2023 Annual Meeting Report

Basic Information

Project No. and Title: NC1187: Particulate Reactivity and Cycling in a Changing Environment: Implications for Agriculture and Human Health

Period Covered: 10/01/2022 to 09/30/2023

Date of Report: 12/15/2023

Annual Meeting Dates: 07/14/2023 to 07/14/2023

The annual meeting was held in conjunction with PALSA 2023, the 3rd International Pan American Light Sources for Agriculture (July 12-14) at Cornell University with virtual option

Participants

Stephen Anderson, Jorge Guzman, Christina Hamilton, Ganga Hettiarachchi, Andrew Huang, Alexandra Kravchenko, Chenxi Li, Angela Possinger, and Wei Zhang

Brief Summary of Minutes of Annual Meeting

Our regional system administrator Christina Hamilton gave a brief remark. Each project participant in the annual meeting provided a brief summary and update of research activities during last year. The group further discussed ways to increase interactions and collaboration among and provide benefits to the project members. One suggestion is to organize online webinars on a regular basis and the speakers will include graduate students and postdocs from each lab. This initiative will provide early career researchers to share their research and also expose them to our multi-state research project, which can help recruit future members. The group will develop online training programs as needed, and potentially apply for the funding support from USDA-NIFA. The group discussed future directions and one area to focus is on the effect of climate change on soil processes and properties and innovative methods to quantify these effects in the agricultural and environmental settings. The group discussed future project renewal and there is a desire to continue this multi-state research project. More efforts need to increase the collaboration among the project members from various states. The renewal proposal will be developed in 2024. The group also decided to have an informal gathering in the ASA-CSSA-SSSA International Annual Meetings at St. Louis, MO.

Accomplishments

The investigators of this multistate research project are committed to basic and applied research on physical, chemical, and biological processes in soils, as well as meaningful outreach activities in order to enhance agricultural productivity and protecting human and ecosystem health. In the past year the investigators studied the role of climate change (particularly flooding and sea level rise) on the cycling of contaminants and elements (e.g., Cr) in coastal soils, the effect of cover crops on soil structure and nutrient transport, nitrate removal from water resources with electrochemical reduction, wind soil erosion, air pollution, the speciation, bioavailability, and transport of metals and nutrients in soil-plant systems, recovery of potable water and valuable nutrients from wastewater sources, and environmental processes and impacts of per and polyfluoroalkyl substances [PFAS], pharmaceuticals, metals, and prions in soil, water, and plant systems, using a multitude of spectroscopic, molecular, experimental,

and computational methods. The results suggest that sea level rise-induced water salinity and redox fluctuation can impact Cr cycling. The use of cover crops can improve soil pore networks and enhance labile P concentrations in soils and runoff sediments. Long-term cover crop treatment affects P speciation in both soil and runoff sediments. Smectite could be redox-activated for the purpose of eliminating nitrate from natural waters using electrochemical reduction without the addition of chemical or biological reducing agents. Fundamental knowledge on P speciation, bioavailability, and transport help better utilize P fertilizers while avoiding the excess loss of P to water bodies. Improved understanding on environmental processes of conventional and emerging contaminants is important to remediating soil pollution and ensure water quality and food safety.

In terms of multi-state collaborative activities, Dr. Ganga Hettiarachchi (KSU) worked together with an NC1187 group member in Texas and his team (Texas A&M, Paul Schwab, and a graduate student, Aditi Pandey) on analyzing and interpreting collected STXM-NEXAFS data on Martian analog soils. Dr. Hettiarachchi also worked with Jonathan Judy and his team at the University of Florida on P speciation work. Michigan State University and Creighton University collaborated on investigating the environmental persistence, bioavailability, and infectivity of prions in soil and water systems. Our group organized an in-person annua meeting in conjunction with the 3rd International Pan American Light Sources for Agriculture (July 12-14) at Cornell University. Following the meeting Michigan State University (Kravchenko) initiated collaboration with Virginia Tech (Possinger) focusing on the role of metals (Mn and Fe) in processes leading to soil C cycling and soil health improvements.

More State-specific research activities are detailed below.

At the University of Delaware, the Sparks Group continues to focus on the role of flooding and sea level rise (SLR) on elemental and contaminant cycling. Chromium (Cr) is a redox-sensitive element in contaminated coastal urban soils. SLR with subsequent soil inundation may facilitate Cr transformation and mobilization through alterations in local redox conditions and porewater ion composition. We investigated the impact of water salinity and redox conditions on Cr chemistry in these environments. Synchrotron-based X-ray spectroscopy and wet chemical analyses revealed that the soils contained very high levels of Cr (up to 4320 mg kg^{-1}) and that chromite (~52%) and Fe-Cr hydroxide coprecipitates (~44%) were the predominant Cr species. The abundance of these two components resulted in low Cr mobility under non-flooded conditions. Chromium(II) was identified in the soils, potentially derived from the waste parent material. Seawater and anoxic conditions resulted in lower Cr release compared to freshwater and aerobic conditions. Up to three to eight times more Cr was released under aerobic conditions versus anaerobic conditions in the freshwater versus saltwater, respectively, with total dissolved Cr values remaining below 0.02 mg L^{-1}. The decrease in Cr release was likely due to Cr reduction by Fe(II) and sulfide. This work provides important information on how salinity and redox fluctuations impact Cr cycling which is likely to occur during SLR.

