



# Joint Hurricane Testbed

Transitioning from Research to Operations

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Shirley Murillo - NOAA/AOML

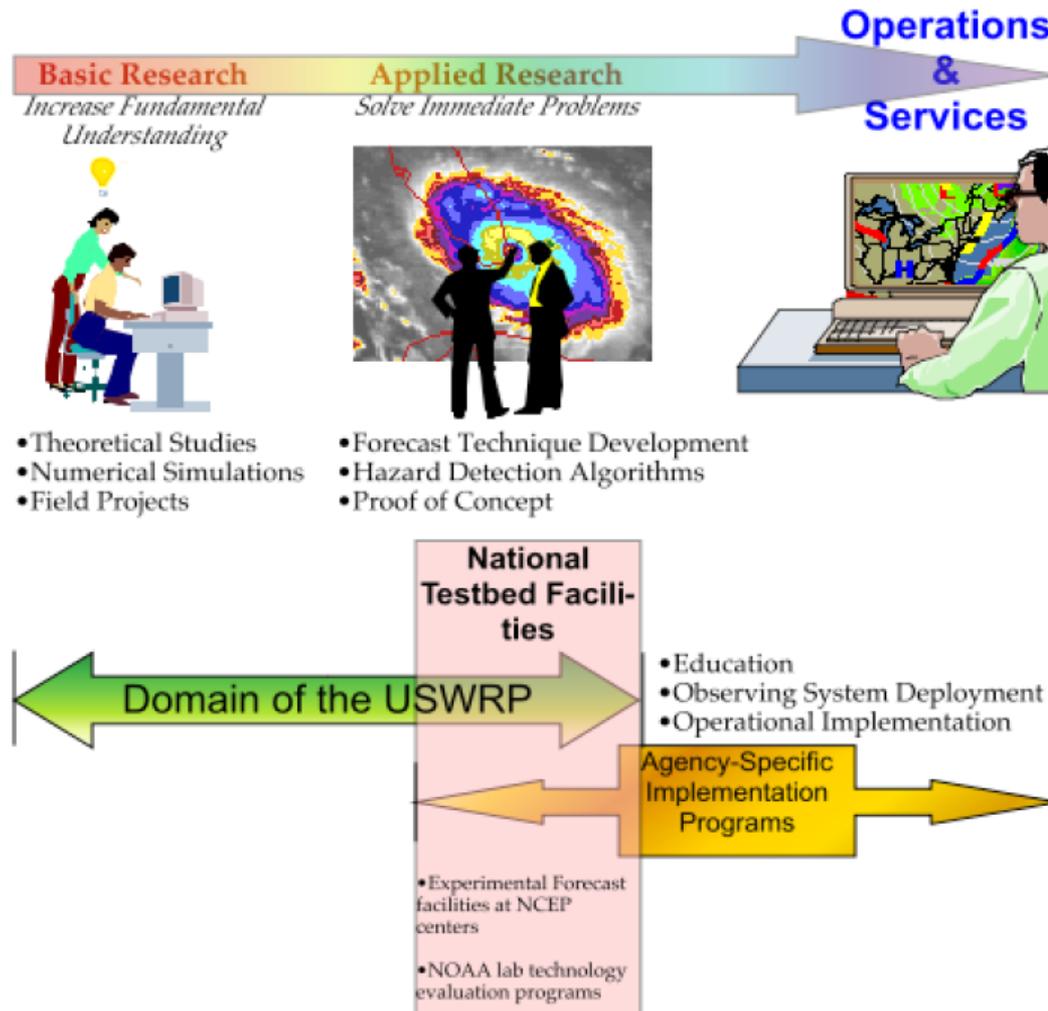
Jiann-Gwo Jiing and Chris Landsea - NOAA/NHC

Joint Hurricane Testbed is funded by the US Weather Research Program in  
NOAA/OAR's Office of Weather and Air Quality.

# Joint Hurricane Testbed (JHT) *since 2001*

- Bridge hurricane research and operations
- Began in 2001 under the USWRP
- **Mission:** successfully transfer new technology, research results and observational advances from research groups to operational centers
- Testing is done at NHC or EMC

# US Weather Research Program's vision



# USWRP Goals relating to hurricane landfall forecasting

- To reduce landfall track and intensity forecast errors by 20%.
- To increase warning lead-time to and beyond 24 hours with 95% confidence without increasing the present 3-to -1 over warning.
- To make skillful (compared to persistence) forecasts of gale- and hurricane-force radii out to 48 hours with 95% confidence.
- To extend quantitative precipitation forecasts out to 3 days and enhance skill of day-3 predictions to improve inland flooding forecasts.

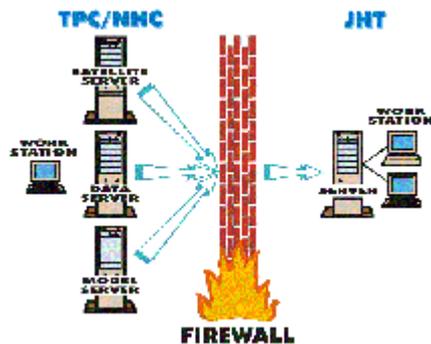
# Major Activities 2001-2011

## Building the JHT 2001-02

- Funded initial round of 10 projects for a first year (FY01) (Mar - Sep 2001)
- Developed Terms of Reference (Mar 2001- May 2002)
- Appointed Director and 2 administrative assistants (all 25% NOAA FTE) (2001)
- Formed Steering Committee (Mar 2002)
- Procured hardware (Q3 2002)
- Hired IT Facilitator (Jul 2002)



Private



Public

PIs/POCs connect on public JHT side

# Major Activities 2001-2011

## Activities associated with each funding cycle

- Preparation, revision, and legal review of Announcement of Federal Funding Opportunities (AFFO)
- AFFO released through Federal Register Notice (FRN)
  - Open to government, academic, and private sector applicants worldwide
  - List forecast center priorities
  - List forecast center IT configuration, available data and format
  - List project selection criteria
  - List criteria for operational acceptance
- Review of pre-applications
- Review and score of full proposals

# Major Activities 2001-2011

Cont.

## Activities associated with each funding cycle

- JHT Directors recommend projects for funding
- NHC assigns Point of Contacts (POC) for each project. POCs work with PIs and forecasters to define timelines/deliverables
- Real-time testing and evaluation activities
- PIs present progress (annual reports) at annual Interdepartmental Hurricane Conference (IHC) ([www.ofcm.gov](http://www.ofcm.gov))
- Review of second year funding for 2-year projects

# Major Activities 2001-2011

## Activities associated with each cycle

- PIs submit final reports when projects end
- POCs and forecasters provide feedback to the JHT
- JHT document IT evaluation on each project
- JHT prepare final evaluation results and submit to NHC Director
- NHC Director makes final decisions on operational acceptance (for non-modeling projects)
- NHC/EMC/NCO implement accepted projects/techniques

# Major Activities 2001-2011

- Completed five rounds of projects
  - Final evaluations on fifth round projects completed
- Sixth round projects started in 2011

# JHT Infrastructure

## *Personnel*

- Quarter-time Director (NOAA FTE)
- 7-member Steering Committee
  - Three from NOAA (one NHC), two from DOD, and two from the academic community
  - NHC member serves as co-Chair
- Two quarter-time administrative assistants (NOAA FTE)
- One IT Facilitator (contractor)

## *Computing Resources*

- Server and workstations
- Software

# What does it take to support the JHT?

## JHT Staff:

- Jiann-Gwo Jiing (JHT Director)
- Jose Salazar (JHT IT specialist)
- Shirley Murillo (JHT Admin. Asst.)
- Chris Landsea (JHT Admin. Asst.)

