Using AMDAR Aircraft Observations at the National Weather Service Forecast Office Raleigh, North Carolina

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The Problem

Traditional observations of the troposphere via the National Weather Service (NWS) radiosonde network often lack the spatial and temporal density that operational meteorologists at the local Weather Forecast Office (WFO) desire.

AMDAR Soundings Can Provide Much Needed Data

Aircraft Meteorological Data Relay (AMDAR) is an international effort within the World Meteorological Organization to coordinate the collection of environmental observations from commercial aircraft. There are several overlapping subsets of AMDAR data including ACARS, MDCRS, TAMDAR, Canadian, and E-AMDAR which are differentiated based on sensor type and communication system. Meteorological instrumentation of aircraft and the dissemination of that data can provide forecasters with a tremendous increase in the number and location of observations of the troposphere which often result in improved forecasts and greater forecast confidence.

AMDAR Benefits

- Real observations of temperature, wind direction, wind speed, and at times moisture
- Increase in temporal frequency of observations vs. radiosondes
- Increase in horizontal frequency of observations vs. radiosondes and profilers
- Availability of data at asynoptic times

Hourly statistics of AMDAR observations at the Raleigh-Durham International Airport (KRDU) and the Piedmont-Triad International Airport in Greensboro (KGSO) were collected and analyzed. During the 12 month period from June 1, 2008 through May 31, 2009 over 6,400 AMDAR observations were recorded at KRDU and over 4,000 AMDAR observations were recorded at KGSO.

The two charts below show the average number of AMDAR soundings during each hour of every day of the week at KRDU and KGSO. The times shown have been adjusted to local time. The greatest frequency of observations generally occurs from Tuesday through Saturday at 600 AM, 1000 AM, 600 PM, and 1000 PM local time.

KRDU	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
Monday	0.0	0.0	0.0	0.0	0.0	1.3	1.1	0.4	0.9	2.1	0.4	0.9	1.5	0.4	0.8	0.5	1.4	2.4	2.0	1.4	0.3	0.8	0.3	0.0
Tuesday	0.0	0.0	0.1	0.7	0.7	2.4	1.7	0.5	1.1	2.0	0.8	0.8	1.5	0.5	0.6	0.4	1.5	3.2	2.8	1.2	0.4	3.1	0.3	0.0
Wednesday	0.0	0.0	0.1	0.7	0.9	2.1	1.9	0.7	1.0	1.8	0.7	0.8	1.8	0.3	0.8	0.5	1.4	3.1	2.0	1.5	0.4	3.0	0.4	0.0
Thursday	0.0	0.0	0.3	0.6	0.9	2.3	1.8	0.5	1.0	1.8	0.7	1.2	1.4	0.3	0.7	0.5	1.3	2.8	2.8	1.3	0.3	3.0	0.3	0.1
Friday	0.0	0.0	0.1	0.7	0.9	2.3	1.6	0.5	1.0	2.4	0.6	1.0	1.8	0.4	0.9	0.4	1.4	3.1	2.8	1.5	0.5	3.1	0.2	0.0
Saturday	0.0	0.0	0.0	0.0	0.1	2.2	1.8	0.3	0.6	1.9	0.5	1.0	1.4	1.2	0.6	0.2	0.7	1.2	1.8	1.7	0.3	1.6	0.3	0.1
Sunday	0.0	0.0	0.0	0.0	0.0	0.7	1.2	0.3	0.7	1.4	0.8	0.8	1.5	0.7	0.7	0.5	1.3	2.9	1.5	0.5	0.2	0.1	0.0	0.0

