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LABORATOIRE SOLS ET ENVIRONNEMENT

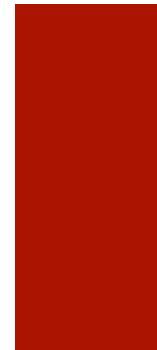


PAH plant uptake prediction:

**evaluation of combined availability tools
and modeling approach**

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General uptake modeling

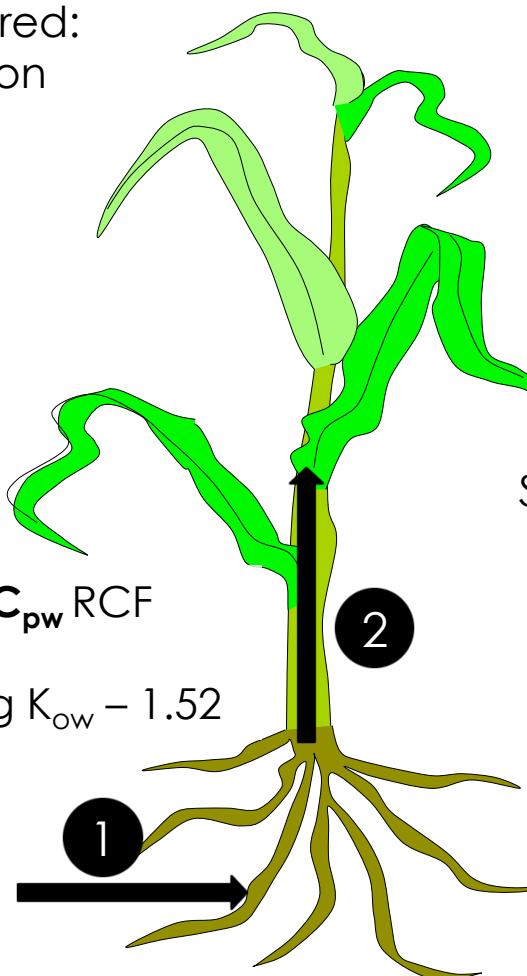


Main process considered:
pore water absorption

1 Root uptake
(Briggs et al., 1982)

$$\text{Root concentration} = C_{\text{pw}} \text{RCF}$$

$$\log (\text{RCF} - 0.82) = 0.77 \log K_{\text{ow}} - 1.52$$



2 Shoot transfer
(Briggs et al., 1983)

$$\text{Shoot concentration} = C_{\text{pw}} \text{SCF}$$

$$\text{SCF} = [10^{(0.95 \log K_{\text{ow}} - 2.05)} + 0.82] \\ 0.784 e^{-[(\log K_{\text{ow}} - 1.78)^2 / 2.44]}$$

Question



- Are these models adapted for PAH ?
- What sensitivity to C_{pw} measurement ?
- Interest for availability tools implementation ?



Materials & Methods

Industrial soils



- 14 industrial soils from France, Sweden and Belgium
- Former industrial activities: coking, manufactured gas
- PAH gradient: 0.2 -> 1900 mg kg⁻¹



