Computational Parameters

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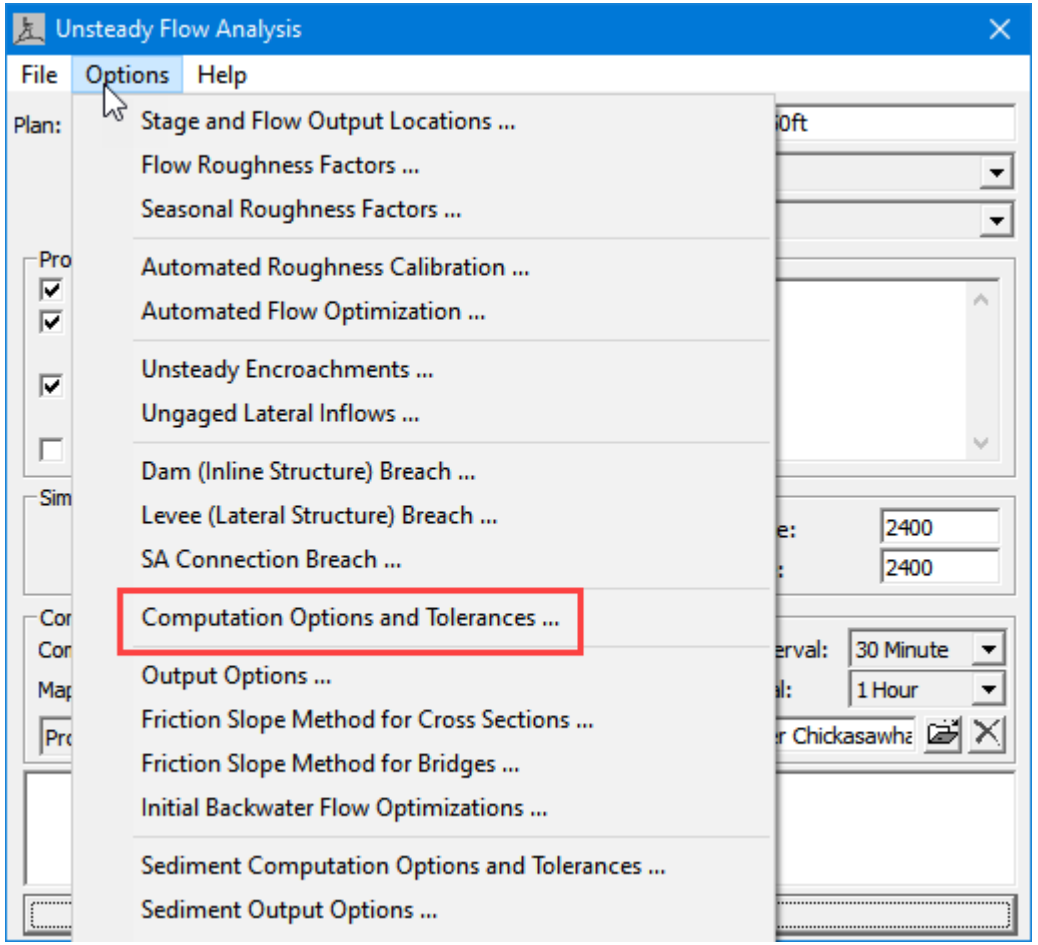
Overview

- Performing Computations
- Computation Options
  - 2D and 1D/2D
- 2D Cell Size Considerations
- Time Step Selection and Options

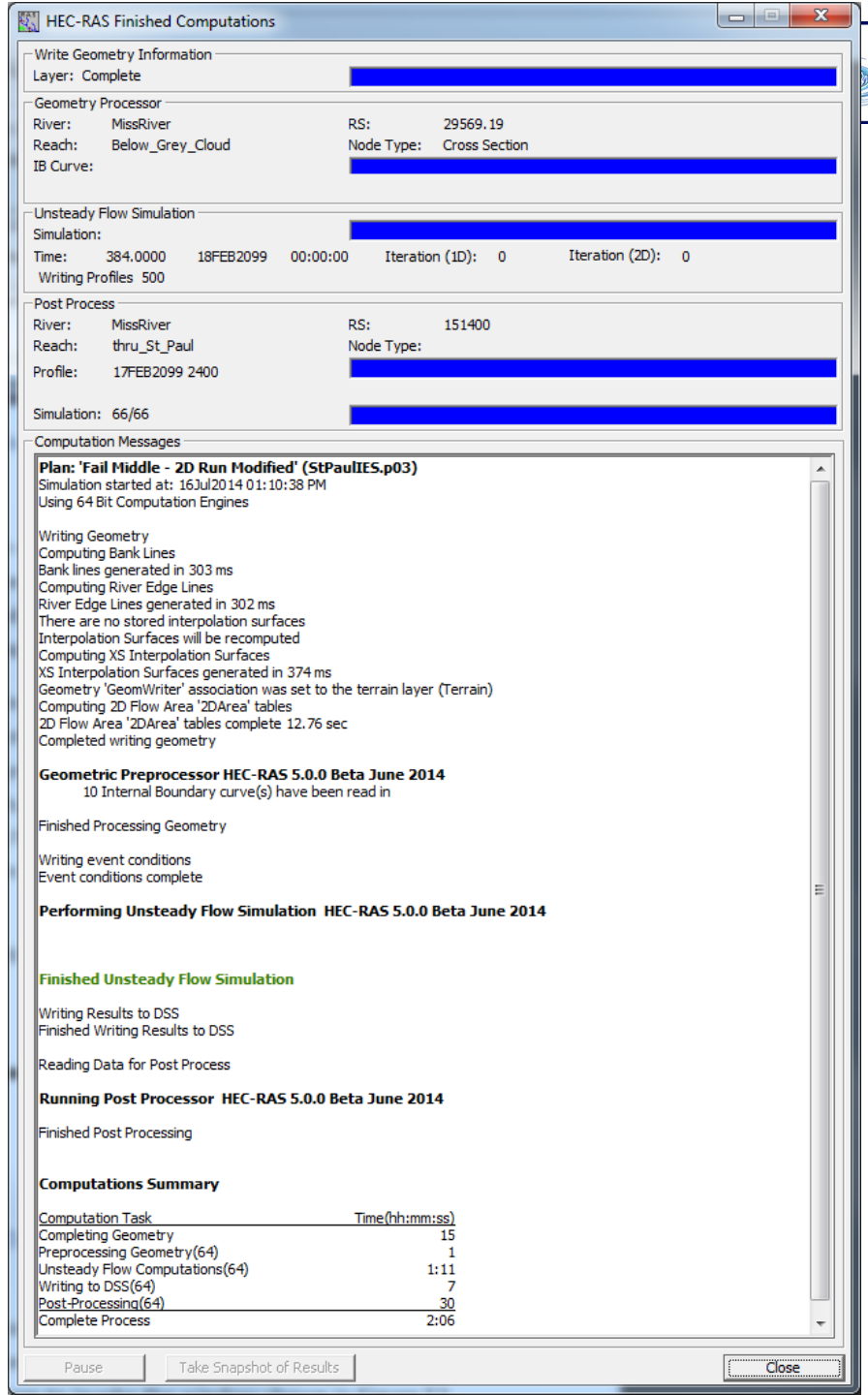
Performing Computations

- Plan Data
- Programs to Run
- Simulation Window
- Computational Settings
  - Computation Timestep
  - Output Intervals
- Computation Options and Tolerances