At University of Missouri Dr. Stephen Anderson's group investigated the effect of cover crops on soil structure. Cover crops (CC) may improve soil physical, chemical, and biological properties; however, the micrometer scale quantification of geometric pore characteristics in CC soil is limited in the literature. The objective of this study was to differentiate geometrical pore characteristics between CC and no CC (NCC) by computed tomography (CT). The study design consisted of winter CC and summer corn (Zea mays L.)–soybean [Glycine max (L.) Merr.] rotation with no-till management. The sample cores were collected after seven years of mixed species CC establishment. Six 0-to-65-mm-long soil cores (28-mm diam.) were imaged at 29-µm resolution, and three-dimensional volumes were analyzed using Fiji-

ImageJ2 software. Slice thickness was 29 μm, and the minimum achievable voxel size was 90 nm. Images within the top and bottom 7.25 mm were removed, and two depths within a core were analyzed for soil pore parameters. The total pore volume was significantly greater ($P < 0.05$) in CC compared with NCC, with 8.4 and 2.5 times greater values in CC at 7.25–27.25 and 37.25–57.25 mm, respectively. The total (individual + branched) and the individual pore count were significantly greater ($P < 0.05$) in CC compared with NCC for both depths. The porosity of CC soil at 7.25-to-27.25-mm depth was 10 times greater than that of NCC. The branched pore count was not significantly different between two treatments. Overall, the micrometer scale determination of geometrical pore network characteristics showed added benefits of CC use compared with NCC; thus, the use of CC can be beneficial in improving soil pore networks.

At University of Illinois, Dr. Yuji Arai's group designed and fabricated the prototype of the wind erosion and soil particle collectors for the field experiments. The audiences will be educated in the important application of modern techniques to study the important soil nutrient transformation and translocation in agricultural systems affected by wind erosion. Dr. Joseph Stucki investigated redox-activated smectites as agents for removing undesirable pollutants such as nitrate from water. The goal of this study was to find an inexpensive and natural resource that can be used to eliminate nitrate from agricultural waters and drinking water reservoirs. A very promising candidate for this purpose is the clay mineral group known as smectite, which contains iron (Fe) in its crystal structure. Smectites are ubiquitous in nature and readily available. The Fe stays inside the clay as an integral part of the mineral lattice network and is susceptible to changes in its electrical charge, known as oxidation-reduction (redox, for short), in which Fe^{3+} is reduced to Fe^{2+}, also denoted Fe(III) and Fe(II), respectively. This change in oxidation state impacts important reactions at the clay mineral surfaces. One of the potential redox reactions at the surface is for Fe(II) to reduce nitrate to less harmful forms of nitrogen. An important advancement was made during this time period, involving an electrochemical reduction reaction that does not require the addition of any chemicals.

At Kansas State University, Dr. Hettiarachchi's group conducted research on wastewater as a renewable resource. Recovered nutrient products (RNPs) from wastewater may contain high concentrations of plant-available nutrients such as phosphorus (P). Therefore, they can provide promising alternative fertilizers for crop production. In collaboration with a team of researchers at the College of Engineering (Dr. Prathap Parameswaran and his team in the KSU Civil Engineering Department), Dr. Hettiarachchi's (Kansas PI) team tested the hypothesis that an anaerobic membrane bioreactors (AnMBR) can produce potable water from swine wastewater while recovering nutrients and producing soil amendments for crop production. Although not as soluble as conventional fertilizers, the Ca-based RNPs (hydroxy apatite-like) recovered from synthetic and natural swine wastewaters acted as a phosphorus source in all tested soils (acid, alkaline, and/or neutral soils). Further, these RNPs contained very low levels of potentially toxic trace elements, successfully meeting the safety standards set for fertilizer products. Optimizing Ca-based RNP recovery will likely offer applicable secondary P sources for agriculture.

Phosphorus loss from non-point agricultural sources is a crucial contributor to decreased surface water quality. Phosphorus can be found in both dissolved and sediment-bound forms in agricultural runoff. In the second cycle of the Kansas Agricultural Watershed Field Laboratory research project entitled "Sustainable Phosphorus Management with Enhanced Soil Health (2020-2025), detailed characterizations of runoff sediments and soils were introduced to elucidate the underlying mechanisms of phosphorus loss in runoff waters. Synchrotron-based X-ray near-edge structure spectroscopy (XANES) analyses of soil and sediment samples were completed. The XANES analysis showed iron-associated phosphorus depletion in soil and sediment from cover crop systems compared to no cover crop systems.

This suggests that changes in P speciation caused by cover crops play a vital role in the solubility of phosphorus in cover crop-incorporated agricultural systems. Wet chemical P fractionation studies further complemented these results.

The project also allowed several KSU graduate students to travel to the Advanced Photon Source to collect various synchrotron-based X-ray spectroscopy data and train in analyzing data. Provided training for two graduate students at the University of Adelaide (Australia) and Texas A&M to collect, analyze, and interpret XAS and/or STXM-NEXAFS data.

At University of California, Berkeley, Dr. Allen Goldstein's group studied the residential PM2.5 concentrations, and air pollutants such as VOC and NOx in urban, farm, and wildfire settings.

