AEEC ARINC 620 Meterological Report Version 6 (ARINC 620-8) ▪ Several extensions have been made to appendices to provide further information and clarity for applications developers. ▪ Several corrections have been made to various sections. Changes made are documented within Appendix H, AOSFRS Version Control. The AOSFRS is published and will be maintained as a CIMO, Instruments and Observing Methods (IOM) technical report.

1. AMDAR Software

Once we have AMDAR developed on aircraft, we carry out testing.

- Airline generates test WXM messages
- Routed to data processing system and message content quality control
- Airline then integrated into data processing system

1. AMDAR Software

View Message

Raw | Hex | Decoded

```
QU LHRWXXA
.DDLXCXA 061943
WXM
FI U259AL/AN G-EZOG
DT DDL PUY 061943 M18A
-  02A061931LIRNEGGWN40535E014178061911- 17P080      33P097177004G      92P092273005G     149P085278007G     198P070276011G
239P057272011G     273P060286013G     294P060300014G     311P057306014G     330P055306014G     353P052310015G     375P047309016G
386P045305018G     408P040309014G     438P035308014G     478P032326015G    /N40431E014141 723M005343014G    N40439E014092
960M050346009G    N40447E014039110OM080008014G    N40461E013580127 9M107014008G    N40481E013521146 9M147072005G
N40501E013460168 5M195352003G    N40521E013398182 7M225130007G    N40543E013333199 4M267104008G    N40565E013267215 4M307102007G
N40589E013199229 1M345098010G    N41010E013129243 1M380110009G    N41033E013058255 5M407077011G    N41057E012586266 8M435081011G
N41080E012513277 2M455079012G    N41107E012441289 2M480070011G    N41147E012379298 9M505069009G    N41187E012316307 7M525061011G
N41227E012252317 1M545049007G    N41267E012188329 7M572015005G    N41305E012126343 2M592343014G    N41341E012064352 1M610339015G
```

View Message

Raw | Hex | Decoded

Vld	Aircraft	Phase	Time	Latitude	Longitude	Height (m)	AirTemp (K)	WindDir (degs)	WindSpd (m/s)	Turb
	G-EZOG	ASC	19:11:00	40:53:30N	014:17:48E	101	282.8	177	2.1	/
	G-EZOG	ASC	19:11:00	40:52:54N	014:17:36E	280	282.3	273	2.6	/
	G-EZOG	ASC	19:11:00	40:52:18N	014:17:24E	454	281.6	278	3.6	/
	G-EZOG	ASC	19:11:00	40:51:42N	014:17:12E	604	280.1	276	5.7	/
	G-EZOG	ASC	19:11:00	40:51:06N	014:17:00E	728	278.8	272	5.7	/
	G-EZOG	ASC	19:11:00	40:50:30N	014:16:48E	832	279.1	286	6.7	/
	G-EZOG	ASC	19:11:00	40:49:54N	014:16:36E	896	279.1	300	7.2	/
	G-EZOG	ASC	19:11:00	40:49:18N	014:16:24E	948	278.8	306	7.2	/

2. Stakeholders

- Airlines: Identify appropriate focal points e.g. within datalink, operations/dispatch and IT departments.
- NMHSs: As with the airline, identify focal points to capture national meteorological requirements – this has the advantage of “speaking the language”!
- DSPs: In addition to software, the airline provides information on their data service provider – we have good contacts with both Rockwell Collins(ARINC) and SITA.
- Avionics Vendors: Good relations with Rockwell, Honeywell, Teledyne and others (AMDAR representation at Avionics forums e.g. AEEC DLUF)

2. Stakeholders

- Aviation Industry: Collaboration with identified organisations;
  - IATA, utilise their contacts with member airlines to assist with technical aspects,
  - ICAO for ADS and policy issues,
  - AEEC for industry standards (DataLink Users Forum etc)

- WMO: Use of experts within the ET-ABO/ET-AO;
  - assistance with software issues, implementation of AMDAR, development of a National (or regional) Programme,
  - Relationships with DSPs and avionics vendors.

Benefits for regional collaboration.

The immediate benefits are;

Shared costs and development of infrastructure

- NMHSs, airlines, agencies/stakeholders can work together to develop and manage data in their region.

The following points have all been achieved in current Regional Programmes, technical support can be provided.

- Development of data processing system,
- Development of optimisation system (and QEv),
- Negotiations on data costs with participating airlines,
  - The more airlines, the greater potential for data volumes and associated “tiered” pricing,
- NMHS combined voice in the region – assists in discussions with airlines.

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EUROPEAN METEOROLOGICAL SERVICES NETWORK

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Mode-S System

- Primary radars
  - a pulse is reflected back by the aircraft, enabling its position to be computed
- Secondary radar systems
  - transponder on board the aircraft transmits its identity, as well as the aircraft's altitude
- Mode-S
  - selective communication between airframe and ground station (possibility to transmit various 56-bit data registers, up to 5 for a standard system).

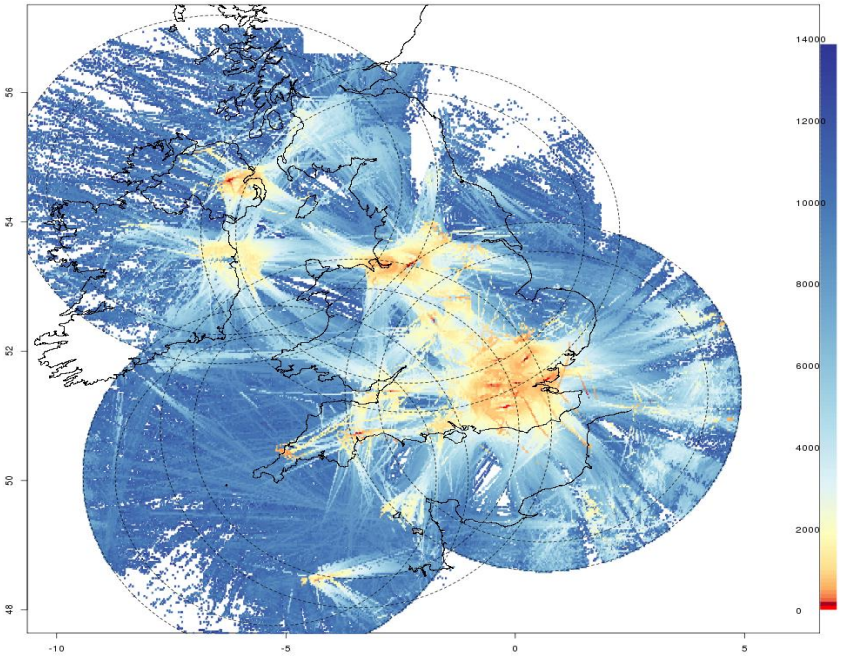
Types of Mode-S Meteorological data

name	MODE-S MRAR *Meteorological routine air report*	MODE-S EHS *Enhanced surveillance (report)*
data	▫ (BDS 4,4) – met. routine air report wind speed, direction, temperature, turbulence, humidity ▫ (BDS 4,5) – met. hazard report (turbulence, wind shear, microburst, icing)	▫ (BDS 4,0) selected vertical intent (selected altitude) ▫ (BDS 5,0) track and turn report - roll angle, true track angle and rate, ground speed and true air speed ▫ (BDS 6,0) heading and speed report indicated air speed and mach, barometric altitude rate, magnetic heading
type	Direct data	Indirect (temperature) data
rep. by	around 5 % of all Mode-S equipped aircraft (depends on the transponder configuration)	all Mode-S equipped aircraft

Aircraft Based Observing with Mode-S Enhanced Surveillance (EHS)

