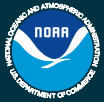


NSSL Briefings

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Since 1995, NSSL Briefings has been published from the National Severe Storms Laboratory to provide federal managers, staff, and other colleagues in the meteorological community with timely information on our activities. This newsletter also contains information about NSSL's scientific collaborations with the OU Cooperative Institute for Mesoscale Meteorological Studies (CIMMS). To receive NSSL Briefings by mail, e-mail, or to change your address, please forward requests by e-mail to susan.cobb@noaa.gov.

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NSSL co-hosts NOAA Hazardous Weather Testbed Spring Experiment

More than 60 researchers and forecasters from government agencies, academia and the private sector visited the National Weather Center (NWC) in Norman, OK this spring to work towards improving forecasts of severe weather.

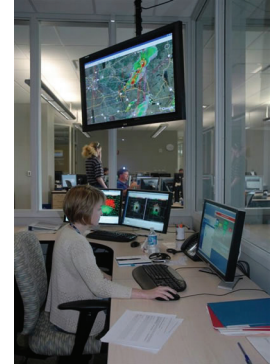
The 2007 Spring Experiment hosted by NOAA's Hazardous Weather Testbed (HWT) offered an irresistible opportunity for research scientists and operational forecasters to change roles for a week during the active spring severe weather season that affects large parts of the nation.

The exchange allowed researchers to immerse themselves in the challenges of front-line forecasting while giving forecasters a chance to examine emerging scientific and technological advances. Both will walk away from the experience with increased knowledge of thunderstorm processes that will improve forecasts and vital forecasting tools.

Although it's the seventh year for the experiment, this was the inaugural year for the new Hazardous Weather Testbed facility, strategically located in the recently built NWC between the operational forecast areas of the NOAA Storm Prediction Center and the NOAA National Weather Service Norman Forecast Office (WFO-OUN). These two offices, along with NOAA NSSL, led HWT spring experiment activities from mid-April through June. Several collaborators also provided valuable research and computing resources, some of which were available for the first time, allowing for significant improvements in precision.

The Hazardous Weather Testbed emerged from the mutual interests of forecasters from the SPC and researchers from NSSL, and was inspired by the culture of collaboration that already existed between researchers and the WFO-OUN forecasters. ♦

Daily weather briefings during the Hazardous Weather Testbed Spring Experiment draw a crowd



CIMMS Pam Heinselman working in the HWT facility





EXPERIMENTAL WARNING PROGRAM
A PART OF THE NOAA HAZARDOUS WEATHER TESTBED

Severe weather warning precision targeted

Early and precise warnings of severe weather hazards were the focus of the Experimental Warning Program (EWP), part of the 2007 NOAA Hazardous Weather Testbed Spring Experiment. NSSL researchers and their collaborators targeted the detection and prediction of mesoscale and smaller weather hazards on time scales of minutes to a few hours, and on spatial scales from several counties to fractions of counties.

Teams participating in the EWP focused on the shorter-term convective weather warning needs of forecasters by testing new hazardous weather services, products and applications in a real-time operational setting. Successful results will help improve the skill of severe weather warnings issued by the NWS by reducing false alarms and allowing warnings to be more focused on the people who are truly in harm's way.

Early and precise warnings of severe weather hazards are the target of the Experimental Warning Program, part of the NOAA Hazardous Weather Testbed

2007 EWP results

Phased Array Radar Demonstration

EWP participants collected and evaluated in real-time, and in case study mode, numerous data sets from the NWRT phased array radar. These evaluations will be used for further development of the phased array radar.

Experimental Warnings

An initial test began in the EWP during spring 2007 to create experimental “threat area” severe weather warnings.

CASA Radars Demonstration

EWP participants viewed real-time and archive products from the Center for the Collaborative Adaptive Sensing of the Atmosphere (CASA) radar demonstration network in southwestern Oklahoma. These formal evaluations will be used in the 2008 CASA demonstration and to eventually determine the efficacy of low-cost, low-power, high-density radar networks.

Severe Hazards Analysis & Verification Experiment (SHAVE)

The SHAVE 2007 project collected over 5000 surface reports in support of high-resolution verification experiments, including numerous long-lived “swaths” of severe weather. Numerous ground surveys of wind and/or tornado damage were conducted in Central Oklahoma in support of testbed data.

