# Dissipation due to Vegetation in Nearshore Wave Models

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# Motivation

- Estimate importance of wave attenuation by wetlands
- Determine if models can replicated it

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# Description

- Bottom friction in STWAVE
- South Louisiana simulations
- Calibration with lab and field data
- Open questions…

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# Summary

- Friction values must be function of vegetation height relative to water depth
- Much more validation data is needed
  - Large scale
  - Large events
- Present formulation is reasonable for the state of knowledge
- To use vegetation for coastal protection, much more knowledge is needed

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# Bottom Friction in STWAVE

- Holthuijsen (2007) with Manning n

$$S_{bf} = \frac{-1}{g}\left(\frac{gn^2}{d^{1/3}}\right)\frac{\sigma^2}{\sinh^2 kd}E(f,\alpha)u_{rms}$$

- n values are spatially variable, but temporally constant

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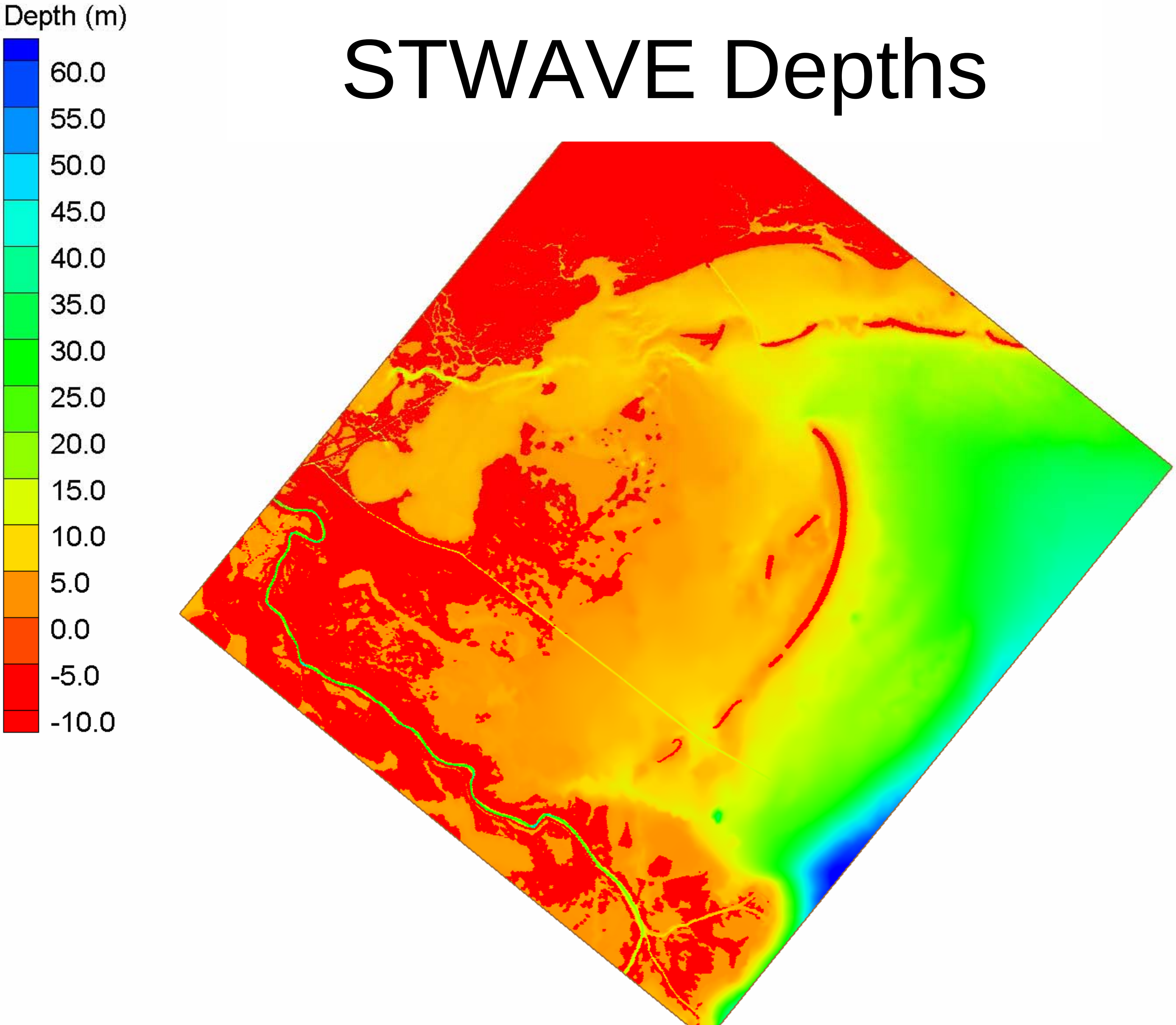
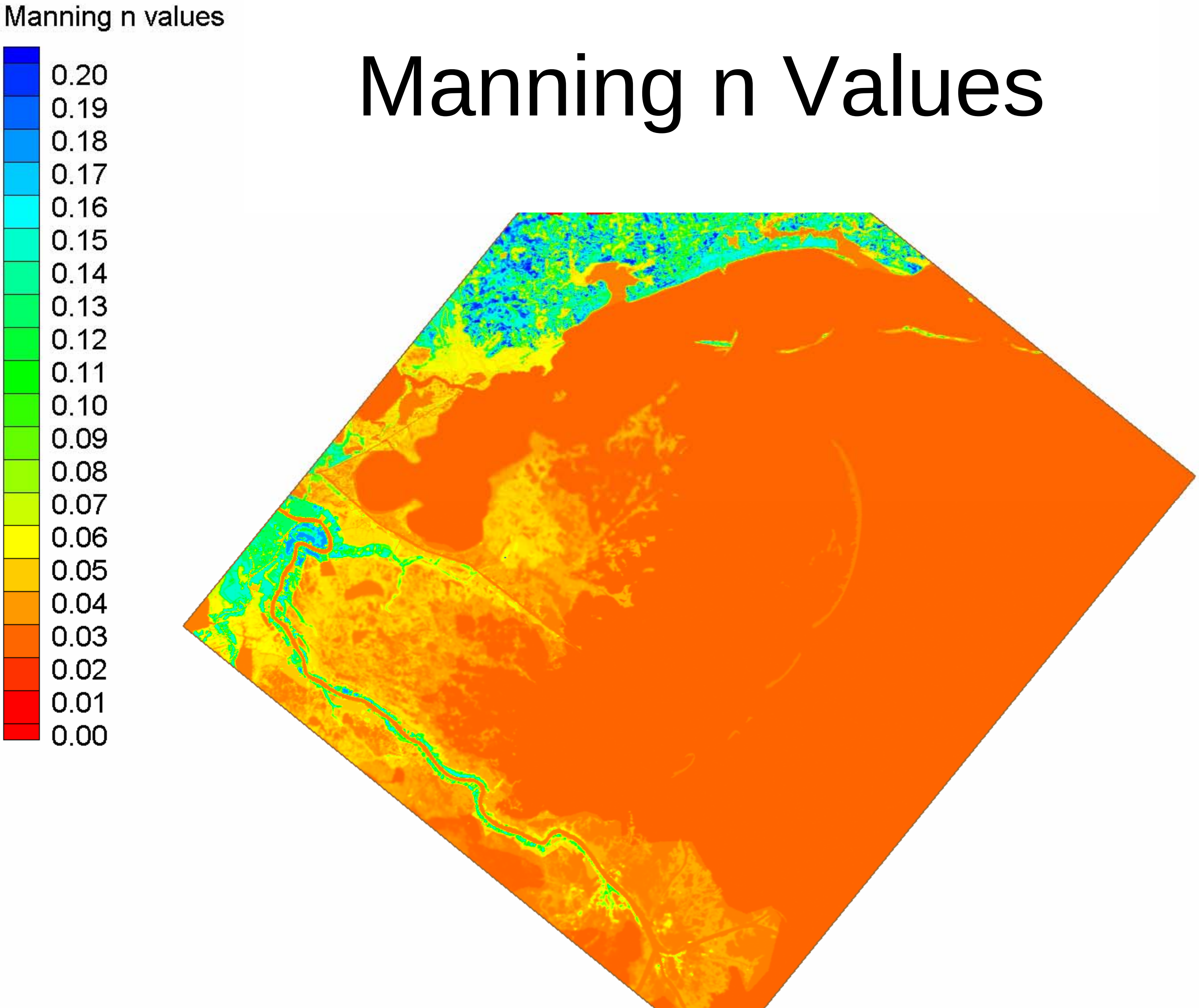
# New Orleans & SE Louisiana

