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Ozone and secondary organic aerosol production by interaction between and organophosphorous pesticide and biogenic VOCs mixture

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Pesticides are the chemical compounds most widely used worldwide, and their toxicological characteristics can have harmful effects on human health.

The entry into the atmosphere of pesticides occurs during application or subsequent processes. Once they are emitted, they can be distributed in the gas phase or particulate phase. However, most of them are in both phases, since they are semi-volatile compounds. As with other organic compounds, pesticides' removal in the atmosphere can be mainly accomplished by wet or dry deposition, by photolysis or by reaction with hydroxyl radicals (OH), nitrate radicals (NO_3) and ozone (O_3) [1]. All these processes give rise to the formation of other products, which could become more harmful than the starting compounds. It is therefore necessary to know all these processes to estimate the impact of pesticides in the atmosphere. In addition, it is important to study how the pesticides interact with organic compounds naturally emitted by crops and their possible impact on the formation of secondary organic aerosols, ozone and other compounds.

In this work, the gas phase atmospheric degradation of an organothiophosphate insecticide has been investigated at the large outdoor European Photoreactor (EUPHORE) in the presence of a biogenic compound mixture typical from orange trees emissions. Its photolysis has been studied under sunlight conditions, in the presence of different concentration ratios of chlorpyrifos and biogenic VOCs mixture and in the absence of initial inorganic seeds. Reaction with ozone has also been studied.

Gaseous phase compounds were determined by a Fourier Transform Infrared Spectrometer (FTIR), Proton Transfer Reaction – Mass Spectrometry (PTRMS), Solid Phase Microextraction (SPME) coupled to gas chromatography-mass spectrometry (GCMS) and NO_x, O_3 and SO_2 monitors. Aerosol mass concentration was measured using a scanning mobility particle sizer (SMPS) and a tapered element oscillating monitor (TEOM). Chemical characterization of degradation products were done by using different off-line analysis with SPME, C18 cartridges and filters plus derivatization and subsequent analysis by GCMS.

The results show that the combination of pesticide and biogenic compounds increase the SOA and O_3 formation, being, in combination, high contributors to photochemical smog.

This study contributes providing useful data about atmospheric degradation processes of pesticides. Knowledge of the specific degradation products, including the formation of secondary particulate matter and ozone, could complete the assessment of their potential impact. The understanding of atmospheric reactions should help to estimate the expected formation of gas and/or particulate products in the troposphere for each pesticide. Hence, these results can contribute to the selection of environmentally sustainable strategies against plagues.

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References

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