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Effects of California's Central Valley $PM_{2.5}$ Pollution on Sequoia National Park

Joseph Rotondo[1], Roya Bahreini[2], Andreas Beyersdorf[3]
[1]University of Oklahoma
120 David L Boren Bvld, Norman, OK, United States
Joseph.F.Rotondo-1@ou.edu
[2]University of California-Riverside
900 University Ave, Riverside, CA, United States
Bahreini@ucr.edu
[3]California State University, San Bernardino
5500 University Parkway, San Bernardino, CA, United States
andreas.beyersdorf@csusb.edu

Extended Abstract

California's Central Valley (CV) is notorious for its poor air quality due to the many agricultural and industrial pollutant sources in the area [1]. There has been extensive data acquisition and research into these sources, and how such pollution may affect its inhabitants. However, there has been significantly less research into how such pollution is transported out of the CV (0 – 500 meters above sea level) and into the Sierra Nevada Mountain Range (SNM; 500 – 4,500 meters above sea level) located to the valley's east. The SNM encompasses the very popular Sequoia National Park (SNP), which hosts over one million visitors annually [2]. This study focuses on the transport of aerosols with diameters less than 2.5 microns ($PM_{2.5}$) from the CV into SNP. The $PM_{2.5}$ data in this study was provided by the California Air Resources Board (CARB). The main locations of interest were Fresno, Visalia, and Ash Mountain, California. Fresno and Visalia are major industrial and agricultural cities that produce large sources of $PM_{2.5}$ pollution for the CV. Ash Mountain is located near the west entrance of SNP, which is directly east of Fresno and Visalia. Prevailing westerlies generally transport pollution from Fresno and Visalia eastwards as shown by the National Oceanic and Atmospheric Administration's (NOAA's) HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) model. Thus, Fresno and Visalia were chosen over other CV cities due to their proximity to SNP and longevity of the data record.

To model the pollution transport, the National Aeronautics and Space Administration's Moderate Resolution Imaging Spectroradiometer (MODIS) reanalysis data was applied to the square grid between Fresno and Visalia. Using MODIS, pollution transport to SNP was determined to be more prevalent in summer months due to higher average planetary boundary layer heights (PBLHs) that occur via enhanced summertime radiational mixing. In summer, PBLHs mix aerosols emitted from the surface in the CV to 1,500-2,500 meters above ground level, allowing CV pollution to reach most of SNP. However, in winter months, a valley inversion due to cold surface temperatures and less radiational heating results in mean PBLHs $\leq$ 500 m, thus prohibiting the transport of $PM_{2.5}$ from the CV to SNP. This seasonal pollution transport was also observed within CARB $PM_{2.5}$ measurements. In summer months, $PM_{2.5}$ concentrations are approximately equal in the CV and SNP (±5%). In winter months, however, $PM_{2.5}$ concentrations in the CV are generally 2-3 times more than $PM_{2.5}$ in SNP. This further supports the PBLH analysis—pollution cannot easily be transported out of the CV in winter. Additionally, SNP is best to be avoided in summer/early fall months due to influences from wildfires. Extremely high $PM_{2.5}$ concentrations (> 200 $\mu g\ m^{-3}$; consistent with unhealthy and hazardous air quality levels) and enhanced potassium and organic carbon concentrations (tracers for fires) in $PM_{2.5}$ were observed in Sep-Oct 2020 and 2021. The results of this study suggest that regulating urban and agricultural emissions can have lasting positive impacts on air quality in protected land. Air pollution from industrial sources can have far-reaching impacts on higher elevations such as the SNM.

References

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