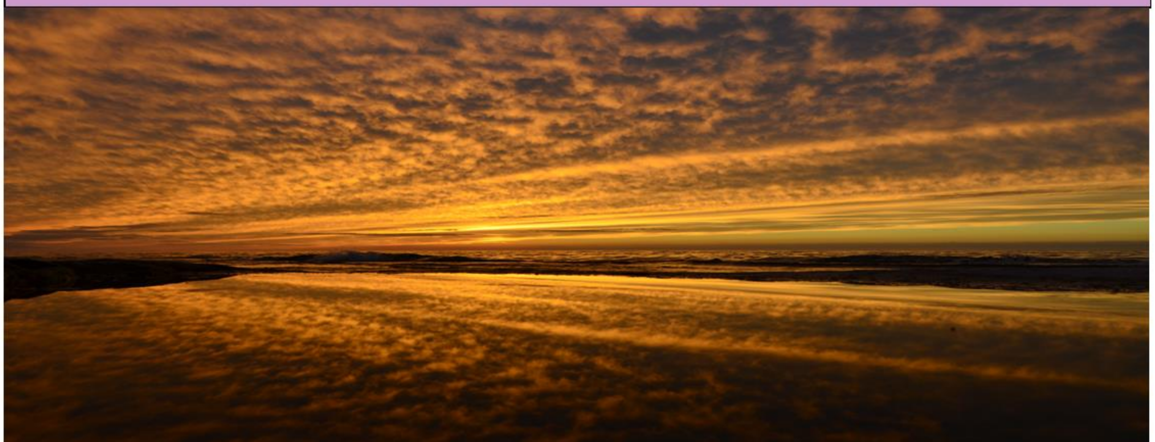
Northeast Regional Operational Workshop (NROW) XXI
November 4 - 5, 2020 | Albany, New York



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Agenda
Northeast Regional Operational Workshop XXI
Albany, New York
Virtual Meeting via GotoWebinar
Wednesday, November 4, 2020

8:50 am
Welcoming Remarks & Webinar Logistics
Raymond G. O'Keefe, Meteorologist-in-Charge
Brian J. Frugis, NROW XXI Steering Committee Chair
National Weather Service, Albany, New York

Session A – Hydrology (9:00 am to 10:20 am)

9:00 am
Hydrometeorological Characteristics of Ice Jams on the Pemigewasset River in Central New Hampshire
Jason M. Cordeira
Plymouth State University, Plymouth, New Hampshire

9:20 am
The Record Breaking Floods of October 31-November 1, 2019 in New York and northern Vermont
Neal M. Strauss
NOAA/NWS Northeast River Forecast Center, Boston/Norton, Massachusetts

9:40 am
A Meteorological Review of the 31 October – 1 November 2019 Historic Flooding Event across Eastern New York
Victoria Zenobio
Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, New York
Christina Speciale
NOAA/NWS Weather Forecast Office, Albany, New York

10:00 am
When the Rivers Rose Scary Fast: Hydrology of the Record Halloween 2019 Flood in the Albany, NY NWS Service Area
Britt Westergard
NOAA/NWS Weather Forecast Office, Albany, New York

10:20 am to 10:40 am
Break

Session B – NWP/Modeling (10:40 am to 11:40 am)

10:40 am
Sensitivity of Forecast Precipitation Type to WRF Boundary Layer Parameterizations over Complex Terrain
Matthew R. Seymour
Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, New York

11:00 am
Modeling Convective Mode Changes in Complex Terrain in the Northeast U.S
Brennan J. Stutsrim
Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, New York

11:20 am
Precipitation Forecast Sensitivity to Horizontal Grid Spacing in Convection-Allowing Models over the central–eastern United States
Craig S. Schwartz
National Center for Atmospheric Research, Boulder, Colorado

Session C – CSTAR (11:40 am to 12:20 pm)

11:40 am
CSTAR Update: Ensemble Clustering and Improving Communication of Uncertainty and Risk through Innovative Forecaster Workshops
Brian A. Colle
School of Marine and Atmospheric Science, Stony Brook University, Stony Brook, New York

12:00 pm
CSTAR Update: Assessing Warm Season Model QPF in New England
Rodney Chai
NOAA/NWS Weather Forecast Office, Boston/Norton, Massachusetts

12:20 pm – 1:40 pm
Lunch

<u>Session D – Severe Weather</u> (1:40 pm to 3:20 pm)

1:40 pm
A Multi-Scale Analysis of the 29 August 2020 Tornadic Event across Eastern New York
Thomas A. Wasula
NOAA/NWS Weather Forecast Office, Albany, New York

2:00 pm
May 15, 2020 Severe Thunderstorms in Southern New England
Joseph W. DelliCarpini
NOAA/NWS Weather Forecast Office, Boston/Norton, Massachusetts

2:20 pm
Tools to Improve Tornado Warning Performance for Supercells: ZDR/KDP Separation and Size Sorting Signals
Michael L. Jurewicz, Sr.
NOAA/NWS, Weather Forecast Office, State College, Pennsylvania

2:40 pm
Application of Diagnostic Techniques from the Tornado Warning Improvement Project to Two Tornadic Convective Storms in the Albany, NY County Warning Area
Michael Evans
NOAA/NWS Weather Forecast Office, Albany, New York

3:00 pm
The 7 October 2020 Severe Weather Event across Upstate New York and New England
Mitchell W. Gaines
NOAA/NWS Weather Forecast Office, Binghamton, New York

3:20 pm – 3:40 pm
Break

<u>Session E – Tropical Storm Isaias</u> (3:40 pm to 4:40 pm)

3:40 pm
Recap of Tropical Storm Isaias and its Hydrological Comparison to Irene and Floyd across the NWS Albany CWA
Brett Rathbun
NOAA/NWS Weather Forecast Office, Albany, New York

4:00 pm

Not Just a Tropical Storm: Hurricane Isaias and its Impacts to the Greater New York City Metropolitan Area

Da’Vel Johnson

NOAA/NWS Weather Forecast Office, New York City/Upton, New York

4:20 pm

Sources of Large Track Errors in Ensemble Forecasts of Hurricane Isaias (2020) as Compared to Past Tropical Cyclones

Nicholas Leonardo

School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, New York

4:40 pm

Wrap up/Adjourn

Brian J. Frugis

Northeast Regional Operational Workshop XXI
Albany, New York
Virtual Meeting via GotoWebinar
Thursday, November 5, 2020

8:55 am
Opening Remarks
Raymond G. O'Keefe, Meteorologist in Charge
Brian J. Frugis, NROW XXI Steering Committee Chair
National Weather Service, Albany, New York

<u>Session F – Cool Season Case Studies</u> (9:00 am to 10:00 am)

9:00 am
Investigating the Forecast Challenges from a Quick-Hitting Heavy Snow Event in Central New York and Northeastern Pennsylvania on 7 February 2020
Michael J. Murphy
NOAA/NWS Weather Forecast Office, Binghamton, New York

9:20 am
Structure and Evolution of the Banded Precipitation during the 7 February 2020 Cyclone Event during IMPACTS
Phillip Yeh
School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, New York

9:40 am
Retrospective Analysis of the 25-27 November 1950 "Great Appalachian Storm"
Kevin Lipton
NOAA/NWS Weather Forecast Office, Albany, New York

<u>Session G –Messaging/IDSS</u> (10:00 am to 11:00 am)

10:00 am
Storm Tide Pathways: A Collaborative Effort to Mitigate the Impacts of Coastal Flooding
Joseph W. DelliCarpini
NOAA/NWS Weather Forecast Office, Boston/Norton, Massachusetts

10:20 am
Enhancement of IDSS and Public Interaction at NWS Boston/Norton during the COVID-19 Pandemic
Joseph W. DelliCarpini
NOAA/NWS Weather Forecast Office, Boston/Norton, Massachusetts

10:40 am
Toward the Implementation of Near Real-Time Forecast Flood Inundation Mapping Services in the Northeast U.S.
Dave R. Vallee
Hydrologist-in-Charge
NOAA/NWS Northeast River Forecast Center, Boston/Norton, Massachusetts

11:00 am – 11:20 am
Break

<u>Session H – Observations</u> (11:20 am to 12:20 pm)

11:20 am
COVID-19 Impact on Aerosol Concentrations in Urban Areas
David Moore
Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, New York

