Importance of exposure dynamics in aquatic ecosystem risk assessment

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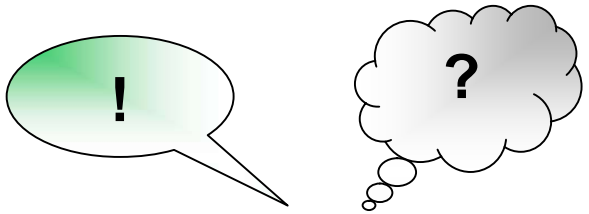
Framework

Environmental Risk Assessment

- **Environmental realism**
- **Ecological relevance**
- **Methodological accuracy**

of current approaches…



... ongoing discussion...

"Addressing the New Challenges for Risk Assessment" (EC Scientific Committees)

E.g., exposure assessment by means of **steady-state models**

CEFIC-LRI project

"ChimERA: An integrated modelling tool for ecological risk assessment"

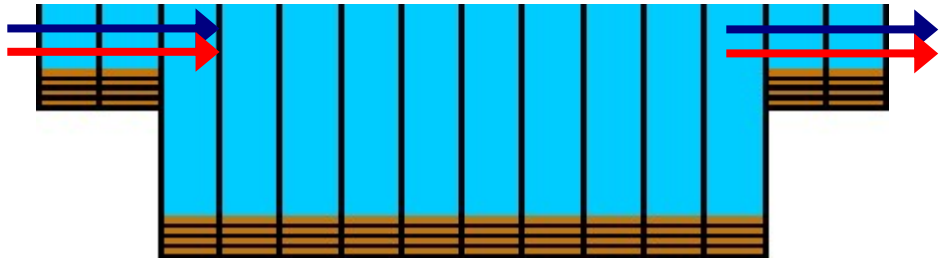
Objectives

Fate and exposure sub-model

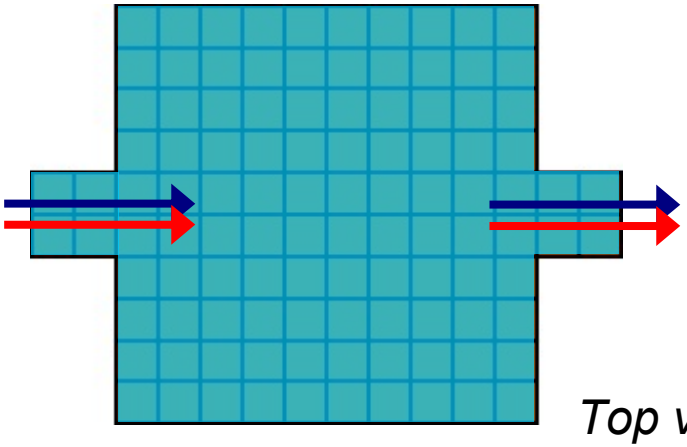
- **Compartments and sub-compartments**: water and sediment + dissolved organic carbon (DOC), detritus, phytoplankton, and macrophytes

- **Dynamics** of emissions, environmental parameters (e.g., temperature), macrophytes, phytoplankton and detritus mass and lipid content and DOC

