Contaminant Transport and Bioaccumulation Modeling

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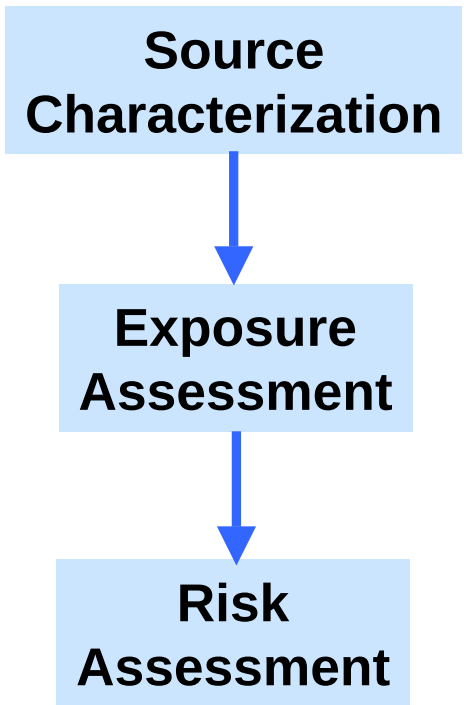


Purpose of Modeling

- To confirm / extend interpretation of field data
- To determine contaminant contributions from various sources
- To provide forecasts of future conditions under various remedial options
- To evaluate relevant mechanisms controlling contaminant transport and bioaccumulation

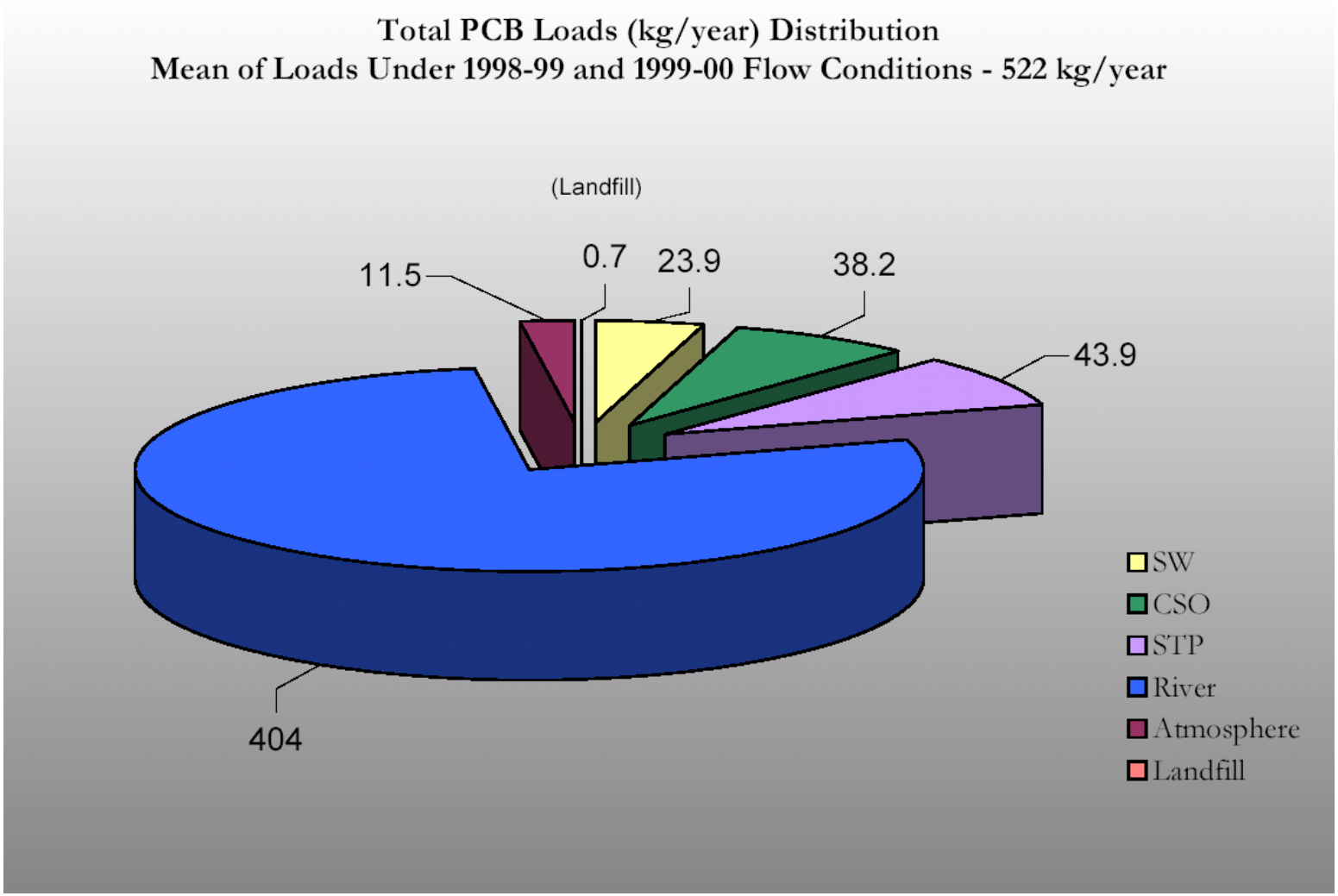
CARP

Contaminants

- PCBs
- Dioxins
- Furans
- Hg
- meHg
- Cd
- PAHs
- Pesticides
- etc.

