The Collaborative Science, Technology, and Applied Research (CSTAR) Program

Improving Analyses, Numerical Models, and Situational Awareness of High-Impact Severe Convective and Mixed-Phase Precipitation Events in Complex Terrain

University: University at Albany

Name of University Researcher Preparing Report: Kristen L. Corbosiero

NWS/AFWA/Navy Office: National Weather Service, Albany, New York

Name of NWS/AFWA/Navy Researcher Preparing Report: Michael Evans

National Oceanic and Atmospheric Administration (NOAA) Award #: NA19NWS4680006

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1. SUMMARY OF STUDENT RESEARCH ACTIVITIES

a) Near-freezing winter precipitation type in complex terrain

Graduate student: None
PI and co-PIs: Justin Minder, Nick Bassill, Robert Fovell, Andrea Lang
NWS focal points: Michael Evans (ALY) and Frank Nocera (BOX)

Research summary:

Co-PI Minder has recruited a new graduate student, Megan Schiede, to work on this project, starting in Fall 2022. Future research will likely focus on using our existing case study result to inform a study of operational high-resolution model skill at forecasting winter precipitation type. Research may also leverage data collected this past winter as part of the NSF-funded Winter Precipitation Type Research Multi-scale Experiment (WINTRE-MIX), led by Minder.

Co-PIs Minder and Bassill, in collaboration with NWS ALY and UAlbany colleges, have also been working on an operationally focused study of the 3–4 February 2022 mixed precipitation event that affected Albany, NY. This study is documenting operational forecast challenges, NWP performance, and the potential of novel nowcasting tools.

b) Severe convection in complex terrain and across severe-weather environments

Graduate student: Rachel Eldridge
PIs and co-PIs: Brian Tang and Robert Fovell
NWS focal points: Thomas Wasula (ALY) and Joe Dellicarpini (BOX)

Research summary:

Rachel Eldridge has continued her work investigating how the HRRR model performed during recent severe weather events in the Capital Region. The primary goal is to assess biases in the HRRR pre-convective environment that could contribute to deficiencies in the forecasted convective evolution of the events, and whether these biases are associated with terrain.

During this reporting period, Rachel compared New York State Mesonet (NYSM) observations to HRRR model forecasts for three events: 31 May 2017, 15 May 2018, and 15 May 2020. These events were chosen due to their large impacts on the region and overlap with events of interest identified by the NWS Albany. Rachel first focused on the 15 May 2020 case and presented her evaluation of the HRRR model forecasts of this event at the Northeastern Storm Conference this past March. Her analysis of this event is focused on the period when a line of severe convection passed over the Mohawk and Hudson valleys. HRRR forecasts of temperature, dewpoint, relative humidity, wind speed, wind direction, and precipitation accumulation were compared to NYSM observations for five locations: Herkimer, Johnstown, Sprakers, Oppenheim, and Voorheesville. NEXRAD reflectivity was also compared to HRRR forecast reflectivity. There was a 1-hour time discrepancy in the passage of convection in a few model runs leading up to this event. Additionally, there was a decrease of the forecast boundary-layer height between the 0900 and 1000 UTC initializations that persisted in future model runs. Rachel applied this same analysis to the other two events. Preliminary results show discrepancies between the model forecast and surface observations in the hours leading up to the convection. The HRRR forecasts tend to have a warm bias, especially in the early morning hours. There is case-to-case variability in the forecasts of the dewpoint and convective evolution that Rachel will be exploring in the future. This analysis will assess whether there are consistent biases that could affect convective initiation/development of which model developers and forecasters should be aware.

In addition to the NYSM surface observations, Rachel is currently exploring ways to use the NYSM profiler network. Our sense is there is relatively unknown value, and little guidance, on using the NYSM profiler data to monitor the environment ahead of severe weather. Figure 1 shows Albany LiDAR profiler data for the 15 May 2020 event that reached the Capital Region at approximately 2230 UTC. Areas of larger carrier-to-noise ratio (yellow, red, and pink shading) indicate the cloud base. Horizontal wind speeds (second panel) increased near the surface (below 1000 m) approximately 2 h before precipitation, which is marked by the streak of negative vertical speeds (right side of the third panel). The next step is to use LiDAR profiler data, microwave radiometer profiler data, radiosonde observations, and HRRR forecasts to compare the boundary-layer height and vertical profiles of temperature, dewpoint, and wind for all three events. This exercise will help assess the utility of using the NYSM profiler data in high-impact events.

