# NWA 46th Annual Meeting Poster Abstracts

**1** Wendy Abshire

Supporting the Weather, Water, & Climate Community: Education, Mentoring and Leadership Development

*The NWA and the American Meteorological Society (AMS) have rich histories of serving professionals and students in the atmospheric sciences. Many in the meteorology community are committed to and/or active in both groups, including the authors of this abstract. One recent collaboration highlight includes the co-sponsorship of multiple offerings of Research Operations NEXUS (RON) events. Inspired by our former colleague, RON meetings serve the membership of both groups by facilitating discussion of this important topic. Although the NWA and AMS share members, not everyone is familiar with some AMS offerings that align with this year's NWA meeting Service theme. Our presentation will highlight education, mentoring, leadership and professional development, and mental health initiatives.The AMS Education Program benefits from meteorologists and educators who contribute to and participate in earth science professional development courses for teachers. The Certified AMS Teacher program may be relevant to broadcasters in their work with local schools. The AMS Career Program offers the weather community many professional development opportunities (e.g. webinars including one addressing mental health in the atmospheric sciences, short courses, and podcasts.) AMS, like NWA, supports mentoring with opportunities to mentor and be mentored and engages in "Mentoring365".Students and professionals involved in the weather community may apply to and participate in the AMS Summer Policy Colloquium, the AMS Early Career Leadership Academy and the annual AMS Washington Forum.Both NWA and AMS have weathered COVID by serving the weather community virtually and both groups continue to evolve to better serve members and the public by 1) including a renewed emphasis on diversity, equity and inclusion with the hiring of a DEI director at the AMS to support the new Culture and Inclusion Cabinet and, 2) the launch of the AMS WeatherBand for weather enthusiasts.*

**2**

Jared Allen

Flood After the Flames: A New Wildfire-SAFER GIS IDSS Approach

*Over 10 million acres burned in 2020 due to wildfires; the second highest total since 1983, and the third time in the past six years 10 million+ acres burned in a calendar year. From the Rockies west to California, new individual record large wildfires occurred with the Mullen Wildfire (WY), Cameron Peak (CO), East Troublesome (CO), SCU Complex (CA),and LNU Complex (CA), just to name a few. To better understand the millions of acres and vulnerable infrastructure points at risk for debris flows and flash flooding, a new Wildfire-SAFER (Situational Awareness For Emergency Response) ArcGIS Online (AGOL) IDSS (Impact-based Decision Support Service) application was developed and shared with multiple NWS Weather Forecast Offices (WFOs).The Wildfire-SAFER AGOL application is designed to highlight experimental debris flow and flash flooding extrapolated channels, USGS debris flow basin and creek segment probabilities, known building footprints, NWS watches & warnings, estimated MRMS rainfall, rain gage data, surface water routing, and latest wildfire hotspots and firefight details. This application evolved during the 2020 wildfire season and was used for both pre-event internal NWS training, core partner mitigation and planning, and also real-time monitoring for enhanced IDSS messaging. Through the NWS GIS Mutual Aid Team, this application has been developed for 11 NWS WFOs and mapped over 30 wildfires across ~6 million acres for plausible debris flow and flash flooding impact locations. This presentation will highlight the NWS Wildfire-SAFER application concept and how it was used by NWS Cheyenne, WY, NWS Boulder, CO, and NWS Monterrey, CA forecast offices for internal training and first-class external IDSS prior to and during atmospheric river and thunderstorm events.*

**3**

Jared Allen

Simulating an EF-5 Tornado Event in a Virtual Exercise World

*For over a year, COVID-19 has prevented NWS personnel from meeting in-person with core partners for table-top and functional weather exercises. As a result, innovative virtual delivery of weather injects were necessary to maintain both internal NWS practice and external core partner proficiency in awareness, communication, and Incident Command Structure (ICS) hazard management. To be weather-ready and maintain skill sets, the NWS offices of Cheyenne, WY and Riverton, WY developed and delivered over 40 severe weather exercise injects for a multi-county, multi-agency functional EF-5 tornado exercise in the state of WY. In this exercise, NWS Cheyenne and NWS Riverton developed a shared Google Drive Folder for simulated County Warning Area (CWA) Situation Reports, simulated radar imagery, mesoscale graphics, watch and warning text products, simulated Facebook and Twitter severe weather* *reports, and a preliminary damage path as a simulated tornado impacted both CWAs. In addition, mock phone calls and statewide radio communication calls were made by both offices during the exercise to further deliver simulated weather impact information. Core partner feedback was very positive of the multi-NWS office weather inject delivery method through Google Meet. Furthermore, several injects were scheduled to be emailed at the precise moment of the verbal sharing over Google Meet for core partner inject delivery. Through this exercise, both offices and core partners determined further best practices and lessons learned for the upcoming severe weather season. This digital inject repository and template can be used repeatedly for future exercises, teleworkers, and delivered remotely to best simulate a table-top to functional exercise in a virtual communication environment.*

**4**

Matthew Anderson

Analysis of Two Lake-Enhanced Snow Events along the Tennessee River

*The synoptic and mesoscale environments conducive to lake-effect snow events, and the societal impacts of such events, have been thoroughly documented in the literature. Lake-effect snow is common across the Great Lakes region from late autumn into much of winter. In rare cases, however, it occurs over much smaller bodies of water, even in the southern United States. Due to the low frequency of these events ,only three to five per decade have been documented by the NWS in Huntsville and University of Alabama in Huntsville researchers, lake effect snow provides significant forecast challenges. Although these events do not produce the magnitude of snow observed across the Great Lakes, the events further south can have similar societal impacts.This study will examine two lake-effect snow events that occurred downwind of Lake Wheeler, along the Tennessee River in northern Alabama, in late 2020. Vertical temperature profiles, surface temperatures, water temperatures, and wind direction will be examined to determine if proven thresholds, found in the Great Lakes, can be used to anticipate these events. Occurrence of typical lake-effect processes on Lake Wheeler, including thermally-direct circulations, convection due to low-level instability, and convergence due to differential friction, will also be investigated. Finally, we evaluate high-resolution numerical weather model output from the 2020 snow events for clues on how these models can be utilized to better forecast lake-effect snow on small bodies of water.*

**5**

Stephanie Avey

Going Virtual With The Aviation Weather Testbed

*The Aviation Weather Testbed (AWT) is a research-to-operations facility within the NOAA National Weather Service's (NWS) National Centers for Environmental*

*Prediction (NCEP) Aviation Weather Center (AWC). As a standalone NOAA Testbed facility, the AWT was established in 2009. The AWT was established to facilitate the mission and realize the vision of NOAA AWC. The AWT achieves this through a physical and technical environment conducive to an efficient research-to-operations (R2O) process.A vital step in achieving the goals of the AWT is the evaluation of experimental and prototype products and services built to improve and support aviation planning in the National Airspace System (NAS). By collaborating with both internal and external stakeholders and partners, the AWT strives to develop and evaluate products that meet the evolving needs of both the aviation and weather enterprises with the goal of improving their decision making tools and processes. To facilitate this collaborative evaluation process, each year AWC invites stakeholders and partners to participate in their annual experiment in Kansas City. However, 2020 brought forth a global pandemic, which was ongoing into 2021, making in-person experiments impossible. To adapt, the AWT team took their experiments virtual. Instead of one large-scale experiment focusing on multiple themes and capabilities as in years past, the team decided that demonstrating one product at a time would lead to a more targeted participant list and enhanced engagement in the virtual realm. With all discussions taking place electronically, the virtual AWT was able to bring in a wider range of perspectives from users and stakeholders who may not have been able to attend the in-person events. A general overview of the 2020 and 2021 virtual AWT evaluations, lessons learned from making the transition to all virtual, and a look at how AWT activities will proceed beyond 2021 will be presented.*

**6**

Patrick Ayd

NWS Duluth Onboarding During Challenging Times In The GS5-12 Progression Era

*2020 brought both challenges and opportunities to change the approach to forecaster development through onboarding in a pandemic. Onboarding, especially new hire onboarding, is a unique mix of technical training, professional coaching, applied graduate school and beyond the forecast mentoring focused not just on developing a forecaster, but a person. A three to four week telework training environment built a knowledge foundation virtually that allowed for an immersive six to eight week operational experience alone with the Science and Operations Officer (SOO) working the day shift one on one together day in and day out. This allowed for an expedited entry of the new meteorologist into the forecast rotation for a near immediate impact to operations as outlined in the 2019-2021 Central Region Roadmap. Best practices, challenges and experiences will be shared in addition to the positive takeaways of pandemic affected training and how these innovative approaches will continue to be applied to forecaster development.*

**7**

William Aydlett

Improved Forecasting Techniques for Increased Lead Times of Deep Tropic Convective Hazards

*The tropical western North Pacific (WNP) is no stranger to hazardous weather with its frequency of tropical cyclones (TCs) and monsoons. However, smaller mesoscale convective systems (MCS)""large clusters of thunderstorms, sometimes spanning 100 miles and lasting for 12-18 hours""periodically develop, packing strong winds, intense lightning, and torrential rains. Occasionally, these MCSs affect some of the many islands that dot the WNP. While TCs and monsoons are readily observable in numerical global model guidance (GFS and ECMWF) with long lead times, smaller-scale convective hazards are harder to assess. New techniques are investigated to improve identification of these potentially hazardous, often quick-forming, weather events. These include the use of multi-model colorized isotachs of surface winds and gusts to improve detection of potential convective downbursts, multi-model colorized upper-level isotachs to aid in pattern assessment and recognition of conditions supportive of widespread deep convection, and multi-model quantitative precipitation forecast (QPF) comparisons of various time ranges (6, 12, and 24 hours) to better assess periods of heavy rainfall. This investigation also includes an assessment of the high-resolution Advanced Research WRF (ARW), produced for the Marianas region by the NOAA NWS Environmental Modeling Center (EMC), and the NWS National Blend Model-Oceanic, (NBM Oceanic), which covers the WNP. Notably, the ARW has performed well with recent hazardous convective weather outbreaks and has become more widely-embraced for short-term convective forecasting at the Weather Forecast Office (WFO) Guam. Continued usage, assessment, and refinement of these techniques (eventually to include the Rapid Refresh Forecast System (RRFS)) will lead to longer lead times of potentially hazardous weather, more accurate and reliable flash flood and high wind watches and warnings, and improved decision support messaging to our partners and the community.*

**8**

John Banghoff

Adaptability/Evolution of a Student Volunteer Program

*In response to the pandemic, the Student Volunteer Team (SVT) totally transformed the program to a virtual medium. Fall 2020 provided the first opportunity to test out the newly-created virtual student volunteer program.The SVT worked diligently to ensure that the core aspects of the in-person experience were preserved in a virtual setting. Assigned mentors (members of the SVT) scheduled weekly or bi-weekly meetings to discuss progress, answer questions, and incorporate the expertise of focal points in explaining different office programs. One of the downsides of the virtual* *format was the lost opportunity to build camaraderie. To combat this obstacle, Google Meet luncheons were scheduled to provide opportunities for socialization and casual discussion of career paths. Additionally, students were added to the office Google chat platform, which enabled the students to quickly become a part of the office culture.Student volunteers presented their projects at the end of the semester. After completing their presentations and answering a few questions from the staff, the Team asked them to share the highlights of their experience. One of the students said, "I thoroughly enjoyed having conversations with each of the meteorologists around the office...I learned that there are a large variety of passions that place people on the different career path other than forecasting..."_ As for the impact the student volunteer experience had on their career trajectory, another student remarked, in regards to learning about DSS and social science aspects, "[The student volunteer program] certainly allowed me to see that there is space for everyone and that I would be excited to work for this agency if given the opportunity after grad school."_ By all accounts, the virtual experience was a success. Through hard work, dedication, and outstanding teamwork, the SVT is helping to build a productive workforce of the future!*

**9**

John Banghoff

Improved Medium-range and Near-term Probabilistic Winter Weather Messaging

*With the continued increase in social media weather aficionados and readily-available model data during the winter season, accessibility to snowfall forecast information - independent of its reliability - is easier than ever. As a trusted source in weather information, our agency has an obligation to provide scientifically-based hazardous weather information ahead of winter storms and does well to engage in the conversation before rumors can run wild. Thanks to an expansion of probabilistic winter weather information coming from various professional sources, there are an increasing number of tools to forecast and communicate uncertainty for winter weather. During the winter of 2020-2021, our office made a concerted effort to employ an array of different probabilistic guidance information within the medium-range and near-term forecast periods. A medium-range Winter Weather Outlook was adapted and localized into a "Probability of Plowable Snow"_ graphic generated twice per day. Additionally, Winter Storm Outlook and NBM probability of exceedance graphics proved beneficial for higher-end events, providing reasonable confidence outside the 72-hour window of more conventional products. Innovative social media graphics templates and Facebook Live briefings helped communicate information beyond the scope of normal operating procedures. Inside of 72 hours, snowfall exceedance probabilities and 25th-75th percentile ranges proved beneficial for messaging varying degrees of uncertainty. The overall result was improved winter hazard messaging and communication that conveyed uncertainty in a responsible way, while helping partners and the public prepare for a variety of events in a very active stretch of winter storms.*

**10 *WITHDRAWN***

Randall Bass

The Federal Aviation Administration's Aviation Weather Research Program: Benefits Beyond Aviation

*The Aviation Weather Research Program (AWRP), a part of the Federal Aviation Administration's Office of NextGen Weather Research Branch, performs applied research to minimize the impact of weather on the National Airspace System from both a safety and operational efficiency perspective. AWRP has a long history of sponsoring important research initiatives including the development of icing, turbulence, and ceiling/visibility capabilities that aviation users rely on in their operations. In addition, AWRP also leads, manages and funds exciting and innovative weather research projects that in many cases have applications beyond aviation including severe weather forecasting, hydrology, the military, shipping, and other transportation sectors. Two somewhat recent examples are the High Resolution Rapid Refresh numerical weather prediction model and the Multi-Radar, Multi-Sensor weather radar display system, both developed using significant funding from AWRP. Working with other government agencies, national labs, and industry partners, AWRP has successfully developed and transitioned many other capabilities to the National Weather Service for implementation over the past 25+ years. This presentation will provide an overview of past and current projects that have applications beyond aviation and provide benefit to all citizens.*

**11 *WITHDRAWN***

Alyssa Bates

Enhancing NWS Severe Weather Warning Decision-Making Training via Stakeholder Research

*A couple of multifaceted, multidisciplinary projects delved into current National Weather Service (NWS) Weather Forecast Office (WFO) warning practices and interoffice collaboration during severe weather warning operations. Although the main goal of these projects was to simulate a potential future with collaborating WFOs in a paradigm of continuously-flowing hazard information, this abstract focuses on the current state of severe weather warning operations, as recounted by forecasters with warning experience. As a representative from the entity charged with training NWS forecasters in warning operations, including teaching best practices, a NWS Warning Decision Training Division (WDTD) employee embedded within these research projects to gain firsthand knowledge of how these future capabilities could affect forecaster training. However, it was realized that some of the research findings might be applicable to today's warning paradigm and may be able to put into practice sooner than experimental concepts. Therefore, key findings from the social science research (consisting of WFO forecaster interviews and an NWS-wide survey) will be source* *material for recommendations of topics to include in current severe weather warning decision-making training initiatives. Some recommendations will apply to directly to current warning operations while some may include experimental concepts that could be utilized in the current warning paradigm. Summaries of these recommendations, proposed steps of how they could be used in current warning operations, and illustrations of how these concepts could look in warning operations will be presented. It will also be noted that this outcome illustrates the benefits of multidisciplinary teams, including trainers working alongside researchers and social scientists working alongside meteorologists.*

**12**

Melissa Beat

An Assessment of Facebook Live Analytics from Texas NWS Offices

*In 2017, the National Weather Service (NWS) started testing the use of streaming services such as Facebook Live. In 2019, nine of the eleven Texas NWS Weather Forecast Offices (WFOs) volunteered to join in the testing. WFOs have typically put either static images or short videos that generally last less than one minute on Facebook to communicate weather information. The addition of Facebook Live allows offices to communicate with the public more effectively because users can ask questions and receive answers in real time. This study evaluates viewership numbers based on the 9 TX WFOs using Facebook Live compared with the shorter videos on Facebook composed by all TX WFOs. When looking at the use of short videos on Facebook for all of the Texas WFOs, the average number of views is about 3 percent of each WFO's Facebook followers. For the 9 offices that volunteered to help test Facebook Live typically used to brief viewers for high impact weather events, there was a 444% increase in viewers, on average. When there is a threat of high impact weather, using Facebook Live gives NWS WFOs a chance to provide the public with an update to the forecast as well as giving partners an update in-between email briefings or webinars. Because of the ability of Facebook Live to provide offices a greater audience reach, it would be of great use to offices to incorporate it as an integral part of their decision support services.*

**13**

Matthew Beitscher

Maps, Messaging, and Maintaining SA: Leveraging ArcGIS Online in NWS Operations

*Geographic Information System (GIS) applications, powered by Esri's ArcGIS Online web-based suite, continue to evolve at NWS Weather Forecast Offices (WFOs) across the nation to meet the unique needs of forecasters and core partners. The tremendous customization potential and the ability to use these tools from home, especially during the COVID-19 pandemic, are some of the many advantages to these applications. The*

*National Weather Service Central Region Weather Ready Nation Roadmap (2019-2021) underscored the importance of addressing the "convective watch-warning gap" and developing situational awareness tools that can be used during on-site weather support. Over the past year, NWS St. Louis developed several web-based GIS tools to achieve these goals. The first tool that will be discussed in detail addresses the watch-warning gap through effective mesoscale analysis. The tool allows the forecaster to annotate current meteorological data (radar, satellite, lightning, etc.) and illustrate the potential for hazardous weather. A screenshot of this annotation can then be used to message the specific threat on graphicasts or weather stories. The second application that will be described is modeled after the SAFER Hazard Dashboard, developed at NWS Cheyenne. This display, with several modes depending on the expected hazard, aids meteorologists on station, teleworking, or providing on-site IDSS with a simple, yet robust situational awareness display. After staff training, feedback, and testing, these tools were integrated into operations with success. In fact, the mesoscale analysis graphics tool was found to be useful in messaging hazards across seasons. Continued leverage of web-based GIS applications across the NWS will further improve operational capabilities and increase the quality of IDSS provided to core partners.*

**14**

Evan Bentley

Should Severe Wind Criteria be the Same Across the CONUS?

*The National Weather Service (NWS) issues severe thunderstorm warnings for severe convection estimated to produce wind speeds of 58 mph or greater. This criterion is generally assumed to be the wind speed where wind damage, which may be a threat to life and property, starts to occur. However, similar wind speeds produce vastly different damaging impacts in different regions of the country, with vegetation and population differences being the primary reasons. This disconnect between established severe wind-speed criteria and impacts in some portions of the CONUS is well known by NWS forecasters, but has yet to be documented. This presentation will document the differences between widespread damaging-wind episodes in different regions around the CONUS and suggest where regional criteria may need to be modified based on these findings.*

**15**

Dan Bikos

VISIT / SHyMet training for operational forecasters on satellite imagery and products

*The Virtual Institute for Satellite Integration Training (VISIT) and Satellite Hydrology and Meteorology (SHyMet) training programs offer different types of training with a* *focus on operational usage of satellite imagery and products. Asynchronous training delivery methods include online videos, quick guides, quick briefs, job aids and blog entries. Synchronous training delivery methods include live webinars (see the presentation titled "FDTD Satellite Applications Webinars"_ at this conference) and teletraining which make use of a combination of software and VOIP that occurs at a scheduled time. The combination of synchronous and asynchronous distance learning methods reaches out to as broad an audience as possible. In the past year, there have been over 4,200 asynchronous training completions by NWS staff on the NOAA Commerce Learning Center (CLC) and 355 office attendees of synchronous training types. In recent years, VISIT / SHyMet developed a number of the modules in the Satellite Foundational course for GOES-R (SatFC-G) and JPSS (SatFC-J) courses. In the spring of 2020, the SHyMet Severe Thunderstorm debuted on the NOAA CLC. The course covers satellite imagery and products for operational forecasting and warning of severe thunderstorms. SHyMet courses are offered to NOAA employees via the NOAA CLC and to non-NOAA users via SHyMet web-pages. This presentation will summarize recent VISIT / SHyMet satellite training accomplishments and future plans.*

**16**

Brandon Black

The Forecast Challenges of Slow-moving and Intensifying Hurricane Sally

*On September 16, 2020, slow-moving Hurricane Sally made landfall causing significant wind and historic flood damage across the Weather Forecast Office Mobile's Area. Sally presented numerous forecast challenges in the days prior to landfall including a slow erratic track, and a period of rapid intensification through landfall. These characteristics resulted in significant impacts including several hours of winds in excess of 125 m/s (80 mph), rainfall amounts over 73 cm (29 in), and total water inundation up to 3 m (9 ft) across coastal Alabama and western Florida Panhandle.The goal of this review is to provide forecasters valuable information when forecasting wind and water impacts for slow-moving hurricanes. A detailed meteorological analysis will be performed to assess the factors that led to strengthening prior to landfall and potential model signals that could aid forecasters along the Gulf Coast.Conceptually, slow-moving hurricanes upwell water from below, leading to periods of little intensification or even slight weakening. However, Sally intensified significantly in the final ten hours through landfall despite this upwelling. We will explore two hypotheses on why Sally rapidly intensified. One hypothesis is that cold upwelling was limited by deeply mixed warm shelf waters. Deep mixed warm shelf waters were originally noted in a study by the Dauphin Island Sea Lab during Hurricane Michael on the influences of early season storms which downwell warm surface waters. This process would lead to reinforced warm water upwelling supportive of intensification. This hypothesis, if confirmed, would support new techniques for forecasters during slow-moving, intensifying Gulf tropical cyclones. A second hypothesis was the influences of an approaching upper trough leading to an increasing poleward jet. In a weak flow regime, slight influences by the approaching* *trough and a deeper storm could have led to a feedback loop impacting the intensity and track of the storm.*

**17**

Jon Bongard

Establishing a Climatology of Cold-air Damming Associated with the Ozark Plateau

*This presentation will focus on the creation and analysis of a micro-climatology of cold-air damming events brought about by the topographic influence of the Ozark Plateau. Cold-air damming is commonly associated with more robust (and linear) topographic elevations like the Southern Appalachians or the Front Range of the Rocky Mountains in the continental United States. This research stems from a case studied previously in which road conditions deteriorated rapidly along a stretch of Interstate 55 in northeast Arkansas in March 2014. The highway became inundated with ice and trapped vehicles and motorists on the interstate overnight. Synoptic and mesoscale conditions at that time lend evidence to the idea that the deteriorating road conditions were caused by cold-air damming. It is the goal of this study to quantify how and when the Ozark Plateau can also produce cold-air damming events. To accomplish this task, the study uses the surface observations present during the cold-air damming event in March 2014. The synoptic pattern along with other datasets including sounding data and appropriate cross-sections will also be considered for the climatology identification process. Surface data from other stations just east or southeast of Ozark Plateau are being analyzed over a 5-year period from January 2016 up through December 2020 in order to find dates of interest for possible cold-air damming. Similar days were identified for investigation of the synoptic pattern and vertical structure through sounding and cross section data; these were used to pinpoint cold-air damming events. Use of the Froude number, an investigative procedure often used by prior researchers will help to further identify and validate these events. This study will provide a dataset of the frequency of these events both annually and more specifically in which portions of the calendar year such cold-air damming events are stronger and more prominent for this region.*

**18**

Faith Borden

Transitioning the National Weather Service Student Volunteer Program into a Virtual Environment

*Despite the challenging work environment during the COVID-19 pandemic, the National Weather Service Forecast Office (NWS) in Nashville, TN welcomed three students as part of the 2020 student volunteer program. Candidates were selected from diverse disciplines to match NWS partners' needs, focusing on emergency management and social science, in addition to meteorology. Due to the uncertainty of*

*COVID-19, the volunteer internship was extended to the fall semester of 2020 and remained 100% virtual. NWS staff and students successfully adapted to collaborate on a number of virtual projects and training initiatives. This included creating mock briefings for emergency managers and developing individual capstone projects. Themes for each capstone project, whose benefits extend to the public and scientific communities, encompassed 911 reference guides, virtual school presentations, and river flood mapping. The students also participated in a lifelike, multi-day exercise that included key partners such as county emergency managers and state officials. To demonstrate interoffice collaboration, students worked with other student volunteers at NWS Louisville, KY during the exercise. While future student volunteers are expected to return to at least partial in-person learning, the experience of 2020 provided some tips and best practices for integrating virtual learning experiences into future student volunteer programs.*

**19**

Kandis Boyd

Research Operations Nexus (RON) - Connections and Collaborations

*This session will provide a summary of the 1st Virtual Research Operations Nexus (RON) held in December 2020. The RON is an annual occurrence at both the National Weather Association Meeting and the American Meteorological Society in which researchers and operationalists discuss emerging needs in the field of atmospheric science. As a result of the 2020 pandemic, the event was shifted to a virtual event. Greg Stumpf and Dr. Kandis Boyd spearheaded the event, which included coordinating with two organizations, securing a contract for the virtual platform, securing volunteers to serve as moderators, facilitators, and notetakers, and advertising the event. As a result, the effective use of technology resulted in the first Virtual RON. The event was a huge success with over 70+ attendees representing early career academics, private sector companies, and federal employees. The team will publish the prioritized list of atmospheric science priorities and present at future conferences*

**20**

Brian Brettschneider

An Evaluation of Medium Range Outlooks for Alaska

*Medium-range forecasts are especially important in Alaska. Many people live in, or travel to areas with limited or no connectivity. Opportunities to receive weather forecast information may only occur every few days and travel plans are made based on the categories shown on the Climate Prediction Center's (CPC's) 6-10 and 8-14 Day Outlooks for temperature and precipitation. These are the only official NOAA forecast products that cover the time periods between days 8 and 14. What are the utility of these forecasts in Alaska and how do their performances compare to the Contiguous*

*U.S. (Lower 48)? Heidke and Ranked Probability scores are currently available at the station-level for the Lower 48, but no scores are published for Alaska. This study uses maps and statistics to identify when the CPC's Alaska medium-range forecasts successfully capture large scale patterns, and when the forecasts provide maximum (and minimum) benefit.*

**21**

Brian Brong

Using Ensemble Based Tools to Message Snowfall Across Northern Nevada

*While synoptic patterns that produce heavy snow events across northern Nevada are easily recognized by forecasters, predicting significant snow accumulations remains a difficult problem due to the inherent variability in model solutions. Impacts can range from minor travel inconveniences to significant air and ground travel delays for peak commute hours and the growing logistics and distribution industry. A wide range of impacts raises some interesting messaging challenges to get the best information to partners and the public in a usable format and sometimes beyond the scope of a forecaster's confidence level. Ensemble based tools, including probabilistic snow forecasts, provide meteorologists with additional information to message snow accumulation possibilities even in situations with large forecast uncertainties. This opens new opportunities to meteorologists by allowing us to tailor our verbal and graphical messaging platforms to better meet the wide variety of partner thresholds. In this presentation we will examine how meteorologists used probabilistic snow information during two heavy snow events that occurred in northern Nevada on November 7th and 8th 2020.*

**22**

Matthew Brothers

Establishing Collaboration for Air Quality Alert Issuance for Wildfire Smoke in Wyoming

*During the summer of 2020, the National Weather Service (NWS) Weather Forecast Office in Cheyenne, Wyoming began issuing Air Quality Alerts (AQA) for wildfire smoke in collaboration with the Wyoming Department of Environmental Quality, Air Quality Division (WDEQ AQD) and the Wyoming Department of Health (WDH). Wildfire smoke can increase concentrations of fine inhalable particles with diameters of 2.5 micrometers and smaller (PM2.5) and be unhealthy for the elderly, young children, and individuals with preexisting respiratory and cardiac conditions. In extreme cases, air quality conditions can worsen and be unhealthy to all individuals with prolonged exposure. The goal of this collaboration was to increase the public's awareness when poor air quality develops across Wyoming due to wildfire smoke.Later on in the fire season, the Mullen Fire was ignited in the Savage Run Wilderness near the Snowy*

*Range west of Laramie, Wyoming. This fire burned 176,878 acres in Wyoming and Colorado combined and created poor air quality across portions of southeast Wyoming for multiple consecutive days. NWS Cheyenne issued AQAs at the request of WDEQ AQD and WDH every day from September 17th through October 12th for at least a portion of the County Warning Area. This presentation will focus on the efforts from the newly established partnership between the NWS, WDEQ AQD, and WDH to inform the public of poor air quality in Wyoming due to wildfire smoke and will also discuss the expanded collaboration between WDEQ AQD and WDH with all Wyoming NWS offices.*

**23**

Matthew Brothers

Random Forest Approach for Improving Non-Convective High Wind Forecasting Across Southeast Wyoming

