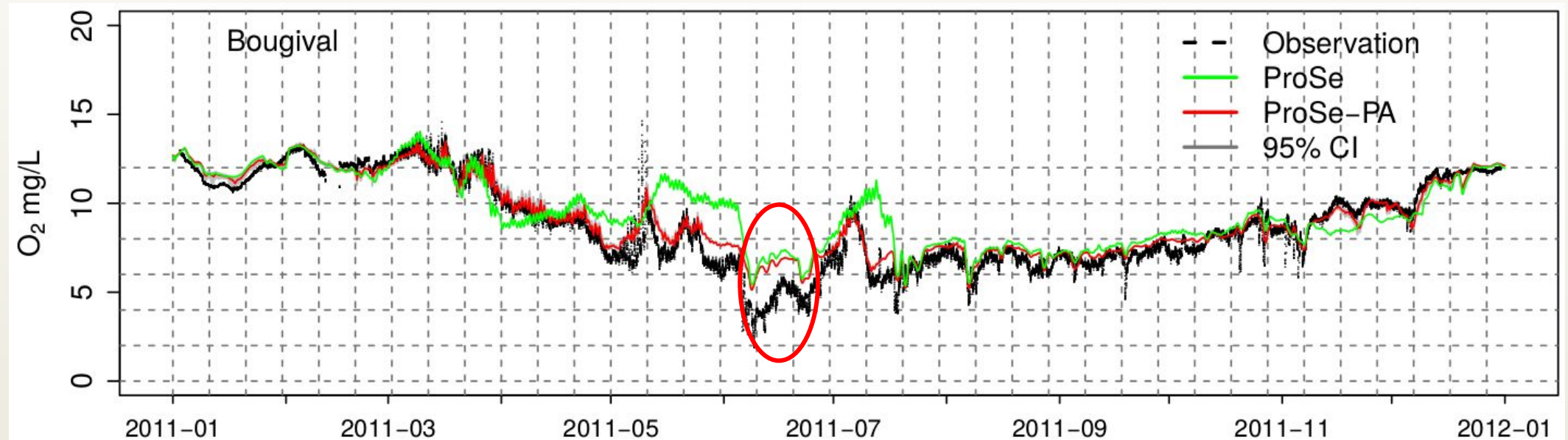


The role of organic matter and bacterial physiology on river metabolism at low flow