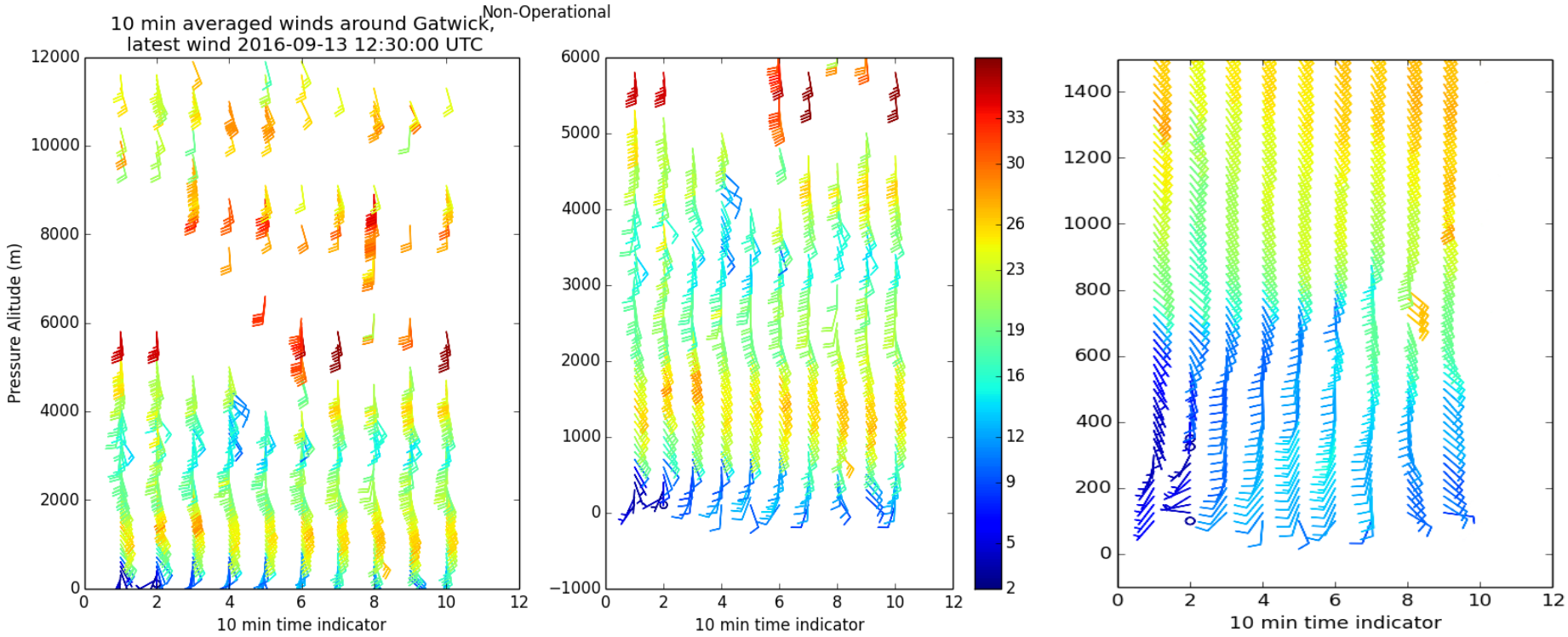
- Huge potential to supplement E-AMDAR data at some airport locations.
- KNMI developing a European Meteorological Aircraft Derived Data Centre (EMADDC) – Operational in 2019.
- Business case for Mode-S (E-ADD) data to be included in E-ABO Programme – from 2020

UK Met Office Mode-S operational coverage, 2018

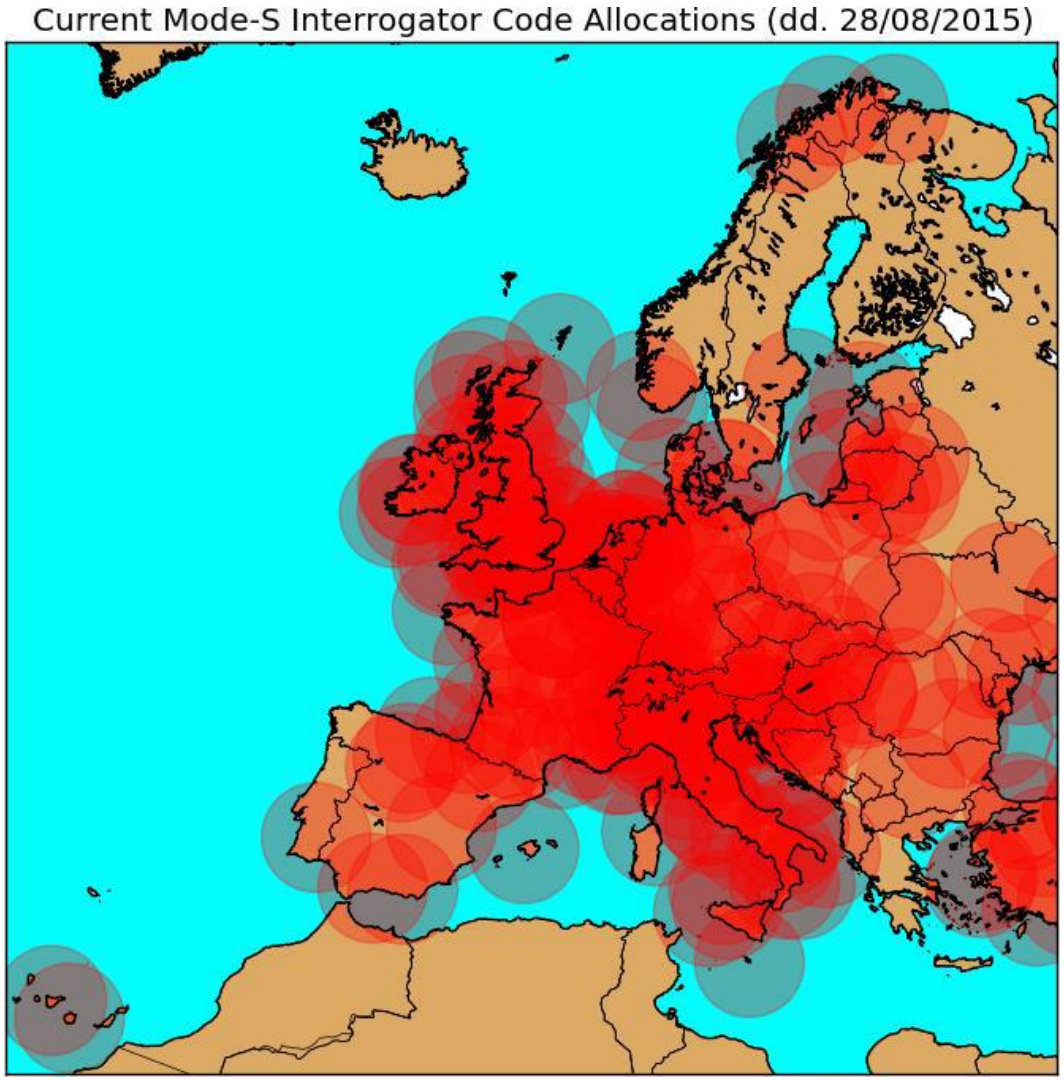


Aircraft Based Observing with Mode-S Enhanced Surveillance (EHS)

- Example of 10-minute wind charts derived from Mode-S EHS (E-ADD) data



Potential for Mode-S EHS coverage in Europe



ADS-C

- uses the same aircraft systems to transmit - aircraft position, altitude, speed, elements of navigational intent and meteorological data.

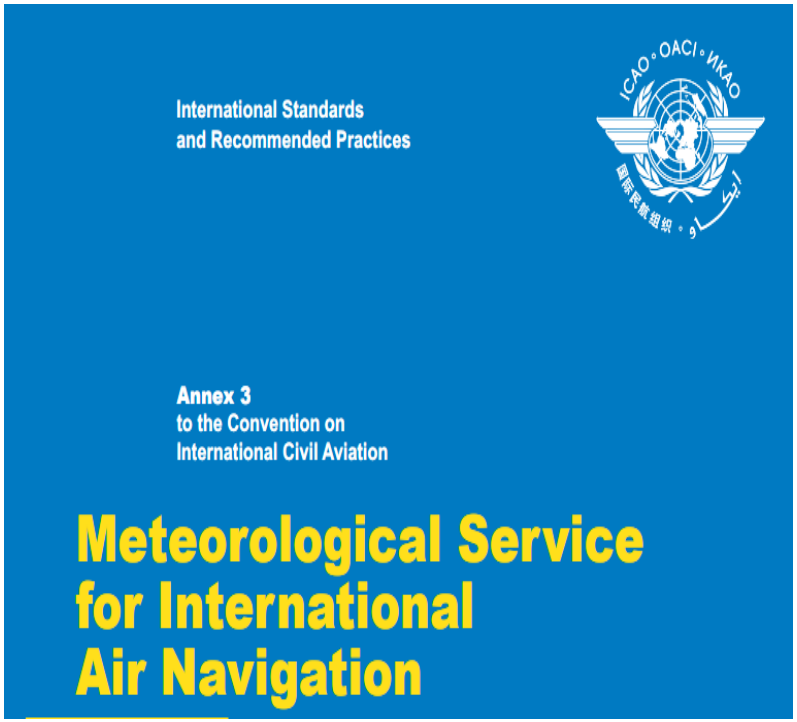
- Transmits data to one or more specific Air Traffic Services Unit (ATSU) or AOC facilities for surveillance and/or route conformance monitoring.

