Soil-Air exchange of PAHs from an old landfill, currently under rehabilitation

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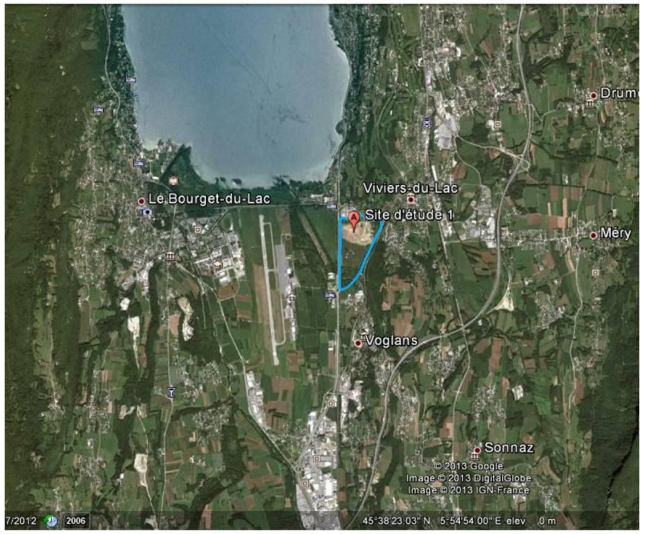
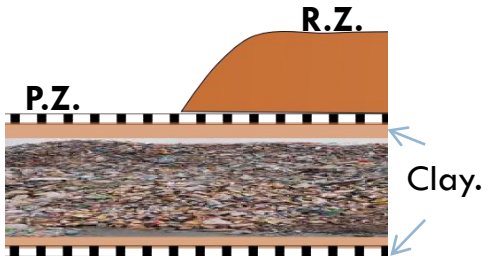
Summary

1. Context & Objectives
2. Materials & Methods
3. Results
4. Conclusions
5. Perspectives

Context

- Old landfill which collected garbages and industrial wastes during 20 years ;
- Pollution observed in soil and water around the site ;
- Site near important water resource (Bourget Lake) ;
- Persistence of SVOCs (PAHs) in the environment, especially in soils => Health concern and environmental risks.
- Buried waste under a new clay level and 5m thickness of new soil on the initial landfill surface.





Objectives

- To evaluate the containment effect of earth recovering on air-soil exchange for all seasons ;
- To establish PAHs mass balance between soil and atmosphere;
- To determine the preferential way of PAHs transfer: the soil being the compartment of reference.

Atmospheric compartment

Atmospheric compartment

- PM10 head
- Low flow: 1 m^3/h
- Gas phase : PUF
- Particulate matter: quartz filter
- Height :1.5 m

Atmospheric deposition

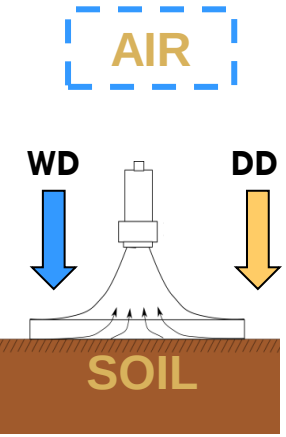
- Automatic sampler
- Dry collector in glass
- IR detector to open wet collector
- Data logger records open and close funnel

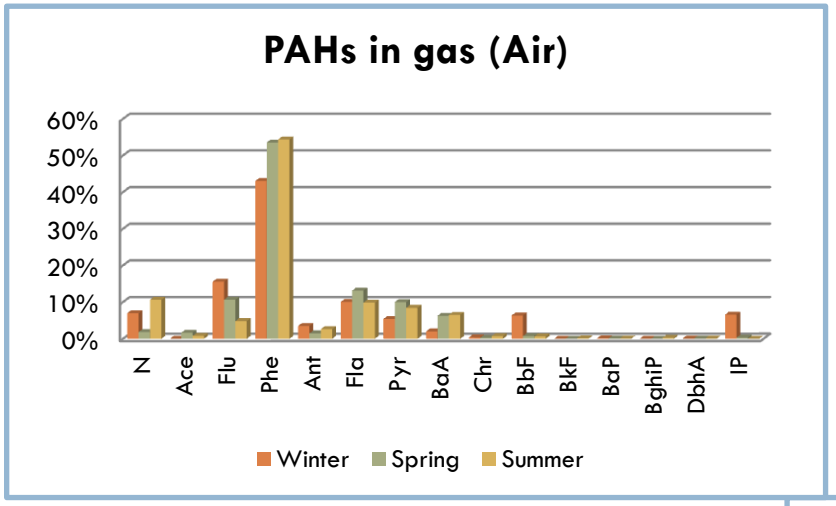
Soil's emission sampler

- Gas phase: PUF
- Particulate Matter: quartz filter
- Low flow: 0.3 m^3/h
- Area = 0.5 m^2
- Tent to limit sunlight & rainfalls

