Toxic Modeling in Baltimore Harbor

Sensitivity Test: Impact of New Sediment from Point and Nonpoint Sources

Technical Outreach

Prepared by

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Prepared for the
Baltimore Harbor Stakeholder Advisory Group

December 3, 2002

UMCES – Toxic Box Model

- Model Status
  - Hydrodynamic/Sediment Transport
    - Linking Nonpoint Source and Point Source Loads – Completed
    - Mass Balance Check - Completed
    - Transfer Coefficients Calculation - Completed
    - Sediment Transport Sensitivity Test
  - Toxic Box/Foodweb
    - Linking Nonpoint Source and Point Source Loads – Completed
    - Sensitivity Test
    - Linking Hydrodynamic/Sediment Transport Model

UMCES – Hydrodynamic/Sediment

- The sediment transport model is built on the existing hydrodynamic model of Baltimore Harbor. (POM)
- The model is driven by observed winds as well as water level and salinity at the Harbor entrance.
- It solves for salinity, water level, velocities and sediment concentrations in three dimensions with temporal resolution of 1 second.
- The horizontal resolution is 360m.
- Vertical resolution: 6 layers.
- The whole study area has been divided into 24 boxes. Model outputs are averaged for each box.

UMCES – Hydrodynamic/Sediment

- Three particle categories for sediments represented with different settling velocity were simulated in this model.
  - slow settling velocity particles: 0.001mm/s.
  - intermediate settling particles: 0.15mm/s.
  - Fast settling particles: 2mm/s.

- Data : Time varying sea level at the Harbor mouth and time-varying winds to predict the temporal evolution of currents, sea-surface elevation, and water properties within the Harbor for 4 observed months.
  - **May 1995**
  - October/November 1999 – **CHARM 1**
  - March/April 2000 – **CHARM 2**
  - July/August 2000 – **CHARM 3**

UMCES – Hydrodynamic/Sediment

- Horizontal Transport:
  - Sediment transfer coefficient (the gross sediment transport) between box boundaries are presented by the gross fluxes divided by sediment concentration:

    $T_{12} = F_{12} / C_1$

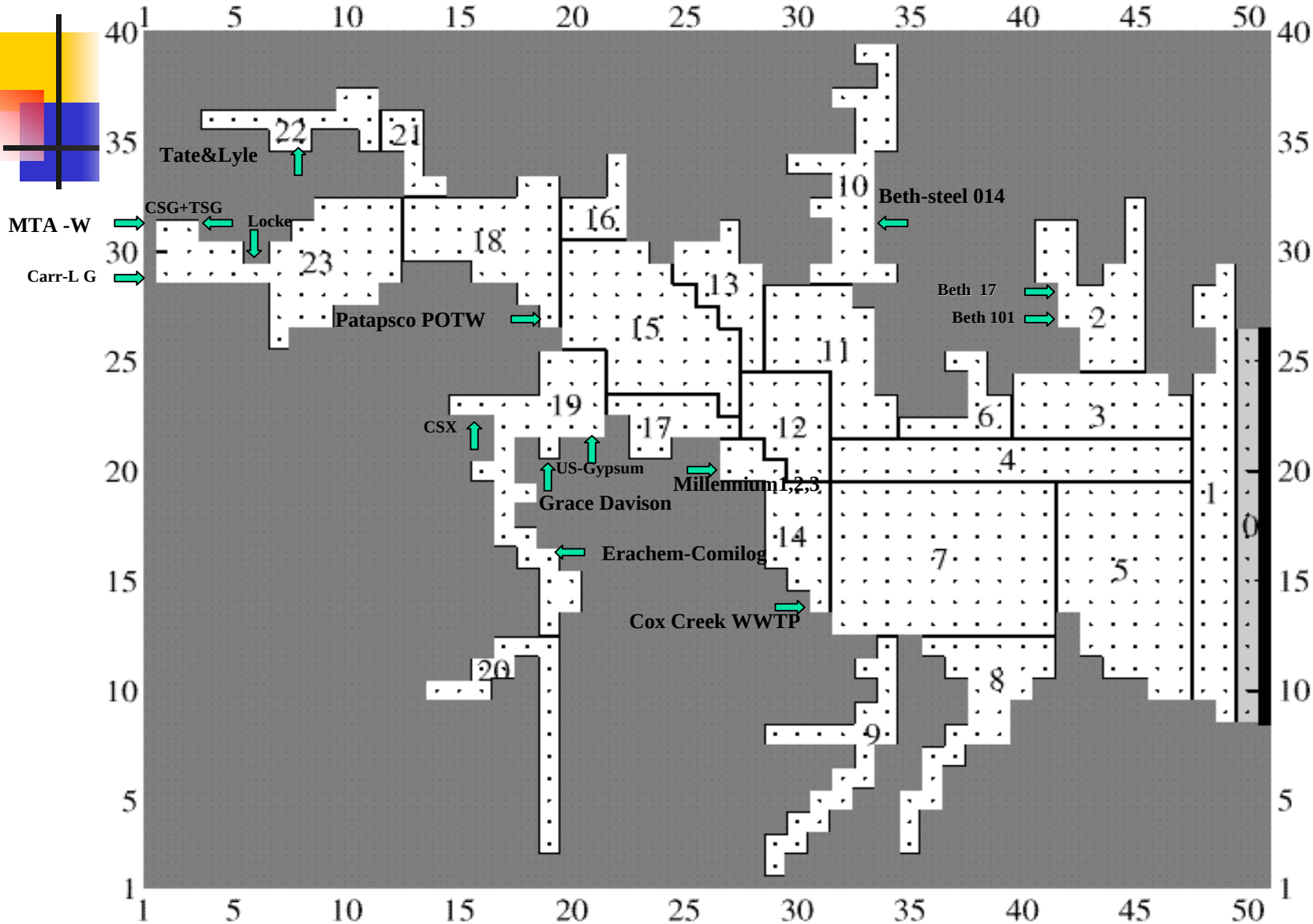
    where T_{12} is the transfer coefficient from box 1 to Box 2

