Towards a Better Understanding of the Lifecycle of the Pesticides in the Atmosphere

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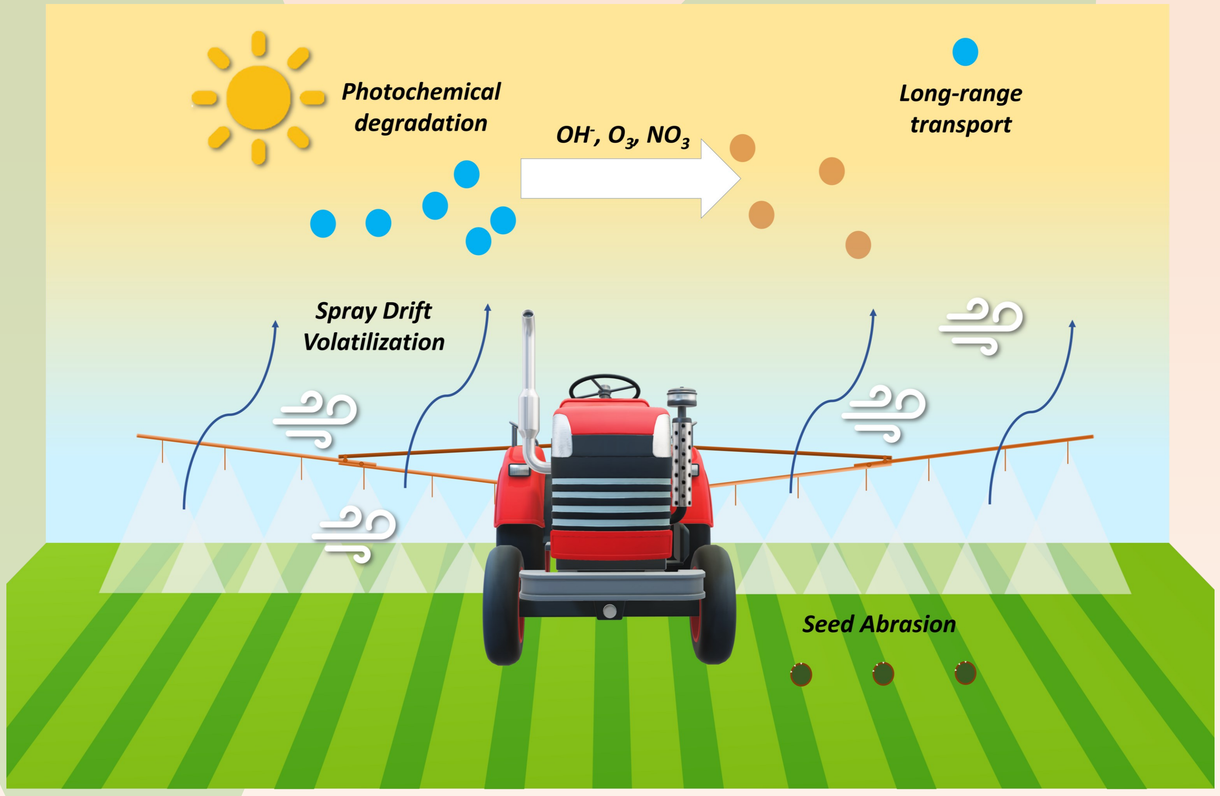
1. Background

- Pesticides used to eliminate or control unwanted pests that can damage crops can be partitioned into the atmosphere, either in gas or particle phase by direct **volatilization**, or by **spray drift**, or can be degraded into the atmosphere either by reactions with $\mathbf{OH}^{\cdot}$, $\mathbf{O_3}$, or $\mathbf{NO_3^{\circ}}$ or by direct **photolysis**[7]
- Agriculture contributes to feeding 8 billion people[3], leads to **Global consumption** of pesticides of around 2.66 million metric tons/year[2], causing an increased persistence in atmosphere. Their **Persistence** is highly dependent on vapor pressure, Henry's constant, and dry and wet deposition[1,6]
- According to FOCUS Air Report $V_p \geq 10^{-4}$(20°C) is considered to have potential of volatilization from surface and once suspended, it will distribute b/w vapour, aqueous and particle phases to reach equilibrium[5].



2. Statement of Problem

- Limited understanding of **biosphere-atmosphere** of pesticides, their **transportation** mechanism, their conversion reactions, their persistence in the environment
- Lack of standards to quantify direct surface **volatilization** of pesticides
- Techniques to quantify range of pesticides is not well explored well to quantify **real-time** reactions and influencing **meteorological** parameters

3. Aim and Objective

The aim of this study is to determine **fluxes** of pesticides from the point of application to the **regional** scale, with the development of an **eddy covariance** (EC) system for both **gas** and **particle** phase characterization, with **HR-TOF-CIMS** in conjugation with a sonic anemometer.

- **Objective 1:** Development of system for **simultaneous** measurement of **scalar** quantity from HR-TOF-CIMS and the **vertical wind speed**
- **Objective 2:** Development of an eddy correlation system for both particle and gas phase species
- **Objective 3:** Deployment into the field at field scale first which can then be scaled to regional scale and for different range of environmental conditions and under **specific farming practices**. **Regional burden** of the pesticides may be examined.

