

# Future of AMDAR in the National Weather Service

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# What is AMDAR?

- ▶ Basically, it is a system that involves the regular real-time transmission of automated weather observations (wind & temperature) via equipment mounted on commercial aircraft.
- ▶ In the **United States**, the system used to collect and transmit real-time automated weather observations from sensors on commercial aircraft was originally referred to as the Meteorological Data Collection and Reporting System (**MDCRS**).
- ▶ With the advent of GPS and enhancements of onboard communications systems, availability of automated aircraft reports expanded globally. The system used to collect and transmit aircraft observations is now part of a broader World Meteorological Organization (WMO) program referred to as the **Aircraft Meteorological Data Relay (AMDAR)**.

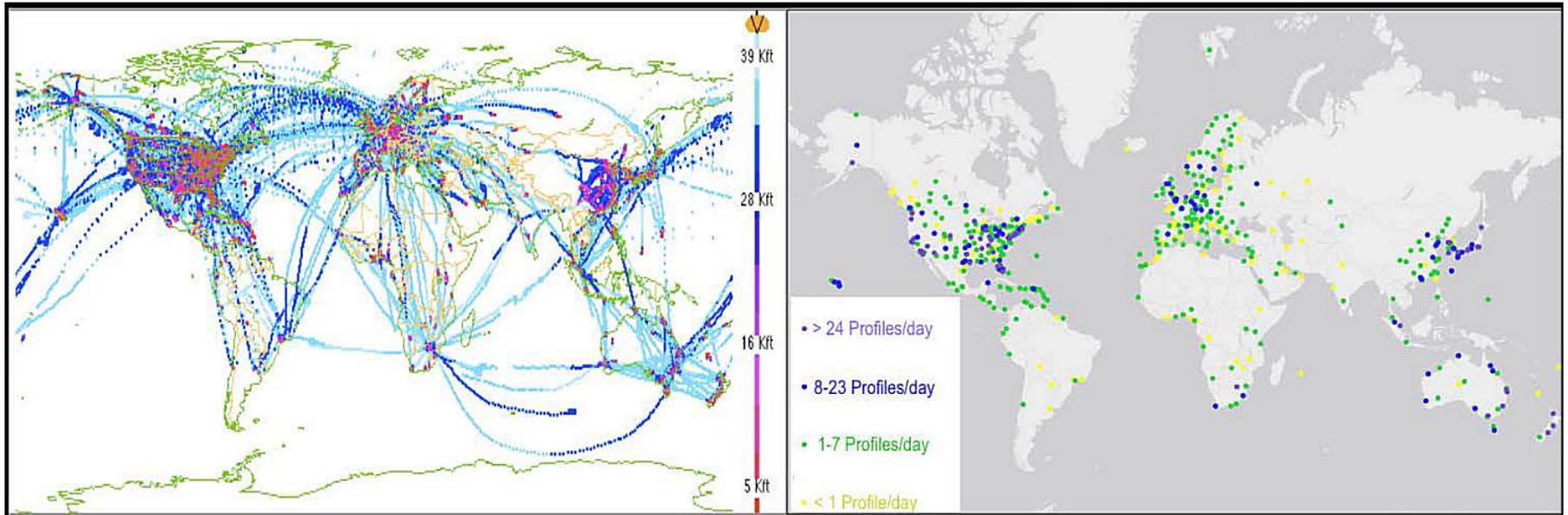
# Renewed NWS Emphasis on Observations

- ▶ NWS Sponsored Aircraft Data Workshop in Annapolis, Maryland in 2014. Meeting highlights:
  - *Establishment of Office of Observations at NWSHQ. Strong support for aircraft observation expansion and formalization of the aircraft observation program. (Louis Uccellini – NWS Director)*
  - *NWS will maintain and expand the aircraft observation program and devote resources required to greatly improve the display of aircraft data in AWIPS II and the AMDAR webpage. (Steve Pritchett – Chief of the NWS Aircraft Observation Program)*

# AMDAR Benefits Summary

- ▶ 450,000 individual data reports per day from over 3000 aircraft from 39 airlines worldwide.
- ▶ Over the past 3 decades, data collected from commercial aircraft have helped reduce flight level wind/temperature forecast errors by nearly 50%.
- ▶ Aircraft wind and temperature observations constitute the 3<sup>rd</sup> most important data set for global NWP and single most important data set for use in shorter-term regional NWP applications (e.g., RAP and HRRR).
- ▶ Extremely cost effective data source. Sounding profiles typically cost less than 5% of a full RAOB launch.
- ▶ Presents an economical alternative for obtaining tropospheric profiles both in areas of diminishing conventional observation and as a supplement to existing data sets, both in time and space.

# Current AMDAR Coverage



Sample distribution of all automated wind and temperature observations over a 24 hour period from all commercial aircraft (left) and daily average takeoffs and/or landings (right).

*WMO Integrated Global Observing Systems (WIGOS) Technical Report No. 2015-01: Impact and Benefits of AMDAR Temperature, Wind and Moisture Observations in Operational Weather Forecasting.*

# AMDAR Data Expansion

**Rockwell Collins expands aircraft observation weather research program through new agreement with NOAA**

- *Joint effort will improve weather forecast accuracy for aviation industry and general public*

**ANNAPOLIS, Md. (February 3, 2015)** – Rockwell Collins is expanding its successful aircraft observation weather research program with The National Oceanic and Atmospheric Administration (NOAA) to improve the accuracy of forecasts for the aviation industry and the general public.

- ▶ 3-year NOAA contract awarded to Rockwell-Collins in September 2014 for provision of new sources of meteorological observations from commercial aircraft.
- ▶ Contract provides for augmentation of current observations in both space and time and in the number of airlines reporting.

# AMDAR Data Expansion

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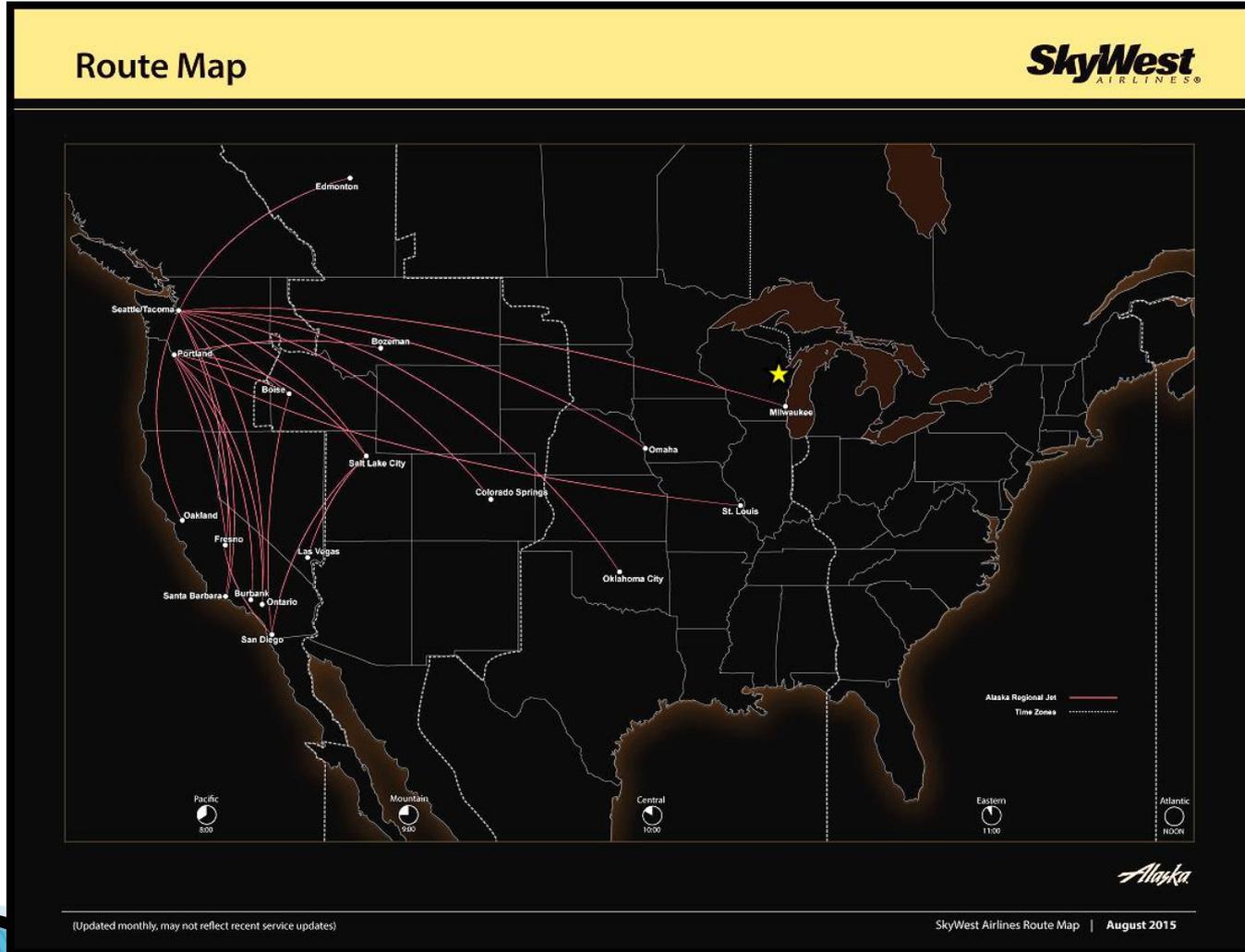
- *Joint effort will improve weather forecast accuracy for aviation industry and general public*

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## ▶ Increase Sounding Profiles

- Number of soundings from Southwest Airline (SWA) routes over U.S., Mexico and Caribbean will increase.
- UPS and FedEx will provide soundings outside the CONUS.
- American Airlines (AA) and United Airlines (UA) will expand data collection over Pacific countries and Guam.
- SkyWest and Air Wisconsin will provide new sources of observations in areas not covered by the major carriers including soundings from more data sparse regions of North America.

