Workshop for Research in Electricity Infrastructure Hardening

Kurt Gurley / Ron cook– Wind effects on infrastructure

Forrest Masters – Hurricane measurement & simulation

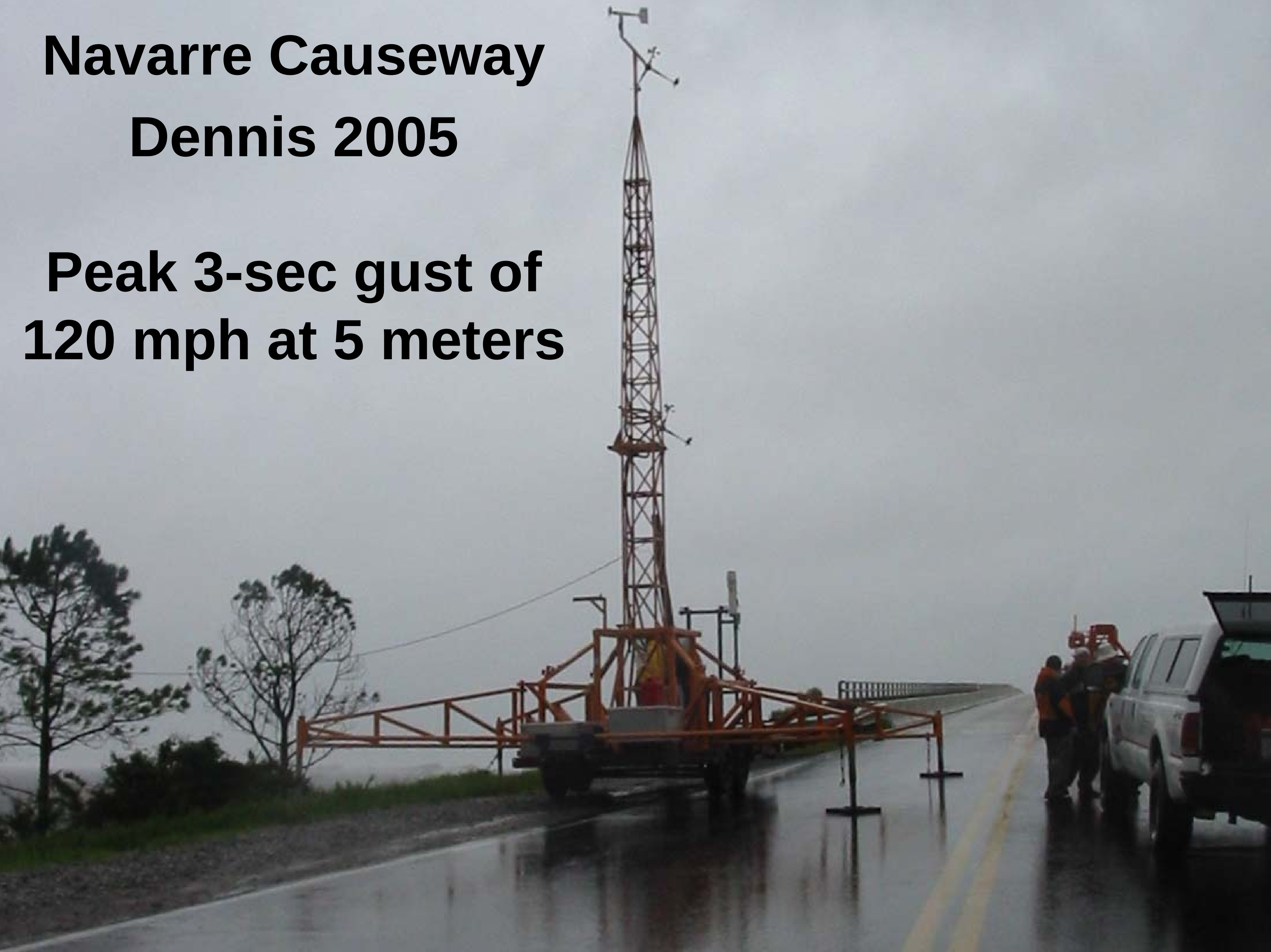
Bob Dean / Peter Sheng – Surge, flooding, erosion

