



# FIS-B NEW PRODUCTS

---

PAUL FREEMAN

To Friends & Partners in Aviation Weather, July 18, 2018

[HARRIS.COM](http://HARRIS.COM) | [#HARRISCORP](https://twitter.com/HARRISCORP)

**HARRIS**<sup>®</sup> TECHNOLOGY TO CONNECT,  
INFORM AND PROTECT<sup>™</sup>

- **SBS background**
- **Current FIS-B products**
- **New FIS-B products**

# SBS background

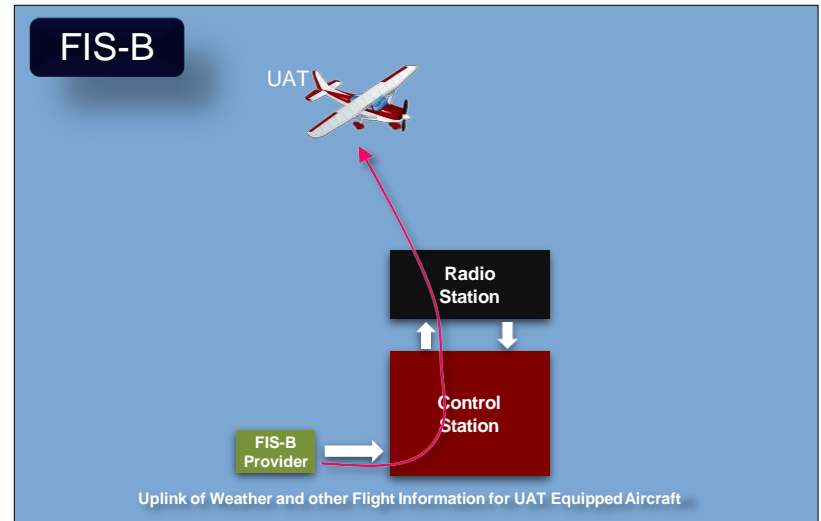
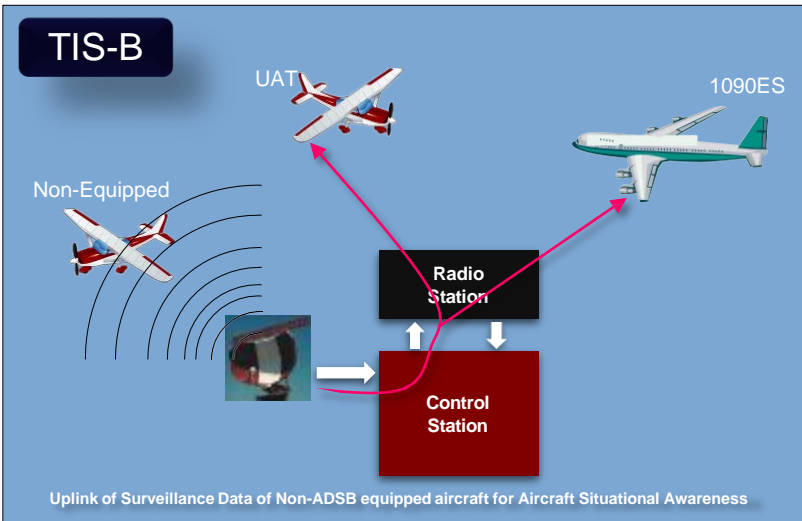
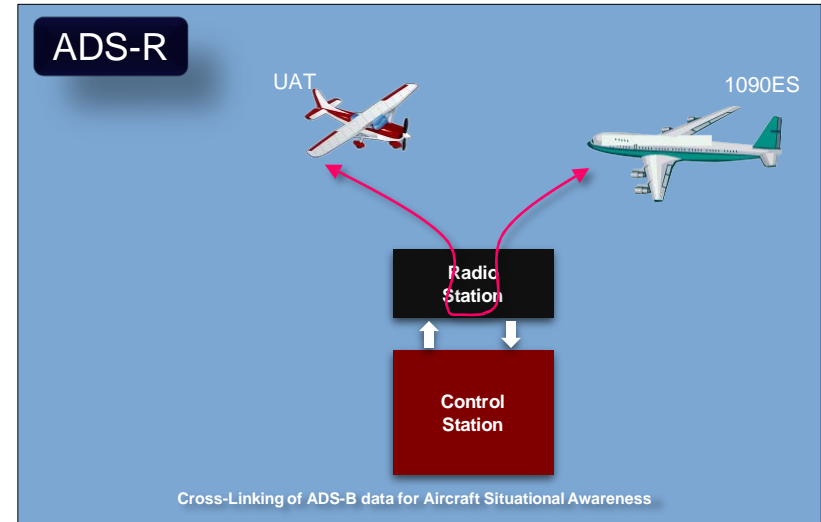
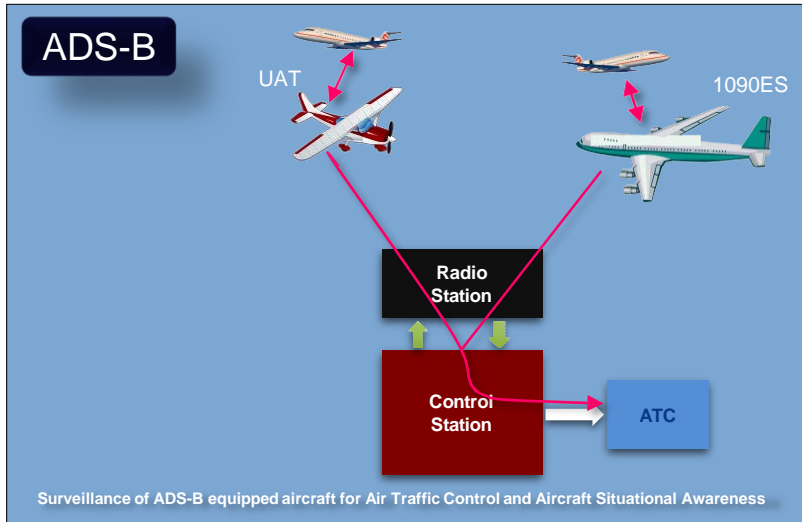
## **The Surveillance & Broadcasts Services (SBS) program:**