# AMDAR Data Expansion

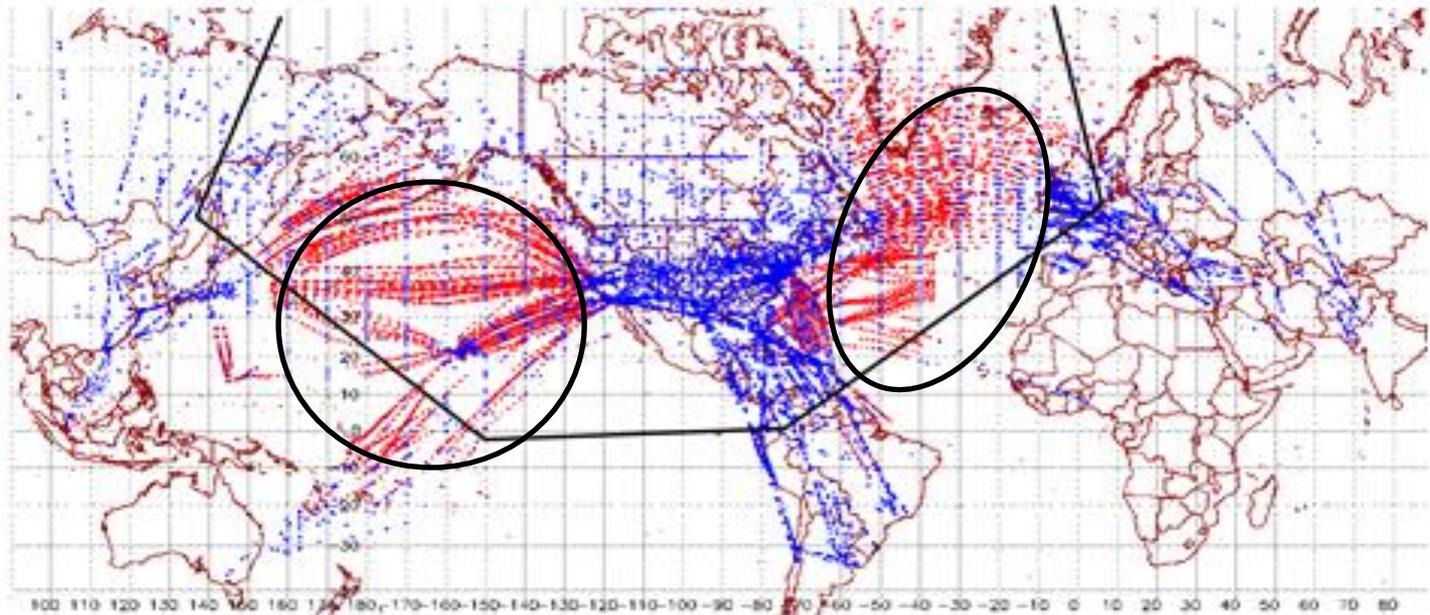


# AMDAR Data Expansion

- ▶ Increase en-route (flight-level) data over oceanic areas.
  - Alaska Airlines will report temperature and wind data from its Hawaii–Alaska and Hawaii–CONUS routes.
  - FedEx and UPS will report over Ocean areas outside of CONUS.
  - New source of aircraft observations from U.S. West Coast destinations from UA and AA aircraft incoming from the Pacific.

# Increased Observations Over Oceans

**ADS-C vs MDCRS** report positions – January 26-30, 2015  
from ADS-C reporting aircraft



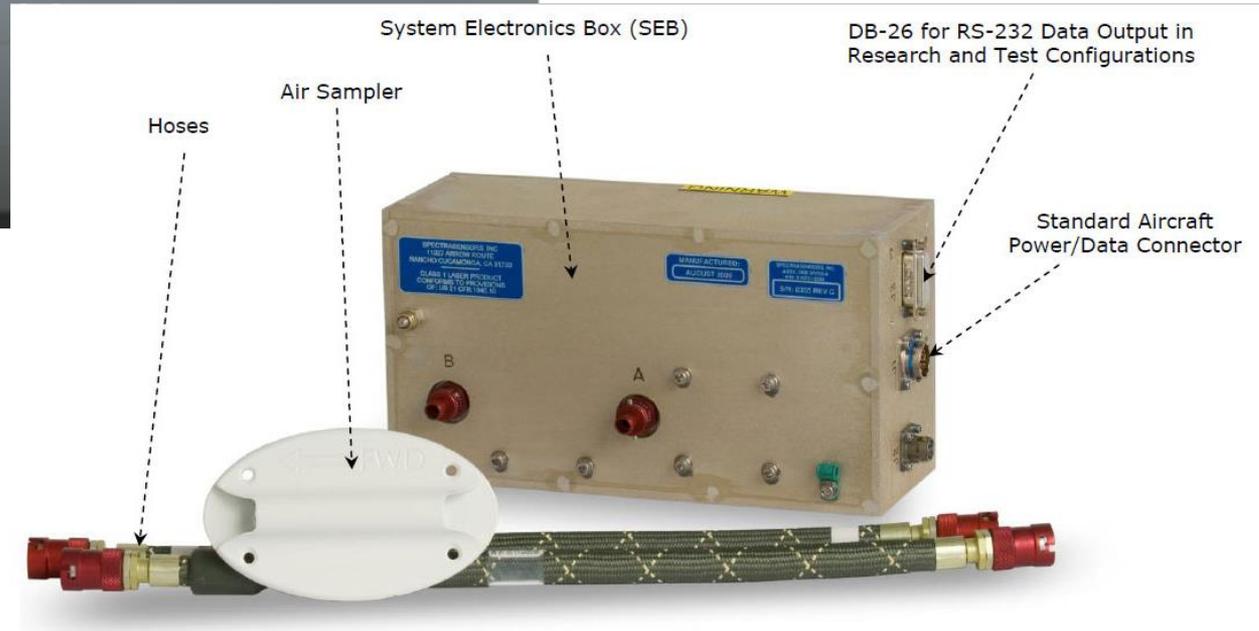
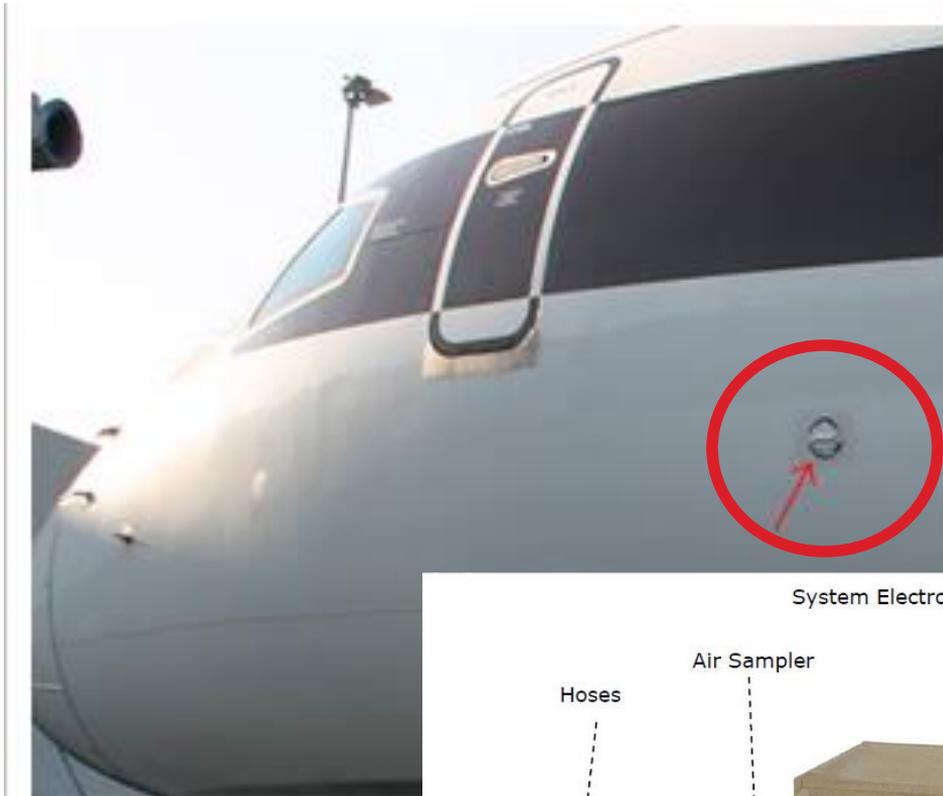
**ADS-C allows additional observation reports over the oceans.**

