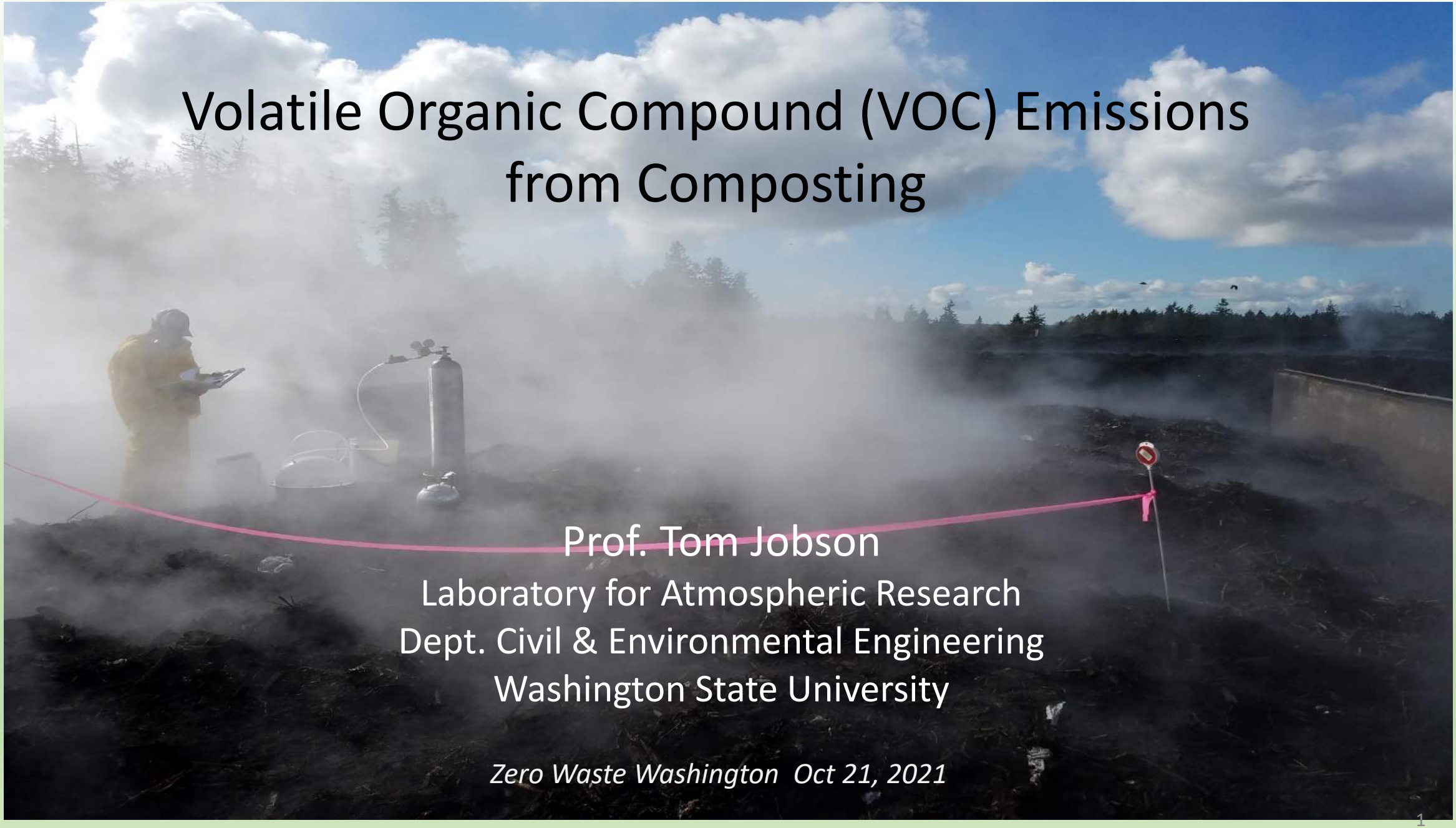
Volatile Organic Compound (VOC) Emissions from Composting



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Composting produces organic gases that are volatile (VOCs) and are emitted into the surrounding air as a discharge

i.e. methanol, acetone, acetaldehyde, 2-butanone, dimethyl sulfide, acetic acid, monoterpenes….