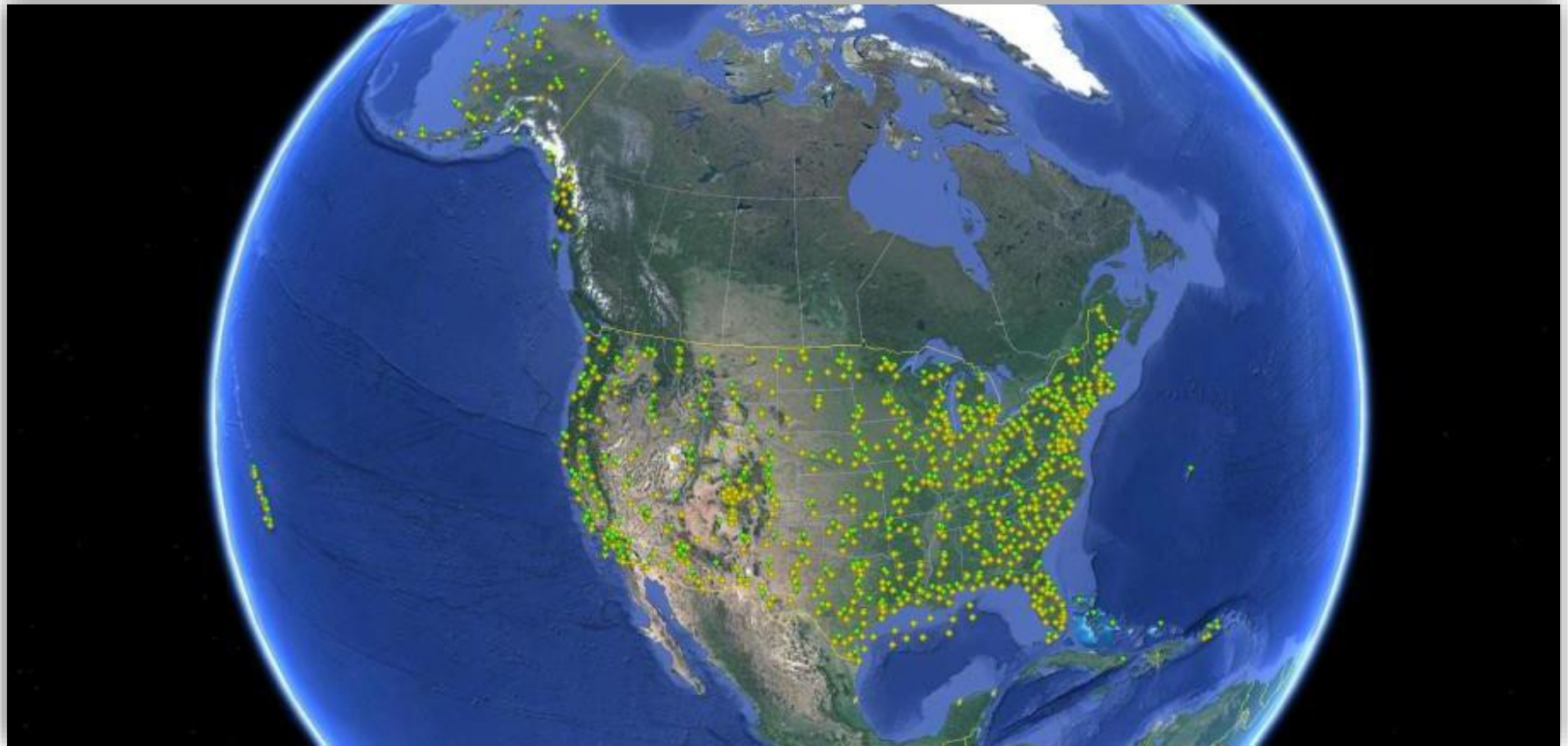
- Awarded 8/30/07, extending over 18 years
- Subscription Service contract to provide SBS services in FAA-defined Service Volumes
- Harris designed, developed, installed and operates the network
- System has passed FAA safety case
- System has achieved security accreditation through independent audit from FAA security office

## **SBS Benefits**

- Significantly more accurate surveillance
- At significantly lower cost
- Common situational awareness picture to Air Traffic Control, Pilots, Airlines/Airports, and other stakeholders – improved safety & efficiency

