Analysis of the July 29th, 2023, Major-Impact Severe Weather Event in the National Capital Region

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20th Conference on Major Weather Impacts

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1: NOAA/NWS Baltimore/Washington Weather Forecast Office

Outline

I. Overview of the July 29th, 2023 Severe Weather Event
II. NWS Outlooks
III. Machine Learning Guidance
IV. How Machine Learning Improved Impact-Based Decision Support Services
V. User Feedback
VI. Summary

Overview of the July 29th, 2023 Severe Weather Event

What happened?

- **Severe thunderstorms with measured wind gusts in excess of 80 mph swept through the National Capital Region (NCR) during the afternoon of July 29th, 2023.**
  - Thousands of trees were downed with many onto houses, structures, cars, and roads
  - Hundreds of buildings were damaged with roofs tore off and chimneys dislodged
  - Around 250,000 people were without power

The storms moving east from South Arlington, VA (@STATter911 on X)

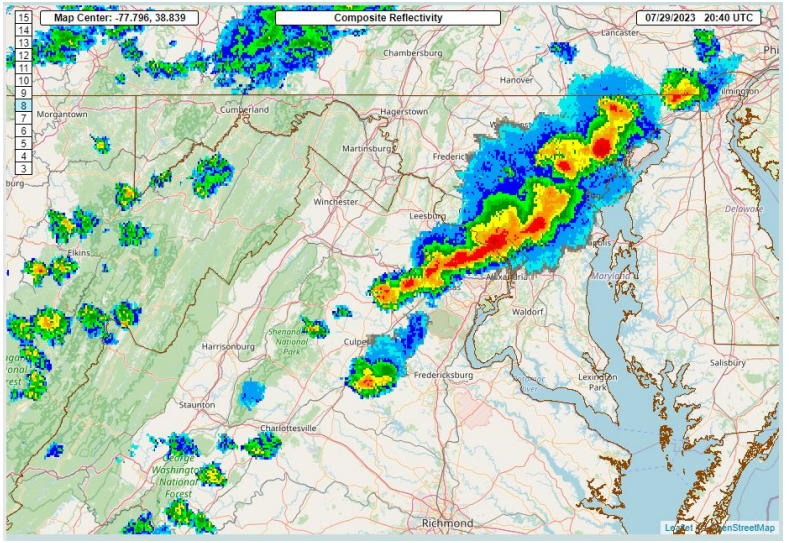
Many called this the *worst* storm since the 2012 Derecho that paralyzed the region.

Event Overview

- Excessive heat and humidity precluded the storms for a few days.
    - DCA, IAD, and BWI were 96-98° July 27th-29th

- A potent shortwave trough moved through the Mid-Atlantic with an area of surface low pressure moving across southern New England.

- The associated cold front coupled with remnant MCS energy and a residual pressure trough led to storms regenerating east of the Blue Ridge Mountains.

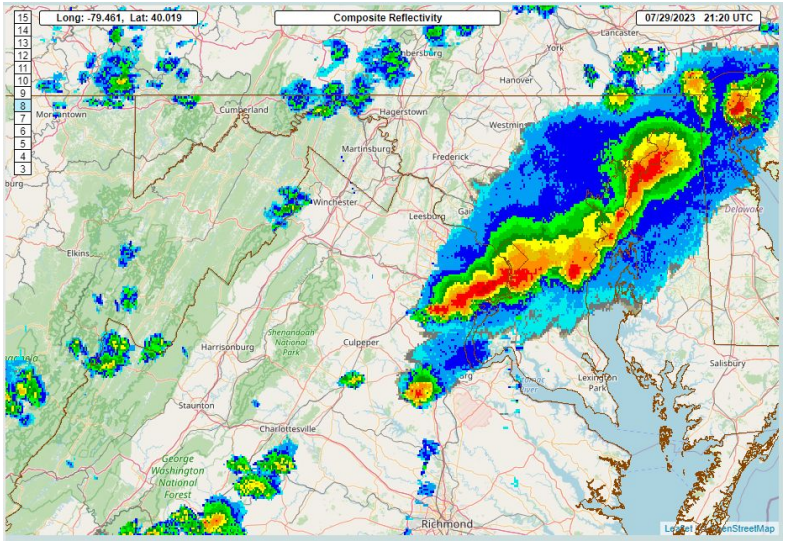


NSSL MRMS Radar Reflectivity valid 20:40Z July 29th, 2023

Event Overview (cont.)

