Airborne Pollution Monitoring Services

Year 2000 Project Summary

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Acronyms and Abbreviations

		Used for
AWOS	Automated Weather Observation Service	Aviation forecasting
BKN	Broken	Cloud cover
CDT	Central Daylight Time	
FAA	Federal Aviation Administration	
fpm	feet per minute	
HSI	Horizontal Situation Indicator	
IFR	Instrument Flight Rules	See footnote page
IMC	Instrument Meteorological Conditions	9 for explanation
in hg	inches of mercury	
kts	knots	
MSL	Mean Sea Level	
ppb	parts per billion	
ppm	parts per million	
QAPP	Quality Assurance Project Plan	
SKT	Scattered	Cloud cover
SOW	Statement of Work	
TexAQS2000		
TSTC	Texas State Technical College	Airport base in Waco
ì g/m^3	micrograms per cubic meter	
VOC	Volatile Organic Compounds	

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- Texas Natural Resource Conservation Commission
- Sonoma Technology, Inc.

Project Summary

1. Introduction

This report is submitted to the Texas Natural Resource Conservation Commission (TNRCC) in conjunction with the electronically delivered processed data in accordance with the contract currently in force between Baylor University and the Central States Air Resource Agencies ("CenSARA").

This work is a continuation of previous contracts between Baylor University and CenSARA. The data and information provided in the previous years about air pollution levels in Texas is extended by this work. However, the 2000 measuring season concentrated on the intensive air quality study for Houston, the TexAQS 2000. Other flights undertaken during the 2000 measuring season included a mission to Corpus Christi and two three day studies of CO levels in the El Paso region.

Changes made to the 1999 contract for 2000 include additional measuring capability, in particular the addition of a CO instrument and a photolytic NO_2 measuring device. Other equipment in the aircraft was essentially unchanged (apart from minor improvements) from 1999 and has been described in previous reports[1, 2]. Thus only a brief description of the new equipment is provided in this report.

The scientific data for the year 2000 has been delivered to TNRCC in electronic format. The aircraft flew 48 flights on 32 days totaling 139.7 hours. The data sent includes flight synopses, tabulated raw data, ENG files of validated data, time series plots and vertical profiles of various pollutants, and surfer track plots appropriately color coded to show pollution levels along the track. Consequently, with the exception of the flight synopses, which describe the essence of what was undertaken during each flight, this information is not repeated in this report.

The analysis and interpretation of selected data collected and processed by Baylor University was performed by Sonoma Technology, Inc. (STI) and further amplification of the material presented in this report is included in their final report[3]. The major conclusions from the Sonoma report are summarized below.

2. Conclusions

Some twenty flights were identified as being of special interest and analyzed exhaustively utilizing additional data from other sources. This work was undertaken by STI and reported separately by MacDonald et. al. Their conclusions are presented here in part. The flights chosen by Sonoma for analysis were those likely to yield constructive and comprehensive conclusions. More basic conclusions are drawn for the flights outside that analysis.

Table 1 on pages 21 and 22 lists all flights and those in bold were chosen for the intensive Sonoma analysis.

Conclusions based on the special interest flights analyzed by STI are:

(a) The aircraft air quality data evaluated are useful for understanding the three dimensional distribution of pollutants in the Houston – Galveston Bay area and, if properly used, will contribute to better modeling of the pollution picture in this and other regions.

(b) The high peak surface ozone levels observed in the Houston – Galveston Bay area are primarily locally produced.

(c) Twenty four hour back trajectories indicated the aloft ozone levels originated over the gulf of Mexico on five of the seven days with available data. Of the other two days, one originated near Corpus Christi and the other over Houston itself.

(d) Aloft (above 2000 ft MSL) morning NO_y concentrations ranged from 0 to 5 ppb.

(e) Aloft morning NO and SO_2 concentrations were negligible.

(f) On days when a full land/sea breeze circulation developed (4 of 11 days), peak surface and aloft ozone concentrations were highest, and on these days, the peak concentrations would typically occur near the ship channel or in Central Houston later in the day.

(g) When a sea breeze prevailed for the entire day (3 of 11 days), peak concentrations occurred north of Baytown or north of Houston.

(h) With a westerly flow (2 of 11 days) the peak ozone concentration occurred near Baytown.

(i) On one day of the 11 analyzed there was a northerly flow the entire day, and peak concentrations occurred on the Gulf coast near Lake Jackson.

(j) On the one day of southeasterly/easterly flow, ozone peaks were lowest at 100ppb at the surface and 110 ppb aloft, and these occurred near Central Houston and north of Houston.

Inspection of the **morning data** showed:

(k) Aloft ozone concentrations ranging from 30 to 70 ppb were typical in the layer between 2000 and 5000 ft MSL and NO_y levels in this layer were typically 3 ppb with NO and SO_2 zero.

(l) Below 1000 ft MSL O_3 concentrations ranged from 0 to 30 ppb due to gas phase titration.

(m) Below 2000 ft MSL, two or three layers were often observed with one or two temperature inversions. Each layer had its own pollution levels with generally low O_3 concentrations, but sometimes very high NO_y and NO levels.

The **afternoon data** showed:

(n) Peak aloft ozone values generally occurred near the Ship Channel near Baytown or in Central Houston.

(o) Peak aloft ozone concentrations ranged from 100ppb on September 4 to 205 ppb on August 25, and generally the peak aloft ozone measurements were similar to the peak surface ozone concentrations.

(p) NO_x sources which also emitted SO_2 contributed to the peak ozone levels as indicated by the fact that, on all days analyzed, high SO_2 levels (5 to 20 ppb) coincided with the peak ozone concentrations and were collocated with NO_y concentrations of 5 to 25 ppb.

The **vertical structure** observed during the afternoon as evidenced by the box climbs over Galveston Bay typically showed a stratification of pollutants as described below, despite no temperature inversions being noted.

(q) Layer 1 250 to 1100 ft MSL, O_3 concentrations of 70 to 80 ppb with NO_y around 7 ppb, NO of about 1 to 2 ppb and SO_2 between 1 and 2 ppb.

(r) Layer 2 around 1200 ft MSL, titration lowered ozone levels slightly with an increase of NO_y, while NO increased to about 2 ppb. SO_2 was essentially zero in this layer. The titrated ozone suggests this layer was relatively fresh.

(s) Layer 3 from 1500 to 2000 ft MSL, provided a layer with high SO_2 levels, (~ 15 ppb) and NO_y of 5 to 10 ppb, but with no NO. Ozone peaked in this layer at 115 ppb suggesting the layer was old enough to produce ozone.

(t) Layer 4 from 2800 to 3200 ft MSL which did not contain SO_2, but with NO concentrations of up to 12 ppb and NO_y up to 40 ppb. The NO titrated the ozone down to about 40 ppb in this layer.

The **highest ozone** levels:

(u) Were noted downwind of the ship channel area, but the peak values occurred when the emissions from central Houston combined with the ship channel contribution.

(v) The peak ozone values generally were associated with SO_2 levels above 5 ppb, indicating some of this ozone was associated with point source NO_x emissions that also emitted SO_2. Other correlations indicated that both point and mobile sources contributed to the ozone levels.

(w) Evidence of photochemical production of ozone was noted on all afternoon flights and some morning flights. Production rates ranged from 3 to 10 ppb of ozone per ppb of NO_y. All flights except one showed evidence of fresh emissions

Wind data comparisons.

(x) Comparison of the wind data from the Twin Otter and a validated radar profiler stationed at Ellington field showed a poor comparison between the two, suggesting additional improvements to the Wind system on the Twin Otter are required.

Other Conclusions and Observations.

On the comparison exercises with reference gases being fed to the instrumentation, the Twin Otter package delivered the following readings (Rozacky[6, 7])

For NO	1% low
For NO_2	7% low
For NO_y	2% high
For CO	9% low
For slow O_3	13% low
For fast O_3	16% low

Ongoing refinement of the data set combined with variation to the calibration procedures now has data for the ozone readings within 5% of the reference value.

The intercomparisons flight between the DOE G1 aircraft and the Twin Otter initially showed a variation of 40% between the ozone measurements in the two aircraft. Again, refinement of the data and new calibrations for both aircraft has this difference at ~ 5%.

Near El Paso during late November/early December flights, Carbon Monoxide levels climbed to elevated levels peaking at 1083 ppb on December 5th 2000 downwind of field fires. However, the ozone levels on all the El Paso flights remained substantially below 60 ppb.

3. Recommendations

The following recommendations are made to maximize the understanding which could be derived from the data collected during the 2000 measuring season, or to improve the aircraft's data collection potential for future measuring programs.

- The Sonoma report suggested that the wind system in the Twin Otter requires further upgrading to provide wind data of the reliability needed, and it is recommended that this suggestion be implemented. However, on occasion the agreement with validated wind speed and direction data was reasonable, as was the agreement with the ground stations when the aircraft flew directly overhead, so a careful validation exercise should first be carried out to determine the extent of the upgrade needed.

- It is recommended that an in depth analysis of all the flights made to the level provided by STI be undertaken to ensure the maximum knowledge is extracted from the data collected.

- Given the strong implications that VOC concentrations have on ozone formation, the data from the analysis of the large number of hydrocarbon canisters taken needs to be integrated into further analysis, both from the point of view of correlating this information with the ozone levels observed, and attempting to pinpoint the major emitters of these materials.

- Further modeling work should be undertaken to refine the three dimensional aspects of the models which can be improved by the provision of aircraft air pollution measurements. In particular the distinct layers of pollutants observed should be incorporated into the models in an attempt to attribute these layers to specific sources, groups of sources or source areas.

- Integration and comparison of the data from all aircraft involved in the TexAQS2000 should be made to provide a more complete understanding of the air quality in the Houston - Galveston Bay area.

- The analytical results from the filter samples taken should also be integrated into further analyses to enable possible correlations with sulfate and other pollutants to be investigated.

4. Methods and Materials

A. Measurement Capability

The Statement of Work (SOW)[4] and Quality Assurance Project Plan (QAPP)[5] outline the items which Baylor was to measure and report on, and these include the following. On a continuous basis, ozone (O_3), sulfur dioxide (SO_2), oxides of nitrogen such as nitric oxide (NO), nitrogen dioxide (NO_2), reactive oxides of nitrogen (NOy and NO_y*), altitude, location, true and apparent wind direction, wind speed, ambient temperature, cabin temperature, dew point and relative humidity, and light scattering are to be measured. On a semi-continuous and/or discrete basis particle sulfate, Teflon™ and quartz filters (used to collect particulate matter <2.5microns) and whole air grab samples in stainless steel containers for volatile organic compounds (VOCs) are also to be measured and/or collected for analysis.

The methodology and data requirements for most of these items has been reported in earlier reports and will not be covered here. New to the measuring capability for 2000 however, is the ability to sample for carbon monoxide (CO) and the addition of a new technology for measuring NO_2 by photolytic means. Because these are new to the aircraft, a short description of each follows. An improvement to the measurement of winds aloft for the year 2000 is also briefly described in section 4B, Aircraft Capability. (See also additional recommendation for further improvement required)

The CO instrument is an improved fast Vacuum Ultra Violet Fluorescence device, model AL 5001, manufactured in Germany by Aero-Laser AG and purchased early in 2000. Its delivery in mid June, however, provided only limited time for installation and trouble shooting, and the initial data from this unit was suspect. Continual improvements made through the year saw this device providing reliable data towards the end of the season.

Fig 1. Aero-Laser Carbon Monoxide Monitor.

Although the AL 5001 weighs only 22 kg (48 lb), it requires two additional gas bottles be carried on the aircraft so the total weight increase associated with this instrument is approximately 100 lb. The instrument requires a supply of a mixture of Argon (Ar) and Carbon Dioxide (CO_2), plus a nitrogen (N_2) supply. These are supplied in gas bottles fixed to the instrument racks. The requirement for carrying a third gas bottle for calibration purposes was circumvented by incorporating a 10 ppm CO standard in with other calibration standards already carried.

The measurement of NO_2 presents difficulties because the reactions between NO, NO_2, ozone and oxygen continue between the time gas is sampled and the time it reaches the measuring cell. Fortunately the nature of the chemistry is well known, as are the kinetics of the reactions involved. An algorithm to account for these ongoing reactions was used to determine the mixing ratios of NO_2 at the sample inlet from the concentration measured.

The residence time the sampled gas spends in various parts of the instrument is important in the calculation algorithm. For the Twin Otter aircraft, these residence times are (i) 2.2 seconds in the inlet tract, (ii) 15.5 seconds in the irradiation chamber, and (iii) 0.41 seconds in the tubing between the irradiation chamber and the measuring cell. The reaction kinetics are also quite temperature dependant, so the temperature in these compartments must also be known.

In essence, the measurement of NO_2 involves sampling a gas which likely contains both NO and NO_2, feeding it to an irradiation chamber where the NO_2 present is converted to NO by UV light then measuring the total NO in this stream by chemiluminescence. This is compared to the concentration of NO measured in the gas which has not undergone the irradiation. The difference between the NO values represents the amount of NO_2 which was converted to NO. The very fast reactions involved in these systems however, continue after the irradiation, and thus the algorithm also takes account of this.

In addition to the new major items, much refinement and refurbishment of the remainder of the instrumentation package also occurred during 2000. The SO_2, NO_y* and dew point systems were returned to the manufacturers for calibration or recalibration and checking under warranty as a measure of preventative maintenance.

An audit of the instrumentation was conducted on May 2 and 3 and the results were sent to TNRCC on May 22, 2000. Following discussion, some changes were made to the calibration procedures and measuring protocols. Additional zeroing of the instruments was initiated during the Houston sampling program by zero air being fed to the instruments at various periods during the flights.

The Buck chilled mirror hygrometer was sent for further repair as a result of the audit process.

The quality control of this project is maintained by adherence to a Quality Assurance Program Plan. A significant rewrite of the QAPP occurred during 1999 to update and upgrade this plan.

Consequently, for the 2000 season, only relatively minor revisions were required from the 1999 version to account for the additional measuring capability (mainly the addition of the CO instrument), and the additional requirements of the TexAQS 2000 study.

B. Aircraft Capability

General details of the de Havilland Twin Otter aircraft were given in the 1999 report[2]. A comparison between the previously used King Air and the Twin Otter was also reported. Consequently, only brief details are provided here. The aircraft in normal operation is a high wing, twin engined, turbine powered airplane which carries about 18 to 20 passengers and has a take off weight of 11,579 lb. To undertake this and previous contracts, the seats have been removed and replaced with approximately 1180 lb of measuring equipment. This was increased by about 100 lb for the year 2000 by the addition of the Carbon Monoxide (CO) measuring equipment, the details of which were provided above.

Quite extensive work was carried out on the Twin Otter aircraft to improve its capability and performance, and to ensure its reliability for the 2000 measuring season, particularly for the TexAQS 2000 study. Some items were safety related and others were mandated by Federal regulations. Minor improvements were also carried out to enhance the working conditions for the crew and the esthetics of the aircraft.

Fig 2
Twin Otter at dawn in El Paso

The Aircraft can carry a useful load of 3277 lb for crew, fuel and equipment, and with full fuel has an endurance of 3.5 hours at a speed of 140 knots, thus providing a straight line range of about 490 nautical miles. It has a service ceiling of 25,000 ft but, because it is not pressurized, a mandatory FAA requirement is to provide oxygen for crew members when operating above 14,000 ft.

The dispatch rate for the Twin Otter was 100% for the season in that each time it was required to fly, it was mission ready. This was achieved in part by the preventative maintenance carried out early in the year, and in part by careful scheduling of other maintenance during weather events which were unsuitable for pollution measuring. On one occasion a mission was aborted because of water damage to the computers in the aircraft following a heavy overnight storm in Houston. On this occasion the aircraft was not hangared to enable a media function to be held. Consequently, the aircraft suffered water damage during the storm .

The major items of work on the aircraft are listed below;

- Hot Section Inspections as required by the FAA were carried out in February and March and these revealed damage to the turbine blades. All components were brought back inside the requisite tolerances and the engines should now be serviceable for several years, depending on usage.

- Radios and Navigation equipment were refurbished with particular attention to the antennae where considerable corrosion was detected and corrected. The aircraft was fully IFR[1] capable for the season. Although no missions would be flown in IMC[2] weather, ferry flights to and from the region of concern could require IFR flying, so this capability was needed to ensure full flight readiness.

- The aircraft was stripped and repainted for the 2000 season. Little corrosion was found, and apart from the improvement in appearance, the overall weight of the aircraft was probably reduced with multiple layers of paint being stripped off and replaced by a single coat on top of a priming coat.

- The other item of major significance installed in the aircraft was a slaved compass system which was primarily done to improve the recording capability for wind speed and direction, but which also had the side benefit of providing improved tracking ability for the pilots with the provision of an HSI (Horizontal Situation Indicator). This installation essentially duplicated the wind measuring instrumentation that was in the King Air.

Other work carried out on the Twin Otter included mandatory checks as well as a wing strut inspection, general flight instrument panel refurbishment and improved communication between the technician and the pilots.

As required by the insurance requirements, an annual refresher course for the pilots of the Twin Otter was conducted.

[1] IFR or Instrument Flight Rules refers to the regulations which pertain when flying is undertaken in IMC weather. When flying IFR, the aircraft is manipulated solely by reference to the flight instruments as opposed to VFR or Visual Flight Rules where the aircraft is manipulated by reference to the ground for navigation and flight purposes with some cross reference to the flight instrumentation. IFR flight affords a higher level of safety as greater coordination with Air Traffic Control is required.

[2] IMC refers to Instrument Meteorological Conditions where the visibility and other factors require that the aircraft be flown according to the IFR regulations. For the style of work undertaken by the Baylor University aircraft, often IFR flying is conducted in VMC (Visual Meteorological Conditions) for safety.

5. Procedures – Description of missions flown

48 flights were flown on 32 days totaling 139.7 hours of flight time during the 2000 measuring season.

The majority of the missions tasked in 2000 were in support of the TexAQS 2000 study conducted around Houston from August 15th to September 15th. 73.1 hours of flight time were flown on 28 separate missions during this period. Table 1 attached provides an indication of the primary and secondary purposes of each flight and to what extent success was achieved in realizing those purposes listed as either Yes, or No, or Part. In some cases a full analysis of all results will be required to determine the success or otherwise of the mission. For example, with inter-comparison flights between aircraft, validated data from all participants might be required before the total success is known. To a certain extent, the "success" of the mission claimed in Table 1. refers to the actual flight going as planned with all instrumentation collecting data as expected.

In addition, a series of flights to El Paso were tasked to investigate high CO levels near the Mexican / USA border. A shakedown flight to Corpus Christi was also undertaken in mid May to ensure the aircraft and measuring systems were operational for the TexAQS 2000.