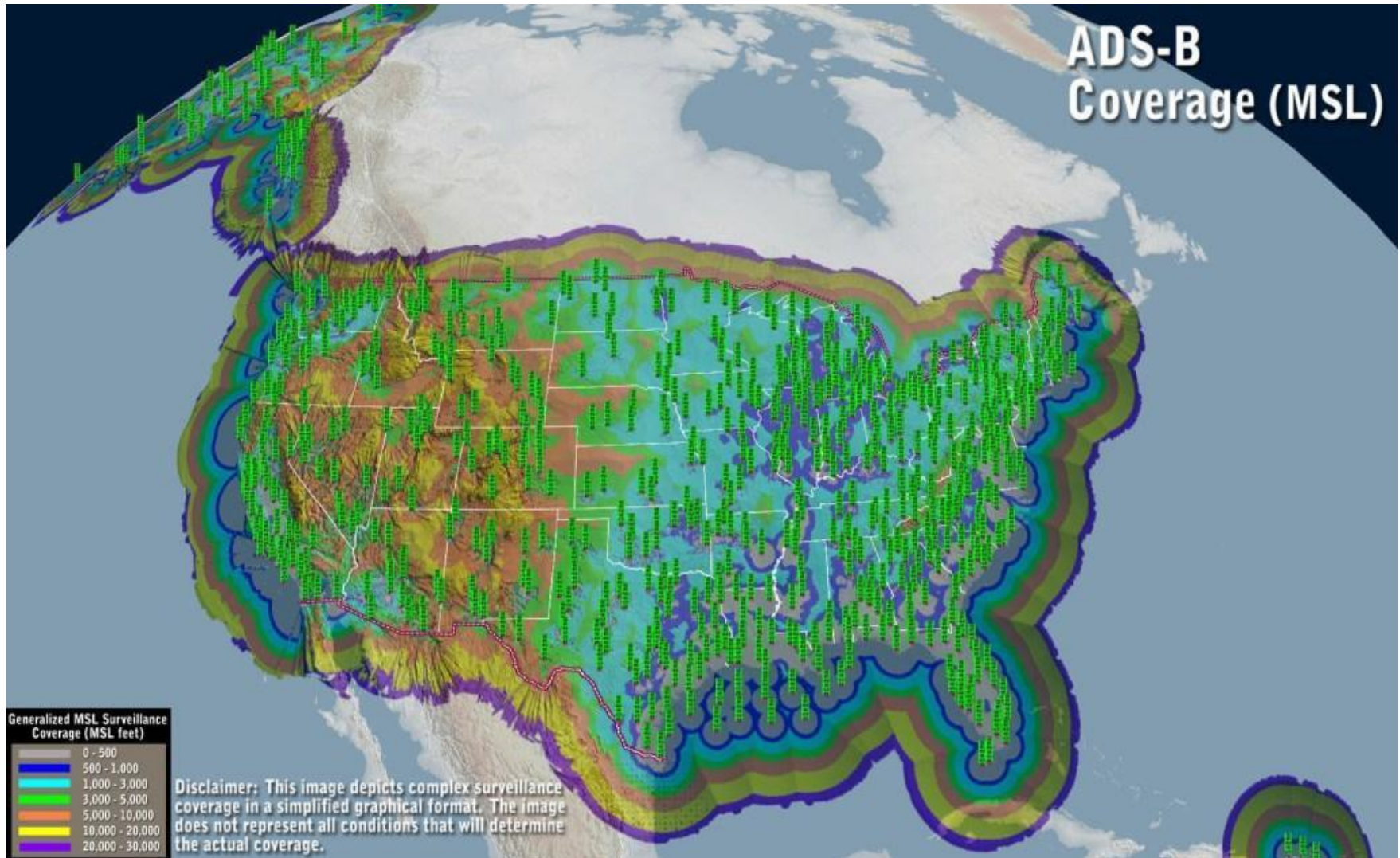
# Four Original SBS Services



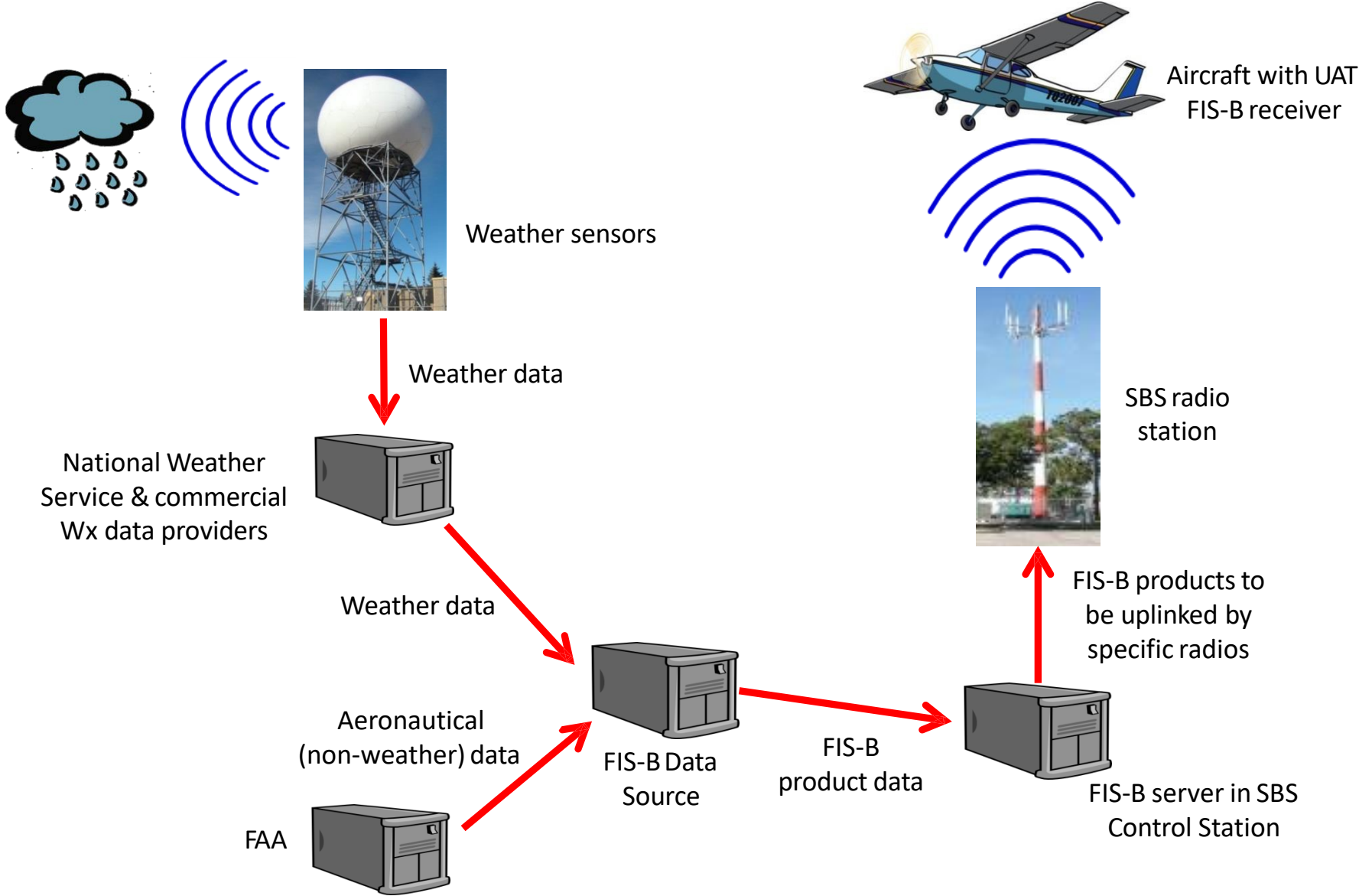


**Harris operates the largest air traffic control surveillance network in the world.**

Harris' SBS sensor network combines data from 650+ Harris SBS radio sites, 425+ FAA radar systems, and 36 ASDE-X/ASSC Systems. This totals 1,110+ air traffic surveillance sensors on our NextGen surveillance data network.



