World Meteorological Organization

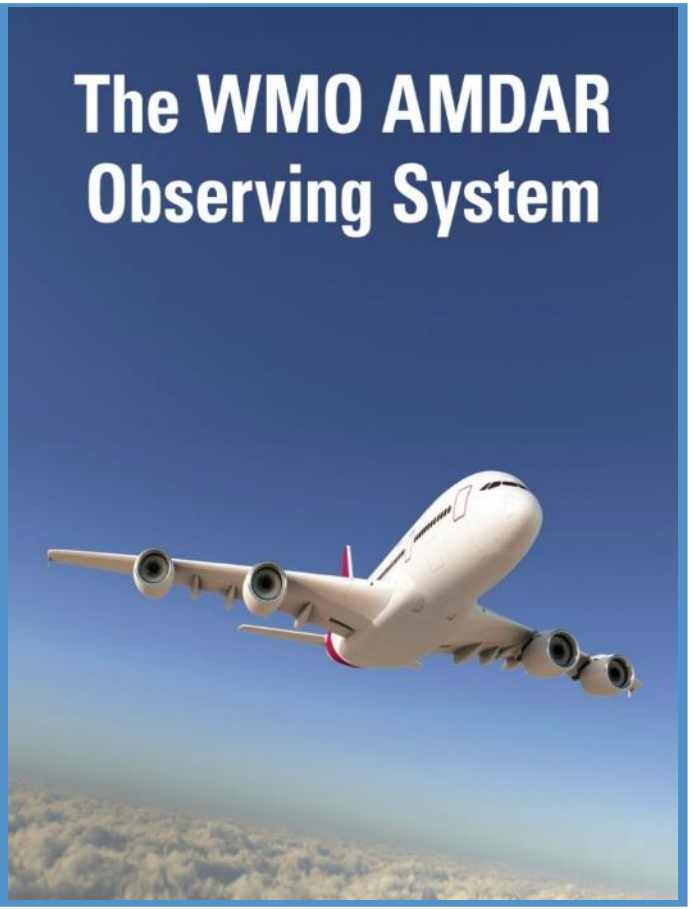
Weather • Climate • Water

AMDAR Global Status, Benefits and Development Plans*

WMO CBS ET

Aircraft Based Observations

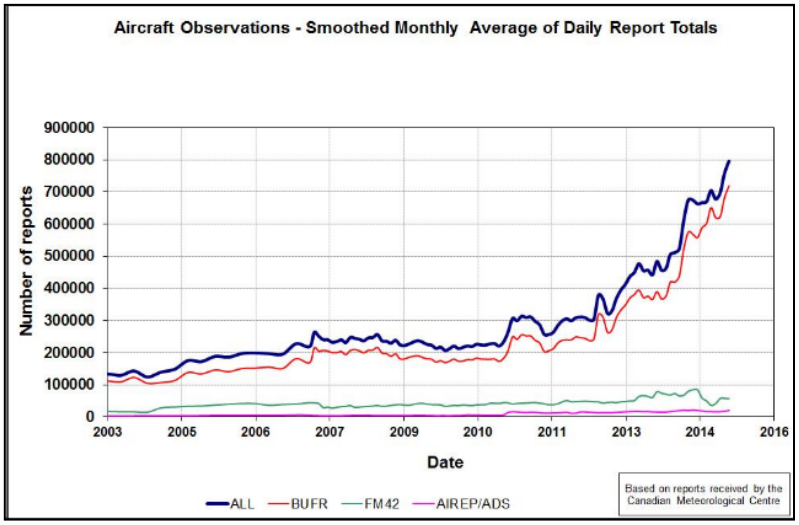
Bryce Ford

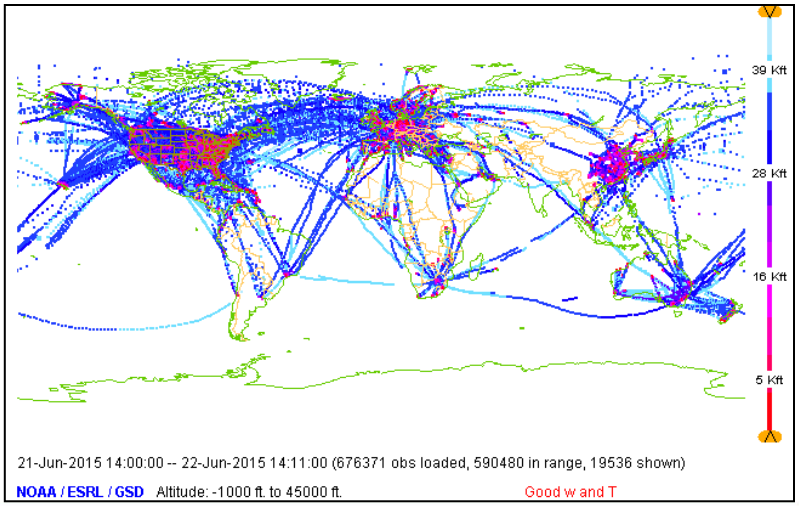


* Adapted from Presentation at WMO Congress XVII, June 2015 by WMO CBS President, reviewed by WMO Technical Coordinator for Aircraft Based Observations

WMO Aircraft Meteorological DAta Relay (AMDAR)

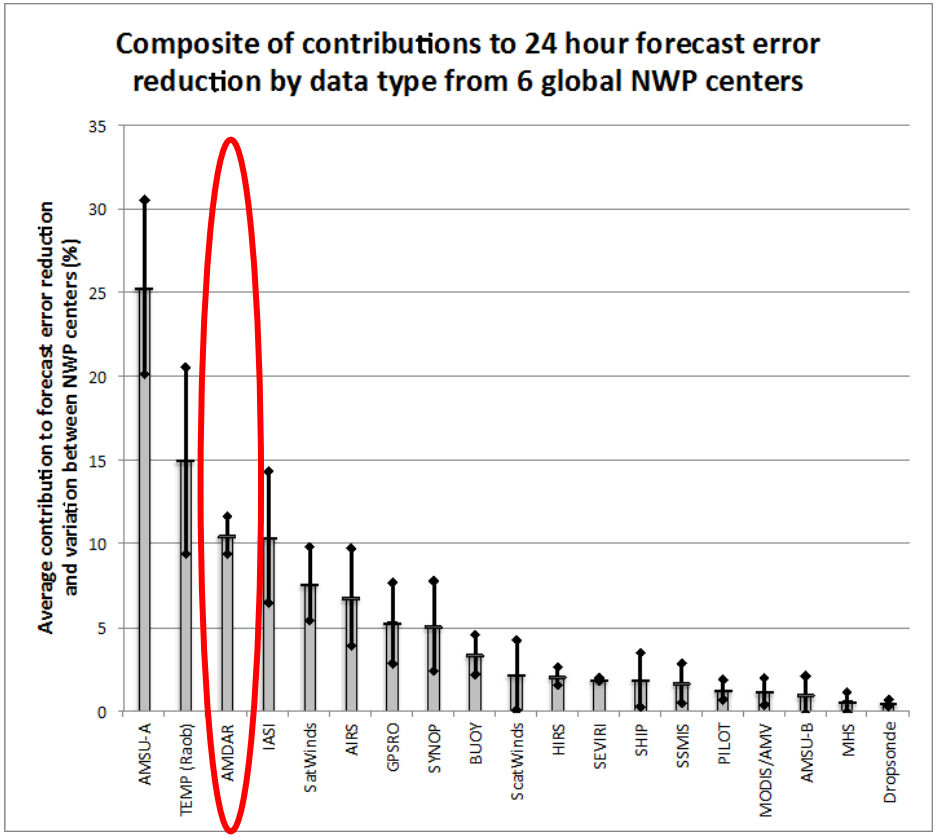
- **AMDAR is the core WMO Aircraft Based Observing System (ABO):**
  - AMDAR is ~95% of all ABO data
  - Supplemented by AIREPs & ADS
- **Data per meteorological specifications**
  - Data Quality equivalent to radiosondes
  - Vertical profiles plus enroute reports
- **Global coverage slowly increasing**
  - Currently 39 participating airlines
  - Over 4000 participating aircraft
  - Over 700,000 observations per day
- **But more is needed in Space and Time**
  - Fill missing Locations and Times of the day
  - Expansion in US, EU, Australia, & E-Asia
  - Development in Africa, So America, Asia





