UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE DATA
AND INFORMATION SERVICE
NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
151 PATTON AVE ROOM 120
ASHEVILLE NC 28801-5001

July 23, 2018

MEMORANDUM FOR: Derek S. Arndt
Chief, Climate Monitoring Section, Center for Weather and Climate
National Centers for Environmental Information

FROM: Karin Gleason
Meteorologist, Monitoring Section, Center for Weather and Climate

SUBJECT: SCEC Decision Regarding Pennsylvania Snowfall in December 2017

Summary:

On 14 February and 9 April 2018, a State Climate Extremes Committee (SCEC) convened to verify / validate a report of a 50.8 inch snowfall in Erie, Pennsylvania over the 24-hour period spanning 25-26 December 2017. In addition, the total snowfall accumulation for the month of December in Erie measured 120.9 inches. If verified, the 24-hour snowfall and monthly maximum snowfall would become new records for the state.

The committee considered the following factors in their decision: the genuine nature of the measured snowfall, meteorological plausibility, and methods and practices of observation. After reviewing the observational evidence, the SCEC voted (1-4) against accepting both the 24-hour snowfall and the monthly accumulated snowfall values. In particular, the committee could not, beyond a reasonable doubt, find the following snowfall amounts to be true and valid:

- LOCATION: Erie, PA International Airport (COOP ID: 362682)
- DATE: 25-26 December 2017
- SNOWFALL: 50.8 inches (24-hour)
- DATE: December 2017
- SNOWFALL: 120.9 inches (monthly total)

The SCEC-recognized 24-hour snowfall record of 38 inches occurred on 20 March 1958 in Morgantown, PA. The record for monthly maximum snowfall of 117.8 inches was reported in Laurel Summit, PA during February 2010. **These values remain intact as the statewide records for Pennsylvania.**

Sequence of Events, Examination & Decision

Background

Significant winter weather events are not uncommon to Erie, Pennsylvania and surrounding areas. The climate site at Erie receives 100.9 inches of snow per season on average with a majority of that snowfall occurring in December and January. The Erie area typically sees about five warning criteria events each winter season, in which 8 or more inches of snowfall in a 24-hour period. Erie lies in the favorable

snowbelt region of the Lake Erie basin that spans from northeast Ohio through northwest Pennsylvania into western New York. For the most significant lake effect snow events to occur in the city of Erie itself, there need to be a couple factors in place. Significant lake effect snowfall events tend to occur with single band development, developing down the long fetch of elliptically shaped lakes. For a single band to develop over Erie, the fetch for the mean layer wind over the lake needs to be just south of due west. When the lake is not frozen, these winds allow for over 200 miles of fetch on Lake Erie, which will greatly aid in the thermodynamics of a lake effect event. Other factors that will enhance a lake effect event over Erie are: increased instability from warmer lake temperatures and/or higher lapse rates, good boundary layer depth and minimal directional wind shear. The event which occurred on 25-26 December 2017 possessed all of these factors and generated single lake effect snow bands, which produced heavy snowfall.

Storm Environment & Meteorological Plausibility

24-Hour Event

An area of low pressure over the southeastern United States at daybreak on 24 December moved north along the spine of the Appalachians, deepening as it approached the eastern Great Lakes. The low pressure itself brought a large area of synoptic snow with it, prompting advisories across much of the Ohio Valley and Great Lakes region with 2 to 6 inches of snow on Christmas Eve into Christmas morning. The low was centered over Buffalo, New York by midnight Christmas morning and had fallen to 1004 mb before it moved eastward, eventually merging with a larger low off the New England coast. As the low pressure moved east, winds at the surface and the low-levels across northwest Pennsylvania veered from the southeast to the southwest and west, allowing for lake effect snow to set up over the Erie, Pennsylvania area for Christmas Day.