11:40 am
Analysis and Verification of Experimental Wet Bulb Globe Temperature Forecasts in Urban NY Locations
Dave Radell
NOAA/NWS Weather Forecast Office, New York City/Upton, New York

12:00 pm
Diagnosing the Relationship between Flash Flooding and NYSM Soil Moisture
Andrew Lunavictoria
New York State Mesonet
University at Albany, State University of New York, Albany, New York

12:20 pm – 1:40 pm
Lunch

<u>Session I – Winter Weather</u> (1:40 pm to 3:00 pm)

1:40 pm
WPC Winter Desk Operations 2020/2021
Bryan Jackson
NOAA/NWS Weather Prediction Center, College Park, Maryland

2:00 pm
Lessons Learned from the First Two Years of NWS Snow Squall Warnings
Jared R. Klein
NOAA/NWS Weather Forecast Office, Binghamton, New York

2:20 pm
Antecedent Road and Air Conditions Associated with High-Impact Snow Squalls
Michael Colbert
NOAA/NWS Weather Forecast Office, State College, Pennsylvania

2:40 pm
Quantifying Snowpack Error in the NOAA National Water Model for the Northeastern United States
Patrick Naple
Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, New York

3:00 pm – 3:15 pm
Break

NROW XXI Key Note Presentation (3:15 pm to 4:00 pm)

Introduction: Neil Stuart

Ready or Not: Understanding how End-users Obtain, Interpret, and Respond to Official and Unofficial Forecast Information
Dr. Amber Silver
College of Emergency Preparedness, Homeland Security and Cybersecurity
University at Albany, State University of New York, Albany, New York

4:00 pm – Wrap Up/Adjourn
Brian J. Frugis

NROW XXII is scheduled for November 3–4, 2021

Hydrometeorological Characteristics of Ice Jams on the Pemigewasset River in Central New Hampshire

Jason M. Cordeira[1], Matthew C. Sanders[1] and Nicholas D. Metz[2]
[1]Meteorology Program, Plymouth State University, Plymouth, New Hampshire
[2]Department of Geoscience, Hobart and William Smith Colleges, Geneva, New York

Ice jams that occurred on the Pemigewasset River draining the western White Mountains in central New Hampshire on 26 February 2017 and 13 January 2018 resulted in significant localized flooding in the towns of Plymouth and Holderness. The precipitation events that preceded these floods occurred in association with regions of enhanced moisture transport characteristic of atmospheric rivers (ARs) that resulted in rain-on-snow, snow-pack ablation, and rapid increases in streamflow across central New Hampshire. Two case studies illustrate different antecedent characteristics that ultimately yielded similar ice jams. The February 2017 event featured a "long melting period with low precipitation" scenario, with several days of warm (~5˚–20˚C) maximum surface temperatures that resulted in extensive snowmelt followed by short-duration, weak AR that produced ~10–15 mm of precipitation during a 6-h period prior to the formation of the ice jam. Alternatively, the January 2018 event featured a "short melting period with high precipitation" scenario with snowmelt that occurred primarily during a more intense and long-duration AR that produced in >50 mm of rainfall during a 30-h period prior to the formation of the ice jam. Composite analysis of 20 ice jam events during 1981–2019 illustrates that 19 of 20 events were preceded by environments characterized by ARs along the U.S. East Coast and occur in association with a composite corridor of enhanced integrated water vapor >25 mm collocated with integrated water vapor transport magnitudes >600 kg m^{-1} s^{-1}. Additional analyses suggest that most ice jams on the Pemigewasset River share many common synoptic-scale antecedent meteorological characteristics that may provide situational awareness for future events.

The Record Breaking Floods of October 31-November 1, 2019 in New York and northern Vermont

Neal M. Strauss
NOAA/NWS/Northeast River Forecast Center, Boston/Norton, Massachusetts

A significant record-breaking flood event impacted central and eastern New York, and northern Vermont on October 31 through November 1, 2019. The flooding was a result of the combination of extremely moist antecedent conditions and a brief period of heavy rainfall on October 31; most of the rainfall occurring in less than 12 hours.

This record setting event was set up by a wet month of October. A significant rainfall event occurred on October 16-17, 2019. One to three plus inches of rain was reported across some of these same areas and five forecast points recorded minor flooding. This allowed antecedent moisture conditions to become much wetter than normal leading up to October 31. For the month of October 2019 rainfall totals would climb to near record values across portions of the region.

This presentation will review the event from a perspective of both the hydrologic setup and the presence of an Atmospheric River which developed during the following October 31-November 1 event. Favorable moisture, lift and instability were key contributors to rainfall totals of two to five inches with locally higher point totals during the event. This heavy rainfall occurring atop already saturated ground led to twenty-two forecast locations reaching flood stage, eight locations exceeding major flood stage, and five locations experiencing record flooding.

A Meteorological Review of the 31 October –1 November 2019 Historic Flooding Event across Eastern New York

Victoria Zenobio[1] and Christina Speciale[2]
[1]Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, New York
[2]NOAA/NWS/WFO Albany, New York

A rapidly intensifying low pressure system on 31 October 2019 associated with a negatively tilted trough traveled into the Northeast and resulted in a prolonged period of heavy rainfall. The anomalously strong southwesterly winds associated with this system directed a plume of anomalously significant warm and moisture rich air out of the Gulf of Mexico and into the Northeast, including the high terrain of the southern Adirondacks of New York. The 850hPa moisture flux values initially at 4 standard deviations above normal quickly exceeded 6 standard deviations as the surface low deepened from 1000hPa to 984hPa in just 24 hours as it traveled along the Saint Lawrence River Valley. Precipitable water values measured on the ALY 00 UTC 01 November Upper Air Sounding measured 1.88 inches (47.75 mm) which ranks as a climatological maximum for this date. The attendant cold front in the presence of a high shear low cape environment also produced a line of convection that resulted in numerous damaging wind reports in the National Weather Service (NWS) Albany, NY County Warning Area. The period of heavy rainfall in the presence of moistened soils from an antecedent rainfall event on 16-17 October 2019 allowed for substantial runoff on area rivers and streams, causing multiple river gauges in the southern Adirondacks to reach record high crest levels.

This presentation will give a synoptic overview of the event and highlight key meteorological features that likely contributed to the historic flooding observed in the southern Adirondacks of New York. Directly following this event, Senior Service Hydrologist of the NWS Albany, NY office Britt Westergard will present a detailed overview of the river flooding aspect of this event.

When the Rivers Rose Scary Fast: Hydrology of the Record Halloween 2019 Flood in the Albany, NY NWS Service Area

Britt E. Westergard
NOAA/NWS/WFO Albany, New York

Heavy rainfall across eastern New York (NY) and western New England from 31 October to 1 November led to a maximum area of storm total precipitation of 5 to 7 inches (12 to nearly 18 cm) across the western Adirondack Mountains, Mohawk valley and Lake George-Saratoga region. A secondary maximum of 2 to 3.5 inches (5 to nearly 9 cm) fell across the elevated terrain of the Catskills in Greene and Ulster County. Elsewhere, widespread rainfall amounts were in excess of 1 inch (2.5 cm) across a large portion of eastern New York. Record flooding occurred at four forecast points in the NWS Albany Hydrologic Service Area and thirteen of NWS Albany's river forecast points experienced flooding as a result of the excessive runoff. This presentation will review both the hydrologic effects and impacts of this event and the operational challenges of forecasting widespread rapid rises to record flooding.

Sensitivity of Forecast Precipitation Type to WRF Boundary Layer Parameterizations over Complex Terrain

Matthew R Seymour and Justin R Minder
Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, New York

Predictability challenges are heightened in winter weather forecasting when the environment for high-impact weather is marginal or varies over short distances. High-resolution numerical weather prediction (NWP) is useful for constraining forecasts. However, its use can be challenging in marginal, near-freezing, situations when precipitation type is uncertain. The skill of NWP is limited, in part, by uncertainties in parameterizations of planetary boundary layer (PBL) turbulence. Complex terrain, such as that of the Mohawk and Hudson Valleys in eastern New York, contribute to shaping these hard to represent processes by inducing significant changes in temperature, precipitation type and intensity.

On 6-7 February 2020, a multi-phase winter weather event impacted eastern New York. Isentropic lift and warm-air advection produced light snow, sleet and freezing rain (FZRA) the morning of 6 February. Later that day, light FZRA persisted north of a stationary front, mainly along and north of Interstate 90. On 7 February, a strongly forced deformation band impacted the region with rain/FZRA switching to a brief period of heavy snow. The event produced 6-12" of snow in the Mohawk and upper Hudson Valleys, and .25-.5" of FZRA accretion – more than forecast – north of Albany into the southeastern Adirondacks and Berkshires.

