



# EFDC\_DSI/EFDC\_Explorer Modeling System

Use and Applications for Alberta  
ESRD Environmental Modelling Workshop  
March 2013



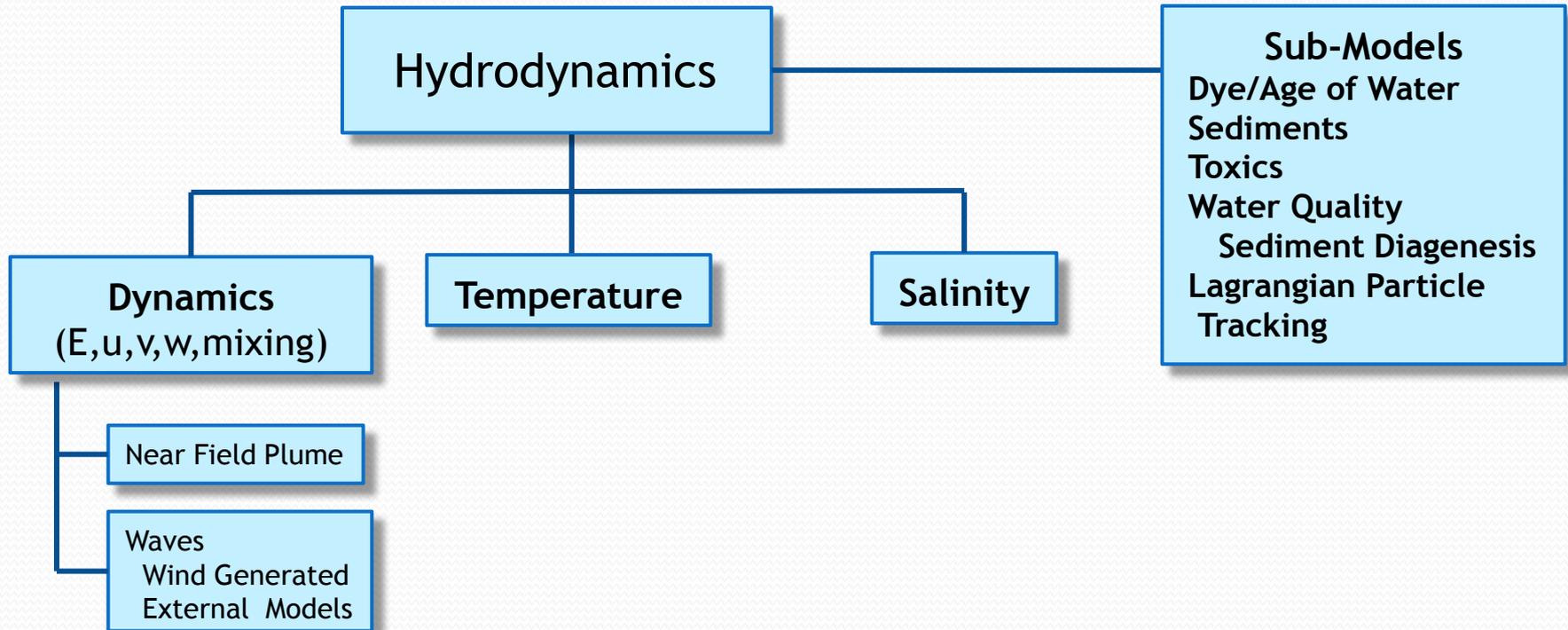
[www.ds-intl.biz](http://www.ds-intl.biz)



# The EFDC Model

- The Environmental Fluid Dynamics Code (EFDC) is a general-purpose hydrodynamic modeling package
- Simulates 1,2 & 3-D flow, transport, and biogeochemical processes in surface water systems (rivers, streams, lakes, estuaries, coastal waters and open ocean)
- EFDC model was originally developed at the Virginia Institute of Marine Science
- EFDC is a public domain model
- EFDC is a widely used and accepted model
- EFDC\_DSI is Dynamic Solutions-International's enhanced and optimized version

# EFDC Architecture



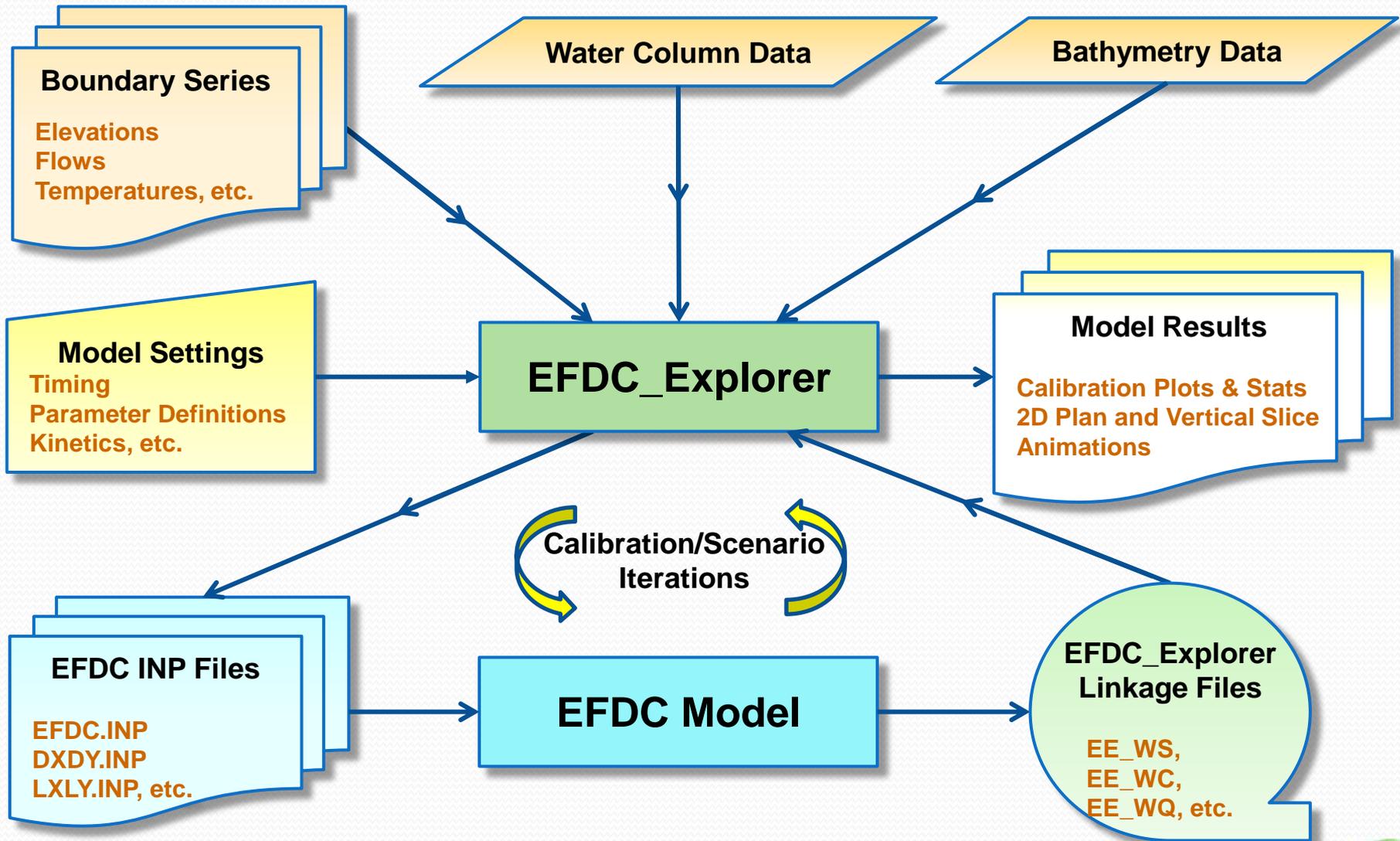
- EFDC's hydrodynamics are based on the 3D hydrostatic equations formulated in curvilinear-orthogonal horizontal coordinates and a sigma or stretched vertical coordinate system.
- EFDC is a coupled model eliminating model linkage issues

