Title: Low-Cost Sensors to Quantify Ozone Exposure in Rural Colorado Communities
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Introduction: Ozone is a criteria pollutant designated by the US Environmental Protection Agency (EPA) that has adverse effects on air quality, climate, and human health. With regard to human health, ozone causes respiratory inflammation and is responsible for nearly 13,000 premature deaths annually. O_3 is formed from the atmospheric oxidation of volatile organic compounds (VOCs) and nitrogen oxides (NO_X) in the presence of sunlight. Both VOCs and NO_X are emitted by anthropogenic (e.g., traffic) and natural (e.g., wildfires) sources. Ozone, unlike some other criteria pollutants such as carbon monoxide and NO_X, is formed regionally and its concentrations are likely to be similar between urban and rural environments. Yet, ozone is measured routinely only in urban areas and ozone concentrations, exposure, and impacts are largely unknown for rural and remote continental regions. Furthermore, the Colorado Front Range is in 'serious' nonattainment (exceeds EPA standards) for ozone and is projected to be noncompliant over the next decade. There is an immediate need to better understand ozone pollution and its impact on regional air quality and in rural communities.

Prior Work: In 2020, a multi-PI team led by Prof. Magzamen quantified ozone exposure at dairy farms as a proxy to study ozone's health impacts on both livestock and human health. One aspect of this project was to develop low-cost ozone sensors and evaluate their performance against reference monitors. Led by Prof. Jathar, the initial study developed a network of five of these sensors (MOOS for Metal Oxide Ozone Sensor; see figure to the left) and deployed them at several locations across the Front Range region between July and September of 2020, with three of them located at dairies. These sensors were ⅙ the cost of a reference monitor in addition to being fully autonomous (solar powered and connected to the Cloud). Preliminary analysis of those data suggest that the MOOS performed extremely well in more 'moderate' environments where they were shielded from traffic and dust and when ambient temperatures were below ~30 °C. Sensor performance also appeared to be affected in the presence of wildfire smoke, which presented a major challenge since fires in the Western US inundated the Colorado Front Range during our sampling period.

This Project: As a follow up to our 2020 study, we will deploy three of the MOOS to several Agricultural Experiment Stations (AES) located on the eastern plains of Colorado (e.g., Akron, Rocky Ford, Plainsman). **Dr. Adams' as an Extension Specialist and Mr. Fickenscher and Mr. Kaan as Extension Directors will facilitate collaboration with local AES and Extension personnel to better understand the surrounding communities, residents, and livestock populations.** More specifically, the project will educate itself about the local problems and challenges and their links to ozone pollution. Both the MOOS and reference monitor will be deployed to each location for 3-4 weeks during the summer of 2021. The student intern (preferably a graduate student) hired on this project will closely interact with the project team and also collaborate with AES personnel to site the MOOS and acquire additional environmental data (e.g., meteorology). The student will acquire technical skills linked to the calibration, use, and field deployment of environmental sensors (4-6 weeks) and analysis (4-6 weeks) of environmental data. Funds are available for day trips to each of the three AES locations.

Expected Outcomes: The field deployments and data gathered during this project will be valuable to our team's research for several reasons. First, by performing these field measurements in early summer (May-June) we will be able to gather data in smoke-free conditions and under more moderate temperatures. Second, these data will add to our growing database and contribute to a better understanding of the spatial variability in ozone levels across Colorado and their relation to more heavily-monitored urban locations. Third, we will, for the first time, provide ozone pollution data for the downwind eastern plains region that is likely to be heavily impacted by emissions in the Front Range. And finally, we will work with the AES and Extension agents to translate and communicate the ozone pollution problem in the Colorado eastern plains to local communities and residents.