Crosscutting Assessment of Hydrometeorological Needs

Summary Report of Two Mini-Workshops




September 2010
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Office of the Federal Coordinator for Meteorological Services and Supporting Research

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Cover Image (left to right)
Top: Aerial view of the Charley River at Yukon - Credit: USGS; Lavon Lake, 3miles east of Wylie, TX – Credit: USACE
Bottom: Western valley of Wisconsin used for agriculture – Credit: USDA; Wildfire in Santa Barbara County – Credit: USFS

Interdepartmental Committee for Meteorological Services
and Supporting Research (ICMSSR)

Committee for Cooperative Research (CCR)

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Office of the Federal Coordinator for
Meteorological Services and Supporting Research

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FOREWORD

At a meeting of the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR), an interagency entity sponsored by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM), the committee supported a review of hydrometeorological products, services, and supporting research within the Federal government. A subsequent meeting of the OFCM-sponsored Committee for Environmental Services, Operations, and Research Needs (CESORN) also supported the need for a crosscutting assessment and the establishment of a Joint Action Group to conduct it.

To start the assessment, OFCM invited partners and stakeholders to participate in two mini-workshops to discuss needs and requirements related to hydrometeorological products, services, and supporting research that are not currently being met (need/requirement gaps). These workshops took place on September 17 and December 10, 2008, and this document summarizes the presentations, and the need/requirement gaps identified, at both. All participants agreed that the workshops were highly informative and provided insight into numerous agency/organization hydrometeorology activities.

The goals of the mini-workshops were to capture Federal agencies' hydrometeorological need/requirement gaps for both operations and research and to recommend solutions to mitigate these gaps. In addition to laying the groundwork for assessing need/requirement gaps, the information gathered from these workshops will be helpful to the OFCM-sponsored Committee for Integrated Observing Systems (CIOS) as it facilitates actions to integrate observational networks and systems, thereby increasing the effectiveness of current and planned capabilities.

I would like to express my deepest gratitude to all the participants who made the Hydrometeorology Mini-Workshops so successful.

//SIGNED//
Samuel P. Williamson
Federal Coordinator for Meteorological Services
and Supporting Research

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SECTION I: PURPOSE, SCOPE, AND OUTCOME OF THE WORKSHOPS

A. Purpose, Goals and Objectives

The Hydrometeorology Mini-Workshops, led by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM), were held to discuss agency/organization hydrometeorological capabilities and to begin identifying those needs and requirements for hydrometeorological products, services, and supporting research that are not currently being met (need/requirement gaps). The mini-workshops aided in identifying key points of contact within the Federal agencies and pinpointed an initial, tentative, set of need/requirement gaps. They were convened in response to direction from the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR) and the Committee for Environmental Services, Operations, and Research Needs (CESORN) to conduct a crosscutting national hydrometeorological need/requirement assessment relating to associated products, services, and supporting research.

The goals of these workshops were to improve the availability and reliability of hydrometeorological information and to identify the hydrometeorological need/requirement gaps of the various participating agencies, as well as any emerging capabilities that will ultimately lead to improvements in products, services, or supporting research. Federal agencies/organizations will be able to apply this information when identifying new requirements and creating more efficient and effective partnerships among the agencies.

The term "hydrometeorological" was used to focus on need/requirement gaps associated with atmospheric water becoming water on or in the ground (e.g., flooding, debris flow, soil moisture, snow melt, drought).Appendix A is a brief introduction to hydrometeorology entitled, *Hydrometeorology - An Important Component of Integrated Water Resource Management*.

The Mini-Workshops had two specific objectives:

Objective 1. Gain insight on Federal hydrometeorological programs, capabilities, products, needs/ requirements, and priorities.

Objective 2. Identify agency-specific and agency-overlapping hydrometeorological related actions and needs/priorities as related to hydro-meteorological operations/services.

Appendix B lists the agency-reported need/requirement gaps that emerged from the presentations and discussions at the two workshops. Appendix C contains the agendas for the workshops, and Section II is structured to parallel the session structure of the workshop agendas.

B. Scope of the Workshops

a. The hydrometeorological mini-workshops considered nine crosscutting functional areas:

- Surface transportation
- Energy
- Health Services
- Ecosystem
- Agriculture
- Water supply and quality
- Air quality
- Climate services
- Flood Management (stream flow)

b. Within each functional area, needs, requirements, and capabilities in nine categories were addressed:

- Data collection, integrity, processing and archival
- Hazard characterization (e.g., Probable Maximum Precipitation [PMP] Documents and Related studies)
- Forecast products and services
- Modeling, prediction, and data assimilation
- Information dissemination and technologies
- Hydrometeorological research and development
- Education, training, outreach, partnering, and collaboration
- User response, decision support, and resulting user impacts
- Funding and human resource considerations
- Socioeconomic impacts

c. For these crosscutting functional areas and need/requirement categories, the workshops were used to explore and identify an initial set of operational need/requirement gaps for hydrometeorological products, services, and supporting research for the Federal agencies and the customers they support.

d. Once the need/requirement gaps for hydrometeorological products, services and supporting research have been determined, next steps in the assessment process will include the following:

- Categorizing the gaps as being either an operational gap, a research gap, or both
- Grouping the gaps within common themes/categories
- Investigating agency plans and procedures for satisfying the gaps
- Identifying the reason for the gap (e.g., lack of observations, communications issues, logistics issues, human resource issues, funding issues and training and

outreach issues)

- Prioritizing the gaps and providing a roadmap to address them
- Identify mechanisms (e.g., test bed) to transition research results to operations

e. Where applicable, the assessment will identify more efficient and effective partnerships among the agencies to better leverage subject-matter expertise and resources to meet the growing need for improved hydrometeorological forecast and warning products and services.

C. Mini-workshop Outcomes

The mini-workshops provided a solid foundation for the initial overview of hydrometeorology-related activities within Federal agencies and organizations and associated need/requirement gaps. All the participants garnered important information from each participant's presentation, and the exchange of information and perspectives was seen by the participants as highly beneficial.

SECTION II: MINI-WORKSHOP PRESENTATIONS

This section summarizes the presentations given at both mini-workshops by the agencies and stakeholders listed in the agendas (Appendix C). Briefing slides for all of the presentations are at http://www.ofcm.gov/jag-nhna/min-workshop/index.htm. Key agency-described hydrometeorological need/requirement gaps that emerged during the presentations are listed in Appendix B, where they are assigned to six broad categories (analysis, climate, data access, education, and modeling/forecasts). While completing this initial list is only the first step, this step is significant in that it demonstrates the benefits gained when the responsible Federal agencies develop a shared vision to address national hydrometeorological need/requirement gaps.