Ralph Ellis – Cost Modeling

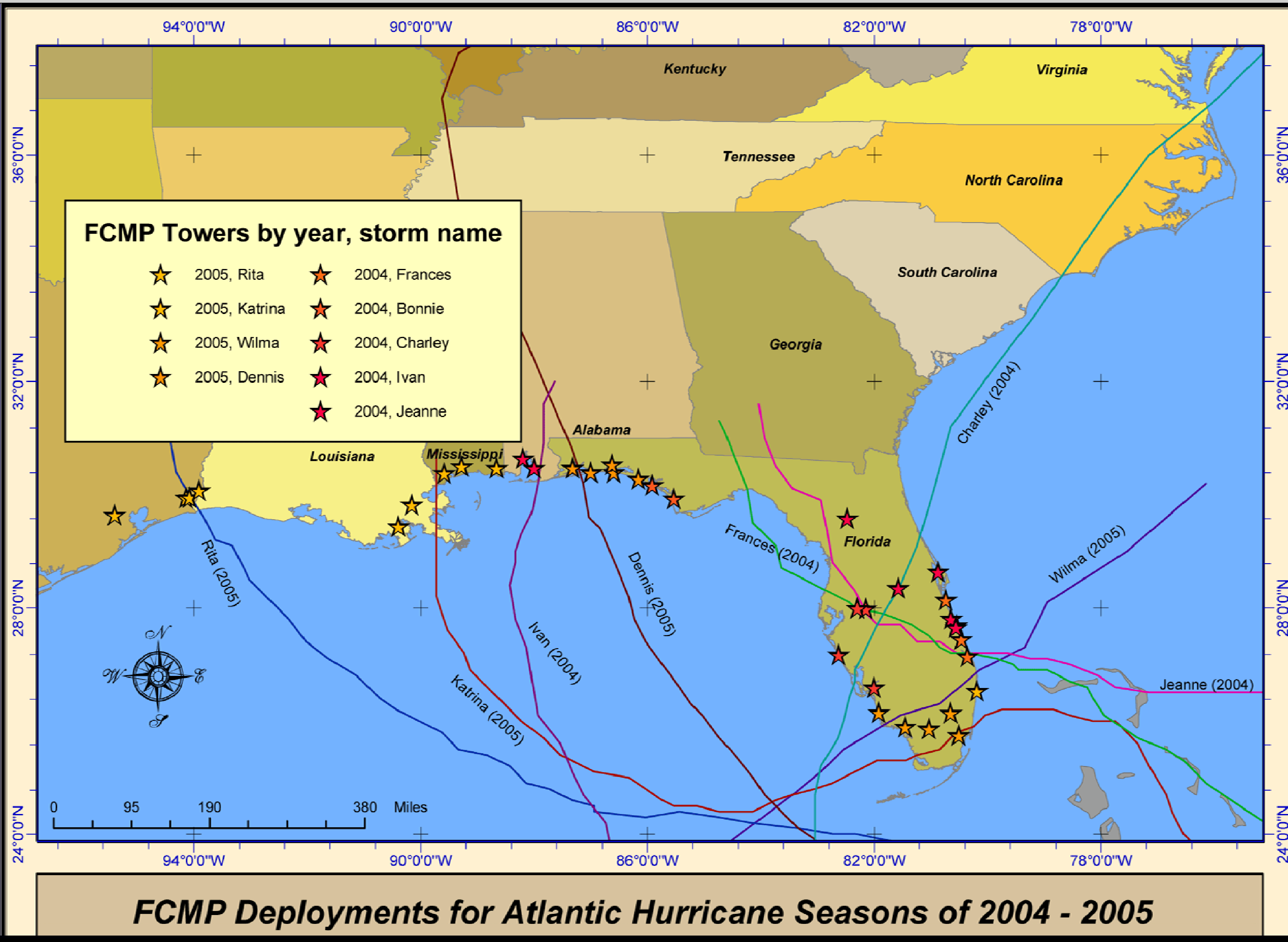
Ed Gilman – Trees in high winds

Defining Wind Loads and Resistance

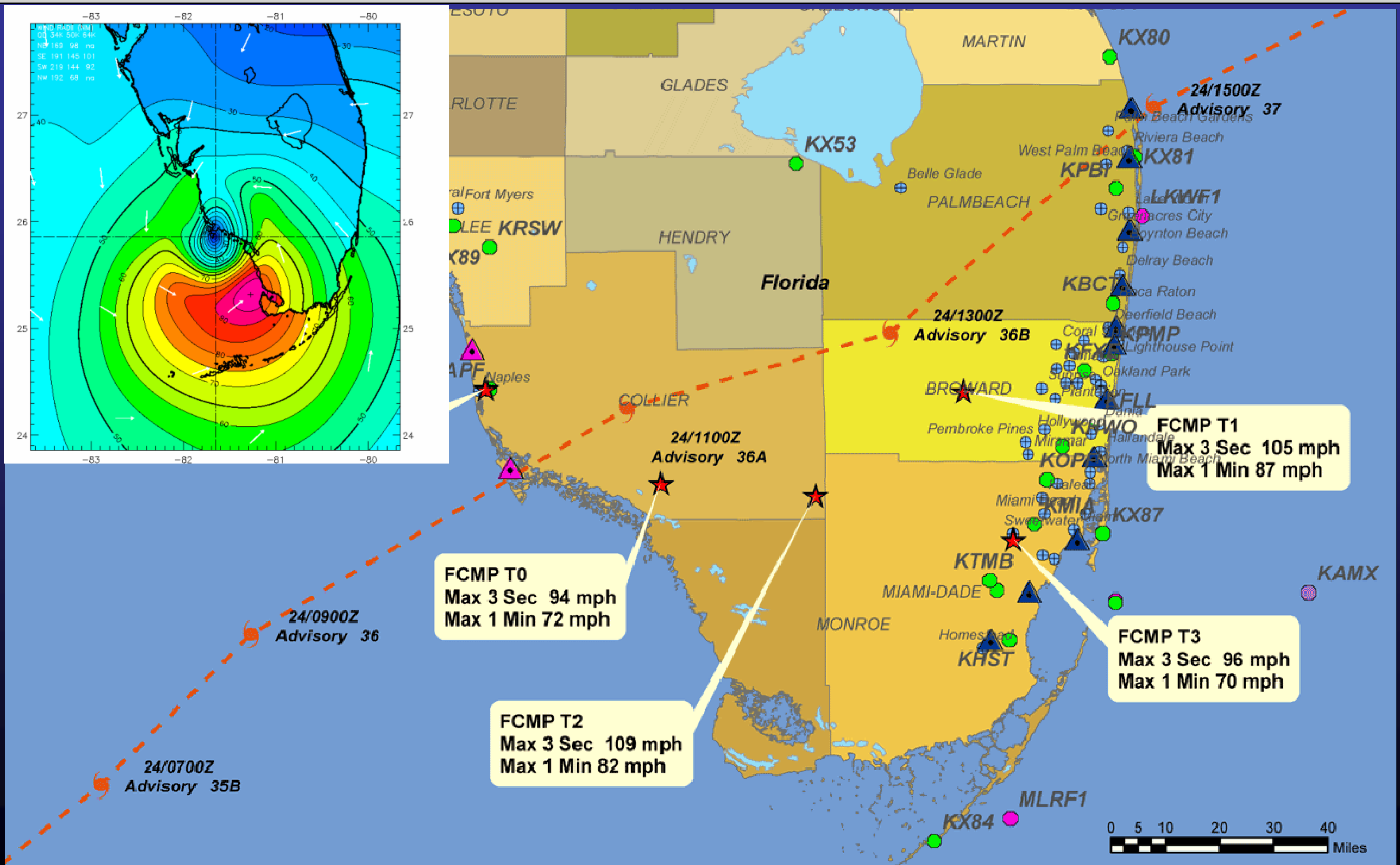
- Measure in-field hurricane ground level wind velocities and relay data in real-time
- Measure the hurricane wind pressures on residential structures
- Test capacity of building components
- Statistical Assessment of structural damage post-event
- Model structural vulnerability, and investigate mitigation measures


