NEWSLETTER 2020

A new Decade, a new year, and a new **Severe Storm Season.** We, the officers and board of Metro Skywarn, take this opportunity to thank each and every one of you for watching, reporting and caring enough about your neighbors and community to provide as much notice as possible of approaching severe weather.

Safety First: Spot from *Home* After Dark

From the Weather Service…

By Todd Krause

The severe weather season of 2019 in the seven county metro got off to a very slow start, and with the exception of 2 ½ weeks, severe weather was infrequent. There were no reports of severe weather in March, April or May. June, historically our busiest month, only had two severe weather days (June 4 in the southwest metro and June 30 in the south metro). It wasn't until July 12 when the metro began experiencing a streak of severe storms. July 12, 15, 16, 18, 20, 26, and 28 all had severe weather, and one might continue that stretch to August 5, which featured our most intense hail day. It quieted down from there, with only three more days of severe weather in the metro (August 13, September 2 and September 24).

Four tornadoes touched down in the metro, all in outer suburbs or rural areas. For each tornado listed, the location denotes distance from the center or a city of town.
July 15: EF0 that touched down 4 miles southeast of Belle Plaine, and was on the ground for 1/3 mile.

July 28: EF1 that touched down 5 miles west of Scandia. It traveled into Chisago County and was on the ground for a total of 8.2 miles.
August 13: EF0 that touched down 2 miles northeast of Castle Rock, and was on the ground for 1/3 mile.
September 2: EF1 that touched down 3 miles east of Watertown, moved into Hennepin County and dissipated in the western portion of Minnetrista. It was on the ground for a total of 3.9 miles.

The most significant days were:
June 4 - Numerous reports of 60-70 wind and large hail in southern Scott and western Dakota Counties.
July 15 - Widespread hail, wind and flooding reports, and one tornado. Severe weather was reported in all seven counties. The largest hail was 2 inches in diameter at Lake Rebecca, just northeast of Delano. Winds were generally 60-65 mph, with numerous trees down across a broad area of the metro. Flash flooding was reported in several northwest metro suburbs as well as near Flying Cloud airport.
July 16 - Several reports of flash flooding just west and south of downtown Minneapolis.
July 18 – Baseball size hail was reported in Prior Lake, with two inch hail in Burnsville. There were no other severe weather reports, but these were definitely some of the biggest hail stones of the year.
July 26 – Anoka and Ramsey Counties were especially hard hit, with large hail from Anoka to White Bear Lake. Numerous reports came in of ping pong ball and golf ball size hail, and a three inch hail stone fell in Shoreview.
August 5 – This day will be remembered for the intensity and extent of the hail storms. Anoka, Carver, Hennepin, and Washington Counties all had reports of golf ball to baseball size hail, and three locations (Independence, Brooklyn Park, and Ramsey) had three inch hail. Some trees were toppled in a few areas, but the main story was the hail in so many areas of the metro.
September 2 – Winds of 60-65 mph moved from the west to northeast metro during the late evening, and there was one tornado east of Watertown that was embedded in the quasi-linear convective system.

