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# Field, Laboratory and Numerical Study of Turbulent Dispersion in Built Environments

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Field measurements were conducted in seven southern Californian cities. These included SF6 tracer studies in Wilmington and Palm Springs and traffic related particulate measurements in Los Angeles, Long Beach, Anaheim, Pasadena and Huntington Beach. Urban areas were selected to cover five typical building arrangements which are 1) low density settlement, 2) low-rise settlement, 3) mid-rise settlement, 4) high-rise settlement, and 5) strip mall with surface parking. In addition to SF6 and particulate concentration extensive micrometeorological measurements were performed at each site. The field experiments were accompanied with systematical laboratory modeling in a water channel. Detailed velocity and concentration fields within model urban settings were simultaneously measured by Particle Image Velocimetry (PIV) and Planar Laser Induced Fluorescence (PLIF) system. Model buildings were created from transparent acrylic blocks to allow for the whole plane measurements inside the urban canopy. Complexity of modeled urban areas ranged from uniform cubical arrays to scaled downtowns of Los Angeles, Long Beach and Huntington Beach. Numerical simulations of flows and dispersion in these urban areas were performed using three fundamentally different models: 1) AERMOD - similarity based US EPA regulatory model, 2) CFD k-e model, and 3) QUIC – semi empirical, fast response model. Performance of each numerical model will be discussed and the advantages and challenges of utilizing laboratory experiments to model urban flows will be presented. Surface energy balance components, measured via net radiometer, krypton hygrometer, sonic anemometer and heat flux plates were utilized to develop new models for estimates of sensible, latent and ground fluxes over different surfaces and surroundings. This extensive study for the first time explained phenomena of lateral channeling in regular arrays which is responsible for a sudden plume spread at the entrance of the obstacle array.