NATIONAL WEATHER SERVICE
GREEN BAY

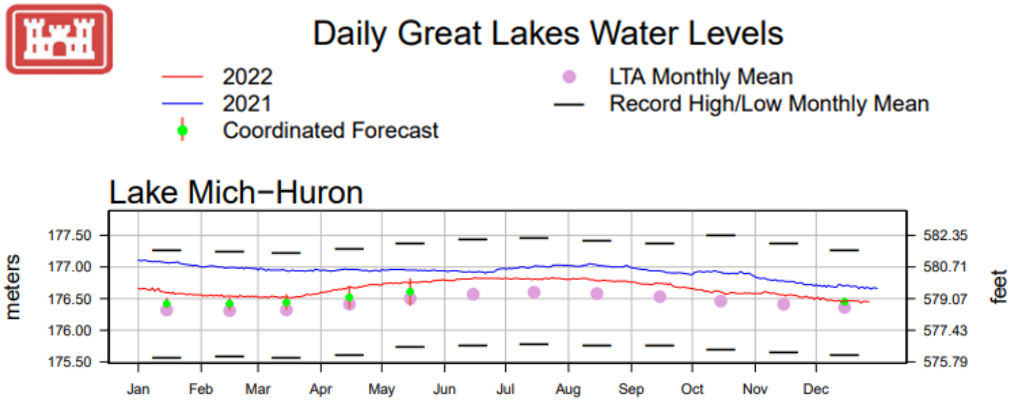
PACKERLAND WEATHER NEWS

Winter 2022/2023
Volume 20

LAKE MICHIGAN WATER LEVELS FALL OVER 2 FEET SINCE RECORD HIGHS

BY: MIKE CELLITTI, METEOROLOGIST

From January to August 2020, the Lake Michigan-Huron basin (Lake Michigan and Lake Huron are treated as one lake from a hydrologic perspective) observed record high water levels. It was the 6th straight year water levels were running above normal. Since these record high water levels 2 years ago, the Lake Michigan-Huron water level has gradually fallen over two feet, and has observed levels only 7 inches above normal as of the end of November 2022.



The water levels on the Great Lakes can fluctuate on a monthly, seasonal, and annual basis, depending upon a variety of factors including: the amount of precipitation, evaporation, and rainfall-induced runoff. Precipitation and runoff typically peak in late spring and summer as a result of snow melt and thunderstorm activity. Although evaporation is difficult to measure, evaporation is highest when cold air flows over the relatively warm waters of the Great Lakes between fall and late winter.

The record high water levels of Lake Michigan-Huron were largely a result of well above normal precipitation across the basin over several years prior to 2020. Looking back, ending in September 2020, the Great Lakes basin recorded the wettest 4-year and 5-year period on record dating back to 1895. In Wisconsin, the city of Green Bay

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Inside this issue:

June 15, 2022 Tornado Outbreak

Severe storms raced across the area on June 15, 2022. There were 10 confirmed tornadoes and many other damaging wind reports. For a detailed summary CLICK HERE.

