

Transformation-Scale Waves

Navigation  
Program



# STWAVE

## Optional Input & Output

Jane McKee Smith  
Coastal and Hydraulics  
Laboratory

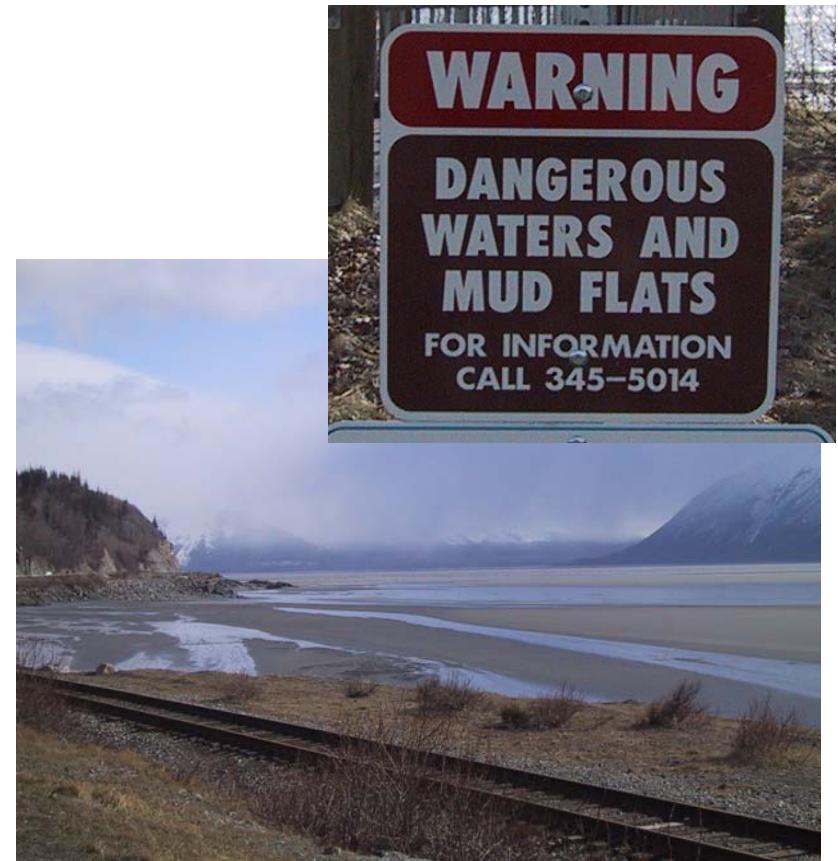


# Outline

## Navigation Program



- Optional Inputs
  - Wind
  - Water elevation
  - Current
- Optional Outputs
  - Radiation stress gradients
  - Breaking index fields
- Grid Nesting



# Wind Input

## Navigation Program



- Wind Speed
  - Meters/second
  - Adjusted, 10-m elevation
- Wind Direction
  - Degrees, STWAVE local coordinates
  - Direction “from” (same as waves)
  - SMS convert global to local



# Wind Input

Navigation  
Program



- Constant over Domain
- Stored in Input Spectra File (.eng)
- IPRP = 0 (source terms & propagation)
- Acts on Half Plane (offshore winds neglected)



# Water Elevation Input

Navigation  
Program



- Tide and/or Storm Surge
- Constant over Domain
- Stored in Input Spectra File (.eng)
- Relative to Bathymetry Reference
- + Increases Depth,  
- Decreases Depth



