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

Development of Improved Diagnostics, Numerical Models, and Situational Awareness of High-Impact Cyclones and Convective Weather Events

University: University at Albany

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1. SUMMARY OF STUDENT RESEARCH ACTIVITIES

a) Forecast and model diagnostics for severe convective weather events in complex terrain

Graduate student: William Flamholtz
PI and co-PIs: Brian Tang, Lance Bosart, and Kristen Corbosiero
NWS focal points: Thomas Wasula (ALY), Michael Evans (ALY), and Matthew Kramar (PIT)

Research summary:

We performed additional analysis to understand the idealized simulations discussed in the previous six-month report. As a reminder, the model domain had a north–south oriented valley surrounded by a plateau. The elevation of the plateau was 300 or 500 m. The initial wind and temperature profiles were based off a HRRR analysis sounding from near Hudson, NY from 1800 UTC 13 August 2016, a severe weather event that we previously analyzed. The wind profile within the valley was modified to adjust the 0–1-km storm-relative helicity (SRH) to produce low, medium, and high-SRH environments. In total, there were 12 simulations (three SRH environments, two elevations, and two [valley/no-valley] configurations). Each simulation was reinitialized (after a spin-up period) with a warm bubble in the western portion of the model domain. The warm bubble initiated convection, which quickly grew into a supercell. Hereafter, we describe the evolution of the supercell in the medium-SHR environment (104 m^2 s^{-2}) and 300-m valley simulation.

The first important effect the valley has on convection is horizontal convergence and weak upslope flow on the western slope of the valley, due to flow channeling and lee troughing. As the supercell passes over this horizontal convergence zone, which has increased convective available potential energy (CAPE) and lift, there is a notable increase in reflectivity (Fig. 1a). There is a concomitant increase in low-level mesocyclone strength (Fig. 1b). Additionally, the cold pool becomes stronger, as it begins to accelerate down into the valley (Fig. 1c). These effects resemble convective behavior that is sometimes observed in the Hudson and Mohawk valleys, where convection can interact with terrain-induced boundaries and increase the short-term risk of severe convective hazards.

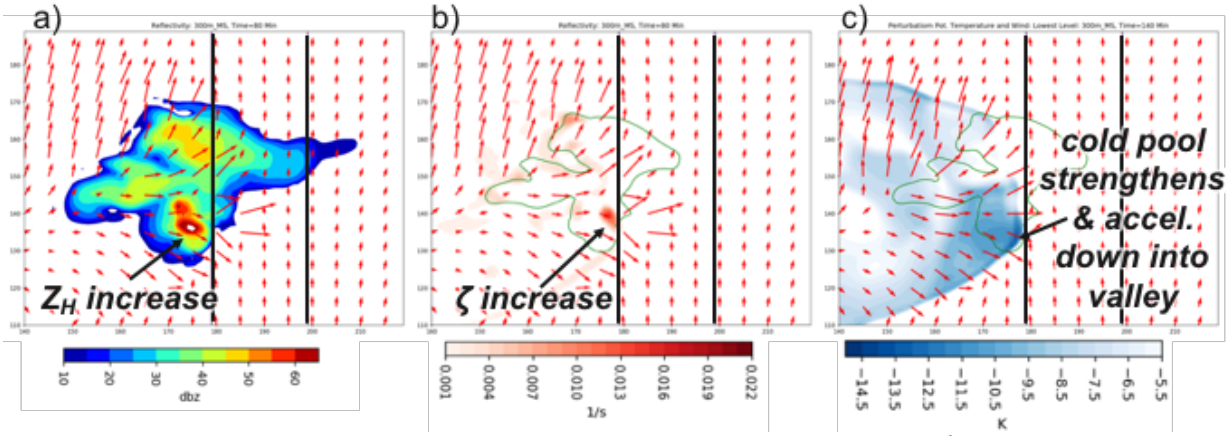

Figure 1. *(a) Simulated reflectivity (dBZ), (b) 1-km relative vorticity (s^{-1}), and (c) perturbation potential temperature (K). Red arrows are the near-surface wind. Black lines denote the edges of the valley.*

Thereafter, the cold pool behavior plays a critical role in the subsequent convective evolution as the cell enters the valley. Five minutes after the time shown in Fig. 1, the rear-flank downdraft (RFD) and cold pool of the supercell surges ahead (Figs. 2a and 2c), and the 1-km relative vorticity reaches its maximum value on the northern end of the RFD (Fig. 2b). The supercell mesocyclone is more occluded and begins to resemble a northern line-end vortex. In contrast, no such transition occurs in the no-valley simulation, i.e., the storm mode remains supercellular. After 25 additional minutes, the cell in the valley simulation, as it crosses over the eastern side of the valley, resembles a bowing segment (not shown). This transition in storm mode may be relevant to observed convective mode changes in complex terrain.