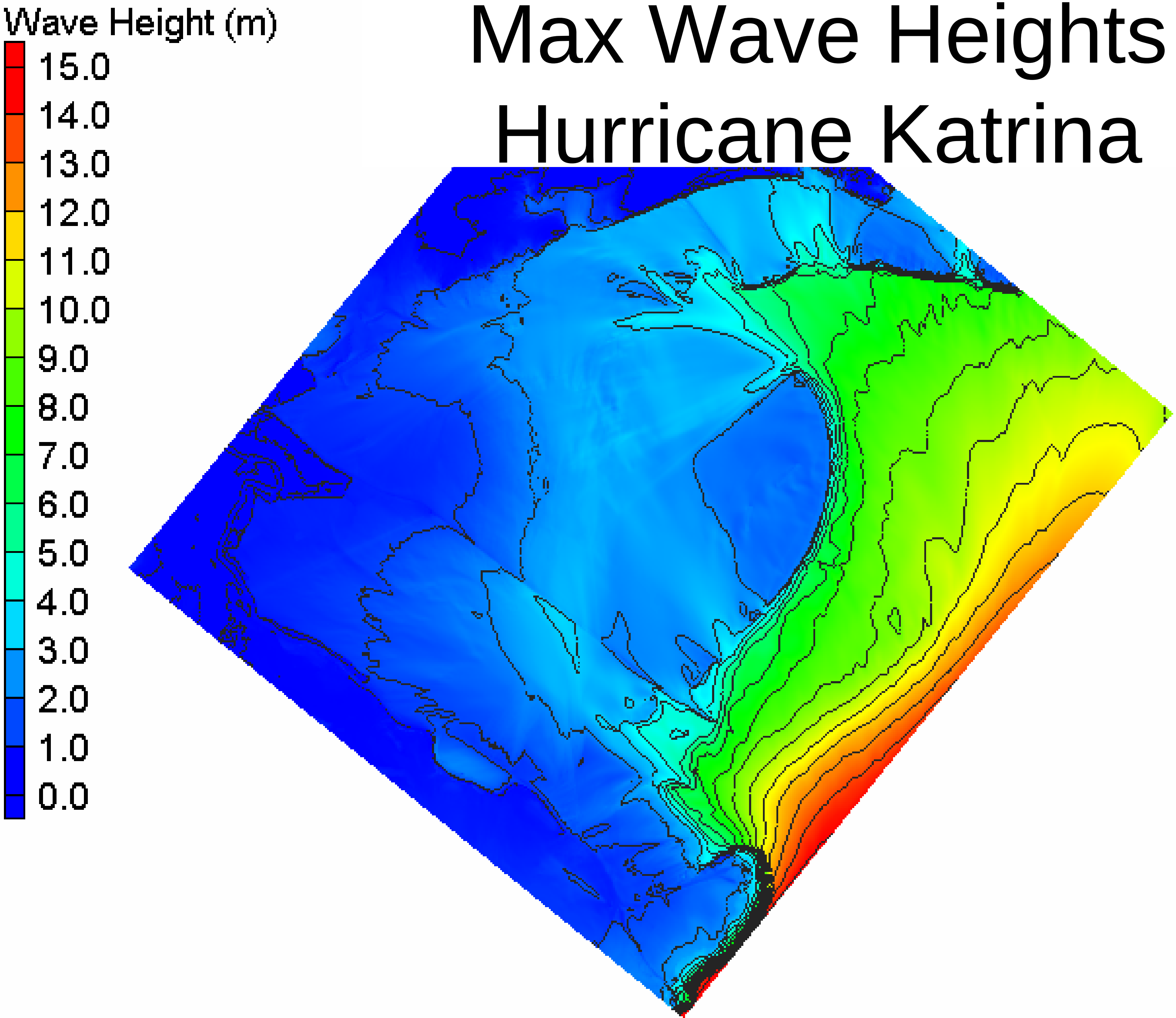
# STWAVE Depths



# Manning n Values



# Max Wave Heights Hurricane Katrina

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