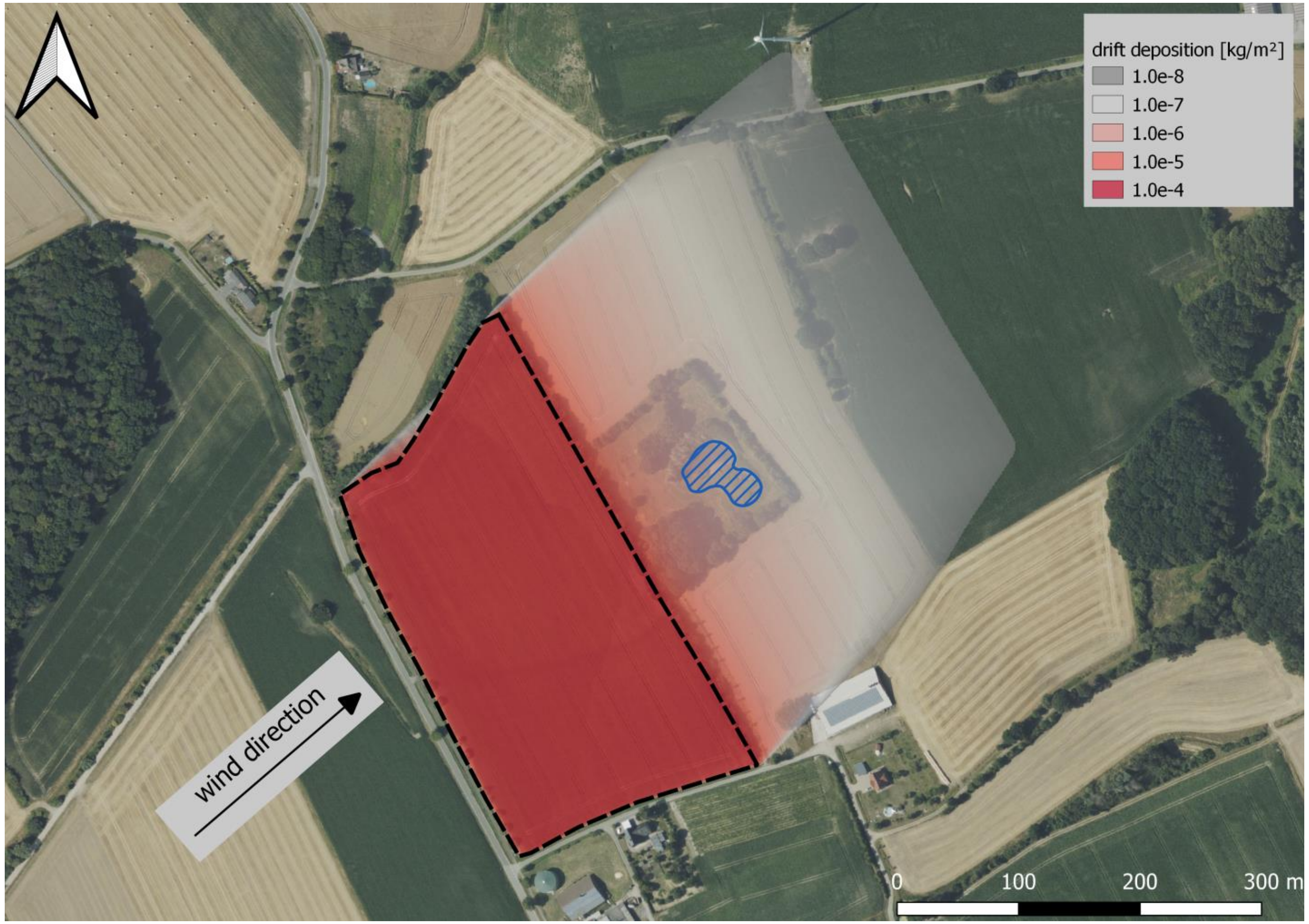
High resolution exposure modelling at landscape-level.

