

67th INTERDEPARTMENTAL HURRICANE CONFERENCE/TROPICAL CYCLONE RESEARCH FORUM SUMMARY REPORT

With the support of the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR) and the sponsorship of NOAA, the Office of Navy Research (ONR), and the National Science Foundation (NSF), the 67th Interdepartmental Hurricane Conference (IHC)/Tropical Cyclone Research Forum (TCRF) was hosted and chaired by Mr. Samuel P. Williamson, Federal Coordinator for Meteorology, from March 5-7, 2013, at the NOAA Center for Weather and Climate Prediction (NCWCP) in College Park, MD. The 67th IHC/TCRF highlighted several observations of particular note:

- By holding the forum at the NCWCP, we were able to reduce travel expenditures and overhead costs, and for the first time, the forum had a large “virtual” attendance, with attendees participating via the internet, using “GoToMeeting” and teleconferencing.
- There were 255 total registrants for the 67th IHC/TCRF; 114 registered to attend in person, and 141 participated virtually.
- It was particularly noteworthy that when the Federal offices in Washington, DC, (including the conference facility) were shut down due to the winter storm on Wednesday, March 6, the forum was conducted exclusively in the “virtual” mode, including many who participated from their homes and hotel rooms, and the day’s agenda was fully and successfully accomplished.
- It was pointed out by several participants upon return on Thursday, March 7, that a significant loss of interaction occurred due to holding the meeting entirely virtually.

This document summarizes the results of the forum and includes the following sections:

- Section I – Overview
 - Purpose and Theme
 - Objectives
 - Abstracts and Presentations
 - Key Takeaways
 - Action Items
- Section II –Synopsis
 - Sessions Conducted
 - Key Events
- Section III – Summary Remarks

I. OVERVIEW

Purpose and Theme:

The Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) annually hosts the IHC to provide a forum for the responsible Federal agencies, together with representatives from the academic community, industry, and other user communities, such as emergency management, to prepare for the upcoming hurricane season and to make improvements to the Nation’s hurricane forecasting and warning program. The theme for the forum was: *“Tropical Cyclone Research: Our Vision for the Future.”*

Objectives:

Forum sessions were structured to address the following objectives:

- Assess the progress in addressing the operational priorities of the operational centers (NHC, CPHC, and JTWC) and adjust future research priorities as needed.
- Review ongoing numerical modeling initiatives within NOAA, Navy, NASA, and NSF.

- Receive updates on Joint Hurricane Testbed projects ready for transition from research into operations.
- Explore other R&D opportunities (modeling and observational) that will promote improvements in forecasting and understanding of TCs and their associated affects.
- Investigate the application of social science to the TC forecast and warning notification problem.

Abstracts and Presentations:

Abstracts for presentations that were given at the 67th IHC and Tropical Cyclone Research Forum can be found at: <http://www.ofcm.noaa.gov/ihc13/20130228%20Booklet%20final.pdf>. Presentation slides may be viewed at: <http://www.ofcm.noaa.gov/ihc13/67IHC-Linking-File.htm>

Key Takeaways:

- **Areas of noteworthy progress:**
 - Complementary research by the agencies was instrumental to our recent progress.
 - Emergency managers (EM) are using the 4-5 day forecasts and praising the accuracy even at these times.
 - The improvement in intensity forecast skill beyond 48 hrs was evident, and the tropical cyclone operations and research community is providing societal benefit through its focused and coordinated R&D, according to the EM community.
 - Hurricane Forecast Improvement Program (HFIP) results are being worked into operations and paying dividends.
 - Forecast skill has improved due to improved resolution, observations, data assimilation, and model physics.
 - The Joint Hurricane Testbed continues to be healthy and productive. Since 2001, 74 projects were supported, 62 completed, 35.5 implemented, and 24.5 of those at NHC.
 - Test and evaluations show high utility for observations from future GOES-R, airborne expendable bathythermographs (AXBT), unmanned aerial vehicles like Global Hawk, etc.
 - Synthetic observations and targeted observations are proving valuable in forecast skill.
 - While still requiring much improvement, 4-week forecasts of genesis and track are showing some promise.
 - While some progress has been shown, much work remains to be done to improve knowledge and application of models and forecast information related to storm tides, surge, flooding, coastal effects, and other storm landfall hazards.
 - Social science issues seem to be getting more direct action with pointed research and implementation (e.g., using post-tropical vs. extra-tropical; changing procedures so NHC doesn't stop forecasting and publicizing information to the media upon landfall; public recognition of colors for surge and wind risk in warnings; etc.,).
- **Gaps in our capability requiring continued focus:**
 - Emergency managers are focused on 35 and 50 knot thresholds (timing) now more than just track/intensity in general.
 - Accurately forecasting intensity change, especially rapid fluctuations and timing of those fluctuations, remains a high priority issue.
 - Research into outflow and aerosols may pay dividends in the future.
 - Ensembles may be key to continued forecast skill improvements and need greater focus.
 - Characterizing forecast uncertainty in ways that can be understood by the public is important.
 - Focused observations have improved forecasts and warnings; enhancing this capability should be explored.
 - The operational centers desire further development of forecaster guidance decision tools.

- Acquiring real-time observations may increasingly become a challenge in the current fiscal environment; efforts to pursue non-traditional observations like Global Hawk and further developing and improving others like AXBTs is crucial.
- Coastal and inland storm effects such as surge, inundation, flooding, etc., require continued attention.
- It's critical to continue to challenge the next generation of scientists and researchers; there is much more to be done.

Forum Action Items:

- The OFCM will post conference presentations and this summary on the conference web page.
- The OFCM will publish the annual NHOP, to include changes recommended to and accepted by the WG/HWSOR, no later than May 15, 2013.
- The OFCM will initiate a Mid-Course Assessment, to be conducted by the WG/TCR, on the *Interagency Strategic Research Plan for Tropical Cyclones: The Way Ahead* (FCM-P36-2007).

II. SYNOPSIS

Sessions Conducted: In addition to the opening ([presentation](#)), poster ([presentations](#)), and plenary sessions ([presentation](#)), the 67th IHC/TCRF agenda included the following:

Session #	Title
1	Tropical Cyclone Research: Federal Agency Overview
2	Working Group for Tropical Cyclone Research
3a	Navy Model Development and Improvement Program/Hurricane Forecast Improvement Program (HFIP)
3b	Earth System Prediction Capability (ESPC)/Next-Generation Suite of Models
3c	NSF Program Initiatives
4	2012 Tropical Cyclone Season in Review
5a	Joint Hurricane Testbed Project Updates: Part 1
5b	Joint Hurricane Testbed Project Updates: Part 2
6	Tropical Cyclone Model Development and Technology Transfer
7	Observations and Observing Strategies for Tropical Cyclones and their Environment
8	Improvements in Tropical Cyclone Forecast and Warning Products and Services
9	Social Science Applications to the Tropical Cyclone Forecast and Warning Notification Problem

Key Events:

- **Working Group for Hurricane and Winter Storms Operations and Research (WG/HWSOR) meeting:** The working group met virtually on March 4, 2013, immediately prior to the formal opening of the 67th IHC/TCRF. Due to fiscal constraints and travel restrictions the meeting was held via GoToMeeting, with the executive secretary running the meeting from OFCM while the chair and meeting participants were logged in virtually from various locations. Final working group results were presented during the final plenary session of the IHC by the working group chair. Twenty new action items were addressed, with 4 closed, 8 airspace-related action items deferred for a follow-on meeting, and 8 information items briefed. Additionally, 4 action items from the 66th IHC were closed, with 2 administrative actions remaining. It was reiterated that the WG/HWSOR meeting is best held during the IHC, and the intent is to hold this meeting during future IHCs. ([WG/HWSOR: Action Item Review presentation](#))

