Preliminary Report

NOAA Science Advisory Board

Hurricane Intensity Research Working Group

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Outline

- Motivation
- Charge
- Working Group Membership
- Process
- Hurricane Intensity
- Preliminary Findings
- Six Preliminary Recommendations
- Summary

Motivation

- Continual improvement over the last two decades in forecasting of hurricane track
- **Simultaneously, little improvement in forecasting of intensity – *why*?**
- Recent “surprises”: rapid changes in hurricane intensity, especially just before landfall
  - Charley – 2004 – rapid strengthening just before landfall
  - Katrina – 2005 – rapid weakening just before landfall
  - Wilma – 2005 – rapid strengthening to record central low pressure

Charge

- Independently assess current “state-of-science” and R&D activities in NOAA and elsewhere with respect to hurricane intensity, and then
- Recommend an agenda of R&D activities that will lead to an improved understanding of the processes determining hurricane intensity and the timely transfer of that understanding to operations.

Working Group Membership

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Dr. Richard Rotunno
National Center for Atmospheric Research

Dr. Peter Webster
Georgia Institute of Technology

Process

- Meetings
  - Washington, D.C.
  - Miami, FL
  - Boulder, CO
- Teleconferences
- ftp site
- Preliminary Report
- Feedback and additional meetings
- Coordination with NSB study
- Final Report

Hurricane Intensity

- NHC: Intensity = peak sustained surface winds anywhere in the storm
- Occurs through a set of poorly understood, complex processes involving both external environmental influences and internal vortex dynamics, e.g.,
  - Environmental influences, atmosphere and ocean
  - Internal variability (e.g., eyewall replacement cycle)
  - Rapid intensification and weakening
- Wide range of time and space scales involved

Preliminary Findings 1: Key National Hurricane Center Guidance Needs

- Formation phase to become named tropical storm
- **Timing and magnitude of rapid intensification**
- **Decay and re-intensification cycles**
- **Timing and magnitude of rapid decay**

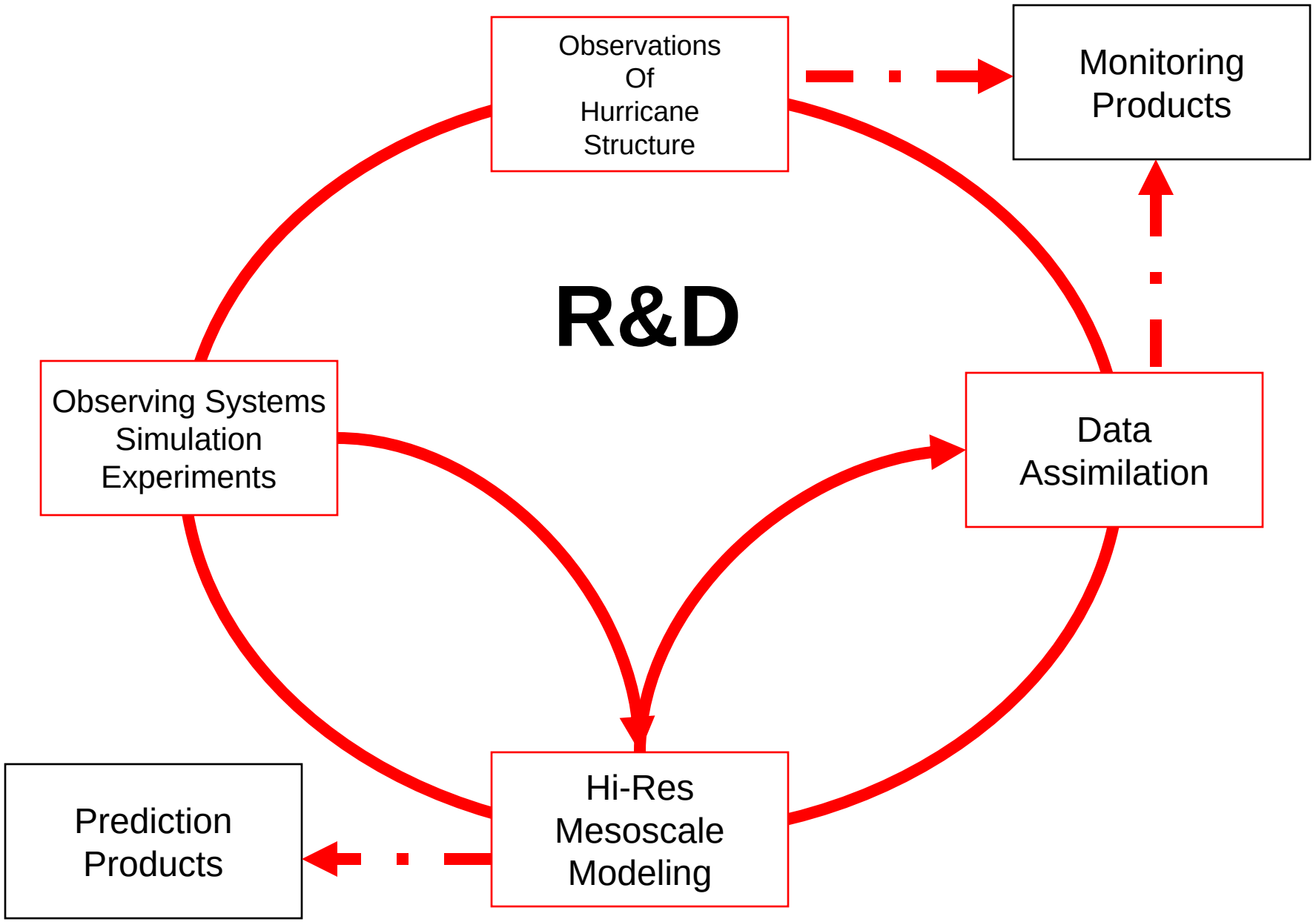
Preliminary Findings 2: Current Situation

