THE SUMMER STUDENT VOLUNTEER PROGRAM AT NWS WFO BALTIMORE/WASHINGTON

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1. INTRODUCTION

Each summer since 2005, the National Weather Service (NWS) Baltimore/Washington Forecast Office (WFO LWX) has hosted one or more university undergraduate student volunteers. As part of the WFO LWX Student Volunteer Program, students undergo a thorough interview process to assess their academic history, research interests and career goals. The selected students are paired with mentor forecasters to conduct a research project focused on problems of operational forecasting relevance. The research results are presented later at national conferences and infused into local operations with great benefit. Of the 19 students that have participated since 2005 (approximately three per year), at least four have gone on to a career in NWS or NOAA.

The program recently has fostered outside collaboration among WFO LWX and the Storm Prediction Center (SPC), the Hydrometeorological Prediction Center (HPC), county government officials and universities. In addition to research experience, the students gain exposure to routine and hazardous weather forecasting operations at the WFO (as the program spans a large portion of the Mid-Atlantic peak severe weather season).

Highlights from some of the recent research efforts conducted by WFO LWX summer students and their mentors are presented herein.

2. PROJECT SUMMARIES

a. Anticipating Tornadic Environments

Kramar and Olmstead (2010) examined synoptic patterns associated with tornado days in the WFO LWX County Warning Area (CWA). Composite plots were produced of several synoptic fields for days with mesocyclonic tornadoes and for days with non-mesocyclonic tornadoes.

It was determined that mesocyclonic tornado days (Fig. 1) featured a relatively less-amplified, positively- to neutrally-tilted mid-level shortwave trough in the Ohio Valley, surface low pressure centered in western Pennsylvania, a broad warm sector over the region and a mid-level jet over the Mid-Atlantic region such that the right entrance region of the jet ageostrophically enhanced vertical motion.

Tornado days that favored a quasi-linear convective system (QLCS) mode (Fig. 2) were characterized by three factors: 1) a relatively deeper and more amplified, negatively-tilted shortwave trough in the Ohio Valley; 2) surface low pressure over Michigan with a negatively-tilted surface trough moving through the forecast area; and 3) a strong mid-level jet passing just to the south of the CWA such that vertical motion was enhanced ageostrophically in the left exit region of the jet.

These composite patterns have been used locally quite successfully to recognize and anticipate potentially tornadic environments in the CWA. In particular, the non-mesocyclonic mode has been identified in model forecasts several days in advance and in upper-air analysis several hours prior to tornado occurrence. Future work will investigate the predictive skill of the composite patterns.

b. Flash Flood Climatology

Werner et al. (2009) analyzed data on flash flood events for January 2001–May 2009 in the WFO LWX CWA to reveal spatial and temporal characteristics of local flash floods. Atmospheric soundings were analyzed for all flash flood events. Composite analyses of the representative soundings helped identify and qualify key meteorological parameters associated with historical flash floods that occurred in the LWX CWA.

This study showed (Fig. 3) that during the cool season (October to March), precipitable water values (PWATs) associated with flash flood events in the LWX CWA tend to be greater than what would be expected using a normal +2SD curve. But during the warm season (May to September) and especially in the summer (June to August), PWATs less than the normal +2SD curve are observed during flash flood events.

Storm-relative winds during flash flood events generally were light (<10 m/s) out of the west or southwest. A majority of flash flood cases occurred in an environment with moderate (10-20 m/s) southwesterly 0-6 km mean winds. Results from this study were used to modify previous local precipitable water curves used to anticipate flash flood potential.

c. The NWS Change in Severe Hail Criterion

In 2009, the NWS definition of severe hail was changed to include only hail of at least one inch diameter. A methodology adapted from Donavon and Jungbluth (2007) [hereafter DJ07] was pursued by Kramar and Waters (2009) to evaluate for the Mid-Atlantic region the relationship between the height of the environmental freezing level and the height of the 50 dBZ core in a thunderstorm. Porter et al. (2005) found notable differences between their results for

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West Texas and those for the Northern Plains in DJ07, likely attributable in part to environmental factors like the elevated mixed layer and the presence of the dryline. These different environmental influences on the results motivated a similar investigation in the Mid-Atlantic Region.