Navarre Causeway
Dennis 2005
Peak 3-sec gust of
120 mph at 5 meters

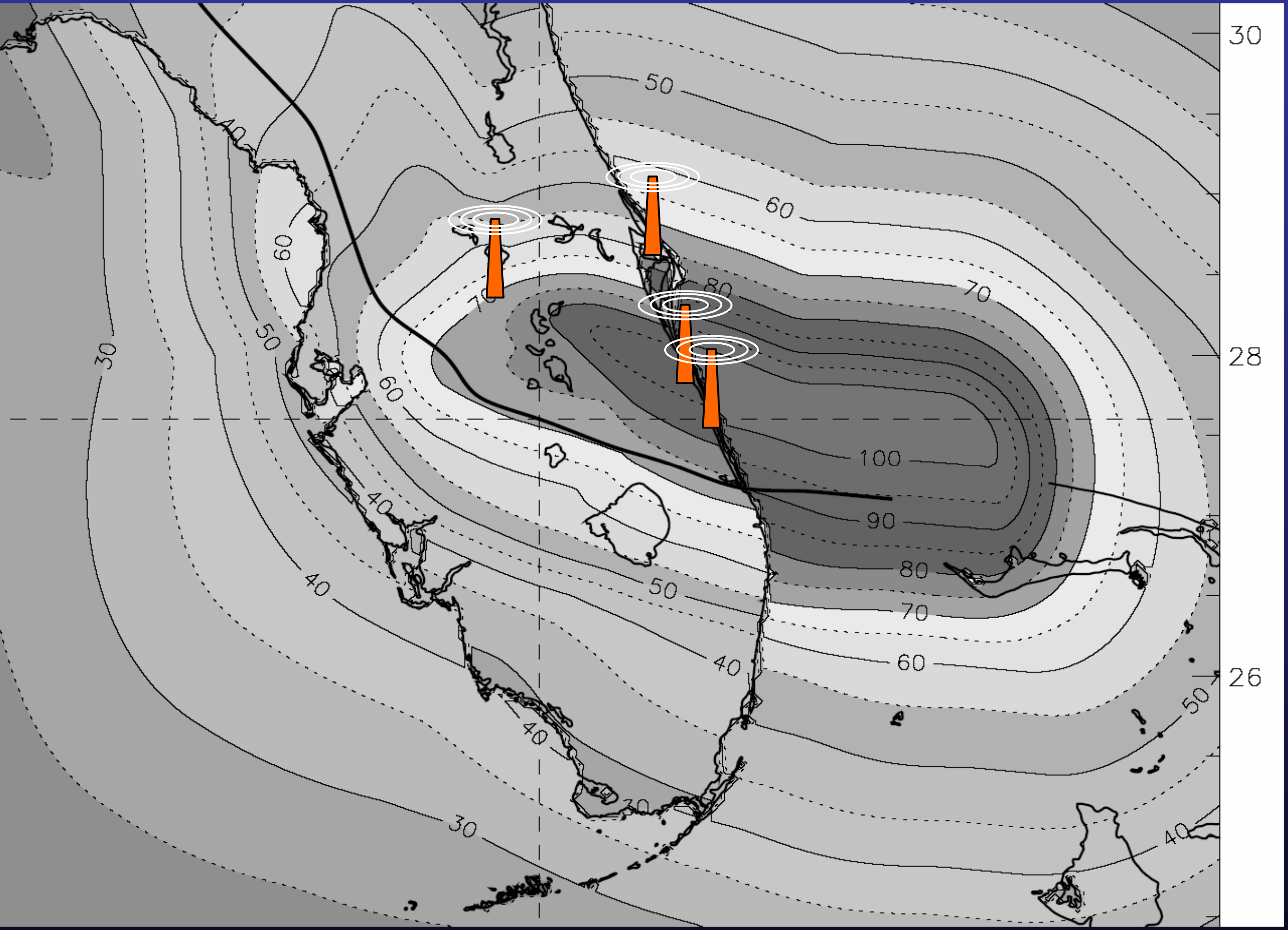
Hurricanes: 2004 - 2005



Wilma Deployment Locations



NOAA Hurricane Research Division Maximum Sustained Wind Swath



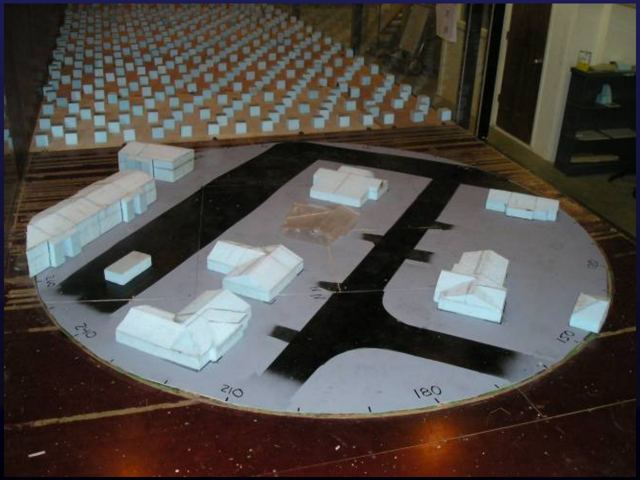
Hurricane Jeanne (2004)

Tower data is one of the sources of ground data input to H*WIND contour model of wind speeds

Wind Pressure on Houses

Full-scale and wind tunnel to define wind loading

Provides basis for rational design and hardening solutions



Simulate Neighborhood on Wind Tunnel Turntable with Surrounding Houses

Accurate 1:50 Scale Model

Post Event Damage Documentation

Failure Capacity Testing

- Determine ultimate loads to failure for as-built and retrofitted structures

- As-built test of connections
- Test of hardened system for direct quantification of performance enhancement

The Wall of Wind

Bringing the Hurricane to the Lab

Wall of Wind: Phase I

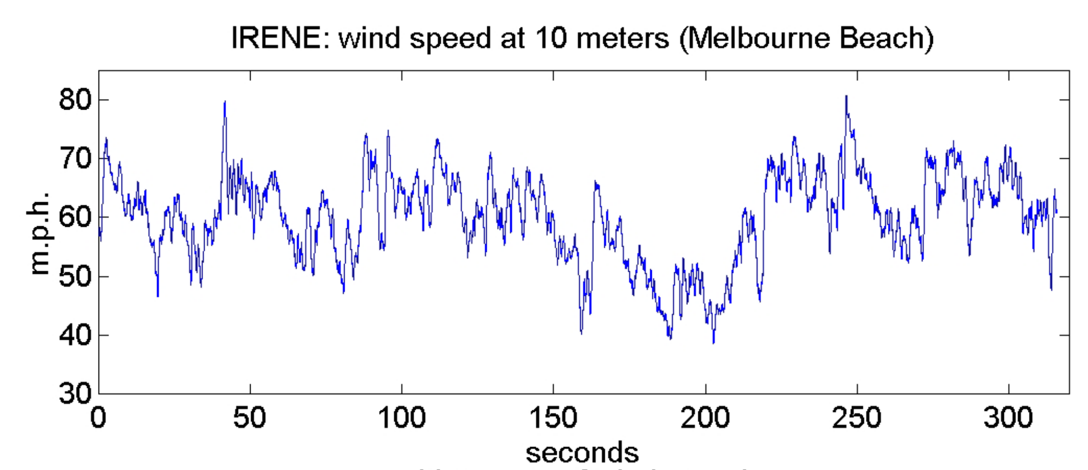
- 120 mph winds
- Rain injection
- Development of methods for larger system

