Cooperative Institute for Mesoscale Meteorological Studies Strategic Plan for Fiscal Years 2006-2009

Overview

The CIMMS Strategic Plan defines our

- Mission – *Reason for existence*
- Vision – *Anticipated impact on the future*
- Values – *Guiding principles*
- Goals – *Desired accomplishments*
- Outcomes – *Specific, measurable, attainable results of pursuing the goals*
- Strategies and Actions – *Activities planned to achieve the goals and produce outcomes*

Our Research Themes (as defined in the Memorandum of Understanding between NOAA and The University of Oklahoma - OU) and our current affiliations are also listed.

This plan is a living document and a roadmap that identifies our goals and action items for setting and implementing the scientific objects now envisioned. It is constructed on the same five-year cycle as our cooperative agreement with NOAA and will be revisited on an annual basis within that cycle. It will be updated as required to reflect advancement in technology and the sciences and responses to opportunities as they arise. It will reflect the goals and objects as stated in NOAA's Strategic Plan, which currently covers fiscal years 2005 through 2010.

The desired outcome of all research performed at CIMMS is to improve fundamental understanding of mesoscale meteorological phenomena, weather radar, forecasting and warning processes, and regional climate that will lead to better, quicker, and more valuable weather and water information to support improved decisions that can reduce loss of life, injury, and damage to the economy.

Research Themes

Basic convective and mesoscale research

Forecast improvements

Climatic effects of/controls on mesoscale processes

Socioeconomic impacts of mesoscale weather systems and regional scale climate variations

Doppler weather radar research and development

Climate change monitoring and detection

Affiliations

NOAA units	OU Units
• OAR National Severe Storms Laboratory • NWS Warning Decision Training Branch • NWS NCEP Storm Prediction Center • NWS Radar Operations Center • NWS Southern Region Headquarters • NWS Norman Forecast Office • NWS Office of Science and Technology • NESDIS National Climatic Data Center	• College of Geosciences • School of Meteorology • Department of Geography • Oklahoma Climatological Survey • Center for Analysis and Prediction of Storms • Sasaki Applied Meteorology Research Institute • Center for Spatial Analysis • Environmental Verification and Analysis Center • International Center for Natural Hazards and Disaster Research • Integrated Radar Data Services • OU Supercomputing Center for Education & Research

Mission Statements

NOAA Mission

To understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs

NOAA Research Mission

To conduct environmental research, provide scientific information and research leadership, and transfer research into products and services to help NOAA meet the evolving economic, social, and environmental needs of the Nation

OU Mission

To provide the best possible educational experience for our students through excellence in teaching, research and creative activity, and service to the state and society

CIMMS Mission

To promote collaborative research between NOAA and OU scientists on problems of mutual interest to improve basic understanding of mesoscale meteorological phenomena, weather radar, and regional climate to help produce better forecasts and warnings that save lives and property

Vision Statements

NOAA Vision	NOAA Research Vision
An informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions	*A society that uses the results of our research as the scientific basis for more productive and harmonious relationships between humans and the environment*

CIMMS Vision

A center of research leadership and excellence in mesoscale meteorology, weather radar, regional climate, and forecast and warning improvement, fostering strong government/university collaborations

Core Values (After NOAA)

People

Integrity

Excellence

Teamwork

Ingenuity

Goals

GOAL – Mesoscale Meteorology

Perform fundamental research on mesoscale and convective weather processes

Supports NOAA Goal to Serve Society's Needs for Weather and Water Information

Outcome 1

Improved understanding of the structure and behavior of deep convection such as supercell storms, tornadoes, damaging straight-line winds, large hail, and heavy snow (1) (6) (CD) – *see Appendix for code descriptions*

Strategies in Support of Outcome	Actions in Support of Strategy
• Utilize weather observations, weather radar data, numerical model simulations, and data from other remote sensing devices to study processes that lead to hazardous convective weather phenomena (1) (6) • Determine how environmental factors, notably the forcing that initiates deep convection and the environmental wind and thermodynamic profiles, control the time-dependent behavior of deep convective storms (CD)	• Use WSR-88D data, tornado reports, and numerical simulations to study the frequency and formation of tornadoes within squall lines • Investigate how tornadoes form in isolated supercell thunderstorms by analyzing data collected in both tornadic and non-tornadic supercells with a variety of sensors • Participate in and analyze data collected during national field programs to understand processes by which the atmosphere becomes convectively unstable and thunderstorms are initiated • Identify methodologies to blend Doppler radar radial velocity and reflectivity information into numerical models using Kalman filter techniques • Analyze dual polarization and dual Doppler radar data to identify the mesoscale and stormscale processes responsible for narrow corridors of large snow accumulations that frequently occur in winter storms • Study and improve the representation of convective parameterizations in mesoscale models • Analyze the climatological distribution of various types of hazardous weather • Test, create, and use low-cost portable sounding systems to observe and study the vertical structure of hazardous meteorological phenomena • Analyze meteorological data obtained during hazardous weather events in order to identify the dominant synoptic-scale and mesoscale physical processes that influence the initiation time, the duration, and cessation time of these events • Identify, investigate, and test accurate methods of verifying objective and subjective forecasts of hazardous weather phenomena • Evaluate and explore different methods for analyzing irregularly spaced data, such as those collected by the National Weather Service

