PRIMEQUAL
Programme de recherche interorganisme pour une meilleure qualité de l'air

ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

Emissions de composés organiques volatils par des sols amendés par des PRO: évolution saisonnière et lien avec la diversité microbienne

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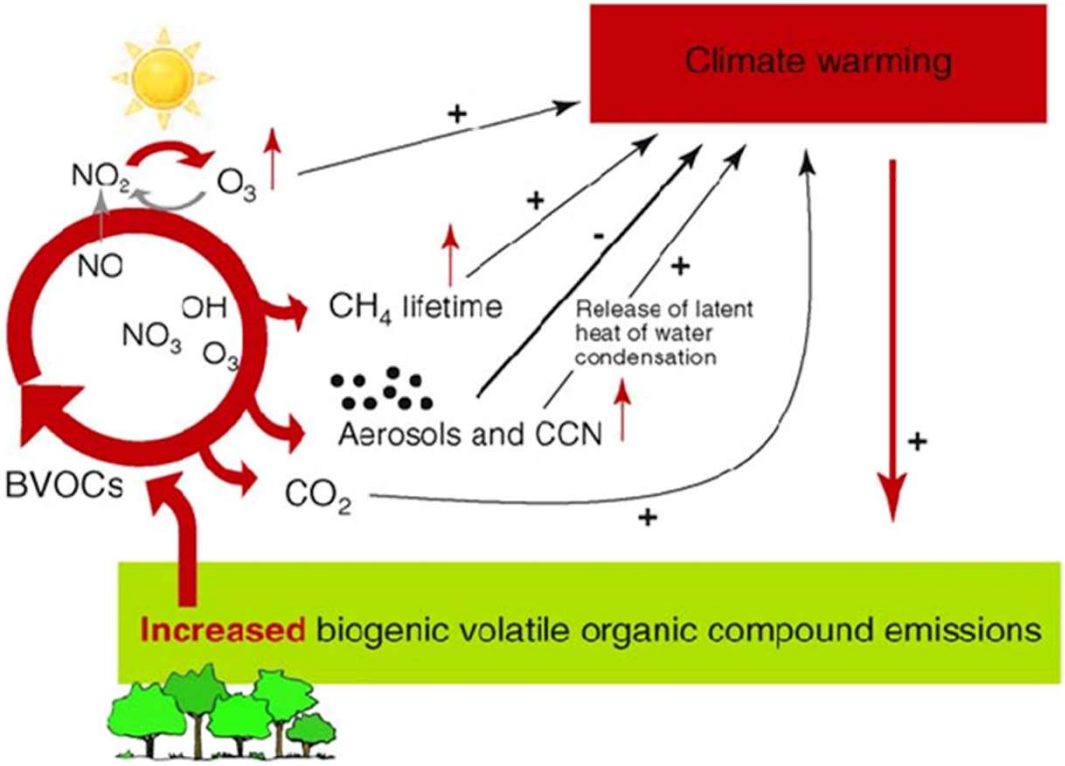
EcoSys

VOCs AND THEIR ROLE IN ATMOSPHERIC POLLUTION



(Source: Peñuelas and Staudt 2014)

VOCs ARE PRECURSORS OF:

Secondary Organic Aerosol (SOA)

Tropospheric ozone

Effects on human health

- PREMATURE DEATHS
- RESPIRATORY DISEASES
- ASTHMA ATTACK

Effects on crop production

- DECREASE ON CROP PRODUCTION (3-20 %)

SOURCES OF VOCs

BIOGENIC SOURCES

Biogenic VOCs emissions (bVOCs)

90 %

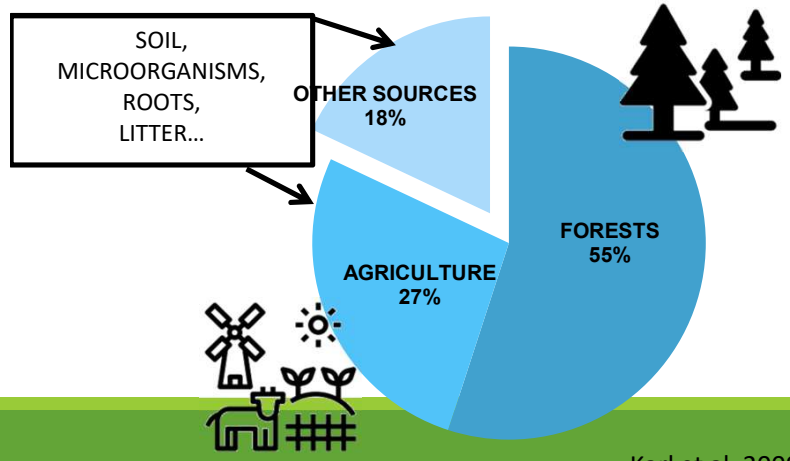
CONTRIBUTION TO THE TOTAL VOC EMISSIONS:

ANTHROPOGENIC SOURCES

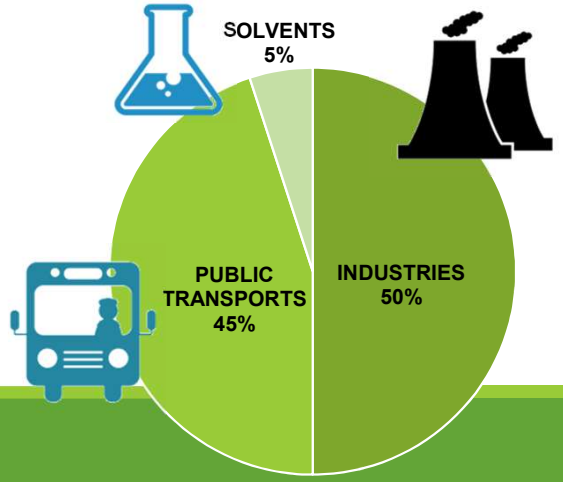
Anthropogenic VOCs emissions (aVOCs)