Wind Driven Rain

Recreating Hurricane Conditions

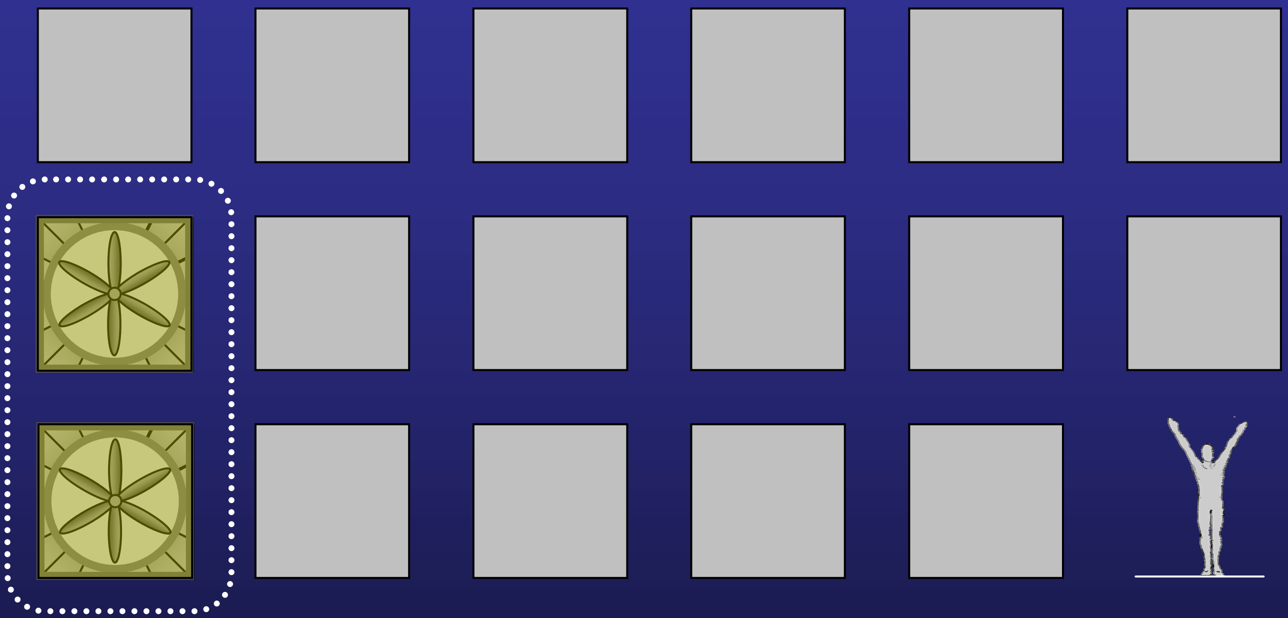
- The Wall of Wind use an active control system to "shape" the longitudinal and lateral turbulence

- "Target" turbulence characteristics drawn from measurements of surface winds collected by the portable towers



Phases of Construction

The fan array consists of modular frame units housing the engines and propellers



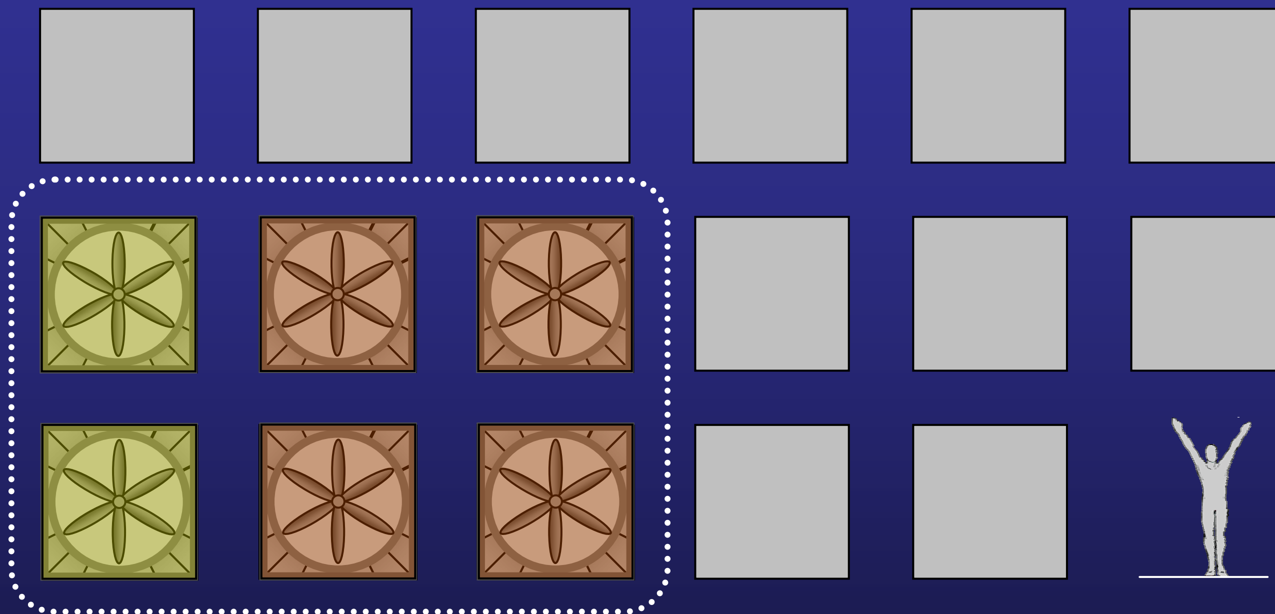
PHASE I

Sponsored by the State of Florida Department of Community Affairs (DCA)

Currently being tested at UF

Phases of Construction

The fan array consists of modular frame units housing the engines and propellers



PHASE II

Sponsored by RenaissanceRe Holdings, Ltd.,
Florida Department of Community Affairs

