Eleventh Meeting of the North American, Central American and Caribbean Working Group - NACC WG
Guatemala City, Guatemala 21 September 2026
Item agenda No. 3

WMO Aircraft-based Observations Programme contribution and regional needs

Nicolás Rivaben / WMO HQ - Scientific Officer

21 September 2026

WORLD METEOROLOGICAL ORGANIZATION

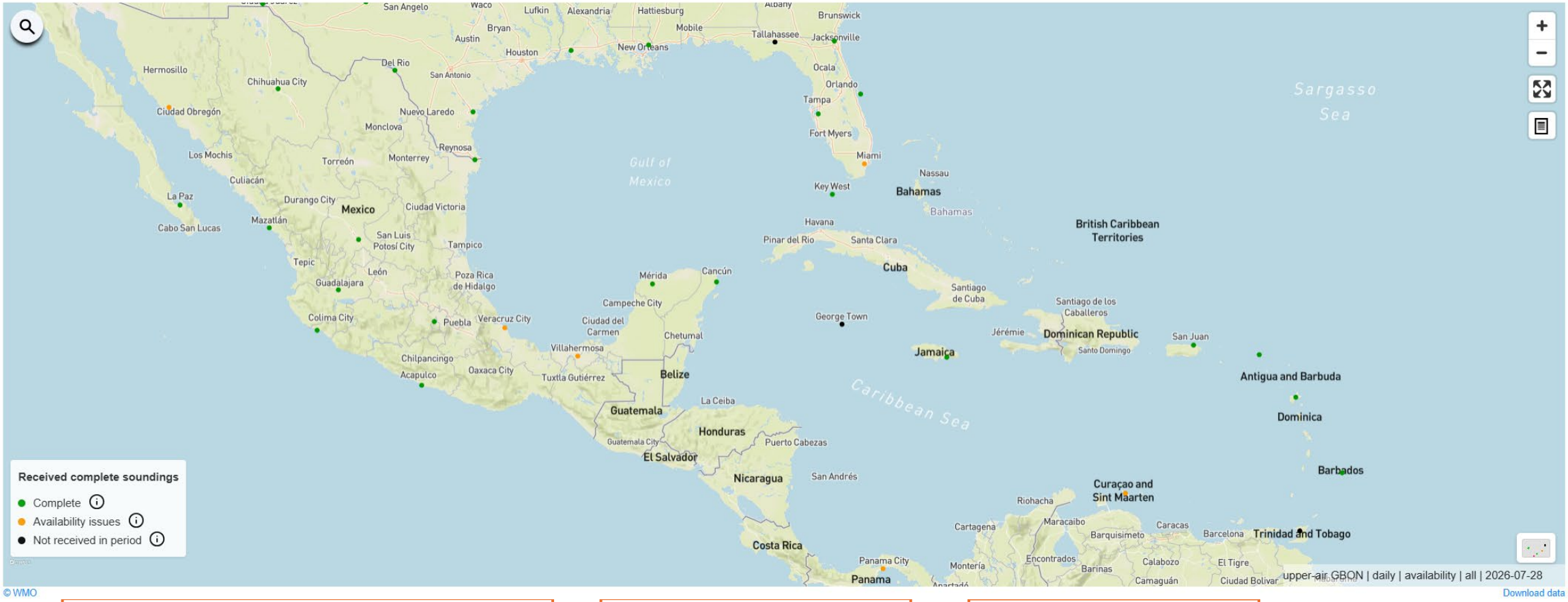
Content

1. Status of upper air observation in the region
2. Review of WMO Aircraft-based Observations Programme
3. Status of ABO in the WMO Region IV (ICAO NAM/CAR)
4. Recommendations and requests raised from ABO Community

Why is so important ABO?

There is a gap in upper-air measurements, which reduces NWP capabilities in the region.

Availability of upper-air land observations (GBON)



Because **lack of upper-air observations:** there are very few places where they are releasing radiosoundings ballon in time (green dots)

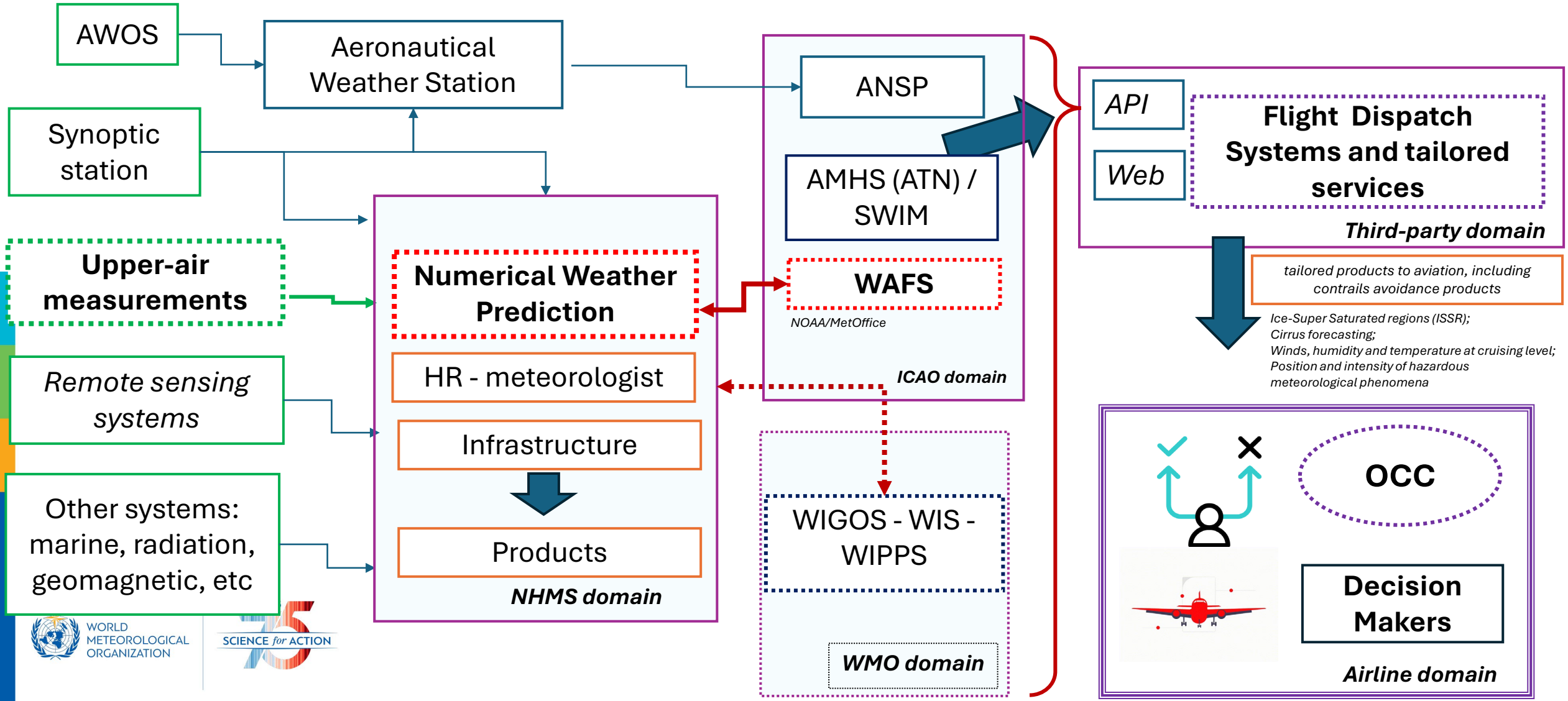
Because **the impact of ABO is well known due to the big amount of** data

Because it is cheap and helps aviation and general communities

Because it **is not necessary install any additional hardware** into the aircraft

Why is so important Aircraft-based Observation for aviation?