- Improvement of intensity forecasting, elimination of "surprises" is high priority for many, but no "national need" has been articulated by national leadership
- Significant number of activities – observational, R&D, tech transfer, operational -- underway inside (and outside) of NOAA, but no single point of leadership
- Interconnections, coordination, collaboration between activities range from poor to good → fragmentation
- Given complexity of problem to be addressed, "critical mass" is lacking – limited human resources, financial wherewithal, no national focus → progress slow
- **Numerous bright spots on which to build, leverage**

Six Preliminary Recommendations

- Attaining Critical Mass
- Observations of Hurricane Structure
- Data Assimilation
- High Resolution Mesoscale Modeling
- Operations Research and Socio-Economic Impacts
- Accelerating Transfer from Research to Operations

Point: Recommendations interdependent


Observations
Of
Hurricane
Structure
Monitoring
Products
R&D
Observing Systems
Simulation
Experiments
Data
Assimilation
Prediction
Products
Hi-Res
Mesoscale
Modeling

1. Attaining Critical Mass

High Resolution Mesoscale Modeling is a key activity – with redirection of GFDL, limited development/implementation staff at NCEP, and lack of modeling capability at HRD, NOAA currently has very limited resources for both in-house mesoscale model development and interfacing with wider research community

- **Short-term:** Ensure H-WRF is implemented in a timely manner; requires an enhanced effort, better connections to external research community
- **Short-term:** Increase modeling capability at HRD (numerous immediate paybacks) and enhance exchanges between NCEP and broader community
- **Medium-term:** Establish hurricane R&D *center of specialized expertise* in proximity to NHC, drawing on HRD, NCEP, DTC, JHT others → restore separate lab status?
- **Medium-term:** Cooperative efforts with other government agencies, universities, private sector

2. Observations of Hurricane Structure

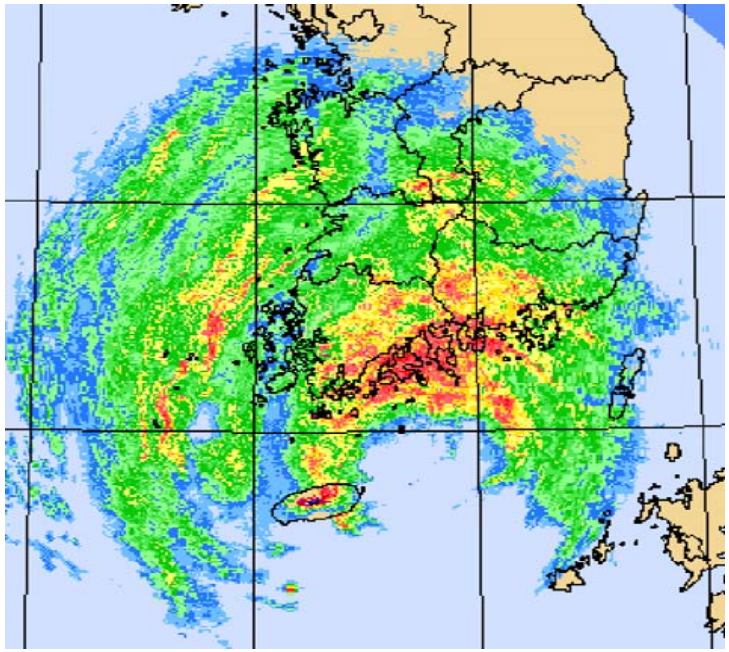
Numerous observing systems provide data on hurricanes (satellites – critical for monitoring, aircraft, buoys, radar) and promising new technology is in-hand (SFMR) or on horizon (UAS, radar on G-3)

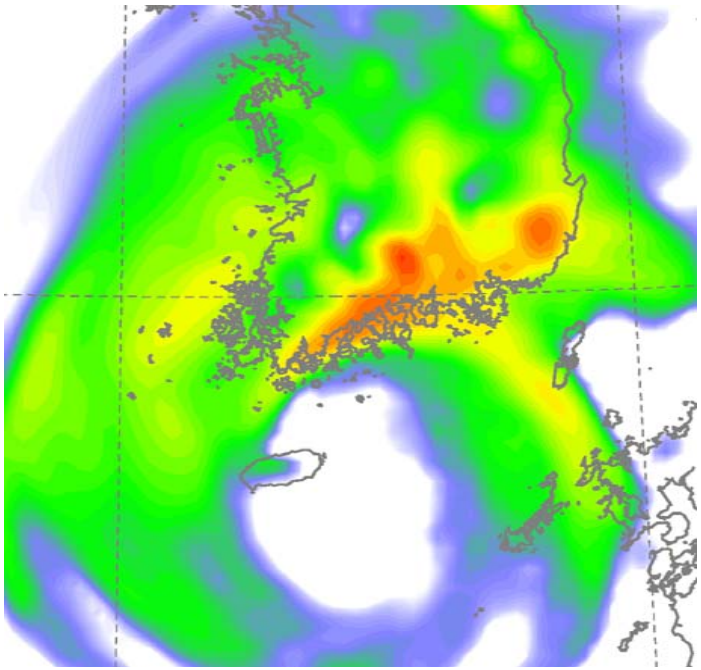
- **Near-term:** Airborne and surface-based radars offer best opportunity to observe mesoscale fields in core region → real time assimilation into models
- **Near-term:** "Low and Slow" Unmanned Aircraft Systems (UAS) demonstrations to assess ability to provide low altitude *in situ* observations, complementing manned aircraft observations
- **Medium-term:** Observing System Simulation Experiments (OSSEs) needed to determine optimal configurations of observing systems for improved forecasts