There is a tension between the

public policy goal of composting more organic waste

and

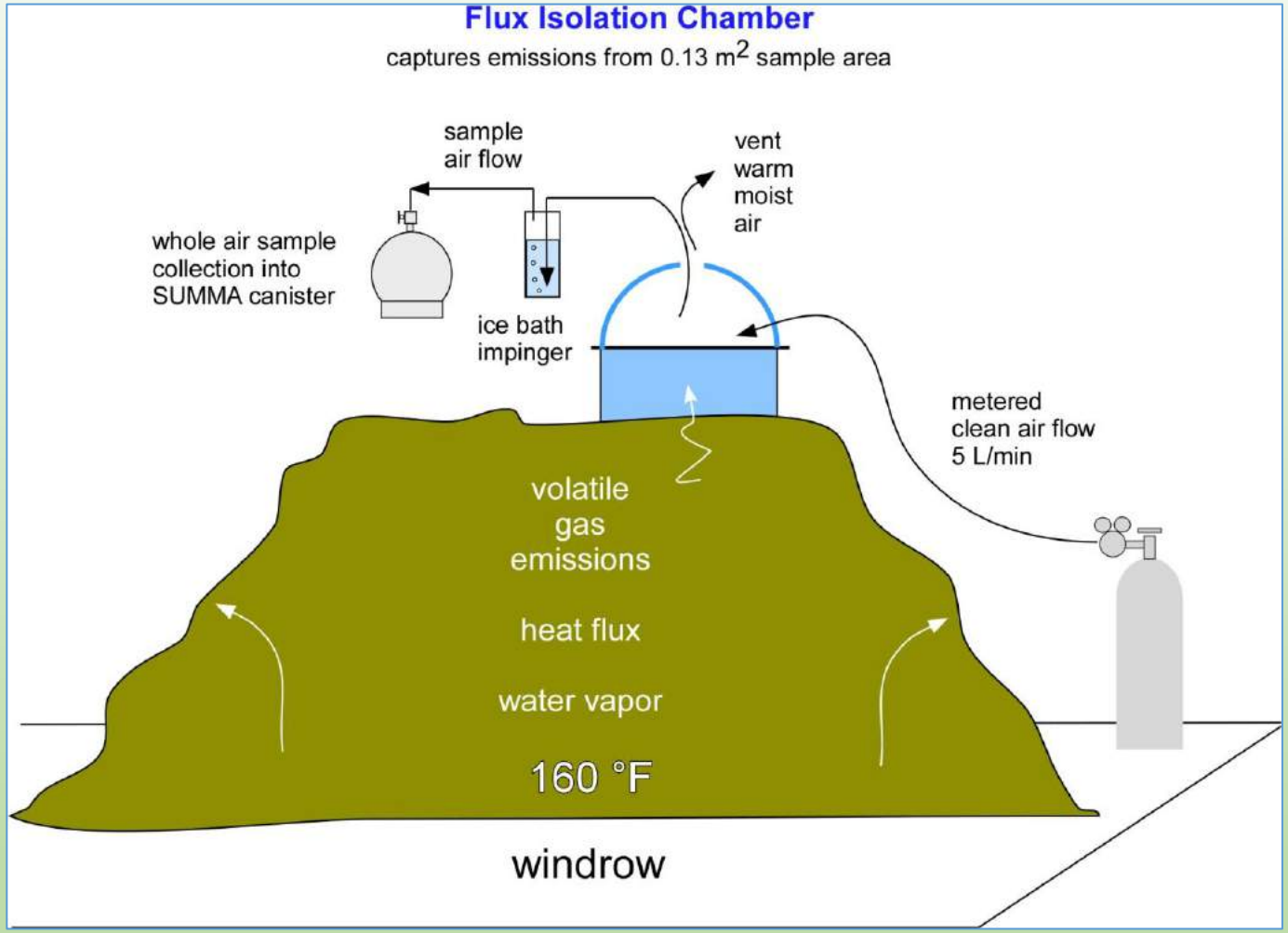
air pollution permitting

Composters are caught in the complicated issue of air emissions permit writing.
A permit is required by law to discharge waste emissions into either air or water.
How much "pollution" do compost facilities discharge into the air?