Masihullah Hasanyar, Nicolas Flipo, Thomas Romary, Shuaitao Wang

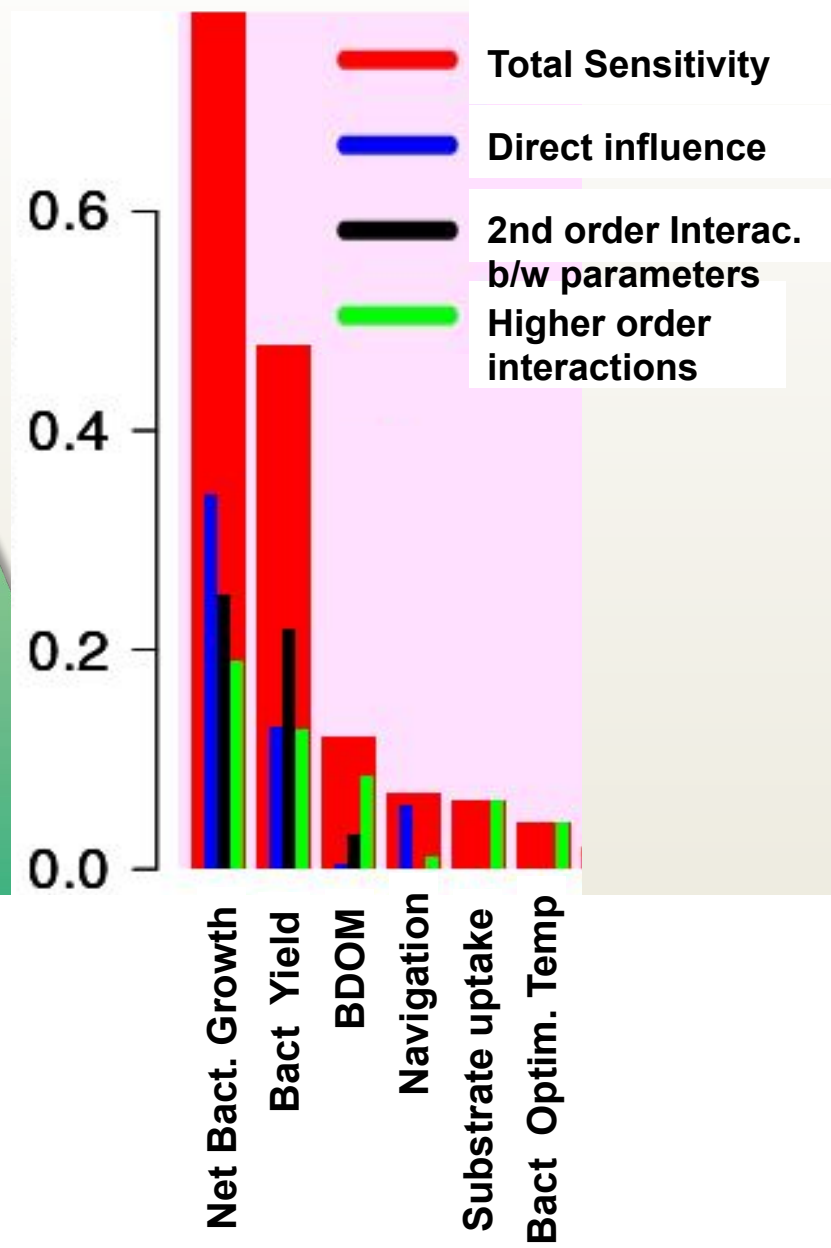


- Discrepancies at low flow modeling
- Need for sensitivity analysis

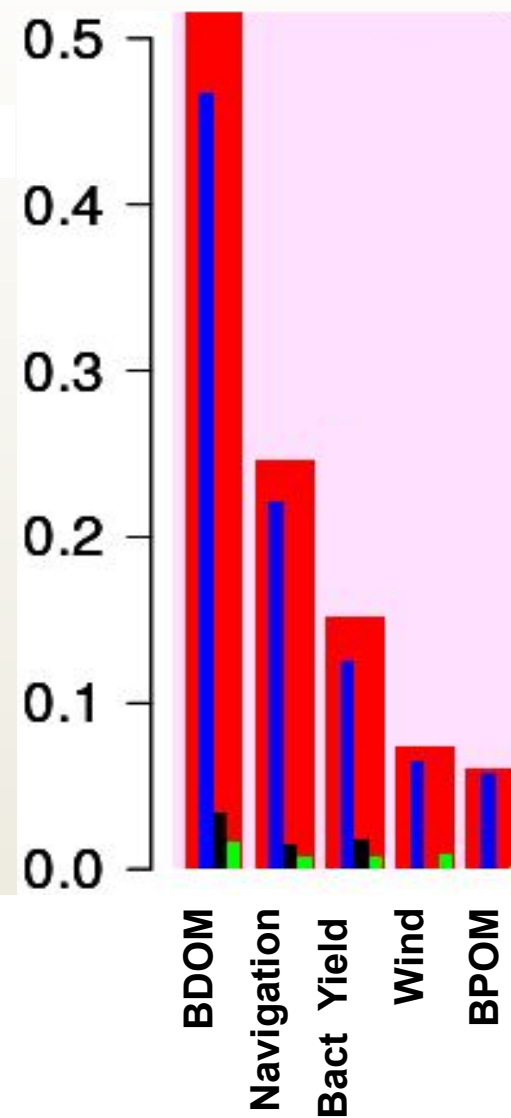
Results

= Growth - mortality

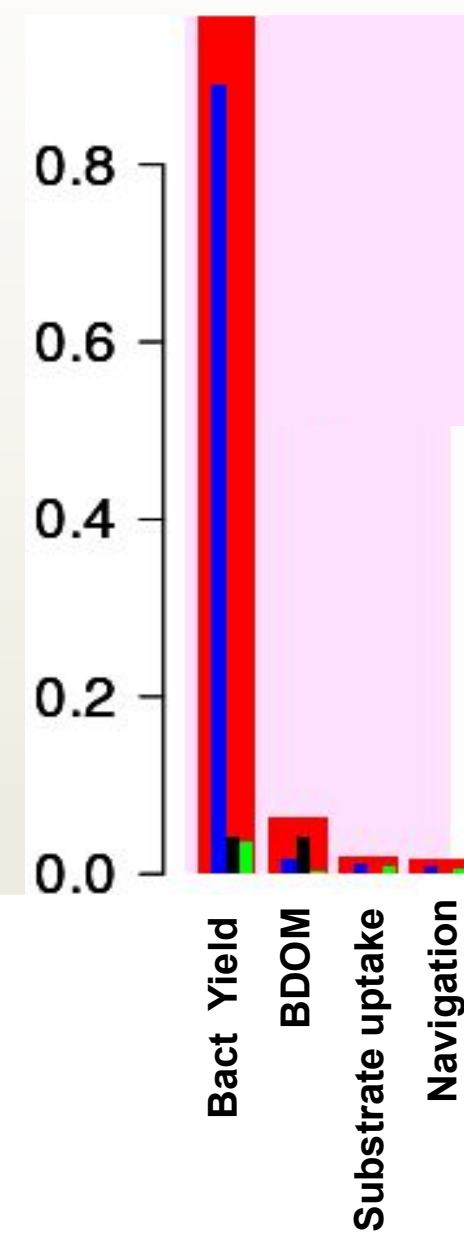
1) Variable Net Growth



2) High (Fixed) Net Growth



3) Low (Fixed) Net Growth





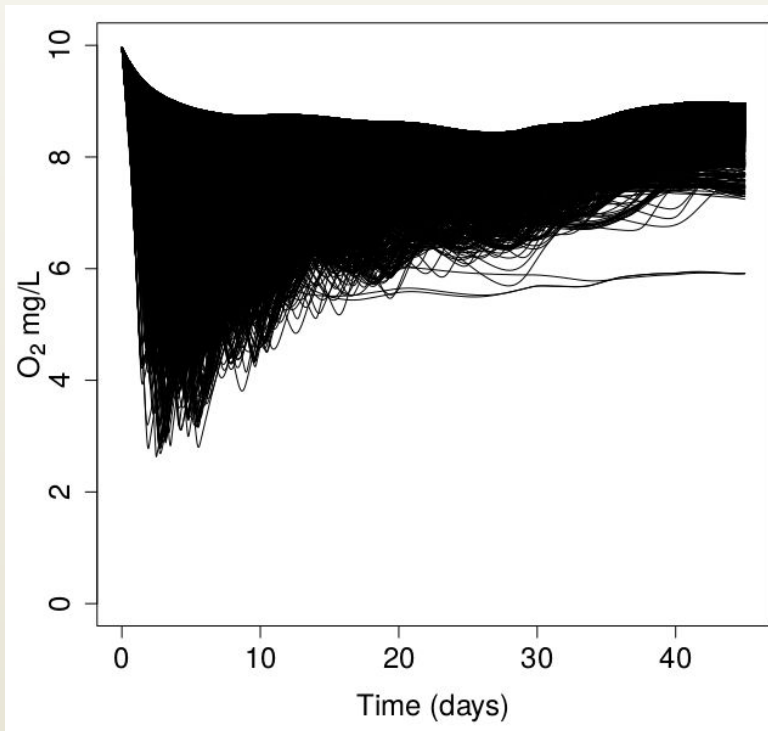
APPENDIX

Sensitivity Analysis: Methodology (*Wang et al., 2018*)

1. Four sensitivity analysis were done
2. The effect of 12-17 parameters were analyzed
3. 260K-360K simulations were run in the model
4. The Sobol' method (*Sobol', 1993*) was used for investigating the sensitivity of model against the parameters

Bact. Growth, BDOM, Bact. Yield, BPOM, ..., ...,

[260K-360K] x [12~17]



Sobol', I.M., 1993. Sensitivity estimates for nonlinear mathematical models. Mathematical Modelling and Computational Experiments 1 (4), 407

Wang, S., Flipo, N., Romary, T., 2018. Time-dependent global sensitivity analysis of the C-RIVE biogeochemical model in contrasted hydrological and trophic contexts. Water Res. 144, 341e355.

Next steps: Expansion of Particle filter to include BDOM

Currently PF holds 12 parameters (4 bacterial, 6 phytoplanktonic and 2 physical)

