20th Annual
SEVERE STORMS &
DOPPLER RADAR
CONFERENC

Agenda & Abstracts
Dear Weather Enthusiast:

Welcome to Ankeny and the 20th Annual Severe Storms and Doppler Radar Conference! On behalf of the membership of the Central Iowa Chapter of the National Weather Association, we are delighted that each of you has chosen to attend and contribute to the success of our conference.

For the 20th conference anniversary, we have assembled an unbelievably stellar line up. Honestly, I am still not really sure how we were able to pull this off! This year’s agenda once again promises presentations and workshops of interest to students, broadcasters, forecasters, emergency managers, enthusiasts, and research professionals alike. This year’s conference will take on both a historical flavor as well as focusing on the more significant events of the 2015 convective season. Some of this year’s presentations include: the most amazing things seen during tornado damage surveys, a look back at the 40th anniversary of the Jordan, IA F-5 tornado, and the history of tornado research and storm chasing. Presentations on more recent events and research include a look at the Rochelle, Illinois and Garland, Texas EF-4 tornadoes, the catastrophic flooding in South Carolina, and the latest ideas on tornadogenesis. We are also honored to have Dr. Louis Uccellini, Director of NOAA’s National Weather Service, as the keynote speaker for our Thursday night banquet.

This year, the Central Iowa Chapter will continue to sponsor the Tim Samaras Memorial Awards for best student oral presentation and best student poster presentation in memory of Tim Samaras, his son Paul, colleague Carl Young, and their accomplishments. Tim always enjoyed working with and involving students in his research and it gives us great satisfaction to continue offering these awards. We are also pleased to announce that the chapter will once again present its Pam Daale Memorial Scholarship at the Thursday banquet. The scholarship was created by the chapter as a way to remember broadcast meteorologist Pam Daale who attended Iowa State University and started her career in the Ames/Des Moines broadcast market. Finally, to celebrate the 20th anniversary, we are offering a second, smaller scholarship just this year, the Anniversary Scholarship, to the Pam Daale runner-up.

In closing, I would like to take this opportunity to thank you for supporting our conference over the years. We have so many fond memories that it is impossible to include them all here. One thing is very clear. We could not have done it without the support of all of our presenters and attendees! If there is anything we can do for you during the conference, please do not hesitate to ask one of our chapter officers or committee chairs. They will be wearing yellow nametags. Thank you once again and here’s to working with you for another twenty years supporting and promoting excellence in operational meteorology!

Sincerely,

Dave Flory
President, Central Iowa Chapter, National Weather Association
Central Iowa National Weather Association
20th Annual Severe Storms & Doppler Radar Conference

March 31-April 2, 2016
Courtyard by Marriott
2405 SE Creekview Drive
Ankeny, IA 50021

2016 Central Iowa NWA Officers:
President: Dave Flory
Vice President: Chris Maiers
Treasurer: Jim Lee
Secretary: Allan Curtis
Webmaster: Dave Flory
Student Liaison: Justin Covert

Conference Committee Leaders:
Agenda: Bill Gallus
Electronics: Willard Sharp
Hotel: Dave Flory
Promotions: Chris Maiers
Radar Workshop: Kevin Skow
Registration: Melinda Beerends
Scholarship: Rod Donavon
Transportation: Aubry Bhattarai

Exhibitors:
Jeff Piotrowski, Baron Weather
Bruce Jones, Midland Radio Corporation

Front Page Photo:
Willard Sharp, intothemeso.com

Please join us next year for the Central Iowa NWA
21st Annual Severe Storms & Doppler Radar Conference
March 30-April 1, 2017!
Pam Daale Memorial Scholarship in Meteorology

The Central Iowa Chapter of the National Weather Association is once again sponsoring a scholarship in memory of broadcast meteorologist Pam Daale in the amount of $1,500. Pam Daale was best known as a television meteorologist at KMGH in Denver, but had numerous ties to Iowa. She was born and raised in Iowa, graduated from Iowa State University, and first worked at WOI-TV (now ABC5 in Des Moines). Pam was an extremely popular meteorologist who courageously overcame adversity to not only succeed in her career but to help others. A horseback-riding accident at age 16 left her a paraplegic, but this did not stop her from becoming a popular broadcast meteorologist. Later, as she fought cancer for nearly two years before her death in April 2004, she used her experiences to educate her viewers about the disease. In every aspect of her life, she had a tremendously positive impact on those around her. Her courage, strength, and concern for others, springing from a deep faith in God, should inspire us all.

The $1,500 scholarship is available to all full-time meteorology students having sophomore or junior status at the time of the chapter’s annual Severe Storms and Doppler Radar Conference (March 31-April 2, 2016) and a cumulative GPA of 2.75 or greater (on a 4.0-point scale). The award will be presented at the annual Severe Storms and Doppler Radar Conference.

Pam Daale Memorial Scholarship Winners

2005 — Elise Johnson  Iowa State University
2006 — Christine Tannahill  University of Oklahoma
2007 — Chris Schaffer  Iowa State University
2008 — Alek Krautmann  University of Oklahoma
2009 — Kelsey Mulder  University of Oklahoma
2010 — JoBeth Minniear  Iowa State University
2011 — Kristy Carter  Iowa State University
2012 — Jacquelyn Ringhausen  Saint Louis University
2013 — Tashiana Osborne  Saint Cloud State University
2014 — Jessica Tomaszewski  University of Oklahoma
2015 — Amy Burnett  California University of Pennsylvania
2016 — Zachary Bruick  Valparaiso University
Tim Samaras Memorial Award
for Best Student Presentations

The Central Iowa Chapter of the National Weather Association will again present awards in memory of Tim Samaras, who lost his life in the El Reno tornado of May 31, 2013. The Tim Samaras Memorial Award for Best Student Presentation includes both an award for best student oral presentation ($200) and best student poster presentation ($150) given at the NWA Severe Storms and Doppler Radar Conference, taking place this year during March 31-April 2 in Ankeny, IA. The award will be determined by a committee of judges and will be presented at the close of the conference on Saturday afternoon, April 2.

Tim Samaras was a world-famous engineer, inventor, and tornado researcher who had very close ties to our NWA Chapter. His presentations were always a highlight of the annual Severe Storms and Doppler Radar conferences since he first volunteered to speak in 2003. After that time, he was frequently an invited speaker at the conference, often revealing to our audiences jaw-dropping video of tornadoes and lightning that was being seen by the general public for the first time. Of even greater impact to our chapter and the conference attendees than his ground-breaking scientific discoveries was his kind, approachable, and encouraging spirit. Numerous stories have been told of young students attending the conference being stunned that Tim treated them as equals, willing to answer their questions. Tim had a passion to create the next generation of scientists, which was evident in his use of student teams as a part of the TWISTEX project during the period 2006-2011. Because of his passion for both the atmosphere and for students, we can think of no better way to honor his memory than to create these awards which encourage students to pursue research and communicate it to the community.

**Eligibility:** The awards are open to any student, undergraduate or graduate, currently enrolled in college. Posters will be evaluated based on the importance and potential impact of the research they convey, their visual appearance and design, and the level of understanding demonstrated both in the poster and in answers to questions posed by the judges. Oral presentations will be judged on the potential impact, importance and level of understanding of the research in addition to visual appearance and design.
Welcome! Before we get started today, ensure that the WarnGEN software has been installed on your group's laptop, along with GR2Analyst (Version 2.0+). If you have any problems, please flag down one of our technical assistants and they'll get you setup and ready to go.

Once you have WarnGEN installed, you will need to configure WarnGEN and GR to work for today's workshop. Please carefully follow the instructions below:

- Connect to the “radarworkshop” wireless network.
- Open GR2Analyst
- Go to File ➔ Configure Polling (see screenshot on right)
- Add the following url to your list of polling addresses: [http://192.168.10.201/l2data](http://192.168.10.201/l2data)
  - Make sure that this address is at the top of the list by using the “Move Up” button.
- Click on the “Start Live Polling” button or go to File ➔ Start Polling.
  - You should see radar data load into GR.
- Set a Storm Motion Vector in GR (button looks like this: 🌀)
  - For now, enter the following numbers:
    - Direction: 230˚
    - Speed: 45 kts
- Add the following placefile: [http://192.168.10.201/lsr.php](http://192.168.10.201/lsr.php)
  - If you need help adding placefiles, please ask one of our technical assistants.
- Open WarnGEN.
- Choose “LAN” as your connection type.
- WarnGen will have you add two mandatory and three optional placefiles. It is highly recommended to add at least the cwa.txt placefile from the optional listing.
- Double-check that you have the following placefiles loaded into your placefile manager:
  - C:\WarnGEN\placefiles\cwa.txt
  - C:\WarnGEN\placefiles\warnings.txt
  - C:\WarnGEN\placefiles\verticos.bat
- Type in your “Group Name” and click “Set New”
  - It is particularly important that you do not use commas, spaces, or symbols in your group name! Letters, numbers, and underscores are okay! Please keep it simple.
  - If the program should close during the workshop, please click “Use Current” when you re-open WarnGEN.

Now, you should be all set up and ready to go for today's workshop!
GR2 Analyst trial extension key provided by Gibson Ridge Software.

- High resolution NAIP imagery.
- Volume explorer.
- Built-in support for storm reports.
- Supports custom shape and placefiles.
- Custom color table support.
- Dual pole radar support.
- Level 2 velocity dealiasing.

Check out GLevel3 and GREarth for even more data!

