

Atmospheric benzene observations from oil and gas production in the Denver Julesburg basin in July and August 2014

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Introduction

This supporting information presents background and supporting plots that are useful for a better understanding of the data presented in the paper. This material includes the canister benzene and PTR-QMS benzene correlation figure, a diurnal representation of the measured boundary layer heights, an over view plot of the vertical aircraft data, a mean vertical benzene profile, the diurnally split benzene polar frequency plot, and a map of the waste pit locations in the Wattenburg Gas Field. These plots were important for the analysis of the paper, but did not significantly improve the story presented in the main body of the text.

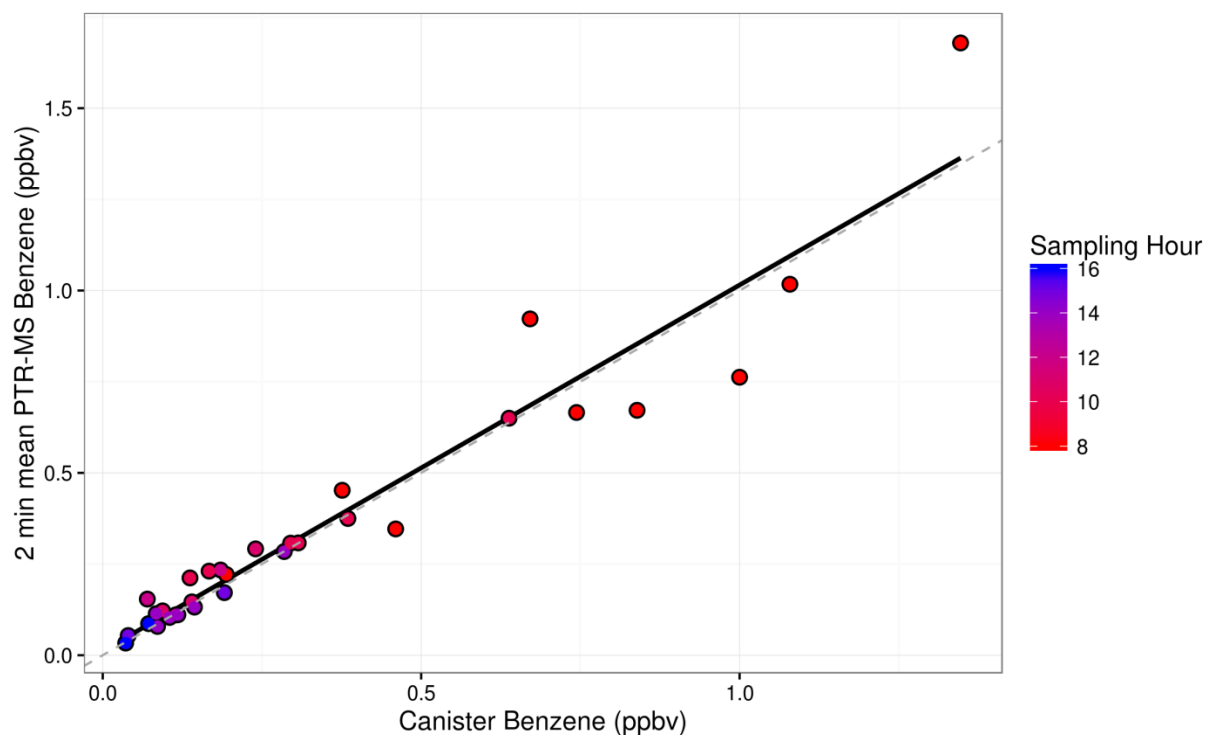


Figure S1. Regression plot of 2-min average PTR-QMS benzene (with the mean benzene window being centered on the canister opening time) vs. benzene in the canister samples. The grey dashed line is the 1-to-1 line. The black line is the linear regression best fit line, which has a slope of 1.003, and an R^2 of 0.9205. The points are colored by their hour of collection, in local time (MDT).