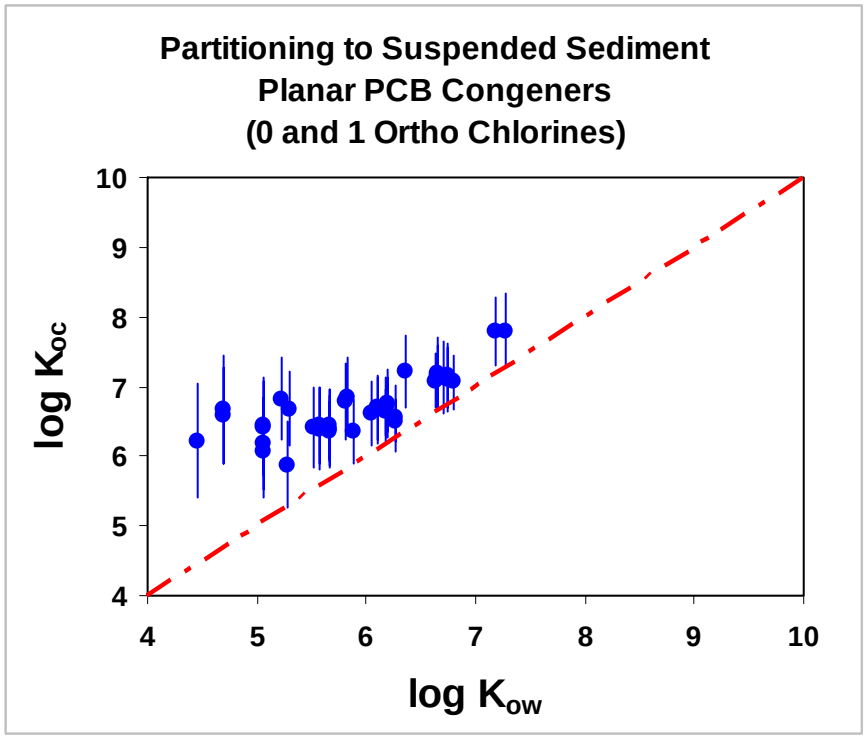
Source Characterization

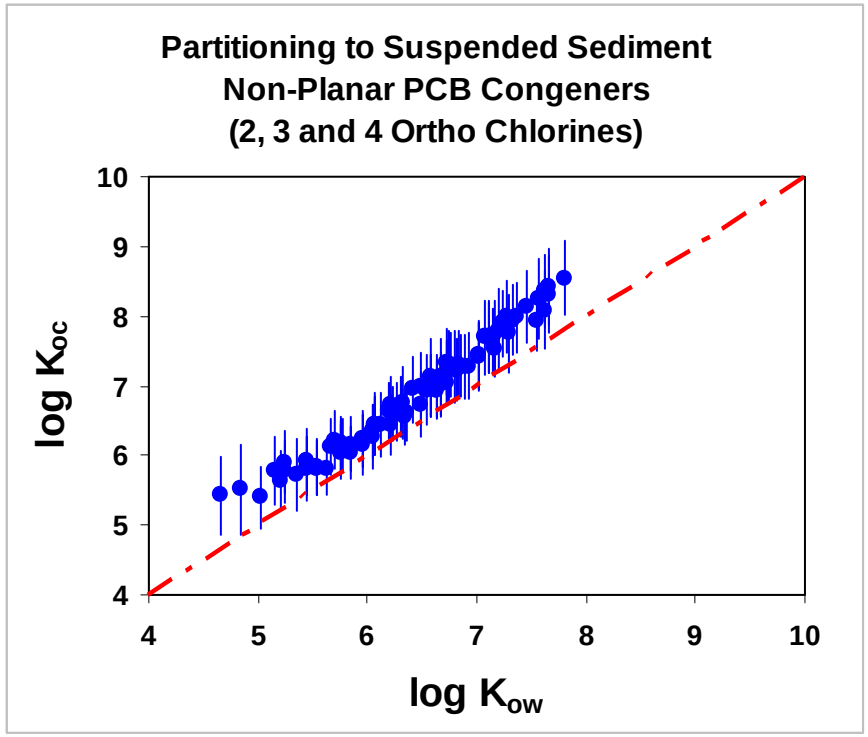
(34 Tributaries, 99 STPs, >1,000 CSOs and SWOs, plus atmospheric and landfill inputs)



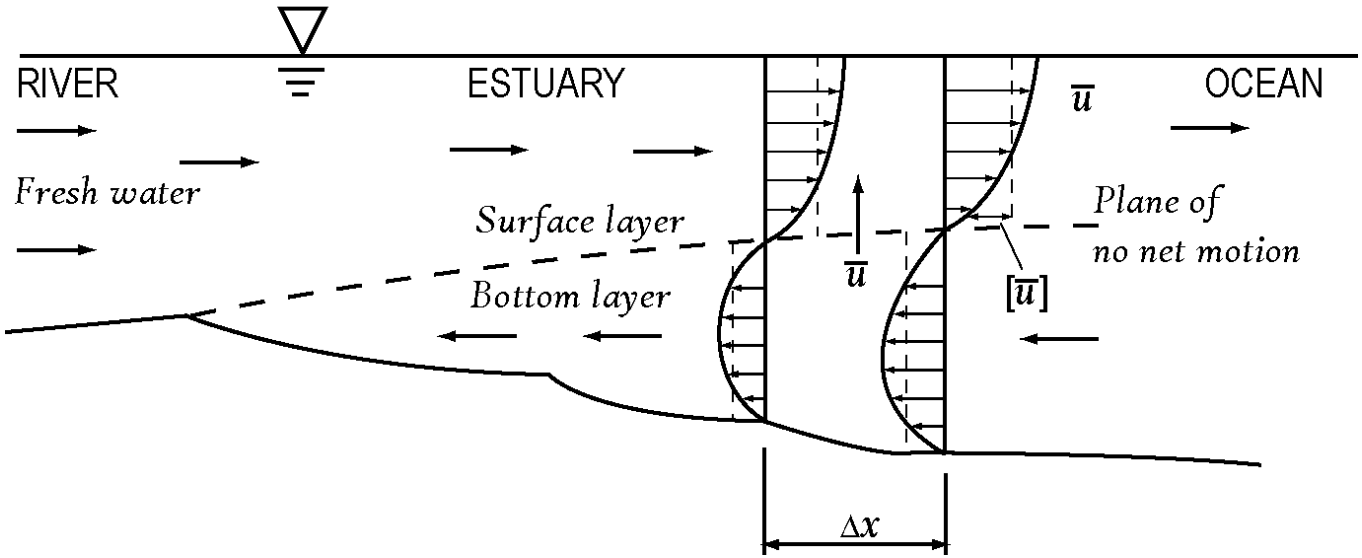
Contaminant Fate Processes

(hydrodynamics, sediment transport, organic carbon cycling, sorption, volatilization, chemical transformations)