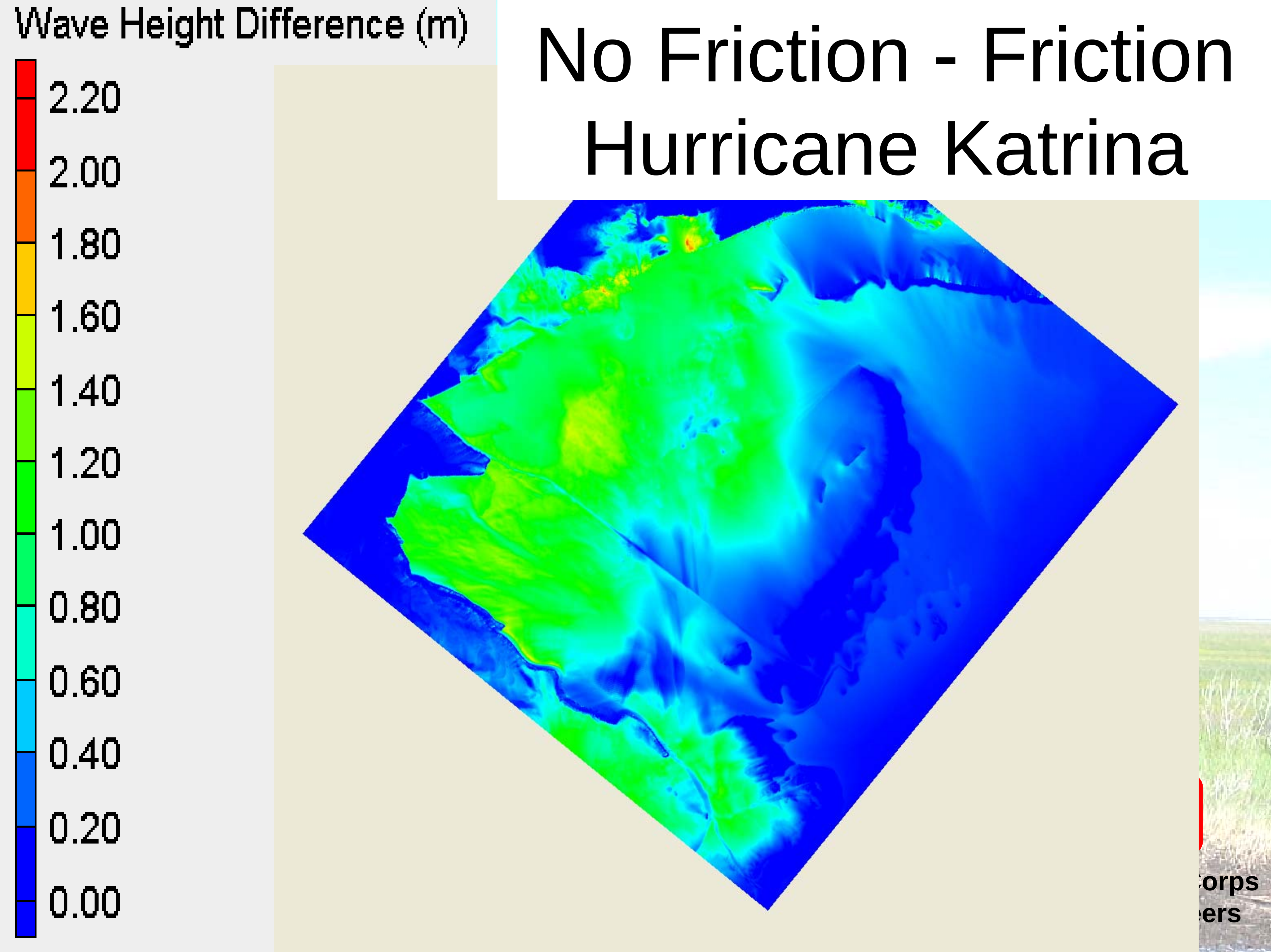
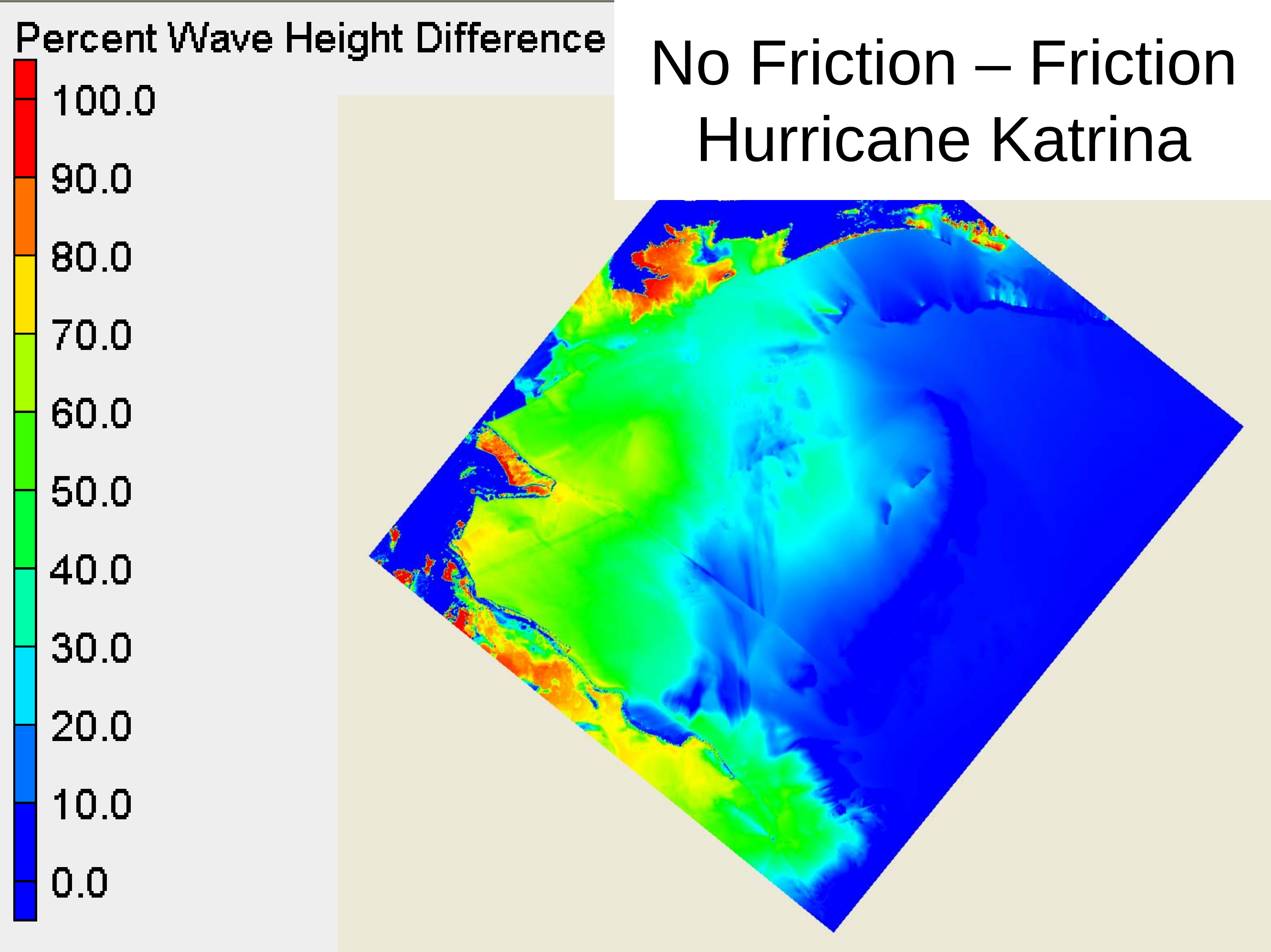
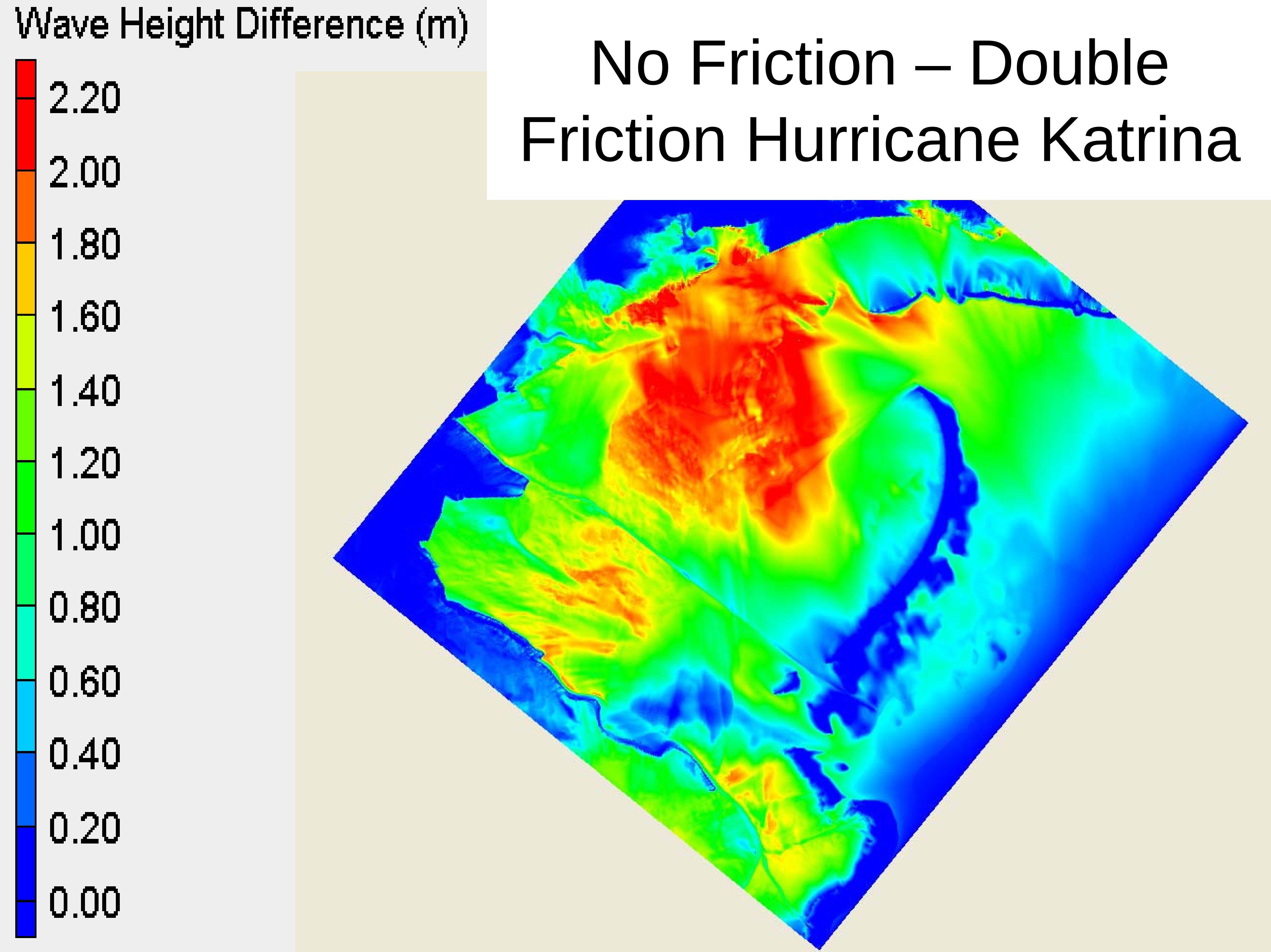
# No Friction - Friction
# Hurricane Katrina



