

Ice, Fire and Rain: Chemical Movement and Exposures in Arctic, Wildfire, Hurricane Cases

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Passive Sampling Technology

2

Total concentration



Bioavailable fraction

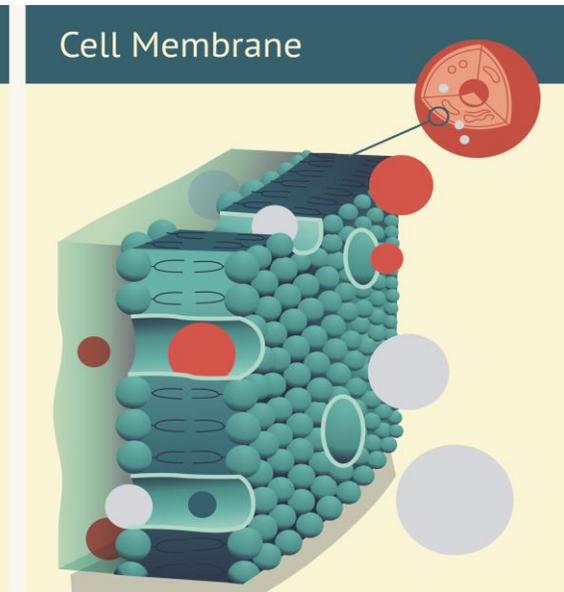
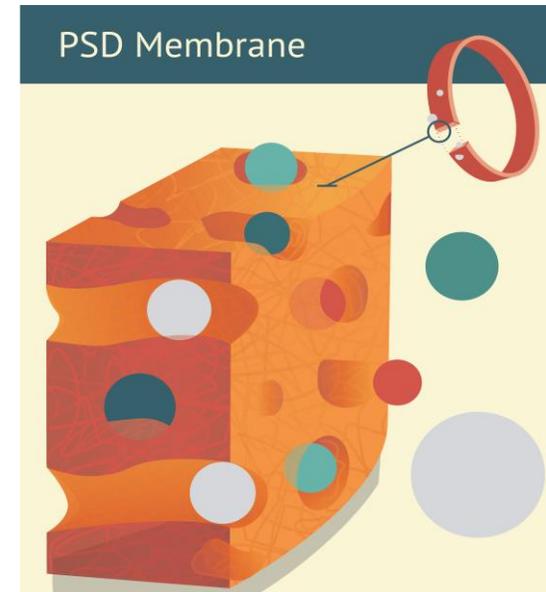


Potential for exposure



RISK

- Freely dissolved*
- Can be taken up by organisms, (people)



Polymers for passive sampling

Technology development and characterization for assessing chemical movement and exposure



3

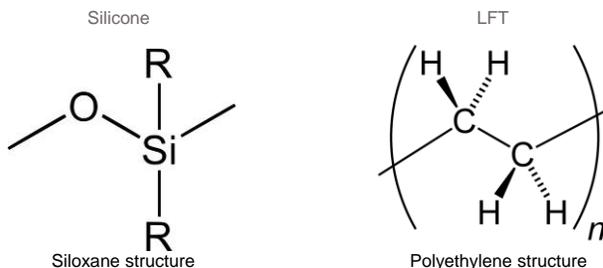
Sequester and concentrate lipophilic organic chemicals

Mimic (bio-) passive uptake and accumulation

- Greenberg et al, Integrated Envir Assess & Manage, 2014
- Forsberg et al ET&C, 2014
- Paulik, et al, Sci Tot Env, 2016

Low density polyethylene carbon

Silicone based



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Bracelets Can Detect Chemical Exposures

The next wave of wrist wear might act as a fashionable archive of your exposure to everything from caffeine to pesticides



Mar 7, 2014 | By Brian Bienkowski and Environmental Health News

Wristbands are the accessory of choice for people promoting a cause. And the next wave of wrist wear might act as a fashionable archive of your chemical exposure.



Researchers at Oregon State University outfitted volunteers with slightly modified silicone bracelets and then tested them for 1,200 substances. They detected several dozen compounds – everything from caffeine and cigarette smoke to flame retardants and pesticides.

Silicone in wristbands absorbs chemicals. Researchers used modified ones to test people's exposure to 1,200 substances, such as flame retardants and cigarette smoke. Credit: LevinGer/Flickr

"We were surprised at the breadth of chemicals," said Kim Anderson, a professor and chemist who was senior author of the study published in Environmental Science & Technology.

ENVIRONMENTAL
Science & Technology

Article
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Silicone Wristbands as Personal Passive Samplers

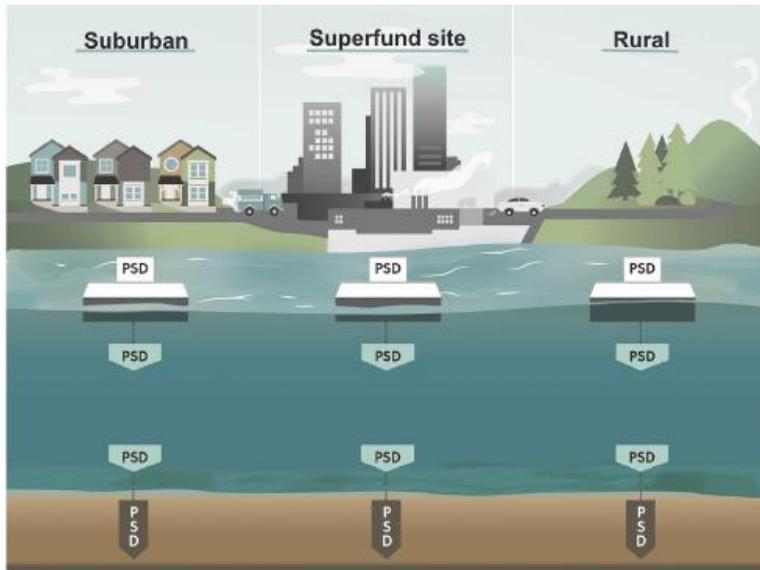
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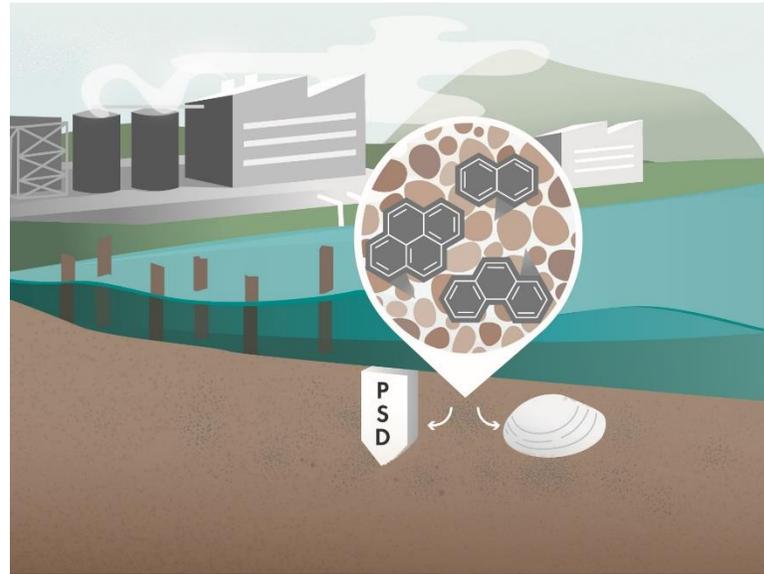
Advancing Chemical Fate, Bioaccumulation and Mixture Toxicity Applied to Disasters

Tanker accidents, Petroleum spills, Train derailments, Legacy leaks, and **Extreme weather**

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Fate



Bioaccumulation



Mixture toxicity

Low density polyethylene, performance reference compound (i.e. internal standards) corrected, GC-MS/MS



