July 2023 Flooding and Comparable Events in Vermont

2023 Vermont Emergency Preparedness Conference

Burke Mountain Hotel and Conference Center
20 September 2023

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Outline

- Largely Focus on July 9-11 Flooding
  - Other Flash Flooding during the Summer of 2023
  - July 7th, July 14th, July 16th, July 21st, August 3rd, August 4th
- NWS Decision Support Services during the Summer Flooding of 2023
  - Briefings, Messaging, On-site deployment
- Comparison with Irene 2011
- Comparison with June 29-30th, 1 ears Ago)
- Are you Storm Ready?

VT Presidential Disaster Declarations (through 2022)

History of Presidential Disaster Program

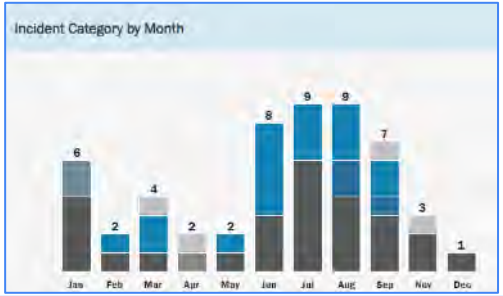
- **1950: Federal Disaster Assistance Program**
  - For the first time, the Federal Government was authorized to respond to major disasters, determined by the President of the United States
- **1970: Disaster Relief Act of 1970**
  - authorized Federal loans and tax assistance to individuals affected by disasters, as well as Federal funding for the repair and replacement of public facilities.
  - The Disaster Relief Act also introduced hazard mitigation as a Federal priority, authorizing the use of Federal funds to reduce the potential impact of future disasters
- **1974: Disaster Relief Act of 1974**
  - established the Presidential disaster declaration process.
- **1988: Robert T. Stafford Act**
  - designed to bring an orderly and systematic means of federal natural disaster assistance for state and local governments in carrying out their responsibilities to aid citizens.
  - encourage states and localities to develop comprehensive disaster preparedness plans, prepare for better intergovernmental coordination in the face of a disaster, encourage the use of insurance coverage, and provide federal assistance programs for losses due to a disaster.

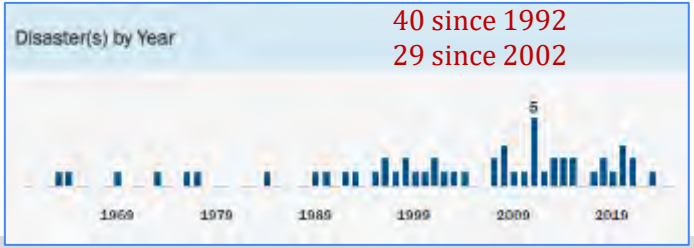
Major Disaster Declaration Thresholds

- State of VT: $1.14 Million Counties: $4.44 per capita

48 Presidential Disasters since 1963

- 39 Flood/Severe (Wind) ~ 81%
- 5 Winter (Ice Storm 1998)
- 2 Tropical (Irene '11, Floyd '99)
- 1 Drought
- 1 Biological (COVID)



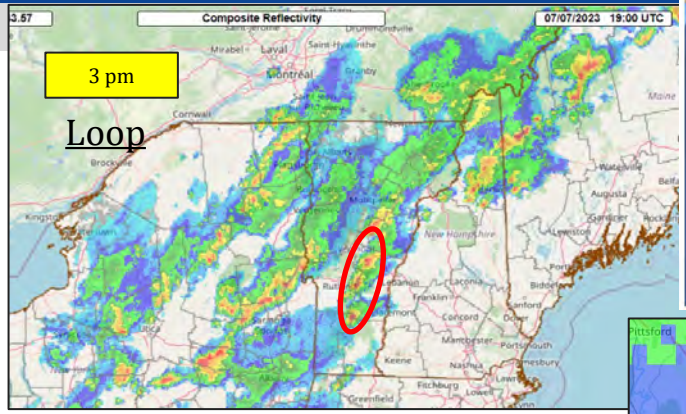


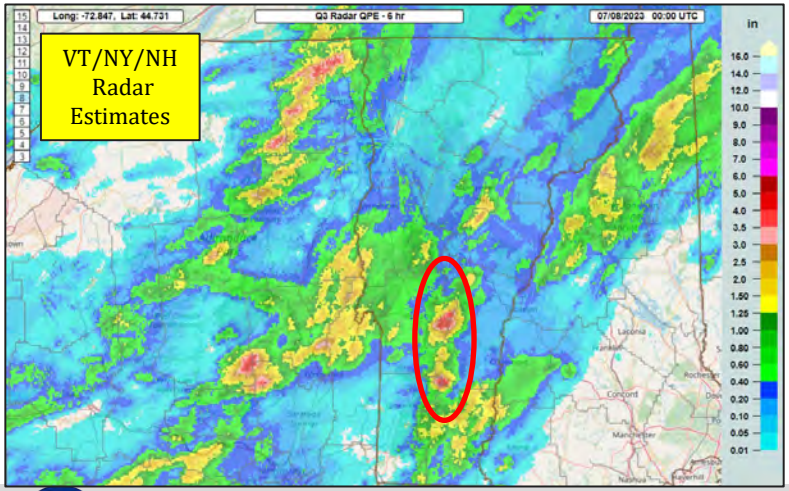
Top Weather Events for Vermont (prior to 2023)

- **November 1927 Flood**
  - 84 fatalities, ~$35 Million (~$615 Million)
  - 1285 bridges lost, hundreds of miles of roads/RR tracks destroyed
- **Tropical Storm IRENE – August 2011**
  - 5 fatalities, ~ $600-900 Million (~ $1 Billion)
  - 200 Bridges, hundreds of miles of roads
- **Long Island/New England Hurricane – September 1938**
  - 5 fatalities, ~$30 Million (~ $600 Million)
  - Devastating WIND and flood damage (~30% timber loss)
- **June 29-30, 1973 Flood**
  - 2 fatalities, ~$64 Million (~$440 Million)
  - Dozens of bridges lost, hundreds of miles of roads/RR tracks destroyed
- **December 1969 Snow/Ice Storm**
  - Feet of snow combined with ≥ 1" Ice accumulation. Roof collapses. Livestock killed.
  - >4 fatalities of stranded motorists due to poisoning, Power outages for week.
- **January 1998 Ice Storm**
  - First $1. Billion storm to impact northern NY, VT and ME
  - Power outages for weeks. Major farm losses. 10% Forests damaged

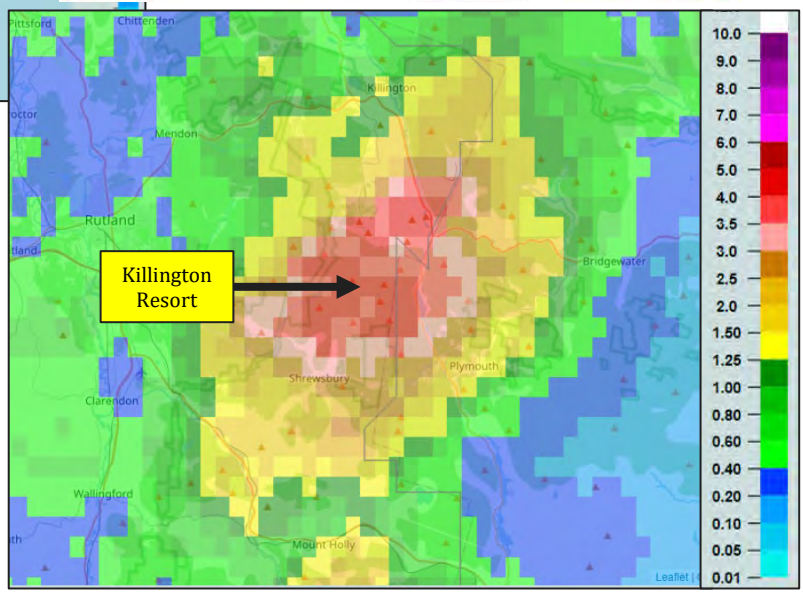
July 7, 2023

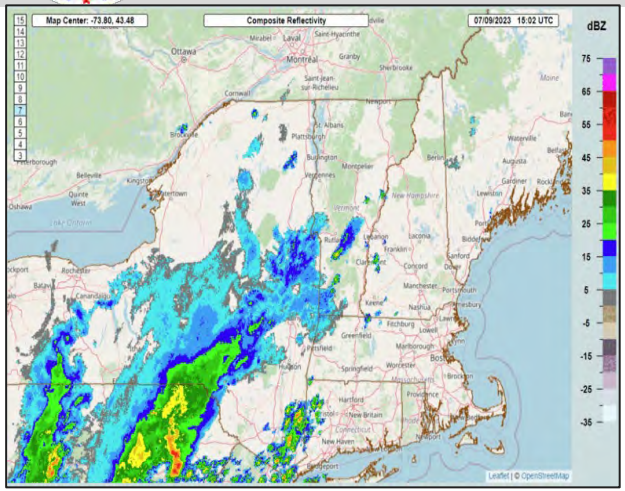
- Thunderstorms developed and moved across the state from Noon to 8 pm.
- Thunderstorms remained nearly stationary between 230-530 pm in Killington area.

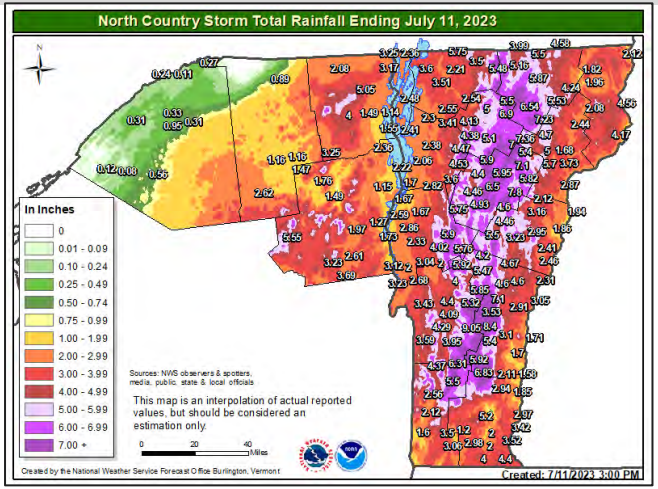




West Bridgewater – 4.60”
Killington – 4.43”
Killington – 3.51”
Bridgewater – 3.11”
Killington – 2.66”
Royalton – 2.48”
Weston – 2.24”
Wilmington – 2.10”
Mount Holly – 2.01”
Okemo – 1.59”
Shrewsbury 1.50”

