Estimation of Black Carbon Concentrations Levels in High Concentration Region Using Machine Learning Models

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Abstract

Black carbon (BC) is emitted into the atmosphere during combustion processes, often in conjunction with emissions such as NO_x and O_3, which are also by-products of combustion. In highly polluted regions, combustion processes are one of the main sources of aerosols and particulate matter (PM) concentrations, which affect the radiative budget. In this study we use machine learning approaches to estimate BC from NO_x, O_3, $PM_{2.5}$, relative humidity (RH), and solar radiation (SR). We assess the effectiveness of various machine learning models, such as random forest (RF), support vector regression (SVR), and multilayer perceptron (MLP) artificial neural network, for predicting black carbon (BC) mass concentrations in areas with high BC levels such as Northern Indian cities (Delhi and Agra), across different seasons. This study evaluates the performance of models in Delhi using data from 2018-19, including NO_x, O_3, $PM_{2.5}$, relative humidity (RH), and solar radiation as input variables and Agra. The results demonstrate comparable effectiveness among the models, with the multilayer perceptron (MLP) showing the most promising results. In Delhi, the MLP shows high correlations between measured and modelled concentrations during winter (R^2: 0.85) and post-monsoon (R^2: 0.83) seasons, and notable metrics in the pre-monsoon (R^2: 0.72). The results from Agra are consistent with those from Delhi, highlighting the consistency of the neural network's performance. These results highlight the usefulness of machine learning, particularly MLP, as a valuable tool for predicting BC concentrations. This approach provides critical new opportunities for urban air quality management and mitigation strategies and may be especially valuable for megacities in medium- and low-income regions.

Early Career Scientist

YES, I am an early career scientist.

IGAC Activities

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