At Michigan State University (MSU) Dr. Wei Zhang's group focused on studying the fate and transport of environmental contaminants in soil, water, and plant systems. Specifically, his group studied the interactions of infectious proteinaceous particles (prions, new groups of emerging contaminants) with soil geosorbents. This study aimed to understand environmental behaviors of chronic wasting disease prions and to develop novel cost-effective mitigation strategies. Molecular dynamics simulation was used to understand the interactions of amino acids and eventually peptides, poly peptides, and prions with aromatic carbon surfaces. The group investigated the crop uptake of mixed metal(loids) as influenced by a variety of soil amendments and developed a high throughput soil microcosm experiments to screen the crop metal uptake. Dr. Kravchenko's group continued exploring the role of soil structure in protection and sequestration of soil organic carbon and in improvements of soil health. The recent focus is the contribution of Mn and Fe to the interactions between soil structure and soil carbon. The work relies on joint analyses of soil pore structure via X-ray computed micro-tomography with XRF mapping of Mn and Fe and with XANES spectroscopy to explore the spatial distribution patterns in Mn oxidation states in intact soils. We examined soils of the land use and management systems relevant to sustainable management, including but not limited to cover crop and organic management, bioenergy switchgrass, and restored prairie systems.

At the University of Idaho Dr. Strawn researched recovery of nutrients from dairy waste for use as soil amendments. To recover phosphorus from dairy waste he is treating waste waters from the dairies with novel biochar materials that can adsorb phosphorus. The recovered biochar and phosphorus are then tested as amendments in soils to determine their effectiveness as alternative soil fertilizer sources. He used advanced spectroscopic characterization to understand the phosphorus reaction processes. Results from the recycling of nutrients from dairy wastewater were shared at a stakeholder meeting that included industry representatives, regulatory agencies, and scientists.

Impacts

The work at University of Delaware advanced the understanding of the mobility of contaminants (Cr) in coastal soils subjected to flooding and sea level rise, related to climate change, which can provide valuable risk assessment data to protect human health.

At Missouri cover crops are used to protect soil from erosion during non-cropped annual periods during crop production, and to help build soil carbon to improve soil health. These systems may improve soil pore systems for improved soil conditions. The State of Missouri is investing more than $40 million per year in cost-share with farmers and ranchers to use cover crops to improve long-term soil health for enhanced crop production and to prevent soil erosion. Current research with tomographic imaging has shown increased levels of soil macropores and improved water transport with cover crop management

compared to traditional management. Dr. Anderson is training 4 PhD and 3 MS students with 1 PhD student and 1 MS student completed degrees.

The work at Kansas State University demonstrated that long-term (five-year) phosphorus application with cover crops reduced iron-phosphorus concentrations, likely causing increased dissolved P levels in runoff waters.

At University of Illinois, wind erosion and soil particle collectors were designed and developed for the field experiments. An electrochemical cell suitable for high throughput operation is also being designed. A new 50 mCi 57Co source for the Mössbauer spectrometer was obtained and the research team is now in the process of ramping up operation of that very valuable instrument. Two members of the team also received training from colleagues at the Advanced Photon Source on the software used to interpret synchrotron data according to the Mössbauer effect.

At Michigan State University, molecular dynamics tools were developed to simulate the interactions of amino acids with carbon surface and prion proteins with metal ions, which can be used by other researchers. A high throughput screening method was also developed to assess the crop uptake of both toxic and essential metal(loids).

Outputs

Publications

Peer-reviewed:

1. Chahal, S.K., G.M. Hettiarachchi, N.O. Nelson, and M.J. Guttieri. 2023. Fate and plant uptake of different zinc fertilizer sources upon their application to an alkaline calcareous soil. ACS Agric. Sci. & Technol, 3, 9, 725–737, https://doi.org/10.1021/acsagscitech.2c00287
2. Arachchige, V.K., T.M. McBeath, R.J. Smernik, G.M. Hettiarachchi, R. Khalil. 2023. The Effect of Metal Oxide Coating of Urea on Mineralization in Two Contrasting Soils. *Soil Sci. Soc. Am. J*. https://doi.org/10.1002/saj2.20576.
3. Kastury, F., H. Li, R. Karna, R., A. Betts, K.G. Scheckel, L. Ma, T.D. Sowers, K.D. Bradham, G.M. Hettiarachchi, and A.L. Juhasz. 2023. Opportunities and Challenges Associated with Bioavailability-Based Remediation Strategies for Lead-Contaminated Soil with Arsenic as a Co-Contaminant—A Critical Review. Curr Pollution Rep. https://doi.org/10.1007/s40726-023-00252-z
4. Wekumbura, C., G.M. Hettiarachchi, and C. Sobin. 2023. Estimating the proportion of bioaccessible lead (BaPb) in household dust wipe samples: a comparison of IVBA and PBET methods J. Environ. Sci. Health A. 58(2):127-138. https://doi.org/10.1080/10934529.2023.2178206
5. Fischel, M.H., Clarke, C.E. and Sparks, D.L., 2023. Synchrotron resolved microscale and bulk mineralogy in manganese-rich soils and associated pedogenic concretions. Geoderma, 430, p.116305. https://doi.org/10.1016/j.geoderma.2022.116305
6. Barreto, M.S.C., Elzinga, E.J. and Sparks, D.L., 2023. The adsorption of arsenate and p-arsanilic acid onto ferrihydrite and subsequent desorption by sulfate and artificial seawater: Future implications of sea level rise. Environmental Pollution, 323, p.121302. https://doi.org/10.1016/j.envpol.2023.121302
7. Yeasmin, S., Singh, B., Johnston, C.T., Quan, H.U.A. and Sparks, D.L., 2023. Changes in particulate and mineral-associated organic carbon with land use in contrasting soils. Pedosphere, 33(3), pp.421-435. https://doi.org/10.1016/j.pedsph.2022.06.042