Development of quantitative screen for 1550 chemicals with GC-MS

Alan J. Bergmann¹ · Gary L. Points¹ · Richard P. Scott¹ · Glenn Wilson¹ · Kim A. Anderson¹

Modified ion source triple quadrupole mass spectrometer gas chromatograph for polycyclic aromatic hydrocarbon analyses

Kim A. Anderson^{a,*}, Michael J. Szelewski^{b,1}, Glenn Wilson^a, Bruce D. Quimby^{b,1}, Peter D. Hoffman^a

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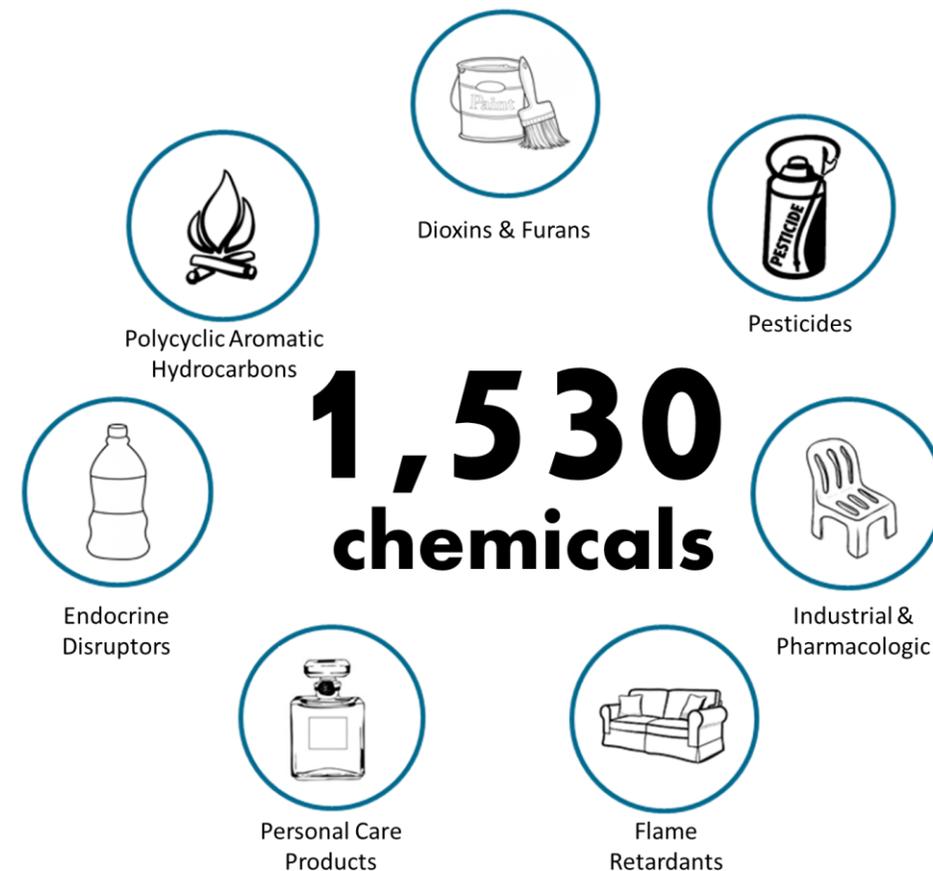
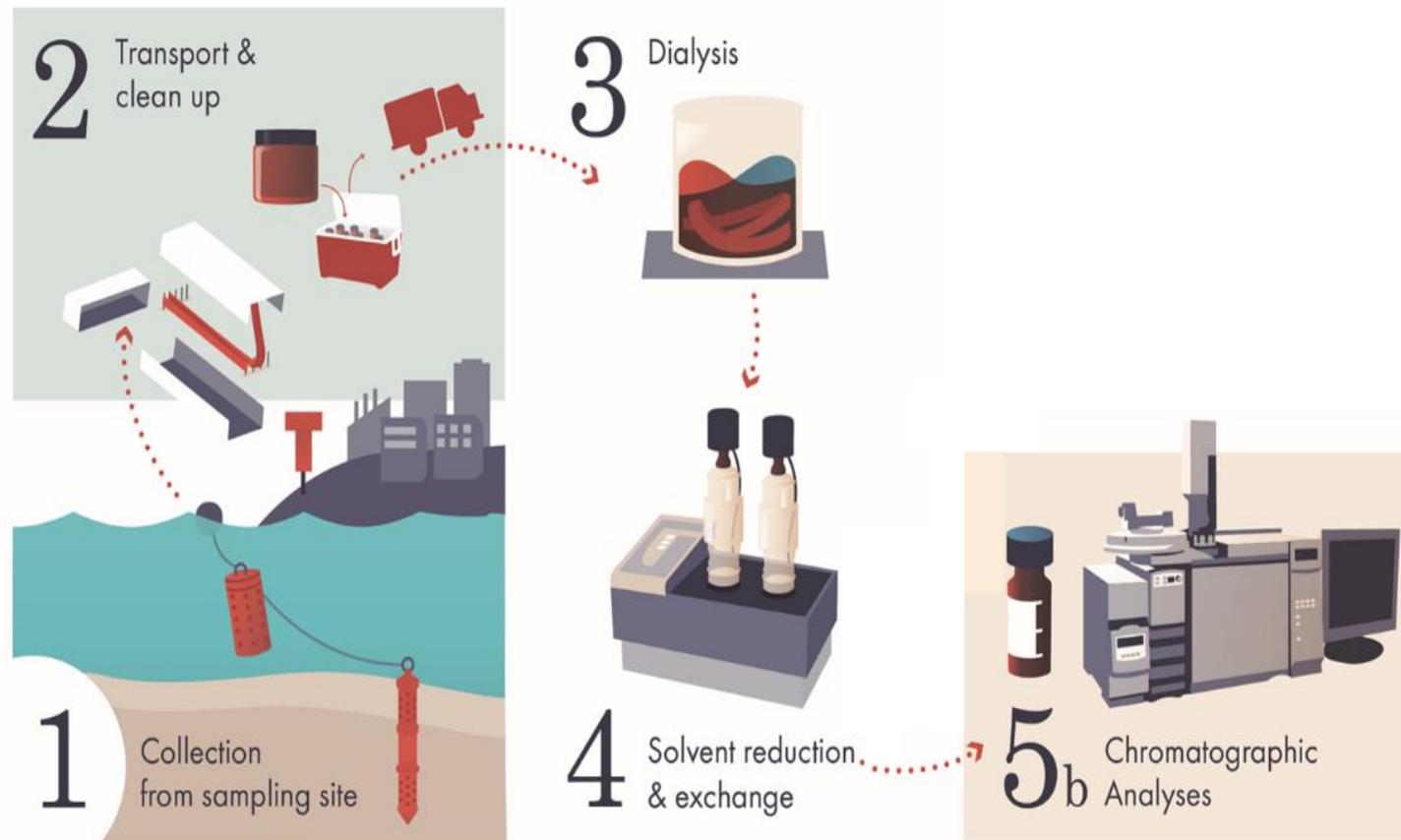