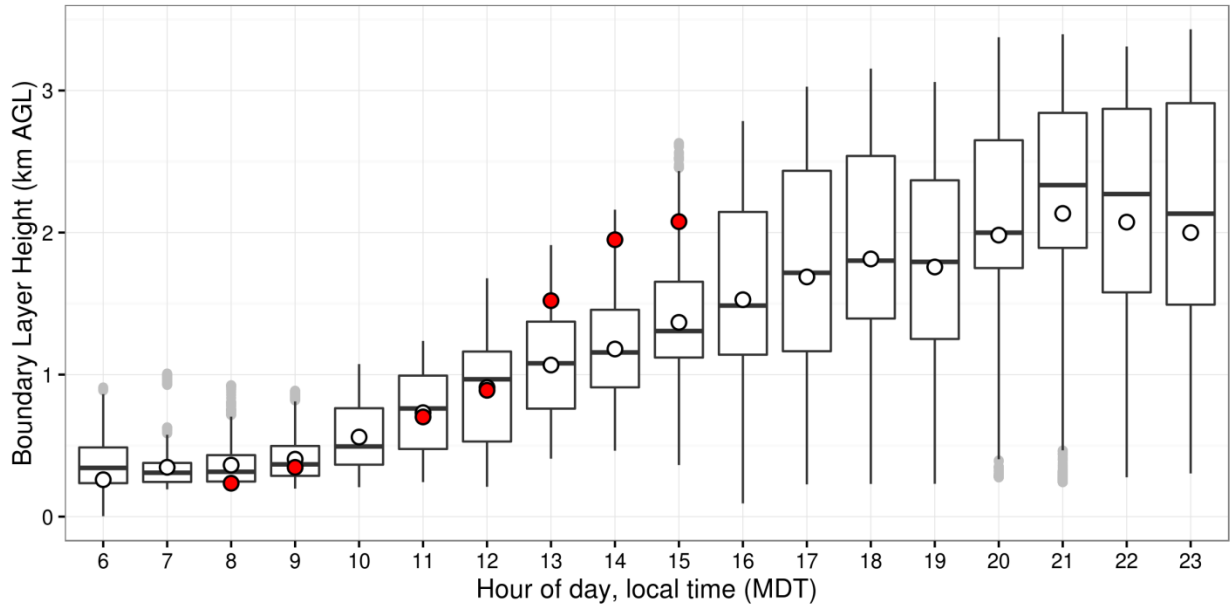


Figure S2. PBLH diurnal profile. The box and whisker plots are created from MPL observations between 22 July 2014 and 11 August 2014. The open points show the mean PBLH derived from MPL data for each hour. The red points show the mean PBLH derived from ozonesonde data for each hour. The daytime-type boundary layer starts developing between 900 and 1000 MDT. The MPL PBLH data is based on aerosol retrievals, which remain lofted into the atmosphere after the collapse of the PBLH at night, so we consider the post-sunset data to be unreliable for PBLH measurements.