National Science Foundation

Additional partners being sought

Phases of Construction

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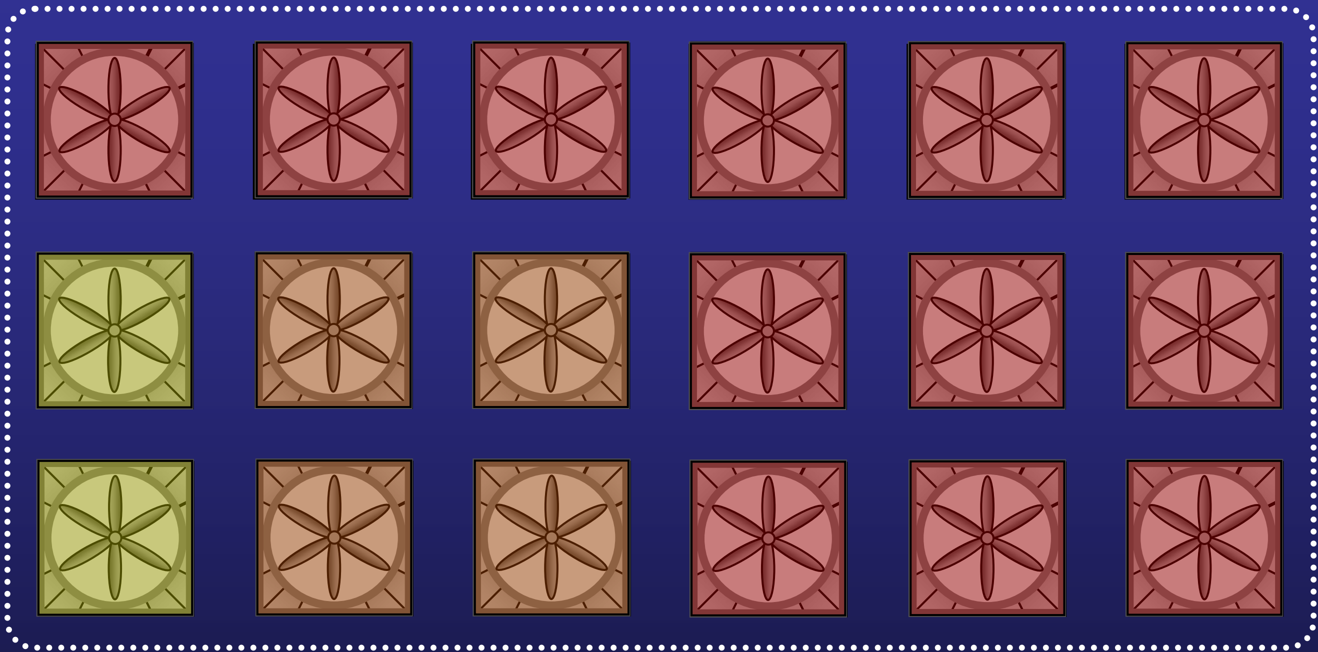