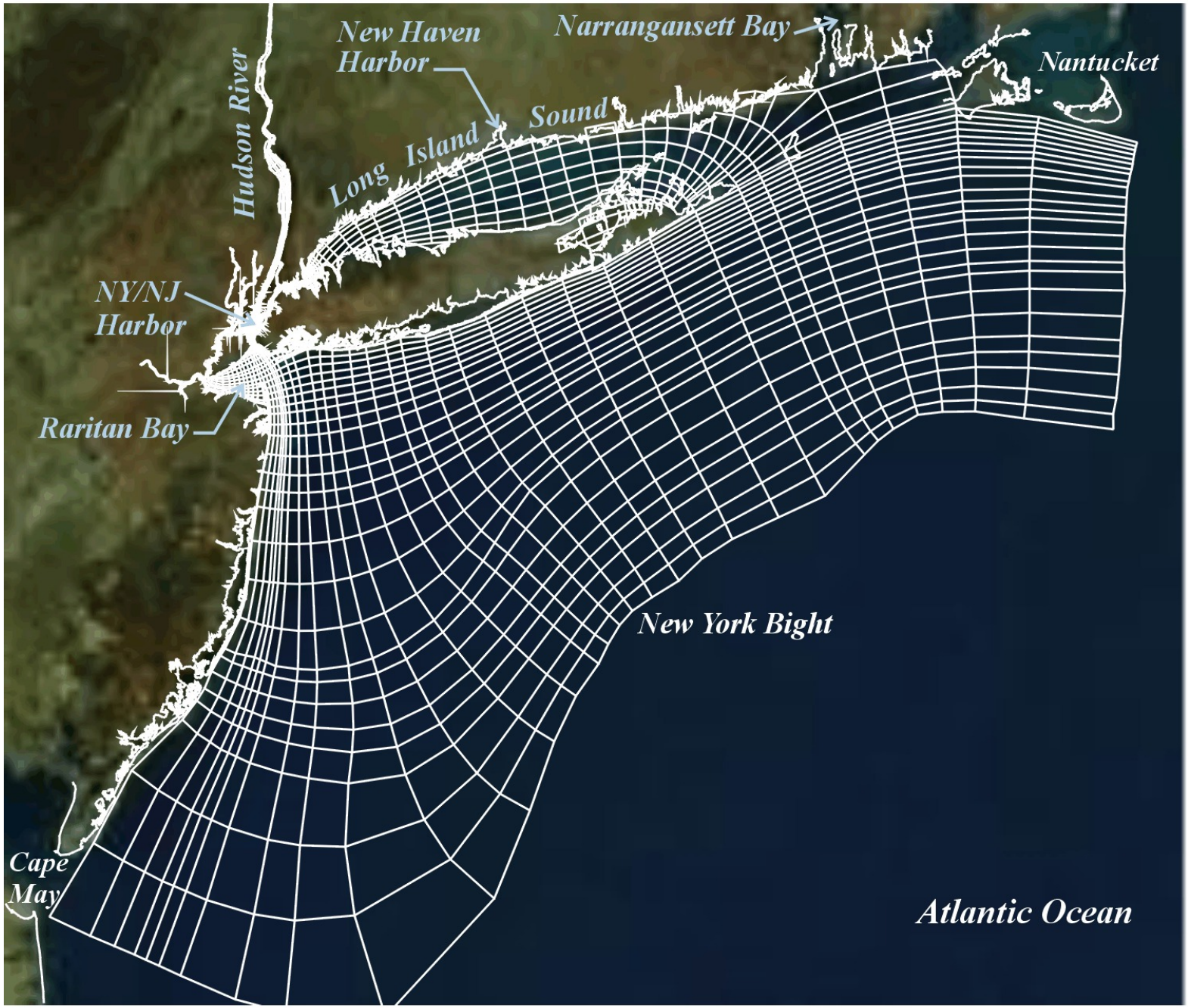


Estuarine Circulation



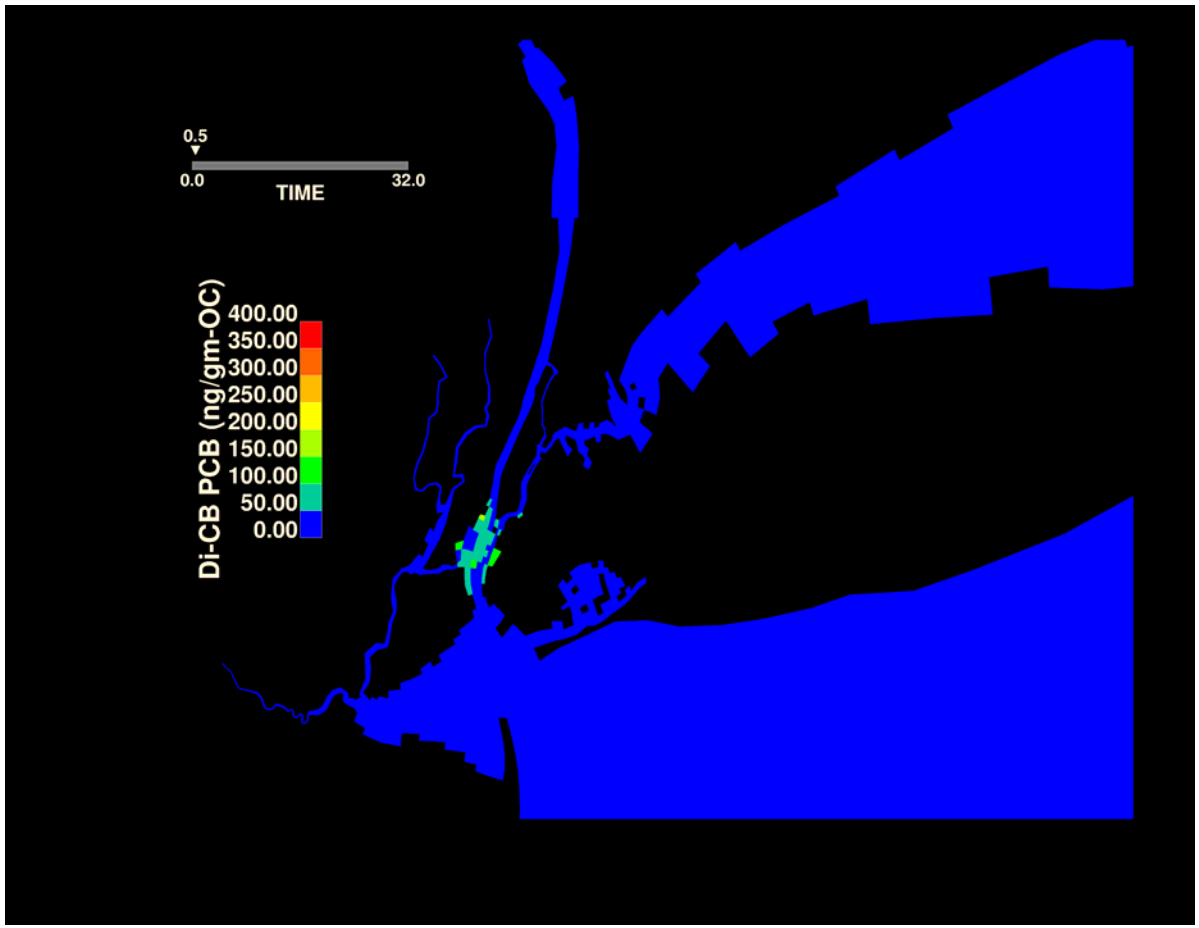
From Schnoor, 1996

Model Grid: 16,000 water column and 16,000 sediment cells


New Haven Harbor
Narrangansett Bay
Nantucket
Hudson River
Long Island Sound
NY/NJ Harbor
Raritan Bay
New York Bight
Cape May
Atlantic Ocean