In Houston, the major role played by the Twin Otter was to study the early morning pollution levels and to characterize the Bay Breeze to determine the pollution levels on either side of the boundary of the changing airflow caused by diurnal temperature shifts. The following excerpt from the TexAQS 2000 newsletter "The Daily Plan It"[6] published on August 19, 2000 aptly describes the nature of these flights.

"The TNRCC/Baylor Twin Otter departed at 1430 yesterday afternoon to conduct a test run of the bay breeze characterization flight plan. The bay breeze occurs when the synoptic conditions are weak relative to local forcing and typically begins between 1000 and 1400 when the land becomes warmer than the water in Galveston Bay and air starts to flow toward the warmer land. This flow continues until - at least - an hour after nightfall. The 2.5 hour flight included a vertical box climb over Galveston Bay to 10,000 feet to provide vertical profile information about the over-water mixed layer and above. The plane then traversed the coastline, 10 miles inland at 5 mile increments, from a point East of Baytown to Texas City in search of the Land-Bay Breeze convergence boundary. If the flow reversal zone is located, canisters for volatile organic compound (VOC) analysis are taken on either side of the boundary. The flight continued to the West side of Houston over the Bayland Park ground monitoring site and traversed northward to I-10, passing close to the Williams Tower monitoring site. Turning East the plane traversed the Houston I-10 corridor to collect a series of canister samples for VOC analysis at predefined points that represent the urban emissions and ship channel emissions. The plane then proceeded to La Porte airport to conduct a low level pass and return to Ellington Field."

A typical Early Morning Pollution Characterization flight is described by the excerpt below which is taken from the flight synopsis describing a mission flown on August 19, 2000. The flight synopses for all flights for the 2000 season are attached at Appendix A.

***"Flight Description**: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the Northeast was made to fly a low pass over La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. The next box pattern was flown centered at N29 42.75, W94 44.5. Subsequent box patterns were flown centered at N29 34 W94 36 and N29 26 W 94 50. All box patterns were flown exactly as the first except for the last, which was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute and descents were made at 1000 ft. per minute. After completing the last box pattern, The aircraft flew in the plume of three approaching tankers. The flight then proceeded to Smith Point and then to Kemah at 2000 ft. Then the aircraft entered the pattern for Ellington Field and landed. Over Galveston Bay, the traverse legs flown between box patterns were flown at altitudes between 250ft. and 500 ft."*

In addition to flights of the nature described above, the Twin Otter was tasked with investigating the pollution levels in the vicinity of Beaumont on a day when marsh fires were also producing high levels of particulate and other pollutants – to the extent that the aircraft was essentially in IMC and flying IFR.

Fig 3 Marsh fires near Beaumont, September 4, 2000

Fig 4 Stratified layer with high SO_2 and NO_y levels near the shipping channel

Three inter-comparison flights were also flown to allow comparisons to be made between the instrumentation in the various aircraft involved in the TexAQS 2000.

In the course of flying the early morning pollution investigation flights, the Baylor Twin Otter also took the opportunity of examining O_3, NO_x and SO_2 levels in the shipping channel which serves the industrial areas of Houston, including flights directly through the plumes generated by vessels in the channel.

The regional plume studies for 2000 were designed to investigate the contribution of the Houston plume on the City of Corpus Christi, as well as the contribution coming directly from the local area. An extension of this study was to determine then how the combined pollution from Houston and Corpus Christi affects San Antonio. Flights 153, 154 and 155 served this investigation.

In the El Paso region, high levels of CO are of concern, and flights 157 through 162 (the last of the season) were all tasked to study this problem. The terrain and altitude which contribute to retaining the CO in the area represented a challenge for the pilots as low level flight was required to properly measure pollution levels.

Fig 5 A refinery plume north of the Houston shipping channel – August 30, 2000

In order to strive for NARSTO level 2 validation, a much greater level of internal checking was undertaken to ensure the data was internally consistent. This added time to the processing task.

With the exceptions listed below, the data processing closely followed procedures from the 1999 season, although there was more data because of the additional parameters measured with concomitant additions to the graphical presentations.

Where the processing did differ from 1999 was in ensuring the new Carbon Monoxide instrument was providing reliable data before incorporating it into the data files, and in establishing an accurate algorithm for the NO_2 measurements which took considerable time and was very resource intensive.

Four examples of track plots and two time series charts from the TexAQS 2000 study are included as appendix B. The particular missions chosen are representative of the bulk of the work done by Baylor University during this study, and show the SO_2 concentrations and Ozone concentrations around the shipping channel in the vicinity of Texas City and the high concentration of heavy industry found in this region. These plots also show the improvement to the data processing over previous years with more

information shown on each graph. Ten parameters are shown for 2000 compared to six for 1999.

Ground measuring station locations, as well as point sources of the pollutant plotted are now included on the surfer plots. The emission level of each point source can be judged by the area of the circle.

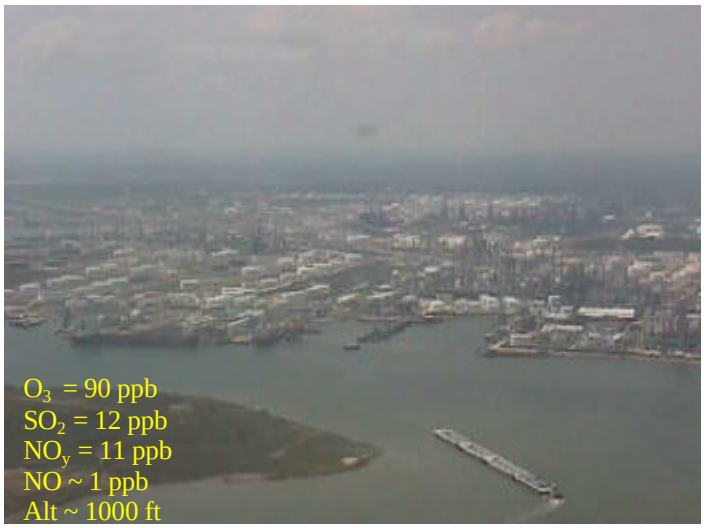

Fig 6 Ships and haze over the shipping channel

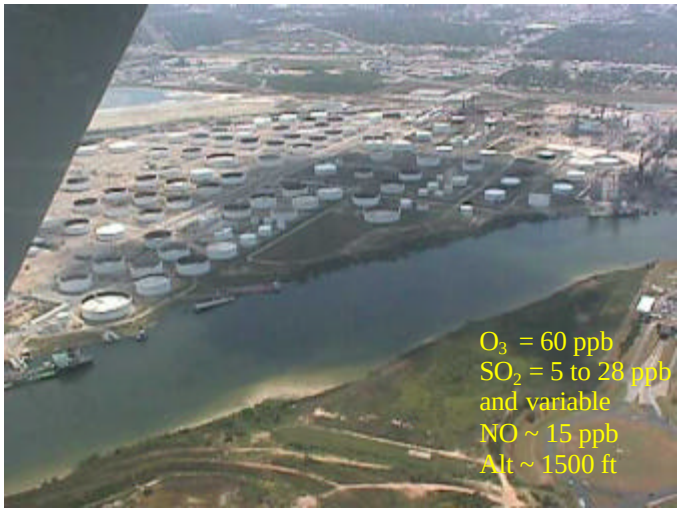

Fig 7 A clear day in the shipping channel

6. Results and Discussion

A number of flights were identified as being of special interest for various reasons. An exhaustive analysis of these flights was undertaken by STI and reported separately. The discussion here draws heavily on that report and thus concentrates on the priority flights. The discussion also draws on information outside of that collected by the Twin Otter aircraft. For example, meteorological data at both surface and upper levels was also considered by Sonoma in reaching their conclusions. For the extent to which additional information was used, the reader is referred to the Sonoma report.

One significant finding from the data analysis was that a stratification of pollutants was often observed. This is not always predicted by the various computer models used for developing emission control strategies. The data produced documents important vertical structure information which would allow the improvement and verification of the 3-D models used to predict photochemical pollutant levels. This is required because the contributions from transported pollutants and the distribution of pollutants within the boundary layer need to be identified (or predicted from models) in order to get a clear understanding of the origins of the various contaminants in the atmosphere.

On most of the days analyzed, an aloft high pressure system was in place over Texas and this limited vertical mixing and provided relatively light wind at sampling altitudes. Very light surface winds were evident when these meteorological conditions prevailed as indicated by the lack of large scale pressure gradients. Locally, peak mixing heights range from 1800 to 3700 m MSL and were on average 2300 m MSL. Ozone levels above the morning boundary layer (at ~ 2000 ft) ranged from 30 to 70 ppb, indicating that the peak surface ozone levels observed in the Houston-Galveston Bay area were mostly locally produced.

Back trajectories (EDAS 24 hours) indicated that the aloft ozone background levels originated over the Gulf of Mexico on five of the seven days of available data, with others originating near Corpus Christi and on one occasion, Houston itself.

Other notable observations of a general nature include the following;

- Aloft morning NO_y concentrations above 2000 ft ranged from 0 to 5 ppb, and were highest on August 30, 2000, when the air originated near Corpus Christi.
- Aloft morning NO and SO_2 concentrations above 2000 ft were about zero ppb
- Land sea breeze circulation occurred in the Houston/Galveston Bay area as expected when high pressure systems aloft combined with weak large scale surface pressure gradients, although this did not always occur. Modeling needs to reflect the observed flows.
- On days where the land/sea breeze did occur generally gave the highest ozone levels noted and the peak concentrations occurred near the ship channel close to Baytown or La Porte, or in central Houston.
- On three of the days there was a sea breeze flow for the entire day, which caused peak ozone concentrations north of Baytown or north of Houston
- Other flight days included a westerly airflow for the day, resulting in highest levels near Baytown, a northerly flow for the entire day resulting in peak concentrations on the Gulf coast near Lake Jackson, and a day of southeasterly/easterly flow which resulted in low peak ozone concentrations (~100 ppb at the surface and 110 ppb aloft) near Central Houston and North of Houston.

Analysis of the flights conducted to characterize the early morning pollution levels as described on page 10 produced the following observations;

- One or two temperature inversions typically provided two or three different layers of pollutants of varying characteristics..
- In the lower layers (say 250 to 1000 ft) ozone levels were typically 0 to 30 ppb (low values due to titration with NO) with collocated NO_y concentrations around 10 to 30 ppb (although sometimes much higher – up to 170 ppb was noted) with NO concentrations typically 0 to 10, but at times as high as 90 ppb. SO_2 levels in these layers ranged from 0 to 15 ppb.
- Between 1000 and 2000 ft, O_3 concentrations were usually around 30 ppb with NO_y at 2 to 30 ppb and NO usually at very low values. SO_2 levels were typically zero, although in some box climbs, values as high as 70 ppb were noted.
- Above 2000 ft and up to 5000 ft, ozone levels ranged from 30 to 70 ppb, and in this layer, NO_y concentrations were typically 3 ppb, but ranged from 0 to 5 ppb, and NO and SO_2 concentrations were essentially zero.

During afternoon flights, the inversion layers had usually collapsed but a lack of vertical mixing still provided a quite stratified air mass (see fig 4, page 12). Generally ozone levels increased dramatically as would be expected from the weather patterns, and peak aloft values ranged from 100 ppb on September 4 to 205 ppb on August 25. These peak O_3 values usually occurred near the Ship Channel near Baytown, or in central Houston.

A typical afternoon flight pattern has been described on page 9 of this report, and additional observations to those above include;

- Normally the peak aloft ozone concentrations were similar to peak surface levels.
- Point source emissions were probably responsible for the peak ozone levels, as shown by the collocated NO_y and SO_2 levels, which both ranged from 5 to 25 ppb.
- Over Galveston Bay where the afternoon box spiral was conducted, a number of layers were identified with pollutant concentrations varying considerably with elevation, and on August 18 for example, the following was measured;
    - From 250 to 1100 ft, O_3 = 70 to 80 ppb, NO_y = ~ 7ppb, NO = 1-2 ppb and SO_2 = 1-2 ppb
    - From 1200 ft, O_3 levels decreased slightly while NO_y and NO increased. SO_2 was not present and this suggests the layer was relatively fresh as indicated by the partial titration of the ozone.
    - Between 1500 and 2000 ft, SO_2 reached 15 ppb and NO_y = 5-10ppb, but no NO was present. O_3 = 115 ppb and these data suggest the layer was old enough to produce ozone, but not old enough for this to be titrated.
    - From 2800 to 3200 ft there was another layer, this time without SO_2, but with NO levels of 12 ppb and NO_y levels of 40 ppb. Ozone levels were only 40 ppb due to gas phase titration with NO.
    - Again, it should be noted that no temperature inversions were detected in these layers.

Peak ozone episodes tended to occur downwind of the ship channel area, especially when air patterns brought the central Houston plume into the region as well. Peak O_3 also usually occurred when SO_2 levels exceeded 5 ppb, indicating that the point sources of NO_x which also emit SO_2 are responsible for at least some ozone. Other correlations indicated that both point and mobile sources contributed to the ozone levels, an aspect

borne out by analysis of observed and expected NO_x emission ratios for all but one flight.

Evidence of photochemical ozone production was observed on all afternoon flights and some morning flights, with production rates ranging from 3 to 10 ppb O_3 per ppb NO_y. All except one of the flights showed evidence of fresh emissions.

One area of the Twin Otter data collection which requires improvement is in the winds aloft measurement which sometimes did not compare well with validated ground based radar wind profiler information. The reader is referred to section 6 of MacDonald et al for further detail.

Several aircraft were involved in the TexAQS2000 study and in some cases these were measuring the same pollutants. Two days were therefore dedicated to comparing the readings from instruments in different aircraft. On one occasion this was done by feeding reference gases to the normal sample acquisition points of the airplanes, with all aircraft on the ground. On the other occasion, the DOE/BNL G-1 and the Baylor Twin Otter were flown through the same airspace at essentially the same time (but with proper separation for safety and allowances for the difference in speed of the two aircraft) with both recording levels for the major pollutants.

Initial results of these intercomparisons have been reported by Rozacky[7, 8]. When fed reference gases, the average results for the Twin Otter showed it under-measured ozone by 13% for the fast ozone and 16% for slow ozone, was 1% low for NO and 7% low for NO_2, 2% high for NO_y but 9% low for the CO measurement. It should be noted that these results are all within specification required under the contract and QAPP, and apart from the ozone, compared favorably with the other aircraft in the data set.

The preliminary data used for the analysis of this intercomparison have been refined and with revised calibration procedures now in use, the ozone data is within 5% of the reference value.

The results for the airborne comparison are harder to reconcile for a variety of reasons, including the difficulty in having each aircraft measuring exactly the same air at the same time. Although “formation flying” is permitted by the FAA under certain conditions, the difference in speed between the two aircraft (about 70 knots) made it impossible to maintain the formation for any length of time. Despite flying on the upwind side, it is also possible that the data reported from the following aircraft was contaminated by the exhaust of the lead aircraft. The initial ozone comparison was around 40% different between the two airplane’s data due to the fact that one instrument was reporting high and the other low. Revisions to the results’ processing with improved calibration factors on both aircraft since the Rozacky analysis have brought the difference to within 5%

Flights 157 (Nov 19 – 21) through 162 (Dec 4 – 6) were undertaken to characterize the CO levels along the Mexican border in the vicinity of El Paso. While the CO levels measured were high on these flights, peaking around 1100 ppb on Dec 5, other levels were relatively low. Ozone was generally < 60ppb for all these flights, despite the potential mechanism for CO to contribute to O_3 formation via OH• radicals, although the low UV levels experienced in the November/December timeframe limited that conversion and was therefore also a factor in the low ozone levels.

The peak CO concentrations detected on each day were approximately as follows ; Nov 19, 800 ppb; Nov 20, 544 ppb; Nov 21, 279 ppb; Dec 4, 1000 ppb, Dec 5, 1083 ppb and Dec 6, 1000 ppb. These peak values were often measured in the vicinity of border crossings where large numbers of idling automobiles were lined up, although the highest value (Dec 5) was recorded downwind of fires burning in fields.

7. Concluding remarks

Baylor University just completed its fifth season of aircraft air sampling for the State of Texas. The TexAQS 2000 study dominated this year's effort. The objective of the Baylor's air quality monitoring operation is to assist the TNRCC in developing a better understanding of air pollution chemistry, its formation and transport in the Texas region.

During the five years of collaboration the Baylor team has more than doubled the information collected during the field operations in a given time period. In addition, more calibration has been required and an extensive QAPP procedure has been implemented.

During the TexAQS 2000 study in Houston, Baylor was able to produce color-coded track plots depicting each flight within a few hours after the aircraft landed. These track plots were valuable for debriefing and planning subsequent flights and analysis.

The air sampling effort initiated in 1996 for the State of Texas and continued through last year is without precedent in its magnitude and intensity. The data produced for the TNRCC over these 5 years, properly exploited, provide unique information that can ultimately assist the development of environmental policy based on sound information.

8. References

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3. MacDonald C., Knoderer C., Roberts P., Buhr M., Analysis of year 2000 air quality data collected by the Baylor University Aircraft. Final Report STI 900930-2096-FR. Prepared for Baylor University, July, 2001.

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5. Monitoring Operations Division, TNRCC. Baylor Aircraft Based Monitoring Support Quality Assurance Project Plan, April 2000.

6. The Daily Plan-it, Issue 5, August 19, 2000. Field Study Newsletter for the TexAQS 2000.

7. Rozacky K., Air to Air Intercomparison of the DOE/BNL G-1 and the TNRCC/Baylor Twin Otter Aircraft Based Measurements, Presentation made at the TexAQS 2000 Data Intercomparison Workshop in Boulder, CO, Feb 6-7, 2001.

8. Rozacky K., Intercomparison of Aircraft Based O_3, NO, NO_2, NO_y and CO Measurements Using Standard Reference Atmospheres, Presentation made at the TexAQS 2000 Data Intercomparison Workshop in Boulder, CO, Feb 6-7, 2001.

