Steel City Newsletter

National Weather Service in Pittsburgh, PA

National Oceanic and Atmospheric Administration (NOAA) -- US Department of Commerce (DOC)

Issue II **FALL 2012**

The Hybridization of Sandy

How A Superstorm Came To Be

By Bob Henson from the University Corporation for Atmospheric Research

While still a hurricane on Sunday afternoon, October 28, Sandy was already beginning to show extratropical characteristics, including strong winds far north of its center and a huge outflow plume stretching from the southeast U.S. coast into eastern Canada. (GOES-13 image courtesy

Every so often, a quiet corner of research suddenly grabs the spotlight. Such was the case this week when a Category 1 Atlantic hurricane morphed into Superstorm Sandy, wreaking tens of billions of dollars in damage and taking scores of lives in the eastern United States.

Sandy's destiny as a hybrid storm was flagged to the public several days before landfall, when the irresistible name "Frankenstorm"—coined by a NOAA meteorologist—went viral. (Of course, in the original Mary Shelley novel, it was the scientist rather than the monster who was dubbed Frankenstein, as Bay Area meteorologist Jan Null pointed out to me.)

While there have been hybrid storms before, Superstorm Sandy was a creation distinct in meteorological annals, as it pulled together a variety of familiar ingredients in a unique way. Sandy could be the storm that launches a thousand dissertations—or at least a few—and some of its noteworthy aspects have implications for hurricane warning in general. *Warning:* there's a bit of unavoidable weather geekery in the material below, although I'll try to keep it as accessible as possible.

Extratropical transition is the formal name for what happened in the 12 to 24 hours before Sandy crashed ashore near Atlantic City on Monday evening, 29 October.

(Continued on page 6)

INSIDE THIS ISSUE:

A Message From the MIC

Rich Kane

NWS Pittsburgh SKYWARNERs,

I want to thank all of you for your continued participation in the SKYWARN program. For many years, I talked to you during SKYWARN sessions about the importance of severe weather observations. The observations that you give us:

1. Add credibility to our warnings
2. Are critical in our warning verification
3. Help to alert everyone downstream of our office
4. Are inserted into our StormData archives forever (part of the nation's severe weather climatology)

Even though our technology is constantly advancing with improved detection capabilities and better short term weather models, there's no replacing "ground truth". Your severe weather reports help many people. Please keep up the great work and remember, we need your help in the winter months just as the summer months.

Once again, thanks for your participation.

Regards,

Rich Kane

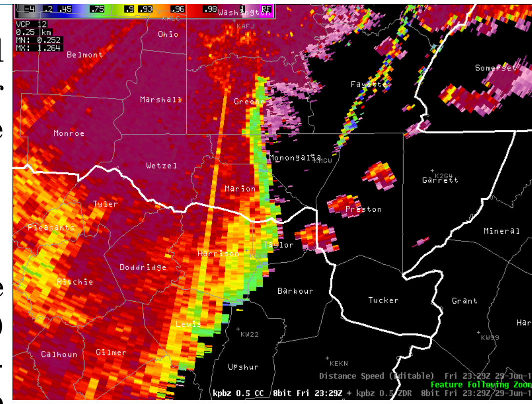
MIC (Meteorologist-in-Charge, NWS Pittsburgh)

Send us your weather pictures and photos!

The National Weather Service in Pittsburgh wants to make it possible for weather spotters across the region to showcase their photos to the world! Pictures may be used in future editions of this newsletter, for spotter training, and in the photo gallery on our website. To participate, send your photos or any other questions to **PBZ-Public@noaa.gov.** Remember to express your permission for your credited work to be displayed on our website, used in this publication, or featured in a spotter training presentation.

