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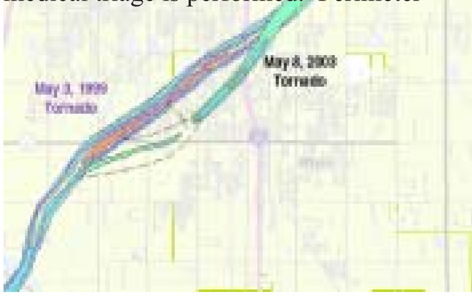
NSSL Briefings

A newsletter about the people and activities of the National Severe Storms Laboratory and Cooperative Institute for Mesoscale Meteorological Studies collaborative researchers

Tornadoes hit home --*Again!*

We've been through this before, and we're starting to know the routine. Experience has brought some order to the usual chaos after a natural disaster. Emergency personnel immediately move in to check for people injured and trapped in destroyed homes. They mark the house with a large red spray-painted "X" when their search is complete. Wounded people are taken to shelters at local churches where medical triage is performed. Perimeter security points are set up that require homeowners to show ID's to enter their destroyed neighborhoods. Debris is hauled to the curb -- twisted garage doors, broken glass, and any random thing that doesn't belong to you but ended up in your yard.



South Oklahoma City and Moore, OK were hit for the second time in five years by an F4 tornado on May 8, 2003. Parts of the damage track, which was approximately 10 miles north of NSSL, coincide exactly with the damage path from the F5 tornado that struck on May 3, 1999. Historically, the immediate Oklahoma City area has been struck by 112 tornadoes and nine violent tornadoes (F4 and F5) since 1893. Another round of tornadoes including an F3 struck the Oklahoma City area the very next day, May 9. ◆

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What are the odds?

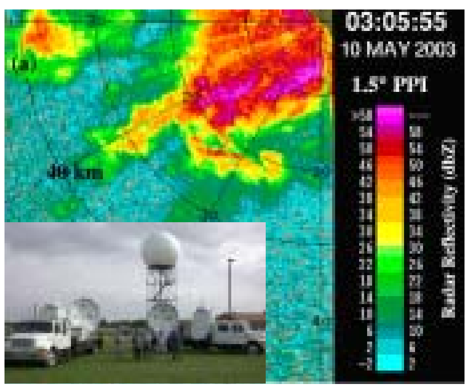
"Once every 4,000 years," says NSSL's Harold Brooks. "But why Moore?" I ask. "Bad luck," is the reply. "There *are* equally rare things in the tornado records," he qualifies. Codell, KS was struck by tornadoes on May 20 in 1916, 1917, and 1918. St. Louis, MO, Gainesville, GA, Skiatook, OK- have all been hit more than one time by tornadoes. "It *is* a rare event," says Harold, "but if you throw enough darts, some place is going to be hit more than once." ◆

A busy spring for SMART Radar(s)

by Lou Wicker

Radar coalition partners (NSSL, the University of Oklahoma, Texas Tech University, and Texas A&M) celebrated the May arrival of the revived SR-2, the Shared Mobile Atmospheric Research and Teaching Radar (SMART-Radar) that was partly destroyed in the July, 2001 NSSL balloon barn fire. SR-1 was at another site at the time of the fire and was unharmed. Efforts by the coalition partners and the extraordinary dedication of Jerry Guynes, the TAMU SMART-Radar engineer, enabled this modern day "phoenix" to literally rise from the ashes. The inset photo shows the two radars during a celebration this past summer. Learning from our experiences with SR-1, SR-2 has improved cab layout, incorporated better computers, and should be able to better withstand the rigors of road travel.

