GOVERNING CHARTER

for the

DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

HAZARDOUS WEATHER TESTBED

August 2010

NOAA Hazardous Weather Testbed

1. Purpose

This Governing Charter (hereafter the "Charter") describes the policies of the signatory parties (henceforth the "Parties") for mutual management, operation and support of the NOAA Hazardous Weather Testbed (HWT).

The mission of the HWT is to accelerate the transition of promising new meteorological insights and technologies into advances in forecasting and warning for hazardous mesoscale weather events throughout the United States. This is accomplished via a disciplined synergy between operations and research that is focused on real-time forecasting and evaluation activities conducted during active severe weather events.

2. Background

The HWT Forecasting component began in 1995 when the NWS Storm Prediction Center (SPC) relocated from Kansas City, MO to Norman, OK to be collocated with the National Severe Storms Laboratory (NSSL). NSSL rearranged its facility to accommodate the SPC and to create a small, but unique Science Support Area where both operational forecasters and scientists could gather to work on challenges related to operational forecasting. The HWT was created by the Directors of the NSSL and SPC solely by re-allocating existing funds and personnel.

The HWT Warning component had its roots in early, yet intermittent interactions between the NSSL scientists and forecasters from the NWS Oklahoma City Weather Forecast Office (WFO) during the late 1970s. Collaboration occurred more regularly after the WFO relocated from Oklahoma City to a Norman location across the street from NSSL in the 1980s. The two organizations cooperated on testing technology such as the DARE Workstation, a prototype for the AWIPS workstations used in WFOs today. Additionally, the NSSL conducted radar-based warning research at a number (20+) of NWS WFOs around the country between 1995-to-2004, focusing on various severe weather algorithm development and information display activities.

Today, the HWT is an integral part of the Norman, Oklahoma NOAA Weather Community, and is located within the National Weather Center. HWT facilities include a large combined forecast and research area situated between the operations areas of the SPC and the Oklahoma City/Norman WFO (OUN), and a development laboratory located nearby on the second floor. The facilities are designed to support enhanced collaboration between research scientists and operational weather forecasters on specific topics that are of mutual interest.

3. Management Oversight

Oversight of the HWT is provided by a team consisting of the Director of the SPC, the Director of the NSSL, and the Meteorologist-in-Charge of the OUN WFO. Core annual goals and resource allocation are established by the Oversight Team. Specific activities in the HWT are conducted by an Operations Team. In addition, this team is responsible for prioritizing potential scientific and technological topics of investigation and selecting specific topics for intensive experimental evaluation. Currently this team consists of two NSSL Applied Research Coordinators, the SPC Science Operations Officer (SOO), and the OUN SOO.

4. Structure

The NOAA components located in Norman, Oklahoma have a long track record of informal, collaborative applied research and science-to-operations transition activities. A listing of past activities and publications can be found in Appendices C and D, respectively. Historically the activities have been divided between SPC-NSSL experiments focusing on forecasting techniques and numerical weather prediction, and OUN-NSSL warning-related science and technology projects.

Conceptually, the traditional arrangement can be viewed as two primary overlapping program areas (Fig. 1): forecast-scale activities under the auspices of the Experimental Forecast Program (EFP); and testing of research concepts and technology specifically aimed at short-fused warnings of hazardous weather under the auspices of the Experimental Warning Program (EWP). Both programs focus on addressing national hazardous weather needs.

