

Hurricane Ida Case Study

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Christina Speciale

Antecedent Conditions

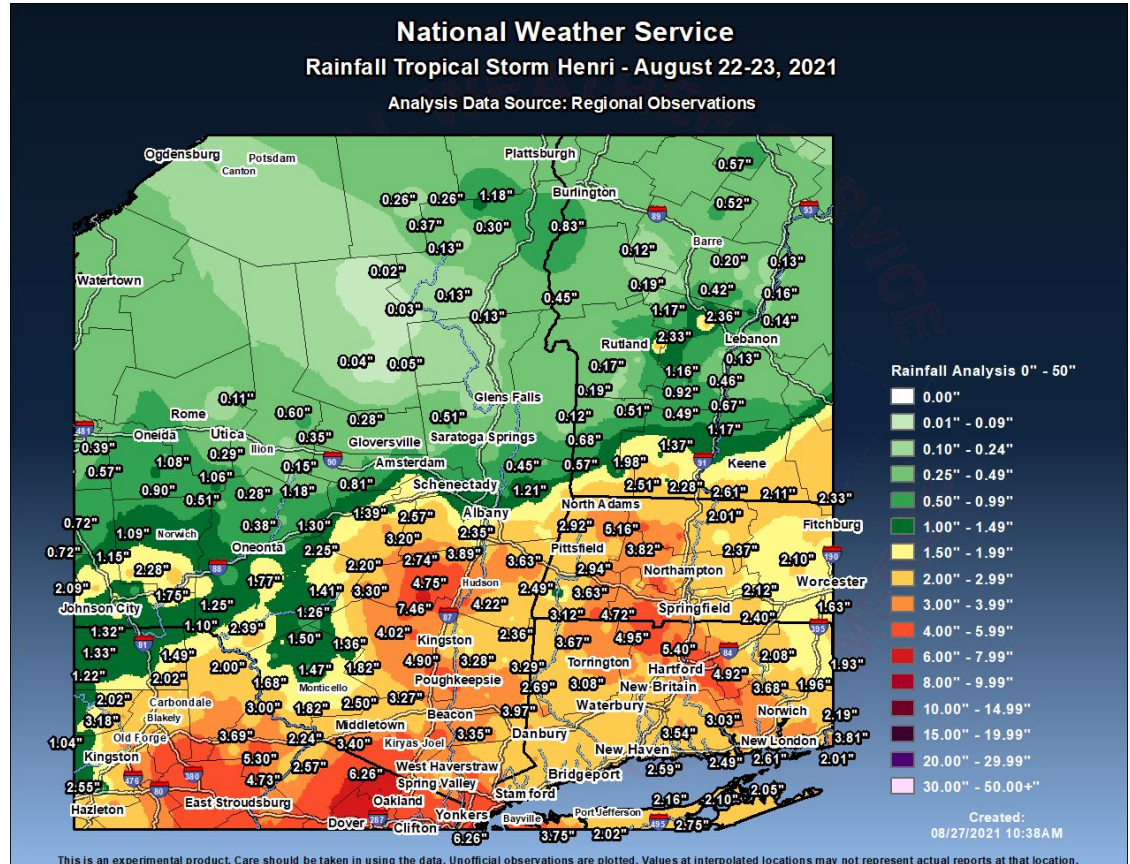
Hurricane Henri - August 22-23, 2021

PRE (Predecessor Rainfall Event)

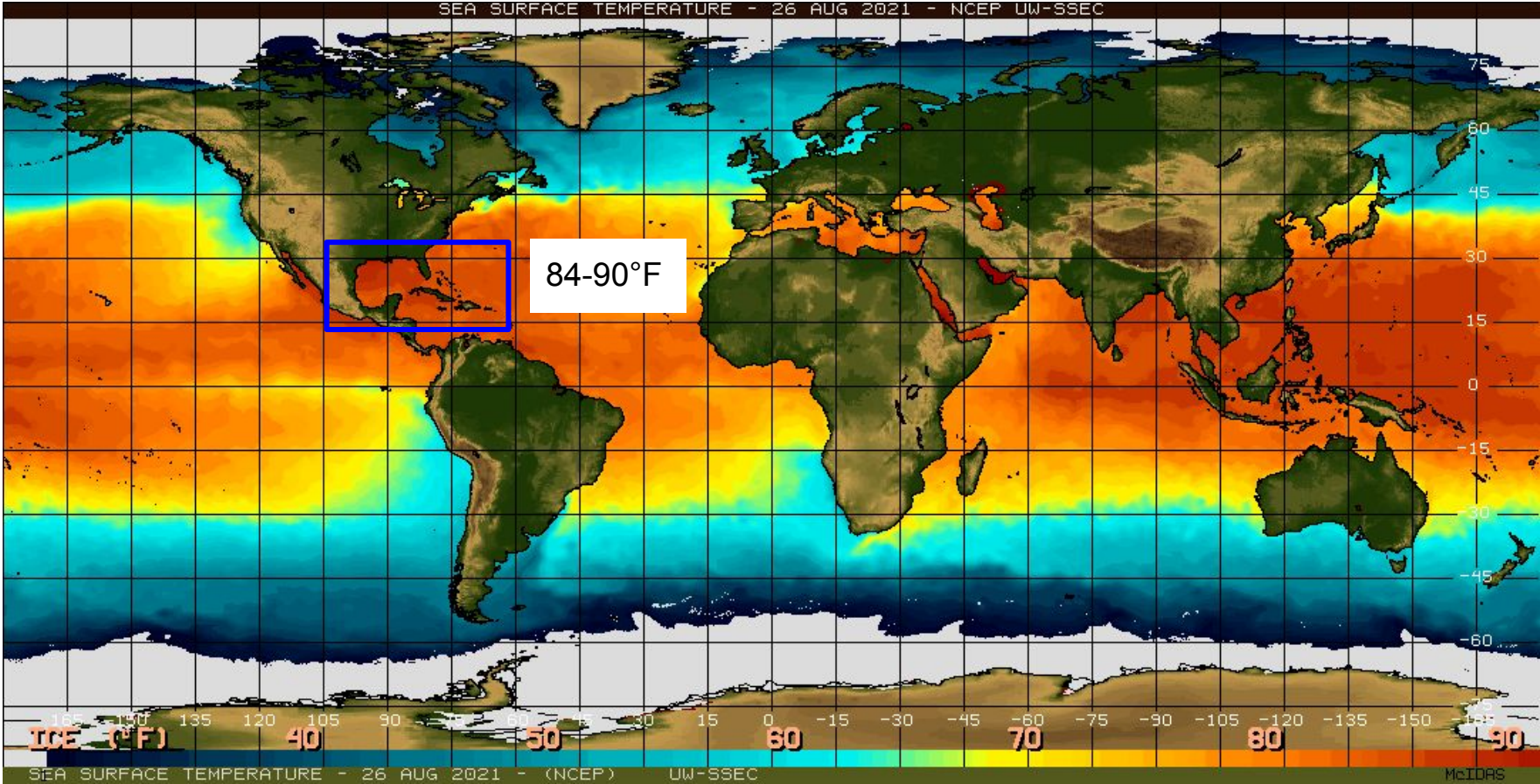
Record-breaking rainfall: 1.94" in one hour observed at Central Park ASOS

4.47" 24-hour rainfall reported at Central Park ASOS

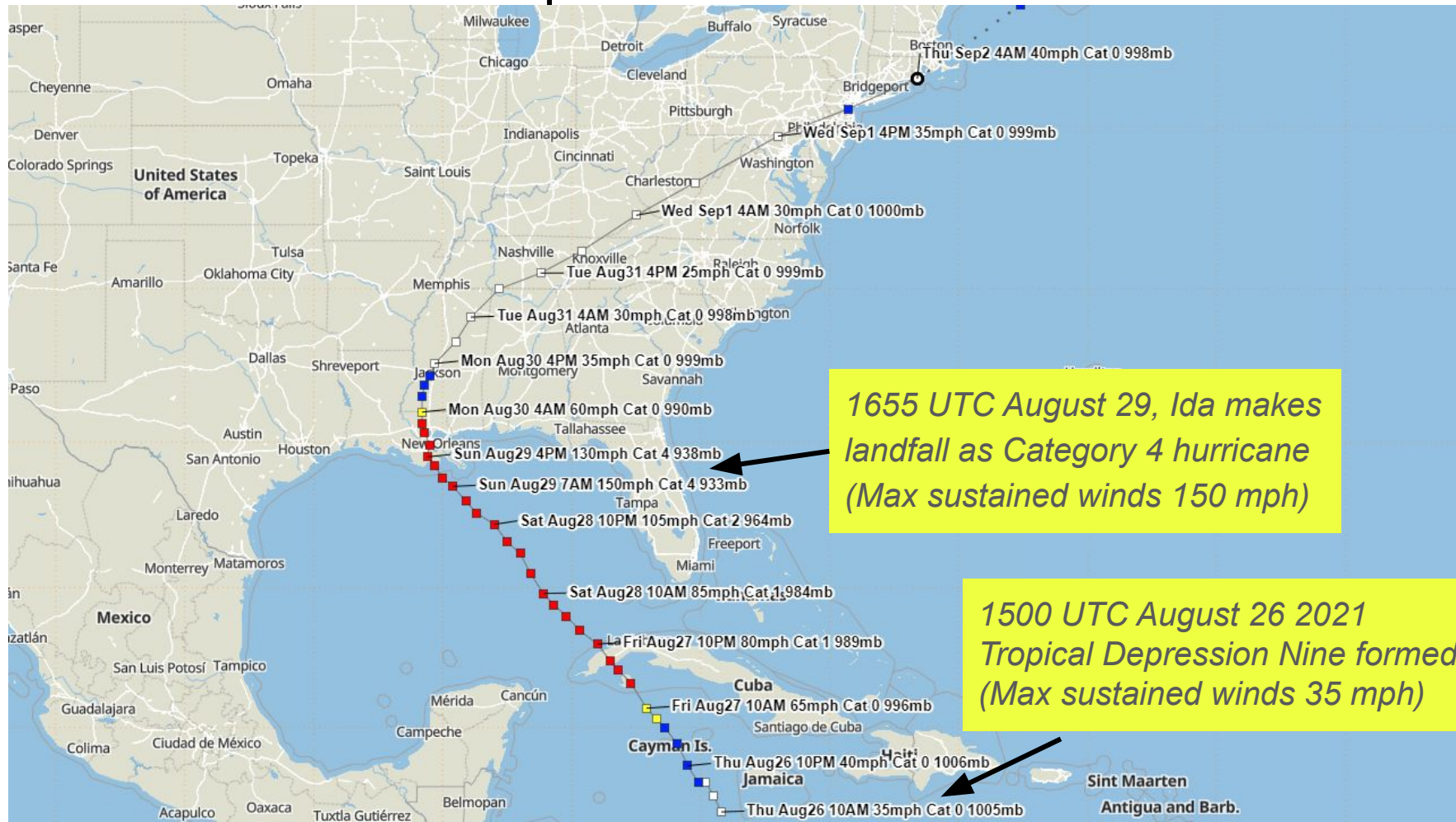
One of the wettest days in Central Park since Long Island flooding event August 14, 2014



