

EEMS Demonstration Model Description

DM_Flow_Past_Rectangular_Obstacle

1 Objective

This demonstration model uses EFDC+ Explorer (EE) and EFDC+ to simulate depth-averaged hydrodynamic flow past a solid rectangular obstruction (block) embedded within a uniform channel. The primary purpose is to demonstrate and investigate how horizontal turbulence and diffusion affect transport patterns in EFDC+, using a dye tracer to visualize the wake structure downstream of the block.

This configuration isolates the effect of background horizontal diffusivity alone on wake development since the horizontal momentum diffusion (HMD) is **disabled**, making it a useful baseline for comparing turbulence parameterization options in EFDC+.

2 Model Description

The model configuration is summarized in Table 1 and the model domain is shown in Figure 1. The domain is a rectangular channel approximately 450 m long and 15 m wide, with a uniform bottom elevation of -5.0 m throughout. A rectangular block with no active cells is positioned the left of center within the channel, representing the bluff body around which flow must divert.

Table 1 Model configuration summary

Run Period (Julian Days)	Horizontal Cells	Vertical Layers	Activated Modules
10–13	5,904 cells	1 layer	- Hydrodynamics - Dye

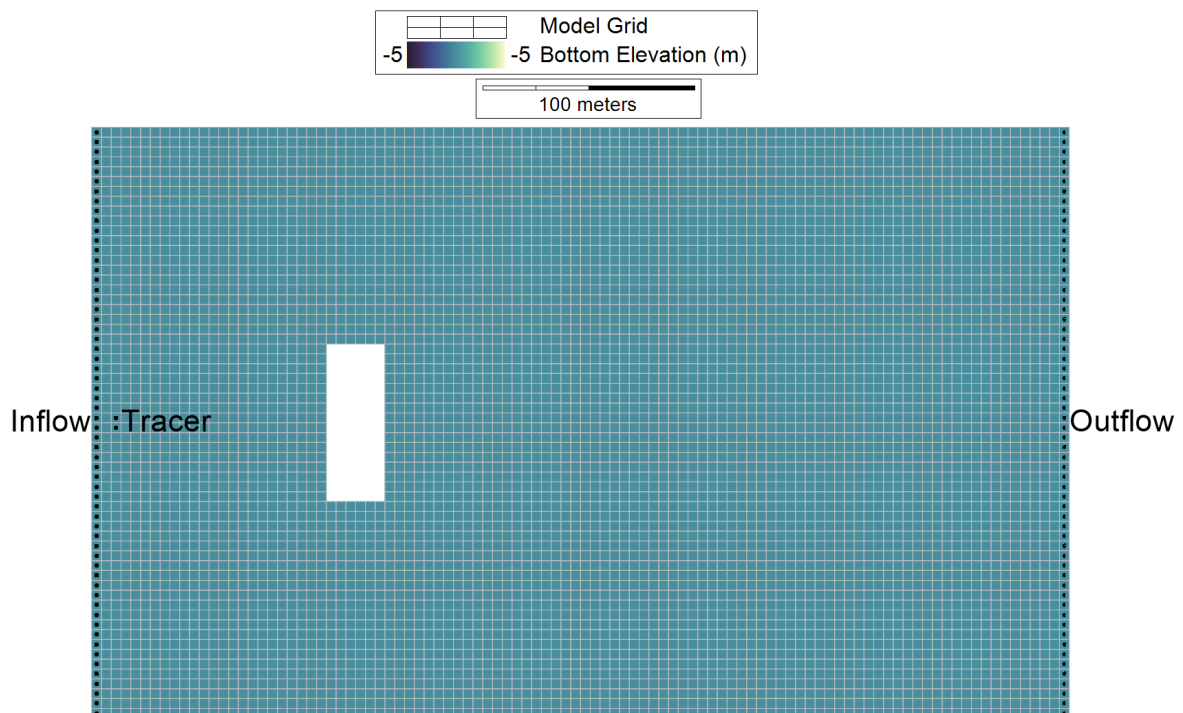


Figure 1 Model domain

2.1 Hydrodynamic Configuration

Flow is driven by 62 constant-velocity inflow source cells at $I = 3$, spanning the full channel width ($J = 3$ to $J = 62$), referencing flow time series 1. The outflow is handled by 60 east open boundary cells at $I = 32$ ($J = 3$ – 62), which are set as free concentration boundaries to allow dye to leave the domain without reflection.

Turbulence is parameterized using a constant background horizontal viscosity of $AHO = 0.1 \text{ m}^2/\text{s}$ with no additional horizontal momentum diffusion ($ISHDMF = 0$). The vertical background kinematic viscosity is $AVO = 1 \times 10^{-6} \text{ m}^2/\text{s}$. The depth-averaged single-layer configuration means all turbulence effects are represented in the horizontal plane only.

