

EEMS Demonstration Model Description

DM_Lake_Washington_Floating_Bridge

1 Objective

This demonstration model uses EFDC+ Explorer (EE) and EFDC+ to simulate the impact of the SR-520 floating bridge on hydrodynamics and particle transport in Lake Washington, Seattle, USA. The model demonstrates two advanced EFDC+ features applied together:

- **Partial Depth Blocking (Vertical Masks):** the floating bridge pontoons are represented as vertical momentum barriers that block flow only within specified depth layers, allowing sub-pontoon water exchange to continue unimpeded below the bridge draft.
- **Lagrangian Particle Tracking (LPT):** particles seeded on both the north and south sides of the bridge at two different depths demonstrate how the bridge selectively restricts near-surface exchange while permitting deeper exchange.

The model also activates the internal SMB (Sverdrup-Munk-Bretschneider) wave model to simulate fetch-limited wave propagation across Lake Washington during a winter storm period, providing a realistic wave-driven flow field in which particle transport is computed. The model builds directly on the Lake Washington grid established in DM-15, adding the bridge blocking, wave modeling, and LPT capabilities to the existing hydrodynamic framework.

2 Model Description

The model configuration is summarized in Table 1 and the model domain is shown in Figure 1. The domain, grid, and bathymetry are identical to DM-15 (1,183 cells, -60 m to $+11$ m bottom elevation), with the SR-520 floating bridge represented by 9 partial-depth blocked cell faces (NBLCKED = 9) located at the bridge crossing in the mid-lake section. The simulation covers 21 days during winter conditions (2010-02-09 to 2010-03-02), when westerly storm winds generate wave activity across the lake and drive the circulation through which particles are tracked.

Table 1 Model configuration summary

Run Period	Horizontal Cells	Vertical Layers	Activated Modules
2010-02-09 to 2010-03-02	1,183 cells	• 55 layers (SGZ) • Minimum 2 active layers	• Hydrodynamics • Temperature • Waves • Lagrangian Particle Tracking