Formation and Rapid Intensification of Hurricane Ida

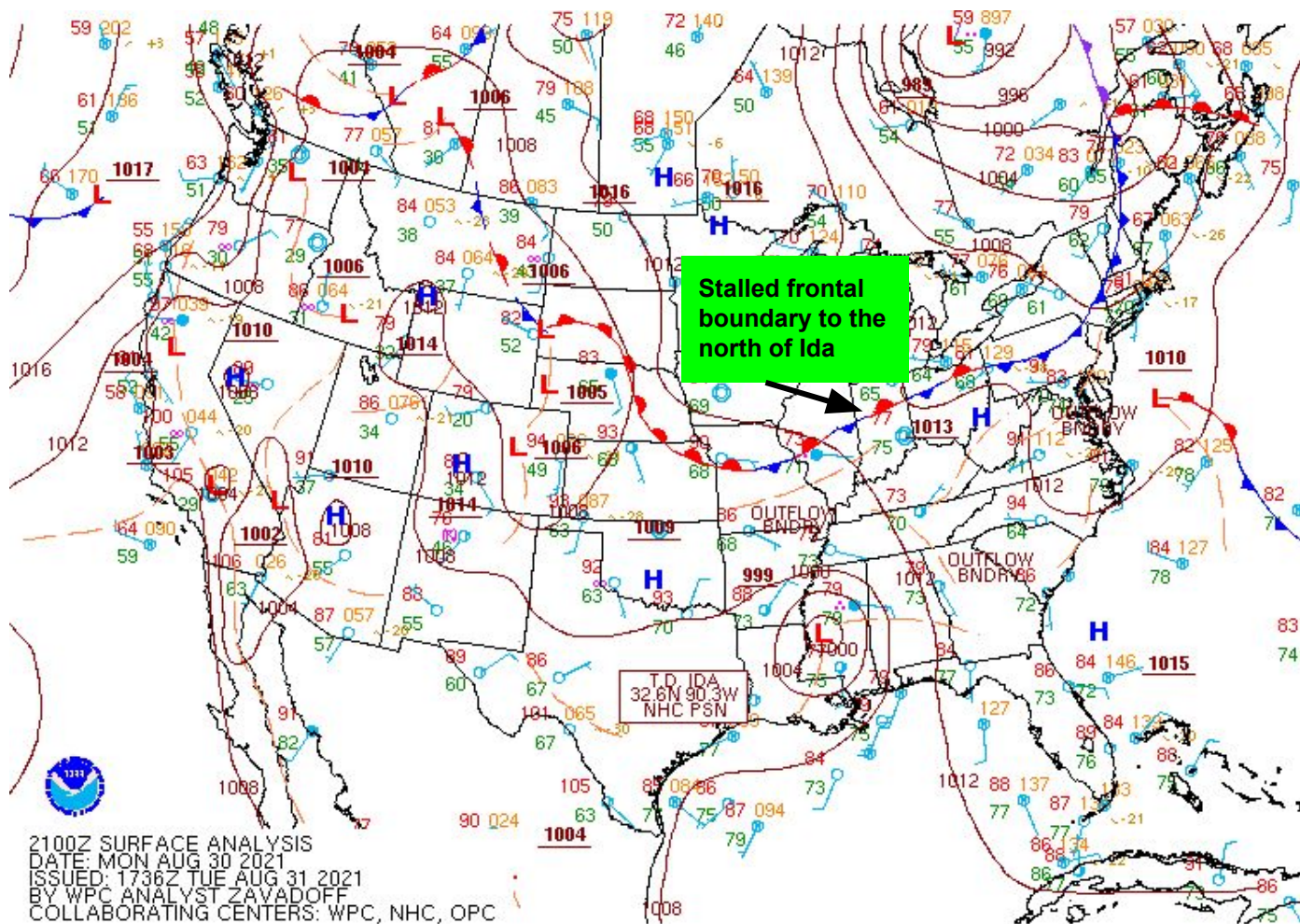


Formation and Rapid Intensification of Hurricane Ida

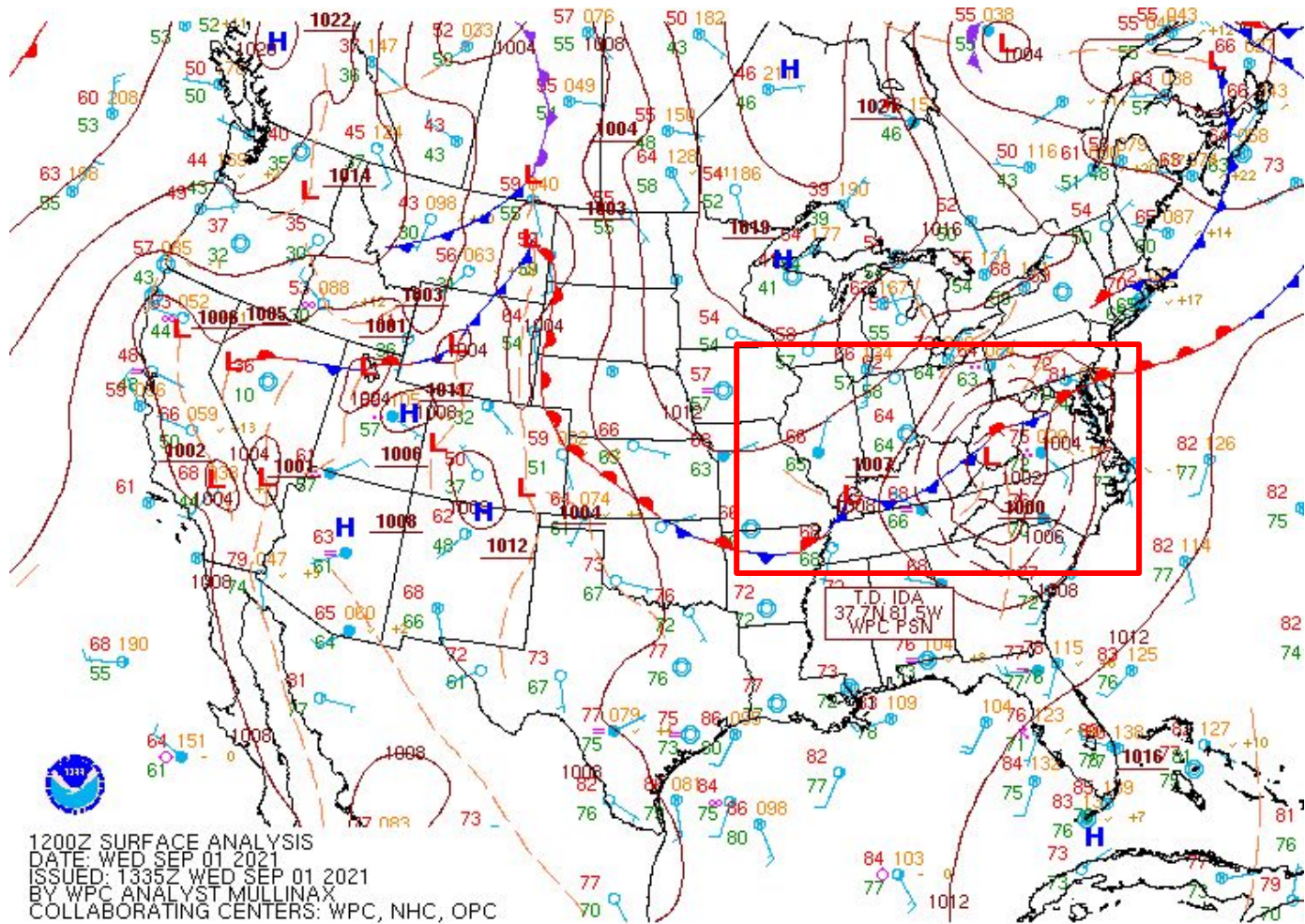


1655 UTC August 29, Ida makes landfall as Category 4 hurricane (Max sustained winds 150 mph)

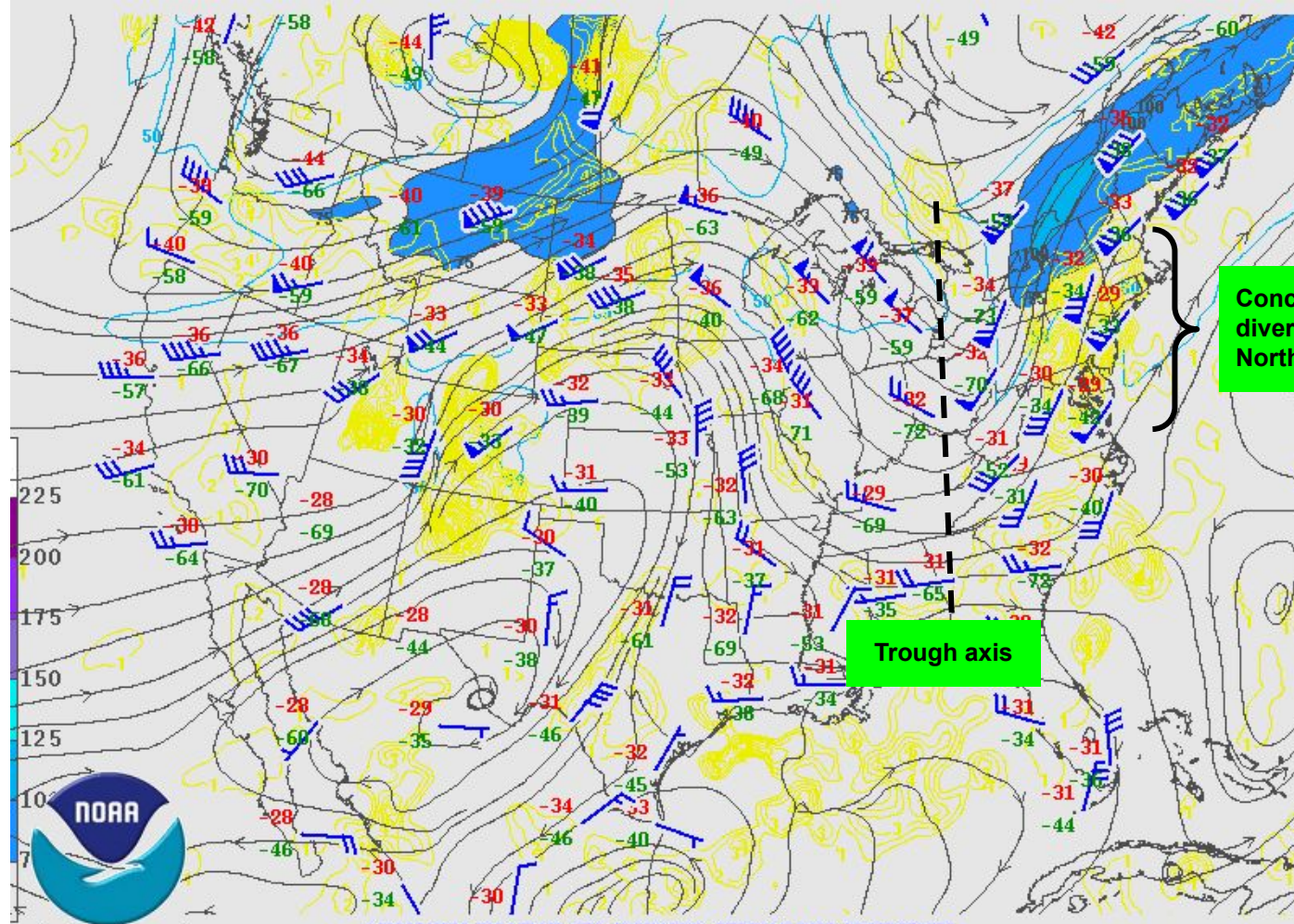
1500 UTC August 26 2021 Tropical Depression Nine formed (Max sustained winds 35 mph)



2100Z SURFACE ANALYSIS
 DATE: MON AUG 30 2021
