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BREAM – exposure to pesticide spray drift

Jan 2010
Final project workshop

Scenarios agreed with PSD and ACP

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- Spray drift
  - Bystander stationary, upright and between 2 and 10 m from sprayed area – adults and children
  - Standard, reasonable worst case and low drift situations
    - Three nozzle designs
    - Range of windspeeds, boom heights and forward speeds
  - Short and tall crop
  - With and without field margin vegetation

- For practical reasons, not all of these have been included in the BREAM model so far – further work is needed

Spray drift – dermal (direct), dermal (indirect), and inhalation exposure

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- Emission and dispersion of droplets from a sprayer
  - A number of existing approaches
- Silsoe spray drift model (Miller and Hadfield, 1989)
  - Updated to include multiple nozzles
  - Forward speed
  - Field margin vegetation

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Other modelling approaches

- Experimental work and CFD simulations to investigate flows around the vehicle
- CFD simulations to investigate the effect of downwind structures

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Experimental set up for examining air flows around the boom and vehicle

- 24 m self-propelled sprayer with 3000 L tank
- Air flows measured with ultrasonic anemometers mounted at different positions on machine and on the ground

- Measurements made with:
  - *No spray*
  - *at speeds of 8.0 and 16.0 km/h*
  - *travelling with and into the wind*

Anemometer positions

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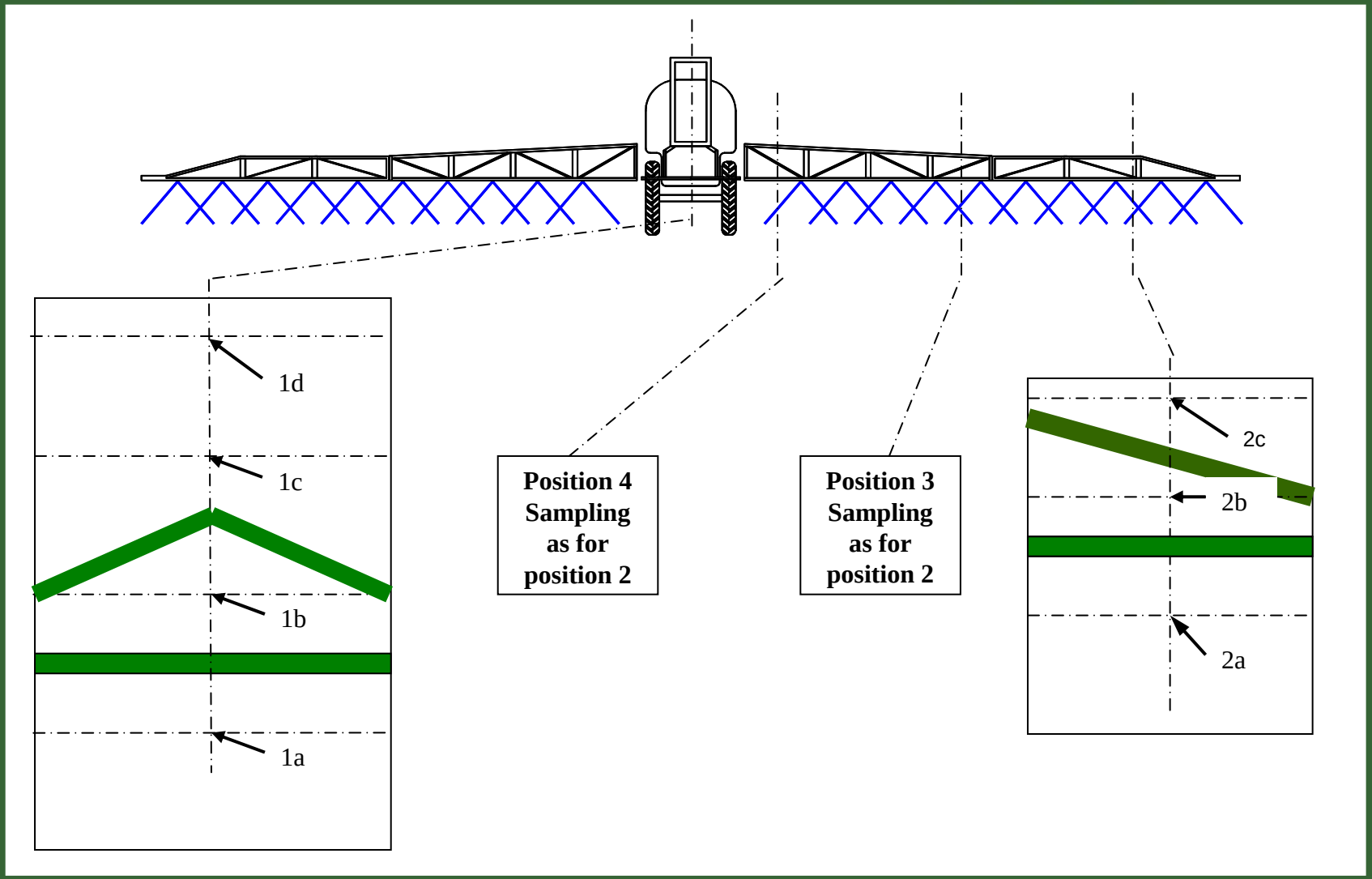

