



NOAA Hurricane Forecast Improvement Project

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Outline



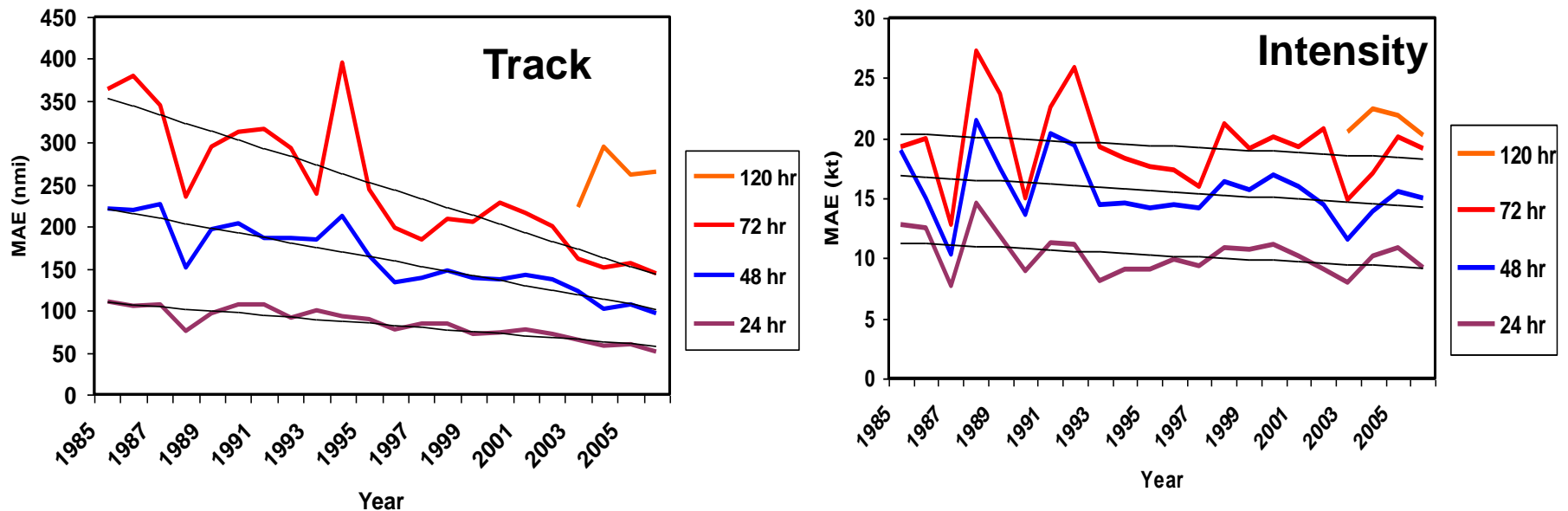
- NOAA Hurricane Forecast Improvement Project
 - Driving Issue
 - Purpose
 - NOAA Vision
 - R&D Priorities
 - R&D Strategy
 - Summary