Many thanks to everyone associated with Metro Skywarn, and a special thanks to those who take so much of their time to teach, operate nets or volunteer at NWS Chanhassen.
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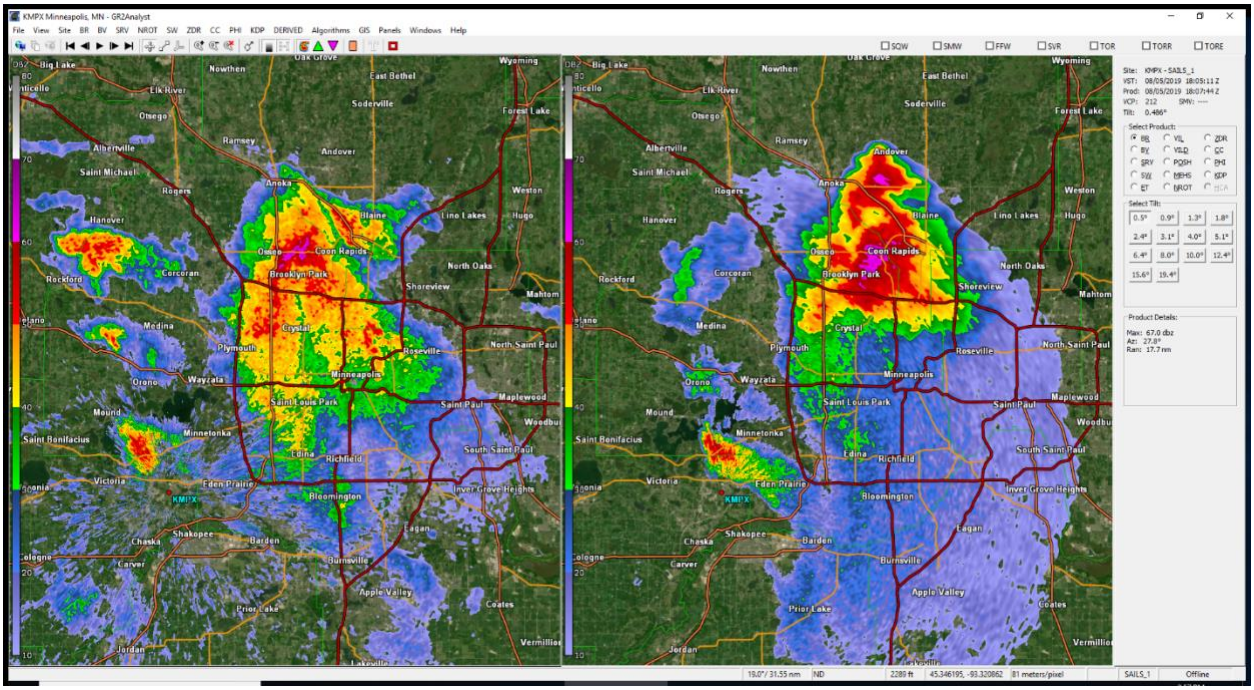

Anatomy of the August 5 hail storm.

This two panel image shows radar reflectivity from August 5, 2019 at 1805Z (1:05 p.m. CDT). Radar reflectivity is a measure of returned power, and it is typically strong when there is large hail. The image on the left shows reflectivity at the angle closest to the ground (0.5 degrees), and at that distance from the Chanhassen radar, the purple area east of Osseo is about 1200 feet off the ground. Meanwhile, the image on the right shows reflectivity at an angle of 16.5 degrees, and the purple area between Brooklyn Park and Coon Rapids measures reflectivity of 65 dBZ, and at that distance from Chanhassen, the radar beam height is about 32,000 feet above ground. The purple area just south of Andover shows 62 dBZ at an elevation of about 40,000 feet above the ground, and no echoes at all near the ground immediately south of Andover!

What causes such strong reflectivity at 32,000 and 40,000 feet? Hail that is being held aloft by an extremely strong updraft! But with supercells, the updrafted is tilted, allowing the storm to maintain its intense updraft while the hail continues to fall adjacent to the updraft. At this time, Brooklyn Park had hail 3" in diameter, and the area southeast of Andover had 2" hail. Why wasn't there larger hail southeast of Andover? Two reasons: there may have been larger hail that wasn't reported, but also the northern storm was nowhere near as long lasting as the one that went through Brooklyn Park.

The storm that hit Brooklyn Park actually intensified southwest of Watertown, where tennis ball size hail was reported. It tracked northeast, producing very large hail all the way. Four inch hail fell just southwest of Delano, three inch hail fell near Independence, baseball size hail hit part of Maple Grove, tennis ball size hail hit the Osseo area, and two inch hail was still falling by the time it reached Forest Lake. To make matters worse, winds were 50-65 mph in some areas. As

the storms were beginning to depart Wright and Carver Counties, Hennepin County Emergency Management activated the Wireless Emergency Alert, which activated cell phones and helped get boaters off Lake Minnetonka and many others had time to seek shelter.
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From the Chair…

The 2020 Metro Skywarn season is underway. We have had some changes on the Board of Directors. Two members of the Board stepped down last year Ryan Kelzenberg had served as Chairman since 2016 and has held many positions within the group since he join the in 1994. I want to thank Ryan for his years of service and his leadership. Matt Holden had been the Vice chairman for the past year. Matt was elected to the position of Director of the Dakota Division for the American Radio Relay League. Congratulations Matt and thank you for your time and guidance. Ron Trainis was elected to the position of Vice Chairman of the board. I am very pleased that Sandra Johnson will remain as Treasurer and Theresa Caspers as Secretary.

