Air Emissions of In-Vessel Rotating Drum and Open Static Pile Composting of Swine Carcasses, Whole and Ground

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Composting

- Used to manage on-farm mortality
  - Increase from 10.5 to 35.9% between 1994 and 2006 (USDA:APHIS, VS, CEAH)
- Traditionally, the most popular method of composting has been the open static pile (OSP)
- In recent years, interest in the use of in-vessel (IV) systems
  - rotating drum
- Whole, opened, or ground carcass

Objective

- The intent of this research was to compare the impact on air quality and the rate of compost material maturity associated with composting swine carcasses in IV or OSP composting systems, and whole (W) or ground (G)

Methods

- Emissions were measured continuously during two phases of composting
  - 20-d primary phase (1º; d 1 to 20)
  - 15-d secondary phase (2º; d 65 to 80 after initial formations of batches)
  - 8 sealed rooms at the Michigan State University Animal Air Quality Research Facility (AAQRF)

IV and OSP

Whole (W) or ground (G)

Beginning of 1º phase

Air sampling

- Sequentially
- 10 to 11 observations/room/d
- Gas concentration
  - O_2, CO_2, CH_4, NMTHC, NH_3, NO, NO_2, N_2O, H_2S, and SO_2
  - Process analyzers
- Air flow
- mg/min and g/d