PHASE III

Presently seeking sponsors

Effect of directional pruning on tree response in wind

Ed Gilman – Environmental Horticulture

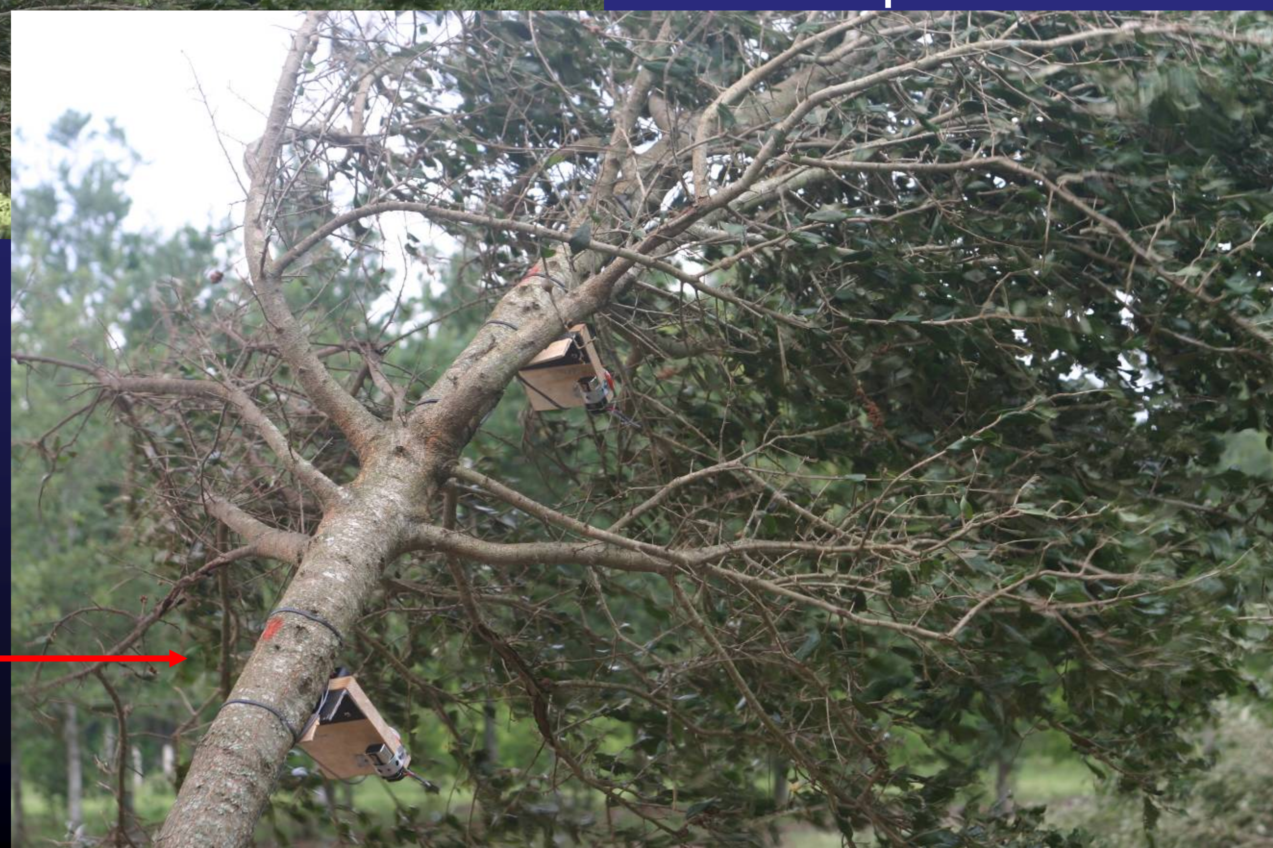
Before pruning

After directional pruning

This has never been studied

The setup

Directionally pruned trees twist up to 20 degrees in 120 mph wind



Non-pruned trees twist very little

Impact of directional pruning on tree twist and failure potential

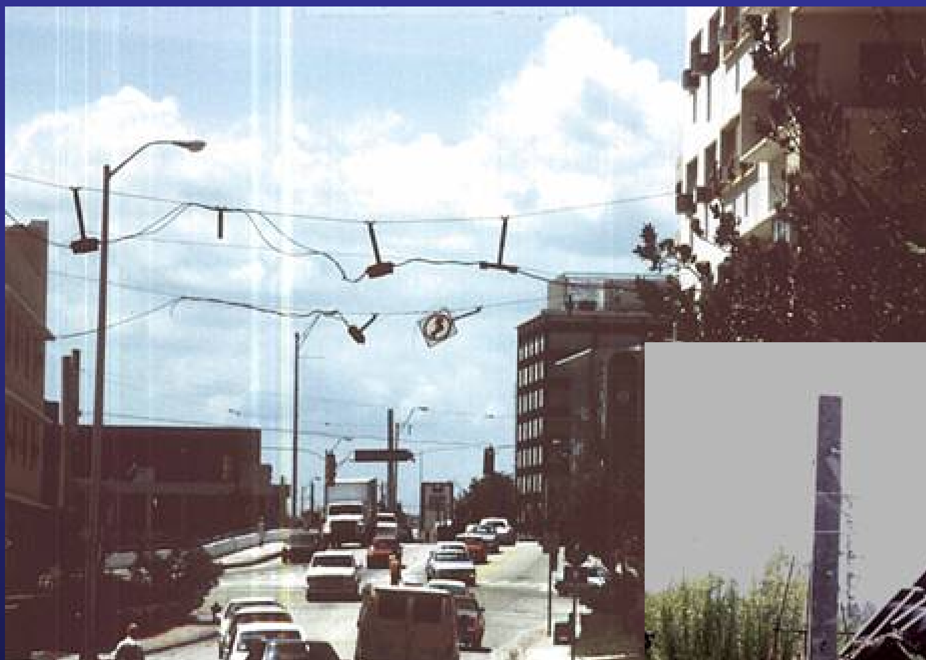
Infrastructure Application

Traffic signal failures in hurricanes

Ron Cook / Forrest Masters planning a series of experiments on suspended traffic signals

Goal is to evaluate failure mode and develop cost-effective hardening system

Cable Supported Signals and Signs



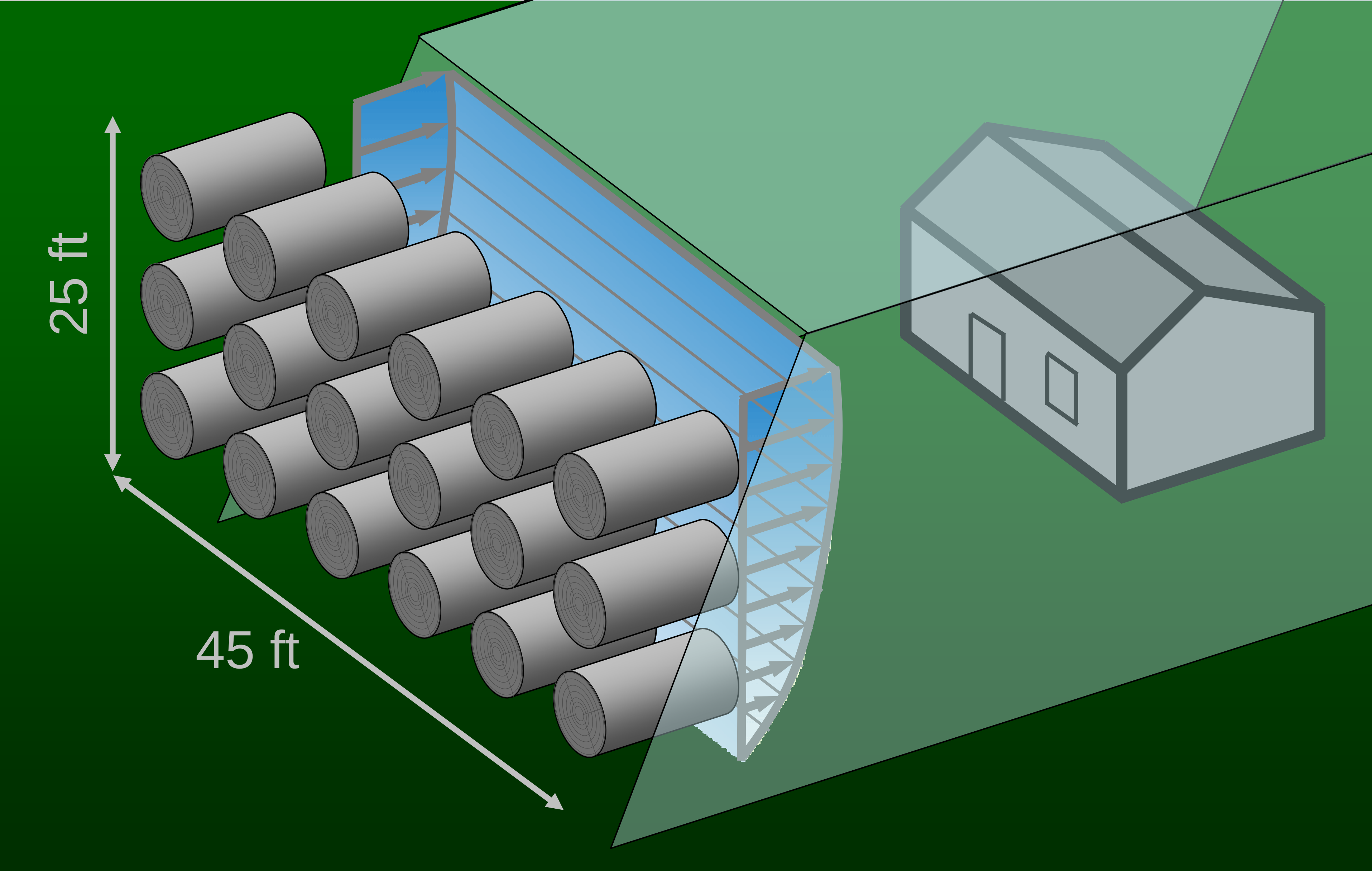
Extensive failures in Andrew and all recent hurricanes

Early full-scale wind load tests for dual cable and single cable support systems

WOW application this summer

Wall of Wind Phase III

Prove hardening solutions before implementation



Cost Modeling

Ralph Ellis

Selection of the optimum hardening approach must be in part based upon economic factors (maximize benefits with the available resources)

A robust life cycle costing model is required for comparing alternative technical hardening approaches

Storm surge, wave, inundation, and erosion

Peter Sheng
Civil & Coastal Engineering Dept.
University of Florida

New Methodology for forecasting flooding vulnerability

Coastal faculty has developed new technology for creating the flood insurance rate map (FIRM), working with Pinellas County and FEMA.