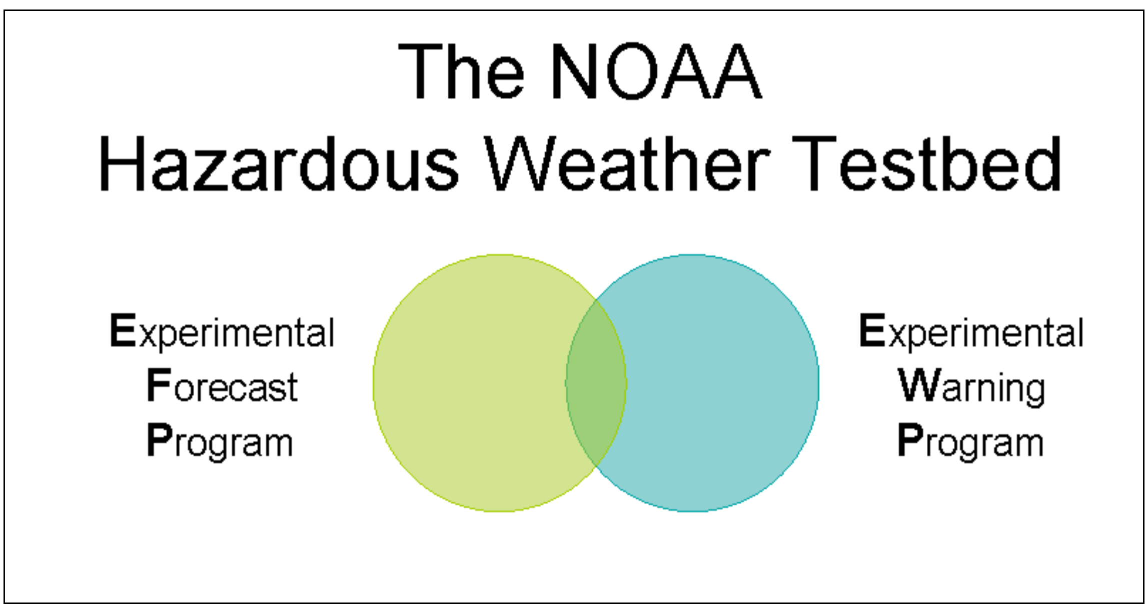

Figure 1: The NOAA Hazardous Weather Testbed (HWT) encompasses two program areas: The Experimental Forecast Program (EFP) and the Experimental Warning Program (EWP).

The specific mission of each HWT program branch is:

The Experimental Forecast Program - EFP

The EFP branch of the HWT focuses on predicting hazardous mesoscale weather events on time scales ranging from a few hours to a week in advance, and on spatial domains ranging from several counties to the CONUS. The EFP embodies the collaborative experiments and activities undertaken by the SPC and NSSL Spring Experiments.

The Experimental Warning Program – EWP

The EWP branch of the HWT is concerned with detecting and predicting meso- and smaller-scale weather hazards on time scales of minutes to a few hours, and on spatial domains from several counties to fractions of counties. The EWP embodies the collaborative warning-scale experiments and technology activities previously undertaken by the OUN and NSSL.

The HWT enables effective utilization of available resources, enhances the ability to address issues ranging from local to national in scope, and provides an efficient mechanism to coordinate projects and collaboration between NOAA organizations and their partners.

HWT collaborations typically involve other NOAA institutions, such as the tri-agency Radar Operations Center, the NWS Meteorological Development Laboratory, various groups within the NWS National Centers for Environmental Prediction (NCEP), the Earth Systems Research Laboratory, the NWS Warning Decision Training Branch, and several NOAA Cooperative Institutes. Non-NOAA partners include such institutions as the National Center for Atmospheric Research, and the University of Oklahoma's Center for Analysis and Prediction of Storms. The HWT concept includes the entire hazardous convective weather forecast spectrum, from the prediction of severe storms for periods up a week or longer, to anticipating storm initiation, to detection and diagnosis of on-going storms. The availability of national data sets, including nation-wide Level II radar data, and NWS operational workstations allows HWT collaborators to address and test concepts for practically any hazardous weather situation in the United States.

Although the HWT is a facility, it has also come to be known as a paradigm for applied research activities related to hazardous mesoscale weather. For example, recent HWT experiments have integrated activities with the GOES-R Satellite Proving Ground and incorporated specific components related to aviation hazards and heavy precipitation. The HWT paradigm provides a framework that serves to unite NOAA applied research activities related to hazardous mesoscale weather. In addition, it fosters cooperative ventures with other testbeds, such as the Developmental Testbed Center, which has worked closely with the HWT in recent years. A typical HWT experiment will have forecasters from multiple WFOs and NCEP Service Centers, private sector meteorologists, NOAA researchers and application developers, representatives of foreign meteorological agencies, and members of academia and other research organizations.

