

EXECUTIVE SUMMARY

TERC Project H60, a collaboration among Environ, the University of North Carolina, and the University of Houston was initiated to provide assessment of regional transport, ozone impact analysis of various control strategies, and source apportionment for Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) areas using both existing air quality model episodes and new episodes developed for 2005 based on the latest emissions and meteorological data, including other data available from the Second Texas Air Quality Study (TexAQS 2). Phase 2 of the project, in particular, consisted of the development of two 2005 episodes (June 19-23 and August 30-September 9), the performance evaluation of these episodes, especially for the Dallas-Ft. Worth area, for which control strategies have been considered in Phase 1 of H60, the intercomparison of modeling platforms (CAMx and CMAQ), and the application and comparison of various source apportionment techniques such as the Anthropogenic Precursor Culpability Assessment (APCA) ozone apportionment scheme and the High-order Direct Decoupled Method (HDDM). This report documents the efforts of the University of Houston to address the issues of Phase 2 of Project H60.

The major findings of this modeling study can be summarized as follows:

- For the DFW area, both CAMx and CMAQ behave similarly and compare well with observations from the Keller and Dallas Hinton St. sites, except on some days (e.g., June 22nd) when the models over-predicted ozone concentrations. CAMx and CMAQ simulations with SARPC99 chemical mechanism generally showed higher O₃ concentrations than those with CB-4.
- For the DFW area, the simulation with CAMx with Kz modification and CB-4 showed the best matches to the observed O₃ concentrations. With the SAPRC99 chemical mechanism, CAMx showed a better performance for medium O₃ concentration range. CMAQ simulations also showed similar behaviors between CB-4 and SAPRC99 versions.

- The selection of PBL option is critical to the quality of the meteorological and air quality simulations. Compared to the MM5-estimated PBL option, CMAQ simulations with MCIP-recalculated PBL generally show better matches to 1-hr ozone concentrations observed for the two new 2005 episodes, but under-predicted peak O₃ concentrations when observations were higher than 100 ppb.
- Inland PBL heights in the early morning and PBL heights over the sea during the night were grossly underestimated when the MM5-estimated PBL option was invoked. CMAQ with this option predicted higher O₃ concentrations than those with the MCIP recalculation option, especially over the sea, which could not be verified by observations. However, for the days with high ozone concentrations observed at CAMS sites, CMAQ with MM5 PBL estimates predicted the high peaks better than the latter. Further verification of the PBL heights and off-shore concentrations will be necessary.
- HDDM simulations assessing the impact of regional transport on DFW ozone concentrations revealed that the Texas intra-state contribution was dominated by NO_x and could exceed 15 ppb, whereas the combination of sources in the neighboring states of Oklahoma, Arkansas, and Louisiana contribute up to around 10 ppb. It was also found that the first term of sensitivity to the inter-state contribution was predominant for the contribution of inter-state emissions, and the diurnal variation of inter-state contribution becomes appreciable compared to that of intra-state contribution, indicating contribution of inter-state NO_x emissions to DFW 8-hour ozone was almost the same with that for 1-hour ozone in the magnitude.
- NO_x reductions of around 50% in the four neighboring states (Oklahoma, Arkansas, and Louisiana, and Mississippi) are required to reduce daily maximum 1-hour and 8-hour ozone by more than 4 ppb (roughly comparable to the current SIP ozone attainment deficit based on projected 2009 8-hour ozone design values).

- Local NO_x and VOC contributions to daily maximum ozone were comparable during the HGB 2000 episode. The VOC point source contribution was highest in the east side of Houston near the Ship Channel areas, whereas the mobile NO_x contribution was predominant in the west side of Houston. The biogenic contribution was more evenly distributed around the Houston area, whereas the boundary conditions appeared to affect ozone mostly over the Ship Channel, Galveston Bay and the Gulf of Mexico.
- When HDDM analysis was applied to the Deer Park and Aldine sites, the first order contribution by NO_x was found to be responsible mainly for NO_x titration of ozone, whereas the second order term contributed primarily to ozone production. The VOC contributions were stronger at Deer Park than at Aldine, due to the large primary emissions of VOCs in the Ship Channel and the aging of pollution plumes that eventually reached North Houston. The NO_x-VOC cross term was mostly negative at both sites, but relatively small compared to other terms at Aldine.
- Based on the analysis with the 2000 HGB episode, deep NO_x reductions of the order of 50% are required to reduce 1-hour and 8-hour ozone peaks by up to 18 ppb and 13 ppb, respectively, in the Houston region. A combined 50% reduction in VOCs and NO_x can result in significant 1-hour and 8-hour ozone reductions of 30 to 40 ppb, and 20 to 30 ppb, respectively. The results of the HDDM analysis showed that the Houston airshed in 2000 exhibited mixed sensitivity to VOC and NO_x emissions control, consistent with the results of the previous CAM_x/DDM-SAPRC sensitivity analysis conducted by Pun et al. (2005).