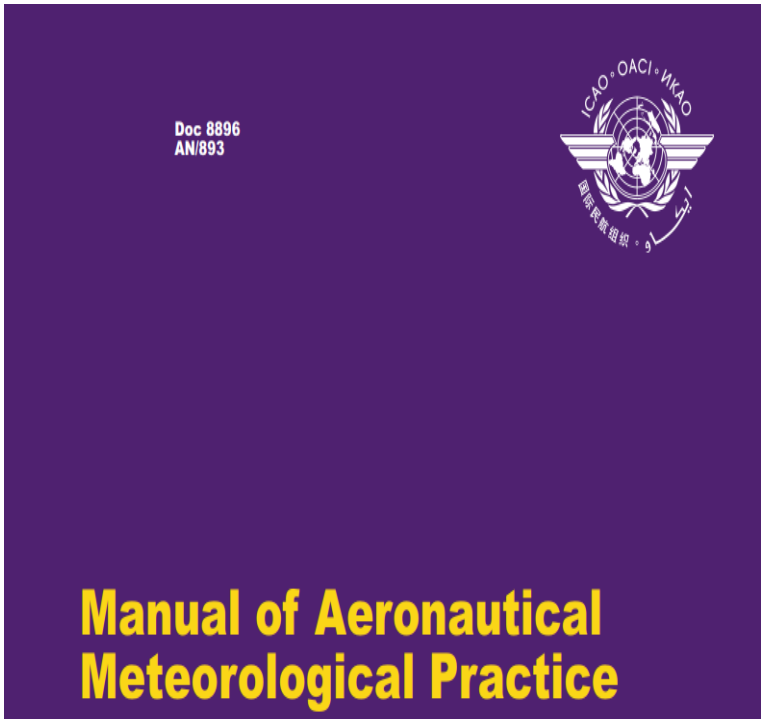
- Data is generated in response to a request within the terms of the ADS contract held by the ground system.

ADS-C

- This contract identifies;
  - the types of information and the conditions under which reports are to be sent by the aircraft.
  - Some types of information are included in every report, while other types are provided only if specified in an ADS contract request.
  - The aircraft can also send ADS-C emergency reports to any ATSU that has an ADS contract with the aircraft.

ADS-C





5.3 Routine aircraft observations — designation

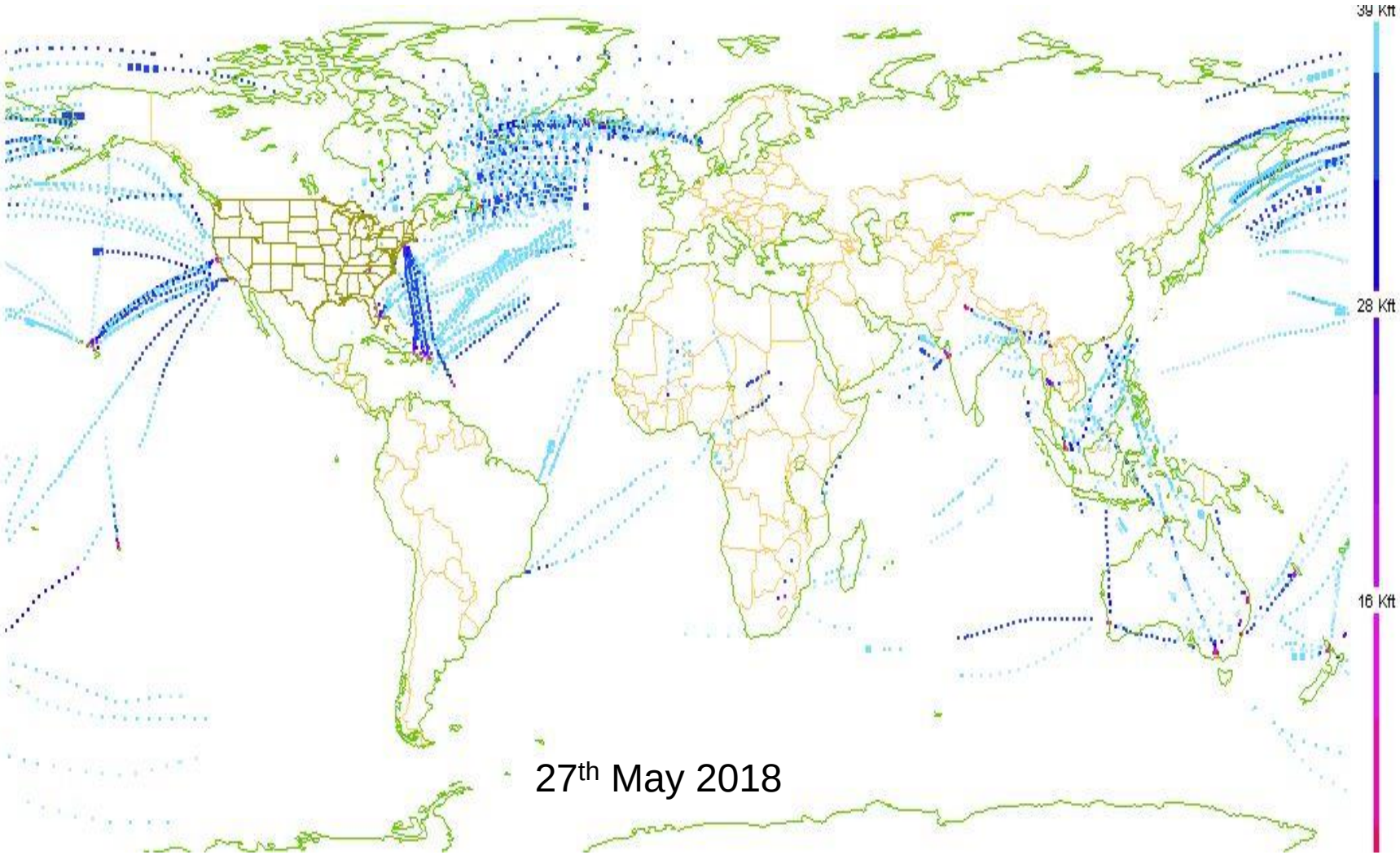
5.3.1 **Recommendation.**— *When air-ground data link is used and automatic dependent surveillance (ADS) or secondary surveillance radar (SSR) Mode S is being applied, automated routine observations should be made every 15 minutes during the en-route phase and every 30 seconds during the climb-out phase for the first 10 minutes of the flight.*

ADS-C

- NOAA and Rockwell Collins have a contract to receive and process all ADS-C data (from Rockwell customers),

- Prior to this arrangement none or very little QC was done on the data – now we have all RC data QC'd (similar to AMDAR data processes)
    - this has identified some data issues e.g aircraft type bias and wind errors.

ADS-C



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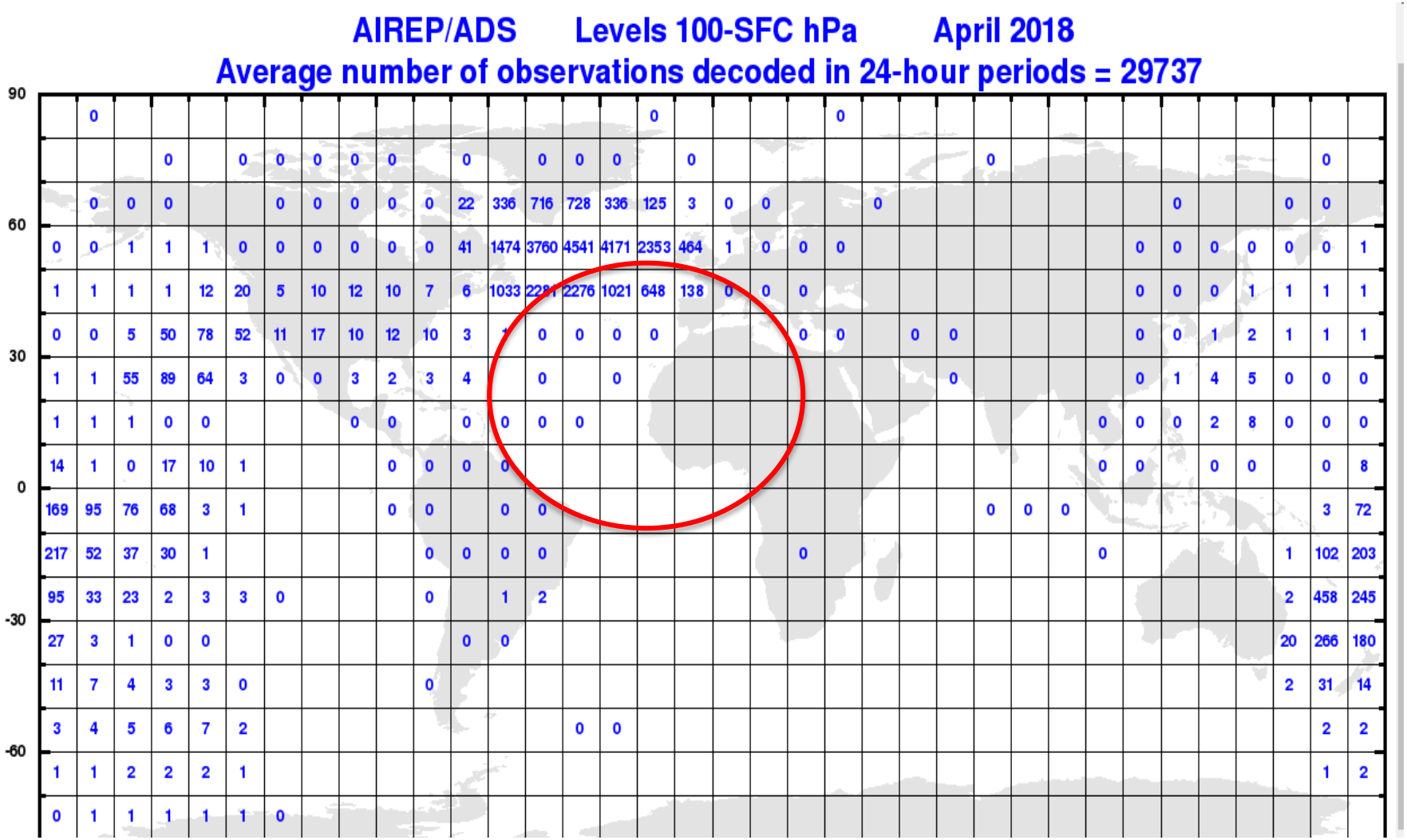
ADS-C