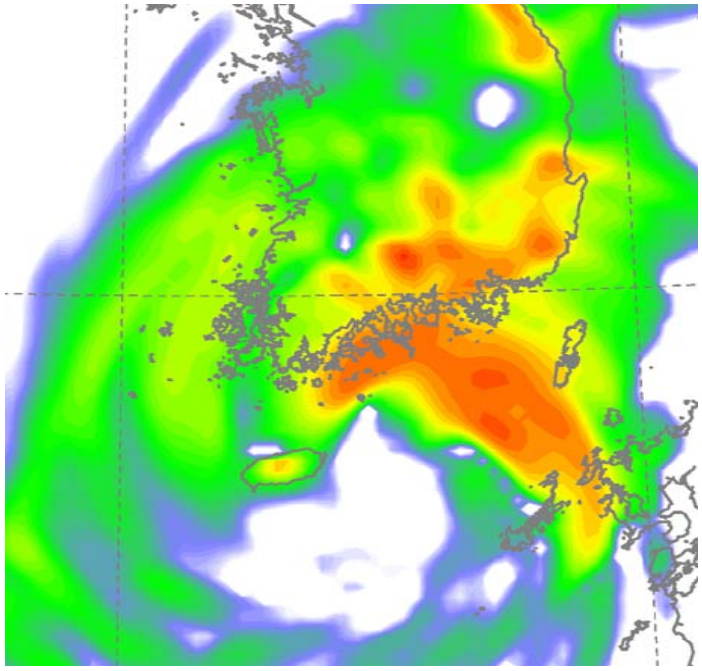
3. Data Assimilation (DA)

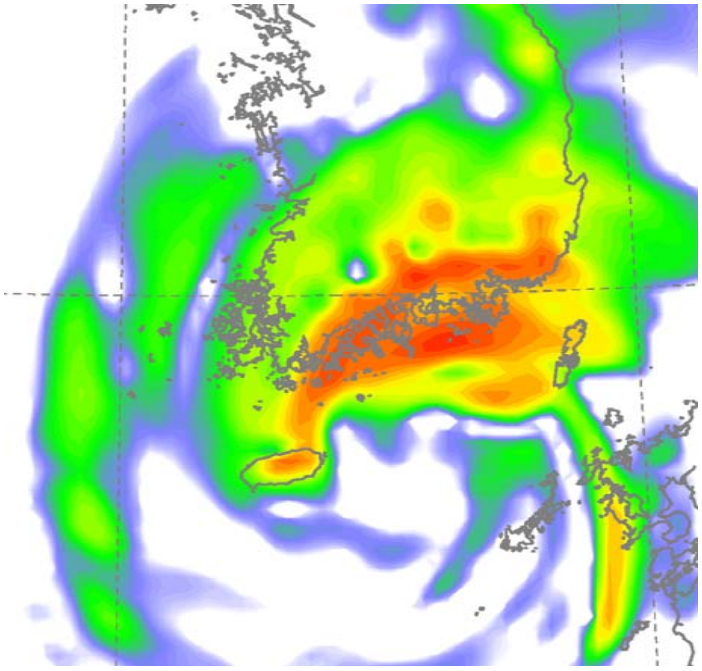
Crucial to obtaining value from nontraditional observations (radar, satellite, dropsonde, etc…) to initialize, update models

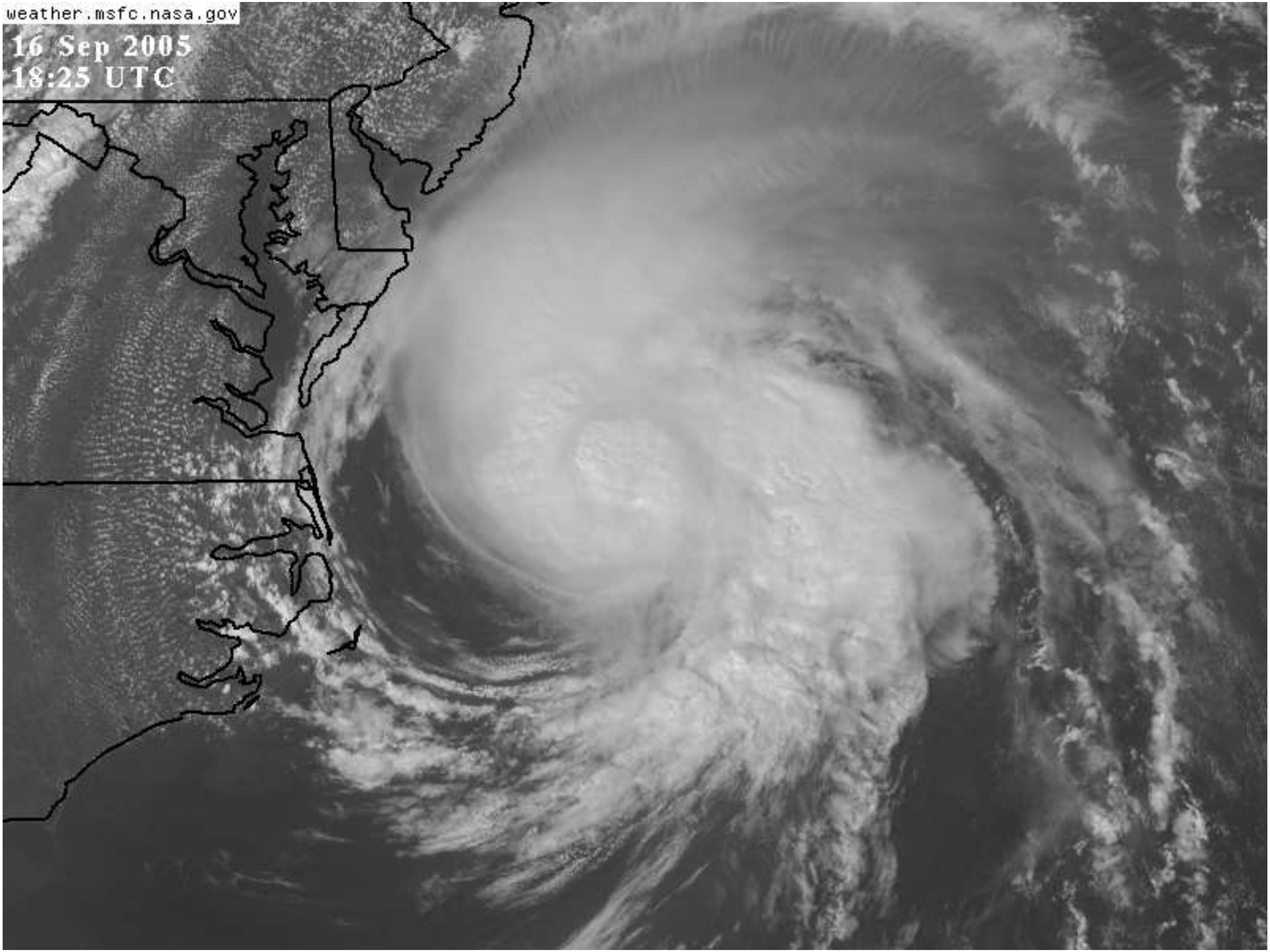
- **Near-term:** Explore developing first-guess fields using mesoscale model output as well as global model output
- **Near-term:** 3DVAR DA
- **Medium-term:** 4DDA