The methodology uses a state-of-the-art storm surge and wave model and Airborne Laser Mapping topography data to simulate the coastal inundation in Pinellas County to be expected in a 100-year storm.

Figure 7-6. FEMA V- and A-Zones vs. UF V- and A-Zones in the Tarpon Springs study area. The buildings inside the yellow line are in the high risk flood area (V-Zone) according to the FEMA approach and in the low risk flood area (A-Zone) according to the UF analysis. Shaded areas are non-flooded areas (X-Zones) for the FEMA (red) and UF (green) approaches

New Methodology for real-time forecasting during an event

Coastal faculty have developed a robust real-time storm surge and inundation modeling system for real-time forecasting of the storm surge, currents, wave, and coastal inundation as the hurricane approaches shore.

- Uses NHC forecast track and best available wind field
- Produces 84-120 forecast every 3-6 hours
- Validated with data in 2003, 2004, and 2005
- Sponsors include NOAA, ONR, Florida Sea Grant, NSF, USDOT, SFWMD

Current Domains

High Resolution CH3D Gri

(40-400m)

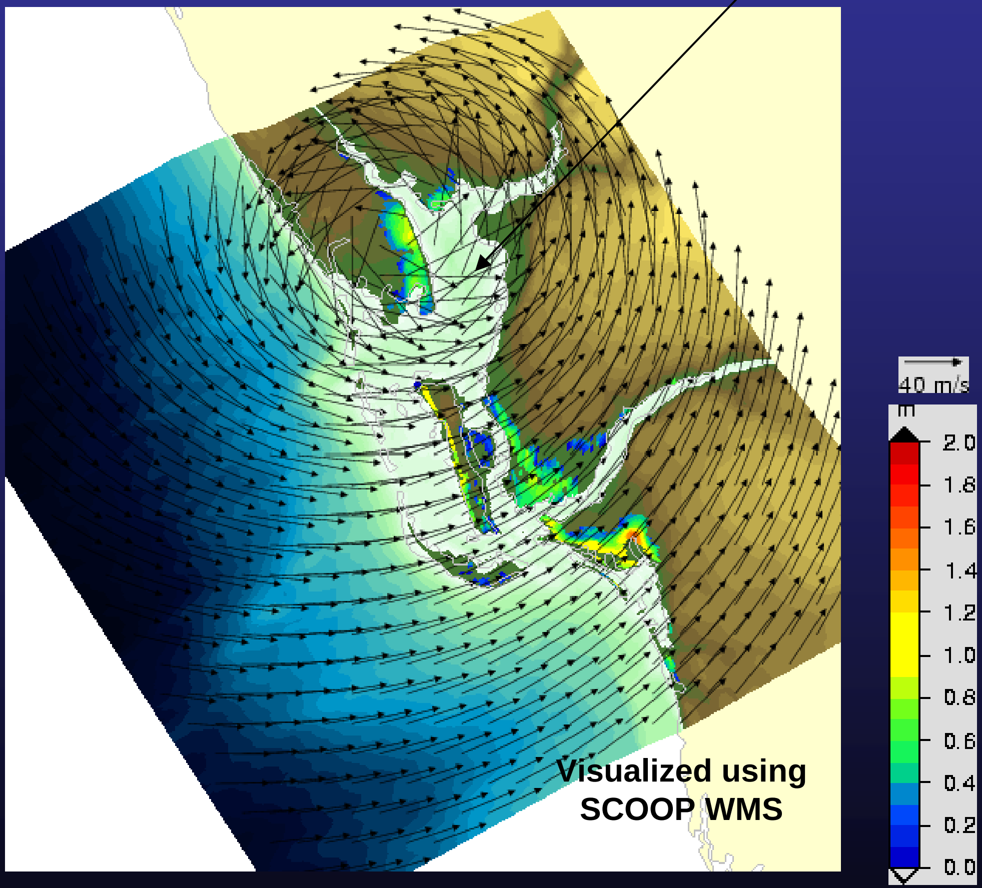
Model has been applied to hurricanes in 2003-2005

Charlotte Harbor, FL

Model proven effective in identifying which coastal communities and streets will be inundated (including power plants in coastal regions)

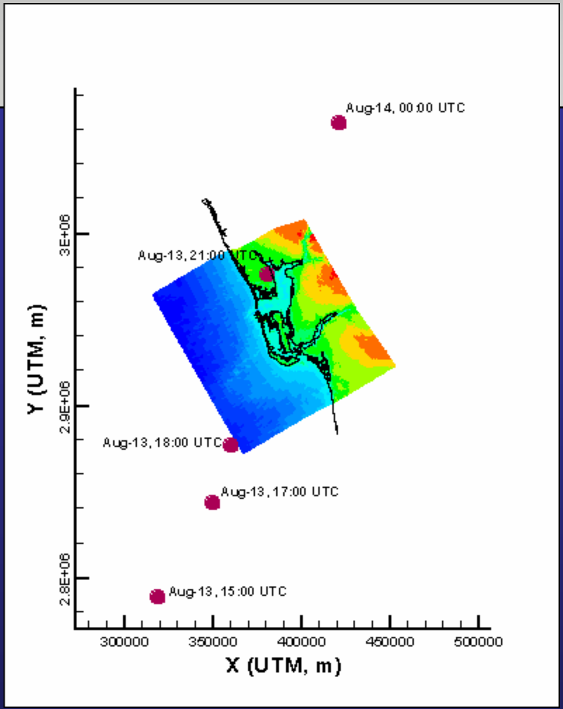
In real-time

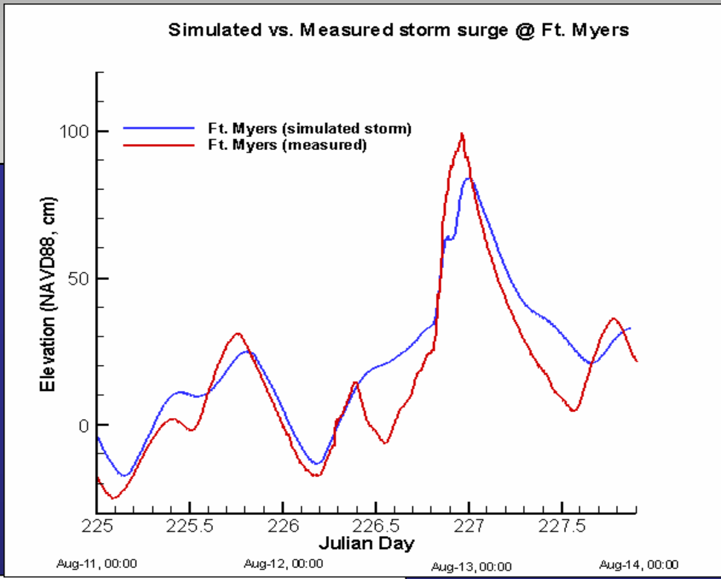
Uses real-time wind data from portable towers

