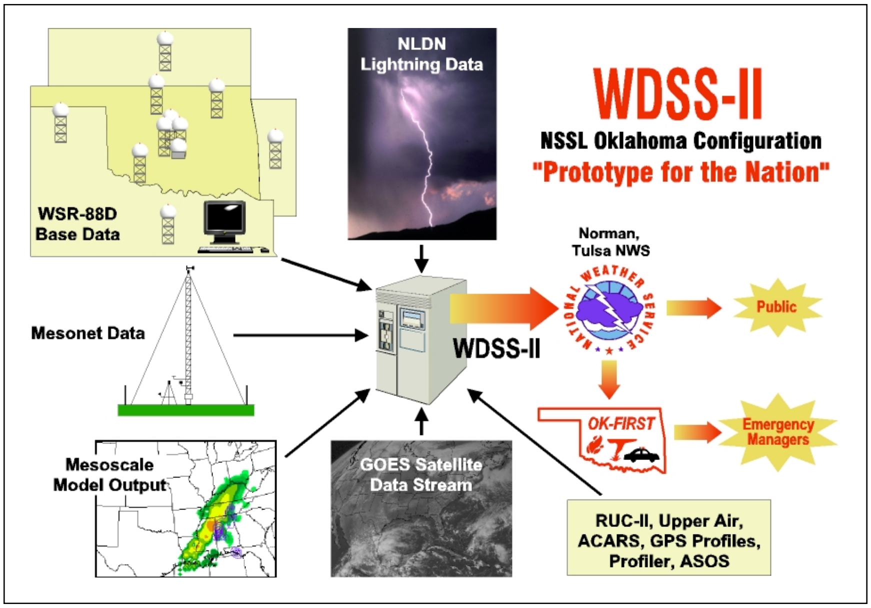
NSSL Briefings

Volume 2 No. 4 Fall 1999

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



WDSS-II: The Next Generation

by J.T. Johnson

When NSSL's Warning Decision Support System (WDSS) is used in a National Weather Service (NWS) office for a period of two years or more, statistics show the lead time for tornado warnings increases from 9 to 17 minutes. For severe thunderstorm warnings, the lead time is extended from 16 to 22 minutes. These statistics were derived from four years of tests at over 14 sites around the country. As a result, the NWS has chosen to integrate WDSS into the Advanced Weather Interactive Processing System (AWIPS) as part of the System for Convection Analysis and Nowcasting (SCAN).

Since 1993, the Stormscale Research and Applications Division (SRAD) has worked to refine and improve the concept of WDSS. Its original purpose remains: to be a development and testing platform for new severe weather detection applications and innovative display concepts. Now SRAD is making a significant investment in the evolution of WDSS.

WDSS-II (Integrated Information) is a completely redesigned system. Our goal is to develop and test warning and short-term prediction applications that utilize all operational data that will be available in AWIPS. Thus the WDSS-II will ingest multiple WSR-88D, satellite, lightning, surface, and mesoscale model data. In addition, WDSS-II will cover the entire County Warning Area (CWA) of a forecast office (several WSR-88D's), rather than using a single radar as the primary source of information.

WDSS-II also sports a newly designed display with a Geographic Information System (GIS) and relational database foundation. The new display will continue to organize critical severe weather information, but the GIS infrastructure will merge weather and relevant geographic information such as streets, terrain, major landmarks, streams and basins as well. The relational database is designed to organize and streamline data and improve the storage of algorithm- and user-created information to be recalled later. Our goal is to prototype these concepts so they can be transferred to AWIPS once they mature and are proven useful.

NSSL is beginning the development of WDSS-II by building a prototype system in Norman (see graphic). The displays will be provided to forecast offices in both Norman and Tulsa.

The WDSS-II development is a major undertaking for NSSL/SRAD. The system is expected to serve as the life-blood of SRAD for the next several years by providing the means to test new severe weather detection and prediction applications that will assist NWS meteorologists with critical warning decisions. ◆

For more information contact J.T. Johnson at: johnson@nssl.noaa.gov

Volume 2 No. 4
Fall 1999

In Brief.....

Special focus : The tornadoes of May 3, 1999

NSSL News Briefs

NSSL employees receive awards and honors

Dick Doviak, senior engineer with NSSL, was elected a Fellow of the American Meteorological Society (AMS). The honor recognizes Doviak's contributions to weather radar research, which include being involved in the development of Doppler weather radar and leading the team whose research laid the foundations for NEXRAD (NEXt generation RADar).

Mike Eilts was awarded the National Oceanic and Atmospheric Administration (NOAA) Administrator's Award "for his positive impact on NSSL's research initiatives while enhancing a core element of the NOAA mission."

Ken Howard received NOAA's Bronze Medal Award for his work on the Franklin Institute's traveling exhibit "Powers of Nature."

Jeff Kimpel, Director of NSSL, was chosen by AMS members to be President-Elect for 1999 and President of the AMS during the year 2000.

Raúl López retired from NSSL after seven years with us as a research meteorologist. Raúl's principal areas of research included lightning, radar polarimetry and rain estimation, and cloud dynamics. During his career, Raúl published 40 refereed papers and more than 70 conference papers and technical reports.

Two NSSL scientists received NOAA/Environmental Research Laboratory (ERL) Outstanding Scientific Paper Awards:

- **Dave Stensrud** for his paper "Effects of persistent, midlatitude mesoscale regions of convection on the large-scale environment during the warm season."
- **Conrad Ziegler** (co-authors T. Lee and R. Pielke) for "Convective initiation at the dryline: A modeling study."

Doug Lilly elected to NAS

Doug Lilly, distinguished senior scientist with NSSL, has been elected a member of the National Academy of Sciences (NAS), a society of scholars dedicated to furthering science and technology and their use for the general welfare. Members are elected in recognition of their distinguished and continuing achievements in original research. Doug's major areas of research have focused on small scale atmospheric phenomena, including convective storms, mountain waves, turbulence and oceanic clouds.

From the Director:

The value of NSSL Research

by Jeff Kimpel

The tornadoes of May 3, 1999 were a tragedy. However, every report from the media, Federal Emergency Management Agency (FEMA), insurance adjusters, and even statements from the victims themselves, point out that it could have been much worse. To a large part, the fact that it wasn't worse is due to NSSL research and the capability of the NWS to deploy these research results. Progress in the socio-economic aspects of severe and hazardous weather eventually will quantify how much worse it might have been.

Storm morphology studies performed by NSSL scientists during early tornado intercepts (a.k.a. storm chases) refined our knowledge of supercell and other convective phenomena. The descriptive and visual models used in training and education programs for emergency managers, law enforcement, volunteer storm spotters and the televised media are products of that research. Hundreds of thousands of school children have been taught severe storm characteristics and safety rules gleaned from NSSL publications and outreach materials.

