NMLong-CW

Numerical Model for Simulating Longshore Current - Wave Interaction

- Theory
- Data Requirements
- Example Cases

NMLong-CW

What does it do?

NMLong-CW simulates wave transformation, the steady-state wave-generated longshore current, and change in water level at an inlet / beach by waves and wind.

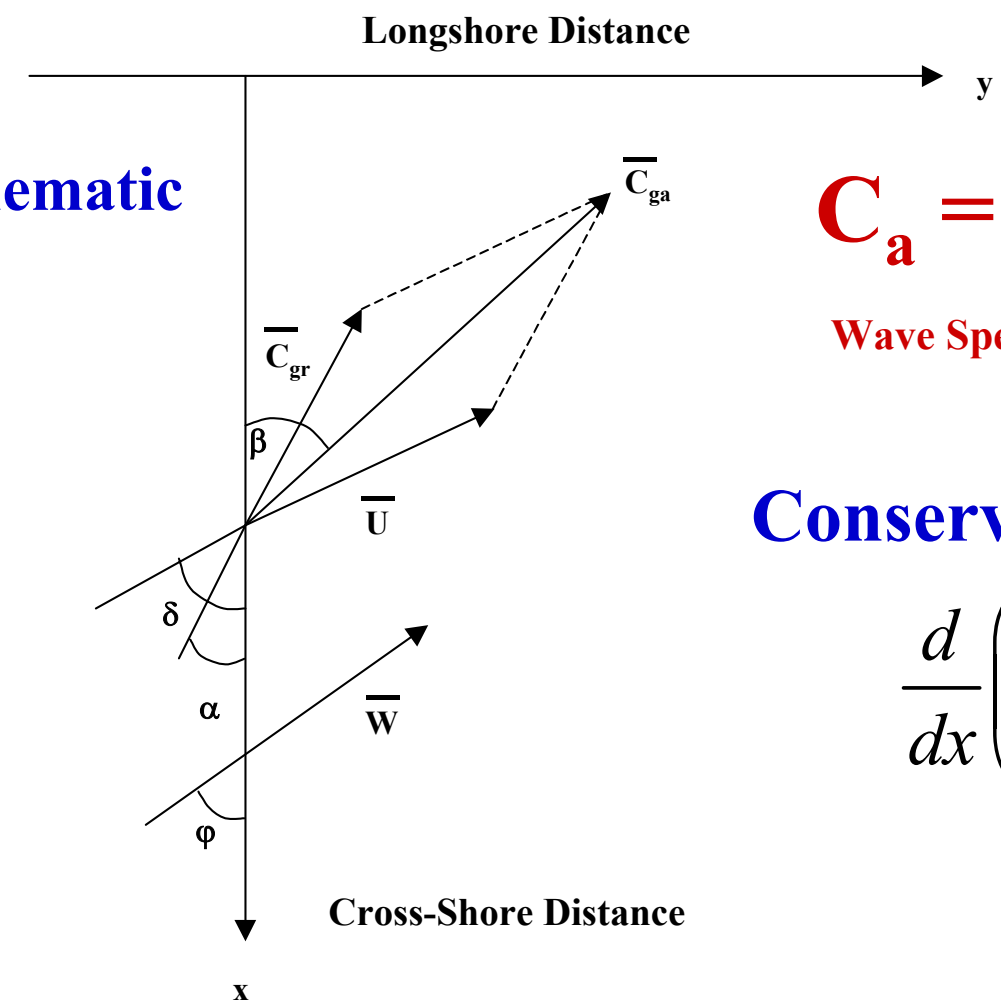
The interaction between a current and waves can significantly alter the wave height and wavelength. NMLong-CW is a one-dimensional model and is limited to situations where longshore uniformity applies.

Model Attributes

- Solves wave energy flux conservation equation
- Accounts for wave shoaling, refraction, breaking, and reforming
- Transformation of random waves calculated by Monte-Carlo simulation
- Wave energy dissipation accompanying depth-limited breaking described in accordance with Dally et al. (1985)
- Cross-shore momentum equation solved numerically to obtain the change in water level
- Equation governing alongshore momentum gives the distribution of the steady longshore current velocity across the shore
- Longshore current and change in water level (setup and setdown) driven by a local wind can be specified
- Nonlinear bottom friction computed from an efficient approximation
- Lateral mixing is modeled with an eddy viscosity that depends on the local wave orbital velocity and wave height
- Revised to describe both depth- and steepness-limited wave breaking
- Uses similar formulation to quantify energy dissipation produced by these two types of breaking
- Provides for an external (large-scale) current in addition to the wave- and wind-driven currents

Waves Propagating in a Current Field

Schematic



$$C_a = C_r + U \cos(\delta - \alpha)$$

Wave Speed = Relative Speed + Current Speed

Conservation of Wave Energy

$$\frac{d}{dx}\left(\frac{EC_{ga}\cos\beta}{\omega_r}\right) = \frac{E_D}{\omega_r}$$

