Determination of in-situ biodegradation rate constants of nonylphenolic compounds in the Seine River

Mathieu Cladière, Lauriane Vilmin, Céline Bonhomme, Johnny Gasperi, Nicolas Flipo, Bruno Tassin

Determination of *in-situ* biodegradation rate constants of nonylphenolic compounds in the Seine River

Cladière Mathieu[1*], Bonhomme Céline[1], Vilmin Lauriane[2], Gasperi Johnny[1*], Nicolas Flipo[2], and Tassin Bruno[1]

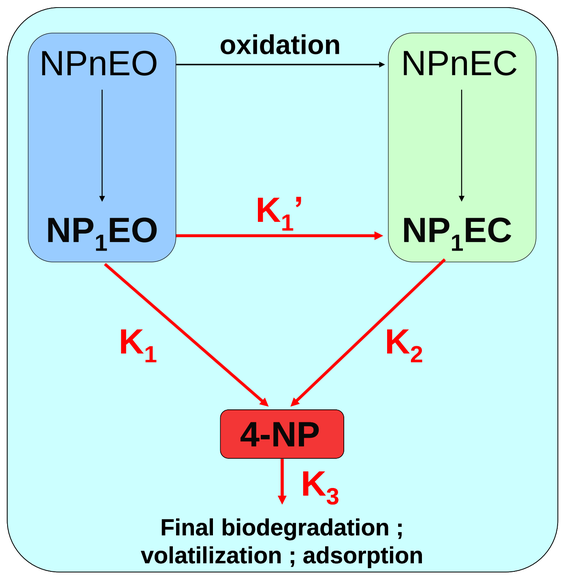
[1] *Université Paris-Est, LEESU, 94010 Créteil, France.* [2] Centre géoscience, Mines ParisTech, Fontainebleau, France

[*] Contact author: mathieu.cladiere@leesu.enpc.fr; gasperi@u-pec.fr

1- INTRODUCTION

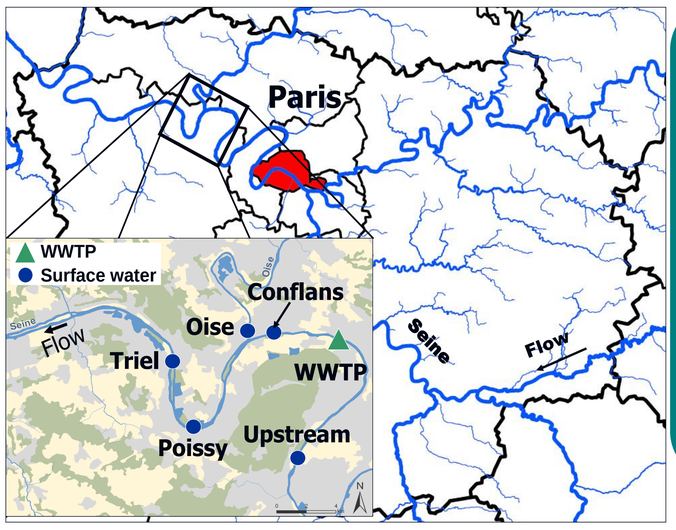
Assessing the fate of endocrine disrupting compounds (EDC) in the environment is currently a key issue for determining their impacts on aquatic ecosystems. The 4-nonylphenol (4-NP) is a well known EDC as well as its precursors, the nonylphenol monoethoxylate (NP_1EO) and the nonylphenol acetic acid (NP_1EC). they result from the biodegradation of surfactant nonylphenol ethoxylates (NPnEO). To date, the biodegradation rate constants of nonylphenolic compounds have been mostly studied in laboratory and only Jonkers et al. (2005) focus on *in-situ* rate constants but in estuarine salt water. Therefore data on *in-situ* biodegradation of nonylphenolic compounds in river water are scarce or not up to date.

This study aims at evaluating the *in-situ* biodegradation of 4-NP, NP_1EC and NP_1EO in the Seine River downstream of Paris City.