Board elections were held in December. Howard Lund and Kim Wilker did not run for reelection. I want to thank them both for their time and service on the board. Theresa Caspers and Ron Trainis were reelected. We have two new members, Tim Arimond and Benton Jackson. They have both been representatives for their severed agencies and Net Control Supervisors. Welcome gentlemen.

We have standing committees. Each Chaired by a member of the Board.

Education –Theresa Caspers. This committee is reasonable for Spotter and Net Control training classes, Instructor training and assignments and working with the National Weather Service keeping the Spotter curriculum up to date.

Technology – Mike Miller. Currently most of this committee's time is being used to get the Metro Skywarn web site updated.

Operations – OPEN. Works with net control stations. Making sure they have on the equipment and materials they need for net operations. Works with Training on net control officer training curriculum. Review and update the Sky Warn net control script manual.

Social – OPEN. Plan and hold annual events, Spotter Appreciation and end of Season Spotter Social.

The Committee Chairs could use your help. If any of the committees' interest you please contact the Committee Chair.

The Skywarn class schedule will be posted soon. Your Skywarn certification must be renewed every two years. If you need to renew make sure to sign up for a class when they are posted. Classes fill up quickly.

You are the eyes in the field for the National Weather Service, be careful, drive safely and make sure you are in a safe position when out spotting. When making reports be clear and concise.

Please feel free to contact me or any member of the Board with questions, concerns and comments.

Thank you for being Metro Skywarn volunteer.

Brian Esmay, Chairman of the Board Metro Skywarn,

Training …

The 2018 and 2019 training seasons were busy. We trained about 650 people each year with about 50% being ham radio operators and 50% Skywatchers. Our classes in May were very busy due to the late season snow events and our minds were on skiing and not the skies. We also had to reschedule a few classes due to ice and snow events. Our policy is that if timing of the class is going to fall inside of a Winter Storm Warning, we will reschedule. We will monitor the situation for other winter storms and email MSWInfo and post on Facebook for cancelations. So, be sure to sign up for the MSWInfo list (email Subscribe to MSWInfo+subscribe@googlegroups.com).

Last year, we received updated training materials from the National Weather Service. The materials were well received by our spotters. We also started to touch on QLCS tornadoes, something that the state of Minnesota has seen more of in recent years. The new program also brings back the base ingredients needed for storm development: lift, wind shear, moisture, and instability. We also took out the reporting of non-rotating wall clouds at the NWS' request.

We also have the materials online, so if you'd like to print them before the class or have them to refer to, feel free to download them. Sorry, we have to remove photos and videos as those are copyrighted by the photographers. They are located on MetroSkywarn.org, click on Spotter Resources and scroll down. The 2019 materials are currently out there, but we'll be uploading 2020 once they are available.

We ask that you register for classes so we have a good estimate of the number of people attending. Some classes require registration, but if there are open chairs at the class begin time, we will take walk ins. We also ask that if you're not planning to go to the class, please cancel your registration to allow for others to take your place. Lastly, don't delay in taking classes as the late April and May classes fill quickly.

We do have 2 classes this year that begin at 5:30pm instead of 6pm. This is due to the library's hours. These classes will go at a faster pace, so if you're a new spotter or prefer a slower paced class, please register for another class.

Thanks for attending our classes and if you didn't take the course last year, we'll see you this spring in one of our classes! You're welcome to attend every year if you wish.

Email Training@MetroSkywarn.org if you have any questions.

The HopWRF – A Local weather modeling project

By: John Wetter

The GFS, NAM, HRRR and others may be familiar acronyms to many folks reading this newsletter. These acronyms make up the base of the current computer modeling suite for National Oceanic & Atmospheric Administration (NOAA) & the National Weather Service (NWS). Each model has its strengths and weaknesses. The GFS was recently upgraded in resolution and physics core with the goal of more accurate forecasts out further in time.