GLevel3 Offers:

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- High resolution NAIP imagery.
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- Multiple derived products like hydrometeor classification and estimated rainfall.
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GREarth Offers:
- GOES satellite image.
- High resolution NAIP imagery.
- SPC Outlooks.
- SPC mesoanalysis products.
- SPC watches and MCDs.
- Hurricane-related data plots.
- METARs, LSRs and model data.
- Integrated spotter data.
- Lightning data (with subscription).
SCHEDULE OF EVENTS – 20th Annual NWA Severe Storms and Doppler Radar Conference

Thursday March 31, 2016

11:30 – 12:30 pm Conference Registration Opens

12:30 pm CONFERENCE BEGINS – Opening Remarks by Dave Flory (Central IA NWA Chapter President)

SESSION 1: INTERACTIVE RADAR/WARNING WORKSHOP (session chair: Kevin Skow – NWS-DMX)

12:35 – 12:40 Introduction (Kevin Skow – NWS-DMX)
12:40 – 12:55 Situational Awareness – Synoptic/Mesoscale Overview (Kevin Skow – NWS-DMX)
12:55 – 1:10 WarnGEN and GR Tutorial, Q/A (Kevin Skow – NWS-DMX and Daryl Herzmann – Iowa State University)
1:10 – 2:50 Interactive Radar Warning Workshop – Kevin Skow (NWS-DMX), Daryl Herzmann (Iowa State University), Dave Flory (Iowa State University), Chris Maiers (DNR), and Rod Donavon (NWS-DMX)
2:50 – 3:05 Event/Session Review (Daryl Herzmann – Iowa State University)

3:05 – 3:20 BREAK

SESSION 2: TORNADOES I (session chair: William Gallus – Iowa State University)

3:20 – 4:05 INVITED PRESENTATION – Howie Bluestein (Univ. of OK) – “A brief history of tornado research: Observations”
4:05 – 4:25 A high resolution satellite post-storm analysis of the August 31, 2014 tornadic QLCS – Kevin Skow (NWS-DMX)
4:25 – 4:45 Operational and climatological implications of the August 31, 2014 tornadic QLCS – Craig Cogil (NWS-DMX)
4:45 – 5:00 Integration of new tools and techniques into National Weather Service WFO operations – Benefits and unintended consequences – Mike Fowle (NWS-DMX)

5:00 – 5:45 BREAK

5:45 – 7:45 EVENING BANQUET, ANNOUNCEMENT OF PAM DAALE SCHOLARSHIP AWARD – Rod Donavon (NWS-DMX – Scholarship Presenter), AND SPECIAL PRESENTATION – Louis Uccellini (NOAA/NWS) “The role of the NWS in severe weather forecasting of the future”

8:00 – 9:30 CAREER MENTORING ACTIVITY (Efren Afante – WTLX-TV, Paul Douglas – AerisWeather, Bob Smerbeck – AccuWeather, Jeff Zogg – NWS-hydrology (DMX), Jana Houser – Ohio University and Bill Gallus – Iowa State University, Ken Harding – NWS-forecasting (DMX) (announcements will be made at opening and banquet)
Friday April 1, 2016

8:00 – 8:05 Weather Briefing

**SESSION 3: **COMMUNICATING HAZARDS** (session chair: Kevin Skow – NWS-DMX)**

8:05 – 8:25 Impact-based decision support services during the 2015 Veteran’s Day QLCS event in Iowa – Kenneth Podrazik (NWS-DMX)
8:25 – 8:45 NWS decision support services ahead of the damaging winds at the 2015 PGA Championship – Tim Halbach (NWS-MKX)
8:45 – 9:05 Communicating uncertainty and increasing awareness in rapidly evolving severe weather scenarios – Matthew Dux and Philip Schumacher (NWS-FSD)
9:05 – 9:25 Hazard Services – Improving hazard communication – Jeff Zogg (NWS-DMX) and Tracy Hansen (NOAA Office of Oceanic and Atmospheric Research)

**SESSION 4: **TORNADEOGENESIS** (session chair: Kevin Skow – NWS-DMX)**


9:55 – 10:10 BREAK

**SESSION 5: **APRIL 8 ROCHELLE, IL EF4 TORNADO** (session chair: Melinda Beerends – NWS-DMX)**

10:40 – 11:10 INVITED PRESENTATION – Brian VanVickle (Sheriff, Ogle County, IL) – “A survivor's story”
11:10 – 11:30 INVITED PRESENTATION – Walker Ashley and Stephen Strader (Northern Illinois University) – “The Rochelle-Fairdale, IL EF4 Tornado: Framing disaster potential”

11:30 – 1:10 Lunch (on your own)

**SESSION 6: **TORNADEOGENESIS II** (session chair: Kenny Podrazik – NWS-DMX)**

1:10 – 1:50 INVITED PRESENTATION – Charles Doswell (retired, NSSL) – “A 40-year perspective of storm chasing”
1:50 – 2:10 Near storm environment and storm structure attributes of tornadic low-topped supercell events across Iowa – Rod Donavon (NWS-DMX)
2:10 – 2:30 Close-range WSR-88D observations of a tornadic supercell -- Matt Bunkers and Jon Chamberlain (NWS-UNR)
2:30 – 2:50 The northern Illinois/Indiana QLCS tornadoes of 30 June 2014 -- Jeff Logsdon, Todd Holsten and Evan Bentley (NWS-IWX) and Kyle Brown (Valparaiso University)

2:50 – 3:10 BREAK

**SESSION 7: **SEVERE STORMS I** (session chair: Kelsey Angle – NWS-DMX)**

3:10 – 3:30 Practical and intrinsic predictability of warm-core mesoscale vortex formation with the 8 May 2009 “Super Derecho” event – Caleb Grunzke* and Clark Evans (University of Wisconsin-Milwaukee)
3:30 – 3:50 Modeling hail amounts aloft in a severe thunderstorm for future A-10 storm penetrating aircraft mission guidance – Jeffrey T. Wetter* and Andrew Detwiler (South Dakota School of Mines and Technology)

SESSION 8: FLOODING (session chair: Jeff Zogg – NWS-DMX)

3:50 – 4:10 Decision support services during the historic Missouri and Illinois December 2015 flood – Jim Sieveking (NWS-LSX)
4:10 – 4:40 INVITED PRESENTATION – Efren Afante (WTLX-TV, Columbia, SC) – “A Once in 9,000 year flood event”

4:40 – 5:45 RECEPTION AND CASH BAR (Simultaneous with Poster Session)

SESSION 9: POSTERS (4:40 – 5:45)

(1) A comparison of tornado-production tendencies of southern-most supercells versus adjacent supercells in a linear series (Sara Marzola* and Jana Houser – Ohio University)

(2) Going social: The integration of Facebook and Twitter into severe weather operations at the NWS Des Moines (Eric McCormick* – University of Oklahoma, with Ken Harding and Kenny Podrazik – NWS-DMX)

(3) Analysis of lake enhanced diabatic heating/cooling on a surface low during a Midwest snow event: November 21st-22nd, 2015 (Matthew Tuftedal* – Central Michigan University)

(4) Multi-scale analysis of August 11th 2014 Metro Detroit flash flooding (Patrick Saunders* – Central Michigan University)

(5) Storm-scale ensemble modeling at Central Michigan University (Tim Thielke* and Andrea Honor – Central Michigan University)

(6) Verification of tornadogenesis in high shear low CAPE environments using the correlation coefficient plume identification technique (Kevin Skow – NWS-DMX)

(7) A comparison between the evolution of the tornado vortex signature associated with multiple tornadogenesis events in cyclic supercells (Kelsey Britt* and Jana Houser – Ohio University)

(8) Synoptic-scale precursors and characteristics of high-end tornado outbreaks in the southeastern region of the United States (Benjamin D. Dillahunt* and Shawn M. Milrad – Embry-Riddle Aeronatuical Univ.)

(9) Topography and land-cover effects on tornado intensity using rapid-scan mobile radar observations and GIS (Nate McGinnis* and Jana Houser – Ohio University)

(10) Going FARther: Are the traditional methods of determining False Alarm Ratio and Probability of Detection enough? (Jacob Strohm*, Grant Bastian, Jeremy Buck, Megan Matheus, Maggie Paucek, Chloe Rehberg, and Porter Vande Voort – University of Wisconsin – Whitewater)

(11) Analyzing climate change in the Arctic by examining indices of severe weather from contemporary climates (Kierstin Blomberg – Iowa State University)

(12) Near storm environmental awareness project purpose and future plans (TJ Turnage and Mike Sutton – NWS-GRR, David Hotz – NWS-MRX, Jason Schaumann -- NWS-SGF, Aaron Anderson --

5:45 – 7:30 (Dinner on your own)

**SESSION 10A: BROADCASTER TAPE SWAP** (session chairs: Zach Maloch – KNWA and Fox 24 Northwest AR and Matt Hoffman – WGBA Green Bay, WI.

7:30 – 9:30 Broadcaster Tape Swap

**SESSION 10B (in parallel): PHOTOGRAPHY AND VIDEO SESSION** (session chair: Willard Sharp, intothemeso.com, with Mike Cox, intothemeso.com, Kevin Skow, NWS-DMX, Ben McMillan, WeatherNation, Joey Krastel, Iowa State University, and Doug Kiesling, stormchasingvideo.com)

7:30 – 9:30 Photography and Video Session
Saturday April 2, 2016

8:10 – 8:15 Weather Briefing

**SESSION 11: IMPROVING PREPAREDNESS** (session chair: Allan Curtis – NWS-DMX)

8:15 – 8:35 Real-time relevance: Severe weather indices and GPS-specific threat notifications – Paul Douglas (AerisWeather)

**SESSION 12: TORNADOES III** (session chair: Rod Donavon – NWS-DMX)

8:55 – 9:15 Forecast and warning challenges with the June 27, 2015 eastern North Dakota tornado event – Jeff Makowski (NWS-FGF)
9:15 – 9:45 INVITED PRESENTATION – Karl Jungbluth (retired, NWS-DMX) – “A look back on the 40th anniversary of the Jordan, IA F5 tornado”

