NSSL Briefings

A newsletter about the employees and activities of the National Severe Storms Laboratory

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Spring/Summer 1996

In Brief.....

__NSSL Briefings__ is a publication from the National Severe Storms Laboratory (NSSL) intended to provide federal managers, staff, and other colleagues in the meteorological community with timely information on activities and employees. If you would like to be added to the NSSL Briefings mailing list, or have a change in your address, please forward requests to Kelly Lynn, NSSL, 1313 Halley Circle, Norman OK, 73069; or email: klynn@nssl.uoknor.edu.

NSSL and NWS working to make NEXRAD an"open system"

by Susan Oakland-Cobb and Michael Jain

Approximately twenty-five years ago, the National Severe Storms Laboratory (NSSL) began investigating the real-time use of a meteorological Doppler radar to identify severe or tornadic storms. Subsequent tests involving the National Weather Service (NWS), the U.S. Air Force's Air Weather Service, the Air Force Geophysics Lab (now Phillips Lab), and the Federal Aviation Administration (FAA) verified the researcher's conclusions: that Doppler radar offered a significant improvement for early and accurate identification of thunderstorm hazards. This conclusion sparked the conception of the NEXt Generation weather RADar (NEXRAD) program that has come to fruition this year with the completed installation of a national Doppler weather radar network. Technology has evolved at a rapid rate since the installation of the prototype radar in Norman, Oklahoma in 1989. To stay on the leading edge of computing technology, and to continue to provide consumers of NEXRAD data and products the best services possible, the NEXRAD system will undergo an aggressive and challenging upgrade over the next three years. Overall project management and sponsorship is being provided by the NWS Office of Systems Development (OSD) with Bob Saffle serving as Project Manager. Primary participants involved in the technical development include NSSL, the Operational Support Facility (OSF) for NEXRAD, and OSD's Integrated Systems Lab (ISL). Several other NWS offices are also participating as well as the Air Weather Service (AWS) and the FAA. NSSL is responsible for the project's software development effort and has assembled a team of software engineering experts to make the NEXRAD system more flexible and user-friendly. Implementation of the upgraded system is expected to begin in late 1999.


Photo by Tim O'Bannon

Goals of the upgrade

The main goals of the software upgrade are to:

- fashion NEXRAD into an open and distributed processing system that will provide greater flexibility and improved performance, and protect the system from technological obsolescence;
- develop a new Graphical User Interface (GUI) for the User Control Position (UCP) that will provide a more intuitive interface to the NEXRAD system; and
- provide the mechanisms to support a Local Development Environment that will allow for the development and evaluation of cutting-edge algorithms and display products.

The Open Systems Radar Product Generator (ORPG)

As an integrated team, NSSL and the OSF will work together closely to develop an Open Systems Radar Product Generator (ORPG). The NEXRAD RPG receives the base-level data, processes it with meteorological algorithms and product generators, then distributes the products to various end users. Currently, the RPG is a proprietary system that is becoming increasingly difficult and costly to enhance. We are developing an “Open Systems” RPG (ORPG) that will have the capacity to compile, link, and run the software code on a wide variety of commercially-available hardware and operating systems with little or no change to the software. This “open systems” aspect coupled with a “distributed computing environment” will allow NEXRAD to incrementally upgrade hardware when additional processing power or new computing technology is required.

A new GUI UCP

A new Graphical User Interface (GUI) for the User Control Position (UCP) is being developed based on human factor considerations. The existing UCP is a text-based, nested menu interface that has been shown operationally to be difficult or inconvenient to use. The development of the new UCP is being guided by a GUI/UCP design team whose members are experienced in human factors, training, and GUI software development. This new, more intuitive interface will serve radar operations more effectively.

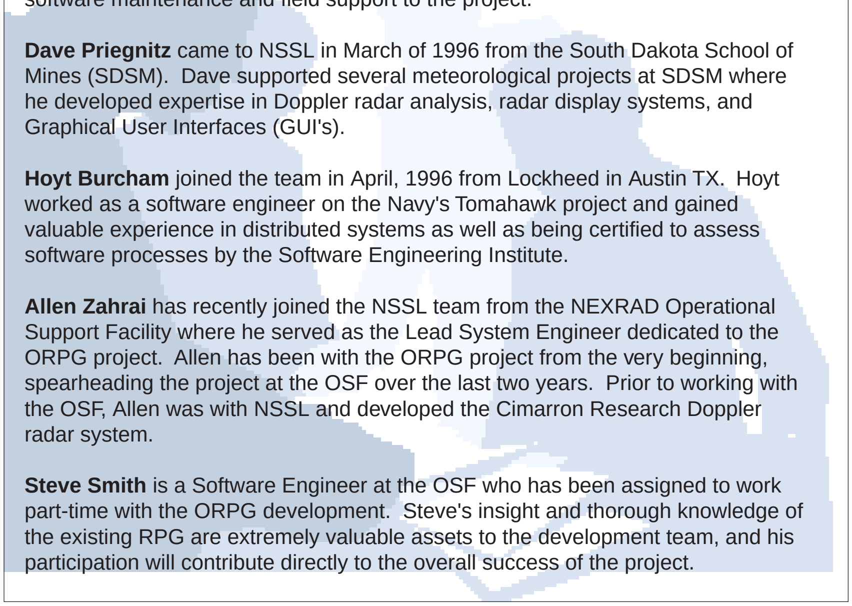
A Local Development Environment

Another goal of the ORPG is to provide the mechanisms to support a Local Development Environment. A Local Development Environment provides

NSSL Software Development Project Manager - Michael Jain has been with NSSL for 12 years as a meteorologist and project manager. Mike has worked closely with the NEXRAD program for most of his career at NSSL. Initially Mike worked as a member of the Interim Operational Test Facility for NEXRAD, then was involved with various NEXRAD-related projects supported by the OSF. Now Mike serves as Project Manager for the NSSL effort in the ORPG Project.

Software Engineers:

Dr. Zhongqi Jing came to NSSL in September 1995 from the National Center for Atmospheric Research/Research Application Program (NCAR/RAP) in Boulder. Zhongqi contributed to many projects at RAP including the development of a real-time Doppler radar display system, meteorological algorithms, and an operational wind shear warning radar system for the new Hong Kong airport.



Arlis Dodson joined the NSSL team in September 1995 after serving as a software maintenance and field support engineer with the Federal Aviation Administration's (FAA's) Terminal Doppler Weather Radar (TDWR) program. From his TDWR experience, Arlis brings the extremely important perspectives of software maintenance and field support to the project.

Dave Priegnitz came to NSSL in March of 1996 from the South Dakota School of Mines (SDSM). Dave supported several meteorological projects at SDSM where he developed expertise in Doppler radar analysis, radar display systems, and Graphical User Interfaces (GUI's).

