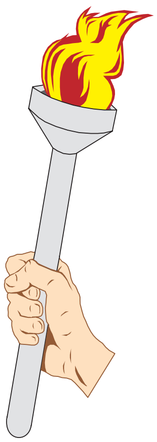
NSSL Briefings

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



NSSL works with NWS to prepare for Olympic weather support

by Susan Oakland-Cobb and J.T. Johnson

World class athletes are not the only ones diligently training for the 1996 Summer Olympic Games to be held in Atlanta, GA. Fifteen forecasters from around the world have spent part of the summer in Atlanta training to provide weather support during the Olympics. They come from the U.S., Canada, and Australia, and will begin forecasting July 1, 1996, continuing through the Olympics, closing August 4, 1996.

A group of alternate forecasters will continue forecast operations through the Paralympics, a competition involving physically challenged athletes. The Paralympics are held two weeks after the close of the summer Olympics and use the same facilities.

All of these forecasters will be a part of the Olympic Weather Support Office (OWSO) and the Olympic Marine Weather Support Office (OMWSO). The OWSO and OMWSO were organized after the Atlanta Committee for the Olympic Games (ACOG) identified several weather concerns that could jeopardize the safety of the athletes, workers, and spectators. Since many of the events are held outdoors, a need for weather support services was evident. The OWSO will be responsible for providing weather services for the majority of the Olympic events. The OMWSO will focus only on the yachting event.

The OWSO and OMWSO are currently in the spin-up stage, coordinated by the Southern Region Headquarters of the NWS. The National Severe Storms Laboratory (NSSL), and other National Oceanic and Atmospheric Administration (NOAA) organizations including the Forecast Systems Laboratory (FSL), the Techniques Development Laboratory (TDL), the National Center for Environmental Prediction (NCEP), and the National Environmental Satellite, Data, and Information Service (NESDIS) are all working to help these activities. NSSL's J.T. Johnson has been working in Atlanta since January, 1995 to help with the OWSO set-up. Johnson will remain in Atlanta throughout the Olympics to provide expertise on NSSL's experimental Warning Decision Support System (WDSS) and to help with the overall hardware, software, and forecaster training for the OWSO.

Olympic Games venue sites

The OWSO and OMWSO operations will utilize new weather analysis tools that have never been combined in an operational setting. Forecasters will use high - resolution mesoscale models, WSR-88D data, GOES-8 satellite data, and an extensive network of surface data (mesonet). The NSSL-developed WDSS will serve as the radar analysis and warning tool as well as the lightning display (for more on preparing WDSS for the Olympics, see page 3). Prior to the Olympics, these tools were utilized in several case analyses of summer thunderstorm events. Through these case analyses, meteorologists hope to better understand thunderstorms in the southeast U.S. environment and will determine what aspects and combinations of these tools will provide forecasters with the best information.

The Olympic Games are one of the largest and grandest festivals in the world. From athletes, to spectators, to the weather forecasters, the Olympic Games are truly an international event. ◆

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

Volume 1 No. 2

Fall/Winter 1995

In Brief.....

NSSL News Briefs

NSSL receives Gold Medal award

NSSL has been honored with the Gold Medal Award by the Department of Commerce. The Gold medal is the highest form of honorary recognition the department bestows and is granted for exceptional contributions to the Department of Commerce. NSSL was recognized for its "*leadership leading to, and continuous improvement of, a national Doppler radar system, significantly advancing our Nation's National Weather Service*."

National Weather Association honors NSSL scientist

Chuck Doswell received the National Weather Association's (NWA) Research Achievement Award. This award is given to the individual whose research has made a significant contribution to operational meteorology. The award was presented at the NWA Annual Meeting in Houston, TX, in December.

Student employee receives national scholarship and OU Outstanding Senior award

Cristina Kaufman, OU Senior in Meteorology and NSSL employee has recently been awarded the $5,000 Paul H. Kutschenreuter Scholarship. This scholarship is awarded to a student who is in their final undergraduate year majoring in atmospheric or related oceanic and hydrologic sciences. The recipient is selected based on academic record, achievements, honors, and college and community activities.

Kaufman was also awarded Outstanding Senior of the College of Geosciences at the University of Oklahoma. The awards are given to one outstanding senior in each college and is sponsored by the OU Parent's Association.

NSSL News Briefs continued on next page. . .

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From the Deputy Director's desk:

As we enter the new fiscal year, we can reflect on our accomplishments and make plans for another exciting year. We have continued to work with the spin-up of the Storm Prediction Center (SPC) and are thrilled that this co-location of NSSL and SPC is occurring. Both organizations have made a few short-term sacrifices to make this happen. Under the fine leadership of Gary Grice, this tremendous task has continued on a smooth course despite the boulders (e.g., protest on the temporary buildings, siting disputes, etc.) laid in our path. Thanks to the SPC and NSSL staffs for their continued support during these turbulent times (i.e., moves, disruptions, less than desirable space, etc.). In particular, the support of the Administrative and Central Support Services has been outstanding. The support from the Mountain Area Service Center (Lois Arford, and Rick Johnson), Special Engineering Program Office (DeAnn Inskeep), and NWS HQ/EG&G (Phil Dodderidge) has been invaluable. A special thanks to John Snow, Dean of the College of Geosciences at OU, for also helping "clear the road."

So far our FY96 budget is staying at the FY95 funding level in both the House and Senate. Although this is not the best news, since we had hoped for new initiative funds to support a Research Development, Operation and Testing WSR-88D with dual polarization capability. This funding level will present some challenges (**opportunities**) for the coming year but should allow NSSL to continue in its quest to improve our understanding and ability to forecast and warn for hazardous weather situations.

We are looking forward to our participation in two new Memorandums of Understanding (MOU) with the NWS. The NWS Headquarters MOU involves NEXRAD product improvement and will start moving the WSR-88D to open systems architecture and replacing the current signal processor. The Western Region MOU concerns collaborative WSR-88D evaluation and development in the West and has moved Steve Vasiloff to Salt Lake City, Utah. Steve is working directly with the Western Region Headquarters to assess and improve the WSR-88D capabilities in the Western United States.

