Spatio-temporal variations of sulfur dioxide concentrations in industrial and urban area via a new statistical approach

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Abstract

Sulfur dioxide (SO₂) is considered the most widespread pollutant that threatens environmental and human health. The purpose of this study is to propose a new method for evaluating the spatial variation of SO₂ levels in the Metropolitan Area of Porto Alegre (MAPA). This method included use of Chi-square test to better identify the origin of SO₂ sources. Additionally, results of the different methods applied allowed to analyze the temporal SO₂ levels and their association with meteorological parameters. SO₂ at five sampling sites (Esteio, Canoas, Charqueadas, Triunfo, and Gravataí) were measured during 2010–2015; using fluorescence SO₂ automated analyzers. Results showed that Charqueadas had the highest average concentration ($\sim 15 \mu\text{g m}^{-3}$), followed by Triunfo ($13 \mu\text{g m}^{-3}$), Esteio ($6 \mu\text{g m}^{-3}$), Canoas ($3 \mu\text{g m}^{-3}$), and Gravataí ($2 \mu\text{g m}^{-3}$). Chi-square test applied to SO₂ and wind direction quadrants showed significant contribution of local emission sources. Seasonal variation revealed higher SO₂ levels on cold days for most of the studied sites, except for Esteio site. Day-wise variations revealed higher SO₂ concentration on weekdays than weekends for Esteio and Canoas sites, indicating traffic influence especially during the rush-hours. Annual averages analysis identified an increasing trend in SO₂ concentrations, implying that applied emission control systems and technological improvement of engines and fuels were not sufficient and thus points out a need for better subsidies mechanisms to pollutant control and effective emission reduction strategies that decision makers, including environmental agencies, must make priority by considering the local realities.

Keywords

Air Pollution; Statistical Analysis; Sulfur Dioxide; Weekend Effect.