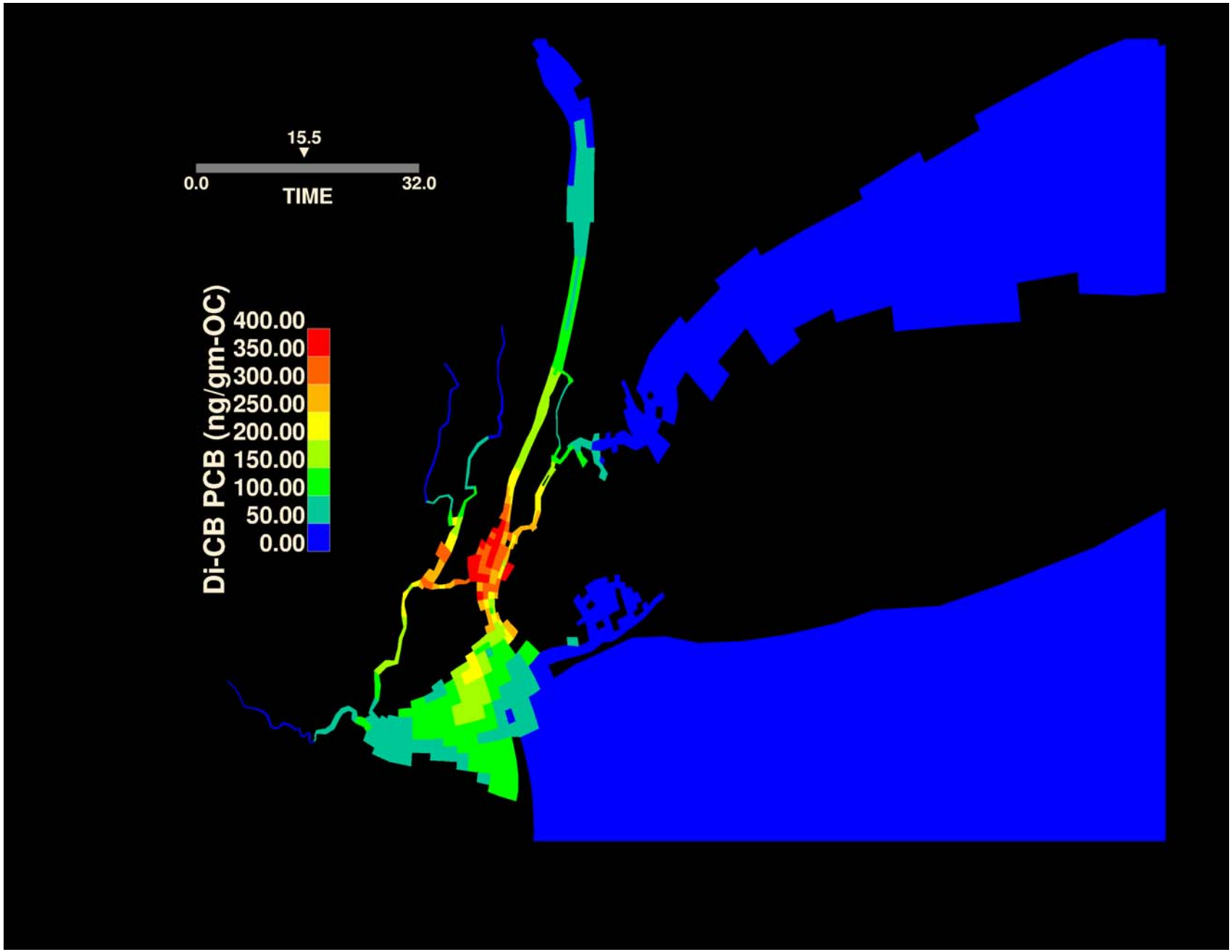
Passaic Valley Sewage Discharge

Release of 3,3’-dichlorobiphenyl: BZ#11



pvsc_16yrW_16yrNWdi.exe

pvsc_16yrW_16yrNWocta.exe


15.5
0.0
TIME
32.0
Di-CB PCB (ng/gm-OC)
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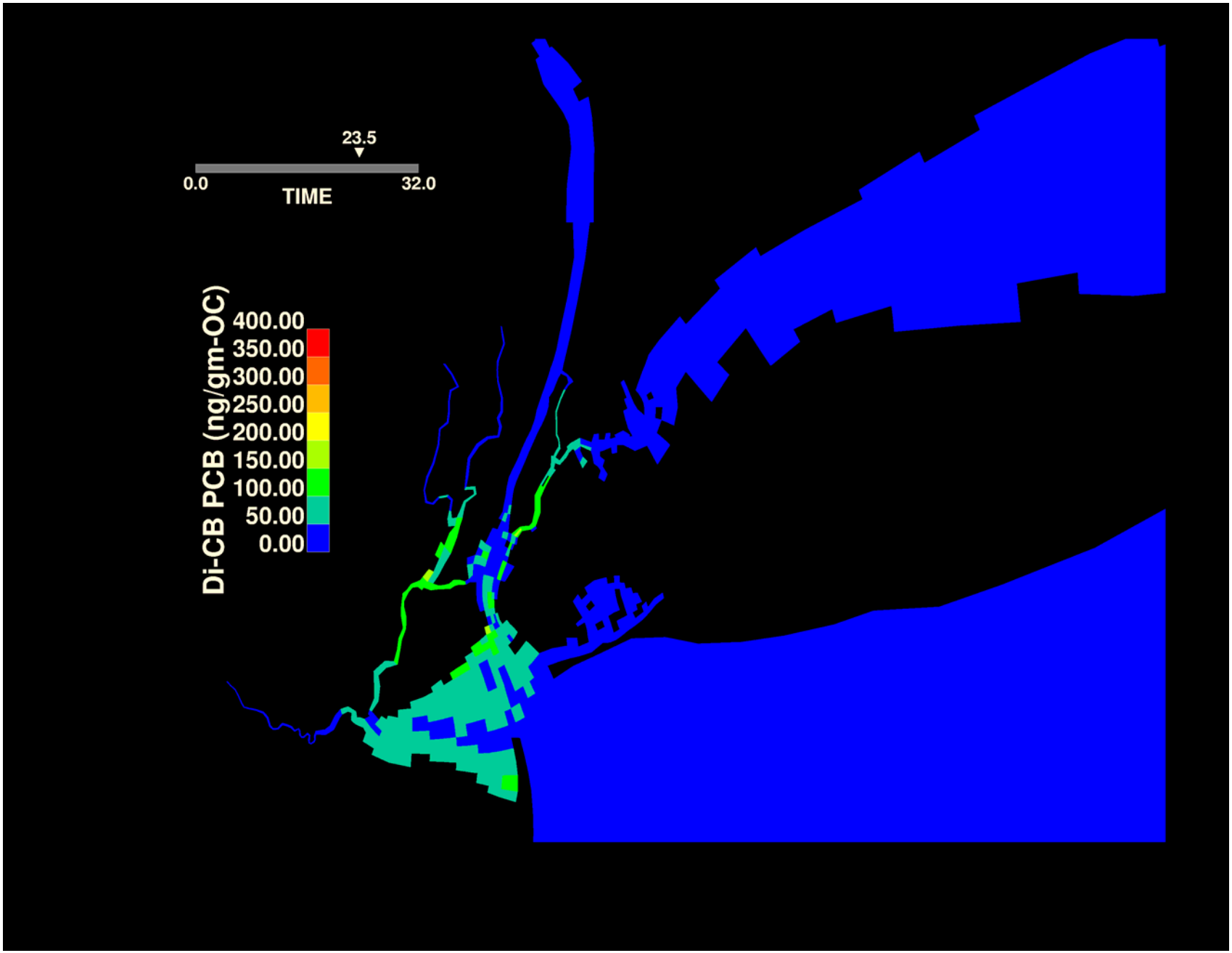
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00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0.0
32.0
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Di-CB PCB (ng/gm-OC)
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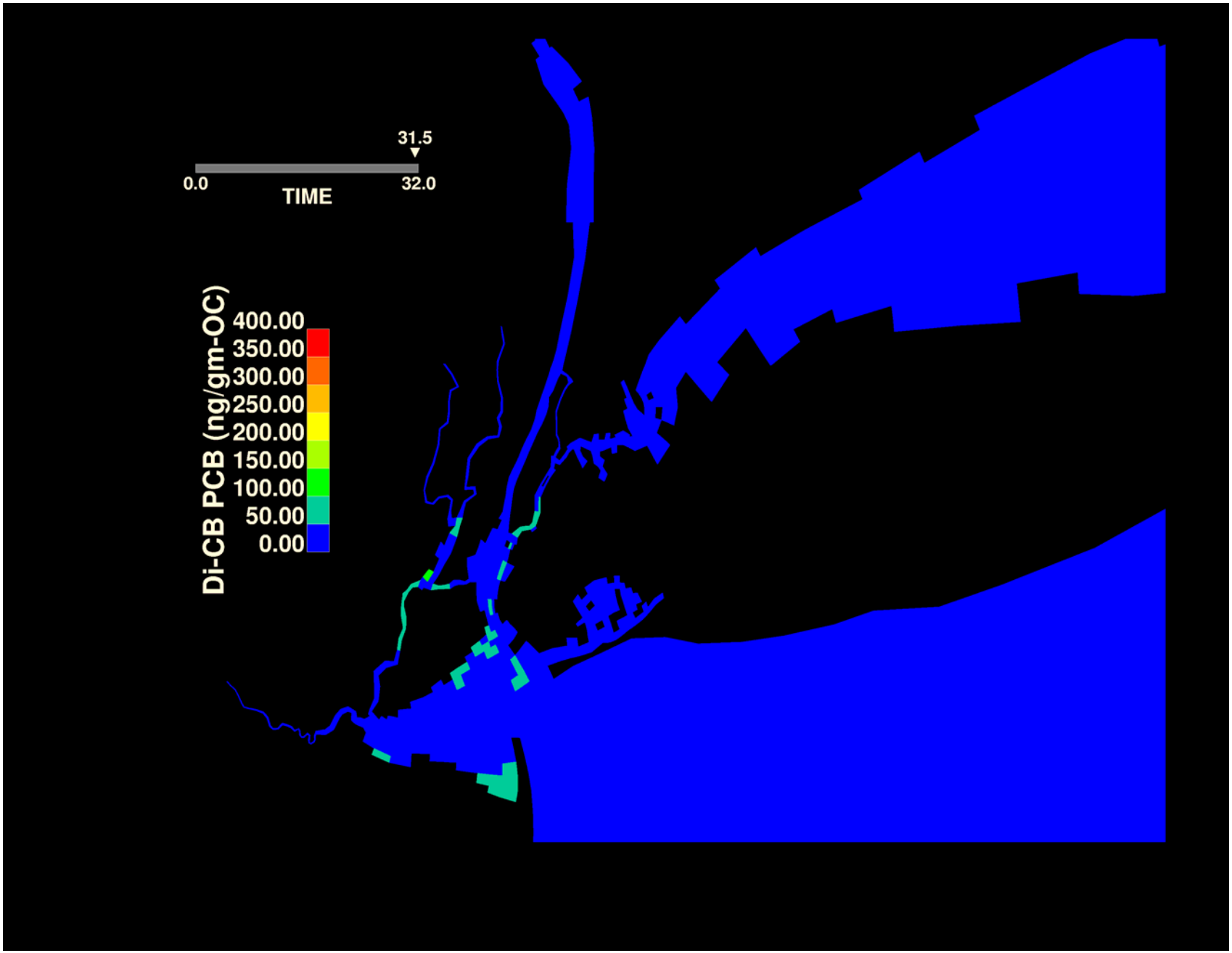
250.00
200.00
150.00
100.00
50.00
0.00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32.0
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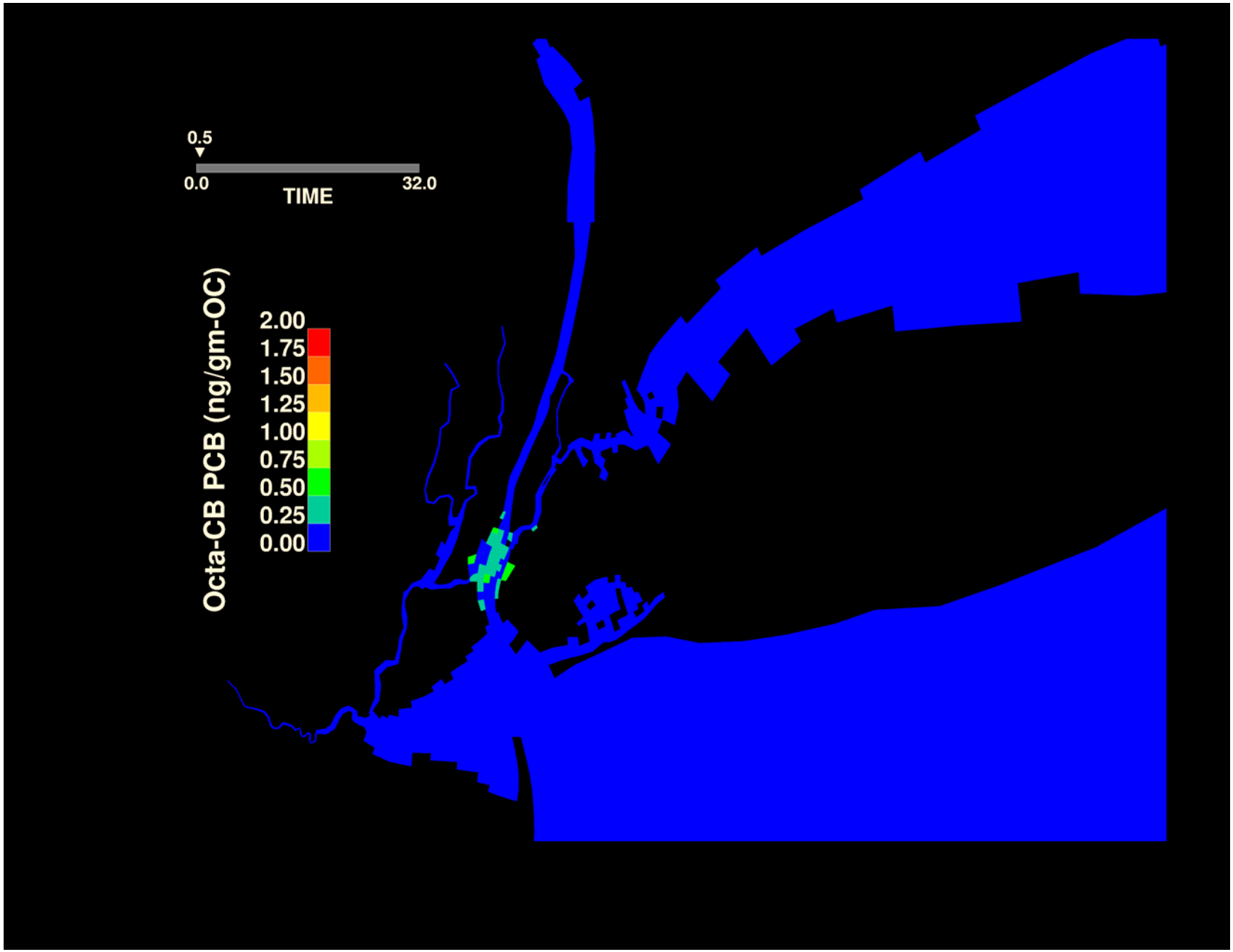
250.00
200.00
150.00
100.00
50.00
0.00