## JHT Steering Committee:

- Ed Rappaport (NHC - Co-chair)
- Ed Fukada (Joint Typhoon Warning Center)
- Jeff Hawkins (Naval Research Laboratory)
- John Gamache (Hurricane Research Division)
- Liz Ritchie (University of Arizona)
- Vijay Tallapragada (Environmental Modeling Center)
- Hugh Willoughby (Florida International University)

## JHT Principal Investigators and other funded participants

- John Cortinas and staff (OWAQ)
- NHC and EMC forecaster and technical points of contact
- NHC/Technical Support Branch IT staff

# NHC Contributions to JHT

## *Logistics*

- Dedicated physical space in operations, offices

## *Personnel*

- TPC dedicating about 1.5 FTE spread across ~12 people
  - 0.5 FTE reimbursed by USWRP for quarter-time JHT Director and one quarter-time JHT administrative assistant
  - TPC contributing 1.0 FTE, including TPC member on JHT Steering Committee, forecasters, and technical support staff
- Forecaster and technical points of contact (POC)
- Programming, system administration, and network support
- Administrative support

## *Computing Resources*

- Network connectivity
- Operational data flow

# JHT Proposal Review Criteria

- **Relevance to program goals** (40 pts)
  - Research maturity (10 pts)
  - Priority-to-payoff factors (25 pts)
  - Other agency use (5 pts)
- **Technical merit** (40 pts)
  - Risk-to-payoff factors (10 pts)
  - Testing (10 pts)
  - Operational usage (10 pts)
  - Technical compatibility (10 pts)
- **Overall qualification of applicants** (10 pts)
- **Project costs** (10 pts)

# Factors in NHC Director's Decisions for Operational Implementation

(Listed in the AFFO announcement)

- **Forecast or Analysis Benefit:** expected improvement in operational forecast and/or analysis accuracy
- **Efficiency:** adherence to forecaster time constraints and ease of use needs
- **Compatibility:** IT compatibility with operational hardware, software, data, communications, etc.
- **Sustainability:** availability of resources to operate, upgrade, and/or provide support

# JHT Summary 2001-12

- Number of projects supported: 75
  - 62 completed
    - 39.5 accepted for operational implementation
    - 6 projects completed but rejected
    - 9.5 projects completed but pending further investigation (decisions deferred)
  - 12 projects started in fall 2011
- Implementation
  - 35.5 projects implemented: (including 4 5th round projects)
    - 10 numerical modeling related projects implemented by EMC/NCO:
    - 24.5 projects implemented by NHC:
    - 4 projects accepted but not yet fully implemented by NHC:

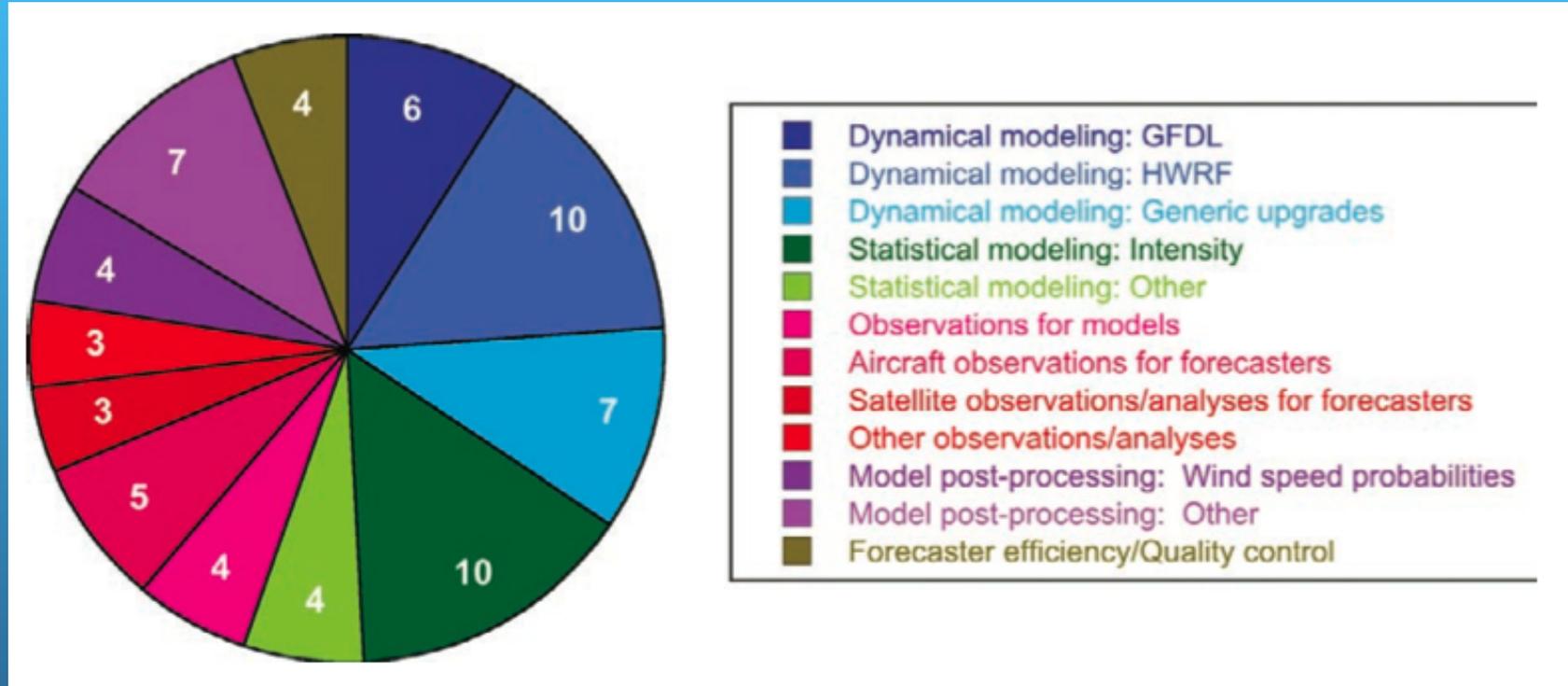
# Implementation

- Some relatively easy
- Some very complicated
- NHC contributes ~0.5 FTE/yr on implementation
- JHT IT facilitator assists in the process
- NCEP/EMC and NCO also contributed