# FIS-B Data Flow





Avionics capable of receiving & displaying FIS-B products range from certified / panel-mounted units through non-certified / portable units costing only a few hundred dollars.



Source: [https://www.faa.gov/nextgen/equipadsb/ins\\_and\\_outs/](https://www.faa.gov/nextgen/equipadsb/ins_and_outs/)

# Current FIS-B products

# Current FIS-B Products: Text Products



<b>Product</b>	<b>Description</b>	<b>Update Interval</b>	<b>Transmission Interval</b>
METAR	Aviation Routine Weather Report	1 minute (where available), as available otherwise	5 minutes
SPECI METAR	Unscheduled Special Weather Report		
PIREP	Pilot Reports	As available	10 minutes
TAF	Terminal Aeronautical Forecast	8 Hours	
TAF AMEND	Amended Terminal Aeronautical Forecast		
Wind & Temperature Aloft	Forecast of winds & temperatures aloft	12 Hours	

# Current FIS-B Products: Text/Graphic Products



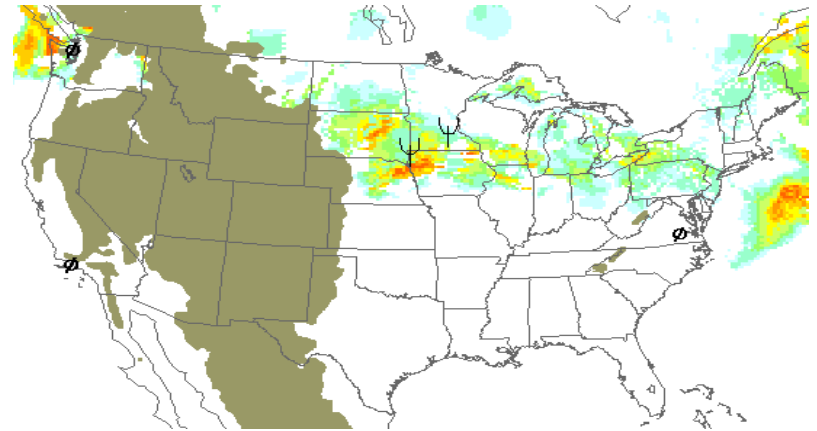
Product	Description	Update Interval	Transmission Interval
AIRMET	Airman's Meteorological Information: mountain obscuration, icing, or turbulence	As available	5 minutes
Convective SIGMET	Convective Significant Meteorological Information: severe, extensive, or prolonged thunderstorm	As available, then @ 15 minute intervals for 1 hour	
SIGMET	Significant Meteorological Information: turbulence, icing, or IMC conditions.		
NOTAM-D	Distant Notice To Airmen: Information requires wide dissemination	As available	10 minutes
NOTAM-FDC	Flight Data Center Notice To Airmen: Information that is regulatory		
SUA Status	Special Use Airspace status		

<b>Product</b>	<b>Description</b>	<b>Update Interval</b>	<b>Transmission Interval</b>
CONUS NEXRAD	Contiguous U.S. Next Generation Radar	~5 minutes (10 minutes for clear air mode)	15 minutes
Regional NEXRAD	Regional Next Generation Radar	~5 minutes (10 minutes for clear air mode)	2.5 minutes

# New FIS-B products

## Harris is adding 6 additional products to FIS-B by the end of 2018:

- Lightning
- Turbulence
- Icing
- Cloud Tops
- Center Weather Advisory (CWA)
- Graphical AIRMET (G-AIRMET)



## The FAA has indicated that an additional 2 FIS-B products will be put under contract in 2018, for implementation in 2019:

- Temporary Restricted Area (TRA)
- Temporary Military Operating Area (TMOA)

- The Lightning product provides locations of recent lightning flashes.
- Observation Product
- Vaisala lightning data is available only in CONUS.
  - FIS-B will provide Lightning product only in CONUS (not in Alaska, Hawaii, Guam, or Puerto Rico).
- Lightning product received from Vaisala is Cloud to Ground

Product Registry ID:	103: Global Block Representation; Run length encoding 4/1/3, 8 levels
Data sent from HWDS:	Full CONUS lightning @ a 2 km resolution
Rate product received from HWDS:	5 minutes
Look-ahead range:	250/200/150 NM for High/Medium/Low tier
Transmission Interval:	5 minutes



- RLE 4/1/3
  - 3 fields (number of bins, polarity and strike count)
  - If ANY strike in bin is positive, then positive polarity; ALL strikes within bin has to be negative for negative polarity
  - Run length determined on Strike Count only
    - If ANY bin in run is positive, then positive polarity encoded; ALL bins in run has to be negative for negative polarity
  - When an entire Block is void of lightning strikes, block is sent with Empty Element Encoding
- “NO DATA” indicated by ‘111’ in FIS-B uplink

- 1x1.5 minutes bin size, which is the same as Regional NEXRAD
- FIS-B will complete uplink within 2 minutes of update epoch
- Block Reference Indicator
  - N/S & Scale bits will be redefined as “Product Specific Bits”
  - But for Lightning, those “Product Specific Bits” will refer to N/S & Scaling
    - N/S set to 0 for northern hemisphere
    - Scale bits set to 00 for 1x scaling (1x1.5 minutes)

# Cloud Top - Summary



- The Cloud Tops product provides altitude of cloud tops
- Forecast Product
- FIS-B Data Source (HWDS) will receive cloud top data from NWS High Resolution Rapid Refresh Model (HRRR)
- HRRR product is available only in CONUS.
  - FIS-B will provide Cloud Tops product only in CONUS (not in Alaska, Hawaii, Guam, or Puerto Rico).

