SKYWARNEWS

NATIONAL WEATHER SERVICE
STATE COLLEGE, PA

FALL 2013

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The Summer in Review

John La Corte—Senior Forecaster

Another summer is in the books, and for most of us in Central Pennsylvania it was a warm one. It wasn't a particularly impressive summer from a record-setting standpoint, but the persistent period of very warm and humid weather that dominated much of July helped assure that the region would continue the recent string of abnormally mild summers we have enjoyed.

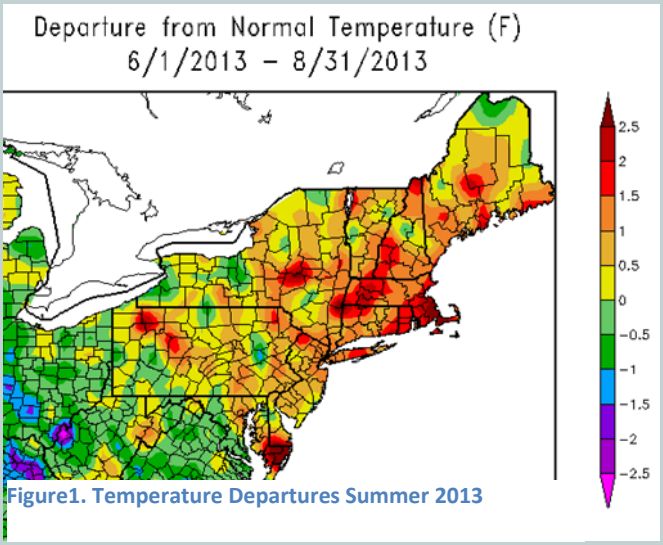

Figure1. Temperature Departures Summer 2013

The state capital of Harrisburg experienced an average temperature of 74.2 degrees for the summer months of June-July -August. This ended up 0.4 degrees above normal. That's the 4th year in a row summer temperatures were warmer than normal. We have to go back to 2009 (cont. p. 5)

Fall Colors

Dave Martin—General Forecaster

Many things influence the color of trees in the fall including the species of tree, health of the tree, weather and soil conditions.

The main factors in the leaves changing color include changing weather conditions in the fall with both light and temperature being important. As the intensity and duration of sunlight decreases in the late summer and fall, chlorophyll production tapers off in the tree leaves. (cont. p. 4)

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Hurricane Sandy—A Storm For The Ages

John La Corte—Senior Forecaster

By the time you are reading this, it will be about a year since Hurricane Sandy earned its place in the world of weather infamy by battering a large portion of the Mid Atlantic coast, killing more than 100 people in the United States and becoming the second costliest hurricane in US history.

Forming off Africa during the second week of October, the disturbance remained little more than a weak tropical wave as it trekked westward, until it began to intensify into a tropical storm over the southern Caribbean Sea on October 22nd. Two days later Sandy intensified into a hurricane just south of Jamaica. It crossed western Cuba as a category 3 hurricane (winds of 96-110 mph) as it plowed through the Bahamas on a track just off the eastern Seaboard.

After weakening briefly on October 27th, Sandy re-intensified into a hurricane just north of the Bahamas. Sandy paralleled the southeast US coast until it got east of Cape Hatteras where something remarkable happened, it turned sharply to the left and slammed head on into the New Jersey coast just north of Atlantic City. (Fig. 1)

The sudden turn to the left that Sandy took on October 29th and 30th is not the whole story as to why this was remarkable, many storms have moved westward in their life cycles. However, most storms that do so at our latitude do it late in their lives as weakening systems. What made this unusual was that Sandy intensified as it bent toward the coast! A complex interaction with a mid-latitude upper level low pressure area helped rejuvenate Sandy as it moved away from the warm waters of the tropics into the colder waters north of the Gulf Stream. The storm which had a central pressure of 960 mb (28.34") late on the 28th deepened another 20 mb down to 940 mb (27.75") by mid-day on the 29th. Sandy by this time was what we refer to as "extra-tropical", a hybrid between a purely tropical cyclone that owes its energy to the warm ocean waters and a mid-latitude cyclone that derives its energy from temperature gradients in the middle and upper atmosphere.

Another unusual aspect of Hurricane Sandy was its huge size. At one point it was more than 1000 miles across! That's the distance from Portland Maine to Savanna Georgia or Bermuda to the western Carolinas.

Sandy caused at least 68 billion dollars in damage along the entire eastern seaboard from Florida to Maine, second only to Hurricane Katrina. Despite remarkably accurate predictions of both Sandy's track and intensity, the storm still resulted in at least 286 deaths in seven countries. (cont. p. 7)

Figure 1. Hurricane Sandy Track

"When the wind is at the threshold and the snow is on the pane," there is nothing cozier than to stoke your open fire or good chunk wood stove against the morning's cold."

The Old Farmer's Almanac 1950

Bolide Meteors, NEOs and Meteor Showers during the Fall and Winter of 2013-14

Barry Lambert—Senior Forecaster

September 2013 was a busy month for Bolide Meteors or fireballs in the USA. The latest occurrence late Friday evening (EDT), September 27th) marked the 13th "significant event" of the month, which is more than any other month in the history of the online American Meteor Society Fireball Report. A "significant event" is defined as a fireball event reported by 25 or more witnesses. The following is a complete list of all fireball sightings (over 2200) in the U.S. so far this year (through early October)- http://www.amsmeteors.org/fireball_event/2013/?page=1

A NASA all-sky camera in Hiram Ohio captured the fireball as it streaked through the sky at 11:33 p.m. EDT (0333 GMT Sept. 28). It was traveling at about 114,000 mph, and slammed into Earth's atmosphere almost directly over Columbus, Ohio. It was visible from 14 U.S. States. You can see video from space of the remarkable fireball here - http://www.space.com/22987-large-fireball-seen-streaking-over-ohio-video.html

Video of this same fireball taken from the ground is here -http://www.youtube.com/watch?v=7iDGwUYLzWo

This bright event brought amazement to people who happened to be watching from the ground. As of late September, the American Meteor Society received more than 450 reports of the fireball sighting with more than 400 still yet to be reviewed. "It was the most brilliant fireball that I have ever seen," Angela McClain told Spaceweather.com. "The entire landscape lit up. I spun around and there it was, a huge, bright green light, streaking across the sky. Even when it was gone, there was still a bright line in the sky about 20 seconds later. We were all stunned."