*Operational Centers are not funded for this task*

# JHT first five rounds

62 projects by topic area

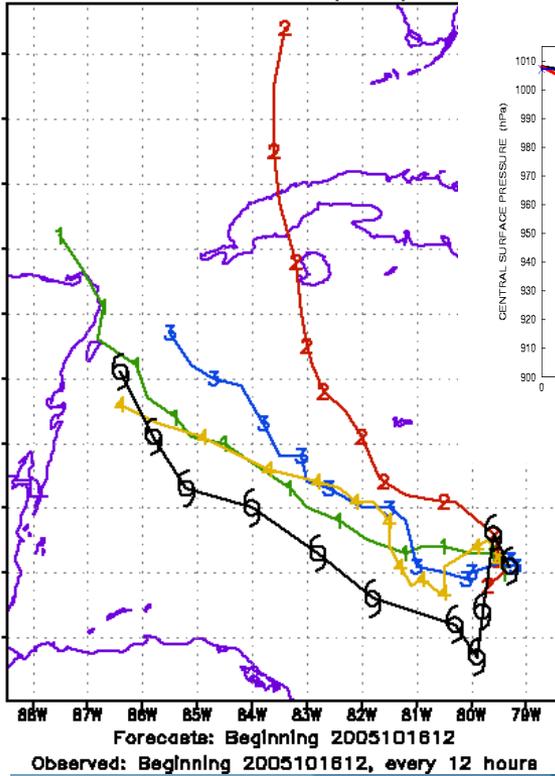


Rappaport et al. 2012 - The Joint Hurricane Test Bed, Its first decade of tropical cyclone research-to-operations activities reviewed, BAMS, March issue.

# Highlights of implemented projects

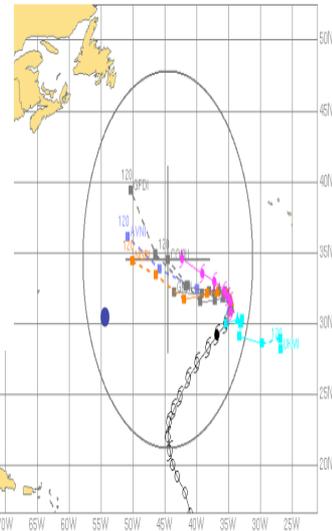
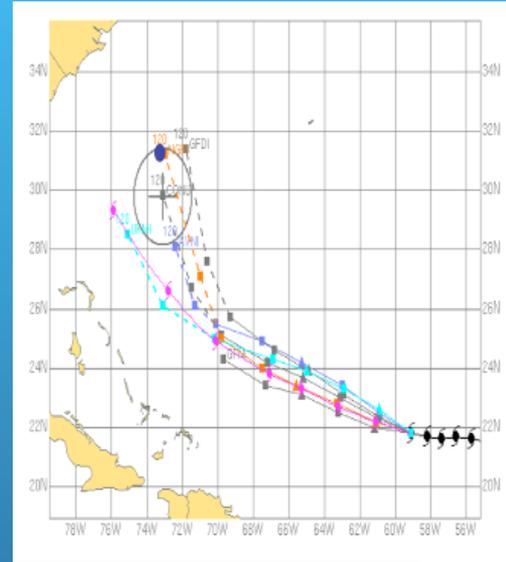
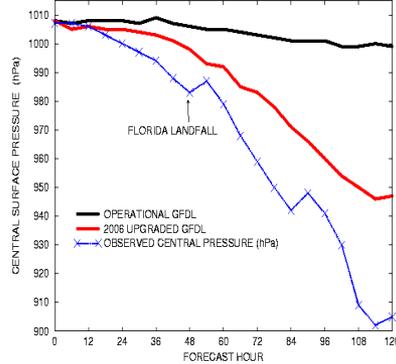
## Track guidance

2005 Tropical Cyclone Tracks  
Storm: AL2405 (WILMA)



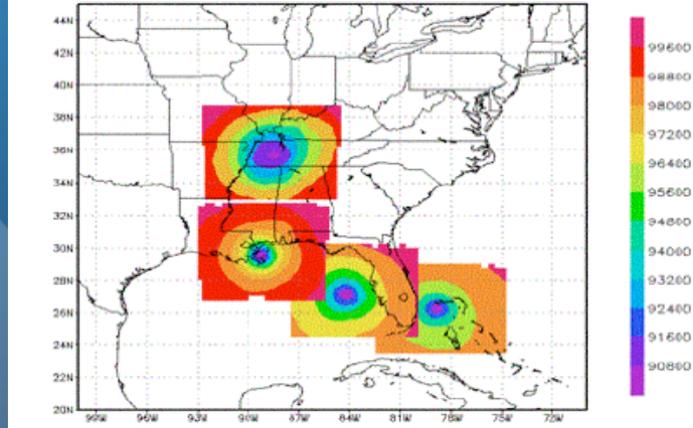
HURRICANE KATRINA (AL12)

INITIAL TIME: (0000 UTC 24 AUGUST)



GFDL

katrina 2005082512 HWRf(fb1dt) 0,2,4,5 days

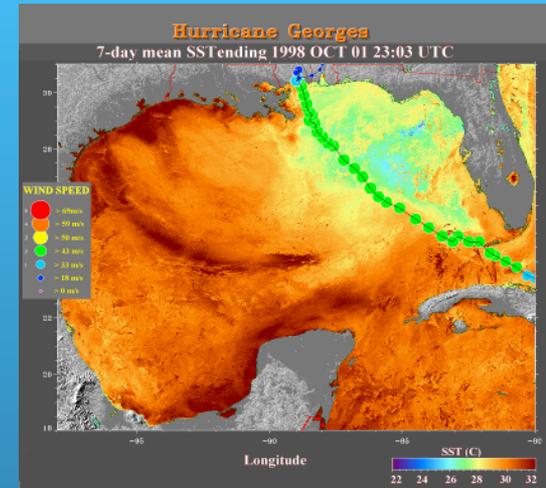
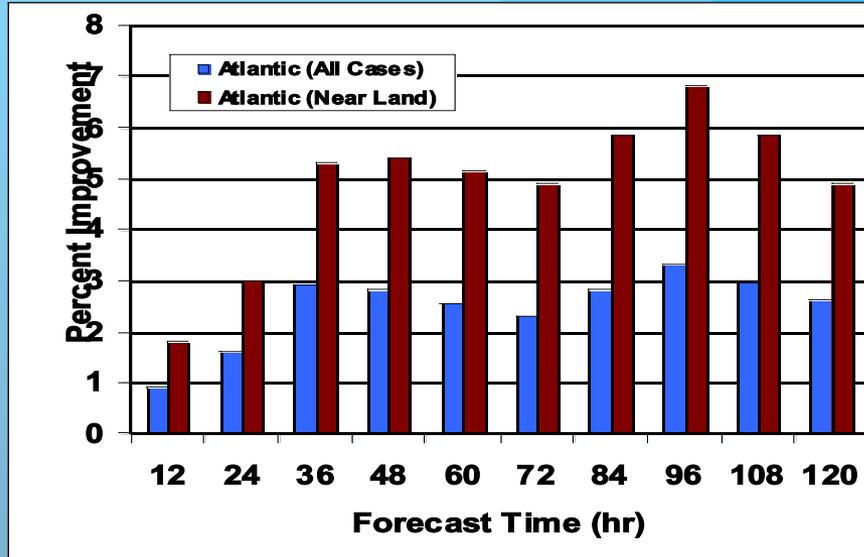