Hoyt Burcham joined the team in April, 1996 from Lockheed in Austin TX. Hoyt worked as a software engineer on the Navy's Tomahawk project and gained valuable experience in distributed systems as well as being certified to assess software processes by the Software Engineering Institute.

Allen Zahrai has recently joined the NSSL team from the NEXRAD Operational Support Facility where he served as the Lead System Engineer dedicated to the ORPG project. Allen has been with the ORPG project from the very beginning, spearheading the project at the OSF over the last two years. Prior to working with the OSF, Allen was with NSSL and developed the Cimarron Research Doppler radar system.

Steve Smith is a Software Engineer at the OSF who has been assigned to work part-time with the ORPG development. Steve's insight and thorough knowledge of the existing RPG are extremely valuable assets to the development team, and his participation will contribute directly to the overall success of the project.

NSSL News Briefs

NSSL employee elected Vice President of NWA

Rodger Brown has been elected Vice President of the National Weather Association (NWA) for 1996. As Vice President, he is responsible for coordinating the activities of the various NWA committees on the NWA Council. Brown also has served the NWA in other positions. He was Secretary of the organization in 1994 and Program Chairman for the 1989 Annual Meeting.

Two NSSL scientists receive prestigious Vaisala Award

Drs. Dusan Zrnic and Alexander Ryzhkov have been awarded the 1995 Vaisala Award by the World Meteorological Organization (WMO). They have been recognized for their work using polarimetric radar data to improve rainfall estimation. This award will be presented to Drs. Zrnic and Ryzhkov on November 5, 1996 by the Secretary General of the WMO.

NSSL scientist returns from Olympic Weather Support Office

J.T. Johnson returned to NSSL on October 1, marking the end of 20 months working with the NWS to set up and operate the Olympic Weather Support Office in Peachtree City GA. Johnson was honored with the Special Distinguished Service Award "in recognition of contributions made as Science and Operations Officer of the Olympic Weather Support Office for the 1996 Summer Olympic Games." Johnson's role was to oversee system development, hardware and software integration, maintaining scientific integrity, and forecaster training.

NSSL STAFF

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Deputy Director	*Doug Forsyth*
Chief, MRAD	*Dave Rust*
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NEWSLETTER

Executive Editor	*Mike Eilts*
Writer/Editor	*Susan Oakland-Cobb*

access from a workstation to the base data and products generated from the ORPG along with the software libraries and tools to develop new algorithms, products, and applications. This allows new algorithms and products to be developed and evaluated “external” to the managed ORPG, and yet be run and evaluated in an operational setting.

NSSL’s team of experts

NSSL has assembled an outstanding team of experts possessing a broad background of software engineering and weather radar experience. Current team members (see inset) have expertise in software engineering and maintenance, distributed processing, meteorological and Doppler radar applications, and GUI development.

NSSL is currently scheduled to complete the “pre-production” ORPG, also known as “Open 0” by summer of 1998. NSSL will continue work on the system, along with the OSF, to develop the first operational ORPG release, currently being referred to as Open 1. Retrofitting of existing systems is expected to begin in late 1999. ◆

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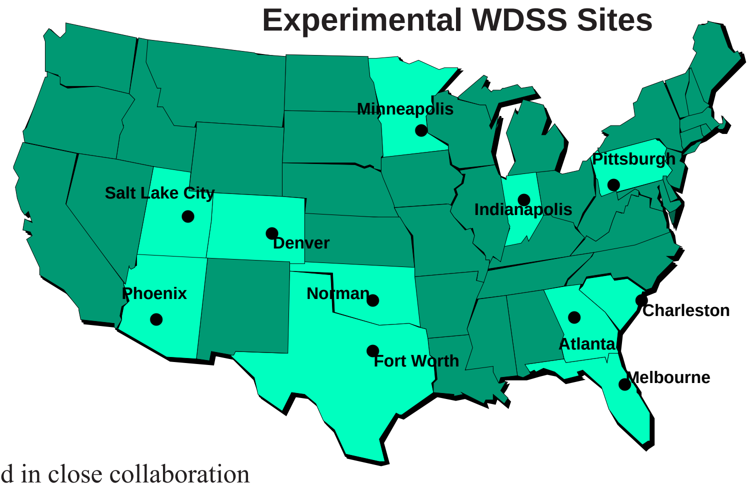
Geographic diversity achieved in WDSS tests

by Susan Oakland-Cobb

The United States is a country rich in geographic and climatic diversity. Bounded by oceans, bisected by mountain chains, and dotted with deserts, swamps, prairies and forests, our country's different environments present numerous challenges to weather forecasters. NSSL has been investigating the utility of their prototype Warning Decision Support System (WDSS) in many different climatic regions of the country and in varied terrain by conducting proof-of-concept tests at National Weather Service Forecast Offices (NWSFO) across the country. The first test, during the summer of 1994, was in Phoenix AZ where damaging winds associated with downbursts and flash flooding were the primary severe weather events. The following spring, the WDSS was tested in Fort Worth TX where the Mesocyclone, Tornado, and Hail Detection Algorithms were more rigorously tested in the Southern Plains springtime environment. A test was also conducted in Atlanta GA during the summer of 1995, in preparation for the Summer Olympic Games, to determine if there were any differences in the Georgia environment that may cause problems or biases with the NSSL developed algorithms.

This spring and summer, testing at five additional sites continued to provide understanding of location-specific user needs for future algorithms and product displays. These sites include Charleston SC, Melbourne FL, Minneapolis MN, Salt Lake City UT, and Indianapolis IN. The Salt Lake City site, in particular, will serve as a testbed for enhancements to operations at other forecast offices in the Western Region.

NSSL's goal is to develop and deliver significantly enhanced algorithm display concepts to both the WSR-88D and Advanced Weather Interactive Processing System (AWIPS) systems. These proof-of-concept tests are being accomplished in close collaboration with NWS staff during actual NWS warning operations. These tests provide a unique opportunity for NSSL scientists and NWS forecasters from around the United States to work together to directly address NWS needs for new and/or improved severe weather warning tools. ◆



For more information contact Mike Eilts at: eilts@nssl.uoknor.edu

Surfing the outflow: VORTEX from the air

by Andrew I. Watson

Figure 1: F3 tornado near Newcastle, TX at 2312 UTC on 29 May 1994, taken from P-3 by C. Ziegler.