Diagram of sprayer arrangement showing the positions of anemometer mountings.

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Results showed:

- Some agreement between CFD modelling and experimental measurement
- Air flows around the nozzle likely to be reduced in the region behind the sprayer
  - Less detrained spray
- Air flows downwind of the boom likely to cause higher levels of dispersion
  - Lower airborne concentrations
  - Lower bystander exposure
- Effect reduced as boom width increases
- Worst case is no sprayer present – not included in BREAM model
- Implications for other aspects of off-target contamination and pesticide application

Accounting for the effect of buildings at the edge of the sprayed area

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- ‘Enhancement Factor’ (EF) =

Ratio of droplet flux for adult or child standing in the gap : flux without buildings

- Emulator study carried out with FDS model to find a suitable worst-case factor

- The parameters varied in the investigation (and their ranges) were:
  - wind speed at 2 m height (1 - 5 m/s),
  - building height (1 - 10 m) and
  - gap width (1 - 6 m).
- Highest factor found f= 3 or reasonable building configuration
- Not included in final BREAM model

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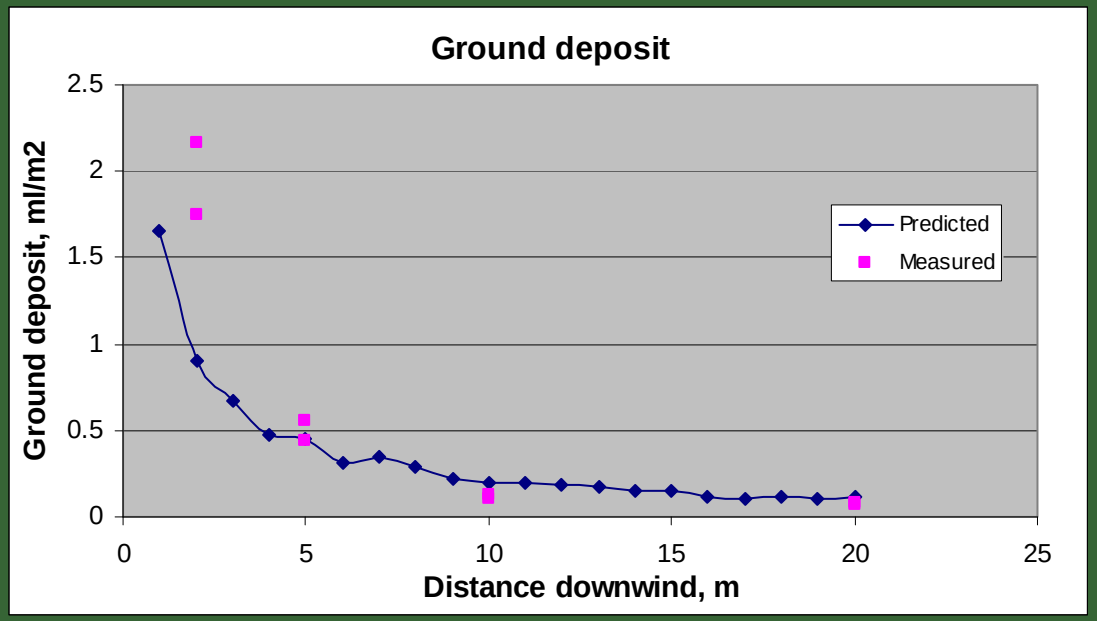
Silsoe Spray Drift Model validations