AMDAR Benefit to Global Numerical Weather Prediction (NWP)

- **AMDAR ranks 3rd in reduction to GLOBAL NWP forecast error (~10%)**
  - Behind satellite vertical sounders and radiosondes
  - Even with limited global coverage
- **Satellites provide**
  - High data volume & global coverage
  - But less accuracy
- **Radiosondes provide**
  - Poor horizontal & temporal coverage
  - But good accuracy when available
- **AMDAR Provides**
  - Higher temporal coverage than radiosondes
  - Better accuracy than satellites
  - Lowest cost of these systems



- **AMDAR Benefit will Increase with**
  - Improved horizontal and temporal coverage
  - Increased Water Vapour measurement

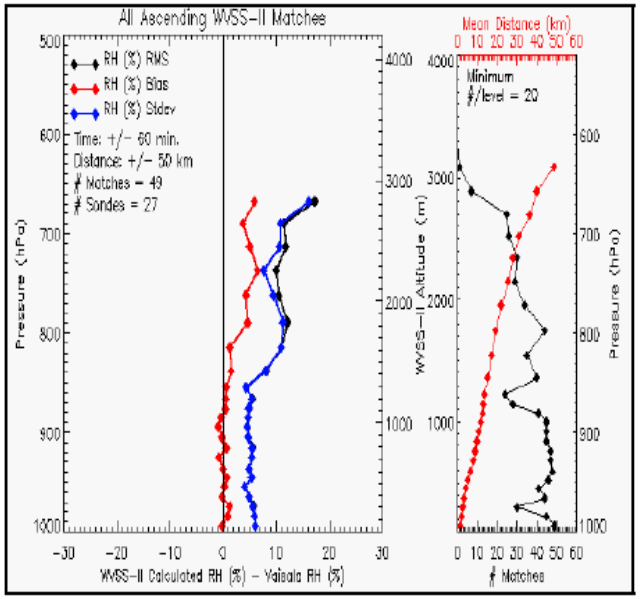
AMDAR Benefit to U.S. Numerical Weather Prediction (NWP)

- **The U.S. NOAA HRRR/RAP NWP models are the backbone for most aviation hazard guidance products for 1-18 hour duration**
- **Skill of NOAA's regional HRRR/NAM models is strongly dependent on high-quality hourly observations over the US and North America**
  - Aircraft Obs are the single most important source for 1-18 hr U.S. forecasts
  - Forecast accuracy further improves with additional aircraft data and methodology (e.g., addition of expanded Alaska Airlines, WVSS-II, ADS-C)
  - Ongoing effort within NOAA to improve assimilation of ABO into global scale NWP such as NOAA's Global Forecast System (GFS) model
- **New 2013 HRRR data denial study**
  - Aircraft obs more dominant than in 2011 for RAP obs denial experiments
  - Now ABO is most important obs type also for moisture/RH in HRRR
- **Improved NWP by ABO Supports Aviation**
  - Improved planning for higher efficiency in aviation operations
  - Less aviation delays due to unexpected weather
  - Fewer aviation incidents due to unexpected weather

Water Vapor Sensing System (WVSS-II)

WVSS-II

- **WVSS-II enables AMDAR aircraft to report Water Vapor, for a complete profile**
  - WVSS-II is specifically designed for use in the WMO AMDAR Programme
  - WVSS-II is as accurate as radiosonde instruments, as determined by WMO organized evaluations
- WVSS-II equipped aircraft satisfy WMO accuracy requirements
  - Upper Air Observations
  - Regional Forecast applications