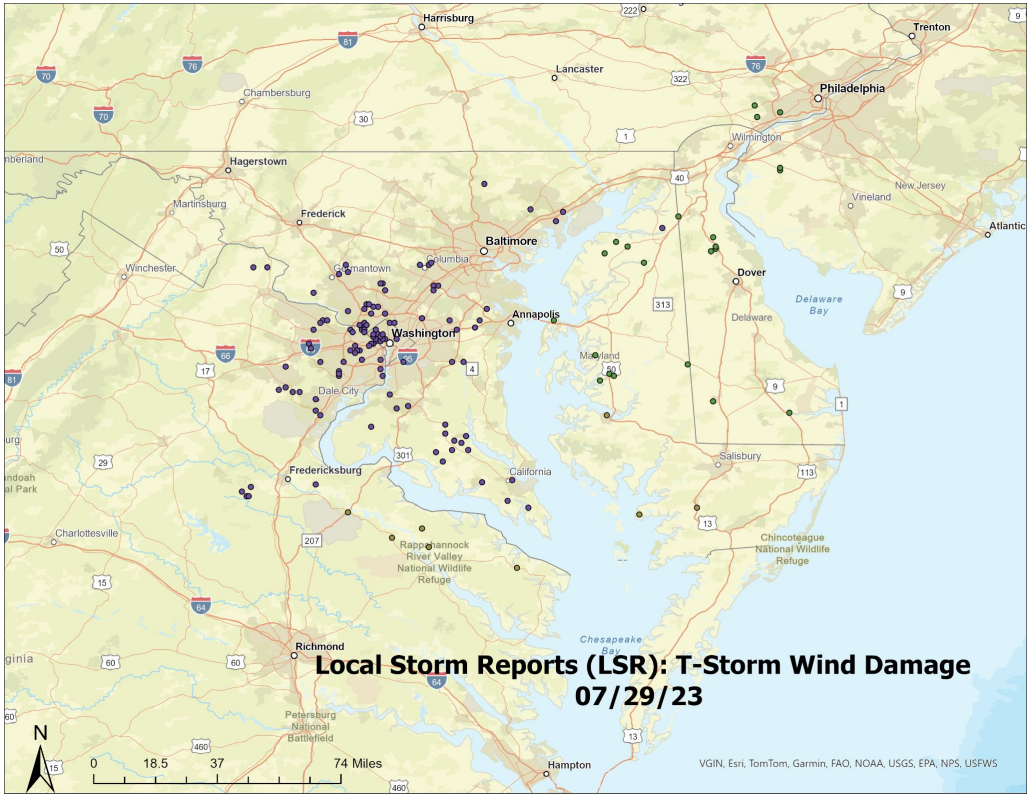
- As the cold front interacted with SBCAPE values of 3,000 - 4,000 J/kg east of the Blue Ridge, the thunderstorms quickly grew upscale.

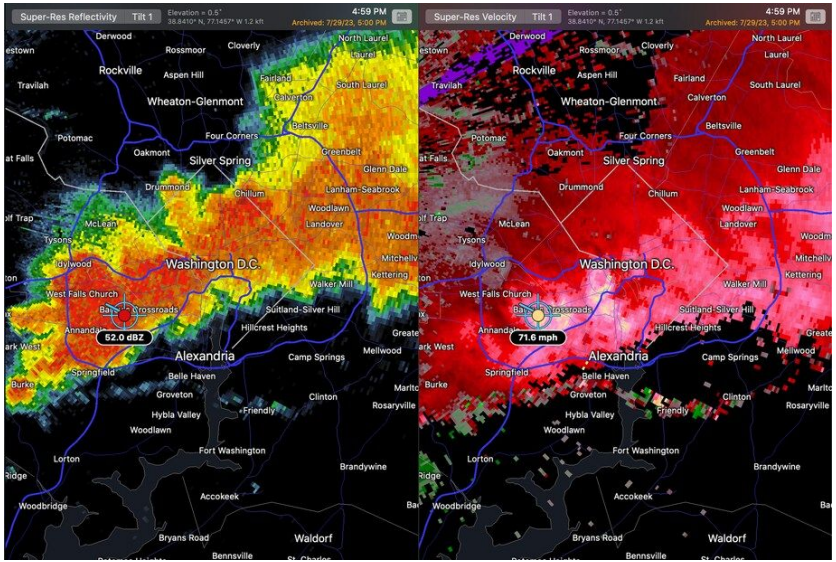
- Dozens of updrafts quickly congealed into a linear segment with embedded macrobursts and microbursts which produced swaths of 60-80+ mph wind damage across the NCR.



NSSL MRMS Radar Reflectivity valid 21:20Z July 29th, 2023

Local Storm Reports





RadarScope Imagery from the Washington Post

Notable Reports

Measured Wind Gusts

- 84 mph at George Washington's Mount Vernon Campus (NW DC)
- 72 mph Saint Charles, MD
- 70 mph near Highland Beach, MD
- 69 mph in Germantown, MD
- 61 mph in Glen Echo, MD
- 60 mph at Reagan National Airport (DCA)

Notable Damage

- George Washington Pkwy closed for 4 days. National Park Service stated 325 trees fell on the road resulting in 500 tons of tree debris being hauled away.
- I-495 and I-66 closed with dozens of trees down.
- National Zoo Closed July 31st to cleanup.