	• Investigate methods to provide improved forecasts of near surface conditions (e.g., 2-m temperature and dewpoint temperature, and 10-m winds) through the use of ensemble forecasts • Use a 3D cloud model to perform a numerical modeling study of the time-dependent behavior of convection, including development of algorithms for parameterized momentum forcing and for identifying and diagnosing the presence of "bubbles" within a convective simulation • Study synoptic scale controls on tornado outbreaks by collecting, databasing and categorizing past events • Estimate supercell storm motion using hodographs
Outcome 2 Improved understanding of the feedbacks between cloud microphysical, radiative transfer, and dynamical processes (YK and KK)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Explore the interactive feedback of longwave multi-dimensional radiative effects on cloud dynamics (YK) • Assess the importance of horizontal radiative transfer on the evolution of radiatively-forced PBL clouds (YK) • Explore improvements in how regional models represent cloud-aerosol interactions (YK) • Develop cloud and radiation parameterizations for use in climate and numerical weather prediction models (YK) • Explore the consistency of certain microphysical parameterizations with the physical processes they are designed to represent (KK)	• Develop a parameterization of cloud variability for use in climate and numerical weather prediction models • Apply a multi-dimensional radiative transfer scheme to cloud fields produced by large eddy simulation to infer feedbacks onto cloud-topped boundary layer dynamics • Couple the radiative transfer scheme to the CIMMS LES Model to address the interactive and evolutionary nature of multi-dimensional radiative effects • Develop parameterizations of subgrid variability, based on probability distribution functions of radar reflectivity, for low altitude stratiform clouds and at scales of 10 and 30 km, taken to be representative of mesoscale and large scale model grid sizes, respectively. • Perform large eddy simulations of warm rain initiation in stratiform clouds, the results of which have implications for cloud microstructure formation, drizzle initiation, and estimation of aqueous chemical transformation rates • Study drizzle heterogeneity in a stratocumulus-topped boundary layer • Characterize cloud processing of aerosol in a coupled ocean/atmosphere mesoscale prediction model (COAMPS) using the CIMMS bulk drizzle scheme • Compare conservation properties of microphysical parameterizations by analyzing a continuous Gamma distribution function with a fixed shape parameter
Outcome 3 Improved understanding of mesoscale dynamics and storm scale data assimilation (QX and KK)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Perform theoretical studies on nearly symmetric and nearly baroclinic instabilities in the presence of	• Analyze in detail the structure and energetics of the nearly baroclinic modes

diffusivity and examine their energetic aspects (QX) • Study nonlinear oscillations of baroclinic waves caused by mesoscale frontal processes and related vertical motions (QX) • Develop state-of-the-art technologies and software for real-time applications of remotely sensed high-resolution measurements, especially those from Doppler radars, to improve numerical nowcasts and forecasts of severe storms and hazard weather conditions (QX) • Develop state-of-art techniques for applications of mesonetwork surface and soil data, including surface and soil data assimilation (QX) • Investigate the dynamics and microphysics of cirrus outflow anvils, isolate the conditions under which mammatus clouds form and are detectable, and make case studies of mammatus events and null events to help assess the role of dynamical and microphysical processes in mammatus cloud formation (KK) • Assess the role of convective boundary layer vertical vortices on boundary layer processes (KK) • Examine the formation of vertical vortices within idealized ellipsoidal convective elements in quiescent ambient flows, and explore the effects of ambient winds, stratification, multiple convective elements, and other variables on the formation of these vortices (KK) • Analyze Martian dust devil characteristics as determined by Mars Orbiter Camera images and make comparisons with terrestrial dust devils to gain insight into dust devil formation and maintenance dynamics, and their role in boundary layer processes (KK)	• Examine the physical processes involved in nonlinear oscillations of Eady baroclinic waves obtained from viscous semigeostrophic models with two types (free-slip and non-slip) of boundary conditions • Utilize satellite data and surface observations in addition to radar data to improve cloud and precipitation analyses and predictions, using a In collaboration with scientists at the Naval 3.5-dimensional variational radar data assimilation package in combination with other data fusion technologies • Incorporate a linear time interpolation into moving frame (with the storm) analysis to develop an improved scheme for three-dimensional Doppler wind analyses and thermodynamic retrievals • Develop a technique to remove bird contaminated velocity scans by using an automated identification technique • Develop a prototype method using linear regression to retrieve daily averaged soil water content from diurnal variations of soil temperature measured at three or more depths and upgrade it by using an advanced technique based on the adaptive Kalman filter • Perform numerical simulations of thunderstorm outflow anvils and summarize the current state of knowledge of the microphysics and dynamics of mammatus clouds and the environments in which they form • Conduct three dimensional, two meter resolution boundary layer large eddy simulations to resolve and simulate vertical vortices with dust devil characteristics and extend the simulation results to consider the effects of ambient winds and wind shears on these vortices • Explore variables such as the effects of ambient wind on the formation of vertical vortices in ellipsoidal thermal elements using a numerical simulation • Determine a representative temperature profile that might be typical of Martian dust devil environments in order to make estimates of tangential wind speeds given the physical dimensions determined from the Mars Orbital Camera images • Evaluate theoretical vortex models using observational data from Martian dust devils and conduct large eddy simulations of the Martian boundary layer