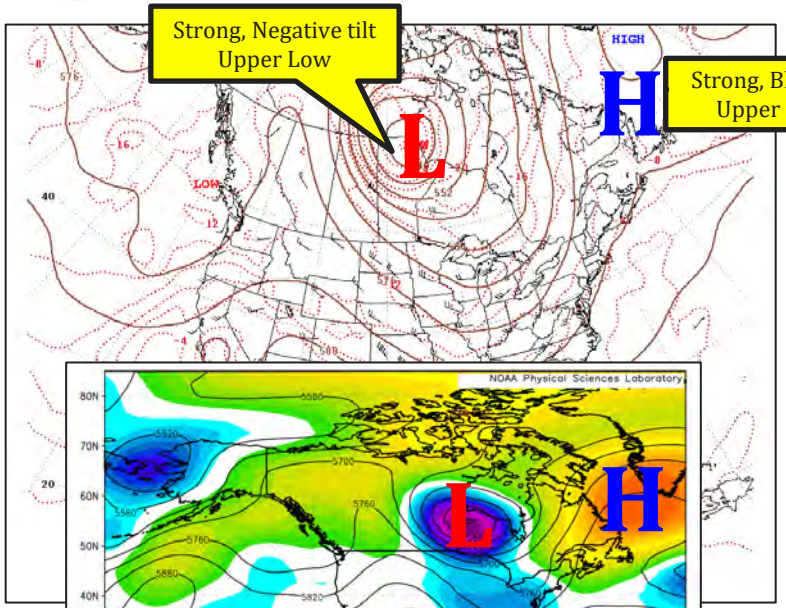


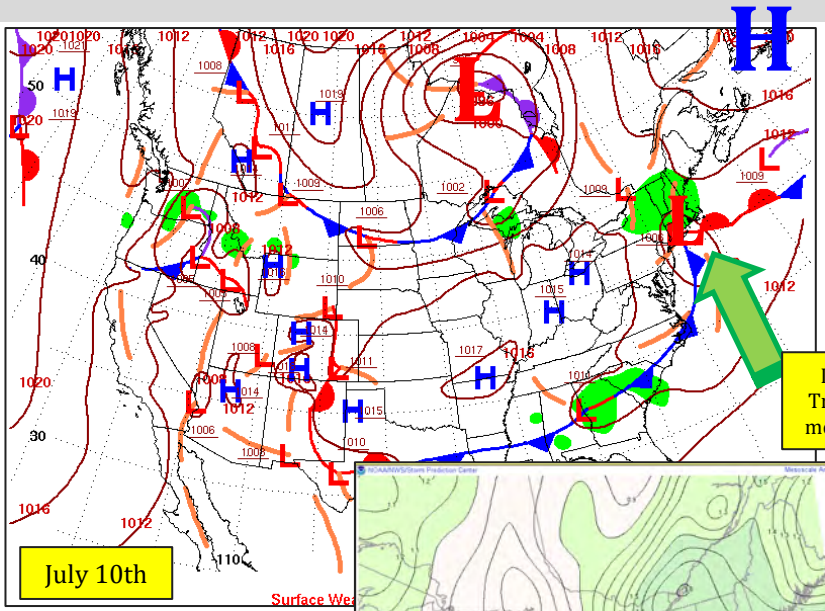


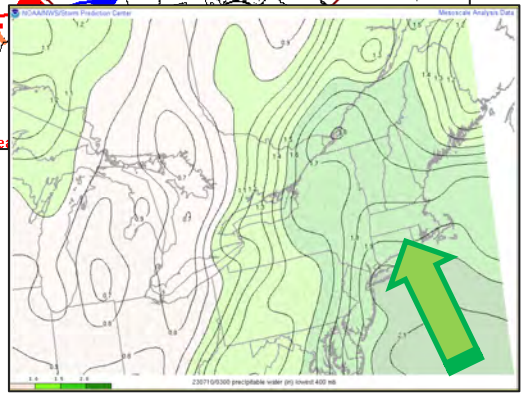


July 9-11, 2023 Flood Event

July 9-11, 2023 - Meteorology



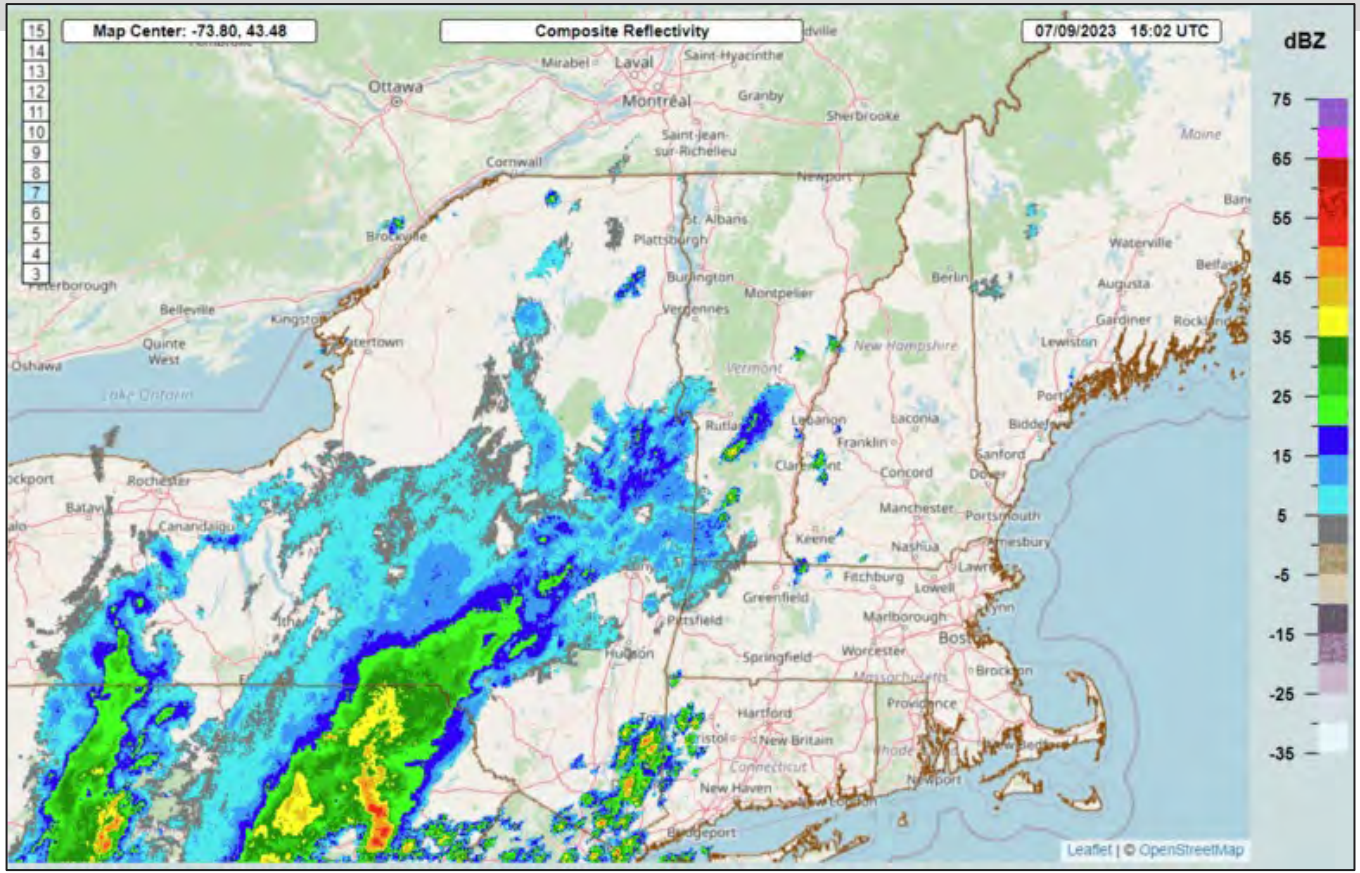




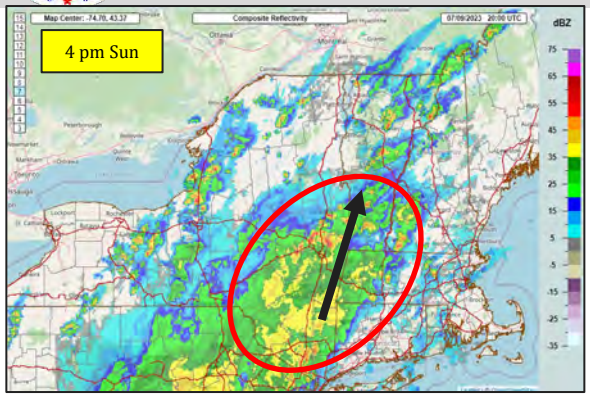
- **Upper/Lower Atmospheric Conditions**
  - **Unseasonably Strong Blocking Pattern, similar to Cool Season (Oct-Apr).**
  - Stalled movement, development of surface wave along the front.
  - **Deep Tropical Moisture**

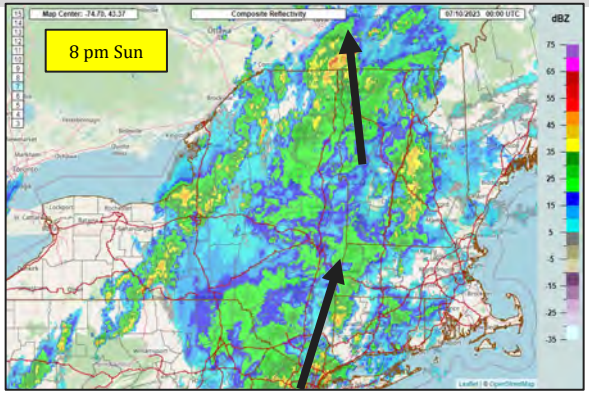
Hourly Radar Loop (Noon 7/9/23 – Noon 7/11/23)

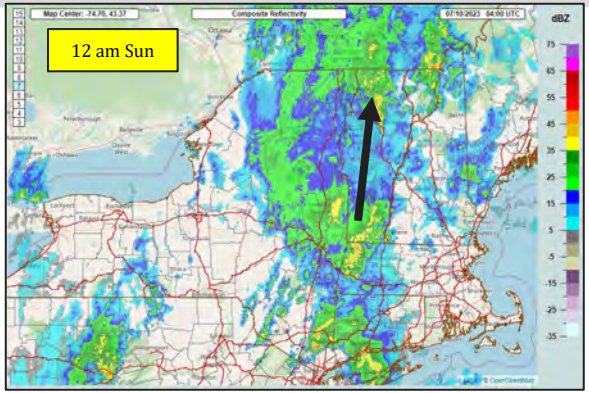
- Main event was late Sunday through Monday evening, moving north across the state.
- Rainfall rates in excess of 1 inch per hour at times, especially at the onset late Sunday, otherwise largely ¼ to ½ inch per hour.
- Flash Flooding early Monday morning through Monday evening transitioning to Major River Flooding that continued into Tuesday.

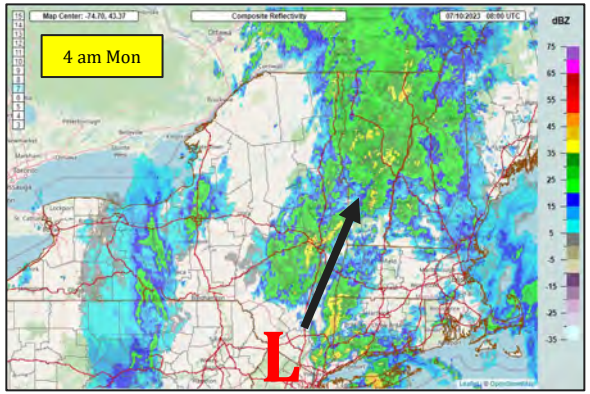


Sunday (7/9/23 – 4 pm) to Monday (7/10/23 – 8 am)

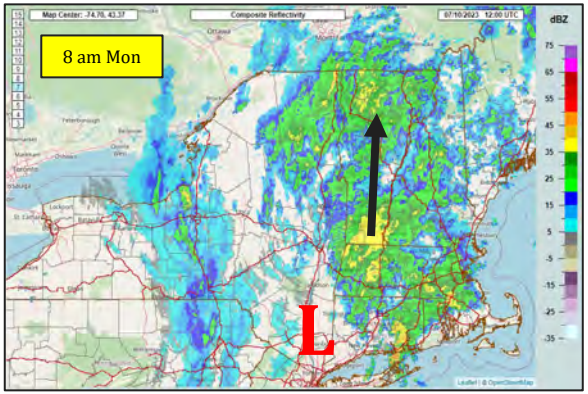




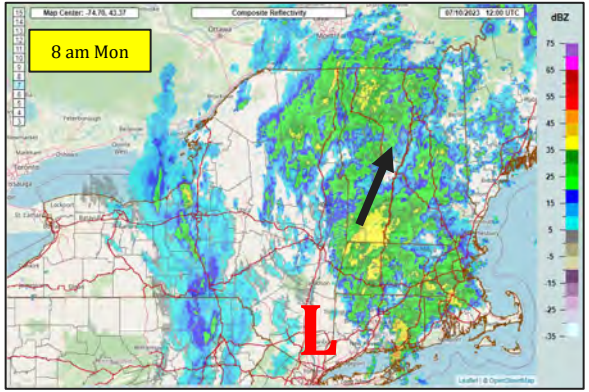


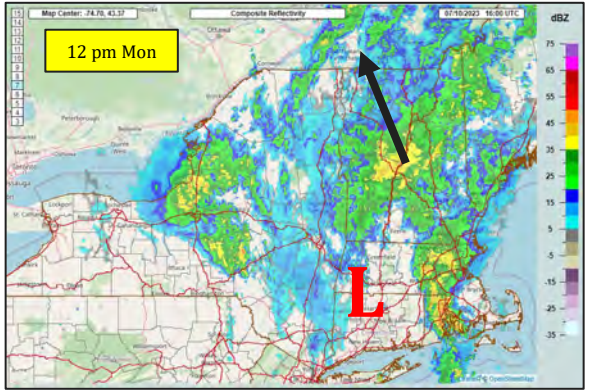


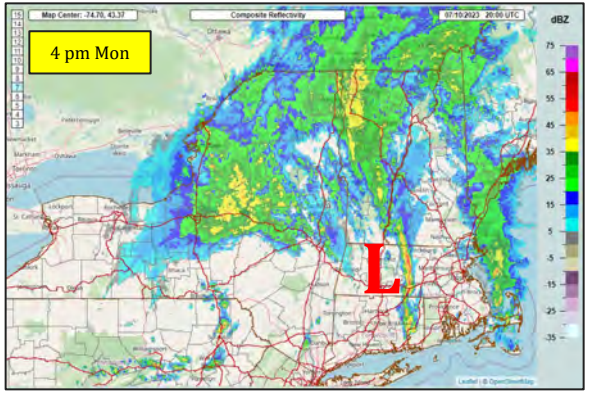
- Event begins across southern VT by late Sunday afternoon.
- Several rounds of heavy rain showers rotate south to north during Sunday night into Monday morning.
- **Rainfall rates in excess of 1 inch per hour at times.**
- Greatest impacts across southern VT, especially eastern slopes of Southern Greens with FLASH FLOODING.