- **Spatial discretization**: different sub-environments in water and sediment

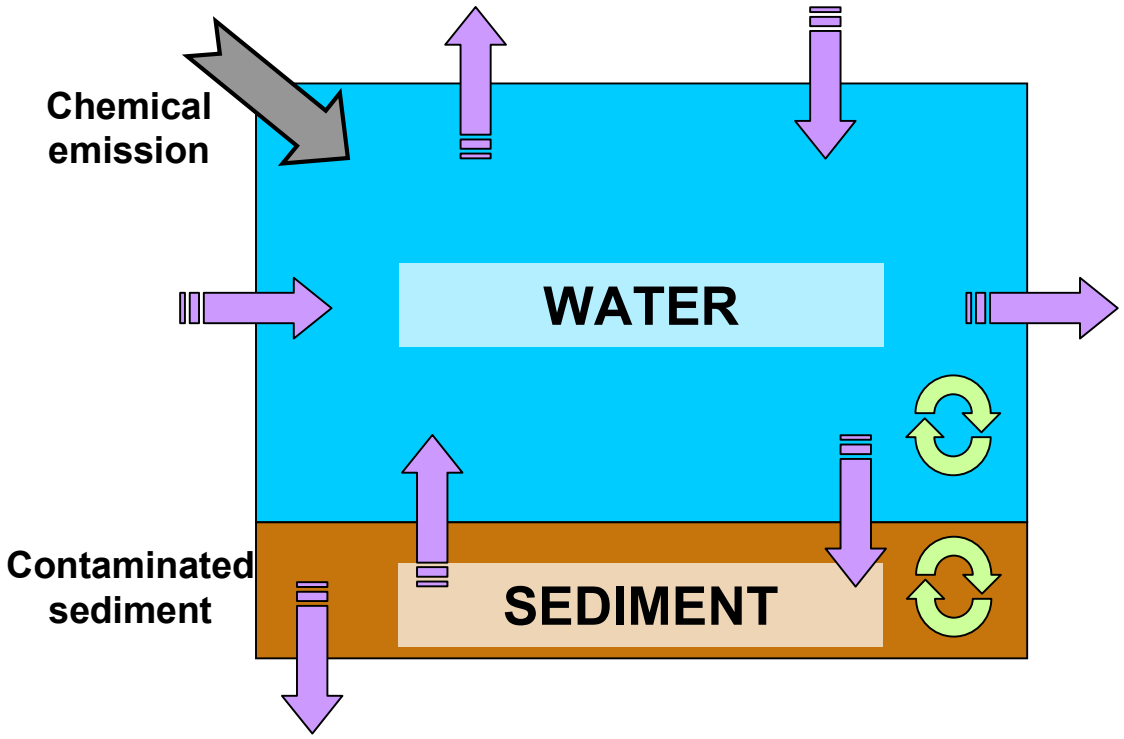


Side view



Top view

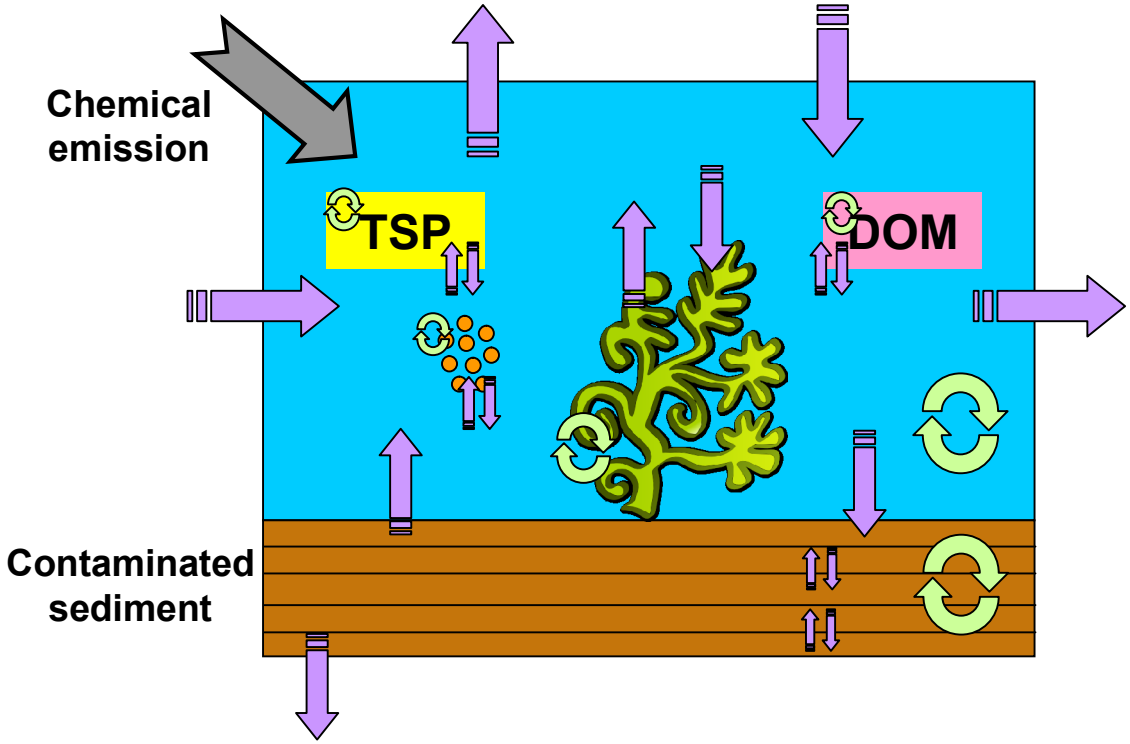
Starting point: DynA Model *



- Dynamic surface water **fugacity** model
- Water (water + suspended solids) and sediment (pore water + sediment solids)
- Hourly concentrations and chemical fluxes between compartments
- **Dynamic** in terms of emission and environmental parameters

* Di Guardo, A., Ferrari, F., Infantino, A. (2006) *Environ Sci & Pollut Res* 13(1), 50-58

1st result: sub-model unit



- **Compartments**: water, sediment, macrophytes *, phytoplankton **, total suspended particles (TSP), dissolved organic matter (DOM)

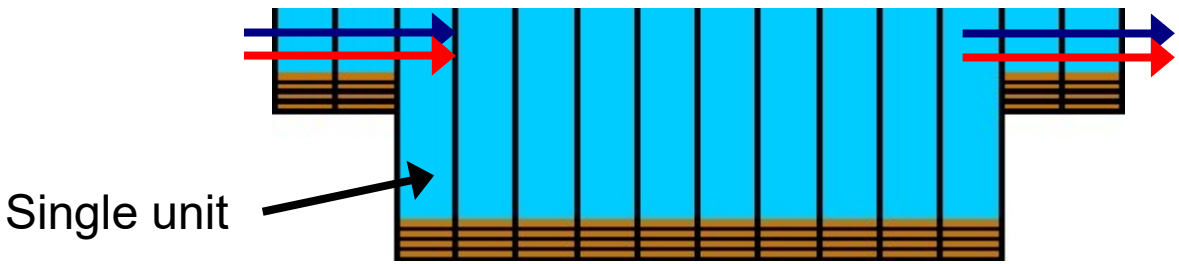
- **Layered sediment**

- **Output**: hourly chemical concentrations in all compartments + chemical fluxes

* Armitage, J.M., Franco, A., Gomez, S., Cousins, I.T. (2008) *Environ Sci & Pollut Res* 13(1), 50-58

** Del Vento, S., Dachs, J. (2002) *Environ Toxicol Chem* 21(10), 2099-2107

2nd result: spatial discretization



Side view

- Multiple **unit connection** through **water flow** (hydrological module)

- **Saint-Venant equation** for rectangular-section channel with variable width and depth *

- Friction accounted for using the **Manning's equation** **

- **Output**: hourly water volumes (m^3) + input and output fluxes for each unit ($m^3\ h^{-1}$)

- From water fluxes: phytoplankton, TSP and DOM fluxes ($m^3\ h^{-1}$)

* Balbas, J., Karni, S. (2009) *ESAIM: M2AN* 43, 333-351

** Gordon, N.D., McMahon, T.A., Finlayson, B.N., Gippel, C.J., Nathan, R.J. (2004) Wiley

Sensitivity analysis

- Simplified system (single sediment layer, 5-cm deep), two chemicals

- **Tested parameters**: emission, physical-chemical properties, MTCs, temperature, compartment volumes and organic carbon fractions