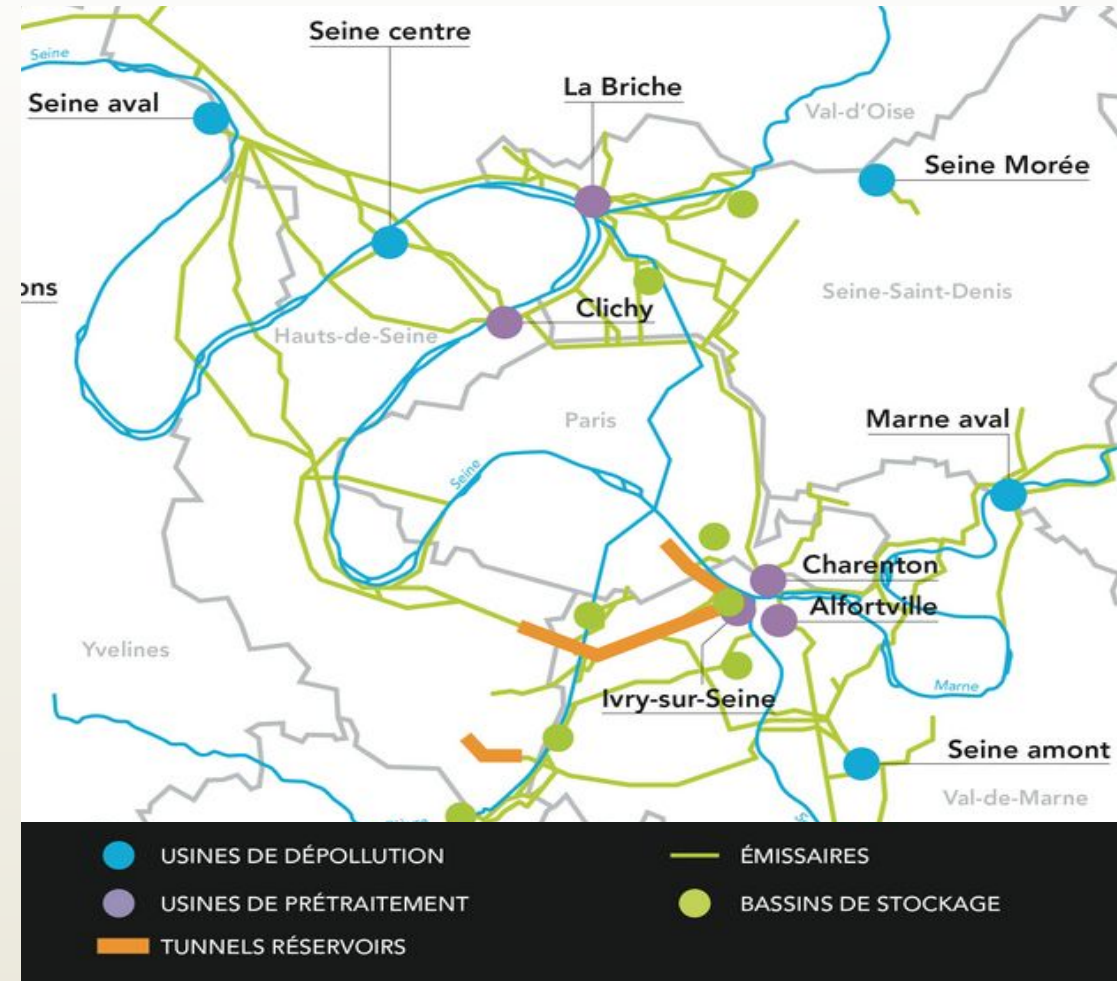
$$\text{BDOM} = \text{TOC} * t * b_1$$

$t = \text{DOM}/\text{TOC}$ (not influential, constant)

$b_1 = \text{BDOM}/\text{DOM}$ (influential under 1st study)

Assimilation of BDOM input sources:

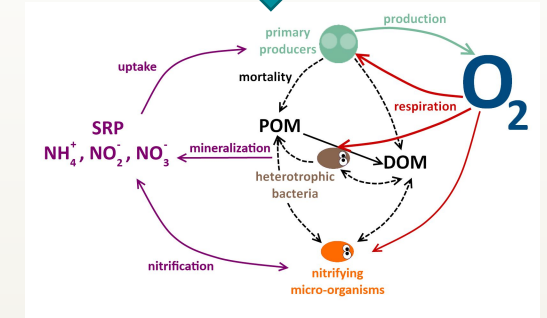
- 1) Tributary rivers (Seine, Marne and Oise)
- 2) WWTPs (Seine Aval etc.) (initially as perfectly known)
- 3) CSOs (Clichy, La Briche)



Background: evolution of water quality modeling

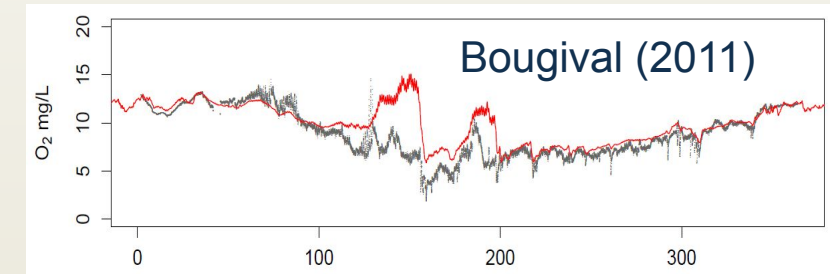
- Dissolved oxygen: a key variable for river system
- First water quality modeling DO-BOD (Streeter and Phelps, 1925)
- Community-centered model RIVE (Billen et al., 1994)
- First release of the Water quality modeling software ProSe (Even 1995, Even et al. 1998)
- Improvements of ProSe (Even et al., 2004, Flipo et al., 2004, 2007, Vilmin et al., 2016, 2018)
- High frequency (HF) data measured by *in-situ* sensors (PHRESQUES-CarboSeine, MeSeine)
- Overestimation of DO during low flow periods (Vilmin, 2014)
- Data assimilation (First particle filter applied to biogeochemistry): ProSe-PA (Wang, 2019; Wang et al., 2019, subm)

