Soil Spreading of Organic Waste Products: Source of Secondary Organic Aerosols

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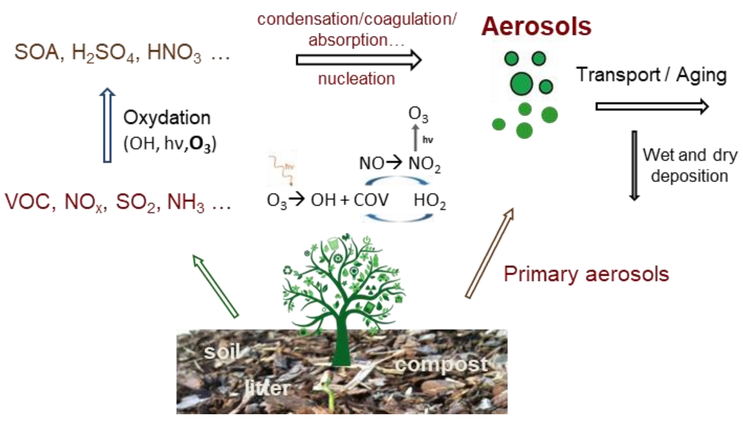
INTRODUCTION

- Agricultural lands occupy about 40-50% of the Earth's land surface. Volatile organic compounds (VOC) emissions from soil, litter or related to agricultural practices receive little attention compared to those emitted by the vegetation even though they may represent important sources of VOC leading further to the formation of secondary pollutants such as O_3 and secondary organic aerosols (SOA). Emissions from agriculture may have important impacts on the quality of air, soil, water and long-term sustainability of agricultural ecosystems (Lal et al., 2008).



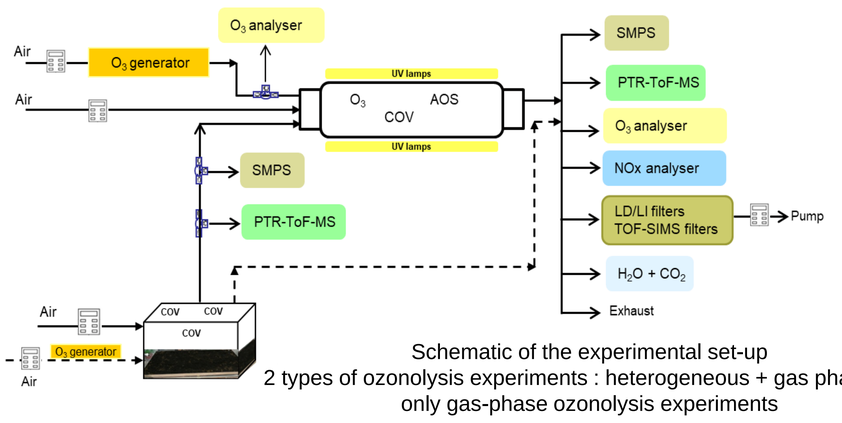
- Organic waste products (OWP) may be used in agriculture as organic amendments to improve soil fertility. The valorization of different types of OWP from farms (cattle, slurry..), urban (sewage sludge, green waste) or industrial origin is currently promoted as a substitute for mineral fertilizers. OWP have a wide variety of characteristics due to their origin and the treatments that they may undergo before spreading and this diversity could have a significant impact on atmospheric emissions (S. Houot et al., 2014).

Aim : investigate VOC emissions from agricultural soils amended with different OWP, their subsequent reaction with O_3 and the SOA formation

