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Abstracts of Presentations

Broadcaster Workshop

The Potential of High Performance, Regional Total Lightning Networks. Nicholas W.S. Demetriades, Vaisala, Inc., Tucson, AZ, and Jean-Yves Lojou, Meyreuil, France

Vaisala has been operating a regional total (cloud and cloud-to-ground) lightning demonstration network in the Dallas-Fort Worth, TX area since 2001. This Lightning Detection and Ranging (LDAR II) network builds upon the VHF lightning detection technology first developed at NASA Kennedy Space Center called LDAR. This same technology has also been modified by New Mexico Tech into the Lightning Mapping Array (LMA). The Dallas-Fort Worth (DFW) LDAR II network detects over 90% of all cloud and cloud-to-ground lightning within 120 kilometers of DFW International Airport. LDAR II's ability to map these lightning flashes in three dimensions, coupled with its high flash detection efficiency, allow a complete three-dimensional reconstruction of the lightning channels in a thunderstorm. Data from this network is currently being used for real-time thunderstorm monitoring at the Fort Worth National Weather Service Office.

Current media display products show cloud-to-ground (CG) lightning. This information only conveys part of the CG lightning threat that exists to the public during thunderstorm activity. The DFW LDAR II network has regularly detected lightning flashes that extend over 50-100 kilometers in length. These flashes pose a significant safety risk to the general public because, at any time, they are capable of producing a CG flash along their path. Many examples of these horizontally extensive lightning flashes will be shown using unique display tools developed by Vaisala. CG-only lightning displays are also not very useful for monitoring thunderstorm growth and dissipation and severe weather trends. Approximately 70% of all lightning stays in the cloud and never reaches the ground. In fact, some thunderstorms produce greater than 10 cloud flashes for every CG flash and a few may only produce cloud lightning for the first 60 minutes of a severe thunderstorm. Total lightning detection provides a rich dataset that can be used with radar data to improve severe weather warnings and potentially increase the lead time for these warnings. Since the total lightning data is a continuous data stream, it can provide valuable information on thunderstorm growth and dissipation trends and severe weather development between radar volume scans.

Finally, a unique storm animation tool will be presented. This display provides an easily-interpreted simultaneous display of storm/cell location, total lighting rate, and cloud-to-ground lightning rate. These fields can be accurately superimposed on a base map of geo-coded information such as terrain height.

Educating Elementary School Children Can Change Lightning Safety Worldwide. Michael P Utley, Struckbylightning.org, West Yarmouth, MA, Dr. Mary Ann Cooper, University of Illinois at Chicago, Chicago, IL, and Ron Holle, Vaisala, Inc., Tucson AZ

In 2004 StruckByLightning.org was founded for the purpose of encouraging lightning injury prevention by disseminating existing information about lightning safety as well as developing other materials. Formed as a charitable, tax free organization (501(c)3), it works with schools, corporations and individuals, to provide safety information, speakers, presentations, and encouragement of lightning safety. While the organization is open to working with any age group, the targeted group is young elementary school children. The goal is to make When Thunder Roars, Go Indoors as familiar to school children as Stop, Drop, and Roll is for fire safety.

In addition, utilizing the internet as a source, the organization has created a searchable database, similar to Storm Data, for lightning injuries but more extensive, detailed and targeted to lightning incidents

gathered from the world press. This database will be demonstrated and will eventually be available for searching by any country or group in order to obtain data specific to their region, mechanism of injury, or other targeted data.

The organization has also begun developing products aimed at elementary school aged children, that can be co-branded with organizations, corporations, schools, and charities to spread lightning safety information. Some of these products will also be distributed at the meeting.

Through the development of products aimed at young elementary school children and the use of the database to directly impact the areas in the most need, coupled with a group of professionals willing and able to do safety presentations we can educate a new generation and change the world of lightning awareness.

Everyone Can Save Lives. Mary Ann Cooper, MD, University of Illinois at Chicago, Chicago, IL

Meteorologists, both government and broadcasters, frequently contribute their time in outreach activities outside their normal job description. These activities often involve school visits and working with students. This paper will present several successful projects that elementary and high school students have done on lightning safety and guidelines on how to work successfully with students of nearly any age.

I Survived Lightning **Video Presentation and Panel Discussion.** Michael P. Utley, Struckbylightning.org, West Yarmouth, MA, Mary Ann Cooper, MD, University of Illinois-Chicago, Chicago, IL, and Ronald L. Holle, Vaisala, Inc., Tucson AZ

This presentation is suggested for the Broadcaster Workshop. Grenada-TV in England produced an episode last year on 'I Survived Lightning' that addressed the question 'how can someone survive the awesome power of lightning?'. This episode never aired in the U.S. The episode focused on three lightning survivors and examined their cases in detail. Several outstanding demonstrations on lightning behavior were done in an electric power laboratory that teach much about how lightning behaves when striking people. See electricity explode a log! See the myth that 'metal attracts lightning' destroyed! See how a damp surface greatly reduces the imact of lightning! The main lightning survivor in this episode will be present to host this event. The episode is 1-hour long, but may be edited to 30-minutes for this airing. This episode will help prepare meteorologists for the questions they will receive when teaching lightning safety. As an added bonus, a panel of lightning safety experts is planned to lead a discussion and answer questions after the episode.

The Presentation of Precipitation Information in Television Broadcasts: What is Typical? Thomas E. Hagen, Justin M. Glisan, Anthony R. Lupo, and Patrick Guinan, University of Missouri-Columbia, Columbia, MO

A statistical analysis of precipitation values for Columbia, Missouri was performed using monthly averages for the 1971 - 2000 period. The data was acquired from the Missouri Climate Center. The analysis demonstrates that, unlike temperature data, precipitation values are not normally distributed, but are closer to a "gamma" distribution. Precipitation data is typically presented as a cumulative monthly total in television broadcasts, unlike temperature information. Thus, a typical daily range for precipitation cannot be displayed as has been recommended for temperature in order to incorporate simple statistical information into a broadcast. Precipitation events result from "randomly" occurring transients, thus, comparing daily precipitation information to daily statistical precipitation information is meaningless. Here it is suggested that historical monthly rainfalls can be used to partition the data into quintiles following Guinan (2004). These quintiles can then be used to compare cumulative monthly precipitation to typical by displaying "stretching" quintiles in order to provide the viewer with a better statistical context for the viewing of precipitation data.

Making Long Range Winter Forecasts Using the Metonic Lunar Cycle. Joe Rao, News 12 Westchester, Yonkers, NY

The Metonic Cycle – named for the Athenian, Meton, who lived in the middle of the fifth century B.C. – is a period of about 6939.6 days, the approximate length of both 235 consecutive synodic months (lunations) and 19 solar years. Knowledge of this cycle is important in determining when to assign intercalary months to lunisolar calendars. Put in simple terms, the Moon's position tonight will be nearly replicated on this same date 19 years from now. So, if, as some claim, the Moon has an influence on our weather, would it not stand to reason that we would have similar weather patterns repeat after 19 years? After five years of experimenting with the cycle, some

thoughts and conclusions are presented.

Hurricane Hype and Katrina Lessons. Alan Sealls, Chief Meteorologist, WKRG-TV, Mobile, AL

When the daily cycle of summer and fall weather is broken by an impending tropical storm landfall, the media comes alive. TV reporters rush to the beach. Meteorologists supply a steady stream of numbers and forecasts. Viewers are subjected to repeated images of surf, plywood purchases, and full grocery carts.

Is it hurricane hype or is it a powerful public service? When a storm turns away after a great deal of anticipation, the TV media is often accused of overdoing coverage and scaring people into making decisions that cost them money, loss of productivity and leisure time. Given the disruption and possible devastation to society from a tropical storm or hurricane, the public deserves clear information and specific safety instructions. In the rush to *be first* and raise ratings, TV media risks crossing the line between effective public service and overplaying the threat of danger.

In *Hurricane Hype*, we examine words and phrases reporters, anchors and weather broadcasters use to describe tropical storms and hurricanes. Many of these are almost sure to be uttered multiple times to the point of being comical, trite or clich.

In attempts to strengthen a weather broadcaster's effectiveness we explore where he/she fits into the perception of *hurricane hype*. Sometimes graphics send an unintended message. The message may be that the storm is bigger than it really is or that the forecast track is 100% certain or that danger only exists near the eye.

In "Katrina Lessons" we focus on the extreme case of Hurricane Katrina to examine the vital role that the TV station meteorologist has in setting the tone of coverage, preparing the news department, and preparing the viewers. Whether it is a hurricane, ice storm or tornado outbreak there is a list of items a broadcast meteorologist must plan for in terms of preparation, resources, staffing, data and communications backup.

The incredible impact and cost on cities and lives of Hurricane Katrina must force TV news departments to deal with the realities of storms not as entertainment but as a public service. Logistically reporters must be better prepared for physical and psychological hardship in the field in reporting the human story. The entire news station must have redundancy in communications and a physical backup broadcast area.

The Great One-inch Diameter Hail Debate. Daniel W. McCarthy (NWA Councilor), Joseph T. Schaefer (NWA Past-President '98), NOAA/NWS/NCEP Storm Prediction Center, Norman OK

For a number of years, the debate continues on making one-inch diameter hail the minimum for severe storms. Currently, the requirement is 3/4-inch, or penny size hail. Thus, this adjustment would eliminate those that are also .88 of an inch, or nickel size hail.

There is research that claims that hail damage doesn't begin until one-inch. This launched an experiment by the NWS Central Region involving seven County Warning Areas on warning for one-inch diameter or larger hail.

This presentation will look at the long range effects the changes in definition will make to the number of hail reports reported each year and look at its effects on the data since 1955.

Have NBC's Weatherplus Channels Changed the Broadcast Weather Environment? Kenneth Reeves, Dr. R. Lee Rainey, Jim Candor, and Michael Steinberg, AccuWeather, Inc., State College, PA

Local television weather broadcasts have always faced competition for the public's attention from other local media weather sources, such as radio and newspapers.

The Weather Channel brought continuous weather coverage to television viewers, but did not offer continuous local weather or local weather anchors. The internet dramatically expanded the public's options in getting weather information, but is generally not available on people's television sets.

A small percentage of television markets have had 24/7 local weather channels available for some time. But now, with NBC's WeatherPlus, many markets have 24/7 local weather channels, including local weather anchors and a focus on local weather.

This presentation will discuss the implications and impact this may have on local television weather broadcasts, and the alternatives available to television meteorologists who wish to remain the leading source of local weather.

Why Can't We All Get Along? A New Template for Public-Private Cooperation. John McLaughlin (NWA Past-President '02), Chief Meteorologist, KCCI-TV, Des Moines, IA, Daryl Herzmann, Iowa State University, Ames, IA, and Brad Small, NOAA/NWS Forecast Office, Des Moines, IA

In Iowa, a unique cooperative effort between the NWS, local media, and Iowa State University has enhanced public safety during times of significant weather. The Iowa Environmental Mesonet (IEM) has fascilited sharing of diverse technologies between groups that produce products and those that consume them. By sharing our talents, time, and resources, we have been able to produce enhanced products benefiting everybody involved with the collaboration and ultimately, the general public.

An example of this collaboration is an Internet-based instant messaging platform, code named IEMChat, that automatically relays products between our groups during times when efficient communication is a must. IEMChat was a solution developed to overcome shortcomings of tradiational instant messaging platforms like Yahoo! or AOL. This project has since been released for use anywhere in the country.

Situational Awareness During the 30 May 2004 Indiana Tornado Outbreak. Sally Pavlow, NOAA/NWS Forecast Office, Indianapolis, IN, and Chris Wright, WTHR Channel 13, Indianapolis, IN

On 30 May 2004, twenty seven tornadoes touched down in the state of Indiana; seven above the average number of tornados in one year. Within the National Weather Service Indianapolis County Warning Area (CWA) 18 tornados were spawned from numerous supercells. This paper will review the Situational Awareness (SA) aspect and briefly review the meteorology of the event. These elements had a direct effect on the warning decision making process.

Winter Weather

Forecasting Frontal Precipitation Bands in an Operational Environment. Philip N. Schumacher, NOAA/NWS Forecast Office, Sioux Falls, SD

The forecasting of mesoscale bands of precipitation is one of the more difficult non-convective forecasts in the operational environment. In winter, these bands of precipitation can produce in excess of 30 cm of snow in 24 h. Gradients of snowfall on the order of 20 cm $(100\ \text{km})^{-1}$ mean small errors in location will result in large errors in snowfall totals at a particular location. While mesoscale model output of precipitation can provide guidance as to the amount and location of precipitation bands, the errors associated with these bands can be in excess of 50 km even within 24 h of the forecast verification. Therefore, operational forecasters need to use other tools to help determine the most likely location for precipitation bands.

Previous research has shown that the development of mesoscale bands is the result of interaction of synoptic and mesoscale forcing mechanisms. Potential vorticity (PV) inversions in the vicinity of strong low-level fronts have shown that the upper-level PV anomaly can have a significant influence on the low-level wind field and 2-D frontogenesis. Therefore the understanding of synoptic scale and mesoscale dynamics, and the interactions of these scales, is critical to accurately forecast the location of mesoscale bands. While PV inversions cannot be done operationally, Q-vectors provide a means to determine the role of the upper-level PV anomaly. The stability above the frontal surface is examined in order to determine the width and strength of the frontal circulation. This paper will use a case study of a snow band across the northern plains to illustrate a methodology for forecasting significant mesoscale bands by examining the different scales involved in the forecast. This will entail access to gridded data at different resolutions so that forcing at both the synoptic and mesoscale can be diagnosed.

The Role of Intense Frontogenetical Forcing and Elevated Convective Instability in Producing the Record December 22-23, 2004 Snowstorm in South-Central Indiana. Theodore Funk, NOAA/NWS Forecast Office, Louisville, KY

A major winter storm pummeled south-central Indiana and much of central Kentucky on December 22-23, 2004. Record snowfall amounts of 24-30 inches paralyzed parts of south-central Indiana, 6-10 inches of snow and sleet pelted the Louisville area, while central Kentucky was slammed with up to 2 inches of ice accumulation from freezing rain causing widespread tree damage and power outages. At the height of the storm, snowfall rates over south-central Indiana were approximately 2-3 inches per hour, while sleet fell

continuously for several hours in parts of Louisville.

Snowfall occurred in two waves, one early on the 22nd and the second in the evening of the 22nd into the early morning hours of the 23rd. During this 24-hour period, a quasi-stationary thermal wind structure existed within southwest flow aloft ahead of a shortwave trough. As the shortwave approached, the upper-level and low-level jets increased dramatically resulting in the development of intense low-to-mid-level frontogenetical forcing along the Ohio River associated with the second period of heavy snow. At the same time, the development of negative EPV values and elevated convective instability on the nose of an upper-level dry slot worked in tandem with the strong forcing to produce intense vertical motions. This produced an MCS-type evolution with rapid cloud top growth, very high precipitation rates, and a number of cloud-to-cloud and cloud-to-ground lightning strikes within the area of heavy snow. This presentation will correlate the evolution of these forcing mechanisms (in plan and spatial cross-section views) to radar and satellite trends within the storm.

A Case Study of the Gulf Coast Thundersnow Event of Christmas 2004. Amy E. Becker, Brian P. Pettegrew, Chris J. Melick, Larry L. Smith, Chris Schultz, Patrick Buckley, Anthony Lupo, and Patrick Market, University of Missouri-Columbia, Columbia, MO

On 24-25 December 2005, snowfall occurred in southern Texas that featured lightning and thunder as a part of the event. The area around Victoria, TX, received up to 33 cm (13 inches) of snow, and national news outlets carried photographs of accumulated snow on Gulf of Mexico beaches. A case study is provided that details the rarity of this event, its synoptic evolution, and the convective aspects of the snowfall. Water vapor imagery reveal a mid- to upper-tropospheric circulation approaching and overtaking an old frontal zone over the Gulf of Mexico. Analysis of hourly RUC initial fields reveals the presence of convective instability over the Corpus Christi, TX, area, well to the north of the surface cold frontal zone. Furthermore, cloud bands on visible satellite imagery lie at a significant angle to the mid-tropospheric thickness field. These characteristics point to a dynamic environment in support of upright convection.

Airstream Analysis Conducive To Production Of Heavy Banded Snowfall: A Numerical Simulation Of The 26-27 November 2001 Snowstorm. Sam Ng, Metropolitan State College of Denver, Denver, CO, James T. Moore (NWA Past-President '99), and Charles E. Graves, Saint Louis University, St. Louis, MO

On 26-27 November 2001 a low-pressure system produced a long, narrow swath of snowfall greater than 12 inches with embedded areas reaching accumulations of greater than 30 inches. The lowest central pressure associated with this extratropical cyclone (ETC) was 997.9 mb at 0600 UTC 26 November 2001 when the system became occluded over the central plains. This ETC neither intensified nor weakened after reaching the occlusion stage and propagated slowly northeastward. Although the magnitude of the central surface pressure was not extraordinary, the snowfall produced by this ETC was comparable to other storms with much lower central surface pressures that often feature strong dynamic factors from the upper-level kinematic and thermodynamic fields. Utilizing the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model from Air Resources Laboratory and the National Center for Atmospheric Research's Mesoscale Model version 5 (MM5), a comprehensive kinematic analysis on the various conveyor belts involved in the generation of heavy banded snowfall will be presented.

Improved WSR-88D Detection of Shallow Lake-Effect Snowstorms over Lake Ontario: Simulations of Lowered Elevation Angles. Rodger A. Brown, NOAA/National Severe Storms Laboratory, Norman, OK, Thomas A. Niziol, NOAA/NWS Forecast Office, Buffalo, NY, and Vincent T. Wood, NOAA/National Severe Storms Laboratory, Norman, OK

Currently, National Weather Service WSR-88D radars do not operate below +0.5 deg. Consequently, shallow lake-effect snowstorms over and around Lake Ontario pose a detection and warning problem for the Buffalo NWS Forecast Office. We use simulated scanning strategies to investigate how much detections would increase using lower elevation angles for the three closest New York State WSR-88Ds: Montague (KTYX), Buffalo (KBUF), and Binghamton (KBGM). Two Canadian radars on the north side of the lake that operate as low as 0.0 deg also are considered.

The Montague radar is located east of Lake Ontario on top of the Tug Hill Plateau 520 m above the lake. Using the current scanning strategies, 2-km-deep snowstorms are detectable to a range of only

100 km from the radar (covering the eastern quarter of the lake). The Buffalo radar covers the western half of the lake. Being farther from the lake, the Binghamton radar covers snowstorms over the southern lake shore.

Simulations show that, when the lowest elevation angle for KTYX is decreased to 0.3 deg, the range of detection of shallow snowstorms increases by 100 km. Lowering the lowest elevation angle for KBUF and KBGM to +0.3 deg increases the coverage range by 20 km. By lowering the scanning strategies for these three radars and operating in conjunction with the Canadian radars, lake-effect storms would be detected over the entire lake and surrounding coastal regions.

What Idiot is Wasting my Storm-Chasing Time Yapping About a Winter Storm? The New Year's Day 2005 Thundersleet Storm in Central Minnesota. Robert A. Weisman, Saint Cloud State University, St. Cloud, MN, and Amanda E. Brandt, NOAA/NWS Forecast Office, Duluth, MN

On January 1, 2005, southern Minnesota had moderate to heavy sleet in thunderstorms. The convective line formed in the early morning hours in southeastern South Dakota and intensified as it moved northeastward. The convective elements were the strongest during during the line's passage through central Minnesota, producing 30 cloud-to-ground flashes in the Saint Cloud area. The convective elements continued further to the northeast leading to snowfall rates of 1-2 inches per hour in the Duluth area. This paper will discuss the synoptic-scale and mesoscale aspects leading to the convective development and propagation across the cold sector.

A Comparison of the Mesoscale Environments and Reflectivity Structures of Two Winter Weather Events Across the Mid-Mississippi Valley Region. Gary K. Schmocker and Ron W. Przybylinski, NOAA/NWS Forecast Office, St. Louis, MO, and James T. Moore, Saint Louis University, St. Louis, MO

The winter of 2002-2003 was quite active across the Mid-Mississippi Valley region with several winter storms and smaller mesoscale snow events. This study will focus on two mesoscale snow events which occurred during the later part of January and early February 2003. Although both cases produced mesoscale snowbands depositing 1 to 6 inches of snow, the subsynoptic-scale setting was strikingly dissimilar. This study is part of a larger undertaking to investigate the environments and banded reflectivity structures associated with mesoscale snow events and to develop conceptual models demonstrating the processes.

As part of the Cooperative Institute for Precipitation Systems (CIPS), we will focus on improving the QPF forecasting of mesoscale winter precipitation events by determining the roles of both forcing and instability mechanisms which generate heavier precipitation bands. We will show a comparison of the synoptic and mesoscale environments and reflectivity structures of the 22 January 2003 and 04-05 February 2003 mesoscale snow events. On the first case, several bands of snow of varying sizes were observed for a twelve-hour period ending at 0000 UTC 23 January, 2003. This case occurred in mid to upper-level northwest flow with a strong arctic surface high pressure system building southeastward into the Mid-Mississippi Valley. A weak mid-level northwest flow shortwave trough deepened during the day while a 300 mb jet streak amplified on the backside of the trough. Strong low-level frontogenesis combined with weak stability moved southeastward through the region during the day while little if any isentropic upglide was noted. Snow began to fall over the St. Louis metro area and parts of east-central Missouri after 1200 UTC and continued through 2100 UTC. Numerous traffic accidents occurred during the day across the Greater St. Louis Metropolitan area as road conditions became very icy with daytime temperatures in the teens.

The 04-05 February snow event occurred in strong west-southwesterly flow over the region with a longwave trough extending from south-central Canada through northern California. Much of the middle part of the U.S. was under westerly to west-southwesterly flow during the winter season of 2002-2003. A weak inverted trough extended from central Missouri through the Texas panhandle region with a cold front approaching from the northern plains. Jet coupling between the polar jet and the subtropical branches combined with low to mid-level frontogenesis and weak stability over parts of the Mid-Mississippi Valley Region and Central Plains. In contrast to the 22 January case, isentropic upglide was present over parts of Missouri, eastern Kansas and Arkansas and appeared to play a role in the development of several mesoscale snow bands. Comparisons of the jet streak contributions, forcing mechanisms and stability will be presented.

Severe Weather

A Comparison of Tornado Statistics From Tornado Alley to Dixie Alley. Alan Gerard (NWA Councilor), NOAA/NWS Forecast Office, Jackson, MS, John Gordon, NOAA/NWS Forecast Office, Louisville, KY, and John Gagan, NOAA/NWS Forecast Office, Jackson, MS

Most Americans are familiar with the term Tornado Alley, which describes an area of the Plains and Midwest which is commonly thought of as the peak location for tornado occurrence in the United States. However, a less commonly known term is that of Dixie Alley, which refers to that part of the Southeastern United States which is also very prone to tornado development. This presentation will look at the similarities and differences between tornado statistics in these two regions.

To begin, we will examine the actual terms Tornado Alley and Dixie Alley, and see how their definitions vary in scientific and popular literature. Then, we will look at the actual occurrences of tornadoes in each of these parts of the country, looking at tornado frequency normalized per square mile, as well as the annual cycle of occurrence. These statistics will be further broken down to look at all tornadoes versus strong/violent tornadoes. Finally, we will take a brief examination at the numbers of casualties in each of these areas, and discuss demographic differences which could account for differing numbers of casualties given the number of tornadoes in each area.

Comparisons of Different WRF Configurations in a Severe Weather Forecasting Environment: The 2005 SPC/NSSL Spring Program. Steven Weiss, NOAA/NWS/NCEP Storm Prediction Center, Norman, OK, John Kain, Michael Baldwin, CIMMS and NOAA/National Severe Storms Laboratory, Norman, OK, David Bright, Jason Levit, Greg Carbin, and John Hart NOAA/NWS/NCEP Storm Prediction Center, Norman, OK

Three different configurations of the WRF model were compared over a seven-week period as part of this year's SPC/NSSL Spring Program. The Spring Program is an annual collaborative effort designed to explore applied research topics that are of mutual interest to the research and operational forecasting communities. The program is conducted during the peak severe weather season, from mid-April through early June.

The different configurations of WRF were run remotely and output was collected at the SPC/NSSL facility, where it was displayed within NAWIPS, the operational computational and display software used at the SPC. Each configuration was initialized by simply interpolating 00 UTC initial conditions from the Eta model to high-resolution grids. Model forecasts ran for 30-36 h, with all domains covering roughly two-thirds of the CONUS or more. Two of the different configurations used the ARW dynamic core with identical model physics and namelist parameters, but different resolution. The first, using 4 km grid spacing with 35 vertical levels, was run at NCAR. The second, using Δx =2 km and 51 vertical levels, was run by CAPS at the Pittsburgh Supercomputing Center. The third configuration used the NMM dynamic core and the NCEP physics package. It was run at NCEP with $\Delta x = 4.5$ km.

Model output was used to produce experimental forecasts for severe weather and it was evaluated by forecast teams using both subjective and objective verification strategies. The evaluation effort had two primary foci. The first was to identify systematic strengths and weaknesses of the different configurations and to link characteristic behaviors to specific components of the model physics. Preliminary results suggest that different boundary layer parameterizations in the ARW and NMM cores have a significant impact on low-level temperature, moisture, and instability fields, with important implications for the forecasting of severe convective weather. The second area of emphasis was to assess the sensitivity to resolution, as indicated by differences between the 2 km and 4 km configurations of the ARW core. Preliminary assessments suggest that convective initiation tends to occur sooner with 2 km grid spacing, but the overall evolution of convective activity is very similar on most days. More detailed results from the Spring Program will be presented and discussed at the annual meeting.