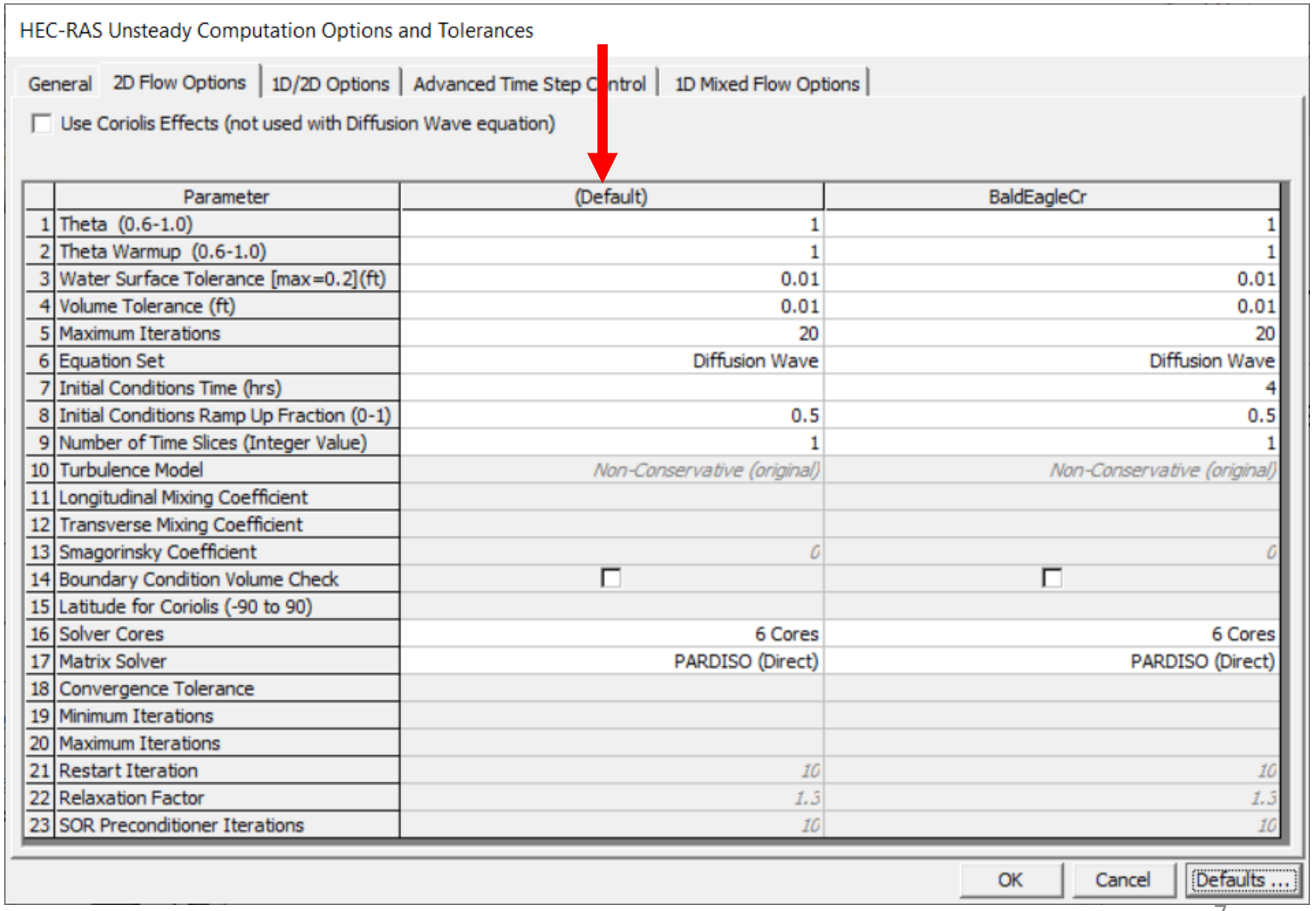
Order of Operations

1. Writing 1D Geometry
   - Bank Lines, Edge Lines (1D)
   - Interpolation Surface (1D)
2. 2D Geometry Preprocessor
   - Process 2D Cells and Faces
3. 1D Geometry Preprocessor
   - Hydraulic Tables for Cross Sections
4. Unsteady Flow Simulation
5. Post Processor (1D only)



2D Computation Options Tab

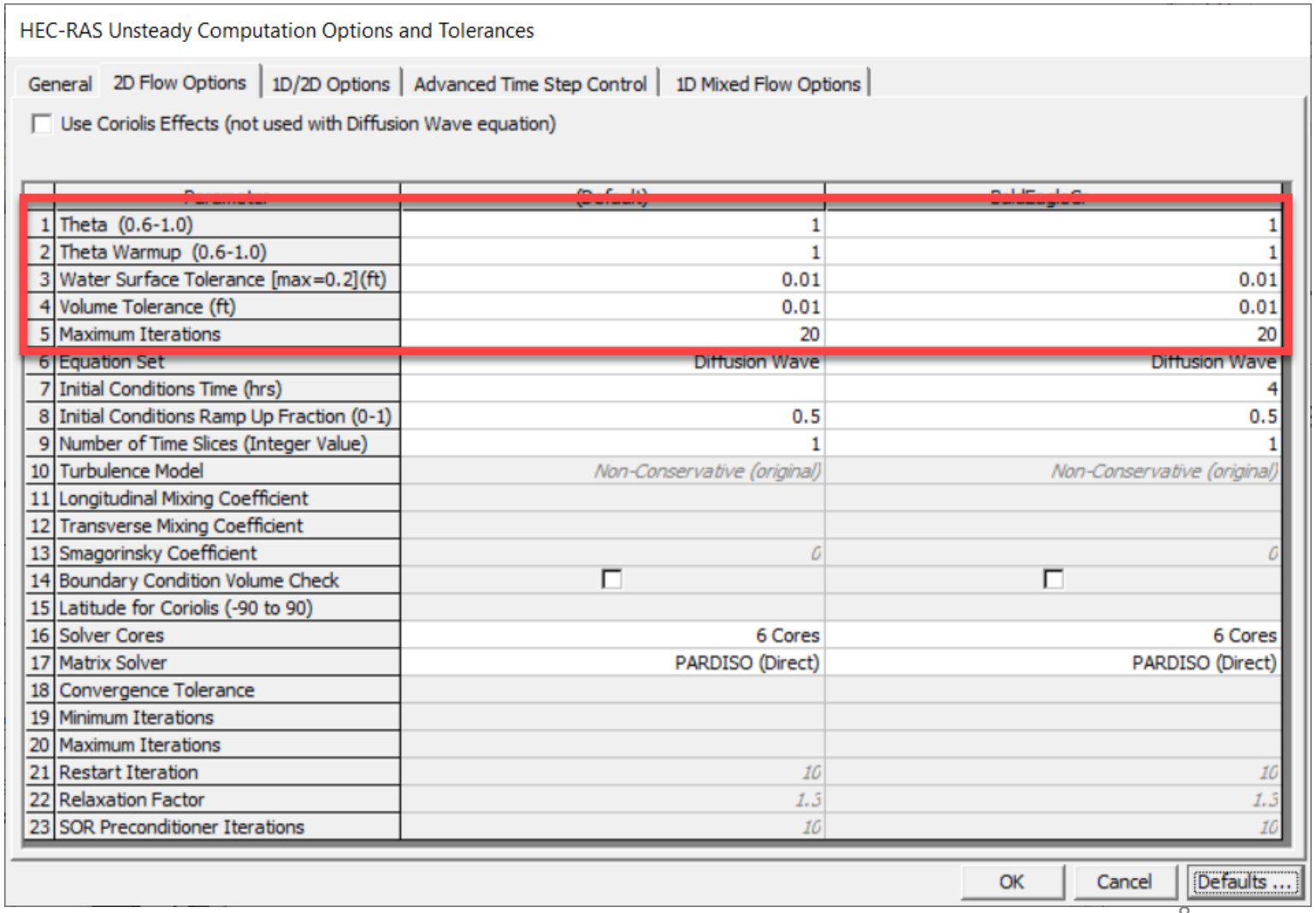
- Defaults
- Column Per 2D Flow Area



	Parameter	(Default)	BaldEagleCr
1	Theta (0.6-1.0)	1	1
2	Theta Warmup (0.6-1.0)	1	1
3	Water Surface Tolerance [max=0.2](ft)	0.01	0.01
4	Volume Tolerance (ft)	0.01	0.01
5	Maximum Iterations	20	20
6	Equation Set	Diffusion Wave	Diffusion Wave
7	Initial Conditions Time (hrs)		4
8	Initial Conditions Ramp Up Fraction (0-1)	0.5	0.5
9	Number of Time Slices (Integer Value)	1	1
10	Turbulence Model	*Non-Conservative (original)*	*Non-Conservative (original)*
11	Longitudinal Mixing Coefficient		
12	Transverse Mixing Coefficient		
13	Smagorinsky Coefficient	*0*	*0*
14	Boundary Condition Volume Check	☐	☐
15	Latitude for Coriolis (-90 to 90)		
16	Solver Cores	6 Cores	6 Cores
17	Matrix Solver	PARDISO (Direct)	PARDISO (Direct)
18	Convergence Tolerance		
19	Minimum Iterations		
20	Maximum Iterations		
21	Restart Iteration	*10*	*10*
22	Relaxation Factor	*1.3*	*1.3*
23	SOR Preconditioner Iterations	*10*	*10*

General 2D Computation Options

- Theta
- Theta Warmup
- Water Surface Tol
- Volume Tolerance
- Max Iterations



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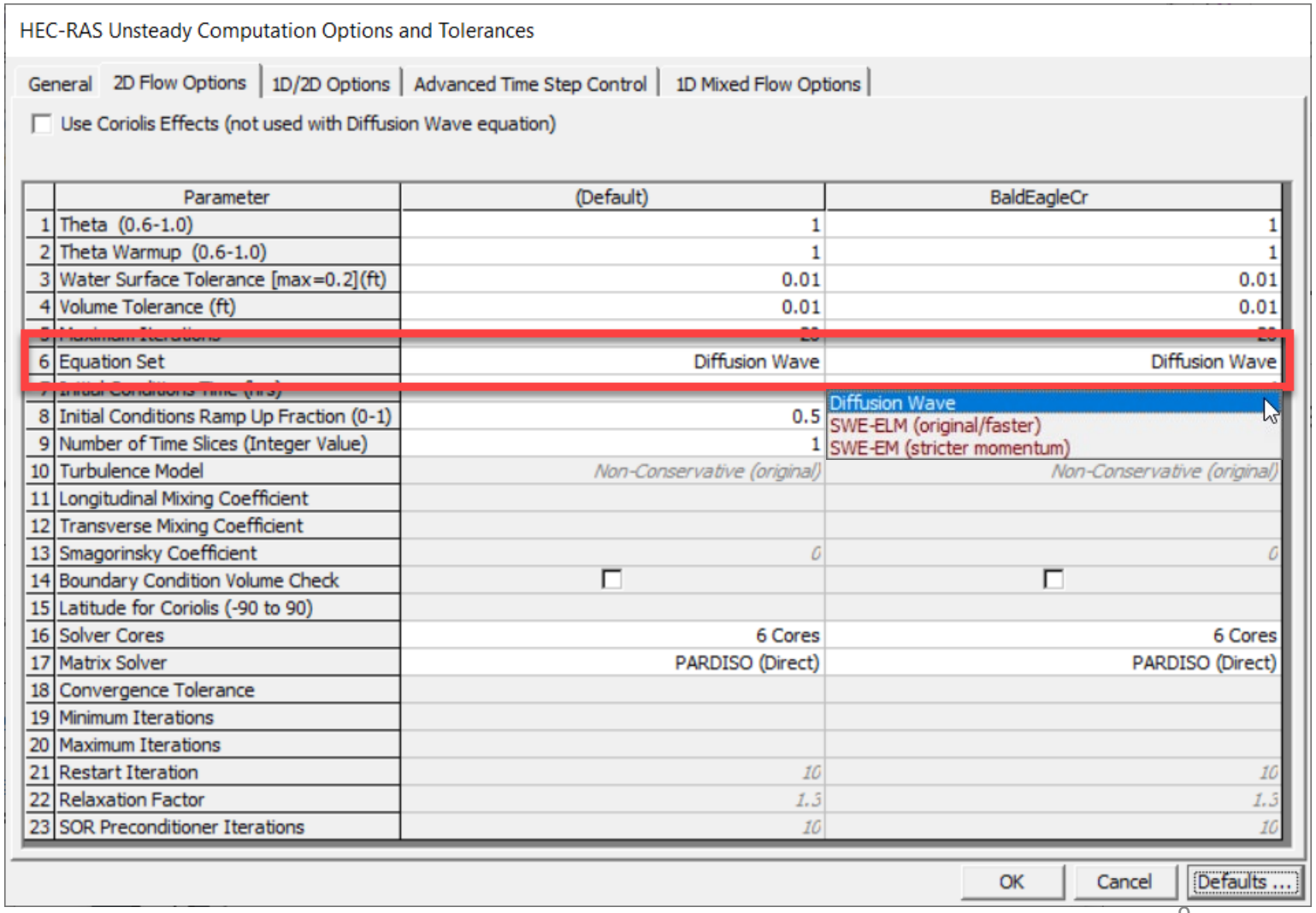
18	Convergence Tolerance		
19	Minimum Iterations		
20	Maximum Iterations		
21	Restart Iteration	*10*	*10*
22	Relaxation Factor	*1.3*	*1.3*
23	SOR Preconditioner Iterations	*10*	*10*

