UC DAVIS AIR QUALITY
RESEARCH CENTER

Dairy Air Quality Research Symposium

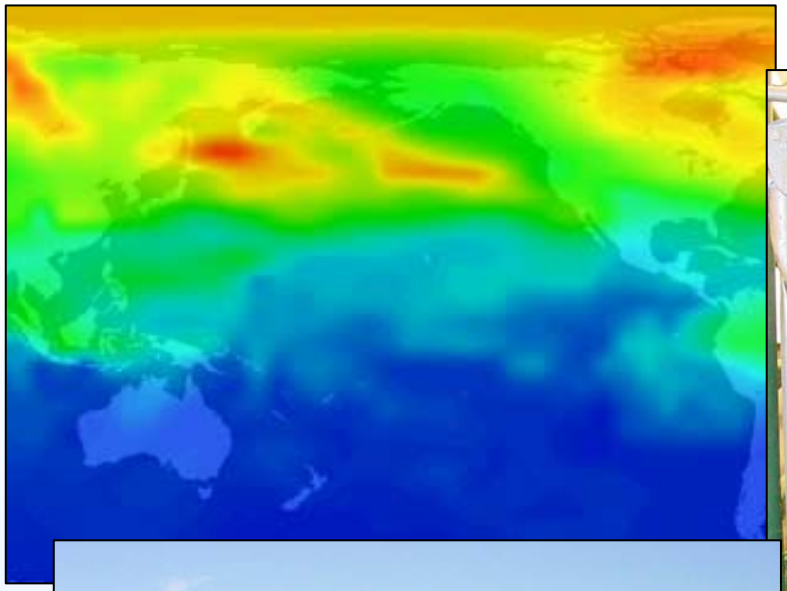
UC Davis, October 11, 2006

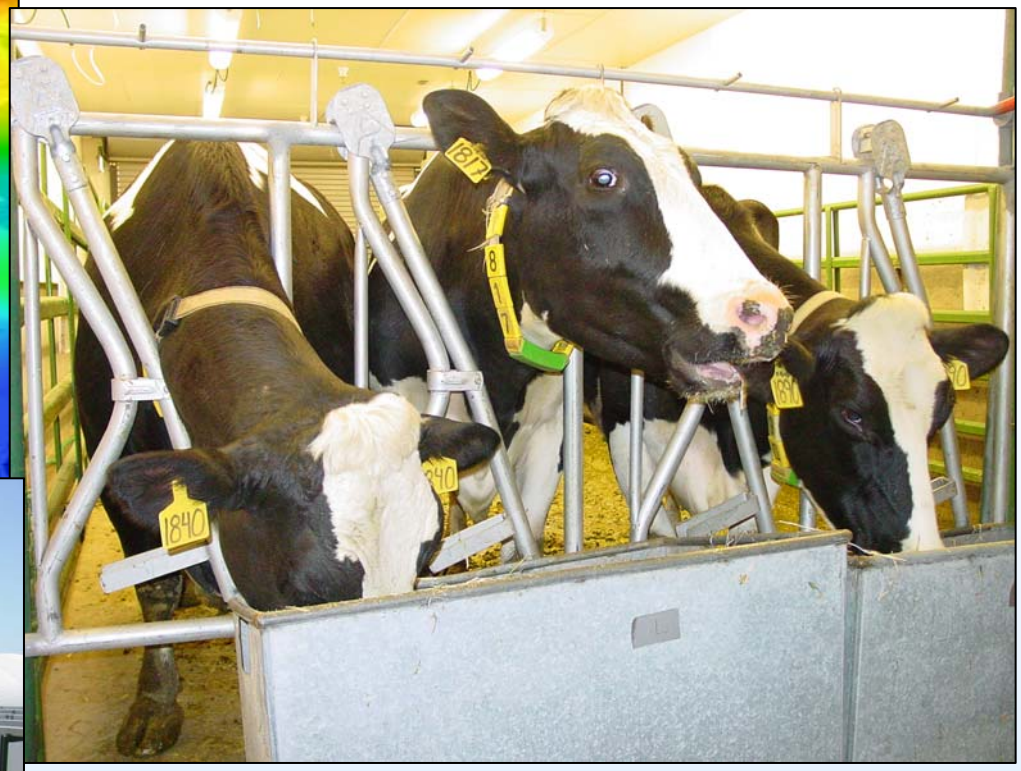
Support provided by:

California Air Resources Board
SJV Air Pollution Control District
Dairy CARES
Air and Waste Mgt Assoc.
UC Davis Animal Science Department
UC Davis Air Quality Research Center