End of 1º phase

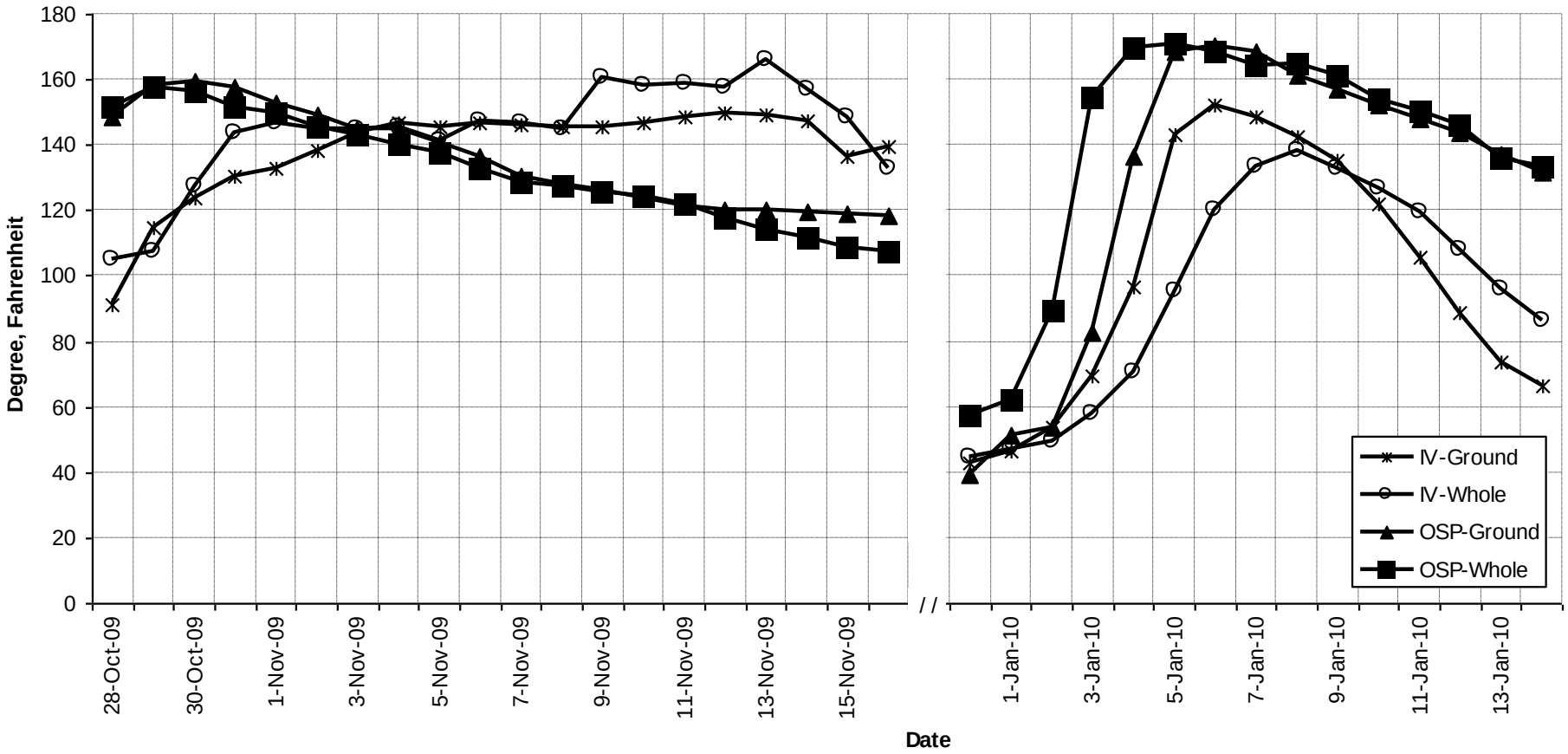
Between phases

Beginning of 2º phase

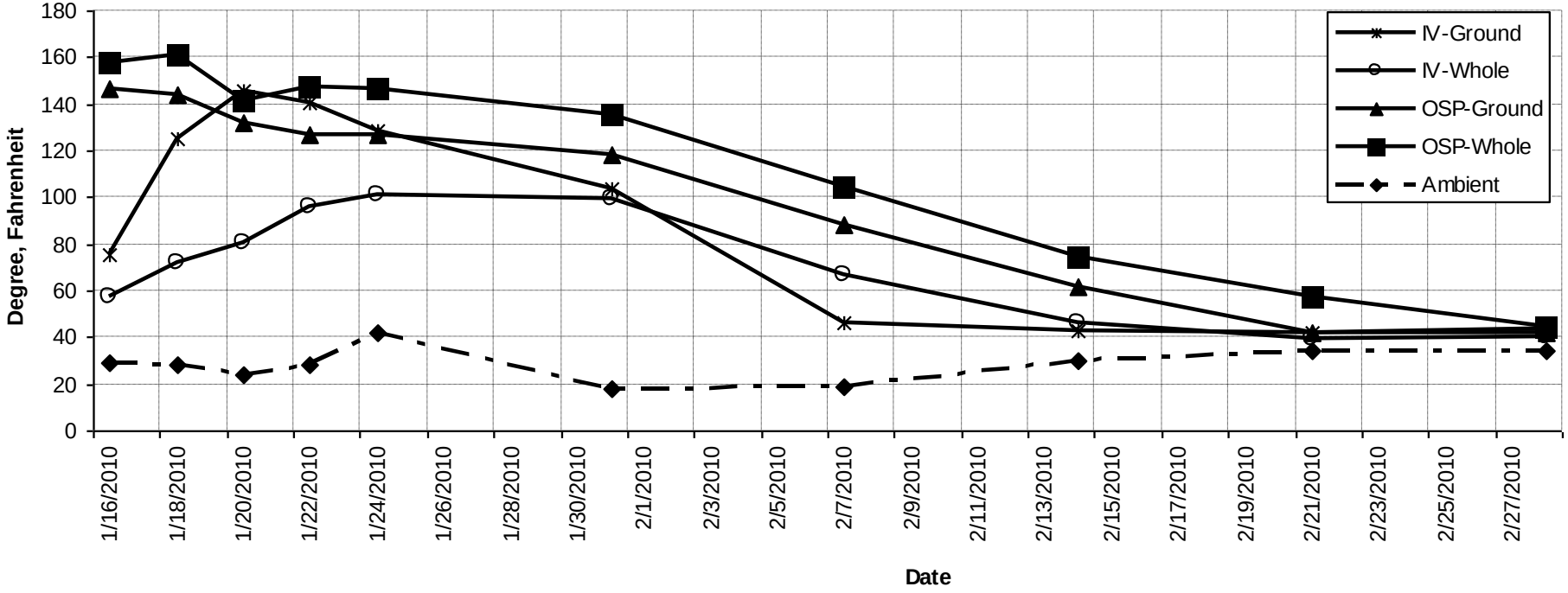
Design and statistics

- Four treatments
  - IVG, IVW, OSPG, and OSPW
- Analysis of variance procedures (Mixed, SAS)
  - Date – repeated variable
  - Covariates: phase, carcass weight
  - Contrasts were used to compare
    - IV or OSP compost system
    - W or G carcass form