The importance of NMHS to the aviation industry



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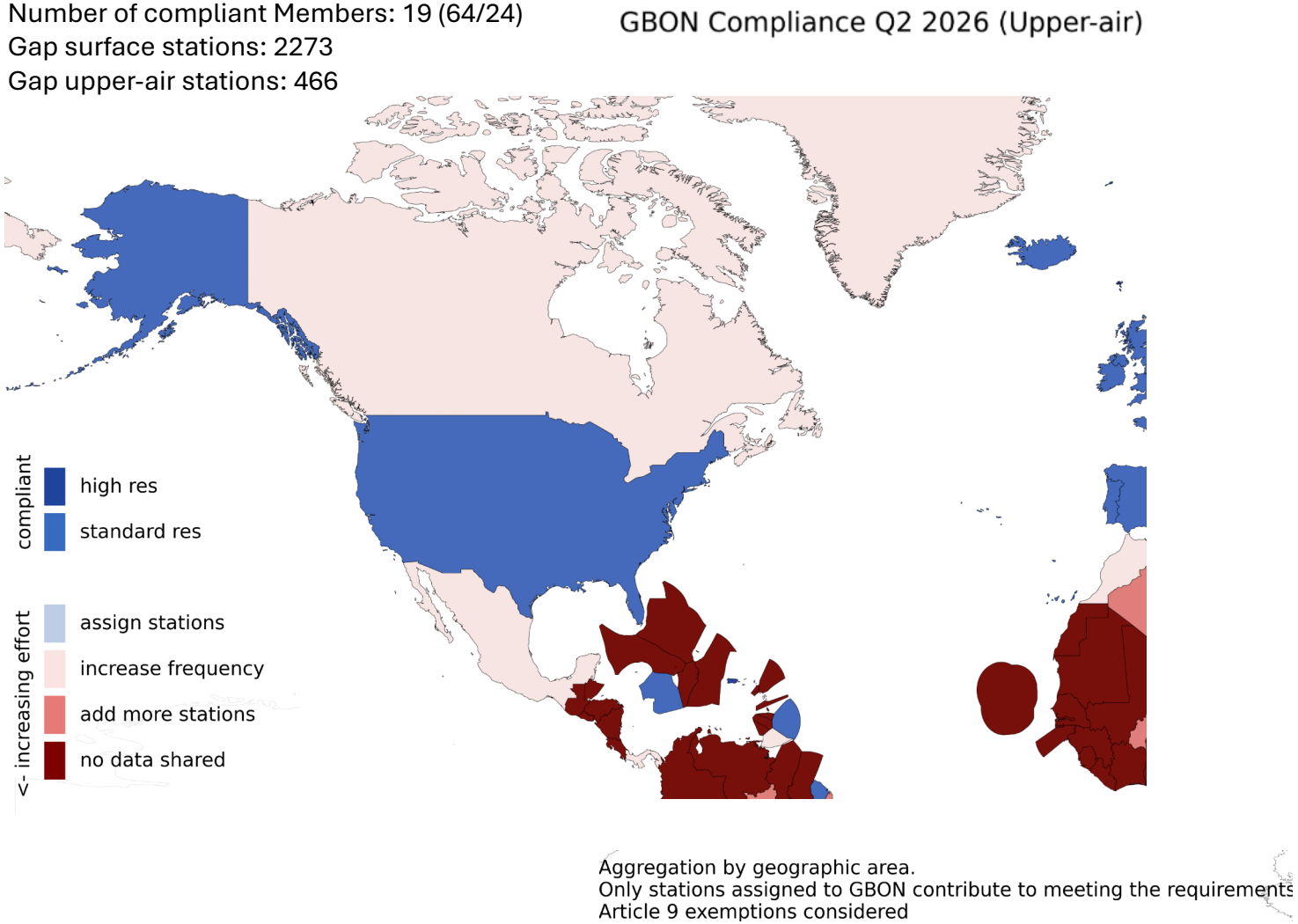
SCIENCE for ACTION

Global Basic Observing Network Compliance for upper-air data

Global statistics:
Number of compliant Members: 19 (64/24)
Gap surface stations: 2273
Gap upper-air stations: 466



Aggregation by geographic area.
Only stations assigned to GBON contribute to meeting the requirements
Article 9 exemptions considered

Most of the countries are not compliant on GBON (UA) and some of them are showing a decrease of radiosounding stations

https://gbon-compliance.wmo.int/

More details available in the document: ***Status report on Global Basic Observing Network (GBON) Implementation and Member-level Compliance Assessment***

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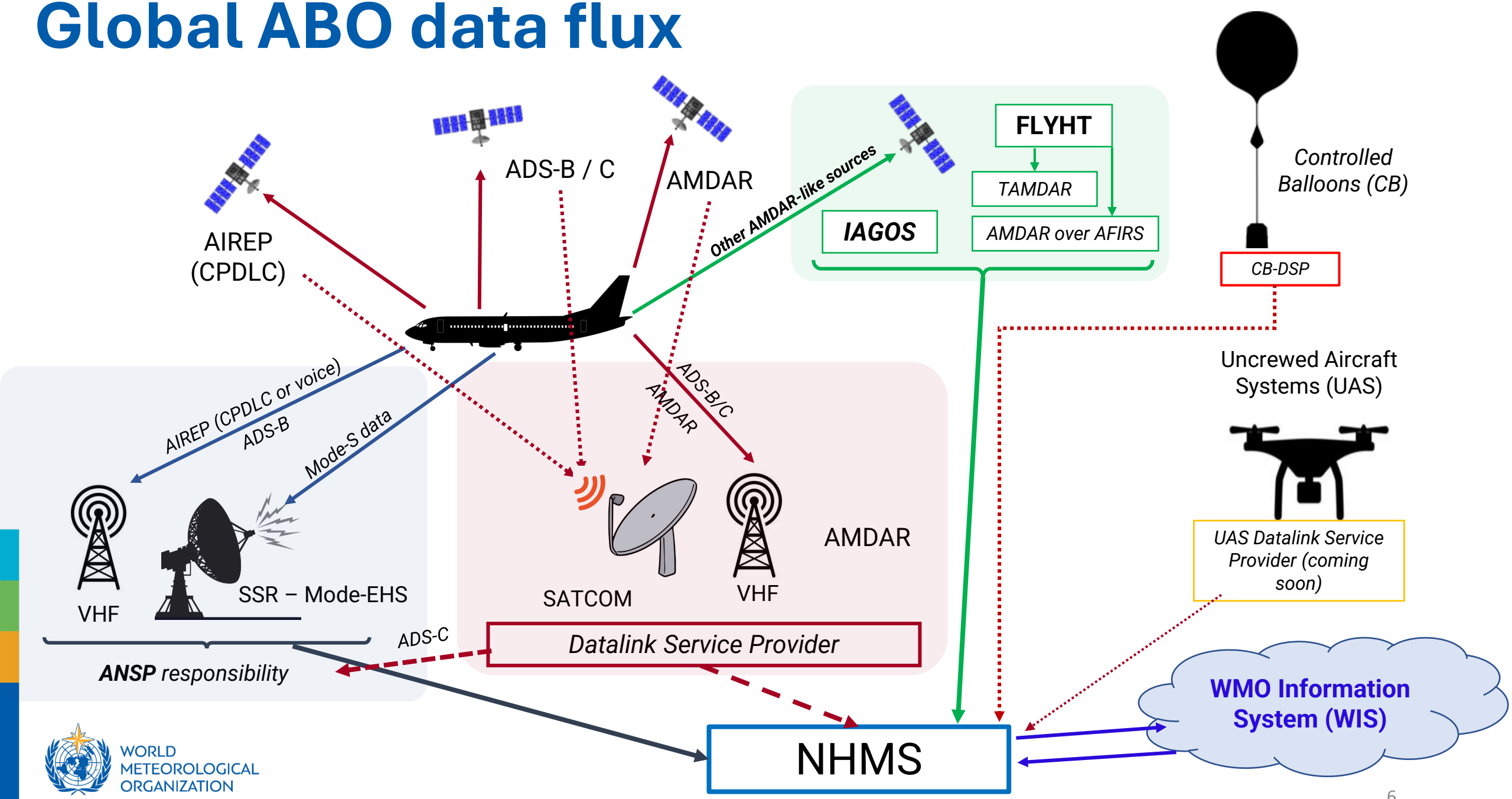
1950-2025 SCIENCE for ACTION

Global ABO data flux



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Adapted from S. Stringer, 2017 – Modified by N. Rivaben, 2026

Review of Sources of Aircraft-Based Observations

ABO Source	*System/ type*	*Regulator/ provider*	*Auto/ manual*	*Sensors*	*Communications*	*Meteorological information*	*Air–ground format*	*Responsible for ground reception*	*Responsible for meteorological processing and WIS provision*	*Preferred WIS format*
WMO ABO	AMDAR	WMO	Auto	Innate to aircraft[a]	ACARS	Always	AMDAR (WMO)	NMHS	NMHS	BUFR
ICAO ABO	AIREP	ICAO	Auto and manual	Innate & pilot (from cockpit display and subjective)	ACARS	Always	AIREP (ICAO Annex 3)	ANSP	Currently NMHS	BUFR
ICAO ABO	PIREP	FAA	Manual	Innate & pilot (from cockpit display and subjective)	VHF radio/ACARS	Always	PIREP (FAA)	NCAA	Currently NMHS	BUFR
ICAO ABO	ADS-C	ICAO	Auto	Innate to aircraft	ACARS	Optional	ICAO aircraft report	ANSP	Currently NMHS	BUFR[h]
ICAO ABO (ADD)	Mode-S	ICAO	Auto	Innate to aircraft	L-Band (SSR)	Derived	ICAO aircraft report	ANSP/EMADDC	EMADDC	NetCDF
Other ABO	TAMDAR	FLYHT Inc.	Auto	Additional	Satellite	Always	TAMDAR	FLYHT/FTG	NMHS	BUFR
Other ABO	UAS	CAA/NMHS	Auto	Innate and additional	VHF/Satellite	Always	Custom by DSP	UAS-DSP	NMHS	UAS-NetCDF
Other ABO	*Controlled* Balloons	WMO	Auto	Additional	Satellite	Always	Custom by DSP	CB-DSP	NMHS	BUFR/NetCDF