**Most – but not all – ADS-C data contained within NAM grid.**

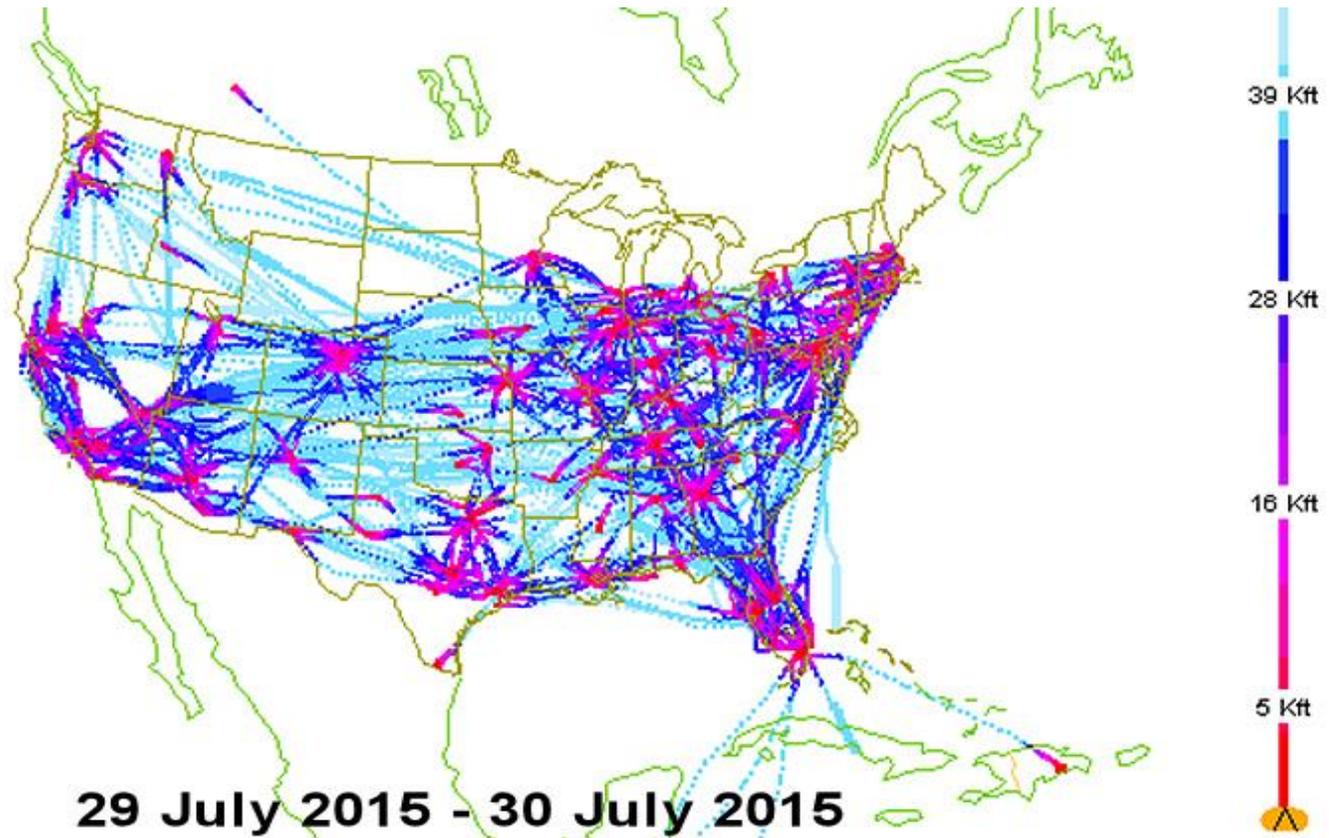
# AMDAR – WVSS II

- ▶ Water Vapor Sensing System (WVSS-II) was designed specifically for measuring atmospheric water vapor from commercial aircraft in support of the global AMDAR program.
- ▶ WVSS-II has undergone numerous independent assessments and evaluations that revealed WVSS-II measurements are at least as accurate as water vapor observations from high-quality RAOBs.
- ▶ The network of aircraft equipped with the Water Vapor Sensing System (WVSS-II) has grown steadily over last 5 years and has become a significant contributor of in-situ data for the U.S. Upper Air Observations Program.
- ▶ Currently 132 aircraft equipped with WVSS-II sensors. Southwest Airlines (SWA) = 107 and UPS = 25.
- ▶ With the benefits to forecast operations demonstrated, plans are for further expansion of the WVSS-II network and research into new applications leveraging this data.

# WVSS II Hardware



# 24 hours of WVSS II Soundings



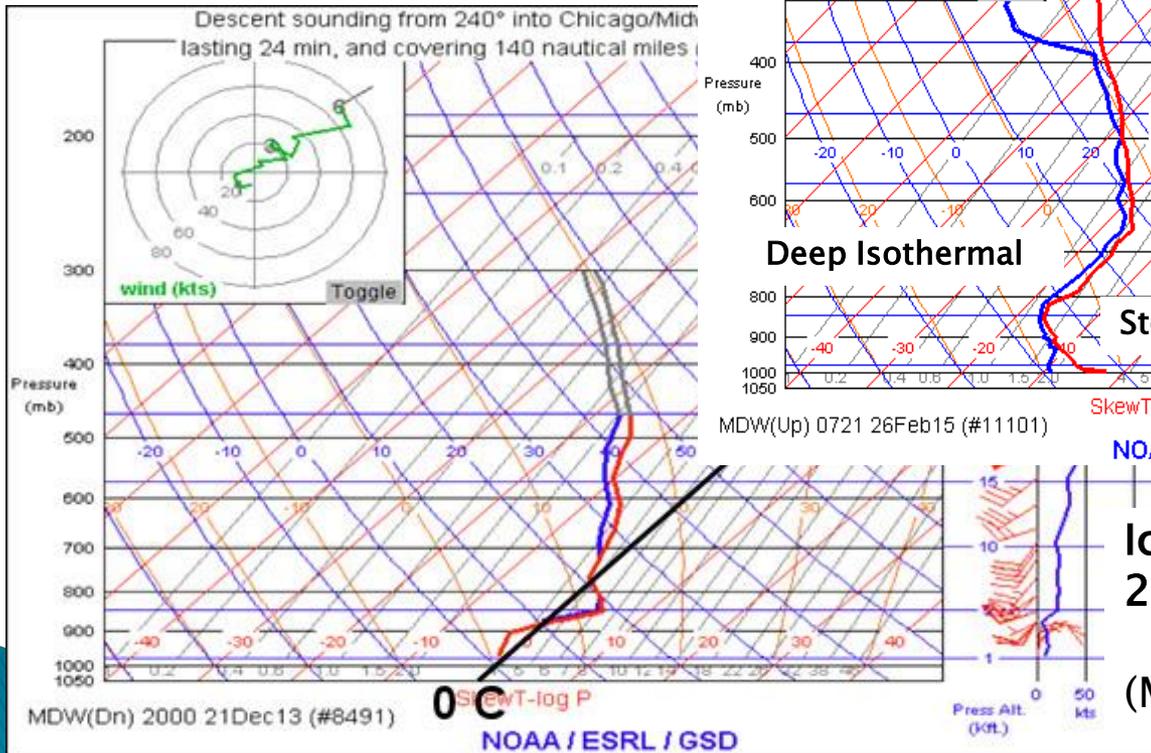
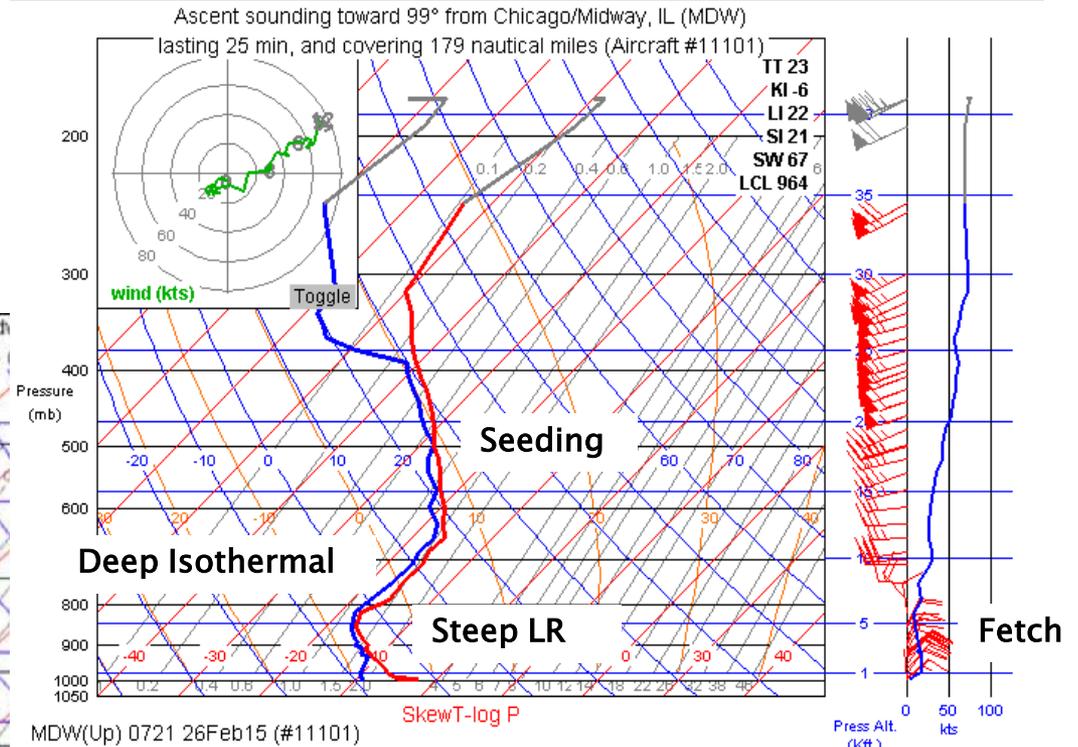
**29 July 2015 - 30 July 2015**

29-Jul-2015 15:00:00 -- 30-Jul-2015 14:59:59 (71535 obs loaded, 69563 in range, 20643 shown)

# WVSS II Soundings

LES Environment  
26 February 2015 (right)

