

# M2D Model Background

By

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# Introduction to M2D

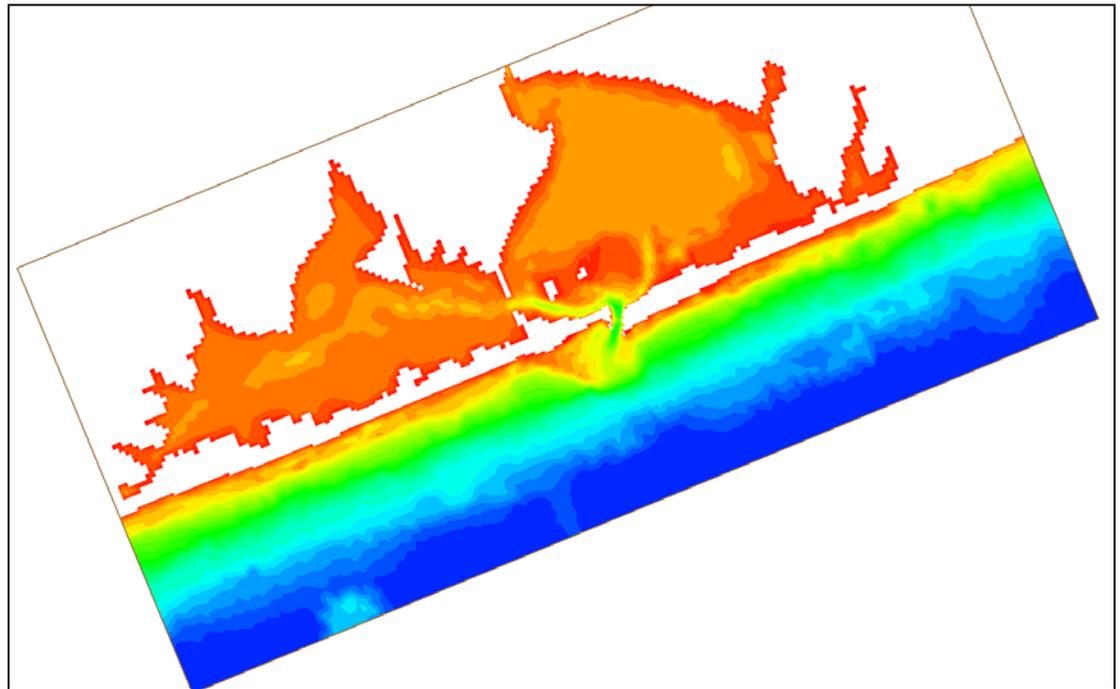


- 2D horizontal circulation model (water level & current)
- Rectilinear grid, variable cell size
- Multiple types of forcing:
  - Water level, wind, waves, flow rate, tidal constituents
- Efficient calculations, no matrix solutions
- Efficient storage in memory
- Easy to configure & run

# Features



- Multiple types of boundary conditions
- Wind forcing
- Wave forcing
- Variable cell size
- Wetting & drying
- Spatially - variable friction coefficient



M2D domain for Shinnecock Inlet, NY

# Grid Storage

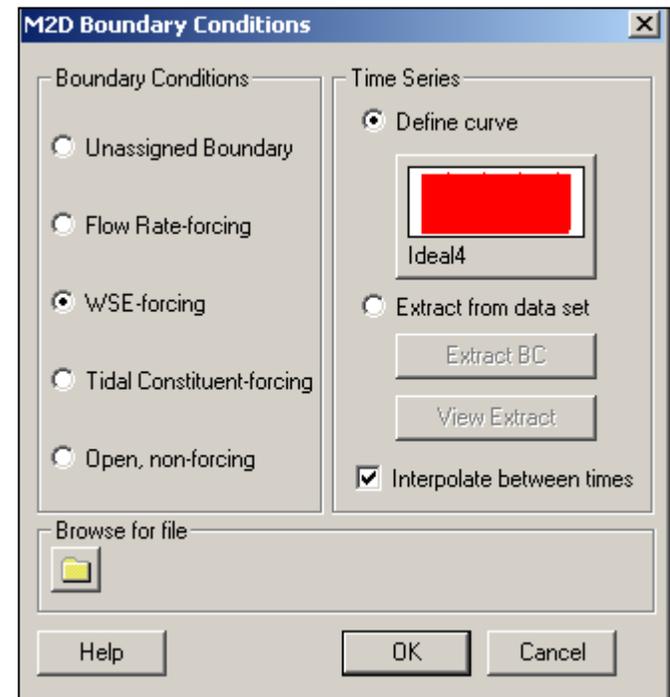
19	20	21	22	23
14	15	16	17	18
11			12	13
6	7	8	9	10
1	2	3	4	5

