May 31st, 1985 Tornado Outbreak
The 25th Anniversary

On the evening of May 31st, 1985, a devastating and deadly tornado outbreak struck the Northeastern United States and Canada. 41 tornadoes and numerous damaging thunderstorms tore across Ohio, Pennsylvania, New York, and Ontario Canada, killing 88 people in total, injuring more than 1000 others, and raking up more than $450 million in property damage in the United States.

The storms were the result of high levels of atmospheric instability present in an environment favorable for tornadic thunderstorms, triggered by the passage of a strong late spring cold front. Quoting the original survey report produced by NOAA in 1985, "perhaps the lesson to be learned from the 1985 outbreak is that under the proper atmospheric conditions, major tornadoes can occur irrespective of the location or terrain". As May 2010 marks the 25 year anniversary of this event, let us look back on the impact the outbreak had on our region, and examine the strides made by the National Weather Service in the past 25 years in order to reduce the loss of life and property if a similar event were to occur today.

I. Overview

In all a total of 23 confirmed tornadoes touched down on the evening of May 31st, 1985 between the hours of 5:05 and 11:00pm across Eastern Ohio, Southwestern NY, and Central and Western PA. This outbreak remains the worst in recorded history for this area. Of these 23 tornadoes, 8 were of violent intensity (F4 or F5), with estimated wind speeds over 200mph, and 9 of these tornadoes produced fatalities.

21 of these 23 tornadoes touched down in Pennsylvania, producing 65 fatalities and over $300 million in damages. To put this in historical prospective, the number of fatalities on the 31st nearly equaled the tornado fatality total during the previous 50 years (69). Furthermore, the F5 tornado that struck Wheatland, PA is still believed to be the strongest tornado to ever touch down in Pennsylvania.

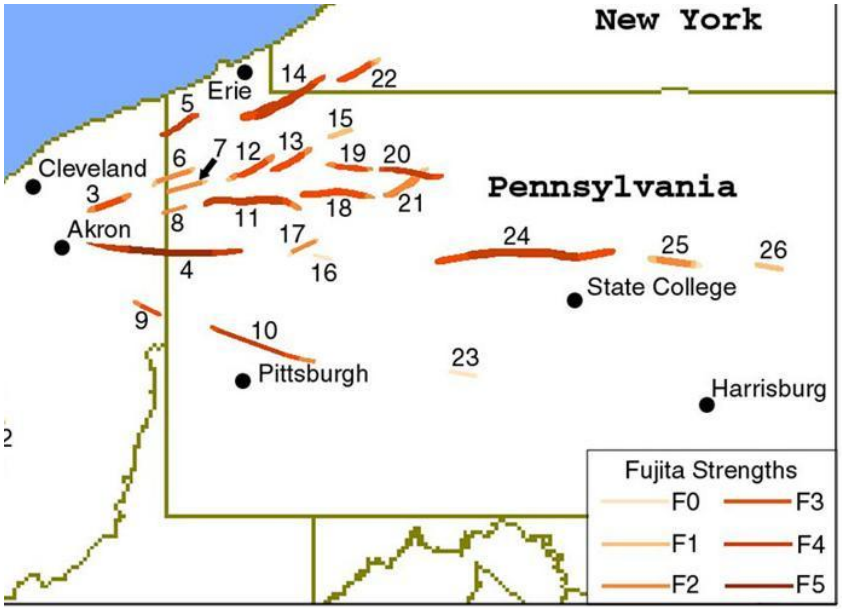
The table below provides a brief summary of these 23 tornadoes, and the general location and extent of their paths is represented in the accompanying figure. The F-Rating appearing on the table refers the estimated strength of each of the tornadoes determined by a damage survey.

Summary of Regional Tornadoes
May 31st, 1985

Id #	Name	F-rating	Length(km)	Width(m)	Time(EST, PM)	Killed	Injured
3	Mesopotamia, OH	3	24	425	5:05-5:20	0	30
4	Wheatland, PA	5	75	425	6:30-7:35	18	310
5	Albion, PA	4	45	425	4:59-5:17	12	82
6	Dorset, OH	2	16	150	5:28-5:41	0	15
7	Linesville, PA	2	6	200	5:10-5:15	1	0
9	Middleton, OH	2	24	200	7:35-7:55	0	20
10	Big Beaver, PA	3	63	250	8:10-9:05	9	120
11*	Atlantic, PA	4	90	350	5:17-6:30	16	125
12	Saegertown, PA	3	37	250	5:23-5:55	0	?

