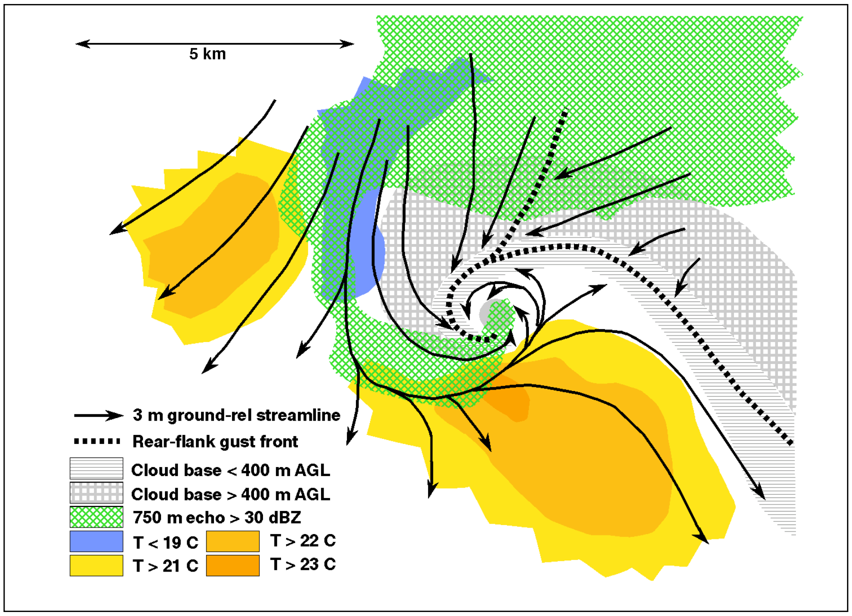
NSSL Briefings

Volume 2 No. 3 Summer/Fall 1998

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



Near-ground fields in the tornadic region of the 2 June 1995 Dimmitt, Texas storm observed by VORTEX. Data are from mobile mesonets, airborne radar (P-3 and ELDORA), mobile Doppler, and multi-camera photogrammetric cloud mapping.

In Brief.....

New findings on the origins of tornadoes from VORTEX

by Erik Rasmussen

For a quarter of a century, researchers at NSSL and their colleagues have been working to unravel the mysteries of tornado formation. In 1994 and 1995, NSSL hosted a major field experiment called the Verification of the Origins of Rotation in Tornadoes EXperiment (VORTEX). This field experiment produced a number of high-quality data sets of tornadic and non-tornadic supercell thunderstorms, including airborne Doppler radar data, mobile mesonet data, special soundings, mobile Doppler radar data, and other conventional data sets. Several studies have been published utilizing the airborne Doppler data, but the difficult work of integrating all of these new, unique data sets into coherent pictures of storm structure and dynamics is ongoing. This integrated research approach is the one being utilized by Erik Rasmussen and David Blanchard of NSSL, along with colleagues Jerry Straka and Paul Markowski of the University of Oklahoma.

Thus far, a few important new findings have been made. We have found that boundaries, which are the leading edges of pools of cooler air left behind by thunderstorms, are prime locations for later tornado formation. Evidence suggests that the temperature contrast along these small-scale "fronts" supplies the air with horizontal rotation like a rolling pin. Then, when a mature storm moves across a boundary, the rotation is tilted upward into the storm's updraft so that the spin has the orientation of a top, while at the same time being stretched and intensified. This process imparts strong rotation to the lower levels of the storm updraft, which seems to be a necessary, but not sufficient, condition for tornado formation.

Tornado formation itself seems to be strongly linked to the character and behavior of a downdraft at the back side of the supercell storm, recognized for many years as the "rear-flank downdraft." In tornadic supercells observed in VORTEX, this downdraft straddles two regions of opposite rotation: the developing mesocyclone, with its cyclonic, or counter-clockwise spin, and a region of anticyclonic, or clockwise spin, that spirals around the outside of the downdraft. As this downdraft develops, it carves its way into the main storm updraft in the shape of a hook. In fact, this downdraft often contains enough rain to produce the hook-shaped echo seen on radar reflectivity displays. In effect, the downdraft draws rotation downward from aloft, while at the same time focusing it toward a common center. Once the rotation is focused enough, it becomes strong enough to develop a funnel cloud and raise dirt and debris at the ground, becoming a tornado.

Most of the above process occurs in a very small area, perhaps a couple of miles across. This was not known during VORTEX, when field teams were deployed across a large region of each storm. In subsequent, small focused field efforts, field teams supported by NSSL and the University of Oklahoma through the NSF have been attempting to operate in this small region, mainly in the hook echo and inside it. This region has been called the "bear's cage" by storm chasers for many years--even experienced storm chasers would rather not

NSSL News Briefs

NSSL scientists publish book The Electrical Nature of Storms

Oxford University Press has just published a new graduate textbook by two NSSL scientists, Don MacGorman and Dave Rust. Their book, The Electrical Nature of Storms, provides a comprehensive, modern treatment of electrical processes of thunderstorms. In recent years, new technologies have led both to dramatic advances in knowledge of these processes and to increasing use of lightning-mapping systems by forecasters and other federal personnel concerned with weather hazards. However, most meteorologists have little experience either in this multi-disciplinary field or with lightning-mapping systems. The authors' goal was to systematically present these wide-ranging topics in a single reference that would be valuable for professionals, but also suitable for teaching meteorology and physics graduate students. More information about their book is available at http://www.nssl.noaa.gov/~elecbook on the internet.

NSSL Signs CRADA with WeatherData Inc.

NSSL recently signed a Cooperative Research and Development Agreement (CRADA) with WeatherData, Inc. to develop a lightning threat algorithm. This is the first time NSSL has entered such an agreement with a private company.

The lightning threat algorithm will combine WSR-88D radar data with data from the National Lightning Detection Network (NLDN) in real-time to forecast areas of lightning threat.

Two algorithms developed by MIT/LL (scale separation and correlation tracking) will be used to identify and forecast the location of radar echoes up to 30 minutes in advance. Then an algorithm developed by NSSL will utilize the cloud-to-ground lightning strike data from the NLDN along with the forecasted echo positions to determine which radar echoes are electrically active and a potential threat to WeatherData customers.

be there! But with knowledge gained through VORTEX, and with an extra degree of caution, field teams have gathered data in this region in many more supercells. The goal of this ongoing work is to determine what sorts of rear-flank downdrafts are supportive of tornado formation as opposed to those that actually work to hinder or prevent tornado formation.