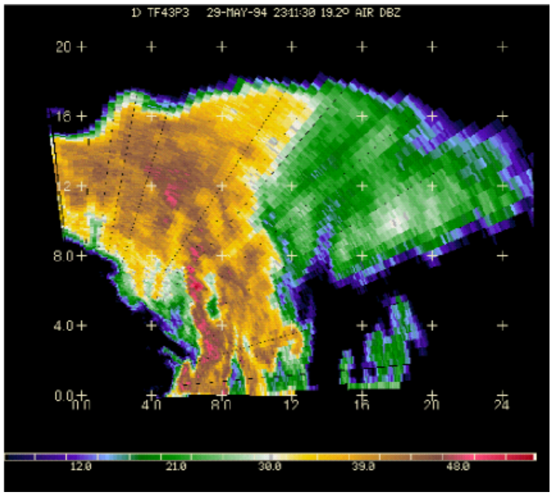


Figure 2: NOAA P-3 radar data from VORTEX mission on 29 May 1994. Tail-forward RHI reflectivity image at 2311 UTC showing a Bounded Weak Echo Region (BWER) and Echo Weak Hole (EWH).

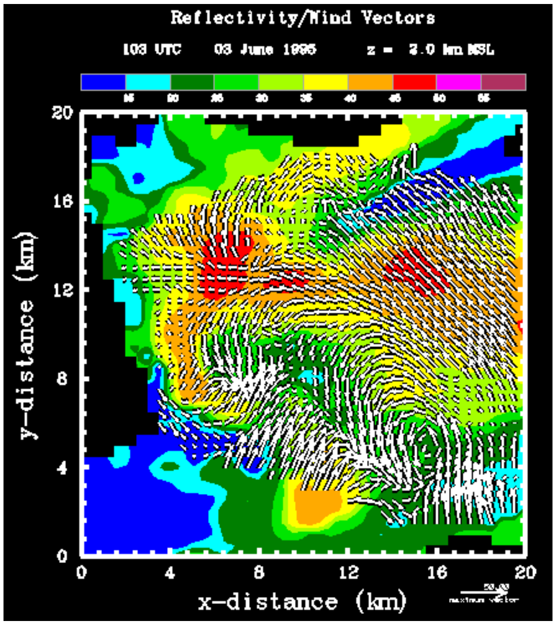


Figure 3: Dual-Doppler analysis of Dimmitt, TX tornado on 3 June 1995 at 0103 UTC at 2.0 km MSL (0.8 km AGL). Reflectivity (dBZ) is color-contoured showing mesocyclone hook. Vectors denote horizontal flow. Two vortices are apparent, one within the hook and the other approximately 8 km ESE of the hook.

In VORTEX-94 and 95, the National Oceanic and Atmospheric Administration's (NOAA) WP-3D aircraft, operated by the Air Craft Operations Center, was used to document the evolution of storm structure. The P-3 is equipped with two radars that allow several techniques in scanning. The lower-fuselage radar is a 5.6 cm (C-band) radar. It scans horizontally, giving the scientist the ‘big picture’ while also monitoring the evolution of the targeted storm in its lowest layers. The tail radar is a 3.2 cm (X-band) Doppler radar that scans vertically. To obtain pseudo dual-Doppler measurements, the radar antenna can be alternately slewed fore and aft of the direction perpendicular to the fuselage by as much as 25 degrees. To maximize the spatial resolution, the tail radar antenna can be sectorized to one side of the aircraft. To further increase the spatial, along-track resolution, we employ " the Alternate Fore-Aft Scanning Technique" (AFAST). Using AFAST, we execute only fore scans as we approach our target storm, and only aft scans as we pass and move away from the target.

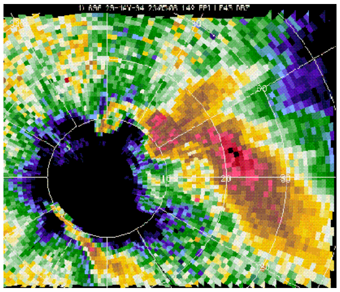


Figure 4: Dealiased tail-forward RHI velocity image at 2311 UTC on 29 May 1994 showing strong inbound velocities (green) over strong outbound velocities (tan) at location of EWH. Note only lower 8 km displayed.

During VORTEX (the Verification of the Origins of Rotation in Tornadoes EXperiment), back-and-forth aircraft patterns were flown on the inflow side of the storm targeted by the VORTEX Field Coordinator, Erik Rasmussen. The aircraft was flown in the lowest 300-2000 m above ground level (AGL) to optimize radar data collection in the region most likely to experience tornadogenesis. The turbulent ride along the boundary between warm moist inflow winds riding up over strong rain-cooled outflow was called "surfing the outflow" by the P-3 pilots. Usually this region was as close as we could come since the cloud boundary was just several hundred meters from the aircraft. The closest we flew to a tornado was on 29 May 1994. We were as close as 7 km to the F3 tornado (see Figure 1) which occurred in open country between Newcastle and Olney TX. Normally we tried to stay within 10 to 15 km of the storm center.

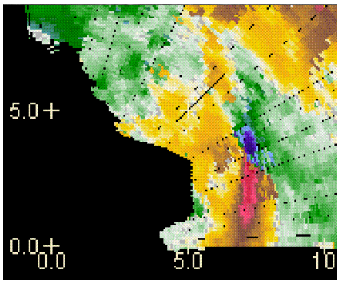


Figure 5: P-3 lower fuselage radar PPI image at 2305 UTC on 29 May 1994 showing tornadic hook.

The unique set of data that we were able to obtain from the air has provided a new set of challenges. With the tail radar’s Nyquist velocity of +/- 13m/s, and expected radial velocities of 50 to 80 m/s, extensive clean-up of the radar data is required. NSSL scientists are working to analyze these data from the aircraft. They hope to find clues into the evolution of storms and the tornadoes they produce. ◆

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Tornado development: reconciling observations with theory

by Jeff Trapp, National Research Council
Postdoctoral Associate

In the 1970's, NSSL scientists Rodger Brown, Les Lemon, and Don Burgess recognized the capability of Doppler radars to detect embryonic and fully-developed tornadoes. Their discovery was a Doppler-radar velocity pattern, appropriately named a *tornadic vortex signature*, or TVS. In radar scans of tornadic storms studied by these scientists, a TVS usually appeared several kilometers above the ground, descended, and then reached the ground coincident with tornado "touchdown." And, the elapsed or "lead" time between TVS appearance and tornado touchdown was a few *tens* of minutes!

Certainly, this application of Doppler radar technology in tornado detection paved the way for the many timely warnings now issued to the general public. With the implementation of the WSR-88D radar network, however, we are now noticing that not every TVS behaves the same. In fact, some (perhaps as many as 50% according to a study by DeWayne Mitchell and me) TVS's form either simultaneously over the lowest ~2 km or very near the ground and then rapidly contract into a tornado with merely a few minutes of advance warning.

This disparity in the way tornadoes ostensibly form has vexed researchers for more than a decade. Recently, however, Bob Davies-Jones and I utilized models of a *mesocyclone* (the tornado's "parent" circulation) to determine a simple and intuitive explanation for what we believe are the two modes of tornado development.