- **Targets**: water-dissolved and sediment pore-water concentrations

Most influential parameters

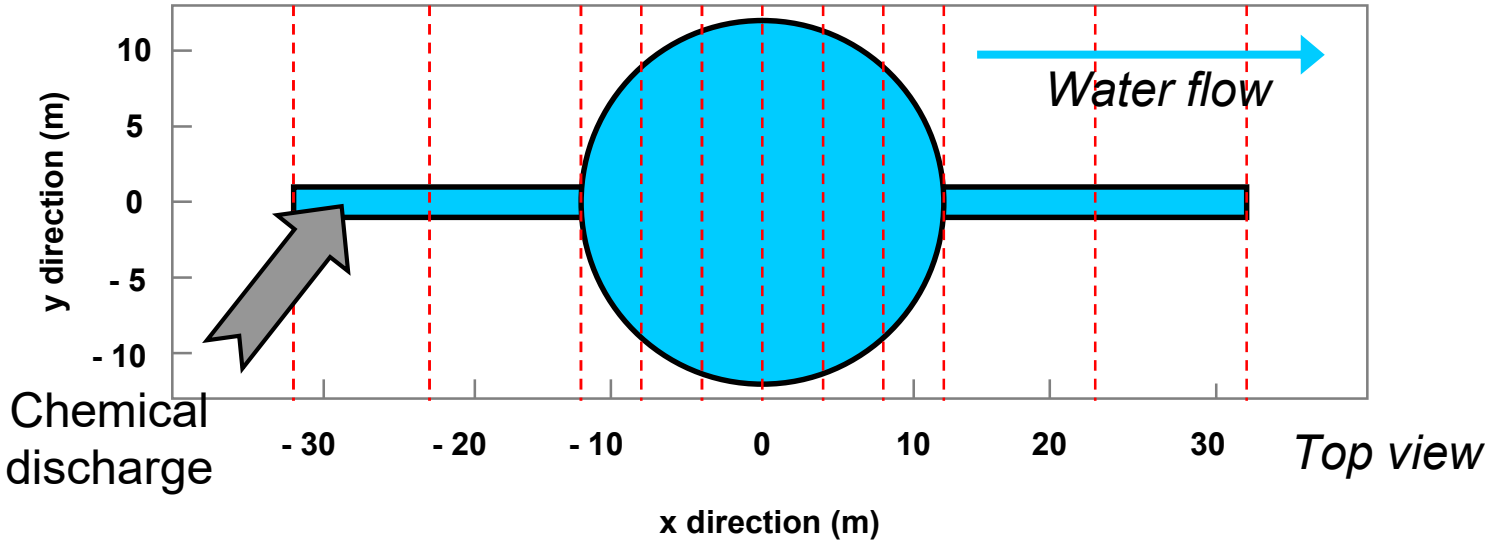
Emission

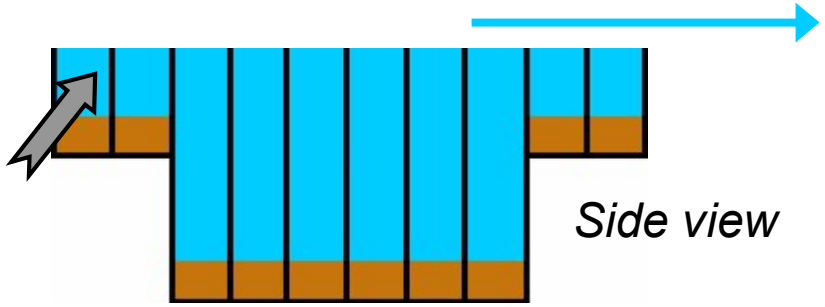
OC fraction of primary producers, TSP and DOM