After the synoptic snowfall moved out of the region and high pressure began building in on Christmas morning, cold air moved across the region and winds veered around to the west to begin lake effect snow development. Snow squalls quickly developed in extreme northeast Ohio and northwest Pennsylvania in the morning hours and eventually turned into a single band of snow over Ashtabula County, Ohio and Crawford County, Pennsylvania. This band carried northward through the morning hours, moving into Erie County by late morning. The band stalled for several hours over the city of Erie and surrounding townships with 2 to 4 inches per hour snowfall rates being reported to the National Weather Service (NWS) Cleveland (CLE) office through the early afternoon hours. By mid-afternoon, the band had lifted north into Lake Erie as the surface winds backed to the south and some shear disrupted the flow. However, cold air advection and a mean WSW flow aloft allowed for snow to continue developing over the Erie area in a more multi-banded squall arrangement. Squalls continued through much of the afternoon and evening in the Erie area until the flow relaxed as high pressure built into the region. Strong low-level convergence developed over the lake with SW and WSW flow at the surface on the south side of the lake and NW and WNW flow on the north side of the lake. The single band was able to redevelop and return to the Erie area late on 25 December and remained over the area through

26 December with 2 to 4 inch per hour snowfall rates over the airport. In all, 50.8 inches of snow was reported during the 24-hour period from 7am on 25 December to 7am on 26 December (Figure 1).

Monthly Accumulation

December 2017 was particularly active for two distinct reasons: above normal Lake Erie water temperatures and the high impact snow event around Christmas.

December 2017 began rather quietly as no accumulating snow fell in the Erie area for the first week of the month with temperatures well above average in the 40s and 50s, which extended into December from a warm late November with near record highs. The first trough and cold spell moved over the area on December 7th and allowed for synoptic and lake effect snow to move over the area. The pattern shift with the trough over the eastern United States allowed for persistent cold westerly and northwest flow over the region to support lake effect snow over the next week and a half. The warm temperatures from late November and early December allowed Lake Erie to remain warm for much of the month of December with water temperatures in the mid to upper 40s, when temperatures should be 5 to 10 degrees colder. The warmer water temperatures allowed for enhanced lake effect snow events, including Lake Effect Snow Warning criteria on 12 and 15 December.

The significant snow event from 25-26 December was the biggest contributing factor for the immense snowfall for December 2017. See the 24-hour snowfall summary for more details on this event. After the significant Christmas event, one final lake effect event in the Erie area gave the area another dose of snowfall as another low pressure system and associated upper level trough made its way into the region. Winds behind the low pressure system allowed for lake effect snow to set up again and high impact snow squalls significantly impacted northwest Pennsylvania on 29-30 December. This event was similar to the Christmas event with some of the higher snowfall totals along the lakeshore areas of Erie, PA. However, the duration of the event was much shorter and did not have the persistent, dominant single band of the Christmas Day event. Most areas had over a foot of snow with this final event with several spots getting closer to two feet of snow. In all, 120.9 inches of snowfall were reported at the Erie Airport during December 2017.

Figure 2 shows the daily observations for the Erie Airport during December 2017 as well as the monthly accumulated snowfall. Liquid equivalent estimates are also noted on the F6 form.

Review of Observing Practices & Equipment

The paid snow observer, who is not with the Federal Aviation Administration (FAA), did not have experience measuring snowfall at the airport prior to that which fell during December 2017. Their first snow measurements occurred at the Erie Airport on 7 December 2017. NWS CLE indicated that all five observers were either trained by NWS personnel or provided with instructions, which were left with their manager, to train the remaining personnel prior to measuring snowfall. NWS CLE personnel indicated there was not sufficient time following the retirement of the previous observer to provide optimal training for all of the new observers. In addition, NWS CLE had a vacancy in their data collection unit since June 2016, which was also a contributing factor to less than optimal time for training new snow observers. These observers were familiar with and instructed to follow the NWS snow measuring

guidelines. During the training, one snow board was designated for new snowfall and marked with a snow stake and traffic cone nearby (Figure 3). Snow was officially measured and the board was cleared 4 times per day. During the training, snow depth was explained as the total depth of snow on the ground at the time of observation and the observers were encouraged to get a snow depth by measuring snow in untouched areas that were representative of the total snow on the ground. The observers were told that sometimes an average depth would be appropriate if conditions were particularly windy and significant drifting was occurring. In addition, a second snow board was placed in the "triangle-shaped" area that could also be utilized for snow depth purposes (Figure 4).