Historical Hurricane Forecast Performance

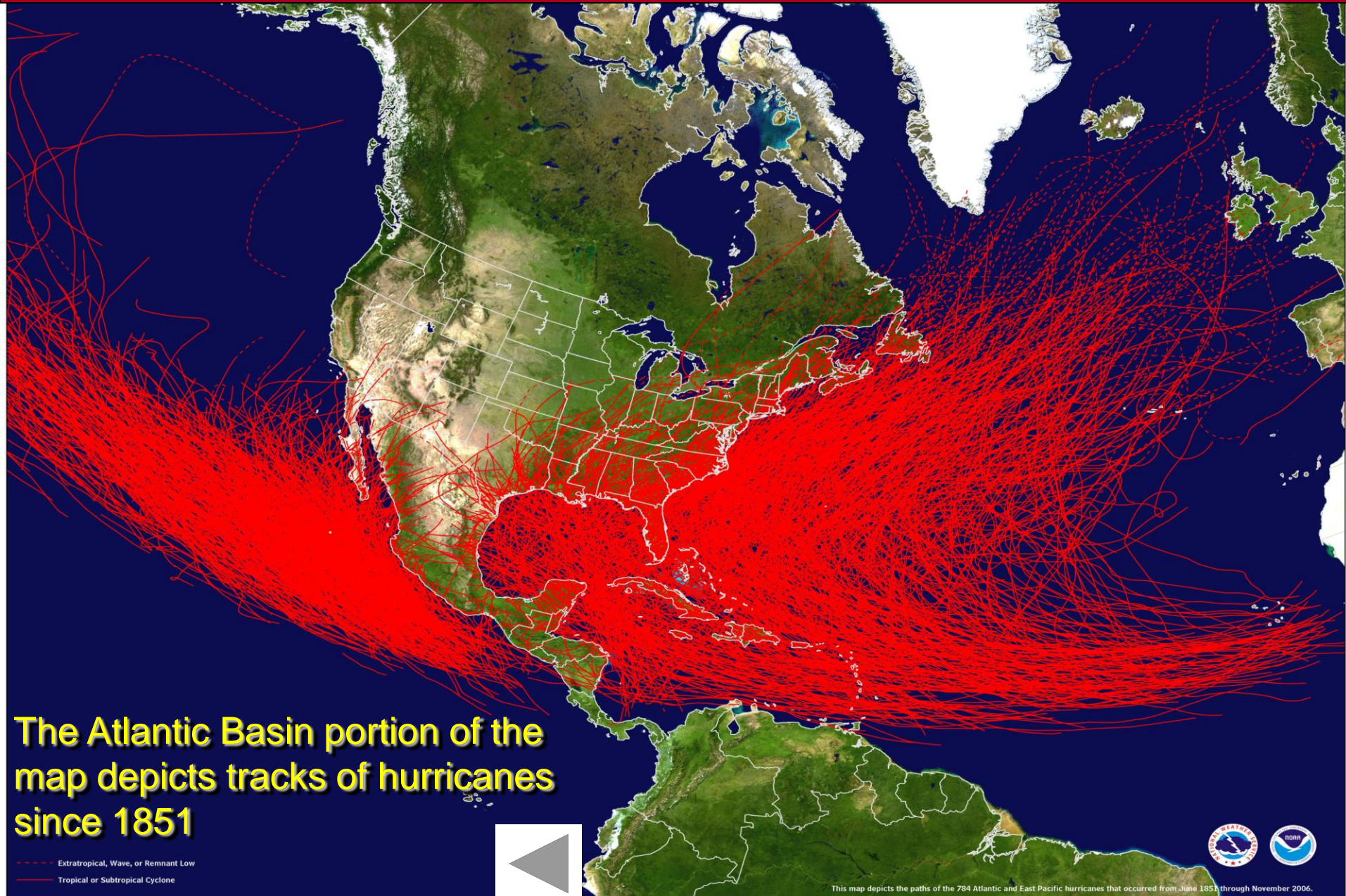


Mean Absolute Error of the 1985-2006 NHC Atlantic Intensity and Track Forecasts



48-hr track forecasts have improved 3.5% per year on average since 1985, while intensity forecasts have improved about 0.8% per year

We are a nation with a vulnerability!





The National Imperative



- Risk to life and property continues to escalate in coastal regions
 - Population continues to increase
 - Value of coastal infrastructure and economic activity continues to rise
- The government can reduce avoidable response and recovery costs with more accurate storm track and intensity forecasts and warnings



NOAA HFIP Issue



- There exists a critical need to improve hurricane forecasts to reduce the impact of these high-threat environmental events. Specific focus:
 - Significantly improve accuracy and lead time of storm track and intensity forecasts (> 50%) – priority – rapid intensity change
 - Improve storm surge forecast
 - Quantify and reduce uncertainty of warnings and forecasts
- Who is/should be involved:
 - NOAA
 - NSF/NCAR, Department of Energy, Navy, NASA, FEMA
 - University Research Community
- Outcome: NOAA forecast performance meeting the national need, both civilian and military
- Why NOAA is supporting this:
 - NOAA has mandate to improve hurricane forecasts and warnings
 - NOAA needs to integrate with national effort to reduce the impacts of hurricanes
 - The desire to help support more hazard resilient communities



