



# ADS-Wx / Mode S Wx Development Status

Friends and Partners in Aviation Weather  
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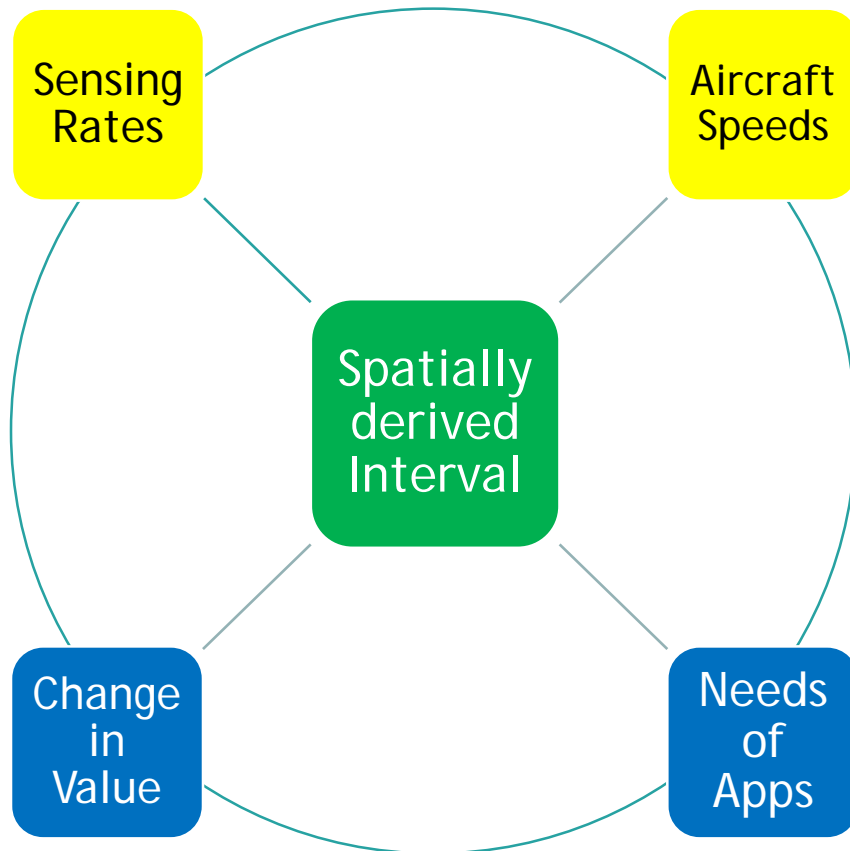
- Purpose:
  - Provide an overview and status on RTCA/ Eurocae Combined Surveillance Committee (CSC) Weather Surveillance Subgroup (WxS SG) activities implementing ADS-Wx / Mode S Wx (Aircraft-based Observations via ADS-B and Mode S)
- Outline
  - RTCA Inter-Special Committee Requirements Agreements (ISRAs)
  - Summary of ADS-Wx / Mode S Wx requirements
  - WxS SG Status and Next Steps
  - Other ADS-Wx / Mode S Wx Considerations

- ISRAs are formal mechanisms RTCA uses to levy requirements developed by one committee on the technology whose standards are developed and maintained by other committees
  - SC-206 is responsible for developing standards for Aeronautical Information and Meteorological Data Link Services
  - SC-186 is responsible for developing standards related to ADS
  - SC-209 is responsible for developing standards related to Mode S and ATCRBS transponders
- After DO-364 was developed, ISRAs were established between SC-206 and SC-186 and SC-209 in CY2016Q4 to:
  - *Establish requirements enabling air-to-air and air-to-ground transfer of Aircraft-based Observation (ABO) meteorological parameters contained in SC-206 MASPS within the MOPS for ADS-B and ATCRBS/MODE S Airborne Equipment.*
  - The RTCA/Eurocae Combined Surveillance Committee (CSC) established the Weather Surveillance Subgroup (WxS SG) to satisfy the ISRAs

