The Front

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CIP and FIP: A Pilot's Perspective

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Since the earliest days of instrument flying, structural icing has posed one of the greatest hazards to aviation. Unfortunately, the science of forecasting this phenomenon is widely recognized as one of the most difficult aspects of meteorology.

Recently two new algorithms have been developed to assist forecasters in identifying potential areas of in-flight icing.

The first, Current Icing Potential (CIP), provides real-time depiction of areas where atmospheric conditions conducive to ice formation may exist.

The second algorithm, Forecast Icing Potential (FIP), forecasts areas where atmospheric conditions may be favorable for icing during the next 12 hours.

Both these algorithms were developed by the National Center for Atmospheric Research under the FAA's Aviation Weather Research Program. The products are maintained by NOAA's Aviation Weather Center (AWC).

CIP and FIP use a combination of weather observations and "fuzzy logic" to calculate the potential for icing over the continental United States. Traditional model output has been effective in forecasting areas where icing will exist, but is not good at forecasting where icing will NOT exist.

Since icing requires both specific atmospheric conditions and the presence of visible moisture, models that do not take this into account often over forecast the geographic extent of icing.

Conversely, direct observations are very good at identifying icing, but are limited by their scarcity. As a result, forecasts based on observations tend to under forecast the potential size of icing areas.

The CIP and FIP attempt to maximize the benefits of model data and direct observations while depicting the results in an easy to understand graphical display. This display shows a color-coded scale ranging from 0-100, where 0 represents no potential for icing and 100 represents a significant potential.

When using these products, there are several important factors pilotsand dispatchers should consider.

First, these two algorithms only show the "potential" that supercooled liquid water will form structural ice on an in-flight aircraft within a three dimentional grid box. The algorithms show only icing "potential," NOT intensity. In other words, CIP and FIP provide clues to the existence of icing but do not provide any information on the severity of that icing.

Second, just as pilots are taught never to rely on one instrument without cross-checking against their

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The Front

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Mission Statement

To enhance aviation safety by increasing the pilot's knowledge of weather systems and processes and National Weather Service products and services.

other instruments, CIP and FIP should never be used as stand-alone icing forecasts. These algorithms, which are generated automatically, should be used only in concert with AIRMETs and SIGMETs, which are generated manually by trained aviation forecasters.

Finally, pilots must remember that one of the major sources of data for the CIP is pilot weather reports (PIREPs). Therefore, it is essential that anytime pilots encounter inflight icing, they initiate a PIREP.

Figure 1 shows a 1300 UTC 3-hour forecast on January 11, 2005, where FIP shows significant icing potential at 15,000 feet over northwest Indiana.

Figure 2 shows the CIP analysis for that same altitude valid at 1600 UTC, which depicts potential values greater than 75 in the same area. During that period, several icing pilot reports were received, including one report from an MD-80 over South Bend, IN, that was picking up severe rime ice:

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SBN  UUA  /OV  GIJ270020/TM
1635/FL150/TP  MD80/IC  SEV
RIME
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Both the 3-hour forecast issued at 1300 UTC and the real-time analysis valid at 1600 UTC, correctly forecast the existence of aircraft structural ice. Nowhere in Figure 1 or 2 is there any depiction of the intensity or type of icing to be expected. It is only through pilot reports that this information is available.

Again, the importance of pilot reports cannot be over emphasized and neither can the importance of not relying on CIP and FIP as stand-alone products.