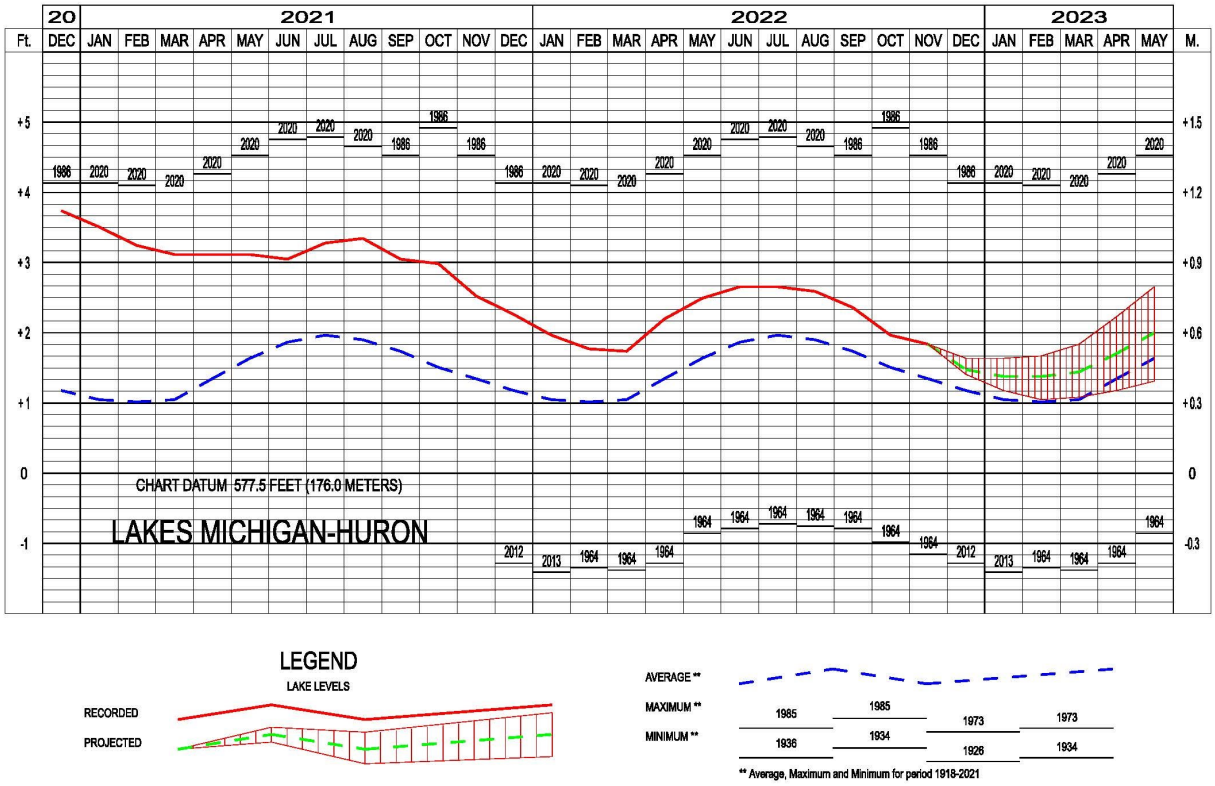
broke annual precipitation records in 2018 and 2019. The record high water levels resulted in flooding on rivers and roads, water damage to structures near the shoreline, and widespread shoreline erosion.

Conversely, the fall of water levels over the past 2 years can mostly be attributed to a decrease of precipitation relative to normal. From September 2021 to August 2022, observed precipitation over the northeast Wisconsin climate division was measured at 30.48 inches, or about 0.09 inches above normal.

Looking ahead, water levels early next year (2023) are expected to fall on Lake Michigan-Huron, which is a normal occurrence during the fall and winter seasons. However, the latest forecast calls for water levels to remain about a half foot above the long-term average through March 2023.

Thank you to the Army Corps of Engineers Detroit District for the water level data and forecasts.

LAKES MICHIGAN-HURON WATER LEVELS - DECEMBER 2022



** Average, Maximum and Minimum for period 1918-2021

DIDYOU KNOW???

We are on Facebook & Twitter. Check us out!

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SNOW SQUALL 101 & CHANGES FOR 2022

BY: TIMM UHLMANN, METEOROLOGIST

What is a snow squall?

A snow squall is a short-lived, but intense, period of moderate to heavy snowfall, accompanied by strong wind gusts at the surface. Snow squalls are often marked by a very rapid onset, going from unrestricted visibility to whiteout conditions in minutes. They can last as long as an hour at any one location, but more typically move through in less than half an hour. Rapidly falling temperatures behind the initial snowfall may also produce a flash freeze, quickly turning roadways icy. While snow squalls do share some characteristics of blizzards, they are not the same. Blizzards are classified by strong winds and whiteout conditions over the course of 3 hours or more; whereas snow squalls are much shorter in duration, can contain a flash freeze, and are similar to severe thunderstorm or tornado warnings in terms of aerial coverage. Additionally, there is no snow accumulation prerequisite for snow squalls, and in many cases it can be less than an inch, despite the brief whiteout conditions. The rapid deterioration of travel conditions is what makes snow squalls a significant winter hazard for motorists, especially if caught unaware. No place on the roadway is safe during a snow squall.

In layman's terms, the timeline of a snow squall could look like this: You're enjoying a quiet day at home and decide to make coffee. Between the coffee maker starting and you taking your first sip, you notice you suddenly can't see the sidewalk out your window, let alone the street, due to blowing snow. "Man, it's like a blizzard out there!" You shrug and decide to finish your coffee, a crossword puzzle, then look outside again, only to see the snow is already gone. At home, snow squalls may not be the most scary thing, but if you were on the freeway, you'd want to know if whiteout conditions are on their way.

