Current Onboard Weather Sensing Technologies for Data Downlink and Flight Operations

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Onboard Weather Sensing Technologies

- In-Situ Wx Sensors in Current Operational Use
  - Production Aircraft Wx Sensors
  - Supplemental Aircraft Wx Sensors
  - Supplemental Techniques

- Onboard Aircraft Wx Radar

- Emerging Technologies
Production Aircraft In-Situ Wx Sensors

Aircraft Based Observations – AMDAR/MDCRS

- Production Aircraft Sensors
  - Air Temperature
  - Wind Speed and Direction
  - Pressure Altitude, Position, and Time
  - No additional equipage required

- AMDAR (MDCRS) Data for Wx Support
  - Over 3,800 aircraft reporting Worldwide
  - Contributing over 670,000 Observations per day
  - Downlinked Globally via ACARS
  - Used in Operations by WMO/ICAO Communities

- Aircraft Type/Tail Specific Dependencies
  - Different sensor types and avionics types
  - Different biases by Type and Specific Tail
  - QC measures developed for common issues

Aircraft Observations Improve Global Aviation Wx Support
Operational Benefits of Aircraft Based Observations

» Supports Airline Operations
   » Strategic and Tactical Operational Decision Support
   » Information relayed to the fleet as appropriate
   » Data available on the flight deck for direct/indirect use

» Supports NMHS Operations (e.g. NOAA/NWS)
   » Used in generation of TAFs and other worded forecasts
   » Used in direct interaction with Airlines
   » AMDAR Data is now a top contributor to Forecast Model performance

» Supports ATC/ATM Operations (e.g. FAA)
   » Strategic and Tactical Operational Decision Support
   » Shared with other ATC organizations as appropriate
   » Information relayed to Pilots as appropriate

Data from WMO AMDAR Supports Aviation Globally
Supplemental In-Situ Wx Sensors

WVSS-II for Aircraft Based Observations

- High Performance Water Vapor Detection
  - Tunable Diode Laser Absorption Spectroscopy
  - Low Impact To Aviation Operations
  - No Routine Maintenance for 5 or more Years
  - Uses existing aircraft communications and processing

- Meets International Aviation Standards
  - Data Interface per ARINC-429 Data Bus Standard
  - Supports Downlink Implementations per ARINC-620 Standard
  - Supports Implementations of RTCA DO-252

- Integrated by WMO Member Aircraft Based Obs Programs
  - WMO AMDAR Reference Manual
  - WMO Manual on Codes
  - WMO Onboard Software Functional Spec (WMO Reports 114 & 115)
  - WMO CIMO Guide

- Assimilated into Operational Forecast Models

Completing the Aircraft Wx Obs with International Standards
Supplemental In-Situ Wx Sensors

WVSS-II in Current AMDAR Operations

- 112 U.S. Aircraft equipped with WVSS-II & more being added

* Graphics Courtesy of NOAA/ESRL/GSD
27-Aug-2014 00:00:00 – 28-Aug-2014 23:59:59 (105828 obs loaded, 104245 in range, 11919 shown)
NOAA/ESRL/GSD  Altitude: -1000 ft. to 45000 ft.

- 3 EU Aircraft equipped with WVSS-II & 6 being added

WVSS-II Contributes to Aviation Operational Success
Supplemental In-Situ Wx Sensors

• The TAMDAR System
  • Multi-function atmospheric sensor installed on aircraft (and UAS)
  • Two-way real time Iridium satellite link
  • Dedicated data center for quality monitoring, archiving, and distribution systems
  • Development and integration of customized forecasts and weather applications

• The TAMDAR Sensor
  • Air temperature (Mach corrected)
  • Winds aloft
  • Relative humidity
  • Static pressure and pressure altitude
  • GPS lat/long/alt/time
  • Indicated and true airspeed
  • Turbulence (Eddy Dissipation Rate, EDR)
  • Ice presence
Supplemental In-Situ Wx Sensors

**TAMDAR Benefits to Partner Airlines**

- Global SATCOM voice & data via Iridium
- Automated Out-Off-On-In times and other aircraft data
- Real-time global aircraft position reports
- Airborne datalinked weather
  - Weather data downlink
  - Auto-PIREPs
- Data base of all flight histories
- EFB integration Ku broadband integration option
- Foundation for future operational benefits:
  - Broadband data to/from aircraft
  - Weather to the flight deck:
    - Near real-time weather data to EFB
    - Graphical weather forecasts
  - Dynamic flight planning
  - Flight path optimization
Supplemental In-Situ Techniques

Turbulence Detection

- **EDR (Eddy Dissipation Rate)**
  - ICAO/AMDR Turbulence Metric Standard
  - *Atmospheric* turbulence intensity metric
  - Vertical-based
    - NCAR (via winds), AeroTech TAPS (via RMSg)
  - Longitudinal-based implementations
    - Panasonic TAMDAR

- **RMSg (Root-Mean-Squared vertical accel.)**
  - *Aircraft-centric* turbulence intensity metric
    - AeroTech TAPS

- **DEVG (Derived Equivalent Vertical Gust)**
  - Legacy AMDAR Turbulence Metric Standard
  - *Atmospheric* turbulence intensity metric
  - Generally, community is moving towards EDR
  - Qantas, British Airways, others?

**EDR is the Aviation Industry Turbulence Metric Standard**

Information Courtesy of the National Center for Atmospheric Research
Onboard Aircraft Wx Radar

Aircraft Wx Radars
- Changed a bit over the years
- Provide flight deck view to short term hazards
  - Precipitation intensity and position
  - Detection of wind shear & turbulence potential
  - New visualization technologies being integrated

Standards Related to Aircraft Wx Radar
- ARINC-708
- ARINC-429

Several Aircraft Wx Radar Suppliers
- Rockwell Collins
- Honeywell
- A few Others

Onboard Wx Radars Offer an Array of Benefits to the Flight Deck
Emerging Technologies

- LIDAR for improved detection of Turbulence/CAT
- Lightning Detection Systems
- Volcanic Ash Sensors
- Greenhouse Gas Sensors
- New Data Communication Techniques
- New Visualization Techniques
- New Integrated Decision Support Techniques
- Etc, Etc, Etc.

Operational Uses of Aircraft Wx Sensors have a Bright Future
Thank You!

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