Uptake/release rate constants for primary producers, TSP and DOM

Temperature

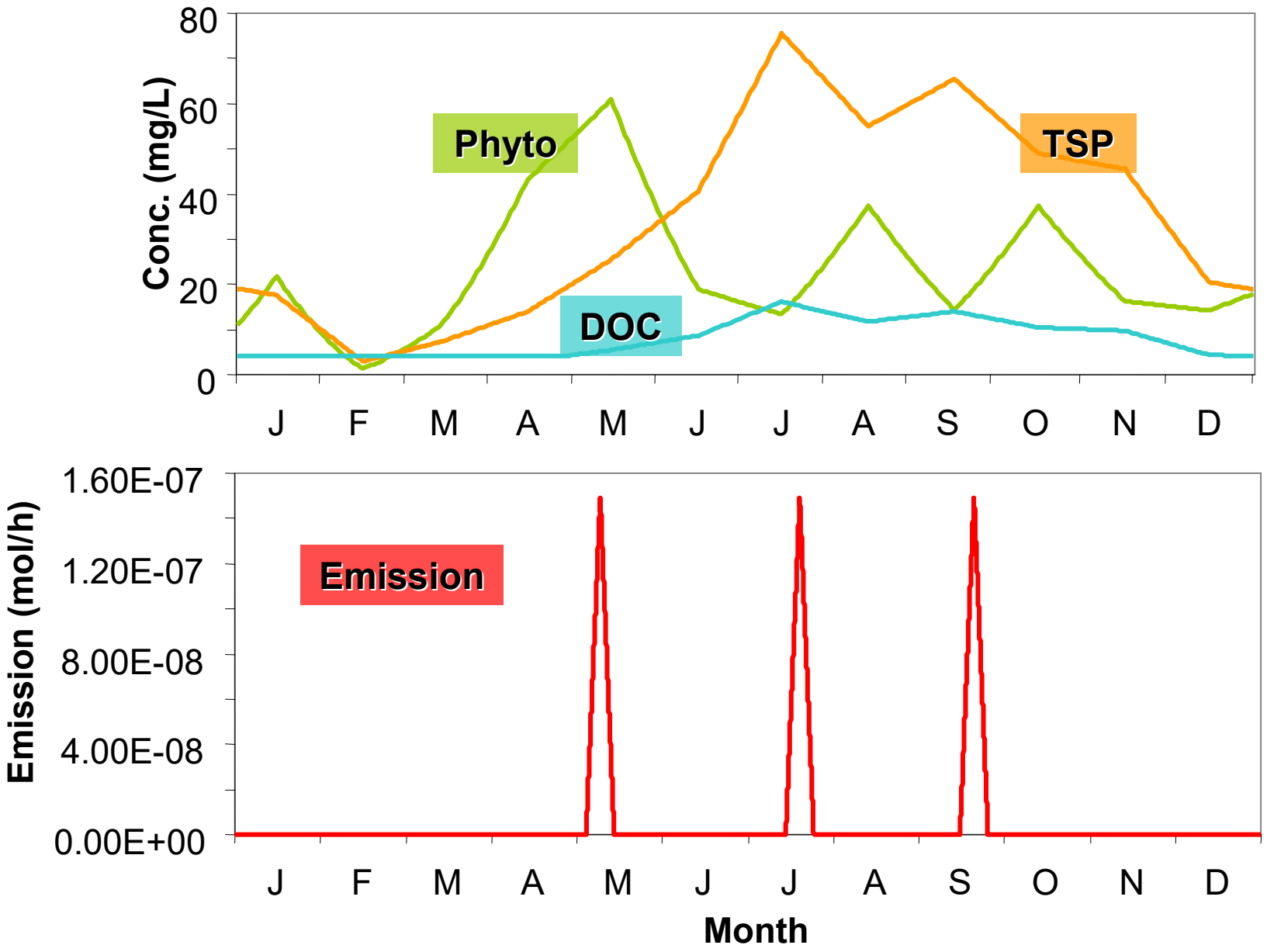
Illustrative application: scenario (1)