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Flight Number	Date	Main Location	Primary Objective (1°)	Other Objectives (2°) OR comments	Objectives Met	
					1°	2°
131	05/10/00	Corpus Christi	Shake down flight to ensure flight readiness			
132	08/08/00	Waco - Houston	Instrument test and aircraft repositioning to Ellington Field, Houston		Yes	
133	08/10/00	Houston	Instrument testing		Yes	
134	08/16/00	Houston	AM Characterization of Early Morning Pollutants	Check flight logistics	Yes	Yes
135	**08/18/00**	**Houston**	**PM Characterization of Bay Breeze**	**Check flight planning**	**Yes**	**Part**
136 a	**08/19/00**	**Houston**	**AM Characterization of Early Morning Pollutants**		**Yes**	
136 b	**08/19/00**	**Houston**	**PM Characterization of Bay Breeze**		**No**	
137 a	**08/21/00**	**Houston**	**AM Characterization of Early Morning Pollutants**		**Yes**	
137 b	**08/21/00**	**Houston**	**PM Characterization of Bay Breeze**	**Modify flight plan**	**Yes**	**Part**
138	08/22/00	Houston	AM Characterization of Early Morning Pollutants		Yes	
139	08/24/00	Houston	Media Flight		Yes	
140	**08/25/00**	**Houston**	**Inter-comparison flight with G1 and Electra**			
141 a	**08/26/00**	**Houston**	**AM Characterization of Early Morning Pollutants**			
141 b	**08/26/00**	**Houston**	**PM Characterization of Bay Breeze – first flight on modified plan**			
142 a	08/28/00	Houston	AM Characterization of mid morning bay breeze onset		Yes	
142 b	08/28/00	Houston	PM Media Relations Flight		Yes	
143 a	**08/29/00**	**Houston**	**AM Characterization of Early Morning Pollutants**		**Yes**	
143 b	**08/29/00**	**Houston**	**PM Characterization of Bay Breeze**		**Yes**	
144 a	**08/30/00**	**Houston**	**AM Characterization of Early Morning Pollutants**		**Yes**	
144 b	**08/30/00**	**Houston**	**PM Characterization of Bay Breeze**		**Yes**	
145 a	**09/01/00**	**Houston**	**AM mid morning characterization of ozone vertical plume**			
145 b	**09/01/00**	**Houston**	**PM afternoon characterization of ozone vertical plume**			
146	**09/03/00**	**Houston**	**Inter-comparison flight and plume characterization**		**Yes**	
147 a	**09/04/00**	**Houston**	**Characterization of Beaumont plume**		**Yes**	
147 b	**09/04/00**	**Houston**	**Characterization of Beaumont plume**		**Yes**	
148	**09/05/00**	**Houston**	**Characterization of afternoon land breeze in urban plume**	**Disrupted by thunderstorms**	**Part due TS**	
149	09/07/00	Houston	Characterization of afternoon land breeze in urban plume	Inter comparison flight with G1	Yes	Yes
---	09/09/00	Houston	Ground comparison with the G1 aircraft		Yes	

Note. Flights shown in bold identified for the Sonoma Analysis

Table 1. Summary of missions undertaken during 2000

Flight Number	Date	Main Location	Primary Objective (1°)	Other Objectives (2°) OR comments	Objectives Met	
					1°	2°
150 a	**09 12/00**	**Houston**	**AM Characterization of Early Morning Pollutants**		**Yes**	
150 b	**09/12/00**	**Houston**	**PM Characterization of Bay Breeze**	**Numerous thunderstorms (TS) late in the flight**	**Yes given TS**	
151	09/14/00	Houston	Point Source sampling	Aborted due to water in aircraft from TS	No	
---	09/14/00	Houston	Instrument checking due to rain water damage during storm		Yes	
152	09//15/00	Houston	Urban plume study – source characterization over Galveston bay		Yes	
153 a	09/28/00	Regional flight	Characterization of regional plume – Waco to Victoria, TX		Yes	
153 b	09/28/00	Regional	Characterization of regional plume – Victoria to Corpus Christi, TX		Yes	
153 c	09/28/00	Corpus Christi	Characterization of regional plume around Corpus Christi		Yes	
154 a	09/29/00	Corpus Christi	Characterization of regional plume around Corpus Christi		Yes	
154 b	09/29/00	Corpus Christi	Characterization of regional plume around Corpus Christi		Yes	
155 a	09/30/00	Regional	Characterization of regional plume - Corpus Christi to San Antonio		Yes	
155 b	09/30/00	Regional	Characterization of regional plume - San Antonio to Waco		Yes	
156 a	10/04/00	Waco/Houston	Study of Parish Power Plant plume		Yes	
156 b	10/04/00	Houston/Waco	Houston urban Plume characterization		Yes	
157	11/19/00	El Paso	Characterization of high CO levels on Border near El Paso	late PM 5:00 to 7:00 pm	Yes	
158 a	11/20/00	El Paso	Characterization of high CO levels on Border near El Paso	early PM 1:00 to 3:00 pm	Yes	
158 b	11/20/00	El Paso	Characterization of high CO levels on Border near El Paso	late PM 5:00 to 7:00 pm	Yes	
159 a	11/21/00	El Paso	Characterization of high CO levels on Border near El Paso	early PM 1:00 to 3:00 pm	Yes	
159 b	11/21/00	El Paso	Characterization of high CO levels on Border near El Paso	late PM 5:00 to 7:00 pm	Yes	
160	12/04/00	El Paso	Characterization of high CO levels on Border near El Paso	late PM 5:00 to 7:00 pm	Yes	
161	12/05/00	El Paso	Characterization of high CO levels on Border near El Paso	late PM 5:00 to 7:00 pm	Yes	
162	12/06/00	El Paso	Characterization of high CO levels on Border near El Paso	late PM 5:00 to 7:00 pm	Yes	

Note. Flights shown in bold identified for the Sonoma Analysis

Table 1. (continued) Summary of missions undertaken during 2000

2000 Project Summary

Appendix A

Flight synopses for flights 131 through 162

NOTE: This flight synopsis was prepared before the standard one page format was adopted. Consequently it is far more detailed than the following synopses.

Flight 131
Wednesday, May 10, 2000

Characterization of Smoke from Central America/ Southeast Mexico Transport to Texas

Baylor University Aircraft (de Havilland Twin Otter DHC-6)

Flight Objective: Vertical profiles of the incoming air mass to determine smoke layer heights, ozone formation potential, and to characterize near shore vs. inland differences, if any.

Weather: South to Southeast winds generally; Skies cloudy with haze

Summary of Findings:

The highest levels of ozone for this flight were found in an entrained layer varying in altitude between 4,500 and 7,000 ft MSL. The entrained layer was discernable from the haze due to good visibility and Green sp (Gsp) values that were near zero. The entrained layer was present in the spirals conducted over Mustang Island from 1422 CST to 1451, the spiral over South Padre Island from 1721 to 1754 CST, the spiral over Mid-Valley Airport located in Weslaco, Texas from 1829 to 1857 CST, the spiral over Colesberg Airport from 1924 to 1950 CST, and the spiral over Interstate 10 from 2141 to 2201 CST.

A plume from an undetermined source was crossed at approximately 8 to 9 miles from Rockdale, Texas from 1237 to 1244 CST. The plume was oriented towards north - north west. Sulfur dioxide levels were found to be approximately 14 ppb and reactive oxides of nitrogen were as much as 7 ppb. Ozone production was found to be 8 ppb above background from 48 up to 56 ppb.

Haze intensified as the aircraft flew towards the coast near Corpus Christi and as the aircraft flew south towards South Padre Island, Texas.

Ozone levels in the Rio Grande Valley area at 2,300 ft MSL were approximately 52 to 59 ppb and Gsp values as much as 213 10^{-6} m^{-1}. However, below the cloud bases at about 1,200 ft MSL, ozone levels decreased to approximately 37 ppb and Gsp values were between 150 to 187 x 10^{-6} m^{-1}.

The aircraft crossed an undetermined point source plume as it descended to land at Corpus Christi International Airport. Reactive oxides of nitrogen peaked at 5 ppb, sulfur dioxide was less than 1 ppb, and Gsp increased from 115 to 144 x 10^{-6} m^{-1}.

Ozone levels en route to Waco, at 3,000 ft MSL, decreased from approximately 65 to 32 ppb. As the aircraft approached Waco, Gsp values also decreased from approximately 170 x 10^{-6} m^{-1} to 71 x 10^{-6} m^{-1}. Just like South Texas, ozone levels decreased to approximately 35 ppb at about 1,500 ft MSL.

An undetermined point source plume was crossed as the aircraft descended into Waco TSTC airport at 1,000 ft MSL. Reactive oxides of nitrogen peaked at 7 ppb, sulfur dioxide peaked at 7 ppb and Gsp peaked to 119 from 80 x 10^{-6} m^{-1}.

In the Central Texas area (Waco spiral), haze was present from the ground up to 5,000 ft MSL. Between San Antonio and Houston (I-10 spiral), the haze was mainly between 2,000 and 6,200 ft MSL. Offshore near Corpus Christi (Mustang Island spiral), hazy conditions existed between 1,500 and 4,800 ft MSL. The haziest layer was found between 3,000 and 4,800 ft MSL. At South Padre Island, the haze was found between 1,500 and 3,600 ft MSL. Similarly, during the spiral conducted over Mid Valley Airport in

Weslaco, Texas the haziest conditions were found between 1,100 to 3,000 ft MSL. Visibility was determined to be less than 1 ¼ mile. As darkness advanced and the aircraft flew north, the haze persisted through Alice, Corpus Christi, and the Interstate 10 area. Better visibility was found in the Central Texas area as the aircraft approached Waco.

S**ummary of Measurements**:

Background ozone in the Waco area varied from 39 ppb to 44 ppb, Green Total Scatter (Gsp) varied from 85 to 87 x 10^{-6} m^{-1}, reactive oxides of nitrogen (NO_y) varied from 3 to 4 ppb and sulfur dioxide (SO_2) levels were between 0 and 2 ppb.

Ozone levels in the Corpus Christi area were approximately 52 ppb at 2,000 ft MSL. Below a broken layer at 1,200 ft MSL, ozone levels were approximately 30 to 33 ppb. Mixing height was determined to be at 1,200 ft MSL due to the base of the clouds.

Spiral conducted near Waco, Texas from 1209 to 1237 CST

- Inversion at approximately 5,500 ft MSL
- Ozone levels increased from 47 ppb to 56 ppb at 1,200 ft MSL and Gsp increased from 10 to 30 x 10^{-6} m^{-1}
- From 7,000 ft MSL to 10,000 ft MSL, ozone levels gradually increased from 54 up to 70 ppb and Gsp decreased from 53 down to 2 x 10^{-6} m^{-1}

A plume from an undetermined source was crossed at approximately 8 to 9 miles from Rockdale, Texas from 1237 to 1244 CST

- Plume oriented towards north-northwest
- Found sulfur dioxide levels to approximately 14 ppb and reactive oxides of nitrogen up to 7 ppb
- Found ozone production of about 8 ppb above background from 48 to 56 ppb

Spiral conducted over Interstate 10 from 1311 to 1338 CST

- Inversion at approximately 6,500 ft MSL
- Ozone levels increased from 56 ppb to 62 ppb and Gsp levels decreased from 25 to 2 x 10^{-6} m^{-1} at approximately 8,000 ft MSL
- Ozone levels at 10,000 ft were approximately 55 ppb and Gsp levels about 1.84 x 10^{-6} m^{-1}

Ozone levels from Interstate 10 spiral to Mustang Island from 1338 to 1445 CST were in the range of 40 to 50 ppb, Gsp varied from 75 to 94 x 10^{-6} m^{-1} and reactive oxides of nitrogen were 0 to 2 ppb. Gsp levels gradually increased as the aircraft approached the coast to a peak of 140 x 10^{-6} m^{-1} at 3,000 ft MSL

Spiral conducted over Mustang Island from 1422 CST to 1451

- Inversion at approximately 6,500 ft MSL
- A second inversion at 7,000 ft MSL
- Ozone levels increased from 44 ppb to 67 and Gsp increased from 78 to 212 x 10^{-6} m^{-1} at 3,000 ft MSL
- Between 3,500 ft MSL and 4,800 ft MSL ozone levels were about 66 to 74 ppb and Gsp levels were between 175 to 212 x 10^{-6} m^{-1}
- At 5,000 ft MSL Gsp decreased from 178 to 44 x 10^{-6} m^{-1} and ozone levels were between 66 and 77 ppb
- Between 5,800 ft MSL and 7,000 ft MSL, ozone gradually increased to 79 ppb and Gsp decreased to as low as 1.5 x 10-6 m-1. Entrained layer visually sited.
- At 10,000 ft MSL ozone was found to be approximately 66 ppb and Gsp 30 x 10^{-6} m^{-1}

Ozone levels from Corpus Christi, Texas to South Padre Island, Texas were between 46 and 54 ppb, reactive oxides of nitrogen were less than 4 ppb, and sulfur dioxide levels were less than 1 ppb. Initially, Gsp values ranged between 108 and 140 x 10-6 m-1 and then increased as the aircraft approached South Padre Island to 216 x 10-6 m-1.

Spiral conducted over South Padre Island from 1721 to 1754 CST

- Ozone levels at 1,500 ft MSL were approximately 46 ppb and Gsp 199 x 10^{-6} m^{-1}
- At 1,700 ft MSL ozone gradually increased to 67 ppb and Gsp rapidly increased from 149 to 239 x 10^{-6} m^{-1}
- At 3,700 ft MSL Gsp decreased rapidly to 43 x 10^{-6} m^{-1} and ozone increased to approximately 70 ppb
- Between 5,000 ft and 6,500 ft MSL, ozone increased to 86 ppb and Gsp values decreased to zero. Sulfur dioxide and reactive oxides of nitrogen were less than approximately 2 ppb. Entrained layer of good visibility was visually sited again.
- Ozone levels between 6,500 ft and 10,000 ft MSL were approximately 68 ppb and Gsp values about 27 x 10^{-6} m^{-1}

Ozone levels in the Rio Grande Valley area at 2300 ft MSL were approximately 52 to 59 ppb and Gsp values as much as 213 10^{-6} m^{-1}, Below the cloud bases at about 1,200 ft MSL, ozone levels decreased rapidly to approximately 37 ppb and Gsp values were between 150 to 187 x 10-6 m-1. Mixing height was about 1,200 ft MSL based on the base of the clouds and the levels of ozone above and below the cloud layer present.

Spiral conducted over Mid-Valley Airport located in Weslaco, Texas from 1829 to 1857 CST

- Between 3,000 and 4,500 ft MSL, ozone levels increased from approximately 48 ppb up to 71 ppb, respectively, and Gsp values began to trend down from about 200 x 10^{-6} m^{-1}
- From 4,500 and 6,200 ft MSL, ozone levels increased to a peak of 86 ppb and Gsp values decreased to near zero. The entrained layer was flown through again
- Ozone levels stabilized to approximately 70 ppb from 6,200 to 10,000 ft MSL and Gsp values were in the range of 26 to 37 x 10^{-6} m^{-1}

Spiral conducted over Colesberg Airport from 1924 to 1950 CST (night)

- Capping inversion at 4,500 ft MSL
- From the ground to 1,600 ft MSL, ozone levels were about 38 ppb and Gsp values about 182 x 10^{-6} m^{-1}
- From 1,600 to 4,500 ft MSL ozone levels steadily increased to approximately 80 ppb and Gsp values decreased to approximately 9 x 10^{-6} m^{-1}
- Between 4,500 to 6,000 ft MSL ozone stabilized in the 70's ppb range and Gsp values were between 3 and 7 x 10-6 m-1. Entrained layer was flown through again.
- Above 6,000 ft MSL ozone gradually decreased to 60 ppb and Gsp was approximately 30 x 10^{-6} m^{-1}

Ozone levels in the Corpus Christi area were approximately 52 ppb at 2,000 ft MSL Below a broken layer at 1,200 ft MSL, ozone levels were approximately 30 to 33 ppb. Mixing height was found to be at 1,200 ft MSL due to the base of the clouds.

Spiral conducted over Interstate 10 from 2141 to 2201 CST (night)

- Inversion at 5,000 feet
- Ozone levels from 3,500 to 4,500 ft MSL were approximately in the range of 67 to 70 ppb and Gsp decreased from 116 to 7 x 10^{-6} m^{-1}, respectively.
- From 4,500 to 6,200 ft MSL entrained layer of ozone was about 80 ppb and Gsp was about 7 10-6 x m-1
- Between 6,200 and 9,000 ft MSL Gsp was approximately 40 x 10^{-6} m^{-1} and ozone was 60 ppb

- At 10,000 ft MSL Ozone was approximately 49 ppb and Gsp values were between 3 and 4 x 10^{-6} m^{-1}

Ozone levels en route at 3,000 ft MSL to Waco decreased from approximately 65 to 32 ppb. as the aircraft approached Waco. Gsp values also decreased from approximately 170 x 10^{-6} m^{-1} to 71 x 10^{-6} m^{-1}. Below 1,500 ft MSL, ozone levels decreased to approximately 35 ppb and Gsp to 91 x 10^{-6} m^{-1}. **An undetermined point source plume was crossed as the aircraft descended into Waco TSTC airport at 1,000 ft MSL. Reactive oxides of nitrogen peaked at 7 ppb, sulfur dioxide peaked at 7 ppb and Gsp peaked to 119 up from 80 x 10-6 m-1.**

Instrument Malfunctions:

- Buck Research hygrometer noisy and slow response
- GPS intermittent on three occasions during flight due to damaged BNC connector
- NO_2 system with high residence time during this flight
- NO_y * lost power momentarily three times during flight

SYNOPSIS AND INTERPRETATION OF FLIGHT #132

Date: 08-08-2000

Pilots: Matt Tilghman, Max Shauck
Instrument Operators: Sergio Alvarez

Take-off from: TSTC, Waco Texas Time: 12:20 CDT
Landing at: Ellington Field, Houston Texas Time: 13:38 CDT

Flight Objective: Instrument test and aircraft relocation to Ellington Field

Meteorological Info: AWOS 1705Z Dew Point 69° F, Wind 070° at 9 kts Gusting to 14 kts, Altimeter 30.04″, Density Altitude 2600 ft

Flight Description: The aircraft departed TSTC Waco on a magnetic heading of 120° and climbed to an altitude of 2,000 ft MSL. A direct track to Ellington Field, took the aircraft down-wind of Gibbons Creek Power Plant and inbound to Houston. In the Houston area, the aircraft was vectored to a heading of 180° and an altitude of 2,500 ft MSL. Additional slight deviations were made for thunderstorms. The aircraft then landed at Ellington Field.

Flight Interpretation: During the flight, winds aloft were 190° at 10 kts and regional O_3 was 28 to 46 ppb. An SO_2 plume of 3 ppb was noted over highway 290.

The objective of the flight was met..

