3rd National Surface Transportation Weather Symposium (3NSTWS)

1. **Purpose:** To provide a summary of the 3NSTWS, which was sponsored by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) and the Department of Transportation's Federal Highway Administration (DOT/FHWA), from July 25-27, 2007, in Vienna, Virginia. The 3NSTWS was conducted to provide a forum for members of the surface transportation operations, research and user communities to work together to enhance collaboration and partnerships to improve surface transportation weather products and services for those individuals who use, operate, and manage America's surface transportation infrastructure. The theme for the symposium was *Improving Commerce and Reducing Deaths and Injuries through Innovative, Weather-Related R&D and Applications for the Surface Transportation System*. The symposium was attended by 132+ people.
2. **Objectives:**
   - Articulate a clear observation strategy for surface transportation weather that defines the types of data that are needed and the optimal mix of observing platforms required to meet those needs.
   - Identify the priorities, challenges, and opportunities for research and development that will contribute to saving lives, reducing injuries, and improving efficiency in the Nation's surface transportation infrastructure.
   - Define the needs for advanced computing capacity required for surface transportation weather modeling and for the assimilation of data from multiple data sources.
   - Identify the needs for new products and services driven by current operations or concepts for future surface transportation systems. Are there existing capabilities or emerging research and development that can be leveraged and/or transitioned into operations to meet these needs? How can probabilistic forecasts be used to meet these needs?
   - Investigate opportunities to document and substantiate the socioeconomic impacts of improved surface transportation weather products and services.
   - Identify the potential and emerging information dissemination technologies available to get the "right message" to surface transportation weather stakeholders.
   - Establish partnerships with the stakeholder community to ensure that customers and stakeholders understand how to effectively use surface transportation weather products and services in their decision-making processes.
3. **Keynote Addresses:** The Keynote Addresses on Wednesday, July 25th, set the stage for the symposium by highlighting partnerships, increasing the safety and efficiency of our nation's surface transportation systems through research and the use of advanced technology.
   - **Jeffrey N. Shane,** Under Secretary of Transportation for Policy. His comments included:
     - Importance of weather information—information vital to addressing many of the challenges the transportation sector faces in unlocking congestion and improving safety.
       - Need to be clear about our research priorities.
       - Need to share information on how weather management and information products and services facilitate better decision making.
       - Need to understand and articulate the social and economic benefits that are derived from weather products and services.

- DOT's interest in the symposium and ongoing surface transportation weather improvement efforts. The DOT is pursuing initiatives in three critically important areas: reducing congestion, improving safety, and advancing 21st Century solutions.
- DOT's commitment to weather and climate research.
  - Weather affects the safety, mobility and productivity of all transportation modes, and DOT is engaged in R&D and deployment activities to mitigate or manage the impacts of weather.
  - DOT also recognizes that climate change holds the potential for more frequent and more severe weather events.
- DOT and NOAA play critical roles to achieve success, with partnership and collaboration at the forefront.
- Cross-departmental coordination is critical to building a system that will allow those who use the transportation networks—drivers, freight shippers, and transit operators—to make better informed decisions.

- **VADM Conrad C. Lautenbacher, Jr.,** USN (Ret.), Under Secretary of Commerce for Oceans and Atmosphere/Administrator of the National Oceanic and Atmospheric Administration (NOAA). His comments highlighted the following:
  - One of NOAA's strategic goals is to support the nation's commerce with weather information for safe, efficient, and environmentally sound transportation—all forms of transportation.
  - An area where NOAA has focused its resources and expertise is severe weather safety.
    - Have achieved significant positive results in the areas of public, aviation, and marine weather safety.
    - NOAA and its partners now have the opportunity to focus their collective efforts toward the surface transportation weather challenge.
  - NOAA already provides support to the Marine Transportation System, as an example of NOAA's support for the surface transportation community.
  - Importance of partnerships that extend well outside NOAA to Federal, State and local governments, along with academia, private companies and the media.
    - Working together to take observations, model future events, and provide forecasts in a useable manner to decision makers.
  - Need to develop a better understanding of user needs for surface transportation weather information, thus improving the focus of R&D to benefit surface transportation.
  - New products and services coming online soon as a result of work occurring within and outside NOAA.
  - Urged participants to work to complete the symposium objectives to help ensure we can the improve commerce and reduce deaths and injuries that occur within the surface transportation system.
- **Dr. Gene Whitney,** Assistant Director for Environment, Office of Science and Technology Policy, Executive Office of the President. His comments included the following :
  - The surface transportation community can benefit from the plans of the Earth Observations and Climate Change communities.
  - The U.S. Climate Change Science Program (CCSP) goals, highlighting that the program has produced three reports that should be of interest to the transportation community:

- Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific islands;
- Effects of Climate Change on Energy Production and Use in the United States; and
- Impacts *of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study*.

- Three CCSP FY09 research priorities that he felt held relevance for the surface transportation community:
  - Assessing abrupt changes in a warming climate: examining the feasibility of developing an abrupt change early warning system;
  - Development of an integrated earth system analysis capability: a focus toward creating a high-quality record of the state of the atmosphere and ocean since 1979; and
  - Development of an end-to-end hydrologic projection and application capability.
- Activities of the U.S. Group on Earth Observations. As the U.S. Group on Earth Observations moves forward to establish U.S. Earth observations policies, this work may provide valuable guidance for the surface transportation community in areas such as: the role of State, local, regional and tribal governments and institutions; the role of the commercial/industrial/private sector/NGOs/academia; guidelines for research-to-operations transition; an Earth observations technical architecture; and guidelines for data collection, archiving and availability.
- Many Integrated Earth Observation System societal benefits that could impact the surface transportation community in a positive way; such as, understand, assess, predict, mitigate and adapt to climate variability and change, and monitor and manage energy resources.

4. **Symposium Sessions.** The eight symposium sessions are summarized below:

1	Improving Economic and Life Decisions: Social and Economic Impacts and Benefits
2	Priorities for Surface Transportation Weather Research and Development
3	Leveraging Related R&D Activities to Benefit Surface Transportation
4	Observation Data Requirements for Surface Transportation
5	Modeling and Prediction: Required Products and Services
6	Weather Information Dissemination in Support of Effective Decision Making
7	Research to Operations: The Pathway to Operational Implementation
8	Keys to Success: Creating Synergy in All Components of Surface Transportation Weather Applications

5. **Summary of Results.** This paragraph summarizes information stemming from the eight symposium sessions into various categories that cut across many of the sessions.

- ***Current and Emerging Capabilities and Transition of Research to Operations Activities to Improve Products and Services.*** Efforts to improve products and services are related to meeting the surface transportation needs—needs that are linked to weather challenges that contribute to deaths, injuries, damage and inefficiencies in the transportation system. The weather challenges that are the highest contributing factors to deaths, injuries, damage and inefficiencies are summarized below:

Roadway	• Liquid precipitation is the number one meteorological factor contributing to death and injuries. • Frozen precipitation is the number one meteorological factor contributing to delays and damage.
Transit	• Liquid and frozen precipitation are the number one meteorological factors contributing to deaths. • High winds and fog are the number one meteorological factor contributing to delays.
Pipeline	• Liquid precipitation is the number one meteorological factor contributing to death, injury, damage and delay.
Marine	• High winds are the number one meteorological factor contributing to death, injury and damage for marine recreation.
Railroad	• Temperature extreme variations are a significant meteorological factor contributing to injury, damages, and delays. • Flooding and landslides triggered by high runoff (rainfall and snow melt) events are significant meteorological factors contributing to fatalities injury, damage and delays. • High winds are contributing to more damages as the use of inter-modal container traffic grows.

