Significance of scavenging processes for the removal of particulate matter from the atmosphere, a case study from Wrocław (Lower Silesia, Poland)

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Keywords: $PM_{2.5}$, scavenging processes, precipitation, Wroclaw.
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The atmospheric particulate matters play crucial role in the climate change, cloud dynamics, health impact, fog formation and visibility through a variety of atmospheric processes (Hueglin et al., 2005). High concentrations of the PM_{10}, $PM_{2.5}$ and PM_1 can cause human health problems, related to both short-term and long-term exposure to these particles (Kappos et al., 2004, Anderson et al., 2012). The highest emission rate of PM is observed in highly urbanized areas with many natural or anthropogenic emission sources. This phenomenon may be observed in Wrocław urban area (Lower Silesia region, Poland), which, from many years has been classified into class C due to exceedances of the standards for PM_{10} and $PM_{2.5}$ concentration. The process of mitigation of aerosol concentration in pollutant Wrocław atmosphere was driven by two main factors: change of air mass in synoptical scale and wet removal of particulate matter by precipitation. In the latter case there are two main mechanisms that should be taken into account: in-cloud mechanism, and a below-cloud scavenging (BCS).

The main objective of presented work was to determine the variability of particulate matter with the aerodynamic diameter less than 2.5 μm ($PM_{2.5}$), with the assessing the seasonality of washout effects and efficiency for removal of pollutants from the atmosphere by wet deposition.

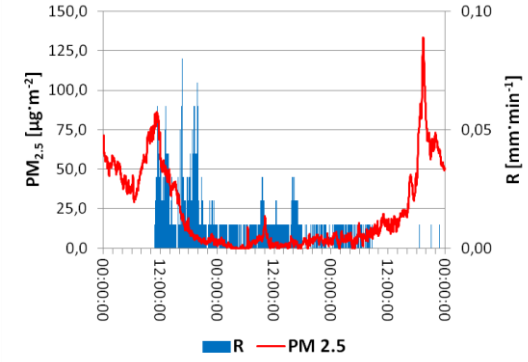

Figure 1. The course of $PM_{2.5}$ changes and 1 minute precipitation sums registered in Wrocław during snowfall episode (24 – 26 December 2010)

The mass concentration of $PM_{2.5}$ have been measured continuously at Wrocław (51°07' N, 17°05' E) by means automatic dust concentration monitor TEOM 1400a. For the measurement of precipitation optical disdrometer PARSIVEL was used. The study presents an analysis of data collected in the period from the start of May 2010 to the end of December 2014.

The scavenging coefficients calculated for the entire dataset ranged in the wide range. The intensity of the atmospheric aerosol wet removal is most often described as the median of dataset of all calculated coefficients, so for the entire analyzed period its value was determined on 3.28 10^{-5} s^{-1}. Characteristics of scavenging coefficients for the different types of precipitation (e.g. drizzle, rain, snow) were also calculated. Average value and median of scavenging coefficient for each type of precipitation ranged from 10^{-4} to 10^{-5} s^{-1}. Those values are comparable with results from similar experiments (e.g. Andronache et al., 2006), but are generally higher than model calculations based only on below-cloud processes. Maximum values were calculated for low intensity drizzle, rain with drizzle and freezing rain.

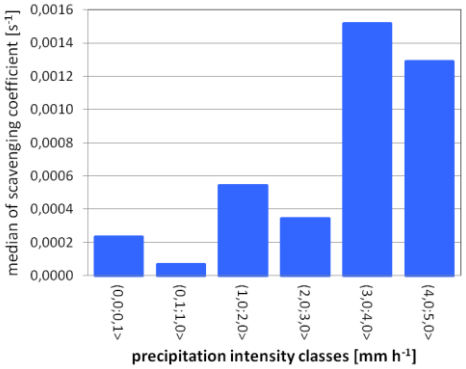

Figure 2. Median of scavenging coefficient for different precipitation intensity classes.

Obtained results will be applied in the forecast system for Lower Silesia region, which is now developed under the project "Air Pollution and biometeorological forecast and Information System" (LIFE-APIS/PL), co-financed by European Union, under the Financial Instrument LIFE+ and The National Fund for Environmental Protection and Water Management.

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