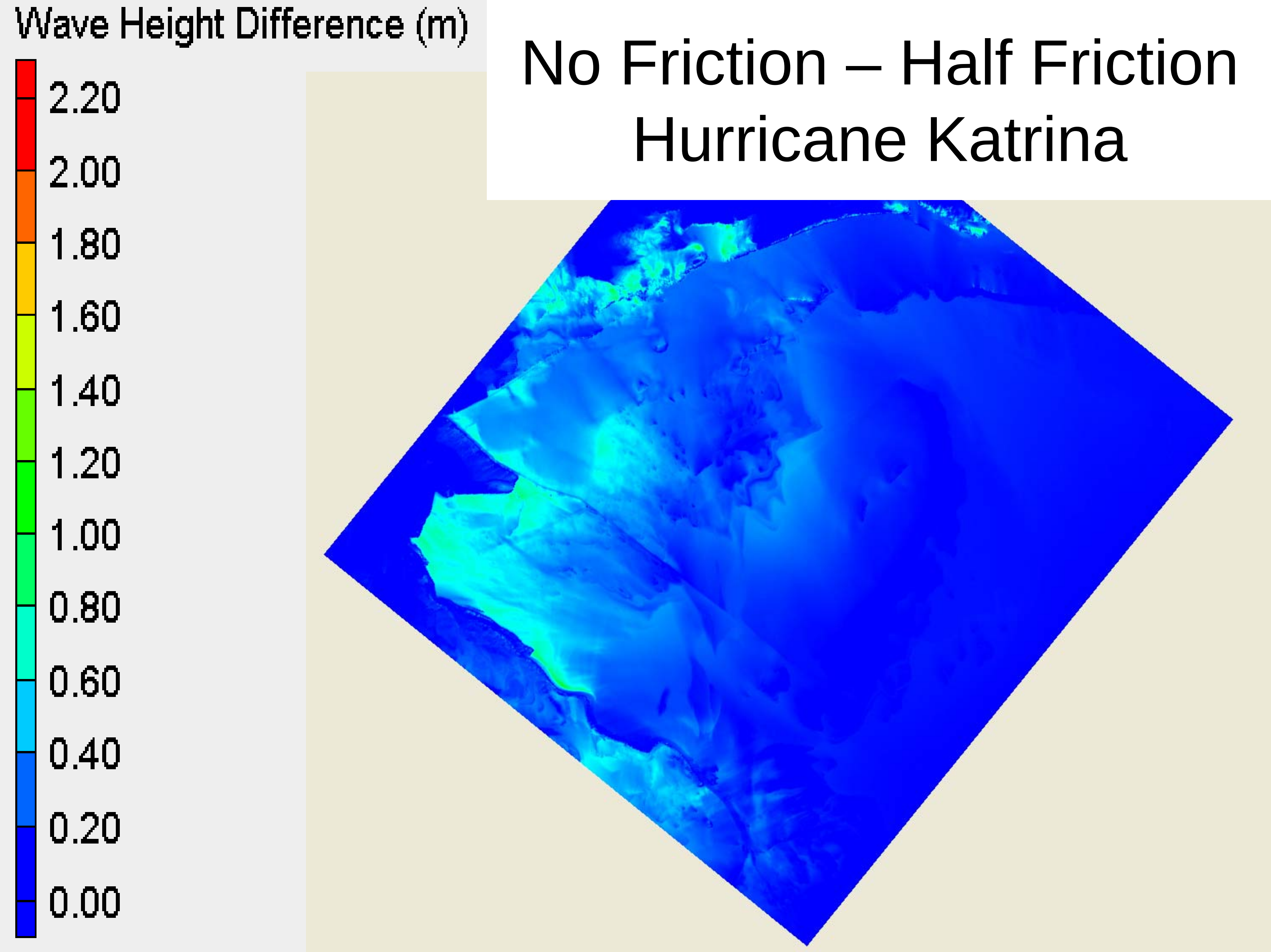
# No Friction – Friction
# Hurricane Katrina