# Current Input

## Navigation Program



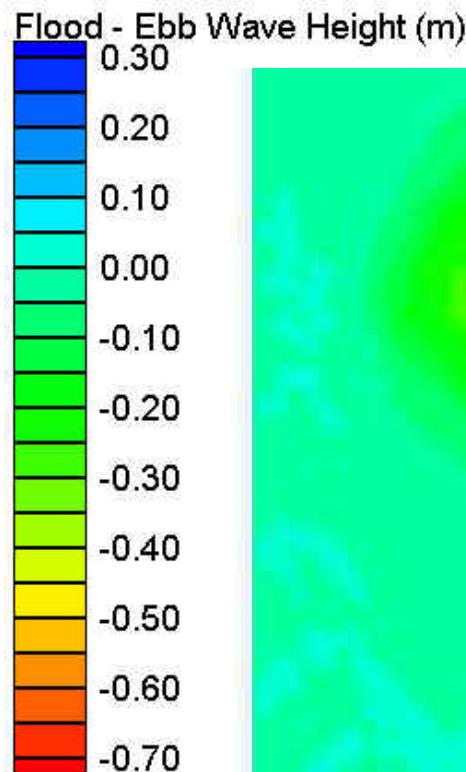
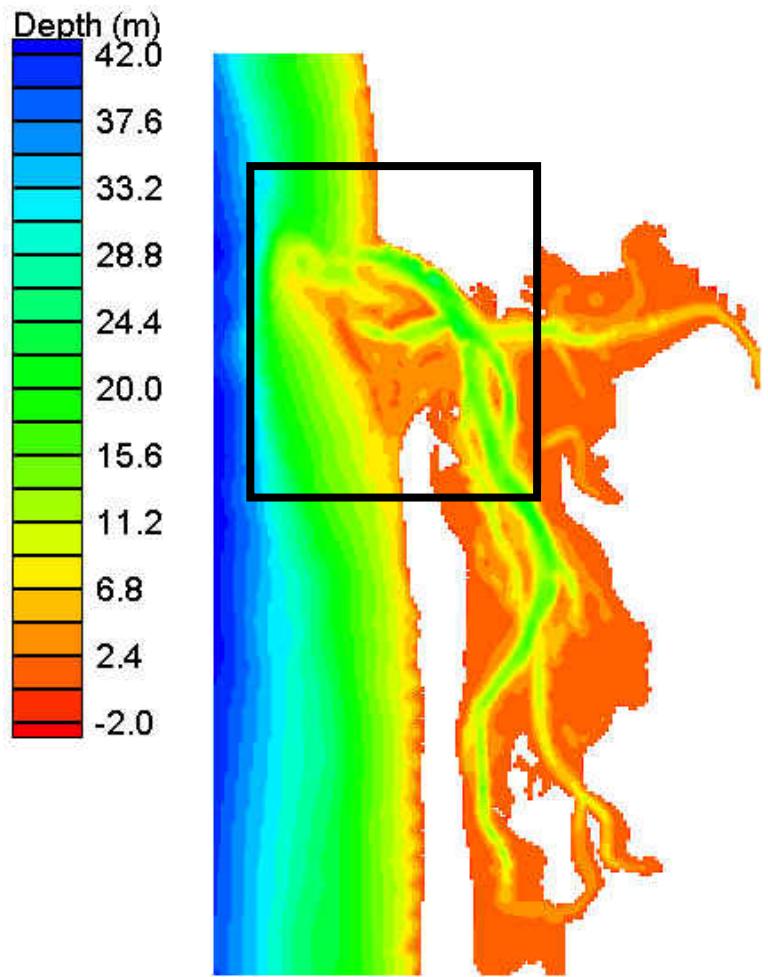
- Wave-Current Interaction
  - Change in wavelength
  - Refraction, shoaling, & breaking
  - Ebb – decrease wavelength
  - Flood – increase wavelength
  - Generally important for  $U > 1 \text{ m/s}$
  - Impact greater for shorter periods



Transformation-Scale Waves

# Willapa Bay, WA

Navigation  
Program



$H=1.5\text{ m}$ ,  $T=8\text{ s}$   
WNW, at MSL



# Current Input

## Navigation Program



- Specify Current at Every Grid Cell (.cur)
  - x and y components (u and v)
  - meters/second
- Interpolate Currents from Circulation Model (SMS)
- Options:
  - ICUR = 0 (no current)
  - ICUR = 1 (current field for each input spectrum)
  - ICUR = 2 (one input current field for all spectra)



# Navigation Program



# Sample Current

41      101    100.0000

**nx, ny, d**

1

**idd**

-0.074441    0.521558

-0.075095    0.522148    -0.075748

0.522737    -0.076402

0.523327    -0.077055    0.523917

-0.074441    0.521558

-0.075095    0.522148    -0.075748

0.522737    -0.076402

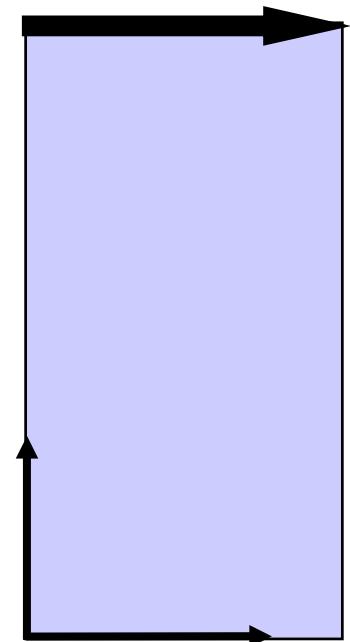
0.523327    -0.077055    0.523917

-0.074441    0.521558

-0.075095    0.522148    -0.075748

0.522737    -0.076402

0.523327    -0.077055    0.523917



**First row of currents (m/s), u and v pairs**  
 $j = ny; i = 1, nx$



# Radiation Stresses

Navigation  
Program



- Longshore Current in Surf Zone
- Rip Currents
- Wave Set-Down at Incipient Breaking
- Wave Setup at the Beach



# Radiation Stress Output

Transformation-Scale Waves

Navigation  
Program



- Short Waves Averaged out of Circulation Model
- Wave Momentum Flux (linear theory):

$$S_{xx} = E \left[ n(\cos^2 \theta + 1) - 0.5 \right] \quad S_{xy} = S_{yx} = \frac{E}{2} n \sin 2\theta$$
$$S_{yy} = E \left[ n(\sin^2 \theta + 1) - 0.5 \right]$$