ADS-C

- Discussions ongoing with SITAONAIR and E-AMDAR to try and implement similar arrangement to NOAA & Rockwell Collins,
- Currently looking at data processing options;
  - SITAONAIR address ADS-C data to E-AMDAR processing system for routing to GTS/WIS and NOAA carry out QC as with other ABO data.

AFIRS


SATCOM VOICE/TEXT MESSAGING
GLOBAL FLIGHT TRACKING
REAL-TIME ENGINE EXCEEDANCES
ENGINE TRENDING
ACARS OVER IRIDIUM
FUEL MANAGEMENT
REAL-TIME AIRFRAME EXCEEDANCES
LIVE FDR STREAMING

AFIRS

FLYHT is a leading provider of;

- Iridium satellite communications,
- Global flight tracking,
- Live FDR streaming capability
- Aircraft health monitoring solutions.

The AFIRS is specifically designed to;

- Enhance operational control,
- Improve dispatch reliability and safety
- Reduce operational costs.

More than 70 customers (airlines, OEMs) worldwide

AFIRS

- **So how does it work?**
  - AFIRS is an Iridium based SATCOM device installed on the aircraft,
  - Uses proprietary software to acquire and transmit aircraft data to the ground in near real time,
  - Data is processed and distributed to customer via FLYHT's ground server network (UpTime),
  - AFIRS also has expandable interface capabilities allowing connection to various aircraft systems.

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AFIRS

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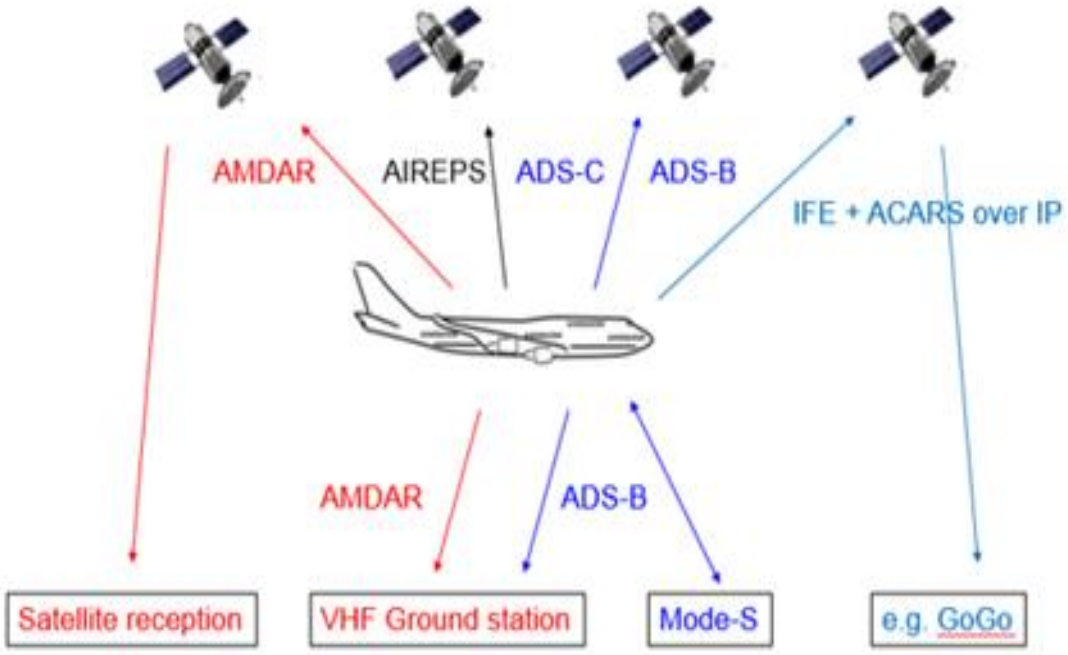
AFIRS

TCCA		FAA		EASA		CAAC		ANAC		
220	228	220	228	220	228	220	228	220	228	
A	A	A	A	A	A	A	A			Airbus A319, A320, A321
			I							Airbus A300
A										Airbus A330
	A		A						A	ATR42-300
	A		A						A	ATR72-100, -200
	A		I						I	ATR42-500
					A*					ATR42-500 "600 Version"
					A*					ATR72-212A "600 Version"
A		A		A		A				Boeing B737 -200
A	A	A	A	A	A	A	A		A	Boeing B737 -300, -400, -500
A		A		A		A				Boeing B737 -600
A	A	A	A	A	A	A	A		A	Boeing B737 -700, -800
			A				I			Boeing B737 -900ER
	A						I			Boeing 747 -200
A	A	A	A	A	A	A	A			Boeing 757 -200
A	A	A	A	A	A	A	A			Boeing 767 -200, -300
	A		A							Boeing B777
A	A*	A	A*	A	A*					Bombardier DHC 8 -100, -200, -300
A	A						I			Bombardier DHC 8 -400
A	A	A	A	A			A			Bombardier CRJ 100, 200, 440
	A		A				A			Bombardier CRJ -700, 900
A		A								McDonnell Douglas DC-10 (KC-10 military)
			A							McDonnell Douglas MD-82
	A		A							McDonnell Douglas MD-83
A										Fokker 100
A	A	A	A	A	A					Hawker Beechcraft -750, 800XP, 850XP, 900XP
A										Viking Air DHC -7 (LSTC)
	A		I				A		A	Embraer EMB 190
		A								Embraer Legacy 600 and EMB – 135/145

…from 3rd party suppliers

Future plans are to utilise as many aircraft data sources as possible.
…to include:

- AMDAR
- Mode-S
  (EHS & MRAR)
- ADS-C
  (via RC & SITA)
- Satellite ADS-B
- 3rd Party data
  (TAMDAR/AFIRS/others)
- Satellite IP data