EXPERIMENTAL SET-UP

Soil and OWP containing chamber coupled to a flow tube reactor

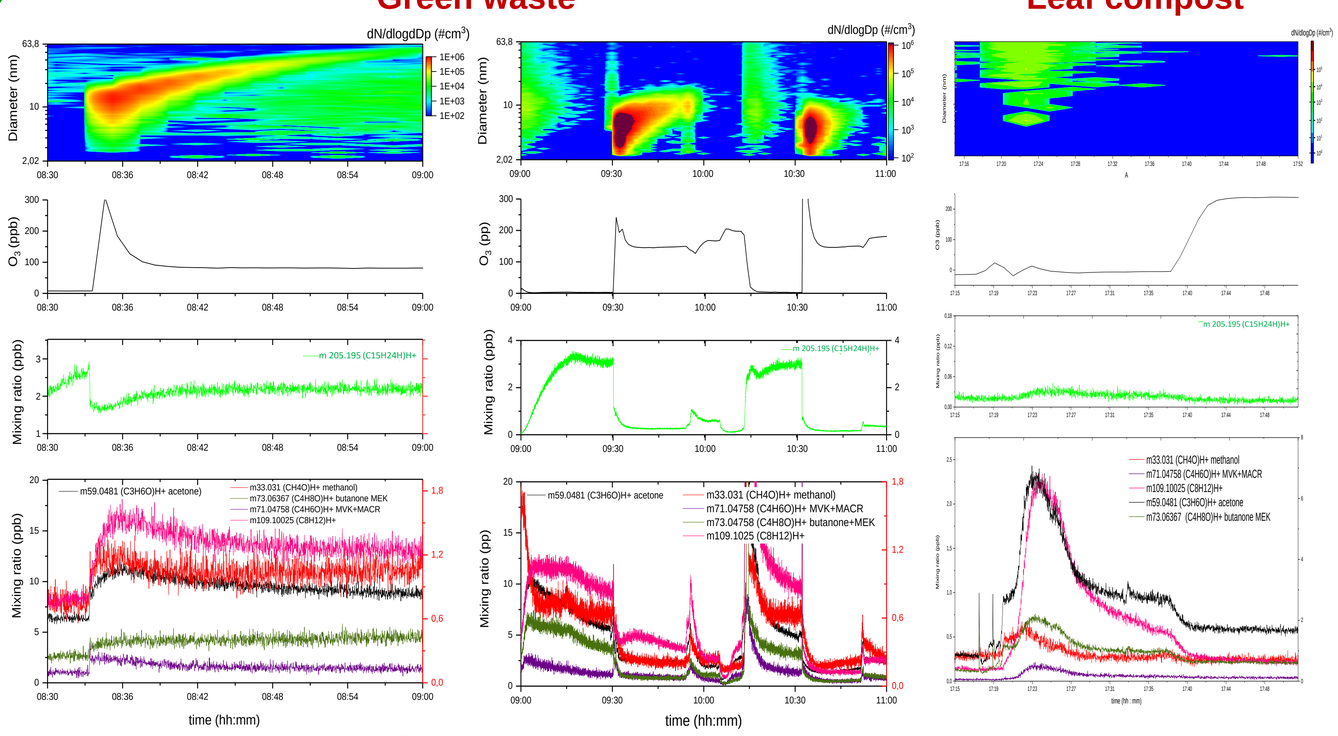
- Soil samples collected in Grignon, ICOS site, France
- Different OWP tested : green waste, leaf compost, sewage sludge, liquid manure
- Measurement of VOC, SOA, O_3, SO_2, NOx, NH_3, CO_2, RH%, particles distribution, concentration and molecular composition
- Chamber dimensions : L=0.55m, l = 0.29m, residence time = 5.3min
- Reactor : L=1m, d = 0.1m, residence time = 1.3min



Schematic of the experimental set-up
2 types of ozonolysis experiments : heterogeneous + gas phase and only gas-phase ozonolysis experiments

RESULTS

Green waste



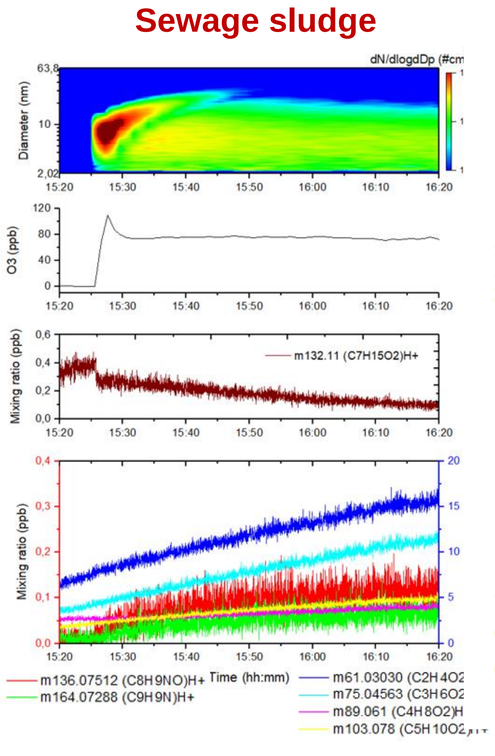
Typical ozonolysis experiment on soil and green waste

