A comparison between field measurements of vapour concentrations of plant protection products and predictions by the BROWSE model

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Introduction

Inhalation of volatilised active ingredients (AI) adjacent to agricultural fields treated with plant protection products (PPP) is one of the exposure routes for residents and bystanders, considered by the European Food Safety Authority (EFSA).
The approach used by EFSA has several identified shortcomings, therefore, CropLife Europe (CLE) compiled a database of field measurements of air concentrations of pesticide AIs.
The BROWSE (Bystanders, Residents, Operators and WorkerS Exposure) model has a component relating to post-application vapour inhalation exposure for bystanders and residents.
It is a mechanistic model, predicting the volatilisation rate from the crop or soil using Consensus-PEARL (Pesticide Emission Assessment at Regional and Local scales), and subsequent dispersion downwind using a plume-dispersion model, OPS (Operational Priority Substances model). The objective of this study was to determine whether BROWSE would provide a more reliable method of predicting exposures to vapour compared with the current EFSA approach.

Materials and Methods

- The CLE database contains data generated by CLE member companies relating to vapour concentrations measured in a range of experimental field conditions:
  - 23 GLP (Good Laboratory Practice) compliant studies
  - Conducted in Europe (FR, DE, IE, IT, ES, LT, PL, UK)
  - Low and high crops: wheat, barley, pome fruit, vineyards
  - Field sizes 0.72 to 8.8 ha
  - Vapour pressures 4.00×10^{-7} to 9.00×10^{-3} Pa at 20ºC
- The predicted rolling 24-h average concentration was calculated for every bystander location and every hour following application (acute exposure).

- A 7-day average was calculated for each location and application and the max value out of the four bystander locations selected (longer term exposure).
- Studies consistent with the BROWSE scenario were selected for comparison, inclusion criteria were:
  - Spray applications;
  - Outdoor applications;
  - Field sizes ≥7200 m²;
  - Measurements of concentrations of primary AI.
- Exploration of the effect of measurement distance and field size were undertaken to establish adjustments to the data.

Results and Discussion

- Simulations showed that the sensitivity of vapour concentration to distance is relatively flat.
- The effect of field size was more marked.
- The ratio between the predicted concentration at the measurement location and field size class for each of the field studies and the predicted concentration at 10 m downwind of a 200 × 200 m field was used to calculate an adjustment factor for the field data. Adjustments made for the factors, that aim to compensate for smaller field sizes and measurement locations closer than the 10 m used in BROWSE, are reflected in the results.
- Fig. 1 and 2 show the comparison between the adjusted data for acute and longer-term exposures and BROWSE predictions.
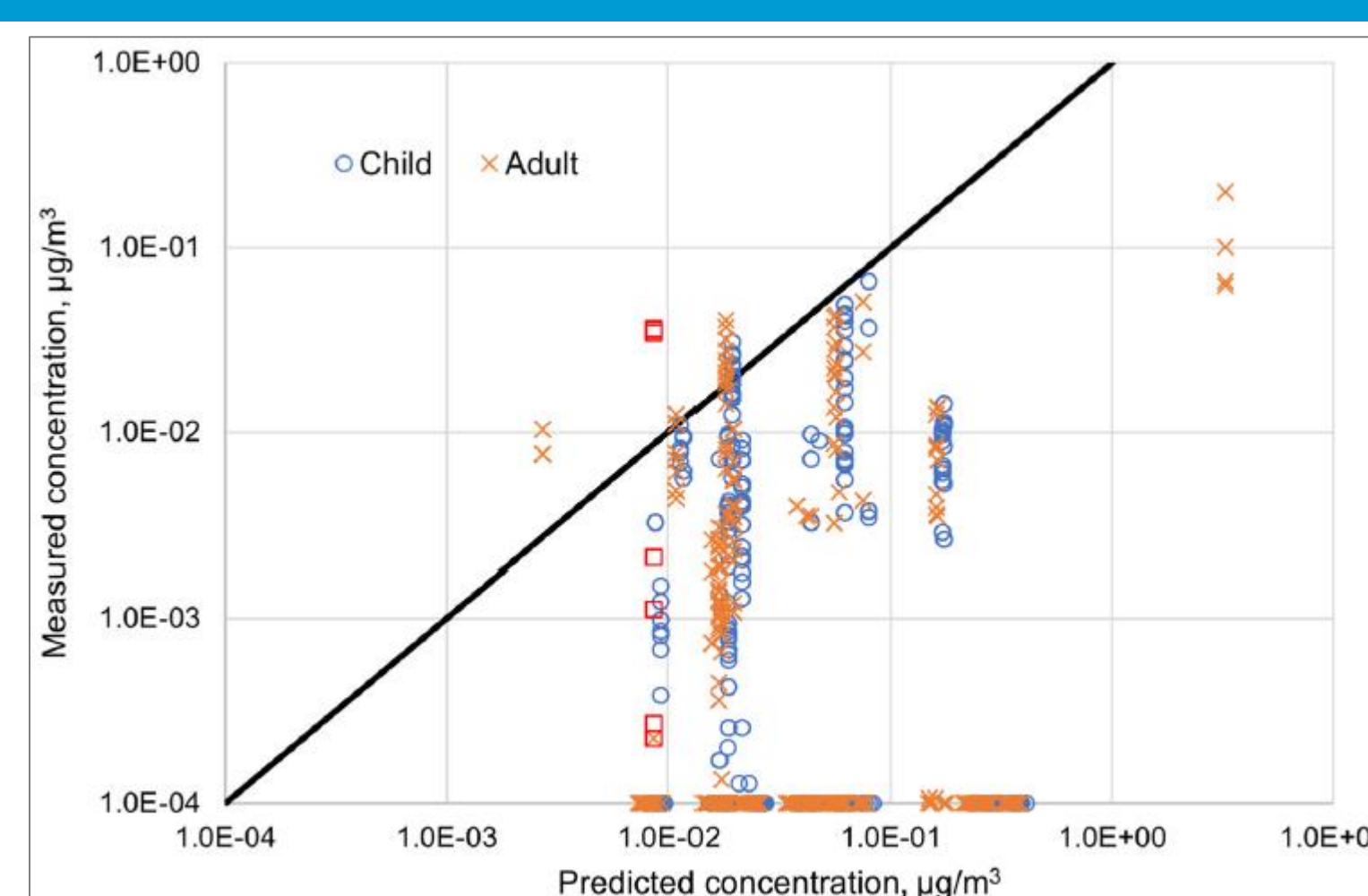