- **Forum Opening Session:**
 - **Keynote Address** – In his keynote address, Congressman Chaka Fattah, a senior member of the House Appropriations Committee and the ranking member on the Subcommittee on Commerce, Justice, Science and related agencies (CJS), noted that improved satellite coverage, the latest research advances, and a roster of talented weather and climate scientists have made great strides in forecasting super-storms such as Sandy, where advance warnings saved lives and property. It is critical that we provide our forecasters with the resources they need to prepare and protect Americans for the increasing number of severe weather events we are experiencing. Future investments to advance science and technology are critical to saving lives and property when storms occur. Weather forecasting shows the public the benefits of investment in scientific research and technology. The U.S. must not equivocate on global leadership. Continuing to be a global leader with a Nation of approximately 300 million people, in a world with nations of over 1 billion people, will require the U.S. to be an innovative leader in science and technology. Congressman Fattah concluded by saying thank you for all the work you have done—remember that the reward for good work is more work!
 - **Welcoming/Invited Remarks** – Dr. Louis Uccellini, Director, National Weather Service, opened by noting that today’s forecasting success relies to a large extent on the beneficial research done in the 1970’s sponsored through the U.S Weather Research Program and THORPEX (The Observing-system Research and Predictability EXperiment). Through this and other key research projects we were able to provide accurate forecasts for Hurricane Sandy and help the affected areas prepare for an historic storm. In the future, NOAA’s priority will be on the work accomplished through the Hurricane Forecast Improvement Program (HFIP) with focused research and advanced operational computers. Gaps still exist, and better use and combinations of ensemble models is needed. Computational capability is still lacking, and knowledge of hurricane structure and environment still needs to improve. ([Presentation](#))
 - **Panel on the Emergency Response to Hurricane Sandy** –The panel was moderated by Mr. Brian Norcross from The Weather Channel. In his remarks, Mr. Norcross stated that there are still gaps in characterizing and communicating threats to the public and that better communication of the personal risk will motivate people to take appropriate precautions, including evacuating when directed. ([Presentation](#))
 - Captain Thomas Scardino, Executive Officer, Emergency Management Section, New Jersey Homeland Security Branch, noted that emergency managers relied very heavily on the National Weather Service forecasts as they prepared for and reacted to Sandy. They used their experience with Irene and Floyd in past years to update some of their preparations for Sandy. He stated that the use of the phrase “life-threatening weather” caused people to take precautions and evacuate as needed.
 - Mr. Richard A. French, New York State Office of Emergency Management, described the preparations and recovery activities in New York State as Sandy developed, approached, and impacted the area. He praised the partnership their emergency managers have with the National Weather Service. Impact and damage from Sandy was far greater than that of Irene. ([Presentation](#))
 - Both panelists highly praised the NWS forecasts for Sandy. Impact messages helped preparations for and recovery from the storm; it was good science that allowed for movement and prepositioning in life-saving assets well before the onset of strong winds, heavy rain, storm surge, and inundation. There remains a need for a better methodology to assess and communicate risk and probable impact at the individual level. Users of weather information still desire improved communication of confidence level in a forecast, more accuracy, and more lead time, particularly for the onset of 35 and 50 knot winds.
- **Session 1: Tropical Cyclone Research, Federal Agency Overview.** John D. Murphy, Director, Office of Science and Technology, National Weather Service, moderated a panel of senior leaders from NASA, the U.S. Navy’s Office of Naval Research (ONR), NOAA’s Hurricane Research

Division (HRD), NOAA's Earth System Research Laboratory (ESRL), and the National Science Foundation (NSF). The panel highlighted that collaborations and partnerships are productive and apparent throughout the tropical cyclone research community; that focused observations improve forecasts and warning; the track forecasting goals set in the Pacific theater in 1984 were met; HFIP clearly bridges research and operations; and intensity change still remains the number one priority in TC research. Gaps include national ensemble prediction capability; science knowledge in ensembles; characterizing uncertainty in predictions; and the education of the next generation of scientists and researchers. ([Dr. Kaye's presentation](#), [Dr. Ferek's presentation](#), [Dr. Marks' presentation](#), [Dr. Morgan's presentation](#))

