Ammonia emissions after field application of organic fertilizer

Evaluating mitigating technologies with high-time resolution flux measurements

AARHUS
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Outline

- Who am I?
- NH_3 emission after field application
- Dynamic chambers
- Example: Acidification
- Example: Low-emission application techniques
- Questions

Who am I?

Johanna Pedersen (jp@bce.au.dk)
Tenure track researcher

Section of Environmental Engineering
Department of biological and chemical engineering
Aarhus University

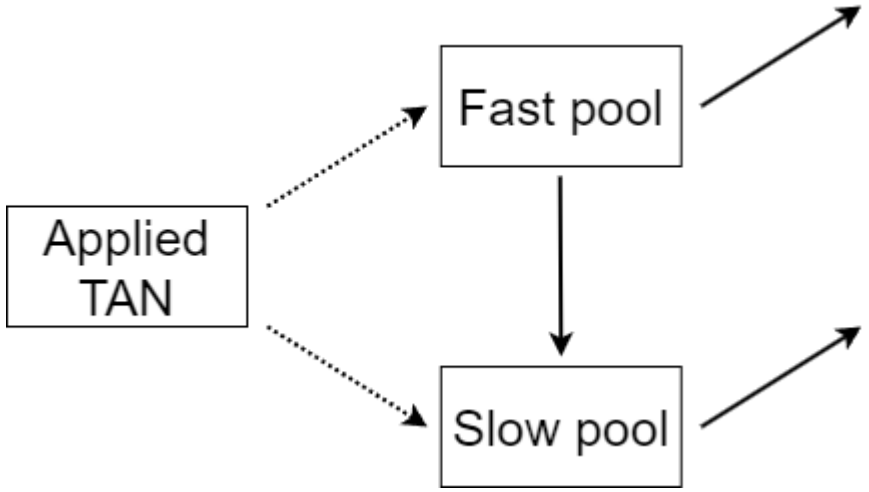
M.Sc. Chemical engineering, 2017

Ph.D. Environmental Engineering, 2020

- Measurements and mitigation of NH_3 and VOC after field application of liquid animal manure

NH_3 emission after field application

Pig slurry, cattle slurry, slurry digestate



Emissions occur rapidly after application

Source: Hafner et al. Atmos Environ, 199, 2019

NH_3 emission after field application

Which parameters affect the NH_3 emissions?

