

Jamie T. Braid\* and Jeffrey E. Rex  
AirDat, LLC, Evergreen, CO

## 1. INTRODUCTION

The TAMDAR (Tropospheric Airborne Meteorological Data Reporting) Sensor is an airborne atmospheric instrument developed under contract by AirDat for NASA. The TAMDAR Sensor measures temperature, turbulence, icing, relative humidity (RH), pressure altitude, GPS altitude, and winds. Using global satellite communications, this data is then streamed to the AirDat data center in real time (Daniels 2004). An example of the TAMDAR Sensor is shown in Figure 1.

The planes on which TAMDAR flies are unique because unlike the larger jets that fly above the weather, these aircraft are flying where the weather is happening. In addition, there are hundreds of flights per day which act as soundings, a large number of which are from airports that do not have normal radiosonde launches. This increased number of soundings can be useful to both modelers and forecasters to improve the accuracy of model forecasts as well as short term forecasts like watches and warnings.



**Figure 1:** Picture of the TAMDAR Sensor

The initial TAMDAR sensors were installed in the summer of 2005 on the Mesaba Airlines Saab SF340 aircraft as part of the Great Lakes Fleet Experiment (GLFE). Since the success of this experiment, AirDat has been working diligently to increase the number of TAMDAR Sensors reporting weather data as well as increasing the overall CONUS coverage of that fleet. As of January 1, 2009, AirDat has a total of 137 aircraft that are equipped with TAMDAR Sensors. Of these, a total of 130 TAMDAR Sensors are flying on the aircraft of five different airlines (Mesaba, Republic, Horizon, PenAir and Piedmont). The remaining seven are installed on assorted research and development (R&D) aircraft.

\* *Corresponding Author Address:* Jamie T Braid, AirDat LLC, 30746 Bryant Drive, Unit 410, Evergreen, CO 80439, jbraid@airdat.com

This paper, and the corresponding presentation, will detail the changes to the TAMDAR fleet since the initial installations of the GLFE as well as outline AirDat's plan to move toward complete CONUS coverage over the next 12-18 months.

## 2. CURRENT FLEET COVERAGE

### 2.1 Mesaba and the Great Lakes Fleet Experiment

As stated in the introduction, the first TAMDAR Sensors to be installed on operational aircraft were installed on the Mesaba Saab SF340 aircraft as part of the GLFE. As of January 1, 2009, a total of 49 TAMDAR-equipped aircraft remain in the Mesaba fleet. Mesaba Airlines has three major hubs (Minneapolis, Detroit and Memphis) and flies to cities in 21 different states in the Midwestern and Southern United States as part of the Northwest Airlines system. A large number of Mesaba's flights are out of its Minneapolis and Detroit hubs which lead to a large number of the TAMDAR observations from this "Great Lakes" region. Figure 2 is the coverage seen from the TAMDAR equipped Mesaba fleet on 12/31/2008 from 00:00Z to 23:59Z.



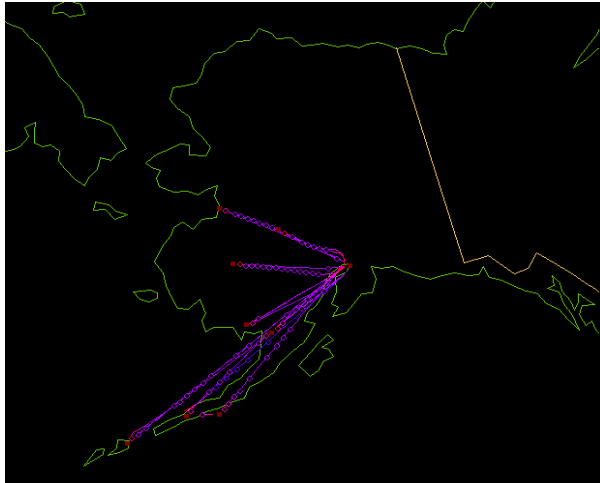
**Figure 2:** Mesaba TAMDAR fleet coverage from 00:00Z to 23:59Z on 12/31/2008.