Finally, as we reflect on our accomplishments and make plans for the future, thanks to everyone who gave something back to our communities by giving generously to the Combined Federal Campaign. ◆

WDSS being tested in Atlanta to prepare for the Olympics

by Susan Oakland-Cobb and J.T. Johnson

As millions of people converge on Atlanta next summer, the Atlanta Committee for the Olympic Games (ACOG) has some concerns with the weather including the threat of thunderstorms during outdoor events. To provide accurate real-time information on thunderstorms to Olympic forecasters, NSSL's experimental WDSS will serve as the radar analysis and warning tool, as well as provide lightning strike information during the 1996 Summer Olympic Games.

To prepare for the Olympics, NSSL conducted a Proof-of-Concept test of its WDSS in Atlanta this past summer. The goal for this testing was to determine if there were any differences that might exist in the Georgia environment that may cause problems or biases with the NSSL developed algorithms. We also wanted to collect data to examine the pre-storm environment for indicators of thunderstorm initiation and movement of existing storms in the Atlanta area.

The Proof-of-Concept test was intended to look at several aspects of the WDSS both in real-time and off-line. Individual performances of the WDSS algorithms were evaluated using algorithm output and ground truth reports. To evaluate the long-term robustness of the algorithms, we are running the algorithms on a daily basis. OWSO, NWS, and NSSL personnel kept a log of successes and failures during or shortly following each day. This record will allow failures to be evaluated and analyzed with the goal of improving algorithm performance.

Proof-of-Concept tests such as the one conducted in Atlanta are invaluable during the development of a system such as the WDSS. Testing the system during real-time operations identifies areas of success, as well as areas that will require additional attention. The WDSS is constantly being enhanced to test out concepts for effective tools for the warning process. The Olympic Weather Support meteorologists and NWS meteorologists around the country will benefit greatly from Proof-of-Concept tests like the one conducted in Atlanta this summer. ◆ *For more information contact Mike Eilts at: eilts@nssl.uoknor.edu*

NSSL team to move NEXRAD to open systems computing environment

The NWS and Environmental Research Laboratories (ERL) have signed a Memorandum of Understanding (MOU) involving NSSL in the ambitious project of evolution and integration of NEXRAD. NSSL's role will be to move the WSR-88D Radar Products Generator and Radar Data Acquisition (RPG-RDA) to an open system computing environment. The MOU includes developing, demonstrating, and validating a prototype for this system, and transitioning it to the OSF for implementation nationwide. ◆

NSSL News Briefs continued. . .

NOAA's bronze medal awarded to NSSL employees

Lawrence P. Griffin and Dennis E. Nealson, NSSL electronic technicians, were awarded a bronze medal by NOAA. Griffin and Nealson were honored for their work in developing a mobile, truck-mounted Doppler radar - a collaborative effort of the University of Oklahoma, the National Center for Atmospheric Research, and NSSL.

The fully mobile radar was used during this year's VORTEX tornado experiment. Using the radar, scientists were able to collect unprecedented close-up, comprehensive data on several supercell storms and tornadoes. Please see the story "Mobile Doppler Radar: A new tool to investigate tornadic storms" on Page 10 for more information.

Scientist on Panel of Independent International Experts

Michael Eilts was invited by the Royal Observatory of Hong Kong to sit on a three member Panel of International Independent Experts. Other members of the Panel included John Kastelein, former President of the WMO Commission for Aeronautical Meteorology, (CAeM), and Neil Gordon, General Manager of National Weather Services for Meteorological Service of New Zealand, Ltd.

The role of the Panel was to provide independent advice on an Operational Windshear Warning System (OWWS) to be installed at the new international airport being built at Chek Lap Kok (CLK) near Lantau Island in Hong Kong. The OWWS will be designed to detect, forecast, quantify, and provide alerts of wind shear and turbulence, both convective and terrain induced, affecting CLK. ◆

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.

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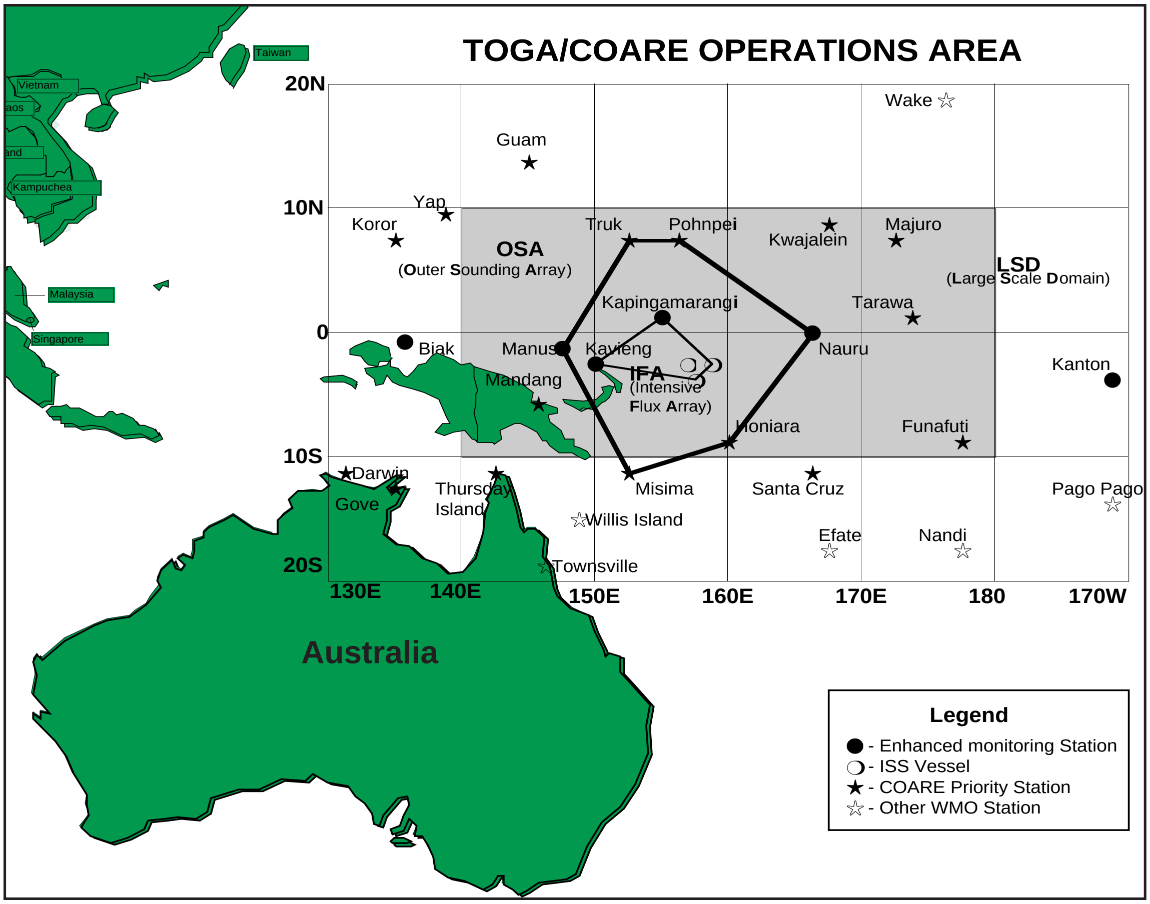