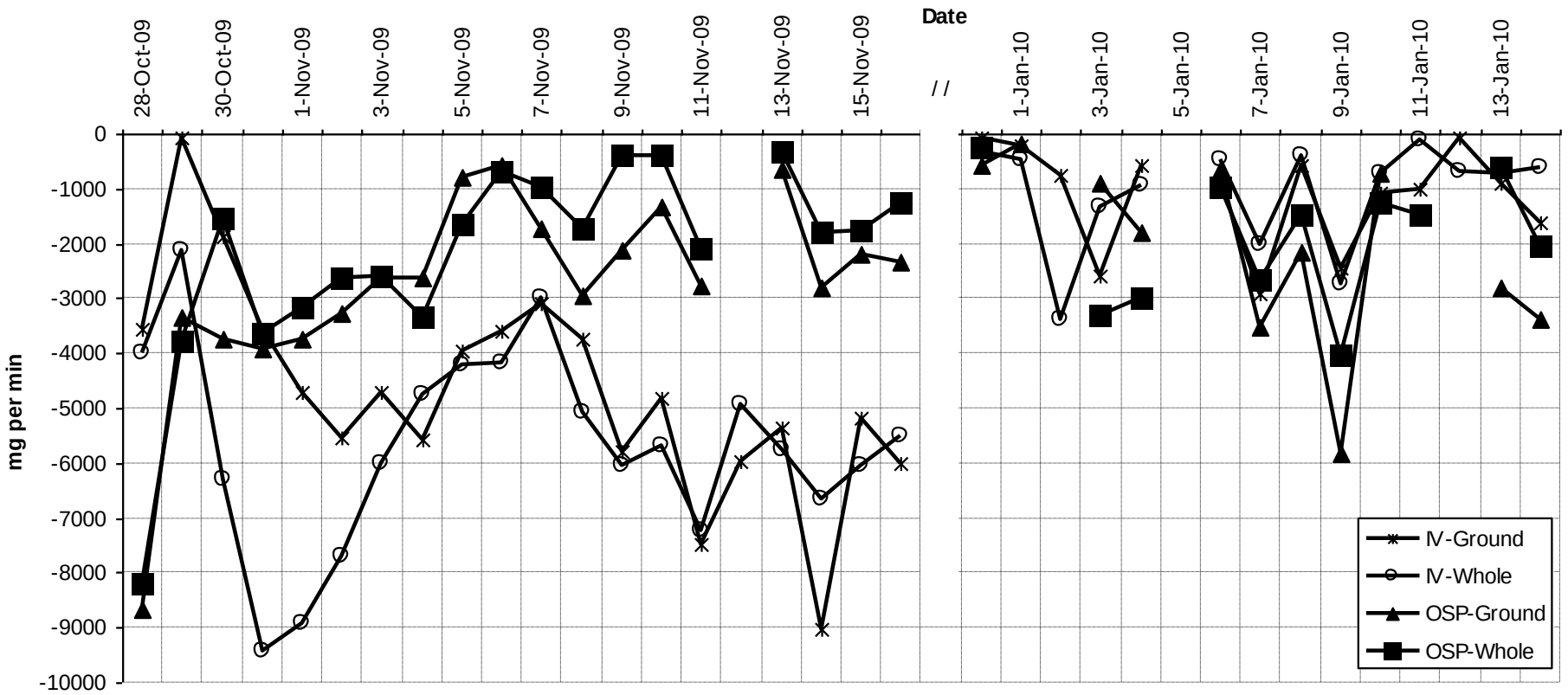
Compost temperature during 1º and 2º phases