Dual-pol Radar Demonstration

EWP participants viewed and evaluated products generated by the KOUN testbed dual-polarimetric WSR-88D. The national radar network will be upgraded in 2010-2011 to include dual-pol capabilities, so the feedback generated by the EWP participants will be used in the development of the nationally deployed product suite.

Lightning Mapping Array Demonstration

Data from the Oklahoma Lightning Mapping Array were available for evaluation for the second consecutive year. EWP participants were able to use these data in near-real-time to evaluate intracloud and cloud-to-ground lightning flash rates and their association with severe weather at the surface.

Radar Refractivity Experiment

EWP participants were also able to view experimental products characterizing radar refractivity, which can help forecasters better diagnose near-surface moisture. Their feedback will be used to determine the feasibility of national deployment of radar refractivity diagnostic products. ♦



CIMMS Mike Coniglio studies storms over eastern Colorado and western Kansas

CI-FLOW moves forward

New technologies and techniques for accurate and timely identification of inland and coastal floods and flash floods are being evaluated and tested through the Coastal and Inland Flooding Observation and Warning (CI-FLOW) project, a research and demonstration program focused on the Tar-Pamlico basin of North Carolina. NSSL was one of the pioneer CI-FLOW partners in 2000, along with the National Sea Grant College Program, University of Oklahoma, North Carolina State University, and the North and South Carolina Sea Grant programs.

CI-FLOW is taking a three-pronged approach towards providing fundamental data to inland and coastal ecosystem assessment, management, and hazard mitigation:

Measure and monitor: A CI-FLOW multi-sensor Quantitative Precipitation Estimation (QPE) will incorporate information gathered from the multiple radars, rain gauges, satellites, numerical weather models, and lightning detection networks monitoring the basin to provide a continuous assessment of precipitation falling onto the watershed.

Model and modify: Water quantity and quality will be monitored and predicted using an ensemble of high-resolution hydrologic and hydraulic models that will create unique streamflow simulations dependent on channel characteristics, soil type, the slope of the land and vegetation patterns. These simulations will be input into CI-FLOW water quality models and allow forecasters to adjust their forecasts based on all the possible solutions regarding timing and amount of river discharge for multiple forecast points in the basin.

Manage and mitigate: CI-FLOW research will also include storm surge forecasts, inundation estimates, and fresh water streamflow flood predictions. Ensembles of storm surge models, currently operating in Carolina academic institutions, the NOAA Tropical Prediction Center and NWS Southeast River Forecast Center, will be coupled with the ensemble of water quantity and quality models to improve forecasts for the area. This information will be critical in supporting decision-making to protect life and property.

The project is ongoing, and now includes other NOAA groups operating programs in the Carolinas – local National Weather Service Offices, the NWS Office of Hydrologic Development, the National Environmental Satellite Data and Information Service, and the Coastal Services Center as well as the Department of the Interior.

The integrated and interdisciplinary CI-FLOW research programs combining coastal storm effects of heavy rainfall, storm surge, and subsequent river conditions, are critical to reducing the number of fatalities due to freshwater flooding, the leading cause of storm related deaths. Historically, devastating flooding in the Carolinas claimed 51 lives and left thousands homeless following Hurricane/Tropical Storm Dennis and Hurricane Floyd in September, 1999. In response to these catastrophic events, the CI-FLOW Project was launched to reduce loss of life and property from hydrologic hazards in the Carolinas and across the nation. ♦



CI-FLOW target area in North Carolina

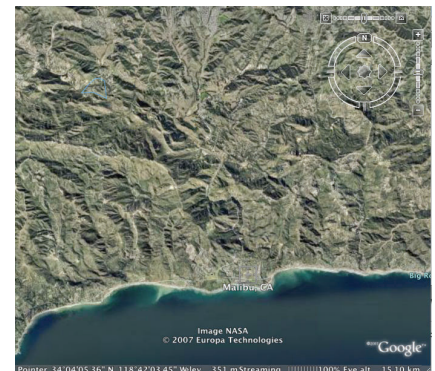
CI-FLOW will provide fundamental data to inland and coastal ecosystem assessment, management, and hazard mitigation

2007-2008 Debris Flow site near Malibu

The "Canyon Fire," a 4565-acre wildfire that started October 21, 2007 in a canyon above Malibu, California, has been chosen as the 2007-2008 USGS Debris Flow Project region for intensive research measurements. NSSL's Shared Mobile Atmospheric and Teaching Radar (SMART-R) crew will participate for the third year by providing high-resolution rainfall measurements.