Doppler-equipped aircraft observe Western Pacific Mesoscale Convective Systems

by Dave Jorgensen, NSSL - Boulder

The region roughly centered on the equator northeast of Australia possesses some of the warmest sea-surface temperatures in the world (usually>30° C). These high sea-surface temperatures help fuel large storm systems which transport tremendous amounts of energy upwards in the atmosphere and drive the upward branch of the Earth's Hadley (north-south) and Walker (east-west) circulations. Understanding the processes that form organized clouds and precipitation over the western Pacific "warm pool" region is one of the principle objectives of the Tropical Ocean-Global Atmosphere (TOGA) Coupled Ocean Atmosphere Response Experiment (COARE). Under a multi-year project supported by NOAA's Office of Global Programs (OGP), NSSL/ Mesoscale Research - Boulder (MRB) scientists are working to document the structure, air flow, and energy transport properties of several mesoscale convective systems observed by aircraft during TOGA/COARE.

Scientists are working to document the properties of large storm systems using "quad-Doppler" data

TOGA/COARE field phase

The most comprehensive data to date on oceanic convective systems were collected during the TOGA/COARE field phase (November 1, 1992 - February 28, 1993). Extensive in-situ and radar data were collected by five research aircraft within many strong mesoscale convective systems. Special flight patterns were devised by MRB principal investigators for the airborne Doppler-equipped aircraft, in which up to four beams of

Doppler radar data (called “quad-Doppler") are combined. Quad-Doppler data will help to more accurately estimate convective vertical motions, and hence, momentum fluxes.

We have documented the precipitation structure, airflow, and momentum flux properties of several of these mesoscale convective systems. Using this information, we are performing computer simulations, in collaboration with National Center for Atmospheric Research/Mesoscale and Microscale Meteorology (NCAR/MMM) scientists, to further elucidate their dynamics using non-hydrostatic mesoscale models. In one of the strongest systems, both the observations and simulations developed a pronounced “bow” in the leading edge convective line which was associated with the development of a mid-altitude vortex (see figure to the right).

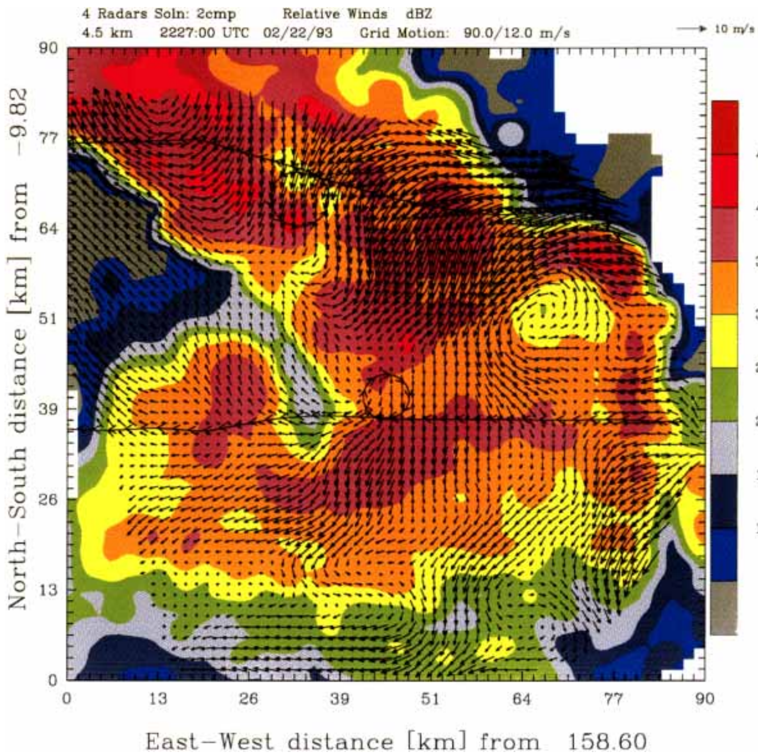
Quad-Doppler analysis results

One of the more intriguing results of the Doppler analysis and model simulations is the presence of a “bi-modal” updraft profile within the convective region. Apparently low-altitude updrafts, triggered by lifting by the gust front, are decelerated by downward-directed pressure gradient forces and water loading just to the rear of the convective line. Once the air ascends through the freezing level, most of the precipitation has dropped out and the upward acceleration can resume. Simulations using a no-ice model also show similar behavior, so latent heating by ice processes apparently are not critical.