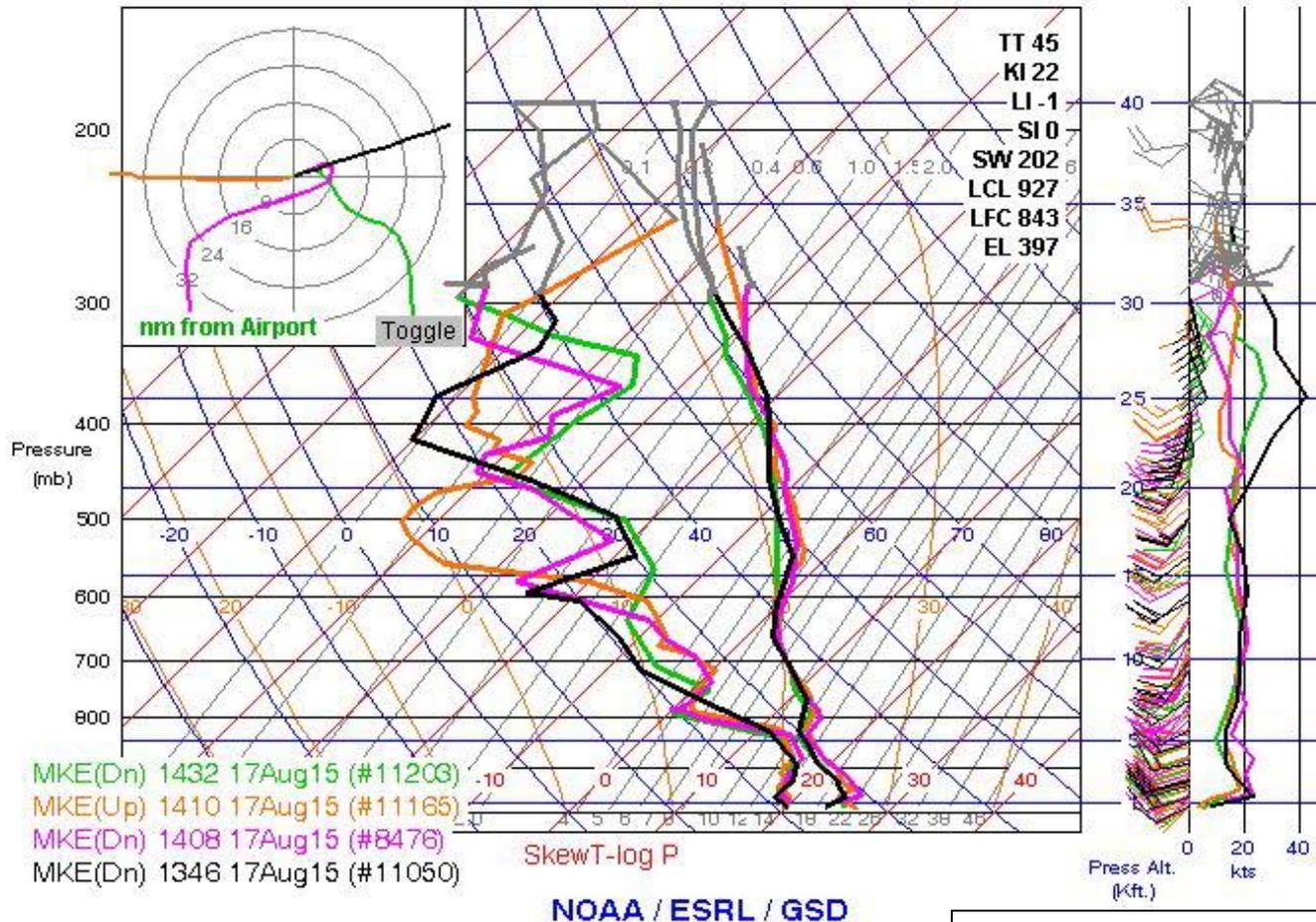
(MDW Ascent Sounding)



Icing Environment  
21 December 2013 (left)

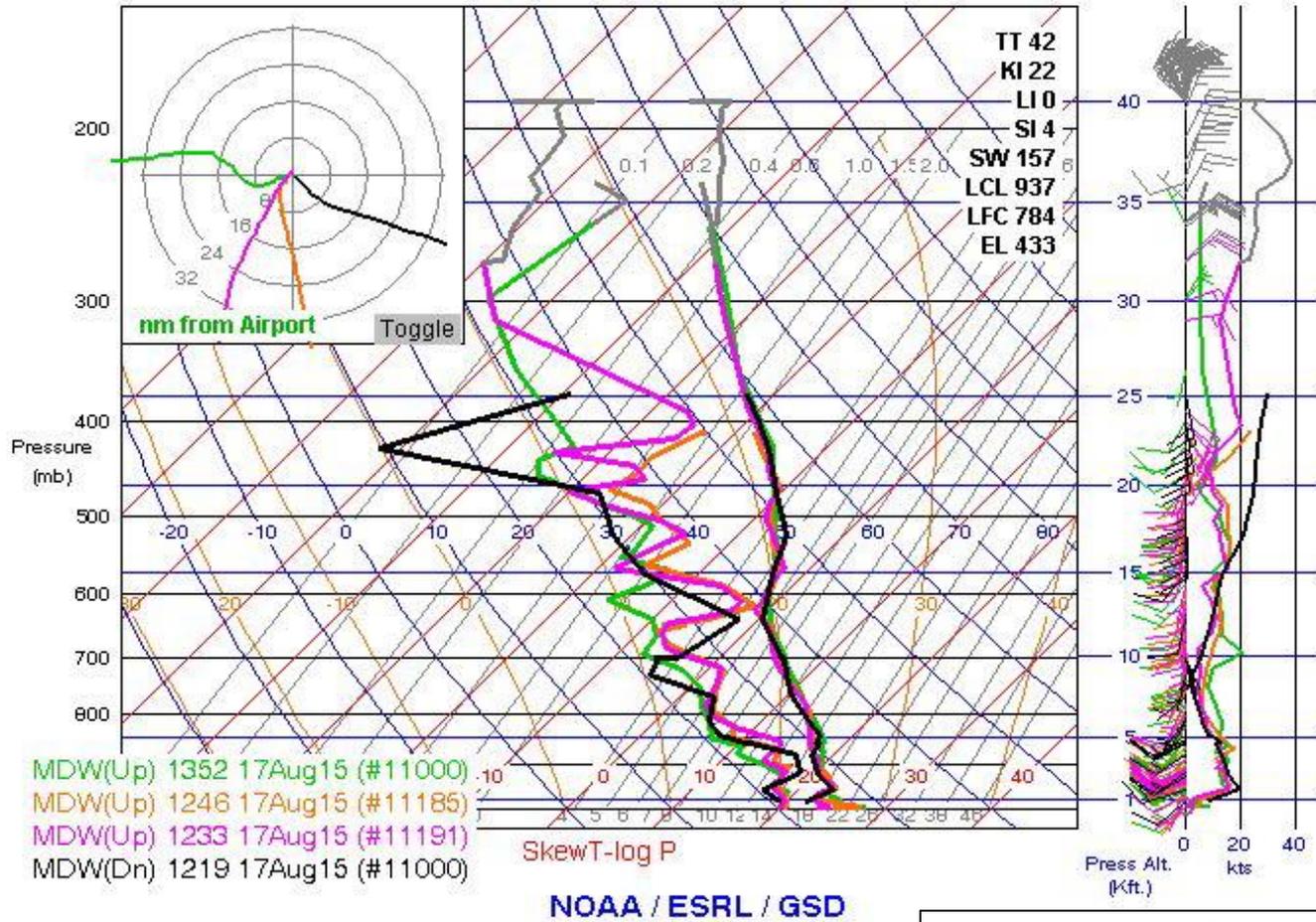
(MDW Descent Sounding)

# WVSS II Soundings - Temporal Resolution



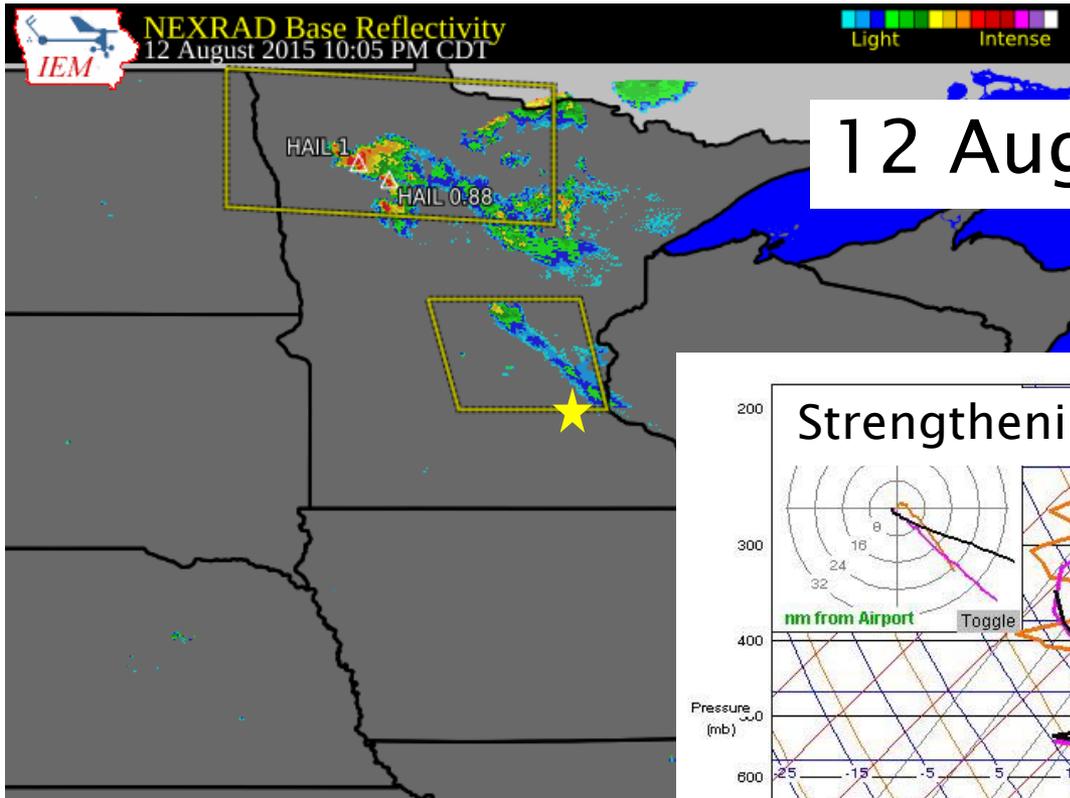
4 MKE profiles between  
1346 and 1432 UTC