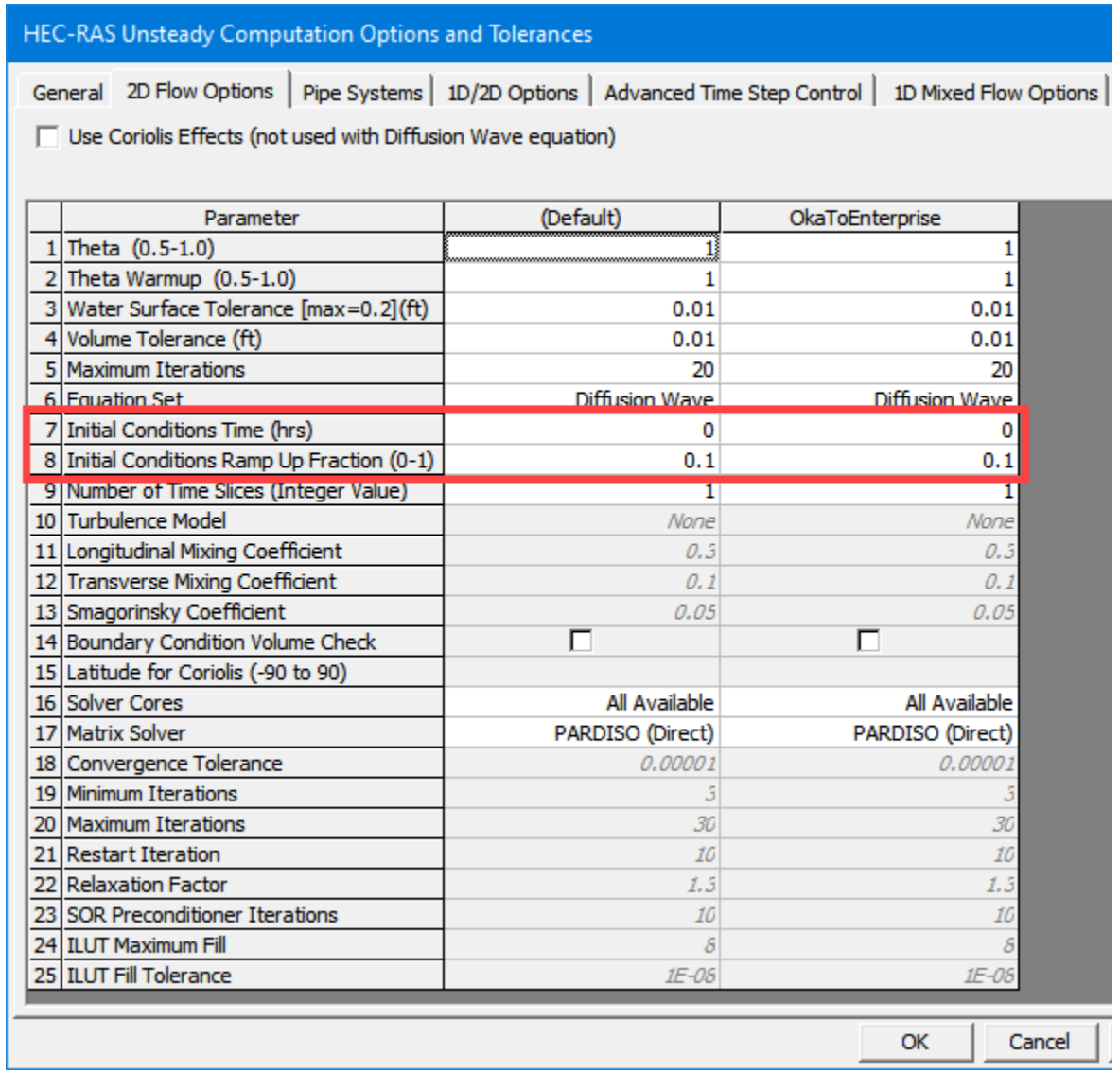
2D Equation Set

- Diffusion Wave
- Shallow Water Eqn (faster)
- Shallow Water Eqn (conservative)
- Local Inertial Approx (LIA)



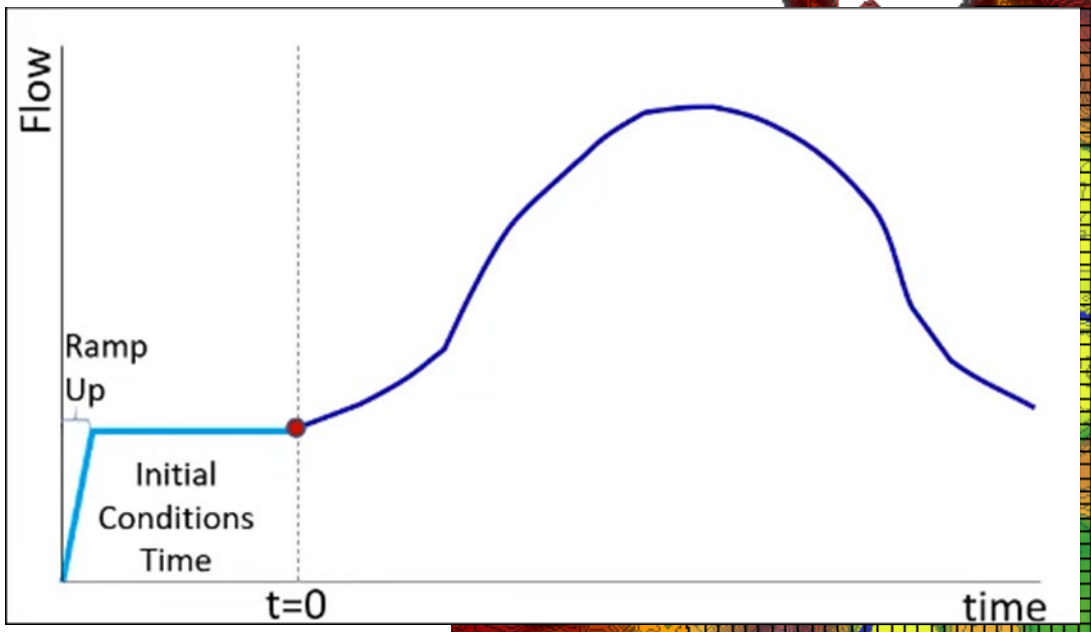
2D Initial Conditions

- Time allowed for each 2D area to compute an initial water surface
- Initial flows and stages can be ramped up during initial conditions



	Parameter	(Default)	OkaToEnterprise
1	Theta (0.5-1.0)	1	1
2	Theta Warmup (0.5-1.0)	1	1
3	Water Surface Tolerance [max=0.2](ft)	0.01	0.01
4	Volume Tolerance (ft)	0.01	0.01
5	Maximum Iterations	20	20
6	Equation Set	Diffusion Wave	Diffusion Wave
7	Initial Conditions Time (hrs)	0	0
8	Initial Conditions Ramp Up Fraction (0-1)	0.1	0.1
9	Number of Time Slices (Integer Value)	1	1
10	Turbulence Model	None	None
11	Longitudinal Mixing Coefficient	0.3	0.3
12	Transverse Mixing Coefficient	0.1	0.1
13	Smagorinsky Coefficient	0.05	0.05
14	Boundary Condition Volume Check	☐	☐
15	Latitude for Coriolis (-90 to 90)		
16	Solver Cores	All Available	All Available
17	Matrix Solver	PARDISO (Direct)	PARDISO (Direct)
18	Convergence Tolerance	0.00001	0.00001
19	Minimum Iterations	3	3
20	Maximum Iterations	30	30
21	Restart Iteration	10	10
22	Relaxation Factor	1.3	1.3
23	SOR Preconditioner Iterations	10	10
24	ILUT Maximum Fill	6	6
25	ILUT Fill Tolerance	1E-06	1E-06