Adapted from WMO N°1200 – Guide to Aircraft-based Observations (*in red, the inclusions will be proposed for WMO INFCOM V*)

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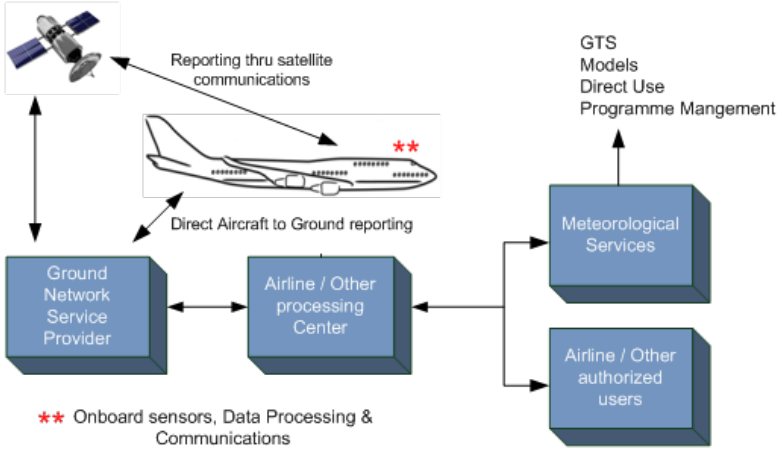
WMO INFCOM/SC-ON/**ET-ABO** leads all ABO activities

Aircraft Meteorological Data Relay - AMDAR

- It uses installed sensors (pitot probe, static port, accelerometer) or additional sensors (WVSS-II)
- AMDAR **is supported by ACARS-type telecommunication protocols** (ARINC 620). It requires an AMDAR Onboard Software (AOS) installed in the aircraft. Other systems such as AFIRS (FTG/FLYHT) can relay AMDAR messages
- It is managed by the **Airline participant, DSP and the NMHS**
- Restricted data policy in some cases
- Data should be **disseminated into WIS** (preferable WIS2) through FM94 BUFR bulletins.
- Data should be **processed and consisted into the DA of G-NWP** systems



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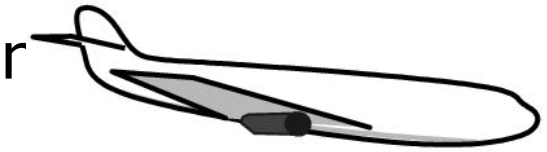
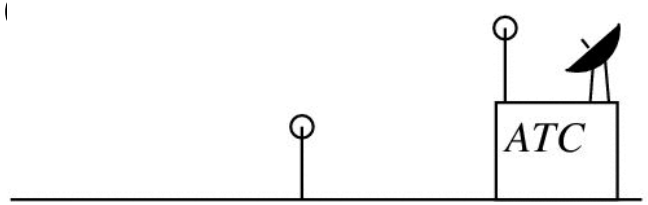
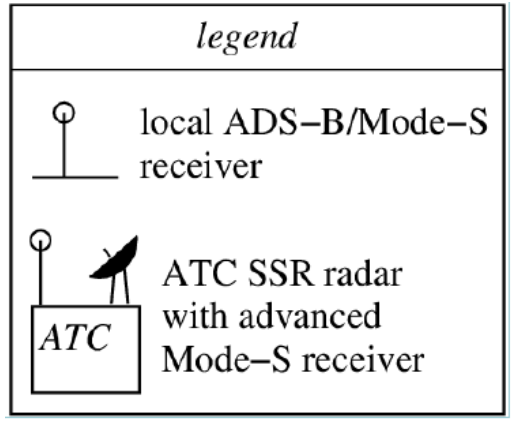
SSR Mode S and ADS-C/B

- **SSR-Mode** : ANSP uses SSR to interrogate aircraft at 1030/1050Mhz bandwidth. Meteorological information can get by:
  - **Using innate instruments** (called as Mode-S Meteorological Routine Air Report – **MRAR**): Quality is very similar to AMDAR and RAOB. Unfortunately, 5% or less of the aircraft have a transponder with BDS 4.4 register and very few ATC radar interrogate this BDS;
  - **Deriving from aeronautical variables** such as Mach Number, heading, true airspeed, ground speed, altitude and ICAO id, among others.
- **ADS-C data use airborne instruments data like AMDAR** and no derivation is required.







