# Overview of the Coastal Modeling System (CMS)

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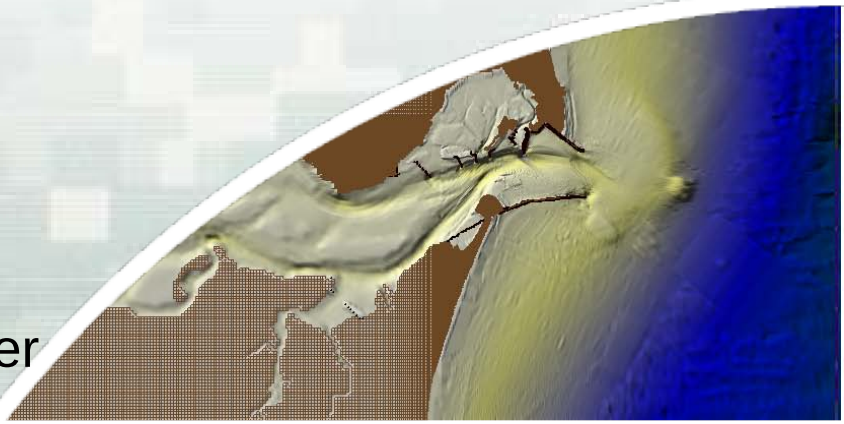

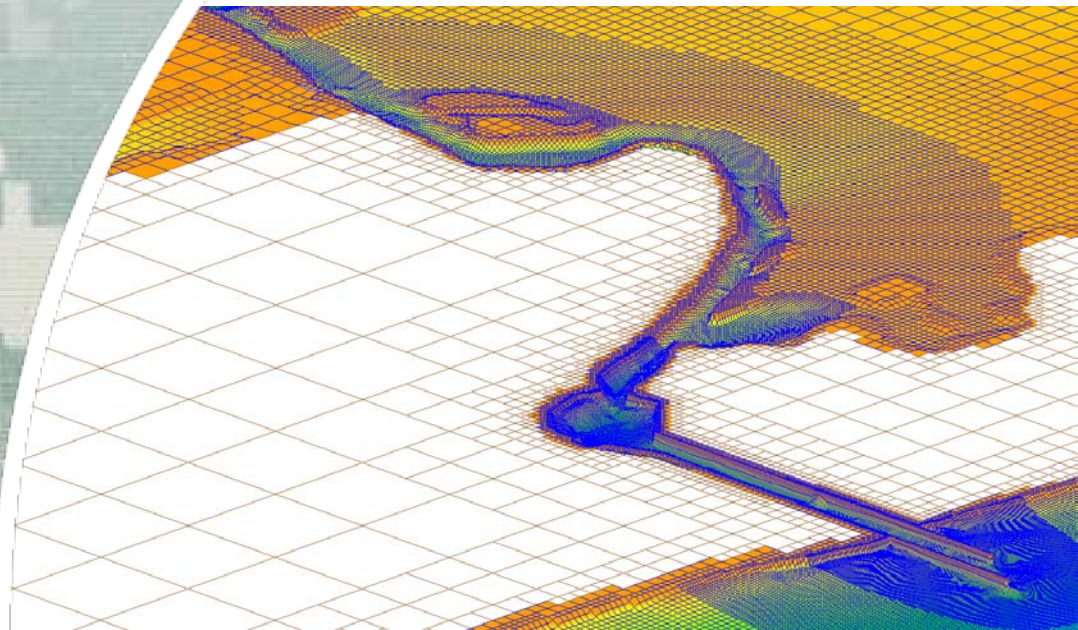

US Army Corps of Engineers

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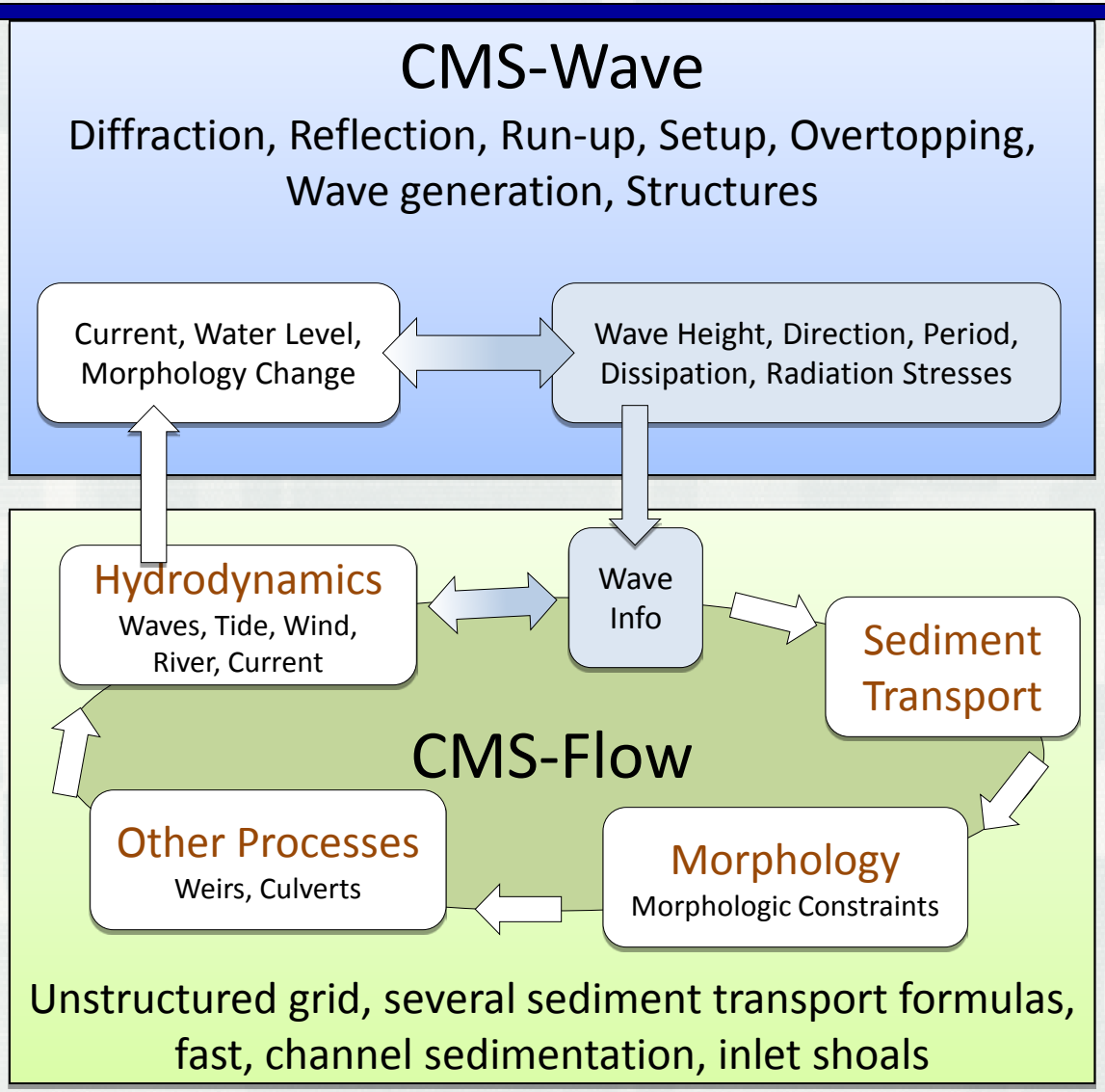
# Objective

- **Deliver** to engineers' desktops **integrated** advanced models that can be used as a **practical** engineering tool for **coastal** shoaling and erosion problems in reduction of O&M costs.
  - Integrated: All relevant processes, models efficiently coupled together
  - Practical: PC-based, user-friendly interface, fast, robust and accurate
  - Deliver: Manuals, tech reports, journal papers, Wiki, workshops, phone help, etc.

