



ADS-B Weather Development Status Update

Friends and Partners in Aviation Weather
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- Using aircraft as weather observation platforms has a long history, beginning with Pilot Reports (PIREPs) and continuing into automated Aircraft Reports (AIREPs)
- ADS-B Weather (ADS-B Wx) is specified as an optional feature of ADS-B Version 3 (V3)
 - ADS-B Wx AIREP enables fully-automated, routine broadcast of meteorological and other data sensed or derived onboard aircraft
 - ADS-B Wx PIREP enables on-condition broadcast of pilot-observed weather data
- ADS-B ground receiver network is operating and updates are planned for reception and distribution of ADS-B V3 messages
 - No mandate for ADS-B V3 aircraft equipage is planned

ADS-B Wx AIREP Parameters: By Message



- ADS-B devices that support the optional ADS-B Wx AIREP capability support the Aircraft State, Weather State, and Alternate Weather State Messages, and the weather subfields in the Emergency/Priority Status and Mode A Code Message
 - If Wind Speed or Wind Direction are unavailable or invalid, as dynamically determined, the Alternate Weather State Message is broadcast in lieu of the Weather State Message
- Transponder-based devices that support the optional Enhanced Surveillance (EHS) capability (and not the optional ADS-B Wx AIREP capability) support the Alternate Weather State Message only.

Weather State Message 2.2 [s] Broadcast Interval	OR	Alternate Weather State Message 2.2 [s] Broadcast Interval	Emergency/Priority Status and Mode A Code Message 5.0 [s] Broadcast interval	Aircraft State Message 5.0 [s] Broadcast Interval
Icing Status	Got Wind?	Icing Status (optional for EHS)	Mean EDR	Aircraft Configuration
Wind Quality Indicator		Roll Angle	Peak EDR	Aircraft Type
Wind Speed		Heading	Peak EDR Offset	Gross Weight
Wind Direction		Air Temperature	Water Vapor	Wingspan
Air Temperature		Airspeed		
Airspeed				

ADS-B Wx PIREP Parameters: By Message



Flight Weather Message On-condition Broadcast	Temp, Wind & Turbulence Message On-condition Broadcast	Hazardous Weather Message On-condition Broadcast
PIREP Time	PIREP Air Temperature	PIREP Icing
Flight Visibility	PIREP Air Temperature Type	Airspeed Change
Flight Weather 1	PIREP Wind Direction	Wind Shear Height
Flight Weather 2	PIREP Wind Speed	Braking Action
Flight Weather 3	Turbulence Duration	Runway Number
Layer 'A' Height	Turbulence Intensity	Runway Position
Layer 'A' Thickness	Turbulence Location	Layer 'C' Height
Layer 'A' Height Type	Layer 'B' Height	Layer 'C' Thickness
Layer 'A' Coverage	Layer 'B' Thickness	Layer 'C' Height Type
	Layer 'B' Height Type	Layer 'C' Coverage
	Layer 'B' Coverage	Flight Weather 1 Vicinity Direction
		Flight Weather 2 Vicinity Direction
		Turbulence Type

- ADS-B Wx PIREP messages transmit the data required to correlate observations in space and time and encode PIREPs using ground-based processing
- Air-to-air reception of PIREP Messages doesn't permit 4D correlation of data

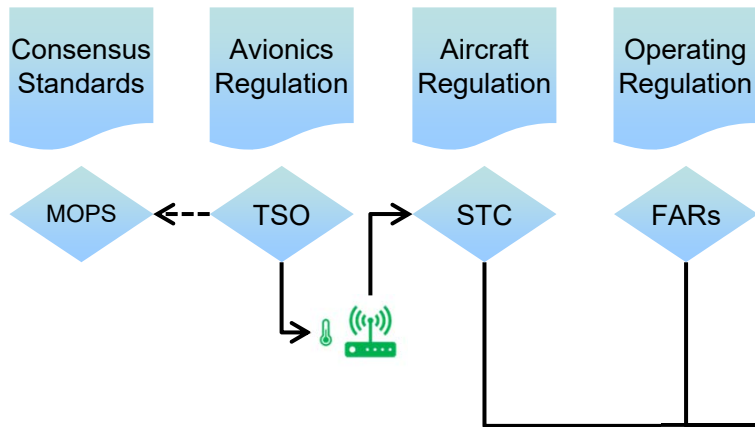
- Air Traffic
 - Routine weather surveillance ^{1,2} and hazardous weather detection and avoidance ^{1,2}
 - Interval management ^{1,2}
 - Traffic awareness ²
- Wake Turbulence
 - Hazardous wake avoidance in en route and terminal airspace ^{1,2}
 - Wake surfing ²
 - Wake Encounter Reporting (with ADS-B PIREP)
- Weather Forecasting ¹
 - Rapid-update observations enable rapid-update forecasts
 - Forecast validation
 - Forecast skill improvements
 - NWP model performance improvements
 - Improved hazardous weather detection and prediction
 - Forecast feature-size reductions, e.g. icing, turbulence