There are a few key components to computer models that we'll cover here, though there are hundreds of differences between them. One item that is often first mentioned is the horizontal resolution of a model. Most current models forecast based on grids (though this is changing!). The size of this grid, known as bins in a 3D space, defines how small of a feature a model can resolve. As these bins get smaller, the computer power required to resolve them increases substantially. For every doubling of resolution, the number of bins increases by a factor of 4! Other components are the initialization of the model, parameterization, and the physics core of the model. The initialization of a model is how the model 'learns' the current conditions of the atmosphere to then use as a baseline to make a forecast. In a global model this initialization is as computationally expensive if not more computationally expensive as running the model itself! Parameterization refers to how the atmosphere is simplified in order to be computed. The old saying is a butterfly flapping its wings in Brazil could cause a tornado in Kansas. This is of course an over-simplification but describes the concept of chaos theory well and what parameterization attempts to do. Let's say a model has 1km horizontal resolution. Through parameterization, you generally come up with the mean flow and composition of all of the atmosphere in that bin. Different models use different parameterizations to help account for these changes. Finally, the physics core of a model refers to the raw computational core of a model and how it processes changes in the atmosphere. These continue to be updated as we better understand the kinematic and thermodynamic properties of the atmosphere.

The HopWRF was born in 2013 out of a few gaps a few of us saw in the model suite of the time along with some compute power locally becoming available. This started a collaboration between me and Tom Hultquist, a PhD student at the University of Minnesota. The gap we wanted to fill was for a short-term high-resolution model, but in an ensemble configuration. At the time, the HRRR had been out for a little while in an experimental state (it wouldn't go operational until 30 September 2014), which was the highest resolution model available at 3km

horizontal resolution. But it was only one model at the time, and to make it more stable to meet the requirements for going operational, it used what we considered some very conservative decisions regarding the parameterizations. So, we wanted to have a high resolution model, use the latest parameterizations available, and…. Make it an ensemble! Ensemble forecasting was a fairly new concept at the time though now is commonplace, if not 'expected'. An ensemble is a set of models that run concurrently with small changes to each model 'member' that handles a part of the atmosphere in a different way. For example, the GFS is only one member of the Global Ensemble Forecast System. There are 20 members plus a control and the operational member.

We went live with a 4-member ensemble set at 4km horizontal resolution with an aggressive configuration. The compute power was at Hopkins Public Schools (the 'Hop' in HopWRF). Hopkins was doing a refresh of their infrastructure building in more resiliency to their systems. As part of this resiliency, there were additional servers added that would automatically start being used if their main data center went offline. This is pretty normal for larger organizations. One challenge to this is that if these servers are waiting for something to happen, their utilization is low or near zero in the meantime,

so configuration issues that only present themselves under load would never be found until the worst possible time, when they are needed. Hopkins was also looking for more information to help in making school safety decisions and this partnership helped all sides along with additional items for STEAM-inspired learning, a great case of a public-public partnership between a local and federal agency.

The ensemble runs every three hours and produces an 18-hour forecast. Though there are many products available including aviation information, the most popular output is the simulated radar reflectivity in the summer and the snow totals in the winter. In the summer, the ensemble helps develop probabilities for severe weather as single high-resolution models are notoriously temperamental with convection, which has always been one of the most challenging parts of warm season forecasting. In the winter, we've seen great success with high impact winter weather events, both forecasting precipitation type, and snow totals. In the first year of the HopWRF existing, the data was a large contributor to the NWS issuing a Winter Storm Warning for an area that had not previously been in any kind of winter weather headline. This was due to the high-resolution ensemble data showing features not available in other guidance and good agreement in the ensemble gave forecasters a high confidence in the data.