# CMS Overview




Since 1997…

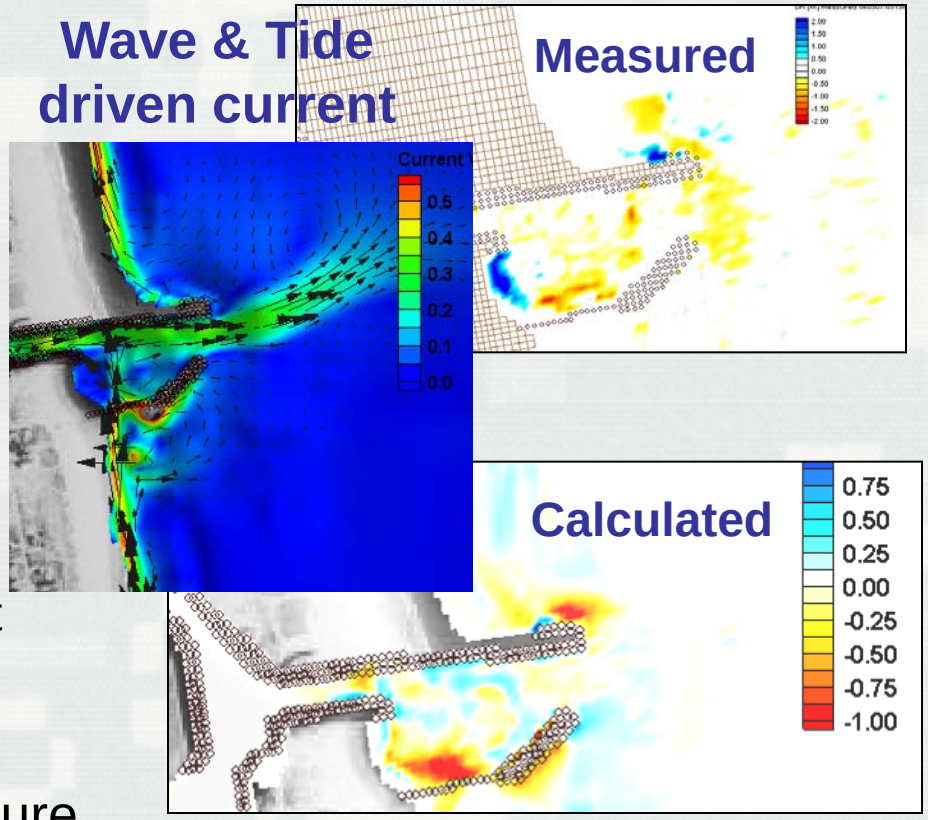
- 32 workshops
- Districts can independently run the CMS!

Advantages…

- Robust
- Physics-based
- Integrated SYSTEM
- In SMS
- User-friendly

# CMS-Flow Key Features

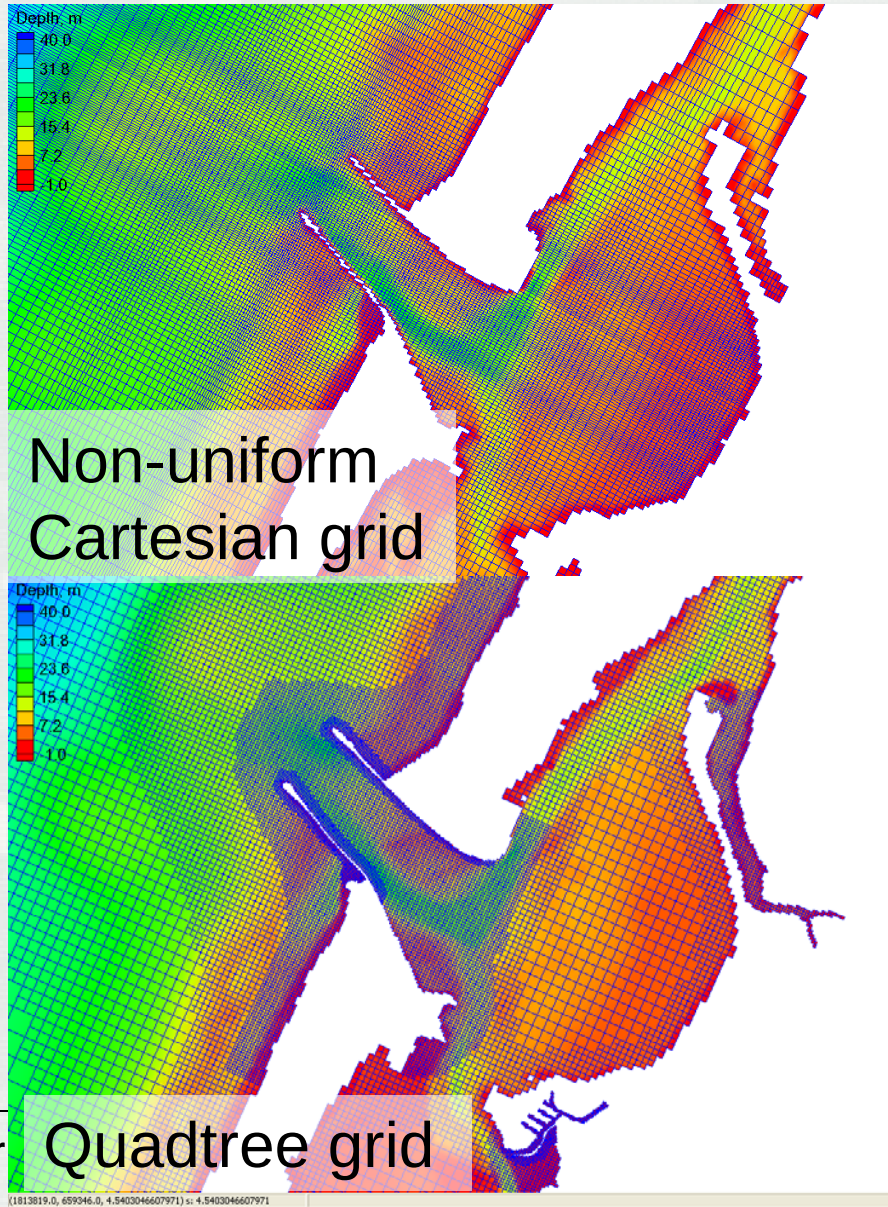
- Finite Volume Method
  - Conserves mass
  - Stable
  - Accessible
- Coupled with spectral wave model (CMS-Wave)
  - Wave-current interactions
- Inline sediment transport and morphology change
  - Non-equilibrium sediment Transport model (NET)
- Nesting capability
- WSE, river, wind/atmospheric pressure forcing
- Tidal constituent forcing (NEW)



# CMS-Flow Key Features

- Grid options
  - Non-uniform Cartesian grid: Easy to setup
  - Telescoping (quadtree) grid: Efficient, flexible
- Solver options
  - Implicit: Tidal flow, long-term morphology change.