Horizontally-converging air at some vertical distance above the ground acts to increase "ambient" rotation (the mesocyclone) at that same altitude. Tornado development will depend on the change in altitude of either the convergence or the rotation (or both). To simplify most of our experiments, we allowed only this change in convergence.

When horizontal convergence is greater aloft (3-4 km) than next to the ground, rotation increases first aloft and *mode I* development begins (Figure 1a). The embryonic tornado will build downward by the *dynamic pipe effect* (DPE), a type of bootstrap process (Figure 1b): Air may not enter through the sides of this vortex but can pass through its ends. In this respect, the vortex acts like a "pipe." Because of the partial vacuum created within the vortex core or pipe, weakly-rotating air is drawn into the pipe's lower end. This causes the air to spin faster and ultimately become part of the pipe. New sections of the metaphorical pipe form at progressively lower altitudes through this same process until the pipe (tornado) is in contact with the ground.

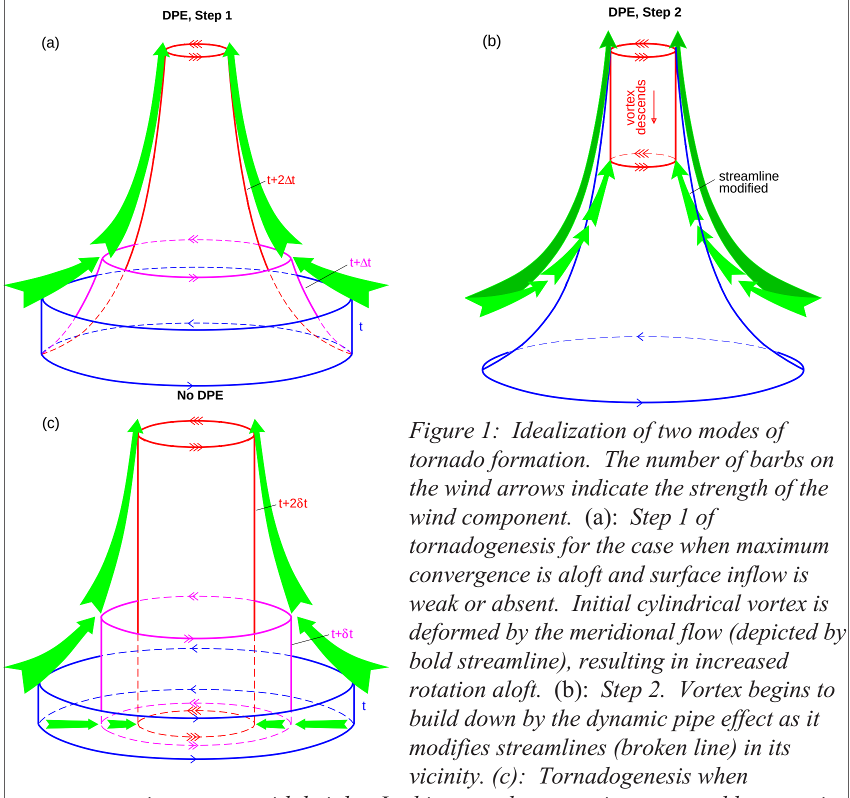

Figure 1: Idealization of two modes of tornado formation. The number of barbs on the wind arrows indicate the strength of the wind component. (a): *Step 1 of tornadogenesis for the case when maximum convergence is aloft and surface inflow is weak or absent. Initial cylindrical vortex is deformed by the meridional flow (depicted by bold streamline), resulting in increased rotation aloft.* (b): *Step 2. Vortex begins to build down by the dynamic pipe effect as it modifies streamlines (broken line) in its vicinity. (c): Tornadogenesis when convergence is constant with height. In this case, the vortex is contracted but remains cylindrical, resulting in simultaneous increase in rotation throughout a large depth.*

When horizontal convergence is constant with altitude, rotation increases at the ground and aloft simultaneously. The tornado in this case forms nearly independently with altitude over the lowest few kilometers (*mode II*), precluding a DPE (Figure 1c).

Our next step in this research is to help ease this information from the basic research arena to that of operational meteorology, so that forecasters can recognize situations in which a TVS is most likely to provide the greatest amount of advance warning. ◆

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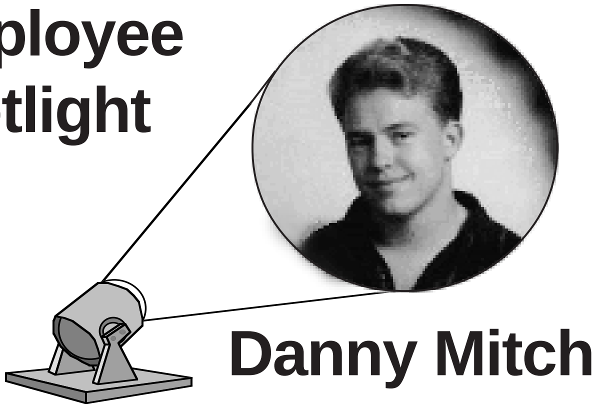
Employee spotlight



Danny Mitchell

by Susan Oakland-Cobb

Danny Mitchell really likes his job as a programmer and systems administrator. He likes it so much that programming is one of his hobbies, and he has even started his own local internet company. Recently, however, he has found something he likes more than his job and hobbies - he likes being a dad! Danny's first child, a son named Blake Wesley Verdell Mitchell, was born on February 29, 1996.

Danny's role at NSSL is in the Mesoscale Research and Applications Division. His responsibilities include providing technical support for his group, programming, and system administration. Danny has a B.S. in Mechanical Engineering from the University of Oklahoma, and has been at NSSL since October of 1994. The challenges of his job include learning new data formats, and developing programs and new systems.

Danny feels his greatest success so far (besides Blake) is a Graphical User Interface program called "Xgribview." This program is used by a lot of people for reading National Center for Environmental Prediction (NCEP) grib data files and any other grib edition 1 data file. The program determines what is in the data file, then allows the scientists to perform various calculations to analyze that data. The program also allows scientists to display various graphs with map backgrounds.

Danny describes himself as a problem solver -- he likes to find new and improved ways of doing things. That's why he likes programming so much. "You're always doing it over," says Danny, " adding or taking things away to make it better".

Danny used to have time for other interests - before the arrival of Blake. He taught Tae Kwon Doe for 6 years, and enjoyed swimming and roller blading. Now Danny chooses to spend time with his family by taking walks and learning more about fatherhood. ◆

The potential of satellite data in warning decisions

by Daphne Zaras

We have now added satellite data to the WDSS so that we can explore multi-sensor approaches to understanding storm structure.

In the near future, high-quality digital satellite data from the Geostationary Operational Environmental Satellite (GOES)-8 and GOES-9 will be available in NWS forecast offices. As the NWS becomes modernized, these data will be available in the same computing platform as WSR-88D, lightning detection, surface and profiler data as well as numerical model output. NSSL is beginning to examine methods to integrate satellite data with these other data streams to help solve short-term forecasting and warning problems.