    F_{12} is the sediment flux from box1 to box2

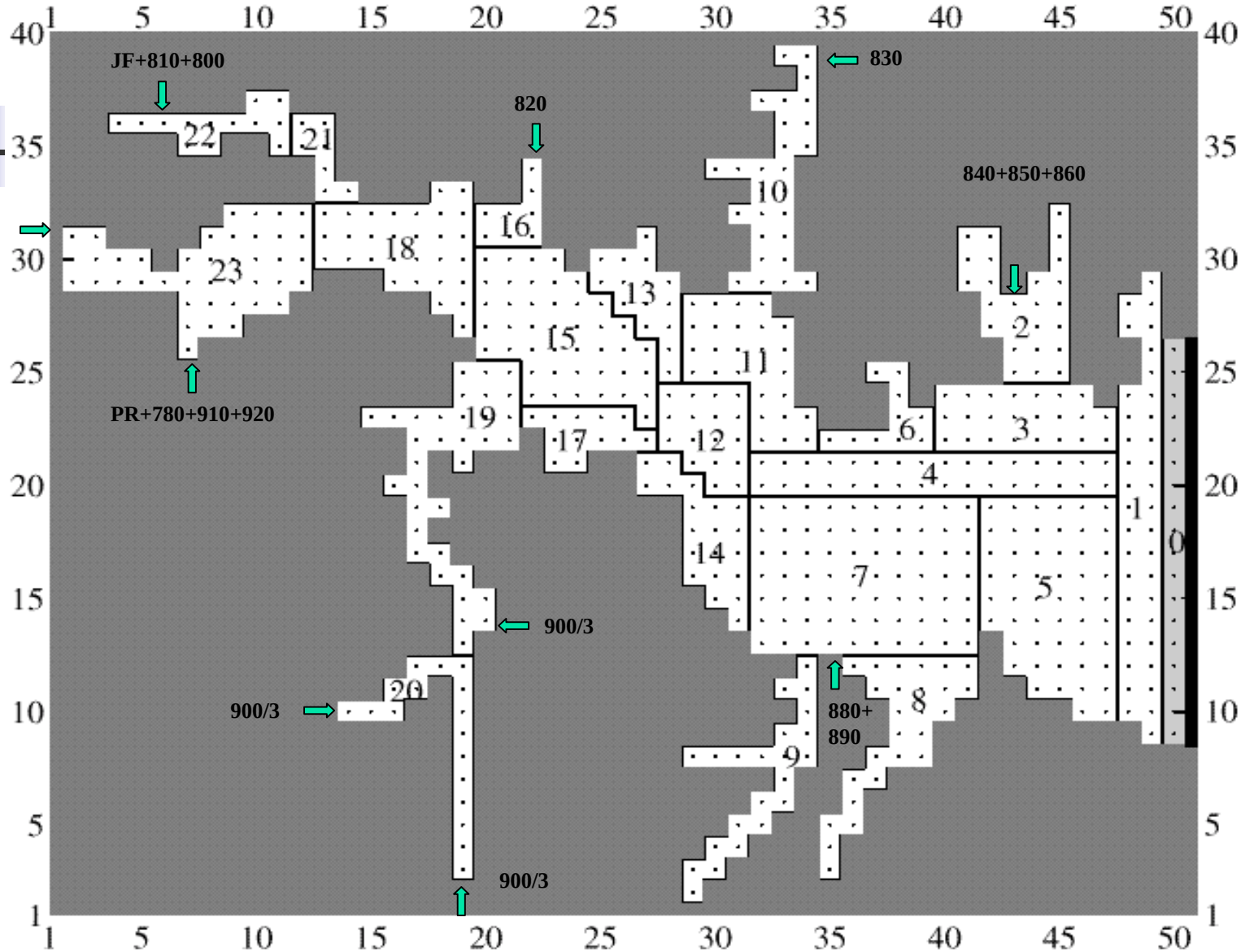
    C_1 is the total suspended sediment concentration of box 1

- Vertical Transport:
  - Erosion/Deposition rate

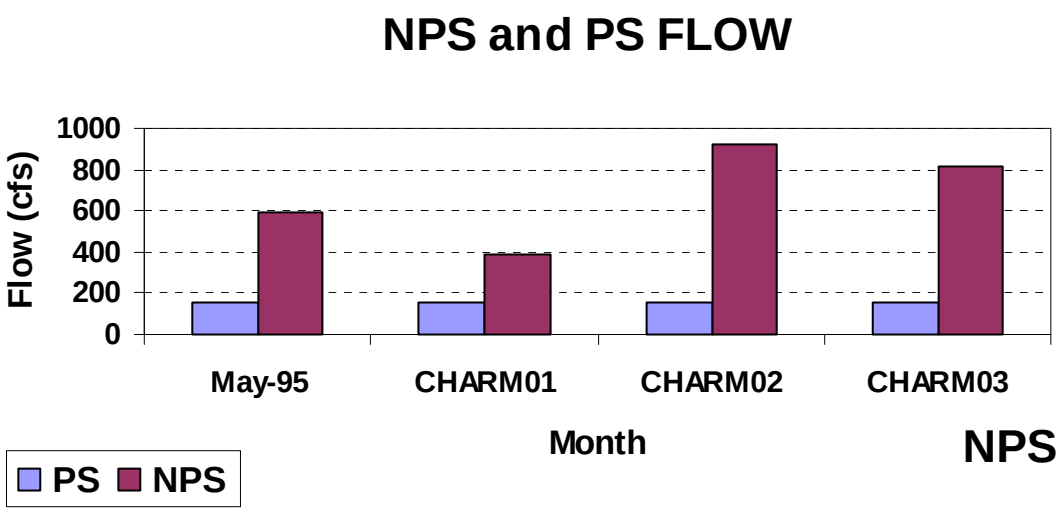
Baltimore Harbor Point Source to UMCES Box Model