    ~10 minute time step
  - Explicit: Flooding, breaching, super-critical flow. ~1 second time step, parallel processing



# Hydrodynamics

## Included terms for the depth-averaged shallow water equations in Cartesian coordinates

Depth - averaged current velocity

Total water depth

Still water depth

Water surface elevation

Gravity

Atmospheric Pressure

Precipitation / Evaporation

Coriolis

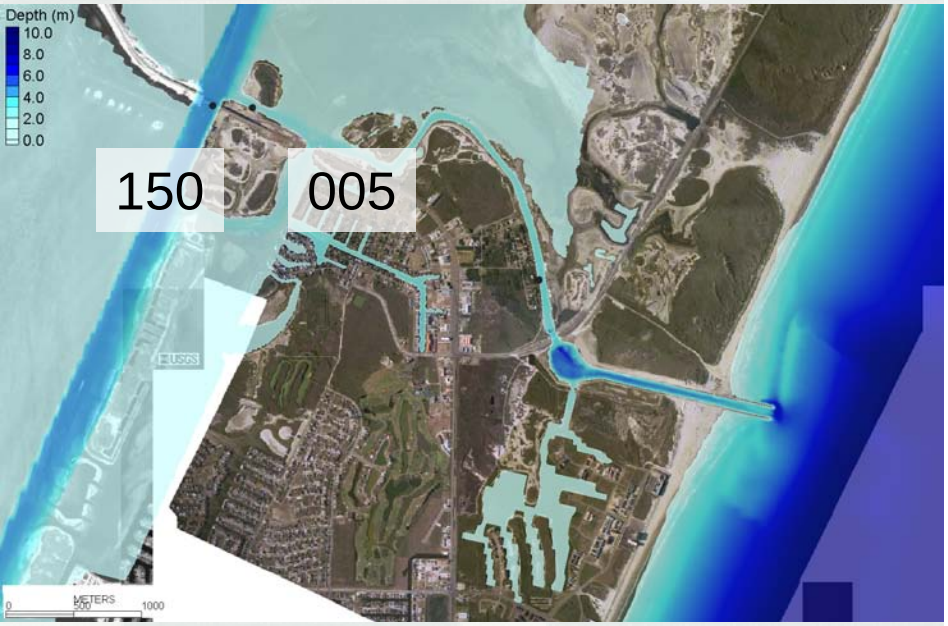
Turbulent eddy viscosity

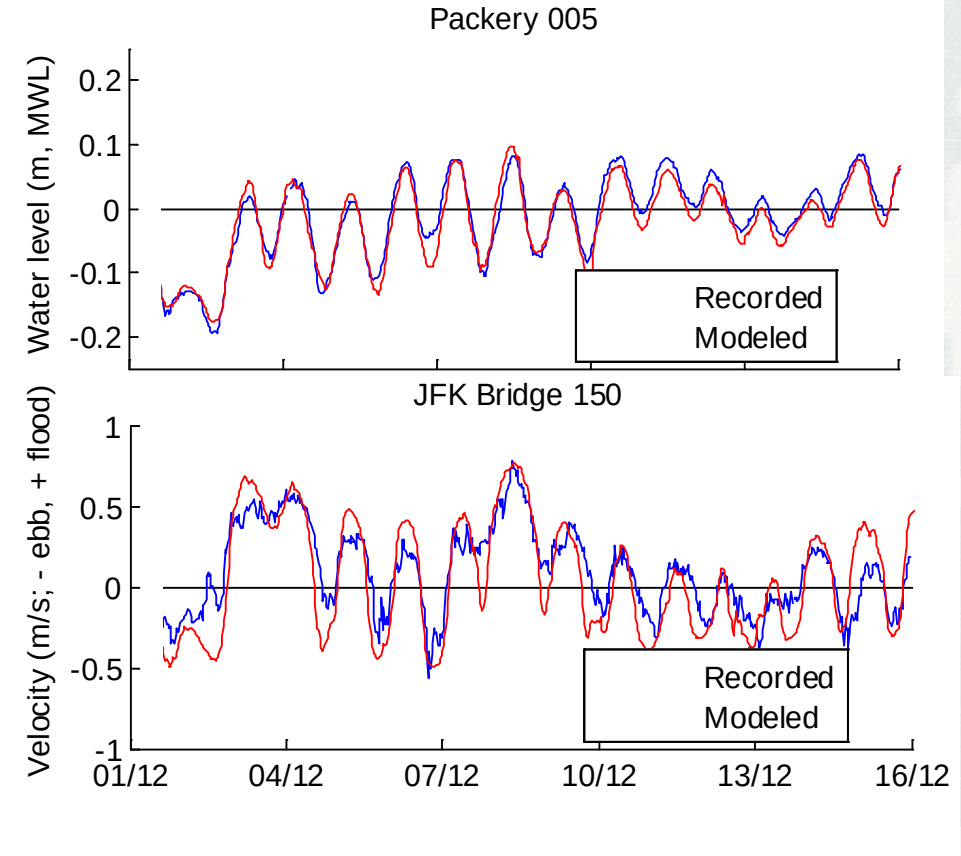
Bottom stress (including waves)

Wave stress (forcing)