In this study, we analyzed the Weather Research and Forecasting (WRF) model's performance in simulating temperature, moisture, wind, and precipitation during the event, using a HRRR-like configuration. PBL parameterizations are altered in experimental runs, in order to determine how uncertainty in PBL processes contribute to forecast uncertainty. WRF simulations are validated against ASOS and NYS Mesonet observations, and soundings from the National Weather Service in Albany, NY. Preliminary results indicated a pronounced warm bias across the full PBL suite of experiments, with the MYNN and YSU PBL schemes significantly warmer compared to the MYJ. The warm bias contributed to a rain vs. FZRA precipitation type bias, especially on 7 February. Several factors, including error in stationary frontal positioning, terrain-altered flow, PBL mixing processes, surface radiative fluxes, and snow depth, potentially contributed to furthering the warm bias.

Modeling Convective Mode Changes in Complex Terrain in the Northeast U.S.

Brennan Stutsrim
Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, New York

August 2019 was an unusually active month for severe convection in the Northeast United States. There were reports of hail, tornadoes, damaging winds, and/or flash flooding on 11 days in August. Since a number of these events presented challenging forecast situations with diverse convective behavior and hazardous weather impacts, we seek to better understand how interactions between the synoptic and mesoscale environment, terrain, and convection impacted the event outcomes.

Upper-level maps from the Climate Forecast System Reanalysis (CFSR) were analyzed. The 300-hPa wind and 500-hPa vorticity showed that these cases often were characterized by weak synoptic forcing (low-to-moderate shear), which tends to favor discrete, pulse-like and multicellular convection. Radar showed that these storms tended to change convective mode, as the storms moved off of the higher terrain of the Catskills into the Hudson Valley, often coinciding with severe weather reports. Some storms also exhibited back-building or quasi-stationary behavior once reaching the Hudson Valley, increasing the threat of heavy rainfall and flash flooding.

One of the events on 21 August 2019 produced of a tornado in Saratoga County, damaging winds, hail, and over 45 mm (1.8”) of rain over a short period of time in the upper Hudson Valley. The convective mode changed from discrete to multicellular convection, growing upscale. To explore the mesoscale details in this case, High Resolution Rapid Refresh (HRRR) analyses and New York State Mesonet data were used to study the mesoscale interactions between the background flow and complex terrain features in and around the Hudson Valley. WRF simulations with HRRR-like physics, initialized with HRRR analyses, were used to study the evolution of the flow channeling, convective cold pools and simulated convection for the event. It was found that channeled flow up the Hudson Valley created a low-level maximum in water vapor flux upstream of the convective cold pool. The high equivalent potential temperature air was lifted over the outflow boundary, initiating new convective cells. The new cells were trained along the convective line by the deep shear vector, reinforcing the cold pool with evaporatively cooled air and creating a region of parallel stratiform precipitation downshear.

Precipitation forecast sensitivity to horizontal grid spacing in convection-allowing models over the central–eastern United States

Craig S. Schwartz and Ryan A. Sobash
National Center for Atmospheric Research, Boulder, Colorado

This presentation will describe results from 497 retrospective, deterministic, 36-h Weather Research and Forecasting (WRF) model forecasts with 3- and 1-km horizontal grid spacing over the conterminous United States (CONUS) east of the Rockies, with a focus on next-day (18–36-h) precipitation forecasts. The 497 cases were chosen based on observed severe weather events occurring between 2010–2017 and spanned both the warm and cool seasons. This unprecedented sample size permitted an exploration of how convection-allowing model sensitivity to horizontal grid spacing varied seasonally and geographically, and although results covering the eastern two-thirds of the CONUS will be detailed, special attention will be given to model performance over the northeast.

In general, 1-km model climatologies of precipitation aligned better with those observed than 3-km climatologies, especially during the warm season in the northeast, where 3-km forecasts grossly overpredicted rainfall > 10.0 mm/h. Regarding precipitation placement, during summertime, when synoptic-scale forcing was weak and precipitation entities were small, 3- and 1-km forecasts had similar skill over all regions east of the Rockies. Conversely, during the cool season and spring, when large-scale forcing was strong and precipitation entities were large, 1-km forecasts were more skillful than 3-km forecasts, particularly over southern portions of the CONUS, whereas 1-km grid spacing yielded lesser benefits over northern regions like the northeast.

These findings have important implications for future operational modeling systems and provide guidance about when and where 1-km horizontal grid spacing is most likely to be beneficial for precipitation forecasting, which could be used to optimize computing resources and inform potential "on-demand" 1-km forecasts.

CSTAR Update: Ensemble Clustering and Improving Communication of Uncertainty and Risk through Innovative Forecaster Workshops

Brian A. Colle[1], Benjamin Kiel[1], Rosemary Auld[2], Kenneth Johnson[2], Christine O'Connell[3], Temis G. Taylor[4], and Joshua Rice[4]
[1] Stony Brook University, New York
[2] NOAA/NWS Eastern Region Headquarters
[3] ED Riley's Way Foundation
[4] Alan Alda Center for Communicating Science, Stony Brook University, New York

Communicating uncertainty for high-impact weather events to the public and decision makers can be challenging. This project addresses the need for more tool/graphics to display ensemble data as well as better communication of uncertainty information. This talk will provide an update on the Stony Brook CSTAR activities, which includes an update on different clustering approaches as applied to the GEFS, ECMWF, and CMC ensembles forecasting U.S. East coast winter storms. This presentation will then review two workshops we had in the past two years to help NWS forecasters improve communication skills and stakeholder interaction.

Several clustering methods, including hierarchical based approaches (e.g., Agglomerative Hierarchical Clustering), density based approaches (e.g., Density Based Spatial Clustering With Noise), and centroid based approaches (e.g., K-Means Clustering, Fuzzy Clustering), are available. A comparison of multiple clustering approaches, whether using different clustering algorithms or different clustering spaces, has not been performed utilizing model ensembles. This study will focus on the clustering of extratropical cyclone solutions in GEFS, ECMWF, and CMC ensembles (90 members) as well as the associated precipitation. The goal is to generate distinct scenarios from model ensembles, which can be easily interpretable by an operational forecaster. This presentation will compare the clustering methods for a specific cyclone event on 27 December 2012. The future work will compare the approaches for over 50 cyclones in the last several years.

In order to help forecasters with communication skills, two 1.5-day workshops in collaboration with the Alan Alda Center at Stony Brook helped 15-20 forecasters distill their message and more effectively engage and communicate risk and uncertainty to decision makers, media, and the general public. The novel aspect of the first workshop focused on using improvisational techniques to help connect with the audience as well as exercises to improve communication skills using short, clear, conversational statements. The same forecasters participated in the 2nd workshop, with a focus on matching the message to the audience and stakeholder interaction. Using a recent high-impact weather event, feedback was provided to the forecasters on their short (2-3 minute) oral presentations and a visual slide from representatives in emergency management, TV media, departments of transportation, and emergency services. This presentation will highlight some of the innovative workshop approaches and techniques used, as well as share some of the participant feedback. The future work, which will likely have an online component, could help the broader forecast community.

CSTAR Update: Assessing Warm Season Model QPF in New England

Justin Arnott[2], Michael Cempa[2], Rodney Chai[3], Margaret Curtis[2], Todd Foisy[1], Christopher Legro[2], Matthew Strauser[1], and Bryce Williams[3]
[1]NOAA/NWS/WFO Caribou, Maine
[2]NOAA/NWS/WFO Gray, Maine
[3]NOAA/NWS/WFO Boston/Norton, Massachusetts

Quantitative precipitation forecasts (QPF) have long been difficult for numerical weather prediction to produce accurately. This is especially true in the warm season where weaker synoptic scale forcing and convective processes dominate. Frequently the result is a modeled areal extent of high QPF that is too large, with a resulting overestimation of the heavy rain and flooding threats.

