Title

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Home is where the SVOCs are: Semivolatile organic compounds in indoor air studied by thermal desorption aerosol gas chromatography (SV-TAG)

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SUMMARY
This study provides novel observations and insight into the chemical composition of indoor air. Utilizing state-of-the-art semi-volatile thermal-desorption aerosol gas chromatography (SV-TAG) we present, for the first time, hourly concentrations and partitioning of semivolatile organic compounds (SVOC) measured in a single-family house in California during normal occupancy. Time series of indoor SVOCs were characterized by temperature-dependent elevated background levels for a broad suite of chemicals, underlining the importance of continuous emissions from static indoor sources, i.e. building materials and interior contents. However, the highest SVOC concentrations were observed during episodic enhancements associated with occupant activities.

KEYWORDS
residential environment; indoor SVOC sources; occupancy; phase partitioning; cooking

1 INTRODUCTION

Semivolatile organic compounds (SVOCs) constitute a major class of organic chemical compounds found in indoor environments, many of which are suspected of having adverse health effects (Weschler and Nazaroff et al., 2008). Indoor sources of SVOCs are numerous, with wide-ranging uses of such compounds as active substances or as additives in building materials and consumer products. Measurement of the chemically complex organic components of air pollution, such as SVOCs, is a challenging task. Methods for analyzing SVOCs in both outdoor and indoor environments have generally relied on long timescale (several hours to days) collection of particulate matter and gases onto filters and sorbents followed by off-line analysis in the laboratory. This approach provides little information on the temporal changes associated with or following transitory activities, such as cooking, cleaning, and the mere presence of occupants. In this work, using the state-of-the-art semi-volatile thermal-desorption aerosol gas chromatography (SV-TAG), we present for the first time, time-dependent gas- and particle-phase concentrations of SVOCs in the indoor environment.

2 METHODS

The study is carried out in a single-family house in the San Francisco Bay Area, USA. Measurements were conducted over a 9-week period starting December 2017. Both occupied and vacant periods were included in the monitoring campaign. The SV-TAG is described in detail in Isaacman et al. (2014). Briefly, the instrument collects particle-only and combined gas-plus-particle samples on two parallel sampling cells. Following sampling, each cell is analyzed in series by thermal desorption into helium saturated with a derivatizing agent and then directed to a gas chromatograph (GC) with a quadrupole mass spectrometer. Collection and analysis of gas-plus-particle and particle-only samples allow for determination of the gas/particle-phase partitioning of SVOCs. In the current study, measurement of indoor gas-plus-particle SVOCs was

obtained with one-hour time resolution. Also, utilizing the dual cell apparatus, indoor vs. outdoor SVOC comparisons, indoor gas/particle partitioning, and outdoor gas/particle partitioning could be obtained every four hours.

3 RESULTS AND DISCUSSION

The SV-TAG measurements reveal a high abundance of SVOCs in indoor residential air, including hundreds to thousands of chemical species. Specific SVOCs, including phthalates, polyaromatic hydrocarbons (PAHs), alkanes, alkanoic acids, alcohols, and siloxanes, have been identified in the recorded SV-TAG chromatograms. In general, SVOCs were found to be more abundant in the indoor environment compared to outdoors with highest concentrations arising in association with occupant activities, such as cooking (Figure 1A). The vacant period shows high background concentrations of SVOCs correlating with indoor temperatures, which suggests the influence of temperature-driven emissions or temperature-modulated phase-shift equilibria with materials and interiors as major source of SVOCs in the studied residence (Figure 1B). The effect of occupant activities, household temperature, humidity and particle concentration on the partitioning of indoor SVOC is being examined and will be discussed further; preliminary results show that increased particle concentrations associated with cooking may enhance phase partitioning of SVOCs to airborne particulate matter.

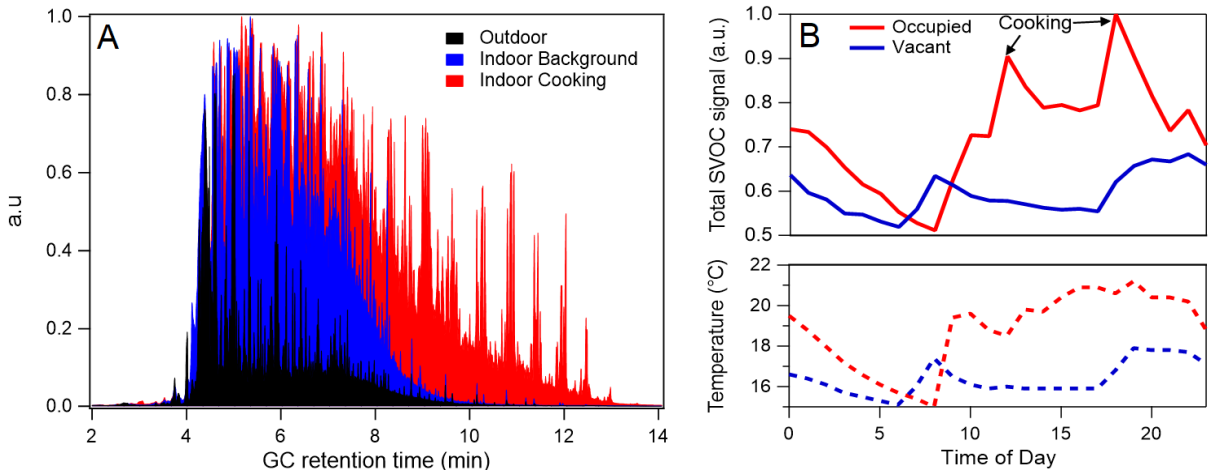

Figure 1. A) Total ion chromatogram recorded by SV-TAG from gas-plus-particle sampling from outdoor (black), indoor background (blue) and indoor cooking (red). B) Total SVOC signal (top) and temperature (bottom) during an occupied (red) and vacant (blue) day.

4 CONCLUSIONS

We have found that SVOCs in the residential environment are affected to large extent by emissions from building materials and household interior furnishings. In addition, we have found that occupant activities, such as cooking, result in strongly increased SVOC concentrations, affecting the chemical composition of indoor air, and even the gas/particle partitioning of SVOCs present. With one-hour time resolution, SV-TAG offers opportunities for novel insight into the complexity, sources, and phase of SVOCs in indoor environments.

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5 REFERENCES

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