

## Airborne Pesticide Dynamics: A Spatiotemporal Analysis Using Passive Sampling.

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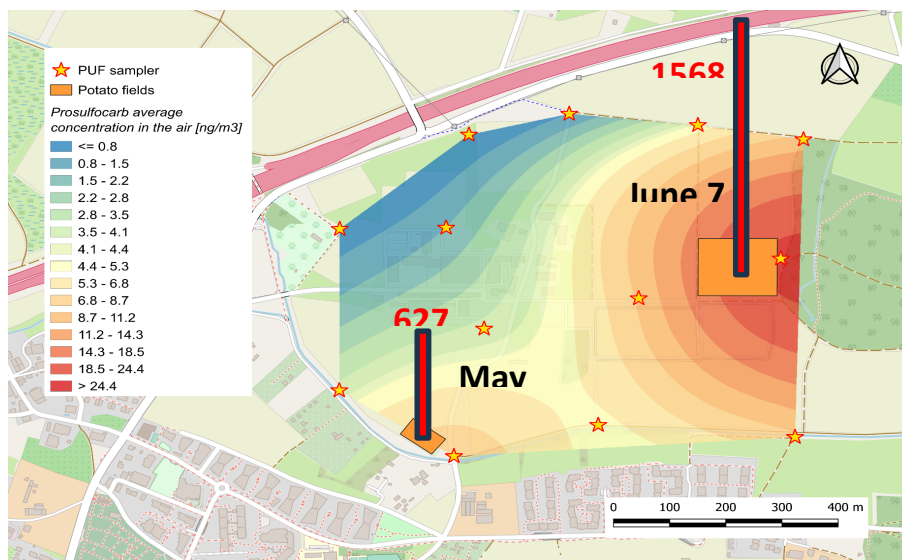
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Current-use pesticides (CUPs) are crucial to modern agricultural practices, yet their off-target transport poses environmental and human health risks. Passive air sampling using polyurethane foam (PUF) disks is a practical method for monitoring CUP occurrence, transport, and temporal patterns [1]. In our study, 13 passive sampling stations were deployed around a controlled area of 39 agricultural fields (~600,000m<sup>2</sup>) with detailed pesticide application records (compounds, quantities, locations). Samples were collected biweekly from late April to late October 2023 using in-house double-bowl samplers. Extracts were obtained using accelerated solvent extraction, and method recoveries were determined for 104 pesticides. A previously published effective sampling volume model [2] was adapted for CUPs and local meteorological conditions to estimate averaged airborne concentrations, enabling time-trend analyses. The high sampling frequency captured short-term application fluctuations and subsequent off-site transport. CUPs were detected at multiple locations, in some cases more than two kilometres from application sites, indicating substantial regional dispersion and potential risks to non-target areas.

Spatiotemporal distribution maps were generated by combining passive sampling data with pesticide application records (Figure 1), allowing systematic comparison of spatial extent, temporal persistence, and pattern stability among compounds.



Based on these spatial and temporal patterns, compounds were clustered according to their dominant atmospheric behaviour. While some pesticides exhibited strong local concentration peaks with sustained temporal persistence, others showed broader spatial dispersion but limited temporal persistence,

Figure 1: Spatial distribution of averaged airborne concentrations during the period 26 May–9 June 2023 for the herbicide prosulfocarb. Two application events are indicated by red bars, representing the total amount applied in the treated field.

suggesting distinct transport and redistribution mechanisms. Linking the observed patterns to physicochemical properties (e.g., volatility and partitioning behaviour) improved our understanding of pesticide fate in air. This pattern-based classification approach enhances understanding of CUP distribution processes and provides a stronger basis for risk assessment and mitigation planning.

[1] Estellano V. H. et al. (2015) Assessing levels and seasonal variations of current-use pesticides (CUPs) in the Tuscan atmosphere, Italy, using polyurethane foam disks (PUF) passive air samplers, *Environmental*, Volume 205, Pages 52-59

[2] Herkert N. J. et al. (2016) A Model Using Local Weather Data to Determine the Effective Sampling Volume for PCB Congeners Collected on Passive Air Samplers, *Environmental Science & Technology* 2016 50 (13), 6690-6697