The NSSL-developed WDSS already integrates radar data with lightning data, surface data, and numerical model output. We have now added satellite data to the WDSS, so that we can explore multi-sensor approaches to understanding storm structure. Our efforts are focused on the development of algorithms and techniques that utilize the strengths that each data source has to offer to help forecasters identify and warn for severe convective weather.

With the addition of satellite data into the WDSS, we are currently developing integrated remote sensing algorithms to analyze storm top and structure (see Figure 1). Present algorithms associate portions of the cloud top with radar-identified cells to graph changes in the cloud top through time. Several previous studies with early geostationary satellites have identified cloud top signatures that were precursors to severe weather. In anticipation of digital satellite data dissemination and improved capabilities of the current GOES satellites, we are revisiting this technique and testing it in a few select NWSFO's.

We are also investigating the strengths of the satellite data to overcome some disadvantages of radar data. In particular, satellites can provide consistent cloud top height information, whereas radar-scanning strategies result in a few areas of poor cloud top sampling. Also, radar resolution varies drastically over the radar domain, while the resolution of satellite data is virtually constant. As storms move from one radar domain to another, satellite data can provide consistent information until the strengths of radar again dominate.

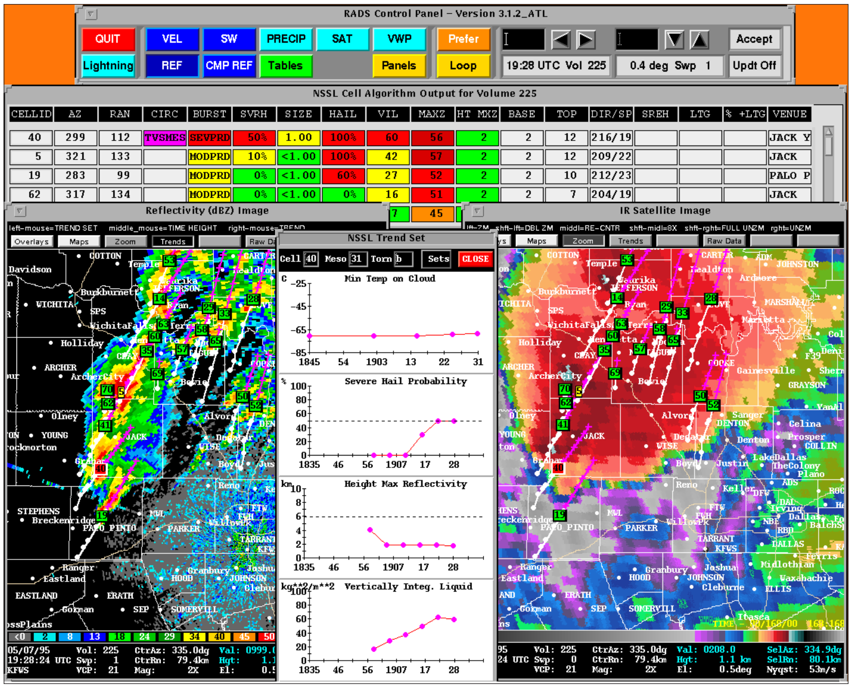
In working through all the issues involved in combining satellite and radar data in particular, we find that the use of satellite data to complement radar is made more complicated by the differences in timing of scans (see table and Figure 2). The U.S. currently has two geostationary satellites positioned near the east and west coasts. For several case studies, the availability of Rapid scan and Super Rapid scan satellite data are allowing us to investigate data sampling issues fully. In Figure 2, boxes A and B illustrate how well or poorly the satellite may sample a storm lasting 30 minutes. The poor sampling of storm B, which occurs during a full disk scan, is somewhat remedied by the staggering of full disk scan times for GOES-East and GOES-West. A more rigorous approach would be to add a third satellite dedicated to severe weather analysis which could be devoted to constant interval, small area, and short interval (such as 3 minute) scans.

With the development of new, high quality digital satellite imagery, forecasters will be able to identify dangerous storms not easily recognizable with current technology. Our goal is to maximize the use of these new technologies by developing algorithms that assist the forecasters responsible for warning citizens of impending severe weather. ◆

Current scanning strategies

Mode	Observation intervals	Area scanned
Routine	Every 15 min	CONUS
Rapid Scan	Every 7.5 min	CONUS
Super Rapid Scan	10 consecutive 1 min scans (2 per hour)	1000 km X 1000 km
	Every 15 min	CONUS
All	Every 3 hours (takes 30 min.)	Full disk (portion of the globe toward the satellite)

For more information contact Mike Eilts at: eilts@nssl.uoknor.edu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NSSL Cell Algorithm Output for Volume 225

CELLID	AZ	RAN	CIRC	BURST	SVRH	SIZE	HAIL	VIL	MAXZ	HT MXZ	BASE	TOP	DIR/SP	SREH	LTG	% +LTG	VENUE
40	299	112	TVSMES	SEVPRD	50%	1.00	100%	60	56	2	2	12	216/19				JACK Y
5	321	133		MODPRD	10%	<1.00	100%	42	57	2	2	12	209/22				JACK
19	283	99		MODPRD	0%	<1.00	60%	27	52	2	2	10	212/23				PALO P
62	317	134		MODPRD	0%	<1.00	0%	16	51	2	2	7	204/19				JACK

Reflectivity (dBZ) Image

left-mouse=TREND SET middle_mouse=TIME HEIGHT

NSSL Trend Set

Cell 40 Meso 31 Torn b

IR Satellite Image

shft-lft=DBL ZM middl=RE-CNTR shft-midl=8X shft-rght=FULL UNZM rght=UNZM

05/07/95 Vol: 225 CtrAz: 335.0dg Val: 0999.0
19:28:24 UTC Swp: 1 CtrRn: 79.4km Hgt: 1.1
KFWS VCP: 21 Mag: 2X El: 0.5

Vol: 225 CtrAz: 335.0dg Val: 0208.0 SelAz: 334.9dg
UTC Swp: 0 CtrRn: 79.4km Hgt: 1.1 km SelRn: 80.1km
VCP: 21 Mag: 2X El: 0.5deg Nyqst: 53m/s

Figure 1: Initial trend studies for satellite data in the NSSL WDSS. Base reflectivity at 0.5 degree elevation is shown along side infrared satellite data with cell number 40 on both. A sample satellite trend set is shown for cell 40.