The USGS/NOAA Demonstration Flash-Flood and Debris Flow Early Warning System project is focused on helping forecasters improve flash flood and debris flow warnings in areas damaged by wildfires. These areas, known as burn scars, are particularly susceptible to flash floods and debris flows during rainstorms. Rainfall that is normally absorbed by vegetation can run off almost instantly, causing creeks and drainage areas to flood much earlier and with higher magnitude than normal.

The Shared Mobile Atmospheric Research and Teaching Radar (SMART-R) is sited to provide high-resolution rainfall measurements during the rain season, December 1, 2007-February 28, 2008. In addition, the SMART-R has been upgraded with satellite internet capability to allow the uploading of 5-minute radar base scan imagery to a web site that can be viewed by forecasters at the Oxnard, CA, Weather Forecast Office. This feature will supplement local NWS radar coverage where the beam is blocked by mountainous terrain and will aid forecasters in warning decisions. ♦



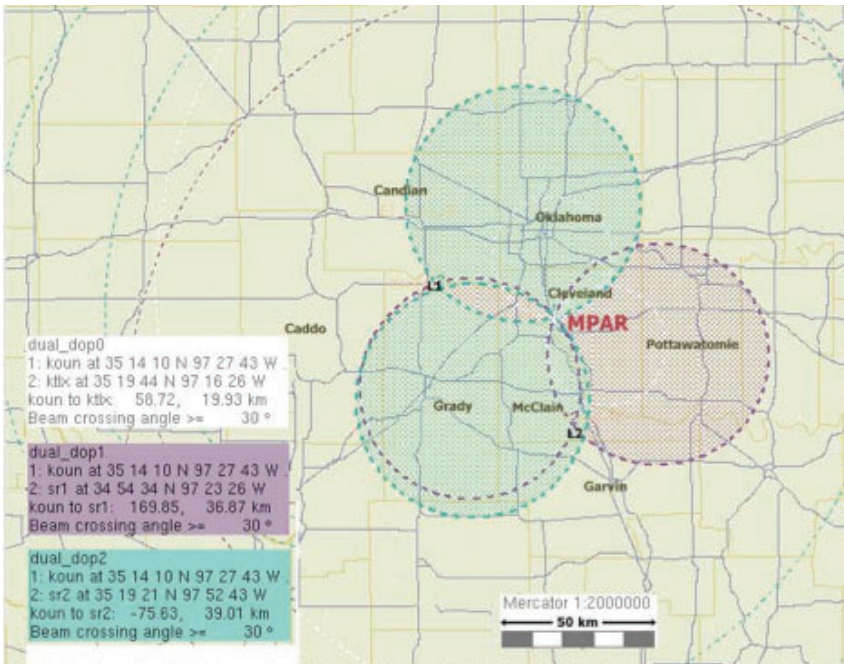
Satellite image of the canyon above Malibu, CA, the target of this year's Debris Flow experiment

2007 National Weather Radar Testbed Demo

Storms across Oklahoma this spring provided NOAA NSSL researchers an unprecedented opportunity to research rapidly evolving weather phenomena and to potentially extend warning lead-times for severe weather using the phased array radar (PAR), part of the National Weather Radar Testbed (NWRT).

The NWRT demonstration was conducted at the NOAA Hazardous Weather Testbed in Norman, Oklahoma during Spring 2007. Designated NWS forecasters from forecast offices across the U.S. participated in coordination with NOAA and University of Oklahoma research meteorologists.

The demonstration introduced real-time PAR data to a simulated operational environment to gather information about the benefits and challenges of using PAR data in warning decision-making situations. In the real-time simulation, the forecaster performed his/her usual warning decision-making duties while the lead/researcher team ran the PAR data collection. Operational benefits and challenges of rapid-update