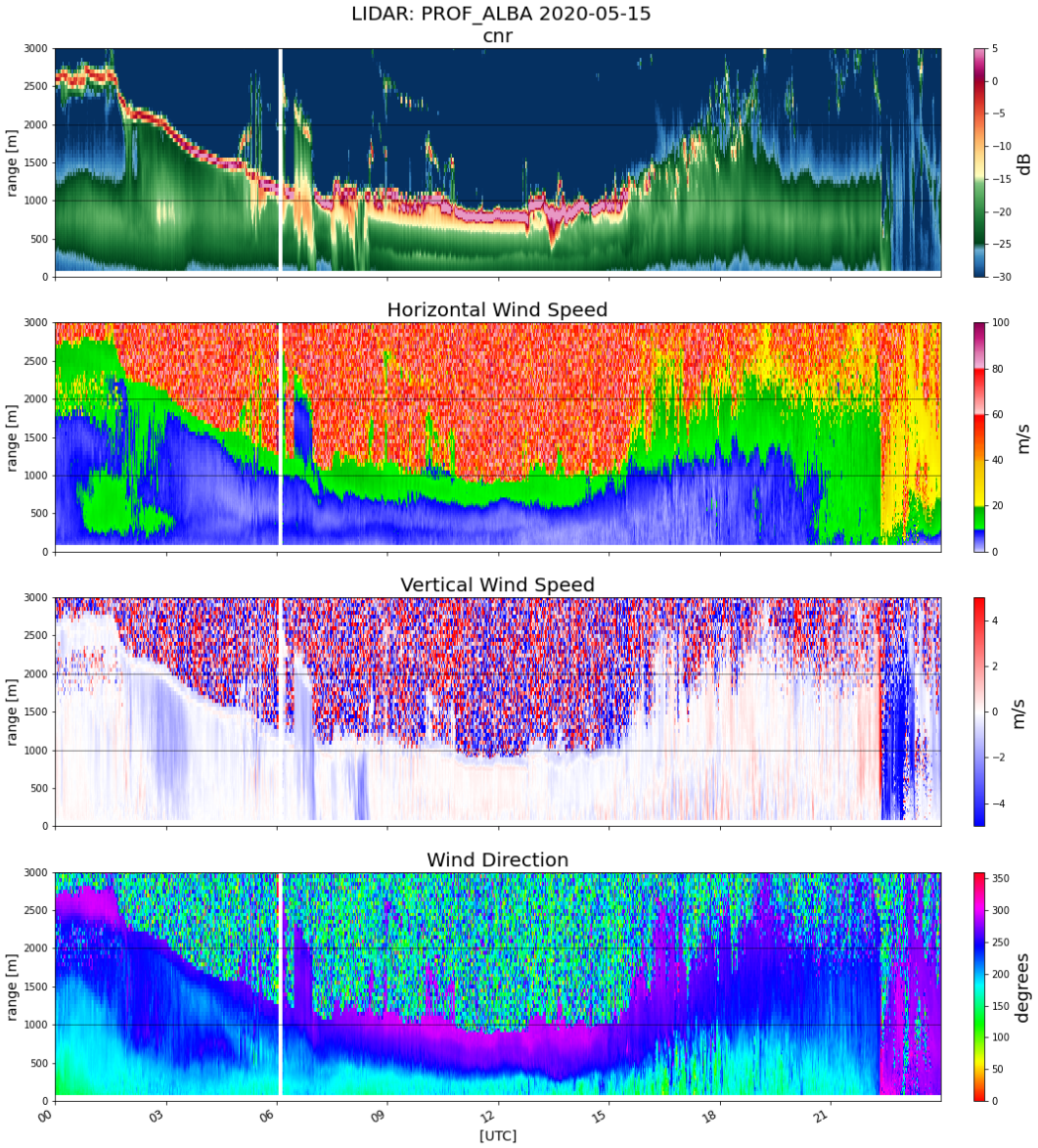

Figure 1. *Time series of LiDAR measurements on 15 May 2020 at the Albany Airport. The panels show, from bottom to top, carrier-to-noise ratio (cnr; dB), horizontal wind speed (m s^{-1}), vertical wind or precipitation fall speed (m s^{-1}), and wind direction (degrees).*

NWS Interactions:

Rachel presented a summary of her research plans at the 15 December 2021 CSTAR Meeting. At this meeting, we discussed research ideas and directions with our NWS partners, based on the intersecting challenges of science and forecasting of severe convection in the Northeast. Rachel is organizing a follow-up meeting with our specific NWS focal points to occur over the summer so that we may update them on progress and refine directions.

Brennan Stutsrim, who concluded his CSTAR project on upscale growth of convection and heavy rainfall, met with NWS focal points, Tom Wasula and Joe Dellicarpini, and Ross Lazear on 15 February 2022 to implement a quick reference guide for the NOAA VLab. The quick reference will help with the situational awareness of environments that are supportive of back building convection, and potential flash flooding, in the Hudson Valley and other areas of the Northeast.

Brian Tang participated virtually in the 2022 NOAA HWT Spring Forecasting Experiment from 31 May 2022 to 3 June 2022. This participation was valuable in learning about both operational and experimental forecast systems, specifically the Warn on Forecast System and machine learning approaches, that have promise in improving the skill of severe weather forecasting.

c) Data fusion applications to assess forecast uncertainty and improve analyses

Graduate student: Brian Filipiak
PI and co-PIs: Kristen Corbosiero, Nick Bassill, Andrea Lang, and Ross Lazear
NWS focal points: Christina Speciale (ALY) and Neil Stuart (ALY)

Research summary:

During this reporting period, Brian has made important advancements in understanding how the random forest (RF) algorithm operates during the most recent winter weather season as well as gained first-hand experience of winter mixed precipitation events. The reporting period corresponds with a majority of the 2021–2022 winter season (December March) that is being used as an evaluation period for the RF algorithm. The real-time website and data processing allowed for improvements in code used for the website. Periods of missing or delayed data that were needed to run the RF occurred during the winter caused errors in running the RF; these errors were rectified when they occurred, and are now accounted for when processing the data for the RF. In addition to the errors that were fixed, an understanding on how the RF performed during mixed precipitation events was gained. While further verification will be done, quick subjective analysis of events was done in real-time as they happened.

While work was done on the website to improvement its consistency and utility, additional work was done to improve understanding of the decision-making process of the RF. Time was spent on examining the unique variables in the training datasets to understand the distribution of these variables. This work gave greater context to how the RF make decisions and classifies the most important variables. Composite soundings, statistically significance tests, wind roses, and graphical displays of all variables were created to complete this process. During this process, it became clear that there were training cases that were not accurate; cases on the periphery of the distributions were re-examined to determine if they should be kept in the training dataset. The cases that were removed were noted; the new training dataset will be implemented in the updated RF coming out in the fall of 2022.

During the winter season, it became clear the NYSM and Upper Air product did not generate realistic probabilities or represent the precipitation type very well. This result will be

confirmed by post-winter verification, but the need for a new NYSM and Upper Air product was evident. In examining key variable distributions for the current NYSM and Upper Air products, it was clear that the key variables were not different enough to clearly identify a precipitation type. To improve the NYSM and Upper Air product, the amount of time and the area the product was valid for were reduced. The new product is based on 5-min NYSM data and NWS Upper Air sounding sites (ALB, BUF, OKX), and is only valid within 100 km of the sounding site and 4 h of the balloon launch (Figure 2). This method creates a more representative training dataset and a more realistic output from the RF; this new NYSM and Upper Product will be evaluated in the post-winter verification process. In addition to the new product that was made, a full archive of products, from 1 November 1 2021 to 31 March 31 2022, was generated. Products made after 31 March are still being archived. This process was done for all three products (NYSM, New NYSM, and NAM), and it sets up the verification process so the RF can be re-run at any given point with the same information.