Emissions of VOCs are regulated under the Clean Air Act because

1. they can contribute to photochemical ozone pollution (ozone is a criteria air pollutant)
2. they can be hazardous air pollutants (HAPS). WA state has a toxics air pollutants list (TAPS).
3. they can contribute to particulate matter formation (PM is a criteria air pollutant)

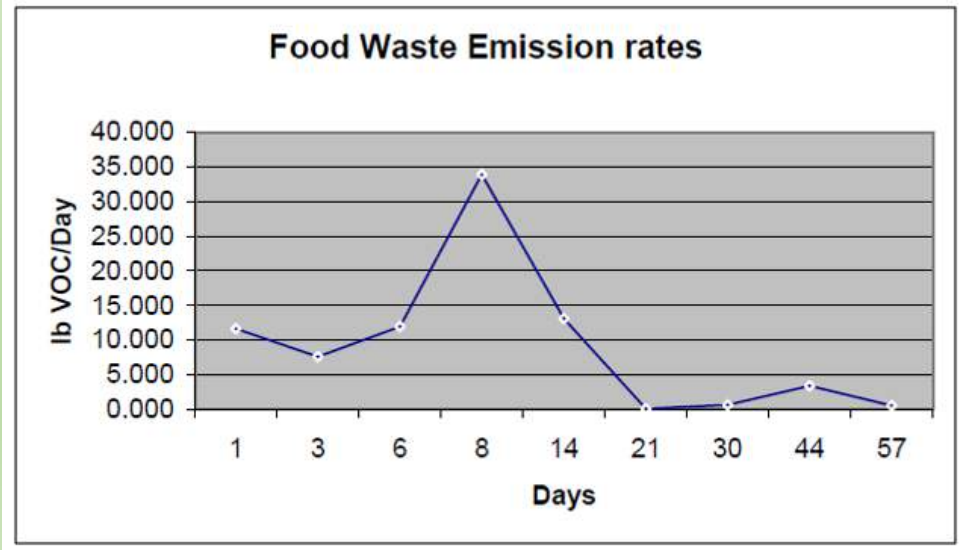
There is limited information publicly available for permit writers on emission rates of VOCs