VORTEX has produced a number of troubling new findings. For example, it appears that perhaps many fewer supercells and mesocyclones produce tornadoes than scientists originally believed. At one time, researchers felt that tornadoes somehow were caused directly by mesocyclones, and that perhaps one-half of all mesocyclones produced tornadoes. We now know that this is not the case, and that tornado formation is a complicated process that depends perhaps only indirectly on the presence of a mesocyclone. Further, we have learned that the difference between tornadic and non-tornadic mesocyclones can be very, very subtle. We are examining a case in which a storm shows all indications of being tornadic on WSR-88D, and in fact in mobile Doppler radar data it has a vortex with a hook and an "eye" in the hook... indicative of very strong rotation and the centrifuging of raindrops, within about 100 m of the ground. This pattern of reflectivity and velocity is in most respects the same as observed in the tornadic supercells. Yet, no tornado formed.

In the near future, VORTEX follow-on experiments will continue to focus on the subtle differences between tornadic and non-tornadic supercells. Increasing attention will be paid to the degree of buoyancy of the rear-flank downdraft; is it warm, so that it can readily rise when ingested into the tornado, or is it cold so that it spreads away from the storm; and the tornado, if it can form, expends much energy lifting the dense air? To explore this, novel new data-gathering techniques must be developed. Don't be too surprised to see NSSL scientists launching small rockets through these downdrafts to measure their temperature structure in the future! ◆

For more information contact Erik Rasmussen at: rasmussen@nssl.noaa.gov

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50th Anniversary of the first tornado forecast brings visitors to NSSL

NSSL employees hosted hundreds of visitors of all ages for an Open House in honor of the 50th Anniversary of the first tornado forecast. The festivities occurred from March 23-25, sponsored by the Oklahoma Weather Center and Tinker Air Force Base (AFB).

Crowds tour Joint Mobile Research Facility vehicles

The Golden Anniversary event was in honor of Air Force Captain Robert C. Miller and Major Ernest J. Fawbush who correctly predicted that atmospheric conditions were ripe for tornadoes in the vicinity of Tinker AFB. This first official tornado forecast was instrumental in advancing the nation's commitment to protecting the American public and military resources from the dangers caused by natural hazards. ◆ *For more information see: http://www.nssl.noaa.gov/GoldenAnniversary/*

From the Director:

Are new facilities in our future?

by Jeff Kimpel, Director NSSL

The National Severe Storms Laboratory has occupied the same building since 1972. At that time NSSL had about thirty-six federal employees, eight University of Oklahoma affiliates and an annual budget of approximately $1.6M. Twenty-six years later those numbers have grown to 54 federal employees, 79 mostly OU employees and two National Research Council postdocs. Annual expenditures have increased to $11.0M. True, we have expanded beyond our 1972 facilities into a menagerie of trailers, storage buildings, and the balloon barn, but the over crowding, cubicle-farms, and lack of meeting space are now impeding our ability to get the job done. In spite of all this, we made the bold decision to invite the NWS Storm Prediction Center to share our main building, enhancing the research and operational effectiveness of both groups. This led to more crowding, more temporary structures, and more excitement in our work environment.

NSSL 1968

Our lease with OU has expired several times and we continue to occupy our present facilities on short term extensions until a suitable alternative is found. We will be moving. The only questions yet unanswered are where and when. Doing nothing is not an option as our present facilities are well below government standards.

There are three possible options: move to commercial space, move into a new facility constructed for NOAA on the present North Campus site, or join our University of Oklahoma colleagues in a shared facility on the proposed South Campus park site (Jenkins and Highway 9). All three of these options are viable and currently under consideration.

NSSL 1971

Organizations like NSSL need to completely reinvent themselves every 20 to 30 years to stay competitive. Under the able leadership of Bob Maddox, NSSL has revamped its mission and garnered the resources necessary to set its strategic direction a decade or so into the approaching millennium. Facilities are a necessary and important component of that strategic direction.

Our major concern now is that we design facilities in harmony with our mission and strategic goals, not only for the present 20-30 year cycle, but also for the next one. What work will NSSL be doing and what type of work environment will support and enhance employee success and morale? Should the new building's appearance be inspiring like the NCAR Mesa facility? Is functionality the first concern? What are the advantages and disadvantages of the Energy Center at OU or the new NOAA building in Boulder, Colorado? Can we get good ideas from the new engineering building at The University of Colorado? Who should our neighbors be? How should groups which occupy the new facilities be organized?

NSSL leadership invites you to help us think about our next facility. What are your thoughts and ideas as they apply to our once-in-a-career opportunity? You can read about some of the early planning and add your two cents worth at www.nssl.noaa.gov/newbuilding/. Hope to see you there. ◆

NSSL News Briefs

NSSL on tour with Universal Studios' *"Twister: Ride It Out"*

NSSL scientists and one of NSSL's mobile laboratories traveled from Boston to Miami and Minneapolis to New Orleans, a 15-state, 23-city promotional tour this summer with Universal Studios Florida. Universal was promoting their new Twister attraction that features a 50-foot high, 15-foot wide vortex. It is the world's largest vortex simulator, and is patterned after work done at NSSL in the early sixties. Most of the stops were at science museums, where NSSL promoted severe storm research along with storm safety and awareness. Participating in this tour were Doug Forsyth, Les Showell, José Meitin, Harold Brooks and Ken Howard.

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
ELDORA - Electra DOppler RAdar
ETL - Environmental Technologies Laboratory
FAA - Federal Aviation Administration
MCS - Mesoscale Convective System
MEaPRS - MCS Electrification and Polarimetric Radar Study
NCAR - National Center for Atmospheric Research
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
OCS - Oklahoma Climate Survey
OU - University of Oklahoma
SOO - Scientific Operations Officer
SPC - Storm Prediction Center
VORTEX - Verifications of the Origins of Rotation in Tornadoes Experiment
WDSS - Warning Decision Support System

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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NSSL scientists mentor students for the summer

by Susan Cobb, Daphne Zaras, and Ron Holle

Ten undergraduate students from around the country spent 10 weeks of their summer in Norman, working under the supervision of an Oklahoma Weather Center scientist. Research projects, writing scientific papers, and giving presentations filled their days. Some of these students were even able to fly on the P-3 during MEaPRS and go out with the field program Sub-VORTEX. Most of them say it has been the experience of a lifetime.

The students were here through the NSF-funded Research Experience for Undergraduates (REU) program. The REU program is designed to attract talented undergraduates to careers in mathematics, science, and engineering through an active research program and the mentorship of those who work in these fields. Most of the students came from small colleges where their exposure to meteorological research is minimal.

