UNIVERSITY AT ALBANY
State University of New York

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24 March 2017

Dr. Christopher Hedge
Office of Science and Technology
NOAA/National Weather Service
1325 East-West Highway, Suite 15328
Silver Spring, MD 20910

Dear Dr. Hedge:

I am transmitting a summary of the UAlbany CSTAR V project activities for the six-month period ending 28 February 2017. Research conducted during this period has continued to address questions related to the occurrence and prediction of high-impact weather events in the Northeast United States.

During the reporting period, second year graduate student Pamela Eck continued to examine the relationship between jumps in lightning flash rate, severe weather, and upslope flow as part of our research into *Severe Convection in Scenarios with Low Predictive Skill* (section 1a). She has used the random forest machine-learning technique to predict whether convective cells will become severe and has obtained promising results. Third year student Molly Smith is concluding her study on *Predictability of Heavy Precipitation associated with Tropical Moisture* (section 1b). Her work is elucidating the synoptic and mesoscale features that produced wet and dry forecasts of Hurricane Irene (2011) using ensemble composite difference and clustering techniques. Molly will graduate in May and begin working as an Associate Scientist in the Global Systems Division (GSD) of NOAA's Earth System Research Laboratory (ESRL) in Boulder, CO on 1 June. Finally, third year student Rebecca Steeves is finishing her analysis of major transition season Northeast snowstorms for her project, *Transition Season Northeast Storms and East Coast Atmospheric Rivers* (section 1c). Rebecca has created composites of major transition season Northeast snowstorms falling into cold pool and baroclinic zone categories, and has examined the climatology of events and their relationship with atmospheric rivers.

The PI, co-PIs, graduate students, and NWS personnel participated in the Fall 2016 CSTAR meeting held at NWS Albany on 4 November 2016. Research results were presented and in-depth conversations on research methodologies and case studies were conducted. As a follow-up to the fall meeting, the PI, several co-PIs, and NWS personnel participated in a teleconference with Eastern Region Science Operations Officer (SOO) Jeff Waldstreicher and Scientific Services Division (SSD) Chief Ken Johnson on 28 November regarding VLab and best R2O practices. Further interactions between NWS forecasters and CSTAR V participants occurred during the 17th Northeast Regional Operational Workshop (NROW) on 2–3 November and at the Lance Bosart Symposium held at the 97th AMS Annual Meeting in Seattle, WA on 25–26 January 2017, during which many CSTAR V participants presented their research.

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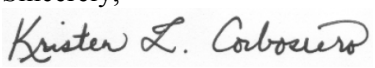
Further information on UAlbany CSTAR I–V theses, presentations, and publications may be found at *http://www.atmos.albany.edu/facstaff/kristen/CSTAR/CSTAR_CumulativePublications.pdf*.

An NWS perspective on CSTAR V project activities is provided by NWS Albany Meteorologist In Charge (MIC) Raymond O'Keefe in section 3. The CSTAR V projects continue to contribute to the legacy of completing operationally focused research, engaging the academic community, providing the NWS with top quality applicants, enabling the involvement of dozens of operational meteorologists from numerous NWS offices, and facilitating the rapid transfer of project results into operational forecasting practice. Section 4 contains a comprehensive progress report on the "Snyder Plan IV," which continues to provide a framework for NWS participation in cooperative R2O transfer.

Section 5 describes activities performed by David Knight and addresses computing and technology transfer, and section 6 contains numerous examples of UAlbany CSTAR project research that has transitioned into NWS forecast operations in the form of Area Forecast Discussions from the NWS Albany office that explicitly refer to the UAlbany CSTAR program.

In summary, the UAlbany CSTAR V project has addressed research questions related to the occurrence and prediction of high-impact weather events in the Northeast United States. The three major projects leverage the activities of the UAlbany PI, co-PIs, and graduate students for the benefit of NWS forecast operations in the Eastern Region and beyond.

Sincerely,



Kristen L. Corbosiero

cc: Lance Bosart
Daniel Keyser
Andrea Lang
Brian Tang
Ryan Torn
Raymond O'Keefe
Ken Johnson
Jeff Waldstreicher
David Knight
Pamela Eck
Molly Smith
Rebecca Steeves

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The Collaborative Science, Technology, and Applied Research Program

Cooperative Research with the National Weather Service on the Occurrence and Predictability of High-Impact Precipitation Events in the Northeastern United States

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: Raymond O'Keefe

National Oceanic and Atmospheric Administration (NOAA) Award #: NA13NWS4680004

Date: 24 March 2017

1. SUMMARY OF STUDENT RESEARCH ACTIVITIES

a) Severe convection in scenarios with low predictive skill

Graduate student: Pamela Eck
Co-PIs: Brian Tang and Lance Bosart
NWS focal points: Joe Villani (ALY), Mike Evans (BGM), and Matthew Kramar (PIT)

Research Summary:

Pamela has continued to improve her prototype real-time lightning website, which is designed to evaluate the utility of lightning jumps for operational severe weather forecasts. The website combines lightning data from the National Lightning Detection Network (NLDN) and radar reflectivity from the Multi-Radar/Multi-Sensor System (MRMS). In addition to improving the lightning density product, a lightning jump product has recently been added. Figure 1 shows an example of the MRMS composite radar and NLDN lightning density. The experimental website will continue to be improved and will be made available to NWS focal points in spring 2017 for evaluation and feedback.

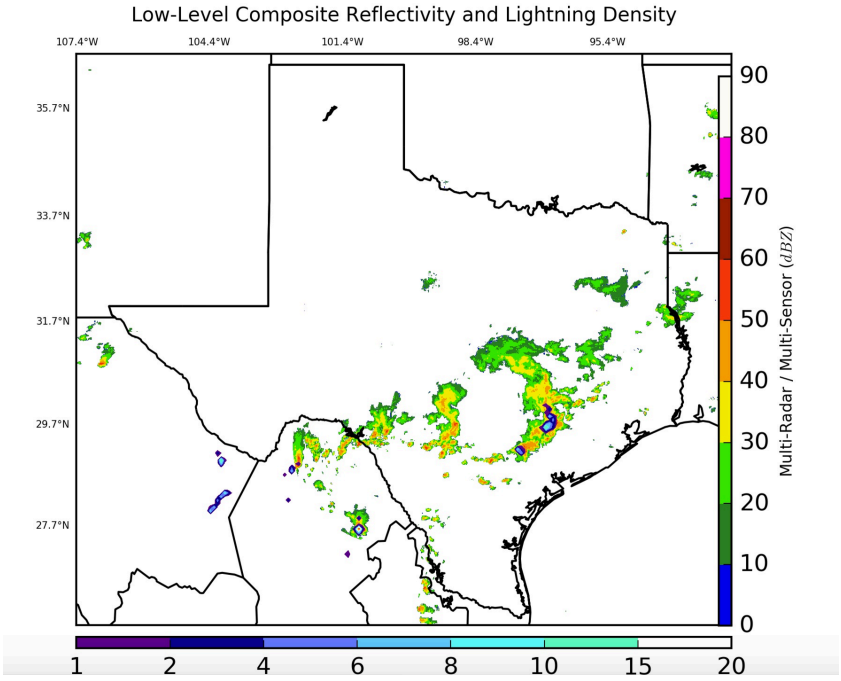

Figure 1. *Sample snapshot of the composite reflectivity (dBZ) from the Multi-Scale/Multi-Sensor System (MRMS) and lightning density (flashes 2-min^{-1}) from the National Lightning Detection Network (NLDN).*

Pamela has continued to assess the relationship between upslope enhancement of convection, lightning behavior, and the subsequent risk for severe weather. To calculate upslope, 80-m winds are dotted with the gradient of terrain height ($\Lambda = \vec{v}_{80\,m} \cdot \nabla z_s > 0$). Both the 80-m winds and terrain height data are taken from the High Resolution Rapid Refresh (HRRR) model for a subset of severe weather days over the Northeast during July 2015 (1, 9, 14, 18, 19, 24, 26, and 28).

In order to objectively combine upslope and lightning jumps to predict severe weather, upslope, flash rate, and flash rate change were all inserted as predictors into a random forest

machine-learning algorithm. The random forest (Breiman 2001) constructs a multitude of decisions trees to predict a classification (severe vs. non-severe) based on patterns in each of the three predictors. The random forest algorithm is run 1000 times to eliminate any bias, and verification metrics, such as probability of detection (POD) and false alarm rate (FAR), are computed (Fig. 2). On average, we obtain a high POD (82%) and a low FAR (28%), which is much improved over our previous methodology.

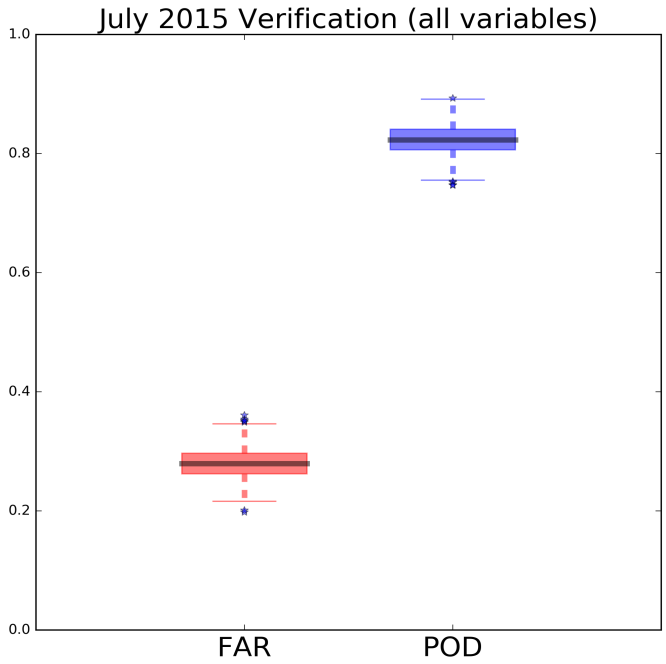

Figure 2. *False alarm rate (FAR; red) and probability of detection (POD; blue) of severe weather. Box-and-whisker plots show the distribution of the results from all 1000 runs of the random forest algorithm.*

Figure 3 shows percentages of variable importance, which indicates how heavily the algorithm relied on each of the input variables in order to predict the classification of severe or non-severe. On average, upslope, flash rate, and flash rate change accounted for 45%, 30%, and 25% of variable importance, respectively. Combined, flash rate and flash rate change account for 55% of variable importance, implying that lightning data is valuable when predicting severe weather.