Observations and Societal Impacts of the 4 July 2004 Southwest Missouri Derecho. Angela Lese, NOAA/NWS Forecast Office, Louisville, KY

During the early morning hours of 4 July 2004, a line of supercells developed over southern Nebraska and northern Kansas. These supercells transitioned into a bow echo over southeast Kansas, which was

later termed a derecho given its persistence and intensity. As the derecho traveled across southwest Missouri, it produced large hail, one tornado, and intense, destructive straight-line winds around 90 mph, which downed thousands of trees and power lines and caused an estimated $750,000 in structural damage.

It is well-known that the majority of bow echoes (line-echo wave patterns/LEWPs) produce damaging straight-line winds as the rear-inflow jet descends to the surface along the updraft/downdraft interface. In this case, however, intense straight-line winds and the most concentrated wind damage clearly were associated with one deep-layered, leading line vortex as shown by the WSR-88D in Springfield, MO (KSGF). Features seen in radar imagery with this mesovortex, in particular, may help NWS radar operators come to the correct warning decision.

The project also will examine the challenges NWS operational forecasters face in increasing public situational awareness and proper response for extreme, dangerous convective wind events like the 4 July 2004 derecho. In other words, what can or should NWS meteorologists do to alert the public and differentiate the rare extreme wind event from the more common MCS which produces sporadic, less severe wind damage?

A Study of Tornado Environment Parameters in Iowa: What Works, and Which Mesoanalysis Output Can You Trust?. Karl Jungbluth, NOAA/NWS Forecast Office, Des Moines, IA

Using data from 2004 in Iowa, the environments of nineteen potentially tornadic storms (most supercells) were examined by collecting close proximity sounding data representative of the storm inflow region. RUC-2 and LAPS analysis output were examined on the Weather Event Simulator (WES) using software available to NWS forecasters on AWIPS. Most sounding data points were chosen within 30-km and 1-hour of a documented tornado occurrence or passage of a non-tornadic supercell.

Data from 13 thermodynamic and vertical wind shear parameters, including B2K (Bunkers) supercell motion predictions, were compared to the results of previous studies. Data were also analyzed to determine if any parameters might serve as tornado occurrence discriminators. Despite the very small sample size of the Iowa dataset, results were similar to previous studies. LCL, LFC and CIN showed the most utility as tornado discriminators.

The study also produced insight into the extreme variability of analysis output for these highly utilized tornado environment parameters. At times, large variability existed between RUC-2, LAPS and the SPC mesoanalysis page, and output varied between different software display programs as well.

This variability will be the main focus of the presentation, and operational recommendations will be shared with the audience.

Damaging Surface Wind Mechanisms and Non-Supercell Tornadoes with the 24 May 2004 Bow Echo Event over Northeast Missouri and West-Central Illinois. Ron Przybylinski and Gary Schmocker, NOAA/NWS Forecast Office, St. Louis, MO

Since 1992, we have been investigating the storm morphology and mesovortex evolution of many Quasi-Linear Convective Systems (QLCSs) over the Mid-Mississippi Valley Region. One of the most recent events occurred during the evening of May 24, 2004 over parts of northeast Missouri and west-central Illinois. A bow echo formed from an HP supercell complex and produced a damage swath more than 100 km in length. Detailed ground surveys completed by the SOO at WFO St. Louis and staff members at WFO Lincoln, Illinois revealed the presence of seven tornado damage swaths of F0-F2 intensity that were produced by the convective system.

This case was particularly challenging since this organized convective system evolved north of the WSR-88D Doppler radar at St. Louis Missouri (KLSX) as it moved eastward across west-central Illinois. In many cases, WSR-88D reflectivity and Doppler velocity data provided equally important clues concerning the location of the greatest degree of both tornadic and straight-line wind damage. In this case, the acceleration of weaker reflectivity, which represented the surging gust front near the bow apex combined with the identification of several mesovortices near and north of the apex of the bow signified the primary damage swath of downburst clusters and non-supercell tornadoes.

We will present detailed radar and damage survey analyses in an attempt to illustrate the structural relationship between the damage swath and the bow echo observed on the WSR-88D radar. It will be shown that the primary damage swath appeared to be created by both a descending mesoscale Rear Inflow Jet and the strong mesovortices near and north of the bow apex. Analysis of the structure and evolution of

four mesovortices will be shown through rotational velocity (Vr) time-height traces. One of the stronger mesovortices lasted over sixty minutes and spawned three tornadoes during its lifetime. Previous observations of mesovortex evolution from other cases studied showed that tornadic mesovortices consistently strengthen at low-levels and deepened rapidly prior to tornadogenesis. In this case, only two of the four mesovortices showed this trend. This may have been in part due to the sampling of the circulations at distant ranges of 120 to 130 km from the KLSX Doppler radar. This case will be compared to previous cases studied over the Mid-Mississippi Valley region. Forecast and warning implications of the above findings will be discussed.

The 1 June 2004 North Texas-Louisiana Derecho: A Case Study. Ted R. Best, Collin County, TX ARES Skywarn, Plano, TX and Dan Dixon, NOAA/NWS Forecast Office, Ft. Worth, TX

A case study of the 01 June 2004 storms that produced high winds across North Texas and Louisiana is presented. The synoptic and mesoscale environment is analyzed with emphasis on the operational forecast parameters. Northwesterly flow aloft combined with strong instability to produce a favorable environment for a linear mesoscale convective system (MCS). Storm evolution is analyzed from initiation through MCS organization using archived data from the Weather Event Simulator (WES). Although surface boundaries played an important role in storm initiation, the storms moved away from those boundaries and were not dependent on them to sustain convection. Early in the episode, right and left supercell splits were observed. Two supercells in close proximity to each other developed intense outflow winds shortly after the mesocyclones collapsed and then expanded into a forward-propagating MCS. In this case as in others, individual supercells played an important role in the event, producing some of the most damaging winds. The intense winds produced damage to trees, buildings, and power lines over a wide swath more than 400 km long and 100 km wide.

Poster Session: I

The Interannual Variability of Midwestern Temperatures as Related to the ENSO and PDO. Kevin Birk, Blake Smith, Anthony R. Lupo, and Patrick E. Guinan, University of Missouri-Columbia, Columbia, MO

Long period temperature and precipitation records in the Midwest are examined in order to determine how longer-term variations have resulted in changes in short-term (ENSO - related) variability using long-term records for several surface stations. This data was acquired from the Missouri Climate Center and some of the data for eastern Kansas was obtained from the Kansas State University Konza Prairie records. Initial results show that across most of the Midwest and plains, the ENSO variations were stronger during the years 1977 - 1999, which was one period of the Pacific Decadal Oscillation. During the years 1947 - 1976 and from 2000 to the present, there is less ENSO variability. ENSO variability was stronger during the winter seasons than during the summer seasons, and this is especially true for precipitation. However, during the summer months, there is strong La Nina-related variability in the timing of heavy precipitation. These results have strong implications for long-range weather forecasts in this region. Additionally, there were only weak trends in temperature and precipitation over the region and these do mirror global climate trends.

Environmental Conditions Associated with Cool Season Strong and Violent Tornadoes in the Middle Mississippi Valley. Mark F. Britt and Fred H. Glass, NOAA/NWS Forecast Office, St. Louis, MO

This study is a preliminary examination of the synoptic conditions associated with significant tornadoes (F2-F5) in Missouri and Illinois during the cool season. A climatology of 36 tornadoes that occurred on 18 days from November through February during the 55 year period covering 1950-2004 is presented. A previous analysis indicated that significant tornadoes comprise a larger percentage of all tornadoes that occur during the late autumn and winter. A closer examination of the cool season subset shows the transition from autumn to winter (November and December) is the most active time for cool season tornadoes with no favored time of day.

Composites of upper air analyses are examined in an effort to find common synoptic patterns associated with such tornadoes. Preliminary results suggest all cases occur in strongly dynamic patterns with nearby upper level jet streaks associated with progressive shortwave troughs. Each case also possessed a sharply baroclinic, low-level boundary mov-

ing into anomalously high moisture rich air transported northward on a low level jet. Data from regional soundings are stratified to determine how background atmospheric conditions compare to accepted kinematic and thermodynamic parameters. In addition, soundings that occur in close temporal and spatial proximity to individual tornadoes are presented. Our study determined these soundings tend to possess weak thermodynamic profiles (CAPEs $< 1,000$ J/kg). However, the wind fields associated with these systems lead to significant kinematic parameters (0-6 km shear $>$ 20 m/s, SREH > 450 m^2 s^{-2})

COHIX: Further Studies of the Heat Island Associated with a Small Midwestern City Using Suominet Data. Patrick Buckley, Patrick Market, Anthony Lupo, and Neil Fox, University of Missouri-Columbia, Columbia, MO

In mid-December 2004, the University of Missouri-Columbia (UMC) moved its SuomiNet station from the flat, graveled roof of a four-story building near downtown Columbia (pop. 84,000) to UMC's Atmospheric and Climatic Experiment Station (ACES), located on UMC's South Farm, about 7 km southeast of the previous location downtown. As an extension of the Columbia Heat Island Experiment (COHIX) from several years prior, a comparison was made between airport (KCOU) data and data from the SuomiNet station both prior to the SuomiNet move (January-February 2004) and after the move (January-February 2005). Analysis reveals an elevation of the mean temperature of ≈1.5C (3.0 F) at the downtown SuomiNet location during 2004, but virtually no difference between the more rural SuomiNet station and KCOU in early 2005. Moreover, the standard deviation of temperature differences between the two sites (SuomiNet vs. KCOU) dropped dramatically from the pre-move to the post-move era. These and other results to be presented support several conclusions, including: 1) To a first approximation, the influence of the Columbia heat island does not yet extend to 7 km from downtown; 2) The present SuomiNet location is far more representative of the surrounding terrain for surface observations than it had been previously.

The use of LDAR II Total Lightning Data in Thunderstorm Nowcasting in the Dallas-Fort Worth Area. Nicholas W. S. Demetriades and Ronald L. Holle, Vaisala, Inc. Tucson, AZ

Vaisala has been operating a real-time Lightning Detection and Ranging (LDAR II) network in the Dallas-Fort Worth area since the summer of 2004. This network detects over 90% of all cloud and cloud-to-ground lightning. The data from this network is being sent to the Fort Worth National Weather Service (NWS) Weather Forecast Office (WFO) where it is integrated into their Advanced Weather Interactive Processing System (AWIPS) display software. This is part of an initiative to bring total (cloud and cloud-to-ground) lightning data into NWS WFOs for operational evaluation during the thunderstorm nowcasting process.

The Fort Worth WFO has found the total lightning valuable during both severe and general thunderstorm nowcasting. Forecasters are using total lightning flash rates and extent to monitor new updraft development and updraft intensification within thunderstorms. They are also using spatial patterns in the total lightning data, along with radar data, to monitor convective organization trends such as developing downbursts. Forecasters have found the rapid updates of total lightning data (every 2 minutes) important for monitoring both severe and non-severe thunderstorms trends that take place during time scales that are shorter than the 5-minute WSR-88D radar volume scans. Cloud lightning mapping in thunderstorm anvils and stratiform rain regions has also allowed forecasters to improve cloud-to-ground lightning threat statements.

Statistical Analysis of Historical Observations in Support of Temperature Forecasts at the NWS Forecast Office in Jackson, MS. John P. Gagan, NOAA/NWS Forecast Office, Jackson, MS

A comprehensive collection of surface (SAO and METAR), upper air and daily cooperative observations has been merged into one large database at the National Weather Service Forecast Office Jackson, MS. This database has been used to investigate how observed upper air and surface parameters affect observed maximum/minimum temperatures for seven sites throughout the Jackson, MS County Warning Forecast Area. Statistical correlations have been generated to isolate parameters that exhibit the greatest influence on observed maximum/minimum temperatures in an effort to enhance forecasts of anomalous temperature regimes.

New Satellite Data Tools For Precipitation Analyses and Forecasts. Sheldon J. Kusselson and Jay Hanna, NOAA/NESDIS, Camp Springs, MD

Satellite-derived atmospheric products from current and next generation polar- and geostationary-orbiting platforms will form the basis for new value added tools that will help improve forecasters abilities to accurately predict heavy precipitation and flash flooding potential 24 hours in advance. Microwave sensors aboard polar-orbiting satellites provide accurate estimates of Total Precipitable Water (TPW) and Rainrate (RR) over data sparse ocean areas, and are being used with low level wind flows for evaluating areas of enhanced moisture transport for flash flood potential. Visible and infrared measurements are available from high spatial resolution imaging instruments such as NASA's Moderate Resolution Imaging Spectroradiometer flown aboard the Earth Observation System (EOS) polar orbiters, as well as from the high temporal resolution sounder and imager sensors aboard NOAA/NESDIS's Geostationary Operational Environmental Satellites (GOES). In particular, bulk atmospheric stability indices such as the K-Index, Convective Available Potential Energy (CAPE) and Lifted Index (LI) derived from these measurements are currently being investigated to facilitate the identification of areas with heavy precipitation and hence flash flood potential on a routine basis. In addition, because of the increasing number of satellite sensors available to the meteorologist for use in near real-time precipitation analyses, efforts are being undertaken to blend hydrometeorological fields such as TPW from the various satellite sensors to provide for a more complete and self-contained picture of global moisture. This will serve to greatly facilitate the job of the analysts and forecasters who require consolidated information at their fingertips, thereby avoiding the need to engage in the time-consuming process of manually comparing, integrating and synthesizing information from multiple satellite sources.

The current suite of satellite-derived products will be reviewed, along with their utility for hydrometeorological analyses in support of flood and flash flood hazards mitigation. The extension of the techniques to future satellite instrumentation such as the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and Global Precipitation Mission (GPM) will also be briefly discussed.

The Impact of the Missouri Ozarks on MCS Events. Nathan McKinnon, David High, and Anthony R. Lupo, University of Missouri-Columbia, Columbia, MO

Ancedotal evidence suggests that the Missouri Ozarks have a discernable impact on the movement of mesoscale convective systems, and thus, on the occurrence of severe weather. A climatology demonstrates that there is a discernable minimum in the occurrence of tornado and hail events near the Ozarks ridge and in the downstream of the Ozarks, even when accounting for population bias in the observation of these events. This minimum is very strong, especially when MCS events approach from the southwest and northwest. This climatology used severe storm reports archives from 1950 - 2004. Additionally, RADAR imagery from 20 events, representing cold frontal, warm frontal, and warm sector MCSs suggest that the tracks are impacted by the Ozarks in that these events will slow down and/or weaken as they cross the region.

The South Atlantic Hurricane ("Catarina") of March 2004. Mandi R. Reagan, Ashley D. Franklin, Patrick S. Market, and Anthony R. Lupo, University of Missouri-Columbia, Columbia, MO

A synoptic-dynamic analysis of the first-ever recorded (observed) hurricane in the South Atlantic is performed using satellite information and the National Centers for Environmental Prediction - National Center for Atmospheric Research (NCEP-NCAR) re-analyses. This event was a strong category 1 hurricane and moved ashore near the Catarina region of Brazil in late March 2004. There is some debate as to whether or not the event was a hurricane. This analysis shows that the event possesses a warm core and exists in a favorable environment for tropical development in spite of sea surface temperatures (SSTs) that are cooler than 26°C. The regional SSTs were even cooler than normal March 2004 over the development region. Thus, the development will be shown to be the result of more favorable atmospheric conditions, and this event is shown to be more similar to early or late season hurricane events in the North Atlantic. The event did grow out of an weak, but old, frontal zone as will also be demonstrated. This frontal zone possessed stronger moisture differences across the frontal zone than temperature differences.

The Initiation of Nocturnal Convection over the Eastern Plains. Philip N. Schumacher, NOAA/NWS Forecast Office, Sioux Falls, SD, Matthew Dux, St. Cloud State University, St. Cloud, MN, Jeffrey A. Chapman, NOAA/NWS Forecast Office, Sioux Falls, SD, and Robert A. Weisman, St. Cloud State University, St. Cloud, MN

Forecasting nocturnal convection in the Northern Plains has always been a forecast problem. Large hail, damaging winds, flash flooding and tornadoes can be associated with storms that develop after sunset. Barring the development of a large convective complex, the usual result is a relatively small area of heavy rainfall and severe weather surrounded by large areas with little convective activity. For the forecast to be useful to the public at these hours, forecasters need to provide long lead times with watches since television and radio warnings and even sirens are less likely to be effective after 2200 LT. The general tendencies of the Northern Plains nocturnal maximum have been well documented, but synoptic and mesoscale processes that support local variations have not been well researched. Regional climatologies have shown that the primary time of thunderstorm reports and summer precipitation events are near local midnight in eastern South Dakota. Cloud-to-ground lightning data have shown that the maximum occurrence of lightning varies across South Dakota from about 1800 LT in the Black Hills to about midnight in the eastern portion of the state. While some have speculated that nocturnal thunderstorms in eastern South Dakota initiated over the Black Hills and east slopes of the Rockies during the late afternoon, others have found that the area to the east of the Missouri River into Minnesota and Iowa essentially have the same late evening to midnight maximum, indicating this region could be one of new development. An analysis of severe weather hours across this area shows where there is a narrow peak of occurrence for tornadoes between 2200 and 0200 UTC, the reports of large hail and damaging wind have broader peaks that extend past midnight. A small number of events continue through the early morning hours and after sunrise.

A basic climatology of the initiation of nocturnal convection was done by using National Lightning Detection Network (NLDN) data. Cloud-to-ground lightning data were examined to find days when convection initiated over portion of eastern South Dakota, southwest Minnesota, northwest Iowa, or northeast Nebraska. When convection was determined to initiate in this area, the date, hour, location for convection initiation, and if there were severe weather reports was recorded. Composite maps of height, temperature, wind, and dew point were computed for dates where there was convective initiation and days where there was not convective initiation. In addition, composites of days with severe weather and days without severe weather were also done. By examining these data sets, we hope to determine favorable patterns not only for convective initiation in the eastern plains but patterns which favor the development of severe nocturnal convection.

The Bow Echo Severe Wind Event of 6 May 2003 Across Eastern Missouri. James E. Sieveking and Ron W. Przybylinski, NOAA/NWS Forecast Office, St. Louis, MO

The week of 4 May 2003 was the most active period of severe convection ever recorded across the state of Missouri. One of the most costly episodes occurred during the late afternoon and early evening of 6 May 2003 across central and eastern Missouri and southwest Illinois, south of the immediate St. Louis metropolitan area. The northern-most storm, which traveled along a nearly east-west warm frontal boundary, revealed High-Precipitation (HP) supercellular characteristics. Other supercells southwest of the HP storm exhibited classic or hybrid supercellular characteristics. Across central Missouri these storms produced severe winds (> 25 m s^{-1}) and large hail, but as the line of thunderstorms approached eastern Missouri, a number of storm mergers occurred within the line resulting in the development of a bow echo and strengthening cold pool. The northern HP storm collapsed during bow echo formation as it encountered developing convection within its inflow region. The resultant strengthening cold pool initiated a rapid acceleration of the bow echo and subsequent formation of a strong mesovortex near the northern end of the storm complex over southern Jefferson County, Missouri. The combination of the bow echo and mesovortex resulted in a prolonged and devastating period (20 to 30 minutes) of severe wind (30 to 45 m s^{-1}) across southern Jefferson County including the town of Desoto, Missouri. Numerous structures including homes, schools, churches, and other businesses were severely damaged, while several injuries were reported to local authorities. Other strong mesovortices formed at or north of the apex of the bow echo across far southwest Illinois. Two of these mesovortices were responsible for spawning weak tornadoes.

This paper will present detailed radar and damage survey analyses in an attempt to illustrate the rela-

tionship between the damage swath, the bow echo and strong mesovortex near the northern end of the bow echo, as observed by the St. Louis WSR-88D. It will be shown that the primary damage swath of straight-line wind damage was first associated with the accelerated bow echo and secondly the strong mesovortex. Detailed analysis of the structure of the northern mesovortex and other mesovortices which formed along the leading edge of the bow will also be presented. In addition, warning and forecast implications of these findings will be discussed.

Observations of Cool Season QLCS Tornadoes in the Lower Ohio River Valley. Patrick J. Spoden, Christine Wielgos, and Matthew T. Friedlein, NOAA/NWS Forecast Office, Paducah, KY

Over the past several years, forecasters at WFO Paducah have observed several cool season quasi-linear convective systems (QLCS) tornadoes. Cool Season is defined as November through March and typically experiences low CAPE and high shear environments. Through the investigation of several cases, we have been able to identify commonalities between the events. These mutual characteristics were identified as having; 1) bowing line segments or arcs in the reflectivity data, and 2) rotation that develops or strengthens just north of the apex of the bowing line segment or arc. In some cases, tornadic circulations spun up quickly, leaving little potential for warning lead time. Three cases will be presented which will attempt to illustrate part of the spectrum of radar signatures that have been associated with QLCS tornadoes in the Lower Ohio River Valley.

The Pulaski County Tornado Event of 13 January 2005. Daniel Spaeth, NOAA/NWS Forecast Office, Paducah, KY

During the early morning hours of 13 January 2005, an F1 tornado produced an 11 mile damage path across Pulaski County in southern Illinois. The tornado developed quickly within a long line-echo wave pattern (LEWP) in an environment characterized by very low CAPE (< 500 J/Kg) and extreme low-level shear (≈ 50 Kts, 0-1 km).

This tornado event provides a good illustration of a little publicized, but difficult cool season warning scenario in the WFO Paducah warning area. The large-scale setting for this event will be presented, along with a detailed investigation of the radar reflectivity and velocity data. Operational implications of this type of severe weather event will also be discussed.

Building Your Audience and Revenue with Wireless Technology. Kenneth Reeves, Jim Candor, Douglas Yule, and Michael Steinberg, AccuWeather, Inc., State College, PA

Weather information is now the most used wireless data service, and even television broadcasts and other video are now available on cell phones. In this presentation, we will explain how you can put wireless technology to work for you to build your brand, better serve your viewers, and stay in touch with them on a 24/7 basis.

SMS, MMS, WAP, J2ME, BREW, LBS and 3G are only some of the alphabet soup in wireless technology that will be explained in this presentation. You will also learn about the weather products they enable, including local forecasts, animated radar and satellite imagery, severe weather bulletins and much more.

The wireless environment is characterized not only by a wide range of competing technologies, but also numerous handset vendors and carriers. Navigating this landscape can be difficult and time-consuming for a station attempting to create a wireless offering from scratch. This session will also discuss available turnkey approaches that allow you to easily use wireless to not only connect with your audience, but to also generate revenue by adding wireless delivery to your web site and promotions.

The Mississippi Mesonet and NERON Activities in Mississippi. Loren White and Elizabeth Matlack, Jackson State University, Jackson, MS

The progress and challenges of establishing a Mississippi Mesonet which will satisfy the requirements of NERON and of researchers will be discussed. We will highlight some of the events and phenomena observed by the initial network, with emphasis on potential significance to local forecasters and emergency managers. The use of GIS and metadata of existing observing stations in designing the network will be shown. We will also describe our efforts at development of a user-friendly World Wide Web interface for public access to the data and metadata.

NOAA's Climate Database Modernization Program. Thomas F. Ross, NOAA/NESDIS National Climatic Data Center, Asheville, NC and Gary Petti, NOAA/NESDIS, Suitland, MD

NOAA's Climate Database Modernization Program (CDMP) has an important mission: to make major climate and environmental data and informa-

tion available via the Internet.

CDMP works to image and key historical climate and environmental records. Once the data are imaged and indexed and/or keyed and placed into a NOAA database, the next step is to make this information available via the Internet. This benefits NOAA by making its data easily accessible to hundreds of thousands of customers in government, commerce, industry, science, education, engineering, and national defense.

These modernization efforts include the keying of observations; imaging original records from paper, microform or photographic copies; vectorization of shoreline maps; and digitizing analog and punch paper tape records.

CDMP supports up to 50 different NOAA tasks in a given year, including imaging historical photographs of Alaskan glaciers, electronically scanning the Daily Weather Map series (from 1871 forward) and Monthly Weather Review volumes published under the auspices of the government, and imaging the Defense Meteorological Satellite Program (DMSP) historical film strips.

In addition, CDMP is supporting efforts in over a dozen countries, including rescuing upper air data from six participating African nations involved in a data rescue project of their historical archive records.

The amount of images online via the CDMP WSSRD system (Web Search Store Retrieve Display) has grown from just one-half million in 2000 to over forty-five million images online by the end of 2004, equating to near 5 terabytes of data. In addition, CDMP has keyed 33 million surface hourly meteorological records, extending the climate database back to the establishment of some 150 airport stations in the late 1920's and early 1930's. The period of record is being extended even further back into the 1800's by keying available Weather Bureau city office and Army Signal Service records.

National Weather Association 30th Anniversary. Ruth Aiken (NWA Secretary), NOAA/NWS Forecast Office, Raleigh, NC

The National Weather Association will celebrate its 30th anniversary at the annual meeting October 15-20th, 2005 in St. Louis, Missouri. The NWA was incorporated December 15, 1975. The first Officers were:

President: Jerry LaRue

President-elect: Tony Tancreto

Secretary/Treasurer: Joe Vazzo

The mission of the National Weather Association is to support and promote excellence in operational meteorology and related activities.

To commemorate the 30th anniversary, there will be brief bios of the first officers and list of the charter members. Additionally, historical highlights of the activities of the NWA for the past 30 years.

Digital Weather Multicasting: New Opportunities for Viewers and Weather Professionals. Jeff Thein, NBC Weather Plus, Secaucus, NJ

The business of live TV weather information is growing rapidly, creating new viewing choices for consumers, and new opportunities for the men and women who bring them locally relevant weather information. In dozens of US markets, viewers are now able to turn on their TV's at any time, day or night, and immediately get the local weather report, including a 5-day forecast, even during commercial breaks. The recent growth of local weather multi-casting led by NBC Weather Plus has created an array of new opportunities and new challenges for the weather information industry, and many new opportunities for forecasters to warn and educate millions.