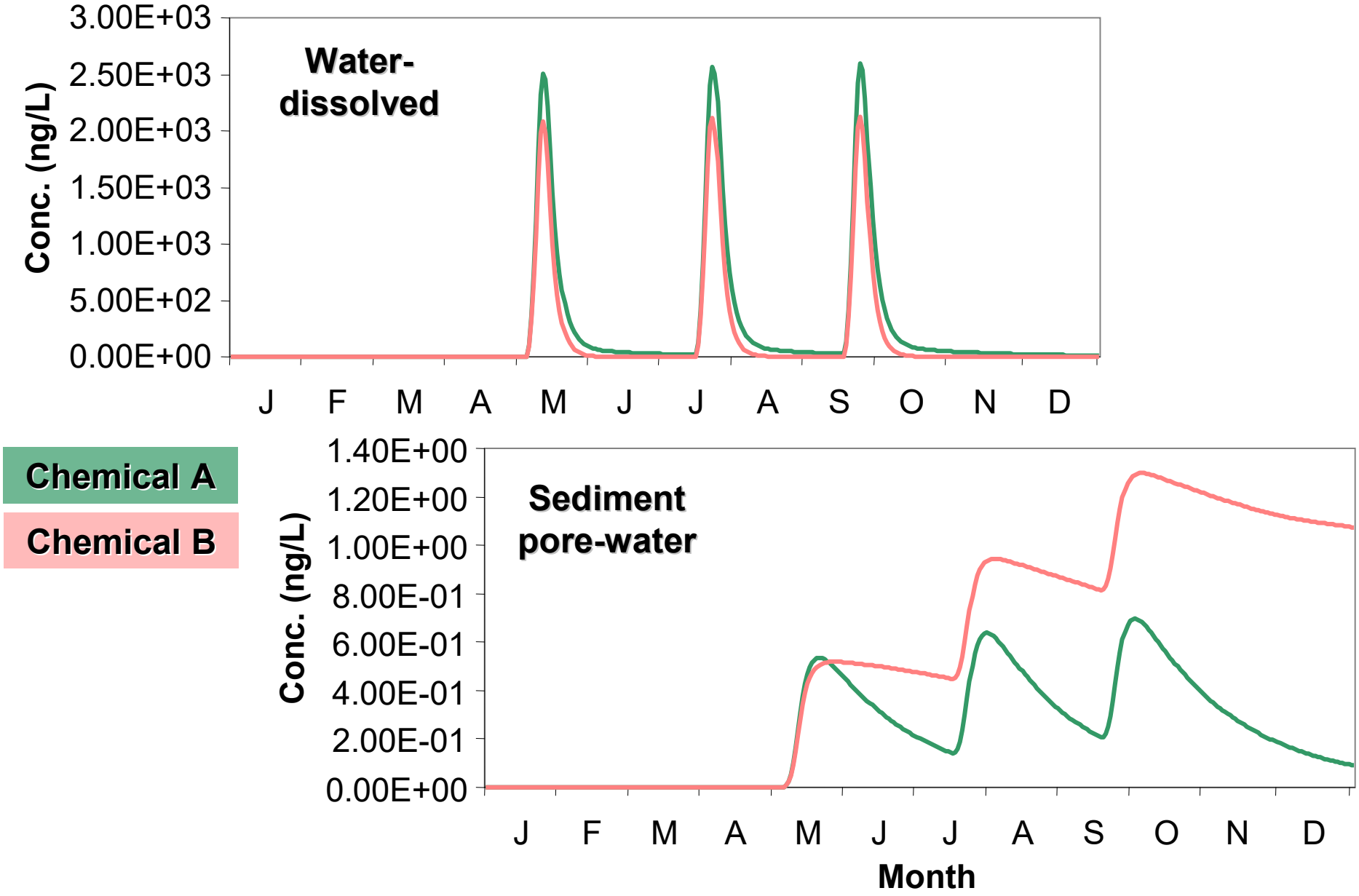


Chemical	WS (mg/L)	VP (Pa)	log K_{OW}	HL wat (h)	HL sed (h)
A	33	3.9E-05	2.5	1320	4800
B	0.132	0.0006	5.18	1700	55000

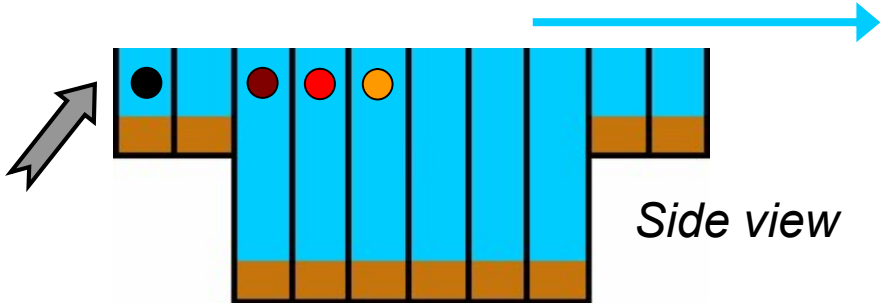
Illustrative application: scenario (2)



Illustrative application: results (1)