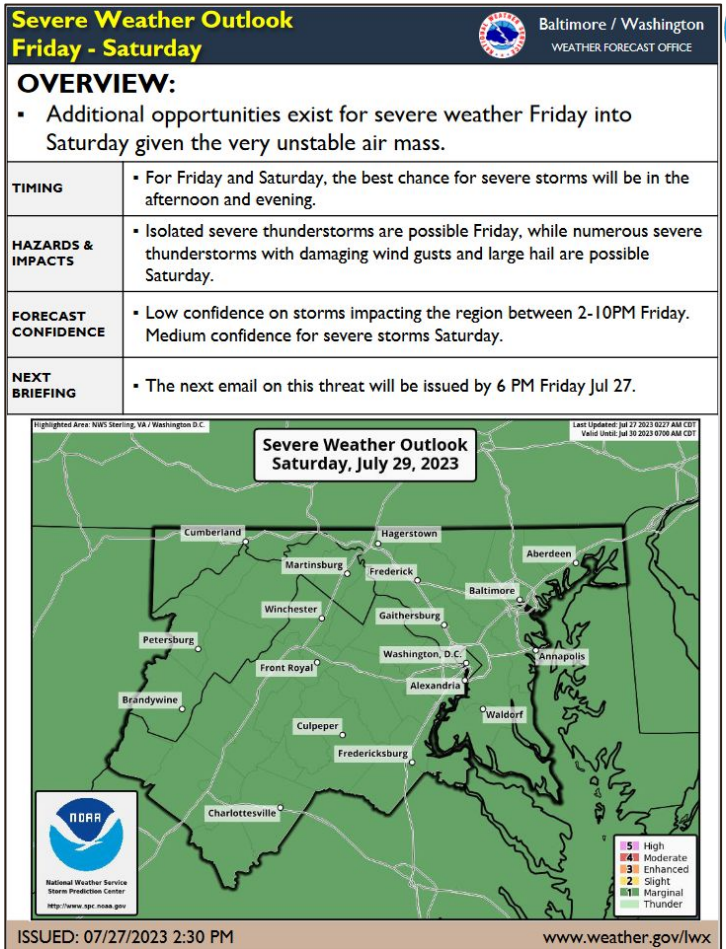
Photos courtesy of DC Fire & EMS

NWS Outlooks and Warnings

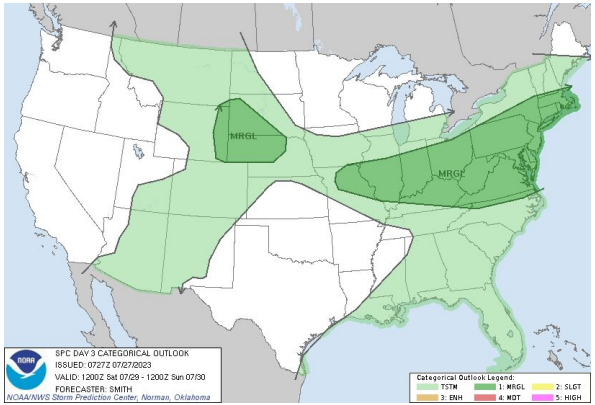
Local Products from WFO Sterling

NWS Balt/Wash forecasters started messaging the potential severe storms on Wednesday, July 26th, 2023.
Message went out through the Hazardous Weather Outlook, Decision Support Emails, and Emergency Manager briefings through the event on Saturday, July 29th.

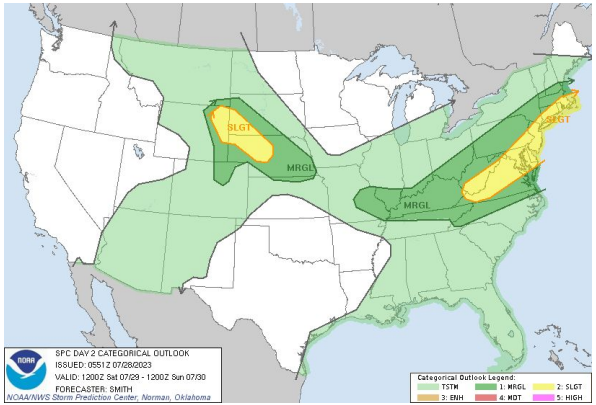
- "Confidence is higher for severe storms Saturday."
- "Numerous severe thunderstorms with damaging wind gusts and large hail are possible Saturday."



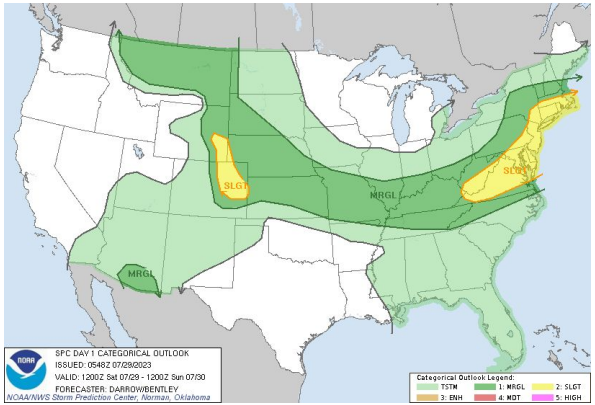
Storm Prediction Center Outlooks (Days 1 -3)



Day 3 SPC Outlook



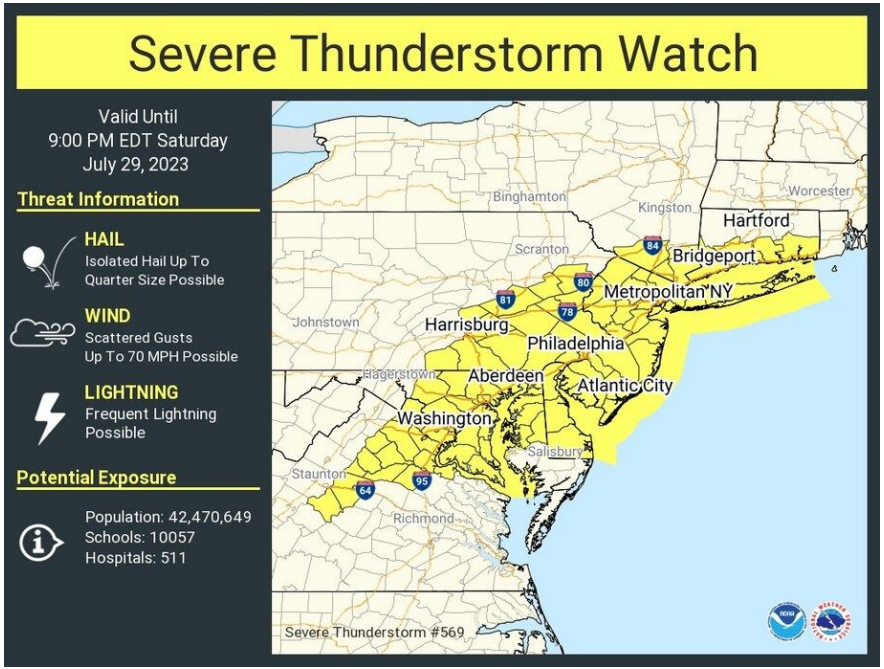
Day 2 SPC Outlook



Day 1 SPC Outlook

No SPC outlooks were issued for this event in Days 4-8 (predictability too low).