Product Registry ID:	84: Global Block Representation; Run length encoding #1 from MASPS
Data sent from HWDS:	Full CONUS cloud tops @ a 2 km resolution
Rate product received from HWDS:	Hourly
Look-ahead range:	250/200/150 NM for High/Medium/Low tier
Transmission Interval:	15 minutes

## HRRR Cloud Top

- Domain
  - CONUS, Lambert Conformal, 3 km
- Product
  - HRRR height @ top of clouds
  - HRRR cloud amount product
- Frequency
  - Model is run on an hourly basis by HRRR
  - Based on data received so far, HWDS has set up a collection window corresponding to HH:10 to (HH+1):10
- Forecast Hour
  - 01h, 02h
- Levels
  - Cloud top
- Units
  - Meters MSL

- HWDS receives Cloud Amount & Cloud Top products
- Sends to FIS-B Server cloud top altitudes for a pixel, which is a cell on the map (2km x 2km)
- Cloud Amount product necessary because:
  - Cloud Top bitmap indicates presence or absence of data
  - In the absence of data, then grid point (pixel) is not sent in GRIB data
  - In cloud top product of HRRR, this method is used both for grid points that are outside of model's geographic domain & for grid points that are clear skies (i.e., no tops)
  - In order to distinguish the difference, HRRR cloud amount product is used
    - If cloud amount product indicates zero, then the omitted grid points of cloud top product is clear
    - If cloud amount product indicates an omitted grid point, then cloud top product indicates that point is outside of model's domain
- Whenever Cloud Amount or Cloud Top product is not available, HWDS counts that as an update not being received for setting Product Status

- RLE Method 1
- When an entire Block has no clouds, block is sent with Empty Element Encoding
- “NO DATA” indicated by ‘1111’ in FIS-B uplink
- 1x1.5 minutes bin size, which is the same as Regional NEXRAD
- Block Reference Indicator
  - N/S & Scale bits will be redefined as “Product Specific Bits”
  - But for Cloud Tops, those “Product Specific Bits” will refer to N/S & Scaling
    - N/S set to 0 for northern hemisphere
    - Scale bits set to 00 for 1x scaling (1x1.5 minutes)

# Icing – Background



- The Icing product provides Icing Probability, Icing Severity along with presence of Supercooled Large Droplet formation @ 12 altitude levels.
- The FIS-B Data Source will receive icing data from NWS Forecast Icing Potential products.
- FIP product is available only in CONUS.
  - FIS-B will provide Icing product only in CONUS (not in Alaska, Hawaii, Guam, or Puerto Rico).

Product Registry ID:	70 & 71: Global Block Representation; 5X scaling
Data sent from HWDS:	Full CONUS Icing @ a 2 km resolution
Rate product received from HWDS:	Hourly
Look-ahead range:	250/200/150 NM for High/Medium/Low tier
Transmission Interval:	15 minutes

## Forecast Icing Potential (FIP)

- Domain
  - CONUS, Lambert Conformal, 13 km
- Products
  - Icing Probability (prod #233)
  - Icing Severity (prod #234)
  - SLD (prod #217)
- Frequency
  - FIP Model is run on an hourly basis
  - Based on data received so far, HWDS has set up a collection window corresponding to HH:15 to (HH+1):15
- Forecast Hours
  - Icing Probability: 01h, 02h
  - Icing Severity: 01h, 02h
  - SLD: 01h, 02h
- Levels (ft MSL)
  - 2000, 4000, 6000, 8000, 10000, 12000, 14000, 16000, 18000, 20000, 22000, 24000
- Units
  - SLD: unit less (likelihood/potential of SLD)
  - Icing severity: 0=None, 1=Light, 2=Moderate, 3=Severe, 4=Trace, 5=Heavy
  - Icing Probability: probability of icing (0-100%)



- HWDS uses Forecast Hour 01 & 02
- HWDS uses Icing Probability, Icing Severity and SLD products
- HWDS encodes per altitude the values for Icing Probability, Icing Severity and SLD & sends to FIS-B Server

- Run length determined on Icing Probability value
  - When Icing Probability is No Data, Icing Severity and SLD will be encoded as No Data
  - Icing Severity priority scheme per encoding on previous slide is 7,5,4,3,2,1,0
    - Any NO DATA Icing Severity value within a run supersedes other values of Icing Severity within that run
  - SLD priority scheme per encoding on previous slide is 3,2,1,0
    - Any NO DATA SLD value within a run supersedes other values of SLD within that run

- 5x7.5 minutes bin size, which is the same as CONUS NEXRAD
- Twelve altitude levels: 2000, 4000, 6000, 8000, 10000, 12000, 14000, 16000, 18000, 20000, 22000, 24000ft
- Block Reference Indicator
  - N/S & Scale bits redefined as “Product Specific Bits”
  - Based on altitude level, there will be an Icing-High & an Icing-Low product (2 different Product IDs)
    - APDU Header for Icing-High products & Icing-Low products are different because of 2 different Product IDs
    - Product ID 70 (Icing-Low) corresponds to altitudes of 2000, 4000, 6000, 8000, 10000, 12000, 14000, 16000ft and Product ID 71 (Icing-High) to the rest

- Turbulence product provides maximum intensity of turbulence.
- FIS-B Data Source will receive turbulence data from the NWS Graphical Turbulence Guidance product.
- GTG product is available only in CONUS.
  - FIS-B will provide Turbulence product only in CONUS (not in Alaska, Hawaii, Guam, or Puerto Rico).

Product Registry ID:	90 & 91: Global Block Representation; RLE Method 1; 5X scaling
Data sent from HWDS:	Full CONUS Turbulence @ a 2 km resolution
Rate product received from HWDS:	Hourly
Look-ahead range:	250/200/150 NM for High/Medium/Low tier
Transmission Interval:	15 minutes

## Graphical Turbulence Guidance (GTG)

- Domain
  - CONUS, Lambert Conformal, 13 km
- Products
  - Clear air turbulence (prod #22)
  - Mountain wave turbulence (prod # 29)
- Frequency
  - GTG Model is run on an hourly basis
  - Based on data received so far, HWDS has set up a collection window corresponding to HH:18 to (HH+1):18
- Forecast Hour
  - 01h, 02h
- Levels (ft MSL)
  - 2000, 4000, 6000, 8000, 10000, 12000, 14000, 16000, 18000, 20000, 22000, 24000
- Units
  - GTG “is scaled to eddy dissipation rate (EDR) ( $=\epsilon^{1/3}$ , where  $\epsilon$  is energy dissipation rate in units of  $m^2/s^3$ ) instead of previous 0-1 scale. It turns out that for representative values of EDR, output is also on a 0-1 scale so there is no difference in appearance of the ... graphics.”