NMLong-CW Formulation

Alongshore Momentum Equation - Current

$$\frac{d}{dx}\left(\varepsilon d\frac{dV}{dx}\right)-f_{by}=\frac{1}{\rho}\frac{dS_{xy}}{dx}-R_w-R_{lc}$$

Cross-Shore Momentum Equation – Mean Water Level

$$\rho g d\frac{d\eta}{dx}=-\frac{dS_{xx}}{dx}-C_D\rho_a|W|W\cos\varphi$$

Where S_{xx} = radiation stress transported onshore

$$S_{xx}=\frac{1}{8}\rho g H^2\left\{\frac{C_{gr}}{C_r}\left(\cos^2\alpha+1\right)-\frac{1}{2}\right\}$$

Assumes no interaction between external current & wave/wind generation

New Features Coming Soon

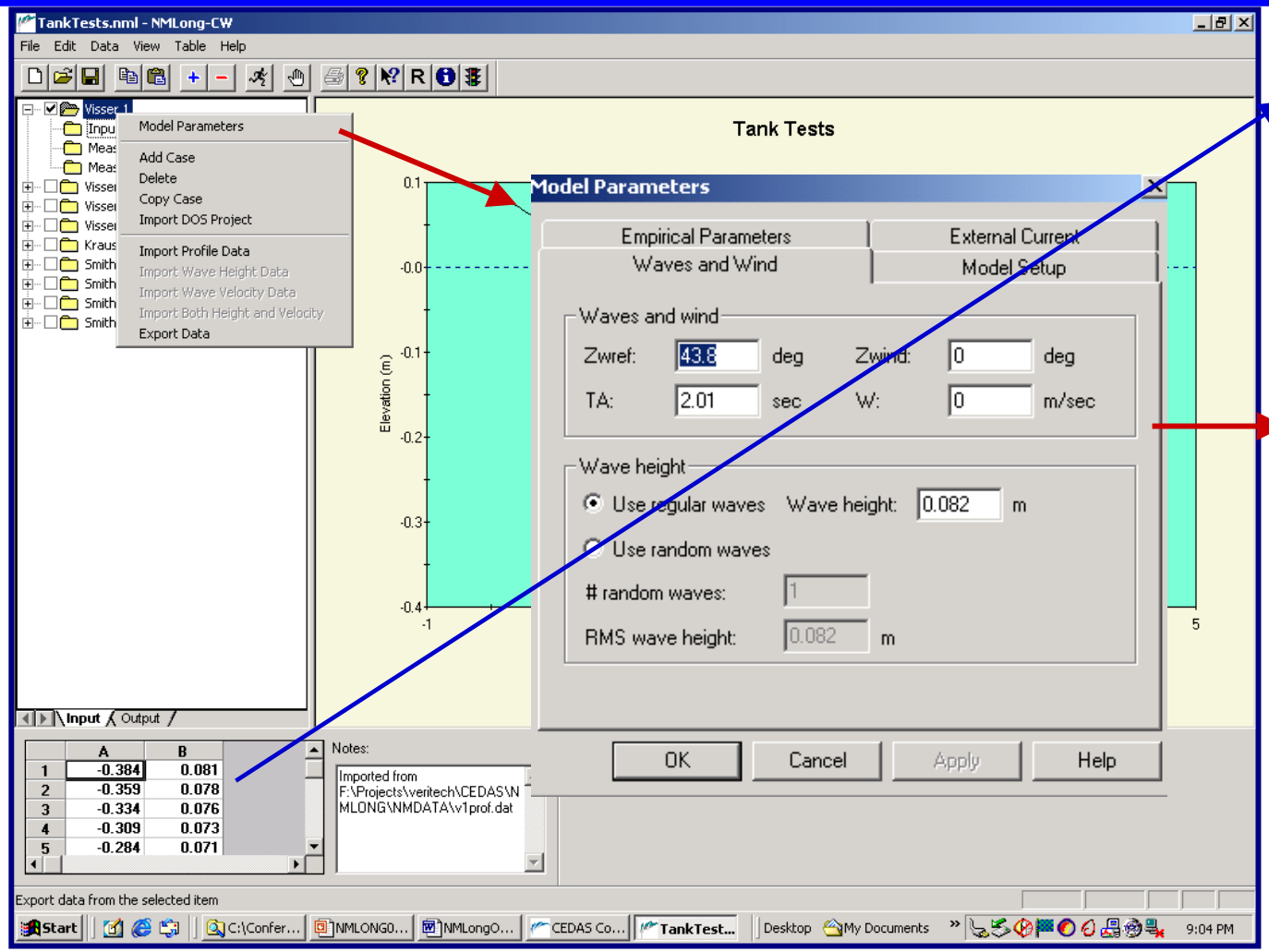
Improved wave blocking – strong opposing current

