2014 TROPICAL CYCLONE RESEARCH FORUM/ 68th INTERDEPARTMENTAL HURRICANE CONFERENCE SUMMARY REPORT

With superb planning support from NOAA, NASA, NSF, and Office of Navy Research (ONR) representatives, the 2014 Tropical Cyclone Research Forum (TCRF)/68th Interdepartmental Hurricane Conference (IHC) was hosted and chaired by Mr. Samuel P. Williamson, Federal Coordinator for Meteorology, from March 3-6, 2014. The forum had a large "virtual" participation with two primary locations where attendees gathered to participate—the NOAA Center for Weather and Climate Prediction, College Park, MD, and the National Hurricane Center, Miami, FL. This document summarizes the results of the forum as outlined below:

- Section I – Status Summaries for Tropical Cyclone Research Priorities
  - Research Priorities of the Operational Forecast and Warning Centers
  - Observation and Observing System Research Priorities
  - NWP Model Development Priorities
  - Social Science Priorities, Including Warning System and E/PO

- Section II – Overview of 2014 TCRF/68th IHC
  - Purpose and Theme
  - Objectives
  - Highlights
  - Abstracts and Presentations
  - Action Items

I. STATUS SUMMARIES FOR TROPICAL CYCLONE RESEARCH PRIORITIES

The 2007 OFCM report, *Interagency Strategic Research Plan for Tropical Cyclones: The Way Ahead*, included four sets of research and development priorities: (1) priorities for the operational forecast and warning centers, (2) priorities for observations and observing systems, (3) numerical weather prediction (NWP) modeling priorities, and (4) social science priorities for improving the warning system/response and improving education and public outreach (E/PO). Capability improvements achieved and capability gaps identified, as reported at the 2014 TCRF/68th IHC, are summarized below for each of these priority sets.

These summaries of capability improvements and gaps are the key takeaways from the forum will become input to the Mid-Course Assessment of the 2007 *Strategic Research Plan*—the major action item from the forum.

RESEARCH PRIORITIES OF THE OPERATIONAL FORECAST AND WARNING CENTERS

This summary highlights capabilities and gaps specific to the seven storm characterization categories of intensity/rapid intensification, structure, track, sea state/sea height, storm surge, precipitation/inland flooding, or tropical cyclogenesis. Note that capabilities and gaps listed under other priority sets (see below)—particularly observations and NWP modeling—are often relevant to two or more of these categories, but for brevity are not listed here.

Intensity/Rapid Intensification (RI)

Capability Improvements Achieved

- Satellite-based 37 GHz Ring RI Index. A new algorithm that uses microwave images to predict rapid intensification, which has not been well understood or predicted. New capability reduces false alarms and can provide a yes/no–type forecast, but so far has not been effective for capturing the beginning of rapid intensification. First year of real-time testing was done during the 2013 season.
    - The objective-ring identification method appears to be a precursor of RI along with three new microwave predictors.
- Passive microwave imagery at 37 GHz depicts the precipitation structure of the TC inner core. Reforecasts using real-time data from 2004-2012 + 2013 evaluation show microwave-imagery-based predictors improve the already competitive logistic regression-based RI model, especially in the Atlantic. (S5-02, Rozoff et al.)
- The new GFDL model significantly improved intensity skill at all time levels in the Atlantic basin and Eastern Pacific region. Overall, the model reduced intensity bias but had neutral impact on track forecasts.
- JHT has recently completed several projects related to the use of the statistically based rapid intensification index (RII) to improve prediction of RI events. (S5-01, Kaplan et al.)
    - Improved multi-lead-time ensemble-based RI models for estimating probability of RI at 12-h, 24-h, 36-h, and 48-h lead times were developed and tested in the Atlantic and Eastern Pacific basins in real time during the 2013 hurricane season.
    - Verification of 2004-2013 independent RI re-run forecasts showed that multi-lead-time forecasts of individual RI models (SHIPS, Bayesian, Logistic regression) were generally skillful at each lead-time in both basins, with the ensemble-based version proving to be the most skillful overall.
    - New versions of the deterministic rapid intensity aid (IVRI) that employ both probabilistic RI guidance and operational intensity model consensus (IVCN) were developed using ensemble-based multi-lead RI models for the Atlantic and East Pacific basins. An evaluation of the new multi-lead-time IVRI forecasts conducted for the independent 2008-2013 RI re-run sample demonstrated that, on average, the IVRI forecasts exhibited lower means absolute errors and smaller biases than did IVCN in both the Atlantic and Eastern Pacific basins.