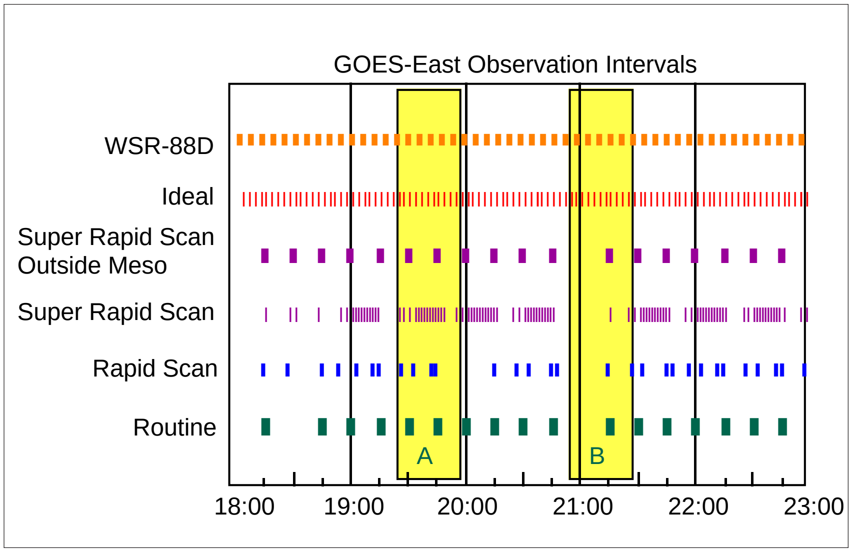


Figure 2: Comparison of GOES-East observation intervals for various scanning strategies. Routine is shown in green and Rapid Scan in blue. Purple lines show sampling under Super Rapid Scan for points inside and outside the mesoscale sector. The "Ideal" shows a proposed scanning strategy for severe storm applications. Intervals of WSR-88D data for most volume coverage patterns are also shown.

NSSL adopts old man winter

by John Cortinas Jr. and Paul Janish

Winter weather in the United States is one of the costliest forms of hazardous weather in terms of property and human lives. Reports from the National Weather Service's Office of Meteorology indicate that winter weather produced 247 fatalities, 4573 injuries, and 2.9 billion dollars worth of damage from 1990 to 1994. Collaborative research between the NSSL Mesoscale Applications Group (MAG) and the Storm Prediction Center (SPC) examines scientific issues related to hazardous winter weather. The goals of this collaboration include: understanding the physical mechanisms that produce blizzards, freezing rain, and heavy snow; developing forecasting techniques that help forecasters anticipate these events and alert the public; and providing the public and commercial interests with climatological information about hazardous winter weather.

One of these collaborative studies is a winter weather forecasting experiment in which data were collected from October through December 1995. The purpose of the forecasting experiment was to test and evaluate several winter weather products that may be issued by the SPC and to evaluate several winter weather forecasting techniques. During the experiment, MAG and SPC forecasters prepared daily 12-hour forecasts of where and when they expected freezing rain, heavy snow, and/or blizzard conditions to occur in the contiguous United States. Since effective dissemination of this information to NWS forecasters will be crucial, meteorologists experimented with different ways of presenting this information. These experimental guidance products were created in various text and graphical forms, focusing on the use of probability forecasting. Many of these products took the form of a US map with probability contours, highlighting areas of concern, while indicating forecast uncertainty. In the analysis phase of the experiment, MAG and SPC meteorologists will examine the utility of the forecasting techniques that were used during the experiment and examine issues related to the verification of hazardous winter weather forecasts.

Another MAG/SPC collaborative effort is the study of physically-based hazardous winter weather forecasting techniques. One such technique relies on an ingredients-based approach and is in contrast to empirical methods used by operational forecasters in the past. Integrating new applications of science and analysis with innovative workstations allows forecasters to improve their conceptual models of atmospheric processes. It also allows for better use of observational and numerical model data to produce more fundamentally sound forecasts. As important parameters become defined, features can be placed on a single chart (known as a composite chart) to highlight winter weather hazards in time and space. Recently, this technique was applied to a hazardous winter weather event in the Pacific Northwest and one in the Southeast. The results from that study show that the technique has the potential to help forecasters identify areas where hazardous winter weather is possible.

Working with the NWS and SPC, the MAG is committed to hazardous winter weather research in order to understand the physical processes associated with winter storms. The unique synergism between meteorologists in the NSSL/MAG and the NWS/SPC allows the rapid integration of these research results into an operational environment.◆

For more information contact John Cortinas at: cortinas@nssl.uoknor.edu

The arctic outbreak of 27 January - 4 February, 1996

Record snowfall, paralyzing ice storms, and dangerous blizzards all occurred during the winter of 1996, but perhaps none more encompassing than the prolific arctic outbreak of 27 January - 4 February.

Heavy snow and thunderstorms associated with a well-organized storm system moved across parts of the central Plains and western Great Lakes on 27 January which moved across the area. Behind the storm, arctic air spilled into the U.S., dropping temperatures to as low as -60° F in Minnesota and setting numerous local and state low- temperature records. The cold air was accompanied by high winds gusting to more than 50 mph, which caused ground blizzards from blowing snow and wind chill temperatures as cold as -90° F in the northern U.S. By the afternoon of 1 February, 42 of the 48 contiguous states in the U.S. were under some sort of hazardous weather watch, warning, or advisory.

As the cold air spilled south, an upper level disturbance approached Texas from the southwestern U.S. This system transported large amounts of moisture northward from east Texas to Tennessee. By the evening of 1 February, a major ice and snow storm was taking place across parts of the deep south and lower Mississippi valley. Shreveport LA reported heavy thunderstorms with freezing rain, and up to 2" of ice accumulated in parts of Louisiana and Mississippi during the night. Numerous power outages, which took over a week to restore in some places, were reported as far east as North Carolina. ◆

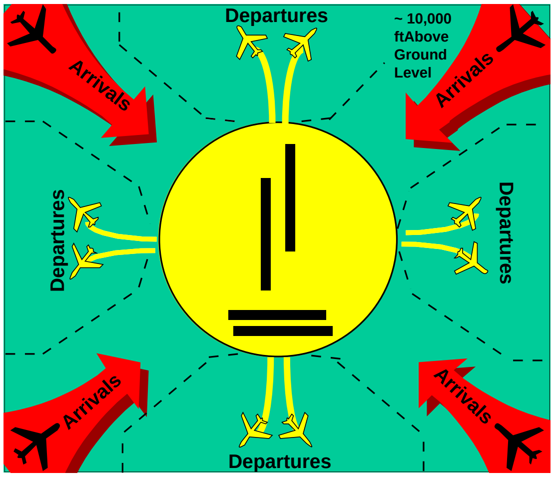
Study looks to reduce aviation delays caused by thunderstorms

*by Susan Oakland-Cobb, Kim Elmore,
and Pam MacKeen*

Most people are all too familiar with airport delays. And while these delays are the source of many headaches for travellers, most don't realize that 80% of delays over 15 minutes are caused by weather. In an effort to reduce delays and improve airport capacity, the FAA is sponsoring the development of the Integrated Terminal Weather System (ITWS). In determining the structure of the ITWS, Lincoln Laboratory (LL) conducted extensive analyses of weather related problems that carriers face. More importantly, LL performed detailed cost-benefit analyses to estimate, in dollars, the benefit that various additional weather information capabilities would yield to the aviation community. They determined that the ITWS should provide Air Traffic personnel with products that include short term predictions (0-30 minutes) of significant weather hazards. One of the ITWS products under development by LL, NCAR, and NSSL is the automated prediction of thunderstorm growth and decay.