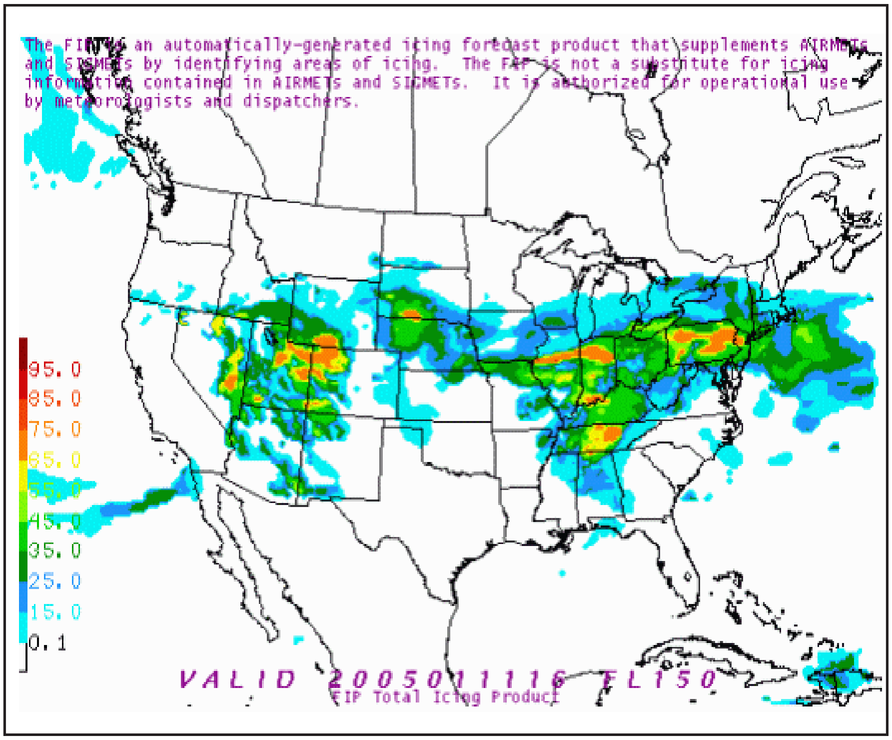

Figure 1: *FIP FL150 13 UTC 3 hour forecast valid 16 UTC 11 January 2005*

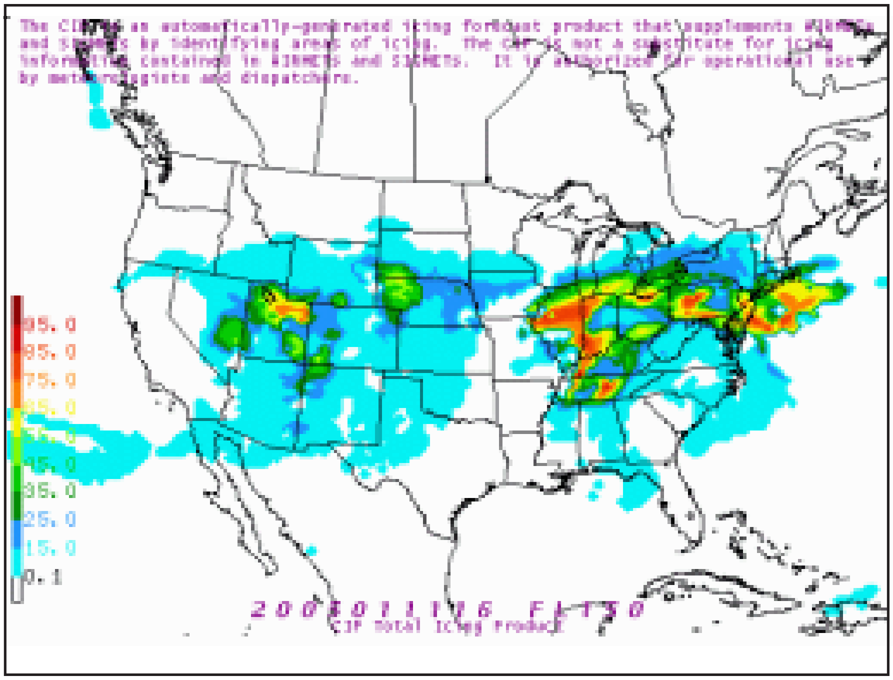

Figure 2: *CIP FL150 valid 16 UTC 11 January 2005*

In the two years of operational forecast use, CIP and FIP have proven to reliably represent areas where no icing occurs. In addition, they have proved to provide a reasonable amount of accuracy in areas where icing is likely to occur. The next step for these products will be to incorporate icing severity into their output. The future plans also call for CIP and FIP coverage to expand to Alaska.

CIP and FIP are available at **http://adds.aviationweather.gov/icing.** ✈

Lake Effect Snow: How Does It Affect Your Day of Flying?

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For anyone who has ever lived in the Great Lakes Region, the late fall and winter months can provide very interesting and at times dramatic weather conditions (**Figure 1**).

As cold air masses spread southward from Canada, the Great Lakes are "turned on" and begin to produce prodigious amounts of snow on their downwind shores.

Contrary to the standard progression of weather conditions, Barney Wiggin, former MIC at NOAA's NWS office in Buffalo, NY, is credited with the saying that "the weather often clears up stormy to the lee of the Great Lakes during winter."