Many presentations at the symposium covered ongoing or emerging initiatives and transition of research to operations activities aimed to meet the surface transportation weather needs. Although many of the items described below are not directly tied to the surface transportation weather focus area, these programs and associated R&D activities provide opportunities for leveraging to meet the surface transportation weather needs.

- Current Observations.
  - Surface transportation weather focus area can leverage existing observational capabilities. Some of the leveraged observational capabilities (e.g., multifunctional observations) include surface observations (e.g., observations from NWS Forecast Offices, National Water Level Observation Network; U.S. Climate Reference Network, surface mesonets, etc.) WSR-88D (Weather Surveillance Radar 88-Doppler radar), satellite data, and many more.
    - ◊ Some observations, such as those obtained from pavement condition sensors, are unique to the surface transportation sector.
  - Service requirements for observations revolve primarily around required accuracy, station density and reporting interval.
  - Still many observational challenges to meet user needs.
  - Need more innovation in sensing systems.
- Some Emerging Observations, Applications and Data Management Systems.
  - Visibility Detection Utilizing Camera Imagery. MIT Lincoln Laboratory (MIT/LL) is evaluating the usefulness of camera imagery for sensing ambient and road weather conditions. Cameras have been used for decades to remotely monitor traffic and protect life and property. The deployment and utilization of cameras has expanded dramatically in the last decade with support from the Department of Transportation for traffic management and 511 services as part of the Intelligent Transportation System (ITS), and the Department of Homeland Security for threat surveillance and emergency management operations. Camera sensors are important for surface transportation applications because they are directly sensing the road/rail environment.

- Multifunction Phased Array Radar offers many weather sensing improvements and increased safety and capacity in severe weather conditions.
- Doppler radar and GIS
  - Real-time decision support applications (e.g., hydroplaning, flooding).
  - GIS adds the specific location (e.g., by road mile, DOT district, County).
- Aerial platform instrumentation (e.g. instrumentation on traffic helicopters, UASs). The potential exists to collect weather parameters within the boundary layer, vitally important to forecasting parameters for surface transportation.
- Meteorological Assimilation Data Ingest System (MADIS). MADIS provides access to an integrated, reliable and easy-to-use database containing the real-time and archived observational datasets. Integrating the DOT/FHWA Clarus initiative and transitioning MADIS to operations (i.e., the National Surface Weather Observing System) is vital to data management support. For more information on Clarus, see "Research and Development Initiatives" below.
- Integrated Ocean Observing System (IOOS). IOOS is a system of systems that routinely and continuously provides quality controlled data and information on current and future states of the oceans and Great Lakes from the global scale of ocean basins to local scales of coastal ecosystems.
- Global Earth Observation System of Systems or GEOSS — Revolutionizing Our Understanding of How Earth Works. Right now many thousands of individual pieces of technology are gathering earth observations around the globe. However, most of these technologies are not yet integrated. GEOSS is intended to connect the scientific dots—to build a system of systems that will yield the science on which sound policy must be built.

- Modeling
  - NCEP modeling programs (e.g., atmosphere, land, coastal, ocean, wave). Several new capabilities focused on higher resolution surface transportation requirements are currently under development. Capabilities include:
    - Real-Time Mesoscale Analysis (RTMA).
    - Land Information System (LIS—NASA/NOAA).
    - Marine Applications Multi-Grid Wave Modeling.
    - NCEP Real-Time Ocean Forecast System (RTOFS).
    - NCEP ensemble products.
  - NCEP needs:
    - Written requirements for surface transportation to the National Weather Service (NWS).
    - Additional personnel resources for timely implementation of higher resolution capabilities; Post-Doc position focused on surface transportation product implementation.
    - Increased operational (and research) NWP computing resources.
- Decision Support.
  - Physical Oceanographic Real-Time System (PORTS®). PORTS® is a decision support tool that improves the safety and efficiency of maritime commerce and coastal resource management through the integration of real-time environmental observations, forecasts and other geospatial information.