- **Three BREAM experiments**
- **Historical Silsoe data, Fera data and some published data (espec Nuyttens PhD thesis)**



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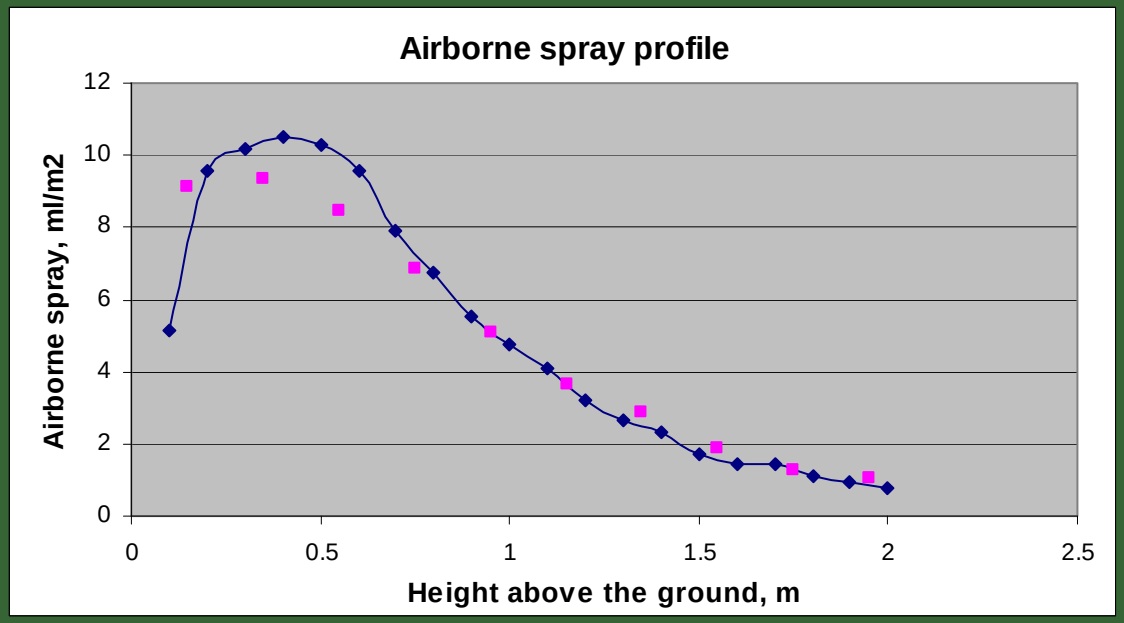
Comparison between model predictions and experimental data



Comparison with Nov 07 trial data
Ground deposits:

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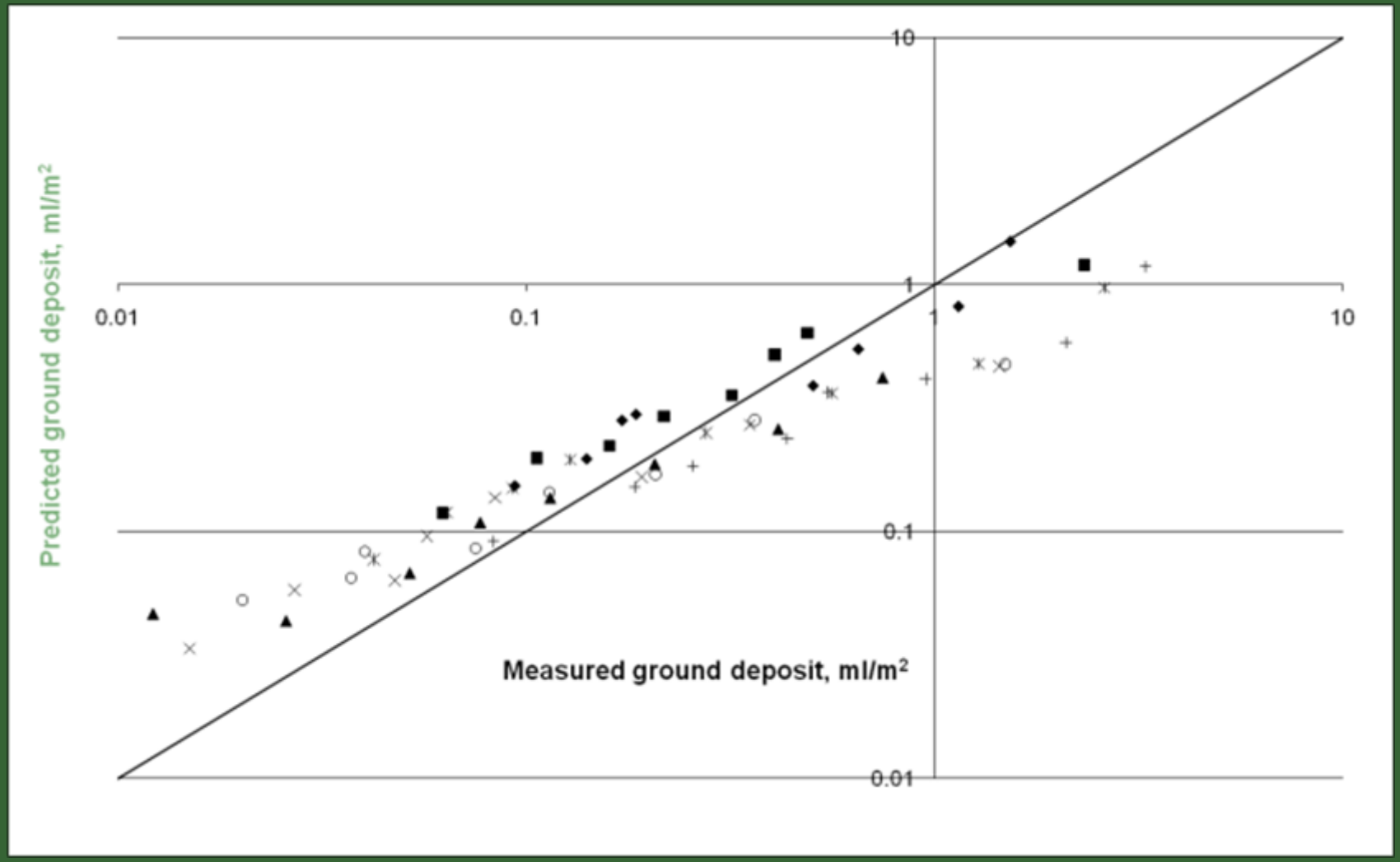

Comparison with Nov 07 trial data
Airborne spray – averaged up to 2 m height at 2.0 – 20 m downwind:

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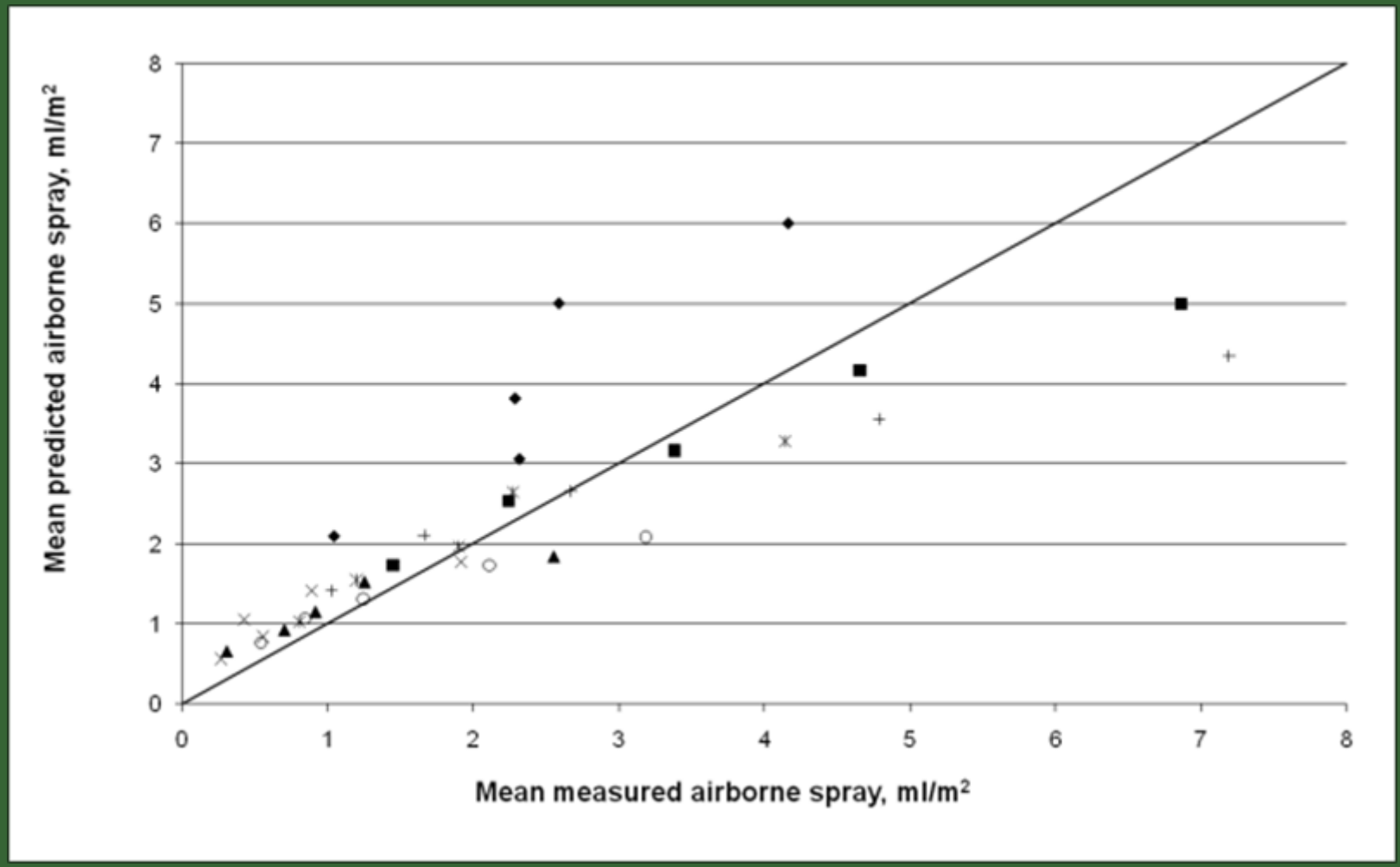
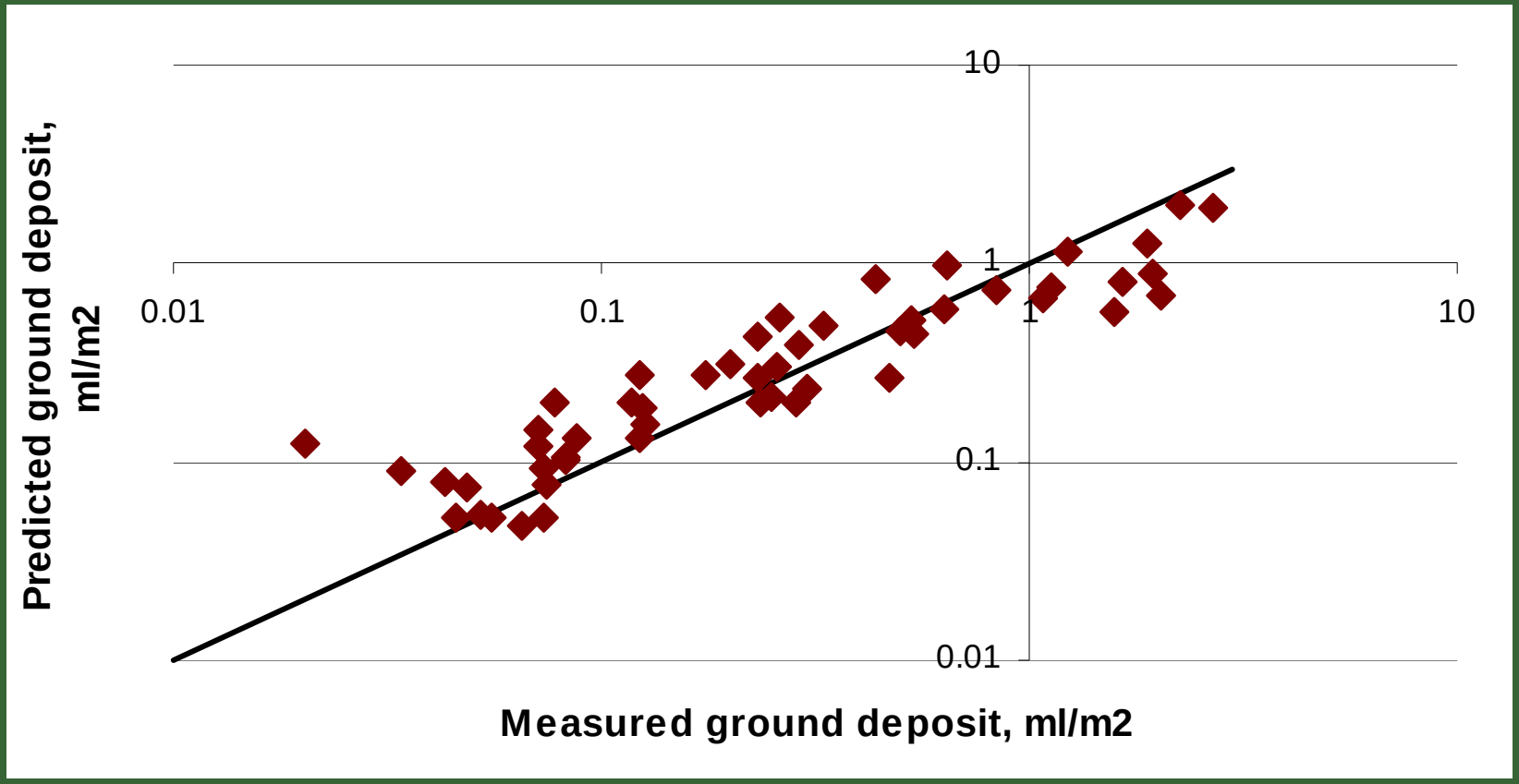