Capability Gaps Identified

- Emergency managers are now focusing on 35 and 50 knot thresholds.
    - JHT is working on wind speed probabilities (similar to work being done on storm surge probabilities). This should lead to operational products to help decision makers know when to start evacuations, close schools, etc.
- Accurately forecasting intensity change, especially rapid fluctuations and timing of those fluctuations, remains a high-priority issue.

- For the Western Pacific region, rapid intensification forecasts are still poor (modeling issue); nearly half of the TCs in this region undergo rapid intensification.
- Statistical models of intensity still more reliable than numerical models in Pacific basin.
- JHT plans to explore potential for improving RI model forecasts by including NHC-derived real-time tropical cyclone structural information.

Structure

Capability Improvements Achieved

- 2013 Global Hawk campaign showed improvements in VAD winds and computation speed.
    - Ocean surface wind data is good, though the magnitude of the wind speed deteriorates with precipitation. Not a lot of error unless wind speeds are high.
    - Two techniques, specifically modified for HIWRAP geometry, have been tested in simulations and on observed data for retrieving full three-dimensional wind field.

Capability Gaps Identified

- Continued research into outflow and aerosols is expected to pay dividends in the future.
- Models seem to have persistent problems with upper level winds within TC.
- An analysis of outer vortex wind structure changes during and following Atlantic basin TC secondary eyewall formation found substantial differences for two types of intensification mechanisms (designated as Mode 1 and Mode 2 secondary eyewall formation) in the relationship of expansion of the outer vortex radius of >34-kt winds (R_{34}) to TC intensity increases and decreases during life-cycle stages. The authors concluded that: (1) axisymmetric (and quadrant by quadrant) R_{34} changes are more complicated than a simple conceptual model that directly correlates R_{34} changes to intensity changes, and (2) additional research is required to understand the dynamic and thermodynamic processes leading to the sharpened outer wind profile. (S5-05, Stenger and Elsberry)

Track

Capability Improvements Achieved

- NWS's Hurricane Forecast Improvement Program (HFIP) is showing strong progress in track forecast accuracy, and there are recent improvements in intensity forecast accuracy.
- Track errors in Central Pacific region have improved to 112 nm at 48 hours—the goal is less than 81 nm.
- Track errors in Western Pacific region are improved, but still higher than desired. Results are better in the Southern Hemisphere. The GEFS ensemble track is used for guidance and performs well in the Western Pacific region. It uses a variety of ensembles (answer to audience questions).

Sea state/Sea heights

Capability Improvements Achieved

- NDBC working on improved methods for correcting overestimation of buoy wave height data to yield more accurate data on significant wave heights.

Capability Gaps Identified

- Navy needs coupled models of sea conditions with high temporal resolution and long lead times.

Storm surge

Capability Improvements Achieved

- The SLOSH (Sea Lake and Overland Surges from Hurricanes) model, which is the basis for NWS tropical and extratropical storm guidance, has been improved with respect to its treatment of tides and use of basin characteristics, nesting grids, and gridded wind forcing data. Further improvements are planned. (S5-06, Fritz et al.)
- To meet the short-forecast window (typically a 6-hour forecast cycle) for storm surge and wave predictions, high-resolution, dynamic simulations are needed. To accelerate model throughput with current computing capacity, a research team has investigated use of pre-computed, high-resolution solutions from the full ADCIRC simulation model as "surrogate models" for use in forecasting. The team has an ongoing validation/ verification study (with predictions for surge and waves) against historical events that were not included in the sample used to create the surrogate models. Authors concluded (S5-07, Leuttich et al.):
    - Surrogate modeling approach can fill a storm surge/wave prediction gap between coarse resolution (fast) and high resolution (slow) dynamic models;
    - Their AdcircLite method is simple to run, robust, and fast, once the surrogate model is defined; and
    - Surrogate modeling provides a mechanism to develop large, ensemble-based (probabilistic) high-resolution water-level predictions.

Capability Gaps Identified

- Coastal and inland storm effects such as surge, inundation, flooding, etc., require continued attention.
- There are currently five-six ADCIRC forecasting systems that need to be evaluated for detailed hazard and risk estimation for storm surge, inundation, and waves.