At present, Air Traffic Control (ATC) is essentially limited to reactive responses to thunderstorms. In the event of a developing thunderstorm that blocks an arrival gate or gates or prevents airport operations, distant departing flights are held until the thunderstorm decays or moves out of the area. This means that, for some time after the airspace becomes available, no aircraft are enroute to use it, and the available capacity cannot be maximized. Even a single 40 dBZe thunderstorm centered in an arrival gate can effectively close it, cutting arrival capacity by at least 25%. To this end, a forecast of thunderstorm growth and decay could be useful for ATC planning purposes, allowing more efficient airspace utilization.

LL, NCAR, and NSSL are all approaching the thunderstorm growth and decay issue from different angles. NSSL is exploring the concept of using a relatively simple 2-D cloud model to forecast thunderstorm characteristics. The study uses both the 2-D ensemble cloud model and the Storm Cell Identification and Tracking (SCIT) algorithm, which is being modified to provide statistics. Ten convective cases from 1995 Memphis TN WSR-88D data have been chosen for analysis. Using sounding data, roughly 40 model runs will be made for each case. Pertinent storm characteristics (such as reflectivity) will be extracted from the model runs and compared with statistics of trends observed in real time by SCIT. If the statistical comparison approach between the 2-D cloud model and SCIT proves to be effective, it could become a useful tool for the FAA's ITWS.



Typical airport layout

Another aspect of this study will look for a way to predict storm lifetime. Severe and non-severe indicators available from the NSSL suite of WDSS algorithms, including Probability of Severe Hail, whether a strong circulation is associated with the storm, and others, will be compared and correlated with storm lifetime. The strength of the association between the two variables will be measured. Predicting storm lifetime can be very valuable for many applications including the longevity of a storm warning, rainfall potential, and flight routing at airports.

If the results of this study are positive, the entire system will be further automated and tested in real time at the Memphis ITWS Operational Testing and Evaluation during Summer, 1997. Because ATC handles an average of 2 flights each second, accurate predictions of storm characteristics and storm lifetime should allow appropriate traffic planning when storms develop. ◆

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Accurate predictions of storm characteristics and storm lifetime should allow appropriate traffic planning by ATC when storms develop

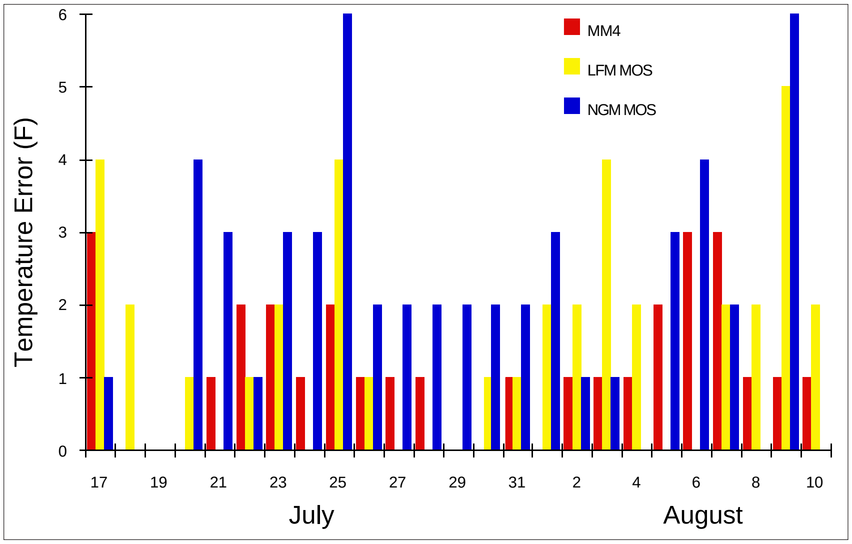

Figure 1: Absolute differences between the observed and modeled predictions of high temperature at Las Vegas NV (LAS) from the adjusted mesoscale model (MM4) gridpoint data, the LFM MOS data, and the NGM MOS data from 17 July to 10 August 1990.

New method to predict high temperatures

by David J. Stensrud and Jon A. Skindlov, Salt River Project

A new method has been developed to predict high temperatures comparable in accuracy to traditional statistical approaches

Statistical forecast guidance has been provided routinely to NWS field forecasters and other users for over 25 years. This guidance has been produced using perfect prog and model output statistics (MOS), which are two very different statistical approaches, on output from the Limited-area Fine-mesh Model (LFM) and the Nested Grid Model (NGM). However, advances in technology and scientific understanding have led to the implementation of an operational mesoscale eta model to provide high-resolution forecasts over the lower 48 states and Alaska. This model presents a significant challenge to traditional statistical forecasting approaches.

Mesoscale models vs. MOS

Operational mesoscale models likely will undergo almost continual changes in both resolution and model physics throughout the next decade or longer. These improvements are driven by the fact that increases in model resolution are closely tied to increases in computer speed, and computer speed is increasing rapidly. In contrast, the MOS approach requires a data archive from an unchanged model of significant length (12 to 48 months) to produce reliable forecast guidance. Processing this size dataset for every significant model change is a time-consuming and computer resource intensive task. Moreover, if the climate regime during this time period differs significantly from the mean climate, then the MOS output may include an inherent bias. It is clear that an alternative to this type of traditional statistical approach must be developed if we are to continue to provide this information to forecasters.

Mesoscale model grid point predictions

A new method has been developed to predict high temperatures comparable in accuracy to those produced using the traditional statistical approaches. Although the mesoscale model grid point predictions of near surface temperature are consistently too low in comparison with observations, this model bias can be removed very easily. This is done by computing the mean temperature bias over the previous seven-day period, and then using this calculated bias to adjust the model raw temperature data for the present day. Thirty-two days of simulations using the Penn State-National Center for Atmospheric Research mesoscale model version 4 (MM4) during the summer of 1990, originally done to examine the Mexican monsoon, show that this running bias correction approach produces predictions of high temperature that are roughly equivalent to those produced by the MOS from the LFM and NGM at seven stations over the southwestern United States (Figure1). The MM4 bias-corrected high temperatures tend to be better than the MOS predictions at lower elevations above sea level, whereas the MOS predictions tend to be better than the MM4 bias-corrected high temperatures in higher elevations. While this study is exploratory in nature, it does suggest that mesoscale model grid point data can be very valuable, and ways to use these data in forecast operations should be investigated more fully. ◆

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Short-Range Ensemble Forecasting

by Harold Brooks

Scientists at NSSL are at the forefront of the exploration of a new approach to numerically forecast the weather using computer models. The technique of ensemble forecasting involves running a large number of forecasts with different initial conditions or models. It has been used successfully for forecasts from 5 to 14 days, but recent experiments by scientists from NSSL and the National Centers for Environmental Prediction (NCEP) are the first efforts at using ensembles for 0 to 2 day forecasts.