Lake effect snows are extremely localized storms that occur downwind of the Great Lakes in the late fall and winter. As cold air moves across a relatively warm body of water, the lower layers of the air mass are modified by heat and moisture from the lake, creating instability in the lower atmosphere.

The moisture eventually condenses into streamers of snow clouds that are generally oriented along the prevailing synoptic scale flow (**Figure 2a**). In special cases, when winds are parallel to the long fetch of elliptically shaped lakes with parallel shorelines, a combination of frictional and thermal convergence can produce a single, intense band of snow that takes on a circulation all its own. These bands are most common on Lakes Erie and Ontario, though under the right conditions can occur on any of the Great Lakes.

Finally, under weak synoptic scale prevailing flow and frigid air temperatures, snow bands can develop as a result of pure thermal convergence between the frigid land and the relatively warm lake waters (**Figure 2b**). These bands of snow can occur at minute scales, roughly equivalent to the size of a summertime thunderstorm at times.

Snowfall rates from the intense single-banded storms may exceed 4 inches an hour at times. As long as the wind remains out of the same di-

Figure 1. *A snow band at sunset off Lake Erie that produced part of the 82.6 inches of snow that fell during Christmas week of December 2001 near Buffalo, NY.*

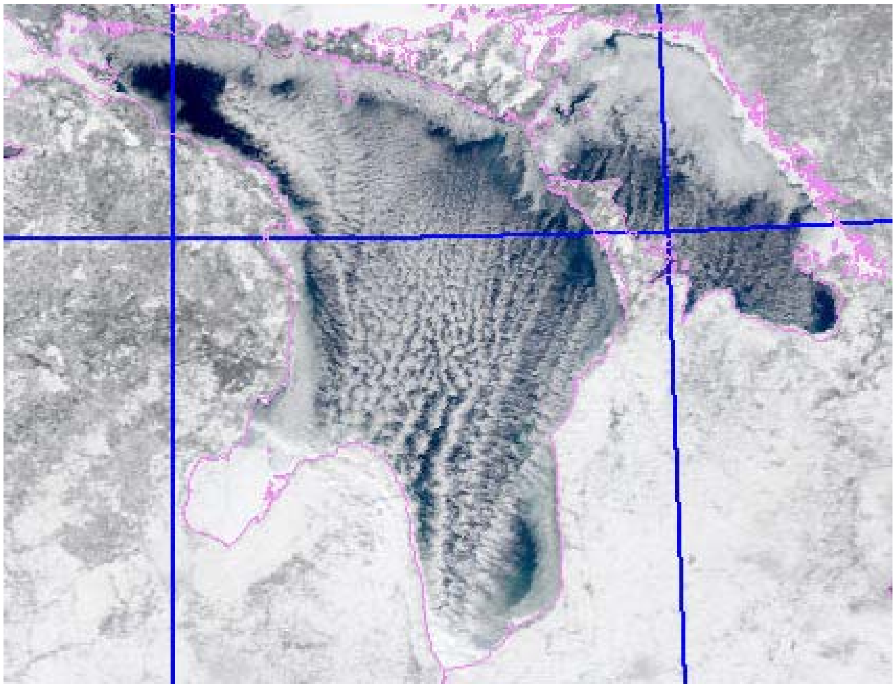

Figure 2a. *Satellite image shows multiple narrow bands of snow over Lake Huron on January 25, 2003 at 1840UTC. The bands formed under NNE prevailing winds as a result of parallel roll convection. This imagery comes from the NRL/NPOESS Moderate resolution Imaging Spectroradiometer (MODIS) provided by the Naval Research Lab at Monterey.*

One portion of a town may be receiving snowfall in excess of 3 inches an hour with lightning and thunder, under a 5 to 10 mile wide band of snow, while less than 5 miles away, the area may be under partly sunny skies (**Figure 4**)!

Flying conditions may look deceptively benign within a few miles of an airport, then change drastically upon approach into a small scale snow band.

The larger bands of snow that occur when winds blow down the long axis of elliptically shaped lakes may also create well defined convergence zones feeding in on both sides of the band.

In these cases, you may see as much as a 60 to 90 degree wind shift as one of these bands of snow oscillates back and forth across your area.

On the edges of the band where the winds are converging toward the direction, the band of snow can remain stationary for several hours, or in rare instances, days at a time.

The resulting snow amounts can be incredible. During Christmas week of 2001, a deep, slow moving vertically stacked polar vortex sitting over James Bay, Canada, produced a frigid west to southwest flow over the Great Lakes for several days. During that one week, Buffalo, NY piled up 82.6 inches of snow.