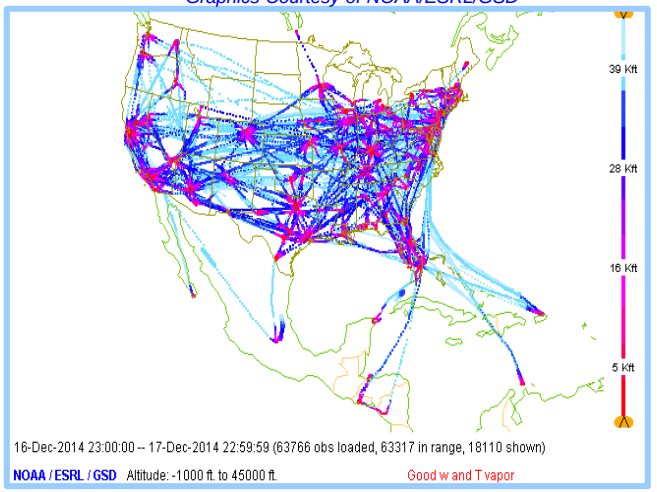
Water Vapor Sensing System (WVSS-II)

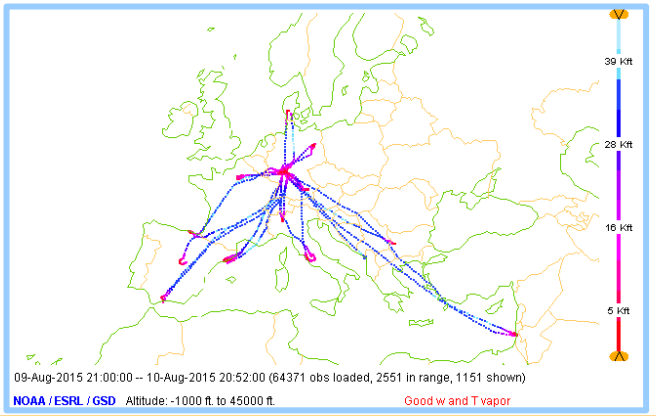
WVSS-II Networks

- **U.S. NWS WVSS-II Network**
  - Currently 130 aircraft equipped
    - 25 UPS aircraft (757s)
    - 105 Southwest Airlines (737s)
    - At least 3 more SWA aircraft by end of 2015
  - Looking to add others in 2015/2016
  - Expanding throughout WMO Region-IV (NA) and beyond

- **E-AMDAR WVSS-II Network**
  - Currently 8 aircraft equipped
    - 3 Lufthansa aircraft (A319)
    - 5 Lufthansa aircraft (A320)
    - 4 more Lufthansa aircraft in 2015
  - Expanding throughout WMO Region-VI (EU)