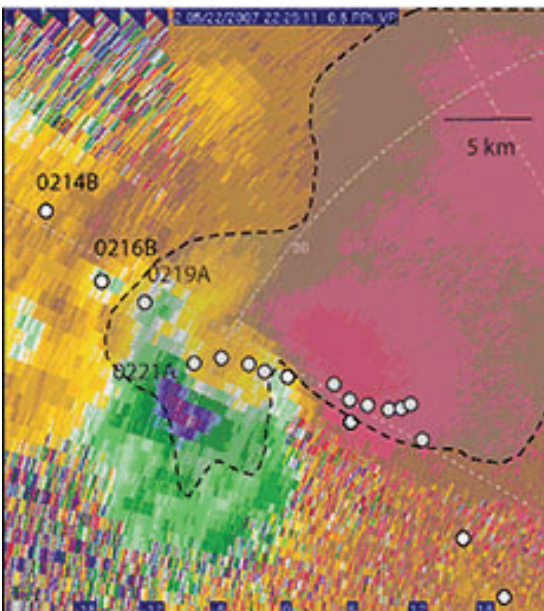
Study region for the coordinated MPAR/stacked SMART radar deployment. Possible SMART radar sites are denoted by L1 and L2.

volumetric PAR data are being assessed.

Other 2007 NWRT interrelated experiments investigated the utility of PAR data in forecasting, modeling, and identifying characteristics of deep convection. The demonstration also gathered high-density verification information for the PAR to support the development of scientifically sound severe storm guidance applications and techniques.

The NWRT PAR became functional in September 2003 and collected data in 2004 and 2005 for engineering tests, weather observations, and system checks. The PAR has been collecting data for research since 2006 to demonstrate the rapid-scan capability of the PAR antenna.

More information can be found at: <http://www.nssl.noaa.gov/projects/pardemo/> ◆



SMART radar data and Texas Tech University "sticknet" (rapid deployment observing platforms) deployments from 22 May 2007 in the northern Texas Panhandle

Storms targeted by mobile radars

Two SMART-Radars were deployed in concert with PAR operations during the Spring 2007 National Weather Radar Testbed Demonstration. NSSL and the University of Oklahoma led a team to investigate the advantages of rapidly scanning the atmosphere and to evaluate, using data assimilation techniques, the impact of phased array radar technology on the prediction of severe weather.

The Phased Array SMART-R Spring Experiment (PASSE) deployed SMART-R's in central and western Oklahoma to collect data on supercell storms at low altitudes. Researchers will use the data to determine if assimilating rapidly updating surface data into models will improve storm scale forecasts. Scientists also positioned the SMART-radars to provide double radar coverage (PAR and SMART-R) on hazardous weather targets to compare differences in radar parameters.

The Data Assimilation Resolution Experiment (DARE) deployed SMART-R's to target data collection on the vertical structure of multicell storms, especially in the mid levels of the storm where the storm's updraft and downdraft structure can rapidly evolve. Better diagnosis of this part of the storm system should improve our ability to model multicell storms for lightning research, quantitative precipitation forecasting, and hail prediction.

The SMART-R's also deployed to the Texas panhandle on 23 May, 2007 to observe a non-classic tornado that was spawned from a supercell storm embedded in multicellular convection. ◆



Employee Spotlight: Greg Stumpf

The project combined several of Greg's passions -- storm chasing, photography, electronic music composition, and--making a difference. Greg Stumpf and Jim LaDue, NWS Warning Decision Training Branch, collected videos of tornadic storms across the Great Plains during the spring of 2004 donated by storm chasers. Together they produced "Storms of 2004," a compilation of those videos set to music, some composed by Greg. Their goal was to raise money for the American Red Cross Disaster Relief Fund -- "Storm Chasers Helping Storm Victims in their Time of Need." The project was so successful they repeated the effort in "Storms of 2005." In the first two years, over \$17,000 (100% of the DVD profits) were donated to charity. The "Storms of 2005" DVD won first place in the First International Journal of Meteorology Film Festival, and the

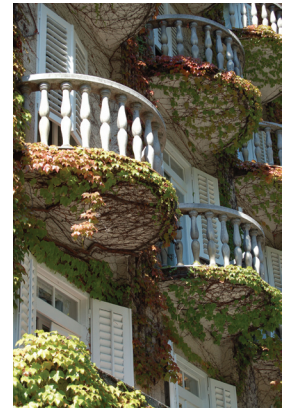
£1000 prize was also donated. But producing DVD's for charity is not Greg's day job.