In the wake of Katrina and other natural disasters, what role will these new digital channels play in the dissemination of timely weather information and pictures? And what opportunities exist for local broadcasters to expand their brand and reach into homes?

Warm Season Weather Events

Important Physical Processes in Some Recent Flash Floods. Matthew Kelsch, UCAR/COMET, Boulder, CO

A detailed examination of precipitation and basin characteristics was performed on several recent COMET flash flood case studies. Particular focus was given on how to utilize the available tools for analyzing and forecasting critical elements of the flash flood process. Storm characteristics such as low echo centroid (LEC) structure, warm rain processes, the role of boundaries, and regenerative storm complexes all have important influences on the intensity and duration of precipitation. Basin characteristics such as

land use characteristics, basin size, and modification of stream channels can have important impacts on the timing and magnitude of the basin response.

Radar-derived precipitation provides critical information for these short-fused events. The accuracy and coverage of radar precipitation can vary with environmental conditions. Because anomalous rainfall rates are often involved with major flash floods, radar parameters may need to be adjusted for the anomalous situation. Radar information has a direct impact on the National Weather Service's Flash Flood Monitoring and Prediction (FFMP) guidance.

Basin details and runoff characteristics are at least as important as the rainfall for determining the location and severity of flash floods. The NWS's Flash Flood Guidance (FFG) can provide useful information related to antecedent moisture, but it does not account for increased risks of flash flooding associated with altered basins. Deforestation, wildfire, human-engineered structures and urbanization all change the natural hydrologic response of a basin. Urbanization in particular plays a role in many modern day flash floods. Studies show that urban streams may need to increase their capacity by 2-3 times over the natural capacity of a stream. Because urban streams are not always permitted to increase in size, flooding will occur at lower rainfall thresholds. Altering the FFG values in basins that have enhanced runoff potential (such as those in urban areas or fire scars) can significantly improve the utility of FFMP products.

Convective Redevelopment Behind the Significant Ohio Valley Derecho of 13 July 2004. Chris Smallcomb and Mark Jarvis, NOAA/NWS Forecast Office, Louisville, KY

A significant derecho event affected much of the lower Ohio Valley during the late afternoon and evening hours of 13 July 2004. The event developed in an environment favorable for intense squall lines, including extreme instability and advection of dry air into the mid-levels of the thunderstorm complex. While the derecho produced widespread wind damage over southern Indiana and central Kentucky, the focus of this presentation will be on the environment which transpired after the derecho's passage during the late evening and overnight hours of 13-14 July. Throughout this period, clusters of elevated strong-to-severe thunderstorms redeveloped over the cold pool left in the wake of (behind) the derecho, which produced large hail to golf ball size and locally heavy rainfall, though little in the way of strong surface winds.

This presentation will conduct an observational analysis looking into potential causes for the convective redevelopment in the post-derecho airmass over the lower Ohio Valley, using data from high-resolution WSR-88D radar, aircraft (ACARS) soundings, surface observations, LAPS analyses, and supplemented with short-term model output. Traditional synoptic-scale lifting mechanisms including an approaching surface cold front and upper tropospheric jet streak were present during the redevelopment phase. In addition to these broad features, localized upslope flow over the cold pool, or so-called effective terrain referenced in past papers regarding cold air damming phenomena, may also have been a source of lift for the redevelopment. This lift occurred in an elevated convectively unstable environment characterized by strong positive theta-e advection above the cold pool.

The primary goal of this presentation is to increase forecaster situational awareness of thunderstorm redevelopment potential behind significant linear convective systems using readily available observational datasets, thereby improving short term forecast capability.

Meteorological and Warning Issues Associated with the Kansas Turnpike Flash Flood of 30 August 2003. Jeffrey D. Vitale, James T. Moore (NWA Past-President '99), Saint Louis University, St. Louis, MO, and Matthew Kelsch, UCAR/COMET, Boulder, CO

On the evening of 30 August 2003, I-35, near Emporia, Kansas received 6-8 inches of rain in about 3 hours. WSR-88D radar revealed the storm to be part of a low-centroid echo system. IR imagery indicated warm cloud tops and the precipitation algorithm for the WSR-88D underestimated the total accumulated rainfall since it was a high-precipitation efficient cell.

Slow storm movement of less than 5 m/s also contributed to the heavy rainfall from 6pm-9pm CDT. The heavy rainfall turned Jacob Creek into a river. The subsequent flooding flowed onto northeast bound lanes where cars were wedged up against concrete barriers which were 20 feet long and weighed from 10,000 to 20,000 pounds. Seven cars were swept away as the flood waters broke through the barriers, leading to several deaths.

Diagnostic evidence for this case will be shown which reveal several intersting meteorological factors which contributed to this deadly event.

A Case Study Of A Surprise Elevated Convection Event over Eastern Missouri: 24-25 July 2004. Martin A. Baxter, Michelle L. Keast-Nachtrab, and James T. Moore (NWA Past-President '99), Saint Louis University, St. Louis, MO

During the period 24-25 July 2004 elevated convection along with stratiform precipitation produced rain totaling up to 5 inches across east-central Missouri when no rain was forecasted for the area by the Eta model. In addition to an analysis of diagnostic parameters, this presentation will focus on the difficulties in forecasting the rain event, and why the Eta model failed to predict the location and intensity of the rain. This will be done by first locating the areas of elevated thunderstorms and examining the extent to which parameters match the elevated thunderstorm conceptual model developed by the Cooperative Institute for Precipitation Systems. Close attention will be paid to the mesoscale convective system's propagation and motion vectors to see how the prognostic and diagnostic vectors compare.

Mini-Supercell Event of 23 October 2004 in the Memphis County Warning Area. Jonathan L. Howell and Jason F. Beaman, NOAA/NWS Forecast Office, Memphis, TN

Low-topped supercell thunderstorms developed on 23 October 2004, and moved over portions of the Memphis County Warning Area (west Tennessee and north Mississippi). These thunderstorms produced one tornado, several funnel clouds, and areas of severe straight-line wind damage. The most significant damage occurred when a tornado moved through the community of Marianna in Marshall county, Mississippi. This tornado was rated F1 on the Fujita tornado intensity scale and produced a 75 yard wide swath of damage along a 3 mile long path. One home in the region sustained significant roof damage, two trailer homes were partially damaged, and many large trees were snapped and uprooted. This tornado was spawned by one of the low-topped supercell thunderstorms that developed.

Many of these thunderstorms exhibited mini-supercell characteristics, with significant storm echo tops averaging between 7-10 km (Kennedy et al., 1993), significant echo diameters (> 30 dbz) ranging between 5-15 miles, and strong rotation through a significant portion of the thunderstorm updraft column (Markowski et al., 2000). The atmospheric conditions in areas where these mini-supercells developed exhibited limited thermodynamic instability and large amounts of low-level environmental shear. Atmospheric environments that support development of mini-supercells generally occur during the cool season and are less common than typical supercell environments across the Mid-South. Most tornadoes that form over this portion of the country are produced by typical supercell thunderstorms. Typical supercell thunderstorms have significant echo tops in excess of 12 km (Wicker et al., 1996), possess much larger significant echo diameters, and exhibit strong, deep rotation to significant heights in the atmosphere. In addition, typical supercell thunderstorms form in environments that exhibit moderate to strong instability and large environmental shear.

This case study will investigate the near storm environment that favored mini-supercell thunderstorm development over the Mid-South. In addition, a radar analysis will be performed to identify storm structures associated with the mini-supercell thunderstorms that developed. These analyses will be used to assist warning meteorologists in quickly identifying environments favorable for low-topped convection and provide techniques for effectively diagnosing storm structure and identifying the severe weather threats these storms pose. Hopefully, this will lead to improved warnings for low-topped convective storms that occur over the Mid-South.

Hail of a Spring in the Ark-La-Miss. Jeffrey P. Craven (NWA Councilor), NOAA/NWS Forecast Office, Jackson, MS

March and April of 2005 were extremely prolific for large hail in the National Weather Service (NWS) Jackson MS County Warning Area (CWA), which includes 47 counties in Mississippi, 9 parishes in Northeast Louisiana, and 2 counties in Southeast Arkansas. Since 1955, this past Spring had the most reports of golf ball size (1.75") or larger.

The average number of golf ball or larger hail reports in the Jackson CWA has been 17 since 1980. This year 82 reports were observed, which is nearly double the previous maximum of 43 in 1996. Of those, 4 were tennis ball size (2.50"), 8 baseball size (2.75") and 2 softball size (4.25").

This presentation gives a summary of the mean 500 mb pattern during March and April 2005, and a quick overview of each of the 7 primary hail events. Comparisons to El Nino/Southern Oscillation (ENSO) warm and cool events are made. Also mid-level lapse rates and deep layer shear values are investigated. This data is then contrasted to climatologies of sig-

nificant hail soundings over a 40-year period and to a 3-year southeastern states climatology of severe weather sounding parameters.

It is interesting to note that only one of the 7 primary hail events was also prolific in producing tornadoes, despite the frequent occurrence of supercell thunderstorms. Brief speculation on reasons for this will be discussed as well.

Development of a Severe Weather Forecast Decision Aid for East-Central Florida. William H. Bauman III, Mark M. Wheeler, and David A. Short, ENSCO, Inc., Cocoa Beach, FL

The Applied Meteorology Unit (AMU) developed a forecast tool that provides an assessment of the likelihood of local convective severe weather for the day in order to enhance protection of personnel and material assets of the 45th Space Wing, Cape Canaveral Air Force Station (CCAFS), and Kennedy Space Center (KSC). The severe weather elements produced by thunderstorms include tornadoes, wind gusts $>$ 50 knots, and/or hail with a diameter $>$ 0.75 inch. Forecasting the occurrence and timing of these phenomena is challenging for 45th Weather Squadron (45 WS) operational personnel. The AMU created an interactive web-based severe weather forecast decision aid to help the forecasters to improve the various 45 WS severe weather watches and warnings. The tool provides severe weather guidance for the day by 7:00 AM local.

In order to develop the decision aid, the AMU evaluated atmospheric stability parameters to determine if they could be used as predictors of severe weather in east-central Florida. They then determined threshold values for the criteria and of the 14 atmospheric stability parameters examined, only 6 showed the potential as guidance to forecasters when considering severe weather in their morning forecast.

These six stability parameters combined with the synoptic-scale flow regime, the position of jet streak dynamics, and other criteria were incorporated into an updated 45 WS severe weather checklist which led to the development of the interactive web-based severe weather forecast decision aid. This interactive tool uses a top-down approach for the forecasters by starting with the big picture weather. The rest of the tool requires the forecasters to think about the local causes of severe weather during the warm season regarding persistence, squall line activity, moisture boundaries, stability parameters, jet dynamics, synoptic flow regime, and sea breeze and boundary collisions. The tool is designed to allow the forecasters to answer Yes/No or enter a stability value for each criterion providing some objectivity to the severe weather forecast. Once all the questions have been answered, a threat score for the day is displayed. The higher the threat score the greater the likelihood of severe weather.

Poster Session: II

Training Forecasters to Effectively Use Smart Tools in The Digital Forecast Process. Samuel K. Beckman and Kevin L. Polston, NOAA/NWS Training Center, Kansas City, MO

NWS forecasters use meteorological algorithms called Smart Tools to edit their digital forecast database. The Smart Tools, which are written in a scripting language called Python, use numerical models, observations, and topography data and other weather element grids to modify a weather element grid.

Several hundred Smart Tools have been developed with varying degrees of scientific validity, usability, and documentation. The National Smart Tool and Smart Initialization Team (STSIT) has identified the most operationally relevant, scientifically-sound Smart Tools and placed them on a recommended tool list. Tools may be specific to certain seasons, climates, or geography.

Training is being developed on these recommended Smart Tools. The training objectives are to:

1. Know which tool to select under different editing scenarios.
2. Know how and when to effectively apply the tool in the forecast process.
3. Recognize the tool limitations.
4. Become proficient in use of the tool.

This poster session will show our approach to meeting these training objectives and demonstrate how we blend different training delivery methods to effectively teach forecasters how to successfully use Smart Tools in the digital forecast process.

A 25-Year Climatology of the Supercell Composite Parameter. Greg Carbin, NOAA/NWS Storm Prediction Center, Norman, OK, Bryan Smith, Ball State University, Muncie, IN, Richard Thompson, and John Hart, NOAA/NWS/NCEP Storm Prediction Center, Norman, OK

For many years Storm Prediction Center forecasters have been using a variety of numerical methods to combine and normalize atmospheric parameters favorable for the formation of severe thunderstorms. One of these ingredients-based indices is named the Supercell Composite Parameter (Thompson et al. 2003: Weather and Forecasting: Vol. 18, No. 6, pp. 1243 1261). The Supercell Composite Parameter (SCP) is a multi-parameter index that includes storm relative helicity, CAPE, and deep layer shear. Each of these input parameters is normalized to "threshold" values determined to be favorable for supercell storms. Storm relative helicity is divided by 50 m^2/s^2, CAPE is divided by 1000 J/kg, and shear is divided by 20 m/s in the shear range of 10-20 m/s. Shear less than 10 m/s is set to zero, while shear greater than 20 m/s is set to one. The resultant positive values are used to highlight locations where atmospheric conditions might support supercellular storm structure.

With the availability of 32 km resolution North American Regional Reanalysis (NARR) data, a 25-year climatology of the SCP was developed in order to view monthly and seasonal variations in the SCP across the continental U.S. This poster will describe the data collection and post-processing techniques used to construct the climatology, display seasonal/geographic variations in the SCP parameter, and consider its relationship to past severe weather events.

Preliminary Synoptic Climatology of Cool Season Severe Weather (2000-2005) for the Philadelphia National Weather Service County Warning Area and Vicinity. Paul J. Croft (NWA Past-President '04) and Michael G. Stroz, Kean University, Union, NJ

Cool season severe weather occurrence in and near the Philadelphia National Weather Service in Mount Holly, NJ, County Warning Area while rare does pose a significant forecast challenge. While most wind events tend to be related to strong pressure gradients given the synoptic forcing common during the cool season, damaging wind events, as well as reports of hail and tornadoes associated with convective systems also take place. Although these are associated with progressive and/or intensifying weather systems they do not have a clear conceptual model for a forecaster to apply confidently in advance.

In an effort to better forecast the occurrence of these events a preliminary synoptic climatology was prepared to determine the associated synoptic features. The intent was to provide greater insight to the characteristic nature of these events, their associated attributes and patterns, and to provide some guidance as to what forecasters might look for in advance to recognize the potential for severe weather. In addition, it would assist in identification of what other work might be necessary to improve prediction and lead-time across such a major metropolitan area.

The study focused on local storm reports (obtained online from the Storm Prediction Center) for the months of October through March during the six year period 2000-2005. Preliminary results indicated that severe weather events occurred only one percent of all days included (for the dataset sampled) and these were dominated by damaging wind reports (80% of all local storm reports). Further examination of the events focused on their associated synoptic patterns as determined from the Daily Weather Map Series.

Results indicated three basic synoptic types driving the severe weather, two of which shared similar features and were dynamically driven. The third synoptic type was characterized by quasi-stationary frontal features and thus much more dependent upon localized thermodynamic forcing. This third synoptic type accounted for all of the hail reports and most of the tornado reports. The spatial distributions of the storm reports revealed little or no evidence of other local effects or population-biased reporting although frequencies were observed to be lower near the coast and in the Pine Barrens region of New Jersey.

An Investigation of Air Quality Index Characteristics and Behaviors for Southern New Jersey During Spring 2004 as a Function Of Synoptic Weather Patterns. Paul J. Croft (NWA Past-President '04) and Belkys V. Melendez, Kean University, Union, NJ

Air quality in New Jersey is of concern given the state's high population density and the significant presence of industry and other pollutant sources. While air monitoring is performed routinely in real-time and the characteristic behavior of peak values of various pollutants are known, little work has focused on the attendant synoptic weather patterns

that precede and occur with these values throughout the state. This is significant given the health impacts posed by pollution, especially if exacerbated by the time of year (e.g., pollen season) and the synoptic weather conditions. In an attempt to better understand the relationship of the unhealthy conditions created by high pollutant levels the Air Quality Index (AQI), as developed by the United States Environmental Protection Agency was examined for the 2004 spring season for eleven counties covering the southern two-thirds of the state. All daily numerical values were considered (as available) for the period 5 April through 31 July and assessed by a synoptic type tabulation to discern any patterns or peculiarities in the spatial and temporal distributions. Synoptic weather types were determined through access and analysis of the Daily Weather Map Series and included high pressure, low pressure, and frontal systems. Summary statistics of each synoptic type's AQI were examined by county and across the state to interpret any maxima and minima that occurred. A variety of statistical and spatial plots provided a view of the role of weather in air quality in the study area as well as the characteristic behaviors of the AQI as a function of the prevailing weather conditions.

Fog During the 2004-2005 Winter Season in the Northern Mid-Atlantic States: Spatial Characteristics and Behaviors as a Function of Synoptic Weather Types. Paul J. Croft (NWA Past-President '04) and Aaron N. Burton, Kean University, Union, NJ

Fog is a major factor for airport operations and understanding the factors that generate widespread versus localized fog under varying synoptic weather patterns is of importance to forecasters and airport terminal managers. Therefore the occurrence of fog during the 2004-2005 winter season (December through February, 90 days) was examined based on the frequencies of fog occurrence for 14 stations in the northern Mid-Atlantic States. Data were obtained for each site from monthly climatic summaries available online to determine both the frequency of fog occurrence days (i.e., at least one station reporting fog on that date) and those days when dense fog was also reported. The intent was to identify the spatial characteristics and behaviors of fog as a function of synoptic weather patterns. This information would be valuable to forecasters and would also allow assessment of the feasibility and ability to employ fog dispersal techniques.

An initial examination of the data indicated 75 fog events (or days) occurred (83% of study period) with at least one station reporting dense fog during 34 of those events (45%). Total frequencies of fog plotted by station showed a clear pattern of maxima in select coastal and inland regions. The data were then considered with regard to the frequency of three basic synoptic weather types: high pressure (34), low pressure (16), and frontal situations (22); with only three events not meeting these criteria. Within each synoptic weather type subtypes were also identified according to the location of the pressure and frontal systems (e.g., over, to the west-northwest, et cetera) with regard to the centroid of the study area (south-central New Jersey). High pressure accounted for 45% of all events with 32% of these experiencing dense fog, low pressure 21% of which 63% included dense fog, and frontal 29% in which 55% of the events included dense fog.

Consideration was also given to the spatial distribution of fog with regard to patterns of maxima and minima and the spatial coverage by event and synoptic types. When more than 10 of the 14 stations (i.e., more than 71% of all study region stations) reported fog, the event was defined to be widespread. The event was defined as discontinuous when 4 to 10 stations reported fog (i.e., 29% to 71% of stations) and as localized (or isolated) when less than 4 sites observed fog (i.e., less than 29% of stations). When examined according to these criteria, high pressure events experienced widespread fog only 29% of the time, discontinuous events 30%, and localized 41% of the time. Low pressure (and frontal) systems experienced widespread fog 69% (50%) of the time, discontinuous 12% (27%), and localized 19% (23%). Applying the same definitions to dense fog events revealed that all high pressure events were localized, 25% of low pressure events were discontinuous (75% localized), whereas for frontal events only 14% and 9% of the occurrences of dense fog were considered to be discontinuous and widespread.

Problem Based Learning: Observing the Earth. Paul J. Croft (NWA Past-President '04), Kean University, Union, NJ

Undergraduate non-science majors are required to complete one lecture course within the science curriculum at most universities. Many of these students dislike or are not interested in science and many also wait until their final academic year (or semester) before completing this portion of their core curriculum. In order for students to meet this requirement, the Department of Geology and Meteo-

rology at Kean University offers a variety of courses including *Observing the Earth* so that students may satisfy their graduation requirements. The course, through the scientific investigative process, provides an overview of content on astronomical, geologic, atmospheric, and hydrosphere information and principles. However, the very limited and brief exposure to science, including the scientific thought process, limits the development of their scientific literacy. The lack of a laboratory component, critical to the synthesis of these aspects, must therefore be provided in some other manner. To provide these, the author made use of the problem based learning (PBL) approach throughout the course (lecture and assignments) to enhance student comprehension and retention of course content as well as to apply these to real situations to help students develop their synthesis abilities.

This was accomplished primarily through the use of the 2004 tsunami disaster in Southeast Asia as a focal point for a culminating group project assignment for the course. This project helped to illustrate the complexity of the geosphere system, particularly when the biosphere is involved, and provided them an opportunity to apply the scientific thought process, science principles, and consider an environmental context with regard to biosphere systems and related issues (e.g., socio-economic, political, cultural, and others). Prior to the project work, students were provided course content and additional written materials for response and reaction as part of their regular course assignments during the first half of the semester. These required critical reading (e.g., good versus bad science), analytic examinations (e.g., observation, hypothesis, and theory), and relation of course content to real-world situations and problems (e.g., natural resources, geosphere interactions, and human responses to and impacts on the geosphere). In addition, groups of students also completed Earth Team presentations to hone their skills in applying principles of science through scientific thought and process to build scientific literacy among all of their classmates in the topics of astronomy, geology, hydrology, and meteorology as related to the biosphere and its systems.

Laboratory experiences were provided by engaging students in class discussions and problem-solving to understand select concepts (e.g., the big bang theory, geocentric versus heliocentric, minerals classification, principles of geologic time, plate tectonic theory). Each of these forced students to consider situations outside of their own experiences and to see the role of both human and instrumental observations. This provided insight as well as to the significance of technology and remote sensing techniques to scientific investigations. Student reaction was positive and their ability to synthesize and apply scientific thought was improved.

Problem Based Learning: Meteorological Instrumentation. Paul J. Croft (NWA Past-President '04), Kean University, Union, NJ

Upper division coursework in instrumentation in atmospheric science is often limited to either a survey of multiple types and uses of weather equipment or to theoretical and mathematical considerations of equipment response. In addition, there is sometimes the lack of a laboratory component given the credit loads of both the college core and major curricular requirements at many institutions. In order to include basic elements of both the equipment and the theory, and to relate course content to real situations, the problem based learning (PBL) approach was employed in several aspects of an instrumentation course (including a class term project) during the spring 2005 term in the Kean University Department of Geology and Meteorology. The course included a laboratory component and was intended to provide an overview of the types of instrumentation used in atmospheric science (and related fields), the theory and application of the measurement and design principles of instrumentation, and the opportunity to apply these to new or unusual circumstances in real settings. The course includes traditional lecture, laboratory exercises, and Geo-Weather Team briefings in which students relate the characteristics and behaviors of the natural environment, as measured by various observational platforms, to atmospheric processes that produce the synoptic weather conditions.

The class term project required the students to be responsible for determining, assessing, and implementing the proper observational, instrumental, and network criteria for weather observations to be made within the campus setting. The term project was presented in the context of a consulting company or group that must examine, review, assess, and determine the appropriate course-of-action to properly observe weather conditions on campus. During the process, students were expected to make use of course content and the principles of instrumentation as applied to the equipment available to them through the Department's Meteorology Program. Therefore, students selected from a variety of work divisions in order to perform tasks that would achieve end goals of

making recommendations (e.g., siting, observations, and equipment), delivery of a technical report (including appropriate documentation), and presentation of their results to an outside review team and the general public. Tasks included obtaining data and reference information, application of statistical analysis techniques learned in the course, and decision-making. Each of these provided professional development experiences as related to job skills and demanded students to approach the project as a job rather than simply a course assignment to be completed. Results were positive, particularly in that students created and developed items that could be included in their own portfolios and that would also help other students in the future when completing a similar project.

Undergraduates Providing Weather Activities for Research and Development of Skills at Kean University (UPWARDS at Kean!). Paul J. Croft (NWA Past-President '04), Kean University, Union, NJ

The Kean University undergraduate Meteorology Program, within the Department of Geology and Meteorology, provides a variety of outreach and professional development opportunities. These include activities for K-12 audiences (e.g., Upward Bound), teacher training and professional development (NJESTA), and undergraduate students (Epsilon Corps). During 2004 and 2005 several programs were offered including *What's with the Weather?* for high school students, *Phenology Nature's Measure of Climate and Climate Change* for teachers, and *Observing the Geosphere Weather Conditions in Time and Space* for new undergraduate students about to begin their college education. Each of these programs considered the atmosphere and weather (or climate) with regard to exploration of scientific principles, measurement and interpretation of the atmosphere, and the use of these to assess and explain the characteristics and behaviors of weather and climate systems or simply the application of science and technology. The components of each of these and their outcomes, particularly for application to real situations, are considered with regard to the enhancement of learning and outreach activities of the Department for a variety of K-12 and public initiatives. These are also providing for the development of professional partnerships and skills for both the undergraduate student majors and the faculty at Kean University to enhance all research and outreach activities.

Ultrasonic Snow Depth Sensors – Can They Help Us Measure Snow? Nolan J. Doesken, Wendy Brazenec, and Steven Fassnacht, Colorado State University, Fort Collins, CO

During the winter of 2004-2005, fourteen sites from California to Maine, including 9 National Weather Service Forecast offices, participated in a nationwide evaluation of ultrasonic snow depth sensors. These sensors use sound pulses to electronically measure and track changes in the depth of snow on the ground. The purpose of this evaluation was to see if this technology may be reliable and appropriate for measuring snowfall and total depth of snow at weather stations in the U.S.