Pamela is currently working on adding radar variables to the random forest algorithm in order to compare the importance of lightning data to the importance of radar data. Proposed radar variables include maximum reflectivity, echo top height, and vertically integrated liquid. The random forest will be able to objectively answer the common forecaster question of whether it is valuable for forecasters to spend time looking at lightning data versus the more traditional radar metrics, especially in a time-limited warn-on forecast scenario.

NWS Interactions:

Pamela presented a summary of her research to NWS Focal Points at the Fall CSTAR meeting on 4 November 2016. The NWS Focal Points provided valuable feedback to Pamela and the co-PIs on improvements to the prototype products may aid them in the warn-on forecast for severe convection. Additionally, both during and after the meeting, NWS Focal Points helped

facilitate in-depth discussions on what radar variables would be the most beneficial to include in the random forest algorithm.

Presentations:

Pamela presented her research at the 17th Northeast Regional Operational Workshop on 3 November 2016 in Albany, NY, the 28th Severe Local Storms Conference on 9 November 2016 in Portland, OR, and the 97th American Meteorological Society Annual Meeting on 25 January 2017 in Seattle, WA.

Co-PIs Brian Tang and Lance Bosart attended all three meetings. Brian, Lance, and Pamela discussed the work with other researchers and forecasters interested in using lightning data for severe weather forecasting. The exchange of ideas will motivate future directions for research and research-to-operations activities.

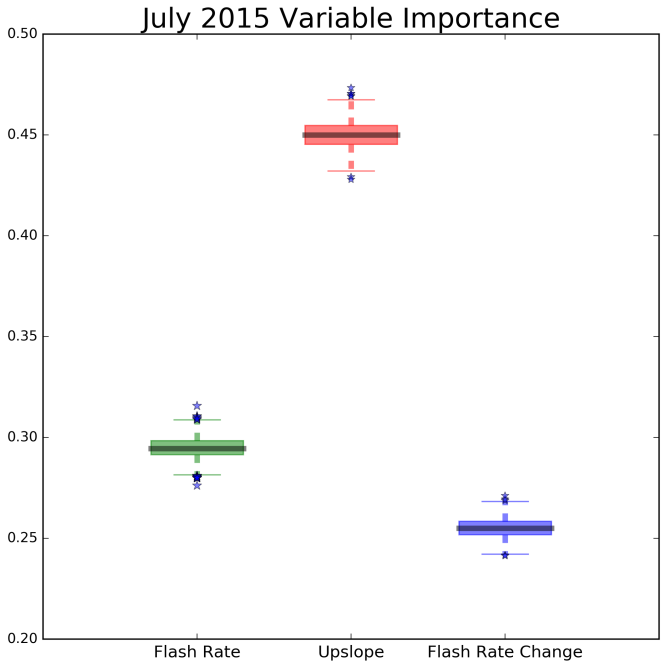

Figure 3. *Variable importance of flash rate (green), upslope (red), and flash rate change (blue). Box-and-whisker plots show the distribution of the results from all 1000 runs of the random forest algorithm.*

b) Predictability of heavy precipitation associated with tropical moisture

Graduate student: Molly Smith
Co-PIs: Kristen Corbosiero and Ryan Torn
NWS focal points: Steve DiRienzo (ALY) and Mike Jurewicz (BGM)

Research Summary:

As tropical cyclones (TCs) move from the tropics into the midlatitudes, they are often associated with extensive regions of heavy precipitation. This precipitation can lead to widespread flooding events, as occurred with Hurricane Irene (2011) over the northeastern United States. Ensemble runs of weather models, such as the Global Forecast System (GFS), are an indispensible tool for predicting this type of catastrophic flood. Ensembles aid in the creation

of probabilistic forecasts by illustrating several possible scenarios that can occur in a single time period. Identifying the correct scenario is particularly vital in the case of TC-fueled extreme rainfall, which can devastate entire communities. As part of the ongoing project to understand what modulates precipitation variability in ensemble modeling of these heavy rainfall events, an in-depth case study is being performed on Hurricane Irene (2011). The case study has two main goals: 1) to determine what particular modeling scenarios produce the heaviest precipitation over the northeastern United States, and 2) to ascertain what ensemble metrics, besides mean and standard deviation, are the most useful in predicting such an event.

An 80-member ensemble of the 2014 operational version of the GFS was initialized at 0000 UTC 27 August 2011, when Irene was situated off the coast of the Carolinas, and run through 0000 UTC 29 August 2011, when Irene became extratropical over New England. The 0.5° GFS output was then downscaled to 3 km using the Weather Research and Forecasting (WRF) model, in order to allow a better representation of mesoscale processes and the effects of terrain on the precipitation distribution. The physics used for this downscaling were comparable to those used in High-Resolution Rapid Refresh (HRRR) model. Finally, the ensemble members were ranked by the amount of precipitation they brought to the Catskill region of New York (41.75–42.75°N, 73.9–75.25°W) during the 48-hour period in question. The Catskills received some of the worst flooding associated with Irene, and are thus a good indicator of whether specific ensemble scenarios accurately captured the precipitation distribution associated with the heavy rainfall event.

This analysis reveals substantial variability in rainfall totals over the Catskills produced by the 80 ensemble members (Fig. 4). Three hypotheses are proposed to explain this variability: 1) wetter members feature the greatest upslope forcing over the Catskills, 2) wetter members have increased moisture flux convergence over the Catskills, and 3) wetter members position the region of maximum Q-vector convergence over the Catskills.

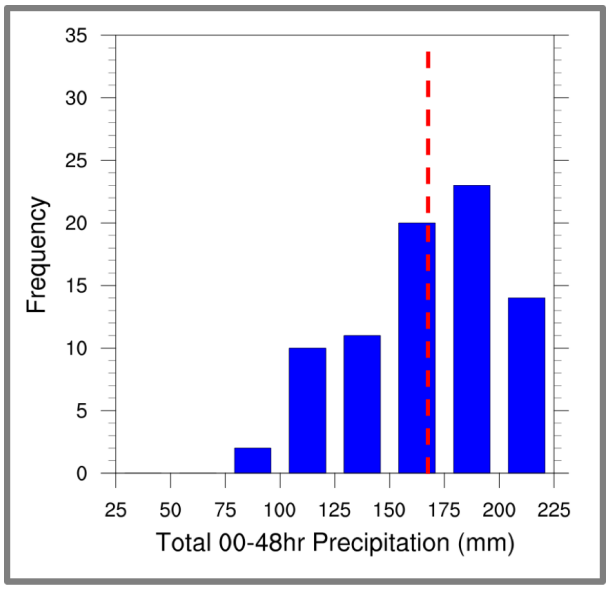

Figure 4. *WRF 3 km ensemble rainfall distribution over the Catskill region of New York (41.75–42.75°N, 73.9–75.25°W) between 0000 UTC 27 August and 0000 UTC 29 August 2011, compared to the observed value (red dashed line).*

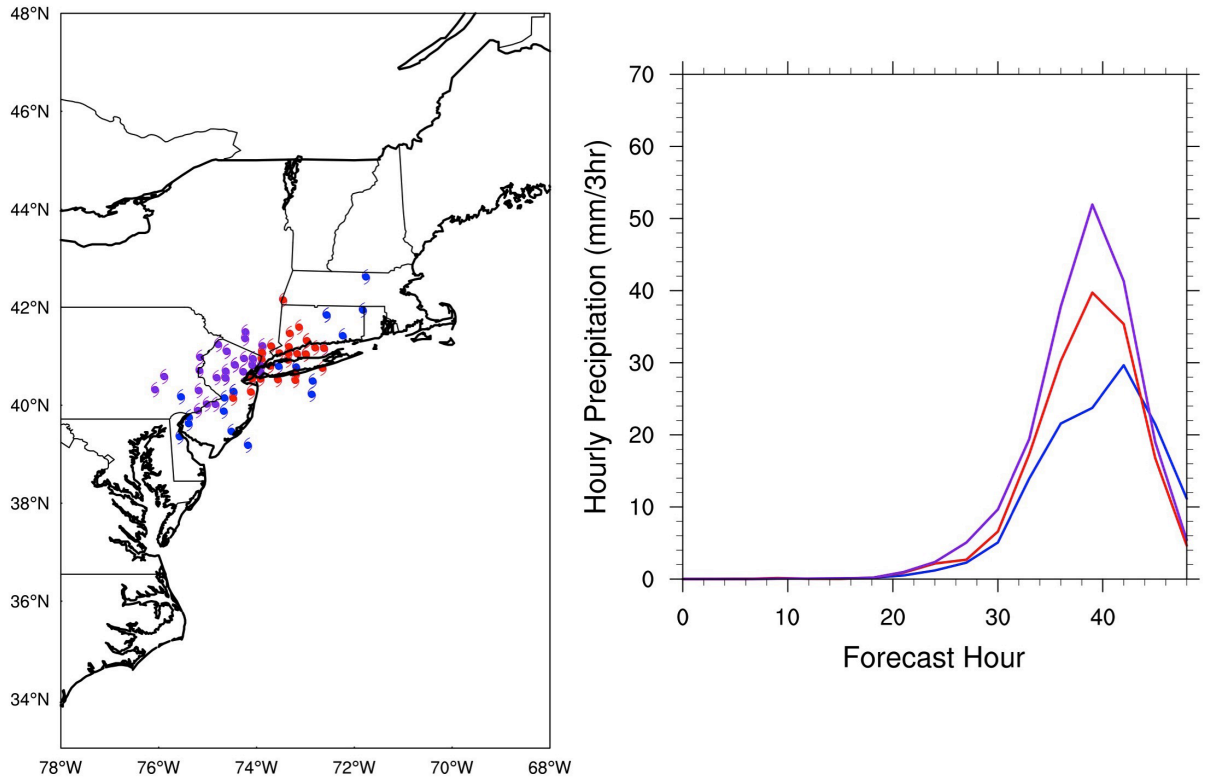

Figure 5. *Three objective clusters of ensemble members based on the horizontal precipitation distribution over the domain 41.5–43.5°N, 73–76.5°W from 36–39-h. The blue markers and trace represent a "low-rain" cluster, the red an "eastward-tracking" cluster, and the purple a "westward-tracking" cluster. Panel a) shows the storm center position for each ensemble member and b) shows the composite precipitation rate for each cluster.*