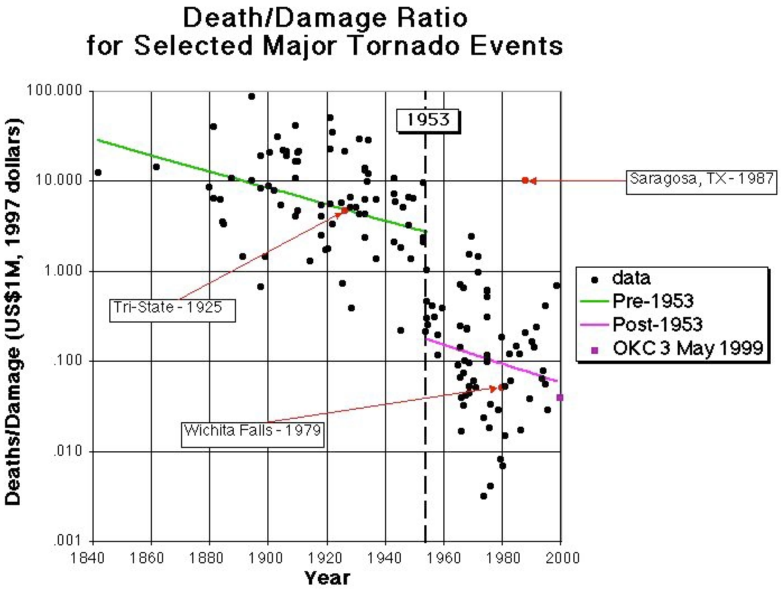
During the 1970s and 1980s, when the Norman Doppler radar was only a research tool, much was learned about internal storm structure, processes and dynamics. Once NSSL and others learned how storms worked, NWS forecasters were given new tools to use in making critical decisions on whether and when to issue outlooks, watches and warnings to the media and public. Applications from this more basic science found their way into the interpretation of data from new observational tools such as the Geostationary Operational Environmental Satellite (GOES) and the [WSR-88D] Doppler weather radar.

Another important contribution is NSSL' s Gold Medal- role in the development of the WSR-88D itself. The research and development path from the Norman Doppler through NEXRAD to the present-day WSR-88D is an achievement now known to the nation. NSSL engineers, scientists, algorithm specialists, computer personnel and support staff all played a role and must share in the credit. The WSR-88D was the crucial tool used by the NWS to issue tornado warnings on May 3rd and 4th.

Wisely, NSSL embarked on a plan to merge WSR-88D data with the best decision science has to offer. Using artificial intelligence, neural network concepts, fuzzy logic, cutting-edge statistics, and ergonomically designed displays, NSSL's WDSS was undergoing field testing at the Norman and Tulsa Forecast Offices on May 3rd. Both offices reported that the WDSS was an important component during this outbreak and assisted in the timeliness and accuracy of the 176 warnings issued that night and morning. Preliminary findings from 14 different NWS offices where WDSS has undergone extensive testing show increases of eight and six minutes for tornado and severe storm warnings respectively, with an increase in overall skill. Further improvements to WDSS by incorporation of other data sets (satellite, mesoscale model output, etc.) and further algorithm development are planned (see cover story).

Socio-economic research performed by NSSL scientists Harold Brooks and Chuck Doswell, using inflation-adjusted ratios of property loss to deaths indicate that 400 to 1,000 lives were saved by the “system” in place on May 3rd and 4th. By system, I am referring to the functioning science, technology, emergency preparedness, and media--especially the local television broadcasters--and their ability to work together for the common good. The warnings issued during this outbreak were of such quality that television weathercasters effectively conveyed the urgency of the situation to the public, and the Oklahoma Highway Patrol, in constant communication with the Norman National Weather Service Forecast Office (NWSFO), stopped traffic on I-44 in advance of a tornado crossing. These two actions alone saved lives and reduced property damage.

NSSL and our three other NOAA Weather Partners, the Storm Prediction Center (SPC), the WSR-88D Operational Support Facility, and the Norman NWSFO, are saddened by the fact that several of our employees' homes were lost to the May 3rd Outbreak. Fortunately, none of our employees or family members living in these destroyed or damaged homes were killed or seriously injured. However, several NOAA or Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) employees lost members of their extended families. The response of our employees to their colleagues in this time of need has been tremendous. Gifts of food, emergency power generators, cash from fund raisers, and assistance in debris removal has been most generous. Other NOAA employees have given their time and volunteered their services to the relief effort. In all, this seems fitting from those who clearly understand the destructive nature of the planet's most violent storm, the tornado. ◆



"With the amount of damage, we can estimate based on a long historical record that, without warnings, hundreds more lives would have been lost ."
-- *Harold Brooks, NSSL research meteorologist*

NSSL News Briefs

Chuck Doswell, Sigma XI Distinguished Lecturer

Chuck Doswell is one of 31 invited scientists who will travel to campuses throughout the country as part of the Sigma XI Distinguished Lecturer program. Sigma XI is an international research society with a lectureship program designed to provide chapters and campuses an opportunity to host visits from outstanding individuals who are at the leading edge of science. Chuck's lecture topics are: "Storm Chasing In Fact and Fantasy," "Uncertainty in Weather Forecasting," and "Recent Findings About Tornadogenesis." More information can be found at: http://www.sigmaxi.org/lectureships/lectureships.html.

AUITI (Acronyms Used in this Issue)

AWIPS - Automated Weather Information Processing System
CAPS - Center for the Analysis and Prediction of Storms
CIMMS - Cooperative Institute for Mesoscale Meteorological Studies
ERL - Environmental Research Laboratory
FAA - Federal Aviation Administration
FEMA - Federal Emergence Management Agency
GOES - Geostationary Operational Environmental Satellite
NCAR - National Center for Atmospheric Research
NEXRAD - NEXt generation RADar (same as WSR-88D)
NOAA - National Oceanic and Atmospheric Administration
NSF - National Science Foundation
NSSL- National Severe Storms Laboratory
NWS - National Weather Service
NWSFO - National Weather Service Forecast Office
OU - University of Oklahoma
SPC - Storm Prediction Center
VORTEX -99 - Verifications of the Origins of Rotation in Tornadoes EXperiment
WDSS - Warning Decision Support System
WDSS-II - Warning Decision Support System-Integrated Information
WSR-88D - Weather Surveillance Radar 1988 Doppler (same as NEXRAD)

NSSL's web site can be found at: ***http://www.nssl.noaa.gov***

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@nsslgate.nssl.noaa.gov.*

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This photo was taken by Jerry Laizure near 134th and south May Avenue just as the tornado was entering south Oklahoma City.

Tornadoes hit home

May 3, 1999

Oklahoma Tornado Outbreak

by Susan Cobb

Most of us have "I remember . . . " events in our lives. I remember when I heard about the Challenger explosion, and when President Reagan was shot. May 3, 1999 will also be one of those events that are forever etched in our minds. And each of us has our own story. We were intercepting the storm with VORTEX (Verification of the Origins of Rotation in Tornadoes EXperiment), chasing on our own, watching the news, advising friends and relatives how to escape the tornado, and some of us were huddled in our homes hoping to survive. Afterwards we were looking for neighbors, watching family members head for the hospitals to treat the injured, and praying for survivors. I remember May 3, 1999 very clearly. By some strange coincidence, I had sat down with my sons that morning and worked through a tornado safety workbook. May 3 is a day we will never forget.

