ROTHAMSTED RESEARCH

STREAMLINING THE SUPPLY CHAIN:

GREENHOUSE GAS EMISSIONS AND DRY MATTER LOSSES FROM WOOD CHIP STACKS

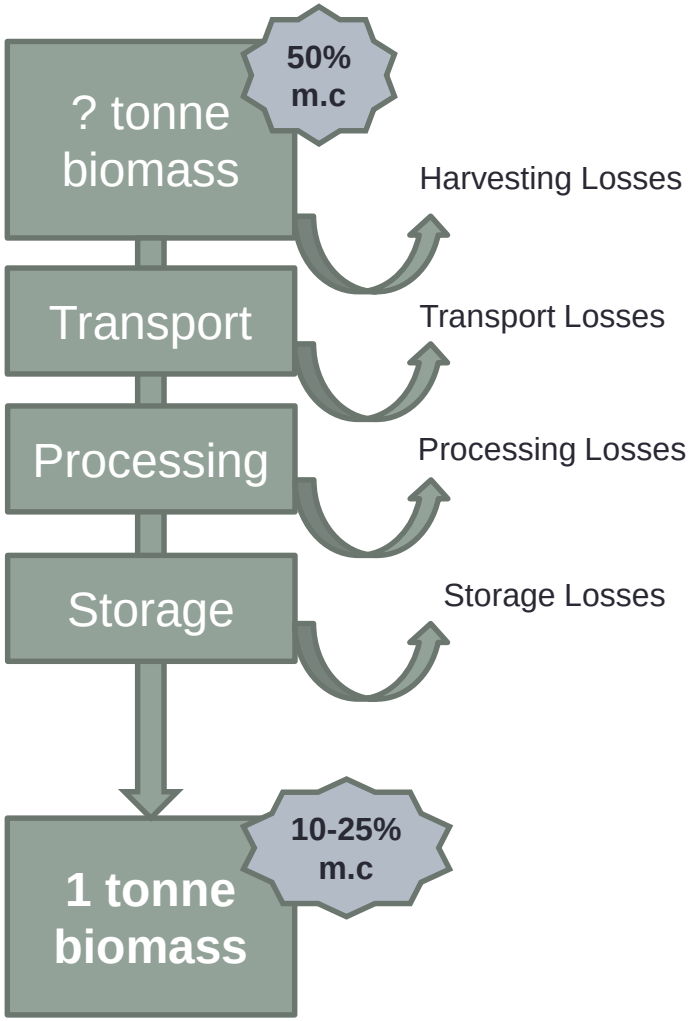
Carly Whittaker, Nicola Yates & Ian Shield

Supergen Annual Assembly. 5th November 2014, Birmingham.

SUPERGEN Bioenergy Hub

Rothamsted Research: Role in Supergen

- WP1.4. ‘Streamlining the supply chain’
  - Examining losses in biomass supply chains
    - Dry matter, lost energy and quality changes
  - Focusing on:
    - Wood chip storage
    - Implications of losses to GHG savings
      - Life cycle assessment approach
      - ‘Hot spot’ analysis



A year ago…

- **Research question:** What are the dry matter losses and greenhouse gas emissions from wood chip storage?
  - Cap layer forms on outside
    - Mouldy and very damp
    - “Protects” core from rain fall
    - What losses occur in pile?
  - Temperature increases up + 60◦C rapidly (1 week)
    - Lots of microbial activity – just a giant compost heap?
    - Are there emissions of GHGs from stacks - methane?

Why Store as Wood Chips?

There are other options to harvest woody biomass: **rods or billets** (SRC) or **round wood or brash bales** (forest residues)

- **Wood chips**
  - Pre-processed and homogenised fuel
  - Harvesting as chip saves a processing step
  - Improves bulk density compared billets/bales
- **Can't avoid a chip storage phase**
  - **Buffer store**
- Some boilers can take wet chips ~ 7 GJ/tonne.
  - Storage to dry from 50% m.c to 25-30% ~11 GJ/tonne
  - Gain ~4 GJ/tonne …In theory

The Experiment: SRC-Chip Piles

East Midlands Parkway

- Commercial system
- Stored on ground
- Approx.200 tonnes
- Cut in March by contractors