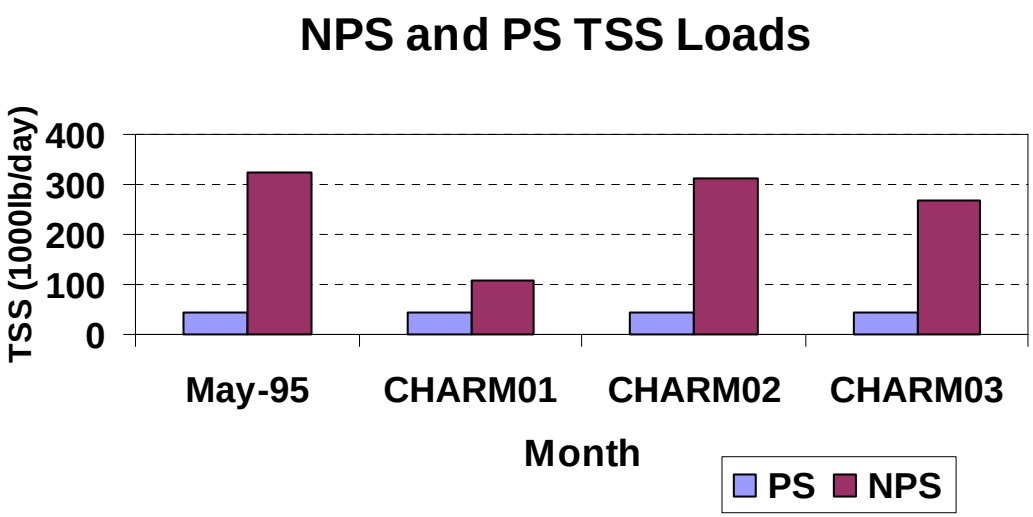


Baltimore Harbor Non-point Source Inputs to UMCES Box Model



Data Analysis





UMCES – Hydrodynamic/Sediment

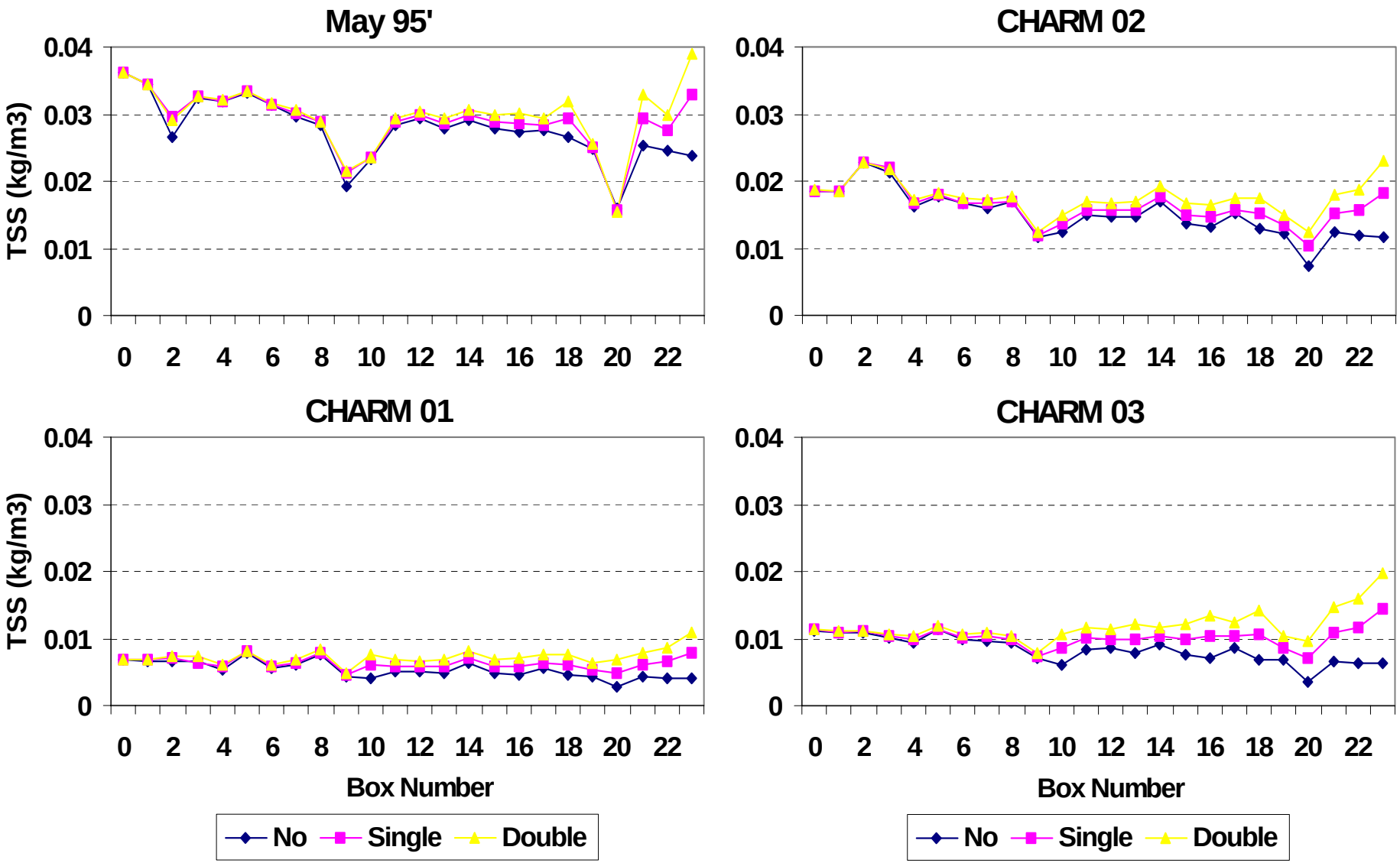
- Sensitivity Tests
  - No Nonpoint + Point Source Loads
  - Nonpoint + Point Source Loads
  - Double Nonpoint + Point Source Loads