Figure 1. *September 27, 2013 Bolide Meteor over Ohio. Photo taken by Angele McClain.*

The fireball on Sept 27th may not have been the only major meteoroid event witnessed in the Midwest during mid September.

On Sept. 26, the American Meteor Society received more than 730 reports of a separate fireball sighting in Ohio, Illinois, Kentucky, Missouri, Indiana and Wisconsin.

Figure 2. *Heat Map showing the highest concentration of observations from the widely viewed Sep 27, 2013 Bolide Meteor.*

Another excellent example of a Bolide meteor streaked across the Alabama sky on September 9, 2013. http://www.youtube.com/watch?v=E_rerjRFwA8. Reports of this meteor came in at 8:18 p.m. and residents of neighboring Georgia and Tennessee also witness this celestial event. More than 200 eyewitness sightings were posted on the American Meteor Society's website. A more comprehensive discussion about this fireball can be viewed here - http://www.youtube.com/watch?v=kpWCNC0PYuw

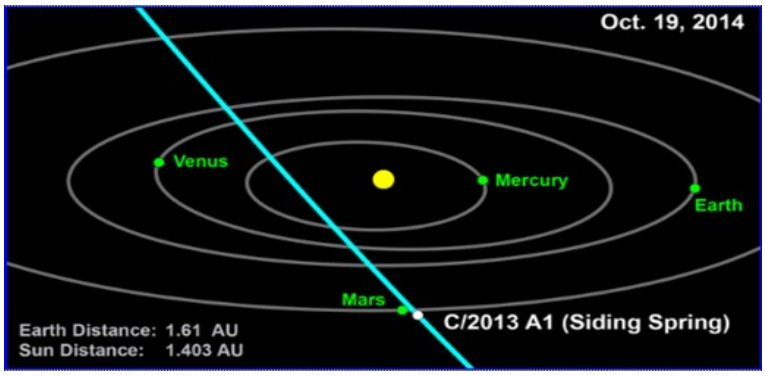


Figure 6. *Path of Comet Siding Spring and its extremely close approach to Mars during the Fall of 2014*

(cont. p. 6)

Fall Colors continued:

Chlorophyll, which gives leaves their green color, also absorbs sunlight and converts it to food for the leaves and tree. The tapering off of chlorophyll happens as veins in the leaf close off resulting in less fluids and mineral intake to the leaf. As chlorophyll production ceases, other pigments become visible. One is xanthophylis which gives the leaves a yellow color. The other main pigment is carotene (Beta-Carotene) which gives leaves an orange color. Both these pigments are present year round but are masked by the green color which prevails during the summer months.

Another compound present is known as anthocyanin. This prevails once half the chlorophyll in the leaf is gone. Unlike the other pigments, anthocyanin is not present all summer but is produced later in the summer and fall.

Yet another compound is phosphate. During the summer the amount of phosphate is high, and it plays a role in the breakdown of sugars made by chlorophyll. Temperatures begin to play an important role in leaves changing color late in the season. When this happens, phosphate moves out of the leaves and back into the stems. This way the trees have something to live on during the winter season.

Different trees show different colors. Carotenoids are present in species such as Maples, Yellow Poplars, Aspen, and Birch. Again carotenoids result in the orange colors we see in these trees.

Anthocyanin gives the leaves a red color. They are present in 10 percent of all species, but upwards of 70 percent of the species found in New England. Species that have a lot of anthocyanin include Maples, Oaks, Dogwoods, and Cherry. Trees where anthocyanin prevail show the best colors with lots of bright sunny fall days with cool nights. Nights should be cool but remain above freezing.

Many factors can influence color change. Aside from temperature and light, soil conditions, water supply, and age and health of the tree are all important. Some species start to show color change in August, especially Cotton and Popular trees when conditions tend to be on the dry side. Diseased trees tend to turn color early.

Weather factors have a lot of influence on leaf color. A summer drought can delay the onset of fall colors by a few weeks. Colors may not be as bright with dry conditions as with wet conditions. A warm period during the fall can lower the intensity of autumn colors. A warm and wet spring, along with favorable summer weather conditions can produce some of the most spectacular fall colors. This is especially the case if there are warm days and cool nights in the fall. An early frost and or freeze will weaken the red colors.

So far this season we have seen some cool nights, and recall that we had a wet spring and early summer. These conditions may offset the effect of the dry late summer and early fall we have seen so far.

Trees normally start to turn across the northern mountains of Pennsylvania by late September, while areas across the southeastern part of the Keystone state may not see much color change until later in the month of October.

Whether the season is bright and spectacular, or just average, each year the changing colors herald the inevitable arrival of colder air and eventually winter. Some of us look forward to that, some of us do not.

to see temperatures that were not on the plus side of average. The highlight of the 2013 season was the 9 days in July where high temperatures topped 90 degrees. In a normal July, that only happens 6 times. See Fig. 1 for a regional depiction of the temperature departures for the summer over the northeastern US.