# WVSS II Soundings – Temporal Resolution

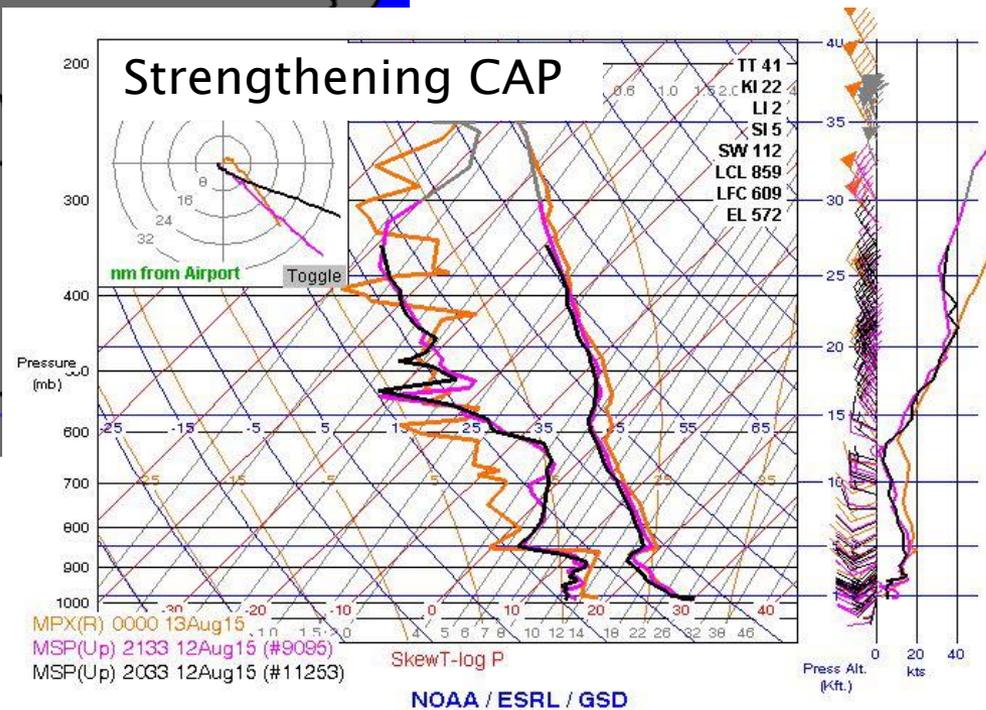


4 MDW profiles between  
1219 and 1352 UTC

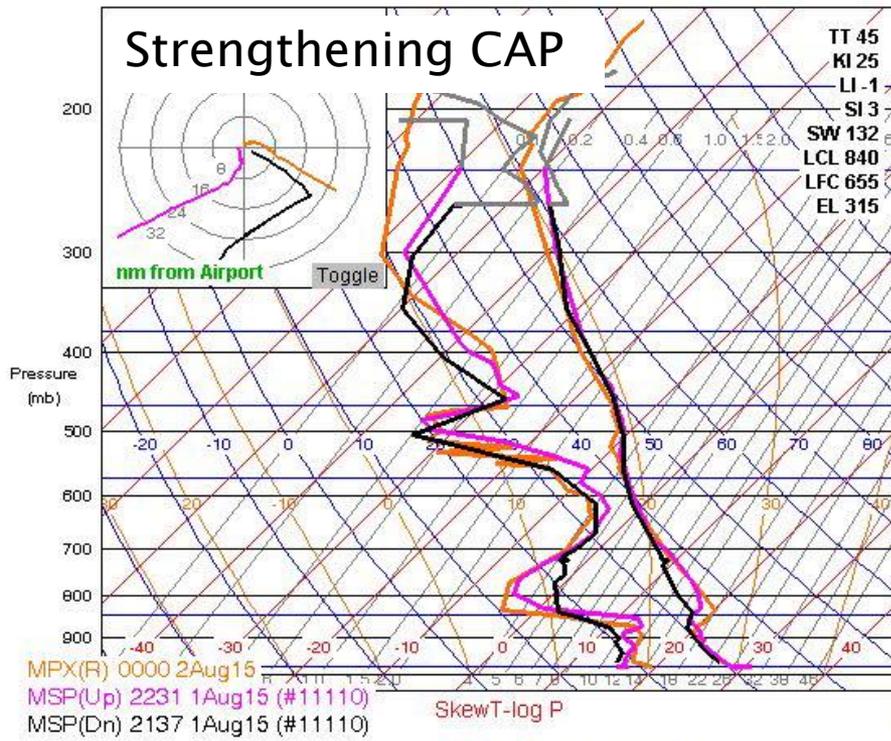
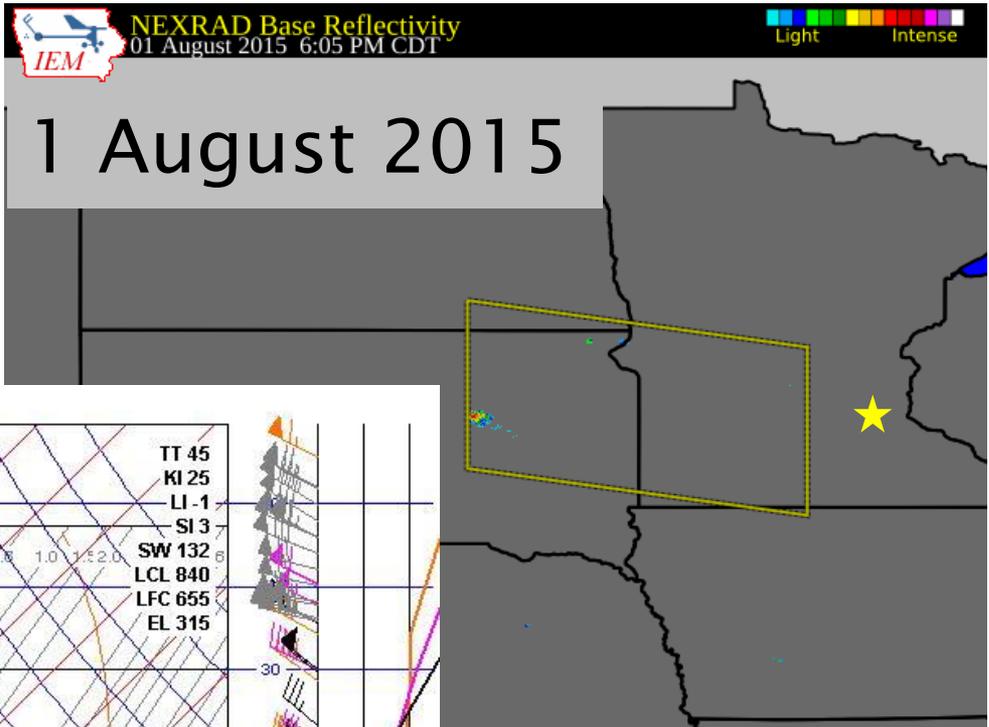
# WVSS-II Examples



