National Science Board Workshop on Hurricane Science and Engineering – FEMA Activities & Perspectives

January 24, 2006

National Science Foundation

Arlington, Virginia

Outline

- Current Activities & Findings
- Gaps in Knowledge
- Future Opportunities & Priorities
- Final Comments

Current Activities & Findings

- Support for Hurricane Evacuation Studies (NHMPP)
- Mitigation Assessment Team (MAT)
- Hazards U.S. – Multihazard (HAZUS-MH)
- Disaster-Resistant Building Codes
- Problem Focused Studies (storm shelters)

Mississippi Coast after Katrina

Current Activities & Findings

- Support for Hurricane Evacuation Studies - National Hurricane Mitigation and Preparedness Program (NHMPP)
  - Science and Technology Objectives
    - Work with the research community to address new research needs and opportunities
    - Use existing technology and incorporate emerging science and technology to enhance products, services, and outreach
    - Assess changing behavioral patterns associated with increased institutional and public knowledge of hurricanes

Current Activities & Findings

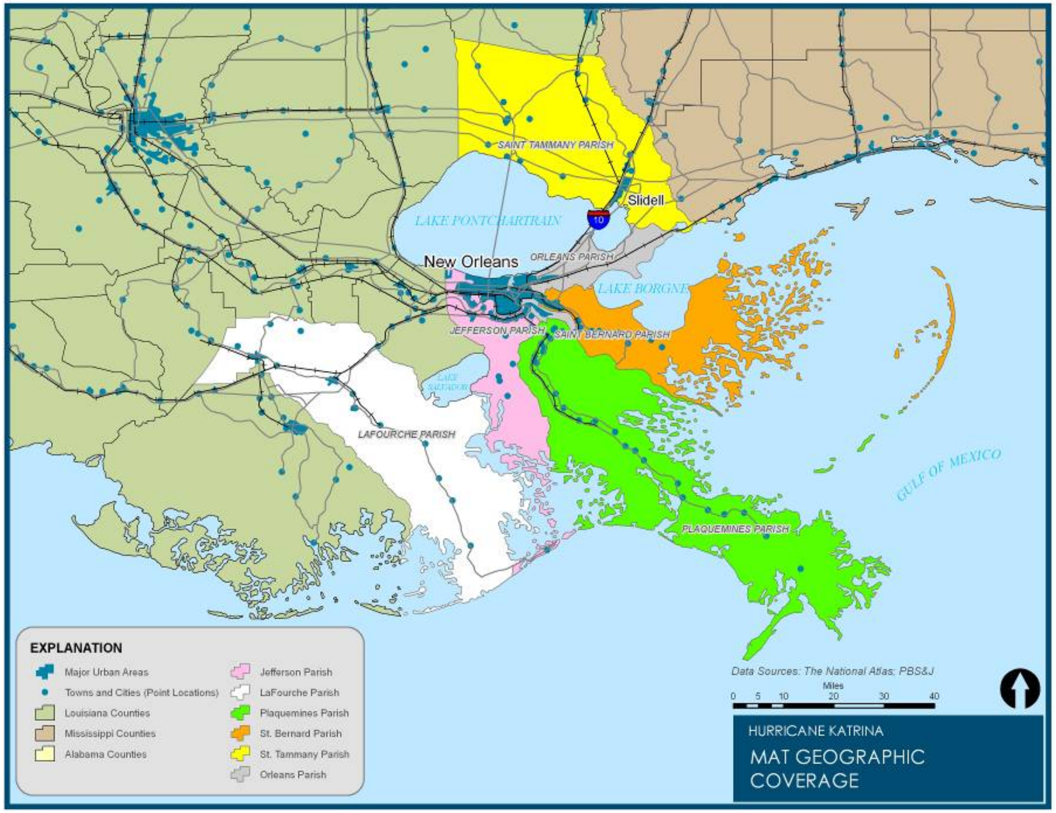
- Support for Hurricane Evacuation Studies -
  - Strategic Products
    - Hazard & Vulnerability Analysis
    - Shelter Analysis
    - Behavioral Analysis
    - Transportation & Decision Timing Analysis
    - HURREVAC
    - Storm Surge Mapping
    - Evacuation Traffic Information System
    - Technical Data Reports
    - Hurricane & Evacuation Liaison Teams