# EFDC\_DSI Enhancements

Dynamic Solutions-International (DSI) has developed an enhanced version the code (EFDC\_DSI) which includes:

- Dynamic Memory Allocation
- Lagrangian Particle Tracking
- Improved/Simplified External Wave Model Linkage
- Internal Windwave Generation
- Added Dynamic Timestepping with WQ Model
- Age of Water/Residence Times
- Rooted Plant and Epiphyte Model (RPEM)
- OpenMP – Multi-Threading
- Upgraded all code to Fortran90 (EE7.1)

# EFDC\_Explorer/EFDC\_DSI Modeling System



# EFDC\_DSI/EFDC\_Explorer Uses

- Models of eutrophication and nutrient processes
- Water quality studies/planning
- Flood and inundation mapping
- Bridge scour analysis
- Oil spill tracking and planning
- Contaminated sediment/toxics analysis and planning
- Thermal discharge/impact studies and planning
- Aquatic vegetation studies
- Lakes/reservoir mixing and residence time studies
- Tailrace investigation for Hydropower
- Hydraulic structure design support

# Applications in Alberta

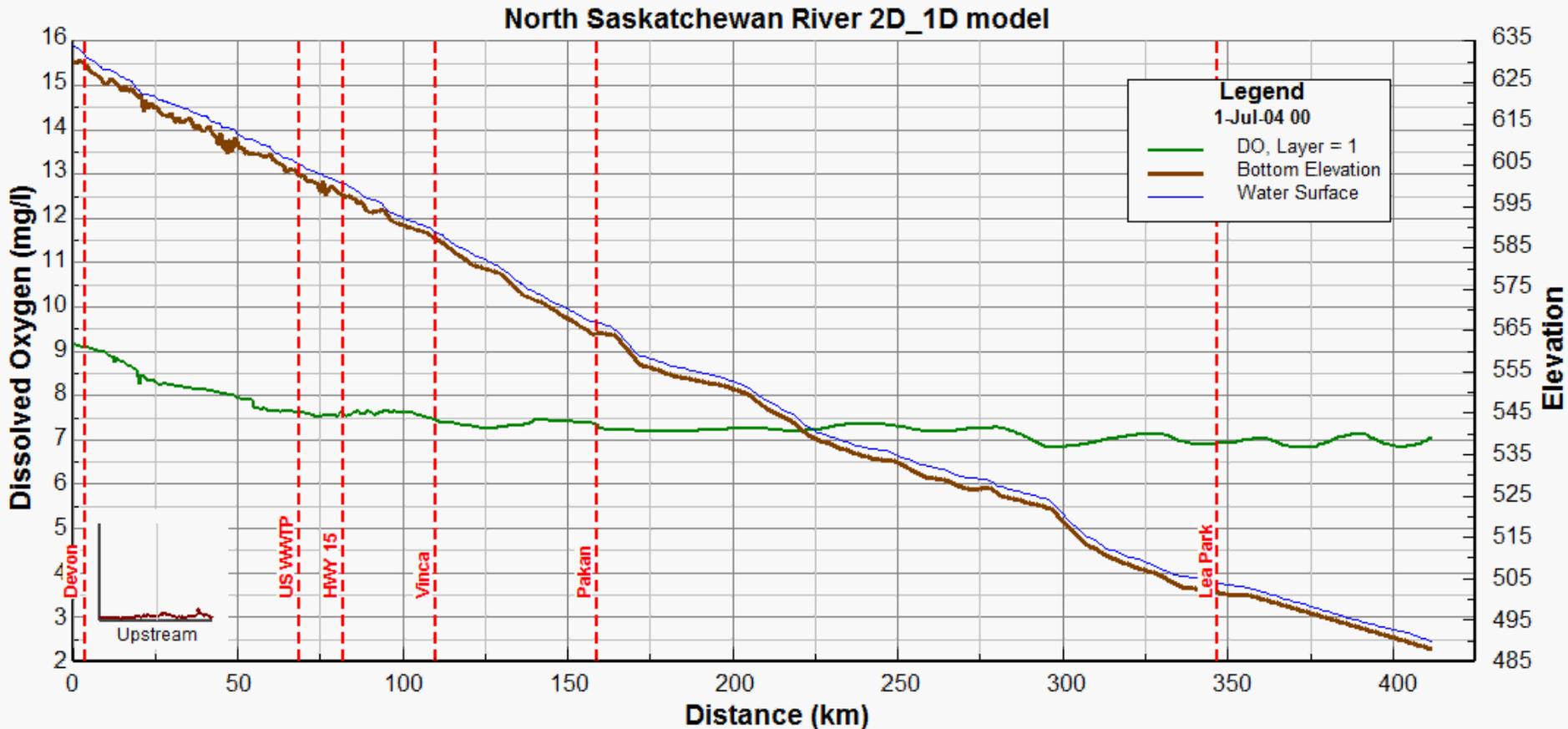
- North Saskatchewan River (NSR)
  - Water quality planning
    - 16 water quality constituents
  - DSI modified the EFDC\_DSI model code to include the Rooted Plant and Epiphyte Model (RPEM)
- Lower Athabasca River (LAR)
  - DSI conducted a scoping study for hydrodynamics, water quality, sediments and toxics
  - Water quality planning
    - 15 water quality constituents
  - Contaminated sediments/toxics evaluation
    - DSI added sediment transport (4 classes)
    - DSI added toxics (24 classes)

# North Saskatchewan River



- Number of Cells: 1776
- Number of Layers: 1
- Dimensions: 2D
- Duration: 1 to 10 years
- Area: 9405 ha
- Length: 412 km
- Processes Modeled
  - Hydrodynamics
  - Temperature
  - Water Quality: 16
  - Sed Nutrient Fluxes: Fixed
  - RPEM