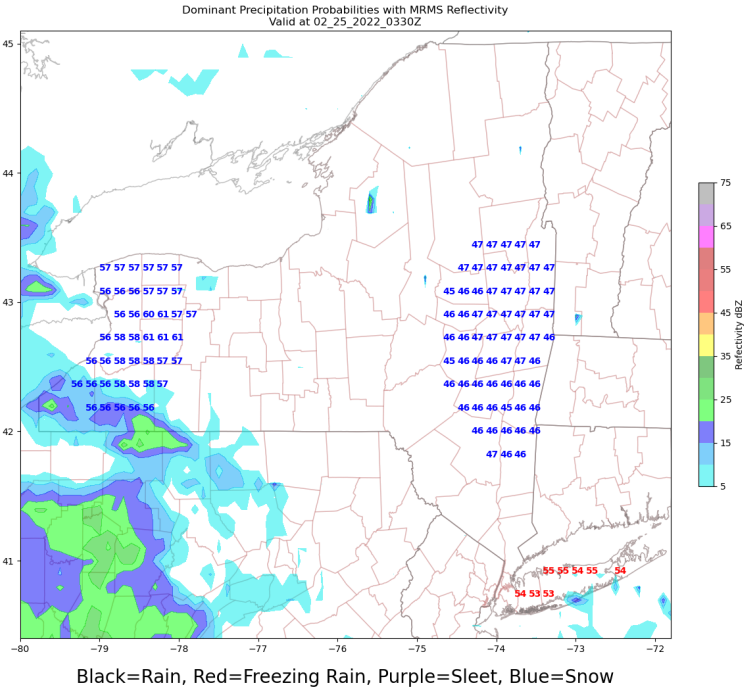

Figure 2. *New NYSM and Upper Air Product with reduced temporal and spatial resolution.*

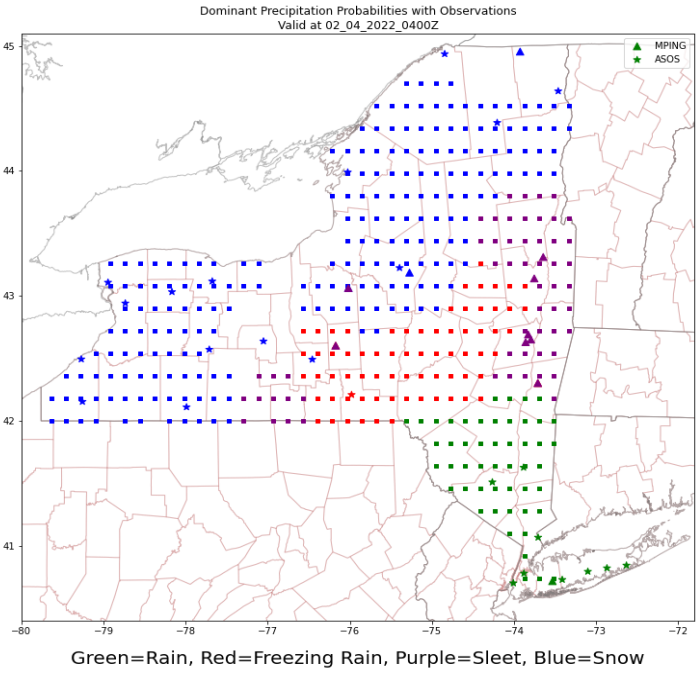

Figure 3. *NAMNEST verification plot. ASOS and MPING report location (stars and triangles) is shown relative to dominant RF-predicted precipitation type.*

After the main winter period was over, work began on collecting ground truth observations to verify how well the RF algorithm did over the winter period. ASOS and MPING reports were collected from the entire verification period; these reports were then processed and cleaned to match up with the categories found in the RF output. Work is currently being done to evaluate the RF both deterministically and probabilistically due to the duality present in the products. Subjective overview maps have been made to show the location of the observations compared to the output of the RF

algorithm (Figure 3). While this method allows for a broad overview of each product, more detailed statistics are needed. Individual event analysis can be classified through skill scores to capture deterministically how often it predicted the correct precipitation types. Broadly, an understanding is needed about what the probabilities from the RF output mean. End users will need to understand what the numerical probabilities represent for each type of precipitation. This evaluation is essential as the numerical values can indicate how likely a given precipitation type, and the potential risk, to specific areas. Because of the way the RF operates, it is important to understand the difference between what a 50% and 75% value represents.

Along with the work done on the RF algorithm and website, Brian participated in an NSF sponsored field campaign, WINTRE-MIX, for five weeks in Northern New York and Quebec, Canada. This experience gave him the opportunity to learn more about the forecasting process for winter mixed precipitation events. In addition, he got to experience these conditions first-hand and learn how hard it can be to identify the precipitation type falling and collect accurate observations during these events. This experience provided Brian with a chance to learn more about the weather phenomena he is trying to create forecasts and products for.

There is much future work to do with the RF algorithm. Final verification of this past winter season will be completed and used to be the basis of improvements in the future. This information will also be shared with NWS partners to source suggestions for improvements as well as share how well the algorithm worked this winter. This will be key to make sure the product brings value to the operational forecasting process. As the verification process finishes up, an accessible website archive will be available; interested parties will have access to all products made including verification maps and forecast maps.

Future work will continue to identify new products and the best way to display information. Work will be done to improve the resolution of vertical sampling points from models because the spacing of BUFKIT sites do not accurately capture the complex terrain. Additional models will be added to the website, and all current products will be re-evaluated to ensure they represent the information and algorithm the best way possible.