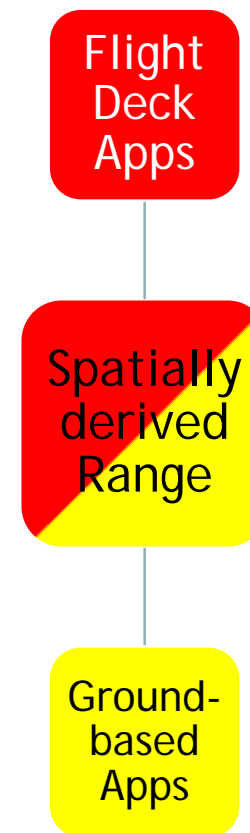
- Identify and resolve ABO reporting requirements & recommendations
  - Primarily driven by SC-206 developed MASPS: DO-364
- Incorporate support provided by existing aircraft sensing and computation and communications (ADS-B and Mode S) requirements
  - As needed, develop parameter derivation requirements
- Develop ADS-B and Mode S message (Out) and report generation (In) requirements
- Incorporate Weather Surveillance as Mode S transponder “Optional Additional Features” similar to Elementary Surveillance and Enhanced Surveillance
- Document and communicate results and status

- Requirements for each ADS-Wx parameter
  - Parameter Range and Resolution
    - Specified by DO-364 and other proposals
    - Verify onboard source and sensing/derivation rates
  - Recommend encoding and register loading requirements
    - Ensure compatibility between data and update rates
  - Update Interval
    - The interval at which the most demanding receiving application requires the parameter to be updated (received)
  - Reception Range
    - The minimum distance between the sending aircraft and the most demanding receiving application (air-air, air-ground)

## Update Interval



## Reception Range



# ADS-Wx / Mode S Wx Met Parameters



Reported Parameter	DO-364	ADS-Wx / Mode S Wx Approach	ADS-Wx / Mode S Wx Approach
Static Air Temperature	Mandatory	Broadcast and Interrogable	Mandatory
Wind Speed	Mandatory	Broadcast and Interrogable	Mandatory
Wind Direction			
Quality Flag			Recommended
Mean & Peak EDR	Required if Equipped	Broadcast and Interrogable	Required if Equipped
Water Vapor	Required if Equipped	Broadcast and Interrogable	Required if Equipped
Icing Status	Optional	Broadcast and Interrogable	Required if Equipped

# ADS-Wx / Mode S Wx Met Parameters



Reported Parameter	Data Range	Data Resolution	Update Interval	Suggested Encoding (see note 2)
Static Air Temperature	+/- 99.9 degrees C	0.1 degree	10 seconds	11 bit Two's Compliment 11 bit ARINC label 213 (512 range @ 0.25 resolution)
Wind Speed	0-255 Knots	1 Knot	Same as position surveillance (3 seconds)	8 bit ARINC Label 315
Wind Direction	0-359 degrees from True	1 degree		9 bit ARINC Label 316 (12 bit)
Quality Flag	0 or 1	Discrete		1 bit, per working paper
Mean & Peak EDR	0.00-0.80 m <sup>2</sup> /3/s	0.01 m <sup>2</sup> /3/s	60 seconds	7 bits
Water Vapor	0-38 g/kg	1*10 <sup>-5</sup>	7.8-23 seconds	12 bits ARINC Label 113 (Humidity, 9 bit)
Icing Status	Discrete	Discrete	60 seconds	5 bits, encoded per working paper Incorporates thresholds for droplet size and ice crystal concentration

## Notes:

1. No reception range requirements for any ADS-Wx / Mode S Wx parameters exceed the reception range requirements for position surveillance.
2. For parameters without existing sensing and communications standards, appropriate methods of providing the data to the ADS-B Transmit Subsystem need to be developed.



# ADS-Wx / Mode S Wx AC Parameters



Reported Parameter	DO-364	ADS-Wx / Mode S Wx Approach	ADS-Wx / Mode S Wx Approach
True Airspeed	Recommended	Broadcast and Interrogable	Required Per DO-260B
Aircraft Type	Recommended	Broadcast and Interrogable	Required
Gross Weight	Recommended	Broadcast and Interrogable	Required
Wingspan	Recommended	Broadcast and Interrogable	Required
A/C Configuration	Recommended	Broadcast and Interrogable	Recommended
Anti-ice	Optional	Broadcast and Interrogable	Recommended