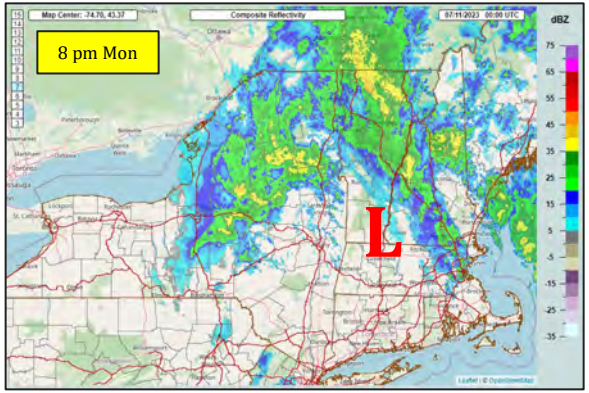


Monday (7/10/23 – 8 am to 8 pm)



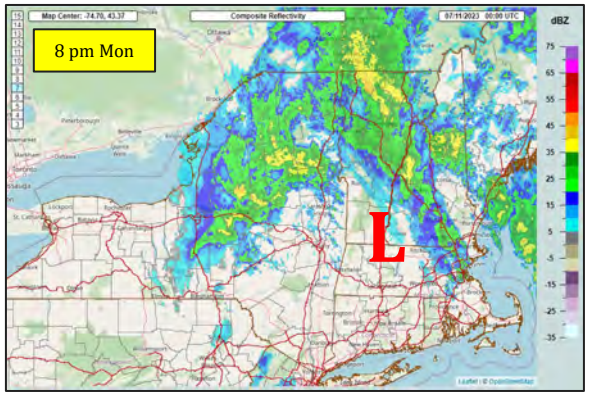


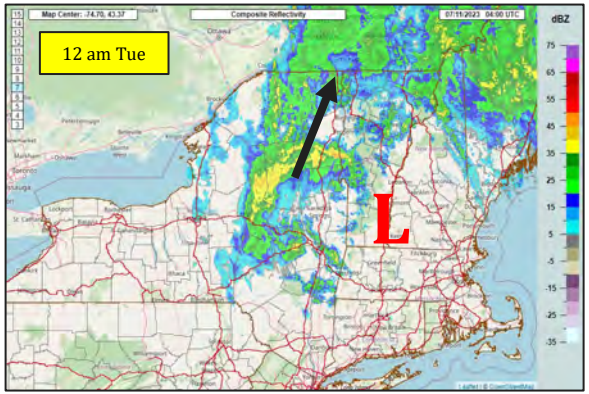


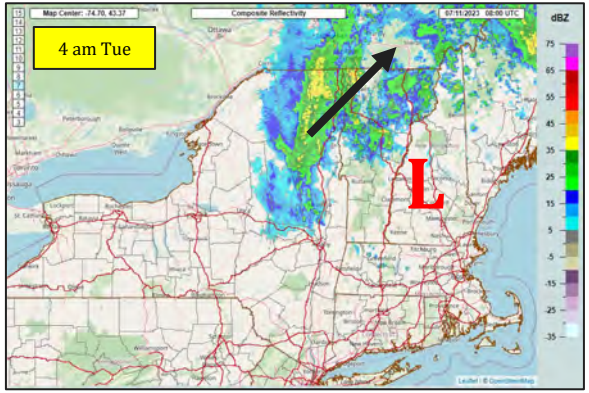


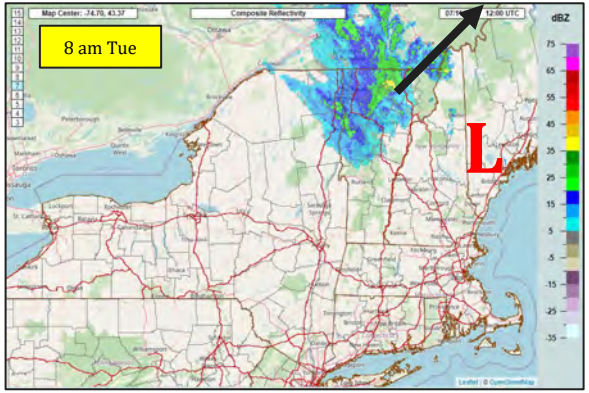
- Slow moving weak area of low pressure moves across southeast NY toward the lower Connecticut River Valley.
- Several rounds of heavy rain showers rotate south to north/northwest. Rainfall is largely ending across southern VT.
- Rainfall rates ½ to 1 inch per hour at times lifting into northern VT.
- FLASH FLOODING on-going across southern - central VT and developing to the north.
- FLASH FLOODING transitioning to Major River flooding.

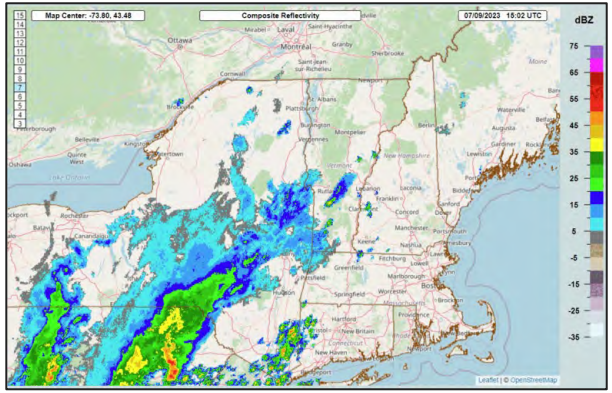
Monday (7/10/23 – 8 pm) to Tuesday (7/11/23 – 8 am)





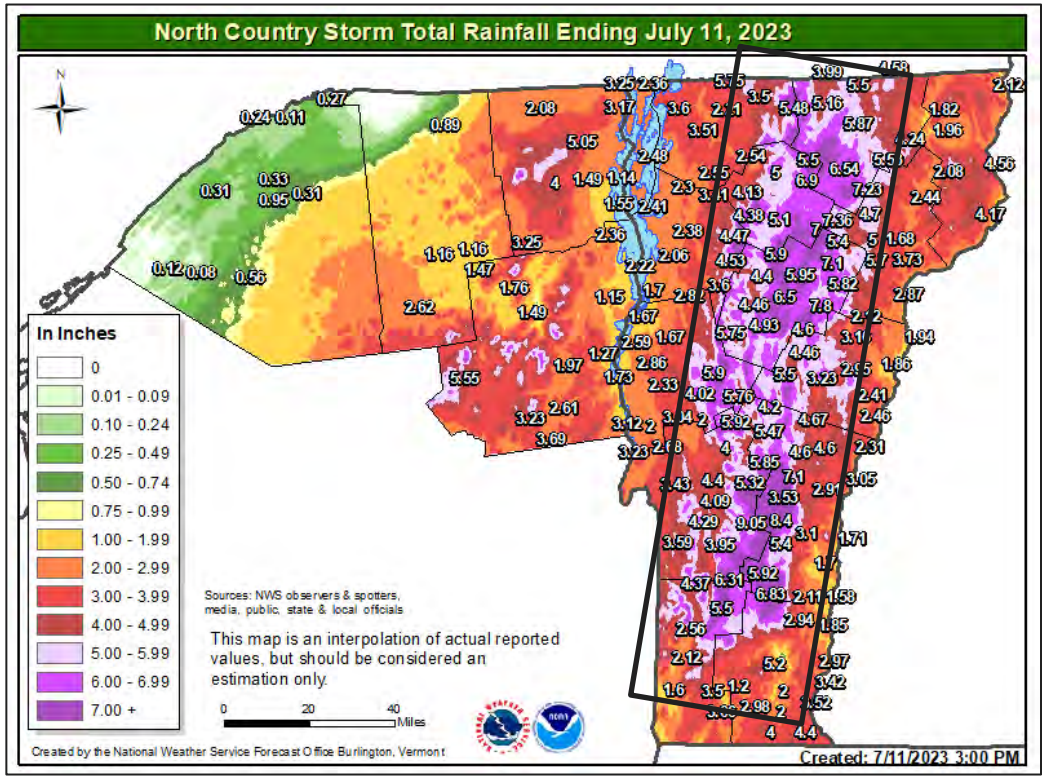




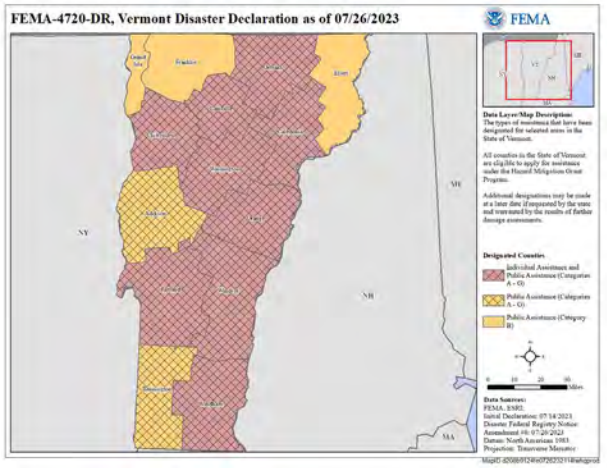


- Slow moving weak area of low pressure moves across the lower Connecticut River Valley into NH/ME.
- Steadiest rainfall is across northern half of VT.
- FLASH FLOODING on-going across central-northern VT and transitioning to Major River flooding statewide.

July 9-11, 2023 Rainfall



- Main event was July 9-11th with widespread 4 to 6 inches of rain across Green Mountains and foothills with 2 to 4 inches elsewhere.
- Major to Catastrophic flooding across a good portion of the area.
- Multiple, more localized flash flooding occurred days prior and after the main event.