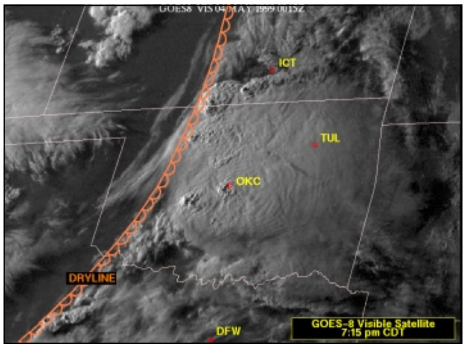
Instability was the only ingredient that was clearly in place for strong tornadoes in Oklahoma on the morning of May 3. As the day wore on, it looked as though high-precipitation supercells were going to develop, due to weak upper-level winds. Then the ingredients started to come together. Profilers showed jetstream winds were stronger then the models had shown. And then, as the first storms were forming near Lawton, OK, VORTEX-99 Principal Investigator Erik Rasmussen noticed a little corridor of surface winds stretching from near south-central Oklahoma toward southeast Oklahoma that were a lot more southeasterly than the southerly winds prevailing over most of the state. And that was the final ingredient--strong shear and significant winds in the lowest few thousand feet of the atmosphere.

The tornadoes first formed in southwest Oklahoma near Apache just before 5pm, and they just kept coming. By 5pm the next day (May 4), 75 tornadoes (72 in Oklahoma alone) had torn through Oklahoma and Kansas--more tornadoes than Oklahoma normally experiences in a year.

Tornado outbreaks of this magnitude are not unusual, occurring approximately every five years. What *is* unusual about the May 3, 1999 tornado outbreak in the central Plains was that F4 and F5 tornadoes hit a highly populated area. Large cities occupy a very small percentage of total land area in the United States, and the 2 percent of all tornadoes in the U.S. that are F4's and F5's generally occur in rural areas.

Amazingly, in the 8,000 buildings damaged or destroyed in Oklahoma alone, only 42 people died. Only 42. It sounds terrible. But seeing the destruction, the 38-mile path of complete devastation in the Oklahoma City metropolitan area alone, most of us were sickened by the surety of hundreds of deaths. Maybe even thousands. Advance warnings from the NWS that were broadcast on local television and radio stations, NOAA Weather Radio and amateur (HAM) radio, gave us plenty of time to seek shelter and kept the loss of life to a minimum.

What also makes this case unusual was that an F5 tornado passed fewer than 10 miles from NSSL and NWS offices. We had teams out studying this tremendous event as it began, and they obtained unprecedented information that will one day bring some good out of this tragedy.◆



Visible satellite photo of the storms over Oklahoma the evening of May 3, 1999

This F3 tornado was moving slowly north-northeast allowing it to be surrounded by three VORTEX mobile mesonet probe cars. This photo by Daphne Zaras in Probe 1 was taken 0 .5 to 1 mile east of the tornado. While this F3 tornado was occurring, a new circulation was forming on the same storm and producing brief touchdowns prior to becoming the large tornado that originated near Chickasha, OK.

Unofficial Summary from Daphne Zaras, Probe 1, VORTEX-99, May 3, 1999

Three VORTEX-99 crews left Norman, OK at 1:30 p.m. and drove southwest to near Lawton, OK in time to see the initial stages of the storm that produced a continuous, deadly tornado, which tracked from near Chickasha through Moore to Del City in the Oklahoma City metro area.

The teams observed the first two brief tornadoes produced by the storm near Elgin, OK and were in place for scientific data collection for several subsequent tornadoes that formed prior to the Oklahoma City metro tornado. The third tornado produced by the storm lasted over 15 minutes and was surrounded by mobile mesonet vehicles. It was rated F3--the first strong tornado from the storm that eventually went through Oklahoma City.

VORTEX-99 collected valuable data on this tornado as the new circulation in the storm organized and began forming weak tornadoes. The storm was doing what scientists call "cycling": the original circulation had spun off toward the back side of the storm while a new circulation formed. The new circulation became the fourth tornado produced by the storm and also was responsible for what became the Chickasha-Moore-Del City, OK tornado. As the deadly tornado developed, the teams abandoned the storm in favor of another storm that was over a good road network west of Chickasha. The second, western storm had produced two tornadoes and was clearly going to continue to produce tornadoes. VORTEX-99 intercepted ten tornadoes on the second storm, for a total count of 12 tornadoes intercepted on two storms.

Key regions sampled included the hook region (behind the tornado) where the air is wrapping around the back side of the thunderstorm. This region is also responsible for the "hook echo" seen in radar reflectivity that meteorologists often point out on television. One mobile mesonet was able to traverse the hook region of the storm for three different tornadoes.

VORTEX-99 is a small follow-on to the original VORTEX, which took place in 1994 and 1995. VORTEX-99 is a joint project between NSSL and the University of Oklahoma. ◆

Excerpts from NOWCASTS transmitted by email from Principal Investigator Erik Rasmussen to VORTEX-99 field teams on May 3, 1999

1610 CDT - The armada is at Geronimo, OK (south of Lawton) observing very strong CB (cumulonimbus) growth W and SW, with very hard anvils and light rain. OK mesonet shows a band of backed surface winds from south of Ardmore to the Lawton area. The teams are going to continue to watch for one storm to become dominant.

1720 CDT - TORNADO! The armada is intercepting a tornado at close range approximately 2 miles east of Apache, OK.

1734 CDT- The armada is reporting a tornado doing a lot of damage, lofting large debris...0.5mi WNW of lat 34.96N 98.26W (decimal degrees) Someone in Norman please convey this to NWS.