UMCES – Hydrodynamic/Sediment Mass Balance Check

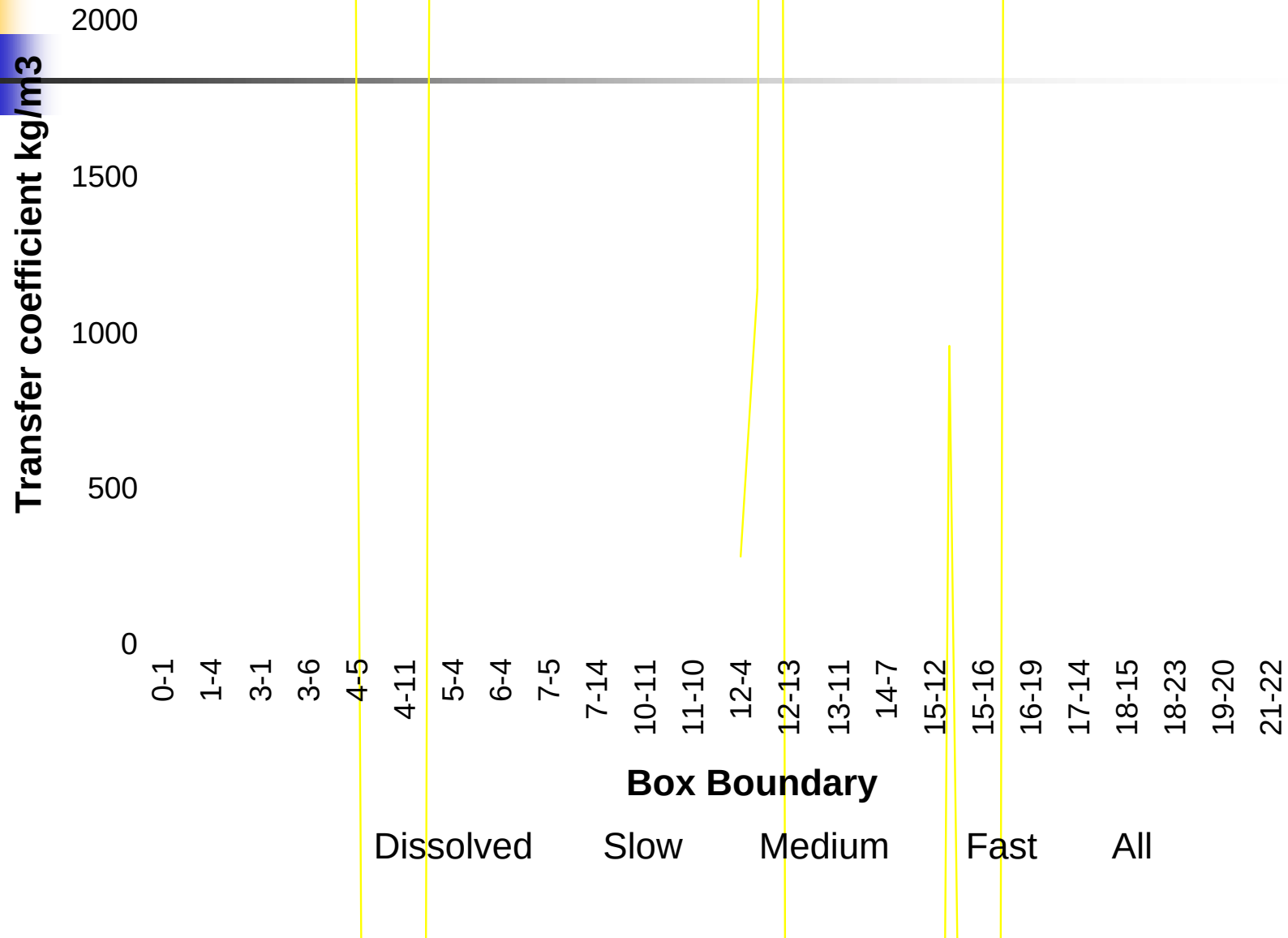
- **October/November 1999 – CHARM 1**

Model run >>>	dissolved	Slow	Intermediate	Fast	All
Mstart (10^6 kg)	0.436	2.789	0.039	0.000	3.265
Mboundaryflux (10^6 kg)	-0.023	-0.144	-1.520	-0.246	-1.932
Meroded (10^6 kg)	0.000	0.000	114.653	1482.040	1596.693
Mdeposited (10^6 kg)	0.000	1.152	114.215	1481.770	1597.137
Meroded-deposited (10^6 kg)	0.000	-1.152	0.438	0.266	-0.449
Mflux3r(10^6kg)	0.000	0.648	0.648	0.000	1.296
Msumfnps(10^6kg)	0.000	0.105	0.105	0.000	0.209
Msumfps(10^6kg)	0.000	0.300	0.300	0.000	0.599
Mremain (10^6 kg)	**0.414**	**2.546**	**0.009**	**0.020**	**2.989**
Mend (10^6 kg)	**0.414**	**2.550**	**0.013**	**0.000**	**2.977**
Mabsolute (10^6 kg)	**0.000**	**-0.004**	**-0.004**	**0.020**	**0.012**
Percent error (%)					0.408

