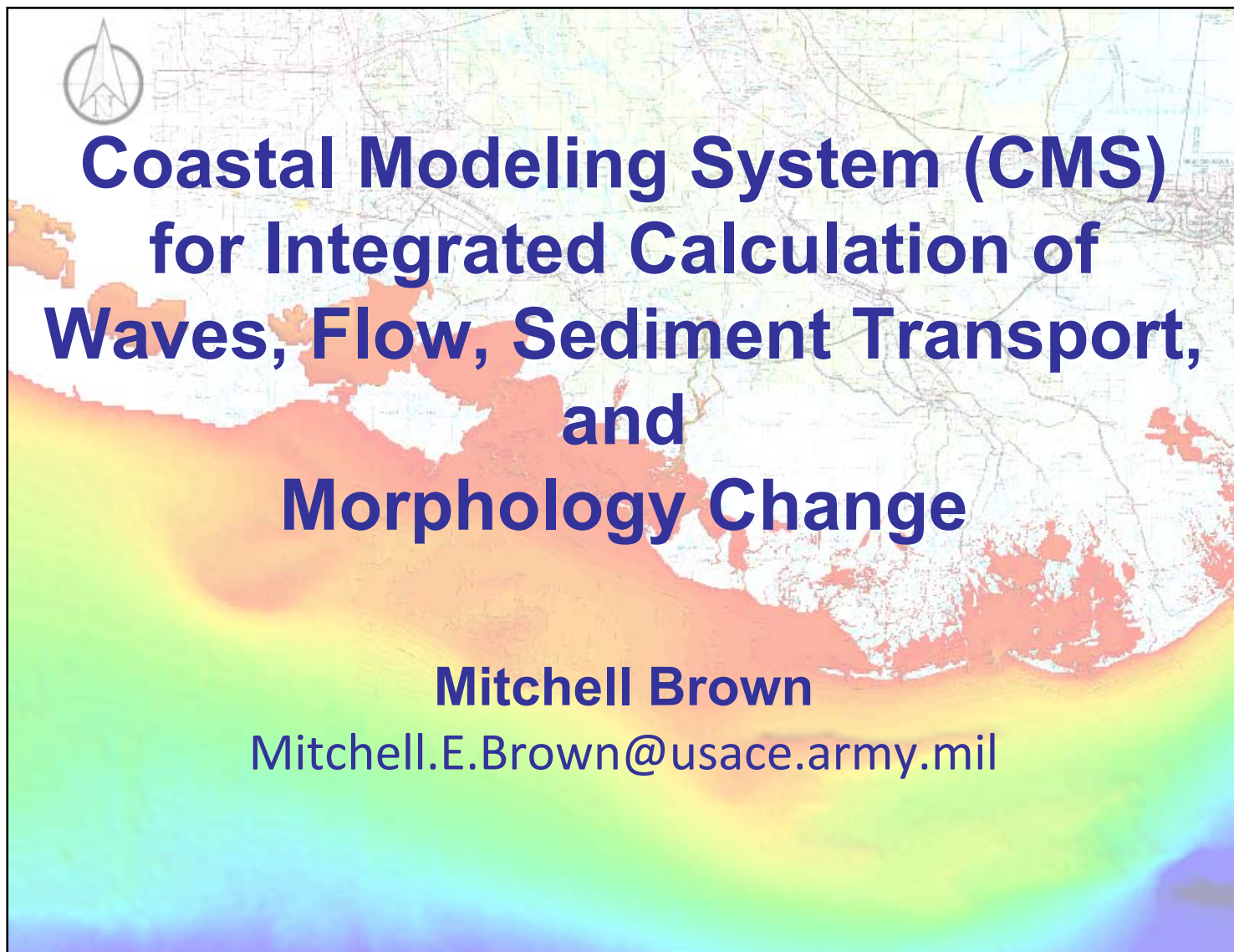
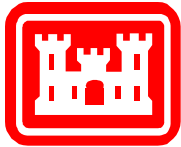


Introduction to the CMS



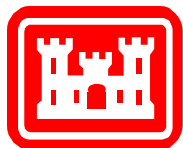


Coastal Modeling System (CMS)

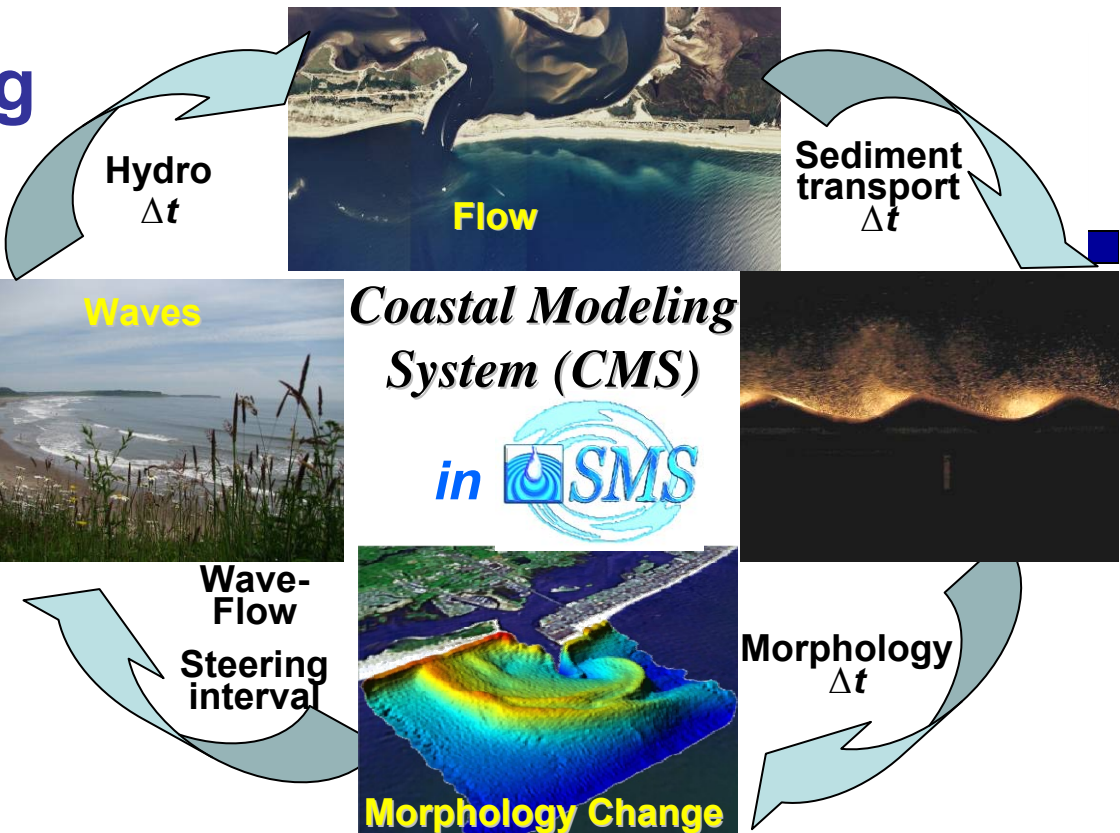


CMS is a CIRP flagship product

- Interactive calculation of waves, current, sediment transport, and morphology change (short term – storms, and long term – decades)
- Channels, jetties, and levees represented.
- 2D version – Non-Equilibrium sediment Transport (NET), Rapid Assessment of Morphology (RAM).
- Represents sediment motion by waves and horizontal gradients in current – **vertical structure starting in FY10.**
- Shoreline change & breach representation (as near jetties) underway.
- Vegetation module underway.
- Long been fully integrated in the SMS.
- Quick to setup and build efficient grids, given good bathymetry/forcing data.
- *Scores of person-years at CHL, at SMS developers, and by academia and consultants.*



Coastal Modeling System (CMS)

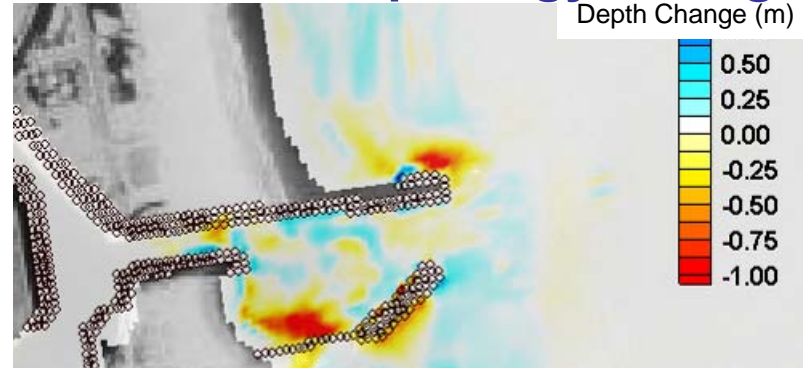


Dynamic feedback between waves, flow, sediment transport, & morphology change

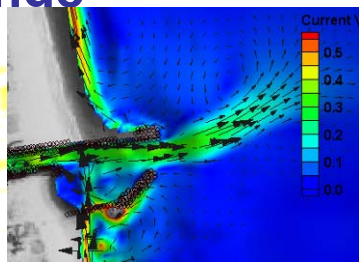
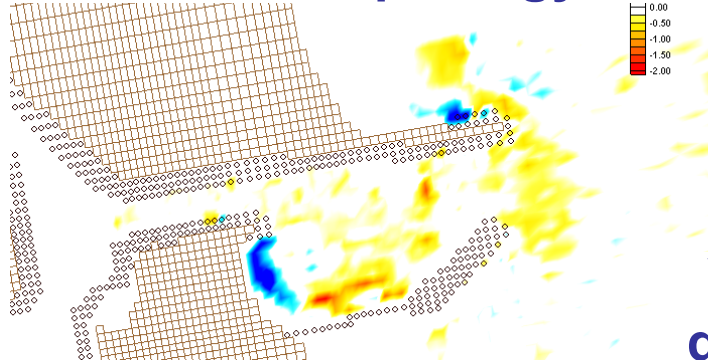
2-D and 3-D Numerical modeling at local- to regional-scale coastal projects including:

- Inlets
- Navigation channels
- Coastal structures

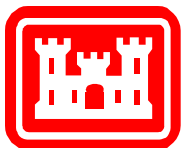
Calculated Morphology Change



Measured Morphology Change



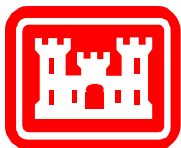
Wave & Tide driven current



Available processes/features in CMS-Wave



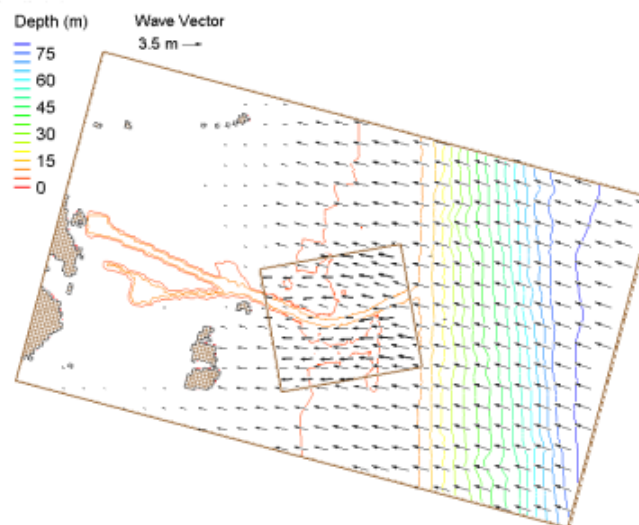
- Directional Spectrum transformation
- Refraction / Shoaling
- Depth-limited Wave breaking
- Diffraction
- Reflection (forward/backward)
- Transmission
- Run-up and set-up/set-down
- Wave-current interaction
- Wind
- White capping
- Bottom Friction
- Muddy Coast

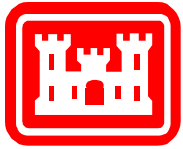


Recent additions to CMS-Wave



- Wave run-up calculation
- Four different wave-breaking formulas
 - Extended Goda
 - Extended Miche (New)
 - Battjes and Janssen (New)
 - Chawla and Kirby (New)
- Ability to specify feature cells for wave transmission, wave run-up and setup on beach face, and wave overtopping structures
- Grid nesting capability
- “Fast mode” (Simplified Formulation) run capability

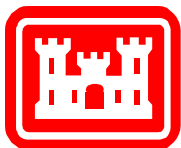




Available processes/features in CMS-Flow



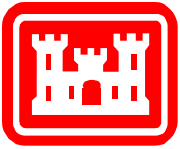
- WL/Tide/Flux forcing
- Wind forcing (spatially constant at present)
- Wave forcing
- Sediment transport (Equilibrium and Non-Equilibrium, Total Load and Advection-Diffusion)
- Wetting/Drying
- Bottom friction (spatially variable)
- Hard-bottom representation (non-erodible layer)
- Basic variable grain size
- Basic 2-d Salinity transport
- Parallel Processing on PC using OpenMP



Recent Changes to CMS-Flow



- **Increased Speed** - An optimization of the coding structure for CMS-Flow has created a 500 to 1,000 percent increase in simulation speed depending on user's selections.
- **Additional Sediment Transport Algorithm** - A Non-equilibrium (NET) version of the advection diffusion sediment transport algorithm in CMS-Flow.
- **OpenMP Parallelization** - Use multiple processors on PCs to reduce runtime.
- **2D Salinity Transport** - Can specify a default global salinity concentration as well as introduce a different sediment sources at boundaries.
- **Variable Grain Size (Phase 1)** – Can specify zones of grain size for sediment transport calculations.
- **Improved Stability and Better Error Diagnostics.**

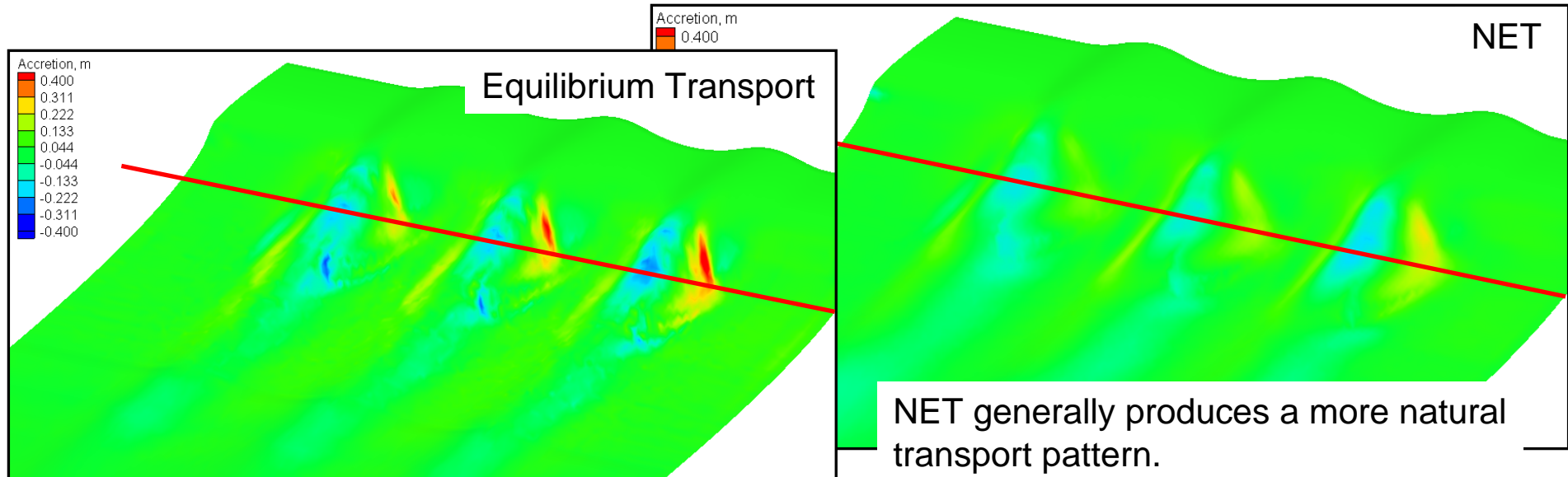


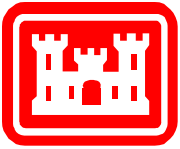
Quick Intro to a Few Features



Non-Equilibrium Sediment Transport (NET)

- Accounts for temporal and spatial lags between flow and sediment transport
- Can easily handle constrained sediment loading (over- or under-loading)
- Hard-bottom (non-erodible bottom) automatically computed
- Can simulate suspended and bed load separately or combined as bed-material or total load
- Much more stable than equilibrium (standard) sediment transport





Parallel Processing

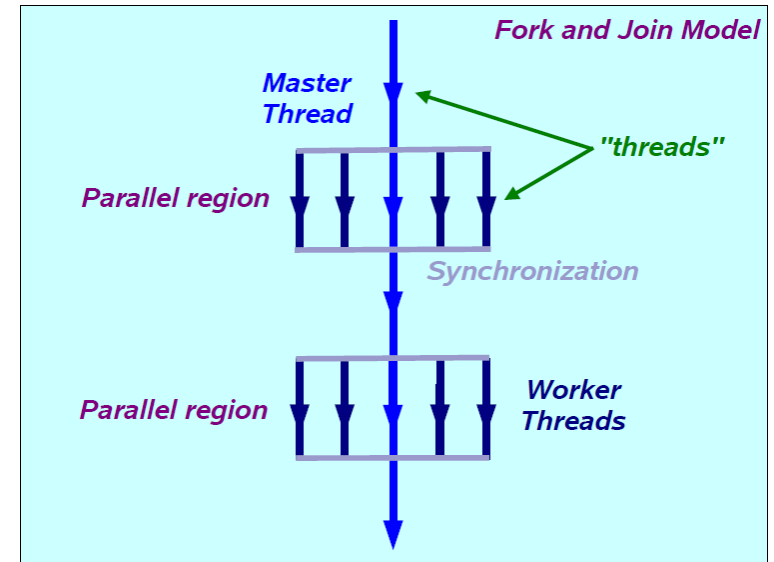


- **CMS-Flow has been parallelized using the OpenMP parallelization method. Routines parallelized are:**