The Latest on Dual Polarization Radar

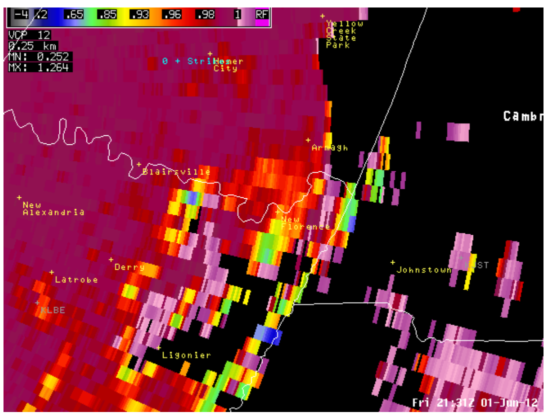
Charlie Woodrum



Over the past year and a half, the National Weather Service in Pittsburgh has observed new radar signatures from Dual Polarization (DP) radar for the first time ever. Below are a few examples:

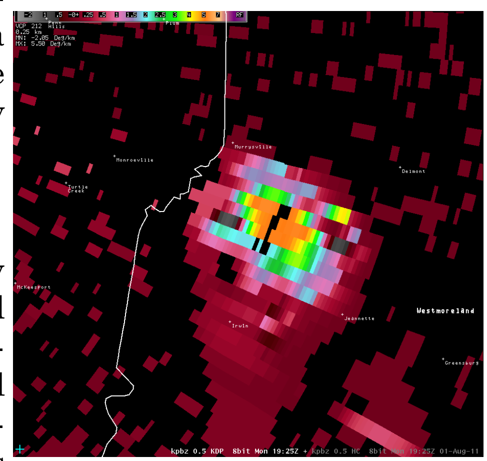
Dust and Debris with a Gust Front

Although it has likely happened more than twice, we have twice observed lower correlation coefficient (CC) values ahead of an organized convective line of precipitation. This area (right) of lowered CC is actually the radar detecting dust particles on the leading edge of an outflow boundary. This occurred ahead of the June 29th Derecho.



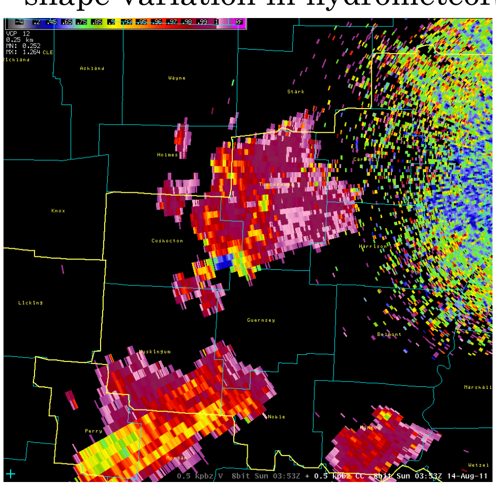
Tornadic Debris Signature

There have been two documented cases of a tornadic debris signature (TDS) in our forecast area. A TDS was detected with tornadoes in Ligonier, PA on June 1, 2012 and in Eighty Four, PA on September 27, 2012. Since most tornadoes in our region are weaker EF0-EF2 in intensity and often short-lived, TDSs can be used as more of an observation tool than a forecasting tool. TDSs confirm debris being lofted into the air based off of their non-uniform properties as indicated by CC [above] (values that are noisy and well below 1).



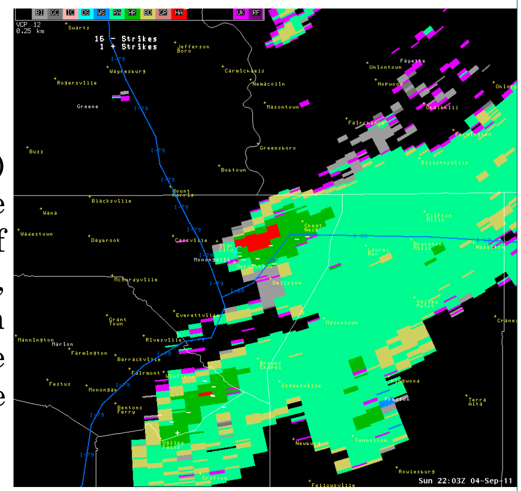
Large Hail

Dual-Pol (DP) helps forecasters detect an area of hail by showing a local minimum in CC (right), indicating size and shape variation in hydrometeors. At this point, DP data increases confidence that hail is present in a storm. However, at this time, there is no definite way to correlate a DP signal to a particular hail size.



