A COMPARISON OF AN AUTOMATED FREEZING DRIZZLE ALGORITHM TO HUMAN OBSERVATIONS

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1. Introduction

In response to the aircraft engine damage caused by freezing drizzle at Denver International Airport (DIA, Rasmussen et al. 2006), an Automated Surface Observing System (ASOS) ice detector sensor was acquired and the Ramsey freezing drizzle algorithm (Ramsey, 1999) was incorporated into the DIA Weather Support to Deicing Decision Making (WSDDM). This system has run for several years, providing sensor-based observations of freezing drizzle to airline and airport operations personnel. Since its installation, no occurrences of freezing drizzle damage have been reported. The original engine damage noted in the Rasmussen paper occurred because the airport observers were often not reporting freezing drizzle in the METAR. Since the ASOS does not report freezing drizzle, human observers augment METARs for reports of freezing drizzle. Because of this, a study was undertaken to determine what types of precipitation are reported in the METARs (both the automated reports of precipitation type from the ASOS and the augmented reports from observers) during times when the Ramsey algorithm indicates the presence of freezing drizzle.

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2. Methodology

In order to accurately compare the METAR reports to the output of the freezing drizzle algorithm, nine years worth of 1-min ASOS data (2001-2009) were collected from the Denver International Airport (DIA), Chicago O'Hare and Pittsburgh International Airport ASOS. The data were processed using the Ramsey freezing drizzle algorithm and then compared to the concurrent METAR reports from each location. For every minute of freezing drizzle detected by the algorithm, the corresponding METAR precipitation-type report was compiled. Histograms were created for each of the sites comparing the output of the freezing drizzle algorithm to the METAR reports. Precipitation-type from the METARs was separated into reports of BR (mist), FZRA (freezing rain), FZDZ (freezing drizzle), FZFG (freezing fog), and SN (snow). Any other types of precipitation (rain, drizzle, ice pellets, etc) were grouped into an additional category of 'other' along with any reports of obscurations to visibility (haze, fog, etc). A null category was created for time periods when the algorithm was reporting FZDZ, but no precipitation was reported by ASOS.

3. Results

Once the ASOS data were processed by the algorithm and the corresponding METAR data collected, each airport site was individually analyzed. In addition to comparing total minutes of observed precipitation types to the output of the algorithm, percentages of the time each precipitation type was occurring were also

analyzed and compared among the three airports.

3.1 Pittsburgh International Airport

For the nine-year time period analyzed at Pittsburgh International Airport, the Ramsey algorithm detected a total of 5962 min of freezing drizzle. Table 1 shows the corresponding METAR reports of precipitation type during these 5962 minutes. The METAR observations were in agreement with the algorithm only 15% of the time. Almost half of the time, BR was reported and almost a third of time, no precipitation was reported. FZRA, FZFG, SN or other types of precipitation were rarely reported (Fig. 1).

Precipitation Type	Total Minutes	Percentage
None	1778	30%
BR	2847	47%
FZDZ	892	15%
FZRA	47	0.5%
FZFG	245	4%
SN	106	2%
Other	47	0.5%

Table 1 – METAR-reported precipitation types during corresponding periods of freezing drizzle as determined by the Ramsey algorithm for Pittsburgh International Airport.

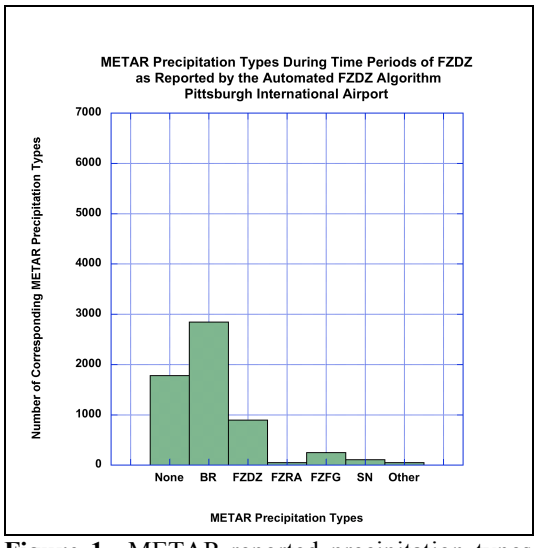

Figure 1 –METAR-reported precipitation types during periods of freezing drizzle as determined by the Ramsey algorithm for Pittsburgh International Airport.

3.2 Chicago O'Hare International Airport

For the nine-year time period analyzed at Chicago O'Hare International Airport, the Ramsey algorithm detected a total of 9845 min of freezing drizzle; twice as much as for Pittsburgh. Table 2 shows the corresponding METAR reports of precipitation type during these 9845 minutes. Similar to Pittsburgh, the majority of the observations reported were BR. Also similar to Pittsburgh is the high percentage of null reports. Only 5% of observations were in agreement with the freezing drizzle algorithm (Fig. 2).

Precipitation Type	Total Minutes	Percentage
None	3319	33%
BR	5359	54%
FZDZ	498	5%
FZRA	18	0.5%
FZFG	350	4%
SN	52	0.5%
Other	249	3%

Table 2 – As for Table 1, for Chicago-O'Hare International Airport.