$$\frac{dL}{dt} = k_1 \cdot L$$



anthropogenic outputs
(DO, STEP...), Forcing
data (T, irradiance...)

HF measurements



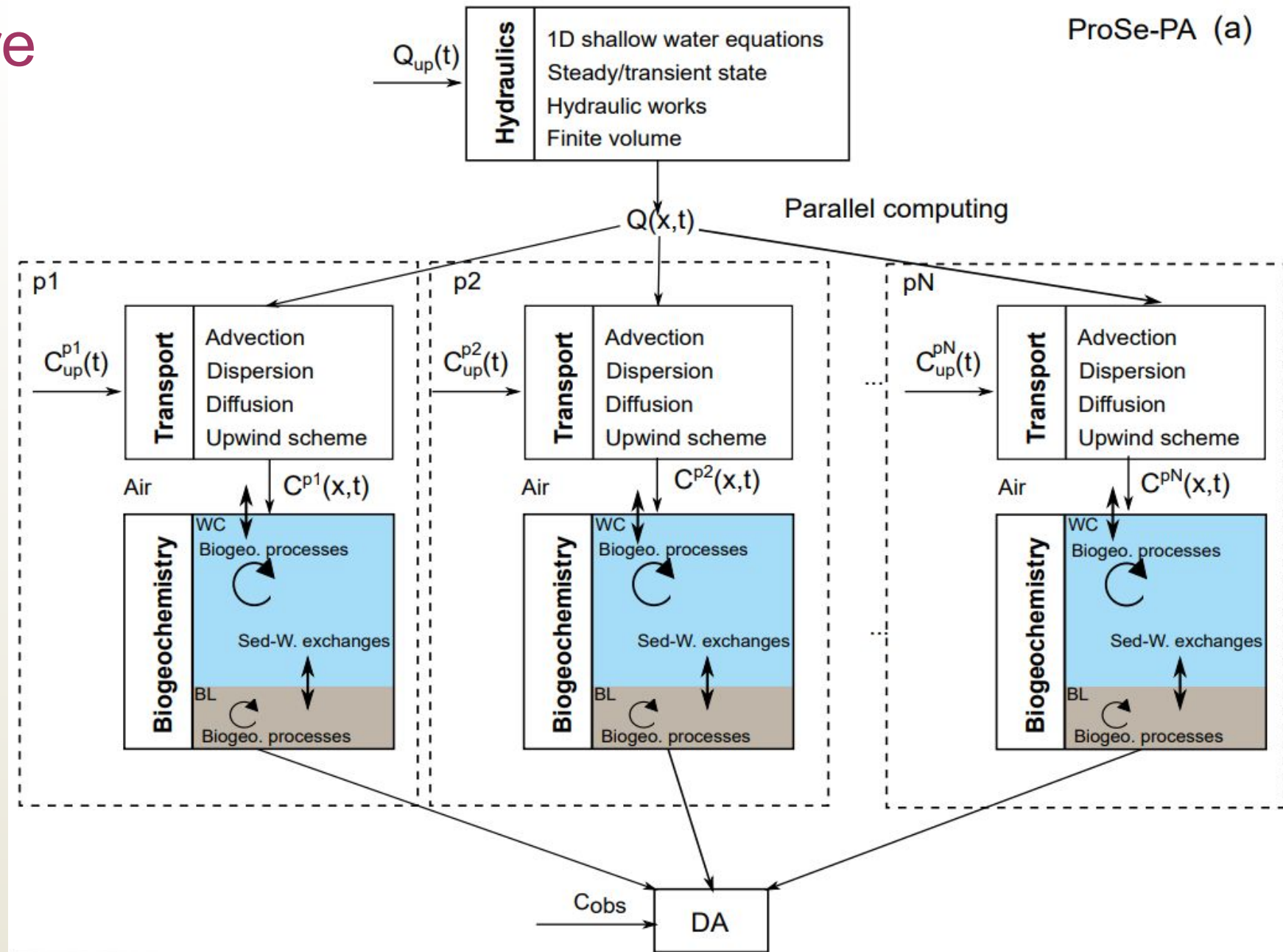
DA (Particle filter) → ProSe-PA

ProSe-PA software

ProSe-PA: **ProSe** Parallel & data **Assimilation** (Particle filter)