Each of the subsections in this section corresponds to a session topic from the mini-workshops:

- Session 1 – Observation, Data Assimilation, and Modeling
- Session 2 – Hydrologic Science and Research
- Session 3 – Hydrologic Forecast, Products, and Services
- Session 4 – Stakeholders Perspective

A. Introductory Comments and Presentation

Overview of Exploratory Mini-Workshops
Mr. Samuel P. Williamson, Federal Coordinator for Meteorology

Mr. Williamson welcomed all attendees and thanked them for taking time out of their busy schedule to participate in the Office of the Federal Coordinator for Meteorology (OFCM) mini-workshops on Hydrometeological Products, Services and Supporting Research. He noted that the hydrometeorology community's strengths are derived from strong collaborative ties among its programs and with its partners and customers. He also noted that many federal, state, and local agencies currently collaborate (in many ways) in providing accurate and updated information to produce hydrometeorological products and services, while avoiding duplication of efforts. He stated "by working together, members of the hydrometeorology community can reach more people more effectively and achieve the core results of our collective missions: to save lives, reduce injuries and protect property". He stated that he fully recognized that these workshops would not be a success without the excellent presentations and stimulating discussions provided by the talented individuals representing each agency/organization.

B. Observation, Data Assimilation, and Modeling

This session addressed agencies' observation techniques and capabilities, how they assimilate data, and how those data are used in numerical modeling.

USGS Tropical Cyclone-Related Hydrometeorology Products and Services
Dr. Harry Lins, Ph.D., Hydrologist, Office of Surface Water, U.S. Geological Survey (USGS), Department of the Interior (DOI)

Dr. Lins described the sensors used in the USGS Storm Surge Program as small self-contained water-level sensors with data logging capability. These sensors are deployed 36 to 48 hours before a tropical storm or other significant weather system makes landfall and are located on bridges, piers, and power-poles in a network cluster of 40 to 70 units. The sensors record data every 2–30 seconds for 3–6 days and are retrieved after the storm passes. He also discussed the following USGS capabilities:

- Storm surge sensor deployment and recovery for Hurricanes Rita and Ike
- Hardened tidal gages (also called Super Gages) and their location along the Gulf Coast
- USGS National Weather Information System, which provides gage height in feet, wind speed in miles per hour, atmospheric pressure in millibars, and wind direction in degrees from north.
- WaterWatch (http://water.usgs.gov/waterwatch), which provides current water resource conditions (stream flow and flooding)

Workshop on Hydrometeorology Programs, U. S. Coast Guard Activities
Dr. Jonathan Berkson, Ph.D., Marine Science Program Manager, U.S. Coast Guard (USCG), Department of Homeland Security (DHS)

Dr. Berkson discussed USCG hydrometeorology related activities from both provider and user perspectives. From the data provider perspective, the USCG provides observations from meteorological sensors at USCG sites as well as from USCG cutters. In addition, the USCG provides information via the National Ice Center International Ice Patrol, radio broadcasts, and GPS Surface Observing System. From the user side, the USCG uses hydrometeorological data to support search and rescue, marine environmental protection, enforcement of laws and treaties, military operations, domestic icebreaking, polar operations and icebreaking, flood relief activities (when requested by ACOE), aids to navigation, boating safety, and marine safety. Dr. Berkson noted that, in certain U.S. coastal areas, USCG stations and cutters are the only sources of weather observations. These data are collected and provided as raw meteorological and oceanographic data to the National Weather Service (NWS). In addition, the USCG disseminates NWS weather forecasts and warnings via radio broadcasts (voice, text, and graphical products). USCG user needs for weather products include NWS products, Fleet Numerical Meteorology and Oceanography Center products and National Ice Center products.

Surface Transportation and Hydrometeorology
Mr. Paul Pisano, Road Weather Management Program Manager, Federal Highway Administration (FHA), Department of Transportation (DOT)

Mr. Pisano discussed the needs and requirements for the Surface Transportation System (i.e., planning and design, construction, and operations and maintenance). He also noted that the

Maintenance Decision Support System relies on high resolution precipitation models and talked briefly about the Clarus System. The Clarus System is designed to collect weather observations from both traditional weather observing stations and roadway surface sources. These data are then turned into valuable roadway information that is sharable among States.

Hydrometeorology Products, Services and Supporting Research
Dr. Ellen Cooter, Research Physical Scientist, Atmospheric Modeling Division, Environmental Protection Agency (EPA)

Dr. Cooter noted that EPA's mission is to protect human health and the environment, and the goal of the Office of Research and Development (ORD) is to solve problems of national significance and to support program/regional office needs through integrated, multidisciplinary research. She talked about integrated multidisciplinary research (land, air, and water) in ORD and noted that the ORD is a consumer of hydrometeorological products, services, and supporting research. Dr. Cooter also discussed air quality model development and evaluation for regulatory application.

- Human Exposure:
  - Water borne diseases and disease vectors
  - Recreational area closures due to storm water runoff or combined sewage overflow events
- Water Supply and Quality:
  - Water treatment infrastructure
  - Water distribution systems
  - Septic system issues
  - Leaky underground storage tanks
  - Groundwater supplies and community drinking water systems
- Homeland Security:
  - Hazardous waste release

Dr. Cooter noted that although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

NPS Hydrometeorological Issues
Mr. John Vimont, Chief, Research and Development Branch, Air Resources Division, National Park Service (NPS), DOI

Mr. Vimont discussed the impact of water quantity, hazards, and air quality concerns within the U.S. national parks. The water quantity concern goes to the heart of the NPS mission, which is to maintain the parks' resources unimpaired for future generations. This is directly related to the sustainability of ecosystems, which are stressed by climate, drought, and development. Hydrometeorological hazards impact national park visitors, infrastructure, and resource protection, and the parks must deal with the impacts of floods, lighting, and severe weather. Mr. Vimont emphasized that most national parks are located in areas of complex

terrain, which makes for forecasting challenges. He concluded by discussing how atmospheric contaminants impact the ecosystems via wet and occult deposition.

The Hydrometeorological Prediction Center
Dr. Jim Hoke, Ph.D., Director, Hydrometeorological Prediction Center (HPC), National Centers for Environmental Prediction (NCEP), NWS, National Oceanic and Atmospheric Administration (NOAA)

Dr. Hoke opened his presentation by stating that he is part of the service assessment team reviewing the NWS services during the Midwest flood in the summer of 2008. He then discussed the mission and vision of HPC. The vision is to be recognized by the NWS Field Offices and other forecast groups as a center of excellence for the following activities:

- facilitating collaboration
- heavy precipitation forecasting
- winter weather forecasting
- medium-range forecasting
- real-time numerical model diagnostics & interpretation
- diagnostics & interpretation
- surface analysis

The HPC mission is to provide:

- Forecast, guidance, and analysis products and services in support of the daily forecasting activities of the NWS and its customers, and
- Tailored weather support to other government agencies in emergency and special situations.

HPC partners with and serves customers from Federal, State, and local agencies; the private sector; media; academia; international interests; and the general public. The center provides the following products and services:

- Quantitative precipitation forecasts (QPFs), excessive rainfall, river flood outlook, and heavy ice & snow guidance
- Medium-range guidance
- Model diagnostic discussions & associated graphics tools
- Surface analyses and daily weather map
- Basic weather forecasts
- South American and Caribbean prognostic discussions and training

Dr. Hoke described the skill that HPC has in the area of QPF. Historical records show that HPC continues to provide significant improvements over model guidance in forecasting this element. He ended his talk by describing the major needs of HPC and mentioning some of HPC's fiscal year 2009 initiatives.