SYNOPSIS AND INTERPRETATION OF FLIGHT #133

Date:	08-10-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, John Young	
Take-off from:	Ellington Field, Houston Texas	Time: 11:28 CDT
Landing at:	Ellington Field	Time: 13:40 CDT
Flight Objective:	Instrument Performance Testing	

Flight Description: The aircraft departed Ellington Field southeast bound while climbing to 2000 ft MSL. Next, a box pattern was flown over Texas City for wind comparison on cardinal headings. The pattern consisted of 2 minute legs at 2000, 3000, 4000, 5000 ft MSL. The pattern was flown between Texas City and Pt. Bolivar. Descended enroute to 2500 ft to a position 4 miles west of the San Jacinto Monument. Canister samples were taken at 2000, 1500 and 1000 ft. Proceeded along I-10 corridor at 2000 ft. A canister sample was taken north of the city. A 20 mile arc from Hobby VOR was initiated at Sugarland Airport, and proceeded south in a counter clockwise direction. This track took the aircraft 5 miles east of the Parish Power Plant. The aircraft continued along the arc until it was due south of Ellington Airport.

163 ppb of O_3 and 80 ppb of SO_2 were measured during hydrocarbon sampling at the San Jacinto Monument. In the vicinity of Parish Power Plant high Ozone levels were encountered.

Flight interpretation: The objective of the flight was to test the equipment in preparation for the Texas Air Quality Study. All the equipment tested performed in a satisfactory manner.

During the flight, winds were light and variable, the high levels of Ozone and Sulfur Dioxide were localized near the Texas City refinery, the Ship Channel, and the Parish Power Plant.

Elevated SO_2 readings were noted in the proximity of refineries. High ozone readings were often observed in the vicinity of power plants and refineries. The nephelometer and ozone readings were poorly correlated in the vicinity of the Parrish power plant.

The objective of the flight was successfully accomplished.

SYNOPSIS AND INTERPRETATION OF FLIGHT #134

Date:	8-16-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 7:20 CDT
Landing at:	Ellington Field	Time: 9:41 CDT
Purpose of Flight:	Characterization of early morning pollutant concentrations and review of flight logistics	
Meteorological Info.:	Winds: Calm; Visibility: 10; Clouds: 2000 Skt.; Temperature 25; Dew Point: 24; Altimeter: 30.19	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the Northeast was made to fly to La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. An excursion was made to the vicinity of Anahuac Lake at low altitudes. The next box pattern was flown centered at N29 42.75, W94 44.5. Subsequent box patterns were flown centered at N29 34 W94 36 and N29 26 W 94 50. All box patterns were flown exactly as the first except for the last, which was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute and descents were made at 1000 ft. per minute. After completing the last box pattern, the flight proceeded to Smith Point and then to Kemah at 2000 ft. Then the aircraft entered the pattern for Ellington Field and landed. Over Galveston Bay, the traverse legs flown between box patterns were flown at altitudes between 90 ft. and 500 ft. MSL.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 30 ppb, were encountered in the vicinity of La Porte Airport and downwind of Texas City. The levels of Ozone encountered below 4000 ft. MSL averaged about 20 ppb. Above 4000 ft. ozone increased to a maximum of about 45 ppb at 10,000 ft. NO was measured at 64 ppb at La Porte. In the vicinity of Baytown airport, Trinity Bay and downwind of Texas City, NO of up to 30 ppb was measured

Significant observations: The elevated levels of pollution occurred in the vicinity of refineries.

Canisters or filter samples location: No canisters or filter samples were taken.

Flight Interpretation

Lessons learned from flight: In this flight, two types of ascents were made, box patterns of 1 minute straight legs and a spiral. Winds were recorded during the box patterns, but no wind information was collected during the spiral ascents because no straight legs were flown.

Suggested modifications to subsequent flights: All vertical profiles should be flown as box patterns with legs of between 45 seconds and 1 minute minimum.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPERTATION OF FLIGHT #135

Date	8-18-00	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Jimmy Flynn, Sergio Alvarez	
Take-off from:	Ellington Field	Time: 3:08
Landing at:	Ellington Field	Time: 5:35
Objective of flight:	Characterization of the Bay breeze	
Met. Data Time: 1504	Scattered clouds at 25,000, 10 miles visibility, winds 180/10, and Barometric Pressure: 30.08	

Flight Description: The aircraft departed from the Ellington airport on a heading of 090 for a point in Galveston Bay where an ascending box pattern was flown on cardinal headings consisting of 1 minute legs from 1500 to 5000 ft. MSL. A descent was then made to 1500 MSL. In order to cross the bay breeze front, the next leg was flown to a position northeast of Galveston Bay. The aircraft then flew a series of traverses from Baytown to Texas City. These traverses were intended to characterize the bay breeze front from about 8 miles inland from Baytown to Texas City. The flight then proceeded to a position west of the city where a canister sample was taken near Williams Tower. The aircraft then flew on an easterly heading north of I-10. A series of four canisters were taken on this leg. A leg was then flown on a westerly heading just south of I-10 to a point just west of the center of the downtown section of Houston. The next traverse was flown eastward to Baytown. During this leg, four more canister samples were taken. On reaching Baytown, the aircraft was flown to La Porte airport where a low pass was made down runway 23. After the low pass, the aircraft returned to Ellington Field.

Location and levels of highest levels of pollution:

The highest level of ozone was measured was 120ppb and SO_2 was measured was 15ppb

Flight Interpretation:

This flight was the first in a series of flights intended to characterize the Galveston Bay breeze front. Some preliminary observations of wind data indicate that it might be possible to identify this front with wind data. Further analysis of wind data and pollutant levels on the bay and land sides of the front will help determine if, in fact, the front can be identified from the wind data.

The planned flight pattern would appear to be well designed to characterize the bay breeze front.

SYNOPSIS AND INTERPRETATION OF FLIGHT #136a

Date:	8-19-2000	
Pilots:	Matt Tilghman, Clint Owen	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 8:07CDT
Landing at:	Ellington Field	Time: 10:29 CDT
Purpose of Flight:	Characterization of early morning pollutant concentrations and review of flight logistics	
Meteorological Info.:	Winds: Calm; Visibility: 6; Clouds: 2000 Skt.; Temperature 29; Dew Point: 24; Altimeter: 30.13	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the Northeast was made to fly a low pass over La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. The next box pattern was flown centered at N29 42.75, W94 44.5. Subsequent box patterns were flown centered at N29 34 W94 36 and N29 26 W 94 50. All box patterns were flown exactly as the first except for the last, which was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute and descents were made at 1000 ft. per minute. After completing the last box pattern, The Aircraft flew in the plume of three approaching tankers. The flight then proceeded to Smith Point and then to Kemah at 2000 ft. Then the aircraft entered the pattern for Ellington Field and landed. Over Galveston Bay, the traverse legs flown between box patterns were flown at altitudes between 250ft. and 500 ft. MSL.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 30 ppb, were encountered in the vicinity of La Porte Airport and downwind of Texas City. The levels of Ozone encountered below 4000 ft. MSL averaged about 20 ppb. Above 4000 ft. Ozone increased to a maximum of about 80 ppb at 4,500 ft. In the vicinity of Baytown airport, Trinity Bay and downwind of Texas City, NO of up to 30 ppb was measured. Elevated levels of NO_x were measured in the shipping channel.

Significant observations: The elevated levels of pollution occurred in the vicinity of refineries.

Canisters or filter samples location: 4 Hydrocarbon cans were taken 1 at La Porte and 3 others spaced between Baytown and S1, S1 and S2, S2 and S3

Flight Interpretation

Lessons learned from flight: In this flight, two types of ascents were made, box patterns of 1 minute straight legs and a spiral. Winds were recorded during the box patterns, Wind information was collected during the box ascents because straight legs were flown.

Suggested modifications to subsequent flights: All vertical profiles should be flown as box patterns with legs of between 45 seconds and 1 minute minimum.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered

SYNOPSIS AND INTERPRETATION OF FLIGHT 136b

Date:	8-19-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, Jimmy Flynn	
Take off from:	Ellington Field, Houston TX	Time: 1:01 CDT
Landing at:	Ellington Field	Time: 3:07 CDT
Objective of flight:	Characterization of Bay breeze flight	
Meteorological Data:	Winds: Calm, Visibility: 6 miles, Temp: 29, Dew point: 24, Barometric Pressure: 31.13	

Flight Description: The aircraft departed from the Ellington airport on a heading of 090 for a point in Galveston Bay where an ascending box pattern was flown on cardinal headings consisting of 1 minute legs from 1500 to 5000 ft. MSL. A descent was then made to 1500 MSL. In order to cross the bay breeze front, the next leg was flown to a position northeast of Galveston Bay. The aircraft then flew a series of traverses from Baytown to Texas City. These traverses were intended to characterize the bay breeze front from about 8 miles inland from Baytown to Texas City. The flight then proceeded to a position west of the city where a canister sample was taken near Williams Tower. The aircraft then flew on an easterly heading north of I-10. A series of four canisters were taken on this leg. A leg was then flown on a westerly heading just south of I-10 to a point just west of the center of the downtown section of Houston. The next traverse was flown eastward to Baytown. During this leg, four more canister samples were taken. On reaching Baytown, the aircraft was flown to La Porte airport where a low pass was made down runway 23. After the low pass, the aircraft returned to Ellington Field.

The high level of ozone was 143 ppb and the highest level of SO2 was 14.13 ppb

Interpretation

The Bay breeze was apparently so diffuse find any that it was very difficult to find

It was decided to start the vertical profile from as close to the surface of Galveston Bay as possible.

SYNOPSIS AND INTERPRETATION OF FLIGHT #137a

Date:	8-21-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 7:23 CDT
Landing at:	Ellington Field	Time: 10:01 CDT
Purpose of Flight:	Characterization of early morning pollutant concentrations.	
Meteorological Info.:	Winds: Calm; Visibility: 7; Clouds: 25000 Skt.; Temperature 25; Dew Point: 24; Altimeter: 30.05	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the northeast was made to fly a low approach was made to La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. The next box pattern was flown centered at N29 42.75, W94 44.5. Subsequent box patterns were flown centered at N29 34 W94 36 and N29 26 W 94 50. All box patterns were flown exactly as the first except for the last, which was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute and descents were made at 1000 ft. per minute. After completing the last box pattern, the flight proceeded to Smith Point and then to Kemah at 1500ft. Then the aircraft entered the pattern for Ellington Field and landed. Over Galveston Bay, the traverse legs flown between box patterns were flown at a altitude of 500 ft. MSL.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 30 ppb, were encountered in the vicinity of Texas City. The levels of Ozone encountered below 4000 ft. MSL averaged about 28 ppb. Above 4000 ft. ozone increased to a maximum of about 65 ppb at 10,000 ft. NO was measured at 64 ppb at La Porte. In the vicinity of Baytown airport, Trinity Bay and downwind of Texas City, NO of up to 30 ppb was measured

Significant observations: The elevated levels of pollution occurred in the vicinity of refineries and Texas City. Elevated levels of SO_2 were noted east of Texas City between 1700 ft and 2100 ft MSL. High levels of ozone were encountered aloft indicating ozone by transport. At lower altitudes, the high NO levels were apparently titrating O_3 to lower values.

Canisters or filter samples location: 4 Hydrocarbon cans were taken, 1 at La Porte and 3 others taken between each box spiral at 500 ft MSL.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPERTATION OF FLIGHT #137b

Date	8-21-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Guelmy Garcia, Sergio Alvarez	
Take-off from:	Ellington Field	Time: 1:06 CDT
Landing at:	Ellington Field	Time: 3:17 CDT
Objective of flight:	Characterization of the Bay breeze. Trial of new flight plan.	
Weather	ATIS: 18:00 Scattered clouds at 25,000, 10 miles visibility, winds 180/10, and Barometric Pressure: 30.08	

Flight Description: The aircraft departed from the Ellington airport on a heading of 090 for a point in Galveston Bay where an ascending box pattern was flown on cardinal headings consisting of 1 minute legs from 1500 to 6000 ft. MSL. A descent was then made to 1500 MSL. In order to cross the bay breeze front, the next leg was flown to a position northeast of Galveston Bay. The aircraft then flew a series of traverses from Baytown to Texas City. These traverses were intended to characterize the bay breeze front from about 8 miles inland from Baytown to Texas City. The flight then proceeded to a position west of the city where a canister sample was taken near Williams Tower. The aircraft then flew on an easterly heading north of I-10. A series of four canisters were taken on this leg. A leg was then flown on a westerly heading just south of I-10 to a point just west of the center of the downtown section of Houston. The next traverse was flown eastward to Baytown. During this leg, four more canister samples were taken. On reaching Baytown, the aircraft was flown to La Porte airport and returned to Ellington Field.

Location and elevations of highest levels of pollutants: The highest level of ozone was measured on I-10 and hwy 45 at 226ppb. The highest level of SO_2 was measured near the ship channel at 23ppb.

Interpretation of flight:

This is the first flight flown with a new modified flight plan designed to better examine the Texas City area and help identify and characterize the bay breeze.

SYNOPSIS AND INTERPRETATION OF FLIGHT #138

Date:	8-22-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 7:11 CDT
Landing at:	Ellington Field	Time: 9:25 CDT
Purpose of Flight:	Characterization of early morning pollutant concentrations.	
Meteorological Info.:	Winds: 050-3; Visibility: 7; Clouds: 2000 Skt.; Temperature 25; Dew Point: 25; Altimeter: 30.11	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where a box pattern was flown at 500ft and 1000ft due to the low overcast and light rain. The next box pattern was flown centered at N29 42.75, W94 44.5. Subsequent box patterns were flown centered at N29 34 W94 36 and N29 26 W 94 50. All box patterns were flown exactly as the first except for the last, which was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute and descents were made at 1000 ft. per minute. After completing the last box pattern, the flight proceeded to Smith Point and then to Kemah at 1500ft. Then the aircraft entered the pattern for Ellington Field and landed. Over Galveston Bay, the traverse legs flown between box patterns were flown at a altitude of 500 ft. MSL.

Location and levels of highest levels of pollutants: The highest levels of SO_4, 14 ìg/m^3, were encountered in the vicinity of Texas City. The levels of Ozone encountered were 60 to 70 ppb east of Texas City.

Significant observations: The elevated levels of pollution occurred in the vicinity of refineries and Texas City.

Canisters or filter samples location: 3 Hydrocarbon cans were taken, 1 between each box spiral at 500 ft MSL.

Spatial correlation of data: Elevated levels of SO_2 and SO_4 were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #139

Date:	8-24-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez	
Take-off from:	Ellington Field, Houston, Texas	Time: 1:10 CDT
Landing at:	Ellington Field	Time: 1:40 CDT
Purpose of Flight:	Media Relations Flight.	
Meteorological Info.	Winds: 180-9; Visibility: 10; Clouds: 3500 Skt.; Temperature 34; Altimeter: 30.05	

Flight Description: The aircraft departed Ellington Field and made a left downwind departure to the northeast proceeding direct Baytown. Then the aircraft turned west on the I-10 corridor toward Downtown, and then reversed coarse and flew down the ship channel to La Porte. Then we entered the pattern for Ellington Field and landed.

SYNOPSIS AND INTERPRETATION OF FLIGHT #140

Date:	8-25-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, Jimmy Flynn	
Take-off from:	Ellington Field, Houston, Texas	Time: 11:50 CDT
Landing at:	Ellington Field	Time: 2:38 CDT
Purpose of Flight:	Inter-comparison of TAQS 2000 Aircraft, Electra and G1	
Meteorological Info.:	Surface winds 160° at 9 knots, Visibility 10 mi, Clouds 3,500 SCT, Temperature 37°C, Dew point 24°C, Altimeter 30.10 in Hg.	

Flight Description: The aircraft departed Ellington Field and climbed to 1,500 feet. It then turned northeast and joined the 120-degree radial at 20 nm DME from the Intercontinental VOR. The aircraft then proceeded to arc north to the 360-degree radial and proceeded to N 30°40' W 95°20'. The aircraft then climbed to 3,000 feet and proceeded to N 31°40' W 95°20'. At this point, a hydrocarbon can was taken at 3,000 feet, and then the aircraft descended to 1,500 feet where a second hydrocarbon can was sampled. Maintaining 1,500 feet, the aircraft returned to N30°40' W 95°20' at which point it joined the 360-degree radial at 20 nm DME and proceeded to arc west to the 234-degree radial. The aircraft then flew east along the I-10 corridor and made a series of transects through the ship channel area before returning to Ellington Field.

Location of highest levels of pollutants: The highest level of SO_2 was 30 ppb, which was encountered in the vicinity of downtown. 238 ppb of O_3 was encountered in the same area.

Significant observations: The elevated levels of pollution occurred in the vicinity of downtown. A significant amount of haze was noted over that area.

Canisters or filter samples location: Seven hydrocarbon cans were taken, two at N 31°40' W 95°20', and one each at points A, C, H, and F. The final can was taken from a "flare plume".

Spatial correlation of data: Elevated levels of SO_2 and O_3 were encountered near downtown.

SYNOPSIS AND INTERPRETATION OF FLIGHT #141a

Date:	8-26-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, Jimmy Flynn	
Take-off from:	Ellington Field, Houston, Texas	Time: 7:18 CDT
Landing at:	Ellington Field	Time: 9:30 CDT
Purpose of Flight:	Characterization of early morning pollutant concentrations.	
Meteorological Info.:	Winds: Calm; Visibility: 7; Clouds: 25000 Skt.; Temperature 25; Dew Point: 24; Altimeter: 30.05	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the Northeast was made to fly a low approach was made to La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. The next box pattern was flown centered at N29 42.75, W94 44.5. Subsequent box patterns were flown centered at N29 34 W94 36 and N29 26 W 94 50. All box patterns were flown exactly as the first except for the last, which was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute and descents were made at 1000 ft. per minute. After completing the last box pattern, the flight proceeded to Smith Point and then to Kemah at 1500ft. Then the aircraft entered the pattern for Ellington Field and landed. Over Galveston Bay, the traverse legs flown between box patterns were flown at a altitude of 500 ft. MSL.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 25 ppb, were encountered in the vicinity of Smith Point. The levels of Ozone encountered below 4000 ft. MSL averaged about 20 ppb to 30ppb . Ozone increased to a maximum of about 57 ppb at 6000 ft. during the box climb east of Texas City.

Significant observations: The elevated levels of pollution occurred in the vicinity of Texas City. Elevated levels of SO_2 were noted east of Texas City between 1500ft MSL.