*High winds are one of the key forecast challenges across southeast Wyoming. The unique terrain across the region frequently results in strong gap winds in localized areas, as well as more widespread bora and chinook winds in the cool season (October-April). The parameters and general weather patterns that result in strong winds across the region are well understood by local forecasters. Forecasters use low-level height gradients, winds aloft, omega fields and low-level lapse rates to identify such threats. However, no single parameter provides notable skill by itself in separating warning-level events from others. In this study, a random forest approach was developed to improve upon high wind prediction using a training dataset constructed of archived observations and model parameters from the North American Regional Reanalysis (NARR). Correlations and verification statistics were calculated for a variety of NARR parameters against the observed wind speeds. The Critical Success Index (CSI) was used extensively in determining which single parameters should be incorporated into the model. Initial results suggest this technique provides skill in identifying high wind events for two major gap wind areas in southeast Wyoming, and encourages the expansion of this technique to additional locations in the region. The Random Forest models are currently being tested with real-time GFS data, which will help to identify targets of opportunity for further improvements to the model. This presentation will also highlight the tools forecasters will be provided with during the initial implementation into real-time operations starting in Fall 2021 to increase forecaster confidence in predicting high wind events.*

**24**

Mark Burchfield

NWS Springfield and Lamar Billboard Partnership: Targeted messages to motorists

*Since 2017, The National Weather Service in Springfield has had a unique partnership with the local Lamar Advertising company that allows for the display of hazardous* *and life threatening weather information on their digital billboards around the Missouri Ozarks and Southeast Kansas. This partnership allows travelers to receive real-time high impact weather warnings and weather safety information via the digital billboards. The digital billboards are activated to display weather alerts for a variety of hazards including: Tornado, Flash Flood, Winter Storm and Excessive Heat Watches and Warnings. This information will automatically interrupt any other ongoing messages or advertisements. The messages also ask citizens to tune to a local radio station for more emergency updates and preparedness information. This messaging partnership directly ties into one of the goals of the NWS 2019-2022 Strategic Plan by reducing the impacts of weather, water and climate events. This is done by transforming the way people receive, understand and act on information. The ability to capture the attention of motorists and convey critical weather information is a key component of developing a Weather Ready Nation.This presentation will first explore the history of the partnership. The specific types of messages, how and when they are posted will then be discussed. Finally, the next steps and future goals of the messaging partnership will be examined.*

**25**

Mark Burchfield

Citizen Weather Observing Program: Creating a Missouri Ozarks Mesonet

*The Citizen Weather Observing Program (CWOP) started around the Summer of 2000. It is a unique partnership between the public and the Weather Enterprise with a main goal to collect and provide weather data for use in weather services. The CWOP partnership directly ties into one of the goals of the NWS 2019-2022 Strategic Plan by reducing the impacts of weather, water and climate events. This is done by increasing the observational dataset that can be used in the bias correction process of the numerical weather prediction (NWP) models. Bias correction is particularly valuable across the Missouri Ozarks given the complex terrain and microclimates. The availability of ground truth measurements to the Weather Enterprise during hazardous weather is also a key component of developing a Weather Ready Nation.The National Weather Service in Springfield has increased the number of CWOP stations across its County Warning Area (CWA) over the last several years from roughly a dozen stations in the early 2000's to nearly 75 stations as of early 2021. Almost every county in the Springfield CWA now has either a public, private or government observation site. A significant recruitment effort consisting of solicitations from the public and core partners was critical in increasing the number of stations across the Springfield CWA. Several references and guidelines were also developed to aid in the recruitment process and assist in the proper siting of weather stations. This presentation will first explore the overall process and history of CWOP as it pertains to the Springfield, MO CWA. The specific types of data, recruitment efforts and inclusion into the numerical weather prediction models will then be discussed. Finally, the next steps and future goals of the local CWOP partnership will be examined.*

**26**

Alec Butner

Applying FLASH to Assist in Flash Flood IBW Operations

*With the implementation of Flash Flood Impacted Based Warnings (IBW), it was found that additional guidance was needed for forecasters to quantify when and where to use the three tiers (Base, Considerable, and Catastrophic) of impact tags within Flash Flood Warnings. As a result, the NWS Office in Wakefield, VA initiated a study to investigate the probabilities of Flash Flood IBW type based on the Flooded Locations And Simulated Hydrographs (FLASH; Gourley et al. 2017) Coupled Routing and Excess STorage model (CREST; Wang et al 2011) Unit Streamflow) values. The findings from this study have been used to create a forecaster aide to enhance decision-making for Flash Flood IBWs. The study focuses specifically on the United States Mid-Atlantic region, east of the Appalachian Mountains, using NWS Storm Data from 2018 through 2020. Flash flood event times and locations were compared with CREST Unit Streamflow values within a 5 km radius. The 75th percentile CREST Unit Streamflow value was then catalogued for each specific event. Each flash flood event was then plotted and categorized by IBW type based on the guidance set by the national Flash Flood IBW team. Finally, each flash flooding event was categorized by USGS land use type, focusing primarily on urban and rural land types. Box and whisker diagrams were created for each IBW category for both rural and urban areas based on the 75th percentile CREST Unit Streamflow value for every point. The box and whisker diagrams help to increase forecaster confidence on when to issue each warning impact tag for each type of location, using FLASH. The results from this study have improved our local flash flood detection/warning services and can potentially be applied to other weather forecast offices across the United States.*

**27**

Timothy Cady

A Nationwide Climatology of Apparent Temperature to Enhance Heat Related Decision Support Services

*Heat-related illnesses remain the largest contributor to weather-related mortality across the United States, resulting in over 700 deaths per year on average between 2004 and 2018. In order to communicate the impacts of excessive heat, National Weather Service (NWS) forecasters issue Excessive Heat Warning and Heat Advisory products when the apparent temperature (AT) is expected to meet or exceed a locally defined threshold. The primary method used to calculate throughout the agency is the NWS Heat Index (NWSHI), developed by Rothfusz in 1990 as an adaptation of Steadman's initial 1979 AT model. Use of the NWSHI to develop local AT impact thresholds has enhanced heat-related decision support services across the agency. However, the index also assumes a constant wind and does not account for variations* *in solar radiation despite variations in each variable contributing to heat stress. Inclusion of a variable wind and solar radiation has a noticeable impact on the calculation of AT, especially in warm and humid climates. Both of these variables' contributions to AT were accounted for in subsequent refinements to Steadman's AT model in 1984.To compare the performance of the NWSHI and Steadman AT scales across a variety of climatological settings, we developed the first gridded climatology of apparent temperature for the entirety of the Continental United States using a 30-year subset of the North American Regional Reanalysis (NARR) dataset. By analyzing the resultant data on a monthly and daily level, we were able to identify regions where the use of the NWSHI may be insufficient for the characterization of heat risk. Ideally, this dataset could be used as a starting point for the creation of dynamic, climatology-based heat impact thresholds for locations across the country as opposed to the static threshold levels used by individual forecast offices.*

**28**

Brian Carcione

UAH-NWS Operational Classes: Enhancing and Expanding Interconnectivity in a Virtual World

*The University of Alabama in Huntsville (UAH) and the National Weather Service (NWS) forecast office in Huntsville have collaborated on a joint Operational Weather Forecasting class each fall semester since 2013. The class has focused on delivering Impact-Based Decision Support Services (IDSS) since 2016, with an end-of-course final exercise allowing students to demonstrate their skills in real time.Due to the COVID-19 pandemic, the 2020-21 UAH school year faced new challenges, as well as opportunities. Although Fall 2020 marked the highest participation yet by NWS Huntsville forecasters, transferring a course focused on teamwork and real-time problem solving to the virtual environment was challenging. Greater flexibility was required to give some communications topics more time. Limited computer access meant that acquiring real-time data for some forecasting topics required a different approach. The students succeeded despite these changes, capping off the course with an outstanding final exercise focused in the midwestern United States.During the Spring 2021 semester, UAH and NWS Huntsville offered a follow-on class for the first time entitled "Advanced Forecasting for Decision Support"_. The course explored IDSS on a deeper level, such as understanding partner needs for briefings, media interview strategies, and a virtual field trip to an emergency management office. The course also addressed emerging topics, such as ensemble forecasting and mesoanalysis, to prepare students for the multifaceted challenges facing the modern operational meteorologist.This presentation will discuss lessons learned and best practices from the new advanced-level course and the transition to virtual coursework.*

**29**

Eric Carpenter

The Graphical Hazardous Weather Outlook Verification System at WFO Jackson, MS

*Continuous verification, validation, and calibration of products and services is an important undertaking to support the NWS mission. Based on feedback from core partners of WFO Jackson MS, a highly regarded product is the Graphical Hazardous Weather Outlook (GHWO). The GHWO is an image that provides a wealth of information, detailing the what, where, and when of hazardous weather forecasts along with associated impacts. Over the years, the GHWO has been subjectively assessed, most often as part of after action reviews. This subjective review can be inefficient as it requires significant time to sift through data and correlate with numerous outlooks that can be issued for any particular event. Moreover, the findings can also be subjective as data can be selected for specific events and disregarded for others. WFO Jackson has developed an application that is capable of verifying the GHWO by using spatial techniques and calculating multiple metrics while maintaining traditional verification statistics. A formal, more objective, GHWO verification application represents a more proper verification methodology.The GHWO verification application methodology begins during the forecast process, when the application captures polygons delineating categorized levels of hazardous impact. Similarly, the application captures polygons delineating categorical exceedance of observed data from the Unrestricted Mesoscale Analysis (URMA). The visual component of the application allows a forecaster to compare the forecast and observed shapes. Additionally, the application computes and displays statistical metrics about the polygon shapes, such as the probability of detection, false alarm ratio, and critical success index. The presentation will include a demonstration of the capabilities of this application and initial verification results.*

**30**

Jonathan Case

Analyzing the Tropical Cyclone Diurnal Cycle with Satellite Rainfall Estimates and Lightning Data

*Tropical Cyclones (TCs) often exhibit a discernible diurnal signal in which the inner-core convection intensifies nocturnally and then expands outward during the daylight hours. The diurnal cycle can affect tropical cyclone structure, clouds and cloud-top changes, precipitation and lightning distribution, as well as boundary layer winds. This diurnal behavior can further complicate structural and intensity changes that are largely determined by environmental factors such as wind shear, sea surface temperature, and the Saharan Air Layer in the Atlantic basin. These TC characteristics are therefore important to understand when diagnosing the potential for rapid intensity changes.We developed methodologies for monitoring the spatial and* *temporal evolution of TCs using satellite precipitation estimates from the Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (IMERG)-Final, Late, and Early products and total lightning flash rates from the Geostationary Lightning Mapper aboard GOES-16. The methodology involves binning rainfall rates and lightning flashes into hourly (or finer, in the case of lightning) intervals and averaging azimuthally relative to the TC center. Results are displayed in both multi-day and diurnally-averaged hovmÃ¶ller diagrams, as well as by compass and shear-relative quadrants to understand the TC structural behavior in relation to the prevailing environmental wind shear. For the 2021 Atlantic hurricane season, we will generate near real-time hovmÃ¶ller diagrams as an experimental operational product that can be utilized by partnering operational entities (e.g., National Hurricane Center) for increased situational awareness and understanding of TC evolution. The longer-term research goal is to extend this analysis to numerous TCs across the globe in order to develop composite results and conceptual models that can improve our understanding of TC diurnal behavior.*

**31**

Kristen Cassady

A Mesoscale Analysis of High Wind Events In the Ohio Valley

*From autumn through spring, the Ohio Valley is susceptible to synoptic-scale high wind events that cause widespread damage and substantial economic losses. These events, usually initiated by the presence of a deep and compact vertically-cohesive low pressure system that traverses the region, often times yield a several-hour period of destructive wind gusts due to the presence and evolution of a favorable mesoscale environment which helps translate strong wind gusts from aloft to the surface. While these wind events are often viewed as non-convective in nature, there are often convective processes within the overall favorable synoptic-scale environment that help support, and ultimately dictate, the translation of damaging wind gusts to the ground over large areal expanses on the smaller temporal and spatial scales typically associated with thunderstorms.This project examined multiple high-impact wind events that occurred within the NWS Wilmington, Ohio service area from both a synoptic scale and mesoscale perspective. The analysis quantifies the unique characteristics of the boundary layer thermodynamic and kinematic environment evolution in order to better identify the circumstances that led to widespread severe wind gusts in the absence of traditional deep convection. Events from February 24, 2019, December 30, 2019, and November 15, 2020 were explored using surface observations, high-resolution model and reanalysis data, and RAOB soundings to isolate key conditions that contributed to the severity of each of these events. The differences and similarities between these events, including one which occurred in the absence of diurnally-driven heating, were explored to better understand the common factors that led to destructive wind gusts in all three cases. This study concludes with recommendations for better recognition of these enhanced wind environments ahead* *of time to promote increased lead time for proper messaging to core partners and communities alike.*

**32**

Jessica Chace

Lessons Learned During the Virtual Tennessee Valley Integrated Warning Team Workshop in 2021

*The Integrated Warning Team (IWT), consisting of the NWS, emergency managers, broadcast meteorologists, key decision makers, and other partners with a role in public safety, is an essential component of the weather enterprise and critical to the National Weather Service's (NWS) mission to protect life and property. It is a common practice for local NWS forecast offices to hold regular IWT workshops to maintain the collaborative relationship amongst different sectors for public safety.On 3 February 2021, the NWS Huntsville office hosted its first IWT workshop in almost four years. The circumstances surrounding the COVID-19 pandemic precluded an in-person workshop and resulted in the need to plan and host a virtual IWT workshop. To ensure that the concerns of all partners were addressed, the NWS Huntsville office included partners across the weather enterprise in the Tennessee Valley in planning this workshop. The goals of the IWT workshop were to prioritize teaching, learning, and engaging other participants, rather than more passively viewing one-way presentations. By limiting the number of presentations, the majority of the IWT consisted of panel discussions and breakout groups. To support the theme of "Enhancing open communication and transparency for consistent threat messaging,"_ session topics included discussing 'rapidly evolving weather threats' and 'how best to message flooding as a secondary threat.' Partner feedback from the workshop was overwhelmingly positive. Dr. Jack Friedman of the University of Oklahoma remarked, "I am amazed (though, not surprised) by the depth of the engagement that you have fostered with your community of partners. This was such an incredibly productive conversation and it was clear how much everybody appreciated it."_ This presentation will highlight some of these best practices learned from hosting the virtual 2021 Tennessee Valley IWT Workshop, to maximize the involvement of external partners attending virtually.*

**33**

Alex Cheung

The Radius of Utility for Identifying Snow Squalls with Radar

*When snow squalls occur over highways and interstates, heavy snow combined with icy road conditions can make roadways treacherous and lead to multi-vehicle accidents. To alert the public of imminent danger to life and property, the National Weather Service issues Snow Squall Warnings when snow squalls are detected. Due to their shallow depth of generally 3 to 4 km, snow squalls are difficult to detect when* *they are located far from a radar. Operational meteorologists utilize other remote and in-situ observations, such as satellite imagery, automated weather observations, and traffic cameras, to fill the observation void when snow squalls occur in gaps without sufficient radar coverage. The main objectives of this study are to better understand the radius in which radar can detect snow squalls, and to document the range of radar reflectivity values associated with snow squalls that led to multi-vehicle pileups.To develop a radius of radar utility, the reflectivity values at the sites of dozens of multi-vehicle pileups in Pennsylvania caused by snow squalls were recorded. These reflectivity values were then statistically examined in bulk. Afterwards, a relationship between how reflectivity varies with the distance of the precipitation from the radar was developed. This relationship will be used to inform operational meteorologists of the radius at which radar utility drops dramatically as the radar beam overshoots snow squalls. In addition, bulk statistics of radar reflectivity associated with high-impact snow squalls occurring within the radius of maximum radar utility will be used to inform operational meteorologists of the mean, median, and variance of radar reflectivity associated with high-impact snow squalls.*

**34**

Hui-Ya Chuang

Operational upgrades and re-engineering efforts of NCEP's Unified Post Processor (UPP)

*NCEP's Unified Post Processor (UPP) was developed at the NOAA Environmental Modeling Center (EMC) to support post processing of all NCEP's Operational Environmental Prediction Models, including GFS, GEFS, NAM, RAP/HRRR, SREF, HWRF, and CFS. Through collaboration with NCAR DTC, UPP has been distributed to the broader meteorological community to be used as a Community Post Processor to facilitate R2O and O2R on post processing algorithms.With NOAA's strategic plan to unify all modeling suites toward the FV3 based Unified Forecast System (UFS), UPP has been continuously upgraded to support the transitions of all applications while maintaining backward compatibility to legacy modeling systems prior to their retirements. The upgrades include adding new products such as GFS synthetic radar reflectivity, updating the I/O algorithms to new model output formats, updating the GFS and RRFS models to run with in-line post processing to save total run time, and tuning existing post processing algorithms to new the FV3 dynamic core and microphysics algorithms.Simultaneously, EMC also started its much needed effort to re-engineer the UPP software system. A two phased approach was planned with phase 1 focused on cleaning up, modernizing, and modularizing the code, while phase 2 focused on unification and improving efficiency through further parallelization. The phase 1 effort finished on schedule in December 2020 and a cleaned-up, modernized, and modularized UPP version 10.0.2 was released in January 2021. This presentation will 1) briefly introduce UPP functionality, 2) discuss all recent and upcoming operational post processing upgrades with more details focused on GFS V15, GFS V16, and RRFS and 3) UPP re-engineering plans and progresses.*

**35**

Alyssa Clements

Understanding the Biases of National Blend of Models in the Southern Rockies and High Plains

*The National Blend of Models (NBM) is becoming an integral part of the National Weather Service's (NWS) forecast operations. Understanding the NBM's biases helps forecasters improve NWS forecasts and enhance decision support services. While this highly calibrated forecast guidance has several advantages, there are weather events in a NWS's County Warning Area (CWA) where the forecaster can improve on NBM guidance. Through extensive analysis, forecasters determined the timing of frontal passages may serve as a significant target of opportunity in the forecast process, particularly for backdoor cold fronts that move south and west through the southern High Plains. Every cold front that impacted our CWA from December 2019 to February 2021 was compared against the NBM guidance to identify its frontal passage timing bias. Our study reveals the NBM to be consistently too slow with moving backdoor fronts through the CWA. Having learned this bias, forecasters are now able to apply gridded forecast corrections using the new NBM V4.0 probabilistic datasets to reduce this bias in forecasts. Similarly, biases in the NBM fire weather forecast variables (i.e., mixing heights and transport winds) were assessed and potential targets for gridded improvements were identified. To determine the performance of the NBM across parts of the southern Rockies and southern High Plains, these fire weather forecast variables were analyzed and compared against the 00Z observed upper air soundings. The NBM performs relatively well when mixing heights and transport winds are near seasonal normals; however, the NBM struggles during inclement weather patterns, such as strong wind and/or precipitation events related to the passage of storm systems. While our study focused on the southern Rockies and southern High Plains, similar research could be applied to other areas of the country to better identify targets of opportunity with the NBM guidance.*

**36**

Leslie Colin

Deriving Probability of Precipitation (PoP) Grids Directly from Model QPF Grids

*New NWS forecasting methods emphasize an ensemble approach to forecasting weather elements over deterministic single-valued methods. The new methods offer ranges of values and their probabilities of occurrence. But PoP (probability of precipitation) is already a probability and the ensemble approach here amounts to forecasting the probability of a probability. For this weather "element", therefore, deterministic forecasting still has value.This article explains a method for producing PoP grids directly from a set of model quantitative-precipitation-forecast (QPF) grids* *using a database of past model forecast grids and observed precipitation (QPE) grids.Given N models, where M of them forecast at least q precipitation, what should the minimum PoP be? For example, if among 10 models 5 of them forecast >= .05 inch precipitation, should the minimum PoP be greater than if all 10 models forecast >= .01 inch? The various combinations of number of models and threshold amounts can all be tested using the historical database. It doesn't matter which models forecast which amounts; the only question is how many of them forecast at least q precipitation. The combination corresponding to the most frequent occurrence of >=.01 inch in the past would determine the minimum PoP. A similar argument would determine the maximum PoP The final PoP would be a number between them. The final values would populate a grid, i.e., a PoP grid. Once the relationships are known (from the historical database) they can be re-used without being recalculated. . The resulting PoP grids can be verified using Brier scores related to QPE grids also stored in the database. The calculated PoPs should outperform (have lower Brier scores) than any single model PoP (if it exists) or model-average PoP . We also hope to output the relationship governing how many models are needed together with a threshold QPF, to produce any PoP.*

**37**

Michael Convey

Supporting Broadcast Meteorologists' Remote Workflows

*During this COVID-19 pandemic, meteorologists were faced with the herculean task of broadcasting outside of the studio within a moment's notice. To help ensure business continuity and keep viewers informed, access to solutions that allow for remote work is crucial. One such solution is their main weather presentation tool. Max and Prism workstations can be accessed remotely from home or other remote sites. Tools like TeamViewer or Splashtop alongside Max can be used for video streaming or to get audio from a local microphone to be heard by the Max application. Meteorologists successfully used these solutions to create engaging weather content from inside their home or even in their backyard. Meteorologists that have Max Reality were also able to layer in augmented reality elements such as a 5-day forecast rising from their living room floor to wind particles immersing the meteorologist on his patio. And Max Connect, a weather app for iPads, could be used for show control, telestration, to pan and zoom maps, and to select preset drawing and query tools all to create even better storytelling.Finally, meteorologists needed to post content not only for TV, but on digital channels, so solutions like Max Engage with Watson eased their workflow by allowing them to set up weather or traffic triggers. Once the thresholds were met, digital content was automatically created, geo-targeted and distributed via mobile, social and web to impacted users. Knowing now what they could do outside the studio will forever change their work life. During severe weather, one met could be in the studio doing wall-to-wall coverage while another met could be at home managing the digital content. No longer does a met need to come into the station on a weekend. A hit* *can be recorded from the backyard. Not only do these tools streamline their workflow, but they also help them achieve their overall mission of keeping their audience safe.*

**38**

Doug Cramer

Correlating National Water Model Data with Overtopping Flows along State Highways

*Flash flooding poses a significant danger to citizens across the Missouri Ozarks. Since 1994, nearly 70 flood fatalities and thousands of swift water rescues have occurred in the National Weather Service (NWS) Springfield, MO County Warning Area. The vast majority of the fatalities involve motor vehicles traversing flooded low water crossings (LWCs). Terrain complexities, small basin sizes, and the high number of LWCs in the Springfield CWA amplify the difficulty of diagnosing when roads will become impassable during flash flooding. In late 2018, NWS Springfield launched a Flood Diagnostic Innovation Project (FDIP) which has made tremendous progress in diagnosing the most sensitive and vulnerable flood points across WFO Springfield's 34 Missouri counties through the identification and cataloging of 346 flood points along roadways. The next phase of this project has entailed the development of a partnership with the National Water Center (NWC) and the Missouri Department of Transportation (MODOT) to develop capabilities to forecast overtopping of state highways associated with headwater streams with no gauging. Ideally, increasing probabilities of a LWC which may experience flooding are conveyed to partners for risk mitigation purposes such as the barricading of roadways. Correlating National Water Model (NWM) forecast flows and crest re-analysis flows have been examined to determine whether or not they show skill regarding the potential for low water crossings to be overtopped. This presentation will largely discuss methodologies and results applying the NWM for LWCs along 18 Missouri highways. We will also briefly examine the partnership between the NWC, MODOT, and NWS Springfield and it's value toward diagnosing flooded highways.*

**39**

Austin Cross

AviationWeather.gov Enhancements and Roadmap

*The Aviation Weather Center (AWC) is part of the US National Weather Service, providing domestic and global aviation weather forecasts and warnings. Forecasters from AWC and across the NWS as well as automated systems disseminate up-to-date aviation weather information through AviationWeather.gov. AWC is continually working to improve the site, providing better impact-based decision support services to the aviation and weather communities. Recent enhancements to the site include continually expanding geographic coverage of the highly popular Graphical Forecasts* *for Aviation and improved ceiling and visibility guidance. This talk will discuss the site, current developments, and future plans.*

**40**

Julie Cunningham

Orographic Spillover and Invigoration of Lake-Effect Precipitation Downwind of Lake Ontario

*The spatial distribution of lake-effect precipitation downwind of Lake Ontario can be influenced by several orographic effects including spillover across the Tug Hill Plateau, a lee-shadow effect over the Black River Valley, and invigoration/persistence over the western Adirondack Mountains. The purpose of this study is to determine factors that influence the strength of these effects. To do this, we use radar-derived precipitation estimates from the Montague/Ft. Drum, New York (KTYX) WSR-88D for eight cool seasons (16 November -- 15 April) during 2012-20 and develop methods to quantify each effect. Environmental factors affecting the strength of each effect are examined using the ERA-5 reanalysis. Results are presented and may be useful for improving numerical weather prediction and operational forecasts in the region.*

**41**

Jason Davis

Evaluation of the HREF's Utility for Day 2 Forecasts of Severe Convection in Central Alabama

*The Day 2 Storm Prediction Center (SPC) Convective Outlook is a key decision support services tool to assist core partners in making proactive decisions on matters such as school cancellations in advance of severe weather events. In addition, the Day 2 Outlook is also used by emergency managers, NWS offices, and broadcast meteorologists to set staffing levels. The High Resolution Ensemble Forecast (HREF) system is comprised of several CAMs with various physics packages, and includes time-lagged members. In April 2019, the forecast length of the SPC's HREF viewer was extended to 48 hours, and some of the individual HREF members have provided forecasts out to 48 hours for several years prior. Many studies have focused on the utility of convection-allowing models (CAMs) in the Day 1 period with relatively less research regarding their performance during the Day 2 period, when predictability typically decreases. This study will provide a qualitative assessment of environmental parameters, simulated reflectivity, updraft helicity forecasts, and calibrated severe weather probabilities provided by the HREF. Assessments will be shown for both the ensemble mean values and individual members, with a focus primarily on events impacting Central Alabama, though results should be applicable to severe weather events across the entire Southeast region. HREF forecasts will also be compared with forecasts by a non-convection-allowing mesoscale model, the North American*

*Mesoscale (NAM) model, to indicate which is more useful to drive better science-based outlook collaboration between the SPC and local forecast offices.*

**42**

Aaron Davis

Exploring Simulated Tornado Probability and Supplemental Low WSR-88D Scans to Improve Warnings

*In August of 2019, a National Weather Service Weather Forecast Office in the southeastern United States began to use a supplemental elevation angle lower than the traditional 0.5Â° base elevation angle for the Weather Surveillance Radar (WSR-88D), in an effort to improve convective warning performance. The new 0.3Â° lowest elevation angle has a center beam height that is approximately 300m closer to the ground than the 0.5Â° angle at a range of 100km in normal atmospheric conditions.This study will detail an ongoing evaluation of the potential for tornado warning skill improvement when using the new 0.3Â° elevation angle in concert with insights from a web-based application called 'œSimulated Tornado Probability and Wind Speed'�, made available in 2018. This application uses multiple regression-based models, based on a robust radar circulation and environmental assessment database, to provide probabilities of tornadoes. Our method involves aggregating tool output using lowest elevation angle data in the 10 minutes preceding initial tornado warning decisions, and also in advance of documented tornadoes, from the start of the dual polarization upgrade (spring 2013) through the spring of 2021. We will provide details on simulated tornado probability trends prior to both tornado warning issuance and tornado occurrence in different convective regimes (supercell versus quasi-linear convective system) and will also offer insight on warning forecaster biases in the different regimes. Finally, a closer comparison of probabilities associated with the 0.3Â° and 0.5Â° data since the fall of 2019 will clarify the operational value of the new data and suggest training avenues to ensure forecasters are taking advantage of this potential gain in skill for the issuance of more timely and accurate tornado warnings.*

**43**

Robert Deal

Using a Neural Network to Forecast Wind Gusts

*Forecasts of wind gusts are of great importance to both the general public and numerous core partners of the National Weather Service (NWS) including emergency managers and the fire weather and marine communities. Unfortunately, wind gust forecasts are routinely one of the poorest verifying elements that NWS offices produce, as many forecast models do not explicitly produce a wind gust grid element. Consequently, the NWS currently utilizes several different methodologies to calculate* *wind gust by proxy from numerical weather prediction (NWP) output. These methodologies range from simple techniques which apply a flat multiplicative factor to the forecast sustained winds, to more complex techniques which factor in boundary layer stability and utilize the mean wind in the mixed layer. While these methodologies can produce decent approximations in certain situations, they routinely fail to produce consistently accurate forecasts. Given the limitations of both raw NWP wind output and the current suite of wind gust approximations, we utilize machine learning (ML) techniques to produce an alternative means of producing wind gust forecasts. ML is becoming increasingly utilized to solve data-driven scientific problems and given an abundance of historical wind and wind gust data, the task of forecasting wind gusts is a particularly well-suited problem for ML. This study utilizes a number of location-specific neural network regressors trained with NWP and observational data to forecast wind gusts at temporal ranges up to 84 hours. We then compare the prediction accuracy from the neural network with results obtained via an exponential regression model developed by Dr Greg Mann at NWS Detroit, and a flat multiplicative factor technique (Kahl, 2020).*