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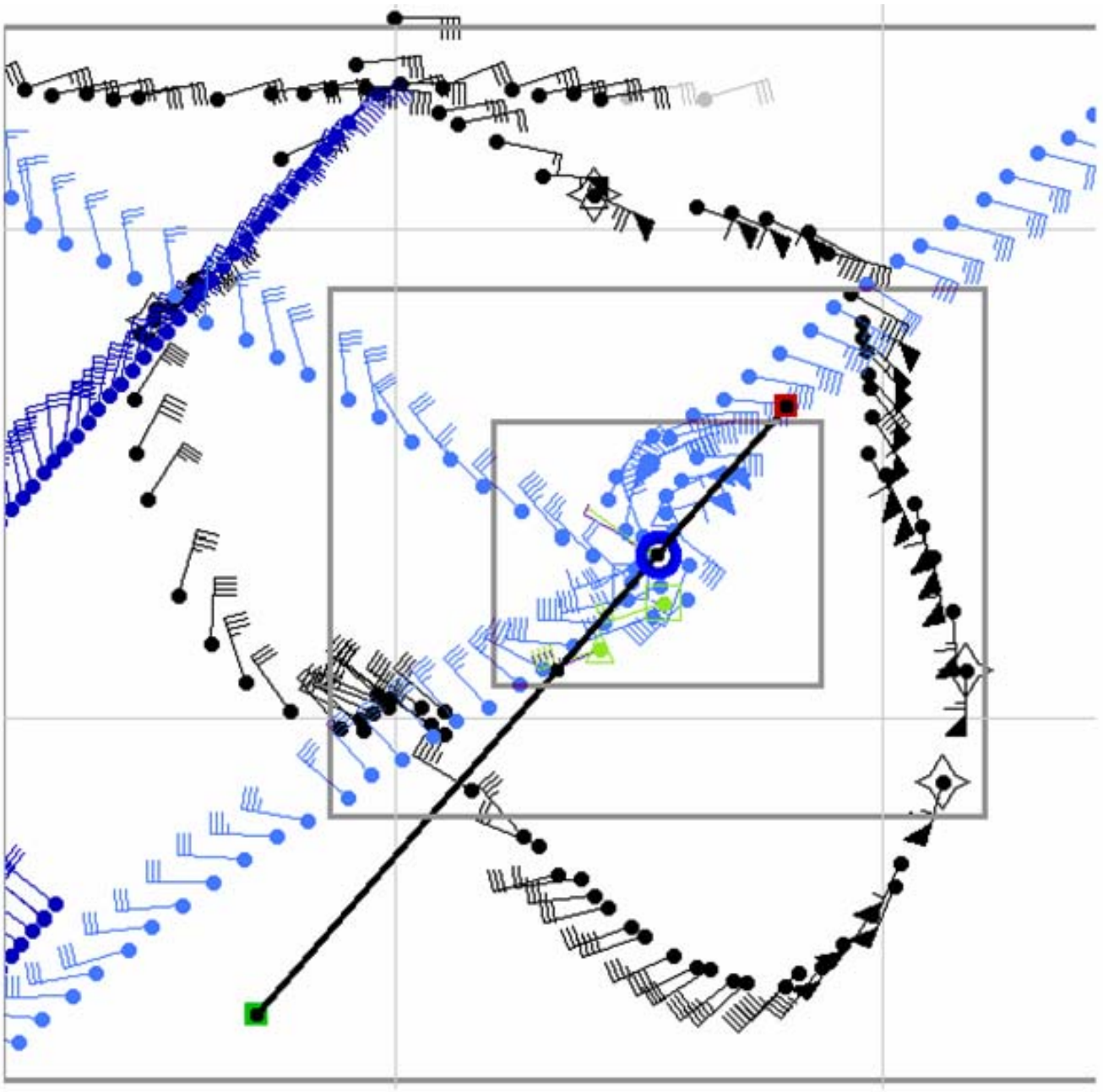
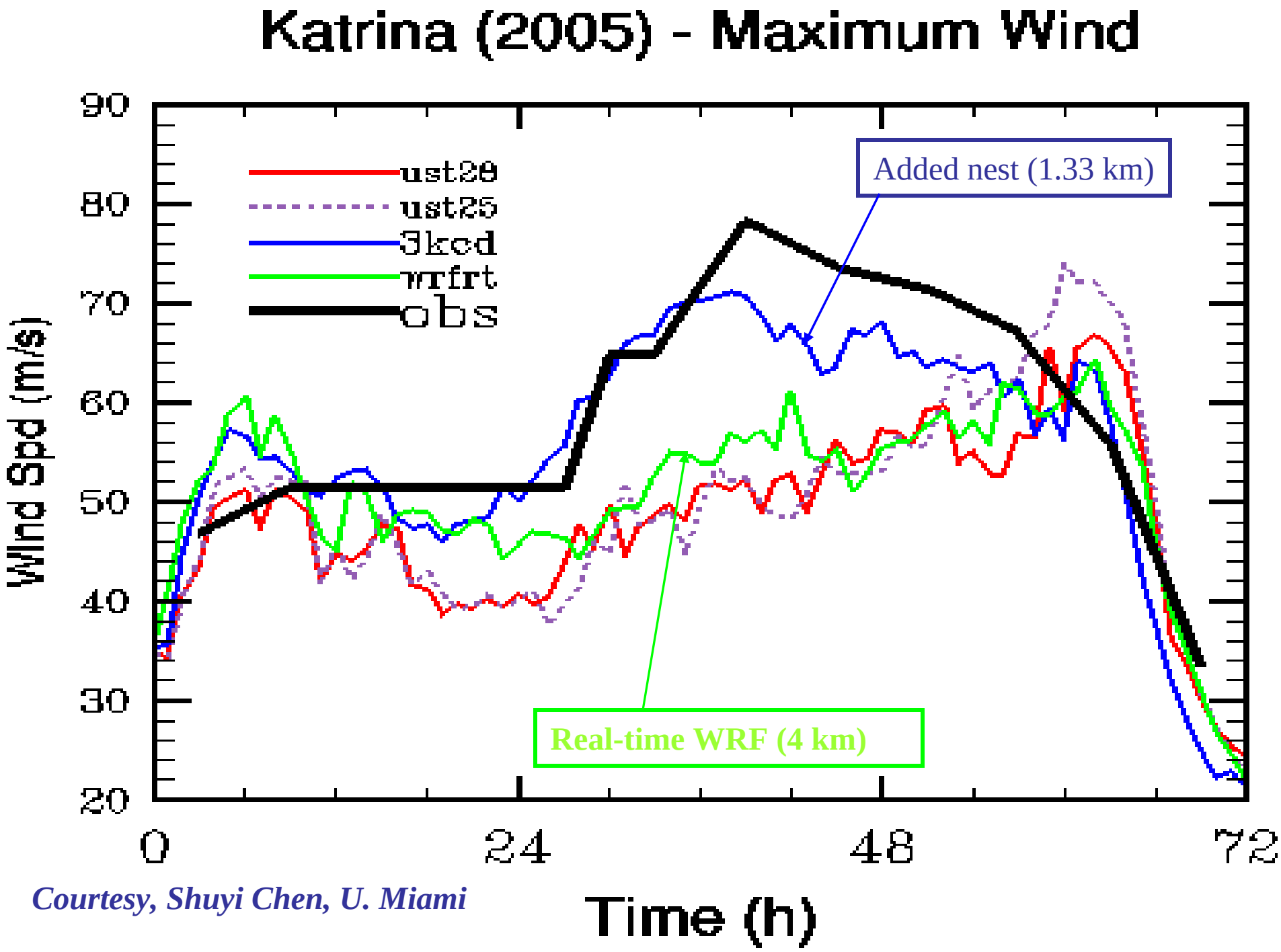


