



U. S. Weather Research Program Joint Hurricane Testbed 2001-2009

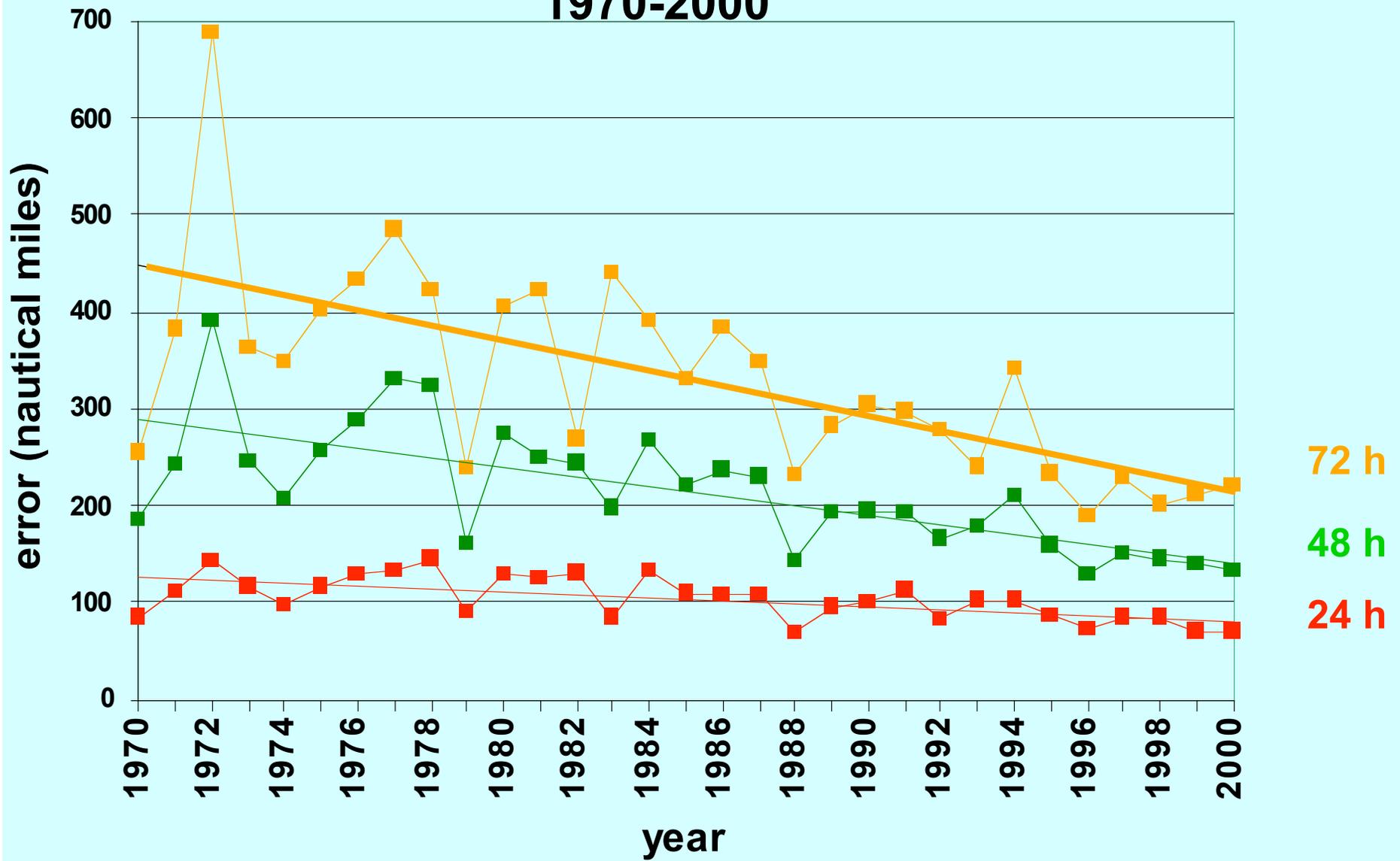
Dr. Jiann-Gwo Jiing

**Chief, Technology and Science Branch
National Hurricane Center
& JHT Director
April 28, 2009**

Outline

1. **USWRP Hurricane at Landfall Goals**
2. **JHT Mission**
3. **Major Activities 2001-09**
4. **Current State of NHC Hurricane Forecast**

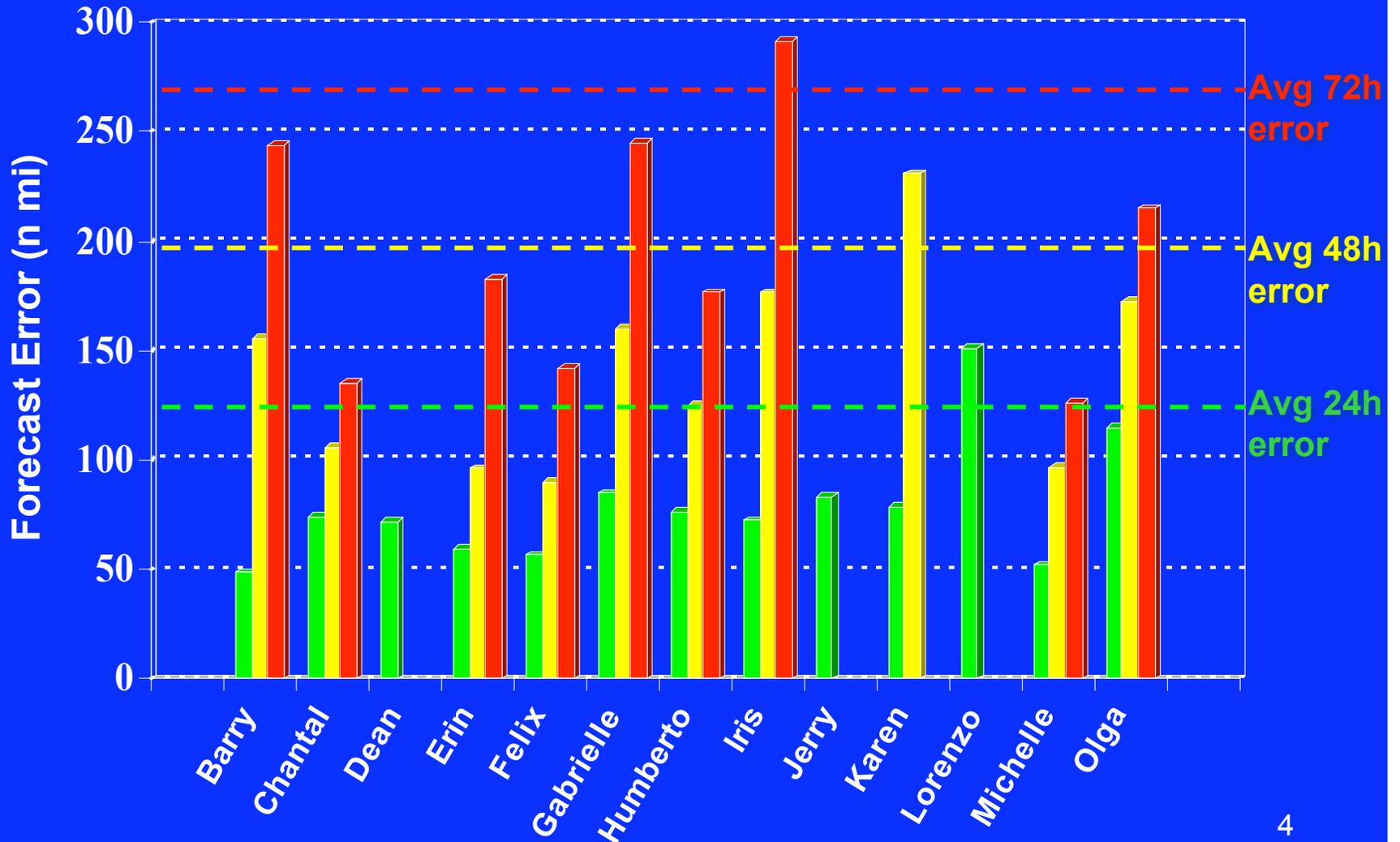
NHC yearly-average track forecast errors 1970-2000



(72-h Linear trend line: - 52 % in 31 years)