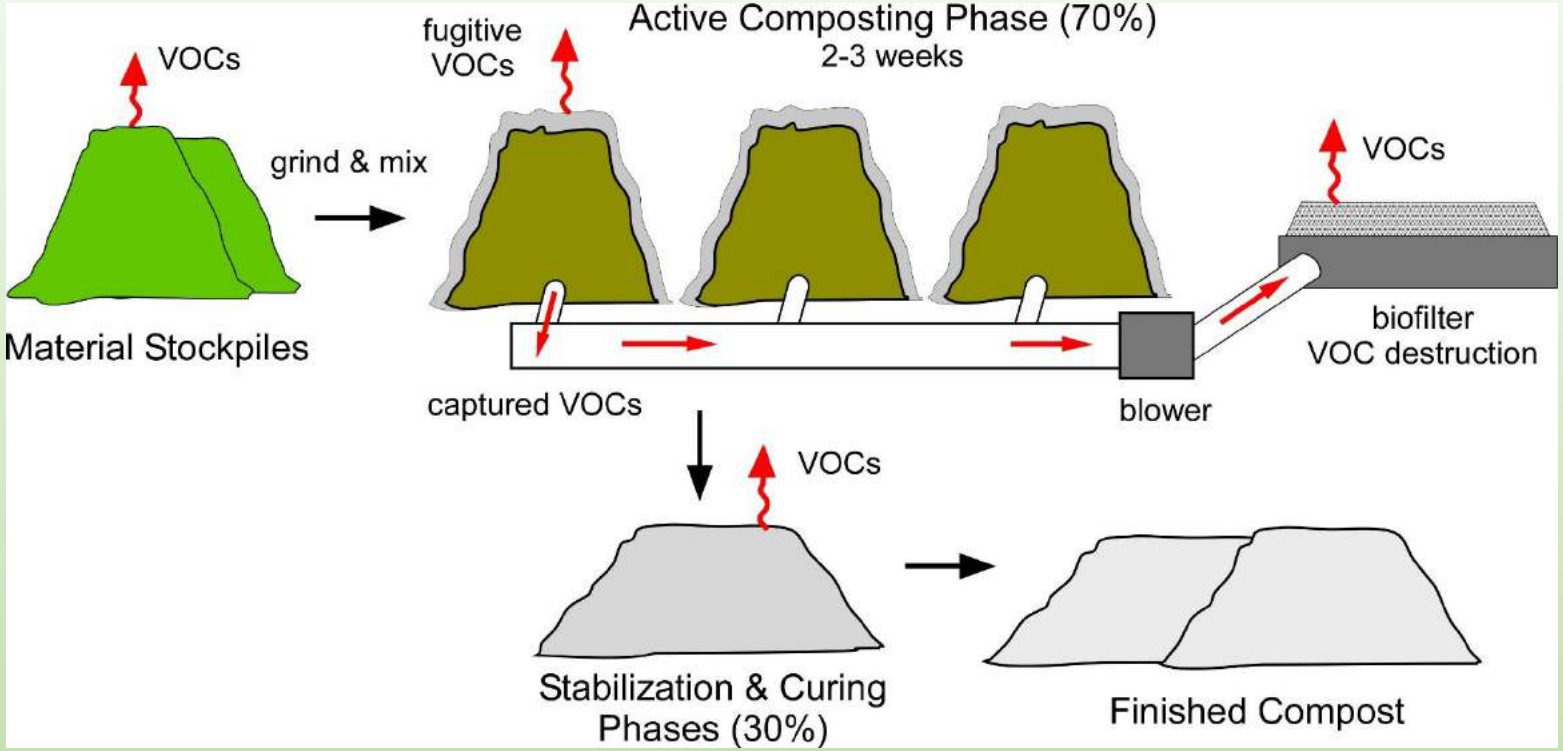
Air agencies in WA State using the VOC emission value determined from California studies on green waste composting using windrows; conducted ~ 10+ years ago.

The potential to emit (PTE) value:
5.71 lbs VOC / wet ton compost
(no pollution control)

Based on SCAQMD method 25.3
(total VOC method, mass carbon)



Negative aeration composting



1. Emission from material stockpiles
2. Emission from active composting piles
3. Emission from biofilter
4. Emission form stabilization / curing piles

Issues with this PTE value:

1. Most facilities are using forced aeration (aerated static piles) and believe the PTE is lower due to better process control of composting conditions (temperature, O_2).

2. For large compost facilities, VOC emissions may be large enough to require a Title V air emission permit.

   VOC > 100 tons/ year

   Significant expense.

Biggest WA facility processing > 200,000 tons material / year

Issues with emissions testing

1. Very expensive to have sampling & sample analysis done (~$100k source test).

2. Sampling method subject to VOC loss from condensation in flux isolation chamber.

3. Small size of flux chamber requires many samples to be taken from pile surface to get a representative average emission rate.

4. SCAQMD Method 25.3 does not report specific compounds so can not determine HAP or TAPS. Requires additional test methods.

5. Method 25.3 reports carbon mass not VOC mass.

Measuring VOC Emissions to help WA State with air permitting of compost facilities.

Two projects

1. Funded by Environmental Research &Education Foundation
   - Collaboration with *Engineered Compost Systems* (Seattle, WA. Tim O'Neil)
   - Build two zone pilot plant at WSU (positive, negative, reversing aeration)
   - Measure emissions as a function of process conditions (O_2, pH, moisture)
     VOCs, CH_4, N_2O, CO_2
   - Two zone allows direct comparison of two different process conditions using same material

2. Funded by Waste to Fuels Technology program (WA Dept. Ecology)
   - Utilize measurement method from California, SCAQMD Method 25.3 to measure VOC emissions
   - Compare 25.3 to other methods (GC-MS, PTR-MS)
   - Compare windrow emissions to ASP system. Is the PTE value different?
   - Utilize two zone pilot plant