**44**

Perry Dehne

Case Study: Severe Mountain-Wave Turbulence through the Sierra Nevada and Carson Range Mountains

*This talk will present a case study of a severe turbulence event which occurred through the Sierra Nevada and Carson Range mountains region on February 9th, 2020. There were two main dynamic drivers of this event. The first was a cut-off low in northern California, and the second was strong northeasterly cross-barrier wind through the northern Sierra Nevada and Carson Range mountains. Together, these atmospheric dynamics interacted with the mountains and resulted in 23 severe turbulence pilot reports. The two primary goals of this case study were to better understand the underlying dynamics that led to the severe mountain-wave turbulence, and what model(s) best handled the event. The vertical velocity and the potential temperatures from the WRF-3km were analyzed to highlight characteristics of the hydraulic jump region, vertically propagating wave, and the antecedent static stability within the vertical profile of this mountain waves. This analysis demonstrates the importance of using high-resolution data cross-sections in an operational setting. This capability can significantly enhance our ability to predict severe mountain-wave turbulence, increase lead-times on aviation warnings and enhance the safety of the aviation community.*

**45**

Joe DeLizio

An ArcGIS Online (AGOL) Web-Mapping Application for Analyzing Winter Weather Potential

*Forecasting wintry weather and heavy snow is particularly challenging across portions of the Intermountain West; true not only from an operational forecasting perspective, but also maintaining good situational awareness. Esri's ArcGIS Online (AGOL) cloud-based technology helps improve both of these aspects. For these reasons, a vision for an 'EPZ Winter Weather Dashboard' was born, which would combine all the necessary resources for the meteorologist to maintain and improve situational awareness of the evolving winter environment. This dashboard tool was built to be beneficial for both current conditions, and also for short-term forecasting as it includes real time mesoscale analysis and high resolution model guidance out to day three. Using the dashboard, we can better communicate hazards and impacts in a timely manner to fellow meteorologists on shift, partners, and the public. This information is supplemented within the dashboard with a regionally-focused winter weather reference guide and training materials, which make it not only advantageous for current employees, but for newcomers to the area trying to become familiar with its associated winter weather patterns. Furthermore, the recent implementation of remote operations support brought a need for easily accessible web-based applications. The EPZ Winter Weather Dashboard fulfills this need by enhancing Impact Based Decision Support Services, either remotely or an on-site deployment.*

**46**

Connor Dennhardt

Operational Impacts to the Southwest U.S. Airspace from Convective Activity within the Newman Gap

*The Newman Gap is a narrow region of open airspace located between the U.S/Mexico border and the nearly 6,000 square miles of restricted military airspace operated by White Sands Missile Range (WSMR) in southern New Mexico. This 20-mile wide gap, residing primarily over the city of El Paso, Texas and KELP Terminal Radar Approach Control, is a choke point in public aviation airspace for the southern U.S. commonly utilized as a prominent commercial flight path. This constraint causes a convergence of cruising flights through a narrow passage in an effort to save money and time. Periodically issued security NOTAMs along the Rio Grande valley in far west Texas further limits the available airspace for east/west bound air traffic in this region of the southern United States.Weather events such as supercells and mesoscale convective systems that prevent air traffic from flowing through this gap are particularly impactful and can cause major disruptions to air traffic and economic impacts to airlines. Redirecting flights northward over ABQ causes delays for current and future* *flights as well as incurring additional fuel use. Overflight fees are charged when US-based flights cross into Mexico, with costs increasing by the kilometer. This project will analyze the operational impacts of convective weather over the Newman Gap airspace as it pertains to air traffic control and commercial flight costs. A brief climatology of SIGMET issuance over KELP will be explored. ARTCC Standard Operating Procedures (SOP) will be explained and simulated for scenarios when the Newman Gap airspace is unavailable. Lastly, this study will add to the situational awareness of NWS forecasters at WFO EPZ, CWSU ZAB, and the Aviation Weather Center by detailing how TAFs, CWAs, and SIGMETs are used by the FAA and pilots in flight path decision-making.*

**47**

Richard Diegan

Developing a Forecast Advisor Tool in ESRI's AGOL for WFO Operations

*Situational awareness (SA) remains key in managing large amounts of data that are available to forecasters. Furthermore, SA can become degraded in times of extreme stress that accompany high-impact weather events. As Impact-based Decision Support Services (IDSS) continues to expand across the National Weather Service, SA is becoming increasingly important to be able to provide weather, water, and climate information to core partners. Utilizing ESRI's ArcGIS (AGOL) platform available in NOAA GeoPlatform, as well as the AWIPS Data Access Framework (DAF), a dashboard was created to increase the SA in an internal setting for operational meteorologists. The DAF extracts forecast model data at different latitude and longitude points that is then evaluated for potential weather hazards. The model data is evaluated for the potential of severe weather, heavy rain, synoptic high winds, snowfall, orographic induced snow, fire weather, etc. The output of these evaluations are displayed on the AGOL FA for each model forecast time and highlighted using a color threshold scale. The objectives of the AGOL Forecast Advisor are the following: Improve the ability to maintain SA of potential weather hazards through the forecast period, Ability to quickly spin-up SA on potential weather hazards that will affect the upcoming Decision Support Services (DSS) period, and highlight forecaster's attention to periods that may require additional forecast interrogation.This presentation will demonstrate the utilization of this application in operations.*

**48**

Evan Direnzo

Trouble is More Than a Name: The Meteorology Behind the East Troublesome Fire

*The East Troublesome Fire in Grand County, CO was first reported on October 14, 2020, and was declared contained on November 30, 2020 at a total of 192,457 acres. This poster will focus on the meteorology and fuel conditions that lead to an extreme period of growth that began the afternoon of October 21 and ended with a fall snow* *storm on October 24 2020. This is a companion paper to the one by lead author Greg Hanson, which focused mainly on the novel aspects of IDSS for this fire.Extremely dry (and/or dead) fuels were in place due to exceptional drought conditions across the west slope of the Colorado Rocky Mountains by mid-autumn. With fuels primed for explosive growth, this combined with high winds, warm temperatures, and low humidity to cause an ideal environment for rapid growth of the fire beginning on October 21, which continued through the night and into October 22. The fire exploded, increasing its size ten-fold from 18,550 acres to 187,964 acres during this period, including leaping across nearly 5 miles of rocky tundra on the Continental Divide. Large scale pressure gradient induced-surface winds gusting well over 50 mph fed the fire, and the fire itself generated a pyrocumulus 'storm' that extended well over 40,000 ft. When this storm collapsed, evidence of high-end straight-line wind damage was found with estimated gusts over 100 mph which forced the fire east-northeastward at an extreme pace. This study will explore the pyrocumulus and ensuing microburst from radar, satellite, and lighting detection platforms as well as the impacts at the ground and on fire behavior.*

**49**

Jennifer Dunn

An Analysis of Communication Using Social Media during the Historic February 2021 Texas Winter Storm

*In February 2021, Texas was impacted by a historic winter storm. Nearly the entire state was adversely affected by the record-breaking cold temperatures that had not occurred in over 30 years. Power outages and burst pipes occurred from the extreme cold. Additionally, snow and ice crippled transportation and distribution of essential supplies. In comparison to severe storm events that usually only impact a localized population, this event was unique in that it impacted virtually every person in North and Central Texas. The National Weather Service's Weather Forecast Office in Fort Worth-Dallas (WFO FWD) began messaging the winter event and its potential impacts up to five days in advance of the coldest air settling into the region. To further enhance the messaging that was being conveyed through standard NWS text products, WFO FWD leveraged social media to assist in disseminating information about the upcoming threats and shared public preparedness actions to take before the worst of the storm arrived. Social science research has given meteorologists many insights into how to message severe weather and tropical systems leading up to an event, but this study will explore unique challenges in messaging winter weather events, especially in southern climates. This presentation will be an in-depth review of the numerous social media posts made by WFO FWD during this extended winter weather event. We will analyze responses to forecast and preparedness graphics, timing of certain messages, message amplification, as well as the reception and interpretation of unique and novel probabilistic graphics. We will compare and contrast the results of our winter weather event messaging study with the recommendations for messaging severe weather and tropical events. From the results of our analysis, we will provide social media* *recommendations to amplify a message and enhance communication and services to the public and partners before and during a winter weather event.*

**50**

Scott Elmore

Multiple Ways of Receiving False Alarms: Is Poor Tornado Warning Accuracy Causing More Fatalities?

*An examination of tornado warning accuracy has resulted in correlations being drawn between National Weather Service (NWS) Offices that have low tornado warning verification rates or high numbers of false alarms and the number of tornado fatalities that occurred in the corresponding offices' County Warning Area (CWA). For this study, tornado warning statistics (how many tornado warnings were issued versus how many verified) were compiled for each NWS Office during the years of 2014 to 2020. Tornado warning verification rates and the number of false alarms, defined as a tornado warning that did not verify, were then computed for each office. Next, every tornado fatality location was examined to determine in which NWS Office's CWA the fatality occurred. These fatality numbers were computed for all NWS Offices and showed that 37 NWS Offices had observed a tornado fatality during the given period. NWS Offices were then ranked in order based on tornado warning verification rate, number of false alarms issued, and the number of tornado fatalities that occurred in their CWA. Those NWS Offices that did not average issuing at least ten tornado warnings per year during the studied period were not included in the rankings which resulted in a ranking sample set of 72 NWS Offices. From 2014 to 2020, tornado warnings issued by all NWS Offices verified 25.59% of the time and resulted in 12,097 false alarms. Ten NWS Offices that ranked in the top 15 of tornado fatalities also ranked in the top 15 of most false alarms issued. Nine NWS Offices that ranked in the top 15 of tornado fatalities also have a tornado warning verification rate below the overall NWS average for the studied period. Six NWS Offices met the criteria of both aforementioned statements, including all three NWS Offices in Louisiana. All NWS Offices that ranked in the top 15 of tornado fatalities and had at least one fatality for 4 or more years of the study were also in the top 15 of most false alarms issued.*

**51**

Sean Ernst

Cracking the TORFF Code: Testing an AI Coding Scheme on Broadcaster Coverage of TORFF Events

*Simultaneous Tornado and Flash Flood (TORFF) events are difficult to message and potentially deadly threats that occur throughout the year in the contiguous US. As the primary source of weather information for the general public, the burden of communicating the threat from these events falls on the shoulders of broadcast* *meteorologists, though studying broadcaster communication can be extremely time- and resource-intensive. In this study, we seek to develop a deterministic coding model that can automatically analyze transcribed broadcaster coverage using labeling functions derived from a scheme developed by researchers. As an early test of the efficacy of this model and coding scheme, we apply the system to coding broadcaster coverage of TORFF events, specifically to define how often broadcasters cover on air flood and tornado threats and compare those coverage rates across time, location, and event type. Findings suggest that the deterministic model can code broadcaster coverage without human intervention for some of the hazard codes, although continued training of the model will improve its output for hazards including hail. The model's output reveals that broadcasters heavily favor coverage of tornadoes over flooding during TORFF events, especially those caused by supercell thunderstorms versus tropical storms. These results suggest that broadcaster coverage can be efficiently interrogated with this coding scheme, and that broadcaster coverage during TORFFs is biased towards the more sensational threat posed by tornadoes. Future work will seek to identify what actions and impacts broadcasters focus on during these TORFF events, as well as to analyze more TORFF events to confirm these findings with a larger sample.*

**52**

Madeline Est

The Impact of NH Flow Regime Transitions and Blocking on Central USA Weather: Winter 2019 and 2021

*The Impact of NH Flow Regime Transitions and Blocking on Central USA Weather: Winter 2019 and 2021. Studies have shown that maxima in the time series of Northern Hemisphere (NH) Integrated Enstrophy (IE) can be associated with large-scale flow regime transitions and often, the onset and decay of blocking events. Others have demonstrated that IE maxima can be identified in ensemble model forecasts as much as 10 days in advance. During February and March 2019, and then February 2021, strong IE maxima were associated with changes in the NH flow regimes that brought very cold conditions to the central United States. These colder conditions also were associated with very strong Pacific or Atlantic Region blocking events. Using the NCEP re-analyses, three different teleconnection indexes, and surface temperature data from six different cities in the central USA, these IE maxima and flow regime transitions are identified. The maximum, minimum temperature and precipitation characteristics for these cities during the different large-scale flow regime characteristics are determined. The results will demonstrate that relatively warm conditions occurred through the first part of February 2019 before a period of anomalously colder (as much as 20o F below normal) and drier weather, with more snow, persisted into early March. This period was bookended by major changes in the NH IE time series and a strong simultaneous NH blocking episode. Following this period, the temperature regime returned to values that were closer to normal. In 2021, the results were similar and a strong stratospheric warming event and polar vortex intrusion caused record* *cold over much of the United States from the Rockies to the Appalachians. Finally, these flow regime changes were anticipated well by an ensemble model.*

**53**

Michael Evans

High-impact model biased right of track winter storms in the northeast United States

*Forecasters making predictions of snowfall and other storm-related impacts associated with winter storms along the northeast U.S. coast rely on accurate model forecasts of cyclone tracks. Over the past several years, several notable storms have occurred in this area that exhibited a right of track model forecast error, meaning that the model forecast cyclone track was to the right of what was observed. This error can contribute to heavy snow farther north and west than forecast, and the observed rain / snow line being north and west of the forecast. These recent storms have led many forecasters to believe that this right of track error is a consistent characteristic of model forecasts in this area, however recent research on forecasts from the Global Ensemble Forecast System (GEFS) showed no overall tendency for right of track errors vs. other types of error for a large dataset of storms. However, a review of high-impact winter storms along the northeast coast of the United States indicates that a significant subset of these storms is characterized by right of track model forecast errors, and anything that would help forecasters to identify these storms in advance would be beneficial. This presentation will summarize results from a study of high-impact east coast storms characterized by a right of track error in the GEFS forecasts. Forecasts vs. observations will be shown for several cases, and impacts from these events will be summarized. A composite analysis from the North American Regional Reanalysis shows that these events are typically Miller A storms, characterized by a strong southern branch jet stream. It is hypothesized that reduced static stability and convection over the southeastern United States in advance of these storms may be one factor that leads to right of track errors. Finally, factors responsible for errors in model placement of heavy snowfall other than lower-tropospheric storm track will be examined.*

**54**

Jeffry Evans

An overview of surveying storm surge during the 2020 hurricane season in the western Gulf of Mexico

*How high did the surge get?' That simple question is not so simple to answer. While the impacts/damage from storm surge after a tropical cyclone are essential to document, determining how high the water actually rose is often more difficult. This has become even more critical as modeling and warnings for surge evolve; accurate post-storm* *verification of high-water marks (HWM) will become critical in improving our science and service for future events. This presentation will illustrate how a small team from the NWS and the Harris County Flood Control District (HCFCD) addressed a variety of technical and logistical challenges to collect accurate HWM. These HWM were collected both as a fixed datum and as above ground level (AGL) after 4 tropical cyclones in the western Gulf of Mexico during 2020. This prototype team is an example for how the agency may operate in collecting HWM from storm surge in the future under the Coastal Act expected to become law in 2021.Measuring HWM has been a challenge for many years. Historically, the NWS would identify HWM to be later measured by partner agencies (such as the USGS) who would determine the elevation of a HWM above a datum like NAVD88 or MSL. However, social science studies have led the NWS to forecast storm surge in AGL to simplify the life-threatening message. This adds the complex challenge of determining HWM in AGL. We will show examples of what constitutes 'ground level' can be very site specific. This is especially true when there is not a clear mark within a structure or the impacted structures are lifted above the surrounding area on stilts or mounded earth. Other challenges include determining AGL levels above a sea wall or along the open beach, separating out still water HWM from waves, and the many logistical challenges that have to be planned for.*

**55**

Alex Ferguson

Effects of Non-Meteorological Factors on Severe Thunderstorm Warning Performance

*Severe weather warnings are intended to alert the public of imminent threats to life and property. While there has been research into how tornado warning verification varies by time of year and time of day, a similar study has not been conducted for severe thunderstorm warnings (SVRs), which make up the majority of convective warnings issued across the continental United States (CONUS). By exploring SVR verification, we aim to identify performance issues so National Weather Service (NWS) meteorologists can focus training and future research to improve SVR warning services. Our study shows how SVR performance varies by time (hour, month, and season), population density, climatic region, and distance from the nearest WSR-88D. We evaluated nine years of warnings and events (2010-2018), dating back to the last change in SVR criteria, the switch from 1.9 cm (0.75 inch) to 2.5 cm (1 inch) hail. Our initial results showed that wind probability of detection (POD) lagged behind hail POD across the CONUS. Critical success index (CSI) exhibited a diurnal trend regardless of region, with lower values during the nighttime hours and a peak in CSI during the late afternoon. CSI fell as distance from the nearest radar increased, largely due to wind event POD, which fell from 0.81 within 40 km of the nearest radar to 0.60 at ranges greater than 240 km. Average CSI was 0.46, with higher than average values in the Northern Rockies and Plains, Upper Midwest, Ohio Valley, Southeast, and Northeast and lower than average values in the Northwest, West, Southwest, and South. We will* *expand our results to use the Impact-Based Warning (IBW) tags in SVRs, which began in some NWS regions as early as 2010 and nationwide in 2015, which allow the NWS to warn for severe hail, wind, or both. By using the IBW tags, we will calculate CSI for hail and wind separately.*

**56**

Paul Fitzsimmons

Utilization of a Winter Storm Checklist for the December 16-17, 2020 Winter Storm

*On December 16th, 2020 a Nor'easter affected the mid-Atlantic urban corridor, bringing a quick 4 to 8 inches of snowfall. Most of the snow fell over a period of just a few hours around the evening commute, with snowfall rates of 1 to 2 inches per hour, affecting millions of people in a densely populated area. The snow fell with marginal temperatures aloft, resulting in a challenging forecast that included an eventual transition to sleet and freezing rain for much of the area. Climatologically, the I-95 corridor through the mid-Atlantic region often lies near the rain/snow transition zone with coastal storms. During the lifecycle of these winter storms, there are typically several factors working together to create strong lift and heavy precipitation that can also act as competing factors in determining tendencies in the thermal profiles (e.g., strong baroclinicity along the coast due to cold-air damming vs enhanced warm air advection thanks to a strengthening low-level jet). To aid in winter storm precipitation type forecasting, a Winter Storm Checklist was developed that further builds off prior work done by Kocin and Uccellini (Kocin and Uccellini, 2004: Northeast Snowstorms of the Twentieth Century). This study examines the applicability of this checklist, along with a "model ingredients'' approach in the forecast and warning environment. By utilizing this checklist, along with knowledge of model strengths, weaknesses, and biases, forecasters were able to accurately predict both the initial burst of heavy snow and the northwest protrusion of warm air aloft resulting in a change over to sleet and freezing rain in the urban corridor as cold air remained locked in at the surface. This also aided the office in providing useful IDSS to core partners, including the city of Philadelphia, resulting in improved decisions mitigating the impacts of this event.*

**57**

Steven Fleegel

Using the Predictability Horizon of Flash Flood Events to Improve Flash Flood Watch Services

*Extreme rainfall is responsible for a variety of impacts and can lead to property damage, injuries, and death. Prediction and messaging of extreme rainfall from convection is one of the harder challenges in operational forecasting. One way to raise awareness to the potential for extreme rainfall is by issuing a flash flood watch. The National Weather Service (NWS) directive states that these watches are "meant to* *inform the public of the possibility of flooding, typically within a 6 to 48 hour time frame before the event." Many extreme rainfall events occur within similar environments and time scales as severe convection, yet the lead time of flash flood watches is expected to be much larger than other convective watches.During the 2010-2019 period in the NWS's Central Region, our study found that 21% of the forecast zones within a flash flood watch would receive a flash flood warning during the time of the watch. Based on the high false alarm ratio of flash flood watches on the forecast zone level, we are concerned that the predictive skill of extreme rainfall events is too low to consistently provide lead times of over 6 hours for all types of flash flood events. This research will expand the verification of flash flood watches across the continental United States, provide comparisons to tornado and severe thunderstorm watches, categorize by the predictability horizon, and then provide recommendations to improve flash flood watch services.*

**58**

Kari Fleegel

Use of Probabilistic Messaging during On-site Support to the 2020 Mullen Fire in Wyoming

*Utilizing probabilistic messaging with ensemble data was extremely beneficial in bringing increased confidence to the Incident Meteorologist on the Mullen fire, especially when it came to expected wind speeds, temperatures, and precipitation amounts. Incident Meteorologists engage with Incident Command teams on-site to support firefighter and crew safety, and work on strategies that can successfully fulfill team and land management agency objectives, whether that is quickly getting the fire under control or allowing the fire to continue under a managed plan. Strategic planning is critical to the success of incident objectives, and this is where we need to be able to effectively explain probabilities and our confidence with a particular weather parameter. Knowing what tools to use in ensemble forecasting, and being able to successfully explain probabilities to our customers will continue to become more important with time. Ongoing coordination has made the NBM 1-D viewer a prime tool in coordinating probabilities and forecast confidence. The utilization of the NBM 1-D viewer, raw ensemble member output, Climate Prediction Center weekly and monthly outlooks, along with traditional forecast techniques by the Incident Meteorologist on the Mullen fire, provided better service for strategic planning on multiple time scales.*

**59 *WITHDRAWN***

Tammy Flowe

Graphical Turbulence Guidance Nowcast (GTGN) case analysis for February 11, 2021

*Atmospheric turbulence is an aviation hazard that can cause serious injuries to occupants and often leads to rerouting of flights. In an effort to mitigate these serious impacts, the FAA has funded the National Center for Atmospheric Research to research turbulence and develop forecasting and nowcasting capabilities that provide decision support for strategic and tactical flight planning. The Graphical Turbulence Guidance (GTG) forecast product provides three-dimensional turbulence forecasts tailored to the aviation community based on Numerical Weather Prediction model data and has been available operationally for several years. Recently, a new nowcasting capability, the Graphical Turbulence Guidance Nowcast (GTGN), has been developed and approved for operational dissemination. GTGN updates rapidly (every 15 minutes) and combines short-term GTG forecasts with recent turbulence observations, such as airborne observations from aircraft as well as radar-derived in-cloud turbulence estimates from the NEXRAD Turbulence Detection Algorithm (NTDA), to inform tactical route decisions by dispatchers and pilots. The accuracy of GTGN is highlighted in this operational case analysis for February 11, 2021. On this day, there were thunderstorms forming in the Southeastern US in the moist air ahead of a strong cold front and beneath an area of upper-level divergence. This case was especially interesting due to the widespread and long-lived nature of turbulence, with several hundred aircraft reports of moderate or greater (MOG) severity. Wave and clear air turbulence were reported near the right entrance region of a jet streak, along with reports that appear to be associated with convection, in clouds and areas of dryer air. An overview of this case for several times on February 11 will show GTGN was able to pinpoint the precise narrow regions of MOG turbulence as well as adjacent areas of null turbulence showing its value as a decision support tool.*

*Disclaimer: This research is in response to requirements and funding by the Federal Aviation Administration (FAA). The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.*

**60**

Chris Foltz

Incorporating a Consistent Approach to Partner Interactions Across NWS Regional Boundaries

*The National Weather Service continues to seek out opportunities to enhance existing relationships with federal partner agencies. While the focus of National Weather Service Impact-based Decision Support Services tends to center on briefings and direct* *incident support, an increased effort in the planning and exercise phase over the past several years has resulted in a much higher level of interaction with partners. The purpose of this presentation will be to share information regarding the National Weather Service's support of FEMA Region 8 specifically focusing on increased support to the Response and Recovery Divisions as well as increased support for planning and exercises. Like many FEMA Regions, FEMA Region 8's geographic boundaries are split between two NWS regions, Central and Western. As a result of this geographic split, it is critical that there is strong internal coordination between the NWS Central Region Operations Center and the NWS Western Region Operations Center in order for the support to FEMA Region 8 to be seamless. The co-authors both participate in FEMA planning efforts to ensure the necessary support is provided to FEMA Region 8 partners across their six states. This partnership creates greater NWS agency representation when resources are limited at any one Regional Operations Center and allows for a greater reach to regional partners across a broad area. This partnership also allows for redundancy if a major disaster or outage were to occur which would impact or overwhelm any one Regional Operations Center.*

**61**

Andy Foster

Impact-based Decision Support Services (IDSS) National External Core Partner Survey Test Results

*The National Weather Service (NWS) is evolving to enhance its services, organizational structure, workforce model and operating model, including Impact-Based Decision Support Services (IDSS) to better support a Weather-Ready Nation. IDSS focuses on providing tailored information specifically to our Core Partners, and there is an ever-growing demand for these services. Since 2019, the NWS has been researching the best method to gather feedback from its Core Partners, including the Emergency Management community. Building on the 2019 initial survey tested, NWS has further refined two survey instruments to gather information more effectively, and in 2020, initiated a nation-wide test, which closes in June of 2021. This presentation will provide a summary of the data collected, test outcomes and recommended next steps for NWS.*

**62**

Hayden Frank

Forecast and IDSS Challenges Associated With the Coastal Front During the Winter of 2020-2021

*Accurate forecasts of precipitation type and snowfall amount have been a recurring challenge in the coastal plain of southern New England which includes the high population centers of Boston, MA and Providence, RI. Forecast 'busts' (too little or too* *much snow) can have a significant impact on operating costs, not only for these larger cities and state Departments of Transportation, but also for local communities. Two recent winter storms that affected the region, December 15-16, 2021 and February 1-2, 2021, were examples of situations where snowfall totals varied greatly over distances of less than ten miles.This presentation will describe the challenges associated with forecasting and messaging precipitation type and snowfall amounts near the coastal front in eastern Massachusetts for these two winter storms. The importance of mesoscale analysis, including the integration of high-resolution data ensemble sets such as the High Resolution Ensemble Forecast (HREF), will be stressed in order to show how NWS Boston meteorologists incorporated this information into the warning decision making process. As a result, NWS Boston provided effective briefings to core partners by providing detailed information such as hourly snowfall rates and timing of the changeover from snow to rain. This allowed partners such as the Massachusetts Emergency Management Agency, MassPort (which operates Logan Airport), and others to make more informed decisions to help deploy resources in advance of the storm.*

**63**

Paul Frisbie

Building Confidence for Climatologically Infrequent High Impact-Low Probability Snow Events

*A slow moving low pressure system produced two separate heavy snow bands across northern Nevada on November 7 and 8, 2020. Each snow band produced around a foot of snow leading to the travel difficulties. Unusually cold low pressure systems across northern Nevada have the potential to produce narrow convective snow bands leading to a difficult forecast challenge since snowfall can vary widely over short distances. With convective processes driving accumulation rates, the duration of the snow band over a location can mean the difference between a dusting of snow and significant accumulations. Ensemble data may reveal larger snow accumulation spreads even at short lead times that results in a "High Impact, but Low Confidence" regime. In this poster presentation we will examine the tools such as the ECMWF Extreme Forecast Index and the Shift of Tails that combine model climatology with ensemble data to increase forecast confidence and improve DSS messaging in regards to high impact scenarios that have a low probability of occurrence.*

**64**

Brian Garcia

Post-Wildfire Debris Flows: Working with Partners to Improve the Science and Save Lives

*Over the last 4 years the San Francisco Bay Area and Monterey Bay regions have seen a steady increase in wildfire activity. This has led to the wintertime threat of post-wildfire debris flows during high intensity rain events. In 2020 the August lightning siege that impacted the northern half of California with numerous fires left susceptible burn scars across the region. Traditionally scars in the northern half of the state see beneficial rainfall early in the wet season, helping to break up the fire hardened soils and limit the threats of destructive post-wildfire debris flows. As a result, there is very little data to analyze and predict the potential of impactful debris flows. The bulk of data is from Southern California and intermountain west debris flow events. Due to numerous burn scars in the coastal range of Central and Northern California, National Weather Service Forecast (NWS) Office in Monterey worked closely with partner agencies to determine rain intensity threshold limits and set up alert and warning triggers. Through this early coordination Emergency Service personnel was able to take preemptive actions in the face of the first large impactful storm of the winter. People were injured, structures were lost, and infrastructure was damaged as a result of land movement, but no lives were lost.In the wake of the storms, a multi-agency assessment began to determine what rain rates triggered land movement and to increase knowledge of post-wildfire debris flows along the Central Coast. Early data is indicating that rain rates are lower than originally thought for triggering post-wildfire flows. This in turn is changing how the NWS issues warnings and how responding counties move people out of harm's way. While data is still preliminary, decisions are being made on how best to use the improving science to save lives.*

**65**

Richard Garuckas

The Crucial Roles of Messaging and Mesoanalysis of the Easter 2020 Chattanooga, Tennessee Tornado