Polluted area (PZ)	Properties	Rehabilitated area (RZ)
13 - 29	**Moisture (%)**	4 - 29
6	**OM (%)**	5
94	**MM (%)**	95
8.7	**pH**	8.8

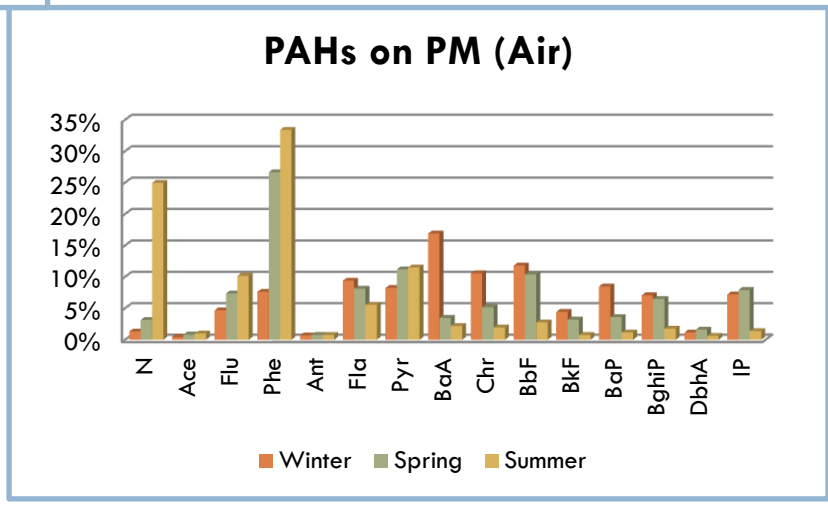
Atmospheric compartment



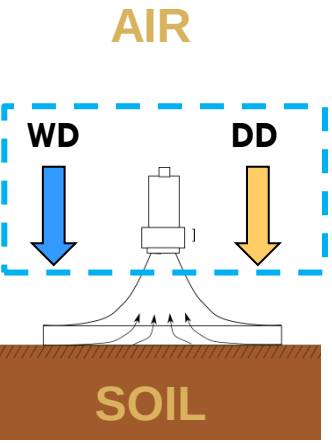


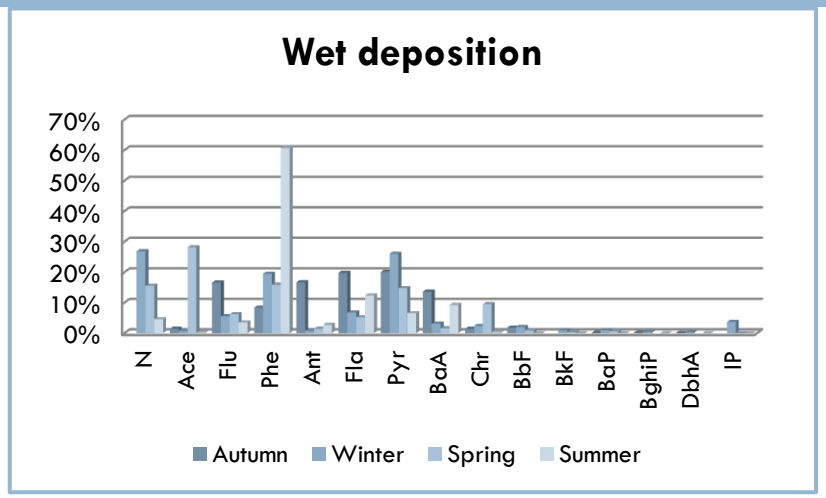
∑ 15 PAHs (ng/m³)	GP	PM
Winter	91 ± 31	48 ± 15
Spring	18 ± 5	4 ± 1
Summer	13 ± 5	3 ± 2

- PAHs concentrations in gas >> particles
- Heavy PAH (> Chrysene) are associated to PM and volatile PAHs (< CHR) to the gas ;
- Maximum concentration in winter =>more sources.