Making a Snow Squall

The main ingredients needed for snow squalls are sufficient instability and moisture in the lower levels of the atmosphere, and the passage of an arctic front. The front provides the additional forcing and winds to get the snow squall organized, and brings in much colder air capable of producing flash freeze conditions behind the snow. The overall organization of snow squalls can be reminiscent of a line of severe thunderstorms in the summer, forming a line of narrow, heavy snow bands along the arctic front.

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THERE IS NO SAFE PLACE ON A HIGHWAY WHEN SNOW SQUALLS ARE APPROACHING

Snow Squall Warnings

While snow squall conditions are not new, Snow Squall Warnings are still relatively new, as they have only been in use since the 2018-19 winter season. The main motivation for their implementation is to allow for better messaging of high-impact, short-duration events that may not be fully covered by other products such as advisories or special weather statements. For example, a few of inches of snow over a few hours with little wind may merit a Winter Weather Advisory, but may not be considered a high-impact event. However, IF all of the snow were to fall in 15 minutes or a few of the snow showers had strong wind gusts producing whiteout conditions, messaging would need to be ramped up to promptly notify motorists to get off of the roadways.

New this year, Snow Squall Warnings will feature more specific information on both their anticipated impacts and their source, as shown in the table below. This is similar to the methodology the NWS uses for Severe Thunderstorm and Tornado Warnings. Up until this winter season, all Snow Squall Warnings would activate WEA (Wireless Emergency Alerts), but now only the more impactful events bearing the Significant tag will do so.

It is also worth noting, conditions capable of producing snow squalls are relatively rare in northeast Wisconsin. Despite the fact that the warnings were implemented in the 2018-2019 season, it wasn't until February 2022 that the first Snow Squall Warnings were issued by the NWS Green Bay office. The second round of warnings would follow in April 2022.

Snow Squall Safety Tips:

- Delay travel until conditions improve.
- If on the road, exit when it is safe to do so.
- Slow down gradually and do not attempt sudden turns or lane changes.

Snow Squall Warning Tags	Explanation
IMPACT TAG	
General (No Tag)	To be used frequently for snow squall conditions, but mitigating actions, combined with societal context, will reduce the threat to safe travel.
Significant*	Used only when snow squalls pose a substantial threat to safe travel, such that WEA is warranted to alert all devices in the path.
SOURCE TAG	
Radar Indicated	Evidence on radar and near storm environment is supportive, but snow squall conditions are not confirmed.
Observed	Snow squall conditions are confirmed by ASOS, spotter, webcam, law enforcement, emergency management, or other visibility observations.

Up to 2 Impact-Based Warning Tags will be appended to the bottom of Snow Squall Warnings.
**Category utilized for a Wireless Emergency Alert (WEA)*

Remember to visit www.weather.gov/grb for the latest watches, warnings, statements, and forecasts.

WINTER 2022-23: LA NIÑA CONDITIONS CONTINUE

BY: ROY ECKBERG, METEOROLOGIST

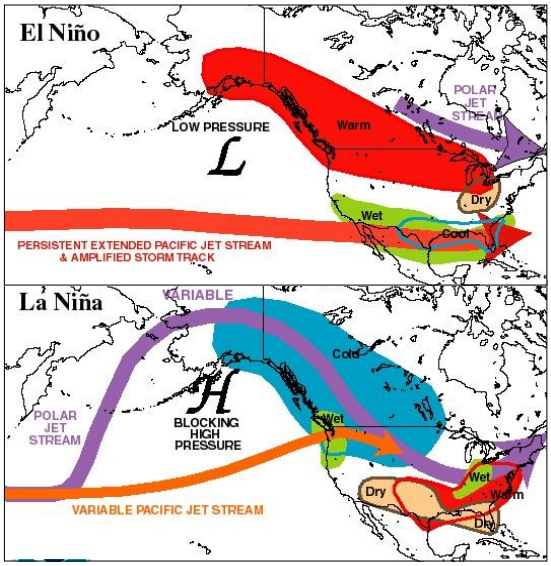


Figure 1: Typical jet stream patterns during El Niño and La Niña winters.

