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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

Photo by Michael James

NEXRAD PMC approves polarimetric upgrade to WSR-88D radar network

by Terry Schuur

For over 20 years, NSSL has been a leader and major contributor to the scientific and engineering development of polarimetric weather radar. This long history of accomplishment was rewarded in the fall of 2003 when the NEXRAD Program Management Committee (PMC) approved taking the first step towards upgrading the operational WSR-88D network to include polarimetric capabilities. This PMC decision, based on results from the year-long Joint Polarization Experiment (JPOLE), represents a significant milestone in the continuing evolution of the WSR-88D radar network.

JPOLE data collection and analysis

JPOLE, which was conducted from the Spring of 2002 through the Spring of 2003, was designed to test the proof-of-concept polarimetric KOUN WSR-88D radar engineering design, evaluate radar data quality, demonstrate the utility and feasibility to operational users, and collect data and information that could be used to perform a cost/benefit analysis.

The KOUN data archive from JPOLE contains an unprecedented collection of exceptional quality polarimetric measurements of 98 events contatining meteorological and non-meteorological data. Using this data set, analyses were conducted to demonstrate KOUN's ability to provide improved Quantitative Precipitation Estimates, discriminate between hydrometeor types, and eliminate non-meteorological artifacts. Rainfall estimation was found to be dramatically improved in terms of both bias and RMS (root mean square) error while classification algorithms demonstrated great skill at pinpointing the location of hail within storms, discriminating between snow and rain, identifying the location of strong tornadoes, and improving data quality.

Operational evaluation

The utility of polarimetric data to operational forecasters was also examined during JPOLE. A KOUN scanning strategy was designed to emulate the elevation angles, scanning rates, and volume coverage times used by standard WSR-88D radars. Real-time polarimetric data and products were then supplied to forecasters at the Norman, OK National Weather Service (NWS) office. NSSL observers assisted the forecasters in the analysis and interpretation of the polarimetric radar data and products during the intense 3-month data collection period in the Spring of 2003. In several instances, KOUN data and products provided value-added information to the warning decision process. For example, results of the polarimetric rainfall accumulation algorithm provided flash flood warning guidance during several heavy rain events. Hydrometeor classification algorithm output were used to discriminate precipitation types in winter storms and identify the location of hail in severe convective storms.

Network upgrade

Several NSSL reports documenting JPOLE data collection and operations, improvements in data quality, hydrometeor discrimination, rainfall estimation, and evaluation of the engineering design are available on the JPOLE web site at http://cimms.ou.edu/~schuur/jpole.

The polarimetric upgrade of the WSR-88D network, supported by the NWS, the Federal Aviation Administration, and the Air Force Weather Agency through the NEXRAD Product Improvement Program, may ultimately prove as significant as the nationwide upgrade to Doppler radar in the 1980's. The first phase of the deployment will utilize results obtained from JPOLE to prepare system specifications and identify procurement procedures needed to move towards the pre-production stage of the polarimetric upgrade, eventually leading to full production. ◆

Spotlight on: Lou Wicker

Lou Wicker got stuck with climatology. A lifelong procrastinator, Lou put off pre-registering for a college calculus class. When the section he had to have was filled up, he got "stuck" choosing a climatology course instead.

At the time, Lou was in high school in Springfield, MO and was taking a college class at Southwest Missouri State University as part of an advanced study program available to seniors. He liked the weather -- having lived through classic lake-effect snow storms in New York state and seen a few of those late-summer severe squall lines with great roll clouds. But surely, he thought, studying the weather had to be boring. His assumption was shattered the moment he walked into the synoptic map room for the first time. Radar echoes? 500 mb maps? Severe weather watches? Now THAT was cool. Who knew?

Lou decided to make a career out of it, and went to OU in the fall of 1979 to obtain an undergraduate degree. He continued on at OU, obtaining a master's degree in 1986 working with Dr. Tzvi Gal-Chen. Though storm chasing and field research helped define his career, he says he was in the right place at the right time to be drawn into modeling. He earned his Ph.D. at the University of Illinois Champaign-Urbana in 1990, and stayed for a two-year post-doc with the National Center for Supercomputer Applications and the Department of Atmospheric Sciences. Lou then spent seven years on the faculty at Texas A&M before coming to NSSL in 1999 to do research full-time. Publishing one of the first papers on simulated tornadogenesis is one of his successes, he says, and the other would be the development of the Shared Mobile Atmospheric Research and Teaching Radar (SMART-Radar). Lou says it was a successful collaboration built from "common interests and needs," along with the recognition that successful multi-institutional collaborations require the right kind of people who are committed to a common goal.

His passion is to keep learning -- which fits with his job to "increase our understanding of severe storms and then help get that knowledge applied to real world problems." One of his current goals is to get a more detailed understanding of tornadogenesis and supercell processes. He then wants to create simulations at ultrafine resolutions and compare them with observations. Another goal is to leverage all the people and talent NSSL has to offer to develop real-time data assimilation systems for stormscale prediction using ensemble modeling methods.