NWS officials learned the following about the observing practices which occurred during the event on 25-26 December 2017:

- A traffic cone was used to stabilize the snow board from blowing due to high winds. Although resourceful, this practice may have impacted the snowfall accumulation (Figure 5).
- The snow board was always placed on top of the snow after a measurement was made, although there was higher snow around the board, allowing for a cratering effect.
- The snow board did not always make it on top of the highest snowpack after each clearing.

Snowfall reported by other observers in the Erie metropolitan area near the airport location reported 18 to 22 inches less snowfall over the 24-hour period in question. Stations which were closely examined were within 2 to 9 miles of the Erie Airport (Figure 6). Officials from NWS CLE stated that there was considerable banding of snowfall over the airport which did not equally impact the surrounding stations. Looking at the radar echoes during this time, it was extremely difficult to discern this phenomenon. Erie is approximately halfway between the Cleveland and Buffalo radars (about 100 miles NE and SW) and lake effect snowfall events, such as this one, typically are shallow (near to the surface) and are not detected by the radar beam at such a distance from the event in question. In addition, the comparison of snowfall measurements to snow depth at the Erie Airport consistently illustrated lower snow depth amounts than one would expect to see, given the high snowfall rates. Even compared with the neighboring observers, the snowfall and snow depth characteristics varied enough between these observers and the Erie Airport measurements to cause questions about observing practices (Figure 6). Although liquid-equivalent estimates are derived and reported on the F-6 form (Figure 2), the Erie Airport observers did not have access to a liquid gauge to capture the water content for the snowfall in question nor were they required to do so. This is not considered a standard observing practice for this type of station. Being able to measure the snow-to-liquid ratio may have helped to resolve any undercatch which may have occurred due to snow drifting during the 25-26 December event (see recommendations for more details).

Snow depth measurements at the airport appear to under-represent the snowfall amounts and are not consistent with that of the other local snow observers. In addition, after investigation of other snow events at the Erie Airport throughout the 2017-18 snow season, the SCEC compared reported snowfall

and snow depth measurements and noticed a similar pattern. This cast a shadow of a doubt on what may be either an overestimate for snowfall or some systematic error in under-representing snow depth.

Finding of Committee

All of the above evidence was either shared with the SCEC, electronically, or discussed amongst the group leading to more than three hours of deliberation on 14 February and 9 April 2018. The SCEC solicited input from additional local Weather Forecast Office (WFO) employees familiar with this event as well as other regional climate experts to assist with the analysis of the metadata and evidence.

Based upon this documented body of evidence, the SCEC voted (1-4) against recognizing the 24-hour snowfall and monthly maximum snowfall accumulations as new records for the state of Pennsylvania and **recommends the NCEI Climate Monitoring Chief continue to recognize the 38 inch, 24-hour snowfall record from 20 March 1958 in Morgantown, PA and the 117.8 inch monthly maximum snowfall in Laurel Summit, PA during February 2010 as the current Pennsylvania 24-hour and maximum monthly snowfall records, respectively.**

NCEI Climate Monitoring Chief Decision

Approved (as recommended in boldface above):

ARNDT.DEREK.SHANE.1384496519

Digitally signed by ARNDT.DEREK.SHANE.1384496519
Date: 2018.08.22 11:05:38 -04'00'

Signed _____ Date: _____

Not approved (will be returned to SCEC with no action taken):

Signed _____ Date: _____

Thoughts and Recommendations:

There is a large body of evidence suggesting that a large and significant snowstorm occurred in and around Erie, PA during 25-26 December 2017.

The SCEC would like to recognize the effort to accurately measure snowfall and snow depth made by an inexperienced observing team during extremely challenging conditions.

