



WORKING TOGETHER TO SAVE LIVES



# SKYWARN NEWSLETTER

National Weather Service

STATE COLLEGE, PA

## The Winter of 2017-18 in Review

John La Corte – Lead Meteorologist

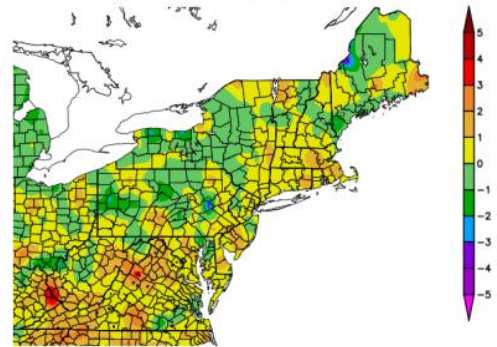
Another winter is in the record books and overall it was pretty unremarkable. After December and January seemed to be setting the pace being colder than normal, February more than righted the ship and ended up being so warm, it tilted the scales for the entire winter to the warm side in many locations. Table 1 shows a summary of the winter average temperatures and their departures for a handful of climate sites in Central Pennsylvania.

| Station      | Avg Temp | Departure |
|--------------|----------|-----------|
| Harrisburg   | 33.2     | 1.0       |
| Williamsport | 30.8     | 1.6       |
| Altoona      | 31.4     | 2.5       |
| Bradford     | 25.4     | 1.9       |
| Johnstown    | 29.2     | 2.2       |

Table 1. Winter Dec-Feb Average Temp and Departure

Region-wide, winter temperatures ended up warmer than normal across the south up into the norther mountains. Colder than normal readings wedged down into the Central Mountains, Figure 1 shows this complicated pattern.

Departure from Normal Temperature (F)  
12/1/2017 – 2/28/2018



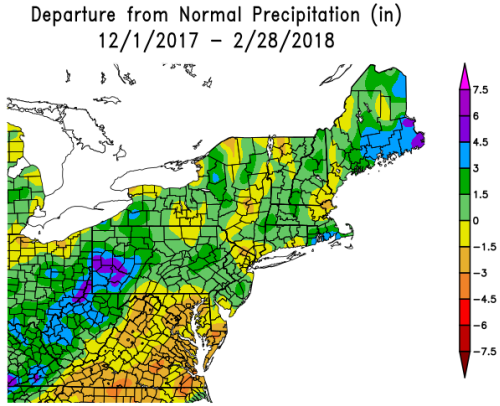
Generated 3/20/2018 at HPRCC using provisional data.

NOAA Regional Climate Centers

Figure 1. Average Temp Departures Winter 2017-18

## PRECIPITATION

As far as rainfall goes, most of the region ended up wetter than average. February matched its warmth with much above normal precipitation (melted). The storm track favored systems moving into the Great Lakes to our west, and Figure 2 shows the much above normal precipitation over the western portion of the state.



Generated 3/20/2018 at HPRCC using provisional data. NOAA Regional Climate Centers

Figure 2. Precip Departures from Normal Winter 2017-18

**SNOWFALL**

As far as snow goes, it was another disappointing winter for most snow lovers. Table 2 is a sampling of snowfalls and departures for the winter months, with the far southeast and northwest areas being snowier than normal. For the remainder of the region, Old Man Winter was stingy with the white stuff.

| Station       | Snowfall | Departure |
|---------------|----------|-----------|
| Harrisburg    | 18.1     | -6.3      |
| Williamsport  | 18.9     | -7.3      |
| Altoona       | 21.0     | -0.4      |
| Bradford      | 59.9     | 7.4       |
| State College | 21.3     | -10.0     |
| Ridgway       | 47.4     | 9.4       |
| Chambersburg  | 17.4     | -7.0      |
| Lancaster     | 20.9     | 4.6       |
| Lockhaven     | 21.8     | 1.2       |
| Selingsgrove  | 20.2     | -1.9      |
| Somerset      | 65.8     | -2.3      |
| Warren        | 53.0     | 1.8       |

Table 2. Winter 2017-18 Snowfall and Departures

**Seasonal Forecast**

While spring has been cold so far, there are signs of warmer weather on the horizon, and that leads us to speculating what the upcoming summer might hold. The Climate Prediction Center’s (CPC) outlook shows that all of the eastern US has an elevated chance of being warmer than normal (Figure 3). Nowhere in the lower 48 is the forecast for a cool summer, though the EC stands for “equal chances” meaning there is no clear signal one way or another.