HWRf

Guidance on guidance

# Highlights of implemented projects

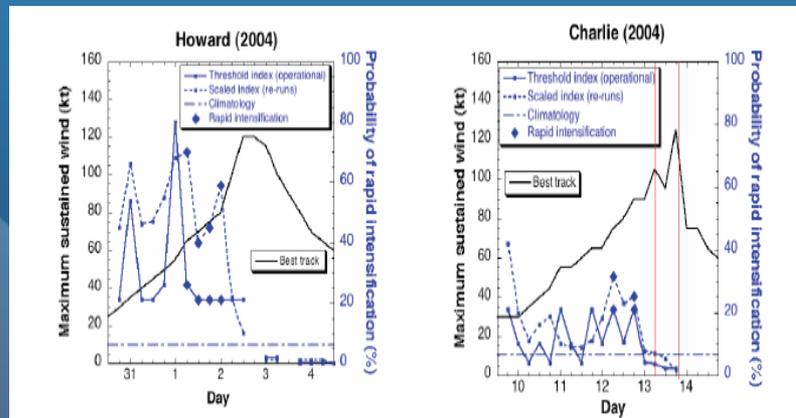
## Intensity guidance



Inner core SST

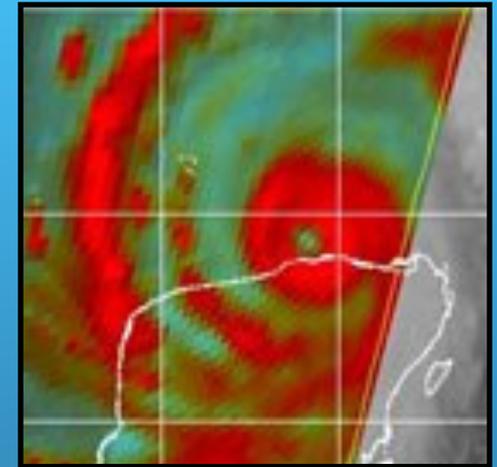
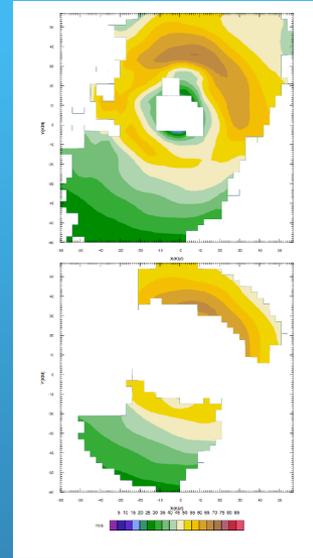
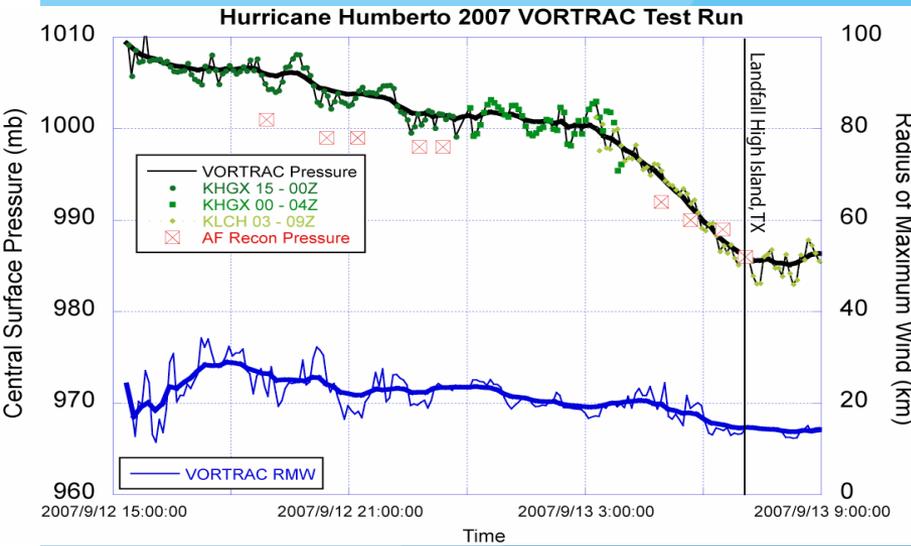
Revised SHIPS intensity forecast scheme

Probability of rapid intensification



# Highlights of implemented projects

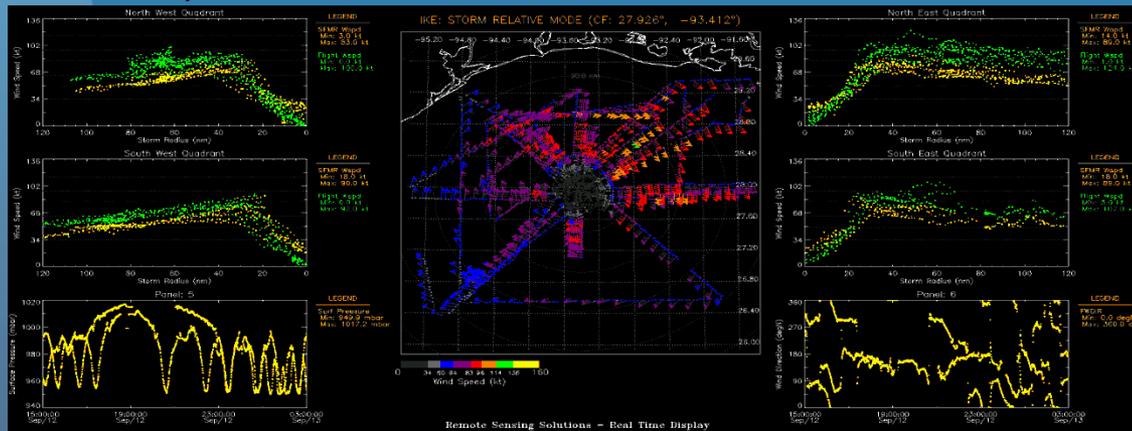
Improved use of observations



VORTRAC (Intensity estimates using coastal 88-D radars)