SPC Watch



- **Issued by SPC at 2:50 PM local time**
  - Summary: “Widely scattered to scattered thunderstorms are expected to form this afternoon and spread eastward to the Mid-Atlantic coast. The storm environment supports a mix of multicell clusters and some supercells capable of producing damaging winds and isolated large hail through late evening.”

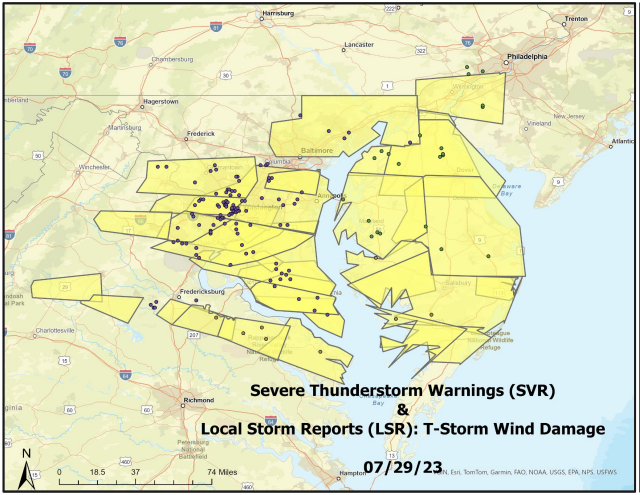
NWS Thunderstorm Threat Categories

Considerable / Destructive Tags

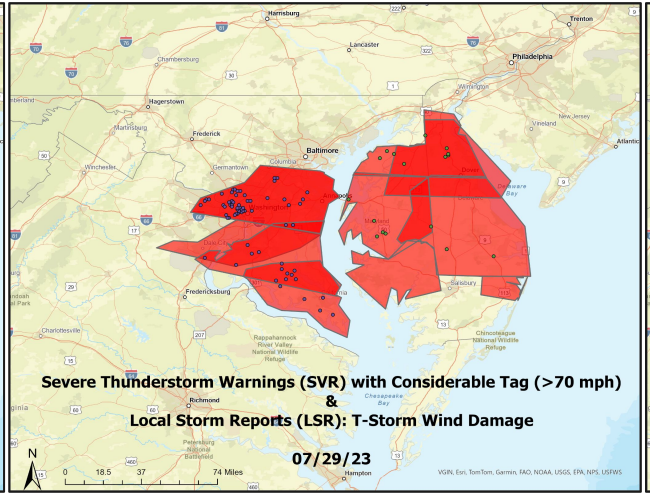
Thunderstorm Damage Threat (tag category)	Wind	Hail diameter	WEA?
Base (no tag; default)	58 mph (60 mph will appear in the warning)	1.00 inch (U.S. quarter)	NO
Considerable	70 mph	1.75 inch (golfball)	NO
Destructive	80 mph	2.75 inch (baseball)	YES

- The highest of the categories will be invoked from either a qualifying wind or hail value, or both.
- Wireless Emergency Alert (WEA) messages will be activated on mobile devices whenever a Severe Thunderstorm Warning with a 'Destructive' tag is issued or updated. For more information on WEAs, please visit **weather.gov/wrn/wea**.