On the development of a mechanistic drift module for SWAT+



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INTRODUCTION

- Modelling environmental concentrations of pesticides at landscape-level is of growing interest for pesticide registration, product stewardship, monitoring and decision making.
- Spray drift often is simplified or neglected, while transport pathways via runoff, lateral-flow, drainage, and leaching are typically well represented by different modelling concepts.

- Objectives:
  - Enable better prediction of drift behaviour, taking typical short-term weather conditions into account.
  - Develop computational efficient predictions of landscape-level drift patterns by combining a mechanistic droplet model with a 3D gaussian diffusion model.
  - Enable a modular design as standalone or in combination with other modelling approaches:
    - Landscape level assessment (e.g. SWAT+ (soil and water assessment tool))
    - Exposure assessment in combination with ecotoxicological modelling

THEORY

1) Model Inputs:

- Weather conditions
- Droplet size distribution
- Operational characteristics
- Physio-chemical properties of spray solution

2) Mechanistic Droplet Model:

- Simulates droplet kinetics and evaporation
- Estimates dynamic trajectory of single representative droplets

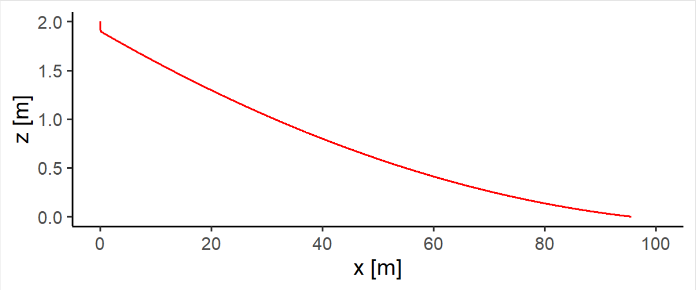

Fig. 2: Vertical droplet position against distance as predicted by the mechanistic droplet model.

3) 3D Gaussian Diffusion Model:

- Longitudinal advection
- Vertical, lateral and longitudinal dispersion

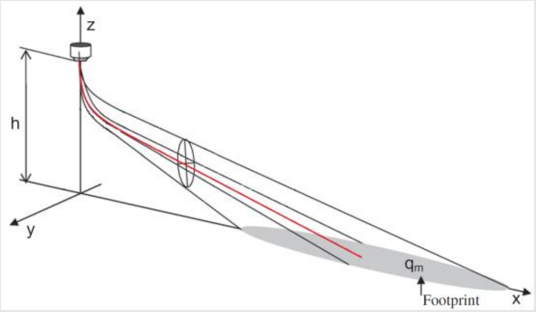

Fig. 1: Schematic representation of the diffusion model. (Lebeau et al. 2011)

4) Prediction of Drift Pattern:

- Mass flux defined by concentration and vertical droplet velocity

5) Model Output:

Drift Curve Prediction:

- Based on boom width and number of swath´s

Landscape-level drift prediction:

- Based on land use map

RESULTS

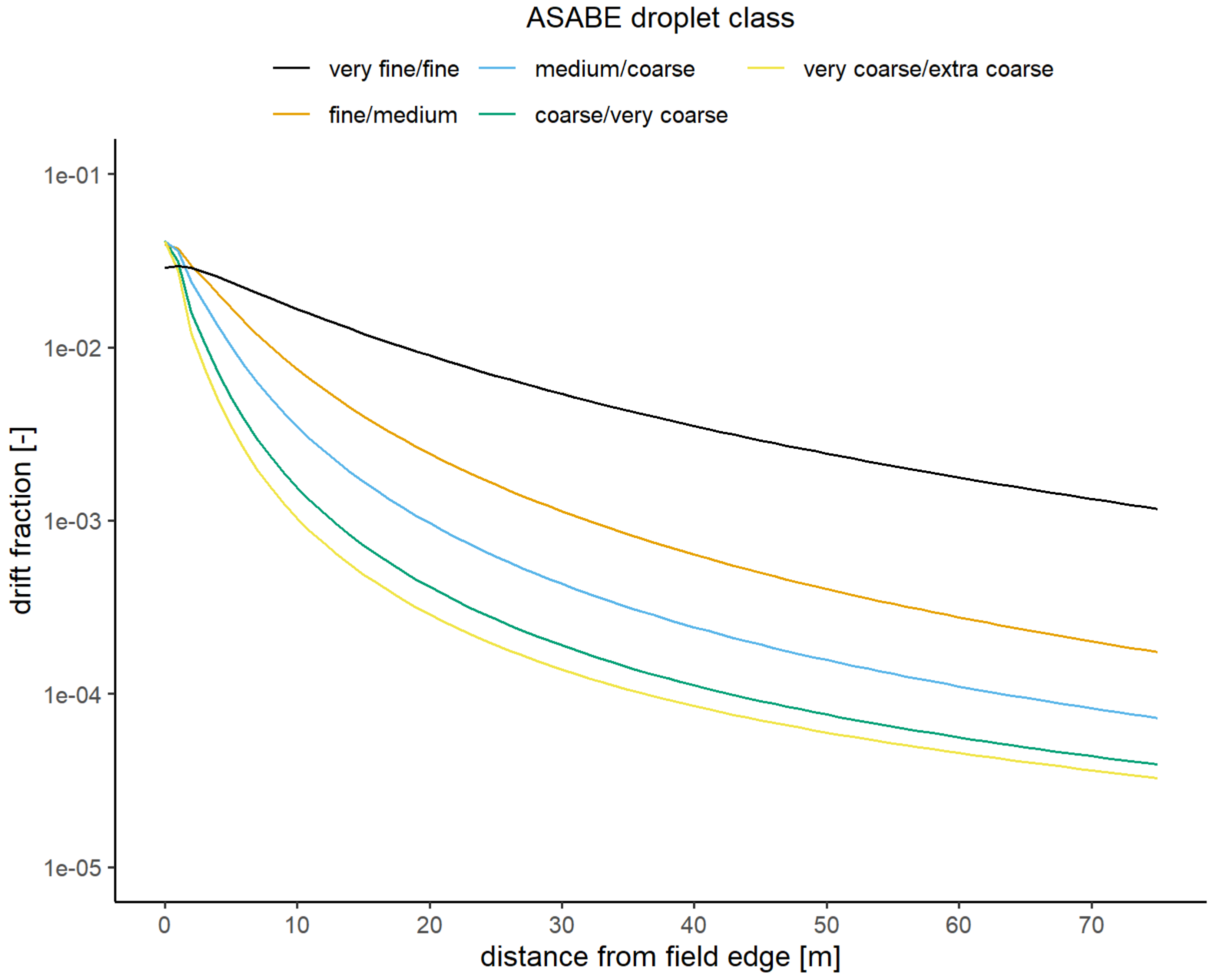

Fig. 3: Drift curve in dependency of the ASABE reference droplet classes, with a wind speed of 3 m/s.