- Initialization
- Hydrodynamics
- Morphology
- **Sediment Transport (ongoing)**
- Salinity

- **SMS interface implementation is underway.**

- Workaround: Access via **“Advanced”** tab in model control
- Add card **“OPENMP_PROCESSORS <white space> #”**

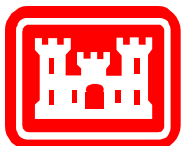


- **On some newer computers (Intel and AMD) there are sometimes two “threads” per processor. This is called Hyper-threading (HT)**

- CMS will determine if the computer has HT capability and adjust the number of threads accordingly.
- **If User specifies 1 processor and HT is available, CMS-Flow will operate with 2 threads !!**

- **Works best on grids with more than 20,000 cells.**

- **At some point, adding more processors will no longer speed up the run down and cause unnecessary use of processors (see next slide).**



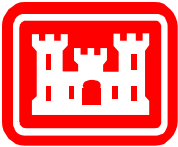
Parallel Processing



Time comparison from 1 interval of steering run

- Flow grid ~42,000 cells
- Hydro Timestep – 0.5 sec
- Transport Timestep – 10 sec
- Morphology update – 0.5 hr

	Serial 1 Processor	Parallel 1 Processor (2 Threads)	Parallel 2 Processors (4 Threads)	Parallel 3 Processors (6 Threads)	Parallel 4 Processor (8 Threads)
Hydro + Waves only	12 m 52 sec	8 m 23 sec ~1.5x faster	4 m 29 sec ~2.8x faster	6 m 6 sec ~2.1x faster	5 m 4 sec ~2.5x faster
Hydro + Waves + ST : Total Load – Lund CIRP	15 m 46 sec	8 m 37 sec ~1.8x faster	5 m 10 sec ~3.0x faster	6 m 37 sec ~2.4x faster	6 m 34 sec ~2.4x faster
Hydro + Waves + ST : NET – LundCIRP capacity	17 m 28 sec	11 m 15 sec ~1.5x faster	7 m 17 sec ~2.4x faster	7 m 50 sec ~2.2x faster	7 m 15 sec ~2.4x faster



Salinity



Presently, a combined transport timestep for both salinity and sediment.

- Activate salinity transport.
- Assign default global salinity concentration.
- Salinity concentration boundary conditions are enabled
- Activate sediment transport.
- Choice of fundamental type of equations (Equilibrium or Non-equilibrium).
- Assign various sediment parameters, coefficients, and formulations.

CMS-Flow Model Control

Model Parameters | Transport | Tidal | Wind/Wave | Output | Cells | Advanced

Time steps

Transport rate: 1.0 secor Morphologic: 9.0 secor

Salinity

Calculate salinity Global concentration: 28.0 ppt

Sediment

Calculate sediment transport Use non-equilibrium transport

Formulation:	Advection-diffusion
Transport capacity formula:	Lund-CIRP
Sediment density (kg/m ³):	2650.0
Water density (kg/m ³):	1025.0
Water temperature (deg C):	15.0
Bed load transport rate coefficient:	1.0
Suspended load transport rate coefficient:	1.0
Morphologic acceleration factor:	1.0
Bed slope coefficient:	1.0

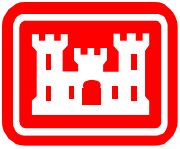
Hard Bottom

Create Dataset Select Dataset... Hard Bottom

D50

Create Dataset Select Dataset... D50

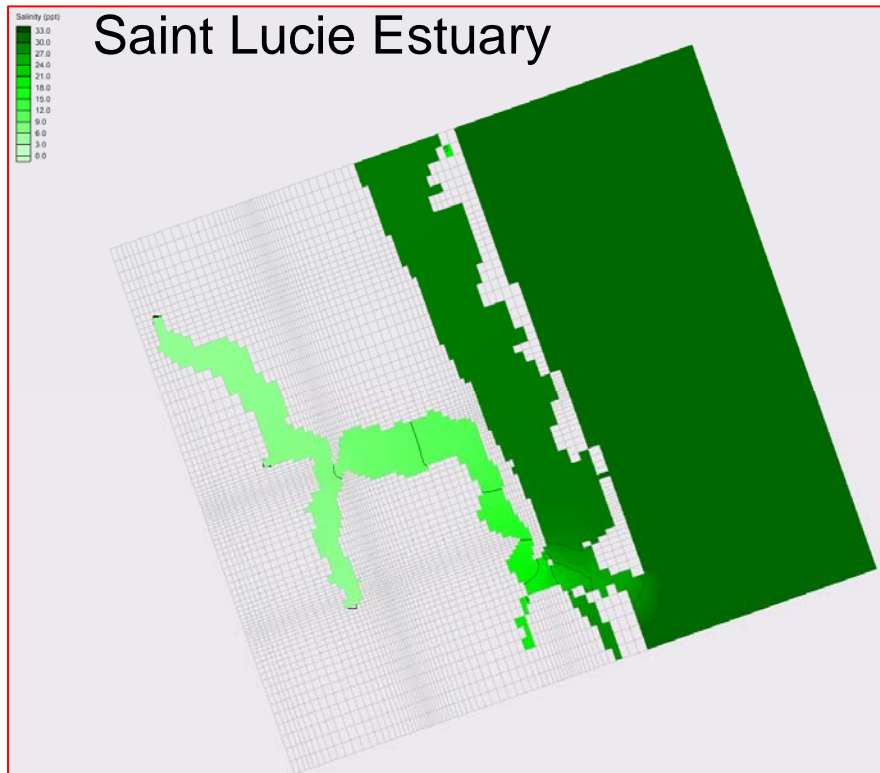
Help OK Cancel



Salinity



- Select cellstrings to assign salinity boundary forcing curves.
- Pull-down menu has option for “Assign BC”
- Cellstring has new “Salinity” option to assign concentration forcing information.



Boundary Conditions

Land

Flow rate-forcing

WSE-forcing

Tidal constituent-forcing

WSE and Velocity-forcing

Time Series

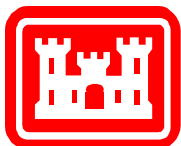
Curve undefined.

XY Series Editor

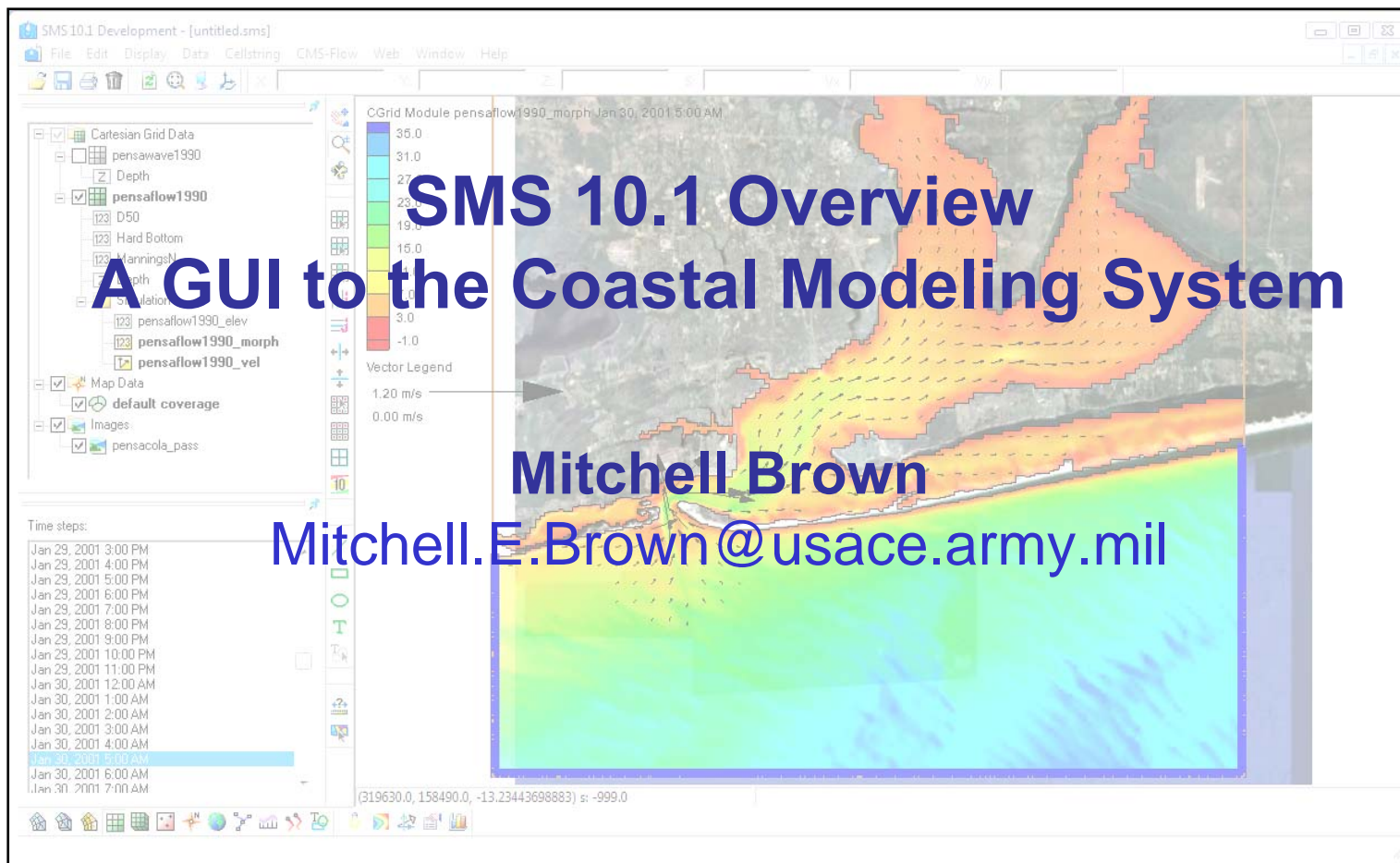
time(hrs)	salinity(ppt)
1 0.0	10.0
2 1.0	10.0
3 2.0	9.0
4 3.0	11.0
5 4.0	12.0
6 5.0	11.0
7 6.0	12.0
8 7.0	10.0
9 8.0	8.0
10 9.0	9.0
*	