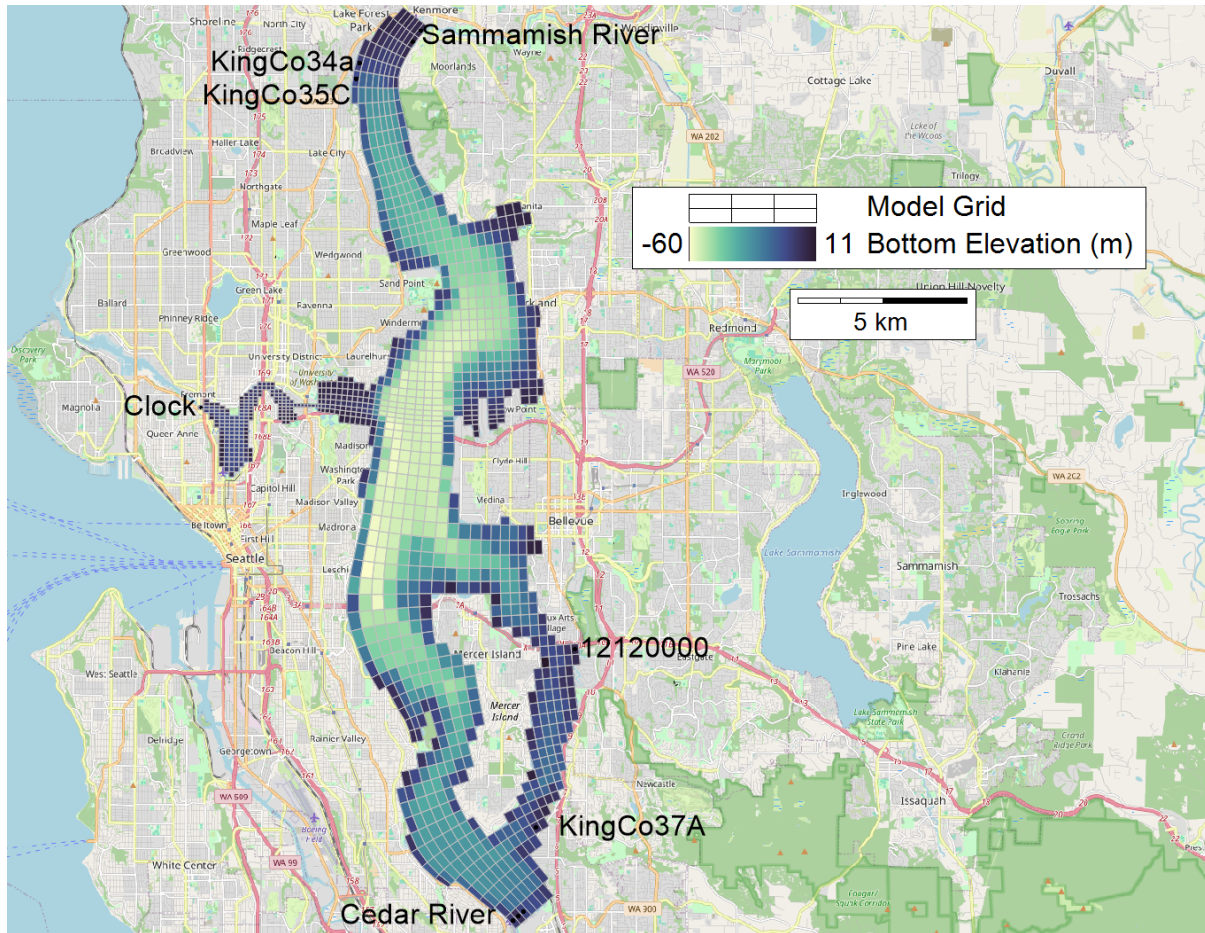


Figure 1 Model domain

2.1 Partial Depth Blocking — Floating Bridge

The SR-520 floating bridge is represented using 9 blocked cell faces distributed along the bridge alignment. In EFDC+, partial depth blocking applies momentum resistance only across the specified vertical layer range corresponding to the bridge pontoon draft, while layers below the pontoon remain unblocked. This allows the model to simulate the physically correct behavior: surface and near-surface exchange is impeded by the bridge structure, while sub-pontoon exchange at depth can proceed. The blocked cell geometry is configured in EE under the Vertical Masks (Partial Depth Blocking) tool.

2.2 Wave Modeling

Wave effects are included using the internal SMB wave model, activated via the Wave module in EE. Wave computations are performed on a subset of 1,094 cells defined in `wavecells.inp`, covering the open lake area where fetch-limited wave growth is significant. Radiation stress is included in the momentum equations, along with rotational radial stress. Wave Stokes drift, irrotational radial stress, and moving bed effects are not activated. The Nikuradse sand roughness is set to $K_s = 2.5 \times 10^{-5}$ m, with a wave dissipation fraction in the vertical TKE closure of 1.0 and an eddy viscous length scale weight of 0.1.

2.3 Lagrangian Particle Tracking

LPT is activated. Two particle release polygons are provided:

- **Seed_N.p2d**: releases particles on the **north** side of the bridge
- **Seed_S.p2d**: releases particles on the **south** side of the bridge

For each release region, particles are seeded at two depths: 1.5 m (near-surface, within the depth range of the bridge pontoons) and 4.5 m (below the pontoon draft). This creates four particle groups — North 1.5 m, North 4.5 m, South 1.5 m, South 4.5 m — whose divergent trajectories directly demonstrate the depth-selective effect of the partial blocking.

3 Folder Structure

The model package contains the following components:

- **Model**: The complete EFDC+ model project directory, loadable in EE. Includes the SWAN coupling configuration files (**SWAN.EE**, **wavecells.inp**).
- **Data**: Contains three subfolders:
 - *Bathymetry*: **Bathymetry.dat**
 - *Boundaries*: time series for all inflow, wind, and atmospheric boundary conditions (same as DM-15)
 - *Lagrangian particle tracking*: **Seed_N.p2d** (north release polygon) and **Seed_S.p2d** (south release polygon)
- **Grid**: **LW_Grid.gpc** and **LW_Grid.kml**.
- **Maps-Images**: Geo-referenced topographic imagery (**LW-Topo.jgw/.jpg**).

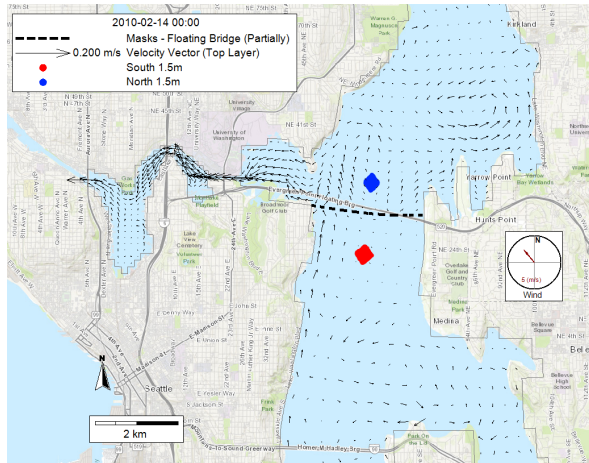
4 Model Results

Figures 2 and 3 show the evolution of the four particle groups from their initial positions (day 0, 2010-02-14) to day 2010-02-18 20:00, overlaid on surface velocity vectors.