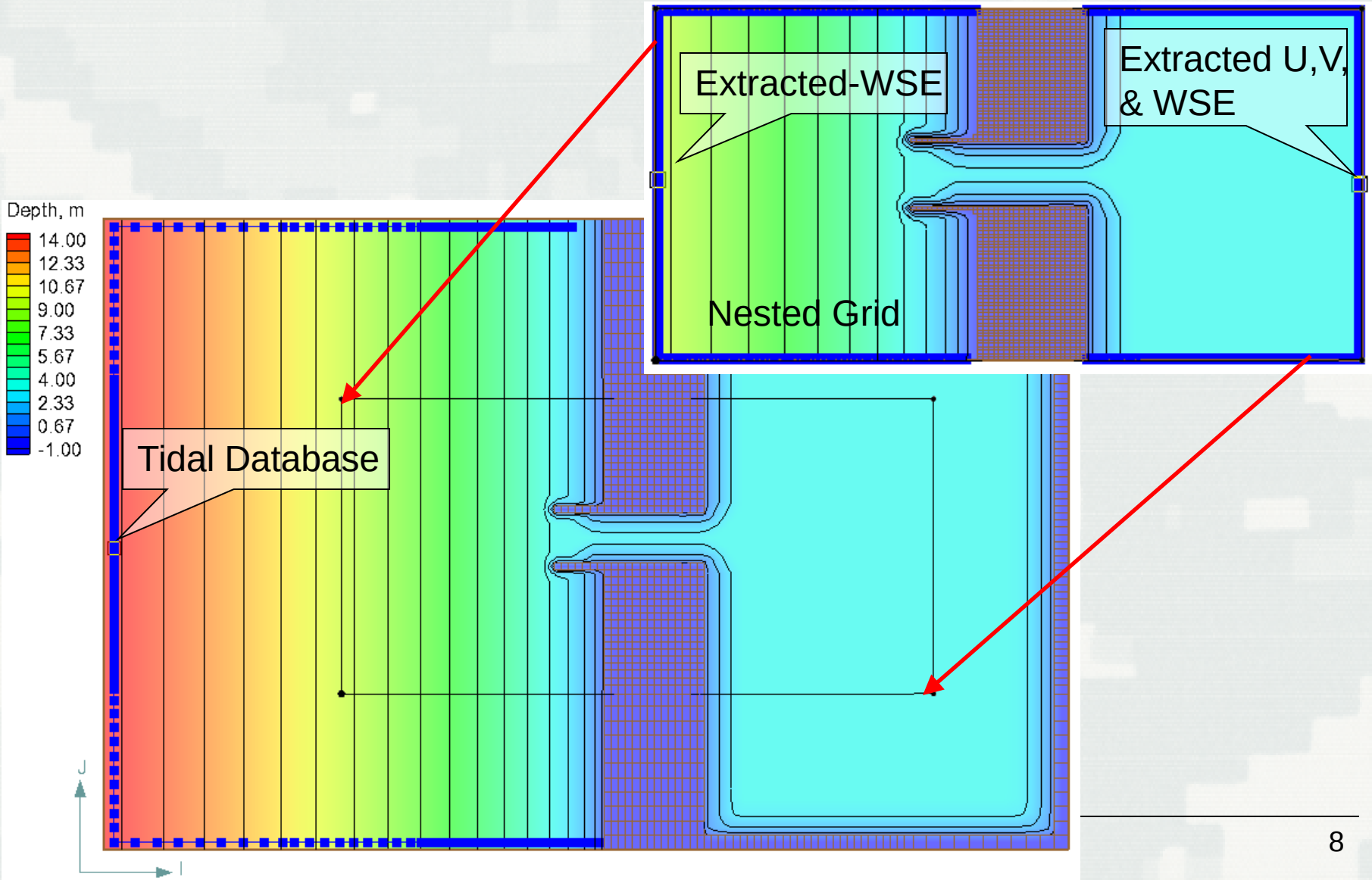
Wind stress

# Packery Channel, TX



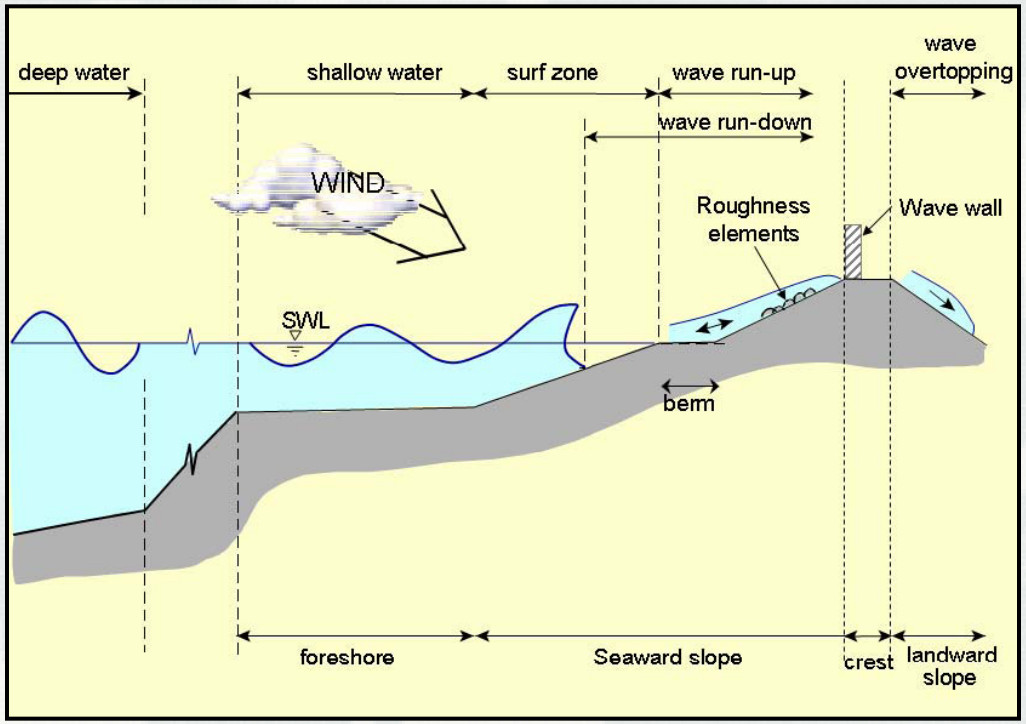



# Nested Grid Capability

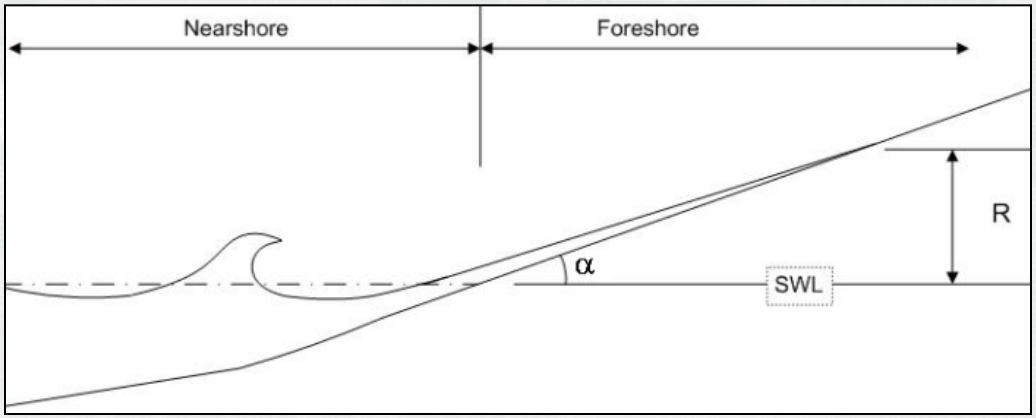


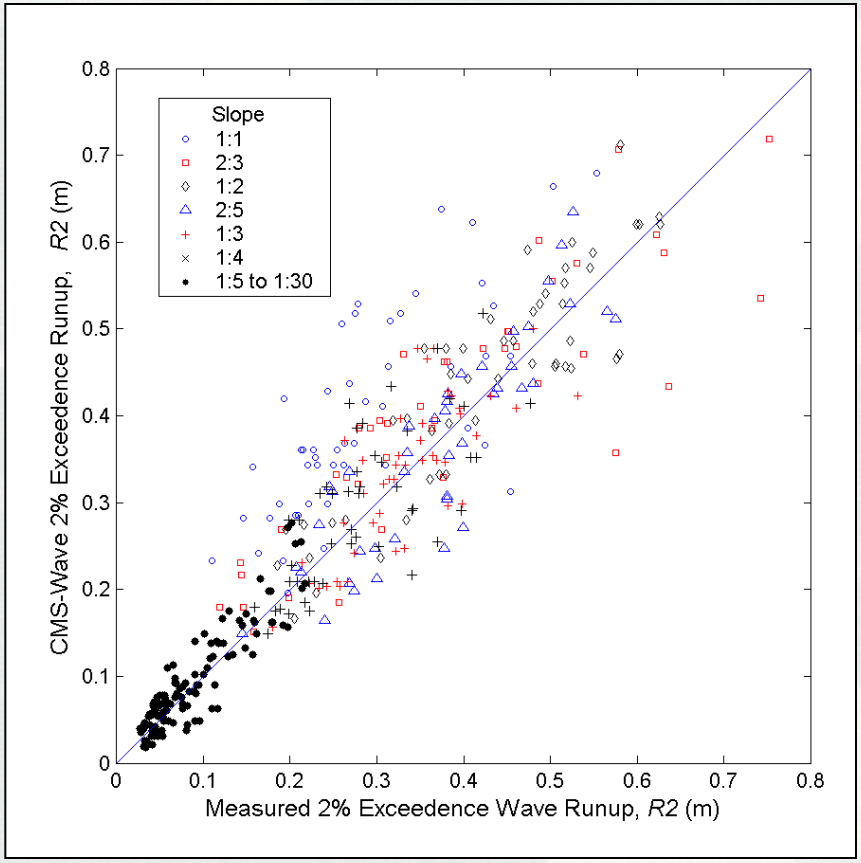
# CMS-Wave: Key Features

- Shoaling, refraction, diffraction, reflection
- Bottom friction
- White capping
- Wave breaking (4 options)
- Wind generation
- Wave-current, and wave-wave interactions
- Transmission, runup and overtopping
- Muddy bottom
- Automatic grid rotation
- Non-uniform Cartesian grid with nesting capability
- “Fast Mode”