Thousands of miles away from Wisconsin, water temperature anomalies across the equatorial Pacific Ocean between Hawaii and Central America can have significant influence on winter temperatures and precipitation/snowfall across the western Great Lakes. The phenomena is called the El Niño-Southern Oscillation (ENSO) which is a recurring climate pattern involving changes in water temperatures in the central and eastern Pacific Ocean. There are 3 phases of ENSO: El Niño, La Niña, and neutral. El Niño occurs when water temperature anomalies are +0.5°C or warmer for five consecutive months, while La Niña occurs when water temperature anomalies are -0.5°C or colder for five consecutive months. Neutral conditions occur when water temperature anomalies are within +/- 0.4°C.

The water temperature anomalies impact where there is the greatest concentration of thunderstorm activity in the tropics, which in turn impacts the jet stream pattern (Figure 1). During an El Niño winter, the thunderstorm activity is focused across the eastern Pacific Ocean, which allows for a stronger sub-tropical jet stream and a weaker polar jet stream. In this scenario, there are less arctic intrusions, especially extreme bitter cold events, into the western Great Lakes. During a La Niña winter, thunderstorms are more concentrated across the western Pacific Ocean. This scenario usually causes the jet stream to move northward towards Alaska and then dive southeast across western North America. There are usually more arctic outbreaks, in some cases extreme bitter cold events, that move into the northern United States.

For the past two years, La Niña conditions have dominated, and are expected to continue this winter (Dec-Feb). This would make it the 3rd consecutive winter with La Niña conditions. Since 1950, three consecutive La Niña winters have occurred only twice: winters of 1973-74/1974-75/1975-76, and 1998-99/1999-00/2000-01.

The Climate Prediction Center (CPC) temperature and precipitation outlook (Figure 2) for January through March is calling for nearly equal chances of above, below, or near normal temperatures and above normal precipitation. A recent local study was conducted looking at temperature and precipitation trends (at Green Bay) examining the past 24 La Niña events. The study revealed some distinct patterns. Starting with temperatures, the fall season was warmer than normal 63% of the time, especially in October and November. The probability of warmer than normal conditions fell to near 50% in December and January, and then down to only 25 to 35% during February and March. Basically, start warm and then end cold! The study also revealed snowfall for the season (Oct-Apr) ended above normal 63% of the time. This included some of the snowiest winters on record: 3rd snowiest in 2010-11, 4th snowiest in 2008-09, 5th snowiest in 2007-08, 8th snowiest in 1995-96, 17th snowiest in 1984-85, and 18th snowiest in 1971-72. Most recently, the winter of 2017-18 recorded the 21st snowiest. Caution! The jet stream pattern that sets up (more likely well south of the state for much of the winter), has led to not so snowy winters. Of the top 40 least snowiest winters on record there have been 7 La Niña winters. The last two La Niña winters at Green Bay, the winter of 2020-21 was the 18th least-snowiest winter and the winter of 2021-22 ended at 43.8 inches of snow or 12.4 inches below average. (Records at Green Bay date back to September 1886.)

Will this winter follow the typical trends of a La Niña winter?

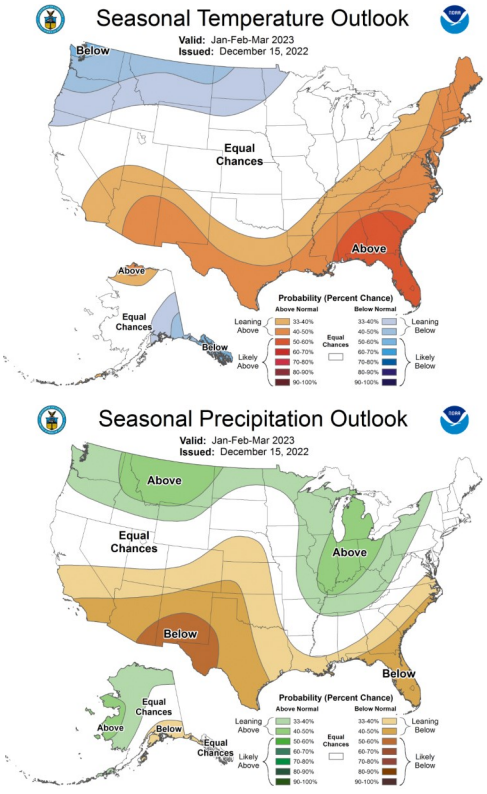


Figure 2: Temperature/Precipitation Outlook (CPC)