Results (Fig. 4a) yielded a strong correlation. Quantile regression techniques applied to the data provided guidance to forecasters on the 10% and 50% expected core heights. An interactive tool (Fig. 4b) was developed as a radar display overlay in AWIPS to make these values available to the warning meteorologist in real time using hourly LAPS (Local Analysis & Prediction System) freezing level analyses. Office performance with hailstorms has been outstanding since making the local tool operational, including improved accuracy in anticipated hail size. *(Note: the KLWX WSR-88D radar recently was upgraded to dual-pol technology in late February 2012.)*

d. Upslope Snow Showers

For many years, the mountainous region of the Allegheny Front in the western portion of the WFO LWX CWA presented a particularly difficult snow-forecasting challenge to forecasters, since the area is sparsely populated and has few observing sites, the nearest weather radar beam overshoots the often-shallow convection, and the wintertime meteorology of the Allegheny Front was not well-understood.

Mechanisms by which these lake-effect or upslope snow showers are generated were examined by Wegman and Lasorsa (2008). Factors such as inversion height and strength, wind direction and speed and depth of the snow growth layer were investigated. The results of this research were distilled into a checklist to aid forecasters in distinguishing between events likely to produce warning- and advisory-level snowfall.

Mountain forecast zone breaks were developed locally to give forecasters greater specificity when dealing with upslope snow situations. WFO LWX forecasters now have a greater understanding of the winter weather (Fig. 5) of the Allegheny Front, enabling them to provide emergency managers more time to prepare before snow begins and better information of what to expect once it does.

e. Additional Projects

Additional projects since 2005 have ranged from case studies of significant weather events to assessments of local office services. A 2006 study led to documentation of flash flood-prone areas in each county of the WFO LWX CWA—information that has been used since to provide specific threat locations in Flash Flood Warnings. Research conducted in 2009 led to better defining and evaluating Small Craft Advisory events in the Maryland Chesapeake Bay and the Tidal Potomac River. And a study in 2011 investigated differences between active severe weather days in the WFO LWX CWA and days with similar patterns but no severe weather.

3. SUMMARY

The Summer Student Volunteer Program at WFO LWX was summarized. Several integral forecasting research projects were documented, and the impacts of their results on forecasting operations were discussed. As a part of the program, undergraduate students are exposed to meteorological research and NWS routine and severe weather operations, thus providing them first-hand experience of a career in operational meteorology.

4. REFERENCES

Donavon, R.A. and K.A. Jungbluth, 2007: Evaluation of a technique for radar identification of large hail across the Upper Midwest and Central Plains of the United States. *Wea. Forecasting,* **22***,* 244-254.

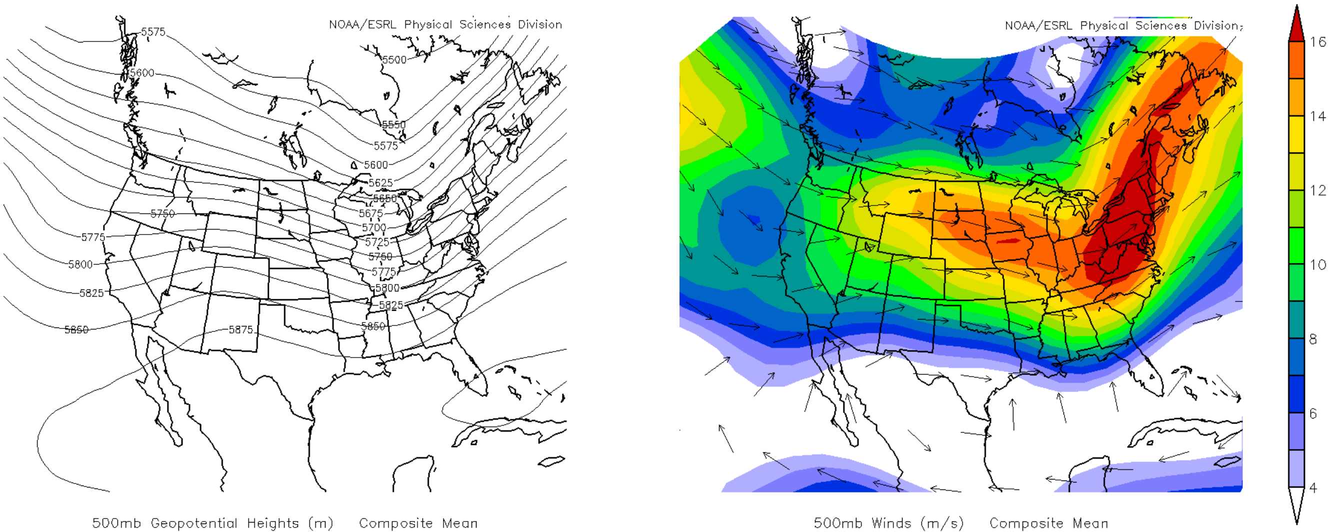
Kramar, M.R. and K.M. Olmstead, 2010: A “survey” of tornadoes and their environments in the WFO Sterling, VA forecast area. Preprints, *12th Northeast Regional Operational Workshop*, Albany, NY.