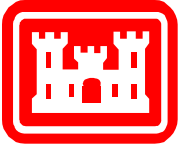
salinity(ppt)

time(hrs)



Introduction to the SMS



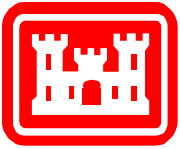


What is the SMS?



- **A Pre-Processor**
 - Organize and create input files for Corps of Engineers' Numerical Models
- **A Post-Processor (visualize results)**
 - Create plots
 - Create film loops
 - Data calculator
 - Data set creation
- **Connect with outside tools**
 - Import/export CAD data
 - Import/export GIS data
 - Import/export tabular ASCII data
 - Import/export image data





SMS Interface



Toolbars

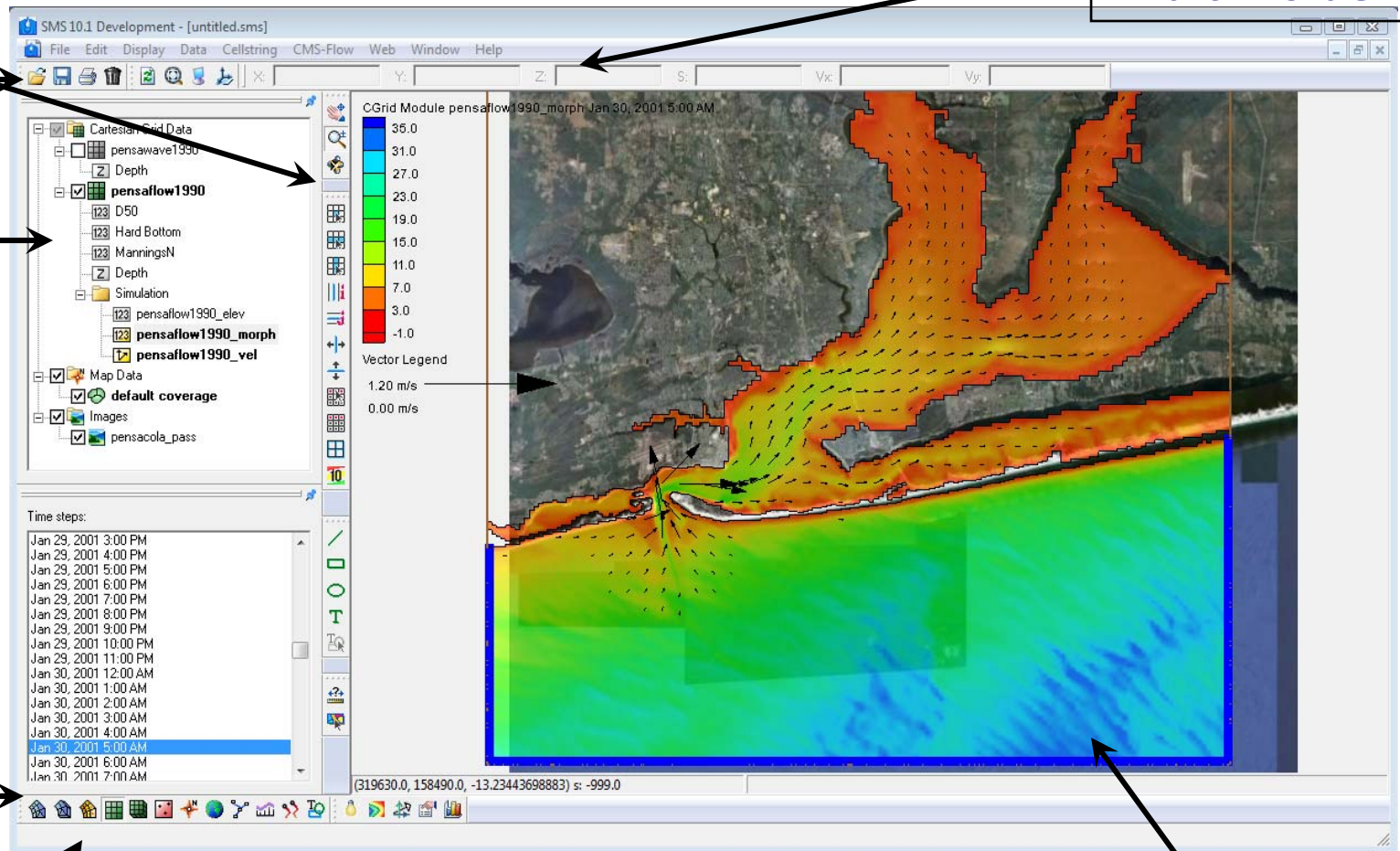
Project Explorer

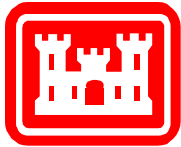
Modules

Help/Status

Edit Fields

Display

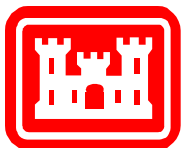




Major Functionality



- **Manage/Transform/Edit/Optimize data**
- Construct model domain (grids)
- Simplify model parameter specification
- Format data (File I/O)
- Solution review/Post-processing
 - Visualization
 - Data set creation
 - Plots and reports

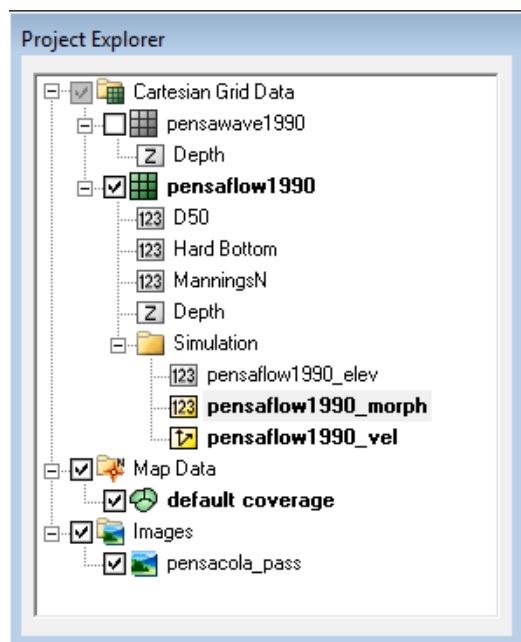


SMS Modules



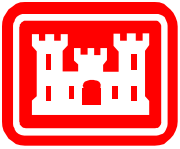
- **Separate Commands for Separate Data Types**

- Scattered Data
- Conceptual/Map Data
- Finite Difference Data



- **Project Explorer (Data Tree)**

- Geometric objects in base level of the tree
- Functional data sets organized below



SMS Tools



- Toolbars

- Toolbar switches which current geometric object.
- Controls effects of mouse activity in graphics window
- Arrow in icon indicates “select” tool
- Dependent on current module and model

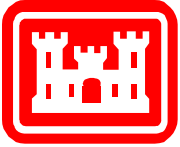


- Macro Bars



- Display settings set in preferences (Edit|Preferences)
- Menu command equivalents
- Available at all times