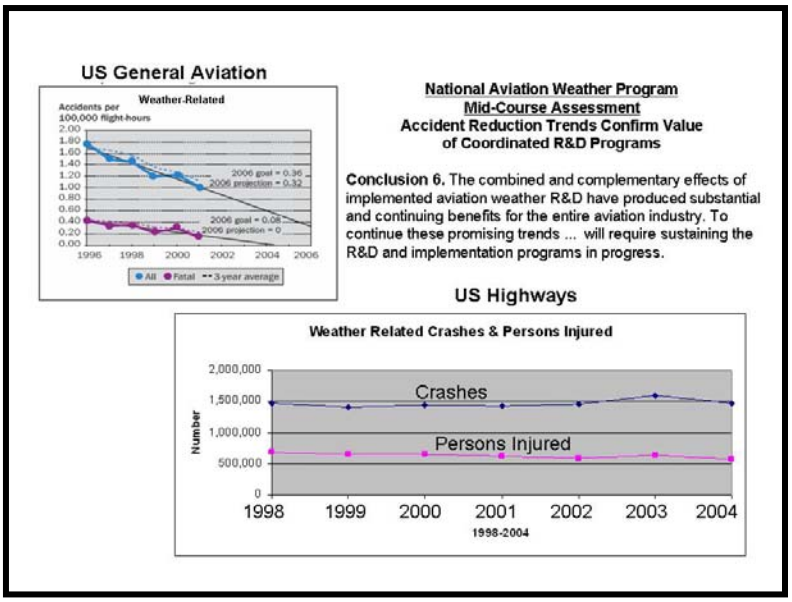
- IRRIS. IRRIS technology is designed to provide timely and relevant information about road conditions, construction, incidents, and weather to facilitate the rapid deployment of military assets.
- National Digital Forecast Database (NDFD). As the foundation of the NWS Digital Services Program, the National Digital Forecast Database (NDFD) consists of gridded forecasts of sensible weather elements (e.g., cloud cover, maximum temperature). NDFD contains a seamless mosaic of digital forecasts from NWS field offices working in collaboration with the National Centers for Environmental Prediction (NCEP).
- The 4-D virtual weather data cube for the Next Generation Air Transportation System (NextGen) will be a common weather information data base; improved with emerging observational and forecasting technologies; a (virtual) single authoritative source; with probabilistic as well as deterministic information; and integrated into user applications and decision technologies.

- Research and Development Initiatives/Programs.
  - 511 Services—National traveler information number. The goal of the 511 Deployment Coordination Program is "the timely establishment of a national 511 traveler information service that is sustainable and provides value to users."
  - Clarus (which is Latin for "clear") is a DOT/FHWA initiative to develop and demonstrate an integrated surface transportation weather observing, forecasting and data management system, and to establish a partnership to create a Nationwide Surface Transportation Weather Observing and Forecasting System.
  - Vehicle Infrastructure Integration (VII) will provide the opportunity to capture new road weather observations to fill the current gaps in data along the Nation's transportation systems.
  - Maintenance Decision Support System (MDSS) project is a multiyear effort to prototype and field test advanced decision support for winter maintenance managers. MDSS Release-5.0 materials will be available in late summer 2007.
  - WIST Impacts Planning Tool (WIPT). WIPT is an integrated weather effects surface transportation decision aid being developed by the US Army Research Laboratory.
  - Weather-Related Research and Development Priorities for the Maritime Transportation System (MTS). Weather-related research and development priorities for the MTS, which other sectors of surface transportation can potentially leverage, can be categorized as follows: new and improved sensors and sensor technology; models for improved decision making; remote sensing technologies; and delivery mechanisms/communications.
  - FAA Aviation Weather Research Program (AWRP). The purpose of the AWRP is to identify and develop science and technology, which will improve safety as well as increase capacity. The program also promotes cooperation between the government and industry in the efficient development of new weather related capabilities. Some of the research and development activities managed through the AWRP have applicability to the surface transportation weather focus area.

