**Final Report, August 1, 2014**
**Satisfying Task 3**
WORK ORDER UNDER THE CONTRACT BETWEEN TCEQ AND CONTRACTOR:
**The University of Texas at Austin**

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# Eagle Ford Shale Mobile Monitoring Study

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## 1. Background

Over the past few years, the availability of new drilling technology has made drilling for oil and natural gas in previously uneconomical geologic formations affordable. There has been a large increase in oil and gas drilling (and production) in deep shale formations like the Haynesville, Barnett, and Eagle Ford Shale areas of Texas that lie on the outskirts of large metropolitan areas. Because the Eagle Ford Shale (EFS) formation lies in proximity to the San Antonio metropolitan

area, there exists the possibility that oil and gas activities over the formation may increase emissions of volatile organic compounds (VOC) and nitrogen oxides (NOx) close to the San Antonio metropolitan area. The purpose of this project is to determine the general representativeness of the Wilson County continuous ambient monitoring station (CAMS) number 1038 site (established in mid-2013) data and to evaluate if there are significant differences in ozone precursor concentrations generally upwind and downwind of the EFS.

The EFS formation runs from southwest to northeast in a relatively narrow band from Laredo to central East Texas. There is a large amount of oil and gas extraction related activity along the formation from 25 to 75 miles southeast of the San Antonio metropolitan area. The prevailing wind directions in the San Antonio area are south-southeast. This configuration means that the winds often blow nearly perpendicular to the EFS band, providing an ideal opportunity for upwind-downwind sampling of this formation and associated activities. Consequently, the TCEQ has funded upwind and downwind monitoring of VOCs and NOx concentrations in order to evaluate any significant differences in the concentration of ozone precursors. The data collected from mobile monitoring will add to the TCEQ's current knowledge of EFS emissions upwind of the San Antonio area.

## 2. Summary of Operations

A Category Level III QAPP was sent to TCEQ on in November, 2013. Table 1 below is an edited version of Table B2.A from the QAPP listing the samplers covered by that document, with two edits in the notes below the table.

**Table 1 TCEQ QAPP table of Pollutant Methodologies**

| Parameter/Target Compound/Group (Unit of measure) | Possible Analytical Method | Resolution | Monitoring Range of Interest | Sampling Period | Frequency |
|---|---|---|---|---|---|
| Sulfur Dioxide ($SO_2$ as ppb) | Pulsed Fluorescence | 2-5 second poll of 10 second updates | 0 – 300 ppb | 1 second | Continuous |
| Nitrogen Oxides (NO, $NO_2$, $NO_x$ as ppb) | Mo Catalytic Sample Reduction @ 320°C and Chemiluminescence | 2-5 second poll of 10 second updates | 0 – 200 ppb | 1 second | Continuous |
| Total Nonmethane Hydrocarbons (TNHMC as ppbC) | Back-flush gas chromatography (GC) with flame ionization detection (FID) | 70 seconds | 0 – 200 ppm | 70 seconds | batch |
| Volatile Organic Compounds (VOC) – species of interest | Gas Chromatography with Mass Spectroscopy / Flame Ionization Detection | 0.1 ppbv | NA | Discrete grab whole air sample in canister | As directed by UT |
| Latitude and Longitude | Global Positioning System (GPS) | 1 second | *Lat: 23N to 51N* Lon: -70W to -124W | 1 second | Continuous |
| Notes: A carbon monoxide monitor was operated but all data have been invalidated. | | | | | |

Twelve mobile monitoring trips were taken with two or three person crews. On each trip, data were continuously recorded from departure from the UT Pickle Research Campus until after the return. Table 2 lists the dates on which trips occurred. Carbon monoxide (CO) was also measured but the data have been invalidated owing to repeated instrument drift. Maintenance will be done to prevent CO data loss should any future project come about. Measurements of the parameters listed in Table 1 were made continuously from pre-trip to post-trip.

A map of the Eagle Ford Shale Region with oil and gas wells from the Texas Railroad Commission database as of January 2014 is shown in Figure 1. The map shows how the region is divided into a wet region (oil) to the north and a dry region (gas) to the south.

On each trip, canister grab samples were taken under the protocol described in the project QAPP and were later analyzed in UT's laboratory[1]. Time, date, location, and classification of each grab sample canister are shown in Table 3, and locations are plotted in Figure 2. Canisters are

[1] The canister laboratory at UT is certified under the National Environmental Laboratory Accreditation Program

classified as to whether the canisters were sampled upwind or downwind of the Eagle Ford Shale wells shown in Figure 1. One canister sampled on June 3 labeled "M" in Figure 2 does not follow this protocol and is not representative of background conditions; as a result, this canister is excluded from subsequent discussion.

On all trips but the initial May 10 trip, at least one canister sample was taken upwind and at least one canister sample was taken downwind of the shale region during each day's travel.

Within this report, times are reported in both central daylight savings time (CDT) and central standard time (CDT).

**Figure 1 Eagle Ford Shale Region with oil and gas wells from the Texas Railroad Commission database as of January 2014: wet region (oil) in red to the north and a dry region (gas) in yellow to the south**

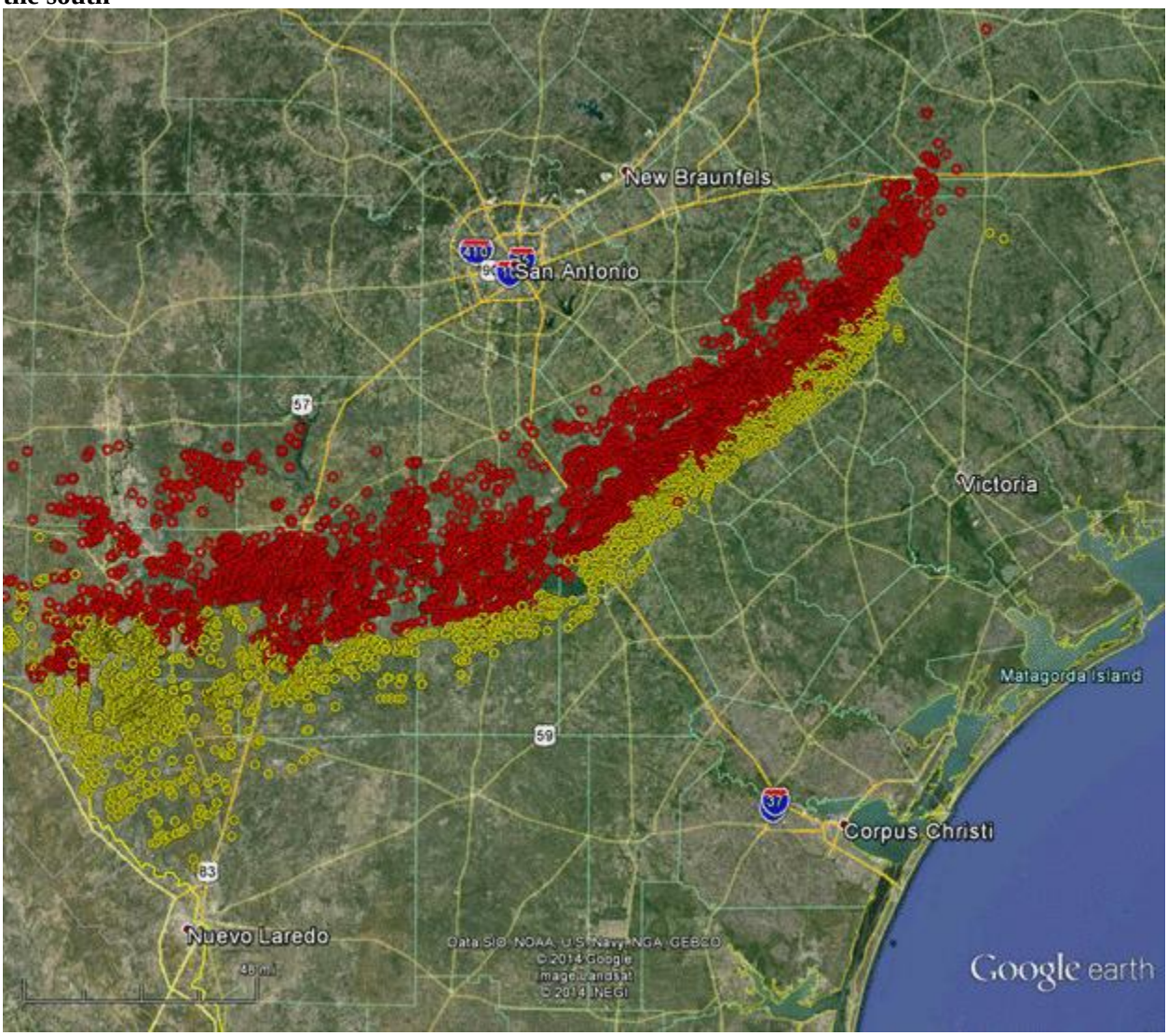


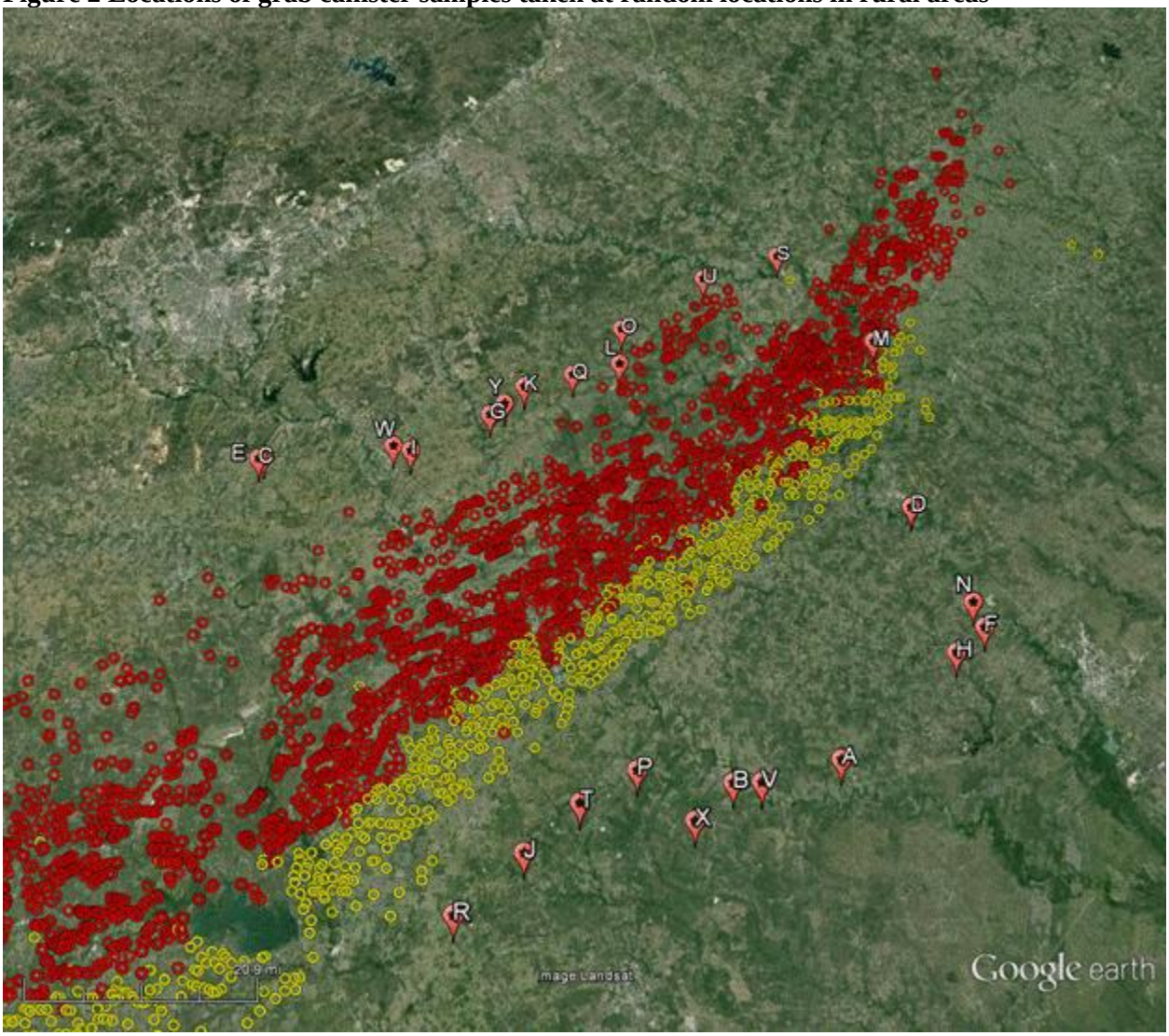
**Table 2 Trips taken on these days in 2014**

| Trip | Date | Trip | Date |
|---|---|---|---|
| 1 | May 10 | 7 | June 3 |
| 2 | May 17 | 8 | June 5 |
| 3 | May 19 | 9 | June 6 |
| 4 | May 21 | 10 | June 9 |
| 5 | May 22 | 11 | June 11 |
| 6 | June 2 | 12 | June 12 |

**Table 3 Canister samples taken at random locations in rural areas**

| Site Code | Longitude | Latitude | Trip | Date | cdt30 | Classification |
|---|---|---|---|---|---|---|
| A | -97.4148 | 28.6663 | 1 | 5/10/2014 | 14:44 | Upwind |
| B | -97.5858 | 28.6354 | 2 | 5/17/2014 | 11:17 | Upwind |
| C | -98.3811 | 29.1093 | 2 | 5/17/2014 | 14:49 | Downwind |
| D | -97.2613 | 29.0322 | 3 | 5/19/2014 | 11:00 | Upwind |
| E | -98.3725 | 29.1137 | 3 | 5/19/2014 | 14:05 | Downwind |
| F | -97.1629 | 28.8502 | 4 | 5/21/2014 | 11:51 | Upwind |
| G | -97.9830 | 29.1823 | 4 | 5/21/2014 | 15:38 | Downwind |
| H | -97.2140 | 28.8139 | 5 | 5/22/2014 | 11:00 | Upwind |
| I | -98.1182 | 29.1225 | 5 | 5/22/2014 | 14:12 | Downwind |
| J | -97.9086 | 28.5452 | 6 | 6/2/2014 | 13:02 | Upwind |
| K | -97.9241 | 29.2298 | 6 | 6/2/2014 | 15:59 | Downwind |
| L | -97.7545 | 29.2689 | 6 | 6/2/2014 | 16:22 | Downwind |
| N | -97.1763 | 28.8871 | 7 | 6/3/2014 | 11:12 | Upwind |
| O | -97.7500 | 29.3299 | 7 | 6/3/2014 | 15:24 | Downwind |
| P | -97.7346 | 28.6524 | 8 | 6/5/2014 | 12:55 | Upwind |
| Q | -97.8382 | 29.2501 | 8 | 6/5/2014 | 15:29 | Downwind |
| R | -98.0123 | 28.4674 | 9 | 6/6/2014 | 12:32 | Upwind |
| S | -97.4585 | 29.4632 | 9 | 6/6/2014 | 15:23 | Downwind |
| T | -97.8238 | 28.6094 | 10 | 6/9/2014 | 12:15 | Upwind |
| U | -97.5982 | 29.4210 | 10 | 6/9/2014 | 15:29 | Downwind |
| V | -97.5413 | 28.6361 | 11 | 6/11/2014 | 12:32 | Upwind |
| W | -98.1490 | 29.1305 | 11 | 6/11/2014 | 14:47 | Downwind |
| X | -97.6469 | 28.5860 | 12 | 6/12/2014 | 13:11 | Upwind |
| Y | -97.9579 | 29.2008 | 12 | 6/12/2014 | 15:59 | Downwind |

**Figure 2 Locations of grab canister samples taken at random locations in rural areas**

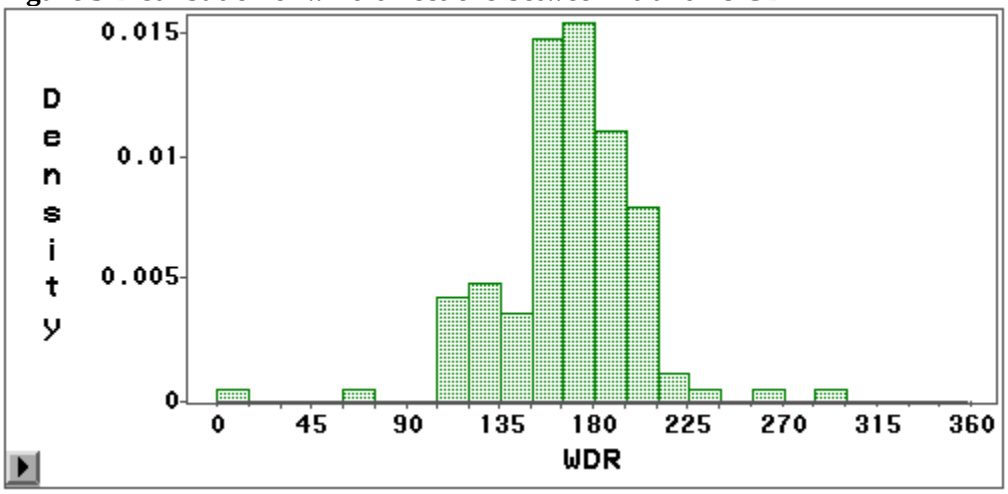


# 3. Data Analyses

## Meteorological Data Analyses

Meteorological data were downloaded from the TCEQ Leading Environmental Analysis and Display System (LEADS) and were analyzed using SAS[2]. The results were exported to Excel in several cases to create graphs and tables. Figure 3 shows the statistical distribution of hourly wind direction resultant measurements from the Floresville Hospital Blvd. CAMS 1038 site in Wilson County for the 12 days of monitoring between the hours of 10 am CDT and 6 pm CDT, inclusive. Surface winds were predominantly from the south-southeast. HySPLIT[3] back-trajectories (100 meter starting altitude) were run from three CAMS sites in the San Antonio area for eight hours each day, and the pooled wind directions are shown in Figure 4. These show a more southeasterly distribution. A table of the resultant wind speeds and directions from the HySPLIT back-trajectories is shown in Table 4.

**Figure 3 Distribution of wind directions between 10 and 18 CDT**




[2] Not an abbreviation; formerly stood for Statistical Analysis Software.

[3] Draxler, R.R. and Rolph, G.D., 2013. HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://www.arl.noaa.gov/HYSPLIT.php). NOAA Air Resources Laboratory, College Park, MD.

Rolph, G.D., 2013. Real-time Environmental Applications and Display sYstem (READY) Website (http://www.ready.noaa.gov). NOAA Air Resources Laboratory, College Park, MD.

**Figure 4 Twelve-hour back-trajectories distribution of wind directions from 100 m starting altitude on sampling days**

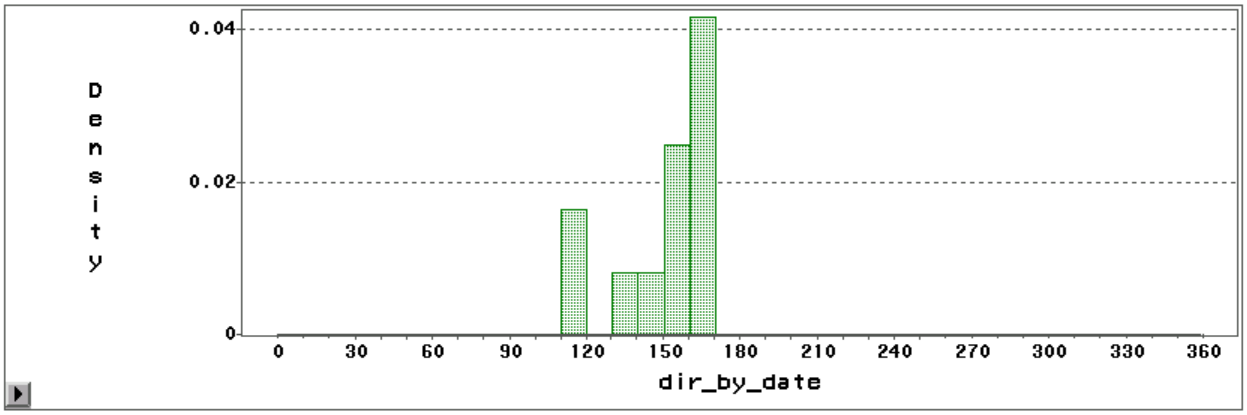



**Table 4 HYSPLIT Mean u, v components in miles per hour, and resultant wind speed and direction**

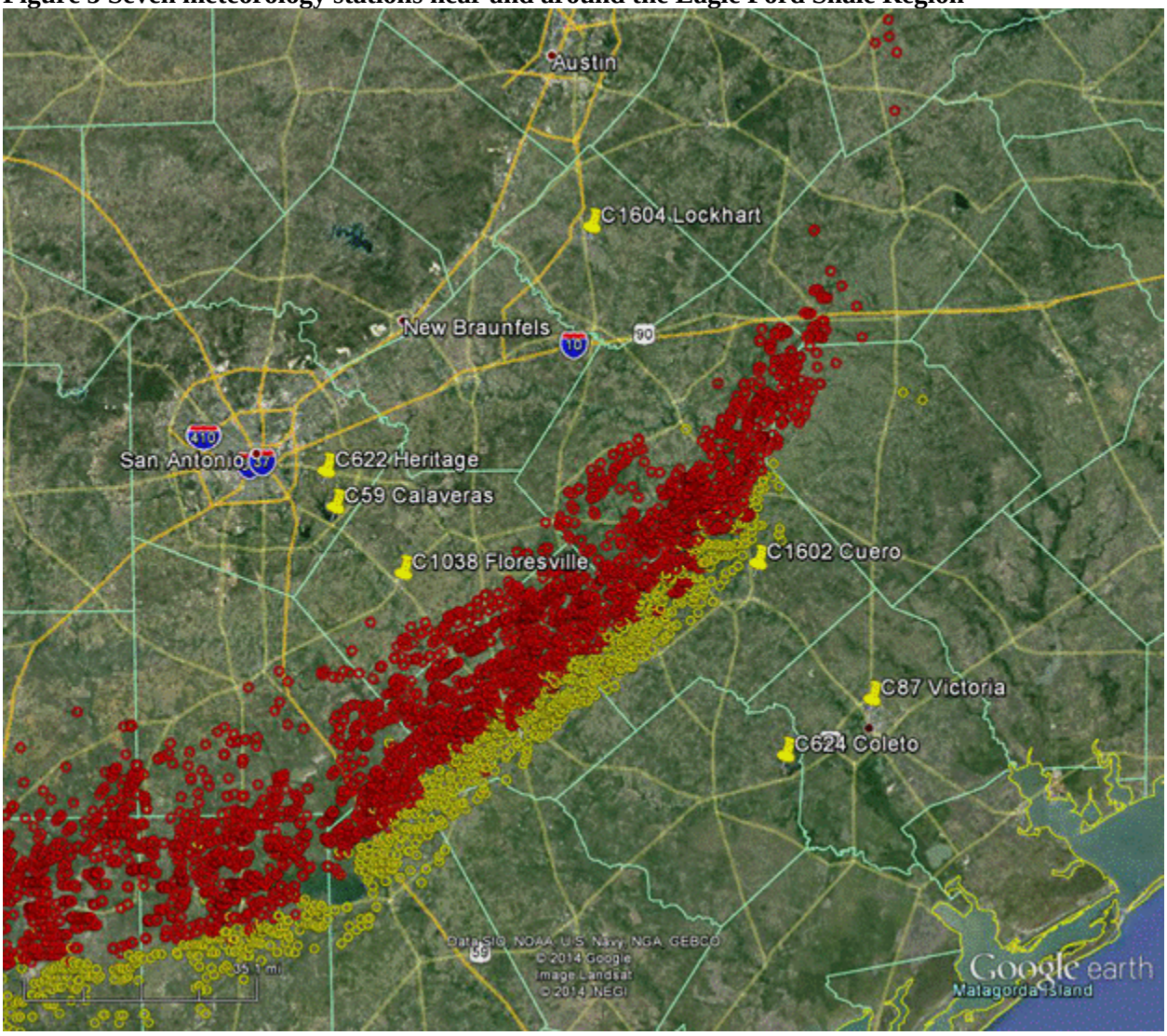
| date | U mean | V mean | Mean mph | Net direction |
|---|---|---|---|---|
| 5/10/2014 | 2.562 | -1.086 | 2.8 | 113 |
| 5/17/2014 | 2.436 | -12.835 | 13.1 | 169 |
| 5/19/2014 | 3.529 | -10.963 | 11.5 | 162 |
| 5/21/2014 | 5.915 | -10.715 | 12.2 | 151 |
| 5/22/2014 | 7.091 | -8.725 | 11.2 | 141 |
| 6/2/2014 | 4.173 | -4.967 | 6.5 | 140 |
| 6/3/2014 | 4.15 | -1.976 | 4.6 | 115 |
| 6/5/2014 | 2.479 | -9.235 | 9.6 | 165 |
| 6/6/2014 | 5.199 | -10.94 | 12.1 | 155 |
| 6/9/2014 | 2.617 | -12.135 | 12.4 | 168 |
| 6/11/2014 | 2.398 | -4.464 | 5.1 | 152 |
| 6/12/2014 | 2.225 | -9.54 | 9.8 | 167 |

Hourly surface wind speed and wind direction resultant data from seven meteorology stations near the Eagle Ford Shale Region were downloaded and examined to characterize the surface air flow over the region each day. The sites are listed in Table 5 and shown in a map of the region in Figure 5.