This year's effort was lead by OU/CAPS's Mark Palmer and Shannon Shropshire with a coordinating committee including Andrea Melvin (OCS), Randy Peppler (CIMMS), and NSSL's Ron Holle and Daphne Zaras, also NSSL/CIMMS. Two of the ten students were mentored by scientists at OU, and the remaining eight were under the supervision of NSSL/SPC scientists.

In casual interviews conducted towards the end of their term, we discovered what some of this summer's REU students valued most about the program. ◆

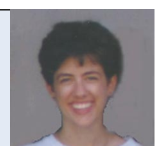
The REU program is important because...

"Too few students have a chance to work closely with real scientists doing real scientific projects before they graduate. This is important for at least two quite different reasons. (1) If they become scientists, this experience can be a good beginning, (2) even if they don't become scientists, at least they gain some insight into what scientists do. In a society increasingly ignorant about science, #2 is quite significant!"

- Chuck Doswell, NSSL scientist/mentor

Student: Ryan Fuller
College: Northland College, Ashland, WI
Mentor: Dave Stensrud (NSSL)
Project: Relationship between easterly waves and surges over the Gulf of California during the summer monsoon period

Ryan says he appreciated "having his eyes opened "to the wide range of career possibilities in meteorology."



Student: Alicia Cacciola
College: State University of New York at Albany
Mentor: Bob Johns (SPC)
Project: Shortwave troughs and tornadoes

Alicia's favorite part of her experience was working an entire shift with SPC SOO Bob Johns. She analyzed some maps and listened to him talk through the process of putting out watches and calling the local offices. Afterwards, she was able to go out and chase the storms that had been forecast

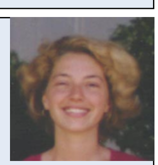
Student: Christina Hannon
College: University of Oklahoma
Mentor: Don MacGorman (NSSL)
Project: Coevolution of lightning strikes and storm structure

Christina's favorite activity was being in the field with MEaPRS and learning about research first hand. She says, "finding the problem is fun."

What do YOU get out of it (as a mentor)?

"Satisfaction of seeing the student carry out a project and feel good about it."

- Carl Hane, NSSL scientist/mentor

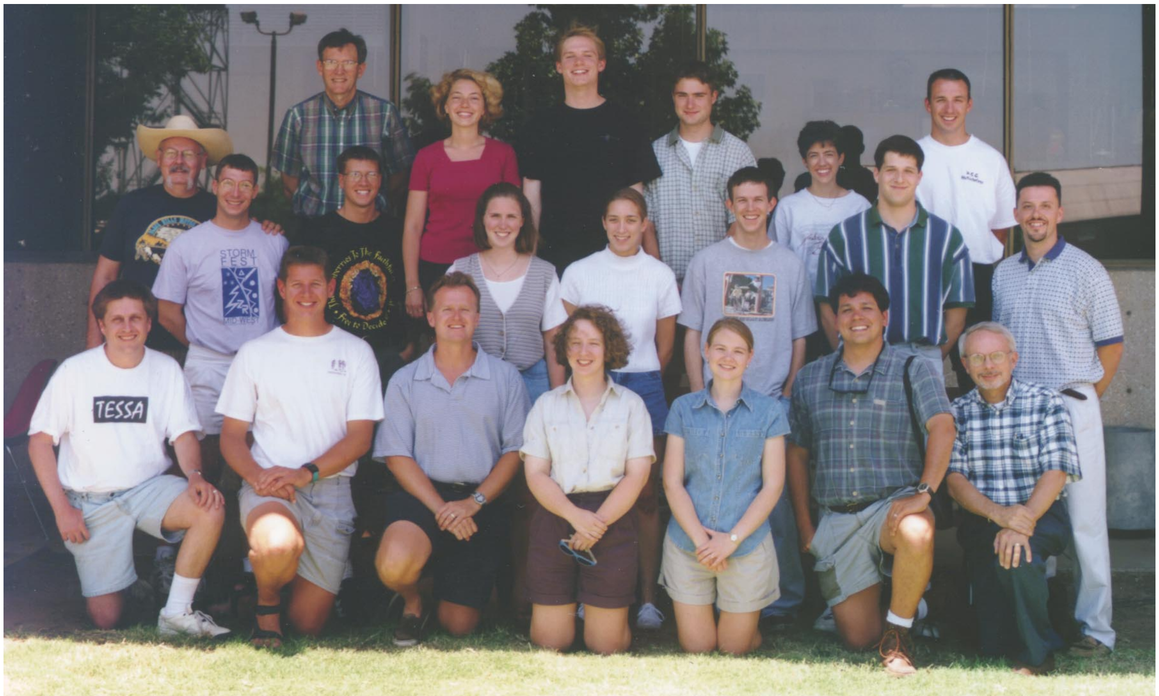


Student: Jamie Casto
College: Lyndon State College, VT
Mentor: Chuck Doswell (NSSL)
Project: Effects of shortwave troughs and tornado formation

Jamie loved being able to participate in field programs like Sub-VORTEX. She says she liked "knowing what they do (data collection) to get to the research part."

Student: Christopher Rozoff
College: University of Wisconsin-Milwaukee
Mentors: Harold Brooks (NSSL) and Jeff Craven (SPC)
Project: On hail forecasting schemes and future directions

Chris liked participating in "totally relevant research on serious issues."



REU participants: (Bottom row, left to right) - Harold Brooks, Scott Richardson, Randy Peppler, Daphne Zaras, Shannon Shropshire, Mark Palmer, Ron Holle. (Second row, left to right) - Chuck Doswell, David Schultz, Ryan Fuller, Jill Derby, Christina Hannon, Russell Teabeault, Gregory Gallina, J.T. Johnson. (Top row, left to right) - Carl Hane, Jamie Casto, Steven Decker, Chris Rozoff, Alicia Cacciola, Chris McAloon. (Not pictured) - Don MacGorman, Dave Andra, Bob Johns, David Stensrud, Jeff Craven, Kelvin Droegemeier, Andrea Melvin.

Other students and their projects:

Student: Steven Decker
College: Iowa State University
Mentor: David Schultz (NSSL)
Project: Are potential vorticity anomalies associated with flash floods?