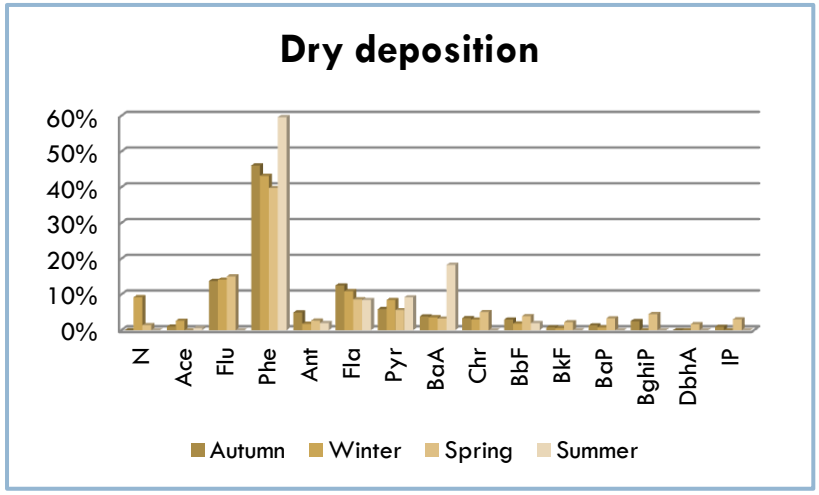
Atmospheric deposition



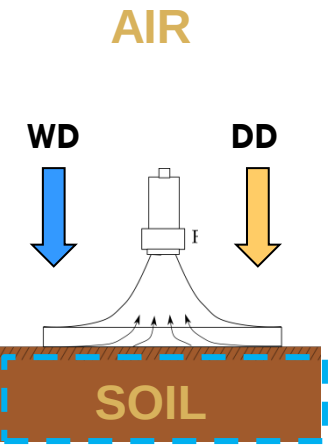


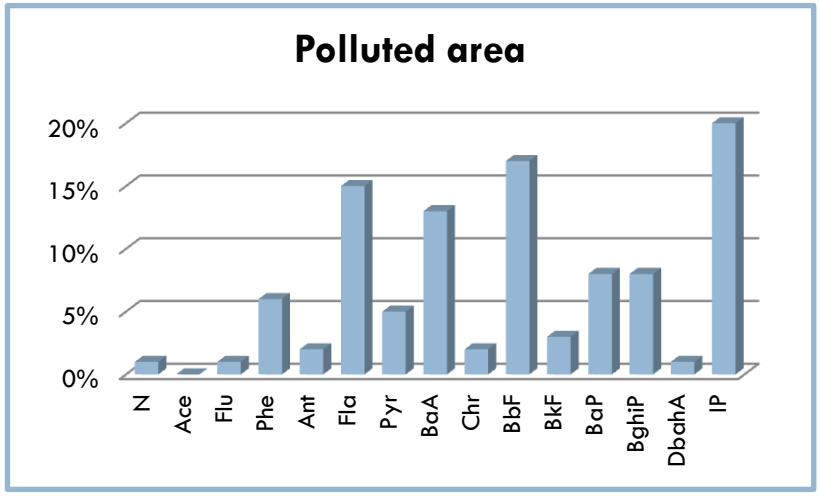
∑ 15 PAHs (ng/m²/d)	WD	DD
Autumn	462	1 987
Winter	502	3 093
Spring	26	1 855
Summer	316	1 366

- DD main pathway : 5 times higher than WD
- Heavy PAH present in dry deposition (> CHR), water soluble PAHs in wet deposition (< CHR) ;
- Maximum concentration in winter => more sources.