Slurry/digestate

- Dry matter, pH, viscosity, particle size distribution

Soil

- Soil type, soil-water content, crops

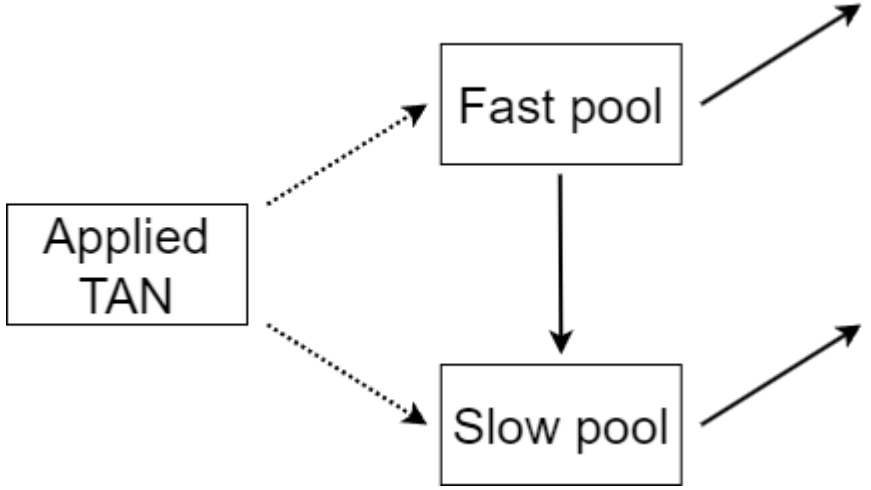
Climate

- Temperature, wind speed, rain

Management choices

- Technique, amount, timing, treatment

Interactions



Dynamic chambers

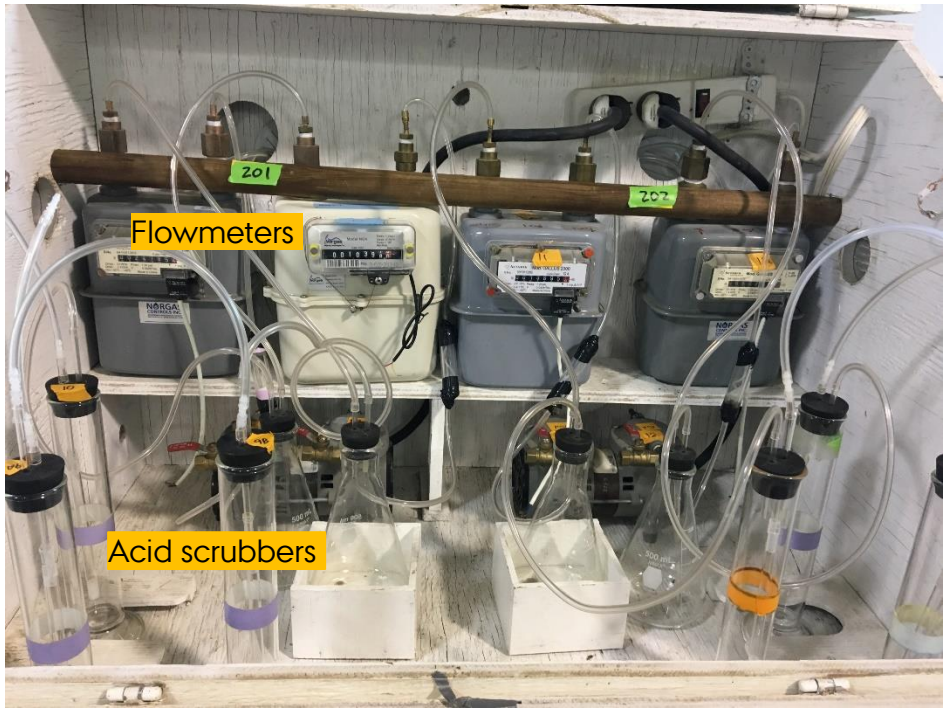
Aarhus University, Denmark

Aarhus University, Denmark

Field excursion tomorrow