# NSR Dissolved Oxygen Profile

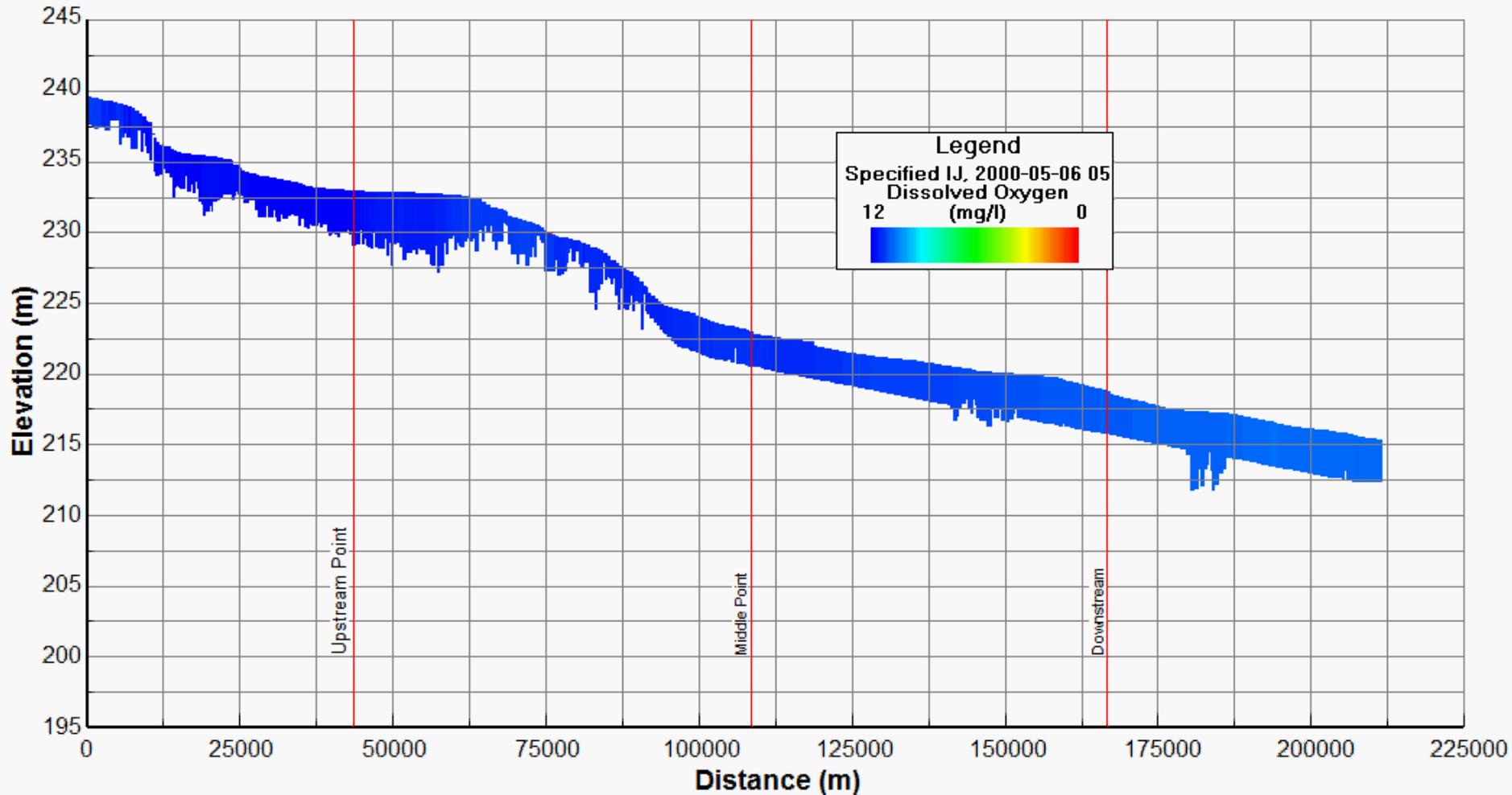


# Lower Athabasca River

- McMurray to Old Fort
- Number of Horizontal Cells: 2257
- Number of Layers: 1
- Dimensions: 2D
- Duration: 1 to 10 years
- Area: 12,981 ha
- Length: 214 km
- Processes Modeled
  - Hydrodynamics
  - Temperature
  - Water Quality: 15
  - Sediment Nutrient Fluxes Fixed
  - Inorganic Sediments 4
  - Toxics
    - Metals 8
    - Organics 16

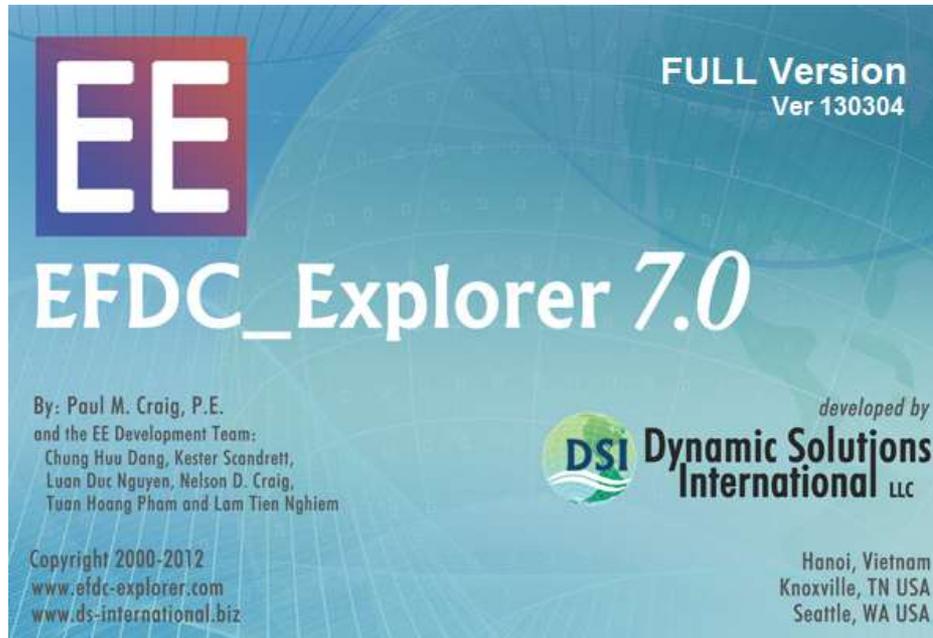


# LAR Dissolved Oxygen Profile



# The Graphical User Interface for EFDC

# EFDC\_Explorer



The image shows the software box art for EFDC\_Explorer 7.0. It features a blue background with a globe and circuit-like patterns. The 'EE' logo is in the top left, and the text 'FULL Version Ver 130304' is in the top right. The main title 'EFDC\_Explorer 7.0' is in the center. Below it, the authors and developers are listed, along with the DSI logo and company name. Copyright information and website URLs are at the bottom left, and office locations are at the bottom right.

**EE**

FULL Version  
Ver 130304

## EFDC\_Explorer 7.0

By: Paul M. Craig, P.E.  
and the EE Development Team:  
Chung Huu Dang, Kester Scandrett,  
Luan Duc Nguyen, Nelson D. Craig,  
Tuan Hoang Pham and Lam Tien Nghiem

*developed by*  
**DSI Dynamic Solutions  
International LLC**

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[www.efdc-explorer.com](http://www.efdc-explorer.com)  
[www.ds-international.biz](http://www.ds-international.biz)

Hanoi, Vietnam  
Knoxville, TN USA  
Seattle, WA USA



# EFDC\_Explorer Main Form

EE EFDC\_Explorer7 (FULL Version)

EFDC Information

Directory: F:\Projects\Alberta\LAR\Models\TOX\Run33\

Title: Revision 01 to Original Model 2013-01-22 23:44 Browse

# Cells: 2272 Curvilinear Dates: 0 to 365 Sed Layers: 10 Water Layers: 1

Map

**Description**

Domain

Active Modules

Timing

Hydrodynamics

Temperature

Sediments

Toxics

Water Quality

Model Analysis

Project ID: Lower Athabasca River

Run Title: Revision 01 to Original Model

Run Log /Notes

No.	Toxic
1	Acenaphthene
2	Acenaphthylene
3	Anthracene
4	Benz (a) anthracene
5	Benzo (a) pyrene
6	Benzo (b) fluoranthene
7	Dibenzo (a, h) anthracene
8	Dibenzothiophene
9	Fluoranthene
10	Fluorene
11	Indeno (1, 2, 3-cd) pyrene
12	Naphthalene
13	Pyrene
14	Phenanthrene
15	Chrysene

Activated Parameters

Salinity	Dye	<input checked="" type="checkbox"/> Cohesives [1]	<input checked="" type="checkbox"/> Water Quality	Particle Tracks
<input checked="" type="checkbox"/> Temperature	<input checked="" type="checkbox"/> Toxics [24]	<input checked="" type="checkbox"/> Non-Cohesives [3]	Shellfish	Waves

