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Nonlinear relationships between atmospheric aerosol and its gaseous precursors: Analysis of long-term air quality monitoring data by means of neural networks

I. B. Konovalov
Institute of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, Russia

Abstract. The nonlinear features of the relationships between concentrations of aerosol and volatile organic compounds (VOC) and nitrogen oxides (NO_x) in urban environments are revealed directly from data of long-term routine measurements of NO_x, VOC, and total suspended particulate matter (PM). The main idea of the method is development of special empirical models based on artificial neural networks. These models, that are basically, the nonlinear extension of the commonly used linear statistical models provide the best fit for the real (nonlinear) PM-NO_x-VOC relationships under different atmospheric conditions. Such models may be useful in the context of various scientific and practical problems related to atmospheric aerosols. The method is demonstrated on an example of two empirical models based on independent data-sets collected at two air quality monitoring stations at South Coast Air Basin, California. It is shown that in spite of a rather large distance between the monitoring stations (more than 50 km) and thus substantially different environmental conditions, the empirical models demonstrate several common qualitative features. Specifically, under definite conditions, a decrease in the level of NO_x or VOC may lead to an increase in mass concentration of aerosol. It is argued that these features are due to the nonlinear dependence of hydroxyl radical on VOC and NO_x.

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