Wave Roller Model – breaker-induced turbulence

Generates a momentum flux before energy dissipation occurs

Computation of significant OR RMS wave heights

Data Requirements



Beach profile

Waves & Wind

- Direction, Period, Speed
- Regular or random

Model Setup

- # cells, Xstart, Dx, Dref
- Dtide

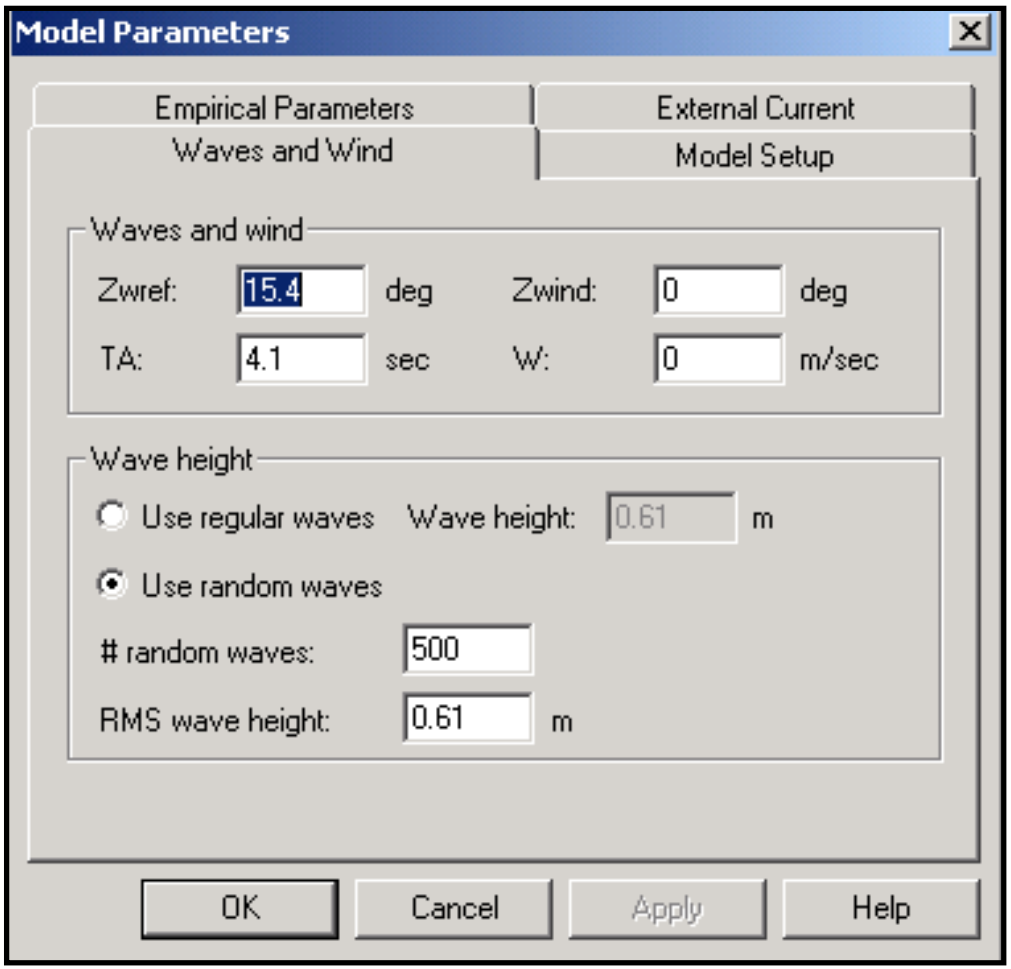
Empirical Parameters

- Various coefficients

External Current

- Constant or variable

Waves and Wind



Zwref: Wave direction at the reference depth.

TA: Absolute wave period of the incident waves – absence of a current

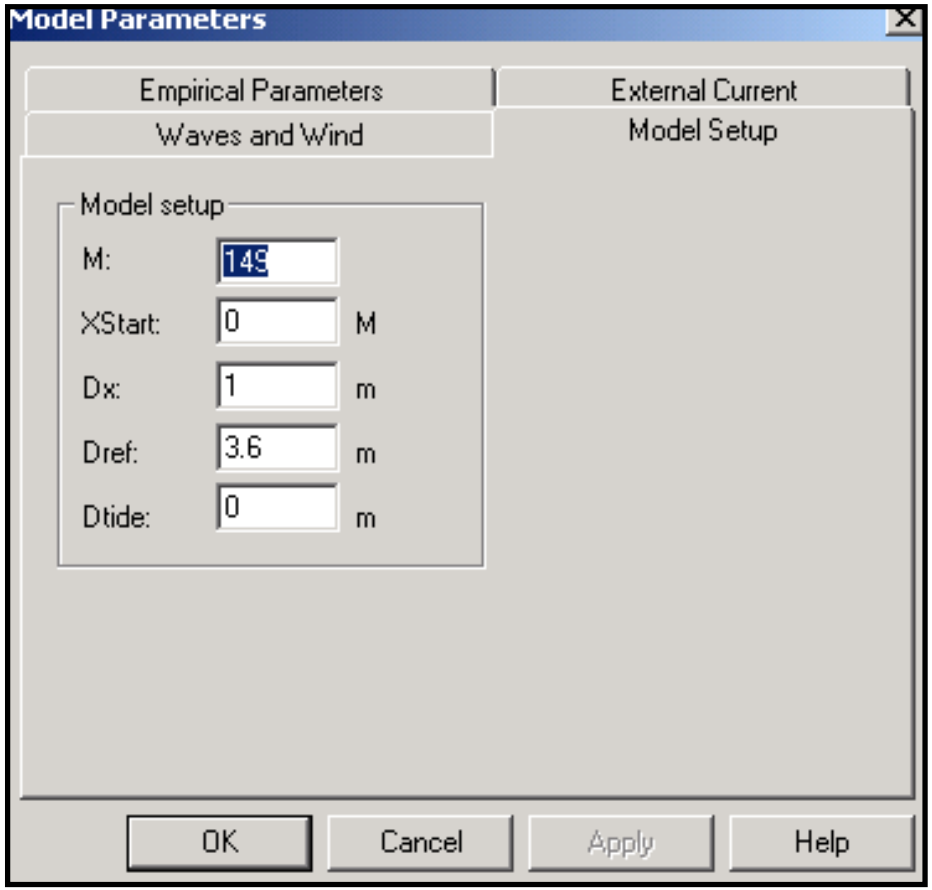
Zwind: Wind direction from which the wind blows