8. Betts, A.R., Siebecker, M.G., Elzinga, E.J., Luxton, T.P., Scheckel, K.G. and Sparks, D.L., 2023. Influence of clay mineral weathering on green rust formation at iron-reducing conditions. Geochimica et Cosmochimica Acta, 350, pp.46-56. https://doi.org/10.1016/j.gca.2023.04.001
9. Sricharoenvech, P., Siebecker, M.G., Tappero, R., Landrot, G., Fischel, M.H. and Sparks, D.L., 2023. Chromium Speciation and Mobility in Contaminated Coastal Urban Soils Affected by Water Salinity and Redox Conditions. Journal of Hazardous Materials, p.132661. https://doi.org/10.1016/j.jhazmat.2023.132661
10. Blanco, H., S. Kumar and S.H. Anderson. 2023. Soil hydrology in a changing climate. 262 pp. CRC Press, Routledge Taylor & Francis Group, Boca Raton, Florida, USA.
11. Haruna, S.I., and S.H. Anderson. 2023. Carbon storage and dynamics under sustainable soil management: Lessons learned from long-term experiments. pp. 50-85. S. Jayaraman, R. Dalal, and R. Lal (eds.) Sustainable Soil Management Beyond Food Production. Cambridge Scholars Publishing. Newcastle Upon Tyne, United Kingdom.
12. Alagele, S.M., C.D. Diggins, S.H. Anderson, and R.P. Udawatta. 2023. Cover crop and biofuel crop effects on hydraulic properties for claypan soils. Agrosystems, Geosciences & Environment 6: e20384. https://doi.org/10.1002/agg2.20384 .
13. Al-Awwal, N., S.H. Anderson, M. El-Dweik, R.P. Udawatta, J. Yang, and F. Zaid. 2023. Effects of conservation buffer systems on adsorption of fluorescent-labeled E. coli. J. Env. Qual. 52:303-314.
14. Ansari, J., F. Eivazi, S.H. Anderson, and S. Bardhan. 2023. Selected enzyme activities under different land use management in lower Missouri River Floodplain soils. Communications in Soil Science and Plant Analysis 54:(in press).
15. Ansari, J., M.P. Davis, S.H. Anderson, F. Eivazi, and S. Bardhan. 2023. Greenhouse gas emissions from row crop, agroforestry, and forested land use systems in floodplain soils. Water, Air, & Soil Pollution 234 (issue 4), 227. https://doi.org/10.1007/s11270-023-06227-6.
16. Ansari, J., R.P. Udawatta, and S.H. Anderson. 2023. Soil nitrous oxide emissions from agroforestry, row crops, grassland and forests in North America: A review. Agroforestry Systems 97:(in press).
17. Ansari, J., S. Bardhan, F. Eivazi, S.H. Anderson, and S.S. Mendis. 2023. Bacterial community diversity for three selected land use systems as affected by soil moisture regime. Applied Soil Ecology 192:(in press).
18. Conway, L.S., K.A. Sudduth, N.R. Kitchen, and S.H. Anderson. 2023. Repeatability of commercially available visible and near infrared proximal soil sensors. Precision Agriculture 24:1014-1029.
19. Moody, A., R.N. Lerch, K.W. Goyne, S.H. Anderson, D.G. Mendoza-Cozatl, and D. Alvarez. 2023. Vegetative buffer strips show limited effectiveness for reducing antibiotic transport in surface runoff. J. Env. Qual. 52:137-148.
20. Salceda, M., R.P. Udawatta, S.H. Anderson, and S. Mendis. 2023. Agroforestry buffers on nitrogen reduction in groundwater on a grazed hillslope. Agrosystems, Geosciences & Environment 6: e20370. https://doi.org/10.1002/agg2.20370 .
21. Svedin, J.D., K.S. Veum, C.J. Ransom, N.R. Kitchen, and S.H. Anderson. 2023. An identified agronomic interpretation for potassium permanganate oxidizable carbon. Soil Sci. Soc. Am. J. 87:291-308.
22. Li, Y., Livi, K.J.T., Arenberg, M.R., Xu, S., Arai, Y. 2021. Depth sequence distribution of water-extractable colloidal phosphorus and phosphorus speciation in intensively managed agricultural soils. Chemosphere. 286, 131665.
23. Xu, S. and Arai, Y. 2022. Competitive sorption and accumulation of organic phosphorus in phosphate-rich soils and sediments. Advances in Agronomy. vol. 173. 38, 337-374.
24. Xu, S., Martin, N.F., Matthews, J.W. and Arai, Y. 2022. Accumulation and release of organic phosphorus (P) from legacy P-affected soils to adjacent drainage water. Environmental Science and Pollution Research. 22, 29, 33885-33899.