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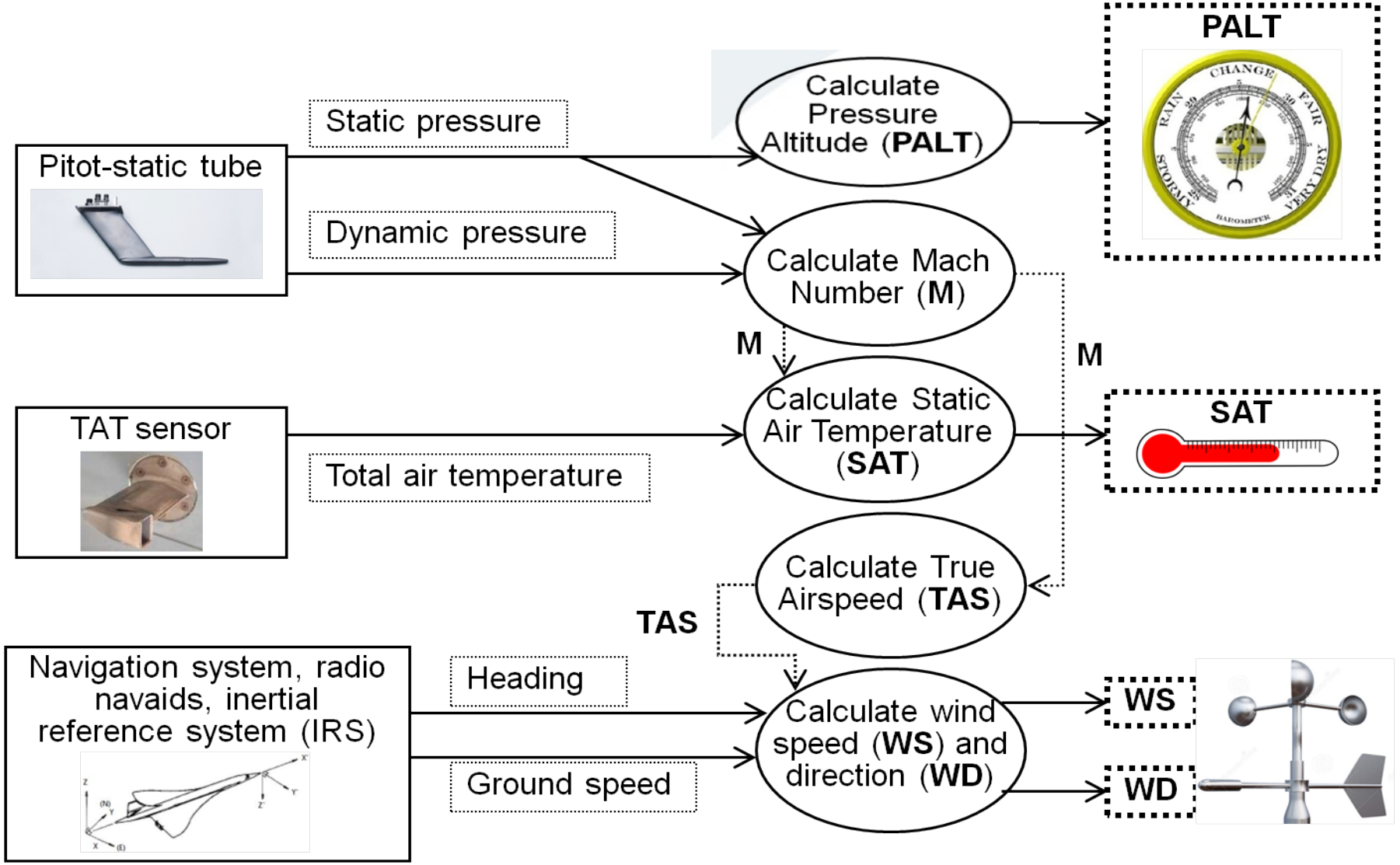
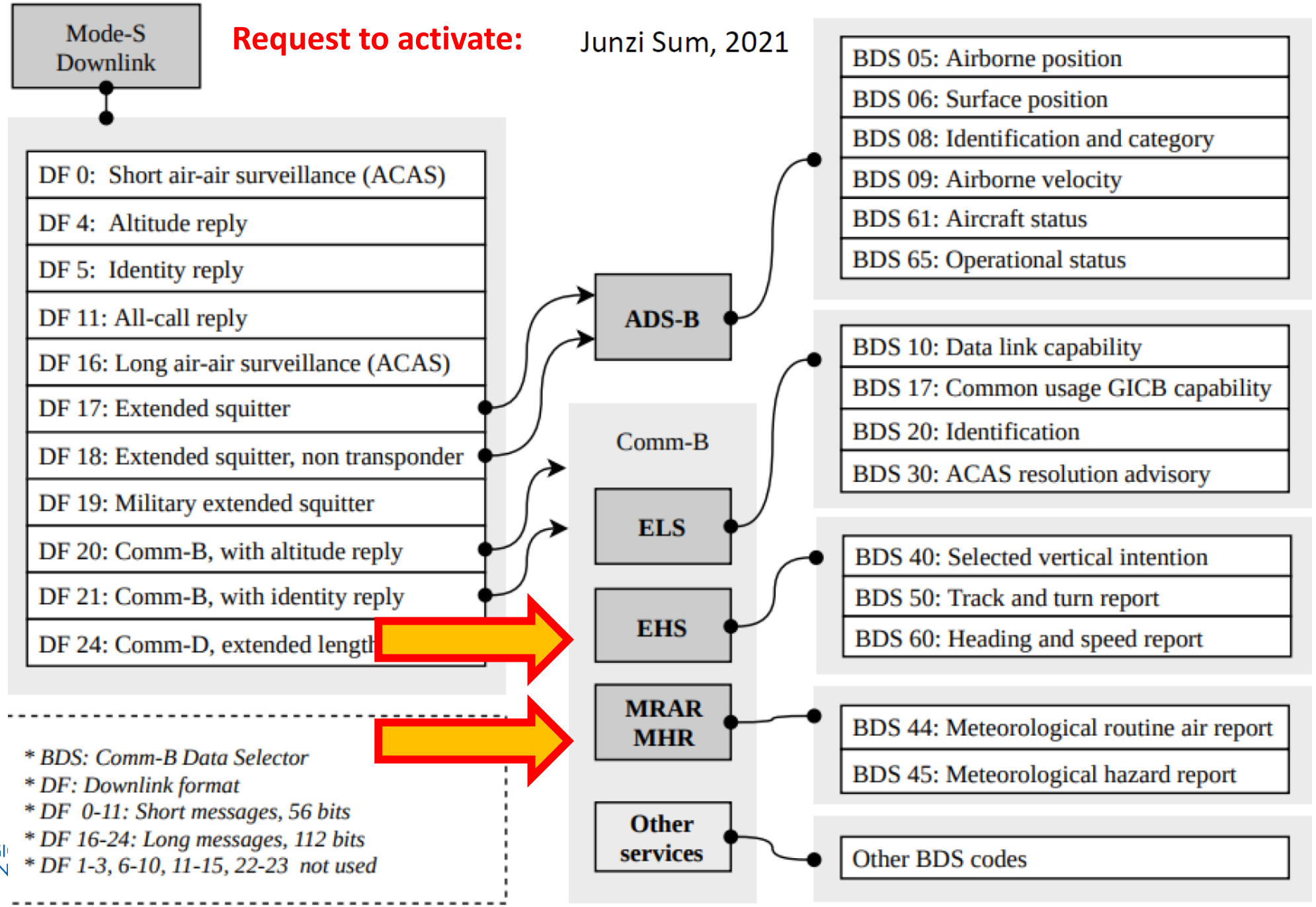
How is the process of deriving meteorological data from aeronautical parameters?





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Global ADS-C Coverage

ADS-C: Non MET reporting FIRs

ANSPs that are not enabling the MET group in periodic ADS-C contracts (based on analysis of several weeks in 2019)

ICAO code	FIR/ANSP	RA	ICAO code	FIR/ANSP	RA
DAAA	Algeria	I	FIMM	Mauritius	I
FNAN	Angola	I	VIDF	New_Delli	II
ENOB	Bodo	VI	DNKN	Nigeria	I
GCCC	Canary_Islands	I	SPIM	Peru	III
GMAC	Casablanca	I	LPPO	Portugal/Santa Maria	VI
ZLLL	China_West	II	GVSC	Sal	I
ZWWW	China_West	II	SCEZ	Santiago	III
MHTG	Cocesna/Central America	IV	FSSS	Seychelles	I
CZEG	Edmonton	IV	HCSM	Somalia	I
RJJJ	Fukuoka	II	VCCF	Sri_Lanka	II
DGAC	Ghana	I	VVTS	Tan_Son_Nhat	II
WIFF	Jakarta		TTZP	Trinidad/Piarco	IV
WMFC	KUALA_		CZVR	Vancouver	IV
VRMF	Maldives/Male				

Steve Stringer, based on data provided by Collins Aerospace, WMO Workshop on ADD, 2022.

We need enable MET ADS-C in all Oceanic FIRs to enhance Global NWP in those areas

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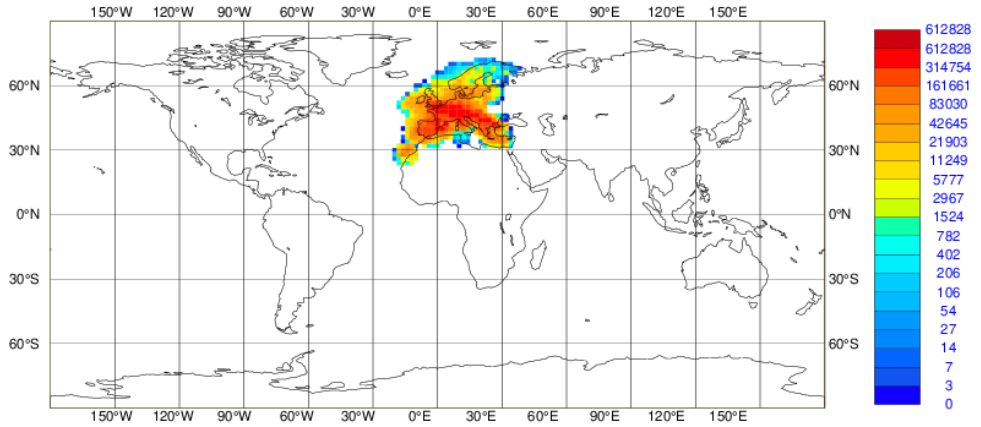
Current operational Mode-S data: EMADDC

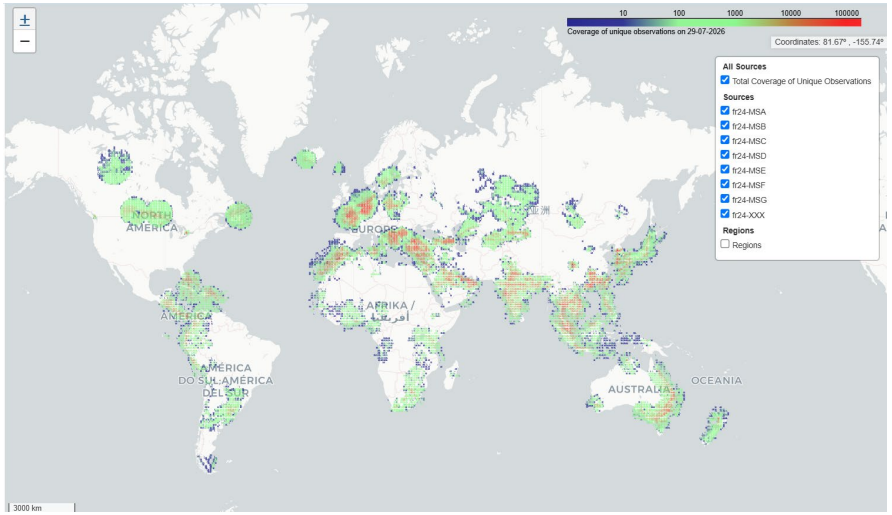
European Meteorological Aircraft Derived Data Centre - EMADDC - is an operational center under development to provide quality-controlled wind and temperature observations that are based on aircraft data.