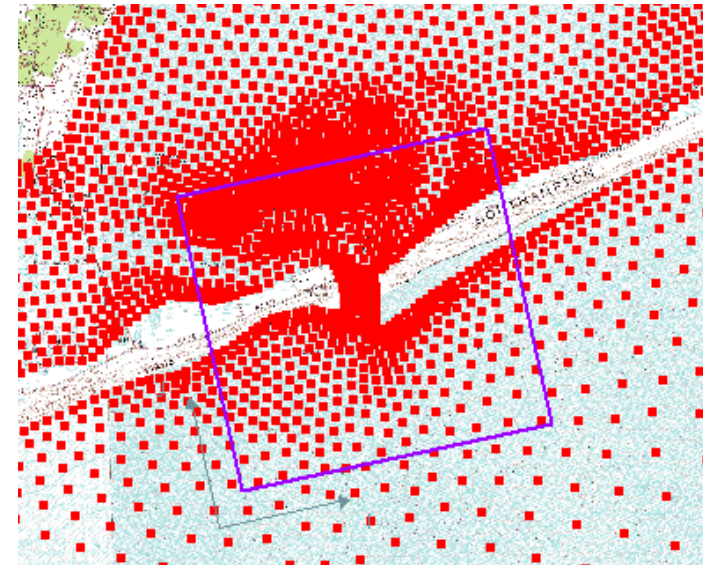
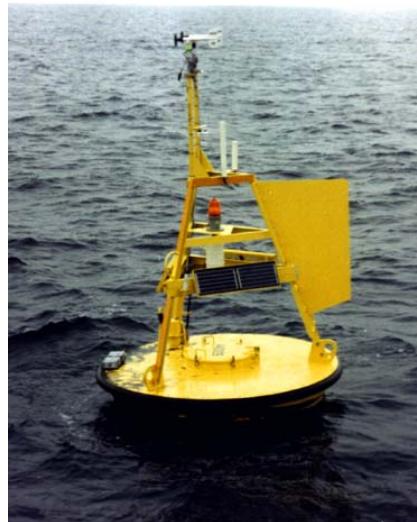


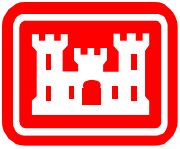


Data In SMS

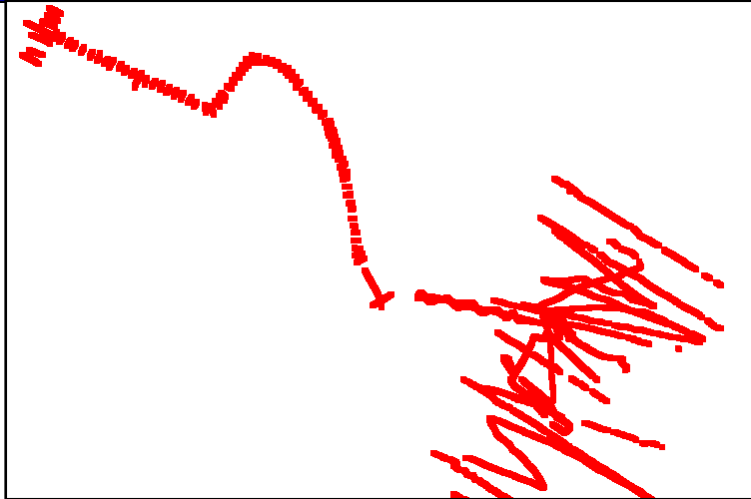


- **Images**
- **Map Module**
 - Coastlines
 - Field data
- **Scatter Module**
 - Scattered depth data





Data Types

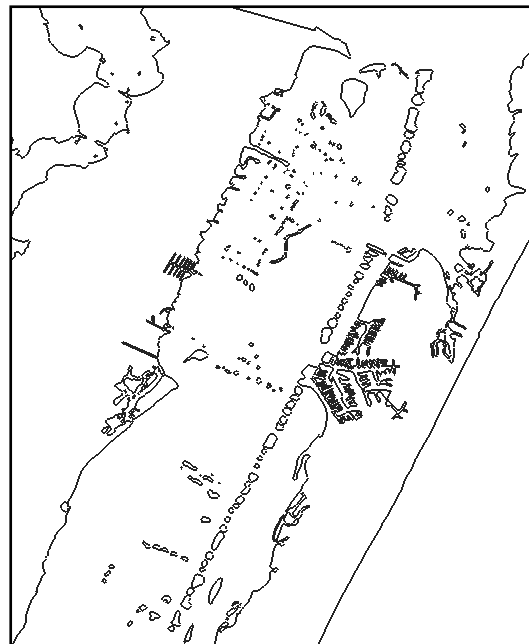


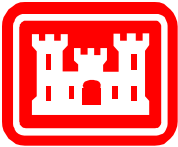
Bathymetry



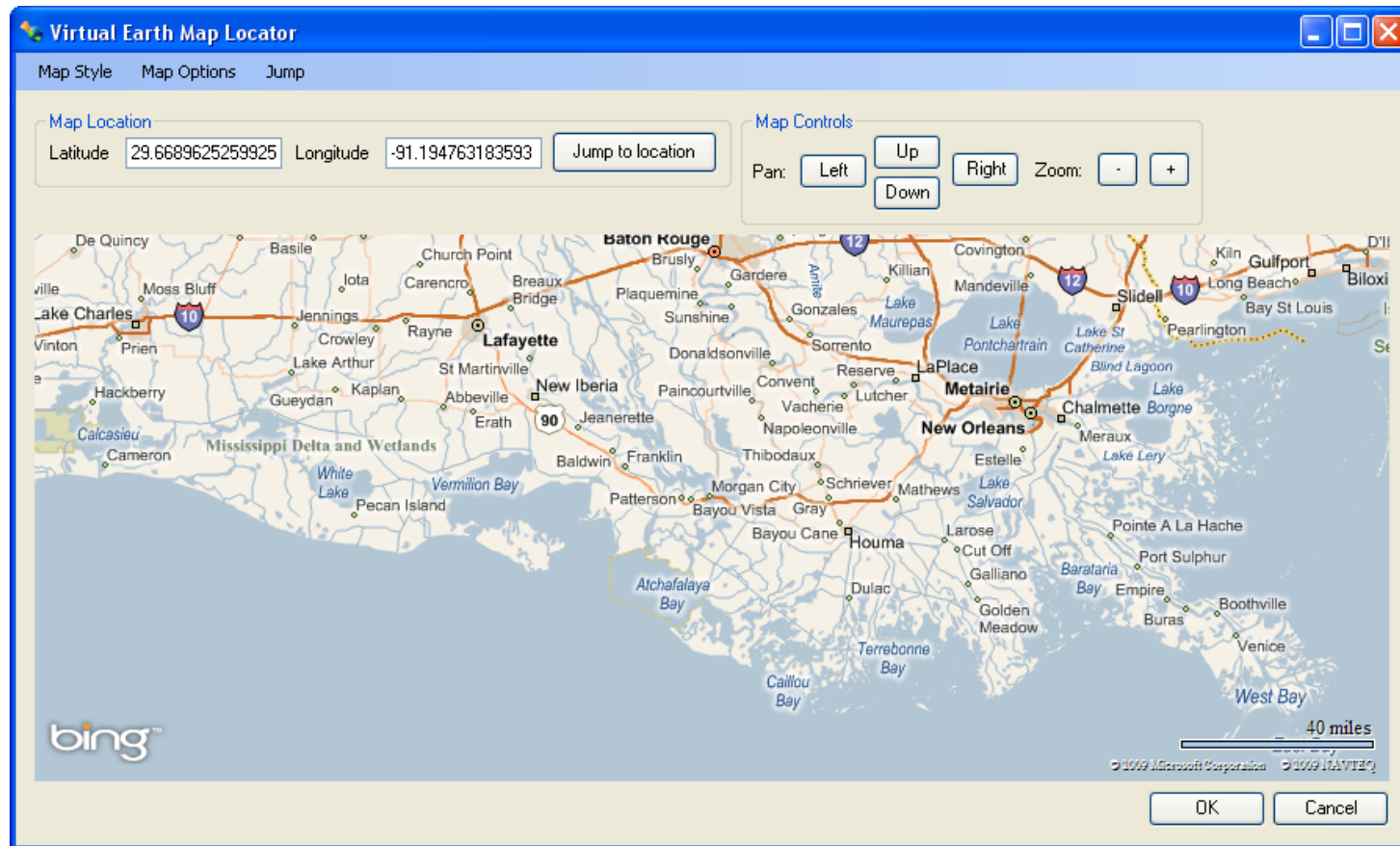
Aerial Photos or other plan-view images

Coastline

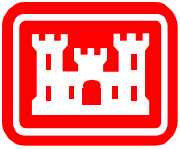




Download Images



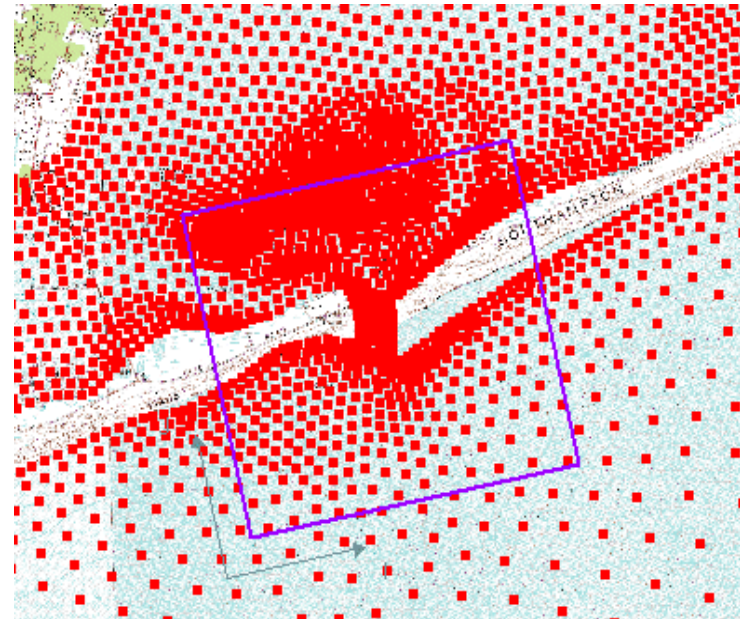
- Virtual Earth to locate site from inside SMS
- USGS as image source

