Current Onboard Weather Sensing Technologies for Data Downlink and Flight Operations

Friends and Partners of Aviation Weather
FPAW 2014 - Orlando, FL

Oct 23, 2014

Bryce L. Ford

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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**

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Aircraft Based Observations – AMDAR/MDCRS

Production Aircraft Sensors

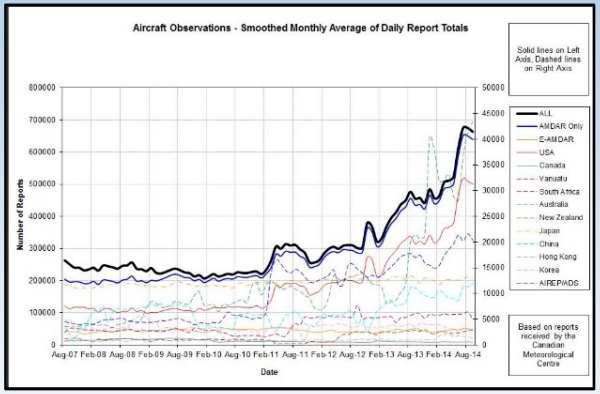
- Air Temperature
- Wind Speed and Direction
- Pressure Altitude, Position, and Time
- No additional equipage required

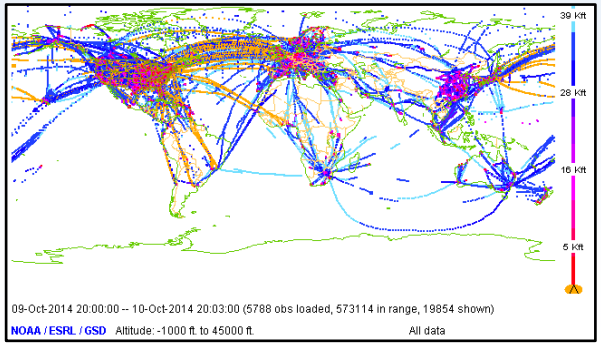
AMDAR (MDCRS) Data for Wx Support

- 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

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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

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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

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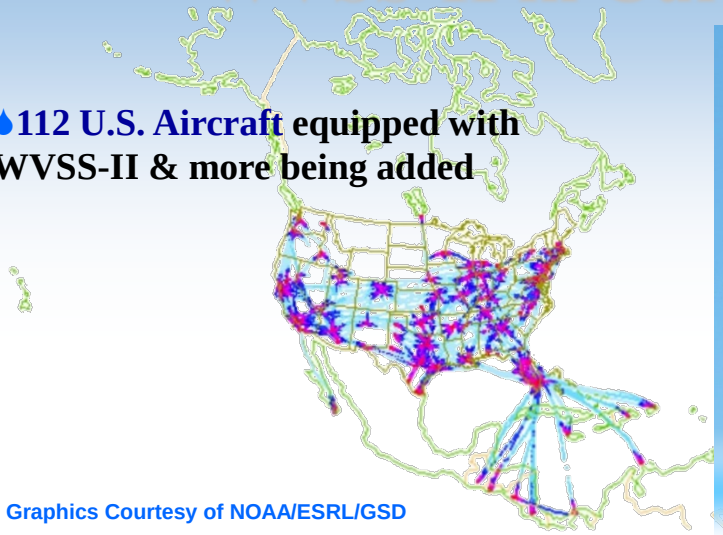
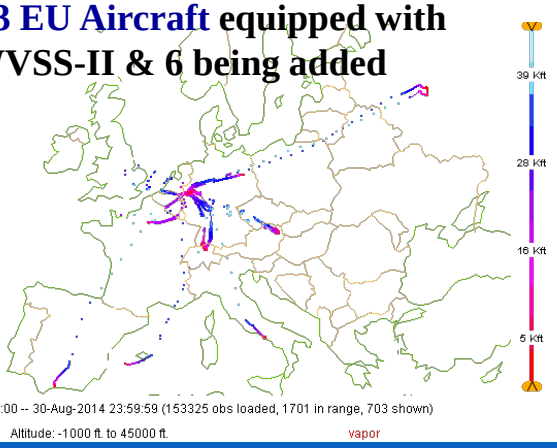
WVSS-II in Current AMDAR Operations