GOAL – Weather Radar Research and Applications

Perform research on weather surveillance radar and develop prototype economical applications and technologies for optimal operational deployment

Supports NOAA Goal to Serve Society's Needs for Weather and Water Information

Outcome 1

Improved quantitative precipitation estimation in the near real-time for watershed management and for better flash flood detection, warnings, and forecasts, including use of prototype dual polarization radar data (2) (5)

Strategies in Support of Outcome	Actions in Support of Strategy
• Perform research and development leading to improved quantitative estimation of precipitation for flash flood monitoring and prediction, watershed management, inputs to hydrologic models and near storm-scale models, and for verification of high-resolution numerical weather forecasts (2) • Assess the benefits of integrating the newest technologies in remote sensing of precipitation using polarimetric research weather radars, a suite of ground instruments, and in situ observations to provide enhancements to our understanding of the physics and dynamics of convection, improve the ways in which estimates of precipitation are made, and verify the operational QPF (2) (5)	• Provide a seamless conterminous U.S. 3D radar reflectivity mosaic that has high spatial resolution (1km x 1km x 500m) and rapid update cycle (every 5 min) for severe weather applications and for mesoscale numerical weather model data assimilation • Provide accurate conterminous U.S. precipitation estimates over a high-resolution (1km x 1km) grid with a rapid update cycle (every 5min) for flash floods and flood warnings, and for water resource management. • Evaluate the improvements in accuracy of precipitation estimates using dual-polarization radar parameters • Assess the usefulness of integrating data in a QPE scheme from radars operating at different wavelengths • Explore calibrating satellite data from multiple channels using radar-derived precipitation estimates • Utilize mesoscale model analyses and explore the use of forecast fields for improving diagnostic and ultimately, prognostic QPE • Couple rainfall fields to a distributed rainfall/runoff model that will provide forecasts of impending floods based on model output of stream flow • Develop GIS basin datasets with hydrologic connectivity attributes to be used in the Flash Flood Monitoring and Prediction System in AWIPS and provide technical support and assistance to NWS Forecast Offices for their FFMP basin dataset customization efforts • Push the polarimetric rainfall measurement technique to the limit by determining if the radar can be self sufficient for measurements of rainfall (i.e., reduce or eliminate the need for rain gauges) • Study the more difficult aspect of quantitative measurement of ice hydrometeors, including all types of snow, hail, and graupel using polarimetric radar data

	• Study and develop polarimetric techniques to effectively use data for quantitative precipitation estimation, classification of echoes, and detection of weather phenomena • Create new algorithms that exploit the expanded capabilities of dual-polarization radar and develop techniques to provide improved data quality for the prototype polarimetric KOUN WSR-88D radar • Complete data analyses and produce reports to demonstrate the utility of a polarimetric WSR-88D and support a decision briefing to the NEXRAD Program Management Committee (NPMC) on upgrading the national network of WSR-88D's to include polarimetric capabilities

Outcome 2

Feasibility research and development to explore the capability of phased array radar for weather surveillance (8)

Strategies in Support of Outcome	Actions in Support of Strategy
• Make use of NSSL's phased array radar testbed by exploring its utility for weather surveillance, including improved warnings and nowcasts based on data obtained at rates an order of magnitude faster (few seconds per storm volume) than are possible with conventional weather radar (8) • Explore scanning strategies for phased array radar (8) • Explore the multi-function potential of phased array radar to simultaneously monitor weather, aircraft, and non-cooperative targets (8) • Explore the concept of "warn on forecast" (paradigm now is "warn on detection") using very high resolution, cloud resolving storm scale numerical weather prediction models that can assimilate high resolution real time data, such as those from phased array radar (8)	• Maintain and improve a testbed phased array radar facility • Examine snap shot volume scans in a playback mode to assess the time scales of convective weather features • Improve the radar scheduler component of the phased array radar • Study the structure and dynamics of convective phenomena with the unique capabilities of the phased array radar • Study vortex dominated flows by gathering phased array radar data on tornadic storms • Continue meteorological analyses of phased array radar data to evaluate the utility of using such technology for meteorological purposes

Outcome 3

Expanded WSR-88D network capabilities to extend the network's useful life well into the first quarter of the century (7)