Over the past six months, AirDat has been upgrading the TAMDAR hardware and software on this fleet to bring them in line with the newer TAMDAR Sensors being installed on other fleets.

### 2.2 Peninsula Airlines (PenAir)

In June of 2007, AirDat began equipping the Saab SF340 turboprop aircraft operated by PenAir. The installations were completed as of December 2007. All 10 of the PenAir Saab SF340 aircraft are equipped with

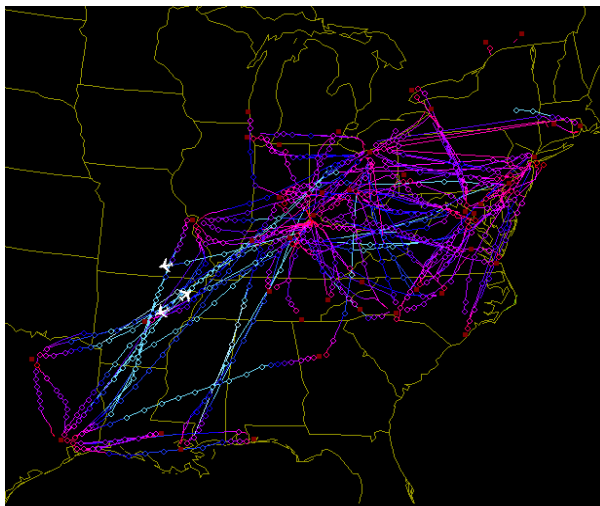
TAMDAR Sensors. PenAir operates out of Anchorage, AK with a majority of their flights traveling down the Aleutians and a few flights flying into the southwestern and south central mainland of Alaska. Figure 3 shows the coverage of the TAMDAR-equipped PenAir fleet over a 24 hour period from 00:00Z to 23:59Z on December 31, 2008.



**Figure 3:** PenAir TAMDAR fleet coverage from 00:00Z to 23:59Z on 12/31/2008.

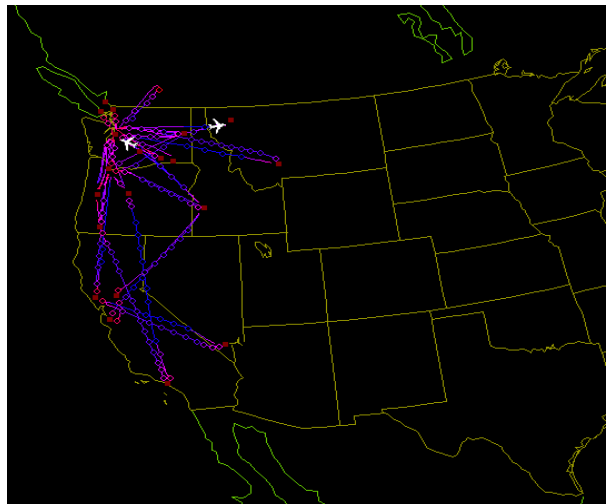
### 2.3 Chautauqua and Horizon Airlines

In late 2007, AirDat initiated TAMDAR installations on Chautauqua EMB-145 regional jets. These TAMDARs began transmitting data in early 2008 and, as of January 1, 2009, there are a total of 52 Chautauqua EMB-145s with TAMDAR installed. The Chautauqua EMB-145 fleet (flown under the banners of Continental Express, Delta, United Express and US Airways) provides a large area of coverage which includes parts of the Midwest, New England, Mid-Atlantic, Southeast and Eastern Texas. Figure 4 is a map showing all of the flights from the Chautauqua fleet on 12/31/2008 from 00:00Z to 23:59Z.