10 %

Guenther et al. 1995



Karl et al. 2009



FACTORS AFFECTING bVOCs EMISSIONS FROM SOIL

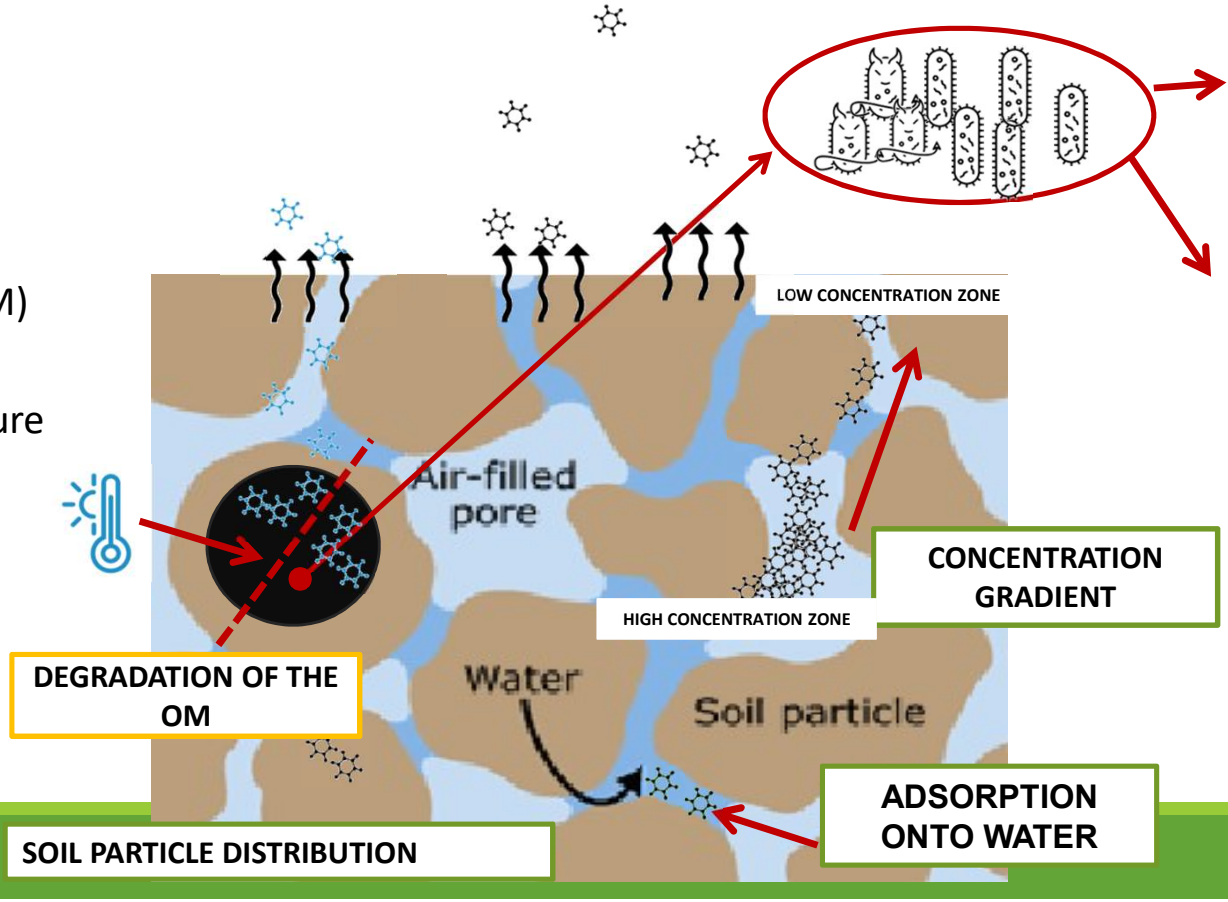
ABIOTIC MECHANISMS | **BIOTIC MECHANISMS**

= VOC

= microorganisms

= Organic matter (OM)

= light and temperature



ENERGY PRODUCTION =

PRIMARY METABOLISMS

DEFENSE AND COMMUNICATION=

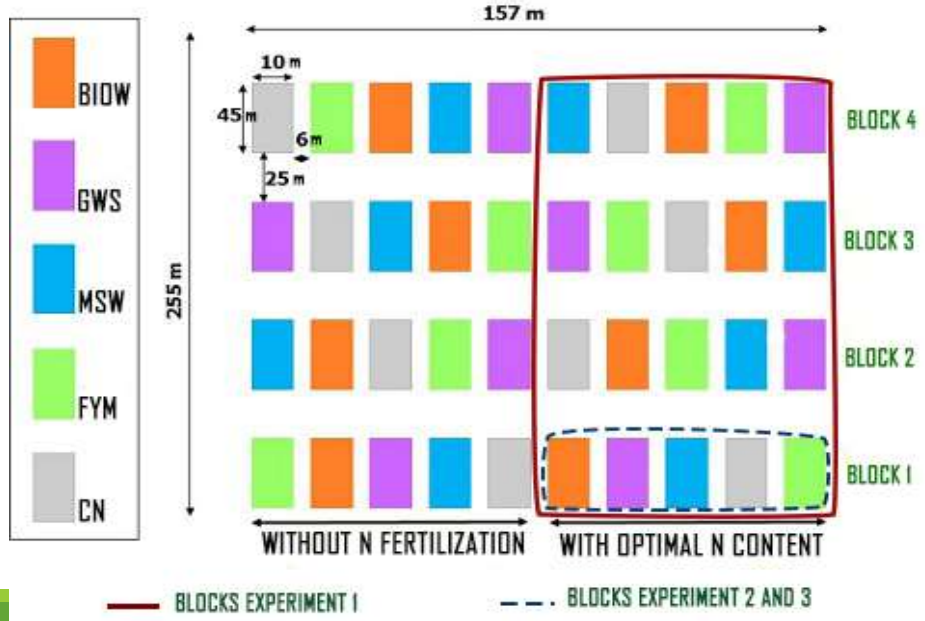
SECONDARY METABOLISM

Materials and methods

THE EXPERIMENTAL SITE: QUALIAGRO

Feucherolles (France, SOERE-PRO site)

LONG TERM APPLICATION OF THE OWP IN SOIL (~20 years)

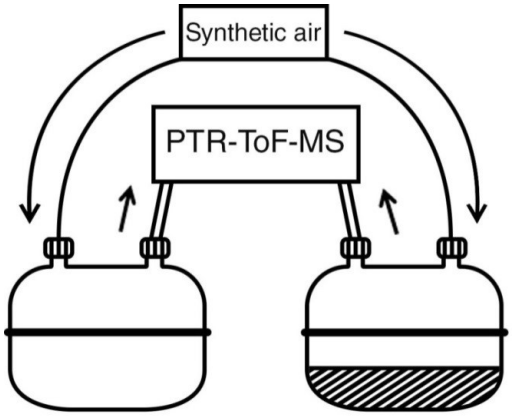


4 OWPs (every 2 years 4 t C ha^{-1}):

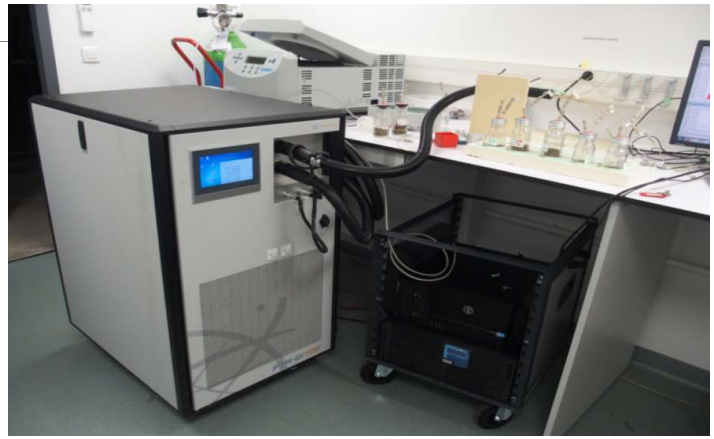
- **BIOWASTE COMPOST** (BIOW)
- **GREEN WASTE AND SLUDGE** (GWS)
- **MUNICIPAL SOLID WASTE COMPOST** (MSW)
- **FARMYARD MANURE** (FYM)

AND A CONTROL WITHOUT ORGANIC INPUT (CN)

