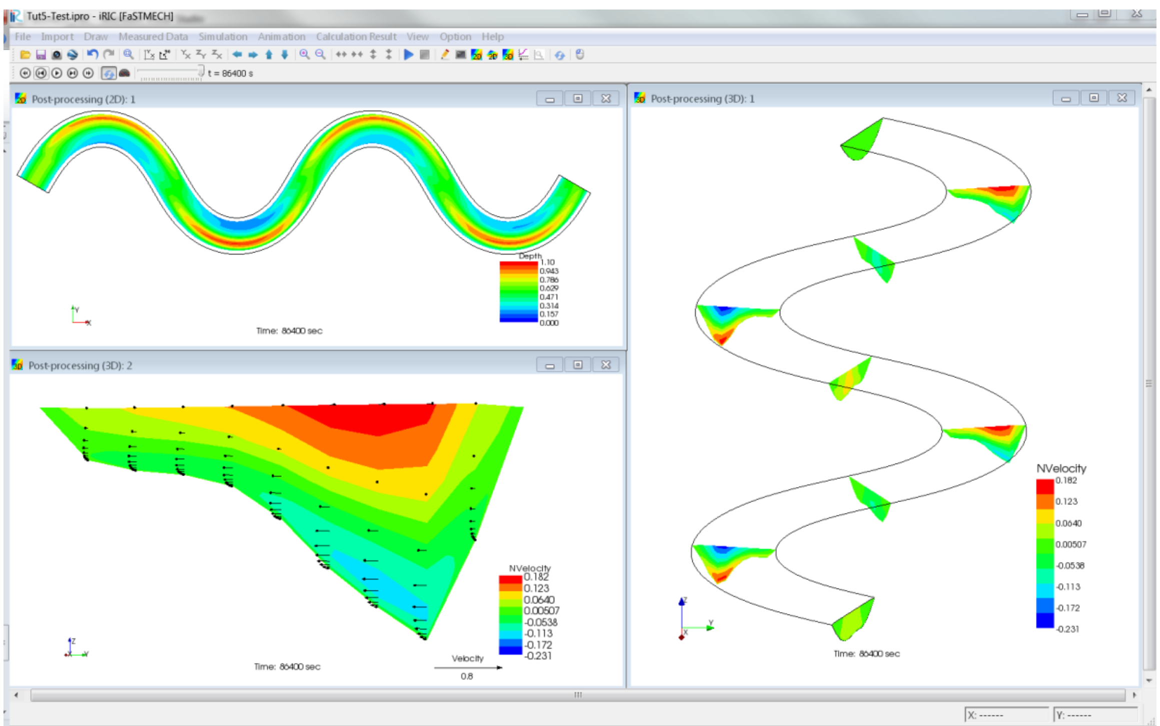
iRIC Software

Changing River Science

FaSTMECH Tutorial 5



Contents

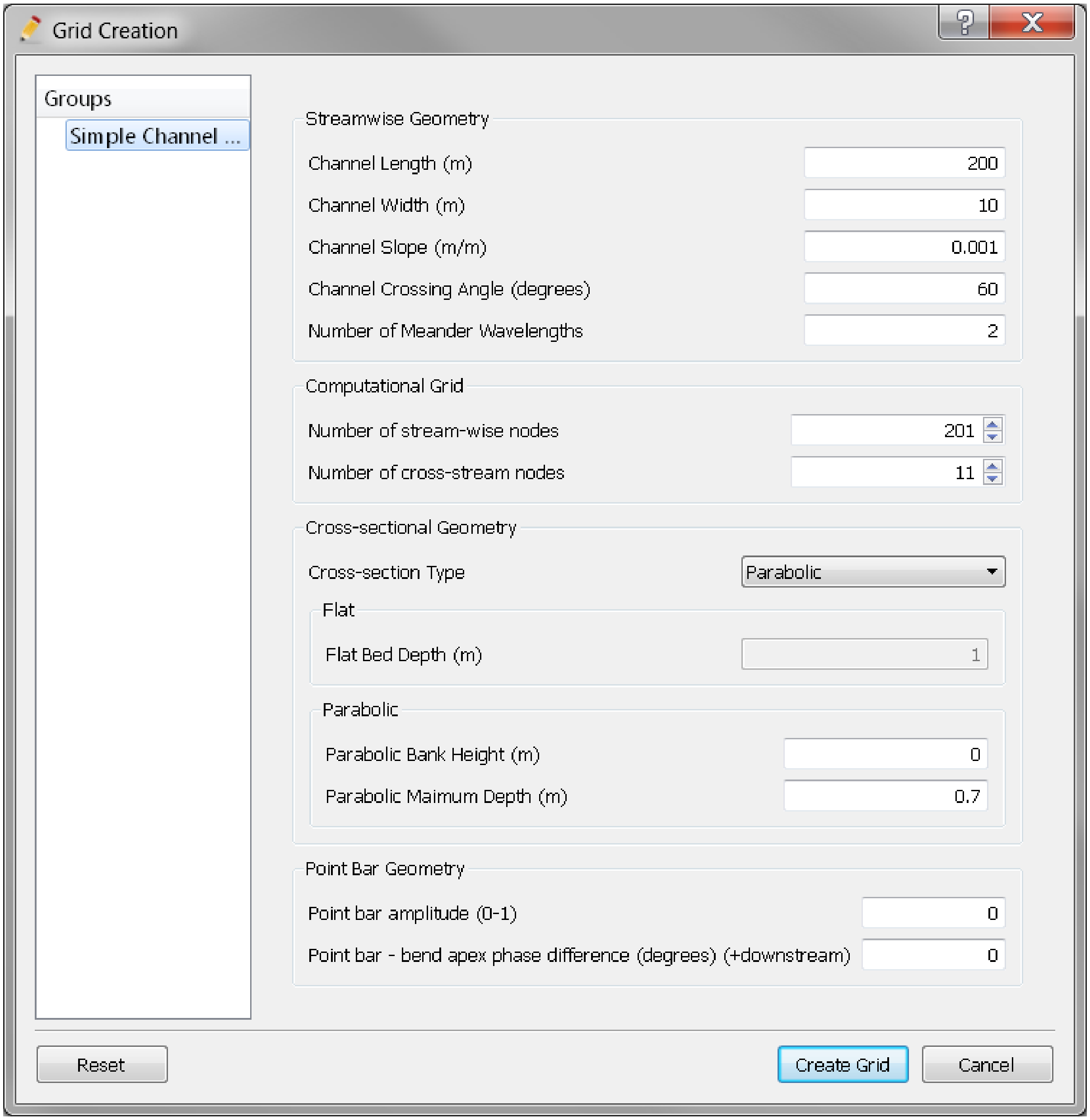
This tutorial introduces simple time-dependent model runs using a constant discharge and the sediment-transport model extension. As in Tutorial 3 you will use the Simple Channel Builder to create a meandering channel with a uniform parabolic cross-section. The simulation will be run for a short period of time and the evolution of point bars in the channel will be observed. In this tutorial you will perform the following steps:

Tutorial 5 Steps:

1. Using the Simple Channel Builder, create a meandering channel with uniform cross-section
2. Create a time-dependent solution using a constant discharge and the sediment-transport model.
3. Observe the simulated channel evolution and development of point bars.
4. Repeat for different crossing angles or width-to-depth ratios

Create meandering channel

As in the other FaSTMECH tutorials, launch the iRIC application and in the iRIC Start Page, choose the FaSTMECH solver. In Tutorial 3 you accessed the Simple Grid Generator from the Object browser. In this tutorial you will access it from the menu by selecting **Grid->Select Algorithm to Create Grid….**In the Select Grid Creating Algorithm dialog select the ***Simple Grid Generator*** and create a meandering channel with parameters as shown in Figure 1.