# ADS-Wx / Mode S Wx AC Parameters



Reported Parameter	Data Range	Data Resolution	Update Interval	Suggested Encoding (see note 2)
True Airspeed	Per DO-260B	Per DO-260B	Per DO-260B	Per DO-260B
Aircraft Type	Discrete	Discrete	60 seconds	Per DO-181 (BDS Code 2,5)
Gross Weight	0-1,415,000 lbs	40 lbs	60 seconds	15 bits per ARINC Label 075 (0-1,310,720 lbs) 11 bits by encoding $GW [lbs] = 254 + 40x + 0.32x^2$ Resolution from 41 - 1347 [lbs]
Wingspan	0-400 ft	1 ft	60 seconds	9 bits 7 bits by encoding $Ws [m] = 0 + 0.2x + 0.006x^2$ Resolution from 0.21 - 1.73 [m] (0.68 - 5.68 [ft])
A/C Configuration	Discrete	Discrete	Interrogated	4 bits, encoded per table in working paper
Anti-ice	Discrete	Discrete	60 seconds	4 bits, encoded per table in working paper

## Notes:

1. No reception range requirements for any ADS-Wx / Mode S Wx parameters exceed the reception range requirements for position surveillance.
2. For parameters without existing sensing and communications standards, appropriate methods of providing the data to the ADS-B Transmit Subsystem need to be developed.

# ADS-Wx / Mode S Wx Message Correlation



Reported Parameter	DO-364	ADS-Wx Approach	Mode S Wx Approach
UNIQUE AIRCRAFT IDENTIFIER	Mandatory	Rely on inclusion of ICAO 24-bit address in all Mode S/ ADS messages- use to correlate Mode S/ ADS-Wx parameters across messages	As per ADS-Wx
LATITUDE	Mandatory	Rely on ADS-B Compact Position Report (CPR)	Position interrogation (BDS 5,1 or 5,2)
LONGITUDE	Mandatory		Rely on position relative to interrogator
PRESSURE ALTITUDE	Mandatory	Rely on ADS-B Barometric Altitude	Position interrogation (BDS 5,1 or 5,2) Rely on Mode C reporting
DATE DAY	Mandatory	Rely on receiver report generation function assigned time within 512 second epochs. If application needs longer scale time, it shall provide conversion	As per ADS-Wx
TIME	Mandatory	Rely on receiver report generation function assigned time within 512 second epochs. If application needs longer scale time, it shall provide conversion	As per ADS-Wx
GNSS ALTITUDE	Mandatory	GNSS altitude will be added to Airborne Velocity Message, making it continuously available via ADS-B, in addition to Barometric Altitude	Not interrogable (optional in BDS 5,2)

Note: None of the above parameters will be changed in support of ADS-Wx / Mode S Wx implementation.

# ADS-Wx / Mode S Wx

## Non-Provisioned DO-364 Parameters



Reported Parameter	DO-364	Mode S/ ADS-Wx Approach	Status of Working Paper Development
VALID PARAMETERS INDICATOR	Mandatory	Adopt scheme used to incorporate into ADS messages	No parameter-specific WP needed
WxS MESSAGE VERSION	Mandatory	Don't provision (enforced by TSO compliance)	Initial Draft (Non-provisioning WP) Presented to CSC October 2017 Final Draft delivered to CSC June 2018
DATA COMPRESSION STATE	Mandatory	Don't provision. No communication channel compression provided in ADS or Mode S. Limited data compression provided by bit encoding schema.	
DEPARTURE AIRPORT	Optional	Used by AMDAR to manage message costs- NA for Mode S/ ADS-Wx	
ARRIVAL AIRPORT	Optional	Used by AMDAR to manage message costs- NA for Mode S/ ADS-Wx	
Note: None of the parameters shown above will be implemented in ADS-Wx / Mode S Wx.			

# ADS-Wx / Mode S Wx

## Non-Provisioned DO-364 Parameters



Reported Parameter	DO-364	Mode S/ ADS-Wx Approach	Status of Working Paper Development
STATIC AIR PRESSURE	Mandatory	Don't provision: report ADS-B Barometric Altitude	Initial Draft (Non-provisioning WP) Presented to CSC October 2017 Final Draft delivered to CSC June 2018
FLAP POSITION	Recommended	Don't provision. Evaluation determined that A/C Configuration is sufficient.	
WINDSHEAR AIRSPEED CHANGE	Required if Equipped	To be derived from multiple wind direction and speed reports by interested applications- coordination complete	
TRUE HEADING	Recommended	Eliminated by CSC- WxS SG evaluated impact on WxS applications and alternatives to parameter, no request to implement is planned	

Note: None of the parameters shown above will be implemented in ADS-Wx / Mode S Wx.