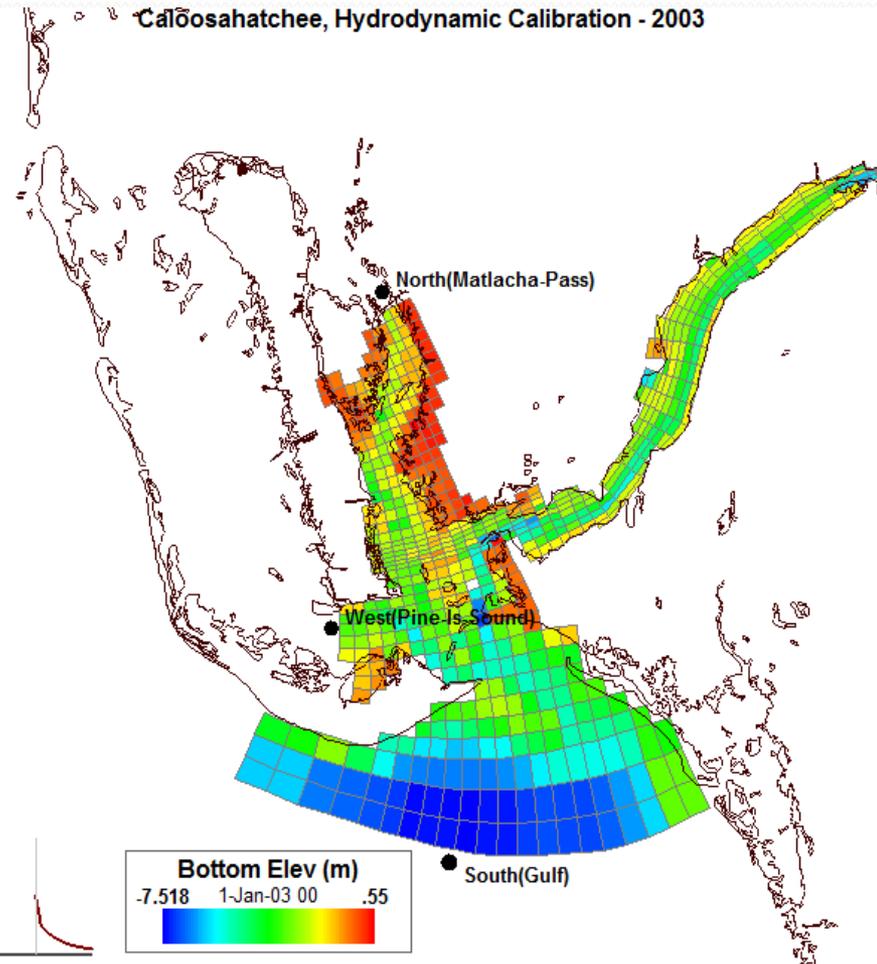
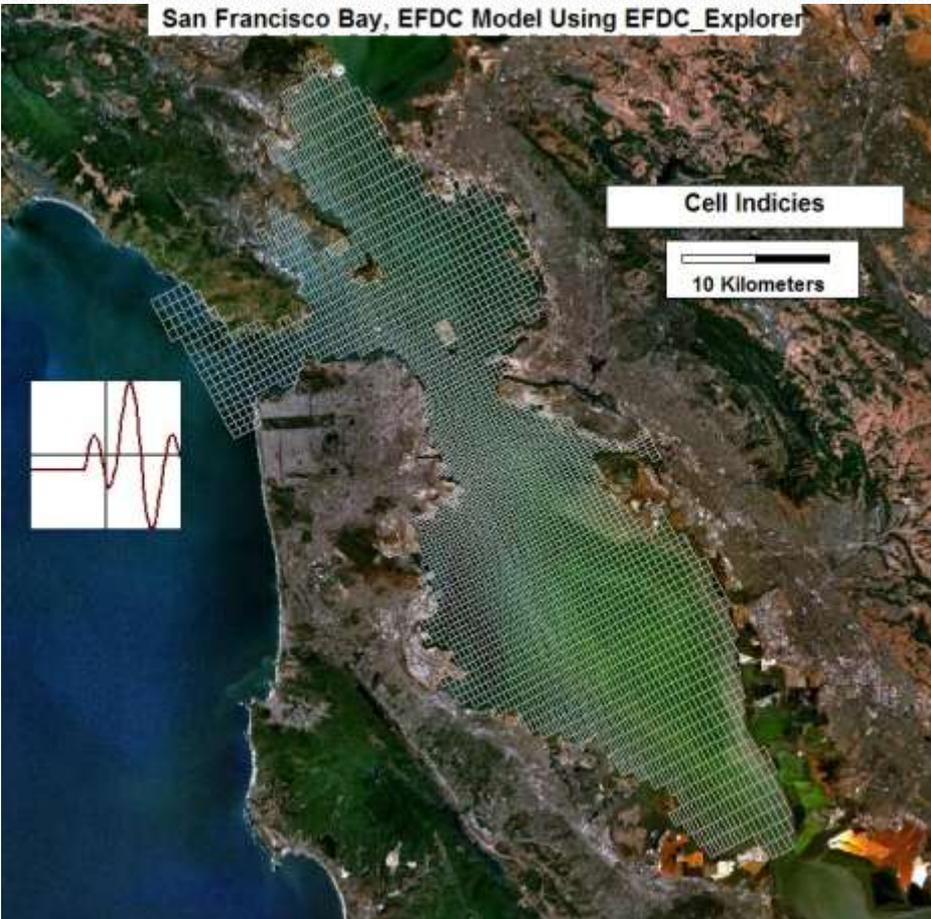
Results Not Loaded Metric DSI Ver 130304



# Example Grids

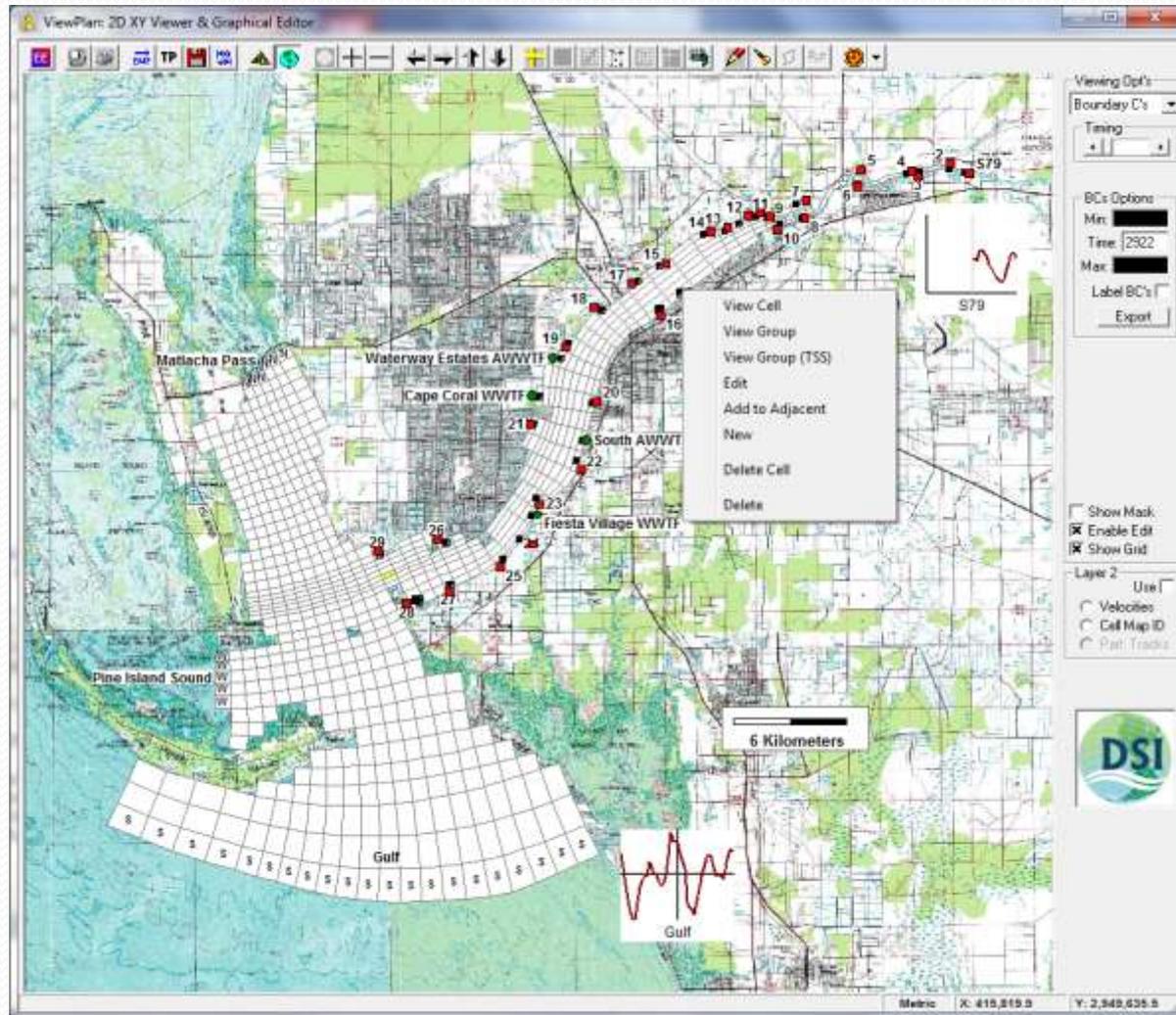
## Rotated and Telescoping Cartesian Grids