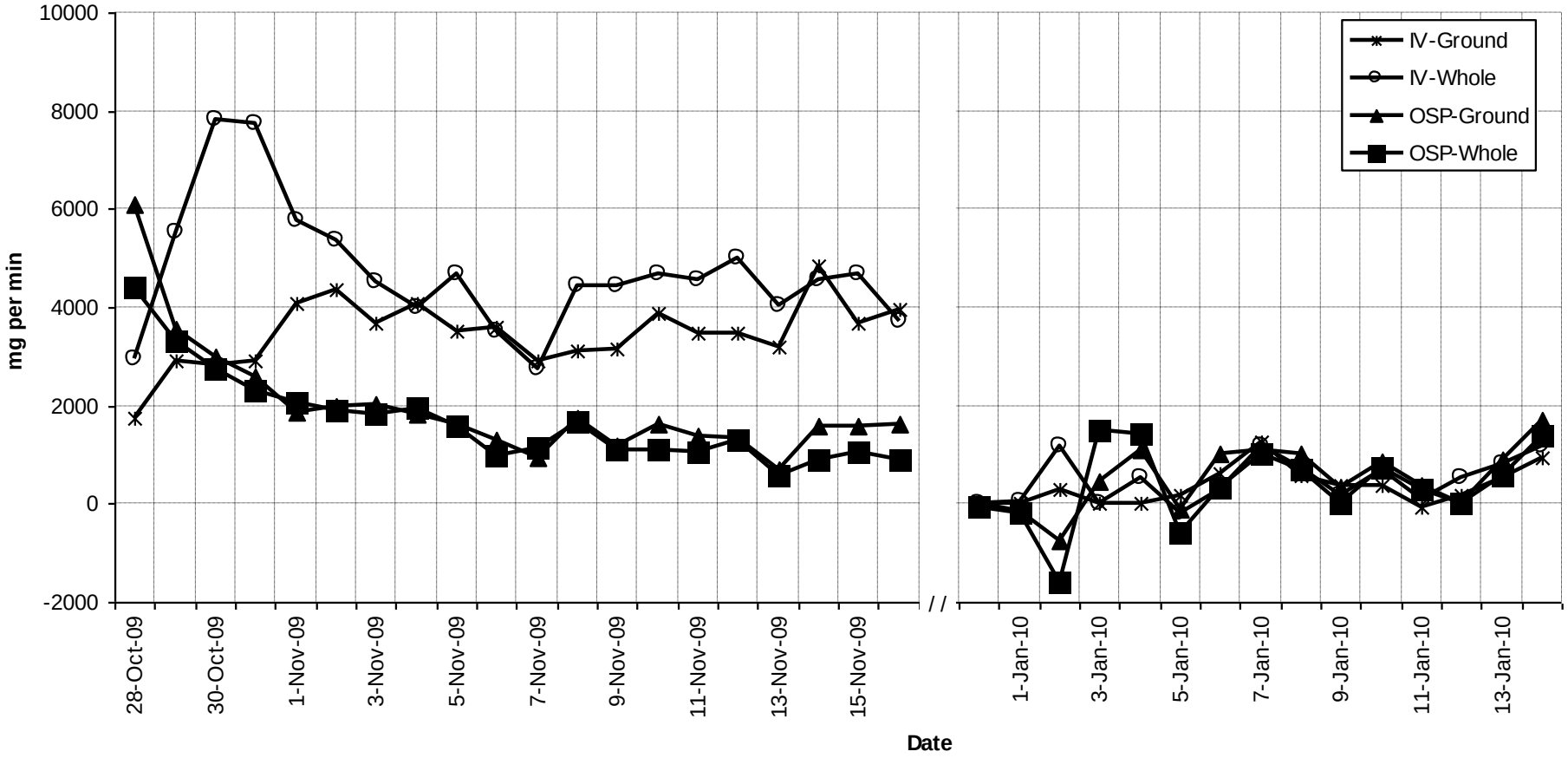
Compost temperature after 2º phase



O_2 consumption rate during 1º and 2º phases



CO_2 evolution rate during 1º and 2º phases



Treatment ($P < 0.05$)
Phase ($P < 0.05$)
IV vs. OSP ($P = 0.07$)
Phase × System ($P < 0.05$)