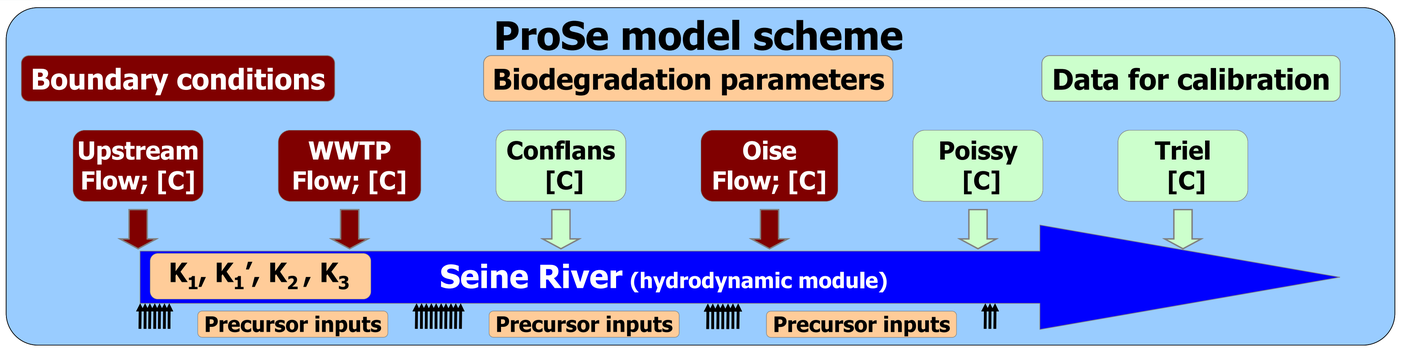
(Giger et *al.*, 2009)

2- METHODOLOGY



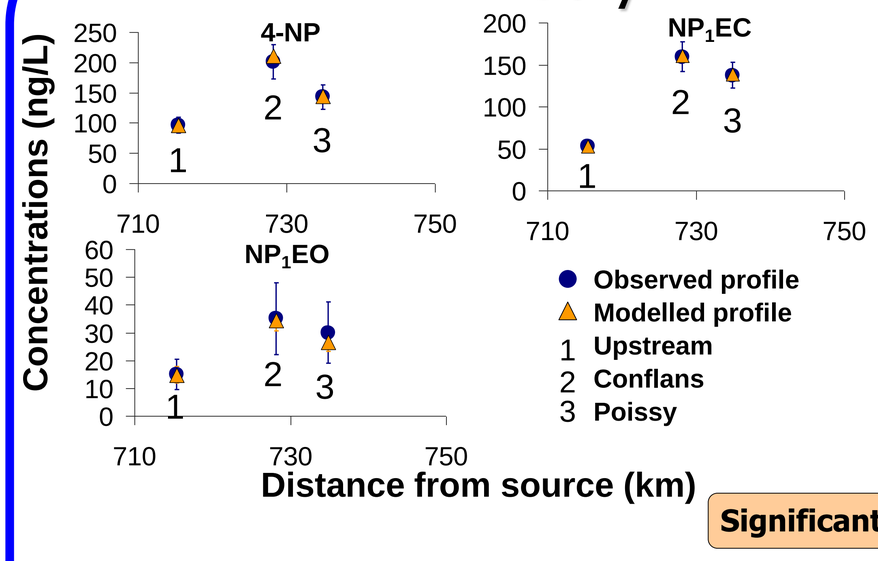
- **40 km long transect downstream of Paris city**
- **2 sampling campaigns: July and September 2011**
- **Hours of sampling estimated according to velocity of the Seine River**
- **Samples collected in the same volume of water**
- **Analysis: UPLC-MS-MS ➔ quantification of 4-NP, NP_1EC and NP_1EO**
- **Results ➔ calibrating a sub-model of NPnEO biodegradation of ProSe model**
- **The spatial and temporal variabilities of concentrations are considered for calibration**
- **Calibration of $K_1 = K_1'$, K_2 and K_3 based on first order kinetics equations**
- **Calibration of "precursor inputs" to symbolize biodegradation of NPnEO and NPnEC**

The hydro-ecological ProSe model is especially design for the Seine River. Its biogeochemical module is updated to simulate the fate of nonylphenolic compounds downstream of Paris (Even *et al.,* 1998).