2D Initial Conditions Warm Up in Progress



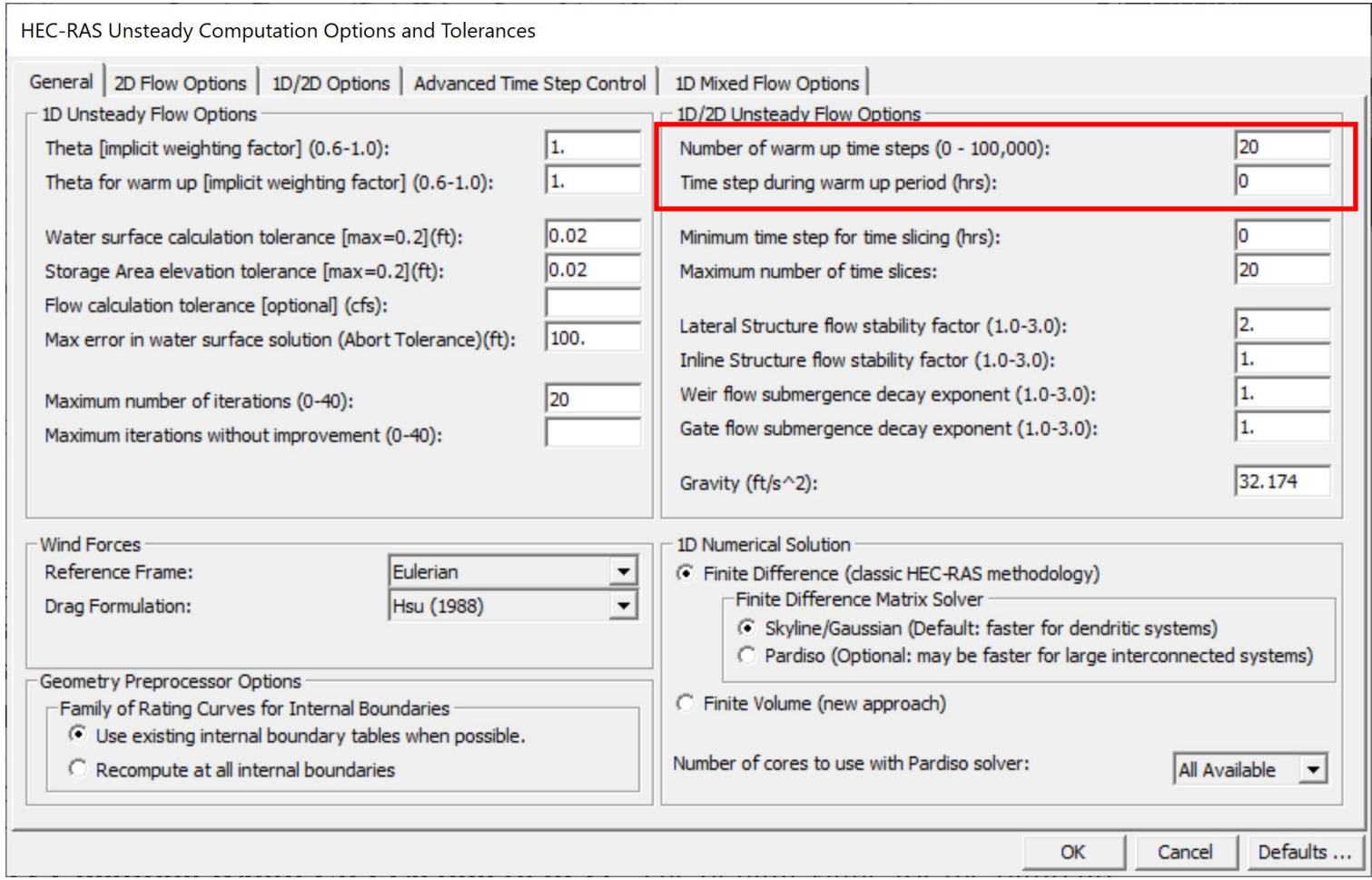
Stage Boundary Condition

	Date	Simulation Time (hours)	
1	01Jan1999 1200	00:00	110.
2	01Jan1999 1300	01:00	110.53
3	01Jan1999 1400	02:00	111.35
4	01Jan1999 1500	03:00	111.68
5	01Jan1999 1600	04:00	112.42
6	01Jan1999 1700	05:00	113.05

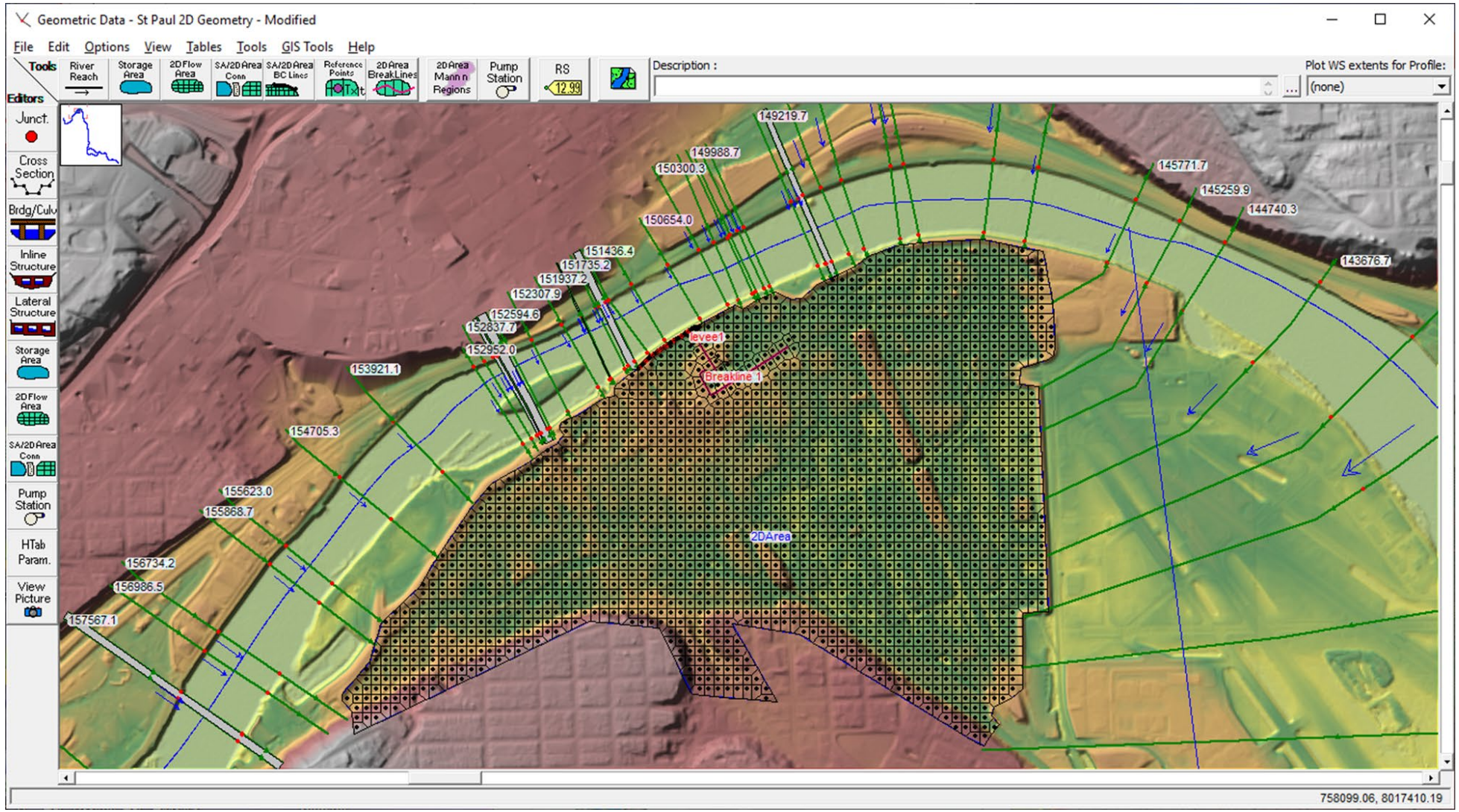
Use Initial Stage (recommended) | t Data | OK

1D/2D Warm Up Period

- Hold all the BC's constant, allow the model to stabilize
- Runs after 2D Initial Conditions Period
- Duration specified as number of time steps
- Time step is optional

