Geophysical Research Abstracts
Vol. 20, EGU2018-2901-1, 2018
EGU General Assembly 2018

Diagnosis of petrochemical industry influences by air quality model with VOCs fingerprint analysis

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The air pollution problems from petrochemical industry, especially the influences of volatile organic compounds (VOCs), are well known environmental concerns. The photochemical assessment monitoring stations (PAMS), with speciated observations of 54 selected VOCs, can provide very useful information to assess the impact of emissions from the petrochemical plants. In our previous study, the ratios of ethylene/acetylene (E/A) and propylene/acetylene (P/A) were shown as very useful indicators to reveal the source/receptor relationship of such environmental concerns. Hourly speciated data from the PAMS enabled a finer assessment of the regional influences from a petrochemical complex (Atmos. Environ, Su et al, 2016). However, establishments and maintenances of large number of PAMS are very expensive. Here we explore how air quality model can be used to supplement smaller set of PAMS observation so as to cover a larger region.

In this study, three kinds of typical cases of simulations and observations (9 sites) under different wind fields around a major petrochemical complex at western coast of Taiwan were analyzed. A three-dimensional Eulerian air-quality model specific to PAMS species (PAMS-AQM) was used, and the PAMS species emissions used in the air quality model were optimized. The non-petrochemical emissions used (such as urban, traffic, and other emissions) were as reported in previous reference study (Atmos. Environ, Chen et al, 2014), and the emissions from the petrochemical complex were optimized by PAMS observation. From the results of these case studies, we found that the impacts of the petrochemical industry are dominated by the meteorological condition around this coast area. Under monsoonal flows, the emissions from this petrochemical complex only affect the coastal areas and VOCs air mass almost never reach beyond about 20km from the coastline. However, downwind of the source pollutants can reach distances over 40 km because of the relatively high wind speed. Under local circulation flows with land-sea breeze, petrochemical pollutants can affect the inland areas but have shorter range of influence, mostly less than 40 km. This result shows that the VOC characteristics of coastal and inland areas are often not the same, i.e. attributed to different sources. In particular, inland areas are often affected by sources other than nearby petro-chemical plants.