5. Transition Philosophy

Rapid science and technology infusion for the advancement of operational forecasting requires direct, focused interactions between research scientists, numerical model developers, information technology specialists, and operational forecasters. The HWT provides a unique setting to facilitate such interactions and allows participants to better understand the scientific, technical, and operational challenges associated with the prediction and detection of hazardous weather events. The HWT allows participating organizations to:

- Refine and optimize emerging operational forecast and warning tools for rapid integration into operations
- Educate forecasters on the scientifically correct use of newly emerging tools and to familiarize them with the latest research related to forecasting and warning operations
- Educate research scientists on the operational needs and constraints that must be met by any new tools (e.g., robustness, timeliness, accuracy, and universality)
- Motivate other collaborative and individual research projects that are directly relevant to forecast and warning improvement

HWT activities are a crucible of real-time forecast and warning experiments. As such they provide a test of applicability to forecast and warning operations. This is a critical component of the science and technology transition process in the HWT.

HWT activities are flexible enough to accommodate operations associated with meteorological field campaigns. For example, the recent IHOP and VORTEX II field projects had operations centers within the HWT. In this context, the proximity to the operations areas of the SPC and OUN provided a unique opportunity for field-program scientists to consult with on-duty operational forecasters in planning for deployment of mobile observing equipment. These field programs are typically multi-agency, interdisciplinary efforts that focus on collecting data to enhance our basic scientific understanding of specific hazardous weather phenomena. As such they promote improved forecasts by National Weather Service personnel, elevating the standards of services provided to the American public.

6. Identification and Selection of Scientific Concepts and Tools for Testing

The HWT addresses improvements in the prediction and detection of hazardous mesoscale weather, especially convective storms producing tornadoes, damaging wind gusts, large hail, heavy rain/flash floods, and excessive lightning. This is consistent with the NOAA Strategic Plan's Mission Goal 3 (Serve Society's Needs for Weather and

Water Information), and the Crosscutting Priorities of "Integrating Global Data Environmental Observations," and "Ensuring Sound State-of-the-Art Research." Accordingly, HWT topics include:

- Methods to increase the lead time and accuracy of short-range predictions of convection initiation, evolution, mode, intensity, and severe weather type by using new observational tools (including radar and satellites) and cutting edge numerical prediction models (including both convection-allowing deterministic models and storm-scale ensemble forecast systems)
- Methods to extend prediction of hazardous weather through 8 days using new medium range ensemble approaches and statistical techniques
- Methods to provide more accurate and detailed detection and very short-term prediction of severe convective storm phenomena using new radar technologies (e.g., dual polarization and phased array systems) coupled with cloud scale modeling approaches incorporating cutting edge dynamic data assimilation procedures

New tools and concepts examined in the HWT are selected from approaches or techniques that have shown promise in previous alpha or beta testing. Typically there are more possible topic areas than there is time to study them, so the different topics must be prioritized on the basis of 1) SPC, OUN, and/or broader NWS priorities, 2) active involvement of one or more research scientists who will champion the topic during the examination and post-analysis periods, 3) on-site technological capabilities for the investigation, and 4) feasibility for infusion into operations if results are positive. The testing and validation of new concepts and technologies most often occurs during experimental programs conducted during the spring and early summer when severe weather occurrence peaks across much of the country; this annual experiment has become known as the HWT Spring Experiment.

During each Spring Experiment, operational forecasters from SPC, OUN, other NWS offices, and private industry work closely with research scientists and model developers from NSSL, other government laboratories, and academic institutions to:

- Assess the operational utility of new scientific concepts and technologies
- Provide direct feedback to developers on the strengths and limitations of their concepts
- Offer insights on how to fine-tune the most promising tools so they can better meet the needs of operational forecasters.

These interactions capitalize on the HWT's simulation of the real-world forecasting environment found in the SPC and OUN. Additional retrospective tests using archived datasets can be conducted at other times of the year by interested scientists.