In this project we aim to address how forecasters can best identify situations when operational guidance will be skillful regarding coverage, location, and maximum QPF. This project leverages convection allowing model (CAM) ensemble guidance during the 2015-2019 warm seasons, providing a probabilistic framework in addition to deterministic forecasts. Project goals include: identifying observed high QPF warm season events in the Northeast during this five-year period, categorizing events that featured strong or weak CAM ensemble QPF performance, and classifying synoptic and mesoscale patterns associated with the aforementioned categories. This information will be compiled into forecaster guides to improve situational awareness of patterns correlating to relatively high or low CAM ensemble QPF skill.

This talk will provide an update on project activities to date. After describing the approach for identifying observed widespread high QPF events as well as those forecast by CAM ensembles, we will review the five-year climatology of observed events followed by a brief analysis of NWS hydrology headlines for these events.

A Multi-Scale Analysis of the 29 August 2020 Tornadic Event across Eastern New York

Thomas A. Wasula and Brian J. Frugis
NOAA/NWS/WFO, Albany, New York

On 29 August 2020, a major severe weather event including tornadoes occurred across much of eastern New York (NY). The NCEP Storm Prediction Center posted a Slight Risk in the morning for much of eastern NY, eastern Pennsylvania, New Jersey, and western New England. Eastern NY and western New England typically have 3 tornado occurrences a season. A tornado event occurred on 27 August 2020 a few days earlier with a couple of touchdowns in the eastern Catskills, and northwest Connecticut. Two EF-1 tornadoes would occur this afternoon from supercells across eastern NY in an area where SPC had 5% tornado probabilities within the Capital Region and Upper Hudson Valley. The tornadoes this day would bring the seasonal total to twelve to the Albany forecast area. The NWS at Albany forecast area had 11 severe reports which were mostly wind damage (winds ≥ 50 knots), a few large hail (≥ 2.54 cm in diameter) and the two tornadoes with this event.

Observational data, as well as SPC Rapid Refresh Mesoanalysis data suggested a major severe weather outbreak would likely occur. A strong 500 hPa short-wave trough would be approaching from the Great Lake Region with a supportive 250 hPa 100+ knot jet streak that would reach upstate NY in the late afternoon. A warm front would lift north of the Mohawk Valley and Capital Region with sufficient surface heating and destabilization during the day. Precipitable water values would be anomalous in the 1.50 to 2.00 inch range with some low-level moisture from the remnant circulation of Tropical Cyclone Laura passing over the Mid-Atlantic States. Mixed layer convective available potential energy values were in the 500-1500 J kg^{-1} range with marginal mid-level lapse rates and low lifting condensation level heights. The effective bulk shear values were in the 35-45 knot range supportive for supercells with rotating updrafts capable of producing tornadoes. 0-1 km storm-relative helicity values were in the 100-200 m^2 s^{-2} in the afternoon with increasing low-level backed flow in the Hudson River Valley enhancing the tornado threat.

This talk will focus on a detailed mesoscale and radar analysis of the tornadic event. Traditional base and derived WSR-88D radar products will also be shown in the analysis. The storm-scale analysis will focus on helpful forecast techniques, including applying results from a normalized rotation (N_{rot}) and tornado V-R Shear studies to determine what caused the tornadoes. Also, utilization of NYS Mesonet observations, and MRMS 0-2 km AGL Low-Level Azimuthal Shear Tracks will be shown in the tornadic analysis.

May 15, 2020 Severe Thunderstorms in Southern New England

Joseph. W. DelliCarpini
NOAA/NWS/WFO Boston/Norton, Massachusetts

On May 15, 2020 a line of severe thunderstorms produced widespread wind damage from central New York to southern New England. Damage was especially severe in Pepperell and Groton, Massachusetts where a microburst with winds of 90 to 100 mph downed or uprooted dozens of trees and caused damage to houses.

The arrival of a robust mid level trough was able to compensate for a lack of instability and marginal mid level lapse rates to help generate the line of severe thunderstorms. Leading up to the event, several high-resolution guidance models suggested the potential for discrete supercells to form in advance of the line of storms, presenting an increased potential for tornadoes. However, short wave ridging over New England provided enough of a cap to suppress convection, and the slower arrival of the mid level trough delayed moisture and instability advection into New England.

This presentation will review the synoptic and mesoscale environments leading up to this event, including a review of model guidance. The importance of using neighboring WSR-88Ds and other sources in the Warning Decision Making process will also be discussed, since the Taunton, MA WSR-88D was out of service that week due to a Service Life Extension Project upgrade.

Tools to Improve Tornado Warning Performance for Supercells: Z_{DR}/K_{DP} Separation and Size Sorting Signals

Michael L. Jurewicz, Sr.[1], Scott Loeffler[2], Matthew R. Kumjian[2], and Michael French[3]
[1]NOAA/NWS/WFO State College, Pennsylvania
[2]The Pennsylvania State University, State College, Pennsylvania
[3]Stony Brook University, Stony Brook, New York

Previous work investigated the possibility of utilizing certain dual-polarization radar fields (Z_{DR} and K_{DP}) to help discriminate between tornadic and non-tornadic storms. The main strategy was to infer trends in near-storm environmental vertical wind shear by evaluating the resulting raindrop size sorting. Later research demonstrated, via idealized numerical simulations, that hydrometeor size sorting is not fundamental to wind shear, but rather to the storm-relative flow itself. However, it was also noted that, particularly in supercell environments, storm-relative flow (using the degree of drop size sorting as a proxy) and lower tropospheric storm-relative helicity (SRH) are likely well correlated. As such, in supercell environments, it is hypothesized that patterns of Z_{DR} and K_{DP} can identify important trends in storm-relative flow and SRH, thereby helping to diagnose a storm's tornadic potential.

To further build on earlier studies and test the hypotheses outlined above, 113 supercell storms (both tornadic and non-tornadic) across geographically diverse regions of the United States were evaluated. Newly developed analysis tools and visualization techniques were used to quantify the separation between Z_{DR} areal maxima in the Z_{DR} arc region and K_{DP} areal maxima within the K_{DP} foot. These radar signatures, when compared to mean storm motions, were then used to infer highly localized modulations of storm-relative flow and SRH over time.

Ongoing efforts to incorporate the outlined research results into National Weather Service (NWS) tornado warning operations, including those specifically undertaken as part of the NWS Central Region Tornado Warning Improvement Project (TWIP), will be discussed, along with future work.

Application of Diagnostic Techniques from the Tornado Warning Improvement Project to Two Tornadic Convective Storms in the Albany, NY County Warning Area

Michael Evans
NOAA/NWS/WFO Albany, New York

Radar and environmental data from two convective storms occurring within the Albany, NY county warning area in 2020 are shown to demonstrate techniques for diagnosing tornado potential as recommended by the National Weather Service's tornado warning improvement project. The first storm was a quasi-linear convective system that tracked across the Saratoga region on May 15, 2020 and produced an EF-1 tornado near Saratoga Springs. The three ingredients method is applied to this storm to demonstrate its potential to produce intensifying meso-vortices, and several confidence builders and nudgers are highlighted which indicated an increased potential for tornadoes with this system. The second storm was a discrete supercell which tracked across northwestern Connecticut and western Massachusetts on August 2, 2020, producing one EF-1 tornado and 3 EF-0 tornadoes. The potential for increasing low-level, storm-scale storm-relative helicity with this storm is diagnosed by examining trends in the magnitude of the angle between the vector defined by the distance between differential reflectivity (Zdr) and specific differential phase (kdp) maxima, and the vector associated with the storm motion. In this case, tornado potential appeared to increase when the angle trended toward 90 degrees as the Zdr maxima surged downstream, relative to the kdp maxima.

The 7 October 2020 Severe Weather Event across Upstate New York and New England

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This presentation will outline many facets of the 7 October 2020 severe weather event across portions of Upstate New York and New England. Shallow-topped convection quickly organized into a quasi-linear convective system (QLCS) while crossing Lake Ontario in the early afternoon. The squall line quickly moved eastward at 40–50 kt, taking about six hours to reach the New England coast. There were 250 storm reports of wind damage and severe wind gusts (≥ 50 kt) that were concentrated in a west to east swath between Central New York and Cape Cod. The storms knocked out power to over one-half million customers in New York and Massachusetts, including around 250,000 outages in the Greater Albany area.

A deep upper trough combined with strong tropospheric-deep wind provided support to maintain convection. Steep low-level lapse rates in the warm sector ahead of a cold front compensated for modest instability (surface-based CAPE < 500 J/kg) and moisture (dewpoints in the low to mid 50s), and may have been a key mechanism for these storms to produce severe winds through downward momentum transfer of 50–60 kt winds near the top of the boundary layer. Past studies have shown low-level lapse rates to be a key discriminator for significant severe storms in high-shear, low-CAPE (HSLC) environments (Sherburn and Parker 2014). An investigation into the performance of convective-allowing models (CAMs) and CAM ensembles will also be highlighted in this presentation.