*A Quasi-Linear Convective System (QLCS) moved across the Tennessee Valley late in the evening of 12 April 2020. A mesocyclone embedded within the QLCS crossed into the WFO Morristown county warning area from northwest Georgia producing a series of tornadoes in Hamilton and Bradley counties in Tennessee. An EF-3 tornado occurred in East Brainerd, TN with additional paths of EF-1 and EF-2 damage farther northeast. A gravity wave/reflectivity tag was identified shortly before the strong mesocyclone and resultant tornadoes developed. Research indicates that bands of radar reflectivity approaching from a southerly direction near the right flank of a storm are likely gravity waves that can increase the rotational velocity of a* *mesocyclone and lead to tornadogenesis. This appears to have been the case here since the rotational velocity quickly increased over Hamilton County after the gravity wave passed. During the event, a mesoanalyst worked adjacent to the warning forecaster, communicating changes in the thermodynamic environment as the QLCS entered the area. Using findings from The Three Ingredients Method, the team identified a developing bow over northwest Georgia along a part of the QLCS where the 0-3 km line-normal bulk shear was greater than 15 m/s. The communication of this information from the mesoanalyst to the warning forecaster helped enhance the lead time of the tornado warning on the EF-3 storm. This event illustrates the importance of having a mesoanalyst working near the warning forecaster to collaborate warning decisions and strengthen situational awareness. The improved situational awareness and ability to discuss warning decisions increased confidence in issuing the early tornado warning and later upgrading this warning to a tornado emergency as the mesocyclone rapidly strengthened.*

**66**

Jordan Gerth

Following the Observations: How weather satellite imagery is used at NWS field offices

*This presentation will provide the first modern comprehensive, quantitative assessment of how National Weather Service (NWS) meteorologists are incorporating observational data into the forecast and warning process, particularly focusing on satellite imagery and products. With a lifecycle budget of over $10 billion, the Geostationary Operational Environmental Satellite R-Series (GOES-R) is among the most valuable observational assets that the National Oceanic and Atmospheric Administration (NOAA) operates to monitor evolving weather conditions in the Western Hemisphere on behalf of the American taxpayers.Despite this sizable investment, the NWS has previously had imperfect metrics for judging the adoption of the new capabilities and monitoring the use of existing capabilities across the geographically-disperse field offices. For example, examining Area Forecast Discussions (AFDs) for key terms provides a snapshot of the integration of observations into some aspects of the weather forecast process. However, such an assessment is incomplete. Similarly, surveys on the usability of observations based on input from forecasters or science officers in testbeds or at field offices are subjective and difficult to calibrate consistently across the agency and over time.Following the data flow from each satellite observation to the forecaster workstation, the NWS Office of Observations and the Total Operational Weather Readiness for Satellites (TOWR-S) team are developing new analytical techniques to determine which observations and derived products are worthy of sustained investment for the next-generation weather satellite era, such as GeoXO, and where observational improvements, algorithm development, more training, or other efforts may be necessary to attain maximum usage today and in the future.*

**67**

Christopher Gitro

2020 Working Together and Refusing to let a Global-Health Pandemic Define Us

*Despite the many challenges presented by the global health pandemic, 2020 saw significant operational and culture change. During this time, a nearly complete management team turnover occurred, in addition to the hiring of several new staff members. Despite mandatory telework orders and the significant reduction of on station staff, we succeeded in revamping how daily shift operations were carried out with a much larger emphasis placed on IDSS and external customer support. In addition, we succeeded in incorporating new forecasters into the schedule rotation at an expedited rate thanks to a strategic and operationally-focused training plan. Despite being faced with many unforeseen challenges, we found ways to succeed in times of unprecedented hardship. The message handed down from station management very early on was that "we won't let this pandemic define us"_. Our success can be attributed to strong and effective two-way communication, focused and achievable office goals, and quite honestly, a little bit of good luck. Looking back, we're a better office because of the COVID-19 pandemic, and we all learned how a strong office culture and effective communication can help bridge the gap during otherwise challenging times.*

**68**

Barry Goldsmith

IDSS in Response/Recovery: How NWS Offices Supported Public Safety Messages for Hurricane Laura

*On August 26, 2020, NWS staff evacuated the WFO in Lake Charles, LA (LCH) as Hurricane Laura bore down. WFO Brownsville/Rio Grande Valley, TX (BRO) assumed primary service backup responsibility for LCH. WFO BRO continued messaging potential devastation, and was the NWS's reassuring voice to communities of southwest Louisiana and southeast Texas during the final evacuation stage through landfall. After landfall, a changed message focus from hurricane response to recovery was crucial to the low number of post-storm casualties, given the scope and duration of hardship that affected hundreds of thousands of residents. When Hurricane Warnings ended, WFOs and NWS Southern Region Headquarters (SRH) provided critical public safety information to communities with widespread damage and power loss. The WFOs and SRH provided extended service assistance when outages rendered WFO LCH inoperable. WFO BRO produced safety graphics to address injury prevention, proper use of generators, and food safety. Graphics were shared on multiple platforms for maximum exposure, and re-posted for several weeks to keep the information in focus during a prolonged period of hardship, joined by late summer heat and humidity. Two days after landfall, nearby WFOs and the SRH Regional Operations Center (ROC)* *coordinated with Texas' and Louisiana's Emergency Management agencies to temporarily lower NWS Heat Advisory criteria for counties and parishes with more than 10 percent of utility customers without power. The temporary reduction was designed to protect a population at risk from heat-related illnesses.This presentation will describe seamless communication to people in the path of Laura's devastating wind and storm surge through landfall, and describe collaborative efforts to increase public awareness from dangerous post-hurricane recovery activities and from weather conditions that became life-threats after communities sustained severe damage. Each effort helped limit casualties from Laura.*

**69**

Samuel Gould

The Impact of Inaccurate Geotags of Hail Reports in the National Storm Events Database

*The National Centers for Environmental Information (NCEI) Storm Events Database has been used by a variety of scientists in various fields and it is important for the purposes of forensic meteorology and engineering that the location of those reports be as accurately and precisely recorded as possible. The forensic meteorology and engineering communities use this data to make determinations about the occurrence and severity of hail at specific locations to settle legal and insurance claims. Hail reports which are not specific with both time and geographic location are problematic for forensic purposes because those reports cannot be used to confirm the occurrence (or absence) of hail at a specific place and time for legal purposes. This paper examines case studies involving the inaccurate geotagging of hail in certain metropolitan areas spanning hundreds of square kilometers and the implications and impacts upon forensic examination.*

**70**

Jeremy Grams

Verification of 2016-2020 NWS Severe Weather Watches: Evaluation of hazards, intensity, and timing

*The NWS Storm Prediction Center (SPC) is responsible for the issuance of Tornado and Severe Thunderstorm Watches in collaboration with Weather Forecast Offices (WFOs) across the contiguous United States. Every watch has various forecast attributes (e.g., probabilities of individual hazards, maximum intensity of wind gusts and hail, temporal duration). SPC forecasters typically self-verify individual forecasts using metrics based on the preliminary Local Storm Reports (LSRs) issued by WFOs. The final LSRs are used here to verify nearly 2700 Tornado and Severe Thunderstorm Watches during the five-year period of 2016-2020. SPC has the most favorable watch verification metrics in forecasting the occurrence of two or more tornadoes and* *significant severe hail (?2 inches). The least favorable verification metrics are with the forecast occurrence of significant severe wind (gusts ?65 knots). The daily ratio of preliminary to final LSRs for each hazard was subsequently evaluated. This comparison shows that while significant severe hail is largely at or near a 1:1 ratio between preliminary and final LSRs, the number of significant severe wind events are vastly underestimated in preliminary LSRs. It is hypothesized that this is a contributing factor to the relatively poor verification metrics of significant severe wind in watches. Exploring potential refinement of intensity forecasts and the watch issuance process, maximum wind and hail magnitudes along with lead time to severe reports are evaluated. While deviations from default values become increasingly rare at extreme wind and hail magnitudes, SPC can demonstrate skillful forecasts for both hazard types. Lead time to the first severe report commonly overlaps the warning scale and typically ranges to several hours for the last report. This large spread provides a benchmark for consideration of a Threats-in-Motion-based paradigm focused on providing more consistent lead time within a watch.*

**71**

Chris Hammer

Assessing the Operational Utility of a Random Forest Model for High Wind Prediction in Southeast WY

*Forecasters currently have access to multiple tools to aid in the prediction of downslope and gap winds across southeast Wyoming. These tools focus on three specific locations, including the city of Cheyenne and two gap regions along Interstate 80 (Arlington) and Interstate 25 (Bordeaux) where strong crosswinds frequently result in blow overs of campers and tractor trailers. An early 2000s study found that the occurrence of high winds at Arlington was strongly correlated with the 700 millibar CAG-CPR (Craig, CO to Casper, WY) height gradient. The critical gradient threshold is based on a linear regression analysis, and coincides with a greater threat for high winds. A 2015 study developed multi-parameter logistic regression models to assign probabilities of exceeding 50 knot wind gusts at Bordeaux and Cheyenne. Optimal probability thresholds were determined using a test dataset not seen in the training process of the statistical models. These numerical tools are accessible through text products which are automatically updated based on GFS model output. A new Random Forest approach is currently being considered for potential improvement to these existing tools. This study investigates a number of actual high wind cases of various intensities across southeast Wyoming. A case-by-case verification analysis was performed in a hypothetical real-time forecast and warning environment to determine the validity and potential benefits of the proposed Random Forest models for each site as compared to existing guidance. This analysis of model performance will also identify targets of opportunity for potential model improvements. This presentation will also highlight the potential utility of the Random Forest Regressor for determining the timing and strength of peak wind gusts as opposed to a Boolean classification for a*

*given time range. A preliminary assessment of how these analyses will shape future tools for high wind forecasting and messaging will also be discussed.*

**72**

Nicholas Hampshire

An Analysis of Northward Moving Tornadoes within an Open-Warm Sector Across Eastern Texas

*In general, tornadoes across the eastern half of Texas track in easterly directions within predominant upper flow from the west forces convection to the east after storm maturation. However, this study found that 22% of all tornadoes move in northerly directions, and develop in the warm sector prior to the arrival of a main linear forcing mechanism (e.g., front, dryline). This bifurcation of storm/tornado motions is an important aspect to understand for forecasting, warning, and messaging of these events. Tornadoes from 2000 to 2018 were examined in a study area between 26Â°N and 34Â°N and 94Â°W and 100Â°W. Tornadoes with overall movement from 170Â° to 210Â° were selected for analysis. Results show these tornadoes typically occur eastward of slow moving, mid to upper-level long wave troughs and underneath the left exit region of an upper-level jet streak. A low-level jet in eastern Texas, a surface low centered over southwestern Texas, and a warm/stationary front extending northeast of the surface low were also common for these events. The typical air mass had weak instability, low convective inhibition, and high 0-6 km shear. Radar analysis of the tornadic storms showed mesocyclonic circulations with smaller diameters and lower rotational shear than typical tornadic storms when compared to previous research. This study seeks to aid forecasters with their understanding of the environments these tornadoes form within and to help make sound tornado warning decisions prior to tornadogenesis.*

**73**

Greg Hanson

Trouble is more than a name: NWS WFO Boulder IDSS Activities for the East Troublesome Fire

*The East Troublesome Fire exhibited many troubling characteristics, including a late-fall, nocturnal explosive run in the Colorado Rockies.This presentation will focus on Impact Based Decision Support Services (IDSS) provided by NWS Boulder to Deep Relationship Core Partners during a period of explosive wildfire growth that began the afternoon of October 21 and ended with a fall snow storm on October 24 2020. There is a companion abstract (lead author Evan Direnzo) that will detail the science behind what made the fire so explosive. The East Troublesome Fire in Grand County, CO was first reported on October 14 2020, and was declared contained on November 30 2020. At a total of 192,457 acres, it was the second largest fire in Colorado history, and most* *of the burned area was gained in several hours of almost unimaginable growth. The unique nature of the growth resulted in several aspects of life saving IDSS. High winds, warm temperatures, and low humidity caused an ideal environment for rapid fire growth and extreme fire behavior that began on October 21. The fire exploded, increasing its size ten-fold from 18,550 acres to 187,964 acres during this period. Conventional wisdom holds that the 5 miles of rocky alpine tundra on the Continental Divide at an elevation above 11,500 ft MSL is an effective fire break, however the fire jumped the divide and began burning in Rocky Mountain National Park (RMNP) just above Estes Park in Larimer County. Decision support efforts were primarily twofold: Amplifying evacuation messaging for Grand County the night of October 21, and notification of and support for the fire's continued growth east of the Continental Divide into (RMNP) and toward the town of Estes Park CO for a massive evacuation effort. The NWS office in Boulder was the first agency to recognize the fire had jumped the divide, and provided initial notification to an incredulous Larimer County and RMNP of its presence.*

**74**

Andrew Heidinger

NOAA's Geostationary Satellite Systems Now and through 2050

*NOAA's Geostationary Operational Environmental Satellites (GOES)-R Series is now fully in operation with GOES-16 serving as GOES East and GOES-17 as GOES West. Together these two next-generation geostationary satellites watch more than half the globe -- from the west coast of Africa to New Zealand, and from Antarctica to the Arctic Ocean. The GOES-R satellites have been a game-changer for forecasters and those who rely on accurate environmental monitoring. With the upcoming launches of GOES-T in 2021 and GOES-U in 2024, these satellites will continue operations into the 2030s.NOAA is now making plans for the system that will follow GOES-R with the next generation system named Geostationary Extended Observations (GeoXO). The GeoXO System will continue the critical observations made by GOES-R, and also add new measurements to improve weather forecasting and monitor the oceans and atmosphere. The proposed GeoXO observations include a visible/infrared imager, lightning mapper, hyperspectral infrared sounder, atmospheric composition instrument, and ocean color instrument. A new system architecture employing additional satellite platforms is planned to accommodate the new instruments. The first GeoXO launch is targeted for 2032 and the operational phase will extend into the 2050s. This presentation provides a status on GOES-16 and GOES-17 in operation and GOES-T and GOES-U in development. It will discuss the results of the recently concluded GeoXO pre-formulation activities and also the GeoXO program requirements, mission concept, architecture, and timeline.*

**75**

Matt Hemingway

NWS/ULM/COMET Partners Project: Verifying the Three-Ingredients Method for Nowcasting QLCS Tornadoes

*The southeastern United States contains a local maximum in tornado frequency, second only to the well-known maximum in the U.S. Great Plains. A significant fraction of Southeast tornadoes are produced by quasi-linear convective systems (QLCSs). However, warning skill scores for QLCS tornadoes tend to be lower than those for supercellular tornadoes, due, in part, to QLCS tornadoes often being shorter lived and weaker. Additionally, there is an incomplete understanding of the QLCS tornadogenesis process. Understanding the QLCS tornadic environment and tornadoes in this region is critical to improving tornado warning performance and thus advancing the National Weather Service (NWS) core mission of protecting life and property.Leveraging the existing relationship between a NWS Weather Forecast Office (WFO) and a partner in academia, this study will attempt to clarify how a subset of NWS meteorologists forecast and warn for tornadic QLCSs through focused survey responses and anonymous warning simulation results. To advance our understanding, this study will also statistically evaluate a technique commonly used to nowcast QLCS tornadogenesis called the "Three-Ingredients Method". Additionally, this study will compare this technique to other commonly used tornado forecasting/nowcasting parameters in an effort to identify opportunities to further enhance nowcasting of QLCS tornadoes. Our presentation will provide the very latest outcomes and deliverables of this ongoing joint project funded through late 2021. Results from the project will not only have the potential to improve NWS warnings of tornadic QLCSs, but will provide evidence of how strong collaborative ties between academia and an NWS WFO can yield results which advance the NWS mission.*

**76**

Ronla Henry-Reeves

Evaluating a Collaborative Forecast Process

*With the expanding capability to produce and communicate high-resolution georeferenced data within the various domains of the National Weather Service (NWS), there is an urgent need to better define the forecast process. For the past five years, the Program Management Office of the NWS has been exploring what is referred to as the "Collaborative Forecast Process (CFP)."_A goal of the CFP is to leverage expertise at all levels of the agency to produce forecast data that is consistent in space, time, and scale--without loss of skill.In the companion abstract entitled "On a Collaborative Forecast Process in the United States National Weather Service - Past, Present and Future", the history of the CFP demonstration will be presented. Both a Quantitative Precipitation Forecast (QPF) CFP Demonstration Plan and a Test and*

*Evaluation Plan were approved in [2020]. The Test and Evaluation plan provides the framework to determine the effectiveness of the process, technology, and training employed within NWS operations during the CFP demonstration. The foundation of the demonstration focuses on a common starting point, common forecast tools, and common collaboration tools that will all guide collaboration among NWS offices. This presentation will review the test and evaluation activities leading up to the CFP demonstration and discuss the current status and next steps, as the CFP demonstration is planned to start in the summer of 2021.*

**77**

Ronla Henry-Reeves

NWS AWIPS Program: Evolving tools and technology for an evolving NWS

*The Advanced Weather Interactive Processing System (AWIPS) is the key visualization and forecast system utilized by National Weather Service (NWS) forecasters to support their mission of saving lives and property. To ensure that NWS forecasters have access to the best tools possible, the AWIPS Program strives to stay on top of the rapid changes in technology that range from increasing amounts of data, more compute power for weather models, and innovative software applications. This presentation will highlight projects and initiatives within the NWS AWIPS Program that will help evolve this important computer system toward an agile, innovative infrastructure that will be more adaptive to the increasingly advanced and flexible needs of the NWS forecaster as they provide life-saving Impact-based Decision Support Services (IDSS) to core partners. Many of the various projects and collaborative efforts will be discussed that are steps in the path toward providing NWS forecasters with the best tools that the weather industry has to offer. The information presented will also be of interest beyond the NWS, as advancements to AWIPS capabilities have impacts reaching far beyond the agency, notably by NWS partners benefitting from streamlined forecast processes and improved watch and warning products. AWIPS software is also free and openly accessible, so external agencies and organizations that include the United States military and universities can learn from the program's vision to improve their own system for their unique needs.*

**78**

Lindsay Hochstatter

The Temporal Evolution of Tornadic vs. Non-Tornadic High Shear Low CAPE Environments

*High-shear low-CAPE (HSLC) severe weather events, defined as those in which surface-based CAPE is below 500 J/kg or most unstable CAPE is less than 1000 J/kg and have a 0-6 km bulk wind difference of at least 18 m/s, are uniquely challenging to forecasters due to their rapid evolution times and relatively infrequent production of severe* *weather. Additionally, these environments tend to occur during the cool season and overnight hours, which present their own challenges in terms of current conceptual understanding and forecaster verification. To better understand how rapid environmental evolution contributes to severe weather production in HSLC environments, nearly 230 tornado reports from HSLC events in the southeastern U.S. between 2014-2018 were categorized based on their radar signature near the time of tornadogenesis. More than half of the reports were from supercells, with the next largest contributor being bowing segments. Next, model soundings are used to characterize the near-storm environment and its temporal evolution, focusing on the time of tornadogenesis, as well as the hour before. For comparison, two nearby locations not associated with tornadoes also had their environmental evolution quantified. Differences in environmental shifts between tornadic and non-tornadic reports will be shown, along with sensitivities to associated radar signatures, time of day, and the intensity of associated tornadoes. The goal of this study is to enhance short-term forecasts of HSLC events by quantifying the impact and degree of environmental variability associated with severe and non-severe convection.*

**79**

Larry Hopper

Warm Season CONUS Airport Climatology of Vicinity Versus Prevailing Thunderstorms

*Improving impact-based decision support services (IDSS) during thunderstorm events is critical for helping aviation core partners protect life and property while mitigating disruptions to the National Airspace System and unnecessary added fuel costs. One area of debate is whether or not Terminal Aerodrome Forecast (TAF) usage of "vicinity thunderstorms" (VCTS), defined as lightning within a 5-10 statute mile (SM) annulus centered on an airport, provides value to aviation customers. This project's primary objective is to determine if there is a greater chance of VCTS in the Desert Southwest and Intermountain West (SW-IW) relative to other regions of the continental U.S. (CONUS). Secondary objectives include determining possible causalities and mapping the climatological frequency and duration of VCTS versus prevailing thunderstorms (within 5 SM of airports) as defined by lightning count at TAF sites.Cloud-to-ground (CG) lightning data from 53 airport sites (in the top 50 of total operations and/or passengers) are analyzed for ten years (2010-2019) from April to October, provided they have at least 50 storms that produced 2+ CG strikes. Preliminary results show that "VCTS Only"_ storms (that produce CG strikes within 5-10 SM without generating any CG strikes within 0-5 SM) are significantly more likely to occur in the SW-IW region (37%) than at coastal (30%) and inland (25%) sites. These results imply that VCTS TAF groups may verify more often in the western CONUS, while also resulting in more false alarms when using lightning within 5-10 SM to predict lightning within 5 SM. If time permits, additional airport sites will be added to minimize regional data voids and the proximity of wind and dust impacts from their parent thunderstorms will be investigated in the SW. This work may have applications for convective TAFs output by*

*Digital Aviation Services grids and improving IDSS for thunderstorm impacts ranging from AWWs to outdoor events and emergency responses.*

**80**

David Hotz

Collaboration Between the NOAA ARL ATDD at Oak Ridge, TN and the WFO at Morristown, TN

*NOAA Air Resource Laboratory (ARL) Atmospheric Turbulence & Diffusion Division (ATDD) at Oak Ridge, TN and NWS/WFO at Morristown, TN (MRX) have partnered on multiple projects to improve our understanding of meteorology and hydrology across the Southern Appalachian region. Data from auxiliary radiosonde in Oak Ridge support severe weather forecasts requested by MRX, and most recently ATDD has performed routine vertical profiles up to 1 km AGL using a small Uncrewed Aircraft System (UAS). ATDD Meteorological towers have also been placed across the MRX forecast area. This collaboration has expanded beyond NOAA to other agencies such as the Tennessee Emergency Management Agency. Expanded observational capabilities across east Tennessee provide NOAA and its partners with a greater understanding of mountain wave high wind events, fire weather conditions, mesoscale situational awareness, and also enhance the decision support services at MRX.The collaborative efforts have also included improving meteorological awareness across east Tennessee by partnering in an open house at MRX. Another aspect of the collaborative is improvement of the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) dispersion model parameterizations with sUAS based measurements of winds. This presentation will discuss these different collaborative efforts between these NOAA offices.*

**81**

Scott Jacobs

Cloud Environments for AWIPS: The Future is Today

*AWIPS provides NWS forecasters with the critical platform to hydrometeorological data and issue forecasts and warnings. As the program strives toward an innovative vision to offer NWS forecasters the best tools and user experience possible, activities have been identified that would benefit from the more flexible resourcing and data storage architecture supported within a cloud environment. These activities include software development and functionality testing which would help the AWIPS Program tap into software development talent within the NWS field. A cloud environment could also create more collaborative, dynamic, and innovative training opportunities for NWS forecasters.The AWIPS Program has established a solid development environment within Amazon Web Services (AWS). Each cloud instance contains a full standalone AWIPS installation, including a real time data flow. Developers are able to* *work on the core AWIPS code and local applications without affecting the operational system.Additional work is in progress to provide cloud instances as an alternative to the AWIPS Thin Client. Thin Client is used by Incident Meteorologists (IMETs) and other out-of-the-office use cases to provide on-site support for events such as wildfires and other environmental hazards.Plans are being developed to reimagine and modify AWIPS to support transitioning AWIPS operations to the cloud. Instead of the current "lift-and-shift" activities future plans will include rearchitecting the system to be composed of microservices that work in unison to provide information to the user applications. This presentation outlines how the AWIPS Program is progressing on plans to use the AWS cloud for development, training and testing of capabilities, and how certain functions can be transitioned to an operational support model. Finally, an overview of the re-architecture plans will be presented.*

**82**

David Jahn

Machine-learning tornado forecast guidance using significant tornado parameter and updraft helicity

*Because convection-allowing ensembles (CAE) using grid spacing of order 3-km are capable of predicting storm development and evolution but not tornadogenesis itself, various studies have investigated CAE-derived variables as forecast proxies for tornado occurrence such as updraft helicity (UH), linked to storm rotation, and the significant tornado parameter (STP), which climatologically has been shown to be positively correlated with tornado frequency. However, it is yet unclear what is the appropriate UH threshold to filter right-moving rotating potentially tornadic supercells, nor how best to identify a single STP value (and associated tornado frequency) from the distribution of STP values that characterize the near-storm environment.A machine learning (ML) system has been developed as a relatively efficient means of identifying the most influential percentile values from the UH and STP distributions that determine a tornado probability forecast. Forecast STP and UH values are derived from High Resolution Ensemble Forecast (HREF) system. This ML system is unique because it uses training data of spatial resolution consistent with the native HREF 3-km grid as opposed to a 40-km or 80-km grid often used by other ML methods for severe weather forecasting. Tornado probability forecasts generated using this ML system for a set of tornado cases are compared to forecast results from other HREF-based calibrated systems. Guidance is also given as to which UH and STP variables are most influential in generating tornado probabilities in the ML system.*

**83**

Susan Jasko

Connecting Communities: Private Enterprise and University Research 'Swipe Right'

*Connecting across sectors within the weather enterprise can be challenging, tricky, a bit contentious, but sometimes exciting, joyful, and rewarding. The best of intentions can run up against different missions, goals, value systems, and regulations. But this case illustration offers both an example of success as well as a set of guiding principles to use when seeking to form and engage a productive partnership that benefits not only the principle partners but also publics in a range of communities. This is the story of how X Corporation and a research center at a local university were able to form a partnership, seek grant funding, receive the award, and successfully complete phase one of a shared project, and the lessons learned about how to repeat our success. We surmounted the challenges of a) legal dimensions binding each partner; b) defining the roles and responsibilities; c) understanding the perspective and needs of the other; d) learning the ropes of the funding agency and its requirements; and e) finding a division of work and working rhythm appropriate to all. We learned in the process that the following lessons: 1) find an expert partner and respect that expertise; 2) put time in upfront to brainstorm and engage in discussions that do not end in action too soon; 3) ask questions about organizational processes without making a judgment; 4) exercise patience and good will when processes internal to one partner organization remain invisible and experience glitches; 5) agree on both the shared goal and motivation; 6) exercise trust in each other; 7) hold to professional integrity while remaining flexible. The specifics we will share about our experiences behind these lessons offer insight into how others can initiate their own successful cross-sector collaborations.*

**84**

Matt Jeglum

What is the Goal of Predicting the Weather? Evolving the Forecast in the NWS's Western Region

*Allan Murphy famously stated that weather forecasts possess no intrinsic value. They only acquire value through their ability to influence the decisions made by users of the forecasts. Furthermore, a synthesis of social science literature found that "nearly all of the studies we review indicate that people make better decisions, have higher trust in information, and/or display a greater understanding of forecast information when shown a probabilistic forecast instead of a deterministic one." The National Weather Service's Western Region (NWS WR) is evolving our operations to use probabilistic guidance to power world-class impact-based decision support (IDSS), maximizing the value of what we do. There are three parallel initiatives that we are pursuing to achieve this goal. The first initiative focuses on the tools we use. This presentation will* *describe the post-processed model guidance and visualization methods that we have found most useful, including National Blend of Models (NBM) probabilistic output, High-Resolution Ensemble Forecast (HREF) output, synoptic clustering, and situational awareness tools such as the Extreme Forecast Index.The second initiative focuses on the culture of the forecast process and what we prioritize. The NWS has historically focused on using deterministic models to produce deterministic forecasts. This presentation will describe how NWS WR is working to prioritize assessment of potential outcomes using probabilistic tools as opposed to grid editing based on deterministic output. The third initiative focuses on how we interact with our partners and users. To provide world-class IDSS, we need to be intimately familiar with our users. If we know our users specific needs, we can use probabilistic information to tailor our message to the questions they need answers to. This presentation will describe how NWS WR is integrating the findings of social science to translate our knowledge of the weather into optimal decision-making.*

**85**

Eric Jones

Verifying the NWS' NWC Flood Inundation Mapping for the ABRFC for the 2015/16 and 2019 Flood Events

*The National Weather Service (NWS) National Water Center (NWC) has developed Flood Inundation Mapping (FIM) for real-time events. The NWS River Forecast Center (RFC) official forecasts are the primary input for the Replace and Route (RnR) method of the hydrologic model. Inundation mapping is then produced using the Height Above Nearest Drainage (HAND) method.The NWC has run retrospective forecasts for five significant flood events for each RFC using RnR and the HAND method to produce FIM products. Two of the retrospective forecasts produced for the Arkansas-Red River Forecast Center (ABRFC) were for the Dec 2015/Jan 2016 and May/Jun 2019 flood events. A post-event high water mark survey was completed for the Illinois River in Oklahoma after the 2015/16 event. Real-time satellite imagery and mapping were produced for the 2019 event. Little previous work has been done to verify NWC modeled FIMs to provide confidence in the output, especially in the ABRFC area. This presentation will examine the inundation maps produced by the NWS NWC retrospective runs and compare them to actual surveys and images. This will show where the FIM areas are representative enough to use for future events and where improvement should be made before they are used operationally.*

**86**

Michael Jurewicz

Support for 9/11 Ceremonies at the Flight 93 Memorial

*The National Memorial in Shanksville, PA honors the 40 heroes of Flight 93. For the past several years, our office has provided a combination of remote and on-site support for commemorative ceremonies. In 2020, we worked closely with the National Parks Service (NPS) to coordinate support for two main ceremonies (described below). We provided remote support and daily email briefings from 9/4 through 9/11, with meteorologists providing on-site support on 9/10 and 9/11.The first ceremony, held on 9/10, marked the completion of the Tower of Voices chimes (right). Two meteorologists set up a portable weather station and provided on-site support at the Incident Command Post. With nearby showers threatening to produce lightning, both briefed NPS staff multiple times through the afternoon and eventually gave the "all-clear" for the 6pm Tower of Voices Ceremony. Mesoanalysis from staff at the home office was invaluable to effective, accurate thunderstorm predictions and on-site support. No lightning was observed within 10 miles of the venue.On Friday, the 19th anniversary of 9/11/01, meteorologists provided on-site support for a ceremony to remember and honor the heroes of Flight 93 (left). Dignitaries included President Donald Trump, First Lady Melania Trump, and U.S. Congressman James Joyce, among others. Following the ceremonies, NPS Eastern Incident Commander Josh Manley expressed his sincere appreciation for timely weather support. Regarding the decision to proceed with the Tower of Voices ceremony, he noted that "the ability to look meteorologists in the eye and hear that you were 100% confident was invaluable."_ We look forward to continuing this partnership in 2021, which has the potential to be a very well attended, high profile event, given that it will be the 20th anniversary of the September 11th, 2001 terrorist attacks.*

**87**

Andrew Just

The Evolution of Precipitation Type Forecasting In NWS Central Region

*Precipitation type forecasting has changed a lot over the past two decades, both in NWP and in NWS operations. In NWS Central Region (CR) operations prior to the Winter 2016-2017, each office and forecaster potentially used a different technique. This led to downstream issues of inconsistency both internally and between offices for elements like snow amounts, ice accumulation, and tangible weather. During Winter 2016-2017, to improve consistency, a program named ForecastBuilder was rolled out across the region. This application provided two precipitation type approaches: one from SnowLevel and another via an environmental assessment approach called "top-down."_ Additionally, integration of research from Bourgouin (2000) using an integrated energy based method, manifested in a revised "top-down"_ precipitation* *type algorithm as described by Birk et al. (2021). This method is being tested across a dozen offices in the eastern part of CR from Winter 2018-2019 to present.CR has been evolving changes to precipitation type forecasting techniques, as has the NWS National Blend of Models (NBM). In version 3.0, and continued into version 3.1, the NBM calculated precipitation type from a blended environmental "top-down"_ approach that much of CR was using. Then with NBM version 3.2 and continued into version 4.0, the NBM switched to the Birk et al. (2021) technique. Instead of blending the environment prior to evaluation of the supported precipitation types, each input member is evaluated individually with the resultant ensemble frequency representing the potential fractional precipitation types. In an effort to discern the value of migrating toward a NBM based probability of weather type forecast workflow, CR conducted a testbed composed of ten offices for Winter 2020-2021. This presentation will examine results from the NBM Precipitation Type testbed, how this technique can improve precipitation type forecasts, and limitations and weaknesses in the methodology.*

**88**

JP Kalb

An Application of Weather to Baseball Pitching Analytics using Python

*Major League Baseball (MLB) has been implementing advances in analytics including pitch tracking technology the past few years. These advances have led to baseball pitchers and coaches at all levels adjust the release angle and point of pitches which affects the movement of the pitch and developing tutorials online on how to "build"_ pitches. In addition, some of the MLB teams such as the New York Yankees have been developing labs specifically to analyze pitches but without weather being a factor. Some baseball players have started to wonder and inquire on social media if weather can affect the outcome of a game most notably how wind affects the speed and location of pitches. This presentation investigates how the physics of pitching is affected by weather using Python and explains how pitchers at all levels could adjust their spin rate and angles, speed, and release approach based on the weather forecast. In addition, this presentation allows you to step into the shoes of a pitcher to see how weather could affect the pitch as well as experience the advances in analytics by interactively simulating an at-bat also in Python.*

**89**

John Keyes

Sorry We Aren't Able to Make It, But We Will Make It Work!