During the March–August 2016 research period, these hypotheses were tested by objectively clustering the 80 ensemble members into three groups (Fig. 5) based on the horizontal precipitation distribution over the domain 41.5–43.5°N, 73–76.5°W from 36–39-h (the period of maximum rainfall for the Catskills), representing three particular scenarios indicated by the ensemble. The first cluster, represented in blue in Figure 5, represents a "low rain" scenario, and consists of storms that were too far away at 39-h to bring much rain at all to the Catskills. The second cluster, represented in red in Figure 5, represents an "eastward-tracking" scenario, and consists of storms that were able to bring elevated precipitation to the region while moving to the eastern side of the track distribution. The third cluster, represented in purple in Figure 5, represents a "westward-tracking" scenario, and consists of storms that brought the largest precipitation totals to the Catskills, while moving to the western side of the track distribution. The research that was performed during the current research period (September 2016–February 2017) has focused on refining the results obtained by this objective clustering and ensuring their robustness. As the first, low-rain cluster represents residual storms, this study compares the other two clusters to determine why one brought elevated rainfall to the Catskills, and the other brought less.

To summarize the results of this hypothesis, precipitation in the wetter cluster was driven primarily by mesoscale processes and terrain effects (strong upslope forcing and moisture convergence), while precipitation in the drier cluster was driven primarily by synoptic forcing for

ascent (Fig. 6). The wetter cluster featured easterly low-level flow directly into the sharp terrain gradient of the eastern Catskills, creating large upslope magnitudes, while the drier cluster had more northerly low-level flow, which failed to impact as large a terrain gradient. Likewise, the wetter cluster simulated stronger moisture transport into the region than the drier cluster, and greater convergence of that moisture (the larger upslope magnitudes likely contributed to this convergence). The drier cluster, on the other hand, had stronger Q-vector convergence than the wetter cluster, which generally featured either weak or negative Q-vector convergence (and thus reduced synoptic forcing for ascent). All of this illustrates the importance of terrain and mesoscale processes in producing large rainfall totals, as the cluster with a favorable mesoscale setup was able to produce substantially more precipitation than the synoptically forced cluster.

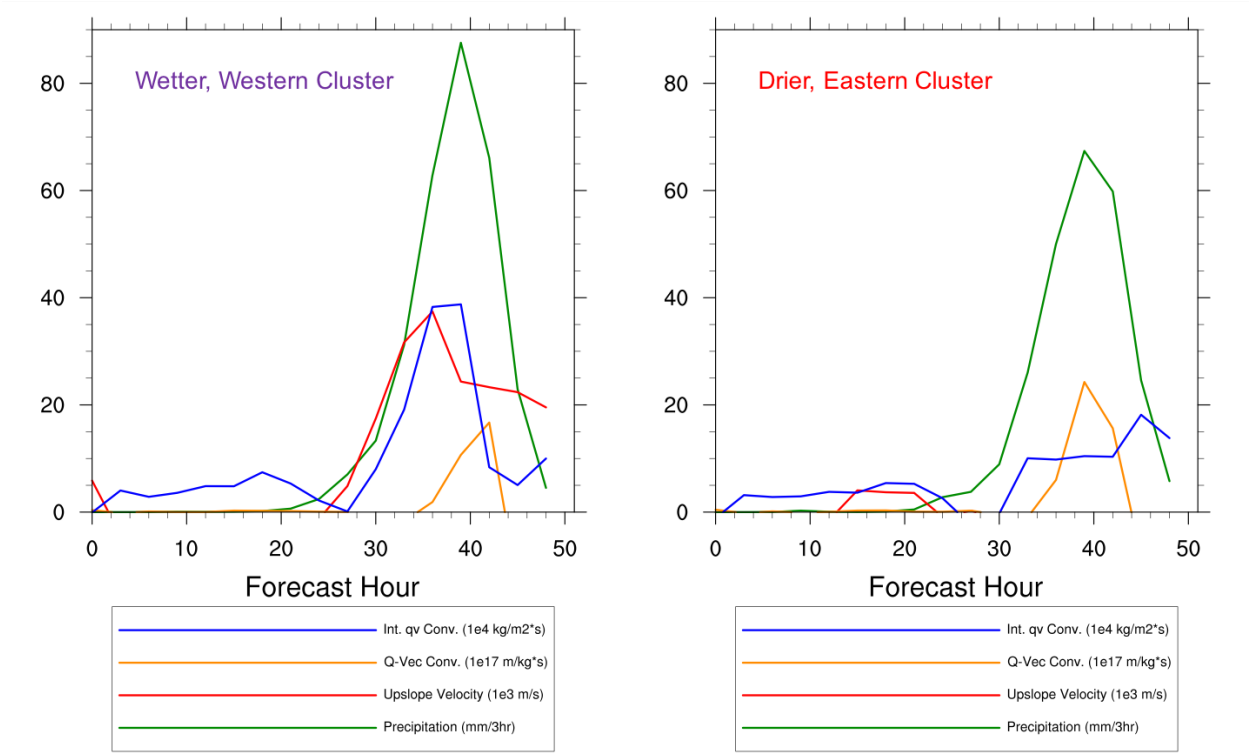

Figure 6. *WRF 3 km ensemble forecasted precipitation (green curve), upslope (red curve), moisture convergence (blue curve), and Q-vector convergence (orange curve) for the wetter, western cluster (a) and the drier, eastern cluster (b) over the Catskill region of New York between 0000 UTC 27 August 2011 and 0000 UTC 29 August 2011.*

NWS Interactions:

Molly Smith presented a summary of her project at the November 2016 CSTAR meeting.

In regards to this project's R2O, we have continued to revise our GEFS ensemble forecast difference page (*http://www.atmos.albany.edu/facstaff/torn/CSTAR_ediff/index.php*), which is an outcrop of this research. Currently, the page displays the difference between members with higher or lower 48–72-h high temperature, low temperature, and precipitation for Albany, Buffalo, Binghamton, Upton, and Portland using forecast data every six hour. In addition, co-PI Torn has been engaged with our NWS focal points on developing training materials for how to interpret this output and disseminate to a broader set of forecasters. In the

future, we will add capability to plot the difference between the ensemble-mean forecast and verifying analysis in anticipation of expanding to a real-time decision support product.

Presentations:

Smith, M. B., R. D. Torn, K. L. Corbosiero, and P. Pegion, 2016: Ensemble variability in GFS rainfall forecasts of Hurricane Irene (2011). Oral presentation at the 17th Northeast Regional Operational Workshop (NROW), 2–3 November, Albany, NY.

Smith, M. B., R. D. Torn, K. L. Corbosiero, and P. Pegion, 2017: Ensemble variability in rainfall forecasts of Hurricane Irene (2011). Poster presentation at the 28th Conference on Weather Analysis and Forecasting at the 97th American Meteorological Society Annual Meeting, 22–26 January, Seattle, WA.

c) Transition season Northeast storms and East Coast atmospheric rivers

Graduate student: Rebecca Steeves
Co-PIs: Andrea Lang and Daniel Keyser
NWS focal points: Thomas Wasula (ALY) and Neil Stuart (ALY)

Research Summary:

Work efforts during the previous six-month reporting period were distributed among analyzing composites, expanding upon a climatology, and conducting event studies. A preliminary analysis for each of the major transition season Northeast snowstorms (97 events) revealed that the characteristic patterns of lower-tropospheric cold air that coincided with areas of heavy snowfall could serve as distinguishing characteristics for composite categories. The composite categories included a baroclinic zone category (49 events), a cold pool category (36 events), and an unclassified category (12 events). The baroclinic zone category was further divided into two subsets for compositing, as a spatial and temporal average of the thermal wind direction to the northwest of the surface cyclone center observed during the event yielded a division of the events into two distinct subsets of snowstorms. The two subsets were comprised of southwesterly thermal wind events (29 events) and westerly thermal wind events (20 events). After dividing the events into the baroclinic zone subsets or the cold pool category, a set of composite maps was created for each baroclinic zone subset and for the cold pool category. Each set of composite maps focused on documenting the planetary-to-mesoscale flow patterns occurring prior to and during each major transition season Northeast snowstorm. One of the composite maps included the 1000–500-hPa thickness, 250-hPa wind speed, and mean sea level pressure (MSLP) (Fig. 7). From Figure 7, it is evident that major transition season Northeast snowstorms can occur in various synoptic flow patterns. The various synoptic flow patterns are exemplified by the thermal trough manifested in the 1000–500-hPa thickness field. Specifically, the baroclinic zone: southwesterly thermal wind subset features a deep thermal trough (Figure 7a), the baroclinic zone: westerly thermal wind subset features a shallow thermal trough (Figure 7b), and the cold pool category features a moderate thermal trough (Figure 7c). The cold pool category also features greater thickness values than the two subsets of the baroclinic zone category in the vicinity of the surface cyclone center. This thickness difference suggests that both subsets of the baroclinic zone category feature colder air than the cold pool category in the vicinity of the surface cyclone center.

