2019 Environmental Chemistry Symposium
University of Alaska

20th April 2019 – 9:00 AM to 5:30 PM UAF Akasofu (IARC) 401
Awards and Posters (and dinner 5:30 – 7:00 PM) UAF Akasofu (IARC) 401

Organizers:
William R. Simpson, Jennifer J. Guerard, Jingqiu Mao

Sponsors:
Department of Chemistry and Biochemistry, UAF
College of Natural Sciences and Mathematics (CNSM), UAF
Geophysical Institute (GI), UAF
Undergraduate Research and Scholarly Activities (URSA), UAF
# Symposium Schedule

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Career Panel

**Ashley Adamczak** is a proud Fairbanks resident with a M.S. Degree in Chemistry from UAF. She has been working preventing, preparing for and responding to oil and hazardous substance releases in Alaska for the last 8 years.

**Amanda Barker** has a Ph.D. in Environmental Chemistry from the University of Alaska Fairbanks and currently works for the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) as a Research Chemist.

**Jennifer Guerard** has a Ph.D. in Environmental Sciences from The Ohio State University and is an assistant professor in the Dept. of Chemistry & Biochemistry at UAF, where she researches the composition and reactivity of environmental media and contaminants.

**Rodney Guritz** holds a B.S. in Environmental Chemistry from UAF (class of 2006) and is owner and principal chemist of Arctic Data Services, an environmental data-quality consulting firm based in Fairbanks, Alaska.
Abstracts

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Oral presentation:

Ground validation of satellite formaldehyde retrievals at northern high latitudes and its implication for Arctic greening

Sujai Banerji$^1$ and Jingqiu Mao$^1$

$^1$Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, Alaska

The Arctic region (> 65 °N) has undergone seemingly anomalous temperature, and ecological changes over the past century. HCHO has been measured by several sensors to quantify biogenic emissions dominated by various polar-orbiting satellites in recent times for the Arctic region like OMPS on SUOMI-NPP, GOME-2 on MetOp-B, and TROPOMI on Sentinel-5P. However, there is a dearth of information regarding emissions from BVOCs and their chemical fate in the atmosphere, especially in the Arctic region. Some of the studies done so far, have reported an increasing trend in the total column amounts of HCHO in the northern high latitudes during 2005-10. There appear to be significant inconsistencies between the data from different sources such as the above due to instrument sensitivities, averaging kernels, etc. Measurements differing by a factor of two have been observed among some of the satellites, which indicates that there exists a major gap in the understanding of BVOCs in the Arctic region. Therefore, we discuss the potential of using two ground-based spectrometers - Pandora and MAX-DOAS for the ground validation for HCHO observations from various satellites at northern latitudes. Both work on the principle of differential optical absorption spectroscopy which uses the Lambert-Beer’s law. Preliminary measurements of HCHO taken by these instruments at the GI Building, UAF Campus for Summer 2018 show dissimilar variation diurnally. Our work investigates how to reconcile these differences in order to achieve coherence of ground data required for satellite validation.
Rapidly changing Arctic conditions have presented a need to better understand the current chemical and physical environments within this region. Sea ice is an intrinsic component of the Arctic system that influences the chemistry of the Arctic Ocean, including the distributions of trace metals. Limited studies have measured trace metals within the sea ice environment, leaving an unclear understanding how rapidly changing sea ice dynamics will affect trace metal distributions. This study looks at the partitioning between particulate and previously measured dissolved bioactive trace metals (Fe, Cu, Zn, Mn, Pb, Ni, Ti, and Co) within snow, sea ice, and underlying surface waters of the Central Arctic Ocean, and characterizes the chemical lability of trace metals within the particles. Sea ice samples were collected during the US GEOTRACES Arctic Section cruise in September 2015 using a custom-made trace metal clean ice corer, from 6 stations north of 82.5°N. In general, throughout the ice column bulk salinity was less than 4, and temperature was relatively warm (~1.5°C to -2.5°C), indicating that the sampled sea ice was porous and likely had undergone desalination. Overall, particulate metal concentrations were elevated in the upper 0.1 m of sea ice and the overlying snow relative to underlying surface waters. This suggest that the atmosphere was the dominant source of particulate metals relative to particle incorporation during sea ice formation processes. Alternatively, because desalination had likely occurred, brine drainage could have flushed particles from the sea ice matrix prior to our sampling, resulting in a lower particle load within the lower portions of the core. Additionally, metals that were measured within the sea ice matrix had lower than expected labile particulate concentrations, suggesting that reactive metals had been leached from particles over time via abiotic interactions with brine or biotic cellular uptake.
January and February, the two coldest months in Fairbanks, have the worst air pollution of the year. The extreme cold causes an inversion layer which traps air pollution from many different sources (car emissions, wood-burning stoves, etc.) in the town. In fact, the inversion layer creates such bad air quality that Fairbanks was recently ranked the worst in the nation for PM$_{2.5}$ (particles less than 2.5 microns in diameter), and air quality standards are rarely met. Thus, the composition of the air pollution is worth examining for health and environmental reasons. In this section of the project, the focus was on the total organic carbon (TOC) content of the ambient air samples. In wintertime Fairbanks, wood-burning stoves are the main source of PM$_{2.5}$. The TOC data is valuable for many reasons. For one, it gives us real data values over 24-hour periods, which reveals trends in TOC concentrations throughout the day. Another reason is that the data can be compared to other samples that we have collected and analyze. This will help us determine correlations between chemicals, which will help determine sources. (For example, high TOC and potassium correlation would indicate biomass burning.) The analysis done with this data will be helpful in determining where air pollution mainly comes from, and hopefully to find steps to reduce it.
Diurnal cycles for fine particulate matter and temperature during the late-winter season in Fairbanks and North Pole, Alaska