Kramar, M.R. and J. Waters, 2009: Predicting severe hail in the WFO LWX County Warning Area: toward increased accuracy in hail size forecasts. Preprints, *24th Conference on Hydrology*, Atlanta, GA. Amer. Meteor. Soc.

Porter, D.L., M.R. Kramar and S.D. Landolt, 2005: Predicting severe hail for the Southern High Plains and West Texas. Preprints, *32nd Conference on Radar Meteorology,* Albuquerque, NM. Amer. Meteor. Soc.

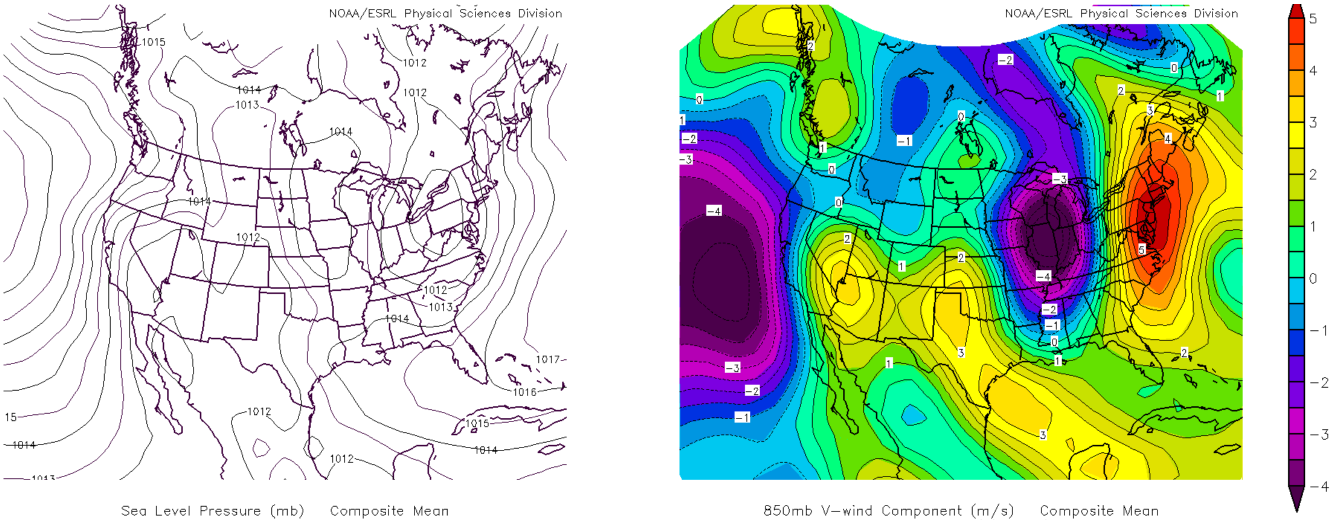
Wegman, J.P. and B.J. Lasorsa, 2009: Upslope and lake-effect snow climatology along the Mid-Atlantic’s Allegheny Front Range. Preprints, *34th Annual Meeting*, Norfolk, VA. Nat. Wea. Assoc.

Werner, N.L. and S. Konarik and J.R. Klein, 2009: Analysis of flash flooding events in the Baltimore/Washington National Weather Service Forecast Office’s area of responsibility. Preprints, *34th Annual Meeting*, Norfolk, VA. Nat. Wea. Assoc.



