A real-time weather system that provides current weather, *including liquid equivalent snowfall rate from snowgauges*, and short term forecasts of weather information important to airline, airport, and air traffic operations including pilots during winter weather conditions.
Visibility During Snowfall

Case #1

Visibility = 1/4 mile (0.4 km)
NWS Snowfall Rate = Heavy (S+) Note: based on visibility
Liquid Precip Rate = 0.10 in/hr (2.5 mm/hr)

Snow Crystals: 3-5mm Dendrites
Crystal Rimming: None - Light
Aggregates: 5-25mm

Case #2

Visibility = 3/4 mile (1.2 km)
NWS Snowfall Rate = Light (S-) Note: based on visibility
Liquid Precip Rate = 0.10 in/hr (2.5 mm/hr)

Snow Crystals: 1-3mm Dendrites/Plates
Crystal Rimming: Heavy
Aggregates: None
Current status

1. ARINC decided to no longer be the commercial provider of WSDDM due to Sept. 11 and other issues.

2. ARINC will support WSDDM at LaGuardia, JFK, Newark through April 15, 2002.

3. Working on obtaining a new vendor for WSDDM.

4. Working on implementing WSDDM at Denver International Airport this winter (most likely through UCAR).
Current status (cont.)

1. Working with George Legarretta (FAA) and Warren Underwood (Chairman, SAE G-12 Committee on Ground Deicing), to make WSDDM eligible for Airport Improvement Program (AIP) funding.

2. Have nearly completed a WSDDM Spec in support of this (on third revision).

3. Need to Ballot through the SAE, and once approved will be AIP eligible.

4. Will pay for up to 90% of up front hardware costs of WSDDM.
Recent Developments

Implemented National Weather Service RUC 0-12 hour forecast model output into WSDDM
Recent Developments

Developed drizzle detection algorithm based on ASOS raw data. Working to implement into operational ASOS system (ASOS does not currently report drizzle automatically). Al Ramsey freezing drizzle algorithm based on freezing rain sensor being implemented.
Recent Developments

National Weather Service currently evaluating the new algorithm. Implemented into the current ASOS software load for testing.
Recent Developments

Holding discussions with a vendor regarding the commercialization of the hotplate snowgauge.
Recent Developments

Developed “Frisby” Hotplate. Able to measure precipitation rates up to 25 mm/hr.
Currently evaluating performance at Marshall. Ring allows for lower snowfall rates to be detected and higher catch efficiency.
Recent Developments

Evaluated the performance of the real-time Z-S for Denver. Problems with ground clutter contamination identified and being addressed.
Future Developments

Develop ceiling and visibility product for ITWS and WSDDM

Visibility nowcast product will be developed based on real-time correlation of radar reflectivity and visibility and the advection of radar reflectivity.
Future Developments

Establish Rutgers field site in support of the Northeast Ceiling and Visibility Programs (jointly supported by Winter Weather, National C&V, and Terminal C&V PDTs.)
Future Developments

Instrumentation at Rutgers will include:
- Ceilometer
- Two Visibility sensors
- 20 m instrumented tower
- Fog spectrometer
- IR and Visible up/down radiative flux sensors
- Latent and sensible heat flux sensors
- Video camera
- Soil moisture sensors
Future Developments

Instrumentation will be installed mid-Jan.

Data collection to commence the end of January.

Robert Tardiff and Jeff Cole; Co-leads.
Purpose of Rutgers site will be to provide detailed ground truth for the COBEL and RUC model predictions of fog and other visibility and ceiling reducing phenomenon.
Future Developments

Develop 0-12 hr frost forecasting system based on RUC model output. Ground truth site at Marshall.
Future Developments

Improve method to predict precipitation type based on RUC model output. Currently performing analysis on data collected last year.
Future Developments

Include 0 – 12 hour time series forecast of temperature and winds from RUC in the WSDDM system.
Develop 3-12 hour improved snow forecast method based on assimilation of radar data into numerical models.
SNOWBAND FORECAST
1-4 hour

CLOUD SCALE MODEL
- VDRAS RADAR DATA initialization
  - simpler model
capability to retrieve fine structure
no mesoscale forcing

MESOSCALE MODEL
- MM5 TRADITIONAL DATA initialization
  - better physics
mesoscale forcing
spin-up problem
lacks fine structure in initialization
- MM5 RADAR DATA initialization
  - high-resolution data effect
no spin-up problem
computationally expensive

4DVAR
- high resolution data effect
less spin-up problem
computationally inexpensive
real-time operations

3DVAR

NUDGING
NUDGING RADAR DATA INTO MM5

I. Cloud analysis from radar data and other observations:

- radar reflectivity $\rightarrow$ 3D precipitation field

- 3D precipitation field + microphysical equations
  $\rightarrow$ cloud water, water vapor
  and latent heating distributions

II. Using the analysis to initialize MM5 forecasts in a four-dimensional data assimilation (FDDA) manner (nudging)
Snowfall Rate categories in holdover tables:

1. Currently available WSDDM system has the ability to provide light, moderate, and heavy liquid equivalent snowfall rates every 5 minutes with the same rate divisions used for testing de/anti-icing fluids (0-10 g/d2/hr: light, 10 – 25 g/d2/hr: moderate, > 25 g/d2/hr: heavy).