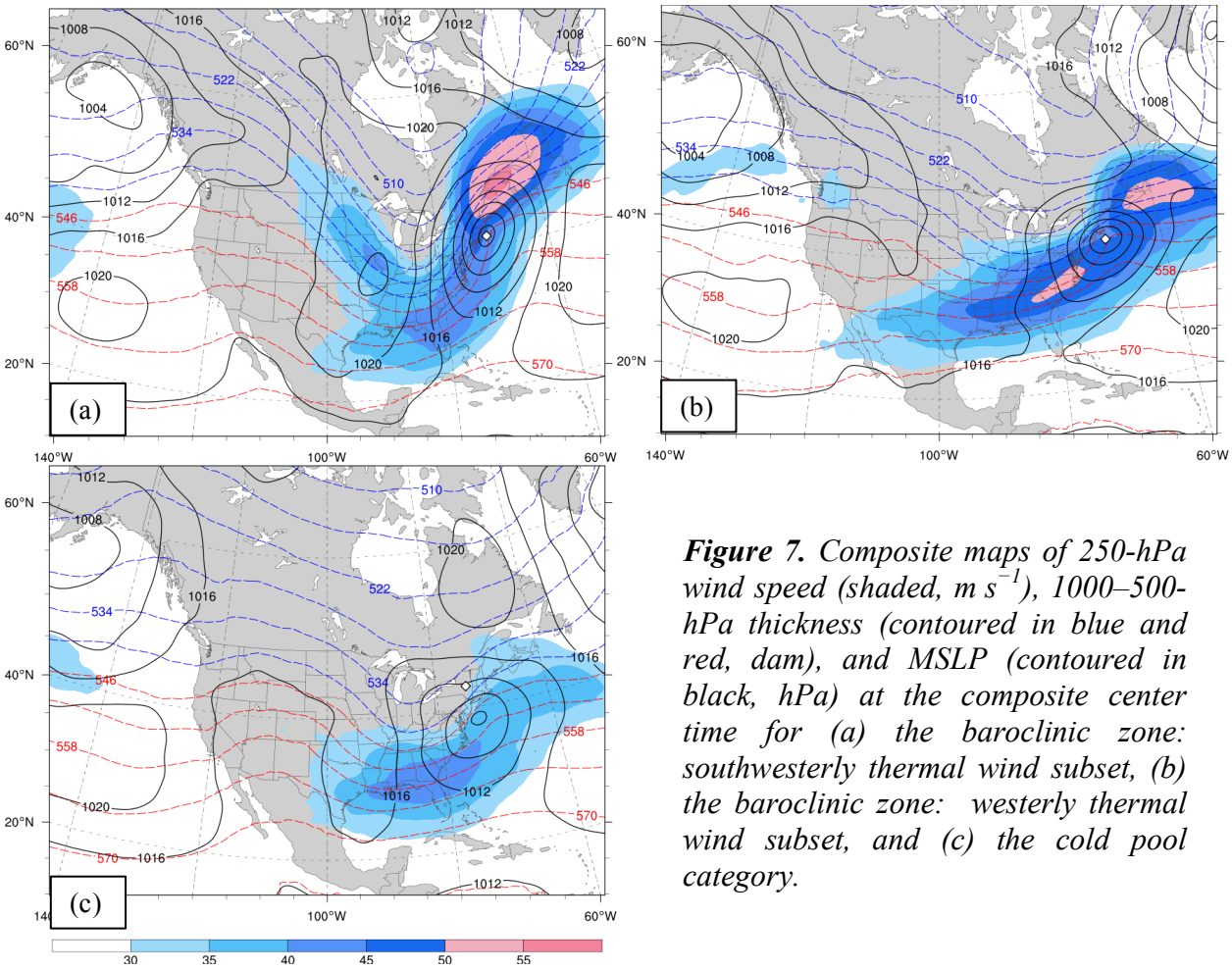

Figure 7. *Composite maps of 250-hPa wind speed (shaded, m s^{-1}), 1000–500-hPa thickness (contoured in blue and red, dam), and MSLP (contoured in black, hPa) at the composite center time for (a) the baroclinic zone: southwesterly thermal wind subset, (b) the baroclinic zone: westerly thermal wind subset, and (c) the cold pool category.*

The climatology of major transition season Northeast snowstorms was expanded upon during the previous six-month reporting period. During this period, plots were created to display the number of cold pools in each county at the initial and midpoint time of the cold pool for the cases in the cold pool category. These plots were created in order to illustrate the geographical distribution of the cold pools. For each baroclinic zone subset or cold pool category, plots were created to display the number of events in a county warning area (CWA) where at least one point of snowfall accumulation that met or exceeded the 12-h heavy snow warning criterion threshold was associated with an atmospheric river (AR). These plots were created in order to investigate the role of objectively identified ARs in areas of heavy snowfall during major transition season Northeast snowstorms. Points of snowfall accumulation were diagnosed as being associated with ARs from both Eulerian and Lagrangian perspectives. The methodology to make the associations for both perspectives was based on the methodologies from Lavers and Villarini (2015) and Mahoney et al. (2016). The association of a point of snowfall accumulation with an AR from a Lagrangian perspective is exemplified in Figure 8, which shows the association during an exploratory event study, the 8–9 March 2005 snowstorm. Figure 8 shows that parcels with trajectories ending within an area of heavy snowfall spent some portion of their lifetime within an AR, which suggests that an AR was an important ingredient for the event. The methodology used in the exploratory event study will also be applied to the event studies that are

representative of the baroclinic zone subsets or the cold pool category. Rebecca Steeves began conducting the representative event studies during the previous six-month reporting period. Also during this period, Rebecca continued to write her M.S. thesis. The first two chapters (i.e., introduction and methodology) were completed and detailed outlines of the third (i.e., results of the climatology and composite analysis) and fourth (i.e., results of the case studies) chapters are currently in preparation. Upon completion of the third and fourth chapters, conceptual diagrams will be designed to summarize the planetary-to-mesoscale flow patterns for each subset of the baroclinic zone category and for the cold pool category.

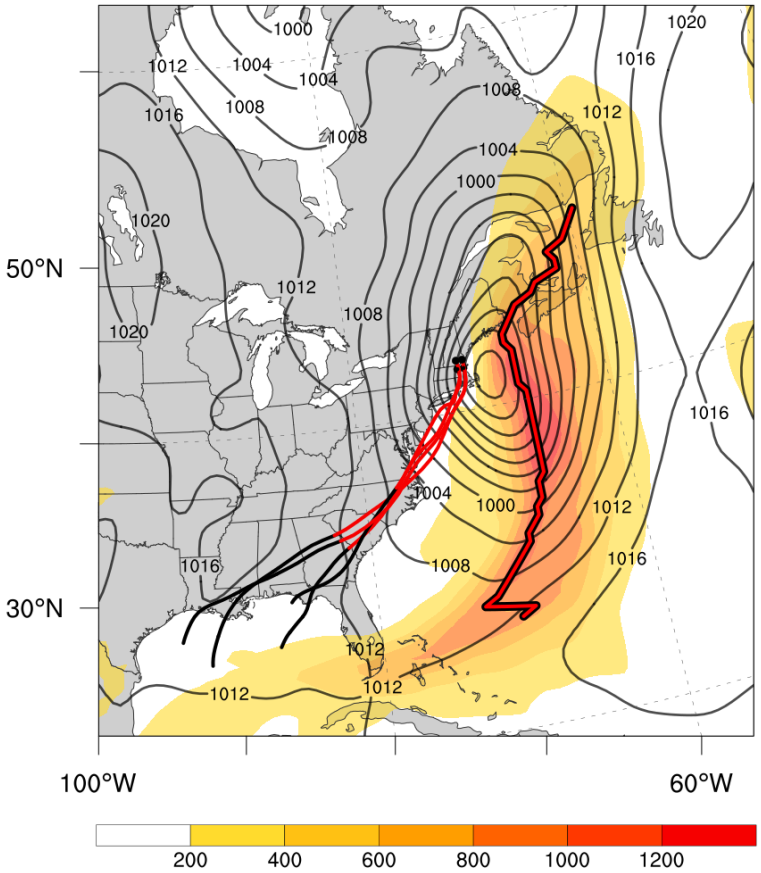

Figure 8. *Vertically integrated water vapor transport (shaded, kg m^{-1} s^{-1}), MSLP (contoured, hPa), and an objectively identified AR axis (red line with black outline) at 0000 UTC 4 March 2005, and 72-h backward trajectories (red if within 250 km of AR axis, otherwise black) ending at 600 hPa on 0000 UTC 9 March 2005.*

NWS Interactions:

Rebecca Steeves presented at the Fall 2016 CSTAR meeting on 4 November 2016. Also during the previous six-month reporting period, Rebecca met with the departmental liaison between CSTAR project research and NWS operations, Ross Lazear, in order to discuss plans for transitioning the project research to operations.