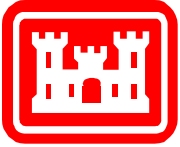


Scatter Data (TINs)

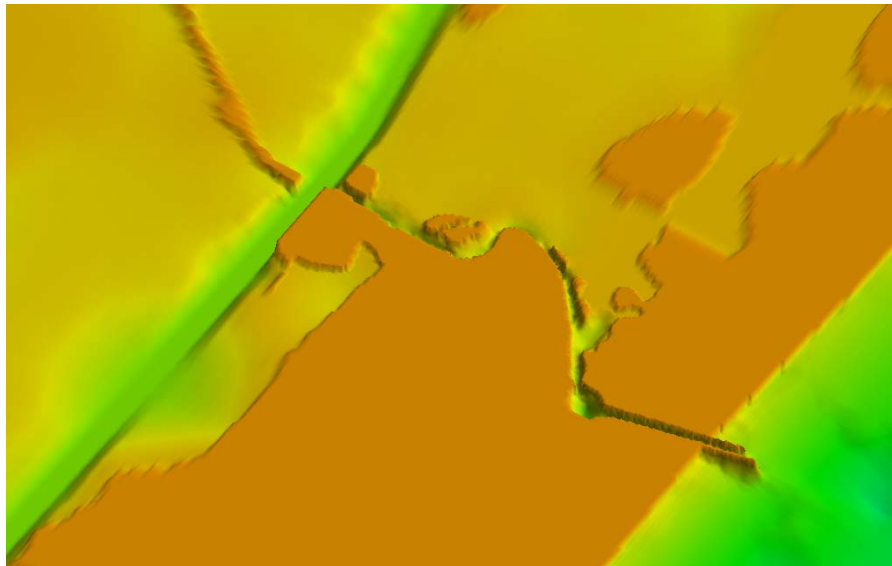


- **Stores spatially varied data**
 - Bathymetric data most common
 - Interpolates from one grid/mesh to another
 - Allows combination of data sources
 - Data thinning or filtering



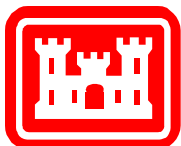


Visualization of Scattered Data



Packery Channel, TX
Oblique view

- **Options**
 - Magnify in Z direction
 - Oblique or plan views
 - Fill with contours options
 - Shading



Coordinate Systems



- Projection defined by user (or projection file)
- Conversion or reprojection supported

Reproject Current

Current projection

Specify

Horizontal

Local projection

Units:

Global projection

Current projection: UTM, NAD83 (FLORIDA HPGN)...

Vertical

Projection:

Units:

New projection

Horizontal

Local projection

Units:

Global projection

Current projection: UTM, NAD83 (FLORIDA HPGN)...

Vertical

Projection:

Units:

Select Projection

Projection

Projection:

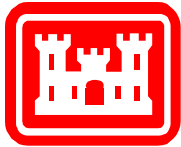
Datum:

Planar Units:

Zone:

Parameters:

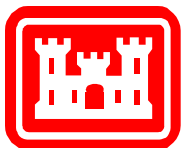
Attribute	Value
STATE PLANE SCALE FACTOR	1.000000000



Major Functionality



- Manage/Transform/Edit/Optimize data
- Construct model domain (grids)
 - CMS-Flow/CMS-Wave/PTM
- Simplify model parameter specification
- Format data (File I/O)
- Solution review/Post-processing
 - Visualization
 - Data set creation
 - Plots and reports



