Chemistry of Indoor Environments Shapes Human Exposure to Air Pollution

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Abstract

Our understanding of the chemical composition of outdoor and indoor atmosphere, spatiotemporal variability of pollution sources, chemical exposures, and their effects on human health is limited by the lack of chemically speciated and spatially resolved ambient measurements. Little is known about indoor chemistry and how outdoor and indoor atmospheres interact. This presentation focuses on novel real-time measurements of volatile organic compounds (VOCs) aboard an electric mobile lab enabling spatiotemporal evaluation of pollution hotspots outdoors and quantification of community exposure to conventional and emerging gas-phase air pollutants. Indoor and outdoor comprehensive air chemistry measurements were conducted by connecting the inlets from the mobile laboratory to living spaces indoors and outdoors. A Vocus 2R proton transfer reaction time-of-flight mass spectrometry (Vocus-PTR-TOF-MS aka the "Sniffer") offers a sub-part-per-trillion detection limit (sub-ppt) and a high time resolution (<1 s). It was deployed to map out spatiotemporal distribution of hundreds of gas-phase chemicals including air toxics at the community level in different regions of Texas, focusing on chemical fingerprinting of anthropogenic and biogenic sources, indoors and outdoors. We report outdoor biomass burning and industrial pollution plume penetrations to indoor environments where reduced ventilation rate is shown to slow down intrusion of pollutants. In contrast, in a clean (non-plume) scenario, increasing air exchange rate could significantly reduce human exposure to indoor air pollution. Human indoor activities such as cooking, cleaning, the use of consumer care products, solvents and indoor combustion contribute to indoor air chemistry. Because of the high surface-to-volume ratios of indoor spaces atmospheric oxidants such as ozone are quickly titrated on indoor surfaces containing unsaturated chemicals including human-derived squalene to produce ozone reaction products (ORPs). Indoor microbiome can be a significant contributor to indoor chemical composition. Finally, engineering solutions to reduce human exposure to gas-phase and particle-phase pollutants are also demonstrated and discussed.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, CCMi: Chemistry Climate Model Initiative, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, BBURNED: Biomass Burning Uncertainty: ReactioNs, Emissions and Dynamics, Allin-Wayra: Small Sensors for Atmospheric Science

IGAC Regional Working Groups

Americas Working Group