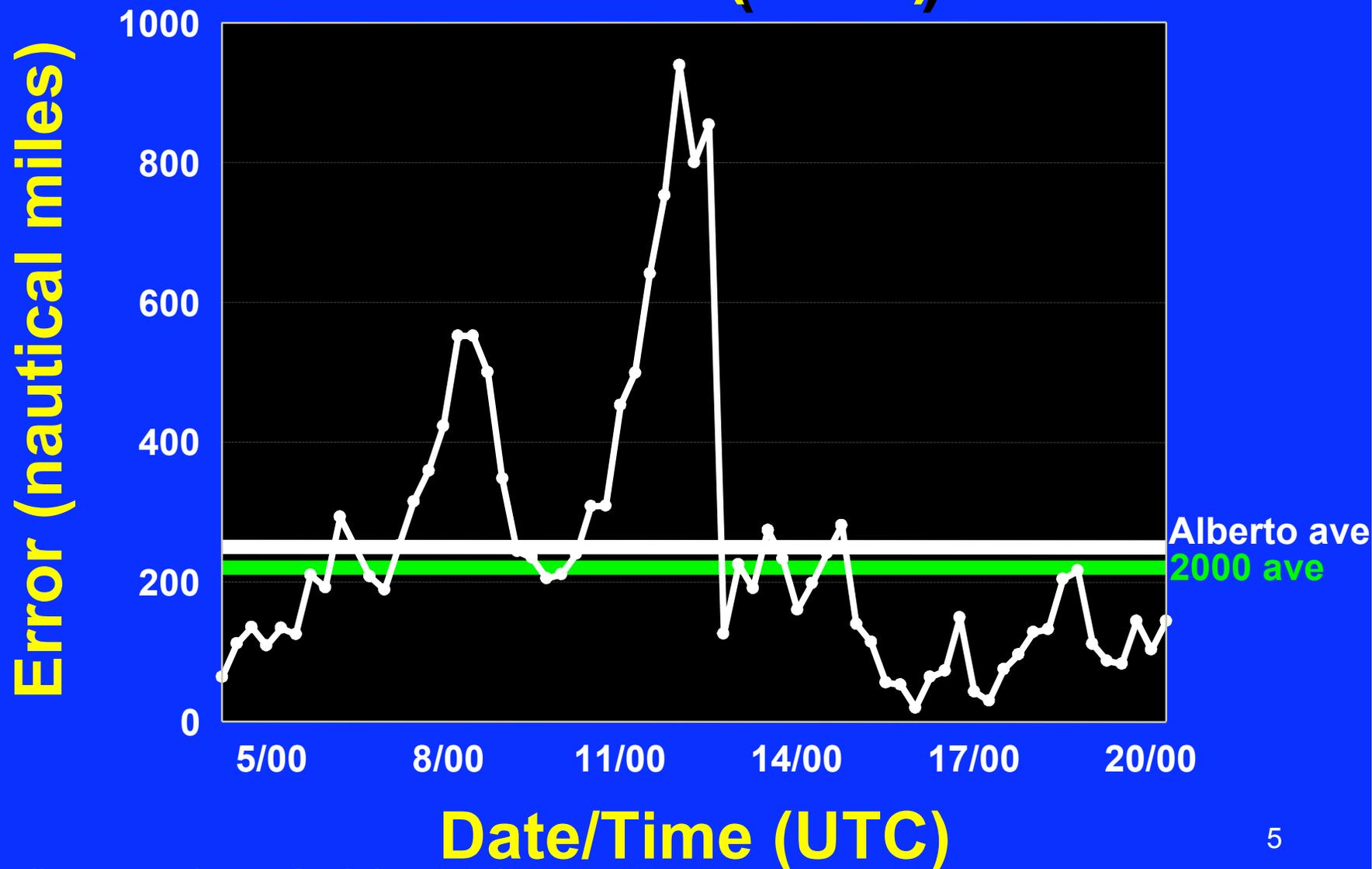
2001 TRACK FORECAST ERRORS BY STORM

24 h 48 h 72 h

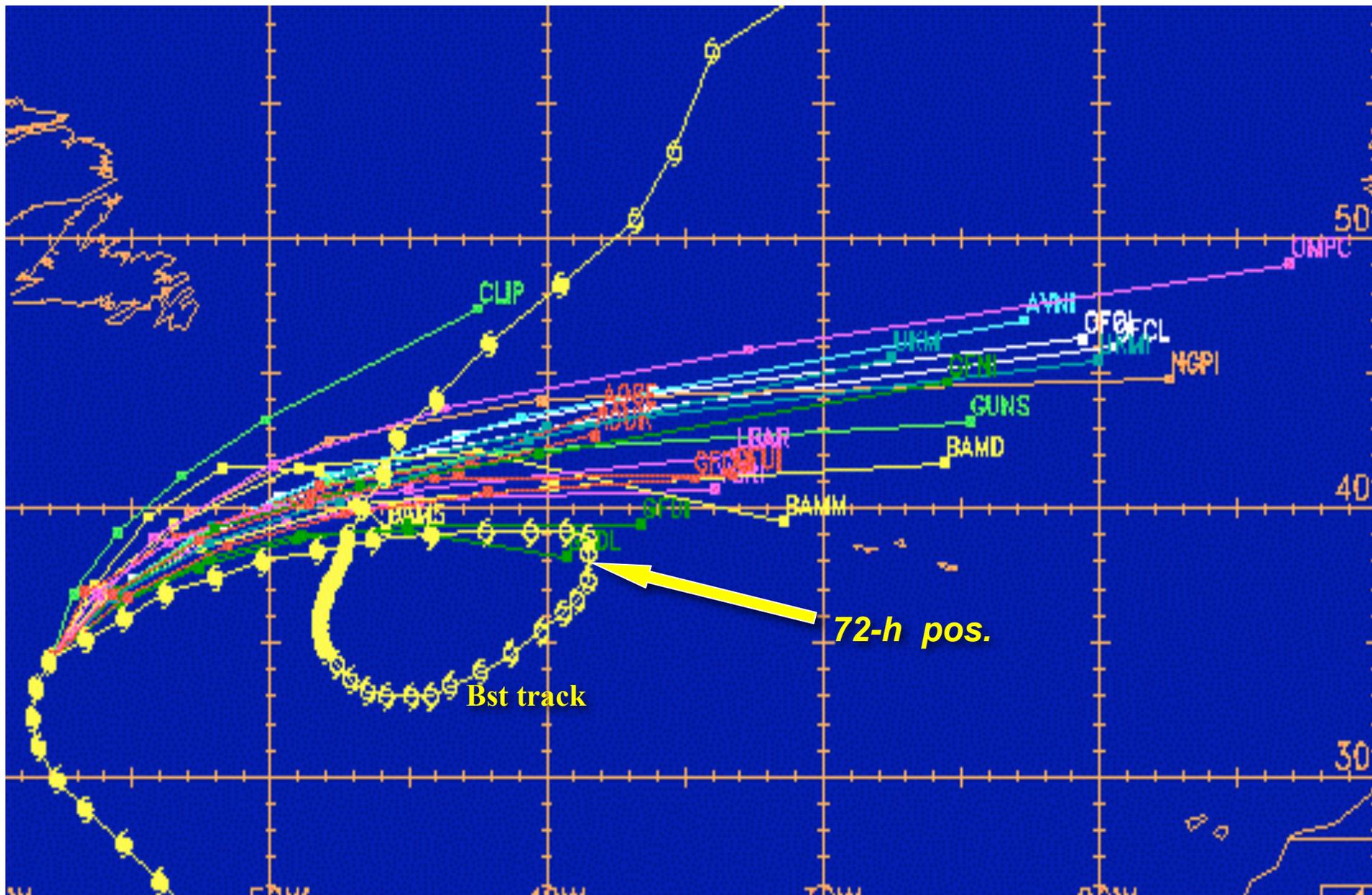


Some are more difficult to forecast. The outliers – we didn't know which one

NHC 72-Hour Track Forecast Errors Alberto (2000)

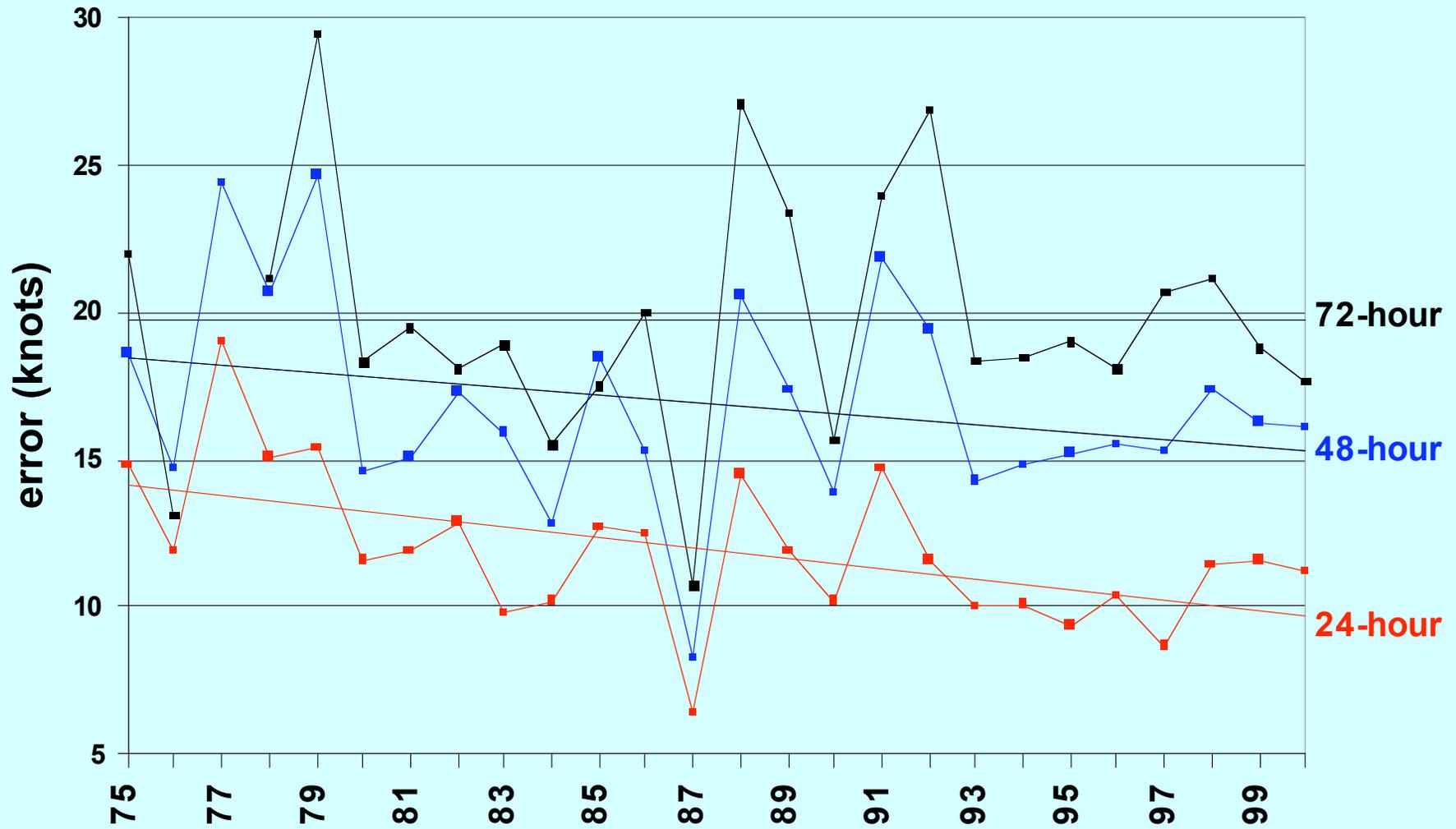


The outliers – and you don't know when



TRACK GUIDANCE FOR HURRICANE ALBERTO
0000 UTC 12 AUGUST, 2000

NHC yearly average wind speed forecast errors and trend



(LITTLE OR NO SKILL IN 2-YEAR DAY INTENSITY FORECASTS)

USWRP goals relating to hurricane landfall forecasting

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

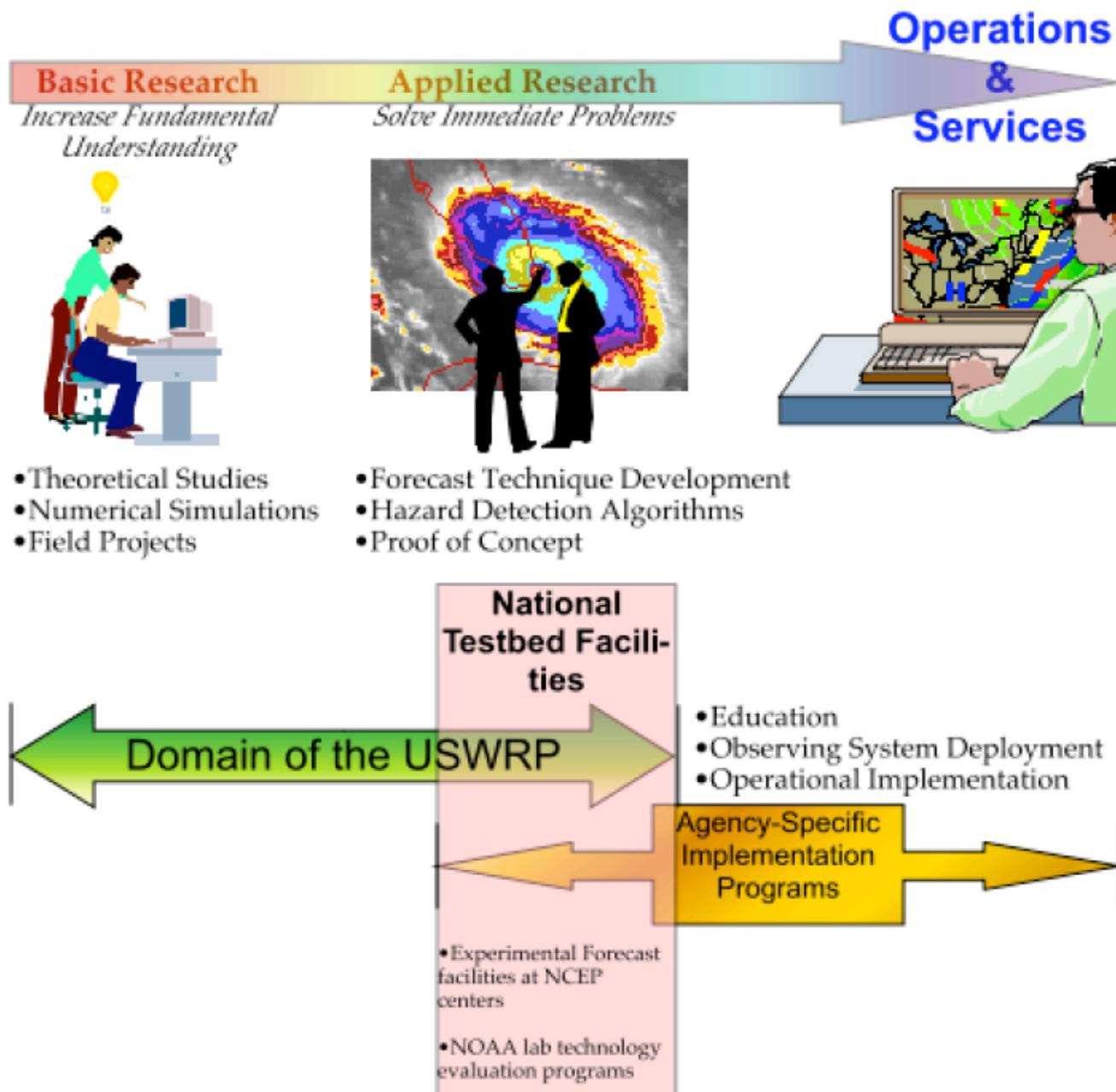


Fig. 1. Schematic of the relationship of the USWRP to the continuum from basic research to operations and services and to agency-specific technology-infusion programs. Within the region of overlap in applied research responsibilities are the national testbed facilities. Research ideas

JHT Mission Statement

The mission of the Joint (NOAA, Navy, and NASA) Hurricane Testbed is 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 into improved tropical cyclone analysis and prediction at operational centers.