Long term Project Goals

Help air permit writers and composters: what are the VOC emission rates?
Test commercial facilities next biennium: can VOC emissions testing be simplified?
Biochar + compost: carbon sequestration and enhanced soil amendment

Emission testing at WSU Compost Facility: negatively aerated piles (10 piles: 160 ton piles) Summer 2019

WSU Instrumented Van (MAML)

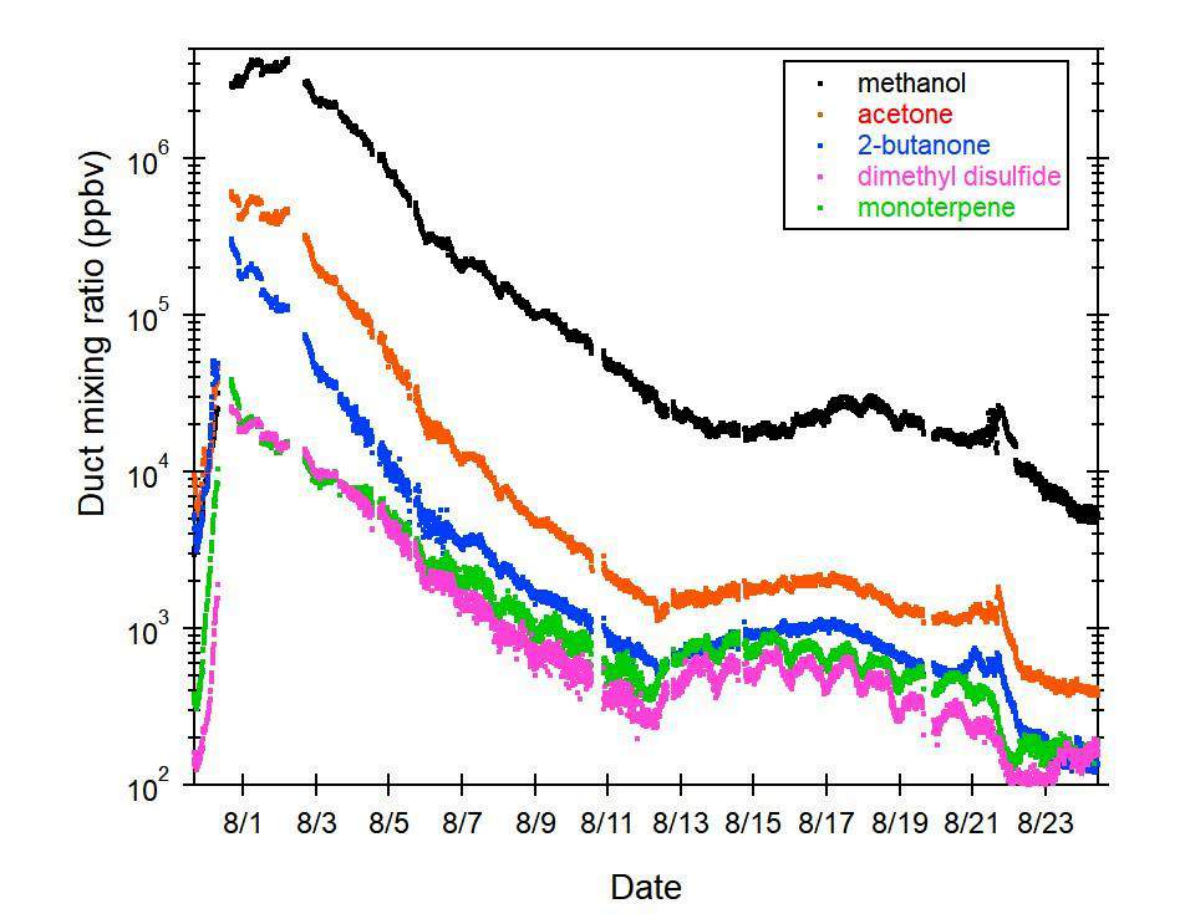
Allows for continuous on-site measurements of:

1. VOCs – by proton transfer reaction mass spectrometry (PTR-MS)
2. Greenhouse gases CH_4, N_2O, and CO_2
3. Duct (continuous) & flux chamber measurements
4. Meteorological conditions