San Francisco Bay, EFDC Model Using EFDC\_Explorer



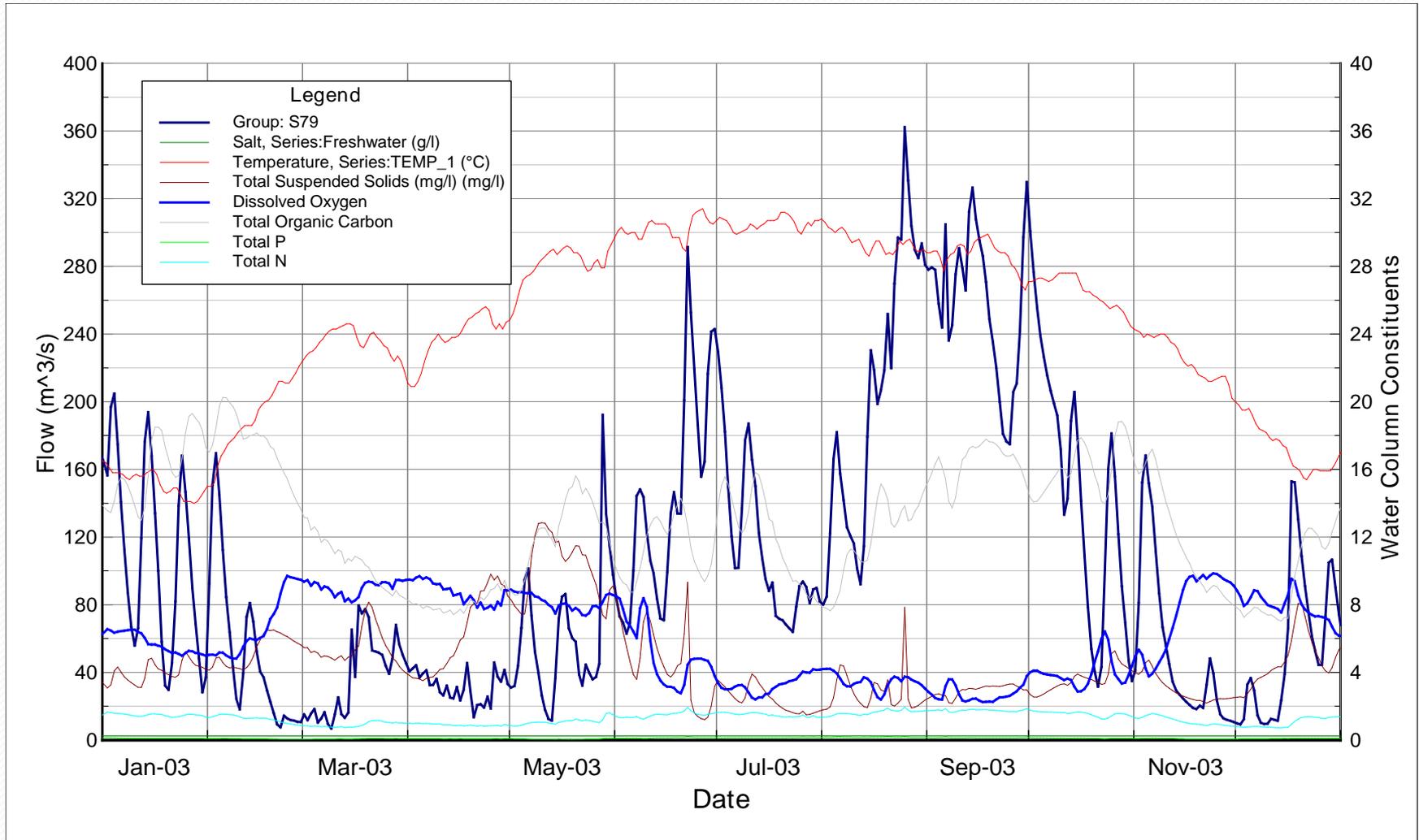
Orthogonal Curvilinear Grid

# Boundary Condition Assignment



- Flow
- Withdrawal/Return
- Open (EWNS)
- Hydraulic Structure
  - At Boundary
  - Internal
- EE Management
  - By Group