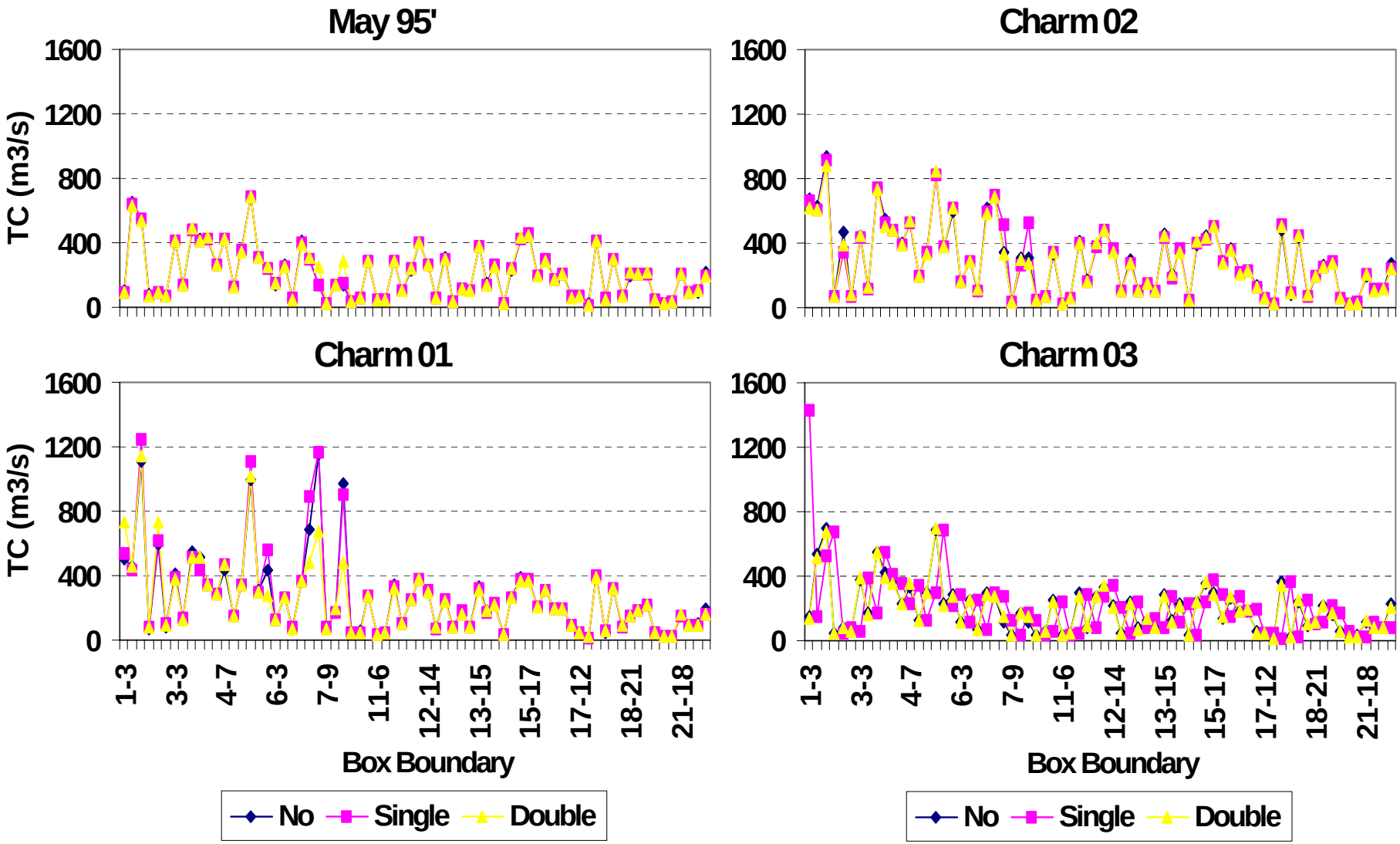
TSS Concentration



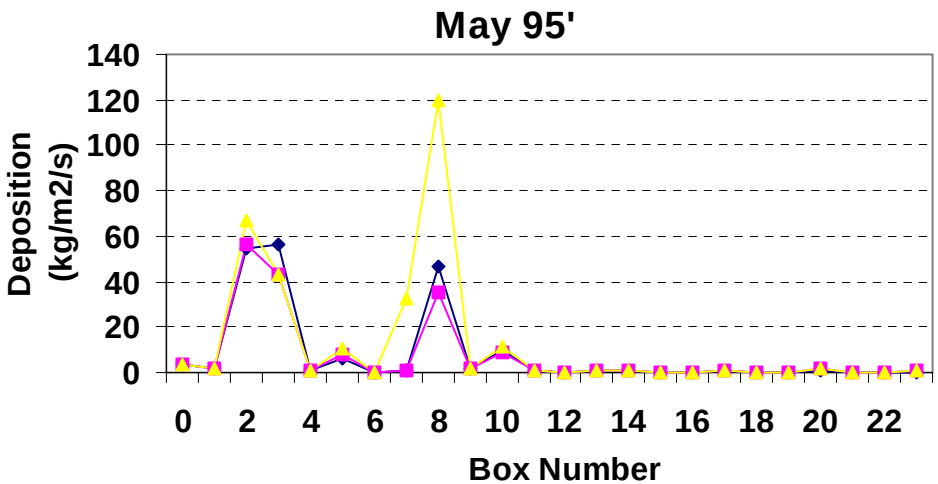
Horizontal Transport

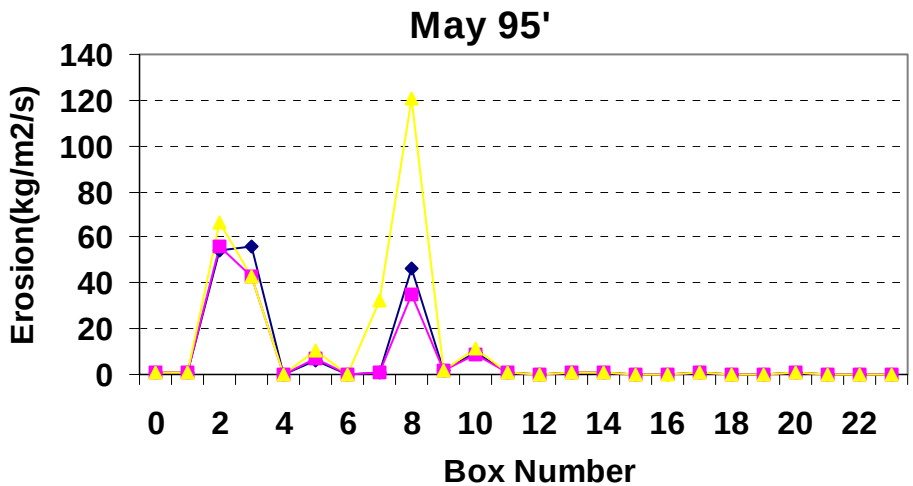


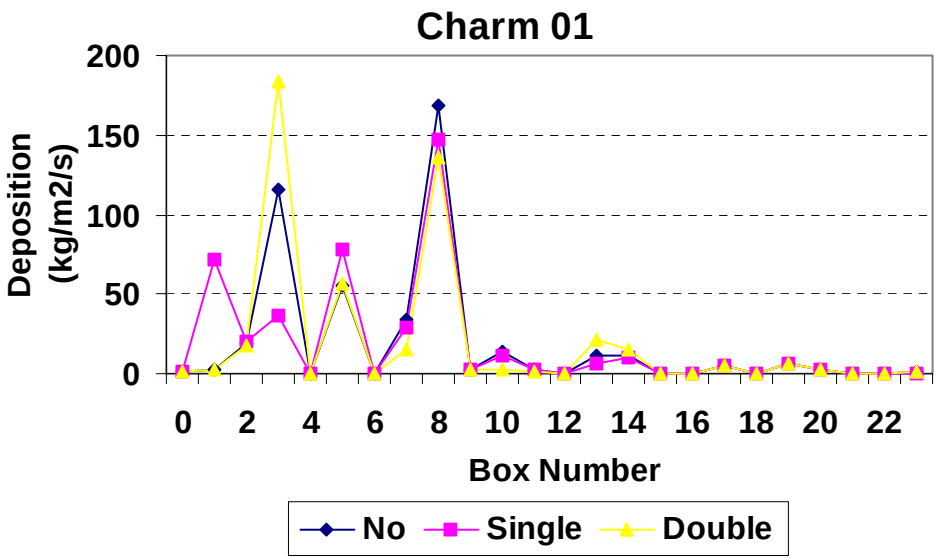
Transfer Coefficients

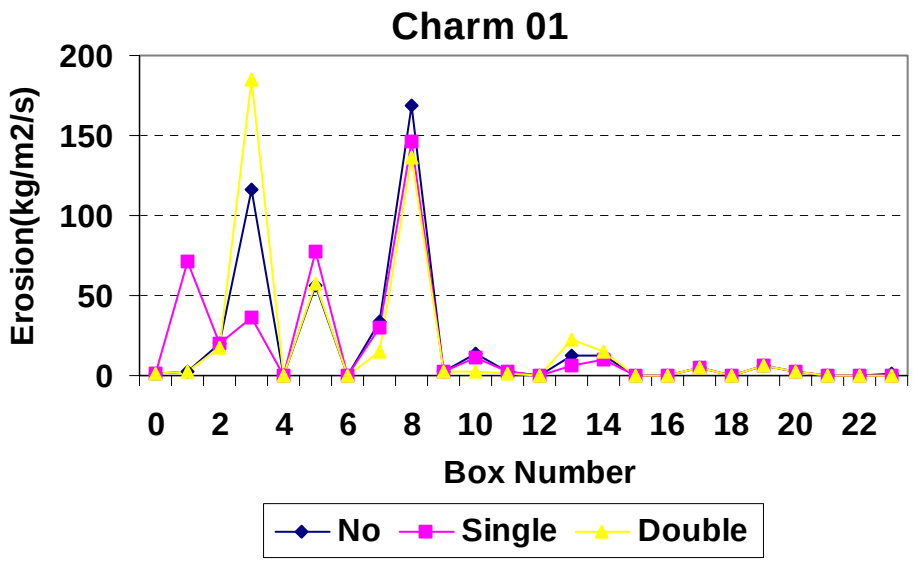


Vertical Exchange









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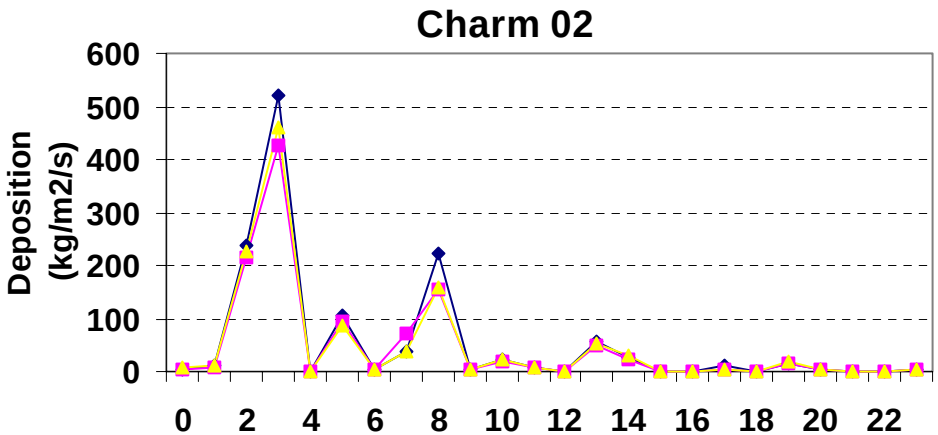