**Figure 4:** Chautauqua Airlines TAMDAR fleet coverage from 00:00Z to 23:59Z on 12/31/2008.

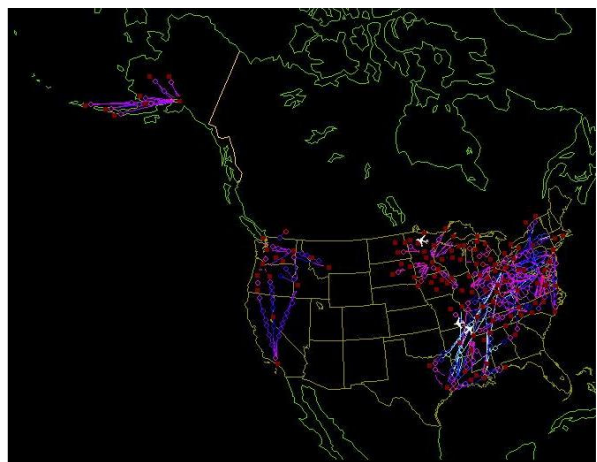
Also in 2008, AirDat started to install TAMDAR Sensors on a fleet of Bombardier Q400 Dash 8 turboprop aircraft operated by Horizon Airlines, a subsidiary of Alaska Airlines. These TAMDAR Sensors started data transmittal in October 2008 and, as of January 1, 2009, a total of 17 Horizon Bombardier Q400 aircraft are TAMDAR-equipped. The Horizon Q400 fleet has flights to over 40 cities in the Pacific Northwest, California, Montana, Nevada, and Arizona. Figure 5 is a map of the flights from the Horizon fleet on 12/31/2008 from 00:00Z to 23:59Z.



**Figure 5:** Horizon Airlines TAMDAR fleet coverage from 00:00Z to 23:59Z on 12/31/2008.

### 2.4 Current Coverage – Combined

Figure 6 is a map showing the coverage all TAMDAR-equipped aircraft flying on 12/31/2008 from 00:00Z to 23:59Z. As seen from Figure 6, there is very good coverage from the Midwest to the east coast and down to the southern U.S., as well as increasing coverage along the west coast and in southwestern Alaska.



**Figure 6:** Total coverage for TAMDAR equipped fleets for December 31, 2008 from 00:00Z to 23:59Z

There are a few regions that are not yet covered by the currently equipped TAMDAR fleet. These include mainland and southeastern Alaska, the Southeast (portions of Florida, South Carolina, Georgia and Alabama), Mountain West, and the Great Plains. AirDat is currently working to fill the gaps to cover these regions and plans to have TAMDAR-equipped aircraft flying in these areas by the end of 2009.

### 3. PROJECTED FUTURE COVERAGE FOR 2009

#### 3.1 Additions to the Horizon and Chautauqua Fleets

Horizon aircraft continue to be equipped with TAMDAR Sensors, and an additional 30 aircraft will be equipped by fall of 2009, bringing the total number to 47. This will greatly enhance the flight coverage in the areas where Horizon flies. Similarly, there are 12 remaining aircraft to be equipped in the Chautauqua fleet.

#### 3.2 Mainland Alaska – Frontier Alaska

AirDat has an agreement in place to equip 12 Beech 1900 turboprop aircraft operated by Frontier Alaska. Frontier Alaska runs flights from their Anchorage and Fairbanks hubs to many cities in the mainland and the west coast of Alaska. The first installation is scheduled for February 2009 and all 12 of these aircraft should be equipped with TAMDAR by summer of 2009. This will bring the total number of TAMDAR-equipped aircraft in Alaska to 22 and will greatly increase the overall coverage in Alaska. Figure 7 shows the current coverage map for Frontier Alaska.



**Figure 7:** Current coverage map for Frontier Alaska Airlines. Referenced from the Frontier Alaska Airlines website (<http://www.frontierflying.com/>)

#### 3.3 Mid-Atlantic, East Coast and South - Piedmont

AirDat also has an agreement in place with Piedmont Airlines to equip a combination of 56 of their Bombardier Q100 and Q300 Dash 8 turboprop aircraft. The Piedmont fleet flies to a large number of cities along the East Coast, Mid-Atlantic and Southeastern United States. The second TAMDAR-equipped Piedmont aircraft was completed in December 2008 with the remainder of the fleet scheduled for installations at a

rate of four to five aircraft per month. At this rate, the 56 Piedmont aircraft should be equipped with TAMDAR by the end of 2009. The Piedmont fleet has some coverage overlap with the Chautauqua fleet, but increased coverage in the southern states and along the leeward side of the Appalachians was a primary reason AirDat deployed TAMDAR on this fleet. Additionally, it should be noted that the Q100 and Q300 turboprops fly lower and slower than the EMB-145 jets. Figure 8 illustrates the coverage from Piedmont Airlines as of July 3, 2008.