# Boundary Condition Plots



# Model Calibration

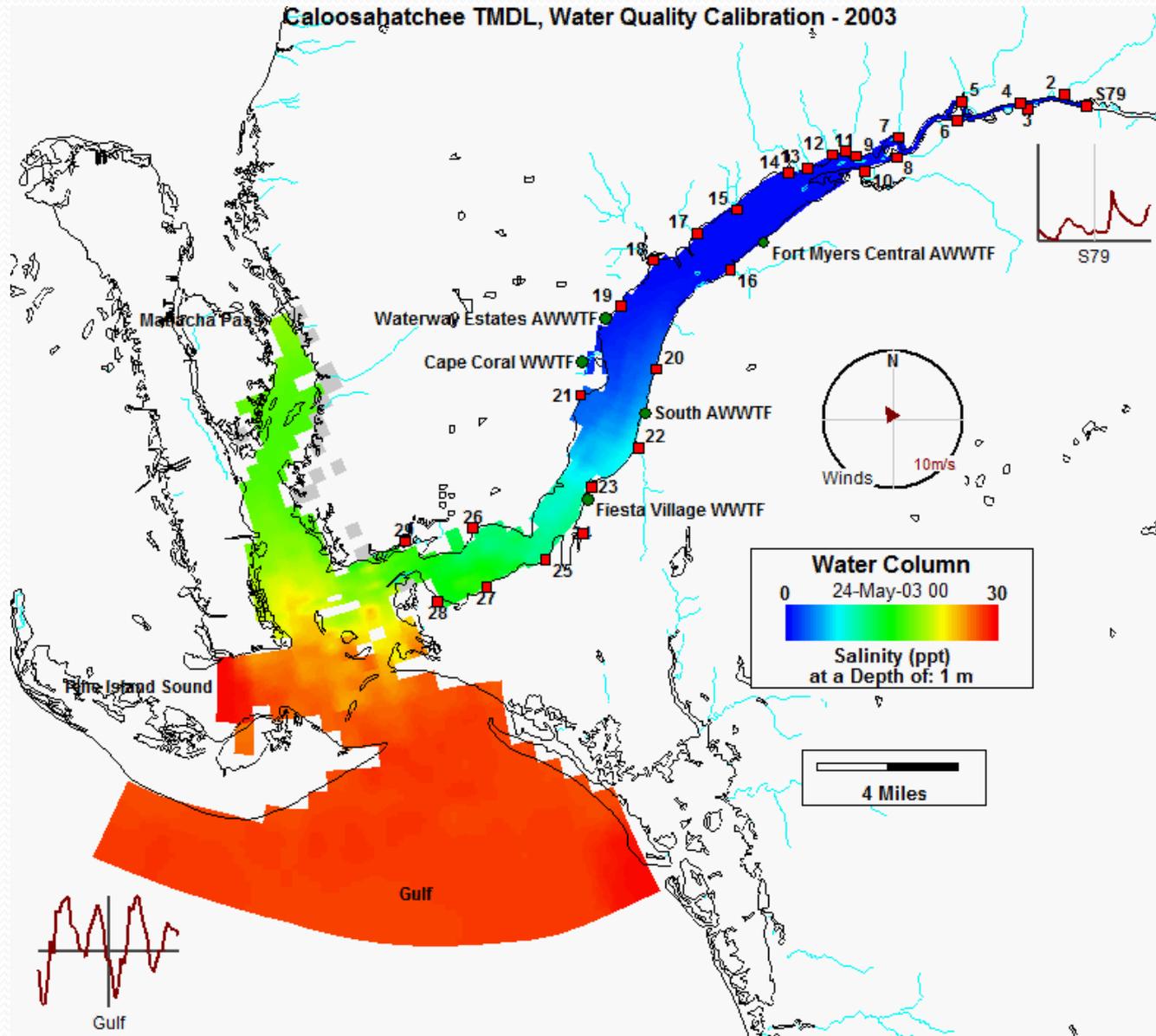
- Plots

- Time Series
- Correlation Plots
- Vertical Profiles
- Plan View Overlays

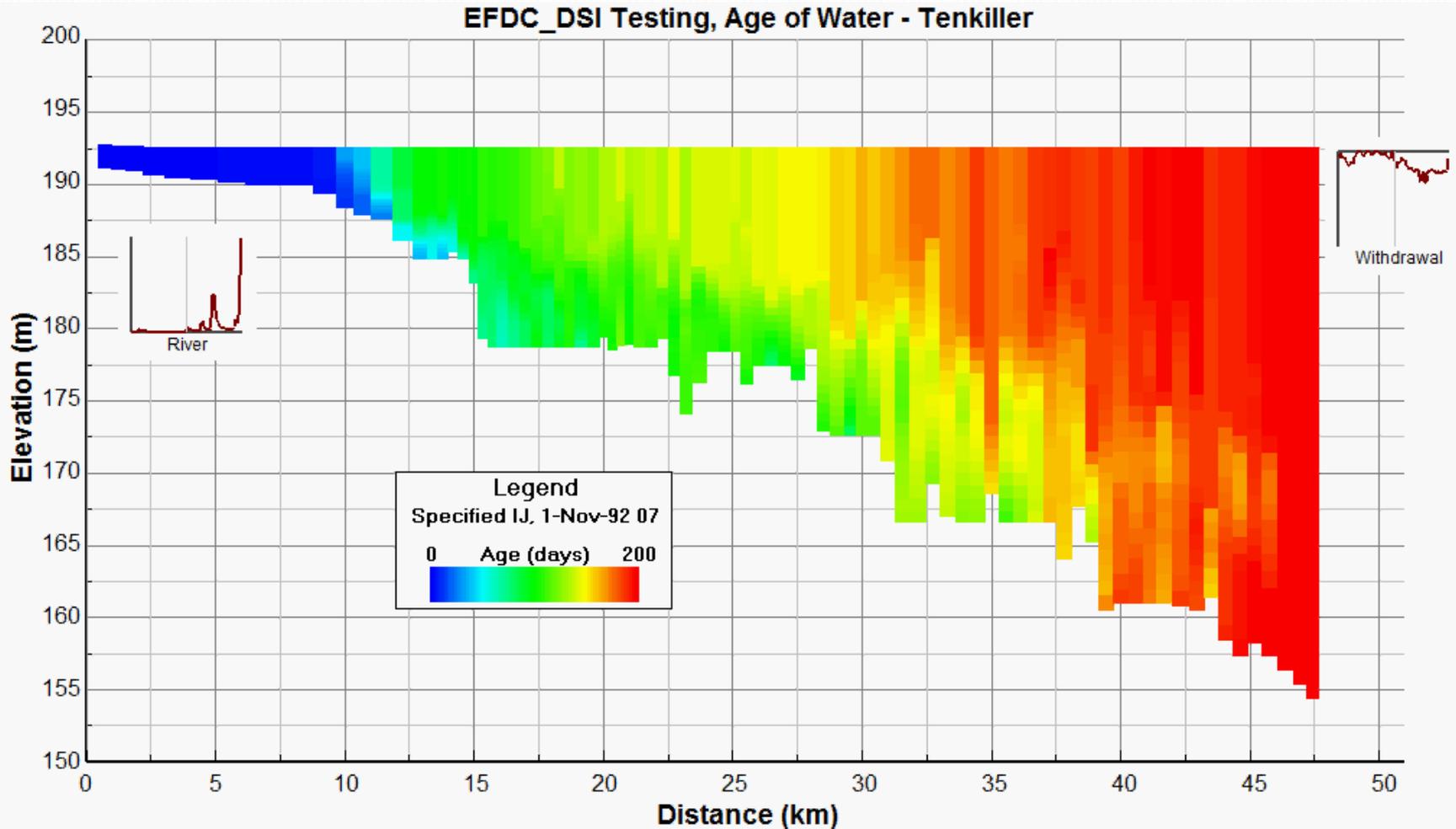
- Statistics

- Average
- Relative
- Absolute
- Root Mean Square
- Relative RMS
- Nash-Sutcliffe
- Model Bias
- R-Squared (CP Only)