- Cells given unique identification numbers
- Never-wetted areas are not stored
- Calculations point to neighbor cells
- No matrix indexing
- Reduces memory requirements for complex shorelines

# Boundary Conditions



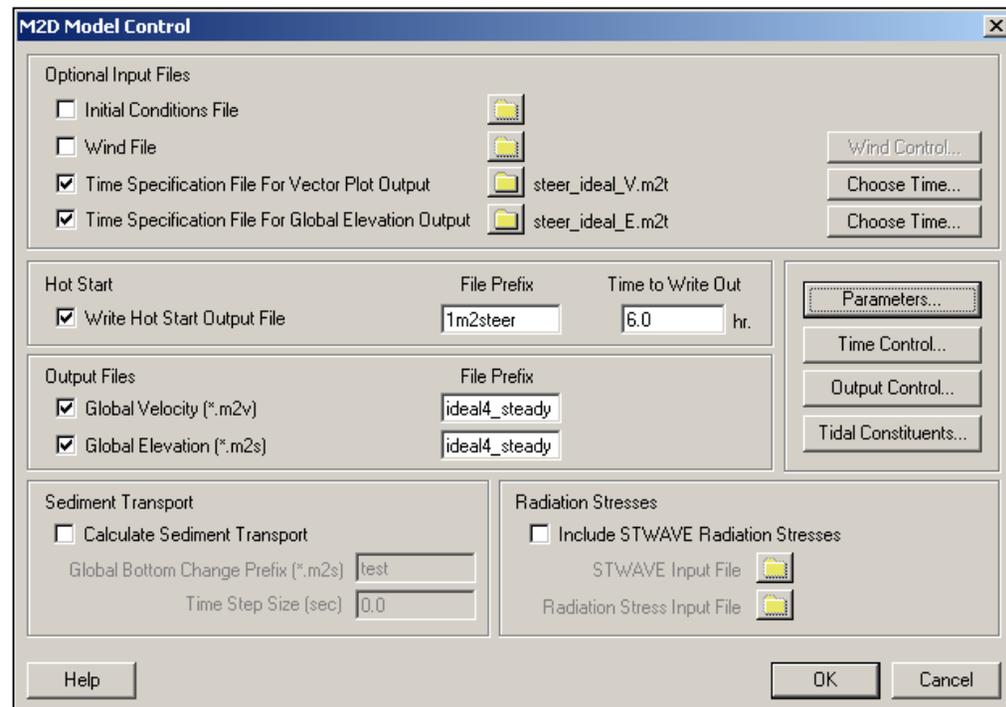
- Water-level time series
  - Provided by user
  - Extracted from ADCIRC or other models, automated in SMS
  - Generated in SMS
- Tidal constituents
- Flow rate
- Passive open boundary
  - Lets water move in & out of boundary (not forced)
  - Needed nearshore w/ waves, wind