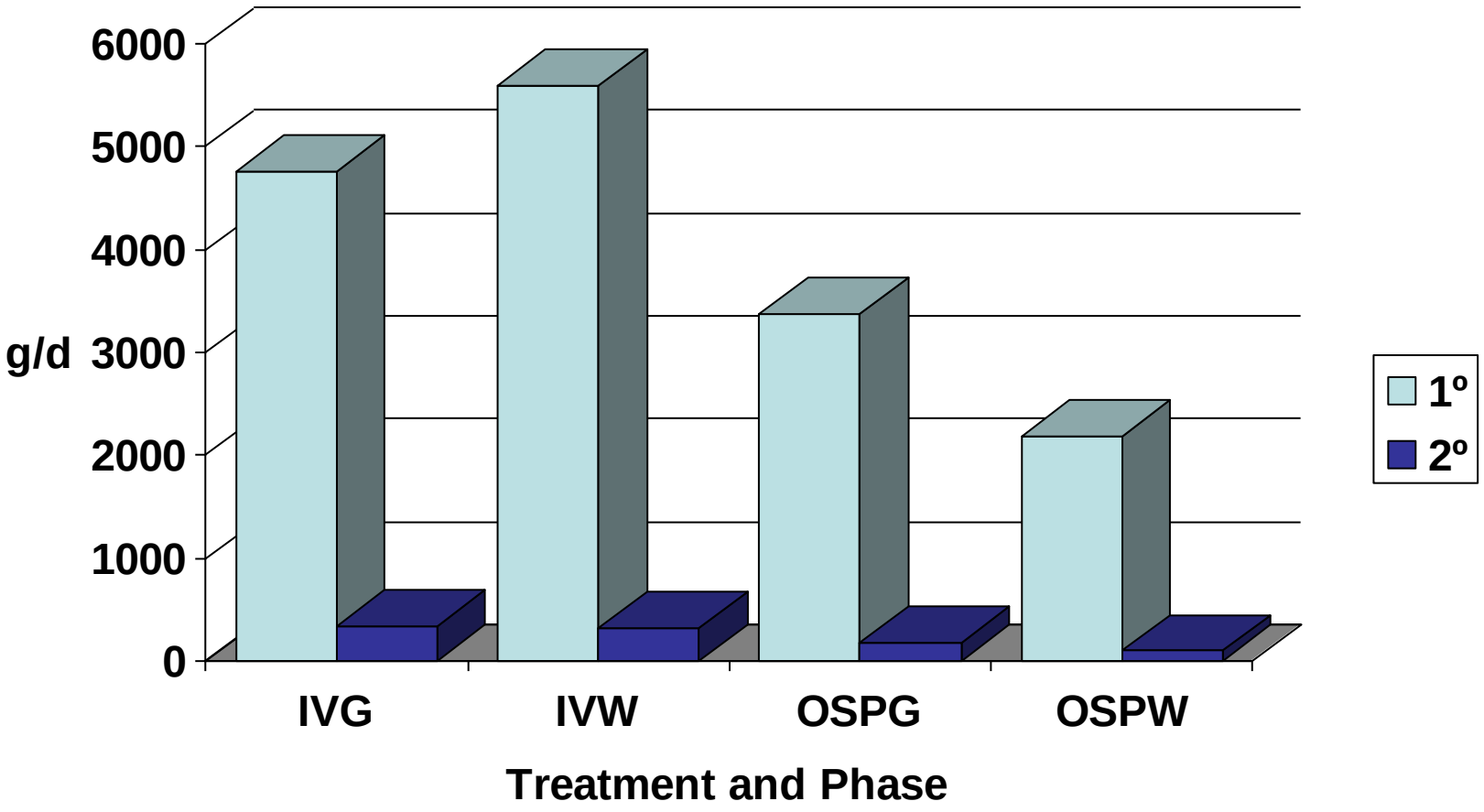
Compost maturity

- Respiration - last week of the 2º phase
  - IVG, IVW, OSPG, and OSPW, respectively
  - O_2 consumption was 3.47, 2.51, 9.25, and 5.95 mg/g organic matter/d
    - IV less than OSP ($P < 0.001$)
    - Ground less than whole ($P = 0.05$)
  - CO_2 evolution was 1.49, 1.90, 2.52, and 1.95 mg/g organic matter/d
    - Not different - treatment, composting system, or carcass form

Compost maturity

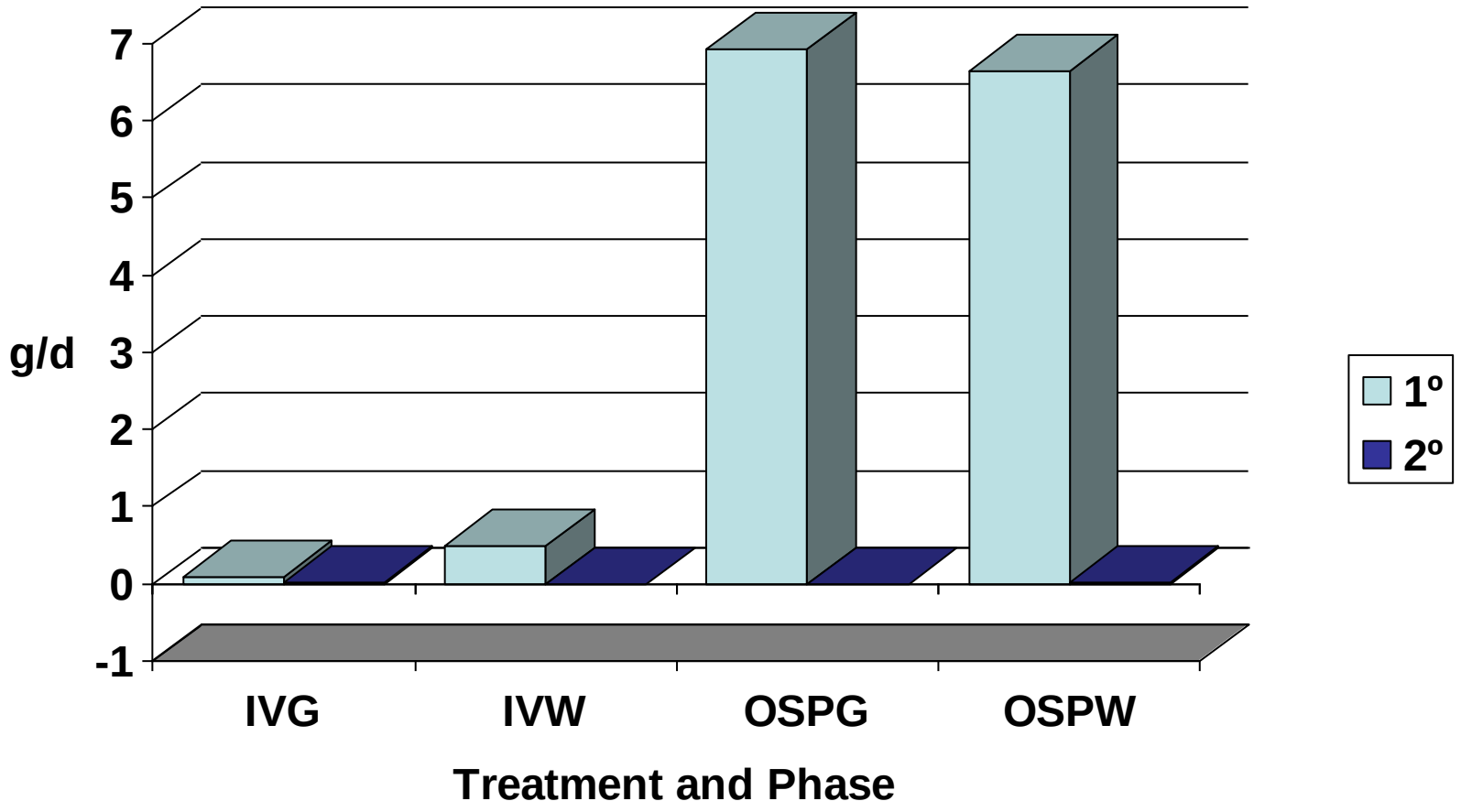
- California Compost Quality Council (CCQC, 2001) and Canadian Council of Ministers of the Environment (CCME, 2005)
- Must meet one or more requirements
  - ≤ 12 or 9.6 mg O_2 per g of organic matter per day **YES**
  - ≤ 2 or 4 mg C (as CO_2) per g of organic matter per day **YES**
  - a temperature rise of the compost above ambient temperature of ≤ 46 or 50 ºF **NO**