¹ Ground-based

² Flight Deck-based

- ADS-B Wx AIREP and PIREP are each specified as an optional feature in the 1090ES ADS-B MOPS
- ADS-B Wx AIREP Messages will only be implemented by manufacturers choosing to offer the AIREP feature
 - External systems supply AIREP data and the MOPS applies only to ADS-B systems. Therefore, only AIREP input recommendations are provided in the MOPS. Interface definition work is underway.
- ADS-B Wx PIREP Messages will only be implemented by manufacturers choosing to offer the PIREP feature
 - No PIREP data entry interface is specified in the MOPS. An external interface is anticipated for PIREP data entry by pilots.

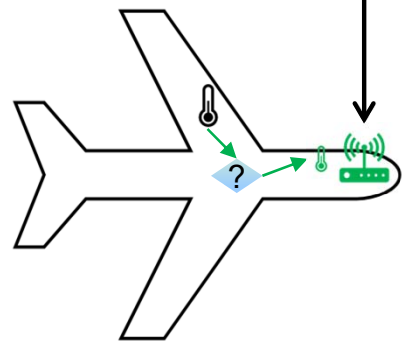
Getting to Signal-in-Space



Regulators will invoke the ADS-B V3 MOPS in TSO and could specify ADS-B Wx AIREP and/or PIREP as required functions.

Operating regulations could require operators to equip, and could let them choose which ADS-B Wx inputs to connect .

ADS-B Wx AIREP and PIREP are specified as optional features in the MOPS.



ADS-B Wx is enabled on the basis of standards, regulations, and the interests of operators.

1. Should AIREP and/or PIREP be required by TSO?
2. Should AIREP be mandated for entry into ADS-B airspace?
 - a. For available information from installed systems, e.g. pressure, temperature, wind?
 - b. For all AIREP data, including those requiring specialized equipment, e.g. EDR and Water Vapor?

- ADS-B V3 standard to be published in December 2020. Messages could be available from avionics in 2022.
 - Ground receipt and distribution planning for ADS-B Wx (AIREP & PIREP) information will require continued coordination with users to maximize benefits
- Integration into user systems needs to be planned and implemented
 - AIREP Message handling and data dissemination
 - PIREP Message handling and PIREP Encoding

- Continue ADS-B Wx development (AIREP and PIREP)
 - Plan and prepare to receive ADS-B Wx Messages
- Continue coordination with:
 - Weather community (FAA, NWS, AWC, WMO, FPAW, others)
 - Other standards bodies and regulators (RTCA, EUROCAE, ICAO, Eurocontrol, FAA, SAE, others)
 - Manufacturers and Operators
- Harmonize UAT ADS-B with 1090ES ADS-B Standards

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QUESTIONS

Encoded PIREP creation from ADS-B Wx PIREP Messages



Item	Element (Code)	Contents	ADS-B Wx PIREP Message Source
1	3-letter station identifier (XXX)	Nearest weather reporting location to the reported phenomenon	Assigned by ground-based data processing
2	Report type (/UA UUA)	Routine or Urgent PIREP	
3	Location (/OV)	Lat/Long, or in relation to a VOR	Determined on ground from Track, based on Time
5	Altitude (/FL)	Essential for turbulence and icing reports	
4	Time (/TM)	Coordinated Universal Time	Translated on ground from PIREP Time in Flight Weather Message
6	Type Aircraft (/TP)	Essential for turbulence and icing report interpretation	Direct: ADS-B Wx AIREP Aircraft State Message Indirect: ICAO 24-Bit Address, Flight Plan, Aircraft Registration
7	Sky cover (/SK)	Cloud height and coverage (sky clear, few, scattered, broken, or overcast)	Flight Weather Message
8	Weather (/WX)	Flight visibility, precipitation, restrictions to visibility, etc.	Flight Weather Message
9	Temperature (/TA)	Degrees Celsius	Temp, Wind & Turbulence Message
10	Wind (/WV)	Direction in degrees magnetic north and speed in knots	Temp, Wind & Turbulence Message
11	Turbulence (/TB)	Intensity, Duration, Location, Type	Temp, Wind & Turbulence Message
12	Icing (/IC)	Type and Intensity	Hazardous Weather Message
13	Remarks (/RM)	For reporting elements not included or to clarify previously reported items	Required Condition Remarks, Wind Shear, Braking Action, Mountain Wave Encounter, Volcanic Odor

ADS-B Wx AIREP Impacts

- More accurate, more precise weather forecasts
- More rapid, more accurate weather awareness
- Improved avoidance of hazardous weather

ADS-B Wx PIREP Impacts

- More PIREPs with fewer errors
- ATC/FSS-independent, fully automated:
 - PIREP data submission
 - PIREP encoding
- Continued PIREP dissemination via existing networks
- AIREP impacts where PIREPs are submitted