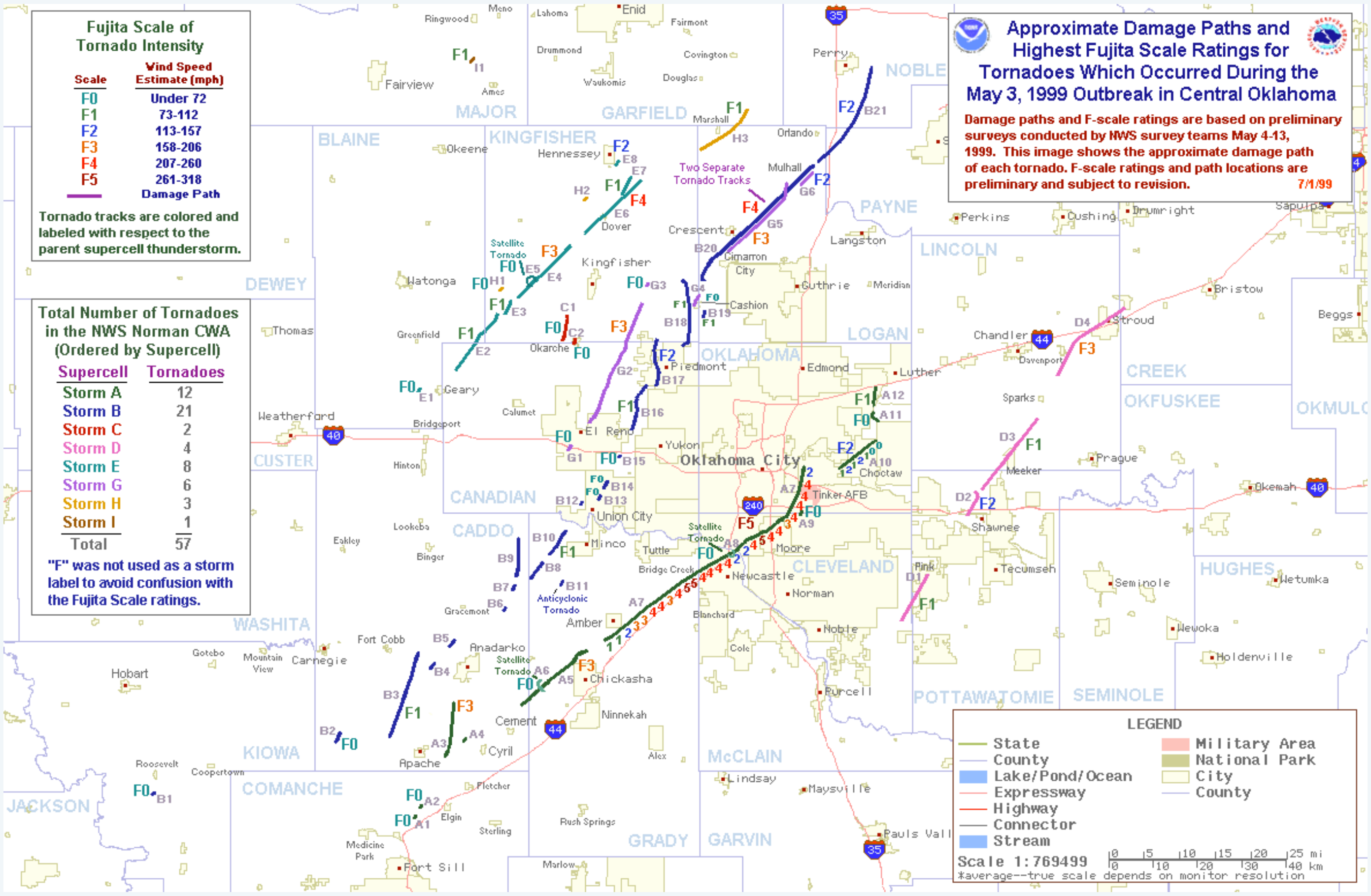
1751 CDT - Second tornado forming; first has dissipated. The armada has observed a possible brief large cone tornado 2.5 [miles] NNE of Cement. At this moment it is a large rotating wall cloud. Condensation is occasionally to the ground.

1800 CDT - Large tornado west of Chickasha. VORTEX-99 is intercepting a large tornado at this time to the west of Chickasha, OK.

1844 CDT - The armada is now heading for Anadarko; there is an intense near-ground mesocyclone southwest of town. The pursuit of the Chickasha storm ended at a point where the road was so clogged with debris that a bulldozer will be required to determine where this damage path is.

2045 CDT - All chasers: for our research, we will need extensive documentation (esp. photographic) of the supercell from Lawton to Chickasha, and the storm from SW of Anadarko up to E of El Reno. Several tornadoes were intercepted on these supercells by the mobile mesonet. More details to follow in the next several days. For tonight, please scribble down notes or transcribe tapes while your memory is fresh. ◆

Photo of the Oklahoma City tornado during its larger stages by Jason Lynn and Steve Strum.



NSSL scientist works with FEMA in the aftermath

Chuck Doswell, NSSL scientist, had the experience of walking through the tornado destruction with a team of engineers. With his permission, excerpts from some of his personal thoughts are included below.

"As it turns out, I was selected to participate in the Building Performance Assessment Team (BPAT) for the tornadoes of 03 May 1999, sponsored by FEMA, one meteorologist among a diverse group of engineers and other related disciplines. It has been our job to walk the paths of some of the tornadoes, including the F-5 tornado that hit parts of the Oklahoma City metroplex (including Moore, Del City, and Midwest City). We also looked at Mulhall, Oklahoma; Haysville, Kansas; and Wichita, Kansas. . . ."

"We spent Tuesday through Saturday looking at the impacts of tornadoes in several cities. The tracks have certain common factors. I am acutely aware by now of the smell of a tornado track. This musty smell is hard to describe and I don't know its origins. Perhaps it's the smell of wet ceiling tiles, paper, rotting food, and insulation. . . .Everywhere, the rubble has a monotonous sameness: shattered framing lumber, shards of insulation, broken glass, drywall boards, shelving units, refrigerators, shingles, collapsed brick veneer, jagged leafless branches from trees. . . .Vehicles in various stages of destruction sit in heaps or intrude where vehicles were never intended to be. . . .I'm also struck by the huge amount of "stuff" that fills the rubble piles: toys, Christmas decorations, magazines, vases and lamps (mostly broken), televisions, boxes of baseball cards, food from pantries (jars of pickles, bags of chips, cans of beans, spice bottles), stuffed animals, video cassettes, compact discs, photos in frames, decorative items of all sorts and descriptions. . . . These, after all, are real people, with 'stuff' that looks a lot like my 'stuff'."

The goals of BPAT, in walking through the damage, were to: (1)Determine if there were ways to mitigate damage by modifying construction methods; (2)Address the question of saving lives in violent tornadoes where F4-F5 events sweep foundations clean; (3)Validate basic assumptions underlying above ground shelter designs that FEMA approved and Texas Tech developed.