Glenn Wilson



Richard Scott

Methods

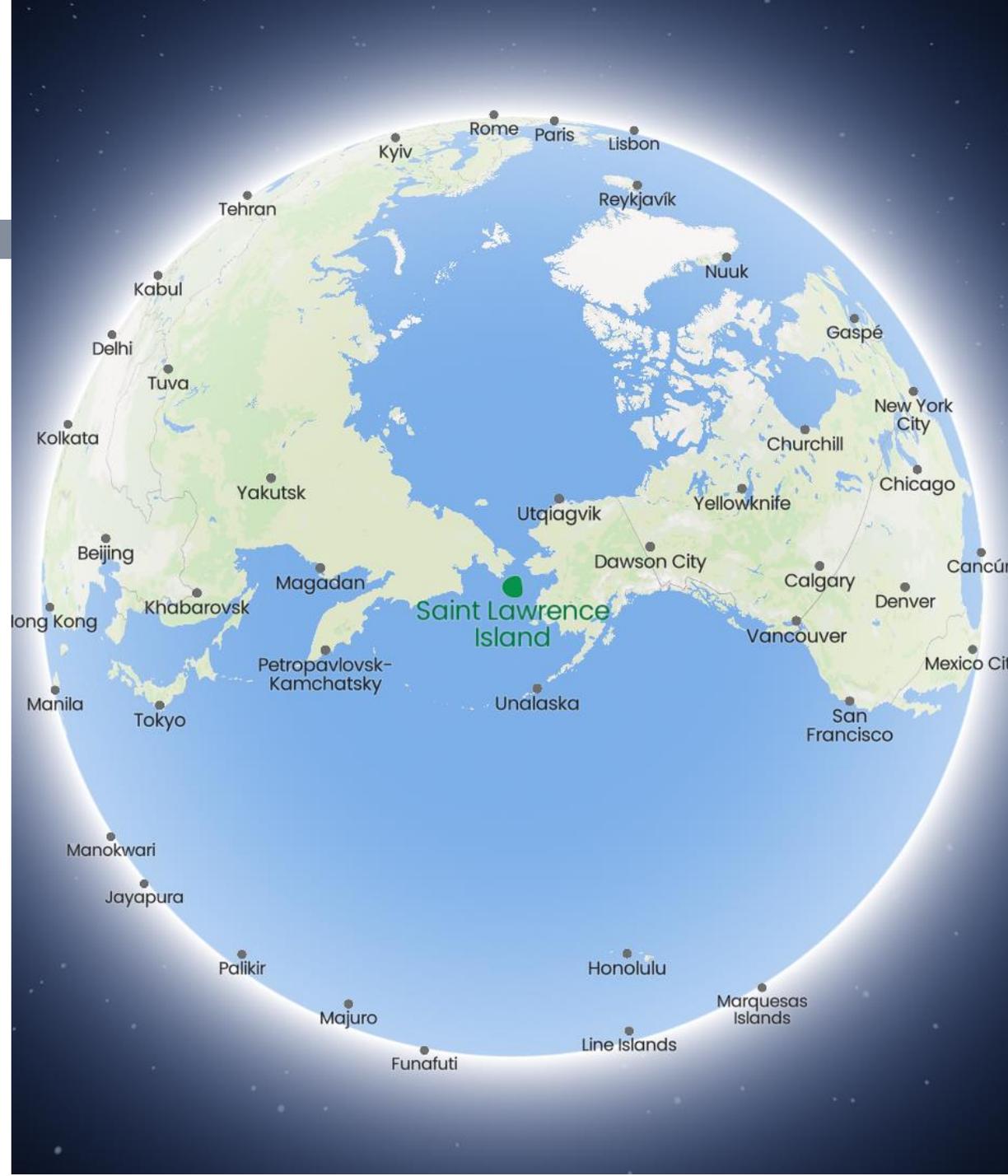


Ice, chemical movement

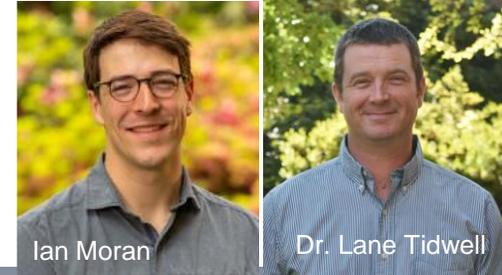
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Extreme weather,
changing climate
assessing chemical
movement

Community
engaged



Diffusive Fluxes of Persistent Organic Pollutants Between Arctic Atmosphere, Surface Waters and Sediments

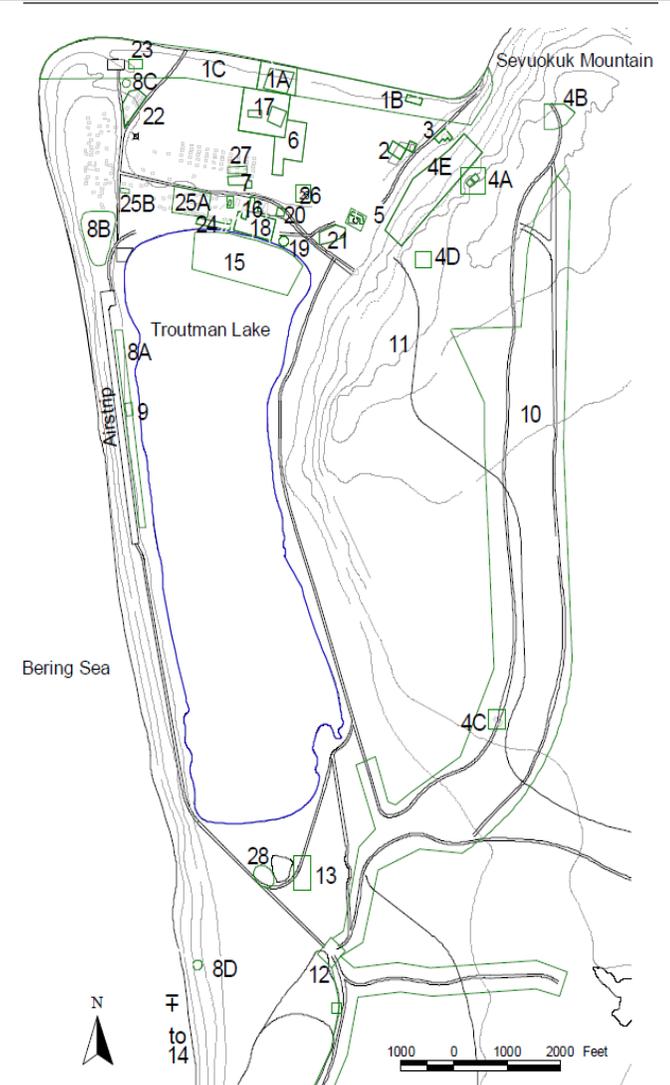


Ian Moran

Dr. Lane Tidwell

7

- 40 mi off the coast of Siberia, St. Lawrence Island
- 1 400 Yupik residents
- Passive Samplers air, water, sediment to assess movement between sediment and water and between water and air

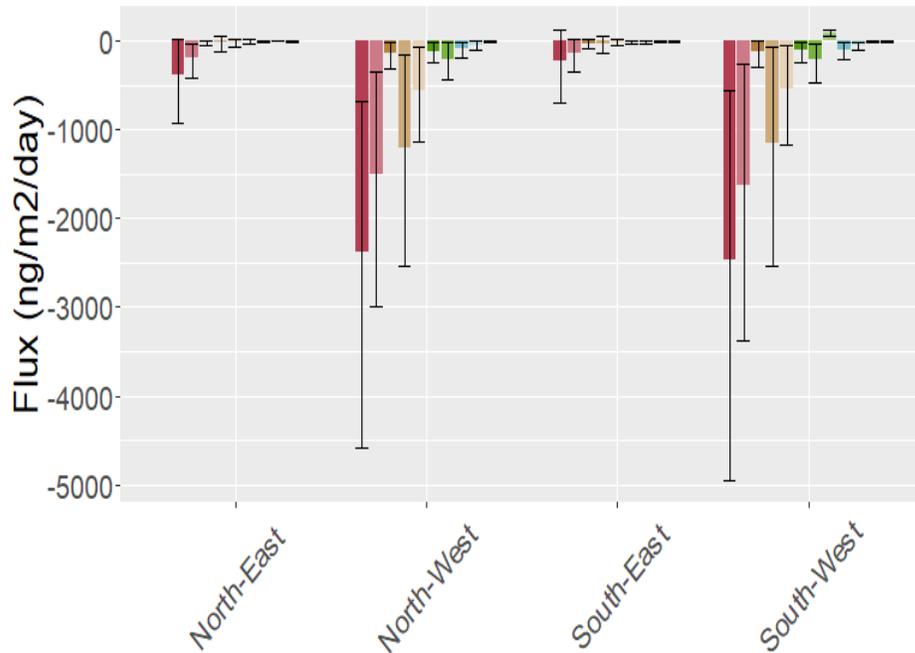


Diffusive Fluxes of Persistent Organic Pollutants Between Arctic Atmosphere, Surface Waters and Sediments