Chamber and Proton Transfer Reaction-Time Of Flight-Mass Spectrometer (PTR-TOF-MS) to measure VOC emissions

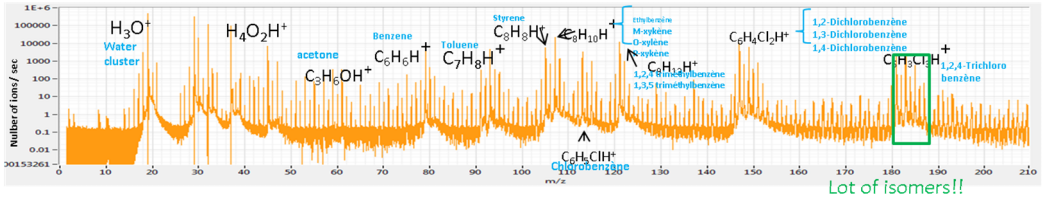


chambers used for the VOCs detection from the microcosms



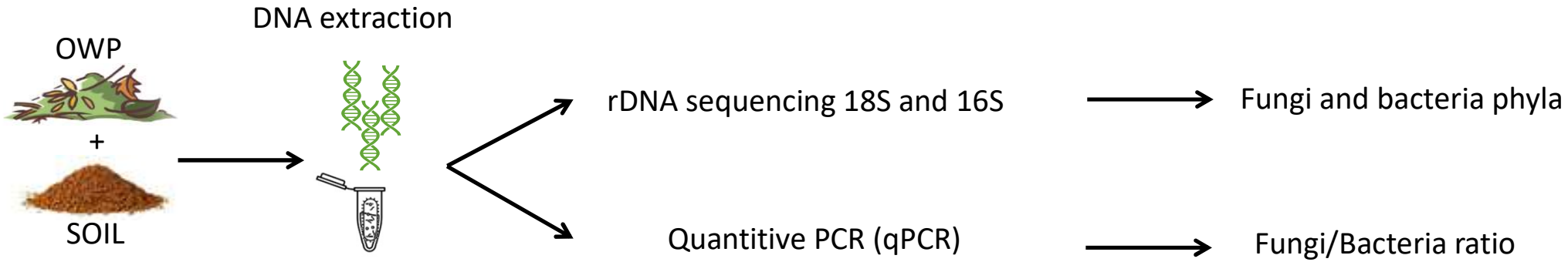
The Ionicon PTR-TOF-MS used during analysis.

$$E_{VOC} = \frac{Q_{air} \times (x_{voc_{soil}} - x_{voc_{empty}})}{V_{air\ mol} \times m_{dry\ soil}}$$



PTR-MS spectrum, lot of compounds detected with same m/z

BIOMOLECULAR ANALYSIS



SHANNON INDEX

INDEX OF MICROBIAL DIVERSITY IN SOIL WHICH HAS BEEN ALSO APPLIED TO THE VOC EMISSIONS

$$H = -\sum_{VOC} E_{VOC} \log(E_{VOC})$$

THE PERFORMED EXPERIMENTS

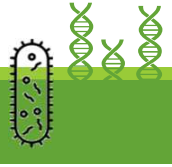
OWPs IN SOIL AND
VOC EMISSION

VOCs DETECTION SYSTEM

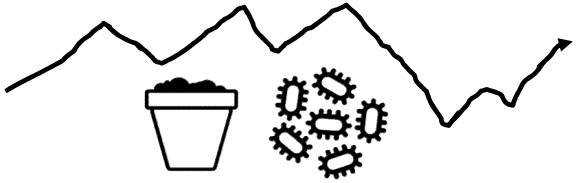
MICROBIAL DIVERSITY IN SOIL
AND
VOC EMISSION

VOCs DETECTION SYSTEM

rDNA sequencing

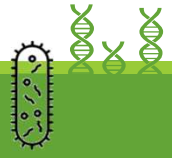


LongTERM MICROBIAL
COMMUNITY AND
VOC EMISSION



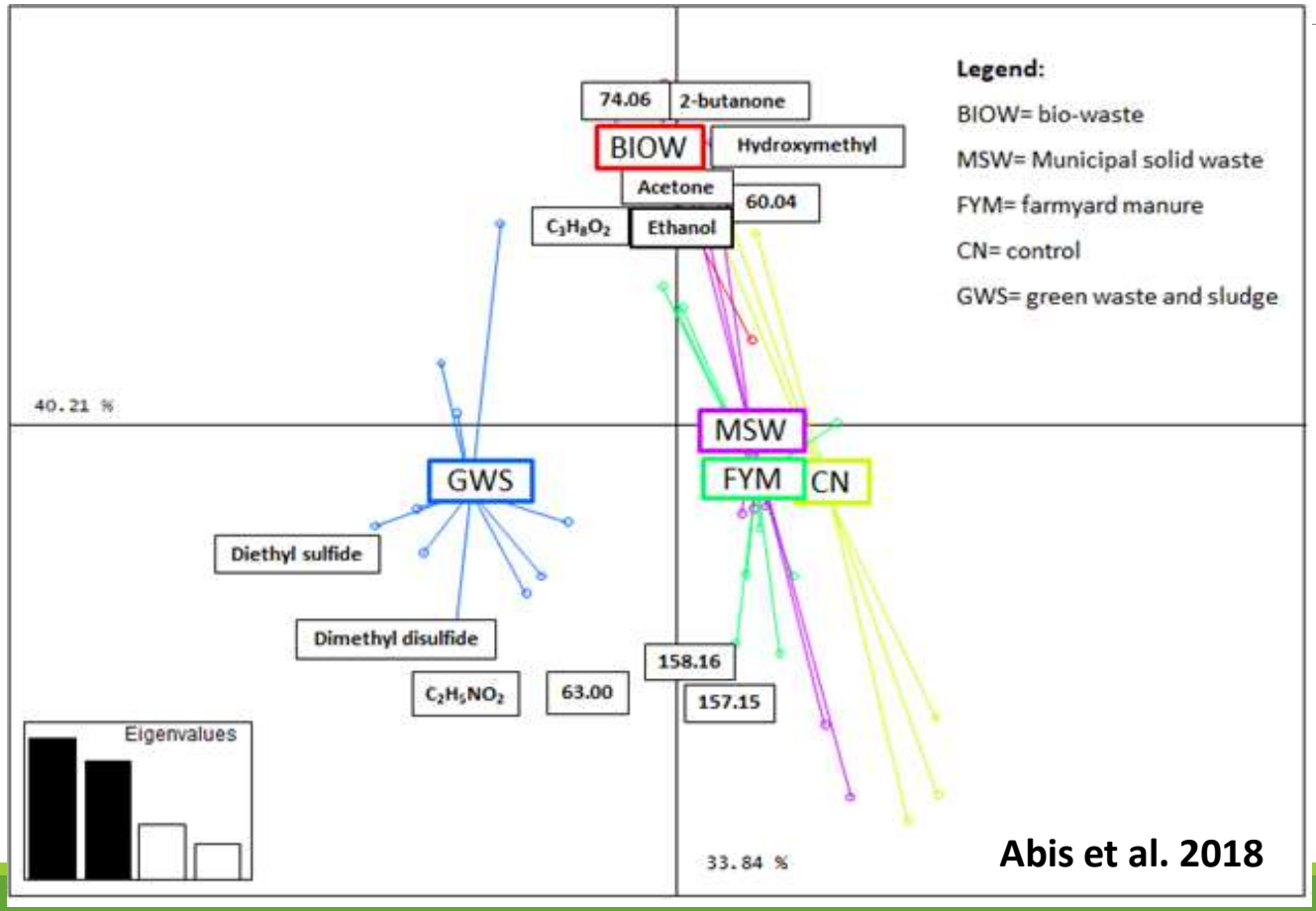
VOCs DETECTION SYSTEM

rDNA sequencing



Lien entre apports de PRO et émissions de COV en situation “de fond”

VOCs MARKER OF THE OWPs ?