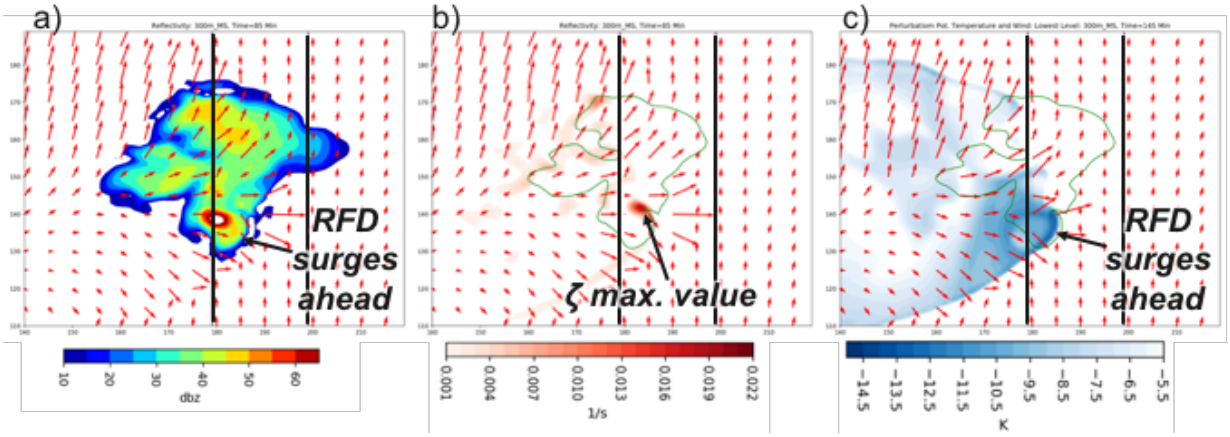

Figure 2. *Similar to Fig. 1, except five minutes later in the simulation.*

Subsequent research, which encompasses activities in the next CSTAR project, will continue to investigate some of the questions and hypotheses raised herein. Additional simulations, including semi-idealized simulations that introduce more realism and complexity, will be helpful to further understand the role that complex terrain has on convective evolution and mode, and for developing conceptual understanding that forecasters can use to increase their awareness of situations where terrain-convection interactions may locally increase the risk of severe weather.

NWS Interactions:

Brian Tang and Lance Bosart attended the 20th Northeast Regional Operational Workshop. Brian presented the research that was detailed in this report. We had useful discussions with National Weather Service forecasters and other scientists who were in attendance.

Brian Tang also presented a research overview to NWS Focal Points at the Fall CSTAR Meeting. The overview highlighted main results from the two previous CSTAR projects on severe convection, concentrating on results that have operational value. We also discussed the biggest convective forecasting challenges with forecasters, and how we can improve research-to-operations transfer of knowledge, so that we can better plan research priorities and activities for the next CSTAR project.

b) High-resolution numerical forecasts of lake-effect snowstorms: model performance, physics sensitivities, and synoptic predictability

Graduate student: Massey Bartolini
PIs and co-PIs: Justin Minder, Daniel Keyser, and Ryan Torn
NWS focal points: Joseph Villani (ALY) and David Zaff (BUF)

Research summary:

During the past six months, Massey Bartolini, the graduate student assigned to this project, finished all project tasks. His M.S. thesis was completed in December 2019, along with "quick reference" slides published by Ross Lazear on VLab. A manuscript on the microphysical parameterization portion of the research is in preparation. Massey presented this research at the Northeast Regional Operational Workshop and the AMS Annual Meeting.

A paper on the planetary boundary layer and surface layer parameterization portion of the research has been accepted and published by AMS. This work was also presented at the AMS Annual Meeting.

c) Applying forecast track and intensity diagnostics to high-impact Northeast winter storms

Graduate student: Tomer Burg
PI and co-PIs: Andrea Lang, Ryan Torn, and Kristen Corbosiero
NWS focal points: Neil Stuart (ALY), Joseph Dellicarpini (BOX), and Justin Arnott (GYX)

Research summary:

The research portion of this project concluded in summer 2019 with the submission of a M.S. Thesis by Tomer Burg. The project's research goal was to identify and quantify systematic biases with forecasts of high-impact Northeast U.S. winter cyclones. During this six-month reporting period, the project's activity focused on operationally relevant outcomes of the research and adapting the research results for publication. The Co-PIs on the project are currently working with Tomer Burg on adapting his thesis results into a format to be submitted to an AMS journal. Members of this project team worked with Ross Lazear on transitioning the project results to an R2O framework via VLab. The team also discussed plans for the maintenance of the real-time web products that were produced during the course of this research.