Map Grid Frame to Grid Constant Cell Size



Map -> 2D Grid

Origin and Orientation

Origin X: 319050.000000 Angle: 0.000000 I size: 46790.385765 m

Origin Y: 134020.000000 J size: 44570.000000 m

I Cell Options

Define cell sizes

Cell size: 4679.038576 m

Number of cells: 10

Use refine points

Maximum cell size: 0.000000 m

Maximum bias: 1.100000

Use inner growth

J Cell Options

Define cell sizes

Cell size: 4457.000000 m

Number of cells: 10

Use refine points

Maximum cell size: 0.000000 m

Maximum bias: 1.100000

Use inner growth

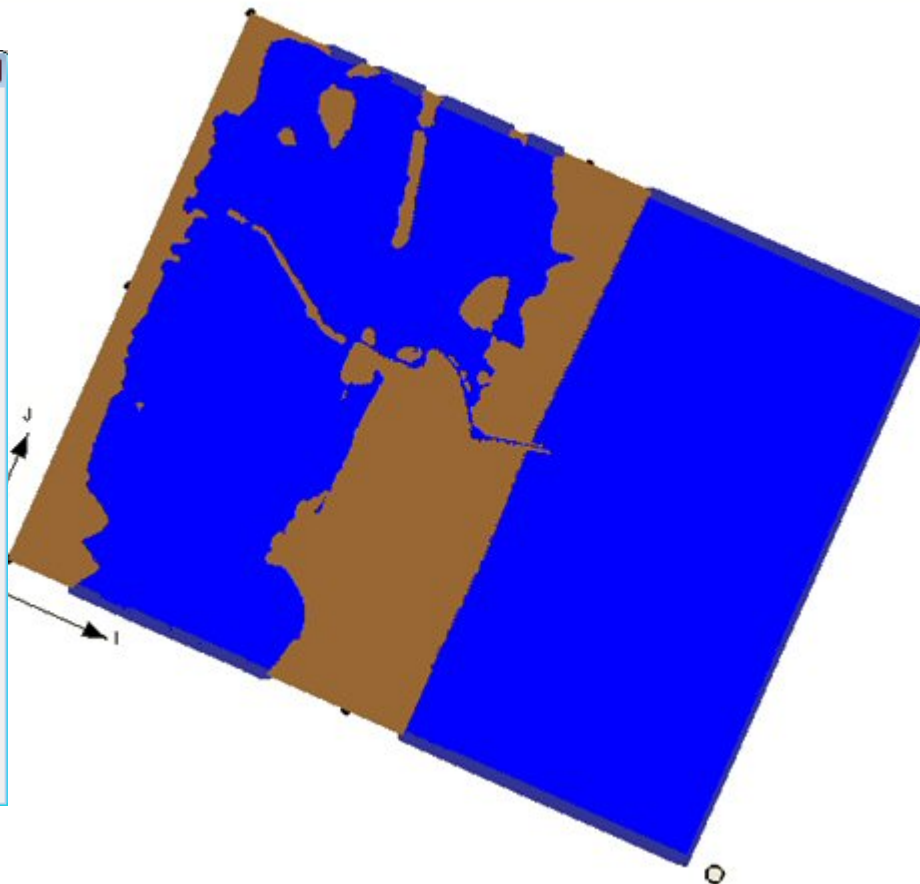
Depth Options

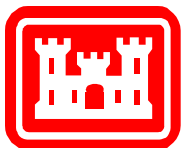
Constant: 0.000000 m

Interpolated

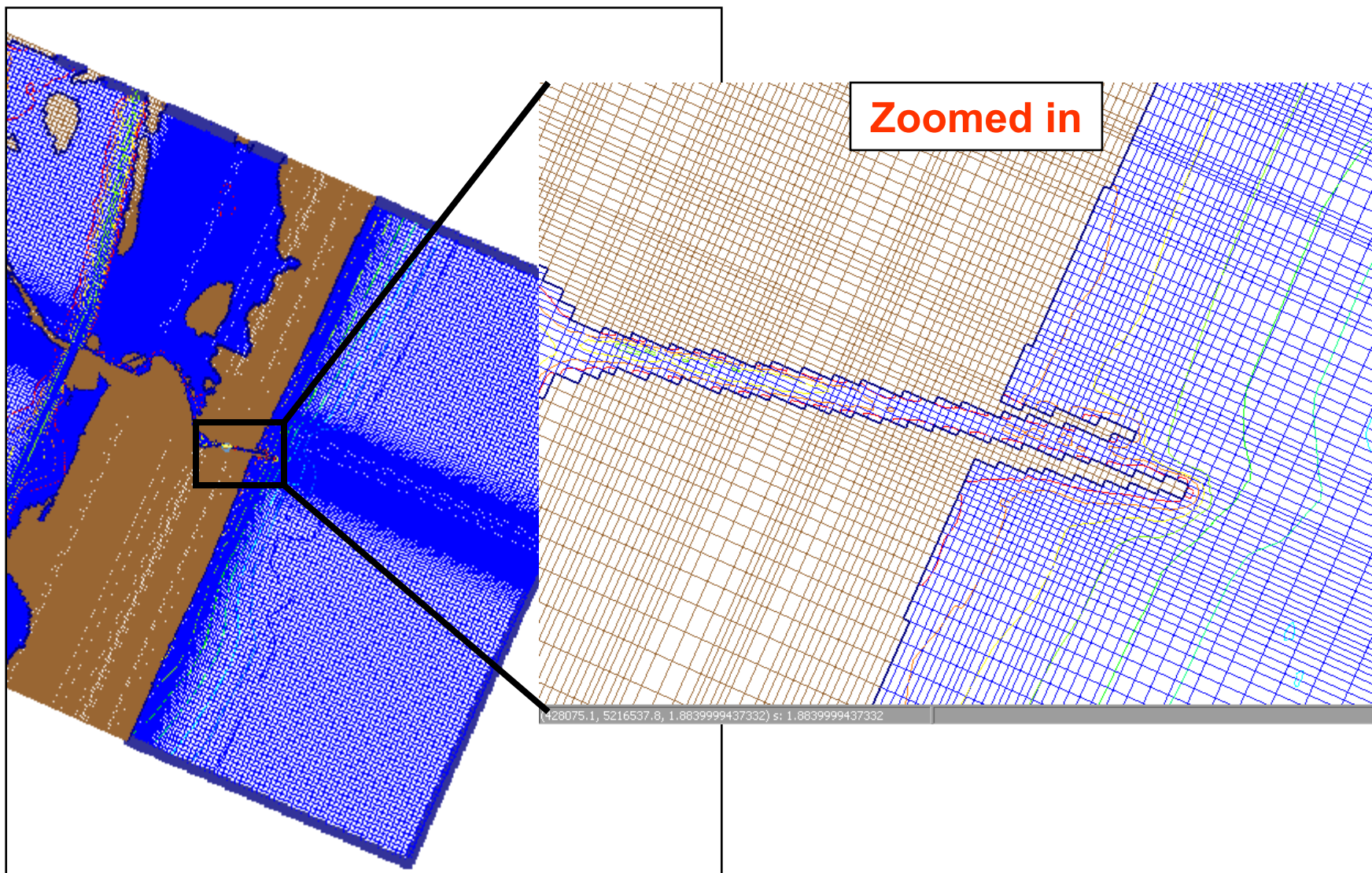
Select: none selected

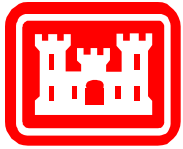
Help... OK Cancel





Map Grid Frame to Grid Variable Spacing

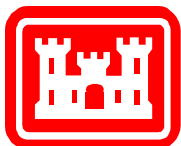




Major Functionality



- Manage/Transform/Edit/Optimize data
- Construct model domain (grids)
- **Simplify model parameter specification**
- Format data (File I/O)
- Solution review/Post-processing
 - Visualization
 - Data set creation
 - Plots and reports



Parameter Specification and File I/O



- Time Control
- Auxiliary Files
- Parameters
 - Solver type
 - Flags
 - ...

CMS-Flow Model Control

Model Parameters | Transport | Tidal | Wind/Wave | Output | Cells | Advanced

Time Control

Start date: 01/01/2001

Start time: 12:00 AM

Simulation duration: 8760.0 hrs

Ramp duration: 4.000008 hrs

Hydrodynamic time step: 3.0 secs

Hot Start

Initial conditions file

Write Hot Start output file

Time to write out: 1524.0 hrs

Automatic recurring Hot Start file

Interval: 0.0 hrs

Parameters

Anemometer height: 10.0 m

Depth to begin drying cells: 0.05 m

WSE smoothing iterations: 3

Advection extrap. coeff.: 1.0

Include wall friction

Latitude throughout grid

Cell-specific latitude

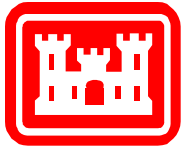
Average latitude: 0.00

Momentum Equation

Include advective terms

Include mixing terms

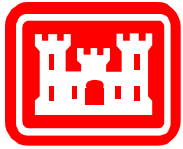
Help OK Cancel



Major Functionality



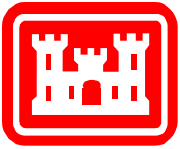
- Manage/Transform/Edit/Optimize data
- Construct model domain (grids)
- Simplify model parameter specification
- Format data (File I/O)
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What's New in SMS 10.1



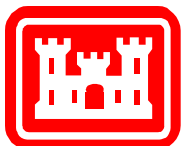
- Dataset Toolbox
- Grid duplication/rotation tools
- Web Menu
- Spatial Data Coverages
 - Data types
 - Plot types
 - Compass plots



What's New in SMS 10.1



- Coordinate Projections
 - More projections
 - Automatic reprojection of data with projection file
 - Images
 - CAD Data
- Annotation Layers
 - North Arrows
 - Legends
 - Screen Space Images



Dataset Toolbox



Dataset Toolbox

Tools

- Math
 - Compare data sets
 - Data Calculator
- Temporal
 - Sample time steps
 - Compute derivative
- Conversion
 - Scalar to Vector
 - Vector to Scalar
- Modification
 - Map activity
 - Filter

Compare data sets

Base

- pensafLOW 1990 (CMS-Flow)
 - D50
 - Hard Bottom
 - ManningsN
 - Depth
 - Simulation
 - pensafLOW 1990_elev
 - pensafLOW 1990_morph

Alternate

- pensafLOW 1990 (CMS-Flow)
 - D50
 - Hard Bottom
 - ManningsN
 - Depth
 - Simulation
 - pensafLOW 1990_elev
 - pensafLOW 1990_morph

Data Set Info...

Value if base is inactive: -99.0

Value if alternate is inactive: 99.0

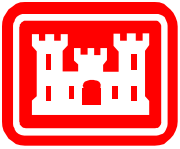
Output data set name: new data set

Update Available Tools

Help...

Compute

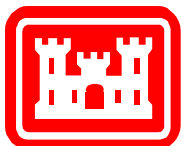
Done



Dataset Toolbox



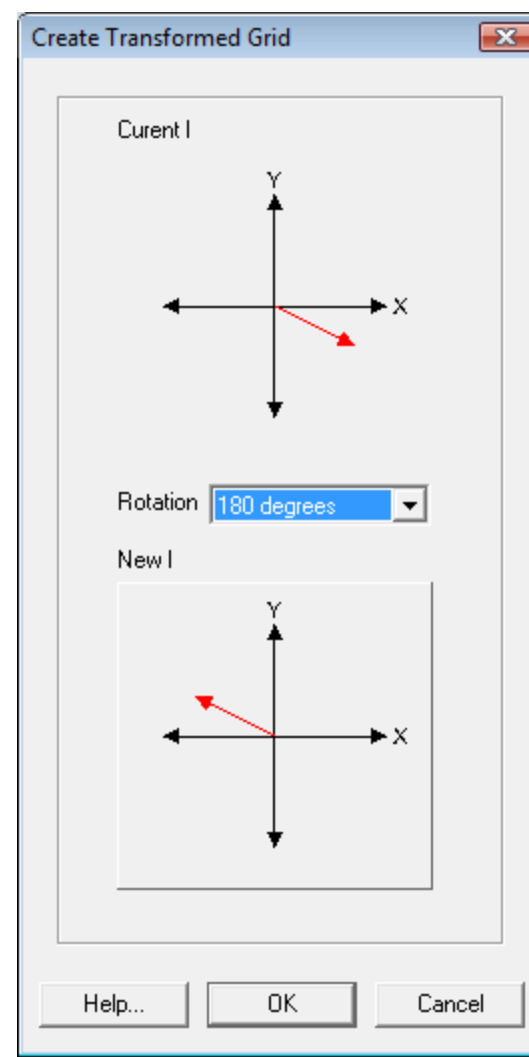
- Temporal Operations
 - Sample times
 - Temporal derivatives
- Mathematical Operations
 - Comparisons
 - Data Calculator
- Spatial Operations
 - Spacing
 - Gradients/Derivatives
 - Smoothing
- Conversions
 - Vector <-> Scalars
- Coastal Functions
 - Wavelength/Celerity
 - Courant number
- Activity Mapping
 - Map activity
 - Value filtering

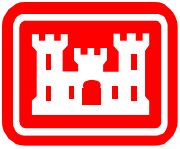


Duplicate/Rotate Grid



- Accessed by Right Click on Grid in Project Explorer
 - Duplicate Flow grid for Wave model or vice-versa
 - Rotate Wave grid to appropriate orientation