0.5
0.0
TIME
32.0
Octa-CB PCB (ng/gm-OC)
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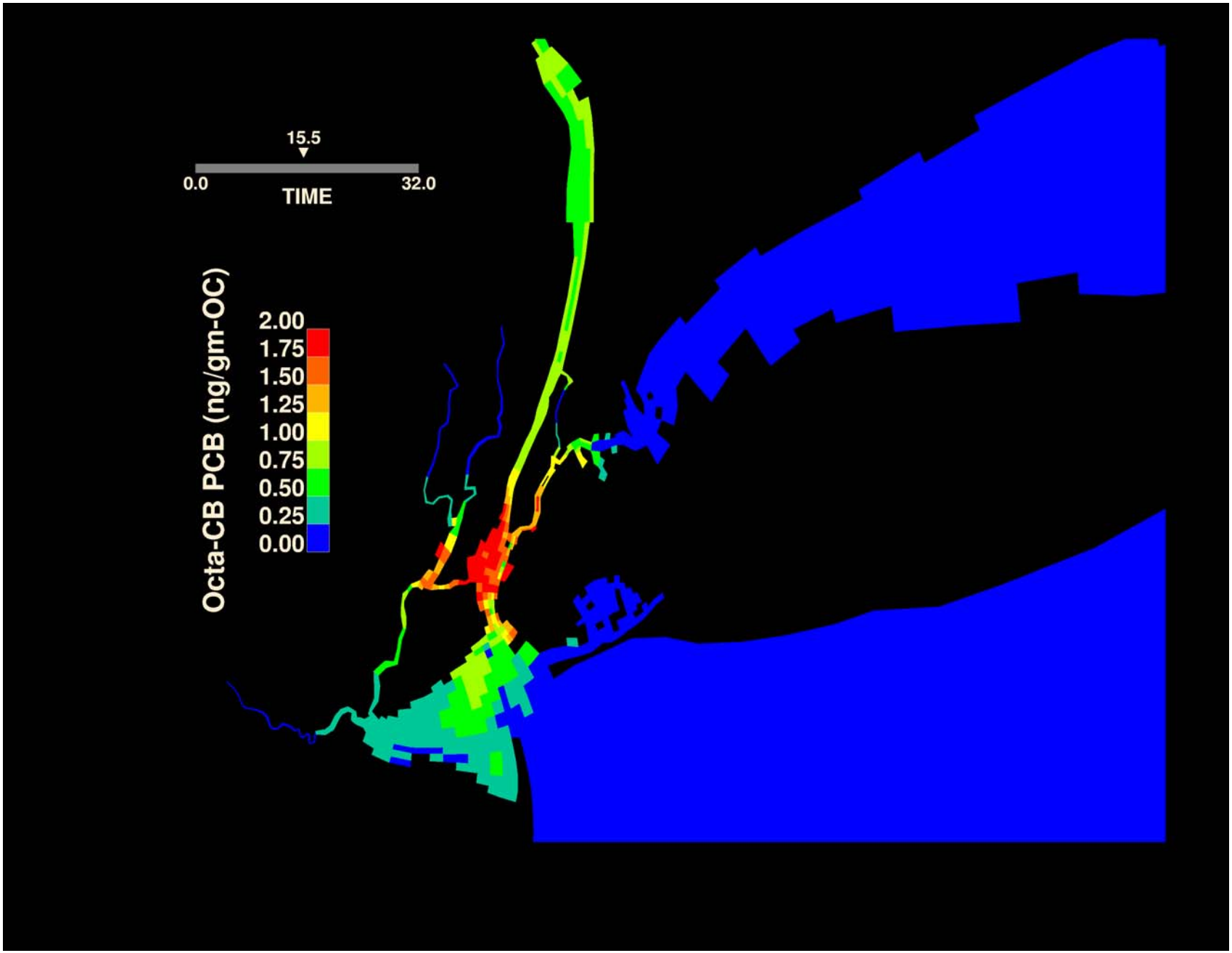
1.50
1.25
1.00
0.75
0.50
0.25
0.00