Precipitation/Inland flooding

Capability Improvements Achieved

[See crosscutting improvements listed below, particularly under Observations/Observing Systems Priorities and NWP Model Development Priorities]

Capability Gaps Identified

- Coastal and inland storm effects such as surge, inundation, flooding, etc., require continued attention.

Genesis (Tropical Cyclogenesis)

Capability Improvements Achieved

- EMC investigators expect that the new GEFS (GFS T574L64 Ensemble) implementation will provide more reliable TC genesis guidance for the coming hurricane season. (S5-03, Peng et al.)

Capability Gaps Identified

- The best-performing model for TC genesis forecasts varies from year to year. The Eastern Pacific region is consistent, but there is less consistency in the Atlantic and Gulf of Mexico. Three regression models for genesis events will be ready for testing by June 2014.
    - Four ensembles over-predicted Atlantic TC genesis in 2013. Four ensembles had reliable forecasts for Eastern Pacific TC genesis and a higher hit rate in Western Pacific TC genesis in 2012. (S5-03, Peng et al.)
- Vortex initializations continue to present challenges to the models.

OBSERVATION AND OBSERVING SYSTEM RESEARCH PRIORITIES

Capability improvements

Satellite-based Observing Systems

- NASA Global Precipitation Mission (GPM) was launched successfully, enabling new observational reference standards, increased knowledge, and prediction of climate and water events.
- GEOS-5 and other NASA satellite-based sensors are yielding results on the impact of tropical cyclones on surface CO2 distribution.
- The GOES-R Proving Ground has been effective at informing and educating forecasters on new products they'll be able to use. It enables forecasters to provide feedback to the developers well in advance of an expensive satellite actually being in orbit.
- The VIIRS Day Night Band (DNB) offers substantial benefits for nighttime monitoring/tracking of TCs.
- The determination of an effective measure of daily ocean heat content (OHC) can assist forecasters in anticipating rapid intensification events. Determining OHC by satellite can significantly improve rapid intensification forecasts.

Airborne Observing Systems

- Disaster relief funding obtained after Hurricane Sandy to mitigate gaps in satellite data will fund P3 wing replacements and expanded Global Hawk activities.
- Service life extension plan for NOAA/OMAO P3s ("new" refurbished wings, replaced horizontal stabilizer, and upgraded fuel system, avionics, radar, and engines – 10% more fuel efficient.) More than $40M was made available through the Hurricane Sandy supplemental funding.
    - Sandy Supplemental provided funds for aircraft and engine upgrades of NOAA WP-3D aircraft, leading to longer endurance.
    - Will potentially yield longer flights as well as extend the life of the aircraft.
    - Without Sandy Supplemental funds, would have had to search for funds to make these repairs and upgrades.
- NOAA P3s are undergoing avionics upgrade and increased sensitivity and sampling by the Tail-Doppler Radar (TDR).
- Focused observations have improved forecasts and warnings; enhancing this capability should be explored.
- Pilot study shows that data from NASA's Global Hawk missions have proven useful and valuable for TC research and operations (hurricane analysis and forecasting).
    - Data recorded is very high resolution.
    - Global Hawk data from 2012 has been shown to have positive impacts on modeling and forecasting.
    - Dual-aircraft operations during 2013 demonstrated back-to-back flights were possible. Detailed observations from 4 storms were recorded.
    - 2013 results yielded improvements in data processing, VAD winds, and ocean surface winds.
- High Definition Sounding System (HDSS) provides new expendable digital dropsonde (XDD) capability that offers a new-generation atmospheric profiling system for sampling TCs and outflow/inflow layers in other high-impact weather events. In three validation experiments over 2 years, XDD-measured atmospheric profiles of pressure, temperature, relative humidity, and wind speed/direction were in good agreement with research aircraft spiral descents, conventional RD-94 drospondes, National Weather Service radiosondes, and NDBC moored buoys.

Ocean Observing Systems (Including Air-launched Systems)

- Research reported by the ocean community showed great promise to improving TC forecast of track and intensity because of increased types and accuracy of ocean data in the TC environment.
- AXBT Demonstration Project has goal of increasing hurricane forecast accuracy by assimilating ocean observations from beneath TCs (using AXBTs) into coupled ocean-atmosphere models in near-real time.

