

EEMS Demonstration Model Description

DM_River_Contaminant_Transport

1 Objective

This demonstration model uses EFDC+ Explorer (EE) and EFDC+ to simulate hydrodynamics, sediment transport, and toxics in a sloping one-dimensional (1D) river system. The model was designed primarily to test and verify mass balance for sediment and toxic constituents, and to demonstrate how coupled sediment transport and toxics modules can be configured within the EFDC+ framework for a river with a significant longitudinal bed slope.

The sloping channel geometry creates a gradient-driven flow regime that produces spatially variable sediment transport conditions along the reach, providing a useful test case for validating erosion, deposition, and toxic partitioning between the water column and the sediment bed.

2 Model Description

The model configuration is summarized in Table 1 and the model domain is shown in Figure 1. The river reach is oriented horizontally with bottom elevations ranging from approximately 0 m at the downstream end to 36 m at the upstream end, reflecting a pronounced longitudinal slope.

Table 1 Model configuration summary

Run Period (Julian Time)	Horizontal Cells	Vertical Layers	Activated Modules
0–180	80 cells	1 layer (water column) 2 layers (sediment bed)	- Hydrodynamics - Sediment Transport - Chemical Fate & Transport

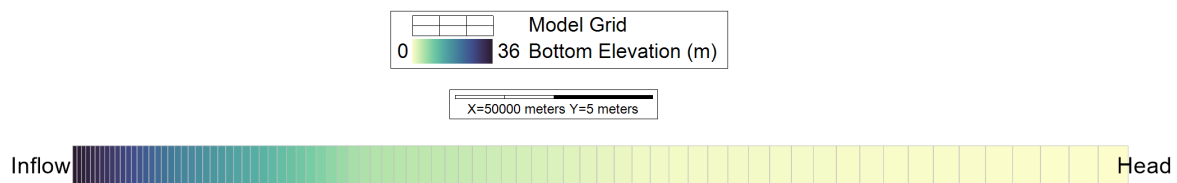


Figure 1 Model domain showing bottom elevation

2.1 Sediment Transport Configuration

The sediment transport module simulates the erosion, transport, and deposition of cohesive and non-cohesive sediment along the sloping channel. The two-layer sediment bed structure allows the model to track:

- **Upper bed layer:** the surficial zone subject to active erosion and deposition, exchanging sediment and associated toxics with the overlying water column.

- **Lower bed layer:** a deeper storage zone that receives material deposited from the active layer and can supply sediment upward through net suspended-load erosion when the active layer is depleted.

The longitudinal bed slope drives a downstream increase in bed shear stress under uniform flow conditions, producing a spatially variable pattern of net erosion in the upper reach and potential deposition in the lower reach where slopes and velocities diminish.

2.2 Toxics Configuration

A single toxic constituent (Tox_1) is simulated in both the water column and the sediment bed using an inorganic solids partitioning approach (K_d method) with a uniform partition coefficient applied equally to all sediment classes in both the water column and the bed. No decay or biodegradation kinetics are activated, isolating the mass-balance behaviour of sorption, settling, and bed–water exchange.

The model is initialized with Tox_1 present throughout the domain: $1.0 \mu\text{g/L}$ uniformly in the water column and $100 \mu\text{g/L}$ (Top layer) / $50 \mu\text{g/L}$ (Bottom layer) in the sediment bed. The upstream inflow introduces clean water, so the simulation exercises the flushing and downstream redistribution of the pre-loaded contaminant mass as it partitions between dissolved and particulate phases and exchanges with the bed under the varying shear stress conditions along the four-slope reach.

3 Model Results

Figure 2 shows a 2D vertical cross-section (2DV) of the total water column toxic concentration along the reach at simulation day 5. The figure also displays velocity vectors, and the sloping bed geometry is clearly visible, with the channel dropping from approximately 36 m elevation at the upstream inflow to near 0 m at the downstream outlet over a reach length of approximately 250 km. Flow accelerates down the steep upper segments, as indicated by the velocity vectors, and decelerates in the flatter lower reach.

At this early stage of the simulation (day 5), the upstream reach shows low concentrations as clean inflow water dilutes and flushes the initial toxic load. Peak concentrations occur in the mid-reach around 130–150 km, where the transition from steep to mild slope reduces advective flushing. Concentrations then decline toward the downstream boundary. This spatial pattern reflects the interplay between advective transport driven by the slope gradient and the partitioning of Tox_1 onto suspended sediment.

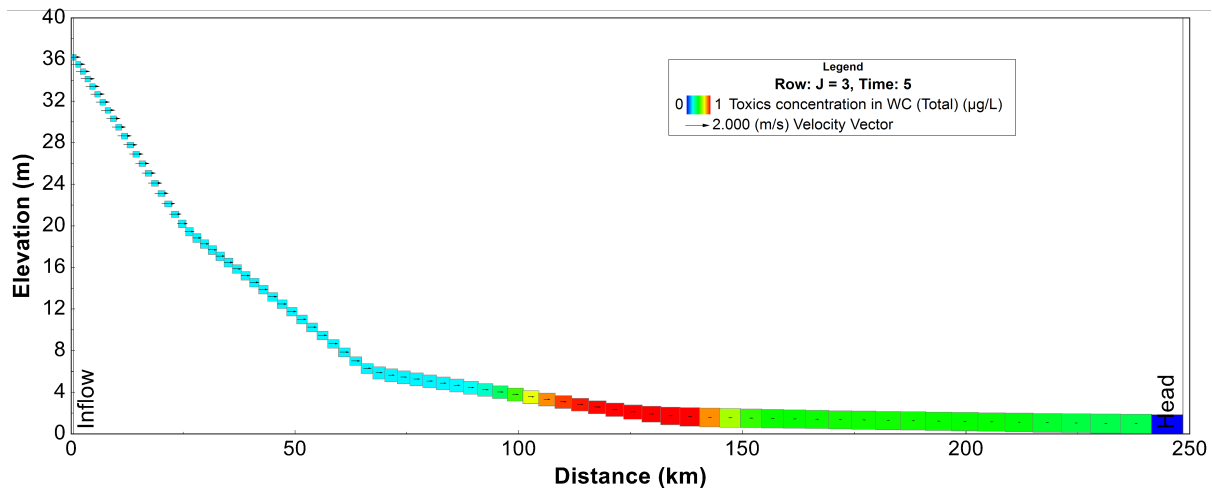


Figure 2 2DV cross-section of total water column toxic concentration (Tox_1; $\mu\text{g/L}$) at simulation day 5

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