Dairy Volatile Organic Gas and Greenhouse Gas Emissions

Dairy Air Quality Research Symposium
Davis, October 11, 2006



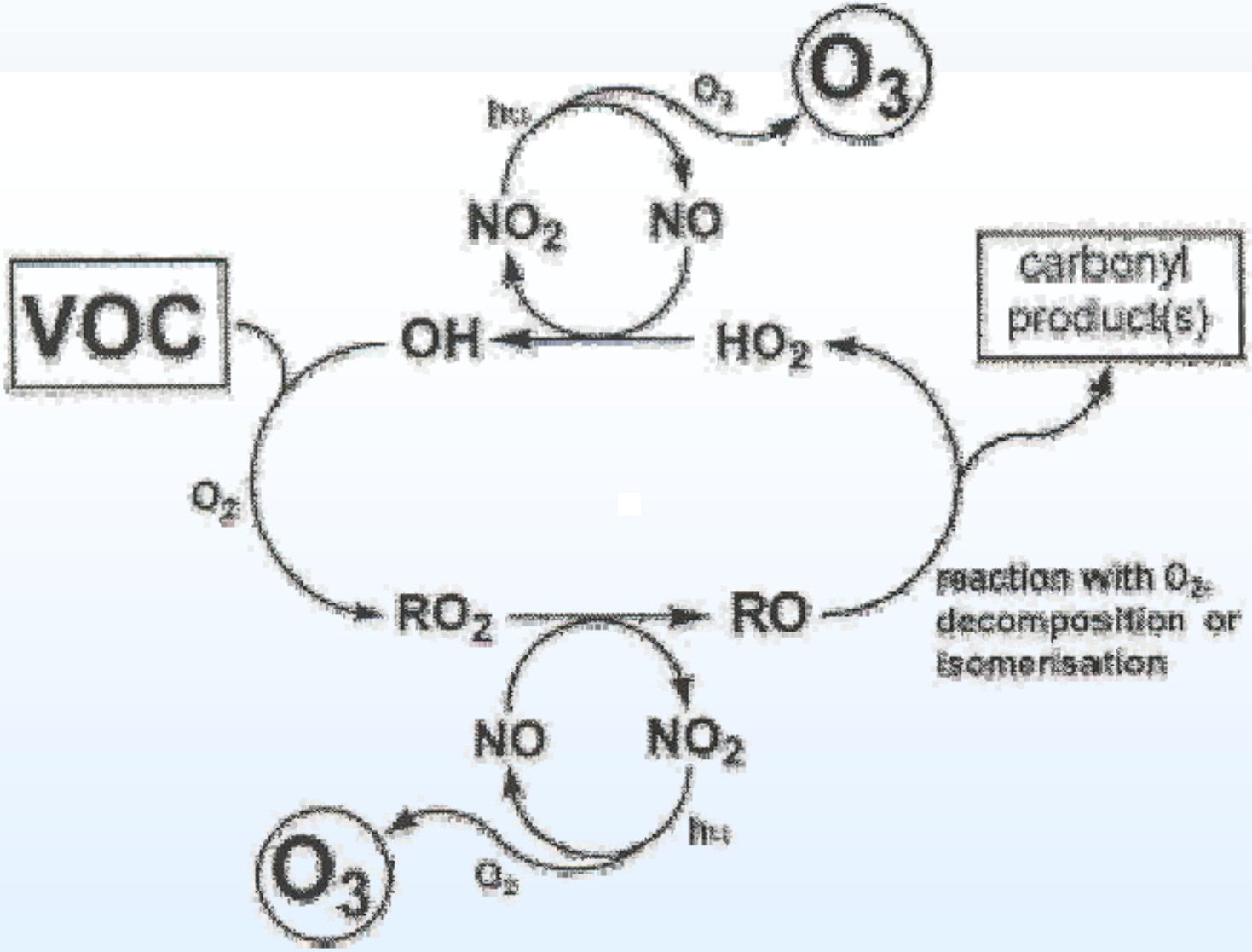


Frank Mitloehner, PhD
Air Quality CE Specialist
Animal Science, UC Davis

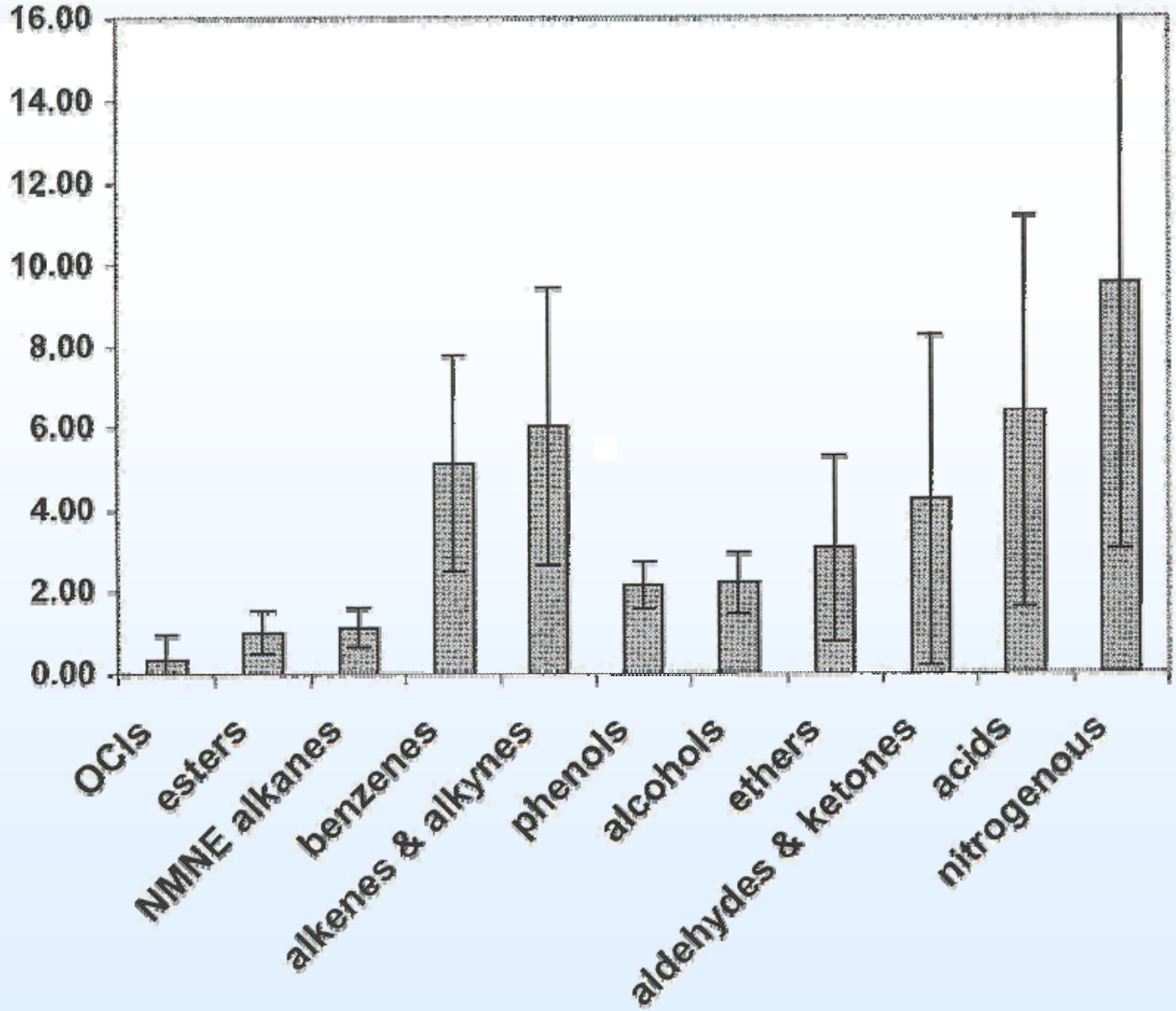
Volatile Organic Compounds (VOC)

What <u>do we know</u> about VOCs?

- VOC = approx 700 individual reactive gases (also referred to as ROG)
- VOCs are compounds like ketones, alcohols, aldehydes, acids, esters etc.
- VOCs plus NOx forms ozone (smog)
- New district regulations are based on SB700


VOC
O_2
RO_2
RO
reaction with O_2, decomposition or isomerisation
carbonyl product(s)
HO_2
OH
NO_2
NO
O_2
O_3
NO
NO_2
O_2
O_3

Average MIR by Chemical Class



Greenhouse Gases (GHG)

What do we know about GHGs?

Global Warming Potential (GWP) of Main GHG

• Carbon Dioxide, CO_2	1
• Methane, CH_4	21
• Nitrous Oxide, N_2O	310

• AB32 regulates GHG

Team

Expertise: Atmospheric Chemistry, Physics, Mechanical Eng., Bio. & Ag Eng., and Animal Science

Professional Staff

- Leticia Valadez
- Yongjing Zhao
- Yuee Pan
- Irina Malkina

Post Doctoral Fellows

- Harrison Sun
- Aysel Ozpinar
- Yangoa Ma
- Vaselios Bampidis

Graduate Students

- Nichole Marcillac
- Kevin Eslinger
- Eddie Veenendaal
- Andrea Schnitz
- Wendi Jackson
- Lisa Nuckles
- Michelle Calvo
- Kim Stackhouse
- Scott Hamilton

Emission estimate studies

Effects of Dairy Rations on VOC Emissions from Cows and their Waste under Controlled Conditions

Environmental Protection Agency IX

UC Davis: Dr. F. Mitloehner, Dr. B. Flocchini, Dr. E. DePeters, Dr. P. Robinson, Dr. J. Fadel

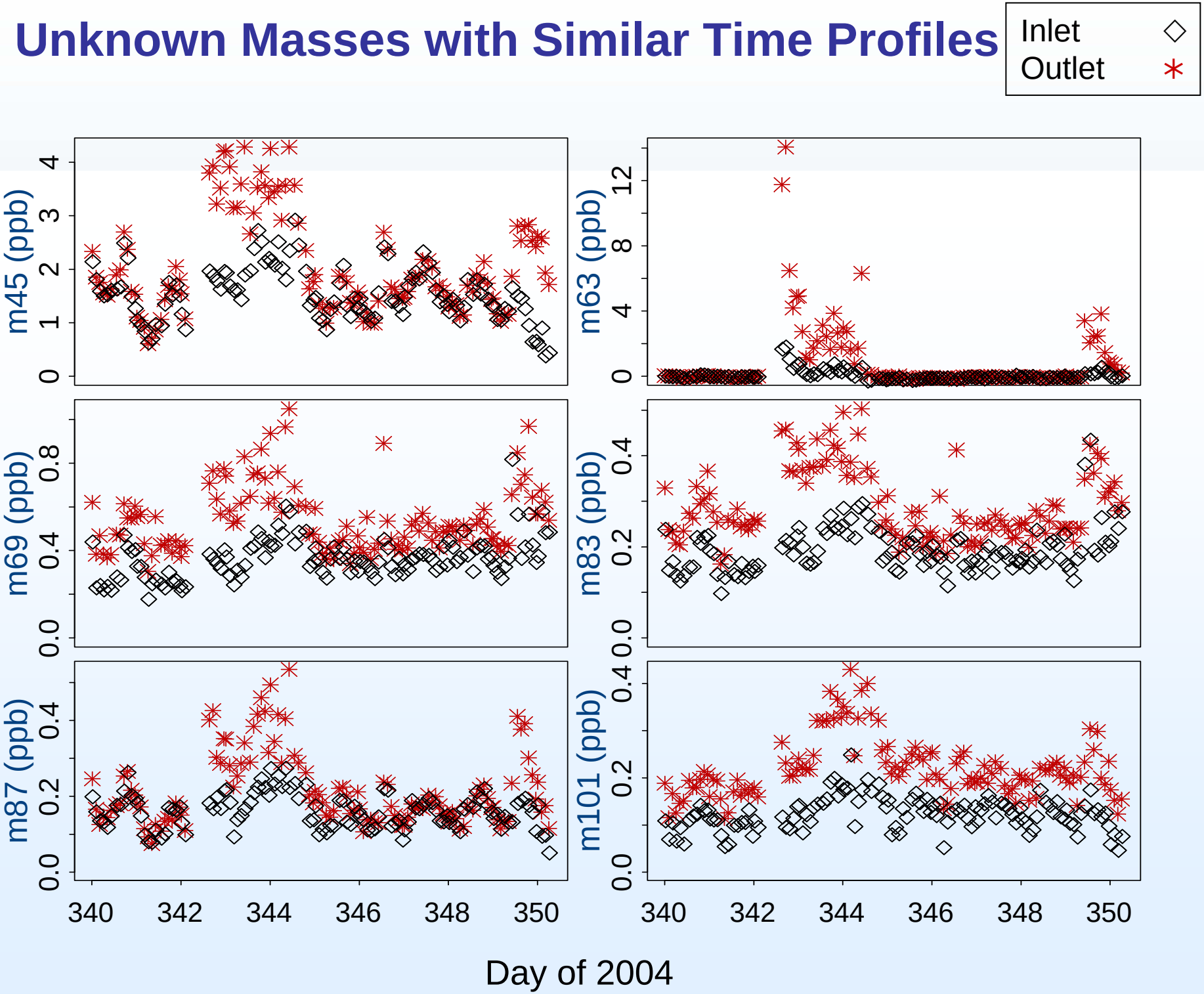
UC Berkeley: Dr. A. Goldstein, Dr. S. Lyn Shaw

Materials and Methods

- Close-up dry cows
- Far-off dry cows
- Low producing lactating cows
- Medium producing lactating cows
- High producing lactating cows

