Hydro-Meteorological Requirements Analysis and Modernization Planning Services

Office of Weather Programs and Projects
University of Oklahoma

1. Executive Summary

All countries are continually challenged by the effects of weather and its influences on economic stability, national commerce, and growth. While significant weather episodes are unavoidable, the impacts of such events can be substantially mitigated through the implementation of modern hydro-meteorological monitoring, prediction, and warning systems.

As a world-recognized leader in meteorological research, applications and education, the **University of Oklahoma** (**OU**), through its **Office of Weather Programs and Projects (OWPP)**, is pleased to provide its expertise to help national Meteorological and Hydrological Services (MHS) develop and implement hydro-meteorological modernization plans. As part of the **Weather Sphere** (http://www.weathersphere.org/) -- a collaborative partnership centered in Norman, Oklahoma, growing to become international leaders in weather and climate-related education and training, research and development, and operations and services -- OWPP specializes in the transfer of meteorological knowledge to applied meteorological projects both nationally and internationally. Collocated with its university and federal colleagues in the recently completed **National Weather Center** (**NWC**) building as well as private partners on OU's Research Campus, OWPP possesses a unique blend of qualifications and capabilities necessary to successfully complete hydro-meteorological modernization feasibility studies for countries worldwide.

2. University of Oklahoma Qualifications and Capabilities

Over the past 40 years, the University of Oklahoma has developed a world-renowned program in the atmospheric sciences. It is a recognized leader in research, development, implementation and application of science and technologies to monitor and forecast hazardous weather and climate. Situated in a region of the United States that historically has suffered great losses to heat, cold, flood, drought, ice, snow, wind, hail, lightning, wildfires and tornadoes, the University of Oklahoma attracts scientists and engineers from across the United States and around the world. They come to Oklahoma to learn, develop, test, and apply cutting-edge ideas and technologies to research operational hydro-meteorological problems similar to those faced by national agencies worldwide.

Figure 1. The National Weather Center building.

The United States federal government, through the **National Oceanic and Atmospheric Administration** (**NOAA**), and the State of Oklahoma, through the University of Oklahoma, has invested enormous resources into the collaborative institution now known as the National Weather Center (Fig. 1). These investments were made with the mission to develop advanced in-situ and remote-sensing monitoring technologies, numerical analysis and prediction of high-impact, local weather, mesoscale and storm-scale dynamics, and user-centric products and applications.

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THE WEATHER SPHERE

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The 23,000-m^2 National Weather Center building (http://nwc.ou.edu) was completed in September 2006 and is occupied by OU, federal and state organizations with more than 550 employees, faculty, researchers and students focused on weather and regional climate. The facility is located on OU's growing University Research Campus (http://urc.ou.edu/) which is home to a collection of private weather companies, university facilities, and research laboratories. The missions of the primary National Weather Center organizations are as follows:

University Weather and Climate Programs

>> OU School of Meteorology
(**SoM**; http://weather.ou.edu/) – Serves as the academic home to the faculty, graduate students, and undergraduate students who work and study at the National Weather Center. The OU School of Meteorology is considered one of the premier meteorology departments in the United States and hosts exchange programs with universities in Reading, England; Monash, Australia; and Hamburg, Germany. SoM has over 320 undergraduate and 80 graduate students making it the largest meteorology program in the United States.

>> Oklahoma Climatological Survey
(**OCS**; http://ocs.ou.edu/) – Mandated by the State Legislature to acquire, process, and disseminate climate and weather data and information for use by state decision makers. OCS maintains an extensive array of climatological information, operates the Oklahoma Mesonet, hosts a wide variety of educational workshops, and conducts cutting-edge research on land-air-vegetation interaction. The Oklahoma Mesonet is the nation's premier statewide, permanent, mesoscale environmental monitoring network. OCS is the largest state climate office in the United States and serves customers across the state's 177,848 km^2.

>> OU Center for Analysis and Prediction of Storms
(**CAPS**; http://caps.ou.edu/) – Developed and operates the Advanced Regional Prediction System (ARPS) for regional-to-storm-scale atmospheric modeling and prediction and the associated ARPS Data Assimilation System (ADAS). CAPS pioneered scientific work in assimilating Doppler radar data for numerical weather prediction models. In recent years, CAPS has been a leader in the development of the national Weather Research and Forecasting (WRF) model. CAPS partners with the University of Massachusetts on the "Collaborative Adaptive Sensing of the Atmosphere" project to design and test an adaptive network of low-cost radars for observing the atmospheric boundary layer.