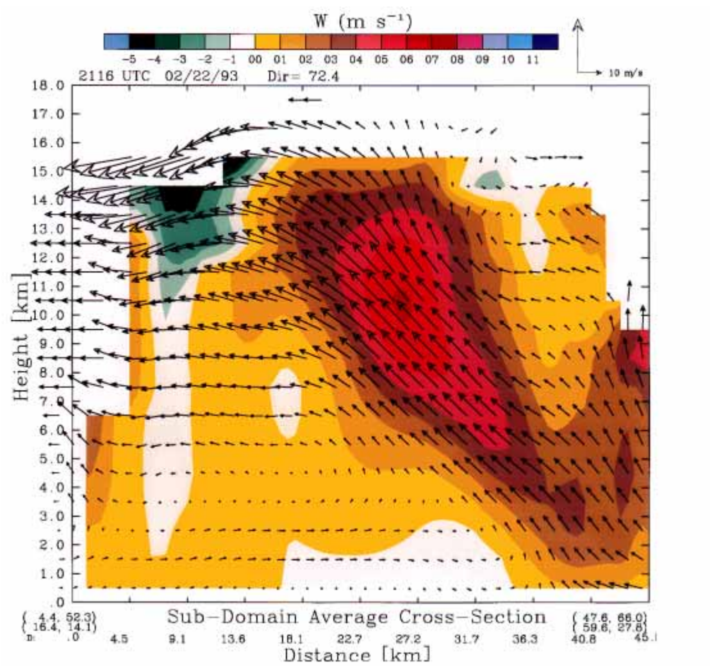
We are also collaborating with NCAR theoreticians to understand more fully why oceanic mesoscale convective systems transport momentum in an organized manner, in order to better parameterize their effects in global climate prediction models. The ultimate goal is to use these models to predict climate change more accurately.

Our primary results to date show the usefulness and accuracy of the “quad-Doppler” methodology through comparisons between Doppler-derived vertical motion and in-situ observations made by the aircraft. Using the quad-Doppler technique to calculate air motions and vertical momentum fluxes in several TOGA/COARE systems has shown that the fluxes compare reasonably well with earlier studies in a different part of the world. Future work will focus on modeling of the non-squall systems and their momentum flux properties. ◆

For more information contact Dave Jorgensen at: davej@mrd3.mmm.ucar.edu

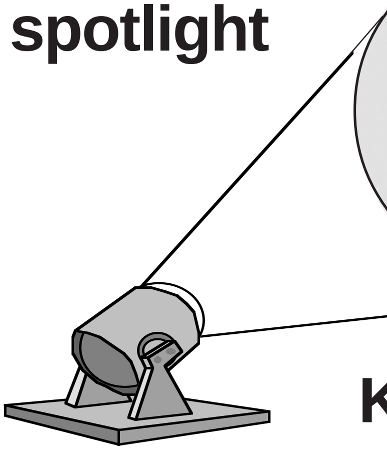


Horizontal depiction of system relative airflow (arrows, scale at top right) and radar reflectivity (contours in dBZ) at 1.5 AGL from the "quad-Doppler" analysis of the 22 February squall line. Flight tracks of the two P-3 aircraft are indicated as the horizontal lines with arrows.



This figure is a vertical cross section of system relative airflow (arrows) in the plane of the cross section and radar reflectivity. Cross section is normal to the leading edge convective line shown in the top figure. Contours are vertical velocity (m/s).

Employee spotlight



Kevin Kelleher

by Susan Oakland-Cobb

Northeastern U.S. snowstorms and school closings first drew Kevin Kelleher to the field of meteorology at an early age. Kevin developed his interest in weather by cutting out articles in the paper about weather (especially snowstorms) and by collecting weather data.

Kevin has traded snowstorms for severe storms, and is now the Manager of Central Support Services at NSSL. His group provides support to managers in the areas of computing, data management, networking, public relations, technical support, library resources, and graphic resources. One of his short-term goals is to help the lab make a smooth transition from the VAX to a UNIX based computer system.

Kevin decided to pursue the field of meteorology as a career with goals of working with data, graphics, and computers. His other interest, however, was skiing. Kevin found he could have the best of both these worlds by attending the University of New York - Oneonta, where he could work towards his B.S. in Meteorology, and ski in New York's Catskill Mountains. Kevin worked at the National Weather Service during college on a special project studying rain gauge patterns using the WSR-57 radar.

Kevin made the move from the mountains to the Great Plains and the University of Oklahoma to work on his master's degree in meteorology. His master's thesis was on performing an objective analysis in time and space using Oklahoma thunderstorm surface data.

There isn't much skiing in Oklahoma, and definitely not in Saudi Arabia, where Kevin worked for four years in several areas including telecommunications, computer operations, and programming. Kevin also worked as an analyst, and finally as Chief of Data Processing at a Saudi Government-owned hospital. Looking back, Kevin was glad he went to Saudi Arabia. He says he had many opportunities to gain experience in the workplace that he would not have had in most places in the U.S. It also gave him a chance to explore Europe and the Far East.

Kevin came back to Norman to work full time at NSSL as a Research Associate in the Meteorology Research Group. Shortly after returning to NSSL, Kevin started handling computer-related issues on the side, and began working on another master's degree in computer science. After a year at NSSL he transferred permanently into the Scientific Support Division as a Systems Analyst. He began to manage this group in 1990 (now under a different name: Central Support Services), and graduated with his master's in C.S. in 1992.

It took some time for this Easterner to become accustomed to living in Oklahoma, but he does enjoy the severe weather. Kevin values his family time with his wife (Debbie) and sons (Braden-age 3 and Shane-age 6). The favorite thing his two boys like to do with their dad is wrestle. Golfing, skiing, playing softball and basketball, and working out are among Kevin's other free-time favorites.

Kevin enjoys the blend of meteorology and computer science that demand his attention on a daily basis. He is intrigued by the types of weather studied by the Lab, as well as new technology and the overall changing nature of the field. Kevin finds constant funding issues a challenge but feels one of his greatest successes has been bringing the lab up to an advanced technical level with a limited budget. ◆