Current Activities & Findings

- Support for Hurricane Evacuation Studies
  - Current State Direction
    - Reverse Lane Planning
    - Intelligent Traffic Systems
    - Traffic Analysis Modeling/HLT
    - Inland Flooding/Mapping
  - State Needs and Concerns
    - Equal Emphasis Placed on Storm Hazards
    - Hazard Amnesia – Storm Surge Concerns
    - Clearance Time Reduction/Evacuation Education
    - New Issues After Landfall- Needs and Concerns.

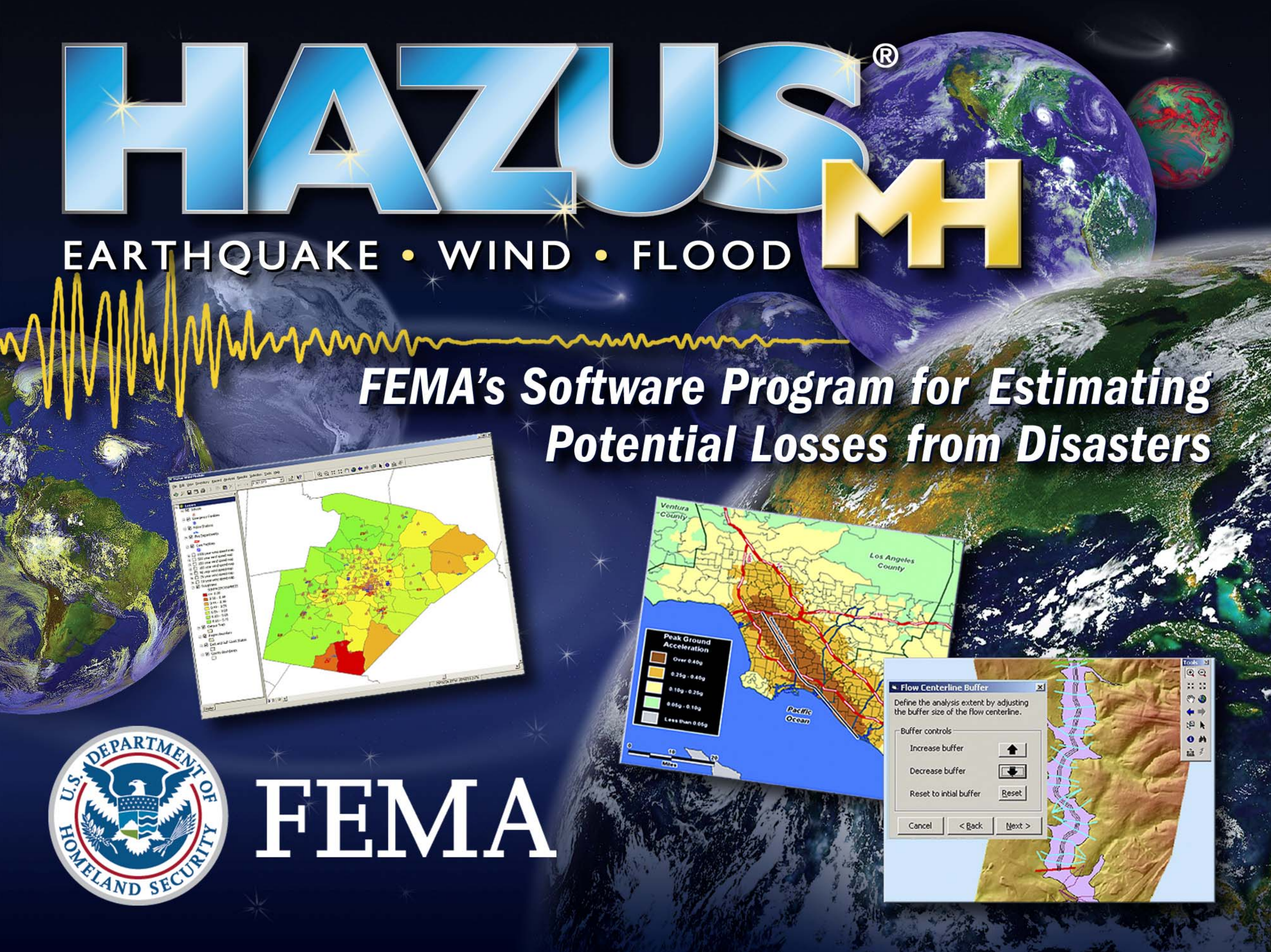
Current Activities & Findings

- Mitigation Assessment Team (MAT)



Current Activities & Findings

- Mitigation Assessment Team (MAT) Objectives
  - Conducts general *forensic engineering analyses* to determine causes of structural failure and success
  - Provides *recommendations* that communities, states and organizations/agencies can take to reduce future damages and protect lives and property in hazard areas
  - Increase damage resistance through *improvements in construction codes and standards, designs, methods, and materials* used for both new construction and post-disaster repair and recovery


HAZUS®
MH
EARTHQUAKE • WIND • FLOOD
FEMA's Software Program for Estimating Potential Losses from Disasters
Ventura County
Los Angeles County
Peak Ground Acceleration
Over 0.40g
0.25g - 0.40g
0.10g - 0.25g
0.05g - 0.10g
Less than 0.05g
Pacific Ocean
Miles
Flow Centerline Buffer
Define the analysis extent by adjusting the buffer size of the flow centerline.
Buffer controls
Increase buffer
Decrease buffer
Reset to intial buffer
Reset
Cancel
< Back
Next >
Tools
U.S. DEPARTMENT OF HOMELAND SECURITY
FEMA

Current Activities & Findings

- HAZUS-MH Hurricane Module Features