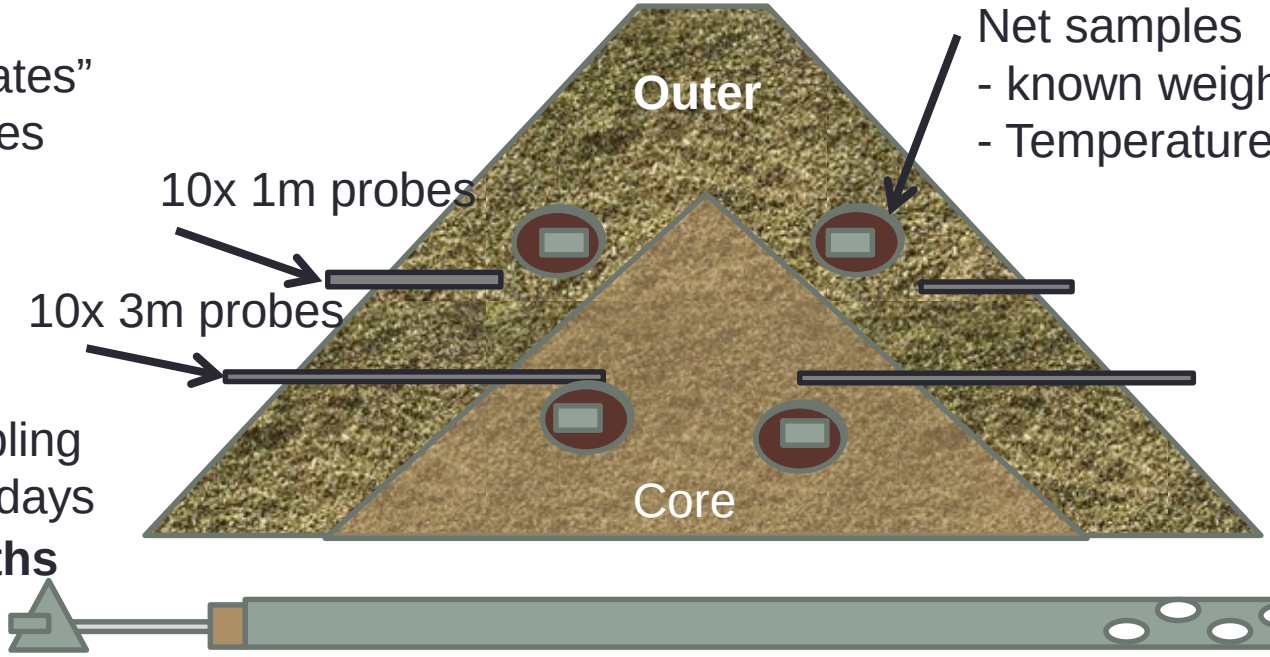
Rothamsted Research

- Cut in April (after bud flush)
- Harvested and built by Rothamsted
- Stored on concrete landing
- ~same height
- 84.1 tonnes

Sampling Methods

- Sampling for:
- Dry matter losses
- Temperature changes during experiment
- Moisture content changes
- GHG emissions within stack