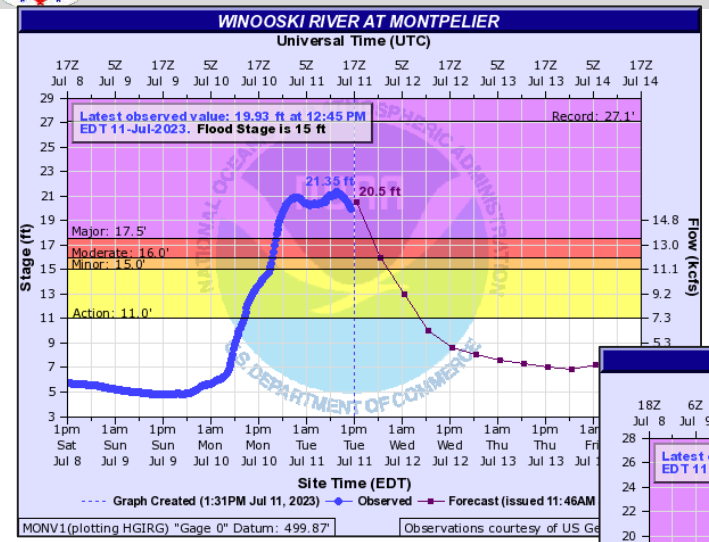



TIMBER INN
MOTEL


NORTH
VERMONT
14

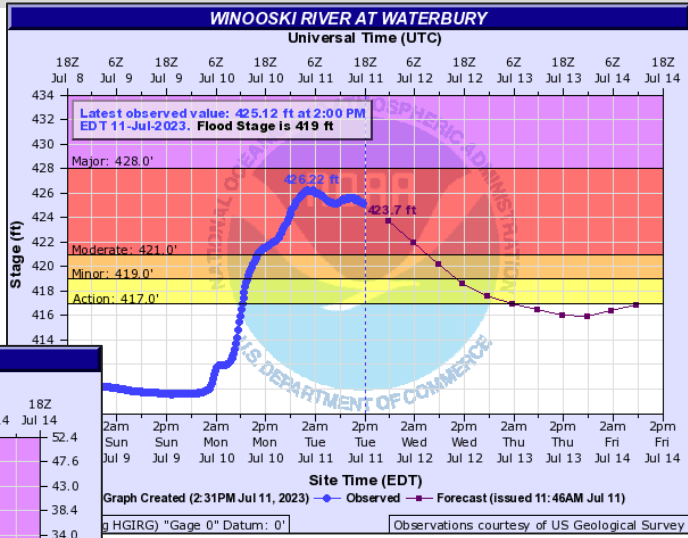

Courtesy of VT Digger

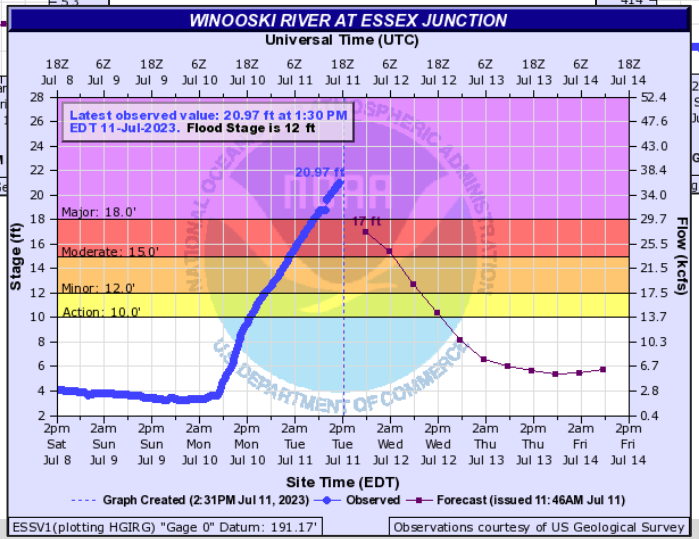
Winooski River Basin



Historic Crests

(1) 51.40 ft on 11/04/1927
(2) 24.54 ft on 03/19/1936
(3) 23.28 ft on 07/11/2023 **(P)**
(4) 22.19 ft on 08/29/2011
(5) 22.17 ft on 02/21/1981
(6) 19.06 ft on 03/14/1977
(7) 18.72 ft on 09/22/1938
(8) 18.60 ft on 04/19/1933
(9) 18.28 ft on 04/18/1982
(10) 17.47 ft on 07/01/1973





Historic Crests

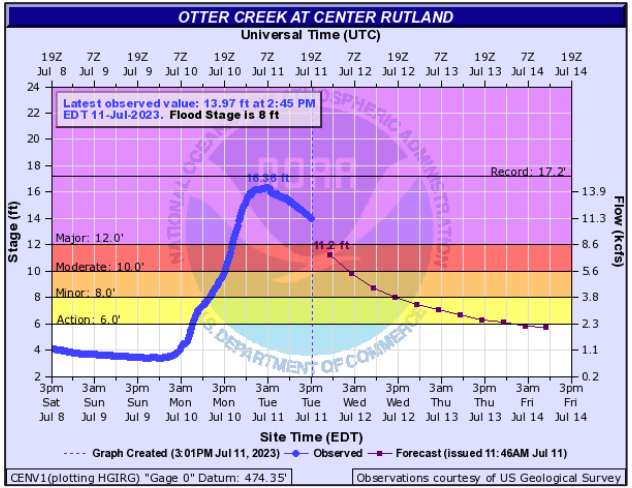
(1) 27.10 ft on 11/03/1927
(2) 21.35 ft on 07/11/2023 **(P)**
(3) 19.05 ft on 08/29/2011
(4) 17.59 ft on 05/27/2011
(5) 17.55 ft on 06/30/1973

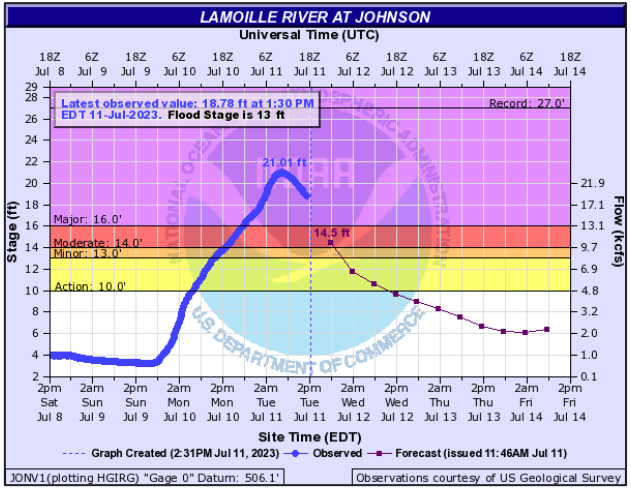
Historic Crests

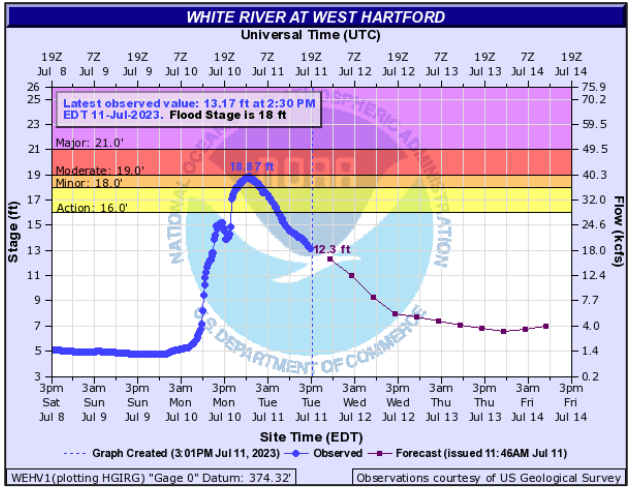
(1) 430.00 ft on 08/29/2011
(2) 426.22 ft on 07/11/2023 **(P)**
(3) 423.30 ft on 05/27/2011

Red = July 2023
Bold Black is Irene 2011
Blue is June 1973

Main Stem Rivers at/near Major Flood







Historic Crests

(1) 17.21 ft on 08/29/2011
(2) 16.36 ft on 07/11/2023 **(P)**
(3) 13.45 ft on 09/22/1938
(4) 13.25 ft on 06/30/1973
(5) 13.01 ft on 04/06/1987

Red = July 2023
Bold Black is Irene 2011
Blue is June 1973

Historic Crests

(1) 27.00 ft on 11/04/1927
(2) 21.01 ft on 07/11/2023
(3) 19.98 ft on 08/06/1995
(4) 17.33 ft on 07/01/1973
(5) 17.28 ft on 11/01/2019
(6) 16.97 ft on 04/27/2011
(7) 16.54 ft on 08/29/2011

Historic Crests

(1) 29.30 ft on 11/04/1927
(2) 28.36 ft on 08/29/2011
(3) 19.26 ft on 09/22/1938
(4) 19.13 ft on 06/30/1973
(5) 18.89 ft on 03/18/1936
(6) 18.87 ft on 07/11/2023

- Any Quick Questions?

- Next – NWS Decision Support Services during the July 2023 Flooding

NWS Decision Support Services

Forecasts and Services:

What you need, When you need it and in the format(plain language) for the user to understand

WHY?! – Forecasts have NO "intrinsic value" alone.
They acquire value by people taking the correct, appropriate action to mitigate the hazard.

Which is more effective?

Forecast

Rainfall amounts of 2-4 inches with localized 5+ inches

Decision Support Services

Rainfall amounts of 2-4 inches with localized 5+ inches

Numerous Flash Flooding

"Most significant event since Irene, perhaps localized comparable damage."

NWS Decision Support Services

Forecasts and Services: *What you need, When you need it and in the format and plain language for the user to understand*

WHY?! – Forecasts have NO "intrinsic value" alone.
They acquire value by people taking the correct, appropriate action to mitigate the hazard.

- **Working closely with partners; prior, during and after a weather event**
  - **Partners**
    - Local, State and Federal Agencies, VEM, RPC, LEPC, Local EM/1st Responders, Health Dept, Transportation, FEMA, Academia, electronic media, etc.
  - **Prior, During and After an event**

Prior

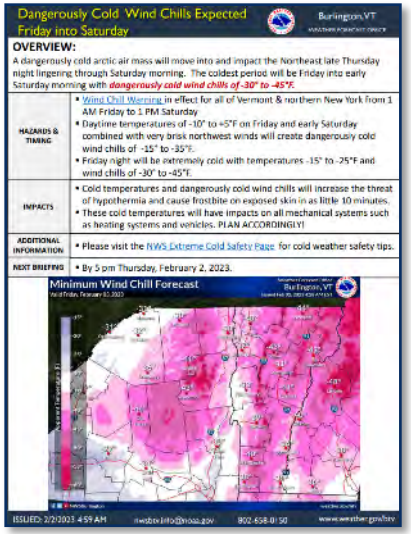
- Tabletop Exercises (TTX), Planning meetings, training, workshops, mitigation
- Interacting with partners **BEFORE** hand for what, when and how they want/need services/support…"building relationships", "building trust".

During

- **Situational Awareness e-mails/briefings/conference calls**
- EOC Deployment for BIG weather or public safety event?
- Specialized forecasts for public safety at public events via the Public Safety community

After

- Forecasts and support for/during recovery operations
- Collaborate with NWS Regional Operation Centers for assistance to FEMA for potential Presidential Disaster Assistance (PDA) declarations
- Participating in After Action Reviews, Hot Washes



NWS Burlington Decision Support – July 2023

- **Twice Daily "Heads-up" Briefings to Decision Makers (Before/During)**

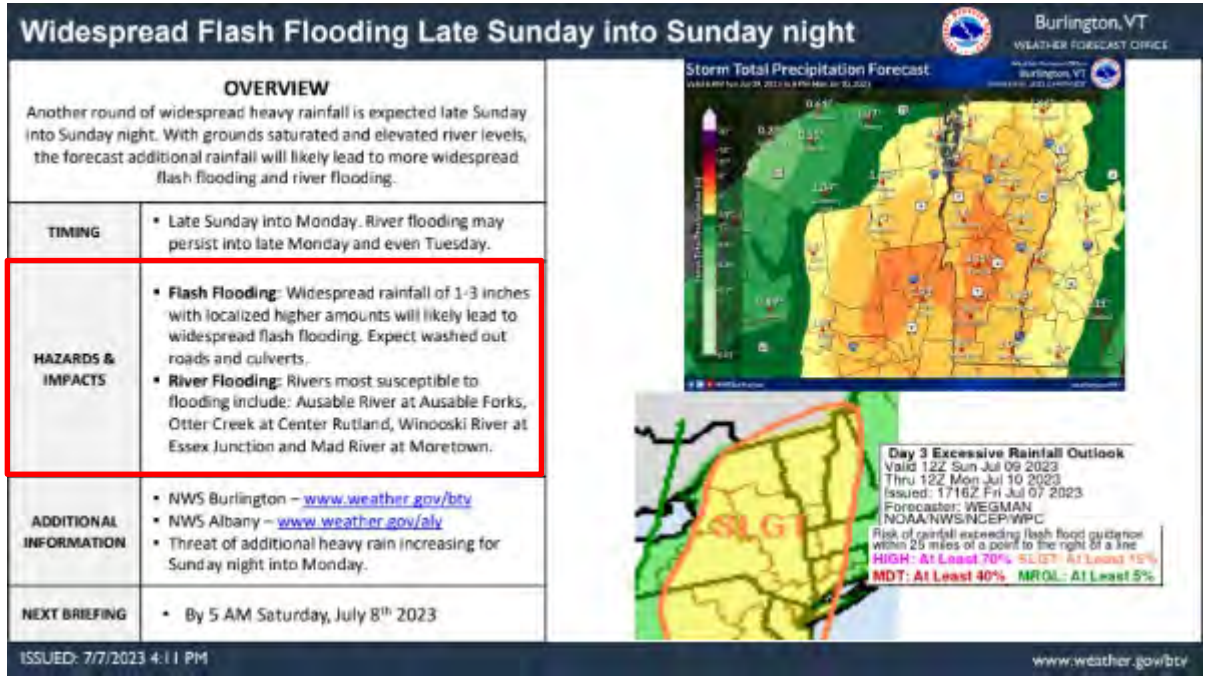
- **On-site Deployment to VT State Emergency Operations Center (SEOC)**
  - July 10th – July 21st
  - 3-4 briefings daily (including Governor)
  - Support Situational Awareness Section and entire SEOC
  - Forecasts and Weather Safety information/support

- **Remote Support to VT SEOC from July 22nd to September 1st**
  - Providing the same support/functions

- **Conducted Flood surveys to QC and improve Flood Impact statements**
  - Working with Town Officials to possibly change Flood categories (Winooski @ Waterbury).