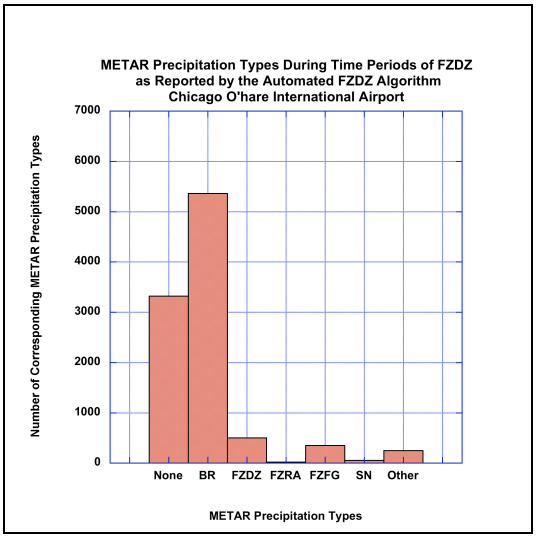

Figure 2 – As for Figure 1, for Chicago-O'Hare International Airport

3.3 Denver International Airport

The Ramsey algorithm detected a total of 20771 min of freezing drizzle for DIA over the nine-year time period; twice as much as Chicago and three times as much as Pittsburgh. Table 3 shows the corresponding METAR reports of precipitation type during these 20771 minutes. Only 8% of the time was the METAR observations and the freezing drizzle algorithm in agreement. As with Chicago and Pittsburgh, the majority of the METAR observations were BR. Unlike the other two locations, reports of FZFG were almost equal to the number of BR reports (Fig. 3). No reports of FZRA were observed which is not unusual since Denver rarely experiences freezing rain events.

Precipitation Type	Total Minutes	Percentage
None	3964	19%
BR	6703	32%
FZDZ	1610	8%
FZRA	0	0%
FZFG	6698	32%
SN	1229	6%
Other	567	3%

Table 3 – As for Table 1, for Denver International Airport.

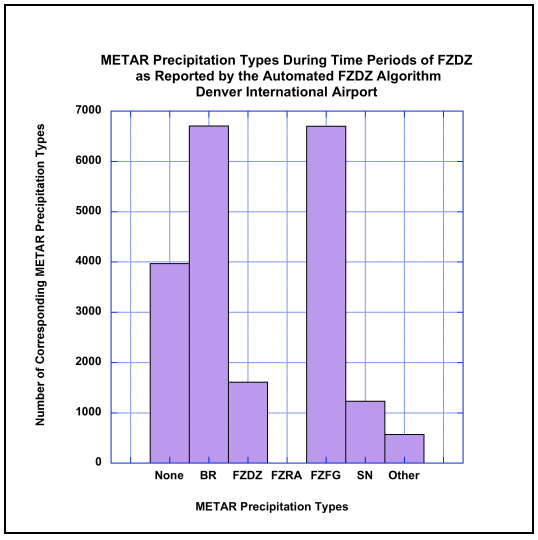

Figure 3 – As for Figure 1, for Denver International Airport.

4. Conclusions

The comparison of the Ramsey FZDZ algorithm to METAR-reported precipitation type reveals several similarities between the three airports. Mist was the most frequently reported type of precipitation from the METARS for all three airports. According to the AMS glossary of meteorology (Huschke, 1989), mist is defined as "a hydrometeor consisting of an aggregate of microscopic and more-or-less hygroscopic water droplets suspended in the air. Mist is intermediate in all aspects between haze and fog" However, the criteria for observing and reporting mist in a METAR are not related to actual cloud drops; BR is reported when the ASOS is not detecting precipitation but the temperature-dew point spread is less than 4°C and visibility is between 4 and 5/8 SM. This is based on the assumption that some sort of fog or precipitation is obscuring visibility, but is not intense enough or the drops are not of sufficient size for ASOS detection and classification.

Drizzle is defined as "very small, numerous, and uniformly dispersed water drops that may appear to float while following air currents. Unlike fog droplets, drizzle falls to the ground. It is sometimes popularly called mist." Freezing Drizzle is defined as "drizzle that falls in liquid form but freezes upon impact to form a coating of glaze". In this instance, it is likely that the observers and the ASOS itself may be confusing drizzle/freezing drizzle with mist. While this may not be a problem for drizzle, misreporting freezing drizzle as mist can have severe consequences for any aircraft experiencing these conditions.

Null precipitation reports in the METARs were the second largest group at all three airports though FZFG also accounted for a significant number of observations at DIA. This may be due to the observers and ASOS misclassifying freezing drizzle as FZFG.

Agreement of FZDZ between the METAR observations and the Ramsey Algorithm accounted for less than one-fifth of observations at all three airports. The potential misclassification of freezing drizzle as mist or freezing fog can create a serious ground-icing hazard to aircraft. This shows the need and importance of incorporating an automated freezing drizzle detection algorithm as part of ASOS.

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