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Multivariate analysis of effects of diurnal temperature and seasonal humidity variations by tropical savanna climate on the emissions of anthropogenic volatile organic compounds

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HIGHLIGHTS

- The VOC distributions during the day and night in the dry and wet seasons were studied.
- The VOC data was analyzed by using principal component analysis and cluster analysis.
- The influence of humidity variation on the VOC distributions was important.
- Aromatic VOCs were likely more important under the influence of humidity variation.
- The effect of diurnal temperature change on the VOC emissions was not negligible.

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ABSTRACT

Volatile organic compounds (VOCs), particularly those from anthropogenic sources, have been of substantial concern. In this study, the influences of diurnal temperature and seasonal humidity variations by tropical savanna climate on the distributions of VOCs from stationary industrial sources were investigated by analyzing the concentrations during the daytime and nighttime in the dry and wet seasons and assessing the results by principal component analysis (PCA) and cluster analysis. Kaohsiung City in Southern Taiwan, known for its severe VOC pollution, was chosen as the location to be examined. In the results, the VOC concentrations were lower during the daytime and in the wet season, possibly attributed to the stronger photochemical reactions and increasing inhibition of VOC emissions and transports by elevating humidity levels. Certain compounds became appreciably more important at higher humidity, as these compounds were saturated hydrocarbons with relatively low molecular weights. The influence of diurnal temperature variation on VOC distribution behaviors seemed to be less important than and interacted with that of seasonal humidity variation. Heavier aromatic hydrocarbons with more complex structures and some aliphatic compounds were found to be the main species accounting for the maximum variances of the data observed at high humidity, and the distinct grouping of compounds implied a pronounced inherent characteristic of each cluster in the observed VOC distributions. Under the influence of diurnal temperature variation, selected VOCs that may have stronger photochemical resistances and/or longer lifetimes in the atmosphere were clustered with each other in the cluster analysis, whereas the other groups might consist of compounds with different levels of vulnerability to sunlight or high temperatures. These findings prove the complications in the current knowledge regarding the VOC contaminations and providing insight for managing the adverse impacts of the anthropogenic VOCs on the environment and public health.

1. Introduction

The pollutions of volatile organic compounds (VOCs) have been of substantial concern and widely studied with respect to their occurrences and relative magnitudes (Cetin et al., 2003; USEPA, 2012; Zou et al., 2003). Besides their potentials of being involved in photochemical reactions concerning ozone and particulate contaminations, a large number of VOCs are known as toxic air pollutants causing cancers and other serious health effects by inhalation (Chang et al., 2010; Guo et al., 2004; USEPA, 1995). Key symptoms associated with exposure to VOCs include various acute and chronic adverse health effects such as eye and throat irritation, headaches, loss of coordination, nausea, damages to liver, kidney, and central nervous system (USEPA, 2012). Volatile

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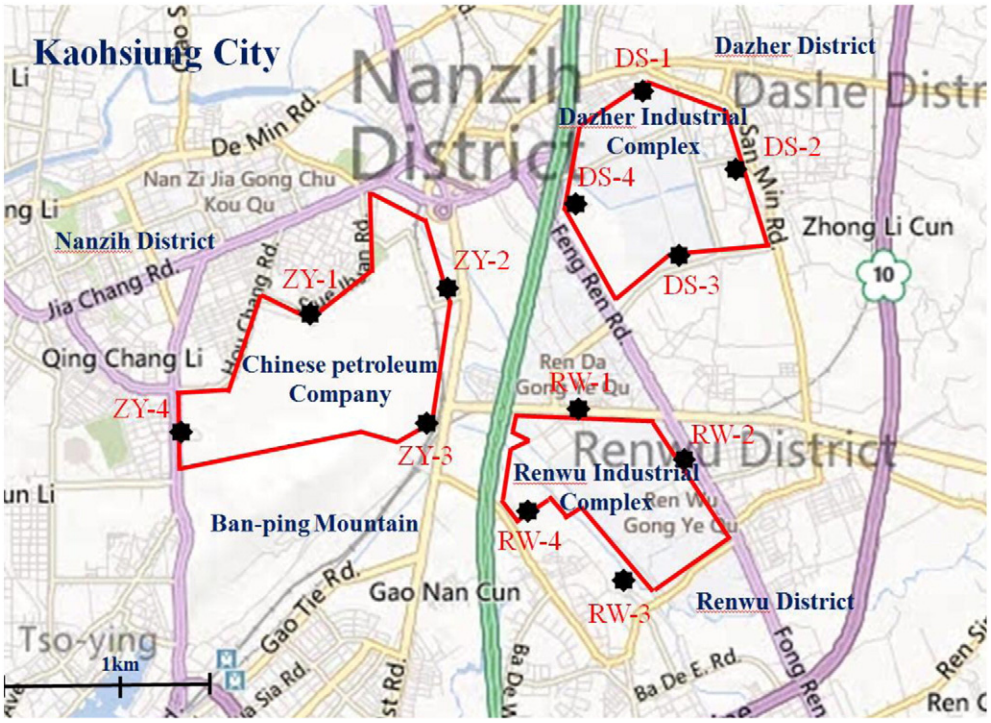