    - AXBT observations from Hurricanes Ernesto and Isaac in 2012 revealed important subsurface temperature departures from climatology.
    - Observing system experiment (OSE) examined the impact of AXBT data on coupled COAMPS-TC forecast. Inclusion of the AXBT data assimilation yields a maximum 1°C reduction in the 24-hour model SST forecast errors. Exclusion of the AXBT data from COAMPS-TC led to the westward displacement in the modeled position of the Gulf warm core eddy when compared to observations. Conclusion: AXBT data integration into COAMPS-TC had a large positive impact on reducing sea surface temperature model forecast errors. Integration of AXBT data also improved track forecasts.
- USAF 53WRS's AXBT portable launching system is being replaced with a fixed system. This will reduce need to install/configure a launcher for operations.
- Targeted ocean temperature/current profiles are important for improving ocean-atmosphere coupled models and for resolving mixing and 3-D upwelling issues.
    - Upgrades/fixes to Airborne Expendable Current Profilers (AXCP) have corrected structural failures and increased data accuracy.
    - The goal is to effectively assimilate 3-D ocean temperature data into models in order to understand oceanic impact on hurricane intensity changes. But deeper ocean temperature profiles are necessary to initialize ocean models.
    - 3-year project to observe upper ocean temperature in order to enhance/improve track and intensity forecasts and reduce error in initialization of ocean models.

Capability Gaps Identified

- Navy has the following observational gaps: wave heights, surface winds, and microwave radiances.
- Navy needs global imagery to fix tropical cyclone center positions.
- Acquiring real-time observations may increasingly become a challenge in the current fiscal environment; efforts to pursue nontraditional observing strategies such as Global Hawk and further developing and improving others like airborne expendable bathythermographs (AXBTs) is crucial.
- Continuing work on satellite-based 37 GHz Ring Rapid Intensification Index. Real-time data access has been requested for the 2014 season; team will continue to adapt algorithm to increase forecast accuracy and reduce false alarm ratio.
- Global Hawk operational constraints and capability improvements needed:
    - Global Hawk operations limited to Atlantic basin; audience member asked about using Global Hawk in Eastern Pacific during possible 2014 El Nino.
    - Improvements needed in onboard processing (wind products, Doppler data, ocean surface wind, Doppler pulse pair), Ku-band transmitter power, improved real-time data, and remote sensing.

- Study of Hurricane Irene intensity established significant effect of turbulent mixing below the thermocline on the hurricane's intensity. One-dimensional models cannot capture the 3-D processes involved. Conclusion: 3-D modeling will be increasingly valuable for intensity forecasting, especially as a TC approaches landfall.

NWP MODEL DEVELOPMENT PRIORITIES

Capability Improvements

- Advances in NWP for tropical cyclones point to future improvements in forecasts for track, intensity, rapid intensification, and genesis.
    - Worldwide air-sea interaction (wave-air-ocean) models are undergoing improvements resulting in greater fidelity. Explicit wave coupling is next for HWRF and GFDL/GFDN.
- HWRF improvements (from Session 4)
    - 2014 HWRF is configured with higher vertical resolution and increased model top. Further enhancements forthcoming to model physics and to data assimilation.
    - Preliminary results indicate significant improvements in track and intensity for Western Pacific (similar performance noted for Atlantic and Eastern Pacific basins). HWRF ready for operational use in Pacific basin due to its high reliability.
    - HWRF ensemble is outperforming deterministic models. Also, ensemble means seem to do better than observational methods
- The Joint Hurricane Testbed (JHT) and the Developmental Testbed Center (DTC) continue to provide excellent new technologies and techniques for the TC forecast centers.
    - A multiple linear regression analysis technique has been developed and /tested for predicting real-time model forecast error. Objective is to yield a more reliable model, as existing operational TC forecast models have been inconsistent. Work is being done under the JHT.
    - The operational model for Monte Carlo wind speed probabilistic prediction is being improved to give better time interpolation, new arrival and departure estimates of high winds, extension of the model out to 7 days, and other software upgrades. The 2014 season will be used to compare performance of the updated model with the current version used operationally at the National Hurricane Center (NHC).
    - During the 2014 season, the JHT will conduct an operational evaluation of the new optimized multi-sensor application in the Automated Rotational Center Hurricane Eye Retrieval (ARCHER) application, whose purpose is to provide a tool for automated real-time fixing of a TC's center (hurricane eye). The new application is expected to improve on current NHC real-time analysis capability by about 30 percent..
- NSF support of basic research for TC requirements in observations, modeling, and prediction is increasingly productive and beneficial to the Nation.