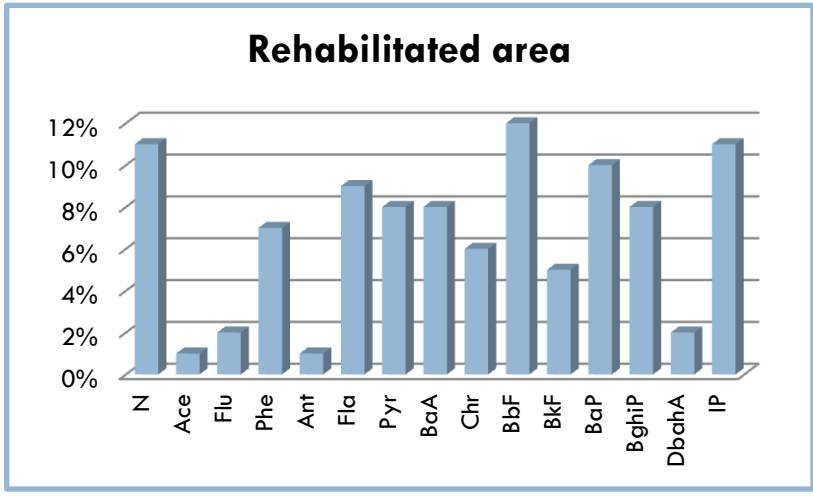
Soil compartment



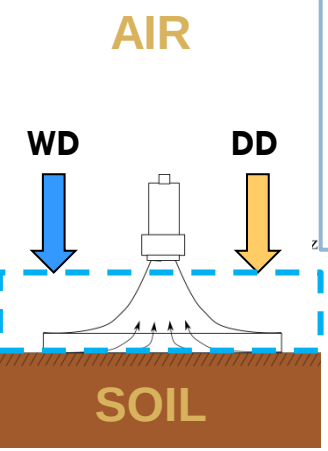


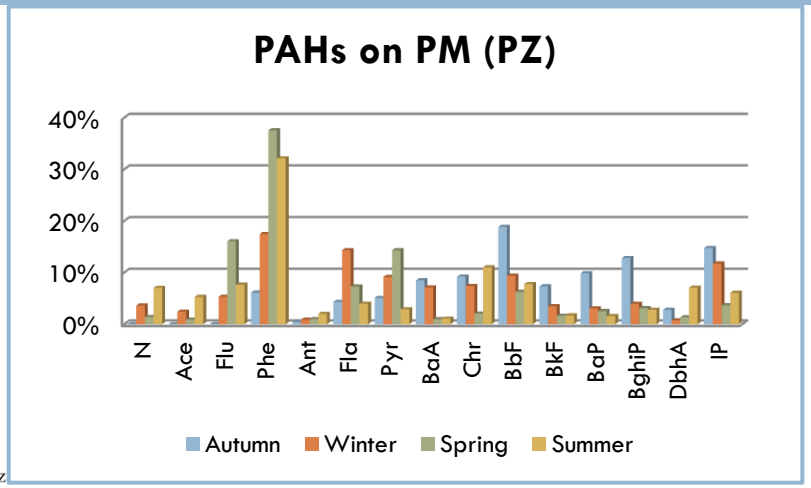
∑ 15 PAH (µg/kg DS)	
P. Z.	**R. Z.**
1780 ± 739	817 ± 126

- All PAHs present in soil ;
- PAHs profile similar to those of a weakly polluted soil;
- Maximum concentration in polluted soil => history of site.

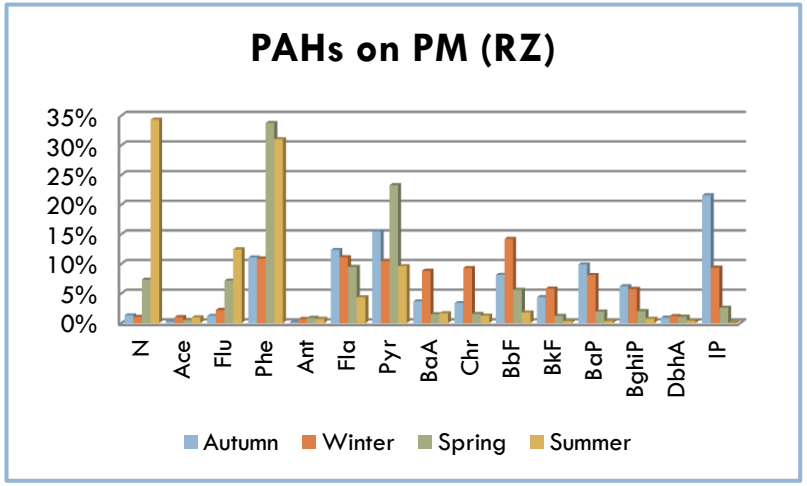


Soil's emissions (PM)