Meteorologists faced many challenges before and during this event, including messaging forecasts for a low-predictability event as is common with HSLC setups. While the Storm Prediction Center highlighted most of the affected region in a marginal risk for severe thunderstorms as far back as two days before the event, this event had a much larger footprint and impact compared to a typical low-end severe weather event. Additionally, WSR-88D radars at KGBM and KTYX were down as the storms went through Central New York. Meteorologists at the National Weather Service Weather Forecast Office in Binghamton, NY were faced with short-fused warning decisions for an area of unusually poor radar coverage (the radar beam from the closest working radars, KBUF and KENX, overshot the low-topped convection).

Recap of Tropical Storm Isaias and its Hydrological Comparison to Irene and Floyd across the NWS Albany CWA

Brett Rathbun
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On 4 August 2020, Tropical Storm Isaias tracked across the northeastern United States, bringing heavy rainfall and strong winds to the entire National Weather Service Albany, New York County Warning Area. While the majority of the forecast area received at least 1 inch of rainfall, a zone from the eastern Catskills through the Capital District and into the Lake George/Saratoga Region picked up 3 to 5 inches of rain with localized amounts up to 7 inches! The 3.92 inches of rain at the Albany International Airport on 4 August 2020 was a daily record rainfall and now stands as the 4th wettest day on record for the site. Strong winds were also a factor with Isaias as 30 to 50 mph wind gusts were common which resulted in numerous reports of downed trees and power lines. Power outages occurred as a result with the worst damage across Litchfield County, Connecticut. The heavy rainfall resulted in localized flash flooding, mainly across urban areas. However, no river flooding occurred with this storm.

A brief synoptic recap of Isaias was done, analyzing upper-air patterns and 700 and 850 hPa Frontogenesis, which performed well in tracking the band of heavy rainfall. This event was also reminiscent of a Predecessor Rainfall Event (PRE) per previous CSTAR research in which tropical moisture is advected poleward of a tropical cyclone and interacts with ascent in the right entrance region of a southwesterly upper-level jet.

Finally, a comparison was done regarding the hydrological impacts of Isaias to previous tropical systems Irene (2011) and Floyd (1999). All three storms had fairly similar storm tracks, but the pre-storm hydrological environment differed. Irene impacted the area which was anomalously wet with year-to-date rainfall running 3 to 7 inches above normal. The additional rainfall resulted in widespread river flooding across the region. Isaias and Floyd entered a much drier environment where year-to-date rainfall was running more than 3 inches below normal and drought conditions were present across the region, with rivers and streamflows running below normal as well. Despite the heavy rainfall, year-to-date rainfall remained near to below normal in the wake of both Isaias and Floyd. It is believed the differences in the yearly normal rainfall in advance of these tropical systems was one of the main determining factors with regards to whether or not river flooding would be an issue.

Not Just a Tropical Storm: Hurricane Isaias and its Impacts to the Greater New York City Metropolitan Area

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Hurricane Isaias was the most impactful tropical system for the Tri-state area (NY, NJ, and CT) since Hurricane Sandy in 2012. Though Hurricane Isaias struck the area on August 4th, 2020 as a strong tropical storm with winds 58-73 mph, it produced hurricane force gusts greater than 75 mph causing widespread damage throughout New York City, Long Island, northeast New Jersey, and portions of southern Connecticut. Moreover, the storm left 2.5 million people without power and even spawned an EF-1 tornado near Westport, CT.

In the days leading up to landfall, the National Weather Service Weather Forecast Office New York NY conducted numerous briefings with regional, state and local public safety partners, such as NYS and NJS OEMs, NYCEM, Port Authority, and USCG, to provide them actionable information to protect lives and property. In the aftermath, Isaias has established itself as a new and recent benchmark for tropical storm damage potential in terms of tree damage and power outages. Ultimately, Isaias is a reminder that every storm has its unique threats and challenges. This presentation serves as a detailed summary of Hurricane Isaias, lessons learned from the system, and how a storm of its caliber can affect the Greater New York City Metropolitan area.

Sources of Large Track Errors in Ensemble Forecasts of Hurricane Isaias (2020) as Compared to Past Tropical Cyclones

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Models have overall improved throughout the last three decades in their ability to forecast the tracks of North Atlantic tropical cyclones (TCs). However, even the most reliable models can still have medium-range (day 3-5) track errors multiple times larger than climatology, as seen with Hurricanes Sandy (2012) and Joaquin (2015). These cases raise questions regarding whether abnormally poor track forecasts are associated with common steering patterns that are inherently unpredictable or that tend to have systematic model biases. How sensitive are the track forecasts to changes in these patterns and can the errors be traced to the initial conditions?

The verification by Leonardo and Colle (2020) is extended to include the 2008-2020 North Atlantic hurricane seasons. The track forecasts by the GEFS (21 members) and ECMWF (51 members) ensembles are verified by the NHC best-track data. The largest ensemble mean along- and cross-track errors from each day 3-5 forecast are analyzed. The forecasts are defined as "ET" ("non-ET") cases based on the cyclone phase space diagram (Hart 2003) and whether the observed TC (never) crosses north of 30°N at any time in the forecast, thereby separating TC's strongly interacting with mid-latitude baroclinic systems. For ET and non-ET cases separately, the top 20% most negative and most positive of these along- (cross-track) errors are considered "slow" and "fast" ("left" and "right"), respectively. Differences in synoptic fields are composited between members with contrasting directional biases in each of these cases.

We will demonstrate that similar mechanisms behind the large track biases of many past cases were also apparent in different stages of Hurricane Isaias (2020). The GEFS had a 200-300-km right-of-track bias for several forecasts initialized prior to Isaias curving north of northwest on 0000 UTC 30 July. Preliminary results suggest that much of this right-of-track bias corresponded to excessive convection and upper-level divergence expanding north of Isaias within the first 36 h of the forecast, inducing height falls along the south and southwestern edge of a 700-hPa subtropical ridge. In the forecasts later verifying Isaias while it began undergoing extratropical transition on 0000 UTC 4 August, the GEFS and ECMWF both had negative along-track (slow) biases of -400 to -600 km. The slow biases corresponded to an initial weak bias in the amplitude of an upstream 300-hPa trough-ridge couplet over southern Canada. Developing weak biases in Isaias's divergent outflow and its advection of PV further worsened the underamplification of the approaching trough-ridge couplet by ~36 h. Additional tests will determine if these developing biases involving moist convective processes can be traced to initial conditions errors near Isaias.

Investigating the Forecast Challenges from a Quick-Hitting Heavy Snow Event in Central New York and Northeastern Pennsylvania on 7 February 2020

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A major winter storm impacted Central New York (CNY) and the Twin Tiers region on 7 February 2020. A southwest to northeast oriented band of heavy snow with amounts ranging from 6–12 inches (locally 14 inches) fell across the area. Much lower snowfall totals (1–4 inches) were observed farther south and east across the Catskills and Northeastern Pennsylvania (NEPA) where a residual warm layer closer to the low track kept precipitation mainly a wintry mix. This event stands out for being such a quick-hitting storm with most of the snowfall and high impacts occurring in less than a six-hour period on the morning of the 7th. Several locations in CNY and the Twin Tiers reached National Weather Service (NWS) Winter Storm Warning criteria in as little as three hours.

Verification of snowfall forecasts from the NWS Weather Forecast Office in Binghamton, NY (WFO BGM) was conducted using the Gridded Automated Zonal Precipitation and Complete Hi-res Output (GAZPACHO) software. Overall, the analysis revealed relatively small forecast biases in snowfall. However, errors in orientation and placement of the axis of heavy snow were noted initially with the forecast from the Winter Storm Watch issuance (24–30 hours before the event). Subsequent forecasts were able to better resolve the details of the mesoscale banding. This improvement could perhaps be tied to the availability of convective-allowing models (CAMs) within 24 hours. This presentation will also highlight the performance of CAM and CAM ensemble guidance for this event with respect to mesoscale snow bands.