12 August 2015

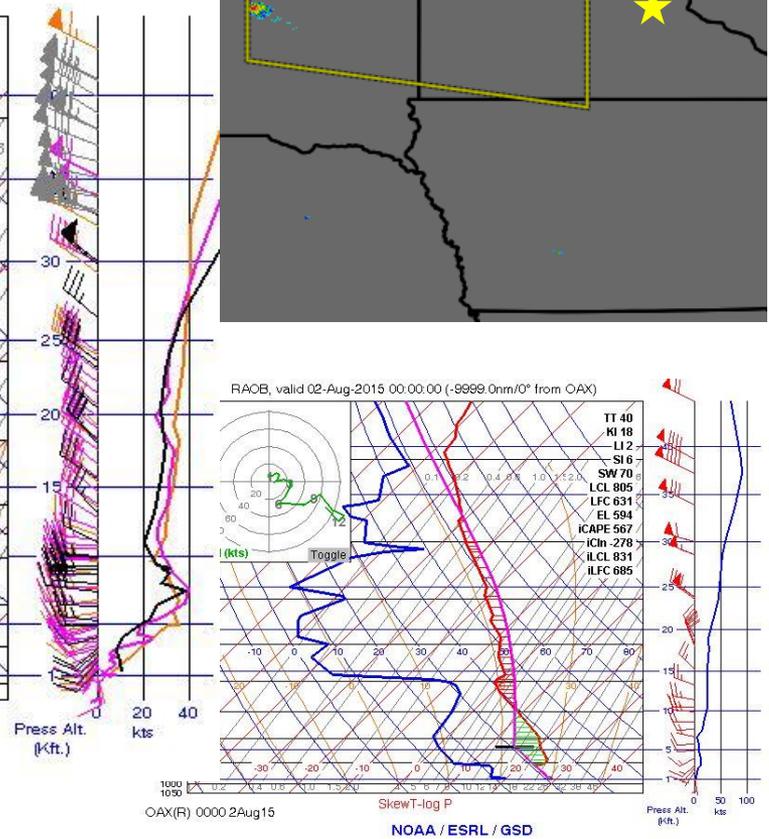


# WVSS-II Examples



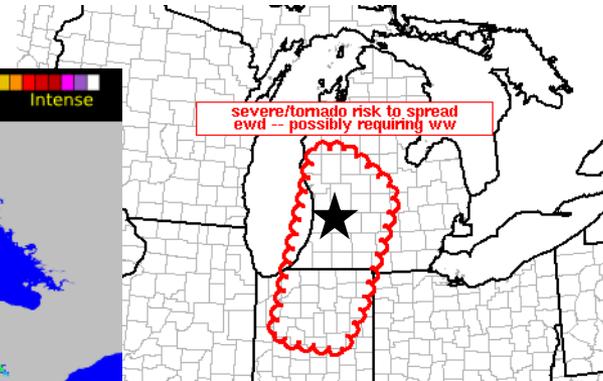
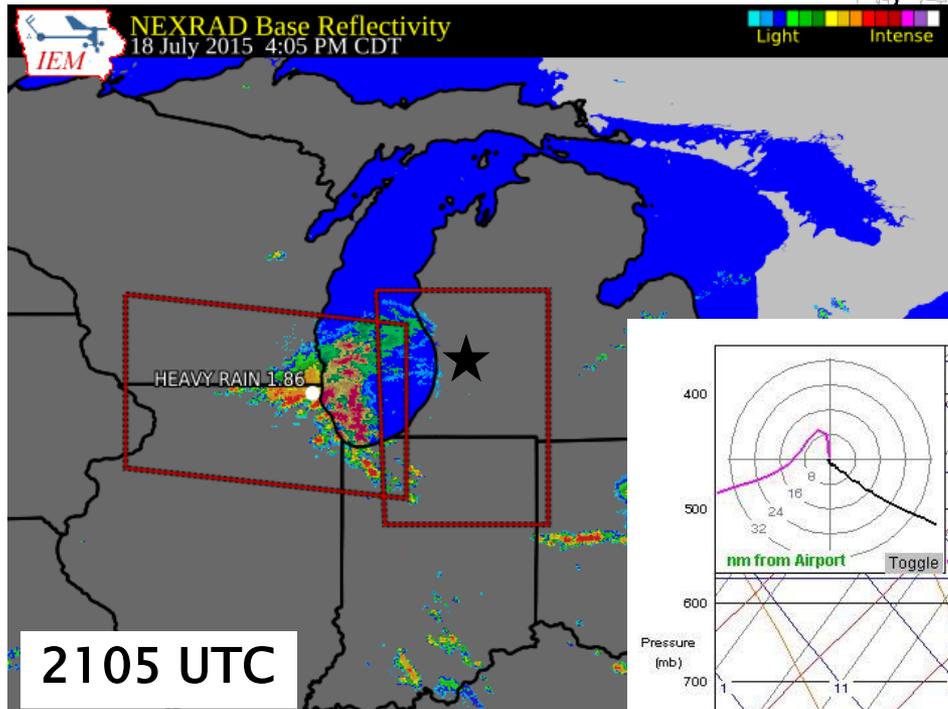
MPX(R) 0000 2Aug15  
MSP(Up) 2231 1Aug15 (#11110)  
MSP(Dn) 2137 1Aug15 (#11110)

NOAA / ESRL / GSD

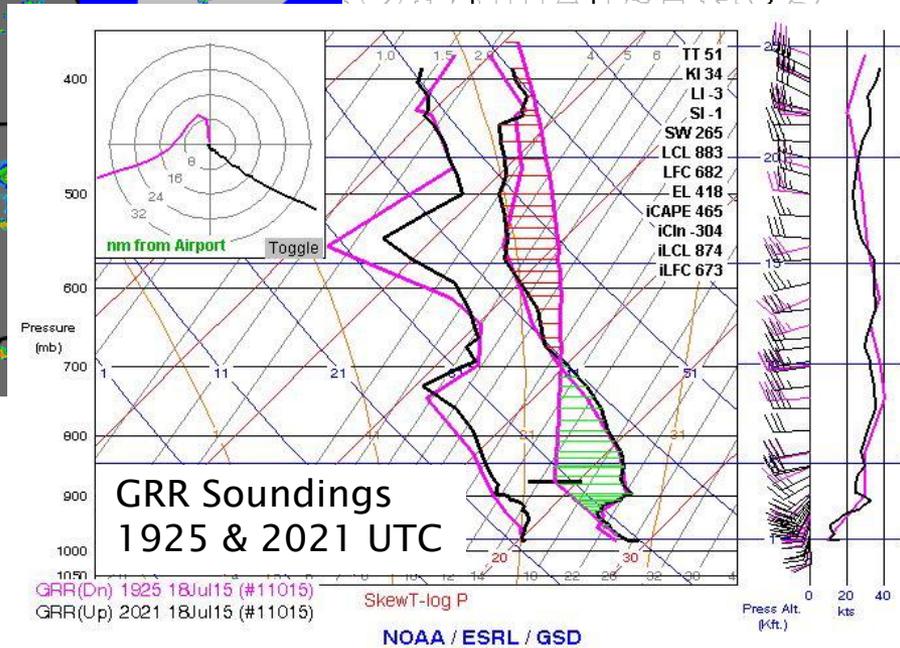


NOAA / ESRL / GSD

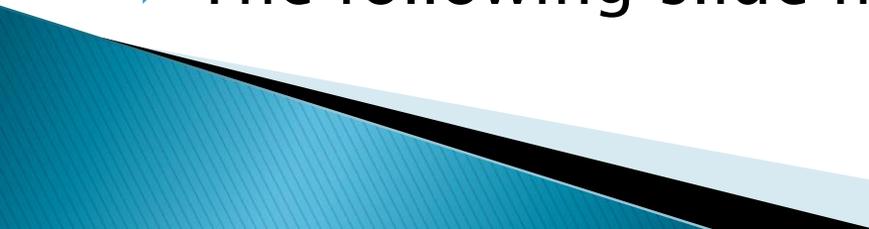
# WVSS-II Examples



18 July 2015



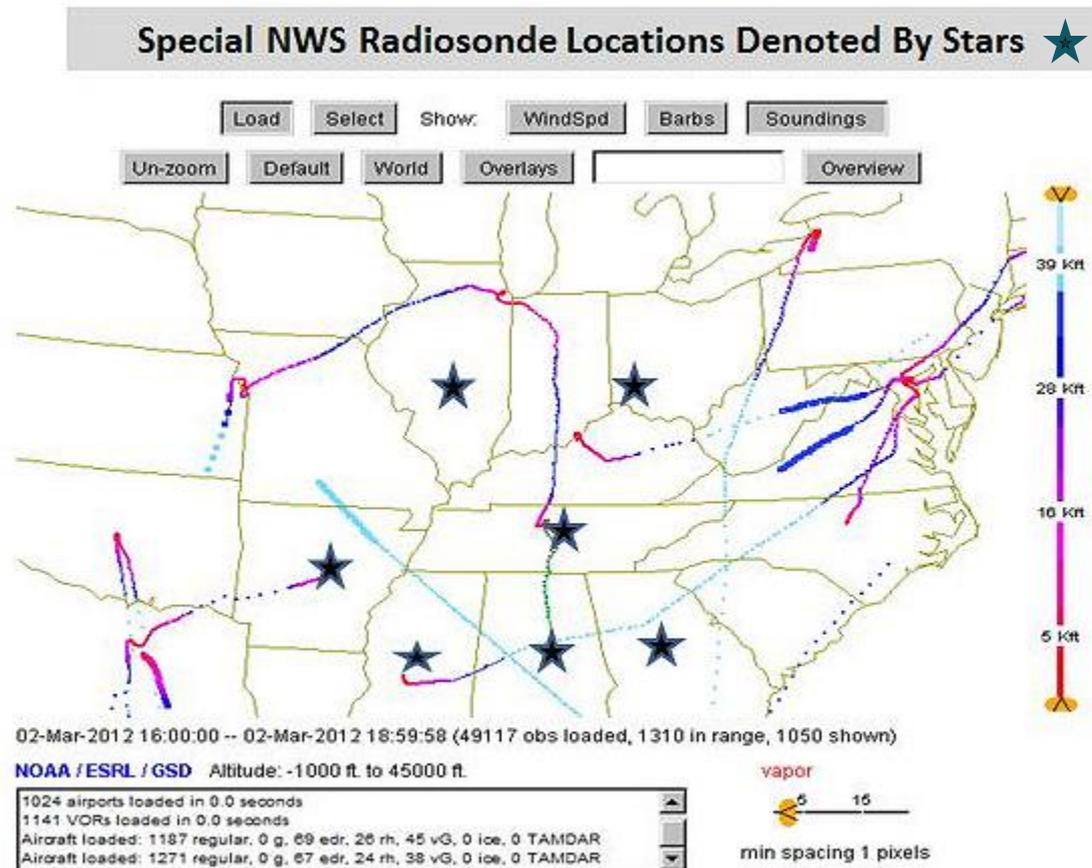
# March 2, 2012 Severe Storms

- ▶ Special 18 UTC RAOB launches were requested by SPC in support of an anticipated significant severe weather outbreak.
  - ▶ Seven NWS offices conducted special releases that afternoon.
  - ▶ At least three of them were not needed, as suitable aircraft soundings were available.
  - ▶ The following slide has the
- 