2. CSTAR VI PROJECT THESES, PRESENTATIONS, AND PUBLICATIONS

a) Theses completed

Bartolini, W. M., 2019: Convection-permitting ensemble forecasts of the 10–12 December 2013 lake-effect snow event: sensitivity to microphysical, planetary boundary layer, and surface layer parameterizations, University at Albany/SUNY, 103 pp.

b) Presentations

Bartolini, W. M., and J. R. Minder, 2019: Single-parameter perturbations: Quantifying microphysical parameterization uncertainty in convection-permitting forecasts of the 10–12 December 2013 lake-effect snow event. *20th Northeast Regional Operational Workshop,* Albany, NY.

Bartolini, W. M., and J. R. Minder, 2020: Quantifying microphysical parameterization uncertainty in convection-permitting forecasts of the 10–12 December 2013 lake-effect snow event. *100th AMS Annual Meeting / 30th Conference on Weather Analysis and Forecasting / 26th Conference on Numerical Weather Prediction,* Boston, MA.

LeBel, L., B. Tang, and R. Lazear, 2020: Examining the variable impact of terrain on Upstate New York severe weather events. *45th Northeastern Storm Conference*, Saratoga Springs, NY.

Minder, J. R., and W. M. Bartolini, 2020: Characterizing and constraining uncertainty associated with surface and boundary layer turbulent fluxes in simulations of lake-effect snowfall. *100th AMS Annual Meeting / 30th Conference on Weather Analysis and Forecasting / 26th Conference on Numerical Weather Prediction,* Boston, MA.

Tang, B., W. Flamholtz, and L. Bosart, 2019: Simulating the effects of terrain-induced perturbations on severe convection using an idealized valley. *20th Northeast Regional Operational Workshop*, Albany, NY.

Wasula, T. A., B. J. Frugis, and M. S. Evans, 2019: The Multi-Hazard Severe Weather Event of 21 August 2019 across eastern New York and western New England. *20th Northeast Regional Operational Workshop*, Albany, NY.

Wasula, T. A., 2020: The 4 August 2018 severe Weather Event across east central New York. *New York State Mesonet Forum*, Albany, NY.

Wasula, T. A., and M. S. Evans, 2020: Application of recent northeast cool-season CSTAR conceptual models to three March 2018 snowstorms impacting eastern New York and western New England. *100th AMS Annual Meeting / 30th Conference on Weather Analysis and Forecasting / 26th Conference on Numerical Weather Prediction,* Boston, MA.

Wasula, T. A., B. J. Frugis and M. S. Evans, 2020: The multi-Hazard severe weather event of 21 August 2019 across eastern New York and western New England. *45th Northeastern Storm Conference*, Saratoga Springs, NY.

c) Refereed publications

Minder, J. R., W. M. Bartolini, C. Spence, N. R. Hedstrom, P. D. Blanken, and J. D. Lenters, 2020: Characterizing and constraining uncertainty in simulations of lake-effect snowfall associated with surface and boundary layer turbulence. *Wea. Forecasting,* **35***,* 467–488.

Smith, M. B., R. D. Torn, K. L. Corbosiero, and P. Pegion, 2020: Ensemble variability in rainfall forecasts of Hurricane Irene (2011). *Wea. Forecasting*, In review.

3. RESEARCH TO OPERATIONS

Updates to the Albany CSTAR Virtual Lab (VLab) community page are ongoing. The legacy CSTAR page now directs all web traffic to the VLab, enhancing the linkage between the research and operations communities. Traffic to the page is monitored using Google Analytics.

With recent CSTAR M.S. students having recently completed their degrees, Massey Bartolini's and Tomer Burg's theses have been to VLab. Additionally, after consultation with NWS Focal Points, both students' operationally relevant quick references were added to the VLab:

- Massey Bartolini created a table documenting differences in simulated lake-effect snow band intensity, position, and graupel content using a variety of microphysics and boundary layer parameterization schemes.
- Tomer Burg created a phase-space and conceptual diagrams showing along- and across-track biases for Northeast cyclone tracks from the GEFS.