Particle filter: Bayesian approach

A particle: a parameter set ($p_1, p_2, \dots, p_N$)



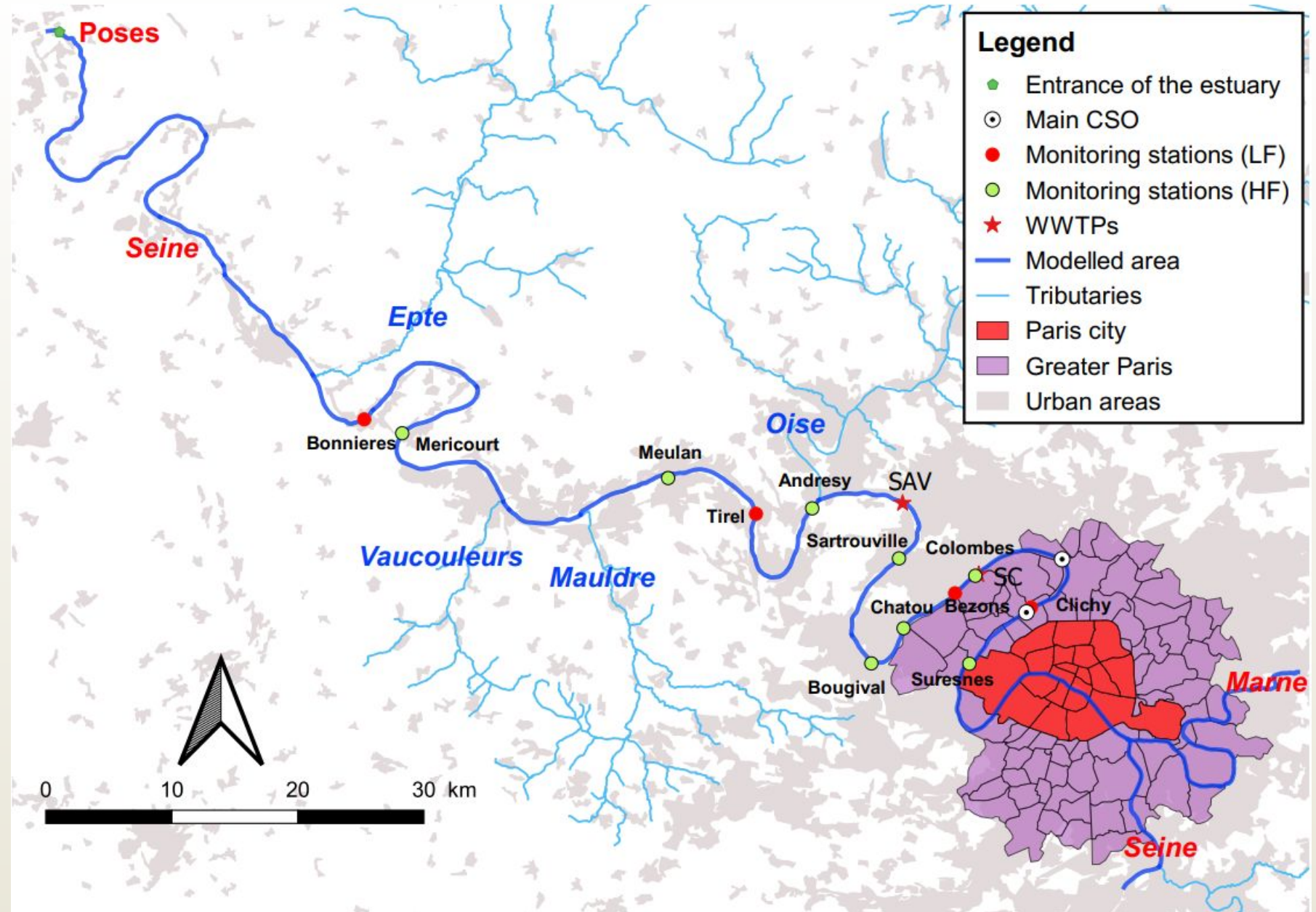
Study area

8 high frequency monitoring stations (MeSeine), in green

4 low frequency monitoring stations (LF), in red

Cross-validation: using measured data at 7 HF stations to predict oxygen concentration at the last station (HF)