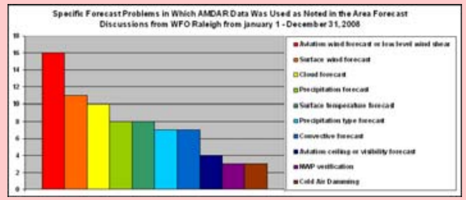
KGSO	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
Monday	0.1	0.0	0.0	0.0	0.5	0.6	0.1	0.0	0.4	1.0	0.8	0.6	0.7	0.7	0.2	0.4	1.0	1.2	0.4	0.1	0.2	0.4	0.8	0.2
Tuesday	0.1	0.1	0.0	0.1	1.4	1.4	0.1	0.8	0.5	1.1	0.7	0.8	0.8	0.7	0.2	0.6	1.2	2.1	0.8	0.2	0.1	1.8	1.1	0.1
Wednesday	0.1	0.0	0.0	0.1	1.4	1.6	0.3	0.9	0.6	1.1	0.8	0.7	0.7	0.7	0.3	0.5	1.2	2.0	0.8	0.2	0.0	2.0	1.1	0.2
Thursday	0.0	0.1	0.0	0.0	1.5	1.5	0.2	0.7	0.4	0.9	0.9	0.6	0.6	0.9	0.1	0.4	1.3	2.1	0.8	0.1	0.2	1.8	1.0	0.1
Friday	0.0	0.0	0.1	1.0	1.4	0.6	0.7	0.6	0.7	0.8	0.6	0.9	1.1	0.5	0.5	0.9	1.7	1.2	0.3	0.2	1.3	1.3	0.4	0.1
Saturday	0.5	0.1	0.1	1.1	1.0	0.2	0.2	0.9	0.4	0.4	0.3	0.2	0.8	0.9	0.1	0.0	0.5	1.2	0.6	0.2	0.0	2.0	1.1	0.2
Sunday	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.8	0.5	0.8	0.6	0.4	0.8	0.7	0.3	0.5	1.4	2.0	0.5	0.3	0.1	0.2	0.2	0.0

AMDAR Challenges

- Many AMDAR soundings lack dew point data
- Sounding availability is limited and can be irregular due to flight schedules
- Data impacted by mesoscale or microscale phenomenon
- Data interpretation for a sounding location can be complicated by varied flight and landing patterns
- Hazardous weather can impact flight schedules and data availability
- Height of data is not measured directly but based on standard atmosphere
- Data availability is restricted to NOAA and other specific user groups

Asset for Numerous Forecast Problems

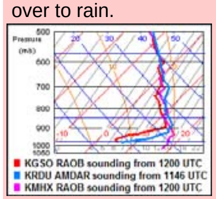
- Precipitation-type forecasts
- Evaluating environment for near term severe convection
- Aviation forecasts of cloud coverage and height
- Determining potential for low level wind shear
- Forecast of surface temperatures and dew points
- Examining cold air damming events
- Fire weather forecast parameters including mixing height, winds, and boundary layer moisture
- Forecast of fog and low cloud decks
- Hazardous materials events and decision support services
- Comparison of numerical weather prediction forecasts with observed data

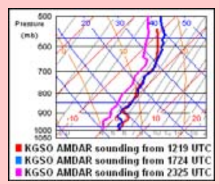


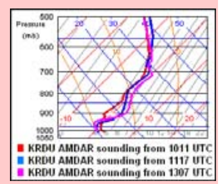
Area Forecast Discussions from WFO Raleigh were examined during a 12 month period from January 1, 2008 through December 31, 2008. A total of 77 unique cases were identified in which AMDAR data was used or mentioned.

Precipitation-Type Examples

AMDAR soundings can be used to determine and monitor the depth of the cold air near the surface especially in cold air damming events such as April 4, 2008 (lower left). The soundings can also be used to monitor the degree of cooling aloft due to melting snow. On January 19, 2008 (center), melting snow gradually cooled the above freezing temperatures at KGSO eventually allowing snow to be observed at the surface. On January 17, 2008 (right), forecasters used AMDAR soundings to verify model guidance which indicated that warming near 900 hPa would increase changing light snow over to rain.







Aviation Example

The AFD for the 12 UTC TAF issuance on May 20, 2008 notes that AMDAR observations were used to assess and Include the threat of low level wind shear (LLWS) conditions. Both the SkewT-log P diagram and the text output were used for this analysis.