CO_2 mass



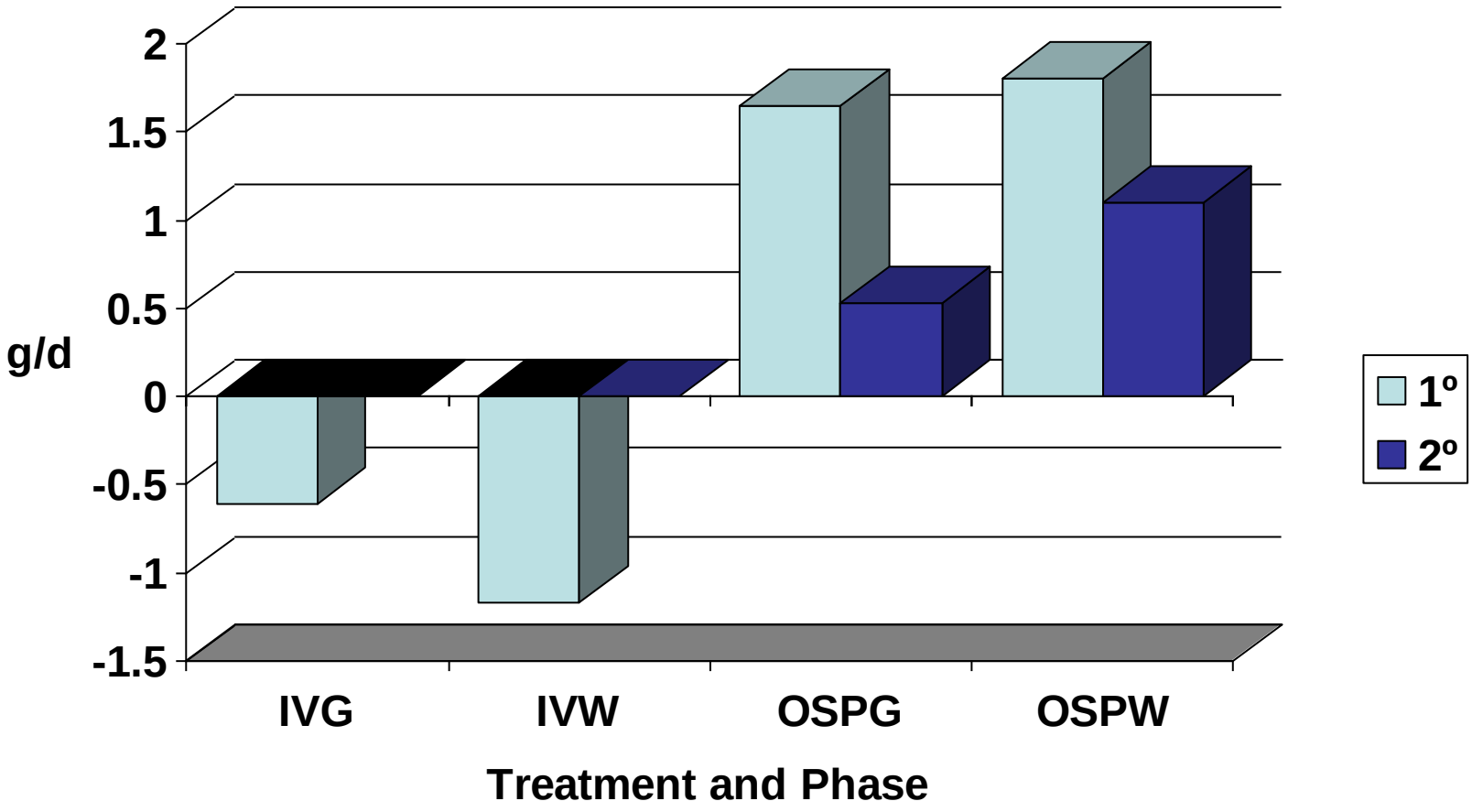
Treatment ($P < 0.05$)
Phase ($P < 0.05$)
IV vs. OSP ($P = 0.07$)