25. Xu, S., and Arai, Y. 2022. Adsorption mechanisms of inositol hexakisphosphate in the presence of phosphate at the amorphous aluminum oxyhydroxide-water interface. Science of the Total Environment. 837, 155525.
26. Gunathilaka, G.U., H. Li, W. Zhang, and E.T. Ryser. 2023. Persistence of silver nanoparticles sorbed on fresh-cut lettuce during flume washing and centrifugal drying. Journal of Food Protection, 86, 100097. DOI: 10.1016/j.jfp.2023.100097.
27. Chen, Z., W. Zhang, A. Peng, Y. Shen †, X. Jin, R.D. Stedtfeld, S.A. Boyd, B.J. Teppen, J.M. Tiedje, C. Gu, D. Zhu, Y. Luo, and H. Li. 2023. Bacterial community assembly and antibiotic resistance genes in soils exposed to antibiotics at environmentally relevant concentrations. Environmental Microbiology, 25(8), 1439-1450. DOI: 10.1111/1462-2920.16371.
28. Hu, X., Y. Zhang, Z. Chen, Y. Gao, B. Teppen, S.A. Boyd, W. Zhang, J.M. Tiedje, and H. Li. 2023. Tetracycline accumulation in biofilms enhances the selection pressure on *Escherichia coli* for expression of antibiotic resistance. Science of the Total Environment, 857, 159441. DOI: 10.1016/j.scitotenv.2022.159441.
29. Lunderberg, D.M., Y. Liang, B.C. Singer, J.S. Apte. W.W Nazaroff, and A.H. Goldstein, Assessing residential PM2.5 concentrations and infiltration factors with high spatiotemporal resolution using crowdsourced sensors, Proceedings of the National Academy of Sciences, 120 (50) e2308832120, 2023.
30. Goldstein, A.H., K.C. Barsanti, J.J. Battles, S.L. Stevens, R.A. York, T. Kirchstetter, N.M. Kreisberg, D. Sengupta, Y. Liang, D. Foster, J. Butler, A. Tasnia, G. Lara, P. Van Rooy, Understanding and Mitigating Wildfire Risk in California, Final Report, California Air Resources Board Award No. 19RD008, 2023.
31. Schulze, B.C., R.X. Ward, E.Y. Pfannerstill, Q. Zhu, C. Arata, B. Place, C. Nussbaumer, P. Wooldridge, R. Woods, A. Bucholz, R.C. Cohen, A.H. Goldstein, P.O. Wennberg, and J.H. Seinfeld, Methane Emissions from Dairy Operations in California's San Joaquin Valley Evaluated Using Airborne Flux Measurements Environ. Sci. Technol., https://doi.org/10.1021/acs.est.3c03940, Article ASAP, 2023.
32. Zhu, Q., R.H. Schwantes, M. Coggon, C. Harkins, J. Schnell, J. He, H.O.T. Pye, M. Li, B. Baker, Z. Moon, R. Ahmadov, E.Y. Pfannerstill, B. Place, P. Wooldridge, B.C. Schulze, C., Arata, A. Bucholtz, J.H., Seinfeld, C. Warneke, C.E. Stockwell, L. Xu, K. Zuraski, M.A. Robinson, A Neuman, P.R. Veres, J. Peischl, S.S. Brown, A.H. Goldstein, R.C. Cohen, and B.C. McDonald, A better representation of VOC chemistry in WRF-Chem and its impact on ozone over Los Angeles, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/egusphere-2023-2742, 2023.
33. Pfannerstill, E.Y., C. Arata, Q. Zhu, B.C. Schulze, R. Woods, C. Harkins, R.H. Schwantes, B.C. McDonald, J.H. Seinfeld, A. Bucholtz, R.C. Cohen, and A.H. Goldstein, Comparison between Spatially Resolved Airborne Flux Measurements and Emission Inventories of Volatile Organic Compounds in Los Angeles, Environ. Sci. Technol., https://doi.org/10.1021/acs.est.3c03162, Article ASAP, 2023.
34. Coggon, M.M., C.E. Stockwell, M.S. Claflin, E.Y. Pfannerstill, X. Lu, J.B. Gilman, J. Marcantonio, C. Cao, K. Bates, G.I. Gkatzelis, A. Lamplugh, E.F. Katz, C. Arata, E.C. Apel, R.S. Hornbrook, F. Piel, F. Majluf, D.R. Blake, A. Wisthaler, M. Canagaratna, B.M. Lerner, A.H. Goldstein, J.E. Mak, and C. Warneke, Identifying and correcting interferences to PTR-ToF-MS measurements of isoprene and other urban volatile organic compounds, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/egusphere-2023-1497, 2023.
35. Goldstein, A.H., R. Cohen, A. Bucholtz, E. Pfannerstill, C. Arata, Q. Zhu, C. Nussbaumer, Airborne flux measurements of volatile organic compounds and oxides of nitrogen in California, Final Report, California Air Resources Board Award No. 20RD003 and 20AQP012, 2023.
36. Lyu, X., K. Li, H. Guo, L. Morawska, B. Zhou, Y. Zeren, F. Jiang, C. Chen, A.H. Goldstein, X. Xu, T. Wang, X. Lu, T. Zhu, X. Querol, S. Chatani, M.T. Latif, D. Schuch, V. Sinha, P. Kumar, B. Mullins, R. Seguel, M. Shao, L. Xue, N. Wang, J. Chen, J. Gao, F. Chai, I. Simpson, B. Sinha, D.R. Blake, Mitigating global tropospheric ozone threat through a synergistic control with climate, One Earth, 6, 8, 964-977, 2023.