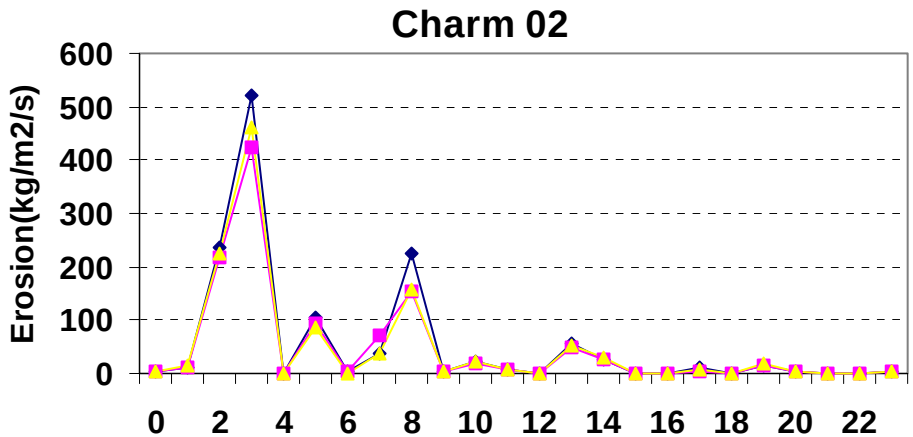

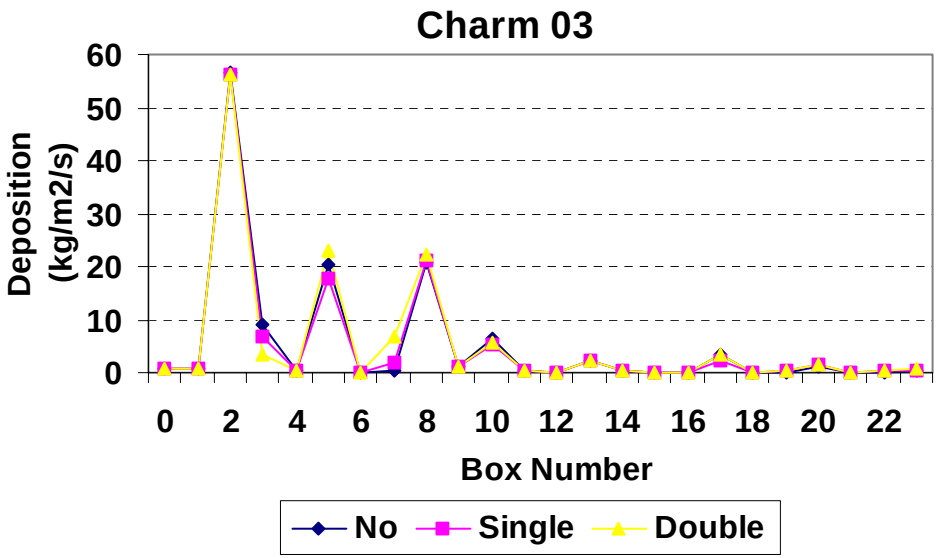

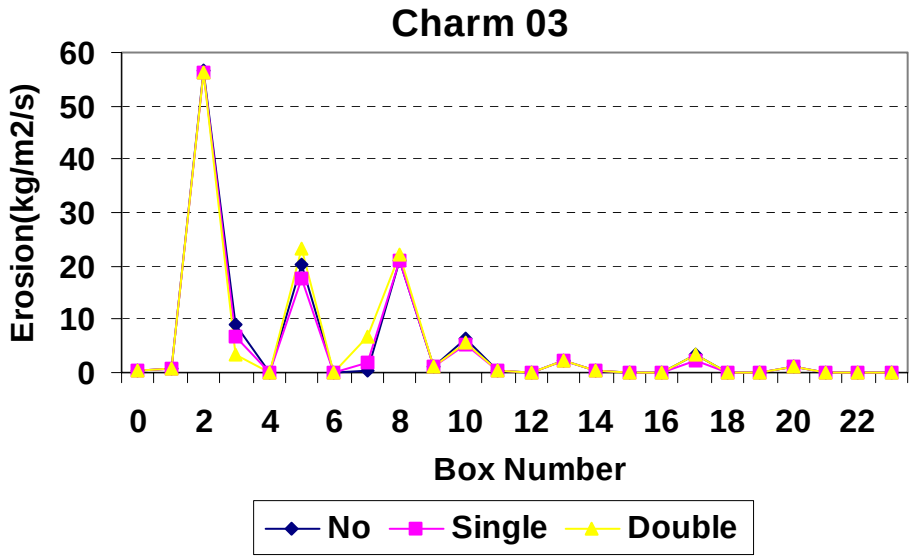

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