Agassiz Research and Development Centre, BC, Canada

Dynamic chambers



Air-flow direction

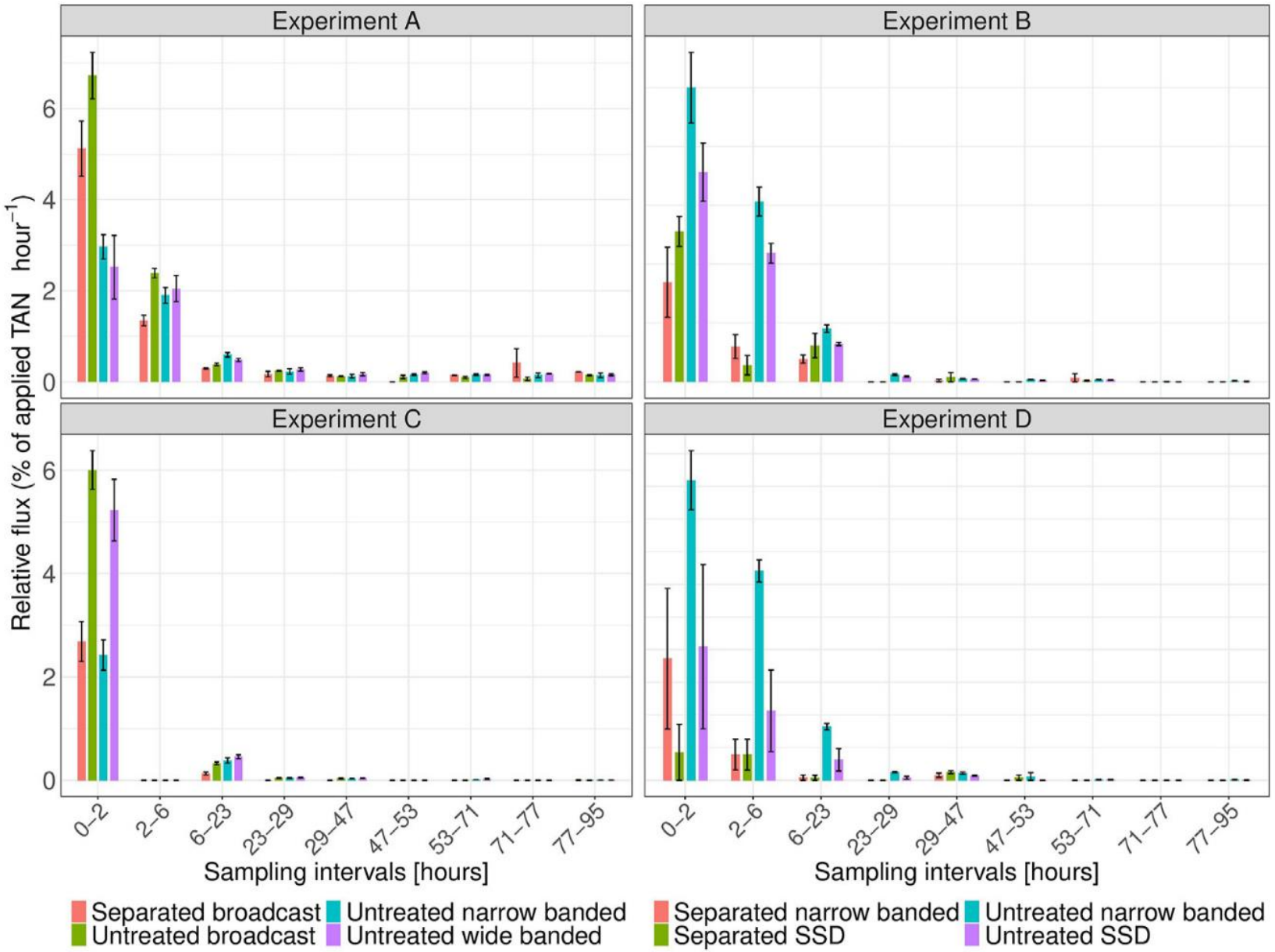
Air sampling points

Dynamic chambers

Dynamic chambers with acid traps

- Time integrated sampling
- Manual collection of acid for each sampling point
- Sources of error:
  - Application rate
  - Air flow in chamber
  - Air flow in sample tubes
  - Acid trap setup
  - Manual handling of sample collection
  - Laboratory analysis of acid