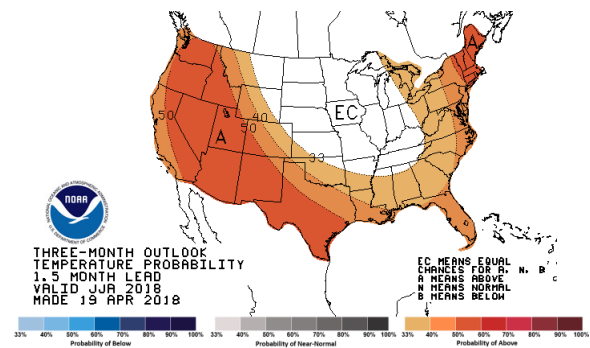


Figure 3. CPC Summer Temperature Outlook

As far as summer rain is concerned, the CPC also thinks there will be a good chance we will be wetter than average. Figure 4 shows the entire northeastern US shaded for a wet forecast.

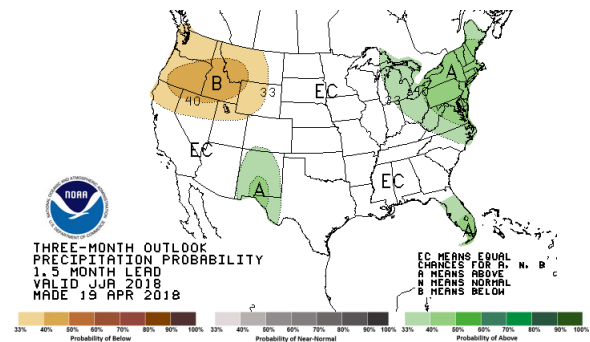


Figure 4. CPC Summer Precipitation Outlook

## 2017 Hurricanes

### John La Corte – Lead Meteorologist

After more than a decade of the US mainland being spared a hit from a major hurricane, 2017 reminded everyone how deadly and destructive hurricanes can be.

Three storms in particular, Harvey, Irma and Maria all made the case for having their names retired as they wreaked havoc from the Caribbean to Texas. Harvey dropped rain that was measured in feet in and around Houston. Irma took aim and caused severe damage to south Florida including the Keys.

Hurricane Maria was in a league of her own ravaging the island of Dominica as a category 5 storm on Sept. 19, and later devastating Puerto Rico as a high-end category 4 hurricane. Maria is the third costliest hurricane in U.S. history, behind Harvey and Katrina. It caused 31 deaths with 34 missing in Dominica, and two deaths in Guadeloupe. In Puerto Rico, the death toll stands at 65. Maria at peak intensity had sustained winds of 170 mph and a minimum pressure of 908mb/26.81". That makes it the

10<sup>th</sup> most intense hurricane ever in the Atlantic basin.

### OUTLOOK

The first forecast for the season has been released by Colorado State University and they are calling for another active year.

They predict 14 named storms in the Atlantic basin. They expect 7 to become hurricanes, and 3 of those to be major hurricanes (category 3 or higher).

A slightly less active outlook has been issued by The Weather Company (an IBM Company) who cited cooler than normal ocean temperatures in the tropical Atlantic as a reason for their forecast of "only" a near average hurricane season. That would equate to 13 named storms, 6 hurricanes and 2 major hurricanes.

For a more complete summary of Maria, go to: [https://www.nhc.noaa.gov/data/tcr/AL152017\\_Maria.pdf](https://www.nhc.noaa.gov/data/tcr/AL152017_Maria.pdf)

For summaries of all the storms of 2017, go to: <https://www.nhc.noaa.gov/data/tcr/>