Chuck, again in his thoughts says,

"The real problem with this situation. . . a violent (F4 or F5) tornado in a population center within "Tornado Alley". . . is finding appropriate shelter. . . .For most of the victims of the Oklahoma City tornado, they survived by doing just what we have been telling folks to do. . . . Unfortunately, in violent tornadic winds, even interior walls are swept away, such that there is no safety from those extreme winds except below ground ... **OR**, in a specially-reinforced interior room solidly attached to the foundation/slab. . . .Finally, it has become clear that these special shelters work (one of them functioned perfectly in the OKC [Oklahoma City] tornado disaster area, in spite of the rest of the house being swept clean)." ◆

NSSL helps with damage surveys

NSSL helped staff several of the nine NWS teams that determined the damage locations, times and Fujita ratings for the majority of the tornadoes in the Norman NWSFO county warning area. NSSL also participated in a more detailed damage assessment of the 38-mile track of the major tornado that struck the Oklahoma City metro area. This was the second time Greg Stumpf, damage survey point of contact at NSSL, had surveyed an F5 tornado. The first for Greg was the Andover, Kansas tornado that occurred April 26, 1991. The F5 damage in Andover was confined to one subdivision neighborhood and a trailer park, with farmland surrounding each. "What makes the Oklahoma City event surpass the Andover event," Greg says, "was not the strength of the damage, which was about the same as Andover, but the scope of the damage. The Oklahoma City event consisted of miles and miles of subdivision neighborhoods being destroyed." Preliminary details are available at: http:/www.nwsnorman.noaa.gov/storms/3may99/. ◆

Damage photos taken by Kevin Kelleher. Mike Eilts is pictured in the photo on the lower left standing next to a car that was blown 1/2 mile and came to rest under a bridge

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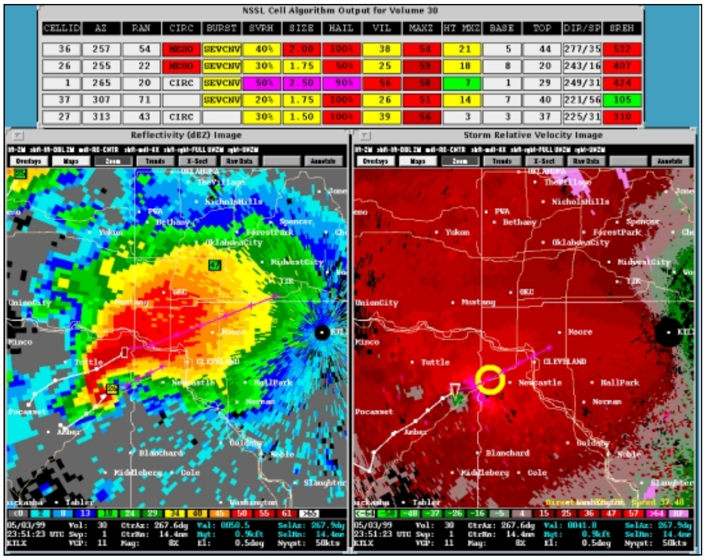
WDSS proves invaluable

The WDSS was developed by NSSL to meet the needs of forecasters in NWS offices to help them make timely, effective and efficient warning decisions regarding severe weather, tornadoes and flash floods.

On May 3, 1999 a series of tornadoes occurred in Oklahoma that claimed 42 lives and caused over $1 billion in damage. Although there were many lives lost, the number was significantly reduced by the long lead-time warnings (20-60 minutes) that were provided by the NWS to the general public.

The NWS forecasters relied on the WDSS to help them make these very timely and accurate tornado warning decisions. David Andra, the Scientific Operations Officer at the Norman NWS office, utilized the WDSS to help make warning decisions on this day. Andra said that the WDSS greatly increased forecaster's confidence in their warnings by allowing them to be more precise. WDSS also allowed them to determine the exact character and movement of the tornadoes with better fidelity. In addition, the WDSS's ability to automatically examine, every five minutes, the numerous storms on this day and tell which storms were most likely to be tornadic and/or severe helped them manage their time and focus on the most serious threats.

The combination of the WDSS with NEXRAD and AWIPS provided the necessary technology to the forecast office to allow it to issue excellent tornado warnings to the public on this day, ultimately saving many lives. ◆



NSSL Cell Algorithm Output for Volume 30

CELLID	AZ	RAN	CIRC	BURST	SVRH	SIZE	HAIL	VIL	MAXZ	HT MXZ	BASE	TOP	DIR/SP	SREH
36	257	54	MESO	SEVCNV	40%	2.00	100%	38	54	21	5	44	277/35	532
26	255	22	MESO	SEVCNV	30%	1.75	50%	25	59	18	8	20	243/16	407
1	265	20	CIRC	SEVCNV	50%	2.50	90%	56	58	7	1	29	249/31	424
37	307	71		SEVCNV	20%	1.75	100%	26	51	14	7	40	221/56	105
27	313	43	CIRC		30%	1.50	100%	39	56	3	3	37	225/31	310

Example of WDSS display at 6:51 CDT during the May 3, 1999 tornado event. The table at the top shows the relative ranking of all storms at that time. The left graphic is the reflectivity field from the NEXRAD, the right is the velocity field. The squares on the left image show the location of detected storms, the triangle on the right shows the location of the detected tornado, and the yellow circle shows the location of the larger circulation. The white dotted lines are the past tracks and the cyan cross-haired lines are the forecasted positions, with each cross-hair the location at five-minute intervals.

Employee spotlight:

Matt Wandishin

by Susan Cobb

A bin of *Pixy Stix* had been knocked over at the candy factory one night during the third shift. Matt Wandishin, as he was picking them up, decided to count them. He counted up to a few hundred, then decided to continue to 10,000, seeing how long it took to get there. Once he made it to 10,000, he calculated how long it would take him to get to 1,000,000. At the time Matt was a math major at Rice University. But it was the summer after his sophomore year at Rice, while sitting on an overturned paint can during some down time at his job at a paint factory, that he contemplated his future career. Matt had a wide range of interests, and his struggle was choosing which one would be his focus. He had been interested in weather for a long time. While he was growing up, he would often watch *The Weather Channel* during breakfast before school. Under the influence of paint fumes, Matt decided to pursue his math degree at Rice (which didn't offer a meteorology program) and attend graduate school at Texas A&M for his M.S. in meteorology.

Matt joined NSSL in 1998 under a three year National Science Foundation (NSF) grant sponsored by the Institute of Atmospheric Physics at the University of Arizona. He works with Steve Mullen from Arizona, and Dave Stensrud and Harold Brooks of NSSL on short-range ensemble forecasting. Matt likes problem solving and the challenge and discovery of research. He especially enjoys his work at the lab because the practical applications are apparent. He hopes his work will make forecasting more informative, allowing users to make decisions based on their own potential costs of preparing or not preparing for a possible weather event. Matt also appreciates the collaboration between scientists at NSSL. "I'm working with some pretty bright people--and you can pick up a lot from normal interaction," he says.