Keywords for both quick references allow this work to be accessed using the AWIPS Interactive Reference (AIR) utility.

Ross Lazear will be meeting with William Flamholtz and his NWS Focal Points in Summer 2020 to develop a quick reference for his work on severe weather and complex terrain.

Finally, the agenda and preprints for the Northeast Regional Operational Workshops dating back to 2000 have begun to be added to the VLab.

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

Progress continues on the initiative to migrate Albany CSTAR training materials and research findings to NOAA's VLab, in order to facilitate increased research to operations for our projects. Ross Lazear is working with our Information Technology Officer Vasil Koleci on the CSTAR VLab page, which now contains CSTAR reports, Master's theses, and web tools derived from previous and ongoing projects. In addition, cold-season and warm-season quick reference graphics and links to recorded training have also been added to the page, and a link to previous NROW presentations is being developed. Reference material from the research is also available to forecasters via the AWIPS Interactive Reference Tool. This tool allows operational forecasters to access VLab material on AWIPS with a mouse click on a product legend. This is an ongoing project, as there are many references that have been added over the past several months, but many more remain to be added.

The 20th Annual Northeast Regional Operational Workshop was presented on 6–7 November. Attendees included representatives from the NWS forecast offices at Albany, Binghamton, State College, Burlington, and Norton, Massachusetts. Universities represented at the conference included UAlbany, SUNY Stony Brook, the University of Utah, Appalachian State University, Hobart and William Smith Colleges, and Hofstra. The New York State Mesonet was also represented, and keynote speakers were Louis Uccellini and David Novak.

Research has been completed on the three Major Foci projects of CSTAR VI, and work to transition this research to operations is beginning. The first major project, with graduate student, Tomer Burg, was titled "Applying forecast track and intensity diagnostics to major northeast winter storms". The three Focal Points (Neil Stuart from NWS Albany, Joe Dellicarpini from NWS Taunton, and Justin Arnott from NWS Gray) worked with Mike Evans to modify Tomer's Master's thesis PowerPoint presentation into a presentation that could be presented to operational staff prior to the beginning of the winter of 2020–2021. A webinar will be presented to operational staff in late fall 2020. Findings from this work are highly relevant to operational forecasters.

There is a belief among forecasters that the operational forecast models have a "right-of-track" bias for eastern CONUS cyclones. The results from Tomer's work indicate that that no such bias exists when a comprehensive collection of eastern CONUS surface cyclones were examined; however, there may be synoptic patterns that are favorable for a right of track bias. In particular, Tomer has demonstrated that amplified midlevel flow patterns with strong western CONUS ridges may be favorable for a right of track bias. Tomer has also demonstrated that the GEFS is under-

dispersive with tracks of cyclones regarding both positioning and timing. Note that a major effort to increase the dispersion of the GEFS has been accomplished with the latest version of the GEFS, which will become operational later this year. The NWS Focal Points for this project are examining the results from Tomer's project, and are working to organize it in a format that will be easy for forecasters to interpret. Once this is done, his findings should result in improved forecasts for east coast winter storms.

The second major project, completed by graduate student Massey Bartolini, was titled "Predictability and variability of lake effect snow events". As part of the project, NWS Albany Focal Point Joe Villani is planning on conducting a local study with regards to high-resolution model output (from the NAMNest and HRRR) and inland extent of lake effect snow bands. This would be an extension of his prior lake effect snow research mentioned in the Future Work section of his NWA paper. This project will utilize a new capability in the GAZPACHO program (*https://vlab.ncep.noaa.gov/redmine/projects/nwsscp/wiki/Gazpacho*; version 4.0 released February 2019) that computes gridded verification of snowfall from the HRRR and NAMNest. Over the duration of an event, the program compares the observed snowfall analysis to the positive snow depth change in the NAM Nest and HRRR.

The findings from Massey's work are useful for operational meteorologists forecasting lake effect snow over the eastern Great Lakes. Massey's work shows that large differences in intensity and timing of lake effect snow can occur in high resolution forecast models when changes are made to microphysics schemes. Importantly, there has been a long-held belief by forecasters that operational models have a southward bias in their forecasts of lake effect snow. It appears that, in the case that Massey studied, this bias was not evident, which is an indication that high-resolution modeling may finally be overcoming this southward bias. If true, this improvement would be a major advancement for operational forecasters, as forecasting the southward extent of lake effect snow has been a consistently difficult challenge for decades.

