

# Are Pesticides Important in the Atmosphere?

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## Pesticides in the Environment

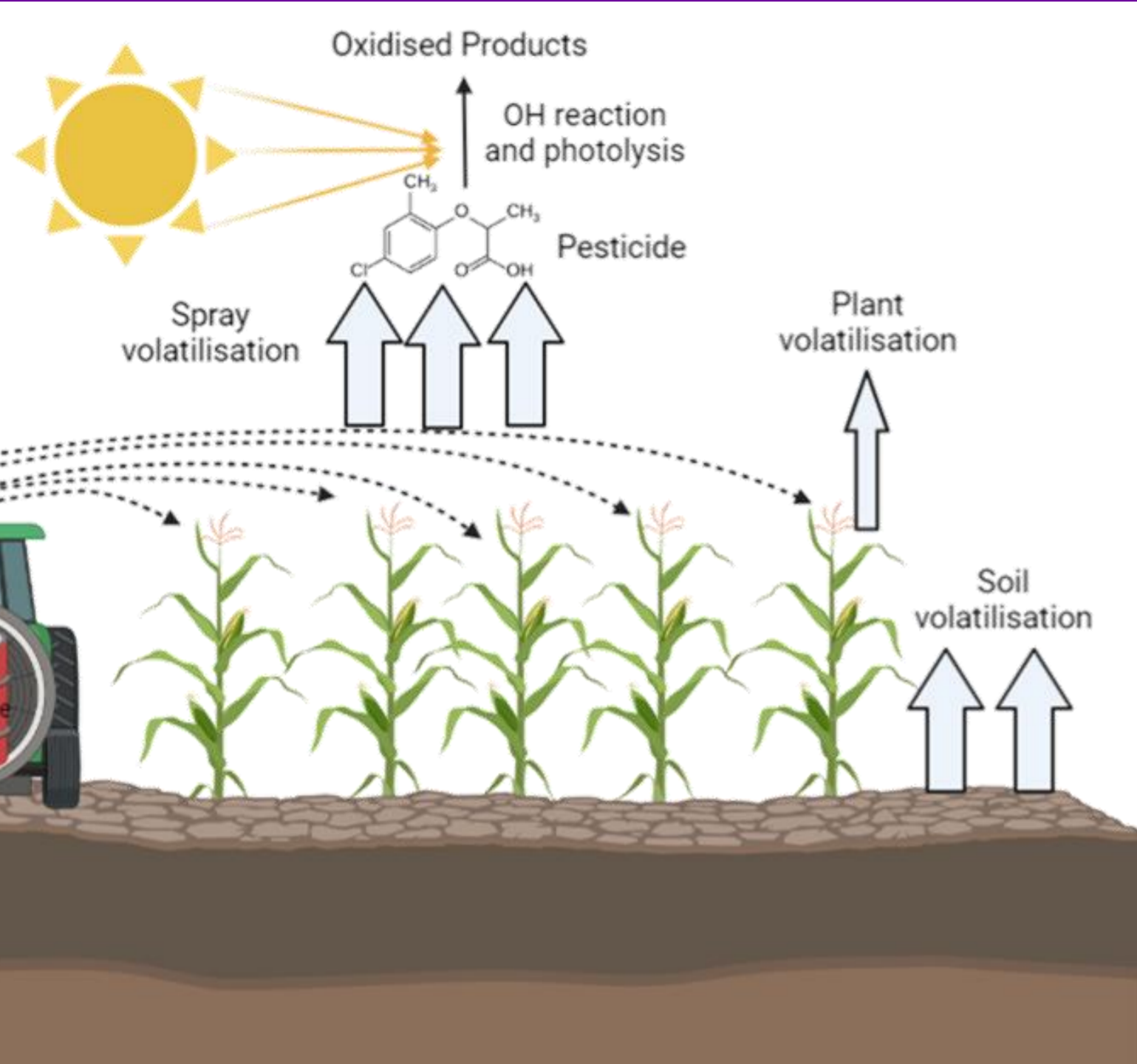


Figure 1: Description of key atmospheric processes occurring when pesticides are sprayed.