Three Body Scatter Spikes in Weak Precipitation

A Three Body Scatter Spike (TBSS) is observed as a spike of weak reflectivity extending out from a thunderstorm and away from the radar site. This spike indicates hail in a thunderstorm. With DP radar, the TBSS can be observed as a down-radial spike of lower CC (left) in addition to the spike of lower reflectivity. DP has also indicated lowered CC values corresponding with both severe and sub-severe hail and in locations where the reflectivity's TBSS is more difficult to detect in surrounding areas of light reflectivity.



Delineated Precipitation Type

Although the Hydrometeor Classification Algorithm (HCA) has performed poorly in identifying wintry precipitation, the HCA does have some utility for detecting characteristics of thunderstorms. The HCA can help distinguish hail (right, in red). It was used to show emergency managers from West Virginia University the location of a hail core relative to their football stadium during a post-event briefing at the office.

Student Volunteer Program

Tom Green

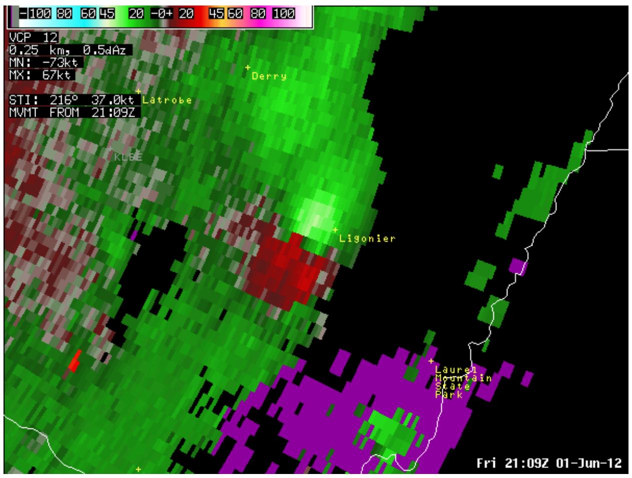
Our office typically takes on 1 or 2 student volunteers during the summer months. This gives students a chance to build their resumes and gain some experience in a professional setting, while the office gains information through projects that the volunteers work on. The volunteers spend about 100 hours at the office over the summer, working in 3 different areas. First, students are taught about the upper air balloon launch that we do twice a day, and by the end are launching the balloons on their own. Next, they move to aviation forecasting, learning what variables are forecast for local airports and collaborating with forecasters to test their own skills. Finally, they spend time with the forecasters doing the 7-day public forecast, finding out what goes into that process.

This summer we had Richard Poremba (right) from Millersville University and Trever Steele (left) from Penn State University work with us. Trever worked on a project that combined hydrology and Google Earth to develop better documentation of locations that have an enhanced flash flood risk in heavy rain events, while Richard worked on a project to determine how well particular computer models do in forecasting wind speed during high wind. If you or anybody that you know is interested in applying for the student volunteer opportunity during the summer of 2013, make sure to keep an eye on our home page during the months of January and February for more information.

EF-1 Ligonier Tornado

Rihaan Gangat

On June 1, 2012, a low pressure system moving east across the lower Great Lakes extended a cold front through the Ohio Valley. Thunderstorms became more organized into a quasi-linear convective system along the cold front as it began to cross western Pennsylvania. A couple of Special Weather Statements were issued to address gusty winds up to 40mph. The bottom half of the squall line, from Pittsburgh southward, was moving into a more unstable environment around the ridges of southwest Pennsylvania and West Virginia. Although the instability didn't seem impressive enough to induce tornadoes, very strong low level shear was available to help sustain any thunderstorms and possibly cause rotation at low levels. The Storm Prediction Center (SPC) forecasted the region for slight risk of thunderstorms three days in advance. The SPC issued a Tornado Watch for Westmoreland, Fayette, Preston, Garrett, and Tucker counties for our forecast area at approximately 1:30pm on June 1 as conditions seemed favorable for severe weather and possible tornadoes to develop.