500mb Geopotential Heights (m) Composite Mean
Mesocyclone Geopotential Height
NCEP/NCAR Reanalysis

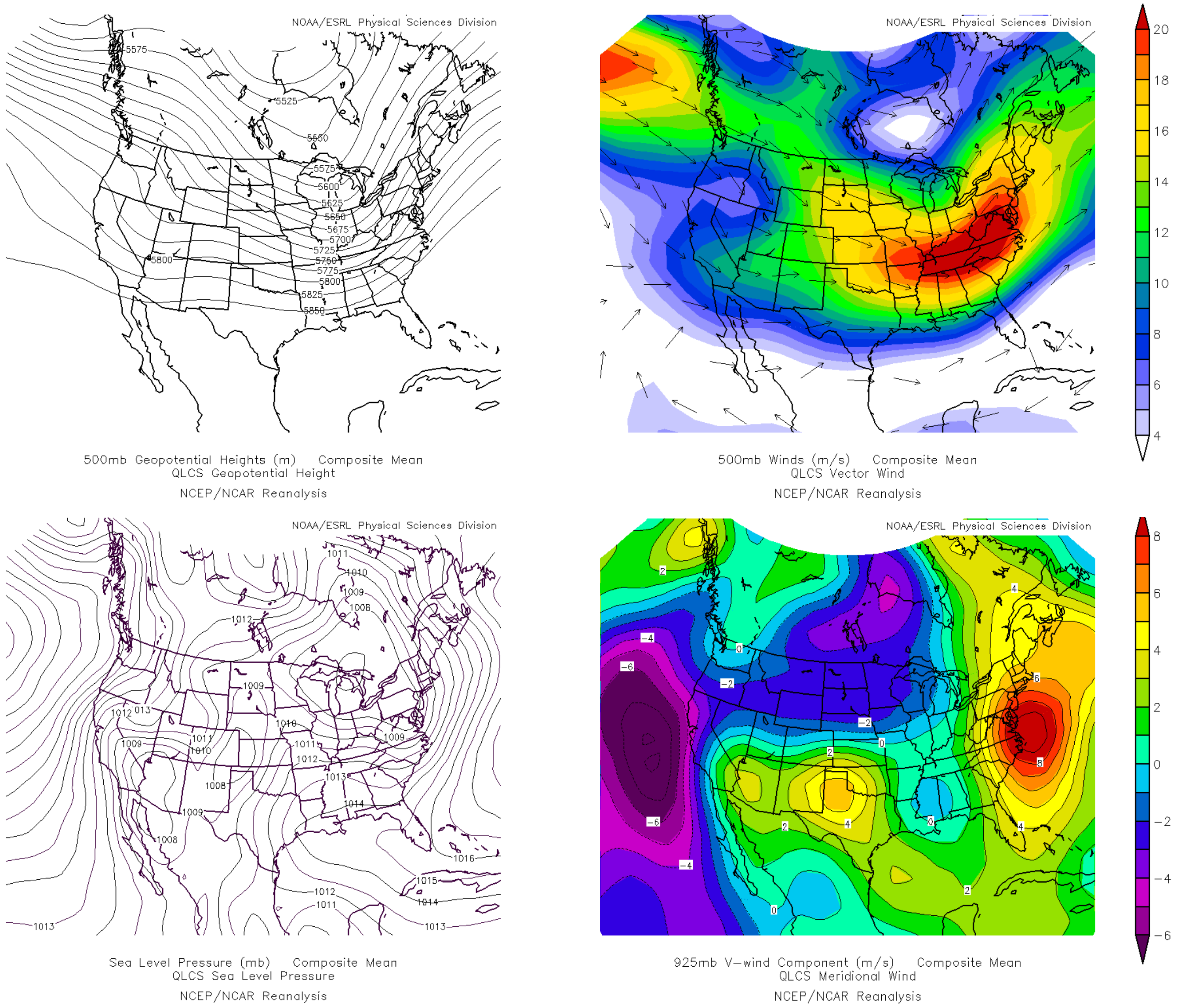
500mb Winds (m/s) Composite Mean
Mesocyclone Vector Wind
NCEP/NCAR Reanalysis



Sea Level Pressure (mb) Composite Mean
Mesocyclone Sea Level Pressure
NCEP/NCAR Reanalysis

850mb V−wind Component (m/s) Composite Mean
Mesocyclone Meridional Wind
NCEP/NCAR Reanalysis

Fig. 1. Composite plots of meteorological fields for days with mesocyclonic tornadoes in the WFO LWX CWA. Shown are 500 hPa heights (upper left), 500 hPa wind magnitude and vectors (upper right), sea level pressure (lower left) and 850 hPa meridional wind speed (lower right).