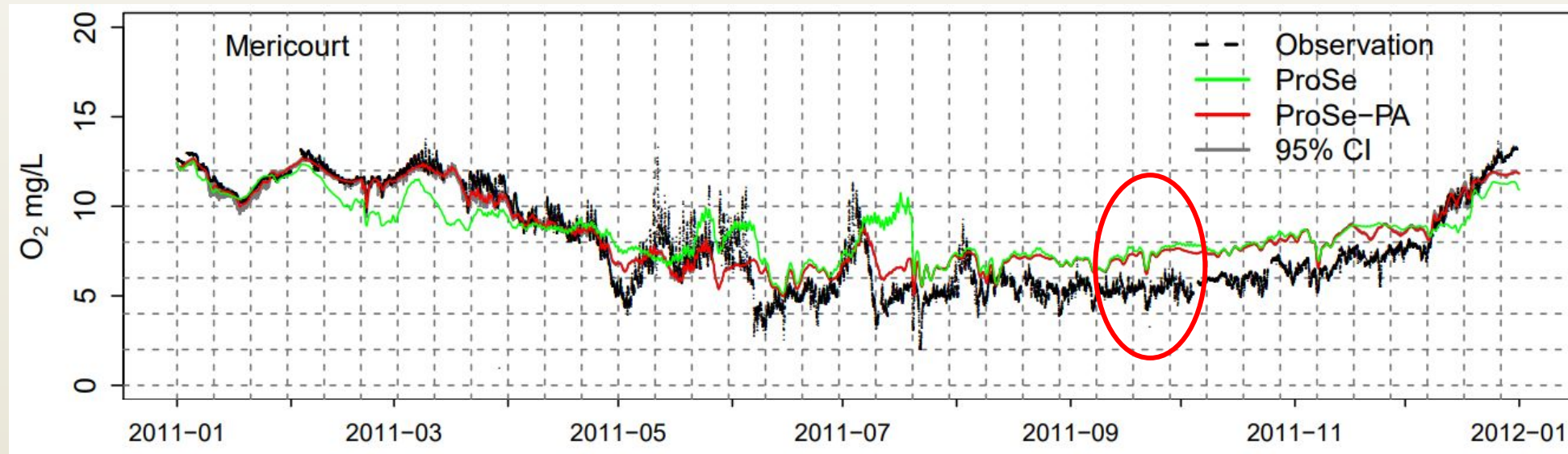
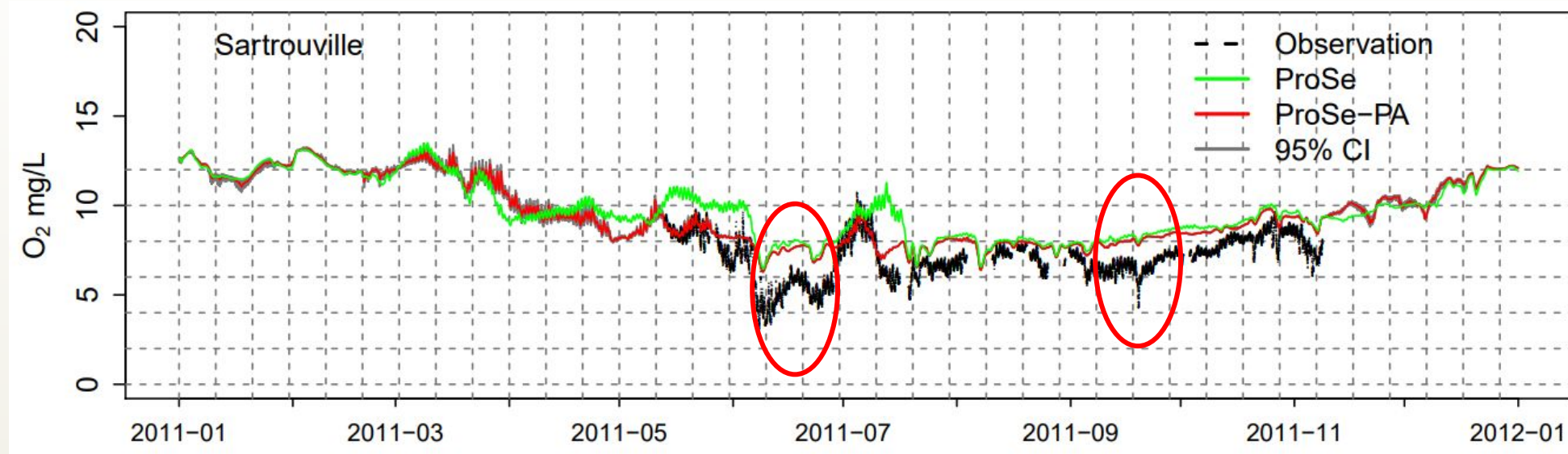
Assimilating oxygen data at 8 stations (HF) to predict oxygen concentration at 4 LF stations



Simulated DO concentrations during low flow without algae blooms

Overestimation of DO concentrations during low flow periods

Deficit of BDOM ?