NWS Interactions:

During this period, Brian met with NWS focal points regularly to maintain an open line of communication regarding the RF algorithm. NWS focal points regularly asked questions about the algorithm and helped Brian understand how his website can be used in operational forecasts. The website was used to assist forecasts during the winter with a mention of the experimental products in an NWS AFD on 4 February 2022. The focal points kept Brian in the loop about any issues they ran across while using the website. Brian has made sure they have access to all information and figures generated from the RF algorithm. Brian has plans to develop an accessible archive that the NWS focal points will have access to. Brian plans to meet with his focal points once the verification process is complete and debrief algorithm successes and challenges.

2. CSTAR VII PROJECT THESES, PRESENTATIONS, AND PUBLICATIONS

(For a complete list of UAlbany–NWS Albany CSTAR project publications, please see *http://www.atmos.albany.edu/facstaff/kristen/CSTAR/CSTAR_CumulativePublications.pdf*.)

a) Theses completed

None

b) Presentations

Eldridge, R., B. Tang, and R. Fovell, 2022: Evaluating HRRR model forecasts on the 15 May 2020 severe weather event in Upstate New York. 47th Northeastern Storm Conference, 13 March, Burlington, VT.

Filipiak, B., K. Corbosiero A. L. Lang, R. A. Lazear, and N. P. Bassill, 2021: Data fusion: A machine learning tool for forecasting winter mixed precipitation events. 2021–2022 NOAA Weather Prediction Center Winter Weather Experiment Seminar Series, 7 December, Albany, NY. (Virtual)

Filipiak, B., K. Corbosiero, A. L. Lang, R. A. Lazear, and N. P. Bassill, 2022: Data fusion: A machine learning tool for forecasting winter mixed precipitation events." 102nd AMS Annual Meeting/31st Conference on Weather Analysis and Forecasting/27th Conference on Numerical Weather Prediction, 26 January, Houston, TX. (Virtual)

Filipiak, B., K. Corbosiero A. L. Lang, R. A. Lazear, and N. P. Bassill, 2022: Data fusion: A machine learning tool for forecasting winter mixed precipitation events. *New York State Mesonet Forum,* 15 April, Albany, NY.

c) Refereed publications

None

3. RESEARCH TO OPERATIONS

Updates to the *Albany CSTAR Virtual Lab (VLab) community page* are ongoing, with traffic to the page monitored using Google Analytics. Agendas and preprints for the Northeast Regional Operational Workshop (NROW) dating back to 2000 were added to the VLab page. In collaboration with NWS ALY, NROW presentations are now also added to the VLab each year, starting with 2021. In the past six months, traffic on the VLab page peaked twice during January and early February 2022, prior to and during major winter storms. The majority of page hits came through social networks and social media platforms. There were 248 visits to the page, from 195 unique users, and both numbers increased from the previous six-month period.

Ross Lazear continued work with Brennan Stutsrim along with his NWS focal points Tom Wasula (ALY) and Joe Dellicarpini (BOX) to develop an operationally relevant quick reference of his major research results. Brennan's quick reference includes a two-dimensional phase–space highlighting variables most important in forecasting back-building convection in the Hudson Valley (in this case, a lower lifted index and cooler surface temperatures). Additionally, mean soundings for back-building and false positive cases indicate the importance of weaker deep-layer winds and slightly reduced instability in cases where back-building is most likely. Finally, a decision tree enables a forecaster on shift to walk through a check list to determine the likelihood of back-building convection in the Hudson Valley. The quick reference has also been posted to the VLab at *https://vlab.noaa.gov/web/albany-cstar/backbuilding-convection-in-the-hudson-valley*.

Finally, as has been done with previous CSTAR research, these references are linked to operations using keywords via the AWIPS Interactive Reference (AIR) tool, although views of quick references through AIR are not monitored.

4. NWS PERSPECTIVE ON CSTAR VI PROGRESS *(Michael Evans, SOO WFO ALY)*

The collaborative relationship between the NWS Albany forecast office and UAlbany's Department of Atmospheric and Environmental Sciences has remained strong, despite recent

challenges associated with COVID-19. The collaboration associated with CSTAR VII continues to be one of the cornerstones of this relationship. From the NWS perspective, work on this and other projects with UAlbany remains critical for maintaining a strong culture of science-based forecasts, warnings, and decision support at the Albany forecast office. The recent move to collocate the NWS with the department in the new ETEC building will strengthen our relationship moving forward.

An excellent example of the collaborative relationship between the NWS and UAlbany occurred during February 2022. On 3–4 February, a major ice storm affected parts of the NWS ALY Warning area. Temperatures during the event were near-freezing and precipitation type was impacted by the complex terrain in our area. Three of our forecasters worked to develop a case study on the event, and presented it to the faculty and staff at UAlbany. As a result of this presentation, our participating staff members are working with staff from UAlbany and the Atmospheric Science Research Center to write a paper that relates this case to the Winter Precipitation Type Research Multi-scale Experiment (WINTRE-MIX) field study that occurred last winter.

There remain many forecast challenges with winter weather events associated with marginal, near-freezing temperatures and the impacts of terrain on these types of events. The event on 3–4 February 2022 highlighted many of these challenges. In particular, model forecasts of this event were similar, but with temperatures through a deep layer so close to freezing, minor differences in temperature resulted in big differences in forecast precipitation types. In addition, subtle impacts on the temperature profile caused by upslope/downslope flows, cold air funneled by terrain, and elevation resulting in variable depths of cold-air layers made the forecast challenging. This event ranged from a major freezing rain over portions of our southern counties, to a major sleet event over the Capital District, to heavy snow across our northern counties.

For Major Project #2, a National Weather Service Eastern Region Science Sharing webinar was provided to meteorologists in the region, on 2 June 2022. Joe Villani, Tom Wasula, and former CSTAR student Brennan Stutsrim worked together to produce the presentation. Two recent case studies were shown that helped to reinforce Brennan's work. The Boston Forecast Office is planning on applying Brennan's work to storms interacting with the Connecticut River Valley, to see if similar evolutions occur in that north–south oriented valley.