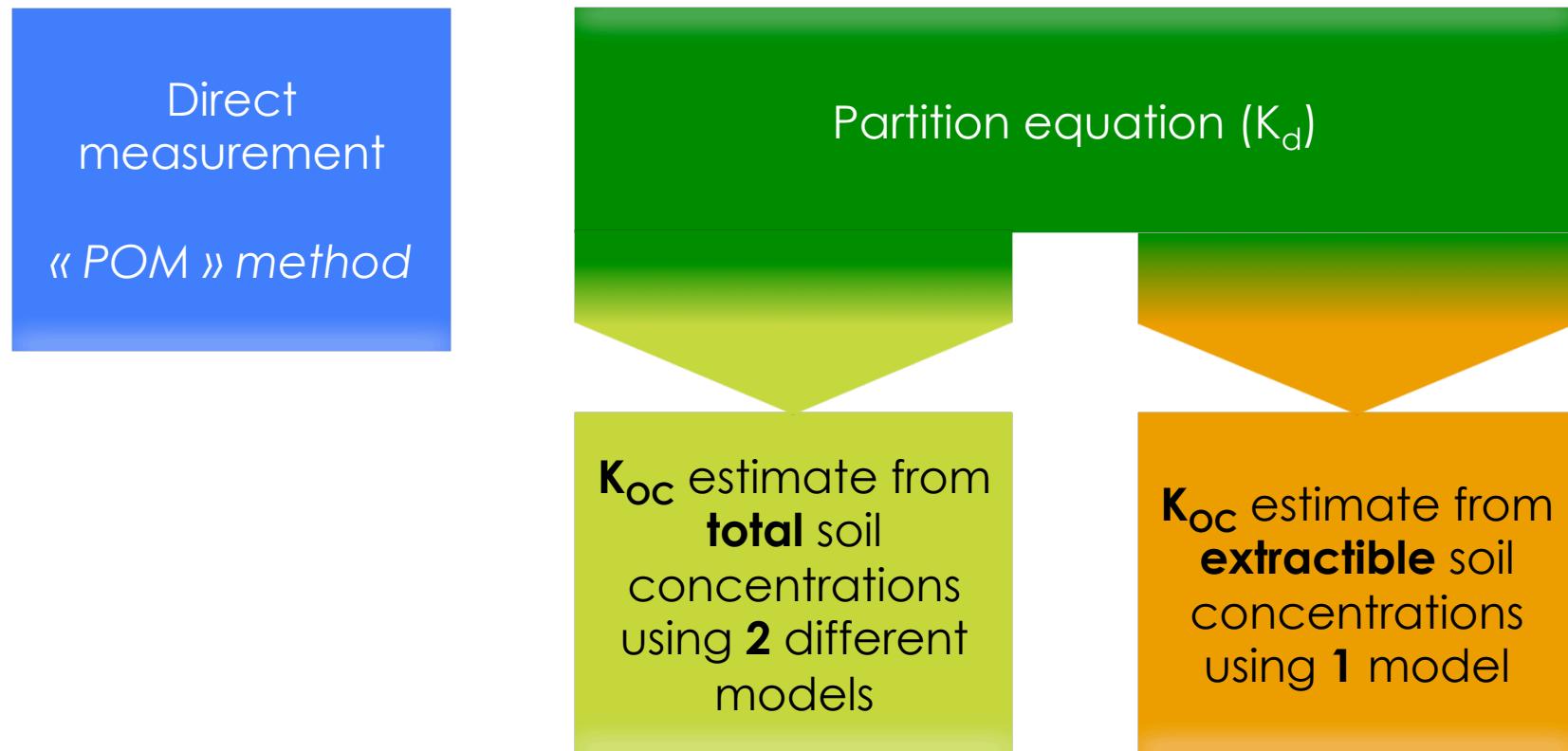
Growth experiments

- 5 weeks, 4 replicates,
16 h photoperiod,
23 °C / 18 °C day/night,
70% humidity,
- 1.3 kg soil/pot
+ 1 plant of maize/pot,
80% WHC
- PAH analysis in roots and shoots
 - DCM/sonication extraction
 - HPLC analysis



Pore water concentration

Comparison between 4 methods



Pore water concentration C_{pw}

Direct measurement: POM method



- 5 g sol + 100 mg polyoxymethylene membrane (POM)
+ 30 mL solution (0.01 CaCl_2 , 150 mg L⁻¹ NaN_3)
- 28 days agitation in the dark at 20 °C
- PAH extraction using 80:20 heptane:acetone
and GC-MS quantification
- $C_{pw} = C_{POM} / K_{POM}$ (Hawthorne et al., 2011)



Pore water concentration C_{pw}

Calculation from total or extractable soil fractions

- Extractible fraction
 - Solid phase extraction for 30h using Tenax® resin
(Barnier et al., 2014)