Canisters or filter samples location: 4 Hydrocarbon cans were taken, 1 at La Porte and 3 others taken between each box spiral at 500 ft MSL.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPERTATION OF FLIGHT #141b

Date	8-26-00	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Jimmy Flynn, Sergio Alvarez	
Take-off from:	Ellington Field	Time: 12:11 CDT
Landing at:	Ellington Field	Time: 3:12 CDT
Objective of flight:	Characterization of the Bay breeze	
Weather	Wind: 120/07, Visibility: 10 miles, Temperature: 32, Dew Point: 23	

Flight Description : The aircraft departed from the Ellington airport on a heading of 090 for a point in Galveston Bay where an ascending box pattern was flown on cardinal headings consisting of 1 minute legs from 1500 to 6000 ft. MSL. A descent was then made to 1500 MSL. In order to cross the bay breeze front, the next leg was flown to a position northeast of Galveston Bay. The aircraft then flew a series of traverses from Baytown to Texas City with a box pattern flown around Texas City, and Lake Jackson. Hydrocarbon cans were taken at each of these points. These patterns were intended to characterize the bay breeze front from about 8 miles inland from Baytown to Texas City. The flight then proceeded to a position west of the city where a canister sample was taken near Williams Tower. The aircraft then flew on an easterly heading north of I-10. A series of four canisters were taken on this leg. A leg was then flown on a westerly heading just south of I-10 to a point just west of the center of the downtown section of Houston. The next traverse was flown eastward to Baytown. During this leg, four more canister samples were taken. On reaching Baytown, the aircraft was flown to La Porte airport and returned to Ellington Field.

Location and altitude of highest levels of pollution: The highest level of ozone was measured on I-10 and hwy 45 at 120ppb. The highest level of SO_2 was measured near Texas City at 25ppb.

Interpretation of flight:
This is the first flight flown with a new modified flight plan designed to better examine the Texas City and Lake Jackson area. This pattern will also help identify and characterize the bay breeze.

SYNOPSIS AND INTERPRETATION OF FLIGHT #142a

Date:	8-28-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 9:29 CDT
Landing at:	Ellington Field	Time: 11:19 CDT
Purpose of Flight:	Characterization of the onset of the mid morning bay breeze.	
Meteorological Info.:	Winds: Calm; Visibility: 10; Clouds: 25000 Skt.; Temperature 29; Dew Point: 26; Altimeter: 30.02	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the northeast was made to a heading of 038 direct Baytown while performing an enroute climb. Once over Baytown a box spiral to 4000ft. Was flown. The aircraft then proceeded to a position in the center of Trinity Bay N29 36.00 W95 49.48 and started an enroute climb to 6000ft. Once at Trinity Bay a descent to near surface was made. The aircraft then flew direct to La Porte and started a Box climb to 2000ft,and then proceeded to Ellington Field and landed.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 7 ppb, were encountered in the vicinity of Baytown. The levels of Background Ozone ranged from 30ppb to 60ppb. Ozone increased to a maximum of about 100-ppb near the surface of Galveston Bay.

Significant observations: The elevated levels of pollution occurred in the vicinity of Galveston Bay. Elevated levels of SO_2 were noted east of La Porte at 1700 ft MSL.

Spatial correlation of data: Winds aloft data verified by local AWOS and pilot observations of surface plumes.

Correlation of data between pollutants: A disagreement of pollutant levels was noted between the Slow O_3 and Fast O_3 of 40 ppb.

SYNOPSIS AND INTERPRETATION OF FLIGHT #142b

Date:	8-28-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez	
Take-off from:	Ellington Field, Houston, Texas	Time: 12:10 CDT
Landing at:	Ellington Field	Time: 1:40 CDT
Purpose of Flight:	Media Relations Flight.	
Meteorological Info.	Winds: 180-9; Visibility: 10; Clouds: 3500 Skt.; Temperature 34; Altimeter: 30.05	

Flight Description: The aircraft departed Ellington Field and made a left downwind departure to the northeast proceeding direct Baytown. Then the aircraft turned west on the I-10 corridor toward Downtown, and then reversed coarse and flew down the ship channel to La Porte. Then we entered the pattern for Ellington Field and landed.

SYNOPSIS AND INTERPRETATION OF FLIGHT #143a

Date:	8-29-2000	
Pilot:	Matt Tilghman	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 7:24 CDT
Landing at:	Ellington Field	Time: 9:53 CDT
Purpose of Flight:	Characterization of early morning pollutant concentrations.	
Meteorological Info.	Winds: 110-3; Visibility: 10; Clouds: 25000 Skt.; Temperature 24; Dew Point: 24; Altimeter: 30.02	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on a heading of 170. The aircraft turned northeast and flew a low approach at La Porte airport. A box pattern was flown around La Porte airport on cardinal headings while ascending from 1000 ft. to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. The next box pattern was flown centered at N29^{o}42.75, W94^{o}44.5'. Subsequent box patterns were flown centered at N29^{o}34' W94^{o}36' and N29^{o}26' W94^{o}50'. All box patterns, except for the last one, were flown on cardinal headings while ascending from 1000 ft. to 2000 ft. MSL. The last climb was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute (fpm) and descents were made at 1000 fpm. After completing the last box pattern, the flight proceeded to Smith Point and then to Kemah at 500 ft. MSL. The aircraft then returned to Ellington Field and landed. The traverse legs between box-patterns over Galveston Bay were flown at an altitude of 500 ft. MSL.

Location of highest levels of pollutants: The highest level of SO_2, 32 ppb, was encountered in the vicinity of Trinity Bay. The highest levels of O_3 were encountered below 4000 ft. MSL; O_3 only averaged about 30 ppb above 4000 ft. Low-level O_3 peaked at about 179 ppb at 1500 ft. while high-level O_3 peaked at 75 ppb at 6500 ft. An NO measurement of 20 ppb was observed in a plume near Baytown.

Significant observations: Elevated levels of pollution, including SO_2, were observed in the vicinity of Trinity Bay. Winds observed by the pilot using a smoke plume near Baytown as a reference agreed with logged winds aloft. Several stratified layers of pollution were noted and pictures were taken.

Canisters or filter samples location: Four hydrocarbon cans were taken: one at La Porte and one each between each box spiral at 500 ft MSL.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near Trinity Bay.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of O_3 were encountered..

SYNOPSIS AND INTERPERTATION OF FLIGHT #143b

Date:	8-29-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Guelmy Garcia, Sergio Alvarez	
Take-off from:	Ellington Field , Houston, TX	Time: 12:07 CDT
Landing at:	Ellington Field	Time: 3:00 CDT
Objective of flight:	Characterization of the bay breeze.	

Flight Description: The aircraft departed from the Ellington airport on a heading of 090 for Galveston Bay; an ascending box pattern was flown over the bay on cardinal headings consisting of one- minute legs from 1000 to 6000 ft. MSL. A descent was then made to 1000 MSL. In order to cross the bay breeze front, the next leg was flown to a position northeast of Galveston Bay. The aircraft then flew a series of traverses from Baytown to Texas City with box patterns flown around Texas City and Lake Jackson. Hydrocarbon cans were taken at a series of predetermined points. These patterns were intended to characterize the bay breeze front from about 8 miles inland of Baytown to Texas City. The flight then proceeded to a position west of the city where a canister sample was taken near Williams Tower. The aircraft then flew on an easterly heading north of I-10. A series of four canisters were taken on this leg at predetermined sites. A leg was then flown on a westerly heading just south of I-10 to a point just west of downtown Houston. The next traverse was flown eastward to Baytown. During this leg, four more canister samples were taken. On reaching Baytown, the aircraft was flown to La Porte airport and returned to Ellington Field.

Location of highest levels of pollutants: The highest level of O_3 was 200 ppb, observed over the intersection of I-10 and Hwy 610 E. The highest level of SO_2 was 32 ppb, observed near Parish Power Plant.

Interpretation of flight: The aircraft crew noted reduced visibility accompanied by elevated levels of O_3, SO_2, and NO over I-10. The aircraft's winds-aloft data was verified by surface observations from Galveston AWOS.

SYNOPSIS AND INTERPRETATION OF FLIGHT #144a

Date:	8-30-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Cathy	
Take-off from:	Ellington Field, Houston, Texas	Time: 7:16 CDT
Landing at:	Ellington Field	Time: 9:35 CDT
Purpose of Flight:	Characterization of early morning pollutant concentrations.	
Meteorological Info.	Winds: Calm; Visibility: 10; Clouds: 2500 Skt.; Temperature 25; Dew Point: 24; Altimeter: 30.05	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the Northeast was made to fly a low approach was made to La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. The next box pattern was flown centered at N29 42.75, W94 44.5. Subsequent box patterns were flown centered at N29 34 W94 36 and N29 26 W 94 50. All box patterns were flown exactly as the first except for the last, which was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute and descents were made at 1000 ft. per minute. After completing the last box pattern, the flight proceeded to Smith Point and then to Kemah at 250ft. Then the aircraft entered the pattern for Ellington Field and landed. Over Galveston Bay, the traverse legs flown between box patterns were flown at an altitude of 500-ft. MSL.

Location and levels of highest levels of pollutants: The highest levels of SO_2, off scale, were encountered in the vicinity of Trinity Bay. The levels of Ozone encountered below 4000 ft. MSL averaged about30ppb. Above 4000 ft, Ozone increased to a maximum of about 70-ppb at 4500 ft. NO was measured at 90 ppb at Trinity Bay.

Significant observations: The elevated levels of pollution occurred in the vicinity of Trinity Bay off scale levels of SO_2 and NO were noted. A thin yellowish layer was also noted at 1300ft and photographs were taken.

Canisters or filter samples location: 4 Hydrocarbon cans were taken, 1 at La Porte and 3 others taken between each box spiral at 500 ft MSL.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near Trinity Bay and near refineries in the Baytown Area.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered

SYNOPSIS AND INTERPERTATION OF FLIGHT #144b

Date	8-30-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Guelmy Garcia, Sergio Alverez	
Take-off from:	Ellington Field	Time: 12:06 CDT
Landing at:	Ellington Field	Time: 3:05 CDT
Objective of flight:	Characterization of the Bay breeze	
Meteorological info	ATIS: 18:00 Scattered clouds at 25,000, Temp. 34/23, 10 miles visibility, winds variable, and Barometric Pressure: 30.00	

Flight Description: The aircraft departed from the Ellington airport on a heading of 090 for a point in Galveston Bay where an ascending box pattern was flown on cardinal headings consisting of 1 minute legs from 1500 to 6000 ft. MSL. A descent was then made to 1500 ft MSL. In order to cross the bay breeze front, the next leg was flown to a position northeast of Galveston Bay. The aircraft then flew a series of traverses from Baytown to Texas City. These traverses were intended to characterize the bay breeze front from about 8 miles inland from Baytown to Texas City. The flight then proceeded to a position west of the city where a canister sample was taken near Williams Tower. The aircraft then flew on an easterly heading north of I-10. A series of four canisters were taken on this leg. A leg was then flown on a westerly heading just south of I-10 to a point just west of the center of the downtown section of Houston. The next traverse as flown eastward to Baytown. During this leg, four more canister samples were taken. On reaching Baytown, the aircraft was flown to La Porte airport and returned to Ellington Field.

Location and altitudes of highest levels of pollution: The highest level of ozone was measured in the Lake Jackson area at 115 ppb. The highest level of SO_2 was measured off the coast of Galveston at 27 ppb.

Interpretation of flight:
This flight was flown with a flight plan designed to better examine the Texas City area and help identify and characterize the bay breeze. Elevated levels of pollutants were noted in a plume off the coast of Galveston.

SYNOPSIS AND INTERPRETATION OF FLIGHT #145a

Date:	9-01-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, Jimmy Flynn	
Take-off from:	Ellington Field, Houston, Texas	Time: 11:07 CDT
Landing at:	Ellington Field	Time: 1:03 CDT
Purpose of Flight:	Characterization of Ozone Vertical development	
Meteorological Info.	Winds: 250/11; Visibility: 10; Clouds: 25000 Skt.; Temperature 31; Dew Point: 23; Altimeter: 29.96	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the Northeast was made to fly a low approach to La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. Next the aircraft proceeded direct to Chambers Co. airport at 1000 ft MSL Then a Traverse was flown between Chambers Co. and Houston Gulf, were a Box spiral was flown to 10000 ft MSL centered at the highest Ozone level.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 20 ppb, were encountered in the vicinity of La Porte. The levels of Ozone encountered in the vicinity of I-10 were 108-ppb.

Significant observations: The elevated levels of pollution occurred in the vicinity of refineries and Baytown. Elevated levels of SO_2 were noted east of La Porte between 1000 ft and 2000 ft MSL. NO in this area was measured at 20-ppb

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #145b

Date:	9-01-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, Jimmy Flynn	
Take-off from:	Ellington Field, Houston, Texas	Time: 3:25 CDT
Landing at:	Ellington Field	Time: 5:00 CDT
Purpose of Flight:	Characterization of Ozone Vertical development	
Meteorological Info.	Winds: 220/04; Visibility: 10; Clouds: 25000 Skt.; Temperature 40; Dew Point: 20; Altimeter: 29.90	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 170. A turn to the Northeast was made to fly a low approach was made to La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. Next the aircraft proceeded direct to Chambers Co. airport at 1000 ft MSL. Then a Traverse was flown between Chambers Co. and Houston Gulf, were a Box spiral was flown to 10000 ft MSL centered at the highest Ozone level.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 10 ppb, were encountered in the vicinity of Chambers Co. The levels of Ozone encountered in the vicinity of Chambers Co. airport were 160 ppb.

Significant observations: The Winds Aloft data logged on the aircraft at 3:58CDT showed 220 at 10kts.and Doppler radar at Dickinson TX. Showed 240 at 10. Elevated levels of NO were noted in the ship channel.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #146

Date:	9-03-2000	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez, Jimmy Flynn	
Take-off from:	Ellington Field, Houston, Texas	Time: 11:02CDT
Landing at:	Ellington Field	Time: 2:06 CDT
Purpose of Flight:	Inter-comparison Flight with G1 / Plume Characterization.	
Meteorological Info.:	Winds: 220-5; Visibility: 10; Clouds: 25000 Skt.; Temperature 40; Dew Point: 24; Altimeter: 29.92	

Flight Description: The aircraft departed Ellington Field and climbed to 1500 ft MSL and flew direct to N30 08, W94 45 at which point the aircraft turned south to N29 17, W94 45. The aircraft then reversed course north to I-10 and then west on the I-10 corridor to Katy TX. where a box spiral to 10000 ft was made. Then the aircraft turned east on I-10 and flew over the ship channel to Baytown. Finally the aircraft made a series of north south transects spaced at 10-mile intervals eastward and returned to Ellington for landing.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 9ppb, were encountered in the vicinity of Shell. The levels of Ozone encountered below 4000 ft. MSL averaged about 15 ppb. Above 4000 ft. Ozone increased to a maximum of about 164ppb at 1500 ft.

Significant observations: The elevated levels of pollution occurred in the vicinity of refineries and Texas City. Elevated levels of SO_2 were noted east of Texas City at 1500ft MSL.

Canisters or filter samples location: 8 Hydrocarbon cans were taken, 1 at La Porte and 4 others taken at 610E, hwy59, hwy45, 610w. Also 4 cans were taken at refineries along the ship channel

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #147a

Date:	9-04-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 12:14 CDT
Landing at:	Southeast Texas Regional	Time: 15:38 CDT
Purpose of Flight:	Characterization of Beaumont plume.	
Meteorological Info.	Winds: 330-10; Visibility: 10; Clouds: 25000 Skt.; Temperature 38; Dew Point: 18;	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading. The aircraft then turned northeast to a point just south of Silsbee TX. The flight continued east to Deweyville TX. where a box spiral was flown to 10000 ft. and then further east to Vinton TX. A spacing segment was flown to the south centered at N29. 50, W93. 42. The aircraft then started the second traverse west to China TX. This was flown at 1000, 2000 and 3000 ft. respectively. Next a spacing segment was flown south to Winnie Stowell airport where the third traverse was started eastbound to N29. 41, W93. 44. where traverses were flown at 1000, 2000 and 3000 ft. respectively. The last leg was cut short and turn was made due north to Southeast Texas Regional airport where a landing was made.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 10 ppb, were encountered in the vicinity of the second traverse. Ozone increased to a maximum of about 140-ppb at 2000 ft. SO_4 increased to a high of 17 ìg/m^3 over refineries near I-10. Reduced visibility was noted by the Nephelometer throughout the day due to marsh fires. Photographs of the marsh fires were taken.

Significant observations: The elevated levels of pollution occurred on the south side of town, and the Nephelometer noted reduced visibility due to marsh fires along the coast.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #147b

Date:	9-04-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Southeast Texas Regional	Time: 16:35 CDT
Landing at:	Ellington Field	Time: 15:47 CDT
Purpose of Flight:	Characterization of Beaumont plume.	
Meteorological Info.	Winds: 120-10; Visibility: 10; Clouds: 25000 Skt.; Temperature 38; Dew Point: 18;	

Flight Description: The aircraft departed Southeast Texas Regional airport and headed southeast to N29. 50, W93. 42. and then turned west to Winnie Stowell airport. This pattern was flown at 1000, 2000 and 3000 ft. respectively. The aircraft turned north to China TX. for a spacing segment where the second traverse was started from China westbound to N30. 04, W93. 35. This traverse was also flown at 1000, 2000 and 3000 ft respectively. The aircraft then turned north to Deweyville TX. where the third and final traverse was flown between Deweyville and a point just south of Kountze. This traverse was flown at 1000 and 2000 ft. The third leg of this traverse was flown from Deweyville to Winnie Stowell at 1300ft. Finally the aircraft proceeded direct to Ellington Field for a full stop landing. GPS data was sometimes intermittent during this flight.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 37 ppb, were encountered in the vicinity of the third traverse. Ozone increased to a maximum of about 130-ppb at 2000 ft. SO_4 increased to a high of 15 ppb over Winnie Stowell. Reduced visibility was noted by the Nephelometer through out the day due to marsh fires and at times the flight was in IMC conditions. The highest level of CO noted was 500ppb.

Significant observations: The elevated levels of pollution occurred on the south side of town, and the Nephelometer noted reduced visibility due to marsh fires along the coast.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #148

Date:	09-05-00	
Pilots:	Matt Tilghman, Clint Owen	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 3:10 CDT
Landing at:	Ellington Field	Time: 4:40 CDT
Purpose of Flight:	Characterization of afternoon land breeze on urban plume.	
Meteorological Info.	Winds: 020/8; Visibility: 10; Clouds 6000 few.; Temperature 41; Dew Point: 17; Altimeter: 29.86	

Flight Description: The aircraft departed Ellington Field and climbed to 1500 ft. MSL on the runway heading of 170. A turn to the Northeast was made to fly over La Porte airport, and then direct Baytown. The aircraft then turned west on I-10 to West Houston airport. A turn was then made to the south towards Houston Southwest airport and then back eastward toward Trinity bay. At this point a spacing segment was made to the south and traverses were flown east to west. On the third Traverse the aircraft flew direct to Galveston Shoals where a landing was made and the aircraft secured for passing widespread thunderstorms. After the storm passed the aircraft was flown direct to Ellington field and no data was taken on this leg.