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



* Graphics Courtesy of NOAA/ESRL/GSD

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



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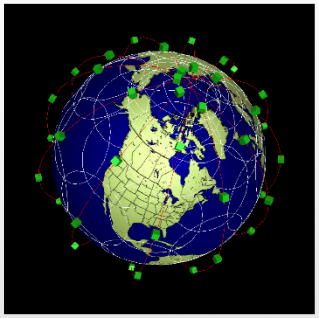
WVSS-II Contributes to Aviation Operational Success

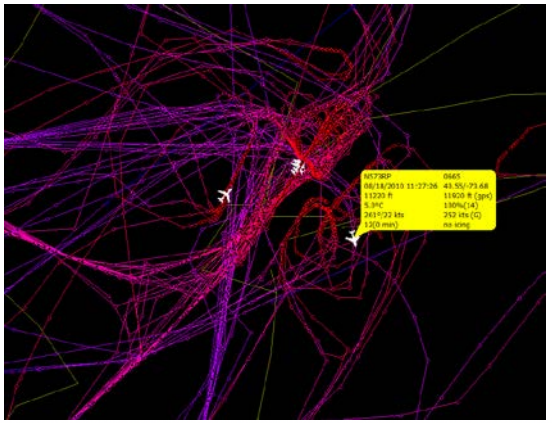
Supplemental In-Situ Wx Sensors

- **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



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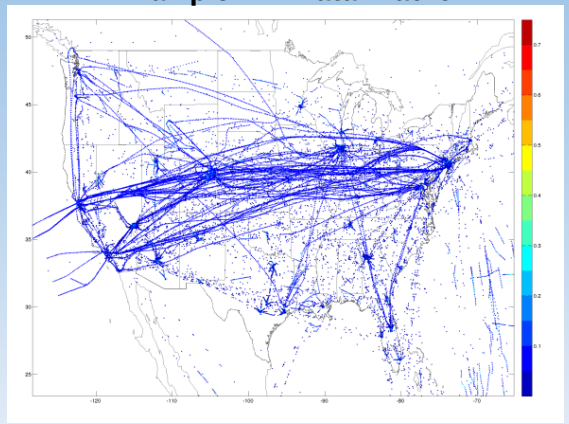
Turbulence Detection

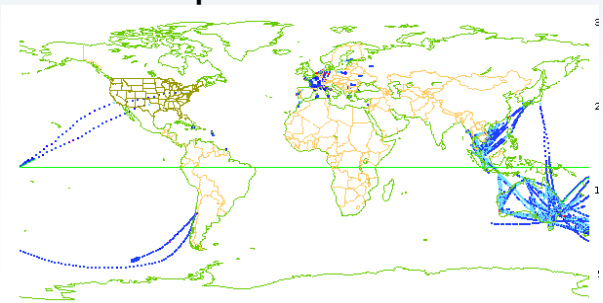
- **EDR (Eddy Dissipation Rate)**
  - ICAO/AMDAR Turbulence Metric Standard
  - **Atmospheric** turbulence intensity metric
  - Vertical-based
    - NCAR (via winds), AeroTech TAPS (via RMSg)
  - Longitudinal-based implementations
    - Panasonic TAMDAR
- **RMSg (Root-Mean-Squared vertical accel.)**
  - **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?

Example EDR Data Tracks



* Courtesy of the National Center for Atmospheric Research

Example DEVG Data Tracks



* Graphic Courtesy of NOAA/ESRL/GSD

EDR is the Aviation Industry Turbulence Metric Standard

Information Courtesy of the National Center for Atmospheric Research

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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

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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

Contact Information

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Thank You!

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