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D) Water-Air Flux



Analyte

- Naphthalene, 2-methyl-
- Naphthalene, 1-methyl-
- Naphthalene, 2-ethyl-
- Naphthalene, 2,6-dimethyl-
- Naphthalene, 1,6 and 1,3-dimethyl-
- Naphthalene, 1,4-Dimethyl-
- Naphthalene, 1,5-Dimethyl-
- Naphthalene, 1,2-dimethyl-
- 2-Methylphenanthrene
- 1-Methylphenanthrene
- 1-Methylpyrene
- Retene

Flux:

negative value = deposition

positive value = release

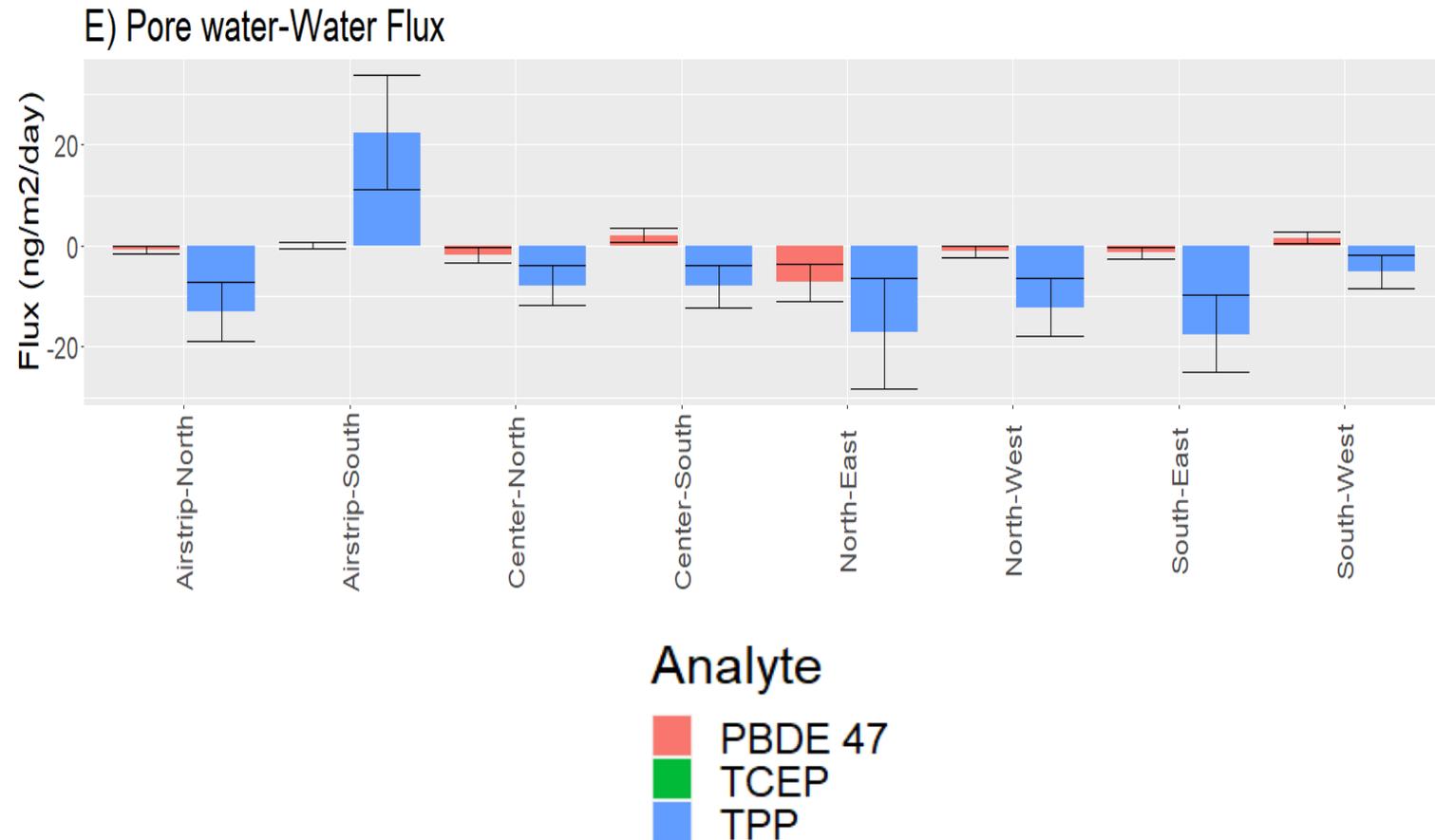
PAHs in air are depositing to the waters

Diffusive Fluxes of Persistent Organic Pollutants Between Arctic Atmosphere, Surface Waters and Sediments



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- Flux:
 - **negative** value = deposition
 - **positive** value = release
-
- **Flame Retardants in water are mostly depositing to the sediments**
 - Note other uses of TPP beyond FR