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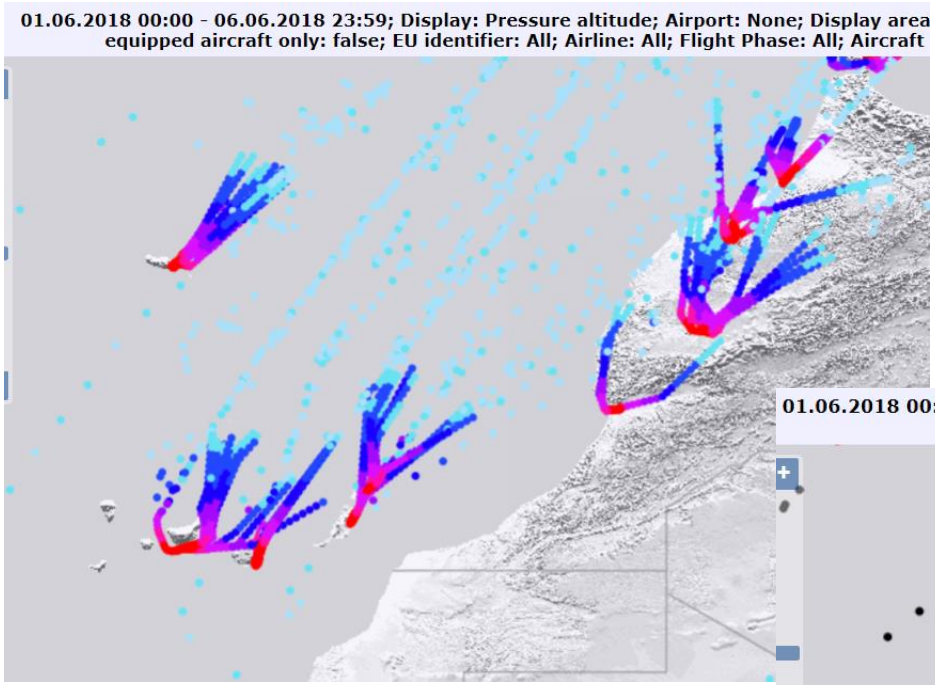
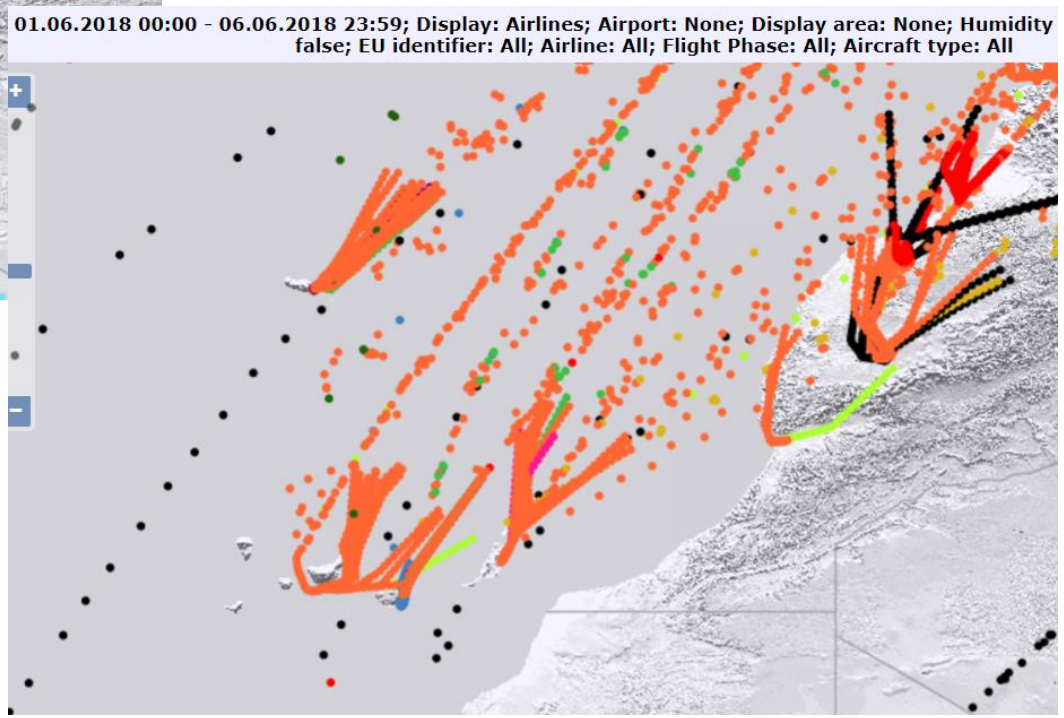
Content of Presentation

- Overview of AMDAR and the E-AMDAR Programme.
- Why do we need aircraft observation data?
  - Impacts & benefits
- How do we get aircraft observations?
  - What is E-AMDAR?
- What airlines need to do to participate in E-AMDAR.
- Other ABO platforms
  - Mode-S EHS/MRAR data
  - Aireps/ADS-C data
  - AFIRS, TAMDAR
- ABO use in Wind Shear Forecasting
  - Some examples

E-AMDAR: Network Coverage 3 - Canaries

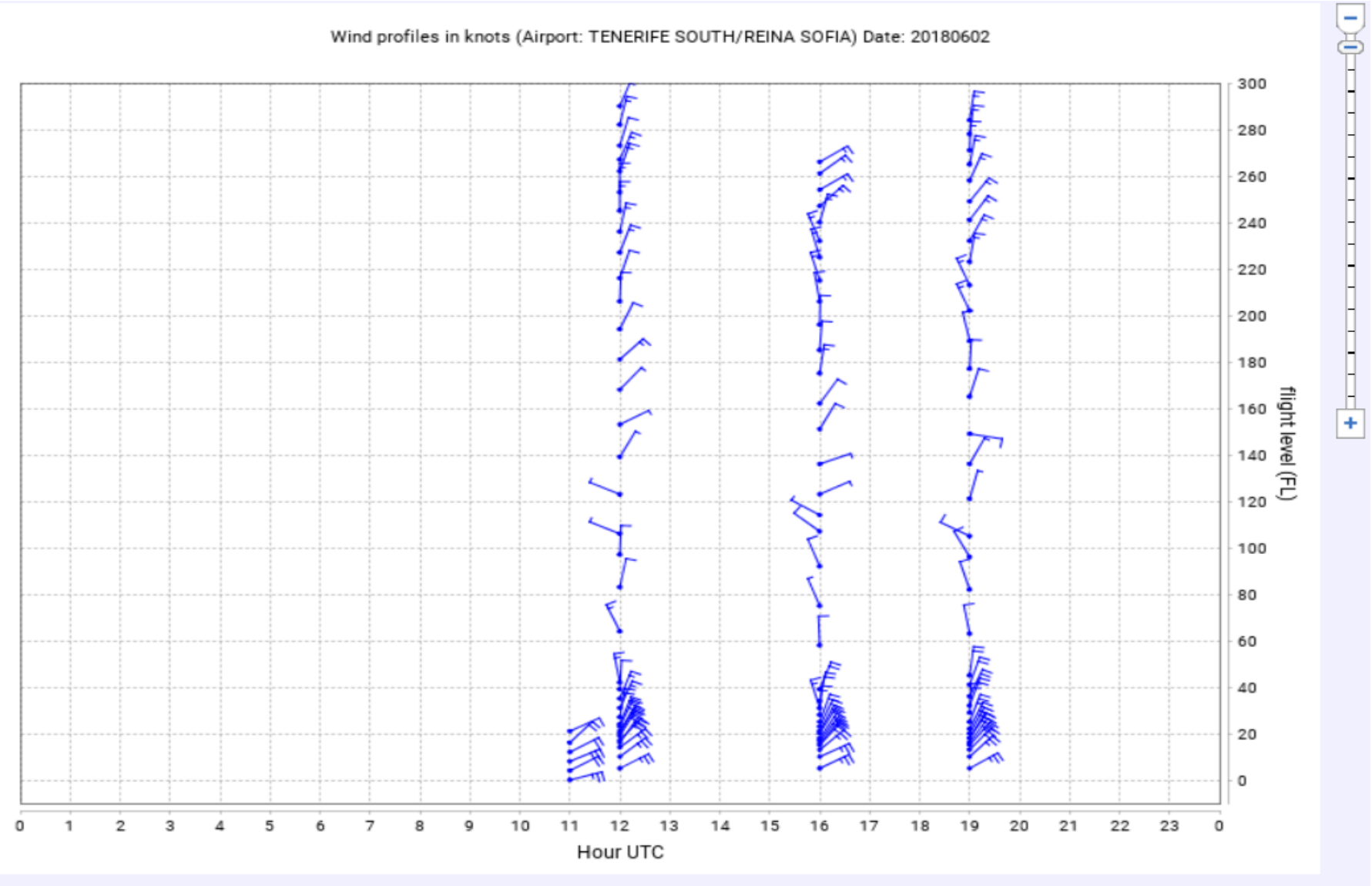


1 week snapshot AMDAR data by altitude.