*My office has spent the past 2 to 3 years collaborating a program with local fire dispatch centers to deploy meteorologists onsite to individual centers, to provide real-time weather information. In 2019, we had a successful "trial run"_ with one local fire* *dispatch center. They wanted an 11th hour rapid deployment, as fire season went from nothing to multiple fires within a day, and felt extra weather support was necessary. In 2020, we had scheduled specially-trained meteorologists (on a rotating weekly basis) to provide this support...then COVID-19 hit. The office was unable to send meteorologists in person, however we were able to provide support remotely. We will take a look at how we did this, leveraging existing technology. We look at various existing tools and programs developed locally, including Google Slides and our Weather Impact Matrix, to help deliver superior decision support services to our important fire weather partners. This includes real-time updates for severe thunderstorms and multiple fire starts within a 12-15 hour period, as well as multiple emailed forecast updates.*

**90**

Daniela Pirraglia

Rural Areas: Connecting Disparate Communities through Discovery and Service

*The National Weather Service's (NWS) 2019-2022 Strategic Plan emphasizes the reduction and mitigation of impacts from weather, water, and climate events by transforming the way people receive, understand, and act on information. The NWS ####, Nevada's Weather Forecast Office (WFO) program's work to provide "better information for better decisions"_ to our disparate partners and communities. #### strives to collaborate within the weather enterprise to give decision-makers the types of communication, tools, and safety skills to make informed decisions and improve responsiveness to protect lives and livelihoods. The #### Media and Communications Group (MCG) identified opportunities to increase decision support services within the diverse and rural communities of ####. Several years of natural disasters and human-caused accidents required #### to adapt in the face of change while helping our partners recognize impacts and challenges. #### strove to improve emergency preparation and resilience at every level. As a result, NWS #### WFO spearheaded additional products and services, focusing on communication that improved rural and underserved populations' weather-readiness and emphasized future mitigation planning. This poster documents how the ### MCG enhances and fosters relationships with local communities and government officials, and various strategies the team uses. A series of best practices, including focusing on cultural shifts, utilizing virtual resources, and carefully expanding, evaluating and testing new products, will be included. The goal is to show other teams that using effective methods to reach diverse groups will ensure our communities are antifragile.*

**91**

Jonathon Klepatzki

Multi-Scale Analysis of Cool-Season Dixie Alley Tornado Events

*Numerous tornado events have occurred in the Gulf Coast States (i.e. Louisiana, Mississippi, Alabama, Georgia) for more than a decade. This study presents a multistate and scale environmental analysis associated of 24 Louisiana tornado and 98 null events; 46 Mississippi tornado and 92 null events; 33 Alabama tornado and 65 null events; 21 Georgia tornado and 32 null events (2002--2019). A tornado event were defined as ? 4 tornadoes within a 24 h period during December--May, which was chosen to eliminate tornado events associated with tropical cyclones. However, null events were defined as 24 h periods in which the NOAA Storm Prediction Center had Day 1 tornado probabilities ? 5% over any part of the Gulf Coast, but< 4 tornadoes occurred. Using the North American Regional Reanalysis, a composite synoptic analysis showed tornado events were associated with a negative-tilted anomalous mid-tropospheric trough over eastern Oklahoma and an anomalous mid-tropospheric ridge from central Illinois extending into the Carolina's (vs. northeast United States). Preliminary results suggest stationary boundaries are the dominant factor during these events however, correlating teleconnection daily values (e.g. -1.0 ? x ? -0.5) to specific synoptic conditions will prove useful for forecaster's in identifying potential tornado events.*

**92**

Pamela Knox

The University of Georgia Weather Network: 30 Years of Service to User Communities and the NWS

*The University of Georgia (UGA) Weather Network began its service to the Georgia community in 1991, thirty years ago. It is one of the largest and longest running weather mesonets in the United States. The network, which is also known as the Georgia Automated Environmental Monitoring network (GAEMN), currently consists of 87 Campbell Scientific stations scattered around the state. It provides data that are updated every 15 minutes through their webpage at http://weather.uga.edu/ and measures the meteorological variables of temperature, pressure, humidity, wind speed and direction, and precipitation using two separate gauges. It also measures the agriculturally important variables of soil temperature and moisture and solar radiation. Derived products like evapotranspiration, chill hours, and degree days are also available. Stations are visited monthly for maintenance and data are quality-checked daily. While the network was originally started to provide data to UGA scientists and students in agricultural fields, it has expanded to provide service to other universities as well as state agencies such as the Georgia Department of Natural Resources, the Georgia Forestry Commission, solar and conventional energy utilities,*

*civil engineering firms, and agricultural commodity groups (cotton, peanuts, blueberries, peaches, soybeans, tobacco, corn, and vegetables). Media and K-12 educators also use the data for documenting extreme weather and local climate. Funding over time has varied, but now the National Weather Service supplies the majority of the non-university funding by providing the data to MADIS through data sales to Synoptic Data. In 2020, undergraduate students at UGA began the work of compiling the data into 30-year averages; that work is continuing and will be published by Extension when the summaries are complete.*

**93**

Ryan Knutsvig

Communicating Flood Risk through the Experimental Probabilistic Flood Outlook Summary (PFOS)

*Residents along the Red River Valley of the North and its tributaries have consistently been impacted by spring snowmelt flooding over the last two decades. Flooding in the "Major"_ category has occurred in 43 percent of years at one location or more along the mainstem of the Red River since the catastrophic "Flood of 1997". Probabilistic flood outlooks leading up to the annual spring snowmelt flooding are created at the National Weather Service (NWS) North Central River Forecast Center in Chanhassen, MN. The NWS Grand Forks office then communicates this spring flood outlook information with partners along the Red River and its tributaries.It has been demonstrated in previous research that probabilistic (uncertainty) information leads to more optimal decisions by decision makers. However, research in the area of probabilistic flood forecasts also indicates that a collaborative effort between the developer and end user helps create a product that will be most useful for the intended recipient.A process to improve the presentation of probabilistic flood outlook information for the Red River of the North was initiated at the NWS Grand Forks office in the fall of 2017. This presentation highlights the iterative process of engaging partners and incorporating their input to create an improved method for displaying probabilistic flood outlook data for the 2018-2021 spring flood seasons, as well as plans to improve upon the project for the 2022 season. It is theorized that improvements to the communication of probabilistic flood information will lead to an increased understanding of flood risk and result in improved preparedness.*

**94**

Dorothy Koch

Forecaster Requirements to Drive Model Research and Development

*In order to maximize improvements to NOAA's forecast systems, it is imperative to identify the top model-related forecast issues, and to use that information to motivate and focus the model research and development community. In order to identify the top* *forecast concerns, we convened three workshops including representatives from the NWS forecast Centers and Regions together with modeling leaders from the Unified Forecast System (UFS). The first workshop (November 2020) identified common forecast concerns, the second workshop (January 2021) followed up on issues that were most prevalent in the global forecast models and the third (February 2021) on issues that were most prevalent in the regional forecast systems. The format of the workshops included active dialogue between forecasters and modelers in order to discuss the current model status and development plans and to identify likely steps to address needed improvements. In this presentation, we will provide the top outcomes from the three workshops, grouped under the workshop topical areas: precipitation, surface temperature, clouds and visibility, convection and storms, coupling with land and ocean, winds and cyclones, and complex terrain. We will also discuss next steps for working with this information and our plans for future forecaster-modeling workshops.*

**95**

Alexander Korner

Icing and Cloud Consistency Study for GFA Improvement

*The Graphical Forecasts for Aviation (GFA) web page from the Aviation Weather Center (AWC) is a graphical replacement for the former hand-written, plain text area forecast. This web capability provides observations and forecasts for aviation fields including clouds and visibility, icing severity, turbulence, and winds. Using the full Rapid Refresh (RAP) model domain, the GFA operationally provides these forecasts over the Continental United States (CONUS), the Carribean, the Gulf of Mexico, and portions of the North Atlantic and North Pacific oceans. The icing severity forecasts are provided from the Forecast Icing Product (FIP) algorithm while cloud coverage forecasts use post-processed fractional cloud coverage fields from the native RAP model. While both the cloud and icing products are meteorologically sound algorithms, due to the differing cloud derivations within, some inconsistency between the products can arise.Inconsistencies were evaluated for the time period 11/18/2020-12/15/2020. These were shown to occur between the icing and cloud products at a rate between 2-5% around flight level FL180. Further studies using other cloud coverage methods were evaluated. This study will show the difference in cloud algorithms, its coverage and how the consistency of the forecasts vary*

**96**

Lisa Kriederman

2020 - A Record Colorado Wildfire Year

*While the state of Colorado had only two-thirds of its area in Drought at the beginning of 2020, a fairly dry spring followed by a non-existent Monsoon Season and then* *record warmth in the summer into early fall, the state ended up having the 9th largest area of D4-Exceptional Drought. The drought stressed vegetation into record dryness levels, and coupled with hot, dry, windy conditions, three of the largest wildfires in Colorado history occurred in 2020. This presentation will explore the antecedent fuel and climate conditions, including the prevalence of beetle-killed forests, as well as the specific weather ingredients that led to the three largest fires in history. The study will briefly highlight the impacts from each fire and novel IDSS provided by the NWS offices affected, and the Incident Meteorologists (IMETS) deployed to the fires.*

**97**

Sheldon Kusselson

Applications of Advected Layer Precipitable Water for Hazardous Weather Events

*Ten years ago the vision of developing an experimental layered precipitable water product for weather forecasters was to supplement and complement the then newly operational Blended Total Precipitable Water with water vapor information at four layers of the atmosphere. Today, Advected Layered Precipitable Water (ALPW) is being prepared to become an operational hourly satellite moisture product in late 2022. In the past ten years applications have been developed for the Advected Layered Precipitable Water product that span many different hazardous weather events such as heavy precipitation that can result in catastrophic flooding/mudslides, excessive snow and ice events and also severe weather such as tornadoes. We are all keenly aware of the importance of low-level moisture to produce hazardous weather. But the origins and transport of upper-level moisture, especially when converging and aligned with low level moisture can many times be the difference between an ordinary weather event and an extraordinary one. Recent case studies and applications of ALPW for several different hazardous weather events that have occurred in different parts of the country and at different times of the year will be presented.*

**98**

Evan Kutta

Developing a Data-Rich Event Planning Tool to Improve Decision Making

*Community event planners often rely on climatic information to identify favorable weather windows while avoiding inclement weather that delays, postpones, or cancels events, especially at outdoor venues. Traditional climatic information is often limited to daily precipitation and maximum and minimum temperatures that are poorly suited to planning events occurring at specific times. An alternative to this may be hourly meteorological terminal aviation routine (METAR) weather reports that were recorded at many United States airports since the mid-20th century thus providing a long-term and temporally rich dataset that is better suited to event planning. METAR observations also contain wind speed and direction, precipitation type and intensity,* *dew point temperature, and sky cover information that would further enhance decision making capabilities of event planners relative to traditional climate datasets. The objective of the current work is to quantify and present hourly averages and variances of multivariate METAR observations in ways that NOAA partners and the general public can understand and use. Preliminary results show diurnal patterns and variability of ambient and apparent temperatures, cloud cover, and precipitation for airports distributed across the country. The current work demonstrates potential to leverage an underutilized, federally-funded dataset to improve community service, outreach, and collaboration while pursuing the National Weather Service's mission to protect life and property while enhancing the economy.*

**99**

Michael Lawson

Decision Support Services in the Bering Sea and Gulf of Alaska: Time to revisit vessel icing class?

*Anchorage/Alaska Sea Ice Program Vessel icing forecasts (also known as "freezing spray"_) are extremely important during the winter months for the Bering Sea, the Gulf of Alaska and their adjacent waters. Vessel icing is a factor in many marine accidents and fatalities involving the Alaska commercial fishing fleet that targets valuable harvests during that time of the year. Commercial fishing vessels remain extremely interested in the location of the sea ice edge, one captain of a crab boat highlighted the importance of freezing spray forecasts in saying, "Sea ice has never killed anyone, but freezing spray has." The primary method for forecasting vessel icing is using the "Overland Nomograms"_ (Overland, et. al., 1986) where sea surface temperature, ambient air temperature, and wind speed are predictands for rate of ice accretion. Two recent examples of catastrophic vessel icing will be presented to reassert that the Overland methodology continues to be fundamentally sound and worthy of application to the forecasting challenge of vessel icing. However, currently, only two classes are used in National Weather Service marine forecasts, light, and heavy; the Overland method divides icing into four distinct classes: light, moderate, heavy, and extreme. The examples presented will highlight the need for a way to differentiate low end moderate events from high end extreme events. Messaging these types of events to our marine customers remains a challenge due to dissemination; i.e., reception by vessels at sea.. We will review some recent examples of decision support service in addition to regular marine products. Overland, J.E., C.H. Pease, R.W. Preisendorfer, and A.L. Comiskey, 1986: Prediction of Vessel Icing. Journal of Climate and Applied Meteorology, pp. 25, 1793-1806.*

**100**

T. Lindley

Assessing Warning Decisions with Enhanced Simulations

*The Weather Event Simulator allows National Weather Service forecasters to meet experiential learning objectives using past weather events in displaced real-time. In 2020, the Norman, OK Weather Forecast Office (WFO) administered simulations with enhanced archival capabilities as a component of Seasonal Readiness Training. These training simulations were self-guided and used to maintain proficiency during the COVID-19 pandemic, establish a baseline measure of unit and individual warning performance, and identify proficiency and training gaps. While similar results are possible via traditional one-on-one WES simulations, automated data collection during these cases permitted unique evaluation of warning decision making. Twelve forecasters were presented with an environmental briefing, concise (<1 hour) convective warning challenges, and a video debrief with outcomes and best practices for immediate self-evaluation while warning issuance metadata were retained within the WES for later analysis in GIS applications. Each forecaster's warnings were compared to a consensus of subject matter experts (SMEs) decisions and relative to their peers. Aggregate simulated warning performance revealed novel insight on the variance of warning decisions. While 100% of forecasters correctly warned for a classic tornadic supercell, warning issuance times for a long-lived EF2 tornado varied by 23 minutes with lead times ranging from 0 to 21 minutes. An average lead time of 8 minutes was compared to 14-minute advanced warning by SMEs based on hindsight knowledge and corollary precursor radar signatures. Only 5.5% of the warned area was common to all warnings, yet the small geographically consistent area was approximately centered over the tornado's point of origin. Otherwise, large variance in the warned area was observed from 307 km2 to 1,311 km2. Lastly, the simulations were designed to have small file sizes that are easily exportable via Google Drive for use at other WFOs.*

**101**

Dan Lindsey

NOAA's Satellite Weather Imaging of the Future

*What will satellite observations of storms look like in 2045? That's one of the questions a NOAA team is actively working to answer. NOAA is preparing to launch its final two satellites in the GOES-R series in 2021 and 2024, and in order to continue uninterrupted geostationary satellite coverage of the western hemisphere since the 1970s, the beginnings of its follow-on program are now underway. The Geostationary Extended Observations (GeoXO) Program is targeting operations from the early 2030s to 2050, and a geostationary imager will be part of that observing constellation. Imagers have been a part of NOAA's GOES series since the very beginning. The*

*Advanced Baseline Imager (ABI) currently flying on GOES-R spacecraft has proven to provide significant observational capabilities in a wide range of applications, including tropical cyclone monitoring, severe storm analysis, fire detection, aerosol detection and tracking, and many others. Given its overall success, the plan for the new GeoXO imager is to start with similar requirements to ABI and then implement some strategic upgrades. These include the addition of a channel in the green portion of the spectrum (near 0.55 ?m), as well as an improvement in the resolution of the 3.9 ?m fire detection/cloud band to 1 km. Additional potential improvements are currently being studied as part of Phase A studies with industry, including spectral channel additions and spatial resolution improvements in some bands, including the "red"_ visible band near 0.64 ?m. This presentation will provide an overview of the envisioned baseline concept and highlight the meteorological implications of the various imager upgrades under consideration.*

**102**

Scott Lindstrom

Forecast Decision Training Division (FDTD) Satellite Applications Webinars: Peer to peer training

*The Cooperative Institutes for Meteorological Satellite Studies (CIMSS) and for Research in the Atmosphere (CIRA) jointly sponsor monthly webinars led by National Weather Service forecasters who discuss how satellite imagery has affected interpretation of the weather, leading to better decision support. CIMSS and CIRA scientists recruit presentations from Twitter postings and conference presentations, and elsewhere. These 30-minute presentations cover a wide variety of seasonal topics; recorded versions are available at http://rammb.cira.colostate.edu/training/visit/satellite_chat/ . Since their inception in 2017, more than 4 dozen presentations have occurred.*

**103**

Scott Lindstrom

CIMSS satellite training support to the NWS Pacific and Alaska Regions

*The Cooperative Institute for Meteorological Satellite Studies provides regionally-focused training to forecast offices in the National Weather Service's Pacific Region (Honolulu, Guam, Pago Pago) and Alaska Region (Fairbanks, Anchorage, Juneau). The climatology of the stations means event-based training is different than over CONUS, with severe weather and sub-freezing events replaced by tropical wind and rain events, and occasional fires during the dry season. This talk will describe how CIMSS scientists created training videos that describe the CIMSS products, and also specific product websites for forecasters, and how training to these remote locations was accomplished during COVID.*

**104**

Kathleen Magee

Interpersonal Training in a Virtual World

*As the world came to a halt in early 2020, the National Weather Service (NWS) continued onward in its goal of protecting life and property. In addition to the normally-scheduled scientific training, the Huntsville Weather Forecast Office (WFO) shifted some focus to traditional "soft-skill"_ training to better help the office acclimate to the virtual world, as well as the rapidly changing methods of communication. Because all offices have faced this challenge over the past year, it is integral to the scientific community that best practices are shared and improved upon by others.In this spirit, some of the best practices for both scientific and leadership training include utilizing Google Forms, Slides, and Jamboard to try and simulate a Weather Event Simulator case, as well as monthly or semi-monthly webinars. The webinar topics ranged from giving and receiving feedback to winter weather forecasting, tying in both professional and personal development to ensure forecaster and office growth during a time when the group cannot gather in the office together. This presentation will go over successes and challenges faced when transitioning planned training to a virtual environment, with the hope that these best practices will continue post-pandemic to ensure a wider audience can be present and involved in training sessions.*

**105**

Kathleen Magee

A Review of the Use of the "Tornado Possible Tag" in Severe Thunderstorm Warnings

*Impact-Based Warning tags were introduced as an addition to severe thunderstorm warnings (SVR) on April 1, 2015 for the National Weather Service (NWS) Huntsville, AL (HUN) Weather Forecast Office (WFO). One of the additions included an appendage at the end of a SVR for a "tornado possible."_ This statement adds an extra sentence to communicate the potential for a tornado that may be difficult to detect on radar, and therefore may not have as long of a lead-time. Since 2015, the "tornado possible"_ tag has been used 208 times out of a total of 749 severe thunderstorm warnings, or roughly 28% of the time. When compared to surrounding offices, the tornado possible tag has been used nearly four times higher than four out of the five neighboring offices for NWS Huntsville, and two times higher than the remaining neighboring office. This study investigates how to verify the "tornado possible" tag in severe thunderstorm warnings. These include determining whether a tornado occurred within the severe thunderstorm warning, downstream of the severe thunderstorm warning, or if a tornado warning replaced the existing severe thunderstorm warning. Additionally, this* *study goes beyond verification statistics and presents additional data, such as primary storm mode, total number of days the tag is used, and "missed"_ events in which tornadoes occurred in a severe warning without the tag, nor a tornado warning. Based on successful uses of the "tornado possible"_ tag, the most common storm mode is linear, such as a line echo wave pattern (LEWP) or a quasi-linear convective system with a history of tornadoes. Future research will investigate these statistics across the Southeast, and compare the use of the tornado possible tag, as well as primary storm mode, to other regions across the United States.*

**106**

Melissa Mainhart

Stop Making Ugly Weather Stories: Developing a Brand to Build a Weather-Ready Nation

*National Weather Service (NWS) meteorologists utilize social media platforms Twitter, Facebook, and Instagram to communicate timely hazardous weather forecasts and information to the public and core partners. In an effort to maximize the reach of this information, NWS offices must create engaging posts with visually-pleasing and easy-to-understand graphics to build the base of followers on these platforms. Inspired by social media posts from NWS Sacramento and NWS Twin Cities, NWS St. Louis overhauled their social media graphics in 2019 by implementing a unique branding, with consistent use of fonts and color, a reduction in number of colors used in graphics, and the addition of unifying features like the "logo bar"_ on all graphics. A major component of this change was the shift to a weather hazard based system for the colors used on a social media graphic; where the dominant color scheme is dependent on the weather hazard being messaged. Microsoft Powerpoint templates were created to streamline graphic production, while also ensuring consistency among rotating operational staff. Macros were utilized in automating common, repetitive tasks such as switching between dominant color schemes or changing out the forecast map used in the graphic. The simplification, modernization, and branding of social media graphics at NWS St. Louis contributed to a substantial jump in public engagement, with nearly double the number of Twitter "impressions"_ from 2018 to 2019. An unintended byproduct of the social media graphics overhaul is the increased amount and quality of weather-related content that is not directly linked to the immediate forecast or hazardous weather, which helped to build and engage the base of followers. As NWS St. Louis examined and adjusted its presence on social media, a culture shift occurred among meteorologists as they recognized the power of social media and its importance to the mission of the NWS.*

**107**

Andrew Mangham

Catastrophic Flooding on the Tittabawassee River

*The Tittabawassee River flows through central Lower Michigan as a major tributary of the Saginaw. The river passes through four dams at Secord Lake, Wixom Lake, Edenville and Sanford Lake before flowing through Midland, Michigan. On May 19, that region of Michigan received precipitation in excess of five inches, surpassing expected totals. The amount of rainfall alone drove a Major Flood forecast for Midland. That evening the Edenville Dam failed, sending a flood surge that breached the Sanford Dam and resulted in record flooding in Midland County and the City of Midland.In the following hours and days the North Central River Forecast Center (NCRFC) worked closely with the Detroit Weather Forecast Office and Midland County, providing twice daily forecasts. The Detroit division of the U.S. Army Corps of Engineers (USACE) began to develop a HEC-RAS model for the Tittabawassee and contacted the NCRFC to ask us for inflows at each of the dam locations. The NCRFC model did not include that level of detail, simply treating the watershed upstream of Sanford Dam as a single hydrologic unit. However, we were able to decompose the total flow at Sanford into four components and provide those flows to the USACE for their model development and calibration. This presentation will include a discussion of the dam failures and the forecasts before, during and after the event. It will also describe our efforts in providing Impact Decision Support Services to critical partners of the National Weather service.*

**108**

Danielle Manning

Impact-based Heat Messaging after Hurricane Laura

*Hurricane Laura made landfall in southwestern Louisiana on August 26th, 2020 as a Category 4 hurricane. Due to the fast movement of the storm, Laura remained a hurricane as it moved across the state of Louisiana, finally weakening to a tropical storm just before crossing into southern Arkansas. The swath of damaging winds extended well inland and resulted in prolonged power outages. Nearly 100% of customers from southwest Louisiana through north central Louisiana were without electricity. With these outages expected to last into mid-September for some areas, forecasters at the NWS offices in Louisiana identified the potential for heat to have major impacts on the recovery efforts and residents. NWS offices throughout the state coordinated with state partners to help highlight heat-related risks and potential hazards during the response and recovery periods. In Laura's wake, forecasters expected afternoon temperatures over 90 degrees Fahrenheit and heat indices in the 100-115 degree Fahrenheit range for weeks. With power outages limiting access to air conditioning, residents and workers would have little reprieve from excessive heat* *conditions. To address this issue, WFOs Lake Charles, Shreveport, and New Orleans/Baton Rouge coordinated with the Louisiana Department of Health, Louisiana Governor's Office of Homeland Security and Emergency Preparedness, the Texas Division of Emergency Management, and the Arkansas Division of Emergency Management to lower Heat Advisory criteria in areas with greater than 10% of the population experiencing power outages during the weeks following Hurricane Laura. In addition, a coordinated social media campaign was made to emphasize heat safety, generator safety, and injury prevention during the recovery period. This presentation will discuss how the National Weather Service partnered with these agencies to address the heat threats following Hurricane Laura and create a unified safety message for both residents and responders.*