Following the success of the HopWRF ensemble and with the increase in computer power from modern processors, additional models are also run. In the summer when more processing power is available we have experimented with a 250m resolution model (the HopWRF HD), a "HopAhead" model that runs from 36 hours to 108 hours, and also a global model based on the brand new MPAS model core. The MPAS model is a really interesting one. We run both a high-resolution local domain as well as a lower resolution global run. The MPAS is significant because it was one of two finalists for the new dynamic core for the GFS model. The NWS chose the competing FV3 dynamical core due to it being a bit further along in development and therefore

a bit more efficient from a compute standpoint. With that choice, we decided to implement "the other one" to compare and contrast the output. One outwardly apparent difference with the MPAS is that instead of it using square 'bins' it uses 6-sided bins in a Voronoi Mesh. We also do post processing of the Climate Forecast System (CFSv2) for 3-6 week guidance. The CFS runs 4 times a day, so we run a time lagged ensemble meaning we take the past 20 runs (5 days) and then put them together into an ensemble to help give additional confidence to the forecaster as well as to smooth outlier runs. This data is valuable to sub-seasonal forecasters to get general ideas around trends in severe weather over the next few weeks.

Using our data

I'll focus on our ensemble products as related to severe weather for this area to be useful to spotters. When you go to HopWRF.info we put the data right there. Across the top are each of the four individual runs in our ensemble. Don't start here! Use the power of the ensemble to look at how much agreement there is between the different members of the ensemble. Depending on the forecast, I either start at the ensemble mean or the postage stamps. The postage stamps are pretty straight-forward. It is just a single graphic with a smaller representation of each of the 4 ensemble members. This is a great way to analyze the differences between the members, especially when you are looking at convection. What time do the storms start? This is the hardest question to answer. Looking at Composite Reflectivity is a quick and dirty way to look at this in the model data. This gives you an idea of when storms may initiate, as well as what storm mode might be.

Looking for the possibility of severe weather, there are a couple proxies in the data that can give you an idea for what kind of a day it will be. First I'd look at instability and shear. We know from Skywarn

classes that storms are a combination of moisture, instability, and lift. For very strong supercell storms you also need shear. I use the ensemble means to look at these three key ingredients and also what goes into them. I'll take a look at both the surface based CAPE (Convective Available Potential Energy), as well as the bulk shear and the Storm Relative Helicity. I'll also take a look at the composite indexes of Significant Tornado Parameter and the Supercell Composite Parameter. This helps give me an idea of the general atmosphere and potential for the afternoon. Next I'll take a look at the postage stamps again and take a look at hail potential by using graupel as a proxy. Then on to one of the products that many chasers have come to use which can be very valuable but can also lead you astray. That is updraft helicity. Updraft helicity is the measure of rotation within an area, used to show the location of rotating storms. In high resolution models updraft helicity paths or 'swaths' can be used to determine the path of storms with rotation over time, giving the appearance of swaths. This product is often mis-represented as possible tornado tracks. A 3km resolution model is not able to resolve a tornado. Standard radar isn't even able to do that with a resolution of a couple to a few hundred meters! What this product does do though is give you an idea where the computer models think the best chance for rotating storms will be.

The area of high resolution modeling is rapidly changing and expanding. When the HopWRF began, there were only a couple other models doing approximately the same thing. Now, there are a few dozen models available. On the NWS roadmap is to roll out the HRRR Ensemble, or the HRRRE. We are still a couple years away from it going operational.

If this article has piqued your interest in learning more, below are some links for continued reading. Hopefully this has given you some insight to local modeling that is being done to help produce better forecasts and promote a Weather Ready Nation!

HopWRF data & information: Http://www.hopwrf.info

SPC HREF (Storm Prediction Center - High Resolution Ensemble Forecast) viewer: https://www.spc.noaa.gov/exper/href/

Webinar Slides talking about the history and reasons for moving forward with the FV3 as the new dynamical core for the GFS: https://cpo.noaa.gov/sites/cpo/MAPP/Webinars/2017/11-30-16/Cola_NGGPS_pub.pdf

National Blend of Models (ensemble of many operational models) data viewer: https://www.weather.gov/mdl/nbm_home

Ensemble Weather Forecasting primer from Penn State Online: https://www.e-education.psu.edu/meteo3/node/2284

Hennepin West Mesonet (realtime data for the Twin Cities metro): https://www.hennepinwestmesonet.org

MPAS information: https://ncar.ucar.edu/what-we-offer/models/model-prediction-across-scales-mpas