The SCEC would like to recognize NWS CLE for their efforts gathering evidence, documenting these events, visiting the airport and discussing the events in question with the Erie observers as well as the

neighboring observers. All of these efforts helped the committee to better understand the nature of these events as well as the complexities of measuring extreme snowfall.

The SCEC recommends that when possible, observer(s) should take photographs in/around observation site during and immediately following heavy snowfall events. This information may be useful if/when snowfall or snow depth amounts come into question.

The SCEC recommends that snow boards be designed or outfitted such that their position can be secured during heavy wind snow events. This may involve attaching a tripod or another type of telescoping apparatus to the underside perimeter of the board to accommodate the height of the snowpack at the time of observation. This would eliminate the desire to stabilize the snow board by placing an object on top of the board where the measurements take place.

Liquid-equivalent measurements should become a standard practice for paid snow observers. The (All Weather Precipitation Accumulation Gauges) AWPAGs used as part of the ASOS network during snow events often have an undercatch, especially in windy locations. Since precipitation is critical to the climate record and frozen precipitation can account for a significant amount of the monthly or annual precipitation in some locations, having an accurate liquid total would be useful not only for climate but for hydrology and drought analysis. **The SCEC recommends that liquid equivalent measuring equipment and appropriate training/guidance are provided to the observers. The NWS should consider providing supplemental funds to pay observers, if needed.**

The SCEC recommends a sub-committee be formed to evaluate the Erie Airport observed snowfall during December 2017 as well as throughout the 2017-18 snow season. This sub-committee convened on 7 May 2018 and 5 July 2018 and evaluated the data in question. The SCEC sub-committee recommend the following:

- The December 2017 snowfall and snow depth values for the Erie Airport be replaced with values which were measured by the Millcreek Township snow spotter (Observer “B” – see Figures 6 & 7). The new 24-hour total for 25-26 December at the Erie Airport is 32.6” and the December monthly total is now 93.8”. The sub-committee reviewed data from the entire snow season and determined that snowfall observations for the Erie Airport during March 2018 are also suspect and remain under review. A recommendation for the March 2018 snowfall will be forthcoming in a comprehensive special report detailing the evaluation of the Erie 2017-18 snowfall season.

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Voting Members of the State Climate Extremes Committee:

Zachary Sefcovic, General Forecaster and Climate Services Focal Point, NWS, Cleveland, OH

Kyle Imhoff, Pennsylvania State Climatologist

Keith Eggleston, Regional Climatologist, Northeast Regional Climate Center (NRCC)

Chris Stachelski, Meteorologist, Climate Services Program Manager, NWS Eastern Region

Karin Gleason, Meteorologist, National Centers for Environmental Information (NCEI)

Also participating in the verification:

Robert LaPlante, Science and Operations Officer, NWS, Cleveland, OH
Sarah Jamison, Senior Service Hydrologist, NWS, Cleveland, OH
Brian Mitchell, Observation Program Leader, NWS, Cleveland, OH
Will Kubina, Lead Forecaster and StormData Focal Point, NWS, Cleveland, OH
Gary Garnet, Meteorologist-in-Charge, NWS, Cleveland, OH
Bryant Korzeniewski, Meteorologist/Datzilla Programmer, NCEI

See attachments below

12/24		700	0.0	2
		1300	0.0	2
		1900	0.0	2
		2400	2.0	3
12/25		700	2.0	3
		1300	9.3	10
		1900	9.5	12
		2400	13.0	20
12/26		700	19.0	28
		1300	1.5	30
		1900	4.0	30
		2400	2.0	26
12/27		700	1.3	23
		1300	1.3	18
		1900	T	18

Figure 1. Erie International Airport snowfall and snow depth measurements taken at 7am, 1pm, 7pm and midnight during December 2017. The 50.8 inch accumulation fell between 7am on 25 December and 7am on 26 December.