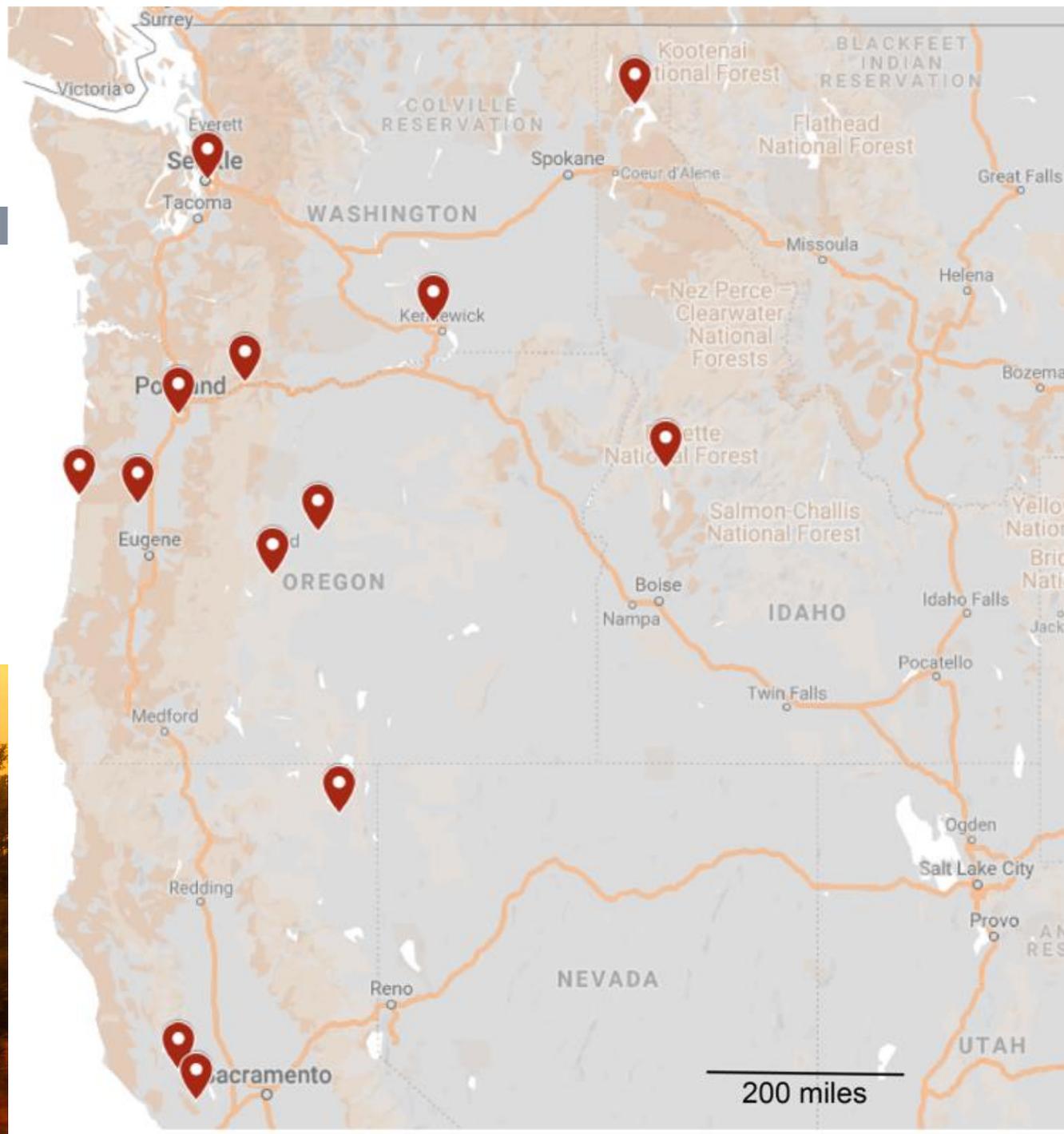


Fire, chemical movement

10

Extreme weather,
changing climate
assessing chemical
movement

Community
engaged

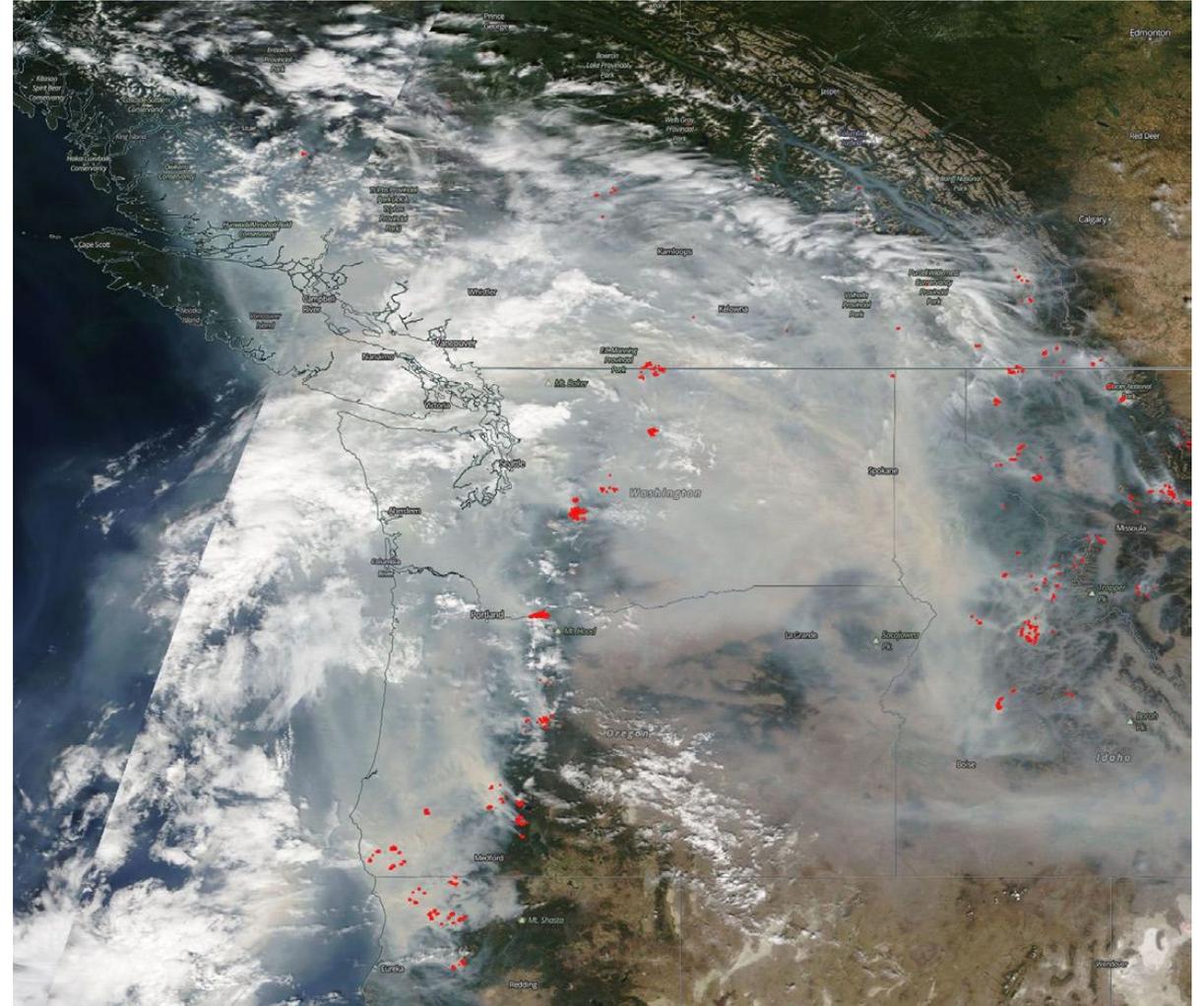


Disaster Response: Wildfire Chemical Exposures

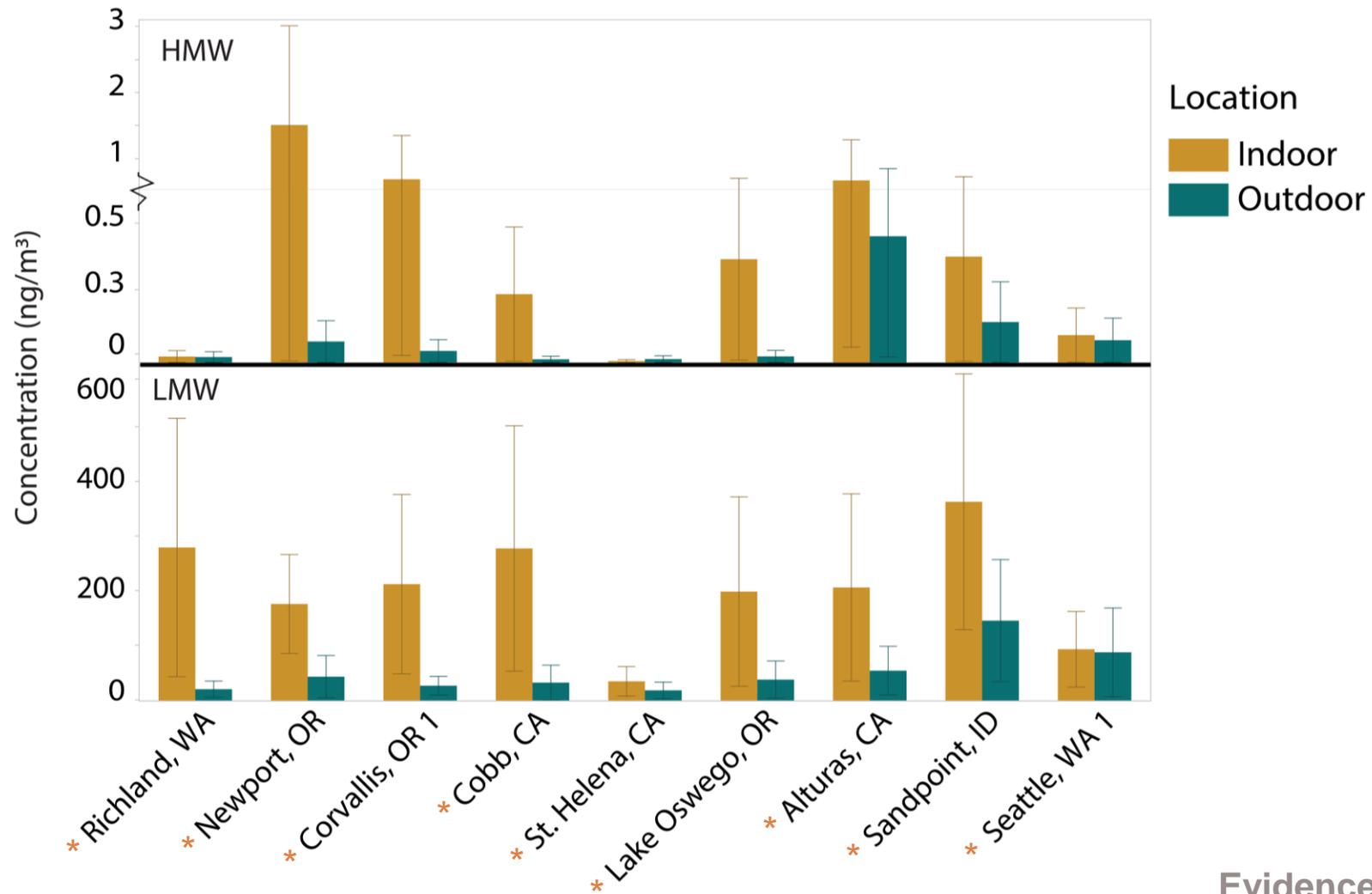
Wildfire Impact on Indoor and Outdoor Air Quality



Dr. Christine Ghetu



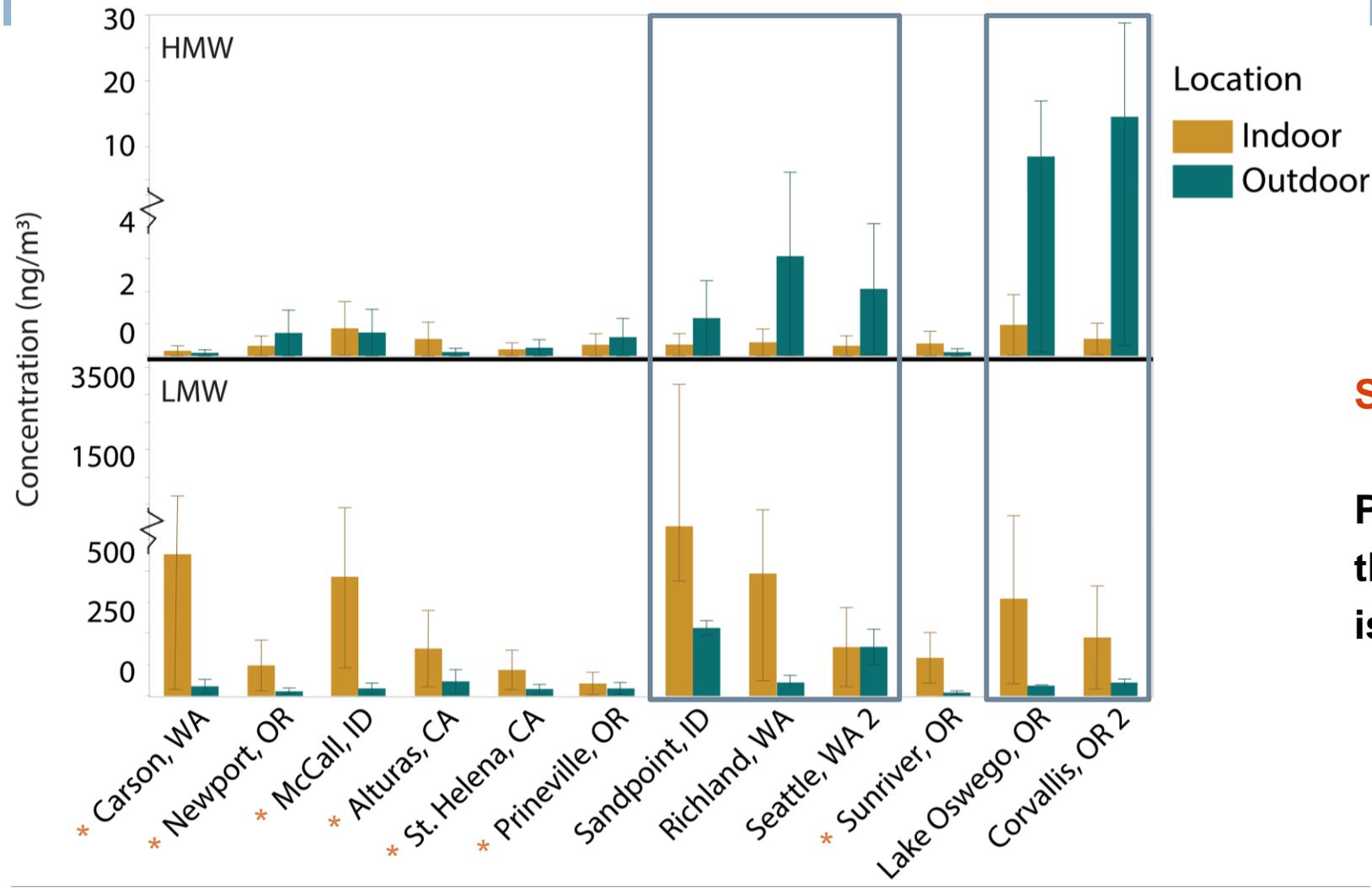
Before wildfires, PAH air concentrations indoors were higher than outdoors.



Evidence rejecting H₂

*One-sided paired t-test using Bonferroni procedure ($p < 0.0042$)

During wildfires, PAH air concentrations indoors were often higher than outdoors



Surprise finding

**PAHs are *higher indoors*
than outdoors until the AQI
is > 150 for HMW PAHs**

Increasing average AQI

Evidence rejecting H₂ at average AQIs < 140

Rain, chemical exposures

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Extreme weather,
changing climate
assessing chemical
exposures

Community
engaged



Air Pollutants Were Released Across the Region



Estimated data from Aug. 23 to Aug. 30, 2017



Response, Recovery, and Resilience to Oil Spills and Environmental Disasters: Exploration and Use of Novel Approaches to Enhance Community Resilience

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Rapid Response Hurricane Harvey



Holly Dixon



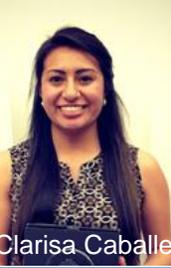
Diana Rohlman



Lane Tidwell



Pete Hoffman



Clarisa Caballe

- Chemicals exposures can not be known *a priori*, lots of unknowns....
- The Houston Health Dept stated that "**millions of contaminants**" were present in floodwaters.
- Hiroko Tabuchi & Shelia Kaplan, [A Sea of Health and Environmental Hazards in Houston's Floodwaters](#), *New York Times* (August 31, 2017)



Harvey Hits Houston

Days after the Harvey, OSU partnered with UT School of Public Health and Baylor College of Medicine



Data Collection #2

267 participants
90% compliance



↑
**Longitudinal Cohort
(n = 99)**



Researchers recruited 32 individuals living or working in flooded area to wear a wristband for seven days as a pilot project (84% compliance)