LGR
DLT-100

Unknown Masses with Similar Time Profiles



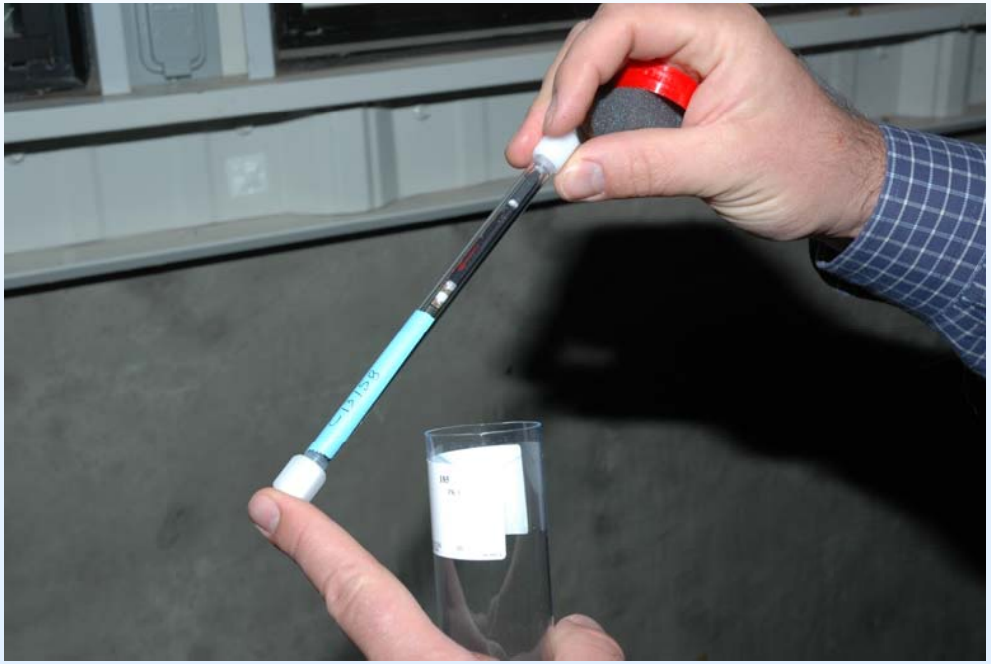
VFA, phenol, amine and alcohol emissions from dairy cows and fresh waste

CARB and SJVAPCD

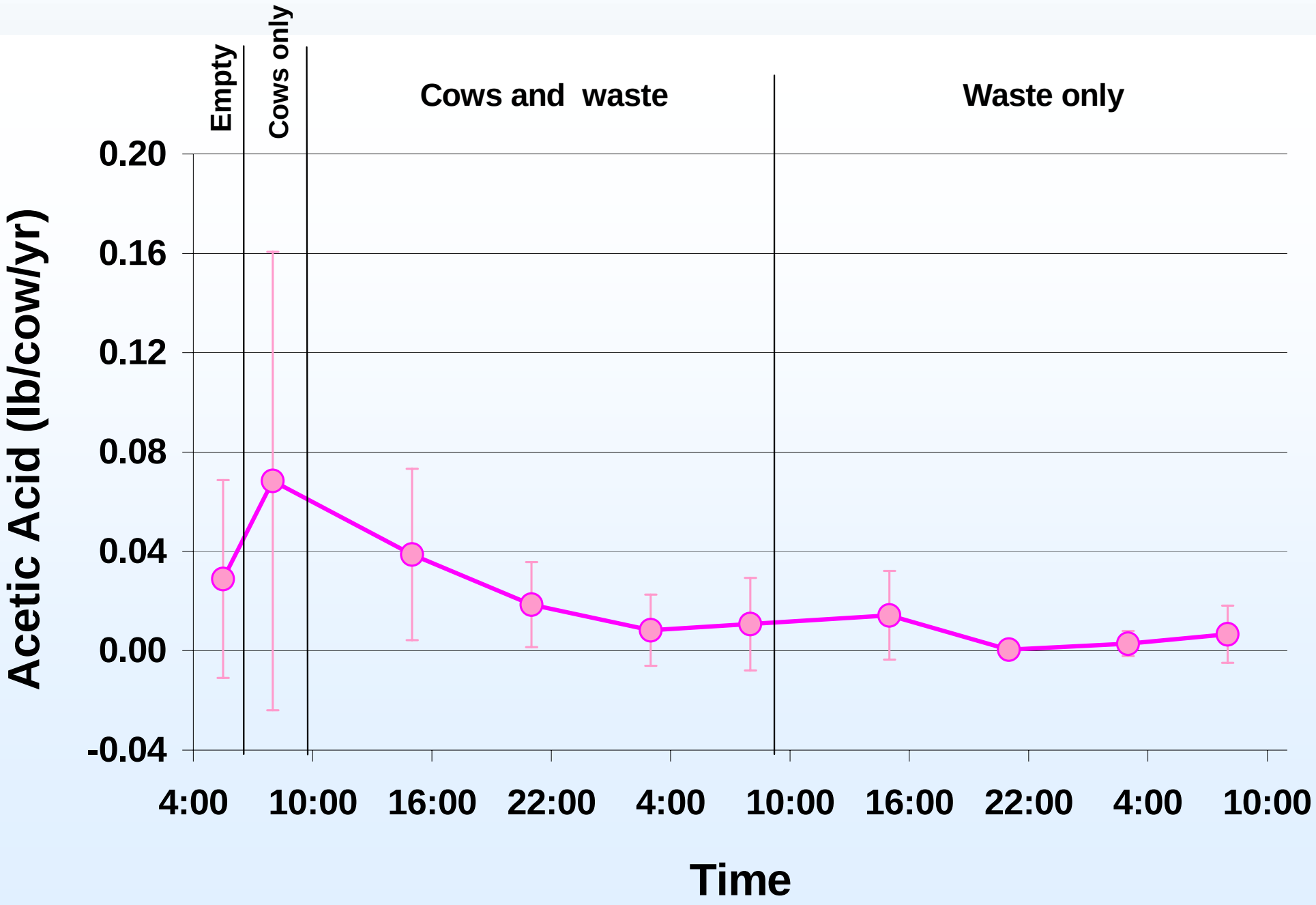
UC Davis:	Dr. F. Mitloehner
USDA-ARS:	Dr. S. Trabue
Iowa State:	Dr. J. Koziel