>> OU Cooperative Institute for Mesoscale Meteorological Studies
(**CIMMS**; http://cimms.ou.edu/) – Serves as site science team for the Southern Great Plains Atmospheric Radiation Measurement (ARM) facility and the data quality office for ARM data worldwide. CIMMS serves as the formal liaison between OU and NOAA. CIMMS was the first joint cooperative institute between NOAA and an academic institution. CIMMS allows university scientists and federal employees to work alongside one another and collaborate on problems of mutual interest.

>> OU Center for Spatial Analysis
(**CSA**; http://csa.ou.edu/) – Collaborates with institutions on projects that both research and employ geospatial technologies such as geographical information science, remote sensing, and geospatial statistics. CSA maintains extensive geospatial databases with a wide variety of data and metadata. CSA develops expertise in linking traditional GIS to time-variant meteorological applications.

>> Atmospheric Radar Research Center
(**ARRC**; http://arrc.ou.edu/) – Under the auspices of the University of Oklahoma's Strategic Radar Initiative and in close collaboration within the Weather Sphere, interested faculty members from the Schools of Meteorology and Electrical/Computer Engineering have united to form an interdisciplinary team of scientists and engineers to solve challenging

radar research problems and prepare the next generation of students. Through a number of partnerships, the ARRC is developing long-term research and development projects, unique educational opportunities for OU students, and economic growth for the State of Oklahoma.

NOAA Weather Partners

>> NOAA National Severe Storms Laboratory
(**NSSL**; http://www.nssl.noaa.gov/) – Serves as the research and development agency for the United States WSR-88D radars, advanced analysis and nowcasting applications, and next-generation weather observing and forecasting systems for mesoscale weather, including the Multifunctional Phased Array Radar. As a NOAA research laboratory, NSSL leads investigations of all aspects of severe weather. NSSL designed the world's first Doppler weather radar and supported deployment and refinements of the WSR-88D network.

>> NOAA National Weather Service (NWS) Forecast Office - Norman, Oklahoma
(**NWSFO** – Norman; http://www.weather.gov/norman/) – Prepares and disseminates life-saving warnings, watches and advisories for all types of hazardous weather conditions for more than two million citizens across 56 counties in central, western and southern Oklahoma and western north Texas. With the SPC, the NWS Forecast Office serves as an operational testbed for new technologies and methodologies, including evaluation of the WSR-88D and risk reduction experiments for prototype integrated data analysis workstations.

>> NOAA National Weather Service (NWS) Storm Prediction Center
(**SPC**; http://spc.noaa.gov/) – Provides hazardous weather forecasts including critical tornado and severe thunderstorm watches to protect life and property and improve economic productivity. Part of the National Weather Service's National Centers for Environmental Prediction, the SPC is the primary center of expertise for forecasting short-term hazardous weather events.

>> NOAA National Weather Service (NWS) Radar Operations Center
(**ROC**; http://roc.noaa.gov/) – Provides centralized meteorological, computer software, maintenance and engineering support for all 158 operational NEXRAD (WSR-88D) radar systems deployed worldwide. Supported by the Departments of Commerce, Transportation and Defense, the ROC is responsible for modifying and enhancing the WSR-88D systems during their operational life to meet changing requirements, technology advances, and improved understanding of the application of these systems to real-time weather operations.

>> NOAA National Weather Service (NWS) Warning Decision Training Branch
(**WDTB**; http://wdtb.noaa.gov/) – Develops and delivers training on the integrated elements of the hazardous weather warning process within a National Weather Service forecast office. With an emphasis on accuracy, timeliness and composure in forecasting performance, WDTB provides training through multiple delivery systems. While traditional, in-residence training is still utilized, approximately ninety percent of training is now done via distance learning.

3. The OWPP Approach to Meteorological and Hydrological Service (MHS) Modernization Planning

The **Office of Weather Programs and Projects** (**OWPP**) is the University of Oklahoma organization charged with facilitating the transfer of meteorological knowledge created within the Weather Sphere to applied meteorological projects both nationally and internationally. OWPP is positioned to draw on the pool of human capital present in the faculty, research staff and students of the NWC's academic, research and operational units.

The OWPP team is committed to finding the best solution to MHS's needs by:

- **Partnering with the MHS** to explore and understand the explicit and implicit needs of the MHS in an environment of mutual trust and respect;
- **Imparting state-of-the science methodologies and solutions** into the MHS to solidify and enhance its leadership role, nationally and regionally;
- **Assessing options objectively** to find excellent, innovative and open-source solutions;
- **Maintaining disciplined processes** to deliver on our promises and to adhere to accepted standards; and
- **Considering the entire cycle of the modernization project from day one** to ensure that future investments are made wisely and to minimize the risks and impacts arising from an ever-changing environment.