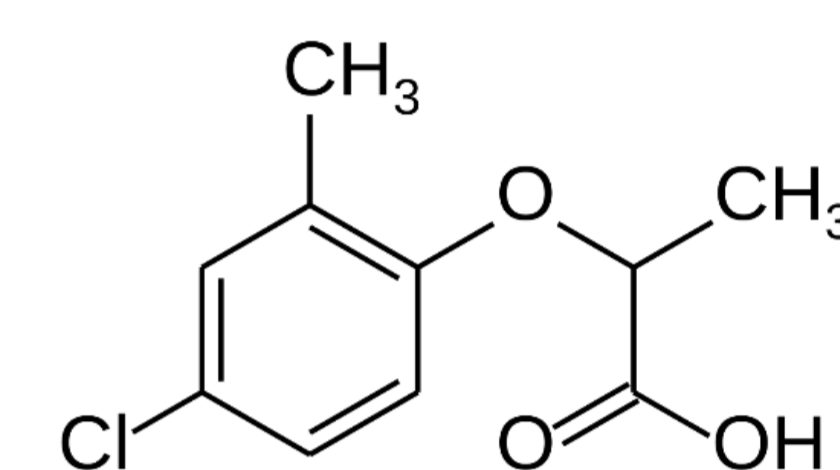
- **2 million tonnes** of pesticides are used globally per year<sup>1</sup>.
- Potential to be **volatilised** into the atmosphere.
- Previously been observed to be **transported large distances** as far as the Arctic<sup>2</sup>.
- Fundamental properties and **behaviours are not well understood**.
- A range of mass spectrometry techniques will be used to probe their properties and behaviour once in the atmosphere.

## Manchester Aerosol Chamber

- Experiments allow observations of transformation products (SOA) when exposed to OH.
- 18 m<sup>2</sup> bag made of fluorinated ethylene propylene (FEP)<sup>3</sup>.
- Temperature and humidity controlled.
- Contains 2 arc lamps to initiate OH radical formation.
- Sampling lines are attached to several instruments including:
  - Chemical Ionisation Mass Spectrometer (CIMS)
  - Aerosol Mass Spectrometer (AMS)
  - Scanning Mobility Particle Sizer (SMPS)
  - NO<sub>x</sub> and O<sub>3</sub> sensors.
- Pesticide is introduced into the chamber through nebulisation.



Figure 2: Image of the chamber.



**Pesticide studied:**  
**Mecoprop-P (MCP)**  
Aryloxy alkanolic acid herbicide

## Chamber Observations

### A) Nebulising starts

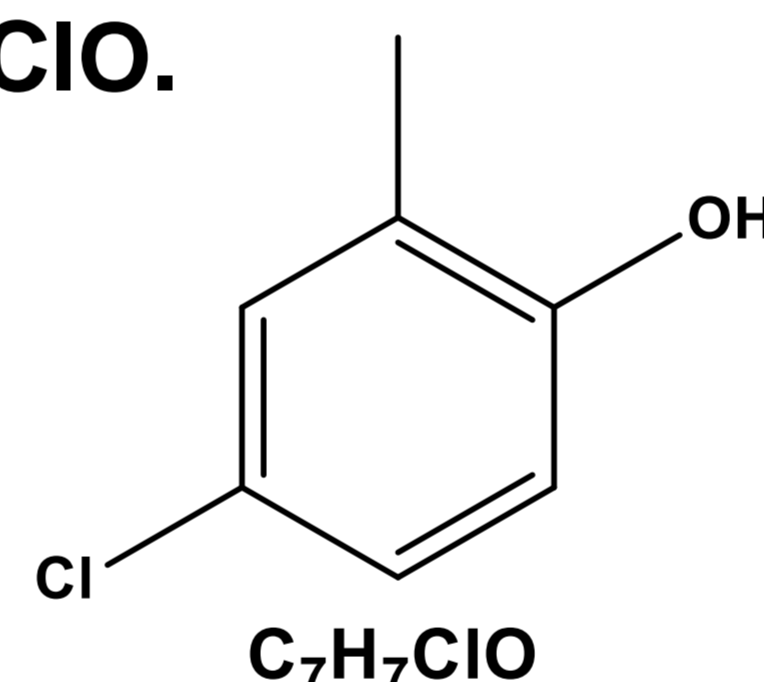
- Pesticide is introduced into the chamber.
- Increase in MCP concentration in both the particle and gas phases.

### B) Nebulising stops

- MCP concentration drops due partitioning to gas phase.
- Significant wall loss suggest wall loss rates need to be determined<sup>3</sup>.

### C) Lights on

- 1/3 concentration of OH of a typical Manchester sunny June day.
- Fragmentation to form a major first generation product C<sub>7</sub>H<sub>7</sub>ClO.