In the meantime, SR-1 was busy. During May 2003, the SR-1 was used to study severe storms and tornadoes as part of a small cooperative project called COMPASS-2003 (Cooperative Observational and Modeling Project for the Analysis of Severe Storms). The first two



weeks of May 2003 turned out to be an excellent time to collect data as the central U.S. endured more than 400 tornadoes in a 15-day period. SR-1 collected data from tornadic storms on May 8, 9, and 15. A potentially historic data set was collected from the Oklahoma City tornadoes during the evening of May 9 (an example is shown above) -- This storm was observed by two operational radars and five mobile Doppler radars in Central Oklahoma. SR-1 collected volumetric data every two minutes for over three hours from two locations while other mobile research radars collected data at different times very close to the tornado. The combination of the long time series of volumetric data from the SR-1 at high time resolution, combined with the more intermittent higher resolution data from the other mobile radars, should provide a unique and detailed look at the evolution of a tornadic storm.

The SR-1 was also used in some non-conventional ways this past spring. SR-1 participated in two Homeland Defense programs, run by the U.S. Army, to investigate how weather radar could be used to detect the release of hazardous chemical or biological materials via aircraft. In February, SR-1 was used in a 10-day experiment at Camp Gruber near Muskogee, OK. During late March and early April SR-1 was part of an experiment conducted around Central Oklahoma. Data from SR-1 and other radars and instruments used during the experiment, are currently being analyzed.

Information regarding the SMART-Radar program as well as the latest news can be found at http://www.nssl.noaa.gov/smartradars. ◆

Spotlight on: Jian Zhang

Jian Zhang has two children, Alice (6) and Andrew (2), whose names begin with "A" to compensate for a last name that begins with "Z." Their middle names contain the Chinese word for "rain." "Before children," Jian says she liked to go to movies, be outdoors, and drive long distances to see natural wonders. Now she likes to spend most of her time at home, playing with her children, reading, listening to classical music and taking walks to relax. Jian has been married for 15 years to Pengfei Zhang, a CIMMS employee who works on single Doppler wind retrieval.

Jian grew up on the edge of the Tibetan Plateau in Lanzhou, China, on the Yellow River, where early Chinese civilization began. She has a passion to explore ancient civilizations - she's amazed by how similar wisdom can come from vastly different cultures, especially cultures that existed thousands of years ago. Someday she hopes to travel to Europe and Africa and see the places she has read about.

Jian originally wanted a vocation in journalism, but her father convinced her to pursue the natural sciences -- leading to a more "serious" career. Her intrinsic appreciation for mathematics made it a comfortable choice. Jian's exceptional high school test scores gained her admittance into the prestigious Beijing University, where she earned her B.S. in atmospheric physics. During school, she was a host for the university radio station (news and entertainment). After graduating with her master's in atmospheric science degree from the Chinese Academy of Meteorological Sciences, she worked as a research associate in the National Satellite Meteorological Center for three years. On a visit to the U.S. to see her husband, Jian learned of a research project with Dick Doviak and moved to Oklahoma permanently in 1991 to work on her Ph.D.

Jian is haunted by a recurring nightmare: she is informed that she lacks six credit hours to graduate with her Ph.D. After an eight-year journey with two topic changes, Jian considers her Ph.D her biggest success. Her dissertation was on data assimilation, but her other areas of expertise include radar data analysis and applications and satellite data application. She was able to stay on at NSSL/CIMMS following her post doc with a USWRP project. She is currently working on radar Quantitative Precipitation Estimation (QPE) and related studies, hoping to submit a paper to the "Monthly Weather Review" on radar mosaic work. Jian likes knowing exactly how her work can be used in the forecast office -- it makes her job dynamic to know her efforts have a real-life purpose. ◆

REU students spend the summer at NSSL

NSSL hosted one Significant Opportunities in Atmospheric Research and Science (SOARS) and five Research Experience for Undergraduates (REU) students this summer. Coordinated by Lead Principal Investigator Daphne Zaras (CIMMS), REU is an NSF-sponsored grant program is designed to attract talented undergraduates to careers in mathematics, science, and engineering through an active research program and mentorship by people who work in those fields. Most of the students came from small colleges where exposure to meteorological research is minimal.