# Cost Saving Measure

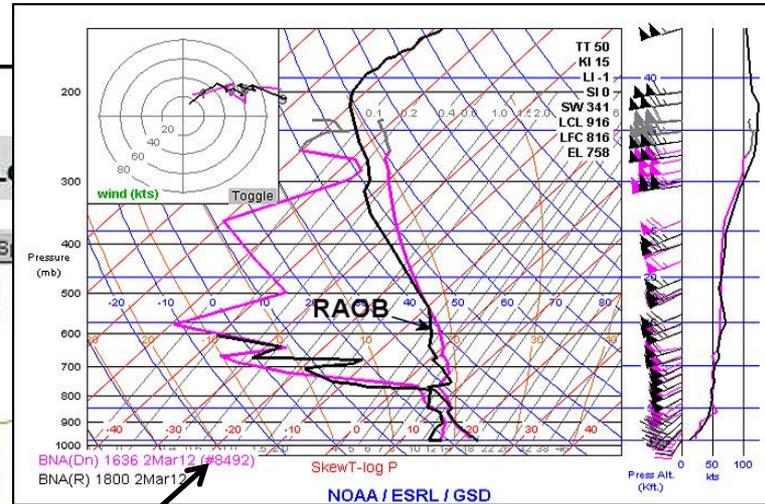
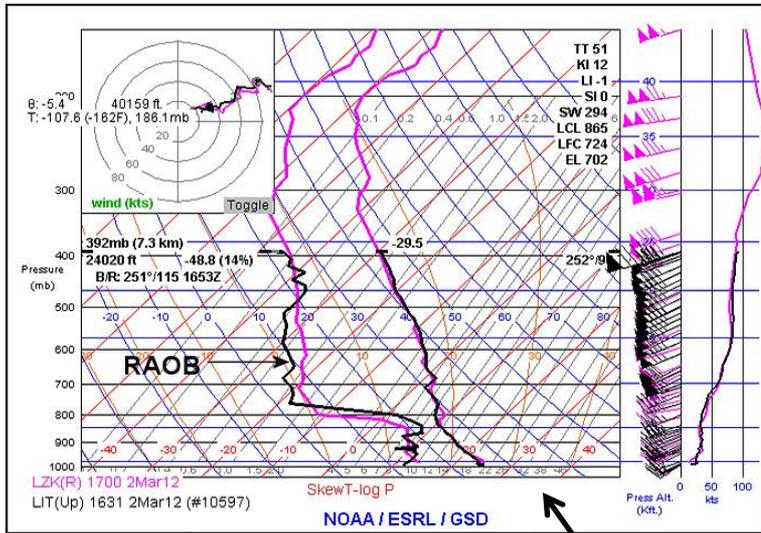
Locations of special 18 UTC releases and tracks of WVSS-II aircraft.

AMDAR Web Page



WVSS-II Soundings available between 1600 and 1900 UTC on 3/2/2012

# Cost Saving Measure

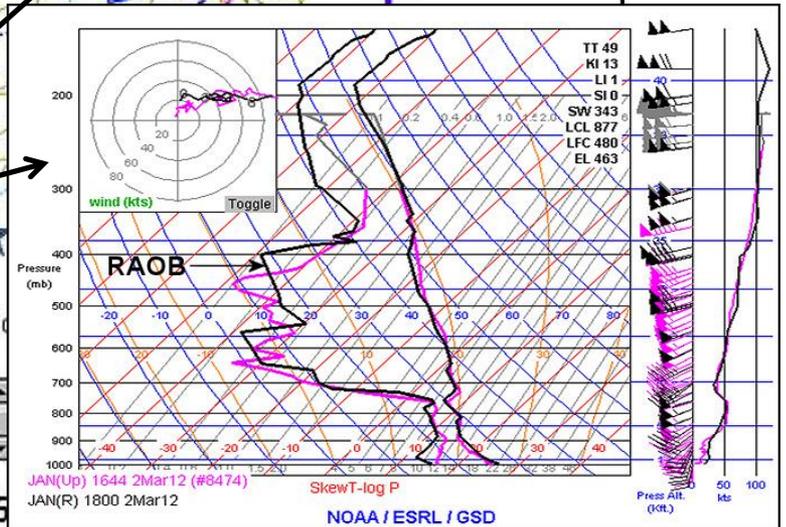


02-Mar-2012 16:00:00 -- 02-Mar-2012 18:59:58 (49117 obs loaded, 1310 VORs loaded)

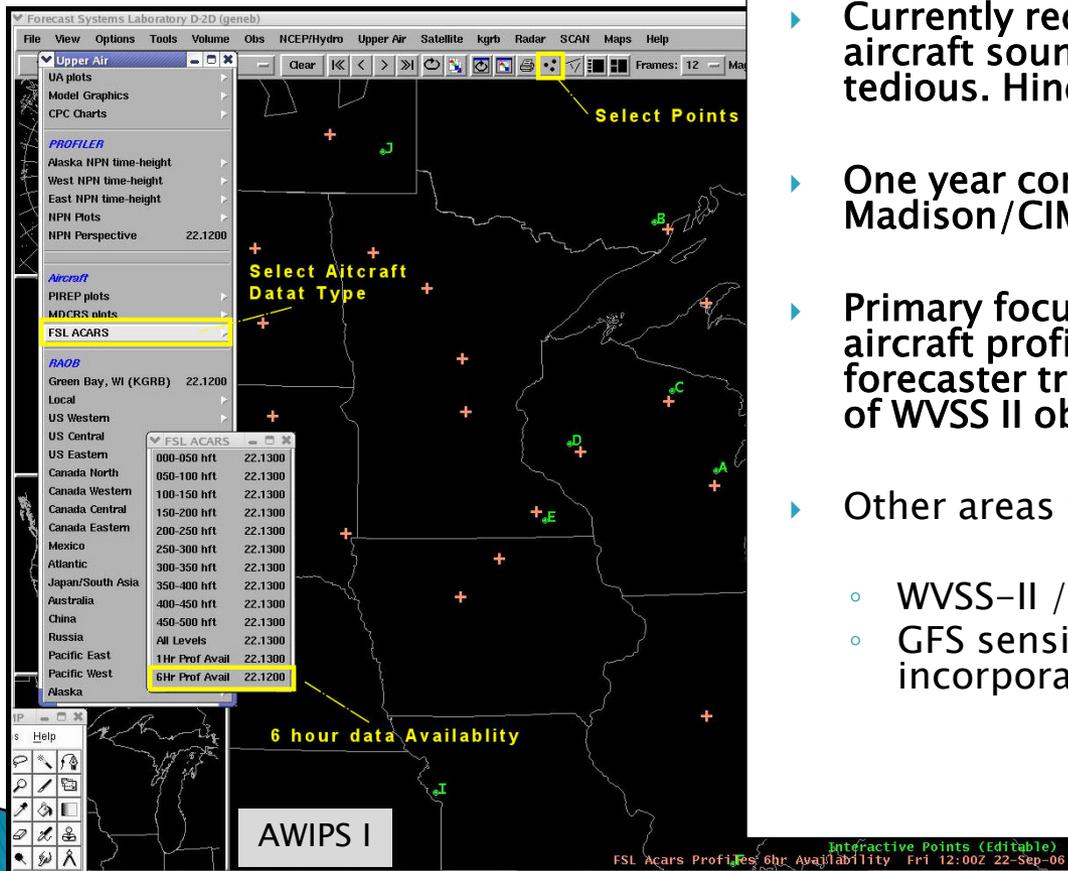
NOAA / ESRL / GSD Altitude: -1000 ft. to 45000 ft.

1024 airports loaded in 0.0 seconds  
1141 VORs loaded in 0.0 seconds  
Aircraft loaded: 1187 regular, 0 g, 69 edr, 26 rh, 45 vG, 0 ice, 0 TAMDAR  
Aircraft loaded: 1271 regular, 0 g, 67 edr, 24 rh, 38 vG, 0 ice, 0 TAMDAR

**WVSS-II Soundings available between 16:00 and 18:59 on 02-Mar-2012**



# AMDAR Data Display Improvements in AWIPS II



- ▶ Currently requires several steps to display aircraft sounding in AWIPS. Inefficient and tedious. Hinders operational use.
- ▶ One year contract awarded to UW Madison/CIMSS.
- ▶ Primary focus to improve display capability of aircraft profiles within AWIPS II and develop forecaster training material (particularly value of WVSS II observations).
- ▶ Other areas of focus include:
  - WVSS-II / NWS RAOB comparisons
  - GFS sensitivity studies for possible incorporation of WVSS-II into the GFS.

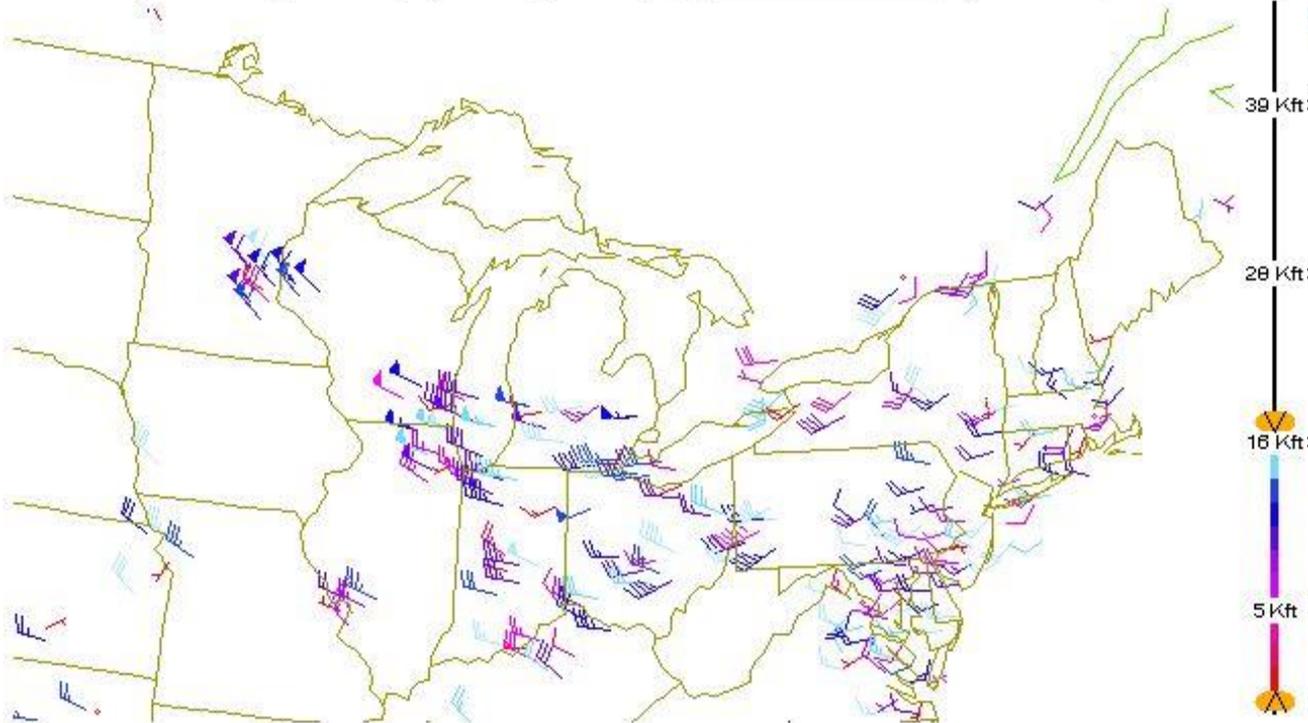


# AMDAR Data Display Improvements in AWIPS II

AMDAR Web Page

Load Select Show: WindSpd Barbs Soundings  
Un-zoom Default World Overlays  Overview