Major Activities 2001-2009

Establishing 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)

JHT Infrastructure

Personnel

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

Computing Resources

- Server and workstations
- Software

NHC Contributions to JHT

Logistics

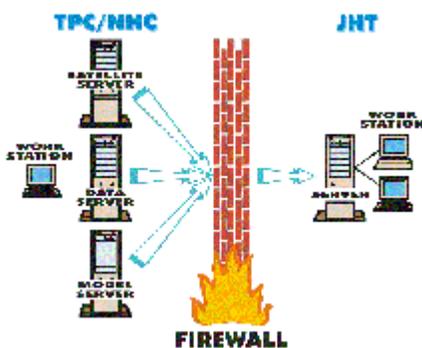
- Dedicated physical space in operations, offices

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



Private

Public

PIs / POCs connect
on public JHT side

Major Activities 2001-2009

- Completed three round of projects.
- Fourth round of projects will complete in August 2009
- Fifth round projects selected and will start before August 2009

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 of full proposals**

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 presented updates (annual reports) at annual Interdepartmental Hurricane Conference (IHC) (www.ofcm.gov)
- Review of second year funding for 2-year projects

Activities associated with each funding 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**
- **NHC/EMC/NCO implement accepted projects/techniques**

In the Federal Announcement

- **Operational Centers' forecast Improvement Needs** (Complementary to USWRP goals)
 - **NHC highest priorities, for example:**
 - Rapid intensity changes
 - “Guidance on guidance”
 - Precipitation amount and distribution
 - Track outliers
 - Improved observational systems
 - Tropical cyclone size
 - **EMC highest priorities, for example:**
 - General model improvements
 - Improved boundary layer representation for coupled models
 - Improved targeting strategies for surveillance missions
 - Model validation techniques
 - Diagnostic techniques

Summary of JHT projects 2001-2009

- **1) Number of projects supported: 50**
 - 41 completed, 30 accepted for operational implementation
 - Number of projects rejected: 5
 - Number of projects completed but pending further investigation (decisions deferred): 5
 - Number of projects in process: 9
- **2) Implementation**
 - Number of projects implemented: 26.5
 - Number of numerical modeling related projects implemented by EMC/NCO: 10
 - Number of projects implemented by NHC: 16.5
 - Number of projects accepted but not yet fully implemented by NHC: 3.5

Note:

- 1) Implementation is defined when a project is completed, accepted, and the technique installed on NCEP/NCO or NHC operational systems and runs on operational time frame.
- Some techniques were “implemented” on JHT platform for testing.

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

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

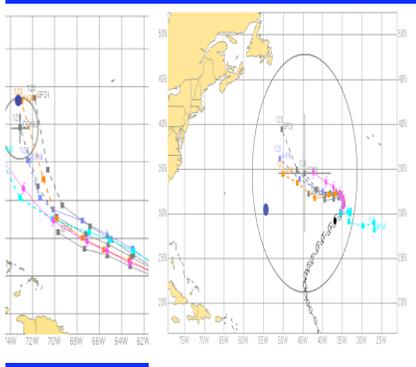
2nd Round Project Focus Areas

Primary Area of Focus	# of Projects
Improvements to dynamical models (for track, intensity, and precipitation forecasts)	4
Track forecast guidance algorithms	3
Intensity forecasting algorithms	3
Enhancements to observed data, assimilation	2
Initial intensity estimation	1
Tropical cyclogenesis	1
Rainfall	1
Total	15

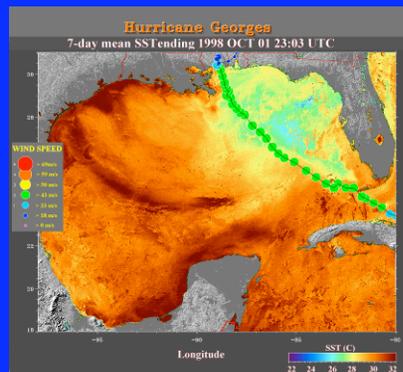
4th Round Project Focus Areas

Primary Area of Focus	# of Projects
Improvements to dynamical models (for track, intensity, and precipitation forecasts)	5
Statistical intensity forecast guidance	1
Enhancements to observed data, assimilation	0
Tropical cyclone structure/wind/wave distribution	2
Track forecast guidance	1
Enhancements to operational environment	1
Total	10*

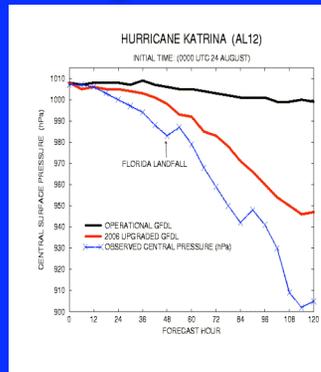
JHT 2nd Round Implemented Projects



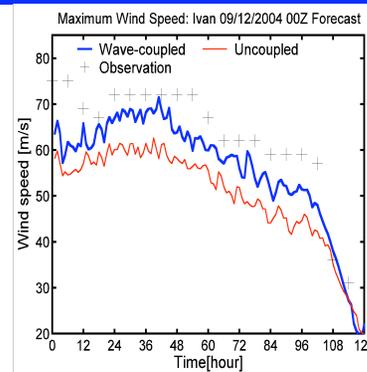
Track Uncertainty Estimates (Goerss)



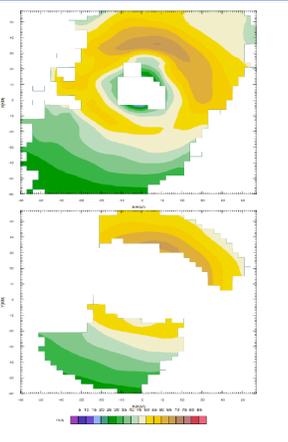
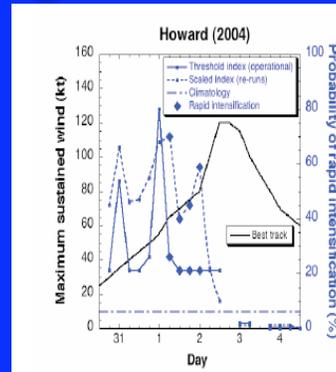
Inner Core SSTs (Cione)



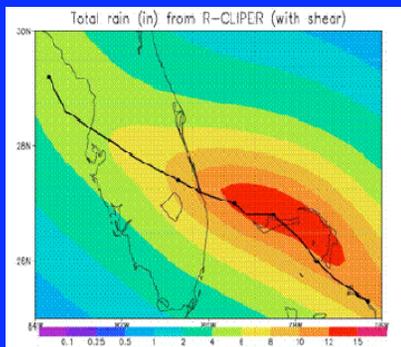
GFDL/URI Hurricane Model upgrades (Bender; Ginis)



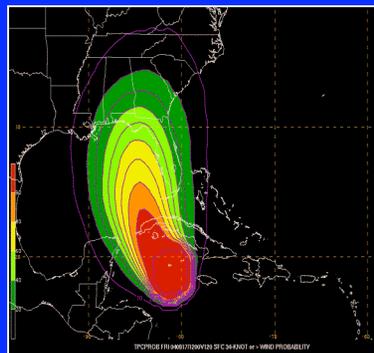
Probability of rapid intensification - ENP (Kaplan)



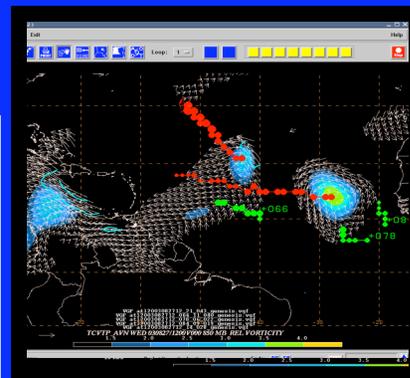
Doppler Winds (Gamache)



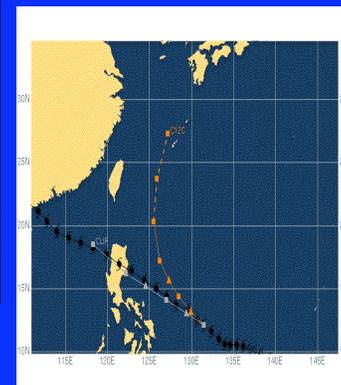
Rain-CLIPER & rainfall verification (Rogers)



SHIPS & Wind Probabilities (DeMaria/Knaff)



Genesis forecasting assessments (Harr)



5 day CLIPER - NWP, ENP, ATL (Aberson)