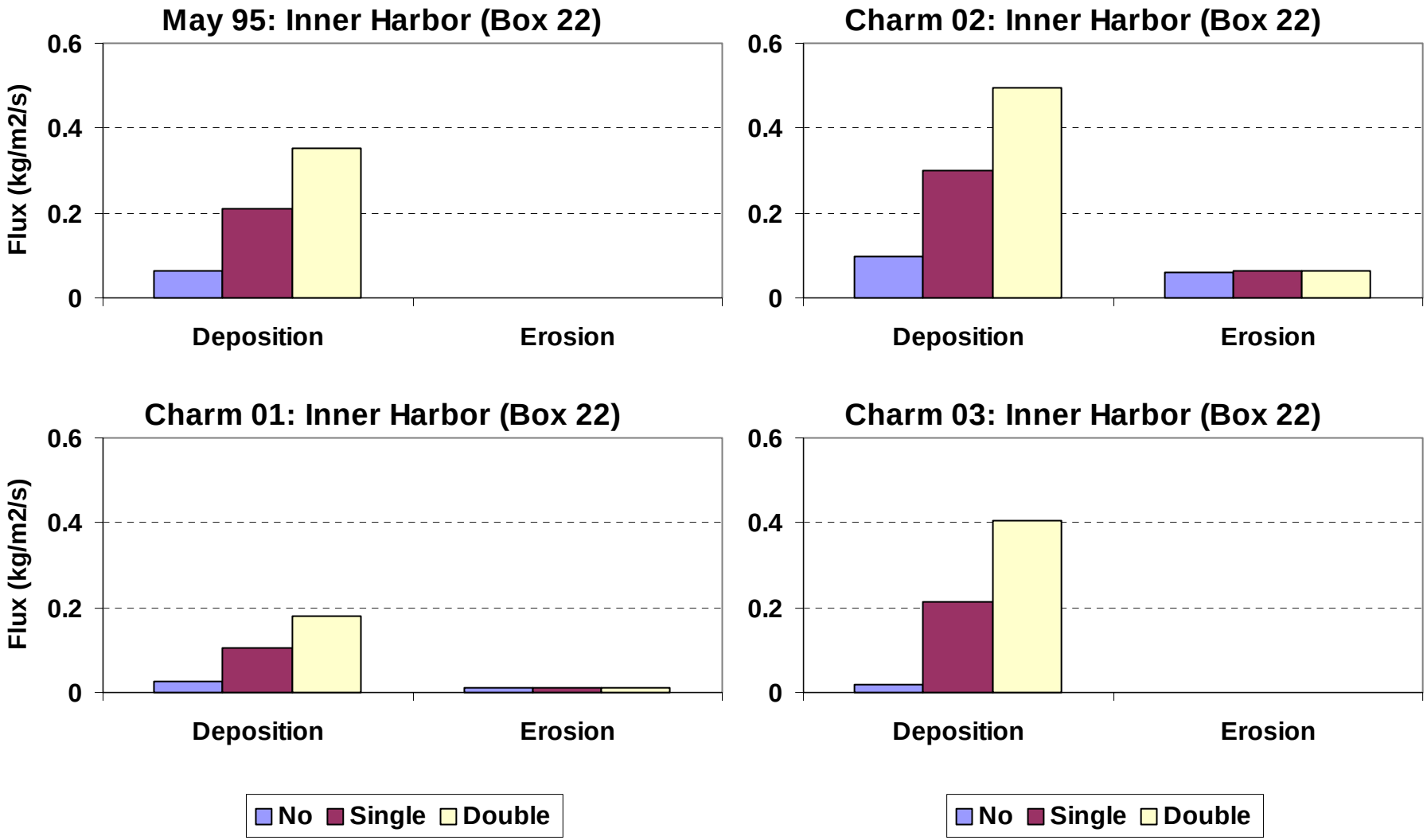

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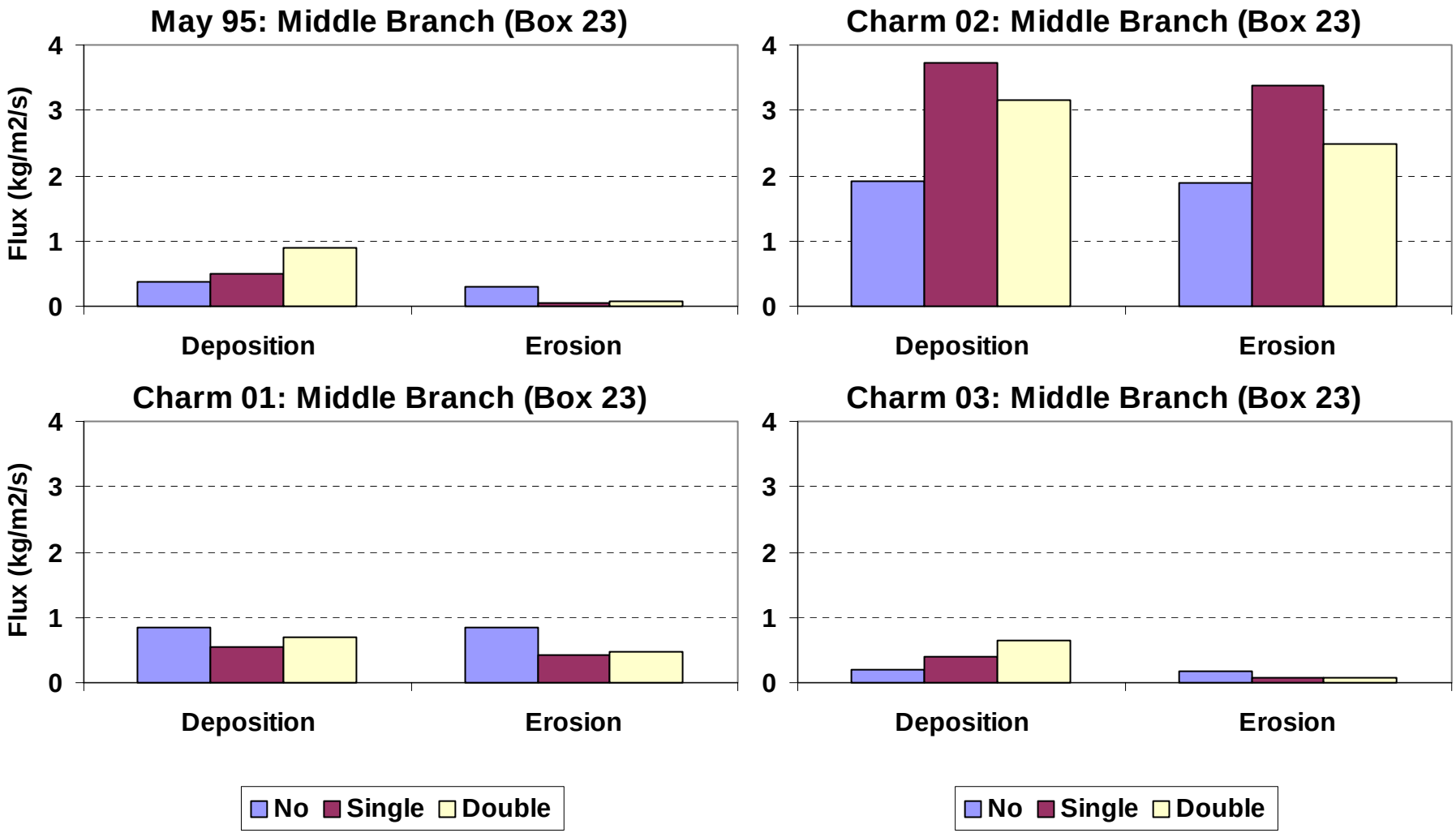