USACE Hydromet Data Needs
Mr. Doug Clemetson, Chief, Hydrology Section, U.S. Army Corps of Engineers (USACE)

Mr. Clemetson began his presentation with an overview of the various programs under the control of the USACE, including the following programs:

- Water Management & Emergency Operations
- Civil Works Planning & Design
- Dam Safety
- Coastal

Each of these programs uses a variety of hydrometeorological information, which is provided by other Federal agencies. He then discussed the following products and services provided by the Corps:

- Corps Water Management System (CWMS)
- Hydrologic analysis
- Reservoir analysis
- River profile modeling
- Flood impact analysis
- Data dissemination

The USACE provides a variety of hydrometeorological data. These data are used to supplement the existing data networks.

Mr. Clemetson then transitioned into talking about the coastal emphasis of the USACE. There is a field research facility located at Duck, North Carolina, with 25 years of coastal data, including data on waves, currents, tides/water level, meteorological parameters, morphology, and water characteristics.

Following the coastal discussion, Mr. Clemetson discussed the hydrometeorological data needs of the USACE. A significant gap exists in the area of hydrometeorological reports (HMRs) and probable maximum precipitation (PMP) studies. These services have been reduced due to recent budget cuts.

He ended his presentation by discussing the Extreme Storm Events Working Group. This interagency working group was established to coordinate studies and databases used to develop Extreme Design Storms up to PMP studies. The working group's initial meeting was held on September 4, 2008, and was open to Federal/State agencies, universities, and the private sector.

Post Storm Data: USGS Uses, Needs and Capabilities
Mr. Robert Mason, Hydrologist, Office of Surface Water, USGS

Mr. Mason began by describing the USGS and its Water Resource Discipline (WRD). The WRD mission is to provide reliable, impartial, timely information that is needed to understand the Nation's water resources. WRD actively promotes the use of this information by decision makers as it relates to:

- Hazard mitigation,
- Resource availability for all uses, and
- Environmental and human health issues.

He then noted that most of the funding for this program is provided by reimbursable funds from States and other entities via the Cooperative Water Program. He then described the USGS NWISWeb database, which hosts the variety of water measurements collected by USGS. He discussed in detail how the USGS collects stream flow data and other stream information.

The next program discussed by Mr. Mason was the Storm-Surge Program. He ended the presentation with a review of the storm surge data collected from Hurricane Rita.

C. Hydrologic Science and Research

This session provided information on agencies' current hydrologic science techniques and research activities.

NASA Presentation to Mini-Workshop on Hydrometeorological Products, Services, and Supporting Research
Mr. David Toll, Applied Sciences Water Resources Deputy Program Manager, National Aeronautics and Space Administration (NASA)

Mr. Toll discussed NASA's hydrology related missions (water cycle mission, water and energy cycle mission, and energy cycle mission). He discussed the actual water consumption by industry and the role of ecosystems and water as the underlying elements in droughts, wildfires, energy production, and agriculture. He also discussed:

- Tropical Rainfall Measurement Mission (TRMM),
- Global Precipitation Measurement (GPM),
- Value of Soil Moisture Data to Weather and Climate,
- Predictability of seasonal climate, and
- Downscaling climate predictions to local/regional scales.

Mr. Toll next discussed future NASA priorities and NASA approved future missions, including Global Precipitation Measurement (GPM), Soil Moisture Active Passive (SMAP) Phase II and III, and the Satellite Sensors for Hydrology program. The latter includes Surface Water Ocean Topography, Gravity Recovery and Climate Experiment-II, and Snow and Cold

Land Processes.

Two NSF Data Services Projects
Dr. Richard P. Hooper, Ph.D., President and Executive Director, Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)

Dr. Hooper discussed the Services-Oriented Architecture for Publishing Time-Series Data. He also discussed linking geographically distributed information servers through Internet, Web Services Description Language (WSDL) from W3C, designing WaterML as a web services language for water data, and functions for computer-to-computer interaction. He stated that communication of the Nation's water data should include government water data, academic water data, and the CUAHSI National Water Metadata Catalog. Dr. Hooper also provided information on the CUAHSI National Water Metadata Catalog, which can be accessed at http://his.cuahsi.org.

He ended his presentation with a discussion on Hydro-NEXRAD: A Community Resource for Hydrologic Research and Applications Project. Its goal is to provide the hydrologic community with ready access to the vast archives and real-time information collected by the national network of NEXRAD radars. Hydro-NEXRAD is a web-based prototype information retrieval system that allows ordering customized radar-rainfall maps for hydrologic applications based on WSR-88D data.

NASA's Land Information System as a Hydrometeorological Testbed for Agency Partners and Investigators
Dr. Christa Peters-Lidard, Ph.D., Physical Scientist and Head, Hydrological Sciences Branch, NASA

Dr. Peters-Lidard provided information about NASA's Land Information System (LIS). LIS is envisioned to be the land component for Earth system models. She described how LIS can be used in an uncoupled or analysis mode as well as a coupled or forecast mode. The presentation covered the basics of the LIS architecture and design. She then described the hydrometeorological activities in which LIS is being used and provided examples of using LIS to enhance data assimilation.

Dr. Peters-Lidard ended the presentation by describing the following future plans for LIS:

- Prepare for new NASA sensors that offer high-resolution precipitation, soil moisture, snow, and water surface elevation
- Assimilation system contributions to mission design & products
- As land surface models evolve, model parameters will become model states (e.g., dynamic vegetation models – 614.4 & GISS)
- Multivariant "Integrated Earth System Analysis" (atmosphere + ocean + land)

NOAA Research Supporting Hydrometeorological Science and Services: The NOAA Hydrometeorology Testbed
Mr. Tim Schneider, HMT Project Manager and Lead, Hydrometeorology Team, Office of Atmospheric and Oceanic Research (OAR), NOAA

Mr. Schneider described the NOAA Hydrometeorology Testbed (HMT; http://hmt.noaa.gov/). The HMT is a national strategy with regional implementation to improve hydrometeorological, science and services. HMT is about building partnerships in order to solve scientific problems.

The HMT began by establishing a testbed focused on hydrometeorological problems on the West Coast (centered on the high flood-risk region near Sacramento, California). Executive oversight of the HMT occurs through the Management Council. An Advisory Panel, chaired by the HMT Project Manager and consisting of key NWS stakeholders as well as research and operational representatives, was formed to provide guidance to the program. The Advisory Panel assists in one of the main purposes of the testbed: the transition of research to operations.

Mr. Schneider then discussed the plans to evolve the HMT. The planning group consists of a smaller advisory panel to focus on topics of national scope and the formation of regional implementation teams. HMT West, which has been focused on cool season hydrometeorological topics, will be transitioning to a legacy mode, while the next planned testbed, which will be in the Southeast, will contend with all-season hydrometeorological challenges including hurricane landfall.

He followed this overview of the HMT with examples of results from the HMT West implementation. He then spoke on the following transition projects scheduled for the HMT:

- High-resolution ensemble
- QPF/PQPF Moisture Flux Tools
- Snow Information Tools
- Atmospheric River (AR) Tools Pacific Atmospheric River Threat Indicator, "PARTI"
- Flash Flood Monitoring and Prediction (FFMP) Alpha Tests of new, HMT-produced tools and products
- Enhanced Flood Response and Emergency Preparedness (EFREP): An HMT Legacy in partnership with the State of California

Finally, Mr. Schneider presented an overview of activities of the NOAA Integrated Water Resource Services (IWRS) Priority Area for fiscal year 2009. The IWRS provides a framework within which HMT and other water resource–related projects can be coordinated.