Highlights of 3rd Round Implemented Projects

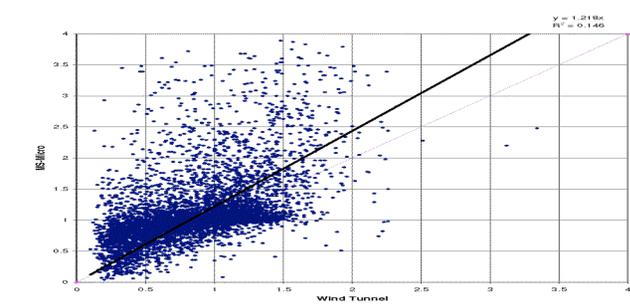
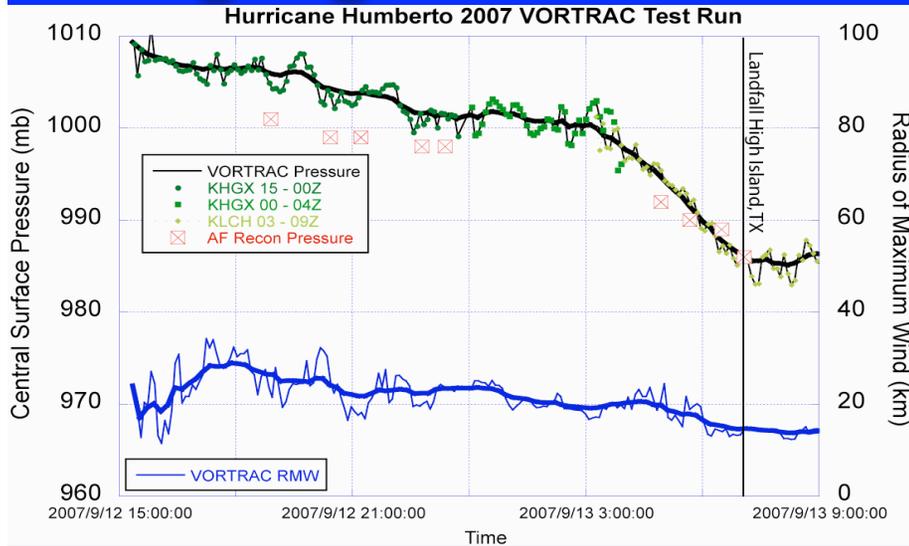
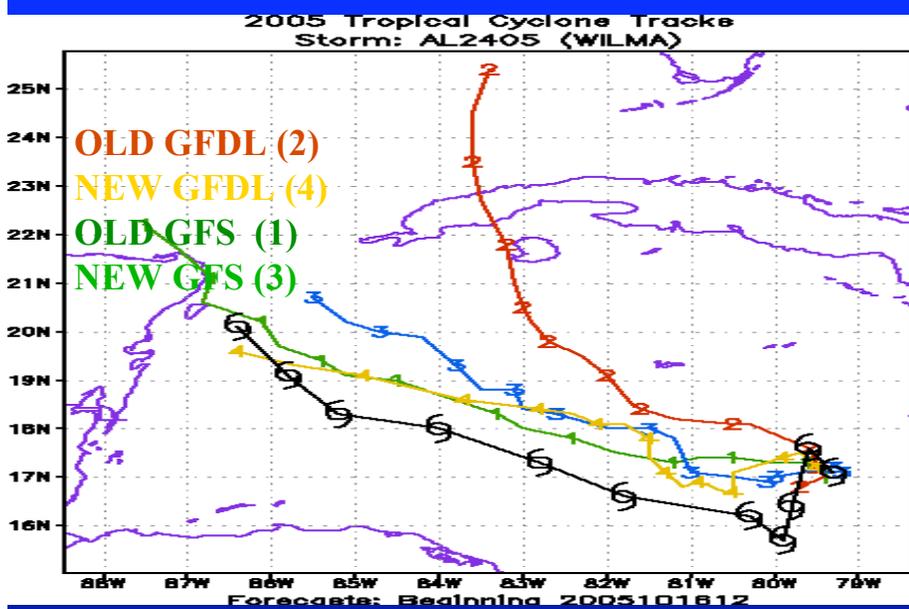


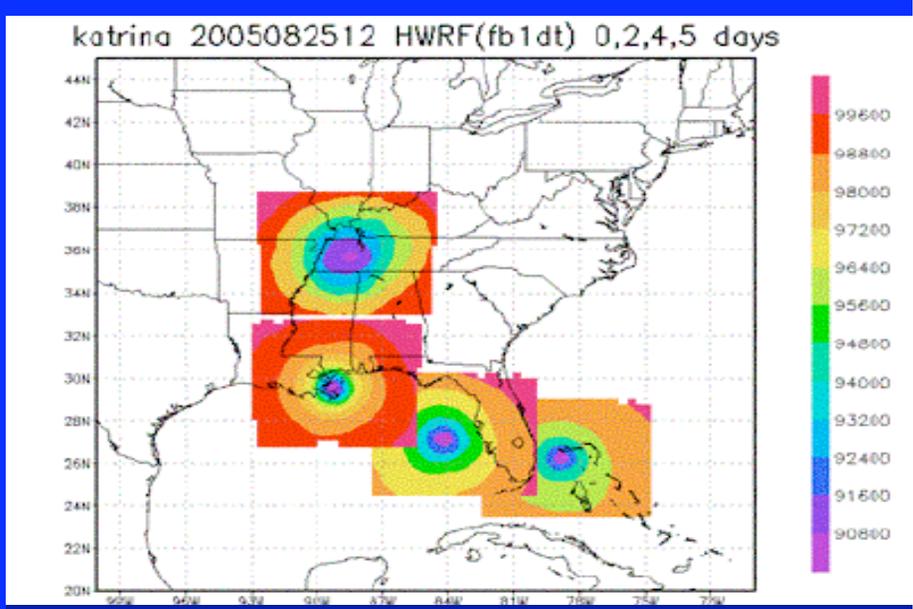
Figure 1: Scatter plot of MS-Micro predicted speed-up factors versus speed-up factors measured in the wind tunnel study of Chock *et al.* (2002) for the islands of Oahu and Kauai

VORTRAC – Lee/Bell/Harasti

Topographic Wind Effects - Miller

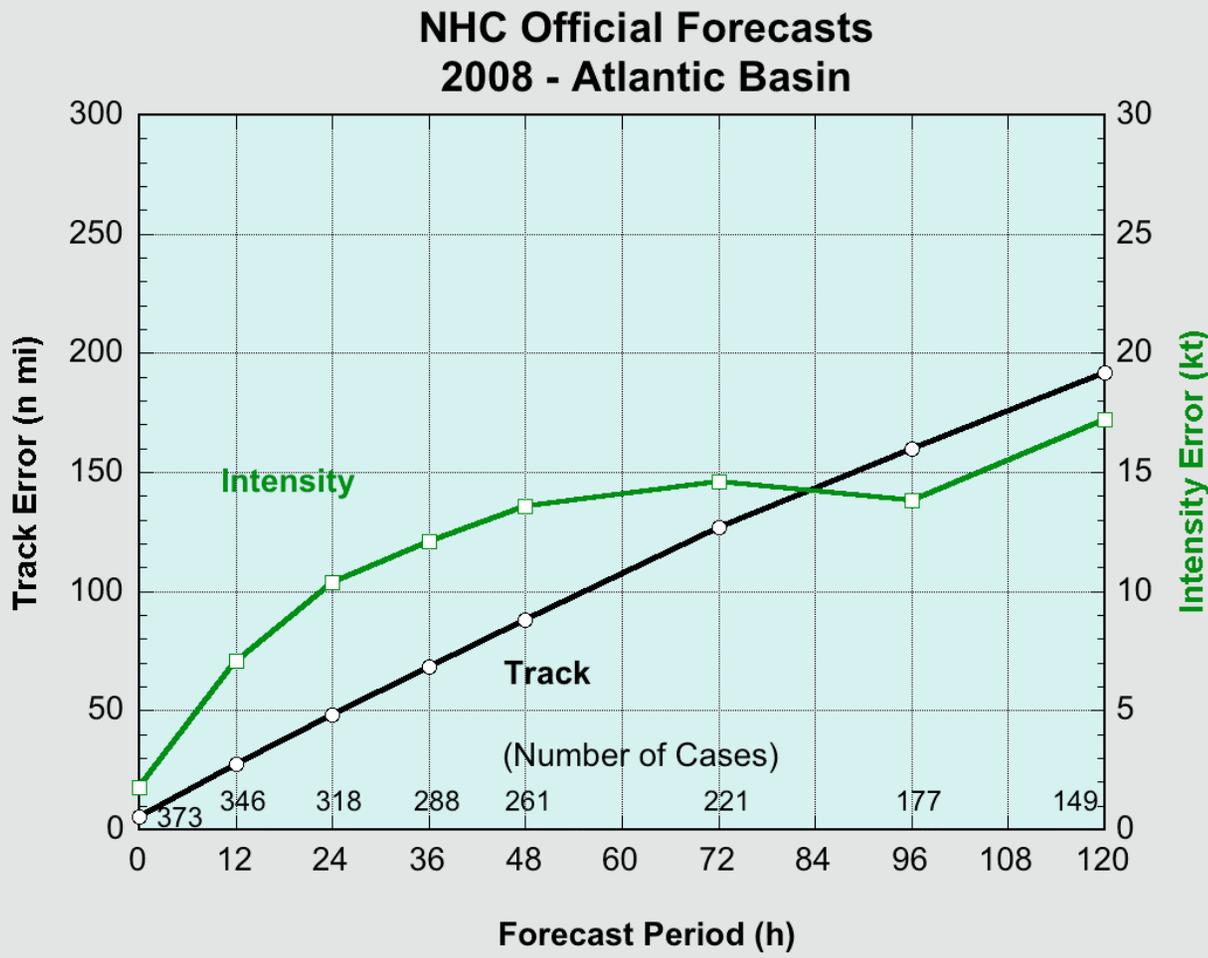


GFDL – Bender



HWRf – Tuleya, Powell

2008 Atlantic Verification

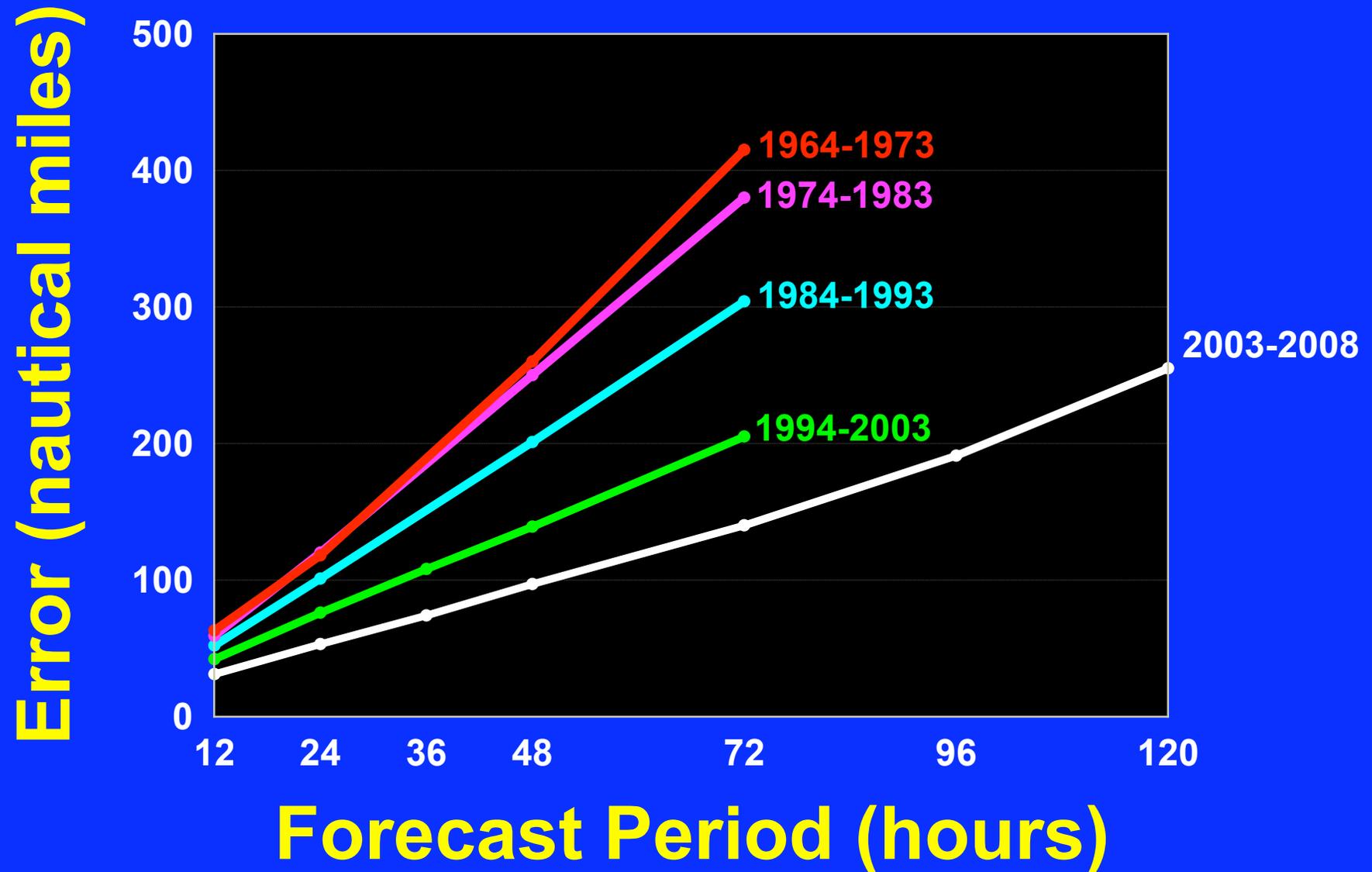


VT (h)	NT	TRACK (n mi)	INT (kt)
000	373	5.7	1.8
012	346	27.7	7.1
024	318	48.3	10.4
036	288	68.6	12.1
048	261	88.2	13.6
072	221	126.9	14.6
096	177	159.8	13.8
120	149	191.8	17.2