15.5
0.0
TIME
32.0
Octa-CB PCB (ng/gm-OC)
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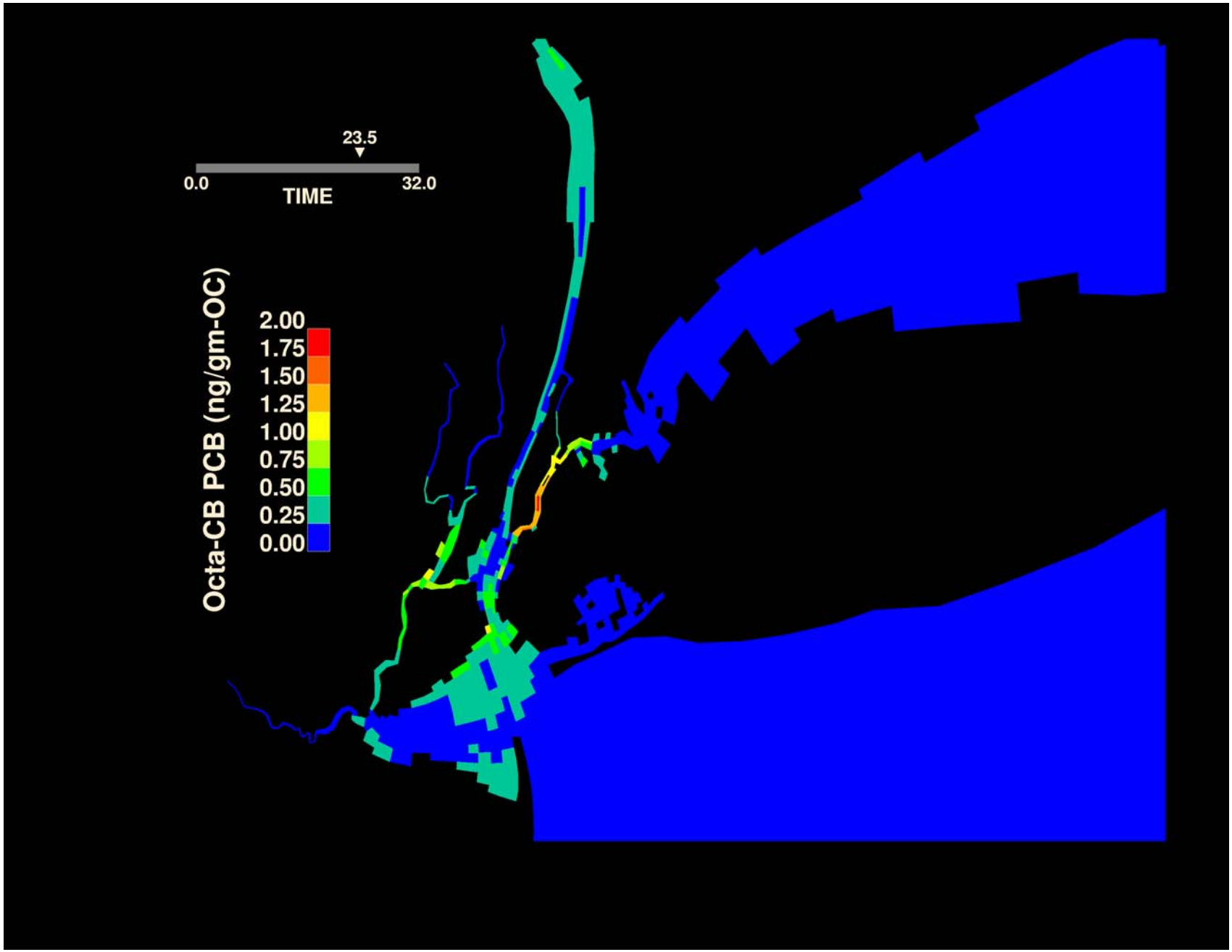
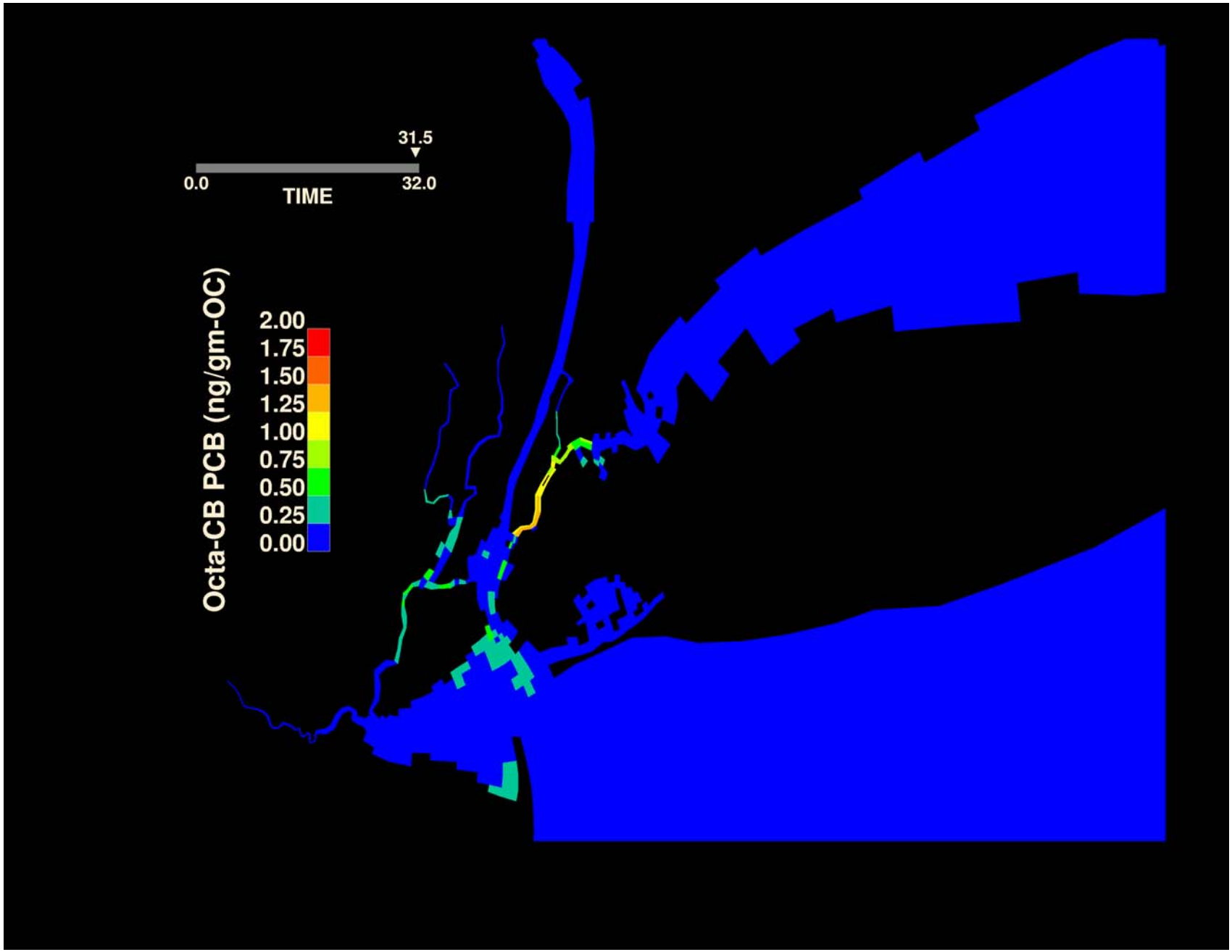
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00