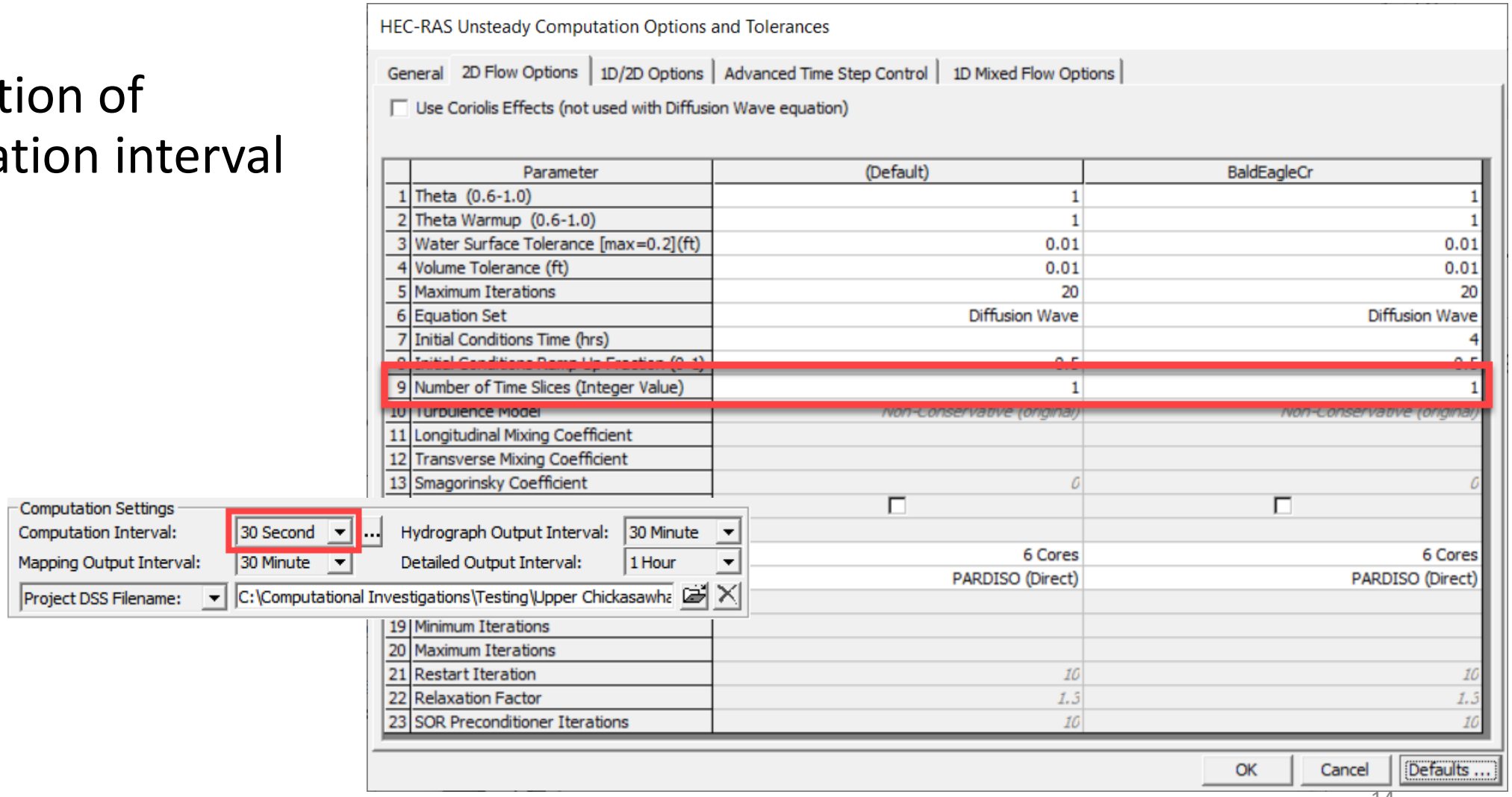


1D/2D Modeling Computational Time Step



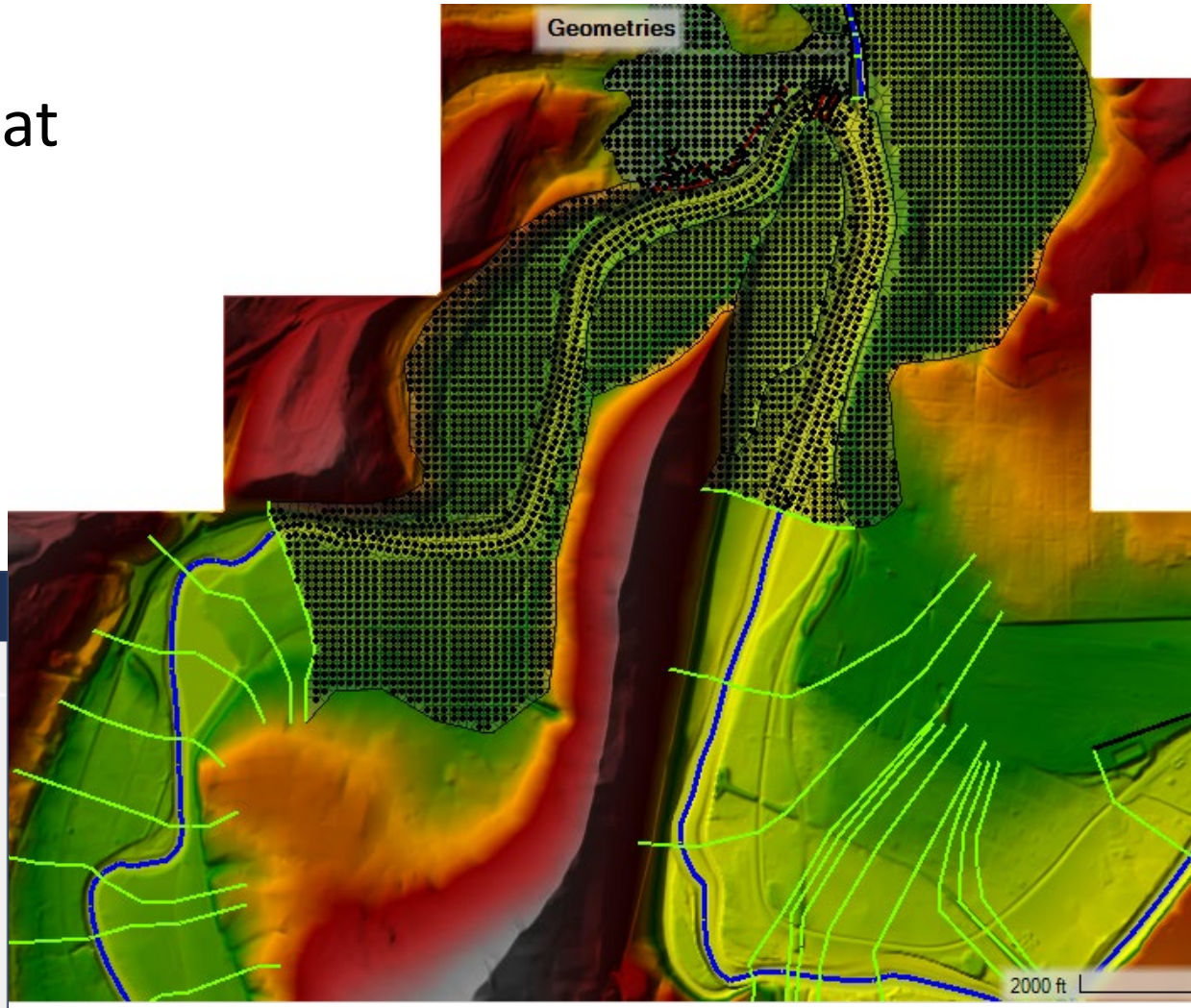
2D Time Slicing

- Use fraction of computation interval



1D/2D Iterations Option

- Monitors WSEL and Flow Tolerance at boundaries
- Iterates the 1D and 2D domain until tolerances are met
- Off by default (0 iterations)



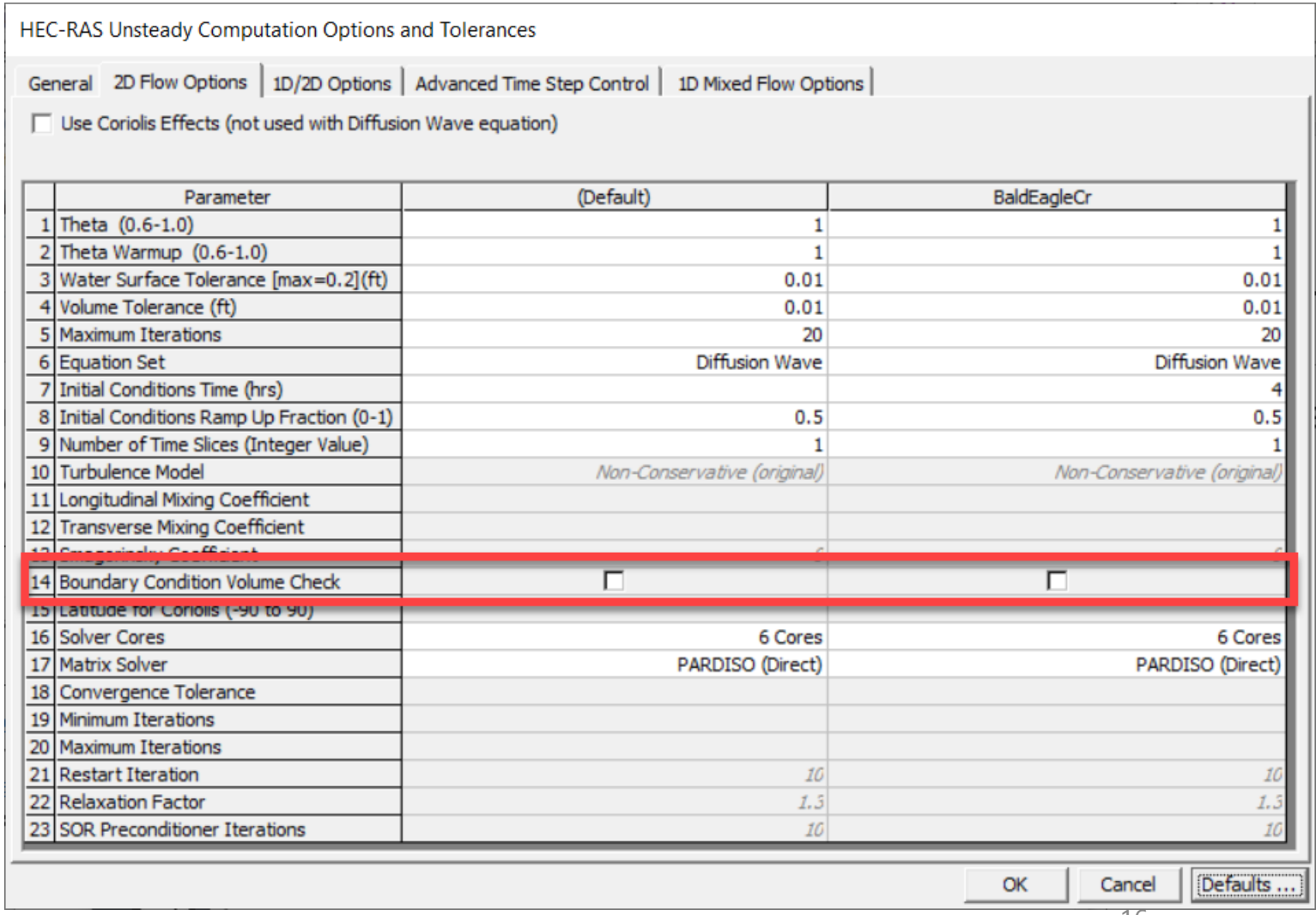
HEC-RAS Unsteady Computation Options and Tolerances

General | 2D Flow Options | 1D/2D Options | Advanced Time Step Control | 1D Mixed Flow Options

Maximum iterations between 1D and 2D (0=off, 1 to 20):	0
Water surface tolerance (ft):	0.01
Flow Tolerance (%)	0.1
Minimum flow tolerance (cfs):	1.