- Wave Stresses Introduced in Circulation Model

$$\tau_x = -\frac{\partial S_{xx}}{\partial x} - \frac{\partial S_{xy}}{\partial y}$$
$$\tau_y = -\frac{\partial S_{xy}}{\partial x} - \frac{\partial S_{yy}}{\partial y}$$



# Radiation Stress Output

Transformation-Scale Waves

Navigation  
Program



- x and y Components:
  - $\tau_x/\rho_w$  and  $\tau_y/\rho_w$
  - Units meters<sup>2</sup>/seconds<sup>2</sup>
- Format is same of Current Input File



# Breaker Index Fields

Navigation  
Program



- Identify Regions of Wave Breaking
  - 0 = nonbreaking
  - 1 = breaking
- Visualize with SMS
- Format same as Radiation Stress Output
- Sediment Transport or Navigation



# Grid Nesting

Navigation  
Program



- Reduce Computational Demands
- Complex Nearshore Bathymetry
- Regional Applications
- Change in Models or Processes
  - Deep to shallow water model
  - Tidal currents
  - Nearshore bathymetry alterations
- Draft CHETN Reference

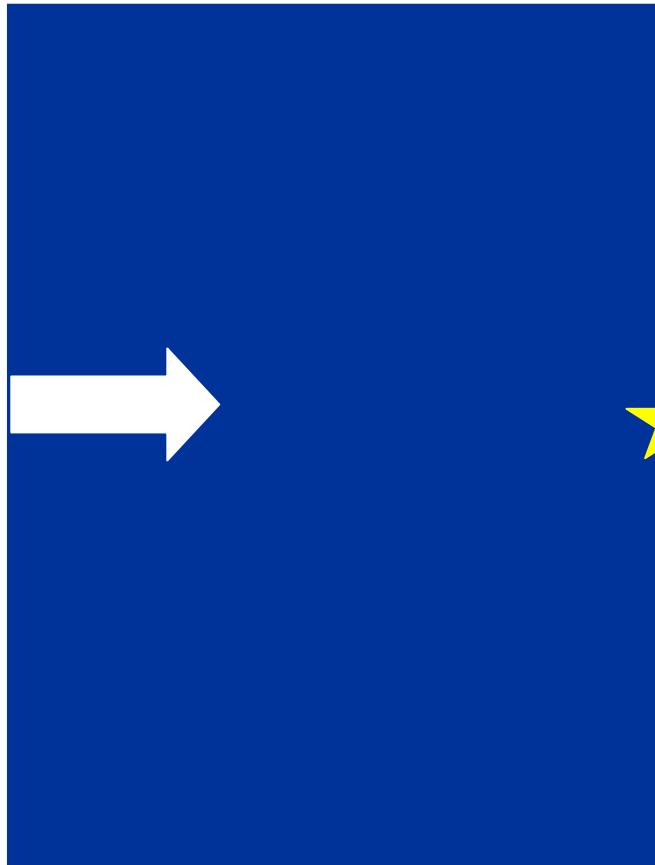


# Grid Nesting

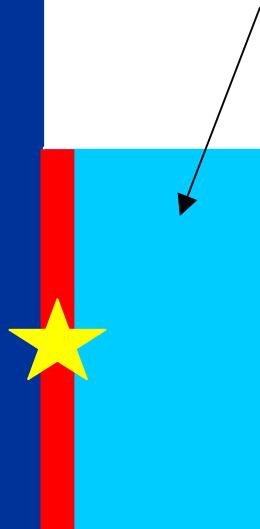
Navigation  
Program



## OFFSHORE GRID



## NEARSHORE GRID



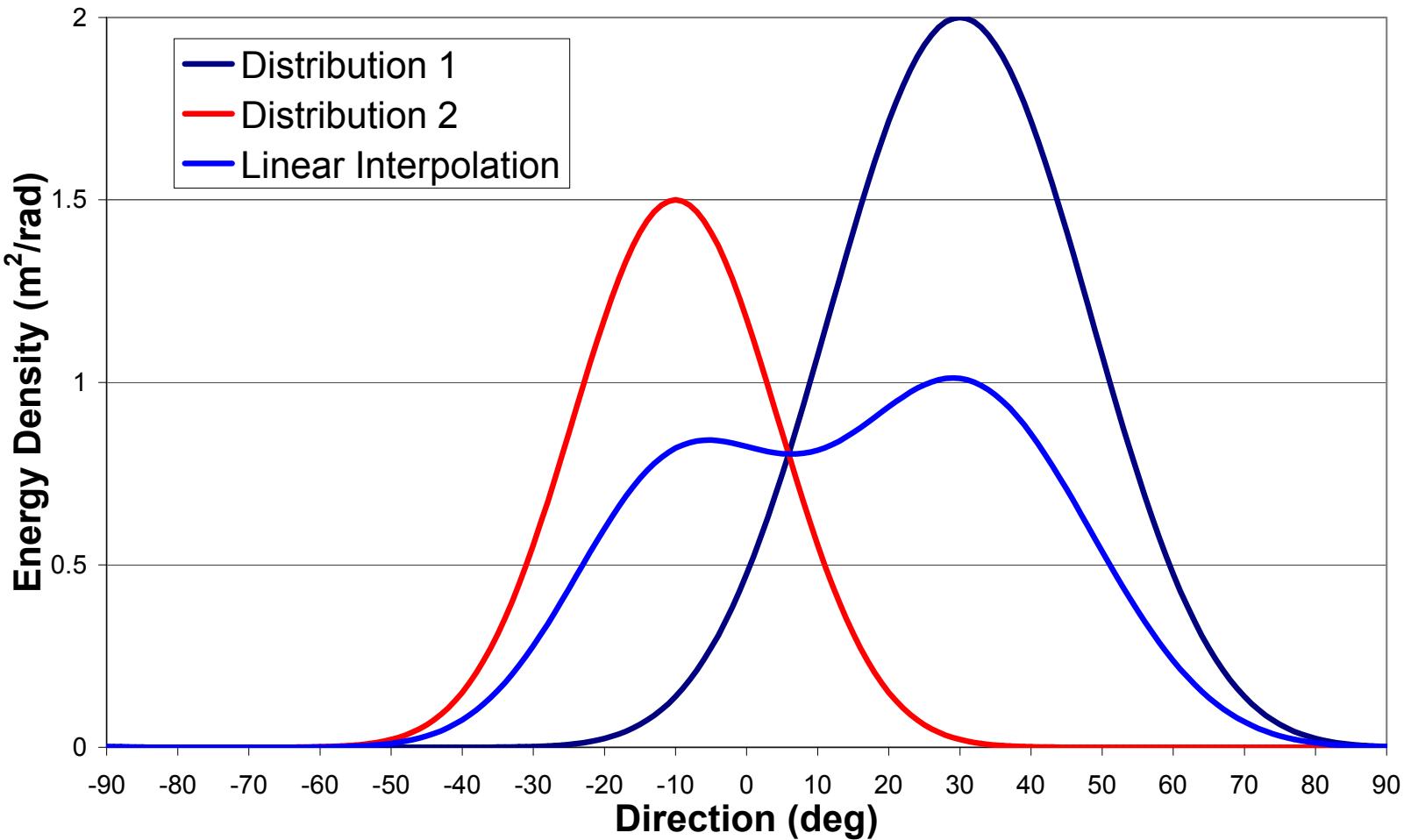
- Previously Single Point
- Now Variable Boundary
- Interpolate to Finer Grid
  - Course-grid model
  - WIS
  - Measurements
- Linear or Morphic Interpolation