The season was also wetter than usual in the state capital, with 12.11 inches of rain being observed. This was 0.70 inches above normal. The last drier than average summer there was 2008.

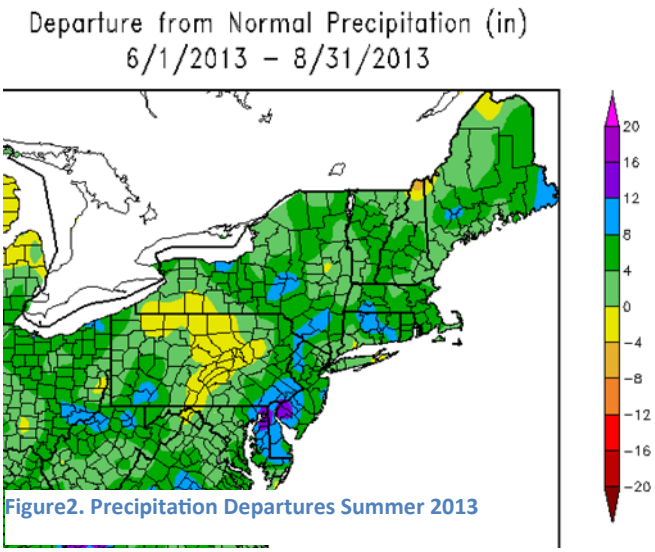


Figure2. Precipitation Departures Summer 2013

For Williamsport, it was also a warm summer. The average temperature of 72.1 was 1.2 degrees above normal. This continued a very long trend of summers that have been normal or warmer in the home of the Little League World Series. We have to go back as far as 2004 to find a summer where temperatures were chillier than usual.

It was also drier than normal in Williamsport with a rainfall deficit of 3.07 inches. This marked the 3rd year out of the last 5 that the summer has been drier than average. Regional precipitation departures can be seen in Figure 2. Note that while most of the Northeastern US was wetter than normal, a significant chunk of Pennsylvania was dry during the 3 month period.

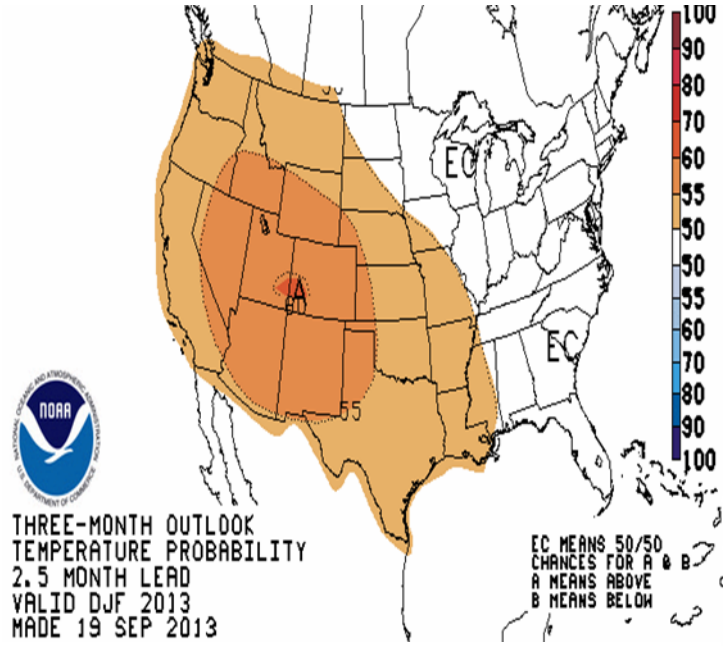


Figure 3. CPC Seasonal Temperature Outlook

At this point we have the inevitable curiosity about what the upcoming winter season will bring. Seasonal forecasts are always fraught with uncertainty, especially so here in the Northeastern United States where even large scale atmospheric events like El Nino or La Nina tend to have little influence. This year is no exception, with either a weak La Nina or neutral conditions forecast in the tropical Pacific. As a result the official forecast from the Climate Prediction center (CPC) for temperature here in the northeast is what we refer to as “equal chances” (Fig 3). That means there are equal chances of the winter being above or below normal temperature-wise. If it sounds like a coin flip, it literally is.

As for precipitation, the same equal chance (not shown) outlook exists for our entire region.

It’s also fun to look at what The Old Farmer’s Almanac has to say about things. Boasting a 90% accuracy rate, and having been around since 1792, their outlooks have become the subject of lore for many a weather enthusiast. This year, they are calling for a cold and dry winter overall. As for snow, they call for below normal snowfall over northern areas with above normal snow over southern parts of the region. The forecast implies the passage of perhaps at least a couple of potent nor’easters. If you are a snow crow, this will no doubt be pleasing. See you in the Spring to see how things turned out.

Figure 3. *Heat Map showing the highest concentration of observations of the Sep 9, 2013 Bolide Meteor.*

Bolide Meteors continued:

Meteor Showers -

Here is a snapshot of the meteor showers in 2013 and 2014. Contained in the following tables are the peak dates and times to observe each one, where in the sky to look, and the name of the associated comet that produced the lingering debris field of minute particles.