No Friction – Double Friction Hurricane Katrina



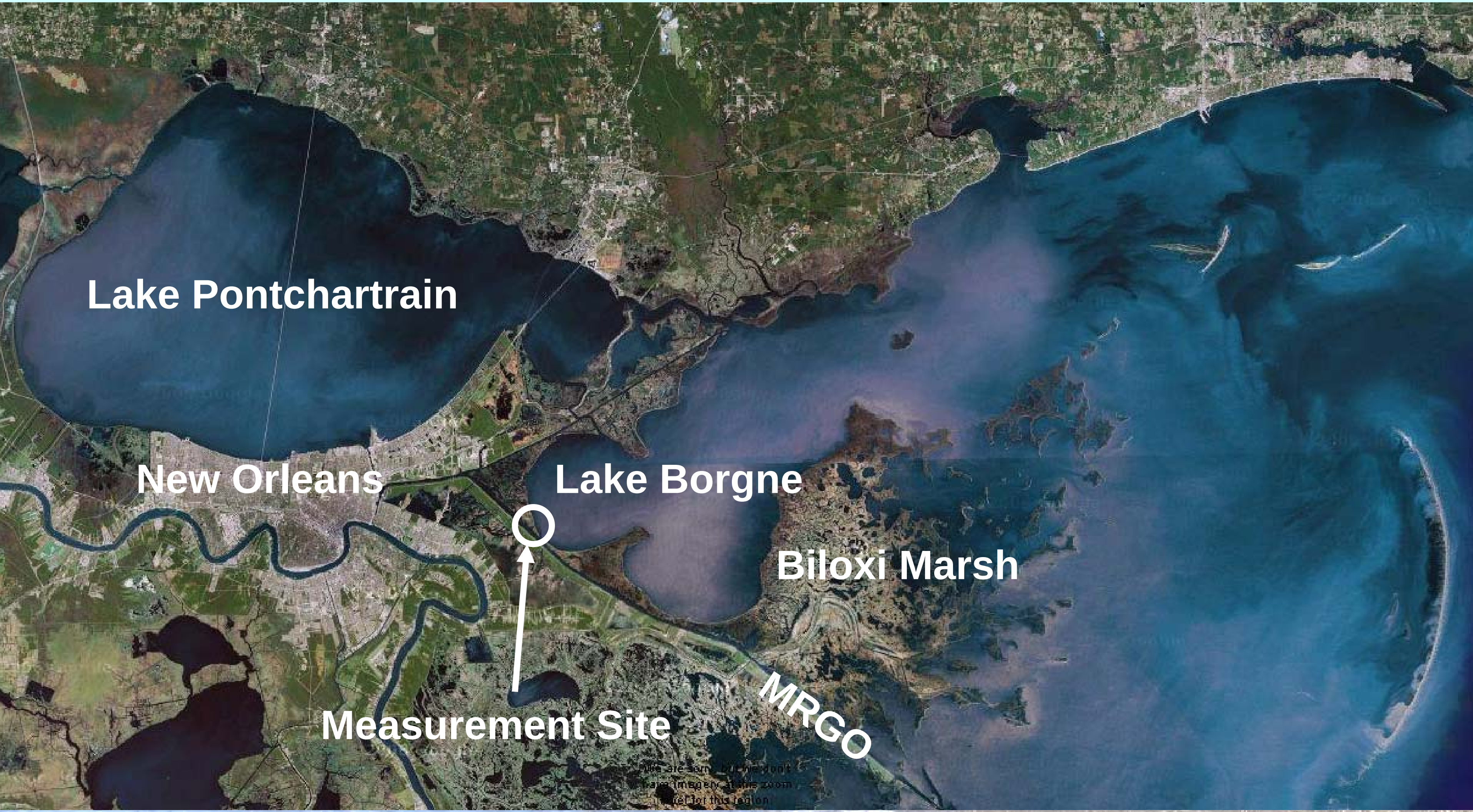
# No Friction – Half Friction
# Hurricane Katrina



# Lake Borgne Measurements

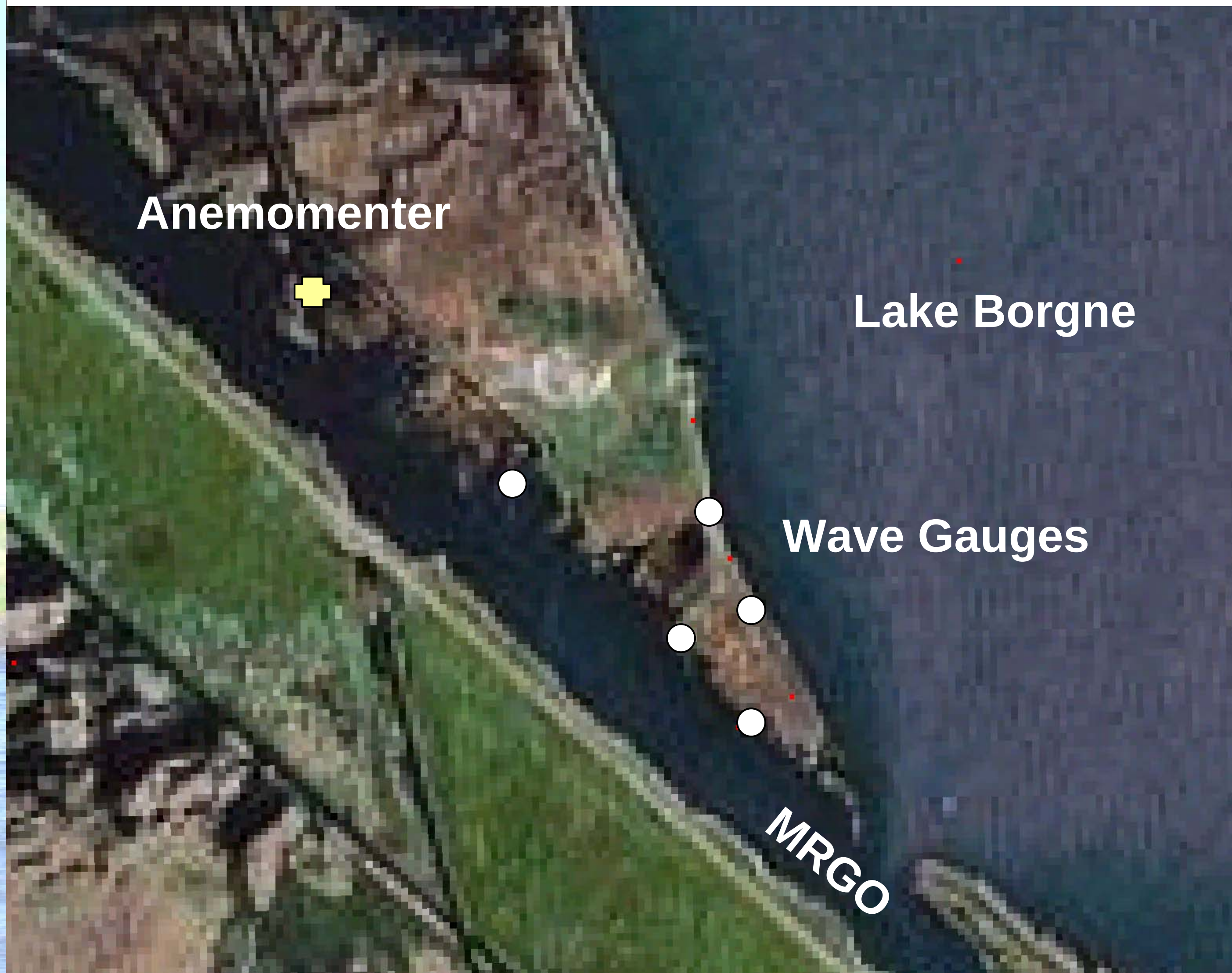
- Measure wave attenuation across wetlands
  - Five non-directional wave/water level gauges
  - Anemometer
  - Characterization of wetland (elevation, plant type, plant density, plant height, …)