### D) Stronger UV lights on

- 2x concentration of OH of a typical Manchester sunny June day.
- Nucleation event seen on SMPS data.
- Oxidation of C<sub>7</sub>H<sub>7</sub>ClO to form highly oxidised molecules.
- SOA formation observed.

### Summary of Processes

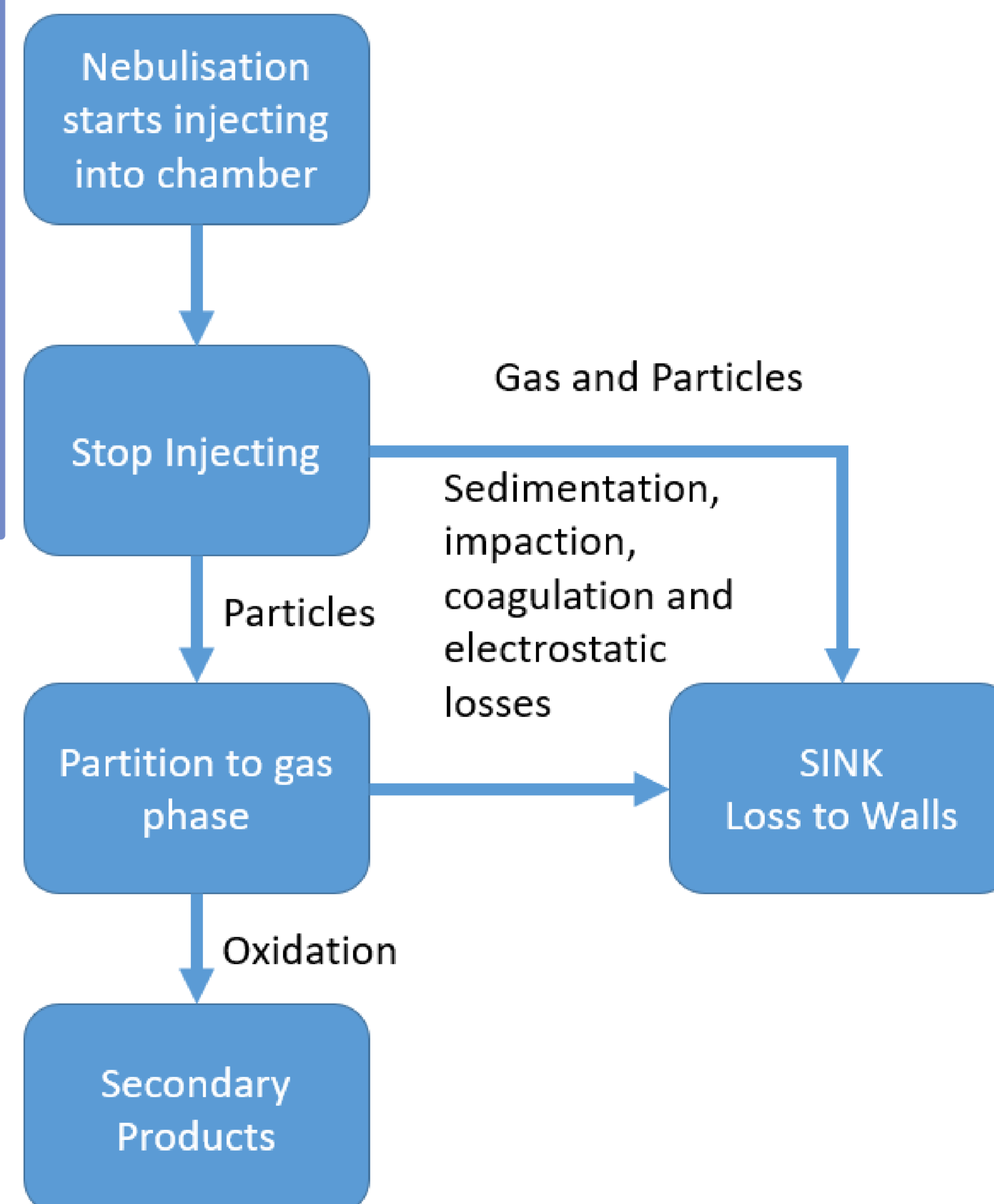


Figure 4: Flow diagram of the processes observed from the chamber experiments.