- **Session 2: Working Group for Tropical Cyclone Research.** Dr. Frank Marks, Director of NOAA/AOML/HRD, and fellow co-chair Dr. Ronald Ferek, ONR, presented a comparison of the 2008/2010/2012 Snapshots of Tropical Cyclone Research and Development. Overall funding and man-year effort for TC R&D increased from 2008 to 2010, and decreased from 2010 to 2012; funding and man-year effort are still higher in 2012 than 2008. The TC research program is bearing fruit, operational priorities of the forecast centers are being kept up to date, and these priorities continue to influence the supporting research efforts. Intensity change remains the top operational priority. Users would like the research community to take more of an interest in guidance decision tools. There is a gap in how to sustain the program beyond 10 years; an action item was taken to produce a mid-course assessment on the 2007 Interagency Strategic Research Plan for Tropical Cyclones (FCM-P36-2007). ([WG/TCR presentation](#))
- **Sessions 3a/b/c: Federal Modeling Initiatives.** Three sessions were conducted on specifics of various model development, forecast improvements, and science initiatives by Dr. Ronald Ferek, ONR and Dr. Frank Marks, AOML/HRD (3a); Dr. Alexander (Sandy) MacDonald, OAR/ERSL (3b); and Dr. Michael Morgan, NSF (3c). Progress continues in global and regional models and show increasing skill in prediction of tropical system features. HFIP results are working into operations. HWRF has shown improved track, rainfall, and structure prediction skills. Progress continues in global and regional models and show increasing skill in prediction of tropical system features.
 - **Session 3a. The Navy's Model Development and Improvement Program/Hurricane Forecast Improvement Program: Supporting Talks** ([presentations](#))
 - HFIP Vision: Organize the hurricane community to dramatically improve numerical forecast guidance to forecast centers in 5-10 years.
 - Goals: Reduce numerical forecast errors in track and intensity by 20% in 5 years, 50% in 10 years; extend forecasts to 7 days; increase probability of detecting rapid intensification at day 1 to 90% and 60% at day 5.
 - For the 2012 NCEP Operational Models (GFS, GFDL, and HWRF), the GFS reached the 5-year goal level. GFDL and HWRF were close to reaching the 5-year goal, except at 12 hours and then at the longer time period (72 hr and beyond for GFDL and 96 hr and beyond for the HWRF). Upgrades to the 3km triple-nested HWRF in 2012 was the result of multiagency efforts under HFIP support, and produced major improvements.
 - While a lot of work has gone into improving our numerical models, the importance of field programs for model evaluation is critically important. We need field data to conduct evaluations and sensitivity studies to understand what the models are giving us in terms of reality.
 - **Session 3b. Earth System Prediction Capability /Next-Generation Suite of Models: Supporting Talks** ([presentations](#))
 - Earth System Prediction Capability (ESPC) is an interagency collaboration (DOD, NOAA, DOE, NASA, NSF) to coordinate R2O for an extended range earth system analysis and prediction capability at the weather to climate interface. Common prediction requirements and forecast model standards enable agencies to improve leverage and collaboration. ESPC will provide the next generation of operational

environmental prediction service to the Nation in order to meet increasing needs for guidance beyond ten days to decades. Some ESPC efforts directly support improved TC forecasting at sub-seasonal to seasonal time scales.