Far away from his favorite place in the tall deciduous forests of New York's Hudson Valley, Greg has been roaming the Plains in search of tornadoes since 1987. Even during high school in upstate New York he had a friend's mom drive them around to "get in the better storm cores." He had always been interested in many aspects of earth sciences, but meteorology seemed to draw him in. Greg earned his B.S. at the State University of New York College at Oswego, and worked as a student intern at The Weather Channel for a semester. He wanted a position that would benefit the public more, and after working at the New York Power Authority at their emergency operations facility, he knew he wanted to help warn people and protect assets in harm's way from a public/service/government perspective. His journey took him west, where he enjoyed the diversity of a bigger school, Colorado State University, for his M.S. degree.

Greg came to NSSL in March of 1989. His job grew from developing techniques for aviation wind shear alerts for the first few years, to developing NWS severe weather warning algorithms. A few years ago he moved into his current position with the NWS Meteorological Development Laboratory (MDL) Decision Assistance Branch (DAB) in a collaborative NSSL-MDL partnership, sponsored by CIMMS, to facilitate the transition of this research and technology into NWS operational systems for severe weather warning decision making. This *is* his day job. Knowing that some of the work he's done has already made positive changes to NWS warning services is his favorite part of his job. Greg co-hosted the "2nd Workshop on Severe Weather Technology for NWS Decision Making" this past summer to bridge the gap between research and operations. Researchers presented their latest results to forecasters, and the forecasters shared stories "from the field" with researchers. Together they came up with a strategic list of findings and recommendations for fast-tracking emerging technologies through the NWS operations implementation process.

Greg is a firm believer in storm chasing to benefit others - to do his best to energize other chasers to give something back to the people affected by storms. The DVD projects came out of this effort. Storm-chasing has also enriched Greg's understanding of storms. "The benefit of taking that *in-situ* experience with nature in its most violent state, and using that to learn more about storms. In my case, seeing storms in person, and at the same time using the remote sensing devices (e.g., radar) to help me understand how NWS warning forecasters can make their decision without the added benefit of visuals, and to understand how these storms affect regular people, knowing we are making a difference." The DVD project eventually became too consuming and now Greg has stepped back a little - to chapter producer and consultant.

Greg's constant travel companion is his camera (see sample photos upper and lower right), but he hopes to take his six-year old daughter on chases when she gets a little older. A 48 state trip in an R.V. with his wife Julie is another aspiration - but maybe without their two cats and one salamander. ♦



Notables:

Born: New York state

Specialty: Developing
warning decision-
making tools

Current position: CIMMS-
sponsored NWS
MDL at NSSL

Hobbies: Storm chasing
Photography
Music composure



NOAA Administrator's Awards



NSSL's **Doug Forsyth**, Executive Director of Facilities and Strategic Planning and Chief of the Radar Research and Development Division was honored with a 2007 NOAA Administrator's Award. The citation reads, "In recognition of leadership in overseeing the design, construction and occupancy of the National Weather Center, a joint NOAA and University of Oklahoma project which was realized both on time and under budget."



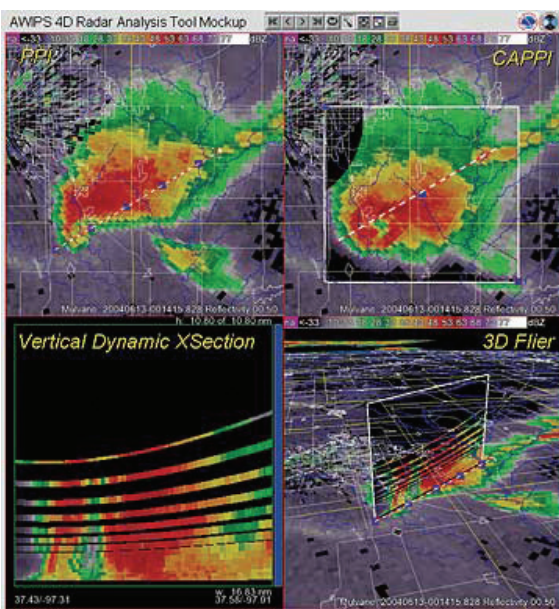
NSSL scientist **Dave Jorgensen**, Chief of Warning Research and Development also received a 2007 NOAA Administrator's Award as part of the NOAA team that participated in the Debris Flow Project with the USGS. NSSL's role was to use mobile radar to gather high resolution rainfall data sets to be used by USGS to refine their thresholds for debris flows. Dave continues his involvement with this project this winter. ♦

NSSL's "slice and dice" radar tool

NSSL's prototype Four-Dimensional Stormcell Investigator (FSI), a 3D/4D base radar data display tool, was alpha-tested in three NWS Weather Forecast Offices (WFO's) this summer - Melbourne, FL, Omaha, NE, and Huntsville, AL.