**109**

Kevin Manross

Tiny TiM: A Potential Technological Bridge toward Threats-In-Motion

*Most short-fused weather threats, especially convective threats (i.e. tornadoes and severe thunderstorms) move in space and evolve over time. However, the current mechanisms for updating products like severe thunderstorm and tornado warnings often results in inequitable lead times for people out ahead of the approaching weather threat(s). By the nature of the current storm-based warning (SBW) paradigm, those nearest to the current location of the threat(s) in Tornado and Severe Thunderstorm Warnings receive less lead time than those at downstream locations. Even though these warnings can be updated until their expiration, they cannot be nudged forward in either time, nor area, resulting in the need for a new warning, even if the threat continues.The Threats in Motion (TiM) concept, developed by the NOAA National Severe Storms Laboratory (NSSL), in cooperation with the NOAA Global Systems Laboratory (GSL), has aimed to support the technical paradigm necessary for convective warnings that could automatically translate forward in both time and area, providing equitable downstream lead times. However, there are a number of technical challenges that TiM faces before any potential onboarding into the NWS operational environment. Therefore, a technological bridge capability, called "Tiny TiM"_ has been created, in order to demonstrate the core TiM functionalities that could better be incorporated into the current NWS technical and dissemination architecture.Â Although Tiny TiM only provides a limited amount of the full TiM technological capacity, it is seen as a significant step toward potentially equipping the NWS convective paradigm with a more flexible and adaptable public warning service. Additionally, lessons learned from the Tiny TiM project can greatly aid the ongoing development of the full TiM concept. This presentation will detail the specifications of the Tiny TiM project, including development, anticipated timeline and the need for various updated policies.*

**110**

Patrick Market

Preliminary Tests of 'Scaffolding' Efficacy in Student Forecaster Development

*As of this writing, a pilot study is underway to test the efficacy of 'scaffolding' in the training of student forecasters. Scaffolding has been described as "…an instructional technique in which a teacher provides individualized support by incrementally improving a learner's ability to build on prior knowledge." The Campus Weather Forecast effort at the University of Missouri is produced mostly by students in the Synoptic Meteorology I & II sequence. However, these students forecast in a scaffolded environment, where they receive individualized support from the instructor as well as several graduate students, and other undergraduates who have completed the Synoptic Sequence. As such, there is a tiered structure to the expertise and support offered to these students. Through removal of the scaffolded environment, we aim to assess student forecaster performance and confidence and any link that might exist between them. The two tools to assess performance and confidence are: 1) basic numerical forecast scores, and; 2) frequency of terms used in mock area forecast discussions.*

**111 *WITHDRAWN***

Alexandra Marmo

Improving NWS Severe Weather Forecast Briefings by Better Understanding Local Officials' Needs

*During 2016-2017 VORTEX Southeast, one of the authors observed that local officials often attended National Weather Service special briefings. Depending on the situation, they would then engage in intense conversations about the implications a severe weather forecast had on their planning. Background interviews in Alabama revealed that many decisions, with significant cost implications, had to be made about five hours in advance of when severe weather was expected when there is still uncertainty in the forecast. This study is designed to gain a better understanding of the challenges faced in providing severe weather forecasts and how that information is used to make timely decisions. In the first part of this study 24 Weather Forecast Offices were interviewed from Eastern, Southern, and Central Regions. Each forecaster stated that the most important factor conveyed in severe weather forecasts is timing, yet it is one of the most difficult aspects to communicate. The second part of this study conducted focus groups that explored the forecast needs for decision-makers from local emergency management, fire departments, public works, and schools from each of these WFO county warning areas. Background and event-based interviews with these officials were conducted from September 2020 through summer 2021. This presentation focuses on what end-users need in a severe weather forecast and how severe weather forecast products are used for preparations and decision-making.*

*Timing aspects of severe weather forecasts are of particular interest to these groups and the NOAA Storm Prediction Center has made experimental tools available to assist WFOs in providing timing information specifically for tornado, wind, and hail threats. We pay special attention to whether that information is used and if there are instances of misunderstanding or misuse of timing information in forecasts more generally.*

**112 *WITHDRAWN***

Patrick Marsh

Lessons Learned from the 2021 Eastern Oklahoma Severe Weather Season

*This presentation will review select events from the 2021 severe weather season across eastern Oklahoma, with a focus on highlighting potential forecast and nowcast challenges along with the difficulty in communicating them to the public. Included in this presentation will be discussion as to how new products and services being developed by the Storm Prediction Center, such as severe hazard timing guidance, new forecast and nowcast tools, and next-generation mesoanalysis might help address these challenges in the future.*

**113**

Steven Martinaitis

Performance of MRMS QPEs at Different Spatial Resolutions

*The Multi-Radar Multi-Sensor (MRMS) system for the CONUS domain contains a suite of quantitative precipitation estimation (QPE) products at a 1-km horizontal spatial resolution on a Cartesian grid. Two projects under the Disaster Related Appropriation Supplemental: Improving Forecasting and Assimilation (DRAS 19 IFAA) look at applying different spatial resolutions to two different projects. One project examines the potential use of the MRMS framework for a new Multisensor Precipitation Estimator (MPE) system that moves MPE away from the 4-km HRAP grid to the 1-km MRMS grid. The other project investigates the use of a 500-m horizontal resolution for the MRMS CONUS domain.This study uses a limited domain area centered over Harris County, Texas to evaluate the statistical performance of MRMS radar-derived QPEs generated at a 4-km, 1-km, and 500-m resolution. Four cases of different meteorological phenomena (Hurricane Harvey, frontal passage with stratiform precipitation, and two severe convective events) were examined over the limited domain area using hourly and daily gauge observations. Results focused on typical QPE statistical measures along with results examining the statistical significance between resolutions. QPE coverage compared to hourly gauge observations were also conducted to generate skill scores of the different horizontal resolutions. The results from this study will help determine the best path forward for implementing the most beneficial resolution of QPE data within the MRMS system and in future MPE development.*

**114**

Kristian Mattarochia

Probabilistic Characteristics of the Damaging January 18th-19th 2021 Mono Wind Event

*Downslope winds are common during the fall and winter months across the west facing slopes of the central Sierra Nevada and the foothills of central California. This event was anomalous and widespread, partly due to the weakening of trees from the 2020 Creek Fire. Yosemite National Park (YNP) estimated $200 million in damage with a loss of 15 Giant Sequoia trees approximately 1500 years old. Research has been conducted to classify Mono Wind events by Charles Ruscha Jr. in "Forecasting the Mono Wind"_. This was a Type 2 event (Jet Stream Mono), characterized by the polar jet axis flowing perpendicular to the Sierra Nevada (Northeast to Southwest oriented jet axis), allowing cold air from the Great Basin to travel into the Sierra Nevada foothills. Type 2 events can be destructive in the foothills overnight, which occurred. Observed gusts exceeded 50 miles per hour (mph), with 100 mph gusts along the Sierra Nevada crest.The EFI (Extreme Forecast Index), NBM (National Blend of Models) Wind Gust Probabilities, NAEFS (North American Ensemble Forecast System) anomalies, NAEFS climate record return intervals and the HREF (High-Resolution Ensemble Forecast) Gust Max, all contributed to effective probabilistic IDSS (Interactive Decision Support Services). This unique combination of datasets led to high forecaster confidence. These datasets can be further verified, since YNP is working with Pacific Gas & Electric to install a wind sensor, after the partners were introduced during an NWS Hanford simulation. This verification will increase the use and confidence of probabilities at NWS Hanford to align probabilities with core partner impacts.*

**115**

Shannon McCloskey

Exploring How Early Season Tropical Cyclones Indicate Full Season Activity

*Colorado State University's tropical meteorology project has made annual predictions of tropical cyclone activity for each hurricane season since 1984. Others have since joined this effort, with seven organizations making predictions for the 2019 Atlantic-basin season by early August. While their predictions are made using skillful numerical models, these predictions do not factor in information about tropical storms that have already occurred. Climatologically, the goal of this research is to find out if early tropical cyclone formation can help indicate how active the rest of the hurricane season will be. A skillful relationship from early season activity from historical data could aid seasonal hurricane predictions.The data shows a significant relationship between when the season's first five tropical storms form and the number of storms that form across the full season. This relationship is increasingly strong with each* *tropical storm that forms. As we go from the first to the fifth storm, the increasing strength of this relationship also reduces the range in the confidence interval. This gives us a range that is narrow enough to be useful for predictions.*

**116**

Lukas McGuire

The Long Term Variability of Soil Moisture and Recent Severe Weather Activity in the Central USA

*Previous studies have demonstrated that El Nino and Southern Oscillation (ENSO) have a distinct impact on the occurrence of severe weather and the attendant environment in the eastern two thirds of the USA. Typically, La Nina years have been shown to be more active in the central USA. Here, a previous study for severe weather (tornado and hail) activity Missouri and the neighboring states of Iowa, Nebraska, and Kansas is performed for the most recent two decades. The tornado activity study revises an earlier study of the late 20th century by this group. The datasets used in this study were the National Centers for Environmental Prediction / National Center for Atmospheric Research (NCEP / NCAR) re-analyses and the National Oceanic and Atmospheric Administration (NOAA) Storm Prediction Center (SPC) event archive. The results demonstrated that recently severe weather activity in this region was higher than that of the late 20th century suggesting interdecadal variability. The interannual variability in the latest two decades is similar to that of the last half of the 20th century. Finally, these results will show that there is a correlation between the in-season soil moisture and severe weather activity, but it is not clear whether the correlation was a lead or lag.*

**117**

Dan McKemy

Is it a bird? Is it a plane? No, it's a drone!

*River flood and storm damage surveys have looked a little different this past year in parts of the Ohio Valley. The author's agency was the recipient of a grant/proposal from the Office of Marine and Aviation Operations Uncrewed Systems Operation Center that provided funds to acquire drones for use on river flood and storm damage surveys in their region. While portable drone technology has been around for many years, its use in surveying flood and damage from storms has been very limited. The primary focus of this project has been for hydrology surveys during times of river flooding. In addition to video imagery, still images collected from the drones have been transformed into orthomosaic maps and 3D models that will give researchers and scientists additional datasets to improve river flood forecasts and models. This imagery may also lead to validation of flood inundation maps for specific river points across portions of the region. The secondary focus of this project has been for storm* *damage surveys. Drones have allowed storm surveyors to assess damage quickly from the air, improve tornado damage length and width estimates, and provide safety benefits to personnel. This presentation briefly will discuss how we acquired the drones, the benefits that we have noted with the use of drone technology in these types of surveys, as well as some of the results/imagery that have been generated from this project.*

**118**

Casey Davenport

Radar Characteristics of Observed Supercell Thunderstorms Interacting with the Appalachian Mountains

*Few studies have ventured to understand how supercell thunderstorms behave while interacting with complex terrain, though it poses a significant short-term forecasting problem. The few that have investigated this relationship tended to use small sample sizes, limited idealized simulations, or only focused on convection initiated by the terrain. This study aims to fill that gap by analyzing a large observed dataset of supercells interacting with the Appalachian Mountains. A total of 62 isolated supercells observed within the central and southern Appalachians between 2008 and 2019 were analyzed. Each supercell was categorized based on the extent of their interaction with the terrain (either crossing or non-crossing); the majority (37) were classified as non-crossing, while a smaller minority (25) were classified as crossing. Initial analysis of storm tracks suggest that terrain effects are sensitive to the local topography, meaning that results should be examined within various subregions of the Appalachians. To better understand how supercells respond to variations in terrain, each supercell was tracked over its lifetime using GR2 software. GIS was used to obtain additional information about the elevation, slope, angle of approach, and aspect. A variety of radar characteristics were collected for each storm, including reflectivity, velocity, maximum expected hail size (MEHS), echo tops, and mesocyclone intensity, depth and diameter. These parameters will be compared to variations with the terrain among the crossing and non-crossing categories, and will also be correlated to the production of severe weather. Further statistical analysis will be used to compare crossing storms to non-crossing storms. The goals of this study are to understand how radar characteristics change as supercells interact with complex terrain and to provide forecasters with a better understanding of what supercells are more likely to produce severe weather for more accurate forecasts.*

**119**

Keith Meier

On a Collaborative Forecast Process in the US National Weather Service-Past, Present and Future

*With the expanding capability to produce and communicate high-resolution georeferenced data within the various domains of the National Weather Service (NWS), there is an urgent need to better define the forecast process. For the past five years, the Program Management Office of the NWS has been exploring what is referred to as the "Collaborative Forecast Process (CFP)."_ A goal of the CFP is to leverage expertise at all levels of the agency to produce forecast data that is consistent in space, time, and scale--without loss of skill.In the Fall of 2018, a tabletop exercise was performed to map the workflow between the NWS's Weather Prediction Center (WPC) and NWS Weather Forecast Offices (WFOs) in the contiguous United States (CONUS) during the creation of a CONUS quantitative precipitation forecast (QPF). From this activity, a framework of attributes for a CFP demonstration was developed in the Spring of 2019. Technical requirements for this demonstration (e.g., dataflow), were tested in 2019 and a comprehensive Demonstration Plan was written and approved in 2020. During the Summer of 2020 a virtual demonstration test was conducted by the NWS Operations Proving Ground. This presentation will go over the activities leading up to a CFP demonstration and talk about where we are at the current time and where we plan to go. Also, how this will affect NWS products and services.Specifically, the QPF CFP demonstration just beginning this summer, tests the ability of direct collaboration between WPC and the WFOs, while minimizing operational risk. The foundation of the demonstration focuses on a common starting point, common forecast tools, and common collaboration tools that guide the need for collaboration. Roles, responsibilities, and deadlines that best meet needs related to Impact-based Decision Support Services (IDSS) will be defined.*

**120**

Valerie Meola

The Nor'easter of January 31 - February 2, 2021: A Study of Winter Precipitation Types

*The winter of 2020-2021 offered a cornucopia of various winter precipitation types across the Mid-Atlantic region. One example of such an event was a strong Nor'easter at the end of January 2021. Initially, the precipitation type was snow across most of the region. As the deformation band formed, a zone of mixed precipitation occurred just northwest of the I-95 urban corridor with light snow being reported both northwest and southeast of the mesoscale banding. This unique precipitation-type sandwich occurred as a zone of warm air in the low and mid-levels fractured west of a developing low pressure center. Exactly where banded precipitation forms and what* *type it is, has a big impact on the area due to the highly populated I-95 corridor. This study describes the synoptic overview leading up to the event, and the resulting potential for a prolonged period of a narrow, but impactful, band of heavy precipitation over the National Weather Service (NWS) Mount Holly forecast area. This is followed by a detailed precipitation- type analysis of the Nor'easter using both WSR-88D legacy and dual-polarization products. Ground truth from supporting social media and mPING reports are then compared alongside the radar imagery to confirm the analysis.*

**121**

Robert Millis

Optimize Weather Storytelling and Workflows in the Cloud

*The demands of modern broadcasting are challenging stations to break out of traditional structures into new production models designed for speed and flexibility. Not only must stations create cohesive user experiences across broadcast and digital platforms, they must also do so with an infrastructure that supports employee access and collaboration from remote locations, whether it's a sister station across the country or a meteorologist's garage. Imagine if you could leverage the collective skills of producers, designers and meteorologists across your station group to create more content in a faster and more efficient manner. Hyper-scalable hybrid cloud solutions extend broadcast capabilities beyond the walls of a station, unlocking the full potential of an entire station group through increased collaboration, streamlined workflows and more cost-effective, faster disaster recovery options.Max Cloud was built to deliver these capabilities. Meteorologists can simultaneously work together in regional workgroups or even fill in for one another as needed. Max Cloud also allows for low-friction content sharing and distribution, enabling virtually any producer, designer, or -meteorologist to contribute to shows for multiple markets. This feature is especially valuable during long-duration severe weather, winter, or tropical events where any meteorologist can contribute scenes or coverage to the impacted market.Max Cloud also helps with managing costs because it reduces the need for hardware in every market. It maximizes the efficiency of your digital video production by centralizing the management of rendering tasks and distributing them across all Prism workstations in your station group.In summary, Max Cloud helps deliver a level of enhanced collaboration between meteorologists who can maximize their value, whether they're on-air or behind the scenes, and elevate weather presentations across the entire station group to help keep their audiences informed and safe.*

**122**

Matthew Morris

An Update on the Development of NOAA's 3D Real-Time Mesoscale Analysis (3D-RTMA) Suite

*Work has been underway at NOAA's Environmental Modeling Center (EMC) and Global Systems Laboratory (GSL) since 2018 to upgrade the variational 2D Real-Time Mesoscale Analysis (RTMA) system into a hybrid ensemble/variational 3D-RTMA system with a 15-minute update cycle. The final upgrade of the 2D system, which provides hourly analyses of sensible weather elements over domains that encompass CONUS, Alaska, Hawaii, Puerto Rico, and Guam, was implemented operationally on 28 July 2020. The first operational implementation of the new 3D-RTMA system is expected in FY2023. The system will compute full-column analyses of sensible weather parameters (e.g., temperature, wind, clouds), and will diagnose fully consistent 2D weather parameters such as cloud ceiling height and horizontal visibility, which are critical to aviation operations. The system will also provide diagnostics of a range of land-surface fields and convective fields. Work is underway to replace the current Gridpoint Statistical Interpolation (GSI) system with the emerging Joint Effort for Data assimilation Integration (JEDI) system, and the HRRR model, which provides the background fields, with the upcoming Rapid Refresh Forecast System (RRFS). A highly scalable multigrid/beta filter that incorporates AI/ML techniques is also under development to replace the GSI's recursive filters for background error covariance modeling. The use of a dynamic downscaling for the RRFS-based background field is being explored. The 3D-RTMA system will also include an enhanced, fully automated quality control package for surface observations with the goal of more efficiently removing poor quality observations from the analysis in real-time. This presentation will provide a brief overview of recent development on the 3D-RTMA system, as well as results from evaluations in NOAA testbeds. Lastly, current and future opportunities for stakeholder engagement in the 3D-RTMA development process will be discussed.*

**123 *WITHDRAWN***

Richard Mosier

Trends in Severe Storm Reports and Associated Environments Over the Past 20 Years (2001 - 2020)

*The National Centers for Environmental Information maintains a database of official storm reports dating back to 1955. This database includes storm reports associated with severe thunderstorms, including large hail, damaging wind gusts, and tornadoes. Additionally, the National Weather Service (NWS) Storm Prediction Center maintains a database of preliminary severe storm reports, with report data going back over 20 years. Various trends within these datasets are explored and compared, including the number of days per year with more than 100 severe reports, number of days per year* *with significant severe reports (i.e., ?2"_ hail, ?65 kt wind gusts, and/or ?EF2 tornado), and ratio of estimated wind gusts to measured wind gusts per year. Trends within specific geographic areas, including regions, counties, and NWS County Warning Areas, are also presented. The trends in report occurrence are compared to the trends of the associated severe thunderstorm environments. Various hypotheses attempting to explain the more notable trends are also made.*

**124**

Robert Munroe

Bringing it Home: Infusion of Social Science into WFO Culture

*The field of social science (ss) in meteorology holds great promise in assisting the National Weather Service (NWS) to achieve its goals related to impact based Decision Support Services (iDSS). Assimilating ss into the operational environment of the NWS also presents various challenges. These include forecaster recognition of the value of ss in meteorology and its incorporation into an already burdened forecaster workload. To address these challenges, the NWS Weather Forecast Offices (WFOs) in Greenville-Spartanburg, SC and Morehead City, NC, in collaboration with social scientists at the NWS Weather Program Office, are working to integrate ss into NWS operations. The ultimate goal of this work is to improve NWS products and services through increased forecaster participation in ss efforts. The first step to incorporating ss into NWS operations is an education campaign aimed at connecting meteorologists with social scientists. This effort targets creating more awareness of research that has already been done in the field and demonstrating products and services currently available for forecasters to use in their current workflow. This includes NOAA Hazardous Weather Testbed experiments, social scientist presentation, and demonstration of web based tools. The second step in the immersion process is to merge forecaster innovation and ss concepts to enhance iDSS products and services. The creation of a WFO ss focal point has shown promise in infusing ss related concepts and tools into operations. Taking these progressive steps will help to better meet the needs of NWS core partners, such as emergency managers and members of the media, to identify and more effectively message at risk populations. Examples of challenges and successes regarding the incorporation of ss into NWS operations are provided here in an effort to raise awareness and elicit further input from all interested parties in order to advance the state of ss within operational meteorology.*

**125**

Sylvia Murphy

Report from the 2021 Threats-in-Motion (TIM) Dissemination Workshop

*Threats-In-Motion (TIM) is a warning dissemination approach that would enable the National Weather Service (NWS) to enhance the capabilities of severe thunderstorm* *and tornado warnings from the current static polygon system to continuously-updating polygons that can be advanced spatially and temporally with the storm. TIM represents an initial step in shifting the current NWS convective watch and warning paradigm toward a continuous flow of information. More specifically, a warning polygon is allowed to more appropriately follow the path of an advancing threat, keeping the warned area ahead of the approaching threat, such as a tornado. Moving polygons are just part of the picture, however. At some point, the results of this new system must be disseminated. To do so, will current NWS software need to be modified? Will data formats need to change? Will forecaster workflows need to be changed? What will be the needs of downstream partners? To answer these questions, the TIM program conducted a workshop to gather input from the community. Because of COVID-19, the workshop was held virtually and the sessions spread out over several months from March-May 2021. This presentation will provide a summary of the results of the workshop, how these results will be folded into future development, and lessons learned that can be applied across the operational weather enterprise.*

**126**

Laura Myers

A Case Study: Developing a Foundation for Connecting Vulnerable Communities

*Deep connections create lasting change -- as true for relationships between organizations as for interpersonal relationships. Connecting communities within and beyond the weather enterprise is essential to the core success of the enterprise. This presentation will describe and distill the efforts of a multi-organizational team to improve future climate and disaster resiliency for the over 3,500 square mile area and population of 26,000 northern Arapahoe and eastern Shoshone residents on the Wind River Reservation in central Wyoming. Rich in perspectives, experiences, expertise, and collaborative spirit, and supported by a grant from the Bureau of Indian Affairs, we are faced with the challenges of working effectively and well in partnership with the residents of the Wind River Reservation. Coming from different socio-cultural backgrounds, we need to think from the perspective of the tribal community, and to do that, we need to learn to see from their perspectives and come to understand their worldview. Placing the community of Wind River at the center of our efforts means letting the community educate us about their values, beliefs, and practices as well as about their practical needs and expectations. We are adapting human centered design strategies to transform how we have come to work with the community from the perspective of the community. Human-centered design begins from the perspective of the community and not from that of an external "expert"_. Here are 5 guidelines derived from our work in this vulnerable community:1.Ask open questions and listen carefully to the answers.2.Be a student of the sub(culture) and learn their manners.3.Be humble even when you are the expert in that moment.4.Be patient even if you have to learn how to do that.5.Look for what lies beneath and beyond the words spoken.*

**127**

Steven Nelson

Lessons Learned from Hurricane Delta's Forecasts and Impacts to Metropolitan Atlanta

*Hurricane Delta made landfall along the Louisiana coast on Friday, October 9th, 2020 and tracked west of Georgia over the weekend. Unfortunately, model forecasts 12 to 72 hours in advance of the expected impacts in Georgia were not ideal. While precipitable water values were correctly forecast to be in excess of 5 cm, instability and low-level vertical wind shear were substantially under-forecast. The forecasts did not resolve the potential for severe storms until after staffing and other planning decisions by the Atlanta WFO and partner agencies had been finalized.Numerous severe weather warnings were issued Saturday afternoon and Saturday night, including 21 tornado warnings. Seven weak tornadoes were later confirmed. Later that evening, as deep moisture associated with the center of the remnants of Delta moved into the area, the increased convection and efficient rain processes resulted in much greater rain rates and runoff than forecast. Ultimately, 15 to 25 cm of rain fell within a 3 hour period, and primarily over the more urbanized parts of the Atlanta Metropolitan area. The resulting flash flooding led to numerous swift-water rescues and washed out or closed numerous roads.This presentation will compare the forecast and observed parameters for tornadoes and flash-flooding and document the resulting impacts to NWS and partner planning and operations. Best practices obtained from the lessons learned will also be crafted in order to minimize future risks associated with planning decisions based on limited information.*

**128**

Steven Nelson

Performance of the Georgia Automated Environmental Monitoring Network during Extreme Wind Events

*Since 1991, the University of Georgia's Automated Environmental Monitoring Network (AEMN) has provided mission-critical weather and soil environmental data to various private and public users, including the National Weather Service. The usefulness and resiliency of the network, particularly during extreme wind events, has proven to be significant. As Hurricane Michael moved northeast into southwest Georgia during the afternoon of October 10, 2018, the AEMN site near Donalsonville remained operative through the peak of the storm and measured a peak wind of 51 m s-1. An EF-2 tornado on March 3, 2019, came within 200 feet of the AEMN station near Cairo which measured a peak wind of 47 m s-1. Several other extreme wind events have also been captured with AEMN and will be presented. These extreme wind events are just a few among many types of weather and environmental phenomenon that have been captured only by state-based surface mesonetworks. It also demonstrates the need for* *continued support and cooperation between private weather services partners and NOAA's National Mesonet Program and Meteorological Assimilation Data Ingest System (MADIS).*

**130**

David Novak

The Weather Prediction Center: Leveraging Ensembles to Aid Partner Decisions

*The Weather Prediction Center (WPC) is the nation's premier Center for forecasting heavy rain, winter storms, and relaying the big-picture weather story to enable national readiness for hazardous weather events. The Center accomplishes this mission through human interpretation and specialized post-processing of ensemble information. This talk will discuss WPC's experience in serving as a bridge between raw ensemble information and the critical decisions partners make. Particular emphasis will be placed on the improvement and development of probabilistic winter weather and rainfall services that aid partner decisions.WPC is committed to supporting a cascade of NWS services from probabilistic Outlooks, to Watches, to Warnings that gradually ramp up urgency as the confidence increases and details become clear. The Center has recently developed probabilistic outlooks that help partners with the predictability challenges of heavy rainfall, winter weather, and medium range forecasts. Recent focus has been on improving the calibration and sharpness of the heavy rainfall and snowfall ensemble distributions - particularly at the tails of the distribution (representing extreme events). Further, the Center provides specialized post processing to place ensemble forecasts in context - quantifying the rarity of forecast events through recurrence intervals, record alerts, and standardized anomalies. Examples of these products will be shown.The expansion of probabilistic forecasts, extensions in time, and increased provision of decision support have revealed challenges. Partner expectations of accuracy, specificity, and lead time often exceed current capabilities. To address these challenges the Center hosts intensive annual experiments testing new ensemble techniques among a diverse audience of operational forecasters, developers, and researchers. Examples of these challenges and key experiment findings will be highlighted in the talk.*

**131**

Kyle Pallozzi

Comparison of 90th Percentile Accumulation Snowfall Guidance: NCEP/WPC and National Blend of Models

*National Weather Service (NWS) impact-based decision support services (IDSS) are a critical function of the agency at all times, but especially so leading up to high-impact winter weather events. In addition to traditional deterministic snowfall forecasts, the 10th (low-end amount) and 90th (reasonable worst case scenario) accumulation* *percentiles of snowfall provide critical information used in IDSS messaging leading up to high impact winter events. The 10th and 90th snowfall accumulation percentiles from the NWS, National Centers for Environmental Prediction (NCEP), Weather Prediction Center (WPC) Probabilistic Winter Precipitation Forecast (PWPF) guidance, have traditionally served as the forward-facing product briefed to partners during IDSS within 72 hours of an event. Over the past five years (2016-2020), WPC's percentile snowfall products have portrayed the range of possibilities in storm total snowfall accumulations reasonably well in most cases.More recently, starting for the 2019-2020 winter season, the NWS National Blend of Models (NBM) has been routinely producing probabilistic snowfall percentile accumulation forecasts. With the advent of visualization tools (such as the WSUP and NBM 1-D viewers), these data are now more readily available to NWS forecasters. This study examined the performance of the 90th percentile from both WPC and the NBM for a portion of the Mid-Atlantic region. Findings from this study may help to identify future areas for improvement in both products.*

**132**

Brian Pettegrew

Transition of World Area Forecast System Hazard Forecast Upgrades

*The World Area Forecast System (WAFS) was sanctioned by the International Civil Aviation Organization (ICAO) regarding the provision of meteorological information. The WAFS consists of two World Area Forecast Centers (WAFCs), the United Kingdom's Met Office and the United States' National Oceanic and Atmospheric Administration (NOAA) Aviation Weather Center (AWC). As part of the WAFS service, the WAFCs provide gridded forecasts of meteorological hazards to aviation, including turbulence, icing, and convection. To meet ICAO requirements, the AWC and the NOAA Environmental Modeling Center (EMC) collaborated to upgrade gridded hazard data on the upgraded Global Forecast System version 16 (GFSv16) to demonstrate to users the latest advancements in numerical weather modeling. These enhanced hazard grids include the implementation of the global Graphical Turbulence Guidance (GTG) turbulence forecasts in the units of Eddy Dissipation Rate (EDR) and the categorization of in-flight icing into impactful hazard severities. Future work will include the implementation of enhanced hazard grids into global ensemble forecast post-processing.*

**133**

Steven Piltz

Creating Near-Storm Environment Data for Use In Hazard Services In Support of Warning Operations

