The Department of Mechanical Engineering presents:

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Si Tan

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Estimating Pollutant Concentration Maps at Multiple Spatial and Temporal Scales for Exposure Studies

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Chronic exposure to high concentrations of pollutants such as NO2 and ultrafine particles is associated with negative health effects. Studies of exposure to these pollutants require estimates of concentrations at temporal and spatial scales relevant to exposure calculations. We have developed and applied methods to construct these concentration "maps" by using a combination of measurements and modeled results. To estimate concentration patterns at the urban scale of tens of kilometers we have formulated a Lagrangian model to estimate concentrations of NOx, NO2, and O3 over a domain extending over hundreds of kilometers. The model is evaluated with data collected at 21 regional monitoring stations in the San Joaquin Valley Air Basin during 2005. The model provides adequate descriptions of the spatial and temporal variation of concentrations of NO2, and NOx. We then use "residual" Kriging to combine the results from the dispersion model with observed concentrations to produce realistic concentration maps.

To estimate concentration patterns at scales of tens of meters in urban areas we developed a dispersion model that accounts for the effects of local building morphology on dispersion. The data used to evaluate the model was collected in field studies conducted in Los Angeles, California. The studies measured ultrafine particle concentrations and associated micrometeorology at several locations with different building morphologies. Surface concentrations in urban areas are primarily controlled by vertical dispersion, which depends on the street aspect ratio, defined as the ratio of the equivalent building height to the street width, and the vertical turbulent velocity σw. The presence of buildings increases the concentrations due to local traffic emissions relative to open areas. Since routine measurements of micrometeorological variables are usually not available in urban areas, we have developed models that allow us to estimate urban surface variables using values measured at an upwind rural location. Results from the urban dispersion model can be combined with measurements from urban monitors to generate concentration maps with spatial resolution of meters and time resolution of minutes.