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AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RALEIGH NC
745 AM EDT TUE MAY 20 2008

10Z AMDAR SOUNDINGS OUT OF GSO/RDU SHOWED WINDS OF NEAR 50 KTS AT
2 KFT. THIS HAS CAUSED ALMOST CERTAIN LOW LEVEL WIND SHEAR IN THE
PREDAWN TO SUNRISE HOURS ACROSS THE REGION.

TAF
KRDU 200531Z 200606 VRB05KT P6SM SCT100
     FM1000 17007KT P6SM OVC120 WS020/22040KT
     FM1300 21017G30KT P6SM SCT040 SCT080
     FM1800 23017G30KT P6SM VCTS BKN040CB
     FM0000 31008KT P6SM SCT100=
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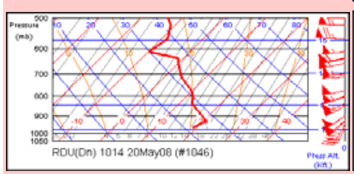


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RDU(Dn) 1014 20May08
Descent sounding from 282° into Raleigh-Durham, NC (RDU)
lasting 35 min, and covering 219 nautical miles (Aircraft #1046)

 P_alt    mb     t/td     w_dir/w_spd Time   Bng/Rng
 (ft)            (°C)           (kts) (UTC)      (nm)

 1300    967   19.1/-----   203°/022 1014   32°/003
 1860    947   20.0/-----   208°/043 1013   40°/005
 2350    930   20.0/-----   224°/051 1012   33°/006
 2499    925   20.4/-----   225°/051
 3200    899   18.5/-----   233°/051 1011   10°/008
 4779    850   14.2/-----   239°/053
 5100    837   13.1/-----   241°/053 1010  350°/011
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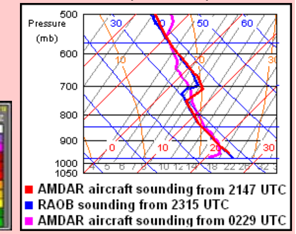
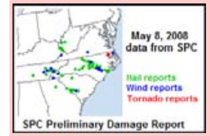
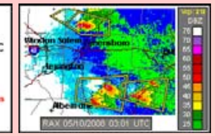
Severe Convection Example

Severe thunderstorms were not expected across central NC late on May 9, 2008 because of a capping inversion near 700 hPa. The Skew-T plot below shows the erosion of the cap via the 2147 UTC AMDAR aircraft sounding at KGSO (red line), the KGSO RAOB released at 2315 UTC (blue line), and an 0229 UTC AMDAR aircraft sounding at KGSO (purple line). AMDAR data was used to verify the model forecasts and anticipate an increase in convection.

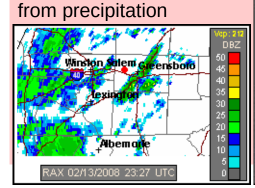


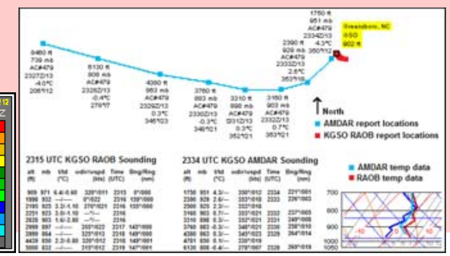




Interpretation Example

Differences between the temperature profile in the RAOB (red line) and the AMDAR sounding (light blue line) are noted in the SkewT-log P diagram below despite the fact that the two instruments sampled the atmosphere within 20 minutes of each other – likely from diabatic cooling from precipitation





How AMDAR Usage was Increased at WFO Raleigh

- Ensure as many AMDAR observations as possible are available in AWIPS via the GSD LDM feed
- Demonstrate the utility and added value of AMDAR data at shift briefings, case studies and post mortems
- Provide training on accessing the data, using it properly, and its limitations
- Developed a local application to alert forecasters of the arrival of AMDAR data when it becomes available in AWIPS
- Examine the frequency of observations and build awareness of days and times in which the data is likely to be available
- Note the utility of AMDAR in Area Forecast Discussions

Acknowledgements

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