Presentations:

Rebecca Steeves presented at Northeast Regional Operational Workshop (NROW) XVII on 2 November 2016, the Fall 2016 CSTAR meeting on 4 November 2016, and the 28th

Conference on Weather Analysis and Forecasting of the 97th American Meteorological Society (AMS) Annual Meeting on 24 January 2017. The presentation at NROW focused primarily on the 8–9 March 2005 exploratory event study and showed that parcels with trajectories ending within an area of heavy snowfall spent some portion of their lifetime within an AR. The presentation at the Fall 2016 CSTAR meeting summarized climatological characteristics of major transition season Northeast snowstorms and introduced composite maps of the baroclinic zone subsets and the cold pool category for major transition season Northeast snowstorms. The presentation at the 28th Conference on Weather Analysis and Forecasting showed climatological characteristics of objectively identified ARs and summarized the synoptic-to-mesoscale flow patterns of the composite maps for the baroclinic zone subsets and the cold pool category.

2. CSTAR V PROJECT THESES, PRESENTATIONS, AND PUBLICATIONS

a) Theses completed

None

b) Presentations

Wasula, T. A., B. J. Frugis, and I. R. Lee, 2016: A comparison of two recent anomalously large hail events that impacted the Albany Forecast Area. Poster presentation at the 41st Annual Meeting of the National Weather Association, 10–15 September, Norfolk, VA.

Wasula, T. A., and N. A. Stuart, 2016: A multi-scale analysis of the 26–27 November 2014 pre-Thanksgiving snowstorm. Poster presentation at the 41st Annual Meeting of the National Weather Association, 10–15 September, Norfolk, VA.

Eck, P., B. Tang, and L. Bosart, 2016: Lightning jumps as a predictor of severe weather in the northeastern United States. Oral presentation at the 17th Northeast Regional Operational Workshop (NROW), 2–3 November, Albany, NY.

Smith, M. B., R. D. Torn, K. L. Corbosiero, and P. Pegion, 2016: Ensemble variability in GFS rainfall forecasts of Hurricane Irene (2011). Oral presentation at the 17th Northeast Regional Operational Workshop (NROW), 2–3 November, Albany, NY.

Steeves, R. B., D. Keyser, and A. L. Lang, 2016: A multiscale analysis of major transition season Northeast snowstorms. Oral presentation at 17th Northeast Regional Operational Workshop (NROW), 2–3 November, Albany, NY.

Wasula, T. A., and B. J. Frugis, 2016: A multi-scale analysis of the 1 July 2016 null tornado watch across eastern New York and western New England. Oral presentation at the 17th Northeast Operational Workshop, 2–3 November, Albany, NY.

Eck, P., B. Tang, and L. Bosart, 2016: Lightning jumps as a predictor of severe weather in the northeastern United States. Oral presentation at the 28th AMS Severe Local Storms Conference, 7–11 November, Portland, OR.

Corbosiero, K. L., A. L. Lang, B. Tang, A. Wasula, N. A. Stuart, and T. A. Wasula, 2017: Lance Bosart's 20 years of contributions to operational meteorology, Part I: History and scientific contributions. Poster presentation at the Lance Bosart Symposium at the 97th American Meteorological Society Annual Meeting, 22–26 January, Seattle, WA.

Eck, P., B. Tang, and L. Bosart, 2017: Lightning jumps as a predictor of severe weather in the northeastern United States. Oral presentation at the Eighth Conference on the Meteorological Applications of Lightning Data at the 97th AMS Annual Meeting, 22–26 January, Seattle, WA

Smith, M. B., R. D. Torn, K. L. Corbosiero, and P. Pegion, 2017: Ensemble variability in rainfall forecasts of Hurricane Irene (2011). Poster presentation at the 28th Conference on Weather Analysis and Forecasting at the 97th American Meteorological Society Annual Meeting, 22–26 January, Seattle, WA.

Steeves, R. B., A. L. Lang, and D. Keyser, 2017: A multiscale analysis of major transition season Northeast snowstorms. Poster presentation at the 28th Conference on Weather Analysis and Forecasting at the 97th American Meteorological Society Annual Meeting, 22–26 January, Seattle, WA.

Stuart, N. A., 2017: Utilizing partnerships between state departments of health, universities, and the National Weather Service to improve public preparation and response to extreme heat. Oral presentation at the 12th Symposium on Societal Applications: Policy Research and Applications at the 97th American Meteorological Society Annual Meeting, 22–26 January, Seattle, WA.

Stuart, N. A., T. A. Wasula, A. Wasula, K. L. Corbosiero, A. L. Lang, and B. Tang, 2017: Lance Bosart's 20 years of contributions to operational meteorology, Part II: Impacts in the operational forecasting community and beyond. Poster presentation at the Lance Bosart Symposium at the 97th American Meteorological Society Annual Meeting, 22–26 January, Seattle, WA.

c) Refereed publications

Villani, J. P. and M. Jurewicz, 2017: Forecasting the inland extent of lake effect snow bands downwind of Lake Ontario. *J. Operational Meteor.*, In press.

3. NWS PERSPECTIVE ON CSTAR V PROGRESS *(Raymond O'Keefe, MIC WFO ALY)*

The three major projects of CSTAR V are nearing completion. CSTAR students Matt Vaughan, Rebecca Steeves, and Molly Smith have already received, or will receive, their M.S. degrees. Matt received his M.S. degree in December 2015 for his work on, "Severe convection in scenarios with low-predictive skill". Rebecca and Molly will receive their M.S. degrees in May 2017 for their research on, "Transition season northeast storms and East Coast atmospheric rivers", and, "Predictability of heavy precipitation associated with tropical moisture" respectively. My congratulations to these students and their advisors for the outstanding science produced in CSTAR V.

CSTAR V Collaborative and Associate Projects have resulted in numerous presentations and publications, have largely been completed, and are addressed in the following section of this report. Publications and presentation from NWS personnel associated with CSTAR V in this reporting period are listed in section 2.

The Fall 2016 CSTAR meeting was attended by NWS personnel from Albany and Binghamton. CSTAR V graduate students Molly Smith and Rebecca Steeves presented on their research during the meeting and at the preceding 17th Northeast Regional Operational Workshop. Incoming CSTAR VI students Tomer Burg, Pamela Eck, and Massey Bartolini discussed their projects as well. Tomer will be working on, "Applying forecast track and intensity diagnostics to major Northeast winter storms"; Pamela is looking at, "Effects of mesoscale inhomogeneities on severe convection in complex terrain"; and Massey will be studying, "Predictability and variability of lake effect snow events". UAlbany staff member Ross Lazear outlined an exciting initiative to advance R2O. Ross will direct a comprehensive program to create operationally

relevant job sheets and YouTube videos on completed CSTAR work. This effort is aimed at injecting CSTAR research into operations more quickly and broadly.

Dan Thompson, former CSTAR student, joined NWS Albany as a General Forecaster on 17 November 2016. Dan has been a great addition to our office. He received his M.S. degree from UAlbany in 2012 and wrote his thesis on, "Appalachian lee troughs and their association with severe convective storms".

CSTAR continues to provide a large payback to the NWS for the modest amounts expended. This grant's projects continue to build on CSTAR's legacy of completing operationally focused research, engaging the academic community at a high level with operational forecasters, providing the NWS with top quality applicants, and enabling the involvement of dozens of operational meteorologists in applied research and conferences from numerous NWS offices across the Northeast United States. CSTAR resources in the NWS Collaborative and Associate Projects of this grant also raise the level and sophistication of involvement by NWS Albany staff and UAlbany undergraduates in support of the CSTAR research.

4. STATUS OF "SNYDER PLAN IV" PROJECTS *(Raymond O'Keefe and focal points)*

This status report addresses work on CSTAR V projects, which began on 1 October 2013. The project descriptions are available in the grant, and have been omitted to conserve space. (* Denotes the Team Lead of each project)

CSTAR V Collaborating Projects

1. Development of Improved WSR88D Warning Criteria

Team: Thomas Wasula*, Brian Frugis, Ian Lee (now MFL), Luigi Mecarriello (now AMA), and Steve Moore (ALY); Sarah Jameson and Robert LaPlante (CLE); Mark McKinley (ZOB)

Part 1: Identifying new capabilities of dual-pol data

This work has been completed and summarized in previous reports.

Part 2: Establish modern Vr-shear tornado warning thresholds for the Northeast

a. Tom Wasula gave an oral presentations at the 17th Northeast Regional Operational Workshop on 2 November entitled, "A multi-scale analysis of the 1 July 2016 null tornado watch across eastern New York and western New England". Brian Frugis was a co-author. Results in the Vr-shear and NROT study led by Brian, and assisted by Tom, were shown for a couple of warned severe thunderstorms that did not produce tornadoes. The convective environment did yield 25 damaging wind and large hail reports (this event accounted for six out of the 12 large hail reports for the entire season). Dual-pol applications were also briefly shown for the large hail. The lack of tornadoes was likely due to low to moderate instability (dew points in the 50s to lower 60s F), LCL heights being slightly too high, lack of very steep mid-level lapses, and an elevated mixed layer (EML). This case did have a large societal impact on the Friday before the long holiday weekend with several events canceled and the NY Park Services having to close in some areas.
b. Dual Pol QPE Project/ER QPE Field Study: No new work was done on this study with the departure of Ian Lee to WFO Miami, and Luigi Meccariello to WFO Amarillo.

c. Tom, Brian, Ian, and Luigi began work on a potential NWA publication in the late winter into the early spring. The working title is, "The utility of updated radar studies for improving tornado warning guidance". The manuscript will review the latest Vr-shear local results, NROT, and TDS study highlights. Three cases will be reviewed including one null case.

2. Applications of mesoscale modeling

Team: Warren Snyder* (retired), Vasil Koleci, and Ian Lee (now at MFL) (ALY); Mike Evans (BGM); Mark McKinley (ZOB); David Knight (University at Albany)

This project has ended with the NWS focus toward using local modeling only in support of research. Two versions of the WRF continue to run, one on the UAlbany RIT System, and the other on a local cluster.