Plot from Peter Black 2005, provided by Greg Holland, 2006

4. High Resolution Mesoscale Modeling

Many indications that models must have resolution approaching 1 km to capture phenomena in the core region important to accurate prediction of intensity

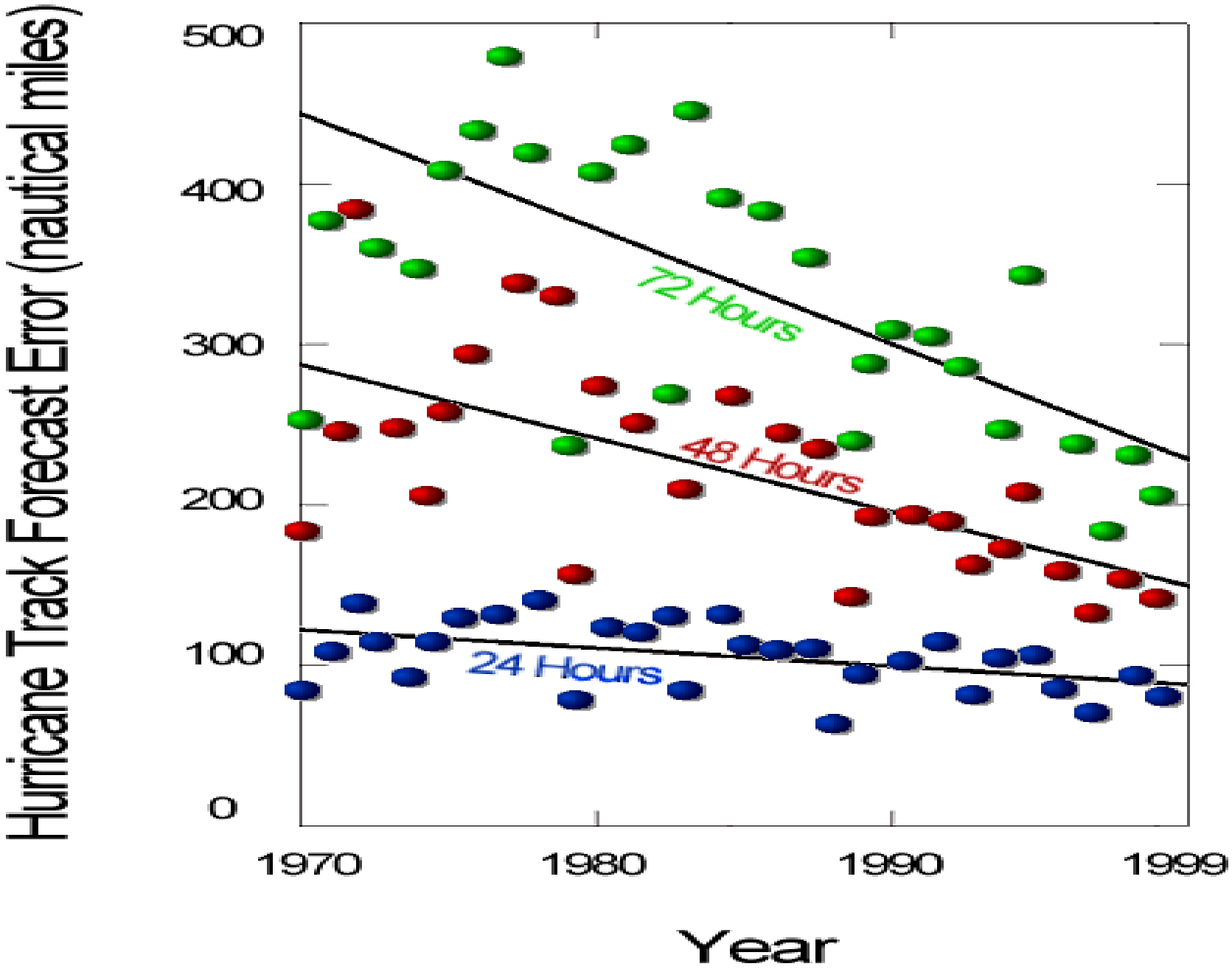
- **Near-term:** Exploit recent field experiments (CBLAST, RAINEX) for improving models
- **Medium-term:** Additional field experiments to validate high-resolution models
- **Medium-term:** NOAA acquire capability to produce 1 km resolution forecasts