# Wave Run-up



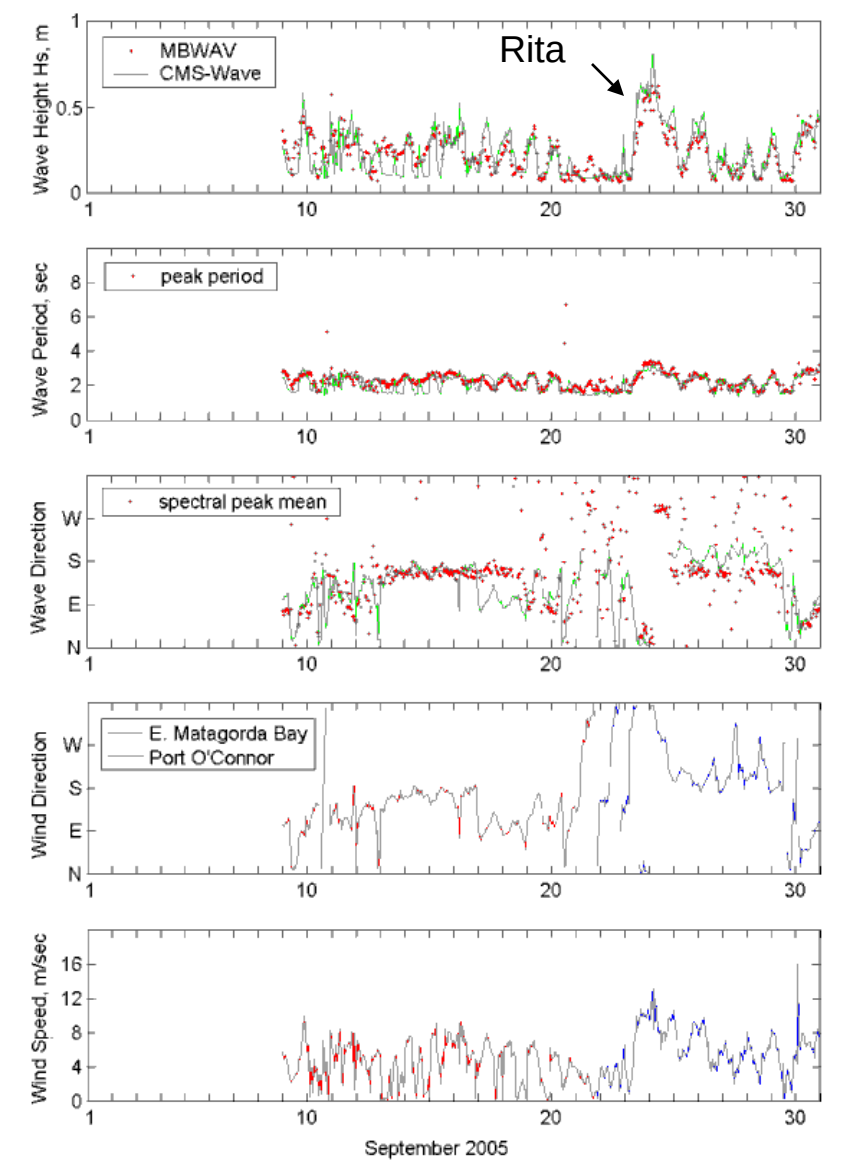




**Wave run-up: rush of waves up a slope or structure**

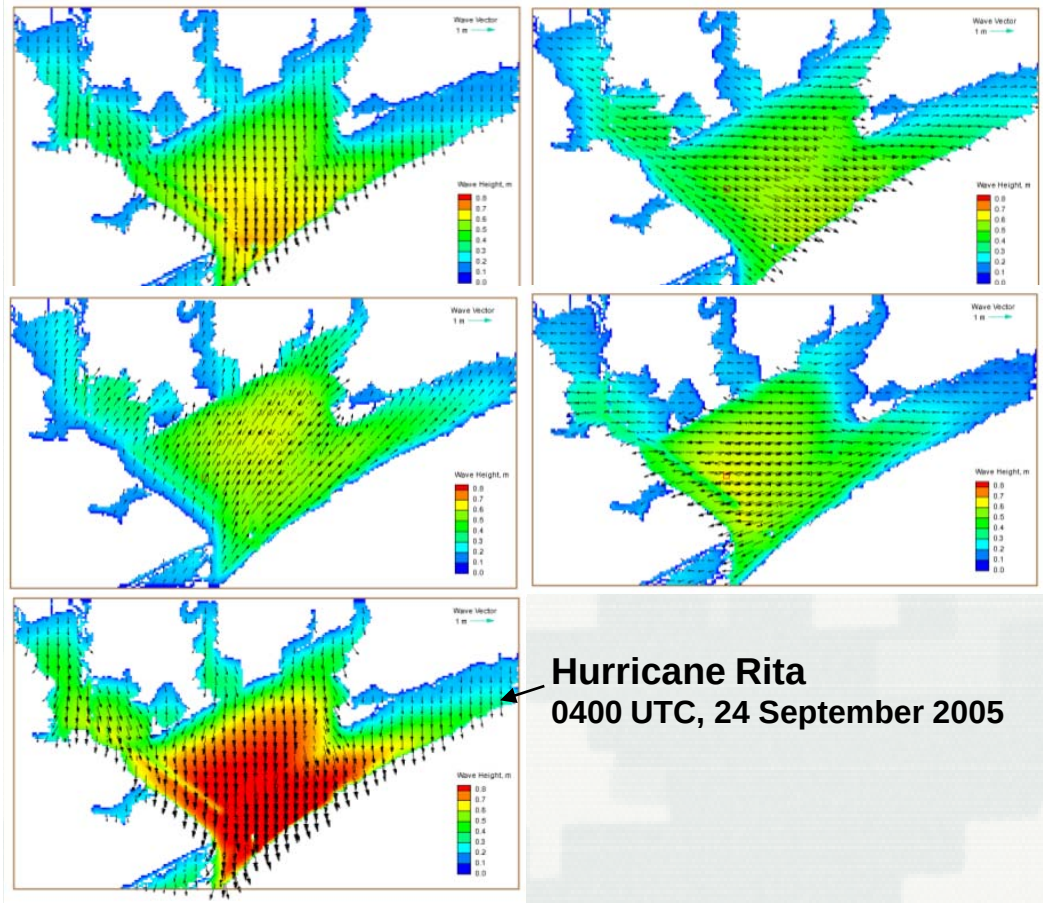
**Two-percent run-up, *R2* : the vertical up-rush level exceeded by 2-percent of the larger run-up height**