Abis et al. 2018

PCA results:

- OWPs have different VOCs profiles

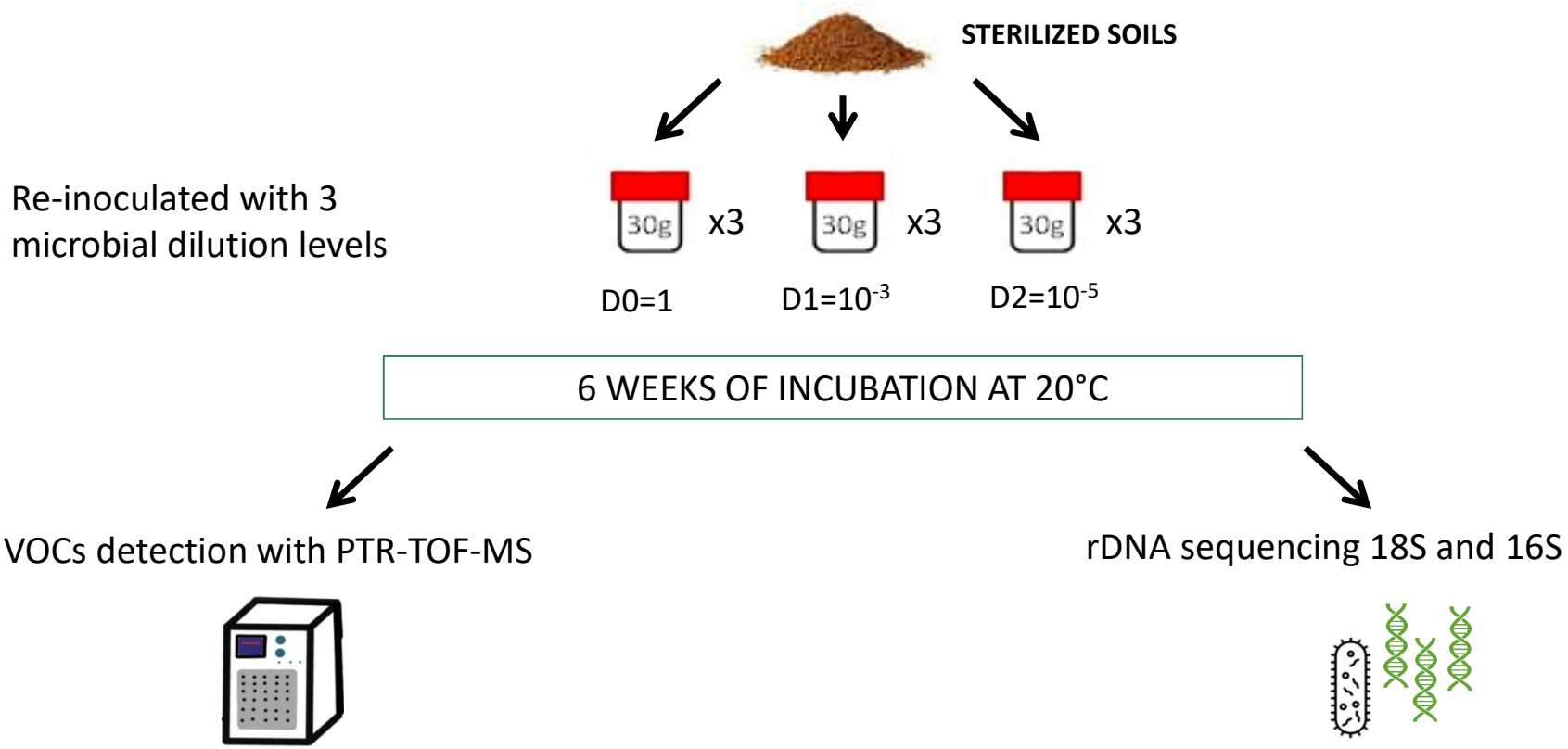
ANOVA results:

- 21 markers compounds differentiating between OWPs

BIOW emits more BVOCs quantities

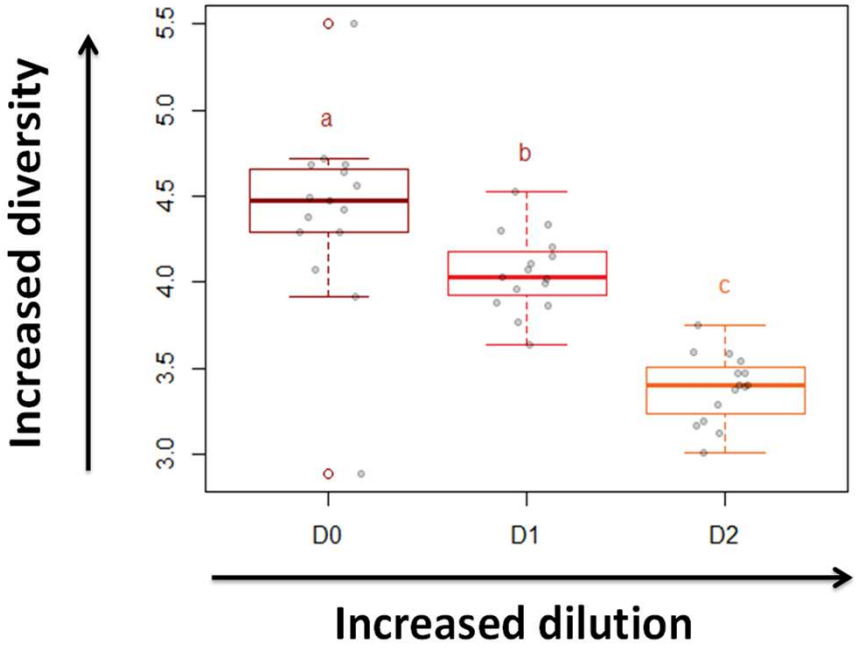
Effet de la dilution de diversité sur les émissions