This radar image shows strong inbound (green) velocities next to strong outbound (red) velocities indicating rotation near the town of Ligonier.

At 5:12pm, the National Weather Service issued a tornado warning as the Doppler radar indicated a storm capable of producing a tornado. A tornado indeed did touch down at approximately 5:25pm in Westmoreland County in the borough of Ligonier causing sporadic damage occurring over a length of about eight miles. The most severe damage occurred to a house where the entire roof was blown off and parts of it were scattered about 50 yards away. Numerous trees were snapped and uprooted at another location along with three stationary vehicles being moved. The width of the tornado at this location was its widest of approximately 300 yards. Before lifting, the tornado did its last bit of damage to 14 cabins. Windows were broken and roofs were damaged mainly due to trees being snapped and uprooted. After conducting a storm survey, the National Weather Service confirmed that the damage was from an EF-1 Tornado, a tornado consisting of wind speeds from 86 to 110 mph. The damage indicated that winds were convergent; meaning the damage done was from a tornado as opposed to straight line wind damage from a downburst. Fortunately, no injuries occurred. The Ligonier tornado was the 37th recorded tornado to affect Westmoreland County since 1800 and this places the county in a tie with Crawford County for the most tornadoes in the commonwealth of Pennsylvania.

One of many trees snapped or uprooted from the tornado. The estimated path length of the tornado was 8 miles causing sporadic damage to trees and structures.

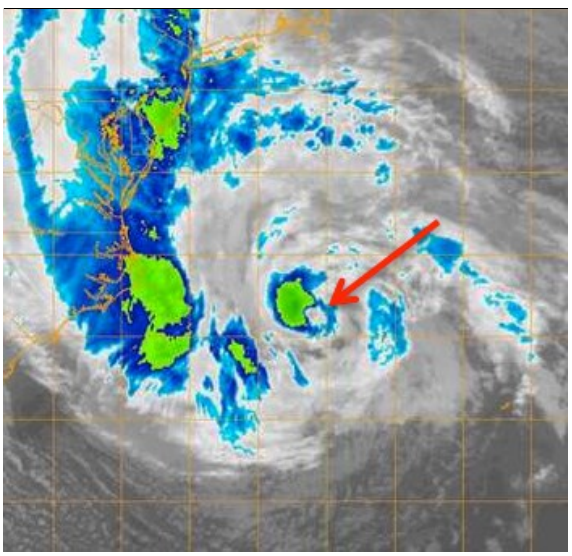
(continued from page 1)

A hallmark of tropical cyclones (known as hurricanes, typhoons, or cyclones in various parts of the world) is that their circulations revolve around a core of warm air. Hurricanes draw energy from oceanic heat and moisture, and they thrive when the surrounding air is uniformly warm and humid and upper-level winds steering the storm are relatively weak. In contrast, an extratropical low is typically positioned at or near the intersection of a cold front and warm front. Such a low is helped rather than hindered by temperature and moisture contrasts and the accompanying strong winds of the polar jet stream.

Here are three of the routes that warm- and cold-core systems can take as they evolve:

* It's not unusual at all for a tropical cyclone to shift from warm-core to cold-core. In an average year, one or more hurricanes will evolve into extratropical storms in a fairly straightforward manner as they move into the North Atlantic. As colder, drier air intrudes into the warm core, the storm typically loses symmetry and begins tilting toward the coldest upper-level air.

* It's also possible for an extratropical cyclone to develop what's known as a warm seclusion. In this case, a pocket of warm, moist air is drawn into the cold-core circulation, then pinched off through a complicated set of dynamics involving air pulled down from the stratosphere. This is dubbed the Shapiro-Keyser process, after veteran researchers Mel Shapiro (now at NCAR) and Daniel Keyser (University of Albany, State University of New York). Some of the Atlantic's most intense storms of any type have emerged from warm seclusions. These are most common in winter over the far North Atlantic, but rarely do they move onto the mid-Atlantic coast, especially in mid-autumn.