 ISSUED: 1736Z TUE AUG 31 2021
 BY WPC ANALYST ZAVADOFF
 COLLABORATING CENTERS: WPC, NHC, OPC



1200Z SURFACE ANALYSIS
 DATE: WED SEP 01 2021
 ISSUED: 1335Z WED SEP 01 2021
 BY WPC ANALYST MULLINAX
 COLLABORATING CENTERS: WPC, NHC, OPC



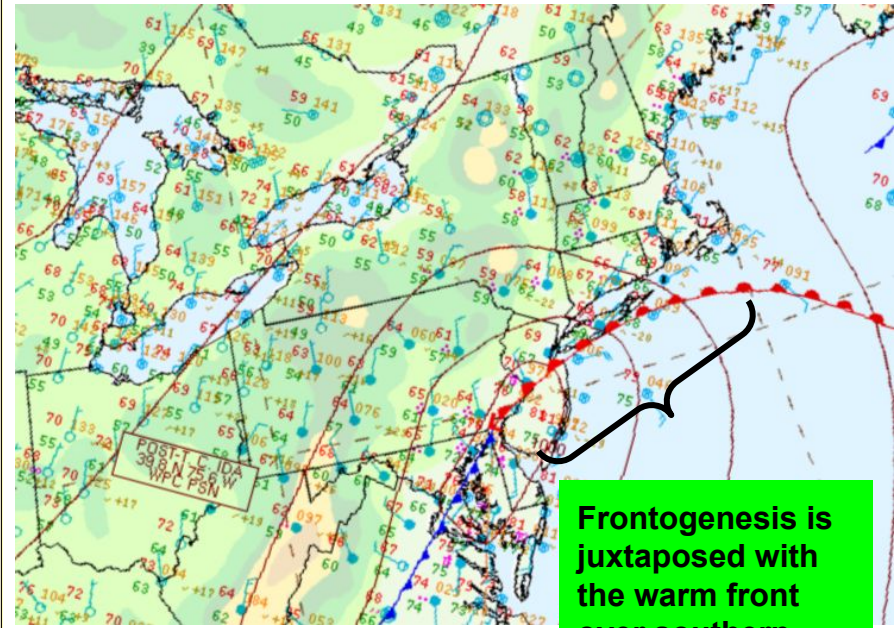
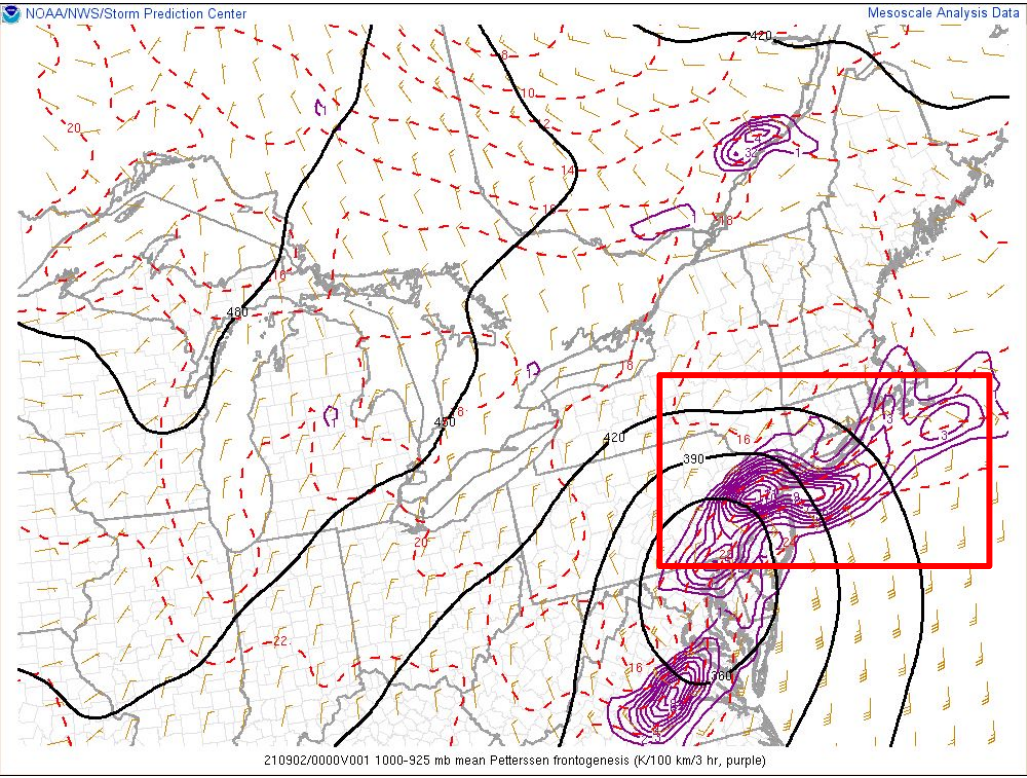
Concentrated divergence over Northeast

Trough axis



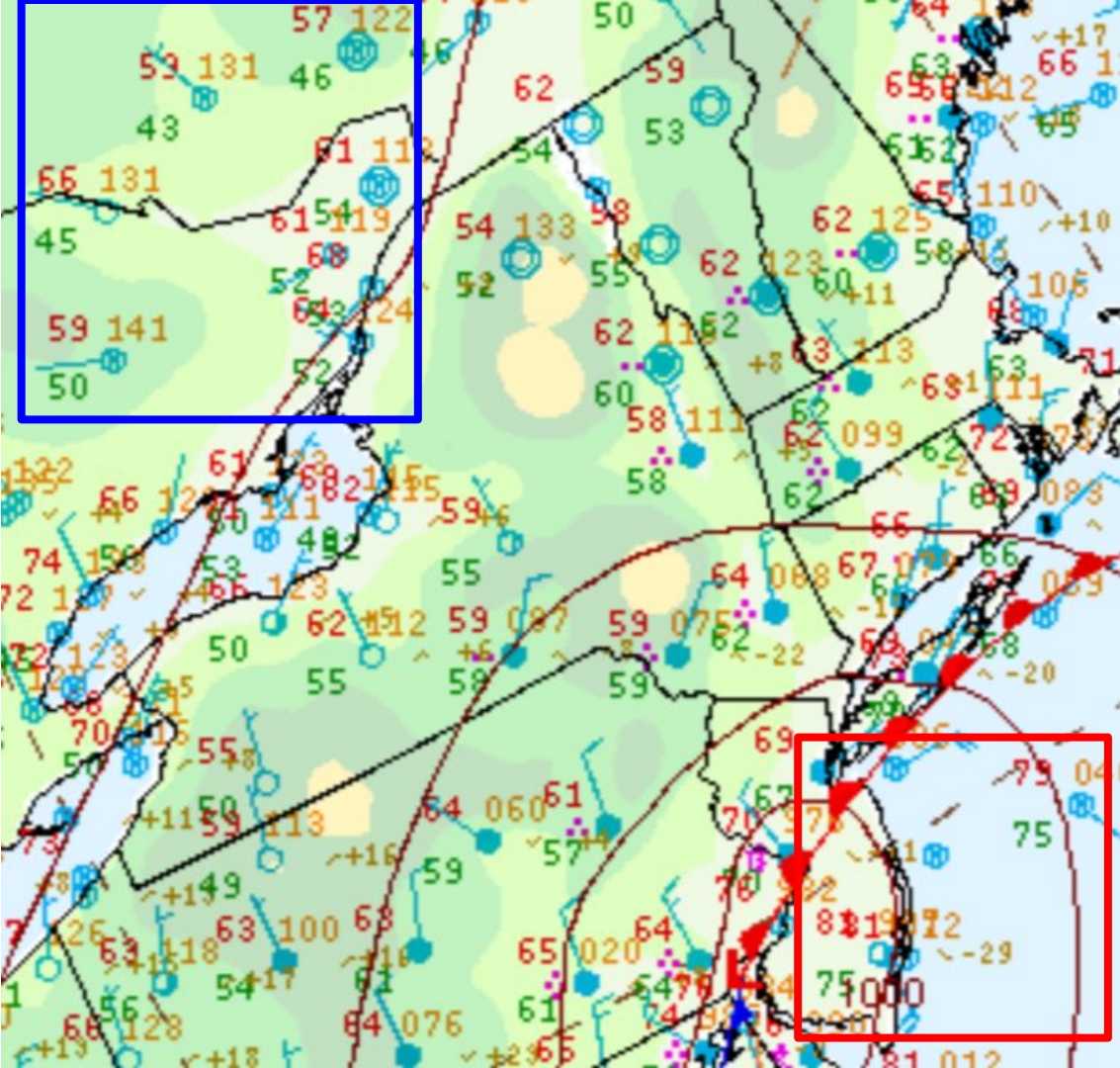
National Weather Service
Storm Prediction Center