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PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6)

STATION: ERIE PA
MONTH: DECEMBER
YEAR: 2017
LATITUDE: 42 4 N
LONGITUDE: 80 11 W

TEMPERATURE IN F:							:PCPN:		SNOW:	WIND			:SUNSHINE:			SKY	:PK WND	
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17	18
									12Z	AVG	MX	2MIN						
DY	MAX	MIN	AVG	DEP	HDD	CDD	WTR	SNW	DPTH	SPD	SPD	DIR	MIN	PSBL	S-S	WX	SPD	DR
1	46	32	39	2	26	0	0.00	0.0	0	5.4	13	290	M	M	4		17	300
2	47	32	40	3	25	0	0.00	0.0	0	4.3	9	170	M	M	2	8	13	170
3	48	31	40	3	25	0	0.00	0.0	0	7.0	16	260	M	M	1	18	20	270
4	56	32	44	8	21	0	T	0.0	0	16.1	30	160	M	M	1		41	150
5	54	33	44	8	21	0	0.24	0.0	0	19.9	36	180	M	M	9	3	53	180
6	39	28	34	-1	31	0	T	T	0	17.0	29	260	M	M	8		37	260
7	35	24	30	-5	35	0	0.45	6.1	0	15.0	23	230	M	M	10	128	34	260
8	30	21	26	-9	39	0	0.01	0.3	4	15.0	24	210	M	M	4	18	31	210
9	33	20	27	-7	38	0	T	T	2	10.8	18	160	M	M	7	8	24	150
10	33	27	30	-4	35	0	0.17	2.0	1	14.1	24	230	M	M	10	128	35	230
11	33	27	30	-4	35	0	0.18	2.3	2	7.4	16	180	M	M	10	18	22	280
12	33	17	25	-8	40	0	0.52	6.8	4	14.7	25	280	M	M	9	128	38	270
13	22	19	21	-12	44	0	0.18	3.4	2	11.7	24	290	M	M	10	18	34	280
14	24	18	21	-12	44	0	0.04	0.8	4	8.9	23	20	M	M	9	18	29	20
15	30	13	22	-10	43	0	0.48	7.2	3	13.5	26	270	M	M	9	128	44	280
16	32	25	29	-3	36	0	0.46	6.0	6	8.8	22	260	M	M	10	18	31	280
17	38	20	29	-3	36	0	0.00	0.0	7	5.7	14	200	M	M	3	18	19	190
18	41	37	39	8	26	0	0.01	0.0	4	12.9	20	210	M	M	10	18	24	200
19	49	39	44	13	21	0	0.00	0.0	0	15.3	24	250	M	M	7	18	37	260
20	40	30	35	4	30	0	0.00	0.0	0	9.8	20	280	M	M	7		28	290
21	36	28	32	1	33	0	0.00	0.0	0	5.8	15	60	M	M	10		18	60
22	38	33	36	6	29	0	0.11	0.0	0	5.8	12	60	M	M	10	18	14	150
23	36	31	34	4	31	0	0.70	2.3	0	8.1	15	310	M	M	9	12	20	320
24	33	29	31	1	34	0	0.15	2.0	2	6.6	15	60	M	M	9	1	17	60
25	30	14	22	-8	43	0	1.77	33.8	3	18.2	30	260	M	M	10	128	44	240
26	15	11	13	-17	52	0	1.00	26.5	28	11.4	18	220	M	M	10	128	27	270
27	15	11	13	-16	52	0	0.13	3.6	23	11.7	18	280	M	M	10	18	25	290
28	16	10	13	-16	52	0	T	T	18	5.7	14	360	M	M	8	8	22	350
29	19	8	14	-15	51	0	0.27	5.5	14	9.7	18	220	M	M	9	128	26	210
30	19	13	16	-13	49	0	0.68	12.3	20	13.1	22	300	M	M	9	128	33	310
31	15	11	13	-16	52	0	T	T	19	7.9	16	350	M	M	8	8	25	330
SM	1035	724		1129		0	7.55	120.9	337.3				M		242			
AV	33.4	23.4								10.9	FASTST		M	M	8		MAX(MPH)	
								MISC ---->		# 36	180						# 53	180

NOTES:

Figure 2. Erie International Airport snowfall and snow depth daily observations for December 2017.