Although the results from the verification analysis indicate skillful storm-total snowfall forecasts, it doesn't tell the whole story. Precipitation type and intense snowfall rates within mesoscale snow bands on the northwest side of low were especially challenging to forecast for this storm. Predicting the timing of the changeover from mixed precipitation to heavy snow was a high-stakes decision as timing errors of just a couple of hours during the peak of the storm could have made the difference between a location receiving 2–3 inches versus 8–12 inches. The challenges of messaging forecast uncertainty, especially given large ranges of plausible outcomes in snowfall accumulations, will be discussed. One possible solution would be to use dynamic range bins (instead of the standard 1–2, 2–4, 4–6, etc.) on NWS snowfall forecast graphics that are based on probabilistic snowfall guidance and forecaster confidence.

Some of the unique real-time observing tools from the NASA IMPACTS field campaign that WFO BGM had access to during the 7 February 2020 event will be highlighted. Forecasters were able to leverage these observations to make near-term adjustments to precipitation type forecasts.

Structure and Evolution of the Banded Precipitation during the 7 February 2020 Cyclone Event during IMPACTS

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The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) is a field campaign operated by NASA to better understand the structure of mesoscale snow bands. Although significant research has gone into single bands, much remains unknown about smaller multi-bands. Additionally, it is not well understood what conditions help cause multi-bands, and the small time and length scale of these bands make them difficult to forecast. The remote sensing instruments on the high-altitude ER-2 aircraft and the microphysics probes on the P-3 aircraft provide highly detailed observations of the ambient and in situ conditions within a storm. Additional observations are also provided from ground-based and mobile radars, rawinsonde launches from the National Weather Service and mobile sounding units, and the New York State mesonet. The first year of the campaign was completed from mid-January through February of 2020, and it will last two more winters.

This talk will highlight the February 7, 2020, case study, which follows a developing cyclone along the Appalachian Mountains. For this case, both the ER-2 and P-3 flew multiple flight legs within the storm, with three coordinated legs from 1500 UTC to 1600 UTC. Observed features include many wavelike features in visible satellite, a strong "bright band" signal from the sharply defined melting layer and precipitation type transition zone, and otherwise ill-defined banding features. Structures resembling mesoscale snow bands are hard to distinguish from the melting bright band until after 1400 UTC, as colder air moved into the region and the freezing level dropped. One primary band appears to develop after 1600 UTC in central New York and propagate eastward, weakening after 2000 UTC as it moves into Vermont.

The lack of banding in this event is unexpected given the environmental conditions typical of band-producing snowstorms. Despite a very strong jet, strong frontogenesis, low stability, and a rapidly deepening cyclone, this case failed to produce a coherent snow band for much of the time of interest. Additionally, despite the appearance of gravity waves from visible satellite, there are no clear multi-band features. Toward the end of the flights, as the cyclone continued to deepen and the 700 hPa low became better defined, a primary band-like feature began to organize. To investigate some of these features and the change in banding, WRF version 4.0 was configured and set up over the region. Two different initialization times and two different microphysics parameterizations were run, for a total of four simulations. A comparison of key features from the model output with observations from both aircraft will be presented. Although this storm is somewhat of a "null" case, it lends itself for a comparison with storms that do produce coherent multi-bands.

Retrospective Analysis of the 25-27 November 1950 “Great Appalachian Storm”

Kevin S. Lipton
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One of the most impactful storms of the 20th century affected the northeast U.S. and New England on 25-27 November 1950. Although the track of the storm was across the Mid-Atlantic States and northern Appalachians, significant effects from wind and coastal flooding occurred throughout the northeast U.S. and New England. The extreme impacts from this storm led to approximately 383 deaths, and nearly $700 million in damage (adjusting for inflation).

This presentation will examine the track, wind and precipitation distribution and impacts, and synoptic characteristics associated with the storm, with particular emphasis on the northeast U.S. and New England. Analyses will include tropospheric circulation patterns and anomalies before and during the storm utilizing the NCEP/NCAR and NOAA-CIRES 20th Century Reanalysis datasets.

Storm Tide Pathways: A Collaborative Effort to Mitigate the Impacts of Coastal Flooding

Joseph W. DelliCarpini
NOAA/NWS/WFO Boston/Norton, Massachusetts

Coastal flooding along the eastern Massachusetts coastline has become a more frequent occurrence in the context of sea level rise over the past several years. Flooding occurs from the combination of tide and storm surge (referred to as total water level) and damage is exacerbated by wave action on top of the surge. The more significant events, which can cause structural damage, are often associated with strong coastal storms such as nor'easters but even minor impacts do occur during high astronomical tides when no storm is present.

For decades, the National Weather Service (NWS) has issued Coastal Flood Watches, Warnings, and Advisories in a text-based format to inform decision makers and the public of coastal flooding. These products cover long reaches of coastline with limited specificity. Over the past several years, WFO Boston/Norton, MA has produced gridded forecasts of total water level and more recently integrated GIS technology to highlight specific areas at risk through visualization.

Storm tide pathways, by virtue of their elevation relative to the elevation of a storm tide, provide a direct hydraulic connection between coastal waters and low lying inland areas. The Center for Coastal Studies (CCS) in Provincetown, MA identifies and maps current storm tide pathways and those that may function as pathways in the future. When integrated with WFO Boston/Norton's inundation mapping of total water level forecasts, the storm tide pathway information can be used by emergency managers to prepare for coastal flooding events and to plan for future improvements.

This presentation will describe the NWS forecast process and show the methods used by CCS to develop Storm Tide Pathways for a community. Examples of how the information has been used by officials in Provincetown, MA to mitigate flood impacts will be shown in order to demonstrate the utility for other communities that are affected by coastal flooding.

Enhancement of IDSS and Public Interaction at NWS Boston/Norton during the COVID-19 Pandemic

Joseph W. DelliCarpini
NOAA/NWS/WFO Boston/Norton, Massachusetts

The COVID-19 pandemic has given the staff at WFO Boston/Norton, MA the opportunity to experiment with new ways of providing IDSS and interacting with the public.

Traditional conference calls by phone have been replaced by the use of video conferencing. Over the summer, the office began holding a weekly briefing on Mondays for state and larger city Emergency Managers in Connecticut, Massachusetts and Rhode Island which focus on potential hazardous weather for the next seven days. Storm-based briefings, such as those done for Tropical Storm Isaias in August, were also conducted by video conference. Feedback has been overwhelmingly positive and several Emergency Managers noted they prefer to interact with the office face-to-face since it helps them better understand our message.

The office's Science and Training Team developed an innovative way to increase science sharing and strengthen relationships with core partners and the public. Webinars have been used to share reviews of significant weather events and for topics of interest to broader audiences that focus on weather, climate, and historical weather events. These webinars have drawn large audiences and have helped develop a positive relationship between the NWS and those in local communities, enhancing weather safety in an effort to protect life and property.

This presentation will describe these new initiatives in more detail and will discuss best practices so that other NWS offices can consider implementing these new programs to help enhance IDSS and partner relationships.

Toward the Implementation of Near Real-Time Forecast Flood Inundation Mapping Services in the Northeast U.S.

David R. Vallee
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The NOAA National Weather Service (NWS) has a mission to issue forecasts for the protection of lives and property and the enhancement of the national economy. Partners across the nation have expressed an urgent need for the provision of more detailed flood forecasts and the resulting inundation. In support of the 2018-19 Department of Commerce/National Oceanic and Atmospheric Administration Agency Priority Goal (APG) to mitigate flood impacts, the NWS's Office of Water Prediction demonstrated a novel approach to real-time flood inundation mapping capability, implemented as a service, over the state of Texas. This capability uses the Height Above Nearest Drainage (HAND) method to infer forecast stage given forecast streamflow and forecast inundation extent given forecast stage.

Following the successful completion of the Texas Demonstration, a new 2020-21 Department of Commerce / National Oceanic and Atmospheric Administration APG has been established. Its purpose is to improve flood related decision support services by expanding the demonstration of a new flood inundation mapping capability to at least an additional 10% of the U.S. continental population residing in flood-vulnerable freshwater basins. Additional coverage includes population served with National Water Model (NWM) hydrography downstream from a subset of NWS official forecast locations throughout the continental U.S., plus populations in the NWS Northeast River Forecast Center (NERFC) service area served by the National Water Model Streamflow Predictions. An additional major milestone of the 2020-2021 APG is to develop and conduct tabletop exercises with core partners to demonstrate these new services and to have them apply these services in a simulated flood event.