**Table 5 Seven meteorology stations near the Eagle Ford Shale Region**

| AQS Code | CAMS | Site Name | County | Latitude | Longitude |
|---|---|---|---|---|---|
| 480290059 | C59 | Calaveras Lake | Bexar | 29.27538 | -98.3117 |
| 484690003 | C87 | Victoria | Victoria | 28.83617 | -97.0055 |
| 480290622 | C622 | Heritage Middle School | Bexar | 29.3529 | -98.3328 |
| 481750624 | C624 | Coleto | Goliad | 28.72093 | -97.2209 |
| 484931038 | C1038 | Floresville Hospital Boulevard | Wilson | 29.13068 | -98.1481 |
| 481231602 | C1602 | Cuero | De Witt | 29.13478 | -97.2766 |
| 480551604 | C1604 | Lockhart | Caldwell | 29.86492 | -97.6649 |

**Figure 5 Seven meteorology stations near and around the Eagle Ford Shale Region**




Hourly surface wind speed and wind direction resultant data from each of the 12 days mobile monitoring trips have been combined for the midday hours of each day beginning at 9 a.m. CDT (10 CST) through the end of the hour starting at 5 p.m. (18 CST) using data from the seven meteorology stations in Table 5/Figure 5. These pooled data help characterize the surface air flow over the region each day. Figure 6 through 17 show histograms of the hourly resultant wind directions for the 63 observations from each day (9 hours times 7 sites). Wind direction and speed resultants, treated as scalar variables, are summarized in Table 6. One date, June 9, appears to be an outlier in terms of the amount of scatter in the surface winds, and has the most southerly overall characterization. June 3 had the most easterly and lowest speed winds, and May 17 had the highest average wind speeds.

**Figure 6 May 10, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

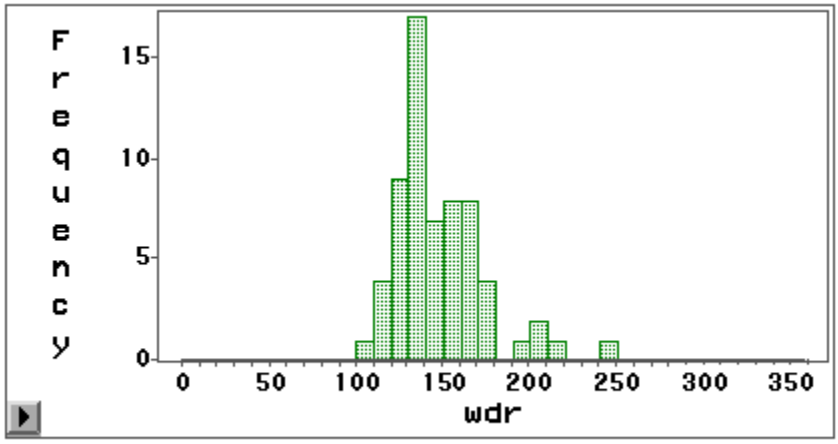



**Figure 7 May 17, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

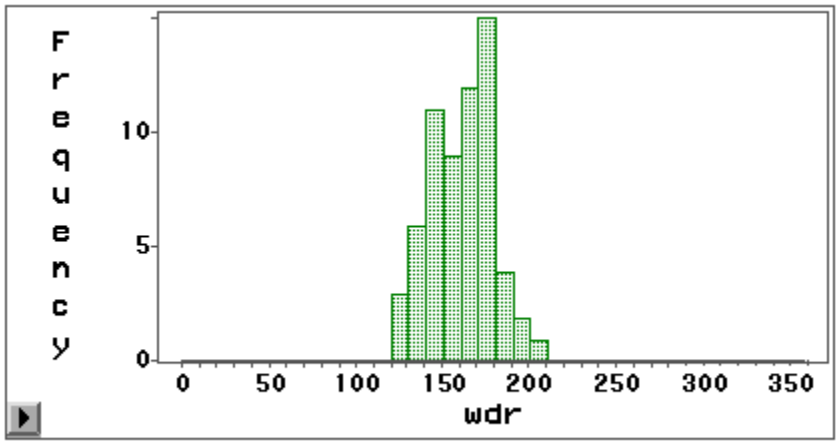



**Figure 8 May 19, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

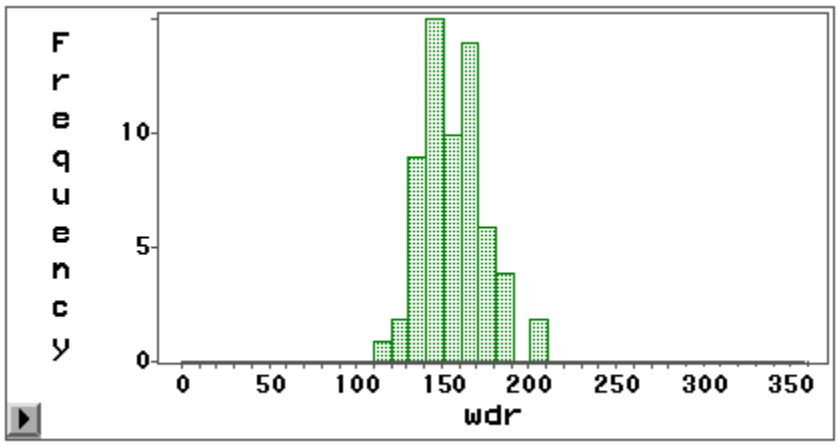


**Figure 9 May 21, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

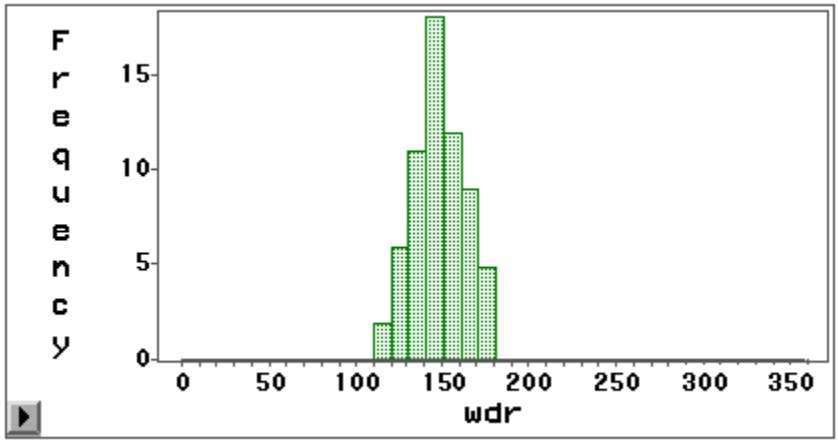



**Figure 10 May 22, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

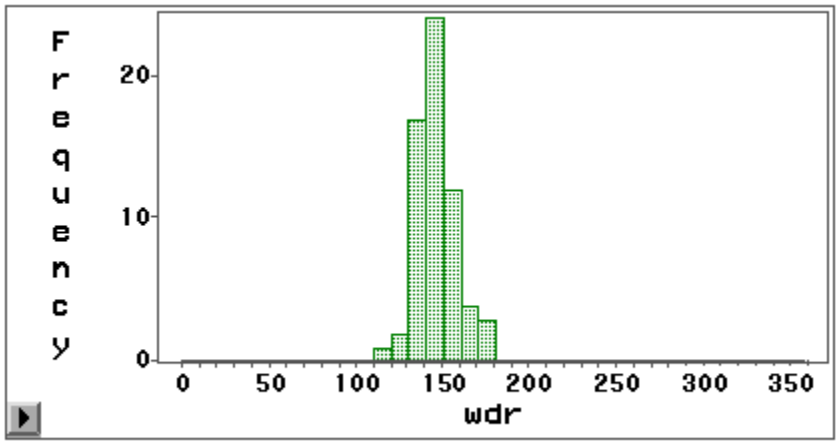



**Figure 11 June 2, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

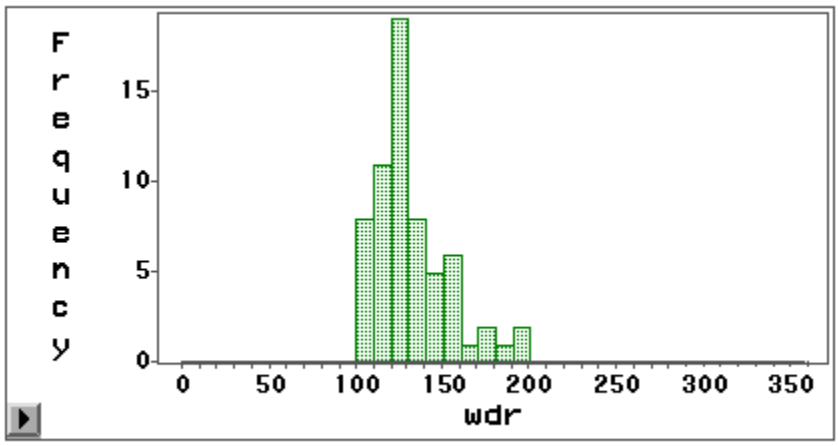


**Figure 12 June 3, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

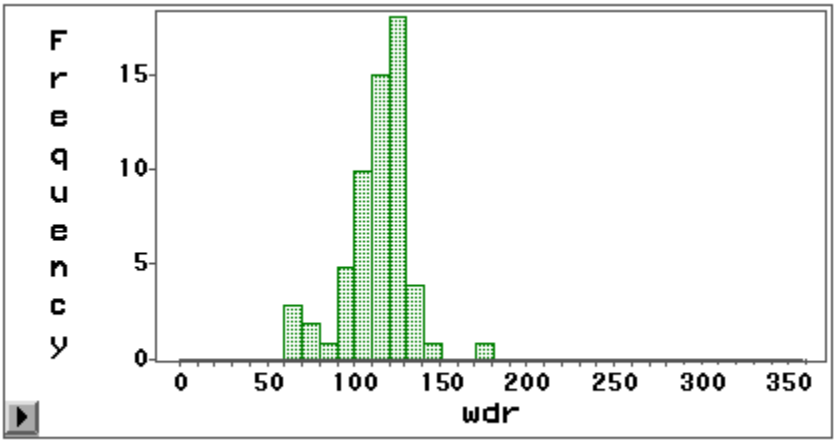



**Figure 13 June 5, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

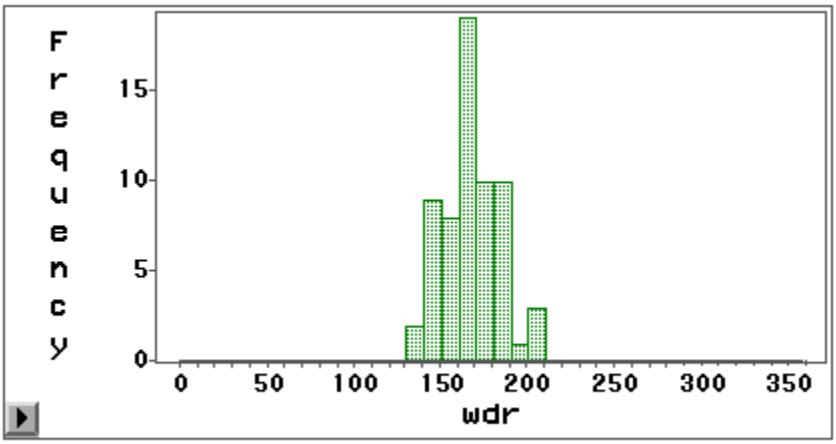



**Figure 14 June 6, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

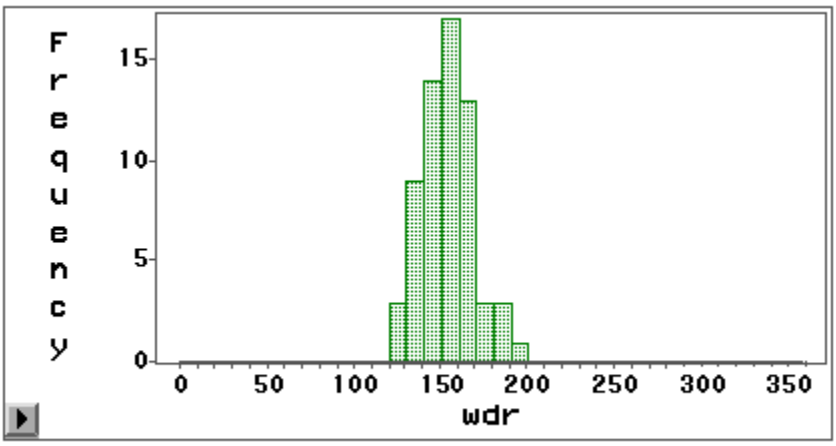


**Figure 15 June 9, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

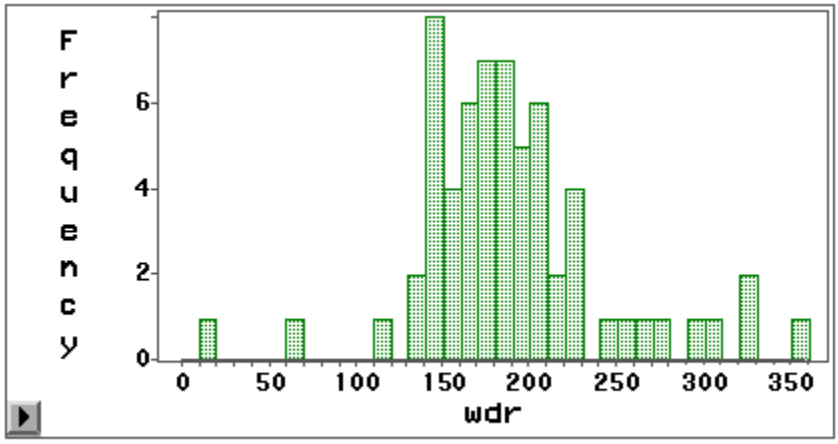



**Figure 16 June 11, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

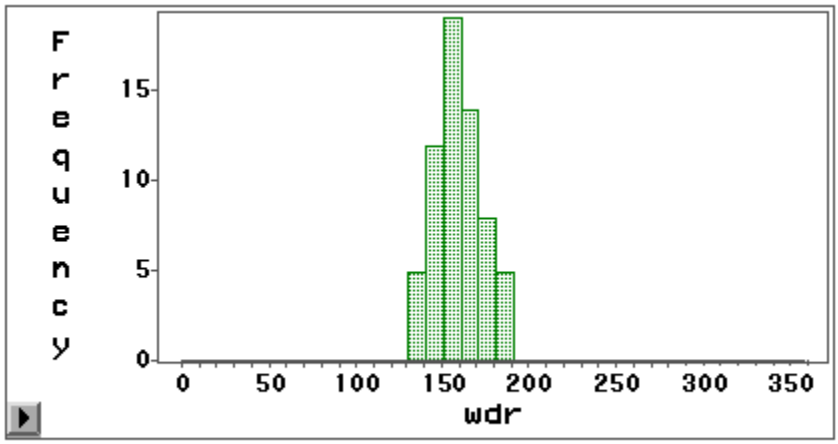



**Figure 17 June 12, 2014 distribution of hourly wind direction measurements from 7 sites for 9 hrs**

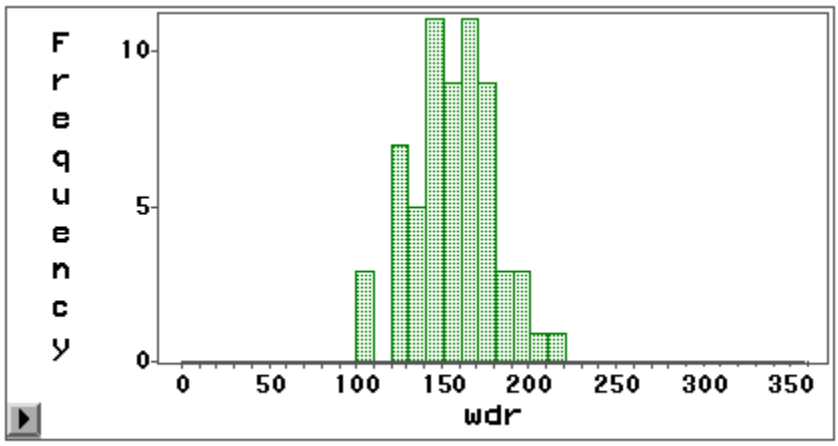


**Table 6 Summary of surface winds from seven sites, 9 a.m. CDT through 5 p.m. CDT for 12 dates, extremes highlighted (red for maxima, blue for minima)**

| Date | Hourly wind direction resultant (WDR) mean | WDR 90th percentile value from 63 obs | WDR 10th percentile value from 63 obs | WDR standard deviation | Hourly wind speed resultant (WSR) mean | WSR 90th percentile value from 63 obs | WSR 10th percentile value from 63 obs | WSR standard deviation |
|---|---|---|---|---|---|---|---|---|
| 5/10/2014 | 147.3 | 175.0 | 121.1 | 26.4 | 8.7 | 13.2 | 3.9 | 5.0 |
| 5/17/2014 | 160.5 | 183.3 | 136.3 | 18.1 | 14.6 | **22.2** | 11.0 | 4.1 |
| 5/19/2014 | 156.1 | 179.3 | 133.9 | 18.0 | 13.4 | 19.0 | 9.9 | 3.8 |
| 5/21/2014 | 147.4 | 167.7 | 129.3 | 14.7 | 13.4 | 18.6 | 9.6 | 4.0 |
| 5/22/2014 | 145.3 | 160.9 | 132.1 | 11.7 | 13.2 | 20.0 | 10.3 | 3.9 |
| 6/2/2014 | 131.9 | 157.2 | 108.4 | 21.4 | 9.4 | 14.7 | 6.3 | 3.6 |
| 6/3/2014 | **113.1** | 129.4 | 89.6 | 19.5 | 7.3 | **10.5** | 4.4 | 3.3 |
| 6/5/2014 | 166.3 | 183.9 | 146.1 | 16.3 | 11.9 | 17.3 | 8.7 | 3.4 |
| 6/6/2014 | 153.1 | 172.1 | 132.5 | 15.1 | 13.3 | 20.8 | 10.4 | 3.8 |
| 6/9/2014 | **189.5** | 260.7 | 143.9 | **56.7** | 8.8 | 15.3 | 2.7 | **5.4** |
| 6/11/2014 | 158.6 | 178.5 | 141.5 | 14.0 | 8.9 | 14.5 | 6.2 | 3.2 |
| 6/12/2014 | 155.8 | 186.2 | 125.7 | 23.4 | 11.6 | 19.4 | 7.8 | 4.4 |

## Canister Sampling Results

Concentrations of most gaseous pollutants are expressed in units denoting their "mixing ratio" in air; i.e., the ratio of the number molecules of the pollutant to the total number of molecules per unit volume of air. Because concentrations for all gases other than molecular oxygen, nitrogen, and argon are very low, the mixing ratios are usually scaled to express a concentration in terms of "parts per million" (ppm) or "parts per billion" (ppb). Sometimes the units are explicitly expressed as ppm-volume (ppmV) or ppb-volume (ppbV) where 1 ppmV indicates that one molecule in one million molecules of ambient air is the compound of interest and 1 ppbV indicates that one molecule in one billion molecules of ambient air is the compound of interest. In general, air pollution standards and health effects screening levels are expressed in ppmV or ppbV units. Because hydrocarbon species may have a chemical reactivity related to the number of carbon atoms in the molecule, mixing ratios for these species are often expressed in ppb-carbon (ppbV times the number of carbon atoms in the molecule), to reflect the ratio of carbon atoms in that species to the total number of molecules in the volume. This is relevant to measurement of auto-GC species and TNMHC, which are reported in ppbC units.