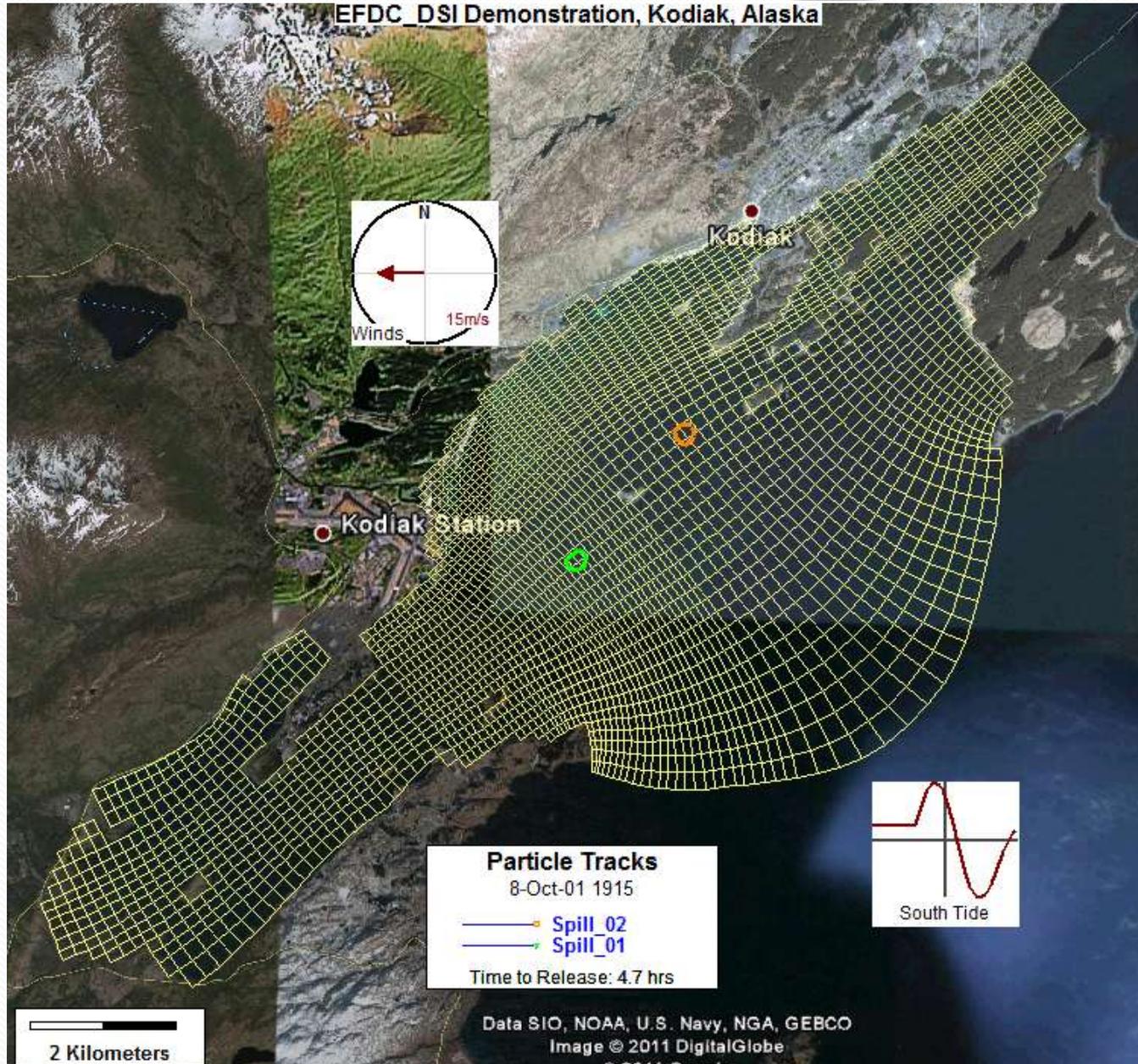
# 2D Plan View - Salinity



# Age of Water - Reservoir



# Hypothetical Oil Spill- Kodiak, AK

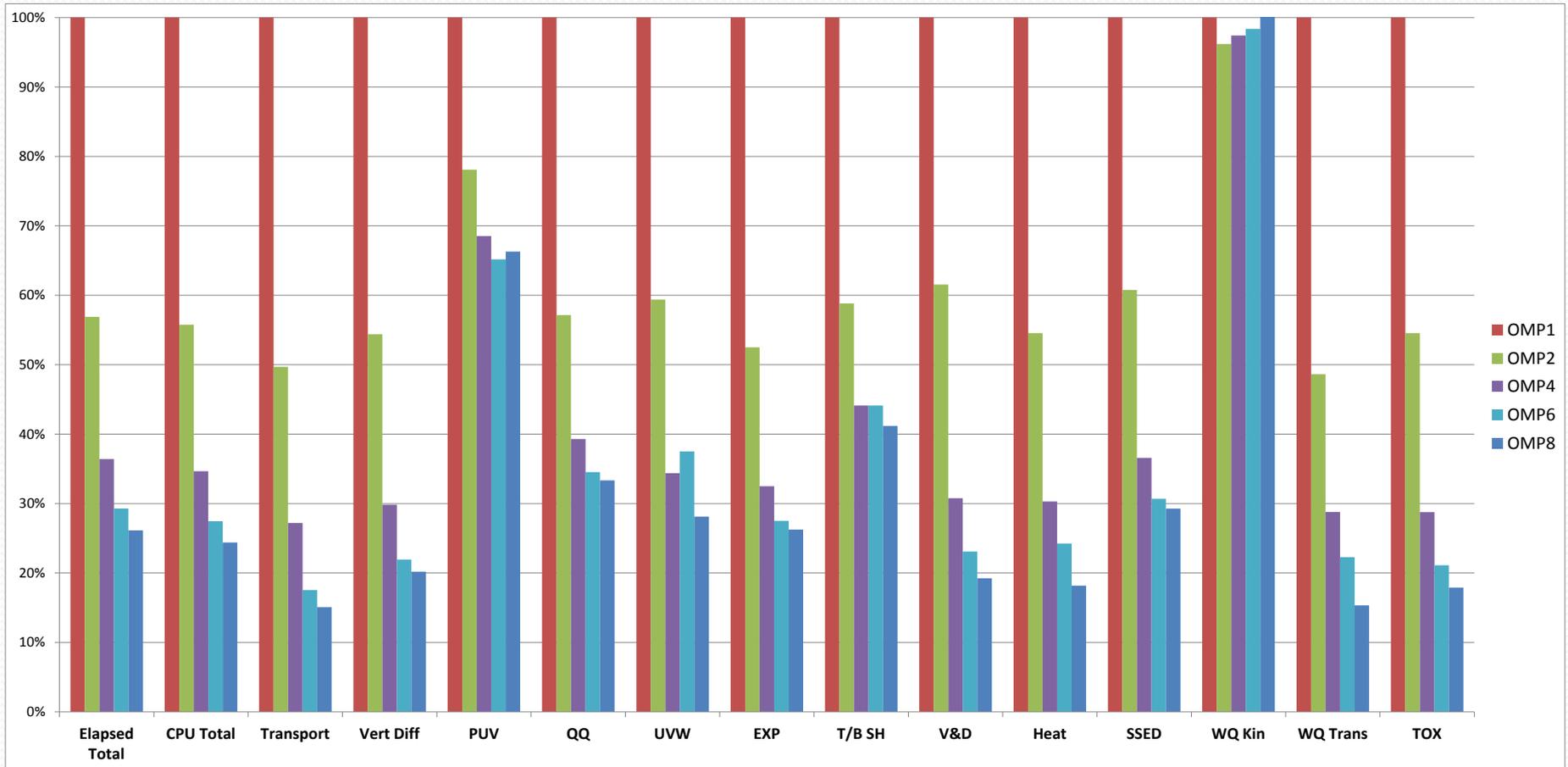


# openMP

## Multi-threaded EFDC\_DSI

- Remarkably faster run times, proportional to the number of processors being used.
- Number of cores used fully configurable by the user.
- Run times up to 6 times faster on a eight core processor than the conventional single-threaded EFDC model.
- Working with Linux and Windows.