IT CAME IN A FLASH! - MAY 12, 2022 OCONTO COUNTY FLASH FLOODING

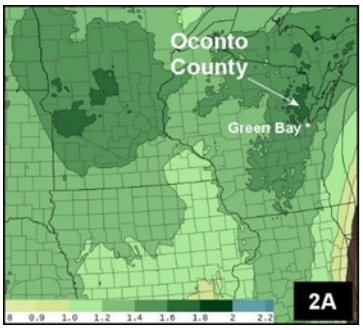
BY: GENE BRUSKY, SCIENCE AND OPERATIONS OFFICER

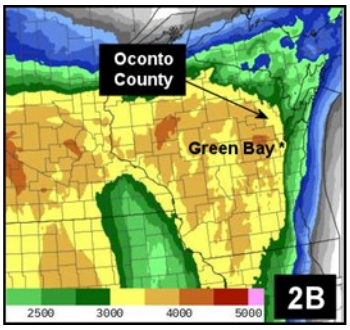
Introduction

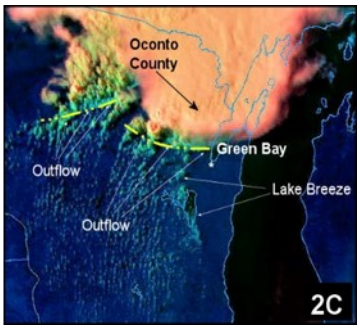
During the late afternoon and early evening of May 12, 2022 numerous severe thunderstorms impacted parts of northern Wisconsin, producing hail up to 1 inch in diameter and locally heavy rainfall. What made this event particularly impactful and somewhat unusual was not the hail, but rather, the duration and intensity of the rain that fell over a small geographic area focused over central Oconto County. The copious rainfall caused dangerous flash flooding that not only inundated homes and farmsteads, but also washed out several county roads. These impacts led to the declaration of a Flood Emergency by Oconto County Emergency Management. Radar rainfall estimates revealed that 7-9 inches of rain fell over 3 to 5 hour period as thunderstorms continually reformed and moved east across the same geographic area. This characteristic of thunderstorm evolution is often referred to as "thunderstorm training" and is a common contributor to summer time flash flood events in the western Great Lakes region.

Environmental Ingredients

Moisture, instability, and lift are the fundamental ingredients for thunderstorm formation. All three of these ingredients came to together across northern Wisconsin during the afternoon of May 12, 2022. Available moisture (Precipitable Water) was near 2.0 g/kg in Oconto County which is well above normal for the month of May (**Figure 2A**). The high moisture, in concert with strong daytime heating, led to a very unstable air mass with mean Convective Available Potential Energy (CAPE) near 4000 J/kg (**Figure 2B**). The unstable air mass was lifted upward by cool thunderstorm outflow positioned just south of Oconto County (**Figure 2C**). This lead to regenerative thunderstorm development just north of the outflow boundary.

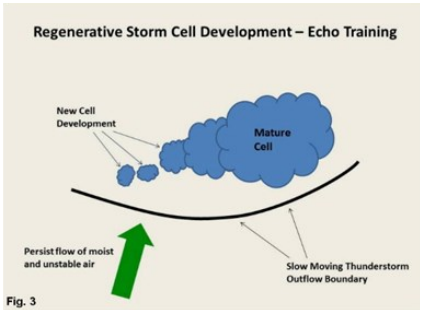






Training Thunderstorms

The formation and persistence of the W-E orientated thunderstorm outflow boundary was the critical ingredient that ultimately contributed to repeated thunderstorm development west of Oconto County. **Figure 3** (right) is a simple conceptual model illustrating key features associated with this process.