# Lake Borgne Field Site



# Lake Borgne Deployment

Inner gauges ~300-600 m from lake

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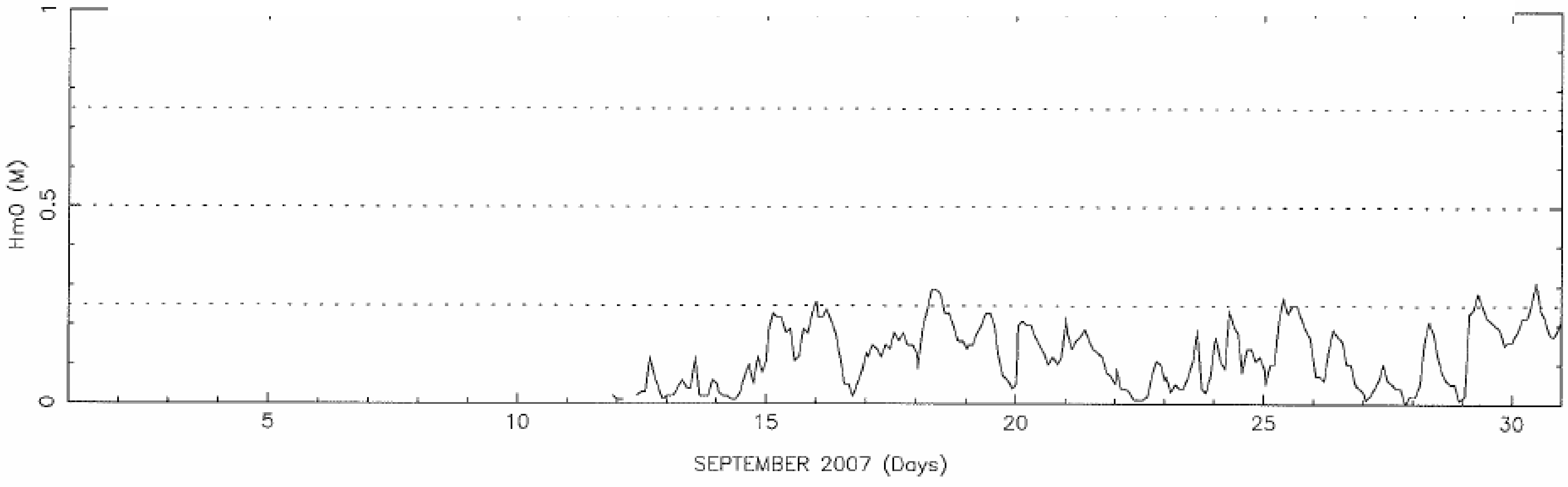
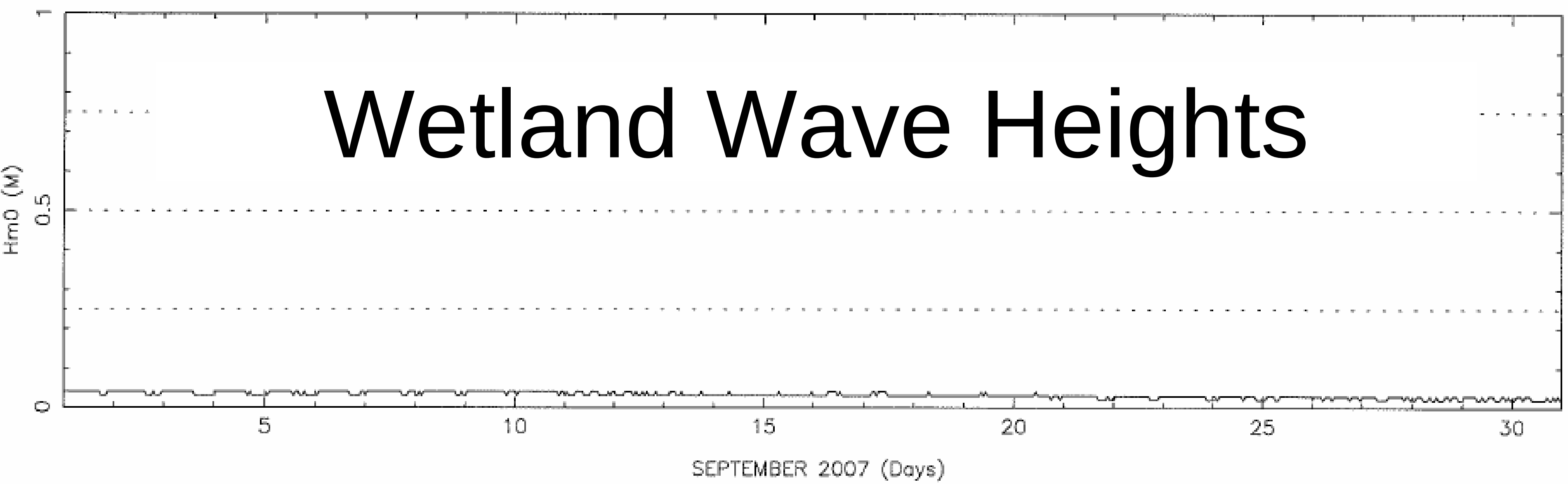
# Lake Borgne Wave Heights




Lake Borgne, LA Site 2

# Wetland Wave Heights



# Existing Data Sets

- **Knutson et al. 1982**
  - Spartina alterniflora, field, individual waves, l/d ~ 0.75 - 1
- **Fonseca & Cahalan 1992**
  - Four plants, lab, individual regular waves, l/d ~ 1
- **Dubi & Torum 1996**
  - Kelp, lab, regular & irregular waves, l/d ~ 0.3
- **Lovas 2000**
  - Kelp, lab, irregular waves, l/d ~ 0.2-0.3
- **Wallace & Cox 2000**
  - Posidonia Australis, lab, regular waves, l/d ~ 0.8-1.0