A third project, with graduate student William Flamholtz, is advancing Pamela's Eck's research on "The effects of mesoscale inhomogeneities on severe convection in complex terrain". This study appears to be setting the foundation for work that will ultimately be useful for operations. Additional work in this area is slated for CSTAR VII. The work that William has done has been mostly theoretical. For maximum use in operations, that work now should be transitioned to develop conceptual models that operational forecasters can apply to help anticipate where and when convection may intensify or change its structure. This could be most useful during the gap between issuance of watches, and issuance of warnings, allowing forecasters to highlight areas where intensification is likely, prior to the actual occurrence of severe weather. For example, highlighting environments that would be favorable for intensification of convection as it moves off of higher terrain and down into heavily populated valleys. There seem to be some days when convection intensifies as it moves off of higher terrain down to the Hudson Valley, while on other days this fails to occur. A conceptual model including maps highlighting favored areas would be very helpful for forecasters.

5. STATUS OF "SNYDER PLAN V" PROJECTS *(Michael Evans and focal points)*

Work has been completed on most of the Collaborative and Associate Projects of CSTAR VI, details of which are presented below. Six NWS offices are participating in this work.

CSTAR VI Collaborating and Associate Projects

1. Assessment of polygon-based lake-effect warnings

Team lead: Jon Hitchcock (BUF)

There were seven events this year, which is less than normal. WFO BUF continued to lead the project, along with collaboration for a second year with WFOs at ALY and BGM. This year the project was also expanded to include WFO CLE. The feedback from the public continues to be positive with many clearly understanding the utility of warnings based on meteorology instead of geo-political boundaries.

Interestingly, during the 2018–2019 year, there was a minor issue with the polygons when transitioning from a blizzard warning to experimental polygons. This year the opposite issue appeared: transitioning from experimental lake effect polygons to a blizzard warning without polygons. Moving toward, long-fused, impact-based polygons for all hazards would help alleviate these scenarios. We anticipate moving the software into the NWS Hazard Services program either this winter or next winter, which will make the software more easily configurable throughout the NWS.

2. Expansion of Buffalo high wind study and decision aide to other offices

Team lead: Shawn Smith (BUF)

The project completed last year and an NWS technical attachment was published.

3. Improving forecasts of snow along the west-facing slopes of the Appalachians

Team lead: Matt Kramer (PIT)

Work never began on this project.

4. Integrating advanced boundary layer physics and theory into operations

Team lead: Ian Lee (DTX)

Nothing new to report.

5. Heat waves/extreme heat events in the Northeast United States

Team leads: Neil Stuart and Kevin Lipton (ALY)

Nothing new to report.

6. Develop methods/best practices for development of conceptualized models for (parameter) use by operational forecasters using previous event analysis/reanalysis

Team lead: Alan Cope (PHL)

Nothing new to report. Alan has retired.

7. Development of IFR climatologies for inland TAF sites

Team lead: Joseph Dellicarpini (BOX)

Discontinued due to short-staffing and other commitments.

8. Development of improved WSR-88D warning criteria using dual polarization datasets

Team leads: Tom Wasula and Brain Frugis (ALY)

a. Tom gave a poster presentation at NROW XX on 7 November 2019 on the "The Multi-Hazard Severe Weather Event of 21 August 2019 across eastern New York and western New England". The poster included an illustration of the utility of research by Brian Frugis on looking for descending columns of KDP for damaging winds, and also on the utility of applying thresholds from Brian and Tom's local V-R Shear study for identifying tornadoes. Three tornadoes occurred on this day with lots of wind damage, some hail and isolated flash flooding. Updates of the tornado climatology in ALY's forecast area were also shown.
b. Tom gave a NYS Mesonet Webinar series talk on 28 February 2020 entitled "The 4 August 2018 Severe Weather Event across east Central NY". Little to no severe weather was predicted that afternoon from the local to national level. It was a low predictability and localized high-impact event across eastern NY with 18 wind damage reports occurring from the Upper Hudson Valley and the Glens Falls area into the Capital District from discrete severe cells and an outflow boundary or gust front.
c. Tom gave an updated poster presentation at the 45th Northeastern Storms Conference on 6 March 2020 entitled the "The Multi-Hazard Severe Weather Event of 21 August 2019 across eastern New York and western New England". Application of the KDP descending columns research Brian Frugis was shown, and the local V-R Shear study Brian and Tom worked on was applied.
d. No new or significant additional work was done on the Albany Forecast Area significant hail study climatology and case studies. There were no 2" or greater hail stones in the 2019 warm season in the ALY forecast area. More work will be done on this study in CSTAR VII.
e. Work continued on a study to examine the relationship between elevated KDP cores and significant severe thunderstorm wind occurrences. The results from the 51 ordinary (non-significant) severe thunderstorm events that were shown at NROW XX in November have been added to the study. The presence of collapsing KDP columns in significant severe events was found to be statistically significant when compared to the ordinary severe events. This finding helped strengthen the use of collapsing KDP columns as a precursor for significant severe thunderstorm wind damage and its utility during the warning process. The updated paper has just gone through a final review with ER SSD and will be published as an Eastern Region Technical Attachment in May.