At 0245 UTC on Monday, 29 November—about a day before Sandy struck New Jersey—the storm began carving out a thin eyewall (indicated by red arrow), a sign of hurricane intensification, even as the outer part of the storm increasingly resembled an extratropical cyclone. (GOES-13

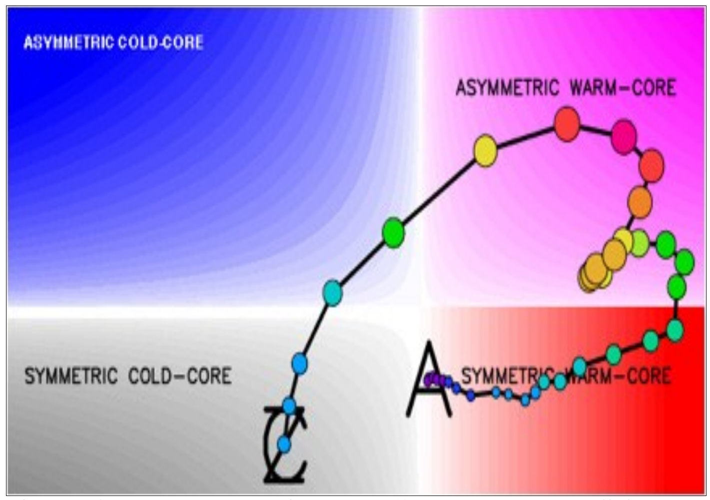
* Once in a while, an extratropical cyclone will get a boost of energy by absorbing the remnants of a hurricane. Well east of New England, the iconic "perfect storm" of October 1991 was fueled by heat and moisture from the late Hurricane Grace. While it never moved ashore, this great storm still pushed destructive surf into much of the U.S. East Coast.

Meteorologists are still parsing the maps, but it appears that Sandy may have incorporated elements from all three of the above processes. While Sandy was still a hurricane, the storm's outer edges began to reveal some aspects of an extratropical cyclone, with an enormous zone of strong surface wind and "a great chimney of upper-level outflow," as Shapiro puts it (see satellite image above). The storm's warm core briefly intensified about a day before landfall.

Then, a few hours before landfall, Sandy began a sharp curve toward the west, moving toward the heart of the approaching midlatitude trough of low pressure. In Shapiro's view, this marked an apparent warm seclusion trying to take place on top of the storm's fast decaying warm core.

I asked Shapiro how often he's seen a storm like Sandy. He replied, "Never."

The one that may come closest in Shapiro's view is the "Long Island Express" hurricane of 1938, which killed hundreds of New Englanders as it slammed ashore virtually without warning. "There was a dramatic upper trough coming in from Canada, just like there was with Sandy," says Shapiro. The 1938 storm reportedly raced northwards at speeds of close to 70 mph, making it the fastest-moving hurricane on record, and hooked northwest after landfall. While not as much of a speed demon, Sandy did accelerate to a forward motion of nearly 30 mph as it curved west and approached New Jersey. Upper-air observations from the 1930s are sparse, however, so it might not be possible to pin down the commonalities between the two events.



Sandy's circuitous life: This "phase diagram" from Robert Hart (Florida State University) shows how the storm's characteristics changed from point A (0000 UTC on October 22, when Sandy was forming in the Caribbean Sea) to point C (1200 UTC on October 31, when Sandy's remnant low had moved near Lake Erie). Dots are indicated every six hours; warmer colors denote lower pressure and thus a stronger system. Beginning at point A with the structure of a typical hurricane (symmetric warm-core), Sandy became asymmetric as it grew in size. The diagram shows Sandy quickly becoming an asymmetric cold-core low in the 12 hours after landfall and a symmetric cold-core low as it decayed further over the next 24 hours. The kink in the curve at upper right corresponds to the strengthening of Sandy's inner core about a day before landfall. The phase diagrams are explained in a 2003 article in Monthly Weather Review. (Image courtesy Robert Hart, FSU.)

