Model Setup and Validation
South Florida Coastal Storm Surge Study

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Presentation Overview

- FEMA coastal studies
- Overview – SWAN+ADCIRC modeling in South Florida surge study
- Ongoing efforts and work completed
  - SFWMD spillways
  - Stability review
  - Hurricane Andrew
- Questions???
Approach – Storm Surge SWEL

Storm Forcing
- Hurricane Tracks

Storm Surge Modeling
- Winds
- Waves
- Water Levels

High-Resolution
Bathymetry / Topography Mesh

Return Period Analysis
- JPM-OS 2%, 1%, 0.2% Annual Chance
- Tide Gage Analysis 50%, 20%, 10% A.C.

SWEL

JPM-OS: Joint Probability Method - Optimum Sampling
SFL Coastal Surge Study Extent
Special Features

- Florida Keys
- End of peninsula - east and west storm tracks
- Very low topography
- Unique land use types – coral reefs, mangroves, seagrass
- Water Management District control structures
  ➢ Lake Okeechobee
- Narrow canals
South FL Narrow Canals
South FL - Narrow Canals

no elements in channel

one element across channel
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SFWMD Spillways

Source: USGS
For any given synthetic storm...
  - Initial headwater condition?
  - Spatial and temporal variability in structure operations?
- Need constant state of operations for production storm suite
  - Gates “closed”
- Capture canal from ocean to seaward-most spillway
  - ~25 in South FL project area
  - Upstream of spillway captured as floodplain
SFWMD Spillways

- Boca Raton Inlet
- Hillsboro Inlet
- Fort Lauderdale
- Port Everglades
- Bakers Haulover Cut

Project area shoreline

Government Cut

Miami
SFWMD Spillways
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Southwest FL Findings

- Production run instabilities necessitated development of an additional mesh with canal node elevations altered to “fill in” the canals
- Instabilities not necessarily caused by most powerful storms
- Canals captured by one element tend to experience more stability issues than those that are 2+ elements
Canal sensitivity

- Validation phase
- Validation storms do not represent a well-rounded test suite
- Recently completed mesh with canals filled in to have on hand during production
Canal sensitivity

Elevation, ft-NAVD

[Map of canal sensitivity with color scale and circled areas indicating specific elevations]
Canal Sensitivity Test

Andrew, shifted 0.5 degrees north
Maxele, m-NAVD

- 2.5
- 2.25
- 2.0
- 1.75
- 1.5
- 1.25
- 1.0
- 0.75
- 0.5
- 0.25
- 0.0

Regular mesh
Canal Sensitivity Test

Andrew, shifted 0.5 degrees north
Maxele, m-NAVD

Mesh with canals “filled in”
Canal Sensitivity Test

Maxele_diff
[canal-filled – regular], meters

- 0.5
- 0.4
- 0.3
- 0.2
- 0.1
- 0.0
- 0.1
- 0.2
- 0.3
- 0.4
- 0.5

Black shapefile outlines filled in canals
Low/Oscillatory Topography

• High resolution in canals → natural oscillations in nearby terrain
  • Smaller averaging area for LIDAR data
  • Oscillations form “potholes” that have no means to drain as flood wave recedes
• Generally includes golf courses, mangroves, and Everglades National Park
Southwest FL Findings

- During production runs, potholes tended to cause locally spurious solutions.
- Because these nodes represent features which are under-resolved in the mesh, local topo smoothing serves as a reasonable solution.
- Topographic changes on the order of 2 – 4 ft seem to trigger the problem.
South FL – Pit-filling Routine
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Validation
Hurricane Andrew (1992)

- Fast, well-organized storm
- Anecdotal reports and High Water Marks of ~15 ft in Biscayne Bay that model does not reproduce
  - No tide gage data available near landfall
- Test Andrew sensitivity to model parameters
Andrew Sensitivity Testing

- 20 runs
  - Initial water surface elevation
  - Seagrass manning’s n
  - 10 minute wind conversion factor
  - Turn off wind stress on account of vegetation canopy
  - Use 5 minute wind forcing instead of 15 minutes
  - Deepen reef at mouth of Biscayne Bay
  - Apply sector-based drag coefficient in ADCIRC
  - Reduce bottom friction near Deering Estate
  - Deepen bay near Deering Estate
Andrew Sensitivity Testing

- Discuss southern Biscayne surge results with Joannes Westerink at UND
  - Hydrodynamics appear reasonable
  - Look at meteorological input
  - Compare wind models - OWI vs. HWIND
8/24/1992 09:00
OWI input; 1 min average wind speed
Winds reduction ON

HWIND plot shows much higher wind speeds in Biscayne Bay and near BB shoreline.
Largest OWI winds occur outside of BB

8/24/1992 09:00
HWIND model results (1992 report)
Andrew Sensitivity Testing

- 20 runs cont’d
  - Apply “v2” winds, stronger south of eye
  - “Kitchen sink”, combination of many above factors
  - Reduce friction in southern Biscayne Bay and points south
  - Shift track 2 nm, 4 nm, and 6nm south
  - Strengthen original winds only in area of max surge
Hurricane Andrew (1992)

- Summary
  - Alterations in model settings and/or meteorological inputs did NOT improve validation metrics
  - FEMA: validate, don’t “calibrate”
  - Use original OWI winds with 5 minute forcing
Conclusions

• Canals resolved from ocean to seaward-most SFWMD control structure
• Increasing resolution to capture very small canals (<150 ft wide) increases accuracy in some ways, but introduces stability challenges
  • Smoothing topography provides reasonable solution
• Hurricane Andrew – challenging validation storm due to insufficient meteorological data and tide gage data
THANK YOU