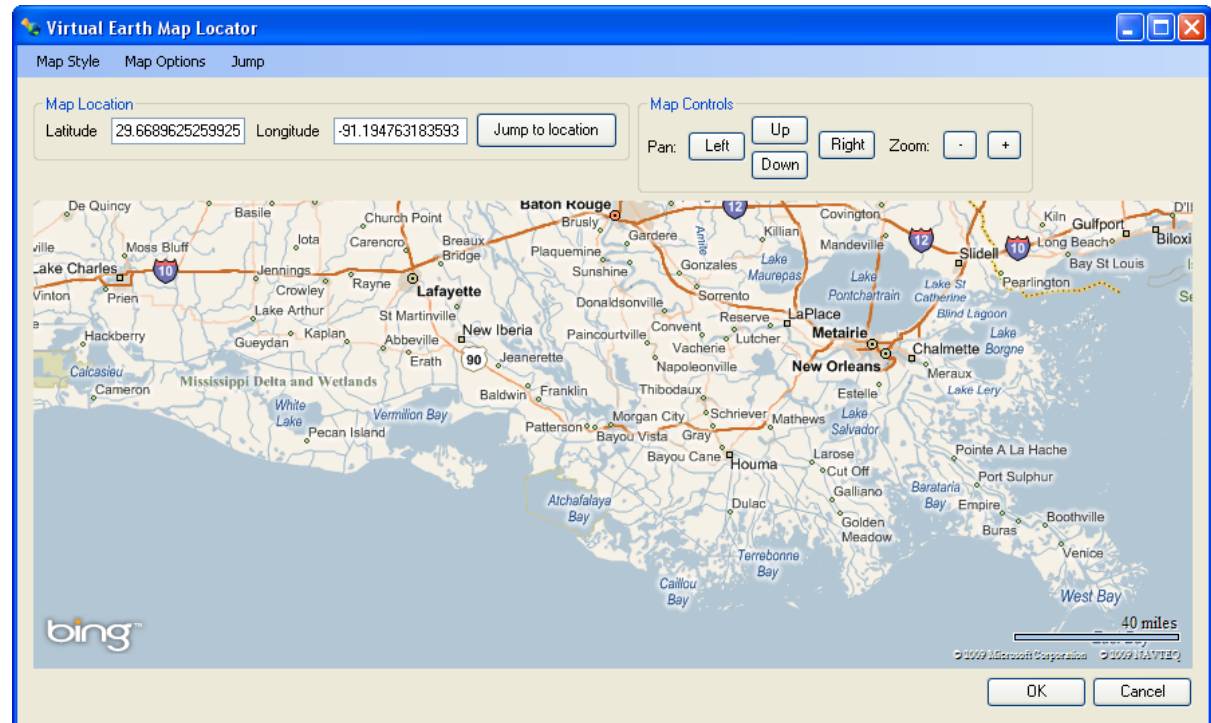


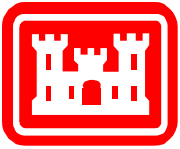


Web Menu



- Import data from web ...
 - Virtual Earth
 - Image data
 - Elevation data
- Find Data
 - Links to useful web sites
- Tidal Data
 - Links to coastal filtering tools

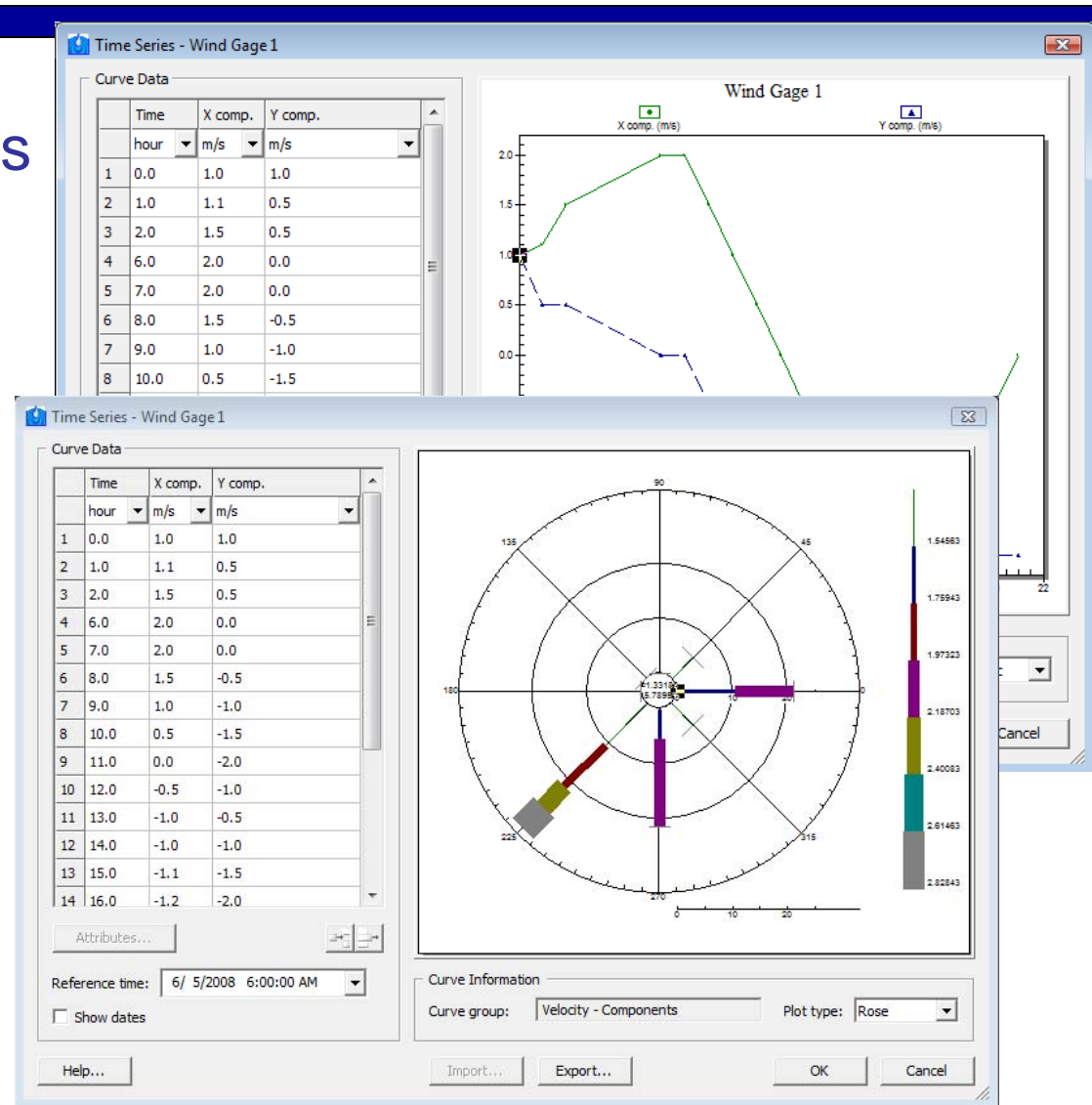


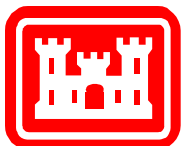


Spatial Data Coverages



- Create nodes at locations of interest (gauges)
- Associate temporal data with the location
 - Scalar data
 - X/Y vector data
 - Mag/dir vector data
- Plot types
 - Scientific
 - Multi-axis
 - Rose plots





Spatial Data Coverages



Compass plot

- Displayed on graphics window
- Updates with dates
- User managed



Compass Plot Properties

Name: Wind (10m)
 Display with compass

Spatial Data

Data	Show	Color
Wind Gage 1	<input checked="" type="checkbox"/>	Red

Legend Display Options

Show legend
Location: Right
 Show min and max values
 Show one vector for each compass ring
Precision: 2

Rings

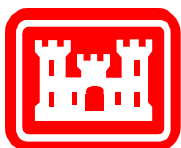
Number of rings: 3

	Percent of maximum (0 - 100)
1	33
2	66
3	100

Display Options

Compass size: 60
 Only show direction
 Show connection lines
 Filled background
Background color: [Color Picker]
 Specify min/max values for rings
Min: 0.0
Max: 1.0
Arrow style: Normal

Buttons: Help..., OK, Cancel



Coordinate Projections



- All major datums
- Project
 - Point
 - Object
 - Entire project
- Support for projection files
- Automatic detection of projections
 - Images
 - CAD
 - GIS

Reproject Current

Current projection

Specify

Horizontal

Local projection

Units: []

Global projection

Set Projection

Current projection: State Plane Coordinate System

Vertical

Projection: [Local]

Units: [Meters]

New projection

Horizontal

Local projection

Units: []

Global projection

Set Projection

Select Projection

Projection

Projection: [State Plane Coordinate System] Load From File... Save To File...

Datum: [NAD83]

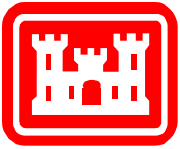
Planar Units: [METERS]

Zone: [Florida West (FIPS 902)]

Parameters:

Attribute	Value
STATE PLANE SCALE FACTOR	1.00000000

OK Cancel



Annotation Layers



- Replaces Drawing Objects
- New Objects
 - Screen space images (logos, etc)
 - Scale bars
 - North Arrows
- Organizes entities into layers
- Anchored in either world or screen