W: Wind speed

Regular waves: constant height, period, and direction

Random waves: random in height obeying a Rayleigh Distribution, but with fixed direction and period.

Model Setup



M: Number of cells in offshore grid

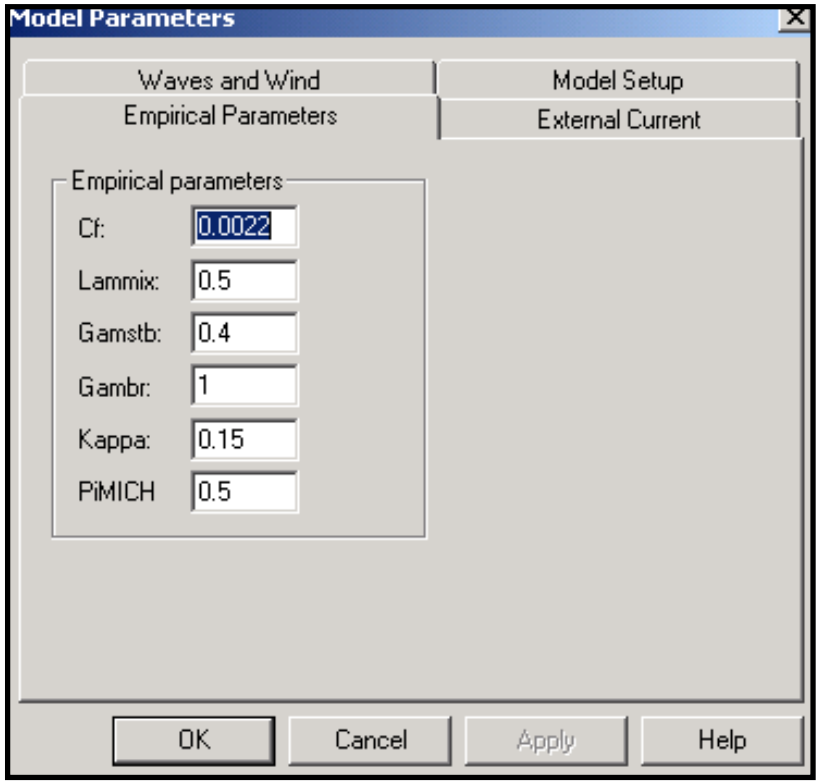
Xstart: 1st active calculation point

Dx: Distance between calculation points (dx)

Dref: Reference depth – the depth which offshore information is calculated and boundary values specified

Dtide: Offset in mean water level

Empirical Parameters



Cf: Bottom friction coefficient (0.005 - 0.015)

Lammix: Eddy viscosity coefficient (length × velocity 0.15 – 0.5)