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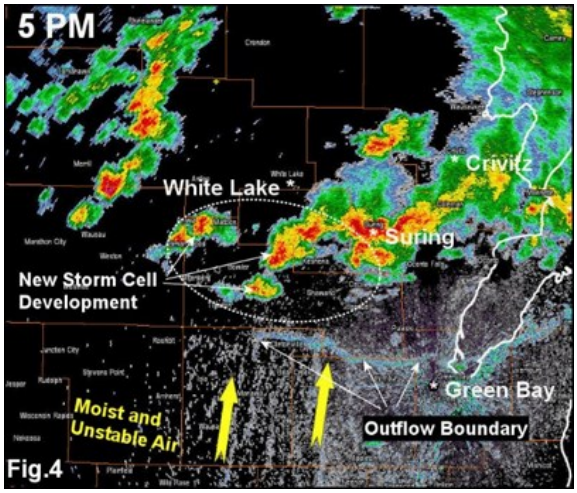
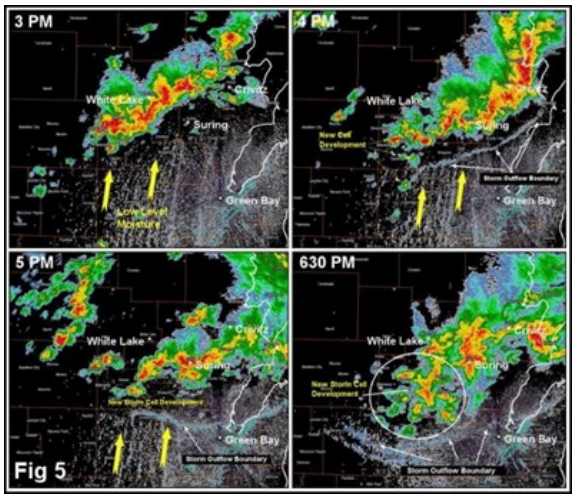
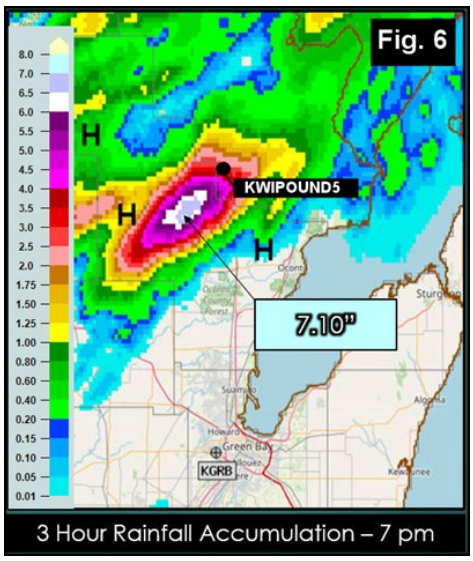
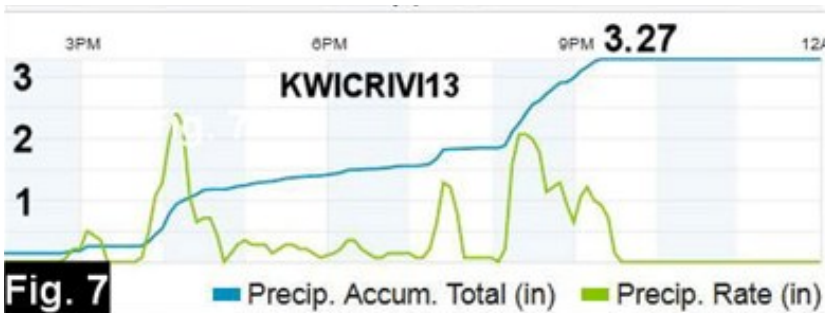






Note the similarity of the conceptual model to what was actually observed via the WSR-88D Green Bay Doppler radar at around 5 pm on May 12th (**Figures 4 & 5**). Note the thunderstorm outflow boundary located just north and northwest of the Green Bay area.

This boundary was drifting slowly south and moving directly into a very unstable low-level southerly flow. Storms continually developed over Menominee, southern Langlade and Shawano counties, then moved east across central Oconto County roughly between Oconto Falls and Mountain. During a three hour period ending at approximately 7 pm CDT, radar estimated rainfall (**Figure 6**) exceeded 7 inches! A nearby observation near Pound, WI outside the core of heaviest radar-estimated rainfall indicated 3.27 inches with hourly rainfall rates of over 2 inches/hour at times (**Figure 7**).



Summary

Based on a 30 year average (1992-2021), flooding is the second leading cause of weather-related fatalities annually in the United States (heat is #1). So, although tornadoes, damaging winds and large hail often get all the attention, it is vitally important to always keep in mind that when thunderstorms roar, remain alert for flash flooding too!