# Grid Nesting: Linear Interpolation

Transformation-Scale Waves

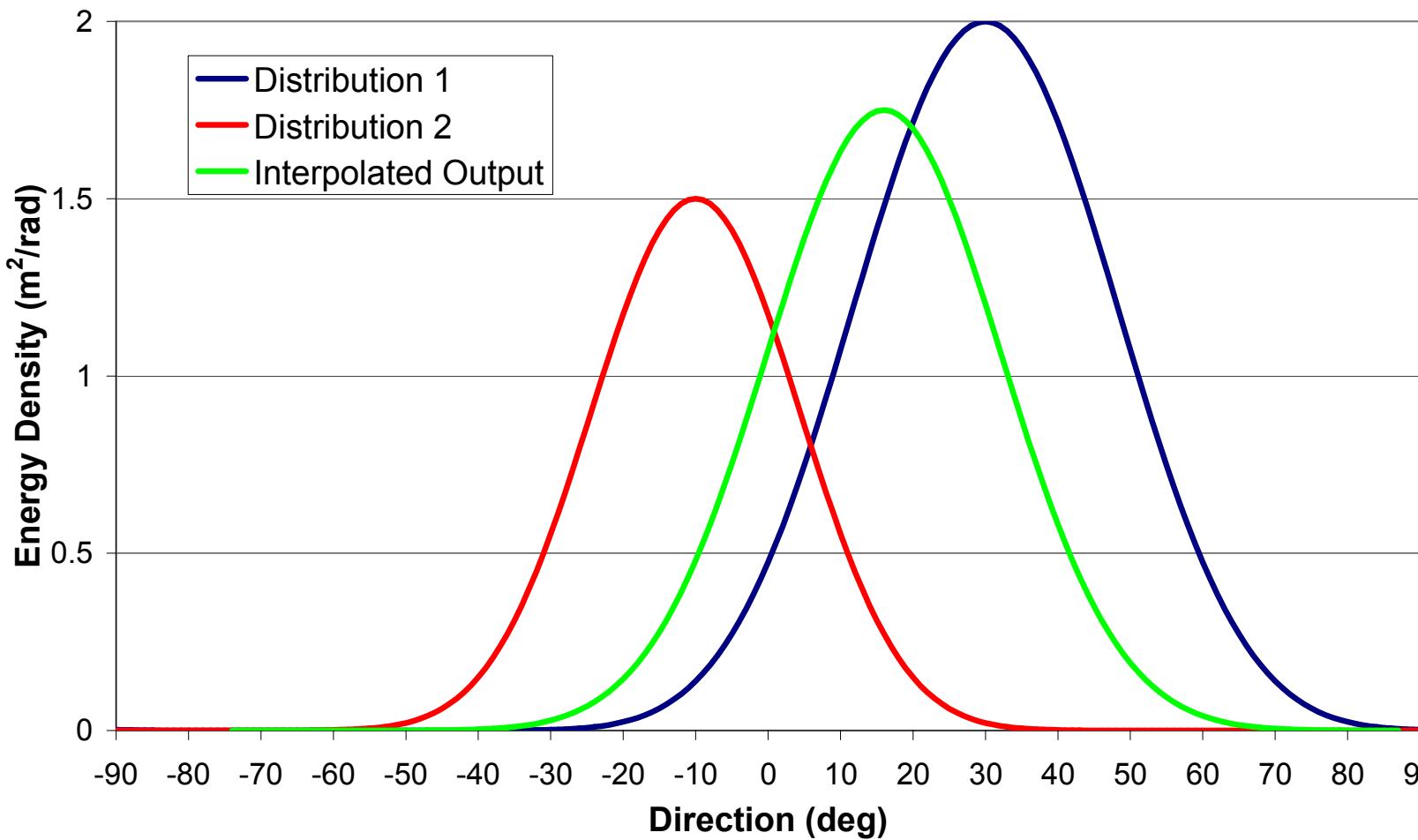
Navigation  
Program