10 “Replicates”
- 20 samples



Net samples
- known weight
- Temperature recorder

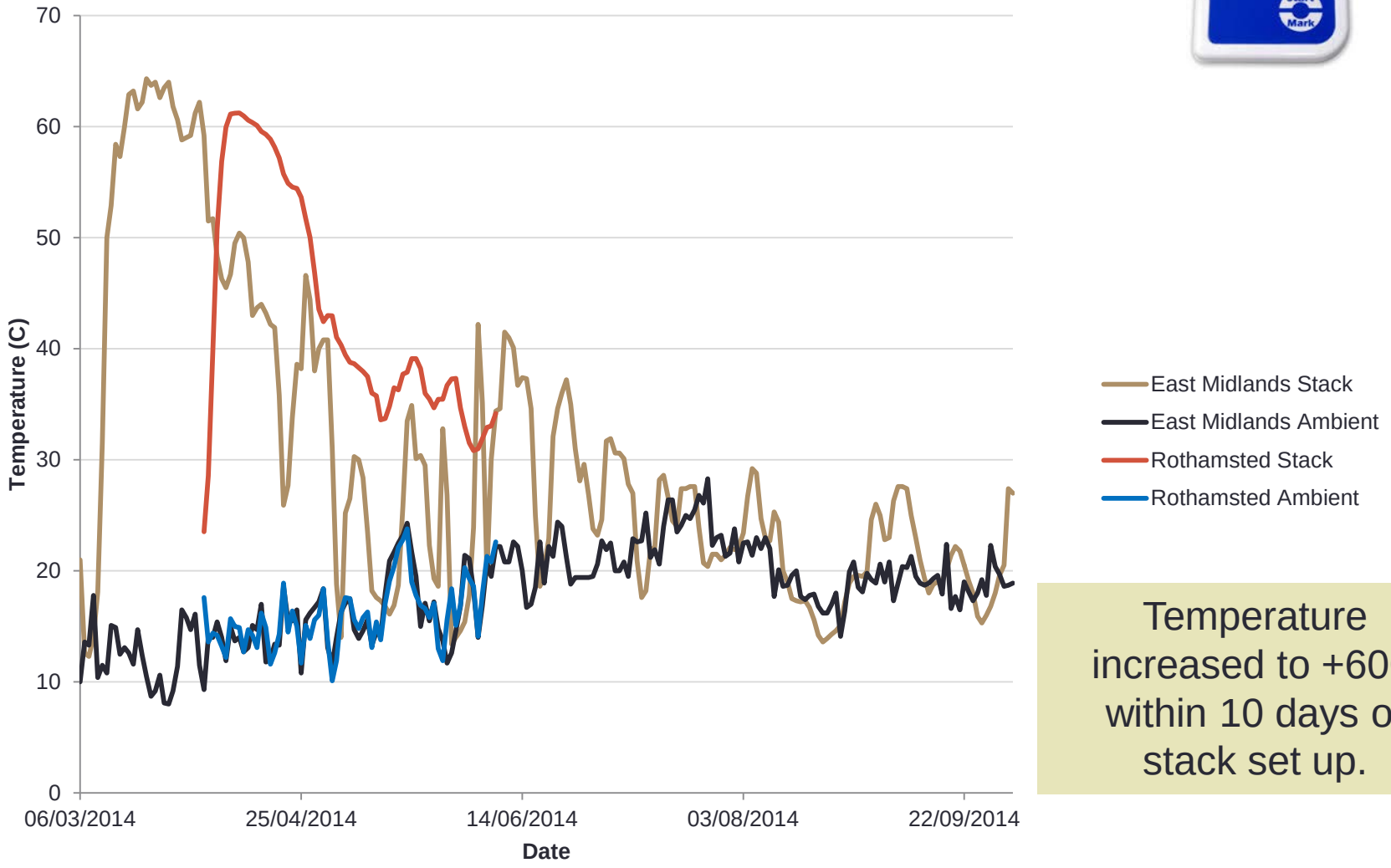
Gas Sampling
every 2-7 days
4-7 months

Results

Start