- HWDS receives Mountain Wave & Clear Air Turbulence Products from GTG, with EDR values in 0-1 scale
- HWDS uses worse-case EDR value (higher value) of MWT & CAT grids to create a composite grid
  - This process is followed for each altitude grid (e.g. 2000ft, 4000ft, etc)
  - If for a grid point, CAT value is .158 & the MWT value is .167, the .167 value is used
  - If a grid point for either grid has a value of “NO DATA”, “NO DATA” value is used
- HWDS multiplies received EDR value by 100 to get the EDR\*100 scale
  - HWDS sends integer values to FIS-B
  - HWDS uses ceiling value instead of rounding
    - For example, if EDR is .232, the EDR \*100 value is 23.2, the value sent to the FIS-B Server will be 24
- If either of MWT & CAT for a specific altitude is absent, HWDS counts this as an update not being received for setting Product Status

- RLE Method 1
- When an entire Block is encoded as 0, block is sent with Empty Element Encoding
- “NO DATA” indicated by ‘1111’ in FIS-B uplink
- 5x7.5 minutes bin size, which is the same as CONUS NEXRAD
- 12 altitude levels: 2000, 4000, 6000, 8000, 10000, 12000, 14000, 16000, 18000, 20000, 22000, 24000ft
- Block Reference Indicator
  - N/S & Scale bits will be redefined as “Product Specific Bits”
  - Based on altitude level, there will be a Turbulence-High & a Turbulence-Low product (2 different Product IDs)
    - APDU Header for Turbulence-High products & Turbulence-Low products are different because of 2 different Product IDs
    - Product ID 90 (Turbulence-Low) corresponds to altitudes of 2000, 4000, 6000, 8000, 10000, 12000, 14000, 16000ft and Product ID 91(Turbulence-High) to the rest

- A graphical advisory of weather that may be hazardous to aircraft, but are less severe than SIGMETs.
- Only valid @ specific time "snapshots"
- Issued @ 02:45, 08:45, 14:45 and 20:45 UTC (with updates issued as necessary).
- G-AIRMETs are issued by AWC for lower 48 states & adjacent coastal waters.
- Greater spatial & temporal resolution than current AIRMET
  - 3-hour snap shots instead of a 6-hour time smear

Parameter	Value	
Update interval	As Available	
Transmission interval	5 minutes	
Product type	Text/graphical overlay	
Product ID	14	
Product look-ahead range (NM)	500	High-Tier radios
	375	Medium-Tier radios
	250	Low-Tier radios

Product Look-ahead does not apply to Freezing Level since they are provided to all radios.



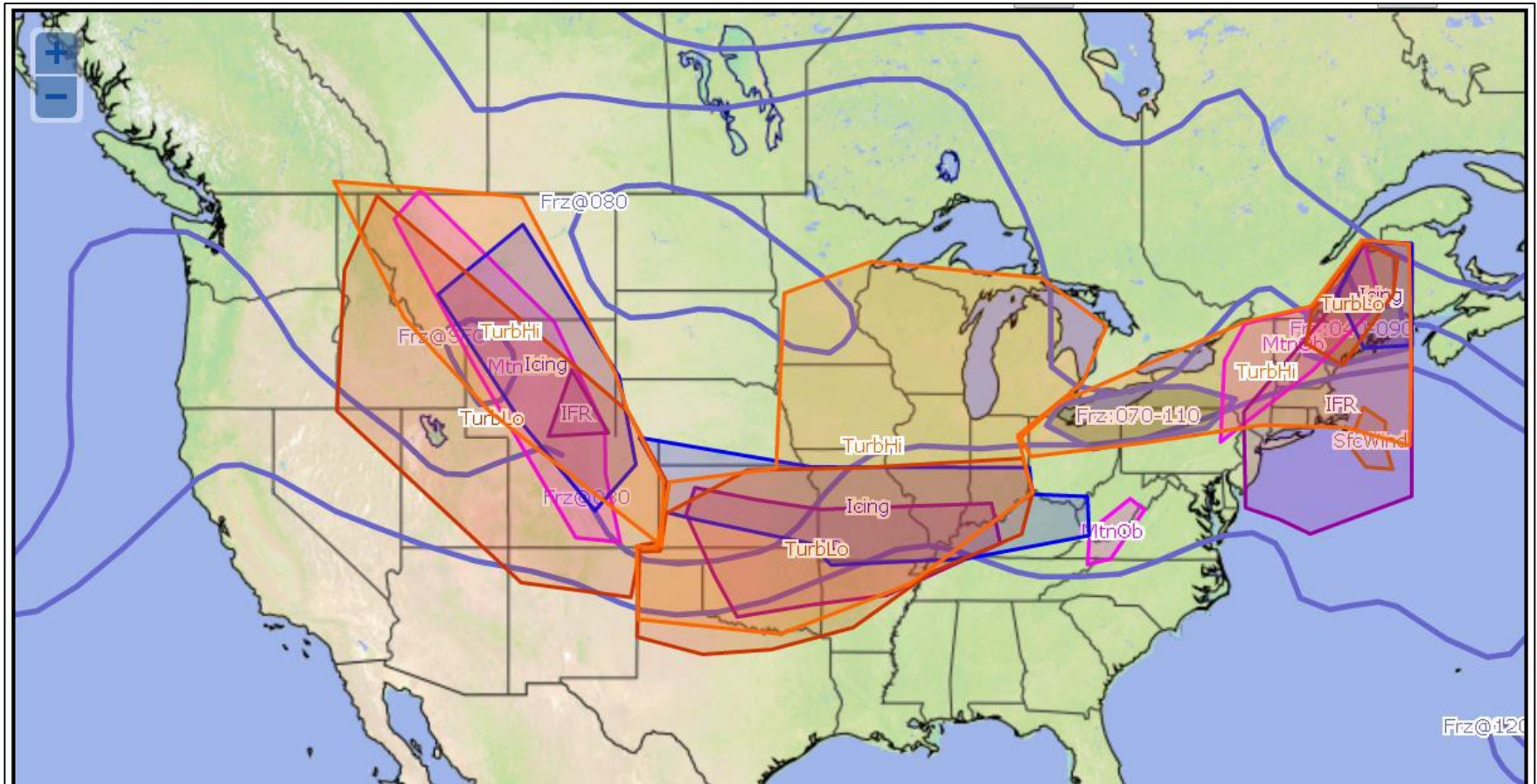
- Domain
  - CONUS
- Product
  - Graphical AIRMET
- Frequency
  - Forecasts are available 4 times / day (0245z, 0845z, 1445z, and 2045z)
    - This is the regular issuance
  - Amendments & Corrections can be sent any time between the regular issuance
    - For Amendments & Corrections, only G-AIRMETs within given G-AIRMET type are re-issued
- Forecast Hour
  - 00h, 03h, 06h, 09h, 12h