9:45 – 10:00 BREAK

10:00 – 10:40 INVITED PRESENTATION – Tim Marshall (Haag Engineering) – “Those Amazing Tornadoes ”
10:40 – 11:10 INVITED PRESENTATION – Mollie Rivas (Emergency Manager, Garland, TX) – “An emergency manager account of the Garland TX EF4 December tornado”
11:10 – 11:30 Use of satellite imagery within the damage assessment toolkit with the Des Moines Weather Forecast Office – Lori Schultz and Jorden Bell (University of AL-Huntsville), Kelsey Angle, Kevin Skow, Andrew Molthan and Jason Burks (NWS-DMX), and Kevin McGrath (NASA)

11:30 – 1:10 LUNCH (on your own) [Special ISU Alumni Luncheon at Hotel Lobby]

**SESSION 13: RADAR AND TORNADOES** (session chair: Mike Fowle – NWS-DMX)

1:10 – 1:30 The utility of considering ZDR and KDP signatures in the tornado warning process – Michael Jurewicz, Sr. (NWS-BGM) and Christopher Gitro (NWS-EAX)
1:30 – 1:50 An examination of radar signatures associated with high-shear low-CAPE tornadoes – Zach Uttech, Ray Wolf, and Alexander Gibbs (NWS-DVN) and Kyle Mentre (Western Illinois Univ.)
1:50 – 2:10 Rapid-scan, mobile radar observations of the tornadic debris signature of the 24 May 2011 El Reno tornado – Jana Houser (Ohio University), Howard Bluestein (University of Oklahoma) and Jeffrey Snyder (NSSL)

**SESSION 14: TORNADOES IV** (session chair: Mike Fowle – NWS-DMX)

2:10 – 2:30 Regional comparison of tornado FAR and environmental parameters – Alexander Gibbs and Ray Wolf (NWS-DVN), Kyle Mentre (Western Illinois University), Steven Nelson and Steven Listemaa (NWS-FFC) and Andy Dean (NOAA/SPC)
2:30 – 2:50 Tornadoes and flash flooding in close proximity over Kansas and Nebraska on 6-7 May 2015 – Jeffrey Halblaub (NWS-GID)

2:50 – 3:00 BREAK
3:00 – 3:20 Temporal and spatial resolution considerations when assessing near-storm environment – Tom Hultquist (NWS-MPX)
3:20 – 3:40 Identifying the challenges in QLCS warnings and verification – Jacob Beittlich (NWS-MPX)
3:40 – 4:00 The impact of different microphysics and boundary layer parameterization on storm-scale diagnostics in convection-allowing models – Philip Schumacher (NWS-FSD) and Joshua Boustead (NWS-OAX)

**4:00 – 4:05 PRESENTATION OF THE TIM SAMARAS AWARDS FOR BEST STUDENT PRESENTATION**

**4:05 – 4:10 CLOSING REMARKS**

NOTE * indicates student presentation
A Brief History of Tornado Research: Observations
Dr. Howard (Howie “Cb”) Bluestein, University of Oklahoma

A summary of studies of tornadoes and their parent storms, mainly from an observational perspective, beginning in the 1950s, will be given. Serendipitous observations, storm chasing, in situ measurements, and Doppler radar observations will all be discussed. The history of observations will be put into the context of other theoretical and numerical work. A look to the future will conclude the presentation.

A High Resolution Satellite Post-Storm Analysis of the August 31, 2014 Tornadic QLCS
Kevin Skow, NOAA/NWS Des Moines, IA

On the evening of August 31, 2014, a powerful but short-lived quasi-linear convective system (QLCS) tracked across the central third of Iowa. The system developed in a thermodynamically favorable and shear-rich environment; exhibiting a classic shear-dominant, balanced, and outflow-dominant structure. In the weeks following the event, the entire path of the QLCS was imaged at 1-m resolution using a commercial satellite through the National Agriculture Imagery Program (NAIP). The predominantly flat, mature agricultural land cover of central Iowa presented an excellent medium on which to document all scales of wind phenomena. A total of 105 ground circulations were cataloged along the storm’s 350-km path, ranging in length from 100 m to nearly 18 km. Forty-one of these circulations were classified as tornadoes using a subjective set of criteria that weighed the damage path characteristics, radar signature, and location within the storm. Eleven of these tornadoes produced tornadic debris signatures (TDSs) detected by the KDMX WSR-88D correlation coefficient product at ranges up to 90 km away from the radar. The vast majority of the circulations developed along the shear-dominant segment of the QLCS, as has been theorized and demonstrated in previous studies. However, the high-resolution satellite data, in combination with the newly implemented Supplemental Adaptive Intra-Volume Low-Level Scan (SAILS) and dual-polarization radar upgrades to the WSR-88D network, provides a unique and unprecedented look at the quantity and evolution of tornadoes throughout the entire lifespan of a QLCS.

Operational and Climatological Implications of the August 31, 2014 Tornadic QLCS
Craig Cogil, NOAA/NWS Des Moines, IA

The August 31st, 2014 QLCS event across Iowa produced a total of 105 ground based circulations including forty-one circulations categorized as tornadoes. The application of high resolution satellite imagery and dual-pol radar data, while not necessarily new in meteorology, was instrumental in showing the scope and detail of this tornadic event. As these technologies continue to develop and proliferate, such events will be documented more frequently and more in depth. Other comparable events, although not as prolific, have also been documented across Iowa in a similar fashion. All of these episodes introduce new and unique challenges to mainstream operations of the National Weather Service (NWS) that need to be considered as the agency moves forward in developing strategic goals for building a Weather Ready Nation.

Integration of New Tools and Techniques into National Weather Service WFO Operations – Benefits and Unintended Consequences
Michael Fowle, NOAA/NWS Des Moines, IA

Two of the primary goals of the National Weather Service (NWS) Science and Operations Officer are to 1) assess continuing and future training needs, and 2) incorporate new technology and science into the Weather Forecast Office (WFO) operations. These are often interrelated
tasks that require coordination and consultation with partners such as the NEXRAD Radar Operations Center, Warning Decision Training Branch, National Severe Storm Laboratory, and universities. One primary program area where this applies is the development and enhancement of severe weather prediction and detection.

Examples of future tools and techniques planned for WFO incorporation include the Multiple Elevation Scan Option for the Supplemental Adaptive Intra-Volume Low-Level Scan (MESO-SAILS), dual-polarization raw correlation coefficient products (SDC) for the WSR-88D, rotational tracks via the Multi-Radar/Multi-Sensor (MRMS) products, NOAA/CIMMS ProbSevere Model, and the use of unmanned aerial vehicles (UAV).

WFO benefits of such tools include, but are not limited to: 1) enhance the ability to monitor rapid tornadogenesis and intensification, 2) support the earliest detection of tornadic debris signatures (TDS), 3) provide forecasters a means to integrate azimuthal shear from multiple radars into a single display, 4) enhance severe weather detection and lead time by fusing together data from several sources as input into a statistical model, 5) enhance post storm damage surveys by effectively utilizing UAVs.

Assessment of the benefits of these tools and techniques must also include the potential drawbacks. Beyond the well-established limits to integrating new technology, such as additional training time, and personal and cultural resistance to change, this project will examine several “unintended consequences” that could pose additional training, warning-decision, and administrative challenges.

A Personal Journey from Severe Weather Research to Improving the Forecast and Providing Impact-Based Decision Support Services

Louis Uccellini, NOAA/NWS Headquarters

Be prepared for an engaging discussion with the Director of the National Weather Service.

Impact-Based Decision Support Services During the 2015 Veterans’ Day QLCS Event in Iowa

Kenneth Podrazik, NOAA/NW, Des Moines, IA

Consistent messaging plays a vital role in NWS impact-based decision support services (IDSS) during severe weather events. On Veterans’ Day, November 11, 2015, a strong Quasi-Linear Convective System (QLCS) produced widespread wind damage and multiple tornadoes across South Central Iowa. The challenge with this event was portraying multiple significant impacts to NWS partners and the public.

National Weather Service Des Moines efforts to communicate impact-based information to key stakeholders and the public will be outlined. A timeline of IDSS activities and communication methods for the event will be examined. Examples of best practices and recommendations supported by social media analytics will be presented.

NWS Decision Support Services ahead of the Damaging Winds at the 2015 PGA Championship

Tim Halbach, NOAA/NWS Milwaukee, WI

The National Weather Service has been working closely with government officials in situations where large crowds are gathered in vulnerable situations. On August 14th, 2015, a line of severe thunderstorms moved south along the Lake Michigan shoreline and caused damage at Whistling Straits Golf Course in Sheboygan, Wisconsin. Thanks to planning that was coordinated months ahead of the event by the National Weather Service and Sheboygan county emergency management, the entire golf course was evacuated 2 hours before the storms moved through. A
review of this weather event and the planning that occurred with emergency management will be reviewed in this presentation.

Communicating Uncertainty and Increasing Awareness in Rapidly Evolving Severe Weather Scenarios
Matthew Dux, Philip Schumacher, NOAA/NWS Sioux Falls, SD

During times when there are lower occurrences of severe weather, maintaining public awareness of severe weather risks can be a significant problem. This awareness concern is amplified when a severe weather risk develops in less than six hours especially when severe weather is not previously anticipated. Forecast offices need to develop procedures which allow forecasters to quickly communicate greater certainty or changes in the risk of severe weather. We propose a methodology that allows communication to evolve from general weather awareness to immediate alert of a severe weather threat. The message will be sent by multiple avenues - in cooperation with the media, National Weather Service web pages, and social media. This will maximize the number of people who receive that message and act upon it.

There are four phases to this methodology utilized for both communication and forecasts – outlook, alert, watch, and warning. As one goes from outlook to warning phase, forecasters will use a combination of radar, satellite and numerical model data to recognize potential severe weather events. During this evolution, the outgoing message will evolve. Initially an area of several thousand square kilometers over several hours may be addressed in the outlook phase. By the warning phase, the threat area may be less than a few hundred kilometers as the severe weather is imminent. Communication of risk will also evolve through this phase – from providing a broad assessment of an increasing thunderstorm risk in the outlook phase to specific severe weather threats and timing during the warning phase. The evolution of the message needs to relay the potential threat while also conveying uncertainty - especially during the outlook and alert phase. Successful messaging will allow both the public and other officials to prepare for a rapidly increasing severe weather threat.