Bio Box

Current position: *Research scientist*

Current project: *Short-range ensemble forecasting*

Education: *B.S. Math, Rice University, 1994*

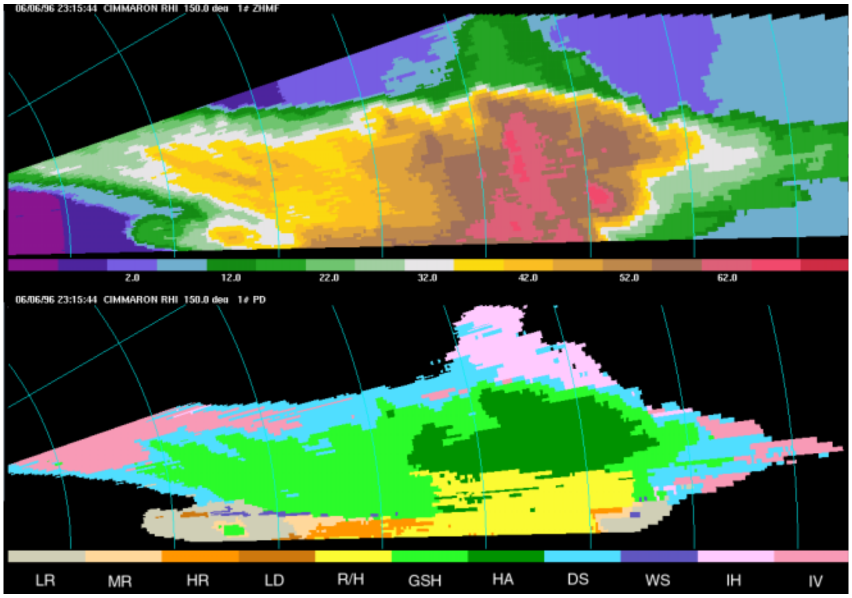
M.S. Meteorology, Texas A&M, 1998

His most interesting experience since joining NSSL occurred on a bumpy flight last year. The P-3 and its passengers, including Matt, were bounced around enough that after they had landed, one of the pilots walked back into the cabin area with a handful of knobs that had fallen off during the flight. The plane was grounded until it could be visually inspected.

Matt has a passion for knowing things. He is generally optimistic and sees no advantage to worrying about things. He is an avid reader--especially of Irish history, but is currently reading a book called Einstein's Dreams and another about 17th century mathematician Fermat. He also likes old movies, particularly those that showcase the talents of Jimmy Stewart, Cary Grant and Kathryn Hepburn.

Matt describes his favorite places as: Colorado, the bottom of the Grand Canyon at night, any place away from cars and lawn mowers, or coming home on a cold grey winter day, with the aroma of roast beef cooking. He says this list may change after he and his wife of two years, Ann, take a trip to Europe this fall. They also plan to do some more hiking in Colorado, eventually taking on the 10 mile trail above the treeline from Breckenridge to Copper Mountain. Matt loves team sports too, and plays in softball and basketball leagues through church. Outdoor soccer is next, he says.

By the way, if you were wondering how long it might take to count to 1,000,000, Matt figures if you counted for 8 hours a day, 7 days a week, it would take just under three weeks. Unless you wanted to rest on the weekends, then it would take an extra week and a day. ◆



Vertical cross-sections of a) reflectivity factor and b) result of hydrometeor classification for the June 6, 1996 storm in Oklahoma. The class designation is as follows: LR - light rain < 3 mm/h, MR - moderate rain between 5 and 30 mm/h, HR - heavy rain > 30 mm/h, LD - large drops, R/H - rain /hail mixture, GSH - graupel small hail, HA - hail aloft, DS - dry snow, WS - wet snow, IH - ice crystals horizontally oriented, IV - ice crystals vertically oriented.

Exposing the multiple personalities of precipitation

by Dusan Zrnic and Alexander Ryzhkov

Wind, temperature and precipitation are the weather conditions that affect our daily activities. The “Jekyll and Hyde” of these is precipitation. Some precipitation is indispensable, too much is disastrous. And because it reaches ground in a variety of forms, it produces effects from beneficial (needed rain or snow) to detrimental (hail and floods). Remote classification and measurement of precipitation was an evasive goal of radar meteorologists until the advent of polarimetric radar.

Polarimetry entails probing of precipitation with orthogonal electric fields. For example, horizontally and vertically polarized electric fields interact differently with contrasting hydrometeors, such as rain or hail, to produce tell-tale signatures in the fields of polarimetric variables. Several polarimetric variables can be measured; among the useful ones are differential reflectivity, differential phase, correlation between the orthogonally polarized returns, and linear depolarization ratio.

NSSL began accumulating a gamut of polarimetric radar data in 1992. Soon thereafter, in collaboration with the University of Oklahoma, we began to develop an automatic procedure for discrimination of hydrometeors. Within the past year, scientists from National Center for Atmospheric Research (NCAR) have joined this venture. With partial sponsorship from the Federal Aviation Administration (FAA), the automatic procedure has further evolved into a real-time algorithm that was implemented on the NCAR’s S-Pol radar, and testing began last summer in Florida.

For a given precipitation type, the polarimetric variables cluster in a specific region. The crux of the classification process is to separate overlapping clusters so that the probability of correct classification is high, while the probability of mis-classification is low. Classification is based upon weights assigned to the various multiparameter variables. The choice of weights is founded on previous measurements, physical reasoning, modeling, and sometimes gut feeling.

The example in the figure at the top of the page is well-suited to demonstrate the potential of polarimetry for the classification of hydrometeors. This, we believe, is a fundamental condition for accurate determination of precipitation amounts. First, a correct classification needs to be made, and then, appropriate semi-empirical relations should be applied to each class to estimate the corresponding amounts. This is quite different from the current practice (with reflectivity in the operational world), whereby the choice is between a few relations, and the operators decide if precipitation is frozen or liquid.

The results presented here and elsewhere are very promising, yet much testing and comparisons with in-situ measurements are required to evolve the algorithm into a useful tool. ◆

For a given precipitation type, the polarimetric variables cluster in a specific region