23.5
0.0
32.0
TIME
Octa-CB PCB (ng/gm-OC)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00


31.5
0.0
TIME
32.0
Octa-CB PCB (ng/gm-OC)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00

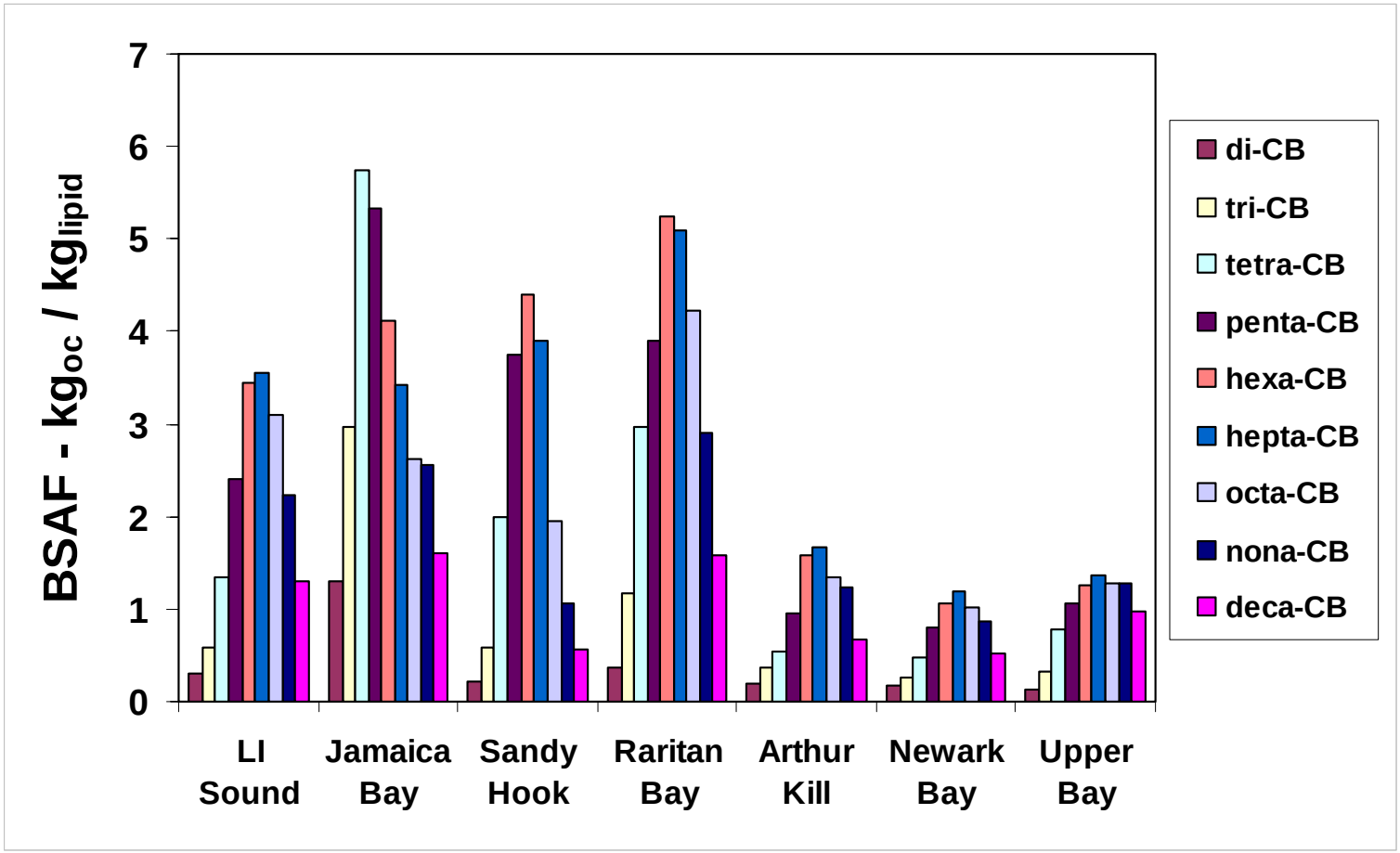
Courtesy of John Waldman, Hudson River Foundation

Contaminant Transfer through Aquatic Food Webs

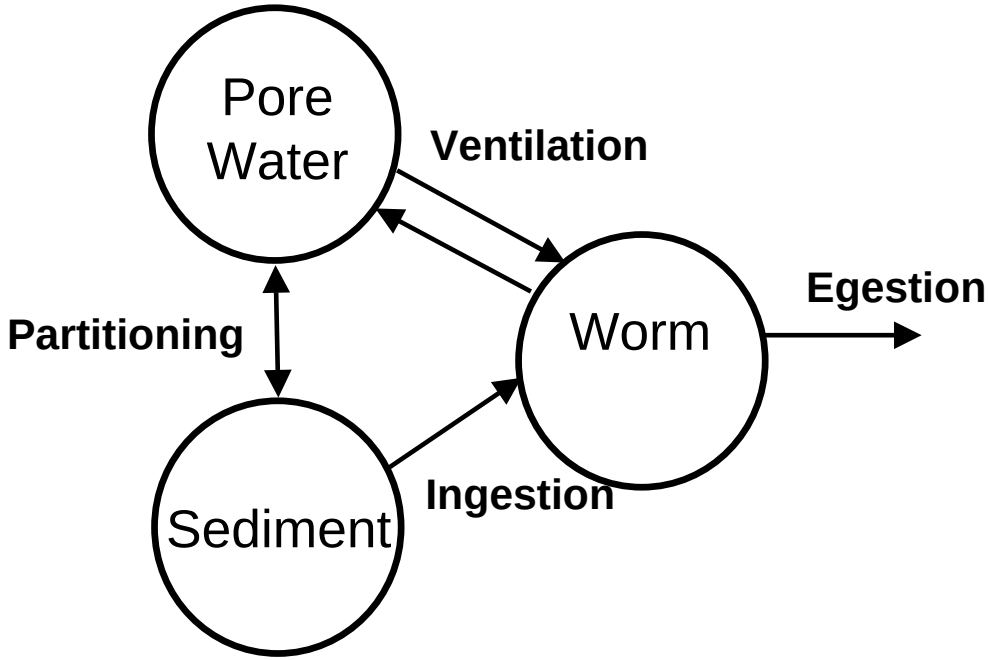
Bioaccumulation Modeling

CARP: Harbor Worm Data

$$BSAF_{lipid} = \frac{\nu_{lipid}}{\Gamma_{oc}}$$



Bioaccumulation Model(1)