210902/0000 300 MB UA OBS, ISOTACHS, STREAMLINES, DIVERGENCE



Frontogenesis is juxtaposed with the warm front over southern New York & New Jersey

Air mass well north of the warm front in 50s and low 60s, dewpoints in 40s or low 50s



Air mass behind the warm front in high 70s-low 80s, dew points in high 70s

0000 UTC
02 September

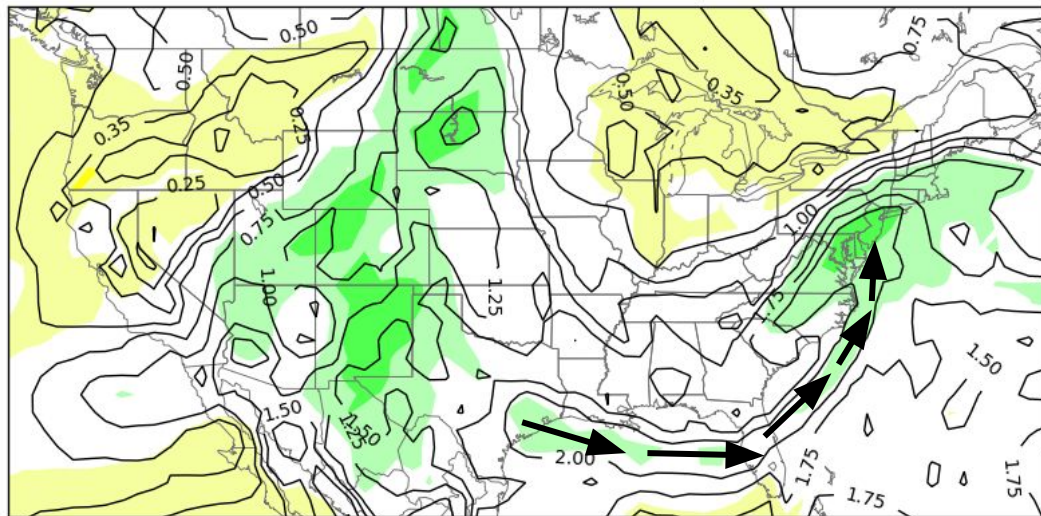
CONUS PWAT Anomalies

Ida brought an influx of warm, moist tropical air (1-3 standard deviations above normal) to the Northeast U.S. as it propagated north from the Gulf of Mexico.

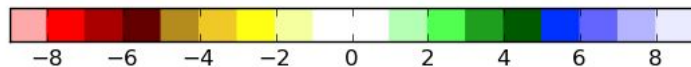
Strong southwesterly winds downstream of the amplifying trough enhanced the moisture transport from the Gulf and western Atlantic.

The combination of high precipitable water values and forcing for ascent due to the surface frontal boundary and strong jet streak resulted in intense rainfall.

NAEFS Mean Precipitable Water (in) and Standardized Anomaly
HOUR 000 - VALID 00:00 UTC Thu Sep 02 2021

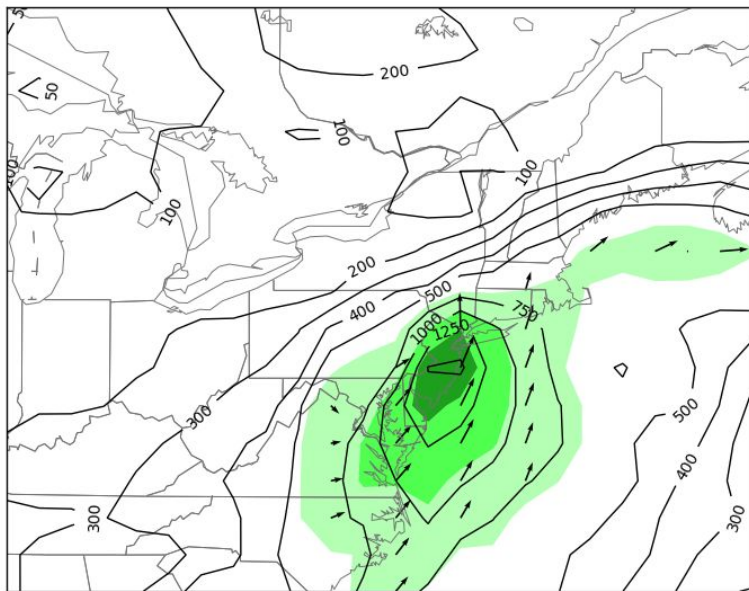


Relative to the 22-Aug to 12-Sep 1979-2009 CFSR climatology



Moisture Transport & PWAT Anomalies for Northeast U.S.

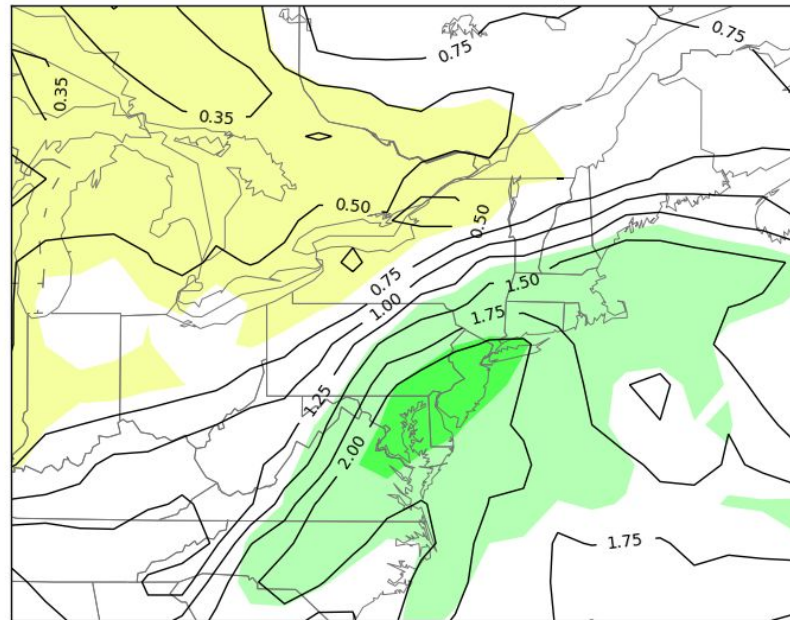
NAEFS Mean Integrated WV Transport ($\text{kgm}^{-1} \text{s}^{-1}$) and Standardized Anomaly
HOUR 000 - VALID 00:00 UTC Thu Sep 02 2021



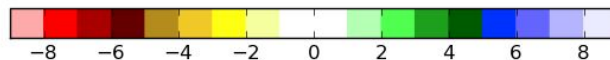
Relative to the 22-Aug to 12-Sep 1979-2009 CFSR climatology