Chris Davis, head of NCAR's Advanced Study Program, has carried out extensive research on how warm- and cold-core processes interrelate. Like Shapiro, Davis finds Sandy an intriguing case. "It seems to have had a remnant inner core that was somewhat tropical, embedded in a much larger nontropical structure," says Davis. He notes other cases where a remnant warm core can persist well into a storm's extratropical life. "You end up with two definable structures at once," he says. "There was a point where you had a huge arc of cloud over land, but you also had a complete eyewall surrounding the inner core."

Sandy's vast wind field provides more evidence for the warm-within-cold theory. Along with a small central core of winds near hurricane force, focused on Sandy's south side, there was a second maximum of high wind well to the north. It pounded portions of New England with wind gusts as high as 86 mph in Rhode Island. This outer wind band later moved into Long Island and New York City.

This dual wind structure isn't a common occurrence with hurricanes. Fortunately, computer models predicted the unusual outer band of high wind more than a day ahead of time. And upper-air observations caught its development several thousand feet above ground a few hours before the winds mixed down to the surface. As a result, the National Weather

Service provided a specific "nowcast," putting people in the New York area—especially those in skyscrapers—on alert that dangerous hurricane-force gusts could occur in a window of several hours on Monday evening. Gusts reached 90 mph at Islip, in central Long Island, and 79 mph at John F. Kennedy International Airport, in Queens.

There's still much to digest about the physics of this remarkable weather event, not to mention the host of societal issues it's raised. What's heartening to researchers is that computer models, by and large, predicted many of Sandy's most unusual features days ahead of time. That gave forecasters confidence in predicting unprecedented impacts to the most densely populated part of the nation, regardless of whether Sandy was dubbed a hurricane, an extratropical storm, a hybrid, or—in the label that now seems to be winning out—a "superstorm."

The full article can be found on http://www2.ucar.edu/atmosnews/opinion/8243/hybridization-sandy