- ***Getting the Right Message Out—Need for Social Science Involvement.*** Session 1 presentations at the symposium focused on the need for greater social science involvement in the surface transportation weather area to help ensure the needs of the community can be met. These presentations included the following recommendations:
  - Metrics for improved surface transportation weather should be based upon user needs.

    - User needs are often defined by the process of interpreting and responding.
    - Suppliers of the information must understand this process.
    - Social scientists (vice meteorologists) understand this process best.
    - Quantifying socioeconomic impacts involves understanding the entire process.
    - Must involve partnerships among agencies and social scientists in addition to physical scientists (two-way street).
  - Must leverage the public-private partnership in the media community to ensure we can get the message to the public when required, using a variety of dissemination methods.
- ***Education and Outreach.*** Several presentations at the symposium discussed the need for greater education and outreach efforts to support the surface transportation weather focus area and provided recommendations for further work. The following summarizes some key points:
  - Potential use of the NWS Warning Coordination Meteorologists
    - Training
    - Decision Support
  - Better education on safety hazards associated with just plain rain.
    - It is not always the "severe" stuff.
    - How do we get people to take it seriously?
    - We kill over 5,000 people a year with rain and wet pavement. Where is the outrage?
  - Private-media and public-agency partnerships.
    - Several public agencies have partnered with private-media companies (e.g., The Weather Channel) to produce education and training materials.
  - National Highway Institute (NHI) Course Number 137030—Principles and Tools for Road Weather Management.
    - NHI now offers this one-day, FHWA-designed course to all transportation agencies.
  - Fundamentals of Road Weather Management CD-ROM: Professional Development Module.
    - Developed by FHWA in partnership with the Institute of Transportation Engineers (ITE)
    - Provides transportation practitioners with a quick, concise, and easy way to learn about the basics of road weather management (i.e., professional development).
- ***Need for Metrics to Measure Success and Guide Resource Allocation.*** During Session 8 of the symposium, the aviation success story for reducing deaths and accidents was discussed. There needs to be similar metrics for the surface transportation weather focus area.
  - Evaluate the sensitivity of U.S. economic sectors to weather variability (i.e., economic impacts of weather).
  - Perform a socioeconomic valuation and impacts analysis of surface transportation weather efforts (e.g., lives saved, time saved, and environmental values). Results could be used for program justification and program evaluation, as guidance for research investment, and to inform users of forecast benefits.
  - Aviation Weather Research and Development Program example. The program had a target metric to meet—an 80% reduction in weather-related accidents and fatalities over 10 years.

- Referring to the figure below, weather-related general aviation accidents/ fatalities are well on their way to meeting this metric resulting from focused complementary R&D efforts (see figure on left below), whereas weather-related US highway crashes and injuries (see figure below on right) illustrate the critical need for increased R&D efforts focused upon weather support for surface transportation.
- Post-symposium discussion among the symposium participants noted that the surface transportation weather research and development program would benefit from a similar set of targeted metrics, and the community needs to develop and agree on such metrics. Below is a draft set of metrics to consider:
  - A 5-year target of a 25% reduction in roadway weather-related injuries?
  - A 10-year target of a 50% reduction in roadway weather-related injuries?
  - A 5-year target of a 25% reduction in roadway weather-related congestion?
  - A 10-year target of a 50% reduction in roadway weather-related congestion?
  - A 5-year target of a 50% reduction in recreational boating weather-related deaths?
  - A 10-year target of an 80% reduction in recreational boating weather-related deaths?