NWS Burlington Decision Support – Briefing e-mails

Friday (7/7) – First Briefing

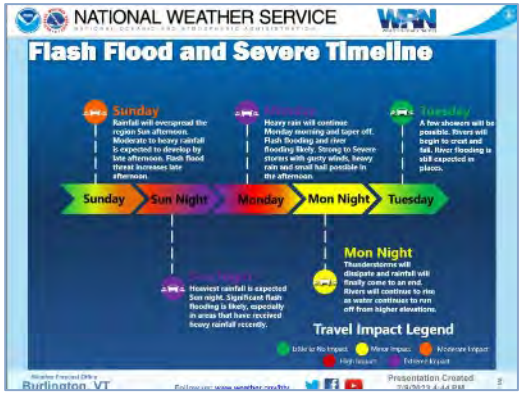


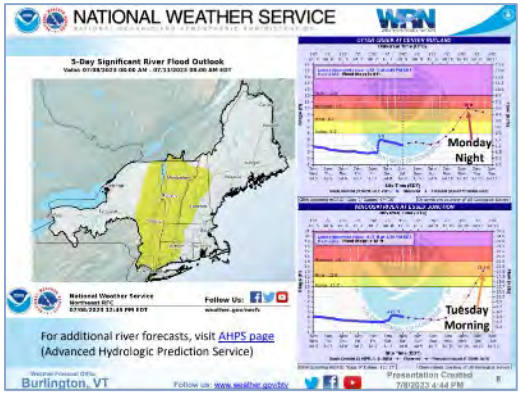
- Initial brief to notify decision makers leading into the weekend.
- Rainfall 1-3+ inches with locally higher.
- ***"Threat of additional heavy rain increasing Sunday night into Monday."***

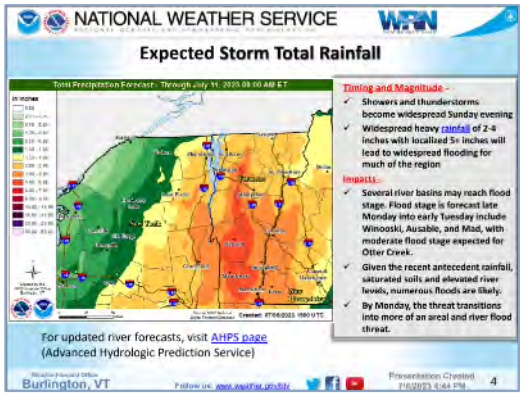
NWS Burlington Decision Support – Briefing e-mails

Saturday (7/8) – **Flood Watch Issued**

- **Flood Watch issued**
  - 2-4 inches with localized 5+ inches Sunday night into Monday.
  - **Widespread Flooding Sun Ngt-Mon.**
  - **Flash Flooding transitioning to River flooding on Monday.**

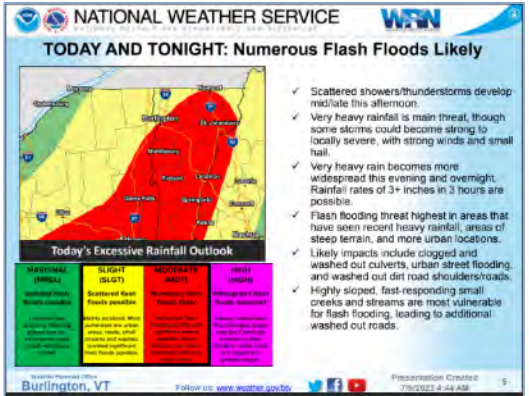


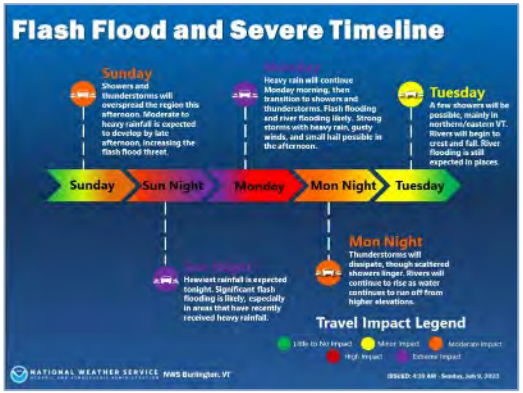


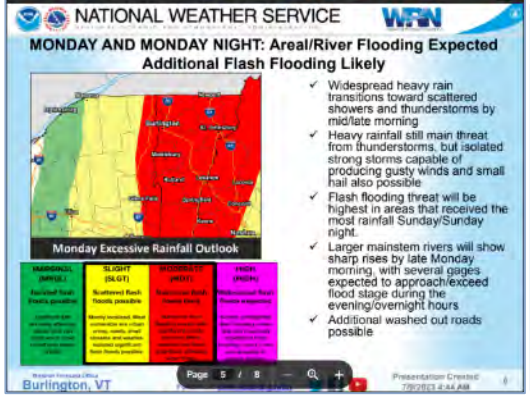


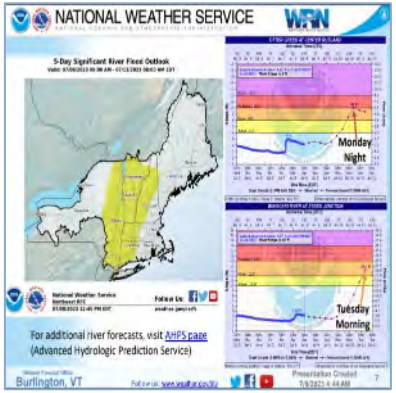
NWS Burlington Decision Support – Briefing e-mails

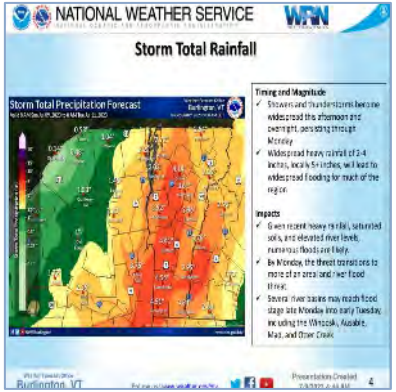
Sunday morning (7/9)







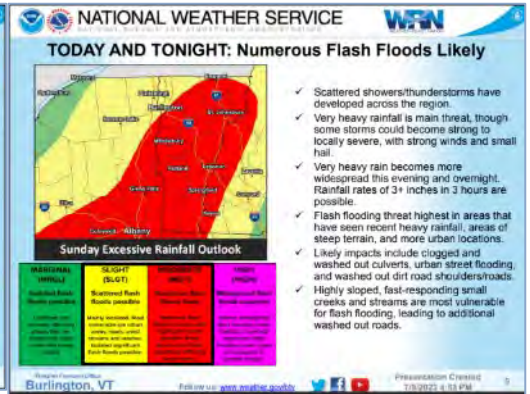


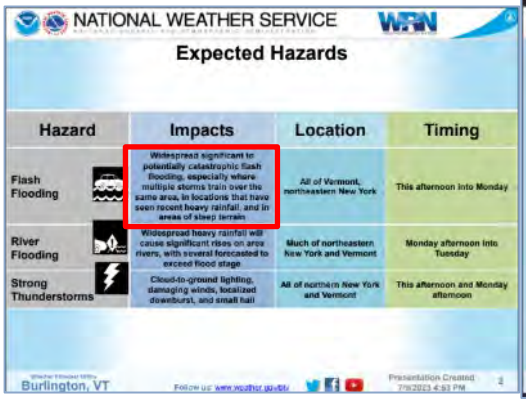


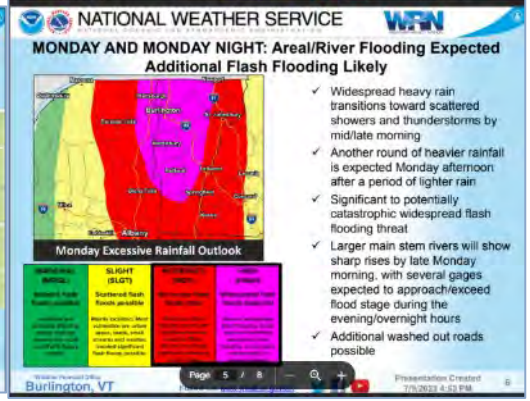
- **Flood Watch in effect**
  - 2-4 inches with localized 5+ inches Tonight into Monday.
  - **Numerous Flash Flooding transitioning to River flooding.**
  - **Comparisons to IRENE during State of VT conference call**
    - *"Most significant event since Irene, perhaps localized comparable damage."*
    - Assisted VT USAR to seek outside resources

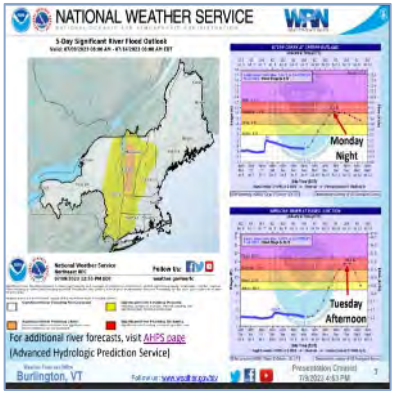
NWS Burlington Decision Support – Briefing e-mails

Sunday afternoon/evening (7/9)









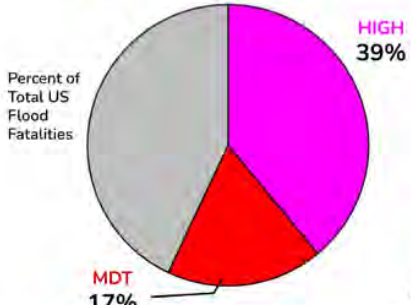
- **"Widespread significant to catastrophic flooding"**
  - **HIGH** Risk for Flash Flooding (WPC-ERO)
  - 3-5 inches with localized 7+ inches Tonight into Monday. (System stalling).
  - **Numerous Flash Flooding transitioning to River flooding**
    - **Significant River flooding expected**

First HIGH Risk for Flash Flooding in VT since Irene (August 28, 2011)

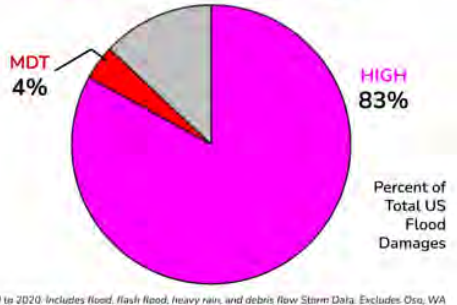
WPC High Risk Days are a BIG DEAL

High Risks are only issued by WPC on ~4% of days, but "High Risk Days" have accounted[1] for:

2/5 of ALL Flood-related **Fatalities**

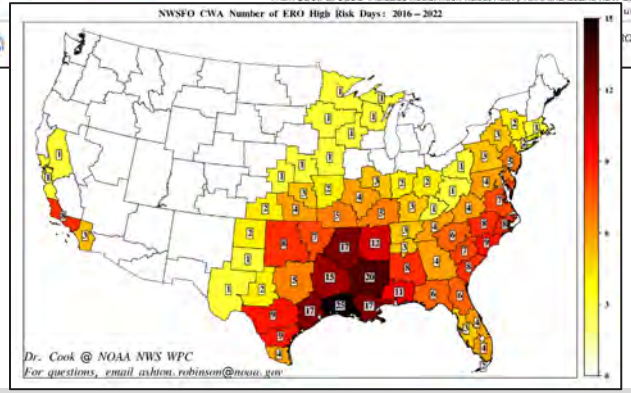


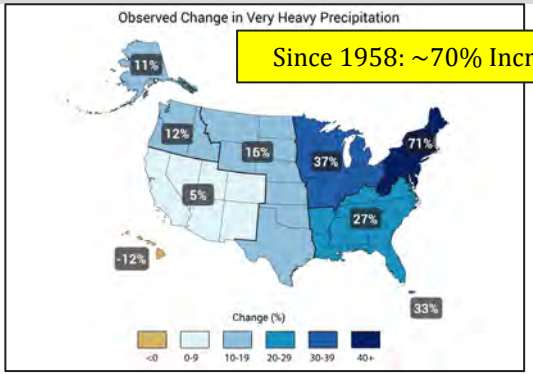
4/5 of ALL Flood-related **Damages**



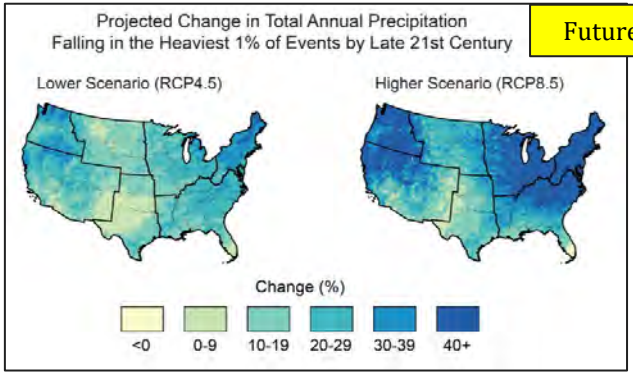
[1] From 2010 to 2020. Includes flood, flash flood, heavy rain, and debris flow Storm Data. Excludes Oso, WA [illegible] for Montecito debris flow.