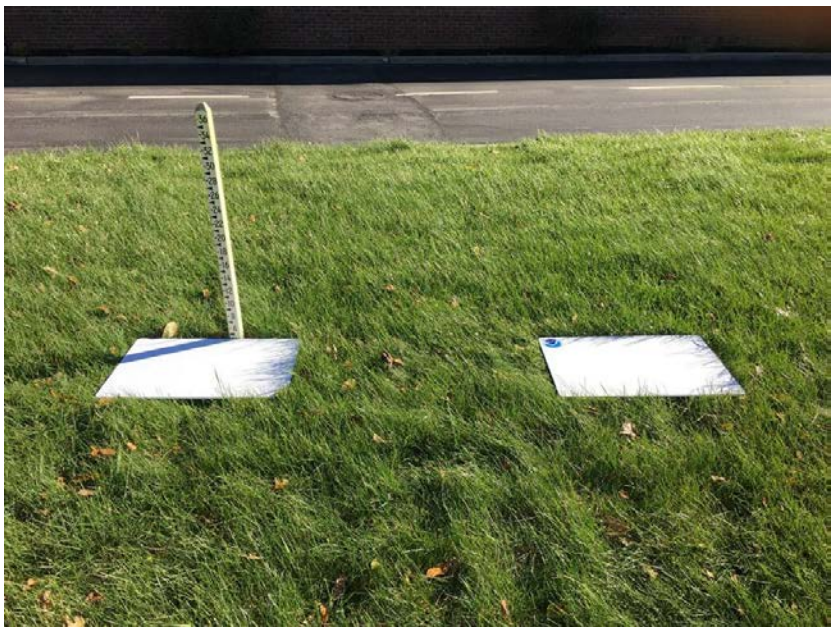

Figure 3. Snowfall and snow depth boards located at Erie Airport.

Figure 4. Location where Erie Airport snowfall & snow depth measurements are taken. The blue airplane symbol denotes the patch of grass where the snow boards are positioned.

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Figure 5. Snow board placement at Erie Airport. Photo taken on 29 December 2017