7. Governance

The HWT will be governed by a Board of Directors and Program Team Leaders whose membership is shown in Appendix A. The Program Team Leaders will be responsible for administering the HWT. The Board of Directors will seek advice from the Program Team Leaders when a Board decision is required. The Program Team Leaders are responsible for setting the focus of the testbed experiments, inviting participants, obtaining resources needed for the program with the support of the Board of Directors, carrying out the programs, analyzing the data, disseminating and publishing the results, and assisting with the transition of the results to operations. The Program Team will strive for consensus on every issue, but if consensus cannot be reached, the Board of Directors will decide.

Appendix A – Membership

The HWT Board of Directors will consist of the OAR NSSL Director, NWS SPC Director, and NWS OUN WFO Meteorologist in Charge (MIC.

<u>Experimental Forecast Program (EFT) Team Leaders will be</u>:

NSSL HWT/EFP Applied Research Coordinator	Jack Kain
SPC Science Operations Officer & HWT Coordinator	Steve Weiss

<u>Experimental Warning Program (EWP) Team Leaders will be</u>:

NSSL HWT/EWP Applied Research Coordinator	Travis Smith
OUN WFO Science Operations Officer & HWT Coordinator	David Andra

Appendix B - Current resources involved in the HWT

Without supplemental financial support for the HWT, activities within the testbed are highly leveraged both in human resources and in IT infrastructure to minimize monetary expenditures. Participants in HWT activities are overwhelmingly funded by their own organizations. Thus while topics explored within the HWT focus on hazardous weather, they must also be of critical importance to the diverse interests of the participants. Human resource estimates illustrate the typical annual HR contribution (in FTEs) to HWT activities by SPC, NSSL, and OUN:

- HWT Oversight Team and associated management staff
    - SPC 0.1
    - OUN 0.1
    - NSSL 0.3
- HWT Operations Team
    - SPC 0.35
    - OUN 1.0
    - NSSL 1.2
- Information Technology Support
    - SPC 0.3
    - OUN 0.1
    - NSSL 0.4
- Science and Software Support
    - SPC 0.45
    - OUN 0.6
    - NSSL 1.6
- Forecaster Participants
    - SPC 0.1
    - OUN 0.1
    - NSSL 0.1
- Documentation and Communication of Results
    - SPC 0.3
    - OUN 0.1
    - NSSL 0.4
- Transition to Operations (software, training, hardware, data management etc.)
    - SPC 1.0
    - OUN 0.2
    - NSSL 1.0
- Administrative Support
    - SPC 0.05
    - OUN 0.05
    - NSSL 0.3

Appendix C - Past Collaborative Experiments and Activities

SPC – NSSL Spring Forecasting Experiment foci and notable results:

- FY10 – Joint Experiment with Aviation Weather Center, Hydrometeorological Prediction Center, Developmental Testbed Center, VORTEX II
    - 26 member ensemble convection-allowing (provided by OU-CAPS) used to help quantify uncertainty associated with convective-scale predictability for severe storms, heavy rainfall, and aviation impacts
    - Utility of frequent updated high-resoluiton analyses and forecasts (provided by ESRL/GSD) evaluated
    - Utility of CONUS-scale very high resolution (1 km grid-spacing) forecasts (provided by OU-CAPS) assessed
    - Sensitivity to WRF different microphysical parameterizations evaluated
    - Utility of explicit model-generated convective storm attribute fields examined for correspondence with severe events
    - Utility of explicit total lightning and simulated satellite imagery from NSSL WRF forecasts examined
- FY09 – 20 member convection-allowing ensemble, collaboration with VORTEX II field experiment
    - Satellite-based convective-initiation detection algorithms evaluated in collaboration with GOES-R Proving Ground CI algorithm
    - Developmental Testbed Center provides expertise for daily activities, implements new verification tools
    - Impacts of data assimilation strategies used by CAPS and ESRL/GSD compared in first few hours of high-resolution forecasts
- FY08 – 10 member convection-allowing ensemble with assimilation of radar data
    - Phenomena-based data-mining strategies show promise in producing useful guidance products for specific convective phenomena.
    - Examination of pre-convective environments reveals important biases in convection-allowing forecasts.
    - Impact of radar-data assimilation assessed by visual comparison of forecasts with and without assimilation
    - Refinement of post-processing and display techniques for probabilistic output
- FY07 – Convection-allowing ensemble prediction system introduced in partnership with OU-CAPS
    - Numerous new post-processing and display techniques developed to visualize probabilistic output
    - Initial-condition perturbations resulted in varied placement and phasing of convective features while physics diversity contributed primarily to differences in amplitude of features
    - Remarkable similarity found between forecasts with 2 and 4 km horizontal grid spacing
- FY06 – Annual Spring Experiment cycle disrupted as NOAA units moved to a new building