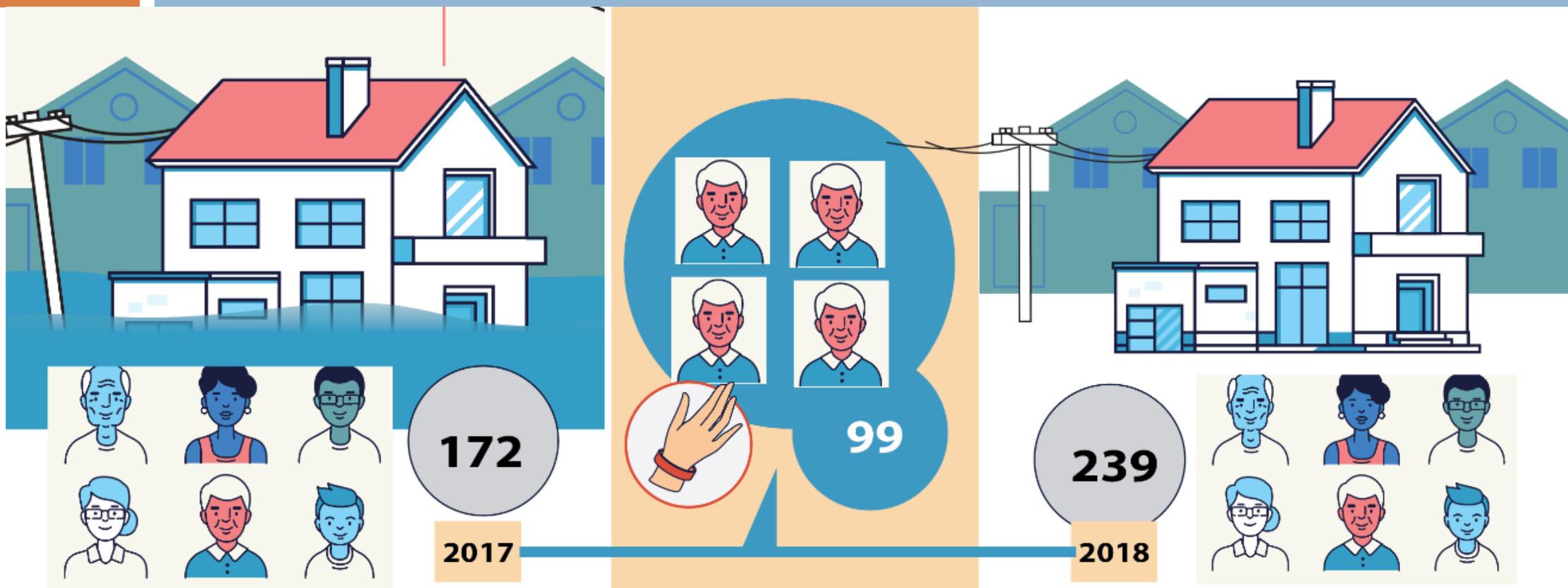
208 participants
83% compliance

Associating Increased Chemical Exposure to Hurricane Harvey in a Longitudinal Panel Using Silicone Wristbands

Samantha M. Samon ¹, Diana Rohlman ² , Lane G. Tidwell ¹, Peter D. Hoffman ¹, Abiodun O. Oluoyomi ^{3,4} and Kim A. Anderson ^{1,*}

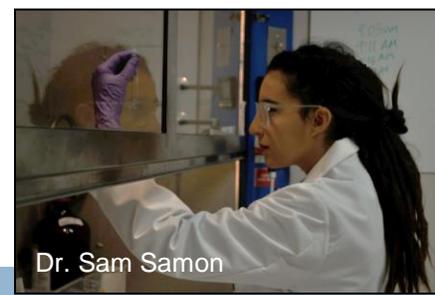


Rapid Response Hurricane Harvey chemicals exposures can not be known *a priori*, lots of unknowns...



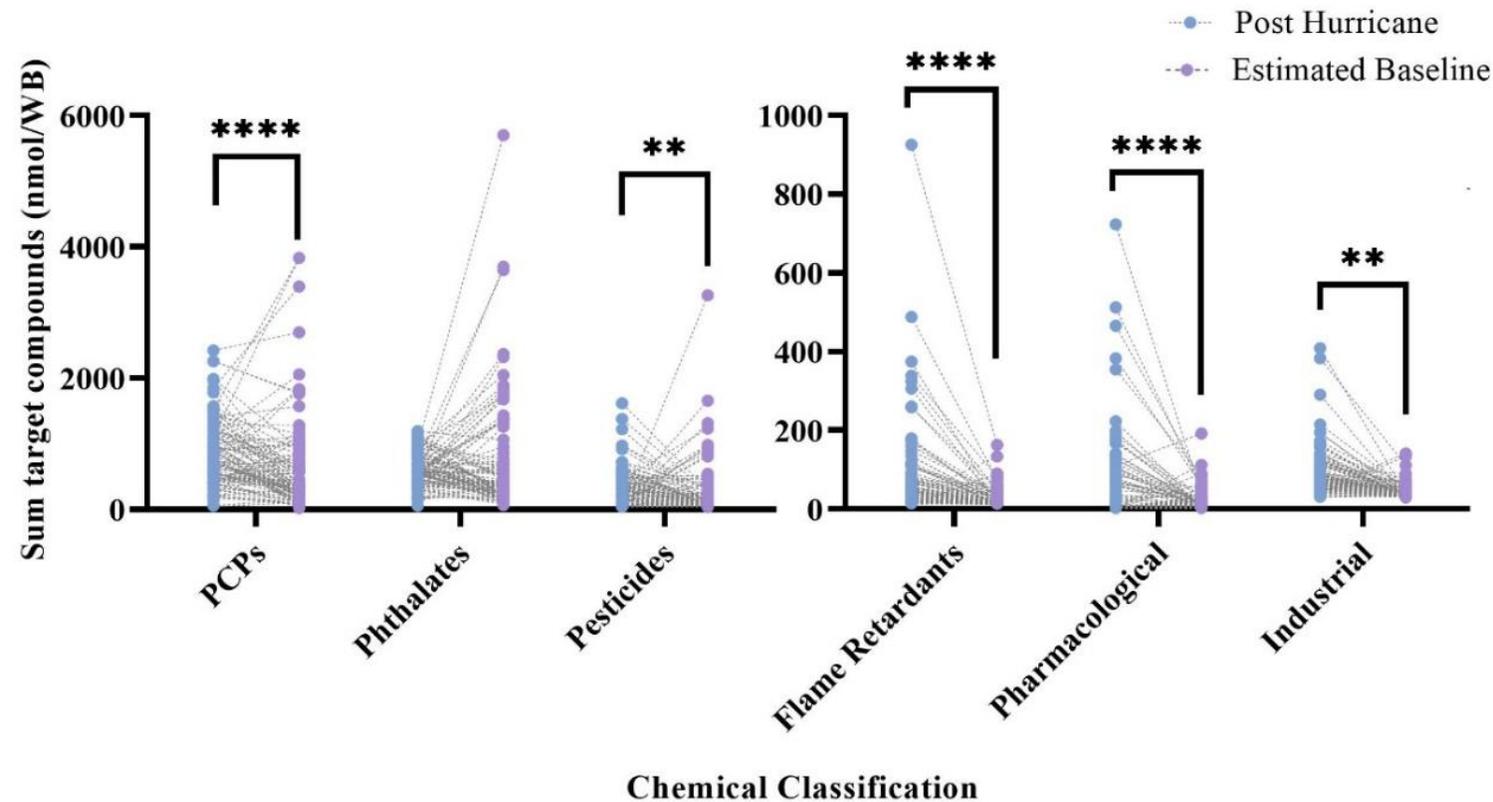
Disaster Response: Hurricane Harvey Chemical Exposures