INNOVA 1412 Photoacoustic Field Gas-Monitor
RESET
LOCK
MEASURE

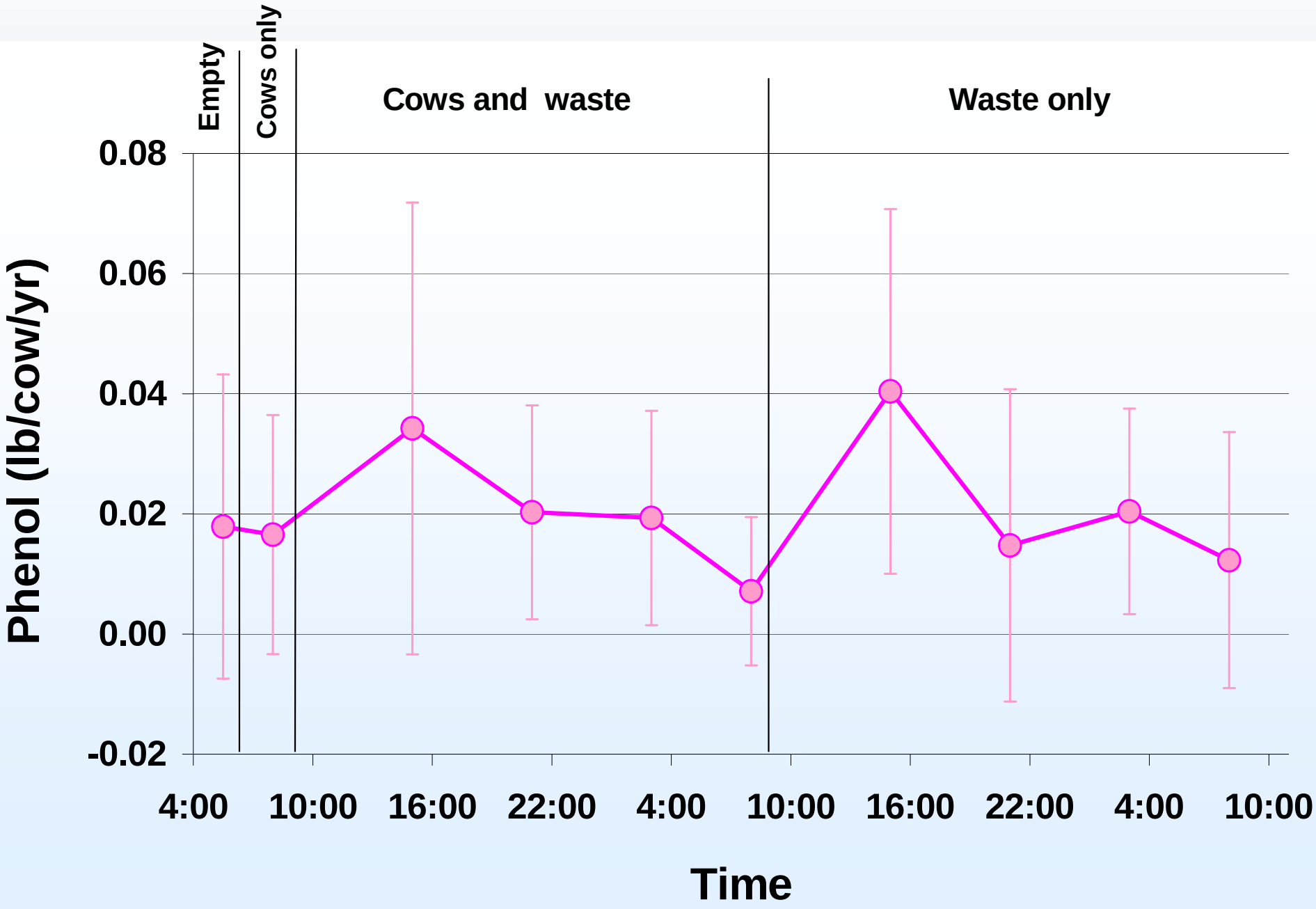
DISPLAY
FUNCTION
GERSTEL
GS 1
Inlet



Emissions from dry cows and waste



Emissions from dry cows and waste