- Partition equation using « K_d » and corresponding organic carbon normalized « K_{OC} »
 - $C_{pw} = C_{\text{total or Tenax}} / (f_{OC} K_{OC})$

$$\log K_{OC} = 1.14 \log K_{ow} - 1.02 \quad (\text{Nguyen et al., 2005})$$

or

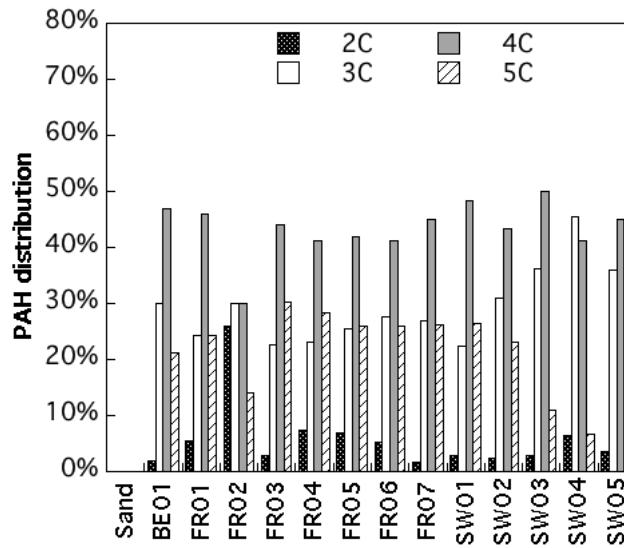
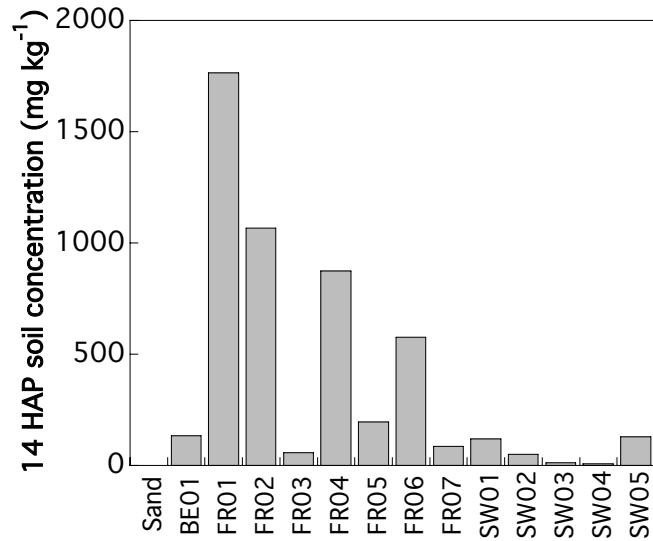
$$K_{OC} = (S_L^* MW_{OC})^{-1} \quad (\text{Arp et al., 2009; "coal tar" model})$$



Poral water & total soil concentrations

Concentrations et distributions

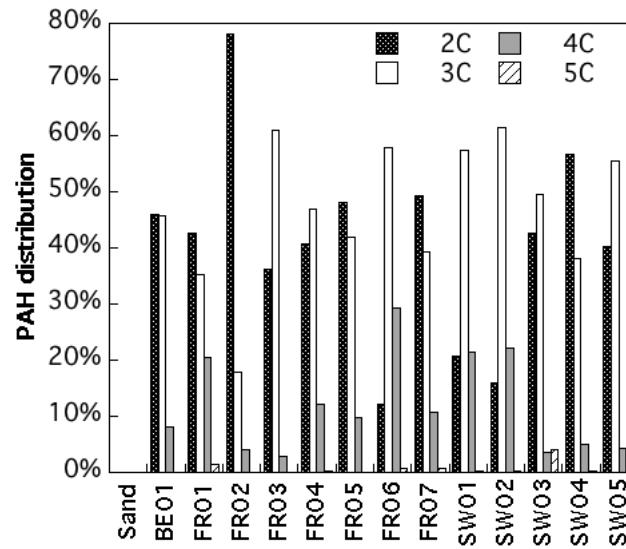
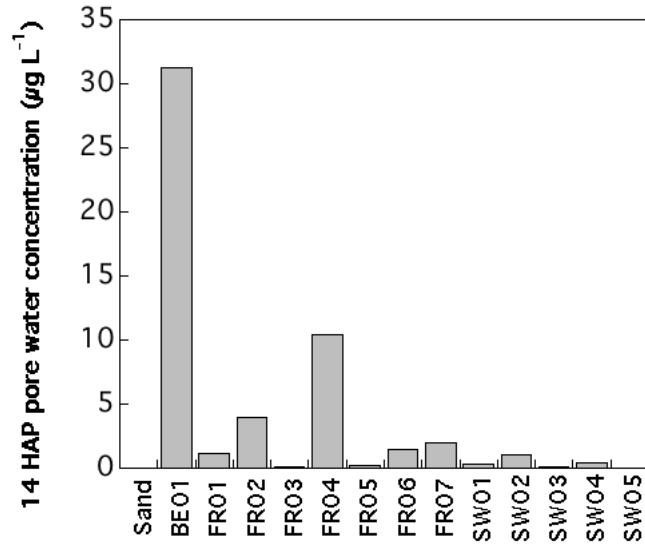
Soils