Comparison between predicted and measured ground deposit – March 09



Comparison between predicted and measured mean airborne spray up to 2.0 m height, measured 2.0 m downwind march 09

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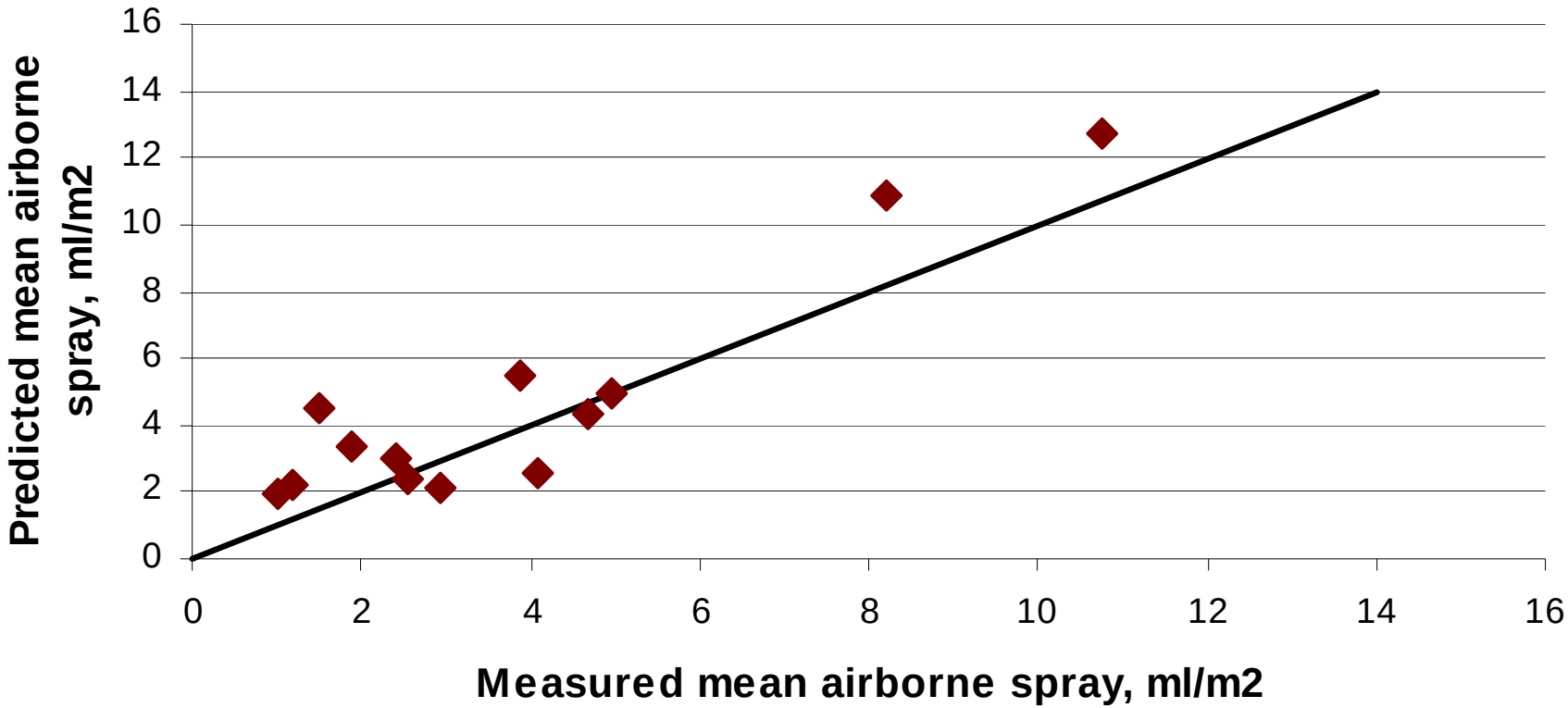

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Conclusions from model validations

- Model predicts well for FF 110 ‘03’ nozzle design, short crop and short vegetation
- Still difficulties with predicting exposure with a tall crop
  - Filtering effect of vegetation not yet modelled correctly – filtering underestimated
  - There are difficulties where there are discontinuities – noticeable for ground deposit
- Model for short crop more reliable
  - Ground deposits only available for short crop
- Experimental data suggests short crop is the worst case for human exposure