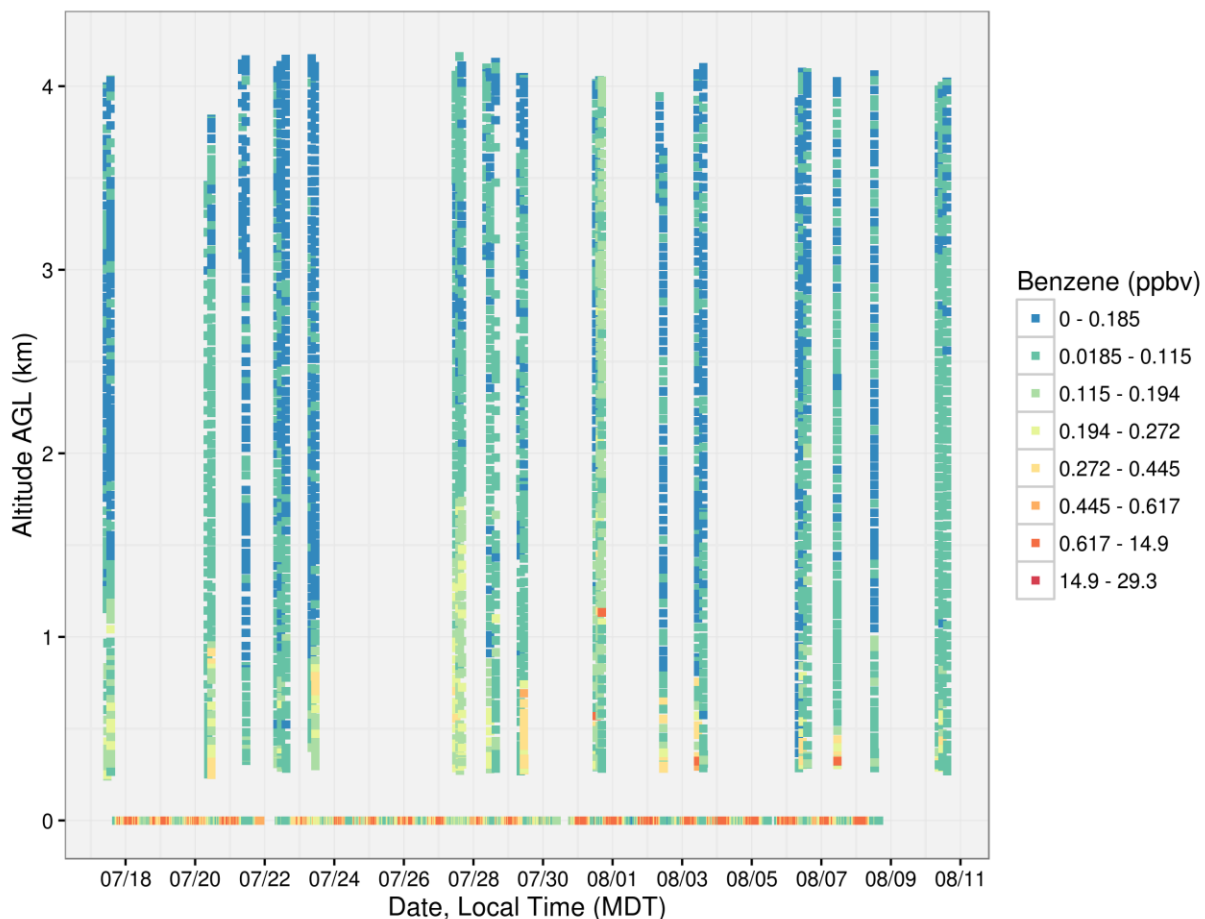


Figure S3. Vertical benzene profiles and ground benzene measurements collected at PAO during the DISCOVER-AQ 2014 study. Each point is plotted based on the time stamp and GPS altitude data from the P₃-B spirals. The altitudes are reported above ground level (AGL). Each point is colored by measured benzene mixing ratio. The color plot is based on the quartiles of the benzene data.