# Grid Nesting: Morphic Interpolation

Transformation-Scale Waves

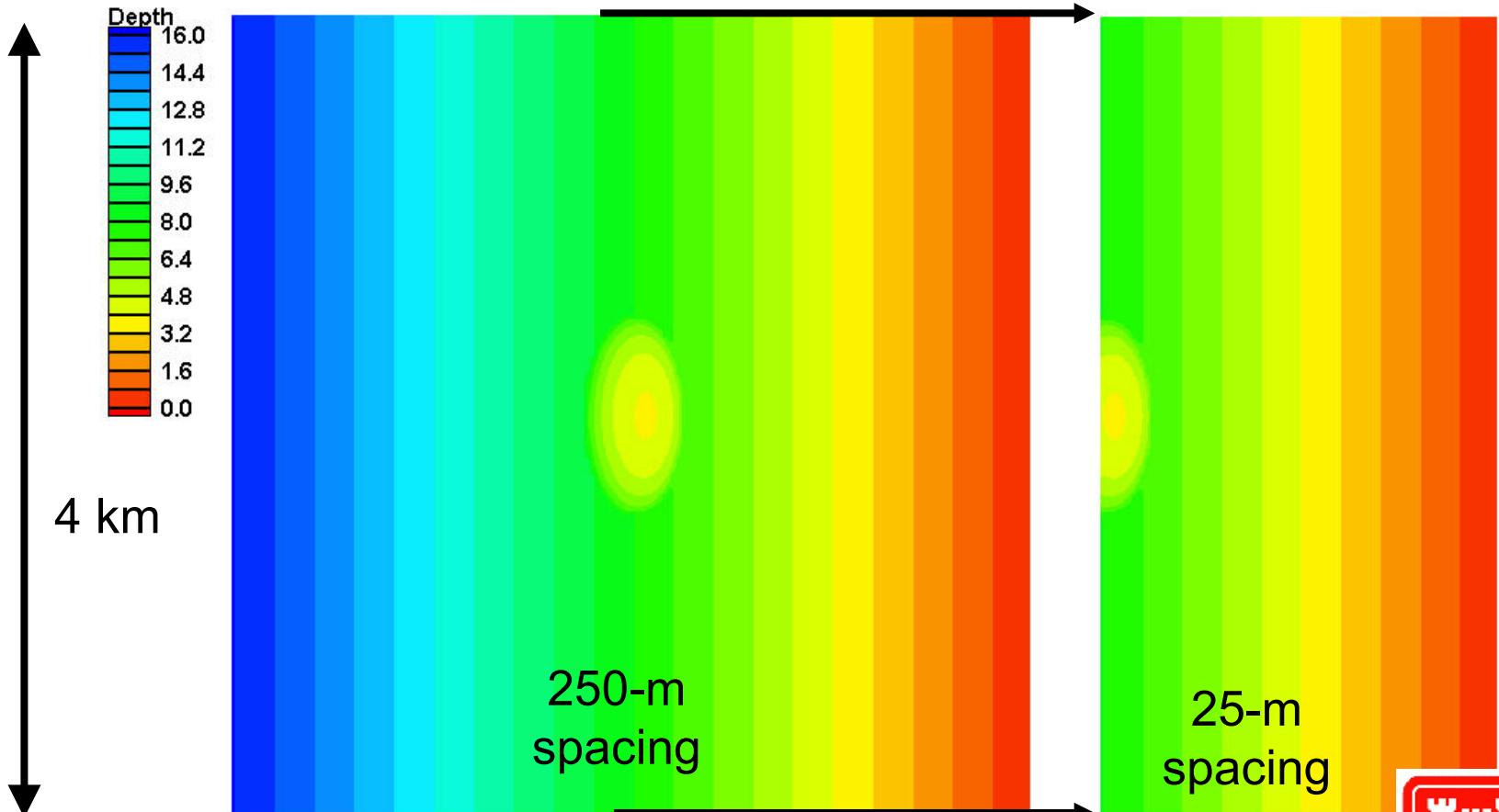
Navigation  
Program