Based on this single season evaluation, ultrasonic snow depth sensors performed well under a wide range of weather conditions and provided useful estimates of total depth of snow on the ground that could easily augment manual and automated surface weather observations. Measurement of snow depth to the nearest 0.1" was not always possible due to high frequency fluctuations in sensor output, but estimates to the nearest 0.5" appear possible. The quality and representativeness of the data were very sensitive to instrument location. Data quality was impaired during periods of strong wind and heavy snow. Sensors tended to report less snow on the ground than traditional human observations. But despite some weaknesses, the continuously updated time series of total depth of snow on the ground offered a fascinating view of snow accumulation, redistribution, melting and settling.

This presentation will show examples of test facilities across the country and will compare results from the ultrasonic snow depth sensors with traditional manual measurements. The impact of "noise" on real-time uses of the data will be discussed. An algorithm to estimate 6-hour and daily snowfall totals from a continuous snow depth time series will be described and the results compared to co-located manual measurements. Finally, potential operational and climatological uses of the data will be mentioned.

A Case Study of Supercell Thunderstorm Merger and Tornadogenesis. William Gilmore and Neil I. Fox, University of Missouri-Columbia, Columbia, MO

On May 4, 2003, a record outbreak of tornadic supercells struck portions of the central United States. In Missouri alone, 38 tornadoes were documented, setting not only a new single day record, but a new

monthly record of tornadoes. An interesting feature of this outbreak involves the evolution, interaction and merger of cells that produced a tornado in Southwest Missouri that devastated the town of Pierce City. This paper presents results from an analysis of the evolution of the storm using radar data. The analysis concentrates on the impact of the merger of two storm cells on the intensity of the tornado. The Doppler radar analysis shows that there was increased intensity and rotation of the main storm prior to the merger, and a very intense resulting thunderstorm with very strong rotation signatures. These features may be of interest to forecasters attempting to predict the timing and intensity of severe weather associated with storm cells that are merging or in close proximity to one another.

The Historic Missouri-Illinois High Precipitation Supercell of 10 April 2001. Fred H. Glass and Mark F. Britt, NOAA/NWS Forecast Office, St. Louis, MO

An overview of the devastating high precipitation (HP) supercell event which affected Missouri and southwest Illinois during the afternoon and evening hours of 10 April 2001 is presented. Evolving during the mid-afternoon over extreme eastern Kansas, the single storm produced nine weak short-lived tornadoes as it tracked eastward over a seven hour period. While the spawning of nine tornadoes (including one deadly tornado) alone is noteworthy, the HP supercell will long be remembered for its prolific hail production. The storm produced golf ball to baseball size hail during its track east through the highly populated Interstate-70 corridor from Kansas City through Columbia and St. Louis, resulting in hail damage of historic proportions. Even to the south of the largest hail, penny size hail caused considerable damage as it was propelled by rear flank downdraft winds of 60 to 70 mph. Insurance losses of 1.5 billion dollars make this the most costly hailstorm in U.S. History.

This study will review the role of a pre-existing thunderstorm outflow boundary along with environment shear and instability profiles in the development and evolution of the long-lived storm. Doppler radar observations from the National Weather Service offices in St. Louis (KLSX) and Pleasant Hill (KEAX) will be presented. These observations included continually evolving storm structure, cyclic mesocyclone production, and multiple co-existent rotating updrafts within a larger updraft current.

The Role of Coupled Jet Streaks in a Midwestern Heavy Snow Event. Chad Gravelle, Saint Louis University, St. Louis, MO, Scott Rochette, State University of New York at Brockport, Brockport, NY, and Thomas A. Niziol, NOAA/NWS Forecast Office, Buffalo, NY

Numerous studies have recognized the role of jet streak interaction on enhanced vertical motions and cyclogenesis. However, the transverse circulations that are induced by coupled jet streaks can also produce heavy precipitation hundreds or even thousands of miles from the nearest cyclone. On 21 January 2005, a band of heavy snow developed north of a weak area of low pressure from eastern North Dakota southeastward into the lower Great Lakes. The 15-30 cm snowfall amounts within this band fell over a 12-hour period and were not associated with a strong area of low pressure. An analysis of the event shows that the heavy snow occurred 200 km north of a weak and disorganized area of low pressure under the influence of a strong transverse circulation pattern. The coupled jet streak circulation enhanced the ingredients for winter precipitation and quasi-geostrophic forcing in the location of the ascending branches of the ageostrophic circulation.

Incorporating Local Climatology into Aviation Forecasts. Gino Izzi, NOAA/NWS Forecast Office, Springfield, MO

The commercial aviation industry has wide reaching impacts in the United States economy. In these times of tightening airline budgets, the importance of accurate Terminal Aerodrome Forecasts issued by local National Weather Service offices has grown. Forecasts of low ceilings, low visibilities, and thunderstorms are the most crucial for pilots. Prolonged periods of fog or low stratus can lead to airport delays as well as significant monetary losses for the airlines. Ironically, as costly as those conditions can be, just as costly to the airlines is an inaccurate forecast of fog or low ceilings. The weight of the additional fuel causes the aircraft to burn significantly more fuel in route, thereby increasing the overall fuel costs of the flight. Typically, the number of these relatively infrequent events that are forecast far outnumber how many actually occur. This poster will illustrate just how climatologically infrequent these events are, and show how results from local climatological studies have been incorporated into local aviation operations.

Two Incredible Tornadic Supercells: Field Observation and Analysis Reveals Distinctly Different Tornadic Modes. Ted Keller, KOLR/KSFX-TV, Springfield, MO

Two storm chases separated by a week in May of 2004 resulted in the interception of two powerful tornadic supercell storms.

The chase of May 22, 2004 documented the beginning of the infamous Hallam, Nebraska tornado. The storm started with twin tornadoes and evolved into a 2 mile wide tornado as it struck Hallam. This storm formed in close proximity to three surface boundaries: the dry line, an old outflow and an anvil shadow. The role these boundaries may have played in the development of this storm will be explored.

One week later on May 29th, a cyclic mesocyclonic supercell was tracked from nearly start to finish in Harper and Sumner counties in Kansas. This storm produced at least nine tornadoes generated by at least three separate mesocyclones. The near-storm environment will be analyzed to ascertain whether the observed shear fits into conceptual models which attempt to differentiate between non-cyclic/cyclic, occluding/non-occluding tornadic supercells.

This presentation will also focus on the visual documentation of both storms and give some insights into the storm chase decisions made on these two days.

Tornadic High-Precipitation Supercell Cluster of 29 May 2004, Part II. Greg Koch, Suzanne M. Fortin, and Michael J. Hudson, NOAA/NWS, Forecast Office, Pleasant Hill, MO

During the course of the evening hours of 29 May 2004, isolated, classic supercells developed in northeast Kansas and evolved into a high-precipitation supercell cluster across northwestern Missouri. Tornadoes were associated with the supercell cluster, including one killer F4 tornado. From the operational forecaster's perspective, transition of supercell thunderstorms through various phases of the supercell spectrum resulted in challenges in the warning decision making process. The most challenging warning decision aspect occurred when one of the high precipitation supercells within the cluster exhibited multiple, mesovortices (mesocyclones) rotating around a meso-gamma circulation. Each of these mesocyclones simultaneously was producing tornadic activity. An operational retrospective of the storm-scale analysis of a tornadic high-precipitation supercell cluster will offer insight to critical warning decisions made during the course of the event.

The Creation and Utility of Historical Weather Posters. Andrea Lammers, NOAA/NWS Forecast Office, Louisville, KY (Indiana University), and Sarah Ede, NOAA/NWS Forecast Office, Louisville, KY (Western Kentucky University)

Historical weather posters can make excellent educational and outreach tools. They are well-suited for use during in-office tours and for various community events such as state and local fairs, science centers, spotter talks, community meetings, etc. At such forums, posters can spark interactive discussions on various significant hazards, situational awareness, and safety rules. They also can heighten public meteorological interest and keep the memory of major events alive, while promoting NWS functions. Posters also can help beautify the WFO environment.

With current technologies such as Microsoft Powerpoint or Publisher and various image editing software, informative, eye-catching posters are inexpensive and quite simple to create, and ignite individual creativity. The first step in a poster's creation is choosing an appropriate weather event significant to the forecast area. Subsequent steps include researching pertinent data and facts, determining storm societal impacts, and collecting event photos, graphics, and even clip art. Text, photos, and graphics must then be laid out in an attractive, creative, and colorful manner. Posters are an effective way to integrate office and outreach programs. We will concentrate on effective creation and outreach benefits, and display actual posters for 3 historical events across central Kentucky and south-central Indiana.

Integration of SODAR Technology into Military Aerodrome Operations. David Law, U.S. Air Force, Medical Lake, WA

Climatologically, Fairchild AFB, WA's Nov-Feb prevailing visibility falls below three statute miles 63 percent of days. During the 2001-2002 winter, dense fog impacted 28 percent of all operational and training flying missions. Local fog forecast techniques were stagnant and based on 1940-1950's research with latest rule of thumb 30 years old. An accurate fog lifting/clearing forecast would improve mission operations cost efficiency & result in substantial savings due to takeoff delays. Pitched and acquired Sonic Detection and Ranging (SODAR) acoustic Doppler system. Organization now armed with high-resolution wind and shear profiles reap safety & operational ku-

dos! Dangerous windshear was detected before approach twice, performance gains were had with accurate take-off inversion data, and precise paradrop winds had troops on target.

Team members formulated research priorities and implemented innovative methods to advance the concept of integrating weather data into daily operations and command and control systems. Researched persistent dense fog structure under Northeasterly flow and discovered double inversion/shear layer developing after sunrise; depth of original fog increased from 300 to 750 ft in single hr (phenomena virtually undetectable by historical rawinsonde data), climatology tables validated and valuable local effect was documented. During densest fog episode in five years, aircrews were briefed mission no-go based on study; result: engines never started, $25K fuel saved and the system 45 percent paid off in a single month. Conducted time-sensitive analysis of weather limitations correlated to a threshold that reliably indicated visibility would improve to take-off minimums within the hour; aircrews poised, then launched. The weather forecasters' credibility has come of age. Our local SODAR successes continued when a new rule of thumb allowed us to predict additional launch window opportunities: light precipitation disrupts the existing inversion, causing a temporary break in the fog/stratus. A exciting venture into understanding microscale and boundary layer meteorology and applying that to aerodrome operations.

Analysis and Forecasts of 300 hPa Divergence Associated with Severe Convection Using Eta-212 and MM5 Model Data. Captain Scott Lisko, U.S. Air Force, Scott AFB, IL

This study investigates severe weather events occurring in the Midwest, Central, and Northeastern United States from May through September 2004. Severe weather events are pinpointed using tornado and hail reports and correlating them with NEXRAD radar data to determine maximum intensity of the event. Severe storms that occur within 30 minutes of a model forecast hour are catalogued for further investigation. Once these events are diagnosed, ETA-212 and MM5 model data is regridded, centered on the storm. Divergence values at 300 hPa are extracted from the model data for each storm event. These storms are then grouped in three ways: all storms, tornadic storms, and hail producing storms. The averaged maximum divergence values from the ETA-212 for each group are examined from the 0 hour analysis through the 21 hour forecast. From these averaged divergence values, a matrix of recommended divergence threshold values is derived. For the MM5 data, a subset of storms is examined. The MM5 and ETA-212 are run on an identical set of storms, and the divergence forecasts are compared.

Weather Forecasting: Getting Order Out of Chaos? Anthony Lupo, Patrick Market, and Andy Kunz, University of Missouri-Columbia, Columbia, MO

During the past 40 years, there has been a great deal of discussion about Chaos theory and it's applications in meteorology. Chaos is described as "order without periodicity" and one key characteristic of chaotic systems is a quantity known as "sensitive dependence on the initial conditions". Chaotic systems are those in which two nearly identical systems diverge rapidly over time. The development of ensemble forecast systems are a recent example of a tool that has been developed in order to take advantage of the characteristics of chaotic systems. However, there are simple quantities that have been developed by researchers and these can be used in everyday analysis that can also provide the forecaster with relative measures of predictability. These quantities are shown to be directly linked to Lyapunov exponents, which are direct measures of system stability or predictability. We will demonstrate successfully the use of these quantities in both smaller and larger scale forecast problems, and these tools do not necessarily require the need to examine previous data in order to become familiar with the evolution of the system.

The Permian Basin Haboob of 3 June 2003: An Analysis Using Modern Remote Sensing and Photographic Observations. Seth Nagle, Jeffrey Cupo, Todd Lindley, and Pat Vesper, NOAA/NWS Forecast Office, Midland, TX

During the evening hours of 3 June 2003, an intense dust storm affected much of the Permian Basin of west Texas. Remote sensing and visual observations from the event suggest that this was a classic example of the legendary haboob normally observed near Khartoum, Sudan (Sutton, 1924). Maximum sustained winds associated with the dust storm reached 23 knots with a peak gust of 34 knots, and visibilities were reduced to less than one quarter of a mile for approximately forty minutes at Midland International Airport.

The relationship between haboobs and thunderstorm outflow has been well documented by Free-

man (1952), Idso et al. (1972), and Lee and Finley (2002). Lawson (1971) noted that such events are occasionally generated by rain-cooled outflow from cumulonimbi, coupled with very dry mid-levels, and can propagate significant distances from the source convection. They are maintained by the resulting horizontal density gradient associated with the thunderstorm outflow, which also distinguishes these phenomena from synoptic scale dust storm events that take place in west Texas. As many of the previously cited studies have noted, haboobs are characterized by an awesome display of blowing dust that takes on the form of a density current, and frequently appear as solid walls of dust rising to heights between 1000 and 2000 meters.

Despite the potential impacts on public and aviation safety, few studies have focused on the occurrence of haboobs in the United States. This may be attributed to the relatively infrequent nature of the phenomena in proximity to the modern remote sensing network utilized in this country. This poster will present an analysis of volumetric Doppler radar data from the Midland, TX, (KMAF) WSR-88D, as well as meteograms derived from the KMAF Automated Surface Observation System during the passage of the 3 June 2003 haboob. These data will be correlated to photographic observations of the haboob's visual appearance, and compared to haboob characteristics documented by previous studies that used less sophisticated observation methods in Sudan and Arizona.

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On the Frequency of Occluded Frontal Occurrence over North America. Zach Paul and Patrick Market, University of Missouri-Columbia, Columbia, MO

Casual questions arise from time to time regarding the relative frequency of cold-front-type versus warm-front-type occluded fronts, in particular: Which occurs most often? In order to shed some light on this debate, North American weather maps were examined for the eight more active months (September - April) of the year over three seasons (2001-2002, 2002-2003, 2003-2004). Those occluded frontal zones analyzed at 1200 UTC on the Daily Weather Map series of maps were the focus of this investigation, provided that adequate data were available both upstream and downstream of the front's location. Surface potential temperatures were then calculated for the pertinent stations (≈200 km downstream versus ≈200 km upstream) in order to eliminate adiabatic differences due to elevation. We determined that in all three years, cold-front-type occluded fronts occur with about the same frequency as warm-front-type systems. Neutral fronts (with a downstream-upstream temperature difference of less than 3C) outnumbered either of the other categories. Additionally, no category seemed to exhibit stronger downstream-upstream temperature changes than another.

South Florida Seabreeze/Outflow Boundary Tornadoes. Russell Pfost, Pablo Santos, and Thomas Warner, NOAA/NWS Forecast Office, Miami, FL

In the late afternoon and evening of 7 August 2003 two tornadoes produced significant damage across parts of metropolitan Palm Beach County, Florida. These tornadoes were produced as a strengthening updraft encountered cyclonic shear along a sea breeze convergence line enhanced further by an outflow boundary from previous convection farther west. The second tornado in particular produced substantial damage to a trailer park and industrial areas in both Palm Beach Gardens and Riviera Beach and crossed a major interstate highway (Interstate 95). Detection and warning of the tornadoes was a challenge for National Weather Service (NWS) forecasters at the Weather Forecast Office (WFO) in Miami because of the distance from both the Miami (KAMX) Weather Service Doppler radar (WSR-88D) and the Melbourne (KMLB) WSR-88D resulting in beam elevation and sampling issues.

The Effect of a Gravel Base on the Temperature Profile in the Lowest 2 meters of the Atmosphere. Justin Pucket and Anthony R. Lupo, University of Missouri-Columbia, Columbia, MO

During the early 1990s, temperature readings in the United States at all major surface stations were replaced by Automated Surface Observing System (ASOS) instruments. These instruments were placed over a gravel surface rather than a grassy surface. In this study, the temperature profiles in the lowest 2 m of the atmosphere over a gravel and grass surface will be measured over the course of one year. In each case, thermometers will be placed every 40 cm on a pole in a shaded area. Initial results suggest that the gravel surface does absorb more radiation and is warmer, not only at the ground, but at the 2 m level as well. The general profile shape is similar, but the profile over grass shows a steeper decline in temperature with height over the gravel surface. The biggest differences in temperature were largest in the warm season as expected, and became smaller in the cooler months.

Timmy the Twister. Dan Valle, Jim Belles, Scott Cordero, Jason Beaman, Jonathan Howell NOAA/NWS Forecast Office, Memphis, TN and Amanda Roberts NOAA/NWS Lower Mississippi River Forecast Center, Slidell, LA

Successful severe weather preparedness requires targeted programs that reach diverse populations. One group is residents of mobile homes, since they are particularly vulnerable to tornadoes. Of all tornado deaths, 36% occur in mobile homes. To help mitigate the tragic loss of human life the National Weather Service in Memphis began a campaign to increase awareness on days when a significantly high risk of tornadoes was forecast. The campaign utilizes a cartoon character named Timmy the Twister.

The inspiration for *Timmy the Twister* comes from the United States Department of Agriculture's Forest Service, Smokey the Bear. This incredibly successful campaign has Smokey the Bear showing the day's fire danger at national forests and campgrounds across America. In similar fashion, Timmy the Twister points to the day's tornado risk. By highlighting the tornado risk at mobile home parks and across the community, people are alerted well beforehand and can make plans to adequately shelter themselves during the duration of the threat.

The Severe Weather Outbreak of 17-18 December 2002 over Central and Southern Missouri. Benjamin Roudenis, Patrick I. Buckley, Neil I. Fox, and Anthony R. Lupo, University of Missouri-Columbia, Columbia, MO

On December 18, 2002, a tornado was reported near Springfield, MO over an area which does not usually experience these types of events in December. A synoptic-dynamic analysis of a large-scale cyclone that produced this event will be conducted using the idea of the "forecast funnel". On the largest scales, it will be demonstrated that this event was the result of unusually strong wave amplitudes in place over the North American continent. In spite of this, the environment was not favorable for the production of severe weather over a large portion of the area. While the environment was not favorable for the occurrence of severe weather over a large portion of the region, the event was marginally unstable. Thus, the occurrence of severe weather was limited. Moving downscale, it will then be shown that the complex terrain of the Ozarks area may have played a role in the occurrence of the unusual tornado event described above. The role played by the complex terrain will be demonstrated using a mesoscale model, in which the terrain of the region is removed. This will demonstrate that without the terrain, there may not have been severe weather which occurred over the region.

The National Oceanic and Atmospheric Administration Commitment to Developing Minority Meteorologists and Atmospheric Scientists. John L. Shoemake, R. Suseela Reddy, Monesa Watts, Douglas Gavin, and Darnell Newton, Jackson State University, Jackson, MS

Jackson State University (JSU) is the only Historically Black College and University that offers an undergraduate degree in Meteorology. Some thirty years ago, the National Oceanic and Atmospheric Administration (NOAA) was selected by the professional atmospheric science community to assist and sponsor JSU with the development of a Meteorology Program. NOAA has constantly nurtured the JSU Meteorology Program in the convening years by providing both personnel and specific programs for faculty, staff and student development and professional growth through continuing agreement and/or direct contribution. Currently, the local National Weather Service Forecast Office (NWSFO) provides two part-time instructors to the Meteorology Program. Through the NOAA Grant, Increasing Diver-

sity in Atmospheric Science through Research, Application, and in Partnership with the NWS (IDASRAP) four JSU meteorology students are also provided opportunities for meteorological training, professional weather skills preparation, operational forecast experiences and/or climatic research at the local NWSFO during the year. In addition, NOAA's Diversity Summer Research Program provides other research opportunities or training/operational experiences for our students at various NOAA/NWS locations around the nation each summer. The summary and breadth of JSU meteorology student involvement in NOAA/NWS operational and research activities demonstrates the commitment of NOAA to increasing the number of minority professionals in meteorology and atmospheric science.

Decision Support Page - NWS Weather Forecast Office, Tulsa, Oklahoma. Raymond Sondag, J. Brad McGavock, and James Frederick, NOAA/NWS Forecast Office, Tulsa, OK

The National Weather Service (NWS) Weather Forecast Offices (WFO) issue a Hazardous Weather Outlook one or more times daily in order to inform the public, media, and emergency management of the potential for weather related hazards. The information contained within the Hazardous Weather Outlook potentially covers a wide range of weather phenomena, along with the the associated timing, uncertainty, and expected impacts. The usefulness of this product is thought to increase with a graphical representation of the potential hazards augmenting the text product. This idea led WFO Tulsa, Oklahoma to design a Decision Support Page.

The WFO Tulsa Decision Support Page is intended to provide a rapid assessment of hazardous weather potential for the next seven days. This is done through a column of lights that cycle through four different colors based on the level of threat for each hazard. The color of the lights correspond to the locally assigned threat levels of NONE, LIMITED, ELEVATED, and SIGNIFICANT, respectively. The hazards and their corresponding lights are divided into two forecast periods: Day 1 (the current day and night) and Days 2 through 7. Each hazard has a corresponding graphic that is color-coded to help the user visually assess the threat, with each graphic having an explanation and a list of potential action information.

The WFO Tulsa Decision Support Page is based on a five kilometer gridded database of forecast variables, with a portion of this database also populating the National Digital Forecast Database. Forecasters both populate and quality control this database using observed data, numerical model output, or a representative blend of both. The database is updated at least once hourly, with any update also reflected on the Decision Support Page. The high spatial resolution of the forecast database and its associated graphics, along with frequent updates, makes the WFO Tulsa Decision Support Page instrumental in maintaining hazardous weather situational awareness to external customers, and allows WFO Tulsa operations to efficiently monitor current forecasts.

A Report On The Multisensor Precipitation Estimator National Operations Team. Gregory J. Story, NOAA/NWS West Gulf River Forecast Center, Fort Worth, TX

Over the past decade, the National Weather Service, the Department of Defense and the Department of Transportation joined to implement the most sophisticated weather radar network in the world with the installation of WSR-88D radar systems. In addition to the improved sensitivity and the addition of Doppler capabilities, the WSR-88D was designed with an enhanced, complex precipitation algorithm. The precipitation estimates produced by this algorithm are very useful to hydrometeorologists at the thirteen River Forecast Centers around the United States for real-time rainfall estimates. A new tool to enhance and correct the radar-derived precipitation estimates is now being used. This interactive new program which optimizes the radar precipitation estimates is called the Multisensor Precipitation Estimator (MPE) Processing System.

The MPE program is now being used operationally at several RFCs around the country. The MPE software has also been deployed at the National Weather Service Forecast Offices (WFOs) around the country for use at the local level. To assist the WFOs in their use of the MPE software, a national team was formed to discuss what information the RFCs could share with the WFOs so that they could use the MPE software with satisfactory results.

As team leader, this poster explains our teams charter, and will discuss in detail the purpose and the latest activities of this team. We will also discuss the operations concept for MPE at the nations WFOs. And while the work of our team is not finished, we will illustrate what different parameters in MPE exist which have been identified as data which may be shared between WFOs and the RFCs. A case study showing the challenges of achieving correct es-

timates during an extreme rainfall and flood event using MPE will be presented.

Verification of the GFS Guidance Ensemble Mean over a Portion of the Northern Plains. Kyle Weisser, Jeff Chapman, and Phil Schumacher, NOAA/NWS Forecast Office, Sioux Falls, SD

The use of ensemble fields has shown skill in the development of mean fields. In recent years, statistical forecast guidance from each member of the Global Forecast System (GFS) has been developed to produce an ensemble mean guidance (MEN). The MEN is becoming more widely used by local and national forecasters. Since the ensemble mean gridded fields will provide a better large-scale forecast on average, it is hypothesized that following the ensemble mean guidance would also produce a superior forecast. To test this hypothesis the GFS ensemble mean guidance has been verified from August 2003 to May 2005 for 4 sites across the northern plains to determine whether the MEN can outperform the GFS guidance data (MEX) and human forecaster. In addition to mean absolute error, bias information was also collected for all forecasts. The use of ensemble data also allows for the calculation of a standard deviation of all members. MAE and bias as a function of the standard deviation were also calculated to discover if forecast skill for the MEN, MEX, and human is dependent on the possible range of solutions.

The MEN generally performed worse than the MEX. While this was unexpected, an examination of the data did indicate some potential flaws in the MEN output. A cold bias, particularly on highs, seemed to produce decreased forecast accuracy during many situations. It was also discovered that as the standard deviation increased or, as any one model solution became less reliable, the MEN performance over the MEX increased. In addition, a 30 day running mean and percent improvement is used to define periods where one particular guidance forecast was better than another.

Mesoanalysis of Straight Line Wind Damage Event 29-30 July 2002: It Beats Coming Up with a Lecture. Robert A. Weisman, Saint Cloud State University, St. Cloud, MN, Jeffrey M. Buck, Bradly E. Nelson, DTN, Inc., Todd A. Nelson, and Matthew M. Kay, WeatherEye, Inc.

Other co-authors: Michael P. Schulte, Michael P. Jones, Peggy O. Willenberg, Amanda E. Brandt, Matthew A. Dux, Cynthia L. Althoff, Serena S. Dietrich, R. Alan Klein, David G. Lerach, Kristen D. George, David J. Pearson, Sarah R. Spurzem, David A. Winslow, and Jacob H. Yurek.