13	Centerville, PA	3	13	400	6:12-6:23	2	10
14	Corry, PA	4	45	425	5:25-5:55	0	17
15	Thompson Run, PA	1	8	200	6:30-6:37	0	0
16	Emlenton, PA	0	8	30	7:56-8:03	0	0
17	Big Bend, PA	2	10	130	7:54-8:03	0	2
18	Tionesta, PA	4	48	800	6:30-7:10	7	30
19	Tidioute, PA	3	27	800	7:30-7:55	0	8
20	Kane, PA	4	46	950	8:00-8:40	4	40
21	Lamont, PA	2	33	300	6:50-7:35	0	?
22	Busti, NY	3	21	175	6:25-6:45	0	10
23	Penn Run, PA	0	10	25	9:53-10:02	0	0
24	Moshannon St. Forrest	4	115	1000	7:35-9:00	0	1
25	Watsontown, PA	4	34	850	9:25-1015	6	60
26	Hollenback Twp, PA	1	16	400	10:45-11:00	0	?

(*) Please note that the tornado appearing on the image with an ID # of 8 has been included in the statistics for the Atlantic, PA tornado (11).



The general locations and strengths of the various tornadoes to impact the region on May 31st, 1985. Path lengths and widths are not drawn to scale.

II. Moshannon State Forrest Family of Tornadoes

In the surveys that took place in the days after this event, it was determined that a number of these tornadoes could be grouped into one common family, spawning from the same parent super cell thunderstorm. Easily the most intense and memorable family of tornadoes to strike the area now encompassed by the NWS State College, PA county warning area that occurred during the outbreak were the Moshannon Family of tornadoes, #'s 24 and 25 in particular.

In fact the tornado that passed over Moshannon State Forrest had the longest and widest path of any of the tornadoes that touched down that evening. If it was ever believed that tornadoes can

not successfully navigate mountainous terrain, the Moshannon State Forrest tornado (24) proved other wise. The F4 tornado easily traversed the ridges and valleys of Clearfield, Southern Cameron, Northern Centre, and Clinton counties, cutting out a path that was over 71miles long and a half a mile wide, even crossing over the west branch of the Susquehanna River twice. Countless trees were uprooted and toppled, many of which remain on the forest floor 25 years later, serving as a stark reminder of the power of Mother Nature. Remarkably, only 1 injury was reported from this particular tornado. This can most likely be attributed to the fact that, despite its strength and longevity, its path did not cross any densely populated areas.

While its path was not nearly as long or wide, nor its winds quite as intense as the aforementioned tornado, the Watsontown tornado (25) did impact populated areas, and hence, proved deadly. In all, the F4 tornado was blamed for 6 fatalities and 60 injuries. Numerous homes and businesses were damaged or destroyed as the tornado moved through Lycoming, Union and Northumberland counties.

An aerial view of the patch carved out of Moshannon State Forrest by the F4 tornado that came through the area on May 31st, 1985.

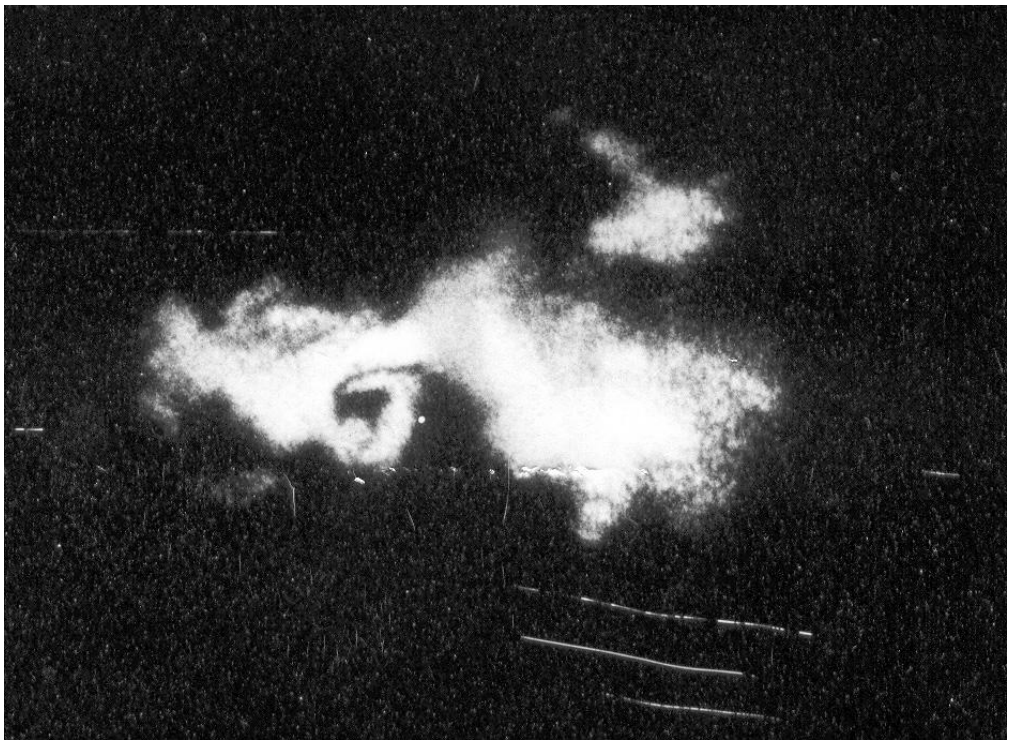
III. Advances in the Weather Service since 1985