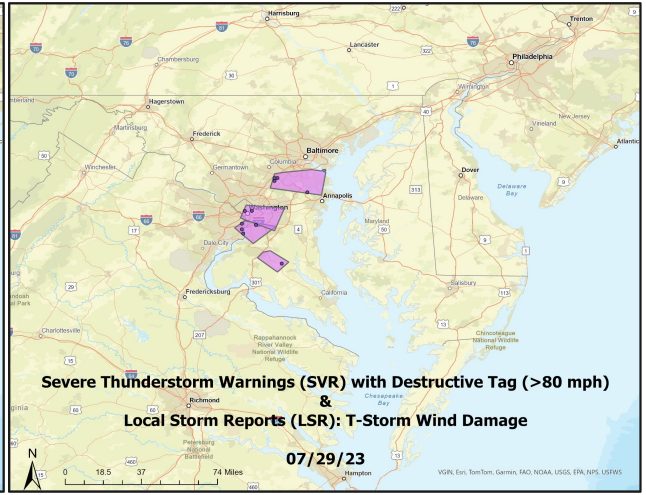
NWS Warnings



26 Total Severe Warnings (>58 mph)

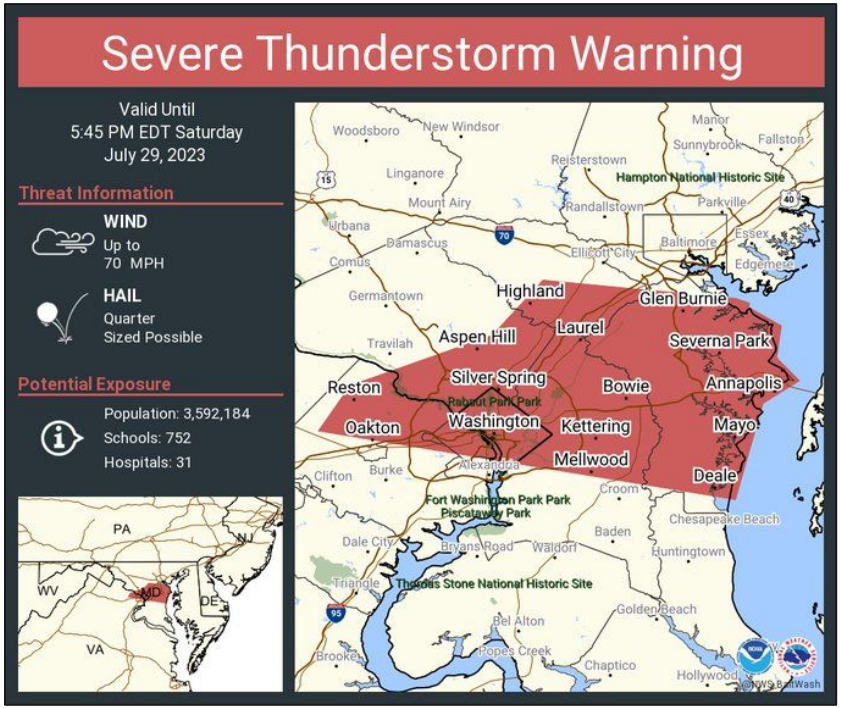


12 Considerable Severe Warnings (>70 mph)

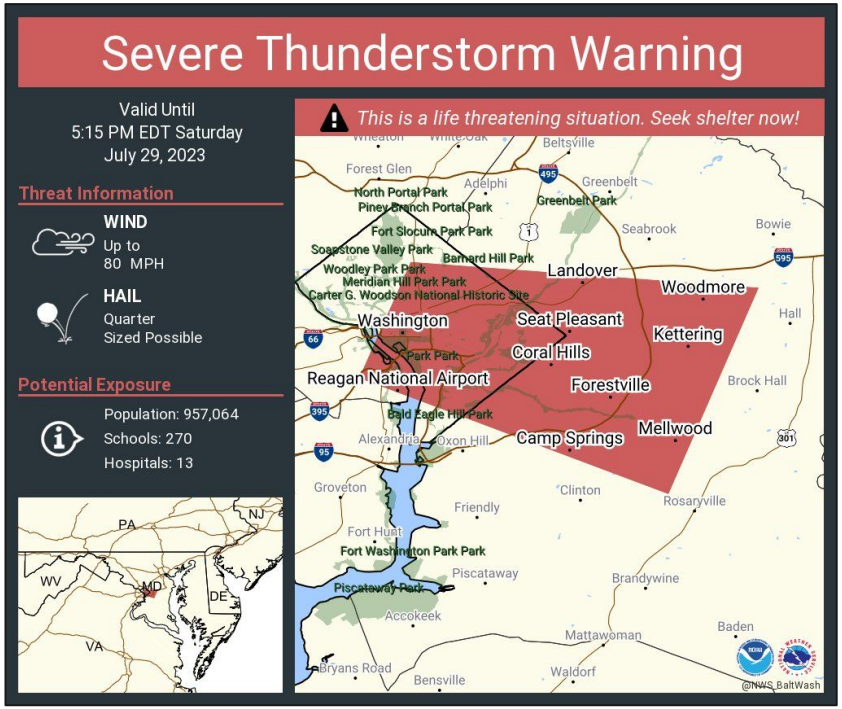


4 Destructive Severe Warnings (>80 mph)

Local NWS Warnings

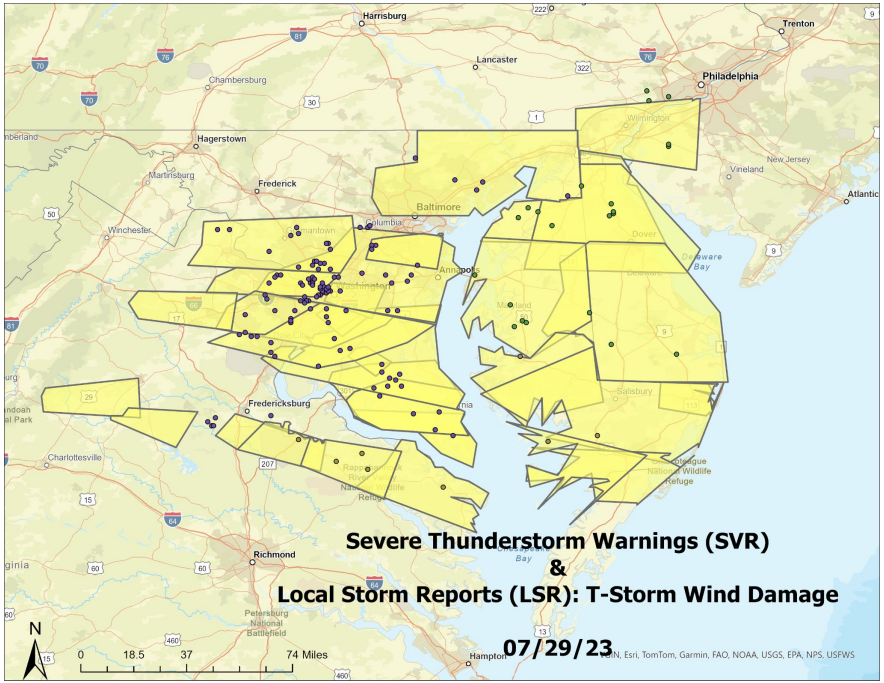


~3.5 million people in this considerable severe



Nearly 1 million people in this destructive severe

Local Severe Thunderstorm Warning Statistics



- 11 Base Warnings (>58 mph)
  - 67 different “events”
  - POD - 0.97
  - Lead Time - 22.6 minutes
- 3 Considerable Warnings (>70 mph)
  - 24 different “events”
  - POD - 0.71
  - Lead Time - 10.4 minutes
- 4 Destructive Warnings (>80 mph)
  - 9 different “events”
  - POD - 0.33
  - Lead Time - 2.1 minutes