- Internal evaluation of NCEP 12 km NAM-WRF model as a replacement for operational Eta model conducted

- FY05 - Evaluate various configurations of high resolution WRF for convective forecasting.
  - Biases were identified for various WRF configurations.
  - Various configurations had comparable skill.
  - Algorithms can effectively identify rotating updrafts in model output.
  - Simulated reflectivity fields revealed mesoscale structures not visible in other output.
- FY04 - High Resolution (4km) WRF use in severe weather forecasting
  - Lead to EMC decision to operationally implement Hi-RES WRF Windows in the 3rd Quarter of FY-05
  - Preliminary validation and feedback to EMC on operational utility of 4km WRF-NMM forecasts
  - Documented ability of high resolution WRF to provide improved guidance on convective initiation, evolution, and mode compared to operational mesoscale models
  - Courtesy of EMC, once daily experimental high resolution WRF-NMM forecasts have been provided to SPC operations since spring 2004
- FY03 - Short Range Ensemble (SREF) model forecasts
  - SREF tools developed on N-AWIPS for severe weather forecasting were subsequently refined and implemented as a operational SPC forecast technique in Fall 2003
- FY02 - International H2O Program (IHOP) Forecast Support
  - Probabilistic short range forecasts of convective initiation for experiment
- FY01 - Convective Watch Lead Time Improvement through better forecasts of convective initiation
  - Compared deterministic models to early short range ensembles
- FY00 - Convective Initiation and Evolution; Surface Objective Analysis; Hail Forecasting Techniques
  - Eta-KF Updaft Mass Flux developed to aid forecasts of convective intensity
  - Documented short comings in traditional hail size forecast techniques triggered Brimelow hail model investigation culminating in its implementation as an operational SPC forecast technique in Spring 2003
  - Validated and refined RUC based real-time mesoscale environment analysis which became an operational SPC forecast technique in Spring 2000
- FY99 - Experimental SPC Outlooks
  - SPC national fire weather guidance became operational product in April 2000
  - SPC Probabilistic Convective Outlooks became operational product in January 2001
- FY98 - MEaPRs (storm electrification) field program forecasts and nowcasts
  - Dual polarization radar validation
  - Experimental SPC Fire Weather Outlooks

    - Experimental nationwide Day 3 Convective Outlooks
- FY97 – Winter Short Term Winter Weather advisories
    - Based on this experiment SPC winter weather mesoscale discussions became operational in Fall 1997
    - Spawned research into precipitation type forecasting (PTAX 2001) which resulted in improved SPC & HPC forecast technique in Fall 2002
    - Experimental Day 3 Convective Outlooks for the greater Washington D.C. area produced.
- FY96 - WINWEX '96 (WINter WEather EXperiment) - SPC winter weather forecast technique and product refinement
    - The results of this experiment led to a change in the proposed SPC winter weather product from scheduled forecasts to as-needed mesoscale advisories
    - Evaluation of the Operational utility of the ARPS model
    - Enhanced model sounding analysis for convective parameterization interpretation became operational SPC forecast technique in Spring 2002

Experimental Warning Program foci (FY06-FY10):