EMADDC is a SESAR deployment project and co-funded by the EU (INEA):

- KNMI process **ASTERIX CAT48 format** to derive MET data**.**
- MetOffice collects SSR Mode S (EHS) available through FlightRadar24 and shares to KNMI.
- **Absolute quality estimated:**
  - Wind speed: 1-1,5m/s
  - Wind direction: 5 – 10 degrees
  - Temperature: 0,5 – 2°K
- Format available: WMO BUFR, NetCDF and ASCII

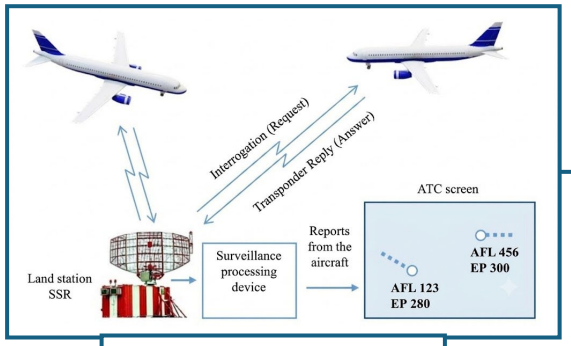


Original network using SSR Mode S (Asterix CAT048) for MUAC airspace – Jan de Sondij (EMADDC) WMO ADD Workshop 2022



SSR Mode S Global Coverage provided by FR24 and supported by MetOffice to EMADDC – 29 July 2026. Source: EMADDC

Global SSR-Mode S Data Flux – Two scenarios for ANSP' contribution



ANSP

Provides SSR mode S data (EHS) in Asterix CAT048 format part 4

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and Water Management

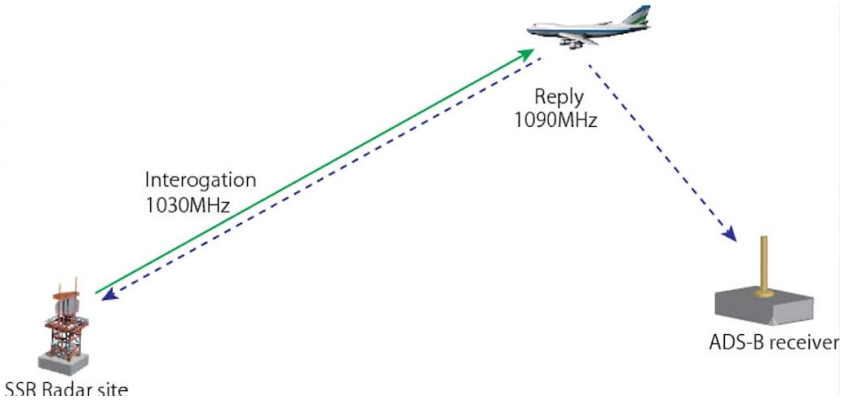
EUMETNET

EMADDC

Derive MET information from raw data and put it into WIS and G-NWP (ECMWF)

Scenario 1

Scenario 2



ANSP

Operates SSR Mode S EHS antennas

FlightRadar 24

Receives data from transponders

Collects and send pre-processed data

Met Office

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and Water Management

EUMETNET

EMADDC

Derive MET information from raw data and put it into WIS and G-NWP (ECMWF)

Experience raised by COCESNA in SSR Mode S

- Asterix **CAT021 is not** suitable for EMADDC
- Only Asterix **CAT048 is useful.**
- SSR Mode S data should be requested in mode EHS
- Several radars in the region are operation in mode ELS
- ADS-C should enable ‘MET’ over oceanic RNAV areas

Tabla de Data Items (DI) según figura – ASTERIX CAT021 versión 2.1

Orden según figura	DI en figura	Data Item CAT021	Nombre del DI - ASTERIX CAT021 v2.1	Presencia aprox. (%)	Observación
1	DI010	I021/010	Data Source Identification	100	Identificación de la fuente de datos ADS-B.
2	DI040	I021/040	Target Report Descriptor	100	Tipo y características del reporte.
3	DI080	I021/080	Target Address	100	Dirección única del blanco/emisor.
4	DI090	I021/090	Quality Indicators	100	Indicadores de calidad ADS-B.
5	DI077	I021/077	Time of ASTERIX Report Transmission	100	Hora de transmisión del reporte ASTERIX.
6	DI210	I021/210	MOPS Version	100	Versión MOPS reportada.
7	DI073	I021/073	Time of Message Reception for Position	100	Hora de recepción del mensaje de posición.
8	DI131	I021/131	High-Resolution Position in WGS-84 Co-ordinates	100	Posición WGS-84 de alta resolución.
9	DI015	I021/015	Service Identification	100	Identificación del servicio.
10	DI400	I021/400	Receiver ID	100	Identificador del receptor.
11	DI295	I021/295	Data Ages	100	Edades de los datos.
12	DI200	I021/200	Target Status	100	Estado del blanco.
13	DI170	I021/170	Target Identification	99	Identificación del blanco/callsign.
14	DI161	I021/161	Track Number	99	Número de traza.
15	DIRE	RE	Reserved Expansion Field	98	Campo de expansión reservado; no es DI numérico I021/xxx.
16	DI020	I021/020	Emitter Category	98	Categoría del emisor ADS-B.
17	DI075	I021/075	Time of Message Reception for Velocity	97	Hora de recepción del mensaje de velocidad.
18	DI070	I021/070	Mode 3/A Code in Octal Representation	97	Código Mode 3/A en representación octal.
19	DI145	I021/145	Flight Level	97	Nivel de vuelo barométrico.
20	DI008	I021/008	Aircraft Operational Status	96	Estado operacional de la aeronave.
21	DI130	I021/130	Position in WGS-84 Co-ordinates	96	Posición en coordenadas WGS-84.
22	DI016	I021/016	Service Management	96	Gestión del servicio.
23	DI132	I021/132	Message Amplitude	96	Amplitud del mensaje recibido.
24	DI160	I021/160	Airborne Ground Vector	92	Vector terrestre en vuelo.
25	DI140	I021/140	Geometric Height	92	Altura geométrica respecto al elipsoide WGS-84.
26	DI146	I021/146	Selected Altitude	85	Altitud seleccionada.
27	DI155	I021/155	Barometric Vertical Rate	84	Razón vertical barométrica.
28	DI271	I021/271	Surface Capabilities and Characteristics	10	Capacidades y características en superficie.
29	DI157	I021/157	Geometric Vertical Rate	8	Razón vertical geométrica.
30	DI074	I021/074	Time of Message Reception of Position – High Precision	4	Hora de recepción de posición de alta precisión.
31	DI071	I021/071	Time of Applicability for Position	4	Hora de aplicabilidad de la posición.
32	DI151	I021/151	True Airspeed	1	Velocidad verdadera.
33	DI152	I021/152	Magnetic Heading	1	Rumbo magnético.
34	DI165	I021/165	Track Angle Rate	0	Tasa de cambio del ángulo de trayectoria.
35	DI076	I021/076	Time of Message Reception of Velocity – High Precision	0	Hora de recepción de velocidad de alta precisión.
36	DI150	I021/150	Air Speed	0	Velocidad aérea.
37	DI230	I021/230	Roll Angle	0	Ángulo de alabeo.
38	DI072	I021/072	Time of Applicability for Velocity	0	Hora de aplicabilidad de la velocidad.
39	DI260	I021/260	ACAS Resolution Advisory Report	0	Reporte ACAS Resolution Advisory.
40	DI148	I021/148	Final State Selected Altitude	0	Altitud seleccionada de estado final.
41	DI220	I021/220	Met Information	0	Información meteorológica.
42	DI110	I021/110	Trajectory Intent	0	Intención de trayectoria.
43	DI250	I021/250	Mode S MB Data	0	Datos Mode S MB.
44	DISP	SP	Special Purpose Field	0	Campo especial ASTERIX; no es DI numérico I021/xxx.