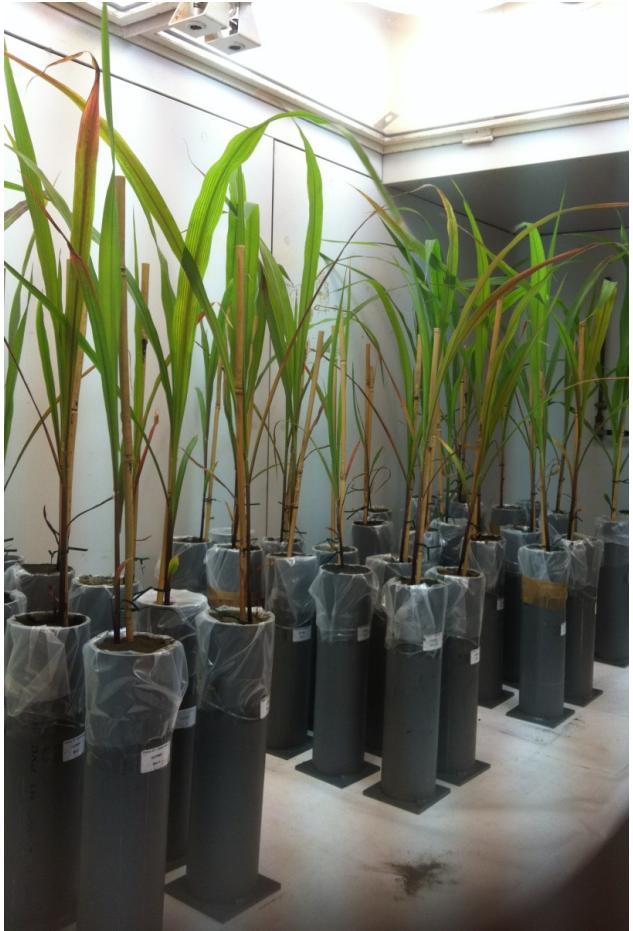
- wide concentration range
- molecular distribution reflects past industrial activities