One of the big advantages of ensemble forecasts, compared to traditional forecasting methods, is that probabilities of weather can be taken directly from the forecast model. An example of the use of ensemble forecasting came in the ice storm that crippled the southern United States at the beginning of February 1996. The ensemble probability forecast indicated that freezing rain was likely much further east than the single, higher-resolution operational forecast started at the same time (Figure 1). At the time the forecast was valid, freezing rain had begun through northern Mississippi and Alabama (Figure 2). If the ensemble had been an operational forecast, earlier warnings of a weather event that caused millions of dollars in damage might have been possible. Dr. Zoltan Toth of NCEP said, “This is a great result for the ensemble and shows how it could be used.” The ensemble forecast took less computer time than the single operational forecast currently being used.

The ensemble forecast is run once each week at NCEP and the results stored and analyzed at NSSL. From there, scientists around the world access the data to carry out their own studies of ensemble forecasting. Techniques for getting information out of the vast amount of data generated and for starting the ensemble in the best way are under development. Ensemble forecasting with numerical models for 1 or 2 days could be a part of routine weather forecasting by the end of the decade. ◆

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36-Hour Freezing Rain Forecasts
(Valid 0000 UTC 2 Feb 1996)

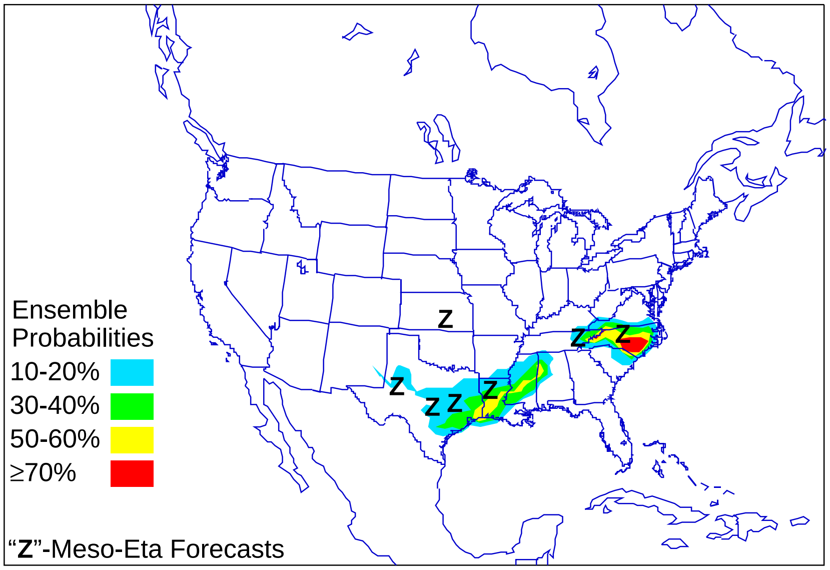

Figure 1: Forecasts of freezing rain made at 1200 UTC 31 January 1996, valid 36 hours later at 0000 UTC 2 February 1996. “Z” indicates locations of freezing rain from “Meso-Eta” numerical model and colors show probability of freezing rain from ensemble forecast.

Freezing Rain/Drizzle Observations
(Within 2 hours of 0000 UTC 2 Feb 1996)

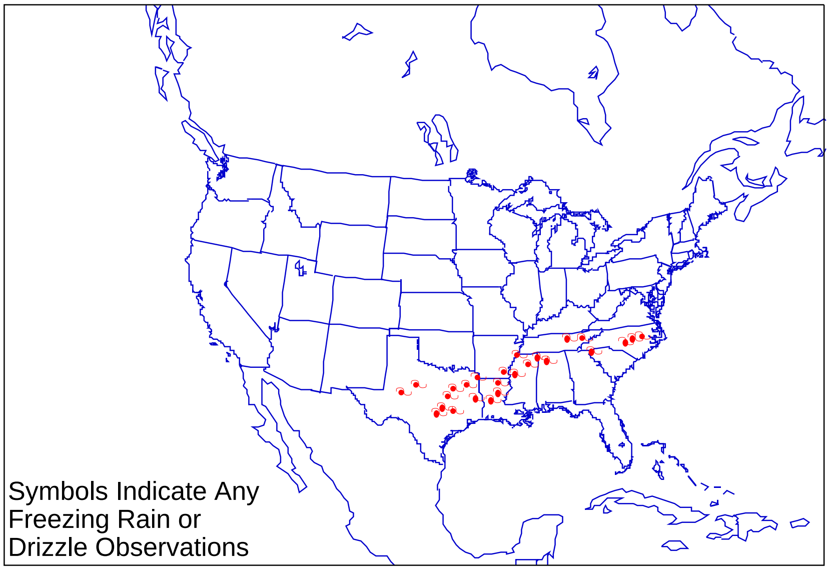

Figure 2: Observations of freezing rain or drizzle within 2 hours of 0000 UTC 2 February 1996.

NSSL Briefings
National Severe Storms Laboratory . 1313 Halley Circle . Norman, OK . 73069

Bob Maddox

From the Director's desk:

I would like to use this issue of "NSSL Briefings" to announce that I'll be taking early retirement from Federal Service at the end of this Fiscal Year. Everyone who has worked here during the past ten years has helped NSSL make substantial progress in advancing the understanding of severe weather processes and phenomena. Just as importantly, the laboratory has responded to changing objectives and priorities within NOAA, the NWS, and the Environmental Research Laboratories (ERL). The organizational expectations and needs of NSSL have changed dramatically as the National Weather Service Modernization has been implemented. We are currently working at the forefront of radar applications, utilizing the data gathered during VORTEX to improve understanding of tornadic storms and to learn how to use the new operational radars more effectively, working in partnership with the NWS to develop the next generation of radar data processing and analysis hardware and software, and preparing to explore the capabilities and potentialities of polarization on the new WSR-88D research radar that we are bringing on-line as a research facility, with continuing support from ERL Headquarters.

The contributions of NSSL to our operational agency, NOAA, are many and clear; I am proud that NSSL is the only laboratory to be awarded the Department of Commerce's Gold Medal. I'm sure that the laboratory's contributions to severe weather research, forecasting, and warning will continue to grow in importance during the tenure of its next director. ◆