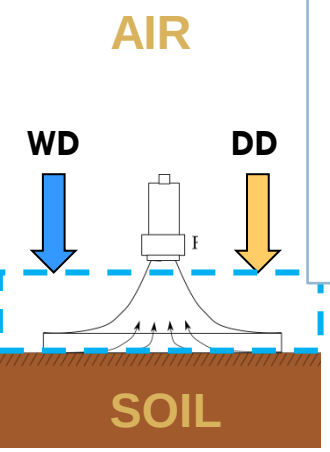


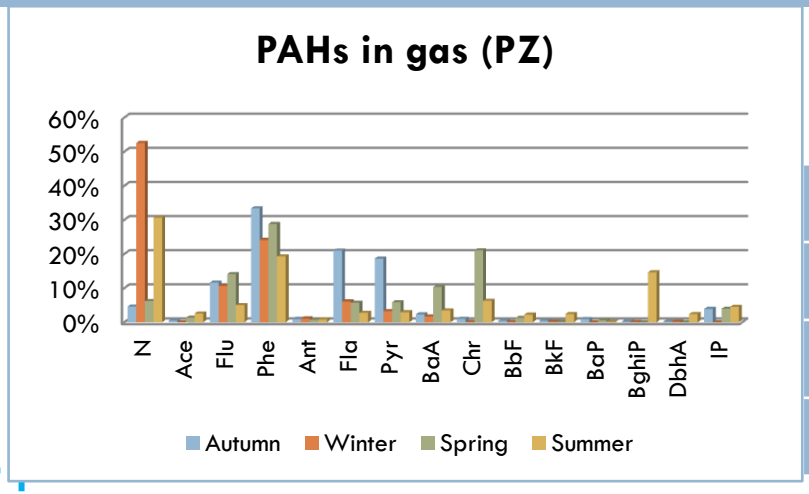
	∑ 15 PAHs (ng/m²/d)	
	P. Z.	R. Z
Autumn	164 ± 125	70 ± 39
Winter	689 ± 158	562 ± 152
Spring	128 ± 76	85 ± 31
Summer	81 ± 82	136 ± 27



- Presence of all PAHs on PM.
- Amount of PAHs on PM is 2 times higher for the P.Z compared to the R.Z in autumn and spring, equivalent in winter and summer.

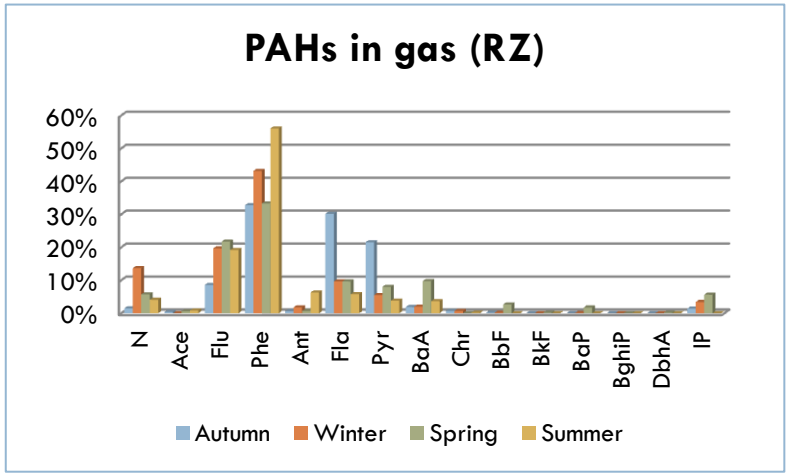
Soil's emissions (GP)