# Graphical AIRMET – Hazards Depicted



Condition	Description
Turbulence (TANGO)	Areas of moderate turbulence, other than convectively induced, including vertical extent.
Low Level Wind Shear (TANGO)	<ul style="list-style-type: none"> <li>wind shear below 2,000' AGL, other than convectively induced, resulting in an air speed loss or gain of 20 knots or more</li> <li>LLWS potential information is included after AIRMETs for moderate turbulence and/or sustained surface winds greater than 30 knots or statements indicating no significant turbulence is expected</li> </ul>
Strong Surface Winds (TANGO)	Areas of sustained surface winds greater than 30 knots. In received data, this value is actually 29.1 knots.
Icing (ZULU)	Areas of moderate airframe icing, other than convectively induced, including the areal extent.
Freezing Level (ZULU)	<ul style="list-style-type: none"> <li>Lowest freezing level above the ground or @ the SFC as appropriate</li> <li>Included after AIRMETs for moderate icing or statements indicating that no significant icing is expected.</li> <li>Freezing levels above ground are delineated @ 4,000' intervals AMSL</li> <li>Range of freezing levels across forecast area is also included.</li> </ul>
IFR (SIERRA)	<ul style="list-style-type: none"> <li>Areas of cloud ceilings with bases less than 1,000' AGL &amp;/or areas of surface visibilities below 3 statute miles, including weather causing visibility restriction.</li> <li>Cause of visibility restriction includes only PCPN, FU, HZ, BR, FG, and/or BLSN.</li> </ul>
Mountain Obscuration (SIERRA)	<ul style="list-style-type: none"> <li>Areas of widespread mountain obscuration where VMC cannot be maintained, including Wx causing the obscuration.</li> <li>The Wx causing obscuration includes only CLDS, PCPN, FU, HZ, BR, and/or FG.</li> </ul>

# Graphical AIRMET – Data Depiction Example



Criteria	
Data source upstream of HWDS:	Generated by AWC; received via NOAAPort
Processing performed @ HWDS:	BUFR file converted to XML
Format sent to FIS-B:	XML
Data Structure:	Polygonal area and/or open lines over range of vertical levels. Vertical levels can be FL###, MSL###, AGL### in 100's of feet or special value SFC. Categorized by phenomenon & type.
Valid period:	Valid over a range of time.
Frequency:	Issued by AWC approximately every six hours, with amendments and/or corrections between regular issuances. All forecast hours forwarded when new G-AIRMETs are issued.
Update paradigm:	Latest issuance
Missing Data:	Elements have empty value if missing.