Figure 18 shows a map of the Eagle Ford Shale points indicating the locations of Texas Railroad Commission permitted wells as of January 2014 (red for oil, yellow for natural gas) along with the locations at which canister grab samples taken on a random basis on 12 trips (repeat of Figure 2). A summary of canister contents is shown in Table 7. A variety of statistical tests have been carried out with the canisters to compare upwind and downwind samples. In pairing upwind

and downwind canisters in Table 8, the downwind canister has a higher concentration, expressed in ppbC units, in 7 out of 11 cases, or 64% of cases. This difference is not statistically significant (p-value = 0.11). The canister labeled W taken at the Floresville CAMS 1038 site on June 11 was split into two samples for duplicate analysis. The agreement between split samples was excellent. The agreement between the site W grab sample at 14:08 CST (3:08 p.m. CDT) sample and the 40-minute auto-GC sample at CAMS 1038 started at 14 CST (3 p.m. CDT) is shown in Figure 19. Qualitatively, this agreement was quite good. A summary showing the principal species weighted by maximum incremental reactivity (MIR)[4] is in Table 9. **Note that isoprene, a highly reactive species, represents the largest single compound in terms of reactivity in 18 out of 24 samples**. Isoprene is produced by trees and some other types of vegetation and typically constitutes only a very small fraction of the hydrocarbons found in fossil energy sources.

**Table 7 Summary of canister contents in total ppbC, light alkanes, isoprene, percent light alkanes**

| | Sample type | CST | date | Sum pol ppbC | Isoprene | E+P+B+P* ppbC | % EPBP* |
|---|---|---|---|---|---|---|---|
| A | Up Wind | 13:44 | 5/10/2014 | 10.21 | 3.10 | 4.94 | 48% |
| B | Up Wind | 10:19 | 5/17/2014 | 13.81 | 1.72 | 10.87 | 79% |
| C | Down Wind | 13:56 | 5/17/2014 | 30.69 | 0.00 | 28.42 | 93% |
| D | Up Wind | 10:02 | 5/19/2014 | 9.50 | 0.00 | 9.11 | 96% |
| E | Down Wind | 13:06 | 5/19/2014 | 22.17 | 0.00 | 19.59 | 88% |
| F | Up Wind | 10:54 | 5/21/2014 | 9.38 | 4.44 | 4.24 | 45% |
| G | Down Wind | 14:38 | 5/21/2014 | 24.28 | 0.88 | 22.48 | 93% |
| H | Up Wind | 10:02 | 5/22/2014 | 7.95 | 3.46 | 3.79 | 48% |
| I | Down Wind | 13:15 | 5/22/2014 | 27.31 | 0.49 | 21.18 | 78% |
| J | Up Wind | 12:04 | 6/2/2014 | 12.20 | 6.41 | 5.79 | 47% |
| K | Down Wind | 15:01 | 6/2/2014 | 55.54 | 0.44 | 49.11 | 88% |
| L | Down Wind | 15:24 | 6/2/2014 | 239.49 | 2.59 | 151.00 | 63% |
| N | Up Wind | 10:15 | 6/3/2014 | 8.39 | 0.75 | 6.67 | 80% |
| O | Down Wind | 14:22 | 6/3/2014 | 89.52 | 1.92 | 77.28 | 86% |
| P | Up Wind | 11:57 | 6/5/2014 | 15.08 | 9.08 | 6.00 | 40% |
| Q | Down Wind | 14:31 | 6/5/2014 | 14.86 | 9.01 | 5.85 | 39% |
| S | Up Wind | 11:35 | 6/6/2014 | 49.95 | 4.97 | 33.72 | 68% |
| S | Down Wind | 14:20 | 6/6/2014 | 1.98 | 0.56 | 1.42 | 72% |
| T | Up Wind | 11:17 | 6/9/2014 | 21.29 | 1.32 | 17.53 | 82% |
| U | Down Wind | 14:28 | 6/9/2014 | 22.66 | 18.19 | 3.61 | 16% |
| V | Up Wind | 11:33 | 6/11/2014 | 78.83 | 0.70 | 52.75 | 67% |
| *W* | *Down Wind* | *14:08* | *6/11/2014* | *24.45* | 2.17 | *20.64* | *84%* |
| *W* | *Down Wind* | *14:08* | *6/11/2014* | *24.87* | 2.01 | *20.40* | *82%* |
| Y | Up Wind | 12:13 | 6/12/2014 | 16.36 | 8.96 | 7.09 | 43% |
| Z | Down Wind | 15:02 | 6/12/2014 | 47.97 | 1.45 | 38.64 | 81% |

* E+P+B+P is the sum of ethane, propane, n-butane, iso-butane, n-pentane, and iso-pentane; % EPBP is the ratio of the sum of ethane, propane, n-butane, iso-butane, n-pentane, and iso-pentane to the sum of all species.

[4] MIR is calculated from controlled experiments that calculate the amount of additional ozone produced for a unit increase in an individual chemical species.

**Figure 18 Locations of grab canister samples taken at random locations in rural areas**

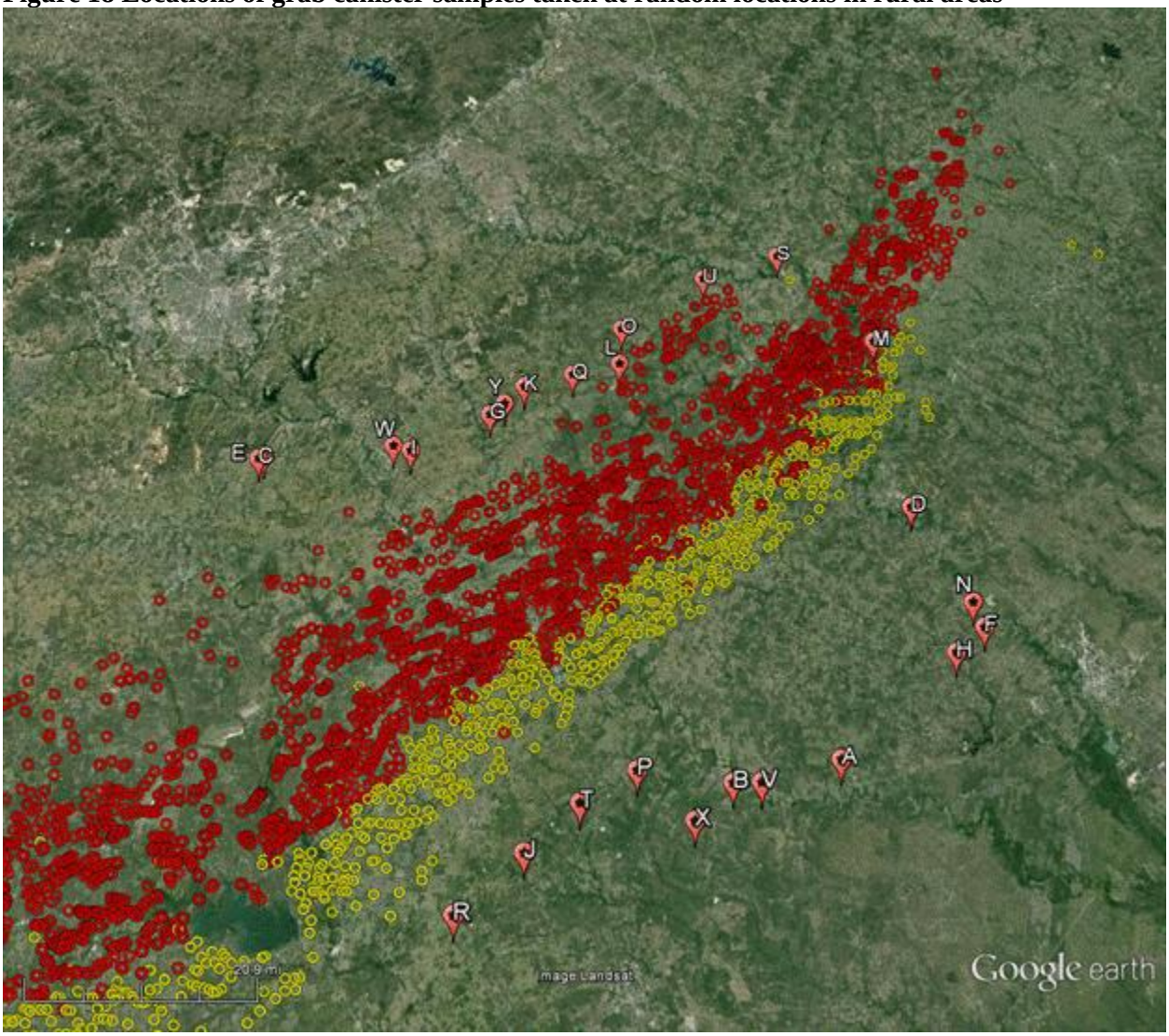


**Figure 19 Comparison of grab sample W with Floresville auto-GC measurement at 3pm CDT June 11, 2014**

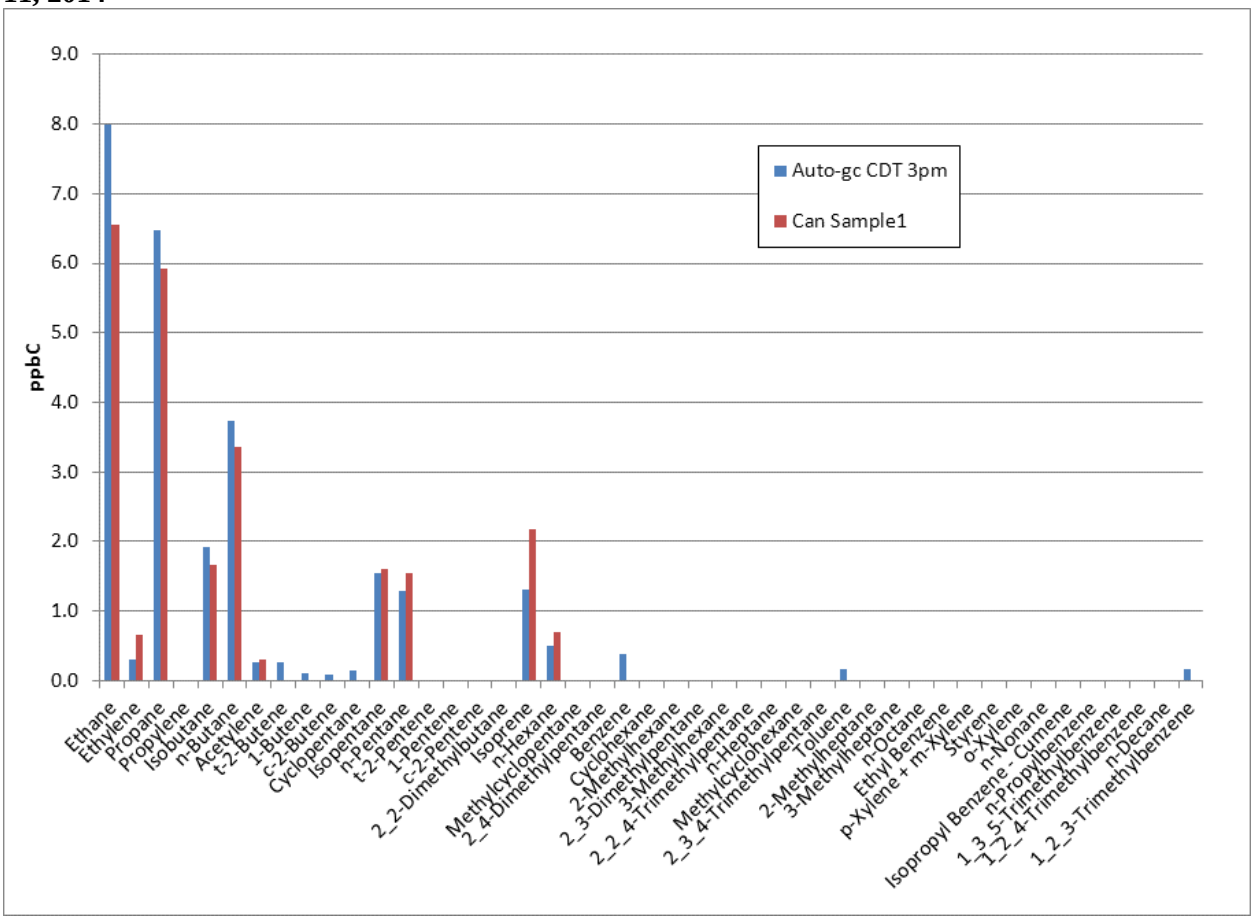


**Table 8 Canister grab samples principal species upwind downwind pairs, ppbC units**

| Up/Down | Site | Date time CST | Acetyl-ene | Ethane | Ethyl-ene | Propane | Propyl-ene | Butane | Iso-butane | Iso-pentane | Isoprene | Pentane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Up Wind | B | 5/17/14 10:19 | 0.37 | 4.92 | 0.85 | 2.38 | 0.00 | 1.13 | 0.93 | 0.89 | 1.72 | 0.61 |
| Down Wind | C | 5/17/14 13:56 | 0.43 | 10.13 | 0.00 | 7.80 | 0.00 | 4.16 | 2.17 | 2.22 | 0.00 | 1.92 |
| Up Wind | D | 5/19/14 10:02 | 0.39 | 5.53 | 0.00 | 2.33 | 0.00 | 0.77 | 0.00 | 0.48 | 0.00 | 0.00 |
| Down Wind | E | 5/19/14 13:06 | 0.33 | 7.29 | 0.00 | 5.36 | 0.00 | 2.72 | 1.51 | 1.39 | 0.00 | 1.32 |
| Up Wind | F | 5/21/14 10:54 | 0.23 | 2.71 | 0.47 | 1.06 | 0.00 | 0.47 | 0.00 | 0.00 | 4.44 | 0.00 |
| Down Wind | G | 5/21/14 14:38 | 0.31 | 6.14 | 0.00 | 6.24 | 0.00 | 4.36 | 2.11 | 1.91 | 0.88 | 1.72 |
| Up Wind | H | 5/22/14 10:02 | 0.24 | 2.88 | 0.45 | 0.91 | 0.00 | 0.00 | 0.00 | 0.00 | 3.46 | 0.00 |
| Down Wind | I | 5/22/14 13:15 | 0.29 | 5.25 | 1.18 | 3.71 | 0.00 | 2.22 | 1.12 | 7.70 | 0.49 | 1.17 |
| Up Wind | J | 6/2/14 12:04 | 0.00 | 2.92 | 0.00 | 1.70 | 0.00 | 0.67 | 0.00 | 0.50 | 6.41 | 0.00 |
| Down Wind | K | 6/2/14 15:01 | 0.00 | 11.39 | 0.00 | 14.28 | 0.00 | 9.45 | 4.66 | 4.83 | 0.44 | 4.50 |
| Down Wind | L | 6/2/14 15:24 | 0.00 | 51.10 | 0.00 | 36.56 | 0.00 | 20.95 | 13.67 | 16.21 | 2.59 | 12.52 |
| Up Wind | N | 6/3/14 10:15 | 0.34 | 3.14 | 0.63 | 1.99 | 0.00 | 0.93 | 0.00 | 0.61 | 0.75 | 0.00 |
| Down Wind | O | 6/3/14 14:22 | 0.29 | 19.65 | 0.64 | 24.86 | 0.00 | 13.67 | 7.08 | 6.27 | 1.92 | 5.74 |
| Up Wind | P | 6/5/14 11:57 | 0.00 | 2.05 | 0.00 | 1.47 | 0.00 | 0.87 | 0.00 | 0.97 | 9.08 | 0.64 |
| Down Wind | Q | 6/5/14 14:31 | 0.00 | 2.03 | 0.00 | 1.44 | 0.00 | 0.80 | 0.00 | 0.94 | 9.01 | 0.63 |
| Up Wind | R | 6/6/14 11:35 | 0.70 | 6.69 | 0.94 | 9.01 | 0.00 | 7.15 | 4.04 | 3.74 | 4.97 | 3.09 |
| Down Wind | S | 6/6/14 14:20 | 0.00 | 1.42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 | 0.00 |
| Up Wind | T | 6/9/14 11:17 | 0.00 | 5.09 | 0.00 | 4.86 | 0.00 | 2.89 | 1.69 | 1.63 | 1.32 | 1.37 |
| Down Wind | U | 6/9/14 14:28 | 0.23 | 1.96 | 0.63 | 1.21 | 0.00 | 0.45 | 0.00 | 0.00 | 18.19 | 0.00 |
| Up Wind | V | 6/11/14 11:33 | 3.42 | 10.33 | 3.60 | 12.32 | 1.53 | 8.97 | 3.62 | 10.55 | 0.70 | 6.95 |
| Down Wind | W | 6/11/14 14:08 | 0.30 | 6.56 | 0.66 | 5.92 | 0.00 | 3.35 | 1.66 | 1.61 | 2.17 | 1.54 |
| Down Wind | W | 6/11/14 14:08 | 0.32 | 6.51 | 0.57 | 5.85 | 0.00 | 3.18 | 1.66 | 1.66 | 2.01 | 1.55 |
| Up Wind | Y | 6/12/14 12:13 | 0.31 | 2.34 | 0.00 | 1.73 | 0.00 | 0.96 | 0.00 | 1.20 | 8.96 | 0.86 |
| Down Wind | Z | 6/12/14 15:02 | 0.28 | 8.91 | 0.47 | 11.39 | 0.00 | 7.40 | 3.46 | 3.79 | 1.45 | 3.68 |

**Table 9 Canister grab samples principal species weighted by MIR upwind downwind pairs (maximum weighted value in bold)**

| Up/Down | Site | Date time CST | Acetyl-ene | Ethane | Ethyl-ene | Propane | Propyl-ene | Butane | Iso-butane | Iso-pentane | Isoprene | Pentane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Up Wind | B | 5/17/14 10:19 | 0.35 | 1.38 | 7.65 | 1.17 | 0.00 | 1.30 | 1.14 | 1.29 | **18.25** | 0.80 |
| Down Wind | C | 5/17/14 13:56 | 0.41 | 2.84 | 0.00 | 3.82 | 0.00 | **4.78** | 2.67 | 3.22 | 0.00 | 2.52 |
| Up Wind | D | 5/19/14 10:02 | 0.37 | **1.55** | 0.00 | 1.14 | 0.00 | 0.89 | 0.00 | 0.70 | 0.00 | 0.00 |
| Down Wind | E | 5/19/14 13:06 | 0.31 | 2.04 | 0.00 | 2.63 | 0.00 | **3.13** | 1.86 | 2.02 | 0.00 | 1.73 |
| Up Wind | F | 5/21/14 10:54 | 0.22 | 0.76 | 4.23 | 0.52 | 0.00 | 0.54 | 0.00 | 0.00 | **47.11** | 0.00 |
| Down Wind | G | 5/21/14 14:38 | 0.29 | 1.72 | 0.00 | 3.06 | 0.00 | 5.01 | 2.60 | 2.77 | **9.34** | 2.25 |
| Up Wind | H | 5/22/14 10:02 | 0.23 | 0.81 | 4.05 | 0.45 | 0.00 | 0.00 | 0.00 | 0.00 | **36.71** | 0.00 |
| Down Wind | I | 5/22/14 13:15 | 0.28 | 1.47 | 10.62 | 1.82 | 0.00 | 2.55 | 1.38 | **11.17** | 5.20 | 1.53 |
| Up Wind | J | 6/2/14 12:04 | 0.00 | 0.82 | 0.00 | 0.83 | 0.00 | 0.77 | 0.00 | 0.73 | **68.01** | 0.00 |
| Down Wind | K | 6/2/14 15:01 | 0.00 | 3.19 | 0.00 | 7.00 | 0.00 | **10.87** | 5.73 | 7.00 | 4.67 | 5.90 |
| Down Wind | L | 6/2/14 15:24 | 0.00 | 14.31 | 0.00 | 17.91 | 0.00 | 24.09 | 16.81 | 23.50 | **27.48** | 16.40 |
| Up Wind | N | 6/3/14 10:15 | 0.32 | 0.88 | 5.67 | 0.98 | 0.00 | 1.07 | 0.00 | 0.88 | **7.96** | 0.00 |
| Down Wind | O | 6/3/14 14:22 | 0.28 | 5.50 | 5.76 | 12.18 | 0.00 | 15.72 | 8.71 | 9.09 | **20.37** | 7.52 |
| Up Wind | P | 6/5/14 11:57 | 0.00 | 0.57 | 0.00 | 0.72 | 0.00 | 1.00 | 0.00 | 1.41 | **96.34** | 0.84 |
| Down Wind | Q | 6/5/14 14:31 | 0.00 | 0.57 | 0.00 | 0.71 | 0.00 | 0.92 | 0.00 | 1.36 | **95.60** | 0.83 |
| Up Wind | R | 6/6/14 11:35 | 0.67 | 1.87 | 8.46 | 4.41 | 0.00 | 8.22 | 4.97 | 5.42 | **52.73** | 4.05 |
| Down Wind | S | 6/6/14 14:20 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **5.94** | 0.00 |
| Up Wind | T | 6/9/14 11:17 | 0.00 | 1.43 | 0.00 | 2.38 | 0.00 | 3.32 | 2.08 | 2.36 | **14.01** | 1.79 |
| Down Wind | U | 6/9/14 14:28 | 0.22 | 0.55 | 5.67 | 0.59 | 0.00 | 0.52 | 0.00 | 0.00 | **193.00** | 0.00 |
| Up Wind | V | 6/11/14 11:33 | 3.25 | 2.89 | **32.40** | 6.04 | 17.84 | 10.32 | 4.45 | 15.30 | 7.43 | 9.10 |
| Down Wind | W | 6/11/14 14:08 | 0.29 | 1.84 | 5.94 | 2.90 | 0.00 | 3.85 | 2.04 | 2.33 | **23.02** | 2.02 |
| Down Wind | W | 6/11/14 14:08 | 0.30 | 1.82 | 5.13 | 2.87 | 0.00 | 3.66 | 2.04 | 2.41 | **21.33** | 2.03 |
| Up Wind | Y | 6/12/14 12:13 | 0.29 | 0.66 | 0.00 | 0.85 | 0.00 | 1.10 | 0.00 | 1.74 | **95.07** | 1.13 |
| Down Wind | Z | 6/12/14 15:02 | 0.27 | 2.49 | 4.23 | 5.58 | 0.00 | 8.51 | 4.26 | 5.50 | **15.38** | 4.82 |

## Mobile Monitoring Upwind and Downwind

Mobile Monitoring Upwind and Downwind of the Eagle Ford Shale Region was conducted on 12 days. A summary of the averaged concentrations on legs judged as upwind and downwind are shown in Table 10. For 10 out of 12 trips, total nonmethane hydrocarbon (TNMHC) concentrations were higher downwind than upwind. This is a statistically significant result ($p= 0.019$). For NOx, there was no significant or practical difference in upwind vs downwind comparisons.

Displays of the ambient data collected along the driving routes are shown in Figures 20 through 31. Data have been rolled up to 30-second averages for both GPS and pollutant measurements. Times are expressed in central daylight savings time. TNMHC is in ppbC units. $SO_2$ was collected continuously, but no significant concentrations were measured at any point, so $SO_2$ is not included in the discussion below. NO, $NO_2$, and NOx are expressed in ppb units. All carbon monoxide (CO) data have been invalidated and excluded for very poor quality.