The students' projects were: *"Extratropical Cyclones with Multiple Baroclinic Zones and Their Relationship to Severe Weather"* by Nick Metz, mentored by Dave Schultz (CIMMS/NSSL) and Bob Johns (CIMMS/SPC); "*A Validation Study of the National Centers for Environmental Prediction's Short Range Ensemble Forecast"* by Andy Hamm, Northland College, mentored by Kim Elmore (CIMMS/NSSL); *Quality Control of Radar Data to Improve Mesocyclone Detection"* by Becca Mazur, Northern Illinois University, mentored by Greg Stumpf (CIMMS/NSSL) and V. Lakshmanan (CIMMS/NSSL); *"Summertime Precipitation Variability and Atmospheric Circulation over the Bolivian Altiplano: Effects of Lake Titicaca and Salar de Uyuni"* by Maura Hahnenberger, University of Utah, mentored by Mike Douglas (NSSL), and *"Analyzing Statistical Models of Hourly Precipitation Events"* by Jenny Esker, Southern Illinois University, mentored by Harold Brooks (NSSL). ◆

News briefs

Coming and going

Jeff Trapp *is now an associate professor in the Department of Earth and Atmospheric Sciences at Purdue University. Jeff says, "I lived a dream in my affiliation with the premier research lab for severe and hazardous weather, but now I'm off to follow another dream of teaching and working closely with students."*

Renee McPherson *is on loan for one year from the Oklahoma Climatological Survey as the assistant director of CIMMS, replacing John Cortinas. Renee's main role is acting as the liaison between NOAA and OU.*

Awards

Mike Baldwin*, CIMMS, received the Editor's Award from the "Journal of Weather and Forecasting," "for his thoughtful, helpful, and detailed reviews that consistently assisted in improving submitted manuscripts."*

SMART Radars capture complete picture of Hurricane Isabel

Two SMART Radars placed 40 miles apart gathered data as Hurricane Isabel came ashore along the North Carolina coast in mid-September. The data will be used to study the detailed structure of the near-surface winds in the storm as well as to determine how the storm generates a large area of intense rainfall.

Visitors to NSSL

NSSL recently hosted the Undersecretary of Homeland Security for Emergency Preparedness and Response, Michael D. Brown, along with Gary Jones, acting Regional Director, FEMA Region 6, and NWS Southern Region Director Bill Proenza. The group listened to a presentation on "Tornado Deaths and Mobile Homes" by Harold Brooks and received a tour of the Phased Array Radar by Doug Forsyth.

News briefs, continued

Map discussions resume

Daily NSSL/SPC map discussions resumed after Labor Day providing an opportunity to interact in an informal setting and discuss the daily weather as well as operationally-relevant research topics, results, problems, and works in progress. The discussions are held in the Science Support Area adjacent to the SPC Operations Room from 1:00-1:30 Monday through Friday.

Cimarron radar retired

NSSL's Cimarron radar, located 15 miles west of Oklahoma City, has been decommissioned. The radar, based on a Navy FPS-18 surplus radar, was first commissioned in 1973. It was converted to dual polarization in 1988. Data collected from the Cimarron radar lead to many scientific discoveries, and made a valuable contribution to dual polarization research.

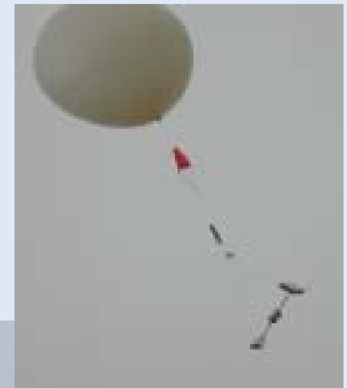
Severe Weather Workshop

The 2004 Severe Weather Workshop has been scheduled for March 4-6, 2004. More information can be found at: www.norman.noaa.gov/nsww2004/

NSSL's Web site is at: http://www.nssl.noaa.gov

NSSL Briefings *is a publication from the National Severe Storms Laboratory intended to provide federal managers, staff, and other colleagues in the meteorological community with timely information on our activities. This newsletter also contains information about NSSL's scientific collaborations with the OU Cooperative Institute for Mesoscale Meteorological Studies (CIMMS). 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; by phone: (405) 366-0429 or by email: kelly.lynn@noaa.gov.*

Students help scientists launch an instrumented balloon into a morning mesoscale convective system during TELEX 2003. The yellow tube is the launch tube containing the balloon, and crew members on the right are holding instruments in the balloon train.



