

EEMS Demonstration Model Description

DM_Jet_plume_Discharge

1 Objective

This demonstration model uses EFDC+ Explorer (EE) and EFDC+ to simulate a submerged jet-plume discharge into a rectangular channel with ambient cross-flow. The model is designed to demonstrate how the EFDC+ near-field jet/plume sub-model is configured in EE and how the resulting three-dimensional plume structure can be visualized using the 2D vertical slice post-processing tool.

The jet/plume boundary in EFDC+ resolves the near-field momentum-dominated and buoyancy-affected zone of a submerged discharge (the region immediately surrounding the port where the discharge velocity, angle, and buoyancy flux govern plume behavior) before transitioning into the far-field Eulerian hydrodynamic model. This two-zone approach allows the model to capture both the near-field dilution and the far-field transport of the discharged constituents with a single modeling framework.

2 Model Description

The model configuration is summarized in Table 1 and the model domain is shown in Figure 1. The domain represents a straight rectangular channel approximately 102 m long and 5 m wide, with a uniform flat bottom elevation of 95 m and a water depth of approximately 5 m. The highly resolved vertical grid of 30 sigma layers provides the resolution needed to capture the vertical structure of the rising plume. The simulation runs for 3 hours with a fixed timestep of 0.04 s, providing the fine temporal resolution required to resolve the near-field jet dynamics.

Table 1 Model configuration summary

Run Period (hours)	Horizontal Cells	Vertical Layers	Activated Modules
0-3	693 cells	30 layers (sigma)	- Hydrodynamics - Temperature - Dye

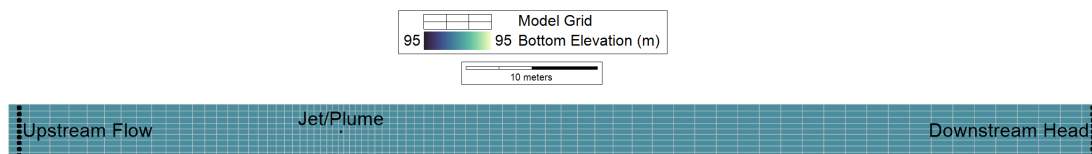


Figure 1 Model domain

2.1 Ambient Flow Configuration

A background ambient current is established by 9 constant inflow cells distributed across the upstream cross-section ($I = 3$, $J = 3-11$), each carrying a width-weighted share of the total inflow of $\approx 0.18 \text{ m}^3/\text{s}$. The inflow temperature is 10°C throughout. Nine east-facing open boundary cells provide the outflow boundary. No tidal or wind forcing is applied; the ambient flow is a steady, unidirectional current providing the cross-flow into which the jet discharges.

2.2 Jet/Plume Configuration

A single submerged jet discharge is configured using the EFDC+ jet/plume boundary type at cell $I = 31$, $J = 7$. The port parameters are summarized in Table 2.

Table 2 Jet/plume port parameters

Parameter	Value
Cell location	$I = 31$, $J = 7$
Port elevation (ZJET)	95.1 m (10 cm above bed)
Port diameter (DJET)	0.10 m
Number of ports (NPORT)	1
Horizontal angle (PHJET)	45° to ambient flow
Vertical angle (THJET)	0° (horizontal discharge)
Flow rate	From time series (NQSERJP = 1)
Discharge temperature	From time series (ICSER2 = 1)
Discharge dye	From time series (ICSER3 = 1)
Near-field elements (NJEL)	10
Max plume elements (NJPMX)	150

The jet discharges horizontally at 45° to the ambient flow direction, 10 cm above the bed. The near-field plume is resolved using 10 jet elements with a maximum of 150 plume elements, updated every 40 time steps. The discharge carries dye (dye series 1) and temperature (temperature series 1) tracers, allowing the plume trajectory and dilution to be directly visualized in the model output.

3 Model Results

Figures 2 and 3 show 2D vertical cross-sections along row $J = 7$ at time 0.08 days (2 hours).

Temperature

Figure 2 shows the temperature field ($10-11^\circ\text{C}$). The ambient background flow entering from the left is at 10°C throughout the water column. At the port location (distance = 31 m), the warmer jet discharge ($\approx 11^\circ\text{C}$) near the surface creates a sharp thermal stratification: warm discharged water accumulates at the surface while cooler ambient water occupies the lower water column. Downstream of the port, the warm surface layer advects to the right and gradually mixes downward, producing the smooth vertical temperature gradient visible across the far-field domain.