Hazard Services -- Improving Hazard Communication
Jeff Zogg, NOAA/NWS Des Moines, IA and Tracy Hansen, NOAA Office of Oceanic and Atmospheric Research, Boulder, CO

Currently, National Weather Service (NWS) forecasters must use several different software applications to compose and provide warnings, watches and advisories and related information for hazardous weather. Each tool also has different abilities to support the forecasters in their decision-making. Since each tool is uniquely designed, forecasters must learn each one and be able to quickly switch between them multiple times while on duty.

Hazard Services--an AWIPS software application presently in development--is an integral part of the NWS’s Weather-Ready Nation vision. Hazard Services represents a paradigm shift in how the NWS will communicate hazard information and aims to streamline NWS operations by integrating the functionality of the aforementioned tools into a single interface for providing timely, accurate and actionable hazard information. Within this single interface, Hazard Services will analyze data from various inputs and assist the forecaster in diagnosing and communicating the hazard information. In addition, Hazard Services will also shift the present focus on legacy text products to multiple pathways of communication such as social media, cell phones, graphics, text and XML. Thus, Hazard Services will act as a conduit for transforming leading-edge science into timely, accurate and actionable information to the end user in ways that meet their needs.

Hazard Services is also designed to be highly configurable, flexible and extensible. While work continues on the operational version for NWS local forecast offices, experimental efforts are underway to extend Hazard Services to regional and National offices such as River Forecast Centers and National Centers. An added advantage of using the same application across various levels of the NWS is the opportunity to share forecast information for consistency and collaboration.
which will help facilitate a unified NWS message. With a common platform interfacing to existing and new model guidance, including ensembles, it is possible to grow to the next phase of Forecasting a Continuum of Environmental Threats (FACETs).

The Rochelle-Fairdale, IL EF4 Tornado: Environment and Observations
Walker S. Ashley, Northern Illinois University

On 9 April 2015, a violent, long-track tornado traversed areas of northern Illinois, moving at highway speeds across largely rural areas before killing two people in the small town of Fairdale. The parent supercell developed and matured rapidly in a unique environment ahead, and in the wake, of multi-modal clusters of severe storms. This case is illustrative of how quickly a storm can evolve—both visually and on radar—from unremarkable to violent in a matter of minutes. It is hypothesized that, while the mesoscale environment was supportive of supercells and tornadoes, the storm’s interaction with a warm front reinforced by a preceding supercell’s wake boundary was critical for its rapid transformation into a violent tornado producer. This presentation will examine all scales of this event, from the larger meteorological setting, to visual tour of the event from a number of angles, to the post-event aftermath and historical context.

The Rochelle-Fairdale, IL EF4 Tornado: Framing Disaster Potential
Walker S. Ashley and Stephen M. Strader, Northern Illinois University

At the most fundamental level, tornado impacts and disaster potential are caused by the interrelationship of hazard risk with a multitude of physical and social vulnerabilities. An essential vulnerability that determines the magnitude of tornado impact is exposure, which is defined as people, assets, and characteristics of the built environment that may be affected by the hazard. Using the Rochelle-Fairdale, IL EF4 tornado as a reference point, a statistical resampling simulation is employed to explore the potential built-environment impacts of a similar magnitude event on thousands of iterations across northern Illinois. Results reveal that the Rochelle-Fairdale tornado path was far from a worst-case scenario since it traversed land largely considered rural. Shifting the path just miles would have affected orders of magnitude greater houses and people. On the extreme probabilistic end, present-day paths across Chicago, Rockford, or the Quad Cities would far exceed the impacts associated with the Joplin (2011) and Moore (2013) tornado disasters. How the potential impacts change over time is investigated using a demographic model that provides historical context, as well as future projections of land use. Results confirm that the expanding bull's-eye effect in many developed regions is increasing the likelihood of tornado disaster, as well as the expected consequences when that disaster occurs.

A 40-year perspective of storm chasing
Dr. Charles Doswell, NOAA/NSSL, retired

A brief history of storm chasing from my personal perspective is presented, including some of the highlights and some of the low points, as I see them. A spectrum of storm chasers is described, with some of my personal opinions about them. Some thoughts about the events associated with the 2013 El Reno tornado will be offered. The end of the talk will feature a potpourri of photographs and a short time-lapse video.

Near Storm Environment and Storm Structure Attributes of Tornadic Low-Topped Supercell Events across Iowa
Rod A. Donavon, NOAA/NWS Des Moines, IA

Low-topped supercells are responsible for some of the more prolific tornadic events across central Iowa. Low-topped supercell events account for 4 of Iowa’s top ten days for most tornadoes on an individual day, including the top day which produced 28 tornadoes on 2001 April
11. Composite analysis reveals that these events tend to be associated with a closed upper level low pressure system that is lifting northeast through central and eastern Nebraska during the afternoon hours. The near-storm environment (NSE) is characterized by high shear and low CAPE and storm motions that often exceed 40 kts.

Low-topped supercell events present numerous challenges to warning meteorologists. For example, shallow mesocyclones may be overshot by the radar beam with little to no couplet present in the storm relative velocity data and the fast storm motions demand quick warning decisions. Anticipation of low-topped supercells prior to storm initiation in addition to a strong knowledge of the NSE and storm structure characteristics associated with these storms, will lead to more successful tornado warning decisions.

Close-Range WSR-88D Observations of a Tornadic Supercell
Matt Bunkers and Jon Chamberlain, NOAA/NWS Rapid City, SD

A long-lived supercell moved across a climatologically favorable corridor of southeastern Montana and western South Dakota on 19 June 2015 and produced an EF-2 tornado near Hereford, South Dakota. The tornado was associated with the first-ever tornadic debris signature (TDS) observed from the New Underwood, South Dakota (KUDX), Weather Service Radar-1988 Doppler (WSR-88D) radar. The TDS lasted 20 min and helped confirm the presence of a tornado. The TDS maximum height was only 1.33 km (4370 ft) above radar level—likely owing to a lack of debris-producing objects. The KUDX WSR-88D also observed a weak-echo hole (WEH) that was nearly coincident with the tornado location and timing. The WEH had a maximum width of 0.83 km (0.45 n mi) and maximum height of 6.6 km (21.6 kft) AGL, similar to other documented WEHs.

Despite the EF-2 tornado, the most noteworthy severe reports from this storm were the wind gusts of 33–51 m s⁻¹ (65–100 kt) and hailstones of 5.1–16.5-cm (2–6.5 in) diameter that occurred—sometimes simultaneously—over a 150-km (81 n mi) stretch of west-central South Dakota. The strongest winds were associated with a particularly intense rear-flank downdraft, with the KUDX WSR-88D measuring inbound velocities >51 m s⁻¹ (100 kt). This particularly intense supercell was supported by a tall and wide updraft as indicated by a differential reflectivity column that was 5–6-km above the melting level and 18.5-km (10 n mi) wide at its greatest extent. The presentation will focus on high-resolution observations of this supercell, made available because of the storm’s proximity to KUDX as well as the radar’s supplemental adaptive intra-volume low-level scanning algorithm.

The Northern Illinois/Indiana QLCS Tornadoes of 30 June 2014
Jeff Logsdon, Todd Holsten, Evan Bentley NOAA/NWS Northern Indiana, and Kyle Brown, Valparaiso University

On the night of June 30/July 1, 2014, two separate quasilinear convective systems (QLCS’s) tracked across the southern great lakes region. This event had a complex evolution as thunderstorms developed across Iowa during the early afternoon of June 30th. The storms organized into a forward propagating QLCS and tracked east—northeast toward Lake Michigan by early evening. The lead portion of this system split and lifted northeast while southwestern flank reorganized, yet quickly outran better shear and became outflow dominant before dissipating over northwest Indiana. This left behind a pronounced southwest—northeast oriented outflow boundary across eastern Illinois and northern Indiana. New convective storms rapidly developed and intensified further west along a prefrontal trough in eastern Iowa and northwestern Illinois and organized into a second QLCS. This second system, aided by an enhanced mesoscale environment, became a prolific tornado producing QLCS as it accelerated eastward and moved through northeast Illinois and northern Indiana. This presentation will examine some of the mesoscale processes and storm-scale evolution during this event as well as radar interrogation and warning decision making considerations, including application of research techniques to operations.
Practical and Intrinsic Predictability of Warm-Core Mesoscale Vortex Formation with the 8 May 2009 “Super Derecho” Event

Caleb T. Grunzke and Clark Evans, University of Wisconsin-Milwaukee, Milwaukee, WI

On the morning of 8 May 2009, a particularly intense mesoscale convective system, or MCS, developed over southwestern Kansas. This MCS, colloquially known as the “Super Derecho,” spawned the development of an intense, warm-core mesoscale vortex on its northern flank and was responsible for straight-line wind gusts of up to 50 m s^{-1}, twenty-six tornadoes, and approximately $115 million in damage as it traveled from southwestern Kansas to the southern Appalachians (Evans et al. 2014, J. Atmos. Sci.). A numerical simulation conducted in real-time at NCAR was able to successfully replicate the observed event (Weisman et al. 2013, Wea. Forecasting). This and other studies have demonstrated that numerical models are capable of providing skillful forecasts of MCSs and their associated hazards in spite of imperfect initial conditions and physical parameterization methods. However, it remains uncertain whether these forecast successes are primarily serendipitous or instead imply that MCSs and their associated hazards are to some extent predictable.