3. Probabilistic QPF

Team: Neil Stuart* and Vasil Koleci (ALY)

This project has been superseded by national initiatives and has been cancelled.

4. Improvement of forecasts of IFR ceilings and visibility in TAFs: Develop methods to improve IFR forecasts of TAFs and improve accuracy in forecasting flight categories

Team: Kevin Lipton*, Hugh Johnson, and Ian Lee (now at MFL) (ALY); Mike Evans (BGM); David Fitzjarrald (University at Albany's Atmospheric Sciences Research Center [ASRC])

Ian Lee developed a decision aide to assist forecasters in application of the methods he developed. A Java-based algorithm was developed and used to create an AWIPS application to use this method operationally. In addition, a Google form was created to allow performance of the research to be verified. Operational staff entered feedback on its successes and failures during the fall 2015 fog season.

Ian Lee has been promoted to the NWS Miami, FL office. With Ian's departure, this project has been suspended.

5. Graphical TAF verification of ceiling and visibility forecasts at Taunton, Massachusetts

Team: Joseph Dellacapini*, Kevin Cadima, and Frank Nocera (BOX)

We have had to cancel the rest of our study. The GFE verification data is not yet available and we have decided to fold our study into the CSTAR VI project on IFR instead. In addition, we no longer have access to the "virtual TAF" verification data due to an issue at the Verification Branch. I'm not sure how long that outage will last, but it has been going on for months.

6. Using and assessing new technology to provide decision support service (DSS) to a variety of customers as part of Weather Ready Nation initiative

Team: Brian Montgomery and Steve DiRienzo (ALY)

DSS continues to be at the forefront of our Weather Ready Nation (WRN) initiative and our staff was recently deployed during the January 2016 blizzard that impacted the mid-

Atlantic and Northeast states. Most of our staff has completed the required training for active deployments with recent enhancements to local checklists, which are available on our Google site's intranet to ensure all items for deployment are available. Skype has been approved for use at WFO Albany. We first utilized Skype during a television interview with the Weather Channel on 16 February 2016. WFO Albany is creating a "studio" to enhance our dissemination services. Finally, WFO Albany has successfully tested New York State's Mutualink system with the New York State Office of Emergency Management. Mutualink facilitates sharing of voice, video, and data for cross-agency collaboration in real-time.

7. An evaluation of winter weather warning and advisory criteria in the NWS Eastern Region from a scientific and societal impact perspective

Lead: John Quinlan (ALY)

This project has been cancelled.

CSTAR V Associate Projects

1. Improving forecasts of snow along the west facing slopes of the Appalachians

Lead: Matt Kramar (PIT)

This project has been moved to CSTAR VI.

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

Team: Kevin Lipton* and Neil Stuart (ALY)

a. Neil Stuart submitted an abstract and gave a presentation at the American Meteorological Society's 97th Annual Meeting in Seattle titled, "Utilizing partnerships between state departments of health, universities, and the National Weather Service to improve public preparation and response to extreme heat". This presentation was coauthored by Dr. Shao Lin of the UAlbany School of Public Health and Dr. Seema Nayak of the NY State Department of Health. Neil, Shao, and Seema coordinated the presentation through email correspondence. Neil was invited to contribute a chapter to a book addressing extreme weather hazards as a result of his presentation. Neil is waiting for guidance from the Scientific Services Division of Eastern Region Headquarters before he commits to contributing to the book.
b. Neil Stuart, Kevin Lipton, and Steve DiRienzo plan to have a meeting with the NY State Department of Health in March or April 2017 to discuss the latest research done by the NY State Department of Health. They have studied temperature and apparent temperature data across the state and tracked hospital emergency department visits and people with chronic health conditions to determine if the heat advisory threshold needs to be lowered in NY. If the data and research supports lowering the apparent temperature threshold, then it may be changed beginning the summer of 2017.
c. Dr. Shao Lin and Dr. Wayne Lawrence have sent a manuscript on the topic of wind chill and its effects on people with respiratory conditions to Neil, Steve, and Kevin for review for the journal *Environmental Health Perspectives*. The manuscript is currently under review and will be sent to the Scientific Services Division of Eastern Region Headquarters when the internal review at NWS Albany, NY is completed. Dr. Shao Lin also has sent a draft proposal for a new National Institute of Health research grant to

assess how multi-weather factors or large temperature variation and air pollution jointly affect human health. Neil, Steve, and Kevin would act as consultants providing weather data and analysis if this proposed research grant becomes funded. The Atmospheric Science Research Center and the NY State Department of Health are also included in this proposed research grant. Neil, Steve, and Kevin are planning to meet with the UAlbany Department of Public Health during the spring of 2017 to coordinate the wind chill paper, the proposed research grant and any other ways we can help the UAlbany Department of Public Health with weather-related and health studies.

d. Kevin Lipton has proposed a workshop or seminar on extreme heat in either late 2017 or 2018. This workshop would be a collaboration with the UAlbany departments of Atmospheric Science and School of Public Health and Public Policy. Local media and other NWS offices in the region would also participate. This possible workshop or seminar is in the very early planning stages.

5. COMPUTER AND TECHNOLOGY TRANSFER ISSUES *(David Knight)*

The results described herein would not have been possible without appropriate computing infrastructure. Students are exposed to NWS facilities and software, and NWS staff has access to capabilities not available in the local office. Both groups benefit from this interaction and sharing of facilities. Several Linux workstations and PCs are available for use by CSTAR participants. Approximately 4 TB of disk space on the UAlbany DAES servers is dedicated to storing CSTAR related data and software. This disk space is available on all DAES workstations and provides a central location where both UAlbany and NWS personnel can store, process, and exchange large datasets. Each CSTAR student has a PC or Mac laptop, which enables them to take familiar computers with them when visiting NWS staff and provides them ready access to the DAES UNIX machines. CSTAR email lists originally created on the DAES computers at the beginning of the project have been superseded by the "map" listserv (*map@listserv.albany.edu*). The "map" listserv reaches a much larger audience (out of 731 members, more than ¼ are from NOAA), allowing discussion of CSTAR related research among many more people.

NWS Albany maintains content for the CSTAR webpage (*http://cstar.cestm.albany.edu*). The web page provides an additional mechanism for exchanging information and ideas. The DAES web and ftp servers (*http://www.albany.edu/atmos* and *ftp://ftp.atmos.albany.edu*) are being used to facilitate the exchange of large datasets between CSTAR collaborators. The DAES computing resources are available for CSTAR related research including a Linux server (with 32 CPUs and 256 GB RAM) and two large network attached disk storage arrays (85 TB total usable space). While CSTAR money was not used for this, and the machines were not bought specifically for CSTAR use, they nonetheless directly benefit CSTAR research by providing much faster servers for computation and storage space for commonly used datasets. A Linux server (Peebles) with 48 CPUs and 96 GB RAM, 100% dedicated to CSTAR computations was recently purchased. This computer will facilitate increasingly complicated computations.

In addition to DAES and NWS computing facilities, the formal CSTAR collaborative grant effort has allowed access to University Research Information Technology (RIT) services. In particular, the Albany WSFO is using the RIT 144 CPU Linux cluster for Weather Research and Forecasting (WRF) model simulations. This computing facility allows the NWS to perform computations not possible at the local office. The facility is used to generate additional members for the collaborative ensemble and to generate higher resolution runs for research purposes. Thus

far, this facility has been made available at no cost to the CSTAR project. The RIT group has also recently made an additional 10 TB of disk space available for CSTAR data storage.

6. CSTAR PROJECT RESEARCH IN NWS AFDs

Tuesday 27 September 2016

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

FXUS61 KALY 270825
AFDALY

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE ALBANY NY
425 AM EDT TUE SEP 27 2016

.SHORT TERM /6 PM THIS EVENING THROUGH THURSDAY NIGHT/...

Thu-Thu night...**Cutoffs are always challenging to forecast in terms of the timing of rain and the amounts /CSTAR research has shown this over the years/.** The guidance is converging on the threat increasing for scattered showers during this time frame and east to southeast h850-700 low-level flow increasing. A front actually sets up over NY and PA with the cutoff still well to the south and west of the region...and high pressure trying to build in from southeast Quebec and Northern New England. The convergence along this front and the onshore fetch of Atlantic moisture will increase the chances for showers and damp conditions. Temps will be a shade cooler during the day...and similar to the previous nights mins in maritime air mass.

SHORT TERM...Wasula

Monday 5 December 2016

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

FXUS61 KALY 051742
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
1242 PM EST Mon Dec 5 2016

.NEAR TERM /UNTIL 6 PM THIS EVENING/...
As of 1230 PM EST...Synoptic light snow has ended as we transition toward lake effect activity downwind of Lake Ontario. KTYX radar reveals multi-bands of lake effect with a mix of rain and snow per the dual-pol data. However, NY MESONET observations show snow showers mainly above 1000 feet where temperatures were around the freezing mark. **As for inland lake extent, per CSTAR research, the band of precipitation should make inland about 75 miles where we will place likely PoPs for Herkimer County.** Otherwise, just a slight chance elsewhere with rain/snow showers depending on temperatures. Highs this afternoon are close to seasonal temperatures in the 30s to mid 40s for highs.

NEAR TERM...IAA/BGM/JPV

Tuesday 6 December 2016

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

FXUS61 KALY 062144
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
444 PM EST Tue Dec 6 2016

.SHORT TERM /WEDNESDAY NIGHT THROUGH THURSDAY NIGHT/...
Lake Effect Snow to develop and possible impacts to the western Adirondacks Thursday through Friday morning.