NOAA HFIP Purpose



- *Unify the NOAA effort*
- *Provide the basis for NOAA co-leading with NSF, Navy and others a national effort to:*
 - *Define and coordinate National Hurricane Research Agenda*
 - *Apply new science and technology to the hurricane and storm surge warning and forecast problem*
- *Significantly improve guidance to NHC for hurricane track and intensity forecasts*

**Significantly improve NOAA's forecast services
for tropical storms and hurricanes
through
improved hurricane forecast science and technology**



NOAA HFIP Vision



- **A National Hurricane Forecast System (NHFS)** focused on providing accurate and reliable forecast guidance to NHC out to 5-7 days
 - Multi-component global and storm scale atmospheric, wave and oceanic modeling system -- to accurately model the evolution of the hurricane and the environmental controls on intensity
 - Managed ensemble diversity to:
 - Provide ‘Most Probable’ forecast
 - Quantify, bound and reduce forecast uncertainty
 - Optimal use of existing and planned observing systems
 - Advanced forecast techniques for forecaster use
- **Technical Approach**
 - Advanced forecast technology development effort -- IOC ~2013 – initially built upon available research and infrastructure
 - Expanded research effort to produce transformational prediction capability
 - Necessary to advance NHFS capabilities past IOC
 - Include necessary research infrastructure to entrain broader research community
 - Build in transition to operations upfront



Key NOAA R&D Priorities

Basic and Applied Research



- **Focused basic and applied research** effort to improve NOAA's overall ability to predict tropical storms and hurricanes
 1. Better Understanding and representation of dynamics and physics driving the intensification and weakening of storms
 2. Better understanding and modeling of interaction of storm with its environment – ocean, atmosphere, land
 3. Improved specification and characterization of forecast through the application of probabilistic techniques
 4. Improved modeling techniques
 5. Improved data assimilation and specification of initial state (data assimilation)
 1. Better use of existing and planned/programmed observing systems
 2. Better observing strategies
 3. Identification of data gaps



Key NOAA R&D Priorities Technology Development and Transition to Operations



- **Transition research from all sources, federal and academic, to operations** through forecast technology development, test and evaluation
 - Implement global and storm-scale high-resolution modeling technology
 - Accelerate evolution of storm scale operational modeling technology -- using NOAA sustained operational HPC
 - Global and hurricane model data assimilation
 - Transition into operations appropriate (bathymetry, tides, freshwater) upgrades to storm surge modeling system
 - Accelerate development and transition to operations of advanced forecast techniques

A balanced approach to research and development and transition to operations of hurricane forecast technology



NOAA HFIP Goals

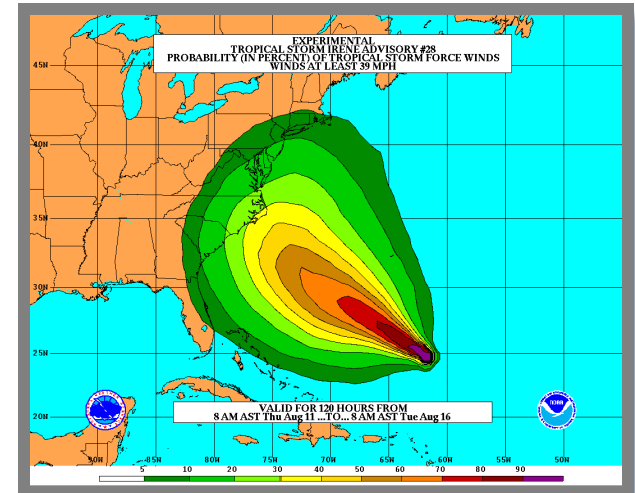


- **Improve** Forecast Accuracy

- Hurricane impact areas (track) – 50% in 10 years
- Severity (intensity) – 50% in 10 years
- Storm surge impact locations and severity

- **Extend** forecast reliability out to 7 days

- **Quantify, bound and reduce** forecast uncertainty to enable enhanced risk management decisions