2D Boundary Condition Volume Check

- Boundary Condition Volume Check
- Checks if enough volume is available to satisfy flow rate leaving



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5	Maximum Iterations	20	20
6	Equation Set	Diffusion Wave	Diffusion Wave
7	Initial Conditions Time (hrs)		4
8	Initial Conditions Ramp Up Fraction (0-1)	0.5	0.5
9	Number of Time Slices (Integer Value)	1	1
10	Turbulence Model	*Non-Conservative (original)*	*Non-Conservative (original)*
11	Longitudinal Mixing Coefficient		
12	Transverse Mixing Coefficient		
13	Stagger Coefficient	6	6
14	Boundary Condition Volume Check	☐	☐
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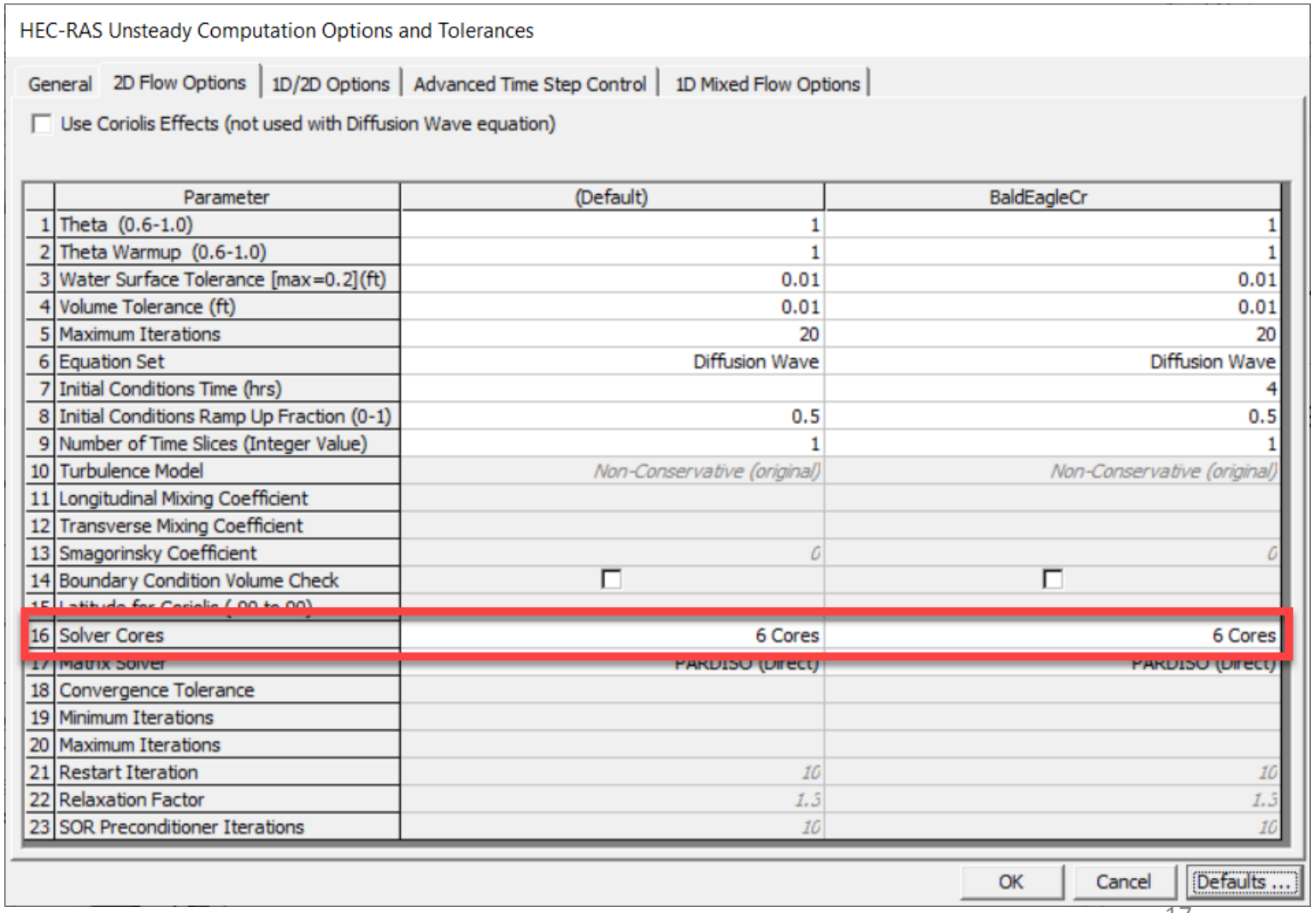
2D Solver Cores

- Number of Cores



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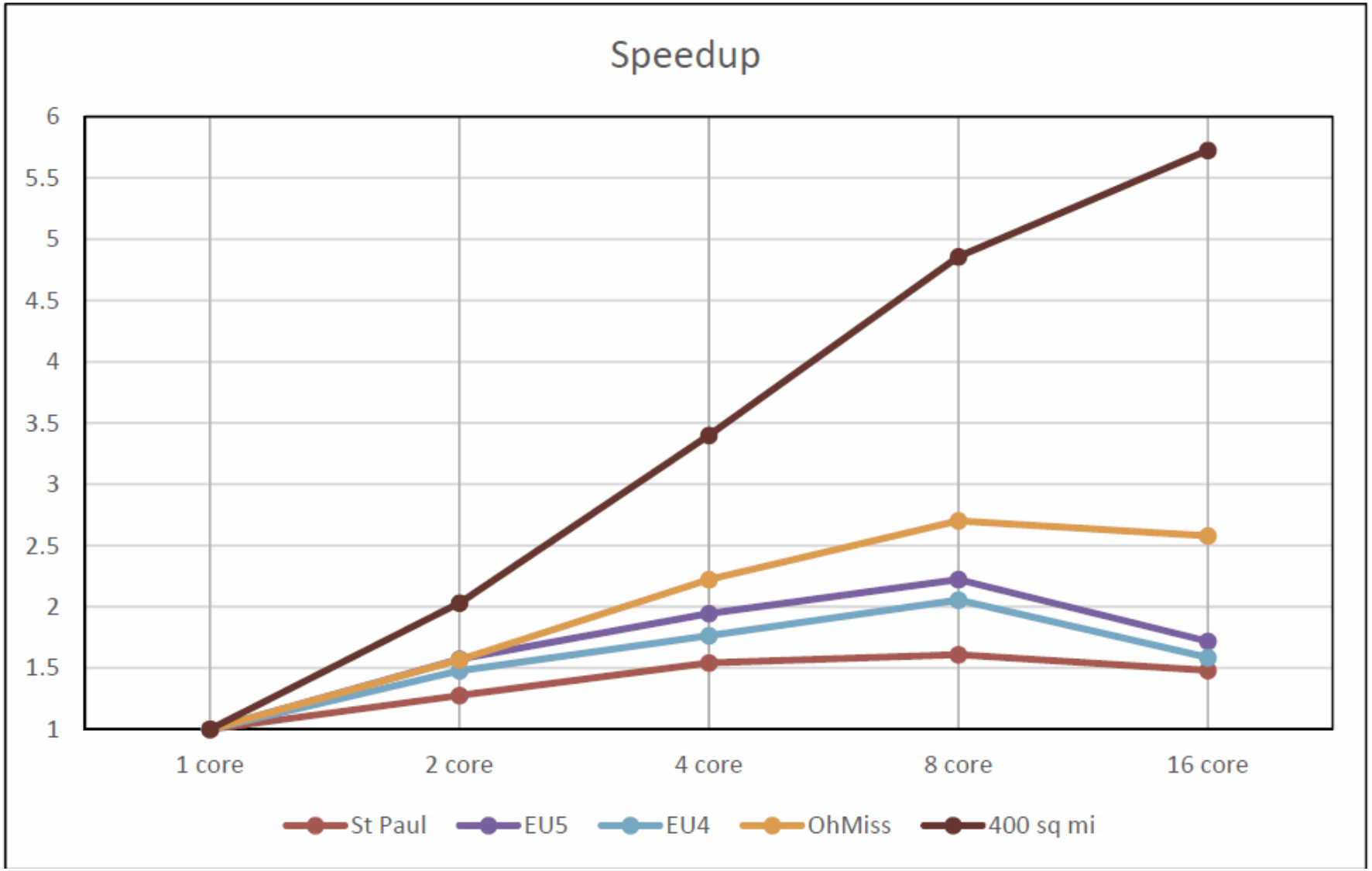
Processing Time vs Number of Cores



Mesh Cell Size

- Mesh Cell size determination is based on
  - Land surface features of the Terrain
    - Faces control water movement
  - Water Surface Slope
    - Capturing localized effects in model requires smaller cell sizes (analogous to cross section spacing for rapidly varied flow).
  - Velocity
- Start with a “large” cell size and refine the model through iteration
- Always test different cell sizes to see what affect they have on water surfaces and velocities

Time Step Selection

- Time Step selection will be based on the size of the grid cells and velocity of water in the cells.
- Dependent on Equation Set selected
  - Diffusion Wave approximation
  - Full Shallow Water Equations

$$\underbrace{\frac{\partial \boldsymbol{V}}{\partial t}}_{\text{Temporal}} + \underbrace{(\boldsymbol{V}\cdot\nabla)\boldsymbol{V}}_{\text{Advection}} + \underbrace{f_c \boldsymbol{k}\times\boldsymbol{V}}_{\text{Coriolis}} = \underbrace{-g\nabla z_s}_{\text{Pressure gradient}} + \underbrace{\frac{1}{h}\nabla\cdot\left(\nu_t h\nabla\boldsymbol{V}\right)}_{\text{Diffusion}} - \underbrace{\frac{\boldsymbol{\tau}_b}{\rho R}}_{\text{Bottom Friction}} + \underbrace{\frac{\boldsymbol{\tau}_s}{\rho h}}_{\text{Wind Stress}}$$