To investigate the practical and intrinsic predictability of the 8 May 2009 “Super Derecho” MCS and its warm-core mesoscale vortex, a fifty-member Ensemble Kalman filter (EnKF)-based cycled data assimilation and numerical simulation forecast system is developed. The EnKF-based data assimilation system utilized within this study is that implemented within the Data Assimilation Research Testbed (DART). Cycling of the data assimilation system is conducted using version 3.7.1 of the Advanced Research version of the Weather Research and Forecasting (WRF-ARW) numerical forecast model. Technical details of the cycled data assimilation and numerical simulation forecast system closely resemble those of Romine et al. (2013, 2014, both Mon. Wea. Rev.) and Schwartz et al. (2015, Wea. Forecasting). Cycled data assimilation commences at 1200 UTC 2 May 2009 and proceeds every six hours until 1200 UTC 7 May 2009, at which time numerical simulations (extending out 36 h at a horizontal grid spacing of 3 km) are launched. Results from the cycled data assimilation and numerical simulation system will be presented. Particular emphasis will be given to quantification of the ensemble's ability to accurately forecast the development and structure of the “Super Derecho” event, including its accompanying warm-core mesoscale vortex, and evaluation of the effects of initial condition uncertainty upon forecast variability and skill.

Modeling Hail Amounts Aloft in a Severe Thunderstorm for Future A-10 Storm Penetrating Aircraft Mission Guidance

Jeffrey T. Wetter and Andrew Detwiler, South Dakota School of Mines and Technology

One of the primary hazards to aircraft that fly into thunderstorms is impacts from hail. The previous storm penetrating aircraft that SDSMT operated, the T-28 Trojan, had the capability to fly into thunderstorms and collect data at approximately 6 km MSL. This is in contrast to the A-10 aircraft, which is currently being outfitted for research flights and should be able to collect data up to approximately 10 km MSL. Because of the T-28 altitude restriction, we do not have in-situ observations above the 6 km flight ceiling. More needs to be known about the microphysical and dynamical processes governing hail occurring above this altitude in order to provide quality mission guidance to the future pilots of the A-10, and in lieu of observations we turn to numerical modeling as a source for that information. To test this model, a thunderstorm that occurred over western Kansas on 29 June 2000 was simulated. Model data was compared to T-28 observations of hail at the 6 km level, and model output from higher altitudes is also shown.

The technique used to model hail amounts, to our knowledge, has not been implemented in any previously published literature. It involves using model-predicted values for number mixing ratio and number concentration to solve for the slope parameter in the entire hail size distribution and then integrating the equation for the size distribution over the desired size range (for example,
to find the fraction of hail in the storm 1” or greater, we would integrate from 1” to infinity) to find a mass of hail in each grid box. Results from the simulation suggest that the model does a reasonably good job at replicating the actual hail amounts in the storm, showing very little hail over 1” in diameter, in line with the airplane observations that recorded no hail over 1”. Limitations to this new method, however, exist and will be discussed.

**Decision Support Services during the Historic Missouri and Illinois December 2015 Flood**

*Jim Sieveking, NOAA/NWS St. Louis, MO*

A record heavy rainfall event occurred from 26-28 December 2015 across the nation’s midsection including portions of Missouri and Illinois. Rainfall of 6 to 12 inches was observed along a 50-to 75-mile-wide swath from southwest Missouri, through St. Louis, to central Illinois. The excessive rainfall and resultant runoff caused deadly and destructive flash flooding along creeks and brought many rivers to major flood level. The Meramec and Bourbeuse Rivers in east-central Missouri observed record crests, topping the Flood of December 1982. There were 24 fatalities directly related to the flooding across Missouri and Illinois and thousands of homes and businesses were damaged or destroyed by flood waters. Significant impacts to travel and commerce occurred, which included the closures of Interstate 55, Interstate 44 in multiple locations and Interstate 70 in two locations. Early damage estimates place the cost of this disaster in excess of 1 billion dollars.

The National Weather Service (NWS) Weather Forecast Office (WFO) in St. Louis, Missouri (LSX) worked closely with emergency management and the Missouri Department of Transportation to provide specific weather and river forecast information to support critical decisions prior, during, and after the historic event. Missouri Governor Nixon was briefed at WFO LSX on 29 December 2015 and immediately held a press conference onsite that warned the public of the record river flooding and praised the work of the NWS. The high level of decision support services offered to core partners by WFO LSX ensured the safety of the public and limited the impact on the nation’s economy during this historic flood event.

**A Comparison of Tornado-Production Tendencies of Southern-Most Supercells Versus Adjacent Supercells in a Linear Series**

*Sara Marzola and Jana Houser, Ohio University*

Frequently, storm chasers will target the southern-most supercell in a series of discrete supercells oriented in a linear manner, as being the storm most likely to produce a tornado. However, there have been no studies that have examined whether or not this storm is indeed more likely to produce a tornado than its neighbors to the north. In an effort to address the veracity of this statement, an analysis of the 21-24 May, 2011 tornado outbreak was conducted to determine whether or not the southern-most discrete supercell is more likely to produce a tornado compared to other storms within the linear configuration. During the span of these four days, over 87 supercells were spawned and 125 tornadoes were reported (NCEI). Archived level-2 WSR-88D radar data were collected from the NCEI radar archive and imported into the GR-Level2 Analyst software to record how many supercells were produced, and of those supercells which ones did or did not produce a tornado. An analysis was then conducted to compare the likelihood of tornado production by southern-most supercells to other supercells in the series.

**Going Social: The Integration of Facebook and Twitter into Severe Weather Operations at the NWS Des Moines**

*Eric McCormick, University of Oklahoma, Ken Harding and Kenny Podrazik, NWS Des Moines, IA*
This poster summarizes this past summer’s NOAA Ernest F. Hollings Scholarship research project I conducted at the National Weather Service Forecast Office in Des Moines, Iowa. This research project sought to analyze how Facebook and Twitter have been incorporated into severe weather operations at the forecast office, and focuses on social media analytics, real-time office weather operations, and user survey feedback to consider best practice methods and recommendations for improved social media presence as severe weather unfolds. The Des Moines Weather Forecast Office heavily emphasized social media use during the revisions of its Significant Weather Operations Plan in 2014 and 2015, and this project delves into this incorporation to analyze strengths and weaknesses to allow the forecast office to better serve those in their County Warning Area. The project highlights recommended best practice and suggestions for improved social media use that can be utilized on a broader scale for entities that provide severe weather information to users. This social media project is geared towards the Weather-Ready Nation initiatives by providing insight and effective utilization of these means to disseminate severe weather and preparedness information.

Three components make up this project and are summarized on the poster: Nine social media case studies for severe weather events in Central Iowa from 2013 to 2015 that identify social media key takeaways and trends, personally working as social media communicator during real-time severe weather events to test feasibility of these takeaways, and inclusion of conducted survey feedback about social media use and how respondents receive National Weather Service Watch and Warning notification.

These project components combine to produce an overarching model of social media presence during severe weather events by the Des Moines Weather Forecast Office. From this model, both strengths of and recommendations for improving these channels of dissemination are identified and discussed, of which could be applicable to a wide variety of organizations and entities that utilize social media as a means of disseminating severe weather information to their followers.

Analysis of Lake Enhanced Diabatic Heating/Cooling on a Surface Low During a Midwest Snow Event: November 21st-22nd, 2015
Matthew Tuftedal, Central Michigan University

On November 21st and 22nd, 2015, a wide-scale synoptic snow event brought heavy precipitation to the Midwest. During the period of 15 UTC on the 21st and 6 UTC on the 22nd, areas of Michigan started to receive snow at up to an inch an hour. Locations such as Howell, Michigan, received 16.8 inches of snow and the Detroit NWS office received 15.5 inches of snow. To evaluate this event, the Petterssen Development Equation will provide some insight into what caused this large-scale event. As the low progressed through Michigan, it slowed down once it became influenced by warmer than average Great Lake temperatures. Looking at the warm lake temperatures, there was evidence to believe that the lakes provided lake enhancement to the low. To evaluate this, we use the Laplacian of the average diabatic heating/cooling in the 1000-500 mb. Layer found in the Petterssen Equation. This term is known to help aid cyclogenesis. Looking at this term as well as the absolute vorticity advection at 500mb. and, the Laplacian of thermal advection in the 1000-500 mb. layer, we determine that lake enhancement played a role in cyclogenesis.

Multi-scale Analysis of August 11th 2014 Metro Detroit Flash Flooding
Patrick Saunders, Central Michigan University
On August 11, 2014 the Metro Detroit area experienced a historic rainfall that brought 4 to 6.5 inches of rain to parts of Wayne, Oakland, and Macomb Counties with most of it occurring during a four hour period in the evening. Total damage estimated to be around $1.8 billion with a Presidential Disaster Declaration being issued for the three counties mentioned above. Because of the huge impact and historical implications, it is typical to do further analysis on events like this. RUC- reanalysis data along with radar data was used to further analyze the event to help understand how and why the moisture, lift, and instability evolved as it did to lead to flash flooding. The primary focus of this research is the interaction between the synoptic and mesoscale features that led to the event.

**Storm-scale ensemble modeling at Central Michigan University**

*Tim Thielke and Andrea Honor, Central Michigan University*

Central Michigan University’s Meteorology program has obtained hardware to run the WRF-EMS in real-time over Michigan and Wisconsin. Four ensemble members are initialized daily at 09 UTC, with forecasts out 27 hours. The ensemble is configured to mimic a similar real-time system known as the HopWRF, with 4 km horizontal grid spacing, 45 vertical levels, and a variety of physics and boundary conditions. After the model has finished, a number of shell scripts run GrADS to create the latest imagery for display on the web. We create a variety of ways to visualize the ensemble data, including probability, plume, and stamp images that can be used to aid in forecasting. These images are placed on an easy to use website so that others may utilize the data for forecasting. The website, http://weather.eas.cmich.edu/menu.html, is typically updated around 12 UTC. The primary goal of the modeling effort is to aid in teaching students about appropriate use of both convection-allowing models and probabilistic output, also others in the meteorological community may find the data useful.