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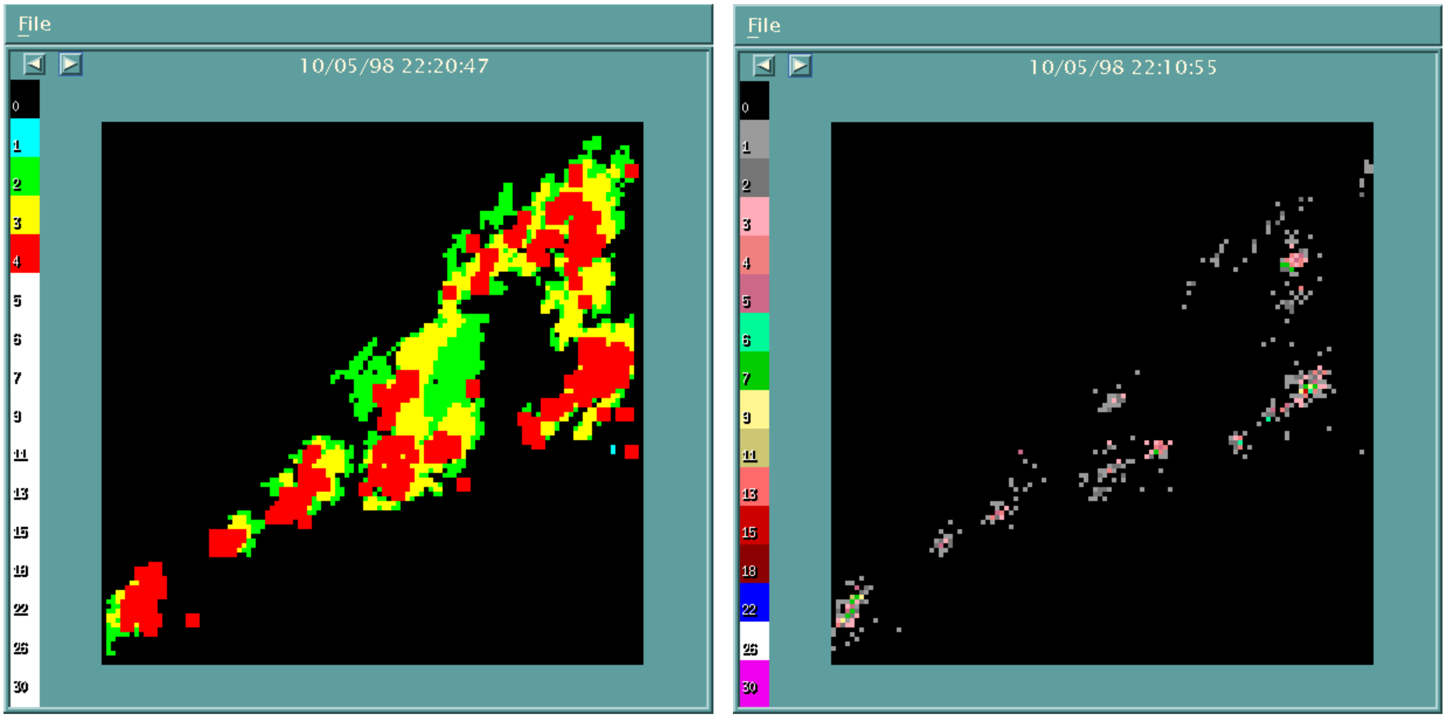

The image on the left is a lightning threat forecast valid up to the time at the top of the image. The colors correspond to the lightning threat for the forecast period. Red indicates a high threat of lightning, yellow indicates a moderate threat, and green indicates a low threat. The image on the right is the "verification" of the forecast, or the lightning observed during the forecast period. The colors in this image represent the accumulation of strikes per grid box within the previous 20 minutes.

NSSL Lightning Threat Algorithm

by Amy Wyatt

Scientists at NSSL are involved in research on all types of severe weather: thunderstorms, flash floods, winter storms, tornadoes and lightning. Their work constitutes both basic research into the processes that produce severe weather, and development of algorithms and display systems to predict and monitor severe weather. With these systems, NSSL is providing improved warning capabilities to such entities as the NWS and the FAA.

NSSL recently broke new ground by creating a specialized algorithm for a customer in the private sector. The Lightning Threat Algorithm was developed as part of a Cooperative Research and Development Agreement with WeatherData, Inc., a commercial meteorological firm whose clients include railroads, utility companies, trucking companies and the media. WeatherData's clients are sensitive to all types of severe weather, but especially to lightning, a threat WeatherData previously had not been able to address specifically. Following brainstorming sessions with NSSL lightning specialists Ron Holle, Ken Howard, Don MacGorman and Raul Lopez, the Lightning Threat Algorithm was developed by Kurt Hondl, Kim Elmore, Amy Wyatt, V. Lakshmanan, Venkat Ganti, and Kevin Thomas.

The Lightning Threat Algorithm is designed to predict areas of potential lightning up to 30 minutes in advance. Lightning threat is classified as high, moderate or low. Areas where the potential for lightning exists within the next forecast interval are also identified. The algorithm functions by first determining storm motion utilizing a technique developed by Lincoln Laboratory, producing forecast images of the radar and lightning products, and finally combining the forecast images to determine the lightning threat.

Testing at NSSL showed that the Lightning Threat Algorithm has a high degree of skill. For 30 minute forecasts, over 90 percent of the lightning strikes were observed within 4 miles of where the algorithm predicted they might occur. For 10- and 20 minute forecasts, the observed correspondence was as high as 97 and 95 percent respectively. ◆

The Lightning Threat Algorithm is designed to predict areas of potential lightning up to 30 minutes in advance.

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NSSL prepares for network facelift

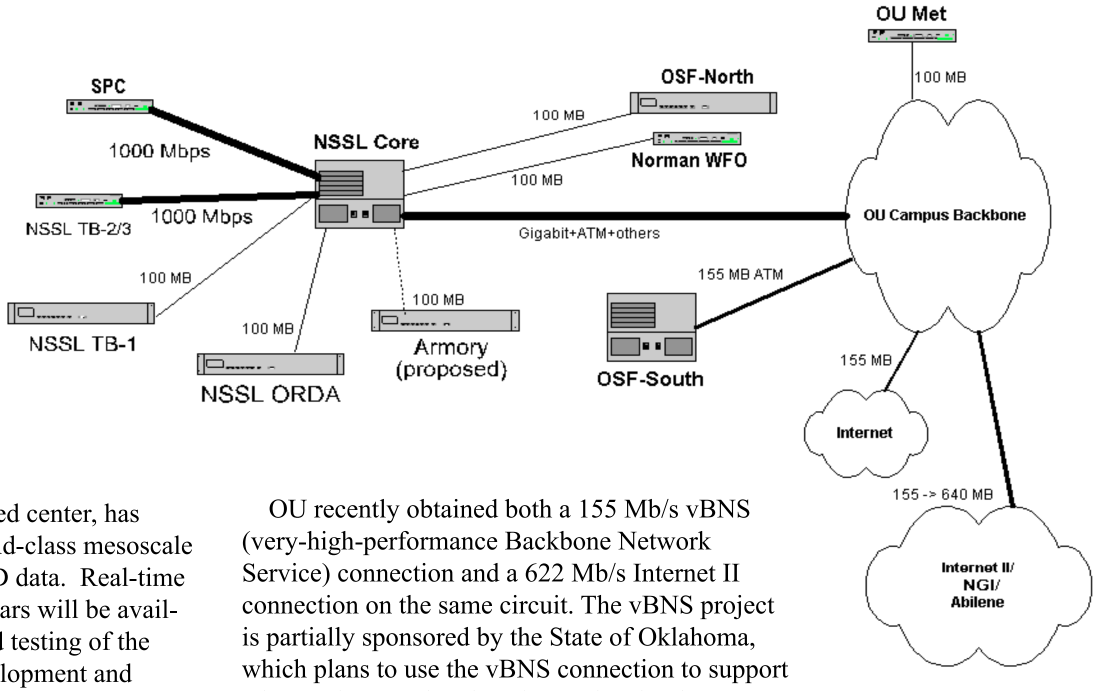
by Kevin Kelleher and J.T. Johnson

A multi-year effort to upgrade the NOAA/Norman networking infrastructure is taking place with the cooperation of NSSL and our NWS partners, the Norman NWS Forecast Office (NWSFO), the WSR-88D Operational Support Facility and the SPC. The networking upgrades lay the foundation for NOAA Weather Partners to obtain a Next Generation Internet (or NGI, a.k.a., Internet II) connection through our NGI partner, the University of Oklahoma (OU) (see figure). Funding and resources for this multi-year effort have been provided by the four NOAA/Norman groups, the University of Oklahoma, and the U.S. Government's High Performance Computing and Communications Program.