Tom Wasula presented a case study on the 24 August 2020 Whitehall, NY flash flood at our yearly CSTAR meeting on 15 December 15 2021, and an Eastern Region Science Sharing webinar on 26 May 26 2022. Tom has also had an abstract accepted to present this case at the AMS Severe Local Storms Sonference in Santa Fe, NM in October 2022. The case was related to Brennan's work in that storms moved out of higher terrain into the upper-Hudson and Champlain valleys and began to back-build, causing flash flooding. Finally, Tom gave a presentation on Brennan's work and his case study at the NWS BOX Spring Workshop on 26 April 2022.

After Brennan's work, NWS ALY has noticed how frequently his findings on the evolution of convective storms as they reach the Hudson Valley can be applied to warning operations. A good example occurred this spring when storms appeared to be weakening as they approached the Hudson Valley, then re-organized and strengthened as they reached the valley. Brennan's work helped the radar operator that day to anticipate the possibility that this would happen, and helped forecasters issue warnings more quickly than would otherwise have occurred. NWS ALY continues to share instances on these types of events with the rest of the staff in local Quality Assurance Reports, which are developed after every significant weather event in the forecast area.

Finally, for Major Project #3, CSTAR student Brian Filipiak met with NWS focal points Neil Stuart and Christina Speciale on multiple occasions to discuss his progress on the project.

Discussions included optimum data sets to include in his random forest decision tree algorithms and ideas for displaying results on his web page. Discussions also included analysis of several events with mixed precipitation during the winter of 2021–2022 and the performance of the machine learning tool. Subjective analysis suggested that the tool did provide accurate analysis and near-term predictions in some of the cases. Preliminary results using this tool are being included in a multi-scale study of a high-impact ice and mixed precipitation event that impacted the mid-Hudson Valley on 3–4 February 2022, in collaboration with the UAlbany Center of Excellence and NY State Mesonet.

Brian also gave a presentation to UAlbany staff and NWS forecasters on his work at a joint case study review and NWS ALY Severe Weather Workshop, which was held on 15 April. Neil included a mention of the Data Fusion project, web site and its utility during a 2 March meeting with UAlbany faculty, the Center of Excellence, UAlbany students, and NY State Mesonet representatives discussing the high-impact mixed precipitation event on 3–4 February. Brian gave a presentation at a NY State Mesonet workshop on 15 April titled, "Data fusion: A machine learning tool for forecasting winter mixed precipitation events".

This project has evolved into the development of a machine learning application to help NWS ALY predict high-impact winter weather events. Machine learning techniques are becoming increasingly utilized in operational meteorology, and the development and use of this tool has been an excellent learning experience for NWS staff, especially focal points Neil Stuart and Christina Speciale. The office expects that this tool will be expanded to include forecasts of warm season convective weather, heavy rainfall, and perhaps other types of high-impact weather. NWS ALY continues to focus on short-range prediction of high-impact weather events, which means that this application will continue to be highly relevant to the most important aspects of our operations.

5. COLLABORATIVE AND ASSOCIATE PROJECTS *(Michael Evans and focal points)*

The eight collaborative projects associated with CSTAR VII are listed below, along with updates on progress from December 2021 through May 2022.

1. Improvement of tornado detection and lead time

Team leads: Joe Dellicarpini (BOX) and Christina Speciale (ALY)

Joe updated the database with events from 2018–2021, and created tables and graphs that showed favorable parameters for all events, for EF-0 and EF-1+ tornadoes, and separated the events by synoptic class. The next step will be to review radar data for these events and update the Radar Warning Guide as needed. All information was shared info with NWS ALY and OKX.

Dave Radell (NWS OKX SOO) reports that environmental data has been evaluated for a database of local tornado events. Radar signatures will be evaluated soon and will be added to the database, as well as data from the November 2021 outbreak.

2. Warm season QPF challenges: identifying when model precipitation, areal coverage, location and maximum amounts will be skillful

Team lead: Justin Arnot (GYX)

Over the past six months, the team has been working on wrapping up the project. A presentation was created summarizing the results for an April Eastern Region Science sharing webinar (given by Rodney Chai and Justin Arnott;

https://www.youtube.com/watch?v=dDFKBkDiD3g). Similar results were given at the spring station meeting at WFO Gray.

3. Recent dual-polarization radar techniques to support severe weather operations

Team lead: Mike Jurewicz (CTP)

Mike continues to test GR2 Analyst place files locally in research mode with past events. He is planning on working with Aaron Johnson and Matt Bunkers from NWS Central Region to install an application on GR2 Analyst that does some automation on the evaluation of tornado potential using his dual polarization variables. Apparently, Aaron and Matt have done that in their offices working through one of their Linux boxes, with promising results.

4. Using GLM lightning data in operations for severe weather forecasting and enhanced DSS

Team leads: Jared Klein (LIX) and Mike Jurewicz (CTP)

No new activities reported.

5. Using GAZPACHO to verify high-resolution model snowfall forecasts from 2017–2019

Team leads: Joe Villani and Mike Evans (ALY)

A new upgrade to the GAZPACHO program has been developed which allows users to evaluate the 5th, 10th, through 95th percentile snowfall from the National Blend of Models (NBM) with gridded observations. In addition, the program can be used to determine the best percentile forecast from the NBM for each grid point in the domain. This information has been shared with the National Weather Service's Eastern Region Scientific Services Division and a meeting is being planned on the best ways to utilize some of this new functionality.

6. Examination of significant hail events: expand the project across the Northeast U.S.

Team lead: Tom Wasula (ALY)

Some limited work has been completed on the climatology. The database has been updated through February 2022 for New York and New England. The database is now being stratified by various environmental parameters, such as CAPE, shear, equilibrium level, etc..

7. The role of the strength of large-scale low-level forcing on severe weather event magnitudes

Team leads: Neil Stuart (ALY) and Joe Cebulko (National Water Center)

This project has been completed.