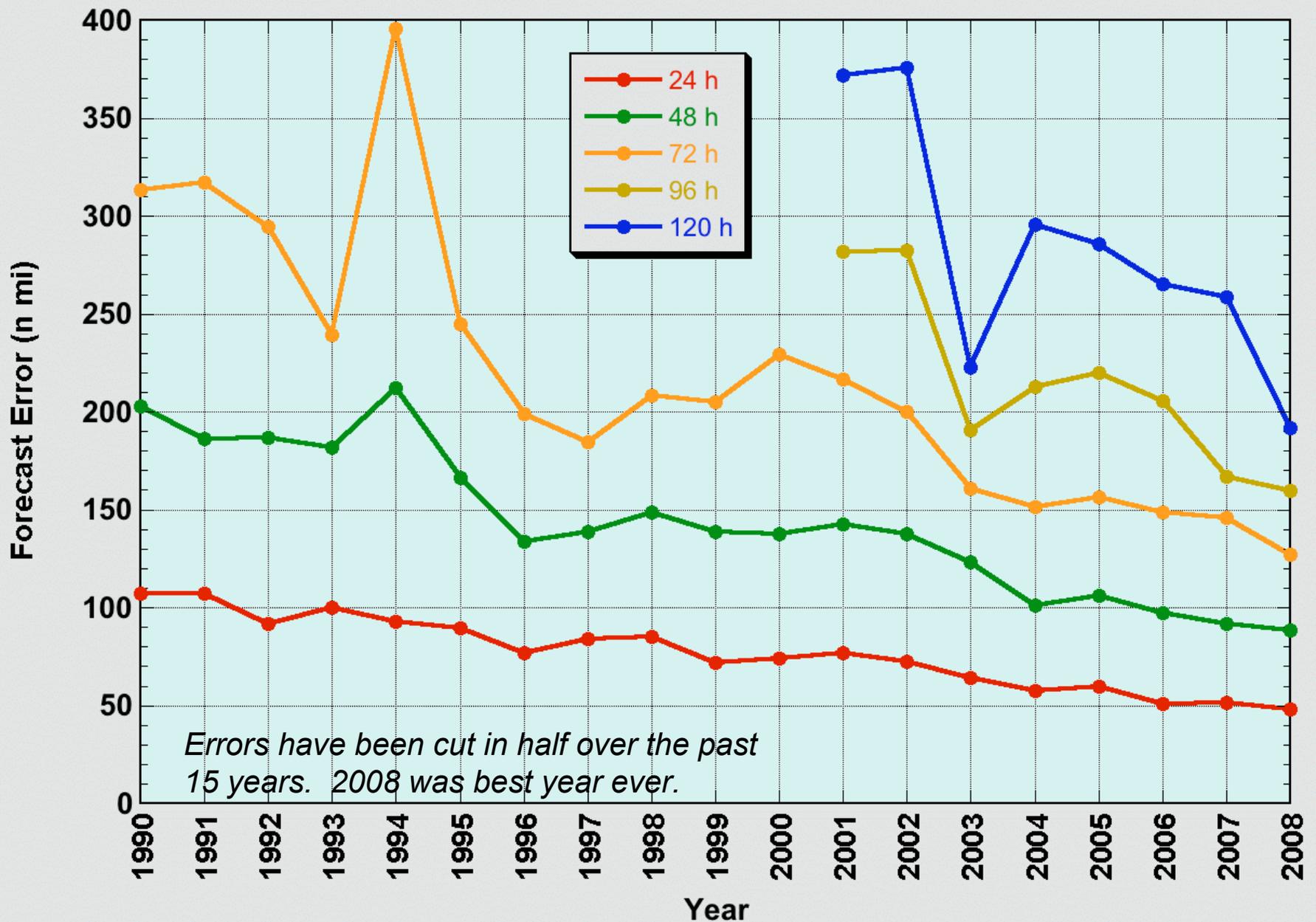
Values in green exceed all-time records.

* 48 h track error for TS and H only (GPRA goal) was 87.5 n mi, just off last year's record of 86.2.

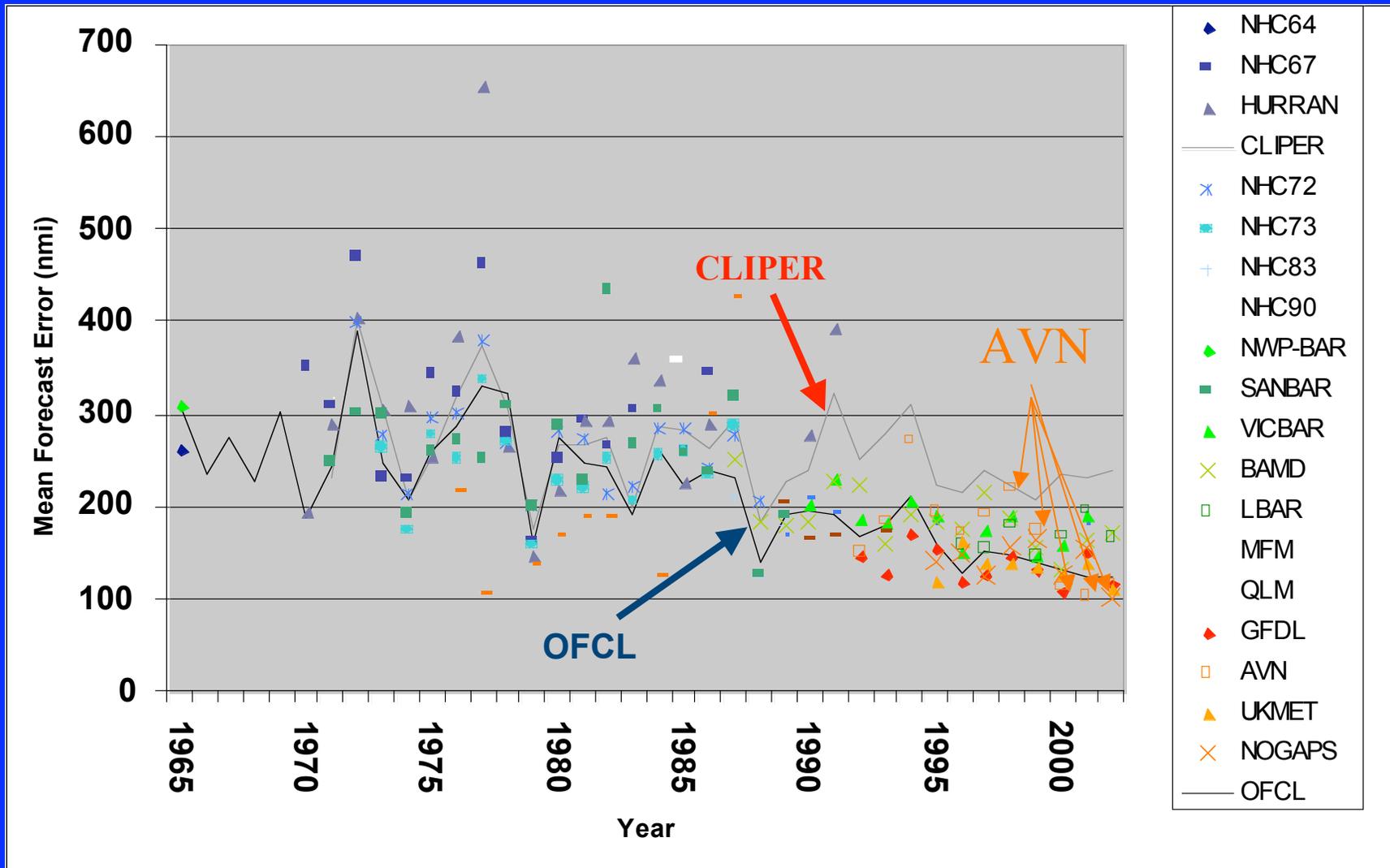
NATIONAL HURRICANE CENTER ATLANTIC TRACK FORECAST ERRORS



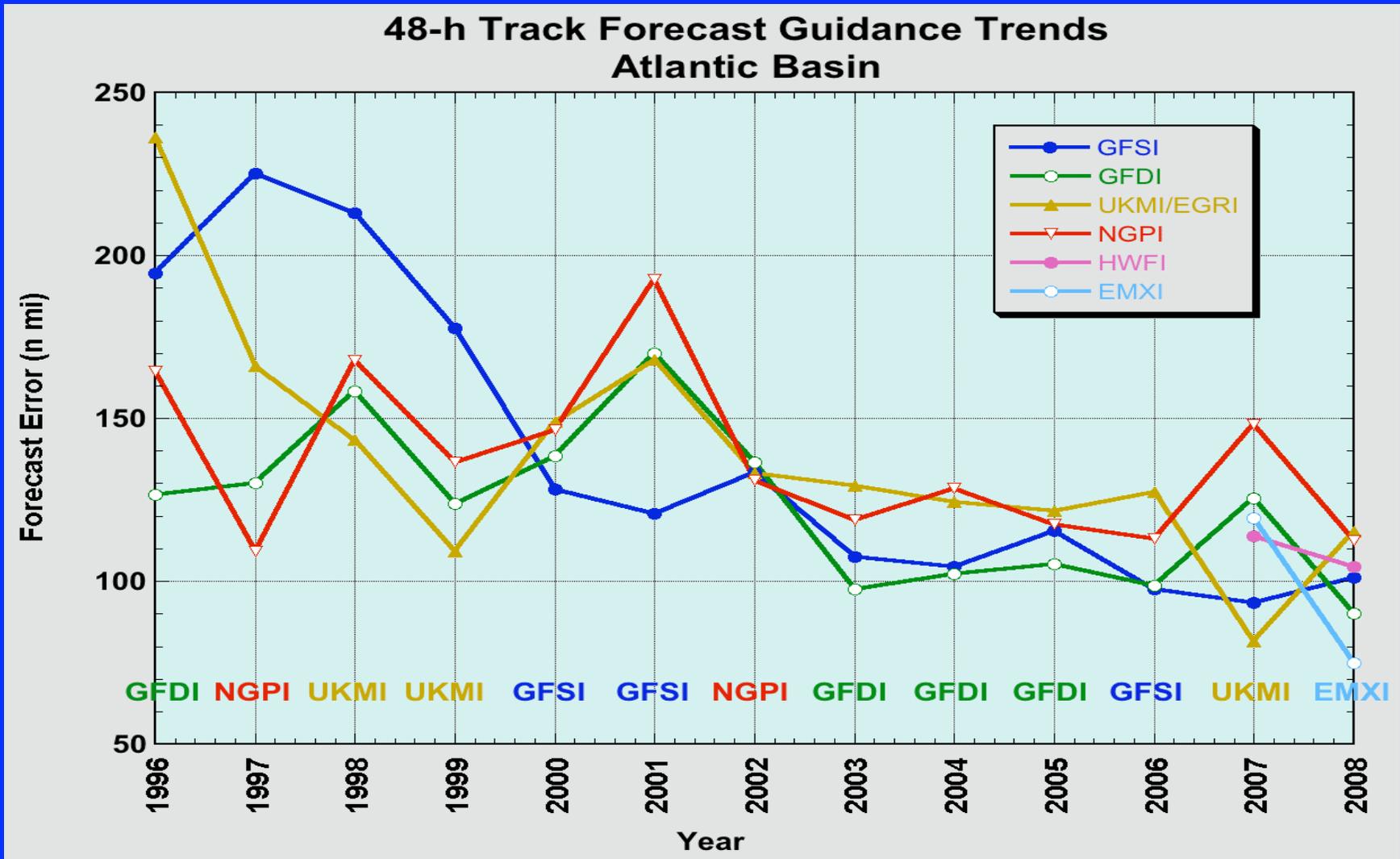
NHC Official Track Error Trend Atlantic Basin