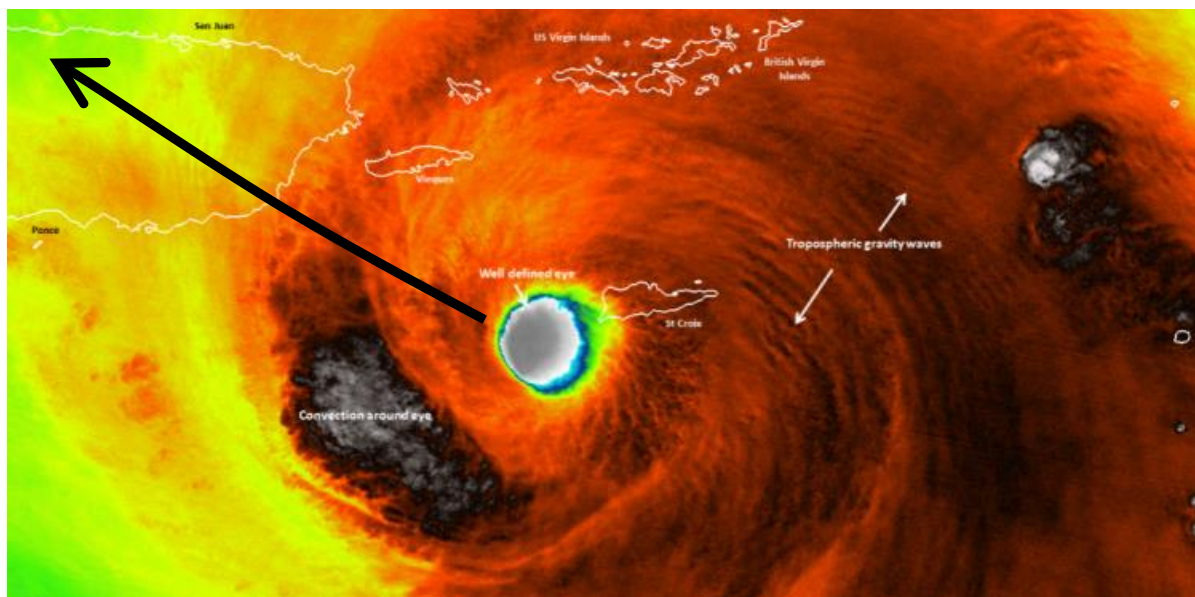


Figure 1. Cat 5 Hurricane Maria just west of St. Croix

## Summertime Severe Weather Products and Criteria

Peter Jung – Warning Coordination Meteorologist

With the advent of another severe weather season in Central Pennsylvania, we thought it would be a good time to review some of the weather criteria the National Weather Service uses to issue Severe Thunderstorm and Tornado Watches and Warnings, as well as Special Weather Statements.

likelihood are: Marginal, Slight, Enhanced, Moderate and High. Details can be found at the Storm Prediction Center web page:






<http://www.spc.noaa.gov/products/outlook/>

and specifically

<http://www.spc.noaa.gov/misc/about.html#Thunderstorm%20Outlooks>

**Severe Thunderstorm Watch** – A Severe Thunderstorm Watch is issued (in consultation with the Storm Prediction Center) for all or portions of Central Pennsylvania. A Severe Thunderstorm Watch means that conditions are *favorable* for the development of severe weather in and near the watch area. It does not mean that severe thunderstorms are imminent. A Watch is a good time to check preparedness,

## Understanding Severe Thunderstorm Risk Categories

| THUNDERSTORMS<br>(no label)   | 1 - MARGINAL<br>(MRGL)  | 2 - SLIGHT<br>(SLGT)  | 3 - ENHANCED<br>(ENH)   | 4 - MODERATE<br>(MDT)  | 5 - HIGH<br>(HIGH)  |
|---|---|---|---|--|---|
| No severe*<br>thunderstorms<br>expected   | Isolated severe<br>thunderstorms<br>possible  | Scattered<br>severe storms<br>possible  | Numerous<br>severe storms<br>possible   | Widespread<br>severe storms<br>likely  | Widespread<br>severe storms<br>expected   |
| Lightning/flooding<br>threats exist with <u>all</u><br>thunderstorms                | Limited in duration<br>and/or coverage<br>and/or intensity                          | Short-lived and/or<br>not widespread,<br>isolated intense<br>storms possible        | More persistent<br>and/or widespread,<br>a few intense                              | Long-lived,<br>widespread and<br>intense   | Long-lived, very<br>widespread and<br>particularly intense                            |
|  |  |  |  |  |  |

\* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.

**Severe Weather Outlook** – This is a product issued by the Storm Prediction Center. It typically will encompass a multi-state area, and can be issued up to 7 days in advance of a Severe Weather Outbreak. Criteria for issuing outlooks are lower than Watches and Warnings. Categories, in order of Severe Weather

and keep a watchful eye to the sky. Closely monitor forecasts, and be prepared to take action to stay safe should a Warning be issued. Remember, a Severe Thunderstorm Warning can occur without the issuance of a Watch!

**Tornado Watch** – Similar to a Severe Thunderstorm Watch, a Tornado Watch is



issued (in consultation with the Storm Prediction Center) for all or portions of Central Pennsylvania. A Tornado Watch means that conditions are *favorable* for the development of severe weather and possible tornadoes in and close to the watch area. It does not mean that tornadoes are imminent. As above, a Watch is a good time to check preparedness, and keep a watchful eye to the sky. Closely monitor forecasts, and be prepared to take action to stay safe should a Warning be issued. Remember, a Tornado Warning can be issued without the issuance of a Watch!