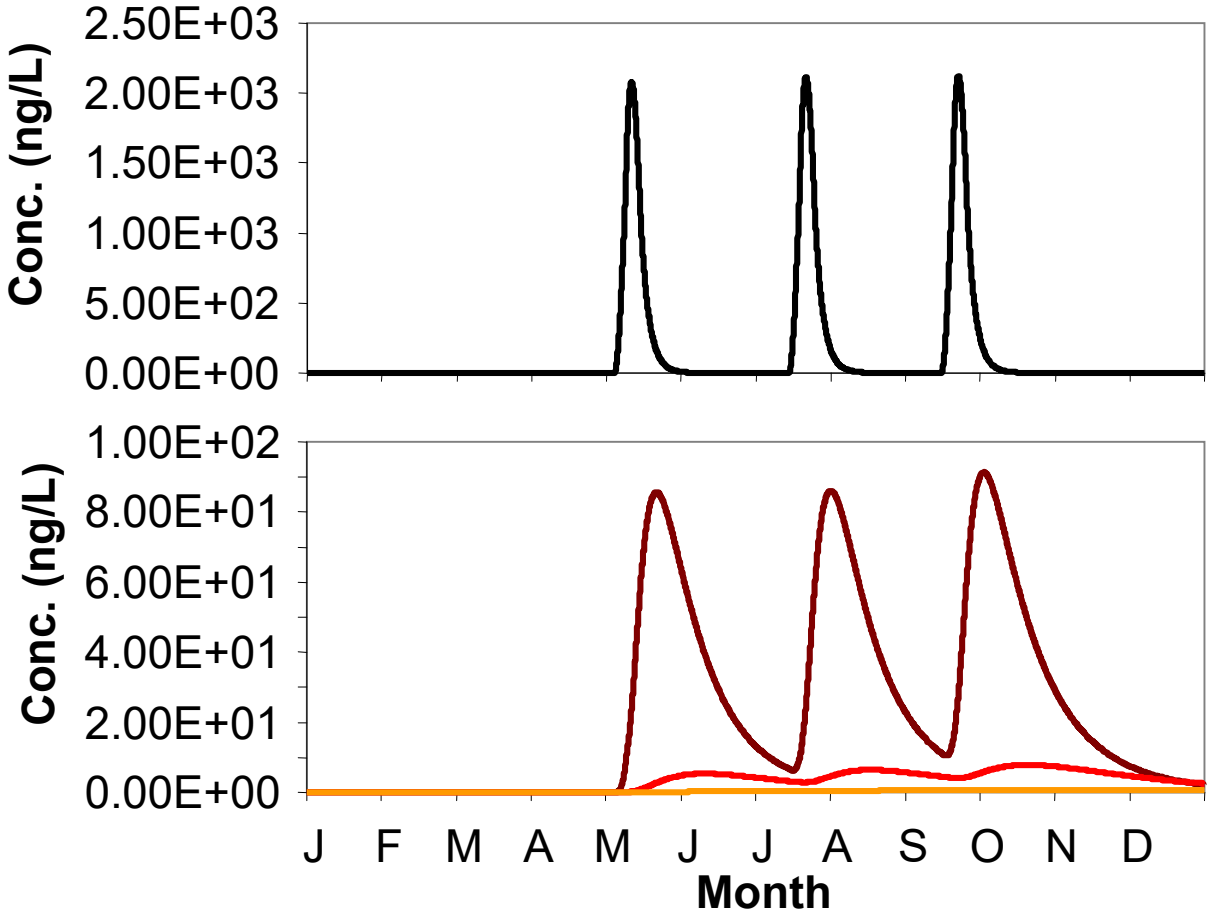


Illustrative application: results (2)



Chemical B

Slice 1 (Emission)