Bio-Box

Current position: *Manager of Central Support Services*

Current project: *Complete transition from VAX to a UNIX-based system*

Education: *B.S. Meteorology - University of New York - Oneonta*

M.S. Meteorology - University of Oklahoma

M.S. Computer Science - University of Oklahoma

Polarimetric measurements of rain

by Alexander V. Ryzhkov and Dusan S. Zrnic

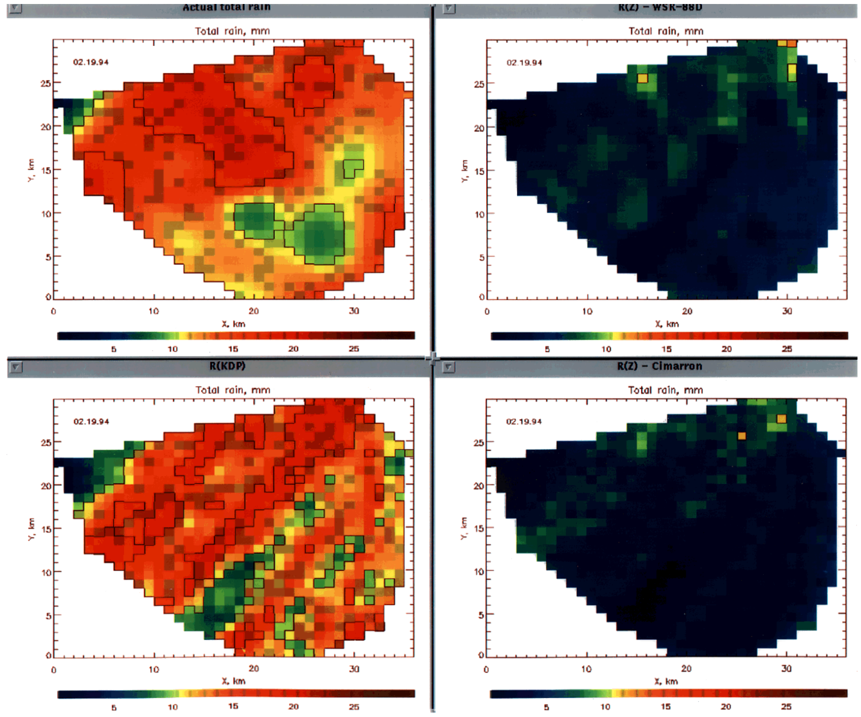
The potential exists to improve the estimation of rainfall amounts using polarimetric weather radars. These radars alternate the polarization of transmitted fields and sense differences in the corresponding received fields. The differences are caused by characteristics of the precipitation that backscatters the electromagnetic waves. An example is when the radar beam is backscattered by rain, the horizontally-polarized waves experience larger phase shift than the vertically-polarized waves because falling raindrops are larger in their horizontal dimension. The phase difference per unit length (km) between these two waves is the specific differential phase K_{DP}. It has been found that this parameter is almost linearly related to the rain rate. K_{DP} can be obtained with NSSL's Cimarron radar.

K_{DP} advantages over reflectivity

Because K_{DP} is obtained from phase measurements, it retains several advantages over reflectivity Z, obtained from power measurements. These are:

1) K_{DP} is independent of receiver and transmitter calibrations
2) K_{DP} is not affected by attenuation
3) K_{DP} is less affected by beam blockage
4) K_{DP} is not biased by ground clutter cancelers
5) K_{DP} is insensitive to variations in drop-size distribution
6) K_{DP} is little biased by the presence of hail
7) K_{DP} can be used to detect anomalous propagation.

Because of these advantages, addition of K_{DP} measurements to an operational radar network would enhance utility for hydrologic applications and short term flash flood forecasting. Routine absolute calibration of echo power could be simplified by comparing rainfalls obtained from K_{DP} and reflectivity factor Z. In the presence of partial beam blockage, such as exists at many WSR-88D sites near mountains, rainfall measurements would improve. They would be obtained at heights closer to the ground to minimize the effects of changes in precipitation with height and the horizontal drift of hydrometeors.



An example of rainfall totals contours for a convective rain in February demonstrates large differences between gauge totals and totals obtained with R(Z) from the WSR-88D and the Cimarron radar.

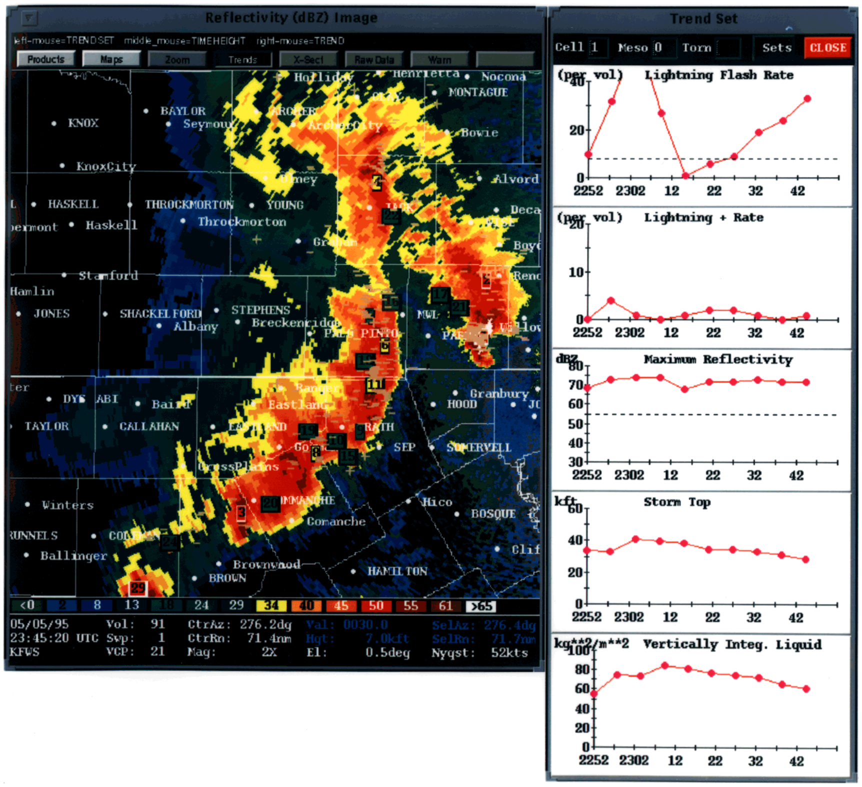
Quality of rainfall estimates evaluated

Currently we are evaluating the quality of rainfall estimates $R(K_{DP})$ obtained from K_{DP}. For verification, we use cumulative rainfall from a dense gauge network located in the Little Washita river basin. Analysis of four events confirms several advantages of the $R(K_{DP})$ estimates. In three convective cases, polarimetric $R(K_{DP})$ estimates agree better with gauge totals than the estimates R(Z). The root mean square differences between rain totals for the $R(K_{DP})$ estimates range from 1 to 17%, whereas the differences for the R(Z) estimates are between 6 and 65%. Although it requires further scrutiny, $R(K_{DP})$ also outperforms the conventional estimate in light rain (3 mm h^{-1}).