Location and levels of highest levels of pollutants: The highest levels of SO_4, 16 ppb, were encountered in the vicinity of 3rd. traverse. Ozone increased to a maximum of about 250-ppb at 1,500 ft. in the vicinity of Galveston.

Significant observations: The elevated levels of pollution occurred south of town. Winds aloft were 010 at 10 kts. Thunderstorms in the Houston area washed out the chance of further traverses.

Canisters or filter samples location: 4 Hydrocarbon cans were taken 1 at 610E and hwy59, hwy45, 610W respectively.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #149

Date:	09-07-00	
Pilots:	Matt Tilghman, Clint Owen	
Instrument Operators:	Sergio Alvarez, Jimmy Flynn	
Take-off from:	Ellington Field, Houston, Texas	Time: 2:20 CDT
Landing at:	Ellington Field	Time: 5:50 CDT
Purpose of Flight:	Characterization of afternoon land breeze / Inter-comparison with Battelle's Gulfstream 1 (G1).	
Meteorological Info.	Winds: 040-10; Visibility: 10; Clouds: 3000 scattered; Temperature 30 ^{o}C; Dew Point: 17 ^{o}C; Altimeter: 29.88.	

Flight Description: The aircraft departed Ellington Field and climbed to 1,500 ft. MSL on the runway heading of 040. The aircraft then turned south towards Galveston and then paralleled the coast to the east. Next, a turn was made toward Baytown. Upon reaching Baytown, the aircraft loitered while waiting for the G1. Once intercepted, the Twin Otter followed the G1 west on Interstate 10 (I-10) to West Houston airport and turned south towards the Parrish power plant. A plume study was then flown towards the west with north-south traverses. The Twin Otter next flew north to I-10 where a second inter-comparison leg with the G1 was made heading south on the W 95°44' meridian. The aircraft then continued the power plant plume study and flew southwest to the Gulf of Mexico and north to Palacios. The aircraft finally flew directly to Ellington Field for a full stop landing.

Location of highest levels of pollutants: The highest level of SO_2, 5 ppb, was encountered in the vicinity of Parrish power plant. The highest level of Ozone was about 96 ppb, and was encountered at 1,500 ft. in the vicinity of a Nuclear power plant near Palacios.

Significant observations: Elevated levels of pollution occurred southwest of Parrish power plant while winds aloft were 060 at 10 kts. Elevated levels of pollutants were noted up to 20NM into the Gulf of Mexico. Ozone measurements oscillated in this vicinity. The temperature decreased from 31 to 24 degrees Celsius. The dew point increased from 16 to 19 degrees Celsius.

Canisters or filter samples location: 3 Hydrocarbon cans were taken: at W 95°00', W 95°10', and W 95°20' respectively.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #150a

Date:	9-12-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 7:43 CDT
Landing at:	Ellington Field	Time: 10:31 CDT
Purpose of Flight:	Characterization of early morning pollutant concentrations.	
Meteorological Info.	Winds: Calm; Visibility: 10; Clouds: 25000 Skt.; Temperature 25; Dew Point: 24; Altimeter: 29.88	

Flight Description: The aircraft departed Ellington Field and climbed to 1000 ft. MSL on the runway heading of 040. A turn to the Northeast was made to fly 3 low approaches at La Porte airport. A box pattern was flown centered on La Porte airport on cardinal headings while ascending from 1000 ft. MSL to 2000 ft. MSL. The aircraft then descended to 1000 ft. MSL and proceeded to the Baytown airport, where the same type box pattern was flown. The next box pattern was flown centered at N29 42.75, W94 44.5. Subsequent box patterns were flown centered at N29 34 W94 36 and N29 26 W 94 50. All box patterns were flown exactly as the first except for the last, which was a spiral to 10,000 ft. MSL. All climbs were made at 500 feet per minute and descents were made at 1000 ft. per minute. After completing the last box pattern, the flight proceeded to Smith Point and then to Kemah at 500ft. Then the aircraft entered the pattern for La Porte airport where three additional low passes were flown. Finally the aircraft entered the pattern at Ellington Field and landed.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 7 ppb, were encountered in the vicinity of La Porte airport. The levels of Ozone encountered below 4000 ft. MSL averaged about 30 ppb. Above 4000 ft. Ozone increased to a maximum of about 60-ppb at 8,400 ft.

Significant observations: The elevated levels of pollution occurred in the vicinity of La Porte airport. The highest levels of SO_2 were noted over La Porte airport between 1000 ft and 2000 ft MSL.

Canisters or filter samples location: 5 Hydrocarbon cans were taken, 2 at La Porte and 3 others taken between each box spiral at 1000 ft MSL.

Spatial correlation of data: Elevated levels of SO_2 and NO were encountered near downwind of refineries near the La Porte/Baytown area.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #150b

Date:	9-12-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Guelmy Garcia	
Take-off from:	Ellington Field, Houston, Texas	Time: 1:11 CDT
Landing at:	Ellington Field	Time: 3:22 CDT
Purpose of Flight:	Characterization of bay breeze	
Meteorological Info.	Winds: variable-5; Visibility: 10; Clouds: 3000Skt.; Temperature 33; Dew Point: 24; Altimeter: 29.90	

Flight Description: The aircraft departed Ellington Field and climbed to 1100 ft. MSL on the runway heading of 220 per ATC instructions. The aircraft then turned east to Galveston Bay, but had to turn early due to weather. Next we turned north to I-10 and then west on the corridor to Channelview. A turn was then was made south three miles and then east along the ship channel. Then we flew direct to La Porte airport where three low passes were made. The aircraft then turned south to League City area and then west to southwest Houston and north toward Missouri city and to I-10 at which time we turned east taking a series of Hydrocarbon cans. This was repeated twice. Next we flew direct to La Porte where four low passes were made. Finally we proceeded to Ellington Field for a full stop landing.

Location and levels of highest levels of pollutants: The highest levels of CO observed on the south side of Houston 40-ppb. Elevated levels of O_3 were noted on the I-10 corridor east of downtown at 137-ppb, background levels of O_3 ranged from 50 to 60-ppb.

Significant observations: The elevated levels of pollution occurred in the vicinity of the I-10 corridor, The wind speed and direction was very erratic due to numerous thunderstorms and the aircraft's passes through areas of storm outflow.

Canisters or filter samples location: 11 Hydrocarbon cans were taken, 2 cans at La Porte and 9 others taken on the I-10 corridor

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #151

Date:	9-14-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Jimmy Flynn	
Take-off from:	Ellington Airfield, Houston, TX	Time: 13:43 CDT
Landing at:	Ellington Airfield	Time: 13:55 CDT
Purpose of Flight:	Point source sampling	
Meteorological Info.	Winds:140 at 6 knots; Visibility: 10; Clouds: 1,100 Scattered; Temperature 31 degrees Celsius; Dew Point: 25 degrees Celsius; Altimeter: 30.01 in Hg	

Flight Description: The aircraft departed Ellington airport and returned immediately to land due to water leaks inside aircraft.

Location and levels of highest levels of pollutants: Not applicable

Significant observations: Not applicable

Canisters or filter samples location: Not applicable

Spatial correlation of data: Not applicable

Correlation of data between pollutants: Not applicable.

SYNOPSIS AND INTERPRETATION OF FLIGHT #152

Date:	09-15-00	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez,	
Take-off from:	Ellington Airport, Houston, TX	Time: 10:00 CDT
Landing at:	Ellington Airport	Time: 12:04 CDT
Purpose of Flight:	Characterization of urban plume.	
Meteorological Info.	Winds: 340,6 kts; Visibility: 10; Clouds: 5500skt; Temperature 28; Dew Point: 22; Altimeter: 30.02	

Flight Description: The aircraft departed Ellington field and flew north east, and then over the Exxon, Shell, and Goodyear plants. At this point, the course was reversed parallel to the ship channel toward the Bay. The aircraft then turned south to Texas City and then west to Lake Jackson . The aircraft then flew direct to Parish power plant and north to over fly Sugarland airport and Williams Tower, then intercepting I-10 East bound to La Porte and inbound for landing at Ellington field.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 10ppb, was encountered in the vicinity of Texas City. Ozone increased to a maximum of about 80-ppb at 1,000 ft. in the vicinity of Texas City

Significant observations: The elevated levels of pollution occurred southwest of Texas City plant.. Elevated levels of pollutants were noted around the Ship Channel and over Texas City.

Canisters or filter samples location: A 47 mm Teflon Filter sample was taken for the duration of the flight and 18 hydrocarbon canisters were sampled.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #153a

Date:	09-28-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez,	
Take-off from:	Waco ,TSTC	Time: 11:32 CDT
Landing at:	Victoria, Texas	Time: 2:08 CDT
Purpose of Flight:	Characterization of Regional plume.	
Meteorological Info.	Winds: 050/69kts; Visibility: 10; Clouds: >12000; Temperature 29; Dew Point: 6; Altimeter: 30.14 mm Hg	

Flight Description: The aircraft departed TSTC Waco on a southerly heading over-flying the city of Temple and flying in the vicinity of the Rockdale power plant. The aircraft then turned slightly more westbound toward I-10 where a spiral was flown to 10,000 ft. and back down. At this point, we started North-South traverses about 45 to 50 nm long moving west at 15 mile intervals until we were south of Victoria. The aircraft then flew direct to Victoria airport to land and fuel.

Location and levels of highest levels of pollutants: The highest levels of SO_2, 45ppb, was encountered in the vicinity of Rockdale power plant. Ozone increased to a maximum of about 65-ppb at 1,000 ft. in the vicinity of Rockdale power plant. The highest levels of CO observed were also in the Rockdale power plant plume at 210ppb.

Significant observations: The elevated levels of pollution occurred near Rockdale Power Plant.

Canisters or filter samples location: A 47 mm filter samples was taken for the duration of the flight and no hydrocarbon samples were taken.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #153b

Date:	09-28-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez,	
Take-off from:	Victoria Texas	Time: 2:34 CDT
Landing at:	Corpus Christi, Texas	Time:4:01 CDT
Purpose of Flight:	Characterization of Regional plume.	
Meteorological Info.	Winds: 100/13kts; Visibility: 10; Clouds: >12000; Temperature 28; Dew Point: 11; Altimeter: 30.09	

Flight Description: The aircraft departed Victoria, Texas heading northbound for the first traverse. Then, the aircraft began a spacing leg to the west 15 miles, From the spacing leg, a third traverse was started at 1000 ft. MSL. This pattern continued until the fifth traverse and finally a landing at Corpus Christi International airport.

Location and levels of highest levels of pollutants: The highest levels of SO_2,5 ppb, was encountered in the vicinity of Corpus Christi. Ozone increased to a maximum of about 92 ppb at 1,000 ft. in the area north east of Corpus Christi. The highest levels of CO observed were north east of Corpus Christi at 222 ppb.

Significant observations: The elevated levels of pollution occurred just north east of Corpus Christi.

Canisters or filter samples location: One 47 mm Teflon filter was sampled for the duration of the flight.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #153c

Date:	09-28-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez,	
Take-off from:	Corpus Christi, Texas	Time:5:10 CDT
Landing at:	Corpus Christi, Texas	Time: 7:39CDT
Purpose of Flight:	Characterization of Regional plume.	
Meteorological Info.	Winds: 100/13kts; Visibility: 10; Clouds: >12000; Temperature 28; Dew Point: 11; Altimeter: 30.09 mm Hg	

Flight Description: The aircraft departed Corpus Christi airport on a northerly heading and then started a spacing segment to the west. After the spacing leg, the first of four north/south traverses were made flying westward towards Brooks County airport where a spiral was conducted from near surface to 10,000 ft. Finally, the aircraft flew direct to Corpus Christi airport for landing.

Location and levels of highest levels of pollutants: The highest levels of SO_2,3 ppb, was encountered in the area west of Corpus Christi. Ozone increased to a maximum of about 82-ppb at 1,000 ft. in the area west of Corpus Christi. The highest levels of CO observed were west of Corpus Christi at 200ppb at an altitude of 5,000 ft.

Significant observations: The elevated levels of pollution occurred just west of Corpus Christi.

Canisters or filter samples location: A 47 mm Teflon filter was collected for the duration of the flight.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #154a

Date:	09-29-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez,	
Take-off from:	Corpus Christi, Texas	Time:11:27 CDT
Landing at:	Corpus Christi, Texas	Time: 2:34CDT
Purpose of Flight:	Characterization of Regional plume.	
Meteorological Info.	Winds:090/11 kts; Visibility: 10; Clouds: CLR; Temperature 30; Dew Point: 13; Altimeter: 30.06	

Flight Description: The aircraft departed Corpus Christi airport on a northeasterly heading of 026 to a point to complete a box spiral from near the surface to 10,000 ft and back down to 1000 ft MSL. At this point, a series of traverses was started oriented north/south moving westward spaced at approximately 15 mile increments. Five traverses were completed, then the aircraft returned to Corpus Christi for landing.

Location and levels of highest levels of pollutants: The highest levels of SO_2,3 ppb, was encountered in the area west of Corpus Christi. Ozone increased to a maximum of about 85-ppb at 1,000 ft. in the area west of Corpus Christi. The highest levels of CO observed were west of Corpus Christi at 208ppb at an altitude of 1000 ft.

Significant observations: The elevated levels of pollution occurred just west of Corpus Christi.

Canisters or filter samples location: One 47 mm Teflon filter was sampled for the duration of the flight.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #154b

Date:	09-29-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez,	
Take-off from:	Corpus Christi, Texas	Time:3:48 CDT
Landing at:	Corpus Christi, Texas	Time: 6:21CDT
Purpose of Flight:	Characterization of Regional plume.	
Meteorological Info.	Winds:100/11 kts; Visibility: 10; Clouds: CLR; Temperature 29; Dew Point: 13; Altimeter: 30.03	

Flight Description: The aircraft departed Corpus Christi airport on a southwest heading over Navy Cabinus airport. At this point, a series of traverses was started oriented north/south moving westward spaced at approximately 15 mile increments. Three traverses were completed. Then, the aircraft flew to Brooks county airport and started a box spiral from 1,000 ft to 10,000 f t After the spiral, the aircraft flew direct to Corpus Christ to land.

Location and levels of highest levels of pollutants: The highest levels of SO_2,2.2 ppb, was encountered in the area west of Corpus Christi. Ozone increased to a maximum of about 88-ppb at 1,000 ft. in the area west of Corpus Christi. The highest levels of CO observed were west of Corpus Christi at 145 ppb at an altitude of 1,000 ft.

Significant observations: The elevated levels of pollution occurred just west of Corpus Christi.

Canisters or filter samples location: One 47 mm Teflon filter was sampled for the duration of the flight.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #155a

Date:	09-30-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez	
Take-off from:	Corpus Christi, Texas	Time: 11:06 CDT
Landing at:	San Antonio, Texas	Time: 13:48 CDT
Flight Objective:	Characterization of a Regional Plume.	
Meteorological Info.	Winds:070°, 10kts; Visibility: 10mi; Clouds: CLR; Temperature 28°C; Dew Point: 8°C, Altimeter: 30.04″Hg	

Flight Description: The aircraft departed Corpus Christi Airport and flew to a point near Georgewest and started the first of four traverses oriented west/east moving in a northerly direction. Altitude was gradually increased to compensate for terrain in order to maintain 1,000 ft agl. These traverses took the aircraft downwind of several power plants including the Calavaras Power Plant. The aircraft landed at San Antonio International Airport.

Location and levels of highest levels of pollutants: The highest levels of SO_2 at 6 ppb were encountered near the power plant. O_3 increased to a maximum of about 87-ppb at 1,000 ft. in the area near the Calavaras Power Plant. The highest levels of CO were also observed near the plant at 182ppb at an altitude of 1000 ft.

Significant observations: The elevated levels of pollution occurred just down wind of the Calavaras Power Plant.

Canisters or filter samples location: One 47 mm Teflon filter was sampled for the duration of the flight.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of O_3 were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #155b

Date:	09-30-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez	
Take-off from:	San Antonio, Texas	Time: 3:37 CDT
Landing at:	TSTC Waco, Texas	Time: 6:33 CDT
Flight Objective:	Characterization of Regional plume.	
Meteorological Info:	Winds: 170° @ 9kts; Visibility: 10mi; Clouds: CLR; Temperature 83°F; Dew Point: 42°F; Altimeter: 29.94 Hg	

Flight Description: The aircraft departed San Antonio International airport on runway 12R and flew to a point just south of Kelly AFB. The aircraft then flew an arc to the west and started a series of north/south traverses west bound to a point as far as west as Kerrville, Texas. From there, the aircraft flew directly to Waco for a landing.

Location and levels of highest levels of pollutants: The highest levels of SO_2 were at 2.3ppb north of Hondo Texas. O_3 increased to a maximum of about 103-ppb at 1,000 ft MSL. in the area north of Hondo Texas. The highest levels of CO observed were north of Hondo Texas at 187 ppb at an altitude of 1,000 ft.

Significant observations: The elevated levels of pollution occurred north of Hondo Texas.

Canisters or filter samples location: One 47 mm Teflon filter was collected for the duration of the flight.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of O_3 were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #156a

Date:	10-04-00	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez	
Take-off from:	TSTC Waco, Texas	Time: 1:22CDT
Landing at:	David Wayne Hooks Airport	Time: 3:40CDT
Flight Objective:	Characterization of Parish Power Plant Plume.	
Meteorological Info.	Winds: variable @ 4 kts; Visibility: 10mi; Clouds: 550 ft MSL SCT; Temperature 33°C; Dew Point: 19°C; Altimeter: 29.98	

Flight Description: The aircraft departed TSTC Waco and flew directly to Sugarland Airport and then began a diamond pattern around the Parish Power Plant. We then started a box climb to 10,000 ft and back down to 1,000 ft. The aircraft then started to make northeast/southwest traverses out from the power plant tracking the plume to background levels. The aircraft then returned to David Wayne Hooks Airport to land.

Location and levels of highest levels of pollutants: The highest levels of SO_2 were at 17 ppb and they were encountered down wind of the Parish Power Plant. O_3 increased to a maximum of about 54ppb at 1,500 ft. in the area northwest of the power plant. The highest levels of CO observed were south of the power plant at 244ppb at an altitude of 1,500 ft MSL.

Significant observations: The elevated levels of pollution occurred north west of Houston, Texas. The plume to the north west of Parish Power plant was quite coherent out to 50 miles.