Balloon flight following the launch. The instrument train consists of (top to bottom) a parachute, GPS radiosonde (the cylinder), and an electric field meter for determining the electrical structure of storms.

Thunderstorm Electrification and Lightning Experiment

by Don MacGorman

Day and night during the month of May, a crew of 14 scientists and students scrambled to get in position beneath storms to launch instrumented balloons. The balloons were part of TELEX, the Thunderstorm Electrification and Lightning EXperiment. TELEX 2003 is the first of two sequential spring field programs. The broad objective of TELEX is to learn how lightning and other electrical storm properties are dependent on storm structure, updrafts, and precipitation. This information will point to new ways for the National Weather Service to use lightning observations to improve forecasts and warnings of hazardous weather.

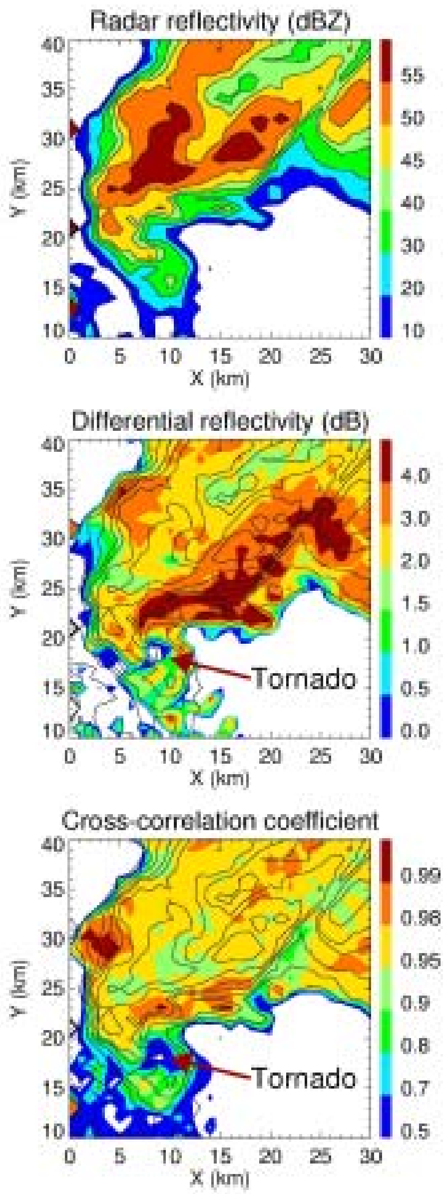
TELEX plans incorporated new sensors now used routinely by NSSL: the Norman KOUN radar, a WSR-88D radar modified with polarimetric parameters to provide information about the particle size and water phase of precipitation, and the Oklahoma Lightning Mapping Array (OK-LMA). The OK-LMA is a network of ten stations in central Oklahoma that continuously maps the structure of all types of lightning in three dimensions out to a range of 75 km and in two dimensions out to a range of 200 km.

To these two systems, the TELEX team added balloon soundings to measure the electric field profile of storms. An electric field profile can provide scientists information about how a storm becomes electrified and about the forces responsible for lightning. This effort, funded partly by the National Science Foundation (NSF grant ATM-0233268), was the maiden field program for NSSL's newest mobile laboratory used to collect the balloon data. The electric field sensor was custom-built by NSSL with assistance from OU, New Mexico Institute of Mining and Technology, and the National Center for Atmospheric Research (NCAR). Temperature, pressure, and humidity were measured by an NCAR system that also provided GPS tracking of the balloon.