Student: Jill Derby
College: North Carolina State University
Mentors: Carl Hane (NSSL) and David Andra (NWSFO)
Project: Climatology of warm season morning mesoscale convective systems and their environments

Student: Gregory Gallina
College: Valparaiso University, IN
Mentor: J.T. Johnson (NSSL)
Project: Development of the County Warning Area (CWA) database and testing

Student: Christopher McAloon
College: Plymouth State College, NH
Mentor: Scott Richardson (CIMMS)
Project: OASIS (Oklahoma Atmospheric Surface-Layer Instrumentation System)

Student: Russell Teabeault
College: University of Oklahoma
Mentor: Kelvin Droegemeier (CAPS)
Project: Size, spacing, and predictability of deep convective storms

For more information contact Ron Holle at: holle@nssl.noaa.gov or Daphne Zaras at: zaras@nssl.noaa.gov

I wanted them to learn:

"Not every road you take during research is a profitable one."

- Harold Brooks, NSSL scientist/mentor

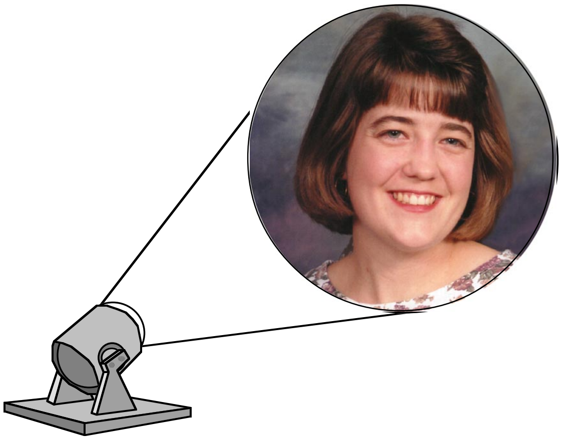
"I want them to understand the care and hard work that go into collecting and analyzing data. When they read some 'fact' in their classes, they need to understand that the data on which the fact is based typically have shortcomings that require ingenuity and care to overcome."

- Don MacGorman, NSSL scientist/mentor

I chose to be a mentor because:

"It is a way to try to sustain good science for years to come by fostering someone's excitement for the field."

- J.T. Johnson, NSSL scientist/mentor



Employee spotlight: Pam Mackeen

by Susan Cobb

Blowing sand and dirt had tormented the third grade "Bumblebees" softball practice one afternoon. When the team found out later that the source of the blowing dirt was a tornadic thunderstorm, it caught the attention of their second baseman, Pam Mackeen. By her eighth grade earth science class, the weather did more than just catch Pam's attention. It was then that she seriously began considering meteorology as a career--it seemed to offer the sort of challenge on which she thrived. College at Saint Louis University provided the smaller program and well-rounded education she desired. In addition, the campus was located within walking distance of Forest Park, the Fox Theatre, and Powell Symphony Hall.

After completing her B.S. and M.S. at St. Louis University, Pam began pursing her Ph.D. at the University of Illinois in the area of climatology. After one semester, however, she decided that she wanted to gain some real-life work experience. At that time Pam saw a job opening at NSSL for algorithm development. The chance to work on a project that the NWS would actually use and in the end would benefit society was just what she wanted to do. Pam moved to Norman on New Year's Day, 1995.

Bio Box

Current position: *Research scientist, Severe Weather Warning Applications and Technology Transfer Team*

Current project: *Investigating the use of environmental parameters derived from the RUC-II and satellites in forecasts of growth and decay for organized convective systems*

Education: *B.S. Meteorology, 1992 Saint Louis University*

M.S. Meteorology, 1994 Saint Louis University

Favorite book: *Pride and Prejudice*

Favorite movie: *Sound of Music*

Favorite place on earth: *Skyline Drive Park, Shenandoah Valley, VA*

At NSSL, Pam first worked on projects such as the evaluation of the Storm Cell Identification and Tracking (SCIT) algorithm and the implementation of SCIT into Build 9, and WATADS. Then she became an active member of the Convective Weather Product Development Team which is sponsored by the FAA. Scientists from NCAR, NSSL, and Lincoln Laboratory work together toward a common goal: to develop algorithms, using components developed at each lab to predict initiation, growth, and demise of convection. Over the last two years, Pam's contribution was to analyze radar-derived storm characteristics from the algorithms that NSSL has developed for the NEXRAD program to determine which characteristics, if any, could predict storm longevity. With these projects completed, her focus has broadened to include larger-scale systems (regional to national scale) "to determine the operational value of environmental parameters derived from the RUC-II in forecasts of growth and decay for organized convective systems, such as squall lines. In addition to the RUC II, we will be investigating the use of satellite, lightning, and radar data to predict the system's evolution." On the side, Pam has also studied heat bursts.

If you are ever in a morning meeting with Pam, and there is a plate of donuts on the table, you might notice she won't touch them. She worked in a donut shop as a teenager and hasn't eaten one since. Another interesting thing about Pam is how she met her husband Dan. Pam was the Teaching Assistant for a Map and Chart Analysis class he was taking. She says Dan wisely waited to ask her out until after the grades were posted.

Pam has carried her passion for softball from the third grade team "Bumblebees" through college and the present. She was responsible for helping start the coed softball team at NSSL named the Cyclones. Pam also enjoys hiking in Southeast Oklahoma, and aerobics (to relax she says!) Playing the piano, singing in the choir at church, reading, and watching movies are her other favorite pastimes. Pam says she tries not to "get sucked into one thing."

Recently, Pam submitted her first "lead author" paper to "Weather and Forecasting." Further ahead, she says she is considering finishing her Ph.D. In the meantime, she has gone back to school part time. The class she is taking, "Forecast Evaluation and Decision Analysis," is in another area of interest to her--the application of statistics to meteorological data. This opportunity to keep on learning is what Pam likes about her job. ◆

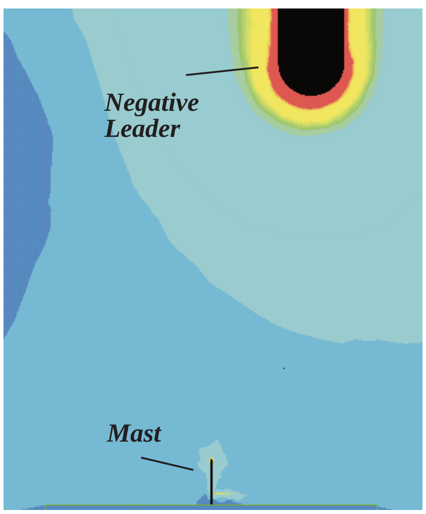
Model sheds light on lightning protection of WSR-88D sites