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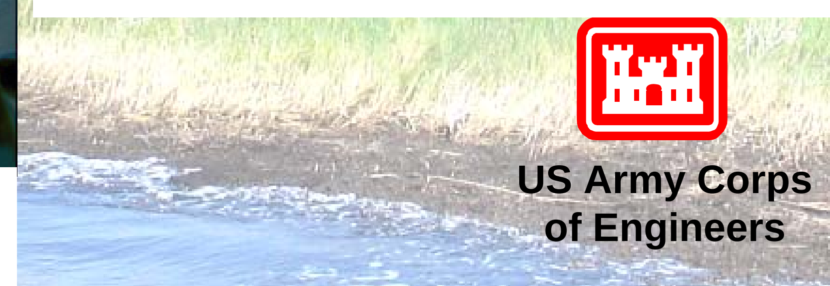
Spartina Alterniflora

Laminaria Hyperborea

Posidonia Australis



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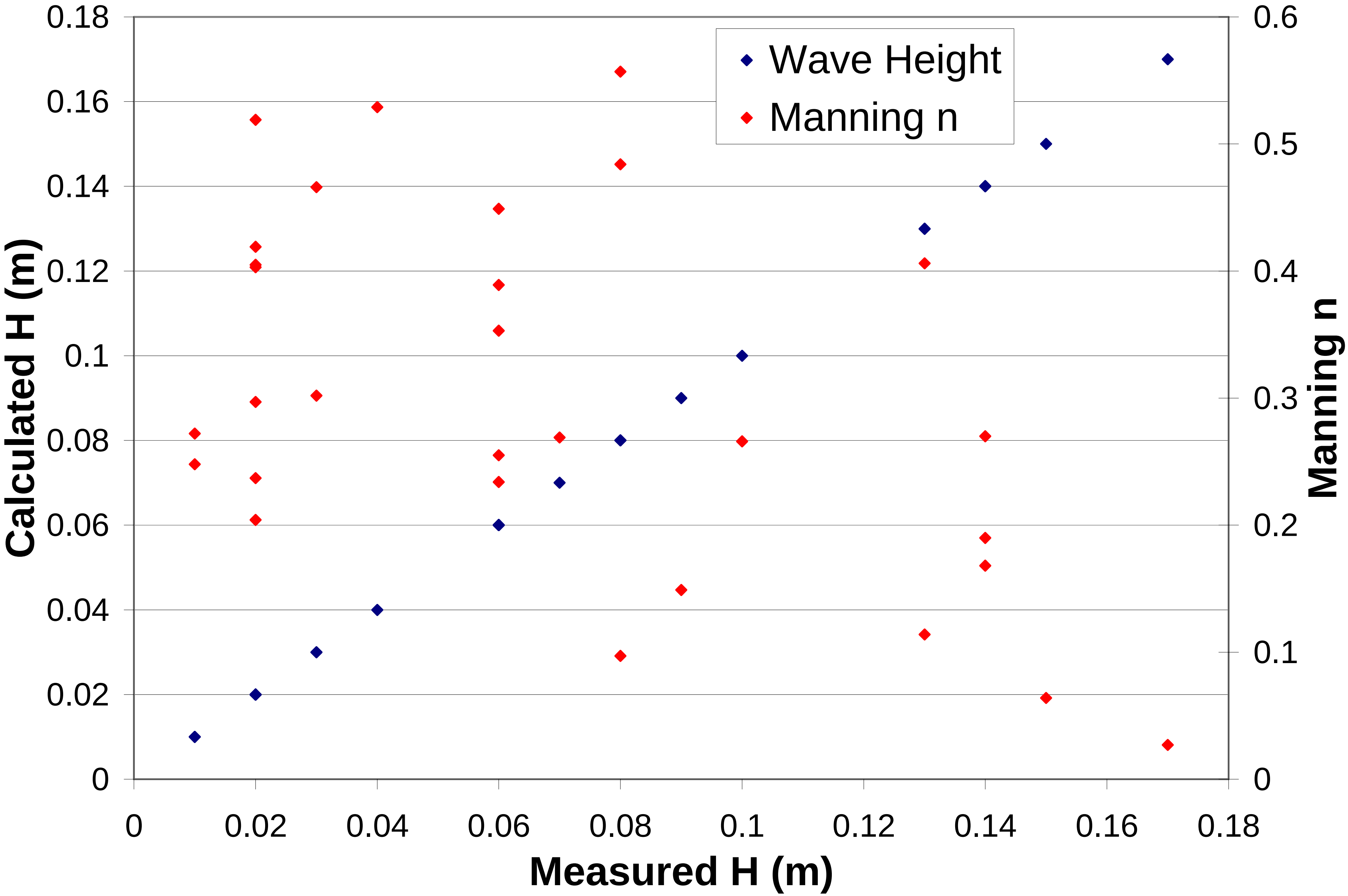
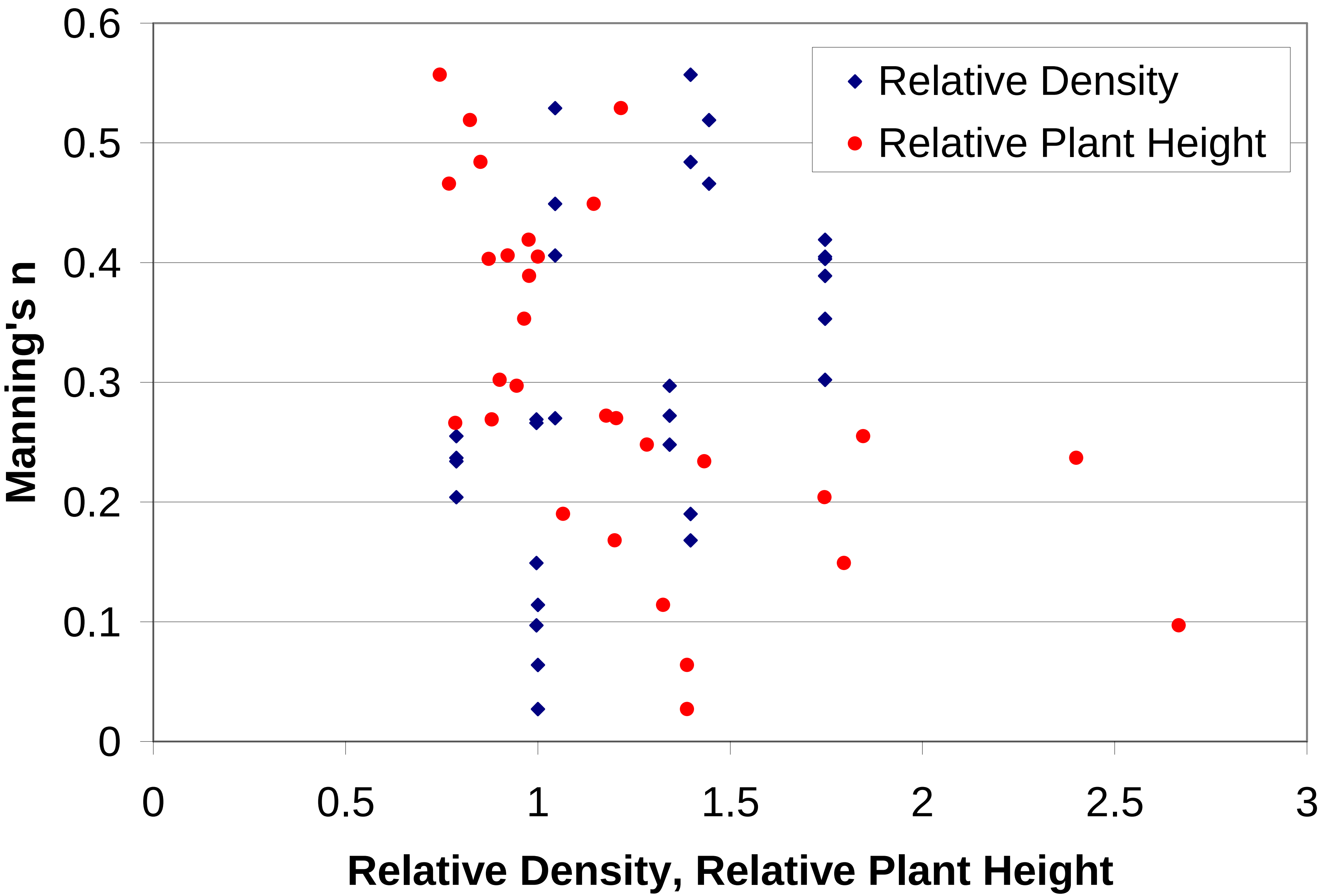
# Knutson et al. Data