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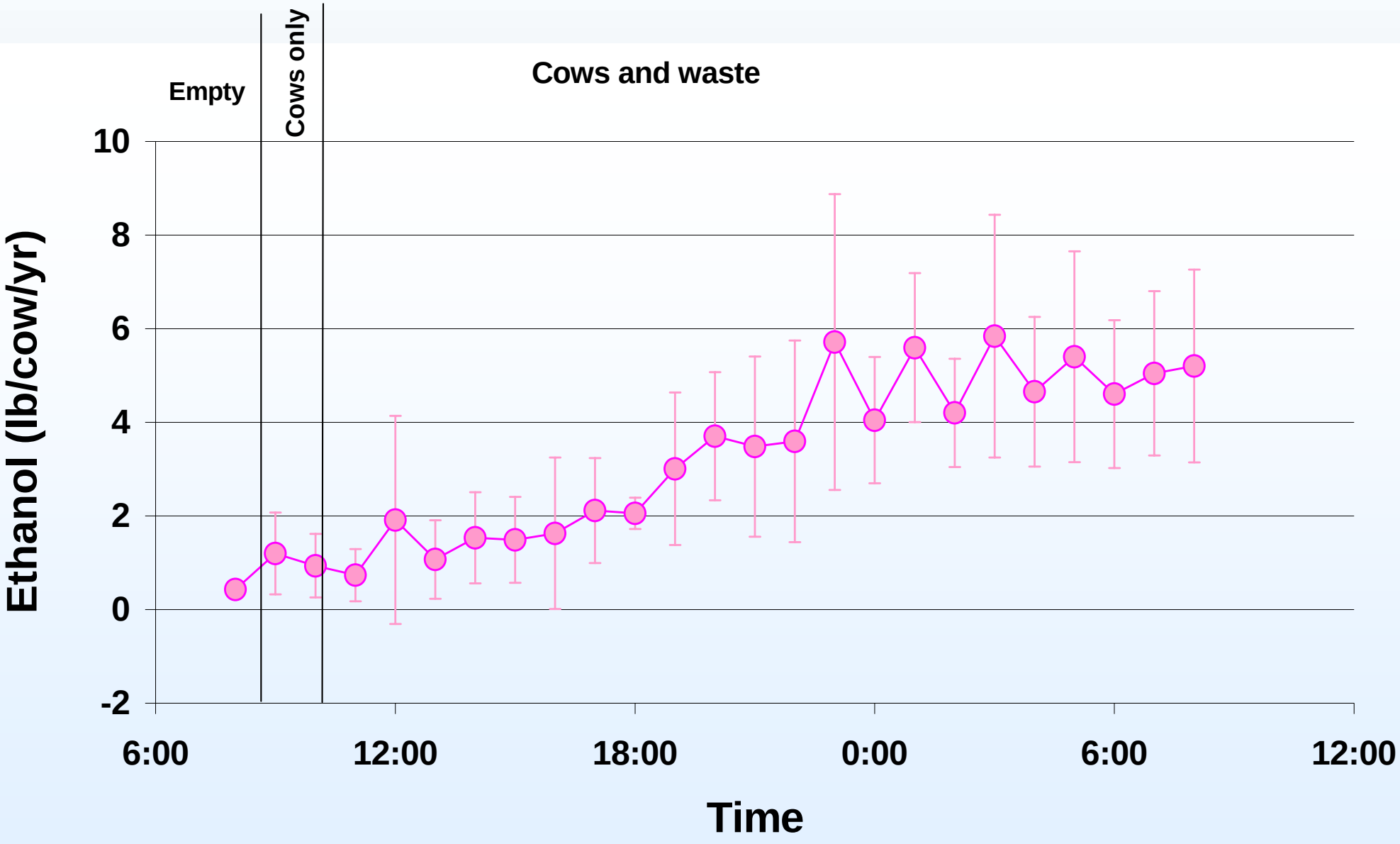
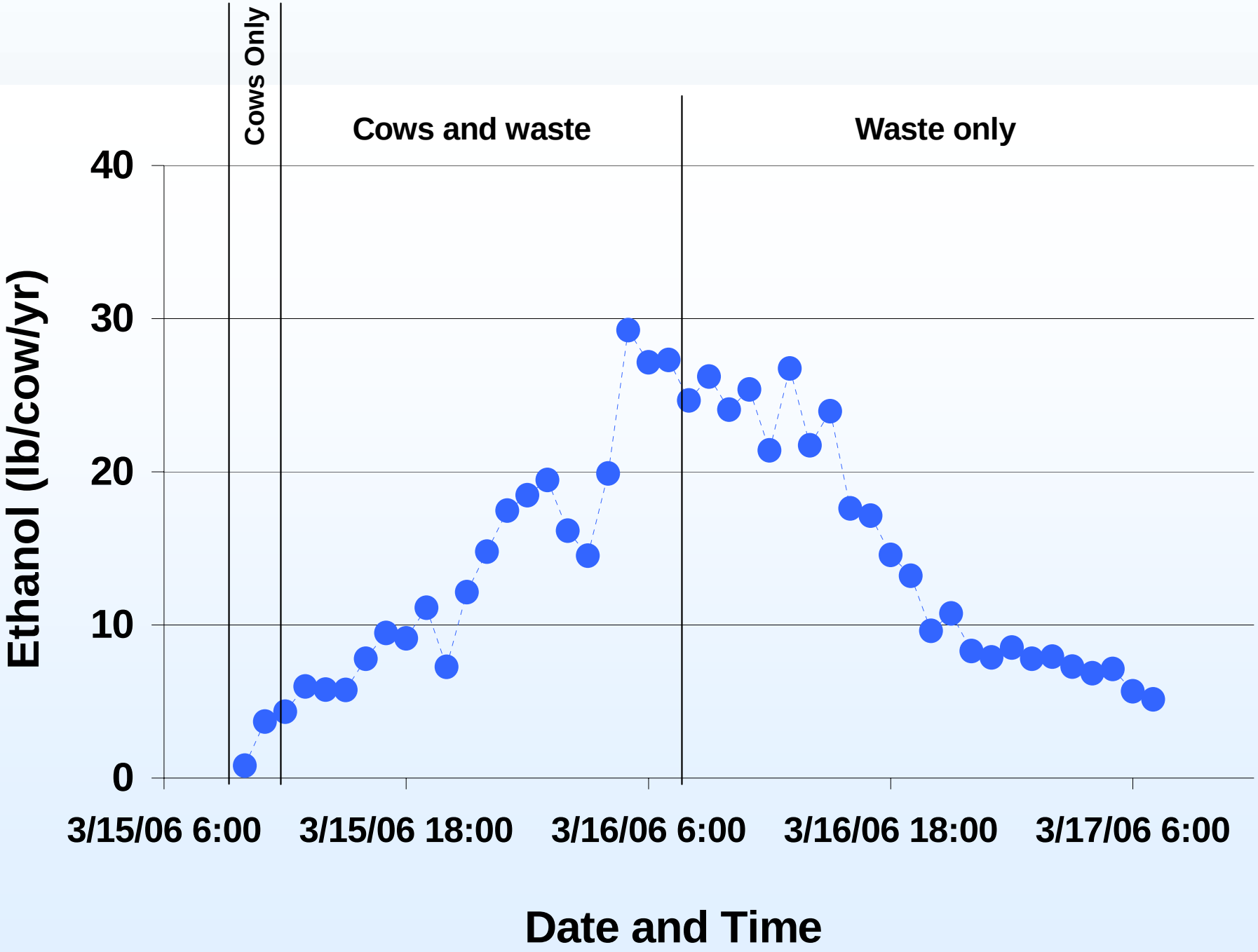
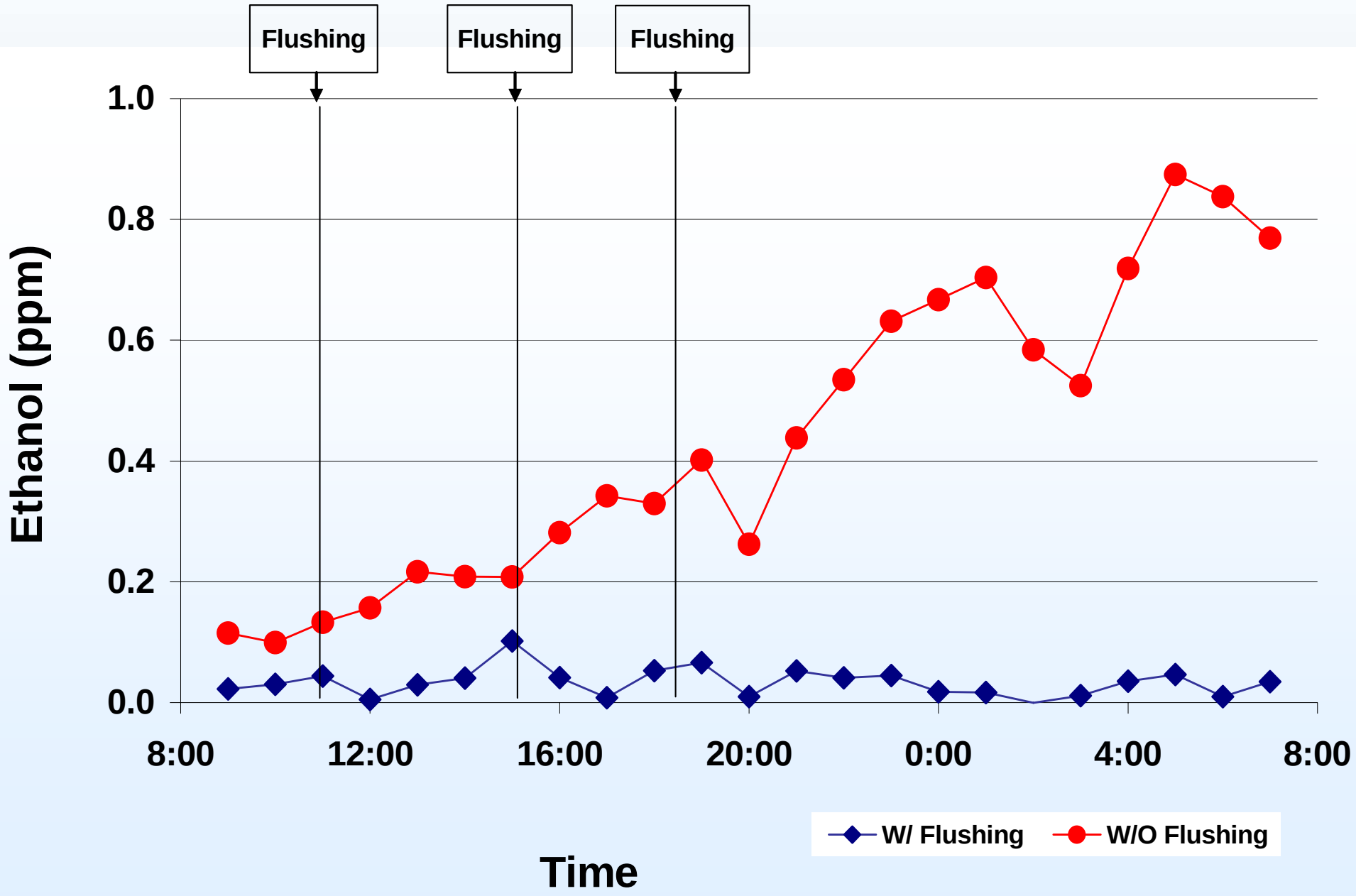
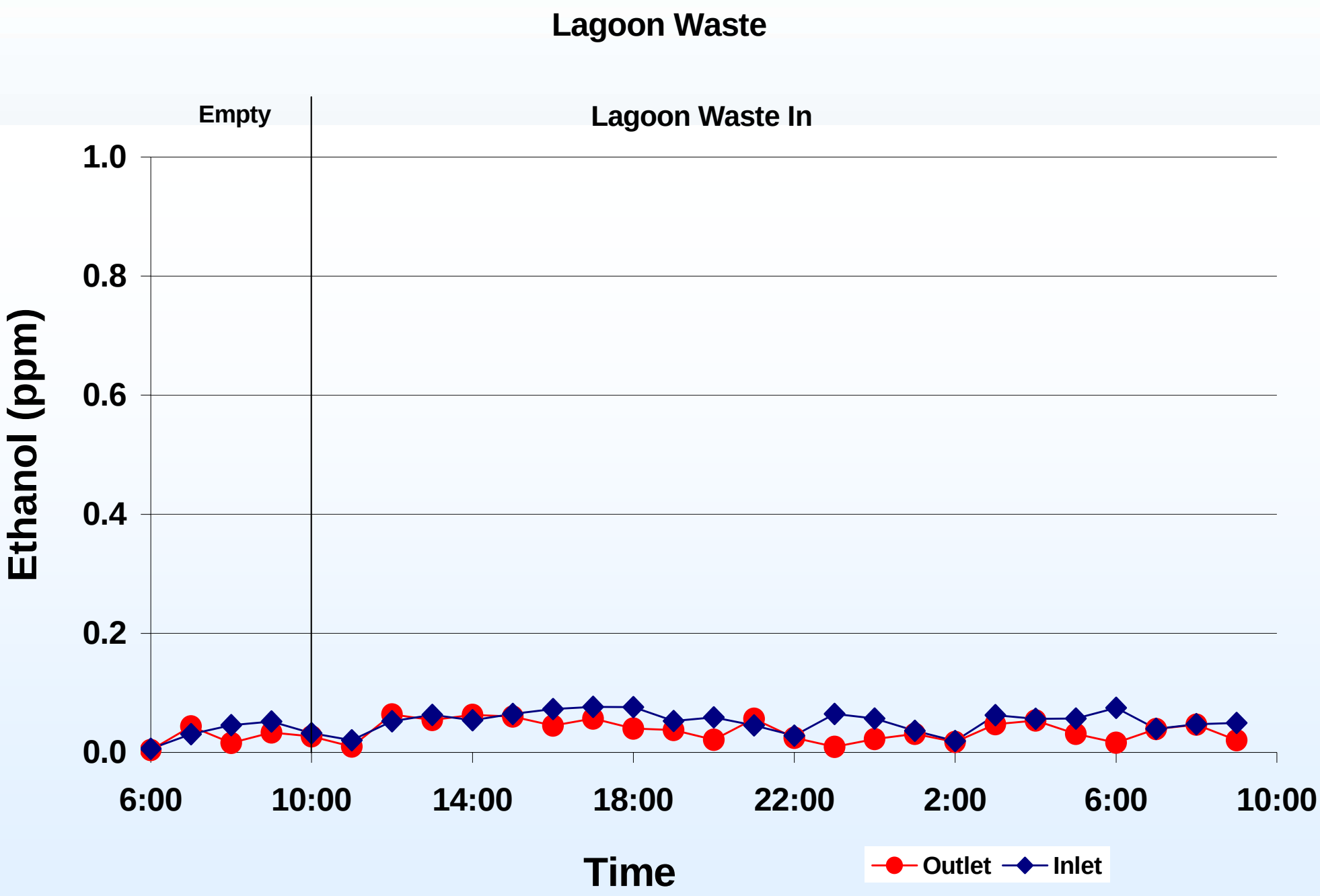