**Severe Thunderstorm Warning** – A Severe Thunderstorm Warning is issued when severe weather is imminent or occurring. A Warning means to TAKE ACTION NOW to protect your life. Warnings are typically issued when radar indicates severe weather, or reliable reports of severe weather are received by the NWS. Sometimes, severe thunderstorms can produce a tornado with little or no warning. The NWS will often append this disclaimer onto a Severe Thunderstorm Warning if conditions are favorable for tornadoes, or if the area is already in a Tornado Watch. The criteria used by the National Weather Service for issuance of a Severe Thunderstorm Warning are:

- Winds in excess of 58 mph
- Winds causing structural damage (implying winds over 58 mph)
- Winds causing trees to fall or snap (implying winds over 58 mph)
- Thunderstorms producing hail 1 inch in diameter or larger (the size of a quarter)

**Tornado Warning** – A Tornado Warning is issued when a tornado is imminent or occurring. A Warning means to TAKE ACTION

NOW to protect your life. Warnings are typically issued when radar indicates severe weather, or reliable, verifiable reports of a tornado are received by the NWS. Remember that a Wall Cloud and Funnel Cloud may be predecessors to a Tornado, but are not classified as a tornado.

**Special Weather Statement** – For some summertime severe storms, the criteria of a Warning are not met, but there are still some limited impacts. In these cases, a Special Weather Statement may be issued highlighting the impacts of storms. Some Criteria often used in the issuance of a Special Weather Statement include:

- Winds gusting between 30 and 50 mph
- Winds having the potential to produce minor damage, such as removing awnings, flipping tents, and knocking down tree branches
- Hail the size of dimes or nickels. (under 1 inch in diameter)

#### **Reporting Severe Weather to NWS State**

**College** – There are several methods to report severe weather to the National Weather Service office in State College.

- Facebook – US National Weather Service State College
- Twitter - @NWSStateCollege
- Online Reporting Form - <https://www.weather.gov/ctp/WeatherReports>
- Phone – Our Public Number is 814-231-2408. Option 1, then Option 6

- Phone – Trained Spotters: Call the unlisted number supplied during spotter training.

When reporting, remember to include WHO, WHERE, WHAT and WHEN!

Be sure to bookmark our web page for the latest forecast information:

<https://www.weather.gov/ctp/>

NWS State College wishes all citizens of Central Pennsylvania a Safe Summer Season!

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## Update on Warm Season Hazards

**David Martin – General Forecaster**

### Ticks

While we had several weeks of abnormally cold weather in late December into the first part of January, this spell of cold temperatures was not quite long enough to help control the tick population. In fact with ticks, cold weather alone has been shown to not be very effective in killing them. It seems the best way to limit them is to have an extended dry spell. Ticks tend to like moist conditions. When it is dry, they will seek out bodies of water, and if it is then cold enough, the ticks can freeze in the ice.

Anyone who spends time outside is advised to shower when they come in. You may think washing the clothes you wore is sufficient, but it is not. The best way to assure that any ticks that may be in your clothes are killed is to run them through the drier on high heat before washing.

Even in colder climates such as central PA, ticks can be present year round. These parasites can also carry diseases, many in fact. A relatively unknown disease is the Powassan virus. It is not as common as Lyme disease and has no known cure. Unlike Lyme, the tick only has to be on a person for a few minutes for transmission. After

several hours of being bitten by a tick infected with Powassan, you may experience headaches, nausea, vomiting, muscle weakness, memory loss, and problems with speech. The good news is that so far, the number of reported cases of the disease has been few.

A new tick problem has arisen in nearby New Jersey. The East Asian tick has been noted in several counties and it can carry the SFTS virus. SFTS stands for Severe Fever with Thrombocytopenia Syndrome. The symptoms include a high fever and thrombocytopenia (low blood platelet count). It's just another reason to be wary of the little pests this upcoming warm season and to always be sure to use insect repellent.

### CWD UPDATE

The Pennsylvania DCNR (Department of Conservation and Natural Resources) has been warning about CWD (Chronic Wasting Disease) for a few years now. The PA Game Commission has stated that extreme care should be used when handling slaughtered deer.

CWD is a transmissible spongiform encephalopathy of mule deer, white-tailed deer, elk, moose, and reindeer. The first case of this disease was noted in Colorado in 1967. Chronic wasting disease results in loss of motor function, weight loss and eventually death. It is

essentially the deer equivalent of the better known Mad Cow disease and there is no cure. In recent years CWD has been documented in south central Pennsylvania just outside of Philadelphia up into Clearfield County.

As of March 2018, the PA Game Commission established a new disease management area. This decision was based on finding a CWD positive deer in Lancaster County. This management area includes portions of Lancaster and Lebanon counties in southeast PA. Those engaged in animal production, deer hunting and other outside activities should use care when coming in contact with these animals. The most updated information from the Pennsylvania Game Commission is that the spongiform can stay in the soil for upwards of 16 years and plants can absorb it. It is not a virus or bacteria, but an abnormal protein so cooking will not destroy it. People who consume hunted deer need to carefully avoid tissue that can harbor the CWD agent such as the brain, spinal cord, eyes, spleen, tonsils, and lymph nodes. This is especially the case for animals from areas where CWD has been identified.