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Courant Number and Timestep

- Full Shallow Water Equations
  - Experience shows, max C = 3.0

$$C = \frac{V * \Delta T}{\Delta X} \leq 1.0$$

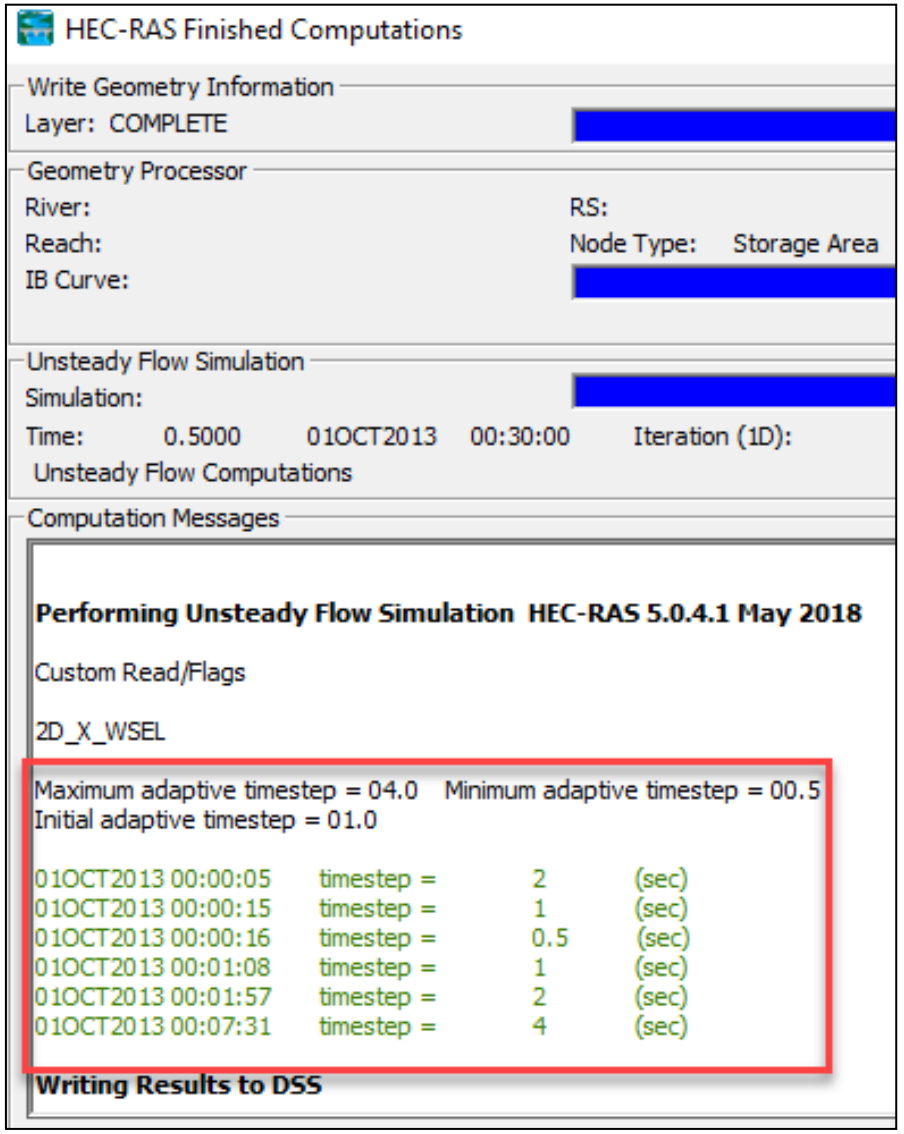
- Diffusion Wave Approximation
  - Experience shows, max C = 5.0

$$C = \frac{V * \Delta T}{\Delta X} \leq 2.0$$

C	=	Courant Number
V	=	Velocity of the Flood Wave (ft/s)
ΔT	=	Computational Time Step (seconds)
ΔX	=	The average Cell size (ft)

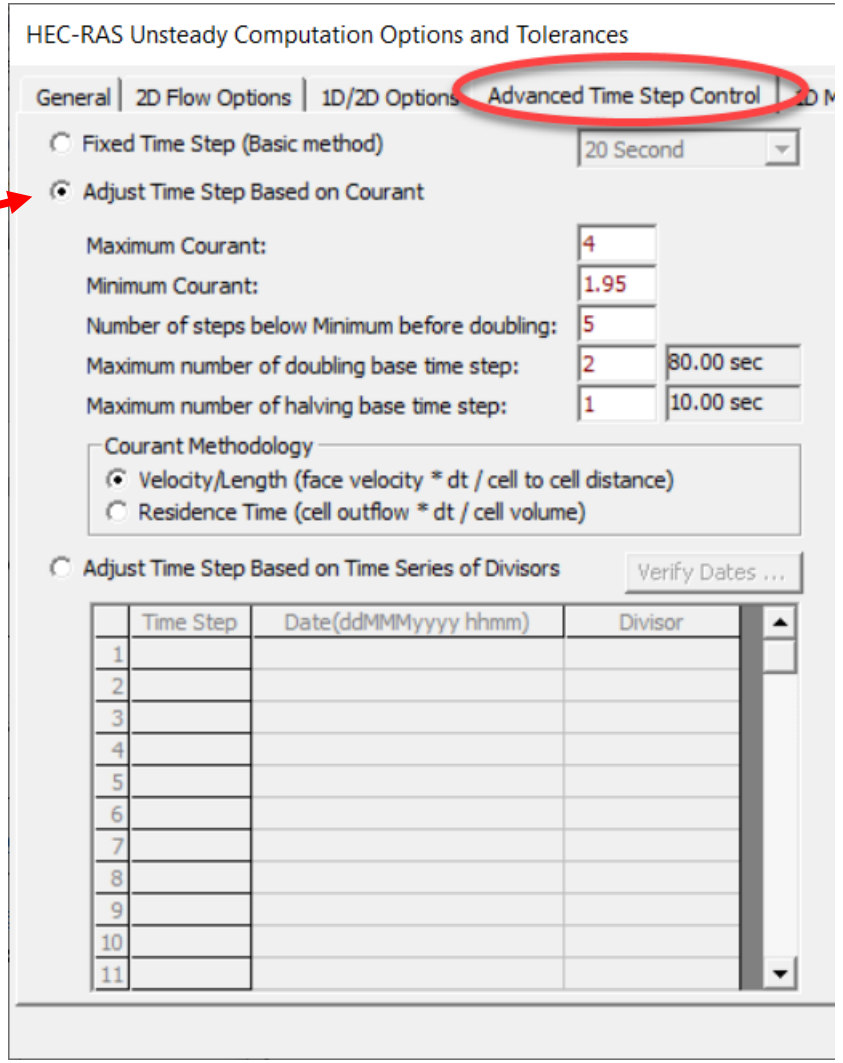
Variable Time Step

- Reduce time step to improve accuracy
- Increase time step to reduce computation times



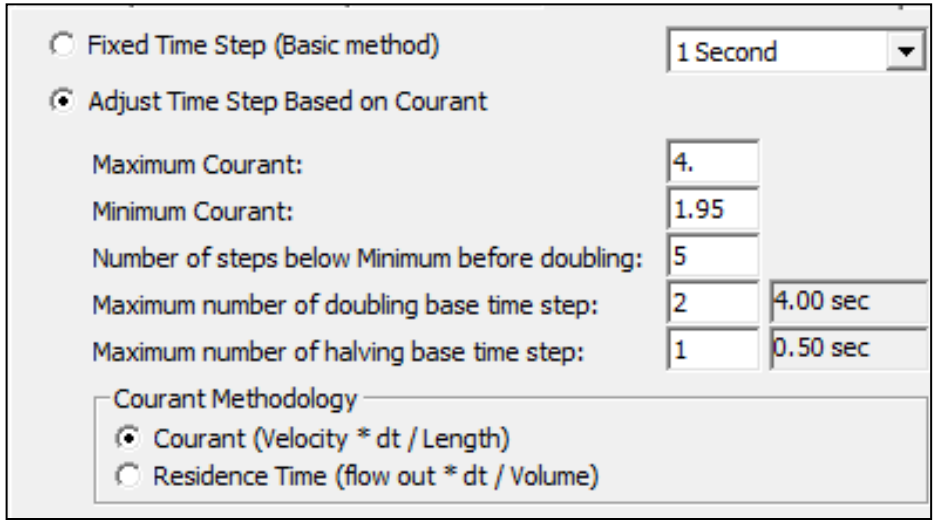
Variable Time Step Options

- Fixed Time Step (default)
- Adjust Time Step Based on
  - Courant Number (adaptive)
  - Date/Time and a Time step divisor