8. Use of collapsing specific differential phase columns to predict significant severe thunderstorm wind damage across the Northeast United States

Team lead: Joe Cebulko (National Water Center)

Joe Cebulko has taken a position with the NWS Water Center and, as a result, this project will not be completed.

6. CSTAR PROJECT RESEARCH IN NWS AFDs

Monday 6 December 2021

CSTAR research on the inland extent of lake-effect snow bands was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 060939
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
439 AM EST Mon Dec 6 2021

.NEAR TERM /THROUGH TONIGHT/...
The precip will end in most areas shortly after frontal passage, turning to snow at higher elevations before ending with minor accumulations possible over the southern Greens and Berkshires. A lake effect band will set up over the western Adirondacks as surface to 850 mb delta-Ts increase to 15-20C. Some uncertainty in the CAMs with how far south the band will sink. Greatest accumulations of 1-3 inches along the Route 28 corridor, but we could see some light accumulation as far south as the NYS Thruway corridor. **Good inland extent parameters per CSTAR research with strong winds in the 1-3 km AGL layer, little directional shear, inversion heights around 2.5 km, and a multi-lake connection from Superior.** Lows range from the upper teens to upper 20s.

NEAR TERM...Thompson

Tuesday 7 December 2021

CSTAR research on the inland extent of lake-effect snow bands was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 070840
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
340 AM EST Tue Dec 7 2021

.NEAR TERM /THROUGH TONIGHT/...
As of 330 am, breezy conditions have kept temperatures elevated somewhat overnight. Lake effect bands have shifted southward toward the Route 8 and I-90 corridors. NAM3 and HRRR have had a pretty good handle on this thus far. **Multi-lake connection is evident on IR imagery, and strong 0-3 km winds with little directional shear along with moderate lake-induced**

instability continue to favor good inland extent per CSTAR research, so slight chance PoPs were maintained eastward into the Capital District/Berkshires through this morning. Most of the accumulation should be confined to areas west of Albany with generally a dusting up to an inch expected, locally up to a few inches over the western Mohawk Valley/SW ADKs if the band remains relatively stationary for a few hours.

NEAR TERM...Thompson

Friday 7 January 2022

CSTAR research on mesoscale snowbands was cited in the near-term section of the NWS ALY AFD.

FXUS61 KALY 070920
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
420 AM EST Fri Jan 7 2022

.NEAR TERM /UNTIL 6 PM THIS EVENING/...
MRMS imagery shows some bands of heavier snowfall in response to an area of frontogenesis is located close to coast. **As anticipated by the 00z HREF, this heavier band of snow (CSTAR research depicts this as a quasi-stationary band) which extends from the Jersey Shore northeast across the NYC/Long Island area towards coastal CT and eastern New England will remain south/east of our area.** While there has been some somewhat heavier snowfall across southeastern Litchfield County, the more intense 1"+ per hour rates are remaining outside of the area.

NEAR TERM...Frugis

Friday 7 January 2022

CSTAR research on mesoscale snowbands was cited in the near-term section of the NWS ALY AFD.

FXUS61 KALY 071136
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY

636 AM EST Fri Jan 7 2022

.NEAR TERM /UNTIL 6 PM THIS EVENING/...
MRMS imagery shows some bands of heavier snowfall in response to an area of frontogenesis is located close to coast. As anticipated by the 00z HREF, this heavier band of snow which extends from the Jersey Shore northeast across the NYC/Long Island area towards coastal CT and eastern New England has been remaining mainly south/east of our area. **CSTAR research depicts this as a quasi-stationary band, perhaps transitioning to a pivoting band for eastern New England).** While there has been some somewhat heavier snowfall across southeastern Litchfield County (rates up to 3/4" per hour), the more intense 1"+ per hour rates are remaining outside of the area over southern CT and eastern New England.

NEAR TERM...Frugis

Saturday 8 January 2022

CSTAR research on the inland extent of lake-effect snowbands was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 082132
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
432 PM EST Sat Jan 8 2022

.SHORT TERM /MONDAY THROUGH TUESDAY NIGHT/...
As for lake effect potential, thermodynamics will be quite favorable, with surface to 850 delta-T values falling into the -15 to -20C range Monday. In addition, this cold airmass will be spreading across the entire Great Lakes, which are only 7% ice covered per latest GLERL analysis (normal is around 15% for this time of year). There are good signals in the 12Z.08 NAM/GFS for a multi-lake connection back to Superior. These models both depict a lake aggregate pressure trough, whose convergence could act to focus a heavy band in one area for much of the day Monday. Where exactly this sets up is questionable, but it would likely be north of the Thruway and south of Route 28. As this is near the northern/southern Herkimer zone split, both were included in the Lake Effect Snow Watch. **Lake effect snow could extend far downstream of the typical snow belts per CSTAR research given the multi-lake connection, strong 0-1km speed shear, weak 1-3km speed shear, and weak directional shear, possibly reaching toward the Glens Falls/Saratoga region into southern Vermont.** Although it wouldn`t be as heavy, accumulations are still possible. The single band will transition to multi-bands as winds veer Monday night, shifting the lake effect toward the western Mohawk and Schoharie Valleys.

SHORT TERM...Thompson

Monday 10 January 2022

CSTAR research on the inland extent of lake-effect snowbands was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 101154
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
654 AM EST Mon Jan 10 2022

.NEAR TERM /THROUGH TONIGHT/...
As of 5:15 AM EST...narrow band of lake effect snow has developed off of Lake Ontario and is extending through southern Herkimer County all the way into the Berkshires. Band of lake effect has developed in response to strong cold advection over the Great Lakes. Lake Ontario has anomalously low ice coverage this year, and water temperatures remain in the mid 40s, which is around +6C. With 850 mb temperatures of -16C and expected to drop through the day, this will yield considerable instability, hence the strong band of lake effect snow. With relatively strong low-level winds and very little directional wind shear between the surface and 850 mb, inland extent of the band will be much further than for some of our typical lake effect events. **In fact, local/CSTAR research suggests the band could extent up to 130 miles inland this morning, and increase to upwards of 150+ miles this afternoon as inversion heights rise with daytime mixing.** Therefore, it makes sense that the band is extending into the Berkshires this morning, and it will likely extend into southern VT this afternoon/evening where a few inches of snow is possible with upslope enhancement in the southern Greens. Strong lift and saturation through the dendritic growth zone will yield high snowfall ratios of 15-20:1, which will allow for localized amounts of 8-10" of snow across portions of Herkimer County.