CH_4 mass



Treatment ($P < 0.001$)
Phase ($P < 0.001$)
IV vs. OSP ($P < 0.001$)

N_2O mass



Treatment ($P < 0.001$)
Phase ($P = 0.01$)
IV vs. OSP ($P < 0.001$)

CO2*e* in 1º phase

(2000 head finishing swine farm)

	IV	OSP
	tons/year	
CO_2	1.4008	0.7524
CH_4	0.0016	0.0385
N_2O	0.0000	0.0145
TOTAL	1.40	0.81

42.6% more CO2e with IV system

99.9 and 93.4% of CO2e from CO_2 for IV and OSP, respectively

CO2*e* in 2º phase

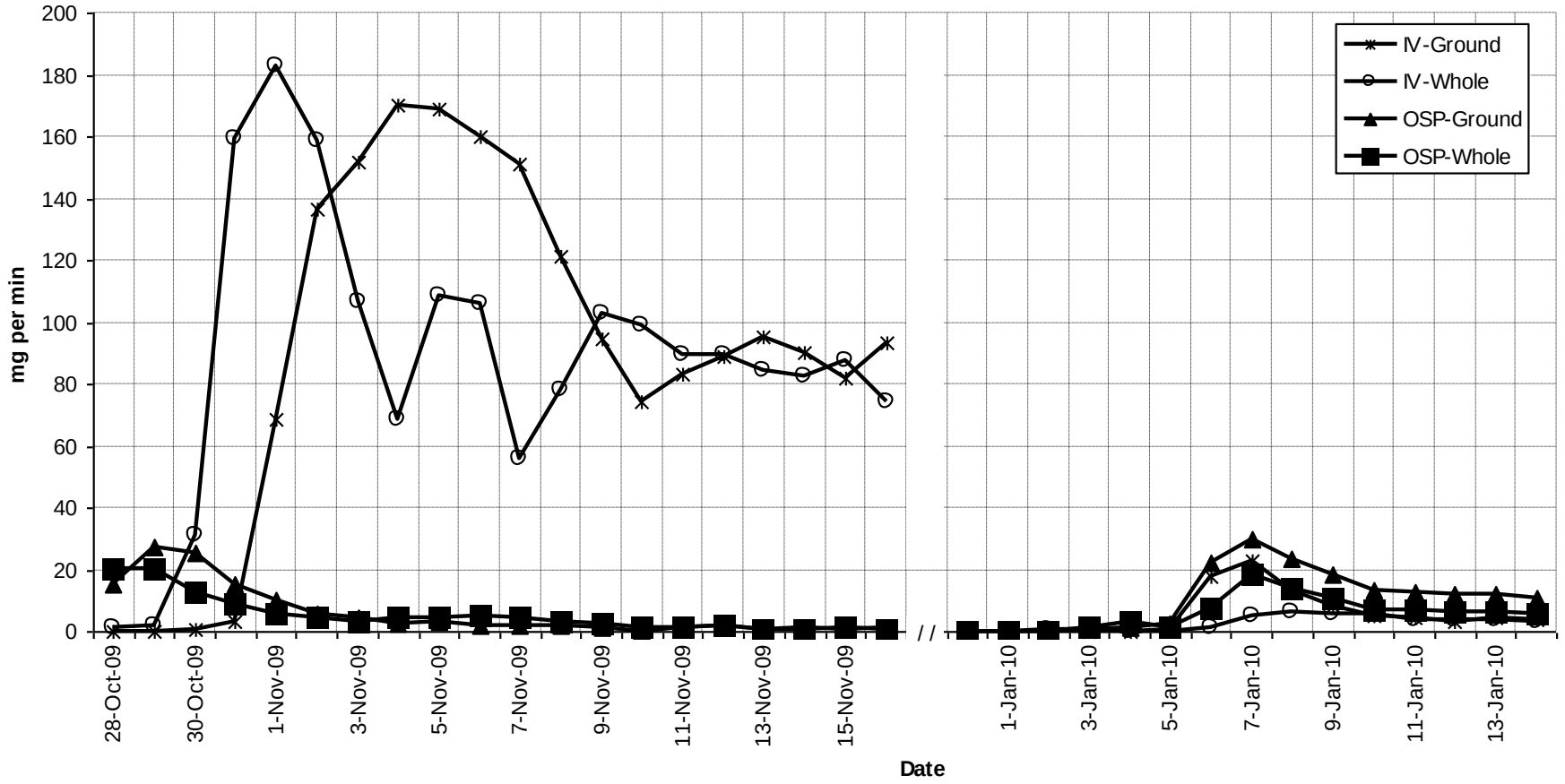
(2000 head finishing swine farm)

	IV	OSP
	tons/year	
CO_2	0.066	0.028
CH_4	1.479E-05	2.000E-05
N_2O	0.000	0.005
TOTAL	0.066	0.033