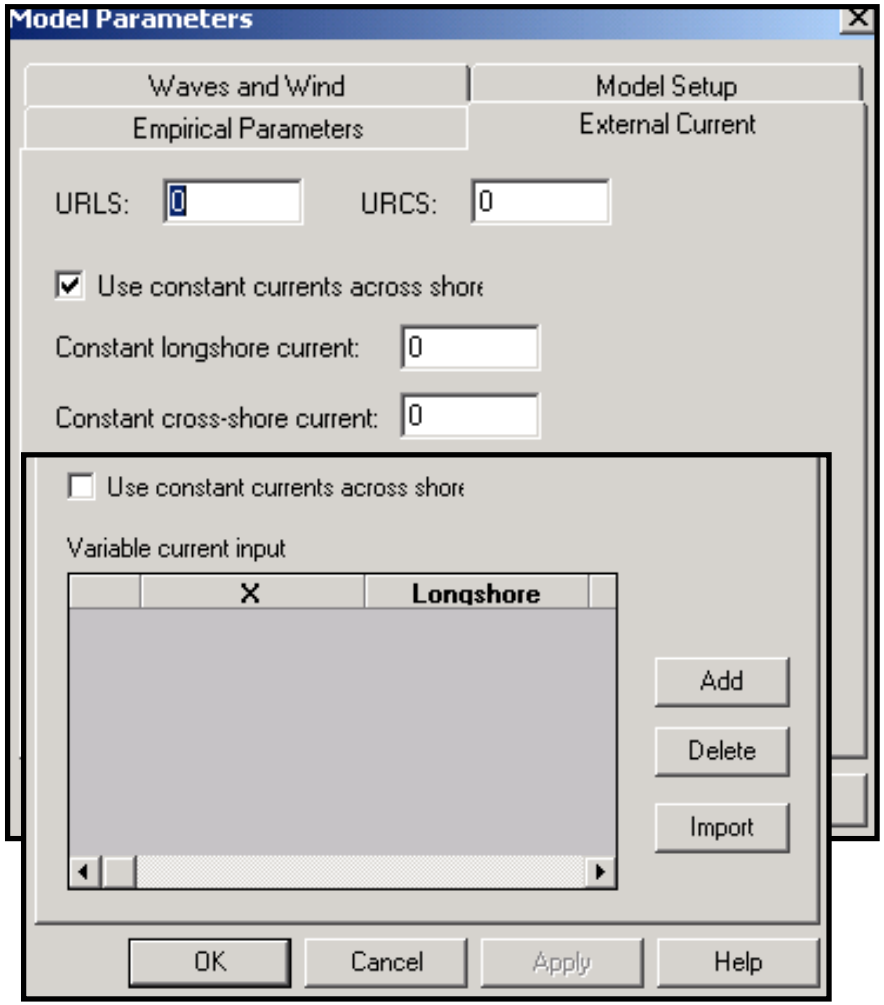
Gamst: Coefficient controlling the depth at which a wave will be stable and not break or decay as broken wave (typical 0.4)

Gambr: Breaker index – controls depth-limited breaking of individual waves (typical 0.78)

Kappa: Coefficient controlling decay of a depth-limited broken wave in the model of Dally, Dean, and Dalrymple (typical 0.15)

PiMich: Coefficient controlling at what height a wave will be stable after breaking because of wave steepness limitations (typical 0.4)

External Current

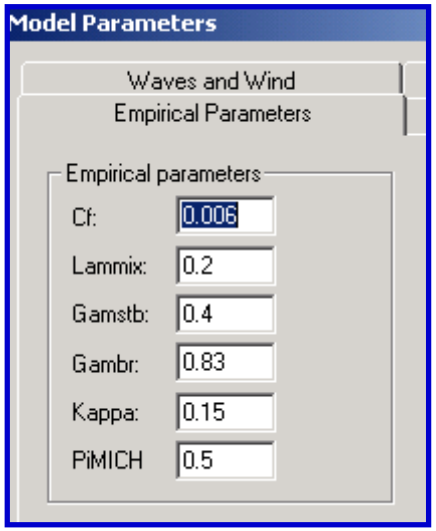


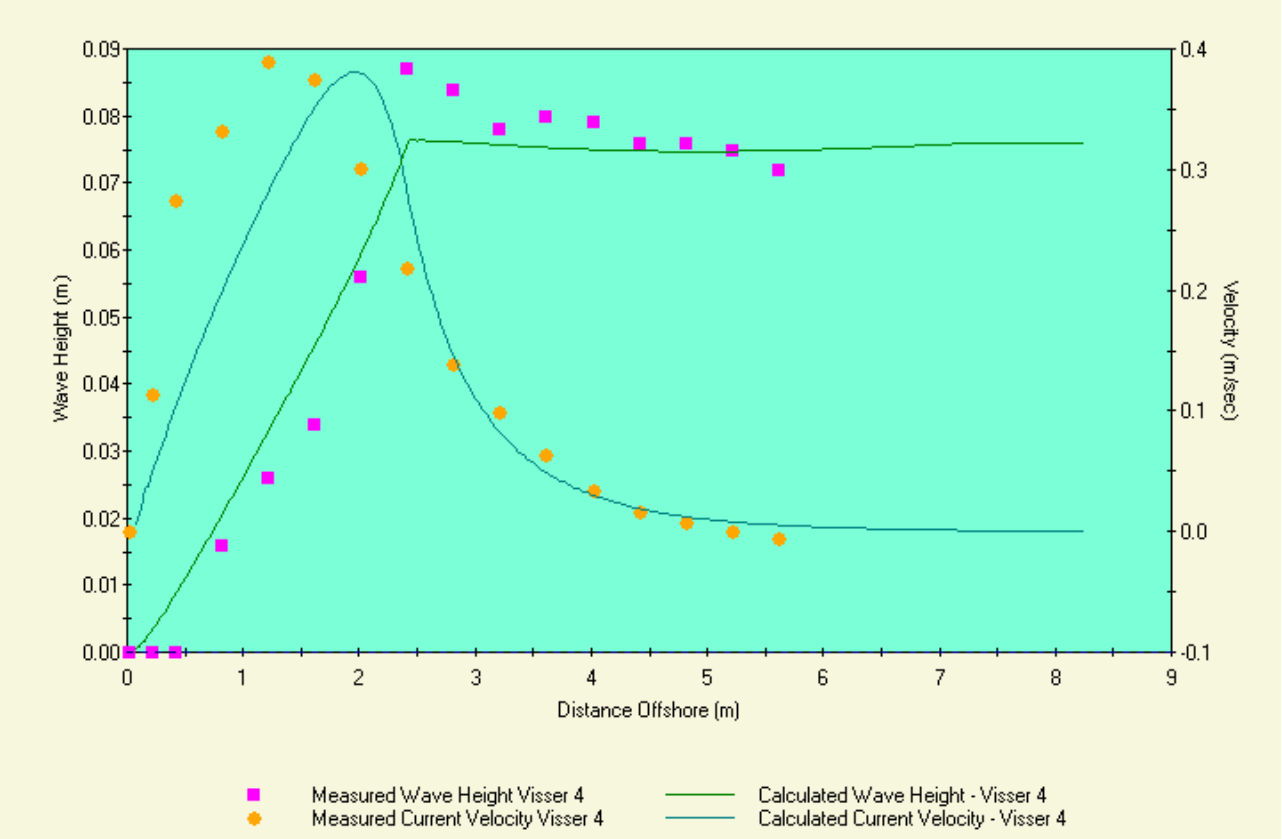
URLS and URCS: External longshore current and cross-shore current, respectively at the reference depth. URLS is directed positively in a right-handed coordinate system with the current moving alongshore, and URCS is directed positively for a current moving offshore.