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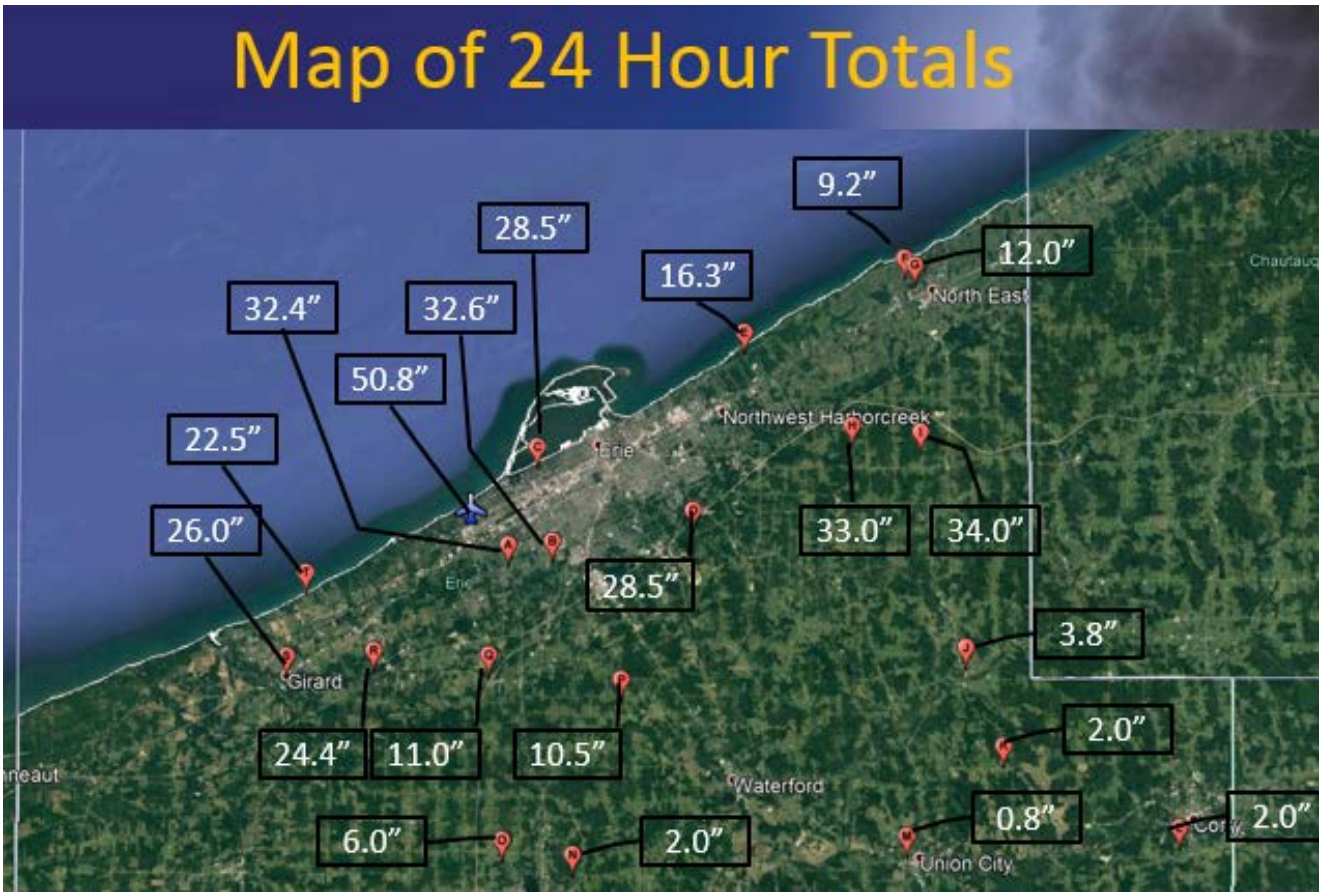

Figure 6. Map of Erie Airport and regional snowfall totals from approximately 7am-7am, 25-26 December 2017. Erie Airport denoted by blue airplane symbol.

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A)

Date and Time of Observation (24 Hour Reports)	New Snow	Snow Depth
12/25/2017- 7 AM	3.9	6.4
12/26/2017- 7 AM	32.4	40.1
12/27/2017- 7 AM	5.5	37.9
12/28/2017- 7 AM	2.6	39.5
Storm Total	44.4	

B)

Date and Time of Observation (12 Hour Reports)	New Snow	Snow Depth
12/25/2017- 8 AM	3.1	5
12/25/2017- 8 PM	12.1	14
12/26/2017- 8 AM	20.5	27
12/26/2017- 8 PM	6.7	26
12/27/2017- 8 AM	4.1	25
12/27/2017- 8 PM	1.4	25
12/28/2017- 8 AM	1.0	21
Storm Total	48.9	

C)

Date and Time of Observation (12 Hour Reports)	New Snow	Snow Depth
12/25/2017- 8 AM	4.4	6
12/25/2017- 8 PM	16.1	21
12/26/2017- 8 AM	12.4	38
12/26/2017- 8 PM	5.2	43
12/27/2017- 8 AM	3.4	47
12/27/2017- 8 PM	2.3	49
12/28/2017- 8 AM	0.0	49
Storm Total	43.8	

D)

Date and Time of Observation (Avg. 12 Hour Reports)	New Snow	Snow Depth
12/25/2017- 9 AM	3.0	7
12/25/2017- 6 PM	14.0	17
12/26/2017- 8 AM	14.5	28
12/26/2017- 8 PM	15.0	35
12/27/2017- 8 AM	5.0	26
12/27/2017- 8 PM	3.0	28
12/28/2017- 9 AM	1.5	28
Storm Total	56.0	

Figure 7. Nearby snowfall and snow depth observations and timing during entire event for stations A, B, C and D, as noted on Figure 6.