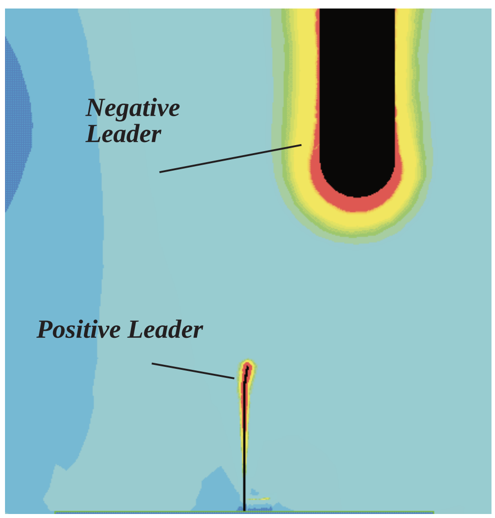
by Vlad Mazur

Lightning is a serious threat to WSR-88D sites around the United States. NSSL is working to improve lightning protection of WSR-88D sites through a Memorandum of Understanding (MOU) between NSSL and OSF. Part of the MOU includes the development of a 3-dimensional model of lightning interaction with a ground structure protected by a vertical rod. The following figures illustrate an example of the results. The model was created to help evaluate present and proposed lightning protection systems.

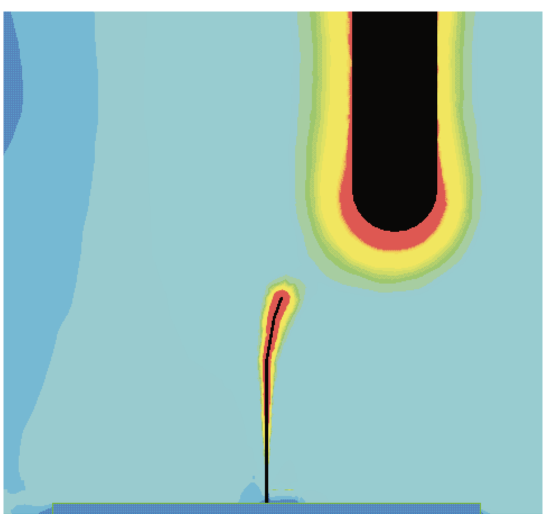
Results of the modeling suggest that the idea of an universal definition of a zone of lightning protection is unrealistic, because the dimension of the region where a vertical rod of a given height serves as a lightning protector depends heavily upon the potential of the lightning leader. In particular, it would be very difficult to protect a ground structure with a vertical rod against lightning leaders with a low potential. ◆ *For more information contact Vlad Mazur at: mazur@nssl.noaa.gov*

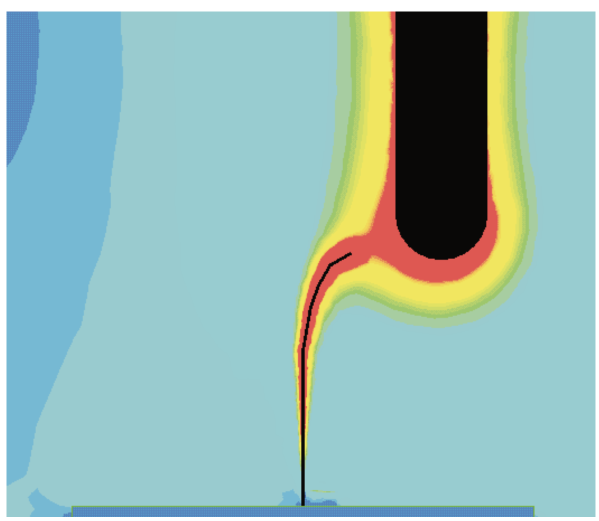
"...a universal definition of a zone of lightning protection is unrealistic"

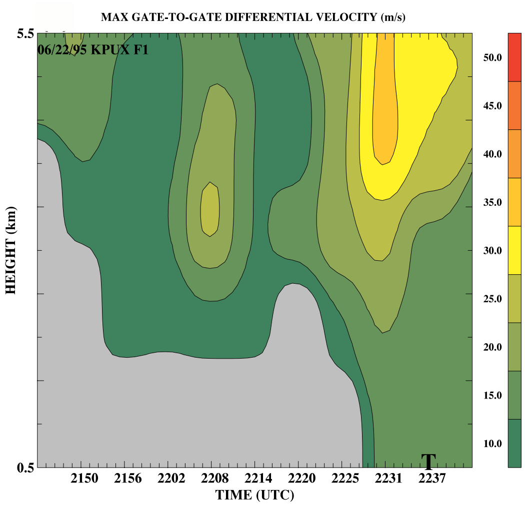


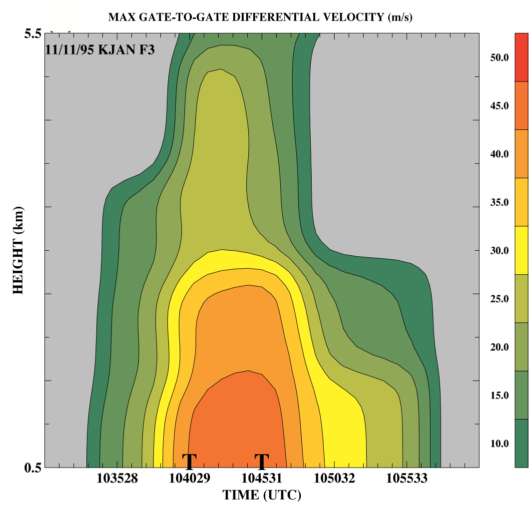


__Upper left:__ Downward leader of 30m diameter, 100 MV potential, 45m away. Leader's tip is 185m above ground. Breakdown occurs at the tip of the vertical rod.
__Upper right:__ The same as in upper left, except leader's tip is 125m above ground, and the positive leader from the vertical rod is 37.5m long.
__Lower left:__ The same as in upper left, except leader's tip is 95m above ground and the positive leader from the vertical rod is 52.5m long.
__Lower right:__ The same as the upper left, except two leaders contact when the downward leader tip is 80m above ground.









Left figure: *Time-height diagram of maximum, gate-to-gate differential velocity, from a tornadic storm near Falcon, CO on 22 June 1995. This shows a descending TVS. Bold-faced "T"s denote tornado times.*

Right figure: *Same as above except from a tornadic storm near Jackson, MS on 11 Nov 1995. This shows a non-descending TVS.*

Descending and *Non-descending* Tornadic Vortex Signatures

by Jeff Trapp

In a previous issue of *NSSL Briefings*, I reported on research Bob Davies-Jones and I did on hypothesized modes of tornadogenesis. In what is considered by many to be the archetype of tornadogenesis, the embryonic tornado develops within the mesocyclone, several kilometers above the ground, and gradually descends to the ground, perhaps through a process known as the "dynamic pipe effect." We showed, however, that tornadoes also may form somewhat uniformly over a several-kilometer vertical depth, or appear only at the lowest altitudes and then "ascend."