NEAR TERM...Main

Thursday 13 January 2022

CSTAR research on mesoscale snowbands was cited in the long-term section of the NWS ALY AFD.

FXUS61 KALY 132053
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY

353 PM EST Thu Jan 13 2022

.LONG TERM /SUNDAY THROUGH THURSDAY/...
A strong east-southeast low-level jet will be in place ahead of this approaching storm system. 850 hpa winds will as strong as 50 to 70 kts according to the latest 12z GFS/ECMWF. The GEFS suggest the 850 u winds will be about -3 to -4 STD. This all suggests that a period of heavy precipitation is likely across our area, as strong frontogenesis will occur with plenty of moisture being pulled in off the western Atlantic. **With plenty of cold air (both at the surface and aloft), p-type will initially be snow for Sunday night, and a laterally translating band of snowfall (based on CSTAR research) is expected to lift northward across from south to north across the area for the late-night hours.** Snowfall could begin as early as around midnight for southern areas, but the heaviest rates (exceeding 1 inch per hour at times within the heaviest band) will occur during the late-night hours towards daybreak Monday. In addition, the strong e-se flow aloft will allow for very strong winds, especially across western New England and the Taconics. Some gusts may exceed 40 mph across areas of the high terrain that channel this type of flow, which may lead to whiteout conditions and difficult travel.

LONG TERM...Frugis

Friday 13 January 2022

CSTAR research on mesoscale snowbands was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 142116
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
416 PM EST Fri Jan 14 2022

Strong isentropic lift, aided by a powerful low-level jet of 50+ knots, will be allowing for a laterally translating band of snowfall (based of CSTAR research) to lift from south to north across the area for late Sunday night. 12z GEFS show 850 u wind anomalies of -4 to -5 STD, which is very impressive. This suggests very strong flow, which will supply abundant moisture and will upslope into the high terrain. Snowfall rates will easily exceed 1" per hour within this snowband and rates could reach 2" to 3" per hour where the upslope enhances the precip. The band looks to move quickly and will be rocketing northward across the area for the late overnight hours.

SHORT TERM...Frugis

Sunday 16 January 2022

CSTAR research on mesoscale snowbands was cited in the near-term section of the NWS ALY AFD.

FXUS61 KALY 162128
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
428 PM EST Sun Jan 16 2022

.NEAR TERM /THROUGH MONDAY/...
Ahead of the main cyclone, strong isentropic lift evident on the 285K or 290K surfaces will overspread locations south of the Capital Region prior to 10 pm, and then the Capital Region north and east between 10 pm - 1pm. Tremendous QG lift will occur with strong low to mid level frontogenesis as Atlantic moisture is tapped. Good pcpn efficiency is expected early on with snow to liquid rations of 8-12:1. In fact, an anomalous low-level jet at H850 of 50-70+ knots will advect in the copious amounts of moisture. It looks like an atmospheric river along the Gulf Stream tapping the subtropics based on the integrated water vapor transport anomalies on the latest NAEFS. In fact, the u-wind anomalies /easterlies/ are -4 to to almost -6 STDEVS greater than normal overnight prior to 12Z/MON. PWAT anomalies are 1 to 3 STDEVS above normal. The right entrance region of the poleward jet streak will also enhance the snowfall rates. In fact, snowfall rates will increase to 1 to 3 inches an hour in the early to mid morning hours based on the HREF probs. **A laterally transitioning snowband based on the CSTAR cool season research will pivot across the region west of the Hudson River Valley into central and western NY.**

NEAR TERM...Wasula

Wednesday 2 February 2022

CSTAR research on mesoscale snowbands was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 020958
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
458 AM EST Wed Feb 2 2022

.SHORT TERM /6 PM THIS EVENING THROUGH FRIDAY/...

The snowfall rates could increase to an inch or two an hour Friday morning through the commute. Some areas may be in an advisory while others a warning. Overall, an impactful event is expected. A mesoscale snowband on the northwest side of wave is possible. The snow should taper to scattered snow showers by Friday afternoon. **The right entrance region of a powerhouse jet aloft and a wave moving along the front with rich moisture indicate perhaps a Laterally Quasi-stationary Band of intense snow may form based on the documented CSTAR research with SUNYA.** This band could go through the morning commute.

SHORT TERM...Wasula

Thursday 3 February 2022

CSTAR research on uncertain precipitation type forecasting was cited in the near-term section of the NWS ALY AFD.

FXUS61 KALY 040234
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
934 PM EST Thu Feb 3 2022

.NEAR TERM /THROUGH FRIDAY/...
Based on reports from spotters, social media and data from the NY State Mesonet, and experimental precipitation type CSTAR output, sleet and freezing rain occurring to the Johnstown/Amsterdam area and even near the Herkimer sawtooth. Some slight reductions in the snow forecasts out there and a slight increase in the ice forecasts from the Capital Region east and south.