Emissions from lactating cows and waste



Comparison for the waste treatment with/without flushing



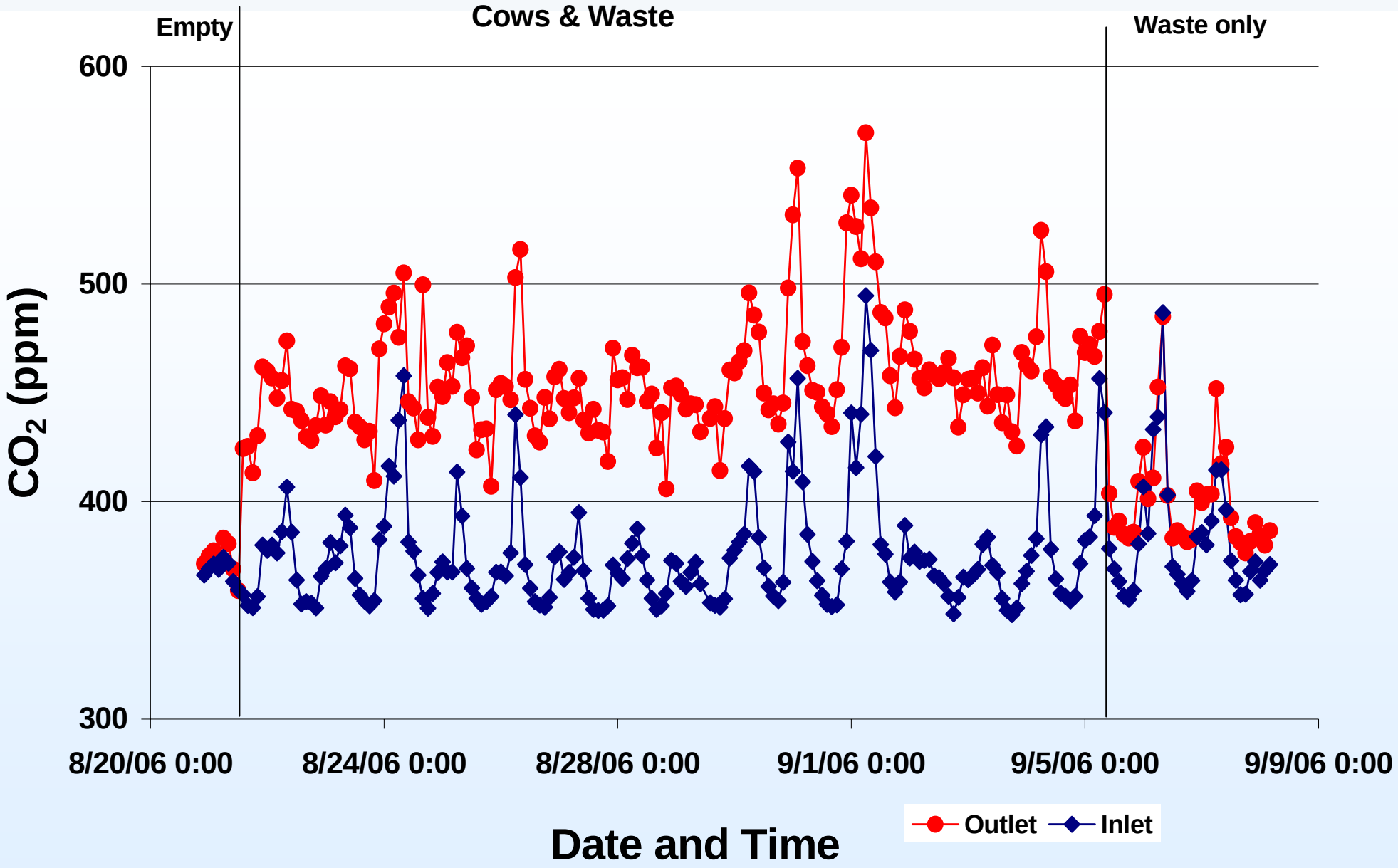

Lagoon Waste
Empty
Lagoon Waste In
1.0
0.8
0.6
0.4
0.2
0.0
Ethanol (ppm)
6:00
10:00
14:00
18:00
22:00
2:00
6:00
10:00
Time
Outlet
Inlet

Greenhouse Gas Studies

California Energy Commission - PIER

UC Davis:	Dr. F. Mitloehner
Applied Geosolutions:	Dr. Bill Salas
UNH:	Dr. Changsheng Li
CSU Fresno:	Dr. Charles Krauter

Concentration from dry cows group and waste, bubble exp.



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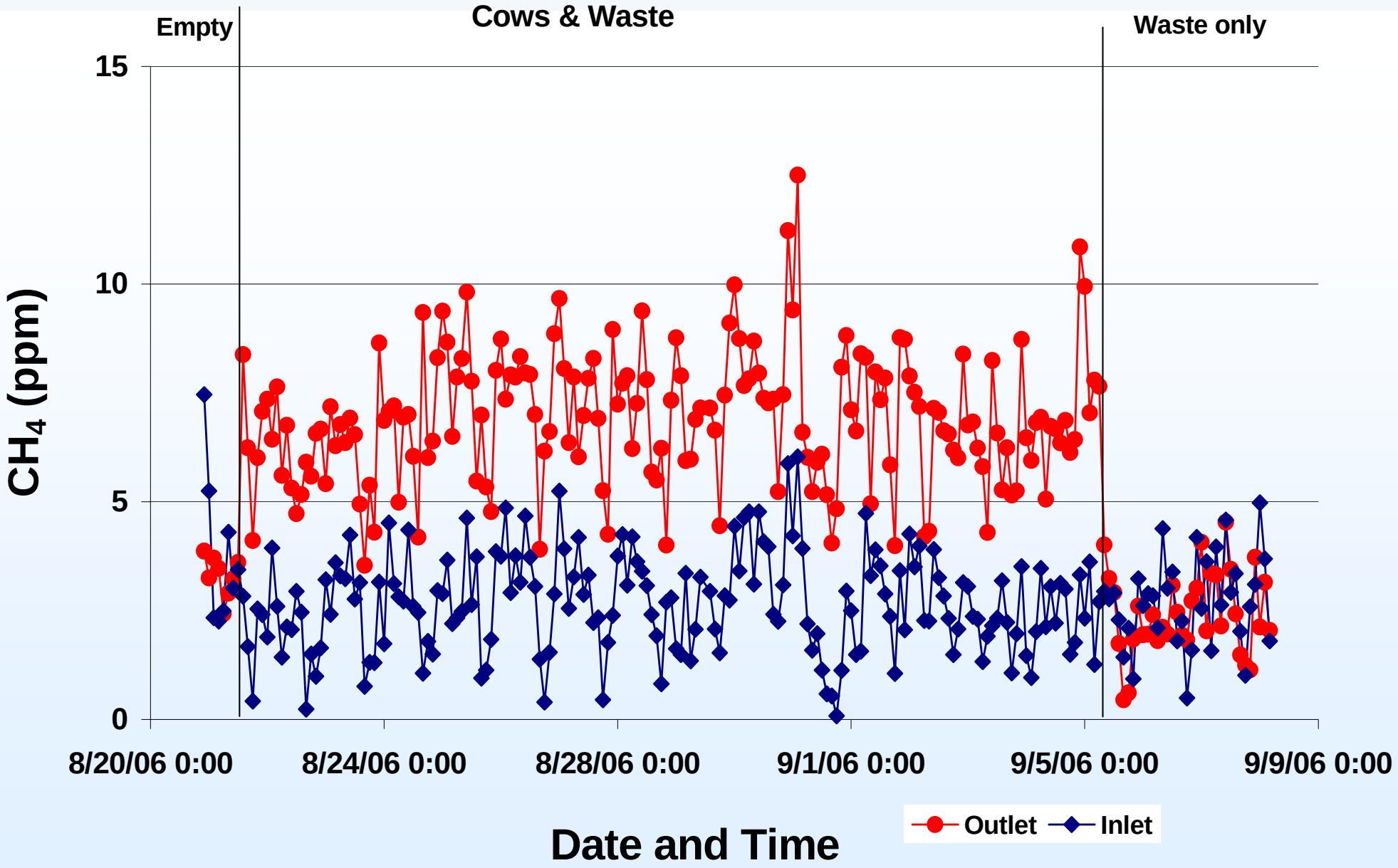

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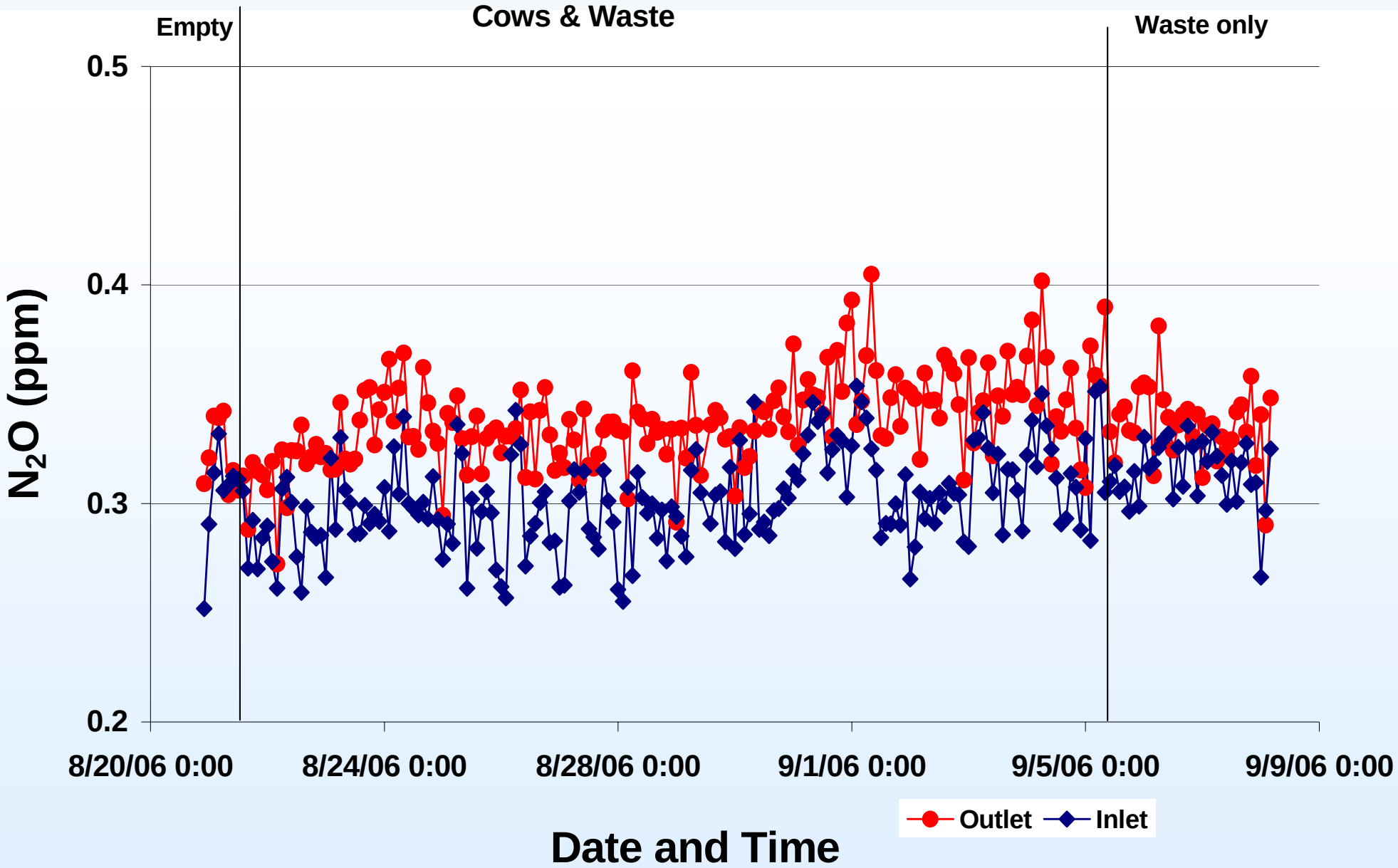