Canisters or filter samples location: Filter samples or hydrocarbon canister samples were not taken on this flight.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #156b

Date:	10-04-00	
Pilots:	Matt Tilghman, Max Shauck	
Instrument Operators:	Sergio Alvarez	
Take-off from:	David Wayne Hooks, Texas	Time: 4:43 CDT
Landing at:	TSTC Waco, Texas	Time: 6:02 CDT
Flight Objective:	Characterization of Houston urban plume..	
Meteorological Info:	Winds: variable @ 4 kts; Visibility: 10mi; Clouds: 550 ft AGL SCT; Temperature 33°C; Dew Point: 19°C; Altimeter: 29.98″Hg	

Flight Description: The aircraft departed David Wayne Hooks airport on a heading of 039° towards the Houston IAH 8 DME surface airspace. The aircraft then turned to make a north spacing segment and completed one traverse. The last leg was direct to the TSTC Waco airport to land.

Location and levels of highest levels of pollutants: The highest level of SO_2 of 4 ppb was encountered down wind of Houston Intercontinental Airport. O_3 increased to a maximum of about 119 ppb at 1,000 ft. in the area northwest of Houston. The highest levels of CO observed were south of Parish Power Plant at 368ppb at a altitude of 1,000 ft. northwest of the Houston Intercontinental airport.

Significant observations: The elevated levels of pollution occurred North of IAH airport.

Canisters or filter samples location: Filter samples and Hydrocarbon canister samples were not taken on this flight.

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of Ozone were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #157

Date:	11-19-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operator:	Sergio Alvarez	
Take-off from:	Las Cruces Airfield, Las Cruces, New Mexico	Time: 17:57 CDT
Landing at:	Las Cruces Airfield	Time: 20:38 CDT
Flight Objective:	Characterization of high concentrations of CO along the U.S./Mexico Border in El Paso, Texas between 5:00 to 7:00 pm MST.	
Meteorological Info:	Winds: Less than 5kts; Visibility: 10mi; Clouds: 1,100 ft sct; Temperature 24°C; Dew Point: -1°C; Altimeter: 30.00″ Hg	

Flight Description: The aircraft departed Las Cruces Airport climbed to 6,200 ft. msl on a heading of 145°. The aircraft flew abeam the Dona Ana Airport to position for the first pass from west to east. A total of ten passes were conducted at approximately 1,000 ft agl along the U.S./Mexico Border. On the tenth pass the aircraft flew from the east to the west and returned to land at Las Cruces Airport in New Mexico.

Location and levels of highest levels of pollutants: The highest concentration of CO was approximately 800 ppb, and it was measured over downtown El Paso near a border crossing. The concentration of O_3 encountered averaged about 30 ppb. The highest NO concentration was approximately 4 ppb and the source was not detected. SO_2 concentrations were less than 2 ppb and NO_y was highest at 43 ppb. The highest green wavelength particle scattering coefficient was recorded at 72.6mm^{-1} (inverse megameters).

Significant observations: The elevated levels of pollution, especially CO, and some haze occurred in the vicinity of dense automobile traffic near border crossings and in downtown El Paso.

The NO concentrations were not as high on the evening flight as they were during the daytime flight. A preliminary observation of the raw data values indicated that most of the NO_y was composed of NO_2.

A cloud of haze was visually identified on the east side of the Davis Mountains. It was more concentrated over Juarez. The haze had a light yellow-brownish color over the urban area of both El Paso and Juarez. Winds were generally light and variable.

Canisters or filter samples location: One Quartz filter (BVATQ021) was sampled for the duration of the flight. When the filter was removed from the URG assembly, a light stain was observed on the filter where the sample was collected.

Spatial correlation of data: Elevated concentrations of CO, NO_2, NO_y, and NO_y* were measured mostly over the urban area.

Correlation of data between pollutants: When concentrations of NO_2, NO_y, and NO_y* increased, particle scattering coefficients also increased.

SYNOPSIS AND INTERPRETATION OF FLIGHT #158a

Date:	11-20-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez	
Take-off from:	Las Cruces Airfield, New Mexico, TX	Time: 14:17 CDT
Landing at:	Las Cruces Airfield	Time: 16:13 CDT
Flight Objective:	Characterization of high concentrations of CO along the U.S./Mexico Border in El Paso, Texas during the hours of 1:00 to 3:00 pm MST.	
Meteorological Info.	Winds: 140° @ 4 knots; Visibility: 10mi; Clouds: Clear below 12,000ft; Temperature 14°C; Dew Point: -1°C; Altimeter: 30.36″Hg	

Flight Description: The aircraft departed Las Cruces Airport on a heading of 130°. The aircraft flew directly abeam the Dona Ana Airport to position for the first pass from west to east. A total of six passes were conducted at approximately 1,000 ft agl (above ground level) along the U.S./Mexico Border. On the sixth pass the aircraft flew a from the east to the west and returned to land at Las Cruces Airport in New Mexico.

Location and levels of highest levels of pollutants: The highest concentration of CO was approximately 544 ppb, and it was measured on the northwest side of the Asarco stacks. The concentration of O_3 encountered averaged approximately 34 ppb. The highest NO concentration was 32 ppb near a point source that powered gas turbines. NO_y, NO_y* and NO_2 instruments also measured the highest concentrations near this point source. This point source is located on the western side of the Asarco stacks. The highest SO_2 concentration was 4 ppb. The highest green wavelength particle scattering coefficient was recorded at 54mm^{-1} (inverse megameters) near the same location where the nitrogen compounds measured their highest.

Significant observations: The highest concentration of pollution was found over urban area of the city. There was more NO over the urban area than the previous evening's flight conducted on November 19, 2000. Smoke from a grass fire near the Rio Grande River indicated wind was blowing towards Mexico (south- southwest).

Canisters or filter samples location: One Quartz filter (BVATQ022) was sampled for the duration of the flight.

Spatial correlation of data: Elevated concentrations of CO, NO_2, NO_y, NO and NO_y* were measured mostly over the urban area. SO_2 concentrations increased when the aircraft flew downwind of the El Paso International Airport and a refinery.

Correlation of data between pollutants: When concentrations of NO, NO_2, NO_y, and NO_y* increased, particle scattering coefficients and CO also increased.

SYNOPSIS AND INTERPRETATION OF FLIGHT #158b

Date:	11-20-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez	
Take-off from:	Las Cruces Airfield, New Mexico, TX	Time: 18:14 CDT
Landing at:	Las Cruces Airfield	Time: 20:12 CDT
Flight Objective:	Characterization of high concentrations of CO along the U.S./Mexico Border in El Paso, Texas during the hours of 5:00 to 7:00 pm MST.	
Meteorological Info. Winds:	140° @ 4 kts; Visibility: 10mi; Clouds: Clear below 12,000 ft ; Dew Point: -6°C; Altimeter: 30.41″Hg	

Flight Description: The aircraft departed Las Cruces Airport on a heading of 130. The aircraft flew direct abeam the Dona Ana Airport to position for the first pass from west to east. On the fourth pass, the aircraft descended to approximately 500 ft agl(above ground level) over downtown El Paso. A total of eight passes were conducted at approximately 1,000 ft agl along the U.S./Mexico Border. On the eighth pass, the aircraft flew a from the east to the west and returned to land at Las Cruces Airport in New Mexico.

Location and levels of highest levels of pollutants: The highest concentration of CO was approximately 466 ppb, and it was measured while flying near the Asarco smoke stacks. The concentration of Ozone encountered averaged approximately 35 ppb. The highest concentrations for the nitrogen compounds NO_2, NO_y, and NO_y* were encountered in the Davis Mountain Pass near the Asarco stacks. The highest SO_2 concentration was 4 ppb in the vicinity of the Asarco stacks. The highest green wavelength particle scattering coefficient was recorded at 11mm^{-1} (inverse megameters).

Significant observations: The highest concentration of pollution was found in the vicinity of the Davis Mountain Pass and the Asarco stacks. NO (Nitric Oxide) concentrations were less than 1 ppb most of the flight as compared to higher concentrations measured in the 1:00 to 3:00 pm MST flight. Particle scattering coefficients were significantly less than those in the flight flown earlier in the day.

Canisters or filter samples location: One Quartz filter (BVATQ023) was sampled for the duration of the flight. When the filter was removed from the URG assembly, there was no visible stain on the filter.

Spatial correlation of data: Elevated concentrations of CO, NO_2, NO_y, and NO_y* were encountered when the aircraft flew in the vicinity of the Asarco stacks.

Correlation of data between pollutants: When concentrations of NO_2, NO_y, and NO_y* in creased, concentrations of CO increased.

SYNOPSIS AND INTERPRETATION OF FLIGHT #159a

Date:	11-21-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez	
Take-off from:	Las Cruces Airfield, New Mexico	Time: 14:20 CDT
Landing at:	Las Cruces Airfield	Time: 16:15 CDT
Flight Objective:	Characterization of high concentrations of CO along the U.S./Mexico Border in El Paso, Texas between the hours of 1:00 and 3:00 pm MST.	
Meteorological Info:	Winds: 150° @ 6 kts; Visibility: 10mi; Clouds: Clr blw 12,000 ft msl; Temperature 13°C; Dew Point: -5°C; Altimeter: 30.29″ Hg	

Flight Description: The aircraft departed Las Cruces Airport on a heading of 120° towards Anthony. The aircraft then flew to position for the first pass from west to east. Five passes were conducted at approximately 1,000 ft agl along the U.S./Mexico Border. On the sixth pass, the aircraft flew from the east to the west and returned to land at Las Cruces Airport in New Mexico. The aircraft also made a descent to approximately 500 ft agl over downtown El Paso on the last pass.

Location and levels of highest levels of pollutants: The highest concentration of CO was approximately 279 ppb, and it was measured on the fourth pass after the aircraft flew downwind of a refinery and the El Paso International airport. The concentration of O_3 averaged approximately 34 ppb. The highest NO concentration was 5 ppb south of a refinery. The highest concentration levels of NO_y, NO_y* and NO_2 were detected in this area, and the SO_2concentration peaked at 5 ppb . The highest green wavelength particle scattering coefficient was recorded at 24 mm^{-1} (inverse mega meters).

Significant observations: The highest concentration of pollution was found over the city. Traces of SO_2 and nitrogen compounds were detected during each downwind leg of the refinery traverse located south of El Paso International Airport.

Canisters or filter samples location: One Quartz filter (BVATQ024) was sampled for the duration of the flight.

Spatial correlation of data: Elevated concentrations of CO, NO_2, NO_y, NO and NO_y* were measured mostly over the urban area. SO_2 concentrations increased when the aircraft flew downwind of the El Paso International Airport and a refinery.

Correlation of data between pollutants: When concentrations of NO, NO_2, NO_y, and NO_y* increased, CO concentrations also increased.

SYNOPSIS AND INTERPRETATION OF FLIGHT #159b

Date:	11-21-2000	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez	
Take-off from:	Las Cruces Airfield, New Mexico	Time: 17:55 CDT
Landing at:	Las Cruces Airfield	Time: 19:51 CDT
Flight Objective:	Characterization of high concentrations of CO along the U.S./Mexico Border in El Paso, Texas during the hours of 5:00 to 7:00 pm MST.	
Meteorological Info:	Not available	

Flight Description: The aircraft departed Las Cruces Airport on a heading of 120° to position for the first pass from west to east. Two passes were conducted at approximately 1,000 ft agl along the U.S./Mexico Border. The last four passes were conducted at approximately 500 ft AGL over the downtown airspace. On the last pass, the aircraft flew to Socorro and climbed to 11,000 ft msl. Data was not collected after the aircraft climbed to 11,000 ft msl to return to Waco, Texas.

Location and levels of highest levels of pollutants: The highest concentration of CO was approximately 295 ppb that was encountered near a border crossing. The concentration of O_3 averaged approximately 35 ppb. The highest NO concentration was less than .5 ppb. NO_y, NO_y* and NO_2 were measured the highest as the aircraft flew near the Asarco smoke stacks. The highest green wavelength particle scattering coefficient was recorded at 10.6 inverse mega meters.

Significant observations: The highest concentration level of pollution was found as the aircraft flew through the mountain pass near the Asarco stacks. There was a definite gradient that separated the urban pollution from regional air on the eastern side of El Paso.

Canisters or filter samples location: One Quartz filter (BVATQ025) was sampled for the duration of the flight.

Spatial correlation of data: Elevated concentrations of CO, NO_2, NO_y, NO and NO_y* were measured mostly over the urban area.

Correlation of data between pollutants: When concentrations of NO, NO_2, NO_y, and NO_y* increased, CO concentrations also increased.

SYNOPSIS AND INTERPRETATION OF FLIGHT #160

Date:	12-04-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Josh Begbie	
Take-off from:	Las Cruces, NM	Time: 6:22 MST
Landing at:	Las Cruces, NM	Time: 8:30 MST
Flight Objective:	Characterization of the El Paso CO. plume.	
Meteorological Information:	Winds:160°@ 6kts; Visibility:10mi; Clouds:11,000 ft sct.; Temperature: 7°C; Dew Point: 0°C; Altimeter: 30.33″ Hg	

Flight Description: The aircraft departed Las Cruces airport heading to a point just abeam Santa Theresa Airport on I-10. From this point the aircraft flew directly to the Asarco Plant and then flew eastbound along the Rio Grande River at 5,500 ft to a point abeam West Texas Airport. The aircraft then reversed course and flew westbound along the Rio Grande River again and descended to 5,000 ft msl. It completed four more passes along the same ground track before returning to Las Cruces Airport for landing.

Location and levels of highest levels of pollutants: Highest level of pollutants noted was in the vicinity of downtown El Paso to Anthony Pass at 1,000 ppb of CO.

Significant observations: The elevated levels of pollution occurred in the area where Anthony Pass bottlenecks at Asarco. Levels were concentrated.

Canister or filter samples location: 47mm filter sample was taken

SYNOPSIS AND INTERPRETATION OF FLIGHT #161

Date:	12-05-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Josh Begbie	
Take-off from:	Las Cruces, NM	Time: 6:00 MST
Landing at:	Las Cruces, NM	Time: 8:09 MST
Flight Objective:	Characterization of the El Paso CO. plume.	
Meteorological Information:	Winds: 290° @ 5kts; Visibility: 10 mi; Clouds: 11,000 ft sct.; Temperature: 7 °C; Dew Point: 0 °C; Altimeter: 30.33″ Hg	

Flight Description: The aircraft departed Las Cruces airport and proceeded direct to a point just abeam Donna Anna airport on I-10. From this point we flew direct to the Asarco plant and flew eastbound along the Rio Grande river at 5,500 ft to a point abeam the West Texas airport. The aircraft then reversed course westbound along the Rio Grande and descended to 5,000 ft msl. On the fourth pass the aircraft descended to near surface and started a box climb at 500 ft/min to 6,500 ft msl and then back down to 4,500 ft. Two more passes were completed and then the aircraft returned to Las Cruces for landing.

Location and levels of highest levels of pollutants: Highest level of CO was 1,083 ppb in the vicinity abeam West Texas airport on the Rio Grande River. NO and O_3 levels of 42 ppb and 80 ppb respectively were also observed in the same area.

Significant observations: The elevated levels of pollutants that were observed were very concentrated within 300 ft agl in the vicinity of West Texas Airport. Numerous fires were noted in this area.

Canister or filter samples location: 47mm filter sample was taken

Correlation of data between pollutants: When elevated levels of NO were measured, decreased levels of O_3 were encountered.

SYNOPSIS AND INTERPRETATION OF FLIGHT #162

Date:	12-06-00	
Pilots:	Matt Tilghman, Clint Owens	
Instrument Operators:	Sergio Alvarez, Josh Begbie	
Take-off from:	Las Cruces, NM	Time: 6:24 MST
Landing at:	Midland, TX	Time:
Flight Objective:	Characterization of the El Paso CO Plume.	
Meteorological Information:	Winds: light and variable; Visibility: 10 mi; Clouds: 11,000 ft msl sct; Temperature: 1 ^{o}C; Dew Point: -1°C; Altimeter: 30.33″ Hg	

Flight Description: The aircraft departed Las Cruces Airport and proceeded to Anthony and then followed I-10 to Asarco. At this point the aircraft continued eastbound along the Rio Grande River to a point 10 miles ESE of West Texas Airport. This was followed by a course reversal and the aircraft turned westbound along the Rio Grande River again to Asarco and then along I-10 to the steel mill in Anthony. The aircraft continued this track respectively twice, at which point it started an upwind traverse of the power plant west of Asarco. From there the aircraft flew east-west traverses at five mile spacing. The aircraft then flew an upwind traverse of the Anthony steel mill and several downwind traverses continuing the westbound legs 35 nm at an altitude of 20 feet agl.

Location and levels of highest levels of pollutants: Highest level of CO was 1,000 ppb in the vicinity of Anthony. NO was 68 ppb in the same area.