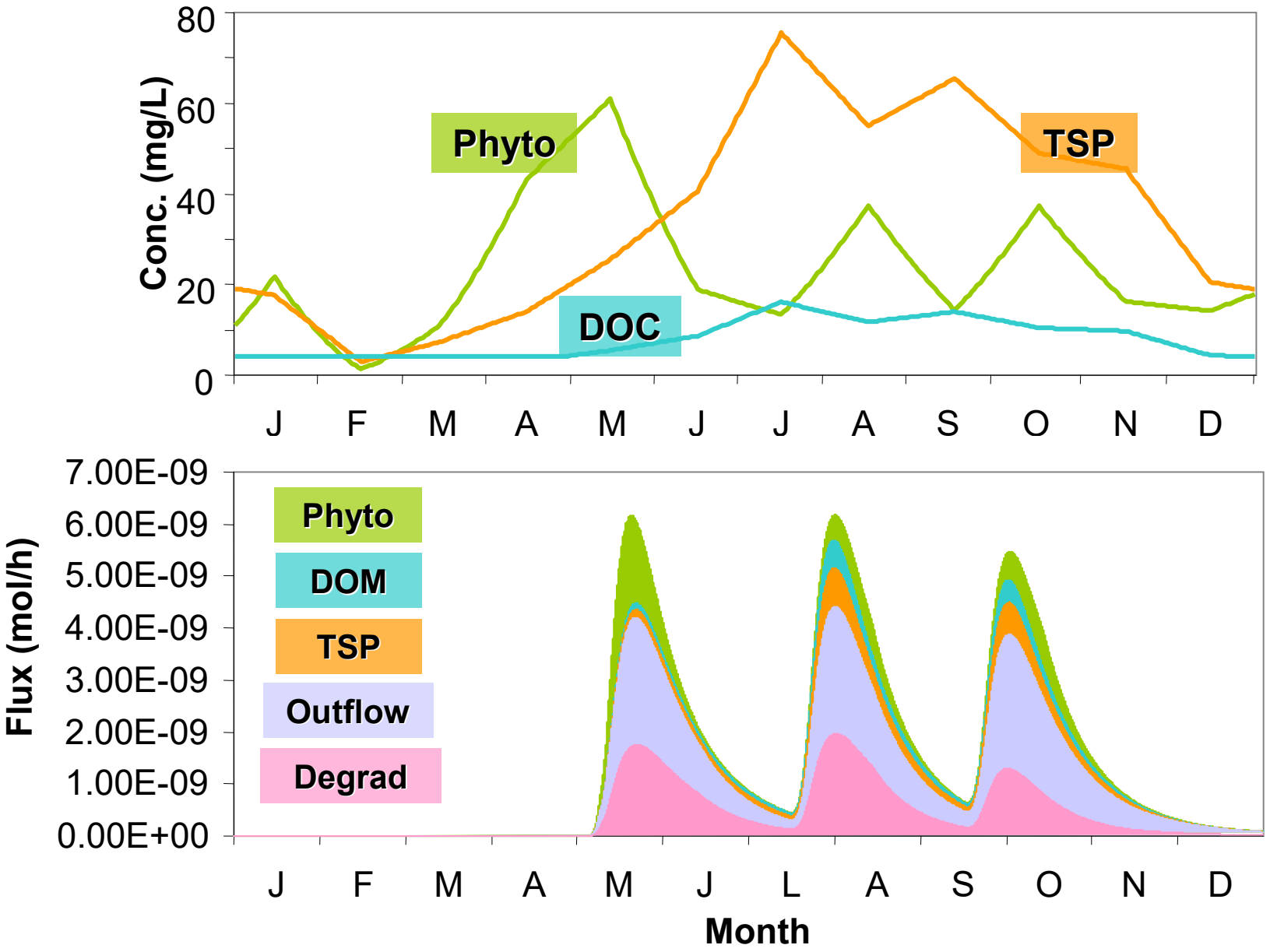
Slice 3

Slice 4

Slice 5

Illustrative application: results (3)

Slice 3



Conclusions

- Flexible dynamic unit model

- Basis for the simulation of connected water bodies (rivers/ponds)

Ongoing work

- **Coupling** with effect models (TK/TD-IBM sub-models)

- Implementation of equations to describe phytoplankton, macrophyte and detritus dynamics

Future work

- **Sensitivity** and **uncertainty analyses**

- **Calibration** and **validation** (literature + experiments)

Acknowledgements

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Thanks for your attention

You can also find me in the Exhibition Hall (poster TU193)