NEAR TERM...SND/NAS

Wednesday 23 February 2022

CSTAR research on mesoscale snowbands was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 232119
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY

419 PM EST Wed Feb 23 2022

.SHORT TERM /6 AM THURSDAY MORNING THROUGH FRIDAY/...
Initially, a band of snow should develop and move northeast across the region, starting around midnight across the eastern Catskills, then shortly after midnight across the Mohawk Valley/Capital Region and mid Hudson Valley/NW CT. By daybreak Friday, most of eastern NY and western New England could have snow, moderate to heavy at times. 12Z/HREF indicates a general west-east band shifting northward around daybreak, with high probabilities for snowfall rates of 1-2 inches/hour around daybreak near the I-90 corridor, and shifting north of that corridor during the morning hours. **This fits in with the general paradigm of laterally-translating F-Gen snowband within a warm advection regime, according to CSTAR research.**

SHORT TERM...KL

Thursday 24 February 2022

CSTAR research on mesoscale snowbands was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 240900
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
400 AM EST Thu Feb 24 2022

.SHORT TERM /6 PM THIS EVENING THROUGH SATURDAY/...
Southerly flow in the low levels will steadily increase tonight into Friday morning (40-50 kt at 850 mb) as the system approaches. Along with a tightening thermal gradient, strong isentropic lift maximized on the 285-290K surfaces will quickly develop by shortly after midnight, allowing for snow to begin and rapidly become widespread/steady. Best F-Gen from the NAM/GFS will be in low levels around 850 mb and is maximized from early Friday morning through early Friday afternoon. This is when heaviest snowfall rates are likely to occur, with 00Z HREF indicating a large gradual northeastward advancing/expanding swath of 1-2 inch/hour snowfall rates during this time**. Pattern/evolution looks to be indicative of a laterally-translating snow banding situation (CSTAR research).**

SHORT TERM...JPV

Thursday 24 February 2022

CSTAR research on mesoscale snowbands was cited in the short-term section of the NWS ALY

AFD.

FXUS61 KALY 250924
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
424 AM EST Fri Feb 25 2022

.NEAR TERM /UNTIL 6 PM THIS EVENING/...
00Z HREF continues to indicate high probability for 1-2 inch per hour snowfall rates shifting from SW to NE across the region from this morning through early afternoon, indicative of a laterally translating snowband (from local UAlbany CSTAR research). These high snowfall rates will make for a problematic morning commute.

NEAR TERM...JPV

Friday 11 March 2022

CSTAR research on mesoscale snowbands was cited in the near-term section of the NWS ALY AFD.

FXUS61 KALY 112141
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
441 PM EST Fri Mar 11 2022

.NEAR TERM /THROUGH SATURDAY NIGHT/...
The question is where does a mesoscale snow band set-up with 1-2"/hr snow rates. The latest 12Z HREFS favors the Capital Region/northern Catskills/southern VT north and east in the late morning into the early evening. The latest NAM/HRRR would be from the Capital Region/southern VT and the eastern Catskills south and east. **Based on past CSTAR research, a dual jet structure within the northwest quadrant of the cyclone with strong 2D FGEN in the 850-700 hPa/700-500 hPA layers with some -EPV may support a "Pivoting band" of heavy snow.** The strong ascent from the band should tap into the favorable dendritic growth zone in some areas. We did increase snow amounts from the Capital Region south and east due to a more rapid cool down Saturday morning. This potential mesoscale snow band will impact the area late Saturday morning into the early/mid afternoon. The cyclone will pass south of the region from the Delmarva to near Cape Cod by 18Z/SAT based on the 12Z NAM/GFS. The EC/CMC are a little faster and northeast into the Gulf of Maine. We could be looking for a 6-9 hour period from 7 am to 4 pm Saturday with moderate to heavy snow. Some rain could curtail totals in the valley areas,

and this forecast would unravel. Also, getting the snow to liquid ratios right is challenging. Going from low ones to average or higher ones.

NEAR TERM...Wasula

Saturday 12 March 2022

CSTAR research on mesoscale snowbands was cited in the near-term section of the NWS ALY AFD.

FXUS61 KALY 120935
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
435 AM EST Sat Mar 12 2022

.NEAR TERM /UNTIL 6 PM THIS EVENING/...
We are also expecting mesoscale banding of snow to set up. A very strong sloping band of frontogenesis is expected to track across the region late this morning into the early afternoon. **Based on CSTAR research, this setup checks some of the boxes for a laterally quasistationary band over our area with the upper trough remaining open and a right entrance region of an upper jet to our north.** However, the frontogenesis band is expected to track eastward with the cold front, so it appears that the mesoscale band may track eastwards through the day as well, which would help to create more uniform snow totals versus if the band remained truly stationary or pivoted. HREF guidance suggests that snowfall rates of 1" per hour are likely late this morning into this afternoon as this band moves across the region. The HREF also suggests that snowfall rates of 2" per hour are not out of the question, especially across western New England early this afternoon.

NEAR TERM...Main

Thursday 7 April 2022

CSTAR research on wind direction and heavy rainfall was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 070838
AFDALY

AREA FORECAST DISCUSSION

National Weather Service Albany NY
438 AM EDT Thu Apr 7 2022

.SHORT TERM /6 PM THIS EVENING THROUGH SATURDAY NIGHT/...
Tonight, steady rain should overspread the region this evening, with moderate to locally heavy elements embedded within. **The best chance for heaviest rain will be across favorable upslope areas of the southeast Catskills, and portions of the SW Adirondacks and northern portions of the Mohawk Valley, which tend to maximize QPF within a southeast H925-850 flow regime per CSTAR research.** There could be localized rainfall amounts of 2-3" in some of these areas. In addition, there could be some rumbles of thunder, mainly for areas south of I-90 this evening through around midnight, as some elevated instability develops. Models remain consistent suggesting a wave of low pressure develops near or over the Delmarva region this evening, and then translates north/northeast into southern New England, intensifying the southeast low level jet into our region this evening. In fact, some hi-res guidance suggests H925 winds reach 40-45 KT across portions of the Taconics, southern Greens and northern Berkshires for a few hours this evening. If there remains any dry air within the boundary layer, this could allow for slightly deeper mixing and stronger winds to reach the surface in these areas. At this time, current forecast indicates max wind gusts of 35-45 mph in this area, however should the potential for even stronger wind gusts increase, a wind advisory may be needed. Steady rain should taper to showers from southwest to northeast after midnight, along with decreasing winds for areas of the southern Greens/Taconics and northern Berkshires. Lows by daybreak mainly in the mid 30s to lower 40s. There could be some wet snow mixing in for elevations above 1800 feet as well after midnight.

SHORT TERM...KL