# Grid Nesting Example

Transformation-Scale Waves

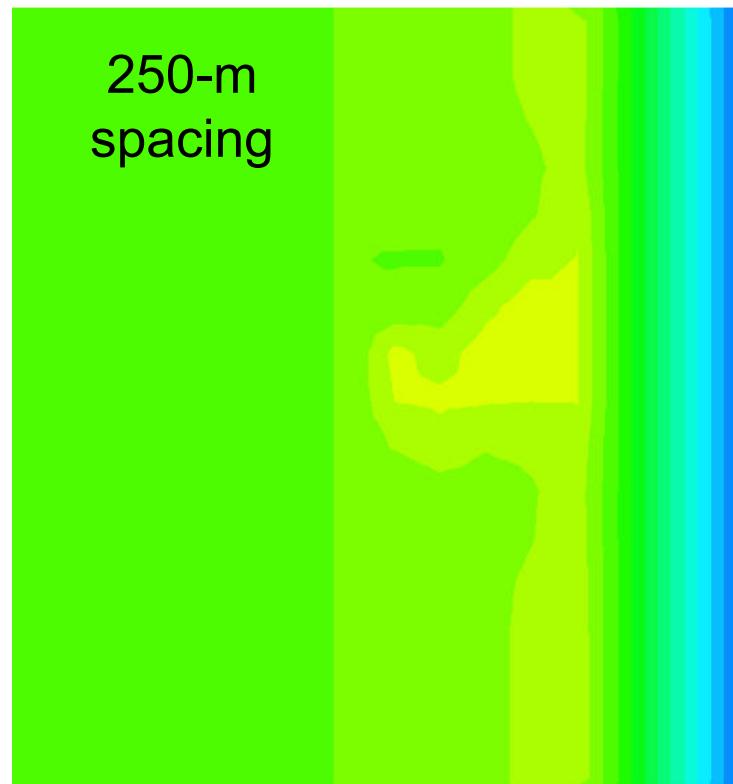
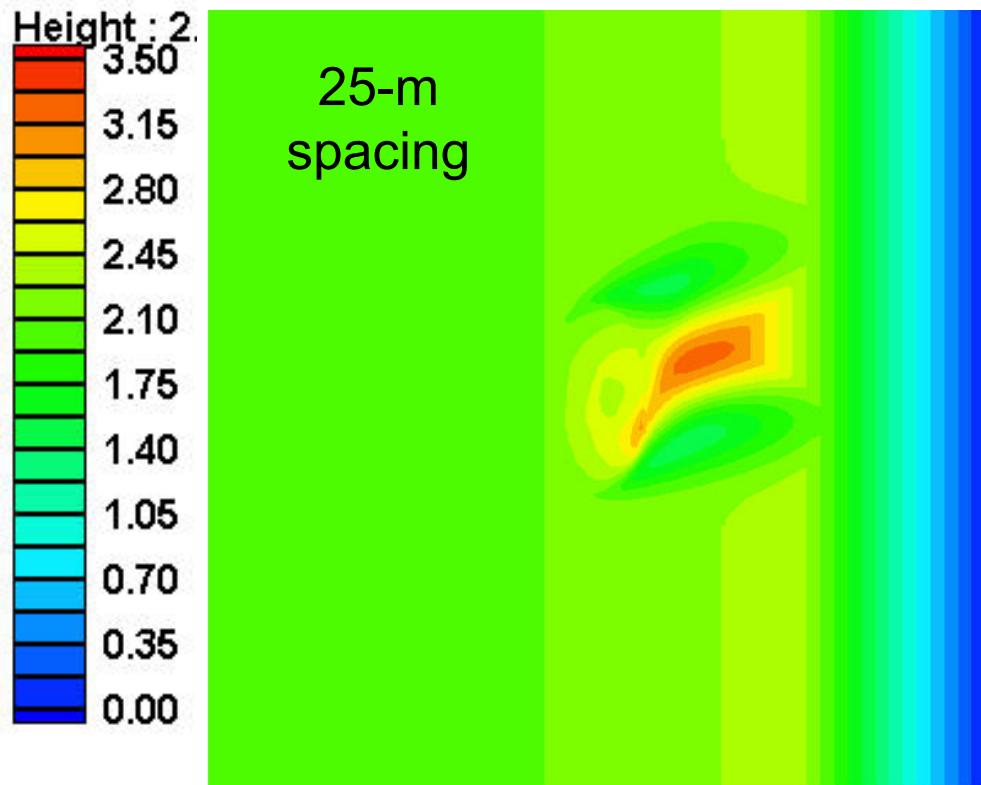
Navigation  
Program