An example of rainfall totals contours for a convective rain event in February demonstrates large differences between gauge totals and totals obtained with R(Z) from the WSR-88D and the Cimarron radar (see above figure). Although the reflectivity factors of the two radars agree, the rain is underestimated by about a factor of three. Use of K_{DP} leads to good agreement with the gauge totals and illustrates the robustness of the method. ◆

For more information contact Dusan Zrnic at: zrnic@nssl.uoknor.edu

Addition of polarimetric measurements to an operational radar network would enhance utility for hydrologic applications and short term flash flood forecasting.



Reflectivity image from KFWS radar with superimposed lightning strike locations and storm cell ID numbers. The trend set plot (right side of figure) shows some lightning and reflectivity characteristics from an individual storm cell during the past hour.

Lightning data overlay provides new information

by Don MacGorman, Ron Holle, and Kurt Hondl

A user can select any individual cell and display plots of trends in its flash rates simultaneously with plots of trends in cell properties measured by radar.

NSSL is examining how lightning data can be combined with radar data in real time to provide additional information about storms for NWS forecasters and others concerned with weather hazards. A natural framework for our investigation is provided by NSSL's Warning Decision Support System (WDSS), which already has been used extensively to develop and test improved algorithms for diagnosing weather hazards using WSR-88D data. To handle lightning data, we modified WDSS to overlay lightning strike locations on displays of radar data in real time. Lightning flash rates were added through the use of a new algorithm, the Lightning Association Algorithm (LAA), which correlates lightning with storm cells. During each radar volume scan (typically lasting 5-6 minutes), the LAA tabulates the number of lightning flashes striking ground within 10 km of the center of storm cells identified from radar data by the Storm Cell Identification and Tracking Algorithm (SCIT) in WDSS.

NSSL has used lightning data in operational tests of the complete WDSS package at various locations for more than a year. This past spring, we used WDSS in Oklahoma specifically to test its lightning capabilities. Radar data for the test were provided by the WSR-88D radar at Twin Lakes (KTLX) in central Oklahoma. Lightning data were obtained from the National Lightning Detection Network operated by Global Atmospherics, Inc. (formerly GeoMet Data Services). There were two goals: 1) to examine whether the flash counts determined by the LAA were consistent with what a trained observer would measure, and if not, to determine how the algorithm should be modified; and 2) to test a large number of cells for consistent relationships between lightning trends and storm evolution and hazards, particularly relationships that would be useful for severe weather warning operations.

During our investigation, a wide variety of storms were observed, from small isolated storms to tornadic supercell storms and mesoscale convective systems. In real-time operations, no relationships between lightning and radar data appeared valid for all storms. However, large hail was produced consistently by strong storms where the majority of cloud-to-ground flashes lowered positive charge to ground, instead of negative charge, as is more common.

More detailed analyses during the next year will examine the evolution of lightning flash rates for a more complete set of storm types and environments. The ultimate goal is to determine the relationships between lightning and severe weather so that better short-term predictions of hazardous weather can be made.

◆

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

FASTEX studies cyclogenesis

Dave Jorgensen of NSSL/Mesoscale Research - Boulder (MRB) is a member of the science steering committee for the Fronts and Atlantic Storm Tracks Experiment (FASTEX). FASTEX is largely a European-lead project to improve forecasts of rapid cyclogenesis that often occurs during the winter just to the west of Europe. An experiment is planned for January-February 1997 to gather aircraft observations to better define the mesoscale structure of developing cyclones. A major component to the experiment is special targeted dropsonde observations of upstream precursors which will hopefully improve numerical forecasts in the 24-48 hour range. Results from FASTEX are applicable to U.S. winter storms that strike the west coast. People interested in perusing drafts of the operations plan can do so via the MRB www home page: "file://mred3.mmm.ucar.edu/www/nssl.html" under the FASTEX link. MRB involvement in FASTEX is funded by the office of the ERL director. ◆

FASTEX hopes to improve forecasts of rapid cyclogenesis during the winter west of Europe

NSSL/SPC hold daily weather briefing

by Chuck Doswell, Head, Mesoscale Applications Group

Every day at 11:00 a.m., NSSL and the Storm Prediction Center (SPC) hold a daily weather map discussion in the large conference room at NSSL. The purpose of the briefings is to explore what sort of products might be operationally feasible. Ultimately, the ideas explored during the map discussions and forecasting experiments will contribute to decisions about SPC operational practice and areas of needed research. The primary briefing tool is a new workstation being developed for SPC capable of displaying satellite, upper air data, radar, and model forecasts.

The SPC is charged with providing guidance forecasts of hazardous weather in support of NWS field offices. The informal map discussions focus on weather events that potentially are of interest to the SPC: severe thunderstorms, flash floods, heavy snow, blizzards, and freezing precipitation. On October 23, an experimental winter weather forecast program began. The map discussions became more formal, focusing exclusively on winter weather forecasting problems.

Much of the needed scientific research in support of the SPC's operational services is provided by NSSL's Mesoscale Applications Group (MAG). NSSL participants from the MAG group (Chuck Doswell, Charlie Crisp, Paul Janish, John Cortinas, and Ron Holle) will eventually be serving as SPC duty forecasters for up to 20% of their time. Their involvement with the weather briefings is an important part of becoming familiar with SPC operations. NSSL scientists, especially those in MAG, have an opportunity to make substantial contributions to the NWS modernization by means of the interactions represented by these map discussions. ◆

NSSL/SPC weather briefing

September 13, 1995

11:00 a.m. The NSSL/SPC weather briefing begins with a review of the previous day's weather. Items of special interest are the convective reports. Amarillo and Childress, TX, and Ft. Sill, OK reported hail between 3/4" and 1 1/4". Two tornadoes were reported in Florida, one northwest of Palm Beach and one north of Ft. Myers. Precipitation totals in the south were as high as 2.95" in Ft. Worth, TX.