NCEP





Since 1958: ~70% Increase



Future

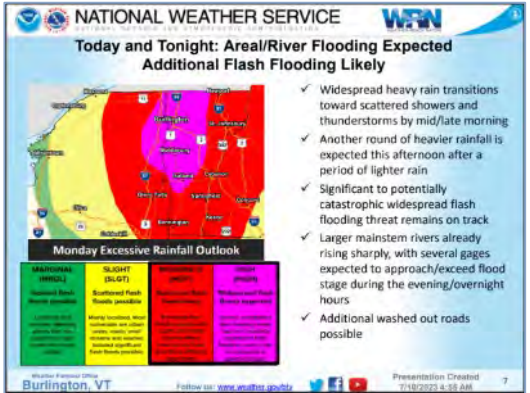
30-40+% increase in Heaviest 1% Rainfall Events*

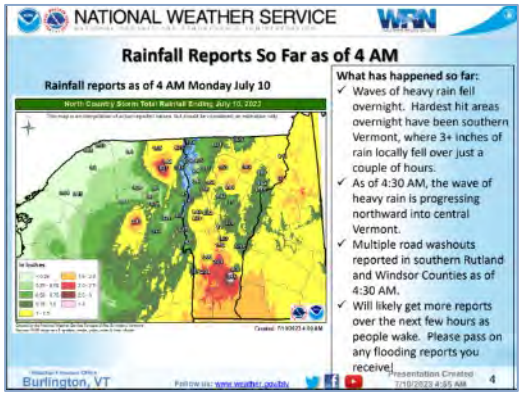
GlobalChange.gov

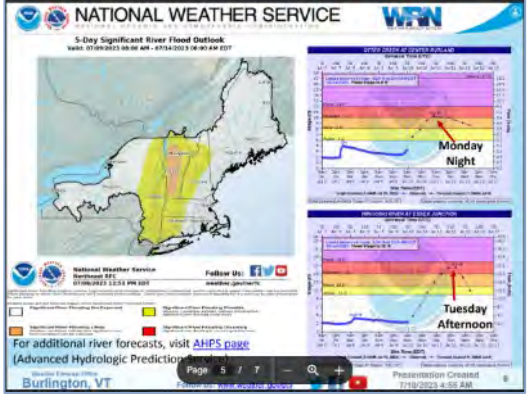
*National Climate Assessment 2014, 2018

NWS Burlington Decision Support – Briefing e-mails

Monday morning (7/10) - Event ongoing – Flash Flooding stage



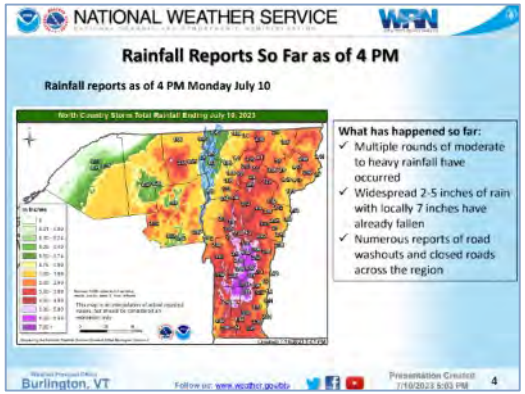


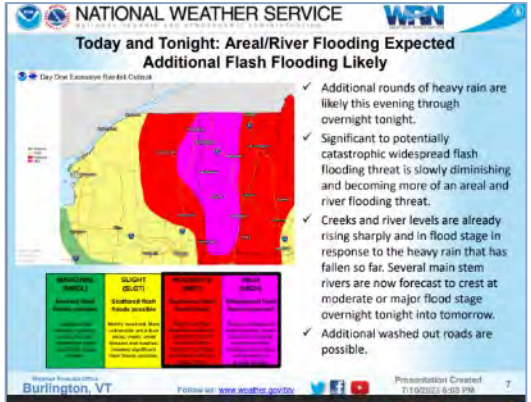


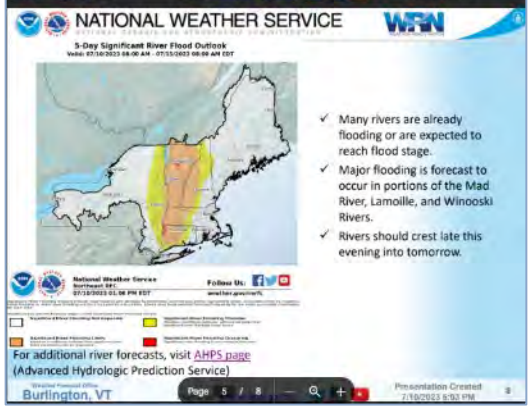
- **"Widespread significant to catastrophic flooding"**
  - **NO CHANGES** – messaging remains the same
  - **HIGH** Risk for Flash Flooding (WPC-ERO)
  - Rainfall of 3-5 inches with localized 7+ inches.
  - **Numerous Flash Flooding transitioning to River flooding.**
  - **Significant River flooding expected.**
  - Ground truth rainfall and storm reports of flooding.
  - **NWS Forecaster deployed to VT SEOC.**

NWS Burlington Decision Support – Briefing e-mails

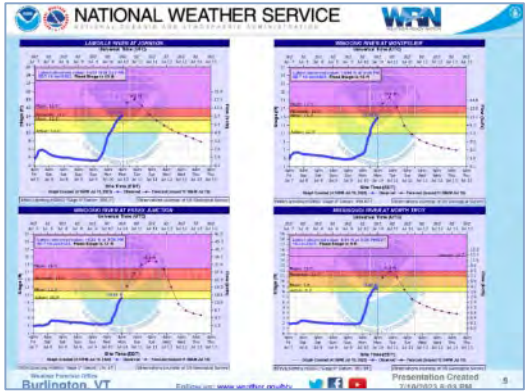
Monday afternoon/evening (7/10) - Event ongoing – Flash to Major River Flooding







- **"Major flooding for area rivers"**
  - **Observed** 3-5 inches with localized 7+ inches.
  - **Numerous, significant Flash Flooding observed.**
  - **Significant River flooding expected with main stem rivers already in flood.**
  - **NWS Forecaster and VT SEOC** evacuated from Waterbury Office complex.

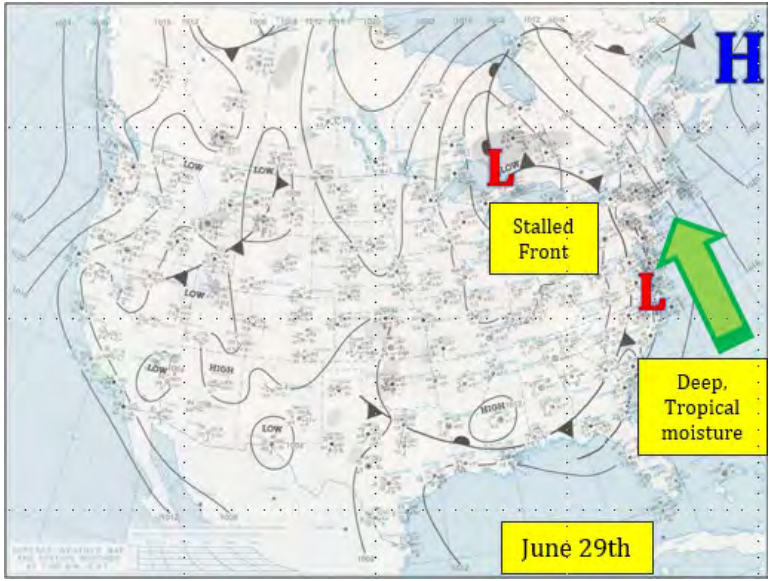


- Any Quick Questions?

- Next – July 2023 Flooding vs. Other Flooding events

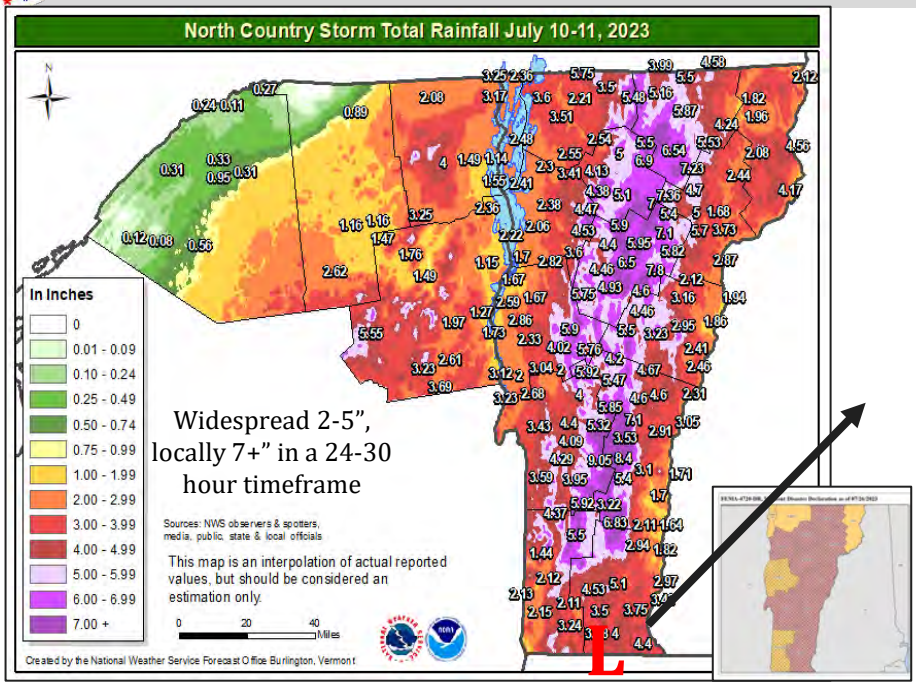
July 9-11, 2023 Rainfall/Flooding Comparisons