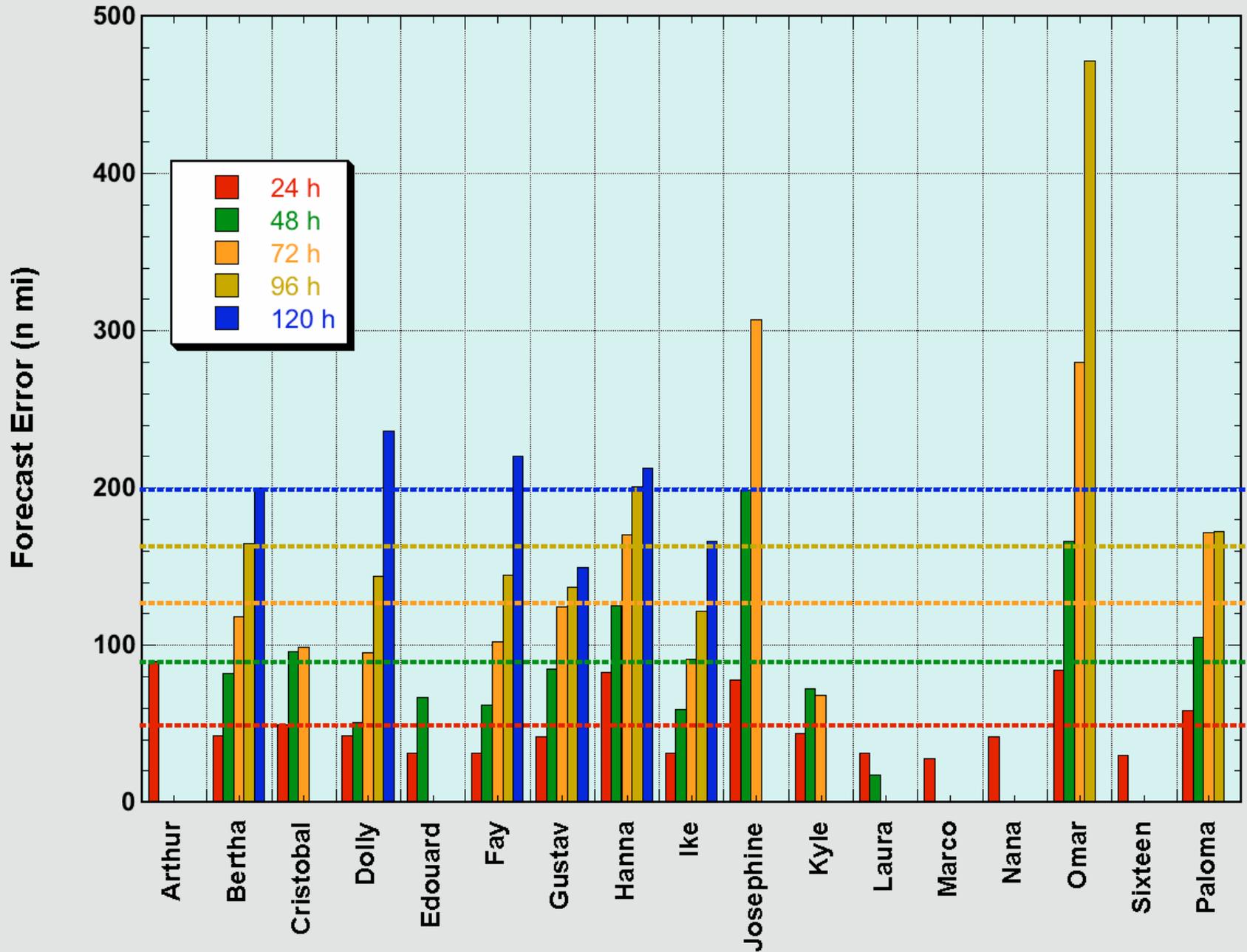
PERFORMANCE OF TRACK MODELS OVER THE YEARS: NOTE THAT THE TOP PERFORMER CHANGES ALMOST EVERY YEAR!



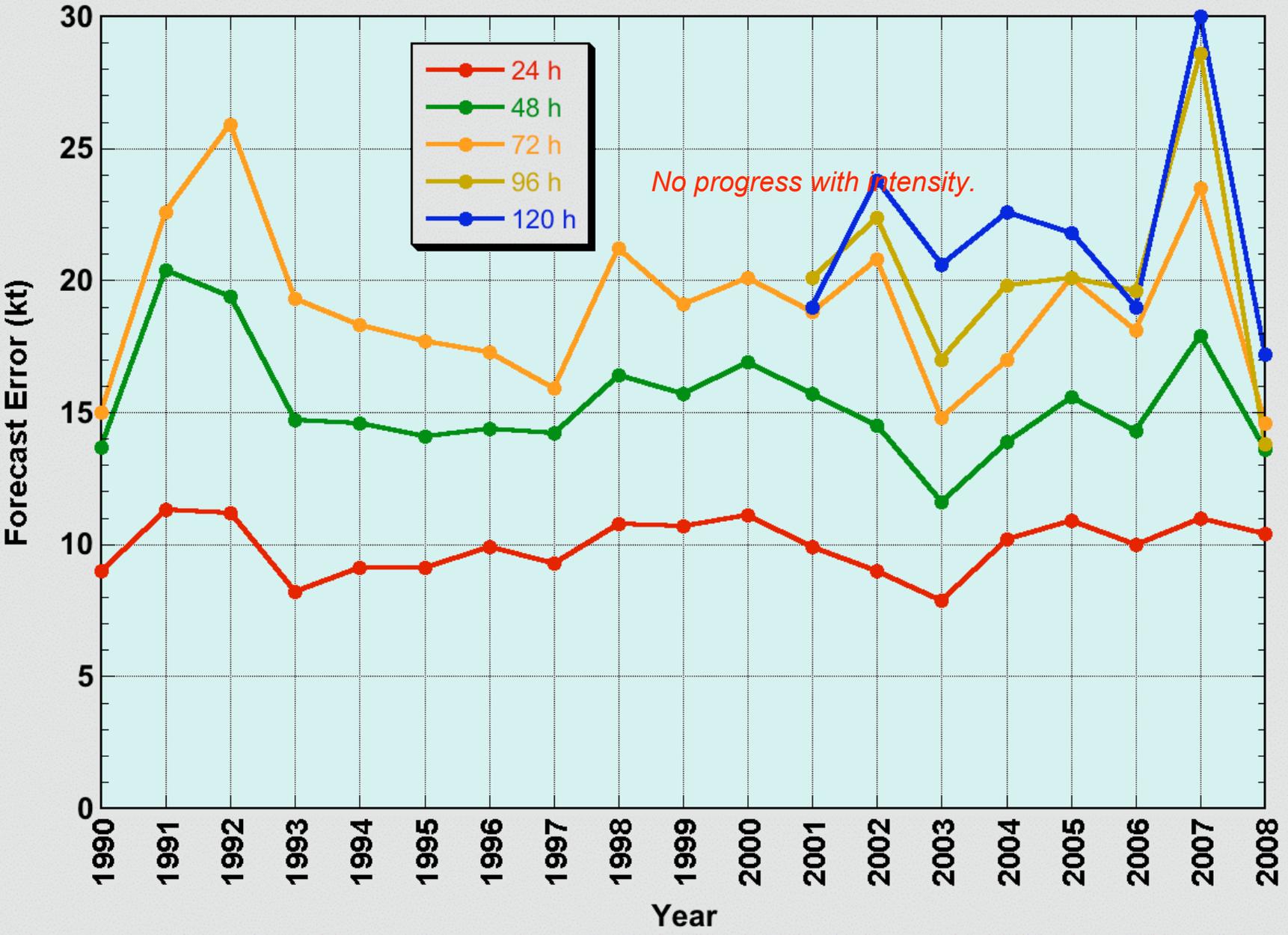
PERFORMANCE OF TRACK MODELS OVER THE YEARS: NOTE THAT THE TOP PERFORMER CHANGES ALMOST EVERY YEAR!



NHC Official Track Forecast Error by Storm 2008 - Atlantic Basin



NHC Official Intensity Error Trend Atlantic Basin



No progress with intensity.