Concentrations et distributions

Poral water



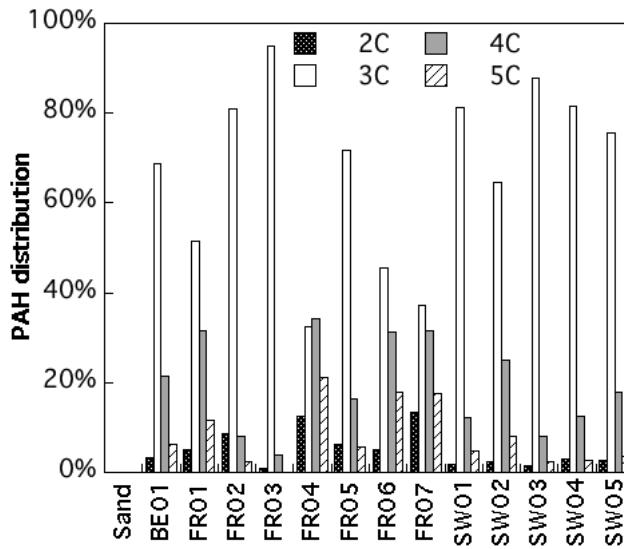
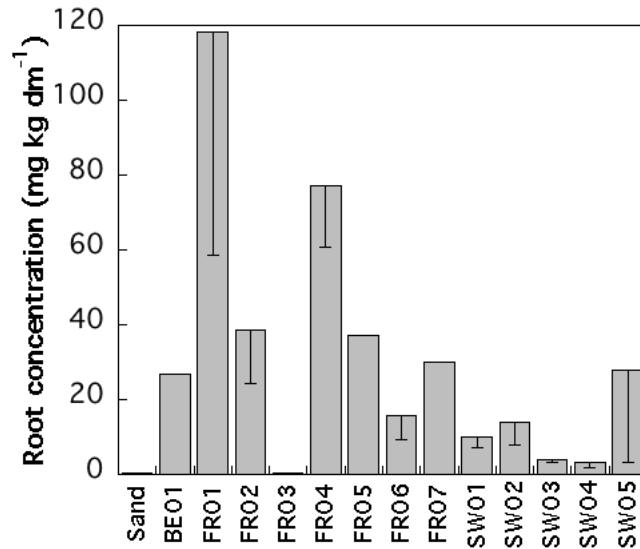
- highest contribution of low molecular weight molecules
- no direct influence of total soil concentrations



Plant uptake

Concentrations and distributions

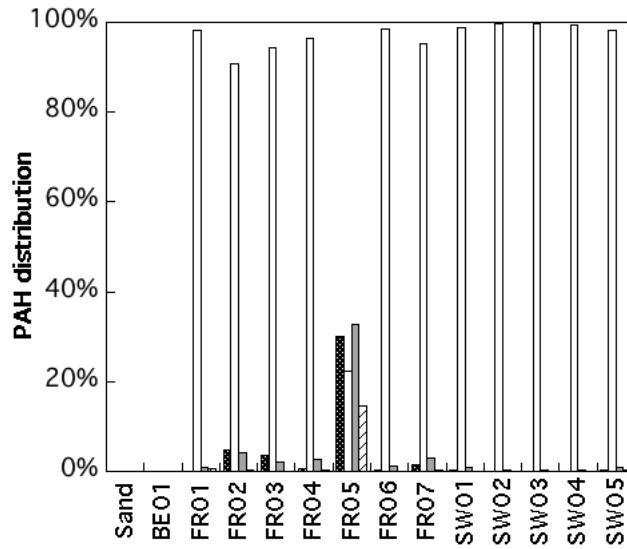
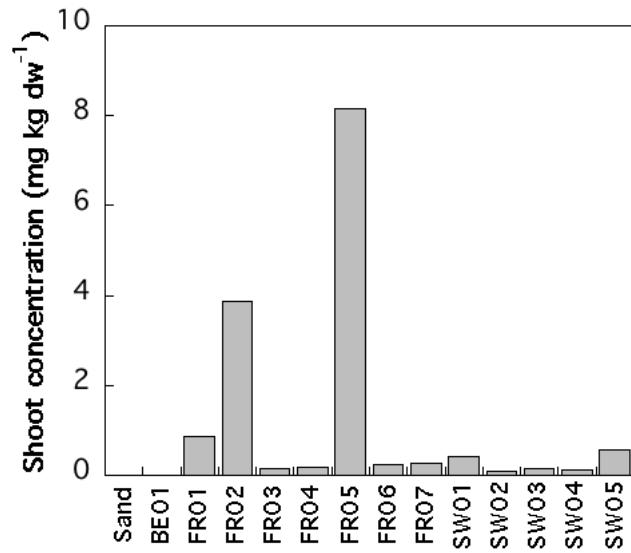
Roots



