

AOML Transfer of Research to Applications/Operations
Some Examples From the Past, Present, and Future

	A	B	C
1	Project Title	Brief Description	Customer(s)
2	INSTRUMENTS		
3	Step Frequency Microwave Radiometer (SFMR)	tested and proved reliable in tropical storms	NHC, EMC
4	Dropwindsondes	first instrument that provided wind and thermodynamic profiles in the hurricane eyewall and revolutionized hurricane science.	NHC, EMC
5	The Hurricane Imaging Radiometer (HIRad)	sensor for hurricane observations that is currently under development by NASA and HRD. HIRad is being designed as a next generation SFMR (Stepped-Frequency Microwave Radiometer) to enhance the real-time airborne ocean surface winds observation capabilities of hurricane hunter aircraft currently using the SFMR. Unlike SFMR, which measures wind speed and rain rate along the ground track directly beneath the aircraft, HIRad will provide images of the surface wind and rain field over a wide swath.	NOAA and USAF Weather Squadron hurricane hunter aircraft
6	Doppler Wind Lidar (DWL)	be performed at HRD will address the most important gap in the present observing system for numerical weather prediction (NWP) --global wind profiles. Based on previous forecast impact tests with simulated and actual (airborne) DWL measurements, the use of ADM global wind profiles and those from the follow-on U.S. mission are expected to improve NOAA NWS weather forecasts. For example, lidar wind profiles can be used to improve the depiction of the large-scale steering current, which is critical to accurate hurricane track forecasts, and to improve the analysis of vertical wind shear, which in turn affects the hurricane intensity forecasts.	ADM launch evaluation will feed into the design of the more-capable U.S. space-based lidar winds demonstration mission planned for 2013. Data from ADM and the U. S. lidar winds demonstration mission are expected to be used in the NOAA NWS operational NWP models after evaluation.
7	CO2 in Surface Sea Water	developed automomous, continuous underway instrumentation for measuring dissolved CO2 in seawater, deployed on volunteer observing ships, research ships, etc.	climate and oceanographic researchers; Chinese gov't; possible application to ocean acidification; now available commercially from General Oceanics

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8	Electrochemical Sensor Development	developing electrochemical sensors to detect DNA associated with human pathogens more quickly and in the field (versus long laboratory studies)	Alderon (industrial partner in sensor development), ultimately state departments of health and Federal and state departments of environmental protection
9	Continuous Underway Amonium Sensor	developed continuous underway instrumentation for measuring amonium at extremely low levels (sub ppb) in seawater, deployed on research ships, etc.	ultimately, state departments of health and Federal and state departments of environmental protection
10	Continuous Underway Fish Egg Sampler	adapted a continuous underway fish egg sampler (CUFES) to increase the volume to 500L per minute and incorporation of a synced-frame video recorder	NMFS
11	Oceanographic Sensor for Biological Tow System	adapted the standard 4-sensor MOCNESS to 8-sensors	NMFS
12	Zooplankton Silhouette Video System	developed a towed underwater silhouette video camera system for detection of zooplankton in concert with net tows	NMFS
13	Low-level Nutrient Measurement Process Using Liquid Waveguide System	AOML described in peer-reviewed literature a new measurement process that allows a two order of magnitude improvement in the measurements of nutrients. Private industry took the guidance from the publication and constructed a new device that is now widely used in nutrient measurement	EPA, the State of Florida, civic municipalities
14	"Mini-drifter" to Track Currents in Very Shallow (1-3 m) Waters	designed and produced a "mini-drifter" for use in tracking the currents in very shallow (1-3 m) waters. These drifters are approximately 1 ft in diameter, and are tracked via satellite	scientists, Florida Keys National Marine Sanctuary
15	Real time Spar Buoys for Measurements in Shallow Waters	designed and produce spar systems on which to mount atmospheric and oceanic sensors in a shallow coastal environment for real-time transmission via satellite (CREWS, Looe Key)	scientists and coastal resources managers
16			
17			
18	PRODUCTS & METHODOLOGIES		