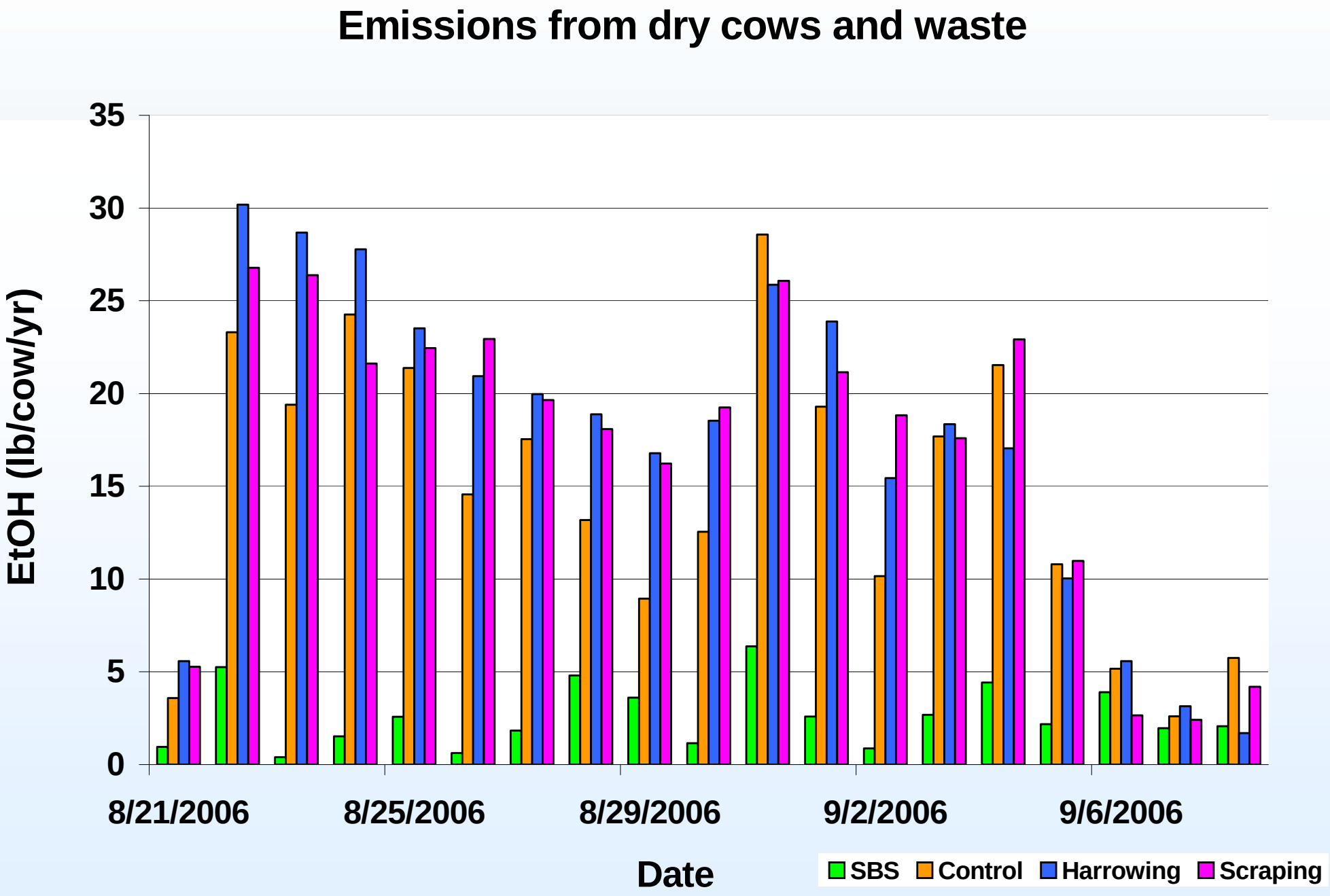
Emission Mitigation Studies

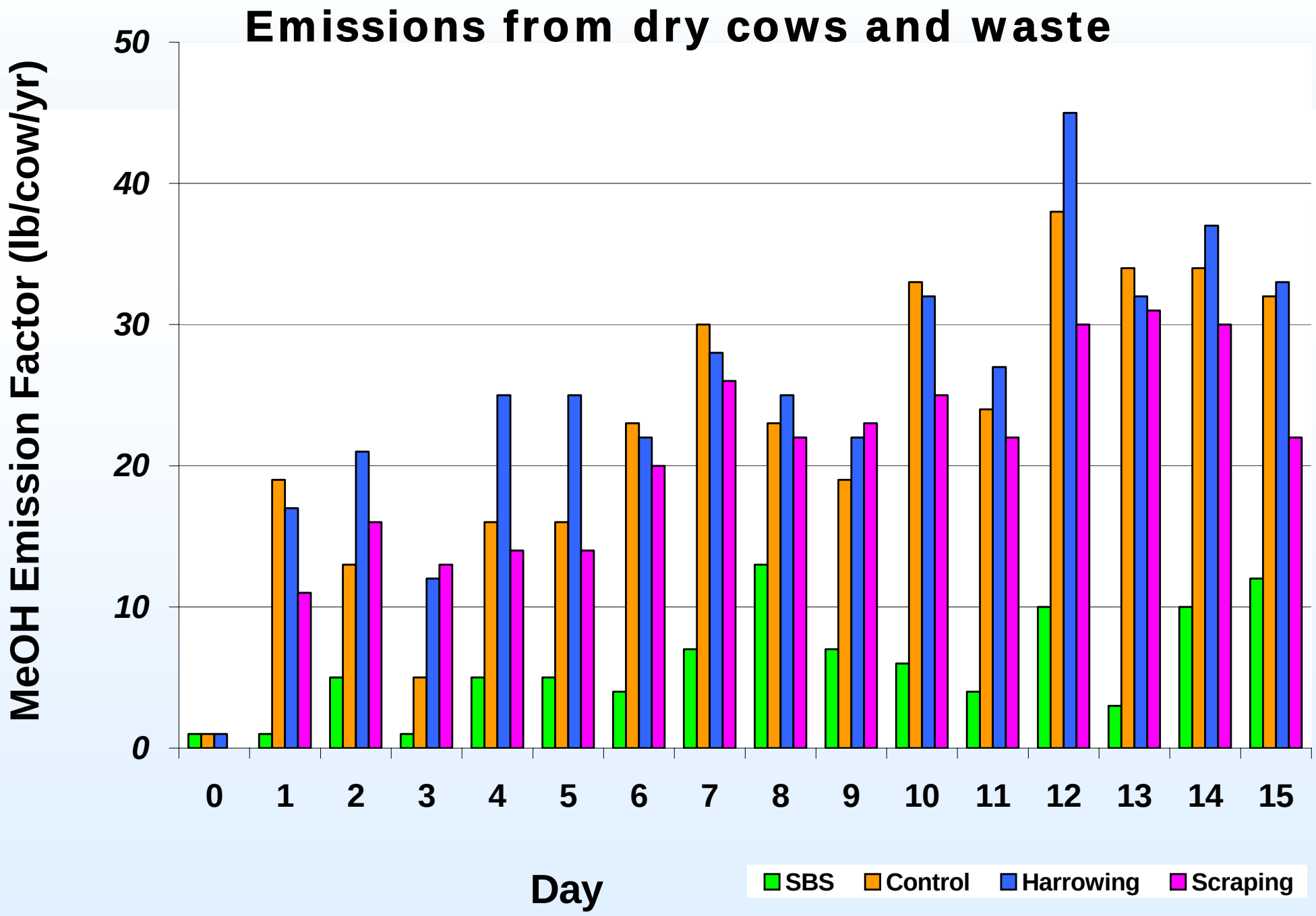
SWRCB &

Merced County, Dept of Env. Health

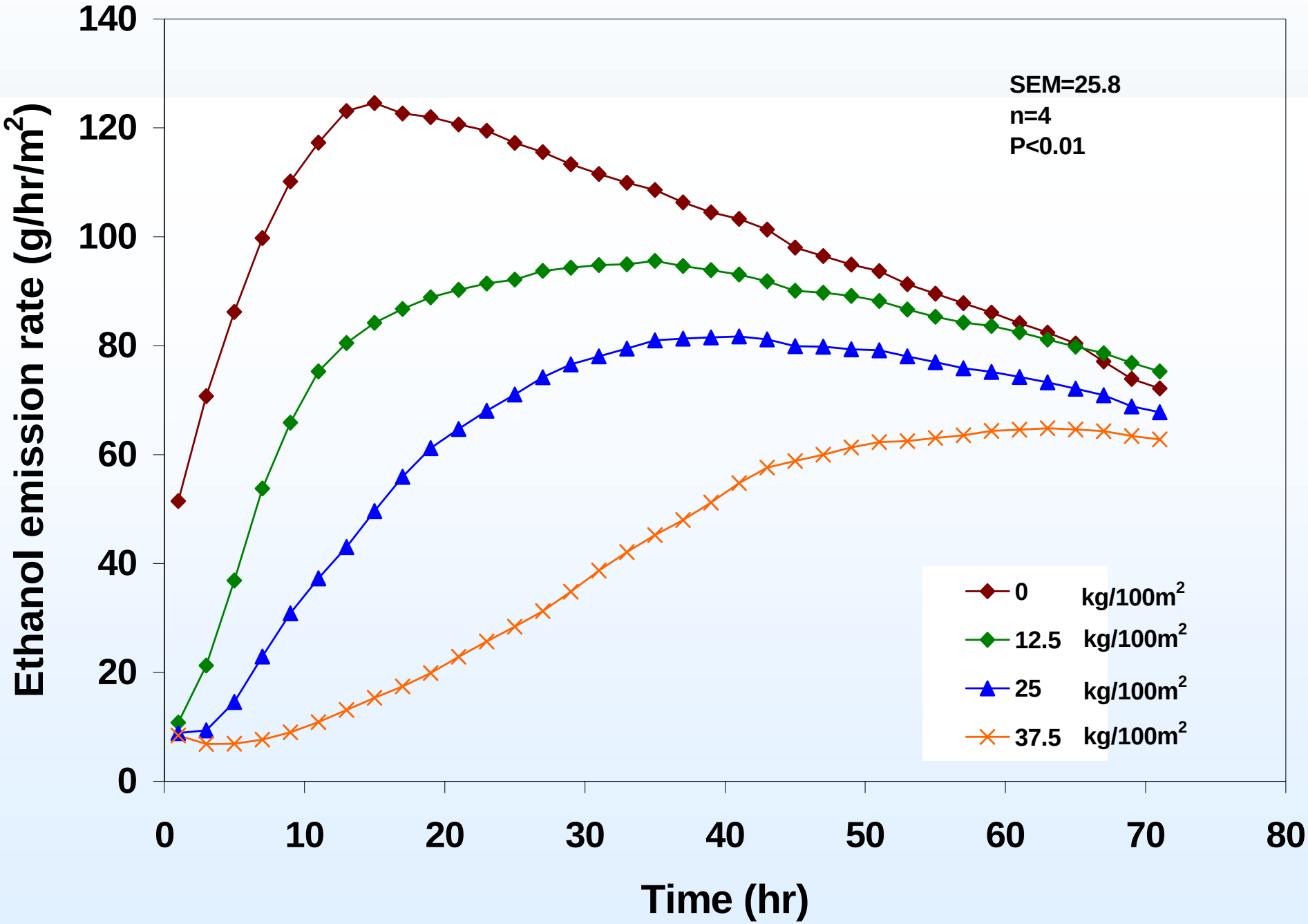
UC Davis: Dr. F. Mitloehner, Dr. R. Zhang, Dr. T. Harter, Dr. P. Robinson, Dr. J. Fadel, Dr. E. DePeters, Dr. S. Berry

USDA ARS: Dr. J. McGarvey

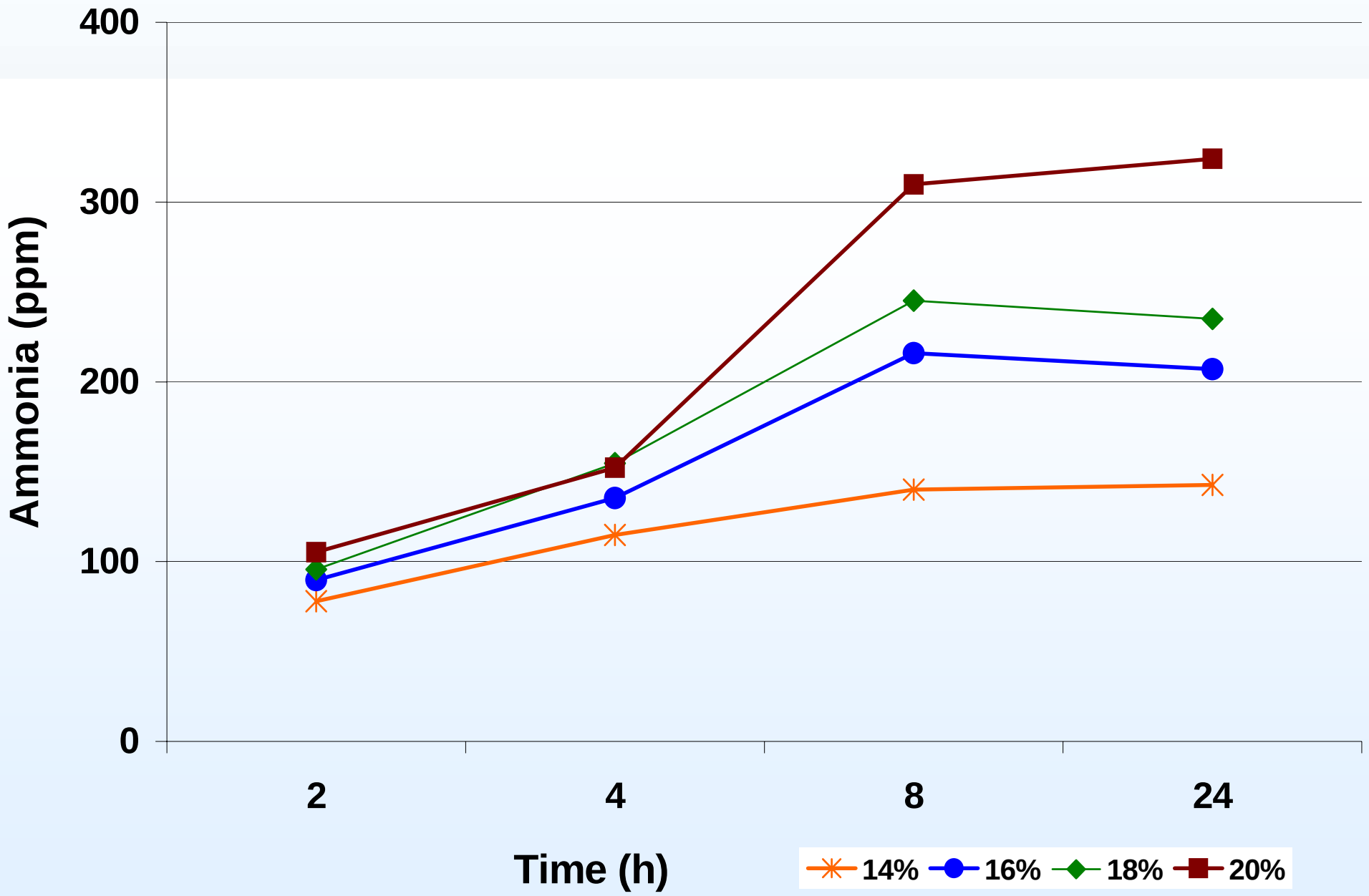

Emissions from dry cows and waste
EtOH (lb/cow/yr)
35
30
25
20
15
10
5
0
8/21/2006
8/25/2006
8/29/2006
9/2/2006
9/6/2006
Date
SBS
Control
Harrowing
Scraping


Emissions from dry cows and waste
MeOH Emission Factor (lb/cow/yr)
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Day
SBS
Control
Harrowing
Scraping

Effects of acidification (SBS) on EtOH



Effects of protein in feed on ammonia from fresh waste



Conclusions

- Dairies can be a significant alcohol and GHG source
- Main VOCs from dairies are ethanol and methanol
- Main EtOH and MeOH sources on dairies are fresh waste and fermented feed
- Flush waste systems are an important mitigation practice (water solubility of alcohols)
- Acidification of drylot corral surfaces reduces alcohol producing bacteria thus controlling alcohol emissions
- Present study results were confirmed by WSU and Schmidt

Conclusions

- Main dairy GHG source are cows (i.e. enteric fermentation and respiration)
- CH_4 emissions from enteric fermentation might be reduced through improvements of feed efficiency (feed additives) and adjustments of feeding strategies
- N_2O dairy emissions are comparatively unimportant
- CO_2 emissions from cow respiration cannot be mitigated w/o reducing herd size
- Source/Sink

Future studies

- USDA-CSREES funded mitigation studies on feed (silage) and housing mgt
- CARB funded study on PBM
- NMPF funded monitoring study
- NIOSH funded Ag center study on exposure and health effects of dairy air pollutants
- Dairy Process Based Model study

Areas for VOC mitigation in SJV Rule 4570

- VOC mitigation for the following areas:
  - Feed (5 of 13 options)
  - Milk parlor (1 of 3 options)
  - Freestall barn (2 of 10 options)
  - Corral (6 of 19 options)
  - Solid waste (2 of 9 options)
  - Liquid waste (1 of 11 options)
  - Land application (2 of 7 options)
  - Alternative

Research to Practice – R2P

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