- FY10:
    - Phased Array Radar Innovative Sensing Experiment (PARISE), year 2: to evaluate the operational impacts the higher temporal update rates of PAR in the warning-decision-making process
    - Collaborative Adaptive Sensing of the Atmosphere (CASA), year 3: observation of decision-making and communication interactions among spotters, emergency managers, and NWS forecasters as severe weather passes through the CASA testbed
    - GOES-R satellite platform: evaluate operational utility of experimental applications, including total lightning, convective initiation, and overshooting top algorithms and data
    - Multi-radar/Multi-sensor (MR/MS) Severe Weather Algorithm Experiment, year 2: determine how MR/MS products can be used to produce more efficient, precise, and accurate severe weather warnings
    - Warn-on-Forecast: evaluation of real-time assimilated multi-radar data fields at 1km resolution
    - Severe Hazards Analysis and Verification Experiment: focus on improved collection of high-resolution verification data from severe wind events

- FY09:
    - Phased Array Radar Innovative Sensing Experiment (PARISE), year 1: to evaluate the operational impacts the higher temporal update rates of PAR in the warning-decision-making process
    - Collaborative Adaptive Sensing of the Atmosphere (CASA), year 2: forecaster assessment of the strengths and limitations of CASA moment

    - data for severe weather decision-making; 2D wind fields from 3D variational analysis
    - Multi-radar/Multi-sensor (MR/MS) Severe Weather Algorithm Experiment, year 1: initial assessment of MR/MS products for use in NWS warning operations
    - Lightning Mapping Array experiment: evaluate the use of for 3D lightning products and GOES-R Global Lightning Mapper "proxy" products
    - Severe Hazards Analysis and Verification Experiment: focus on collecting initial hail reports from developing storms - led to a better understand of the life cycle of hail-producing storms

- FY08:
    - Phased Array Rader: strengths and limitations of using PAR data to investigate severe storms. Results led to improved scanning strategies optimized for PAR
    - Collaborative Adaptive Sensing of the Atmosphere (CASA) focus on identifying storm features that may be detected at the finer-than-WSR-88D scales of CASA data
    - Probabilistic Hazard Information: determining if human forecasters quantify probabilities of severe weather occurring in a warned area
    - Severe Hazards Analysis and Verification Experiment: initial testing of methods to collect high-resolution flash flood reports

- FY07:
    - Initial spin-up of EWP in the new National Weather Center facilities, with limited visiting forecasters. Foci were on Phased Array Radar data collection, creating probabilistic hazard grids of severe weather threat areas, and evaluating new WSR-88D radar products.
    - Severe Hazards Analysis and Verification Experiment: refinement of hail data collection methods, resulting in many more cases collected

- FY06:
    - Severe Hazards Analysis and Verification Experiment: initial collection of high-resolution hail data

Science and Technology Transition Activities at OUN (pre-FY06)

- FY05 – Polarimetric radar sensitivity test. (OUN/NSSL/ROC)
    - Assess operational impact of 3 dB sensitivity loss compared to WSR-88D in base and algorithm radar products.

- FY05 – Integration of multi-radar, multi-sensor severe weather algorithm information into AWIPS and the warning decision process. (OUN/NSSL/SRH)
    - Includes new hail diagnosis, "rotation tracks", and 3D Lightning Mapping Array products.

- Establish means to display data sets in AWIPS
- Validate utility of algorithm data sets to warning decision process

- FY03 – JPOLE: Operational evaluation of polarimetric radar data. (OUN/NSSL)
    - Established operational utility of polarimetric base moments and derived rainfall estimates
    - Identified case studies involving winter weather, tornadoes, hail, and heavy rainfall.

- FY04 -- Developed and implemented NWS' first Situation Awareness Display System (SADS). (OUN/WDTB)
    - Documented role of enhanced SA in warning operations
    - Designed SA enhancing software and assisted other NWS offices in its implementation

- FY03 – Enhanced graphical hazard depiction and technical information exchange initiative. (OUN/FSL)
    - Refined FSL's FX-Connect application to construct graphical weather hazard graphics on AWIPS for posting to WFO homepage in real time
    - Developed and implemented the warning decision update message to share technical details of warning decision making with advanced customers

- FY02-05 – Operational test and evaluation of WDSS II radar display workstation. (NSSL/OUN)
    - Trained WFO forecasters on principles and use of WDSS II
    - Collaborative interaction between NSSL developers and WFO forecasters
    - Evaluated and documented operational utility of Terminal Doppler Weather Radar (TDWR) to WFO operations
    - Beginning FY05: Test of new 4D base radar data analysis tool with interactive dynamic cross-sections and CAPPIs.