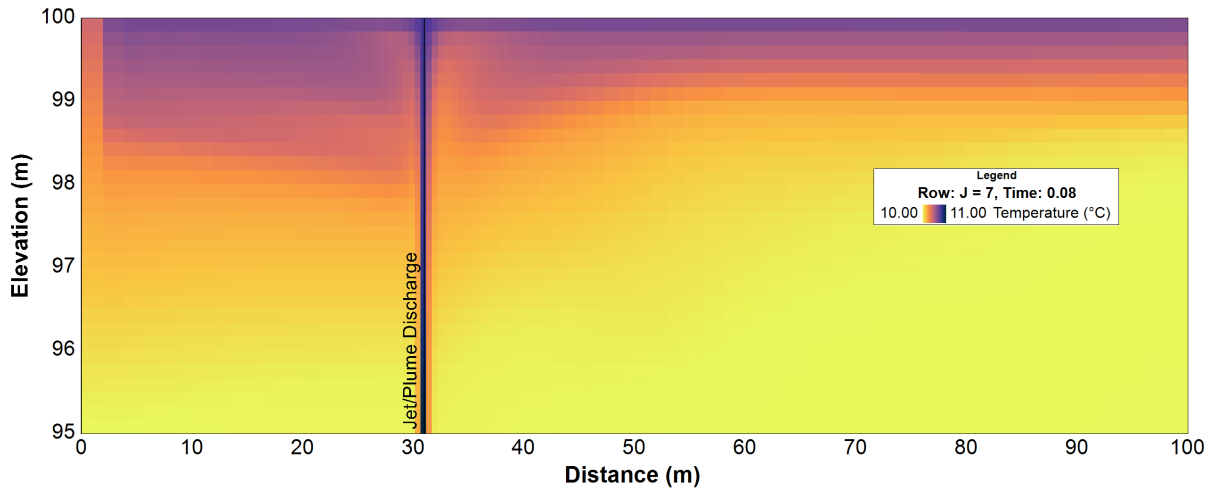


Figure 2 2DV cross-section of temperature ($^{\circ}\text{C}$) along $J = 7$ at time 0.08 days

Dye

Figure 3 shows the dye concentration field (0–1 mg/L). The intense near-field dye signal is visible as a narrow vertical band at the port location, representing the undiluted jet discharge at distance = 31 m. Upstream of the port, dye has been carried back by recirculation or diffusion into the near-field zone and occupies the upper water column. Downstream, the dye plume is confined to the upper half of the water column and decreases progressively with distance as the far-field transport dilutes the discharge.

Comparing the two figures, the temperature and dye fields show closely matched spatial patterns, confirming that both tracers are transported together by the buoyant plume.

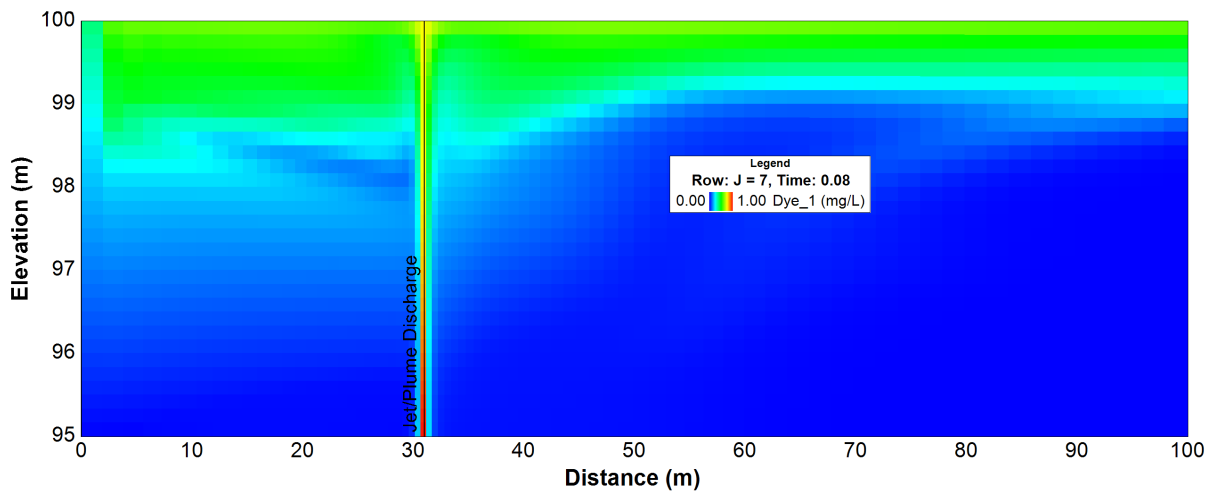


Figure 3 2DV cross-section of dye concentration along $J = 7$ at time 0.08 days

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