# Graphical AIRMET – Uplink Types



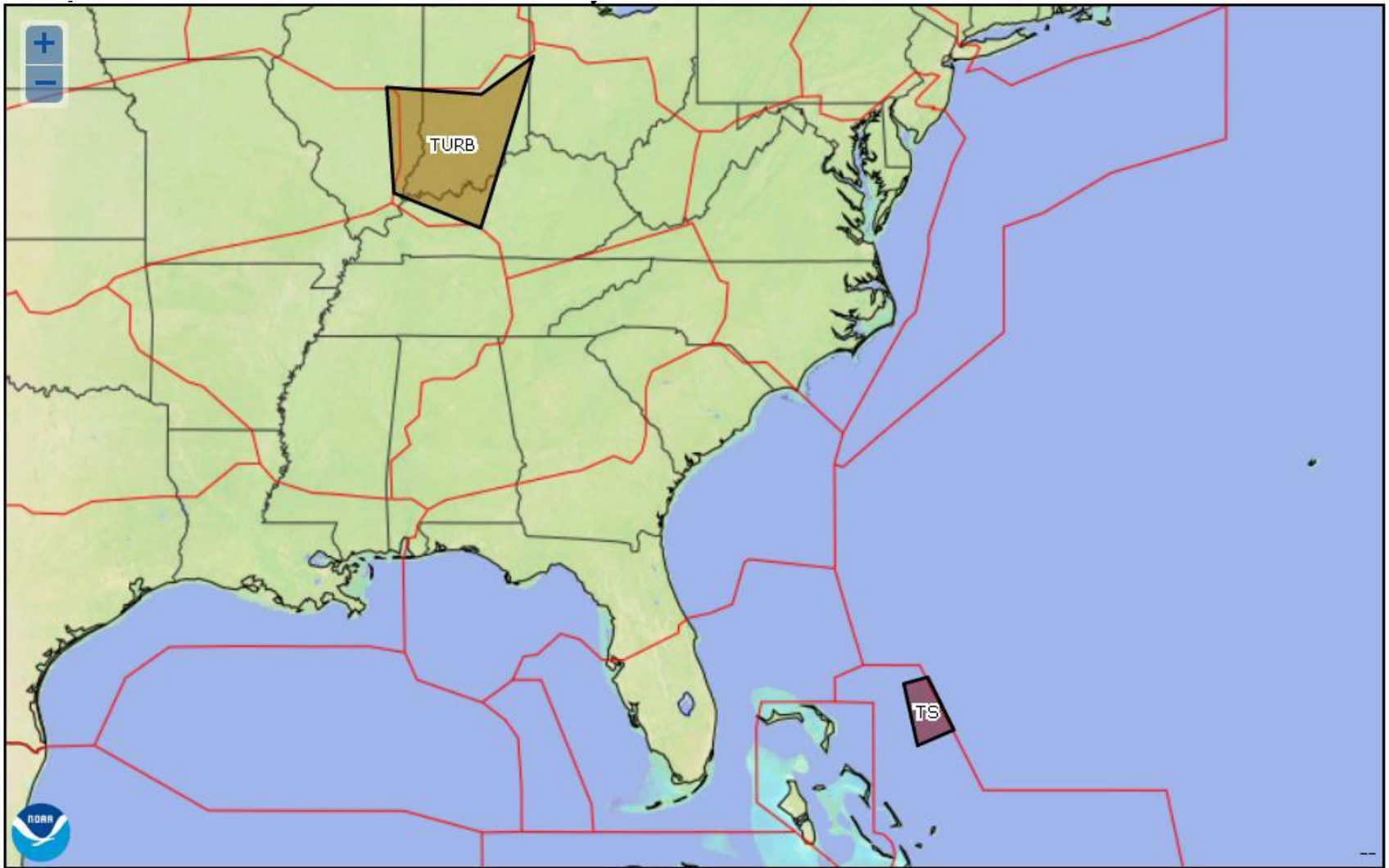
G-AIRMET Type	Area Data	Metadata	Comments
Turbulence	Polygon	Upper Altitude Lower Altitude	<ul style="list-style-type: none"> <li>• AWC website differentiates high &amp; low altitude Turbulence</li> <li>• Altitude in ft MSL</li> </ul>
Low Level Wind Shear	Polygon	None	Altitude in ft AGL
Strong Surface Winds	Polygon	None	Altitude in ft AGL
Icing	Polygon	Upper Altitude Lower Altitude	<ul style="list-style-type: none"> <li>• Lower altitude could be a range of altitudes</li> <li>• Altitude in ft MSL</li> </ul>
Freezing Level	Line; Polygon	5 Levels: <ul style="list-style-type: none"> <li>• Surface (ft AGL)</li> <li>• 4000ft MSL</li> <li>• 8000ft MSL</li> <li>• 12000ft MSL</li> <li>• 16000ft MSL</li> </ul>	<ul style="list-style-type: none"> <li>• Normally represented by a line with the indicated altitude</li> <li>• However, areas where there are multiple freezing levels are represented by polygon with upper &amp; lower altitude values</li> </ul>
Ceiling/Visibility IFR	Polygon (altitude in ft AGL)	Low Ceiling: none Low Visibility: <ul style="list-style-type: none"> <li>• Precipitation (PCPN)</li> <li>• Mist (BR)</li> <li>• Fog (FG)</li> <li>• Haze (HZ)</li> <li>• Smoke (FU)</li> <li>• Blowing Snow (BLSN)</li> </ul>	
Mountain Obscuration	Polygon (altitude set to 60000ft MSL)	<ul style="list-style-type: none"> <li>• Precipitation (PCPN)</li> <li>• Mist (BR)</li> <li>• Fog (FG)</li> <li>• Haze (HZ)</li> <li>• Smoke (FU)</li> <li>• Clouds (CLDS)</li> </ul>	

- An unscheduled aviation weather warning for conditions meeting or approaching national in-flight advisory (AIRMET, SIGMET or SIGMET for convection) criteria
- Primarily used by air crews to anticipate & avoid adverse weather conditions in en route & terminal environments.
- Not a flight planning product because of its short lead time & duration..
- Valid for up to 2 hours & may include forecasts of conditions expected to begin within 2 hours of issuance.
  - If conditions are expected to persist after advisory's valid period, a statement to that effect should be included in last line of text.
- If forecaster deems it necessary, CWAs may be issued hourly for convective activity.
- CWAs should be issued for any of the following events when they are expected to occur within 2 hours a&d have not been previously forecast by AWC or AAWU products, or to supplement AWC & AAWU products
  - Conditions meeting convective SIGMET criteria
  - Icing - moderate or greater
  - Turbulence - moderate or greater
  - Heavy precipitation
  - Freezing precipitation
  - Conditions @ or approaching Low IFR
  - Surface winds/gusts >30 knots
  - Low Level Wind Shear (surface - 2,000')
  - Volcanic ash, dust storms, or sandstorms

Parameter	Value	
Update interval	As Available	
Transmission interval	10 minutes	
Product type	Text/graphical overlay	
Product ID	15	
Product look-ahead range (NM)	500	High-Tier radios
	375	Medium-Tier radios
	250	Low-Tier radios

- Domain
  - CONUS & Alaska
- Product
  - CWA
- Frequency
  - As available

# CWA – Data Depiction Example





Criteria	
Data source upstream of HWDS:	Issued by CWSUs; received via NOAAPort
Processing performed @ HWDS:	Alphanumeric message converted to XML
Format sent to FIS-B:	XML, raw message is embedded.
Data Structure:	Polygonal area over range of vertical levels. Vertical levels can be FL###, MSL###, AGL### in 100's of feet or special value SFC.
Valid period:	Valid over a range of time.
Frequency:	Forwarded when new CWA is issued.
Update paradigm:	Latest issuance
Missing Data:	Elements have empty value if missing.

- Upon reception from NOAAPort, HWDS:
  - Formats & encodes as XML
- FIS-B receives & decodes XML file
- If CWA text indicates cancellation of an existing CWA:
  - FIS-B will only uplink 5-byte Text Record Header with status bit set to Cancelled
    - This will be done for 2 retransmissions
  - FIS-B ceases to uplink corresponding Graphical Overlay Record
  - Avionics will have to use combination of Report Number/Report Year to purge existing text/graphic records
- FIS-B will only send a polygon to radio for uplink if any part of polygon lies within lookahead range of that radio
- FIS-B sets APDU Header Time to Issue Time of CWA w/ time option set to 2
  - This means Month, Day, Hour and Minute will be provided

- CRL transmitted @ twice the rate of the corresponding product (2.5 min for G-AIRMET & 5 min for CWA).
- Product Range set to Lookahead of transmitting Radio Station.
- Report Year/Report Identification Number will match that of each transmitted G-AIRMET/CWA.

Thanks for the opportunity to present this information.

*Paul Freeman*

Deputy Program Manager, ADS-B/SBS

Harris Corporation

2235 Monroe St, Herndon, VA 20171

703-245-4303

[paul.freeman@harris.com](mailto:paul.freeman@harris.com)