Meeta Cesler-Maloney¹, Tate Miles¹ and William R. Simpson¹

¹ Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, Alaska

For years, Fairbanks, AK has violated the US Environmental Protection Agency's (EPA) 24-hr standard (35 μg m⁻³) for air pollution from fine particulate matter (PM₁₀). Violating this standard puts residents at heightened risk for respiratory illness and the first step in developing a control strategy is to understand how the amount and composition of PM₁₀ varies by location. Late- winter offers a unique time to investigate PM₁₀, as surface temperature inversions mimic wintertime conditions at night, but warming to near-freezing temperatures during the day causes pollution to clear out. Behavior of PM₁₀ from three EPA references was compared from February 20 - March 2, 2019, when consistent diurnal temperature cycles were observed. Peak PM₁₀ in North Pole was measured at night between 12am - 6am AKST and two distinct peaks were measured in Fairbanks ~12am and ~9am AKST. Differences in temperature and wind speed between Fairbanks and North Pole were noticed and will be discussed. To evaluate the accuracy of Purple Air sensors, PM₁₀ from EPA references was compared to PM₁₀ from co-located Purple Air sensors. Purple Air sensors were well-correlated with EPA references, suggesting that these sensors may be used as an approximate method for measuring PM₁₀ if they are validated by an accurate reference. During winter 2019/2020, PM₁₀ will be sampled for chemical speciation across multiple locations in Fairbanks and North Pole to further explore spatial differences in PM₁₀. Speciation results and trace gas measurements from winter 2019/2020 will be used in future source apportionment analysis and the potential for secondary aerosol formation in the area will be evaluated.
Rotenone attenuation in high latitude lakes and laboratory assessment of photolytic vs. microbial degradation

Jordan Couture¹, Jake Bozzini¹, Brandon Briggs, ¹ Robert Massengil², and Patrick Tomco¹

¹ Department of Chemistry and Biochemistry, University of Alaska Anchorage, Anchorage, Alaska
² Alaska Department of Fish and Game