Courtesy, Shuyi Chen, U. Miami

5. Operations Research and Socio-Economic Impacts

- **Near-term:** Understand how forecasters, other users will apply improved intensity predictions to decision making, use to inform design of intensity products and services
  - explore results from improved track forecasting
- **Medium-term:** Explore possibilities, options for providing “impact” products as opposed to simple warnings about intensity



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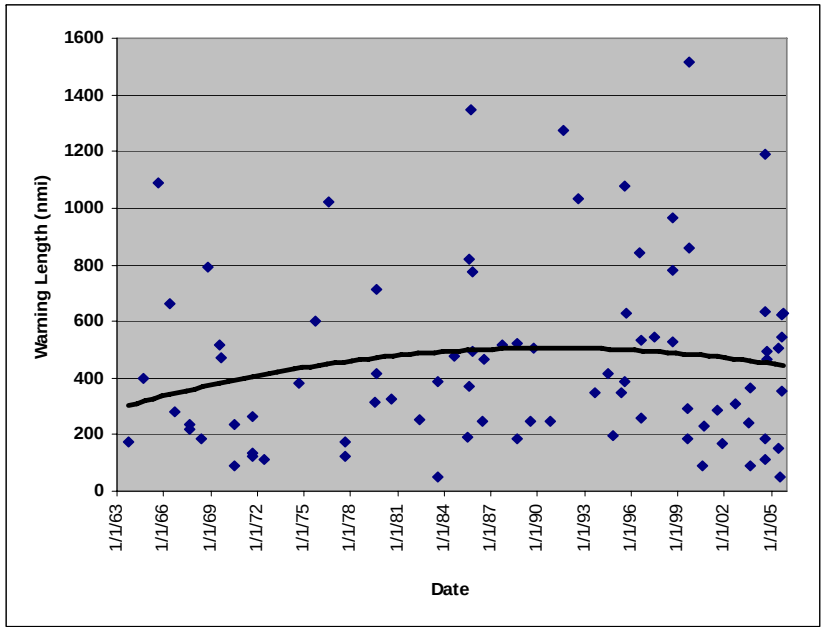
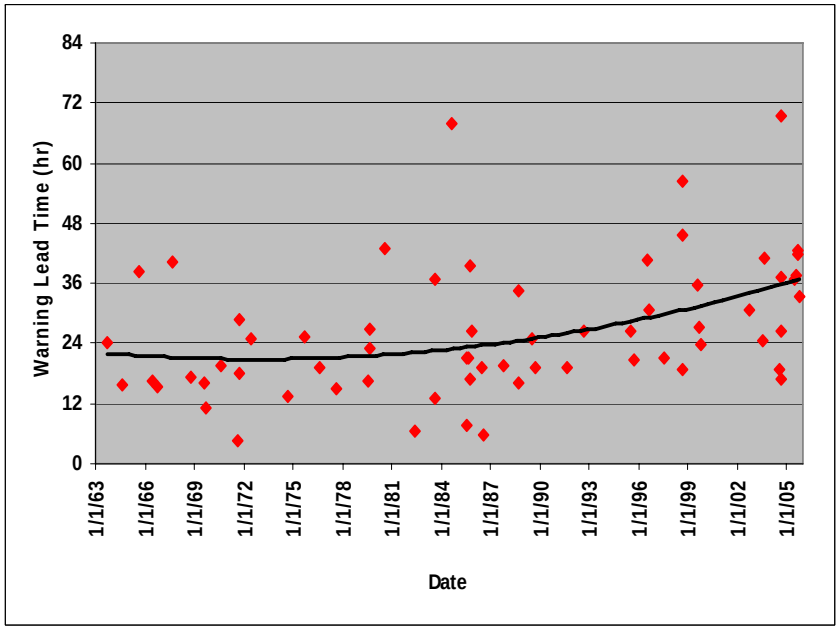
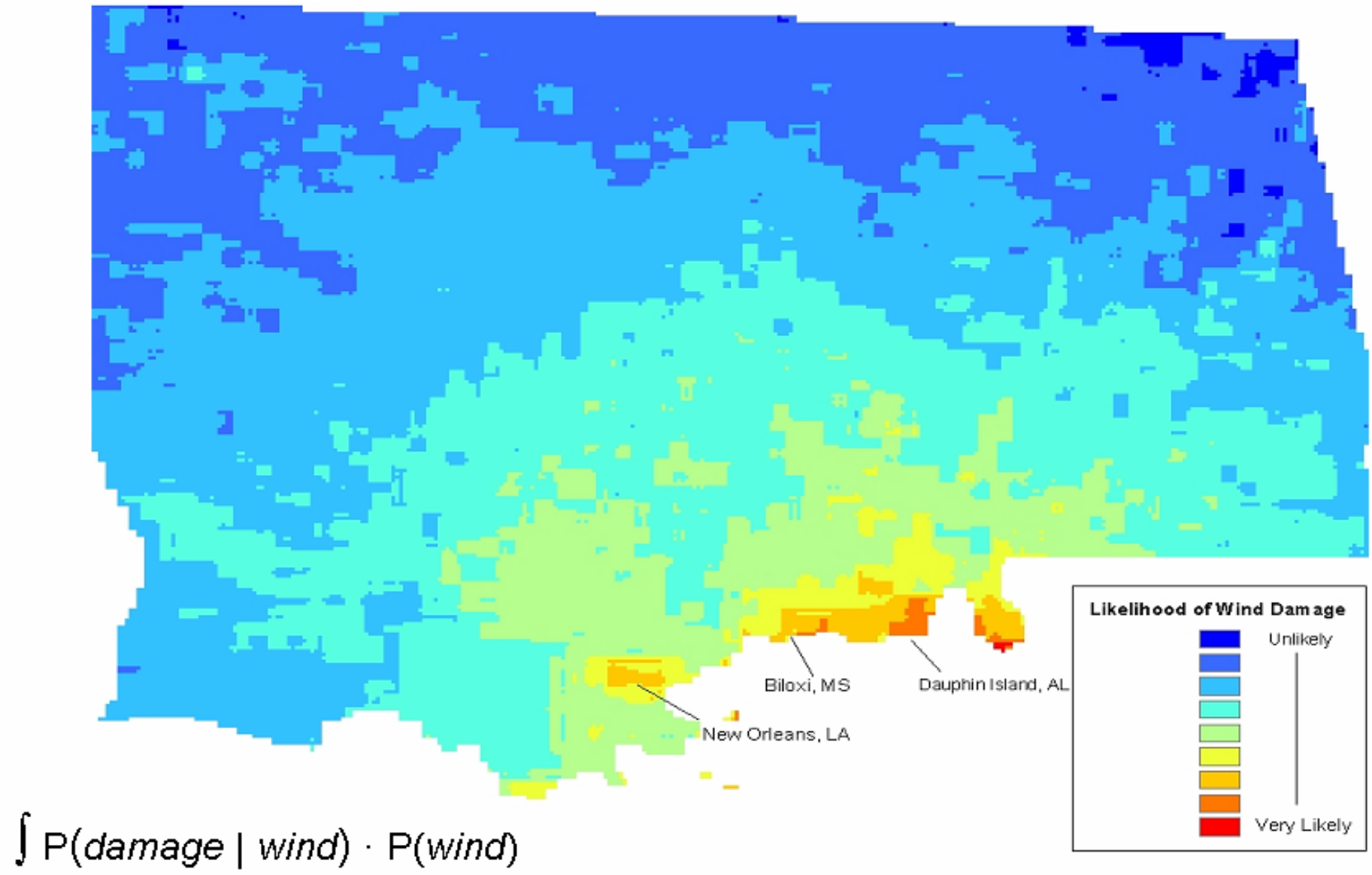
NHC Hurricane Warning Lengths and Lead Times
Storm Total Statistics



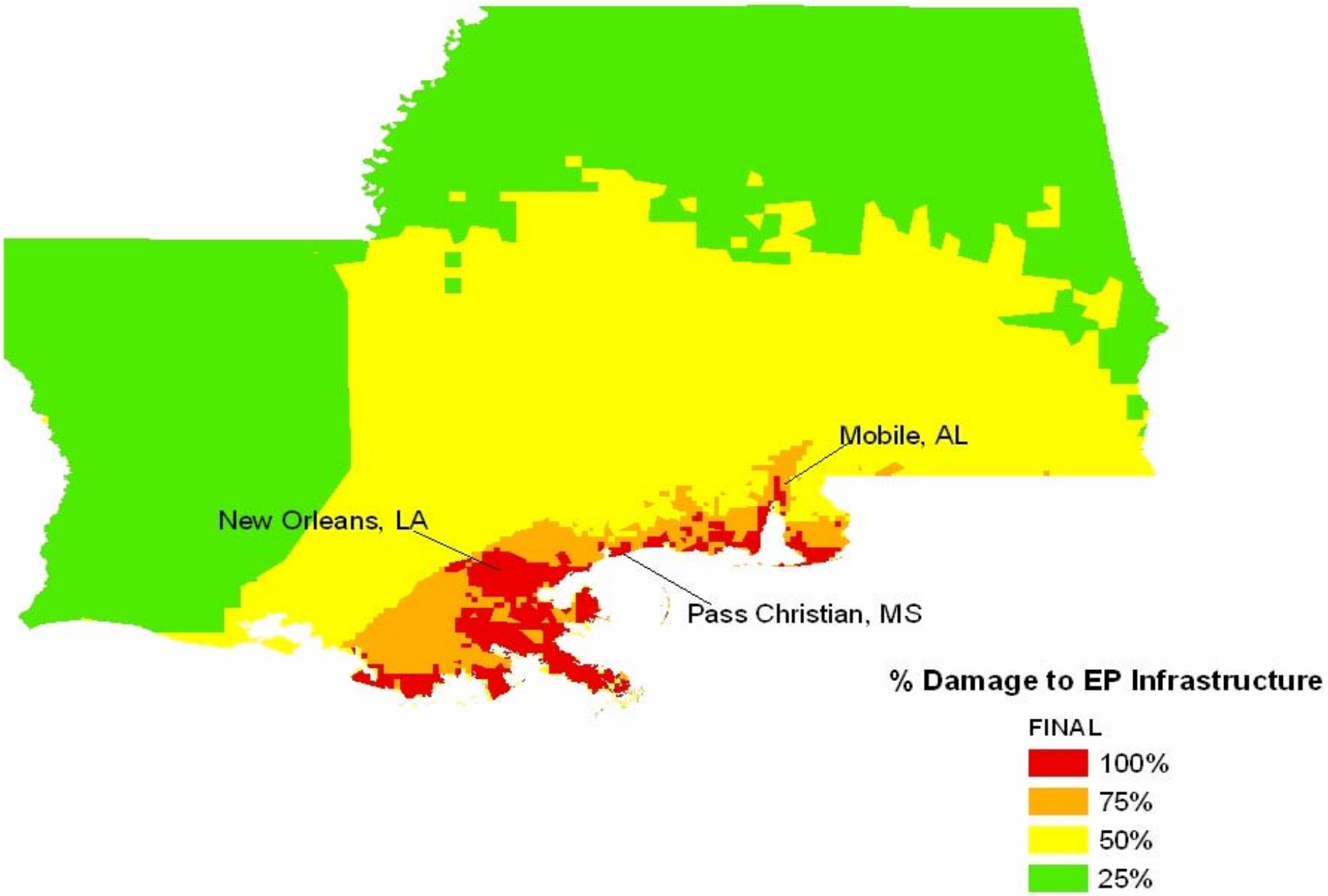
NHC storm total hurricane warning lengths 1963-2005