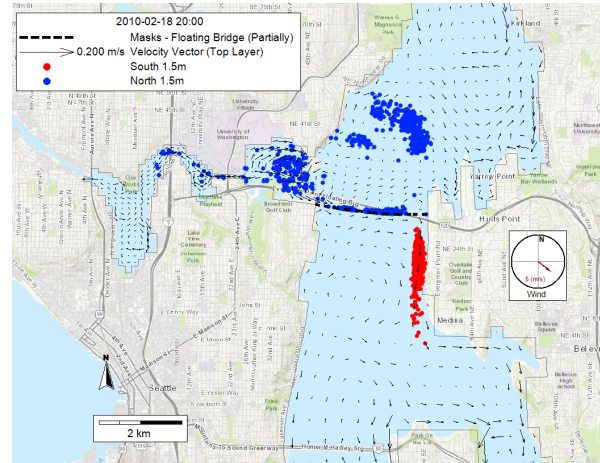
The two depth layers exhibit different dispersal behaviors due to the partial-depth blocking imposed by the floating bridge masks.

Near-surface particles (1.5 m depth; Figure 2): Starting from seed locations on each side of the bridge, the 1.5 m particles undergo strong lateral dispersal about 5 days after the seeding time while remaining confined to their respective sides of the bridge. The absence of cross-bridge exchange at this depth confirms that the vertical mask blocking intercepts near-surface transport pathways.

Deep particles (4.5 m depth; Figure 3): The 4.5 m particles, starting from the same seed locations as the 1.5 m particles, show broader lateral dispersal and partial cross-bridge exchange by about 5 days after the seeding time. The South group disperses more diffusely compared to the tightly banded 1.5 m southern group, with some particles evident on both sides of the bridge alignment, consistent with partial mask passage where the blocking layers do not extend to this depth. The contrast between the 1.5 m and 4.5 m spatial distributions directly visualizes the depth range over which partial blocking is active.

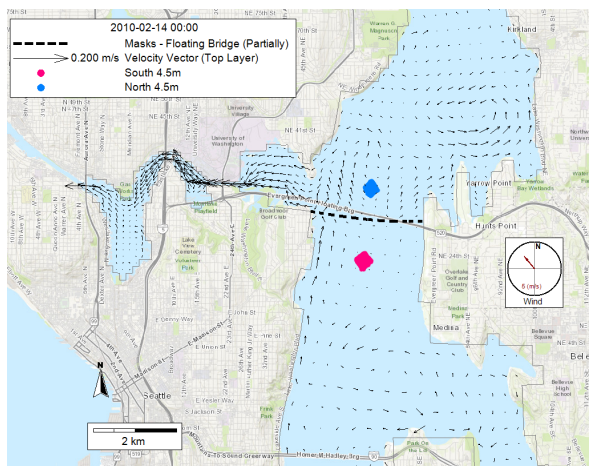


(a) Day 0 (2010-02-14 00:00) — initial positions

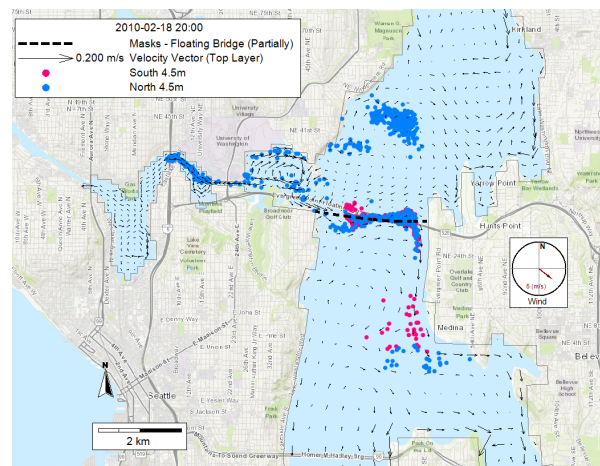


(b) Day 18 (2010-02-18 20:00) — dispersed distribution

Figure 2 LPT particle groups at 1.5 m depth overlaid on surface velocity vectors. Dashed line indicates the floating bridge alignment.



(a) Day 0 (2010-02-14 00:00) — initial positions



(b) Day 18 (2010-02-18 20:00) — dispersed distribution

Figure 3 LPT particle groups at 4.5 m depth overlaid on surface velocity vectors. Dashed line indicates the floating bridge alignment.

5 Notes

5.1 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.

5.2 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.

5.3 Support

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