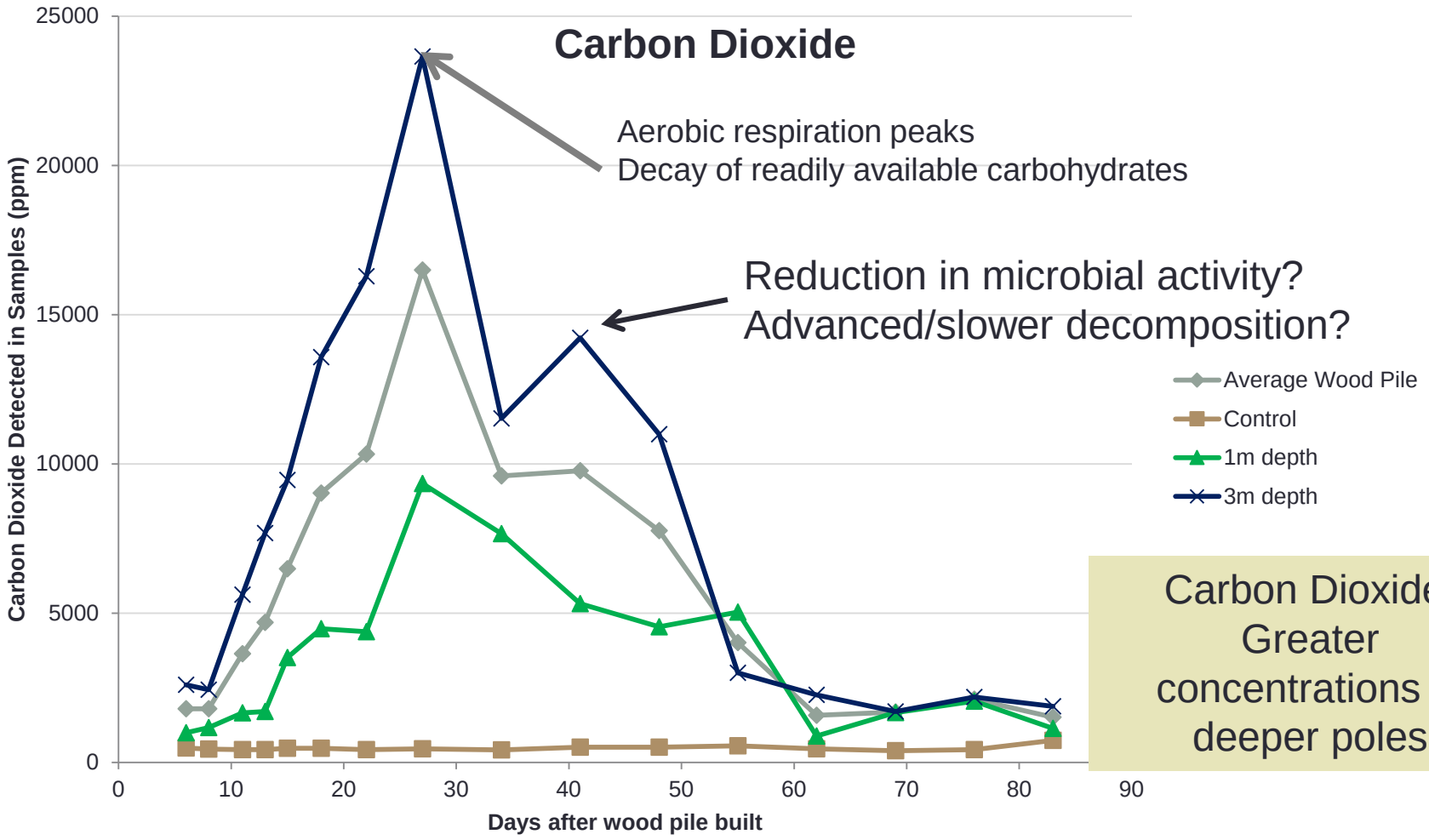
4 months later

Temperature Records



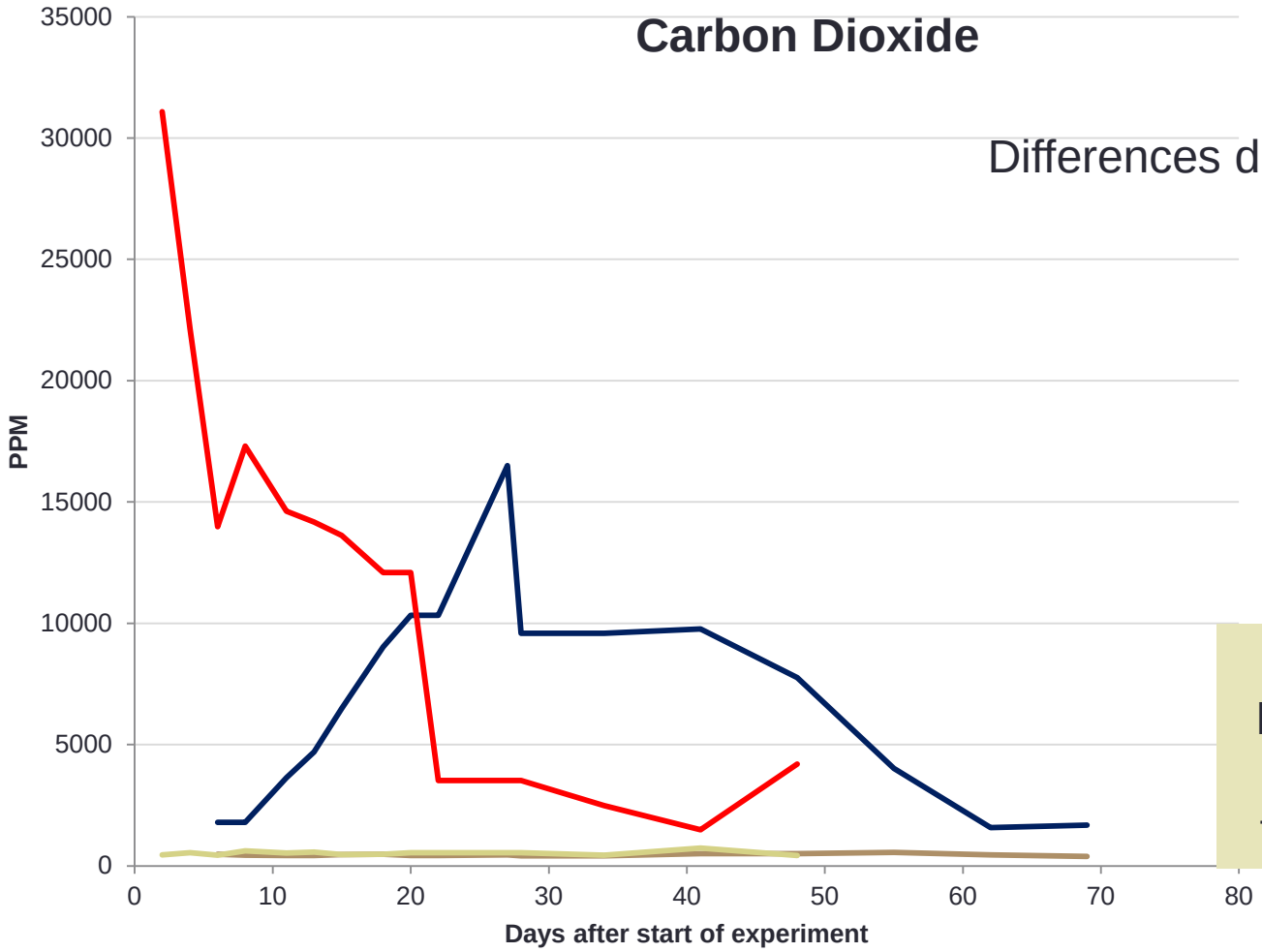
Temperature increased to +60C within 10 days of stack set up.