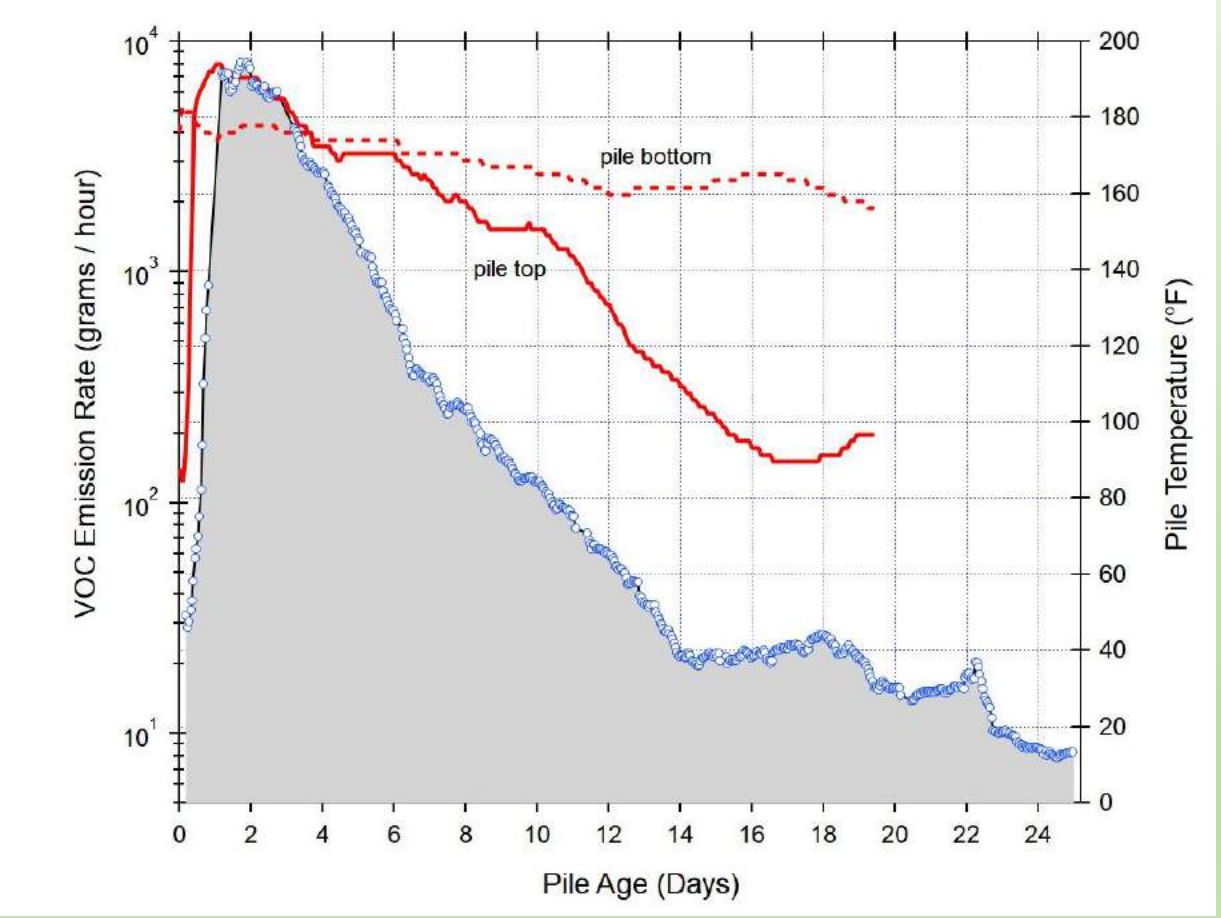
WSU Compost pile VOC emissions (summer 2019)