9. Assessing the relationship between flash flooding verification and values of instantaneous precipitation rate (DPR)

Team lead: Ian Lee (DTX)

Due to time constraints, this project has been discontinued.

10. Explore and assess use of MRMS in warning operations

Team lead: Ian Lee (DTX)

Nothing new to report at this time.

11. Verification of gridded ceiling and visibility forecasts at Taunton, MA

Team lead: Joseph Dellicarpini (BOX)

Nothing new to report.

12. Expanding Decision Support Services
Team lead: Brian Montgomery (ALY)

This project has been completed. All forecasters in the NWS have completed extensive training in decision support services based partially on this work.

13. A climatology of damaging QLCS storms that produce mesovortices
Team lead: Matt Kramer (PIT)

Work never began on this project.

14. Expressing uncertainty with lake-effect snow in the ER probabilistic snow project
Team lead: Matt Kramer (PIT)

Work never began on this project.

15. An expanded analysis of BUFKIT methodologies to forecast wind and wind gust speed for the upper Ohio River Valley
Team lead: Matt Kramer (PIT)

Work never began on this project.

16. R2O and CSTAR project support by UAlbany undergraduate interns
Team lead: Vasil Koleci and Michael Evans (ALY)

Ross Lazear and Vasil Koleci continue to work on the VLAB page, which will act to transition findings related to the CSTAR research to operations. All past CSTAR theses and some conceptual models have been added to the page. Recorded training based on CSTAR research has been added in 2019. The AWIPS Interactive Tool has been setup with CSTAR projects that have been uploaded to VLAB.

6. CSTAR PROJECT RESEARCH IN NWS AFDs

Sunday 24 November 2019

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

FXUS61 KALY 240839
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
339 AM EST Sun Nov 24 2019

.NEAR TERM /UNTIL 6 PM THIS EVENING/...
Due to transitioning precip types, snow accumulations will vary greatly with the highest amounts over the mountains of the eastern Catskills and Helderbergs. We are noting a strong signal in the

latest model guidance, with regards to an area of strengthening 850- 700mb F-Gen to the north and west of the 700mb low/deepening surface cyclone by late this morning into early afternoon. **Previous CSTAR research has shown this to be favorable for mesoscale banding.** Hi-res guidance such as the NAMNest/HREF focusing bands of moderate/heavy snow across the eastern Catskills and Helderbergs during this time. This is the area we have increased snowfall totals to around 3-6 inches. Warm nose aloft is still expected to progress northward across the Taconics, Litchfield Hills, Berkshires and eventually southern VT from this morning into this afternoon. So in these areas we have increased ice slightly due to freezing rain, with slightly less snow and greater potential for sleet into early afternoon.

NEAR TERM...JPV

Monday 16 December 2019

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

FXUS61 KALY 162105
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
405 PM EST Mon Dec 16 2019

.NEAR TERM /THROUGH TUESDAY/...
The trough sweeps eastward tonight into Tuesday with the northern stream flow becoming more amplified ahead of a digging, robust upper low. This process will allow the upper jet to become more anticycloncially curved with a strong equatorward jet entrance region becoming positioned over the area by late tonight. Models are now in fairly good agreement with the track of the surface low ahead of the southern stream trough, tracking from the central Appalachians offshore of southern New England. Combined with large- scale ascent from the jet entrance region, the isentropic lift ahead of the approaching wave will allow snow to spread into the region gradually from south to north 03-12Z. Good sloped 850 to 700 mb frontogenesis will coincide with the onset of the snow, which could come down moderately to locally heavily south of Albany between 06-12Z. **The pattern is reminiscent of the laterally translating snowband composite in CSTAR research, but the bands will likely not be moving very quickly.** HREF mean suggests snowfall rates of 0.50-0.75 inches per hour are likely with this activity, with low probability of brief 1 inch per hour rates. Warming aloft will allow the snow to turn to sleet and freezing rain from south to north after about 09Z. Current expectations are for the mixing line to remain south of the Capital District. Temperatures aloft warm such that a period of freezing rain is likely across southern portions of Dutchess and Litchfield Counties, with a good cold air drainage signal replenishing the cold air near the surface.