If you observe strange animal behavior such as weight loss, decreased interactions with other animals, listlessness, lowering of the head, tremors, repetitive walking in set patterns, excessive salivation or grinding of the teeth, contact your local game commission. Research is being done to determine if certain deer from different areas of the state are more or less likely to get CWD based on their genes.

### **MONARCH BUTTERFLY UPDATE**

The winter Monarch Butterfly population in Mexico this past winter was down by about 14-

15 percent from 2016-2017 levels. This is the second year that a decline in the number of butterflies has been noted. An active hurricane season last year cut across the main migration routes. We can all help out by planting milkweed, not destroying it. Monarch Butterflies need this plant to survive and breed.

## **Gazing the 2018 Spring through Fall Skies for Meteor Showers**

**Barry Lambert – Senior Meteorologist**

After an unusually chilly late March and April of 2018, we're sure that many of you would truly enjoy heading outdoors on a nice clear and warm evening to gaze at the sky and patiently wait for that coveted glimpse of a thin streak of light from a meteor as it passes through the upper part of Earth's atmosphere.

The small particle from Outer Space is not actually "burning up." Rather, friction flash-heats air molecules along the particle's path to thousands of degrees. The air molecules cool down in just a split second, giving off light as they do so.



**Figure 1. The little nuggets contained in Grape-Nuts cereal (or a fantastic pan of gold) are a close match to the size of particles that typically create meteors in our atmosphere. Photo by J. Kelly Beatty**

The goal here is to supply you with the best information possible so that you can enjoy one of these celestial light shows.

Please use our Office's Webpage (<https://www.weather.gov/ctp/>), Facebook or Twitter pages to monitor the weather. We encourage you to send us a Facebook message or Tweet us at #ctpwx to inquire about the forecast weather conditions as we close in on each event, or report severe weather occurrences, wind damage, flooding, rainfall, snowfall and yes, an observation of a vivid meteor shower or much rarer Bolide Meteor streaking across the nighttime sky. Your information can be critical and at the least helps us to verify what we see on radar and information from forecast model data. This information and positive feedback cycle serves to greatly improve Decision Support Service we provide to Core Public Partners, and our biggest user of information – the General Public.

Most months of the year contain one or more meteor showers, which occur as a result of the earth passing through the debris trail left behind by a comet. Some comets (such as Halley– whose location is now at the orbital distance and opposite of Neptune) have taken a path through the solar system that leads to the Earth intersecting its debris trail twice in a year.

The meteor showers derive their names from the constellation where most of the fleeting and faint flashes of light originate. Occasionally, a slightly larger piece of debris (ice or dust particles) can lead to a more pronounced “fireball” leaving a thin, glowing trail across a long arc in the sky.

These tiny bits of interplanetary debris race through the upper atmosphere at 20-45 miles

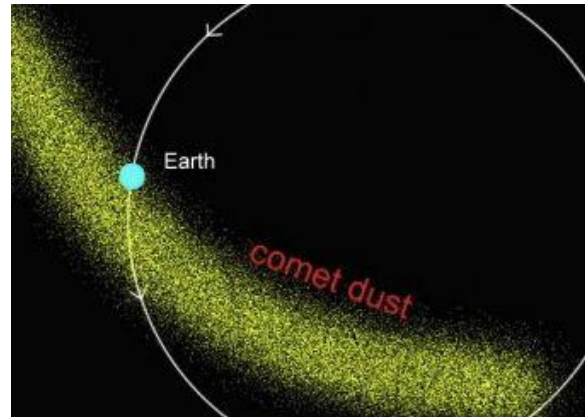


Figure 2. Illustration of the earth's orbit taking it through the lingering debris cloud of small particles from a comet, leading to a meteor shower.

per second and are very high up there at 50-75 miles above ground!

The CAMS Program (<http://cams.seti.org/>) from NASA's Ames Research Center is an automated video surveillance of the night sky (comprised of numerous cameras throughout the world) to document the occurrence, frequency and intensity of meteor showers. A recent study on long duration (Greater than 15 days) meteor showers was done by Peter Jenniskens from the SETI Institute in Mountain View CA, and published in: Planetary and Space Science (2017). This comprehensive work mapped 820,000 meteoroid orbits in Sun-centric ecliptic coordinates in 5 degree intervals of solar longitude. From this mapping, 18 showers were noted to emerge from the antihelion source, and subsequently follow a drift pattern toward higher ecliptic latitudes. 27 Halley-type showers noted in the apex source moved mainly toward lower ecliptic latitudes. You can read the complete abstract of the study here - <http://dx.doi.org/10.1016/j.pss.2017.01.008>

The bulk of the meteor showers we see are the result of our Earth's orbit passing through the



particle debris fields left over from 18 “Jupiter Family” comets (the kappa Cygnids), and 27 long-period “Hally-type” comet showers (omicron Eridanids), both of which have a moving radiant over a period of 15 days or longer. Click on both of these links and see how the earth’s orbit passes through both of these families of comet showers.