"...we found (with a standard error of 7%) that 52% of the sampled tornadoes had descending TVSs, and 48% had non-descending TVSs."

Our study provided theoretical explanations for these two primary modes of tornado development but could say nothing about their occurrence in the atmosphere. In particular, knowledge of the relative frequency of each mode is important because, theoretically, the "non-descending" tornadoes tend to develop much more rapidly than do their "descending" counterparts. This has obvious implications on the issuance of timely warnings by operational meteorologists.

A tornadic vortex signature (TVS) in Doppler weather radar data is a degraded image of an embryonic or fully-developed tornado, as shown by Rodger Brown, Les Lemon, and Don Burgess in the 1970's. The opportunity to examine a large variety of tornadoes via TVSs has only recently been provided by the implementation of the WSR-88D network. Thus, with support from the Cooperative Program for Operational Meteorology, Education and Training, we (DeWayne Mitchell, David Andra, Dan Effertz, Greg Tipton, Irv Watson, a few others, and I) sought to determine the frequency of descending versus non-descending TVSs, and hence tornadoes, by analyzing signatures of radar-detected tornadoes.

A geographically-diverse data set, comprised of 52 events varying from southern Great Plains supercell tornadoes to landfallen tropical cyclone-spawned tornadoes, was considered. Upon classifying each by an objective means, we found (with a standard error of 7%) that 52% of the sampled tornadoes had descending TVSs, and 48% had non-descending TVSs.

The results were stratified according to attributes of the tornado and TVS. For example, the descending TVSs in our sample were associated with greater *differential velocity* (the change in Doppler velocity across two adjacent radar beams) and greater tornado lead time. Tornadoes within squall lines and bow echoes tended to be associated with non-descending TVSs (see figure), an identification which provided a mean tornado lead time of 5 minutes.

Based on the results of this study, radar operators should recognize, while interpreting Doppler radar signatures for tornado warning decisions, that a large percentage of tornadoes form in a manner different than had once been thought. ◆

For more information contact Jeff Trapp at: trapp@nssl.noaa.gov

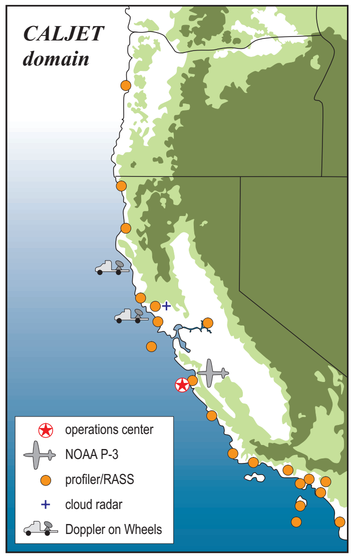
Blame it on El Niño

by Tom Shepherd and Susan Cobb

When NSSL scientists first agreed to assist in project CALJET (CAlifornia Land-falling JETs), they thought they were just going to lend their expertise temporarily to Principal Investigator (PI) Marty Ralph (ETL) on his first aircraft project. But, as in everything else this year, El Niño changed that.

The project was initially awarded 80 flight hours on the NOAA P-3 aircraft to study the low-level jet associated with the frontal boundaries of Pacific storm systems. This jet often contains a great deal of moisture, causing extreme coastal rains when it hits the mountains along the west coast of the United States. While CALJET was not targeted as an EL Niño study specifically, the result of the record El Niño event was a greater-than-average number of storms than CALJET was designed to study.

The P-3 involvement in CALJET was scheduled to begin on January 16, 1998 and end on February 28, 1998. Before CALJET even started, an additional 100 flight hours were awarded due to the heightened interest in the continuing strong El Niño event. Mid-project, NOAA officials requested another extension--the real-time information that was being provided by instrumentation onboard the aircraft was extremely valuable to the NWS meteorologists on the west coast. They found their forecasting efforts were greatly enhanced by this real-time data that was being ingested into the latest model runs. More aircraft time was added, making a total of 235 flight hours in 26 aircraft missions. In terms of aircraft hours, this made CALJET the largest project to date since the aircraft became a part of the NOAA fleet. The last flight was March 24, 1998, and NSSL participated in CALJET throughout the extended time.



NOAA's P-3 research aircraft has been used in several NSSL research projects including VORTEX and FASTEX. NSSL's role in CALJET was to share our in-flight expertise. NSSL was represented in the project by 5 scientists. Diana Bartels was present the initial 2 weeks of the project as a crew member onboard the P-3. Her role was to train Naval Post Graduate School meteorologists in the use of the Airborne Vertical Air Profiling System (AVAPS). Dave Jorgensen and Brad Smull were part of CALJET for two separate 2-week intervals to provide scientific guidance. Tom Shepherd and John Daugherty were present for the entire project. Shepherd was the radar scientist onboard the P-3 who provided in-flight interpretation of the radar data, and flew on all but one of the 26 missions. John Daugherty was the data manager for the project. He flew on several of the missions as well as provided invaluable pre-flight and post-flight meteorological products to the aircraft PI's. ◆

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

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Development of OPUP

by Kurt Hondl

NSSL has started the development of the Open Systems Principal User Processor (OPUP). This system is being developed on behalf of the Air Force Weather Agency (AFWA) and will replace the WSR-88D Principal User Processor (PUP) hardware that was deployed with the WSR-88D. The OPUP project plan is geared to complete the development effort and begin deployment during the year 2000.

The Air Force is re-engineering its weather operations and consolidating its forces into operational weather squadrons (otherwise known as regional hubs). There will be four regional hubs in the continental U.S. Each hub will be responsible for forecast and warning products for military installations in their multi-state area of responsibility.

The current PUP system was designed for an associated connection to one WSR-88D Radar Product Generator (RPG). The current PUP only provides a display device for a single user. These restrictions are not functional in the re-engineered AFWA operational environment.

The OPUP is being designed to meet the needs of the AFWA. Their new operating environment calls for a regional hub to access up to 20 RPGs in their area of responsibility. There will also be multiple forecasters who will require access to radar data at their individual workstations.

The OPUP system is being designed to re-use the software infrastructure libraries already developed by the Open System RPG (ORPG) development team. This will provide a consistent design across all the open system projects.