*The National Weather Service (NWS) Weather Forecast Office (WFO) in Tulsa, Oklahoma creates near-storm environment (NSE) data within the NWS's Graphical Forecast Editor (GFE). These NSE data have aided in warning decisions when spatiotemporal severe weather parameters have been complex. To further explore the use of these NSE data, the NWS is conducting an experiment at WFO Tulsa during the Spring of 2021. WFO Tulsa staff, with assistance from the National Oceanic and Atmospheric Administration's (NOAA's) Global Systems Laboratory (GSL), have modified a Hazard Services (HS) beta release (the next generation watch/warning creation software) to ingest a probabilistic field based in part on GFE-derived NSE data enhanced by a mesoanalyst. Forecasters use these data inside HS as a starting point to generate the probabilities needed for a Probabilistic Hazard Information (PHI) plume. The resultant probabilities are anchored by the Cooperative Institute for Meteorological Satellite Studies ProbSevere Model and projected forward in the PHI plume using differences between ProbSevere values and the probabilities created by the mesoanalyst. During select events, WFO Tulsa staff ran parallel warning operations utilizing a Weather Event Simulator (WES-2) workstation provided by the NWS's Advanced Weather Interactive Processing System (AWIPS) Program Office. While this WES-2 machine had only a partial live dataset, the functionality was sufficient to test the digital flow of information between the mesoscale meteorologists and the HS environment. By incorporating NSE data into HS, this work builds upon previous experiments that utilized predefined probability curves. This presentation will show the flow of NSE data into HS and evaluate their value. Additionally, the modified HS environment will be shown and the challenges related to the reference classes of the data discussed.*

**134**

Cody Poché

The Richmond Metropolitan Flash Floods of 15 August 2020

*On the morning of the 15th of August, 2020, heavy rain resulted in significant flash flooding across the Richmond, Virginia metropolitan area. The western portion of Chesterfield County, Virginia received between eight and ten inches of rain during the early morning hours. Multiple water recues took place as roadways became flooded and impassible. Rapid rises in local streams and creeks caused major damage, including in Pocahontas State Park, south of downtown Richmond. Several Flash Flood Warnings using the "Considerable"_ Impact Based Warning (IBW) tags were issued for the region.Preceding the heavy rainfall event, Tropical Storm Isaias and a tropical low-pressure system, that would become Tropical Storm Kyle off the Mid-Atlantic coast, tracked across central Virginia during the first two weeks of August 2020. Richmond International Airport (RIC) observed greater than twelve inches of rain from the 1st of August to the 14th of August, 2020. Soil conditions were extremely saturated before the heavy rain began on the 15th. A stalled frontal boundary and ample tropical moisture led to heavy rainfall over central Virginia during the morning of August 15th, resulting in significant flooding. The flooding was likely exacerbated by* *the saturated soils from the previous heavy rain events. This case study will look at the synoptic and mesoscale pattern that led to eight to ten inches of rain over the Richmond area on the 15th of August, 2020 and the role of the antecedent extremely wet conditions. In addition, societal impacts related to the use of the of the "Considerable"_ Flash Flood Warning tag for the Richmond Metro Area will be evaluated.*

**135**

Jason Pudlo

Predicting Staffing Needs at 911 Communications Centers using Localized Weather Data

*Severe weather events strain the emergency management infrastructure and 911 communications centers. The communications center staff are often the first point of contact for those in distress and are essential for dispatching emergency management resources around the community. It is important to maintain adequate staffing at these centers to ensure high levels of operation and compliance with existing regulations. In our study, we show that different types of severe weather watches and warnings lead to unequal demands on 911 communications centers. To address this problem, we demonstrate how municipalities can harness localized big-data to predict which types of severe weather events should result in increased staffing at the 911 communications center.To conduct this study, we partnered with a local 911 communications center to analyze 1.8 million calls along with two years of weather watches and warnings as archived by the Iowa State University MESONET. We sought to understand blue-sky staffing levels and predict which weather events would increase stress on the 911 communications center. Using linear regression and ANOVA, we identify patterns in the time of day, season of the year, and severe weather which increase call volume and thus staffing needs. We opted for these analytical methods to promote the replicability and transferability of our methodology to other communities. Our findings speak to two communities. Primarily, we show that weather events influence demand on 911 communications center in unequal and even ways. By harnessing available, but often underutilized data, centers can predict which weather events will cause the most service demands for their community. This will help 911 communications centers in staffing and budgeting requests. Secondarily, this project demonstrates how social scientists can partner with the emergency management community to facilitate data-driven policy decisions and contribute to local resiliency.*

**136**

Casey Davenport

Environmental Evolution of Supercells Interacting with the Appalachian Mountains

*The Appalachian Mountains within the eastern United States have a considerable impact on day-to-day weather, including severe convection. However, the impact of the Appalachians on supercell thunderstorms is not well understood, posing a significant short-term forecast challenge across the region. While there have been some individual case studies conducted, there has yet to be a broad analysis of storm-scale modifications of supercells as they interact with complex terrain. To address this gap, this study examines 62 isolated supercells occurring within the central and southern Appalachians between April and July from 2009 to 2019. Each supercell was broadly classified as either a "crosser"_ or "non-crosser"_ based on their ability to be maintained during their interaction with terrain; the majority of supercells were not sustained downstream of the Appalachians. To identify the environmental controls resulting in crossing or non-crossing storms, near-storm model soundings (either the Rapid Update Cycle [RUC] or the Rapid Refresh [RAP]) were collected for each supercell at three points: (1) upstream of the mountains, (2) near the peak of the terrain, (3) and downstream of the terrain feature. These soundings were used to compute a number of different thermodynamic and kinematic parameters. Preliminary results indicate that the lowest 3 km of shear and storm-relative helicity (SRH) appear to best distinguish crossing and non-crossing supercells. Other composite parameters such as the Significant Tornado Parameter (STP), Supercell Composite Parameter (SCP), and SHERBS3 also display differing values and trends among the supercell categories. Conversely, instability (CAPE and CIN) do not appear to be useful parameters in differentiating between crossers and non-crossers.*

**137 *WITHDRAWN***

Jared Rennie

#ShowYourStripes: Making climate information local with the use of simple visualizations.

*Time series don't appeal to the public. Using simple, eye-catching visualizations, we can have better conversations on climate change, especially at the local level. Ed Hawkins of the University of Reading knew this when creating the climate stripe. The 'warming stripe' graphic is a visual representation of the change in temperature as measured in an area over the past 100+ years. To this day, the #ShowYourStripes website only depicts information at country and US state level. Since NOAA's National Centers for Environmental Information (NCEI) produce trends as far down as the US county level, it makes sense to provide these to build on the work previously done by Hawkins. To that end, scientists at the North Carolina Institute for Climate Studies (NCICS) have developed an interactive ArcGIS Online tool to display temperature* *warming stripes for each county in the US. Precipitation graphics are also provided to depict local rainfall trends. It is hoped these visualizations will have the public better understand climate change and how it is impacting their neck of the woods.*

**138**

Roger Riggin

Idealized Simulations of Supercell Thunderstorms Interacting with the Appalachian Mountains

*A limited number of studies have investigated supercell thunderstorms interacting with elevated and variable terrain. A number of observation-based case studies have been conducted within the Appalachian Mountain region; most identify the varying terrain features as providing an influential role in storm morphology, but do not present a clear, systematic, or comprehensive assessment of its impacts. Prior numerical modeling studies, while enlightening, have largely been limited to investigating the influence of idealized terrain on supercells. Forecasters lack a comprehensive conceptual model to assist with the decision-making process for supercellular hazards in regions of varying terrain. Our overall research aims to increase understanding of the relationships between supercells in complex terrain. Earlier efforts focused on the analysis of environmental and radar characteristics of 62 isolated supercells that traversed the south-central Appalachians between 2008-2019. Observed storms were tracked via radar and classified based on whether or not they crossed significant terrain or not. The current effort uses an idealized numerical model to further investigate the observation-based results. Proximity soundings were constructed from the upstream, peak, and downstream elevation points along the path of each supercell. Composite proximity soundings were then generated to quantify typical crossing vs. non-crossing storm environments. The composites were used to create an evolving background field via a base-state substitution method to investigate supercell behavior as it traverses the complex terrain. Three terrain configurations are tested as well: no terrain, idealized terrain, and realistic terrain in an attempt to isolate terrain-related influences on storm morphology. Sensitivity tests are performed to discriminate forecasting parameters favorable for crossing vs. non-crossing supercells. Preliminary results will be discussed during the presentation.*

**139**

Lee Robertson

A Study of Synoptic Weather Patterns Associated with Red Flag Warnings in the Mid-Atlantic

*Wildfires can occur in any month of the year across the Mid-Atlantic region, with their frequency usually peaking in the spring and a secondary peak in the early fall. As many as 6,000 to 7,000 wildfires per year can occur across the Mid-Atlantic states of*

*Delaware, Maryland, New Jersey, and Pennsylvania, with as many as 10,000-11,000 acres burned in these fires. Red Flag Warnings are issued by local National Weather Service (NWS) forecast offices in advance of dry and windy days to alert the Fire and Forestry Community of conditions that are conducive to rapid and dangerous fire growth. These advanced warnings can help the fire management community prepare for wildfires that have the potential to rapidly spread. Springtime is considered the peak of fire weather season across the Mid-Atlantic, primarily due to the fact that cold fronts that move across the area during the spring months sometimes produce little or no precipitation, while behind these fronts, strong winds and lowering humidity values can occur. Also, because "green-up"_ has not occurred yet, there are more available dry fuels to burn. Using reanalysis datasets, observed soundings, and NWS warning statistics, this study highlights multiple weather patterns found to be correlated with fire weather events across the Mid-Atlantic region. Reanalysis anomaly charts show synoptic characteristics of these weather patterns and composite soundings provide vertical details of mesoscale and synoptic features that contribute to enhanced fire weather days. This study will also highlight a significant Red Flag Warning event as well as a null day. We will conclude by showing correlations between multiple observed weather patterns and enhanced fire weather potential.*

**140**

Ted Ryan

Examining the Use of Rotational Shear for Tornado Warning Decision Making

*Most National Weather Service meteorologists are taught to use rotational velocity to assist in tornado warning decisions. This methodology is useful, but may be incomplete because it does not objectively incorporate a mesocyclone's diameter. Several studies have hypothesized that smaller diameter mesocyclones produce tornadoes with lower rotational velocity values than their larger-sized counterparts and this must be accounted for by the warning meteorologist. Experienced meteorologists often apply a subjective determination of the character of the radial velocity pattern to complete their decision-making process. However, less experienced meteorologists have not yet developed this intuition which means they would benefit from using an objective metric incorporating rotational velocity and mesocyclone diameter (e.g., rotational shear). While some research suggests that rotational shear may be better at predicting tornadogenesis than rotational velocity, its adoption into warning decision making remains elusive. This is likely due to a combination of the difficulty for a forecaster to calculate rotational shear on-the-fly and the lack of a comprehensive investigation of the parameter within a larger database of tornado-producing convection. Using the tornado climatology database developed by Smith et al. 2015 and the non-tornadic convection database in Thompson et al. 2017, we will show why rotational shear is superior to using rotational velocity. We will also provide suggested rotational shear warning decision thresholds. The results suggest it is not only important to use rotational shear, but also to develop tools and methodologies to quickly interrogate it during the warning-decision making process.*

**141 *WITHDRAWN***

Paul Schlatter

Verifying Landspout Tornadoes

*In the mid-evening hours of May 20, 2020 and with the span of about 90 minutes, 6 landspout tornadoes formed across a relatively small area in Weld County, Colorado. Landspout tornadoes are common across the High Plains of Colorado, but the tornadoes on May 20th were a bit unusual in that they moved to the northwest and were 6-8 miles removed from the nearest precipitation cores. Eyewitnesses reported seeing two simultaneous tornadoes on two separate occasions. This presentation will provide a brief summary of the mesoscale meteorology that generated the tornadoes, and then dive into the myriad of challenges associated with trying to verify the number, location, and timing of the tornadoes. The tornadoes were visible from up to 20 miles away, and with several in close proximity to each other, it was a massive undertaking to determine which eyewitness saw which tornado, at what time, and from how far away. The verification itself was extremely detailed and took a week to sort through all of the eyewitness evidence in the form of emails, videos, photos, and in-person interviews (during the COVID pandemic to boot). Many best practices were gleaned from the verification process that will be of interest to anyone in the verification business. A final, novel aspect of the event was that WFO Boulder had access to Colorado State University's high quality C-Band Dual-Pol Doppler Radar (called "CHIVO"_). The presentation will show how a well-placed C-band radar can make a massive difference in the verification process.*

**142**

Joshua Schroeder

Service Back-Up Redefined: NWS Local Operations amid the Devastation of Hurricane Laura

*The NWS Southern Region (SR) has built a robust service back-up (SBU) network to ensure continuation of the delivery of life-saving forecast and warning information during high-impact events. Each SR Weather Forecast Office (WFO) has three or four offices at the ready to provide SBU, if needed. After Hurricanes Irma and Dorian tested the network, improved documentation was developed and SBU pairings were redrawn. Such improvements proved invaluable when, during the morning hours of 26 Aug 2020, the decision was made to evacuate WFO Lake Charles (LCH) due to approaching Hurricane Laura. This storm was forecast to make landfall as a Category 4 hurricane in southwest Louisiana that evening. WFO Brownsville (BRO), one of the primary backups for LCH, immediately assumed responsibility for all of LCH's forecasts and warnings, including tropical products. Other offices, such as WFO Houston and WFO Tampa Bay, took over LCH's riverine hydrologic and aviation forecasts while WFO Austin/San Antonio provided aviation and warning assistance to BRO. This* *arrangement continued for approximately four weeks, though it had to be temporarily adjusted when Tropical Storm Beta threatened multiple offices along the NW Gulf coast during mid-September. As a result of efforts by SR and local staff, LCH was able to resume all forecast and warning responsibilities on 25 Sep.While a backup of similar length occurred following Hurricane Maria in 2017, this situation was unique in terms of complexity and number of offices involved. This presentation will highlight some of the unique "firsts'' that occurred, such as issuance of an initial Extreme Wind Warning in SBU mode and utilizing teleworkers to draft aviation and hydrologic forecasts. While this backup effort was deemed overwhelmingly successful, I will also discuss several lessons that were learned, such as future best practices in the areas of WFO continuity of operations and reconstitution after extreme weather events.*

**143**

Philip Schumacher

Using Probabilistic Information for Messaging Winter Storm Impacts

*Winter storms have significant impacts on society. Snowfall timing and amounts, precipitation type, and snowfall rates all contribute to the degree of impact. Determining the likelihood and severity of those impacts includes uncertainty, which varies based on the type of event and lead-time. The uncertainty in a forecast can be quantified by ensemble forecasts. Ensemble data is available to the National Weather Service (NWS) and allows meteorologists to go beyond deterministic forecast information and communicate the probability of different weather conditions. The challenge for the NWS is using these data in assessing and messaging winter risks and uncertainty to decision makers and the public in a way that is understood and consistent across the nation.During the winter of 2020-2021, 9 offices in the Central Region of the NWS tested new methods for communicating uncertainty about winter weather to the public and partners using probabilistic data. We developed a messaging strategy based upon the confidence of different winter hazards occurring. This messaging strategy had 4 levels -- outlook, continued outlook, watch and warning phase -- and the type of probabilistic information shared was based upon the messaging level. When the storm was 2 or more days out, probability of exceedance graphics were often used to communicate the snowfall potential. As the storm neared, snowfall graphics using the 25th and 75th percentile were used to message snowfall ranges. Probabilistic information was also used to help define snowfall timing, the evolution of precipitation type, wind speeds, and wind chills. To ensure a consistent message among offices, we developed a messaging dashboard for inter-office collaboration and messaging creation. Results from the testbed, including forecaster surveys, will be used to provide recommendations for improving the use of probabilistic information to NWS partners for the winter of 2021-2022.*

**144**

Philip Schumacher

Verification of Hail and Wind Tags Associated with Severe Thunderstorm Warnings

*Severe thunderstorms cause billions of dollars of damage across the United States each year resulting in numerous injuries and deaths. The impact of severe thunderstorms is related to the associated hail size and wind speed. Maximum hail size and wind speed expected with severe thunderstorms have been included in National Weather Service (NWS) warnings since 2015. The NWS forecasts of hail size and wind speed determine the expected impacts from severe thunderstorms. Severe thunderstorm damage tags, based upon forecasted hail size and wind speed, will be included in warnings beginning in 2021. To determine the reliability of damage tags with warnings, we verified the hail and wind forecasts from NWS severe thunderstorm warnings from 2015-2018. Our initial analysis from the northern plains shows that 63% of warnings were issued for both damaging winds and large hail. Another 22% (15%) of warnings were issued only for hail (wind) only. Forecasters had skill in differentiating between hail-only versus wind-only threats as less than 5% of hail-only (wind-only) warnings were verified by wind (hail). Over 50% of hail-only (wind-only) warnings were verified by hail (wind). Forecasters also showed some skill in differentiating between storms with or without significant hail (? 2 in.) as a plurality of significant hail events occur in warnings where significant hail was forecast. Less skill was shown with damaging winds as a plurality of significant wind events (? 75 mph) occur when wind speeds of 60-70 mph are forecast. For both wind and hail, approximately 20% of significant events occur in warnings where sub-severe hail or wind is forecast. Our analysis will be expanded to include the continental United States and also examine warning performance as a function of time of day, population density, time of year, and region of the country.*

**145**

Travis Schuyler

Including sUAS-Collected Meteorological Data in NWP models to Improve Dispersion & Weather Forecasts

*The National Weather Service (NWS) collaborates with local, state, and national emergency response agencies to provide Decision Support Services (DSS) to maintain public safety during emergency response events. Such events (i.e. train derailments, highway chemical spills, forest fires, etc.), by their nature, provide small lead times and require quick, informed action to disseminate forecasts and order evacuations of affected areas. Traditionally, these decisions were informed through forecasting methods utilizing data collected from satellites, towers, and nearby weather stations. However, the research presented herein suggests that downwind forecast accuracy could be improved by ingesting high spatiotemporal meteorological data, with scales* *on the order of meters and seconds, collected near the pollutant source. Recent operational advancements in small uncrewed aircraft systems (sUAS) at NOAA's Atmospheric Turbulence and Diffusion Division (NOAA/ATDD) provide a promising new platform that enables fast response measurements of temperature, moisture, and wind velocity profiles in the boundary layer. This motivates deploying sUAS to aid in characterizing toxic plume trajectories triggered by emergency response events. This collaborative research demonstrates the challenges to overcome to ingest sUAS-collected boundary layer meteorological data into NOAA Air Resources Laboratory's HYSPLIT model for improved dispersion modeling of plumes. The methodology to develop a system to convert sUAS-collected meteorological data to HYSPLIT format and carry out tests of HYSPLIT dispersion; and the implementation of a test-version of sUAS-collected meteorological data functionality on a development branch of NWS-HYSPLIT for WFO testing is presented. The refinement of NWS-HYSPLIT sUAS implementation through simulated emergency response events in collaboration with Tennessee EMA-NWS-WFO demonstrates the operational capabilities for WFO use during future emergency response events.*

**146**

Kathryn Semmens

Winter Storm Severity Index: Severity and Social Impact Forecasting

*Winter storms present one of the most disruptive hazards in the United States, causing tremendous financial damage, disruption to services, and often, loss of life and property. Along with public audiences, professional users of National Weather Service (NWS) products, including emergency managers, transportation departments, utilities, hospitals, schools and aviation partners, need timely and accurate information about when and where a winter storm may hit.A new product from National Oceanic and Atmospheric Administration (NOAA)'s Weather Prediction Center (WPC), the Winter Storm Severity Index (WSSI), delivers high-level notice of the severity and range of potential impacts from an impending winter weather event, and a new model for decision-support communication. The WSSI has emerged in response to user needs for easily consumable forecast information that identifies the multiple impacts and relative severity of an impending storm.The WSSI has been developed to be used as a tool to assist NWS operational forecasters in maintaining situational awareness of weather-related impacts based on current official forecasts, and also to enhance communication to external partners, media and the general public. The WSSI is intended for use by 116 NWS Weather Forecast Offices and WPC staff as an enhancement to decision-support services.A research team from Nurture Nature Center and East Carolina University is undertaking a social science research study to test and refine WSSI and support its transition to operations. The study includes focus groups and interviews with forecasters and professional stakeholders in six WFO regions, including Boston, MA; Grand Rapids, MI; Jackson, MS; San Joaquin Valley, CA; Boulder, CO; and Omaha, NE. The study will make recommendations for improvement to the WSSI format, elements, and delivery. In this poster, we share information about*

*the WSSI product, as well as the study's research methods, objectives, and findings to date.*

**147**

Matthew Seymour

Initial & boundary condition uncertainty's role in predicting precipitation type in complex terrain

*Predictability challenges are heightened in winter weather forecasting when the environment for high-impact weather is marginal or varies over short distances. Numerical weather prediction ensembles, such as the Global Ensemble Forecast System (GEFS), are useful tools for probabilistic forecasting of winter weather. However, their use can be challenging in marginal, near-freezing situations when precipitation type (p-type) is uncertain. Subtle synoptic-scale model errors complicate the p-type forecast, while complex terrain, such as that of the Mohawk and Hudson Valleys of eastern New York, induce significant changes in temperature, wind and p-type over short distances. In combination, these factors can exacerbate uncertainty and lower forecast confidence. This study focuses on understanding how synoptic-scale uncertainties affect mesoscale numerical p-type forecasts of a challenging high-impact event.On 6-7 February 2020, a multi-phase winter weather event impacted eastern NY, with the greatest impacts between 0900-2100 UTC on 7 Feb. During this period, a strongly forced deformation band impacted the region with rain/freezing rain switching to a brief period of heavy snow. 6-12"_ of snow fell in the Mohawk and upper Hudson Valleys, and .25-.5"_ of ice accreted -- more than forecast -- north of Albany into the southeastern Adirondacks.An ensemble of Weather Research and Forecasting (WRF) model simulations of this case were run using initial and boundary conditions supplied by each of the 21 GEFS members, HRRR-like physics parameterizations, and a 3-km domain over the Northeast US. We evaluate the ensemble's performance against ASOS and NYS Mesonet observations, mPING reports, and ERA-5 reanalysis datasets. By analyzing variability across the ensemble, we diagnose the mechanisms, such temperature advection by terrain-channeled flow, whereby minor synoptic uncertainties translated into considerable differences in surface p-type.*

**148**

Keith Sherburn

Influences of the Black Hills on the Near-Storm Environment of the July 10, 2020 Supercell

*On July 10, 2020, a supercell tracked from southeastern MT into northeastern WY and through western SD before its demise in central NE. Over the course of its lifetime, the supercell produced two tornadoes""one in the northern Black Hills, and the second on the plains of southwestern SD""and very large hail up to softball size. Observations* *during the event indicated a localized area of relatively higher 2-m dew points and backed 10-m winds along the northern and eastern peripheries of the Black Hills when compared to surrounding locations. It is hypothesized that the combined effects of increased low-level moisture content, low-level shear, and low-level storm-relative helicity produced a locally favorable environment for tornadogenesis in the northern Black Hills as the supercell approached. This presentation explores the aforementioned local variations of the near-storm environment in the vicinity of the Black Hills during the afternoon of July 10, 2020. In addition, this presentation evaluates the ability of conventional operational diagnostic guidance [e.g., the Storm Prediction Center (SPC)'s mesoscale analysis] and convection allowing models (such as members of the High Resolution Ensemble Forecast from SPC) to capture the localized modifications to the pre-storm environment during this event. The July 10, 2010 supercell event underscores the importance of mentally adjusting analysis and model fields based on observations to find value in guidance that may be lacking critical details when forecasting and nowcasting mesoscale phenomena.*

**149**

Keith Sherburn

Radar Feature Catalogs from NWS Central Region's Tornado Warning Improvement Project

*In 2016, the NWS Central Region Tornado Warning Improvement Project (CR-TWIP) was assembled to help develop a consistent, scientific approach to the tornado warning process and associated impact-based decision support services across the region. As part of this effort, the CR-TWIP has compiled a wide array of materials suitable for foundational, interactive, and refresher training. One such set of resources, known as Radar Feature Catalogs, provides several bite-sized examples of radar features in quasi-linear convective systems and supercells that can be used to instill confidence and build expertise in the tornado warning decision process through explanation, application, and pattern recognition. Each entry in the Radar Feature Catalogs includes an annotated, animated video showing the evolution of the respective feature during a given case. Additionally, archived GR2Analyst radar data are available for each case so that meteorologists can explore the given case in further detail, if desired. This presentation will demonstrate the CR-TWIP's Radar Feature Catalogs and highlight their usefulness in severe convective training for users spanning all levels of experience.*

**150**

Austin Sheridan

Conditions favoring development of Chesapeake Bay breeze-driven thunderstorms in Baltimore, Maryland

*Due to its proximity to the Chesapeake Bay, the Baltimore, Maryland region is routinely subjected to the effects of the bay breeze front. This boundary can influence the initiation, enhancement and maintenance of thunderstorms. The impacts of Bay-breeze influenced thunderstorms on the region range from sudden and significant wind shifts and gusts (e.g., sudden thunderstorm wind gusts that buffeted and left stranded a tethered balloon and gondola in July 2004 carrying 17 tourists), to dangerous lightning and flash flooding (e.g., flash flooding that occurred in downtown Baltimore City on July 24 and August 12, 2020).In an effort to improve impact-based decision support services (IDSS) for the Baltimore metropolitan area, this project investigated which synoptic-scale, mesoscale and local-scale conditions favor the development of Chesapeake Bay Breeze-driven thunderstorms near the Baltimore region. Thunderstorm location, timing, duration and movement will be explored, as well as the role Baltimore's urban heat island (UHI) plays in thunderstorm evolution along the Chesapeake Bay breeze. Key findings will be reviewed methodologies to include messaging for IDSS.*

**151**

Andrew Siebels

Comparison of Spatial Precipitation Forecasts with a Satellite Dataset

*The purpose of this research is to analyze and compare global precipitation data from the Climate Forecast System Version 2 (CFSv2) with the Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN)-Climate Data Record (CDR) to improve long term precipitation forecasting. The CFSv2 has a 0.5-degree resolution which will provide model data for precipitation forecasts. The PERSIANN-CDR is a satellite derived daily 0.25-degree dataset with 37 years of global precipitation coverage 60 N to 60 S. The 0-to-10, 15-to-25, 55-to-65, and 80-to-90 day forecast time frames will then be analyzed for accuracy, and a quantile mapping (QM) technique will be applied to correct precipitation amounts for the CFSv2. The QM procedure requires both training and test datasets from the CFSv2 and PERSIANN-CDR. Finally, the forecast correction results for the CFSv2 may be used to improve medium range precipitation forecasts by the operational meteorological community.*

**152**

Bill Sjoberg

NOAA's JPSS Proving Ground and Risk Reduction Program – The Power of Scenario-Based Training

*This presentation will focus on the increased use of scenario-based training by the NOAA Joint Polar Satellite System (JPSS) and GOES-R Programs. The programs have identified opportunities to provide this type of dynamic and effective training. They have staged this training in small regional training workshops, as well as day-long shortcourses at international conferences. Details of the PGRR Initiatives who help plan these training events will be presented. Through this training, these initiatives have motivated NOAA's Satellite Programs to move from a focus of meeting defined user requirements to helping users tailor satellite capabilities to meet their unique mission needs. Through the PGRR Initiative program, developers and users have identified specific weather events that represent opportunities for the application of unique satellite data and products to assist in the response to all types of disasters. Specific examples of the scenario-based training in various workshops and short courses will be highlighted to include feedback from the users participating in these workshops.*

**153**

Barrett Smith

Developing an enhanced Flash Flood Climatology for central North Carolina

*The aim of this project is to transform conceptual models and subjective assessments of flash flood prone areas, frequency, and severity into an objective dataset to improve situational awareness and precision in identifying flash flood threats. The initial phases of this project involve reviewing non-tropical flash flood storm reports dating back to 2007 and identifying dates/times where significant flash flooding occurred. The severity of these reports (including monetary damages and loss of life) will also be documented and from there, a clearer understanding of the frequency/location of the most impactful flash flood events across central North Carolina will be achieved. Another aspect of this project will be the creation of composite maps showing key meteorological parameters, such as moisture transport, precipitable water, 250mb wind speed, and 500/700mb geopotential height), which will serve as valuable forecast aids and enhance situational awareness. These composites will be stratified by season (cool and warm), and will also incorporate Predecessor Rain Events (PREs) that occurred without an associated landfalling tropical system. The initial findings of this project will be presented at the conference, along with plans for future work and plans for streamlining these findings into forecast and warning operations.*

