Air Quality Research Program

Administered by the Division of Air Quality

Research Projects: FY 2015: Salt Lake City Ozone Precursor Study

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Problem Statement:

Salt Lake City (SLC) and the surrounding areas experience high levels of ozone (O_3) in summer months. Based on the Utah Ozone Study 2012, the Wasatch Front and adjacent mountain valleys had four to thirteen days exceeding the current National Ambient Air Quality Standard (NAAQS) for ozone (75 ppb) during 2012. Interestingly, the highest ozone concentrations and the most exceedances were observed outside the SLC metropolitan area, at mountain sites east of the Wasatch Front including Park City and Heber, and in the Tooele Valley located south west of the Great Salt Lake. Arens and Harper [2012] suggested that the high ozone in these areas was influenced by the transport of ozone and ozone precursors from Salt Lake City.

Although all counties along the Wasatch Front meet the NAAQS for ozone, the peak 8-hour ozone concentrations are between 70- 75 ppb nearly exceeding the current standard. Under the proposed new standard, an 8-hour average of 65 – 70 ppb, many areas in Utah including Salt Lake City and surroundings will be in non-attainment of ozone. Ozone is formed by photochemical reactions involving volatile organic compounds (VOCs) and nitrogen oxides (NOx). Hence knowledge of relative abundances of ozone precursors, VOCs and NOx, in Salt Lake City is essential for reducing the ozone levels in this air shed. NOx is monitored at several sites along the Wasatch Front. However, there is little or no information available on the levels and composition of VOCs in Salt Lake City, which are known to play an important role in the tropospheric ozone formation. Given the high uncertainty associated with VOCs, measurements and analyses of VOCs are needed to understand the ozone chemistry in SLC and the surrounding areas.

Utah DAQ has been monitoring 57 VOCs at Hawthorne station since 2012 using gas chromatography-flame ionization detection (GC-FID) technique (see Fig.1).

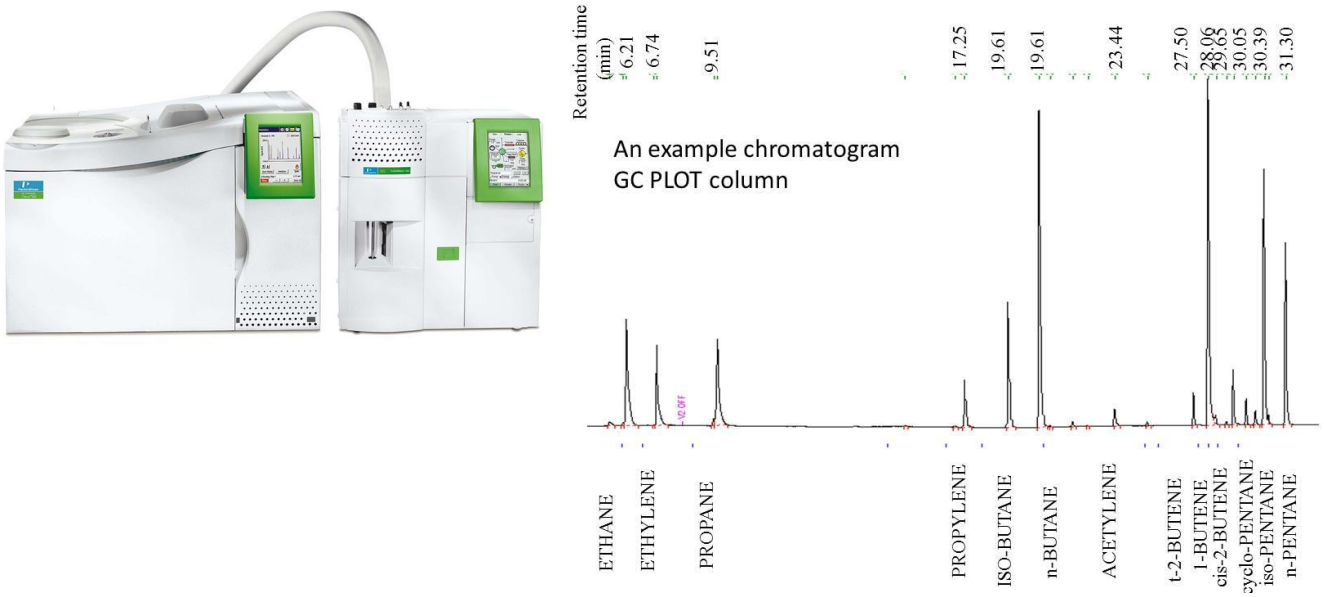

Figure 1: a) PerkinElmer ozone precursor system used for monitoring VOCs. This system consists of a TurboMatrix thermal desorption system for sample pre-concentration and GC-FID system for the analytical separation and detection of C2 - C14 VOCs. b) An example chromatogram that shows individual peaks belonging to species of interest. The area under a peak is related to concentration of the species.