Use constant currents: Constant currents are specified and values given in the boxes indicated with signs according to the discussion above

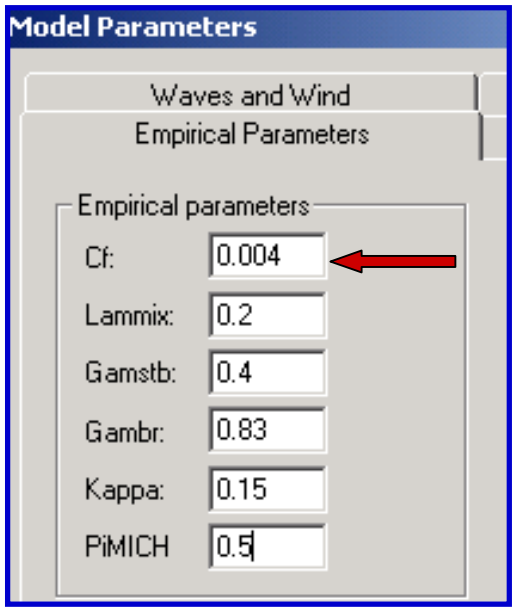
Use constant currents: If this box is unchecked, then longshore and cross-shore currents with distributions across shore are specified

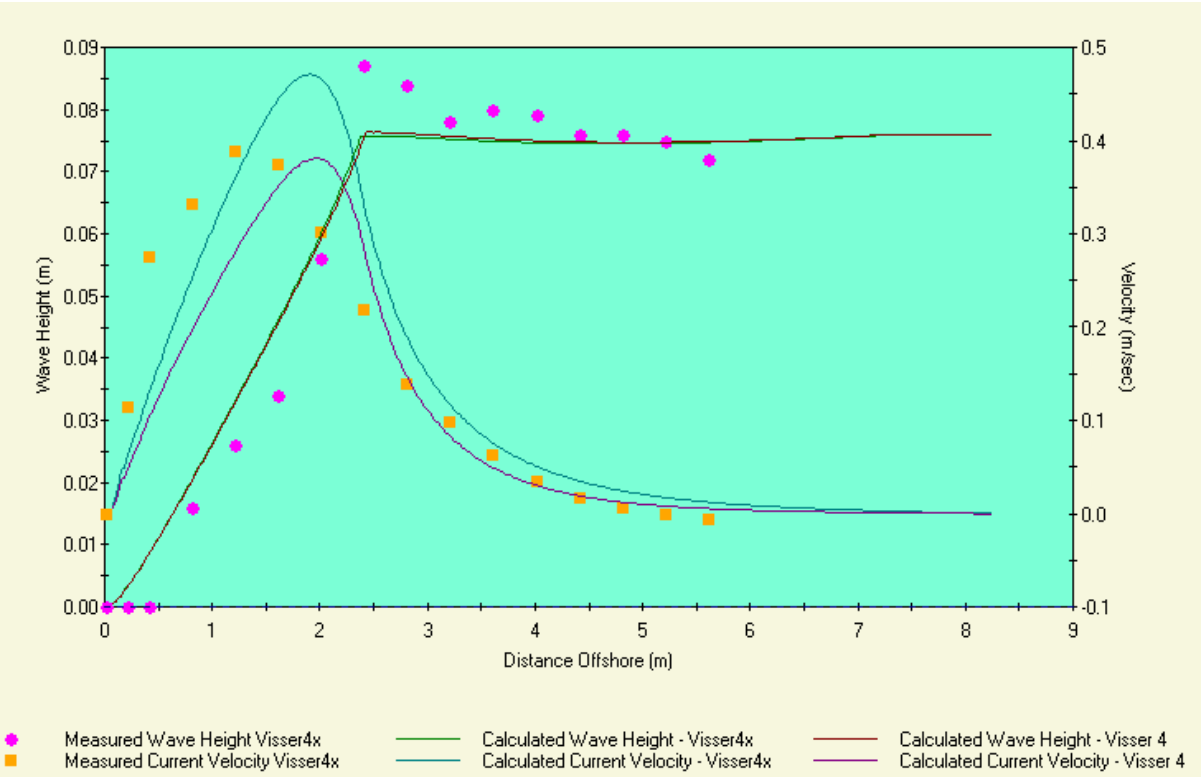
Example Case – Visser Tank Test



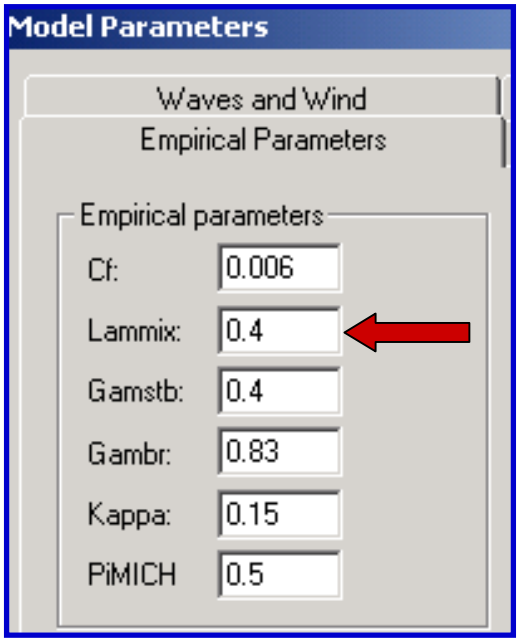