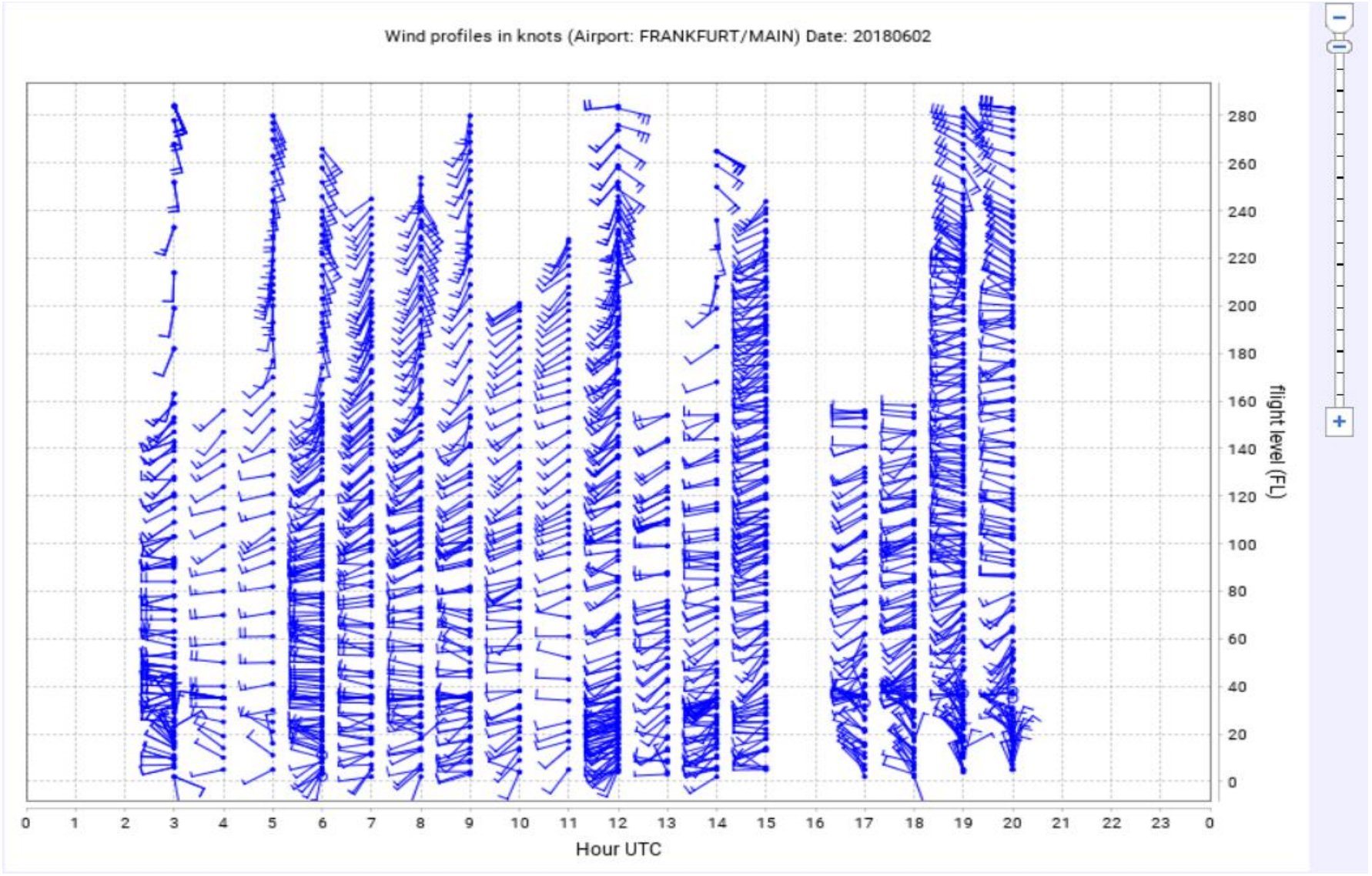


Canary Islands destinations served well by EZY fleets. If “hourly” data requested other E-AMDAR airlines would be recorded as well.

E-AMDAR Wind charts



E-AMDAR Wind charts



Low Level Wind Shear

- AMDAR are ideal for identifying and forecasting LLWS at airports, and to forecast turbulence over broad areas.

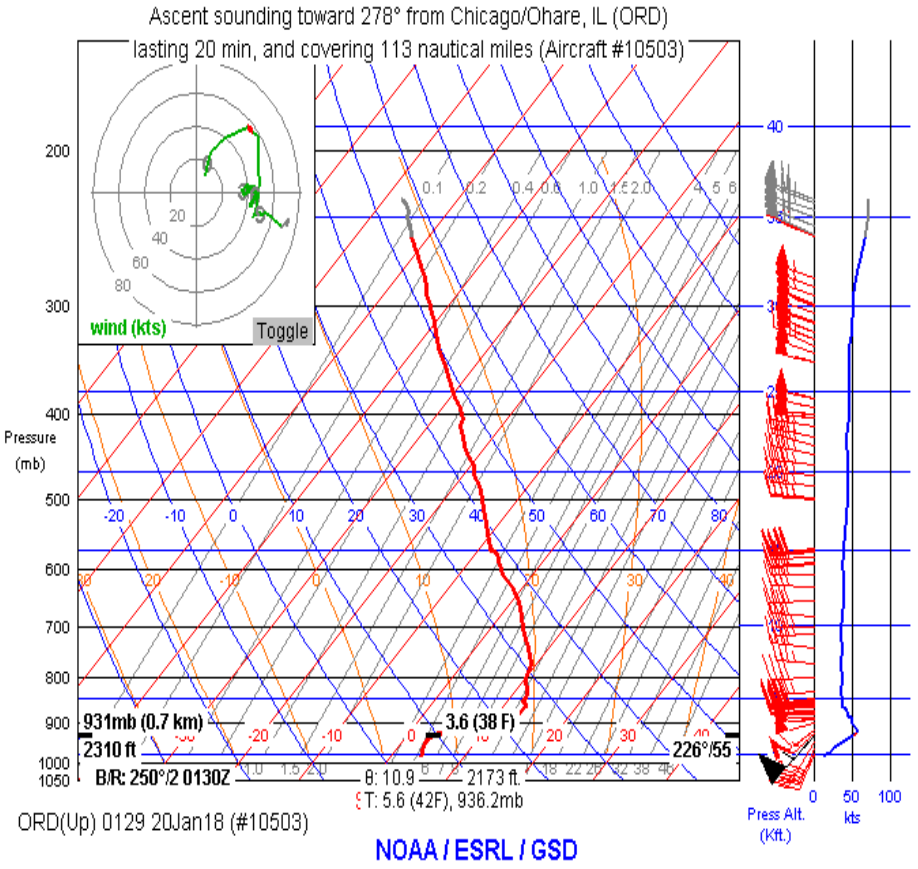
- The data are used frequently by NWS meteorologists, and sometimes mentioned in forecast discussions.

- Here are a few examples from Chicago, Anchorage, and Honolulu.

LLWS at Chicago O'Hare

Area Forecast Discussion
National Weather Service
Chicago/Romeoville, IL
535 PM CST Fri Jan 19 2018

.AVIATION...
The main weather concerns tonight will be LLWS once again. Southwest winds continue to gust up around 22 KT at the surface early this evening, but these winds should gradually ease through the evening. Given that recent **AMDAR** soundings out of ORD are already indicating around 50KT of wind around 2500 FT AGL, LLWS shear will continue to be an issue at least through around 1 am tonight when the winds aloft should ease.



Ascent sounding from O'Hare airport shows Southwest winds at 55 knots at 2300' MSL

Low Level Wind Shear at Anchorage

The location of the airport near Cook Inlet, the Gulf of Alaska and mountains often create conditions conducive for low level wind shear and turbulence.

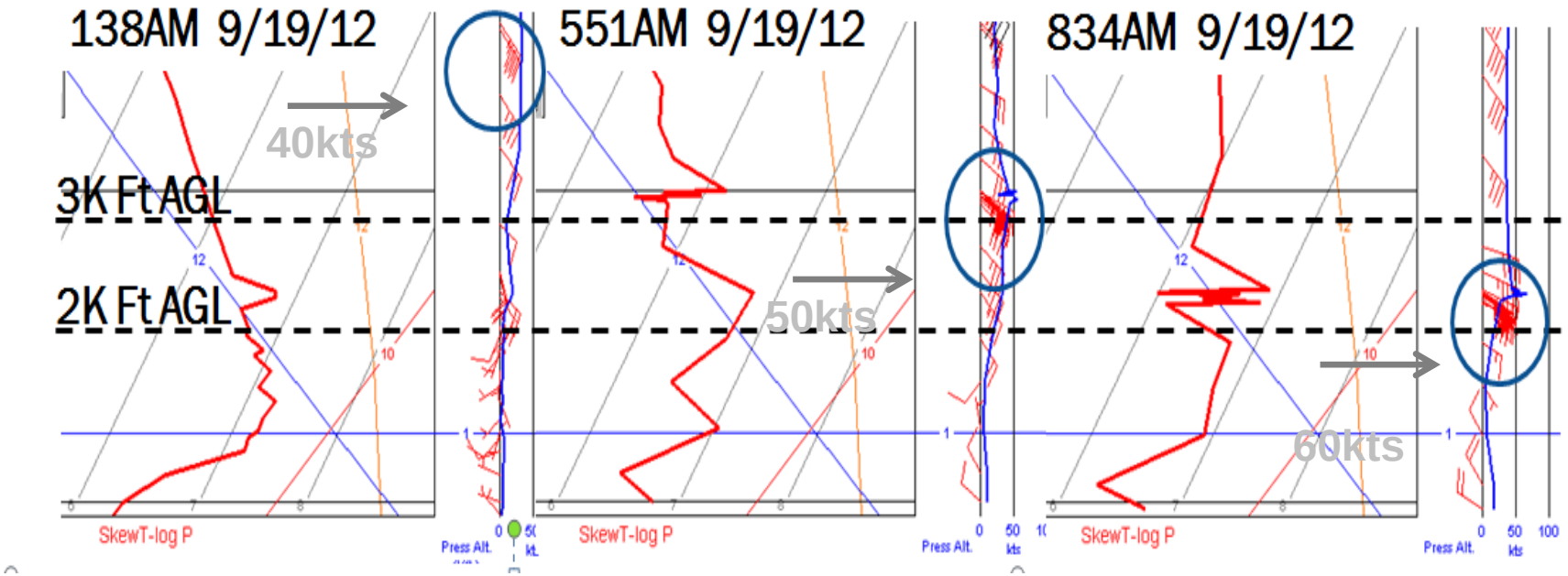
AMDAR is very important to the Anchorage WFO, CWSU and AAWU as the twice daily radiosonde does not provide sufficient temporal resolution to monitor low level wind shear.