This presentation will review these new experimental services, including several success stories since NERFC began leveraging these services in April of 2020. The presentation will also provide a brief overview of two planned Tabletop Exercises; one with core partners in Rhode Island based off the record floods of March 2010 Floods and a second with core partners in the Schoharie Valley of eastern New York based off the devastating floods associated with the passage of Tropical Storm Irene.

COVID-19 Impact on Aerosol Concentrations in Urban Areas

David Moore
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Since December 2019, the COVID-19 pandemic has created a variety of societal problems around the world. The COVID-19 outbreak within the United States started in January 2020 and had already claimed approximately 98,000 lives by June 2020. In March 2020, different states across the county issued lockdown policies as a precaution to stop the spread of COVID-19. The decrease in human mobility has resulted in changes in pollutant concentrations within densely-populated areas. This study analyzes weekly concentrations of particulate matter less than 2.5 µm ($PM_{2.5}$), ozone (O_3), and nitrogen dioxide (NO_2) from January to June 2020 in New York City, Los Angeles, and Houston to assess the degree to which each city's respective stay-at-home order caused deviations from past pollutant concentrations. Meteorological factors such as precipitation and wind direction are taken into consideration when evaluating the change in pollutant concentrations. Air quality data are obtained from the Environmental Protection Agency (EPA), the California Air Resources Board (CARB), and the Texas Commission of Environmental Quality (TCEQ). Meteorological data are obtained from the Automated Surface Observing Stations (ASOS) in each region. Results show below-average $PM_{2.5}$ concentrations across New York City after stay-at-home orders were issued from 22 March to 15 May 15. In Houston, however, $PM_{2.5}$ concentrations show an above-average trend through 1 May despite stay-at-home orders being issued on 1 April.

Analysis and Verification of Experimental Wet Bulb Globe Temperature Forecasts in Urban NY Locations

Dave Radell and Joe Pollina
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Excessive heat remains one of the most impactful types of sensible weather for urban areas. Additional emphasis has been placed on excessive heat forecasts recently due to the vast number of outdoor pandemic testing facilities in urban locations, with workers wearing additional protective clothing. While NWS heat index forecasts have traditionally been used in decision making for thermal stress potential, renewed interest has occurred nationally in the use of wet bulb globe temperature (WBGT). WBGT has been traditionally used by the military, schools, and athletic programs as a tool to assess heat stress for active individuals. As such, the NWS has begun a national effort to produce WBGT forecasts for use in Impact Based Decision Support Services (IDSS). For example, WFO New York utilized experimental forecasts of WBGT for decision support with NYC Office of Emergency Management, in support of the 2019 NYC Marathon.

Analysis and verification of experimental NDFD WBGT forecasts for several heat events this summer were conducted. While WFO New York did not explicitly produce WBGT forecasts in-house, its gridded temperature, sky cover, dewpoint and wind speed forecasts were used in the computation, which is performed centrally. Surface pressure, and solar radiation were computed centrally, at every grid point, to ultimately produce the WBGT at every grid point over the NDFD domain.

In order to assess the ‘goodness’ of the experimental WBGT forecasts for use in IDSS, verification was performed with two of Hofstra University's WBGT observing stations. This allowed for the direct verification of the WBGT, as well as the foundational NDFD component grids. Overall, there was a low bias in the experimental WBGT forecasts relative to the in-situ observations for the period examined. However, given the categorical nature of the WBGT for heat stress impacts, we gained some confidence that the forecasts are good, conditional on the accuracy of the NDFD foundational grids. This presentation will provide an overview of our verification results, with emphasis on WBGT use for IDSS.

Diagnosing the Relationship between Flash Flooding and NYSM Soil Moisture

Andrew Lunavictoria and Nick Bassill
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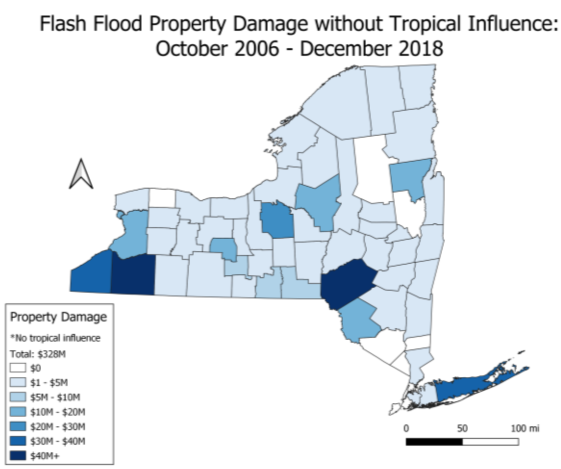
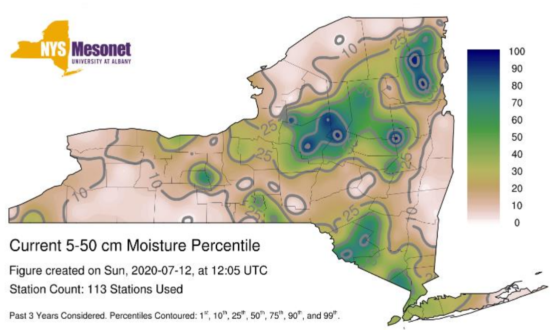
Flash flooding across New York State historically has posed a significant risk to life and property, and typically results from localized heavy precipitation, dam failures, or ice jams. Data from the National Centers for Environmental Information (NCEI) reports that between October 2006 and December 2018 an estimated $328 million in property damage was caused by localized heavy precipitation events (left figure below). For a more detailed review, the authors examined 220 flash flooding events in New York State from 2018-2019 as part of a COMET program grant. We separated the 220 events into two types: thunderstorm events and widespread rain events. By categorizing the events, we were able to determine if the characteristics in the soil moisture varied. Using data collected from the New York State Mesonet (NYSM; http://nysmesonet.org), a statewide network of 126 weather stations, we reviewed soil moisture percentiles (right figure below) and their relationship to precipitation totals and precipitation rates. This case study review evaluates what, if any, NYSM soil moisture data could help the National Weather Service in issuing flash flood warnings. This study is a first step towards understanding how NYSM soil moisture can be related to flash flooding in order to protect life and property across New York State.





WPC Winter Desk Operations 2020/2021

Bryan Jackson
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The Weather Prediction Center (WPC) Winter Weather Desk (WWD) provides deterministic and probabilistic forecasts in support of National Weather Service (NWS) winter services. There are a few exciting updates to the WPC WWD product suite for the winter of 2020-2021. This proposed presentation would be on these changes, information about methods used by WPC to produce deterministic and probabilistic wintry precipitation accumulation forecasts, and WPC winter forecast verification from this past winter.

The Winter Storm Outlook (WSO), defined as the probability of meeting 12 and 24 hour snow and ice accumulation criteria for Winter Storm Watches, has been extended from three to four days. Also, graphical output of the WSO now includes a contour at 80% probability. In order to accomplish this extension, the source ensemble, the WPC Super Ensemble (WSE) was expanded from 45 to 60 members and extended through Day 4. This upcoming winter is the second season to employ the Advanced Weather Interactive Processing System (AWIPS) Graphical Forecast Editor (GFE), which is the software used by NWS field offices, for WPC winter forecast production. A brief review of the methods used to calculate the probability of weather type (defined as the percent of the quantitative precipitation forecast to convert to the accumulation of wintry precipitation) and the snow-to-liquid and ice-to-liquid ratios would be included. WPC deterministic and probabilistic snow accumulation forecast verification would also be shown.

Lessons Learned from the First Two Years of NWS Snow Squall Warnings

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Snow squalls are mesoscale convective systems that produce a brief burst (lasting 15–30 minutes in most cases) of heavy snowfall, gusty winds, and near-zero visibility. Although short lived, travel conditions can rapidly deteriorate shortly after the onset of the snow squall, leading to multi-vehicle pile-ups on state highways and interstates. Recent studies have investigated different scenarios that produce a flash freeze in snow squalls as icy roads greatly increase the severity/risk of travel impacts. In order to better serve the National Weather Service (NWS) mission to protect life and property, the NWS began alerting the public and core partners of impending hazardous snow squalls by issuing Snow Squall Warnings (SQWs) since 2018 (the initial rollout was limited to six Weather Forecast Offices (WFOs) in early 2018 before expanding nationwide for winter 2018-19). The recent implementation of SQWs represents a paradigm shift toward impact-based warnings over the traditional warnings based on a set hydrometeorological threshold (e.g., snowfall accumulation of 7 inches in 12 hours).

