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Recursive neural network model for analysis and forecast of PM10 and PM2.5

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A B S T R A C T

Atmospheric particulate matter (PM) is one of the pollutant that may have a significant impact on human health. Data collected during three years in an urban area of the Adriatic coast are analysed using three models: a multiple linear regression model, a neural network model with and without recursive architecture. Measured meteorological parameters and PM10 concentration are used as input to forecast the daily averaged concentration of PM10 from one to three days ahead. All simulations show that the neural network with recursive architecture has better performances compared to both the multiple linear regression model and the neural network model without the recursive architecture. Results of PM forecasts are compared with the air quality limits for health protection to test the performance as operational tool. The inclusion of carbon monoxide (CO) concentration as further input parameter in the model, has been evaluated in terms of forecast improvements. Finally, all models are used to forecast the PM2.5 concentration, using as input the meteorological data, the PM10 and CO concentration, to simulate the situation when PM2.5 is not observed. The comparison between observed and forecasted PM2.5 shows that the neural network is able to forecast the PM2.5 concentrations even if PM2.5 is not included among the input parameters.

1. Introduction

Over the past years, the effects of atmospheric Particulate Matter (PM) on human health, on ecosystems and on buildings and monuments soiling have become a relevant subject of research. The PM penetrates into sensitive regions of the respiratory system, therefore its inhalation increases respiratory illness and can harm lung tissues and throat (Turner et al., 2011). The PM10 (particulate matter having an effective aerodynamic diameter smaller than 10 μm) is one of the most dangerous pollutants; indeed, high PM10 levels have been correlated to the increase in hospital admissions for lung and heart disease (Ostro et al., 1999). Several epidemiological studies (Dockery and Pope, 1994, Katsouyanni et al., 1997) highlighted that PM can severely affect human health, even in relatively small concentrations in ambient air. PM2.5 (PM with an aerodynamic diameter below 2.5 μm) impacts more negatively the human health than PM10, since it penetrates more deeply in the respiratory system (Dockery et al., 1993; Pope et al., 1995, 2002; Monn, 2001). For these reasons, there is a growing interest on studying the formation, evolution and possible control strategy of PM10 and PM2.5.

Meteorological conditions have an influence on the PM10 accumulation, they can govern the variability of atmospheric PM10 (Amodio et al., 2012; Rodriguez et al., 2001). Usually elevated PM10 concentrations are the result of unfavourable meteorological

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