NOAA Hydrology Program
Mr. Geoff Bonnin, Chief, Hydrologic Science and Modeling Branch, Office of Hydrologic Development (OHD), NOAA/NWS

Mr. Bonnin began by asking what outcomes OFCM expected from the mini-workshops. He

asked how the results of the mini-workshops would be directed at change in Federal activities. He also noted that if OFCM was intent on achieving change, it would need to engage the Federal water community and their existing forums. Federal water agencies have already stated gaps clearly and publically, including in reports to Congress.

Mr. Bonnin provided background on the organization of the hydrology program within the NWS, across NOAA, and among collaborating Federal agencies. The NWS Hydrologic Services Program is focused on flood, streamflow, and water supply forecasting. The NOAA Hydrology Program, run by the NWS, integrates activities across the NOAA organizational structure covering all aspects of water forecasting. The Coastal Estuary River Information Services (CERIS) is an outcome of the NOAA Hydrology Program. It provides services from summit to the sea to improve NOAA water resources services to coastal communities. Externally, the Hydrology Program collaborates with Federal water agencies to improve synergy and effectiveness. The NOAA Integrated Water Resources Science and Services (IWRSS) is focused on this external collaboration.

Then, Mr. Bonnin spoke about the Office of Hydrology Science Plan. This plan sets strategic goals for hydrology science items; such as the following:

- Watershed Processes
- Forcings
- Anthropogenic and natural perturbation to the hydrologic cycle
- Ensemble forecasting
- Data Assimilation and Verification

The plan is available online at http://www.weather.gov/oh/src/docs/Strategic_Science_Plan_2007-Final.pdf. He ended the presentation by talking about how the hydrology program is constrained by lack of data.

Hydrometeorology Application Program (HAP): Supporting Hydrometeorological Research and Applications from Local to Global Scale
Mr. Roy Rasmussen, Director, Research Applications, National Center for Atmospheric Research (NCAR)

Mr. Rasmussen provided information on NCAR's Hydrometeorology Application Program (HAP), which supports hydrometeorological research and applications from local to global scales. He began by describing NCAR's organizational structure. HAP focuses on understanding how water vapor, precipitation, and land surface hydrology interact across scales to define the hydrological cycle. The research results are used to improve weather and climate forecasts and to aid decision makers in a variety of water resource management applications.

Next, Mr. Rasmussen described storm forecast products that NCAR has developed. These include AutoNowcaster, National Convective Weather Forecast, Weather Support to Deicing Decision Making, and Variational Doppler Radar Analysis System. He talked about the transition of the AutoNowcaster into NWS operations.

D. Hydrologic Forecast, Products, and Services

This session provided information on agencies' hydrologic forecasting and the products and services they provide.

NOAA/NWS Freshwater Prediction and Flood Warning Services
Mr. Jeff Zimmerman for Mr. Glenn Austin, Chief, Hydrologic Services Division, NOAA/NWS

Mr. Zimmerman stated that the NWS provides hydrologic forecasts and warnings for the protection of life and property and the enhancement of the national economy. He discussed the following long-term goals of NOAA's Hydrology Program:

- Minimize losses due to floods and droughts
- Increase economic benefits from water forecasts and information
- Improve ecosystem management and enhance America's coastal assets
- Expand information for managing America's water Resources

He discussed the following program elements and activities within the Hydrology Program:

- The Advanced Hydrologic Prediction Service (AHPS)
- Inland Flood Forecasting and Warning System Act of 2002
- NOAA's Water Resources Program
- Real-Time Flood Forecast Mapping on the Tar River Basin in North Carolina
- Integrated Water Resources Science and Services (IWRSS)
- River Forecast Verification System
- Partnerships that are promoting public safety
- NWS Flood Severity Inundation Map Libraries

Mr. Zimmerman discussed partnerships involving NOAA, other Federal agencies, State agencies, local agencies, the private sector, and academia that provide flood warnings for local communities as well as critical information for neighborhoods and watersheds (such as water volume and soil condition). These partnerships with Federal, State, and local agencies and organizations enhance scientific development and operations.

Hydrometeorology and Air Force Weather
Colonel Dean Corpman, Chief, Weather Policy and Exploitation Division, U.S. Air Force (USAF), Department of Defense (DOD)

Colonel Corpman opened with a discussion on the definition of hydrometeorology and hydrology. He discussed the hydrometeorology requirements of the USAF. The Commanding General, US Army Corps of Engineers (CG, USACE) is the director and monitor for Army programs in the atmospheric, topographic, hydrographic, and terrestrial sciences. The Army develops and provides hydrological studies, forecasts, and decision aids

for military training, operations and emergency purposes. The USAF provides weather data and information tailored to assist the Army with hydrological forecasting, terrain analysis, and mobility assessments.

Colonel Corpman stated, “Today, the Air Force Weather Agency runs a hydrometeorological analysis package in AGRMET and plans to run a more advanced version of a hydrometeorological package called Land Information System (LIS). LIS is a data assimilation system that enables AFWA to generate surface characterization data. LIS relies upon land surface models (i.e., Noah LSM, Catchment LSM) to do the "physics" of the hydrometeorological capability.”

He continued, “The goal of [the AFWA LIS] plan is to lay the groundwork for providing surface characterization products optimally tuned to support battlefield scale requirements and various Tactical Decision Aids (TDAs).”

AFWA and NASA have been planning software updates to LIS that would handle surface/subsurface water flow, but since the community is spread so thin among many LSM options, none of the surface flow packages are really ready for operations at this time.

USDA Weather Applications
Mr. Eric Luebehusen, Meteorologist, Office of the Chief Economist, Joint Agricultural Weather Facility (JAWF), U.S. Department of Agriculture (USDA)

Mr. Luebehusen discussed the creation of JAWF and the partnership between the NWS and USDA. He discussed the responsibility of JAWF to support economists in crop assessment decision making and ultimately helping them develop their commodity forecasts. Support Meteorologists are called upon to provide detailed weather-crop assessments prior to “lock-up” and consequently use a vast array of hydrometeorological products. NWS supplies a large suite of U.S. and international products, (e.g., weekly precipitation, monthly precipitation, and seasonal precipitation). These data are used to write the weekly US Crop-Weather story in the Weekly Weather and Crop Bulletin.

He also discussed other products monitored closely at USDA:

- U.S. Forest Service’s Fire Danger
- Keetch-Bryram Drought index and Soil Moisture
- Streamflow data from USGS
- Groundwater data
- Model forecasts, including QPF images
- NWS forecast products

Mr. Luebehusen stated, “USDA/JAWF has a strong international emphasis as well.” Hydrometeorological applications go beyond products produced by other agencies. Much of the data is housed and analyzed at the USDA. In-house programmers wrote easy-to-use macros to access and plot weather data. USGS supplies GIS-ready streamflow data, which is

used to create the Drought Monitor. The NWS Climate Prediction Center (CPC) supplies GIS-ready precipitation data that is also used to create the Drought Monitor and other in-house applications.