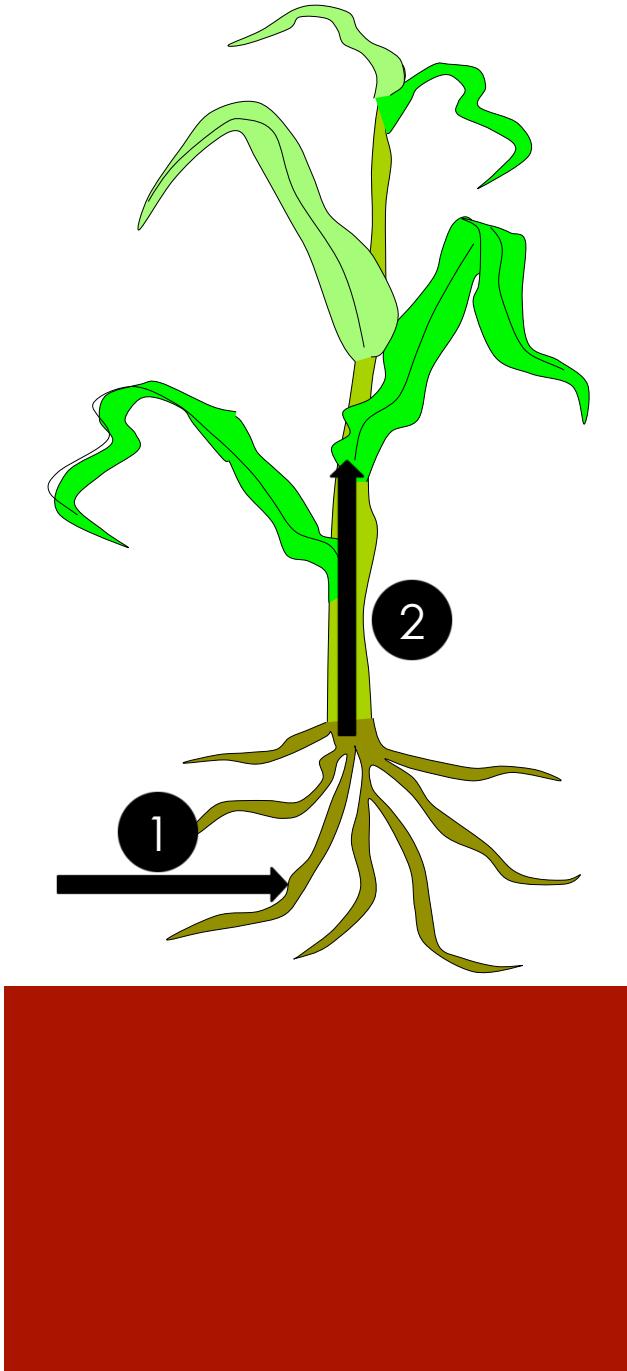
- similar to soil total concentrations in terms of distribution and variability

Concentrations and distributions

Shoots



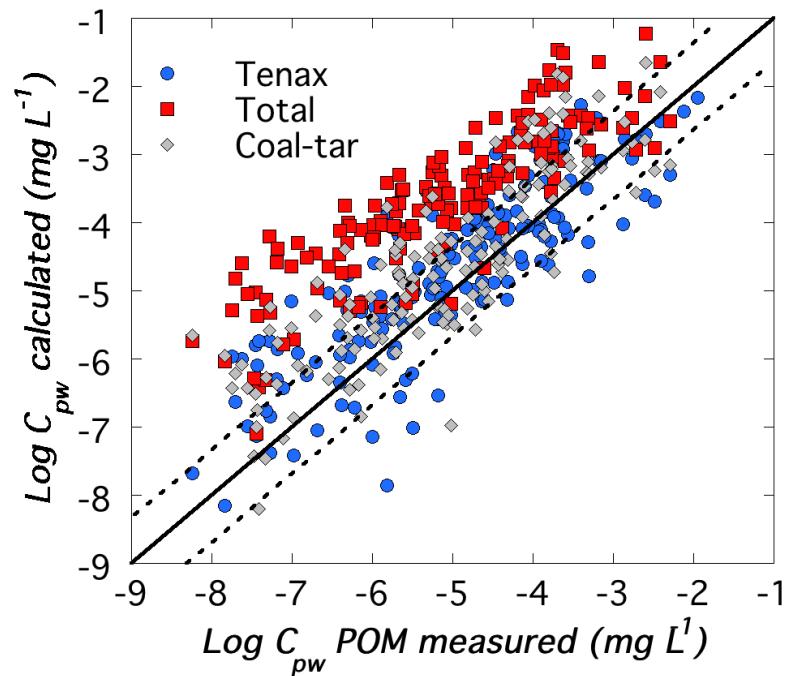
- very low concentrations (often below LQ)
- predominance of few compounds 3 and 4 cycles (FLT, ANT, PYR)