2- RESULTS

July



Biodegradation rate constants are **far higher** than those reported by Jonkers *et al.,* (2005) or by Staples *et al.,* (2001).

Campaign carried out during an **algal bloom**. This **algal bloom** likely induces an **increase of heterotrophic bacterial biomass** (Kisand and Noges, 1998)

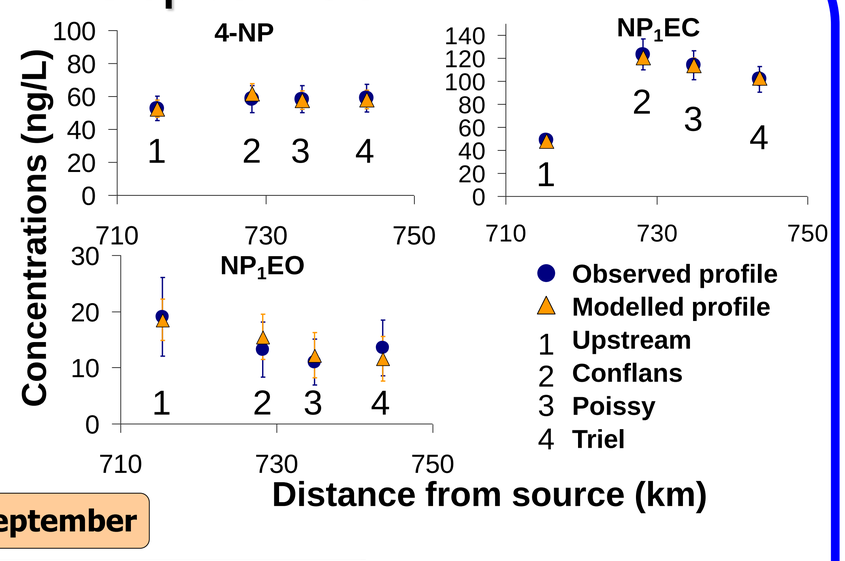
Rate constants (d^{-1}) Min - opt - max	
$K_1 = K'_1$	0.05 - 0.10 - 0.15
K_2	3.14 - 3.30 - 3.47
K_3	2.38 - 2.50 - 2.75

Min : minimum value; opt: optimized value; max: maximum value

<<
>>
>>

September

Biodegradation rate constants are **close** to those reported by Jonkers *et al.,* (2005) or by Staples *et al.,* (2001).



Significant variability of biodegradation between July and September

Rate constants (d^{-1}) Min - opt - max	
$K_1 = K'_1$	0.29 - 0.30 - 0.33
K_2	0.08 - 0.10 - 0.14
K_3	0.09 - 0.15 - 0.19

Min : minimum value; opt: optimized value; max: maximum value

No disruption of biogeochemical conditions of the Seine River during this campaign. The heterotrophic **bacterial biomass** is supposed to be representative of **conventional** conditions of the Seine River

3- DISCUSSION / CONCLUSION

The variability of bacterial biomass likely induces the variance of biodegradation rate constants of nonylphenolic compounds.

The first-order kinetic approach seems reliable to describe a punctual state of biodegradation but does not take into account the variabilities generated by the fluctuation of bacterial biomass.

Even S, Poulin M, Gamier J, Billen G, Servais P, Chesterikoff A, **Hydrobiologia 1998**; 373-374: 27-45.

Giger W, Gabriel FLP, Jonkers N, Wettstein FE, Kohler H-PE. **Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 2009**; 367: 3941-3963.

Jonkers N, Laane RWPM, de Graaf C, de Voogt P. **Estuarine, Coastal and Shelf Science 2005**; 62: 141-160.

Kisand V, Noges T. **International Review of Hydrobiology 1998**; 83: 205-216.

Staples CA, Naylor CG, Williams JB, Gledhill WE. **Environmental Toxicology and Chemistry 2001**; 20: 2450-2455.