Overview of Observations, Forecasts, and Products and Services at the National Ocean Service Center for Operational Oceanographic Products and Services
Mr. Stephen Gill, Senior Scientist, Center of Operational Oceanographic Products and Services (COOPS), Nation Ocean Service (NOS), NOAA

Mr. Gill provided an overview of observations, forecasts and products, and services at NOAA/NOS/COOPS. He began with observational networks for national water level and the meteorological sensor upgrades to the National Water Level Observation Network (NWLON),

The next topic discussed was the Physical Oceanographic Real-time System (PORTS). He then noted that over 150 COOPS stations have at least one meteorological sensor. COOPS follows NWS standards for siting meteorological sensors.

The future improvements of NWLON provided the next presentation topic. Since storm damage of sensor is a big concern, COOPS is looking to increase the number of hardened stations for hurricane landfalls.

The next topic discussed was the operational forecast models executed by COOPS. All of these data contribute to the instrumental records for climate change. He ended the presentation by discussing emerging partnerships and collaborations with USGS, USACE, National Estuarine Research Reserves, and IOOS and Regional Observing Systems.

Hydrometeorology within the Navy Oceanography Program
Mr. Kurt Nelson, Oceanographer of the Navy Staff, Joint Meteorology and Oceanography Integration, U.S. Navy (USN)

Mr. Nelson began by providing an overview of the following maritime strategy imperatives:

- Regionally concentrated, forward-deployed task forces to limit regional conflict
- Deter major power war
- Win our Nation’s wars as part of a joint campaign
- Contribute to homeland defense in depth
- Foster and sustain cooperative relationships with more international partners
- Prevent or mitigate disruptions or crises

He then discussed how hydrometeorological information contributes to these strategies. The Navy’s Oceanography Program contributes and utilizes data from the following disciplines: Oceanography, Meteorology, Hydrology, and Geospatial Information and Services. He then presented the future operational view for Battlespace Sensing Fusion and Integration. All of these items integrate into a joint maritime battlespace which

- Provides Environmental Understanding
- Assures a Safety and Readiness Fleet
- Ensures Educated Decision-Making
- Enables a Dominant Sea Power

E. Stakeholders Perspective

This session provided information on how hydrometeorology partners and stakeholders use Federal agencies' products and services.

Dams
Ms. Jennifer Blanton, Program Analyst, Infrastructure Geophysical Division, Science and Technology (S&T), DHS

Ms. Blanton discussed the vulnerability of zoned embankment dams to attack, bubble jetting against dam structures, full scale explosives testing on homogenous embankment dams, and spillway gate vulnerability and mitigation. She also discussed projects for underwater detection.

A Brief Explanation of the Comprehensive Emergency Management System and Its "Stakeholder" Relationship to Hydrometeorology Products, Services, and Supporting Research
Mr. Daniel Catlett, Program Manager, National Hurricane Program, Federal Emergency Management Agency (FEMA), DHS

Mr. Catlett discussed the Post Katrina Emergency Management Reform Act (PKEMRA) of 2006 and provided its definition of "emergency management." He described the FEMA mission: to lead and support a Comprehensive Emergency Management System. Mr. Catlett posed the question, "What is the relationship between the Comprehensive Emergency Management System and hydrometeorological products, services, and supporting research?" His solution was: "To build emergency management capability, it is necessary to have consistent, credible, defensible, national-consensus standard methodology and calculation of risk." Mr. Catlett concluded by stating, "The purpose of emergency management is to manage emergencies with emergency management capability developed systematically through the Comprehensive Emergency Management System." He also stated, "The purpose of the National Hurricane Program is to manage hurricane emergencies with hurricane emergency management capability developed systematically through the Comprehensive Hurricane Emergency Management System."

Hydrometeorology and Water Power in DOE-EERE
Dr. Michael J. Sale, Ph.D., Senior Energy Consultant, Sentech, Inc., Energy Efficiency and Renewable Energy (EERE), Department of Energy (DOE)

Dr. Sale discussed DOE's Water Power Research and Development efforts. DOE was directed to establish marine and hydrokinetic technology programs. Dr. Sale noted DOE has

reestablished an effective Water Power Program.

Under the Marine and Hydrokinetics program, he discussed:

- Understanding the full-range of technologies and their performance characteristics
- Investigating potential environmental impacts and how they can be mitigated or minimized
- Reducing cost and improve performance through technology development and testing
- Developing National Marine Energy Research, Development, and Deployment Centers
- Working with industry leaders to develop international standards
- Encouraging information-sharing among government, regulators, and industry

For conventional hydropower, he discussed increasing turbine efficiency and environmental performance. Dr. Sale indicated that water use optimization is a growth area for hydropower. He talked about activities underway for FY 2008, and he identified four types of hydropower optimization:

- Individual machines
- Single dam with multiple power plants
- River basin with multiple dams
- Heterogeneous power systems

The renewable energy program is getting more complicated, and better resource estimates are needed. Hydrometeorology is critical to water power development.

Dr. Sale ended his discussion by stating, “Water is addressed in many other contexts, but the complex interactions of water and energy production are largely overlooked. Water is a critical energy issue. To ensure U.S. energy sustainability and security, we need to address the total picture. One missing piece can bring the complex, interdependent energy system to failure.”

Dr. Mike Robinson of the National Renewable Energy Laboratory discussed wind and its importance as an energy source. He discussed DOE’s roadmap to achieving 20% of power generation from non–fossil fuel sources. Wind and ocean technology is a fundamental change in how we collect energy. Some of the things that Dr. Sale talked about in water also apply in wind. Now the United States only receives about 1% of generated energy from wind. The desire is to increase this to near 20%. Wind turbines have an effect on micro-climatology and also affect the jet stream. We talk about the impacts from fossil fuel, Dr. Robinson asked, what are the impacts from renewable sources?

Mr. Rickey Petty, DOE/Office of Biological and Environmental Research, discussed the many dimensions of DOE. He talked about the water cycle, how each agency should have a seat at the discussion table, and the role the water cycle plays in climate change. He indicated that the mini-workshop had been a very good meeting and set the stage for more interagency

discussions.

National Weather Service Climate Services
Dr. Marina Timofeyeva, Ph.D., Physical Scientist, Climate Services Division (CSD), Office of Climate, Weather, and Water (OCWWS), NWS, NOAA

Dr. Timofeyeva began her presentations by stating the needs and requirements of CSD within NWS/OCWWS. She then proceeded to describe the organization of the Climate Program within NOAA and the NWS. As part of this organization, the NWS has established climate focal points at each Weather Forecast Office. These local climate focal points enter local climate service needs that they gather from local users. The secured NOAA database for this information is located at https://ocwws.weather.gov/intranet/climate/directory.php. (Note: access requires a NOAA email login and password).

Then, Dr. Timofeyeva talked about the National Climate Program and related initiatives in the following areas:

- Monitoring climate variability
- Climate assessments and diagnostic discussions
- Climate forecasts
- Climate Test Bed

Regional and local climate programs and initiatives include the following areas:

- Bridging climate user needs and product requirements
- Climate observing system and data records
- Local climate data and forecast products
- Local climate outreach
- Training climate services staff

She ended her briefing by describing national and local climate products and services, climate change issues, research and development opportunities, transitioning of research to operations, and training.