  - Models Losses from
    - Physical Impacts
    - Economic Impacts
  - GIS Technology (ESRI ArcGIS 9.1)
  - Nationwide Databases
  - Nationally Standardized Loss Estimation and Risk Assessment Methodology

Current Activities & Findings

- HAZUS-MH allows you to:
  - **IDENTIFY** vulnerable areas that may require planning considerations (e.g., land use or building code requirements)
  - **ASSESS** the level of readiness and preparedness to deal with a disaster before the disaster occurs
  - **ESTIMATE** potential losses from specific hazard events, including pre-event, near real-time, and post-event report capability
  - **DECIDE** on how to allocate resources for the most effective and efficient response and recovery
  - **PRIORITIZE** the mitigation measures that need to be implemented to reduce future losses

Current Activities & Findings

- Disaster-Resistant Building Codes
  - FEMA has worked with National model building codes and standards organizations since the mid-80's to improve the disaster-resistance of Nation's built environment
  - Conducted numerous problem focused studies including manufactured housing anchor pull out testing, storm surge loading on masonry walls, and developed FEMA 55 "Coastal Construction Manual" to support successful building code change proposals

Current Activities & Findings

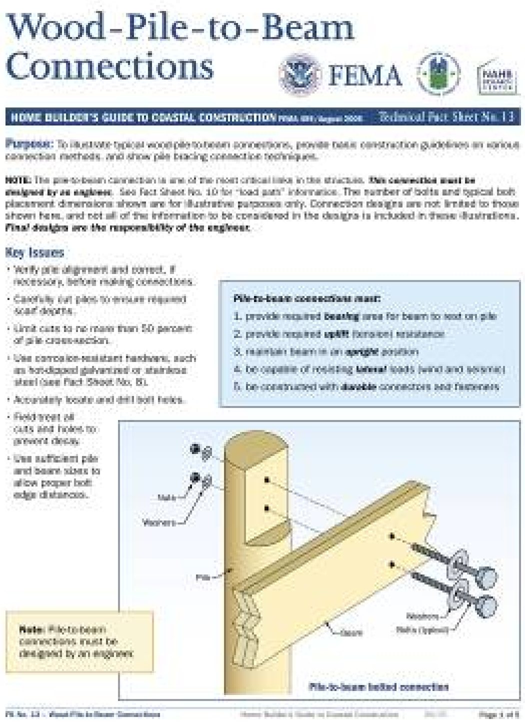
- Problem Focused Studies (storm shelters)
  - Developed design and construction guidance for tornado and hurricane storm shelters
  - FEMA 320 “Taking Shelter from the Storm” distributed over 200,000 copies and over ten thousand shelters constructed
  - FEMA 361 “Design Guidance for Community Shelters”