- FY02 – Advanced AWIPS prototype project. (OUN/SRH)
    - Conducted field test of prototype AWIPS workstation replacement configuration
    - Documented requirements for 3 or more AWIPS monitors, performance of LINUX PC platform, and improved ergonomics of LCD monitors. System now fielded in all NWS offices

- FY01 – Development and field testing of Weather Event Simulator (WES). (OUN/WDTB/FSL/SRH)
    - Evaluated feasibility of simulator capability on AWIPS operational platform versus stand-alone LINUX platform
    - Defined simulator concept in operational training program

- FY96-01 – WDSS Operational use and evaluation (OUN/NSSL)

    - Operational evaluation and use of NSSL single radar algorithms
    - Operational evaluation and use of cell-based table and WDSS display tools
    - Operational evaluation and use of WSR-88D level II data

- FY94-95 – VORTEX (OUN/NSSL/SPC)
    - Nowcast and forecast support for VORTEX

- FY91-95 – NWS Modernization and Risk Reduction Project (OUN/FSL)
    - Experimental Forecast Facility (EFF)
    - Prototyped modernized WFO operations and staffing models
    - Operational test and use of pre-AWIPS workstations
    - First WSR-88D commissioned

- FY79-90 – Many early but important projects including
    - NEXRAD IOT&E II
    - JDOP
    - Numerous Spring experiments including: DOPLIGHT, COPS, MAPS, QED, STORMTIPE

Appendix D - Selected Publications on SPC and OUN Science and Technology Infusion Activities

Experiment Overviews:

Coniglio, M. C., K. L. Elmore, J. S. Kain, S. J. Weiss, M. Xue, and M. L. Weisman, 2010: Evaluation of WRF model output for severe-weather forecasting from the 2008 NOAA Hazardous Weather Testbed Spring Experiment. *Wea. Forecasting*, **25**, 408-427.

Gourley, J.J, J.M. Erlingis, T.M. Smith, K.L. Ortega, and Y. Hong, 2010: Remote collection and analysis of high-resolution data on flash floods, *J. of Hydrology*, In press. (special issue on Flash Flood: Observations and Analysis of Hydrometeorological Controls)

Kain, J. S., S. J. Weiss, J. J. Levit, M. E. Baldwin, and D. R. Bright, 2006: Examination of convection-allowing configurations of the WRF model for the prediction of severe convective weather: The SPC/NSSL Spring Program 2004. Wea. Forecasting, 21, 167-181.

Kain, J.S., M.E. Baldwin, P.R. Janish, S.J. Weiss, R.S. Schneider, and H.E. Brooks, 2003: Collaboration between forecasters and research scientists at the NSSL and SPC. *Bull. Amer. Meteor. Soc.*, **84**, 1797-1806.

Kain, J. S., S. J. Weiss, J. J. Levit, M. E. Baldwin, and D. R. Bright, 2005: Examination of near-convection resolving configurations of the WRF model for the prediction of severe convective weather: The SPC/NSSL Spring Program. (Submitted to *Wea. Forecasting*)

Kain, J.S., M.E. Baldwin, P.R. Janish, S.J. Weiss, M.P. Kay, and G.W. Carbin, 2003: Subjective verification of numerical models as a component of a broader interaction between research and operations. *Wea. and Forecasting,* **18,** 847-860.

Heinselman, P. L., D. Priegnitz, T. Smith, D. Andra, R. Palmer, M. Biggerstaff, 2007: Spring 2007 National Weather Radar Testbed Demonstration. Preprints, 33rd Conference on Radar Meteorology, Cairns, Australia, American Meteorological Society, CD-ROM, P5.7

Kuhlman, K.M., T. M. Smith, G. J. Stumpf, K. L. Ortega, and K. L. Manross, 2008: Experimental probabilistic hazard information in practice: Results from the 2008 EWP Spring Program. *24th Conference on Severe Local Storms*, Savannah, GA, Amer. Meteo. Soc., 8A.2.

