1.039 Influence of NOx emissions on Central Valley fog frequency and persistence.

Early Career Scientist

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Abstract:

From 1930-1970, California's Central Valley (CV) radiation fog significantly increased, with locations such as Fresno seeing an ~83% growth in fog frequency. However, in the last 30 years, researchers identified a ~50% reduction in fog days (Baldocchi and Waller, 2014, Herkes et al., 2014). The dominant hypotheses suggest that the decline in fog can be explained by rising temperatures associated with climate change or urban heat island effect. This assertion fails to explain the significant increase in CV fog midcentury.
Here we assert that changes in air pollution, rather than climate, better explain this upward-then-downward temporal trend. Growth in vehicle use greatly increased emissions of NO_x midcentury, followed by a significant decrease in air pollution due to statewide regulations from 1980-Present. In the CV, ammonium nitrate (NH_4NO_3), the dominant wintertime aerosol, is limited by NO_x concentration. NH_4NO_3's size range and hygroscopicity make it an important source of cloud condensation nuclei (CCN).Thus, air pollution growth from 1930-1970 increased the availability of CCN necessary for fog formation. Subsequent air pollution mitigation after 1980 then reduced NO_x, and thus CCN and fog frequency.
Using over 75 years of meteorological measurements, we developed a detailed fog climatology spanning 15 locations. Additionally, we developed a historical record of nitrogen oxide (NO_x) throughout these sites to determine air pollution trends. We used this data to analyze the spatial and temporal correlation between fog frequency, air pollution, and climatic drivers.
CV fog exhibits a pronounced north-south gradient, with fog consistently more frequent and persistent in southern latitudes than northern. Additionally, NO_x concentration also shows a similar north-south gradient, with concentration consistently highest in the south and a steady ~50% decline in all sites since 1990. We conclude that fog trends in the CV best correlate both temporally and spatially with NO_x trends, rather than with climatic drivers.