



Causal relationship on sulfur dioxide between stationary emission source and ambient air quality: A data-driven approach

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Kaohsiung is the major center of heavy industry and business activity in southern Taiwan. The air pollution problems caused by stationary and mobile emission source in this big metropolitan has been one of the most important environmental issues in recent decades. In the past, most of the studies adopted numerical model or measurement data on air pollutant issue in urban areas to characterize the impacts of stationary emission sources. However, very few studies discussed and gave quantitative evidence of the spatial relationship between stationary sources and ambient air quality. Due to the complexity of the air circulation system and consideration of several factors, the relationship between stationary emission sources and ambient air quality is hard to estimate. This study applied a data-driven approach to evaluating the relative impacts between continuous emission monitoring systems (CEMS) and ambient air quality from air quality monitoring stations provided by Taiwan's Environmental Protection Administration. This study adopted the two-step casual evaluation model, Pearson correlation analysis and time-series Granger causality analysis, to quantify and verify the causality on sulfur dioxide (SO_2) between the CEMS and ambient air quality. In addition, the relative impacts of each CEMS sources have been evaluated via both the number of daily correlation and causality events. In order to exclude the impact of transboundary pollutants, we estimated CEMS impacts in Taipei city, transboundary pollutants major area, to confirm the influence of stationary emission sources through seasonal comparison; and this result could enhance the reliability of relative impact evaluation. According to the results, the number of relative impacts is not affected by transboundary pollutants. Because the major transboundary pollutant period in Taipei is spring and winter; however, there is no significant raise in these two seasons. In spatial comparison, Kaohsiung, as a heavy industrial city, has much more relative impacts than Taipei. The results showed that the major relative impact of SO_2 in Kaohsiung is attributed to several major industrial emission sources in this area. We found that the relative impact is highly related to their SO_2 emission amounts. This study proposed a simpler and faster quantitative approach to characterize the causal relationship between CEMS and ambient air quality. Moreover, the relative impacts in the specific region of each CEMS are quantitatively estimated. The result could provide the administrators with important information to quickly realize the relative impacts of stationary emission sources on the ambient air quality.

Keywords: stationary emission source, ambient air quality, causal relationship, relative impact