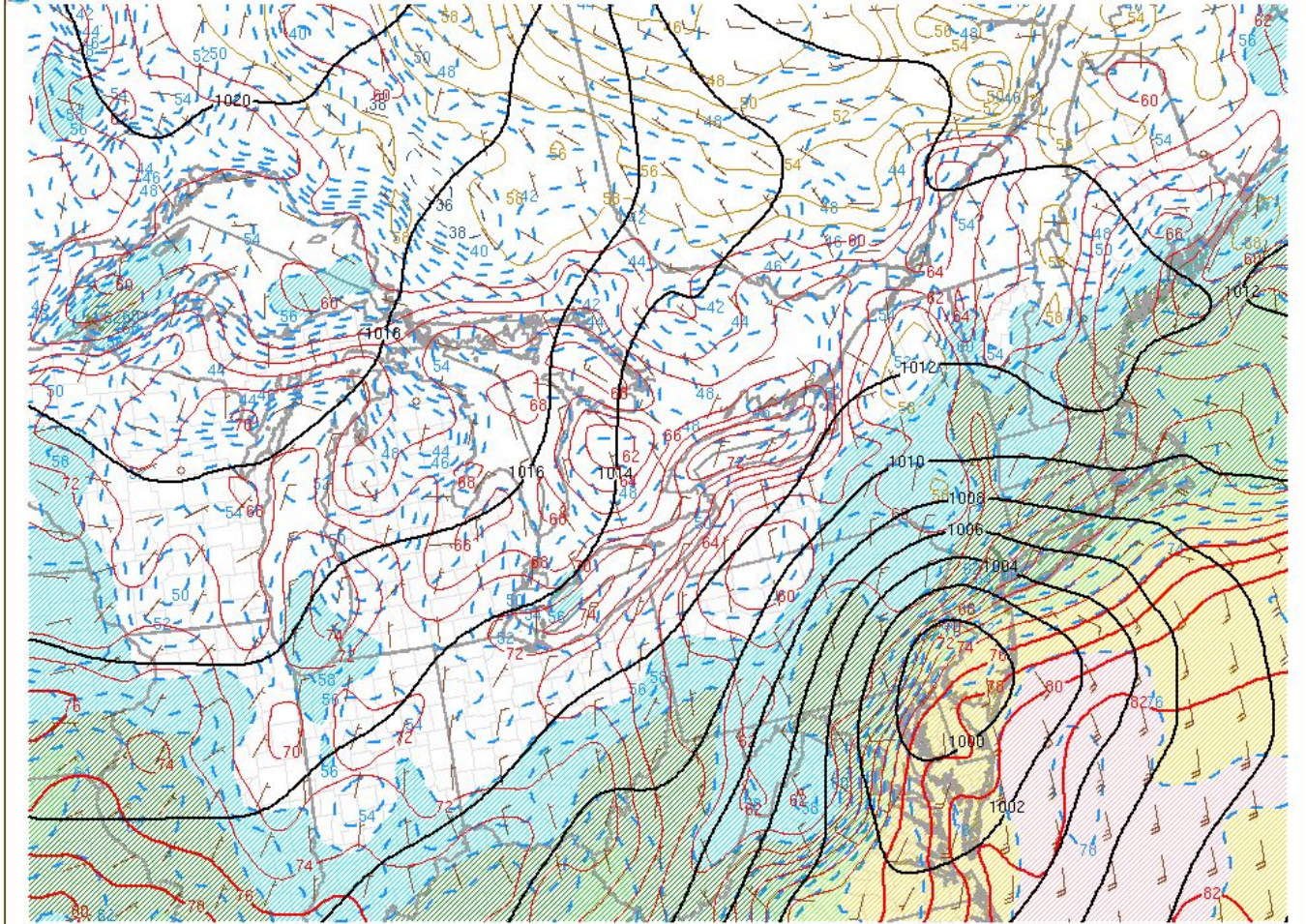


NAEFS Mean Precipitable Water (in) and Standardized Anomaly
HOUR 000 - VALID 00:00 UTC Thu Sep 02 2021

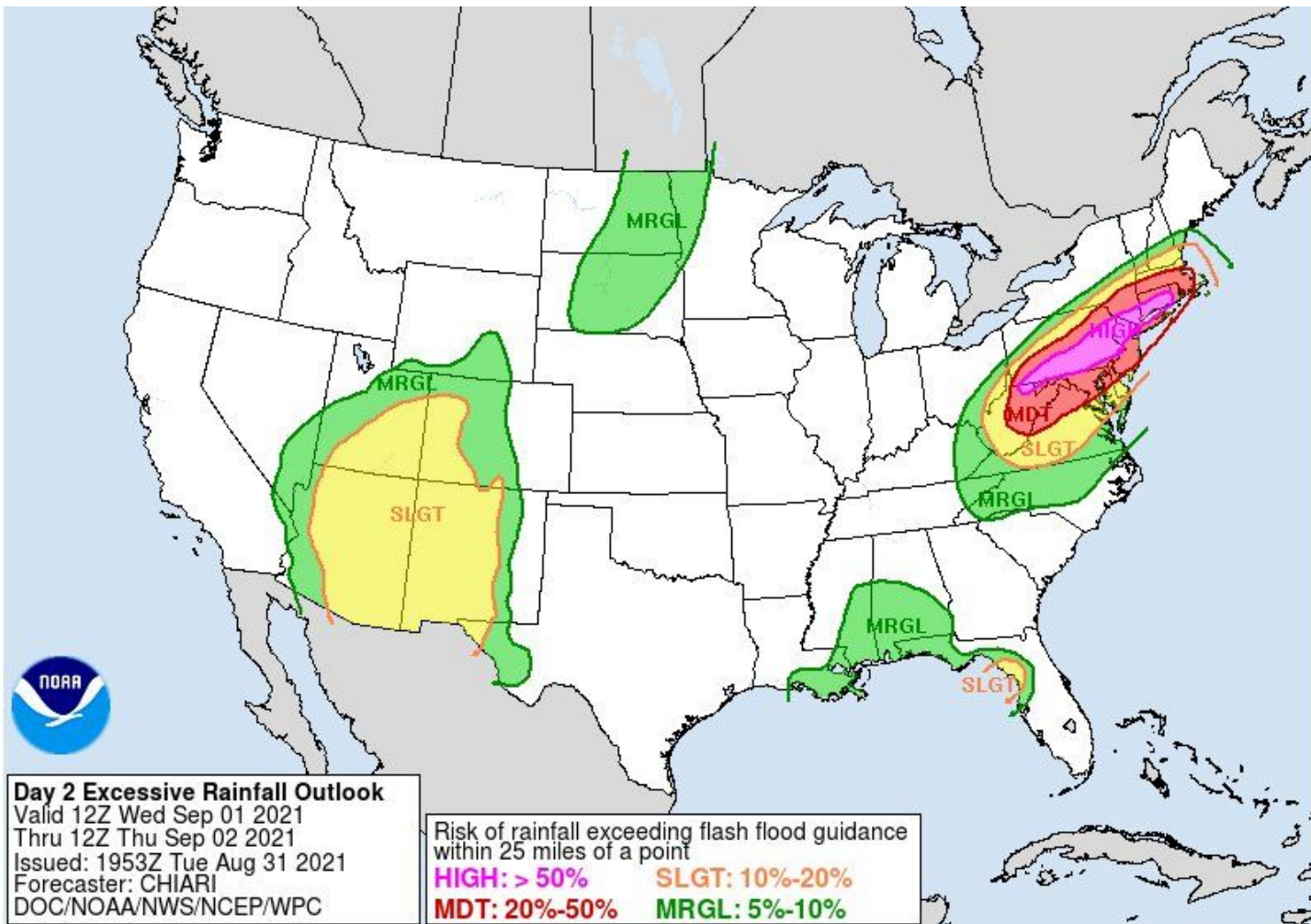


Relative to the 22-Aug to 12-Sep 1979-2009 CFSR climatology





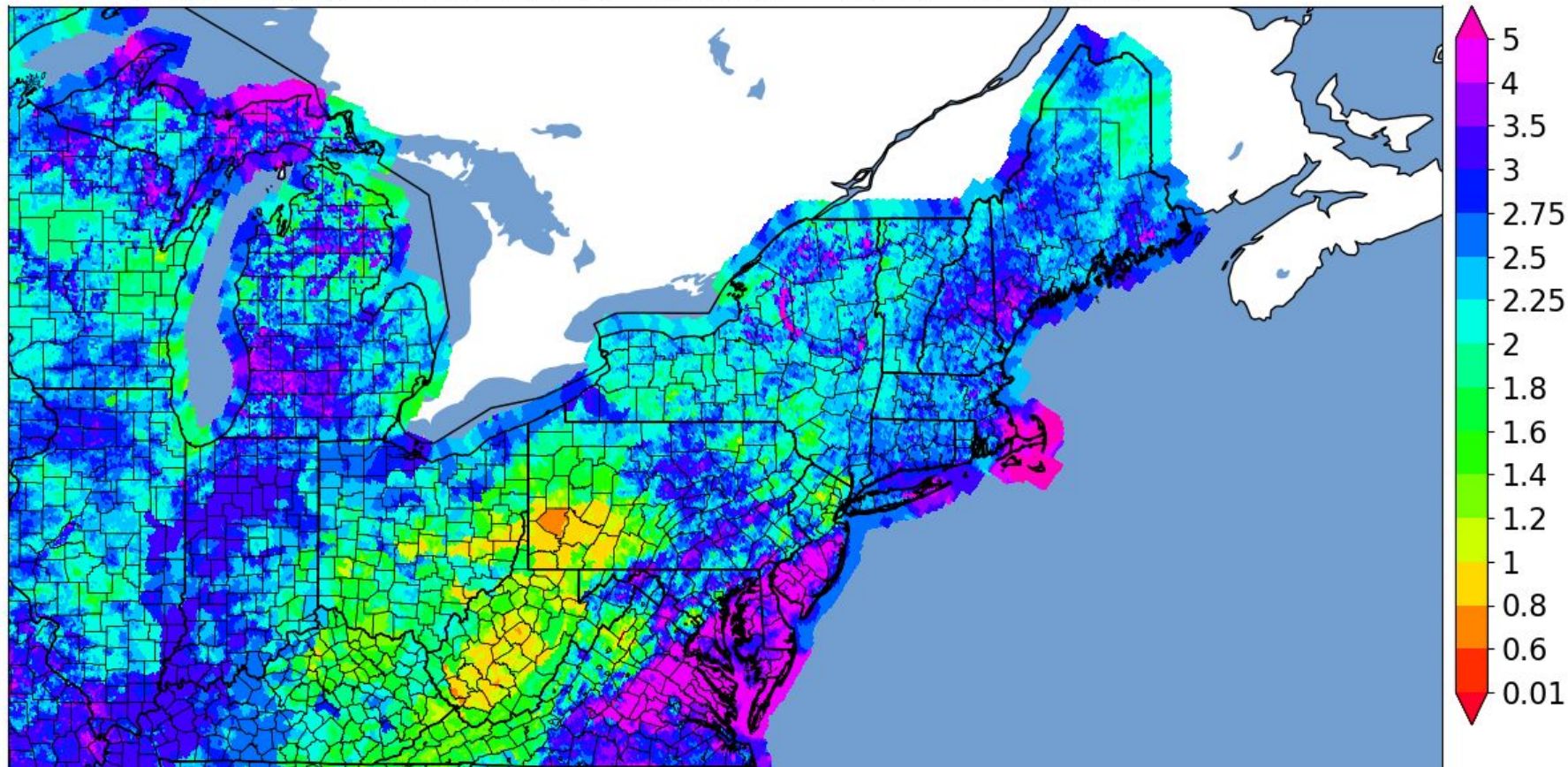
210902/0000 Surface temp, dewpoint, and pmsl





NWS RFC 3 Hour Flash Flood Guidance on 1 Sep 2021 12 UTC

Estimated amount of Three Hour Rainfall needed for non-urban Flash Flooding to commence