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Weather Unmanned Aerial Systems (wx-UAS)

- **Small weather-sensing UAS (WxUAS):**
- **are nearly 100% reusable** - as opposed to radiosondes of which only 20% are recovered and a smaller fraction reused;
- can **rapidly sample the lower atmosphere**; hence they improve the short-term **prediction of radiation fog events** (Leuenberger et al. 2020); and they **can improve the skill of mesoscale weather predictions** (e.g., Jonassen et al. 2012; Flagg et al. 2018; Chilson et al. 2019; Jensen et al. 2021);
- **are extremely adaptable**; capable of flying targeted missions or performing routine systematic profiling (Elston et al. 2015);
- It can be automated or operated remotely

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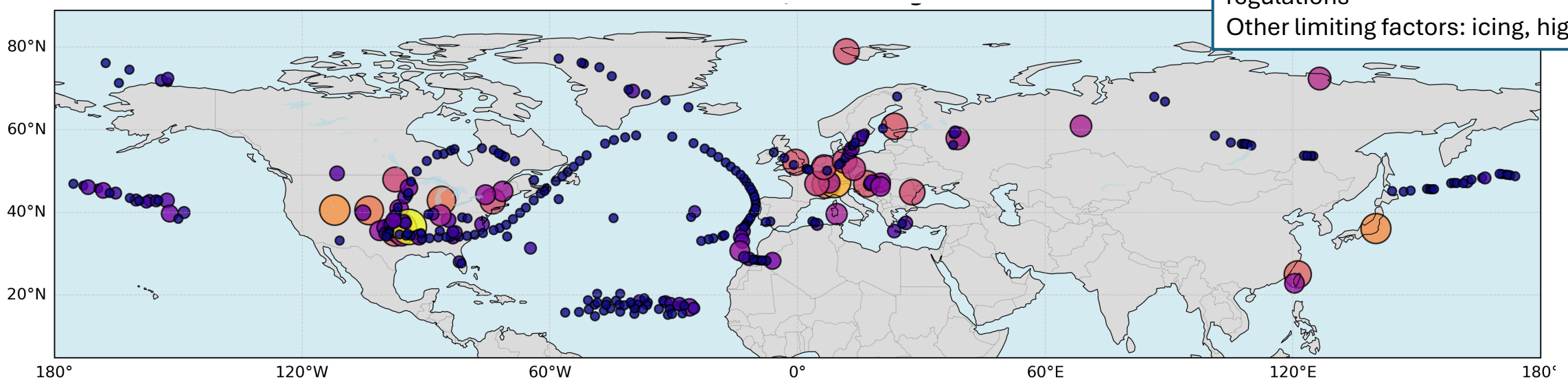
2024 WMO UAS Demonstration Campaign Summary

- **Goal :** Accelerate and Demonstrate Operational Readiness for inclusion in WMO Integrated Global Observing System (WIGOS)
- **Dates :** March – Sept 2024
- **Coverage :** Global (31 cities from 12 countries)
- **Operators :** 44
- Profiles collected as of 21 Sep 2024 : **over 12000**
- **Data format :** CF compliant netCDF & BUFR
- NWP Center Participation: ECMWF, DWD, MeteoSwiss, NOAA GSL.

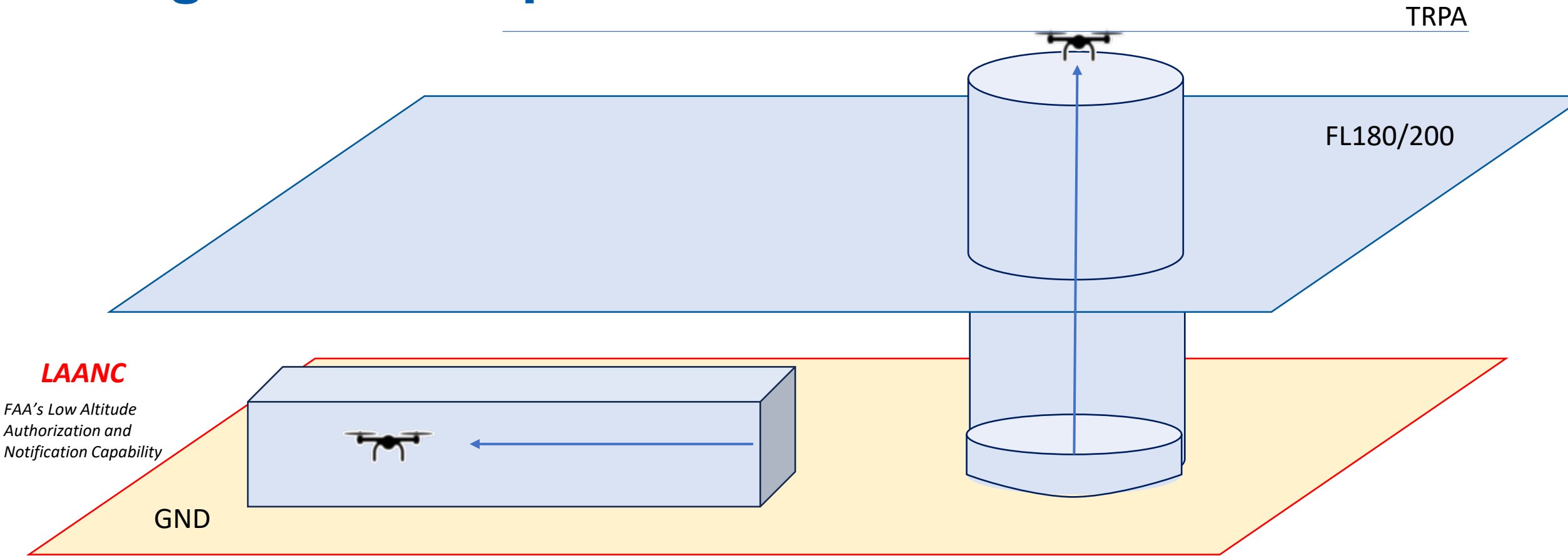
Max altitude mostly limited by regulations
Other limiting factors: icing, high winds



Preliminary report here

83% of uploads </= 1 hour

WMO UAS DC recommedation: UAS airspace management and procedures for MET observations



Limited airspace fixed by NOTAM. Ceiling: FL004 or G/E-class airspace. Only VLOS. NOT USEFUL for regular MET observations

Airspace fixed by AIP ENR 5.1 with a 2-5 NM radius. Max ceiling: ~FL400. BVLOS. USEFUL for regular MET observations

Status of WMO ABO Programme at regional level

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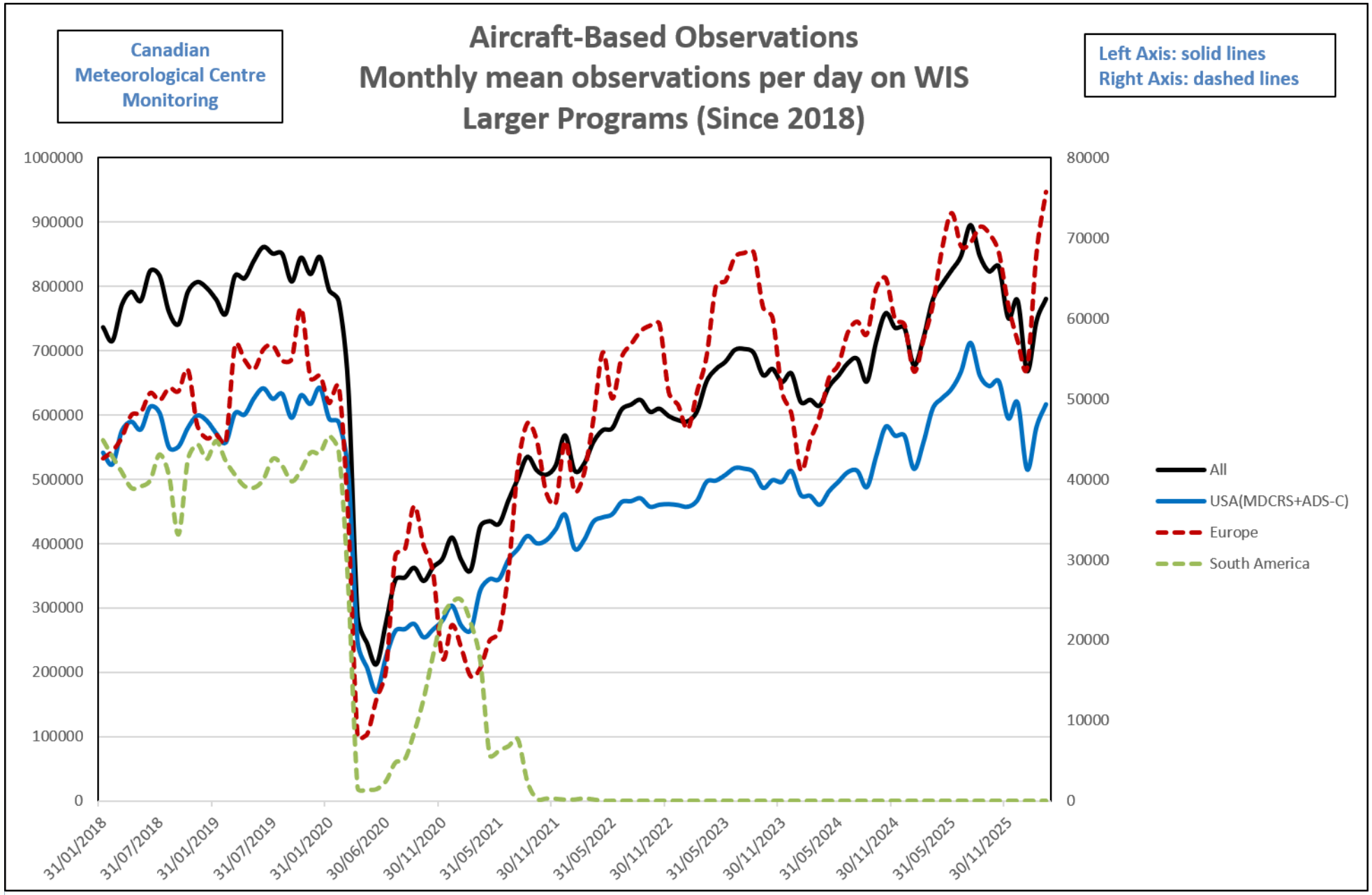