NOAA HFIP R&D Strategy



- **Research**
 - NOAA Program
 - Focus NOAA effort which complements and supports external (non-NOAA) research
 - Encourage external participation with grants program
 - Visiting scientist program at NOAA offices
 - External
 - Support creation of National Hurricane Research Alliance of federal labs and academia, including potential NSF sponsored centers
 - Focus basic and applied research with national basic and applied research agenda
- **Research to Operations**
 - Strengthen critical research and development, test and evaluation, infrastructure, and process
 - DTC/NHRTB
 - Joint Hurricane Test Bed
 - R&D Computing dedicated to hurricane research and forecast technology improvement
 - Storm surge modeling test-bed
 - Adoption of modeling architecture



Critical HFIP Dependencies



- NOAA Airborne Doppler Radar Program
- NOAA Operational Hurricane Observing Program
- Joint Center for Satellite Data Assimilation
- National Unified Operational Prediction Capability
 - Tri-Agency partnership for advancing the National operational global modeling capability
 - Next-generation global ensemble modeling system
- Coordinated development with NOS coastal, estuary, and inundation modeling program
- WRF DTC – Leverage DTC capabilities
- Leverage THORPEX sponsored activities (NAEFS, predictability research)
- USWRP- Support of JHT and DTC Activities in FY09 and FY10
- Coordinated research and development with Navy in atmospheric (global and hurricane), oceanic, and wave modeling
- External High Performance Computing



HFIP Project Summary Output



- **10 year project to improve of hurricane forecast technology to meet national needs – Improved Forecast Guidance**
 - Track - 50% Reduction in average error
 - Intensity – 50% reduction in average error
 - Improved skill in forecasting rapid intensity change
 - Improved storm surge forecasts
- **Requires**
 - **Research to improve understanding** of hurricane dynamics, physics, environmental interaction
 - R&D to **translate improved understanding into improved forecast technologies** – includes R2O
 - **Improved Data Assimilation** to exploit existing and planned observations
 - **Improved HPC** to allow for improved data assimilation and high resolution models
- **NOAA Outcomes**
 - **Improved Service Levels**
 - Increased forecast reliabilities at longer lead times
 - Reduced Over-warning
 - **Optimized Storm Observing Strategies**
 - Substantially increases overall ROI on NOAA observing system investments
- **Bottom Line Outcome**
 - More **effective emergency management response** through more accurate information at longer lead-times prior to landfall
 - Overall **reduction in loss of life and preventable economic losses** to society from storm impacts



HFIP Budget



FY 2009

- HWRF/SLOSH O&M \$1.0M (new)
- NHFS Transition \$3.0M (new)
- NHFS Development (\$17M – supplemental funding)
 - Development \$11.0M
 - HPC - \$6.0M
- Hurricane Research \$6.2M

FY 2010

- HWRF/SLOSH O&M \$1.0M
- NHFS Transition \$3.0M
- NHFS Development (new)
 - Development \$10M
 - HPC - \$3M
- Hurricane Research \$6.2M



Administration Policy



- Executive Office of President, Statement of Administration Policy, Oct 5, 2009:
 - **“However, within this funding level, the administration urges the Congress to provide the additional \$13 million requested to support accelerated improvement of hurricane track and intensity forecasts, which will help to prevent unnecessary and costly evacuations.”**



HFIP Project Risks



- Availability of Computing Resources for development
 - Mitigation
 - MOA with DOE & INCITE Proposal
 - TACC Proposal
- Availability of either sustained or on-demand HPC operational computing in FY 12/13 timeframe
 - Mitigation
 - NOAA leadership in developing a national On-demand computing concept with DOE, NASA, NOAA, and NSF
 - Work to gain concept endorsement by OSTP and OMB
 - Work with Climate Program to develop an in-house capability
- Existing high-resolution systems require significantly more R&D before operational transition
 - Mitigation – Begin model evaluation in FY08 to define R&D needs to prioritize effort
- Insufficient manpower and expertise within NOAA to accomplish goals within NOAA
 - Mitigation – Expand NOAA HFIP to include ONR, NSF, NASA, Academic Community