**Table 10 Upwind and downwind mean observations by date/trip**

| | | | Upwind | | | | Downwind | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | Trip | Hourly WDR mean | Start /stop | Number of observations | NOx: mean ppb | TNMHC: mean ppbC | Start /stop | Number of observations | NOx: mean ppb | TNMHC: mean ppbC |
| 5/10 | 1 | 147.3 | 13:09-14:41 | 147 | 4.2 | 3.1 | 15:51—18:17 | 180 | 3.0 | 1.9 |
| 5/17 | 2 | 160.5 | 10:55-12:53:30 | 138 | 2.9 | 20.0 | 14:20-17:01:30 | 168 | 2.8 | 18.3 |
| 5/19 | 3 | 156.1 | 11:21-13:06 | 180 (178)* | 3.0 | 33.1 (16.3)* | 13:57-15:18:30 | 112 | 2.8 | 46.1 |
| 5/21 | 4 | 147.4 | 11:51-13:32:30, 17:00-17:17 | 158 | 4.8 | 33.5 | 14:19:30-15:51:30 | 149 | 4.0 | 45.7 |
| 5/22 | 5 | 145.3 | 10:55:30-11:18:30, 11:35-12:15, 15:59:30-16:17:30 | 153 | 3.4 | 16.0 | 13:02:30-14:55 | 179 | 3.5 | 24.1 |
| 6/2 | 6 | 131.9 | 11:32-13:26 | 184 | 1.9 | 15.2 | 14:15:30-16:28:30 | 131 | 5.5 | 119.6 |
| 6/3 | 7 | 113.1 | 11:21:30-13:09:30 | 181 | 7.8 | 25.5 | 13:58:30-15:13:30 | 108 | 4.6 | 136.4 |
| 6/5 | 8 | 166.3 | 11:39-13:36 | 192 | 3.3 | 18.5 | 14:26:30-16:18:30 | 186 | 2.0 | 50.7 |
| 6/6 | 9 | 153.1 | 10:49-12:48 | 190 | 1.3 | 16.3 | 13:36:30-15:25 | 165 | 4.5 | 30.9 |
| 6/9 | 10 | 189.5 | 11:02:30-12:47 | 181 | 3.2 | 5.4 | 13:36:30-15:40:30 | 181 | 10.2 | 37.4 |
| 6/11 | 11 | 158.6 | 11:34-13:35 | 191 | 3.9 | 26.5 | 14:23-16:42:30 | 165 | 3.5 | 37.8 |
| 6/12 | 12 | 155.8 | 12:04-14:08 | 197 | 2.9 | 17.2 | 15:05-16:47 | 170 | 3.1 | 42.5 |

'* Number of observations and TNMHC mean recalculated omitting two outlier values on 5/19/2014 are in parentheses. Omission of these two points did not change the NOx mean.