2022 COOP AWARDS

75 YEARS

Jenny Pagel, Keith Graper &
Stephanie Jepson
Clintonville WWTP

50 YEARS

Daryl Rutkowski
Eagle River WWTP

20 YEARS

Richard and Claire Olsen
Forestville

15 YEARS

Andrew Vitek, Gabe Aschbacher
& Warren Howard
Marinette WWTP

Erika Thronson
Denmark WWTP

Others receiving awards (not pictured):

Rhinelander WWTP — 50 Years

Phelps WWTP — 25 Years

Appleton — 20 Years

THANK YOU COOP/UCOOP/COCORAHS OBSERVERS!

BY: SCOTT CULTICE, OBSERVATION PROGRAM LEADER & SCOTT BERSCHBACK, METEOROLOGIST

Happy 2023!

Everyone at NWS Green Bay would like to personally thank each of you for your dedicated snow measuring efforts through the years! Your timely, and accurate measurements allow us to provide better service to our partners and the public, and in some cases, immediate life-saving action. Your observations also help provide important data for research that leads to advances in life-saving technology.

As we push through the winter season, you can find many helpful reminders on measuring snow/ice and water equivalent here:

Slide Shows: https://www.cocorahs.org/Content.aspx?page=training_slideshows

Videos: https://www.youtube.com/user/cocorahs

Have a healthy and safe 2023! If you have any questions, please send us an e-mail or give us a call. Thanks again!

WANT TO BECOME A WEATHER OBSERVER?

For information on COOPs, CoCoRaHS and SKYWARN, please visit: https://www.weather.gov/about/observations

NWS GREEN BAY FAREWELLS

Happy Retirement!!!

NWS Green Bay wished a bittersweet farewell to our longtime Administrative Support Assistant (ASA). Linda Skowronski, as she retired after 20 years of service.

During Linda's 21 years at NWS Green Bay, she managed official business of the office with numerous responsibilities including: budget, invoices, contracts, purchase orders, travel, payroll, timecards, human resources, telecommunications, property, procurement, mail, and so much more. Linda also served as a great mentor to many ASAs at other Midwest NWS offices.

All of us at NWS Green Bay are sad to see Linda go, but happy for her in the next phase of her life. Linda not only had a positive influence on ASA operations for NWS Green Bay, but across the Midwest. We wish Linda the very best in retirement and thank her for her years of service at NWS Green Bay.

Lead meteorologist, Keith Cooley, accepted a position at the NWS Paducah, Kentucky office this past summer. Keith joined the Green Bay NWS staff in August of 2018 and was instrumental in running the hydrology program, working with local and state partners, and maintaining many of our hydrologic sites across northeast WI. Keith was also involved in providing training for staff and preparing the office for each flood season.

Keith will not only have to deal with a lot less snow, but will also be much closer to his family. We wish him, his wife, and their two dogs the best in Paducah!

Good Luck!!!

NWS GREEN BAY GIVES BACK TO THE COMMUNITY

BY: RICH MAMROSH, LEAD METEOROLOGIST & SCOTT BERSCHBACK, METEOROLOGIST

Employees at the National Weather Service office in Green Bay gave back to the community this year by participating in a variety of programs. We hope everyone has a happy and healthy holiday season!

Adopt-A-Family

NWS Green Bay adopted a family during the holiday season, purchasing nearly 50 items, including toys, books, clothes, shoes, gift cards, and hygiene items.

NWS Week of Service

NWS Green Bay staff has collected food for the Paul's Pantry food program for the past several years. This year, we collected around 180 non-perishable food items for the Feeding America – Eastern Wisconsin food program. This organization, started by Rotary Club members 40 years ago, collects food from manufacturers, grocery stores and individuals, and distributes it to more than 400 local food pantries in 35 eastern Wisconsin counties.

Adopt-A-Highway

For the fourth straight year, employees cleaned the park-and-ride parking lot near the Freedom, WI, exit along I-41. Typically, anywhere from 3 to 6 employees volunteer to participate in each of the three cleanings during the spring, summer, and fall seasons. We plan to stay involved with the Adopt-A-Highway program for many years to come.

ADOPT·A·HIGHWAY

STAYING WARM! WORD SEARCH

H M J B F F S V L L U T X X O Q F R P C
G V O P W X H T V Z S S N F V B L A P Y
T E K N A L B A O N D F X B R P O E J A
G S S D K T L O T O L F G F Q O N W B P
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BLANKET	HAT	MITTENS
BOOTS	HEATER	PARKA
EARMUFFS	JACKET	SCARF
GLOVES	LEGGINGS	SWEATER
HAND WARMER	LONG UNDERWEAR	TURTLENECK

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