Relationship between airborne spray and bystander contamination

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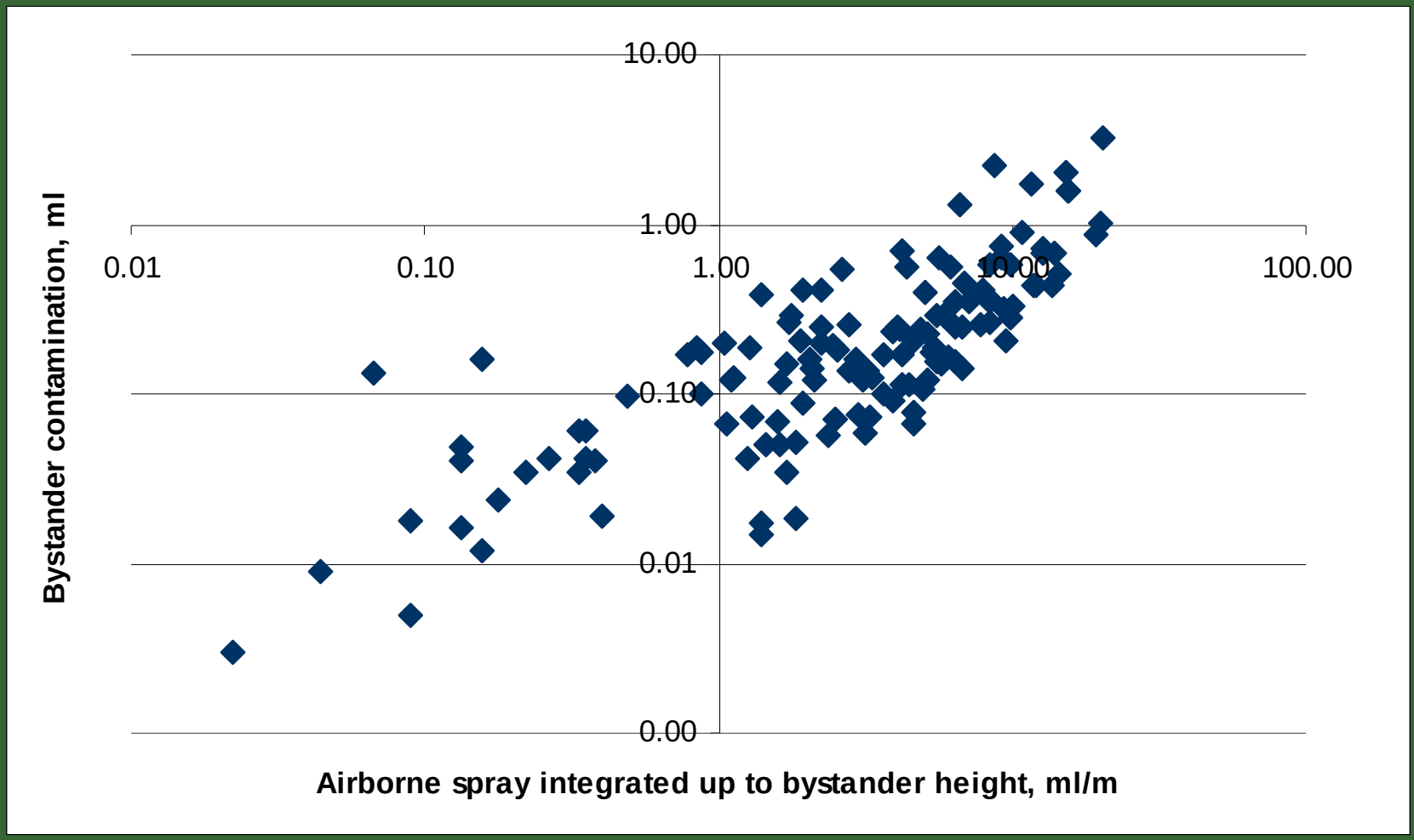

Modelling variability

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- Uncertainty over relationship between airborne spray and bystander contamination
- Wind turbulence/ variation
  - Short timescale, built into model
  - Medium timescale (few seconds)
  - Long timescale (minutes or more)
- Variation in sprayer operation
  - Boom height
  - Forward speed – pressure – spray characteristics
- Emulator being created to allow inputs to be selected from a distribution
  - Include boom height instability and medium timescale wind speed variation
  - Predicted bystander contamination has a distribution