**Verification of Tornadogenesis in High Shear Low CAPE Environments using the Correlation Coefficient Plume Identification Technique**

*Kevin Skow, NOAA/NWS Des Moines, IA*

During the 2015 convective season, four storm complexes, each fitting a different convective mode (mesoscale convective vortex, forward flank convergence zone quasi-linear convective system, discrete convection resultant of downslope growth from a linear line, and low-topped supercells/rear flank convergence zone quasi-linear convective system), traversed central Iowa in similar ambient environmental conditions. Coined as “High Shear, Low CAPE” (HSLC) in previous studies, the environment for all four systems consisted of MLCAPE values of 150 to 400 J/kg, effective shear values of 35 to 45 kts, and effective storm-relative helicity values of 225 to 500 m2/s2. Local tornadic debris signature (TDS) research over the last few years has shown that TDSs vary greatly in characteristics and at times fall outside of the criteria used by academia and NWS training. Depressions in the correlation coefficient (CC) dual-polarization radar product have shown immense utility in identifying TDSs of all sizes. By monitoring CC behavioral trends along favorable areas of tornadogenesis and assessing the spatial and temporal continuity of any CC depression, the likely presence of a TDS can be ascertained even in regions of low reflectivity and weak to non-existent storm-relative velocity couplets (radar characteristics often observed in HSLC environments). This “CC plume” identification technique was tested during the 2015 season in central Iowa with the four aforementioned cases, each of which contained multiple suspect TDSs. All possible storm surveying assets (damage reports, ground assessments, satellite imagery, and aerial photography) were leveraged to locate and catalog these features. When ground covered permitted, scouring and/or likely tornadic damage was found with every CC plume surveyed. The characteristics of these CC plumes and their damage paths will be presented. These results may open the door for the detection of a whole new spectrum of weak tornadoes and the question of how to address these in the operational warning environment.
A Comparison Between the Evolution of the Tornado Vortex Signature Associated with Multiple Tornadogenesis Events in Cyclic Supercells
Kelsey Britt and Jana Houser, Ohio University

This study looks at three cases of tornadogenesis in cyclic supercells using WSR-88D Nexrad Level II radar data. The first case occurred on 24 June, 2002 starting in McPherson County in South Dakota and dissipating in Brown County. The second case began in Garza County, Texas on 12 June, 2005 and ended in Kent County. The third case took place on 28 March, 2007 with a supercell that formed in Briscoe County in Texas, and ended in Gray County. A supercell is considered cyclic in nature if it produces multiple mesocyclones over the course of its lifetime. For the purposes of this study, only cyclic supercells that also produced tornadoes in a cyclic manner were considered. Satellite tornadoes were not included. All of the observed supercells must have produced at least three tornadoes during their lifetime. In all of the cases, the genesis of the first tornado is within 35km of the radar site.

The objective of this study is to examine the patterns of intensification and time-height evolution of the tornado vortex signature (TVS) of the first tornado compared to the subsequent tornadoes produced by the same parent supercell. Radar data were obtained from the National Climatic Data Center archives, and were imported and analyzed using the GR2Analyst radar analysis software. In order to analyze the tornadoes produced, the maximum difference between the outbound and inbound radial velocity observations (∆V_max) within the TVS was calculated as the tornado went through genesis and decay. The values of ∆V_max and the changes of ∆V_max were obtained at multiple radar elevation angles in order to examine the spatial relationship of the TVS intensity with height, and to determine whether the TVS propagated downward or upward with height over time.

Synoptic-scale Precursors and Characteristics of High-end Tornado Outbreaks in the Southeastern Region of the United States
Benjamin D. Dillahunt and Shawn M. Milrad, Embry-Riddle Aeronautical University

Atmospheric conditions and patterns preceding a high-end tornado outbreak (HETO) are important to understand as such events often lead to loss of life and property. This study examines synoptic conditions in the days surrounding a HETO and compares them to large-scale structures associated with moderate-end tornado outbreaks (METO). The domain in this study includes Alabama, Georgia, Kentucky, Mississippi, the Carolinas, and Tennessee. Tornadic events were examined using the NOAA NCEI Storm Events Database from 1 January – 31 May, 2001-2014 inclusive, as these months encompass the peak severe weather season for the southeast United States. After organizing the number of tornado reports in a day in descending order, the top 10% of events were considered a HETO and the top 15% to 25% of events were considered a METO. HETO events were composited together and compared to a composite of METO events. The comparison yielded evidence of a stronger upstream upper-level jet streak, a deeper and more negatively tilted mid-level trough, higher equivalent potential temperatures and a deeper surface low pressure system in the HETO composites. Comparison of composite soundings showed additional pronounced features in HETO events. To obtain a quantitative description of tornadic events, the composite means were compared to the 30-year climatology by calculating weighted anomalies and a two-tailed student t-test at the 95th and 99th confidence intervals was used to show statistical significance. Quantitative analysis showed that HETO events had statistical significance for all of the variables considered in this study in the Southeast accompanied with large anomalies. The primary objective was to compare HETO events to lesser tornadic outbreaks and climatology in order to improve pattern recognition techniques for short to medium range forecasts of severe weather events.
Topography and Land-Cover Effects on Tornado Intensity Using Rapid-Scan Mobile Radar Observations and GIS
Nate McGinnis and Jana Houser, Ohio University

Changes in tornado intensity (as manifest by changes in near-ground Doppler velocities) as a result of varying topography and land-cover (surface roughness) are investigated using observations from the University of Oklahoma’s rapid scanning, X-band, polarimetric, mobile Doppler radar (RaXPoI) and the Mobile Weather Radar, 2005 X-band, Phased Array (MWR-05XP). Few previous studies have examined these topics and those that have utilized either computer simulations with simplified topographic variance and homogeneous surface roughness, or observations from WSR-88-D radar data, which suffer from poor temporal updates, coarse spatial resolution, and relatively high above-ground beam heights at the location of the tornado. By utilizing rapid-scan, mobile radar, the temporal resolution is improved with update times ranging from 2 - 52 seconds, providing a more appropriate temporal scale for such an investigation. Additionally, due to the close proximity between the instrument and the tornado, the spatial resolution is improved, and the lowest available beam height is closer to the surface (mainly below 400 meters), predominately providing better sampling of the low-level circulation rather than the mesocyclone.

In this study, the effects of elevation as well as surface roughness changes as manifest by land-cover (e.g. open water, grass land, agricultural cover, shrubs, forest, etc.) on tornado intensity are examined for five tornadoes: Goshen County, WY on 5 June 2009, Lookeba, OK and El Reno/Piedmont, OK on 24 May 2011, and Shawnee, OK and Carney, OK on 19 May 2013. For each tornado, intensity is approximated by determining the maximum inbound and outbound tornado vortex signature (TVS) is also obtained using radial velocity values of at least 35 ms-1. ArcMap software from the Environmental Systems Research Institute (ESRI) and topographical data from the USGS are utilized to acquire land-cover (30 meter resolution) and digital elevation model data (DEM) at 1/3 arc second resolution. ArcMap tools and techniques are applied to extract elevation and surface roughness changes over the path of the tornado for which radar data exist. Statistical analysis and regression modeling techniques are used to explore the relationship between tornado intensity and varying topography/land-cover. These relationships are then compared to findings from previous numerical simulations and observational analysis.

Title: Going FARther: Are the Traditional Methods of Determining False Alarm Ratio and Probability of Detection Enough?
Jacob Strohm, Grant Bastian, Jeremy Buck, Megan Matheus, Maggie Paucek, Chloe Rehberg, Porter Vande Voort, and John Frye, University of Wisconsin-Whitewater

The traditional methods of determining False Alarm Ratio (FAR) and Probability of Detection (POD) for severe weather events are examined in this study. In this preliminary study, severe thunderstorm and tornado warnings along with reported severe weather phenomenon are examined for two National Weather Service WFOs, Milwaukee/Sullivan (MKX) and Des Moines (DMX), from 2007-2015. After the initial examination of FAR and POD using traditional methods, the data is analyzed to determine if any events were not warned based on three components: timing, location, and under- or over-warned. The timing component is analyzed to see if any original unverified report of a hail, straight-line winds, or tornado occurred prior to the issuance of or after the expiration of the warning. The location variable is examined to determine if an originally unverified report occurred within a threshold distance (based on warning area) outside of the warned area. The final variable examined, is to determine if the storm was under- or over-warned. For example, a tornado warning was issued but no tornado occurred but severe wind and hail event(s) were reported within the warned area. All three of these variables can lead to changes in the traditional FAR and POD values. A lowering of FAR and an increase in POD due to this more
detailed examination of storm reports versus warnings will increase the public’s positive perception of severe weather warnings.

Analyzing Climate Change in the Arctic by Examining Indices of Severe Weather from Contemporary Climates  
Kierstin Blomberg, Iowa State University

This project investigates how climate is potentially changing in relation to two specific severe weather indices on land areas in the Arctic region. According to the Intergovernmental Panel on Global Climate Change's (IPCC) 5th Assessment Report (2013) as well as many other sources, the overall average temperature of the Earth has been increasing and will continue to increase at even higher rates. Also according to the IPCC's 5th Assessment Report, there is a very high confidence that regions in the Arctic are expected to warm more rapidly than the global mean. To see if the potential for more frequent and more intense storms have been occurring and/or will be occurring in the future in this region due to these warming temperatures, data based off of the two severe weather indices, the K-Index and the Total Totals Index, was analyzed.

Near Storm Environment Awareness Project Purpose and Future Plans  

The purpose of the Near Storm Environment Awareness (NSEA) Project is to provide WFOs with intuitive tools that heighten Situational Awareness (SA) using rapidly refreshing datasets that diagnose the state and evolution of the Near Storm Environment (NSE). Current operationally available tools are static and limited to hourly updates. In contrast, the NSEA Project is developing tools provides sub-hourly updates and control over parameters such as background first guess model fields and observed datasets.