- NSF has plans to support development of a university-based ensemble effort that includes better use of forecast uncertainty in the context of socioeconomic benefit.
- The HWRF regional ensemble provides some substantial improvements compared with the GFS ensemble.
- GFDL/GFDN models are undergoing significant upgrades in 2014, including modified bulk coefficients that impact intensity and intensification performance.
- COAMPS-TC was transitioned to Navy operations in 2013. Intensity forecasts from the model verified well in 2012-2013 for the Western Atlantic and Western Pacific. Skill issues related to spin-down, rapid intensification, and track are being addressed. Development of an advanced COAMPS-TC is underway.
- JPL is developing a system to provide fusion of models and observations from all sources (satellite, airborne, in situ) into a common system and developing online analysis and visualization tools. This capability, when developed, will help to improve representations of physical process and their interactions in models, in order to achieve the HFIP goals of improving forecast accuracy of intensity, track, and impact at landfall. (S5-04, Hrisovo-Veleva et al.)

Capability Gaps Identified

- The operational centers desire further development of forecaster guidance decision tools.
- Models seem to have persistent problems with upper level winds within TC.
- Differences in model physics account for large model intensity differences.
- Ensembles are a key factor in continued forecast skill improvements and need greater focus.
    - But a capability gap is proper design of ensembles so members have equal skill probability. (from Session 4)
- Navy needs five to ten day outlooks of clouds, seas, and winds. Model performance beyond day four or five often drops sharply. Model performance after day five suffers from too few cases.
- Major 2014 upgrades are planned for the GFDL/N and HWRF ocean model components.
    - POM-TC is being replaced with MPIPOM-TC. Alternative MPIPOM-TC ocean initialization options are being evaluated and tested for future implementation.
    - A fully coupled atmosphere-wave-ocean framework has been developed for the GFDL/N and HWRF models to explicitly resolve effects of wind-wave-current interactions. The next step is to investigate the influence of explicit wave coupling on hurricane prediction. Near real-time test runs are planned in 2014.
- The DTC supports R2O strategies through code management and visitor and user support. Moving forward, DTC plans to partner with HFIP principal investigators (PI) to facilitate adding innovations to HWRF and conducting testing. Recent results suggest that a closer partnership is needed because innovations need to be tested, tuned, and retested in the HWRF context.

- A capability gap exists for skillful tropical cyclone genesis forecasts. (Session 4)
    - Differences in the ratio of convective to total precipitation are too low on models, affecting TC genesis prediction.
    - Genesis problem invites new ways to classify model tropical cyclones.
    - Since 2013 had weakest ACE index in the Atlantic, it is difficult to make much of the TC genesis model performance.
- There will be a funding shortfall for JHT projects this year.
- There is insufficient computing power to run operational HWRF ensembles in all basins.

SOCIAL SCIENCE PRIORITIES FOR IMPROVING THE WARNING SYSTEM/RESPONSE AND IMPROVING E/PO

Capability Improvements Achieved

- Tropical cyclones occasionally form, strengthen, and affect land within the current 36- to 48-hour watch/warning lead time. Currently, NHC does not have the capability to issue tropical storm or hurricane watches/warnings before TC formation. To address this gap, NHC is exploring options for enhancing its *Tropical Weather Outlook* product to provide TC watches/warnings prior to storm genesis. Although the enhanced products would not incorporate track or intensity forecasts, it could increase public awareness. But there are also concerns about forecast skill and possible public confusion to be addressed (e.g., if track and intensity information is not included). (S6-01, Brown et al.)
    - For 2014, a new ***Graphical*** *Tropical Weather Outlook* will be developed for both 48-hour and 5-day "outlook" windows.
    - NHC is requesting feedback on the concept of issuing watches/warnings before TC formation.
- Over the past 5 years, progress has been made on displaying for a lay audience storm surge predictions from SLOSH. The objective is to address failure of the public to understand and react appropriately to storm surge information in basic hurricane advisories. A SLOSH simulation is combined with elevation (GIS) and tidal data to overlay equivalent water depth on photographs of familiar landmarks. A survey was conducted to assess subjects' understanding of hurricane physics, effects, and uncertainties before and after they had access to an interactive website that showed effects of hurricanes at different categories/storm surge predictions on the selected landmarks. (S6-02, Lindner et al.)
- The TCV and Hurricane Local Statement (HLS) warning products have been reviewed for format and language problems that lead to confusion and miscommunication. A study team has concluded that the improved versions of these products are ready for final versions. However, the combined Potential Impacts Map and TC Hazards Assessment bar graph would benefit from further R&D. (S6-03, Morrow et al.)
- CASA has been conducting real-time experiments with an Integrated Warning System Testbed through which local jurisdictions and private companies can access password-