37. Shetty, N., P. Liu, Y. Liang, B. Sumlin, C. Daube, S. Herndon, A.H. Goldstein, R.K. Chakrabarty, Brown carbon absorptivity in fresh wildfire smoke: associations with volatility and chemical compound groups, Environmental Science: Atmospheres, DOI: 10.1039/d3ea00067b, Advance Article, 2023.
38. Liang, Y., R.A. Wernis, K Kristensen, N.M. Kreisberg, P.L. Croteau, S.C. Herndon, A.W.H. Chan, N.L. Ng, A.H. Goldstein, Gas–particle partitioning of semivolatile organic compounds when wildfire smoke comes to town, Atmos. Chem. Phys., 23, 12441–12454, https://doi.org/10.5194/acp-23-12441-2023, 2023.
39. Zhang, J., J. Liu, X. Ding, X. He, T. Zhang, M. Zheng, M. Choi, G. Isaacman-VanWertz, L. Yee, H. Zhang, P. Misztal, A.H. Goldstein, A.B. Guenther, S.H. Budisulistiorini, J.D. Surratt, E.A. Stone, M. Shrivastava, D. Wu, J.Z. Yu, and Q. Ying, New formation and fate of Isoprene SOA markers revealed by field data-constrained modeling, npj Clim. Atmos. Sci., 6, 69, https://doi.org/10.1038/s41612-023-00, 394-3, 2023.
40. Pfannerstill, E.Y., C. Arata, Q. Zhu, B.C. Schulze, R. Woods, J.H. Seinfeld, A. Bucholtz, A., R.C. Cohen, and A.H. Goldstein, Volatile organic compound fluxes in the agricultural San Joaquin Valley – spatial distribution, source attribution, and inventory comparison, Atmos. Chem. Phys., 23, 12753–12780, https://doi.org/10.5194/acp-23-12753-2023, 2023.
41. Nussbaumer, C. M., B.K. Place, Q. Zhu, E.Y. Pfannerstill, P. Wooldridge, B.C. Schulze, C. Arata, R. Ward, A. Bucholtz, J.H. Seinfeld, A.H. Goldstein, and R.C. Cohen, Measurement report: Airborne measurements of NOx fluxes over Los Angeles during the RECAP-CA 2021 campaign, Atmos. Chem. Phys., 23, 13015–13028, https://doi.org/10.5194/acp-23-13015-2023, 2023.
42. Franklin, E.B., L.D. Yee, R. Wernis, G. Isaacman-VanWertz, N. Kreisberg, R. Weber, H. Zhang, B.B. Palm, W. Hu, P. Campuzano-Jost, D.A. Day, A. Manzi, P. Artaxo, R.A.F. Souza, J.L. Jimenez, S.T. Martin, A.H. Goldstein, Chemical Signatures of Seasonally Unique Anthropogenic Influences on Organic Aerosol Composition in the Central Amazon, Environ. Sci. Technol., https://pubs.acs.org/doi/pdf/10.1021/acs.est.2c07260, 57, 15, 6263–6272, 2023.
43. Zhu, Q., B. Place, E.Y. Pfannerstill, S. Tong, H. Zhang, J. Wang, C.M. Nussbaumer, P. Wooldridge, B.C. Schulze, C. Arata, A. Bucholtz, J.H. Seinfeld, A.H. Goldstein, and R.C. Cohen, Direct observations of NOx emissions over the San Joaquin Valley using airborne flux measurements during RECAP-CA 2021 field campaign, Atmos. Chem. Phys., 23, 9669–9683, https://doi.org/10.5194/acp-23-9669-2023, 2023.
44. Kristensen, K., D.M. Lunderberg, Y. Liu, P.K. Misztal, Y. Tian, C. Arata, W.W Nazaroff, A.H. Goldstein, Gas-Particle Partitioning of Semivolatile Organic Compounds in a Residence: Influence of Particles from Candles, Cooking, and Outdoors, Env. Sci. Technol., doi.org/10.1021/acs.est.2c07172, 57, 8, 3260–3269, 2023.
45. Reidy, E., B.P. Bottorff, C. Marciel, F. Rosales, F.J. Cardoso-Saldaña, C. Arata, S. Zhou, C. Wang, A. Abeleira, L. Hildebrandt Ruiz, A.H. Goldstein, A. Novoselac, T.F. Kahan, J.P.D. Abbatt, M.E. Vance, D.K. Farmer, and P.S. Stevens, Measurements of Hydroxyl Radical Concentrations during Indoor Cooking Events: Evidence of an Unmeasured Photolytic Source of Radicals, Env. Sci. Technol., doi.org/10.1021/acs.est.2c05756, 2023.
46. Lakey, P., A. Zuend, G.C. Morrison, T. Berkemeier, J. WIlson, C. Arata, A.H. Goldstein, K.R. Wilson, N. Wang, J. Williams, J.P.D. Abbatt, M. Shiraiwa, Quantifying the impact of relative humidity on human exposure to gas phase squalene ozonolysis products, Environ. Sci.: Atmos., doi.org/10.1039/D2EA00112H, 3, 49-64, 2023
47. O'Sullivan, J.B., J. Richardson, A.K. Guber, A.N. Kravchenko. 2023. Microscale spatial patterns in manganese oxidation states in soils under annual row crops and a native plant community. Geoderma (in review)
48. Strawn, D. G.; Sparks, D. L. Sorption—Metals. In Encyclopedia of Soils in the Environment (Second Edition), Goss, M. J., Oliver, M. Eds.; Academic Press, 2023; pp 336-342.