East of Lake Ontario, between Watertown and Syracuse, NY, an area known as the Tug Hill plateau recorded 126 inches of snow, reinforcing its reputation as one of the snowiest regions east of the Rockies (**Figure 3**).

For a pilot, these types of weather conditions can be extremely dangerous. The reasons may not be apparent however. Remember that these events occur on a very small scale.

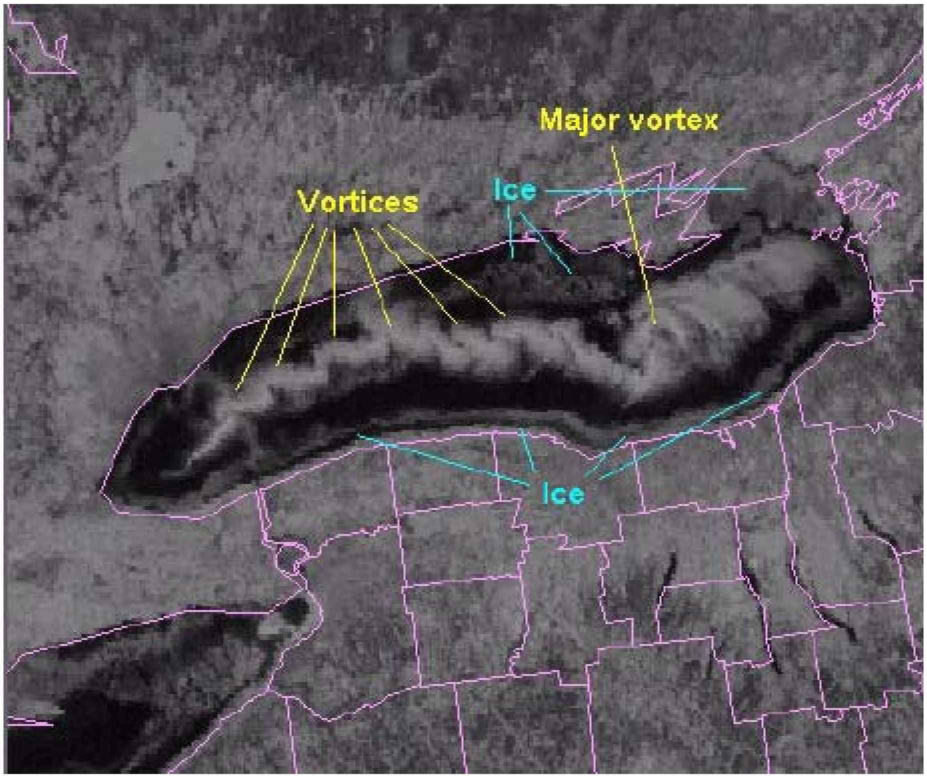

Figure 2b. *NOAA GOES-12 visible satellite image of a land breeze induced snow band under weak synoptic flow on Lake Ontario from January 28, 2005. The snow bands are roughly on the same scale as summertime thunderstorms. In this image, the author points out several even smaller scale vortices within the band.*