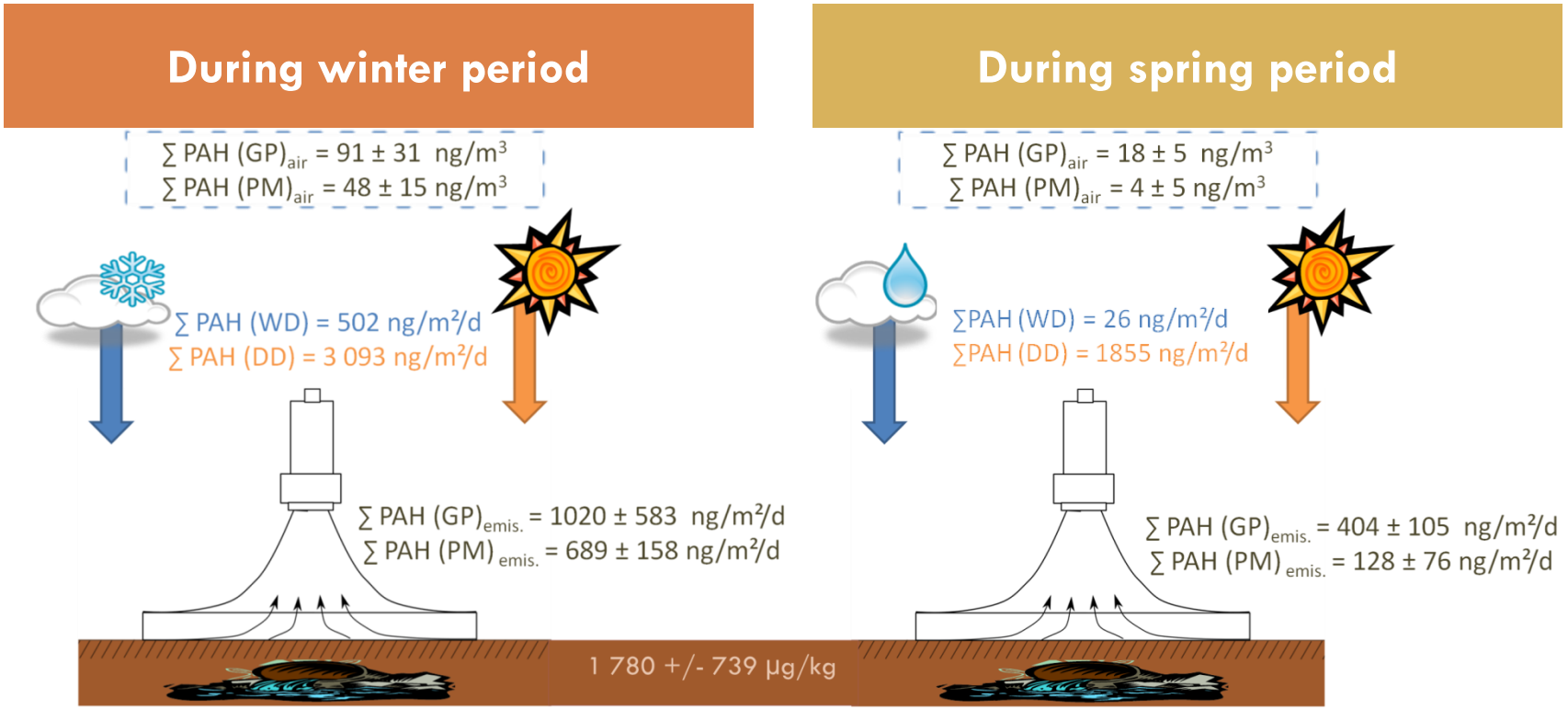


	∑ 15 PAHs (ng/m²/d)	
	P. Z.	R. Z
Autumn	381± 47	177 ± 70
Winter	1020 ± 583	1006± 421
Spring	404 ± 105	170 ± 73
Summer	293 ± 92	180 ± 49

- Light PAHs: major compounds in gas phase
- Except in winter, emissions from the polluted area are from 2 to 4 times higher than the rehabilitated area.