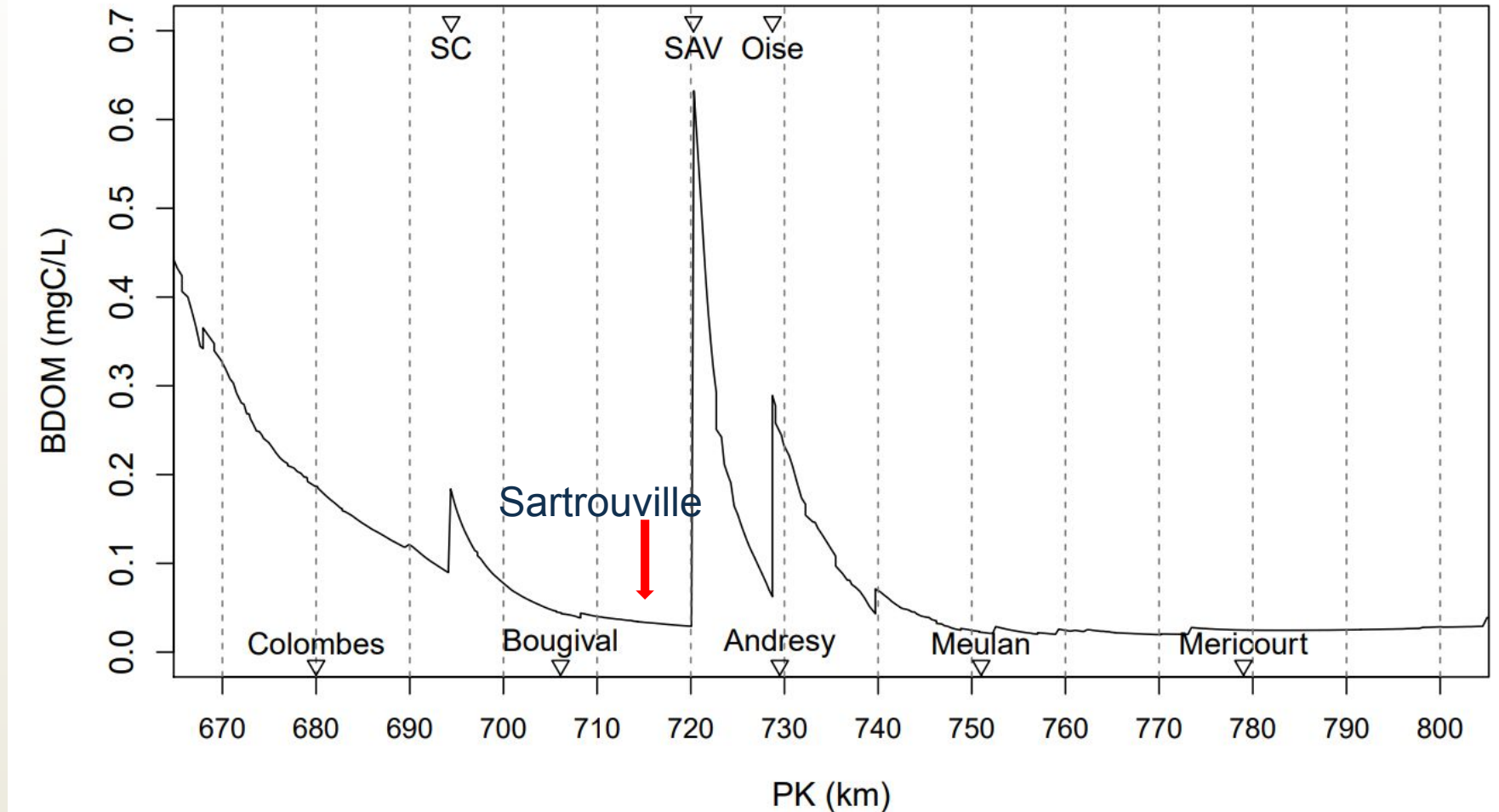


Uncertainties of BDOM concentrations in boundary conditions

$C_{\text{BDOM}} < 0.02 \text{ mgC/L}$ at
Meulan, Mericourt

Assumption of perfect
boundary conditions

Need to study the
uncertainties of BDOM
(parameters, concentrations)



Average concentration of BDOM from 2011-09-07 to 2011-09-27
(Wang et al., 2020 in preparation)