Strategies in Support of Outcome	Actions in Support of Strategy
• Explore the evolutionary changes in radar technology as applied to the current network of WSR-88D radars by studying various algorithms, range and velocity ambiguities, software and hardware enhancements, and data assimilation that could improve the performance of the radar for detecting hazardous weather phenomena (7)	• Develop methods to mitigate range and velocity ambiguities • Improve data assimilation methods for models that require radar data and data from other in-situ and remote sensors • Examine techniques to improve the data resolution of the WSR-88D • Improve Doppler spectral moment and polarimetric variable estimates through use of a pseudowhitening transformation on oversampled range data • Create a platform-independent tool for visualizing radar propagation path with respect to the terrain surrounding the radar • Continue exploring the use of dual polarization to better identify precursors to tornadoes and the tornadoes themselves, including unique detection of debris lofted by tornadoes

	• Provide additional enhancements for forecaster training, such as display of non-standard beam propagation using point soundings, and display of radar algorithm output dependent on range from radar and volume coverage pattern • Use mobile radar platforms to study convective and mesoscale atmospheric processes to help improve forecasts of significant weather events such as flash floods, hurricanes, and tornadoes • Improve tornado detection by identifying vortex signatures in the Doppler spectrum obtained from WSR-88D data
Outcome 4 Improved radar input into severe thunderstorm and tornado warnings (13)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Analyze the structure and morphology of hazardous weather using radar data, identifying any common storm characteristics that have the potential to be identified by an automated procedure, to improve understanding of radar observations of supercell thunderstorms with tornadoes and squall lines with damaging straight-line winds, which could then be used by meteorologists in the public and private sectors (13)	• Completely analyze weather radar reflectivity, mean velocity, and spectrum width data for one or more outbreak-type severe weather events • Advise the WDTB on updating the NWS Office of Services WSR-88D training materials, and incorporate such information into appropriate handbooks, technical documentation, and training materials used by operational forecasters

GOAL – Forecast and Warning Improvements

Transition research findings into knowledge, technology, and training that can be used to improve forecasts and warnings

Supports NOAA Goal to Serve Society's Needs for Weather and Water Information

Outcome 1

New and innovative applications, methods and technologies that streamline forecast and warning decision processes and practices and assist forecasters in the detection, diagnosis, and prediction of severe weather (3) (4) (6) (12)

Strategies in Support of Outcome

- Use contemporary data mining and artificial intelligence techniques on multiple sensor data (conventionally Doppler radar data; dual-polarized and phased array radar data; near-storm environment data, satellite data, lightning data) to analyze and study severe convective weather in order to gain new knowledge about these phenomena and improve derived applications (3)
- Provide expertise to transfer resulting application prototypes to operational groups within the National Weather Service, Federal Aviation Administration, and the Department of Defense (3)
- Develop research prototype systems to synthesize data from multiple sources, derived automated algorithm results, and numerical model output to reduce and organize the amount of information available to the forecaster to facilitate their warning and forecast decisions (4)
- Explore the processes and methods that forecasters use to analyze hazardous weather data (6)
- Participate in a Hazardous Weather Testbed that allows NWS forecasters and NOAA and CIMMS research scientists to collaboratively test, develop, and operationally implement new forecast and warning techniques and technology on a regular basis (6)
- Design and execute an annual collaborative spring program with NSSL and SPC, as part of the Hazardous Weather Testbed, to allow forecasters to evaluate new tools and concepts that emanate from the research community, while immersing research scientists in the challenges, needs, and constraints of the operational forecasting environment (6)
- Examine innovative new techniques to validate and measure the success of forecasts and provide effective feedback to forecasters (6)
- Analyze the predictive characteristics of mesoscale phenomena, particularly severe thunderstorms, and the larger-scale systems in which they may be

Actions in Support of Strategy

- Study and improve methods to detect storm-scale vortices (mesocyclones and tornadoes) within severe thunderstorms
- Study Tornado Warning Guidance statistics
- Analyze the climatological distribution of severe weather using radar algorithm output
- Improve methods to diagnose hail probability, size, and area swath using conventional and polarimetric radar data
- Integrate multi-radar and multi-sensor data into the NSSL/CIMMS display system known as the Warning Decision Support System - Integrated Information (WDSS-II), which uses sophisticated artificial intelligence-based computer programs to automatically analyze radar data to determine preset thresholds for hail size, wind speed, and tornado potential
- Investigate optimum ways to display integrated weather data and information for use by a meteorologist, including the handling of new phased array radar data and the development of image processing and expert systems
- Provide research support to SPC forecasters by assessing whether they can make better predictions of severe convective weather when their current datastream of observational and model data is supplemented with output from near-cloud-resolving forecast models
- Identify specific characteristics of high resolution model output that provide added value for forecasting, as well as characteristics that might have a detrimental or misleading impact
- Increase forecaster awareness and understanding of the Weather Research and Forecasting (WRF) model
- Compare the performance of several WRF model configurations to provide feedback to model developers
- Develop a prototype visually-accurate weather data