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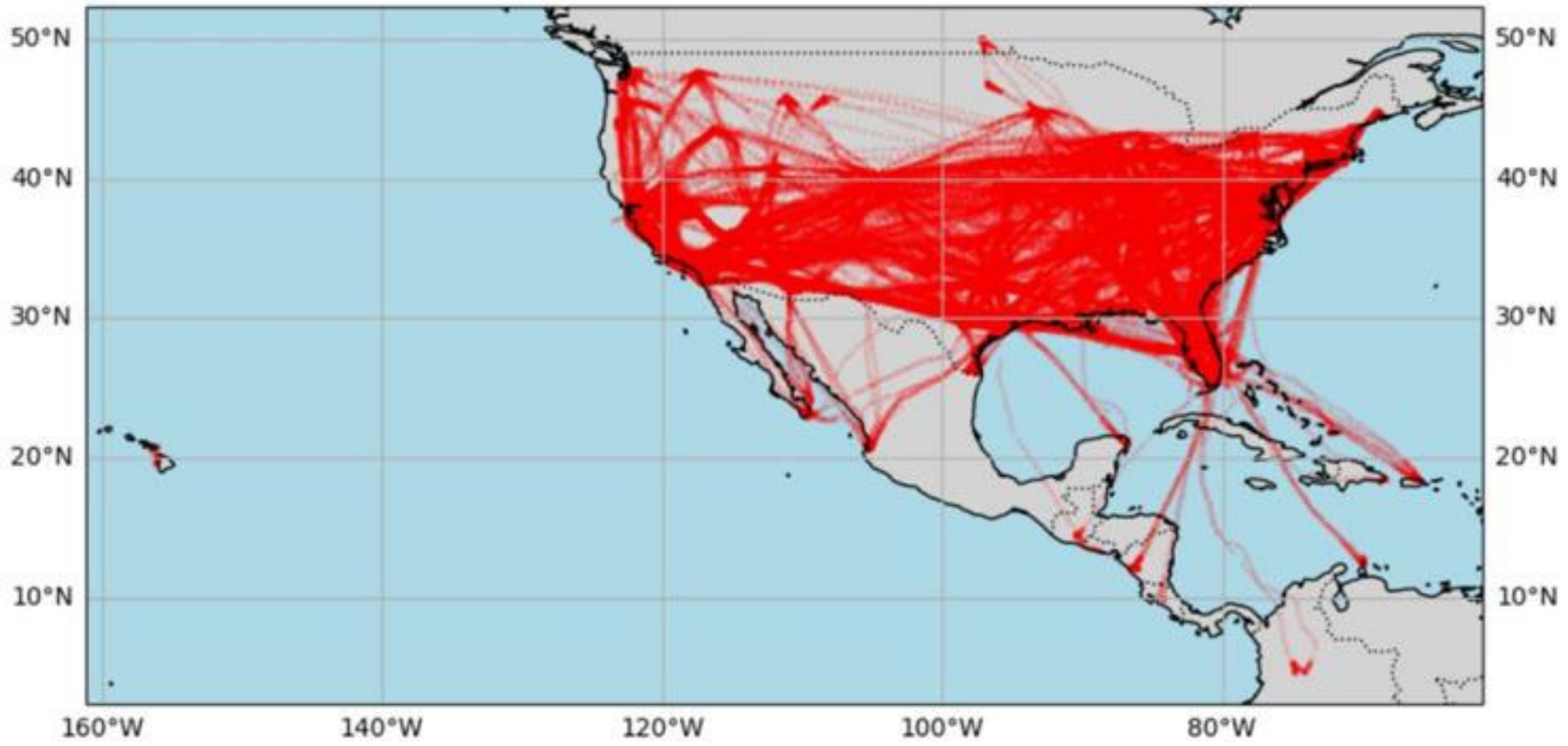
ABO Dataset available for RA IV: WVM



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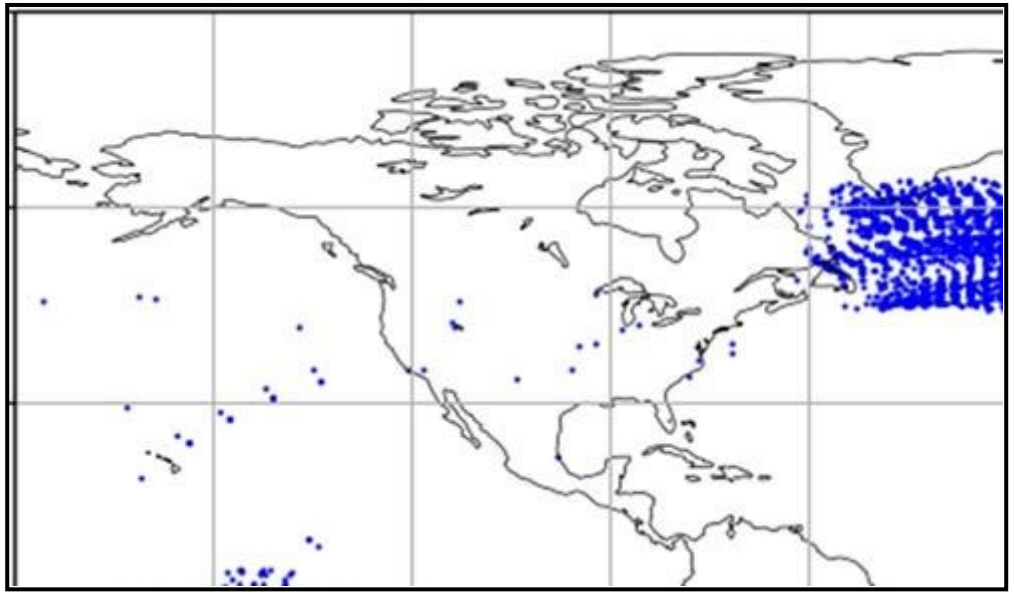
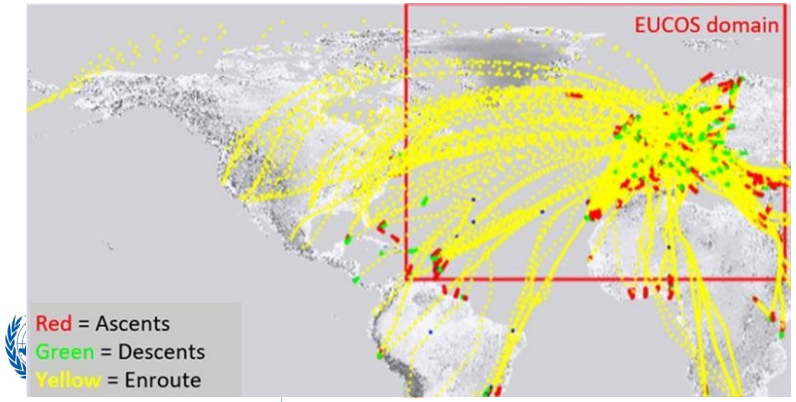
WVSS-II measurements from the North American AMDAR program from 06-12 October 2025 (source: NOAA)