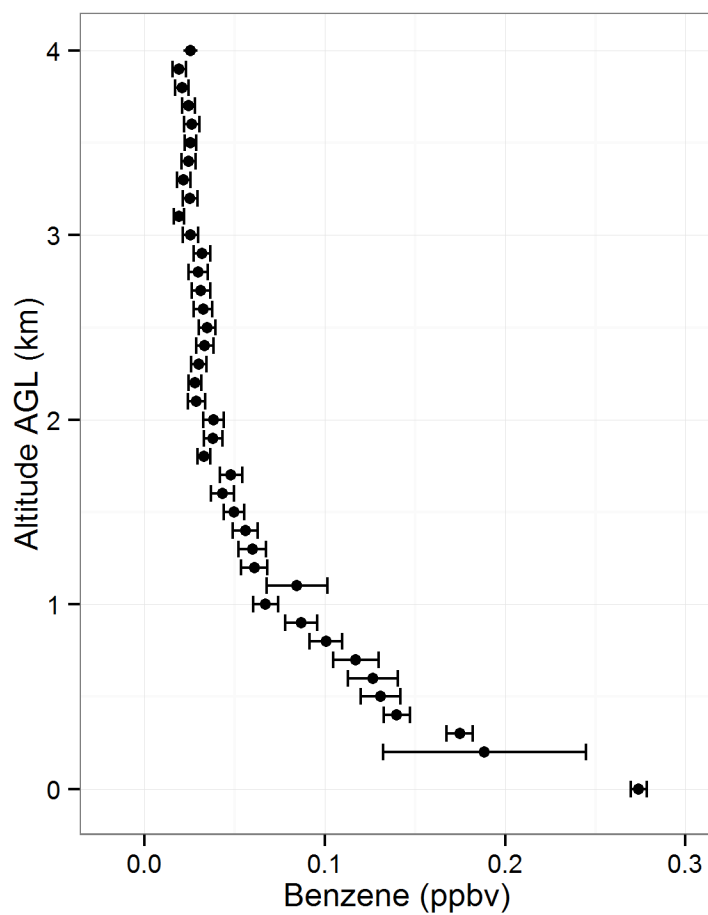


Figure S4. Benzene mean profile over PAO from the aircraft spirals over the site. The points are the mean mixing ratios binned by 50 m bins. The error bars show the standard deviation of the mean for each vertical bin.