WxS SG Next Steps

Other Considerations

# WxS SG STATUS

- Continue ADS-Wx / Mode S Wx development
  - Integrate message set and register requirements
    - Identify any new requirements
  - MOPS verbiage development
  - Develop ADS-B In report generation requirements
- Continue coordination with:
  - Weather community (FAA, NOAA/NWS, AMS, WMO, FPAW);
  - Other standards bodies and regulators (EUROCAE, ICAO, Eurocontrol, FAA); and,
  - Manufacturers and Operators.

- Receipt of ABO by ground systems is not addressed by MOPS
  - Integration into forecast and air traffic systems needs to be planned and implemented, including enabling receipt via ADS-B and/or interrogation via Mode S
- 2020 equipage mandate for ADS-B does not/will not require compliance with 2019 revisions of DO-260 and DO-181



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**QUESTIONS??**

## What constitutes affiliation?

- Employed by a weather interest
- Work to support a weather interest
- Represent a weather interest
- Chair or are members of a weather interest committee or panel
- Are a member of a weather interest
- Other weather interest?  
Please specify.

## Reported Affiliations...

- World Meteorological Organization
- National Meteorology Office/ Weather Service
- ANSP or aviation regulator
- Weather standards development committee
- Weather research organization

# DO-364 WxS Parameters Specifications



Reported Parameter	Unit	Range	Resolution	Reporting Requirement
WxS MESSAGE VERSION	Discrete	NA	NA	Mandatory
VALID PARAMETERS INDICATOR	String (See Note 5)	NA	NA	Mandatory
UNIQUE AIRCRAFT IDENTIFIER	Discrete	NA	NA	Mandatory
DATA COMPRESSION STATE	Discrete	NA	NA	Mandatory
LATITUDE	Degrees, Minutes, Seconds	-90 to 90 (North positive)	1 Second	Mandatory
LONGITUDE	Degrees, Minutes, Seconds	-180 to 180 (East positive)	1 Second	Mandatory
PRESSURE ALTITUDE	Feet in ICAO standard atmosphere	-1000 thru 50175 (See Note 4)	25 or 100 (See Note 5)	Mandatory
DATE DAY	Day of Month	0 thru 31	1 Day	Mandatory
TIME	UTC HH:MM:SS	0 thru 23 hrs: 0 thru 59 mins: 0 thru 60 secs	1 Second	Mandatory
STATIC AIR PRESSURE	hPa (mbar)	100 thru 1051 (See Note 6)	1 hPa (mbar)	Mandatory
STATIC AIR TEMPERATURE	Degrees Celsius	-99 thru 99	0.1 Degree	Mandatory
WIND DIRECTION	Degrees True	0 thru 359	1 Degree	Mandatory
WIND SPEED	Knots	0 thru 400	1 Knot	Mandatory
ROLL ANGLE FLAG	Discrete	Per Roll Angle Flag Table	NA	Mandatory
MEAN EDR	EDR <sup>1/3</sup>	0.00 to 0.80	0.01	Required if Equipped
PEAK EDR	EDR <sup>1/3</sup>	0.00 to 0.80	0.01	Required if Equipped
WATER VAPOR	Mixing ratio kg/kg	0 to 38 g/kg	1x10 <sup>-6</sup> kg/kg	Required if Equipped
WINDSHEAR AIRSPEED CHANGE	Knots	-100 thru 100	1 Knot	Required if Equipped
TRUE AIRSPEED	Knots	0 thru 800	1 Knot	Recommended
AIRCRAFT TYPE	ICAO Type or Emitter Category	NA	NA	Recommended
GROSS WEIGHT (Note 2)	Pounds	0 thru 1415000	40 Pounds	Recommended
WINGSPAN	Feet	0 to 400	1 Foot	Recommended
FLAP POSITION	Degrees	0-50	1 Degree	Recommended
A/C CONFIGURATION	Discrete	Per Aircraft Configuration Indicator Table	NA	Recommended
TRUE HEADING	Degrees	0 thru 359	1 Degree	Recommended
ICING STATUS (Note 3)	Discrete	NA	NA	Optional
DEPARTURE AIRPORT	Character	NA	NA	Optional
ARRIVAL AIRPORT	Character	NA	NA	Optional
GNSS ALTITUDE	Feet in HAE	-1000 thru 50174 (See Note 4)	25 or 100 (See Note 5)	Optional
ANTI-ICE	Discrete	NA	NA	Optional

Participant	Organization
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Jörg Steinleitner	Eurocontrol
Edward Johnson, Tammy Flowe, Chris Tourigny	FAA
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