**Average n = 0.3**

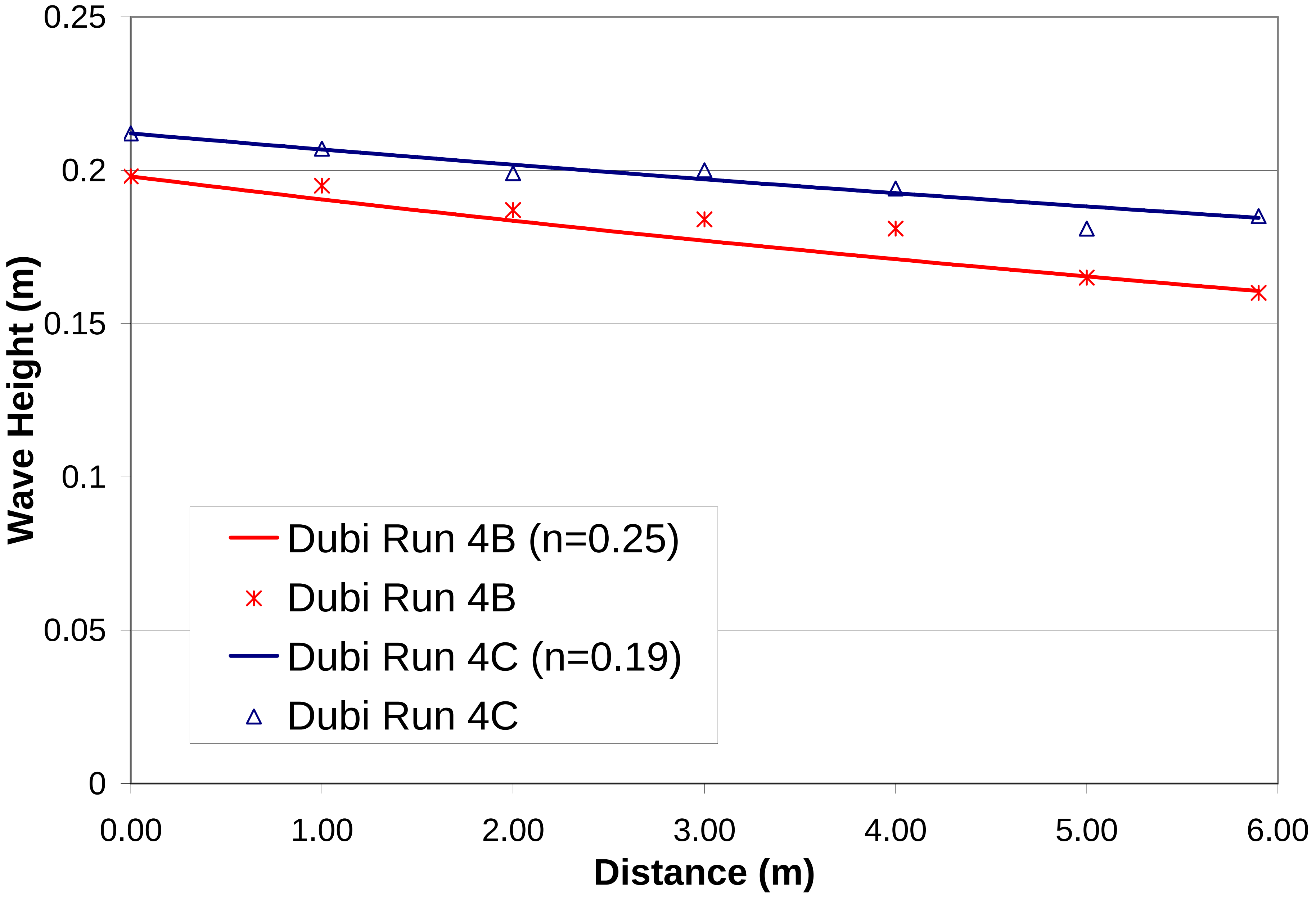
**H > 10 cm = 0.19**



# Knutson et al. Data



# Dubi Data



0.25
0.2
0.15
0.1
0.05
0
Wave Height (m)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Distance (m)
Dubi Run 4B (n=0.25)
Dubi Run 4B
Dubi Run 4C (n=0.19)
Dubi Run 4C

# Summary of Data/Validation

- **Knutson et al. 1982**
  - Spartina alterniflora, field, individual waves, l/d ~ 0.75 – 1
  - n = 0.3 (average), 0.22 (for larger waves)
- **Fonseca & Cahalan 1992**
  - Four plants, lab, individual regular waves, l/d ~ 1
  - n = 0.2-0.6, 40% decay in 1 m (density & species independent)
- **Dubi & Torum 1996**
  - Kelp, lab, regular & irregular waves, l/d ~ 0.3
  - n = 0.22, 15% reduction in n for irregular v. regular waves
- **Lovas 2000**
  - Kelp, lab, irregular waves, l/d ~ 0.2-0.3
  - n = 0.18, showed dependence of n on plant density
- **Wallace & Cox 2000**
  - Posidonia Australis, lab, regular waves, l/d ~ 0.8-1.0
  - n = 0.18

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# Summary

- Biloxi Marsh
  - n = 0.04-0.06 (consistent w/ Chow & ADCIRC)
  - Modeled maximum wave heights reduced 1.5 m by friction in Katrina
  - Lack validation
- Lab and Field data
  - n ~ 0.20, with LARGE variability (factor ~ 10)
  - Chow:  very high vegetation + 0.05 to 0.1

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# Summary

- **Data Requirements**
  - **Controlled experiments**
    - Quantify relative density, relative submergence, flexibility, seasonality (vegetation height/density)
    - Test over range of irregular waves
  - **Field Measurements**
    - Large scale
    - Natural variability
- **Modeling**
  - **Validation**
  - **Increase sophistication**
    - Temporal variability of n
    - Interaction with mean currents
    - Separation of bottom friction and form drag
  - **Impact on setup**

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