49. Laan, M., Kayler, Z. E., Huerta, J., & Strawn, D. G. (2023). Barley (Hordeum vulgare L.) photosynthetic and water use efficiency response to dairy-amended biochar. Agrosystems, Geosciences & Environment, 6, e20423. https://doi.org/10.1002/agg2.20423
50. Yu, P., Baker, M. C., Crump, A. R., Vogler, M., Strawn, D. G., & Möller, G. (2023). Biochar integrated reactive filtration of wastewater for P removal and recovery, micropollutant catalytic oxidation, and negative CO2e: Process operation and mechanism. Water Environment Research, 95(9), e10926. https://doi.org/10.1002/wer.10926
51. Baker, M. C., McCarthy, D., Taslakyan, L., Henchion, G., Mannion, R., Strawn, D. G., & Möller, G. (2023). Iron–ozone catalytic oxidation reactive filtration of municipal wastewater at field pilot and full-scale with high-efficiency pollutant removal and potential negative CO2e with biochar. Water Environment Research, 95(5), e10876. https://doi.org/10.1002/wer.10876
52. Strawn DG, Crump AR, Peak D, Garcia-Perez M, Möller G (2023) Reactivity of Fe-amended biochar for phosphorus removal and recycling from wastewater. PLOS Water 2(4): e0000092. https://doi.org/10.1371/journal.pwat.0000092

Presentations/Abstracts:

1. Hettiarachchi, G.M., C. Wekumbura, R. Kumarasinghe, E. Gutierrez, A. Mudiyanselage, K.G. Scheckel, A. Roberts, A. Bracker, E. Friedman, and C. Sobin. 2023. Reducing bioavailability of lead in urban residential neighborhood soils. 1st Joint International Conference on Biogeochemistry of Trace Elements/International Conference of Heavy Metals, Wuppertal, Germany, Sep 6- Aug. 10.
2. Hettiarachchi, G.M., Alasmary, Z., K. L. Roozeboom, L.C. Davis, L.E. Erickson. 2023. Field- to micro-scale investigations to evaluate phytostabilization of lead-contaminated military sites. International Phytotechnologies Conference, Chicago, IL. May 23-26.
3. Dodampe Mudiyanselage, S.N. and G.M. Hettiarachchi. 2022. Enhancing granular struvite solubility in soil with co-addition of low molecular weight organic acids (LMWOAs). ASA-CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.
4. Gamage, K.H.H., G. M. Hettiarachchi, N.O. Nelson, K.L. Roozeboom, G.J. Kluitenberg and P.J. Tomlinson. 2022. Implications of management practices on sediment and soil phosphorus speciation in no-till corn and soybean rotation. ASA-CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.
5. Gamage, K.H.H., G. M. Hettiarachchi, A.D. Kannan, and P. Parameswaran. 2022. “Green” P-based recovered nutrient products from swine wastewater: Fate and behavior in soils. ASA-CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.
6. Kathri Arachchige, V., T.M. McBeath, R.J. Smernik, G.M. Hettiarachchi, and R. Khalil. 2022. The effect of metal oxide coated urea on urea mineralization in two contrasting soils. CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.
7. Kumaragamage, D., G.M. Hettiarachchi, I. Amarakoon, and D. Goltz. 2022. Phosphorus speciation changes in an alkaline soil amended with gypsum, alum, and magnesium sulfate. CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.
8. Kumarasinghe, R., K. Shunje, C. Aackeröy, and G.M. Hettiarachchi. 2022. Exploring behavior of urea co-crystals for efficient and sustainable nitrogen management in alkaline and neutral soil. CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.

9. Mudiyanselage, A.D.E. and G.M. Hettiarachchi. 2022. Can Struvite and Struvite Mixed-Products be Used As Slow-Releasing P Fertilizers to Enhance Phosphorus Use Efficiency? CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.
10. Pandey, A, E. Rampe, D. W. Ming, G.M. Hettiarachchi, P.S.P. Arachchige and A.P. Schwab. 2022. Synchrotron spectromicroscopic analyses of amorphous phases in palagonitic soil and rock samples. ASA-CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.
11. Wekumbura, C., G.M. Hettiarachchi, and C. Sobin. 2022. Impact of organic and inorganic phosphorus sources on reduction of soil lead bioavailability: Pb-speciation perspective. ASA-CSSA-SSSA International Annual Meeting, Baltimore, MD. Nov. 6-9.
12. Anderson, S.H., C.J. Gantzer, and T.M. Reinbott. 2023. Long-term soil erosion effects on plant available water capacity. Soil and Water Conservation Society International Conference p. 65. Abstracts. 6-9 August, Des Moines, Iowa.
13. Anderson, S.H., C.J. Gantzer, and T.M. Reinbott. 2023. Plant available water capacity influenced by long-term soil erosion on Sanborn Field. 2023 American Society of Agronomy/Soil Science Society of America International Meeting Abstracts. 29 October – 1 November, St. Louis, Missouri.
14. Ansari, J., M.P. Davis, S. Bardhan, F. Eivazi, and S.H. Anderson. 2023. Soil N2O emission and nitrogen-cycling functional gene abundance as affected by extreme hydrological events for three selected Missouri River floodplain systems. 2023 American Society of Agronomy/Soil Science Society of America International Meeting Abstracts. 29 October – 1 November, St. Louis, Missouri.
15. Dhaliwal, J.K., D. Saha, S.H. Anderson, and S. Jagadamma. 2023. CT-scanning of intact soil cores revealed macropore-controlled N2O emissions under long-term soil health practices. 2023 American Society of Agronomy/Soil Science Society of America International Meeting Abstracts. 29 October – 1 November, St. Louis, Missouri.
16. Reinbott, T.M., R.J. Miles, K.S. Veum, S.H. Anderson, and R.J. Kremer. 2023. Sanborn Field: Challenges and opportunities. 2023 American Society of Agronomy/Soil Science Society of America International Meeting Abstracts. 29 October – 1 November, St. Louis, Missouri.
17. Zhou, J., T.M. Reinbott, K.A. Sudduth, and S.H. Anderson. 2023. Assessment of soil health at different cropping systems using UAV images and machine learning. 2023 American Society of Agronomy/Soil Science Society of America International Meeting Abstracts. 29 October – 1 November, St. Louis, Missouri.
18. Dong, Q., Z. Xu, S. Oza, K. Bell, J. Norton, W. Zhang, and H. Li. 2023. The impact of sludge treatment process on the fate of PPCPs in biosolids. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO, October 29-November 1 (oral presentation).
19. Xu, Z., Q. Dong, S. Oza, K. Bell, J. Norton, W. Zhang, and H. Li. 2023. Analysis of PFAS in biosolids collected from municipal wastewater treatment plants. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO, October 29-November 1 (oral presentation).
20. Li, C., A. Huang, Q. Dong, H. Li, K. Steinke, Z.D. Hayden, R. Hammerschmidt, and W. Zhang. 2023. A high-throughput soil microcosm method to assess crop uptake of mixed metals and metalloids. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO, October 29-November 1 (oral presentation).