2.2 Dye Configuration

One dye class is simulated ($NDYE = 1$) to visualize the wake structure downstream of the block. The dye source is a point-like injection at two adjacent cells ($I = 5$, $J = 32$ and $J = 33$), located immediately upstream of the block along the channel centerline. The two tracer cells each carry a flow split of 0.5 and are linked to dye concentration time series 1. The main inflow cells carry zero dye, so the tracer plume highlights only the streamline that passes directly through the block region and its wake, rather than the full channel flow.

3 Model Results

Figure 2 shows the 2DH plan view of depth-averaged dye concentration at the end of simulation. The dye plume originates from the centerline injection point upstream of the block, enters the high-velocity acceleration zones on either side of the obstruction, and divides into two symmetric arms that wrap around the block faces.

Immediately downstream of the block, the two arms converge into a trailing wake region. The peak upstream concentration is approximately 0.27 mg/L , rapidly diluting as the plume spreads laterally due to horizontal diffusion. The long, downstream plume shows the combined effect of advection by the mean flow and diffusive spreading controlled by the background $AHO = 0.1 \text{ m}^2/\text{s}$. Because HMD is disabled, no additional momentum-based diffusion acts on the wake, so the spreading pattern reflects purely the background diffusivity and the local velocity field around the block.

The near-zero dye concentrations in the far field confirm that the main channel inflow remains dye-free and that the tracer is a reliable indicator of fluid originating from the centerline upstream of the obstruction.

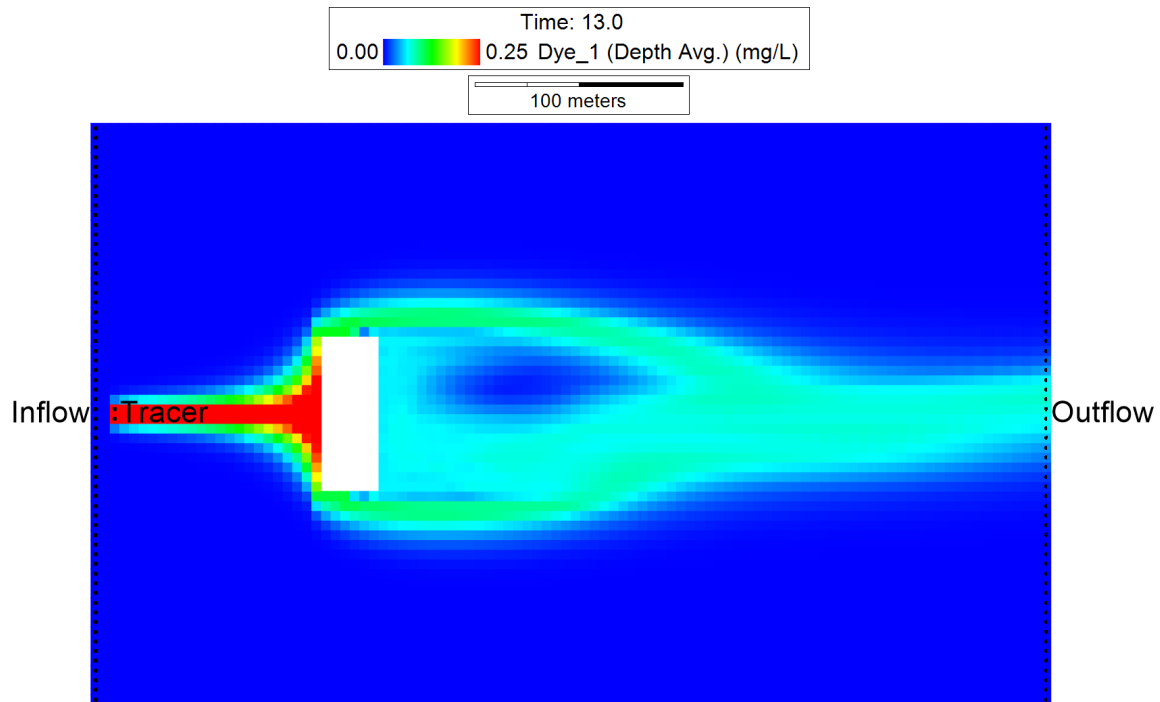


Figure 2 2DH plan view of depth-averaged dye concentration at the end of simulation

4 Notes

4.1 Disclaimer

This model is provided to demonstrate that EFDC+ Explorer and EFDC+ can be used to build and analyze this type of models. The simulation results are consistent with expected behavior; however, the model should not be considered a final or validated product. Users are encouraged to review, modify, and refine model parameters to obtain results appropriate for their specific application.

4.2 EEMS Demo Mode

In Demo mode, the model is validated against a set of predefined signatures, including grid size, domain area, center coordinates, transport count, and module configuration. While certain parameter values may be adjusted, the grid cannot be modified, transports cannot be added, and the prescribed module setup cannot be altered. Any deviation from these conditions results in the model no longer being considered a valid demo model.

4.3 Support

For technical support, additional documentation, or to obtain the latest version of EFDC+ Explorer, please visit: www.eemodelingsystem.com