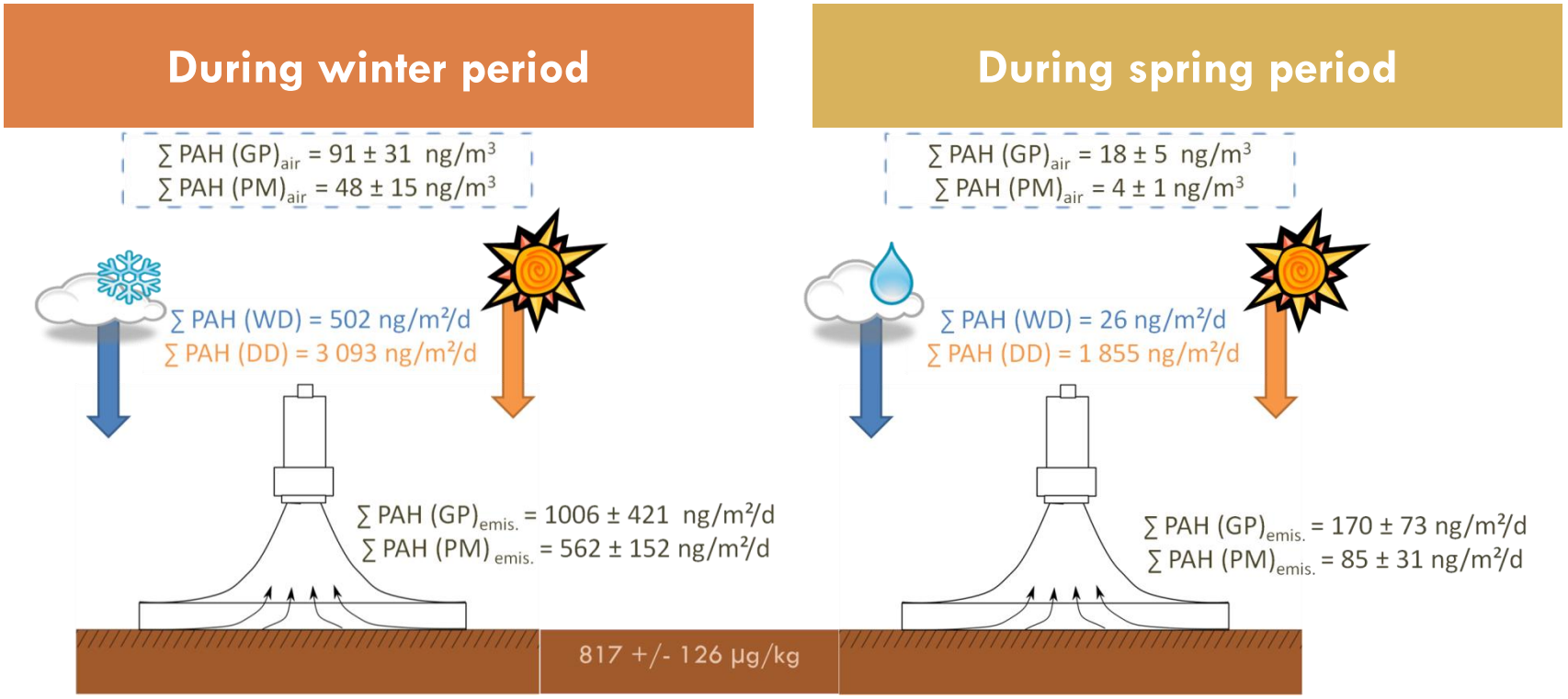


Mass Balance: Polluted area



- In winter, high atmospheric PAHs level => more primary sources (heating),
- Dry deposition: main pathway whatever the season,
- Enhancement of PAHs emissions from soils in winter / spring.

Mass Balance: Rehabilitated area



- Dry deposition: main pathway.
- In winter, similar fluxes of PAHs emitted (PM & GP) from the R.Z and the P.Z soils.
- Spring period : PAHs emission from P.Z soil (x2) >> R.Z soil.

Higher Concentrations in winter

Atmospheric contribution to soil emissions ? Similar profiles between atmospheric PAHs and emissions of PAHs from soils.

=>Punctual analytical failure or experimental bias ?

- On PM :
  - Low humidity in soil => high amount of adsorbed PAHs on emitted PM.
- In the GP:
  - Presence of very fine particles (filter cut-off = 0.3 µm) associated with the gas phase and water evaporation through the quartz filter (detection of heavy PAHs).
  - Desorption of adsorbed PAHs from particles towards the gas phase, not favoured in winter.

Conclusions

- Soil: a “sink” for atmospheric PAHs, but also a secondary source of emission according the season ;
- Mass balances show that dry depositions are always the preponderant pathway => soil's emission are 5 to 10 times lower than deposition.
- Except in winter, total emissions (GP + PM) from Polluted Zone are higher than on the Rehabilitated Zone, whatever the season => the landscape rehabilitation is a way to stop emission in spring (x2).
- Winter is an unexpected season, with a maximum emission of PAHs in the gas and particles phase from soils (very fine suspended particles <0.3 µm) equivalent to the atmosphere.

Perspectives

- Emissions from soils observed in winter have to be confirmed. Studies are currently carried out with a comparison of emissions between a close and raised (3cm above the soil allowing lateral inputs) fugacimeter on soil.
- To extend measurments to others compounds like pesticides and PCBs.
- To undergo modelization for prediction of mass balances.

Thank you for your attention.
If you have any questions.