One of the features of the new gigabit network will be the ability to obtain sufficient bandwidth for transmitting real-time radar data to the Oklahoma Weather Center, including NSSL and the Center for the Analysis and Prediction of Storms (CAPS). CAPS, a NSF sponsored center, has developed an experimental, world-class mesoscale model that assimilates WSR-88D data. Real-time radar data from at least eight radars will be available for further development and testing of the CAPS model as well as the development and testing of NSSL's WDSS-II. WDSS-II will be a platform for testing future applications destined for both the WSR-88D and the NWS's AWIPS. A very notable feature of WDSS-II will be its focus on the entire CWA of a forecast office involving multiple radars rather than being single radar-centric.

In addition, the network upgrade will help address some of the difficulties associated with the NOAA scientists (located on North campus) and OU weather researchers (located on the main campus) being physically separated. For example, seminars are held several times a week on both campuses. Parking problems and travel time make it inconvenient for the scientists to attend many of the seminars. OU has recently announced their plans to begin construction of a new joint "Weather Center" facility on South Campus, but it may be several years before the four NOAA federal agencies are in a position to join them. Consequently, we are installing an IP-based video broadcast system between the OU School of Meteorology seminar room on the main campus and the NSSL conference room on the North Campus.

Oklahoma Weather Center Connectivity



OU recently obtained both a 155 Mb/s vBNS (very-high-performance Backbone Network Service) connection and a 622 Mb/s Internet II connection on the same circuit. The vBNS project is partially sponsored by the State of Oklahoma, which plans to use the vBNS connection to support advanced research, education and technology transfer activities now underway at Oklahoma's three research universities. The NOAA Weather Partners have access to both the vBNS and the Internet II connection for research purposes while maintaining present Internet capabilities for all other traffic. ◆

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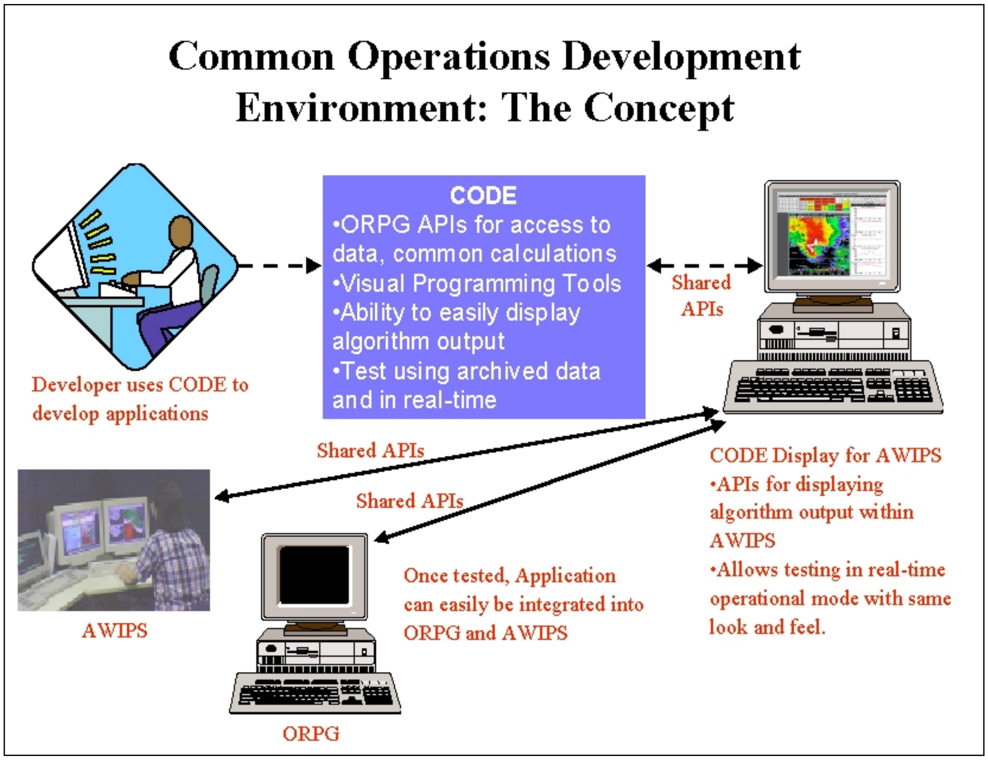

Common Operations Development Environment for NEXRAD

by Mike Eilts

As the WSR-88D makes the transition to an Open Systems/POSIX (Portable Operating System Interface) - compliant world, it is important that the tri-agencies (NWS, FAA, and Department of Defense, together with research and development organizations, develop technology transfer processes that are efficient and effective. Doing so will ensure that the WSR-88D will remain state-of the-art and meet the needs of users. NSSL, working with the OSF, NWS/Office of System Development, and Mitretek, is in the process of developing an infrastructure called the Common Operations Development Environment (CODE), that has the potential to significantly enhance the technology transfer process. By developing this infrastructure, the NEXRAD program will be able to leverage the research and development resources of scientists at universities, federal research laboratories, and National Weather Service offices throughout the country, and at the same time significantly reduce the cost to transfer the applications they build to the operational WSR-88D network.

The main components of CODE include:

1) A development system that allows physical access to operational data streams both from archive devices and in real-time from the WSR-88D and other operational weather data sources;

2) Application Programming Interfaces (API's) to access the above data streams--the same APIs in the operational Open Systems Radar Product Generator (ORPG);

3) Common APIs that perform functions and calculations on the data streams (e.g., calculating the height of a radar beam);

4) A local development display capability that allows display of both data images as well as products from test applications;

5) Common APIs that allow developers to display their products on the local development display;

6) A Visual Programming Tool as part of a development function that allows developers easy methods to develop applications and see the results of their development.

We plan to develop CODE using the software and APIs of the ORPG. This software will be POSIX compliant and will follow Open System standards. The software will perform the above functions and will be made available to research and operational organizations.

This effort will be a continuation and a broadening of the successful WSR-88D Algorithm Testing and Display System (WATADS). WATADS is a tool that allows researchers, operational meteorologists, and others to examine WSR-88D base data and to run both the operational WSR-88D algorithms and some selected future WSR-88D algorithms on archived base data. The present WATADS allows researchers to perform adaptable parameter studies on the algorithms, examine the performance of algorithms using archived data, and to examine the 4-Dimensional Doppler radar data stream. At the present time, there are over 90 NWS offices, Universities, and Department of Defense organizations using WATADS. CODE will be a significant expansion of the capability of WATADS. ◆

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