Northern Pike (Esox lucius) are an invasive fish species in the waterways of Southcentral Alaska. Pike have been found across the region after being illegally introduced for sport fishing. Once established, pike destroy salmon and other native fish populations and must be eradicated before native species can be reintroduced. In combination with mechanical removal techniques, integrated pest management plans often utilize the pesticide rotenone. Rotenone’s mechanism of rotenone toxicity is through blocking electron transport within the cell mitochondria, disrupting oxygen transport on the cellular level. Although approved for use in Southcentral Alaska, prescribed application rates and predicted degradation rates are commonly based on models developed for more temperate climates. In northern regions with seasonally frozen lakes, rotenone may persist over cold, dark winters. The aim of this study was to develop a regionally-accurate model of the degradation rates of rotenone in eight lakes on the Kenai Peninsula, Alaska, during treatment in October 2018. We assessed attenuation through field and laboratory studies in collaboration with the Alaska Department of Fish and Game (ADFG) field crews, combined with data gathered from laboratory incubation experiments, to establish the individual effects of light, temperature, and microbial activity in the overall degradation rate of rotenone. An ESI-LC/MS analytical method for rotenone and the major degradation product rotenolone in lake water was validated and we report the results of this study.
Oral presentation:

Characterizing Fairbanks wintertime aerosol composition and sulfate formation

Ragen Davey¹, James Campbell¹, and Jingqiu Mao¹

¹Department of Chemistry and Biochemistry and Geophysical Institute, University of Alaska Fairbanks, Fairbanks, Alaska

Fairbanks, Alaska is classified as a “serious non-attainment zone” due to the exposure of high levels of air pollutants throughout the winter months. This causes the city to violate the Fine Particulate Matter (PM$_{2.5}$) National Ambient Air Quality Standards set in place by the United States Environmental Protection Agency. These fine particulates, with a diameter less than 2.5 μm, are pollutants that cause major health risks to the citizens of Fairbanks. Previous studies have shown the significant amount of sulfate aerosols observed in Fairbanks winters, but the formation mechanism of sulfate aerosols in the atmosphere is still unknown. While sulfate formation is commonly driven by oxidants including OH, H$_2$O$_2$ and ozone, these species are limited in Fairbanks winter months. This indicates sulfate formation may occur through a non-traditional pathway, and this project investigates the mechanism in which transition metals catalyze sulfate formation. Winter air samples are collected using a Particle into Liquid Sampler (PILS) and analysis of sulfate and metal concentrations is conducted using Ion Chromatography (IC) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). By establishing a link between the two species, mechanisms of sulfate formation and the sources of the poor winter air quality is investigated. A Microorifice Uniform Deposit Impactor (MOUDI) has been added to the study for the winter of 2018-2019 in order to understand size-resolved chemical composition. Finally, the MOUDI allows for further analysis of total organic aerosols in comparison to the PILS water soluble organic aerosols.
Oral presentation:

Permafrost thaw impact on natural organic matter photoreactivity and chemical composition

Kristin Gagné¹, Sara Ewers¹ and Jennifer Guerard¹

¹Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, Alaska

Permafrost is undergoing rapid thaw, especially across the sub-Arctic discontinuous landscape. Carbon in the form of natural organic matter (NOM) has the potential to be released from permafrost upon thaw, whereby it may transform and/or incorporate with modern aquatic sediment and surface water carbon. Deriving from different source material, permafrost NOM is expected to have differing composition and therefore different photoreactivity compared to overlying modern NOM. However, the extent and consistency of variability in chemical composition and reactivity are not well understood. In this study, soil cores were collected from four discontinuous permafrost sites in boreal interior Alaska and separated into sections to analyze NOM from both active layer and permafrost sections. Additionally, 20 liters of surface water was collected from a variety of different permafrost underlain lake taliks. This water was filtered and NOM was isolated from the water in order to conduct experiments simultaneously with the permafrost NOM. All samples were analyzed for their chemical reactivity which, was probed through photobleaching kinetics experiments and analyzed by UV/Vis and fluorescence upon the addition of various reactive species scavengers to probe for triplet and radical reactivity. For chemical characterization, isolated NOM material from each sample was run on both solution state and solid state nuclear magnetic resonance to determine hydrogen and carbon functional group composition. Permafrost NOM results indicate variability in both composition and photobleaching reactivity among permafrost NOM as the chemical composition varies remarkably with depth and location in the watershed, highlighting the complex heterogeneity of NOM composition and reactivity in discontinuous permafrost soils. When observing the chemical composition and photoreactivity of surface water underlain by various degrees of permafrost thaw preliminary results show that photoreactivity has a seasonality difference between winter and summer. Furthermore, the majority of isolates collected from surface waters had photoreactivity that was greater than the reference materials. The combination of permafrost NOM observations and surface water observations will allow for an increased understanding on how permafrost thaw will influence surface water chemistry in a changing climate.
Analyzing photodegradation of the antiretroviral drug nevirapine in natural water systems