Figure 1: Comparison between 24-h rolling average vapour concentrations determined from adjusted measured data and the 95th percentile of BROWSE predictions for acute exposure. The black line shows the 1-1 relationship. Outliers are shown as squares.
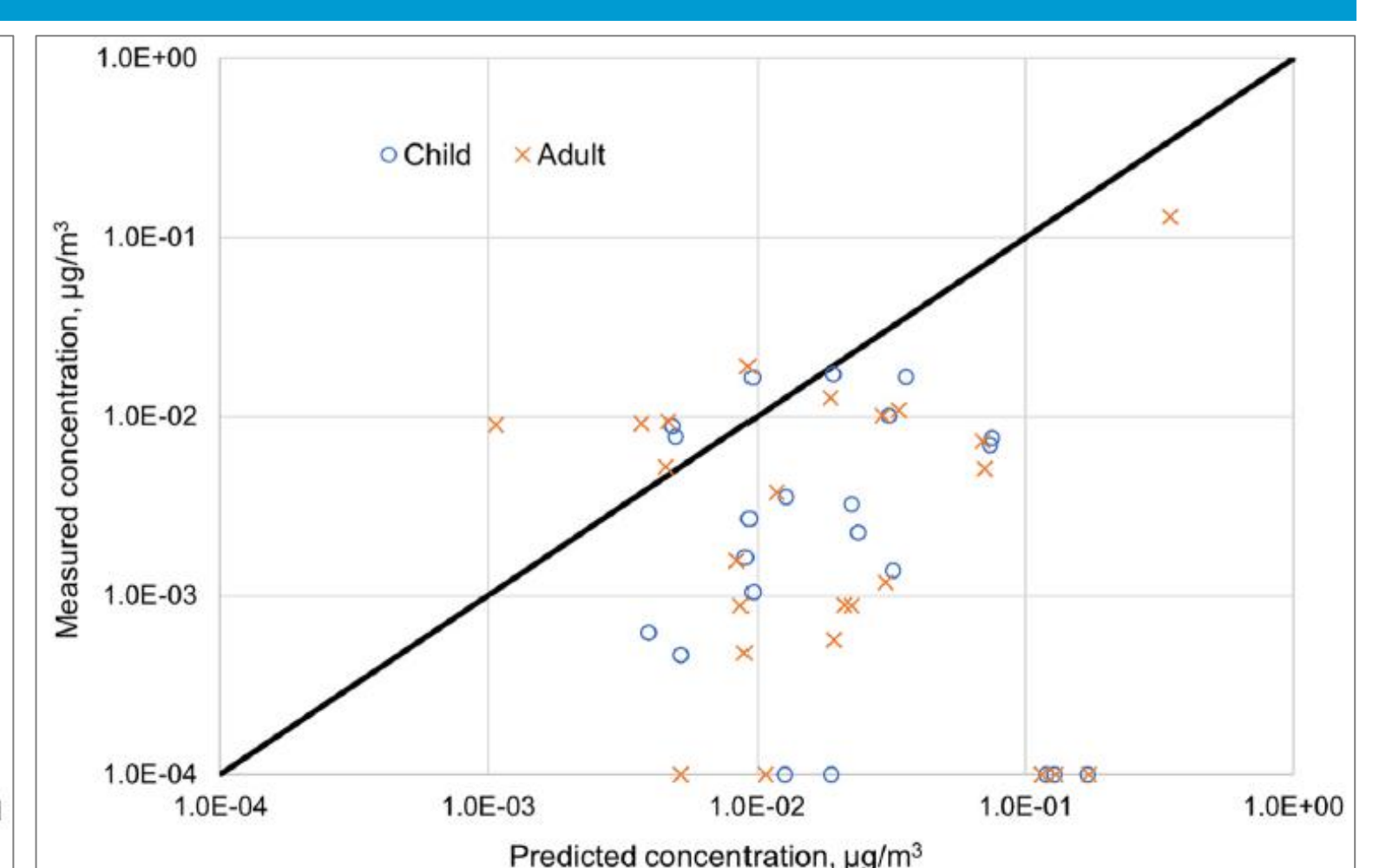

Figure 2: Comparison between 7-day average vapour concentrations determined from adjusted measured data and the 75th percentile of BROWSE predictions for longer-term exposure. The black line shows the 1-1 relationship. Each data point relates to a different study.

- Improvements recommended for BROWSE validation purposes: increased size and dimensions of treated areas; measured air concentrations >7-day period; wider range of physico-chemical properties, vapour pressures for AIs, crops and meteorological conditions, climatic zones; and applications with multiple AIs with different properties.

Conclusions

- A comparison between BROWSE and the available field data suggests that BROWSE provides a satisfactory level of conservatism in determining potential exposures of residents and bystanders to vapour.
- No patterns of vapour concentrations or specific experimental conditions could be identified that explain differences between measurements and predictions.
- This study shows that BROWSE could be a reliable alternative to replace the current EFSA approach for predicting vapour inhalation exposures for pesticides where no compound-specific data are available.

References

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