The following links contain a complete listing and details of the major meteor showers in 2013 and 2014.

http://www.amsmeteors.org/meteor-showers/meteor-shower-calendar/

http://www.amsmeteors.org/meteor-showers/meteor-shower-calendar/?y=2014

Principal Meteor Showers

SHOWER	BEST VIEWING	POINT OF ORIGIN	DATE OF MAXIMUM*	NO. PER HOUR**	ASSOCIATED COMET
Quadrantid	**Predawn**	**N**	**Jan. 4**	**25**	**—**
Lyrid	Predawn	S	Apr. 22	10	Thatcher
Eta Aquarid	Predawn	SE	May 4	10	Halley
Delta Aquarid	Predawn	S	July 30	10	—
Perseid	**Predawn**	**NE**	**Aug. 11–13**	**50**	**Swift-Tuttle**
Draconid	Late evening	NW	Oct. 9	6	Giacobini-Zinner
Orionid	Predawn	S	Oct. 21–22	15	Halley
Taurid	Late evening	S	Nov. 9	3	Encke
Leonid	Predawn	S	Nov. 17–18	10	Tempel-Tuttle
Andromedid	Late evening	S	Nov. 25–27	5	Biela
Geminid	**All night**	**NE**	**Dec. 13–14**	**75**	**—**
Ursid	Predawn	N	Dec. 22	5	Tuttle

May vary by one or two days* ***Moonless, rural sky* **Bold = *most prominent*

Figure 4. *Listing of the primary meteor showers during 2013.*

<< 2014 >>	METEOR SHOWER	Rate/Hr	PEAK	LOOK	CONSTELATION	PARENT COMET
03-Jan-2014	Quadrantids	120	16h56	-	Bootes	Asteroid 2003 EH 1
08-Feb-2014	alpha Centaurids	7	12h49	SE	Centaurus	
14-Mar-2014	eta Virginids	2	22h48	E	Virgo	Comet D / 1766 G1 (Helfenzrieder)
05-Apr-2014	kappa Serpentids	4	20h40	NE	Corona Borealis	
22-Apr-2014	Lyrids	18	21h43	NNE	Lyra	Comet C / 1861 G1 Thatcher
23-Apr-2014	pi Puppids	20	18h39	SW	Puppis	Comet 26P Grigg-Skjellerup
07-May-2014	eta Aquariids	85	19h58	E	Aquarius	Comet 1P Halley
10-May-2014	eta Lyrids	7	02h34	NNE	Lyra	Comet C / 1983 H1 (IRAS-Araki-Alcock)
28-Jun-2014	Bootids	10	08h19	-	Bootes	Comet 7P Pons-Winnecke
29-Jul-2014	South. delta Aquariids	20	01h26	E	Aquarius	
30-Jul-2014	alpha Capricornids	4	12h35	E	Capricornus	Comet 45P Honda-Mrkos-Pajdusakova
04-Aug-2014	South. iota Aquariids	2	10h29	E	Aquarius	
13-Aug-2014	Perseids	110	07h03	-	Perseus	Comet 109P Swift-Tuttle
18-Aug-2014	kappa Cygnids	3	12h12	-	Cygnus	
31-Aug-2014	alpha Aurigids	10	23h43	-	Auriga	Comet C / 1911 N1 Kiess
03-Oct-2014	Capricornids	2	06h46	E	Capricornus	Comet D / 1978 R1 (Haneda-Campos)
06-Oct-2014	Camelopardalids	40	04h41	-	Chamaeleon	
09-Oct-2014	Draconids	10	01h32	-	Draco	Comet 21P Giacobini-Zinner
22-Oct-2014	Orionids	30	09h08	NE	Orion	Comet 1P Halley
06-Nov-2014	Northern Taurids	4	19h04	NE	Taurus	Asteroid 2004 TG10
06-Nov-2014	Southern Taurids	7	19h04	NE	Taurus	Comet 2P Encke
18-Nov-2014	Leonids	115	06h31	NE	Leo	Commet 55P / Tempel-Tuttle
22-Nov-2014	alpha Monocerotids	4	00h18	ENE	Monoceros	
14-Dec-2014	Geminids	120	11h03	NNE	Gemini	Asteroid 3200 Phaethon
23-Dec-2014	Ursids	10	05h22	-	Ursa Minor	Comet 8P Tuttle
26-Dec-2014	Comae Berenicids	5	04h03	NE	Coma Berenicis	

Figure 5. *Listing of the primary meteor showers during 2014.*

Have you ever wondered what the difference is between a **comet, asteroid, meteoroid, meteor and meteorite** is? The following definitions should help clear things up.

Comet

• *A comet is a relatively small solar system body, often made of ice that orbits the Sun. When close enough to the Sun they display a visible coma (a fuzzy outline or atmosphere due to solar radiation) and sometimes a tail.*

Asteroid

- *Asteroids are small solar system bodies that orbit the Sun. Made of rock and metal, they can also contain organic compounds. Asteroids are similar to comets but do not have a visible coma (fuzzy outline and tail) like comets do.*

Meteoroid

- *A meteoroid is a small rock or particle of debris in our solar system. They range in size from dust to around 10 meters in diameter (larger objects are usually referred to as asteroids).*

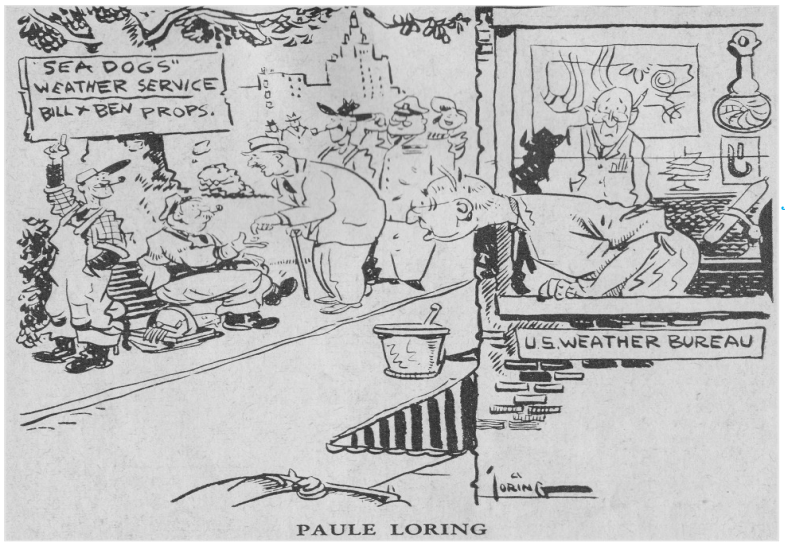
(cont. p. 8)