Machine Learning Guidance

Machine Learning in NWS Operations

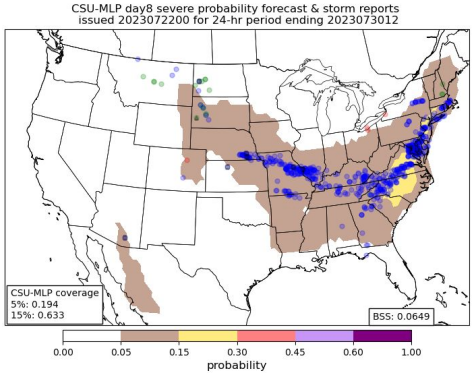
Forecasters at NWS Baltimore/Washington Continuously Evaluate Machine Learning Guidance

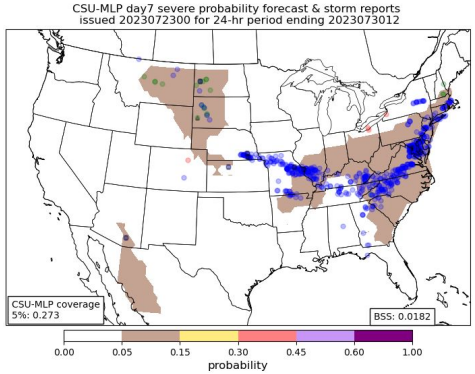
- Adds confidence when messaging severe weather threats
- Makes forecasters aware of potentially active days and higher impact days
- Gives increased confidence on when the best potential for severe weather may occur
- Differentiates threat probabilities for wind, hail, and tornado

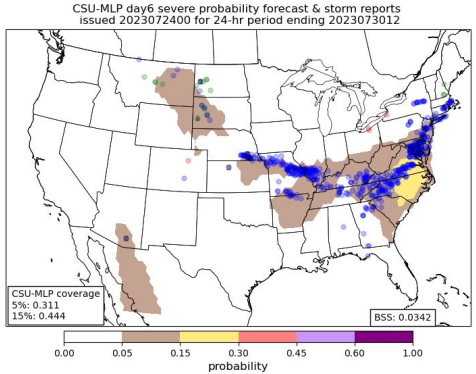
Machine Learning Algorithms and Analogs

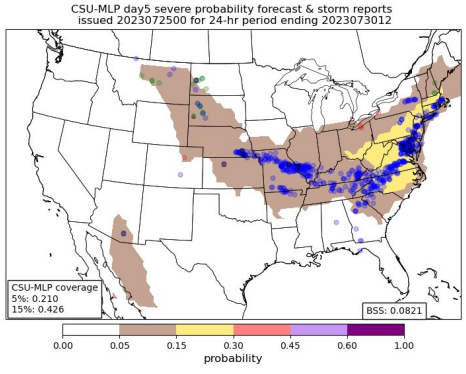
- Colorado State University (CSU) Machine Learning Probabilities Prediction (Days 1-8 updated 00Z & 12Z)
- CIPS Experimental Analog-Based Severe Probability Guidance (Days 1-8 updated 00Z)
- National Center for Atmospheric Research (NCAR) Neural Network (48 hour forecast updated synoptic hours)