Airborne Doppler Winds

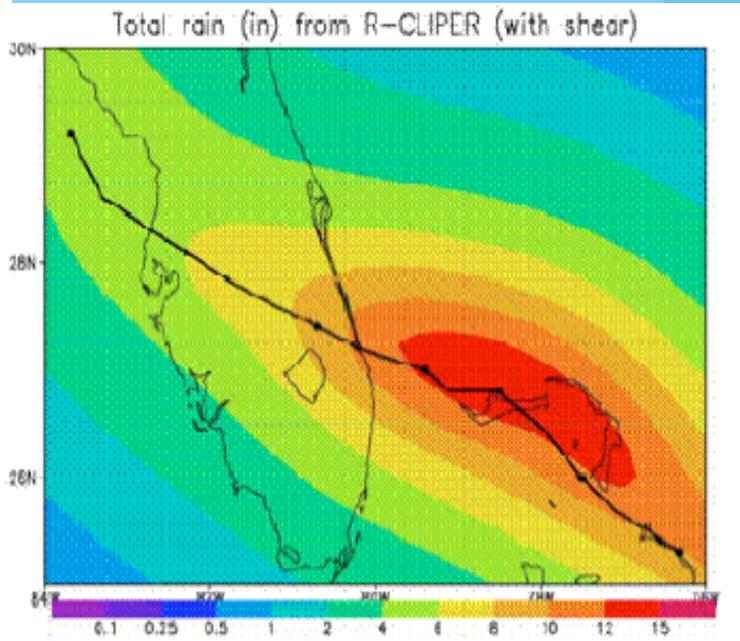
Satellite intensity and size estimates



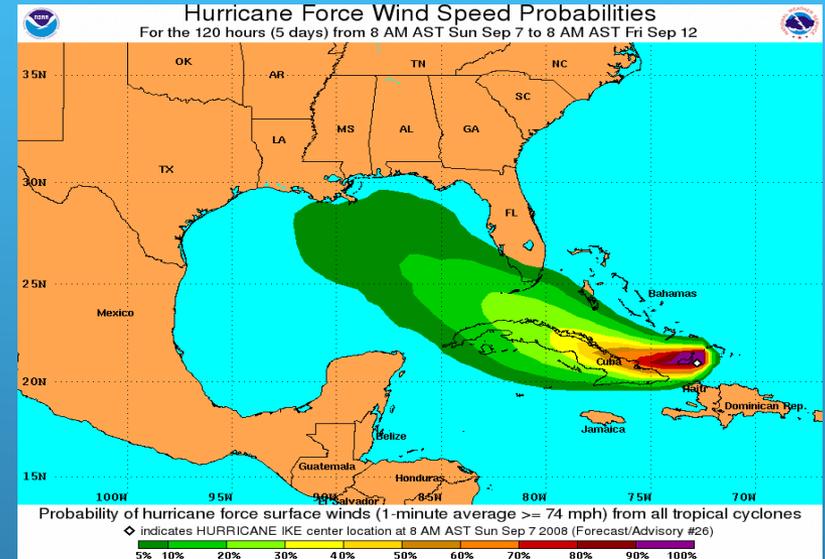
SFMR

# Highlights of implemented projects

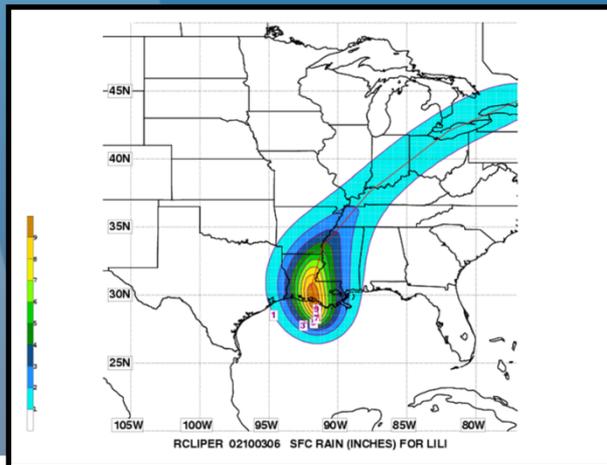
## New products



Rainfall CLIPER

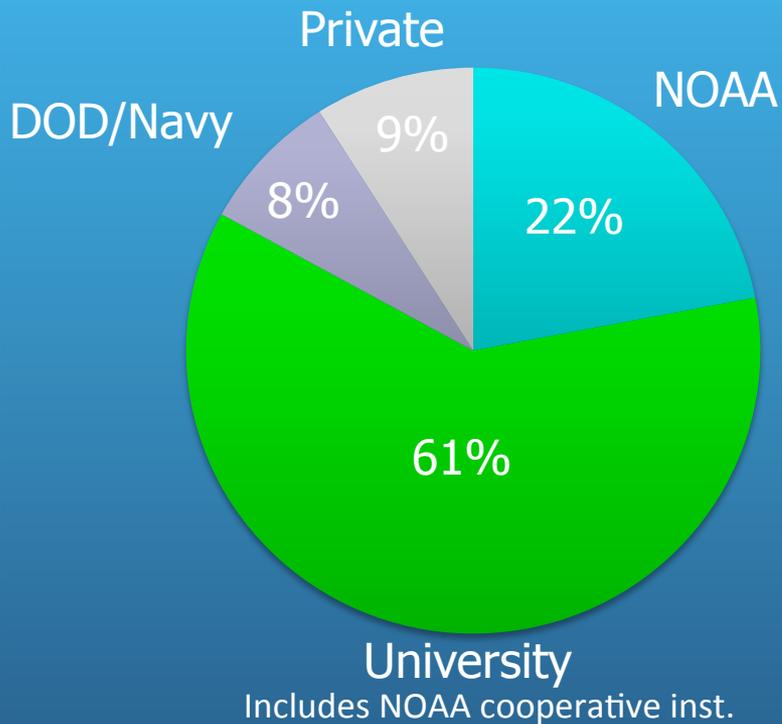


Probabilistic wind forecast

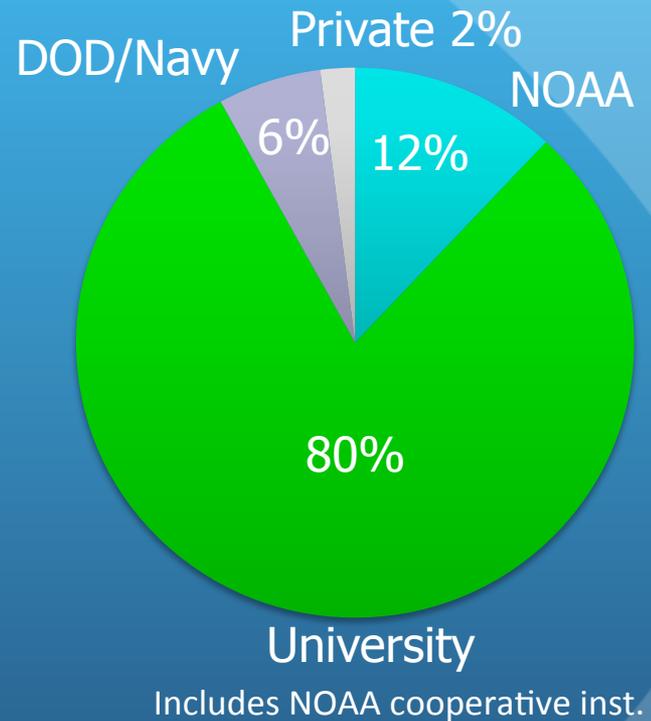


# Funding Distribution

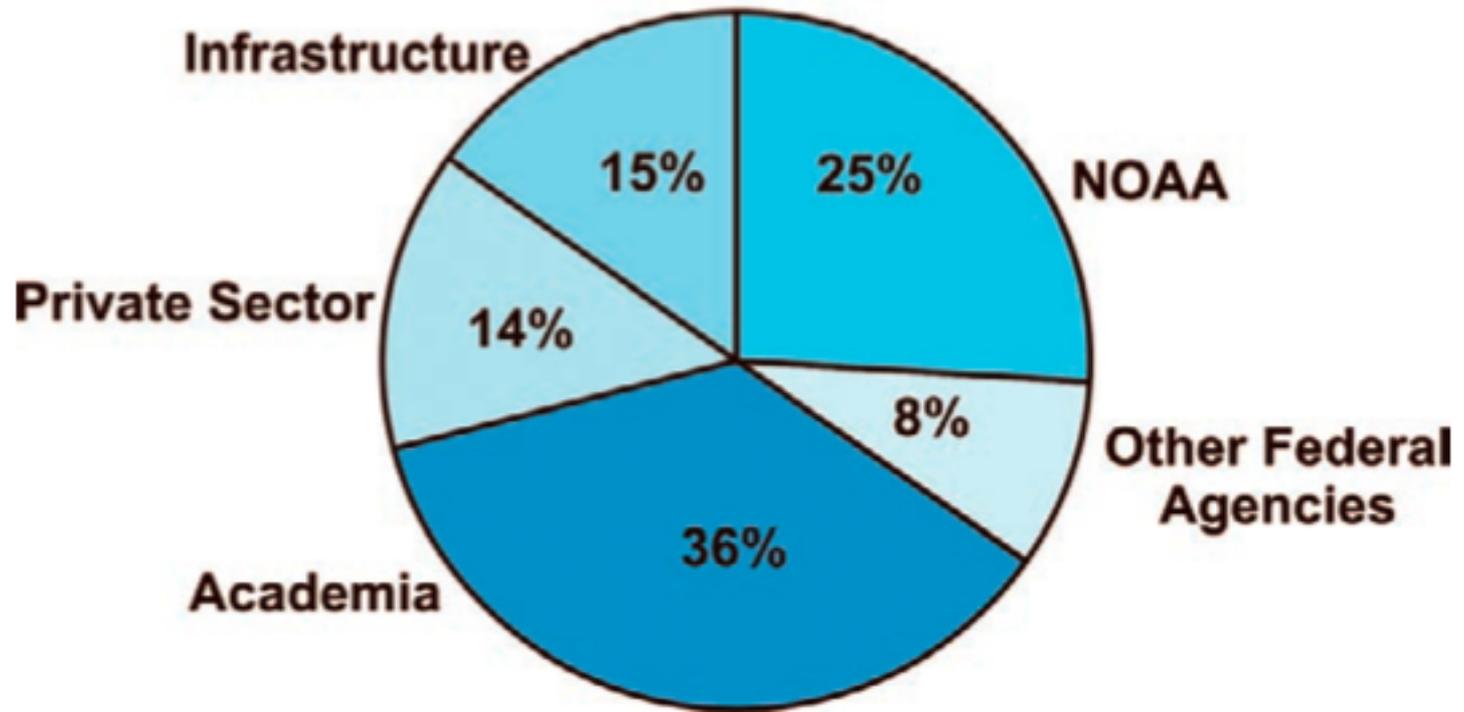
## 5th Round (2009-2011)



## 6th Round (2011-2013)



## Distribution of JHT Funds 2001 - 2010



*Figure from Rappaport et al. 2012*