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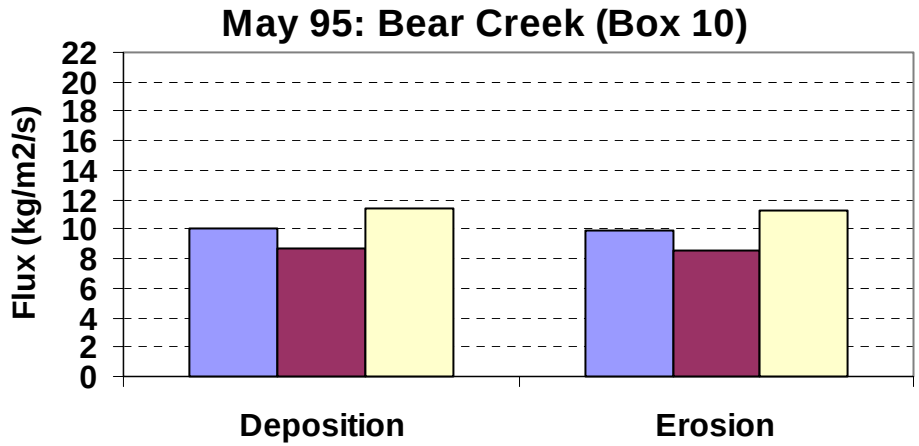

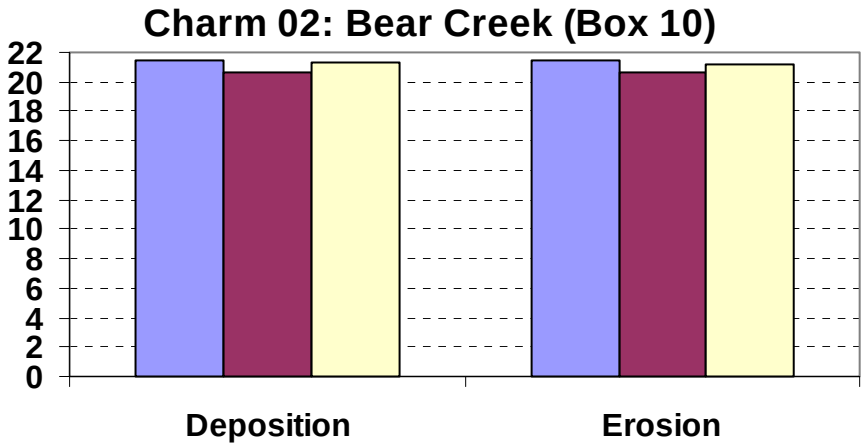

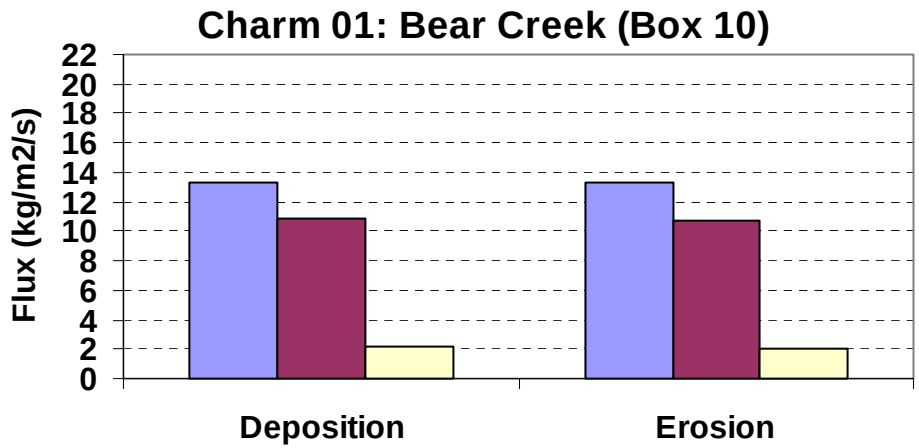

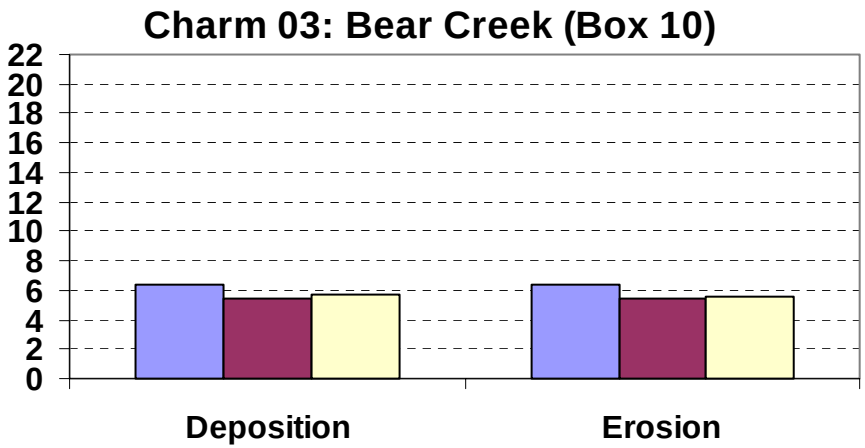

No Single Double

No Single Double

Summary

- The model responds to increasing external loads with increasing sediment concentration (mass) which was dominated by slow settling particles.

- Overall transport pattern will be changed with new sediment inputs from external sources (point sources + non-point sources) depending on the balance of external loads, vertical exchanges and horizontal transport.

- New sediment input does enhance vertical exchange (more erosion and deposition resulting in longer residence time) which will be important for contaminant transport.

Future Actions

- Sensitivity tests of Nonpoint Source/Point Source load reduction using UMCES Box Model.
- Propose Preliminary TMDL Scenarios
- Suggestions?