**Figure 20 Trip 1 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

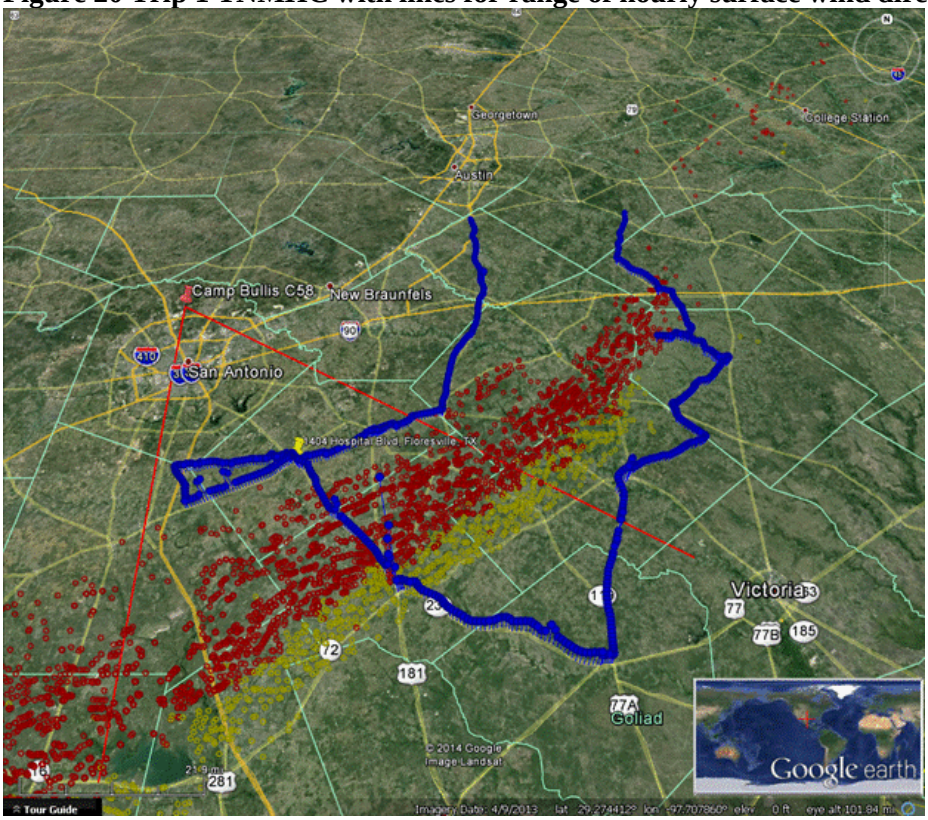



**Figure 21 Trip 2 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

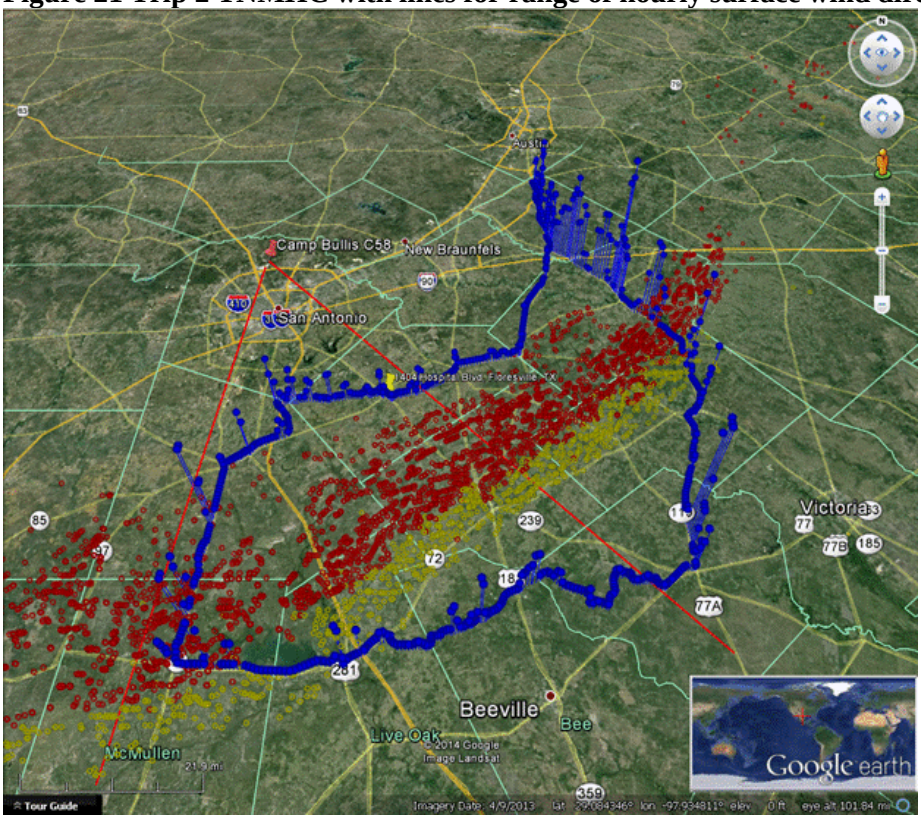


**Figure 22 Trip 3 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

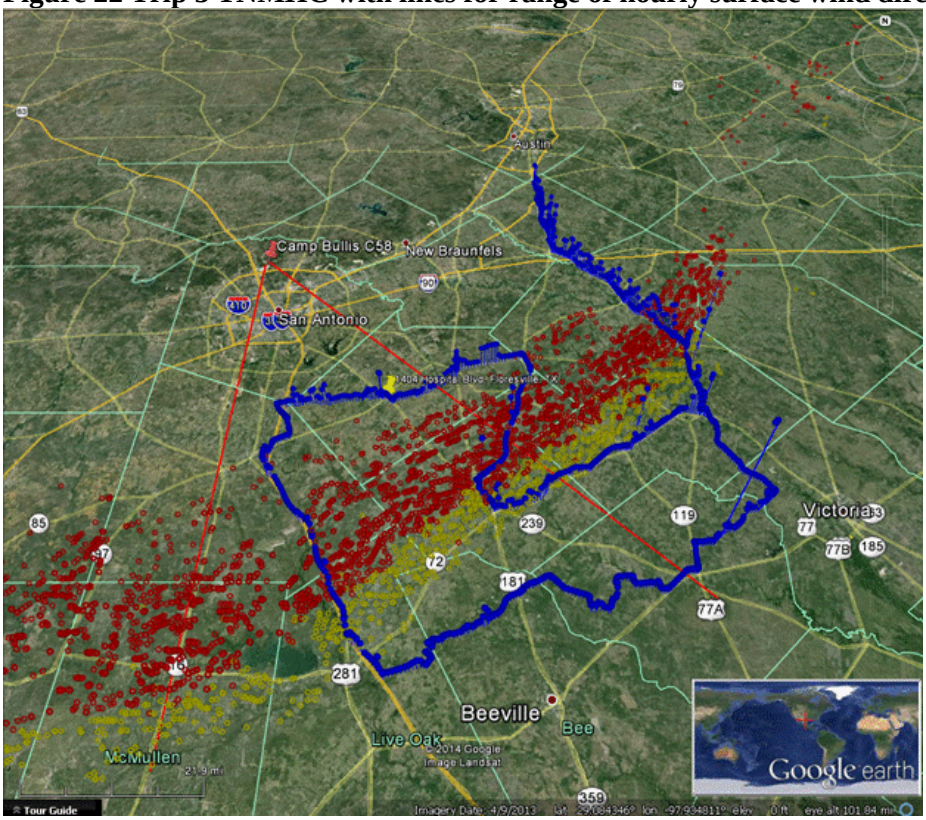



**Figure 23 Trip 4 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

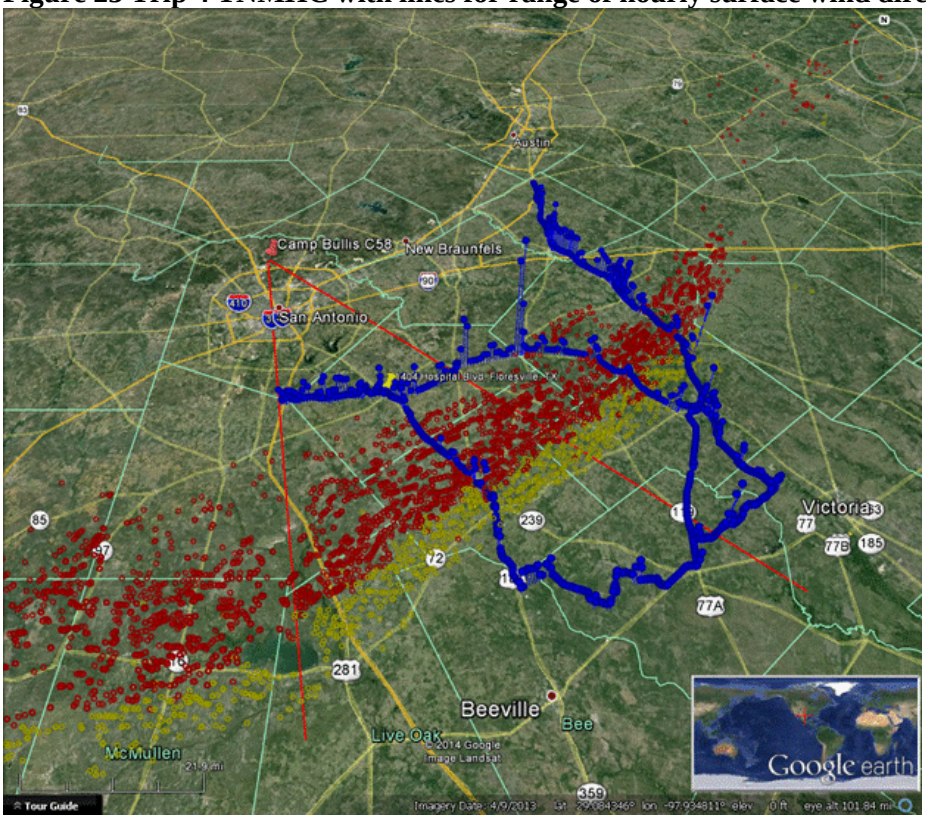


**Figure 24 Trip 5 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

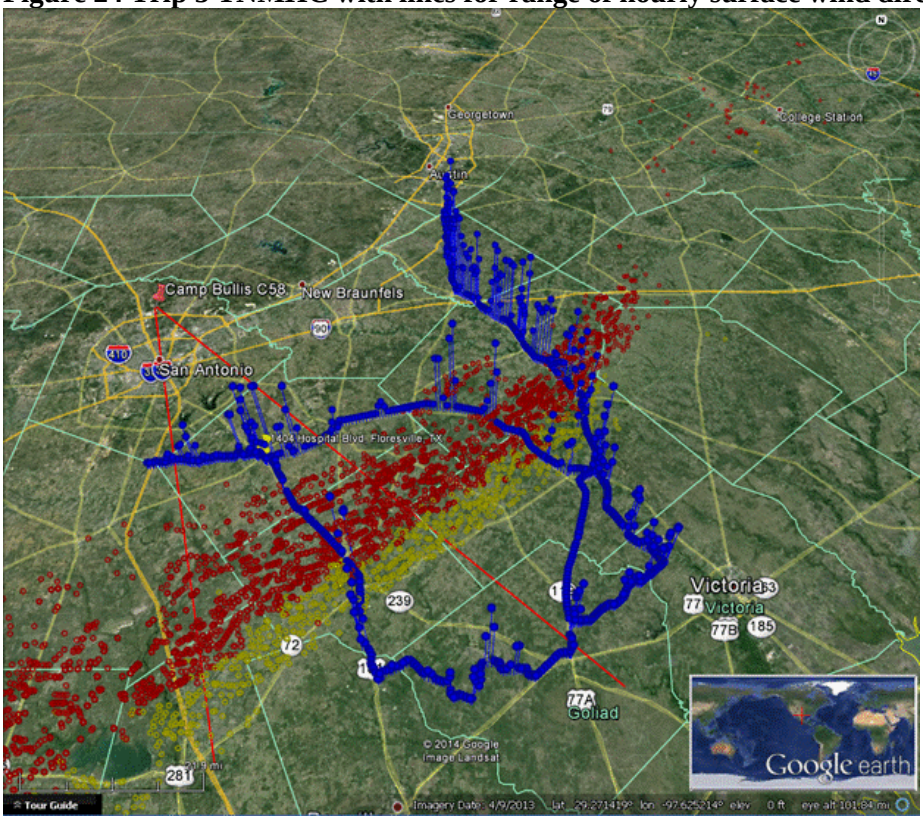



**Figure 25 Trip 6 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

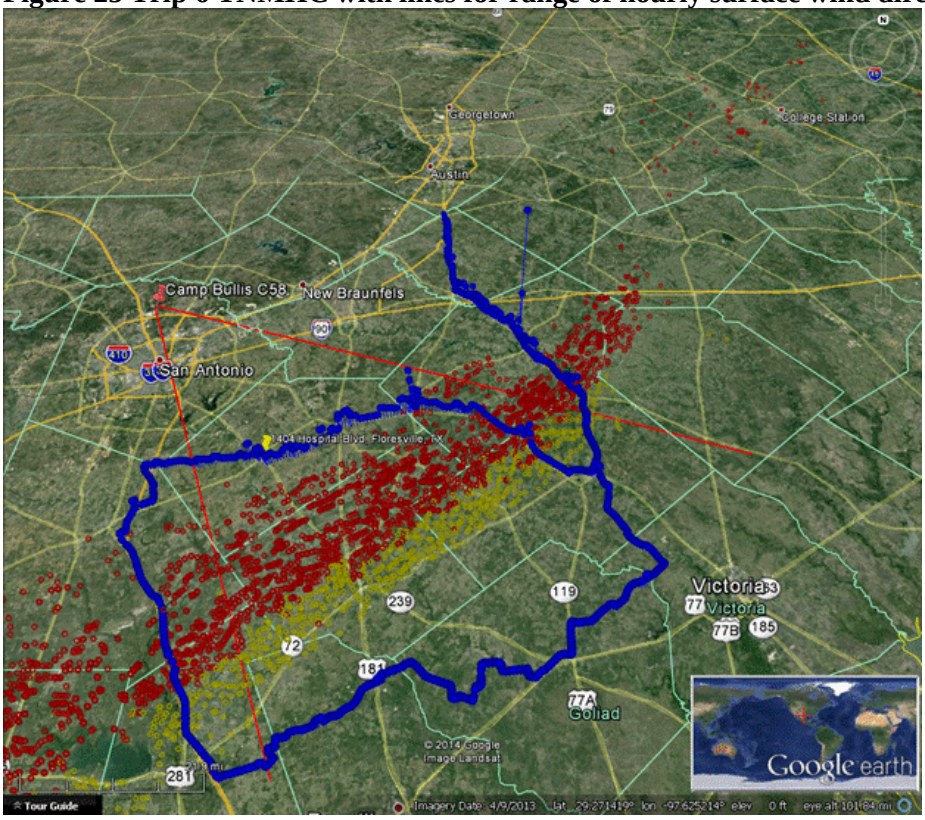


**Figure 26 Trip 7 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

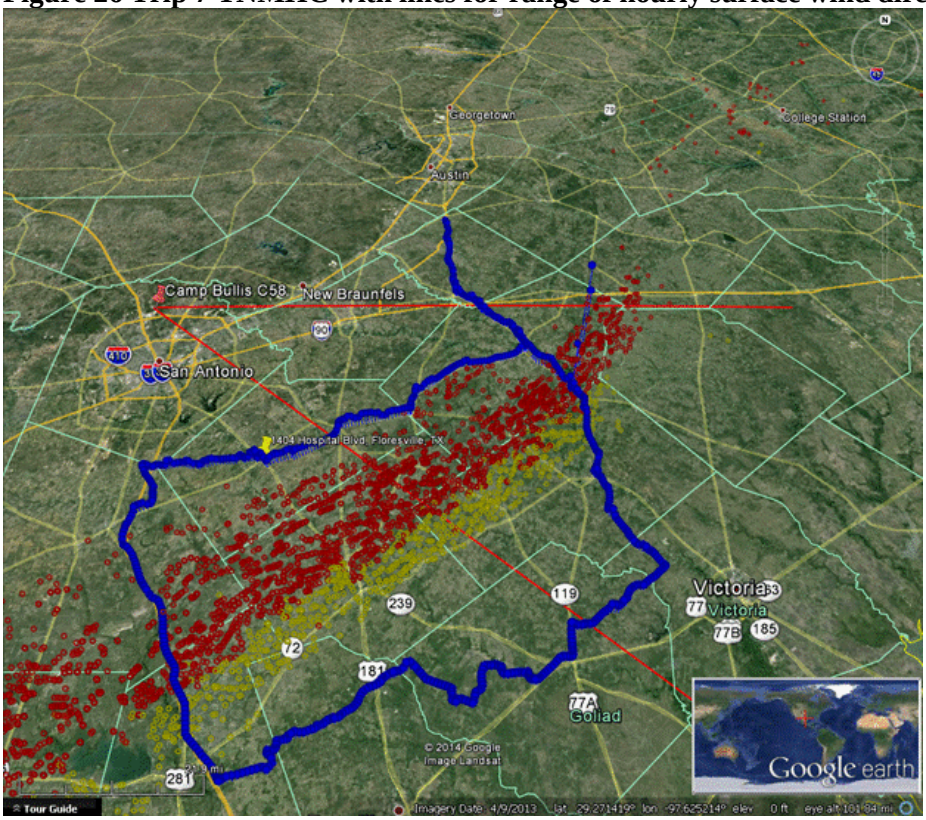



**Figure 27 Trip 8 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

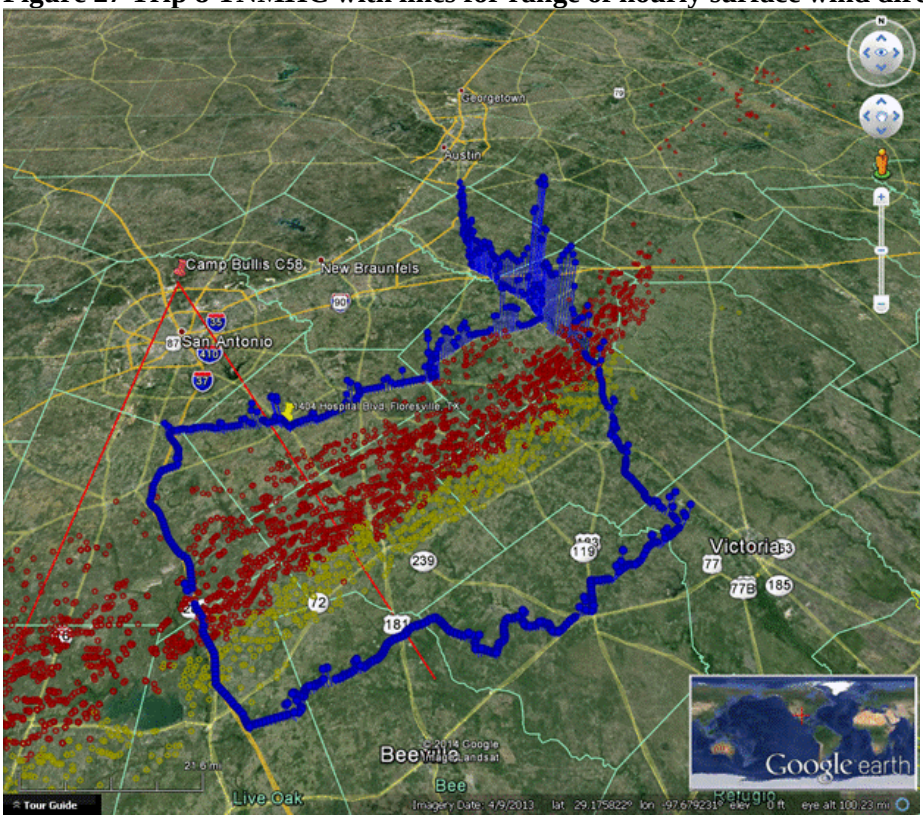


**Figure 28 Trip 9 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

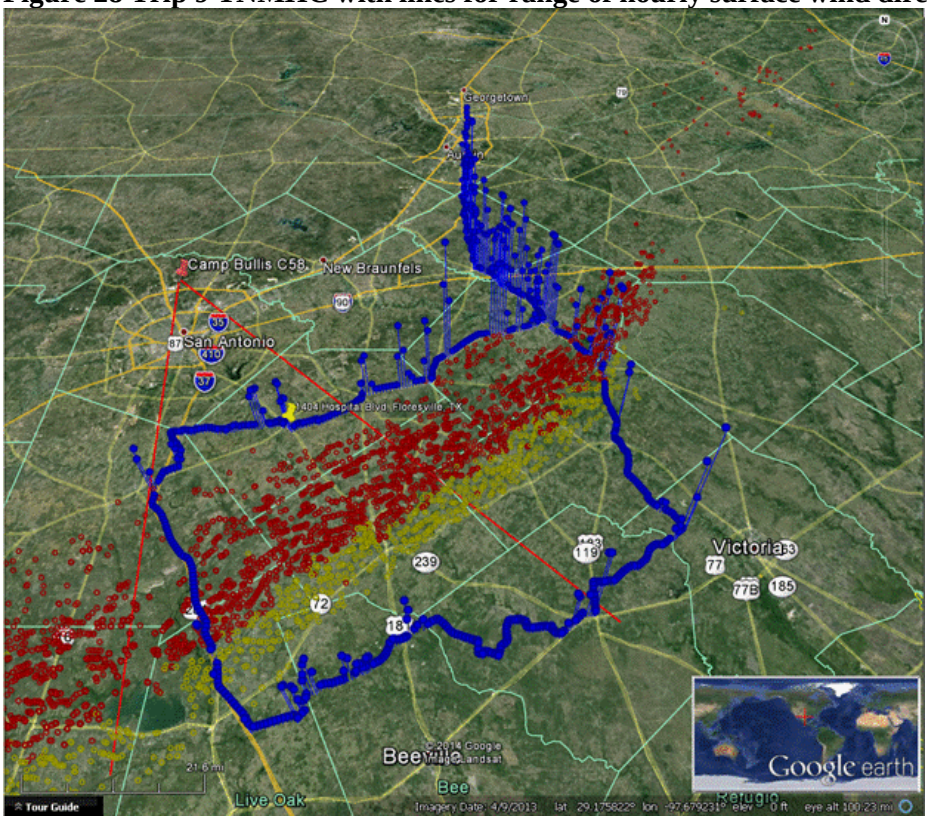



**Figure 29 Trip 10 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

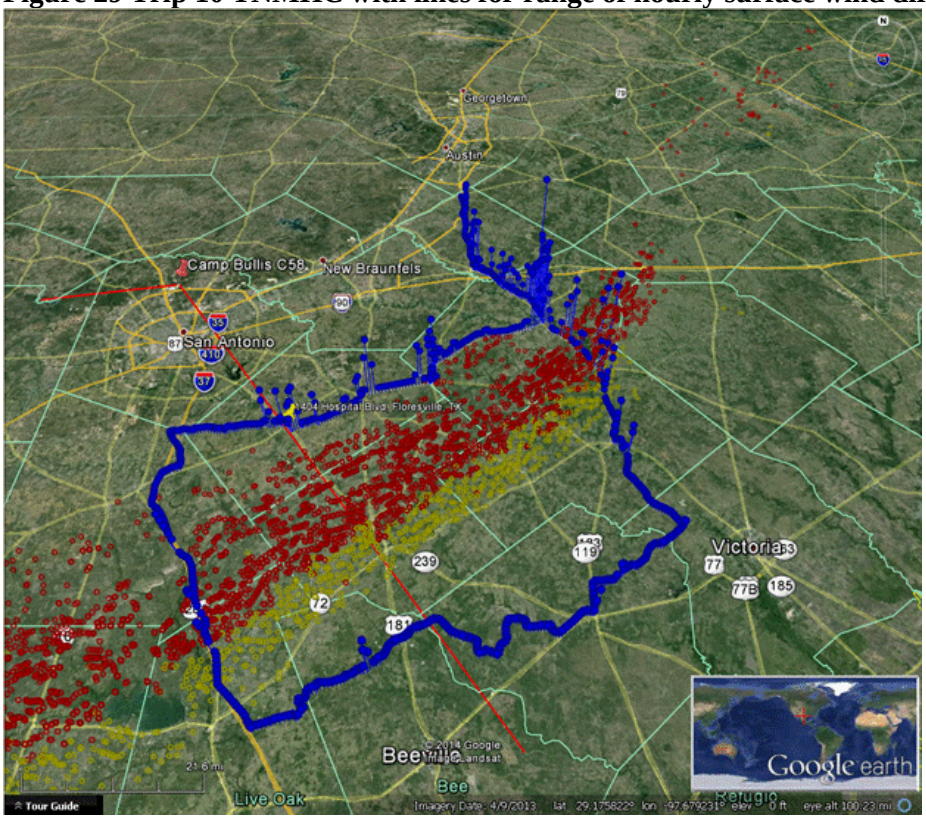


**Figure 30 Trip 11 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

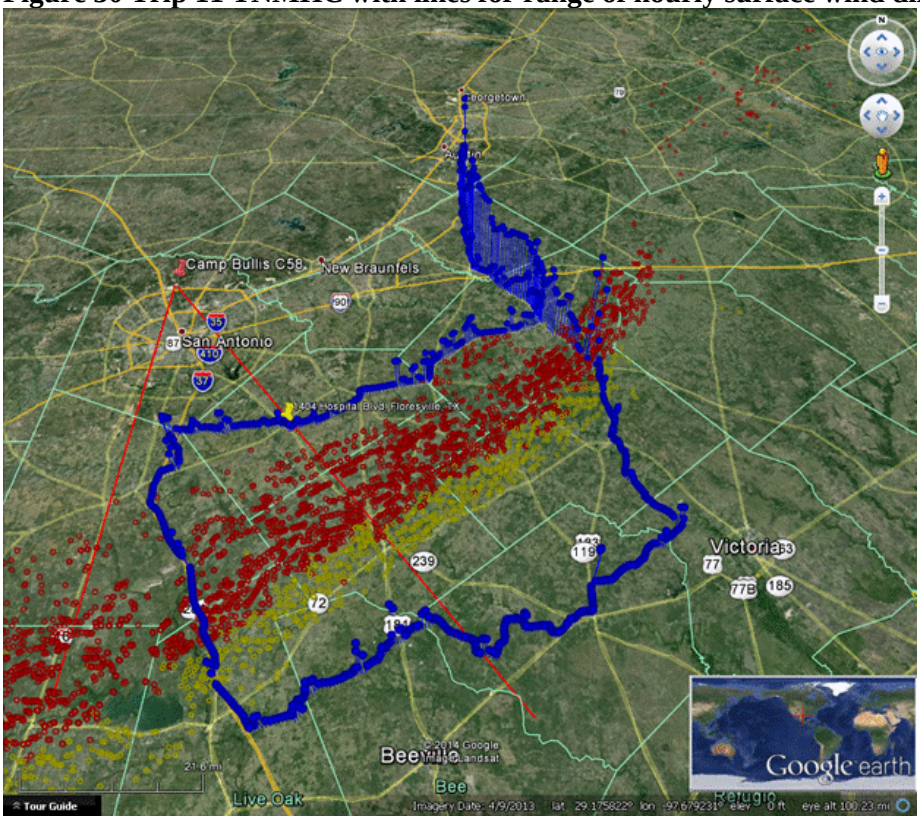



**Figure 31 Trip 12 TNMHC with lines for range of hourly surface wind directions 10th & 90th p-tiles**

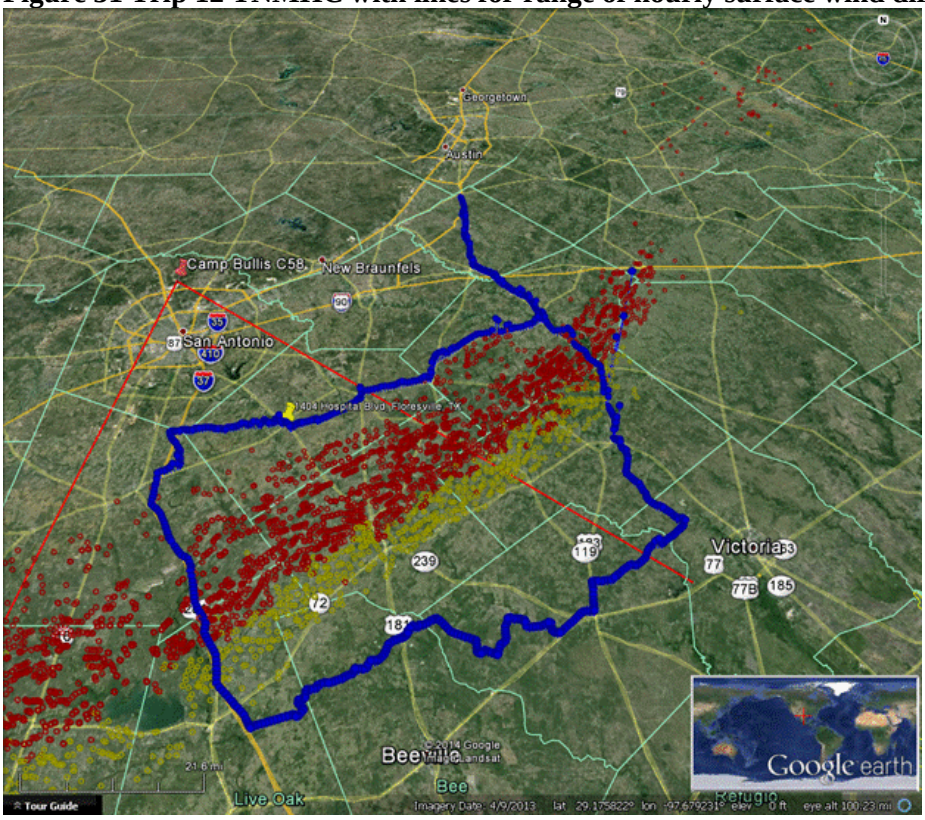


**Figure 32 Another view of NOx concentrations from Trip 3, May 19; max concentration 99 ppb**

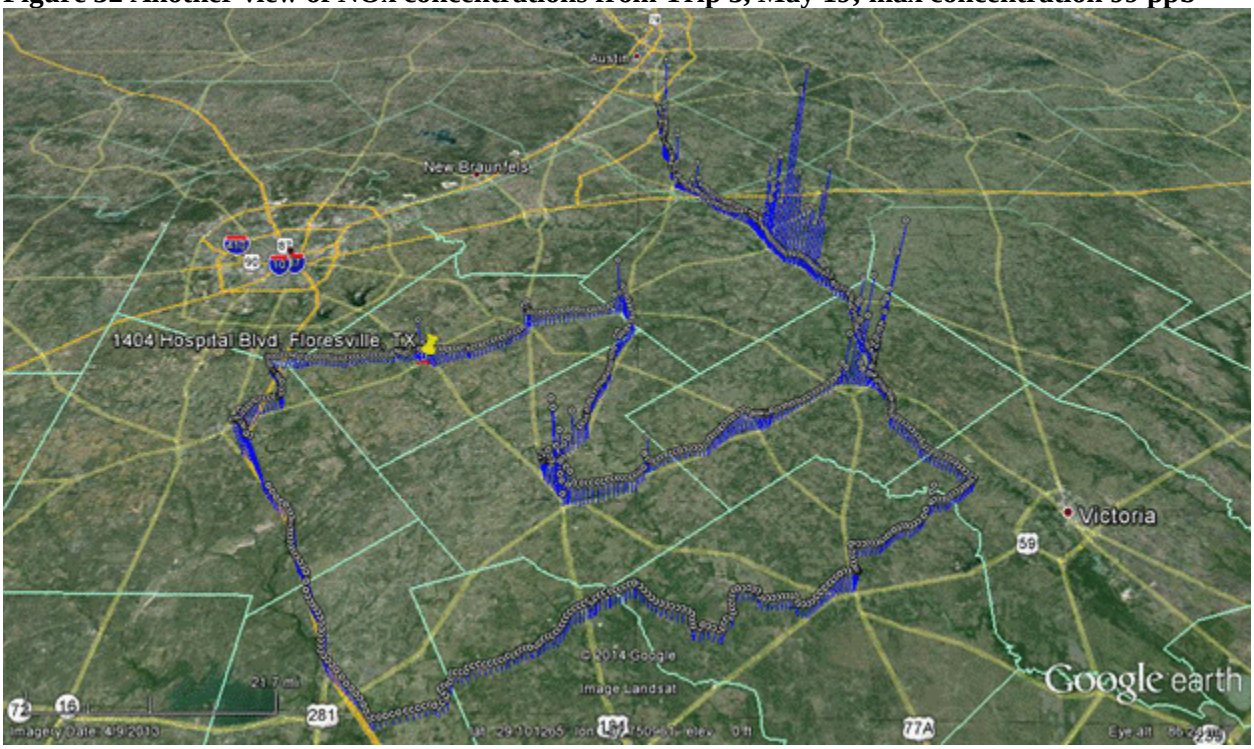
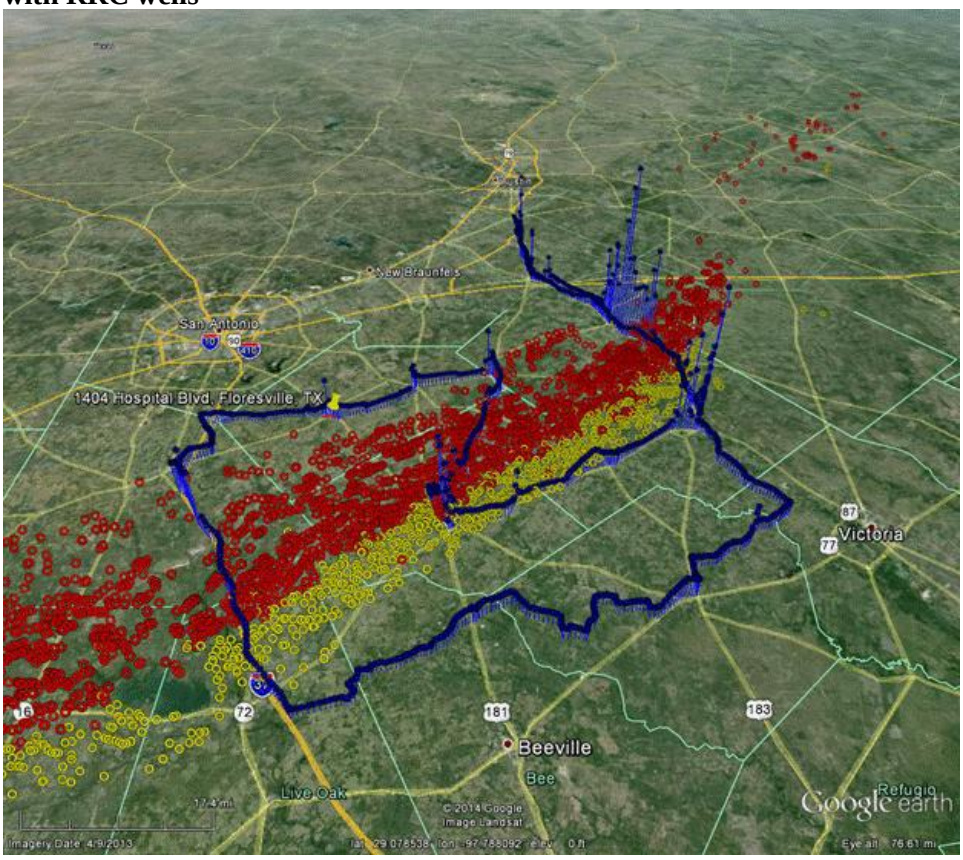



**Figure 33 Another view of NOx concentrations from Trip 3, May 19; max concentration 99 ppb, with RRC wells**



## Comparing Canister Sample Measurements with the Floresville Auto-GC

To assess the representativeness of the Floresville auto-GC, UT has performed a comparison between the downwind canister samples and the mean daytime concentrations from the auto-GC. Table 11 contains the mean daytime concentrations for the months of May and June 2014 from the Floresville CAMS 1038 auto-GC. These data have been validated. Only data from hours between noon & 5 p.m. CDT were used in Table 11 to be comparable with the canister sampling. Also in Table 11 there is a column for mean concentrations for the twelve canisters sampled on the downwind side of the Eagle Ford Shale. An examination of the individual canisters suggests that the downwind sample from June 2, 2014, labeled "L" in Figure 18 and Tables 7 and 8 is a statistical outlier. Total mass in this canister was 239.5 ppbC compared to the second highest canister mass at 89.5 ppbC and a mean mass for the 11 canisters at 32.9 ppbC. In Table 11 there is a tabulation of the mean concentration both with and without canister "L". The data in Table 11 are graphed in a bar chart in Figure 34. With all 12 samples, the agreement is better for ethane, propane, iso-butane, and n-butane. With 11 samples, omitting the outlier, agreement is better for iso-pentane, n-pentane, and most other species. Overall, the comparison of the downwind canister samples and the auto-GC daytime May and June averages is very close, although the mean Floresville isoprene concentration is notably lower than the canister average[5]. An additional comparison appears in Figure 35 with scatterplots of the canister means versus the auto-GC means for the 12 and 11 canister averages.

[5] Since isoprene reacts rapidly in the atmosphere its concentrations are more spatially variable than those of longer-lived hydrocarbons such as ethane and butane which can disperse over long periods of time. Since the canisters represent an average of samples collected at several locations, large deviations between the spatially-averaged canister samples and observations made at a single location are to be expected.

**Table 11 Comparison of daytime mean Floresville auto-GC mean ppbC concentrations for May & June 2014 with 12 downwind and 11 downwind (omitting one outlier) canister mean ppbC concentrations**

| Species | Auto-GC ppbC | Mean Downwind 12 Cans ppbC | Mean Downwind Cans ppbC (1 outlier removed) |
|---|---|---|---|
| Ethane | 11.307 | 10.987 | 7.340 |
| Ethylene | 0.157 | 0.299 | 0.326 |
| Propane | 10.524 | 9.897 | 7.473 |
| Propylene | 0.049 | 0.000 | 0.000 |
| Isobutane | 3.099 | 3.119 | 2.160 |
| n-Butane | 6.324 | 5.795 | 4.418 |
| Acetylene | 0.174 | 0.204 | 0.223 |
| t-2-Butene | 0.115 | 0.000 | 0.000 |
| 1-Butene | 0.103 | 0.000 | 0.000 |
| c-2-Butene | 0.023 | 0.000 | 0.000 |
| Cyclopentane | 0.155 | 0.000 | 0.000 |
| Isopentane | 2.619 | 3.906 | 2.788 |
| n-Pentane | 2.212 | 2.895 | 2.021 |
| t-2-Pentene | 0.002 | 0.000 | 0.000 |
| 1-Pentene | 0.000 | 0.000 | 0.000 |
| c-2-Pentene | 0.000 | 0.000 | 0.000 |
| 22-Dimethylbutane | 0.014 | 0.078 | 0.000 |
| Isoprene | 0.540 | 3.142 | 3.192 |
| n-Hexane | 0.840 | 1.350 | 0.719 |
| Methylcyclopentane | 0.127 | 0.198 | 0.082 |
| 24-Dimethylpentane | 0.009 | 0.000 | 0.000 |
| Benzene | 0.201 | 0.000 | 0.000 |
| Cyclohexane | 0.097 | 0.186 | 0.049 |
| 2-Methylhexane | 0.064 | 0.371 | 0.000 |
| 23-Dimethylpentane | 0.017 | 0.000 | 0.000 |
| 3-Methylhexane | 0.085 | 0.697 | 0.292 |
| 224-Trimethylpentane | 0.123 | 0.000 | 0.000 |
| n-Heptane | 0.186 | 0.623 | 0.000 |
| Methylcyclohexane | 0.151 | 0.434 | 0.000 |
| 234-Trimethylpentane | 0.013 | 0.000 | 0.000 |
| Toluene | 0.253 | 0.499 | 0.080 |
| 2-Methylheptane | 0.009 | 0.321 | 0.000 |
| 3-Methylheptane | 0.007 | 0.353 | 0.000 |
| n-Octane | 0.030 | 0.549 | 0.000 |
| Ethyl Benzene | 0.003 | 0.000 | 0.000 |
| mp-Xylene | 0.054 | 0.836 | 0.000 |
| Styrene | 0.001 | 0.000 | 0.000 |
| o-Xylene | 0.009 | 0.000 | 0.000 |
| n-Nonane | 0.029 | 0.513 | 0.000 |
| Isopropyl Benzene | 0.001 | 0.000 | 0.000 |
| n-Propylbenzene | 0.003 | 0.000 | 0.000 |
| 135-Trimethylbenzene | 0.004 | 0.222 | 0.000 |
| 124-Trimethylbenzene | 0.022 | 0.000 | 0.000 |

**Figure 34 Bar chart comparison of daytime mean Floresville auto-GC mean ppbC concentrations for May & June 2014 with 12 downwind and 11 downwind (omitting one outlier) canister mean ppbC concentrations**