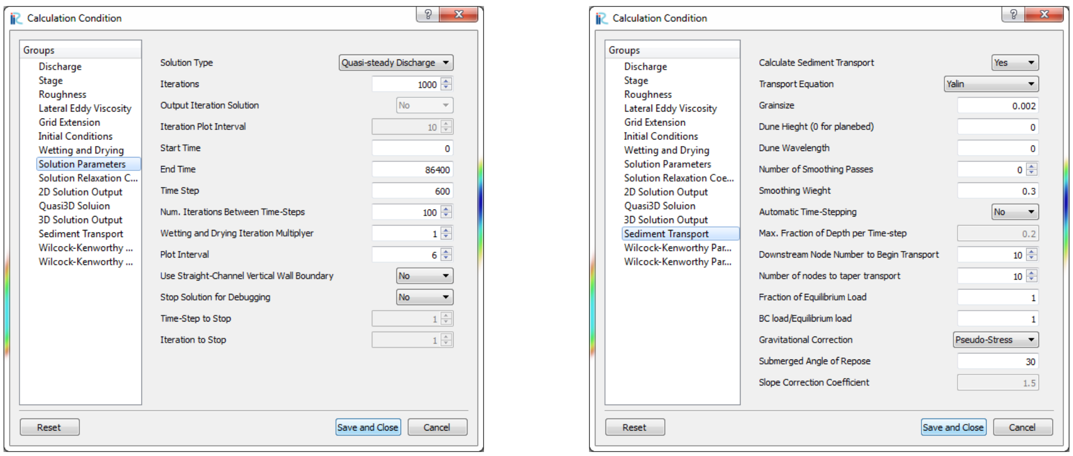


Create time-dependent solution

Time-dependent solutions are developed by first running the model for the initial time-step with the Number of Iterations set to obtain a well converged solution. At each subsequent time-step the previous solution is used as the initial condition and therefore the number of iterations required is usually much less than the initial number, especially if the time step is chosen so that the change in the channel geometry is small. From the menu select **Calculation Condition->Setting** and enter the following parameters in the dialog, and those in Figure 2, then Save and Close. Run the simulation.

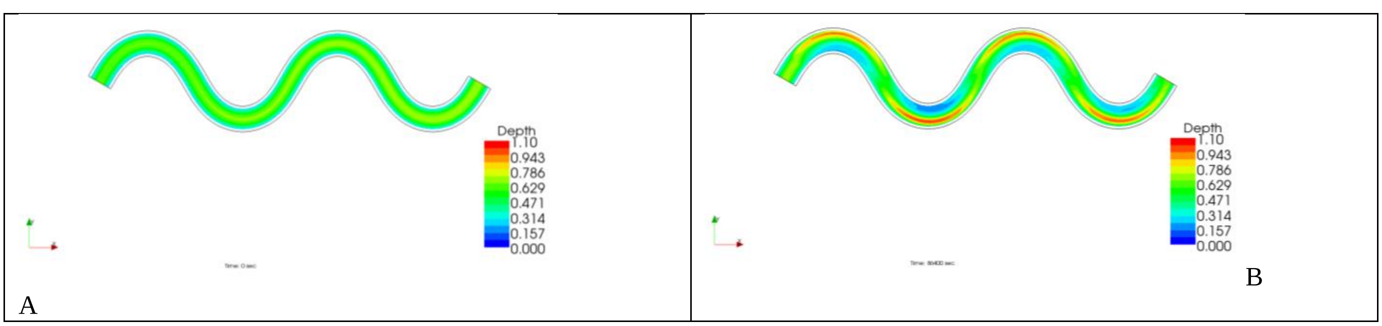
- A constant discharge of 2.5 cms
- Downstream stage of 10 meters
- Constant drag coefficient of 0.007
- Lateral Eddy Viscosity of 0.05 m^2/second
- 10 grid extensions with a slope of 0.001
- An initial water-surface elevation using the 1d-model. Enter the appropriate parameters.

- Enter the solution properties as in Figure 2.
- Set the relaxation parameters to 0.3, 0.6, 0.6.
- Be sure to select the Solution Output you would like to visualize.
- The Quasi-3D solution extension on with 11 vertical nodes.
- Turn on Both the 3D Solution Output options.
- Enter the Sediment Transport parameters as in Figure 2.
    - We assume no bedforms in this solution so there is no bedform correction.
    - Use the Yalin bedload equation.
    - Set the grain-size equal to 0.002 meters.
    - Calculate a gravitational correction using the gravitational pseudo stress technique



A B

Figure 1. (A) Solution properties for time-dependent constant discharge simulation. Note that the parameter Iterations during a Quasi-steady simulation, is the number of iterations the initial solution will be run after which the final solution will be used as the initial condition for all other time steps. The number of iterations for subsequent time steps is set as the Num. Iterations Between Time-Steps. (B) Sediment transport properties.