embedded, making use of weather observations, radar data, numerical model simulations, and data from other remote sensing devices (12) • Expedite the transfer of research knowledge from the academic community to the forecast community (12)	rendering system, using the latest computer graphics technology, to visualize WRF data with a stretched vertical grid • Refine and further develop the Kain-Fritsch convective parameterization and consult with worldwide users of the scheme • Automate data collection of quantitative precipitation forecasts from NCEP's operational models for use in verification studies and establish a long-term archive of forecast fields such as winds and temperatures on mandatory pressure levels from daily runs of NCEP's operational Eta model and NSSL's experimental version of the Eta model • Develop an event- or object-oriented approach to verification and build a database of forecasts and observations for ongoing verification studies • Analyze Fourier kinetic energy spectra of forecasts from various mesoscale models (NCEP NMM, NSSL Eta, NCAR WRF) in order to determine whether the spatial structure and variability of forecast fields is being predicted in a manner consistent with observations • Examine the false alarm problem as it relates to tornado detection and lead time, including the use of dual polarized radar technology, phased array radar, and WDSS-II, along with the integration of geographic information system (GIS) technology for dissemination
Outcome 2 Quick and successful science and technology transfer into NWS operations (9)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Research and prototype new applications for the benefit of NWS warning operations that exploit data from new WSR-88D algorithms, polarization diversity radar, phased-array radar, GOES-R sensors, 3-D lightning networks, surface mesonets, and ACARS, all high resolution data sources that either are operational now or will be during the next 10 years (9) • Better leverage university research and expertise through the use of testbeds and other methods to shorten cycle times from research to operations (9)	• Work with CIMMS and NSSL scientists to establish a multi-sensor development team and testbed in order to prototype new multi-sensor applications suitable for short-fuse warning operations and short-range prediction, such as severe weather and flash flood applications, for NWS operational systems • Serve as a liaison between operations at NWS/OST and research at CIMMS and NSSL on a host of technical and scientific issues • Carry out research and software development for AWIPS decision assistance tools, including multiple-sensor (e.g., multiple radars, mesoscale models, lightning, etc.) severe weather warning decision-making applications (detection, diagnosis, and prediction algorithms) for use in ongoing basic and applied research projects at CIMMS • Work with other MDL staff, and the NOAA Forecast Systems Laboratory and the Office of Hydrological Development on a variety of projects that leverage the research conducted at CIMMS and NSSL • Provide expertise to help transfer applied research results from CIMMS and NSSL to the National Weather Service for use in operational hazardous weather decision assistance systems

Outcome 3

Forecasters trained in the latest warning decision making techniques (10)

Strategies in Support of Outcome	Actions in Support of Strategy
• Investigate the incorporation of new scientific research results, new technologies, and new decision-making methodologies, particularly those related to weather warnings, into prototype forecaster training materials (10) • Investigate warning decision making issues with NWS forecasters to evoke a better understanding of the warning decision making process and transfer that knowledge to warning decision makers to improve performance (10) • Develop simulation capabilities to enhance warning decision making research and training (10)	• Provide subject-matter expertise to update materials to current technologies and research results for the WSR-88D Distance Learning Operations Course (DLOC) • Provide subject-matter experts and investigate methods to effectively deliver asynchronous training for both severe weather and winter weather Advanced Warning Operations Course (AWOC) • Prototype new training content by assessing the contents of each build, investigating the build integration and testing process, and providing prototype materials for training to the beta sites during beta testing for WSR-88D Build Training • Prototype new training materials focused on new warning functionality items associated with each AWIPS release for AWIPS Build Training • Provide subject-matter expertise and prototype training materials that incorporate the following basic requirements: 1) familiarity with the Incident Command System (ICS), 2) basic hydrometeorological needs of first responders, 3) an understanding of tools used by first responders during an emergency (CAMEO, ALOHA, etc.), 4) an ability to provide effective and concise briefings, and 5) an understanding of microscale and urban meteorology, for Homeland Security Distance Learning • Leverage University of Oklahoma expertise in natural hazards training for emergency managers and combine it WDTB expertise in distance learning to prototype a 3- to 4-hour course in Weather Decision Making for Emergency Managers • Make use of the WDTB/CIMMS Weather Event Simulator to study decision-making processes during hazardous weather events, including development of 1) more robust training tools to maximize the learning and evaluation in WES training, and 2) improved integration of warning decision-making training in the AWIPS development process; continue to refine the WES scripting language support tool with innovative techniques to measure situation awareness and forecaster reasoning using automated query options; prototype an integration of the Radar Product Generation (RPG) software on the WES to mitigate the loss of radar data playback capability • Develop new simulation cases to demonstrate the critical role and effective use of the WES for new NWS Science and Operations Officers in support of the COMET Mesoscale Analysis and Prediction Course (COMAP)