The NSEA Project is multi-regional team of field meteorologists from Eastern, Central and Southern Regions in the National Weather Service. The two applications being developed and tested by the NSEA project team is the Near Storm Environment (NSE) Application and NSE Standard Environment Data Package (SEDP). The NSEA Project tools will be initially beta tested at select field sites this summer and fall, demonstrated at the Operations Proving Ground (OPG) early 2017, and then fielded nation-wide by mid-2017.

Real-Time Relevance: Severe Weather Indices and GPS-Specific Threat Notifications  
Paul Douglas, AerisWeather

Doppler radar has revolutionized severe weather detection, tracking and warning, and NOAA SPC recently launched new convective terminology designed to better communicate threat levels and relative risk. Private companies are also iterating and refining threat indices to reflect real-time risks, from tornadoes and flash floods to blizzards. But a fundamental paradigm shift is unfolding: from watching live video streams to receiving a continuous “stream” of severe weather notifications (text, e-mail, voice) tailored for mobile devices - personalized for a user's GPS location and specific user-selected criteria. How do we simplify severe weather notifications for consumers, to better set expectations when skies are about to turn violent? How do we successfully transition from watching video channels to creating personalized, individualized weather streams, continuously updating in real-time, on our smart phones? What happens when new GPS-specific threat indices and updates conflict with official NOAA watches and warnings? Personalizing the (severe) weather story brings opportunity – and risk.

L. Barker, C. Miller, D. Hansing, NOAA/NWS Lincoln IL

A slow-moving storm system brought heavy rainfall during the later third of December 2015 to Missouri and Illinois. During the 72-hour period from the afternoon of December 25th into the afternoon of December 28th, this system was able to draw climatologically extreme amounts of Gulf of Mexico moisture northward into the Midwest where it fell as rain over the central and southern portions of Illinois and Missouri. A band of rainfall between six and ten inches stretched from the southern Plains northeast into central Illinois eventually producing major flooding on most of the rivers in the region and record flooding along the Mississippi River between St. Louis and Cairo. NWS staff were embedded at the Illinois State Emergency Operations Center (SEOC) in Springfield to assist in the state-level decision-making process regarding the allocation of state resources to protect life and property. Several significant factors combined to heighten the importance of that on-site support such as time of the year, precipitation distribution, and state fiscal issues.

Weather Forecast Office (WFO) Lincoln, Illinois (ILX) has provided support to state agencies since 2006, as the liaison NWS office for the state of Illinois, through the State Emergency Operations Center (SEOC). WFO ILX has provided Impact-based Decision Support Services (IDSS) in many formats both remotely and on-site. Forms of IDSS have included assistance during event activations, participating in pre-planned exercises, and disseminating daily briefing slide sets for ongoing and anticipated weather and water impacts across the state. These efforts have become an important component of the office’s emphasis on the NWS Weather-Ready Nation initiative.

In the years leading up to this event, critical communication and documentation tools were developed by the WFO to facilitate support. A Google Site was designed to enhance knowledge exchange between WFO ILX, the other Illinois WFOs, the Regional Operations Center (ROC), and any IDSS meteorologists on-site at the SEOC. Through this site, other Illinois WFOs, and the ROC, were able to stay up-to-date on information flowing through state agencies in near real-time by viewing situation reports and log entrees from the on-site meteorologists.

Although ten fatalities occurred in the state of Illinois associated with this flood event making it the deadliest flood event in the state in the past 25 years, none of these fatalities occurred in the Main-stem Mississippi River Basin which became the primary focus of state-led emergency management activities.

Forecast and Warning Challenges with the June 27, 2015 Eastern North Dakota Tornado Event

Jeff Makowski, NOAA/NWS Grand Forks, ND

A significant northwesterly flow severe weather episode unfolded across eastern North Dakota and far western Minnesota on June 27, 2015, resulting in at least 20 tornadoes. Environmental conditions were favorable for the development of supercellular storms, although the magnitude of the event in terms of tornadoes was greater than anticipated. Radar analysis, in addition to photographic evidence, indicated that both mesocyclonic and non-mesocyclonic tornadoes occurred during the event. The mesoscale environment was supportive for the development of non-mesocyclonic tornadoes near a weak surface cyclone and surface wind shift axis, as well as mesocyclonic tornado formation preferentially in the vicinity of weak surface boundaries, evident on radar imagery. This presentation will examine the environmental conditions and radar evolution through the event. Forecast and warning challenges associated with an event consisting of multiple modes of tornadic thunderstorms will be highlighted.
Those Amazing Tornadoes  
Tim Marshall, Haag Engineering

This talk will present some extraordinary things that tornadoes have done as well as debunk some of the long-standing myths.

Pay Attention To Me! The struggle to warn about the Garland Tornado  
Mollie Rivas, CEM, Garland Office of Emergency Management

On the evening of December 26, 2015, an EF-4 tornado devastated the City of Garland, Texas claiming the lives of 9 people. The Emergency Management Coordinator shares what information was available and what methods were used to provide warning to the public, as well as what lessons were learned and what improvements can be made.

Use of Satellite Imagery within the Damage Assessment Toolkit with the Des Moines Weather Forecast Office  
Lori Schultz and Jordan Bell, University of Alabama in Huntsville, Kelsey Angle, Kevin Skow, NOAA/NWS Des Moines, IA, Andrew Molthan, Jason Burks, and Kevin McGrath, NASA

The National Weather Service (NWS) has developed the Damage Assessment Toolkit (DAT), an application for smartphones, tablets and web browsers that allows for the collection, geolocation, and aggregation of various damage indicators collected during storm surveys. As part of an ongoing collaboration between NASA and NOAA, members of the NASA Short-term Prediction Research and Transition (SPoRT) team have been working to integrate Earth-observing remote sensing from operational, polar-orbiting satellites to support the damage assessment process. Imagery assists by identifying portions of damage tracks that may be missed due to road limitations, access to private property, or time constraints. This support includes data and imagery from Terra and Aqua MODIS, Landsat-7, Landsat-8, S-NPP VIIRS, Terra Aster, and EO-1 in addition to high resolution commercial imagery such as Digital Globe-Worldview and other DOD imagers. Image products that utilize change-detection techniques can identify damage to vegetation and the land surface, aiding in the survey process. Higher resolution commercial imagery can be corroborated with ground-based surveys to improve accuracy by providing a highly-detailed overview of the damage. Daily and publically released products and imagery are pushed to a web mapping server (WMS) as they are received, while commercial imagery is acquired by the USGS, then ingested and provided upon request of a NWS office in support of a damage survey.

During the 2015 severe storm season, the SPoRT team had the opportunity to work with and support the Des Moines Weather Forecast Office on multiple occasions as their forecasters used the DAT with satellite imagery and products to support ongoing storm surveys. This presentation will describe the training, acquisition, processing and delivery of the data to the DAT interface. Finally, we will provide an overview of where and how the imagery was used and how it affected the storm survey process.

The Utility of Considering ZDR and KDP Signatures in the Tornado Warning Process  
Michael L. Jurewicz, Sr., NOAA/NWS Binghamton/Johnson City, NY, Christopher M. Gitro, NOAA/NWS Kansas City/Pleasant Hill, MO

Prior research over the central and southeastern United States demonstrated the usefulness of interrogating certain dual-polarization radar fields in potentially tornadic situations. The two primary variables of focus were differential reflectivity (ZDR) and specific differential phase (KDP). It was shown that in tornadic events, areas of enhanced ZDR typically resembled an arc-shaped configuration. These ZDR arcs tended to form along the right inflow sides of the parent supercells, indicative of areas of preferentially large raindrops near the updraft core. In the
meantime, regions of enhanced KDP tended to develop much deeper into the mesocyclone, indicative of many small raindrops.

Forty-two potentially tornadic events in the northeastern United States were investigated in the 2012-2014 time period. These cases represented a mixture of both linear (quasi-linear convective systems (QLCS)) and discrete supercellular types. Varied degrees of drop size sorting were evident in 23 out of 26 tornadic cases, as areas of enhanced KDP formed well to the west of the regions where ZDR was maximized. For a subset of these tornadic cases (8 out of 26), ZDR arcs were also evident at the leading edges of parent supercells near the updraft core. In 14 out of the 16 non-tornadic database events, ZDR and KDP maxima significantly overlapped, with specific KDP maxima tightly clustered near maximum regions of ZDR. This pattern indicated a lack of drop size sorting/hydrometeor separation.

In addition to evaluating the behavior of ZDR and KDP, patterns of base velocity (V) and storm-relative velocity (SRV) were also investigated for all 42 cases. In this way, direct comparisons could be made between the effectiveness of utilizing newer dual-polarization techniques, versus more traditional velocity analyses, in discriminating between tornadic and non-tornadic storms.

The most recent results over the northeastern United States matched quite well with those previously achieved over the central and southeastern United States. As a result, there is growing confidence that these radar techniques can help discriminate between tornadic and non-tornadic storms, and that they can also be applied in a wide range of geographic settings. Future research efforts will focus on storms removed from the northeastern United States to further test the applicability of utilizing ZDR and KDP radar fields in the operational warning environment.

An Examination of Radar Signatures Associated with High-Shear Low-CAPE Tornadoes


Tornadoes developing in a high-shear, low-CAPE (HSLC) environment have the reputation of being particularly challenging for warning forecasters amongst the spectrum of tornado warning scenarios. The HSLC environment tends to be associated with fast-moving, fast-evolving storms, so while the lifetime of the tornado may not be very long, the quick movement can result in a relatively lengthy track. Signatures seem to develop rapidly with little lead prior to tornadogenesis, and small or low-topped storms characteristic of these environments pose additional challenges at distances from the radar at which classical storms are more clearly sampled.

This study will examine a variety of standard and new data sets to evaluate radar signatures occurring prior to and during the lifetime of the tornado in four HSLC cases across eastern Iowa and northern Illinois in 2015. Specifically the focus will be on spectrum width, an under-utilized tool, the new Multi-Radar Multi-Sensor rotation tracks, and the Tornado Debris Signature occurrence and depth. These signatures will be evaluated for all tornadic storms from these four cases to assess the value of each data set for identifying tornadoes and providing lead time to tornadogenesis.