Social Media Update

Alicia Smith

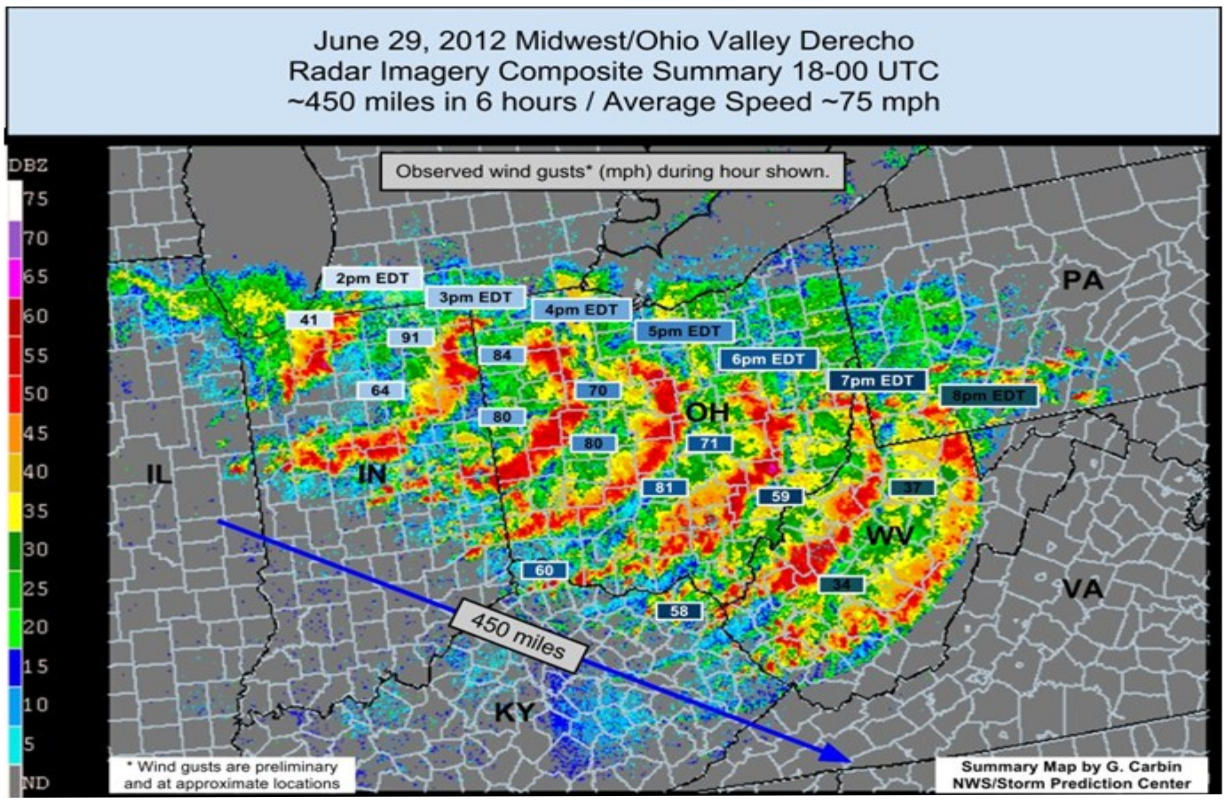
Since its inception in 2011, our Facebook page has gathered over 2400 likes. Facebook continues to gain recognition as a great way to disseminate information, as was the case during both the June 29, 2012 Derecho and Hurricane Sandy. It's been utilized to promote weather awareness activities and Skywarn meetings. We continue to encourage interaction with us through Facebook, especially in times of severe/winter weather. We try our best to monitor posts and update our status regularly, and responses to posts will be made on a time-available basis. We've enjoyed the many posts we've received from our followers including the many photos and storm reports that have been submitted. Please continue to submit these photos, videos, and reports to us. Just as you would do when you call our office; try to give us the date, time, location, and duration of the phenomena that you are recording. If you haven't done so, Please 'Like' our page at https://www.facebook.com/US.NationalWeatherService.Pittsburgh.gov

This summer we also added a Twitter account @NWSPittsburgh. While this will generally be used most during active weather, we encourage you to follow us! We already have over 300 followers and counting! We will try to utilize various hashtags to get the word out and follow various hashtags to gather reports. We encourage you to tweet your reports directly to us though this account. Follow us at https://twitter.com/NWSPittsburgh

June 29th Derecho

Alicia Smith

On June 29, 2012 a strong ridge centered across the Southeast brought record heat to the Upper Ohio Valley. A weak frontal boundary that was set up from northern Indiana into western Pennsylvania became the focus for severe thunderstorm development late in the afternoon. With plenty of low level moisture, strong instability, and moderate shear, a shortwave crossing this region helped spark thunderstorms that intensified and grew into a Mesoscale Convective System – which later was classified as a derecho as it tracked along this stalled boundary. It travelled over 600 miles total from northern Indiana, through Ohio, West Virginia, southern Pennsylvania, Virginia, Maryland, and Delaware causing numerous reports of damage and power outages through the region.



According to the Storm Prediction Center, "A derecho (pronounced similar to "deh-REY-cho" in English) is a widespread, long-lived wind storm that is associated with a band of rapidly moving showers or thunderstorms. Although a derecho can produce destruction similar to that of tornadoes, the damage typically is directed in one direction along a relatively straight swath. As a result, the term "straight-line wind damage" sometimes is used to describe derecho damage. By definition, if the wind damage swath extends more than 240 miles (about 400 kilometers) and includes wind gusts of at least 58 mph (93 km/h) or greater along most of its length, then the event may be classified as a derecho".