Dynamic chambers



Source: Pedersen et al. Biosyst Eng, 211, 2021

Dynamic chambers

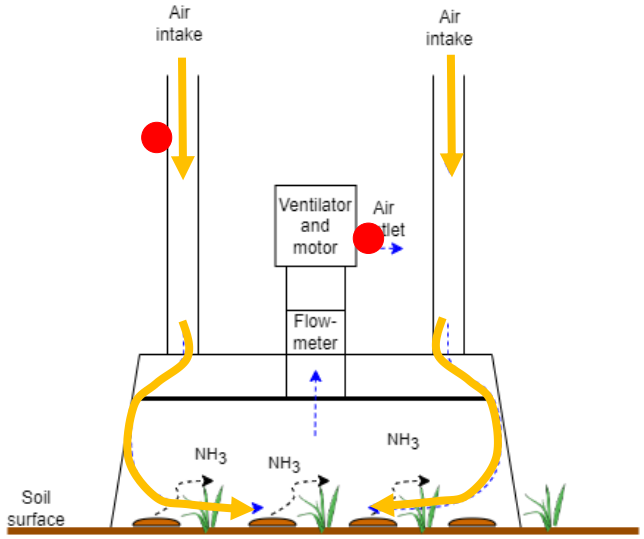
Aarhus University, Denmark

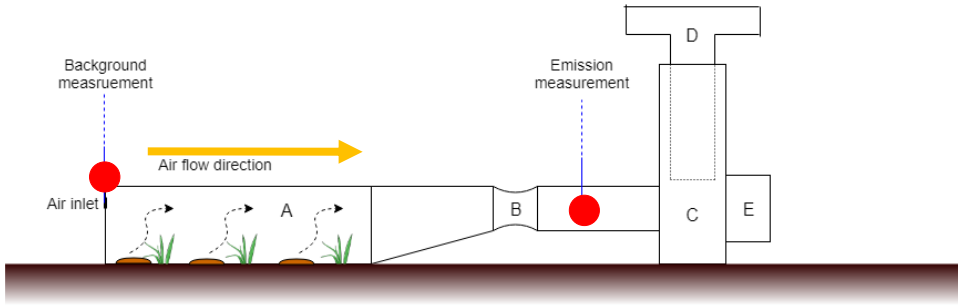
Aarhus University, Denmark

Agassiz Research and Development Centre, BC, Canada

Dynamic chambers

Dynamic chambers coupled with Picarro NH_3 analyzer

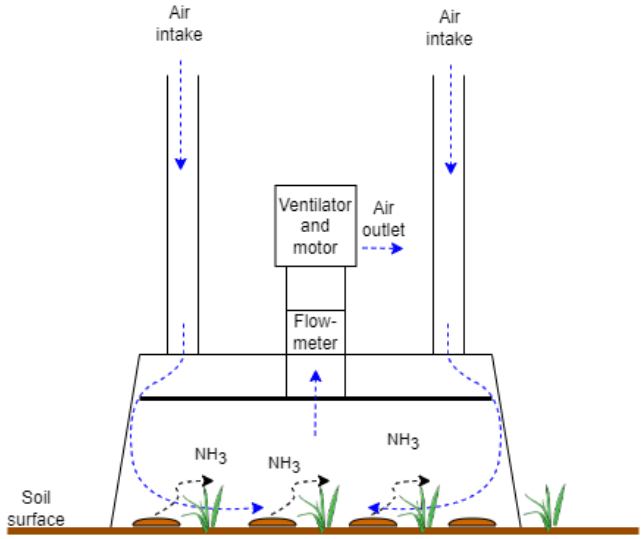


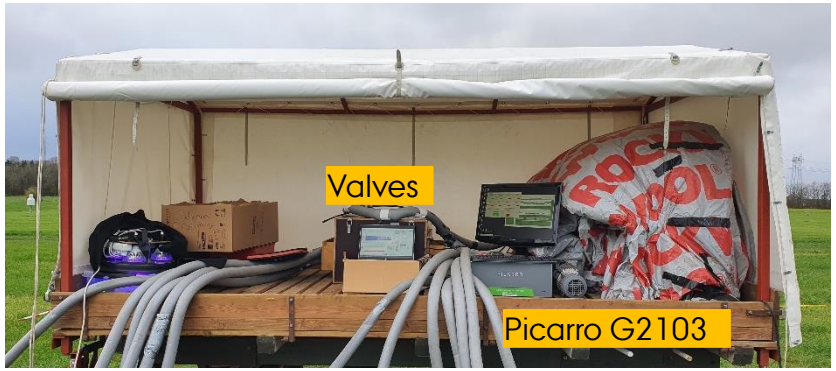


A: emission chamber, B: flowmeter, C: fan, D: hood, E: motor and controller

Dynamic chambers

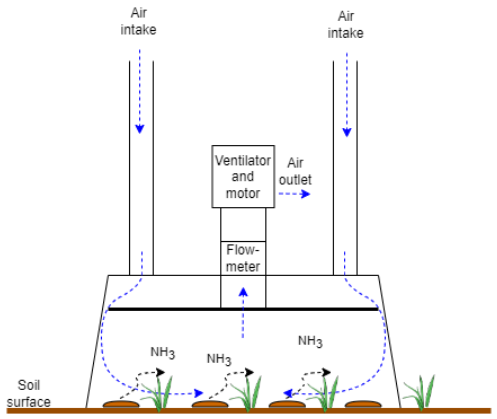
Dynamic chambers with Picarro NH_3 analyzer

