Wind Speed Reduction Induced by Urban Morphology

Accurate prediction of advection and turbulent mixing is fundamental to understanding the transport and deposition of atmospheric pollutants. There is mounting evidence hinting at overestimation of wind speed in the urban airshed by conventional mesoscale NWP models. This has been hypothesized as a factor contributing to air quality models underestimating pollutant concentrations in highly urbanized regions, where the observed wind speed is significantly slower than that predicted. Researchers have proposed that the parametric roughness approach to representing aerodynamic drag and friction induced by urban morphology is inadequate. Specifically, the vertical evolution of momentum deficit developed within, and then propagated above the urban canopy is not realistically captured.

An experimental revision to MM5, code named uMM5, is able to treat urban surface elements in three-dimension. Each grid cell is made aware of a spatially averaged set of morphological parameters that, in the presence of air flow *through* the urban canopy, induce pressure drag, skin friction, and turbulence attributed to interaction with manmade structures.

uMM5 experiments have been conducted for the aggressively urbanized Pearl River Delta in Southern China, to which "factory of the world" often refers. Results indicate that wind speed is reduced throughout the well-mixed PBL. Wind speed reduction appears sensitive to proximity between neighboring urban clusters and canopy depth. Lagrangian particle tracing illustrates that the high-density urban environment is exposed to considerably greater pollutant amounts than its lower density counterpart. uMM5's potential to improve air quality modeling, and to identify problem spots for detailed study, is thereby affirmed.