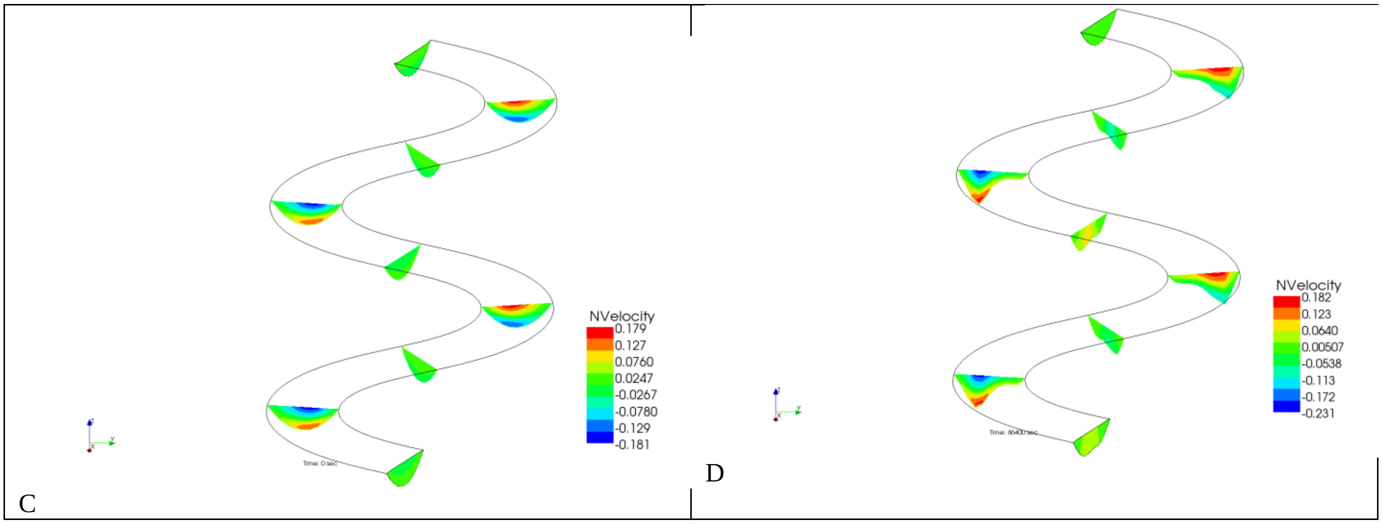


Figure 2. Solution for time-dependent simulation. The 2D simulation of Depth is shown in panels A and B at time-step 0 and 86400 seconds respectively. The 3D simulation of the velocity normal (NVelocity) to the streamwise grid direction at 8 vertical slices is shown in Panels C and D.

Observe point-bar evolution in time dependent solution

The solution can be animated using both the 2D and 3D post-processor views (Figure 3) as follows:

1. To animate or step through individual time steps of the 2D solution and create the images at time 0 and 86400 seconds in panels A and B of Figure 3 follow the steps below:
   - Create a 2D Post-processing window from the **Calculation Result** menu item or from the 2D toolbar button.
   - Select the scalar solution for Depth in the Object Browser. Right-click ***iRICZone | Scalar*** branch in the Object Browser and select the Properties pop-up menu to activate the Scalar Setting dialog. Unselect the Automatic Value range and set the Max: value to 1.1 and the Min: value to 0. This will create a constant color map for every time step. Set the Display Setting to Contour Figure and unselect the Transparent Property.
   - Use the Animation toolbar 

to watch an animation of the Depth solution or to step though individual time steps by moving the sliding toggle or using the and buttons to incrementally step through the solution. These same actions can be accessed through the **Animation** menu.
   - You can save an individual frame of the solution or save a movie of the complete simulation by using the and buttons respectively.
2. To animate or step through individual time steps of the 3D solution and create the images at time 0 and 86400 seconds in panels B and C of Figure 3 follow the steps below:
   - Create a 3D Post-processing window from the **Calculation Result** menu item or from the 3D toolbar button.
   - Right-click the ***iRICZone | Contour*** branch of the Object Browser, select the Property pop-up menu and in the Contour Setting dialog create 8 faces oriented in the I Direction. Each I face is set at multiples of 25 (1,25,50,100…) as shown in Figure 4 below.
   - Exaggerate the vertical scale by selecting View->Z-Direction scale from the menu and setting the vertical scale to 5.