21. Zhang, W., Y. Shen, F. Gao, and H. Li. 2023. Can artificial intelligence predict plant uptake of environmental contaminants? ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO, October 29-November 1 (oral presentation).
22. Curtiss, H., G. Rhodes, R. Hammerschmidt, W. Zhang, H. Li. 2023 Casparian strip retards PFAS translocation from Arabidopsis roots to shoots. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO, October 29-November 1 (poster presentation).
23. Huang, A., W. Zhang, B.J. Teppen, and H. Li. 2023. Evaluation of cation-bridging sorption of per- and polyfluoroalkyl substances by soils from water. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO, October 29-November 1 (poster presentation).
24. Benedict, A.M., M. Jafari, K.M. Merz, H. Li, and W. Zhang. 2023. Copper binding to prion fibril structures: A molecular dynamics study. ACS National Meeting & Exposition, San Francisco, CA, August 13-17 (poster presentation).
25. Zhang, W. 2023. Bacterial community assembly and antibiotic resistance in soil-plant systems: Integrated physicochemical and ecological perspectives. The 7th Young Scientist Forum of Terrestrial Ecosystem Science, Linzhi, China, July 28-31 (oral presentation).
26. Shen, Y., W. Zhang, E. Zhao, A.A. Baccarelli, and F. Gao. 2023. Pesticide exposure assessment and chemical ecotoxicity prediction using machine learning models. SOT 62nd Annual Meeting and ToxExpo, Nashville, TN, March 19-23 (oral presentation).
27. O'Sullivan, J.B., J. A. Richardson, A. K. Guber, M. Cavigelli, and A.N. Kravchenko. The impact of cover cropping on the microscale distribution of Mn. ASA-CSSA-SSSA International Annual Meeting, Oct. 29-Nov.1, 2023, St. Louis, MO.
28. O'Sullivan, J. B., Richardson, J. A., Guber, A., & Kravchenko, A. N. A native successional plant community promotes Mn reduction within the immediate vicinity of soil pores. MicroSoil. July 1-10, 2023, Saint-Loup-Lamairé France.
29. Guber, A.K. M.L. Rivers, and A.N. Kravchenko. Quantifying water fragmentation within soil pores by dual-energy X-ray CT. PALSA. July 11-14, 2023, Cornell University, Ithaca, NY.
30. Kravchenko, A., J.A. Richardson, A. Guber. Spatial Distribution Patterns of Mn Species Are Related to Soil Pores. ASA-CSSA-SSSA International Annual Meeting, Nov. 6-9, 2022, Baltimore, MD, 116-1.
31. Kravchenko, A., A. Guber. What Does Soil Physics Have to Offer for Assessing Soil Health? Examples from X-Ray Computed Micro-Tomography Analyses. ASA-CSSA-SSSA International Annual Meeting, Nov. 6-9, 2022, Baltimore, MD, 385-2.
32. O'Sullivan, J.B., J.A. Richardson, A. Guber, A. Kravchenko. Oxidation States and Micro-Scale Distribution of Manganese in Soils of Long-Term Conventional Agriculture and Native Succession Vegetation Systems, ASA-CSSA-SSSA International Annual Meeting, Nov. 6-9, 2022, Baltimore, MD, 1116-2.
33. Maggi Laan, Daniel G. Strawn, Zachary Kayler, Barbara J. Cade-Menun, and Greg Moller. Availability and Speciation of Soil Phosphorus in Manure-Fortified Biochar-Amended to Soils. ASA-CSSA-SSSA International Annual Meeting, Oct. 29-Nov.1, 2023, St. Louis, MO.
34. Pentrak, L.A., Pentrak, M.P., and Stucki, J.W. 2023. Electrochemically reduced Fe in smectite. 61st Annual Meeting of The Clay Minerals Society, Austin, Texas, 22-25 May 2023. Abstracts and Oral Presentation.

Extension/outreach:

1. Martin, S., G.M. Hettiarachchi, and A. Carrol. 2023. Growing Resilience: What to Know Before You Grow Food on Brownfields. National Brownfields Training Conference, Detroit, MI, Aug. 10-14.
2. Zhang, W. 2023. Evaluating and disseminating soil amendment practices to mitigate heavy metal uptake by carrot. Michigan Carrot Committee Research Meeting, February 16, 2023.