NEAR TERM...Thompson

Tuesday 31 December 2019

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

FXUS61 KALY 311945
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
245 PM EST Tue Dec 31 2019

.NEAR TERM /THROUGH WEDNESDAY/...
As of 230 PM EST...Rather impressive upper low was crossing Lake Ontario with comma tail approaching the I81 corridor. Showers and squalls are accompanying the cold front where some in-cloud lightning has been detected via the NLDN. However, downstream lapse rates and minimal CAPE are forecast to weaken a bit so upstream line should weaken a bit and break up as suggested by the HRRR/NAM3km hires reflectivity. We have already issued an SPS to highlight the potential for snow squalls through this evening. In the wake of fropa, combination of cold advection (H850 temperatures only drop back to around -10C) and tight gradient should allow for brisk conditions across most of the region. Some upslope snow showers are expected as the attention will be downwind of Lake Ontario. Lake Ontario temperatures were near 42F (6C) and delta t/s climbing toward the mid teens for conditional lake instability. A fairly uniform wind flow should allow for bands of snow to make it inland into portions of the Dacks. **Inland penetration per CSTAR research suggests the lake band snow can move inland with excess of 100+ miles overnight and New Years Day morning.** Previous forecast had a winter weather advisory for lake effect snow and per the new guidance and overview, we will not make changes at this time. Generally 3-7" of snow expected through New Years Day as we watch one more short wave swing southeast across the state. This will likely disrupt the band into multi bands and reduce inland extent.

NEAR TERM...BGM

Wednesday 1 January 2020

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

FXUS61 KALY 010922

AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
422 AM EST Wed Jan 1 2020

.NEAR TERM /UNTIL 6 PM THIS EVENING/...
The low and mid level flow will likely veer more to a northwesterly trajectory, as the some narrow multibands may materialize by the mid to late pm, and the lake inland extent will shrink based on the cool season CSTAR research. A light to moderate accumulation is likely and we increased totals west of Indian Lake only slightly into the 3 to 8 inch range.

NEAR TERM...Wasula

Friday 3 January 2020

CSTAR research on Mohawk–Hudson convergence was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 030929
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
429 AM EST Fri Jan 3 2020

.SHORT TERM /6 PM THIS EVENING THROUGH SUNDAY/...
Saturday Night...The mid and upper trough becomes negatively tilted and the secondary low goes through cyclogenesis near Cape Cod and then lifts into the Gulf of Maine. Dynamical cooling and colder air being wrapped into the system will generate a period of snow. **We will have to monitor for some potential Mohawk-Hudson Convergence snowfall for the Capital District into the northern Taconics which is well documented in the cool CSTAR research.** We have light snow accums in the valley areas including Albany with an inch or less, except the upper Hudson corridor near KGFL and the western Mohawk Valley where 1-3" is possible. The higher totals of 2-5" or so could be over the southern Greens, southern Adirondacks, and portions of the northern Berkshires. We may need advisories for some of the higher terrain later. Some orographic enhancement due to westerly upslope flow is possible for the southern Greens, Taconics, and Berkshires in the deformation zone of the system. It will become windier with brisk northwest winds. Lows will fall back into the 20s with some teens over the western Adirondacks and southern Greens.

SHORT TERM...Wasula

Wednesday 15 January 2020

CSTAR research on local terrain effects in winter storms was cited in the long-term section of the NWS ALY AFD.

FXUS61 KALY 152347
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
647 PM EST Wed Jan 15 2020

.LONG TERM /SATURDAY THROUGH WEDNESDAY/...
Then as that aforementioned upper jet moves across the Ohio Valley, left exit region dynamics will further enhance lift across the central and northern part of our region. This in turn also further enhances the warm advection from the south for a wintry mixture to develop from south to north. While difficult to ascertain where that line will develop, trends favor just south and east of Albany Saturday evening which will cut down on snowfall accumulations. **Furthermore, per CSTAR research, these miller-type `B` systems tend to favor upslope areas of the Dacks and southern Greens with a precip diminishing into the Capital Region due to downsloping from the Catskills.** So this places higher accumulation totals for those terrain areas and a reduction in overall accumulations from the Capital Region and points to the south and southeast.