Wind Shear - Anchorage

- The Alaska Aviation Weather Unit **used AMDAR** on September 19, 2012 to monitor the lowering of strong southeast winds aloft, creating over 60kts of wind shear in the lowest 2000 feet.

- The data increased forecaster confidence regarding the severity of the threat prior to coordinating with the FAA.

Wind Shear - Anchorage



Notice how the strong winds aloft increase in velocity and lower from 4,500’ at 01:38am to 3,000’ at 05:51am to 2,200’ at 08:34am. Also notice the directional shear.

Takeoffs on 25 or 33 will go from headwind to tailwind.

Wind Shear - Anchorage

Update, 3:30 p.m.: Alaska Airlines spokeswoman Bobbie Egan said many flights bound for Anchorage today have been diverted to Fairbanks as they wait out the storm.

The flights - two from Seattle, one from Barrow, one from Nome and one from Chicago - had a total of about 500 passengers on board.

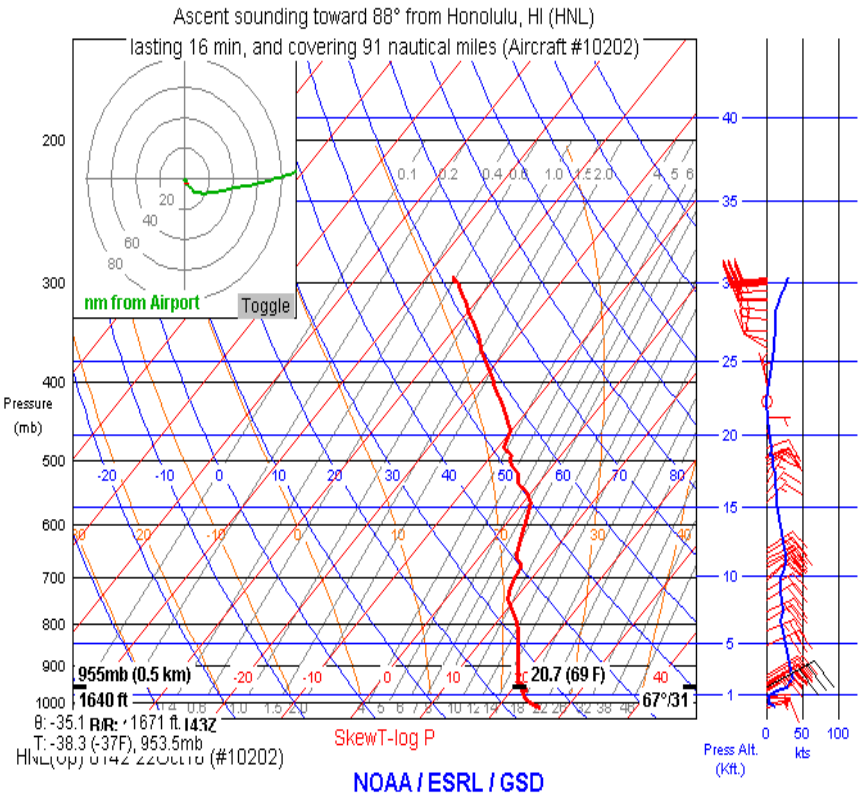
"It's currently not safe to fly into or out of Anchorage International Airport," she said.

Many cargo jets destined for Anchorage were diverted to Fairbanks on Sept 19, 2012

Low Level Turbulence at Honolulu

Area Forecast Discussion
National Weather Service Honolulu HI
355 PM HST Fri Oct 21 2016

.AVIATION...
Radar VAD wind profiles and **AMDAR** soundings from Honolulu/Lihue/ Kahului show 30 knots of wind within a few thousand feet of the surface. Inversions remain weak and elevated, but ***winds this strong should still support turbulence in the lee of the mountains and an AIRMET is in effect for moderate low-level turbulence. The turbulence threat will increase tonight as the inversion lowers and low-level winds remain just as strong.***



Ascent sounding from Honolulu shows northeast winds at 31 knots at 1600' MSL and nearly calm winds at the surface.

Canary Islands – Strong Winds

- Wind shear and high winds velocities produced flight delays and diversions.

CANARIES CHAOS Thousands of Brits left stranded at airports as powerful storm batters the Canary Islands

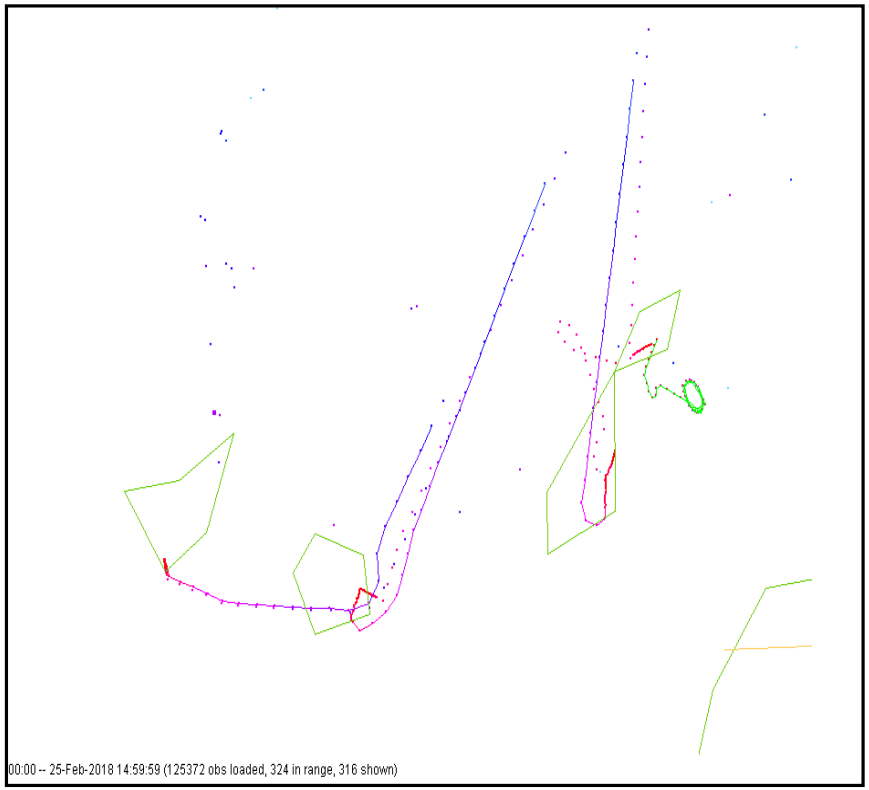
Heavy rain and gale force winds have caused at least 34 flights from Tenerife, Lanzarote and La Palma to be grounded or diverted

By John Lucas
26th February 2018, 2:26 am | Updated: 26th February 2018, 11:07 am