**154**

Patrick Spoden

The Remote MesoAnalyst (RMA) Project in the NWS Central Region

*COVID-19 has affected just about everyone's normal routines. During the initial months, NWS offices tested concepts of how people working at home could assist with operations at the office. One of the many discoveries was the ability to provide mesoanalysis from home for those working severe weather in the office. It was also soon discovered that having someone from an office not experiencing severe weather could assist as well (more eyes on the radar/environment).A proposal was sent into Central Region Headquarters to formally increase the size and scope of the learning experience in the summer of 2020. By the fall of 2020, the Remote Mesoanalyst (RMA) program was established and tested in the Central Region. A team of 15 expert mesoanalysts were selected to facilitate remote mesoanalyst support across the region. The program involves 3 Google chat rooms (in case the outlook area was very large) set up beforehand by the NWS Central Region ROC (Regional Operations Center). A facilitator acts to focus the chat on the next 1-2 hours and not so much on the current radar images. As pertinent points are brought up and discussed in the chat room, the facilitator would then pass those messages on to the WFO(s) in the outlook area. Those messages can then be passed on to the forecasters and communicators within that office. In addition, any forecaster in the region is invited to observe or participate in the discussion which provides an excellent opportunity to learn from expert mesoanalysts and to increase the number of events that forecasters assess the environment associated with severe convection. This presentation will discuss the program and the concepts of "group learning"_ and how the RMA program can rapidly increase the experience levels of all mesoscale forecasters in Central Region. It will also provide examples of how remote mesoanalyst support was provided in Central Region and how offices leveraged this support to enhance their severe weather operations.*

**155**

Alex Staarmann

Challenges and Successes of Operational Telework Shifts in the NWS

*The COVID-19 pandemic has caused significant changes in the way many places of business operate, and the National Weather Service (NWS) is no exception. The unprecedented implementation of mandatory telework has come with many challenges in the way forecast offices distribute shift duties to the staff, especially during high-impact weather events. The NWS Weather Forecast Office (WFO) in Mount Holly serves just over 12 million people across the county warning area while averaging approximately 230 severe and tornado warnings cumulatively, 66 flash flood warnings, and 30 winter weather headlines yearly over the past ten years. In 2020 alone, over 5100 Local Storm Reports (LSR) were issued compared to 3700 LSRs* *in 2019.This presentation will discuss the challenges and successes of operational telework shift duties at the WFO in Mount Holly during the active 2020 convective, tropical, and 2020-2021 winter weather seasons. In particular, Google Meet is utilized to assist operations during high-impact events, especially to facilitate synergistic situational awareness between staff located at WFO Mount Holly and staff working remotely. Participation in operational tasks while teleworking allows for monitoring of social media and observations from home while simultaneously issuing LSRs and Public Information Statements (PNS) in coordination with staff located at WFO Mount Holly. Virtual office briefings, staff meetings, brown-bag seminars, and workshops are also conducted via Google Meet to foster intra-office communication. The use of Google Meet has proven to enhance teamwork and overall office culture and morale at WFO Mount Holly despite the challenges of remote operations.*

**156**

Chris Stachelski

Snow Way! A Look at Extreme Snowfall Amounts from Two Winter Storms

*The winter of 2020-2021 produced two notable nor'easters in the Northeast that produced exceptionally heavy snowfall, even in areas that are often accustomed to it. The first event took place from December 16-18, 2020 and largely impacted areas from Pennsylvania to north-central New England. The second storm took place from January 31 through February 2, 2021 and had the greatest impact in metropolitan New York City. For both of these storms preliminary storm total snowfalls were reported that may have broken state snowfall records. Or did they?The State Climate Extremes Committee (SCEC) is formed to review records that set or tie state extremes. This committee consists of members from across the climate community including National Weather Service, Regional Climate Center, the State Climatologist for the state where the record may have been set or tied, and NOAA's National Centers for Environmental Information (NCEI) in Asheville, North Carolina. State records can receive intense interest from the public, media and even government officials. This presentation will explore the challenges of measuring extreme snowfall, how official reports are received by the National Weather Service and the vetting process for determining a state record including the challenges at interacting with observers during a pandemic. We will also look at the issue of what happens when housekeeping is done and it is discovered that a past record may not have really been correct in the first place. Lastly, we'll look at the challenges of addressing situations of high external user interest in the SCEC's findings, and best practices for communicating them. Snowfall values going into the official climate database at NCEI also provide a basis for snow assistance to impacted communities from the Federal Emergency Management Agency (FEMA) based on their extremity in a given time period, which further underscores the importance of accurate measurements and an accurate climate database.*

**157**

Lance Steele

Applying Machine Learning and CloudSat Observations to Satellite Cloud Height and Low Visibility

*In my previous presentation at the 2020 Virtual Meeting, I showed the verification of utilizing CloudSat observations to verify Cloud-Top Heights (CTH). The data used spanned May to October 2018. With a recent update of CloudSat data including the remainder of 2018 and the first half of 2019, I extended this research to include over a year of observations, allowing for a breakdown into seasonal analysis. I also expanded the research to include fog, low clouds, and low visibility analysis. CloudSat is consistently cited as the most accurate source of objective cloud height observations, and my CTH product uses several channels of infrared imagery from geostationary satellites as the basis for real-time output. I employed machine learning techniques to analyze and correlate the data quickly to reveal important relationships between the infrared brightness temperatures (BT), the difference of BT between various channels, and the single-channel CTH calculated from the atmospheric temperature profile from numerical weather model data. The machine learning output then produces linear regression coefficients that can be encoded into a real-time, continually running operational program. I also study whether this method can be applied to detecting low cloud and fog scenarios in addition to CTH measurements.*

**158**

Amy Stevermer

Online Case Exercises Showcasing Environmental Satellite Capabilities for Weather Decision Support

*The MetEd website (meted.ucar.edu) offers over 500 online self-paced training materials (including over 100 satellite-focused lessons). These lessons help forecasters and users of weather information in various sectors apply the latest advancements and science in observing and prediction systems to real-world applications. NOAA's GOES-R and JPSS programs have sponsored several of these training efforts, completed in collaboration with the National Weather Service and NOAA Cooperative Institute partners. Newer releases include several interactive lessons that provide practice integrating the strengths and capabilities of both geostationary (GEO) and low Earth orbiting (LEO) observing systems. These lessons use a scenario-based approach that allows the learner to interact with and analyze products, make decisions, and answer questions as they step through the timeline of an event. Feedback the learners receive incorporates contextually appropriate foundational science that supports the understanding and interpretation of products. Recent publications include two lessons on detecting and monitoring wildfires; multiple precipitation and flooding lessons; case exercises focused on convective initiation, convective maintenance, and hail and* *tornado events; a lesson on forecasting winter weather; new training related to applications of RGB composite imagery; and training on the use of Geostationary Lightning Mapper (GLM) data. Additional satellite training on MetEd includes foundational materials related to both GOES-R and JPSS, as well as lessons demonstrating the use of satellite-derived climate data records. Spanish or French translations of several lessons, with some also available in Portuguese, help extend the reach of Meted training resources internationally.*

**159**

Vijay Tallapragada

The UFS-R2O Project: Coordinated and Collaborative Model Development for Research and Operations

*The Unified Forecast System (UFS) Research to Operations (R2O) Project, jointly funded by the National Weather Service (NWS) Office of Science and Technology Integration (OSTI) and the Oceanic and Atmospheric Research (OAR) Weather Program Office (WPO) of the National Oceanic and Atmospheric Administration (NOAA), coordinates a large community of researchers, both inside and outside NOAA, to improve numerical weather and climate prediction by further developing and analyzing the UFS, with the ultimate goal of improving the skill of NOAA's operational forecast models. The dual goals of developing modeling innovations suitable for transition from research to operations and broadening the access and usage of UFS by the research community are addressed by this project.The UFS R2O Project focuses on two UFS Application Teams, namely the Medium Range Weather (MRW) and Subseasonal-to-Seasonal prediction (S2S) team and the Short Range Weather (SRW) and Convection-Allowing Model (CAM) team, which have both developed key foci for research and development to address key forecast priorities, with short-term (1-2 year) deliverables and a long-term (3-5 year) vision. The UFS-R2O Project is organized into three main areas: MRW-S2S, SRW-CAM and Cross-Cutting Infrastructure (CCI), with each area having multiple sub-projects focusing on specific aspects of the development of UFS applications. The project is jointly led by representatives from NOAA operations, NOAA research and the academic community, and all the sub-projects have similar representation from within and outside NOAA.This presentation describes the structure and execution of the UFS R2O Project, with emphasis on community engagement, and progress accomplished thus far. We will also discuss how this project fits within the larger UFS efforts and alignment with objectives of the UFS Strategic Plan.*

**160**

Wendy Marie Thomas

Impact-based Decision Support Services (IDSS) Management System (IMS) Concept of Operations

*The National Weather Service (NWS) is evolving to enhance its services, organizational structure, workforce model and operating model, including Impact-Based Decision Support Services (IDSS) to better support a Weather-Ready Nation. IDSS focuses on providing tailored information specifically to our Core Partners, and there is an ever-growing demand for these services. The ongoing evolution of the NWS necessitates new and innovative ways in which we deliver IDSS. The IDSS Management System (IMS) aims to address these growing needs by providing IDSS management and delivery capabilities that lead to greater efficiency and continuity in the way we serve our NWS Core Partners. IMS will provide a suite of tools and applications within an integrated framework to support the NWS in the management of partner information including impacts as well as streamline the delivery of IDSS. This presentation will provide an overview of the concept of operations based on the requirements NWS has gathered so far.*

**161**

Rodney Thompson

Filling the Digital Gap for Broadcast Meteorologists with AI and Visual Design

*In 2019, we were ideating with a mix of weather consumers, asking them to give us "crazy ideas"_ for improving their mobile experience. One of the ideas that someone wrote on a post-it note was "_I want a meteorologist in my pocket to explain the weather to me."_ As they placed the idea on the board, they laughed as they read it out loud. I thought, why can't we do that with augmented intelligence (AI)? Well, as it turns out, augmented intelligence can do this and do it at scale. We look at the exact user's location and pull data for what's normal for that day and location and then the algorithms go to work.As we learned, having a meteorologist in your pocket couldn't be solved with AI alone. There was a second and equally challenging problem. How do you visually surface the results from the AI in an intuitive way?In my talk, I walk through how AI and visual design are helping digital users understand the weather by highlighting when the weather could negatively or positively impact them.*

**162**

David Tomalak

(AGOL) Capabilities through Collaboration. The IDSS impact of a fire wx dashboard in CO during 2020.

*The National Oceanic and Atmospheric Administration (NOAA) signed an enterprise license agreement (ELA) with Esri, the world leader in GIS technology. This agreement enables NOAA employees to gain access to Esri software and services such as ArcGIS for Desktop and ArcGIS Pro, each of which have add-on extensions for greater functionality, e.g. Spatial Analyst, 3D Analyst, and Geostatistical Analyst. Also included in this NOAA/Esri ELA is ArcGIS Online (AGOL). Over the last 6+ years, AGOL has gained popularity in the National Weather Service as it allows an online, collaborative GIS environment that allows users to easily create and share maps, apps, layers and other geospatially-enabled data. The ease of use and effectiveness of AGOL have led to the development of over 700 AGOL map stories in NOAA's instance of AGOL--NOAA Geoplatform. A number of NWS offices have collaborated with local emergency managers to develop AGOL products to aid the delivery of impact-based decision support services (IDSS). To help streamline some of these AOGL NWS IDSS efforts, several small teams of GIS talent collaborate through several working groups to pool resources and develop somewhat standardized AGOL prototype IDSS briefing templates. The efforts learned through this collaborative process will be an investment for the national GIS viewer and other IDSS GIS initiatives. This poster will examine one such success with the enhancement of Impact Decision Support Services (IDSS) through the use of a collaborative AGOL fire weather dashboard during the extreme Colorado fire weather season of 2020.*

**163**

David Tomalak

Advancing (AWIPS) Capabilities through Collaboration and Teamwork

*The Advanced Weather Interactive Processing System (AWIPS) is a technologically advanced information processing, display, and telecommunications system that is the cornerstone application of the National Weather Service. NWS Forecasters use AWIPS to integrate, assimilate, analyze, and manage meteorological and non-meteorological data. Over the past two decades, AWIPS has evolved into a key resource to support the Weather-Ready Nation. Teamwork and collaboration have played a significant role in advancing AWIPS and Impact Decision Support Service (IDSS) tools. These advancements served to innovate and promote additional capabilities and performance improvements that have helped NWS forecasters to expand and optimize their services. These capabilities extend over a diverse air space over the continental United States, Alaska, Hawaii, and even Pago Pago, American Samoa. This poster will highlight a number of these collaborative successes and demonstrate why a* *collaborative environment will be critical in evolving new efforts that will advance the effectiveness of our mission. This includes Hazard Services Hydro as well as Winter and Non- Precipitation support efforts.*

**164**

David Topping

Assessment of Meteorological Phenomena that Impact Winter Precipitation Type in the Mid-Atlantic

*During the period spanning winter seasons from 2018 through 2021, several winter weather events presented forecasters with particular challenges in predicting winter precipitation type (i.e., snow, sleet, and freezing rain, and combinations of each). These events highlighted the challenges in communicating and messaging impacts that arise from uncertainties in model guidance forecasts of winter precipitation types. Events that occurred in the Mid-Atlantic region (specifically within the National Weather Service (NWS) Weather Forecast Office (WFO) Baltimore/Washington DC forecast area) were examined to better understand the nature of these precipitation type uncertainties, and how messaging played a vital role in conveying potential impacts to users (via Impact Decision Support Services-IDSS). Winter precipitation type is driven by several factors such as depth of cold air (profile of atmosphere<=0?) vs. depth of warm air (profile of atmosphere >0?), precipitation rates, magnitude of warm and cold air layers, potential for ice crystals to develop in the clouds, and other variables. This research examined and assessed these relevant meteorological factors to determine any correlations to winter precipitation, and also how different meteorological phenomena (ex: strong vertical velocity co-located where warm layer is developing) impacted the advancement or displacement of the warm layer aloft. Assessment of small changes (less a few degrees C) in vertical temperature profiles, as often indicated in a various model guidance sources, were examined to evaluate the impact on resulting precipitation types. These correlations can be used by forecasters to assist in the forecast process and better evaluate and understand the uncertainties during these events. This will enable forecasters to better communicate the expected precipitation evolution, and accompanying uncertainties during core partner briefings, conference calls, and media interviews.*

**165**

Jorel Torres

JPSS Products, Training Resources, and Teletraining Opportunities available for NWS Users

*The Joint Polar Satellite System (JPSS) encapsulates the Suomi-National Polar-orbiting Partnership (S-NPP) and the National Oceanic and Atmospheric Administration - 20 (NOAA-20) satellites that currently orbit the globe and produce datasets and imagery* *for users. JPSS product applications include detecting and characterizing the properties of water and ice clouds, snow, sea surface temperatures, sea ice/lake ice, fog, fire, severe and tropical weather, vegetation health, aerosols, and Day/Night Band nighttime visible applications. National Weather Service (NWS) users, in particular, can view JPSS product imagery in the Advanced Weather Interactive Processing System - II (AWIPS-II), a forecasting and analysis software package. Notably, every JPSS product that resides in AWIPS-II also has corresponding satellite training materials that users can employ to further reinforce their understanding of JPSS capabilities. For example, numerous JPSS quick guides (1-2 page product documents) and quick briefs (3-5 minute product application videos) assist users in understanding algorithm makeup, RGB recipes, spatial and temporal resolutions, data latencies, applications, and limitations. Furthermore, new, weekly JPSS Teletrainings are offered to NWS users: teletraining that focuses on nighttime visible imagery applications and how users can employ JPSS and GOES datasets for daytime and nighttime fire monitoring. The presentation summarizes JPSS product training resources, the new teletraining opportunities offered to users and highlights the Weather Forecast Office participation in past teletraining sessions conducted throughout 2020-2021. JPSS training activities continue to actively engage and inform NWS users of the latest JPSS products and training resources to assist them in the operational forecasting environment.*

**166**

Sarah Trojniak

Review of the FV3 CAMs Results in the 2021 Flash Flood and Intense Rainfall (FFaIR) Experiment

*The Flash Flood and Interest Rainfall (FFaIR) Experiment has been run annually since 2013 and is part of the Hydrometeorology Testbed (HMT) at the Weather Prediction Center (WPC). Focusing on heavy rainfall and flash flood forecasting, the FFaIR Experiment brings together forecasters, developers, and researchers to use and evaluate experimental tools and guidance to help determine their utility in the forecast process. The testbed plays an integral role in the research to operations (R2O) process within the National Weather Service (NWS) as it allows for unique interactions and provides an environment that fosters communication between a wide range of subject matter experts.Helping to support the NWS's goal to create a Unified Forecast System (UFS), the data evaluated in FFaIR 2021 was focused heavily on various configurations of Finite Volume Cubed-Sphere (FV3) based Convective Allowing Models (CAMs) and ensembles. Last year FFaIR also evaluated FV3-CAM configurations and found that all seven configurations assessed overdeveloped single cell convection, both in size and rainfall totals. This presentation will focus on the performance of the new configurations with respect to this issue as well as additional results regarding the experimental FV3-CAMs and ensembles. Another focus of the 2021 FFaIR Experiment was to analyze the models' and ensembles' utility in forecasting the timing of heavy rainfall and the maximum rain rate via experimental forecasts using the FFaIR* *developed Maximum Rainfall and Timing Product (MRTP). Preliminary results from the MRTP will also be discussed.*

**167**

Christopher Vagasky

The Houghton, Michigan, Father's Day Weekend Flood of 2018

*Between 16 and 18 June 2018, multiple rounds of heavy rain impacted the Keweenaw Peninsula of Michigan. The heaviest of this rain occurred during a three-hour period in the early morning hours of 18 June, with more than 7 inches of rain falling across portions of Houghton County, Michigan. The result of this event was the more than 150 road washouts, 60 sinkholes, tens of millions of dollars of road system damage, and the largest emergency Federal Highway Administration claim in Michigan history. It is worth reviewing the meteorology of such a noteworthy event. This review especially highlights the importance of remotely sensed meteorological data including lightning detection and multi-radar/multisensor (MRMS) products in the sparsely populated western Upper Peninsula of Michigan.*

**168**

Ross Van Til

A New NWS Meteorologist Development Plan

*Within the National Weather Service, development of our meteorologists is key for successfully meeting the needs of our partners and users. A new competency-based Meteorologist Development Plan (MDP) was implemented in 2020. This presentation will explore the motivation for developing this training framework, the rationale behind how it was structured, as well as the ongoing efforts to increase adoption and enhance the utility of the MDP.*

**169**

Joseph Villani

Final Appraisal: Evaluating accuracy of model snow predictions in ERN NY & WRN New England using GIS

*A collaborative project between NWS WFOs in Albany, NY and Morristown, TN resulted in development of a GIS-based application (GAZPACHO) that produces high-resolution analyses of snowfall observations and calculates errors of corresponding gridded snowfall forecasts. Analyses are created from a blend of local WFO observations and the National Operational Hydrologic Remote Sensing Center. Verification results from three combined winter seasons (2017-18, 2018-19 & 2019-*

*20) are presented, examining topographical influences of observed snowfall patterns and the accuracy of corresponding snowfall forecasts. Patterns of snowfall and their relation to topography were examined by collecting data across eastern NY and western New England. A detailed snowfall analysis was performed for each event. Composites of snowfall patterns were used to identify relationships between snowfall and terrain features such as the Catskill and Green Mountains, and the Hudson and Mohawk Valleys. Orographic ratios were calculated to quantify the impact of elevation on snowfall. Observations and short-range model forecasts of environmental characteristics wind, temperature and stability were utilized to determine how these factors affect the topography's impact on snowfall distribution. Snowfall observations were compared to forecasts of snow depth change from the 3 km NAM and HRRR, and snowfall from the NWS's National Digital Forecast Data Base to determine how well these forecasts account for terrain effects. Forecast errors were related to wind, temperature and stability to determine if these factors had an impact on the quality of the forecasts, and the ability of the forecasts to account for terrain effects. Results showed a consistent negative bias (forecast too low) the HRRR and 3km NAM, although forecast error placement and magnitude varied based on environmental characteristics. NDFD forecasts showed mixed positive and negative biases, but with lower magnitudes compared to the models.*

**170**

Amanda Wallace

AWIPS Program COVID Response: Supporting the mission during a pandemic

*The Advanced Weather Interactive Processing System (AWIPS) is the key visualization and forecast platform utilized by National Weather Service (NWS) forecasters to support the agency mission of saving lives and property. While AWIPS is always evolving to accommodate the diverse needs of forecasters, the AWIPS Program faced a unique challenge during the COVID-19 pandemic. The Program was successful in quickly adjusting priorities and processes to sustain 24/7 weather forecast operations within a reduced staffing environment, an exercise that also highlighted new opportunities for AWIPS operations and maintenance. The AWIPS Program team overcame many challenges toward enabling the mission in a pandemic, such as implementing remote connectivity where none had previously existed and establishing a Continuity of Operations strategy for the NWS National Centers and NWS River Forecast Centers. This presentation will discuss how the AWIPS Program worked with all levels of the NWS to meet the needs of forecasters during the pandemic and how changes that were made to support forecast operations will have lasting positive impacts on the technology, processes and support for this important program.*

**171**

Castle Williams

Taking the R2X-it: Translating SBS Hurricane Supplemental Findings Via The Tropical Roadmap Process

*The Weather Research and Forecasting Innovation Act of 2017 requires NOAA to prioritize research that improves forecasts and warnings for the protection of life, property, and the enhancement of the national economy. More specifically, the law targets improvements to hurricane forecasts that incorporate risk communication to create more effective watch and warning products. In 2018, through the Disaster Supplemental Appropriations, OAR's Weather Program Office in collaboration with the National Weather Service (NWS), funded four social and behavioral science (SBS) projects designed to advance these efforts. This presentation will provide a broad overview of the four projects, explain their complementary research design, and provide preliminary findings. Additionally, this presentation will provide an outline of the tropical roadmap process for evaluating social science needs and recommendations. Developed in collaboration between OAR's Weather Program Office and NWS, this roadmap outlines a process for translating social science findings for possible transition. While translating research outputs into operations is a priority, the process also considers translating social science findings into various R2X types that may describe a need for more physical science research (i.e., R2R) and/or development (i.e., R2D), for example, before these findings can be considered for transition. Most importantly, this process highlights the importance of building relationships between research teams, enhancing collaboration between these research teams and NOAA, and sharing what we know for the benefit of society.*

**172**

Travis Wilson

Dynamic Ensemble-based Scenarios for Impact-based Decision Support Services

*As the use of ensembles and probabilistic data increases in operational forecasting, so does the need to interrogate these data. Traditionally, it was relatively easy to compare and contrast a handful of model forecasts and communicate the different scenarios and impacts to partners. However, now with literally hundreds of ensemble members for any given event, forecasters need new tools to quickly understand the range of possible solutions.In our presentation we will outline a new web-based tool that allows forecasters to quickly create dynamic, ensemble-based scenarios for impact-based decision support services (IDSS). Specifically, our tool performs a principal components analysis along with k-means clustering on global ensembles. This groups ensemble members into different physically-based scenarios dependent on the user-defined time and location. From these dynamically generated scenarios, forecasters can communicate not only uncertainties but impacts that could otherwise* *be hidden when viewing bulk ensemble statistics. For example, our clustering may break up the extended forecast into two scenarios: one dry scenario with a 90 percent chance of occurrence and another with strong winds and flooding, but only a 10 percent chance of happening. This is particularly powerful because it shifts away from the deterministic forecast paradigm and presents users with probabilistic outcomes. Eventually, this tool could be ported to other ensemble based forecast systems, such as the National Blend of Models, to enhance IDSS within the National Weather Service and the weather enterprise at large.*

**173**

Peter Wolf

The Mesoscale Environment Analysis (MEA) Course for Enhancing Convective Threat Messaging

*Since the evaluation of the Wind Profiler Demonstration Network and the Oklahoma Mesonet in the 1990s, National Weather Service (NWS) in-house studies of Mesoscale Environment Analysis (MEA) have demonstrated the value of accurate MEA for improving operational results during severe convection events, as well as the risk to those results from inaccurate MEA. Today, new tools and technologies have supported increased interest in MEA in operations. An increasing number of NWS field offices are exploring and evaluating MEA, given the critical value added by its application to enhancing Impact-based Decision Support Services (IDSS), as identified in the NWS Operations Proving Ground Mesoanalyst Bootcamp: (1) extending the duration and the precision of pre-convective-event targeted messaging, and (2) identifying a range of reasonable convective outcomes to support weather readiness. However, until recently, there has been a gap in established training covering MEA for ensuring success of related IDSS enhancements. In 2020, a team of NWS subject matter experts came together to address the challenge of designing a complete, in-depth, advanced-level course, in a form that: (1) supports adult learning, and (2) builds knowledge and experience for forecasters who want to take on the challenge of operational MEA. This course is divided into three sections: Science Assessments, rigorous Course Modules, and hands-on and customizable Case Exercises.This presentation will focus on the value of MEA in severe convection operations. It will then illustrate the history of course design, and the vision and purpose of the training. Finally, it will describe course structure, and its focus on promoting targeted, specific, timely threat messaging, not just during the warning level (30-60 minute lead time) period, but also focused on event evolution during the sub-watch (1-3 hour lead time) period.*

**174**

Raymond Wolf

The Midwest Derecho of 10 August 2020

*Derechos are the most extreme severe wind and wind damage producing systems within the spectrum of Quasi-Linear Convective Systems. The Midwest Derecho of 10 August 2020 was a high-end event relative to historic derechos considering the areal coverage, extremity and duration of severe winds, and resultant damage, which occurred mainly across Iowa, northern Illinois, and northern Indiana. The Midwest Derecho was the most expensive U.S. severe thunderstorm event ever according to NCEI, spawning an estimated 11 billion dollars in damage, and was one of 22 billion dollar weather-climate disasters in 2020. Four fatalities resulted from the fast-moving storm complex, which also damaged around 8000 homes and 1.2 million acres of row and specialty crops, and left 2 million homes and business without power, some for more than 2 weeks. Initial findings suggest that wind speeds exceeded 70 mph over a 25,000 square mile area and exceeded 100 mph over nearly 2,500 square miles. More than half of the tree canopy in the city of Cedar Rapids was destroyed.This presentation will detail the impacts, briefly describe the background environment, then focus on a radar analysis of the derecho at initiation and when maximum wind damage was occurring.*

**175**

Lance Wood

A Comparison of Hurricanes Laura and Rita - How Improved Science and Messaging Saved Lives

*When Hurricane Laura threatened southeast Texas and southwest Louisiana in August, 2020, it reminded some of Hurricane Rita which had occurred 15 years earlier, in September 2005. Rita and Laura both made landfall as major hurricanes just 30 miles apart in southwest Louisiana. As Rita intensified in the Gulf of Mexico, the NHC (National Hurricane Center) track forecast was centered on southeast Texas, prompting a massive evacuation which included the Houston metropolitan area. Unfortunately, many more people died in the evacuation than from the direct effects of the hurricane. From a science perspective, significant improvements have occurred with numerical weather modeling, including the use of ensembles and multi-model consensus aids, which are used as guidance for forecasting at the NHC and elsewhere. Forecast track error has decreased significantly when comparing Rita with Laura, especially at key evacuation decision-making forecast hours, where a 25% to 35% forecast track error reduction occurred. Hurricane specialists also correctly remained on the east side of the Laura model track guidance envelope, despite some key models forecasting a shift west toward a Texas landfall. Forecast track error reduction also allowed the lead time for tropical cyclone watches and warnings to be extended from*

*36 and 24 hours to 48 and 36 hours, respectively in 2010. When comparing products and services between Rita and Laura there are many examples of improvement. For example: the addition of storm surge watches and warnings, location-specific wind speed probability products, the development of an DSS coordinator position and standardized briefing templates, and conference calls becoming Webinars, Google Meetings, and Facebook Live sessions. This presentation highlights improvements in science and messaging since Rita that led to improved decision making and prevented a large-scale evacuation of the Houston metropolitan area during Laura.*

**176**

Andrew Zimmerman

Examining Tornadic Debris Signatures in the Wakefield, VA Forecast Area

*The Wakefield, VA WSR-88D and the Dover Air Force Base WSR-88D are the primary radars used by the Wakefield, VA National Weather Service Forecast Office. Each radar was upgraded to dual polarization capability in February 2012. This upgrade introduced several new fields to the base data, one of which was the correlation coefficient. The correlation coefficient has the ability to highlight non-meteorological targets and the most well-known is the Tornadic Debris Signature (TDS). Additionally, the Supplemental Adaptive Intra-Volume Low-Level Scan (SAILS) was introduced, which provided the WSR-88D the ability to add an additional 0.5 degree scan to once volume scan. The introduction of MESO-SAILS added the ability to include up to three additional 0.5 degree scans within one volume scan for a total of up to four low-level images per volume scan. This increase in low-level data provided more opportunity to see a TDS, even with the short-lived tornadoes that are typical in the Mid-Atlantic region. Several tornado events have occurred in the Wakefield, VA County Warning area during the past five years, with intensity ranging from EF0 to EF3, and TDSs have been often observed real-time during warning operations. This data has been used to add 'radar confirmed' to Impact Based Tornado Warnings. This poster will examine the character of TDSs observed, such as duration, depth, and range from radar, as well as the effectiveness of using TDSs in operations as a communication tool with regard to the actual occurrence of a tornado.*