NHC storm average hurricane warning lead times 1963-2005



Likelihood of Wind Damage – Bush, 2006



Damage to EP Infrastructure – Bush, 2006

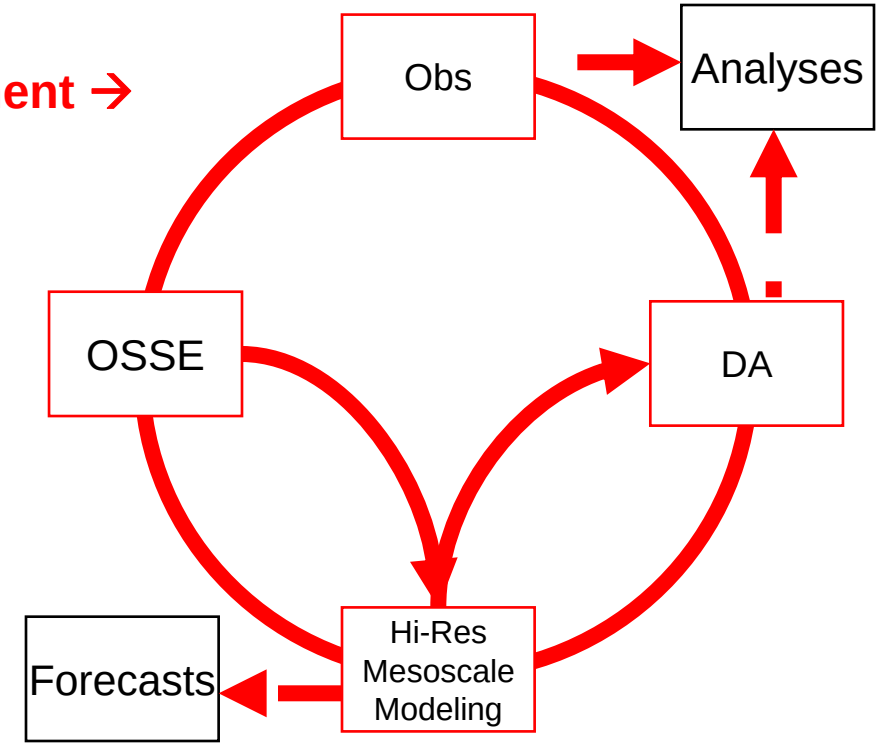
6. Accelerating Transfer from Research to Operations

Many players; requires higher level coordination and support

- **Near-term:** Establish a “NOAA Hurricane Team” to provide better in-house focus (NCEP/NHC, OAR/AOML/HRD) and appoint standing SAB working group on hurricane research to advise this Team
- **Near-term:** Evaluation, intercomparison of in-house models with community models; visitor, post-doc programs, enhanced Joint Hurricane Testbed to link in-house efforts with wider community; establish explicit hurricane theme for a cooperative institute
- **Medium-term:** Hurricane R&D *center of specialized expertise* in proximity to NHC with enhanced modeling development expertise

Summary

- **Attaining Critical Mass** → co-locate leadership, resources, organization in Miami to achieve goal
- **Research and Development →**



- **Operations Research and Socio-Economic Impacts** → optimize utilization of enhanced intensity forecasts
- **Accelerating Transfer from Research to Operations** → expedite implementation of research results to operations through programs such as JHT and DTC

Backup Slides

Key NOAA Development Efforts

Hurricane Weather Research and Forecast model is to be implemented by NCEP in 2007

- Effort is under-funded and under-staffed
- Has not made good use of available external R&D resources
- Version 1 will have inadequate horizontal and vertical resolution to resolve features important to intensity
- Inadequate computer resources allocated to achieve required resolution

Other Recommendations

- Redefinition of Saffir-Simpson Scale
  - Eliminate references to storm surge, focus on wind only
  - Provide wind data with uncertainty estimate as well as category
- Ensure availability of observations from neighboring nations around Gulf and Caribbean