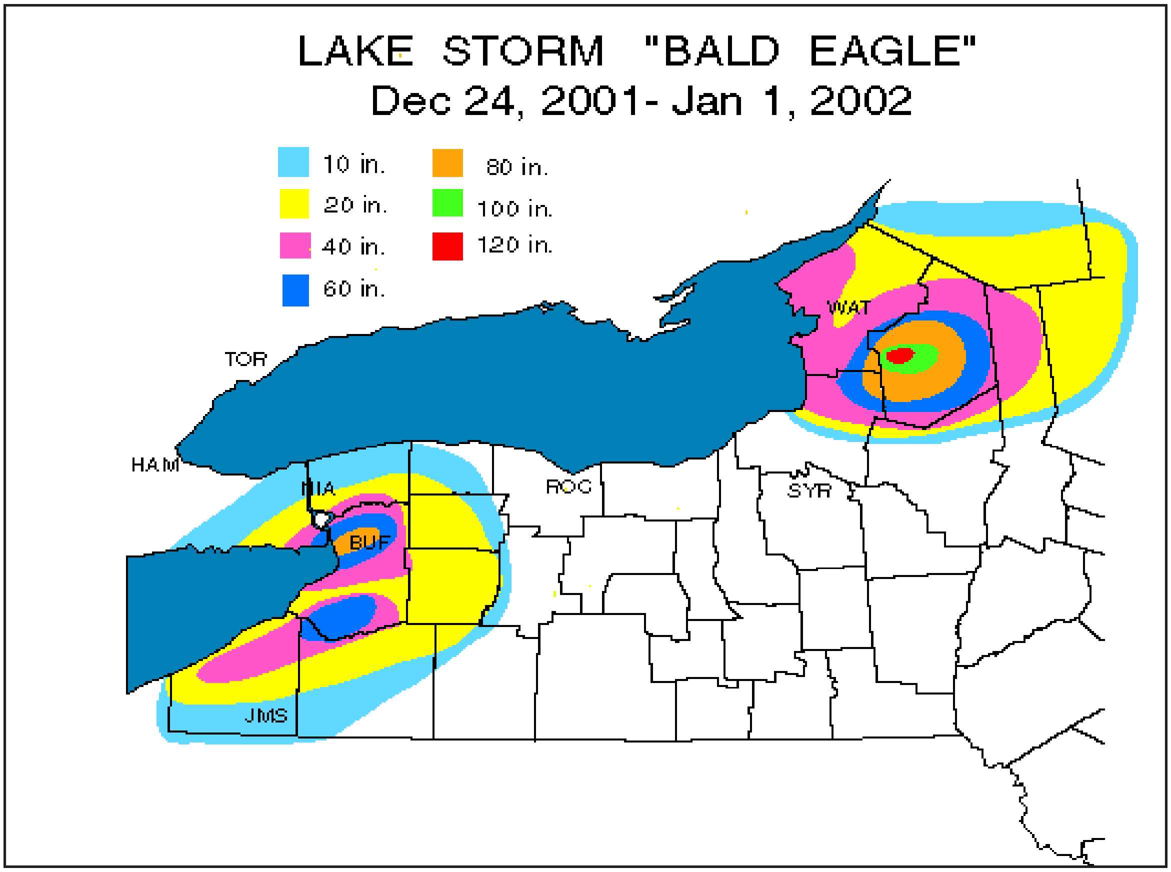

Figure 3. *Storm total snowfall from the lake effect storm that occurred between December 24 and January 01, 2001-02.*