Lawrence Itela¹, Marcos Toniolo¹, Lawrence Duffy¹ and Jennifer Guerard¹

¹Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, Alaska

Nevirapine (NVP) is an antiretroviral non-nucleoside reverse transcriptase used in management of HIV/AIDS infections. Significant concentrations of the drug have been measured in environmental waters of sub-Saharan Africa where its use is prevalent. Owing to its high octanol-water partition coefficient, NVP has a high potential for bioaccumulation in bio-organisms with potential deleterious effects to flora and fauna. There is limited scientific data on the degradation of this compound in aqueous media. The compound was stable in aqueous solutions stored in the dark for a period of two weeks. Photolysis was done in a sun-test over several time intervals with analysis via HPLC with UV detection. Results show that the breakdown NVP happens in two phases, with the second has a faster rate. Photodegradation in neutral and basic media show similar rates but the rate is substantially increased in acidic conditions. Nuclear Magnetic Resonance (NMR) of the photodegradation in natural waters shows that loss of the ring structure is one of the earliest steps in the photodegradation process. Dissolved Organic Matter (DOM)- mediated photolysis shows faster rates of degradation when compared to direct photolysis rates. Knowledge of the rates and processes affecting the photodegradation of nevirapine will greatly determine the effectiveness of open sedimentation pools as an adequate step in reducing environmental concentrations of nevirapine and other antiretroviral drugs to below limits of concern.
Quality controls and seasonality of biases for satellite measurements of CO2 in the Boreal Forest

Nicole Jacobs1, William R. Simpson1, Qiansi Tu2, Frank Hase2, Thomas Blumenstock2, Harrison Parker3,4, Manvendra Krishna Dubey4, Gregory B. Osterman5, Debra Wunch6, Rigel Kivi7

1Geophysical Institute and Department of Chemistry and Biochemistry at the University of Alaska Fairbanks, Fairbanks, Alaska
2Karlsruhe Institute of Technology, IMK-ASF, Karlsruhe, Germany
3California Institute of Technology, Pasadena, CA, United States
4Los Alamos National Laboratory, Los Alamos, NM, United States
5NASA Jet Propulsion Laboratory, Pasadena, CA, United States
6University of Toronto, Department of Environmental Physics, Toronto, Ontario, Canada
7Finnish Meteorological Institute, Space and Earth Observation Centre, Sodankylä, Finland