Iowa Environmental Mesonet :: generated 14 January 2022 11:04 PM

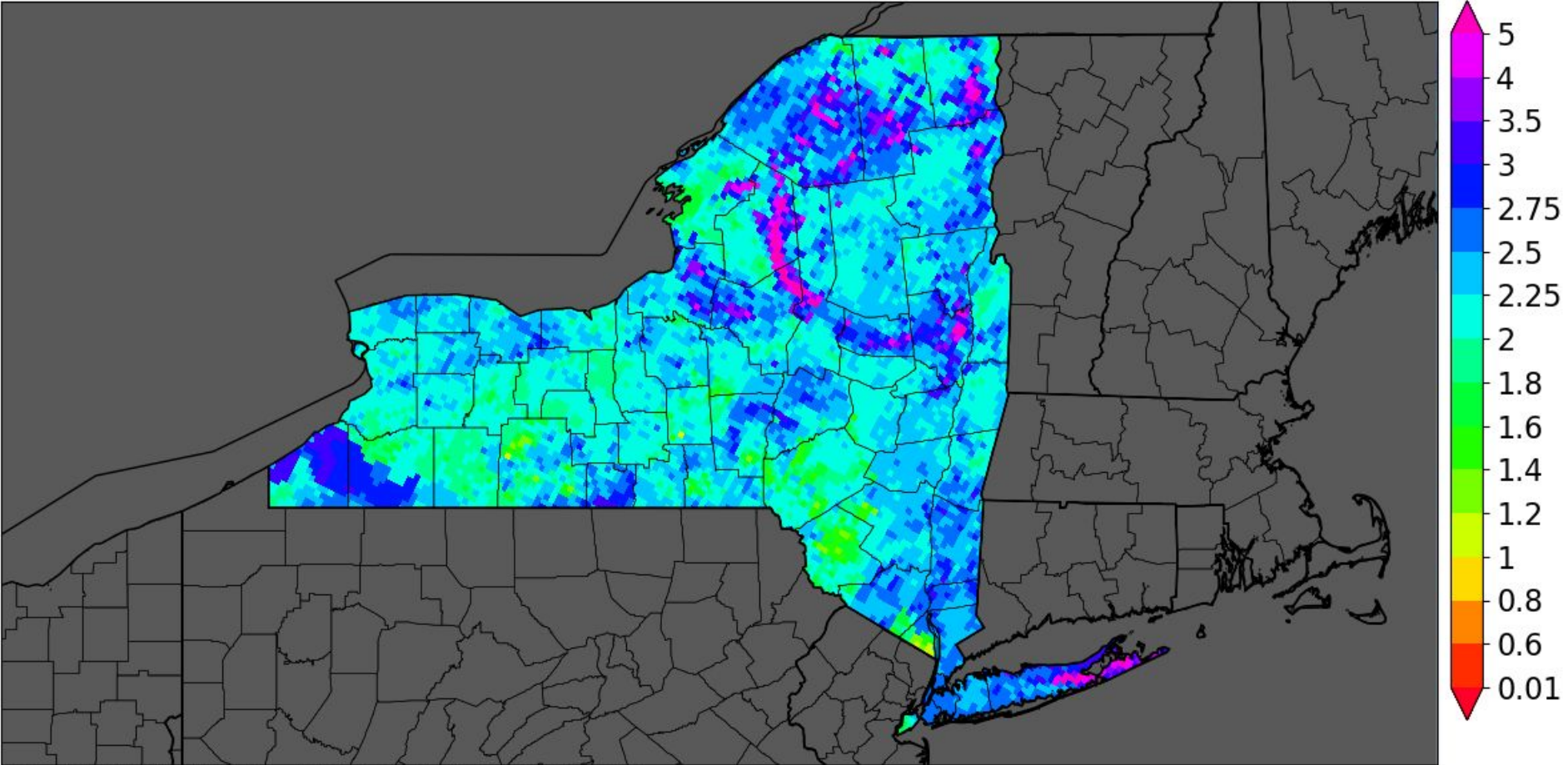
Generated at 14 Jan 2022 11:04 PM CST in 8.03s

IEM Autoplot App #178



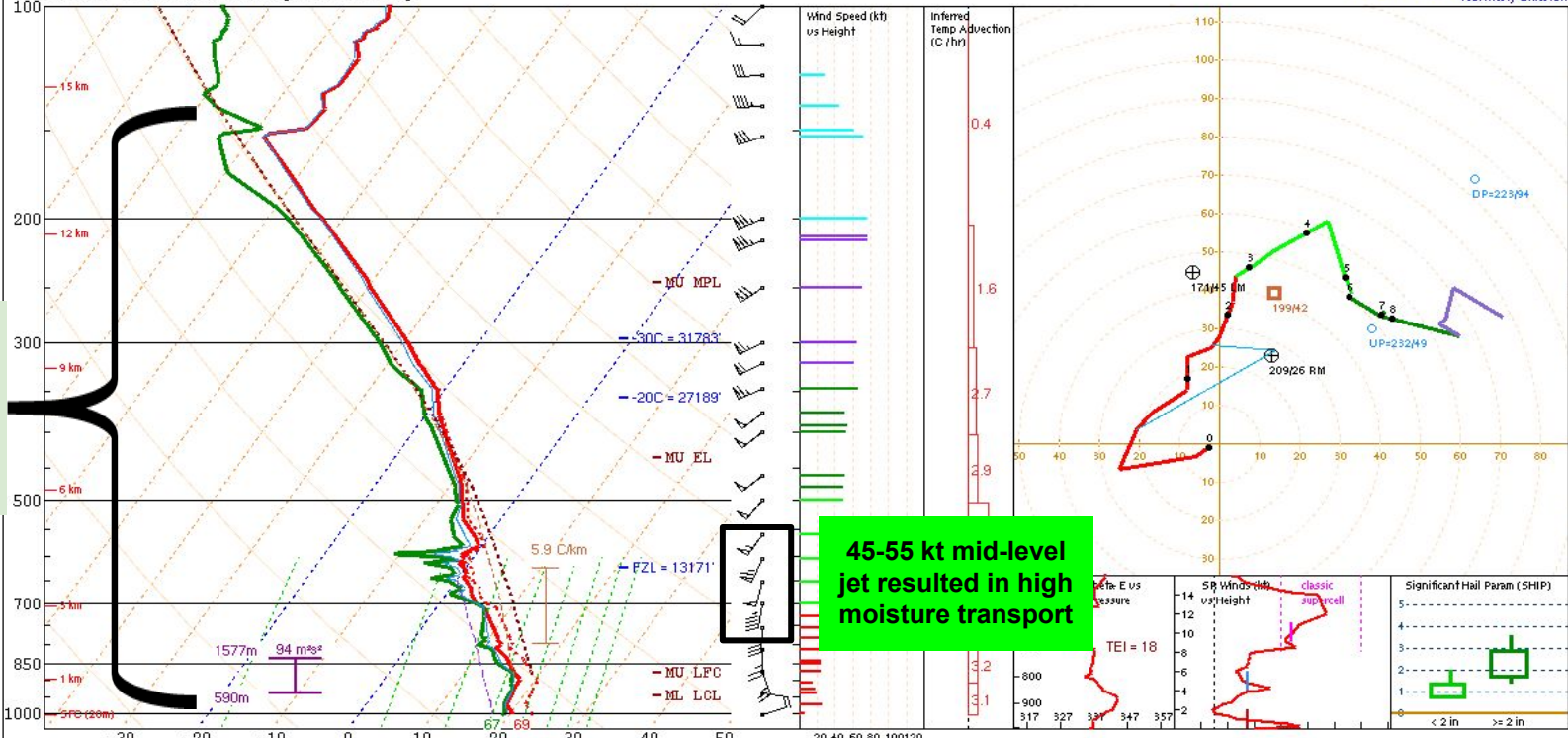
NWS RFC 3 Hour Flash Flood Guidance on 1 Sep 2021 12 UTC

Estimated amount of Three Hour Rainfall needed for non-urban Flash Flooding to commence



OKX 210902/0000 (Observed)

Deep moisture through the column



45-55 kt mid-level jet resulted in high moisture transport

PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	45	-147	170m	2	3058m	14556'
MIXED LAYER	144	-47	538m	1	5072m	17996'
FCST SURFACE	598	0	1236m	-2	1236m	26252'
MU (881 mb)	401	-0	1143m	-1	1192m	22325'

PW = 2.01 in	3CAPE = 18 J/kg	WBZ = 12058'	WINDG = 0.0
K = 36	DCAPE = 367 J/kg	FZL = 13171'	ESP = 0.0
MidRH = 91%	DownT = 65 F	ConvT = 62F	MMP = 0.42
LowRH = 96%	MeanW = 14.2 g/kg	MaxT = 85F	NCAPE = 0.07
SigSevere = 3912 m3/s3			

Sfc-3km Agl Lapse Rate = 4.9 C/km	Supercell = 0.8
3-6km Agl Lapse Rate = 4.6 C/km	Left Supercell = -1.0
650-500mb Lapse Rate = 5.2 C/km	STP (eff layer) = 0.0
700-500mb Lapse Rate = 4.5 C/km	STP (fix layer) = 0.0
	Sig Hail = 0.0

	SRW(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	251	19	98/16	53/38
SFC - 3 km	390	48	162/21	75/21
Eff Inflow Layer	94	29	152/19	72/24
SFC - 6 km	53	53	187/29	113/11
SFC - 8 km	57	57	194/30	125/8
LCL - EL (Cloud Layer)	74	74	178/28	105/15
Eff Shear (EBWD)	59	59	178/30	113/16

BRN Shear = 199 m/s² Storm Motion Vectors
4-6km SR Wind = 215/28 kt	Bunkers Right = 209/26 kt
	Bunkers Left = 171/45 kt
	Corfidi Downshear = 223/94 kt
	Corfidi Upshear = 232/49 kt

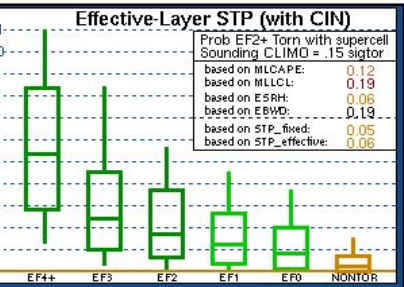
*** BEST GUESS PRECIP TYPE ***

Rain.
Based on sfc temperature of 69.1 F.