GHG Emissions: CO_2 @ East Midlands Pile



Carbon Dioxide: Greater concentrations in deeper poles

CO_2 Rothamsted vs. East Midlands

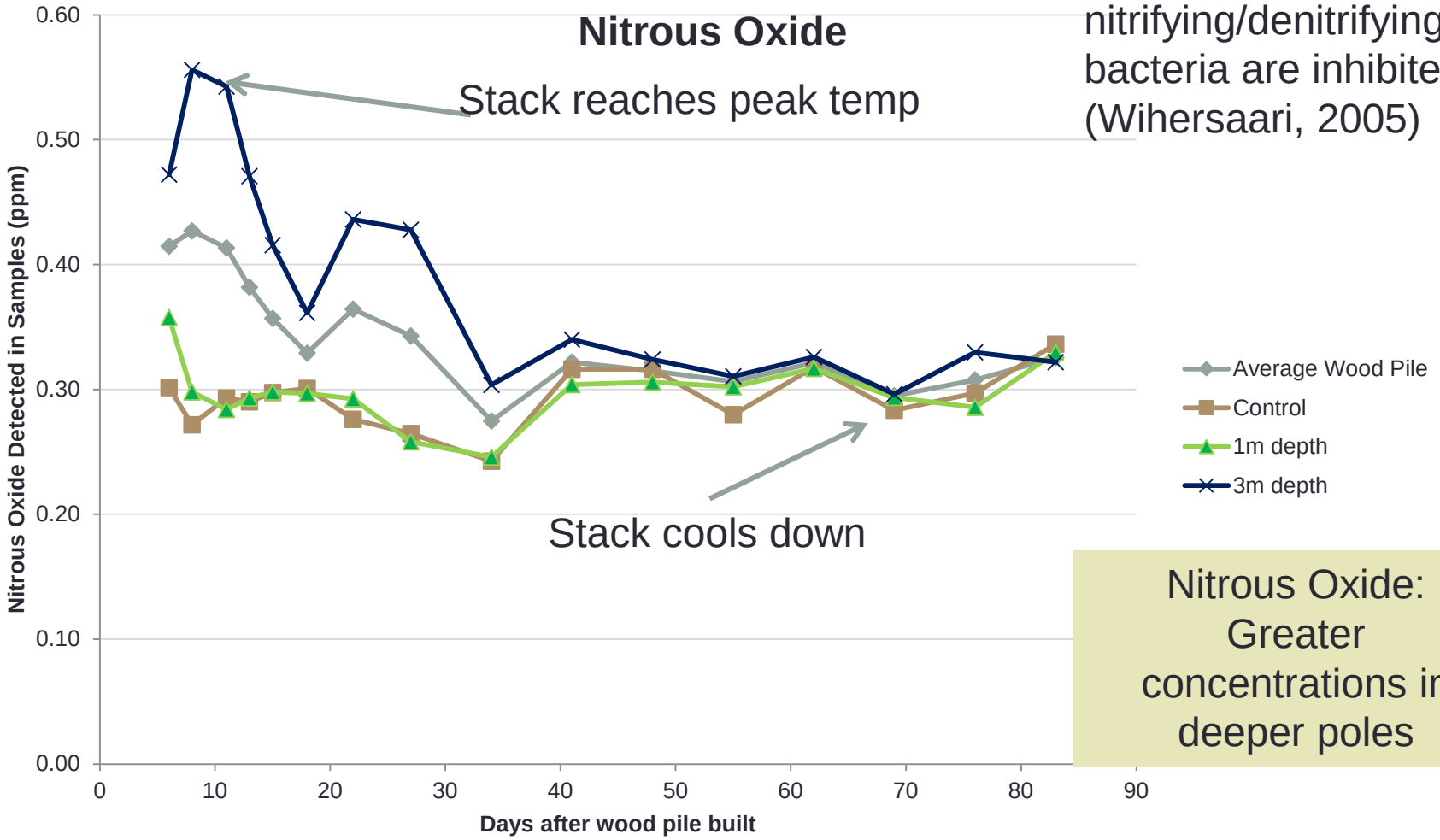