Hurricane Sandy Continued:

Damage was particularly severe in New Jersey and Long Island. The storm surge severely damaged the boardwalk in Atlantic City and inundated large parts of New York City flooding streets, tunnels and subways. Power was out over large portions New Jersey up through New York City. Verizon saw service to thousands interrupted when flooding occurred at several offices over Manhattan, Queens and Long Island. In at least one location, the fuel tank for their backup generator was located in the basement and ended up going under water, leading to the backup generator failing. Damage to lines and equipment was extensive and prompted the company to invest more than a billion dollars in upgrades to avoid similar scenarios in the future.

Another victim of Sandy was the HMS Bounty. The ship was built for the 1962 film version of "Mutiny on the Bounty" which starred Marlon Brando, and appeared in the 2006 film "Pirates of the Caribbean: Dead Man's Chest." The ship began taking on water in heavy seas 90 miles southeast of Cape Hatteras North Carolina when her generator failed. The crew abandoned ship and 14 of the 16 people on board were rescued by the Coast Guard as the Bounty tipped over and sank to the bottom of the Atlantic. The captain and a deckhand were never found.

Sandy ended up being the last tropical storm of consequence in the Atlantic last year but it certainly left its mark and will be recalled for decades as one of the big ones.



The United States Weather Bureau has a new service operated under Merrill Barnard, Chief of the Division of Climatological and Hydrological Service, Washington 25, D.C. This new service is a direct development of uses found for climatalogical data during the war. The new techniques, for example, were successfully used by the Armed Forces to select the week of the year when an invasion attempt would be least likely to be hindered by adverse weather conditions. In this new service, Applied Climatology, the observations of past weather are analyzed… The Old Farmer's Almanac 1948

Meteor

• A meteoroid that burns up as it passes through the Earth's atmosphere is known as a meteor. If you've ever looked up at the sky at night and seen a streak of light or 'shooting star' what you are actually seeing is a meteor.

Meteorite

• A meteoroid that survives falling through the Earth's atmosphere and colliding with the Earth's surface is known as a meteorite.

Near Earth Objects -

Near Earth Objects (NEOs) are by far the most important and most tracked space objects when it comes to the safety and well-being of earth's inhabitants. The primary organization tracking these large and potentially hazardous space rocks is NASA's Jet Propulsion Lab. A wide range of information on NEOs can be found at the website - http://neo.jpl.nasa.gov/

Many smaller groups and individuals also track NEOs (Asteroids and Comets). A comprehensive description of how asteroids are located, tracked, and cataloged is explained in this video - http://www.youtube.com/watch?feature=player_embedded&v=z9iGFbyZELw

The most important NEO to pass through (and potentially impact) our portion of the Solar System during the next year or so appears to be ***Comet 1013 A1***, known as ***"Siding Spring"*** (named after its recent discovery on Jan 3, 2013 at the Siding Spring Observatory in Australia). This comet will pass extremely close to Mars on October 19, 2014. The latest projected path of Siding Spring (as of September 21, 2013) will be within 117,000 km (73,000 miles) of Mar's surface. Read the latest about this comet here - http://neo.jpl.nasa.gov/news/news179.html

Tracking comet Siding Spring in real time can be down via the skylive.com link - http://theskylive.com/c2013a1-tracker

We'll be treated to a sneak peak of sorts to Comet Siding Spring later this fall. After ***Comet ISON*** cruises closely past Mars on October 1, 2013, ISON should be able to re-emerge from its close orbit around the Sun on Thanksgiving Day (November 28. 2013). People across the northern hemisphere could witness one of the most spectacular displays of a comet in many years this coming winter as ISON heads back out through our solar system. For several days around January 12, 2014, we could be treated to a spectacular meteor shower as earth passes through the icy dust debris from the comet's tail. These dust particles that are just a few microns in diameter, will be hitting earth's upper atmosphere at 56 km/second (125,000 mph!).

Two great video presentations of ISON are shown here –

http://www.youtube.com/watch?feature=player_embedded&v=Cw9KICFmPY4

http://www.youtube.com/watch?v=llpx30YzdyQ

Bolide Meteors continued:

A second/later "Meteor Storm" from another comet (209P/LINEAR) may be headed our way on May 24, 2014. This periodic comet that passes between Earth and the Sun every 5 years. Its next perihelion (or closest point to the Sun in its orbit) will be on May 6, 2014. It's forecast by several numerical models that all of the comet's dust trails that were ejected between 1803 and 1924 will cross Earth's path, possibly leading to a meteor "storm" with more than 1000 meteors per hour. Residents of southeastern Canada and the northeastern U.S. will be in the best locations to watch this potentially unforgettable light show.