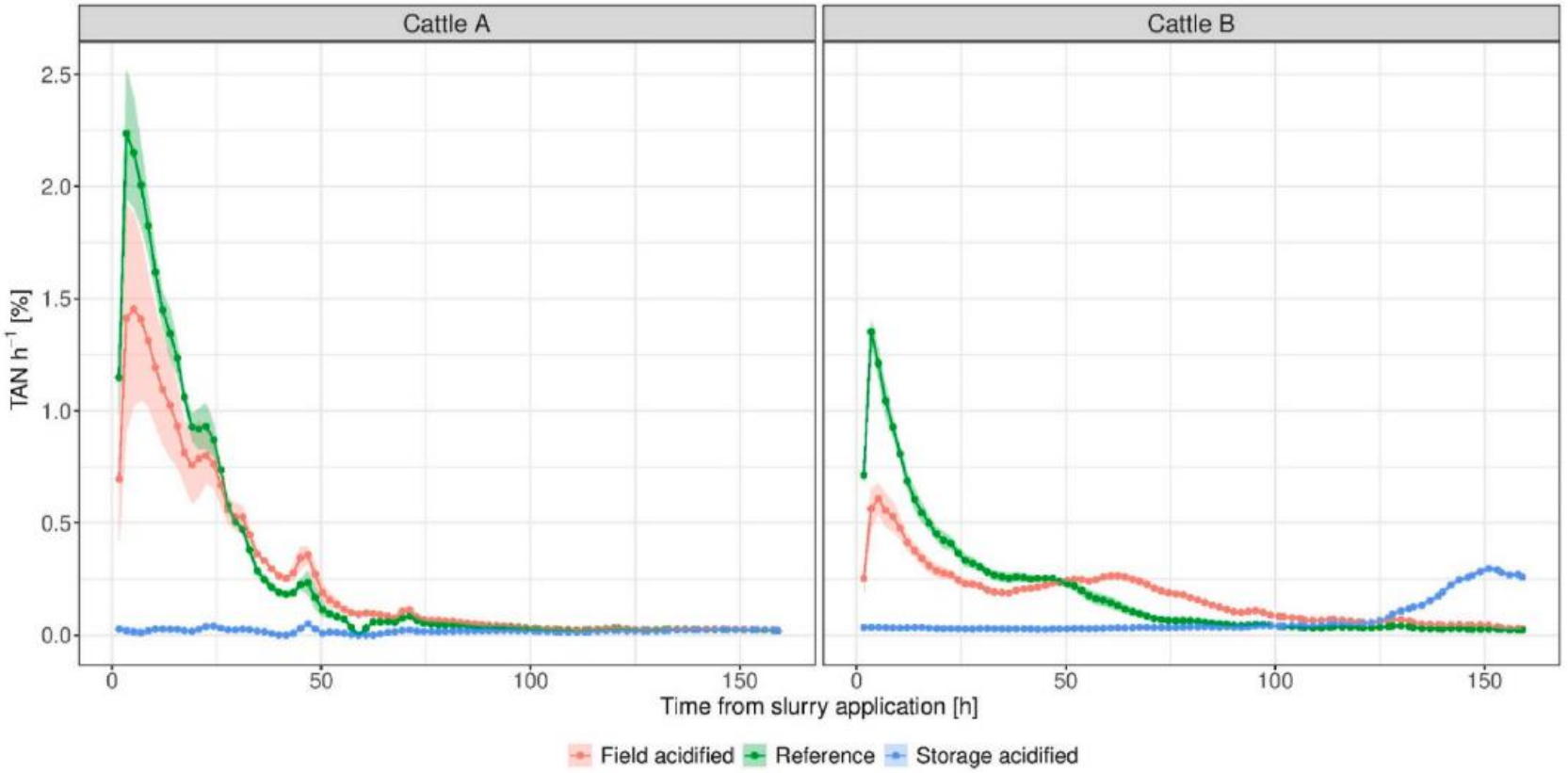




Dynamic chambers

Dynamic chambers with Picarro NH_3 analyzer





Source: Pedersen et al. J Environ Manage, 310, 2022

Dynamic chambers

Dynamic chambers with acid traps

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- Manual collection of acid for each sampling point
- Sources of error:
  - Application rate
  - Air flow in chamber
  - Air flow in sample tubes
  - Acid trap setup
  - Manual handling of sample collection
  - Laboratory analysis of acid

CV 36%

Dynamic chambers with Picarro NH_3 analyzer

- Detailed flux dynamics
- Automatic measurement for each sampling point
- Sources of error:
  - Application rate
  - Air flow in chamber
  - Air flow in sample tubes
  - Valve + Picarro setup
  - Instrument calibration