Led by a senior Project Manager, the OWPP team will provide the MHS with an exceptional blend of relevant experience and capabilities. The team will draw on the core capabilities of its members to conduct and document a modernization study that will satisfy the expectations of the MHS and their broader base of stakeholders. The OWPP team's collective skills include the following:

- An **impressive and award-winning track-record** in the research, planning, design, deployment, and assessment of solutions for integrated hydrological and meteorological system management and operations;
- An **exceptional depth and breadth of knowledge and experience** in meteorology, hydrometeorology, and climatology that covers research; operations; education and training; product development; services to federal, state, and local agencies, the public, and other customer groups; and in the design, development, deployment, and operation of extensive weather observing networks; and
- A **wealth of experience** in open systems design and a strong commitment to disciplined processes developed through practical systems and software development projects.

4. Hydro-Meteorological Modernization Study Overview

Every country faces a unique mix of hydro-meteorological and environmental challenges which have significant impact on the economic and social well-being of the population. To better support the needs of decision makers, all countries must modernize their environmental monitoring systems, hydro-meteorological analysis and prediction tools, and dissemination methods to better protect life and property, and advance public and private economic interests nationwide, while enhancing the MHS to better contribute to regional disaster management activities.

OWPP specializes in carrying out Modernization Studies for Meteorological and Hydrological Services. The goal is to enhance MHS capabilities and to ensure long term success of the MHS's modernization program through the application of state-of-the-science expertise. The OWPP team-members assembled for such efforts not only bring their own expertise, but also that of hundreds of Weather Sphere colleagues at the NWC in Norman, Oklahoma. Unique in both the United States and indeed the world, the NWC is a complete end-to-end enterprise (from basic research to educated end-user), and is a center of excellence with the

capability to address and solve national and international needs for monitoring, predicting, mitigating and responding to weather, hydrologic and climatic hazards.

Recognizing that the funding of such studies is an important consideration for the MHS, the OWPP team is prepared to support the client in arranging financing for the modernization planning process. The OWPP team will work with organizations such as the United States Agency for International Development (USAID) and the U.S. Trade and Development Agency (USTDA) to arrange such funding on a bilateral basis.

5. Study Methodology

5.1. Task Breakdown

MHS Modernization Studies are typically broken down into specific tasks in order to facilitate analysis and planning, as summarized below:

1. Kickoff meeting
2. Needs assessment
3. Implementation and financing plans
4. Human resources development and training plan
5. Cost/benefit analysis
6. Regulatory and environmental review
7. Development impact assessment
8. Final report

5.2. Needs Assessment

The core task of a Modernization Study is the Needs Assessment, since it surveys the existing MHS monitoring and forecasting capabilities, and identifies areas in which nowcast and forecast services are not optimized due to lack of resources and facilities. At a minimum, the following systems will be addressed in satisfying this Task:

- Automated surface observations,
- Oceanographic observations,
- Hydrologic observing systems,
- Environmental monitoring observations,
- Radar network,
- Lightning location and detection network,
- Upper-air monitoring network,
- Hydro-meteorological warning system,
- Data processing and communication,
- Forecast and analysis systems,
- Computer resources and database,
- Back-up systems and data archival, and
- Maintenance and calibration systems.

The Modernization Study will also include Implementation and Financing Plans which will encompass a transition plan, work-breakdown-structure, implementation schedule and requirements for project funding.

We will also provide a Human Resources Development and Training Plan, which will focus on initial and continuing education of MHS personnel, as well as training for completing on-site and depot maintenance of equipment, maintaining an inventory and supply of spare parts, and conducting sensor calibration.

From the financial perspective, we will analyze the project expenses for any potential savings from modernization and will provide a realistic indication for the financial return-on-investment which can be expected from the completed program. Laws, regulations,

organizational structure, personnel and other infrastructural changes needed for the modernization will be reviewed and documented. Lastly, all results of the Modernization Study will be combined into a Final Report and presentations will be designed for briefing expert audiences, government executives and decision-makers.

The end result will be a comprehensive planning document which can be used to justify and gain approval for the modernization program, and then to proceed with actual implementation.

6. Summary

The University of Oklahoma's Office of Weather Programs and Projects is pleased to offer its hydro-meteorological requirements analysis and modernization planning services to national hydro-meteorological services worldwide. As a part of the world-class and ever growing Weather Sphere community, OWPP is well positioned to draw from the meteorological expertise present in central Oklahoma to provide for the needs of any customer. We at OWPP appreciate this opportunity to introduce our team to you, and we look forward to a close collaboration in the future.

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