# 2011-2012 Major JHT Activities - 5<sup>th</sup> round

- February – August 2011

- Testing of 5<sup>th</sup> round (2009-2011) projects

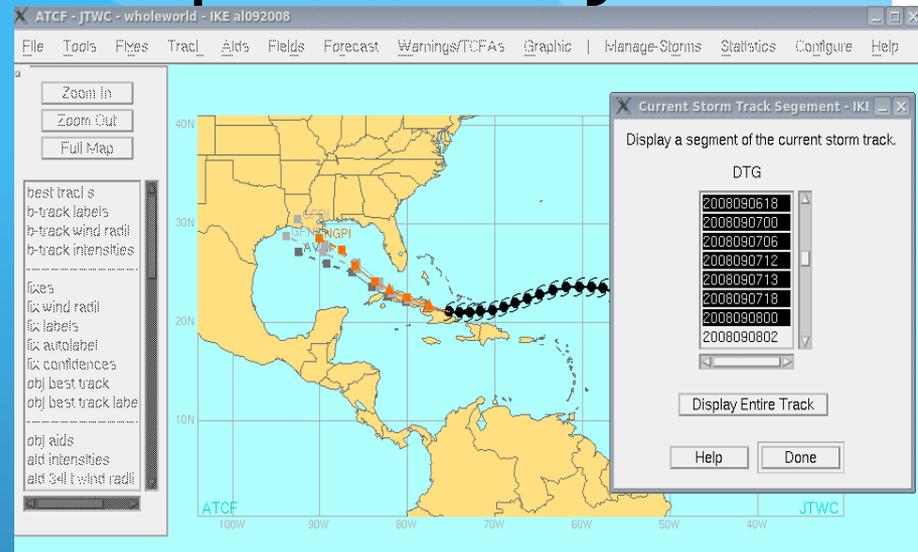
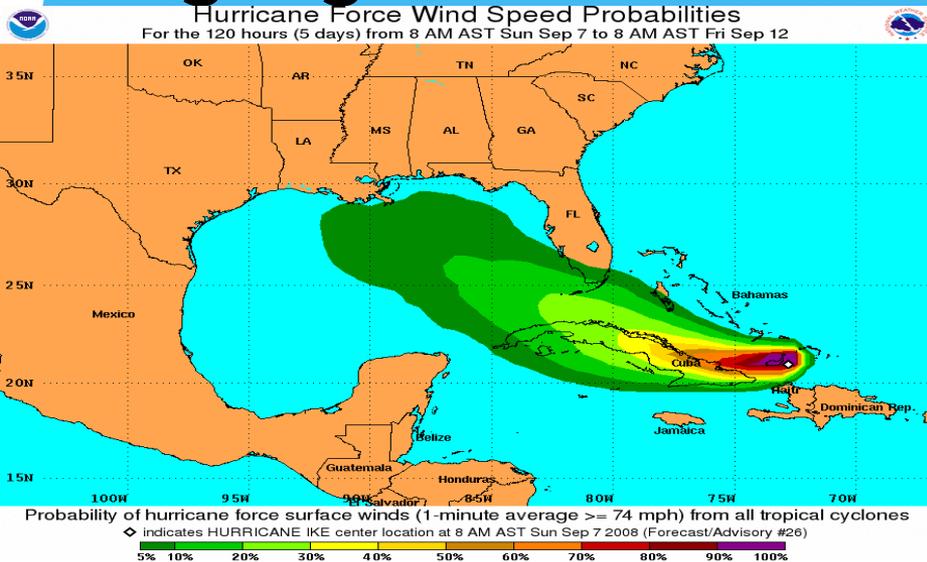
- August 2011

- 9 Projects completed (5th Rd)
- JHT final evaluation/report on 5<sup>th</sup> round projects (through December)
- Decision on acceptance for implementation (NHC and EMC Directors)

- March 2012

- Final decision made

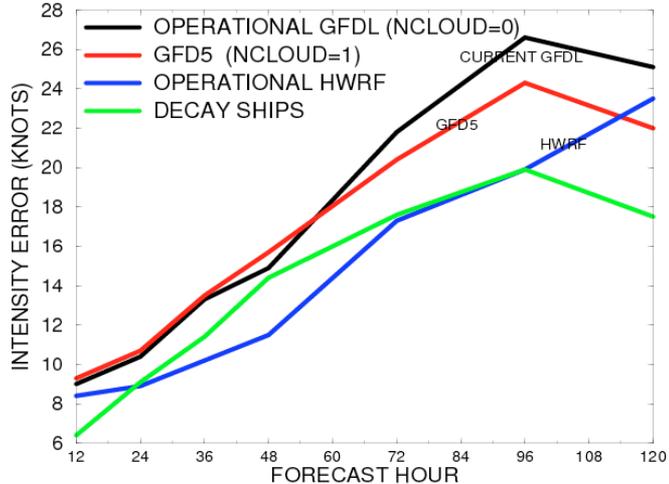
# Highlights of 5th Round Completed Projects