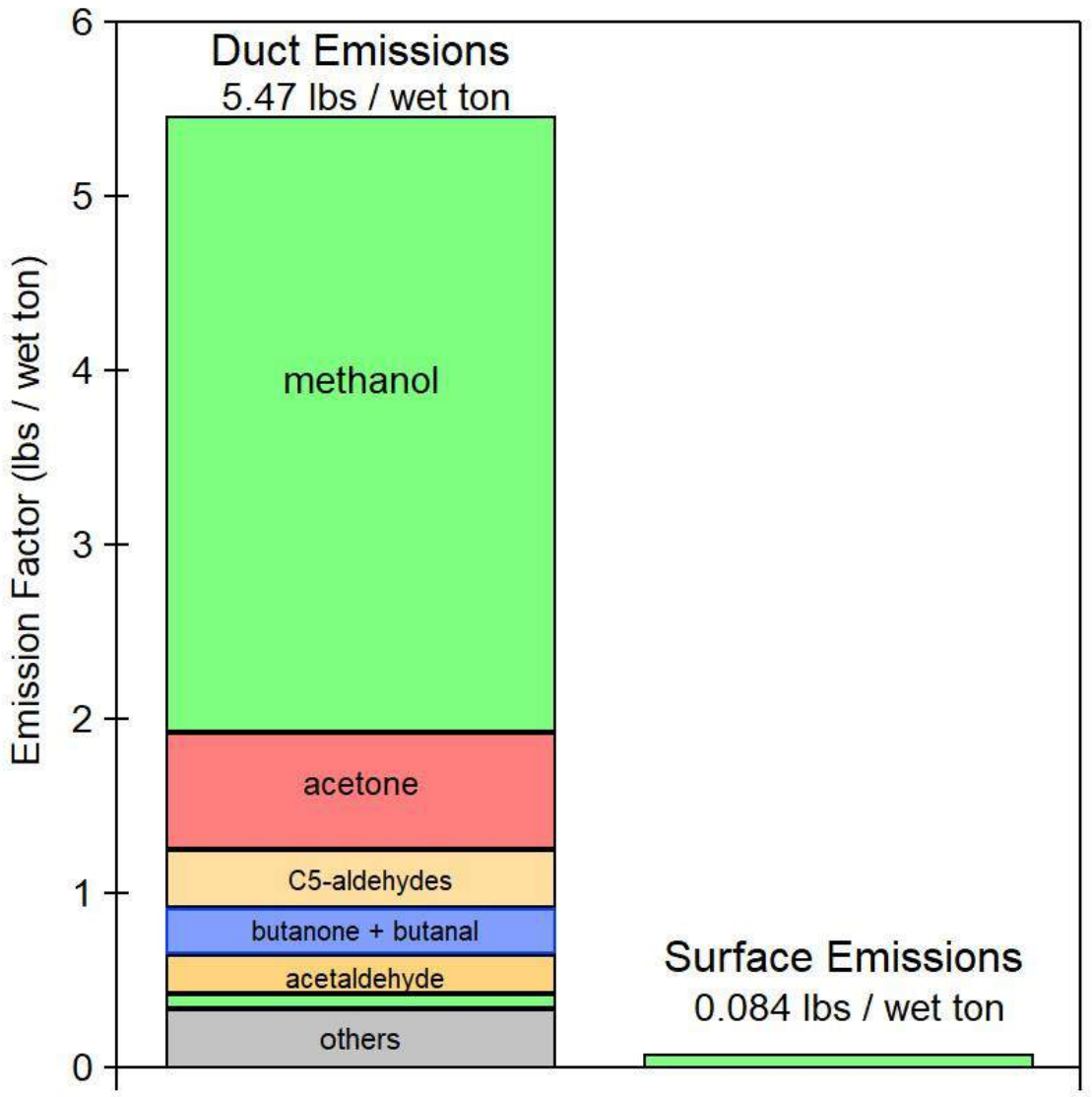
PTR-MS data

VOCs in negative aeration duct as pile ages



VOC emission rates (grams / hour) vs pile age





WSU compost pile results

(mostly manure, bedding, wood chips, straw)

- PTE value 5.6 lbs VOC / wet ton
- Most compounds are oxygenated VOCs.
- Method 25.3 would report 2.6 lbs VOC / wet ton (carbon mass), so less than half the emission rate.
- Surface emissions very low compared to duct.
- 90% VOC mass emitted in first 130 hours. Emission from stabilization piles likely very low.

Going forward: determine PTE for green waste and different aeration processes.