<https://www.meteorshowers.org/#Kappa-Cygnids>

<https://www.meteorshowers.org/#Omicron-Eridanids>

The images are fun and interactive! Click and hold your mouse button to rotate the image on various axes. (web page doesn’t seem to work in Chrome)

The daily tally of meteors viewed by the CAMS program from 2010-2016 is captured and displayed nicely in the colored-tables here - <http://cams.seti.org/tally.html>

There are 64 meteor showers that were designated as “Established” during the IAU General Assembly in 2009 (with some not yet established that are clearly detected by CAMS).

For the purposes and timing of this article, we’ll focus on the summer through late Fall period, which contains the more “brilliant” and “reliable” annual meteor showers. The bulk of these meteor showers also occur under more pleasant viewing conditions when temperatures are mild during the late night hours. There are also a few popular meteor showers that occur during the period January through April.

Coming to your local sky in late July is the southern Delta Aquariids, likely from the debris trail of comet 96P/Machholz. This shower will peak this year over the weekend from Friday night July 27th through early Monday morning, July 30th . However, this meteor shower exists for quite a long period of time, from about July 12th to August 23rd each year. The full moon on July 27th will probably interfere with viewing these faint meteors during their peak, so the best viewing time this year may be during the second week of August when the moon turns new (August 11th).

There will be a rather low frequency of meteors (just 10 to 20 per hour in the northern hemisphere). The meteor shower will be found looking south and fairly low on the horizon just to the north of the Great Square of Pegasus.

Because of the low viewing angle, some of the meteors could be the so-called, slower and dramatic “Earthgrazers”. About 5 to 10 percent of Delta Aquarid meteors result in lingering glowing ionized gas trails that last up to a few seconds after passage of the meteor.

| Meteor shower          | Dates / Peak Night           | Moon Phase | Meteors per Hour | Constellation | Radiant (Right ascension/ Declination) | Associated Comet                |
|------------------------|------------------------------|------------|------------------|---------------|--|---------------------------------|
| <b>Quadrantids</b>     | Jan 1-6<br>Jan 3-4           | 98%        | 120              | Boötes        | 15h 28m<br>+49.5°                      | 2003 EH1 (asteroid)             |
| <b>Lyrids</b>          | Apr 16-25<br>April 22-23     | 38%        | 20               | Lyra          | 18h 08m<br>+32°                        | C/1861 G1 Thatcher              |
| <b>Eta Aquariids</b>   | Apr 19 - May 28<br>May 6-7   | 61%        | 45               | Aquarius      | 22h 32m<br>-1°                         | 1P/Halley                       |
| <b>Delta Aquariids</b> | Jul 12 - Aug 23<br>Jul 29-30 | 96%        | 20               | Aquarius      | 22h 40m<br>-16.4°                      | Unknown, 96P Machholz suspected |
| <b>Perseids</b>        | Jul 17 - Aug 24<br>Aug 12-13 | 3%         | 100              | Perseus       | 03h 04m<br>+58°                        | 109P/Swift-Tuttle               |
| <b>Orionids</b>        | Oct 4 - Nov 14<br>Oct 21-22  | 91%        | 20               | Orion         | 06h 20m<br>+15.5°                      | 1P/Halley                       |
| <b>Leonids</b>         | Nov 5-30<br>Nov 17-18        | 62%        | 15               | Leo           | 10h 08m<br>+21.6°                      | 55P/Tempel-Tuttle               |
| <b>Geminids</b>        | Dec 4-16<br>Dec 13-14        | 35%        | 120              | Gemini        | 07h 28m<br>+32.2°                      | 3200 Phaethon                   |

Figure 3. List of Significant Meteor Showers during the Summer through Fall of 2018.

Our second show will feature the Alpha Capricornids that occur during the period July 11th to August 10th and have their peak during the night of Sunday-Monday, July 29th-30th. The parent of this meteor shower is the Comet 169P/NEAT. This event is quite weak and typically doesn't produce more than 5 meteors per hour. The surprise factor of this meteor shower is the number of much brighter fireballs that streak across the sky.