Ortega, Kiel L., Travis M. Smith, Kevin L. Manross, Angelyn G. Kolodziej, Kevin A. Scharfenberg, Arthur Witt, Jonathan J. Gourley, 2009: The Severe Hazards Analysis and Verification Experiment. Bull. Amer. Meteor. Soc., 90, 1519-1530 doi: 10.1175/2009BAMS2815.1

Stumpf, G.J., T. M. Smith, K. Manross, and D. L. Andra, 2008: The Experimental Warning Program 2008: Spring Experiment at the NOAA Hazardous Weather Testbed. *24th Conference on Severe Local Storms*, Savannah, GA, Amer. Meteo. Soc., 8A.1.

Some Additional Publications Resulting from SPC-NSSL Projects:

Baldwin, M.E., J.S. Kain, and M.P. Kay, 2002: Properties of the convection scheme in NCEP's Eta model that affect forecast sounding interpretation. *Wea. and Forecasting*, **17**, 1063–1079.

Bright, D. B., S. J. Weiss, J. J. Levit, and D. J. Stensrud, 2003: The utility of short-range ensemble forecasts in real-time prediction of severe convective weather at the Storm Prediction Center. Preprints, AMS 10th Conference on Mesoscale Processes.

Bright, D. B. and P. Nutter, 2004: On the challenges of identifying the "best" ensemble member in operational forecasting. Preprints, AMS 16th Conference on Numerical Weather Prediction.

Bright, D. R., M. S. Wandishin, R. E. Jewell, and S. J. Weiss, 2005: A physically-based parameter for lightning prediction and its calibration in ensemble forecasts. Preprints, Conference on Meteorological Applications of Lightning Data, AMS Annual Meeting.

Bright, D. R., M. S. Wandishin, S. J. Weiss, J. J. Levit, J. S. Kain, and D. J. Stensrud
Evaluation of short-range ensemble forecasts during the 2003 SPC/NSSL Spring Program. Preprints, AMS 22nd Conf. on Severe Local Storms.

Bukovsky, M. S., P. R. Janish, J. S. Kain, and M. E. Baldwin, 2002: Evaluation of operational and experimental Eta model forecasts of mesoscale convective systems. Preprints, AMS 21st Conf. Severe Local Storms.

Bukovsky M. S. and J. S. Kain, 2004: Predicting propagating convective systems using operational forecast models. Preprints, AMS 22nd Conf. on Severe Local Storms.

Bukovsky, M. S., J. S. Kain, and M. E. Baldwin, 2006: Bowing convective systems in a popular operational model: Are they for real? *Wea. Forecasting,* **21**, 307–324.

Coniglio, M. C., S. F. Corfidi, and J. S. Kain, 2010: Environment and early evolution of the 8 May 2009 derecho-producing convective system. Conditionally accepted for publication in *Mon. Wea. Rev.*Homar, V., D. J. Stensrud, J. J. levit, and D. R. Bright, 2005: Value of human perturbed simulations in numerical forecasting of severe weather. (Submitted to *Wea. Forecasting*)

Jewell, R. E, and J. C. Brimelow, 2004: Evaluation of an Alberta Hail Growth Model Using Severe Hail Proximity Soundings in the United States. Preprints, AMS 22nd Conf. on Severe Local Storms.

Kain, J.S., M.E. Baldwin, and S.J. Weiss, 2003: Parameterized updraft mass flux as a predictor of convective intensity. *Wea. and Forecasting,* **18**, 106-116.

Kain, J. S., M. E. Baldwin, S. J. Weiss, P. R. Janish, J. A. Hart, and A. Just, 2002: Grassroots science and technology transfer in a collaborative research/operational environment. Keynote address - Preprints, AMS 15th Conf. Numerical Weather Prediction.

Kain, J. S., M. E. Baldwin, and S. J. Weiss, 2002: WRF model evaluation at the SPC and NSSL. Preprints, AMS 15th Conf. Numerical Weather Prediction.

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