Irene – August 2011

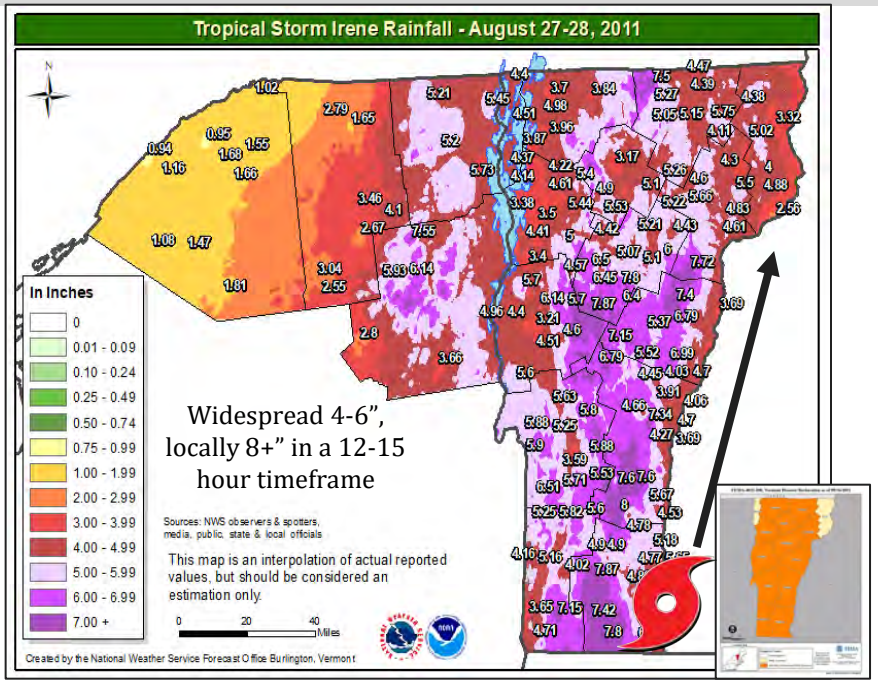


June 29-30, 1973

Storm Rainfall: July 2023 vs. Irene 2011

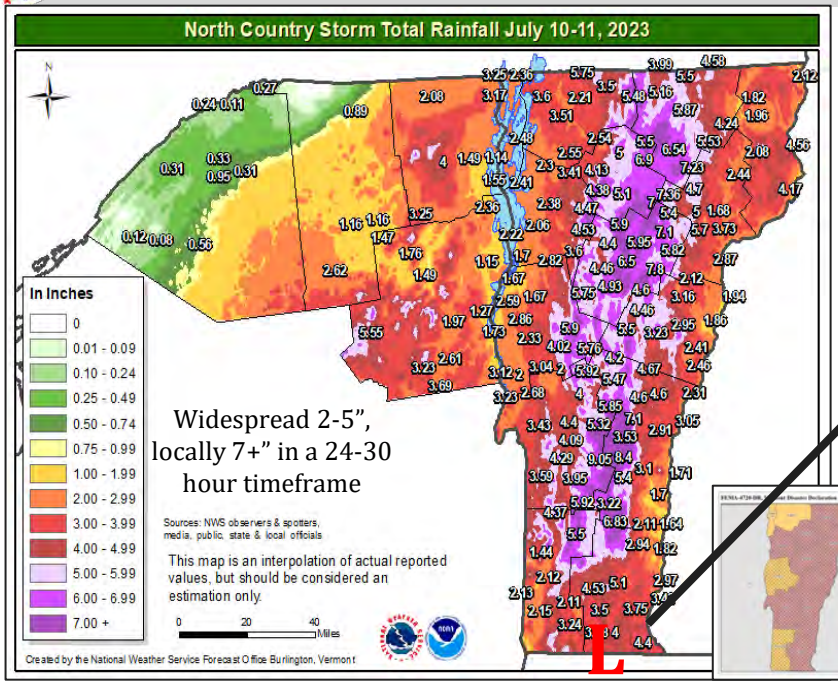


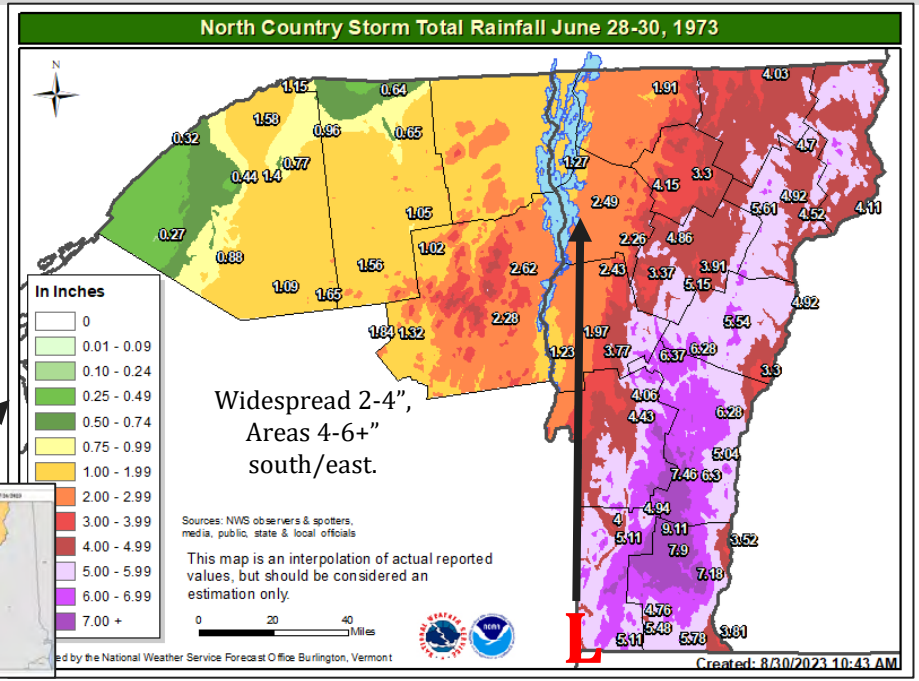
- Rainfall was centered across the Green Mountains from Massachusetts to Canadian border.
- Stalled frontal boundary as well as an unseasonable blocking pattern in the atmosphere. Similar to June 1973.



- Rainfall was more focused on the eastern slopes of Vermont's Greens with greatest rainfall totals in southern half of the state.
- Tropical system: Hurricane weakening to Tropical Storm.

Storm Rainfall: July 2023 vs. June 1973





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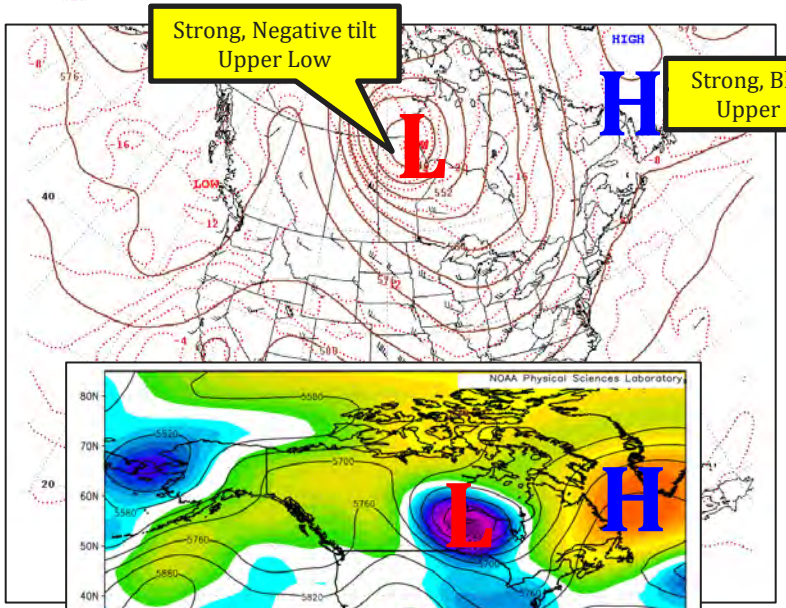
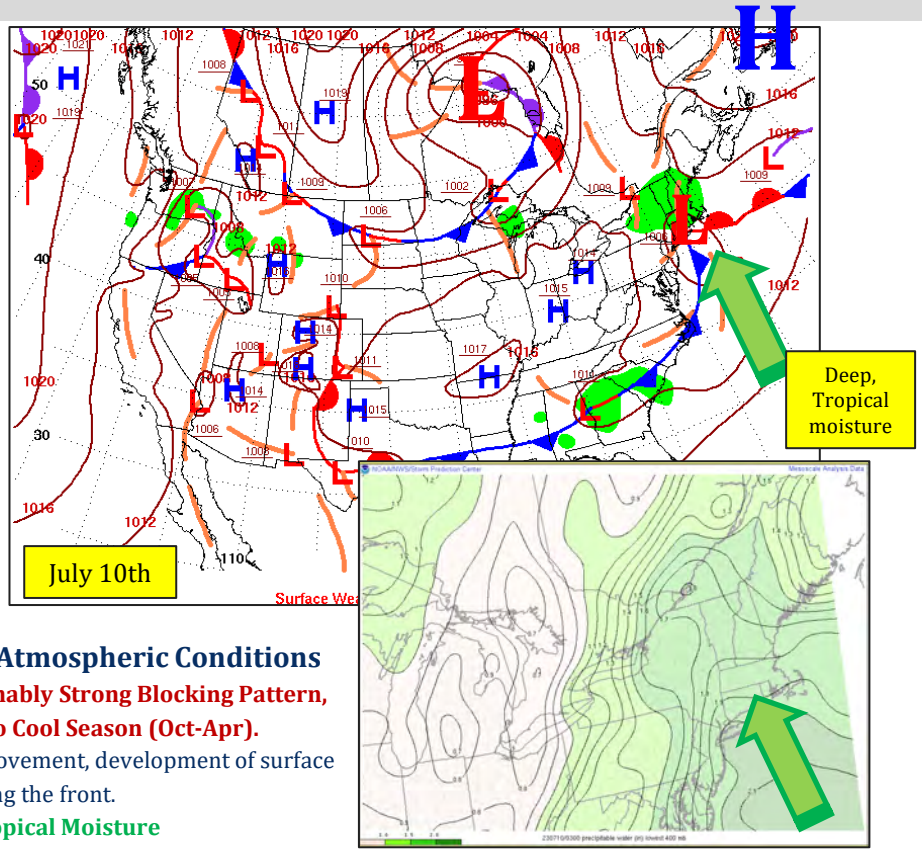
July 9-11, 2023

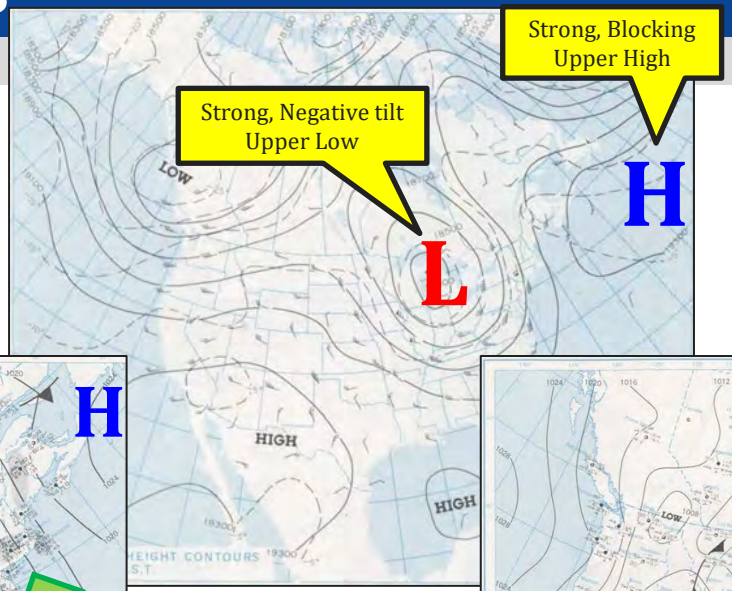


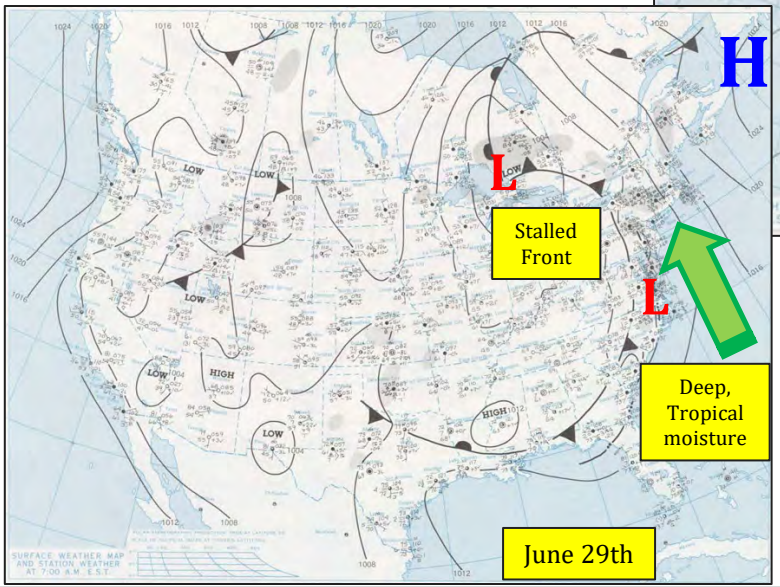


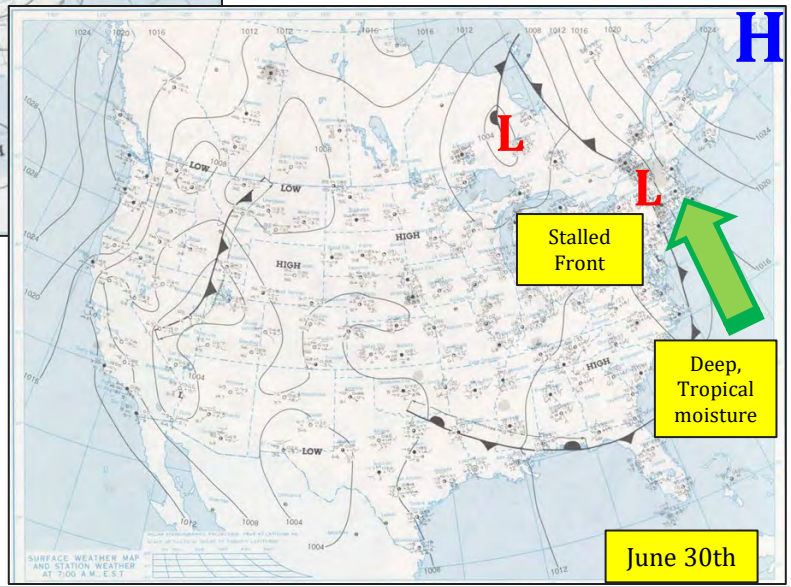
- **Upper/Lower Atmospheric Conditions**
  - **Unseasonably Strong Blocking Pattern, similar to Cool Season (Oct-Apr).**
  - Stalled movement, development of surface wave along the front.
  - **Deep Tropical Moisture**