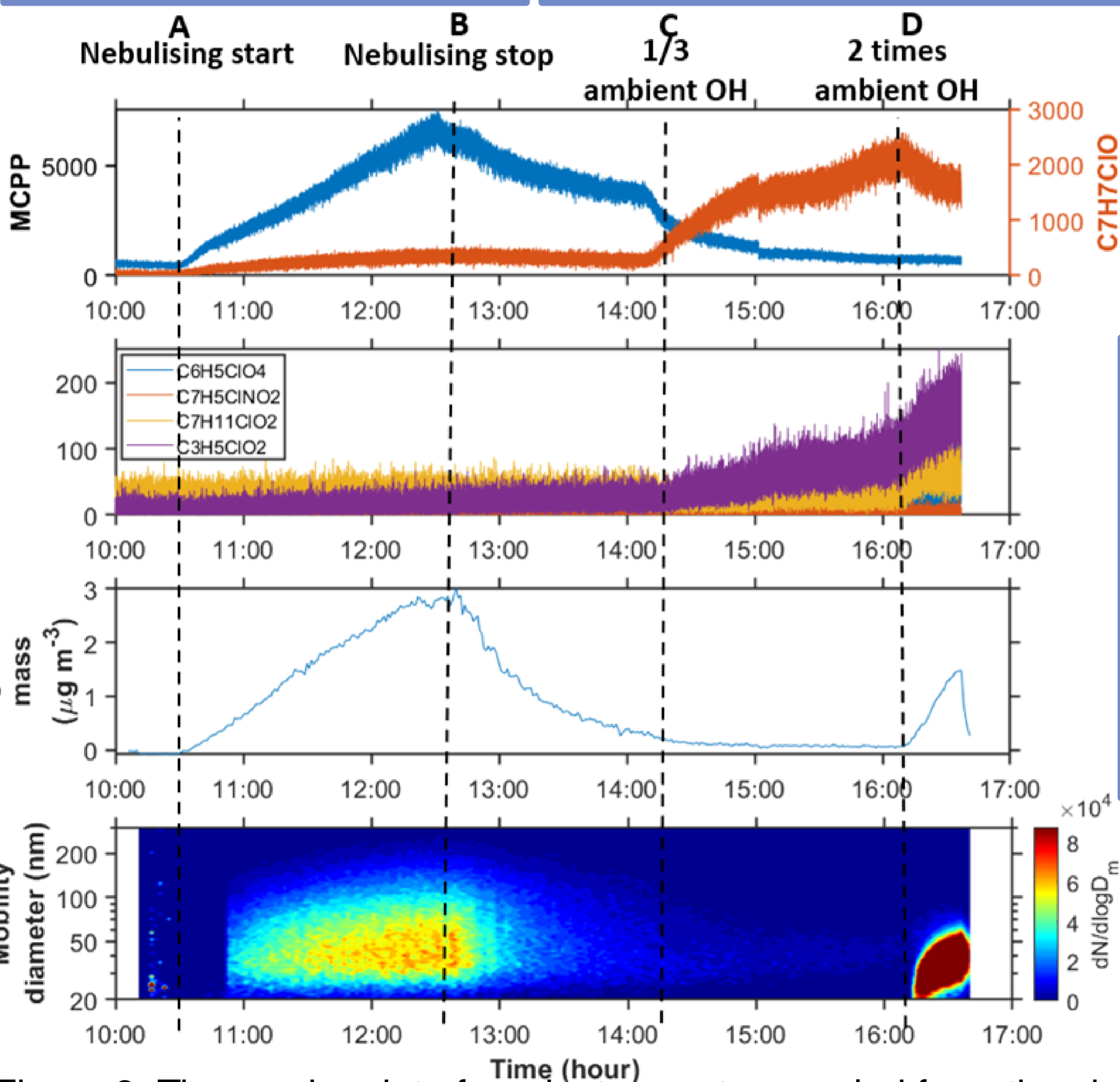
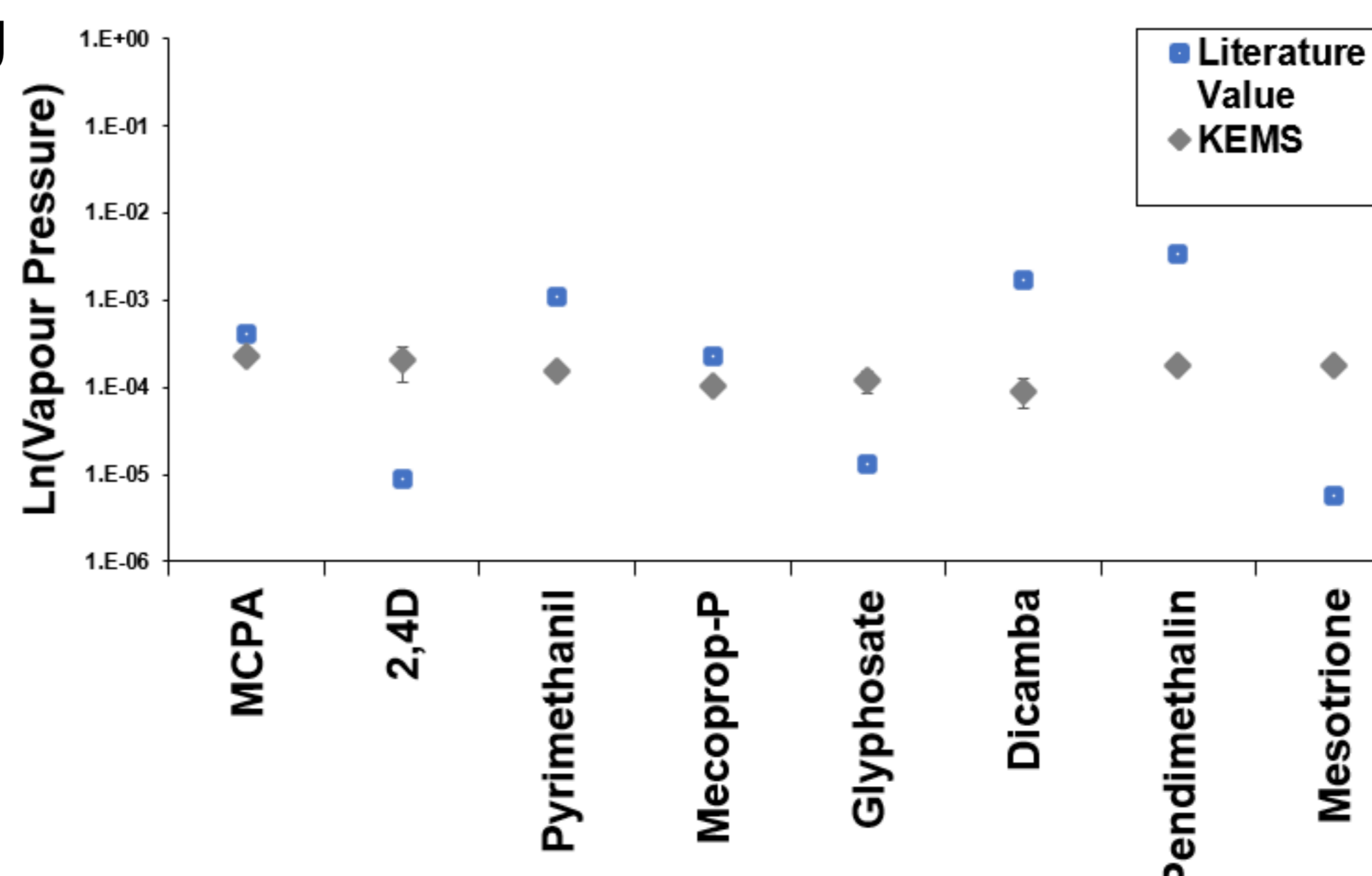


Figure 3: Time series data from instruments sampled from the chamber i) and ii) major peak identification from CIMS, iii) AMS data iv) SMPS data.

## Vapour Pressure Measurements

- Initial vapour pressure pesticide measurements using a well characterised technique - **Knudsen Effusion Mass Spectrometry (KEMS)**.
- Previous literature values of pesticides often come with **large uncertainties** and **discrepancies** between sources - often lead to **confidential reports**<sup>4</sup>.
- Vapour pressure is often measured at high temperature **leading to extrapolation** for ambient results - **KEMS avoids this**.
- The differences in Vapour pressure will **have large effects on predictions** of a pesticides behaviour in the atmosphere.



## Future Work

- Calculate corrections for particles lost to the walls.
- Determination of OH reactivity constant and photolysis rates.
- Proposal of mechanism.
- Assessment of toxicity of proposed products.
- Comparison of vapour pressure measurements from other techniques: KEMS and Filter Inlet for Gases and Aerosol (FIGAERO) - CIMS.

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3. Y.Shao, Y.Wang, M.Du, A.Voiotitis, R.M.Alfarra, S.P.O'Meara, F.S.Turner, G.McFiggans, *Atmospheric Measurement Techniques*, 2022, 15(2), 539-559.  
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