In the case of the June 29th event, wind reports as high as 91mph were recorded from Automated Weather Stations along its path. The Pittsburgh NWS issued 8 severe thunderstorm warnings with enhanced wording to emphasize the wind threat. 3 Tornado warnings were also issued but surveys concluded the damage was indicative of "straight-line" winds versus the convergent signature of a tornado. Storm surveys were conducted in Muskingum and Guernsey counties in Ohio, and Preston County in West Virginia. Numerous structures were damaged including a barn that collapsed in Muskingum County OH, killing a woman and injuring a man as they were checking on their animals and a church in Cambridge (Guernsey County, OH) was completely demolished. Thousands were without power; some for days with temperatures continuing to be well above normal for the time of year. This became one of the costliest disasters to hit Ohio, right behind Hurricane Ike in 2008.

You can find more information about Derechos including some information on past events and climatology at http://www.spc.noaa.gov/misc/AbtDerechos/derechofacts.htm

Recent Weather Photos!





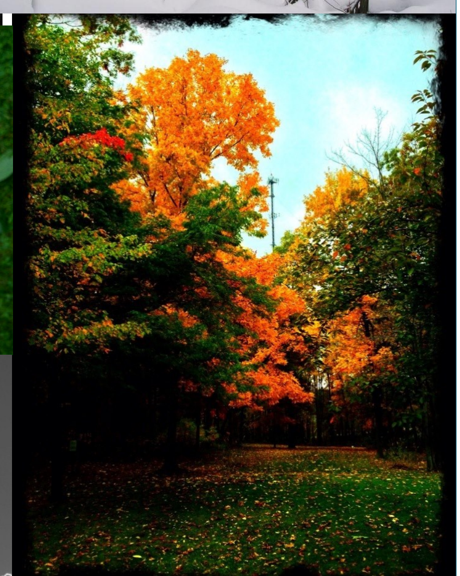



Photo Courtesy of (from top left):
Larry Moyer, George Miller, Scott Buckles, Beau Dodson,
Paul Rupnik Jr., Rihaan Gangat,
Josh Korzendorfer, Rihaan Gangat

Winter is Right Around the Corner!

Rodney Smith

With winter quickly approaching, here's a reminder of our winter weather products, their criteria, and spotter guidelines.

Winter Headlines and Criteria

Winter Spotter Guidelines—What to Report

Winter Storm Watch	6 inches/12 hours or 8 inches/24 hours possible
Winter Storm Warning	6 inches/12 hours or 8 inches/24 hours imminent
Blizzard Watch	Heavy snow / Winds >35 kts (3 hrs) / Vis < 1/4 mile (3 hrs)
Blizzard Warning	Heavy snow / Winds > 35kts (3h rs) / Vis < 1/4 mile (3 hrs)
Winter Weather Advisory	3 inches/12 hours / Blowing & Drifting snow
Ice Storm Warning	Ice accumulation >= 0.25 inches
Freezing Rain Advisory	Any ice accumulation < 0.25 inches
Wind Chill Watch	Indices <= -25F possible
Wind Chill Warning	Indices <= -25F imminent
Wind Chill Advisory	Indices -10F to -24F
Lake Effect Snow Watch	(3 counties) 6 inches/12 hours or 8 inches/24 hours possible
Lake Effect Snow Warning	(3 counties) 6 inches/12 hours or 8 inches/24 hours imminent
Lake Effect Snow Advisory	(3 counties) 3 inches/12 hours

When you report, please give your location (including your county) and the time of the observation. Try to report as soon as possible after observing the event and ***remember to be careful!*** Please concentrate on the following phenomena:

SNOWFALL	After 2 inches of new snow, and then at 4 inches, 6 inches, and every 3 inches thereafter (e.g., 2, 4, 6, 9, 12, etc.)
FREEZING RAIN	As soon as you observe the occurrence of freezing rain or freezing drizzle, especially if it starts to collect on objects. Call again if the glaze/ice accumulation exceeds 1/4 inch
THUNDER SNOW	Location and time of occurrence
WIND SPEEDS	Report wind speeds greater than 40 mph

National Weather Service

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15108

http://www.erh.noaa.gov/pbz/winter.html