Graphics Courtesy of NOAA/ESRL/GSD

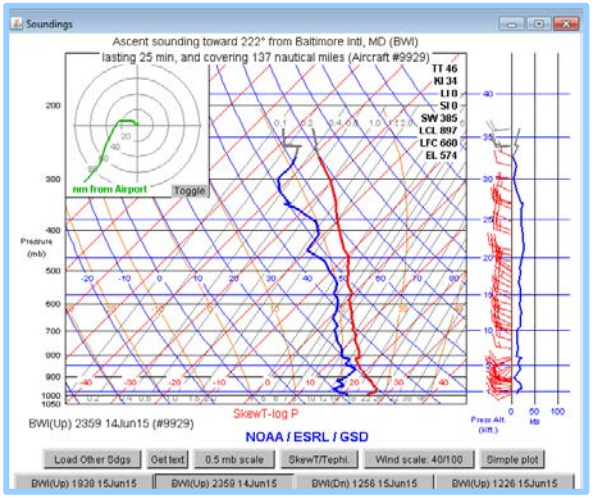


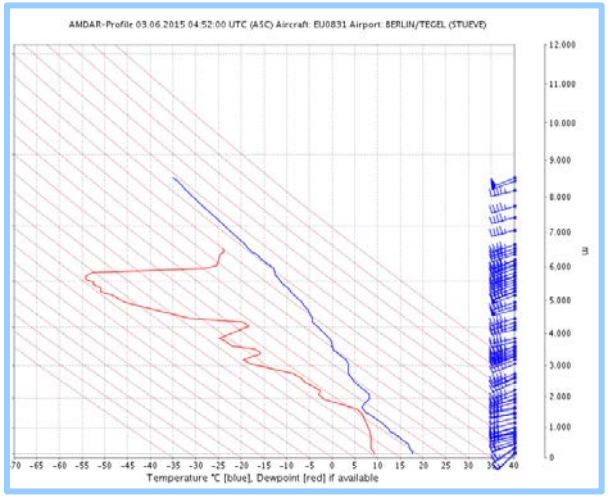


Benefits of Using WVSS-II

WVSS-II Benefits

- **WVSS-II aircraft provide a high volume of complete Upper Air Observations**
- **High Data Quality, suitable for all meteorological applications**
  - Traditional Thermodynamic Analysis
  - Numerical Weather Prediction assimilation
- **Better Quantity/Quality of Upper Air Observations Improves Forecasting**
  - Thunderstorms - Convective initiation, stability
  - Fog, Ceilings, Visibilities, and Icing
  - Precipitation intensity and type
  - Winter Weather
  - Fire Weather support





WVSS-II Benefits

- **Regional Implementations of WVSS-II are easily achieved**
  - International Cooperation with established AMDAR partners
  - Shared Network Infrastructure to minimize implementation costs
  - Can be established through partnership with a service provider
- **A very low Cost / Observation**
  - Under 10% the cost of radiosondes over 5 years
  - Even lower with Regional Cooperation and Cost Sharing
- **Networks are Sustainable into the Future**
  - No operational labor needs – sensor is fully automated
  - No training required for sensor operation
  - No routine sensor maintenance requirements
  - No costly expendable probes

Plans

- **WMO Congress-XVII - Resolution 4.2.2(1)/2** (June 2015)

  (2) Recommendation 17 (CBS-Ext. (2014)) – Enhancement and expansion of aircraft based observations

  (a) Approves this recommendation;

  (b) Requests the General Secretary;

  (i) To invite regional associations to consider further development of aircraft-based observations, primarily through wider implementation of the AMDAR programme;

  (ii) To invite regional associations to develop, maintain and implement regional plans for the enhancement and expansion of aircraft-based observations and AMDAR;