Differences due to leafier pile…?

Carbon Dioxide: Both piles show high initial concentration then gradual decline

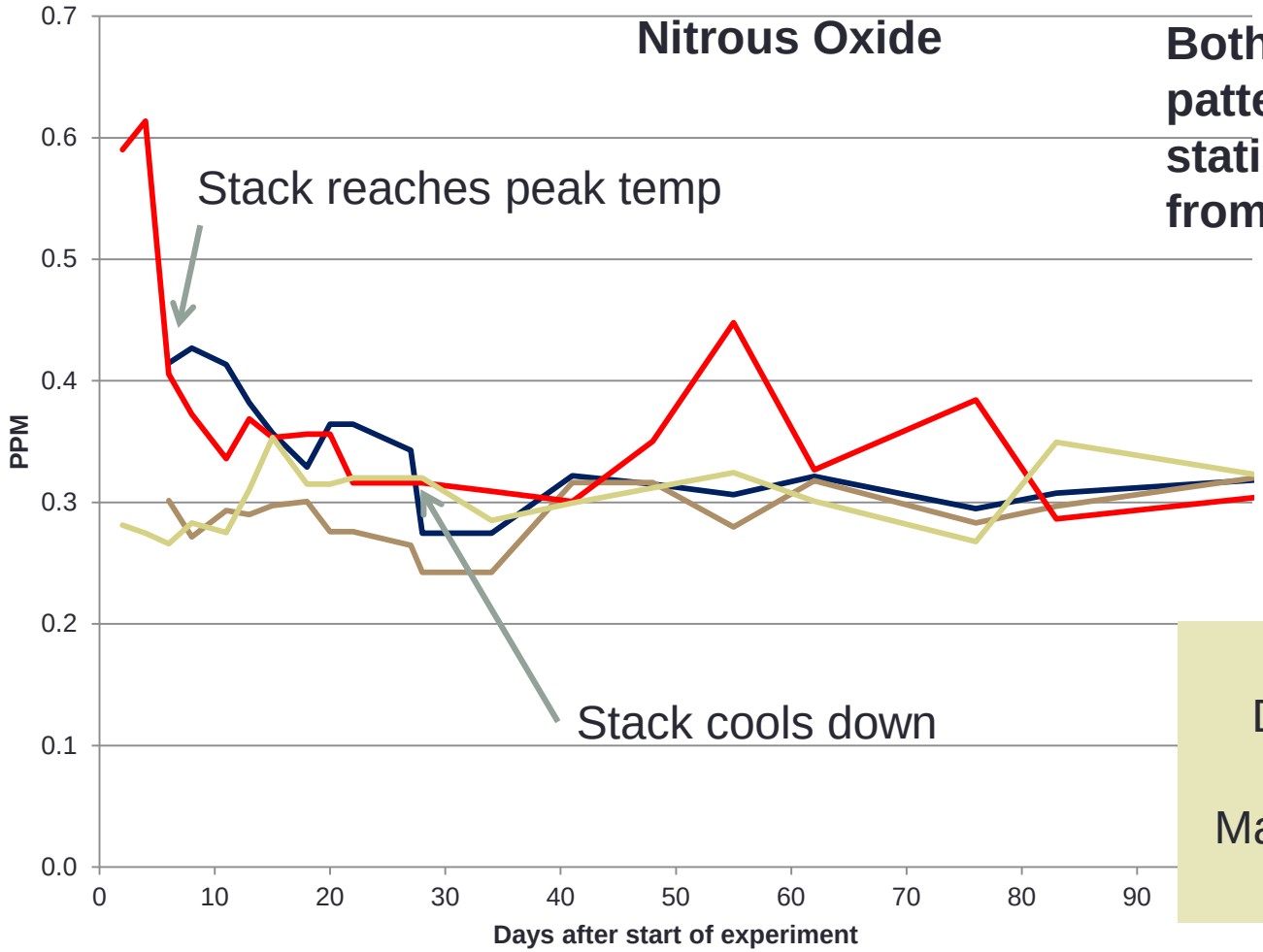
GHG Emissions: N_2O @ East Midlands Pile