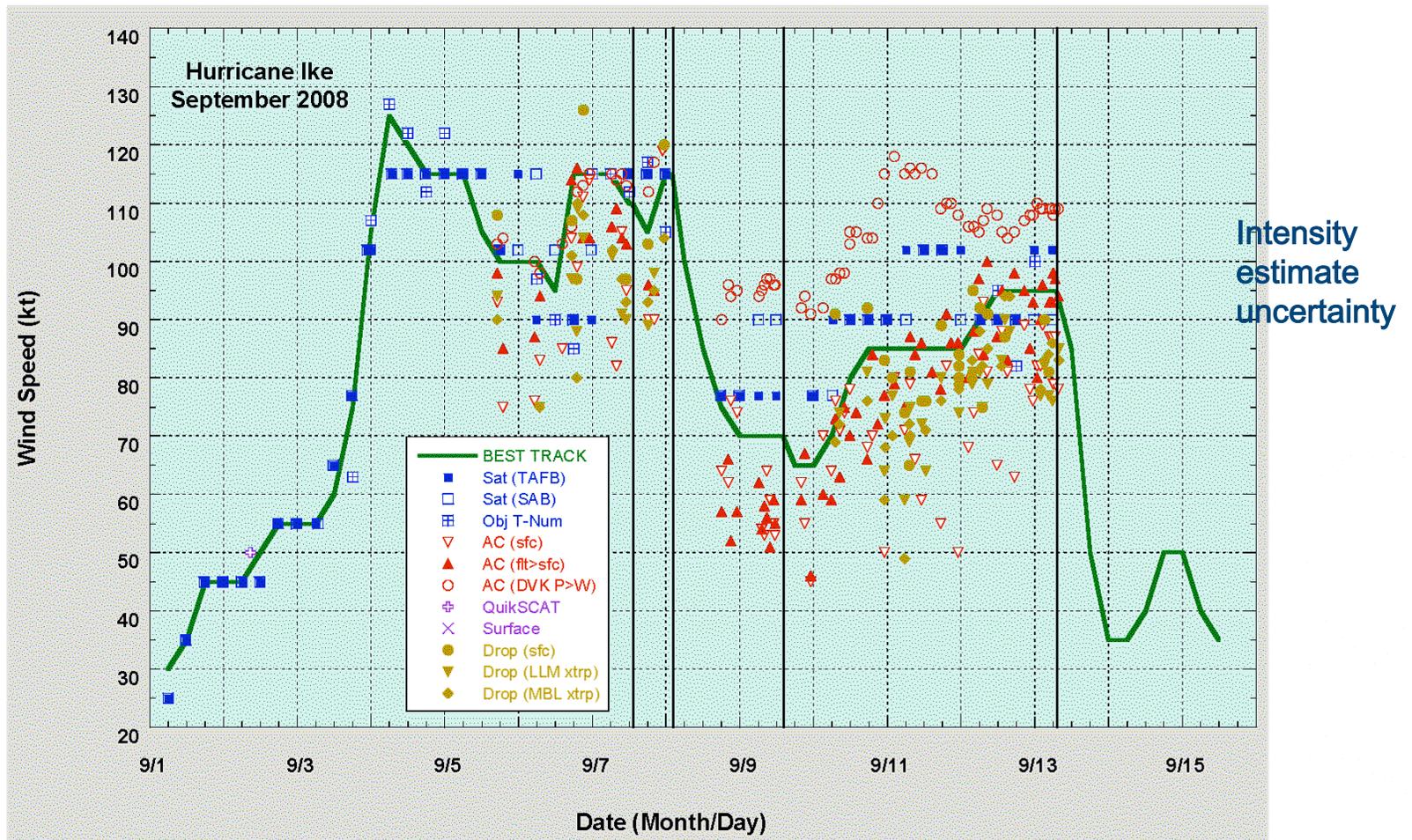


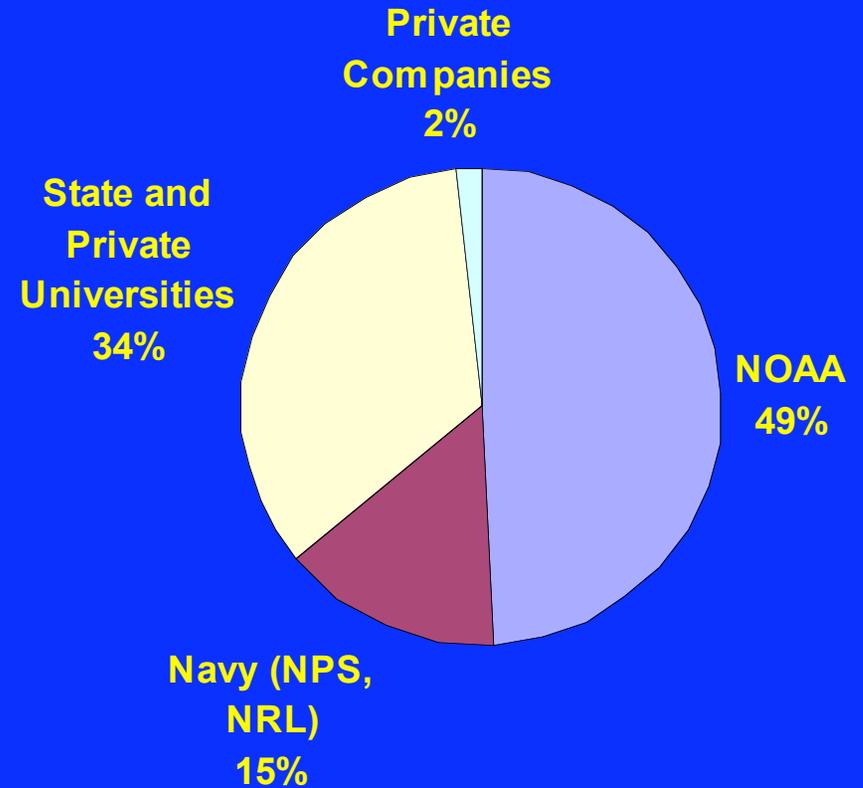
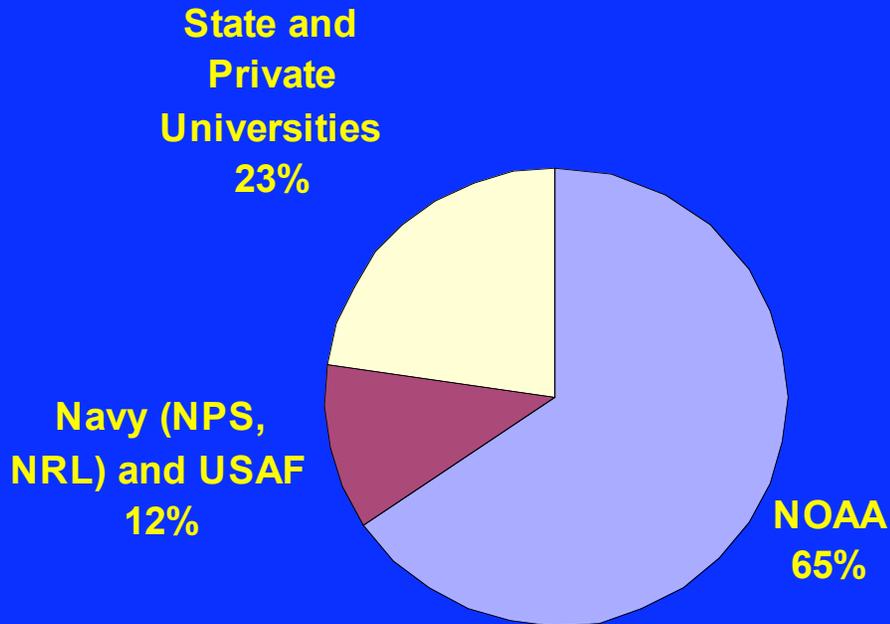
Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Ike, 1 – 14 September 2008. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM), and from the sounding boundary layer mean (MBL). Objective Dvorak estimates represent linear averages over a three-hour period centered on the nominal observation time. Dashed vertical lines correspond to 0000 UTC. Solid vertical lines correspond to landfalls.

Funding Distribution Comparison

Increased funding to researchers outside of NOAA

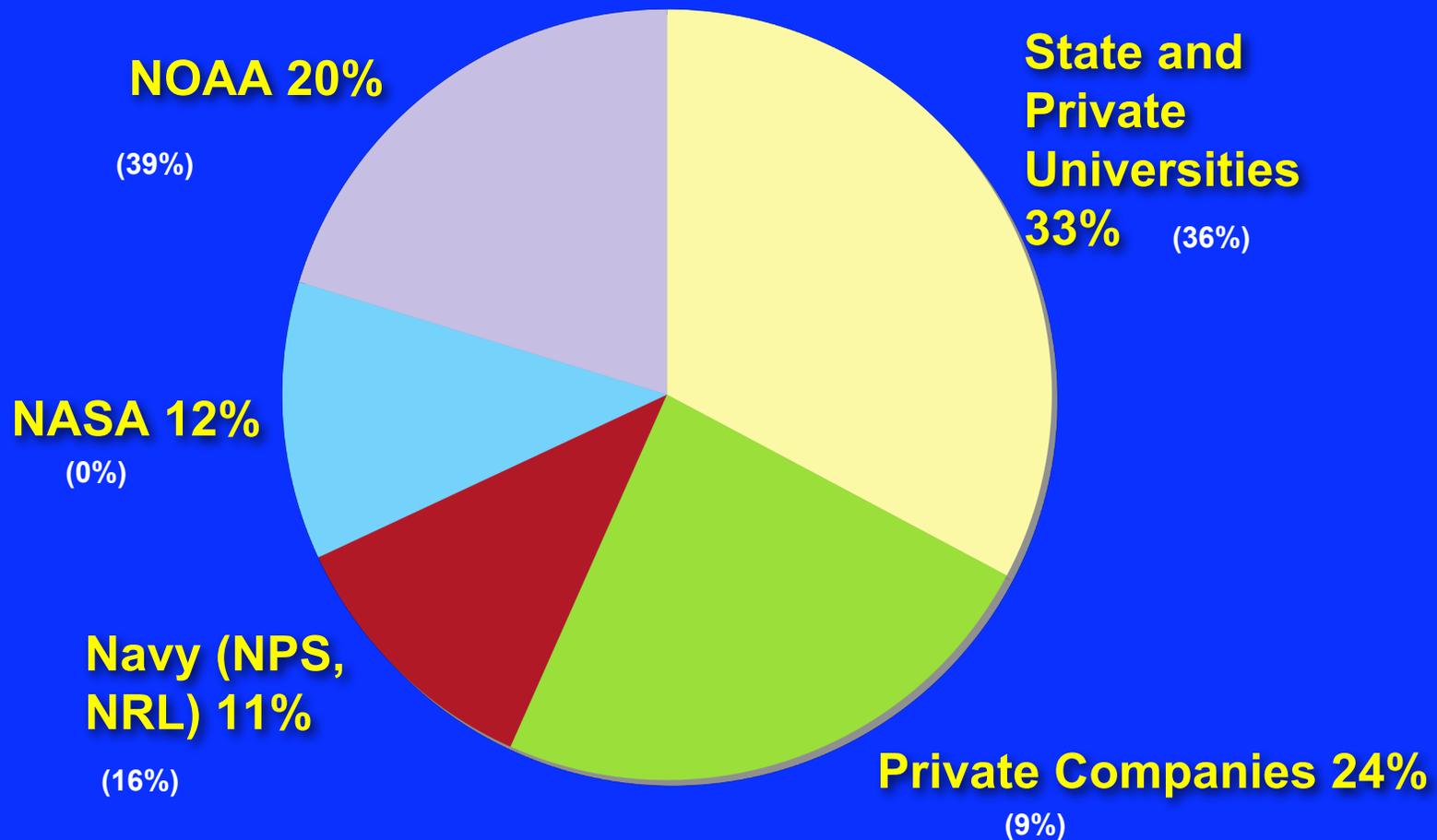
FY2002
\$1.2M

FY2003
\$1.35M



4th Round (FY07-08) Recommended Funding Distribution

Total \$1.04M (\$1.5M announced)



Publicatations

"Large-Scale Characteristics of Rapidly Intensifying Tropical Cyclones in the North Atlantic Basin" by: John Kaplan and Mark DeMaria Weather and Forecasting Volume 18, Issue 6 (December 2003) pp. 1093–1108

"Ocean Data Assimilation and Initialization Procedure for the Coupled GFDL/URI Hurricane Prediction System" by: Aleksandr Falkovich, Isaac Ginis, and Stephen Lord Journal of Atmospheric and Oceanic Technology Volume 22, Issue 12 (December 2005) pp. 1918–1932

"Further Improvements to the Statistical Hurricane Intensity Prediction Scheme (SHIPS)" by: Mark DeMaria, Michelle Mainelli, Lynn K. Shay, John A. Knaff, and John Kaplan Weather and Forecasting Volume 20, Issue 4 (August 2005) pp. 531–543

"On the Decay of Tropical Cyclone Winds Crossing Narrow Landmasses" by: Mark DeMaria, John A. Knaff, and John Kaplan Journal of Applied Meteorology and Climatology Volume 45, Issue 3 (March 2006) pp. 491–499

"A Comparison of Adaptive Observing Guidance for Atlantic Tropical Cyclones" by: S. J. Majumdar, S. D. Aberson, C. H. Bishop, R. Buizza, M. S. Peng, and C. A. Reynolds Monthly Weather Review Volume 134, Issue 9 (September 2006) pp. 2354–2372

"Evaluation of GFDL and Simple Statistical Model Rainfall Forecasts for U.S. Landfalling Tropical Storms" by: Robert E. Tuleya, Mark DeMaria, and Robert J. Kuligowski Weather and Forecasting Volume 22, Issue 1 (February 2007) pp. 56–70

"Prediction of Consensus Tropical Cyclone Track Forecast Error" by: James S. Goerss Monthly Weather Review Volume 135, Issue 5 (May 2007) pp. 1985–1993