**Ahrens & Titus (1981), Mase & Iwagaki (1984) ~ 400 laboratory experiments**

# Wave Generation

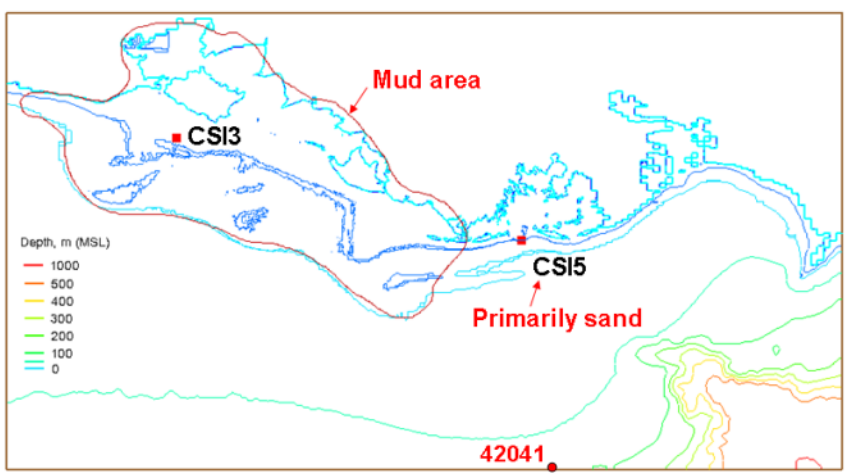


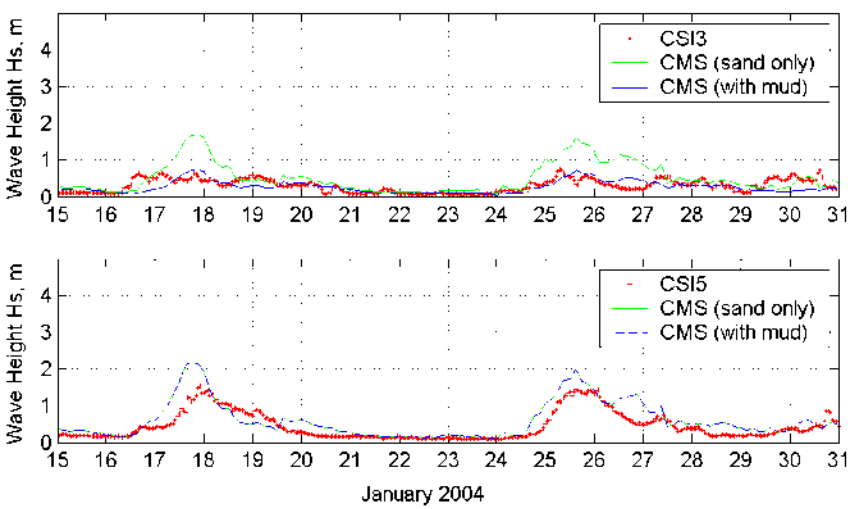

## Matagorda Bay, TX

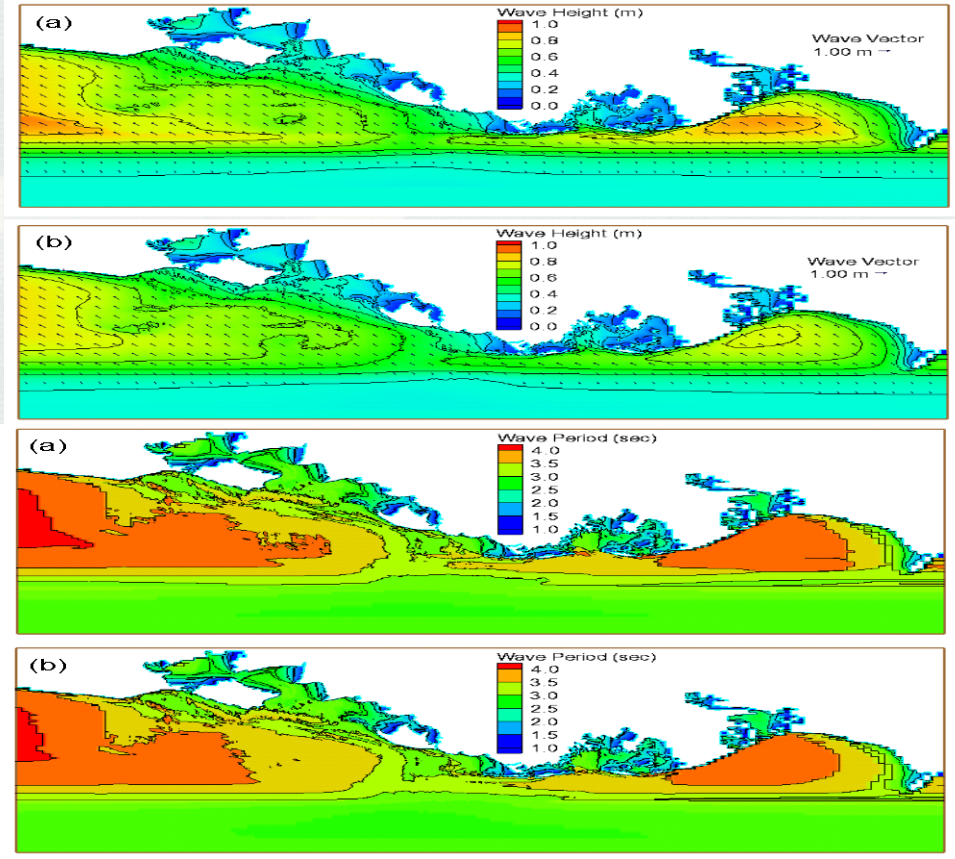


**Hurricane Rita**
**0400 UTC, 24 September 2005**

# Wave Dissipation over Muddy Coast

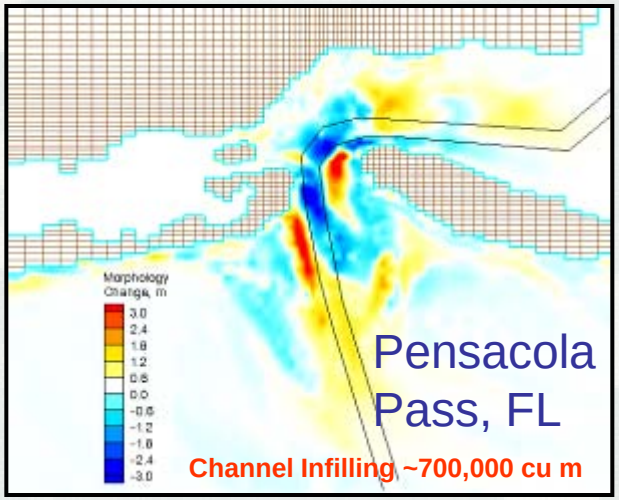


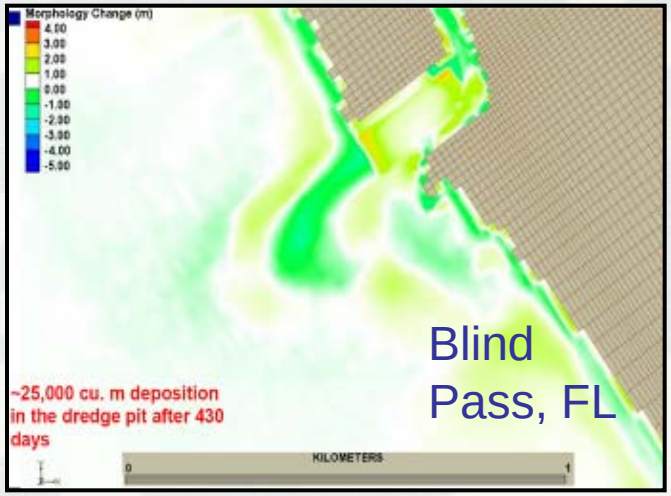