Believed that +40C nitrifying/denitrifying bacteria are inhibited (Wihersaari, 2005)



Nitrous Oxide: Greater concentrations in deeper poles

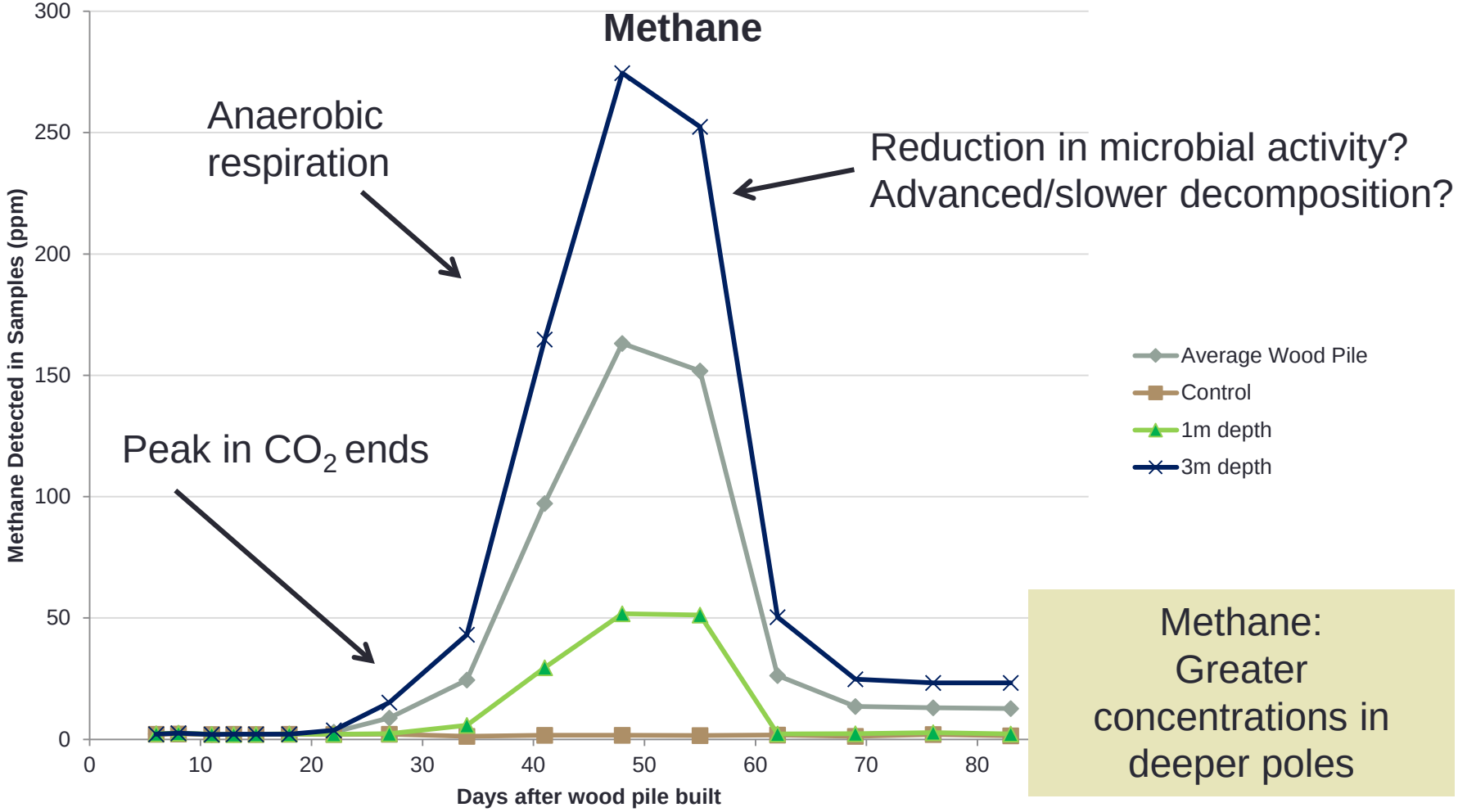
N_2O Rothamsted vs. East Midlands



Both piles show same pattern and are statistically different from control

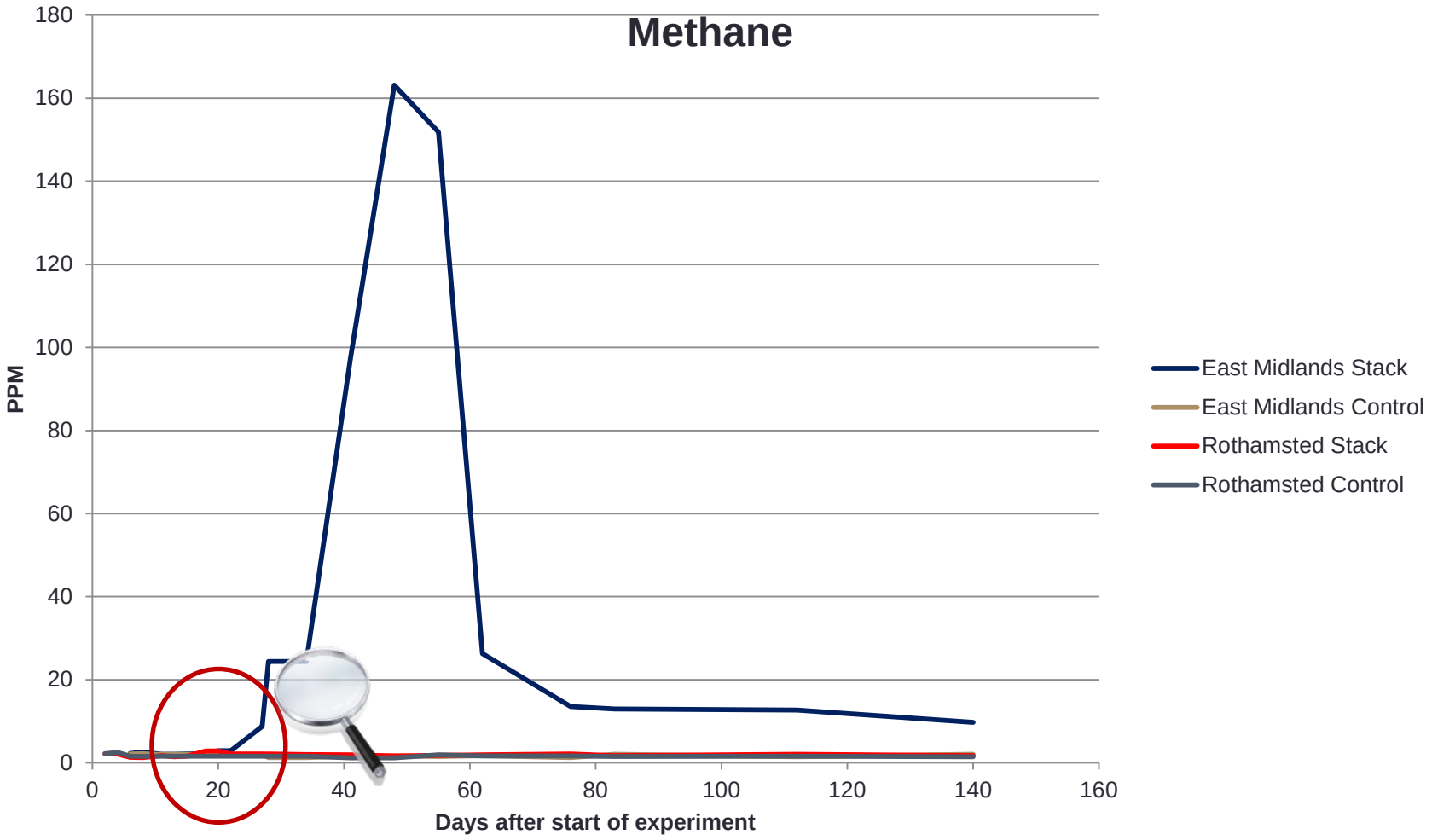
Nitrous Oxide: Detected in small amounts. May be temperature-dependent