Typical gas phase ozonolysis experiment on soil and green waste

Leaf compost

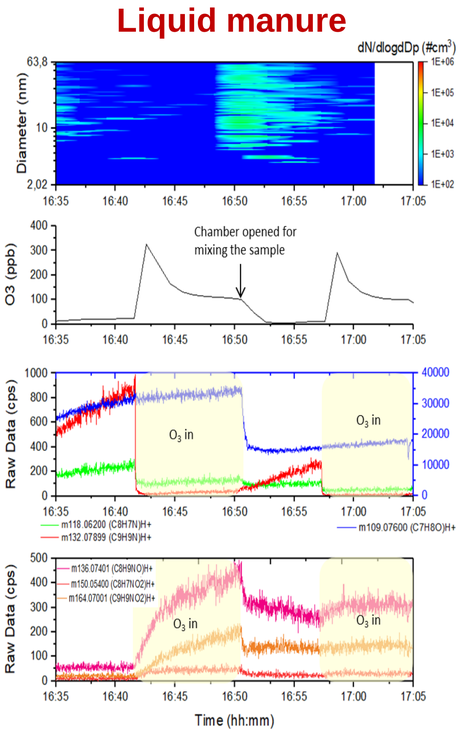
Typical ozonolysis experiment on soil and leaf compost

Sewage sludge



Typical ozonolysis experiment on soil and sewage sludge

Liquid manure



Typical ozonolysis experiment on soil and liquid manure

✓ **Rapid SOA formation due to ozonolysis of sesquiterpenes emitted by green waste (SOA yields of ~ 3%)**

✓ **No SOA formation from leaf compost**

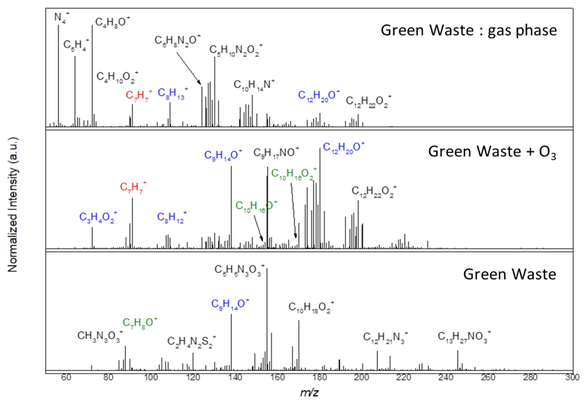
✓ **Different chemical mechanisms between heterogeneous and gas phase ozonolysis**

✓ **Rapid SOA formation due to ozonolysis of VOC emitted by sewage sludge**

✓ **No SOA formation from liquid manure**

Gas phase and offline aerosol filter analysis

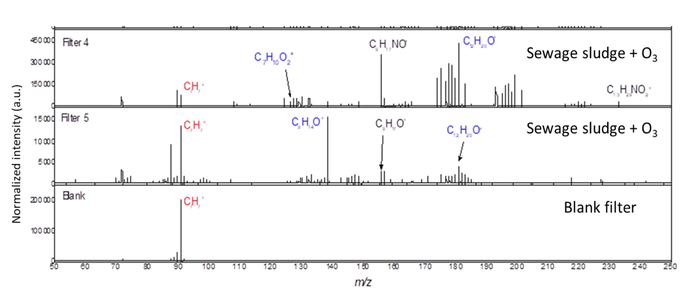
- ✓ Differences between the green waste alone and the green waste exposed to ozone
- ✓ emission and formation of a majority of hydrocarbons and oxygenated hydrocarbons
- ✓ Species in blue : also detected in the gas phase by PTR-TOF-MS



Offline green waste filter analysis by high resolution ToF-MS Laser Desorption Ionization

Gas phase and offline aerosol filter analysis

- ✓ emission and formation of indoles, oxygenated and N containing species
- ✓ Species in blue : also detected in the gas phase by PTR-TOF-MS
- ✓ Identification in progress



Offline sewage sludge filter analysis by high resolution ToF-MS Laser Desorption Ionization

CONCLUSIONS / FUTURE WORK

- **First determination of the oxidation products of ozone reactions with VOCs emitted by OWPs and evaluation of their aerosol formation potential**
- **Reactions of ozone at the OWP interface occur via two simultaneous mechanisms: heterogeneous reactions on the surface with high deposition ozone rates and homogeneous reactions occurring in the gas phase**
- **Offline aerosol filter analyses complement the gas-phase data :**
- **OWP + O_3 → large VOC emissions and oxygenated VOC formation → contribution to secondary atmospheric pollution**

Perspectives: VOC identification, gas-phase and heterogeneous mechanistic chemistry involved in SOA formation …

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