# Sediment Transport: Key features

- Sediment transport models
  - Equilibrium Total Load (Exner equation)
  - Eq. Bed Load + AD Suspended Load
  - Non-Eq. (AD Total Load)
- Sediment transport formulas
  - Lund-CIRP
  - Van Rijn
  - Watanabe
  - Soulsby
- Hard-bottom
- Avalanching
- Bed slope influence on bed load
- Multiple-sized sed. transport (NEW)

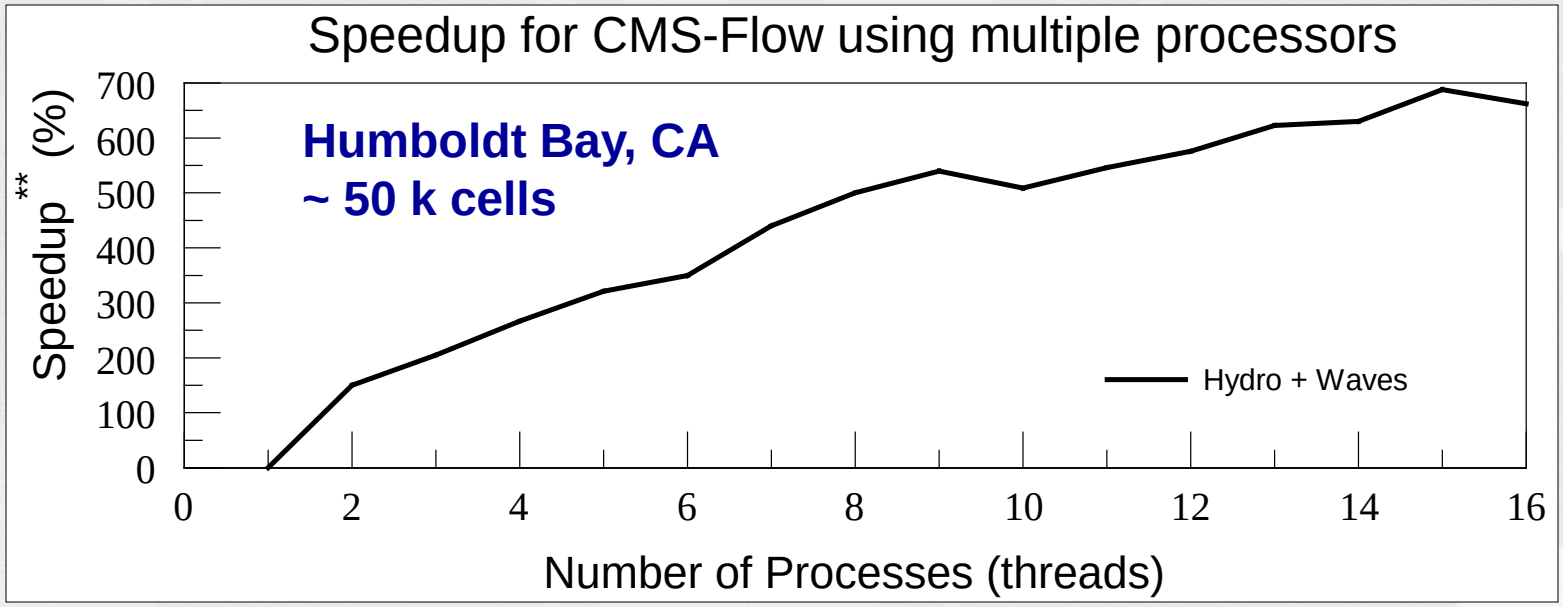


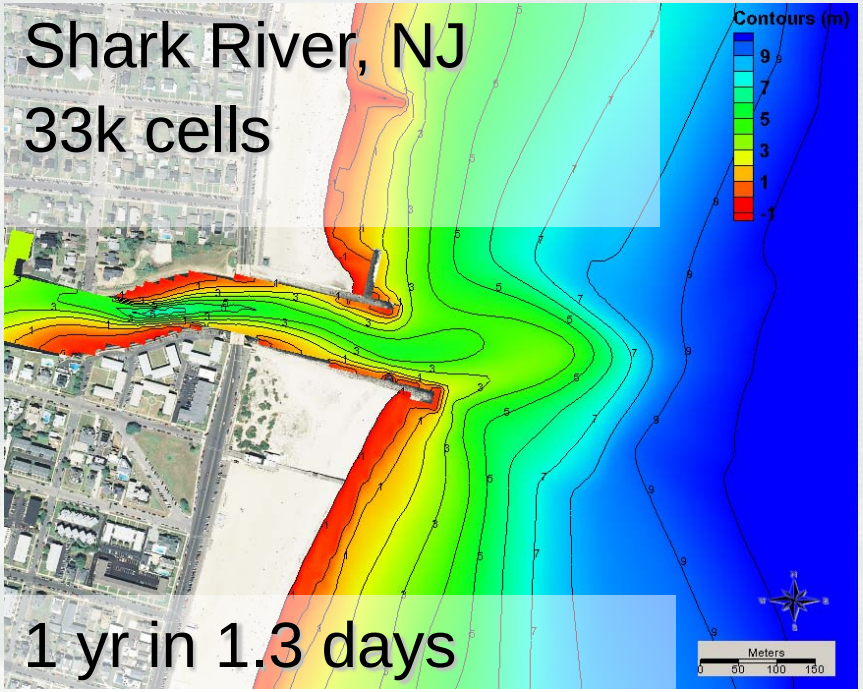
# Parallel Processing (Explicit)