EXPERIMENTAL SETUP

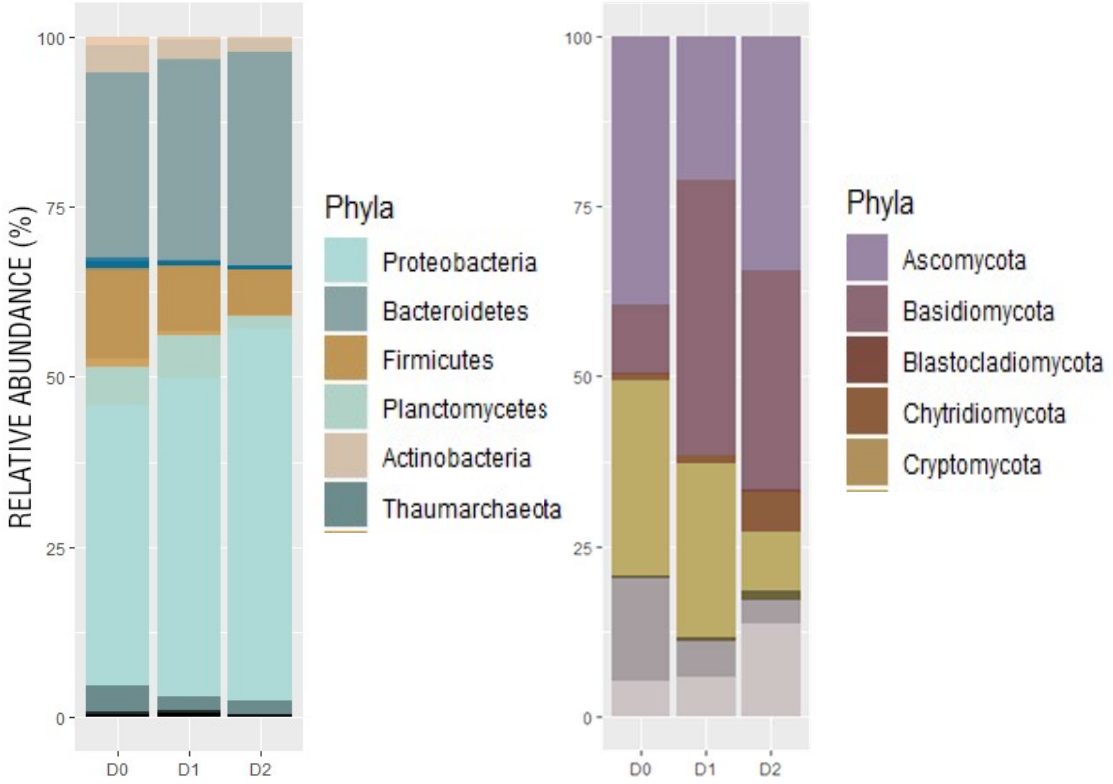


MICROBIAL DIVERSITY

SHANNON INDEX

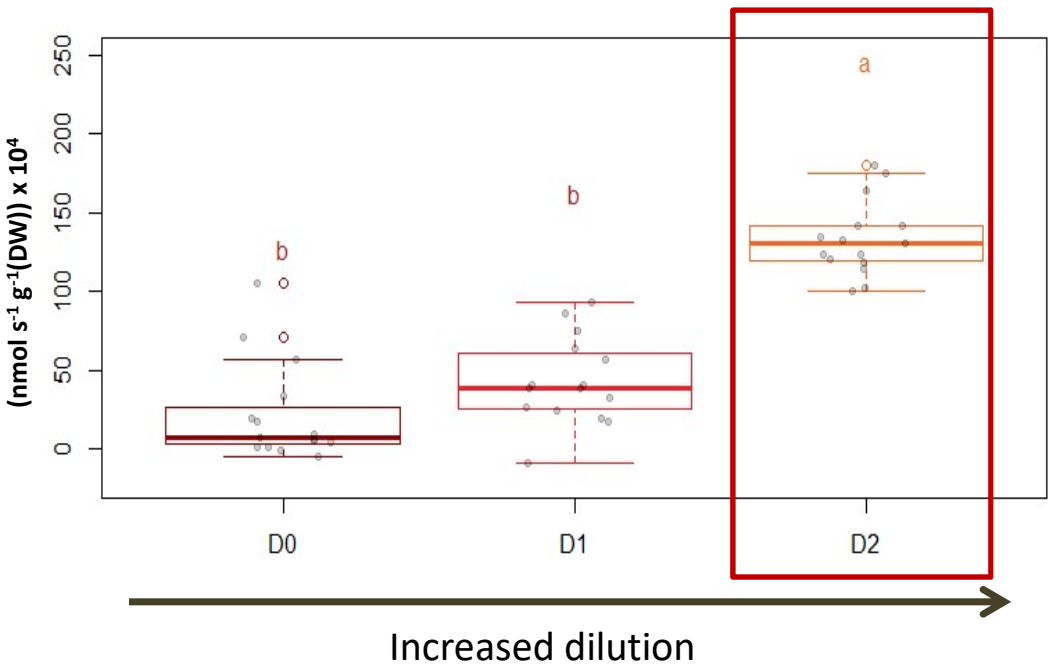


BACTERIAL AND FUNGI RELATIVE ABUNDANCE



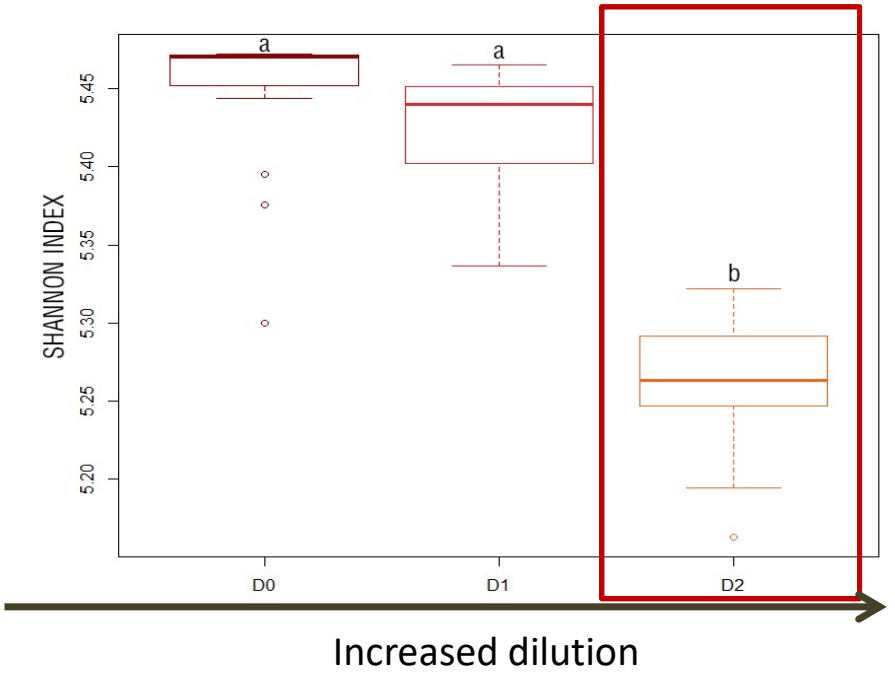
VOC EMISSIONS FROM MANIPULATED SOIL

TOTAL VOC EMISSIONS



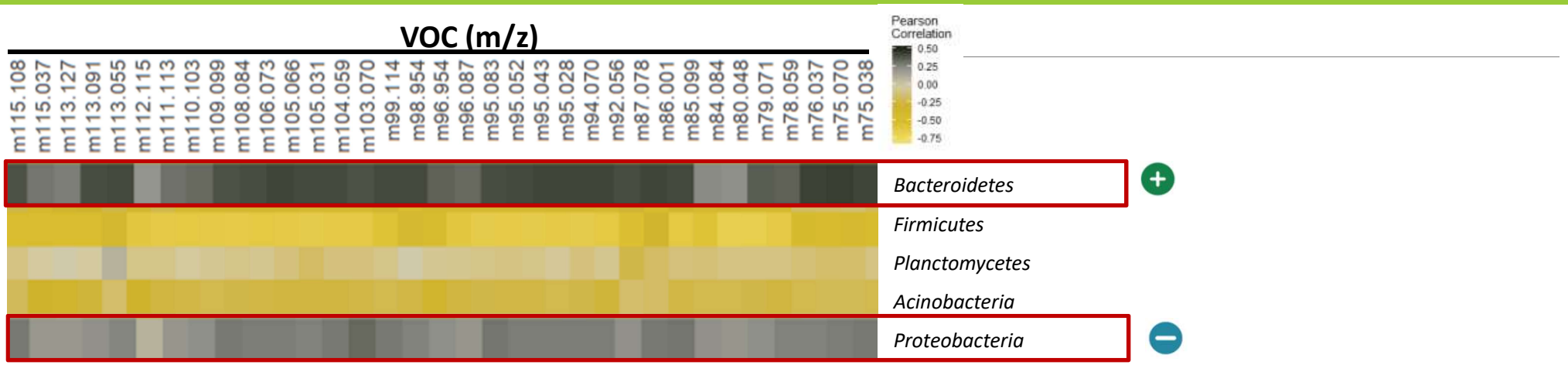
HIGHEST EMISSION FOR THE HIGHEST MICROBIAL DILUTION LEVEL

SHANNON INDEX FOR VOC EMISSIONS



THE VOCs DIVERSITY DECREASEs FOR THE HIGHEST DILUTION LEVEL

VOC CORRELATED WITH MICROORGANISMS



PHYLUM / VOC	↗	↘
↗	MICROORGANISM GROWING PRODUCES THE VOC (VOC PRODUCED BY MICROBIAL FUNCTIONING)	VOC CONSUMMED BY MICROORGANISM (VOC USED AS CARBON SOURCE)
or ↘	MICROORGANISM PROMOTED BY VOC OR VOC PRODUCER (POSITIVE INTERACTION BETWEEN MICROORGANISMS)	VOC OR VOC PRODUCER INHIBITS MICROORGANISM GROWTH (COMPETITION MECHANISMS)

Dynamique annuelle des émissions de COV et des communautés microbiennes

Méthodologie

Parcelles 101 à 105

- OMR
- BIO
- DVB
- FUM
- TEM

Mesure de COV / MO tous les mois
Mesure de diversité bactérienne sur échantillons choisis