11:07 a.m. The current surface map (analyzed by hand and projected on the wall) showed weak surface features. A trough hanging to the southwest over the Great Lakes had very light winds associated with it, making it ill-defined. A second trough over PA/NY was also difficult to find in the surface observations. A trough/convergence zone was noted over the Gulf of Mexico from the SW Gulf towards the northwest along the coast of LA, MS and AL. A ridge remained over the northern Rockies.

11:12 a.m. The satellite loop showed a large area of convection north of Del Rio, TX. Less significant convection was noted over KY and TN. A vorticity maximum was identified over MO and IL by a small area of clouds rotating cyclonically.

11:14 a.m. 850mb analysis showed 30kt winds over the Ohio Valley. 15-20kt SSE winds were providing a fetch of moisture from the Gulf of Mexico feeding the convection near Del Rio, TX. Convection developed yesterday across the TX panhandle in the absence of a strong 850mb flow. An observation was made that strong flow at 850mb is not necessary for the development of strong convection.

11:18 a.m. 500mb analysis showed 80kt winds over Saskatchewan and height falls to the east.

11:20 a.m. The initial panel of the ETA model showed thickness packing over southern Canada into northern ND and MN. A vorticity maximum identified at 500mb in the flow is forecasted to move east and die. A vorticity maximum in Canada is forecasted to move across the Great Lakes. The 24hr forecast shows Lifted Indices of -4 over the Gulf of Mexico, Texas, and the lower Ohio Valley. Instability was also indicated over Oregon.

11:30 a.m. The SPC "area of interest" for today will be Texas where there is a threat of heavy precipitation and flash flooding. A second area of interest is the Ohio Valley where mid-level winds support bow-echo development.

Mobile Doppler Radar: A new tool to investigate tornadic storms

by Erik Rasmussen, VORTEX Director and Field Coordinator

We envisioned a system that could be driven right up to the storm or mesocyclone, parked, and obtain volume scans of high-resolution Doppler velocity data.

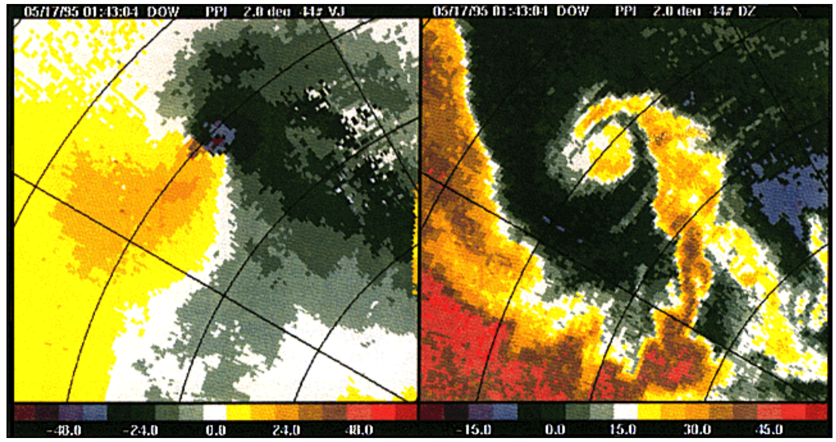
After the end of the first Verifications of the Origins of Rotation in Tornadoes EXperiment (VORTEX) in June of last year, Jerry Straka (University of Oklahoma School of Meteorology; VORTEX assistant director) and I discussed our successes and failures, and whether or not we were collecting the kind of data required to really understand important events in severe storms. It was obvious that the mobile mesonet system, a group of cars instrumented with high-quality weather observing equipment, could give us new insights into the pressure, temperature, and humidity fields near the ground. These fields give rise to the forces that cause air to accelerate and rotate, and knowledge of them would be an important new element in our understanding. However, we also realized that many of the hypotheses of the VORTEX experiment required a detailed view of the three-dimensional airflow in small regions of the target storms. It is quite possible that a lot of the events in the life cycle of a supercell storm may be caused by forces above the ground where we are nearly incapable of measuring temperature, pressure, and humidity directly, except along very isolated trajectories where our rawinsondes, borne by weather balloons, have risen. At the very least, we needed high-resolution observations of the airflow near and above the ground: if one can document the evolution of this airflow in three dimensions, the approximate forces causing the airflow to change can be deduced.

After VORTEX-94, it was apparent that we faced a serious problem that could prevent us from adequately evaluating any of our tornadogenesis hypotheses. We simply were not able to sufficiently resolve and document the motion of the air within the small region of the storm that potentially can give rise to a tornado: the mesocyclone. It was unlikely that a WSR-88D would ever be near enough to one of our target mesocyclones to provide the data we needed. Even the airborne research Doppler radars (on the NOAA P-3 and NCAR Electra) were only providing data every 300 meters or so and failed to resolve the vitally-important variations in wind immediately adjacent to the ground. Data from these aircraft will provide important new knowledge about the structure and evolution of airflow features that range in size from the mesocyclone up to the entire storm. But we needed information about wind variation in features ranging in size from tornadoes up to mesocyclones (100 m up to about 10,000 m).

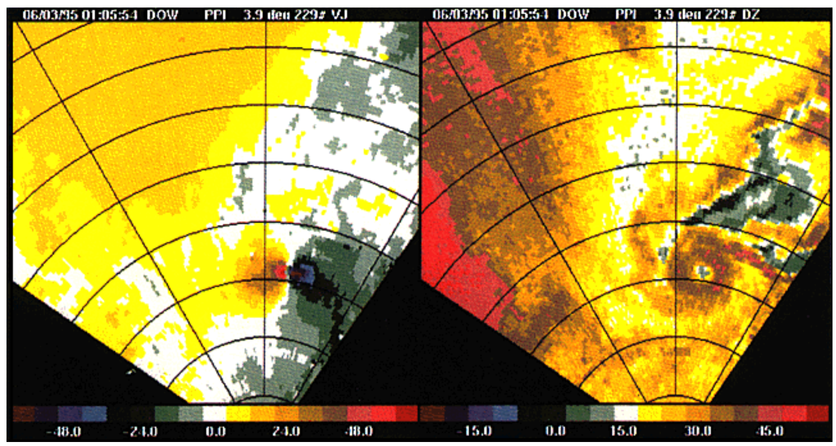
It was this problem that motivated us to develop a research Doppler radar that was fully mobile. We envisioned a system that could be driven right up to the storm or mesocyclone, parked, and obtain volume scans of high-resolution Doppler velocity data.