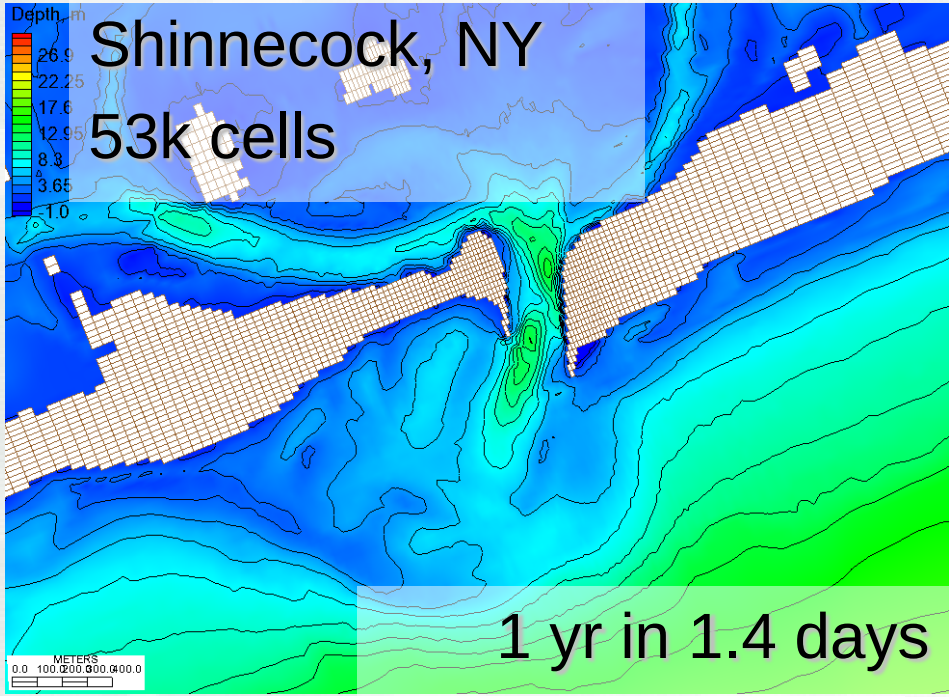
- **Explicit CMS-Flow parallelized using OpenMP**
  - **Ideal for multi-core machines**
- **Implicit parallelization starting using hybrid MPI and OpenMP**
- **Purchase quad and dual-quad PC's!**

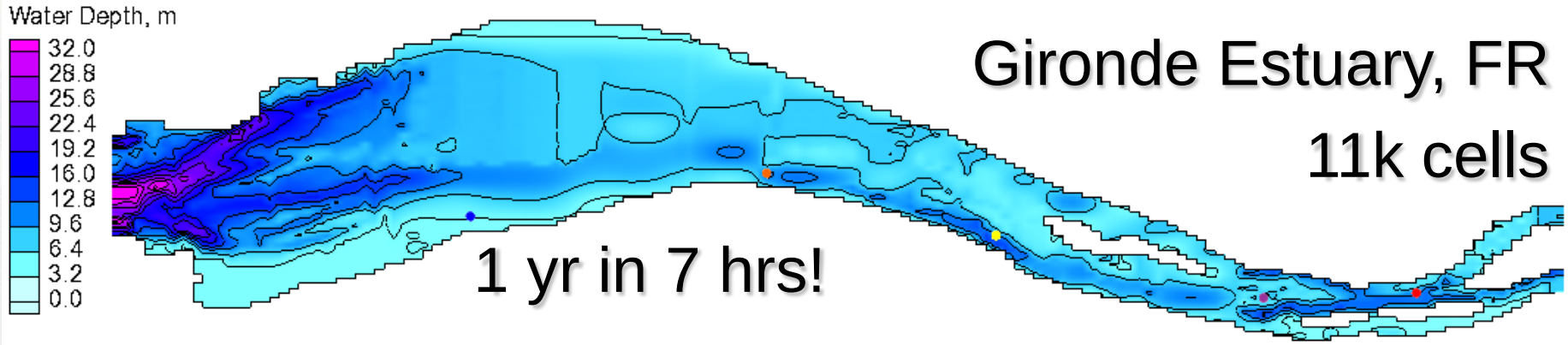
$$\text{speed up} = 100 \frac{\text{Serial run time}}{\text{Parallel run time}}$$



# Computational Speed (Implicit)

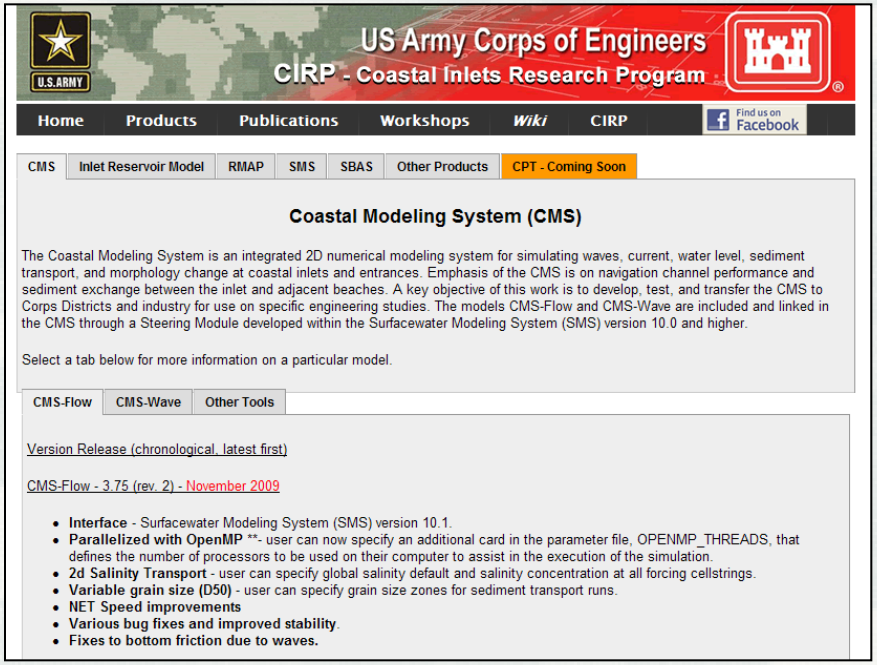


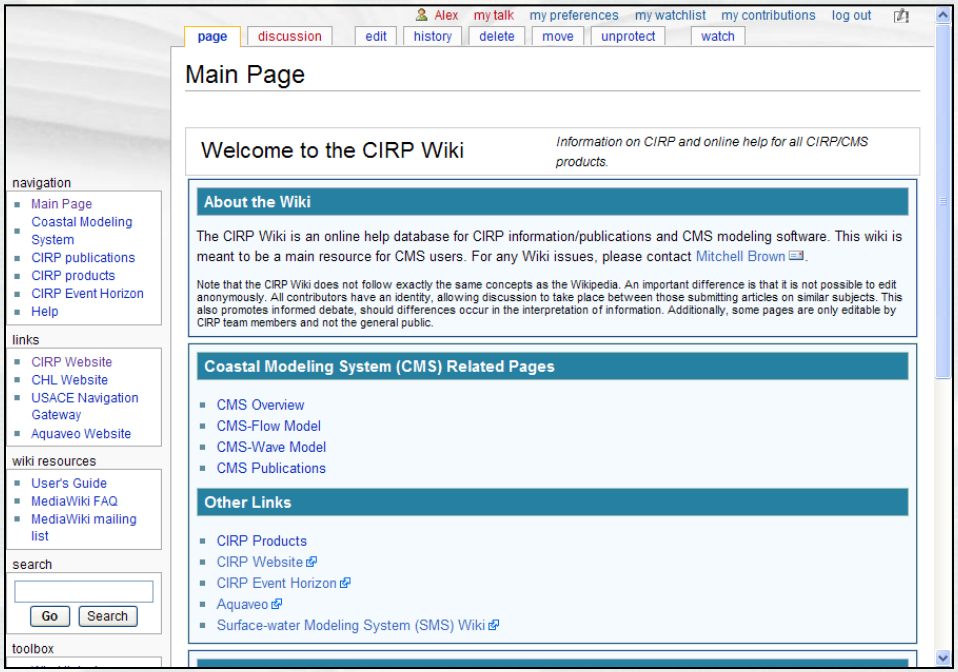



# Documentation

- CIRP website




- Wiki Website




[http://cirp.usace.army.mil/](http://cirp.usace.army.mil/)

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# Questions?

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