500mb Geopotential Heights (m) Composite Mean
QLCS Geopotential Height
NCEP/NCAR Reanalysis

500mb Winds (m/s) Composite Mean
QLCS Vector Wind
NCEP/NCAR Reanalysis

Sea Level Pressure (mb) Composite Mean
QLCS Sea Level Pressure
NCEP/NCAR Reanalysis

925mb V−wind Component (m/s) Composite Mean
QLCS Meridional Wind
NCEP/NCAR Reanalysis

Fig. 2. Composite plots of meteorological fields for days with non-mesocyclonic tornadoes in the WFO LWX CWA. Shown are 500 hPa heights (upper left), 500 hPa wind magnitude and vectors (upper right), sea level pressure (lower left) and 850 hPa meridional wind speed (lower right).

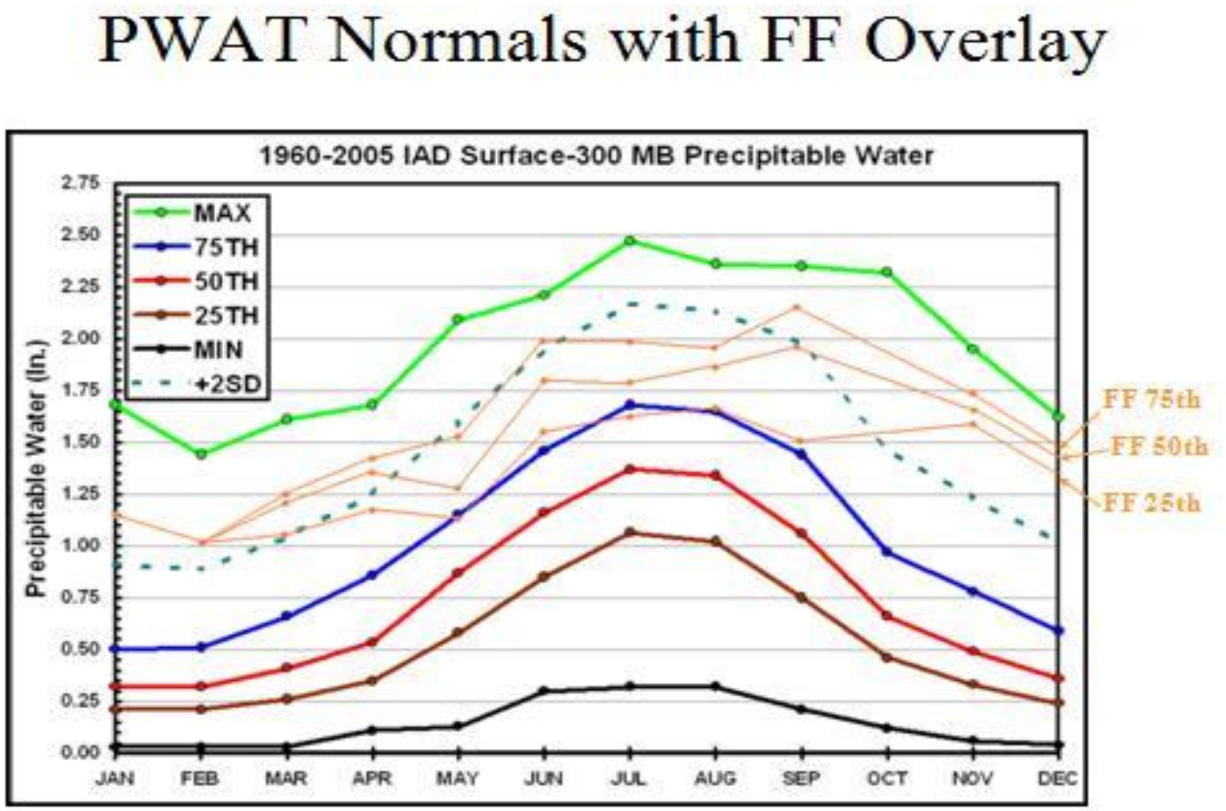
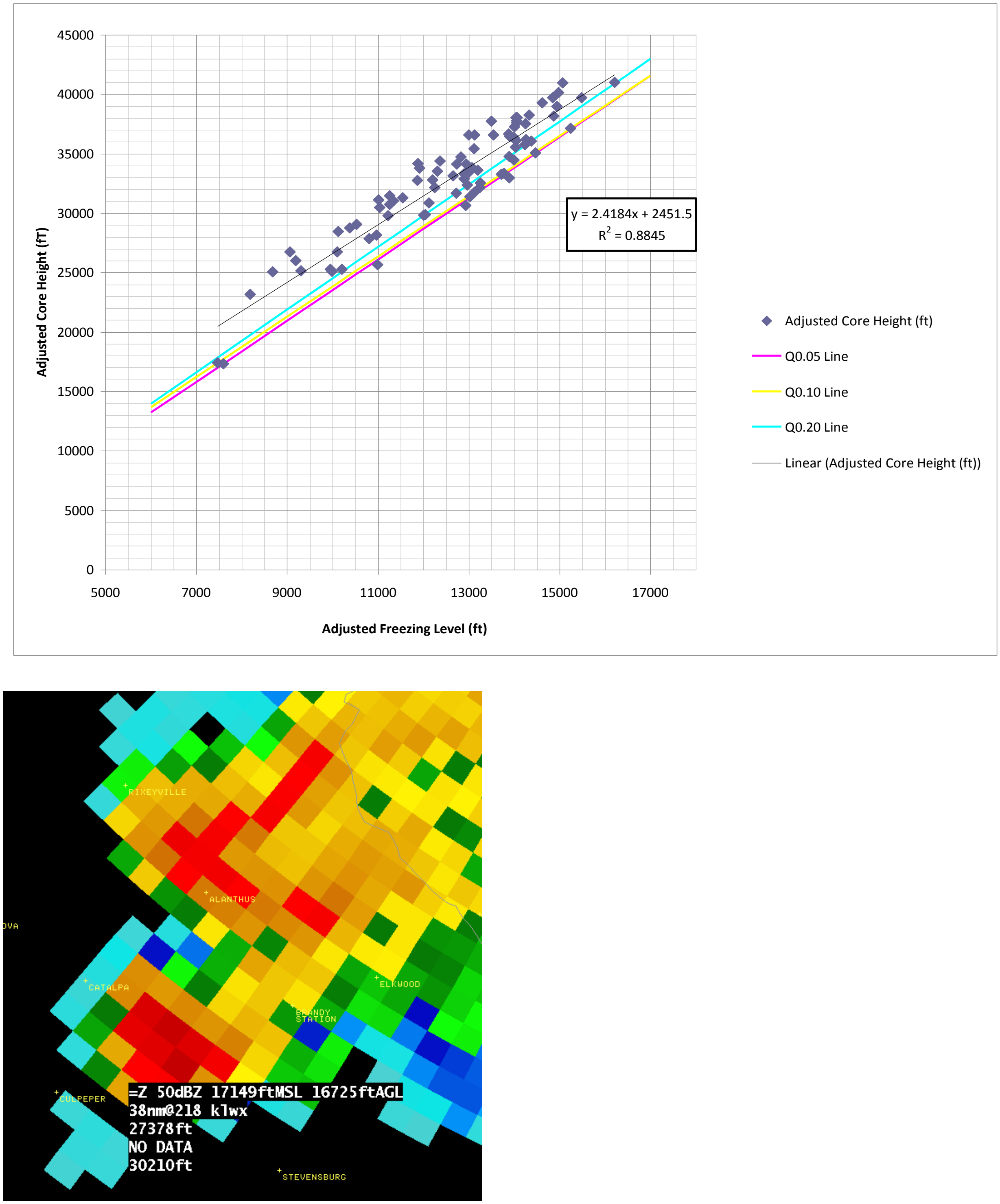


Fig. 3. Annual profiles of precipitable water at KIAD by month versus 25th, 50th and 75th percentile precipitable water values based upon an event-based flash flood climatology at WFO LWX. Cool season flash flood events tended to have precipitable water values higher than 2SD values, while warm season flash flood events tended to have precipitable water values lower than 2SD values.



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=Z 50dBZ 17149ftMSL 16725ftAGL
38nm@218 klwx
27378ft
NO DATA
30210ft
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Fig. 4. (a) Scatter plot of report site freezing level (ft AGL) vs. height of the 50 dBZ core (ft AGL) that generated severe hail. Quantile regression lines at 5, 10 and 20 percent are shown with the least squares linear regression line. (b) Locally-developed storm interrogation tool showing the regression line core height (ft AGL) at the 10 (27378 ft AGL) and 50 percent (30210 ft AGL) quantiles at the sampled location. When the sampled height (16725 ft AGL) exceeds the 10 and 50 percent values, confidence increases in the occurrence of severe hail.

Fig. 5. Snow in western Grant County, West Virginia during the 2009-2010 winter season. Western Grant County is located on the western slopes of the Allegheny Front in the central Appalachian Mountains. The snow pile shown here was created largely from snow plow operations near Bayard, WV.