As of October 2020, 437 SQWs were issued nationwide since the NWS SQW program became operational in 2018. Two-thirds (293) of all SQWs issued during this period were for the Northeast and northern Mid-Atlantic regions. The state that saw the greatest frequency of SQWs was NY with 126 (29% of all SQWs issued across the CONUS). A comparison of SQW counts across all 122 NWS WFOs reveals WFO Binghamton, NY (BGM) issued the most SQWs since implementation with 52. The spatial pattern of these polygons reveals a higher frequency of SQWs issued along interstates and in close proximity to WSR-88D radars. Conversely, there tends to be a relative minimum in SQWs in areas of poor radar coverage (e.g., where the beam overshoots these shallow convective squalls farther away from the radar or where beam blockage is an issue). For the Northeast U.S., the climatological frequency of SQWs peaks in the afternoon hours (2–6 PM), coinciding with the peak of the diurnal convective cycle.

Warning strategies and best practices highlighted in this presentation were refined for the upcoming 2020-21 winter season and based off of lessons learned from evaluating the first 2+ years of the SQW program. A case study of two snow squall events in the WFO BGM county warning area from December 2019 highlight the paradox that NWS operational meteorologists face in the warning-decision process, including a delicate balance between over-warning vs. under-warning the public that is accentuated with the advent of Wireless Emergency Alerts (WEA) for SQWs. All the ramifications that come with mass triggering of cell phones and other mobile devices for SQWs are not yet fully understood.

Antecedent Road and Air Conditions Associated with High-Impact Snow Squalls

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Each winter season, life and property threatening snow squalls impact our Nation's highways (Banacos et al., 2014). The National Weather Service (NWS) implemented formal Snow Squall Warning (SQW) issuances in the winter of 2018-2019 to advise the public to exit or avoid highways and interstates during valid Snow Squall Warning timeframes. Snow Squall Warnings are issued when a combination of heavy falling/blowing snow is expected to reduce visibilities to ¼ mile or less AND air and road surface temperatures are conducive to rapid freezing (i.e., flash freeze) of road surfaces. Wireless Emergency Alerting (WEA) of SQWs commenced in the winter of 2019-2020.

To better identify and isolate conditions leading to flash freezes during snow squalls and more efficiently warn the public and Department of Transportation (DOT) officials, a database of high impact snow squall cases was compiled (SQW criteria reached) using recent and previously published Pennsylvania Department of Transportation (PennDOT) crash data and Roadway Weather Information System (RWIS) data, adding to previous work by Colbert (2019). The database was expanded both in number and geographic extent, now including snow squall incidents from outside of the Commonwealth of Pennsylvania.

In a significant number of cases, surface heating from solar radiation produced pre-squall road surface temperature spikes (above-freezing), even on cold days when ambient air temperatures were in the mid to upper 20s. Case studies on these surface temperature "spike" days support the conclusion that initial melting of heavy falling snow on road surfaces, followed by subsequent surface cooling to or below freezing during snow squalls produces flash freezes, greatly increasing the threat of extreme impacts including substantial personal injuries and deaths, property damage, and costly disruptions to interstate commerce and travel. Furthermore, almost all high-impact snow squalls occurred with subfreezing pre-squall air temperatures, or air temperatures that were hovering just above freezing and fell below freezing with the arrival of the snow squall.

The goal of this study is to develop a robust flash freeze dataset, ultimately increasing forecaster understanding of flash freeze processes, and improving operational performance through more impact-based warning decisions. Results may eventually be used to develop a flash freeze parameter, or perhaps merge such a parameter with the Snow Squall (*SQW*) Parameter (Banacos et al., 2014) and the emerging HRRR probabilistic surface fr*eeze* probabilities to compute a new operational forecasting parameter (aka "*SQWeeze*" parameter) to help forecasters assess the likelihood of snow squalls coinciding with flash freezes.

Quantifying Snowpack Error in the NOAA National Water Model for the Northeastern United States

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Snow has major hydrological impacts across the Northeastern United States (NEUS). Snowmelt can contribute significantly to ice jams and river flooding. The snowpack is also an important variable in water management. Despite its importance, the current operational version of the NOAA National Water Model (NWM) initializes snow states of the forecast using a simple deterministic analysis cycling every hour. This approach can lead to substantial errors in snowpack characterization within the model as biases in forcing and snowpack physics accumulate within the modeled snow state throughout the winter season. Furthermore, the extent of this error is largely unknown and varies according to region due to regional differences in climatological forcing and snowpack history. This work is part of a larger project to improve the snow physics parameterization suite in the NWM as well as implement data assimilation into the NWM. Before doing this though, we need to quantify the snowpack error in the NWM for the NEUS.

To quantify the snowpack error, we leverage snow and meteorological observations from the New York State Mesonet (NYSM). We analyzed snow depth from retrospective runs of versions 2.0 and 2.1 of the NWM at the grid cell nearest each NYSM station for the winter of 2017/2018. The two versions of the retrospective runs use different meteorological forcing datasets. V2.0 uses the NLDAS-2 dataset and v2.1 uses the AORC dataset. We compared temperature and precipitation data from these forcing datasets against NYSM observations to quantify forcing error and bias. The results show snow depth was typically negatively biased for both versions of the model, with less of a negative bias shown in v2.1. For v2.0, the majority of sites had a percent bias within the -50 to -25% range while the majority of sites in v2.1 had a percent bias in the 0 to -25% range. Bias is largest at the end of the winter and generally neutral early in the year for both versions. Bias also varies regionally for each model version with the largest difference in bias between the two versions see in the Tug Hill Plateau.

The analysis of the meteorological forcing datasets shows that differences in error between the two model versions can be mostly explained by differences in the meteorological forcing. Both forcing datasets were biased warm and dry. The majority of temperature biases ranged from 0ºC to 0.5ºC (AORC) compared to 0.5ºC to 1ºC (NLDAS-2). The majority of precipitation biases fell between 0 to -12.5% (AORC) compared to -12.5% to -25% (NLDAS-2). The precipitation biases had a larger overall effect on the snow depth biases than temperature. The warm and dry biases in the forcing datasets contributed to lower snow depths and earlier melt-out in both versions of the NWM as compared to NYSM.

Ready or Not: Understanding how end-users obtain, interpret, and respond to official and unofficial forecast information

Dr. Amber Silver
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Despite considerable advancements in the field of meteorology over the last fifty years, the social and economic losses incurred from high-impact weather continue to rise. The reasons for this increase are complex, and include both geo-physical and socio-political factors. This keynote address will explore the human dimensions of extreme weather and pose the question: what can we do, as meteorologists, forecasters, emergency managers, and other practitioners, to encourage end-users to make good, informed decisions about weather risk? This talk will summarize existing social science research on public attention, risk perception, risk communication, and decision-making to understand how users obtain, interpret, and respond to official and unofficial weather information.

About the Keynote Speaker:

Dr. Amber Silver is an Assistant Professor in the College of Emergency Preparedness, Homeland Security and Cybersecurity at the University at Albany. Her primary research interests focus on how individuals and groups make decisions before, during, and after high-impact weather. More specifically, she is interested in the roles that public attention, risk perception, and communication play in protective action decision making during extreme events.

Acknowledgements

GotoWebinar Configuration and Support
Vasil Koleci

Cover Photo Credit
Matthew Seymour, Christina Speciale, Dr. Chris Walcek, Sara Condon

Northeast Regional Operational Workshop XXI Agenda Review
The NROW XXI Steering Committee

Northeast Regional Operational Workshop Preprints Formatting
Brian Frugis, Christina Speciale, Dan Thompson and Tom Wasula

Northeast Regional Operational Workshop Preprint Cover Design
Christina Speciale

NROW XXI Conference Support
Ray O'Keefe, Mike Evans and Steve DiRienzo

Web Support
Vasil Koleci and Ingrid Amberger

Northeast Regional Operational Workshop XXI Steering Committee Chair
Brian Frugis

Northeast Regional Operational Workshop Steering Committee
Mike Evans, Vasil Koleci, Christina Speciale, Neil Stuart,
Dan Thompson, Joe Villani and Tom Wasula

Thank you to all attendees and presenters! While we miss the in-person experience of a typical NROW this year, we look forward to another great (hopefully) in-person Workshop next year, November 3-4, 2021!