SARS - Sounding Analogs

SUPERCCELL	SGFNT HAIL
No Quality Matches	No Quality Matches

SARS: 0% SIG





NEXRAD Base Reflectivity

01 September 2021 22:30 UTC





NEXRAD Base Reflectivity
02 Sept 2021 00:45 UTC

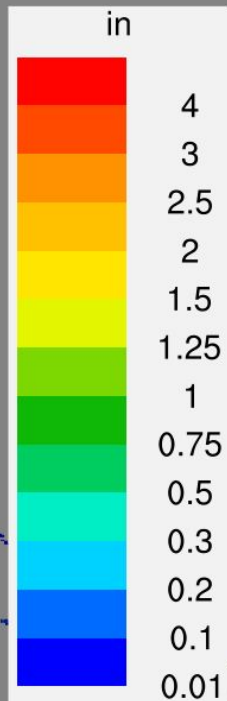
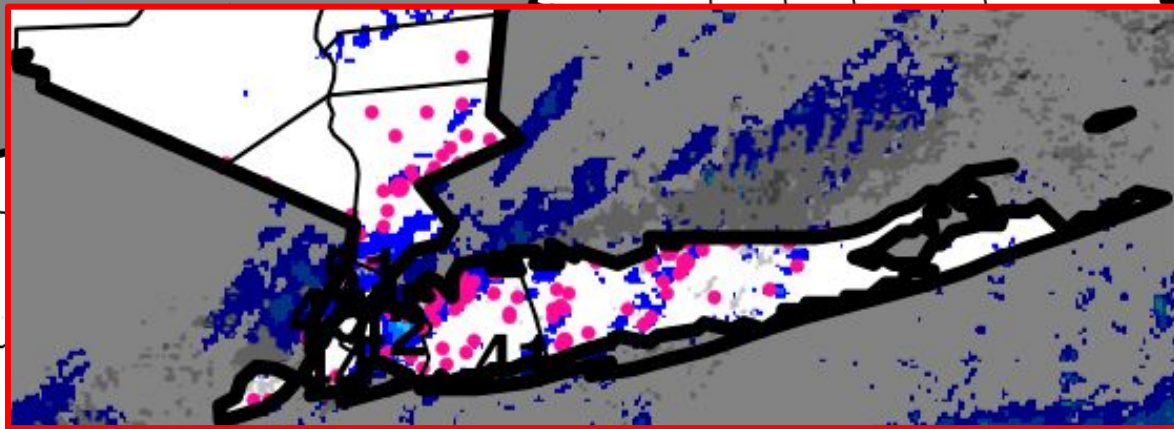


NEXRAD Base Reflectivity
02 Sept 2021 02:10 UTC

23 UTC 01 September - 0230 UTC 02 September 2021 ENX Loop of Very Heavy Rain Training Over Mid-Hudson Valley & Western New England. Notice Sharp Gradient over Capital District



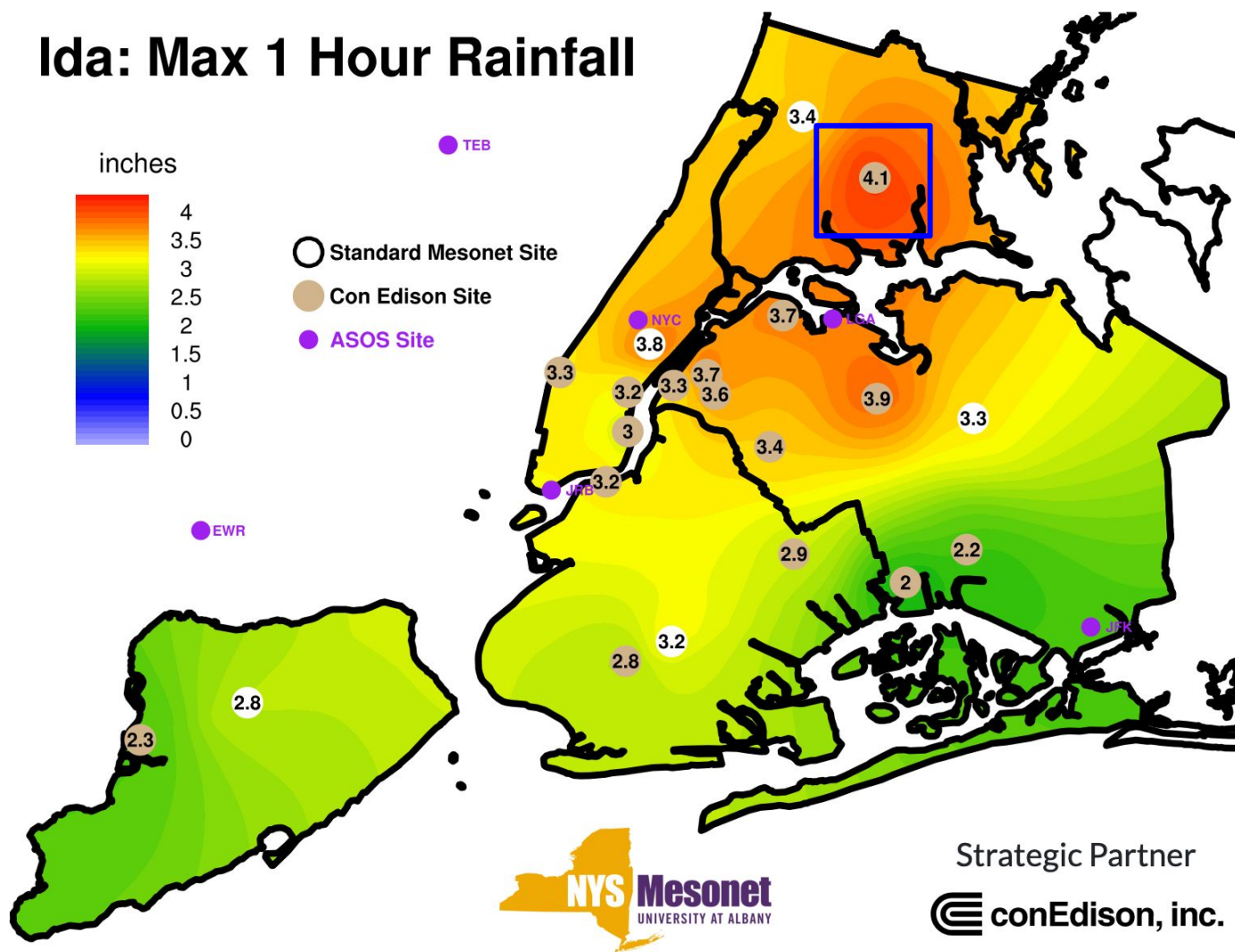
24 Hour T-Storm Summary Ending At 1 AM On Thursday, 2021-09-02



Data From MRMS:
-Peak MESH 500 m Hail (Fill),
-0-2 km Rotation Track (Gray),
-CG Lightning Strikes (Pink)

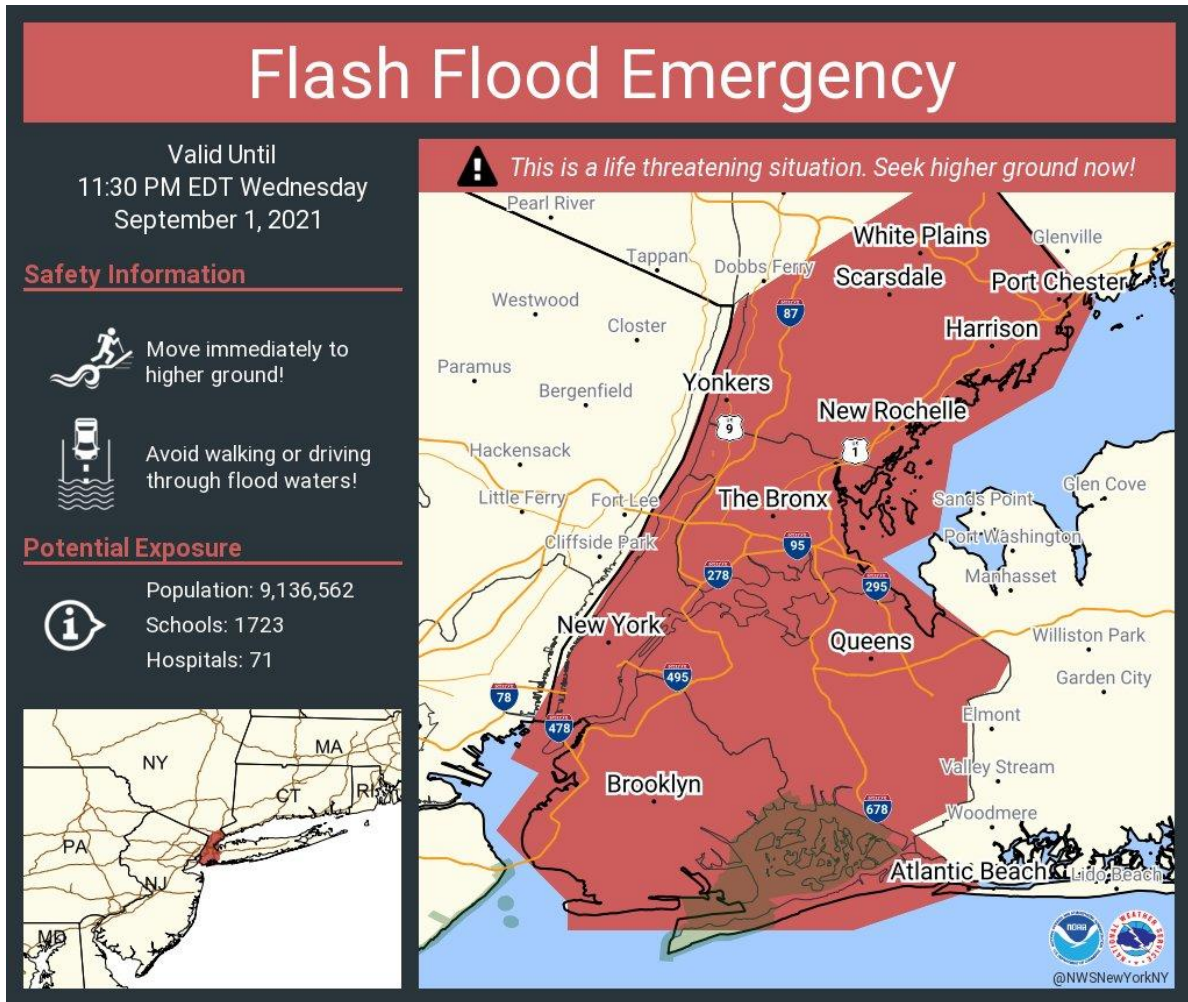
NYS Mesonet Gusts
Above 40 mph Listed (Black)