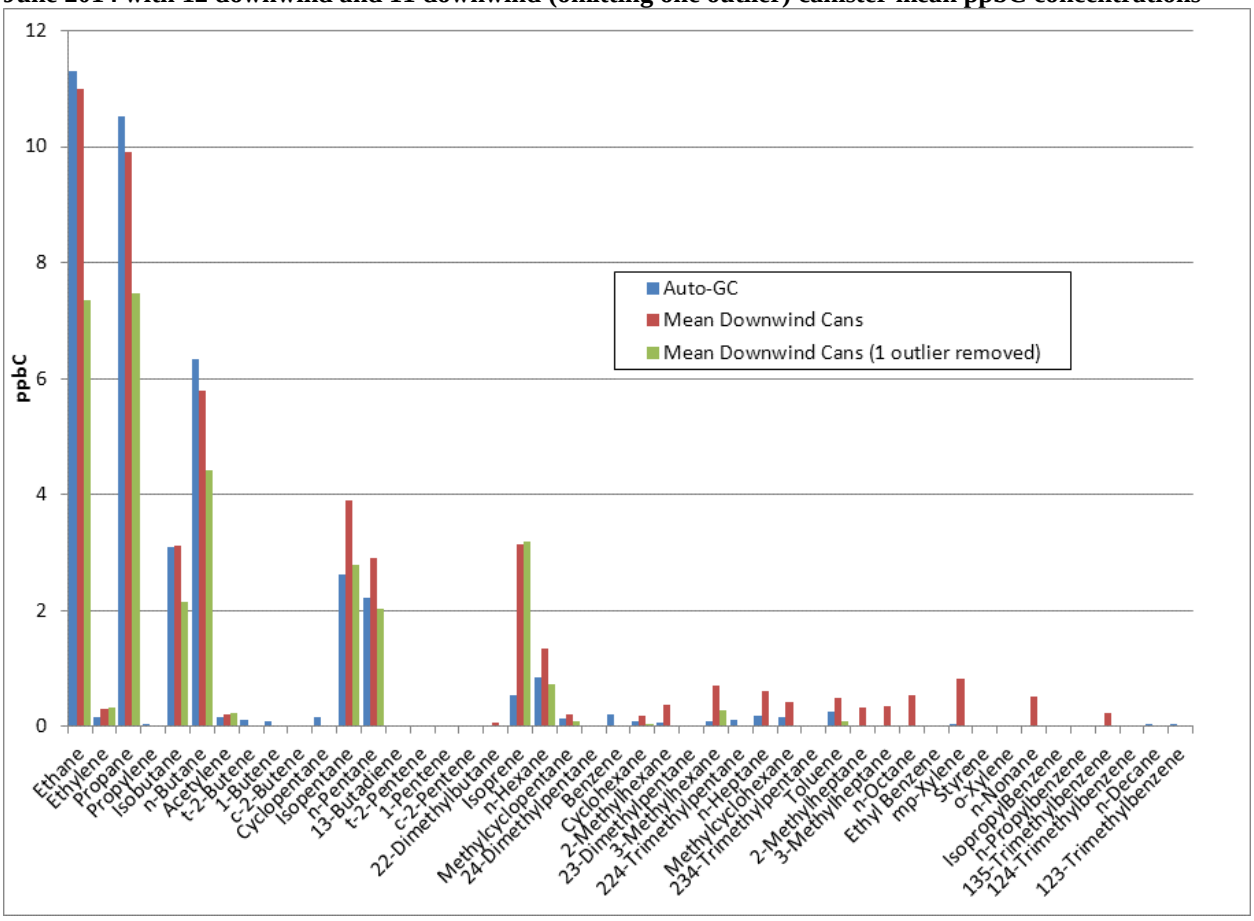
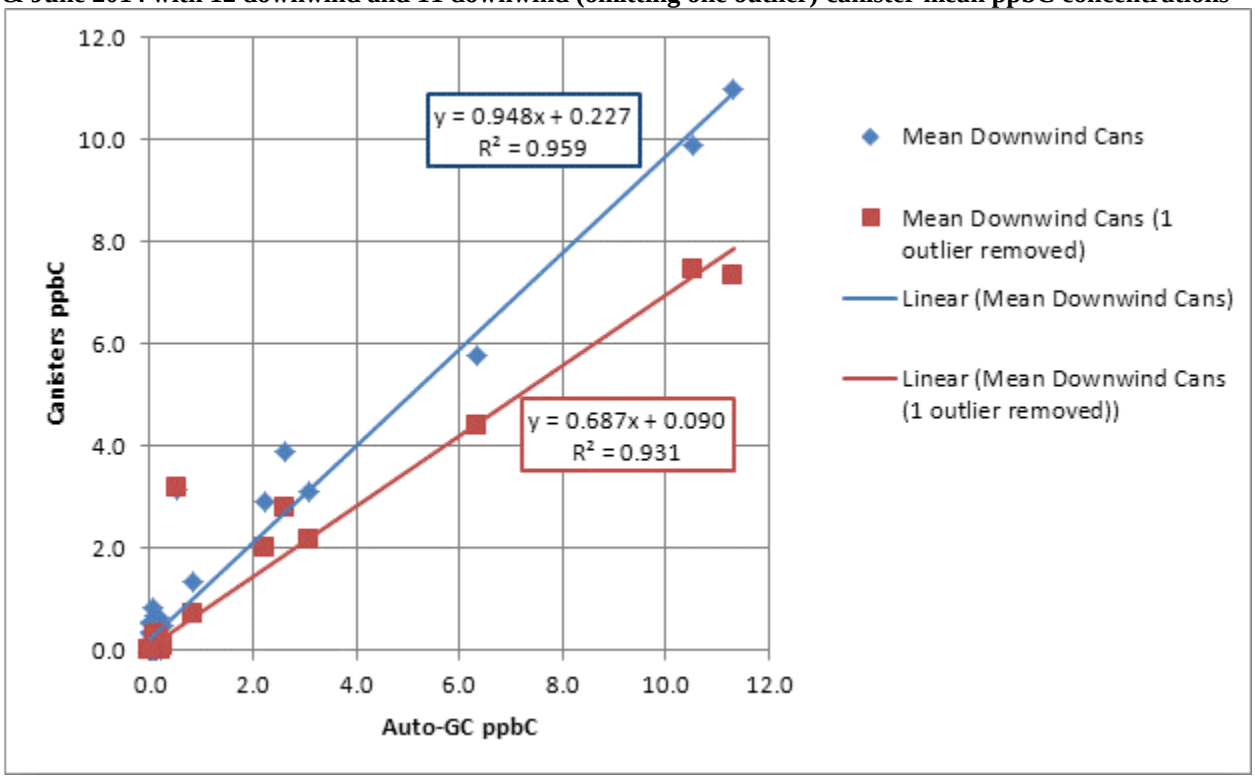


**Figure 35 Scatterplot comparison of daytime mean Floresville auto-GC mean ppbC concentrations for May & June 2014 with 12 downwind and 11 downwind (omitting one outlier) canister mean ppbC concentrations**



## Measured Concentrations and HySplit Back-Trajectories

In the tables summarizing the measurements made near HySPLIT back-trajectory points, the sites used to run 100 meter starting point back-trajectories were as follows:

| Site | Site name & CAMS # | Latitude | Longitude |
|---|---|---|---|
| 1 | Floresville CAMS 1038 | 29.131 | -98.148 |
| 2 | SA NW CAMS 23 | 29.515 | -98.620 |
| 3 | Camp Bullis CAMS 58 | 29.632 | -98.565 |

Back trajectory runs were started every hour from 14 UTC (9 a.m. CDT) to 23 UTC (6 p.m. CDT). SAS code has been written and executed to calculate the measured concentrations on the driven routes within 15 miles of the crossing points of the HySPLIT back trajectories.

Displays of the ambient TNMHC data collected along the driving routes are shown in Figures 36 through 47 for 12 trips with the modeled HySPLIT back-trajectories. The modeled HySPLIT back-trajectories are shown in different colors for the three sites:

- Camp Bullis = purple
- SA NW = light blue
- Floresville = green

As was noted earlier, measurement data have been rolled up to 30-second averages for both GPS and pollutant concentrations. Times are in central daylight savings time. TNMHC concentrations are in ppbC. NOx is expressed in ppb units. Table 12 shows the number of 30-second averages measurements that were within 15 miles of a modeled back-trajectory point. All twelve trips have been combined in the summaries in Table 12. Table 12 shows that in general, concentrations were higher on average when a back-trajectory intersected a **downwind** leg of a monitoring route. The NOx differences are small, but the TNMHC differences are statistically and practically significant.

**Table 12 Mean concentrations of NOx and TNMHC where & when a modeled back-trajectory was near the monitoring vehicle**

| | Upwind | | | | Downwind | | | |
|---|---|---|---|---|---|---|---|---|
| **Site** | **NOx obs** | **NOx mean ppb** | **TNMHC obs** | **TNMHC mean ppbC** | **NOx obs** | **NOx mean ppb** | **TNMHC obs** | **TNMHC mean ppbC** |
| **1. Floresville** | 27 | 4.0 | 27 | 7.2 | 49 | **6.2** | 49 | **48.0** |
| **2. SA NW** | 8 | 2.4 | 8 | 0.4 | 23 | **5.9** | 23 | **37.9** |
| **3. Camp Bullis** | 10 | **3.0** | 10 | 31.9 | 20 | 2.8 | 20 | **53.5** |