FSI is based on NSSL's Warning Decision Support System-Integrated Information (WDSS-II), and allows users to create and manipulate dynamic cross-sections, both vertical and at constant altitude. Forecasters can "slice and dice" storms and view these data in three-dimensions and across time.

Feedback was very positive with forecasters finding the FSI utility to be very useful in the warning decision making process. FSI will be implemented at all WFO's in AWIPS Build OB 8.2 from December 2007 through March 2008. ♦



Four-dimensional Stormcell Investigator 4-panel display mock-up.

Comings and goings

Heather Reeves comes to NSSL from North Carolina State University as an NRC post-doc and will be studying mountain valley cold pools and examining how well they are reproduced in numerical models. These cold pools have a huge influence on air quality in the winter.

Edward R. "Ted" Mansell was appointed to a federal position at NSSL. Ted has been working as a post-doc and OU/NOAA CIMMS Research Scientist. His specialty is storm electrification and lightning physics and cloud scale modeling of electrification and microphysics processes. He is also developing radar data assimilation techniques with applications towards "warn-on-forecast" strategies.

NSSL welcomes **Montra Lockwood** as the new NOAA Sea Grant Climate Extension Agent, sponsored by OU/NOAA CIMMS. Montra will work to find ways to use NSSL research in NOAA Sea Grant outreach and education programs.

NSSL wins two of seven NOAA research awards

A NOAA Research 2007 Outstanding Scientific Paper Award was given to Alexander Ryzhkov, Terry Schuur, Don Burgess, Pam Heinselman, Scott Giangrande (OU/NOAA CIMMS) and Dusan Zrnica (NSSL) for their paper on the "Joint Polarization Experiment: Polarimetric Rainfall Measurements and Hydrometeor Classification."

NSSL's **John Lewis** along with S. Lakshminarayanan (OU/NOAA CIMMS) and Sudarshan Dhall of OU were given Special Recognition by OAR for their book "Dynamic Data Assimilation: A Least Squares Approach, Cambridge University Press, 2006. See research.noaa.gov/research/papers07/ for more information.

Other awards and honors

NWA Research Achievement Award

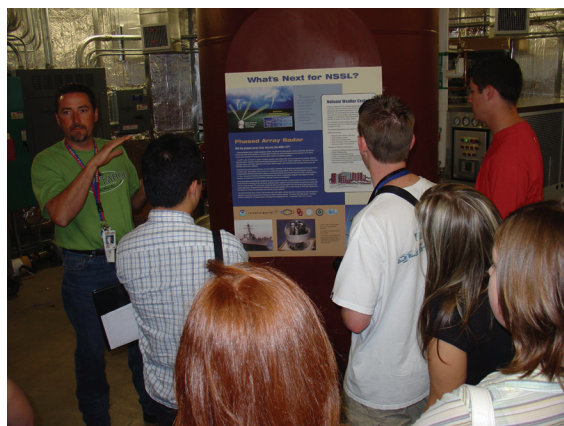
Rodger Brown received the "T. Theodore Fujita Research Achievement Award" from the National Weather Association (NWA) in recognition of 30+ years of applied research and development activities that have led to improved WSR-88D detection of tornadoes and other hazardous weather events, resulting in forecasters issuing warnings with increased lead times.

Rodger received his M.S. degree from the University of Chicago under Dr. Fujita, and was the first of Fujita's graduate students to receive a degree.

Mentors open students' eyes to severe weather research

NSSL's 2007 undergraduate student internship program came to a close at the end of July highlighted by presentations from each of the 12 participants. The students spent the summer with NSSL weather experts to gain exposure to severe weather research. Each mentor and student team chose a topic to study, then conducted research on the subject which culminated in the preparation and presentation of their results. The experience was also supplemented by tours, field trips and lectures, all designed to help encourage them to pursue a future career in atmospheric science research.