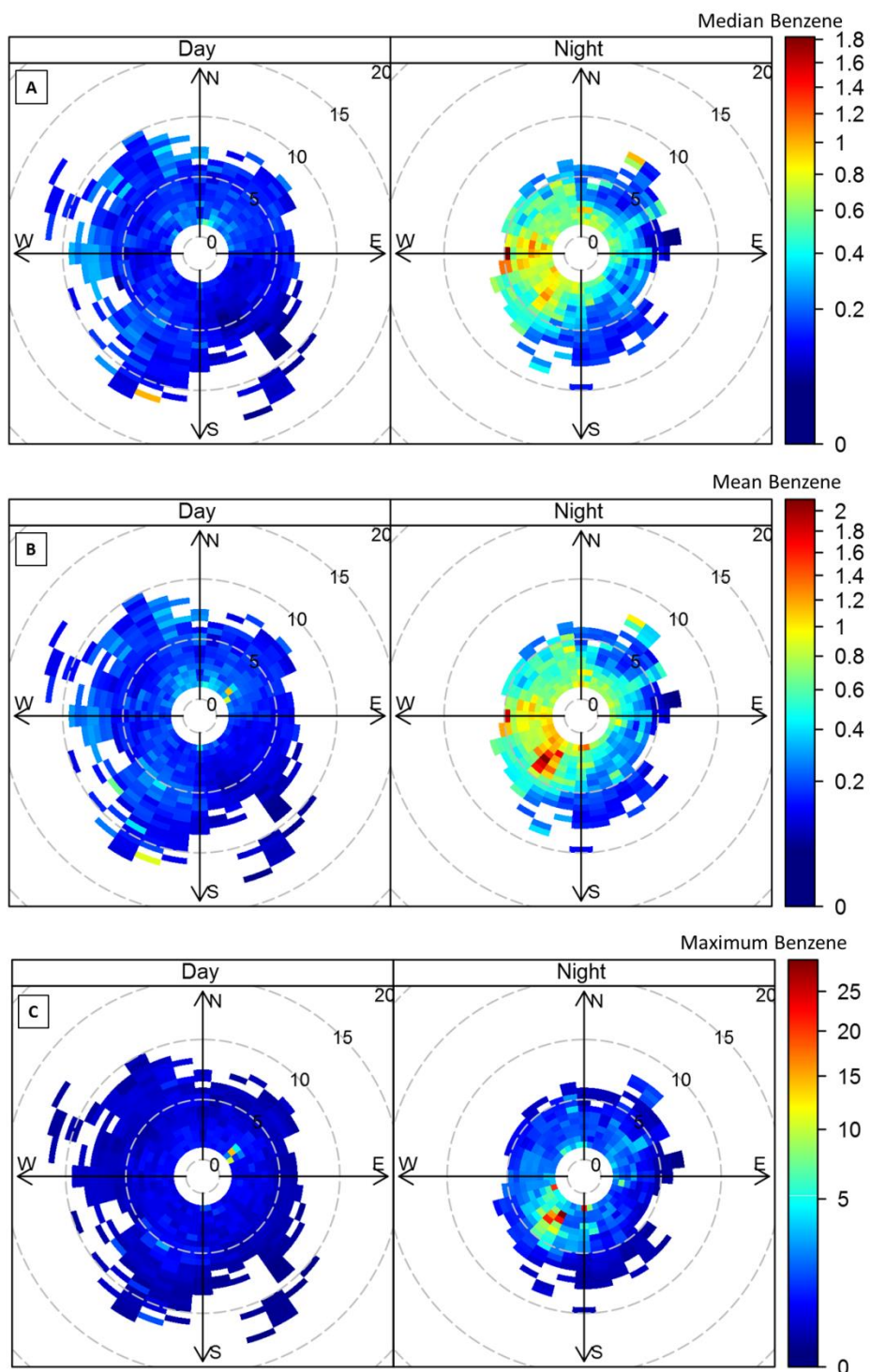


Figure S5. Polar frequency plots of benzene as measured at PAO during the DISCOVER-AQ 2014 campaign, separated by day vs. nighttime. The diurnal conditions were determined by the sun's zenith angle. Wind observations are binned by 10 degrees wind direction and 0.5 ms⁻¹ wind speed.

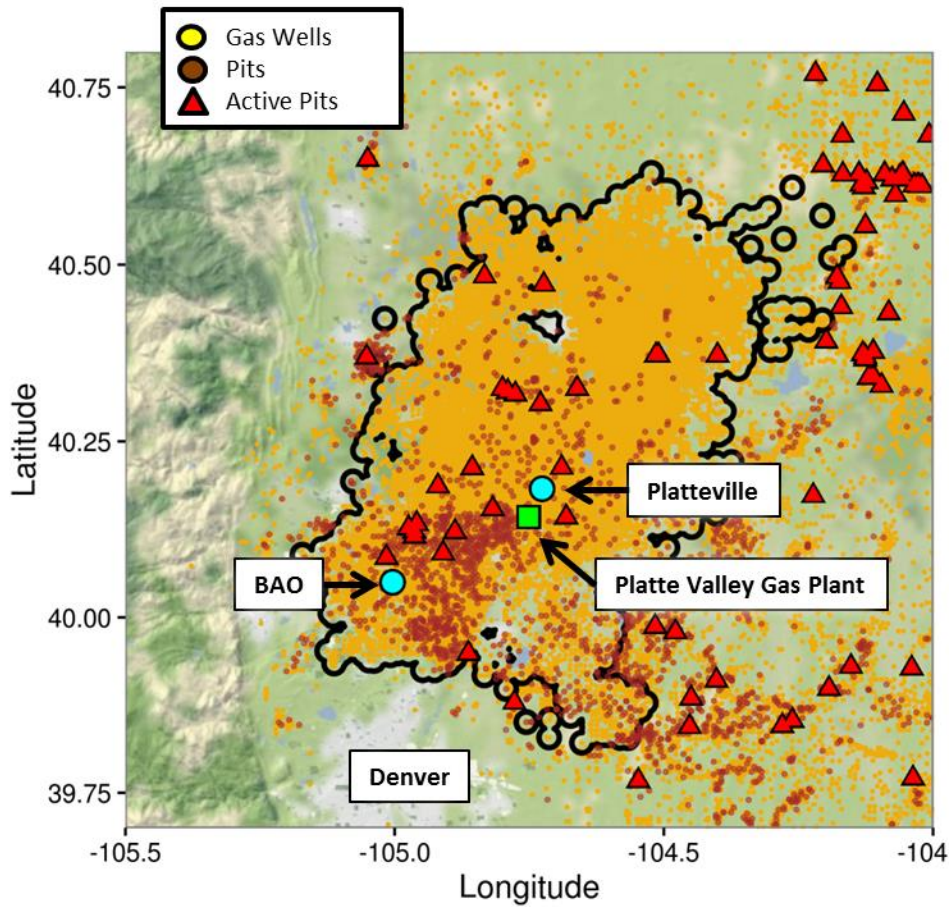


Figure S6. Waste pit locations and statuses provided by COGCC. The cyan points show the locations of the PAO and BAO sampling sites for the campaign. The black outline shows the political boundary of the WGF as defined by the COGCC. The red triangles show the locations of the active waste pit locations as reported from the COGCC data. The green square shows the location of the Platte Valley Gas Plant.