Outcome 4 New and innovative ways to disseminate and display weather information for the general public (11)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Use readily available weather information to examine different dissemination and display methodologies, incorporating Human Factors research into their design, and study system response and extraction times associated with the different methodologies (11)	• Investigate new applications to increase the capabilities of providing new digital services to the public • Examine capabilities of the new technologies for portable web devices such as web-capable PDAs and cell phones and apply these technologies for outreach activities for the public safety community as well as the general public • Study methods to enhance the Point Forecast and Advanced Hydrologic Prediction Service web pages, using feedback from the general public • Investigate enhancements to the back-end web applications, databases, and services that are the backbone of the NWS Southern Region web presence, and study the usefulness and cost-effectiveness of new technologies • Research new or enhanced web services to both the public and targeted entities (such as FEMA) using new and existing collaborations with Federal and non-Federal entities • Examine methodologies for new radar generation programs using archived Level II and III radar data

GOAL – Regional Climate and Climate Change

Perform research to improve understanding of the relationships between mesoscale processes and regional climate and develop techniques to monitor climate and detect its changes

Supports NOAA Goal to Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Outcome 1

New insights into the complex land-atmosphere interactions over the agriculturally important U.S. Midwest (DP, JB)

Strategies in Support of Outcome	Actions in Support of Strategy
• Investigate land-atmosphere interactions on different time-scales over the Midwest in terms of plant behavior, solar radiation forcing, and challenging time-scale interrelations (DP) • Identify the parameterizations in the NOAH land surface model that are sensitive to land surface conditions and use Oklahoma Mesonet data to modify, improve, and test the parameterizations to produce reduced model variability (JB)	• Employ moisture budget analysis, an original recycling technique, information on crop yields, and soil moisture and solar radiation data • Simulate surface energy fluxes as part of a NOAH validation study utilizing Oklahoma Mesonet data • Use the soil moisture network of the Oklahoma Mesonet to demonstrate the temporal and spatial variations of soil moisture in Oklahoma

Outcome 2

Improved understanding of the influence of North Atlantic cyclones on the weather and climate of surrounding areas (DP)

Strategies in Support of Outcome	Actions in Support of Strategy
• Study the spatial and temporal variability of cyclones over the North Atlantic basin, including the eastern U.S. (DP)	• Develop a new approach to study cyclones by constructing a cyclone density function on a 2ºx2º grid for winter (October-March) cyclones to study cyclone characteristics (e.g. location, sea level pressure tendency, intensity and moving speed) simultaneously in space and time

Outcome 3

Improved understanding of the potential feedback between the atmosphere and the land/ocean/cryosphere (DP)

Strategies in Support of Outcome	Actions in Support of Strategy
• Investigate the time series behavior of the seasonal signal of the North Atlantic (DP)	• Document the time series behavior of the North Atlantic Oscillation seasonal signal on different timescales using a mobile NAO index that follows the seasonal migration of the centers of action

Outcome 4	
New insights into the potential links between climate variability and severe storm frequency and severity (PL)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Investigate the predictive links between climate variability and severe storm frequency and severity (PL)	• Work with climate researchers to study historical records to document underlying climatic conditions within which tornadoes have occurred, which might lead to positive results enabling seasonal tornado predictions
Outcome 5	
Climate indices and indicators that provide early detection of important climate changes in the U.S. (DK)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Evaluate U.S. climate indices from observational and model data, document the quantitative character of observed climate changes in the U.S. over the last century, and attribute the observed changes to specific climate forcings, where possible (DK)	• Use data from coupled ocean-atmosphere climate models to calculate two climate indices for the U.S., the Climate Extremes Index (CEI) and the Greenhouse Climate Response Index (GCRI). These were developed by Karl et al. (1996) to quantify observed changes in climate and climate extremes in the contiguous U.S. • Use data from climate model simulations to evaluate the natural variability of these indices and the expected changes of the indices in response to increasing greenhouse gases • Perform simulations with the new NCAR and new GFDL coupled ocean-atmosphere climate models that will be included in the IPCC Fourth Assessment Report

GOAL – Societal and Economic Impacts

Assess the impact to society and the economy of storm systems and regional climate variability and make that information available to policy makers and the public and private sectors

Supports NOAA Crosscutting Priority to Ensure Sound, State-of-the-Art Research

Outcome 1

Socioeconomic impact assessments of severe weather such as tornadoes and hurricanes (DS)

Strategies in Support of Outcome	Actions in Support of Strategy
• Use tornado data from Oklahoma to quantify the benefits of tornado shelters in permanent homes and mobile homes (DS) • Quantify the safety benefits with respect to tornadoes of the installation of Doppler radar by the NWS (DS) • Examine a possible cause of increasing societal vulnerability to hurricanes – the reduction in the lethality of hurricanes (DS)	• Determine the number of fatalities and injuries that might be avoided with tornado shelters using both historical fatalities and predicted fatalities from a regression model of tornado casualties • Estimate the cost per life saved using estimates of the annual probability of a tornado plus the probability of a fatality at a home struck by a tornado • Perform a before-and-after analysis of Doppler radar using a regression model of tornado casualties and a data set of all tornadoes in the contiguous U.S. between 1986 and 1999 • Perform a regression analysis of casualties from F5 tornadoes over the 20th century to see if we can confirm that tornadoes have become less deadly over time • Perform a two-stage regression analysis in which a time-varying measure of hurricane lethality is estimated