During the Spring 2004 Semester, the SCSU Mesoscale Meteorology class applied the mesoanalysis techniques pioneered by T. T. Fujita to a straight-line wind event from July 2002. The surface mesoscale analysis showed that the storm began to the west of a synoptic-scale low pressure system near Aberdeen, then propagated southeastward through southern Minnesota along a mesoscale wind-shift line. Potential instability, as noted by a surface-based lifted index calculation, maximized along this wind-shift line that was neither the conventional cold or warm front. A coarse calculation of surface moisture convergence did show that the southern Minnesota boundary became the dominant surface feature as the system propagated eastward. Secondary convection was launched along this boundary and other outflow boundaries as the evening went on.

This paper shows the relevant data as well as the application of Fujita's techniques to a senior undergraduate classroom.

Comparision of Multi-Sensor Precipitation Estimates to Gage Precipitation Estimates for the Midwest Region. Nancy E. Westcott, Midwest Regional Climate Center, Illinois State Water Survey, Champaign, IL

Daily precipitation estimates are employed year-round for purposes of water management. Real time gage data from the NWS Cooperative Network are often used, but because of spatial density limitations may not be adequate to estimate gradients in precipitation and thus inadequate to estimate precipitation over scales finer than 20-40 km.

Examples of annual, monthly and daily distributions of precipitation will be presented for counties within a 9-state Midwest Region from 3 sources: 1) NWS quality controlled cooperative gage data, 2) gridded radar estimates mosaicked and distributed by the National Center for Environmental Predication (NCEP), and 3) gridded multi-sensor estimates produced at the NWS River Forecast Centers (RFCs) and mosaicked into a national product at NCEP. Comparison of precipitation from two dense gage (10 km) networks of weighing bucket gages, one in Cook County, IL and one in Tazewell and Mason Counties IL gages with the nearest (4×4 km) gridded estimates of radar and multi-sensor precipitation also will be presented.

In general, there is a better agreement between the multi-sensor and gage data than between the radar and gage data. However, the multi-sensor estimates appear to be biased towards lower values on the order of 15-25%. There is good agreement between the multi-sensor, and gage precipitation fields on a daily, monthly and annual basis for the years 2002-2004.

Development of a Comprehensive Database of Weather Observing Sites in Mississippi. Loren White, Albert Williams, and Elizabeth Matlack, Jackson State University, Jackson, MS

To support planning in connection with development of the Mississippi Mesonet and NERON, a comprehensive database has been developed which documents every known weather observing site operating within Mississippi. For use by a Regional Site Selection Team (RSST), stations are binned by 20 mile grid boxes. At a minimum, data for each station include the type of observing station, parameters routinely observed, normal observation frequency, aerial photo of the vicinity, topographic map, a driving map, and relevant contact information. Wherever available, actual site photographs, period of record, elevation, and general siting notes are recorded. It is planned to also develop a user-friendly World Wide Web interface that will facilitate use by researchers, forecasters, and the general public to find out about weather observations within the state.

An Overview of Kodiak Launch Complex Operational Weather Support for the Missile Defense Agency's Integrated Flight Test 13 and 14 Launches. Gregory D. Wilke, Science Applications International Corporation, Cape Canaveral, FL

In early 1998, the Alaska Aerospace Development Corporation (AADC) and the State of Alaska began construction on Kodiak Launch Complex (KLC), Kodiak, Alaska for the first non-federally owned commercial spaceport in the United States. KLC is located at Narrow Cape, on the southeastern tip of Kodiak Island about 250 miles south of Anchorage and 45 miles south of Kodiak City. Kodiak Island is an ideal location for polar launch operations. With a wide launch azimuth range and unobstructed downrange flight paths, spacecraft up to 8000 lbs can be safely launched from KLC.

Meteorological phenomena are a significant challenge to launching rockets in high-latitude coastal locations, such as Kodiak Island. Some of the United State's most intense weather systems develop in the Bering Sea and move through Kodiak Island and the Gulf of Alaska. These systems routinely bring strong winds, heavy rain, fog, snow, and thick cloud cover to Kodiak Island. While thunderstorms are very rare on Kodiak Island, the threat of a rocket triggering a lightning strike during launch is actually quite high because of the type and thickness of local clouds.

KLC's meteorological capability, initially developed by NASA/USAF for the Kodiak Star launch in September 2001, was greatly expanded to satisfy the increased launch weather support requirements for the Missile Defense Agency's Integrated Flight Test (IFT) -13 and IFT-14 launch campaigns. This paper describes KLC's extensive meteorological infrastructure and capabilities required for the planning, processing and successful launching of these rockets.

WRF Implementation by the Kean University Meteorology Program. Shing Yoh, Paul J. Croft, and Guillermo Prescott, Kean University, Union, NJ

The performance of a regional WRF model using 15 km resolution was evaluated for the 2005 summer season in order to establish real-time operational forecast output for use in daily forecasting by students and associated professionals. Comparisons were made for hourly forecast parameters and soundings between the WRF, NAM (formerly ETA), and hourly surface observations at several New Jersey locations and the OKX upper air radiosonde site. Variations in WRF model physics, and their related impact on model verification, were also considered for the New Jersey coastal region in particular.

The model grid was run on a single processor PC (Dell Dimension 8300) in the Department of Geology and Meteorology student computer lab. The model domain was centered over New Jersey and included sections of the northeastern United States. The initial analysis and boundary conditions were derived from the 0000 UTC NAM as ingested through the Unidata LDM data stream. Model output was analyzed using Unidata GEMPAK. The model requires 5-6 hours overnight to run a 36-hour forecast for local resolution of 15 km. The model will be ported to the Kean University Computer Science Department Linux Cluster this fall so that the model run and post-processing will be completed in less than an hour.

Real-time model information will be shared publicly and with colleagues (e.g., NWS, oth-

ers) through the Meteorology Program's website (http://hurri.kean.edu). Modeling work and output will also be incorporated into several of the Department's class offerings (e.g., Synoptic, Thermodynamics, and Physical Meteorology; Methods in Geoscience and Introduction to Meteorology) and will involve students in the process for professional development and training (e.g., through independent study and/or special topics and seminars). These will help form the basis of an operational environment at Kean University and be used in conjunction with on campus weather observations and various outreach activities.

GOES-R Baseline Instruments. James Gurka and Timothy J. Schmit, NOAA/NESDIS, Crofton, MD

In order to meet the requirements, documented by the GOES user communities, the instruments designated for the GOES-R national baseline include an Advanced Baseline Imager (ABI), a Hyperspectral Environmental Suite (HES), a Geostationary Lightning Mapper (GLM), and advanced space and solar observing instruments.

The Advanced Baseline Imager is a state of the art, 16-channel imager covering 6 visible to near-IR bands (0.47, 0.64, 0.865, 1.378, 1.61, and 2.25 mm), and 10 infrared (IR) bands (3.90 mm to 13.3 mm). The band centers of three of the visible and near IR bands were recently modified to be more consistent with corresponding VIIRS channels. Spatial resolutions are band dependent, 0.5 km at nadir for broadband visible, 1.0 km for near IR and 2.0 km for IR. The ABI will scan the Full Disk (FD) in approximately 5 minutes. The HES is a multi channel sounder and imager instrument suite with three threshold tasks.

HES will provide high-spectral resolution Hemispheric Disk Soundings (DS) and Severe Weather Mesoscale (SW/M) soundings and Coastal Waters (CW) imaging. HES DS provides 10 km IR resolution with a one-hour refresh rate of the full disk, 62 local zenith angle. The options for spectral coverage for the sounding functions will be covered in the presentation. The SW/M will cover a 1000 x 1000 km square in 4 minutes, at 4 km resolution for IR. HES CW task will provide at least 14 channels covering 0.4 mm to 1.0 mm, with a 300 m resolution and a 3-hour refresh rate. Coastal waters are defined as the 400 km zone adjacent to CONUS.

Additional capabilities include an improved Space Environment Monitor, a Solar X-Ray Imager, and direct user services, such as Search and Rescue (SAR), and a Data Collection System (DCS). This paper will focus on the planned instrument capabilities of the GOES-R Series, simulated GOES-R products, the space system architecture, and how the new capabilities will complement the future Global Observing System to meet the documented user needs.

Enhancements to the Galileo Weather System. Kenneth Reeves, Ryan Ayres, and Michael Steinberg, AccuWeather, Inc., State College, PA

Since AccuWeather introduced the PC-based Galileo, it has become one of the fastest selling television graphics systems in history, due to its ability to combine unmatched rendering speed with compelling graphics and animations.

Since its introduction, AccuWeather has added numerous enhancements to Galileo, and the latest advances focus on severe weather analysis and display capabilities. These include the exclusive new four-hour Predictive Radar and StormMaster severe weather predictor, offered through collaboration with Weather Decision Technologies (WDT), which utilize advanced artificial intelligence techniques and Level II NEXRAD data to predict radar and severe weather. Also added to Galileo are new automated capabilities for the graphical display of NWS severe weather bulletins.

The Galileo system is built around totally integrated modular software, which allows for the creation of automatically updating graphics and animations in full graphic layers, with masking and transparency features. Its intuitive user interface speeds the process of building a weather show and generating and editing on-screen animations, while at the same time allowing unlimited creativity. An array of custom formats makes it easy to present any weather contingency, and intuitive tools make editing quick and easy, to give viewers up-to-the-second details in fast-breaking weather stories. Graphics are presentable in either static or animated 2-D or 3-D formats, and may be further enhanced with a variety of special effects. The system also has integrated Internet functionality, so that it can seamlessly output on-air presentations as web pages.

These, and other unique capabilities of the next generation in weather systems, will be explained and demonstrated.

An Internet Site for Professional Meteorologists. Kenneth Reeves, Jim Candor, and Michael Steinberg, AccuWeather, Inc., State College, PA

AccuWeather.com Professional Plus is an Internet site designed for use by meteorologists, providing a complete array of highly advanced data and computer model information, all in one place in an easy-to-use, ad-free format. Some of the features include:

1. Complete real-time NEXRAD Doppler radar information, including more than 20 different types of single-site data, Metro Radars, storm tracking and information tables, animations and a variety of mosaics.
2. Unique severe weather products created by WDT (Weather Decision Technologies), including Predictive Radar 4 hours into the future, forecast hail and tornado movement, and real-time street-level lightning data
3. The most comprehensive array of numerical model graphics, data and animations covering the U.S. and worldwide, including the GFS, GFS Rapid Update, GFS Ensembles, ECMWF, UKMET, Navy NOGAPS, Wavewatch III, NAM (ETA), NAM Rapid Update, NAM-215, ETA Ensembles, DGEX (extended NAM), GFDL, NGM, RUC2, RSM Ensembles, Air Force MM5, CFS (Climate Forecast System), CMC, NAEFS, JMA, NDFD, COAMPS, WRF and AccuModel. Available options allow you to map individual model variables or standard combinations of variables, view loops of these maps, create a meta-loop of multiple models, view multiple models on one map, and view changes from the previous model run to the latest.
4. Worldwide satellite imagery, including visible, infrared, enhanced infrared and water vapor images.
5. Worldwide observations and surface plot images.
6. Streaming video weather presentations geared for meteorologists, such as The Long Ranger and Weather Point-Counterpoint .
7. Interactive GIS weather.
8. Full screen versions of radar and satellite imagery that automatically update.
9. Blogs and commentary from AccuWeather meteorologists such as Joe Bastardi, Elliot Abrams, Henry Margusity and Joe Lundberg.
10. The Planner, which combines a detailed forecast, climatological data, radar and current data onto one interactive page.

Content is available through Internet access or with a hand-held PDA.

Professional Development

Fifteen Years of the COMET Residence Program: A Look to the Future. Gregory P. Byrd (NWA Councilor) and Wendy Schreiber-Abshire, UCAR/COMET, Boulder, CO

For the past 15 years, the Cooperative Program for Operational Meteorology, Education and Training (COMET) has conducted a robust residence program in our Boulder classroom facility. During this time, over 150 course offerings totaling nearly 200,000 student hours of instruction have taken place on a wide range of topics, including: mesoscale-, satellite-, boundary layer- and hydro-meteorology, numerical weather prediction, and climate variability. The primary user of the classroom has been the National Weather Service, but others from our field have attended courses as well coming from the Air Force Weather Agency, the Naval Meteorology and Oceanography Command, the Meteorological Service of Canada, the private sector, and several foreign weather services. The COMET Program has also worked to enhance university instruction by offering six courses to nearly 100 university faculty on a similar variety of subjects.

The traditional COMET residence class pairs lead university and operational instructors to facilitate the transfer of recent research results to the operational community. This advanced-level training employs a case study approach with practical lab exercises specifically designed to reinforce concepts from lecture presentations. Over the years, the COMET classroom has evolved to ensure that we have always employed advanced computer and communications technologies. For many years the classroom has used the technology to occasionally include live videoconferences with remote presenters to augment presentations given by live instructors. The facility is currently equipped with co-located lecture and laboratory areas that can accommodate up to 27 students for a single course offering. The past year has seen two substantial upgrades to the hardware

that supports classroom operations. The first upgrade modernized the nine laboratory stations which now each consist of two Intel-based dual-boot (Windows/Linux) PCs. Each PC station has three monitors capable of running AWIPS, GARP, and other analysis and display packages for a variety of applications including running real-time local mesoscale model simulations. The second major upgrade integrated the numerous display options, streamlining the instructors capability to switch between media sources for large screen display to the classroom audience. The upgrade to these features as well as the addition of more microphones, an enhanced soundsystem, and an annotation tablet also allows presenters to easily present live lectures to students in remote locations.

Over the years, tight sponsor budgets have occasionally restricted travel and residence classroom schedules. Future budget uncertainty has caused the NWS and other sponsors to look increasingly to distance learning options to help control the overall cost of training. The Residence Program has used a recent break in the classroom schedule to work on redesigning the classroom Website (http://www.comet.ucar.edu/class/index.html). Additionally, the recent upgrades to the instructor workstation and audio system have ideally prepared COMET to embark on offering aspects of the residence program to students without the expense of having to travel to Boulder. Plans for adding virtual courses and individual key live lectures to remote audiences are in the works. Meanwhile, we continue to conduct traditional residence courses, albeit at a reduced pace, and thus are able to use Web technologies to make classroom lectures of wide interest to the community available through our MetEd Website (http://www.meted.ucar.edu). We have already published over 30 Webcasts that provide expert lectures from our classroom on demand to learners worldwide. Despite the specter of a reduction in future residence course offerings, the COMET classroom operation is poised to exploit these innovative alternative delivery methodologies as a cost-effective means to meet the training needs of the operational community.

Forensic Meteorology...or Perhaps "CSI Meteorology". Stephen W. Harned (NWA Past-President '92), Atlantic States Weather, Inc., Carey, NC

"Forensic", from the Latin word emphforensis, "of the forum", relates to the application of science to help decide questions arising from criminal or civil litigation. "Forensic Meteorology" is the application of climatology and/or meteorological and hydrological concepts to legal cases and related investigations in which weather was a factor. Examples of how forensic meteorology was applied to cases involving damages and injuries associated with high winds, torrentialrains, and blinding sunlight will be presented. Additionally, information will be presented outlining what it takes to become a forensic meteorologist and why one would wish to pursue this aspect of the profession in which only a very few practice.

Initiating Undergraduate Student Research Projects in Operational Meteorology: Kean University Operational Undergraduate Research in Meteorology & Professional Activities and Collaborative Training (KU-OURMETPACT). Paul J. Croft (NWA Past-President '04), Kean University, Union, NJ

Undergraduate student participation in research activities and professional development is paramount to their ultimate career success and also supports their retention and course performance. To be successful these activities must be focused, their relevance made clear, be connected to the students coursework, must involve skills development and application, and the outcomes must be distinct. To achieve these goals, a student educational collective for undergraduate research experiences and development (SECURED) was initiated during the spring 2005 semester at Kean University. The purpose was to develop an initial collective of meteorology students to perform research and professional development activities that would ultimately expand into collaborative and cooperative projects with others.

Three students in consultation with the author developed projects to focus on cool season severe weather events in and near the Philadelphia National Weather Service County Warning Area, air quality observations in relation to synoptic weather conditions in New Jersey during the spring season, and fog occurrence and spatial attributes during one winter season as related to the potential for weather modification applications at selected sites. Each project was focused according to real-time operations-based needs, relevant to prediction and understanding of various meteorological phenomena, involved the relational aspects of data, basic statistical techniques, and interpretation to coursework in dynamic, synoptic, and physical meteorology as well as instrumentation, required specific analytic and other skills to provide improved understanding and application of

meteorological principles in the performance of real-time operational duties.

Additional outcomes for students included the development of abstracts and preprints as well as poster and oral presentations and delivery of these internally and at regional and national professional meetings and conferences. Students were also in contact with professionals and other peers to allow them an opportunity to work directly in the field by considering and handling all aspects of their research endeavor. These provided real career and professional experiences as well as materials for resume and portfolio development. The continued development of the program is expected to involve up to three students per semester prior to its expansion to include students at all stages of their degree work and to ensure continuity with time and study needs.

The Advanced Warning Operations Course (AWOC). John Ferree, Elizabeth Quoetone (NWA Commissioner of Committees), and Ed Mahoney, NOAA/NWS Warning Decision Training Branch, Norman, OK

NOAA's National Weather Service (NWS) has just completed the first year of a major training project known as the Advanced Warning Operations Course (AWOC). This extensive course currently consists of approximately 30 hours of instruction divided into two tracks based on subject matter, Core Track and Severe Track. During the first year of delivery, approximately 2000 NWS employees completed the Core Track, with nearly 1500 employees completing the Severe Track.

The goal of the AWOC is to increase expertise among NWS forecasters to better serve the public in warning situations. The course developers at the Warning Decision Training Branch (WDTB) have begun an evaluation of the impacts of the AWOC on performance. Developers have also begun research on the Root Cause Analysis and Post Mortems submitted by the students. AWOC on-site facilitators and students have completed course surveys to build a knowledge base for potential future training organized within the AWOC framework.

Supporting Professional Development Through Continuing Education. Elizabeth Mulvihill Page (NWA Councilor), UCAR/COMET, Greensboro, NC

The COMET Program has taken the next step in supporting continuing education in the meteorological community. The Meteorology Education and Training (MetEd) Registration and Assessment system provides access to quizzes and completion certificates for 75 modules developed by the COMET Program.

Visitors to the MetEd Website (http://meted.ucar.edu/) can voluntarily register in the system, which will track their completion and give access to module-related quizzes. After successfully passing a quiz, registered customers can download a certificate to document their successful completion of the module. In addition, participants can view transcripts of all their courses with associated quiz scores and dates of completion. This documentation can be helpful in both National Weather Association Broadcaster's Seal recertification and professional development activities for the AMS CBM program.

Another optional feature of the system is the ability to indicate the email address of a supervisor or other individual to receive the customer's quiz results. All data and information is kept secure in accordance with the UCAR Privacy Policy (http://www.ucar.edu/legal/privacy_policy.shtml). The COMET Program will not release quiz scores or other information without permission from the registered customer.

The MetEd Registration and Assessment system was developed to facilitate professional development activities within the meteorological community. As new materials are created and added to the site, they will also be included in the registration system.

Use of the NWS Weather Event Simulator for Emergency Response Training. Bernard N. Meisner, NOAA/NWS Southern Region Headquarters, Fort Worth, TX

The NWS Weather Event Simulator (WES), which has been installed at Warning and Forecast Offices (WFOs) around the country, is a powerful training tool that allows forecasters to replay weather events in either displaced real-time or case study mode and to interrogate archived data in detail within the AWIPS environment. The ability to capture and review AWIPS data in displaced real-time provides a unique opportunity for forecasters at the local forecast offices to sharpen their skills related to weather forecasting, satellite and radar interpretation, and warning generation for winter weather, tropical cyclones, severe storms, flash flooding, and headwater flooding events.

This presentation will introduce a new application

for the WES: training for an emergency response. The WFOs have been asked to play an ever increasing role in providing support to the emergency management community and other Federal, State and local agencies during and after a spectrum of major emergencies.

This WES case is based on the BP Amoco refinery explosion which occurred on 23 March 2005 in Texas City, Texas. The training focuses on obtaining and correctly interpreting for the emergency responders the dispersion information of the plume caused by the explosion. In addition to the typical WES meteorological data, this case includes the output from the National Centers For Environmental Prediction HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) run made in response to the explosion and the ArcExplorer GIS data viewer software which allows the WFO forecaster to overlay the shape files of the HYSPLIT plume with other georeferenced layers of information. Output from the CAMEO (Computer-Aided Management of Emergency Operations) software suite is also provided.

Using the Warning Event Simulator-Displaced Real-Time (WES-DRT). David Reed, NOAA/NWS Lower Mississippi River Forecast Center, Slidell, LA

The Warning Event Simulator-Displaced Real-time (WES-DRT) was developed to simulate severe weather operations at a Weather Forecast Office (WFO). The WES-DRT has the ability to simulate meteorological operations and significantly improve situational awareness of meteorological forecasters during severe weather. Unfortunately, there were no capabilities built into the WES-DRT to simulate River Forecast Center (RFC) model runs in a displaced real-time environment and provide RFC hydrologists these capabilities.

The Lower Mississippi River Forecast center (LMRFC) has developed Simulating Hydrologic Activities During a Real-time Event (SHARE) to simulate RFC model runs during a flood event using the WES-DRT. SHARE affords the RFC hydrologists and Hydrometeorological Analysis and Support (HAS) forecasters the ability to simulate a flood event and gain valuable experience using the WES-DRT.

On the RFC archive computer on AWIPS, SHARE archives rainfall and stage data that is used to support RFC model runs. The initial conditions of the RFC hydrologic model are archived four times daily. All precipitation estimates from the WSR-88D and the necessary files of Quantitative Precipitation Forecasts (QPF) are also saved for use in these cases. The 1st and 15th of each month, the LMRFC stores all data and products used in preparing RFC forecasts for the past 30 days on a CD-ROM for use in future simulations.

All the RFC software used in hydrologic model runs have been ported to the WES-DRT. Software ported to the WES-DRT includes the NWSRFS software, the SHEF-decoder, Digital Precipitation Array (DPA) decoder, and associated IHFS database. Software was developed to take the files written to the CD-ROM and feed them into the SHEF-decoder and DPA decoder in a simulated environment. RFC forecasters can display data, make model runs, and finally use software to prepare test forecasts.

At LMRFC, case studies have been developed for the major flood of May, 2004 in Arkansas and Missouri and Hurricanes Frances and Ivan in September 04, 2004. Case studies consist of a brief description of the antecedent conditions prior to the event and specific tasks to accomplish during the training session. Upon completion of the specific tasks in the case study, a training coordinator will ask probing questions to assist the forecasters in developing situational awareness.

Societal Impacts of Weather

A Review and Discussion of Significant Weather Events Occurring in 2005. Greg Carbin, NOAA/NWS/NCEP Storm Prediction Center, Norman, OK

This presentation will provide an overview of hazardous weather events that have had a significant impact on life and property within the continental United States from late 2004 through September 2005. Selected events will be presented in chronological order and described with photos, maps, and loops of satellite and radar data. While many of the events selected for this talk captured media and public attention, most of the stories quickly faded from the limelight. This review will highlight some of the big stories, as well as smaller short-term events. Included in the presentation will be a couple of major snowstorms, West Coast flooding, and a significant hailstorm in the Plains. A meteorological description and a review of the impacts will be provided for each

of these events.

Given the national scope and varied responsibilities of the Storm Prediction Center, weather events of significant impact, from severe thunderstorm and tornado outbreaks to wildfires and winter storms, are forecast and analyzed regularly. This provides SPC forecasters with a unique opportunity to interpret data related to extreme weather conditions regardless of location over the continental United States. This diversified experience, and the availability of high-resolution archived datasets, provide for the development of this type of presentation.

Tornadoes Galore: The Record Year of 2004. Daniel W. McCarthy (NWA Councilor) and Joseph T. Schaefer (NWA Past-President '98), NOAA/NWS/NCEP Storm Prediction Center, Norman, OK

The year 2004 was an incredible year for tornadoes. Over 1800 tornadoes were recorded breaking the record of 1,424 tornadoes set in 1998. The year not only included a series of outbreaks in late May, but also 300 tornadoes associated with Tropical Storm Bonnie and Hurricanes Charley, Frances, Gaston, Ivan and Jeanne.

This presentation will review the year that was for tornadoes in 2004 highlighting the more significant events. A review of the effects on trends will also be looked at as will the progress of 2005 using current preliminary data.

Lightning Responses During a Football Game Compared with Hiking and Mountain Climbing. Ronald L. Holle, Holle Meteorology & Photography, Oro Valley, AZ and E. Philip Krider, University of Arizona, Tucson, AZ

People's response to the threat of lightning differs widely depending on the situation. Two distinct types of events will be described, the first when a large number of people were evacuated during a university football game. The other is a compilation of responses during hiking and mountain climbing that mainly involve personal actions. The lightning activity during each situation, and the decision-making process relative to lightning safety guidelines will be described.

The presentation will begin with the behavior of lightning that relates to safety issues. Updated information from camera studies on the frequency of multiple return stroke ground locations (40% of flashes), and typical distances (≈3 km) between strokes in these situations. Summaries will also be given of U.S. and global lightning fatalities. The first situation involves a large crowd responding to publicly-announced advice on the threat of lightning. A nationally-televised college football game in Tucson was suspended due to lightning on 18 September 2004. The suspension was caused by thunderstorms that developed as Pacific Tropical Storm Javier fed abundant moisture into southern Arizona. People left the stands for more than an hour late in the first half. Cloud-to-ground lightning (CG) came within 10 km (6 miles), as published in National Collegiate Athletic Association (NCAA) guidelines. The guidelines are based on the 30-30 rule. The first 30 refers to the number of seconds between seeing lightning until hearing its thunder; at 5 seconds per mile, this interval is 30 seconds. The second 30 refers to the number of minutes to wait until resumption of activities. A field mill operating within 500 m of the stadium detected the charge buildup overhead. As thunderstorms moved toward Tucson, game officials contacted the National Weather Service's Weather Forecast Office located 1 km from the stadium. Updates were provided every 15 minutes on CGs detected by the National Lightning Detection Network. After the game resumed, a huge cloud discharge was observed over the stadium, so it appears that warnings based on CG flashes alone led to resumption of play 10 to 15 minutes too soon.