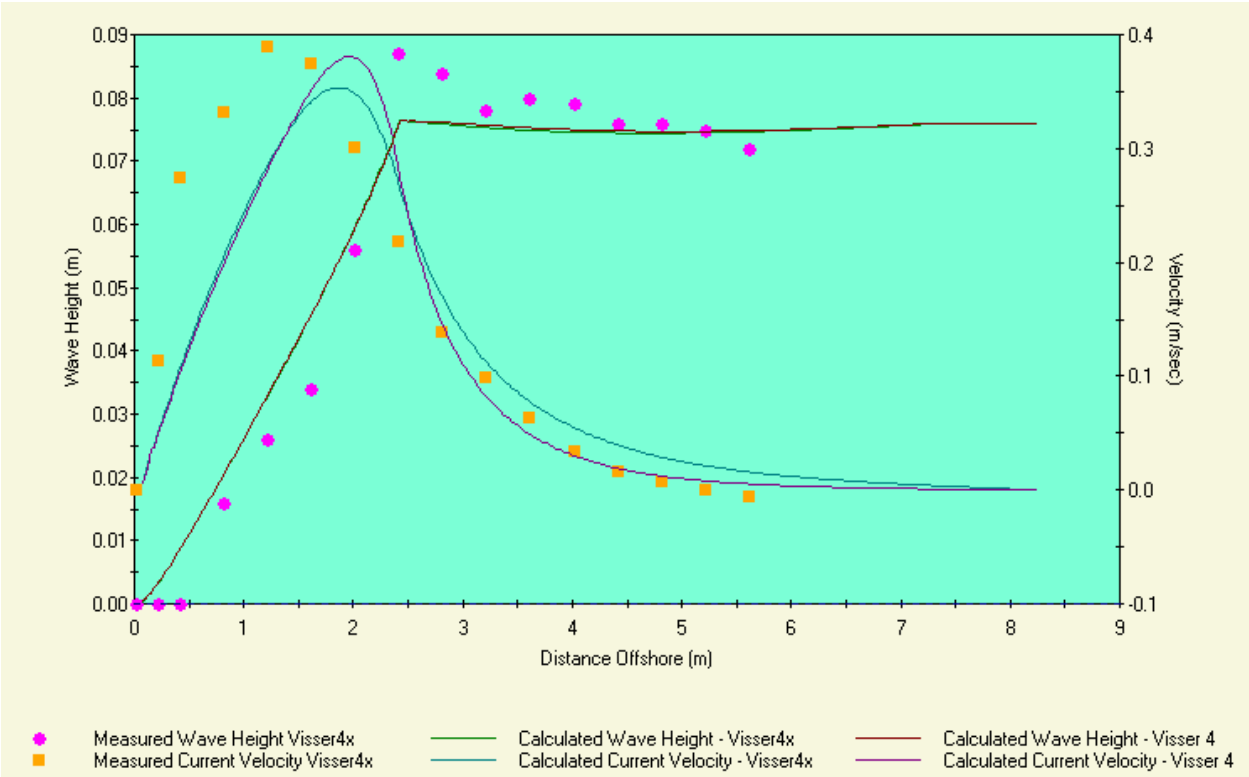
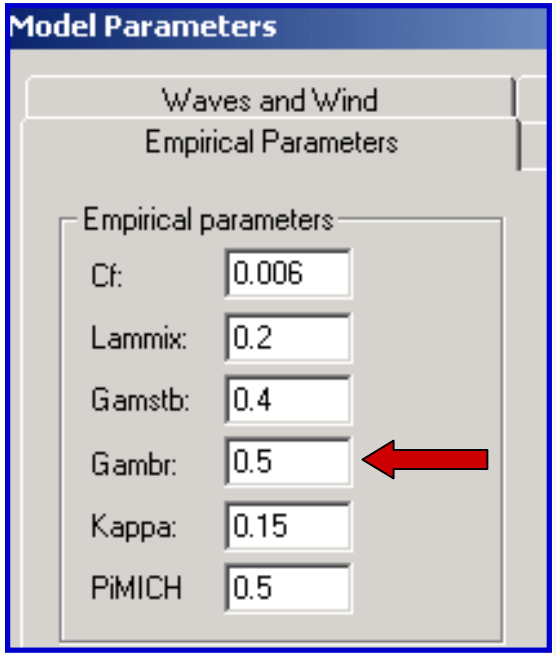
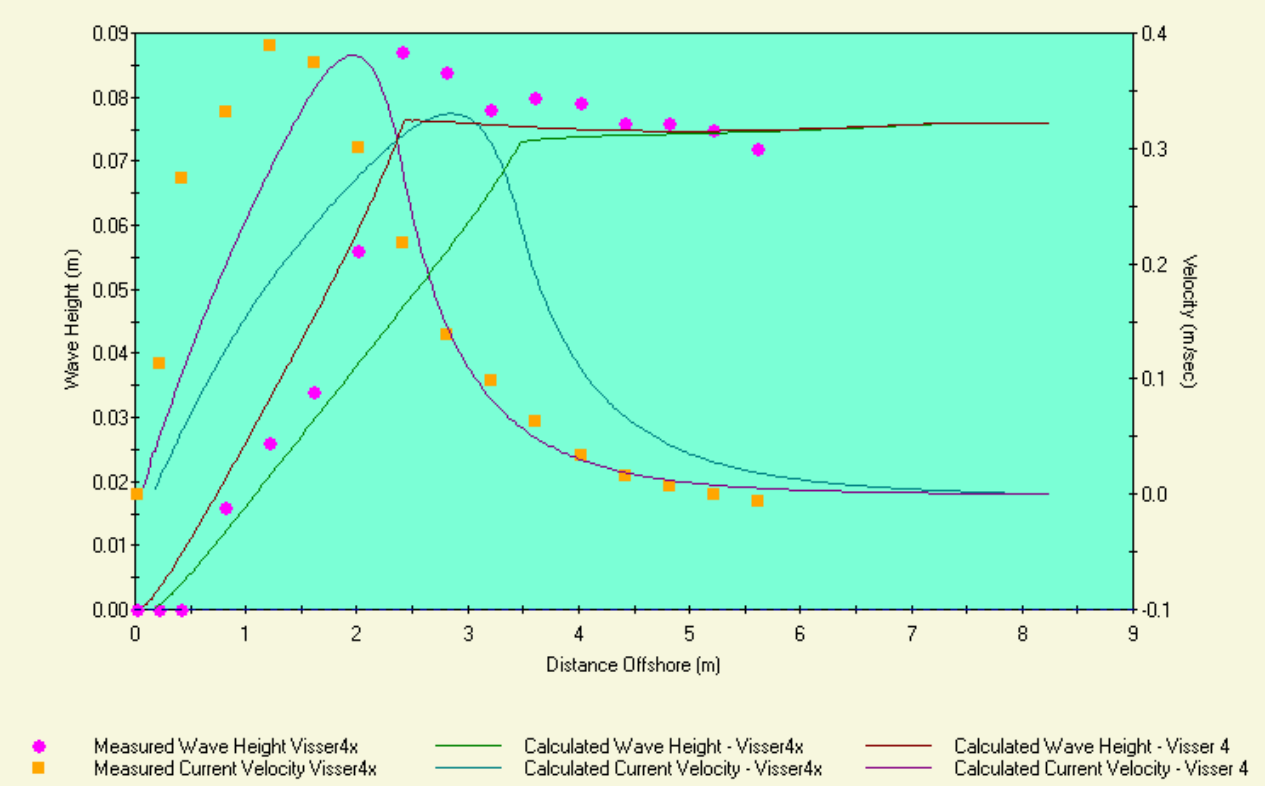
Reduced Friction





Increased Eddy Viscosity





Reduced Breaking Criteria