The TELEX team succeeded in flying 14 balloons into nine storms on seven missions. Two of the storms were mesoscale convective systems, a specific TELEX target. NSSL scientists are now analyzing the processed data to address the project's objectives. ◆

Polarimetric tornado detection

by Alexander Ryzhkov



Composite plot of Z, ZDR, and _hv at El=1.5^{o} fora tornadic storm on 8 May 2003 (2229 UTC). Location of tornado reported on the ground is shown by red arrow.

"Is it possible to improve tornado detection using a polarimetric radar ?" a television crew asked me back in 2001. My answer was, "Very likely, because tornadic debris is supposed to have polarimetric properties that are very different from those of hydrometeors." The follow-up question was: "Did you collect polarimetric data for the May 3, 1999 tornado?" Unfortunately, we had not. The research Cimarron polarimetric radar was lost due to a lightning strike about half an hour before the tornadic storm hit the Oklahoma City metropolitan area.

The interview prompted me to revisit the Cimarron dataset for that day, and I discovered data collected during a less-destructive F3 tornado west of Chickasha prior to the radar shutdown. I found exactly what I was looking for: a well-pronounced tornado signature in the polarimetric data. Two polarization variables, differential reflectivity ZDR and cross-correlation coefficient_hv clearly indicated tornado debris in the hook echo close to the ground at the time and space where the F3 tornado was detected according to ground observations.

ZDR is a ratio of radar reflectivities at horizontal and vertical polarizations expressed in dB. Meteorological scatterers are usually characterized by positive ZDR (0.5 – 4 dB for rain) because their falling habit is such that their horizontal dimension is larger than vertical. In contrast, tornadic debris are randomly oriented, and their ZDR is very close to 0 dB. Another polarimetric variable, _hv, has even better discriminating power than ZDR. The cross-correlation coefficient is very close to 1 for pure rain or pure snow, somewhat lower for a mixture of hydrometeors of different phases (e.g, rain / hail mixture, melting layer), and substantially smaller for non-meteorological scatterers like insects, birds, chaff, ground clutter, etc. This coefficient is anomalously low for tornadic debris because of their large sizes and very irregular shapes. Thus, anomalously-low values of _hv combined with ZDR close to zero observed in the hook echo very likely indicate the presence of a tornado.

Our research group was given the opportunity to confirm our previous findings with the polarimetrically upgraded KOUN WSR-88D radar on May 8-9, 2003, when two tornadic storms hit the Oklahoma City metropolitan area. We observed polarimetric tornado signatures for both events. The figure to the left shows a combined plot of radar reflectivity, differential reflectivity, and cross-correlation coefficient observed with the KOUN WSR-88D radar at an elevation of 1.5^{o} on May 8, 2003, at 2229 UTC (1729 CT) when the F3 tornado was reported east of Interstate 35 in Oklahoma City. The tornado touchdown signature at the very tip of the hook is marked with ZDR close to 0 dB and _hv < 0.5 (red arrow). We identified a very similar signature for the tornadic storm on May 9, 2003.

This experimental evidence gives us much more confidence in the unique capability of the polarimetric WSR-88D radar to detect a tornado when it touches the ground and creates lofted debris. Polarimetric signatures can be detected with coarser resolution than Doppler radar. Also, signatures in the Doppler velocities are dependent on the viewing angle, while those detected with the polarimetric radar do not vary with direction. Heavy debris as well as large hailstones are not perfect tracers of air motions. Polarimetric identification of those scatterers will help with quality control and better interpretation of Doppler measurements.

Although tornado detection is important, prediction and early warning are even more critical. A cursory look into evolution of the 3D pattern of polarimetric variables prior to tornado touchdown reveals quite unusual and intriguing polarimetric signatures aloft that might be related to the subsequent tornado. Understanding and interpretation of these signatures could provide more insight into microphysical aspects of tornadogenesis. ◆