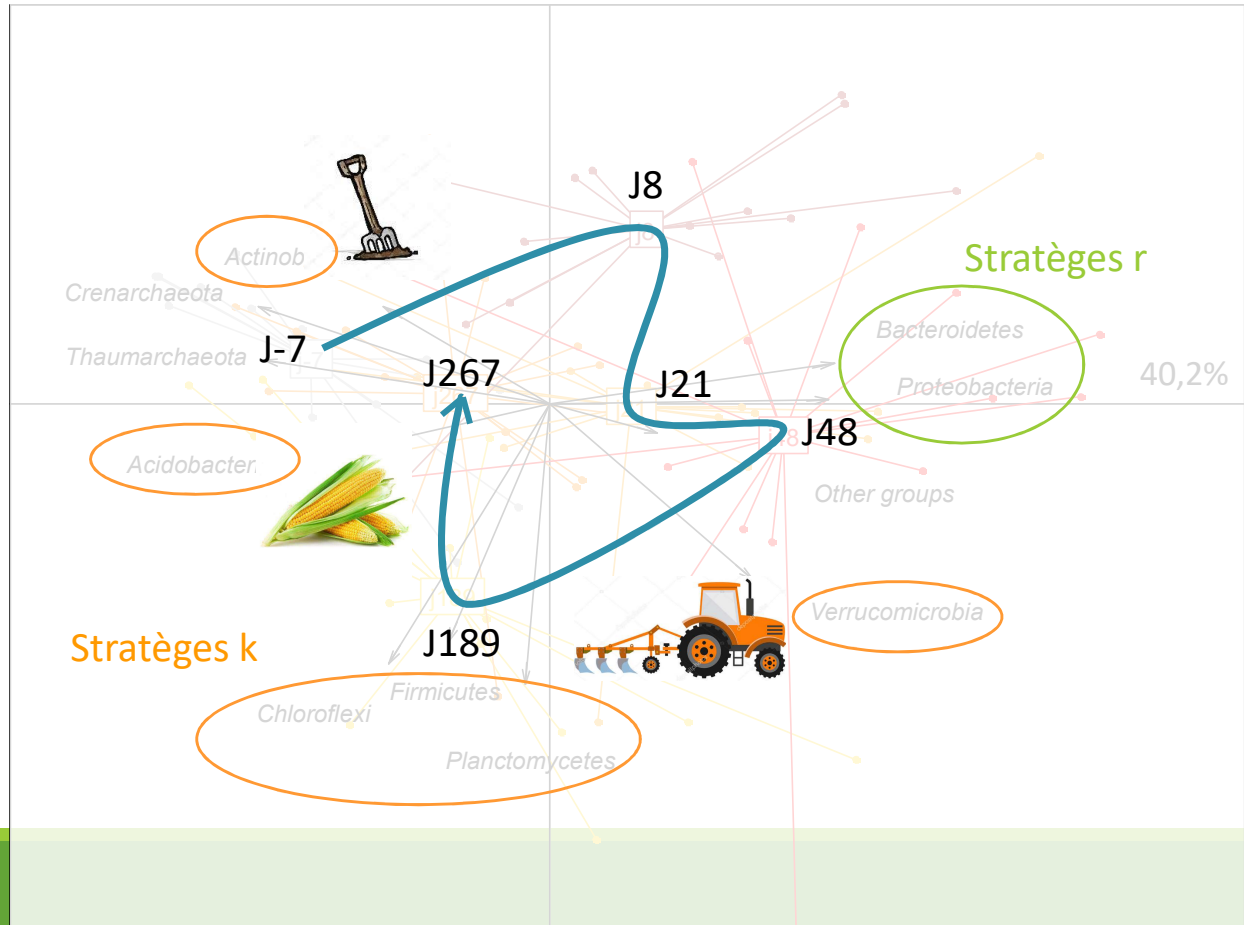
Semi Maïs

J0 J3 J8 J21 J48 J84 J121 J146 J189 J224 J238 J267

Sept 2017
J-7

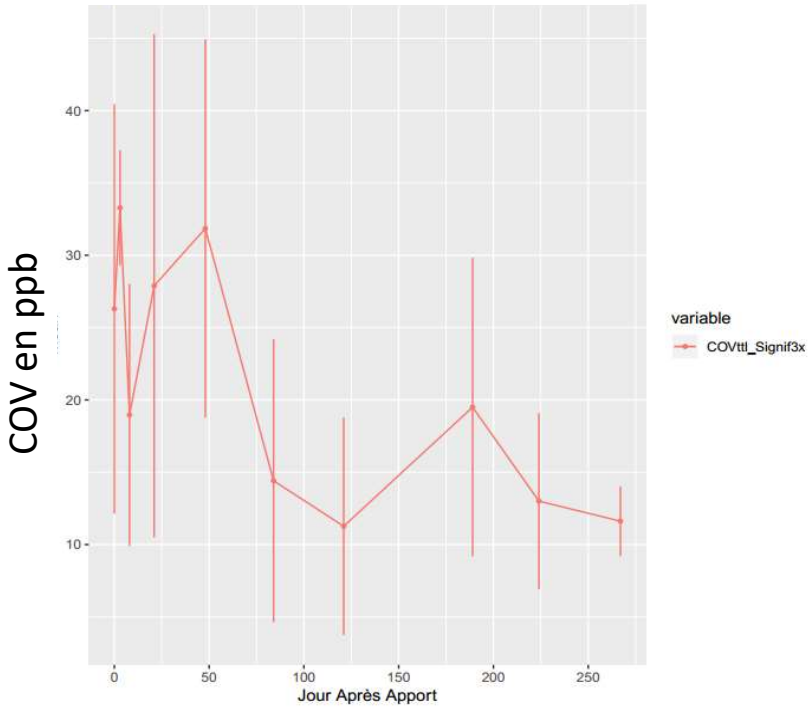
Labour

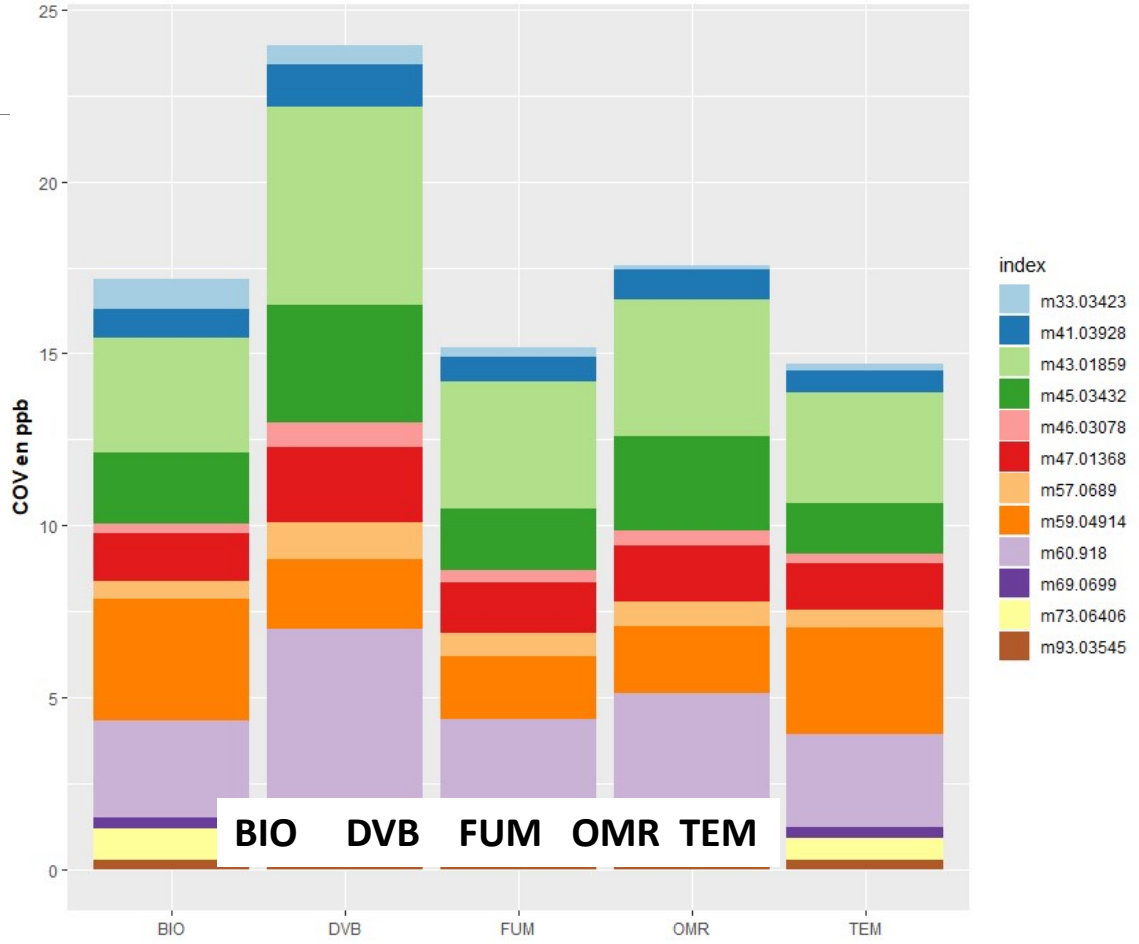
Diversité des communautés prokaryotes



Emissions de VOCs

Emissions totales

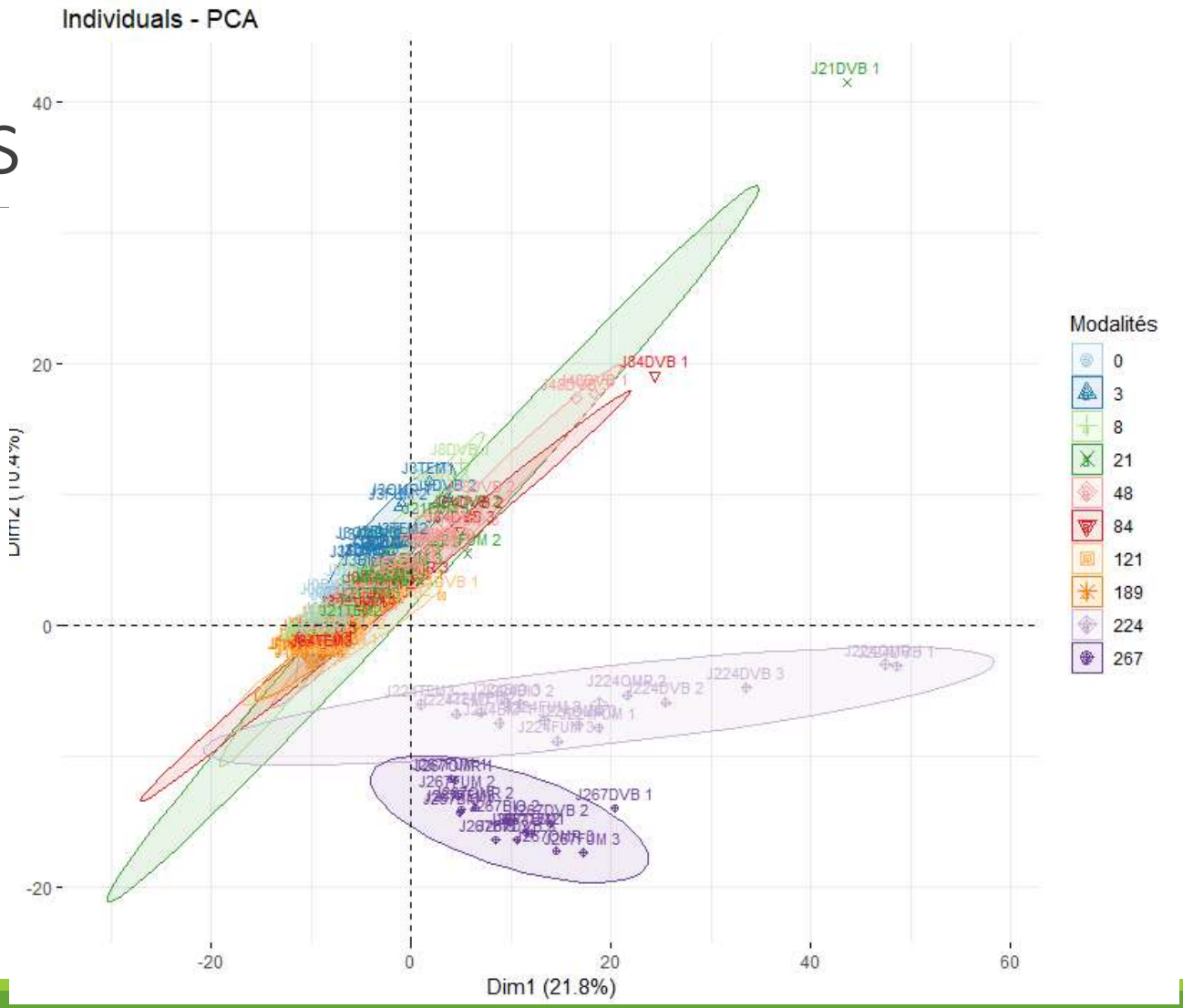




- La plupart des composés les + émis, sont émis par tous les PRO ainsi que dans le sol témoin

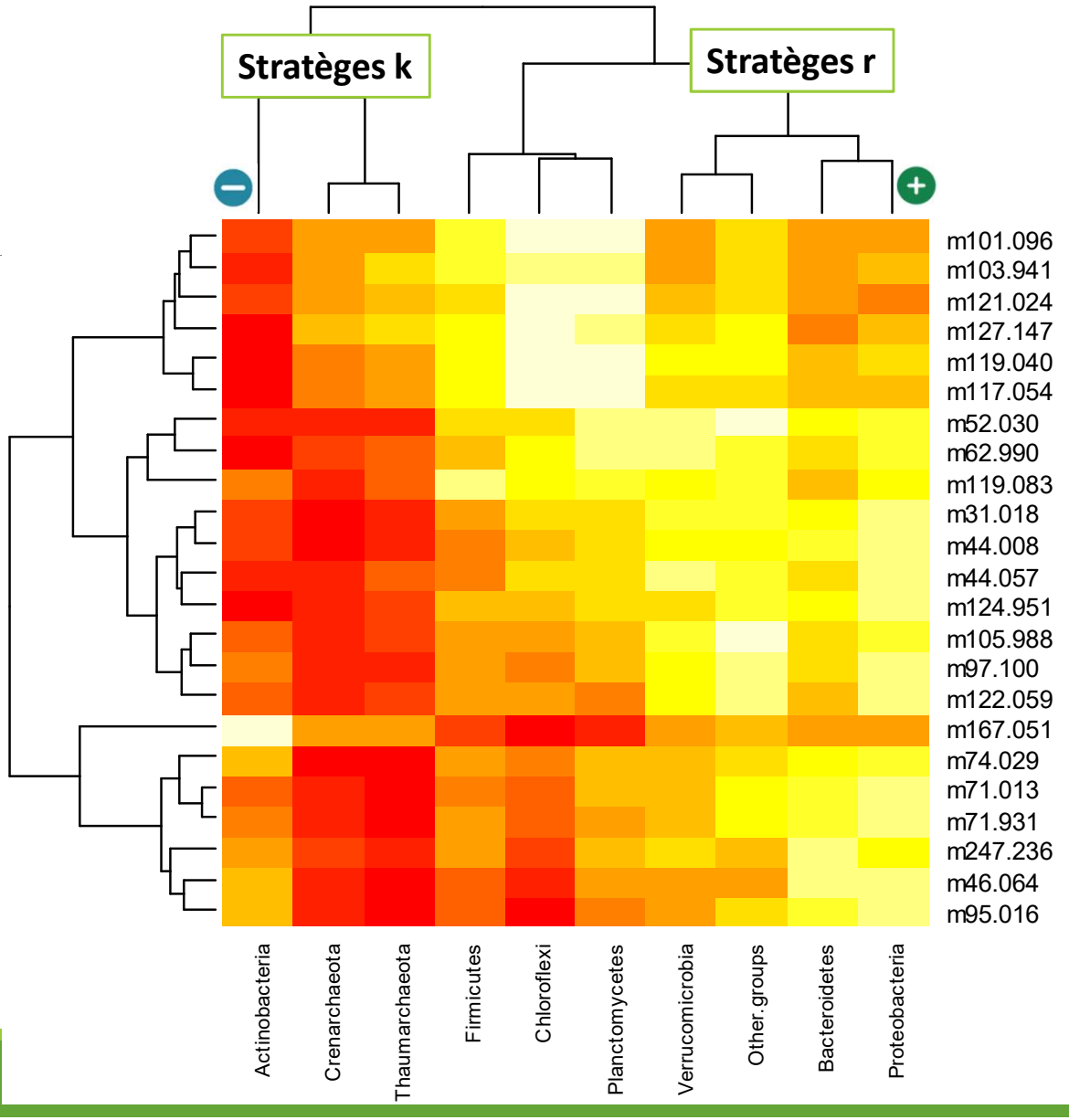
ACP sur les COVs

Fort effet date évolution sur la fin de la période



lien COV -bactéries

ion	formule	Composé	classe
31.018	CH2O	Formaldehyde	O
46.065	C2H7N	Ethylamine/Dim,thylamine	N
71.013	C3H2O2		O
95.016	C2H6O2S	Dimethyl sulfone	S
97.101	C7H12	methyl cyclohexene	HC
101.095	C6H12O	3-Pentanone, …	O
117.055	C5H8O3		O
119.049	C8H6O		O
119.070	C5H10O3		O
119.085	C9H10	Indane or Benzene, …	HC
127.148	C9H18		HC
167.053	C9H10OS		S
247.242	C18H30		HC



Conclusions

Conclusions

- VOC emissions are larger in BIOW than in others
- VOC emissions increase with decreasing microbial diversity (in lab)
- VOC diversity decreases with decreasing microbial diversity
- Large variability of VOC emissions in the field (soil heterogeneity)
- VOC emissions correlated positively to Proteobacteria and Bacteroides (fast growing bacteria)
- Other bacteria are mostly negatively correlated, suggesting VOC mediated negative interactions
- OWP amendment leads to development of stratèges R while stratèges K increase later in the year
- Stratèges R seem to be mostly positively correlated to VOC emissions
- While stratèges k seem to be mostly negatively correlated to VOC emissions