Ida: Max 1 Hour Rainfall

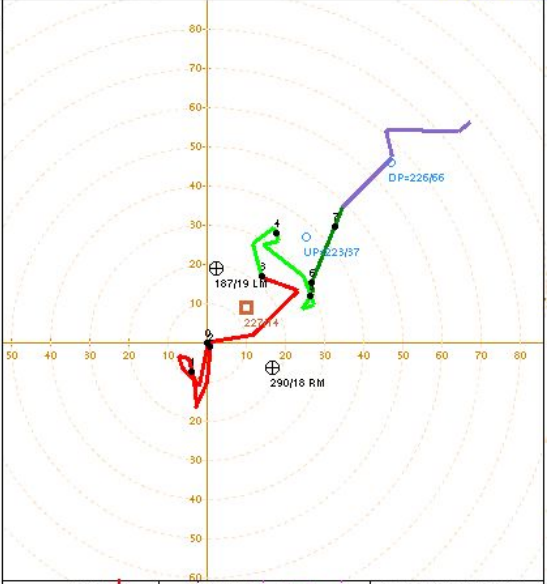
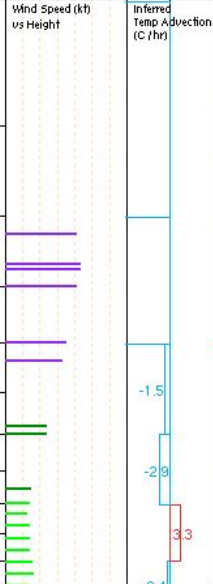
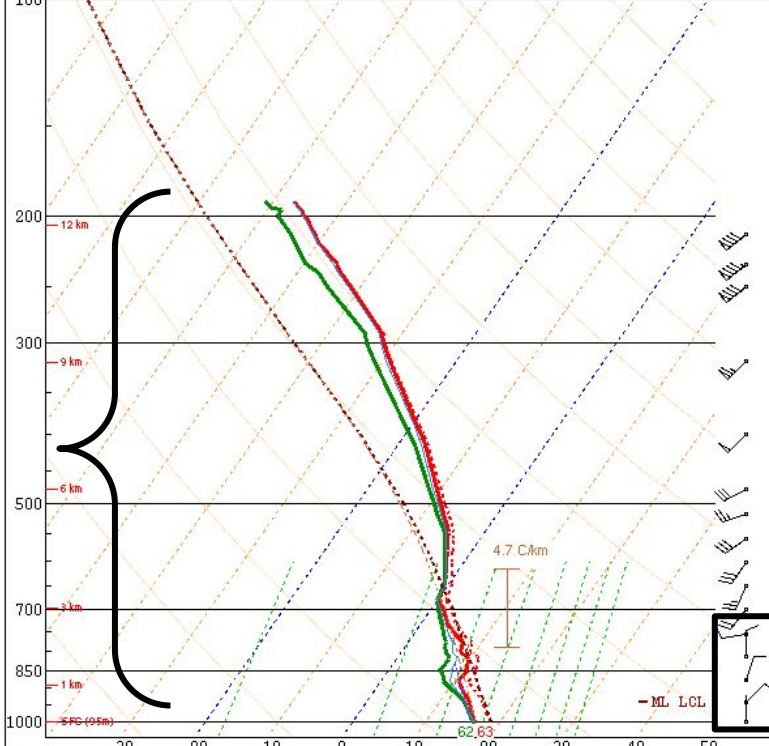


Impacts in NYC

First and second ever
Flash Flood Emergency
issued by the National
Weather Service Office
in Upton, NY for NYC



ALB 210902/0000 (Observed)



Deep moisture through the column

Northerly/backing winds in the lower troposphere suggesting dry/cold air advection

PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	23	-25	22m	6	2555m	10908'
MIXED LAYER	2	-3	526m	7	865m	3843'
FCST SURFAC	75	-0	1014m	4	1785m	11889'
MU (1001 mb)	23	-25	22m	6	2555m	10908'

PW = 1.56 in	3CAPE = 2 J/kg	WBZ = 11152'	WNDG = 0.0
K = 26	DCAPE = 28 J/kg	FZL = 11336'	ESP = 0.0
MidRH = 87%	DownT = 61 F	ConvT = 67F	MMP = 1.00
LowRH = 92%	MeanW = 10.5 g/kg	MaxT = 73F	NCAPE = 0.00
SigSevere = 27 m3/s3			

Sfc-3km Agl Lapse Rate = 5.1 C/km	Supercell = 0.0
3-6km Agl Lapse Rate = 4.1 C/km	Left Supercell = 0.0
850-500mb Lapse Rate = 4.5 C/km	STP (eff layer) = 0.0
700-500mb Lapse Rate = 3.9 C/km	STP (fix layer) = 0.0
	Sig Hail = 0.0

SRH(m2/s2)	Shear(kt)	MnWind
SFC - 1 km	-24	8
SFC - 3 km	8	22
SFC - 6 km	31	2408
SFC - 8 km	55	235/12
LCL - EL (Cloud Layer)	27	310/3

BRN Shear = 30 m/s²
4-6km SR Wind = 193/25 kt

..... Storm Motion Vectors

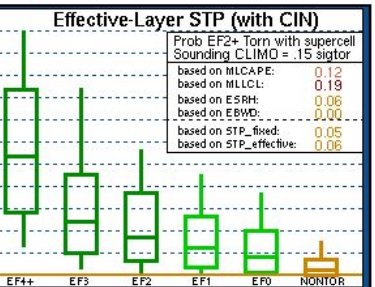
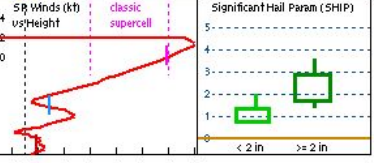
Bunkers Right = 290/18 kt
Bunkers Left = 187/19 kt

Corfidi Downshear = 226/66 kt
Corfidi Upshear = 223/37 kt

Based on sfc temperature of 62.6 F.

SARS - Sounding Analogs

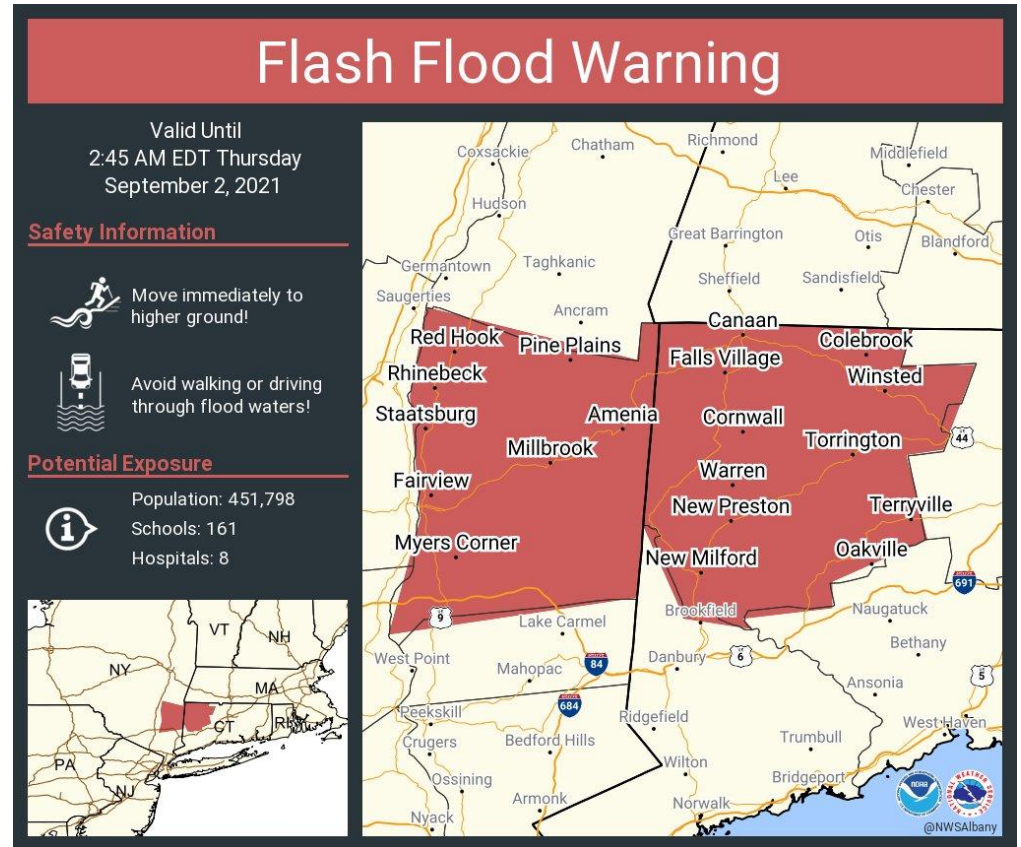
SUPERCCELL	SGFNT HAIL
No Quality Matches	No Quality Matches



1km & 6km AGL Wind Barbs

Impacts in Upstate New York & Connecticut

Though rainfall was not as intense as in NYC, rainfall totals still reached 4 to 6 inches in Ulster and Dutchess Counties in NY as well as Litchfield County CT which prompted Flash Flood Warnings. Regretfully, there was one fatality to flooding in Litchfield County.



Impacts in Upstate New York & Connecticut

Esopus, Ulster County

Rainfall total approx. 4 inches in 24 hours



Conclusions

- The heavy rainfall from TS Henri only ten days earlier resulted in wet antecedent conditions and therefore meant NJ and southern NY was more vulnerable to flash flooding
- The combination of an exceptionally moisture rich environment from Ida's extratropical transition and high moisture transport in the presence of strong forcing for ascent from a jet streak aloft and frontogenesis along a warm front resulted in heavy rainfall that persisted for multiple hours in southern NY.
- Record-breaking rainfall in the NYC metropolitan area resulted in the first ever Flash Flood Emergency issued by the local NWS office and widespread flooding over southern NY
- However, the strong precipitation gradient limited the effects of the heaviest rainfall from impacting most of the Capital region