Slider Bar  
Capability

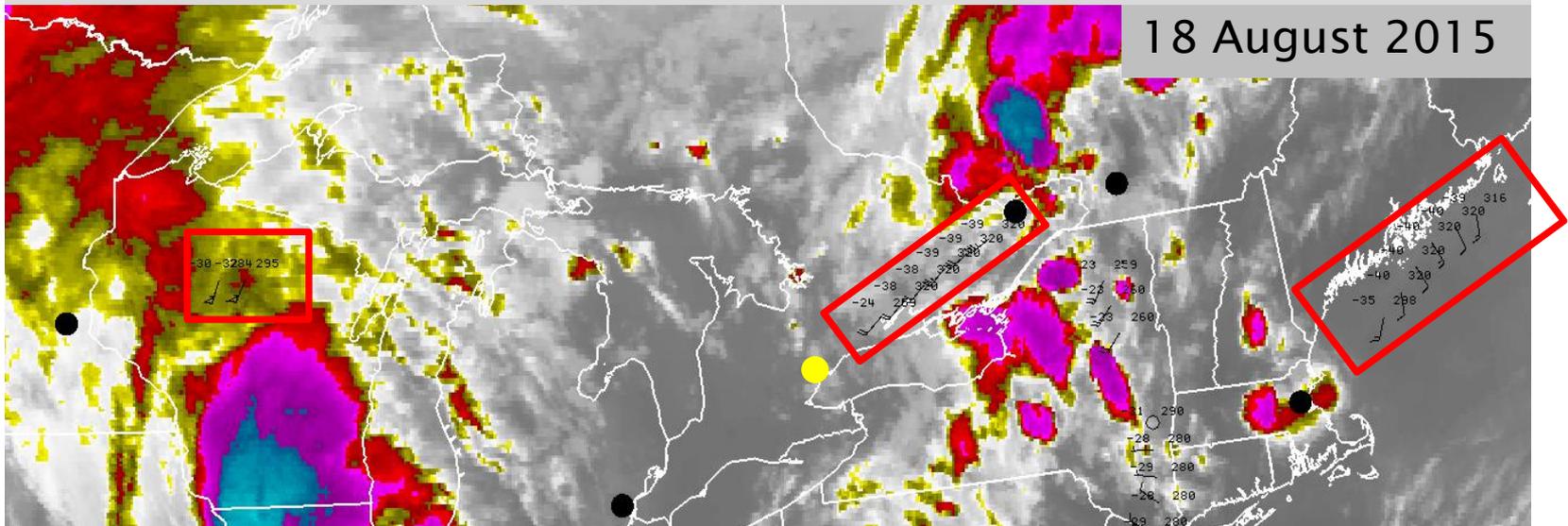


24-Aug-2015 12:00:00 -- 24-Aug-2015 15:33:00 (110140 obs loaded, 12326 in range, 264 shown)

NOAA / ESRL / GSD Altitude: -500 ft. to 17000 ft.

All data

# AMDAR Data Display Improvements



18 August 2015

## Clickable Points Feature

- Simply click on point (black dot) to display sounding.
- Overlay on any image. Time Matching.
- Slider bar to constrain reporting altitude.
- Distinguish soundings containing moisture.
- Overlay with other sounding data (Model, RAOB).
- Animation/trends?
- **Your Ideas?**

CRS 250-300hft Tue 23:00Z 18-Aug-15  
CRS 300-350hft Tue 23:00Z 18-Aug-15  
ibility (Editable) Tue 23:00Z 18-Aug-15  
IR Satellite (C) Tue 23:00Z 18-Aug-15

# AMDAR Internet Web Page

## AMDAR Data Display from ESRL/GSD

 Latest version: **1-April-2015**. E-AMDAR data has returned. Also, in the 'Select' window, you can choose to restrict the display to AeroMexico, Japanese, or Korean. [change details \(new window\)](#) for more information. Please notify [aircraft\\_request.gsd@noaa.gov](mailto:aircraft_request.gsd@noaa.gov) of any problems.

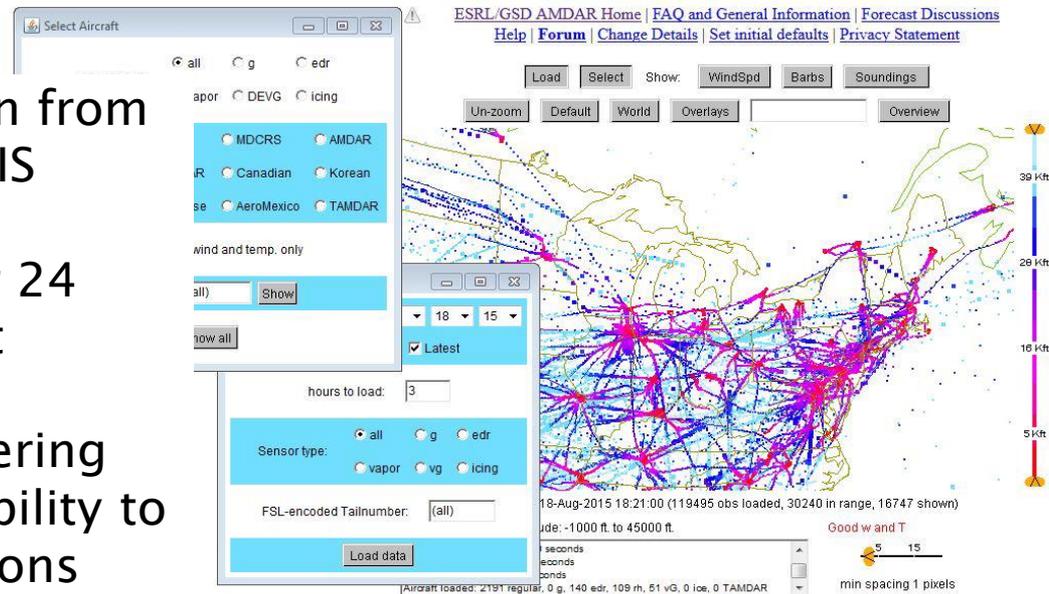
Per our agreements with participating airlines, this data may not be redistributed to third parties. (Use of images in research publications)

Will transition from ESRL to MADIS

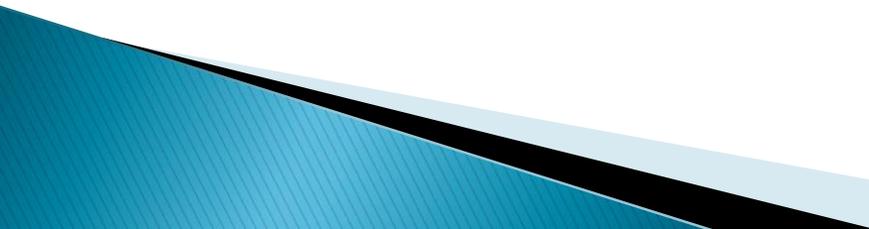
Will allow for 24 hour support

WMO considering display capability to member nations

Provide Archive



# Provide Water Vapor Sensor Data (WVSS-II) To Public Domain

- ▶ AMDAR data have been restricted by the airlines to the airlines themselves, the NWS, defense department and university researchers.
  - ▶ A new contract will permit the NWS to distribute the WVSS-II data to the private sector and public in real-time starting at the end of this year.
  - ▶ Moving these data to the public domain will allow it to be leveraged by pilots, dispatchers, private weather companies, etc.
  - ▶ Data will be provided via the MADIS web page.
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# WMO AMDAR Web Page



World Meteorological Organization  
Weather • Climate • Water

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## Aircraft-based Observations

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## AMDAR and Aircraft-based Observations Papers and References

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1. ABO & AMDAR Systems Operation
2. ABO & AMDAR Use in & Impact on NWP
3. Upper Air Comparisons
4. ABO & AMDAR Use in Forecast Applications



### Links

NOAA, GSD References

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WIGOS

### ABO & AMDAR Systems Operation

Author	Year	Title	Published
Anderson, A. K	2006	AirDat system for ensuring TAMDAR data quality	10th Symposium on Integrated Observing Systems for Atmosphere, Oceans, and Land Surface (IOAS-AOLS), Atlanta, GA, Amer. Meteor. Soc
Baker, R., Curtis, R., Helms, D., Homans, A., Ford, B	2011	Studies of the Effectiveness of the Water Vapor Sensing System, WVSS-II, in Supporting Airline Operations and Improving Air Traffic Capacity	Second Aviation, Range and Aerospace Meteorology Special Symposium on Weather- Air Traffic Management Integration, AMS Annual Meeting, Jan 2011, Seattle, WA
Barth, M.F., P.A. Miller, and A.E. MacDonald	2002	MADIS: The Meteorological	Symposium on Observations, Data Assimilation, and Probabilistic

# Future of AMDAR in the National Weather Service

*Questions?*

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