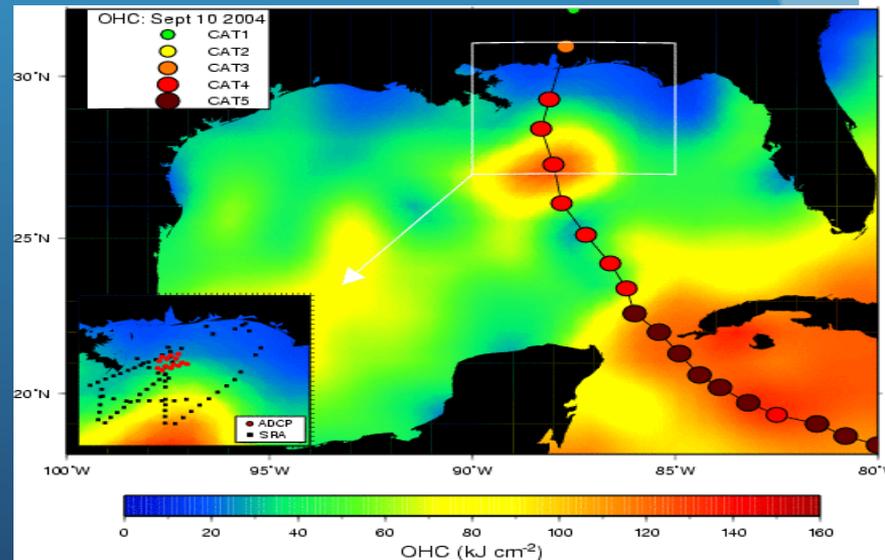
Improved Wind Probabilities – DeMaria/Knauff

Enhanced ATCF - Sampson

2011 ATLANTIC HURRICANE SEASON (SEPTEMBER 12th)  
NUMBER OF CASES: (163, 149, 124, 93, 74, 53)



HWRF-GFDN coupled model- Ginis



Ocean Model Parameterizations - Shay

## JHT: The Process

- Call for Proposals - drafted and disseminated (bi-annually)
- Principal Investigators apply for funding through NOAA
- 7 member Steering Committee rates all proposals
- Funded projects are tested during 1 or 2 hurricane seasons in conjunction with NHC/EMC points of contact
- At the project's end, each are evaluated by NHC/EMC staff
- Implementation of successful projects are then carried out by NHC/EMC staff/PIs

# Forecaster Priorities

(Listed in the AFFO announcement)

## Second Round (2003)

1. Intensity change, rapid intensification
2. “Guidance on guidance” for track, intensity and precipitation - probabilistic
3. Precipitation amount and distribution
4. Reduce the occurrence of guidance and official track outliers
5. Implement improved observational systems in the storm and its environment

## Sixth Round (2011)

1. intensity change, rapid intensification
2. Improved observational systems in the storm and its environment
3. “Guidance on guidance” for track, intensity and precipitation
4. Storm surge, coastal inundation modeling/applications
5. Improved and extended track guidance) and identify and removal of outliers



# Modeling Priorities

(Provided by EMC)

## Second Round (2003)

1. Improved model development to advance track and intensity forecasts
2. Improved boundary layer representation for coupled air/sea/land models-hurricane rainfall and inland flooding problem
3. Improved targeting strategies for hurricane surveillance missions
4. Transforming results from field programs, e.g., Coupled Boundary Layers/Air-Sea Transfer (CBLAST), into tangible results for NWP models.
5. Diagnostic studies of storm scale structure changes from high resolution models

## Sixth Round (2011)

1. General model improvements to advance NCEP global model track forecasts, improve 5-7 day
2. Diagnostic techniques to further increase the utility of global models in forecasting tropical cyclone genesis
3. Improvements specific to operational HWRF modeling system

# 2011-2012 Major JHT Activities - 6<sup>th</sup> round

- 6th round funding recommendation
  - Steering committee review proposals - Complete Feb 2011
  - Rank and select proposals for funding
  - Work with Grants Office to fund selected projects
  - Find Point of contacts among NHC forecasters and support staff
  - Work with PIs to setup timelines for their projects
- 6th round Projects (12) began Aug-Sept 2011

Primary Area of Focus	# of Projects
Improvements to dynamical models (for track, intensity, and precipitation forecasts)	3
Statistical intensity forecast guidance	4
Enhancements to observed data, assimilation	4
Tropical cyclone structure/wind/wave distribution	1
<b>Total</b>	<b>12</b>

# THE JOINT HURRICANE TEST BED

## Its First Decade of Tropical Cyclone Research-To-Operations Activities Reviewed

BY EDWARD N. RAPPAPOORT, JIANN-GWQ JING, CHRISTOPHER W. LANDSEA,  
SHIRLEY T. MURILLO, AND JAMES L. FRANKLIN

Collaboration between researchers, forecasters and technology specialists facilitated the development and implementation of numerous projects benefitting forecast operations.

The National Oceanic and Atmospheric Administration (NOAA), in conjunction with the U.S. Weather Research Program (USWRP), established the Joint Hurricane Test Bed (also popularly, "Testbed") (JHT) in 2001 to expedite the transfer of tropical cyclone research into forecast operations (Rappaport et al. 2009; Knabb et al. 2005). The JHT's first decade coincided with several significant advances at the National Hurricane Center (NHC; see Rappaport et al. 2009; Franklin 2010): NHC extended its forecast horizon from 3 to 5 days and its track forecast errors decreased significantly, in large part due to improvements in operational computer model

forecast guidance and tools available to forecasters. During that period the JHT funded 62 projects, with operational offices implementing most of them.

In this review of the JHT, we look at the program's contribution to the forecast process. We present the JHT's primary objectives and processes, along with key characteristics of the resulting applied research projects it supported. The evaluation describes the operational impact of the program as indicated by the JHT's primary customer, NHC's "hurricane specialists" (forecasters); considers the effect of JHT projects on conventional forecast metrics; and highlights a few nontraditional measures of the test bed's contribution. Along the way, we introduce the projects that have had the greatest impact as a way to give a sense of the kind of successfully applied research that the JHT has sponsored. We also identify some of the program's limitations and discuss prospects for the test bed.