Water Availability in Support of Water Resources and Infrastructure Planning, Operation, and Adaptation (POA)
Dr. Jeff Yang, Ph.D., Hydrologist, Office of Research and Development, EPA

Dr. Yang discussed the Water Resource Adaptation Program (WRAP), whose objective is to provide data, tools, and engineering solutions for adaptation to climate, land use, and socioeconomic changes. He described how the adaptation portion of this program impacts water quality assessments. He then described how model predictions and uncertainties, hydroclimatic change and impacts, and water availability forecasting are used to support water resources assessment and adaptation.

Dr. Yang continued by describing the existing collaborations involved in the activities of this

program. These collaborations include USGS, NOAA, NASA, and US Census Bureau, among others.

F. Discussion

Mr. Mark Welshinger, OFCM Chief Scientist, thanked everyone for their participation in the mini-workshops. He noted that there had been very good interaction among the representatives as the participants learned of hydrometeorology-related activities at other agencies and organization. He also noted that additional agencies and organizations had been invited to the mini-workshops, but due to conflicting schedules they could not attend. He asked the participants to recommend agencies/organization to be invited at a follow-on mini-workshop. The following agencies and organizations were recommended:

- EPA offices
  - Water Quality
  - Ecosystems
  - Human Exposure
  - Homeland Security
- National Science Foundation
- US Agency for International Development
- DOD
  - Naval Research Laboratory
  - Army Research Laboratory
  - Navy
  - US Army Corps of Engineers
- State Department
- Tennessee Valley Authority
- NCAR
- Advisory Committee on Water Information
- NOAA
  - NOS
  - National Marine Fisheries Service
  - OAR
- Federal Regulatory Commission
- Natural Resources Conservation Service
- Federation of American Scientists
- DOI
  - Bureau of Reclamation
  - Bureau of Indian Affairs

    - Bureau of Land Management
    - Minerals Management Service
- International agencies and organizations

Among the final discussions was the topic of sharing data. Everyone agreed that data sharing is extremely important and that solutions obviously need to incorporate security issues and ensure interoperability.

SECTION III: APPENDICES

Appendix A
Hydrometeorology—An Important Component of Integrated Water Resource Management

Integrated Water Resources management is a systematic process for the sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental objectives. Integrated Water Resource management recognizes that working towards sustainable water resources requires the involvement of many stakeholders. To protect and preserve vital water resources will depend largely on sound management decisions supported by an in-depth, reliable scientific knowledge base. Key to this base is the full understanding of the hydrological cycle, the natural process by which water circulates among air, land, and water. With the growing demand on water resources around the globe, decision-makers require more reliable hydrometeorological products, services and supporting research.

Hydrometeorology is an important component of Integrated Water Resource management. It should be noted that the boundaries of hydrometeorology are not clear-cut and overlap with those of the climatologist, hydrologist, cloud physicist, and operational meteorologist.

The American Meteorological Society's *Glossary of Meteorology* defines Hydrometeorology as the study of the atmospheric and terrestrial phases of the hydrological cycle with emphasis on the interrelationship between them.[1] Also, from the *Glossary of Meteorology*, the hydrological cycle is defined as:

> "The cycle in which water evaporates from the oceans and the land surface, is carried over the earth in atmospheric circulation as water vapor, precipitates again as rain or snow, is intercepted by trees and vegetation, provides runoff on the land surface, infiltrates into soils, recharges groundwater, discharges into streams, and ultimately, flows out into the oceans, from which it will eventually evaporate again."

The hydrological cycle plays a major role in weather and climate, strongly influencing human activities. If we focus on atmospheric water vapor becoming water on or in the ground, hydrometeorology and associated products and services are particularly important to managing water resources, including managing the growing risks to our water supply, water quality, healthy stream flows, agriculture and ecosystems.

Hydrometeorological products and services are used for numerous applications, such as designing roads, dams and waterway systems; managing flood plains; planning and conducting emergency management operations when floods threaten. The products and services are also used for other activities such as recreation, aviation, construction and surface transportation system use and management. A few less obvious applications of hydrometeorological products and services include predictions of risks of avalanches and massive mudslides, the freeze-up and break-up of lakes and irrigation and drought forecasts.

Hydrometeorological events can effect food production and agricultural systems, water availability and quality, energy demand and supply and human health. Also, hydrometeorological events and their related hazards can have profound effects, including loss of life, serious personal injuries and significant

[1] From the AMS Glossary of Meteorology (http://amsglossary.allenpress.com/glossary/browse?s=h&p=35).

societal impacts. Given the importance of water resources to people and the environment, it is vital that these events be studied appropriately so their occurrence and nature can be better predicted on both short and long time scales.

Approximately 90 percent of all natural disasters are the results of extreme natural events of meteorological and hydrological origin. There is some evidence that the occurrence of extreme hydrometeorological events have increased over the past few decades, and further changes can be expected associated with anticipated global climate change. The tendency towards an increasing number of potentially dangerous natural phenomena is therefore a growing threat to safety. With a changing climate, water resources and how we manage them is going to become one of the most important issues we face in the coming years. The effective use of hydrometeorological information can help prevent or minimize the impacts of hydrometeorological events.

The hydrometeorology community's strengths are derived from strong collaborative ties among its programs and with its partners and customers. Many Federal, State, and local agencies collaborate (in many ways) in providing accurate and updated information to produce hydrometeorological products and services while avoiding duplication of efforts. By working together, the members of this community can reach more people more effectively and achieve the core results of our collective missions: to save lives, reduce injuries and protect property.

To better support stakeholders and decision makers, we must have a well-developed information system, allowing free exchange of data among the various agencies and avoiding duplication in data collection, modeling, forecasting and dissemination of information. We must continue to enhance the Nation's environmental observing capability, collaborate at all levels (Federal, State, and local) and produce research of consistently high quality. Finally, we need to improve our products and services to help clarify the uncertainty of events such as floods and flash floods, resulting in highly accurate short-term forecasts and warnings and improved public response.