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19	Statistical Hurricane Intensity Prediction Scheme (SHIPS)	developed to provide operational intensity prediction guidance in the Atlantic and E. Pacific basins	NHC
20	Rapid Intensification Index (RI)	estimates of the probability that a tropical cyclone will undergo rapid intensification, a problem that the National Hurricane Center has named as their number one forecast priority	NHC
21	The HRD Hurricane Wind analysis System (H*Wind)	real-time and retrospective surface wind field analyses; one of the main validation data sets used in high resolution model development for hurricane prediction.	emergency managers, U.S. Army Corps of Engineers, insurance companies, university and government scientists in meteorology, physical oceanography and ecology.
22	Drag Coefficient in Extreme Winds	analyzes GPS sonde profiles from hurricanes and uses parameterizations in numerical weather, storm surge, and wave models.	NWP models
23	Synoptic Flow/Surveillance	GPS dropwindsonde observations in the environment surrounding a tropical cyclone improves model track forecasts; acquisition of the NOAA G-IV and operational synoptic surveillance missions	NHC
24	Targeted Observations	dropwindsonde data in the environment leading to 15-20% improvements in operational model track forecasts [smaller than Burpee (1996) due to the rapid increase in satellite observations]	NHC
25	five-day CLIPER (CLImatology & PERsistence) model (CLP5)	model as baseline for 5-day track forecasts	NHC, JTWC
26	EDITSONDE	software to operationally quality control dropwindsonde data on NOAA aircraft before transmission to NHC. This remains the best tool to analyze profiles in the eyewall.	NOAA aircraft, NHC
27	ASPEN-2: ASPEN/EDITSONDE Unification	workstations to quality-control dropwindsonde data before transmission to NHC and assimilation into models, using EDITSONDE, developed at HRD specifically for hurricanes. Other aircraft use a different system, ASPEN, which has difficulties in hurricanes and, in some cases, provides different data than EDITSONDE. A unification of these two systems is underway.	NHC

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28	Assimilation of Humidity from Dropwindsondes	GPS dropwindsonde humidity data assimilated into the NCEP models	NCEP
29	Observing System Simulation Experiments (OSSE)	hurricane surface wind analysis	JCSDA, NASA, DOD, and ultimately NHC
30	Utilization of NEXRAD Radar Data in Landfalling Hurricanes	techniques to deduce wind structure in landfalling hurricanes from the operational NWS Doppler radar network. These techniques have been applied to post storm analyses of storms like Katrina and Wilma of 2005. This work laid the foundation for the recent implementation of a real time Doppler-based central pressure estimation technique by NCAR scientists at NHC	NHC
31	Improved Rainfall Parametric Models	impact of vertical shear on the prediction of tropical cyclone rainfall to explain more of the variance of TC rainfall	NHC
32	Storm Surge	Water), made the calculations, quality controlled the data, and produced the reports that are disseminated to the emergency management community for evacuation planning	Federal, state, and local emergency managers
33	Hurricane Heat Potential	hurricane heat potential index based on satellite altimeter data. This provides a more robust estimate of the energy available in the ocean for hurricane intensification. The index is used as a predictor in the operational SHIPS model	JTWC
34	Reanalysis of Hurricane History	updated and corrected NHC's historical hurricane database of tracks and intensities (HURDAT), based on current knowledge, and extended the history back to 1851. This history is critical for addressing issues such as the relationship between global warming and hurricanes.	climate scientists, insurance industry

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35	Seasonal to multi-decadal hurricane forecasting	characteristics of the multi-decadal fluctuations in Atlantic hurricane activity and furthering understanding of the physical mechanisms involved in the relationship between ENSO and hurricane activity. Other insights that have contributed to the Outlooks include the negative correlation between Atlantic and Eastern Pacific activity, the significance of early season activity in the deep tropics as an indicator of peak season activity, characteristics of October activity, and the impacts of the evolution of the hurricane observational methodology on storm counts for each year. HRD scientists were the first lead authors of the Outlooks, have participated in the Outlooks since they started in 1998 and continue to contribute each year to the ongoing scientific discussions involved in producing the	NHC
36	Unmanned Aircraft Systems (UAS)	led an effort in summer 2005 that resulted in the successful observations at low levels in Hurricane Ophelia. These low level observations are important for prediction, and cannot be obtained by manned aircraft. HRD is working to develop all parts of the operational UAS that will be needed.	NHC, EMC
37	P-3 Tail Doppler Radar	perform quality control of P3 Doppler radar radial velocities aboard the aircraft and transmit analyses from P3 aircraft to the ground for viewing by hurricane specialists and as input to H*Wind	NHC, EMC
38	G-IV Doppler Radar	Development of quality control and analysis software to work with new G-IV tail Doppler radar and Sigmet RVP-8 processing software is underway at HRD.	NHC, EMC
39	Transmission of Tail Doppler Radar	The quality-controlled Doppler radial velocities will be transmitted via satellite link to EMC for assimilation into HWRF model.	NHC, EMC
40	Assimilation of Tail Doppler Radar	Development of techniques is underway at HRD to best incorporate tail Doppler radar data in operational forecast models.	NHC, EMC