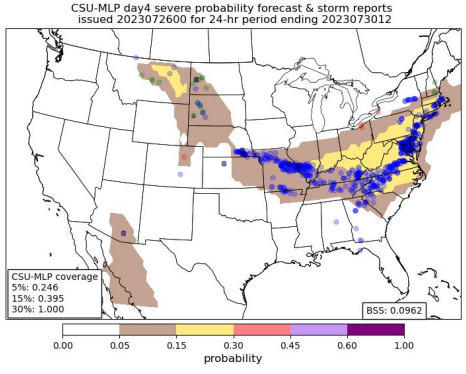
CSU ML July 29th,2023 Example Days 4-8





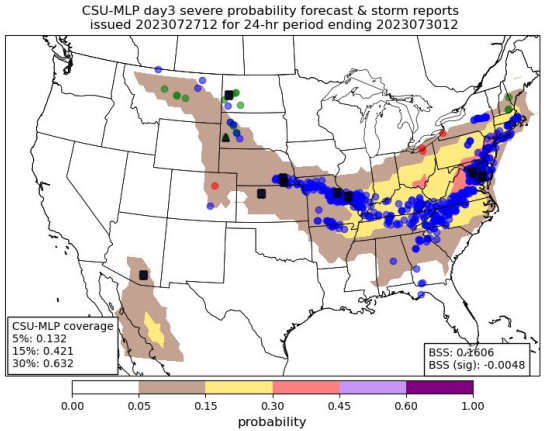


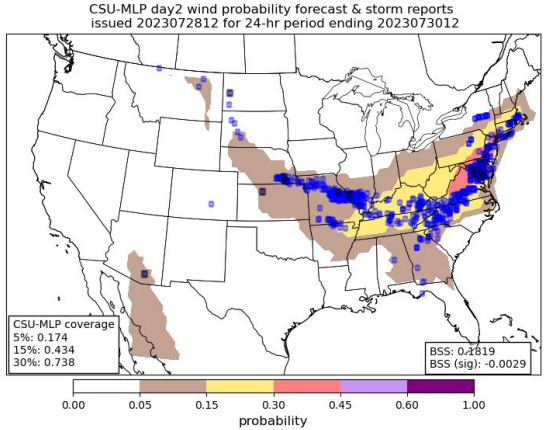


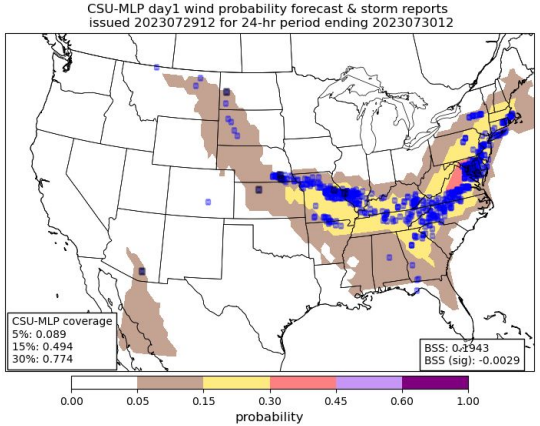


Consistent signal from D8 to D4

CSU ML July 29th,2023 Example Days 1-3

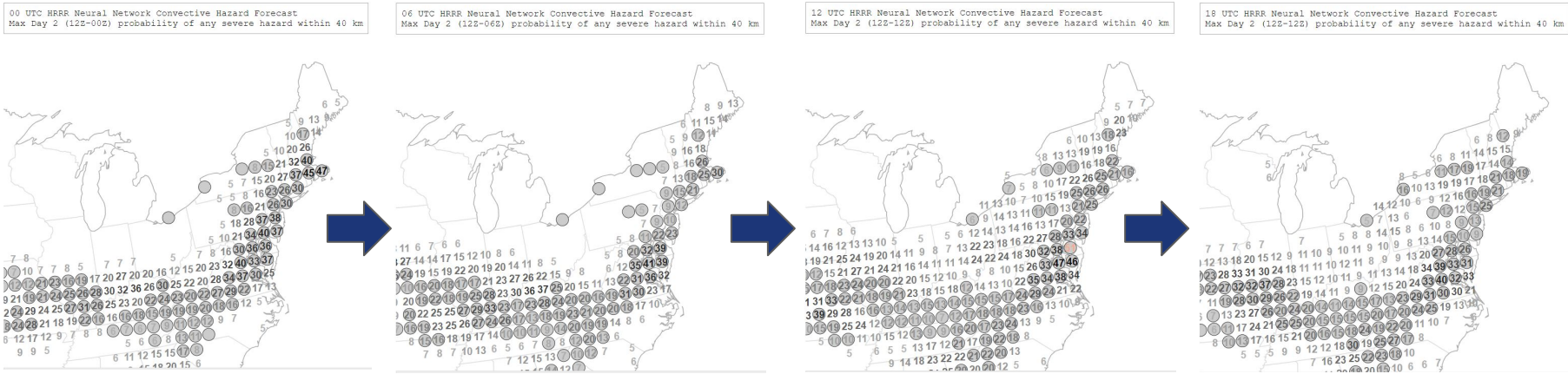






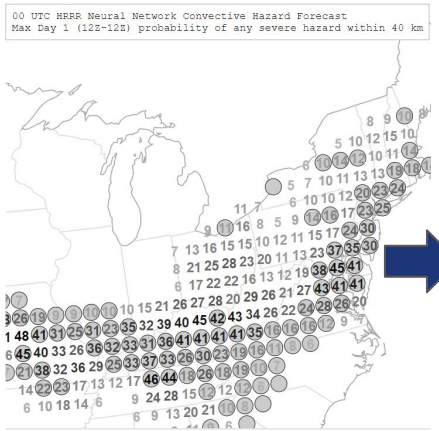
Consistent signal persisted across the Mid-Atlantic from D3 to D1. Consistent signal increased forecaster confidence.

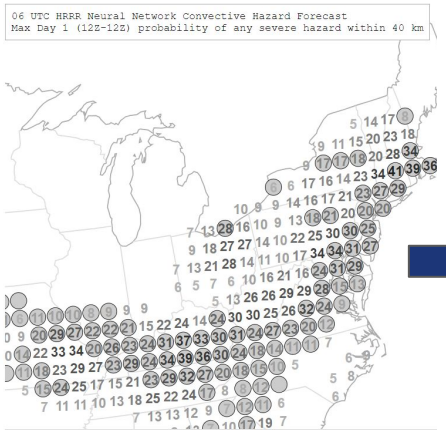
NCAR Neural Network Day 2

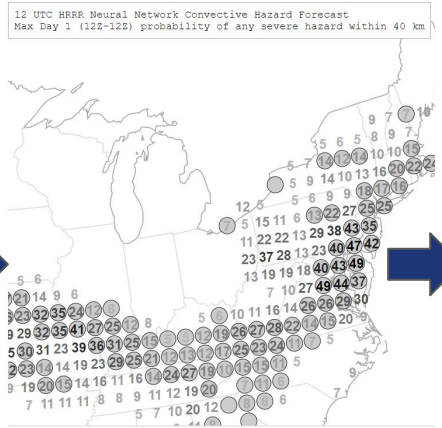


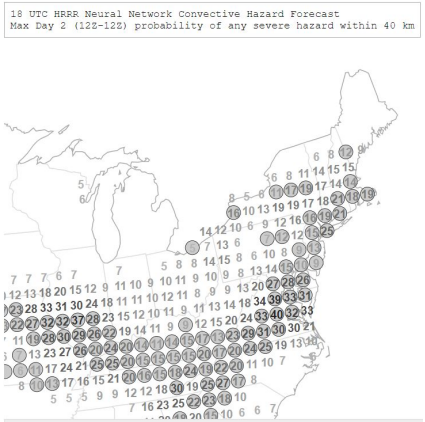
Consistent signal of a local maxima in higher probabilities in the D.C. metro on all Day 2 runs increased forecaster confidence.