June 29-30, 1973

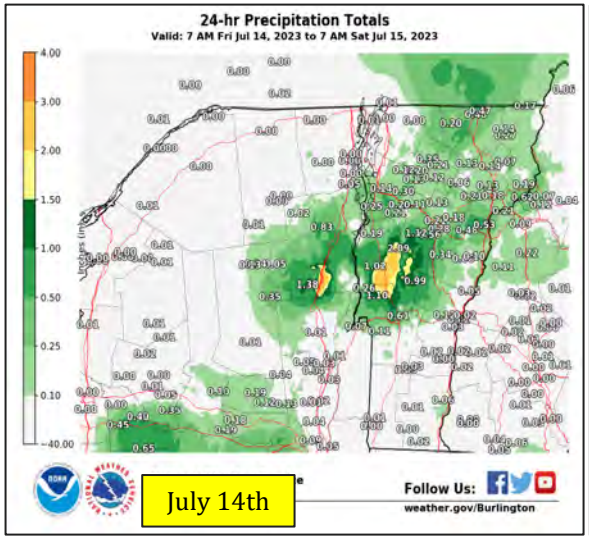
- **Nearly Identical Upper and Lower Atmospheric Conditions**
  - **Unseasonably Strong Blocking Pattern, similar to Cool Season (Oct-Apr).**
  - Stalled movement, development of surface wave along the front.
  - **Deep Tropical Moisture**





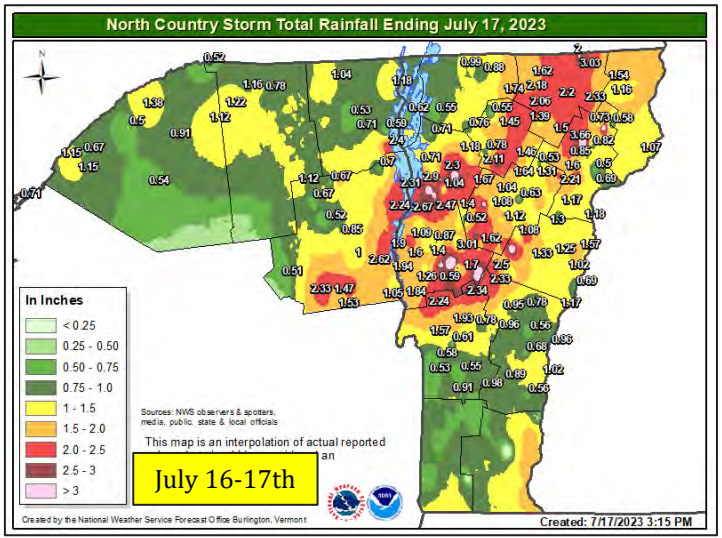


Other Dates of Heavy Rainfall (with > 2 inches reported)



July 14th

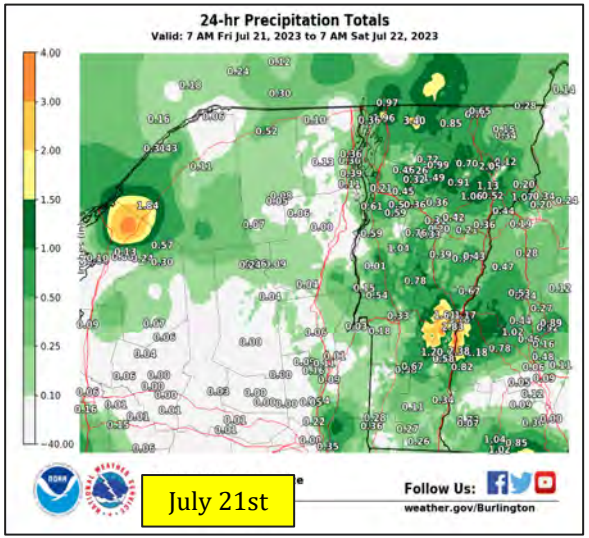
Ripton – 3.42”
Salisbury 3.02”
Ripton – 2.81”
E. Middlebury – 2.50”
Lake Dunmore – 2.18”
Middlebury – 1.80”
Brandon – 1.76”
Hancock – 1.41”



July 16-17th

Wheelock - 4.45"
Ripton - 4.14”
Burke Hollow - 3.89"
Charlotte - 3.89“
Hancock – 3.88”
Richmond - 3.45"
Hinesburg - 3.25"
Williston - 3.15"
Brookfield – 3.15”
Danville - 3.07”
Derby – 3.03”
Warren – 3.01”
Stowe – 2.97”
Eden – 2.81”
Albany - 2.56”
Williamstown – 2.55”
Braintree – 2.50”
Morrisville – 2.41”

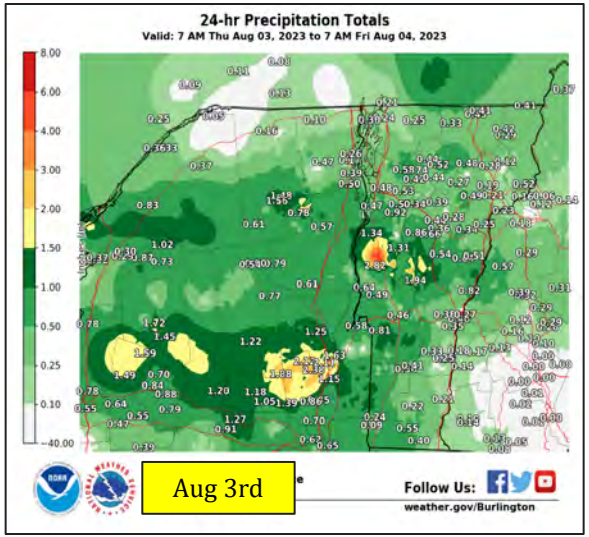
2-Day Totals

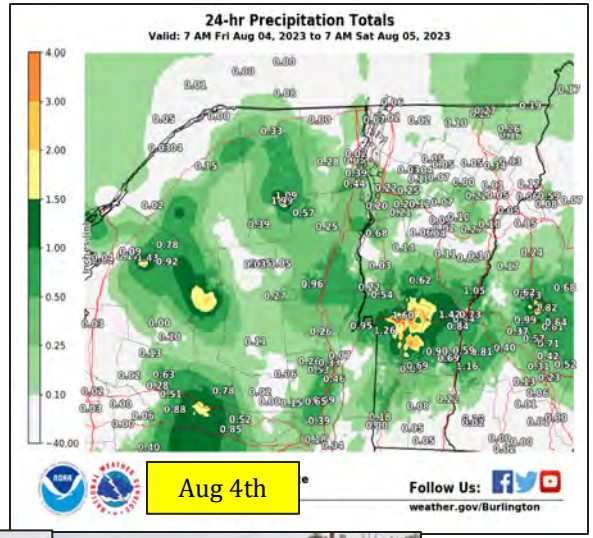


July 21st

Windsor – 3.79”
Reading – 3.40”
N Hartland – 3.10”
Plymouth – 2.93”
W Windsor – 2.72”
Woodstock – 2.64”
S Pomfret – 2.56”
Cornish – 2.36”
Sutton – 2.05”
Brownsville – 1.97”
Swanton – 1.96”
Enosburg – 1.86”
Braintree – 1.66”
Woodstock – 1.61”
Wheelock – 1.57”
Craftsbury – 1.57”

Other Dates of Heavy Rainfall





Middlebury – 6.12”
Middlebury – 5.65”
Middlebury – 5.55”
Middlebury – 4.29”
Ripton – 3.11”
E Middlebury – 2.98”
Hancock – 2.88”
Ferrisburg – 2.05”
New Haven – 1.96”

Rutland – 4.37”
Mendon – 3.78”
Rutland – 3.67”
E Wallingford – 3.48”
N Clarendon – 3.31”
Rutland – 3.10”
W Rutland - 2.44”
W Bridgewater – 2.22”
Killington – 2.13”
Bridgewater – 2.06”

StormReady - https://www.weather.gov/stormready/

- **Extreme Weather Events have increased and will continue to increase. Are you Storm Ready?**
- Being part of a Weather-Ready Nation is about preparing for your community's increasing vulnerability to extreme weather and water events.
- The StormReady program uses a grassroots approach to help communities develop plans to handle all types of extreme weather.
- The program encourages communities to take a new, proactive approach to improving local hazardous weather operations with guidance on how to improve their hazardous weather operations.
- Application process has been streamlined considerably.

AMBASSADOR WRN
WEATHER-READY NATION

SEVERE WEATHER PLAN

SCOPE

Rutland Regional Medical Center (RRMC)

PURPOSE

The purpose of this plan is to clearly outline the different thresholds and recommended actions for different types of severe weather events. This is an incident-specific response plan used to supplement the emergency management procedures outlined in the RRMC Emergency Operations Plan (EOP) and other plans as indicated by the nature of the incident.

POLICY

1. Activation of the plan – This plan will be activated as needed in response to severe weather events.
2. The RRMC Emergency Operations Center (EOC) and the Incident Management Team (IMT) will be activated at this time.
   a. Key Personnel:
      i. IMT and Department Leaders
      ii. Weather Watcher(s)
      iii. Support Services staff
   b. All responsibilities for implementation of the Severe Weather Plan will be carried out in the accordance with the RRMC EOP.

DEFINITIONS

Routine weather monitoring – Weather monitoring that occurs on a day-to-day basis.

Hazardous weather monitoring – Weather monitoring that occurs directly before, during, and directly after a severe weather event.

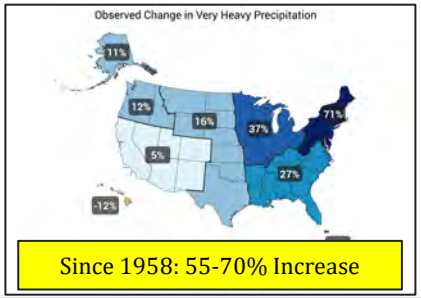
Severe/extreme weather event – Extreme weather or extreme climate events includes unexpected, unusual, severe, or unseasonal weather. This could include but is not limited to dense fog, flash flooding, extreme heat, high wind, lighting, thunderstorms, tornadoes, snow, ice, wind chill, and extreme cold.

Shelter in Place (SIP): A procedure used to take immediate shelter in a current location or refuge area.

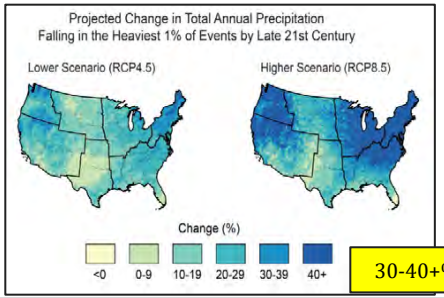
Watch – A watch is used when the risk of a hazardous weather or hydrologic event has increased significantly, but its occurrence, location or timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so. A watch means that hazardous weather is possible. People should have a plan of action in case a storm threatens, and they should listen for later information and possible warnings especially when planning travel or outdoor activities.

Advisory – An advisory is issued when a hazardous weather or hydrologic event is occurring, imminent or likely. Advisories are for less serious conditions than warnings, that cause significant inconvenience and if caution is not exercised, could lead to situations that may threaten life or property.

Warning – A warning is issued when a hazardous weather or hydrologic event is occurring, imminent or likely. A warning means weather conditions pose a threat to life or property. People in the path of the storm need to take protective action.



Since 1958: 55-70% Increase



30-40+% increase in Heaviest 1% Rainfall Events*

Questions?

- NWS Burlington webpage – www.weather.gov/btv

- **If you need to reach a forecaster 24/7**, then please use the following contacts.
  - 802-658-0150 or 802-658-0207
  - nwsbtv.info@noaa.gov

- Scott Whittier – scott.whittier@noaa.gov