**Figure 36 Trip 1 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

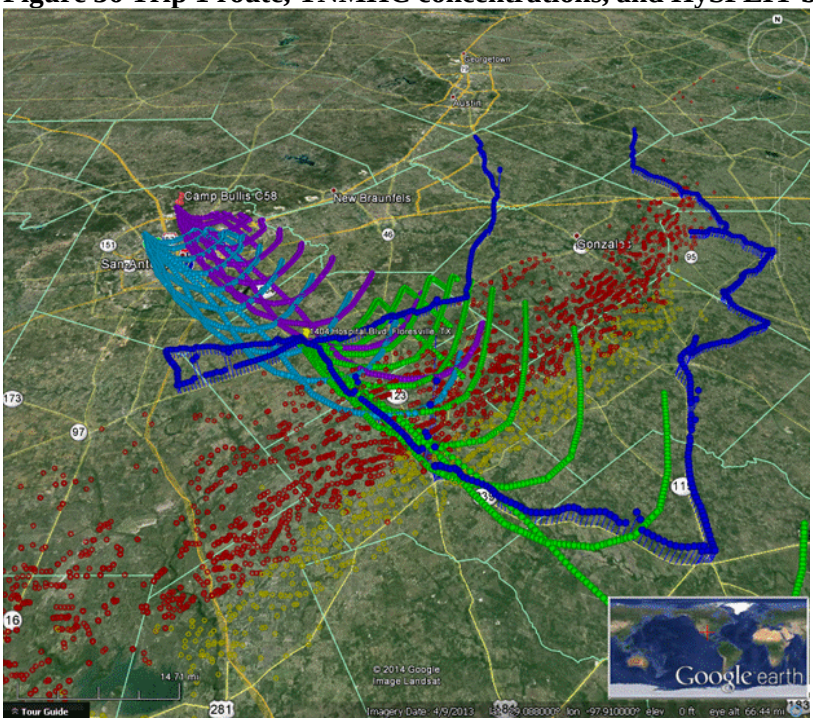


**Figure 37 Trip 2 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

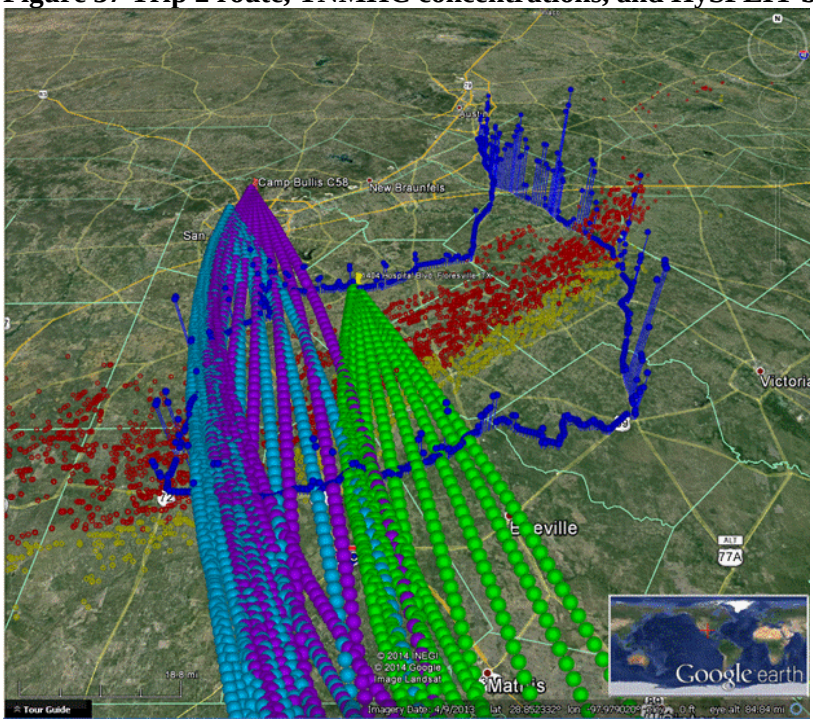



**Figure 38Trip 3 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

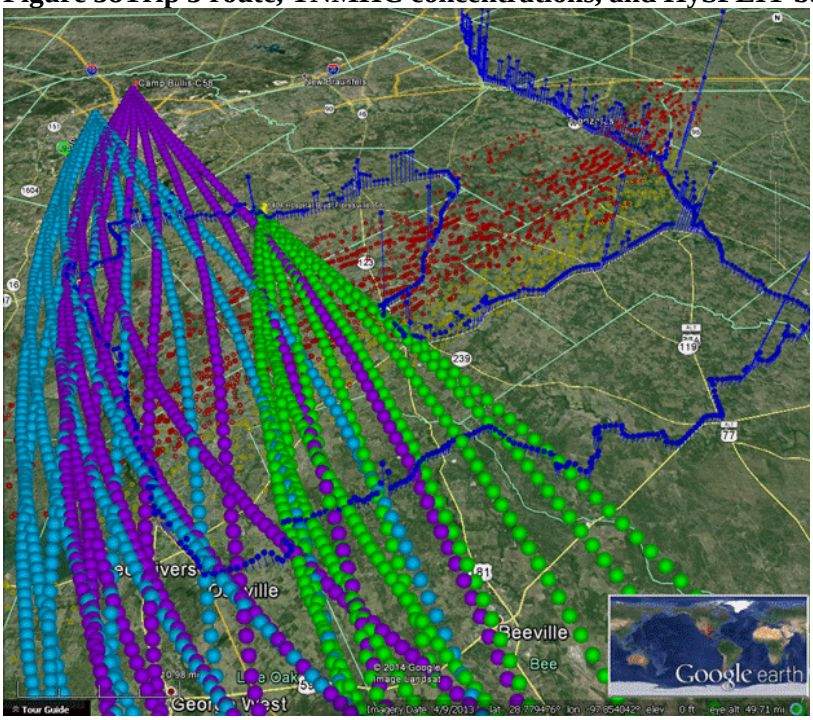


**Figure 39 Trip 4 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

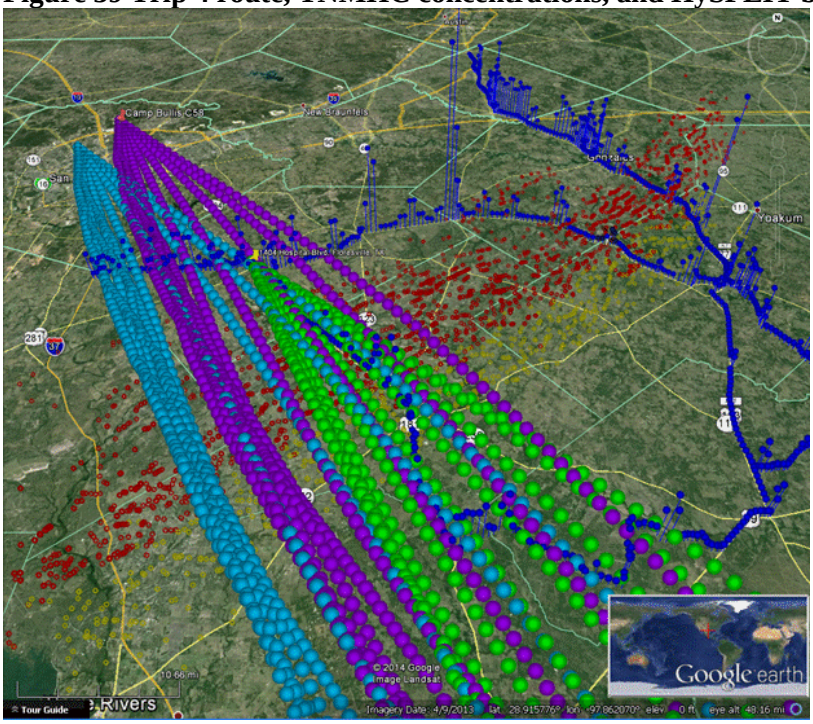



**Figure 40 Trip 5 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

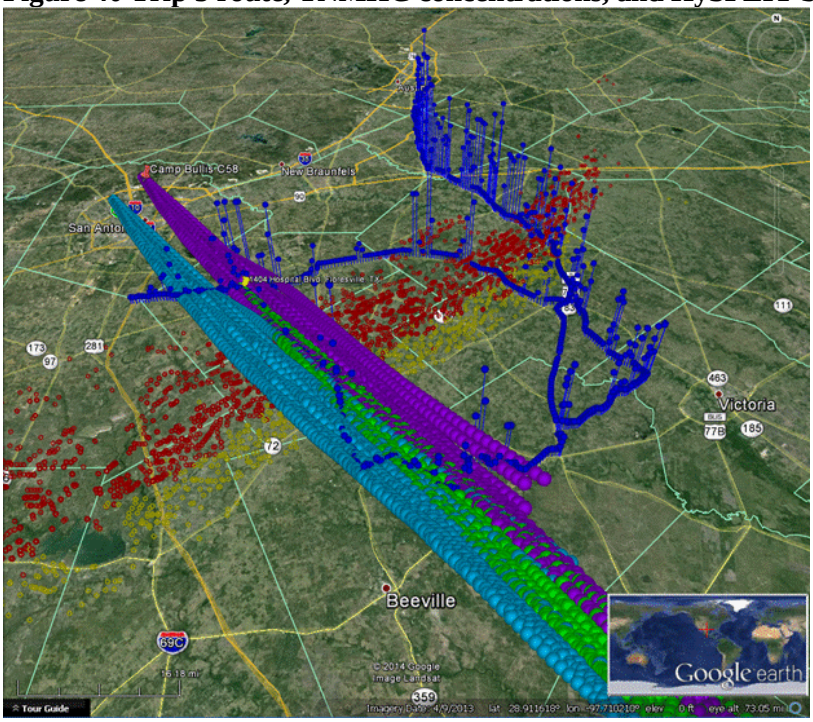


**Figure 41 Trip 6 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

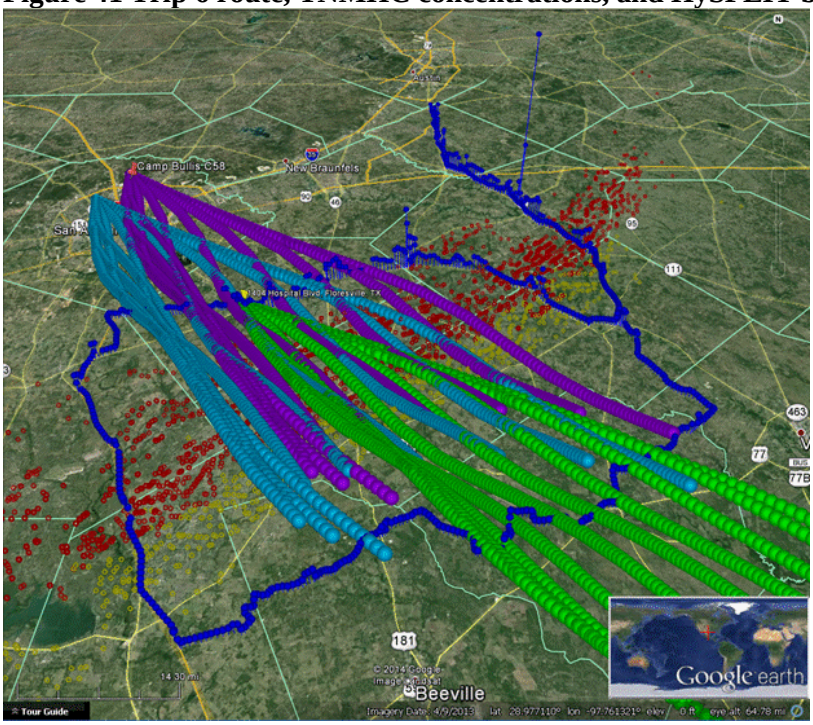



**Figure 42 Trip 7 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

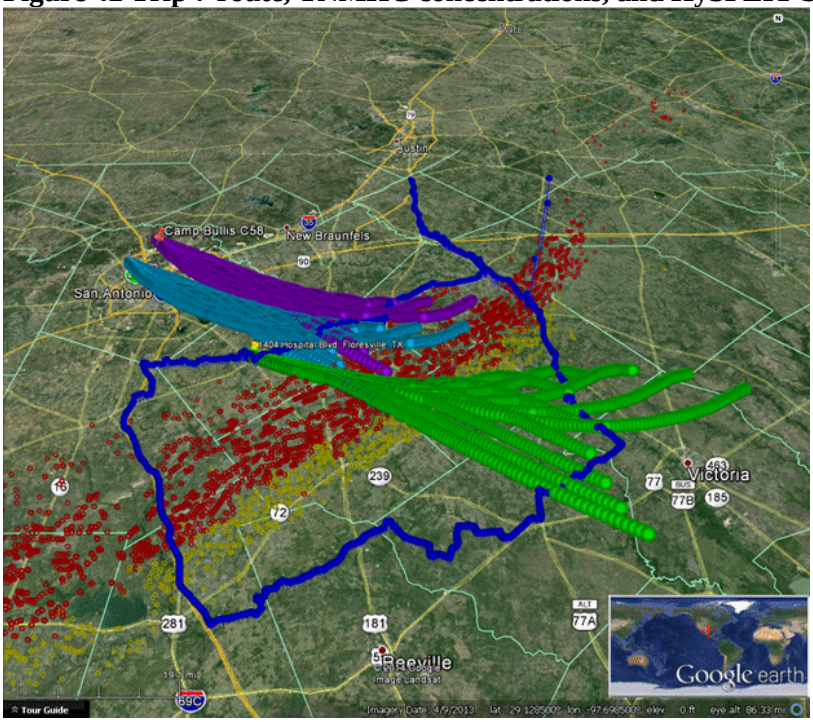


**Figure 43 Trip 8 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

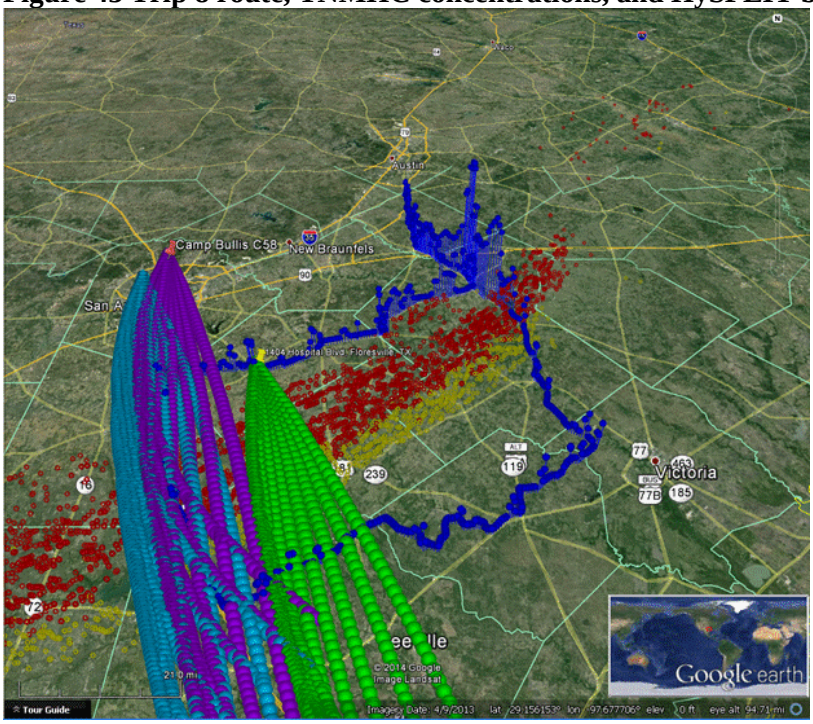



**Figure 44 Trip 9 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

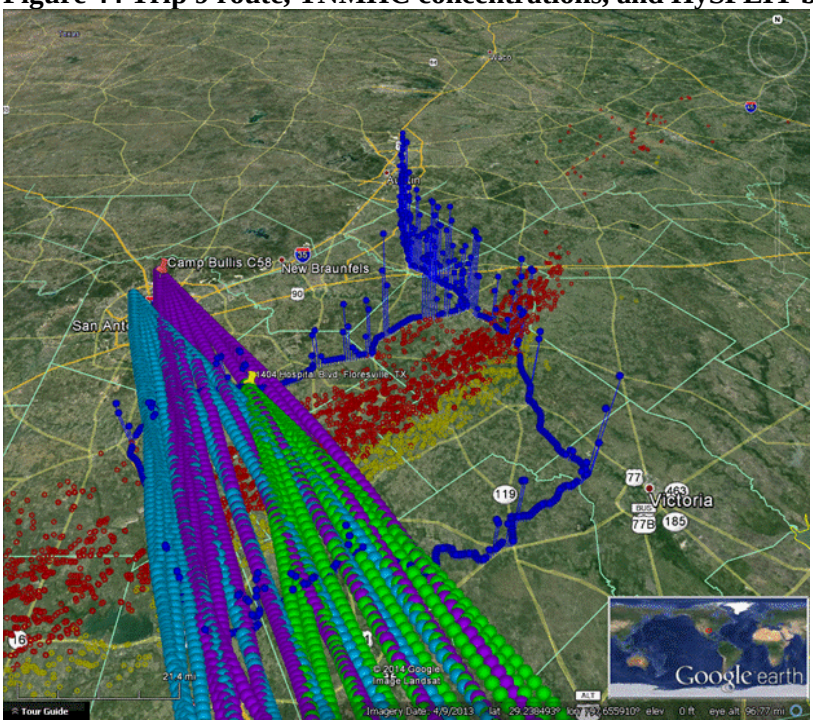


**Figure 45 Trip 10 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

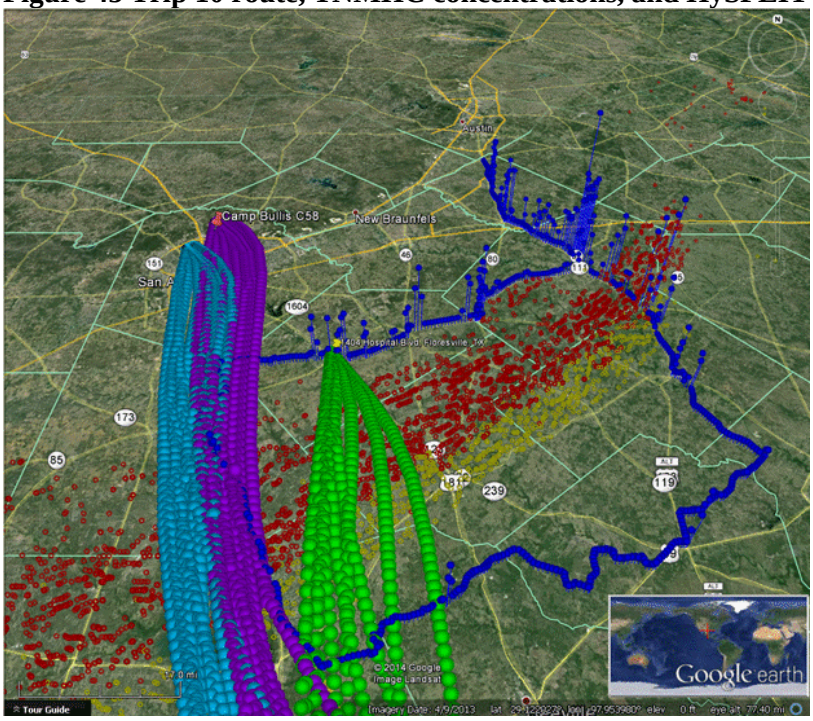



**Figure 46 Trip 11 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**

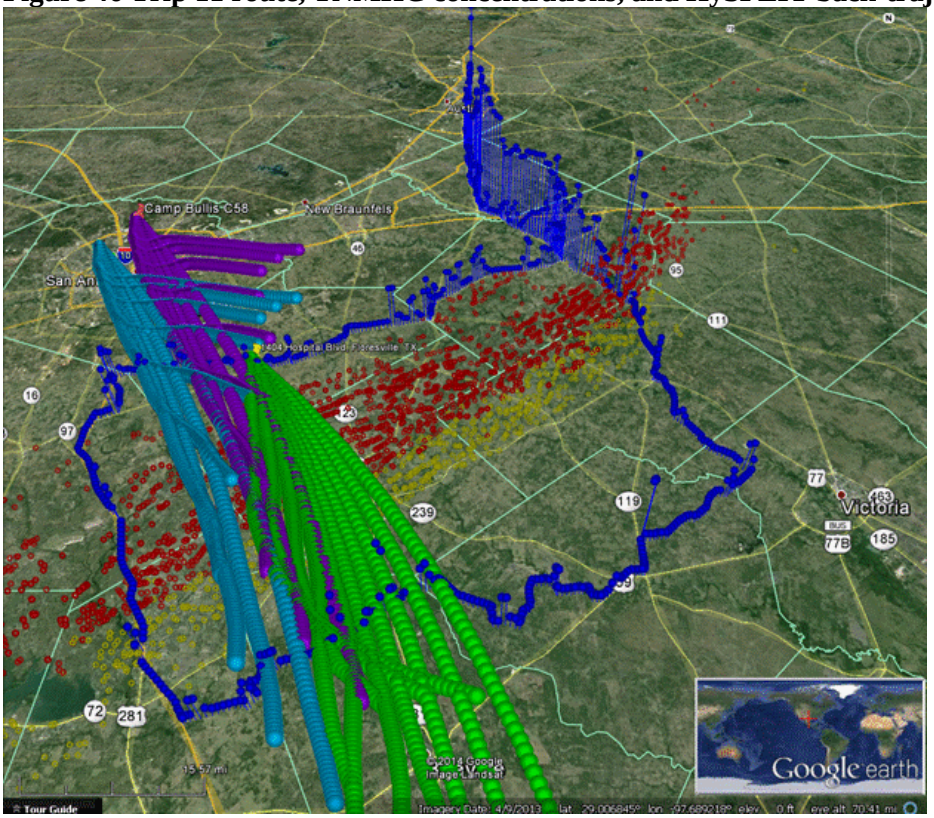
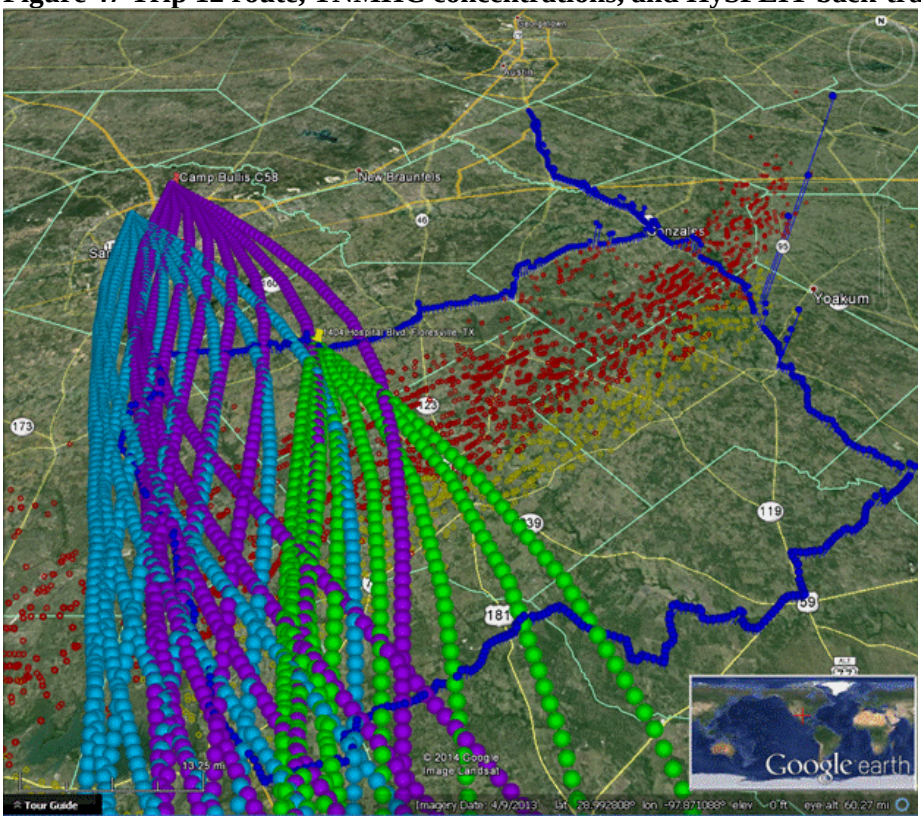


**Figure 47 Trip 12 route, TNMHC concentrations, and HySPLIT back-trajectories from 3 sites**



## 4. Conclusion

The principal findings of this project are as follows:

Twelve monitoring trips were made in May and June 2014. Conditions were such that surface winds were predominantly from the south-southeast. HySPLIT back-trajectories (100 meter starting altitude) were run from three CAMS sites in the San Antonio area for eight hours each day, and the pooled wind directions show a more southeasterly distribution than the CAMS sites. A review of driving routes and surface winds shows that each trip managed to collect data upwind and downwind of the EFS region and upwind of San Antonio.

For 10 out of 12 trips, TNMHC concentrations were higher downwind than upwind. This is a statistically significant result ($p = 0.019$). For NOx, there was no significant or practical difference in upwind vs downwind comparisons.

In examining the 100 meter starting altitude HySPLIT back-trajectories from three locations in the San Antonio area, it was found that TNMHC concentrations were higher on the downwind side than on the upwind side on average for all three starting locations. For NOx, there was no practical difference.

In pairing upwind and downwind canisters, the downwind canister has a higher concentration in 7 out of 11 cases, or 64% of cases. This difference is not statistically significant (p-value = 0.11). **Note that isoprene, a highly reactive species associated primarily with living vegetation, represents the largest single compound in terms of reactivity in most samples**.

The auto-GC at Floresville CAMS 1038 had mean hydrocarbon concentrations qualitatively similar to the concentrations measured in canister samples, with better agreement omitting one outlier for many of the species. The overall conclusion is that there is no evidence that the Floresville site is not representative of a larger area downwind of the EFS.

Additional work could be performed to improve the data displays in the maps in any future work of a similar nature. It is possible that there is more information that could be extracted from the measurements taken.

# Appendix

Note that uncorrected typographical errors exist in these tables

| Trip 1, May 10, 2014 Log Notes | CDT |
|---|---|
| Reset timestamp and GPS. At stop sign of Road A near Ceer building. Everything looks like it is running OK. | 10:34 |
| Getting on 183 south | 10:41 |
| Stopping to check all sample line connections. | 10:50 |
| at MLK and 183. | 10:54 |
| East 71 | 11:00 |
| 95 south | 11:39 |
| Entering Smithville | 11:41 |
| Leaving Smithville | 11:43 |
| Crossing over HW 10 and stopping to check route. | 12:06 |
| east on HW 90 | 12:08 |
| Stopping for a pit stop and downloading data. | 12:09 |
| east on 90 | 12:22 |
| south on1295 | 12:25 |
| Turning west on 340 | 12:40 |
| Turning around on 340 east | 12:49 |
| East on 77 | 13:04 |
| right on 77 south in Hallettsville. | 13:07 |
| west on 318 | 13:08 |
| At Sweet Home | 13:19 |
| Right on 111 | 13:26 |
| left on to 682 Yoakum | 13:27 |
| 1447 towards Cuero | 13:38 |
| Entering Cuero. Downloading data | 13:52 |
| South on 183 | 13:54 |
| Stopping for a pit stop. | 13:56 |
| Right on 183 toward Goliad | 14:11 |
| Goliad | 14:40 |
| Right on 59 | 14:41 |
| Stopping to take canister sample. | 14:44 |
| Resuming on 239 to Kennedy | 14:51 |
| 72/239 towards Kennedy | 15:18 |
| Lots of trucks on 181 toward Floresville | 15:26 |
| Karnes City | 15:27 |
| Leaving Poth | 15:47 |
| Stopping to refuel generators and download data. | 15:53 |
| north 1784 | 16:23 |

| | |
|---|---|
| north 536 | 16:32 |
| Floresville right on 181 | 16:53 |
| at cams 1038 | 16:58 |
| leaving Cams 1038 | 17:17 |
| north on 97 | 17:19 |
| south on 181 | 17:19 |
| north on 181 | 17:20 |
| stopping for gas | 17:21 |
| leaving gas station. | 17:32 |
| north on 537 | 17:35 |
| going over 123 | 17:50 |
| right on 119 | 17:53 |
| left on CR465 | 17:55 |
| left on 1347 | 18:05 |
| South 87 towards Nixon | 18:08 |
| Nixon | 18:14 |
| north on 80 | 18:15 |
| Leesville | 18:24 |
| Luling | 18:42 |
| leaving Luling and downloading data. | 18:48 |
| Lockhart | 18:58 |
| Leaving Lockhart on 183 north | 19:04 |
| at CEER gate | 19:50 |

| Trip 2, May 17, 2014 Log Notes | CDT |
|---|---|
| Put new batteries in GPS and deleted old data. | 7:53 |
| Leaving CEER building and resetting GPS. | 8:13 |
| Turning right on Burnet | 8:14 |
| We had to stop to reboot Zeno | 8:18 |
| Turning south from Waterford center onto Burnet. | 8:18 |
| Entering Lockhart on 183 | 8:57 |
| Leaving Lockhart south on 183 | 9:03 |
| Entering Luling on 183 | 9:13 |
| At light on 183 and HW10 | 9:22 |
| Gonzalez downloading data | 9:34 |
| Stopping at gas station to refuel generators and break. | 9:36 |
| Hochheim | 10:01 |
| We are following 3 heavy duty trucks and getting about 100ppb NOx starting just after Hochheim. | 10:10 |
| passing CAMS 1602 | 10:14 |
| Entering Cuero | 10:16 |
| Taking detour around traffic jam. | 10:20 |
| left on Main | 10:21 |
| right on a side street south | 10:22 |
| Cuero backstreets. | 10:26 |
| right on Hamilton | 10:27 |
| Back on 183 south | 10:28 |
| left to stay on 183 south | 10:31 |
| Behind a large truck after 119. | 10:49 |
| in Cuero turning south on 59 | 10:57 |
| leaving Cuero | 10:59 |
| Right on 1351 | 11:04 |
| Stopping at Welder road to take a can sample. | 11:17 |
| Downloading data and getting back on the road. | 11:30 |
| West on 883 | 11:39 |
| left on to 623 towards Pettus | 11:50 |
| Entering Pettus | 11:51 |
| Stopping at the DQ in Pettus. | 11:53 |
| Leaving DQ after Dave's interview. West on 623. | 12:12 |
| Stopping at corner of 623 and 673.\ | 12:24 |
| Continuing on 623 | 12:36 |
| turning around on 623 | 12:39 |
| turning around on 623 | 12:40 |
| Stopping for news crew. | 12:42 |
| heading west on 623 | 12:43 |

| | |
|---|---|
| News crew repositioning camera. | 12:54 |
| Left on 72 | 13:06 |
| Stopping to remove cameras and downloading data | 13:09 |
| West on 623 | 13:18 |
| entering Three Rivers | 13:20 |
| left onto 281 | 13:22 |
| right onto 72 | 13:24 |
| Lots of truck traffic and many active flares. | 13:44 |
| Turned onto 16 north | 13:46 |
| lots and lots of trucks giving elevated NOx | 13:46 |
| Some trucks. Wind now blowing road emissions away from us. | 13:53 |
| entering Jourdanton | 14:16 |
| North on 97 | 14:17 |
| Leaving Jourdanton. | 14:19 |
| Pleasanton? A whole line of trucks. | 14:24 |
| Taking the 97 split from 181. | 14:28 |
| Leaving Pleasanton. | 14:29 |
| Leaving line of trucks behind at 37. | 14:32 |
| west on 1784 | 14:35 |
| north on 536 | 14:44 |
| Stopping to take a can sample. | 14:49 |
| Leaving for Floresville | 15:18 |
| Entering Floresville | 15:36 |
| right on 181 | 15:37 |
| left on 97 | 15:40 |
| Stopping for fuel and downloading data. | 15:43 |
| Leaving gas station. heading towards CAMS on Hospital Blvd. | 15:51 |
| Leaving CAMS 1038. North on 97. | 16:28 |
| left on 537. | 16:31 |
| left on 123 towards Stockdale | 16:47 |
| right on hw87 | 16:49 |
| Pandora | 16:56 |
| north on hwy 80 | 17:01 |
| leaving Nixon | 17:02 |
| Stopping to take notes just past HW 90 | 17:20 |
| Luling | 17:31 |
| downloading data | 17:41 |
| Entering Lockhart | 17:46 |
| leaving Lockhart | 17:52 |
| exiting 183 at Burnet | 18:31 |
| turning north on Burnet | 18:32 |

| | |
|---|---|
| Turning into CEER and downloading. | 18:34 |

| Trip 3, May 19, 2014 Log Notes | CDT |
|---|---|
| Leaving CEER. Erased GPS and installed new batteries. We have 3 new cans for whole air sampling at the ready. Checked zeno time and matches laptop time. | 8:27 |
| leaving pickle campus heading south on Burnet | 8:34 |
| entering 183 south towards Lockhart | 8:37 |
| Entering Lockhart | 9:21 |
| Leaving Lockhart | 9:28 |
| Entering Luling | 9:38 |
| leaving Luling | 9:46 |
| Entering Gonzales | 9:56 |
| stopping at gas station. refueling suburban, generators and downloading data. | 9:58 |
| leaving south on 183 | 10:15 |
| Entering Cuero. | 10:47 |
| turn left on 236. | 10:52 |
| Leaving Cuero | 10:55 |
| Stopping to take a can sample at Atzenhofer Rd and 236 | 11:00 |
| Finished can sample and continuing on 236 | 11:04 |
| right on 622 | 11:19 |
| Not sure where the 11 ppm CH4 and 1.5 ppm HC came from. We passed a garbage truck during that injection. | 11:35 |
| Left onto 183 south. | 11:38 |
| Entering Goliad | 11:42 |
| right on 59 | 11:43 |
| Leaving Goliad | 11:45 |
| right on 1531 west | 11:49 |
| Right on 883 | 12:07 |
| left on 623 | 12:18 |
| entering Pettus | 12:21 |
| Stopping for a pit stop and downloading data and refuel generators. | 12:22 |
| leaving gas station. on 623 again. | 12:33 |
| left on 1358 | 12:53 |
| right on 37 towards Pleasanton. | 13:04 |
| Taking Floresville exit HW97 north. | 13:41 |
| left onto 1784 West | 13:45 |
| Right onto 536 | 13:56 |
| turning around on 536 | 14:03 |
| turning around on 536 Taking a can sample. | 14:04 |
| North again on 536 | 14:09 |
| 536 east | 14:20 |
| Entering Floresville | 14:23 |

| | |
|---|---|
| Right onto loop 181 | 14:25 |
| Left on 97. | 14:27 |
| Stopping to get gas and download data. | 14:30 |
| Leaving gas station heading east on 181 | 14:42 |
| Left onto 537 | 14:45 |
| left on 537. | 14:51 |
| left on 123 towards Stockdale | 15:00 |
| right on 97 towards Nixon. Stopped for road construction. | 15:02 |
| Pandora | 15:13 |
| South on 80 | 15:20 |
| Gillett | 15:29 |
| Stopping for flat tire | 15:48 |
| Tire replaced. continuing south on 80 | 16:22 |
| in Karnes city | 16:25 |
| 181 business | 16:26 |
| The 55i flame is out and we spent about 15 min trying to lite it. | 16:44 |
| Turning around on 181 business. | 16:45 |
| south on 80/123. | 16:46 |
| left onto 123 south to Kennedy | 16:48 |
| 55i back online | 16:53 |
| left on 72. | 16:54 |
| continuing on 72 from HEB parking lot. | 16:57 |
| entering Yorktown | 17:25 |
| Leaving Yorktown | 17:29 |
| moving again after construction stop | 17:46 |
| entering Cuero | 17:49 |
| left on 183 | 17:50 |
| Stopping At DQ and downloading data | 17:53 |
| Leaving DQ north on 183 | 18:20 |
| Hochheim | 18:34 |
| Gonzales | 18:51 |
| Entering Lockhart | 19:24 |
| leaving Lockhart | 19:29 |
| Arriving at CEER | 20:13 |

| Trip 4, May 21, 2014 Log Notes | CDT |
|---|---|
| Leaving CEER | 9:00 |
| south on 183 access road. | 9:05 |
| south on 183 | 9:06 |
| Entering Lockhart | 9:46 |
| left Lockhart continuing south on 183 | 9:54 |
| Entering Luling | 10:03 |
| Gonzales. | 10:22 |
| Stopping to fuel suburban and generators. Downloading data. | 10:24 |
| Leaving truck stop south on 183 | 10:40 |
| turning around on HW 183 | 10:45 |
| South n HW 183 | 10:52 |
| leaving Gonzalez | 10:56 |
| Hochheim | 11:10 |
| Passing CAMS 1602 | 11:20 |
| Entering Cuero | 11:22 |
| left on 236 | 11:27 |
| Took a short detour through a parking lot and then got back on 236 | 11:47 |
| right onto 622. | 11:49 |
| Stopping at Springwood dr. Taking a can sample. | 11:51 |
| continuing on 622 | 11:57 |
| left on 183 | 12:17 |
| Entering Goliad | 12:20 |
| Right on 59 | 12:21 |
| Stopping at DQ | 12:22 |
| leaving DQ west on 59 | 12:47 |
| right on 1351 | 12:53 |
| Stopping to check NOX sample flow | 12:58 |
| continuing on in same direction. Sample flow for NOx seems OK. | 13:05 |
| right on 883 | 13:18 |
| passed a truck and NOx went up to 30 then back to zero. Looks like NOx is working. | 13:22 |
| turned onto west 623 | 13:29 |
| Right on 181. | 13:32 |
| passed 4 large trucks headed the opposite way. | 13:34 |
| Passed another 5 trucks. | 13:35 |
| Lots of trucks on this road | 13:37 |
| we counted 27 trucks between Pettus and Kennedy. | 13:45 |
| Leaving Kennedy. | 13:49 |
| Passed a rock crushing outfit. Looked like 50 trucks processing something. I think limestone. | 13:52 |
| 21 Trucks inside Kennedy city limits. | 13:54 |