Life radically changed for Lou and his wife, Kristy, this past summer with their adoption of a newborn son, Benjamin. Though Lou enjoys golfing (he helps organize the annual NSSL/SPC Employee Association golf tournament), reading (science fiction, biographies, and popular science), hiking (in the Rocky Mountains), and foster parenting exotic animals (capuchin monkeys, porcupines and deer), Benjamin's arrival has sparked a new passion! ◆

Spring activities update:

NSSL/SPC will host its fourth annual "**Spring Program**" from mid-April to early-June. SPC forecasters and NSSL/CIMMS researchers will work side-by-side to evaluate the latest Short Range Ensemble Forecast systems.

BAMEX - A Bow-Echo and MCV Experiment (BAMEX) workshop was held in St. Louis in early March.

TELEX - The second part of the Thunderstorm Electrification and Lightning EXperiment (TELEX) will be held from May-June 2004. Information gathered from the TELEX project will point to new ways for the NWS to use lightning observations to improve forecasts and warnings of hazardous weather. ◆

News briefs

NOAA Awards

Bronze Medals

Bronze medals were awarded to two NSSL groups during a ceremony in Washington, D.C., in October, 2003.

***Don Burgess, Greg Stumpf (CIMMS) and Travis Smith (CIMMS)** were honored "for innovative actions in collecting, archiving, and analyzing weather radar data to assist the shuttle Columbia accident investigation."*

***Ken Howard, Ami Arthur, Gina Cox and Nathan Kuhnert** were honored "for the development and operational implementation of the Flash Flood Monitoring and Prediction System."*

The Bronze Medal is the highest award given by NOAA and is granted for a significant contribution to NOAA or the Department of Commerce.

NOAA TECH 2004 Award

*The NOAATECH 2004 Award for Best Presentation in the category of Techology Transfer to Operations was awarded to a NSSL/NWS team for "Real-time Dissemination of WSR-88D Radar Data over Internet2." The award was given for the real time demonstration of two technologies developed at NSSL that make use of the real time radar data feed, QPE-SUMS and WDSS-II. NSSL team members included **Kevin Kelleher, Kurt Hondl, Greg Stumpf, Karen Cooper, Travis Smith, J.J. Gourley, Beth Clarke and Wen Wu Xia**.*

National Weather Center

The ground floor of the six-story National Weather Center (NWC) is now in place. Construction on the NWC began last summer and is expected to be completed in Spring 2006. The building will be occupied by both NOAA and University of Oklahoma weather groups to strengthen the government-university science partnership.

News briefs, continued

NSSL represented at annual AMS conference in Seattle

NSSL co-hosted a booth with NOAA at the 84th AMS Annual Meeting in January, 2004. NSSL/CIMMS scientists were lead authors on 13 papers presented at the conference, and several REU students presented posters

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.

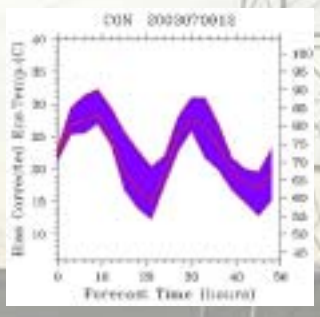
Energy industry to benefit from improved temperature forecasts

by David Stensrud and Nusrat Yussouf

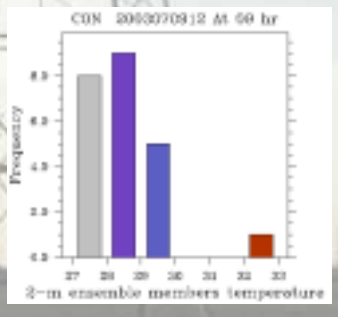
Energy companies rely heavily on temperature forecasts to allocate power in the most economical way. A two-degree error in a temperature forecast, especially in hot weather, can have a substantial impact on energy demand. Improved forecasts of near-surface conditions could result in better and more efficient delivery of electric power and lead to lower costs for consumers. NSSL is one of the partners addressing this issue as part of the NOAA Temperature Forecasting Pilot Project that took place over the New England region the past two summers.

One of the goals of this program is to quantify the improvements in temperature forecasting that result from new and augmented observations and modeling. In collaboration with the National Center for Environmental Prediction/Environmental Modeling Center (NCEP/EMC) and the Forecast Systems Laboratory (FSL), a short-range ensemble forecasting system was constructed using over 20 different model forecasts. Scientists wanted to see if an ensemble approach could provide improved 2-m temperature and dewpoint temperature predictions when compared against model output statistics (MOS), the statistical post-processing available from present operational forecast models.

In our first attempt to improve upon MOS, we developed a simple bias-corrected ensemble mean. This method used the past seven complete days of forecasts and observations to bias- correct both the 2-m temperature and dewpoint temperature predictions for each individual model at each forecast output time. Results from 48 days during the summer of 2002 indicate that this bias-corrected ensemble is competitive with, or better than, MOS from the Nested Grid Model. In addition, the bias-corrected ensemble provides information on the probabilities of temperatures exceeding selected threshold values. This additional probability information provided by the ensemble can be quite valuable to many end users of weather forecasts when used in a simple cost-loss model. In particular, the ensemble adds the most value above that provided by MOS for the more unlikely, and often the most important, events. An additional benefit of the ensemble technique is that it can be developed for any observing station location and needs only a week of forecast and observational data to produce the bias-corrected forecasts. MOS, in comparison, requires many years of data before forecasts can be provided. Forecasts from the summer of 2003 are currently being examined. ◆



Bias-corrected ensemble temperature versus forecast hour beginning at 1200 UTC on 9 July 2003 for Concord, New Hampshire. The solid red line is the ensemble mean temperature, and the blue envelope indicates the maximum and minimum temperatures predicted by any ensemble member.