Current Activities & Findings

- Findings
  - Direct connection between disaster-resistant building codes and improved hurricane performance of buildings and structures
  - Need for improved understanding between population growth and evacuation planning, including alternative approaches
  - Critical link between preserving building envelop integrity and survival of the structure

Disaster-Resistant Building Codes

Disaster-Resistant Construction



Wood-Pile-to-Beam Connections

FEMA

HOME BUILDER'S GUIDE TO COASTAL CONSTRUCTION — Technical Fact Sheet No. 13

Purpose: To illustrate typical wood-pile-to-beam connections, provide basic construction guidelines on various connection methods, and show pile bracing connection techniques.

NOTE: The pile-to-beam connection is one of the most critical links in the structure. **This connection must be designed by an engineer.** See Fact Sheet No. 10 for "load path" information. The number of bolts and typical bolt placement dimensions shown are for illustrative purposes only. Connection designs are not limited to those shown here, and not all of the information to be considered in the designs is included in these illustrations. ***Final designs are the responsibility of the engineer.***

Key Issues

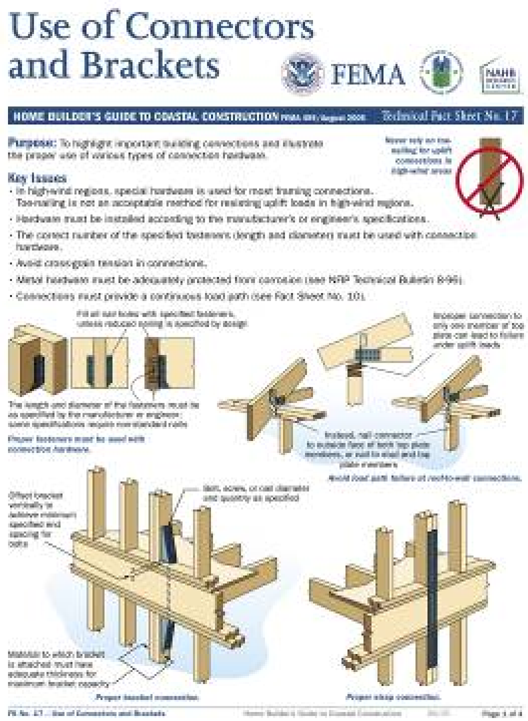
- Verify pile alignment and correct, if necessary, before making connections.
- Carefully cut piles to ensure required scarf depths.
- Limit cuts to no more than 50 percent of pile cross-section.
- Use corrosion-resistant hardware, such as hot-dipped galvanized or stainless steel (see Fact Sheet No. 8).
- Accurately locate and drill bolt holes.
- Field treat all cuts and holes to prevent decay.
- Use sufficient pile and beam sizes to allow proper bolt edge distances.

Pile-to-beam connections must:

1. provide required **bearing** area for beam to rest on pile
2. provide required **uplift** (tension) resistance
3. maintain beam in an **upright** position
4. be capable of resisting **lateral** loads (wind and seismic)
5. be constructed with **durable** connectors and fasteners

Note: Pile-to-beam connections must be designed by an engineer.