2. However, holdover tables don’t have categories for light, moderate, and heavy snowfall. Reasons for this are:
   - Real-time liquid equivalent snowgauge data previously not available operationally.
   - Current light, moderate, and heavy snow intensities available from METARS are based on visibility which is not an accurate measure of liquid equivalent snowfall rates.
   - National weather service METAR reports are not available at a high enough frequency to make decisions regarding holdover times every 5 minutes (only hourlies or specials available).
While it is recognized that visibility is not a reliable indicator of liquid equivalent rate, it is still used today operationally to make decisions regarding holdover times.

- Snow column has a range of times. Pilot needs to determine the time he/she will use. Only available information on rates is the visibility based light, moderate, and heavy.
- The table Barry Myers and I developed to make adjustments to current visibility based METAR snow intensity as a function of temperature and day/night condition should be viewed as an interim solution due to the major role that crystal type plays in determining the reduction in visibility (not predictable by surface temperature or day/night).
- Thus, there still exists a significant safety hazard in the current way of doing business.
Table 6. Modified Visibility Criteria for Snow Intensity Based on Temperature and Day or Night

<table>
<thead>
<tr>
<th>Condition</th>
<th>Temp (°C)</th>
<th>Visibility (Statute Mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/4</td>
<td>1/2</td>
</tr>
<tr>
<td>Snow (SN)</td>
<td>&lt; -1</td>
<td>Heavy</td>
</tr>
<tr>
<td>Daytime</td>
<td>≥ -1</td>
<td>Heavy</td>
</tr>
<tr>
<td>Snow</td>
<td>&lt; -1</td>
<td>Heavy</td>
</tr>
<tr>
<td>Nighttime</td>
<td>≥ -1</td>
<td>Heavy</td>
</tr>
</tbody>
</table>
# Example of Revised Snow Column in Holdover Table

<table>
<thead>
<tr>
<th>OAT</th>
<th>Fluid Concentration</th>
<th>Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light</td>
<td>Moderate</td>
</tr>
<tr>
<td>above 0</td>
<td>above 32</td>
<td>100/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40 - 60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75/25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 - 15</td>
</tr>
<tr>
<td>0 to -3</td>
<td>32 to 27</td>
<td>100/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35 - 45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75/25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 - 15</td>
</tr>
<tr>
<td>-4 to -10</td>
<td>26 to 14</td>
<td>100/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35 - 45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75/25</td>
</tr>
<tr>
<td>-11 to -14</td>
<td>13 to 7</td>
<td>100/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35 - 45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75/25</td>
</tr>
<tr>
<td>-15 to -25</td>
<td>6 to -13</td>
<td>100/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35 - 45</td>
</tr>
<tr>
<td>below -25</td>
<td>below -13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Advantages of new table

1. Safer operations under high-visibility high-snowfall conditions.

2. Provides a direct link to the liquid equivalent rates used to test fluids in the lab and outdoors, rather than the indirect link provided through visibility.

3. Help encourage the use of WSDDM for de/anti-icing operations.
A subcommittee of the SAE Ground deicing holdover time committee has been formed to investigate the division of the snow category in the holdover table into light, moderate and heavy categories based on liquid equivalent rate (0-10 g/d2/hr: light, 10 – 25 g/d2/hr: moderate, > 25 g/d2/hr: heavy).

Roy Rasmussen has been asked to serve on this subcommittee.
SAE Holdover Table Sub-committee Resolution

To request that WMO and National Weather Services report weather categories on Holdover Tables:

Frost;

Light, Moderate, and Heavy Snowfall rate based on liquid equivalent rate, not visibility;

Freezing drizzle intensity based on liquid equivalent rate (currently based on visibility),

Light Freezing Rain

Roy Rasmussen has been asked to make this request on behalf of the SAE G-12 Ground Deicing Holdover Table Sub-committee.
Summary

• Research and development continues for improved WSDDM products based on input from the user community.

• Results of research and development are transferred to private vendor for implementation into the commercially available WSDDM.

• Working with George Legaretta to qualify WSDDM for FAA AIP funds.