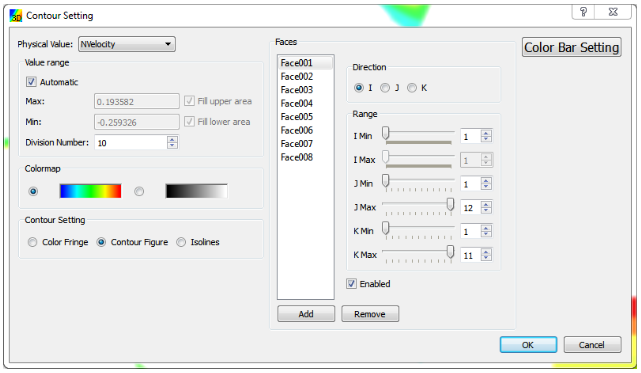


Figure 3. Contour Setting dialog

3. More elaborate time-dependent post-processing displays can be made by selecting multiple post-processing windows of different times and tiling them as shown in Figure 7. A few brief guidelines on how to setup these tiled images follow moving from panel 1 – 5 in a clockwise direction starting a the upper left. Note that in each panel the Object Browser has been turned off by selecting the X in the upper right corner so that more room is available to view the solution. For any panel, the Object Browser can be turned back on by first selecting the panel and then from the menu selecting **View->Object Browser**.
   - Panel 1: A 2D Post-processing window you built in step-1 above.
   - Panel 2: A 3D Post-processing window you built in step-2 above.
   - Panel 3: A 3D Post-processing window is shown with 1 cross-section of NVelocity and Vectors. Following the process in step-2 above for adding cross-sections to the 3D view we'll build a single cross-section as shown in Figure 4. Next add vectors to the cross-section as shown in Figure 5. See if you can arrange the cross-section so that you are viewing head-on from downstream (See Figure 6).

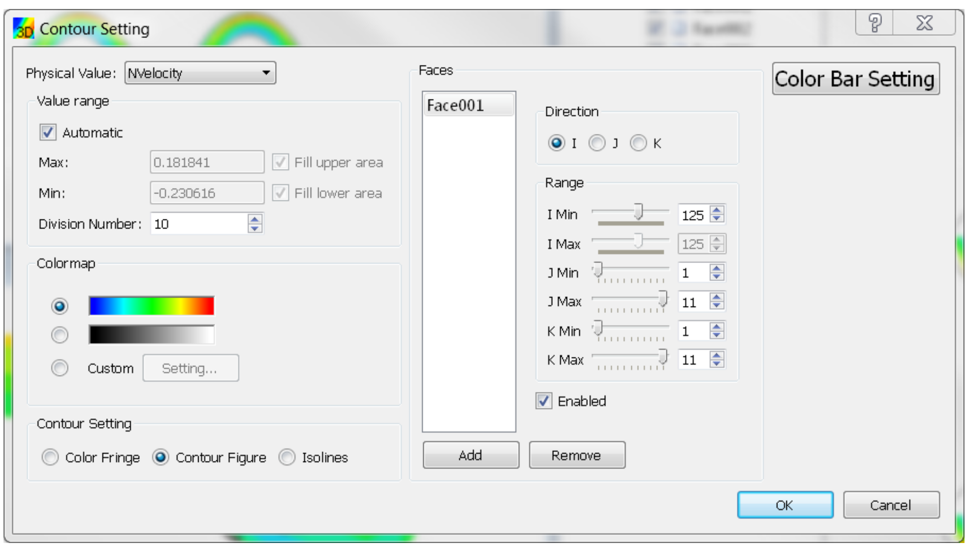


Figure 4. Contour settings for Panel 3.