Rapid-Scan, Mobile Radar Observations of the Tornadic Debris Signature of the 24 May 2011 El Reno Tornado

Jana Houser, Ohio University, Howard Bluestein, University of Oklahoma, and Jeffrey Snyder, NOAA/NSSL

The evolution of the tornadic debris signature (TDS) of a large, violent (EF-5) tornado that occurred on 24 May 2011 in Central Oklahoma is examined using the University of Oklahoma’s rapid-scanning, X-band, polarimetric, mobile Doppler radar (RaXPol). The analyzed tornado formed shortly after a previous tornado decayed, and residual debris from the first tornado is shown to impact the appearance and onset of the TDS in the second tornado: the TDS was
observed about 40 s prior to the formation of a vertically coherent tornado vortex signature. Over the time period during which data were collected, the TDS underwent multiple structural transitions, and asymmetries in the appearance of the TDS were observed often. The structural transitions as well as the hypothesized sources of the asymmetries, including small-scale inflow bands, vertically-propagating wavelike features, debris ejections associated with secondary rear-flank gust front surges, and debris fallout, are analyzed and discussed.

**Regional Comparison of Tornado FAR and Environmental Parameters**

*Alexander R. Gibbs and Ray Wolf, NOAA/NWS Davenport, IA, Kyle Mente, Western Illinois University, Steven Nelson and Steven Listemaa, NOAA/NWS Peachtree City, GA, Andy Dean, NOAA/NWS/SPC*

False alarm tornado warnings account for nearly 3 out of every 4 warnings issued. A high number of false alarms have been suggested as a possible factor in negative public responses to future warnings. Negative public responses, e.g., ignoring the tornado warning, deters from the National Weather Service’s role in the protection of life and property. To decrease false alarms, the end to end process in which warnings are issued needs to be examined. A warning forecaster uses their experience, environmental data, radar data, and ground truth when deciding whether or not to issue a warning. This research examines environmental data associated with tornado warnings and missed tornadoes in the NWS Quad Cities County Warning Area (CWA), and is an extension of previous research conducted in the NWS Atlanta CWA. This study will also compare and contrast results from the Quad Cities area to the Atlanta area to evaluate any similarities or differences between the two regions.

**Tornadoes and Flash Flooding in Close Proximity over Kansas and Nebraska on 6-7 May 2015**

*Jeffrey D. Halblaub, NOAA/NWS Hastings, NE*

During the afternoon and evening hours of 6 May 2015, persistent deep moist convection developed over much of north central Kansas and southeast Nebraska. Convective modes were a mix of discrete classic supercells and quasi-linear multicells, which were occasionally comprised of embedded high precipitation supercells. The discrete supercells were responsible for fifteen tornadoes, mostly concentrated within four counties straddling the Kansas-Nebraska border. In and near this area, repeated cell-generation and training occurred, resulting in a maximum of nearly 11 inches (280 mm) of rain and flash flooding.

Convective initiation occurred early in the afternoon, with numerous small cells forming over north central Kansas. By mid-afternoon, a line of semi-discrete larger cells had evolved. Isolated, smaller supercell storms developed east of this line. These storms were responsible for the majority of the tornadoes. The first tornado occurred at 1923 UTC, with most of the tornadoes occurring between 2000 and 0000 UTC. These tornadoes occurred in the absence of any discernible synoptic or mesoscale boundaries. During the late afternoon hours, the supercells were overtaken by the line which exhibited some eastward progress. However, the line became quasi-stationary from north-central Kansas into southeast Nebraska during the evening. The tail end of the original line did move northeast, but numerous other storms persistently developed to its southwest, resulting in cell-training over areas where previous convection had already deposited heavy rainfall. Osborne County Kansas was the primary origination point for much of the convection in this event. Over the four counties where the tornadoes occurred, the heaviest rainfall ended by 0500 UTC 7 May. However, scattered showers continued to develop and cross the area until 0800 UTC.

Tornadoes and flash floods in close proximity, pose a number of important concerns, including forecaster awareness and recognition, effective communication of the threats, and that the lifesaving actions of each hazard are contradictory.
Rogash and Racy (2002) showed that environments conducive to tornadoes and flash flooding are similar to the various flash flood surface patterns developed by Maddox et al. 1979. However, this case does not fit any of those patterns.

The purpose of this study is two-fold is 1) to examine a case of tornadoes and flash flooding in close proximity to one another, including placing it in context with other studies, and 2) to document the cluster of tornadoes in the absence of a discernible boundary.

**Temporal and Spatial Resolution Considerations When Assessing Near-storm Environment**

*Tom Hultquist, NOAA/NWS Chanhassen, MN*

Proper assessment of near-storm environment is a critical component of warning operations for severe convective weather. Excellent tools resulting from years of research by the operational and academic communities, such as the Storm Prediction Center's mesoanalysis suite of products, assist forecasters in accurately anticipating potential storm development, mode, and severity. However, given the difficulties of accurate environmental sampling and the need to utilize numerical model analyses, there are limitations in such datasets and the research performed to develop the various mesoanalysis parameters and their critical thresholds. Most parameters commonly used by warning forecasters to assess near-storm environment were the product of research that leveraged such model analyses. The spatial and temporal resolution of the model datasets used were coarse by today's standards, which may limit their ability to capture smaller scale features, particularly in kinematic fields. Such limitations may contribute to some of the overlap present in values of critical parameters utilized to assess near-storm environment. This overlap in parameter space between non-severe, severe, and significantly severe events can complicate the warning process, and potentially contributes to both false alarms and missed events.

A few events from the 2015 convective season were evaluated via numerical downscaling to investigate how commonly used mesoanalysis parameters may vary in time and space. The model output was evaluated to see if one could better differentiate between non-tornadic, weakly tornadic, and strongly tornadic cases when utilizing such high spatial and temporal resolution information. Given the particular difficulty in assessing the tornado threat with quasi-linear convective systems (QLCS), this preliminary research focused on QLCS events which produced severe weather, but varied in their production of tornadoes. An initial review of this limited set of cases suggests that the efficacy of many commonly used mesoanalysis parameters and indices could benefit from a re-evaluation at higher temporal and spatial resolution. The operational availability of hourly high resolution three dimensional analyses from the High Resolution Rapid Refresh (HRRR) model could allow for such a re-evaluation of the near-storm environment associated with severe convective storms. Such research could in turn lead to better differentiation of environments supportive and not supportive of the various severe weather hazards, including tornadoes.

**Identifying the Challenges in QLCS Warnings and Verification**

*Jacob Beitlich, NOAA/NWS Twin Cities*

One of the most important parts of the convective warning process is understanding the near storm environment in order to better anticipate potential hazards associated with storm mode. For tornadic storms in particular, there is significant overlap in the forecast parameters between strong tornadoes (EF2+), weak tornadoes (EF0, 1), and even non-tornadic events. This presents a challenge for warning forecasters.

Some of this overlap is likely due to inconsistencies in storm data. Damage survey crews have a daunting task of properly cataloging storm damage, especially considering the fact that more often than not they are confined to ground surveying and cannot physically examine each circulation associated with Quasi-Linear Convective Systems (QLCS).
This presentation compares and contrasts three events from the 2015 convective season. The near storm environment is presented, along with radar data in the context of Smith, et al. 2012. The audience will then be able to decide if one, two, or all of the events were tornadic or non-tornadic. Finally, official storm data will be revealed in hopes that the audience will have a better appreciation for the overlap that exists in the literature between tornadic and non-tornadic QLCS events.

The Impact of Different Microphysics and Boundary Layer Parameterization on Storm-Scale Diagnostics in Convection-Allowing Models

*Philip N. Schumacher, NOAA/NWS Sioux Falls, SD, Joshua M. Boustead, NOAA/NWS Valley, NE*

Alerting the public to the potential for severe weather is critical to mitigating the potential for injuries. Injuries are even more likely at night when the public may not receive warnings unless they proactively set up a way to be alerted. Improving the awareness of nocturnal severe weather requires providing information prior to when most people go to sleep. Information from convective-allowing models (CAMs) can be used by meteorologists to alert the public. CAMs can explicitly predict the time of convective initiation, storm evolution and location.

We tested the use of CAMs to forecast severe weather threats associated with nocturnal supercells. Since nocturnal supercells can be associated with just large hail (hail-only) or both large hail and damaging winds (hail-and-wind), we ran simulations with 3-km grid spacing of nocturnal supercells over the central and northern plains of the United States – 11 hail-only cases and 11 hail-and-wind cases. Our results show that the WRF-ARW successfully differentiated between storms that have only a hail threat from those that have both a hail and wind threat. Updraft helicity, updraft and downdraft strength, maximum reflectivity and 10-m wind speeds associated with simulated convection were significantly stronger in hail-and-wind cases than hail-only cases (p-value < 0.01).

We also investigate the impact of different parameterizations and ran each case with four additional combinations of microphysics (MP) and planetary boundary layer (PBL) schemes. We find that differences between hail-only and hail-and-wind cases remain regardless of which combination of parameterizations was used. But comparing storm-scale diagnostics on the same set of cases (i.e., hail-only cases) using different parameterizations also resulted in differences. In some cases, the differences between the same set of cases using different parameterizations were nearly as large as those between the different groups of cases (hail-only vs. hail-and-wind) using the same parameterization.

These results show that development of critical values of updraft helicity or other storm-scale diagnostics indicative of severe weather within CAMs will have to be derived independently for different combinations of PBL and MP schemes. Forecasters will also need to be aware of the parameterizations being used in CAMs to better interpret the likelihood of the type of severe weather associated with nocturnal supercells. Finally, storm-scale ensembles that vary MP and/or PBL parameterizations will need to be bias-corrected to ensure that impacts of different parameterizations do not lead to a misinterpretation of the likelihood of severe weather.
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