LONG TERM...BGM

Wednesday 15 January 2020

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

FXUS61 KALY 162116
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
416 PM EST Thu Jan 16 2020

.SHORT TERM /6 AM FRIDAY MORNING THROUGH SATURDAY NIGHT/...

A fast moving storm with favorable jet dynamics will bring a widespread moderate to heavy snowfall to the region. A cold airmass will be place across the region ahead of this storm. There will be impressive insentropic lift with strong frontogenetical forcing. **CSTAR research indicates banding will be possible.** Laterally translately bands occur with strong warm air advection and the low approaching from the west. Overrunning warm air advection snow will quickly spread across the area early Saturday afternoon. Once it starts expect it come down heavy with snowfall rates of 1 to 2 inches an hour. The bulk of the snow is expected to fall between noon and midnight. The highest snowfall amounts are expected across the southern Adirondacks, lake George Saratoga Region, Berkshires and southern Vermont where 7+ inches are expected.

SHORT TERM...IAA

Friday 14 February 2020

CSTAR research on flow-dependent snowfall totals was cited in the long-term section of the NWS ALY AFD.

FXUS61 KALY 142031
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
331 PM EST Fri Feb 14 2020

.LONG TERM /MONDAY NIGHT THROUGH FRIDAY/...
Isentropic lift and warm thermal advection will result in a period of light snow overspreading the region Tuesday morning. As per previous excellent forecast discussions, the degree of warm advection will result in a transition toward rain/snow mix and periods of rain during the afternoon hours along and south of I90 and south of KGFL. **Southwest flow regime per CSTAR research would favor the Dacks and southern Greens with higher QPF and perhaps higher snowfall amounts.**

LONG TERM...BGM

Wednesday 26 February 2020

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

FXUS61 KALY 261008

AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
508 AM EST Wed Feb 26 2020

.SHORT TERM /6 PM THIS EVENING THROUGH FRIDAY/...
Lake-effect will be developing behind the departing storm as well for Thursday afternoon into Thursday evening, as temps aloft rapidly cool. 850 hpa temps will be -15 to around -20 C and lake surface temps remain about +5 C. The cutoff upper level low will only slowly be moving across Ontario and Quebec, and there will be a persistent westerly flow at low to mid levels. The flow will be across multiple Great Lakes, with a single long-lake axis parallel band off Lake Ontario. **Local CSTAR research would suggest a band of this setup should have a fairly far inland extent, especially considering the abundant moisture and strong winds in place.** It should be fairly steady state band as well, with the development expected by Thursday afternoon and it looks to impact the western and central Adirondacks through at least Friday. Single point totals look to easily be 1 to 2 feet, and its not out of the question for even higher totals near Old Forge-Inlet based off latest guidance.

SHORT TERM...Frugis

Sunday 22 March 2020

CSTAR research on transition season snow events was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 221044
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
644 AM EDT Sun Mar 22 2020

.SHORT TERM /6 PM THIS EVENING THROUGH MONDAY NIGHT/...
Mon-Mon Night...Transitional season storms are always challenging as shown in recent cool season CSTAR research, as this one has a chance to produce light to moderate snow accumulations in many locations, and possibly heavy amounts in the Berkshires northward into southern VT, and also in the eastern Catskills.

SHORT TERM...Wasula

Monday 23 March 2020

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

FXUS61 KALY 231048
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
648 AM EDT Mon Mar 23 2020

.SHORT TERM /6 PM THIS EVENING THROUGH TUESDAY NIGHT/...
Tonight...Our forecast continues to favor a consensus of the NAM/ECMWF and 00Z HREFS. There are indications the H700 circulation may close off briefly over southeast New England between 00Z-03Z TUE. The short-waves finally phase with the coastal low sliding northeast toward Cape Cod. The mid and upper level deformation zone strengthens with decent low to mid level frontogenesis from the Capital Region south and east. The H850 0C isotherm may briefly reach the I-90 corridor around 03Z. **We will have to monitor if a pivoting pcpn or mesoscale snow band forms per the recent cool season CSTAR research.** We are expecting a transition to snow everywhere at night and it could accumulate quick at a half an inch to an inch and hour especially the grassy and untreated surfaces. Expecting 1-3" in the Capital District, 1-2" in the Mid Hudson valley, and Litchfield County with 1-4" in Washington Co.

SHORT TERM...Wasula