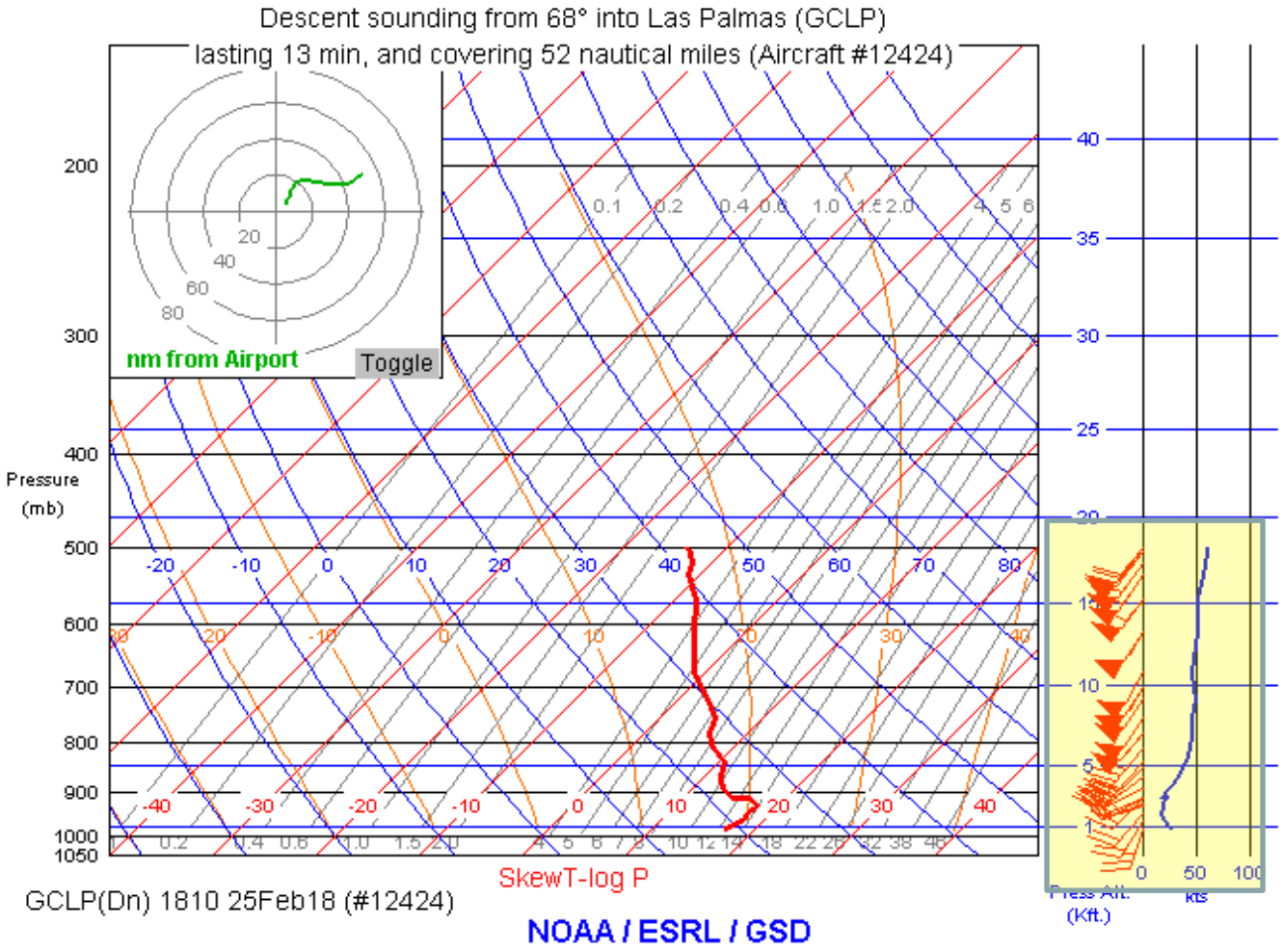
5 COMMENTS

THOUSANDS of Brits faced travel chaos last night after a powerful storm battered the Canary Islands.

Rain and high winds caused at least 34 flights from Tenerife, Lanzarote and La Palma to be grounded or diverted, leaving holidaymakers stranded.



Descent Sounding into Las Palmas



Significant speed and directional wind shear

Hong Kong Observatory, use of AMDAR at HKIA

- The potential of using near real-time AMDAR ascent/descent data to support low-level wind shear alerting,
- Preliminary results indicate that the AMDAR **temperature** profiles are able to reveal **low-level inversions** and low-level jets.
- They usefully supplement the radiosonde ascent profiles in the forecasting of wind shear associated with waves trapped by low-level inversion and with low-level jets."

Shun (2002), Doc 6(4), CAeM-XII

Hong Kong Observatory, use of AMDAR at HKIA

- Observation:
- Apart from windy situation, wind shear may also occur over the airport in lighter wind conditions, when the atmosphere is stable (e.g. presence of a **low-level temperature inversion**).
- In fact, wind shear has been known to occur even when winds of less than 15 knots blow across the hills on Lantau Island, in the spring months.

Reference: HKO (2010), Wind shear and Turbulence in Hong Kong – information for pilots

Hong Kong Observatory, use of AMDAR at HKIA

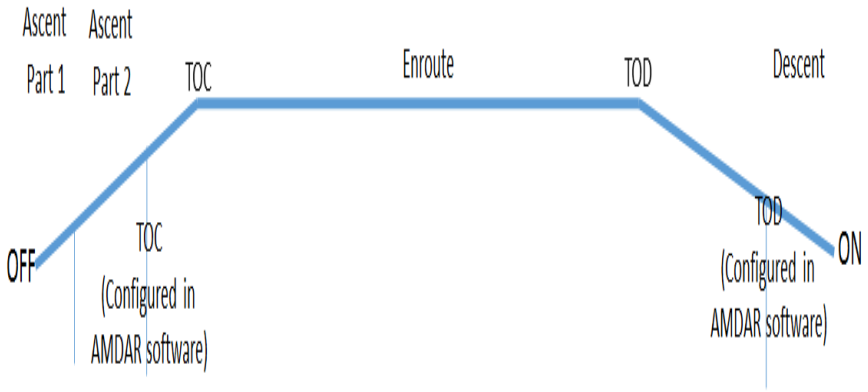
- In 2005, experiments were conducted in applying the AMDAR observations for low-level wind shear reporting at HKIA.

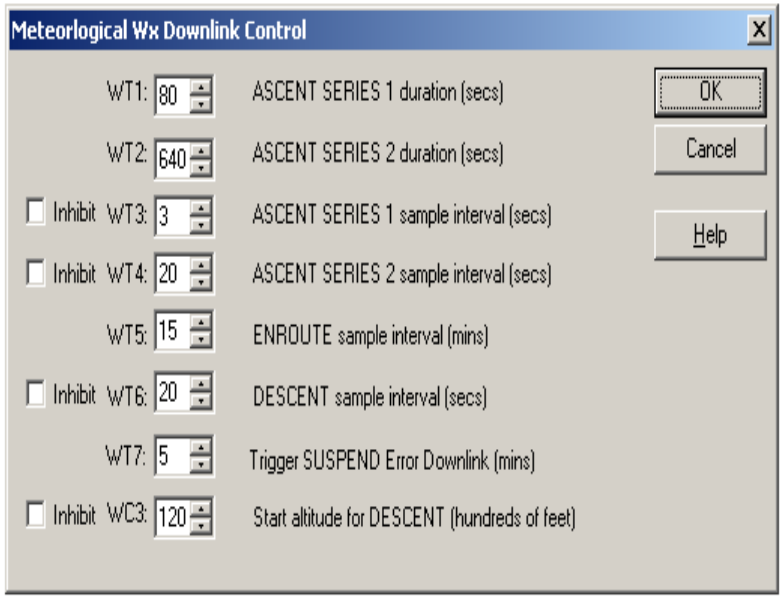
- Wind shear experienced by aircraft during the take-off phase was computed from the high-resolution AMDAR reports received and compared with the Flight Data Recorder (FDR) wind data at 1-second resolution recorder on the aircraft. The AMDAR **wind reports** showed good agreement with the FDR data in respect of the altitude and the headwind (along the runway direction).

- In particular, AMDAR data at **4-second** resolution was able to **capture the significant headwind variations associated with wind shear events**, even though 1-second data would be more useful to capture wind shear events with temporal scale of a few seconds.

Hong Kong Observatory, use of AMDAR at HKIA

Algorithms to identify changes of headwind of 15 knots or more in the AMDAR wind observations from ascending aircraft had been developed to automatically generate **an automatic wind shear report**.
Since 17 August 2006, such AMDAR wind shear reports had been included in the wind shear warnings on the Automatic Terminal Information Service (ATIS) for HKIA with the **same status as the pilot wind shear reports**.





- To enhance the temporal resolution of AMDAR wind data, data during the ascent part 1 are recorded at an interval of **every 3 seconds**.

Case study – Severe Typhoon Khanun on 15 OCT 2017

Wind measurements by an aircraft in Hong Kong, China
AMDAR programme around 10:22 UTC

Height (ft)	Wind speed (kt)	Wind direction (deg)	Headwind component (kt)
470	5	92	4.7
580	6	88	5.8
710	8	84	7.9
850	13	95	12.1
1010	18	89	17.3
1180	24	98	21.8
1350	31	90	29.6
1480	30	80	29.8
1630	27	50	24.9

A windshear report from a pilot received at 10:27 UTC confirming presence, location and magnitude of windshear

E-AMDAR

¿Preguntas?

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