Read additional details about this Spring 2014 event here -

http://www.skyandtelescope.com/observing/home/Meteor-Storm-Brewing-for-2014-173316061.html

On a single hot summer day, nearly 1600 gallons of water may evaporate from the surface of the leaves of a single large elm tree. The Old Farmer's Almanac 1950

Update Your Spotter Information

Bill Gartner—General Forecaster

Please help us to keep your contact information up to date. While we hope to get a report from you when severe weather occurs, from time to time we call or email spotters to investigate significant storms. Thus, it is important to keep your contact information current. If any of your contact information (name, phone number/s, addresses, etc) has changed recently, please let us know. Send an email or 'snail mail' note to us at one of the addresses below.

email: william.gartner@noaa.gov

U.S. mail:
William Gartner/Skywarn Spotter update
NWS/WFO State College
328 Innovation Blvd, Rm #330
State College, PA 16803

If you are not sure if we have the most up to date information on file, go ahead and send us an email or note with your current information and we will verify it.

Please note that your personal information (address, phone #, email mail address, etc) is NOT shared with or given to anyone outside of the NWS (unless your permission is gained first) and is used only to contact you in the event of severe weather, send you SkywarnNews, or communicate important program changes.

Forecasting Snow Storms that Impact Central Pennsylvania

Barry Lambert—Senior Forecaster

The winter season is close at hand, and meteorologists here at the National Weather Service in State College (and elsewhere throughout the Eastern U.S.) will be faced with some difficult forecasting situations related to various types of winter storms. Major Winter Storms impacting the Appalachians and East Coast States come in the form of basically 3 distinct pattern types.

The first (and typically most notorious and well-publicized) is the ***Miller Type "A"*** pattern (or classic Nor'easter). In this case, an old stalled-out frontal boundary is located along the Eastern Seaboard. Significant energy aloft (associated with a strong upper level jet and short wave trough) dives into the Gulf Coast region and southeastern states, then turns northeast up the east coast. The deep, upward vertical motion caused by this disturbance aloft helps to spin-up an area of low pressure along the stalled-out front (also referred to in the weather community as a baroclinic zone). The positive feedback between the surface low and upper trough causes both features to strengthen as they move up the coast toward the northeast Megalopolis. The main challenges associated with forecasting this type of pattern is 1) Exactly where will the rain/snow line be across the Lower Susquehanna Valley and adjacent Southeastern PA, as a marine layer with milder, above freezing air streams inland at several thousand feet above the ground, and 2) In cases with very strong disturbances aloft, there may be a deep "dry slot" moving up the coast, which could cut-off the significant snow or mixed precipitation.

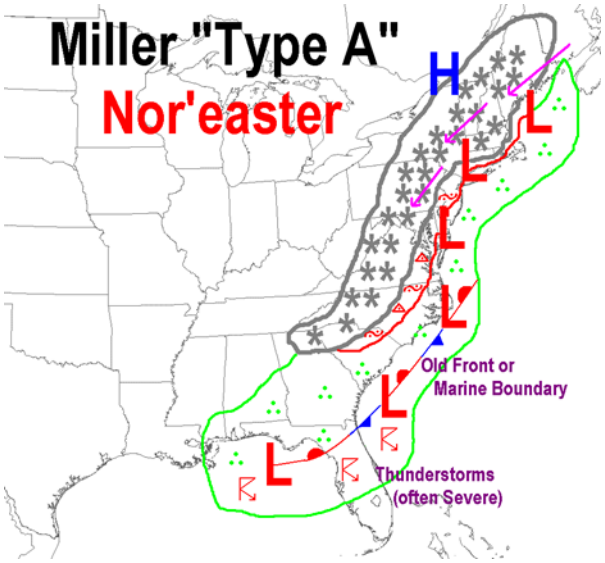


Figure 1. Miller Type "A" Pattern.

The ***Miller Type "B"*** pattern may be the most "common" pattern for east coast snow storms, but are usually the trickiest storms to forecast for several reasons. The main problems associated with forecasting this type of winter storm center around 1) initial weakening of the primary surface low heading east or northeast across the Ohio Valley, 2) the location and timing of coastal (secondary) surface low development near the east coast, and 3) precipitation type, location and amount.

Pattern recognition and in-depth understanding and evaluation of the vertical thermal and moisture structure is key to highlighting the potential of a major snow/ice storm, or just dealing with a more nuisance snow or mixed precipitation event. Two larger-scale weather features that should be focused on leading up to these events are 1) the strength and orientation of the upper level jet, and 2) the depth and persistence of the cold air damming just east of the Appalachians.

A primary area of low pressure (linked to the favorable left exit, or right entrance region of an upper level jet maxima) that tracks northeast through the Ohio Valley (at a shallow angle to the cold air damming over central and eastern PA), and maintains its strength with just weak coastal development too far to the north along the Mid Atlantic coast will likely lead to a period of snow (with light to moderate accumulation) followed by a changeover to sleet, freezing rain or even plain rain and drizzle, as a fairly deep layer of above freezing air aloft surges northeast into the commonwealth.

In contrast, a strong upper jet with its nose (left exit region) aimed east and nearly orthogonal to the low level cold air damming will allow for quicker weakening of the initial surface low (somewhere over the Ohio Valley or Central Appalachians), with rapid intensification of the secondary surface low further south (closer to the Delmarva Coast).

The setup favors strong upward vertical motion over the region of cold air damming resulting in persistent light to moderate snowfall (and even a trend toward periods of heavy snow) as the energy transition to the coastal low occurs and intensification follows. The swath of significant snow from this pattern type is seen stretching across the Central or Lower Mississippi Valley States and Ohio Valley region, curving cyclonically through the Mid Atlantic and New England States.

