

EXECUTIVE SUMMARY

The highest ozone air pollution episode in the Houston, TX region in 2013 occurred September 25-26, which coincided with the Deriving Information on Surface Conditions and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ) field campaign. The maximum 8-hour average ozone peaked on September 25 at La Porte Sylvan Beach reaching 124 ppbv, almost 50 ppbv above the current Environmental Protection Agency (EPA) standard of 75 ppbv. We analyzed this air pollution episode and have quantified the contributions of emissions from various anthropogenic source regions.

We used the Weather Research and Forecasting (WRF) and the Community Multi-scale Air Quality (CMAQ) models along with ground and aircraft observations obtained during the DISCOVER-AQ field deployment to evaluate the model simulations. Our first WRF simulation did not perform well as compared with observations (details described in Section 2.1). The WRF simulation did not accurately capture the sea and bay breeze circulations on September 25. We re-ran WRF using refined model inputs and employing a novel iterative technique developed at the EPA (details described in Section 2.2). This new and improved simulation accurately simulated the sea and bay breeze circulations on September 25. This improved WRF simulation was used to drive a CMAQ simulation. The improved CMAQ run simulated a widespread area that exceeded the EPA ozone standard, which agrees with observations. However, the model still had a low ozone bias downwind of Baytown and Deer Park. This low bias may be due to an underestimate in emissions, errors in the meteorological simulation, or uncertainties in the chemistry.

We identified possible anthropogenic source regions that impacted Houston during this campaign by calculating back trajectories from our WRF simulation. Houston, Dallas, Beaumont, Lake Charles, marine, and other areas were the anthropogenic source regions tagged for a CMAQ ozone source apportionment simulation based on the back trajectory analysis. Results from the ozone source apportionment model run show anthropogenic emissions from the Houston metropolitan area were the primary contributors to surface ozone during this air pollution episode.

Satellite observations were analyzed to determine if they were able to detect the regional transport of air pollution and subsequent buildup in the Houston metropolitan area for this air pollution episode. While satellite observations were not able to detect transport from a specific anthropogenic source region during this episode, tropospheric nitrogen dioxide (NO₂) columns and total carbon monoxide (CO) columns as observed from space did show higher pollution over the continent than over the Gulf of Mexico. This suggests that higher air pollution concentrations are transported into Houston when transport is from the continent than from the Gulf of Mexico, which was the case during this air pollution episode.