Modeling

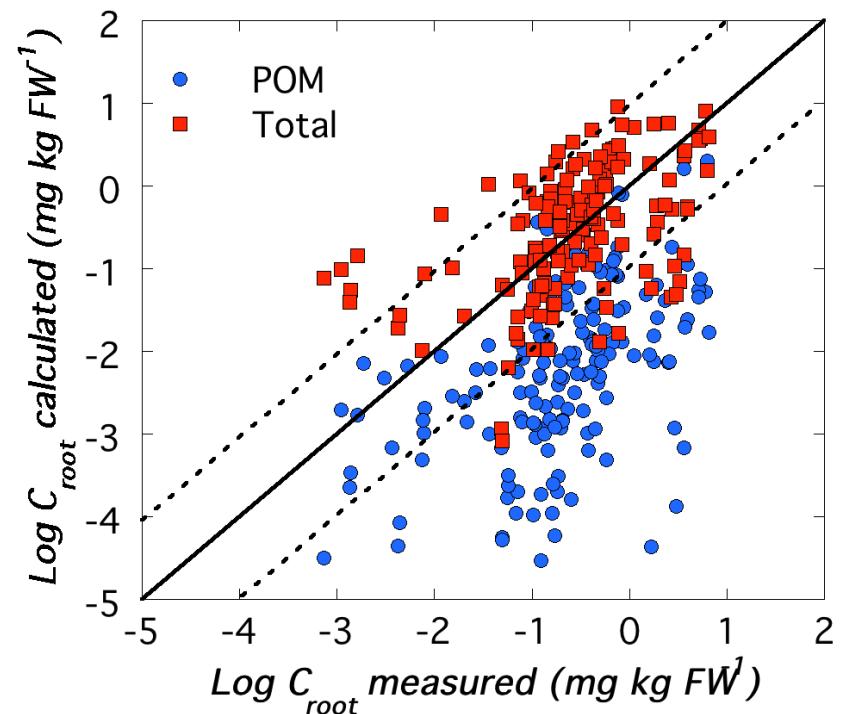
C_{pw} estimate

- Best estimate with
 - partitioning on Tenax-extractible amounts
 - « coal tar » model with total soil concentrations
- Partitioning applied on total concentration over estimate by two orders of magnitude