protected websites with high spatiotemporal resolution observations/nowcasts. The infrastructure delivers user-centric, context-aware warnings aimed at improving public response to severe weather events. (S6-04, Phillips)

Capability Gaps Identified

- Characterizing forecast uncertainty in ways that can be understood by the public is important.
- With respect to the education pipeline, it is critical to continue to challenge the next generation of scientists and researchers; there is much more to be done.
- Due to budget cuts, all Air Force public shows were cancelled last year (impact on public E/PO when civilian events are restricted).
- Public has poor understanding of the risk associated with hurricane surge. Standard floodzone maps are not effective for most people. (S6-02, Lindner et al.)

II. 2014 TCRF/68th IHC 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: Assessing the Past--Planning for the Future*."

Objectives:

- Assess the progress in addressing the research priorities of the operational centers (NHC, CPHC, and JTWC).
- Review the transition of research into operations activities at the Joint Hurricane Testbed, the Developmental Testbed Center, and FNMOC.
- Explore the technologies and strategies to improve the observation of tropical cyclones.
- Review the ongoing work and initiatives to improve the numerical modeling of tropical cyclones.
- Investigate the application of social science to the TC forecast and warning notification problem.

Highlighted features of this TCRF/IHC:

- For the second time, the forum had a large "virtual" attendance, with attendees participating via the internet, using "GoToMeeting" and teleconferencing.
- There were 293 total registrants; 73 registered to attend in person at two primary locations and 220 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 Monday, March 3, the Working Group session was conducted exclusively in the "virtual" mode and the day's agenda was successfully accomplished. On Tuesday, March 4, the forum was conducted from the Federal Coordinator's Office in Silver Spring, MD; part of the staff participated on-site with conference attendees at the NCWCP.
- Mr. John Pavone, Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH), was named the 2014 Hagemeyer Award winner.
- It was pointed out by several participants that a significant loss of interaction occurred when the meeting has a large "virtual" attendance.

The forum sessions addressed the following subject-matter areas:

- *The Research Priorities of the Operational Centers (to include local forecast offices)—specific topics include:*
  - Intensity/Rapid intensification
  - Structure
  - Track
  - Sea state/Sea heights
  - Storm surge
  - Precipitation/Inland flooding
  - Genesis
- *Observations and Observing Strategies—specific topics include:*
  - Satellite applications (geostationary and polar orbiting)
  - Aircraft reconnaissance (GPS dropwindsondes, airborne Doppler radar, SFMR)
  - Unmanned aircraft systems (UAS)
  - Upper-ocean observations/profiles (AXBT, AXCTD, AXCP)
  - Autonomous underwater vehicles (AUV)
- *Federal Numerical Modeling/Data Assimilation Initiatives, to include the following program areas:*
  - NOAA's Hurricane Modeling Initiatives/Hurricane Forecast Improvement Program (HFIP)
  - The Navy's Model Development and Improvement Program
  - NSF program initiatives, to include the University-based National Ensemble Program
  - Earth System Predication Capability (ESPC)/Next-Generation Suite of Models
- *Transitioning Research to Operations*
  - Joint Hurricane Testbed: Project Updates and Plans for the Future
- *Social Science Research Results/Demonstration Projects*
- *Special Session to Summarize Assessment Results and Propose Plan of Action*
- *Closing Plenary Session*

Abstracts and Presentations:
Abstracts for presentations that were given at the forum can be found at: http://www.ofcm.gov/ihc14/final%20booklet.pdf. Presentation slides may be viewed at: http://www.ofcm.noaa.gov/ihc14/68IHC-Linking-File.htm

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, 2014.
- The OFCM will initiate a Mid-Course Assessment, to be completed by the WG/TCR, on the *Interagency Strategic Research Plan for Tropical Cyclones: The Way Ahead* (FCM-P36-2007).