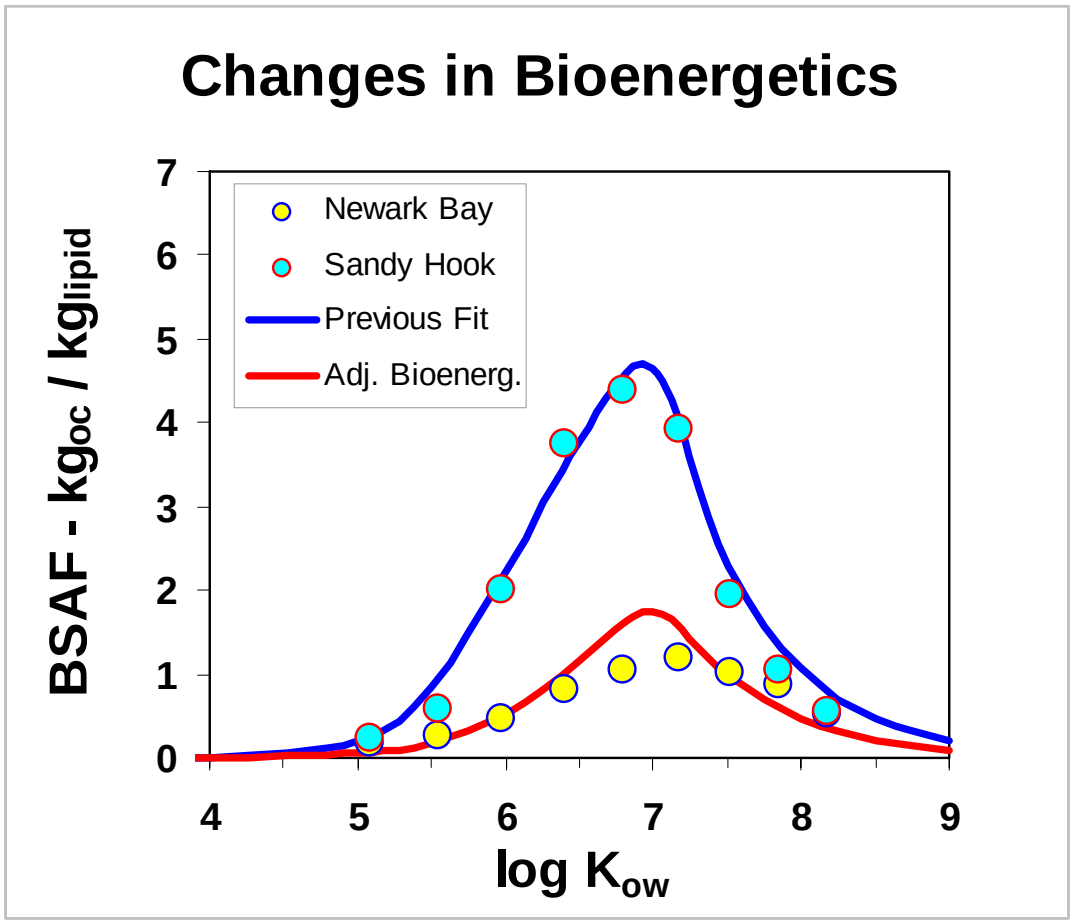


$$\frac{d\nu_{lipid}}{dt} = k_u C_{dis} + \alpha I_{oc,lipid} \Gamma_{oc} \left[\frac{K_{lipid}}{K_{oc}^{app}} \right] - \left(k_e + k_g \right) \nu_{lipid}$$

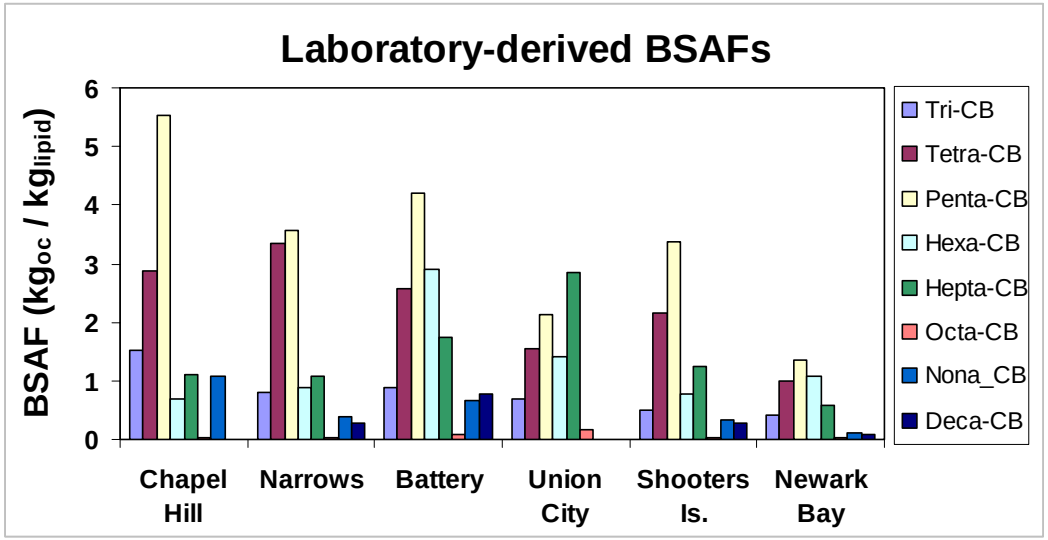
(1) Thomann, Connolly and Parkerton, *Environ. Toxicol. Chem*., 1992

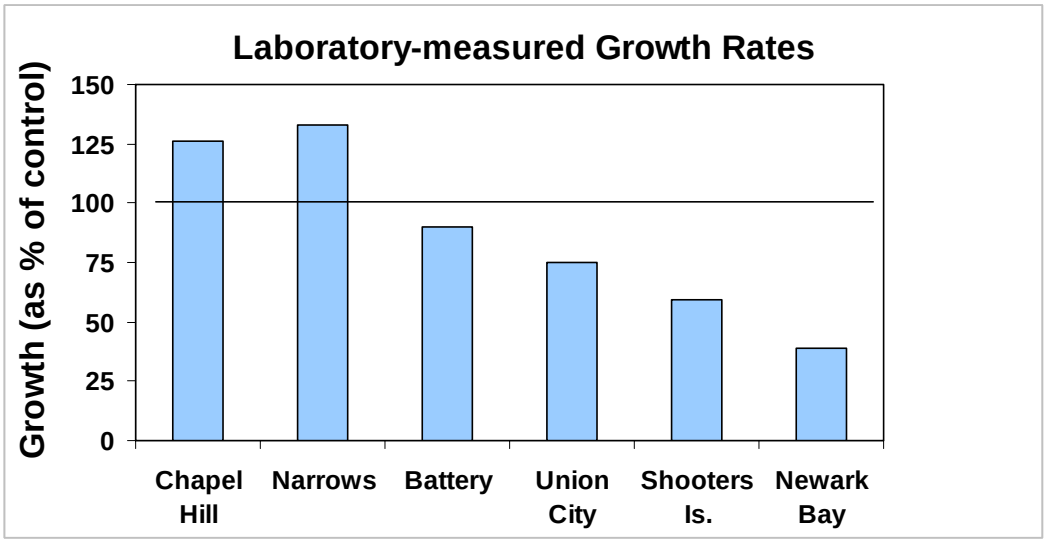
Bioaccumulation Modeling

Changes in organism bioenergetics with levels of contamination



"Urban myth" or serious implications in setting targets for sediment cleanup





Controlled Laboratory Tests

- 10-day Bioaccumulation Tests(1)
  - Non-deposit feeding amphipod (*Rhepoxynius abronius*)
  - Deposit feeding polychaete (*Armandia brevis*)
- 20-day Growth Tests(2)

(1) Meador, Adams, Casillas and Bolton, Arch. *Environ. Contam. Toxicol*., 1997

(2) Rice, Plesha, Casillas, Misitiano and Meador, *Environ. Toxicol. Chem*., 1995

Summary

- Overview of contaminant transport modeling
  - ✓ Partitioning to sediment
  - ✓ Estuarine circulation
- Challenges in evaluating contaminant transport in complex estuarine environments
- Issues in bioaccumulation
  - ✓ Effect of contamination levels on bioaccumulation behavior

Acknowledgments

Sponsors

- NIEHS-SBRP
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- EPA

Collaborators

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- Robin L. Miller
- James R. Wands

Special thanks to

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