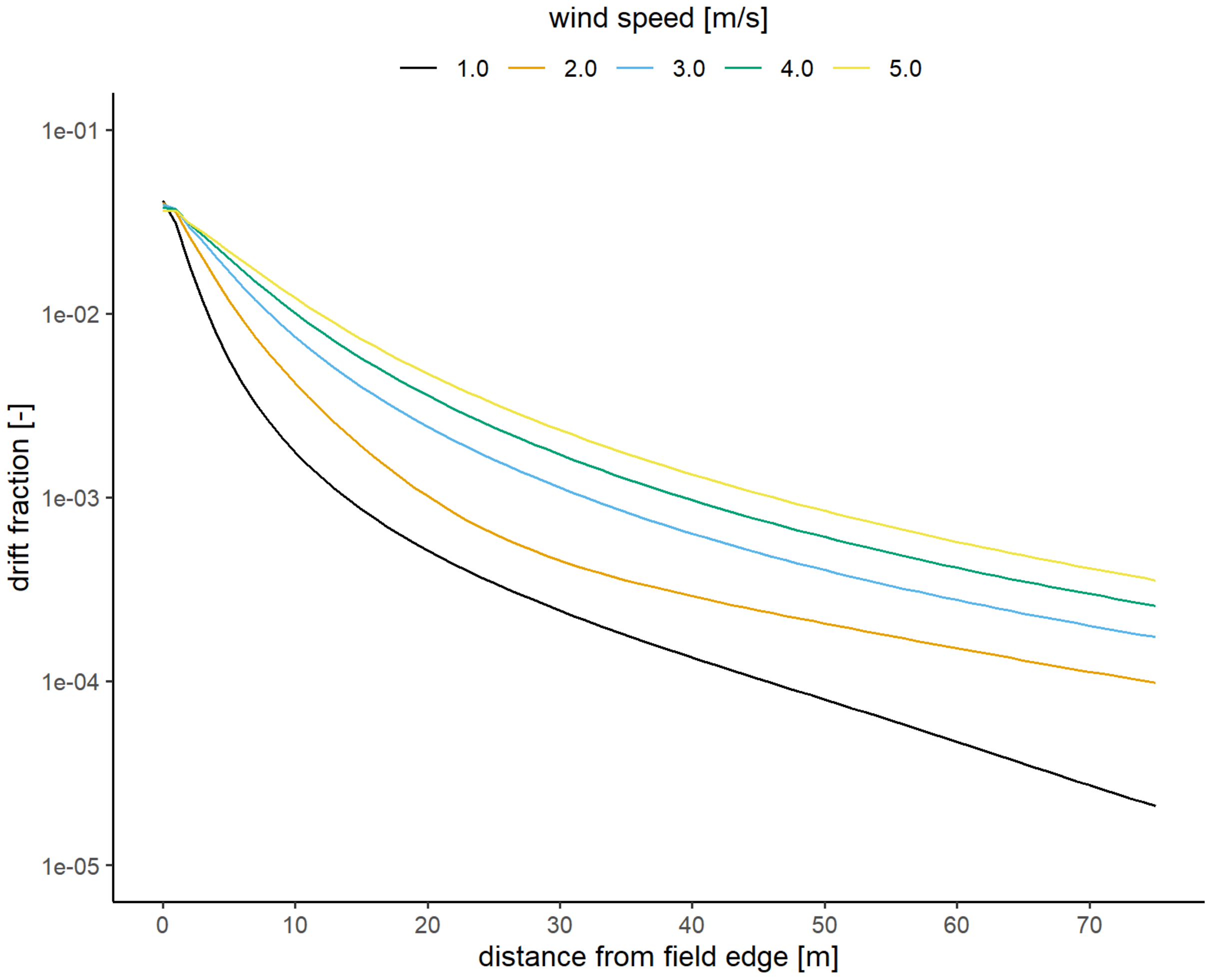

Fig. 4: Drift curve in dependency of the wind speed, with the ASABE reference droplet class of fine/medium.