NCAR Neural Network Day 1







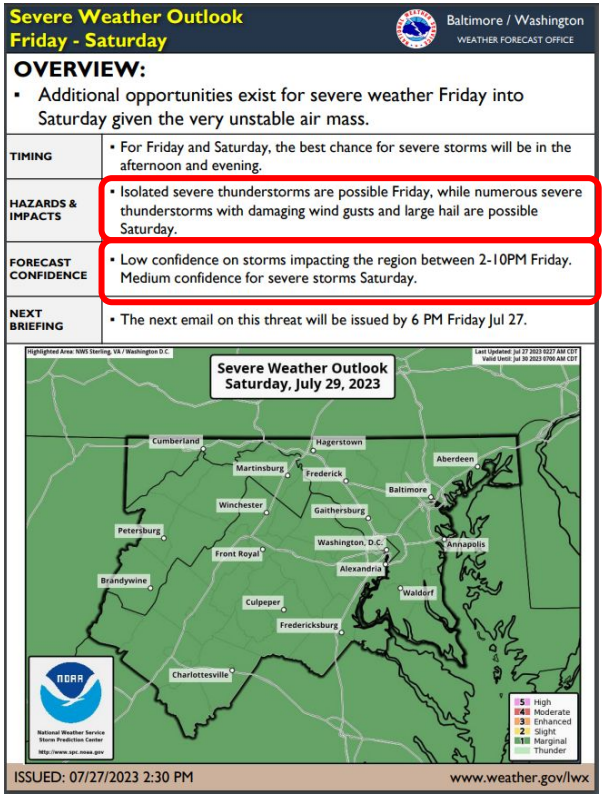


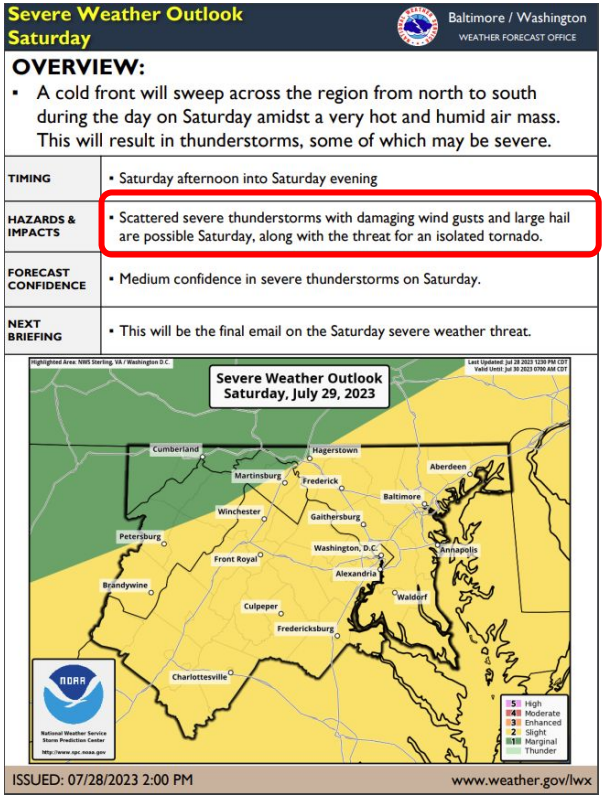
Higher probabilities in the DC metro continued through the Day 1 Neural Network runs.

How Machine Learning Improved Impact-Based Decision Support Services

Machine Learning Increases Confidence in Messaging

- Based on this event, there was a need to improve probabilistic messaging of potential severe weather events.
- NWS Balt/Wash then hosted a user feedback forum to investigate long term messaging of potential severe weather hazards.





User Feedback

User Feedback from LWX Severe Users Forum

"The trend in the forecast is important throughout days 1-7. Is it increasing or decreasing. Seeing a message of increasing risk with time will cause the Maryland Department of Emergency Management to trigger actions."

"Really love probabilistic language."

Chas Eby
Deputy Executive Director Maryland Department of Emergency Management

"We pay attention to severity, but make decisions based on confidence levels."

"Knowing the potential for a higher impact event as far in advance is definitely beneficial form a planning perspective."

Thomas Rosera
Baltimore Gas and Electric

Communicating Probabilistic Threat Information For Severe Storms and Flooding

- Chris Strong, Brian LaSorsa, and Kevin Rodriguez
- 12th Symposium on Building a Weather-Ready Nation
- Session 9 - Applications of Probabilistic Forecasting in IDSS
- Wednesday Jan 31, 9:15-9:30 AM
- Room 349

Summary

July 29th, 2023 Severe Weather Event

- Severe thunderstorms with measured wind gusts in >80 mph swept through the NCR producing widespread damage.
- Machine learning algorithms increased NWS forecasters confidence as the event moved from the long range through warning phase and hinted at a higher impact event.
- Machine learning will improve messaging of severe weather events going forward, especially beyond Days 1-3.

Storm damage in Alexandria (WTOP/Dave Dildine)

Questions

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