The second type of situation involves one or a few individuals responding to a perceived threat of lightning with little or no external information. Casualties during hiking and mountain climbing represent an important and growing segment of the total number of lightning casualties during the last two decades. Recent cases will be summarized from available newspaper, web, and other media reports. In addition, past publications on these subjects will also be utilized. Of particular interest is the behavior of people during such activities. The types of issues to consider are whether people started too late on a summer day to avoid lightning, what type of thunderstorms produced lightning, whether a nearby suitable safe place was available, the length of the hike or climb, and the existence of time pressures in making decisions. It is expected that the two recreation types had a somewhat different typical activity taking place at the time of the events, as well as varying relationships to the thunderstorms producing the lightning. General conclusions will be made of the tendencies shown by hikers and climbers during these events concerning their level of lightning awareness and avoidance

procedures. Among the issues to are whether more attention could have been paid to plans for the event of lightning during the hike or climb.

Spatial and Temporal Variations in the Number and Intensity of Severe Thunderstorms Reports Across the United States. Joseph T. Schaefer (NWA Past-President '98), Daniel W. McCarthy (NWA Councilor), and Jason J. Levit, NOAA/NWS/NCEP Storm Prediction Center, Norman, OK

The general pattern of severe thunderstorm occurrences across the United States is fairly well known. Also, the almost explosive growth in the number of severe thunderstorm reports over the past three decades is well documented. However, there is little data available about the spatial variations in the temporal trends. This presentation will explore how the number of severe thunderstorms of various intensities varies by region across the country. It will show how relatively weak events (F1 and F0 tornadoes; Hail diameters 0.75" to less than 1.00"; Wind reports based only on damage of those less than 65 kt), have come to dominate the reports. It will show the areas of the country where these reports are most common. This will then allow speculation on the impact of changing the long standing definition of a Severe Thunderstorm (any tornado, hail with diameter of 3/4" or larger, and/or wind gusts of at least 50 kt or damage indicative of such winds).

The Community Collaborative Rain, Hail and Snow Network (CoCoRaHS). Nolan J. Doesken, Henry W. Reges, and R. Cifelli, Colorado State University, Fort Collins, CO

What began in 1998 as a small group of volunteers in northern Colorado has grown into a network of over 2000 volunteers in Colorado and five adjoining states. Volunteers as young as 5 years old right up to 90 measure rain, hail and snow. Reports are gathered via the CoCoRaHS website: www.cocorahs.org Maps and reports are immediately updated and publicly available.

Meteorologists and climatologists have long valued and utilized data from volunteers. What is unique about CoCoRaHS is the density of observations – ideally one or more per square mile over populated areas – and the emphasis on education. Each year, dozens of training sessions as well as special seminars, field trips, workshops and social events are held for participants where they can mingle, get acquainted with local scientists, and ask questions.

This presentation will describe how CoCoRaHS developed, the current status of the project and plans for the future. We will show several examples of data from volunteers and how it has helped climatologists, weather forecasters, hydrologists and resource managers document floods, drought, hail and winter storms.

Tornadic High-Precipitation Supercell Cluster of 29 May 2004, Part I Comparison of Observed Storm Scale to Observational and Theoretical Research of the Spectrum of Supercell Structure and Evolution. Michael P. Seaman, Suzanne M. Fortin, NOAA/NWS Forecast Office, Pleasant Hill, MO, and Ron W. Przybylinski, NOAA/NWS Forecast Office, St. Louis, MO

A unique cluster of tornadic high-precipitation supercells developed and tracked across northwest Missouri during the evening hours of 29 May 2004, producing a total of ten tornadoes, including one violent tornado which produced F4 damage and killed three people in the town of Weatherby, Missouri. Although these supercells eventually consolidated into a larger mesoscale convective system as they tracked across northwest Missouri, the individual High-Precipitation (HP) supercells within the larger scale MCS maintained their reflectivity and Doppler velocity characteristics. Multiple pendant echoes and strong mesovortices were present simultaneously as they rotated around a larger- meso-gamma scale storm system and larger circulation which had developed within the parent MCS. A series of Doppler radar observations from the Pleasant Hill WSR-88D of the mesoscale convective system and attending HP reflectivity and Doppler velocity structures will be shown. These observations will compare storm-scale morphology of this HP supercell cluster to earlier conceptual models of HP supercell lifecycles as well as cyclic tornadic supercells derived during the 1980s through early 1990s. Rotational velocity (Vr) traces of three mesovortices linked to each pendant echo will also be used to show the relationship between mesovortex structure and evolution and tornado occurrence.

Support for Operational Meteorology

Integration of Weather into TACC Flight Management for U.S. Air Force Strategic Airlift. Captain Brad Schrumpf and Major Richard Wagner, Tanker Airlift Control Center (TACC), U.S. Air Force, Scott AFB, IL

Established in the early 1990s, the USAF's Tanker Airlift Control Center (TACC) at Scott AFB has been tasked to manage the airlift and air refueling mission for nearly 500 aircraft worldwide and over 95,000 missions per year currently, to include the majority of Operation Iraqi Freedom and Enduring Freedom (Afghanistan) cargo missions that deliver supplies and cargo to deployed U.S. military troops and coalition partners. To better serve the aircrews, the Integrated Flight Management (IFM) concept was created to control all aspects of these long-haul, worldwide missions. In its early stages, the TACC did not have a robust weather support facility and thus lost, delayed or diverted many flight missions due to inferior weather support. To cure this and over the past 4 years since 9/11, the TACC Leadership has better integrated weather support into its operations and IFM, and has enjoyed great increase in success in mission accomplishment with respect to weather delays. Through careful tailoring of weather sources & briefings over the past 3 years and considering specific airframe sensitivities, our Global Mobility Weather Unit has been able to decrease the weather delays to airlift and air refueling missions by nearly 80%, representing a tremendous fuel cost savings of taxpayer dollars and greater velocity of essential wartime supplies to our troops. We will step through the integration of weather into IFM and TACC's mission, as a successful model for other military and civilian aviation weather support.

Comparing Automated Thunderstorm Potential Index Output to Manual Products. David Knapp, (NWA President-Elect) U.S. Army Research Lab, Las Cruces, NM, Earl Barker, Harris Technical Services Corporation, and Gordon Brooks, AF Weather Agency, Offutt AFB, NE

Forecast centers supporting the U.S. civilian and military communities produce time-phased and point-in-time thunderstorm forecasts valid for specific synoptic and mesoscale regions. These forecasts are produced manually a routine number of times each day, with updates/amendments issued when necessary. Forecasters creating the products use a wide variety of data, visualization tools, and output from forecast algorithms as part of their production process. An automated Thunderstorm Potential Index (TPI) algorithm which relies on synoptic and/or mesoscale model data has been developed to provide a first guess product to assist forecasters producing these thunderstorm products. The TPI output is being compared to the time-phased 1- and 2-Day Convective Outlooks produced by the NWS Storm Prediction Center during the Mar-Sep 2005 period. Output is also being compared to thunderstorm forecasts produced by the Air Force's Operational Weather Squadrons supporting CONUS DoD installations. Finally, all products will be verified against lightning data and severe weather reports. The goal of the work is to determine whether or not the TPI provides a useful automated first-guess estimate of the final forecaster-derived products created at the forecast centers, and thus be a potential time- and task-saving tool for civilian and military thunderstorm forecasters.

Review of 2005 Polygon Warning Initiative and One Inch Hail Severe Criteria Experiment in the Pleasant Hill County Warning Area. Lynn P. Maximuk, Michael J. Hudson, NOAA/NWS Forecast Office, Pleasant Hill, MO, and Bryan T. Busby, KMBC-TV, Kansas City, MO

The Kansas City Weather Forecast Office, located in Pleasant Hill, Missouri, was one of 23 offices across NOAA's National Weather Service (NWS) that participated in the 2005 Polygon Warning Initiative. This initiative sought to explore the concept of issuing warnings for the specific area affected by potential severe storms instead of basing the warning area on geopolitical boundaries (counties or portions of counties). The polygon, or area of greatest threat, is represented in the text of an NWS warning by the LAT LON coordinates section located towards the bottom of the text warning bulletin.

With the threat area emphasis as opposed to county emphasis in warnings issued from the Pleasant Hill office in 2005, the nature of warning services provided by the Pleasant Hill office changed substantially. Extensive outreach and planning was required to prepare all partners within the warning team for this new paradigm. Preliminary feedback from media, public citizens and emergency management within the Pleasant Hill County Warning Area

will be shared, along with a media perspective on utilizing polygons to enhance on-air coverage of severe weather.

In addition, the Pleasant Hill office participated in a local experiment within the state of Kansas. This experiment, conducted by all NWS offices that serve a portion of Kansas, focused on raising the hail criteria needed to trigger a Severe Thunderstorm Warning from penny to quarter size. Results of user feedback from the public and emergency mangers will be shared, to quantify the reception of the experimental hail criteria by the user community in terms of warning reduction, user response and the value of the Severe Thunderstorm Warning bulletin. Statistics regarding the reduction of warnings in 2005, along with an analysis of hail size reports, will also be shared to better reflect this service paradigm change.

NWS Spaceflight Meteorology Group Support for the Space Shuttle Return-to-Flight. Frank C. Brody, Karl A. Silverman, Richard A. Lafosse, and Doris A. Hood, NOAA/NWS Spaceflight Meteorology Group, Johnson Space Center, Houston, TX

The National Weather Service Spaceflight Meteorology Group located at NASA's Johnson Space Center in Houston, TX provides weather support to the United States human spaceflight program. Preparations for Return to Flight of the Space Shuttle have been underway since shortly after the catastrophic break-up of Columbia on February 1, 2003. The launch of Discovery, STS-114, was scheduled for mid to late July 2005. During this two year plus hiatus between Space Shuttle missions, SMG has embarked on several improvements in the areas of training, communication and coordination, mission operations, mesoscale modeling, AWIPS, and landing site instrumentation.

TRAINING

A significant change in the training arena was the implementation of high-fidelity weather-centric simulations for both launch and landing. These simulations enhance training for SMG meteorologists and key flight controllers involved with weather-related landing decisions. Some new simulations require SMG meteorologists to assume the roles of a Shuttle Flight Director and other flight control positions; this provides a unique and valuable training perspective.

COMMUNICATION AND COORDINATION

A key recommendation of the 2003 Columbia Accident Investigation Board report regarded improving communication and corporate culture within NASA. SMG staff provided inputs to NASA on this topic via surveys and special feedback meetings, and participated in NASA cultural enhancement training sessions. SMG initiated a series of Weather Users Forums to facilitate discussions and information sharing between SMG meteorologists and flight control team members. These forums have improved the coordination and synergy with NASA customers, and have yielded several customer-derived improvements in SMG operations.

MISSION OPERATIONS

Mission weather support procedures and timelines were evaluated and revised as a result of lessons learned from launch and landing simulations, and from discussions with customers during Weather Users Forums. SMG significantly increased its role in providing forecasts and briefings of upper winds during the pre-launch countdown. NASA requested this change to improve the flow of information to analysts evaluating upper wind loads on the ascending spacecraft. SMG meteorologists actively coordinated two enhancements to Shuttle Weather Flight Rules. The Rain Shower Rule clarified the rain shower evaluation process for Return-to-Launch-Site (RTLS) and Transoceanic Abort Landing (TAL) landings. In addition, a weather terminology section was added to the Weather Flight Rules.

MESOSCALE MODELING

The Advanced Regional Prediction System (ARPS) mesoscale model was implemented for the area surrounding the Kennedy Space Center, Florida area. This high resolution model will help SMG with critical short-term forecasts directly affecting NASA's launch and landing decisions for the Space Shuttle.

AWIPS

The SMG AWIPS has been uniquely configured to support worldwide forecasting. Forecasters may choose from five localizations, including one for TAL sites in Europe. Global GFS one-degree data, Meteosat 8 satellite data, Spanish radar data and French radar data are transferred from the SMG Meteorological Interactive Data Display System (MIDDS) into AWIPS.

LANDING SITE INSTRUMENTATION

SMG coordinated weather instrumentation up-

grades at the White Sands, NM shuttle landing site. The White Sands upgrades include the addition of an Automated Weather Observing System (AWOS IIIP), a new rawindsonde system dedicated for Space Shuttle support, and data reception of 3-D lightning mapping array. SMG also coordinated the siting of weather instrumentation at the new TAL site at Istres, France.

Advanced Hydrologic Prediction Services at the Lower Mississippi River Forecast Center. David Reed, NOAA/NWS Lower Mississippi River Forecast Center, Slidell, LA

The Advanced Hydrologic Predictions Services (AHPS) is the modernization of the National Weather Service (NWS) Hydrologic Services Program. AHPS was begun in the early 2000's and is expected to be completed at all forecast locations by the year 2014. At the LMRFC, AHPS services have been implemented at over 30 locations.

AHPS is using new and existing technology to improve the dissemination of our information and data. Through a national website, all river forecast information is available to the public at a single location. AHPS is working on improving the science behind river forecasts. Efforts are underway to recalibrate the hydrologic models when using the existing science. Also, a distributed model is being developed and tested to make use of new datasets and the increased computing power afforded by desktop computers. With improved science, RFCs and WFOs are issuing probabilistic forecasts to provide users information on potential conditions months in advance. Utilizing high resolution digital elevation data and existing hydraulic models, flood inundation mapping will be developed to assist our partners in making decisions during significant flooding.

AHPS is the modernization of the National Weather Service Hydrologic Services Program. AHPS is helping meet the increased demands from emergency managers and the water resources community.

Operational Integration and Post-Processing Short-Range Ensembles over the Northeast United States. Jeffrey S. Tongue, NOAA/NWS Forecast Office Upton, NY, Brian A. Colle, Matthew S. Jones, Joseph B. Olson, State University of New York at Stony Brook, Stony Brook, NY

This presentation will highlight the collaborative effort between Stony Brook University (SBU) and NOAA's National Weather Service (NWS) to improve short range forecasts at the local Weather Forecast Office (WFO) level. SBU has been running an operationally Short-Range Ensemble Forecast (SREF) system using the MM5 since May 2003 down to a 12-km grid spacing over the Northeast United States for the 0000 UTC cycle. The SREF contains 7 initial conditions and 12 physics (PHYS) members with output available at: http://fractus.msrc.sunysb.edu/mm5rte. Six additional members were also included in the summer of 2004 using the Weather Research and Forecasting model (WRF). Some of the SREF data has been integrated into the Advance Weather Integrate Processing System (AWIPS) and the Graphical Forecast Editor (GFE) at NWS WFOs. Unfortunately, bandwidth limits the amount of data that can be integrated.

Data from the SBU SREF helps forecasters visualize uncertainty of short term mesoscale processes. Case study examples will be shown, including a convective event and land/sea breeze circulations. The integration of real time observations allows forecasters to qualitatively evaluate SREF performance and improve understanding of parameterizations used within the SREF.

The verification of the SBU SREF for both the warm (April-September 2003) and cool (October 2003-March 2004) seasons has shown that systematic biases exist. The largest biases are for the diurnal temperature and wind speed, in which member performance is highly correlated to the planetary boundary layer parameterization used. Point verification has shown that the 00Z SBU SREF ensemble mean does outperform the 12Z run (initialized 12 hours later than the SBU SREF); however, the ensemble performance is limited by clustering of PHYS members with similar biases. This talk will illustrate how simple post-processing (14-day bias correction or MOS) applied to all ensemble members can dramatically improve the ensemble performance and its possible utility within GFE. The ensemble/MM5 statistical results will also be compared with the WRF.

The Interactive Grid Analysis and Display System (IGrADS) for the U.S. Armed Forces. R. Bruce Telfeyan, Daniel M. Rozema, Jennifer C. Roman, HQ Air Force Weather Agency, Offutt AFB, NE

The Air Force Weather Agency's (AFWA's) GrADS-based interactive visualization tool, (called IGrADS, for Interactive GrADS), enables forecast-

ers to pick a wide variety of forecast products tailored to fit the needs of their customers. IGrADS is available over the AFWA's webpage, JAAWIN (https://weather.afwa.af.mil) and has been operational since early 2002. It is also available over the SIPRNET and JWICS. The interface enables forecasters to create (potentially) many hundreds of millions of varieties of visualized or alphanumeric products designed to meet their customers needs. These products range from meteograms, user-defined meteograms, forecast skew-Ts, vertical cross-sections, forecast maps (including four-panel variations), worldwide cloud analyses, and eight different types of alphanumeric meteorological output. Forecasters have the option of choosing from among eight operational numerical forecast models, two of which are global and six regional mesoscale models. The most extensive product lines are available for AFWA's MM5. This will be supplanted with Weather Research and Forecasting (WRF) Model once it is declared operational. IGrADS users can choose any display region they desire, can animate forecast data, and can bookmark frequently needed charts, then recall them with current model data whenever required. The presentation highlights how IGrADS has served operational forces in combat zones as an effective and frequently used forecast display tool. It also highlights recent expansions of IGrADS capabilities in response to customer requests.

Climatological Perspectives

Local Severe Weather Climatologies for WSR-88D Radar Areas across the United States. John A. Hart, NOAA/NWS/NCEP Storm Prediction Center, Norman, OK

A local climatology of severe weather events has been developed for all 114 WSR-88D radar umbrellas in the lower forty-eight United States. Construction of a severe weather climatology in this way is useful due to their equal areas (124nm radius), and because of the wide and uniform distribution of radars around the country. For each radar area, severe weather events have been tabulated for the period 1980-2004, and various statistics have been generated. Plots of daily and monthly severe weather occurrences have been developed, showing longer term trends and patterns. Comparisons of severe weather occurrences between individual areas are shown, providing rankings and probabilities of severe weather. Tornado and significant tornado strike probabilities are also computed for each radar area. All of this information has been organized for easy access on the Internet.

A Baseline Climatology of Precipitation Rates that Induce Flash Flooding in an Urban Environment. Suzanne M. Fortin, NOAA/NWS Forecast Office, Pleasant Hill, MO

An extensive library of case studies focusing on flash flood producing storms exists, as related to excessive rainfall that leads to flash flooding. Operational hydrometeorological forecasters primarily focus on rainfall in excess of flash flood guidance to determine the likelihood of flash flooding. In both rural and urban areas rainfall exceeding flash flood guidance values produces surface runoff that contributes to river and flash flooding. However, in the urban environment high-intensity, short-duration rainfall is the main contributor to critical runoff, as land use has mitigated the impact of antecedent soil moisture conditions on surface runoff onset. Though operational hydrometeorological forecasters address precipitation rate, assessing what is climatologically significant is difficult due to lack of definitive rain rate thresholds which induce flash flood producing runoff in an urban environment. An analysis of precipitation rates recorded during four separate flash flood events and locally-derived precipitation frequency return rates that affected the Kansas City vicinity will attempt to build a local climatology of flash flood producing precipitation rates in an urban environment.

An Analysis of the Impact of Blocking on North American and Eurasian Summers. Nathan Davis, Justin M. Glisan, John P. Burkhardt, Blake Smith, Thomas E. Hagen, and Anthony R. Lupo, University of Missouri-Columbia, Columbia, MO

The summer of 2004 in the central part of North America was unusually cool. During August, temperatures were 5° - 7°F cooler than normal across most of Missouri, and in Columbia this was the third coolest summer since 1889. The cool summer can be linked directly to unusually strong and persistent blocking in the East Pacific and Alaskan Sector. Conversely, blocking was also responsible for the devastating summer heat waves in Eurasia during the summers of 2002, and, especially, 2003. In North America, historically cooler and/or wetter summers can

be linked to unusual summer blocking activity over the East Pacific region. However, there is little to suggest that these events are related to interannual variations such as the El Nino and Southern Oscillation. Thus, the role of blocking plays a larger role in influencing summer season temperature and precipitation regimes than sea surface temperature anomalies. This summer link can also be shown to be influenced by the phase of the Pacific Decadal Oscillation as well.

Convective Significant Meterological Advisory (SIGMET) Climatology. Jonathan Slemmer, NOAA/NWS/NCEP Aviation Weather Center, Kansas City, MO

NOAA's Aviation Weather Center has been issuing Convective SIGMET's (CSIG) since 1978 to define lines and areas of thunderstorms that meet criteria deemed hazardous to aviation. CSIGs are text bulletins routinely issued on an hourly basis at 55 minutes past the hour. They are also issued whenever an area of convection develops rapidly between routine issuance times. CSIGs are subjectively drawn polygons, lines, and circles depicting convection based on the following criteria:

1. Severe thunderstorms due to:
   (a) Surface wind greater than or equal to 50 knots,
   (b) Hail at the surface greater than or equal to 3/4 inches in diameter,
   (c) Tornadoes,
2. Embedded thunderstorms,
3. A line of thunderstorms,
4. Thunderstorms producing precipitation greater than or equal to heavy precipitation affecting 40% or more of an area at least 3000 square miles.

Because thunderstorms affect tactical air traffic flow management by denying airspace, the CSIG climatology quantifies the monthly, interannual, and diurnal impact of thunderstorms on the National Airspace System (NAS). The climatology captures most convection which was confirmed when the CSIG climatology was compared to previous thunderstorm and lightning climatologies.

The CSIG climatology incorporates data from January 1995 through September 2005. Non-routine issuances of CSIGs were ignored to simplify data processing, and because they are issued infrequently, non-routine CSIGs are assumed to have a negligible impact on the CSIG climatology. Each CSIG is interpolated to an 8 km grid covering a CONUS domain from 22°N, 130°W in the lower left to 50°N, 62°W in the upper right. The interpolation matches CSIG endpoint(s) to VOR locations relative to the grid. The distance and direction from the VOR determines which grid cells are contained in the CSIG. Each grid cell found to be a part of a CSIG object (isolated cell, line, area) is counted as a hit and only one hit per grid cell is allowed per CSIG object.

The CSIG frequency is the total number of hits per grid cell divided by the total number of hours during a time period. For example, if a particular grid cell had 50 hits during May 2004, the frequency of time a CSIG was in effect for that grid cell would be 50 hits divided by 744 hours or 6.72 percent.

The annual march of CSIG-defined convection shows the northward and westward expansion of convection during the spring, the development of maximum convection over the southeastern CONUS and the Desert Southwest during the summer monsoon, and the rapid contraction of convection over the CONUS and shifting of convection to just off the Gulf coast during autumn. Interannual variability of CSIG frequency shows how variations in the large-scale circulation impact the location and frequency of CSIG-defined convection. Analysis of diurnal variations of CSIGs illustrate the different dynamic and thermodynamic processes that generate convection across the CONUS during different times of the day such as land/sea breeze interaction, destabilization through diurnal heating, synoptic systems, mesoscale boundaries, orographic effects, and the nocturnal low-level jet.

The CSIG climatology is useful for retrospective analysis of thunderstorm impacts on air traffic. When greater than normal CSIG frequency occurs over sensitive air routes, air traffic delays increase. In the future, the CSIG climatology could be incorporated into an air traffic management matrix that would generate recommendations on the best air traffic routes to use in order to avoid climatologically preferred regions of convection.

Remote Sensing Applications

The Status of Hydrological Products Derived from Satellite-Based Passive Microwave Sensors. Ralph Ferraro, NOAA/NESDIS and CICS, College Park, MD

Passive microwave sensors, operating primarily from operational polar orbiting satellites, have been utilized by domestic agencies such as Fleet Numerical Meteorology and Oceanography Center (FNMOC), the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), to generate a suite of hydrological cycle products that are used in a host of applications ranging from short-term weather forecasting and warning, numerical weather prediction model data assimilation to climate assessments. (It should be noted that international centers such as ECMWF, UKMO and JMA also utilize these products). These products include rain rate, total precipitable water, cloud liquid and ice water paths, land and sea surface temperature, ocean surface wind speed, snow cover extent and water equivalent, and sea-ice concentration. In particular, the Special Sensor Microwave/Imager (SSM/I) and the Advanced Microwave Sounding Unit (AMSU) have been the primary focus of the operational weather centers. Recently, the separation between research missions and operational missions has closed, with several research satellites being used to support operations. For example, measurements from the Tropical Rainfall Measurement Mission (TRMM) and the Advanced Microwave Scanning Radiometer (AMSR-E) have found their niche at operational centers, in particular, to supplement other measurements in data void regions. It is the purpose of this presentation to provide the status of these product suites, show some application examples, and to discuss the future products and missions anticipated over the next decade.

Equivalent Potential Temperature and Lightning Data and Their Relationship to Mesoscale Convective System Life Cycles. Rod Scofield (NWA Past-President '00), Bob Kuligowski, NOAA/NESDIS Office of Research and Applications, Camp Spings, MD, and Shuang Qiu, QSS, Inc.