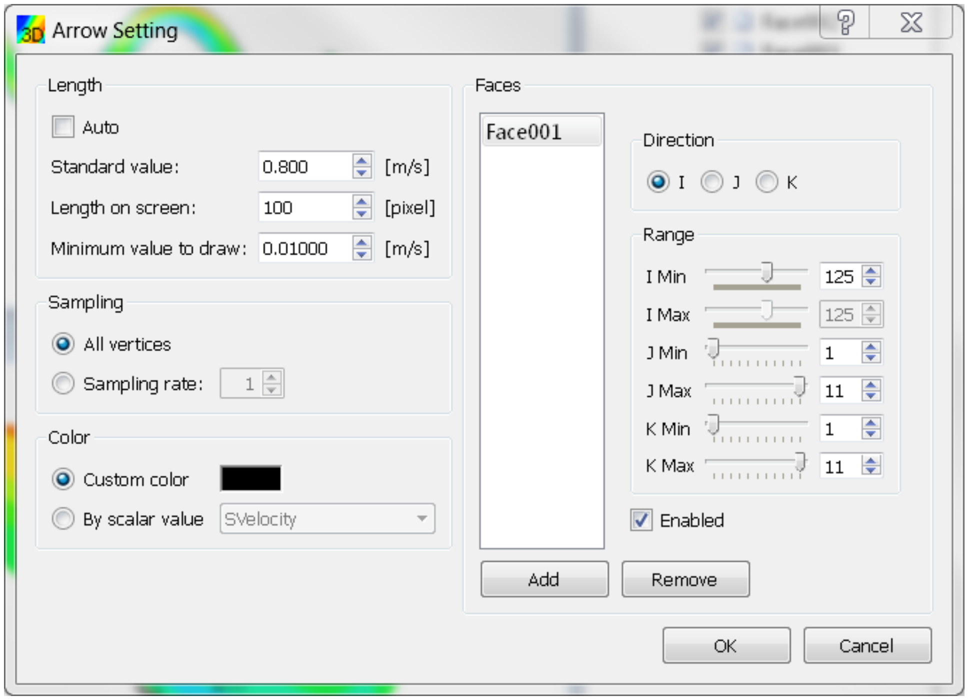
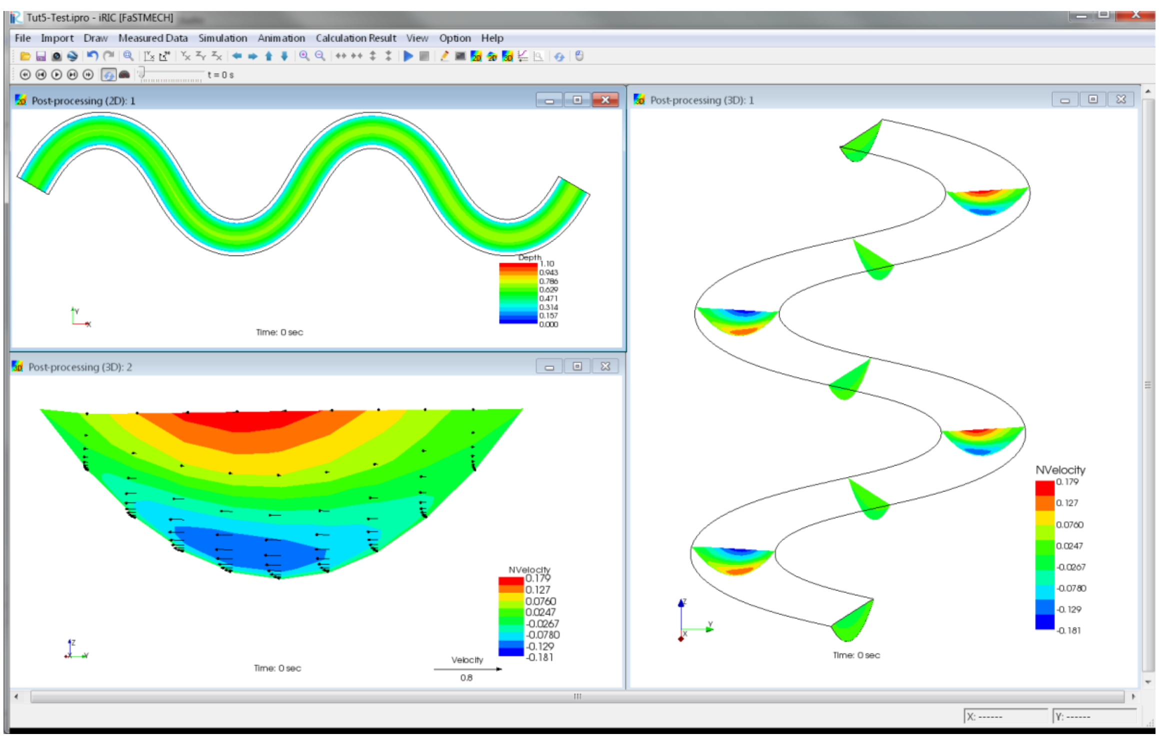
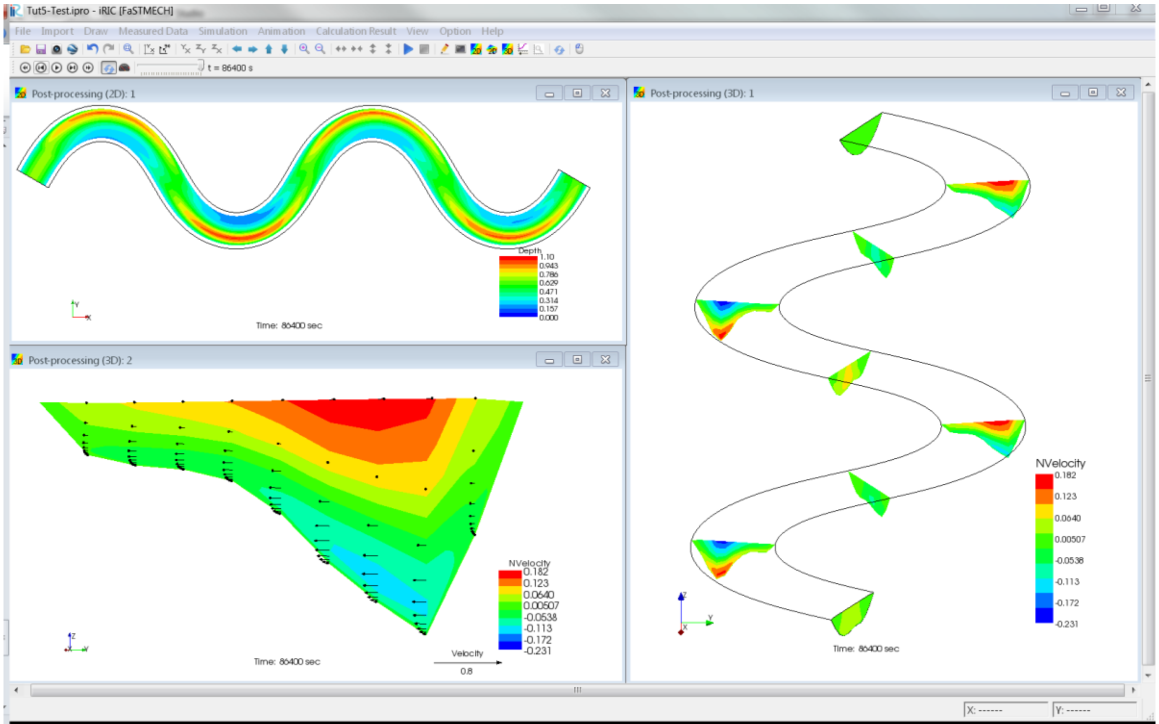


Figure 5. The Data Source Setting and Display Setting dialogs for Panel 3



A



B

Figure 6. The 5 panel post-processing setup at (A) time = 0 seconds and (B) time = 86400 seconds.

Repeat for different crossing angles or width-to-depth ratios

Try to set up and run some other evolution cases with different crossing angles or other parameters. Pay attention to the roughness and how the water surface elevation changes as the bars form. Learning to model channel evolution requires careful attention to the flow solution and how bar drag changes the solution as the bed evolves. This is only more critical as one moves on to predicting evolution of bed morphology in real channels.