A tranquil period of weather expected Wednesday night with ample cloud coverage in place as broad southwest flow regime remains in place. Some light snow with lake enhancement may approach northern Herkimer County as seeder-feeder processes could enhance some light precipitation. Then arctic boundary is expected to approach Thursday with the chance for more snow showers and possible squalls as lake effect develops later in the day and into the night. Lake instability index`s quickly increase Thursday night as boundary layer flow becomes more westerly. **Now per CSTAR research, inland extent through the event impacts northern Herkimer County which is where we will place Lake Effect Snow Watch.** Could be a significant event unfolding as H850 temperatures continue to drop back into the negative teens. Otherwise, a brisk flow with falling temperatures with the chance for snow showers/squalls.

SHORT TERM...IAA/BGM

Wednesday 7 December 2016

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

FXUS61 KALY 070947
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
447 AM EST Wed Dec 7 2016

.SHORT TERM /6 PM THIS EVENING THROUGH FRIDAY NIGHT/...
Lake Effect Snow Warning for northern Herkimer and Hamilton Counties 9 am THU to 7 am Friday...

Thursday-Thu night...An upper level disturbance and its associated arctic front/sfc trough moves across the forecast area. The flood gates open across Lake Ontario for an organized well- defined lake band to form in the veering low-level flow to a favorable 260-270 degree trajectory by the late morning into the afternoon. The NAM shows little directional shear in the sfc to H850 layer. The instability class goes to conditional to moderate and occasionally extreme on neighboring BUFKIT soundings, and the low-level capping inversion is not visible below 10 KFT AGL. The avg lake temp is close to 7C. Favorable delta T readings between the sfc to 850 or 700 hPa will favor a heavy lake effect event for the western Adirondacks. **A quick check of the GFS and NAM sounding data with the KVIE inland extent program /developed from past CSTAR research/ for KUCA and KALB showed lake band extent possibly to 75-100 miles inland.** This band extent would be well into the western Adirondacks. Snow ratios of 20:1 were THU-THU night for that area. Confidence was moderate to high to issue a lake effect snow warning for the northern Herkimer and Hamilton Counties. Locations in the western portion of Hamilton county will be most vulnerable for heavy lake effect snow. Snow rates could reach 1-3" an hour especially late THU pm into Thu night. Total snowfall of 8-14" is possible over northern Herkimer CTY especially from Old Forge northward along Route 28. North and west of Raquette Lake could have 6-10". Elsewhere...isolated to scattered snow showers/squalls and flurries will be possible with light snow accums along the western spine of the southern Greens/Taconics/Berkshires. It will become blustery and colder. H850 temps fall to -10C to -14C THU night. Highs THU will only be in the upper 20s to mid 30s across the higher terrain and mid 30s to around 40F in the valleys. Thu night will feature brisk and cold conditions with the lake effect snowfall. Lows will be in the teens to lower 20s over the mountains...and lower to mid 20s in the valleys.

SHORT TERM...Wasula

Tuesday 27 December 2016

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

FXUS61 KALY 272316
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
616 PM EST Tue Dec 27 2016

.SHORT TERM /WEDNESDAY NIGHT THROUGH THURSDAY NIGHT/...
Snow is expected to quickly develop from NW to NE across the area Thursday morning into early afternoon with an initial surge of isentropic lift and southerly flow aloft. Then, as the cyclone rapidly intensifies along the New England coast late Thursday into Thursday night, mesoscale banding appears likely along the west side of the storm where strong frontogenesis is forecast to occur. **Could be a setup for a strong and potentially large band based on CSTAR research.** The location of this possible band of 2"+ per hour snowfall rates is still in question this far out though. There are still some model discrepancies, with the ECMWF and the NAM most aggressive with heavy QPF from banding making into the north/central Taconics and western New England. For this reason, a Winter Storm Watch has been issued for Washington county, northern and central Taconics, all of southern Vermont, the Berkshires and northern Litchfield counties.

SHORT TERM...JPV

Wednesday 28 December 2016

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

FXUS61 KALY 282104
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
404 PM EST Wed Dec 28 2016

.NEAR TERM /THROUGH THURSDAY NIGHT/...
Then as the cyclone rapidly intensifies late Thursday into Thursday night, mesoscale banding will likely develop along the west side of the storm where strong frontogenesis is

forecast to occur per CSTAR research. Based on 12Z guidance it appears some of this banding will set up across southern Vermont and the Berkshires Thursday afternoon into early evening, which is where the Winter Storm Warning is in effect. Within mesoscale bands, snowfall rates of 1-2 inches per hour will be possible. Otherwise, generally expecting one half inch per hour rates in the Advisory area.

NEAR TERM...JPV

Thursday 29 December 2016

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

FXUS61 KALY 292051
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
351 PM EST Thu Dec 29 2016

.SHORT TERM /6 AM FRIDAY MORNING THROUGH FRIDAY NIGHT/...
Cool and blustery conditions will persist on Friday, with lake effect snow continuing for the western Adirondacks and Mohawk Valley. Looks like more of a hybrid upslope/lake effect event for the western Dacks, but more classic lake effect multi-bands for the Mohawk Valley. **Local forecasting tool from CSTAR research indicates inland extent well into Fulton/Montgomery counties, so have included this area in the Lake Effect Snow Advisory in addition to Herkimer/Hamilton.** Still expecting narrow bands, but within persistent bands going over repeated areas accumulations of 3-6 inches are expected. A few fragmented snow bands may make it into the Capital District at times, with light upslope snow showers in the southern Green mountains and Berkshires with minor accumulations.

SHORT TERM...JPV

Sunday 1 January 2017

CSTAR research on freezing rain events was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 012121
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
421 PM EST Sun Jan 1 2017

.SHORT TERM /6 AM MONDAY MORNING THROUGH TUESDAY NIGHT/...
Weak isentropic ascent develops locally Monday, but with the surface high and its associated dry airmass only gradually retreating, it will be a struggle for any precipitation to develop. In fact, some guidance indicates little to no QPF clear through Monday night, with weak/disorganized forcing. Have reduced PoPs accordingly. The issue of p-type will arise, however, with any precip that manages to fall. Any precip that manages to fall Monday will likely be frozen (snow or sleet), with a transition to liquid from southwest to northeast Monday night as 850mb temps increase to around +4C by 12Z Tuesday. The amount of surface temperature rise is in question Monday with models indicating light easterly flow draining from the surface high. This raises the prospect of freezing rain, as good near-surface warm advection never really develops. **The surface pressure pattern is reminiscent of the Type G composite for freezing rain events in the ALY CWA per CSTAR research.** The most likely locations for light freezing rain to develop Monday night into early Tuesday are across portions of the southern Adirondacks, Mohawk Valley, Lake George Saratoga region, Southern Vermont, Berkshires, and perhaps portions of the Catskills, especially in protected valleys. But again, the major limiting factor will be the lack of forcing/QPF.

SHORT TERM...Thompson

Wednesday 4 January 2017

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

FXUS61 KALY 040951
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
451 AM EST Wed Jan 4 2017

.SHORT TERM /6 PM THIS EVENING THROUGH FRIDAY/...
Tonight, strong west/southwest winds appear likely much of the night, especially areas north of the Mohawk River Valley. Some gusts could reach up to, or slightly in excess of 50 mph, particularly higher elevations above 1000 feet. In valley areas, winds may be more intermittent/sporadic in the advisory area, but still can see a few stronger gusts due to localized downsloping. With the low level winds aligned more from the west/southwest, as opposed to west/northwest, it appears that the traditional channeling effect down the Mohawk River Valley

into the Capital Region and Berkshires may be mitigated, therefore the advisory is in effect north of this region. **Lake Effect Snow from Ontario should be intensifying overnight, with local CSTAR Lake Effect Inland Extent program suggesting an inland extent of well over 100 miles, in a west southwest/east northeast orientation.** This should impact far northern Herkimer and northern Hamilton Cos much of the night. Snowfall rates within the band will likely reach or exceed 2-4 inches/hour at times. The band should remain north of northern Warren County given the expected orientation.

SHORT TERM...KL

Thursday 5 January 2017

CSTAR research on the inland extent of lake effect snow was cited in both the near- and short-term sections of the NWS ALY AFD.

FXUS61 KALY 050840
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
340 AM EST Thu Jan 5 2017

.NEAR TERM /THROUGH TONIGHT/...
Impressive lake effect snow plume evident on radar and regional web cams was impacting northern Herkimer into Hamilton counties. An occasional lightning strike or in-cloud activity has been evident which will only enhance snowfall rates. Per reflectivity analysis, seems 2-4" per hour rates are occurring on average. **CSTAR research of inland extent suggests this band will continue to exceed 100+ mile inland so no changes to headlines at this time.** Furthermore, Lake Erie influence snow band was impacting portions of the Schoharie Valley and Catskills Region but extent and coverage was less so we will keep slight chance to chance PoPs for these areas through the morning hours. H2O vapor loop shows our next disturbance was quickly tracking across the Mid West and approaching the Ohio Valley. This should allow the boundary layer winds to back further and take the lake effect plumes further north this afternoon and may just be north of the Herkimer County northern border (per HRRR and Exp NAM3km). As that aforementioned system approaches, a seeder-feeder process should commence with thickening clouds and the chance for light snow showers or a periods of light snow to evolve across most of the region late this afternoon into tonight. Very broad QG forcing and lift should not amount too much but could be an issue with the Friday morning commute on untreated surfaces. As this feature slides east, low level trajectories are expected to veer back toward a more westerly direction that should allow for the lake plume to return back to northern Herkimer and Hamilton counties where additional accumulations are expected.

.SHORT TERM /FRIDAY THROUGH SATURDAY/...