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41	Rainfall Validation in Operational Models	in conjunction with GFDL and EMC scientists, HRD developed new validation metrics for TC (tropical cyclone) rainfall that enabled a clear identification of operational model (i.e., GFDL, GFS, NAM) biases with respect to TC rainfall. These evaluations will lead to improvements in the specification of microphysical processes and rainfall forecasts from these and similar operational models.	EMC
42	New Rainfall Parametric Models	HRD, in conjunction with GFDL, will continue to develop improvements to the parametric rainfall models, including adding the impact of topography and extra-tropical transition to rainfall predictions. Ensemble methods for rainfall prediction will also be developed.	
43	Empirical Decay Model	The utility of using the Kaplan/DeMaria empirical decay model to provide real-time estimates of the maximum wind and 64.50 and 34 kt wind radii of landfalling tropical cyclones is currently being evaluated as part of the Joint Hurricane Testbed (JHT).	NHC
44	State of Florida Public Hurricane Loss Model	developed the wind field model and lead the meteorological development with university partners. Model was certified by Office of Insurance Regulation in August, 2006, and will be used as a baseline for wind storm insurance ratemaking.	State of Florida, insurance industry, emergency managers
45	New Scales for Hurricane Destructive Potential	Hurricane Katrina showed limitations in the Saffir-Simpson scale. New scales have been developed based on the integrated kinetic energy associated with damaging winds in hurricanes.	insurance industry, emergency managers
46	Boundary Layer Parameterizations	continued analysis of CBLAST measurements and dropsondes will provide new boundary layer parameterizations for heat and moisture flux and boundary layer depth.	
47	New Verification Technique for Intensity Forecasts	currently, if either a model forecasts dissipation before it occurs, or if the model does not forecast dissipation and it does occur, the forecasts are not verified. A new technique is under development to verify these forecasts with the other forecasts.	NHC

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48	Addition of "Off-Time" Land-Based Data	NHC requests off-time (06/18 UTC) rawinsonde data within 48 h of prospective landfall events. An extension of the targeted observation techniques to optimally and most cost-effectively implement this is under development.	NHC
49	Saharan Air Layer	cooperative effort with scientists from the Naval Research Laboratory and NOAA NESDIS to incorporate total precipitable water (TPW) data derived from microwave satellites into the NOAA Statistical Hurricane Prediction System (SHIPS). TPW data is an effective tool for tracking dry layers such as the Saharan Air Layer, which can suppress the intensification of tropical cyclones. Preliminary results indicate that TPW data markedly improves tropical cyclone intensity forecasts produced by the SHIPS model.	NHC, EMC, WFOs
50	AXBT - Aircraft Expendable Bathythermograph Data (water temperature with depth)	these are being used to initialize ocean models for the coupled HWRF system. HRD is also expanding AXCTDs (Aircraft Expendable Conductivity-Temperature-Depth instruments) to include salinity data for the model.	HWRF (Hurricane Weather Research Forecast) Model
51	Mean Atmospheric Soundings for the Tropical North Atlantic and Caribbean Sea	as the Saharan Air Layer moves through the tropical North Atlantic, Caribbean Sea, Gulf of Mexico, and Central America each summer, it replaces the ambient moist tropical atmosphere with air that is ~50% drier than the "normal" tropical environment. HRD scientists are using satellite imagery and thousands of Caribbean rawinsondes (balloon soundings) to identify these dry layers and create a new set of mean atmospheric soundings for the Atlantic basin.	Climatologists