- ***Gaps and Research Priorities.*** Many presentations at the symposium discussed gaps in research for the surface transportation weather focus area, and provided recommendations for further work. The following is a brief, but not all inclusive, summary of these gaps and resultant research priorities:

  - Social Science:
    - Develop a classification of the social impacts and benefits of weather information and their associated metrics.
    - Are we getting the message out in an understandable and actionable way?
  - Observing systems and sensors:

- Mobile sensors (vehicles as probes).
  - What effect does movement and temperature sensor placement on the vehicle have on vehicle temperature reporting accuracy?
- Radar:
  - Continue research of dual polarization radar to see if it may offer improvement in several key observing areas.
  - Continue Multifunction Phased Array Radar assessment and planning.
- Visibility Sensors.
- Mesoscale Multifunctional Observing Networks.
- Integrated observing system; crucial component of improved surface weather products and services.
- Consistent and uniform reporting of road conditions from state DOTs and local municipalities.
- Freezing drizzle, snow, ice, rime, frost—presence and accumulation.
- Insolation.
- Blowing, drifting snow.
- Dust and smoke.

- Modeling and Prediction:
  - Local, regional, and continental modeling capabilities at high- resolution temporal and spatial scales.
  - Improved prediction of:
    - Precipitation start and stop times.
    - Precipitation amounts (particularly for light events).
    - Cloud cover (solar radiation).
    - Water vapor (e.g., fog, frost, dew).
  - Boundary layer meteorology (e.g., friction, turbulence, water vapor flux, heat exchange).
  - Data assimilation and modeling.
- Delivery/Product Format and Mechanisms, Data Management and Communications:
  - Define product concepts (text and graphics) for multiple variables.
  - Methods to best convey uncertainty to decision makers.
  - Probabilistic vs. deterministic.
  - GIS technologies for surface transportation weather.
  - MADIS (Meteorological Assimilation Data Ingest System).
  - Design solution(s) for full data availability (all information, intelligently delivered, available to people at all times).
- Performance Metrics:
  - Need to assess performance of surface weather forecasts using models that utilize new data assimilation methods and next generation, coupled NWP models.
  - Need techniques to assess utility of solar radiation observations.

- ***Opportunity for a Near-Term Intermodal Initiative.*** Several presentations and sessions discussed the need for a near-term initiative to pull many surface transportation weather technologies and capabilities together to formulate the basis of a conceptual surface transportation weather support system. The following is a recap of the recommendations:
  - Urban Test Beds and Surface Transportation Systems—they share the same atmosphere and many common goals, objectives and opportunities.
  - Need several regional-scale test beds—an important step in the transition from R&D to operations; proving ground for science, technology and delivery vehicles.
  - National Demonstration Corridors—to demonstrate effectiveness of road weather improvements, facilitate implementation of research results and provide a stream of road weather information to users and developers.
  - Regional Research Centers—to develop new technologies, foster technology implementation on regional roadways, and facilitate interaction between governments, the private sector and academia.
  - Multimodal Initiative—potential to use a port as a marine transportation system base, and add in support to rail, road (trucking), pipelines and transit, as applicable.

6. **Symposium Action Items.** Session 8, which has been discussed previously, also provided recommended actions:
   - The background work has been done and there is a need for more significant interagency coordination and support.
   - Within the OFCM infrastructure, the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR) should consider raising the level of agency representation for the Working Group for Weather Information for Surface Transportation (WG/WIST) to a level more appropriate for supervising work that falls within and under the WG/WIST's purview.
   - The community should seriously consider requesting OFCM-sponsored Joint Action Group(s) (JAG) be formed to accomplish actions outlined below. The JAG(s) would be aligned under the WG/WIST.
     - Develop an integrated observing strategy to include identification of critical new surface transportation weather and road condition sensor needs.
     - Establish several high-level R&D priorities for agencies to focus on and to collaborate with the academic community and the private sector.
     - Improve interagency coordination of products and services for common applications (joint use/cross-feed/new requirements).
     - Consider sponsoring a multimode surface transportation weather demonstration project (road/rail/maritime/pipeline/ etc.).
     - Conduct socioeconomic surveys of impacts and needed format/semantic changes to improve understanding and usability of required products and services.
     - Consider fast tracking a Post-Doc assigned to NCEP/EMC focused on surface transportation needs for modeling and prediction and products and services.

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