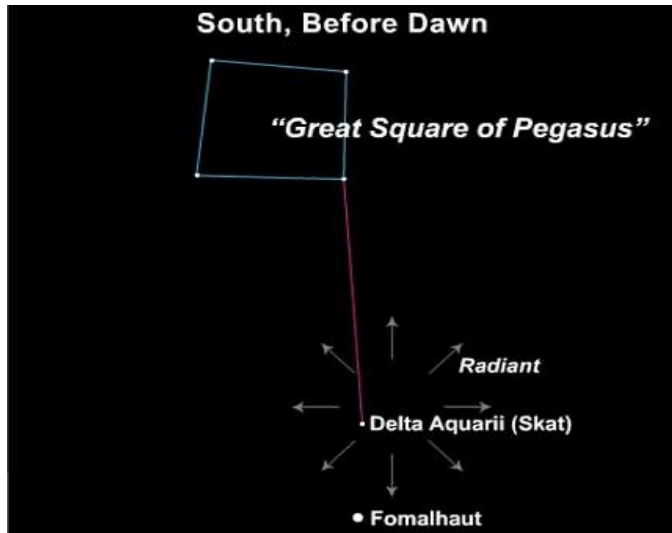


Figure 4. Location of the Delta Aquariids in the sky.

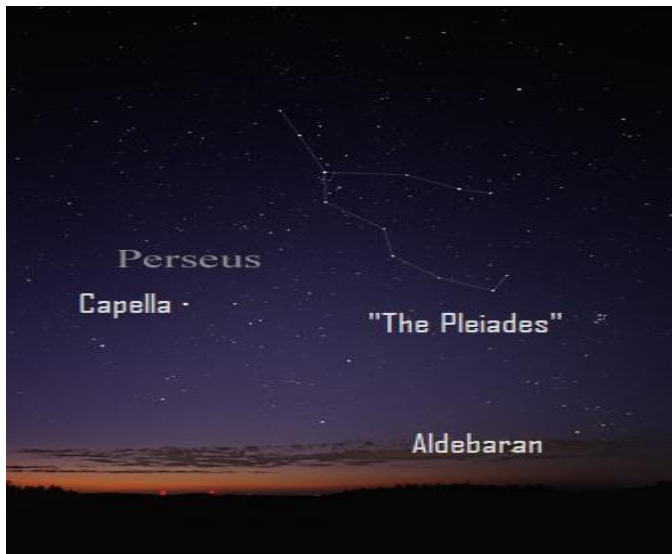


Figure 5. Radiant of the Perseid Meteor Shower.

The 3rd shower of the summer months – The Perseid meteor shower that peaks on August 12th or 13th - could also be the most spectacular not to mention also the easiest to view this year. This shower is associated with the Swift-Tuttle Comet, and will occur this year at its peak with little interference from the moon, right as it becomes new. Some of the highest rates of meteors come with this event – up to 100 per hour! Look toward the northeast sky late at night. The meteors will originate from the constellation Perseus. Perseid meteors can be seen anytime at night between July 13th and August 26th.

The Orionids will hopefully light up the autumn sky when they appear October 21st-22nd. The Earth is passing through Comet 1P/Halley's debris cloud for much of the fall season, so pick any nice night between September 23rd and November 19th to glance up and catch one of these fleeting celestial visitors to the Earth's upper atmosphere.

If you trace these meteors backward, they appear to come from the Club of the famous constellation Orion the Hunter. You might be familiar with Orion's bright, ruddy star Betelgeuse. The radiant is north of Betelgeuse. The Orionids have a broad and irregular peak that isn't easy to predict. This fall, the significant amount of moonlight will surely subdue the Orionid meteor shower. Try to see one of these meteors about an hour or two before dawn on October 21.

The Southern Taurids could seriously light up the autumn sky anywhere between September 23rd and November 19th. This meteor shower has several minor peaks in October and November with the primary peak

occurring on the night of October 28-29th. The meteors are fairly low frequency at only about 5

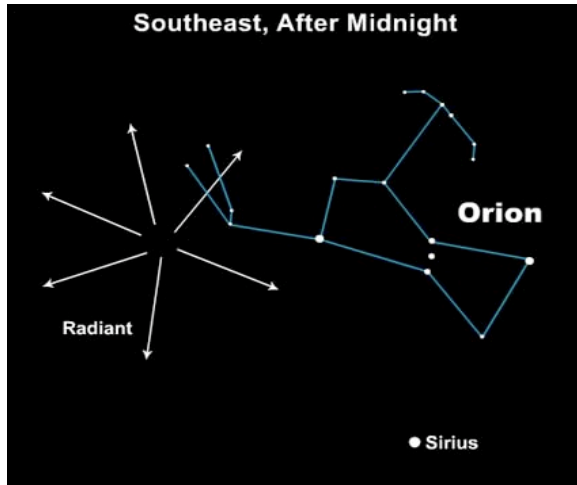


Figure 6. Radiant of the Orionid Meteor Shower.

meteors per hour. It's worth noting though that the Taurids (both Southern and Northern) are well-known for colorful fireballs and are likely the primary reason for the higher concentration of fireball reports during the Fall season.