The Boreal Forest or Taiga Biome is the largest terrestrial biome on Earth and seasonal uptake of carbon dioxide (CO2) throughout boreal forest regions is a major factor in the global carbon budget. Passive satellite observations of atmospheric CO2 by polar orbiting satellites, like NASA’s OCO-2 satellite, offer the potential for amassing large quantities of data for regions that are largely inaccessible and have previously been vastly under-sampled. To take advantage of this wealth of CO2 measurements, spectroscopic considerations and data handling methods for satellite measurements at high latitudes must be carefully evaluated. In this vein, atmospheric column measurements of CO2 from the OCO-2 satellite are compared with measurements from the ground, collected with solar-viewing Fourier transform infrared spectrometers (FTS), at three sites in the Boreal Forest. In Fairbanks, Alaska observations with a Bruker EM27/SUN FTS have been collected from August 2016 to present with plans to continue for at least five more years. The EM27/SUN FTS was designed by the Karlsruhe Institute of Technology (KIT) in collaboration with Bruker (Gisi et al, 2012, doi:10.5194/amt-5-2969-2012) to be robust and compact for urban and rural field deployment. The remaining two ground sites at East Trout Lake, Saskatchewan and Sodankylä, Finland are operating the Bruker IFS 125HR as part of the Total Carbon Column Observing Network (TCCON). A new set of quality controls (QC), specifically tailored to these boreal forest sites, were applied to OCO-2 data to increase the amount of passable data in spring and fall for high latitude terrestrial regions. This presentation will evaluate the effects of these QC changes on biases between satellite-based and ground-based CO2 measurements, discuss seasonal variability in biases observed at these sites, and speculate on the impacts these biases could have on the analysis of CO2 seasonality for the Boreal Forest.
Fine particulate matter (PM$_{2.5}$) can enter the lungs and blood stream, causing potential health risks to those exposed to high concentrations. In the cold, dark Alaskan winters, the dilution of PM$_{2.5}$ into the atmosphere greatly decreases due to temperature inversions. To probe the effect of these temperature inversions and explore the vertical extent of the pollution layer, we built a lightweight PM$_{2.5}$ sensor and deployed this sensor in Fairbanks. Through the months of February and March, we tracked the concentrations of PM$_{2.5}$ within and around downtown Fairbanks, Alaska. Using the data, we compared PM$_{2.5}$ concentrations (µg/m$^3$) between our sensor, which was located 19 meters above ground level and three other ground sites which are around three meters above ground level. The data showed that on nights with stronger temperature inversions, we see much less mixing between layers of air and higher overall PM$_{2.5}$ concentrations at ground level than aloft. During the day when temperatures rise, the air begins to mix again, and all the sensors record much lower concentrations. Due to the observation of lower PM$_{2.5}$ concentrations aloft during strong inversions, we can conclude that the mixing height of PM$_{2.5}$ is on the order of tens of meters above ground level.
Oral presentation:

Photosensitized degradation of chlorpyrifos and chlorothalonil by Arctic derived organic matter

Ginna Quesada¹, and Jennifer Guerard¹

¹Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, Alaska

Organochlorine pesticides have been widely used for agricultural and industrial applications since the 1940’s. Since then, several have been identified by the Stockholm Convention as persistent organic pollutants (POPs) in the environment and there have been ongoing efforts to research the fate and transport of emerging organohalogen contaminants. Chlorpyrifos (CPY) and chlorothalonil (CTH) are two current use pesticides that have recently been detected in the Arctic and are of toxicological concern. CPY and some of its direct photodegradation products have been identified as neurotoxins and CTH is suspected to be a probable carcinogen. This talk will cover ongoing research regarding the degradation of CPY and CTH in Arctic lacustrine systems. In aqueous media, dissolved organic matter (DOM) can act as a photosensitizer, changing the rate of photolytic reactions, as well as influencing the composition of phototransformation products. This talk will focus on photolysis, as the major mechanism of attenuation in the Arctic as long summer days and limited canopy cover favor photolytic degradation. The preliminary experimental data on the influence of dissolved organic matter on the photodegradation rates of chlorpyrifos will be presented. Photolysis was conducted under artificial solar irradiation and samples were analyzed via HPLC-UV/Vis.
Degradation Kinetics and Product Characterization of Photolyzed Antiretroviral drug Nevirapine

Marcos Toniolo¹, Lawrence Itela¹, and Jennifer J. Guerard¹

¹Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, Alaska

Nevirapine (NVP) is an antiretroviral drug belonging to a class of HIV drugs called non-nucleoside reverse transcriptase inhibitors (NNRTIs). Its use is highest in locations with high prevalence of HIV/AIDS, especially in the highly populated rural communities. For example, studies done in the Nairobi River Basin in Kenya resulted in high concentrations of Nevirapine (K’oreje et al. 2012), even at locations after wastewater treatment. Photodegradation is a promising renewable energy and cost-effective tool for wastewater remediation in rural and developing areas and has been shown to degrade other antivirals. The presence of NVP in wastewater is potentially a problem because viral and bacterial genomes can be altered, as well as an increase in ecotoxicity triggered by this drug. A potential method for minimizing environmental health risk is photodegradation, which is attractive in communities with limited infrastructure. Studies I have previously conducted in Spring 2018 have concluded that Nevirapine is photodegradable. Current efforts aim to characterize the degradation products using ¹H NMR and GC-MS, as well as establish degradation kinetics through HPLC. The results will allow us to look at how reactive pathways change in respect to different media and thus suggest more specific photo-remediation strategies.
Oral presentation:

Anthropogenic impacts on biogenic secondary organic aerosol in the Southeast US

Yiqi Zheng and Jingqiu Mao

Department of Chemistry and Biochemistry and Geophysical Institute, University of Alaska Fairbanks, Fairbanks, Alaska

Terrestrial vegetation emits large quantities of volatile organic compounds, including isoprene and monoterpenes, which can be oxidized in the atmosphere and form biogenic secondary organic aerosol (SOA). In heavily vegetated regions such as the Southeast US (SEUS), biogenic SOA contributes to a large fraction of particulate matter, and has important implications for surface air quality, public health and climate. Biogenic SOA is not purely “natural” as it can be enhanced by anthropogenic emissions, including nitrogen oxides (NO\textsubscript{x}) and SO\textsubscript{2}. In the SEUS, observations have shown a decreasing trend of total organic aerosol (OA) in the recent two decades, together with substantial reductions in NO\textsubscript{x} and SO\textsubscript{2} emissions by air quality control. This study develops a detailed SOA scheme in a global 3-D chemical-transport model GEOS-Chem by implementing a coating effect on isoprene-derived SOA (in progress), and an explicit NO\textsubscript{x}-dependent monoterpene chemistry (future work). The updated model will be used to investigate the role of anthropogenic-biogenic interactions in SOA formation, which is likely an important contributor to the observed OA decline. The developed scheme will also be implemented in a chemistry-climate model GFDL AM4 to examine the climate forcing induced by anthropogenic impacts on biogenic SOA, which is neglected in the IPCC AR5 report.
Analysis of an oxbow lake pore water through NMR spectroscopy

Abby Amick¹ and Jennifer Guerard¹

¹Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, Alaska

As climate change warms the arctic, permafrost is disrupted and lakes are affected by rising temperatures. This study examined the composition of organic matter of a non-permafrost lake in the Goldstream Valley by sampling a 104 cm long core and extracting pore waters. Porewater samples were analyzed by nuclear magnetic resonance (NMR) spectroscopy. ¹H NMR results showed the presence and percent composition of aromatics, carbohydrates, peptides, carboxyl rich alicyclic molecules, and material derived from linear terpenoids. The differences in percent composition between the depths of the sampled core will help researchers understand the composition of lakes and how climate change will affect their organic matter.
A low-cost alternative to mitigate heavy metal and phosphorus contamination in water

Brittany Blood¹, Debasmita Misra¹, Srijan Aggarwal²

¹Geological Engineering, University of Alaska Fairbanks, Fairbanks, Alaska
²Civil and Environmental Engineering, University of Alaska Fairbanks, Fairbanks, Alaska

Metals are common contaminants associated with mining, agricultural, and industrial practices. One of the ways these contaminants can be mitigated is through adsorption. A common widely used adsorption method is the application of activated carbon to mitigate metals and other contaminants. As activated carbon is an expensive adsorbent, there has been a growing interest in applying modified agricultural waste materials as adsorbent for different contaminants. In this research, we investigate the potential of Alaskan native agricultural by-products as adsorbent for heavy metals. These by-products are spruce biochar and sodium hydroxide treated birch sawdust. Some recent studies have used these byproducts as a biosorbent to mitigate heavy metal contaminated water, but not for Alaska sourced materials. Several factors to consider for metal adsorption include the effect of sorbent type, environmental pH, and temperature. The objective of this study is to evaluate the application of spruce biochar and treated birch sawdust for removal of cadmium, lead, and phosphorus, with consideration of the factors that may affect adsorption.
Characterizing Fairbanks wintertime aerosol size distribution using scanning electron microscope

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Fairbanks, Alaska is classified as a “serious non-attainment zone” due to the exposure of high levels of air pollutants throughout the winter months. This causes the city to violate the Fine Particulate Matter (PM$_{2.5}$) National Ambient Air Quality Standards set in place by the United States Environmental Protection Agency. These fine particulates, with a diameter less than 2.5 μm, are pollutants that cause major health risks to the citizens of Fairbanks. Fairbanks has wintertime PM$_{2.5}$ pollution days that average 40 to 70 μm and sometimes reach 200 μm during a thermal inversion, causing major health concerns to citizens. This project seeks to understand the size categories of PM$_{2.5}$ to provide a visual representation of particles that are 2.5 μm and smaller.
Poster presentation:

Biolability of an Alaskan permafrost-derived sediment

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Permafrost is soil that has been frozen for a period of at least two years. Deep in the Earth, packed in layers of dirt and ice are the remains of ecosystems from earlier times, many of which are prehistoric and have within them diverse geological compositions. The interaction between living organisms and the chemicals in which they interact with on a daily basis is widely studied by scientists. Even more interesting in the history embedded within is the future that such chemicals and microbes could create for the Earth at higher latitudes. Organic matter is any matter which is predominately hydrocarbon compounds that serve many purposes in nature. Amongst the many uses by the environment are the potential metabolism driver for various organisms that reside within ecosystems. This study was set out to examine this interaction and see just how organisms invisible to the human eye could potentially play a bigger role in the processing of organic metabolites embedded deep within the permafrost of the interior Alaska. In doing so, we hope that this will give scientists a more dynamic appreciation and understanding of the biogeochemical processes underground as well as the impacts this could have on the environment.
Biofilms are a prime concern for drinking water distribution system (DWDS). Biofilms grow in DWDSs pipe network and reservoirs, and degrade the water quality by hosting opportunistic microorganisms, consuming residual chlorine disinfection, and impact the DWDS pipelines by biocorrosion. Biofilm disruption and removal is a challenging and resource intensive process. For efficient removal of biofilms, it is very important to know the structure and strength of the biofilms (mechanical properties). This study is designed to analyze different properties of biofilm both at the laboratory and field scale. The plan is to grow biofilms in the lab and sample naturally growing biofilms from the University of Alaska Fairbanks (UAF) DWDS and analyze the collected biofilm samples for structure, mechanical properties, and microbial community by using Confocal Laser Scanning Microscopy (CLSM), Atomic Force Microscopy (AFM) and 16S rRNA gene sequencing respectively.
Investigating elevated methane emissions in Goldstream Valley thermokarst lakes using magnetic susceptibility signatures to determine presence of iron (III) oxides

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The conductivity effect of iron (III) and magnetic minerals (magnetite, maghemite, etc.) were found to be an important factor affecting the methanogenic response of soil to the co-occurrence of iron (III) oxides in anerobic wetland soils (Zhou, 2014). Substrate incubation experiments have shown that high magnetic minerals provide inter electron transfer to accelerate methanogenesis (methane emissions) between bacteria and Archean methanogenic species, enhancing methane emissions by orders of magnitude compared with aqueous iron alone (Kato, 2011; Zhou, 2014). Fairbanks area lakes have the highest emissions of methane compared to other Alaskan thermokarst lakes North to South (Sepulveda-Jauregui, A., 2015). Rapid permafrost thaw formed thermokarst lakes in Goldstream Valley (8 km north of Fairbanks). We removing lake sediment cores (72cm-1.4 m) in November 2018 and conducted a geophysical survey using methods of magnetic susceptibility to determine if these lakes had iron magnetic minerals and their significance. In all six cores we found magnetic minerals likely composed of magnetite, maghemite, and possibly pyrrhotite. We suspect that the predominant magnetic mineral in all of the cores is magnetite and variations in magnetic susceptibility are related to variations in magnetite abundance, grain size, and degree of weathering. The unique upstream environment and geological setting of placer mine deposits is likely transporting these magnetic minerals downstream, which could have implications for syntrophic electron transfer between certain species of bacteria and Archean microorganisms. To determine if unique iron redox conditions are stimulating higher levels of methane emissions, we suggest replicating incubation experiments similar to those mentioned can ultimately validate or falsify the central hypothesis. We hope to develop further support for our hypothesis over summer 2019.
The composition of the sediment below thermokarst lakes is not well known. Samples from varying depths below two lakes, one with permafrost and one without, were analyzed on the ICP-MS and TOC to characterize trends in metal concentrations, carbon amounts, and nitrogen amounts with respect to depth. These trends are very similar within metals/carbon/nitrogen within each lake, but different between the two lakes which have differing extent of permafrost around them.