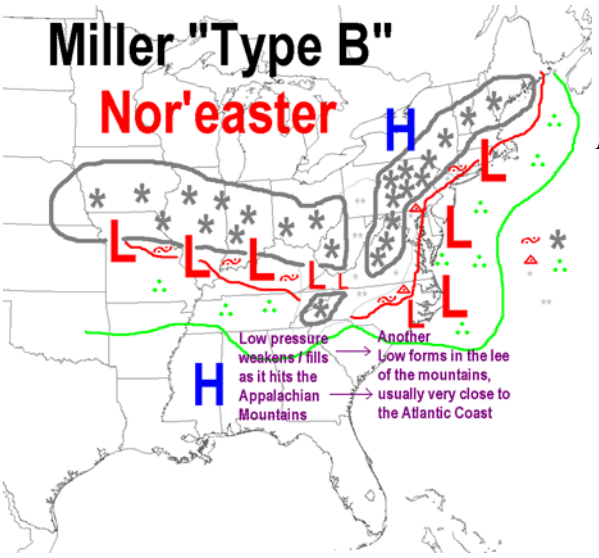


Figure 2. Miller Type "B" Pattern.

The third type of primary snowstorm pattern that we deal with here in Central Pennsylvania and the Susquehanna Valley is the ***"Alberta Clipper"***. Snow from this international visitor typically contains the highest snow/water ratios, which are often as much as 20 or 30 to 1 (or more). This means that the limited moisture (and colder temperatures) during these snow events can create fluffy, wind-blown snowfalls of 6-10 inches, from melted "water equivalents" of only around one-third of an inch.

If the upper trough and associated surface low can deepen/intensify fast enough as they reach the East Coast, then a prolonged and more widespread heavy snow event (Nor'easter) could result with major impacts to the larger metropolitan regions of the northeast.

The Alberta Clipper is probably the most predicable of the 3 major types of Northeast Snowstorms, given its usual, consistent track, strength, and vertical temperature structure over a particular area. The greatest forecast challenge with any type of major winter storm occurs where the tightest gradients in temperature and precipitation rates are expected, and the snowfall pattern stemming from the Alberta Clipper offers no exception. Within these regions, tremendous variations in snow or ice accumulations will occur. Changes in snow accumulation from northwest to southeast could be as much as 8 to 12 inches within just a matter of 10 or 20 miles!

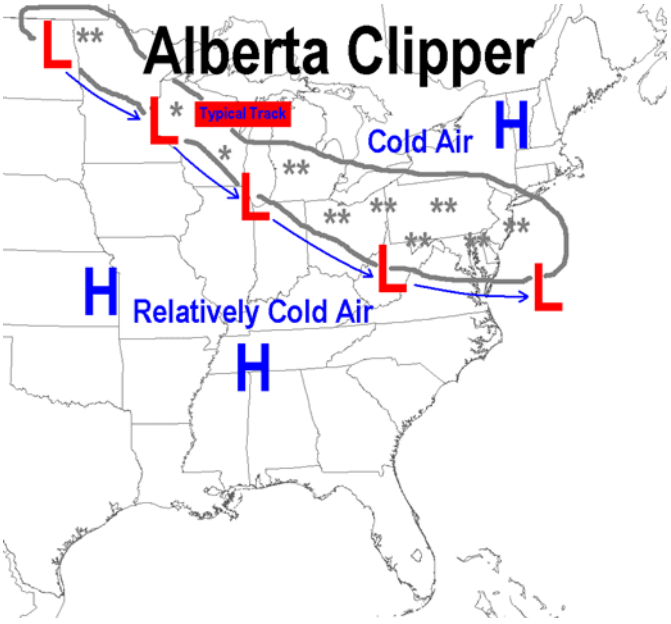


Figure 3. Alberta Clipper

Two other, more localized snow events with significant adverse impacts come in the form of ***"Lake Effect Snow"*** (LES) and a cold frontal ***"Squall Line".*** Both of these winter events produce extreme changes in snowfall rates, visibility, and travel conditions over a short distance. The main difference between the two is that the narrow bands associated with the cold frontal Snow Squalls are oriented nearly perpendicular to the steering flow, while single, intense (or multiple) Lake Effect Snow bands are aligned parallel to the mean, steering wind within the layer. Both events can contain intense updrafts within the snow bands, producing rare wintertime lightning (commonly referred to as "Thunder-snow"). Although the cold frontal Squall Line is not a prolific snow producer with respect to the amount of snow accumulation (which typically varies from just one-half of an inch to 2 inches within 15-30 minutes), this event has been proven to produce numerous, horrific, multiple-vehicle accidents on Interstate Highways throughout Pennsylvania (and also in other states) .

Prior to the arrival of the extensive, quasi north-south snow squall band, the sun may be shining and road surface temperatures could be a few to several degrees above freezing. As the blinding snow quickly overspreads the area from the west (accompanied by colder, sub-freezing air), initially wet roads from melting snow "flash freeze". The combination of this rapid ice-over of the road surface, and near zero visibility in the falling and blowing snow creates life-threatening conditions to unwary travelers as rapid speed changes (and vehicle "pile-ups") occur when the fast moving traffic encounters the blinding snow and glazed roads.