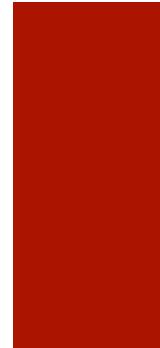


Root uptake prediction

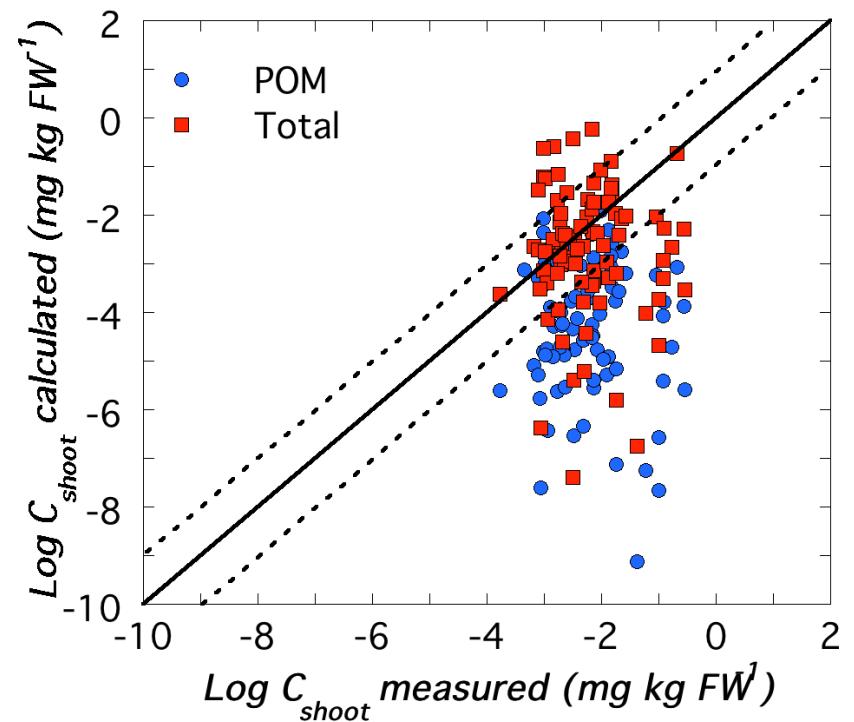
- From “POM” measured C_{pw}
 - strong under prediction
- Calculated from total soil concentration using « classical » model
 - good « accidental » prediction of C_{pw}
- High variability



Shoot uptake prediction



- From « POM » measured C_{pw}
 - strong under estimate
- Calculated from total soil concentration using « classical » model
 - good « accidental » prediction of C_{pw}
- High variability



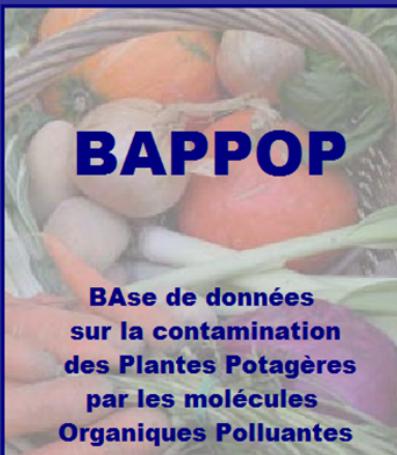
Conclusions

- Good C_{pw} estimate achieved with
 - classical partitioning models applied to Tenax-extractable amounts
 - « coal tar » model applied on total soil amounts
 - Uptake models based on pore water concentrations strongly under estimate both root and shoot uptakes
- ⇒ Models for PAH plant uptake should be re-considered
- ⇒ alternative pathways for PAH
 - ⇒ consider direct soil/plant tissue transfer?

Coming soon !
juin. 2016

BAPPOP database for OP in garden plants

www6.inra.fr/planteval



Nous vous conseillons de
lire attentivement la notice
d'utilisation de la base

Sélection des données

Présentation et notice
d'utilisation

Quitter



PlantEval

Evaluation de la qualité des plantes potagères

Mise à jour et complément de la boîte à outils pour le diagnostic environnemental de jardins potagers :

- guide d'échantillonnage des plantes potagères (2014)
- bases de données des transferts de polluants : BAPPET (2013) et BAPPOP (2015)

PlantEval fait la synthèse de projets soutenus par l'ADEME et l'INERIS, destinés à développer des outils pour le diagnostic environnemental dans le contexte de l'évaluation des risques sanitaires associés à la consommation des productions potagères.

Les travaux sont menés par un consortium composé de :

Université de Lorraine/INRA UMR 1120
Laboratoire Sols et Environnement
Vandœuvre-lès-Nancy

INPT/ENSAT, UPS/CNRS UMR 5044
Centre d'Etude et de Recherche
Travail Organisation Pouvoir
Toulouse

Groupe ISA
Laboratoire Génie Civil et géo-Environnement
Lille

UNIVERSITÉ DE LORRAINE INRA
Laboratoire Sols et Environnement

CNRS

INPENSAT

GROUPE ISA

LGC Laboratoire Génie Civil et géo-Environnement

ISAE-SUPAERO