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대기-1

Air Quality Studies for the Houston-Galveston Metropolitan Airshed

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1. Introduction

The Houston-Galveston Area (HGA) has become one of the most severe ozone non-attainment regions in the US for both 1-hour ozone and the number of days above the US National Ambient Air Quality Standard (NAAQS). HGA contains about 50% of the US petrochemical capacity. Some of Petroleum refinery emissions cause serious air quality problems as they are respiratory irritants causing significant health effects and suspected for elevating cancer risks to certain populations. Nitrogen oxides (NOx) and volatile organic compounds (VOCs) emitted by the petroleum refineries and associated chemical facilities are precursors for the ozone and particulate pollutants that must meet the NAAQS. In addition to the anthropogenic and biogenic emissions, meteorology has been cited as one of the critical reasons for high ozone problem in HGA. The air quality projects at the University of Houston (UH) target understanding of the meteorological and chemical environments that lead to the high ozone concentrations. Our study results will provide essential information to the regulatory agencies for making decisions on the air quality management in the region.

2. Method

We combine both observational and modeling studies. Observational study will use a variety of measurements obtained during the Texas Air Quality Study August 15-September 19, 2000 (TexAQS2000), which involved multiple national laboratories such as DOE and NOAA and State of Texas institutions and universities. The study showed massive and frequent spikes of ozone, which appear to be associated with releases of reactive unsaturated hydrocarbons (alkenes) from the petrochemical industries. Compared with typical ozone evolution patterns in other US cities, several monitoring sites in the area show distinct rapid transient high ozone events. We have incorporated a web-based user interface with the NOAA Air Resource Laboratories HYSPLIT trajectory model. The air trajectory analysis shows that the problem is exacerbated when precursor emissions are sent out to bay area by the land breeze in the morning then returned by the sea breeze in the afternoon.

To understand the HGA air quality problems, UH performs systematic sensitivity studies of meteorological and air quality model (AQM) configurations and emissions inputs. We study the effects of different meteorological model paramterizations and the amount of variations in the emission of highly reactive alkenes on the simulation of the rapid ozone formation events. The objectives are; (1) to quantify sensitivity of AQMs to the input meteorological model parameterizations and to the uncertainties in the industrial volatile organic compound emissions, and (2) to develop recommended model configurations that can facilitate testing of emissions control strategies suggested in the State Implementation Plan (SIP) or other scenarios.

3. Conclusions

The ozone problem in the HGA results from the automobile and other anthropogenic emissions in the metropolitan area, NOx and VOC emissions from the petrochemical industries under the favorable meteorological conditions. Therefore, UH is endeavoring to establish comprehensive observational and modeling systems that take into account all the key factors affecting regional air quality. By developing a set of contrasting meteorological simulations for high ozone episodes during the TexAQS 2000 period, the characteristics of the meteorological conditions and interaction between urban heat island and land-sea breeze in HG area are studied. Also, by performing sensitivity studies of the emissions input to air quality models, effects of NOx-VOC control strategies are studied. Preliminary results indicate that control of highly reactive alkene emissions from the industries, on top of the regional NOx control, may be needed to improve the surface ozone in the HGA. However, uncertainties in the VOC emissions and the nature of operational upset events must be assessed much rigorously to be conclusive.