Histogram from the bias-corrected ensemble member temperatures indicates the number of forecasts that fall within each specified 1° C temperature range. Note that the histogram indicates that it is unlikely that the temperature will exceed 30°C.

Photo by Susan Cobb

Composite mosaicked reflectivity image over the FAA CIWS domain. Similar products will be generated as part of the NMQ project, but for the entire conterminous U.S.

National Radar Mosaic and QPE Project

by J.J. Gourley and Jian Zhang

NSSL's Worldwide Integrated Sensor Hydrometeorology (WISH) team has taken on an ambitious project to seamlessly mosaic all 130 NWS and Department of Defense (DOD) radars across the U.S. The mosaic will provide the first high-resolution depiction of storms and quantitative precipitation estimation (QPE) products from coast-to-coast in real-time. Additional users for the national mosaic will include FSL and NCEP.

Mosaic

The ability to integrate data from multiple radars at their fullest resolution into a single framework was not without significant challenges. The 3D multi-radar reflectivity analysis and mosaic scheme is the result of nearly five years of research and development. The resulting scheme includes quality control, an adaptive objective analysis scheme, and a distance weighted mosaic technique. It takes into account different spatial scales of convective and stratiform weather echoes and reconstructs 3D reflectivity analyses using different interpolation techniques. The code has gone through extensive optimization to assure a high computational efficiency and operational applicability.

The 3D mosaic has been running in real-time in the FAA Corridor Integrated Weather System (CIWS) domain since August 2002. The CIWS 3D mosaic has 1km x 1km resolution and 21 vertical levels ranging from 1km to 17km above mean sea level. The mosaic combines base level reflectivity data from 32 radars with a five minute update cycle. Other product development teams at NCAR and MIT/LL have been using the CIWS mosaic data in convective and wintertime numerical weather modeling.

QPE SUMS

Challenges in radar-based QPE were discovered by NSSL scientists by examining precipitation products for cool season cases over the complex terrain of Arizona. Issues with beam blockages by terrain and bright band effects limited the value of the products. The Quantitative Precipitation Estimation and Segregation Using Multiple Sensors (QPE SUMS) algorithm, which runs in conjunction with the 3D mosaic, was designed to address these issues by integrating satellite and model data in its scheme. Today, it continues to provide improved basin-wide rainfall and snow-water equivalent estimates to the Salt River Project for the purpose of managing large-scale watersheds. In recent years, the 3D mosaicking and QPE SUMS software has been deployed in several other regions in the U.S. and around the world. Data quality control and estimation techniques have been improved from these experiences to accommodate precipitation from typhoons, hurricanes, extratropical cyclones, and mixed-phase events.

The next phase

The WISH group is taking its entire project to the next phase this spring. Up to now, the high-resolution radar data (i.e. level II data) that the algorithms use to operate were available for only select radars in the U.S. In 2004, the Collaborative Radar Acquisition Field Test (CRAFT) network will include all NWS and several DOD radars, thus enabling the WISH group to extend its software deployment to the whole U.S. The National Mosaic and QPE SUMS (NMQ) products will be available every 5 minutes on a 1 x 1km grid covering the conterminous U.S. This project has potential benefits to government, university and private sector users. The resolution and accuracy of the precipitation products will be a natural fit-in to NWS's Flash Flood Monitoring and Prediction (FFMP) project, for which NSSL provided delineated basins for the entire U.S. Moreover, the QPE SUMS products will be useful for verifying quantitative precipitation forecasts that are being produced at higher and higher resolution.

This project provides the WISH group an impetus to partner with other agencies and develop improved products collaboratively during this expansion. NSSL will be working with the Bureau of Reclamation in order to adopt QPE strategies they've developed for snowfall estimation. In addition, satellite-based techniques are being integrated through a collaborative effort with the NOAA National Environmental Satellite, Data, and Information Service. The 3D mosaic will become 4D through development of a new temporally weighting scheme that retains high-resolution storm structure from temporally-offset radar observations and minimizes any dampening effects on storm intensities. Several severe storm monitoring and QPE SUMS products will operate off these new mosaicked reflectivity fields. The WISH group plans to make the NMQ products available to NWS forecasters at local offices and river forecast center. They say, "we believe we can get the most valuable feedback by making the products available to forecasters on an experimental basis in their display systems. This will be a conduit for allowing forecasters to evaluate not just the NMQ products, but all NSSL severe weather monitoring algorithms." The WISH team has always been at the forefront of technologies related to high-resolution radar data mosaicking and QPE, and this new project is the next step towards the NMQ goal. ◆