The graphic tablet and puck of the current PUP will be replaced by a windows Graphical User Interface (GUI). The design of the product display GUI will take concepts from the AWIPS and WDSS display systems. Radar mosaic displays will also be available with OPUP as data from multiple WSR-88Ds will be available in the AFWA regional hubs. ◆

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NSSL and SPC scientists take a bumpy ride

NSSL's Ann McCarthy, meteorologist and web manager, and SPC's Greg Carbin, Mesoscale Forecaster, each took a bumpy ride on NOAA's WP-3D 'hurricane hunter' aircraft during the Mesoscale Convective System (MCS) Electrification and Polarimetric Radar Study (MEaPRS). The role of the P-3 during the project was to make multiple horizontal passes and ascent and descent soundings both ahead of the MCS convective line and within the trailing stratiform deck. Each trip tended to be pretty rough. The following is a brief account of Ann's experience followed by Greg's "Trip Report" for the SPC.

Ann McCarthy, NSSL Meteorologist and Web Manager

"I had the opportunity to join the MEaPRS scientists on the P-3 the Sunday of Memorial Day weekend. The flight lasted about 8 hours. We left Oklahoma City at 10 p.m. Sunday and returned around 6 am Monday morning. Our flight took us to the Oklahoma/Kansas border and north to Wichita. During the first few hours of the flight we bumped around through strong convective storms hitting several updrafts in excess of 10 m/s (23 mph). Later toward morning the flight was more smooth. We spent time taking passes at various levels through a stratiform deck. I did find out, however, that the melting layer can be rather bumpy as well.

I had access to a workstation with displays of the two airborne Doppler radars, flight information, and various atmospheric parameters. Having the opportunity to view all of the data while flying was incredible. The one difficulty I had was adjusting to the radar. Every time the plane took a turn there was a new display. It was not always very clear to me where we were in relation to the storms or the ground.

That night, I was able to see, on radar, a hook echo near Enid and a bow echo with book end vortices, spectacular lightning, St. Elmo's Fire, and interesting cloud particles with the cloud physics instruments.

Several days later, I learned that Greg Carbin from the Storm Prediction Center took a similar flight. The following is his account of the trip. His experience is much like mine, including getting sick. I don't think I could word it any better."

Greg Carbin, SPC Mesoscale Forecaster

We departed Oklahoma City at 8 p.m. CDT (01 UTC) and headed NW toward the Kansas/Nebraska border where a warm front was developing. Severe storms had already developed over eastern Colorado, the Texas panhandle, eastern New Mexico, and northern Oklahoma. An MCS was expected near the warm front and the plan was to fly transects through the stratiform precipitation region of the MCS, generally along and WNW of the strongest storms.

The outbound flight was smooth at a cruising altitude varying from 13,000 to 16,000 feet. The aircraft is equipped with an amazing array of electronic equipment, and I was lucky to get a window seat and workstation with two high-resolution monitors where I could view a number of aircraft and atmospheric parameters. In addition to the display of tail-mounted and belly-mounted radar data, I could view live video from the nose of the plane, the short and long range track on a LAT/LON grid, the graphical output from the cloud micro-physics sensors located under the wings, and a complete listing of aircraft speed, altitude, pressure level, ambient temperature, dewpoint, and electric field strength. Distance to and from various locations was also displayed. Most of the flight was conducted at just under 500 mb. The winds at this level were from the SW at speeds of 25 to 40 KT.

After cruising at over 230 KT for a little over one hour, we arrived over extreme northwest Kansas. The setting sun was highlighting some very impressive thunderstorms to our east and west. The largest storms were located over eastern Colorado with another cluster of storms to our north, over southwest Nebraska. Unfortunately, the developing storms over Nebraska meant that we would be leaving the NSSL ground-based sounding vans behind over central Kansas. The three vans and three balloon trucks had left Norman earlier in the day in an attempt to intercept the developing MCS at the time of our fly-through. With the storms developing farther north, there would be no ground-based balloon soundings tonight.

The flight director and principal investigator decided to fly to the storms that were over southwest Nebraska, near Ogallala. I was able to monitor the flight path and the Doppler radar as we approached the area from the south. This part of the flight was quite turbulent and my stomach was really starting to turn.

Despite having a single dose of Dramamine in my system, I made the mistake of having a snack and a soda during the outbound leg of our journey. The diet Pepsi was starting to rumble and I had little doubt that some of it was going to come back up. Luckily, the bouncing subsided a bit after we got into the large stratiform precipitation area behind the more intense cells.

The seatbelt sign went out and I took the opportunity to walk the aisle and grab an air sickness bag. About five minutes later I dashed into the lavatory and put that bag to good use. After that, and a short rest in an open seat with some leg room, I felt much better.

During my air sickness episode the plane was tracking back and forth on SW-NE and NE-SW legs, through very heavy precipitation and lightning. At times we could hear the rain and small hail pelting the cabin of the plane. Occasionally we would hit an updraft, followed almost immediately by a downdraft. Data collection continued uninterrupted through this phase of the flight. Conrad Ziegler, as chief scientist, coordinated with the nowcast team back at NSSL/SPC, the ground team over Kansas, and the flight director. Tom Shepherd, seated next to Conrad, expertly manned the tail and belly radar systems while Terry Schuur monitored and logged the output from the cloud microphysics equipment. The NOAA Corps flight crew included three members on the flight deck, as well as a navigator, flight director, and at least three other electronics and avionics technicians.

While wandering the aisle recovering from my vertigo, I was impressed by the number of experiments and research projects that this NOAA P-3 has been involved in. In addition to being used routinely for very important hurricane reconnaissance, the walls of the plane are plastered with colorful emblems from numerous field projects including FASTEX, GEWEX, ERICA, TOGA-CORE, and GALE to name a few. There were stickers from the major media including NBC News, CNN, and ABC, and a framed fancy certificate attesting to the NOAA crew's bravery in consuming some of Norway's Golden Elixir, whatever that might be.

As the lightning and turbulence continued I made my way back to my original seat and on the way talked with Terry about some of the cloud microphysics data. The details of the equipment are rather complicated, but the display was very interesting to watch. As we flew through cloud you could actually see representations of the cloud particles and their sizes on the display. At one point we flew through virga, or perhaps anvil debris, and we observed perfectly-shaped six-armed dendrite crystals. A quick check of the flight information showed that these crystals were actually occurring at temperatures a little less than -5C, near 550 mb (rather warm and low). We later climbed higher (up close to 400 mb, or 19,000 feet) where the temperature dropped to -16C, and the cloud particles were almost all ice and very small. Other parts of the lower cloud had relatively huge cloud droplets, and the bigger the particle, the more oblate the shape on the display.

