Sources of Airborne PCB Congeners

The long-term goal of Project 4 is to quantify the relationship between observed concentrations of PCBs in air, their specific sources, and the potential to reduce PCB exposure to sensitive populations. The objective of Project 4 is to examine two major categories of airborne PCB sources: materials found in schools and homes; and highly contaminated waterways. We will be doing this by:

1) Developing novel passive sampling materials.

We hypothesize that tailored electrospun nanofiber mats (ENMs) are efficient and adaptable passive sampler materials to detect and measure PCB congeners in the environment. We will design, calibrate, and deploy ENMs in various application scenarios for quantitative determination of PCB congeners. A new publication reports our development of polymeric electrospun nanofiber mats (ENMs) for equilibrium passive sampling applications in water (Qian et al., 2020). We describe how we integrated two types of multiwalled carbon nanotubes (CNTs; with and without surface carboxyl groups) into polyacrylonitrile (PAN) and polystyrene (PS) ENMs. This study continues our long-term investment in the development of passive sampling methods for measuring PCBs and other pollutants in water and air.

2) Identifying specific sources in schools and homes.

We hypothesize that building materials contaminated with Aroclors, brightly colored products, and polymer coatings contaminated with non Aroclor congeners account for the high levels of PCBs in indoor air. We will conduct measurements in schools, homes, and in the laboratory to quantify specific sources using well-known sampling methods and newly developed methods.

In 2020 we completed a major study that measured and interpreted PCB congeners in ten rooms of a rural Iowa school in Columbus Junction, Iowa (Bannavti, Jahnke et al., in review). This school has been an important study site for Project 3 and Project 4 since 2006. We placed passive air samplings in triplicate in ten rooms and outside the school and measured all 209 PCB congeners. We were surprised to find that concentrations and congener signals differ from one room to the next, suggesting that there are specific and sources in each room. Our studies with this community have elucidated the importance of airborne exposures to PCBs from school air and this study is designed to support our long-term goal of reducing human exposure to PCBs through the application of a targeted material remediation approach. This study was supported by the Data Management and Analysis Core and the Analytical Core.

Most recently, and also in collaboration with Project 3, we are analyzing PCBs in soils collected in East Chicago (Hua et al., in prep). Our initial finding indicates that 1) the concentrations of PCBs in East Chicago is much higher than have been reported in other
communities; 2) the congener signal in most samples is consistent with Aroclor 1248, the commercial mixture we have previously reported to be present in IHSC sediments, water and overlying air. We expect this data to be used in a publication prepared in the next year.

3) Characterizing emissions from contaminated waters nation-wide.

We hypothesize that contaminated waters are a major outdoor source of airborne PCB exposure nation-wide. We will use existing public data to predict dispersion and annual median air concentrations in communities surrounding these waters. We will test our prediction through local measurements of airborne PCBs and communicate our findings to local communities and environmental protection officials, including the Environmental Protection Agency.

Several publications from 2020 are first steps. A collaboration with Boston University reports the health risks associated with the emission of PCBs from the New Bedford Harbor Superfund site (Heiger-Bernays et al., 2020). We found that people living near the harbor experience elevated risk, especially for thyroid disease, due to elevated inhalation exposure to airborne PCBs emitted from the harbor. This paper is the latest in a series of papers that describe our collaboration with Boston University Superfund Research Program, funded by a supplement to both programs in 2015-2016.

We initiated several new studies in collaboration with Project 3, including a study of the effect of dredging a contaminated harbor on the measured levels of airborne PCBs in East Chicago, Indiana and a study of PCBs in East Chicago soils (Bittle et al., in prep). Project 3 collected air samples at homes across East Chicago, both prior to and during the dredging of the Indiana Harbor and Shipping Canal (IHSC) that passes through the city. Our previous studies have shown that the IHSC is an important source of airborne PCBs in the community and our current study is designed to examine whether the concentrations have changed over time and to determine if dredging activities had any impact on those changes. We expect this study to continue for at least one more year because this study requires extensive laboratory and statistical work.

Outcomes of the proposed studies will provide a novel passive sampling approach, and assessment of both Aroclor and non-Aroclor PCB sources in schools and communities. The findings will provide strategies to remediation options that focus on reduction of exposure to PCBs and that are technically and economically practical.

Recent Publications:


>Signal processing methods to interpret polychlorinated biphenyls in airborne samples(link is external)
Research Project 4
Published on Iowa Superfund Research Program (https://iowasuperfund.uiowa.edu)


Jiajie Qian, Andres Martinez, Rachel F Marek, Matthew R Nagorzanski, Hui Zhi, Edward T Furlong, Dana W Kolpin, Gregory H LeFevre, David M Cwiertny; Polymeric Nanofiber-Carbon Nanotube Composite Mats as Fast-Equilibrium Passive Samplers for Polar Organic Contaminants, (link is external)


Wang, Hui; Adamcakova-Dodd, Andrea; Flor, Susanne; Gosse, Laura; Kienow, Violet; Stoterijk, Jeffrey; Lehmler, Hans-Joachim; Hornbuckle, Keri; Ludewig, Gabrielle; Robertson, Larry; Thorne, Peter. Comprehensive Subchronic Inhalation Toxicity Assessment of an Indoor School Air Mixture of PCBs. (link is external) Environ. Sci. Technol. 2020, 54, 24, 15976–15985, PMID: 33256405 [Project 3, Project 1, Project 4, Analytical Core]

Datasets:
Rachel F Marek; Peter S Thorne; Nicholas J Herkert; Andrew M Awad; Keri C Hornbuckle, Dataset for airborne PCBs and OH-PCBs inside and outside urban and rural U.S. schools (link is external) University of Iowa; 01/24/2020, DOI: https://doi.org/10.25820/data.00211 (link is external) [7] (Analytical Core, Project 4, Project 5)

Project Leader: Keri C. Hornbuckle, PhD [9]

Dr. Hornbuckle is a Professor and Chair of the Department of Civil & Environmental Engineering at the University of Iowa. Dr. Hornbuckle's research concerns the fate and transport of pollutants in the environment. She is particularly interested in persistent organic pollutants including PCBs and other legacy industrial pollutants, perfluorinated compounds related to the production of surface protectants, fragrances and other persistent chemicals in household products, and pollutants related to large-scale agriculture.

Co-investigator: Andres Araneda Martinez, PhD

Dr. Martinez is a Research Scientist and Adjunct Professor in the College of Engineering. He has nearly 10 years of scientific research experience, during which he has developed expertise in the areas of field sampling, development of analytical method and analysis of hydrophobic organic compounds in complex environmental matrices, environmental modeling, and data analysis. Distribution, transport, and fate of polychlorinated biphenyls (PCBs) in air, water and sediment/soil
have been his main areas of interest.

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[1] https://iowasuperfund.uiowa.edu/research-projects/project-4
[8] https://doi.org/10.25820/data.00211