RESULTS

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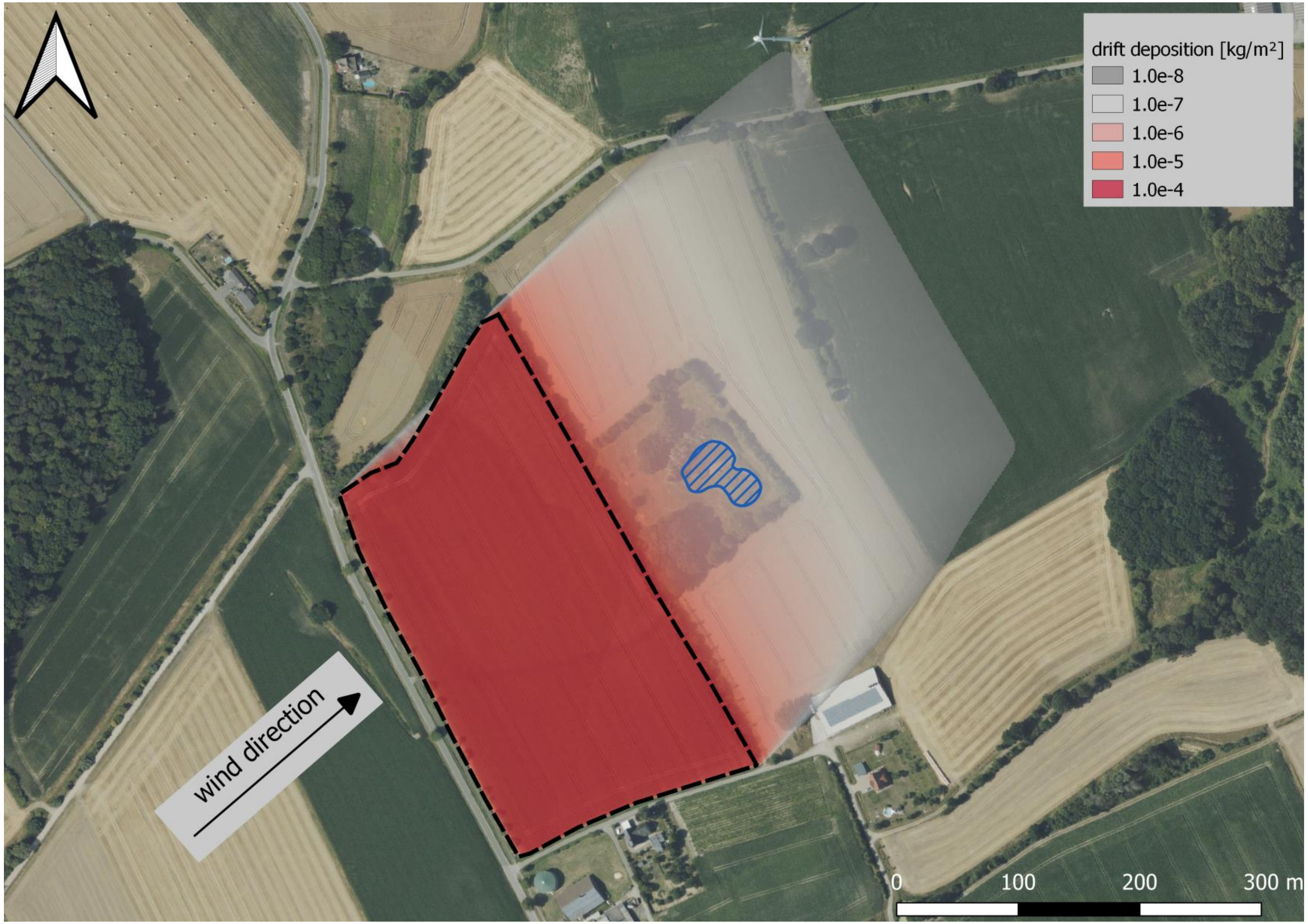

Fig. 5: Example of landscape-level drift prediction. With the black dashed line outlining the area of spray application, the blue hatched area representing a close by waterbody and the colour scale showing the spray drift deposition [kg/m²].

Model inputs:

- Wind speed: 3 m/s
- Wind direction: 225 °
- Temperature: 15 °C
- Relative humidity: 95 %
- Droplet class: fine/medium (ASABE)
- Boom height: 2 m

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Outlook

- Model validation against multiple evaluation data sets is ongoing:
  - Field trial data
  - Computational fluid dynamics (CFD) simulations
  - Rautman drift-tables
- Apply drift approach in landscape-level modelling projects:
  - Elucidation of monitoring data
  - Assessment of total drift entries into water bodies
  - SWAT+ modelling of application behaviour taking uncertainty into account

References:

- Lebeau, F., Verstraete, A., Stainier, C., & Destain, M. F. (2011). RTDrift: A real time model for estimating spray drift from ground applications. Computers and Electronics in Agriculture, 77(2), 161–174. https://doi.org/10.1016/j.compag.2011.04.009

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