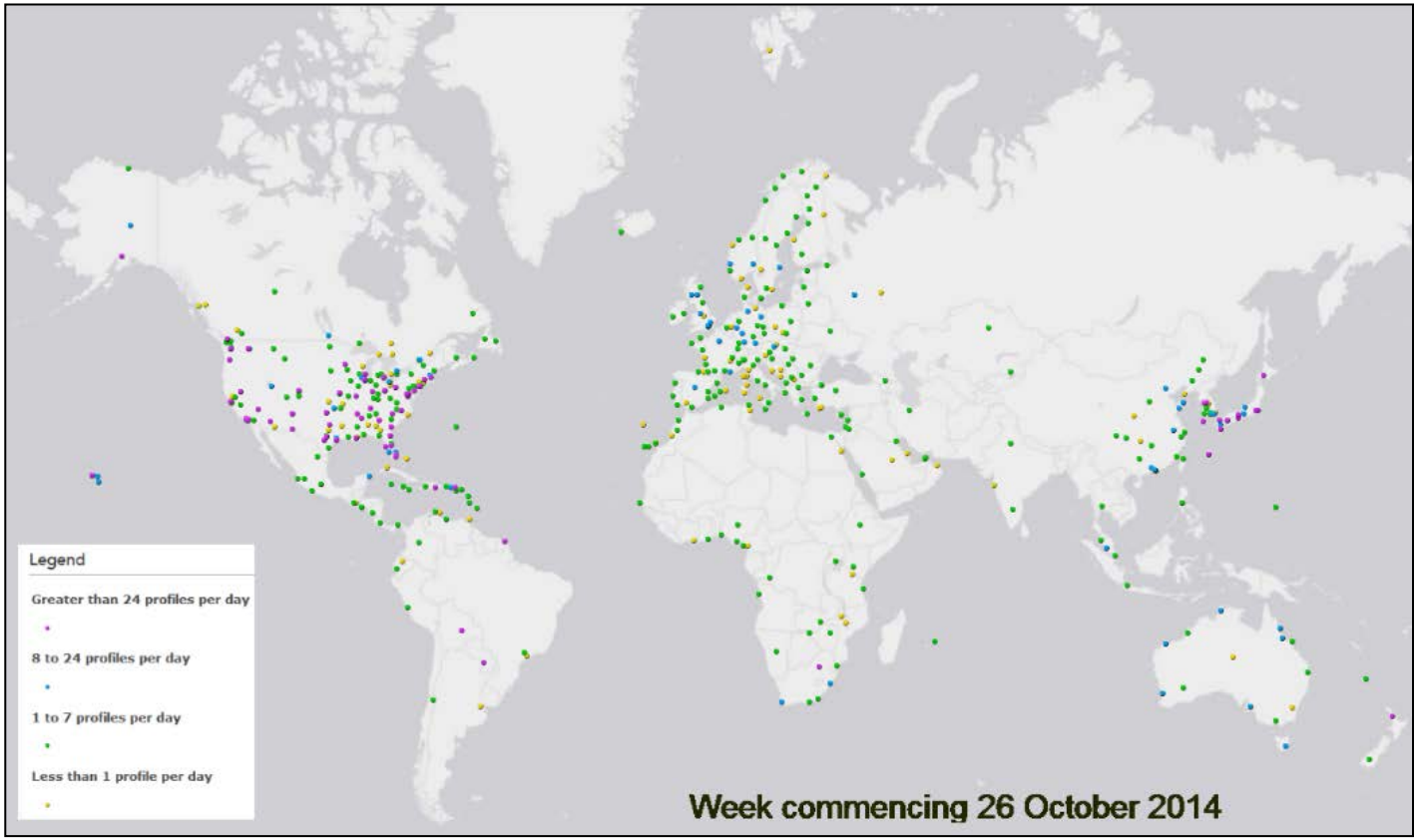
  (iii) To provide support for the coordination of the development and maintenance of these planning and implementation activities through appropriate promotion to Members and at each regional association session;

- **Expand to include use of ADS-C for Met Data Reporting**
  - Particularly for Oceanic Routes
  - Extensive evaluation conducted by NOAA and E-AMDAR

AMDAR – Vertical Profile Coverage

Plans – Expand the Current Coverage

- Coverage very good over USA & Western Europe;
- Coverage good over parts of Asia and Australasia;
- Coverage is poor elsewhere.



What are WMO and Its Members doing?

- **Working to develop and implement Regional AMDAR Implementation Plans as part of WIGOS implementation**
  - Defining AMDAR standards (onboard software, downlink, processing, etc.)
  - Planning expansions in global spatial and temporal coverage
  - Collaborating with World Bank to enable expansion into developing nations
- **WIGOS Tech Report 2015-01, Impact and benefits of AMDAR temperature, wind and moisture observations in operational weather forecasting** - http://library.wmo.int/pmb_ged/wigos-tr_2015-01_en.pdf
- **WIGOS Tech Report 2014-01, The Benefits of AMDAR Data to Meteorology and Aviation:** https://drive.google.com/file/d/0BwdvoC9AeWjUbG1MRlAyU0dhZEk/edit?usp=sharing
- **Promoting AMDAR globally through COMET:** https://www.meted.ucar.edu/training_module.php?id=1114#.VLTb4CvF9xB
- **The WMO AMDAR Observing System:** http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/index_en.html
- **Aircraft-based Observations Work Teams:** http://www.wmo.int/pages/prog/www/GOS/ABO/ABOWorkTeams.html

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Thank you for your attention