# Grid Nesting Example

Transformation-Scale Waves

Navigation  
Program



$$H_{mo} = 2 \text{ m}, T_p = 18 \text{ sec}, \Theta = 30 \text{ deg}$$



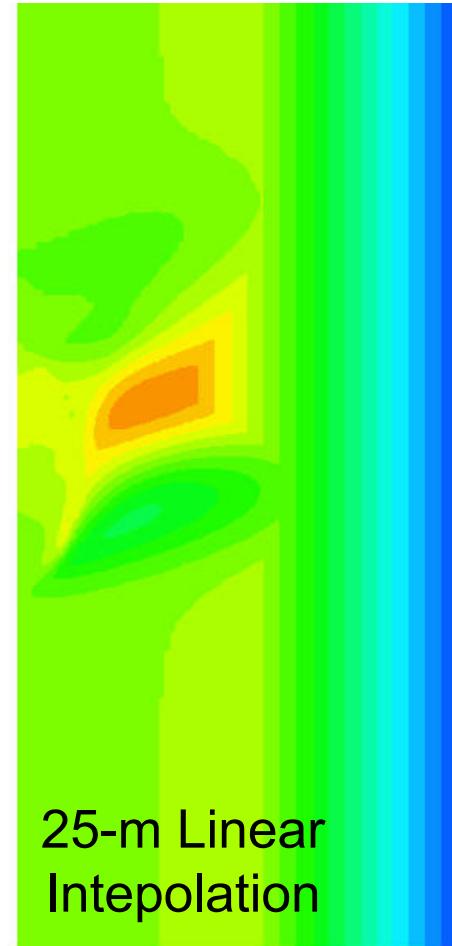
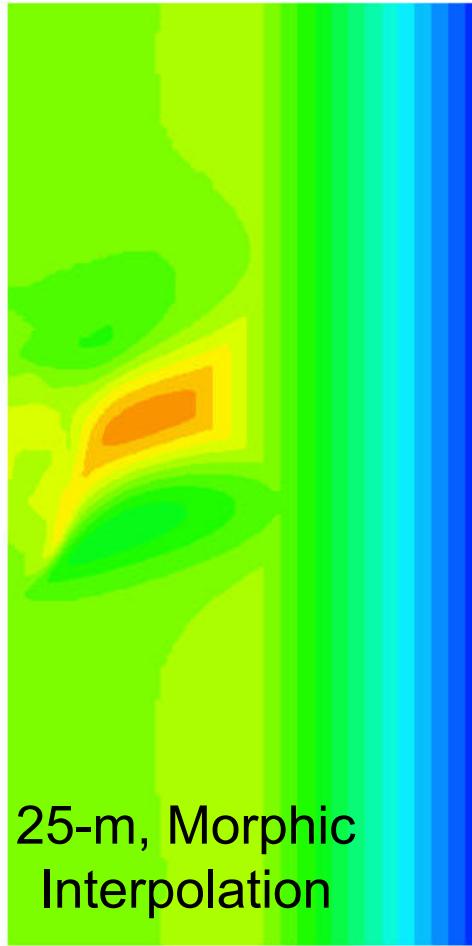
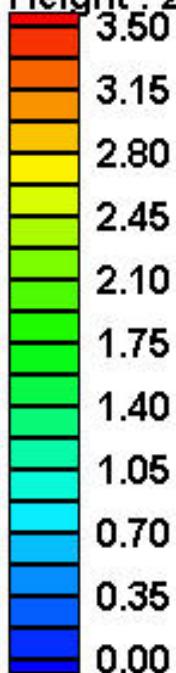
# Grid Nesting Example

Transformation-Scale Waves

Navigation  
Program



Height : 2.