CV 13%

Dynamic chambers

Benefits:

- High time resolution throughout measuring period
- After setup no labor requirements
- Test of system in the field (leakage etc.)
- Low(er) variance between replicates → higher statistical power
- Instant concentration data
  - Possibility to detect issues in the measuring system
  - Possible to assess data very fast

Dynamic chambers with Picarro NH_3 analyzer:

- Detailed flux dynamics
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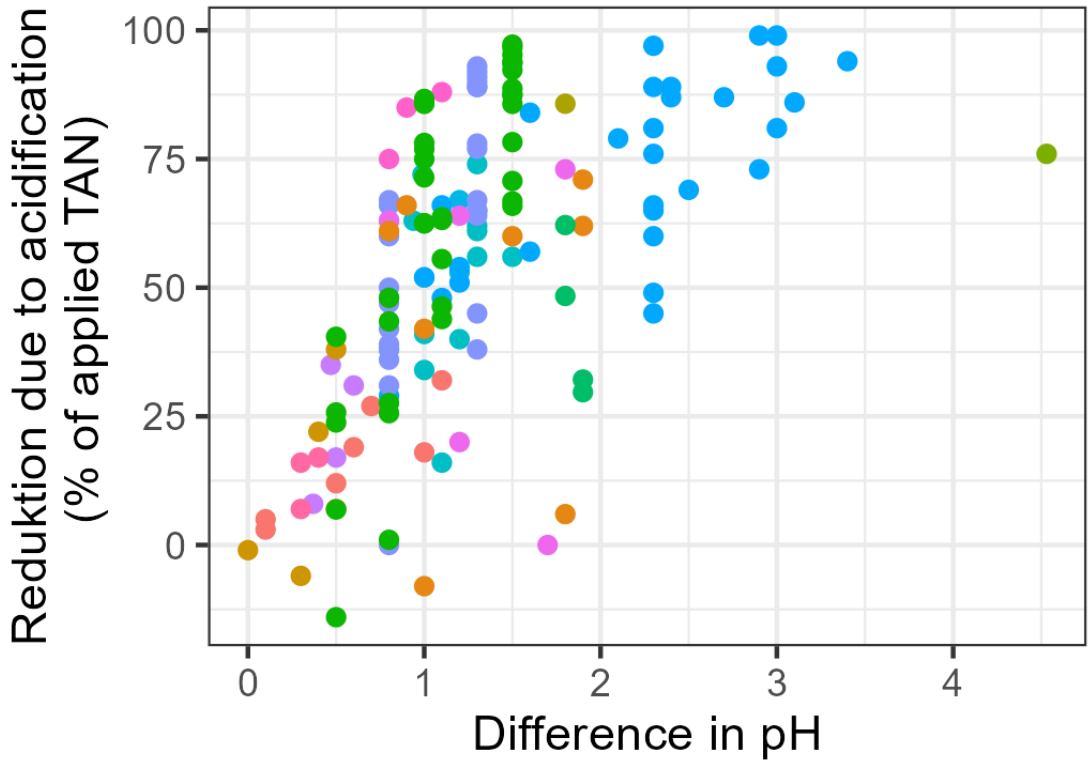
Example: Acidification