- NCEP's next generation operational global model has much higher vertical and horizontal resolution – Semi-Lagrangian with improved physics, inclusion of observed sources, and WAM and AQ applications that have an impact on deterministic runs. The analysis makes better use of current data, uses more data and also uses cloud impacted radiances. Collaboration with external groups is expected to enhance the global prediction system.
 - Outcomes from prolonged blocking events or persistent anomalies include flooding, droughts, excessive fires, heat or cold waves, excessive or season-long absent snow cover, and excessive ice cover or lack of ice cover. Human and economic impact increases exponentially with duration of blocking event.
 - Global models in the future need to be non-hydrostatic and capable of providing ultra-high regional details (1-5km) and be scalable to millions of CPUs. The GFDL FV3 is a non-hydrostatic regional-global modeling framework with no spatial or temporal scale restriction. GFDL's high resolution climate model (essentially the same model used for IPCC AR5 assessments) has been demonstrated to possess remarkably high skill for seasonal hurricane predictions. GFDL is exploring the next frontier of global modeling with non-hydrostatic cloud-system resolving capability to provide ultra-high resolution details for regional stakeholders, to resolve, not just hurricanes (easy), but also tornado-producing thunderstorms (difficult for climate models), and seasonal "tornado outbreak risk" prediction.
 - There is an emerging need for next-generation models that are highly scalable and can be used across scales for Earth System Modeling. The model being developed by the Navy is a non-hydrostatic unified model of the atmosphere. Its attributes include a highly accurate and conservative dynamical core, excellent scalability on massively parallel computers, and flexible dynamical core for global or local area problems. Extensive testing and evaluation are already performed and it is a possible next generation model for the U.S. Navy and a candidate for ESPC.
 - The Goddard Earth Observing System Model, Version 5 (GEOS-5) is a system of models being developed in the GMAO to support NASA's Earth science research in analysis, observing system modeling and design, climate and weather prediction and basic research. Its experimental high-resolution forecasts are regularly evaluated against satellite observations to assess the accuracy of the models representation of various physical processes such as the organization of deep convection and the variability of intense rainfall. During Sandy the model produced accurate 5-day track forecasts and its high resolution improved intensity and structure details. The future 4-d data assimilation strategy will be ensemble-based. Questions and answers involved information related to time steps, number of ensemble members and assimilation and resolution issues.
- **Session 3c. NSF Program Initiatives: Supporting Talks ([presentations](#))**
- Data assimilation is key to realizing predictability. There is also no theoretical predictability limit for tropical cyclones. More research should be conducted on predictability.
 - Errors in the HWRF atmospheric initial conditions have greater effect on initial predictability than ocean errors.
 - 48hr tropical cyclogenesis is relatively well predicted. TC genesis requires definition for proper identification in model output and for calibration with NHC best track. Homogeneous ECMWF v. WRF/EnKF comparison shows similar equitable threat scores with little change with forecast time up to 72 hr although the ECMWF is more reliable at lower probabilities; both models under predict the higher TC genesis probabilities.

- WRF prediction lags actual genesis. Surface data assimilation in WRF-ARW using DART scheme improves NWP forecast fidelity of land-falling tropical cyclones.
- An exponential increase in data volume is expected to continue especially with addition of GOES-R, JPSS, Phased Array Radar, and especially high-resolution modeling forecasting up to decades. This will include five data challenges: volume, variety, velocity, views (many consumers), and virtual communities. There is a need to move from creating data to enabling discovery of knowledge community-wide, and industry is ahead of the scientific and government community in many ways. Data management needs greater transparency and attention by the community. All NSF proposals should include data management plans. Data sharing can be increased by providing tools and incentives to change the cultural mindset. Publications should include all the code and data needed for reproducibility.
- **Session 4: 2012 Tropical Cyclone Season in Review.** Representatives of U.S. AFRC 53 WRS, NOAA/AOC, NWS/CPHC, and JTWC presented seasonal summaries. Overall, forecast skill is improving due to improved resolution, observations, data assimilation, and physics. (Session [presentations](#))
- **Sessions 5a/b: Joint Hurricane Testbed Project Updates.** Representatives of NCEP/EMC and NOAA/OAR guided presenters through two sessions detailing JHT updates. Talks were presented on the following topics: SFMR, VORTRAC, automated TC surface wind analysis, probabilistic TC genesis prediction, planned GFDL/GFDN hurricane model updates for 2013, air-sea-wave coupling improvements for 2013, validation of HWRF with satellite observations, SHIPS Rapid Intensification Index and RI improvements using 37 GHz microwave imagery, improvements in statistical TC models, and transitioning a secondary eyewall formation index to operations. JHT process continues to be healthy and productive. (Session [presentations](#))
- **Session 6: Tropical Cyclone Model Development and Technology Transfer.** Representatives from Navy/CNMOC and NWS/OST guided this session. Experimental real-time guidance from the operational HWRF is provided to JTWC for evaluation in the western Pacific. There is an increased use of synthetic observations to represent TC structure. (Session [presentations](#))
- **Session 7: Observations and Observing Strategies for Tropical Cyclones and their Environment.** Representatives from NASA's GSFC and JPL guided this session. Test and evaluations show high utility for observations from future GOES-R, AXBTs, and Global Hawk. The SFMR is providing increasingly useful data for models and forecasts. There is a need for concerted, coordinated effort to advocate and sustain funding in this area. (Session [presentations](#))
- **Session 8: Improvements in Tropical Cyclone Forecast and Warning Products and Services.** Representatives from NWS/OST and USN/NRL guided this session. A multiagency effort led by the OFCM and NOAA with critical assistance from USGS and the Army Corps of Engineers will satisfy the requirements of the 2012 COASTAL Act and will be an effective mechanism to improve the provision of storm surge and inundation information to our customers and stakeholders. Coastal storm monitoring, surge, and inundation forecasting remain important issues for the tropical cyclone community and for the broader government community to continue to address. Much work remains to be done to improve knowledge and application of models and forecast information related to storm tides, surge, flooding, coastal effects, and other storm landfall hazards. There are gaps in regional/local monitoring associated with funding and coordination issues. The COASTAL Act Capabilities Development Plan should be submitted to Congress by approximately 2 April 2013. This will be followed in July 2013 with establishment of a Coastal Wind and Water Event Database, and in December 2013 with the Named Storm Event Model, along with protocols to collect and assemble data. This will enable FEMA to establish a COASTAL Formula by June 2014 in accordance with the COASTAL Act that enables the insurance industry and the National Flood Insurance Program to better identify the insurance claims responsibility for "slabbed" structures. (Session [presentations](#))

