Air Quality Analysis of Nebraska Using PurpleAir Daily Data

This project was conducted to support the UNMC Water, Climate, and Health Working Group's initiative to better understand air quality conditions across Nebraska and their potential public health implications. In accordance with the established Scope of Work, the analysis focused on organizing and summarizing PurpleAir daily sensor data to identify locations with elevated concentrations of volatile organic compounds (VOC), fine particulate matter (PM2.5), and coarse particulate matter (PM10). The goal of this work was to identify potential air quality hotspots and provide preliminary insights into where further investigation may be warranted.

Daily air quality data were obtained from the provided PurpleAir dataset and analyzed using Python. Data preprocessing included converting date fields to a standardized datetime format and removing incomplete records to ensure consistency and accuracy. Pollutant concentrations were grouped by sensor name, and both mean and median values were calculated for VOC, PM2.5, and PM10. Calculating both statistics allowed for identification of sensors with consistently high concentrations as well as those that experience frequent elevated pollution events, as outlined in the Scope of Work.

Analysis of VOC concentrations revealed that several locations exhibited notably higher levels relative to others across the state. Sensors located in Ogallala, McCook, Norfolk, and areas served by the Three Rivers and Four Corners Health Departments consistently appeared among the top five locations when ranked by both mean and

median VOC concentrations. These findings suggest that VOC levels in these areas may be influenced by local emission sources such as agricultural activities, transportation corridors, or nearby industrial operations. The consistency between mean and median rankings indicates that elevated VOC concentrations are not isolated events, but rather occur regularly at these locations.

PM2.5 results showed a different pattern, with a small number of sensors reporting extremely high mean values. In particular, the Broken Bow sensor and the Southeast District Health Department site ranked highest by mean PM2.5, with values far exceeding those observed at most other locations. Median PM2.5 values, however, were substantially lower at these same sites, suggesting that the high mean concentrations were driven by short-duration extreme events rather than consistently poor air quality. Such events may be associated with episodic sources such as wildfire smoke transport, dust events, or localized combustion sources. Additional locations including O'Neill, McCook, and Richardson County also appeared among the top five PM2.5 rankings, indicating areas where particulate matter exposure may be a recurring concern.

PM10 concentrations followed a pattern similar to PM2.5, with Broken Bow and the Southeast District Health Department sensor exhibiting the highest mean values. As with PM2.5, median PM10 concentrations at these sites were significantly lower than the mean, again suggesting the presence of episodic high-dust or smoke events rather than continuous elevated conditions. Locations such as Norfolk, Wisner, and Ainsworth appeared more prominently in the median PM10 rankings, indicating more frequent moderate PM10 levels that may still pose health concerns for sensitive populations.

Overall, the results indicate that air quality conditions across Nebraska vary substantially by location and pollutant type. Some sensors show consistently elevated concentrations, while others are characterized by infrequent but extreme pollution events. These findings align with the objectives defined in the Scope of Work and provide a data-driven basis for identifying potential air quality hotspots across the state. Further investigation incorporating meteorological conditions, seasonal trends, and known emission sources would help clarify the underlying causes of the observed patterns and support targeted public health and environmental interventions.