4. Methodology

Eddy covariance flux measurements is based on determining **covariance** between changes in **vertical wind velocity** and deviations in **scalar quantity** such as mixing ratio of a trace gas or air temperature[8]

$$F_c = \overline{w'c'} = \frac{1}{n}\sum_{i=1}^{n}(w_i - \overline{w}).(c_i - \overline{c})$$

Sonic Anemometer (SA) with an operating frequency of 10 Hz in conjugation with **CIMS** would provide the Eddy Correlation fluxes, however further Correction are required.

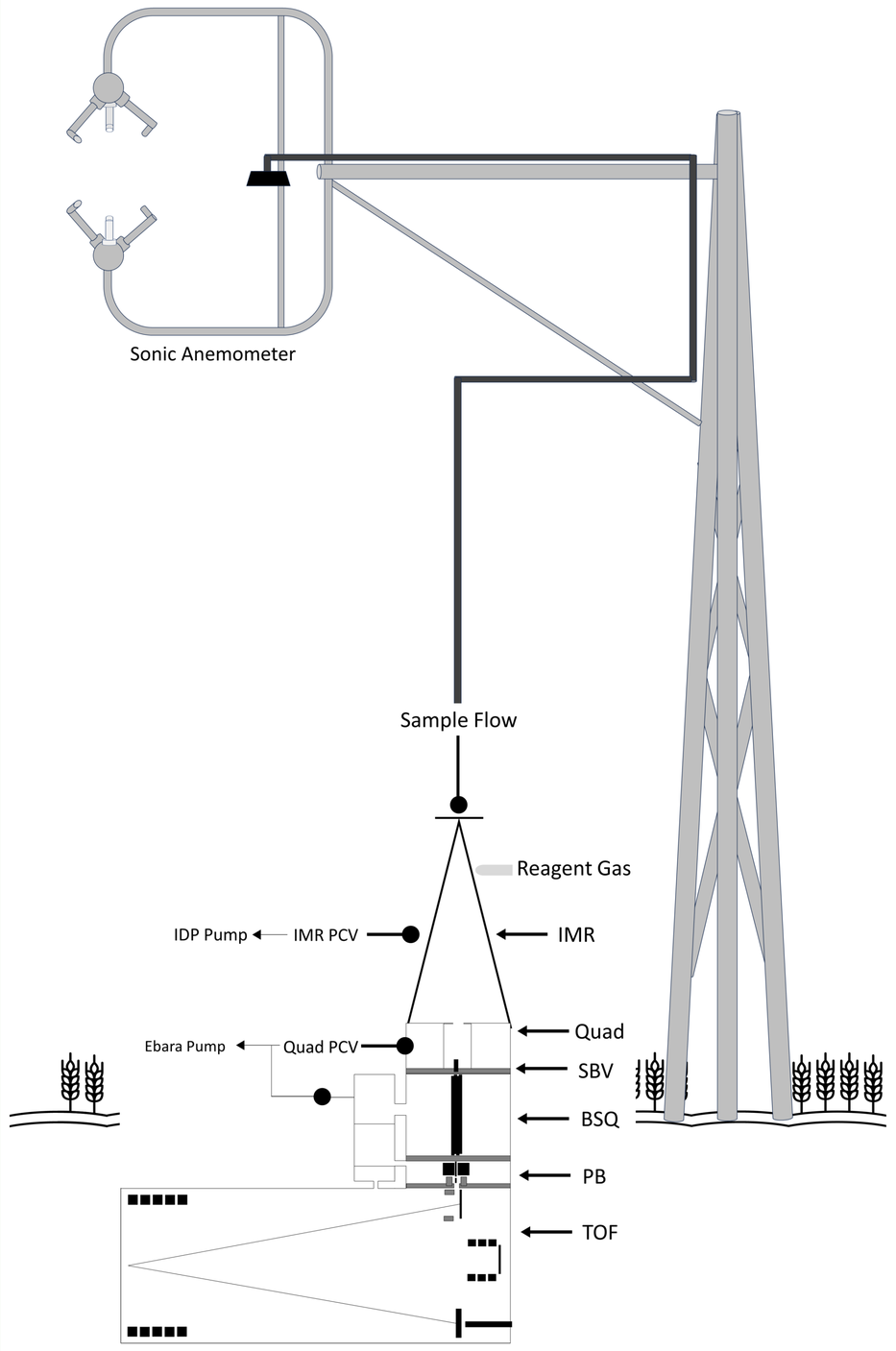
CIMS (Chemical Ionization Mass Spectroscopy) is capable of measuring pesticides in gas and particle phase because of its **reproducibility**, **minimum sample handling**, **high mass resolution** (m/Δm~4000-6000), **high time resolution** (1-10 Hz) allowing measurements of reactive compounds[4]

Consists of five main components:

- **VUV Ion source** which is a Krypton lamp
- Ion molecular Reactor (IMR)
- Big segmented quadrupoles to separate m/z
- An ion lens focusing region
- TOF mass analyzer

(I⁻ CIMS ionization mechanism) $I(H_2O)_n^- + M \rightarrow \ n(H_2O) + I(M)^-$

5. Proposed Setup



Site Specification
- **Homogeneous Terrain**[6] ($\frac{d\xi}{dx_1}$) & $\frac{d\xi}{dx_2}$ **=0)**
- **No flow divergence and convergence**

Pre-Processing
- **Time Lag Analysis**
- **Data gap Filling**

Eddy-Pro for Flux Calculations and further corrections
- **Co-Spectra Analysis:**
- **Storage corrections** (during formation of nocturnal boundary layer)
- **Ogive Optimization**(to determine the averaging time interval)

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