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52	Advanced Weather Research Forecasting Model (WRF)	mesoscale modeling system. HRD/AOML is further developing the operational HWRF/WRF-NMM modeling system. For improving numerical forecasting of track and intensity, this includes: (i) Advancing the WRF-NMM core for hurricane forecasting, down to about 1 km; (ii) Advancing the WRF-NMM modeling system for improving forecast of the vortex scale motions; (iii) Advancing the system with multiple options of physical parameterization schemes; (iv) Determining the value of high-resolution versus ensembles forecasts. A version of the WRF model called the HWRF/WRF-NMM modeling system, developed at NCEP (Gopalakrishnan et al, 2006) was recently adopted for operational hurricane	NCEP
53	Adaptive Hurricane Landfall Observing System	in order to sample catastrophic extreme events, working with several partners, aircraft and robust portable tower assets are deployed in areas expected to receive damaging hurricane winds, waves, and surge. Real-time analysis products are then generated to help guide response and recovery operations by emergency managers.	emergency managers
54	Organization of Peak Winds	An investigation of dropwindsonde, flight-level, and Doppler radar data can shed light on the impact of eye and eyewall meso- and miso-cyclones on extreme hurricane events including rapid intensification.	NHC, emergency managers
55	Inner-Core Structure and Dynamics Related to Rapid Intensification and Genesis	play a lead role in investigating the convective and mesoscale processes important in genesis and rapid intensification, including convective and stratiform dynamics and the interaction with the vortex-scale circulation. This improved understanding will lead to improvements in the ability to model and predict these processes.	EMC

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56	Statistical Model for Genesis	will co-develop a statistical model that will identify the probability of tropical cyclogenesis given various parameters pertaining to features such as the convective structure and the mesoscale and synoptic-scale environment. Such a statistical model can be used in a fashion similar to how SHIPS is currently used for tropical cyclone intensity forecasting.	NHC
57	Improved Rapid Intensity Index	will continue research to improve the rapid intensity index that is employed operationally by the National Hurricane Center. Specifically, total precipitable water, which can provide improved estimates of atmospheric moisture water will be tested as a predictor in the rapid intensification index. In addition, research to develop new predictors that better estimate the transfer of heat and moisture from the ocean surface will be conducted to determine if they can improve the rapid intensity index (RI), and the utility of developing RI predictors based upon output from the 3-dimensional HWRF hurricane model will be tested.	NHC
58	Optimal Observing System for Hurricane Prediction	developing an advanced OSSE (Observing System Simulation Experiment) system and will be conducting both OSEs (Observing System Experiments) and OSSEs to define the optimal observing systems and sampling strategies to improve hurricane track and intensity forecasting. AOML co-developed the prototype for this system and has conducted several (the only) preliminary hurricane OSSEs.	JCSDA, NASA, DOD, and ultimately NHC
59	Observing System Experiments (OSEs)	dropwindsonde data from the global data assimilation system within 111 km of the storm center can lead to 15-20% improvements in hurricane track forecasts in the global and regional hurricane models.	NHC, EMC

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60	Development of an Optimal Ensemble Forecasting System for Hurricanes	diversity in initial, boundary conditions and physical parameterization schemes provide a suite of members for ensemble predictions for hurricane track and intensity forecasting. HRD will develop the perturbation and breeding techniques necessary to extend the current WRF ensemble system for tropical cyclone prediction, which is well adapted as a test bed for ensemble forecasting.	WRF
61	SANBAR	The first operational dynamical model; HRD helped to develop the analysis scheme and the model.	NWS
62	VICBAR/LBAR	high-resolution spectral barotropic model replacements for SANBAR.	NWS
63	Assays for Fecal Contaminants in Coastal Waters for Multiple Source Tracking	developing assays for fecal contaminants in coastal waters for multiple source tracking (human, canine, avian, bovine, etc.)	Luminex (industrial collaborator), ultimately state departments of health and Federal and state departments of environmental protection
64	DNA Hybridization Assay in Microplate Format	developed a DNA hybridization assay in microplate format (in partnership with UMiami), technology underwent market analysis which determined that the best mode of technology transfer was a web portal to provide detailed instruction to do-it-yourself end users	CICEET (Cooperative Institute of Coastal, Estuarine, Environmental Technology), environmental scientists
65	Technical Guidance for Characterizing Waste Water Plumes in Coastal Waters	developed technical guidance recently implemented by the EPA for characterization of waste water plumes in coastal waters	EPA
66	Low-level Nutrient Analysis Techniques	developed methodology for low-level nutrient analysis (NO ₂ , NO ₃ , SiO ₄ , PhO ₄) that has been adopted by the EPA	EPA
67	Salinity Estimates from Temperature Data	developed a methodology for estimating salinity from measurements of temperature. This technique is particularly valuable when data from XBT, which measure temperature but not salinity, are being assimilated into numerical models or being used to infer heat and mass transports that are important for understanding the climatic system	Scientific and Operational Communities