Four of the students were Hollings Scholars, a prestigious program sponsored by NOAA to increase interest in atmospheric science. Inspiring students to pursue research in the atmospheric sciences will ensure the continuation of severe weather research and teach environmental stewardship. ♦

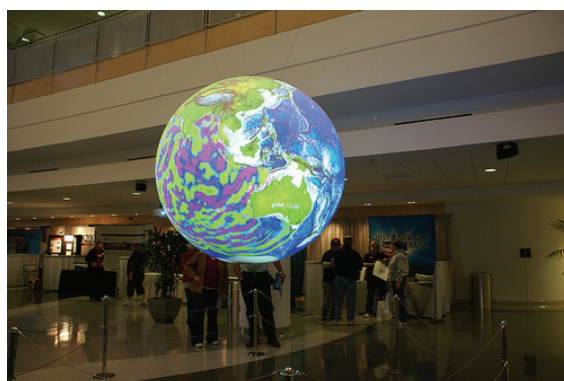


NSSL's Mark Benner gives a demonstration of the phased array radar to the student interns

National Weather Festival draws a crowd

The third annual National Weather Festival was held at the National Weather Center in Norman, OK on Saturday, October 20, 2007. The event provided an opportunity for the community to learn about operational weather activities, current research and to promote interest in weather to people of all ages.

An estimated 2,000 people turned out for the free festival sponsored by the Norman Chamber of Commerce Weather Committee, the University of Oklahoma weather units and the NOAA Weather Partners. Visitors were treated to tours of the National Weather Center, displays by local weather organizations and businesses, weather related seminars, the new Science on a Sphere display, and the second annual Storm Chaser Car Show. Children's activities, hourly weather balloon launches and an amateur radio demonstration were also part of the agenda. This year's festival also had an historical emphasis, with information about NOAA's 200th Anniversary Celebration and Oklahoma's Centennial. ♦



The new Science on a Sphere display in the NWC atrium was a popular attraction at the National Weather Festival.

<http://www.nssl.noaa.gov/news/video/>

Check out our new Video Highlights page! We are posting videos created by NSSL's James Murnan as they become available. The videos are designed to promote NSSL's mission and activities. Enjoy! ♦

NOAA national severe storms laboratory

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Highlights from the 2007 National Weather Festival

The Norman Chamber of Commerce's Weather Committee hosted the 3rd Annual National Weather Festival on Saturday, Oct. 20, at the National Weather Center in Norman. The free public event featured tours, children's activities, a storm chaser car show, displays by local businesses, weather-related seminars, Science on a Sphere, and hourly weather balloon launches. (Time: 03:54) posted 26 October 2007

[Watch the Flash video](#)

(No text transcript -- images and music only)

Multifunction Phased Array Radar

The future of weather radar lies in phased array technology, with its advanced multi-function capabilities and performance. This video gives a brief overview of the advantages to be gained from the implementation of phased array radar technology, with emphasis on improvements in weather forecasting, transportation safety, homeland security, and the cost effectiveness of the system. (Time: 04:55) posted 18 October 2007

[Watch the Flash video](#)

[Text transcript](#)

NOAA Weather Partners Spotlight: NSSL

Severe weather and the tools to forecast and monitor it. This is the focus of researchers at the National Severe Storms Laboratory. This brief video, featuring NSSL Director, Dr. Jeff Kimpel, provides an overview of the research conducted at NSSL, highlighting the three main topics of weather radar, hydrometeorology, and forecast and warning improvements. (Time: 04:44) posted 1 August 2007

[Watch the Flash video](#)

[Text transcript](#)

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NSSL hosts national symposium on Multifunction Phased-Array Radar

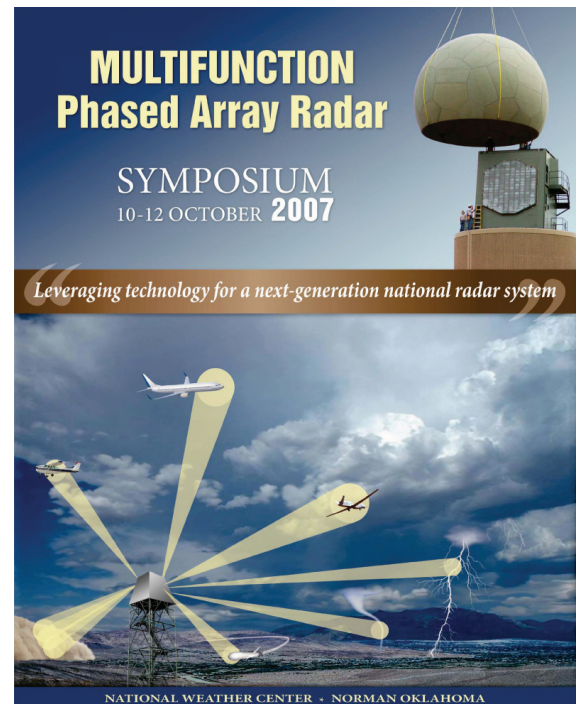
The latest developments in adapting phased array radar technology to weather, aviation and surveillance uses were highlighted at the Multifunction Phased Array Radar (MPAR) symposium hosted by NSSL October 10-12, 2007 at the NWC. The symposium was sponsored by the Office of the Federal Coordinator for Meteorology.