A broad anticyclonic flow evolves at the surface for mainly tranquil conditions across most of the region. The exception will be continuing lake effect snow downwind of Lake Ontario (with further upstream lake support) through the Short Term. **CSTAR research of inland extent continues to support up too or exceeding 100 miles as H850 temperatures fall back further closer to -20C as inversion heights average around 6k feet.** Low level wind trajectories will fluctuate through the period and average flow will remain around 270-280 degrees. Several inches of new snow is expected and by sunset Saturday, a few locations could see up to or exceeding 2 feet.

NEAR TERM...BGM
SHORT TERM...BGM

Friday 6 January 2017

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

FXUS61 KALY 060855
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
355 AM EST Fri Jan 6 2017

.NEAR TERM /THROUGH TONIGHT/...
As of 330 AM EST...Lake effect plume off Lake Ontario with upstream connection is showing signs of limiting inland extent per KTYX doppler radar. However, per web cams, it is still snowing across northern Herkimer County. **This agrees with our CSTAR inland extent lake effect snow program as we will continue with the lake effect headlines.** Inversion heights remain around 2km and per GLERL lake temperature analysis of around 6C, moderate instability class per BUFKIT remains. RAP/HRRR suggest an increase in lake response through the afternoon into early evening, however, inland extent reduces further as the combination of increasing shear and slow/gradual lowering of those inversion heights. The lake effect snow band should dissipate further and remain just upstream of the Herkimer county border overnight. Additional accumulations of approximately 3-6" are expected.

NEAR TERM...BGM

Wednesday 25 January 2017

CSTAR research on the inland extent of lake effect snow was cited in the short-term section of

the NWS ALY AFD.

FXUS61 KALY 251734
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
1234 PM EST Wed Jan 25 2017

.SHORT TERM /6 PM THIS EVENING THROUGH FRIDAY NIGHT/...
With a broad upper level trough over the area for Friday into Friday night, some additional lake effect/lake enhanced snow showers will be occurring, especially across the western Adirondacks. **The local CSTAR inland extent research suggests lake-effect bands should reach into northern Herkimer and northwestern Hamilton Counties during this time period.** Despite the bands reaching into the area, the lake-effect snow bands will be shifting due to subtle changes in the flow and wind direction. Still, some more accumulating snowfall looks to occur across far northwestern parts of the area. Will address this potential for at least moderate lake-effect snowfall in the HWO for the western Adirondacks. Some passing snow showers/flurries will be possible across other parts of the area too, thanks to the cyclonic flow and lake moisture upsloping the terrain, but little accumulation is expected outside of the lake-effect bands. Temps will be noticeably colder, with highs only in the upper 20s to upper 30s and lows in the teens and 20s. In addition, gusty westerly winds will make it feel even colder as well.

SHORT TERM...Frugis

Thursday 2 February 2017

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

FXUS61 KALY 022113
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
413 PM EST Thu Feb 2 2017

.NEAR TERM /UNTIL 6 AM FRIDAY MORNING/...
Upstream VWP`s suggest a slight veering of low level winds over the last 1-2 hours, with lowering inversion heights also noted on 12Z upstream soundings. Based on this, and model forecasts which suggest that the mean mixed layer flow trajectory is forecast to veer to around 280-290 degrees during this evening, expect a period of Lake Effect snow to shift into central

and south central Herkimer and south/southwest Hamilton Cos this evening. **Local CSTAR Inland Extent program also suggests enough inland extent to at least occasionally reach into NW Fulton CO.** The most persistent snowbands should remain north of the NYS Thruway, but cannot rule out a few fragments breaking off and impacting it through this evening. Expect 2 to 6 inches of snow overnight within the advisory area, with the greatest amts west of Caroga Lake in Fulton CO, and across central Herkimer locations such as Cold Brook and Ohio, especially before midnight.

NEAR TERM...KL/JPV

Friday 3 February 2017

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

FXUS61 KALY 032131
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
431 PM EST Fri Feb 3 2017

.NEAR TERM /UNTIL 6 AM SATURDAY MORNING/...
As the trough passes, winds will veer more into the west/northwest, shifting any snowband southward, closer to and south of Route 8 during the evening hours, and eventually into the western Mohawk Valley toward and after midnight. **Our local CSTAR inland extent program suggests that shear within the mean mixed layer flow remains fairly high overnight, as low level winds remain or back slightly into the west/southwest, while winds near the top of this layer remains more west/northwest.** So, it is possible that rather than a pure single band, only fragments of a band/bandlets/ occur across portions of the western Mohawk Valley and northern Schoharie CO. Where snow showers are most persistent, 1-3 inches could occur overnight, while more other areas downstream remain under an inch. There is a possibility of some of these bandlets to extend into the Capital Region/eastern Mohawk Valley and Berkshires after midnight, where some coatings to less than one half inch of accumulation is possible. Additional accums are also likely across upslope areas of southern VT overnight, where at least 1-2 inches are expected.

NEAR TERM...KL

Wednesday 8 February 2017

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

FXUS61 KALY 081015
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
515 AM EST Wed Feb 8 2017

.SHORT TERM /6 PM THIS EVENING THROUGH FRIDAY/...
The NAM/EC/GFS all show strong mid level FGEN in the H850-700 and even the H850-500 layer within the upper deformation zone. QG lift generated by the strong differential thickness advection and some differential cyclonic vorticity advection will generate a moderate to heavy snow event for parts of the region. **The BUFKIT profiles show strong/deep upward vertical motion intersecting the favorable dendritic growth zone /-12C to -18C/ especially towards KPOU. Some classic mesoscale banding is not out of the question /which is documented in the CSTAR research/ with snowfall rates of 1 to 2" in the THU morning commute into the early pm within the warning area.** 6-12" is possible for Dutchess/Ulster/Litchfield Counties...with 6-8" for the Berkshires/Columbia County. Dutchess and Litchfield could be in the sweet spot of the heavy snowfall. A jog northward would increase the totals some. This will have to be monitored. This is a quick moving open wave intensifying in the cyclonic exit region of the H250 upper jet steak of 125+ knots.

SHORT TERM...Wasula

Thursday 9 February 2017

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

FXUS61 KALY 090928
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
428 AM EST Thu Feb 9 2017

.NEAR TERM /UNTIL 6 PM THIS EVENING/...
Mesoscale banding type based on SUNY Albany CSTAR research looks to be a laterally quasi-stationary band based on conceptual model of an open 500 mb trough and confluent flow downstream along with the track/intensity of low initially emerging off the coast this

morning. This will result in intense 1-3 inch per hour snowfall rates producing heavy snow despite the relatively fast forward movement of the storm.

NEAR TERM...JPV

Wednesday 15 February 2017

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

FXUS61 KALY 150957
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
457 AM EST Wed Feb 15 2017

.NEAR TERM /THROUGH TONIGHT/...
As the midlevel trough deepens and pivots northward toward Nova Scotia tonight, some moisture will wrap back around from the north into our area. This appears to be a good scenario for upslope snow showers in the Adirondacks, Greens, and Berkshires. Lift may also be enhanced over the Greens by a midlevel deformation axis pivoting southward. As 850 mb temps cool to near -12C by 12Z Thursday, some lake response will occur. **However, forecast soundings indicate ample directional shear from the surface to 3 km, which is unfavorable for much inland extent /per CSTAR research/ and favors more of a multi-band scenario.** Even so, some lake enhancement is likely over Southern Herkimer County as inversion heights are way up toward 4 or 5 km. Since this is not a pure lake-effect scenario with much of the forcing due to moist upslope flow, have opted for a Winter Weather Advisory in lieu of a Lake Effect Snow Advisory.

NEAR TERM...Thompson

Thursday 16 February 2017

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

FXUS61 KALY 160910
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
410 AM EST Thu Feb 16 2017

.NEAR TERM /UNTIL 6 AM THIS MORNING/...
Also, we expect some multibands of lake enhanced/lake effect snowfall to continue. These multibands could impact the extreme south to southwest portion of southern Herkimer county with 2 to 5 inches of snow. Light amounts of a few inches may be realized across Schoharie CTY and the eastern Catskills. We opted to keep the Winter WX advisory headline for southern Herkimer Co. due to a combination of the upper low and lake moisture. The latest BUFKIT profiles at KUCA/KRME indicate conditional instability with increasing shear in the mixed layer with a lowering inversion height to 3-4 kft AGL. **Again...narrow multi-bands in the NW flow with limited inland extension /west of the Hudson River Valley/ is expected based on the local CSTAR research.**

NEAR TERM...Wasula

Thursday 23 February 2017

CSTAR research on cool-season high wind events was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 230939
AFDALY

Area Forecast Discussion
National Weather Service Albany NY
439 AM EST Thu Feb 23 2017

.SHORT TERM /FRIDAY THROUGH SATURDAY NIGHT/...
Models are in pretty good agreement that a very strong cold front will track through the local area Saturday afternoon into Saturday evening. Forecast temp contrasts across this front are impressive - for instance, NAM shows 2-m temp difference across the front of around 20F, and 850 mb temp difference near 10C, as it tracks through the local area. Though forecast instability is expected to be very little, there is some concern for a strongly forced, narrow frontal rain band that could mix some of the strong wind field down to the surface. Also have to worry about the downward momentum transport immediately behind the front. **NAM cross section shows the front-normal component of the winds of 35-40 kt just off the surface, along with a midlevel dry intrusion, which CSTAR research has shown to be associated with high wind events.** NAM also shows 3-h pressure rise center of 7-8 mb tracking through the area. Will continue to mention this potential in the HWO. A period of moderate to heavy rainfall is likely along and behind the front (see Hydrology discussion below for more details), tapering to showers several hours after frontal passage. Lake effect snow showers will commence downstream of Lake

Ontario late in the night with 850 mb temps falling toward -15C. Windy conditions will continue overnight.

SHORT TERM...Thompson