Pile-to-beam bolted connection



Use of Connectors and Brackets

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HOME BUILDER'S GUIDE TO COASTAL CONSTRUCTION — Technical Fact Sheet No. 17

Purpose: To highlight important building connections and illustrate the proper use of various types of connection hardware.

Key Issues

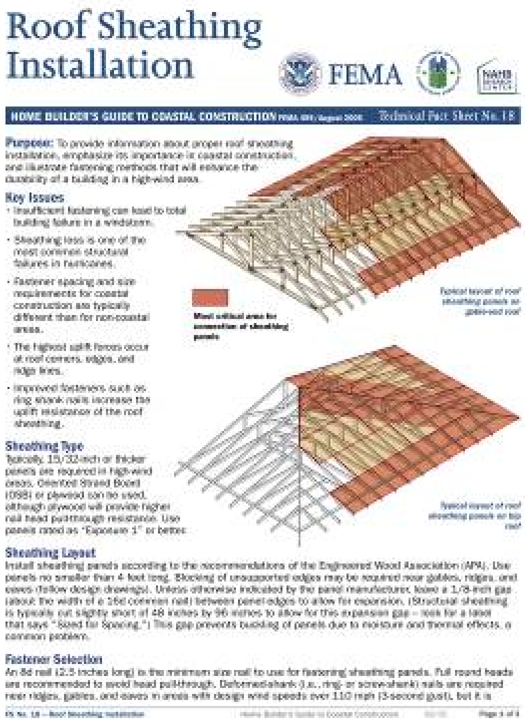
- In high-wind regions, special hardware is used for most framing connections. Toe-nailing is not an acceptable method for resisting uplift loads in high-wind regions.
- Hardware must be installed according to the manufacturer's or engineer's specifications.
- The correct number of the specified fasteners (length and diameter) must be used with connection hardware.
- Avoid cross-grain tension in connections.
- Metal hardware must be adequately protected from corrosion (see NFIP Technical Bulletin 8-96).
- Connections must provide a continuous load path (see Fact Sheet No. 10).

Proper fasteners must be used with connection hardware.

Avoid load path failure at roof-to-wall connections.

Proper bracket connection.

Proper strap connection.



Roof Sheathing Installation

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HOME BUILDER'S GUIDE TO COASTAL CONSTRUCTION — Technical Fact Sheet No. 18

Purpose: To provide information about proper roof sheathing installation, emphasize its importance in coastal construction, and illustrate fastening methods that will enhance the durability of a building in a high-wind area.

Key Issues

- Insufficient fastening can lead to total building failure in a windstorm.
- Sheathing loss is one of the most common structural failures in hurricanes.
- Fastener spacing and size requirements for coastal construction are typically different than for non-coastal areas.
- The highest uplift forces occur at roof corners, edges, and ridge lines.
- Improved fasteners such as ring shank nails increase the uplift resistance of the roof sheathing.

Sheathing Type

Typically, 15/32-inch or thicker panels are required in high-wind areas. Oriented Strand Board (OSB) or plywood can be used, although plywood will provide higher nail head pull-through resistance. Use panels rated as "Exposure 1" or better.

Sheathing Layout

Install sheathing panels according to the recommendations of the Engineered Wood Association (APA). Use panels no smaller than 4 feet long. Blocking of unsupported edges may be required near gables, ridges, and eaves (follow design drawings). Unless otherwise indicated by the panel manufacturer, leave a 1/8-inch gap (about the width of a 16d common nail) between panel edges to allow for expansion. (Structural sheathing is typically cut slightly short of 48 inches by 96 inches to allow for this expansion gap – look for a label that says "Sized for Spacing.") This gap prevents buckling of panels due to moisture and thermal effects, a common problem.