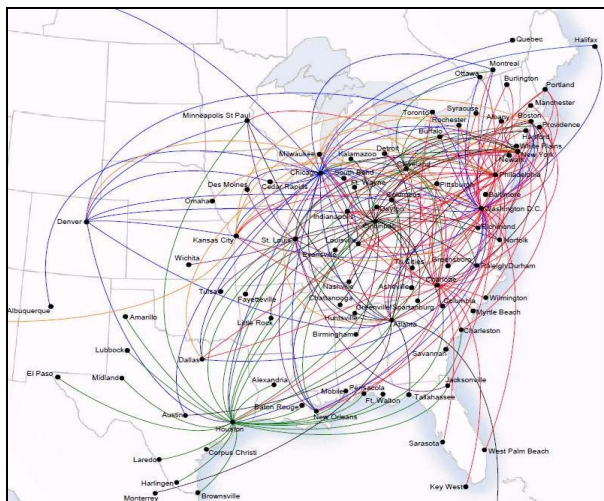


**Figure 8:** Piedmont Airlines coverage map as of July 3, 2008. Referenced from the Piedmont Airlines website (<http://www.allegheynairlines.com>)

#### 3.4 Mountain West, Great Plains and SE Alaska

In order to fill the gaps in the TAMDAR coverage over the Mountain West, Great Plains and SE Alaska, AirDat is establishing relationships with multiple regional airlines. Plans with Shuttle America, another subsidiary of Republic Airways (Chautauqua Airlines and Republic Airlines are the other two operators within this group) look promising and would add an additional 40 aircraft covering much of the Great Plains up to and including some cities along the Rocky Mountains. A coverage map for Shuttle America, as well as other Chautauqua and Republic Airlines routes, can be found in Figure 9.

Additional discussions with other carriers are ongoing to fill in the gap in the Mountain West and Southwest between the Horizon and Shuttle America fleets. Additionally, AirDat is in discussions with a few regional operators in SE Alaska.



**Figure 9:** Coverage map for Shuttle America. Shuttle America routes are in blue and black. This map was referenced from Republic Airways website (<http://www.republicairways.com/destinations.html>)

#### 4. DATA COMPARISONS AND IMPROVEMENTS

With 130 TAMDARs currently installed on operational aircraft, almost 2000 soundings per day are produced. With the additional installs already planned for 2009, the total number of soundings should increase to more than 3000 per day. Once AirDat secures an airline with routes filling the data gap in the Mountain West and Southwest, that number should surpass 4000 soundings per day.

The TAMDAR soundings happen at a greater frequency and at many more locations than the normal radiosonde launches. This additional data can give the weather community a more complete picture of the atmosphere:

- The TAMDAR data can be used in the models to continually improve model forecasts.
- Model improvements have been seen with the addition of the Mesaba TAMDAR data in the RUC (Moninger 2008).
- Some of the TAMDAR data, such as the Horizon data and TAMDAR data from sources in Alaska (PenAir and Frontier Alaska), can be used to help initialize models that are on a CONUS grid.
- Forecasters can use the TAMDAR sounding data to help produce and/or augment watches or warnings with a higher degree of certainty and accuracy.

#### 5. SUMMARY

AirDat is well on the way to attaining the goal of having full TAMDAR coverage throughout the CONUS during the next 12-18 months. By adding aircraft from new airlines, in addition to expanding the number of planes on some of their existing airline partner fleets, AirDat

projects having approximately in excess of 300 TAMDAR Sensors flying within this period. This increased coverage will mean a large increase in the overall data output by the TAMDAR System. TAMDAR soundings will increase from the current 1500-2000 per day up to approximately 3000 per day by the end of 2009. This data increase can be a very useful tool to models and forecasters.

#### 6. ACKNOWLEDGEMENTS

The authors of this paper would like to thank everyone involved in the process of expanding TAMDAR coverage over the last three and a half years since the first TAMDAR was installed.

#### 7. REFERENCES

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