### PROGRAM OBJECTIVES AND PRACTICES.

Two JHT documents and the test bed's annual budget define the focus and scope of JHT activities, including the type and number of funded projects. The NOAA/NHC terms of reference (TOR; NOAA/NHC 2002) provide the test bed's mission "to transfer more rapidly and smoothly new technology, research results, and observational advances of the USWRP, its sponsoring agencies, the academic community and other groups

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**CORRESPONDING AUTHOR:** Edward N. Rappaport, National Hurricane Center, 11691 SW 17th Street, Miami, FL 33165-2149  
E-mail: edward.n.rappaport@noaa.gov

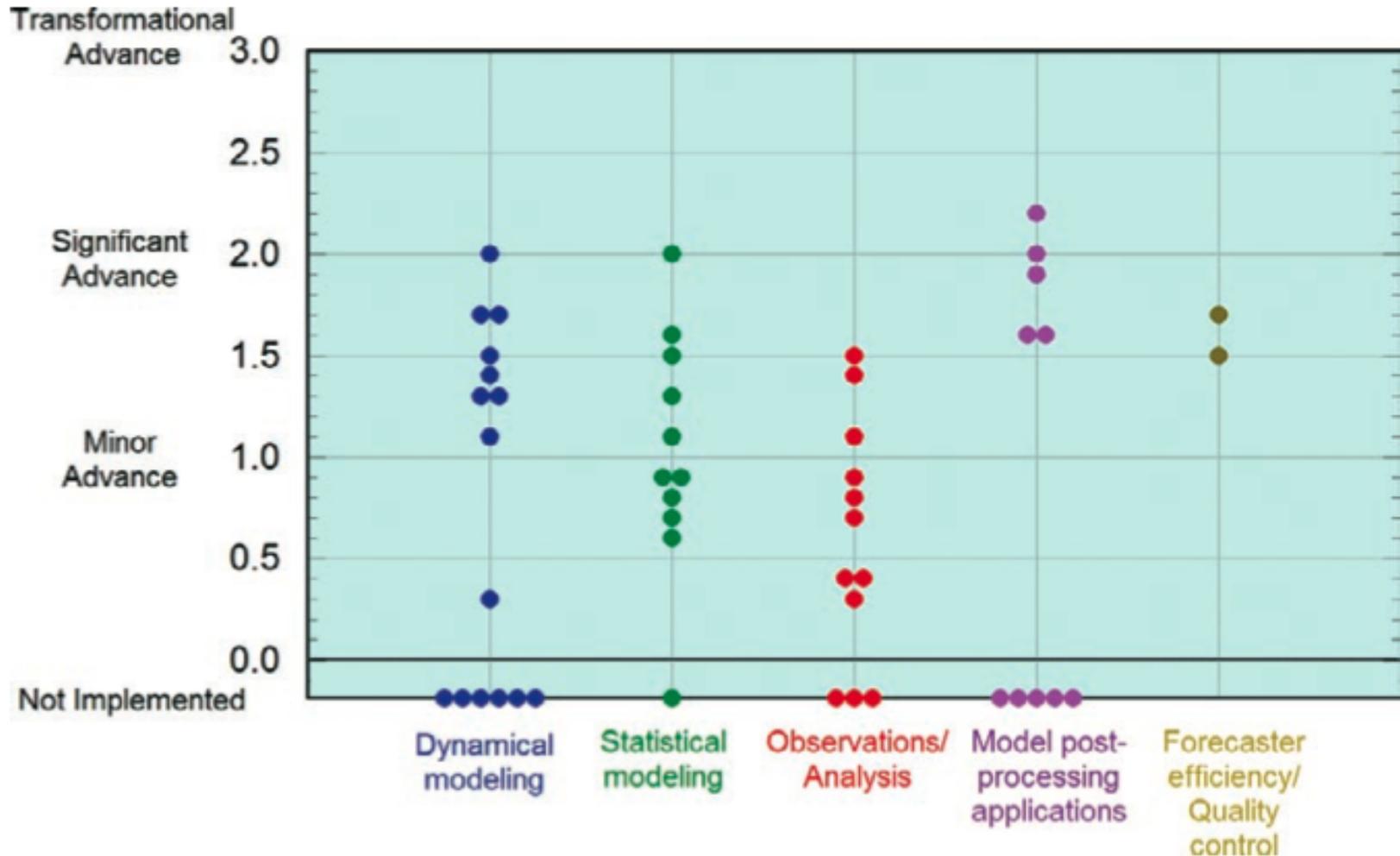
The abstract for this article can be found in this issue, following the table of contents.

DOI:10.1175/BAMS-D-11-00037.1

In final form 11 October 2011

# Average forecaster rating by topic area

50 projects (1-4 JHT rounds)



# Upcoming in 2012

- **Decision on 5th round projects**
  - Final reports for 5th round projects
  - POC feedback
  - JHT final review/reports to NHC Director for acceptance
- **Test and evaluation**
  - Prepare real-time testing & evaluation for 6th round projects
  - Set up necessary software code and data flow
- **Implement newly accepted projects (NHC)**
- **Draft and publish 7th round announcement**
  - **Funding Opportunity (summer 2012)**
- **Review and recommend pre-applications**

# JHT Web site: for additional info

The screenshot shows the NOAA National Hurricane Center website. The browser address bar displays [www.nhc.noaa.gov/jht](http://www.nhc.noaa.gov/jht). The page header includes the NOAA logo, the text "National Weather Service National Hurricane Center", and a "weather.gov" logo. A navigation menu contains "Home", "News", "Organization", "Search", "NWS", "All NOAA", and "Go".

The main content area features a banner for "USWRP Joint Hurricane Testbed" with a satellite image of a hurricane. Below the banner is the "JHT Overview" section, which includes a navigation menu: "Overview | Current Projects | Past Projects | Admin Presentations | Highlights | Staff | Committee".

The "Mission Statement" section states: "The mission of the Joint Hurricane Testbed is to transfer more rapidly and smoothly new technology, research results, and observational advances of the United States Weather Research Program (USWRP), its sponsoring agencies, the academic community and other groups into improved tropical cyclone analysis and prediction at operational centers."

The "News" section lists three items:

- 20 March 2012: [2012 IHC presentations posted for 2011-2013 projects](#)
- 1 November 2011: [Press Release on new 2011 funded JHT projects](#)
- 30 September 2011: [New JHT projects \(Round 6, FY11-13\) announced](#)

A link for "View News Archive" is provided.

The "Main Activities" section lists three bullet points:

- Identify new techniques, models, observing systems, etc. with potential for improving forecast guidance, via an announcement of opportunity and a proposal, review, and funding process.
- Establish and maintain an infrastructure to facilitate the modification and transfer of research applications into the operational computing, communication, and display environment.
- Complete tests in a quasi-operational environment of tools, techniques, etc. provided by funded researchers, with metrics for scientific performance, ease-of-use, and time constraints.
- Prepare documentation, training, and performance evaluations of successfully transferred products to facilitate use and support in operations.

A footer note says: "Please see the [Joint Hurricane Testbed Terms of Reference](#) (PDF) for more background information."

The left sidebar contains a "Local forecast by City, St or ZIP" search box and a "Go" button. Below this are sections for "Alternate Formats" (Text, Mobile, Email, RSS), "Cyclone Forecasts" (Latest Advisory, Past Advisories, AudioPodcasts, About Advisories), "Marine Forecasts" (Atlantic & E Pacific, Gridded Marine, About Marine), "Tools & Data" (Satellite, Radar, Analysis Tools, Aircraft Recon, GIS Datasets, Data Archive), "Development" (Experimental Research, Forecast Accuracy), "Outreach & Education" (Prepare, Resources, Storm Surge, About Cyclones, Cyclone Names, Wind Scale, Most Extreme Forecast Models, Breakpoints, Glossary | Acronyms, Frequent Questions), "Our Organization" (About NHC, Mission | Staff, Visitors | Virtual Tour, Library Branch, NCEP | Newsletter), "Contact Us" (Comments), and social media links for Facebook and Twitter.

A vertical banner on the right side of the page reads "National Weather Service • Since 1870".

Thank you



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Transitioning from Research to Operations

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