# Model Parameter File

## Coarse Grid

Transformation-Scale Waves

Navigation  
Program



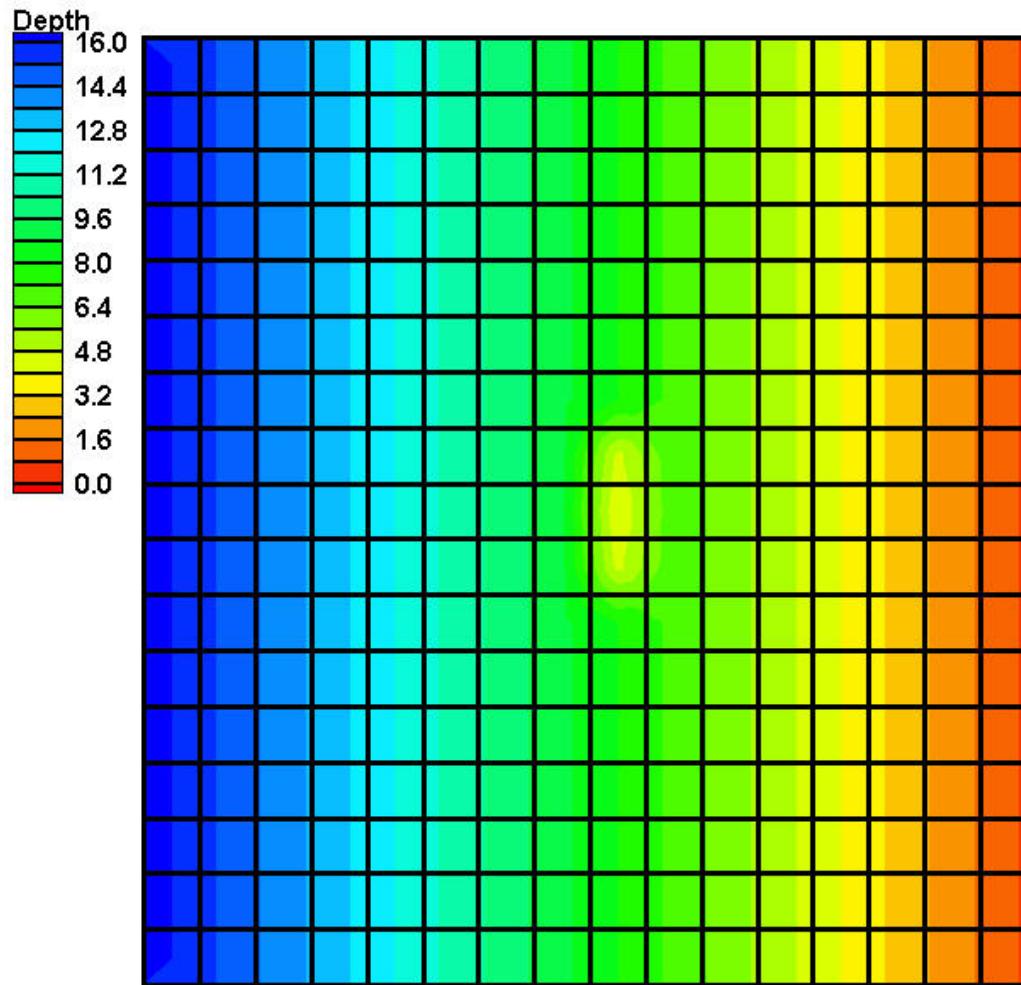
1	0	0	0	2	0	IBND = 0 single point boundary input
10	7					IBND = 1 linear boundary interpolation
11	7					IBND = 2 morphic boundary interpolation
17						save spectra at 17 locations for a nested grid run
9	1					17 (i,j) pair locations to save nesting spectra
9	2					
9	3					These points do not need to be regularly spaced
9	4					
9	5					
9	6					
...						
9	17					



Transformation-Scale Waves

# Coarse Grid

## Navigation Program



# Model Parameter File

## Fine Grid

Transformation-Scale Waves

Navigation  
Program



1 0 0 0 2 2  
11 81  
21 81

- IBND = 0 single point boundary input
- IBND = 1 linear boundary interpolation
- IBND = 2 morphic boundary interpolation



# Summary

## Navigation Program



- STWAVE Input:
  - Model parameters
  - Incident wave spectrum
  - Bathymetry
  - Wind
  - Water elevation
  - Current
- STWAVE Output:
  - Height
  - Period
  - Direction
  - Radiation stress
  - Breaking indicator
  - Spectra
  - Nesting spectra

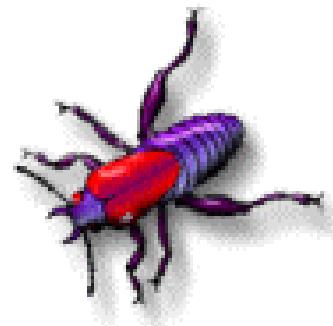


# STWAVE Contacts

## Navigation Program



- Contacts:
  - [Jane.M.Smith@erdc.usace.army.mil](mailto:Jane.M.Smith@erdc.usace.army.mil)
  - [Ann.R.Sherlock@ercd.usace.army.mil](mailto:Ann.R.Sherlock@ercd.usace.army.mil)
- Please Report:
  - Problems (provide input & output files)
  - Bugs
  - Suggestions
  - Needs
  - Applications



Transformation-Scale Waves

# Questions?

Navigation  
Program