"Effects of Precipitation on the Upper-Ocean Response to a Hurricane" by: S. Daniel Jacob and Chester J. Koblinsky Monthly Weather Review Volume 135, Issue 6 (June 2007) pp. 2207–2225

"Validation Schemes for Tropical Cyclone Quantitative Precipitation Forecasts: Evaluation of Operational Models for U.S. Landfalling Cases" by: Timothy Marchok, Robert Rogers, and Robert Tuleya Weather and Forecasting Volume 22, Issue 4 (August 2007) pp. 726–746

"Statistical Tropical Cyclone Wind Radii Prediction Using Climatology and Persistence" by: John A. Knaff, Charles R. Sampson, Mark DeMaria, Timothy P. Marchok, James M. Gross, and Colin J. McAdie Weather and Forecasting Volume 22, Issue 4 (August 2007) pp. 781–791

"A Parametric Model for Predicting Hurricane Rainfall" by: Manuel Lonfat, Robert Rogers, Timothy Marchok, and Frank D. Marks Jr. Monthly Weather Review Volume 135, Issue 9 (September 2007) pp. 3086–3097

"The Operational GFDL Coupled Hurricane–Ocean Prediction System and a Summary of Its Performance" by: Morris A. Bender, Isaac Ginis, Robert Tuleya, Biju Thomas, and Timothy Marchok Monthly Weather Review Volume 135, Issue 12 (December 2007) pp. 3965–3989

"Interpretation of Adaptive Observing Guidance for Atlantic Tropical Cyclones" by: C. A. Reynolds, M. S. Peng, S. J. Majumdar, S. D. Aberson, C. H. Bishop, and R. Buizza Monthly Weather Review Volume 135, Issue 12 (December 2007) pp. 4006–4029

"Application of Oceanic Heat Content Estimation to Operational Forecasting of Recent Atlantic Category 5 Hurricanes" by: Michelle Mainelli, Mark DeMaria, Lynn K. Shay, and Gustavo Goni Weather and Forecasting Volume 23, Issue 1 (February 2008) pp. 3–16

"Experiments with a Simple Tropical Cyclone Intensity Consensus" by: Charles R. Sampson, James L. Franklin, John A. Knaff, and Mark DeMaria Weather and Forecasting Volume 23, Issue 2 (April 2008) pp. 304–312

Acknowledgements

- **JHT Steering Committee**
- **Shirley Murillo, JHT Admin. Asst.**
- **Chris Landsea, JHT Admin. Asst.**
- **Jose Salazar, JHT meteorologist/programmer**
- **NHC and EMC forecaster and points of contact**
- **NHC/Technical Support Branch staff**
- **JHT principal investigators and other funded participants**
- **John Gaynor (USWRP)**
- **NHC admin staff**

JHT Website

Go to www.nhc.noaa.gov

Joint Hurricane Testbed - Home - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.nhc.noaa.gov/jht/index.shtml

NCEP Systems Monitor



- JHT Home
- Terms of Reference (PDF)
- Staff
- Steering Committee
- Main Activities
- Highlights - 2001 to present
- New Projects (2007-2009)
- Current Projects (2005-2007)
- Past Projects
- Administrative Presentations and Information

Mission Statement

The mission of the Joint Hurricane Test Bed 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.

WHAT'S NEW

Updated May 8, 2006:
Please read about the new projects for 2007-2009

Updated November 21, 2006:
The JHT FY07 AFFO Application Deadline has been reopened.

Updated June 16, 2006:
The JHT FY07 Announcement of Federal Funding Opportunity has been released.

Added April 26, 2006:

- The 2005 First Year Reports are available in the Project Table
- Joint Hurricane Test Bed (JHT): 2006 IHC Update, Dr. Jiann-Gwo Jiing, JHT Director, Technical Support Branch Chief, TPC/NHC, Interdepartmental Hurricane Conference, 22 March 2006 presentation. (PDF format)

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Done

Thank you

FY05 JHT Proposal Review Criteria

(Condensed)

- **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)**

Status of 10 First Round Projects (FY01-02)

Project Title	PI(s) and POC(s)	Expected Benefit to TPC	Decision for Operational Implementation
Hurricane Transition to Operations at NCEP/EMC	Naomi Surgi (EMC) Richard Pasch (TPC)	<ul style="list-style-type: none"> • Re-runs show improved forecasts (e.g., ~15% for 2-3 day track in 2001) • Smaller 2003 GFDL track errors 	Implemented by NCEP in 2003
Hurricane Transition to Operations at NOAA/GFDL	Morris Bender (GFDL) Richard Pasch (TPC)		
Tropical Cyclone Rainfall Climatology and Persistence (R-CLIPER) Model	Frank Marks (HRD) Stacy Stewart (TPC) David Roth (HPC)	<ul style="list-style-type: none"> • First guess of TC rainfall potential for use in public advisories • Baseline for verifying rainfall forecasts from numerical models 	Accepted by TPC Director 19 December 2003 Implemented
Ocean Heat Content and Storm-Scale Predictors in the Statistical Hurricane Intensity Prediction Scheme (SHIPS)	Mark DeMaria (NESDIS), John Knaff (CIRA) Miles Lawrence and Michelle Mainelli (TPC)	<ul style="list-style-type: none"> • 2002 results in Atlantic basin show SHIPS improvement out to 72 hours (max about 5% at 48 hrs) • Improvements also in eastern Pacific 	Accepted by TPC Director 19 December 2003 Implemented

Status of 10 First Round Projects (FY01-02)

Project Title	PI(s) and POC(s)	Expected Benefit to TPC	Decision for Operational Implementation
Estimating the Probability of Rapid Intensification Utilizing SHIPS Model Output	John Kaplan (HRD) Lixion Avila (TPC)	Enables forecaster to more quickly assess environment of the current storm in the context of past rapid intensification cases	Accepted by TPC Director 19 December 2003 Implemented
Advanced Microwave Sounding Unit (AMSU) Tropical Cyclone Intensity and Size Estimation Algorithms	Chris Velden (CIMSS), Mark DeMaria (NESDIS), Kurt Brueske (USAF) Jack Beven and Chris Sisko (TPC)	<ul style="list-style-type: none"> AMSU intensity estimates are completely objective, determined from microwave data that can penetrate cloud tops Complements the more subjective Dvorak technique, with similar accuracy 	Accepted by TPC Director 19 December 2003 Being implemented
H*Wind Real-time Hurricane Wind Analysis	Mark Powell (HRD) James Franklin (TPC)	Would provide the ability to assimilate a wide variety of surface wind observations into a common framework for analysis	Not accepted by TPC Director at this time 19 December 2003

Status of 10 First Round Projects (FY01-02)

Project Title	PI(s) and POC(s)	Expected Benefit to TPC	Decision for Operational Implementation
Dynamical Model Track Prediction Evaluation Expert System (DYMES)	Russ Elsberry and Mark Boothe (NPS) Stacy Stewart, Eric Holweg, Laura Salvador (TPC)	Aims to provide track forecast guidance that subjectively improves upon a consensus of numerical models	Deferred by TPC Director until completion of new, related JHT project
Operational Targeting to Improve Prediction of TC Track and Intensity at Landfall	Sim Aberson (HRD) James Franklin (TPC)	Aims to improve upon existing subjective dropsonde targeting strategies by utilizing new objective strategies	Deferred by TPC Director until completion of new, related JHT project
Five-Day Tropical Cyclone Ensemble Forecasting System	Sim Aberson (HRD) James Franklin (TPC)	None	(Not renewed in FY02 after first year of testing)

Second Round (FY03-04) Projects

Dynamical model upgrades, obs/assimilation projects

Proposal	PIs	TPC POC	Yrs
Upgrades to the operational GFDL hurricane prediction system	Bender	Pasch Rhome	2
Improving the GFDL/URI coupled hurricane-ocean model	Ginis	Pasch Rhome	2
Hurricane model transitions to operations at NCEP/EMC	Pan	Pasch Rhome	2
Evaluation of upper ocean mixing parameterizations	Jacob Shay Halliwell	Lawrence Mainelli	2
Real-time dissemination of hurricane wind fields determined from airborne doppler	Gamache	Franklin, McAdie, Blake EMC: several	2
Targeting strategies to improve hurricane track forecasts	Majumdar Aberson Toth	Franklin	2

Second Round (FY03-04) Projects

Cyclogenesis and track forecasting projects

Proposal	PIs	TPC POC	Yrs
Objective and automated assessment of operational global forecast model predictions of tropical cyclone formation and life cycle	Harr	Pasch Avila Blake	2
An updated baseline for track forecast skill through five days for the Atlantic and Northeastern and Northwestern Pacific basins	Aberson	Franklin Gross	1
Quantifying tropical cyclone track forecast uncertainty and improving extended-range tropical cyclone track forecasts using an ensemble of dynamical models	Goerss	Beven Gross	1
Transition of revised dynamical model track prediction evaluation expert system (DYMES)	Boothe	Stewart Roberts	1

Second Round (FY03-04) Projects

Intensity and rainfall projects

Proposal	PIs	TPC POC	Yrs
Improving the validation and prediction of tropical cyclone rainfall	Pan Black Marchok	Stewart Molleda	2
Implementation of the Advanced Objective Dvorak Technique (AODT) and Tropical Cyclone Intensity Estimation (TIE) algorithms at TPC	Kossin Velden	Beven, Rhome, Mainelli, Cobb, Brown	2
Improvements in Deterministic and Probabilistic Tropical Cyclone Surface Wind Predictions	Knaff DeMaria	Lawrence Gross Sisko	2
Development of a rapid intensification index for the eastern Pacific basin	Kaplan	Avila Sisko	2
Developing an inner-core SST cooling predictor for use in SHIPS	Cione Gentemann Kaplan	Avila, Berg, Sisko, Blake	2 47

JHT Third Round (FY05-06) Projects

Dynamical model upgrades, observational, and assimilation projects

Proposal Title	PIs	NHC POC
Hurricane Model Transition to Operations at GFDL/NOAA	Bender	Pasch, Rhome
Hurricane Model Transition to Operations at GFDL/NOAA	Tuleya	Pasch
Drag Coefficient and Wind Speed Dependence in TCs	Powell	Franklin
Dynamic Initialization to Improve TC Intensity and Structure Forecasts	Liou	Pasch
Operational SFMR-NAWIPS Airborne Processing and Data Distribution Products	Carswell , Black, Chang	Beven, Mainelli, Sisko, Lauer
Mapping of Topographic Effects on Maximum Sustained Surface Wind Speeds in Landfalling Hurricanes	Miller	Beven
Assimilating Moisture Information from GPS Dropwindsondes into the NOAA Global Forecast System	Aberson	Franklin, Blake
WSR-88D-derived Diagnosis of Tropical Cyclone Intensity Changes Near Landfall	Lee, Harasti	Stewart, McAdie

JHT Third Round (FY05-06) Projects

Intensity, structure, and track projects

Proposal Title	PIs	NHC POC
Improved Statistical Intensity Forecast Models	Knaff, DeMaria, Kaplan	Avila, Sisko
Enhancement of SHIPS Using Passive Microwave Imager Data	Cecil	Stewart, Sisko
Eastern Pacific Ocean Heat Content Estimates for SHIPS Forecasts	Shay, DeMaria	Avila, Mainelli
Continued Development of Tropical Cyclone Wind Probability Products	Knaff, DeMaria	Lauer
Estimating Tropical Cyclone Wind Radii Utilizing an Empirical Inland Wind Decay Model	Kaplan	Stewart,
Prediction of Consensus TC Track Forecast Error and Correctors to Improve Consensus TC Track Forecasts	Goerss	Beven
Development and Implementation of NHC/JHT Products in ATCF	Sampson	Sisko

* retired