This dataset can provide valuable information on the ozone precursors. This work aims to improve our understanding of ozone chemistry in the greater Salt Lake City metropolitan area by analyzing the existing VOC dataset and collecting new measurements.

Specific Tasks

The main goal of this study is to determine the VOC composition in SLC and identify the most important factors driving the ozone production in this region. The specific goals include:

1) To process the existing VOC data, perform quality check, and compile the data
2) To obtain seasonal, monthly, and daily trends of volatile organic compounds and to determine the chemical speciation of VOCs
3) To study the spatial and temporal variation of VOCs and NOx (e.g. see Fig. 2), and to identify their sources (if possible)
4) To determine the OH reactivity in Salt Lake City and to identify the most important VOCs in terms of ozone production. OH reactivity, which depends on the ambient VOC levels and the respective reactivity toward atmospheric OH radical, provides a way to assess the importance of VOCs.
5) To identify which precursor limits the ozone formation in this region

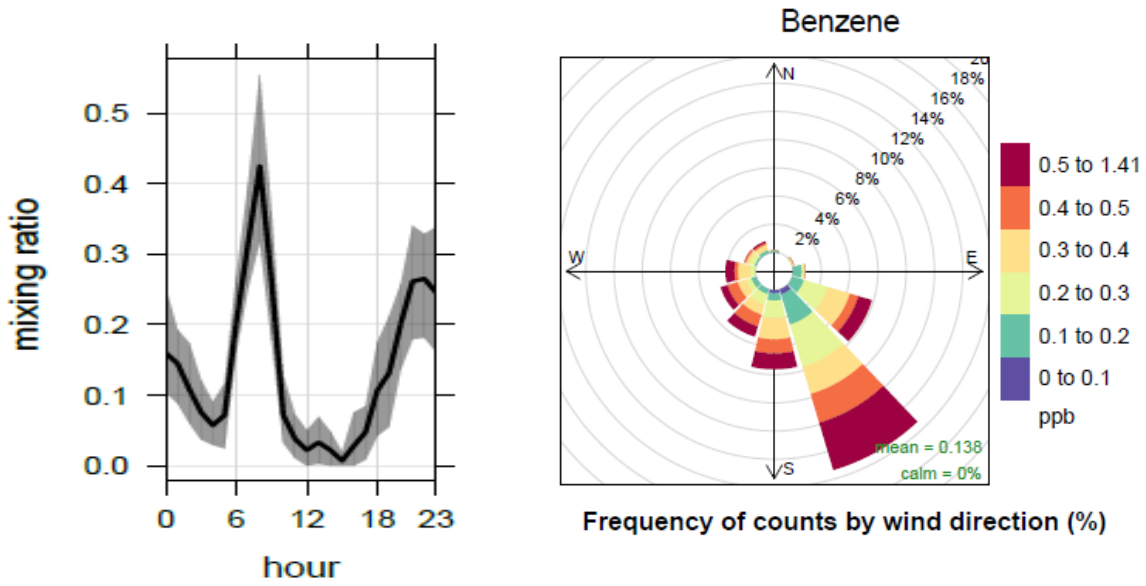

Figure 2: a) Diurnal variation of benzene measured at Hawthorne station in March 2014. The benzene concentration peaks during the morning rush hours indicating importance of on-road sources of benzene at this location. b) Benzene concentration as a function of wind direction. The highest concentrations are observed during Southerly winds, which bring pollutants from interstate I - 80.

Deliverables

The main output of this study will be a comprehensive dataset of ozone precursor species and a publication on the ozone chemistry. The compiled dataset will be submitted to Air Vision and EPA Air Quality System (AQS) database and can be used for future modeling studies or analysis. Specific deliverables include:

- A comprehensive dataset that consists of ozone, ozone precursors, and meteorological parameters
- Analyses of this dataset: spatial and temporal variability, trends, identification of the most important contributors to ozone formation, source characterization (if possible)
- Written report/publication
- Codes for data processing and preparing the data for reporting

References

- Arens, S., K. Harper, 2013: 2012 Utah Ozone Study. Division of Air Quality.