Outcome 2

Monthly and seasonal residential natural gas consumption indices east of the Rocky Mountains (PL)

Strategies in Support of Outcome	Actions in Support of Strategy
• Investigate the percentile threshold of both daily maximum and minimum temperatures that "drive" natural gas consumption (PL)	• Derive monthly and seasonal residential natural gas consumption indices were derived for Petroleum Administration for Defense Districts based on state averages of monthly/seasonal total number of days below site-specific, daily maximum and minimum temperature percentile thresholds

Outcome 3

Improved forecasts of unusual climate anomaly occurrences to mitigate possible social and economic losses (PL)

Strategies in Support of Outcome	Actions in Support of Strategy
• Identify predictable characteristics of unusual climate anomalies (such as the summer 2002 cool	• Combine surface and upper-air observations obtained from locations across the U.S. Southern

anomaly over the U.S. Southern Great Plains) to better understand the physical and dynamical processes responsible for creating them, with the ultimate goal of forecasting similar reoccurrences at lead times exceeding 10 days (PL)	Great Plains with NCAR/NCEP reanalyses to reveal how a series of related severe weather events led to an historic flood near San Antonio, Texas, during summer 2002, which was shown to have initiated regional-scale processes that helped maintain a six-week period of anomalously cool weather over Texas and Oklahoma
Outcome 4 Energy usage and agricultural applications based on summertime temperature extremes analysis (PL)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Analyze daily maximum temperatures available in Lamb/Richman dataset in relation to equatorial Pacific sea-surface temperatures to document summertime temperature extreme differences in North America east of the Rocky Mountains between El Niño and La Niña years (PL)	• Develop plots of the difference between El Niño and La Niña years from the overall average year for June through September, based on defined extreme thresholds, both absolute (90, 95, 100˚F) and relative (5, 10, 15˚F above/below average) • Investigate other patterns, such as 50- and 60-degree daily minimum temperature anomalies in the Midwest and Southern Plains, and above/below average anomalies in the Northeast U.S.

GOAL – Outreach and Education

Support outreach and education programs to educate, engage, advise and inform the public, teachers and students

Supports NOAA Crosscutting Priority to Promote Environmental Literacy

Outcome 1

Public awareness of mesoscale meteorological phenomena and their potential impact on people's lives (All)

Strategies in Support of Outcome	Actions in Support of Strategy
• Inform an interested public about our research activities and how these activities impact their daily lives (All)	• Provide on-site tours; conduct open house events; mentor students; conduct career fairs; speak to school children and local organizations; judge science fairs; provide support for NOAA weather radios at local schools; participate in a planetarium-based educational program about lightning science and safety; answer telephone and e-mail queries; maintain the CIMMS web site

Outcome 2

Enlightened college interns guided by mentors through unique summer research projects (DZ)

Strategies in Support of Outcome	Actions in Support of Strategy
• Provide a rich summer intern experience to ten bright college students from across the U.S. by managing, mentoring, lecturing, and selecting participants for the NSF Research Experiences for Undergraduates Program at the University of Oklahoma National Weather Center (DZ)	• Pair each student with a CIMMS, OU, or NOAA mentor who guides them through project decision making, writing of a 10-page paper, and presentation of a 15-minute conference-style talk • Supplement the students' time with lectures, workshops, and field trips to provide an experience much like that of professional scientists.

Outcome 3

K-12 teachers in Oklahoma and Kansas equipped with valuable ideas and resources for teaching weather and climate concepts (OCS)

Strategies in Support of Outcome	Actions in Support of Strategy
• Team with the Oklahoma Climatological Survey to provide educational outreach opportunities through the U.S. Department of Energy's Atmospheric Radiation Measurement Program (OCS)	• Conduct an annual July Earthstorm Workshop for Oklahoma and Kansas K-12 teachers and the annual February Oklahoma Mesonet/ARM Science Fair for middle and high school students • Participate in regional and national teacher association meetings • Participate in regional and local teacher in-services and workshops throughout Oklahoma and Kansas • Use trained "Storm Team" teacher-consultants to travel throughout Oklahoma and Kansas to conduct workshops on how to use ARM and Oklahoma

	Mesonet data in the classroom • Continue development of The Weather Series, a collection of web-based educational activities intended for use with real-time or archived ARM and Mesonet data.
Outcome 4 Diverse, outstanding graduate students (All)	
Strategies in Support of Outcome	**Actions in Support of Strategy**
• Help recruit, educate, and retain highly sought-after graduate students through integrated graduate programs that involve innovative research and access to world-class NOAA researchers and programs (All)	• Support and advise graduate students

GOAL – Administration and Development

Provide an optimal framework with which to manage the financial, technological, physical, and personnel resources needed to support a world-class research staff

Supports NOAA Crosscutting Priority to Develop, Value and Sustain a World-Class Workforce