Acidification efficiently lowers NH_3 after field application

High variation in efficiency, more research is needed



Source: after Nyord et al., DCA report 2021, AU plot added data, march 2024

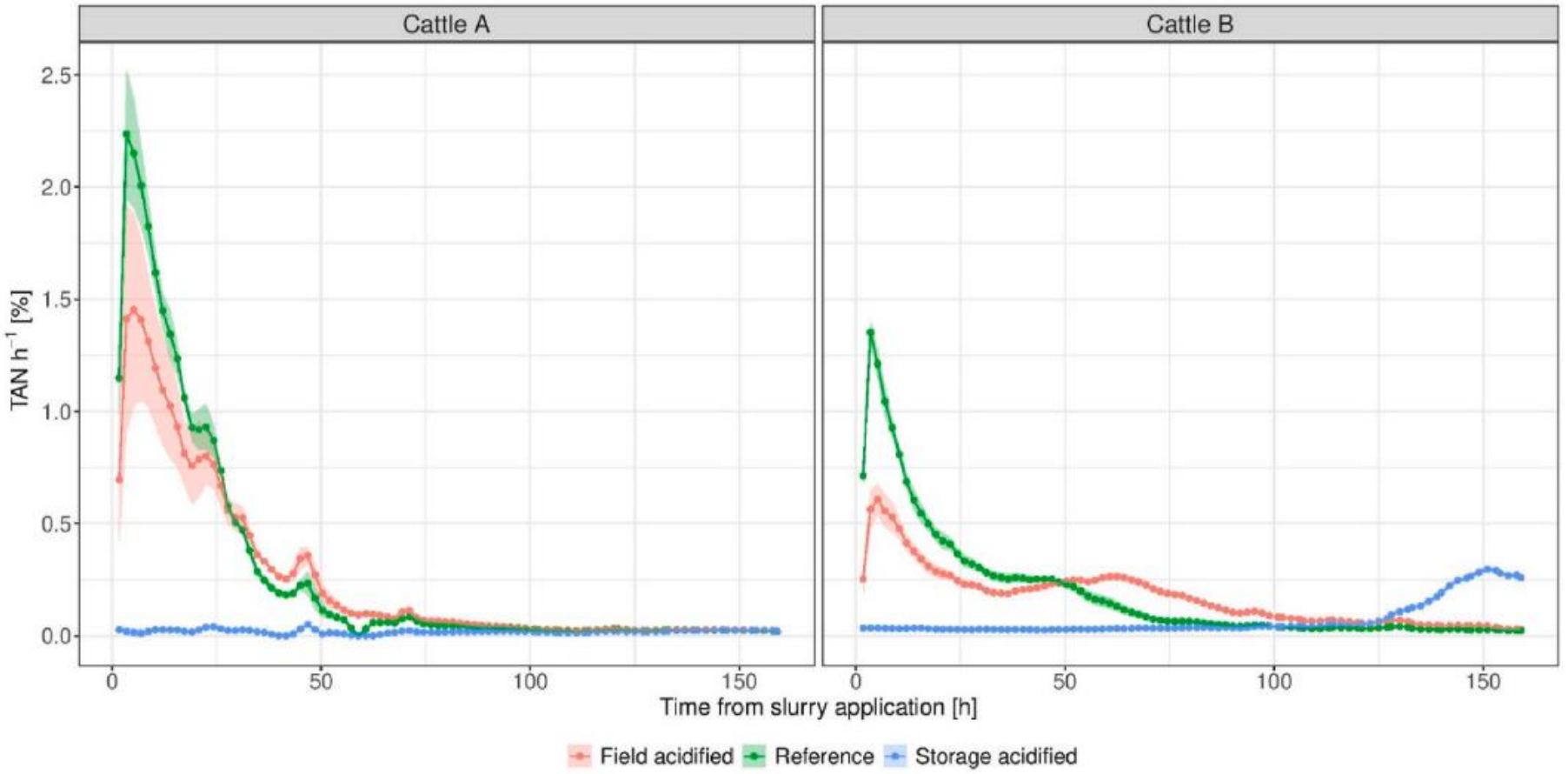
Example: Acidification

Low variation within triplicates

Clear dynamic patterns

Detection of small differences in patterns

Source: Pedersen et al. J Environ Manage, 310, 2022



Example: Low-emission app. techniques

Many different designs of low-emission application techniques

Trailing hose

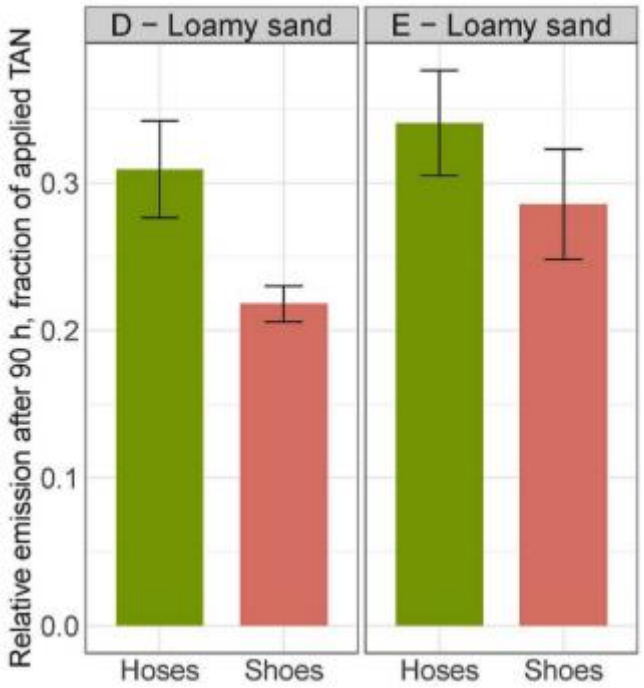
Trailing shoe (Bomech, NL)