# Computational Options



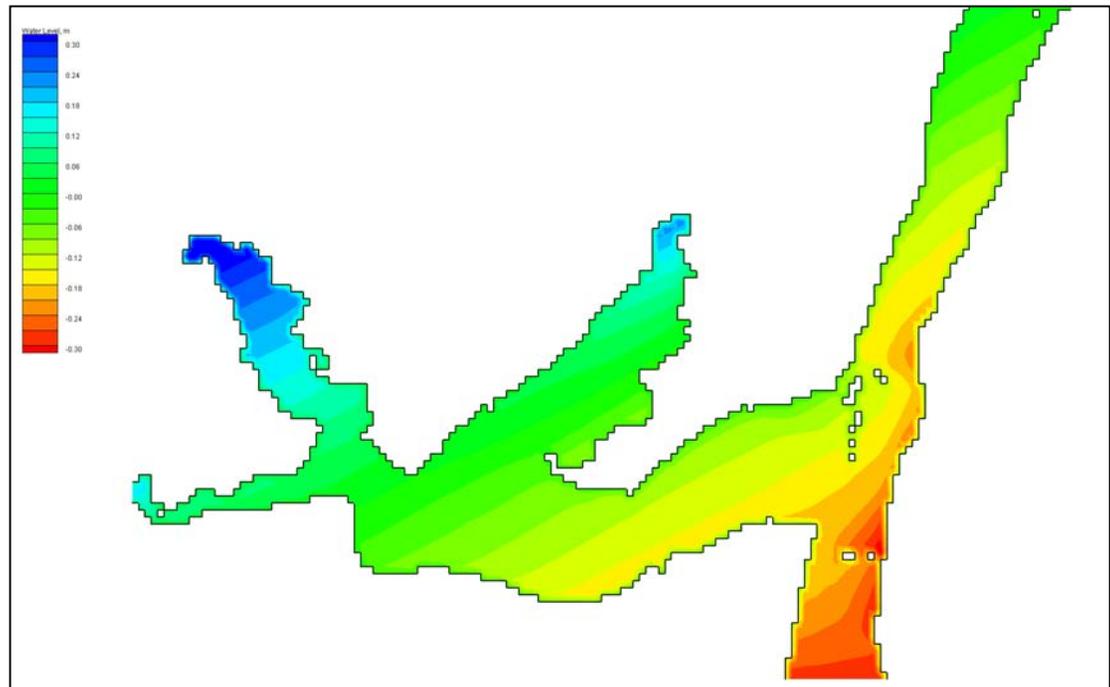
- Inclusion of nonlinear terms in equations
- Time options
  - Time step
  - Duration of simulation
  - Ramp duration
- Output options
  - Global water level & velocity at specified times
  - Time series of water level, velocity, & flow rate at specific points
- Other options (reviewed later in workshop)



# Wind Forcing



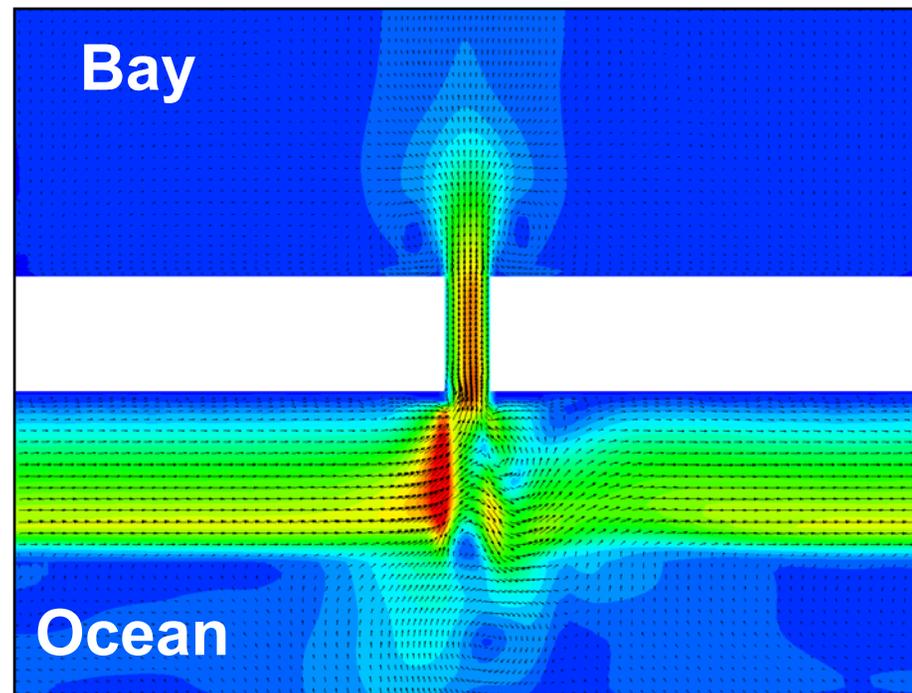
- Calculate wind-generated currents, setup, set down
- Time varying, spatially homogenous
- Wind-stress coefficient (Hsu 1988)
  - Wind speed dependent
  - Developed for shallow water
- Specify anemometer height in M2D control file
- Wind input: time series of speed & direction