Fig. 1. Monitoring and sampling areas in this study.

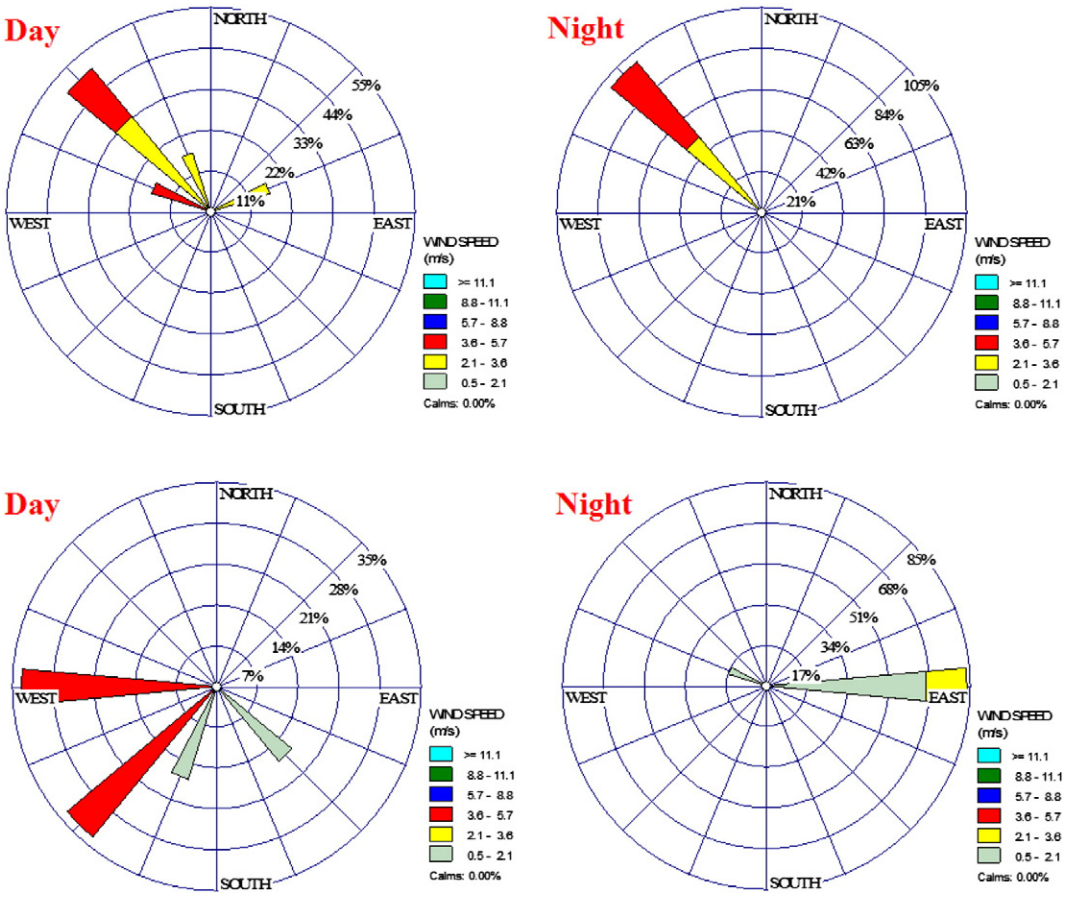

Fig. 2. Typical wind roses of the monitoring area in this study during daytime (top left and bottom left) and nighttime (top right and bottom right) in dry and wet seasons (top and bottom, respectively).