Appendix B
Agency-Described Need/Requirement Gaps

#	Agency/ Organization	Hydrometeorology Need/Requirement Gap Description	Category
1	DOT/FHWA	Understanding of water quality impacts as it relates to highway operation and maintenance	Analysis
2	DOD/USACE	Site-specific probable maximum precipitation studies	Analysis
3	DOD/USACE	Hydrometeorological reports (HMR's) updates	Analysis
4	DOD/USACE	Data archiving & analysis of extreme storm events	Analysis
5	DOD/USACE	Antecedent flood methodology	Analysis
6	DOD/USACE	Temporal distribution of PMP (western US)	Analysis
7	DOD/USACE	Vertical transposition adjustment factor --1,000 feet immunity --HMR55A one-half moisture adjustment	Analysis
8	DOD/USACE	Frequency of extreme storms/PMP/PMF	Analysis
9	DOI/USGS	An acute need for up-to-date flood-frequency (i.e. the 100-year flood) and low-flow frequency (i.e. the 7Q10) statistical characterization and the basis for computing them more efficiently takes into account accessory data. These characterization data are the bases of engineering design, floodplain delineation, and many environmental regulations.	Analysis
10	DOI/USGS	There is an acute need for updating regression equations commonly used to estimate streamflow at ungaged sites. These equations are used by FEMA (100-year floodplains) and Department of Transportation to compute bridge and culvert design requirements.	Analysis
11	EPA/ORD/NERL	More complete reanalysis products - particularly in the West (complex terrain) & off the mid-Atlantic Coast (tropical storm life cycle)	Analysis/ Data Access
12	EPA/ORD/NERL	Better cloud analysis	Analysis
13	DOT/FHWA	Climatological normals – precipitation (annual & monthly amounts, frequency, intensity, duration), river flow, and storm surge	Climate
14	DOT/FHWA	Extremes – precipitation, river flow, storm surge and watershed maps, watershed planning, and flood maps	Climate
15	DOE	Maximum precipitation and flows (e.g., for dam safety)	Climate
16	DOE	In-channel velocity distribution	Climate
17	DOI/NPS	Reliable estimates of hydrometeorological conditions and forecast (e.g., precipitation) with changing climate	Climate
18	EPA/ORD/NERL	Better (i.e., improved performance under current climate) future climate scenarios for temporal and spatial characterization of precipitation volume and frequency, including extreme events (flood and drought)	Climate
19	NASA	Reduce the uncertainty gap in climate-hydrologic forecasts needed for implementing adaptation and mitigation responses to climate change. Especially need improvements towards improved hydrologic downscaling of climate forecasts.	Climate
20	USDA/WAOB	Prefers data in a GIS-ready format...either rater (geoTIFF) or shapefile	Data Access
21	DOD/USAF	Collect and store Hydrological observations (AFWA IT)	Data Access
22	DOD/USAF	High-resolution global background data necessary to run LIS accurately	Data Access
23	DOD/USAF	High-resolution background soil type data	Data Access

#	Agency/ Organization	Hydrometeorology Need/Requirement Gap Description	Category
24	DOD/USAF	High-resolution (1km or finer) soil texture databases to support LIS runs	Data Access
25	DOE	Resource data at appropriate scales for energy development	Data Access
26	DOE	Tools for integrated power systems (wind-hydro integration)	Data Access
27	DOI/NPS	Reliable and timely hydrometeorological hazard information within National Parks	Data Access
28	DOC/NOAA/NWS	"Past weather" data	Data Access
29	DOI/USGS	There is a need for data on hurricane-induced storm surge such as water levels (described in our presentations), wind speed and directions during maximum hurricane winds, and inland, shallow-water and wave velocities and heights to improve and calibrate surge models.	Data Access
30	EPA/ORD/NERL	Better precipitation observations in mountainous west	Data Access
31	EPA	Improve data exchange among agencies and entities, particularly on precipitation, temperature, storm surge, extreme weather, etc. A national center for data coordination would be very helpful.	Data Access
32	NASA	Enhance the free access, dissemination and interoperability of hydrometeorological data for research and applications. Also improve web based hydrometeorology data application solutions.	Data Access
33	NASA	Promote the long-term collection, archiving, and dissemination of hydro-met data needed for climate change assessments.	Data Access
34	DOE	Demonstrations of new data and tools	Education
35	DOI/NPS	Informed resource management and adaption	Education
36	DOC/NOAA/NWS	Outreach activities, materials and trained staff	Education
37	EPA/ORD/NERL	Demonstration of new data, tools and means of access	Education/ Data Access
38	EPA/ORD/NERL	Guidance to the environmental assessment community regarding best-use practices for GCM and regional climate model precipitation scenarios	Education
39	NASA	Improve capability to provide probalistic (ensemble) estimates of hydrometeorological data (e.g., precipitation and streamflow) for short and long term predictions as opposed to deterministic estimates.	Modeling/ Forecasts
40	DOD/USACE	Climate change impacts on extreme storm events and precipitation-frequency	Modeling/ Forecasts
41	DOT/FHWA	High resolution (out to 48 hours, km level) precipitation forecasts (areal extents, intensity, duration, type)	Modeling/ Forecasts
42	DOT/FHWA	Watershed planning and modeling	Modeling/ Forecasts
43	DOT/FHWA	Long-term forecasts of precipitation with the changing climate	Modeling/ Forecasts
44	DOI/NPS	Improved forecasts and modeling of precipitation events in complex terrain	Modeling/ Forecasts
45	DOI/NPS	Precise, accurate modeling of precipitation to analyze source attribution of contaminants reaching park resources.	Modeling/ Forecasts
46	DOD/USAF	Tighter land surface modeling community focus and collaboration	Modeling/ Forecasts
47	DOE	Short-, mid-, and long-term forecasts of flows, including climate change	Modeling/ Forecasts
48	DOE	Magnitude and duration of river flows, wave height, and tidal currents	Modeling/ Forecasts

#	Agency/ Organization	Hydrometeorology Need/Requirement Gap Description	Category
49	DOE	Incorporation of environmental quality variables into power system optimization (flows, temperature, habitat, etc.)	Modeling/ Forecasts
50	DOC/NOAA/NWS	More accurate numerical model forecasts, especially for precipitation	Modeling/ Forecasts
51	DOC/NOAA/NWS	Better tools for forecasting convective precipitation	Modeling/ Forecasts
52	DOC/NOAA/NWS	More advanced forecaster tools for using ensemble model output	Modeling/ Forecasts
53	DOC/NOAA/NWS	Greater use of precipitation forecaster input into probabilistic river forecast models	Modeling/ Forecasts
54	DOC/NOAA/NWS	Additional forecasters to produce precipitation and medium-range forecasts for Alaska, Puerto Rico, Hawaii, Guam, and other OCONUS locations	Modeling/ Forecasts
55	DOC/NOAA/NWS	Climate guidance to national and local decision makers	Modeling/ Forecasts
56	DOC/NOAA/NWS	Information of climate variability and change physical mechanisms, predictability, predictions, and impacts	Modeling/ Forecasts
57	DOC/NOAA/NWS	Timely, continuous and reliable national and local climate forecasts	Modeling/ Forecasts
58	DOT/FHWA	Wind forecasts	Modeling/ Forecasts
59	EPA/ORD/NERL	More accurate numerical model precipitation forecasts	Modeling/ Forecasts
60	EPA/ORD/NERL	Better simulation of clouds	Modeling/ Forecasts
61	NASA	Improve estimates of evapotranspiration, soil moisture, precipitation, groundwater, snowpack, and surface runoff to reduce the often large gap (> 20%) in closing water and energy balance. This is needed over a range of spatial and temporal scales.	Observations
62	DOI/USGS	More stream gages are needed by reservoir management and environmental agencies and river flow forecasters. This is a national need, but it is most acute for small, unregulated, natural basins.	Observations
63	DOI/USGS	There is a need for routine provision of records of streamflow hydraulics (streamflow velocity magnitudes, distributions, and turbulences) to improve the computation of streamflow and to permit the modeling and forecasting of water-quality constituents and loads in rivers and estuaries	Observations
64	DOI/USGS	There is a need for periodic and site-specific continuous provision of water depths and channel cross-sectional geometry data both for computing real-time streamflow, but also for predicting sediment transport and bridge scour and characterization of ecosystem habitat.	Observations
65	DOT/FHWA	Weather information at/on the road to know if water (snow, ice) will bond to pavement, or if flooding, ponding is going to occur	Observations
66	DOT/FHWA	Accurate observations at or on roads at high resolutions	Observations
67	DOD/USAF	Surface characterization/hydromet information at sub-1km scales (Army specification)	Observations
68	DOD/USAF	Written guidance for 5X5 km surface characterization (Intelligence Community)	Observations
69	DOC/NOAA/NWS	More accurate quantitative precipitation estimation	Observations
70	DOC/NOAA/NWS	Denser, more timely and accurate snowfall observations	Observations
71	DOC/NOAA/NWS	Timely, continuous and reliable climate data	Observations