Low-level Equivalent Potential Temperature (Theta-E) analysis, National Lightning Detection Network (NLDN) data, and Geostationary Operational Environmental Satellite (GOES) 10.7 μm imagery are used to examine the life cycles of Mesoscale Convective Systems (MCS). A conceptual model of these relationships follows. Typically, on the west side of the Theta-E ridge axis, the MCS is initiated and exhibits positive cloud to ground (CG) lighting strikes. In the Plains states this western side is often accompanied by low precipitation efficiencies. The MCS grows and the tops become colder as it approaches the Theta-E ridge axis. As the MCS propagates east of the ridge axis, a high precipitation efficient environment may be encountered; often the CG lightning strikes become more negative. During the dissipation stage, CG strikes decrease rapidly but become more positive. Several cases are investigated tracking the life cycle of the MCS with respect to the Theta-E ridge axis and negative/positive CG lightning strikes. Preliminary results indicate that the life cycles of the MCS follow, to some extent, the conceptual model presented above. The MCS tended to initiate in Theta-E ridge gradients. MCS can also develop in Theta-E troughs (minimums) where high Theta-E air is advecting into the area. A surprising result is that many positive CG strikes occurred though less than the negative strikes; there was a tendency for more positive strikes to occur in the downwind anvil. The above results are interesting since positive CG strikes normally have a greater charge transfer and current than negative strikes. Thus, positive CG strikes produce more damage than the negative ones.

Performance of Satellite Infrared Fog Detection Techniques with Major Fog-Related Highway Accidents. Gary P. Ellrod, NOAA/NESDIS, Camp Springs, MD and Scott Lindstrom, University of Wisconsin/CIMSS, Madison, WI

The increase in traffic volume on major, multi-lane highways in the United States and Canada in recent years has led to a number of spectacular, weather-related, multi-vehicle accidents. The accidents have resulted in many injuries and fatalities, not to mention economic losses due to transportation delays and destroyed vehicles. While some states have established ground-based detection and warnings systems, most sections of interstate highways have no means of monitoring weather conditions other than in-situ reports from motorists or the use of satellite remote sensing such as from Geostationary Operational En-

vironmental Satellite (GOES). Meteorological satellites have limitations with respect to resolution, frequency, and sensitivity to dense fog, but nevertheless provide some promise in observing fog formation and precursor conditions. This paper will examine several well known fog-related highway accidents and evaluate the capability of GOES data in the detection of fog prior to those accidents. Among the events to be discussed are: (1) the I-43 accident north of Milwaukee, Wisconsin on 11 October 2002, (2) the Highway 401 accident in southwest Ontario, Canada on 3 September 1999, and (3) the I-10 Mobile Bay, Alabama causeway accident on 20 March 1995. Although analysis of these events is not complete, some preliminary conclusions, supported by prior research and experience with GOES techniques, can be drawn. In most cases, GOES will be able to detect low clouds that produce dense fog at the surface, but usually not the full extent due to the shallow nature of radiation fog, and the insufficient resolution and sensitivity of the GOES Imager to capture small scale events. Also, information about poor surface visibilities associated with low clouds cannot be obtained directly from satellite data. Nevertheless, satellite data can be a useful tool in diagnosing major fog events if complemented by surface data.

RWIS & Pavement-Specific Weather Forecasts: Reducing Maintenance Costs, Economic Losses and Improving Safety. Dale E. Bader, Surface Systems, Inc. (SSI), St. Louis, MO

The impacts of weather on roadways are quite significant. Weather can reduce visibilities, driver performance, pavement friction and increase crash risk. In 2001, there were approximately 1.5 million weather related vehicle crashes. Of all of the weather related vehicle accidents, nearly 7,000 involved at least one fatality and more than 6,000 involved at least one injury.

Weather also impacts productivity and can cause U.S. economical losses. During a winter weather season across the United States, state and local agencies spend more than 2.3 billion dollars on snow and ice control operations and over 5 billion dollars to repair infrastructure. Additional costs to the U.S. economy due to roadway weather are the added drive time for America's workers and delays in shipping of materials and goods by the trucking industry. The trucking industry alone, estimates that the losses due to weather ranges between 2 billion dollars and 4 billion dollars.

To help reduce costs and improve safety due to weather impacts on U.S. roadways, many state and local agencies have turned to using roadway specific weather information. Today, there are more than 2200 Road/Runway Weather Information Systems (RWIS) across North America and is a primary tool in proactive treatment of roadways. These systems provide detailed information about roadway weather conditions such as: air temperature, relative humidity, wind conditions, pavement temperature, subsurface temperature, precipitation and pavement condition. In addition to RWIS, pavement-specific weather forecasts are another key tool in reducing roadway maintenance costs and delays. These forecasts provide crucial forecast weather information such as pavement temperature, air temperature, relative humidity, precipitation and wind information. The information obtained from both RWIS and pavement-specific forecasts helps maintenance officials decide when and how to proactively treat roadways during times of winter weather. The information is also utilized by traffic centers in order to help the commuting public better traverse congested roadways due to weather.

Currently, additional initiatives of the Federal Highway Administrations (FHWA) are planned to add additional benefits and to add even more improvements to the current system. One of these initiatives, the Maintenance Decision Support System (MDSS) will incorporate pavement-specific weather forecasts, RWIS data and maintenance actions to provide a detailed maintenance treatment strategy. This is designed to help maintenance decision makers more effectively treat roadways in times of winter weather. In turn, this should add to reduced maintenance costs and fewer delays. A second initiative now in its infancy is the Clarus Initiative. Clarus is an initiative designed to integrate RWIS and NWOS data and forecasting information to establish a nationwide surface transportation weather observing and forecasting system. In time, RWIS data and pavement-specific forecasts will no longer just be used by state and local transportation agencies and instead will be made available to and used by the general commuting public. These initiatives combined with accurate pavement-specific weather forecasts will help reduce vehicular crashes, time delays and accrued costs of inclement weather on the U.S. roadway system.

Lightning

Total Lightning Data in Weather Forecasting: The SPoRT Experience. Dennis E. Buechler, University of Alabama-Huntsville, Huntsville, AL, Steven J. Goodman, NASA/MSFC, Huntsville, AL, Chris Darden, NOAA/NWS Huntsville, AL, and E.W. McCaul, Jr., USRA, Huntsville, AL

Real-time total lightning data from NASA's North Alabama Lightning Mapping array (NALMA) has been available to forecasters from the Huntsville, Alabama (HUN), Birmingham, AL (BMX) and Nashville, Tennessee (OHX) National Weather Service Offices since 2003. The lightning data has been made to the NWS offices through NASA's Short-term Prediction Research and Transition (SPoRT) Center. The SPoRT center seeks to accelerate the infusion of NASA Earth Science Enterprise (ESE) research and technology into NWS operations. The emphasis is on forecast improvements on a time scale of 0-24 hrs at the regional scale. Grids of total lightning activity are provided every 2 minutes for display on the forecasters Advanced Weather Interactive Processing System (AWIPS) workstation.

Training sessions have been conducted at each of the NWS offices within the coverage region of the NALMA to discuss how lightning information could be valuable in severe weather nowcasting. The lightning data provides additional information on storm kinematics and updraft evolution that offers the potential to improve severe storm warning lead time and decrease the false alarm rate (for non-tornado producing storms). Cells with higher lightning rates contain stronger updrafts. The lightning data thus helps focus the forecasters attention on the stronger storms within the area. In addition, prior studies suggest a rapid increase in the "in-cloud" lightning frequency is associated with the invigoration of the storm updraft followed by a rapid decrease in lightning activity associated with the weakening of the storm updraft and descent of the storm angular momentum from aloft.

Interaction with the forecasters is a very important component in the evaluation of the usefulness of lightning data in forecasting. An online survey has been developed to enable forecasters to provide this feedback. The survey mostly uses one-click questions to try to estimate the added value of the lightning data. There is also a text box for additional comments/observations from the forecaster.

Enhanced lightning products are planned to be introduced in the future. One of these will be a cell-based, time-trend of lightning activity. This will enable the forecaster to easily monitor the evolution of cell updraft strength. Combining the total lightning with cloud-to-ground lightning rates may also prove useful in some cases. Work is also being done in using the lightning data to initialize mesoscale models. The output from these will also be made available to the forecasters.

Real Time Observations of Total Lightning Using the Lightning Mapping Array. William Rison, Paul Krehbiel, Ron Thomas, New Mexico Tech, Socorro, NM, Don MacGorman, and Dave Rust, NOAA/NSSL, Norman, OK

Three-dimensional total lightning activity is a useful metric for evaluating the intensity and severity of a storm. For example, storm cells with similar radar reflectivities may differ greatly in their convective activities. Total lightning can be used as a measure of the convective strength of a storm cell. Cloud-to-ground (CG) lightning is not necessarily a good indicator of convective activity – some storms begin with intracloud lightning only and do not produce CG lightning until the storm turns severe, and some severe storms produce prodigious amounts of intracloud lightning but no CG lightning at all. To be useful operationally, a total lightning system must have real-time capabilities.

The New Mexico Tech Lightning Mapping Array (LMA) produces detailed 3-dimensional images both of individual lightning discharges and of the overall lightning activity of electrically active storms. The LMA measures the total lightning activity of a storm by locating the sources of impulsive VHF radiation events produced by the lightning. LMA networks have been installed in northern Alabama by NASA's Marshall Space Flight Center, and in central Oklahoma by the National Severe Storms Laboratory and the University of Oklahoma. A third LMA installed on the White Sands Missile Range in south central New Mexico should become operational in the summer of 2005.

The North Alabama LMA (NALMA) and Oklahoma LMA (OKLMA) networks have real-time capabilities. The real-time processing and display for the NALMA was developed by NASA. A good example of real-time data from the NALMA can be seen on May 20, 2005 at http://branch.nsst.nasa.gov/cgi-

bin/LMAdp.pl. The real-time processing and display for the OKLMA was developed by New Mexico Tech. Real-time observations can be seen at http://lightning.nmt.edu/oklma (see, for example, May 13-14, 2005).

Real time data from the NALMA have been provided to the National Weather Service for two years, where the observations are successfully being used in nowcasting severe weather conditions. During the summer of 2005, real-time total lightning data from the OKLMA will be provided to the NWS for similar uses. The National Center for Atmospheric Research (NCAR) will work with the data from the White Sands LMA for nowcasting use for range activities on the White Sands Missile Range.

Long-Range VLF Lightning over Oceanic Regions for Tropical and Extratropical Applications. Nicholas W.S. Demetriades and Ronald L. Holle, Vaisala, Inc., Tucson, AZ

Real-time lightning detection data are used for a variety of meteorological and aviation applications over land areas where cloud-to-ground lightning (CG) networks cover all or part of 40 countries. Real-time CG data are typically combined with radar and other information to identify significant weather. The outer limit of land-based CG flash detection networks is set at 625 km from sensors in the U.S. National Lightning Detection Network (NLDN) and the Canadian Lightning Detection Network (CLDN). This distance is determined by characteristics of radiation emitted by CG ground waves. While 625 km is beyond the range of coastal meteorological radars, it is not especially far from land for convective systems that often translate and evolve at 50 km per hour or more. Vaisala has run an experimental long-range lightning detection network at very low frequency (VLF) that detects CGs thousands of kilometers from existing sensors. Detection efficiency and location accuracy varies, but such data provides continuous monitoring over large portions of the Atlantic and Eastern Pacific.

Hurricanes show a preferential spatial patterns in lightning. The eye wall (or inner core) sometimes contains a weak maximum in lightning flash density. Moving outward, there is a well-defined minimum in flash density 80 to 100 km outside the eye wall due to stratiform rain processes that dominate the central dense overcast. Outer rain bands typically contain another strong maximum in flash density. While lightning does not always occur in the eye wall, its presence may be a sign of change within the inner core that will help nowcast storm intensity. Outbreaks of lightning within eye walls of moderate-to-strong hurricanes were found by Molinari et al. (1999) to be caused by either eye wall contraction or secondary eye wall replacement. As a result, eye wall CGs may help forecasters nowcast hurricane intensification (eye wall contraction) or weakening (secondary eye wall replacement). Tropical depressions and storms are generally more prolific lightning producers than hurricanes, but lightning in these systems does not show a preferential spatial pattern. In addition, the identification of large amounts of lightning within outer rain bands may help forecasters anticipate different precipitation amounts for coastal and inland areas than for outer rain bands with little lightning.

In both extratropical and tropical regions, the primary source of information about thunderstorms over the oceans beyond 625 km is satellite imagery, as well as pilot and ship reports. Satellite scans are collected at 15- to 30-minute intervals with a subsequent time delay in availability. Ship reports are sparse, and sporadic pilot reports are often delayed in time. As a result, flights over oceans can enter convective regions with little or no warning. Aircraft can encounter turbulence, icing, direct lightning strikes, and other hazards that can be avoided over and near land regions with CG and radar networks. Similarly, shipping and other offshore interests have little information on convective activity beyond the range of land-based radar. Frequent lightning in oceanic extratropical cyclones during the cold season has shown that CGs often indicate future storm development, intensification, and precipitation intensity. This paper will review some effects that oceanic convection and latent heat release have on extratropical cyclogenesis, and discuss how lightning data can identify these areas. Other applications are the ability to help identify short-wave troughs, rapid intensification of oceanic extratropical cyclones, and deep tropical moisture transported along a cold front into a storm's cold sector. The potential for long-range lightning data to improve numerical simulations of extratropical cyclones will also be described.

Global Positioning System Precipitable Water (GPS-PW) in Forecasting Lightning at Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS). Kristen Kehrer, Brian Graf, NASA/KSC, and William P. Roeder, 45th Weather Squadron, Patrick AFB, FL

This paper discusses the utility of GPS-PW in forecasting lightning at KSC/CCAFS. Previous research indicated that GPS-PW has promise for forecasting lightning at KSC/CCAFS. The performance of the original research is evaluated on independent data and two new tools are presented that are custom tailored to operations at KSC/CCAFS.

The tool from the original research reported the following performance on dependent data for predicting the probability of lightning during the next 6 hours: Probability Of Detection (POD) was 89.3%, False Alarm Rate (FAR) was 16.7%, Hit Rate (HR) was 82.6%, and Kuipers Skill Score (KSS) was 61.5%. However, verification on independent data from the 2000-2003 May-September thunderstorm seasons yielded much lower performance with POD of 40.7%, FAR of 61.2%, HR of 69.8%, and a KSS of 19.9%.

Two new tools were developed that were highly focused on KSC/CCAFS operations. The first of these new tools was devoted to the 45th Weather Squadron lightning advisories, which have a desired lead-time of 30-minutes for any lightning in the lightning advisory areas. However, to develop the tool for real-world conditions, an additional 90 minutes past the GPS PW data time is added. Thus the desired 30-minute lead-time for lightning advisories became 2 hours after the GPS-PW data time. Only cloud-to-ground lightning was used, since the all lightning database is extremely difficult to use. Using the 2000-2003 May-September observations, four predictors were statistically selected for the 2-hour tool: 1) the current GPS PW value, 2) the 0.5-hour change in GPS-PW, 3) the 7.5-hour change in GPS-PW, and 4) the K Index. Logistic regression was used to convert the predictors into a forecast of the probability of cloud-ground lightning within the next 2-hours inside the lightning advisory areas. An optimal value for the regression equation was selected that maximized a locally developed Operational Utility Index that combines POD, FAR, and Kuiper Skill Score (KSS) with operationally determined weights of 3, 2, and -1, respectively A logistic regression threshold of 0.32 was found to optimize the 2-hour tool with an Operational Utility Index of 46.3%. Based on independent data, this new tool and lowered threshold yielded a POD of 94.6%, a FAR of 47.9%, and a KSS of 18.4%.

The 9-hour tool was developed in a similar manner to support major ground processing operations, such as Space Shuttle rollout to the launch pad, with desired lead-times 7.5-hours for any lightning within 20 NM. Adding the 90-minutes of real-world concerns required a tool to predict lightning 9 hours after the GPS-PW data time. Five predictors were selected as statistically best: 1) the current GPS-PW value, 2) the 3.5-hour GPS-PW change, 3) the 8.5-hour GPS-PW change, 4) the 12-hour GPS-PW change, and 5) the K-Index. A logistic regression value of 0.37 was selected, which produced an optimized KSS of 36.8%. Based on independent data, this new tool and lowered threshold yielded a POD of 80.2% and a FAR of 47.7%.

While operational value of the two new tools has yet to be determined, they do contain significant new information - the GPS-PW information, which has not been used in traditional thunderstorm forecasting. Thus this new signal may be useful in improving thunderstorm forecasting. Those interested in investigating GPS-PW as a lightning prediction tool at other locations should be warned that these models were tuned to the KSC/CCAFS area during summer and significant local tuning would likely be required elsewhere. Future research suggestions are also provided.

Local Lightning Watches and Warnings: The Experience at Johnson Space Center. Timothy Oram and Richard Lafosse, NOAA/NWS Spaceflight Meteorology Group, Johnson Space Center, Houston, TX

The National Weather Service Spaceflight Meteorology Group (SMG) provides watch and warning support for NASA's Johnson Space Center (JSC). This local support includes the issuance of lightning watches and warnings for the Center. A lightning watch (officially called a Lightning Advisory) is intended to provide select customers with 30 minutes advance notice of lightning occurrence within 6 miles of the Center. This allows these customers to curtail outdoor activities prior to the development of a hazard. A lightning warning (called a Lightning Alert) provides the entire JSC community notice that lightning is occurring or imminent within 6 miles of the Center. These lightning watch and warning products are used for both daily operations and public events such as the JSC Open House. This presenta-

tion will discuss the development of the JSC lightning watch and warning policy, procedures for disseminating the information, and forecaster challenges during real-time support.

The development of a JSC lightning protection policy has been ongoing since 2000. The process was initially impeded by the lack of a perceived threat of lightning risk and concerns about defining appropriate responses to the threat. While the policy was being developed, weather impacts to two heavily attended public events helped to eliminate the barriers to implementing the policy. Now, the lightning products receive a wide distribution via phone notifications, e-mail, the JSC intranet, and the JSC closed-circuit TV system during routine operations. In addition, event organizers are required to develop a weather plan for all on-site special events. In order to educate our customers, the new lightning policy and products were advertised to the JSC community through the Center newsletter and via management channels. Also, all civil servant and contractor employees are required to complete a yearly Hazard Communication course that now includes a section on lightning safety.

The lightning watch/warning products present several challenges for SMG forecasters. These challenges include anticipating convective development of air mass thunderstorms, assessing the accuracy and validity of lightning data, and determining an appropriate time to end watches and warnings. The presenter will discuss some particularly interesting lightning events as well as tools available to SMG forecasters.

Forecasting Lightning at Kennedy Space Center/Cape Canaveral Air Force Station, Florida. Winifred Lambert, Mark Wheeler, ENSCO, Inc., and William Roeder, U.S. Air Force, 45th Weather Squadron, U.S. Air Force, Patrick AFB, FL

The Applied Meteorology Unit (AMU) developed a set of statistical forecast equations that provide a probability of lightning occurrence on Kennedy Space Center (KSC) / Cape Canaveral Air Force Station (CCAFS) for the day during the warm season (May September). The 45th Weather Squadron (45 WS) forecasters at CCAFS in Florida include a probability of lightning occurrence in their daily 24-hour and weekly planning forecasts, which are briefed at 1100 UTC (0700 EDT). This information is used for general scheduling of operations at CCAFS and KSC. Forecasters at the Spaceflight Meteorology Group also make thunderstorm forecasts for the KSC/CCAFS area during Shuttle flight operations. Much of the current lightning probability forecast at both groups is based on a subjective analysis of model and observational data. The objective tool currently available is the Neumann-Pfeffer Thunderstorm Index (NPTI, Neumann 1971), developed specifically for the KSC/CCAFS area over 30 years ago. However, recent studies have shown that 1-day persistence provides a better forecast than the NPTI, indicating that the NPTI needed to be upgraded or replaced. Because they require a tool that provides a reliable estimate of the daily thunderstorm probability forecast, the 45 WS forecasters requested that the AMU develop a new lightning probability forecast tool using recent data and more sophisticated techniques now possible through more computing power than that available over 30 years ago.

The equation development incorporated results from two research projects that investigated causes of lightning occurrence near KSC/CCAFS and over the Florida peninsula. One proved that logistic regression outperformed the linear regression method used in NPTI, even when the same predictors were used. The other study found relationships between large scale flow regimes and spatial lightning distributions over Florida. Lightning probabilities based on these flow regimes were used as candidate predictors in the equation development. Fifteen years (1989-2003) of warm season data were used to develop the forecast equations. The data sources included a local network of cloud-to-ground lightning sensors called the Cloud-to-Ground Lightning Surveillance System (CGLSS), 1200 UTC Florida synoptic soundings, and the 1000 UTC CCAFS sounding. Data from CGLSS were used to determine lightning occurrence for each day. The 1200 UTC soundings were used to calculate the synoptic-scale flow regimes and the 1000 UTC soundings were used to calculate local stability parameters, which were used as candidate predictors of lightning occurrence.

Five logistic regression forecast equations were created through careful selection and elimination of the candidate predictors. The resulting equations contain five to six predictors each. Results from four performance tests indicated that the equations showed an increase in skill over several standard forecasting methods, good reliability, an ability to distinguish between non-lightning and lightning days, and good accuracy measures and skill scores. Given the overall good performance the 45 WS requested that the equations be transitioned to operations and added to the current set of tools used to determine the daily

lightning probability of occurrence.

A graphical user interface (GUI) was created to facilitate forecaster access to the equations through user-friendly input and fast, easy-to-read output of the lightning probability for the day. Personnel from the 45 WS were involved in the GUI development by providing comments and suggestions on the design to ensure that the final product addressed their operational needs. The probabilities output by the GUI are meant to be used as first-guess guidance when developing the lightning probability forecast for the day. They provide an objective base from which forecasters can use other observations, model data, consultation with other forecasters, and their own experience to create the final daily lightning probability for the 1100 UTC briefing.

A report describing the details of this work can be found at http://science.ksc.nasa.gov/amu/final.html.

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NOAA's Lightning Safety Awareness Efforts. John S. Jensenius, Jr., NOAA/NWS Forecast Office, Gray, ME

During the past 30 years, lightning has been the second greatest storm-related killer in the United States, second only to flooding. To reduce the number of lightning deaths and injuries in this country, the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NWS) have been working to find ways to draw attention to this underrated killer. In 2001, NOAA and the NWS teamed up with outside individuals and organizations to find ways to draw attention to the dangers of lightning. Since then, NOAA's *Lightning Safety Awareness Team* has worked together to provide lightning safety information to local NWS offices, the media, and the public. The centerpiece of this effort has been NOAA's Lightning Safety Web Site which serves as a clearinghouse for the public and the media for lightning safety information. Also during this time, NOAA and the National Weather Service have declared nationwide Lightning Safety Awareness Weeks to highlight the lightning dangers and have worked with organizations and agencies involved with outdoor activities to help deliver these safety messages.

In this talk, we will discuss NOAA's and the National Weather Service's efforts to reduce lightning casualties in this country and show some of the specific resources NOAA, the National Weather Service, and NOAA's Lightning Safety Awareness Team have made available to the public and media. We will also discuss some of the coordinated efforts to promote lightning safety between NOAA and outside organizations and agencies.

Tornadoes

Re-Analyses of the Severe Thunderstorm Outbreak of 18 March 1925. Robert A. Maddox, Research Meteorologist, Tucson, AZ, Matthew S. Gilmore, University of Illinois, Champaign, IL, Charles A. Doswell, III, CIMMS/University of Oklahoma, Norman, OK, and Charlie Crisp, NOAA/National Severe Storms Laboratory, Norman, OK

The Tri-State tornadic storm of March 18, 1925, was one of the most notable severe storms of the past century. This presentation provides an overview of synoptic conditions across the United States for 48-hours encompassing the Tri-State tornado occurrence and also documents the extent of the severe thunderstorm outbreak that occurred on this date. As is currently the case with many extreme weather events, the media focus in 1925 was upon the extreme and deadly tornado event from southeastern Missouri to southwestern Indiana. Subsequent meteorological attention to the events of March 18th tended to have a focus similar to that of the media.

Our re-analysis studies of this event draw upon a number of sources of data that remain available for weather research. These include: Weather Bureau (an organizational component of the Dept. of Agriculture in 1925) surface observation forms, Weather Bureau surface, thermograph, and barograph charts, kite-sonde data, accounts of severe local hail and wind storms reported each month in Monthly Weather Review, and accounts of significant weather tabulated in the Dept. of Agriculture's Climatological Data.

The storms of March 18th were associated with a rapidly moving and deepening synoptic low. Cyclogenesis occurred within a lee-trough over southeastern Colorado and northeastern New Mexico late in the day on March 17th, as a significant middle-level,

short-wave trough moved east-southeastward from the northern Great Basin. The surface low shifted eastward away from the lee of the Rocky Mountains ahead of this short-wave, intensifying and moving rapidly toward the east and then east-northeast, eventually entering southeastern Canada during the early morning of March 19th.

Large areas of the middle Mississippi and western Ohio River Basins reported thunderstorms during the night of the 17th and early morning hours of the 18th. These nocturnal storms apparently occurred far to the east of the surface low in a region of strong, low-level, warm-advection north of a warm front. The first severe thunderstorms that were reported occurred over southeastern Kansas, just to the northeast of the surface low, during the pre-dawn hours of March 18th (from around 3 to 5 am local time - CST). These storms produced large hail and wind damage, with one intense event described as "possibly a tornado."

There seem to be no further accounts of severe storms from 5 am until the Tri-State tornadic storm was first reported over southeastern Missouri around 1pm CST. While the thunderstorms may have weakened temporarily, the surface low, and any associated storms, were passing across a region, southern Missouri and northern Arkansas, that remains to this day largely devoid of surface weather observations. Thus, it is hard to determine the occurrence or character of any thunderstorms from 5 am until 1 pm CST.

However, the data sources that we have studied indicate that severe thunderstorms, mainly characterized by severe hail and strong winds occurred, along with some tornadoes, over a broad region of the country on March 18th that extended from southeastern Kansas to northeastern Louisiana to northern Georgia to southern Ohio and back to southeastern Kansas. If the severe storm reporting system of today had been in place in 1925, the geographical area impacted by the violent storms of March 18th would have been much greater than is indicated in the formal reports of the event, which focused on the killer tornadoes. The extent of the overall severe weather events associated with the cyclone of March 18th was quite similar to several more intensively studied outbreaks, such as that of Palm Sunday 1965.