Formal presentations, senior-level panel discussions and exhibits of the latest phased array radar technology were on the agenda. Panels of invited speakers from government, academia, and the commercial sector provided ample opportunities for discussion.

The symposium aimed to advance the state of MPAR research and development and to further document the needs of the radar user community, which include surface transportation, aviation, severe weather forecasting, meteorological research, emergency management of landfalling hurricanes, flood forecasting and water use management, and aircraft/un-manned aircraft systems surveillance over the homeland (both cooperative and non-cooperative). The symposium also highlighted the social and economic benefits from MPAR risk reduction research.

The MPAR Symposium was a success with 181 participants. Presenters included senior policy level officials from four federal agencies (DOT, DOC, DHS, and DOD), all three services (Army, Navy, Air Force), four Fortune 500 companies (Raytheon, Lockheed Martin, Northrop Grumman, Harris), five smaller radar component manufacturers, and five university groups (OU, MIT, Colorado State, UMASS, and NCAR). Media coverage was provided by reporters from the local ABC, NPR, NBC, and FOX TV/radio stations, and the Daily Oklahoman and Norman Transcript.

Our Nation's legacy radar systems are aging and will need replacement. MPAR offers the most significant new technological capability to address both current and anticipated radar needs and gaps, as well as a single technological pathway. Its versatility and adaptive scanning capability addresses a wide array of national surveillance needs, both for weather and aircraft. See <http://www.ofcm.gov/mpar-symposium/index.htm> for more information. ♦



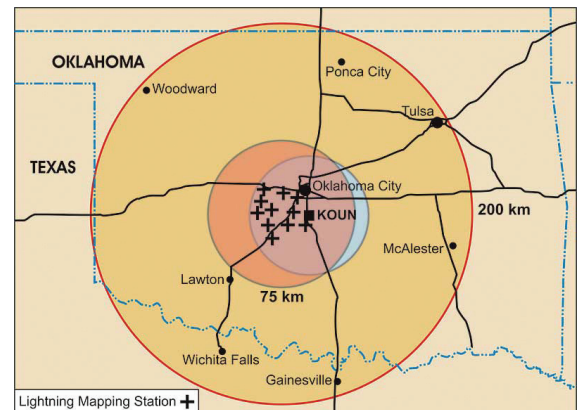
NSSL scientists receive NASA grant to improve lightning observations

NSSL research scientists Don MacGorman and Ted Mansell, along with OU meteorology professor William Beasley were awarded a \$1.44 million three-year grant from NASA to improve ground-based lightning observations.

The team of NSSL and University of Oklahoma scientists will work closely with NASA Marshall Spaceflight Center to establish the Center for Lightning Advanced Studies and Safety (CLASS). During the first two years, the center will focus on expanding the Oklahoma Lightning Mapping Array (OK-LMA), a network of eleven stations in central Oklahoma that continuously map the structure of all types of lightning. They will also establish a ground-based network of electric-field meters, which measure electricity in the atmosphere, and install a high-speed lightning imaging capability for recording.

New NASA satellites will observe lightning from space, and together with the ground-based network, will provide a wealth of new data. This will be used to improve weather forecast models and to develop lightning hazard warning techniques.

The grant is from NASA's Experimental Program to Stimulate Competitive Research (EPSCoR). The proposal was one of 43 submitted to the NASA EPSCoR program; only 23 were funded. ♦



Crosses indicate the locations of the eleven stations of the OK-LMA. Accurate three-dimensional locations of lightning channel segments are indicated by the inner red circle. Height errors increase rapidly with range beyond the red circle and details in the vertical lightning structure become obscure. The outer gold circle shows the nominal region where the OK-LMA provides 2-D locations. The blue circle is centered on the KOUN polarimetric radar and indicates the 60km range where the resolution of polarimetric radar data is optimal.