#	Agency/ Organization	Hydrometeorology Need/Requirement Gap Description	Category
72	DOC/NOAA/NWS	Networks designed for synoptic meteorology (Not hydrology; Co-operative Observing Program based on manual systems -- Data arrives too late for use in real-time operations)	Observations
73	DOC/NOAA/NWS	Desperate shortage of observed: Precipitation, Stream flow and stage (USGS), Soil moisture, Solar radiation, etc	Observations
74	DOC/NOAA/NWS	Radar and satellite based precipitation estimates in mountainous terrain (the west) are poor	Observations

Appendix C
Workshop Agendas

Wednesday, September 17, 2008

8:15 AM	Administrative Information	Ms. Ronla Henry (OFCM)
8:20 AM	Welcome	Mr. Samuel P. Williamson Federal Coordinator for Meteorology
8:30 AM	Opening Remarks	Ms. Carla Sullivan Chief of Staff, NOAA
Session 1- Observations, Data Assimilation & Modeling		
8:45 AM	Department of the Interior/ U.S. Geological Survey	Dr. Harry F. Lins Hydrologist, Office of Surface Water
9:05 AM	Department of Homeland Security/ U.S. Coast Guard	Dr. Jonathan Berkson Marine Science Program Manager
9:25 AM	Department of Transportation/Federal Highway Administration	Mr. Paul Pisano Road Weather Management Coordinator
9:45 AM	**Break**	
10:00 AM	Environmental Protection Agency	Dr. Ellen Cooter Meteorologist, Atmospheric Sciences Modeling Division
10:20 AM	Department of the Interior/ National Park Service	Mr. John Vimont (Remote) Meteorologist Dispersion Modeling
Session 2 – Hydrologic Science & Research		
10:40 AM	National Aeronautics and Space Administration	Mr. David Toll Deputy Program Manager for Water Resources
11:00 AM	National Science Foundation - Consortium of Universities for the Advancement of Hydrologic Science, Inc (CUAHSI)	Dr. Richard P. Hooper President and Executive Director, CUAHSI
Session 3 – Hydrologic Forecast, Products & Services		
11:20 AM	National Oceanic and Atmospheric Administration/National Weather Service	Mr. Glenn Austin Chief, Hydrologic Services Division
11:40 AM	Department of Defense/U.S. Air Force Directorate of Weather	Colonel Dean Corpman Chief, Air Force Weather Policy

Session 3 – Hydrologic Forecast, Products & Services - Continued		
12:00 PM	**Break**	
12:20 PM	**Working Lunch**	
12:20 PM	Department of Defense/U.S. Navy	CAPT Dean Sadanaga **(Invited)** Commander, Naval Oceanography Operations Command (CNMOC)
12:40 PM	U.S. Department of Agriculture	Mr. Eric Luebehusen Meteorologist Office of the Chief Economist World Agricultural Outlook Board
Session 4 – Stakeholders Perspective		
1:00 PM	Department of Homeland Security	Ms. Jennifer Blanton Program Analyst DHS Science and Technology Infrastructure Geophysical Division
1:20 PM	Department of Homeland Security/Federal Emergency Management Agency	Mr. Dan Catlett Program Manager National Hurricane Program Mitigation and Insurance Division
1:40 PM	Department of Energy-Sentech, Inc	Dr. Michael J. Sale Senior Energy Consultant
2:00 PM	**Break**	
Conclusion		
2:20 PM	Discussion/review of needs/requirements and priorities (Operations and Research)	All
3:00 PM	Wrap-up and Next Steps	Mr. Mark Welshinger Chief Scientist, OFCM
3:30 PM	**Adjourn**	

Wednesday, December 10, 2008

2nd Mini-Workshop on Hydrometeorological Products, Services and Supporting Research ***AGENDA*** *Wednesday, December 10, 2008*		
8:30 AM	Administrative Information	Ms. Ronla Henry OFCM
8:40 AM	Welcome	Mr. Samuel P. Williamson Federal Coordinator for Meteorology
8:55 AM	Summary of First Hydrometeorology Mini-Workshop	Mr. Donell Woods OFCM
Session 1- Observations, Data Assimilation & Modeling		
9:15 AM	NOAA/NWS/National Centers for Environmental Prediction (NOAA)	Dr. James (Jim) Hoke Director, Hydrometeorological Prediction Center
9:35 AM	U.S. Army Corps of Engineers	Mr. Doug Clemetson Chief, Hydrology Section US Army Corps of Engineers
9:55 AM	Department of the Interior/U.S. Geological Survey	Mr. Robert Mason Hydrologist, Office of Surface Water
10:15 AM	**Break**	
Session 2 – Hydrologic Science & Research		
10:30 AM	National Aeronautics and Space Administration	Dr. Christa Peters-Lidard Physical Scientist and Head, Hydrological Sciences Branch NASA-GSFC
10:50 AM	NOAA/Office of Oceanic and Atmospheric Research (OAR)	Mr. Tim Schneider HMT Project Manager and Lead Hydrometeorology Team
11:10 AM	NOAA/NWS/Office of Hydrologic Development	Mr. Geoffery Bonnin Chief, Hydrologic Science and Modeling Branch
11:30 AM	National Center for Atmospheric Research	Mr. Roy Rasmussen (**Remote**) NCAR Research Applications
11:50 AM	**Break**	
	Working Lunch	

2nd Mini-Workshop on Hydrometeorological Products, Services and Supporting Research ***AGENDA*** *Wednesday, December 10, 2008*		
Session 3 – Stakeholders Perspective		
12:20 PM	NOAA/NWS	Dr. Marina Timofeyeva Physical Scientist – Climate Services Division
12:40 PM	Environmental Protection Agency	Dr. Jeff Yang (**Remote**) Water Resource Adaptation Program (WRAP)
Session 4 – Hydrologic Forecast, Products & Services		
1:00 PM	NOAA/National Ocean Service (NOS)	Mr. Stephen Gill Senior Scientist, Center for Operational Oceanographic Products and Services
1:20 PM	Department of Defense/U.S. Navy	Mr. Kurt Nelson Joint Meteorology and Oceanography Integration
1:40 PM	**Break**	
1:55 PM	Discussion: Review of Needs/ Requirements and Priorities (Operations and Research)	All
2:40 PM	Wrap-up and Next Steps	Mr. Mark Welshinger Chief Scientist, OFCM
3:00 PM	**Adjourn**	