Chemical exposure levels found on the wristbands were generally higher post-Hurricane Harvey



Post Hurricane Chemical Exposures generally higher than baseline

- Sum concentration of chemical classifications for matched pairs across timepoints. Comparisons represent results from Wilcoxon matched-pairs signed rank tests * ($P < .05$), ** ($P < .01$), *** ($P < .001$), **** ($P < .0001$)



Disaster Response: Hurricane Harvey Chemical Exposures

Chemical exposure levels found on the wristbands were generally higher post-Hurricane Harvey

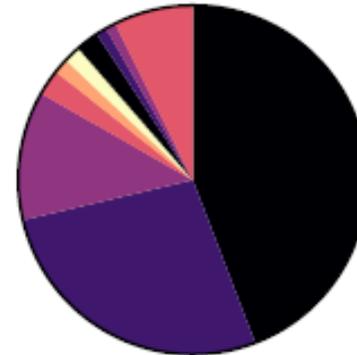


□ **Post Hurricane chemical exposures generally higher than baseline**

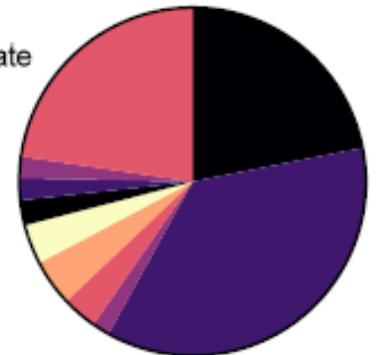
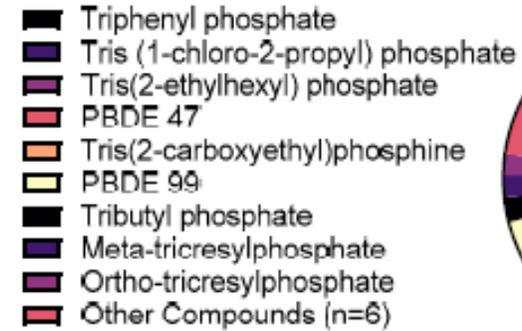
Post - Hurricane

Estimated Baseline

Flame Retardants

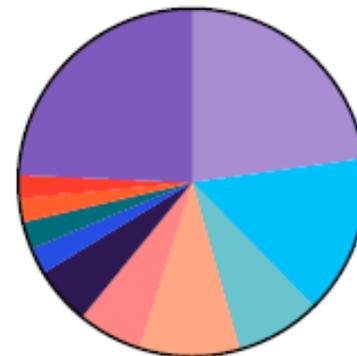


Total= 81 nmoles

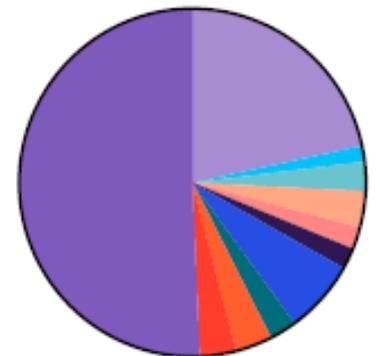
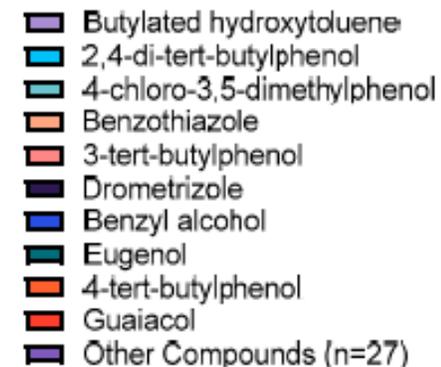


Total= 25 nmoles

Industrial



Total= 85 nmoles



Total= 38 nmoles

Disaster Response, Extreme Weather

Reporting back to communities, Determine chemical concentrations in air, water, sediment, soils, Determine chemical movement (fate), characterize individual chemical exposures

ALL projects community engagement and all project reported back to community first

Extreme Weather- chemical characterizations, chemical movement and chemical exposures

Hurricane Harvey Wristband Study Update

The Highlands Community

June 20, 2018

Oregon State Research Team

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- Lane Tidwell, PhD
- Pete Hoffman
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National Institutes of Environmental Health Sciences

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- Gustavo Elizondo

Texas Health and Environment Alliance

- Jackie Young

CONFLICT OF INTEREST STATEMENT
Kim Anderson and Diana Rohlfman have a conflict of interest related to this study. Their researchers own or are related to someone who owns a company that provides services related to the silicone wristbands and that interest could influence research that you are participating in.

WHO Researchers from Oregon State University Superfund Research Program collaborated with the Texas Health and Environment Alliance

WHAT We used passive wristband samplers to determine personal chemical exposure after the flooding in Houston

WHY These wristbands can measure up to 1,530 different chemicals found in the air, water and soil. We are collecting this information to get a better idea of what types of chemicals people may be exposed to after extreme flooding.

Effects of Hurricane Harvey

41 Superfund sites in the impacted areas

89 TOTAL toxic releases

13 sites flooded

28 sites considered unaffected

Our Study

On September 20, 2017, researchers enrolled individuals living or working in flooded areas to wear a wristband for seven days. More information about the wristband is on the last page of this report.

We looked at chemicals in different chemical classes, as shown on the next page.

Currently, there are no regulations for many of these chemicals in the air. As a result, it is difficult to know how much of a chemical is needed to cause health effects. Therefore, while this report shows the chemicals found in wristbands, that does not mean that you will suffer from any health effects.

Future work will track chemical exposures over time, for example 1 year after Hurricane Harvey.

32 people recruited

27 wristbands returned
27 wristbands analyzed

All wristbands tested for
1530 chemicals

Results at a Glance

Summary of the study

We looked for 1,530 chemicals found in several different chemical classes. Some chemicals are included in more than one class. For example, triclosan is found in both personal care products and is considered a pesticide. On average, each person had 28 chemicals in their wristband. For a full list of all 1,530 chemicals, please visit: <http://hes.oregonstate.edu/1530>

We measured chemicals at the nanogram level, which is a very small amount. However, we are still learning how much of a chemical is needed to cause a negative health effect. Our ability to measure very low levels of chemicals is helping us better understand the relationship between exposures at this level and potential health effects.

We detected a total of 119 chemicals across all 27 wristbands. 1411 chemicals were not detected.

Endocrine disruptors are found in many groups, including pesticides, flame retardants and personal care products.

Industrial chemicals include phthalates, commonly found in plastics.

ng/wristband = nanograms of chemical/wristband

Nanogram = 1 billionth of a gram. That's like 1 second in nearly 32 years.

Take Home Messages

- An average of 28 chemicals were detected in each wristband. The lowest was 12 chemicals in a wristband and the highest was 43 chemicals in a wristband.
- People were mostly exposed to endocrine disruptors, followed by industrial chemicals and chemicals found in personal care products.
- NO dioxins, furans or polychlorinated biphenyls (PCBs) were detected in any of the samples
- Future work will track chemical exposures over time, for example 1 year after Hurricane Harvey.

Questions?

Thank you for your interest in this study. Please do not hesitate to reach out if you have additional questions.

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Acknowledgements



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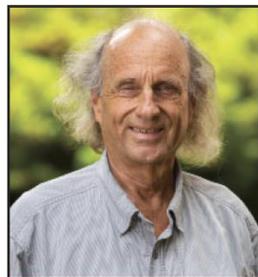
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R21 ES020120 (PI Anderson)
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Oregon DEQ
Oregon DEQ with her management plan, Dr. Kim Anderson, discloses a financial interest in MyExposome, Inc.