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68	Probability Index of Future Atlantic Multidecadal Climate Regime Shifts	developed a statistical technique for estimating the probability of future Atlantic multidecadal (AMO) climate regime shifts based on the distribution of climate regime intervals in tree ring reconstructions of climate indices. This is potentially useful for organizations with long-horizon planning needs. A related decision-support tool and the principles behind it have been presented to and discussed with water engineers at several water management districts in West Palm Beach, Tampa and St. Johns River. In a marked departure from historical practice, the South Florida Water Management District now considers these probabilities in its 20-year water plans, renewed at 5-year intervals as mandated by Florida statute.	The South Florida Water Management District (SFWMD)
69	Climate Indices	developed climate indices for the Atlantic Multidecadal Oscillation, the Western Hemisphere warm pool and the tropical Atlantic that are now maintained and posted by NOAA ESRL. Indices are being updated in quasi-real time by ESRL under AOML guidance.	Scientific and Operational Communities
70	Heat Budget Computation Routine	developed a routine for heat budget calculation using HYCOM, a state-of-the-art Ocean General Circulation Model developed at the University of Miami. The complexity of the model's vertical coordinate prevents the users from performing accurate heat budget analysis. As a part of the NOAA project on modeling Western Hemisphere Warm Pool, AOML developed a heat budget computation routine that uses the exact definition of each heat budget term insuring zero residual	Naval Research Laboratory (NRL) currently use this routine for modeling the upper ocean response to Hurricanes
71	Oceanic CO2 Data Bases	CO2, both at surface and at depth is collected from all available sources	climate scientists
72	Florida Current Daily Transport Estimates	Florida Current daily transport estimates derived from processing of the minute voltages recorded on an underwater cable	Scientific and Operational Communities
73	Quarterly State of the Ocean Reports	Quarterly State of the Ocean Reports on Meridional Oceanic Heat Transport in the Atlantic Ocean, Global Heat Storage, and Global Surface Currents	Scientific and Operational Communities

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74	Near-real-time Quality-controlled Drifter Measurements	drifter Data Assembly Center (DAC) produces a quality-controlled data set of drifter measurements (zonal and meridional speed and sea surface temperature), interpolated to regular quarter-day intervals. Data is made available in near real time via the Internet. Also, web-based distributed products show the surface current variations in maps and animations and show the current distribution of the drifter array	Scientific and Operational Communities including NCEP, USCG International Ice Patrol, and Educators
75	Real-time Upper Ocean Surface Currents Derived from Satellite Altimetry	real-time fields of surface currents derived from satellite altimetry are developed and distributed via the web	Scientific and Operational Communities, Volvo Ocean Race
76	Argo 'Operational' Products for US Argo Floats	as the US Argo Data Acquisition Center products are produced and posted on the web in near-real time: * performance plots by float: trajectories, sections, profiles (sections and profiles are available for temperature, salinity and oxygen, depending on what the floats measure), temperature/salinity diagrams, pressures at the drift depth, the bottom of the profile and the surface, battery voltage; interactive maps (annual by deployment, and current float array) provide access to float-specific trajectory and section plots. * performance plots for float array: float trajectories by ocean and global. * value-added (scientific) plots: monthly mixed layer thickness, temperature and heat storage in the Atlantic Ocean based on gridded fields from all floats.	Scientific and Operational Communities
77	Real-time Quality Control of XBT and Argo Float Data Before Submission to the GTS	real-time quality control of XBT and Argo float data before submission to the GTS for use in seasonal and interannual forecasts	Operational Forecast Centers
78	Real-time Surface Salinity Technology, Data Transmission, and Quality Control Tools	developed the technology, data transmission and quality control tools for providing real-time surface salinity data to the operational centers which use the data to initialize seasonal-to-interannual climate forecasts	Operational Forecast Centers
79	Expert System for Data Integration and Forecasting	developed an artificial intelligence, expert system to integrate global coral reef data to monitor coral health and predict severe events such as coral bleaching	scientists, coastal resource managers

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80	Shipboard Environmental Data Acquisition Software (SEAS)	developed the Shipboard Environmental data Acquisition Software (SEAS) enabling collection of surface marine and subsurface oceanographic data from a variety of instrumentation and the data aboard commercial ships, which are sent via satellite back to NOAA laboratories for analysis.	USCG, Operational Forecast Centers