Wind setup & set down, Baffin Bay, TX

# Wave Forcing

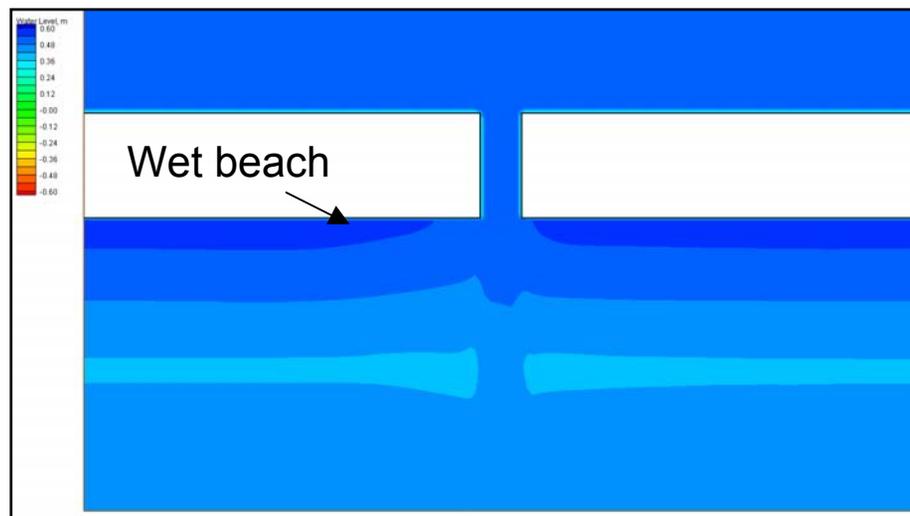
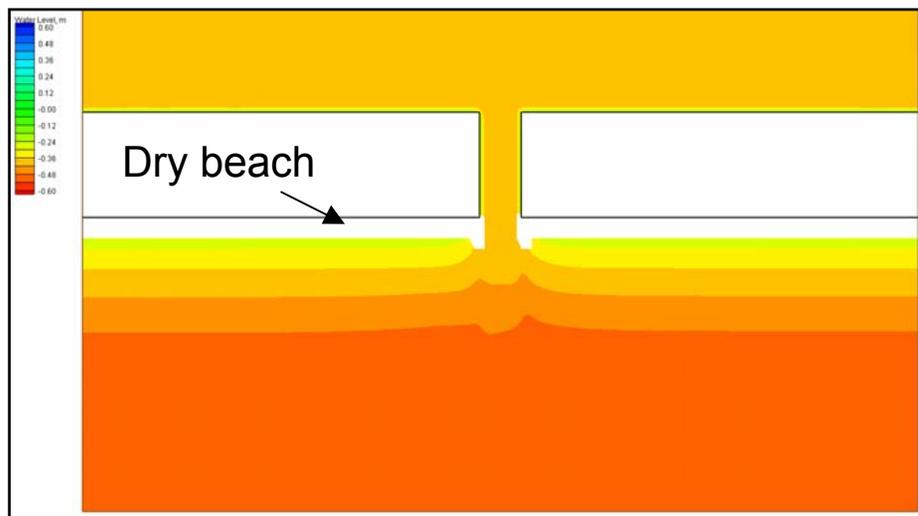
- Calculate wave-driven currents, setup, & set down
- Wave stresses implemented into momentum equations
- Input: time series of radiation stress gradient fields
- Auto coupling w/ STWAVE in SMS Steering Module



Wave-induced current, idealized inlet

# Wetting & Drying

- Represents inundation & exposure of cell bottom w/ variation in water level
- Beaches, shoals, tidal flats



Wetting & drying on a beach, idealized inlet

# Bottom Friction Coefficient



- Specified as Manning's roughness coefficient  $n$
- Spatially variable
- Scaled exponentially in shallow water
  - Depths  $> 0.2$  m, no significant scaling
  - Maximum scaled  $C_f = 2C_f$

M2D Cell Attributes

Cell Type

Active/Ocean Cell

Inactive/Land Cell

Observation Cell

Observation Cell Output Type

Time Series  Flow Rate

Identifier:

Roughness Value (Manning's N):

Help OK Cancel



# Future Capabilities

- Sediment transport (in progress)
  - Multiple transport formulations
  - Bed elevation change
- Flow over structures (weir jetties)
- Change  $dx$  ( $dy$ ) along a column (row) if broken by a barrier
  - M2D can handle this situation
  - Capability is being implemented into SMS