GHG Emissions: CH_4 @ East Midlands Pile

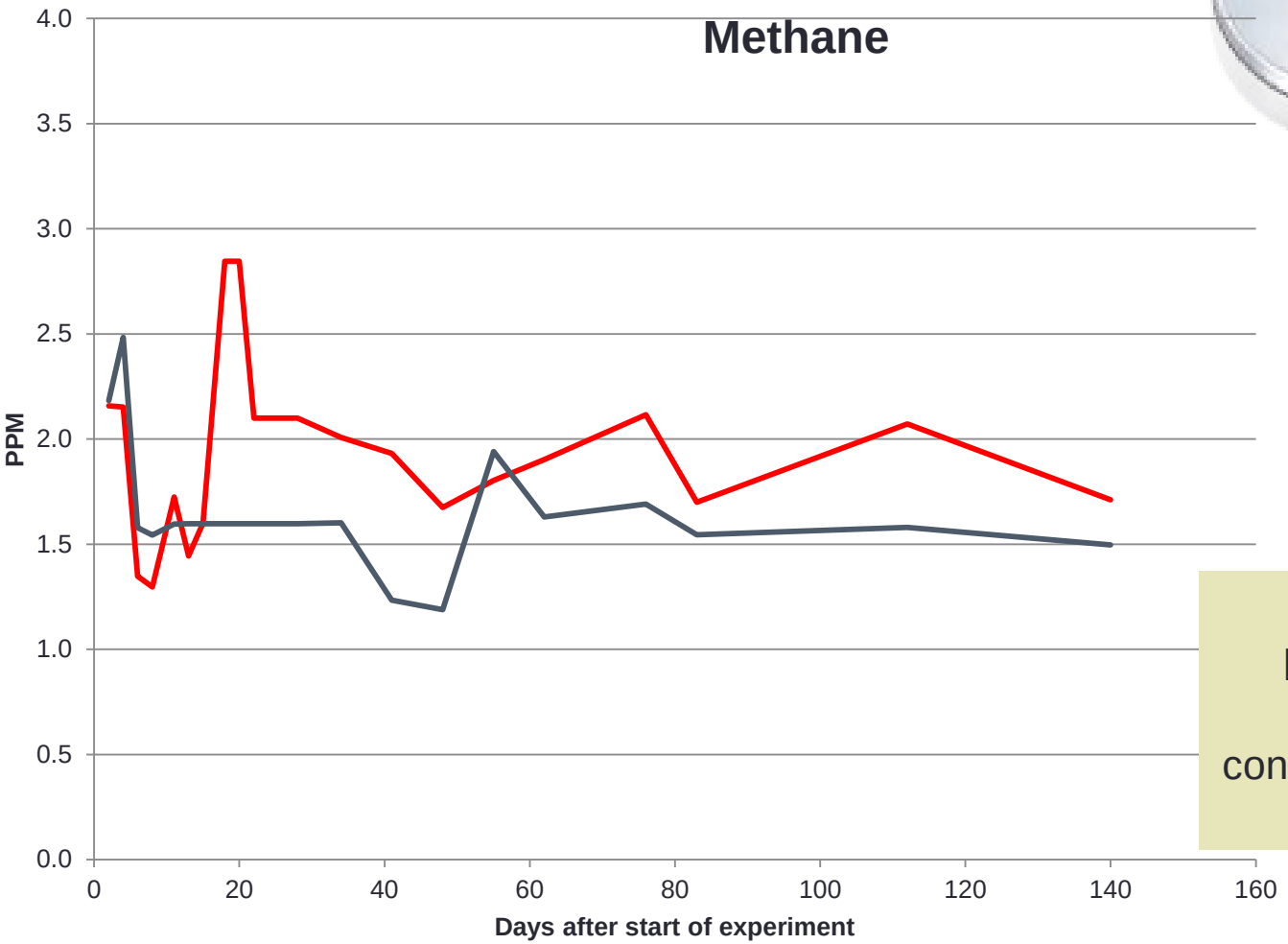


Methane: Greater concentrations in deeper poles

CH_4 Rothamsted vs. East Midlands



CH_4 Rothamsted vs. East Midlands



Statistically different from control

Rothamsted Stack

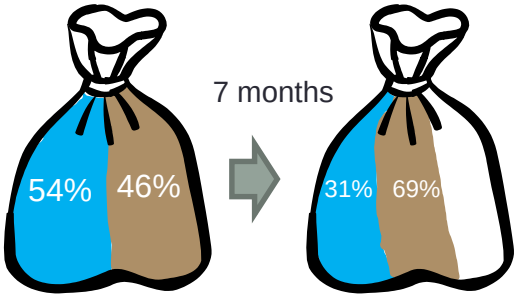
Rothamsted Control

Methane:
Peaks detected- very different concentrations in the two stacks

Dry Matter Losses?

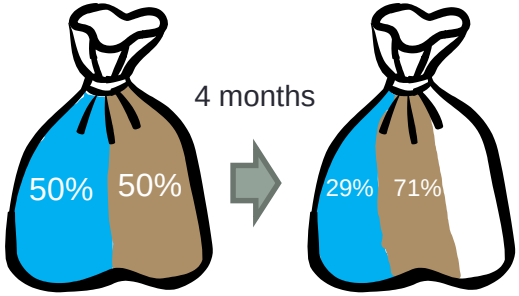
East Midlands

Rothamsted Research



Lost 18% of the dry matter, or -1.1 GJ per tonne stored

- Some very mouldy bags



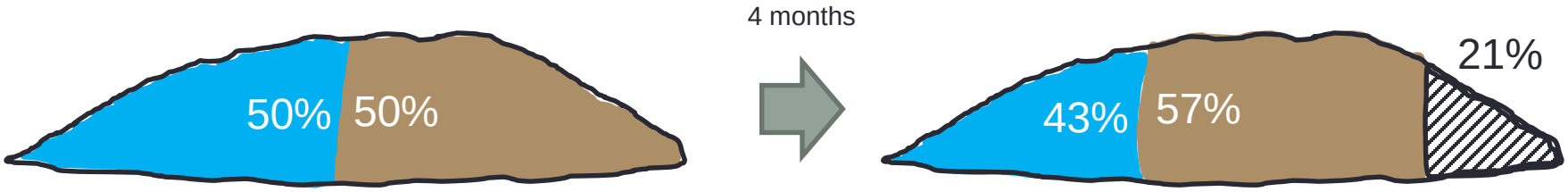
Lost 19% of the dry matter, or -0.1 GJ per tonne stored

- Some dried very well and increased energy content

NET ENERGY LOSS FROM WOOD CHIP STORAGE

Dry Matter Losses?

Dry Matter Losses?



Whole Stack at Rothamsted: Lost 21% of dry matter

- **Energy loss- 1.6 GJ/tonne stored**
- **Energy in/out ratio: 0.8**

NET ENERGY LOSS FROM WOOD CHIP STORAGE

Conclusions and Questions…

- **“There were so many variables”**
- **Higher levels of GHGs were detected in the core of the stacks compared to outer layers**
- **There is a net dry matter (~20%) and energy loss from wood chip storage**
- **Wood chips dried from 54% to 38%over 7 months**
- **There was a relatively large detection of methane in one stack but not the other**

- **Questions:**
- Are the **differences between the piles** due to ground conditions? Pile sizes? Or something else?
- Does the methane **leave** the stack?
- How can we translate our GHG emission results to ‘**per tonne chip**’?
- What is the **net effect** of storage on **GHG emission savings** compared to **alternative** drying and storage options
- How do the **microbial populations** differ between stacks?

Thank You

Contact:

carly.whittaker@rothamsted.ac.uk

ROTHAMSTED RESEARCH