The 1925 Tri-state Tornado: A Re-Examination of the Damage Path and Characteristics of the Associated Convective Storm. Robert H. Johns, Research Meteorologist, Norman, OK, Donald Burgess, Charles A. Doswell, III, CIMMS/University of Oklahoma, Norman, OK, Matthew S. Gilmore, University of Illinois, Champaign, IL, John Hart NOAA/NWS/NCEP Storm Prediction Center, Norman, OK, and Robert Maddox, Research Meteorologist, Tucson, AZ

The 1925 Tri-State tornado was surveyed by U.S. Weather Bureau meteorologists shortly after the event occurred, and from these surveys the damage track was considered to be continuous and associated with a single long-tracked tornado. However, details of these surveys were not officially archived. Further, along the Missouri portion of the track, it was mentioned that there were large areas where the track was not surveyed. Also, it appears that the Indiana portion of the track was not totally surveyed. In recent years, some meteorologists have begun to question just how continuous the damage track of the Tri-State tornado event was. The primary goal of the current study has been to acquire as much information as possible to help determine the detailed nature of the damage path. A secondary effort has been to obtain data that would describe the nature of the convective storm that was associated with the tornado event.

Given that the Tri-State event occurred 80 years ago, data sources are limited. The methodology developed to obtain data for this project involves several steps. The first step has been to visit the libraries along and near the damage path and gather archived local newspaper articles, county school and church location charts, personal stories written and submitted by local citizens, and county plat maps. The second step has been to examine the data and plot damage information (as well as non-damage information near the potential path) on the county plat map. Once this was done, areas where more information was needed became apparent. The third step has been to contact people that live in the areas of interest and find ones who can present useful information that is more specific than what has been found in the libraries. Information from these people has been gathered in several ways. Some can be called by telephone and they can vocally present information. Other contacts can be asked to send information by email or regular mail. However, the most useful method to get the information is to return to the region again and interview people directly and/or go on driving surveys with people that can present specific geographical points were damage occurred (and where it did not occur).

So far, this methodology plan has been used to

gather data in White County, IL, and Gibson County, IN and it has been very effective. Details of how the data were gathered in White County are described as an example. One initially unexpected source of information was from people ranging in age from their mid 80s to mid 90s who were very articulate and able to provide very useful information based on remembering the event. After completing the study in White County, over 100 damage points were obtained. These points suggest the damage path across the county was likely continuous and varies in width from 3/4 to 1 mile. Other useful information describing the nature of the associated convective storm in White County was also obtained. We plan to continue using this methodology to gather detailed data in as many of the remaining counties along the damage track as possible, given limited resources.

Synoptic Patterns Associated with Significant Tornadoes in Illinois. Jared L. Guyer and John A. Hart, NOAA/NWS/NCEP Storm Prediction Center, Norman, OK

While severe weather report climatologies are common, a lesser number of synoptic pattern climatologies related to severe weather occurrence exist on regional and/or local scales. Using observed mandatory level, upper-air data in conjunction with surface data, this study will examine the synoptic patterns associated with significant tornadoes in Illinois. The goal is to summarize the patterns associated with 400+ F2 or greater tornadoes that have occurred in Illinois since 1950. Representative thermodynamic/wind shear profiles may also be incorporated via observational data. A motivating factor for this study is that Illinois is the home state of both authors. Additionally, it is hoped that this study may serve as a template for additional regional pattern climatologies.

The 6 April 2005 Mississippi Tornado Outbreak. John P. Gagan, Eric Carpenter, Dan Byrd, Brad Bryant, and Lora Mueller, NOAA/NWS Forecast Office, Jackson, MS

A strong storm system affected portions of the Lower Mississippi River Valley on 6 April 2005, producing Mississippi's most prolific severe weather outbreak of the spring season. A deep upper-level low, centered over the Southern Plains, sent two strong disturbances into the region. The first affected the region during the morning hours of 6 April, while the second affected the region during the afternoon and evening hours. Kinematic and thermodynamic parameters were highly conducive of severe thunderstorm development. Deep layer (0-6 km) shear near 30 ms^{-1}, 0-1 km shear near 15 ms^{-1}, 100 mb mean-layer CAPE approaching 1500 J kg^{-1}, and 500 mb temperatures of -13°C provided an environment for numerous supercell thunderstorms to flourish.

A highly concentrated area observed these severe thunderstorms. Of the over 190 severe weather reports received from this event, 154 of the reports came from Mississippi. In the Jackson, MS County Warning Area alone, 139 severe weather reports were received. This includes 14 tornado tracks, two of which rated F-3 on the Fujita Scale. At the epicenter of this compact severe weather event was the highly populated Jackson Metropolitan Area. One F-3 tornado ripped through several communities in the southeast and east portions of the metro area just after 1200 UTC, damaging or destroying hundreds of structures and injuring six people (one serious). The other F-3 tornado passed through Smith County, located 65 km southeast of the Jackson, MS, between 1500 and 1600 UTC; severely damaging a high school occupied by over 400 students and faculty (no one was injured). This presentation will offer an overview of the atmospheric factors that contributed to this significant, localized severe weather outbreak, highlighting the two damaging F-3 tornadoes.

Lessons Learned: The F3 Campbelltown, PA Tornado of 14 July 2004. John R. Scala (NWA Councilor), Center for Disaster Research & Education, Millersville, PA and David Ondrejik, NOAA/NWS Forecast Office, State College, PA

Shortly after 3:00 pm on July 14, 2004, an F3 tornado tore through the Country Squire Estates housing development in Campbelltown, PA. The tornado's 7.5 mile path across southwestern Lebanon County damaged or destroyed 149 homes, and injured as many as 24, one seriously. The absence of fatalities, and the relatively small number of injuries is remarkable given the near total destruction of several residential structures, and the 4-5 minute lead time associated with the tornado warning.

Three attributes of this significant tornadic event are worthy of additional study. One, the coincident existence of moderate surface-based CAPE, low-level environmental helicity supportive of supercell development and upper-level forcing produced a convective environment that was somewhat atypical for mid-July in the northern Mid-Atlantic region. Second, mesocyclone development in this region is often

rapid with little precursor signature requiring vigilance on the part of NWS personnel when monitoring convective trends, and prompt action when life and property are threatened. Third, current residential building practices not only complicate damage surveys and F-scale assessments, but may also increase the damage potential for a given wind speed.

These topics will be addressed through the use of synoptic-scale analyses, radar data, and damage survey results.

An Overview of the 10 May 2003 Tornado Outbreak. Fred H. Glass, NOAA/NWS Forecast Office, St. Louis, MO

The period from May 4-10, 2003 was one of the most active severe weather periods documented in United States History. A record 393 tornadoes occurred across portions of the central and eastern U.S.. The culminating event was a tornado outbreak which affected the Mid-Mississippi Valley Region on May 10th. Nine tornadoes were documented in Northeast Missouri and West Central Illinois within the County Warning Area for the National Weather Service Office in St. Louis. Of the nine tornadoes, four of these were classified as strong (F2 or F3) and long tracked with path lengths 10 miles. The Canton-Lima tornado had the longest documented track at 89 miles and a peak width of 300 yards. Despite damage estimated at 5-7 million dollars, there were no fatalities and only 10 minor injuries. This great fortune was due to the fact that the tornadoes occurred over primarily rural areas and the tornado warnings had an average lead time of 23 minutes.

The tornadoes across Northeast Missouri and West Central Illinois were produced by three discrete cyclic supercells. The supercells formed over western Missouri along a pronounced dryline, with supercell convective modes noted 40-50 minutes after the initial convective cells. Tornado production for each of the three supercells did not transpire until 1-2 hours after supercell characteristics were first observed. Each supercell produced multiple tornadoes, each successively stronger. While the large scale and mesoscale environment that day seemed supportive of tornadic supercells over a large portion of the Mississippi Valley, the majority of tornadoes were confined to the north of a retreating outflow boundary, where winds were locally backed and the Lifting Condensation Level (LCL) heights were lower. Notable changes were observed in storm structure with each of the three highlighted supercells upon crossing the outflow boundary and prior to producing their strongest tornadoes. The three supercell thunderstorms morphed from classic "flying eagle" structures with low-level appendages and hook echoes, to High Precipitation structures with smaller overall vertical and horizontal dimensions. Storm splits and cells mergers were also noted, as well as an overall decrease in the highest radar reflectivity levels.

Mesoscale Preconditioning Prior to the 21 April 2005 Southeast Kansas Tornadoes. Gino Izzi, NOAA/NWS Forecast Office, Springfield, MO

Several discrete supercells developed over southeast Kansas during the late afternoon and early evening of April 21, 2005. The supercells produced several tornadoes, including one strong (F3) tornado just southeast of Galesburg, KS in Neosho County.

The overall synoptic environment in which these tornadic supercells formed was forecast to be only marginally conducive for tornadoes, and certainly not favorable for strong tornadoes. Moderately strong instability was forecast in the warm sector as a seasonably warm and moist airmass spread northward from the western Gulf of Mexico. Deep-layer shear, which was initially marginal, was forecast to improve as a 50 kt mid-level speed max rotated around the base of the closed mid level circulation over Nebraska. Surface winds were forecast to remain slightly veered of south as the surface low slowly weakened, resulting in weak low level shear.

However, gravity waves propagating out from a dissipating mesoscale convective system over northeast Colorado during the morning, helped trigger new convection. This new convection, which moved into southwest Missouri, produced a westward propagating outflow boundary which set up an environment considerably more favorable for tornadic supercells to form over southeast Kansas. This presentation will highlight the most significant mesoscale modifications to the near storm environment and highlight the importance of real time mesoscale analysis during severe weather events.

Weather Impacts on Aviation

The Air Force Reserve Hurricane Hunters Missions and The 2005 Tropical Cyclone Season. Major John Gordon, United States Air Force Reserve Hurricane Hunters, Keesler AFB, MS

Today, a typical hurricane warning costs over $200 million due to preparation, evacuation, and lost commerce. Narrowing the warning area could save around $1 million per mile of coastline, and also lend greater credibility to forecasts and foster more controlled and limited coastal evacuations. Furthermore, as coastal populations continue to grow, evacuation decisions need to be made earlier; a few areas already require over 48 hours to clear in advance of a major hurricane.

The 53rd Weather Reconnaissance Squadron flies several different missions including Low Level Invests, Tropical Cyclones, Buoy Drops, Winter Storms and research missions.

Tropical Cyclone Missions

When conditions favorable for hurricane development are observed, either by surface observation or by weather satellite, the National Hurricane Center (NHC), alerts the flying weather crews. The Hurricane Hunters begin flying tropical storm systems whenever they pose a threat, from the middle of the Atlantic Ocean (west of longitude 55W), across the Caribbean and Gulf of Mexico, and also in the vicinity of Hawaii. Their job: Using WC-130 J model aircraft to determine the precise location, motion, strength, and size of the storm, and transmit the information by satellite to the NHC. The crews provide extremely detailed measurements of the temperature, humidity, pressure and winds in the lower to mid troposphere. The aircraft are capable of collecting research-quality data down to one second intervals. This highly accurate information has improved hurricane forecasts by 25%. In 2004, the unit flew nearly every day since July 30th, sometimes into two different storms simultaneously. In August and September, the unit logged over 80 flights into the storms, with the bulk of that into FRANCES and IVAN.

NOAA's 2005 Atlantic hurricane season outlook indicates a 70% chance of an above-normal hurricane season. The outlook calls for 12-15 tropical storms, with 7-9 becoming hurricanes, and 3-5 of these becoming major hurricanes. If this forecast hold true, the Hurricane Hunters will have a very active summer and fall.

Weather Theory for Pilots. Terry Lankford, Author and FAA Retired, Murphys, CA

An urgent need for practical weather education for pilots, especially in the General Aviation community, has long been acknowledged. Recent events support this view.

A goal of the Aviation Weather Committee continues to be the development and presentation of aviation programs and seminars.

In its continuing effort, the committee has completed the first segments of Weather Theory for Pilots, an interactive program designed to help pilots apply weather theory to their flight activities.

The first block provides an introduction to the program with explanations of the three major components in the weather equation moisture, vertical motion, and stability. Additional modules contain discussions of fronts, low ceiling and visibility, and altimetry. A "stand alone" module has also been developed on Aircraft Performance. Additional modules on weather radar and satellite interpretation, low-level wind shear, and weather reports and forecasts are in development.

This presentation will demonstrate the program and present our proposal for both internet and CD distribution. Additionally, we invite interested members to review the program.

Aviation Weather-Related Crashes and Deaths in the United States During Calendar Year 2004. John M. Jarboe, NOAA/NWS, FAA Academy, Oklahoma City, OK

This paper will publish the results of research that was conducted using the National Transportation Safety Board's (NTSB) database. The research was done to determine an accurate count of the number of aviation weather-related accidents and deaths that occurred in the United States during calendar year 2004. An Excel Worksheet was created from the data extracted from the NTSB's database. The Excel Worksheet was used to determine some statistics concerning the type of flight operations involved, weather conditions, geographic distribution, and monthly distributions of fatal aviation weather-related accidents.

The Creation and Impact of a New En-Route Graphical Weather Forecast for Aviation: Graphical AIRMET. Marc Singer, NOAA/NWS/NCEP Aviation Weather Center, Kansas City, MO

The Federal Aviation Administration (FAA) and NOAA's Aviation Weather Center (AWC) have collaborated on the development of a new aviation weather forecasting product - the Graphical Area Forecast (GFA). The GFA serves as a foundation for the way weather information will be represented and assimilated by users in the near future. The GFA represents a major paradigm shift from text-based products to an object based forecast of aviation hazards. The first step in the migration to the GFA involves the creation of the Graphical AIRMET (G-AIRMET). The G-AIRMET is designed to replace the information contained in current domestic AIRMETs using new technology to identify and represent the required weather information to support a standard weather briefing provided by the FAA.

Radar Techniques and Applications

NSSL Experimental Multiple-Radar/Sensor Severe Weather Products in AWIPS. Gregory J. Stumpf, CIMMS/NWS/MDL, Norman, OK, Matthew Foster, NOAA/NWS Forecast Office, Norman, OK, Karen Cooper, SAIC/NSSL, Norman, OK, and V. Lakshmanan, CIMMS/NSSL Norman, OK

Starting in the spring 2005, the Norman, Tulsa, and Fort Worth WFOs began participation in a test of new NSSL experimental products to assist severe weather warning decision making. The Warning Decision Support System Integrated Information (WDSSII) is a system that integrates multiple WSR-88D Level-II radar data, and data from other sensors (e.g., RUC numerical guidance analysis grids) to produce a variety of experimental severe weather warning guidance products. These products include grids to assist in both severe hail diagnosis and storm rotation trends. Both reflectivity data, and velocity-derived shear data from multiple-radars are merged to form a rapidly-updating 3D grid, which is then integrated with near-storm environment (NSE) data. Seven experimental grids are formatted for AWIPS, and then are made available to the WFOs via an LDM process to bring the data through the WFO security firewalls and into the LDAD (grid latency averages between 30-40 seconds). These grids, updated every 60 seconds, are at 1 km resolution or better, viewable from the D2D Volume Browser. The hail diagnosis grids include: Reflectivity at the 0°C and -20°C altitudes, 50 dBZ Echo Top heights, Height Difference between 50 dBZ and -20°C altitudes, gridded Maximum Expected Size of Hail (MESH), and a 2-hour MESH Hail Swath. Also included is a 6 hour rotation track product. (At abstract submission time, work was underway to bring 3D total lightning grids into AWIPS as well.) We will describe the experiment, including a discussion of the operational utility for the various grids during the 2005 convective season.

RIDGE - Radar Integrated Display with Geospatial Elements: The NWS New Radar Webpage. Keith Stellman, Paul Kirkwood, Dennis Cain, NOAA/NWS Southern Region Headquarters, Fort Worth, TX, Scott Rae, North Texas Council of Governments, and Ken Pavelle NOAA/NWS ABRFC, Tulsa, OK

The NWS is responsible to make its weather, water and climate information widely available to taxpayers using commonly accepted standards and technologies. Currently, the NWS provides weather radar information for all Weather Service Doppler Radars (WSR 88-D) in the United States on the NWS Internet page.

The National Weather Service Southern Region, working in cooperation with North Central Texas Council of Governments, has developed a method to display radar images more efficiently than the previous method. These radar images, call RIDGE (Radar Integrated Display with Geospatial Elements), allows the radar image to be combined with geospatial elements such as topography maps, highways, and county boundaries. This not only produces a better image, but provides additional reference information for users to understand where they are located. RIDGE also adds the ability to overlay polygon warnings issued by the National Weather Service Forecast Offices. Lastly, each image is georeferenced which allows GIS users to import any of the images into any GIS based software packages.

Storm Duration Forecasts Using Radar Storm Tracking. David Jankowski and Neil I. Fox, University of Missouri-Columbia, Columbia, MO

Most convective storm forecast systems track the center of the storm as a means of predicting the threat of severe weather. However, for many applications the duration of the storm may be more important than the time of arrival of the storm peak. In particular, forecasts of flash flooding should be related to the length of a precipitation event as well as its intensity. This paper presents results of a study of a number of storms in which comparisons are made between the commonly diagnosed velocity of the storm center with that of the rear edge of the storm. Using the velocity of the rear edge a storm duration factor is developed. The correlation between this factor and rainfall accumulation is examined in order to determine whether this measure is useful as a flood forecasting tool.

Cold Season Weather

Convective Snow Forecasting: Progress in the Winter of 2004-2005. Patrick Market, Brian P. Pettegrew, Chris J. Melick, and Larry L. Smith, University of Missouri-Columbia, Columbia, MO

An update is provided to a similar presentation at the 2004 Annual Meeting. Compared to 2003-2004, our Equitable Threat Scores (ETS) doubled for both Day 1 and Day 2 forecasts during the 2004-2005 winter season. Although still in need of much improvement, both the Day 1 score (0.2631) and the Day 2 score (0.0968) reveal a trend toward fewer missed forecasts and false alarms. Total forecasts issued for this period totaled 197. This improvement occurred against the backdrop of a warmer-than-normal winter season that featured several spectacular events (e.g., Pre-Thanksgiving in the Midwest, Pre-Christmas over the Ohio River Valley; Christmas Day along the Gulf Coast) and a field experiment for which accurate and precise thundersnow forecasts were crucial.

Pattern Recognition of Significant Snowfall Events in Tallahassee, Florida. Jeffrey D. Fournier and Andrew I. Watson, NOAA/NWS Forecast Office, Tallahassee, FL

Case studies of two significant snowfall events in Tallahassee, Florida are presented to illustrate some of the common synoptic patterns associated with these rare occurrences. Since 1895 there have been only seven snowfall events in which accumulations of 0.10 inches or more were reported in Tallahassee. Most of these occurred in February. These snow storms shared some common characteristics: (1) long wave ridging over the western CONUS, (2) a 500 hPa trough moving east along the Gulf Coast, (3) freezing temperatures and a trough at the 850 hPa level, (4) a cold surface anticyclone over much of the U.S., (5) a weak surface frontal wave developing over the Gulf of Mexico and moving quickly eastward across Florida, and (6) a classic snow sounding with freezing temperatures throughout most of the troposphere.

Our findings reveal the following evolution of a Tallahassee snow storm based on a composite of four events that occurred from 1955-1989. The large scale 500 hPa height pattern is relatively cold for the eastern United States. There is a long wave ridge axis between the Pacific Coast and the Rocky Mountains, and a cold polar vortex over the Great Lakes, Maine, or southeast Canada. A short wave trough moves east from west Texas to the central Gulf Coast during the 24-hour period leading up to the snow event.

At the surface a quasi stationary front is oriented east to west over the central or southern Gulf of Mexico. A large, cold anticyclone covers much of the eastern U.S. with a 1045 hPa center (average value) over the central part of the country. A ridge extends from this high down to northeast Mexico, and another ridge extends from the high to the U.S. east coast. As the approaching short wave trough interacts with the stationary baroclinic zone, a weak low pressure wave forms along the western portion of the front. On the surface chart using 4 hPa increments, there are no closed isobars around the wave. However, as the wave develops, large scale ascent and deep layer moisture combine to produce a large area of mostly light precipitation. Freezing rain or snow occurs across portions of south Texas and along the northwest Gulf Coast where the initial thrust of cold air occurs. The frontal wave moves quickly east along the front, crossing south or central Florida within 24 hours after its initial formation over the Gulf of Mexico. The wave then deepens into a closed low over

Florida or off the southeast U.S. coast.

The 850 hPa freezing isotherm traditionally has been used by operational meteorologists as a best first guess line that distinguishes snow from rain. In all the cases analyzed for this paper, this isotherm is in close proximity to Tallahassee at the time of snow. This happens as an 850 hPa trough forms over the southeast United States. This trough, which is oriented from northeast to southwest, is initially north of Tallahassee. However, as it moves southeast, strong cold air advection on the right side of the trough brings the 850 hPa freezing line far enough south to allow the northern portion of the precipitation zone to change to snow. At this point the skew-T Log-P diagram shows the classic snow sounding, with freezing temperatures throughout much of the troposphere.

Pattern recognition is an important skill for operational meteorologists. By recognizing patterns associated with significant weather events, meteorologists may provide better lead time and more accurately describe the expected impacts of the forecast event to their users. Unfortunately this skill is difficult to acquire when faced with rare events. Our paper will describe two significant snow events in Tallahassee, Florida, provide pattern recognition guidance for the events, and give general advise to forecasters along the eastern Gulf Coast who face similar challenges of snow forecasting.

A Conceptual Model Depicting Processes Important for the Generation of Meso-Beta Scale Snow Bands. Michael J. Paddock, Charles E. Graves, and James T. Moore (NWA Past-President '99), Saint Louis University, St. Louis, MO

Meso-beta scale bands of snowfall of 3-6 inches associated with weak cyclogenesis often form in the Midwest during the winter, presenting a difficult forecast problem. An investigation of four of these events from February 2003 has revealed several common factors which contribute to the mesoscale nature of the snow bands. A conceptual model depicting these critical kinematic and thermodynamic processes will be shown, along with a case study that demonstrates key parameters useful for the short-term prediction of these mesoscale snow bands.

Stability Tendency in Mid-Latitude Convective Snow Events As Determined From RUC-20 Output. Larry L. Smith and Patrick Market, University of Missouri-Columbia, Columbia, MO

Thundersnow cases from the 2003-2004 and 2004-2005 winter seasons are being examined in order to determine the stability regime and stability evolution that occurs with each event. These events are compared to a second group where significant snow fell but without lightning activity. In each case, basic operational metrics are compiled on the stability of the atmosphere (K Index, Total Totals, MU CAPE, MU LI, etc) at and near the time of thundersnow, along with calculations of the static stability tendency at the event site. Hourly initial fields from the Rapid Update Cycle (RUC-20) form the primary source of data in this study.

Preliminary comparison to data from serial radiosonde ascents during our field experiment in early 2005 suggests that the RUC-20 adequately portrays the stability evolution (in terms of basic operational parameters) and that even those values are useful in defining regions more prone to thundersnow development.

The Great Lakes Ice Cover-Atmosphere Flux (GLICAF) Experiment: Forecasting Techniques and Challenges. Michael L. Spinar, Michael C. Kruk, Illinois State Water Survey, Champaign, IL, Mathieu R. Gerbush, Stephen K. Jackman, University of Illinois, Champaign, IL, David A. R. Kristovich, Illinois State Water Survey, Champaign, IL, and Neil F. Laird, Hobart and William Smith Colleges, Geneva, NY

Short-duration field experiments, designed to collect measurements of particular atmospheric conditions or weather systems, often require very narrowly-focused forecasts. The forecasts required for these experiments are often targeted for specific locations or regions where observations are limited. Meeting project requirements under these constraints is not only challenging, but also an essential aspect of the field campaign. This presentation will describe techniques used and challenges associated with forecasting near-surface weather conditions over Lake Erie during the Great Lakes Ice Cover - Atmospheric Flux (GLICAF) project, an experiment conducted to examine the influence of ice cover on surface heat fluxes in lake-effect boundary layers.

The GLICAF project was conducted over Lake Erie during 20 - 29 February 2004 as a joint effort

between the Illinois State Water Survey and the Department of Atmospheric Sciences at the University of Illinois. The University of Wyoming King Air was used to collect in situ atmospheric measurements and remotely-sensed information on lake-surface temperature and spatial coverage of pack ice. Support for the field phase of the GLICAF project was received from the National Science Foundation.

The operation of research flights was restricted to a limited set of meteorological and ice-cover conditions necessary for achieving GLICAF scientific objectives. Several of these conditions included weak upward surface heat fluxes, large ice-cover variations, clear conditions in the lowest 1.5 km of the atmosphere, and adequate daylight. To achieve successful flight operation decisions, forecasts of surface air temperatures and boundary layer wind speed, moisture, and cloud conditions were required for an extensive area where operational observations are not collected (i.e., over Lake Erie).

The restrictive nature of desired flight conditions over the lake surface, combined with a limited number of flight hours and Federal Aviation Administration (FAA) pilot requirements, placed a heavy demand on forecast accuracy. This presentation will detail the forecast methodology, discuss conditions during two Intensive Operation Periods (IOPs), and provide verification information, all of which should be especially interesting to those developing tailored forecasts in data-poor regions.

The South Texas Christmas 2004 Snow Event: a Climatological Perspective. Rich Dixon, Texas State University, San Marcos, TX

The south Texas region experienced a rare snow event on 24-25 December 2004. The storm brought over 4 inches of snow to Corpus Christi, while inland locations to the north and east received up to 12 inches. This study provides a long-term climatological context on these rare snow events and places there occurrence in perspective to another rare event in the region; the tropical storm.