| | |
|---|---|
| Stopped for road construction. | 14:02 |
| entering Poth | 14:13 |
| leaving Poth | 14:15 |
| entering Floresville. passed 32 trucks since the construction. | 14:19 |
| left onto 97 | 14:20 |
| right onto 181 business. | 14:22 |
| left onto 536. | 14:24 |
| leaving Floresville | 14:29 |
| turning around on 536 | 14:45 |
| entering Floresville. | 15:05 |
| right on 181 business | 15:06 |
| left on 97 | 15:09 |
| finished refueling heading south on 181 | 15:21 |
| Took a can sample at 3:38. Now continuing on 537. | 15:41 |
| left on 123 | 15:44 |
| right on 97 | 15:45 |
| Nixon | 15:56 |
| continuing on 87 towards Cuero | 15:58 |
| Smiley | 16:06 |
| lots of trucks on this road | 16:11 |
| Stopped for road construction. | 16:23 |
| left on 72 towards Cuero | 16:30 |
| Cuero | 16:33 |
| north on 183 and right on 236. | 16:36 |
| leaving Cuero | 16:39 |
| turned right onto 622 | 16:59 |
| Turned right onto 183 north | 17:17 |
| Cuero | 17:41 |
| leaving Cuero | 17:48 |
| Gonzalez | 18:13 |
| Stopping at Gonzales gas station | 18:17 |
| Luling | 18:46 |
| Exiting Lockhart | 19:05 |
| Turning into PRC | 19:48 |

| Trip 5, May 22, 2014 Log Notes | CDT |
|---|---|
| Leaving CEER Check zeno/laptop time sync, same min. | 8:12 |
| South on Burnet | 8:14 |
| Entering 183. | 8:18 |
| Lockhart | 9:06 |
| going around a truck wreck. | 9:11 |
| back on 183 south. | 9:13 |
| Leaving Lockhart | 9:14 |
| entering Luling. | 9:22 |
| leaving Luling. | 9:29 |
| Gonzalez | 9:42 |
| Stopping for fuel | 9:44 |
| South on 183 | 9:58 |
| leaving Gonzalez | 10:02 |
| Cuero | 10:27 |
| left on 236 | 10:32 |
| right on 622 | 10:54 |
| Stopping to take a can sample near Schroeder. | 11:00 |
| moving again on 622. | 11:05 |
| south on 183 | 11:18 |
| Goliad | 11:21 |
| turning around on 183. | 11:23 |
| Stopping for a rest stop. | 11:24 |
| leaving gas station | 11:33 |
| south 59 | 11:34 |
| right on 1351 | 11:40 |
| right on 883 | 11:59 |
| left on 623 | 12:11 |
| downloading data | 12:12 |
| right on 181 in Pettus | 12:14 |
| Kennedy | 12:28 |
| stopping for road construction. | 12:45 |
| moving again | 12:48 |
| Floresville | 13:02 |
| left on 97 | 13:04 |
| right on 181 business | 13:05 |
| left on 536 | 13:07 |
| leaving Floresville | 13:09 |
| Turning around on 536 just before HW 37 | 13:28 |
| right on 181 business | 13:49 |
| left on 97 | 13:51 |

| | |
|---|---|
| Leaving gas station | 14:08 |
| left on 537 | 14:11 |
| Stopping to take a can sample. | 14:12 |
| moving again on 537 | 14:17 |
| left on 123. | 14:31 |
| right on 97 | 14:34 |
| Nixon | 14:45 |
| Smiley | 14:54 |
| Downloading | 14:57 |
| left on 72 | 15:19 |
| left on 183 | 15:24 |
| right on 236 | 15:25 |
| right on 622 | 15:47 |
| Turning around on 622 | 15:51 |
| left on 236 | 15:52 |
| left on Woodsprite Road | 15:55 |
| turning right on 236. | 15:55 |
| Right on 622 | 15:58 |
| right on 183 | 16:17 |
| Cuero | 16:40 |
| Leaving Cuero | 16:47 |
| Gonzales | 17:12 |
| Stopping to refuel generators. | 17:16 |
| leaving the gas station. | 17:26 |
| leaving Gonzales | 17:28 |
| Luling | 17:40 |
| leaving Luling | 17:48 |
| Leaving pit stop | 18:46 |
| entering PRC and downloading data. | 19:31 |

| Trip 6, June 2, 2014 Log Notes | CDT |
|---|---|
| Leaving CEER | 8:32 |
| Turning right on Burnet | 8:33 |
| South on 183 | 8:38 |
| Entering Lockhart | 9:43 |
| Leaving Lockhart | 9:50 |
| Entering Luling | 10:00 |
| Leaving Luling | 10:06 |
| Gonzales | 10:18 |
| Stopping to get gas miles 6014 Downloading data | 10:20 |
| Leaving Gonzales. | 10:37 |
| Entering Cuero | 11:02 |
| Left on 236 | 11:08 |
| Leaving Cuero | 11:11 |
| Right on 622 | 11:30 |
| left on 183 | 11:50 |
| Entering Goliad | 11:53 |
| right on 59 | 11:54 |
| Right on 1351 | 12:00 |
| right on 883 | 12:19 |
| left on 623 | 12:30 |
| entering Pettus stopping to download. | 12:32 |
| left on 632 | 12:50 |
| mineral | 13:01 |
| Stopping to collect canister sample | 13:02 |
| continuing on 632 | 13:07 |
| left on 1358 | 13:16 |
| right on 37 north | 13:26 |
| a few trucks today giving us NOx on 37 today. | 13:33 |
| right onto 97 | 14:02 |
| left on 1784 | 14:05 |
| right on 536 | 14:14 |
| entering Floresville | 14:35 |
| Right on business 181 | 14:37 |
| Downloading data and stopping at c1038 | 14:39 |
| right on 97 | 15:18 |
| finished refueling heading back to cams 1038 | 15:28 |
| turned right on 97 | 15:37 |
| turned right on 181 | 15:37 |
| left on 537 | 15:39 |
| left on 123 | 15:55 |

| | |
|---|---|
| right onto 97 | 15:57 |
| right onto 538. took can sample | 15:59 |
| continuing on 538 | 16:03 |
| Turning around on 538 | 16:03 |
| right on 97 | 16:04 |
| Nixon | 16:13 |
| leaving Nixon | 16:16 |
| turning around on 87 | 16:17 |
| left on Artesia | 16:21 |
| Taking a canister sample 2nd Ave. and Artesia | 16:22 |
| turned around on Artesia and right on 87 | 16:26 |
| Smiley | 16:33 |
| Whole lot of trucks down this road. | 16:38 |
| I think we are seeing truck Nox. | 16:42 |
| left on 72 | 16:54 |
| Cuero | 16:59 |
| left on to 183 north | 17:00 |
| leaving Cuero | 17:06 |
| Downloading data. | 17:11 |
| Stopping for road construction. | 17:13 |
| Moving again. | 17:15 |
| Stopping at Gonzales to refuel generators | 17:38 |
| 183 north again. | 17:46 |
| Entering Luling | 17:59 |
| leaving Luling | 18:06 |
| Lockhart | 18:18 |
| leaving Lockhart | 18:22 |
| Taking Burnet exit | 19:02 |
| north on Burnet | 19:03 |
| turning into PRC | 19:05 |

| Trip 7, June 3, 2014 Log Notes | CDT |
|---|---|
| Leaving CEER | 8:04 |
| South on Burnet | 8:06 |
| South on 183 | 8:09 |
| entering Lockhart | 8:55 |
| Leaving Lockhart | 9:03 |
| Entering Luling | 9:11 |
| Leaving Luling | 9:21 |
| Entering Gonzales. | 9:35 |
| Stopping at a gas station. | 9:36 |
| 6464miles Downloading data | 9:38 |
| Leaving gas station | 9:52 |
| leaving Gonzalez | 9:55 |
| turning around on 183 | 10:10 |
| turned around and took a canister sample. Heading south on 183 again. | 10:29 |
| Stopping for road construction. | 10:31 |
| The highest readings of this study to date for methane and hydrocarbons. 5.7ppm Methane and 21ppm HC at the site where we took a can sample. | |
| Moving again. | 10:34 |
| Entering Cuero | 10:46 |
| Turning left onto 236 | 10:52 |
| Stopping to take a can sample. | 11:12 |
| moving again | 11:17 |
| right on 622 | 11:20 |
| left onto 183 | 11:39 |
| Entering Goliad | 11:42 |
| Stopping to refuel generators and download data | 11:44 |
| right onto 59 | 11:59 |
| Leaving Goliad | 12:01 |
| Right onto 1351 | 12:05 |
| Right on 883 | 12:25 |
| left on 623 | 12:36 |
| Entering Pettus | 12:38 |
| Leaving Pettus | 12:40 |
| left on 1358 | 13:00 |
| right on 37 | 13:09 |
| getting some NOx from a truck | 13:37 |
| Still reading truck NOx | 13:44 |
| right onto 97 East | 13:46 |
| left on 1784 | 13:49 |

| | |
|---|---|
| right on 536 | 13:57 |
| entering Floresville | 14:17 |
| right on 181 business | 14:18 |
| left on 97 | 14:20 |
| Stopping to get gas. | 14:24 |
| 6681 miles | 14:25 |
| left on 181 south | 14:42 |
| left on 537 | 14:45 |
| left on 123 | 14:59 |
| right on 97 | 15:01 |
| Nixon | 15:12 |
| left on 80 north | 15:13 |
| leaving Nixon | 15:15 |
| right on 97 | 15:19 |
| fished taking a canister sample | 15:24 |
| Some trucks on this road. | 15:29 |
| cost | 15:41 |
| entering Gonzales | 15:46 |
| left on 183 north | 15:47 |
| Leaving Gonzales | 15:53 |
| entering Luling | 16:05 |
| leaving Luling | 16:15 |
| Entering Lockhart | 16:23 |
| Leaving Lockhart | 16:32 |
| arriving at CEER | 17:40 |

| Trip 8, June 5, 2014 Log Notes | CDT |
|---|---|
| leaving CEER | 8:08 |
| South on Burnet | 8:10 |
| South on 183 | 8:14 |
| Entering Lockhart | 9:04 |
| Leaving Lockhart | 9:11 |
| Entering Luling | 9:20 |
| Leaving Luling | 9:28 |
| Entering Gonzales | 9:41 |
| stopping to get gasoline and downloading data | 9:42 |
| Mileage 6877 | 9:43 |
| leaving gas station | 10:26 |
| Leaving Gonzales | 10:29 |
| Entering Cuero | 10:58 |
| Stopping for a break. | 11:05 |
| south on 183 | 11:14 |
| left on 236 | 11:15 |
| Right on 622 | 11:38 |
| south on 183. Downloading data. | 11:57 |
| Turning around on 183 | 12:00 |
| Turning around on 183 | 12:01 |
| entering Goliad | 12:02 |
| Stopping to refuel generators. | 12:04 |
| right onto 59 | 12:18 |
| right on 1351 | 12:26 |
| right on 883 | 12:46 |
| Stopping to take a canister sample. | 12:55 |
| continuing on west 883 | 12:58 |
| left on 623 | 13:01 |
| Entering Pettus | 13:02 |
| leaving Pettus | 13:05 |
| left on 1358 | 13:25 |
| right onto 37 | 13:35 |
| NOx from several trucks on this road. | 13:49 |
| Downloading data | 14:11 |
| right onto 97 | 14:12 |
| following a truck on this road. | 14:14 |
| left on 1784 | 14:16 |
| right on 536 | 14:25 |
| right on 181 business | 14:49 |
| left on 97 | 14:52 |

| | |
|---|---|
| 7090 Stopping for gasoline | 14:53 |
| left on 181 | 15:03 |
| left on 537 | 15:05 |
| left onto 123 | 15:20 |
| right onto 97 | 15:21 |
| Taking a can sample at CR 485 and HW 97 | 15:29 |
| continuing on 97 | 15:33 |
| Nixon | 15:36 |
| Turned around on 97 | |
| left onto Artesia road. | 15:43 |
| Turning around on Artesia. | 15:44 |
| left on 2nd avenue. | 15:45 |
| left on Lowery then back on 2nd avenue. | 15:46 |
| right on Roosevelt | 15:47 |
| left on 97 | 15:47 |
| right on 80 north | 15:49 |
| leaving Nixon | 15:51 |
| right on 97. | 15:54 |
| Bebe, TX | 16:03 |
| Cost, TX | 16:11 |
| Entering Gonzales | 16:17 |
| left onto 183 north | 16:18 |
| Stopping to take break and download data | 16:22 |
| right onto 183 north | 16:32 |
| Luling | 16:49 |
| Lockhart | 17:05 |
| Leaving Lockhart | 17:10 |
| Donloading data | 17:41 |
| Burnet rd. | 18:05 |
| Turning into PRC | 18:06 |

| Trip 9, June 6, 2014 Log Notes | CDT |
|---|---|
| leaving CEER | 8:10 |
| South on Burnet | 8:11 |
| south on 163 | 8:16 |
| Lockhart | 8:58 |
| leaving Lockhart | 9:03 |
| burning brush on left side of road about 200 yards. | 9:09 |
| Entering Luling | 9:12 |
| Entering Gonzales | 9:32 |
| stopping for gas and downloading data | 9:34 |
| left gas station about a min ago. | 9:53 |
| Leaving Gonzales. | 9:55 |
| Entering Cuero. We had a truck in front of us for a while. | 10:19 |
| left on 236 | 10:26 |
| right on 622 | 10:48 |
| left on 183 south | 11:07 |
| Downloading Data | 11:09 |
| Entering Goliad | 11:11 |
| Stopping for a break and to refuel generators. | 11:12 |
| right on 59 | 11:27 |
| right on 1351 | 11:33 |
| Right on 883 | 11:53 |
| left onto 623 | 12:04 |
| Entering Pettus | 12:06 |
| Leaving Pettus | 12:08 |
| Mineral | 12:18 |
| left on 1358 | 12:28 |
| Stopping to take a can sample | 12:32 |
| continuing on 1358 | 12:41 |
| right on 37 | 12:47 |
| right on 97 | 13:24 |
| left on 1784 | 13:27 |
| right on 536 | 13:35 |
| entering Floresville | 13:56 |
| right on 181 business | 13:57 |
| left on 97 | 14:00 |
| 7501 miles and downloading data | 14:02 |
| left on 181 | 14:16 |
| left on 537 | 14:19 |
| left on 123 | 14:34 |
| right on 97 | 14:36 |

| | |
|---|---|
| Nixon | 14:46 |
| left on 80 | 14:49 |
| right on 97 | 14:54 |
| cost | 15:10 |
| just finished taking a can sample. Continuing on 97. | 15:23 |
| Gonzales | 15:24 |
| leaving gas station north on 183 | 15:37 |
| Entering Luling | 15:50 |
| leaving Lockhart | 16:22 |
| north on Burnet | 17:12 |
| turned into PRC | 17:14 |
| Arriving at CEER | 17:15 |

| Trip 10, June 9, 2014 Log Notes | CDT |
|---|---|
| South on Burnet | 8:23 |
| 183 South | 8:26 |
| Entering Lockhart | 9:06 |
| Leaving Lockhart | 9:12 |
| Entering Luling | 9:21 |
| leaving Luling | 9:28 |
| Entering Gonzales | 9:42 |
| Stopping for gas 7697miles | 9:44 |
| south on 183 | 9:58 |
| Leaving Gonzales | 10:01 |
| Stopping for road construction. | 10:19 |
| Entering Cuero | 10:29 |
| left on 236 | 10:35 |
| Leaving Cuero | 10:37 |
| Stopping for road construction. | 10:43 |
| moving again | 10:46 |
| Right on 622 | 11:01 |
| left on 183 south | 11:20 |
| Entering Goliad | 11:24 |
| stopping for a break | 11:25 |
| right on 59 | 11:35 |
| right on 1351 | 11:41 |
| right on 883 | 11:59 |
| left on 623 | 12:09 |
| Entering Pettus | 12:11 |
| Stopping to take a can sample. | 12:15 |
| moving again on 623 | 12:19 |
| left on 1358 | 12:37 |
| right on 37 | 12:46 |
| right on 97 | 13:22 |
| left on 1784 | 13:26 |
| right on 536 | 13:35 |
| Stopping to take a can sample. | 13:56 |
| Decided to not take a can. Continuing on to Floresville. | 13:59 |
| Entering Floresville | 13:59 |
| Right onto 181 business. | 14:00 |
| left on 97 | 14:03 |
| Stopping for gas 7909miles | 14:05 |
| south on 181 | 14:20 |

| | |
|---|---|
| left on 537 | 14:22 |
| left on 123 | 14:38 |
| right on 97 | 14:40 |
| Entering Nixon | 14:50 |
| right on Mesquite | 14:52 |
| right on 3rd | 14:52 |
| left on Rancho | 14:53 |
| turning around on Rancho. | 14:53 |
| right on 3rd avenue. | 14:56 |
| left on Roosevelt | 15:00 |
| right on 87 | 15:01 |
| left on parker | 15:01 |
| right on 2nd | 15:01 |
| turning around on 2nd | 15:04 |
| left on Artesia | 15:06 |
| right on 87 | 15:07 |
| right on 97 lots of trucks here | 15:09 |
| Leaving Nixon | 15:10 |
| Following 97 | 15:13 |
| Just finished taking a can sample. | 15:29 |
| Cost | 15:34 |
| entering Gonzales | 15:39 |
| left on 183 north | 15:40 |
| Stopping to refuel generators. | 15:43 |
| north on 183 | 15:52 |
| leaving Gonzales | 15:54 |
| middle of Luling | 16:09 |
| leaving Luling | 16:13 |
| Entering Lockhart | 16:22 |
| Leaving Lockhart | 16:29 |
| reached CEER | 17:18 |

| Trip 11, June 11, 2014 Log Notes | CDT |
|---|---|
| Leaving CEER | 8:26 |
| South on Burnet | 8:29 |
| south on 183 | 8:33 |
| Stopping to check on instruments | 8:43 |
| south on 183 | 8:55 |
| Following 2 trucks. NOx on this road is from them. | 9:22 |
| Entering Lockhart | 9:24 |
| leaving Lockhart | 9:30 |
| Entering Luling | 9:39 |
| leaving Luling | 9:48 |
| entering Gonzales | 9:59 |
| Stopping for gas | 10:01 |
| leaving gas station | 10:17 |
| Leaving Gonzales | 10:21 |
| Stopping for road construction | 10:35 |
| moving again | 10:42 |
| Entering Cuero. Stopping at CAMS site. | 10:54 |
| continuing on 183 south | 11:05 |
| left on 236 | 11:11 |
| Leaving Cuero | 11:13 |
| Right on 622 | 11:33 |
| south on 183 | 11:52 |
| entering Goliad | 11:56 |
| stopping for a break downloading data at a gas station. | 11:57 |
| leaving gas station. right on 59 | 12:18 |
| right on 1351 | 12:25 |
| Stopping to take a can sample. | 12:32 |
| continuing on 1351 | 12:35 |
| right on 883 | 12:48 |
| left on 623 | 12:59 |
| entering Pettus | 13:01 |
| following a truck just after Pettus. | 13:04 |
| mineral | 13:13 |
| left on 1358 | 13:24 |
| right on 37 | 13:34 |
| Trucks on this road again. | 13:54 |
| right on 97 | 14:11 |
| left on 1784 | 14:14 |
| Entering Floresville | 14:42 |
| right on 181 business | 14:43 |

| | |
|---|---|
| left on 97 | 14:46 |
| at CAMS 1038 | 14:47 |
| right on 97 | 15:28 |
| 8320 miles. Stopping for gas. | 15:29 |
| south on 181 | 15:41 |
| left on 537 | 15:43 |
| generator stopped running. Got out and restarted it. | 15:45 |
| left on 123 | 16:00 |
| Nixon | 16:13 |
| left on 87 | 16:15 |
| Leaving Nixon | 16:17 |
| right on 97 | 16:19 |
| Cost | 16:36 |
| Entering Gonzales | 16:41 |
| Stopping for a break and refuel generators. | 16:46 |
| north on 183 | 16:55 |
| leaving Gonzales | 16:57 |
| Entering Luling | 17:10 |
| Leaving Luling | 17:19 |
| Entering Lockhart | 17:28 |
| Leaving Lockhart | 17:37 |
| turned into PRC | 18:27 |
| Reached CEER | 18:28 |

| Trip 12, June 12, 2014 Log Notes | CDT |
|---|---|
| Leaving CEER | 8:20 |
| South on Burnet | 8:21 |
| South on 183 | 8:25 |
| Entering Lockhart | 9:04 |
| Leaving Lockhart | 9:11 |
| Entering Luling | 9:20 |
| leaving Luling | 9:29 |
| Entering Gonzales | 9:41 |
| stopping at a gas station. | 9:42 |
| South on 183 | 9:57 |
| leaving Gonzales | 10:01 |
| Got a high TNMOC from fresh oil being applied to the road. It smelled like diesle. | 10:22 |
| Entering Cuero | 10:26 |
| Stopping at the Cuero CAMS site for instrument comparison. | 10:28 |
| Leaving Cuero site | 11:34 |
| South on 183 | 11:35 |
| left on 236 | 11:40 |
| Leaving Cuero | 11:42 |
| right on 622 | 12:03 |
| left on 183 | 12:22 |
| Entering Goliad | 12:25 |
| Stopping to refill generators. | 12:27 |
| Right on 59 | 12:43 |
| Leaving Goliad | 12:45 |
| right on 1351 | 12:50 |
| Stopping to take a can sample. | 13:11 |
| west 883 | 13:16 |
| Entering Pettus | 13:32 |
| leaving Pettus | 13:34 |
| Stopping to check equipment | 13:45 |
| moving again | 13:47 |
| left on 1358 | 13:57 |
| Right on 37 | 14:07 |
| right on 97 | 14:44 |
| left on 1784 | 14:47 |
| Stopping for an equipment check | 14:48 |
| continuing on 1784 | 14:54 |
| right on 536 | 15:04 |
| Entering Floresville | 15:24 |
| right on 181 business | 15:27 |

| | |
|---|---|
| left on 97 | 15:29 |
| 8728 miles Stopping for gas. | 15:31 |
| left on 181 south | 15:42 |
| leaving Floresville | 15:43 |
| left on 537 | 15:44 |
| Stopping to take a can sample. | 15:59 |
| Continuing on 537 | 16:03 |
| left on to 123 | 16:04 |
| right on 97 | 16:06 |
| Pandora | 16:13 |
| Entering Nixon | 16:18 |
| left onto 87 | 16:19 |
| leaving Nixon | 16:20 |
| Right on to 97 | 16:24 |
| entering Gonzales | 16:46 |
| Stopping to refuel generators | 16:51 |
| north on 183 | 16:59 |
| Entering Luling | 17:12 |
| Leaving Luling | 17:21 |
| Entering Lockhart | 17:30 |
| leaving Lockhart | 17:41 |
| north on Burnet | 18:29 |
| Turned into PRC | 18:30 |
| Reached CEER | 18:31 |