Joshua Wurman had spent several years at NCAR developing innovative Doppler radar technology. In the fall of 1994 he joined the faculty at the OU School of Meteorology as an Assistant Professor. Teaming with him, we laid the groundwork for the development of the “Doppler-On-Wheels." With the support of NSSL, a significant amount of development funds were provided to VORTEX. This funding paved the way for the collaborative support of the National Science Foundation and the University of Oklahoma. In addition, an NSSL vehicle was modified to transport the radar. The mobile Doppler radar system utilizes a rugged antenna pedestal and dish used in military missile-tracking applications for a number of decades. The transmitter was provided by NCAR and is a spare X-band (3 cm) transmitter formerly used with the NCAR CP-2 research radar. The receiver and signal processor were developed for this application by Mitch Randell and Eric Loew at NCAR/ATD. The system was largely built by Paul Griffin and Dennis Nealson of NSSL. All of this occurred in an amazingly short amount of time. We ordered parts in November and December, and carried out development, construction, and testing primarily in March and April of this year. All members of this team truly performed in a magnificent manner to put together a complicated system in such a short time. The radar was first deployed in VORTEX on 12 May. A few days later, on 16 May, a tornadic supercell moved from Garden City, through Kalvesta, Jetmore, and Hanston, KS. As the sun set, the mobile Doppler commenced scanning from a ridge west of Hanston. A tornado formed rather quickly and then intensified and remained on the ground for at least 45 minutes as it moved toward the east-northeast through open country. The mobile Doppler radar data provided our first-ever view of the reflectivity and velocity near a tornado with such tremendous resolution (top figure).

But the Hanston storm was just a warm-up for the very active early June we experienced. A number of tornadoes were observed with the mobile Doppler that month, but none so spectacular as the Dimmitt, TX tornado of 2 June. After scanning a violent tornado near Friona, TX, I (as the VORTEX Field Coordinator) directed the mobile Doppler to proceed toward Dimmitt as a new mesocyclone was intensifying and moving toward town. Jerry Straka maneuvered the truck through heavy rain and strong winds and drove through city streets to the south edge of town. The hydraulic feet were deployed to stabilize and level the truck, and Josh Wurman had the radar powered up and scanning prior to tornado touchdown. As this violent tornado moved around the east side of town, its arcing path kept it at a nearly constant distance from the mobile Doppler: less than 2 miles! The data obtained at Dimmitt are the best velocity and reflectivity data ever obtained on a tornado. They show (bottom figure) spiralling bands of rain and debris and a hollow core in the middle of the tornado. Although the radar averages windspeed throughout volumes of air about



Velocity and reflectivity fields at 2° elevation for the Hanston, KS tornadic storm. Data are from 01:43 UTC on 17 May 1995. The tornado was in the tip of the hook echo at a range of 8km. Range rings are 2km apart. Up is east.



Velocity and reflectivity fields at 4° elevation from the Dimmitt, TX tornadic storm. Data are from 00:06 UTC on 03 June 1995. The tornado is in the center of the donut shaped echo at 3km. Range rings are 1km apart. Up is east.

60 m on a side, it still detected winds of over 75 m/s (about 170 m.p.h). We expect that the analysis of these data, combined with the comprehensive mobile mesonet, photography, and airborne Doppler data, will provide important new knowledge of the processes of tornado generation, maintenance, and demise. The concept and utility of the mobile Doppler have been proven in VORTEX. It is clear that this system, with its clear-air capability, could be used for a variety of research missions, ranging from boundary layer structure, dust devils, and other phenomena on these small scales, up to documentation of storm outflows, microbursts, and mesoscale weather systems. In addition, the data collected using the mobile Doppler during VORTEX will provide important insight into circulations observed by the WSR-88D's. ◆

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Scientist works with NWS-Western Region to maximize WSR-88D uses in mountains

Steve Vasiloff, a meteorologist with the Stormscale Research and Applications Division at NSSL, has relocated to Salt Lake City for at least three years to gain an understanding of how to best utilize the WSR-88D in a mountainous environment. Vasiloff's relocation is the result of cooperation between NSSL and the National Weather Service - Western Region. The WSR-88D Operational Support Facility and the University of Utah have key roles as well. This project's goal is to improve prediction and detection of damaging downbursts, rain, and snow in mountainous terrain.

The project began this fall with the hook-up of NSSL's Warning Decision Support System (WDSS) to the WSR-88D Radar Products Generator. Much of the work on this project will be done in conjunction with the National Weather Service Forecast Office, located at the Salt Lake City International Airport, where day-to-day weather events will be monitored. The forecast office in Salt Lake City will serve as a testbed for enhancements to operations at other forecast offices in the Western Region.

Forecasters in the Western Region are faced with several operational challenges. One of these challenges is the prediction and detection of low-altitude weather phenomena from radars that are located on higher terrain. Because the radars are located at a higher altitude, certain phenomena typically occur below the lowest radar beam angle and go unseen by the radar. Thus, one objective of this effort is to investigate the feasibility of lowering the elevation angle of the lowest sweep in the radar's scan pattern (if permission is given to do so). Another objective is to test NSSL's Damaging Downburst Prediction and Detection Algorithm and assess the capability to predict damaging downbursts in the west. There is also considerable interest in evaluating parameters in the current WSR-88D precipitation algorithm. The WSR-88D precipitation algorithm enhancement work will use data from several radars in the Region.

Another challenge for the Salt Lake City Forecast Office is increasing the accuracy of snowfall forecasts. Snowfall forecasts will receive increasing attention as Salt Lake City will host the 2002 Winter Olympic Games. Indeed, ski resorts just east of Salt Lake City in the Wasatch Mountains continually demand improvement in snow forecasts. An experimental snowfall accumulation algorithm will be tested on the Salt Lake City radar as part of this project.

We believe cooperation among NSSL, the National Weather Service-Western Region, the WSR-88D Operational Support Facility, and the University of Utah will lead to improved prediction and detection of dangerous weather phenomena in mountainous terrain throughout the western United States. ◆ *For more information contact Mike Eilts at: eilts@nssl.uoknor.edu*