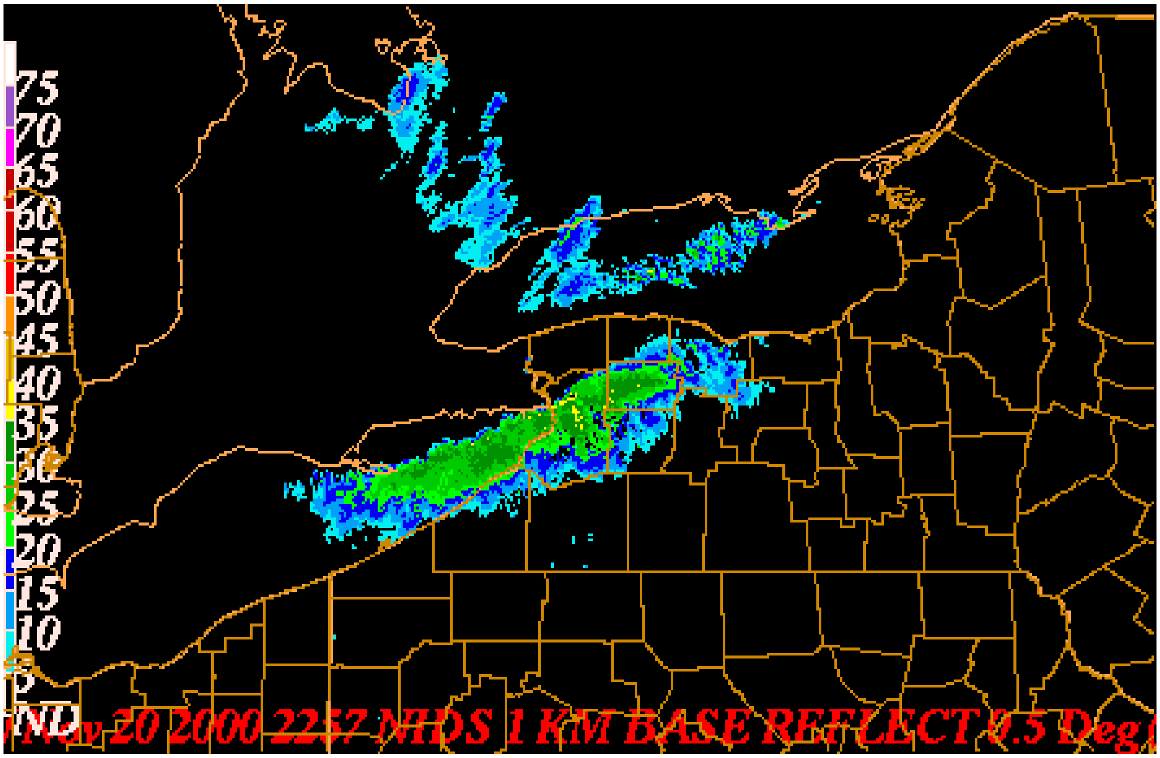

Figure 4. *WSR-88D 0.5 degree reflectivity image from NOAA's NWS Buffalo office during the November 20, 2000 storm that dumped 25 inches of snow on Buffalo in an 8-hour period of time.*

center, strong gusts may occur. Under the center of the band however, winds may drop off to nearly calm. Of course, ceilings and visibilities will change drastically and quickly as you cross into the band or it works its way across your area.

Take a look at **Table 1.** It illustrates an these changes for an event that occurred in Buffalo on November 20, 2000. In an 8-hour period, more than 2 feet of snow fell in Buffalo. While the storm was pummeling the airport, only 15 miles away at Niagara Falls, the conditions were VFR.

Research done on the distribution of snow crystals within these bands shows that depending on the ambient air and water temperatures, areas close to the lakeshores may see more heavily rimed snow crystals and graupel within the band, while winds blow the lighter dendritic crystals some distance inland.

By the way, early in fall, when temperatures aren't quite cold enough for snow, lake effect rain storms occur. These storms can also produce large amounts of precipitation over a small area. Several years back, one of these events actually prompted a flash flood warning north of Buffalo when 5 inches of rain inundated the area.

Although the term lake effect snow refers to storms occurring on the Great Lakes, in theory, anywhere cold air move across a warm body of water, the same mechanisms will produce mesoscale convective snows. These types of storms occur off the Great Salt Lake, Lake Champlain and the Finger Lakes Region in New York to name a few spots. You will also find these types of storms off Cape Cod (Ocean effect snow), the Gulf of St. Lawrence, Chesapeake Bay and Long Island Sound. These snow storms also occur in other parts of the world, such as off the Sea of Japan.

If you are flying around the Great Lakes Region, read NOAA's NWS forecast discussions concerning the threat for lake effect snow.

Pay close attention to TAF forecasts and be prepared to possibly divert to an alternate airport if you are equipped to do so.

Lake effect snow is truly an amazing aspect of Mother Nature, but as with summertime thunderstorms, if not respected by the aviator, they can turn deceptively mean very quickly. ✈

Time	T	Td	WD	WS	G	SLP	Vsby	Cig	Sky	Wx
UTC	°F	°F	Deg	Kts	kts	mb	Mi.	(100)ft		
1254	34	24	210	15		997.3	10	37	OVC	
1354	33	31	220	6		997.3	0.5	2	OVC	S-
1454	33	32	240	14	20	997.3	1	6	OVC	S-
1554	34	31	240	13		997.2	1	13	OVC	S-
1654	32	30	240	23	31	997.1	0.2	5	OVC	S
1754	31	29	270	13		997.2	0.2	9	OVC	S
1854	29	29	260	11		997.3	0.1	1	X	S+
1954	29	28	270	18	22	997.4	0.1	1	X	S+
2054	29	28	230	14	26	997.6	0.1	1	X	S+
2154	28	28	220	16	25	997.7	0.1	1	X	TS+
2254	27	27	220	12		997.9	0.1	1	X	TS+
2354	28	27	210	12		997.9	0.1	1	OVC	S+
54	28	28	220	12		997.9	0.2	1	OVC	S+
154	27	26	270	7		997.8	1	7	OVC	IP-
254	30	30	220	16	25	997.6	2	7	OVC	S-
354	33	29	260	17	21	997.6	10	40	SCT	
454	33	27	260	15	21	997.7	10	60	OVC	

Table 1. *Metars from Buffalo, NY during the 20 November, 2000 storm that dumped 25 inches of snow on Buffalo. Note the rapid reduction in ceilings and visibility as well as the wind shifts that occur as the snow band moved over the airport from the north during late morning, then slid south of the area later in that evening.*