- **Session 9: Social Science Applications to the Tropical Cyclone Forecast and Warning Notification Problem.** Representatives of the NWS guided this session. Progress is being made in the use of graphics and other means to effectively convey storm and risk information. Attention is being given by NOAA and other agencies regarding integration of social science methodologies in TC and storm surge products. While progress is occurring, continuing efforts are needed to improve the integration of the social sciences to the arena of operational forecasting and warning. (Session [presentations](#))
- **67th IHC/TCRF Banquet and Richard H. Hagemeyer Award:**
 - The Richard H. Hagemeyer Award is presented annually to honor the memory of the longtime Director of the NWS Pacific Region and patriarch of the IHC until the time of his death in 2001. It is awarded to dedicated supporters of the IHC who have made substantial and long-standing contributions to our Nation's tropical cyclone forecast and warning program. **The winner of the 2013 award was Dr. James D. McFadden, Chief, Programs and Projects at NOAA's Aircraft Operations Center, MacDill AFB, FL.**
 - The award was presented by the three previous award winners who were present at the banquet: Dr. Frank Marks (2005), Mr. Robert Dumont (2008), and Dr. Jim Goerss (2010).

III. SUMMARY REMARKS:

- In person conferences/forums remain the preferred option by the OFCM; however, virtual capabilities enabled the forum to continue despite the inclement weather. While future OFCM conferences/ forums will likely include a "virtual" component to allow for participants who would otherwise be unable to attend, there is simply no substitute for face-to-face interactions and conversations at scientific meetings as part of the peer review process.
- The tentative dates and location for the next IHC/TCRF are still to be determined. During the final plenary session, the Federal Coordinator for Meteorology expressed a desire to hold the next IHC in Miami, FL; however, funding and Federal travel restrictions may continue to be an issue for the next conference.
- A special thanks to Dr. Ronald Ferek, ONR; Dr. Frank Marks, AOML/HRD; Dr. Alexander (Sandy) MacDonald, OAR/ERSL; and Dr. Michael Morgan, NSF—without their support and sponsorship this forum would not have been possible.
- Finally, to the OFCM staff, the UCAR staff, and the NCEP support staff, a note of deep gratitude for their dedicated and tireless efforts which significantly contributed to the success of the forum.