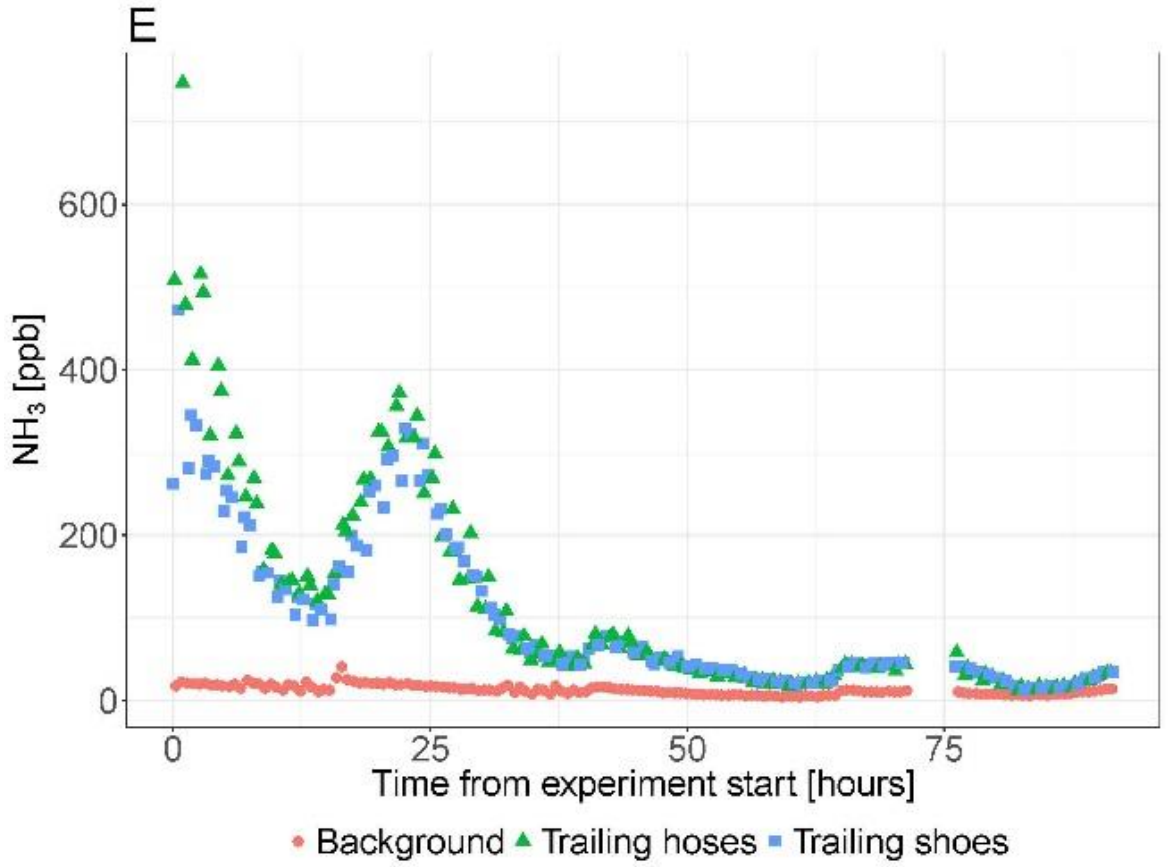
Trailing shoe (Samson Agro A/S, DK)

Example: Low-emission app. techniques

Trailing hose

Trailing shoe





Source: Pedersen et al. Atmos Environ, 230, 2020

Questions?

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