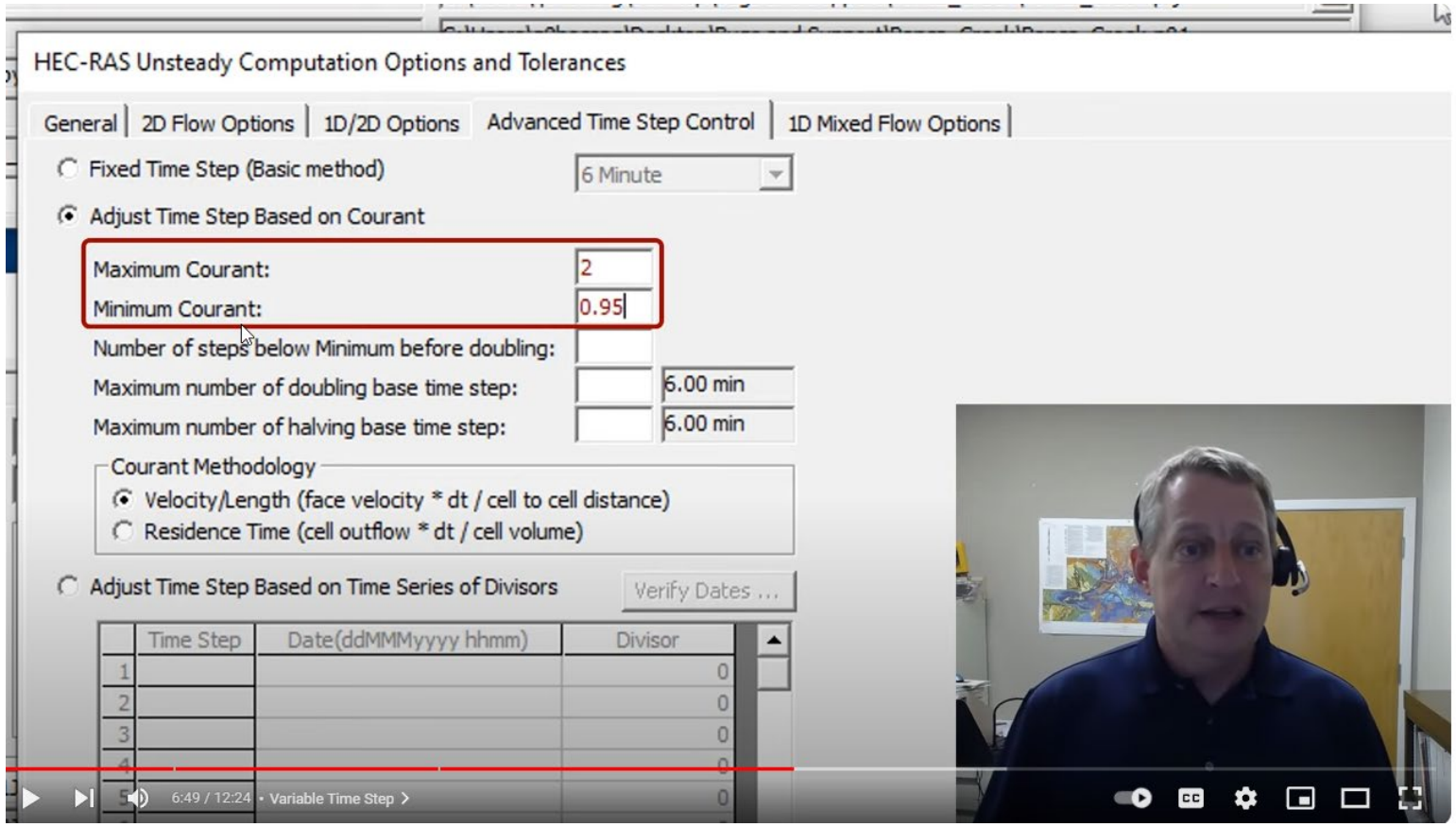
Adaptive Time Step

- Maximum Courant before halving time step
- Minimum Courant before doubling time step
  - **Min < ½ Max !**
- Number of steps before doubling
- Maximum number of doubling
- Maximum number of halving
- Courant (default) or Residence Time



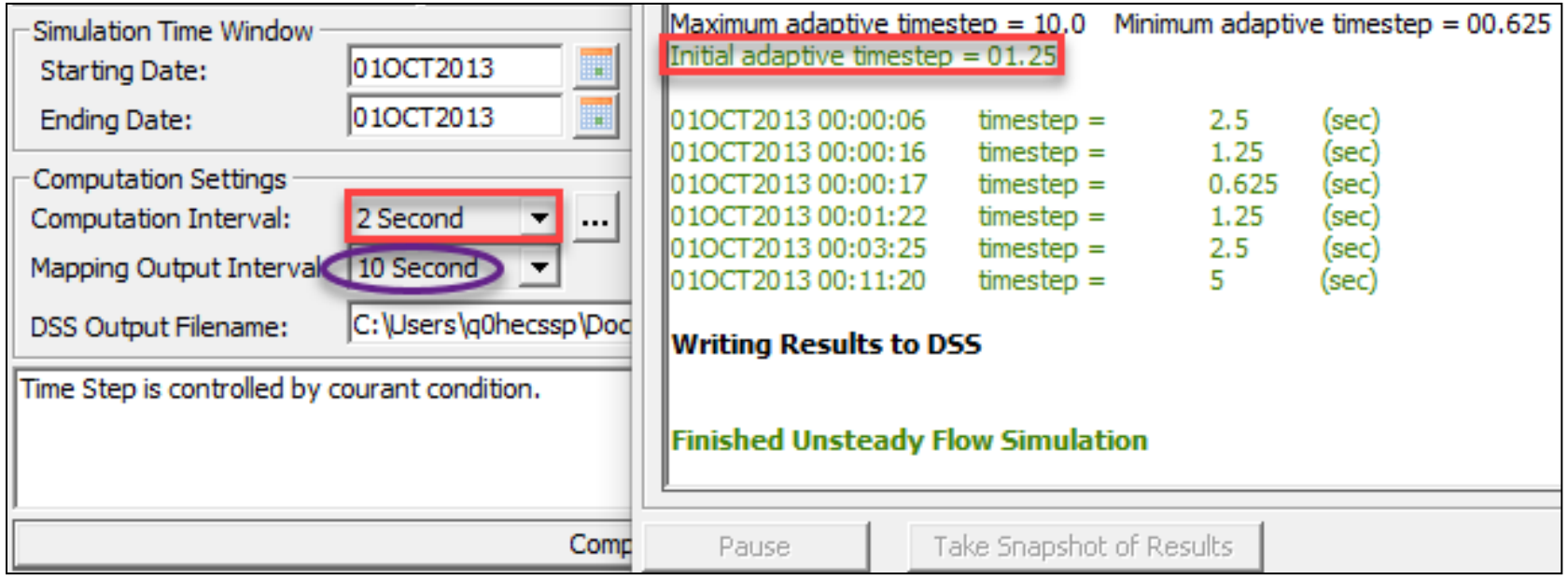
More Resources

- **https://www.youtube.com/watch?v=kcBrOML3iS0**



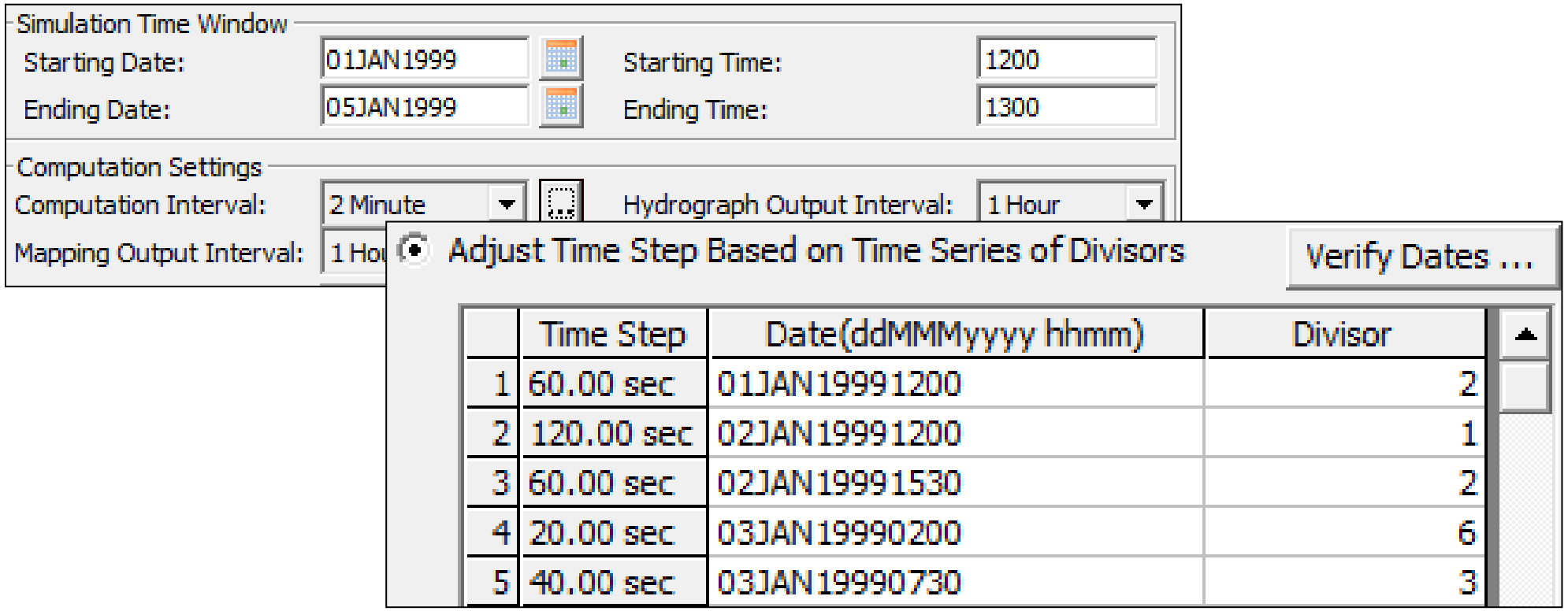
Mapping Output Interval

- Adaptive time step is always integer interval of Mapping Output Interval, so Unsteady may need to adjust base Computation Interval



Time Series of Divisors

- Control time step length by date
- Enter integer halving divisor to reduce time step



Questions?

US Army Corps of Engineers