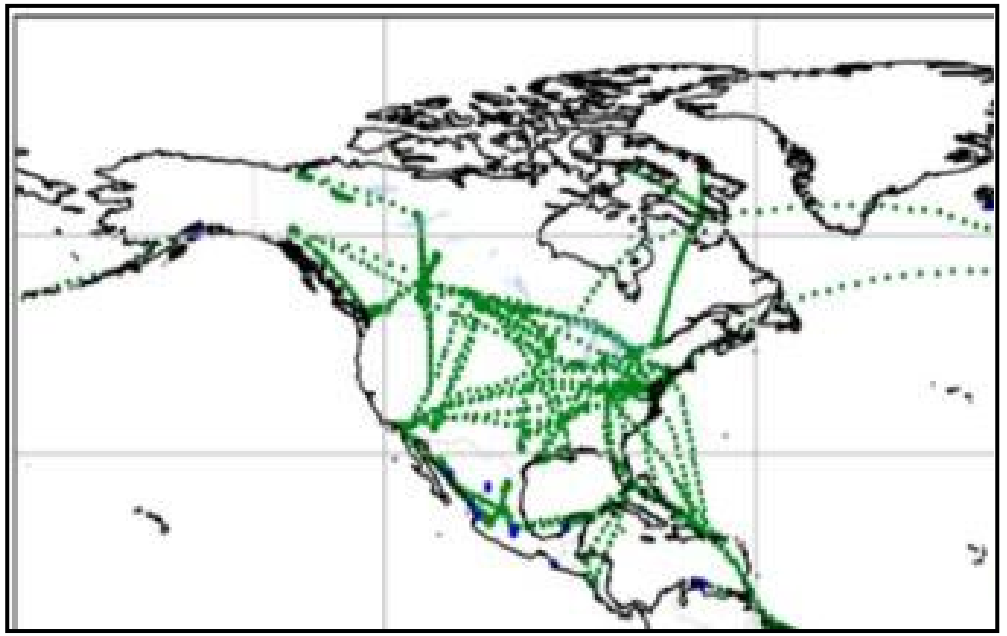
TAMDAR (FLYHT) coverage (Dec 2025)



AIREP coverage (Dec 2025)



EUMETNET coverage (Dec 2025)

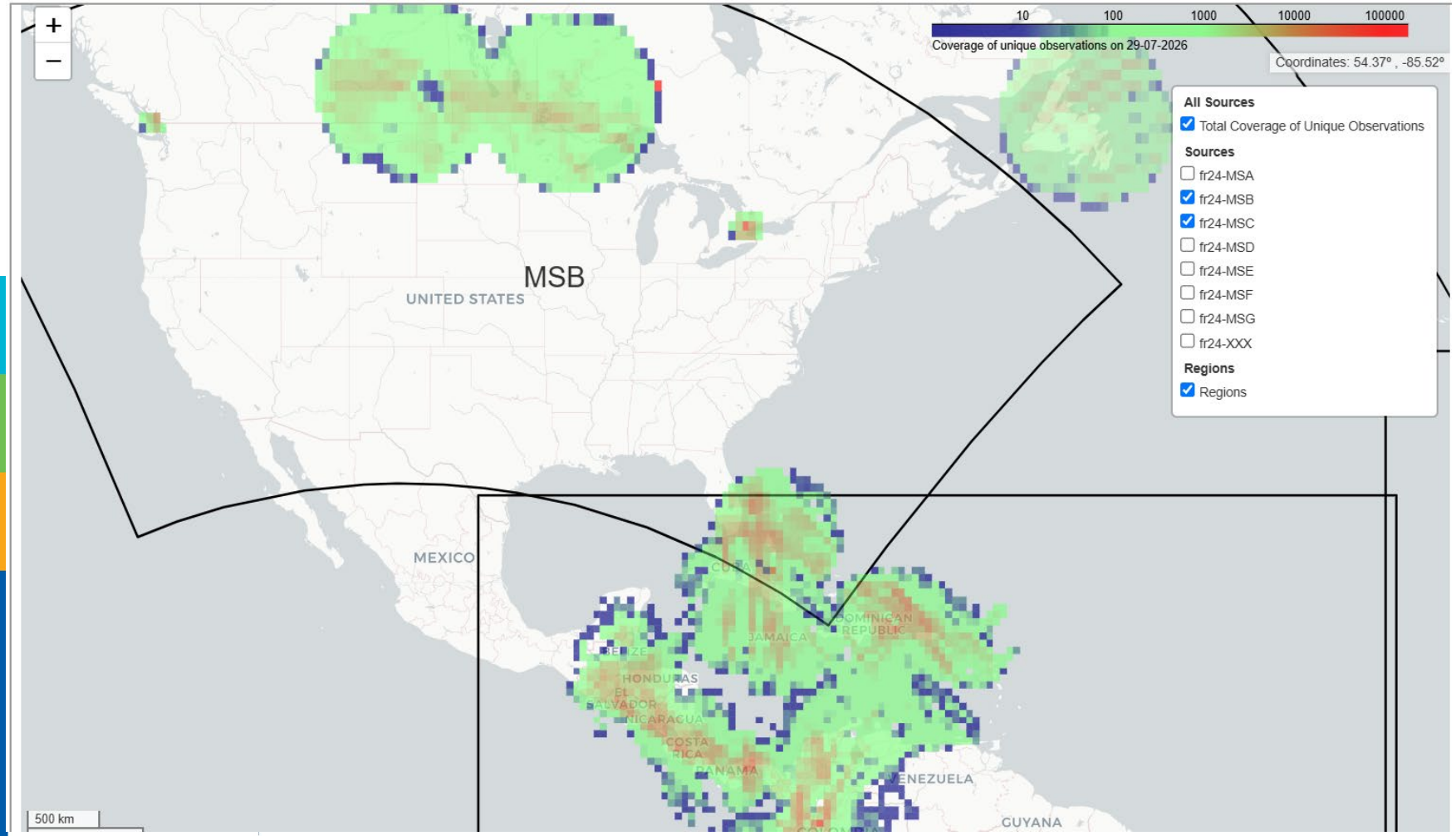


AFIRS coverage (Dec 2025)

Source NOAA/FLYHT

ABO Dataset available for RA IV

- EMADDC/MetOffice/FlighRadar24 data set:



- SSR Mode S EHS is not available in the BNATCS/US. Mexico also is not providing SSR Mode S EHS data,
- Caribbean region is well covered.

ANSPs over RAIV should enable SSR Mode EHS capabilities!

ABO Dataset available for WMO RA IV - ICAO NAM/CAR

- **ACARS-based systems** (US AMDAR) and **ACARS-like systems:** AFIRS/TAMDAR (FLYHT/FTG).
- WIS/GTS messages: **IUAX92 KWBC** bulletins by NOAA (FM94 BUFR)
- MET ADS-C data (US/Canada Airspace) : Coverage over FIRs: CZQX, KZNY.
- Wx-UAS (experimental) in NOAA (US)
- SSR Mode S (MIT-experimental): PADWOS

Data availability:

- US/NOAA MADIS Site: amdar.noaa.gov → Graphical Displays → Public or Restricted
- NOAA/NCEP/MADIS variables: https://madis.ncep.noaa.gov/acars_variable_list.shtml

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Regional Coordination mechanisms

- Currently US is operating the core **Meteorological Data Collection Reporting System** (MCDRS) with: American Airlines, Delta Air Lines, Federal Express (FedEx), Southwest Airlines, United Airlines. United Parcel Service (UPS) y Northwest Airlines (now under Delta).
- **US Water Vapour Programme is composed by 130 B737** with WVSS-ii sensors and 25 within FLYHT/TAMDAR Programme.
- **US NOAA collected in the past data from AeroMexico** (2011-2014) with the participation of CONAGUA.
- US NOAA is looking for resuming data provision from **LATAM Airlines Airlines**. No significant progress with COPA, Avianca, and Caribbean Airlines.

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Recomendations from ABO Community

- **To solve the problem of lack of funding for ACARS-based systems** (AMDAR):
  - AMDAR Onboard Software (development cost)
  - Communication cost (operative costs)
  - Collaboration from targeted airlines
- **To solve the lack of coordination between NMHS and METP/ANSPs/CAAs**
- **ANSP:**
  - to enable SSR Mode EHS (enhanced)
  - to enable ‘MET’ component of ADS-C messages, specially over oceanic areas
  - to encourage large adoption of ADS-B V3 ‘Wx’.
- **CAAs:**
  - To issue operations **BVLOS** certification for wx-UAS
  - To allocate a dedicated airspace for wx-UAS and /or establish SARs for their ops.

More details are available at: **Final report of the WMO Regional Workshop on ABO for the America (Dec 2024)** and the **Final report of the WMO Global Aviation Stakeholders on ABO Meeting**

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Key regional contacts

- **WMO Technical Coordinator on Infrastructure for the Americas**: Dr Daniel Vila – dvila@wmo.int
- **WMO ABO RA IV Focal Point**: Mr Juan Carlos Ramos - juan.ramos@seneam.gob.mx
- **WMO ABO RA III Focal Point**: Mr Hugo Rosado - hrosado@mtc.gob.pe
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Thank you!

Muchas gracias!

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