Satellite remote sensing and in-situ data for assessment of aerosol climate effects on urban air quality

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As one of the most important driver affecting the Earth's energy balance and hydrological cycle, and human health, aerosols have negative climate effects on urban air quality. The current study presents a spatio-temporal analysis of the aerosol concentrations in relation with climate variables in two size fractions (PM10 and PM2.5) in Bucharest metropolitan area during 2012 year. Both in-situ monitoring data as well as MODIS Terra/Aqua time-series satellite data have been used for particle matter PM2.5 and PM10 monitoring in relation with climate changes. It was found that PM2.5 and PM10 aerosols exhibit their highest concentrations mostly in the central part of the town, due to road traffic as well as in the industrialized periurban areas. In addition to the local and regional anthropogenic PM sources, both the levels and composition of air PM depend on meteorological parameters (temperature, humidity, precipitation, winds etc.), and season of the year.

Study area and data used

Bucharest test site town is placed in the South – Eastern part of Romania, being one of the most crowded capital in Eastern Europe and maybe the most polluted due to traffic increase and periurban industries development (sometimes above the acceptable limits). Daily in-situ average particle matters concentrations PM10 and PM2.5 and air quality index for Bucharest metropolitan area have been provided by Air Pollution Network of Environmental Protection Agency. The C005 (version 5.1) Level 2 and Level 3 Terra and Aqua MODIS AOD550 time-series satellite data for period 01/01/2012- 31/12/2012 have been also used. Based on new algorithm MAIAC for MODIS time series data have been derived the aerosol parameters which include optical depth (total aerosol) and fine mode fraction (Chudnovsky et al., 2014).Meteorological variables (air temperature, relative humidity, sea level atmospheric pressure) have been provided by in-situ measurements. ORIGIN 7.0 and ENVI 5.0 software were used for data processing.

Results

Changes in urban atmospheric composition due to the presence of gaseous and aerosol species create 'forcing' which is an external factor that affects local and regional climate (Zoran et al, 2016).

The predominant component in PM10 was PM2.5, as can be seen in Figure 1, which shows clear evidence that high mean PM10 and PM2.5 particle concentrations were observed in winter months, and low values in the summer months, the average ratio of PM2.5/PM10 was 89.12 and yearly average PM2.5 and PM10 values were of 26.88 μgm^{-3} and 30.16 μgm^{-3}.

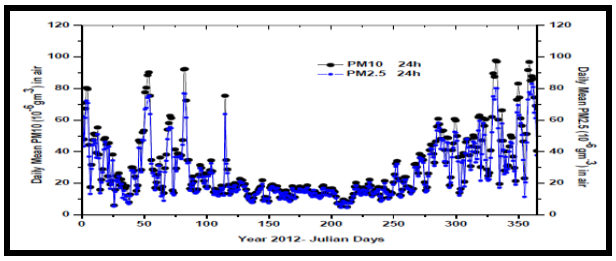

Figure 1. Daily mean PM10 and PM2.5 concentrations ($\mu g/m^3$) during 2012 year in Bucharest test area

Figure 2 shows aerosol concentration map derived from MODIS Terra AOD550 (aerosol optical thickness) daily data. The results revealed a significant month-to-month variability in all AOD550 values, underlying the influence of varying aerosol load function of season. The AOD550 values (Level 3) lie in a wide range, as low as 0.2 up to 0.5. The influence of aerosol particles on urban climate, and how their properties are perturbed by anthropogenic activity have been also discussed in relation with meteorological variables.

Figure 2. Global aerosol concentration map derived from MODIS Terra AOD550 over Bucharest area

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