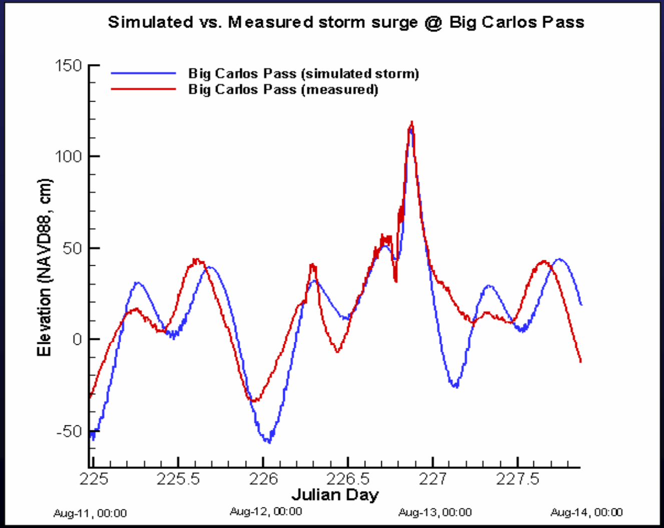


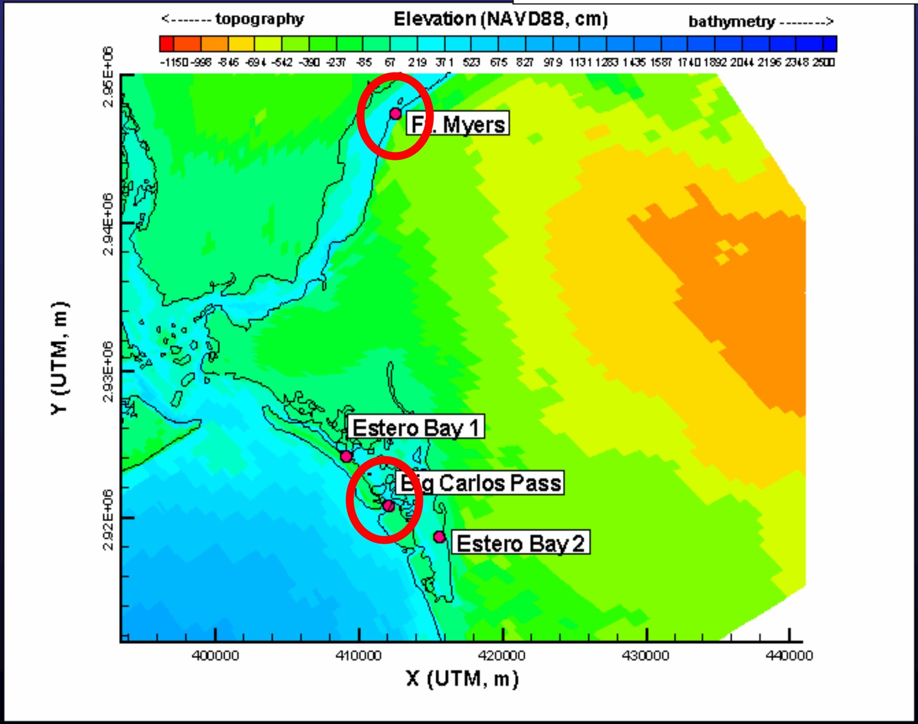
Hurricane Charley (2004)

Charley (2004, 4) in Charlotte Harbor – small, intense, fast



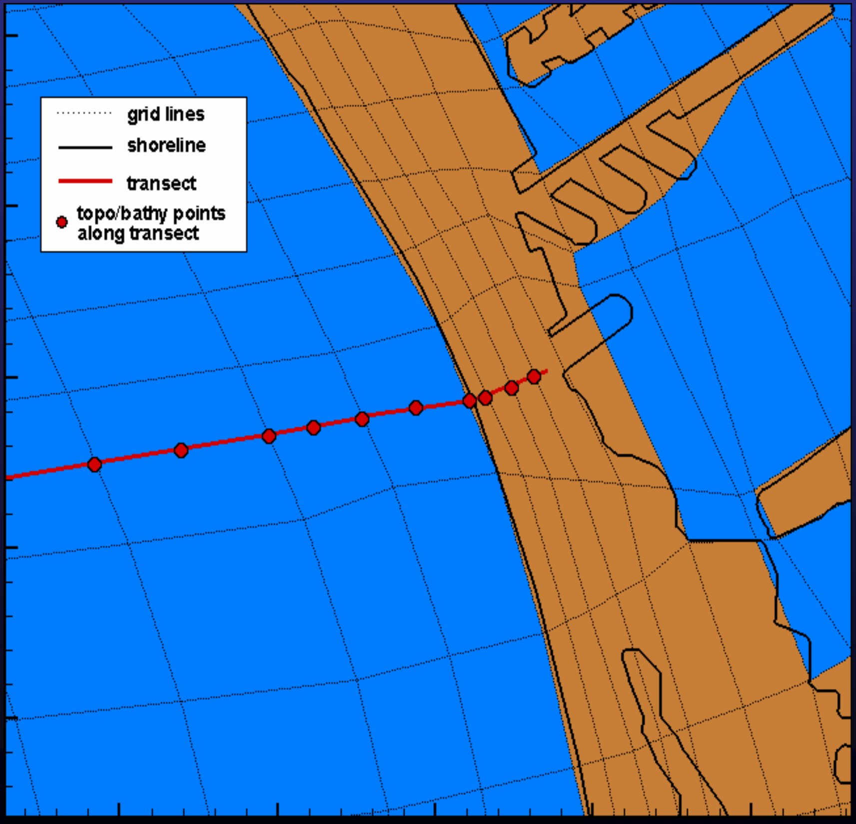






Application to underground power infrastructure

Forecasted storm surge, currents, waves, inundation, and coastal erosion can assist planning of underground power distribution infrastructure resistant to inundation and erosion.



Summary

- Wind speed measurement in real-time
- Wind load quantification
- Infrastructure vulnerability quantification
- Vegetation management issues
- Hardening options (w/cost modeling)
    - Design & engineering
    - Full-scale hurricane simulation
- Coastal surge / flood modeling
    - Real-time during event
    - Forecasting over long term

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