Outcome 1

A highly-skilled, motivated, effective, and collaborative workforce

Strategies in Support of Outcome	Actions in Support of Strategy
• Develop and maintain an efficient, lean administrative structure that recruits and supports a research staff that reflects the communities we serve and allows it to flourish without undue administrative burden • Foster professional and extracurricular collaboration between National Weather Center members	• Maintain a vibrant post-doctoral program to infuse new ideas and creativity into NOAA's future • Create a workplace that rewards teamwork and cooperation • Provide technical support during the recruitment and retention processes and inform staff of university hiring regulations • Improve the recognition and career aspirations of employees through awards programs • Emphasize journal publications as a career development path • Provide the computational resources necessary to conduct high-level research, including fostering use of national computing resources • Coordinate and execute all funding requests to NOAA • Provide budgetary and technical support for submission of funding proposals • Provide staff with adequate information on benefit and retirement packages offered through the university • Provide technical support to those who desire to disclose and license intellectual property • Help define and enact policies and procedures • Ensure a fair employee performance evaluation process • Provide access to training for both workplace and personal enrichment • Conduct and award an annual outstanding research paper of the year contest • Support a colloquium series featuring nationally-recognized speakers addressing societally-relevant topics • Encourage staff extramural activities through entities such as an employees association • Act as a leader for collaborative activities in the new National Weather Center building

The Way Forward

CIMMS research contributes to the NOAA mission through improvement of the observation, analysis, understanding, and prediction of weather elements and systems and climate anomalies ranging in size from cloud nuclei to multi-state and multi-national areas. Advances in observational and analytical techniques lead to improved understanding of the evolution and structure of these phenomena. Such understanding provides the foundation for more accurate prediction of hazardous weather and anomalous regional climate. Better prediction contributes to improved social and economic welfare. Because small-, meso-, and regional-scale phenomena are also important causes and manifestations of the climate of their locales and beyond, CIMMS research contributes to improved understanding of regional climate variability and change and the functioning of the overall global climate system.

CIMMS will strive to be a *"center of research leadership and excellence in mesoscale meteorology, weather radar, regional climate, and forecast and warning improvement, fostering strong government/university collaborations"*. The goals, outcomes, strategies, and actions described in this plan will guide CIMMS through fiscal years 2006-2009, with some review of direction anticipated during fiscal year 2007 as CIMMS enters an extension period before a recompetition during fiscal year 2009. Any change in NOAA research strategy also will require a review of direction. Fiscal year reports will document our progress during these years.

Appendix: Key for Outcome and Strategy Codes

(1) National Severe Storms Laboratory – Project 1: Convective Weather Research

(2) National Severe Storms Laboratory – Project 2: Quantitative Precipitation Estimation and Segregation Using Multiple Sensors

(3) National Severe Storms Laboratory – Project 3: Severe Weather Warming Research and Application Development

(4) National Severe Storms Laboratory – Project 4: Investigation into the Use of Warning Decision Support Systems for Improving Hazardous Weather Detection, Warnings and Forecasts

(5) National Severe Storms Laboratory – Project 5: Investigation of the Use of Dual-Polarization Radar to Improve Quantitative Precipitation Estimation for Improving Flash Flood and Flood Detection, Warnings and Forecasts

(6) National Severe Storms Laboratory – Project 6: Investigation of Synoptic and Mesoscale Meteorological Processes Associated with Hazardous Weather

(7) National Severe Storms Laboratory – Project 7: Investigation of Advancements in Radar Technology Toward the Improvement of Hazardous Weather Detection and Warnings

(8) National Severe Storms Laboratory – Project 8: Investigation into the Use of Phased Array Radar Technology for Improving Hazardous Weather Detection and Warnings

(9) NWS Office of Science and Technology – Project 9: Research on Integration and Use of Multi-Sensor Information for Severe Weather Warning Operations

(10) NWS Warning Decision Training Branch – Project 10: Warning Decision-Making Research and Training

(11) NWS Southern Region Headquarters – Project 11: An Investigation of Communicating Weather Information Effectively Using the Internet

(12) NWS Storm Prediction Center – Project 12: Advancing Science to Improve Knowledge of Mesoscale Hazardous Weather

(13) NWS Radar Operations Center – Project 13: Analysis of Weather Radar Observations of Severe Convective Storms to Understand Severe Storm Processes and Improve Warning Decision Support

(PL) Peter Lamb, CIMMS Director

(YK) Yefim Kogan, CIMMS Senior Research Scientist; plus Zena Kogan and David Mechem

(CD) Charles Doswell, CIMMS Research Scientist

(KK) Katherine Kanak, CIMMS Research Scientist

(DP) Diane Portis, CIMMS Research Associate

(DZ) Daphne Zaras, CIMMS Research Associate

(JB) Jeff Basara, CIMMS Research Fellow

(DK) David Karoly, CIMMS Research Fellow

(DS) Daniel Sutter, CIMMS Research Fellow

(QX) Qin Xu, CIMMS Research Fellow

(OCS) Oklahoma Climatological Survey

(All) All CIMMS Staff