About half-way through the flight the plane completed a "PURL" maneuver which allows the Doppler radar to record 360 degrees of data which can later be used to calculate wind divergence and other kinematic fields (see: http://www.nssl.noaa.gov/~schuur/meaprs/opfig10.html for more info). Shortly after this we headed east toward North Platte, Nebraska. I went up into the cockpit to observe St. Elmo's fire emanating from the large electronic field probe that sticks out about 15 feet in front of the aircraft. When I got onto the flight deck there was a blue haze around the end of the probe; less than a minute went by before a 4 to 5 foot spark came off the end of the probe and the blue haze disappeared. A short while later we broke out of the clouds and the moon was highlighting the undercast. The towering CBs became shadowy gray pillars in the distance, outlined occasionally by a pulse of white lightning.

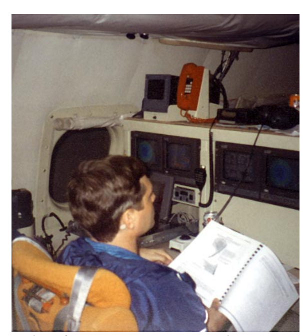
We turned and headed south for home shortly after 1 a.m. CDT (06 UTC). After takeoff with a full load of fuel, the plane had to use 6 hours worth of fuel in order to reach a safe landing weight. On the trip back I enjoyed talking with Terry, Conrad, and Mike Biggerstaff from Texas A&M. I also revisited the cockpit to enjoy the peaceful view of moonlit undercast blanketing the Great Plains below us.

As we approached Oklahoma City it was interesting to watch the increasing head winds of the low level jet. We encountered the highest wind speeds of the flight (about 60 KT) at about 2 km altitude just north of Oklahoma City. The plane touched down a little before 2:30 am CDT (0730 UTC).

According to Conrad and Terry, this flight was a bit shorter and a lot less bumpy than other flights that have been completed during the MEaPRS experiment. There are approximately 40 hours of flight time left for the experiment, and the researchers are still hoping for an MCS to track directly over the Oklahoma City area so that they can collect detailed aircraft data and ground-based polarimetric radar data (from NSSL Cimmaron radar) . ◆

NSSL's Ann McCarthy at about 1 a.m.

Occasionally we would hit an updraft, followed almost immediately by a downdraft. Data collection continued uninterrupted through this phase of the flight.



Chief scientist Conrad Ziegler

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

NSSL/Desert Research Institute begin collaboration

by John Lewis and Susan Cobb

In his colorful history of the American West, Bernard DeVoto gives us a splendid picture of that land between the Front Range of the Rockies and the Pacific Ocean through the eyes of the mountain man Jim Clyman (see inset). About 50 years later, Marc Reisner gave us *Cadillac Desert: The American West and its Disappearing Water*. The message resonates deep inside--if we don't begin to manage our water resources, the American West--and indeed the entire nation--will fall into a calamitous state that will undermine our quality of life.

The scientific strengths of NSSL and DRI will be combined in an effort to combat this problematical aspect of our nation's well being.

Through this collaboration, DRI, in Reno, Nevada, with its multifaceted approach to understanding the broad issues of water, is planning to broaden its approach to regional climate. NSSL will benefit by being able to expand research opportunities in water-related issues. NSSL and DRI's partnership has already been established in Reno through efforts to enhance precipitation estimates using NSSL's WDSS, located in the Reno NWSFO.

The initial phase of the formal NSSL/DRI collaboration involves the assignment and relocation of NSSL scientist John Lewis. Lewis says, "I hope to be a catalyst that will bring NSSL's scientific strength to bear on these issues of water."

Lewis has spent the past 10 years working on moisture return to the U.S. from its southern flank, the Gulf of Mexico. He will continue this work but will gradually focus on the study of moisture along the country's western flank. His major thrust at the present is using deterministic models to understand the sensitivity of model output (in particular the moisture field) to the initial and boundary conditions. This work has been done in collaboration with scientists at NCAR over the past four years.

Other NSSL scientists have already expressed interest in the DRI/NSSL collaboration. Alexander Ryzhkov and Dusan Zrnic have pioneered efforts using a polarized Doppler radar to improve the estimation of rainfall amounts. They feel polarimetric radar could improve rainfall estimation in the mountains because "unbiased measurements of precipitation can be performed even in the presence of severe beam blockage," Ryzhkov says. Also, conventional radar has problems with ground clutter and anomalous propagation (AP) due to the complex terrain. "Polarimetric radar has very promising capability to identify the areas contaminated with ground clutter and AP. Moreover, rain measurements are possible if weather and ground clutter echoes are superimposed." Zrnic adds, "measurement of snow is also important in the Sierra Nevada mountains. Radar polarimetry might lead to better estimates of the type and amount of snowfall. Discrimination between rain and snow has been proven and it remains to be seen if quantitative estimation of snow amounts can be reliably obtained."

Another NSSL employee, J.J. Gourley is focussing his thesis work on exploring ways to improve precipitation estimates in mountainous terrain. Since intervening mountains often shield regions from being adequately sampled by radar, he is utilizing a "multi-sensor" approach. Gourley is obtaining the vertical structures of storms where there is good radar coverage. This information is then combined with satellite imagery and radar data from nearby WSR-88D's to improve the precipitation estimates, and feels that his work is compatible with the goals of DRI.

John Lewis spent the month of July (1998) at DRI and said, "DRI is a vital organization of scientists with strong leadership in the person of Dr. Peter Barber, head of the Atmospheric Science Center and Acting Director of DRI. The DRI scientists are anxious to learn more about NSSL and hopefully there will be exchanges of scientists in both directions." ◆

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> *"The frontiersman's craft reached its maximum and a new loneliness was added to the American soul. The nation had had two symbols of solitude, the forest and the prairies; now it had a third, the mountains. This was the arid country, the land of little rain; the Americans had not known drought...It was the country of intense sun; they had always had shade to hide in. The wilderness they had crossed had been a passive wilderness, its ferocity without passion and only loosed when one blundered; but this was an aggressive wilderness, its ferocity came out to meet you and the conditions of survival required a whole new technique. The Long Hunter had slipped through forest shadows or paddled his dugout up easy streams, but the mountain man must take to horse in a treeless country whose rivers were far apart and altogether unnavigable. Before this there had been no thirst; now the creek that dwindled in the alkali or the little spring bubbling for a yard or two where the sagebrush turned a brighter green was what your life hung on."*
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> *-(DeVoto, The Year of Decision - 1846, 1943, pp.57-58)*