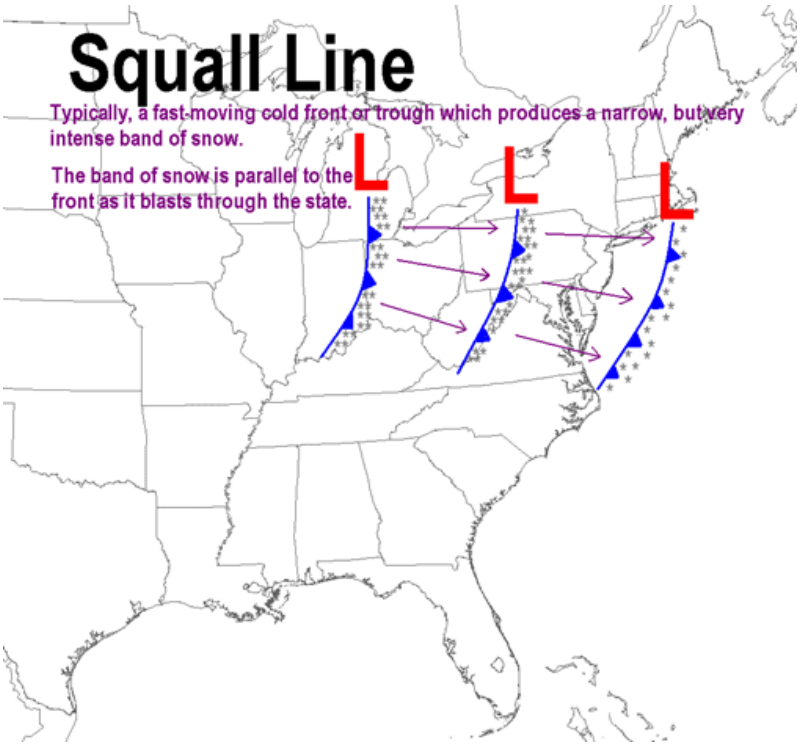


Figure 4. Cold Frontal Squall Line.

Lake effect events have some similarities to the cold frontal snow squall regime, but the snow bands (and their orientation) are typically much more slow-moving (or even stationary). Therefore, the changes in weather and roads conditions are more localized and somewhat less abrupt.

As a result of their persistence, and slow-moving (or stationary) nature with heavy to extreme snowfall rates and thunder-snow, Lake Effect events can be the most prolific snow producers of the winter season in a given location. Snowfall amounts of 1 foot or more are common a few to several times per year just downwind from the Great Lakes, and also in favorable upslope areas of the Appalachians such as the Laurel Highlands of southwestern Pennsylvania, the mountains of West Virginia, and Tug Hill Plateau in northern New York (just to the east of Lake Ontario).

Extreme and rather rare Lake Effect events have dumped over 3 feet of snow within just a 12 to 24 hour period, snarling traffic and literally shutting down cities such as Buffalo, Syracuse and Cleveland.

Whatever we see this winter, be sure to stay tuned to the latest forecasts and drive safely!

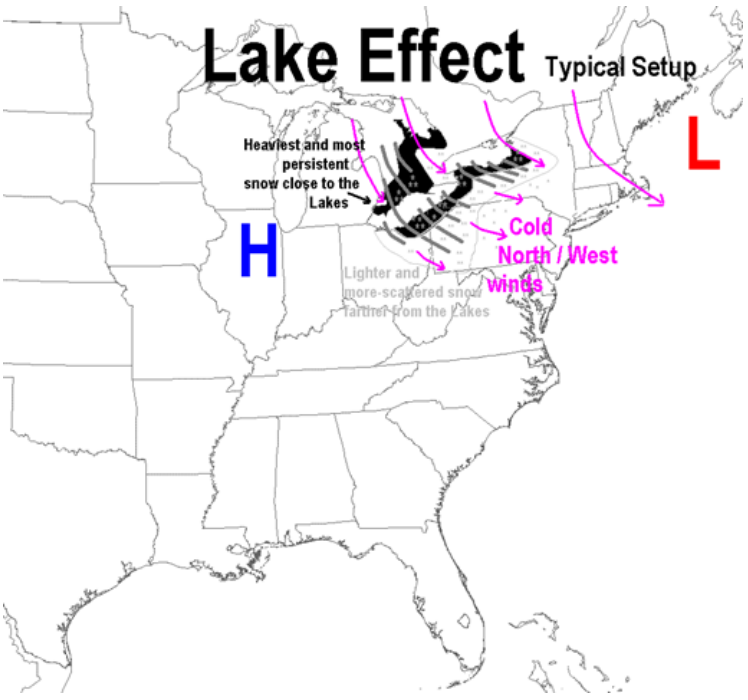


Figure 5. Lake Effect

As many of you know, over the last year we have established a presence on both **Facebook** and **Twitter**. This provides new and easier ways for us to interact with you. These social media outlets allow us to post updates that may pique your interest on the weather system or event of the day. Perhaps more importantly, they also allow us to hear from you in a more informal and robust fashion. We encourage everything from reports on the amount of snow or rain you have had to information on what is going on that may or may not be in the forecast.

Facebook allows for posts of varying lengths and is very friendly to graphical posts while **Twitter** is limited to posts that are no more than 140 characters in length, thus geared more to short precise information bursts that may or may not contain links to pictures or videos.

Using either platform, we look forward to hearing from you!

Remember when using **Twitter** keep messages short and concise (140 character limit). Because of this, abbreviations and punctuation may be used in such a way to keep the messages brief but still decipherable. A key characteristic of **Twitter** is the use of "hash tags". While not necessary, they are encouraged as they allow for easy categorizing and searching. Hash tags start off with the "**#**" (pound sign) character and help other **Twitter** users to find and procreate (re-Tweet) your information. An example we use here at the State College is **#ctpwx**. ***CTP*** is the "call sign" for our office and "**wx**" is the abbreviation for ***weather***. So a report may look something like **#ctpwx 4 inches of snow in your town and it's still snowing hard**. Another hash tag we search for is **#pawx** but these aren't the only ones. If you have a severe thunderstorm you may want to tweet something like #ctpwx #severethunderstorm in your town at the time. The idea is to fit as much information into that 140 character limit as possible and still be descriptive enough to convey what is happening and where.

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