# Time Saving with openMP for the Lower Athabasca Toxics Model



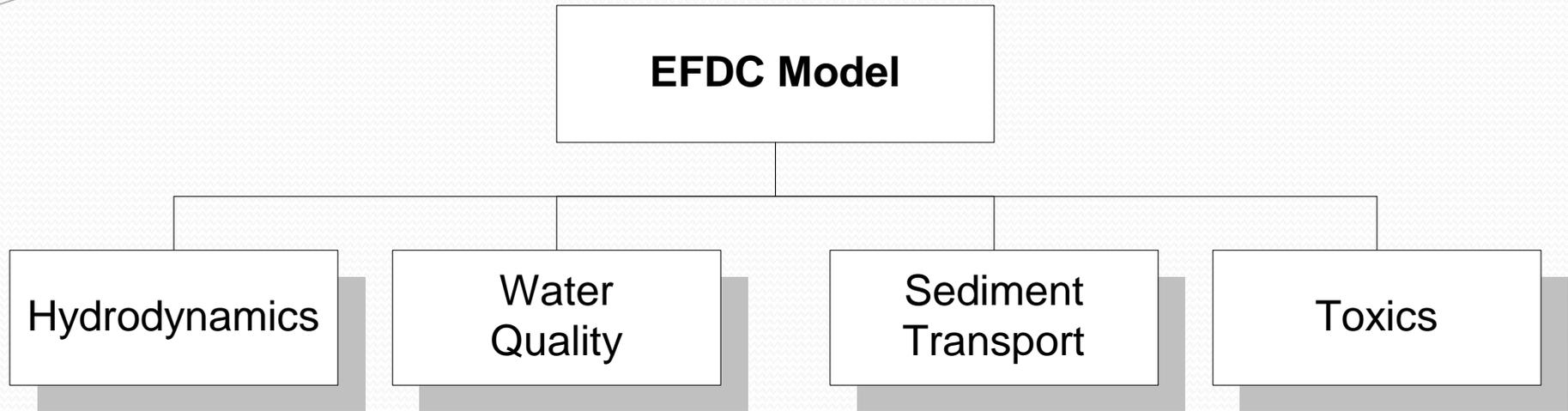
# Testing and Quality Assurance

- All EFDC and EFDC\_DSI features tested against text literature test cases
- Multiple example models available online for download on our website:
  - [www.efdc-explorer.com](http://www.efdc-explorer.com)
- EE has in-built pop-ups for user help, shortcut keys summaries, and a comprehensive user manual
- Pre-Run checks with more being added every month.

# Recent Enhancements

- Automated calibration plots and tables
- Sediment grainsize core management tool
- Multiple Timing Frames
- Fixed depth and/or elevation extraction of model results:
  - 2D Plan view
  - Time series/calibration plots
- Write KML files for grid and model 2D fields, Read KML overlays
- Added DOC as one of the light extinction dependent variables
- Incorporated OMP for more of the sub-models
- 3D Perspective visualizations (EE7.1)

# EFDC/EFDC\_Explorer Packages



- 1,2,3D Capable
- Internal wind waves
- Linked to many wave models
- Vegetation
- Lagrangian Particle Tracking
- Wetting/Drying
- Dye/Age of Water

- Eutrophication
- 21 state variables
- Sediment Diagenesis

- User specified number of sediment classes
- Cohesive(s)
- Non-cohesives
- Bedload

- Metals
- Persistent organic pollutants
- 1-2-3 Phase adsorption

EFDC\_DSI\_SGL

**EE WEB Version**

EFDC\_DSI\_OMP (Optional)

**EE FULL Version**



# EFDC\_Explorer

## Web Site

[www.efdc-explorer.com](http://www.efdc-explorer.com)

The screenshot shows the website for EFDC Explorer 7.0. At the top is a green navigation bar with the DSI logo, 'Dynamic Solutions International LLC', and a search bar. Below the navigation bar are icons for HOME, PRODUCTS, FORUMS, APPLICATIONS, DOWNLOADS, SUPPORT, ACADEMIC, and CONTACT US. The main content area features a large banner for 'EFDC Explorer 7.0' with a list of features: 'New streamlined user interface', 'Rooted Plant & Epiphyte Model (RPEM)', 'Output bitmap images of user defined resolution', 'Write KML files for grid and model 2D fields', 'ViewPlan results of specified depth or elevation', and 'As well as many more enhancements'. Below the banner are three columns for 'FULL VERSION', 'TRIAL VERSION', and 'WEB VERSION', each with a 'Start' button and an 'Updated 21 Jan 2013' date. At the bottom, there is a 'WELCOME TO EFDC EXPLORER' section with an 'Overview' heading and a small image of a plant model. The text describes EFDC Explorer as a Windows-based GUI for pre- and post-processing of the Environmental Fluid Dynamics Code (EFDC), designed for model set-up, Cartesian and curvilinear grid generation, testing, calibration, and data visualization. It also mentions support for hydrodynamics, sediment/flux transport, and the coupled water quality model HECQC, with a new multithreading capability (OpenMP) for faster run times. Language options for English, Korean, Chinese, Spanish, and Vietnamese are listed.

Dynamic Solutions International LLC

HOME PRODUCTS FORUMS APPLICATIONS DOWNLOADS SUPPORT ACADEMIC CONTACT US

### EFDC Explorer 7.0

- New streamlined user interface.
- Rooted Plant & Epiphyte Model (RPEM).
- Output bitmap images of user defined resolution.
- Write KML files for grid and model 2D fields.
- ViewPlan results of specified depth or elevation.
- As well as many more enhancements.

**FULL VERSION** **TRIAL VERSION** **WEB VERSION**

Start Full Version **GET NOW** Updated 21 Jan 2013

Start Trial Version **GET NOW** Updated 21 Jan 2013

Start Web Version **FREE** Updated 21 Jan 2013

WELCOME TO EFDC EXPLORER

#### Overview

English | 한국어 | 中文 | Español | Tiếng Việt

EFDC\_Explorer (EE) is a Windows-based GUI developed by Dynamic Solutions International, LLC (DSI) for pre- and post processing of the Environmental Fluid Dynamics Code (EFDC). EFDC\_Explorer is designed to support model set-up, Cartesian and curvilinear grid generation, testing, calibration, and data visualization, including plots and animation of EFDC model results.

EE supports hydrodynamics, sediment/flux transport and the coupled water quality model HECQC. EE now also supports multithreading capability (OpenMP) for dramatically decreased EFDC model run times.

# EFDC\_Explorer

## EE User Community

[www.efdc-explorer.com/forum](http://www.efdc-explorer.com/forum)

The screenshot displays the EFDC\_Explorer forum website. At the top, there is a navigation bar with the logo for Dynamic Solutions-International LLC and a search bar. Below the navigation bar, there are links for Home, Products, Forums, Applications, Download, Support, Academic, and Contact Us. The main content area is divided into several sections:

- Welcome to our EFDC\_Explorer Forums**: A welcome message for the forum.
- Jump**: A search bar for navigating between forums.
- EFDC\_EXPLORER**: A section header for the main forum.
- EFDC\_Explorer Forum**: A forum listing with columns for Forums, Stats, and Latest Post. The listing shows 65 Topics, 671 Replies, and a latest post by 'vishchen' on Jan-29-13 12:00:51.
- EFDC MODEL**: Another forum listing with columns for Forums, Stats, and Latest Post. The listing shows 29 Topics, 70 Replies, and a latest post by 'efdc\_help' on Feb-03-13 22:42:31.
- BOARD INFO**: A section providing board statistics and user information.

**Board Stats:**

- Total Topics: 94
- Total Posts: 241
- Total Polls: 0
- Dormant:

**User Info:**

- Total Users: 1543
- Newest User: ivy1234567
- Members Online: 1
- Guests Online: 11

**Forum Legend:**

- Topic
- New
- Locked
- Sticky
- Active
- New/Active

# Contact Information

- [www.ds-international.biz](http://www.ds-international.biz)
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  - [ee\\_info@ds-intl.biz](mailto:ee_info@ds-intl.biz)