49.9% more CO2e with IV system

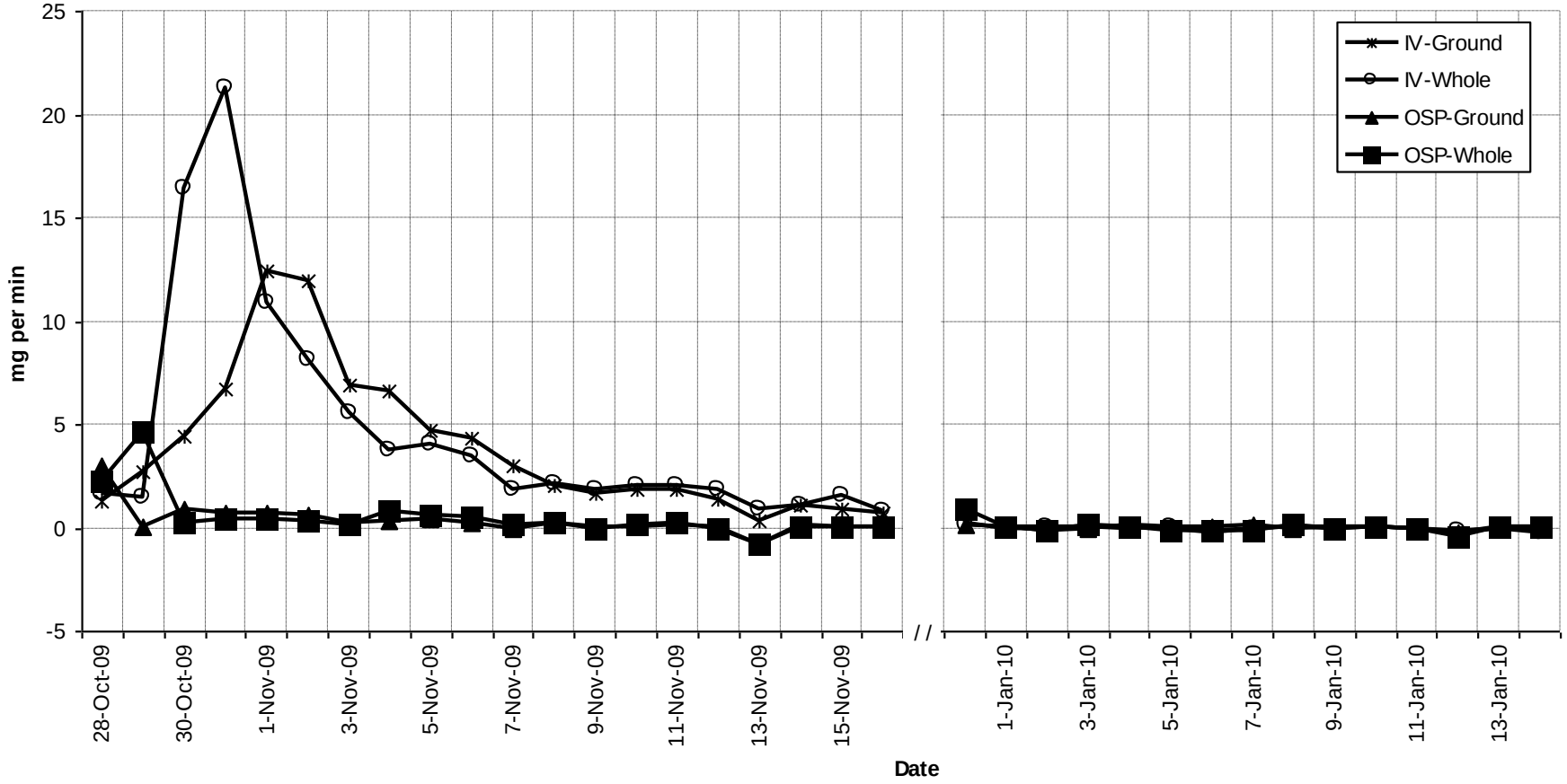
99.9 and 84.3% of CO2e from CO_2 for IV and OSP, respectively

NH_3 emission rate



Treatment ($P < 0.001$)
Phase ($P < 0.001$)
IV vs. OSP ($P < 0.001$)

NMTHC emission rate



Treatment ($P < 0.001$)
Phase ($P < 0.001$)
IV vs. OSP ($P < 0.001$)

Conclusions

- When ‘active’ composting ends and ‘curing’ starts is not an exact science
  - Respiration = mature
  - Temperature ≠ mature
  - Visually ≠ mature
- Emissions with IV first 20 d
  - 1º Greater CO2e’s, NH_3, NMTHC
  - 2º No differences observed
  - Total d 1-80 needs further research
- Air quality is not a reason to grind carcasses