Fastener Selection

An 8d nail (2.5 inches long) is the minimum size nail to use for fastening sheathing panels. Full round heads are recommended to avoid head pull-through. Deformed-shank (i.e., ring- or screw-shank) nails are required near ridges, gables, and eaves in areas with design wind speeds over 110 mph (3-second gust), but it is

Damaged Building Envelop

Opening Protection Preserves Building Envelop

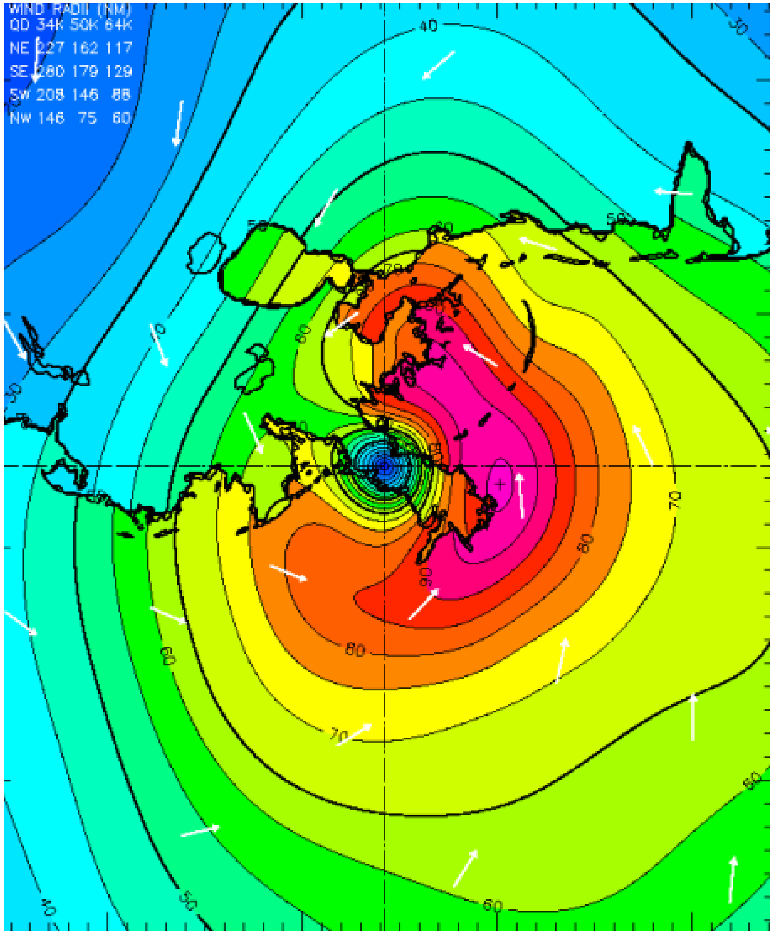
Gaps in Knowledge

- Lack of Coordinated Field Data/Forensic Studies
- Improved understanding of evacuation planning
- Lack of knowledge of near-ground wind effects and impact of windborne debris on structures
- Improvements in prediction of windstorm and surge intensity (including impact on foundations)
- Need for a robust Hurricane Loss Estimation tool
- Need for cost-effective mitigation techniques

Gaps in Knowledge

- Improved understanding of evacuation planning
  - Growing Coastal Population That Is Largely Uneducated About Tropical Cyclone Dangers & How To Respond**- "HAZARD AMNESIA"**
  - Each Storm Exposes New Problems & Issues.

Surge Forecast for New Orleans



Surge in the City of New Orleans

Surge Damage in Mississippi

Future Opportunities & Priorities

- Preparedness, Response, Recovery & Mitigation Focus
- Understanding and Effectively Managing Evacuations
- Coordination of post-event data collection and forensic evaluation
- Improved Federal, State and local coordination before, during and after hurricanes (being actively addressed)

Future Opportunities & Priorities

- Improved understanding of storm surge effects in coastal areas
- Translating new knowledge and lessons learned into improved building design and construction
- Continued development and improvement of loss estimation modeling tools

Final Comments

- Congressional support for resources to implement recently passed Windstorm Hazard Reduction Act would advance Hurricane science and engineering agenda
- Research needs to support goals of improved community resilience and development of cost effective construction and mitigation techniques

Final Comments

- Much more work needs to be done related to critical infrastructure lifelines and critical services
- Need to develop technical resources to support State and local governmental decision-making