Key near term priorities FY2010



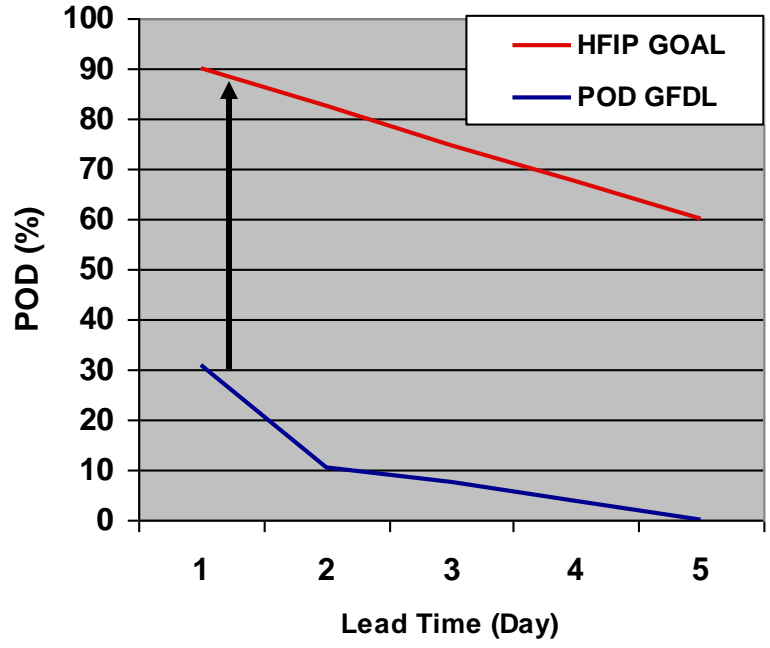
- Continue **demonstration of advanced capabilities**
 - High Resolution ensembles (global and regional hurricane)
 - Model initialization (global and regional hurricane)
 - Advanced Physics
- Continue development of **investment strategy for high resolution NHFS**, including operational computing
 - Develop test plan for quantifying impacts
 - Link to HPC and funding requirements
- **Open the Funnel** – Support development and implementation of tested new functionality
 - Improved Transition processes
 - New Products
 - Operational modeling upgrades
- Continue National Hurricane R&D Alliance Development
 - Roles and Responsibilities – National Partnerships
 - National Funding strategy
- Continue Development of Strategic Global Modeling Partnerships (DoD Partners) for improving global modeling – atmosphere, ocean, wave
 - NAEFS
 - NHFS



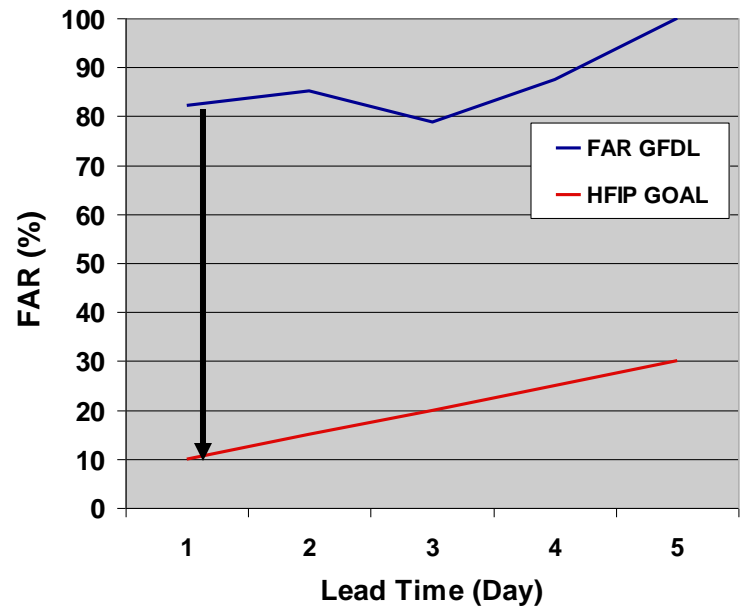
Back-ups



Primary HFIP Metric Goals



HFIP “stretch” goals for model guidance for rapid intensification





NOAA Hurricane Forecast System



Hurricane-Wave-Ocean-Surge-Inundation Coupled Models

