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Quantifying the influence of high rise buildings on urban air quality measurement using numerical modeling approach

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Dynamics of urban morphology has indicated that an increase of high rise buildings in the cities is required to meet the demand of increasing population. As a result, increasing population density has to lead a sudden change in the meteorological condition of the city. High urbanization standards have led to poor air quality and environmental issues. This study examines the variation of the air quality parameters vertically with the heights of the building in and around the city using numerical modeling approach. The study also establishes a statistical relationship between wind speed, particulate matter concentration (PM2.5) and relative humidity, so to investigate the poor air quality standards leading to the formation of natural disorders like fog in the period of winter. To analyze, the role of high rise buildings and wind on urban metrology ENVI-Met CFD package (numerical weather prediction) model was used. A real-time simulated environment was develop using the model to formulate the wind speed and its direction for a period of 4 days. Siri Fort area of South Delhi district, Delhi state was taken as a study area and the simulations were performed from 8th to 11th December 2017. The area was subdivided into 10 meters, 20 meters and the combination of 10 meters - 20 meters buildings of South Delhi district so to study the impact buildings on urban meteorology. The area also consists of six metrological stations for measurement of metrological parameters as well as air quality parameters. The simulated results were compared with observations showed that high underprediction of wind speed and temperature profiles were observed at Siri fort stations at 10 meters as well as 20 meters height buildings and it was over predicting with the combination of 10 meters and 20 meters of the building. The model performed well with the combination of 10 meters- 20 meters height building as it obtains a high correlation (R2) of 0.44 while 0.17 and 0.14 with 20 meters and 10 meters building. Similarly, for PM 2.5 concentration was also calculated. The model results were also used to predict the visibility variation during day and night time in and around Siri fort stations. Thus predicting the fog on 8 December and 11 December 2017 with a visibility range of 50 – 70 meters. The performance of the model is also improved from 67 % to 79 % due to the better availability of observed data.
Keywords: High rising buildings, urban air quality, ENVI-MET CDF, PM 2.5 and Fog