The Northern Taurids follow with a peak just a few weeks later on the night of November 10-11th. When the two sibling meteor showers are simultaneously active, there can be an increased frequency in brilliant fireball activity. The span of the Northern Taurids is from October 19th to December 10th. The parent of both Taurid meteor showers is Comet 2P/Encke.

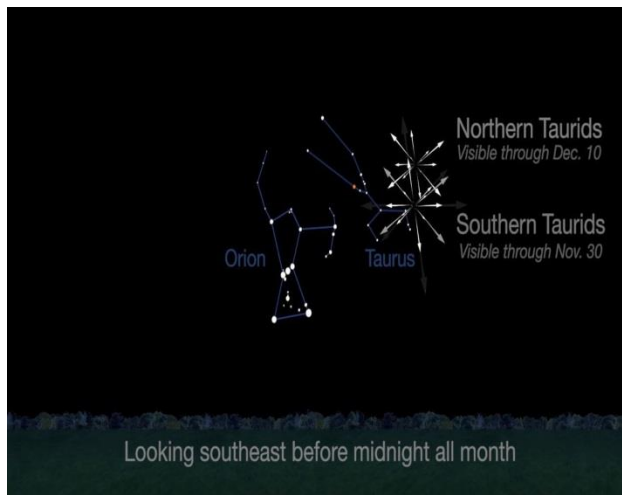


Figure 7. Radiant of the Northern and Southern Taurids



Figure 8. Radiant of the Leonid Meteor Shower.

The Leonids arrive for the late fall and occupy practically the entire month of November, except for the first several days. Look to the constellation Leo the Lion for these meteors (just above and to the left of its brightest star – Regulus). The peak of the Leonids is on the night of November 17-18th. Some of the greatest meteor storms have been associated with the Leonids – Specifically during the years of 1833, 1866, 1966 and 2001. It appears that the Earth will not pass through one of the denser parts of the debris cloud (needed for a meteor storm) from its parent, Comet 55P/Temple-Tuttle, until 2099. Until then, there still could be a nice display of over 100 meteors per hour. One thing that the Leonids are noted for are their high percentage of persistent trains.

One of the final meteor showers of 2018, the Geminids, is typically the strongest of the year. The origin of the Geminids is from the Asteroid – 3200 Phaethon. This event is active for a short 2 week period from December 4th to December 16th, with its peak on the night of December 13-14th. The notable thing with the Geminids is that it's perhaps the lone major meteor shower that contains a rather strong level of activity

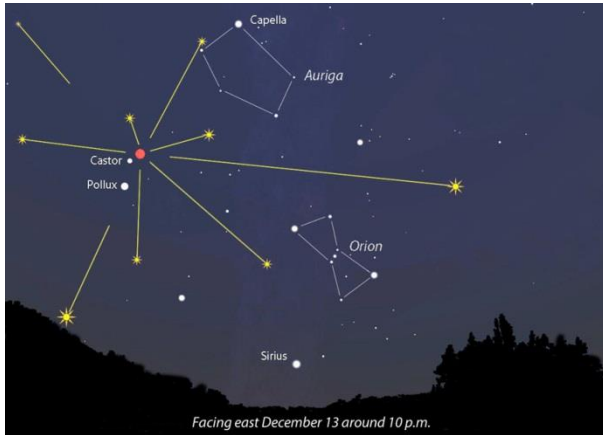


Figure 9. Radiant of the Geminid Meteor Shower.

prior to midnight. The Geminid meteors are routinely bright and quite colorful.

The Ursid Meteor Shower closes out the year. This event is active for the shortest period of time – only about a week, just prior to the Christmas holiday. Although the Ursids only amount to 5 to 10 meteors per hour during a typical year, the outburst of up to 50 per hour this year will be greatly dimmed by the full Moon.

Here are some informative links to help you navigate through the numerous meteor showers during the rest of this year.

Happy meteor shower hunting and gazing!

[Meteor Shower Sky Charts:](#)

<https://www.photopills.com/articles/meteor-guide>

<http://earthsky.org/?p=165416>

<https://www.amsmeteors.org/meteor-showers/meteor-shower-calendar/>

<http://earthsky.org/astronomy-essentials/earthskys-meteor-shower-guide#delta-aquarids>

<http://www.seasky.org/astronomy/astronomy-calendar-2018.html>

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