Looking back on these events, it is important to reflect on how NWS technologies and warnings have improved, and what could be expected if an event of this magnitude occurred today. Unfortunately, if an outbreak like this occurred again, it would still be a damaging and devastating event. However, the organization is better much better equipped to achieve our mission, particularly in the protection of life and property.

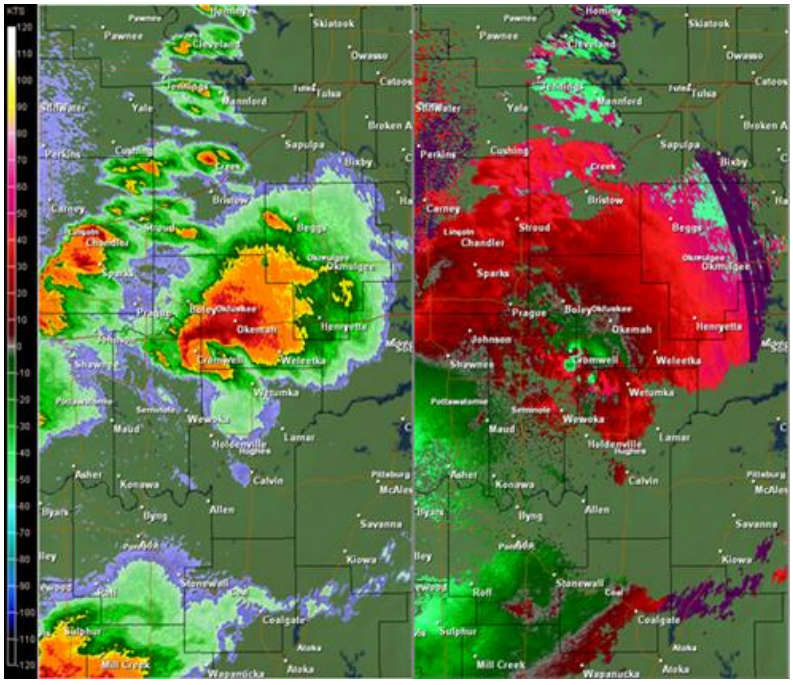
Perhaps the greatest strides made by the NWS in the past 25 years have been in the ability to track and diagnose severe and tornadic storms via Doppler radar. During the tornado outbreak of 1985, the WSR-77 series were the most sophisticated radars in use. The black and white image below shows the supercell that produced the Moshannon Family of tornadoes in Central PA, as seen from the WSR-77 radar maintained by Penn State University at the time. Compare this image to another, similarly structured tornadic supercell seen from modern WSR-88D radar in Oklahoma, and the

technological advancements prove remarkable. The current national Doppler radar network allows forecasters to get a far more detailed view of these dangerous thunderstorms. In fact the WSR-88d's Doppler capabilities can be used to detect a tornado's probable location within a supercell. This helps forecasters predict the movement and development of tornadoes with a much higher level of accuracy, leading to timelier and more spatially accurate warnings.

Beyond the obvious strides in radar technology, the weather service has also made great strides in computer technology, data collection, and warning services. In addition, higher resolution forecast models allow forecasters to more accurately predict the timing and location of potential severe weather outbreaks. Furthermore, research by the weather service and numerous universities nation wide have lead to great strides in understanding of the evolution of these dangerous storms. Overall, the National Weather Service finds itself much better equipped to deal with a tornado outbreak now than 25 years ago. Again, if a similar outbreak were to occur today, while still having an inevitably large and lasting impact, improvements made by the National Weather Service since 1985 would help mitigate loss of life and property.



A view of the supercell that produced the Moshannon Family of Tornadoes on May 31st, 1985, as seen from the WSR-77 at Penn State University.



A dual display of reflectivity (left) and base velocity (right) for a tornadic super cell in Oklahoma in May of 2010. The velocity image shows a well defined area of rotation, marked by adjacent inbound (green) and outbound (red) velocities, near the center of the image.