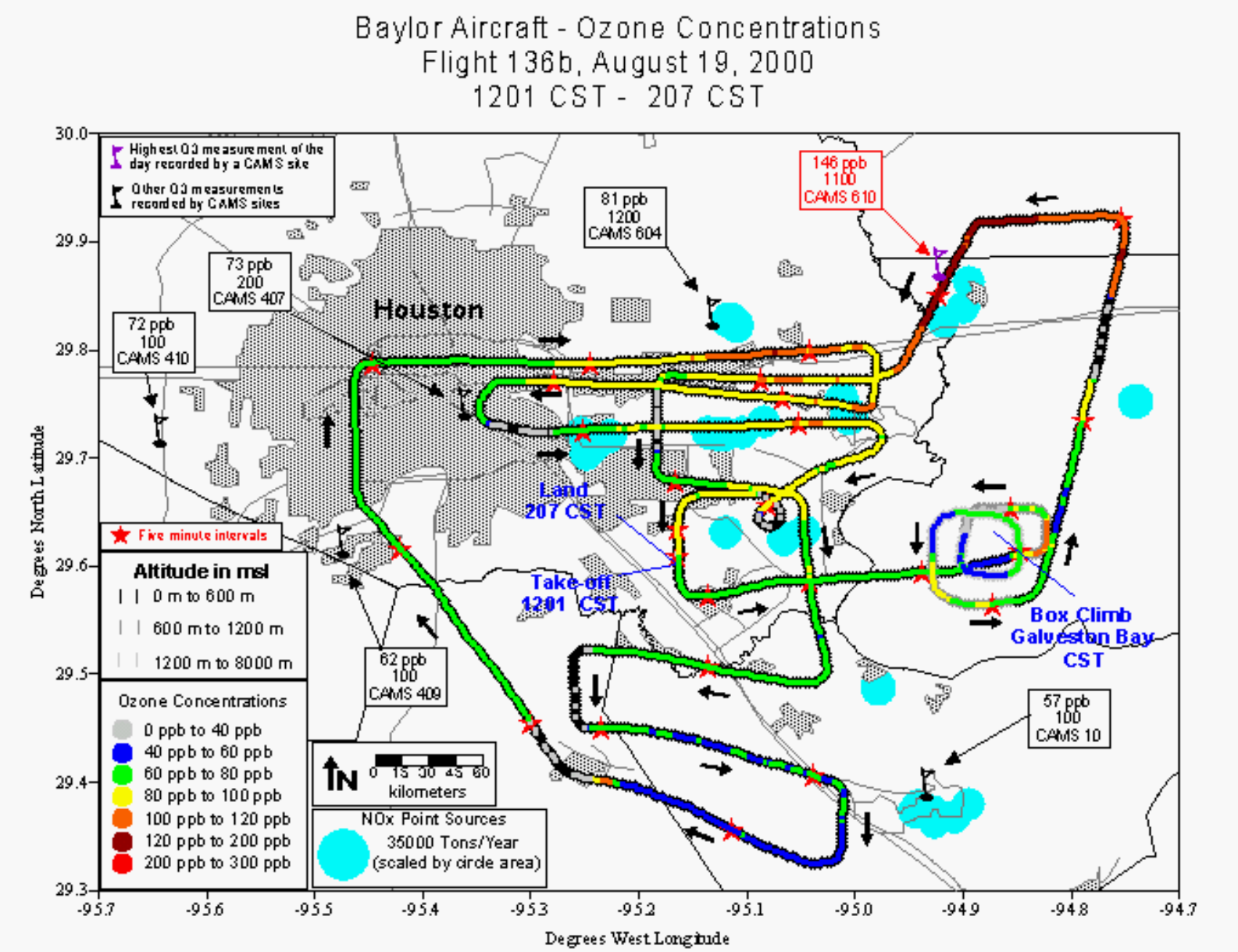
Significant observations: The elevated levels of pollution occurred near the steel mill in Anthony.

Canister or filter samples location: 47mm filter sample was taken

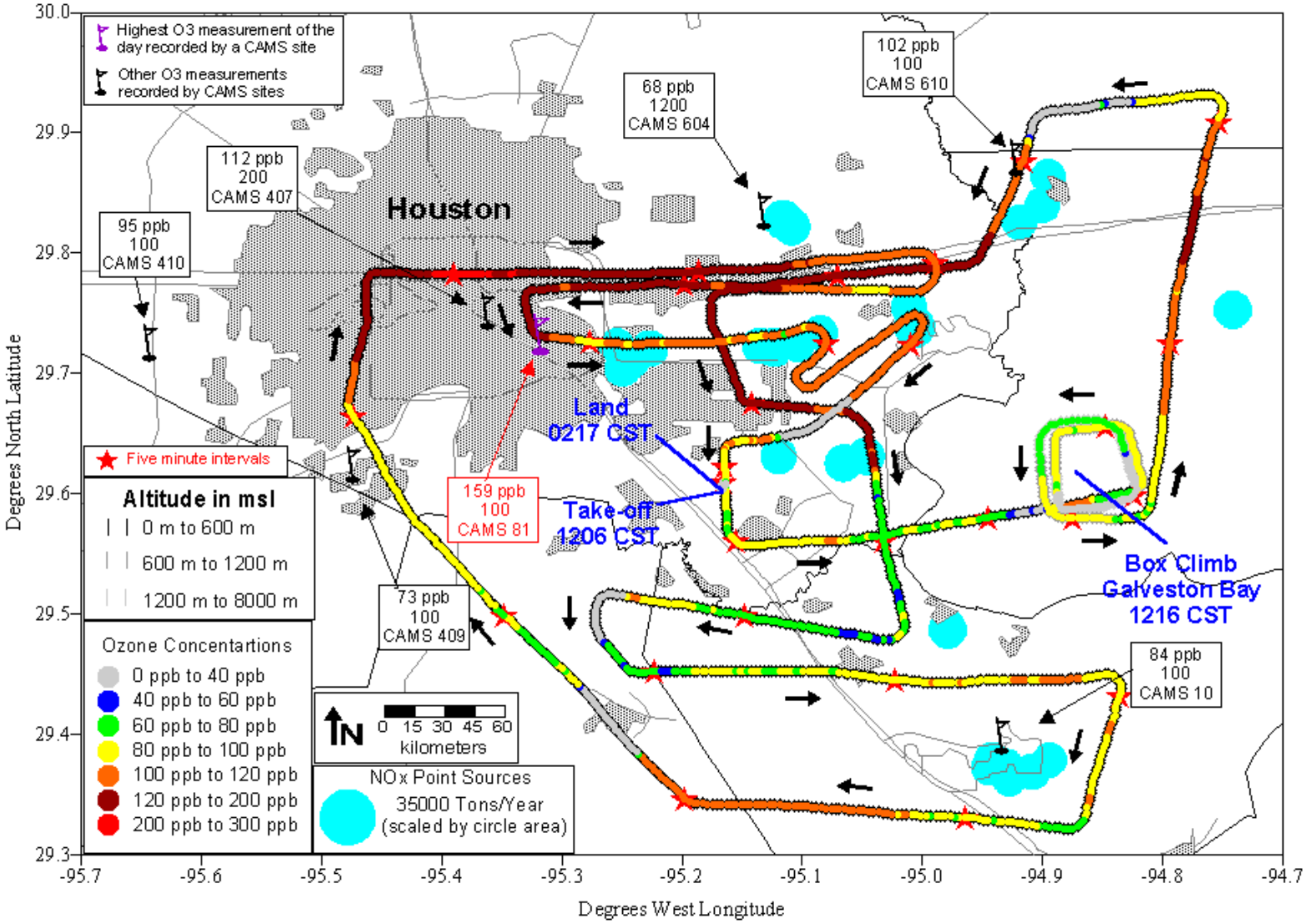
2000 Project Summary

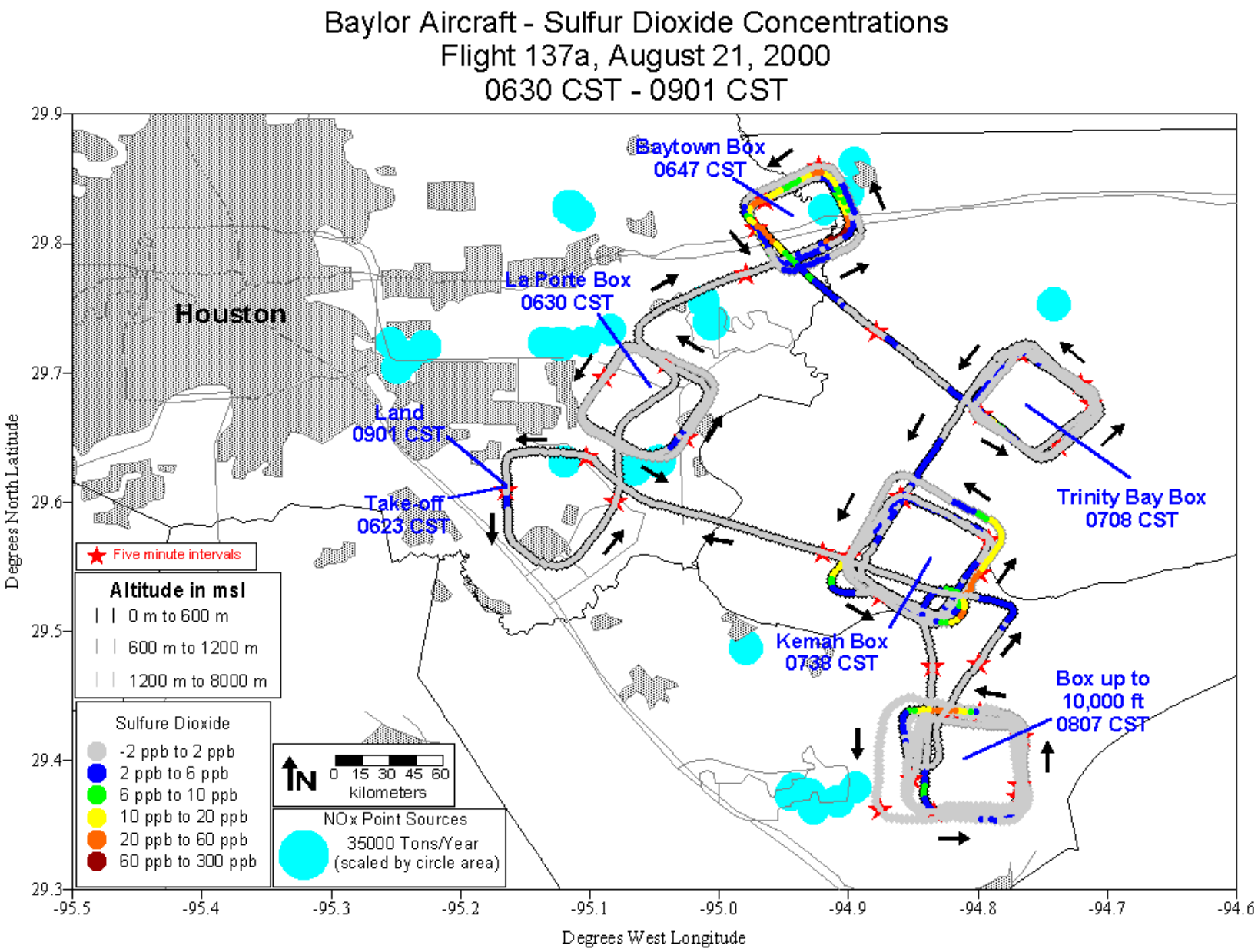
Appendix B

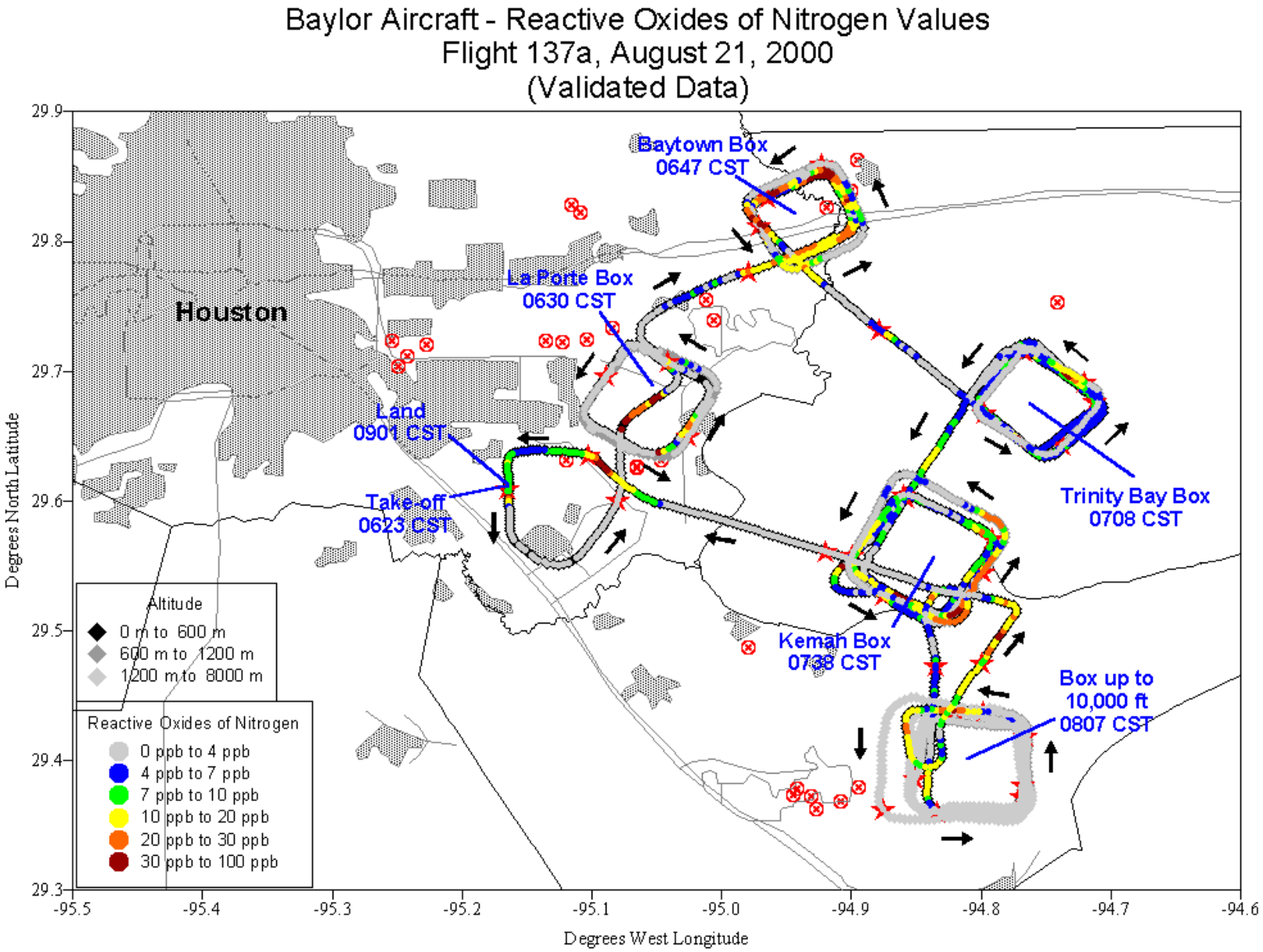
Track plots and Time Series Plots for Selected Flights

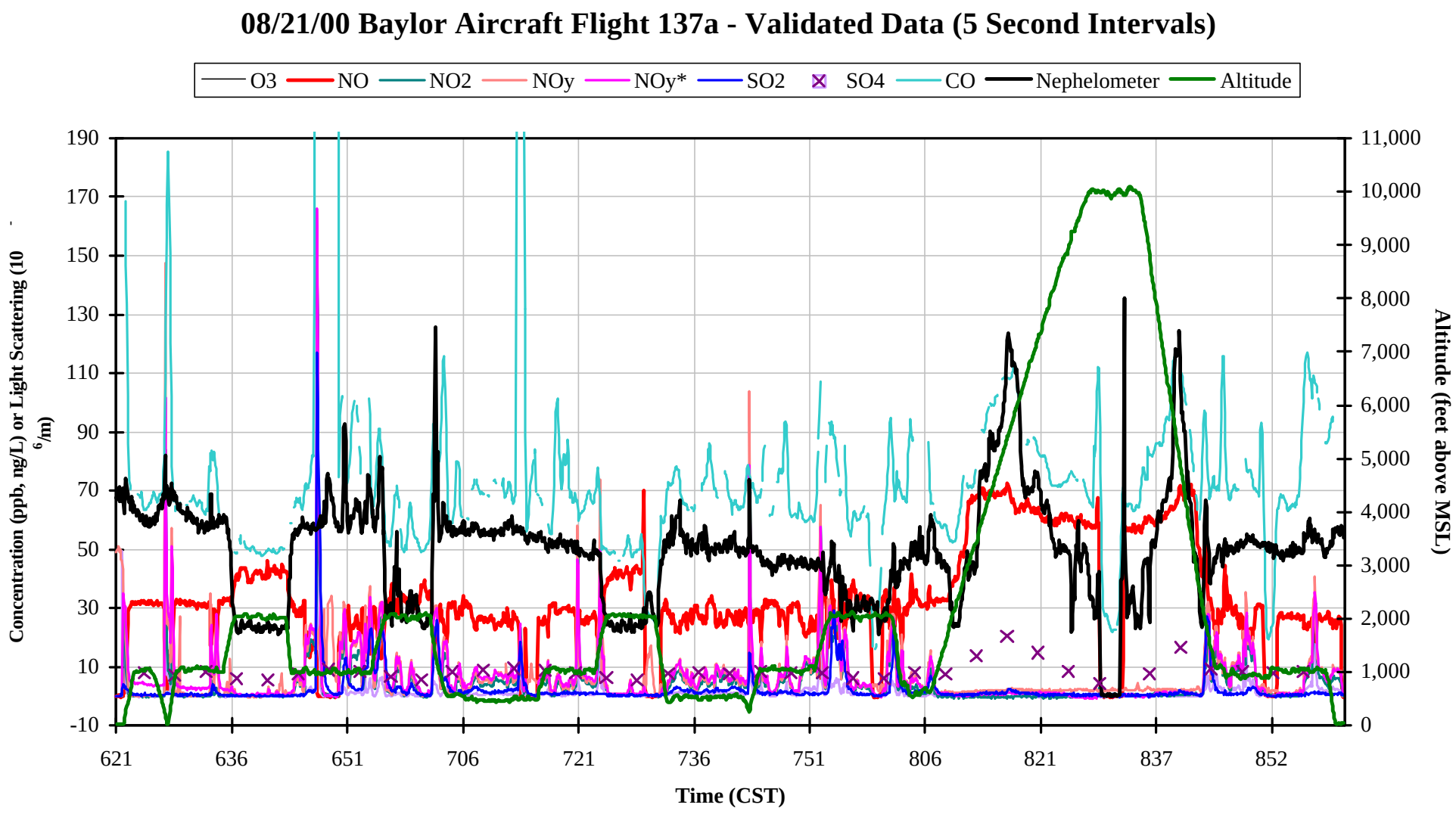

Baylor Aircraft - Ozone Concentrations
Flight 136b, August 19, 2000
1201 CST - 207 CST
Highest O3 measurement of the day recorded by a CAMS site
Other O3 measurements recorded by CAMS sites
146 ppb
1100
CAMS 610
81 ppb
1200
CAMS 604
73 ppb
200
CAMS 407
72 ppb
100
CAMS 410
Houston
Land
207 CST
Take-off
1201 CST
Box Climb
Galveston Bay
CST
62 ppb
100
CAMS 409
57 ppb
100
CAMS 10
Five minute intervals
Altitude in msl
0 m to 600 m
600 m to 1200 m
1200 m to 8000 m
Ozone Concentrations
0 ppb to 40 ppb
40 ppb to 60 ppb
60 ppb to 80 ppb
80 ppb to 100 ppb
100 ppb to 120 ppb
120 ppb to 200 ppb
200 ppb to 300 ppb
N
0 15 30 45 60
kilometers
NOx Point Sources
35000 Tons/Year
(scaled by circle area)
Degrees North Latitude
Degrees West Longitude
30.0
29.9
29.8
29.7
29.6
29.5
29.4
29.3
-95.7
-95.6
-95.5
-95.4
-95.3
-95.2
-95.1
-95.0
-94.9
-94.8
-94.7

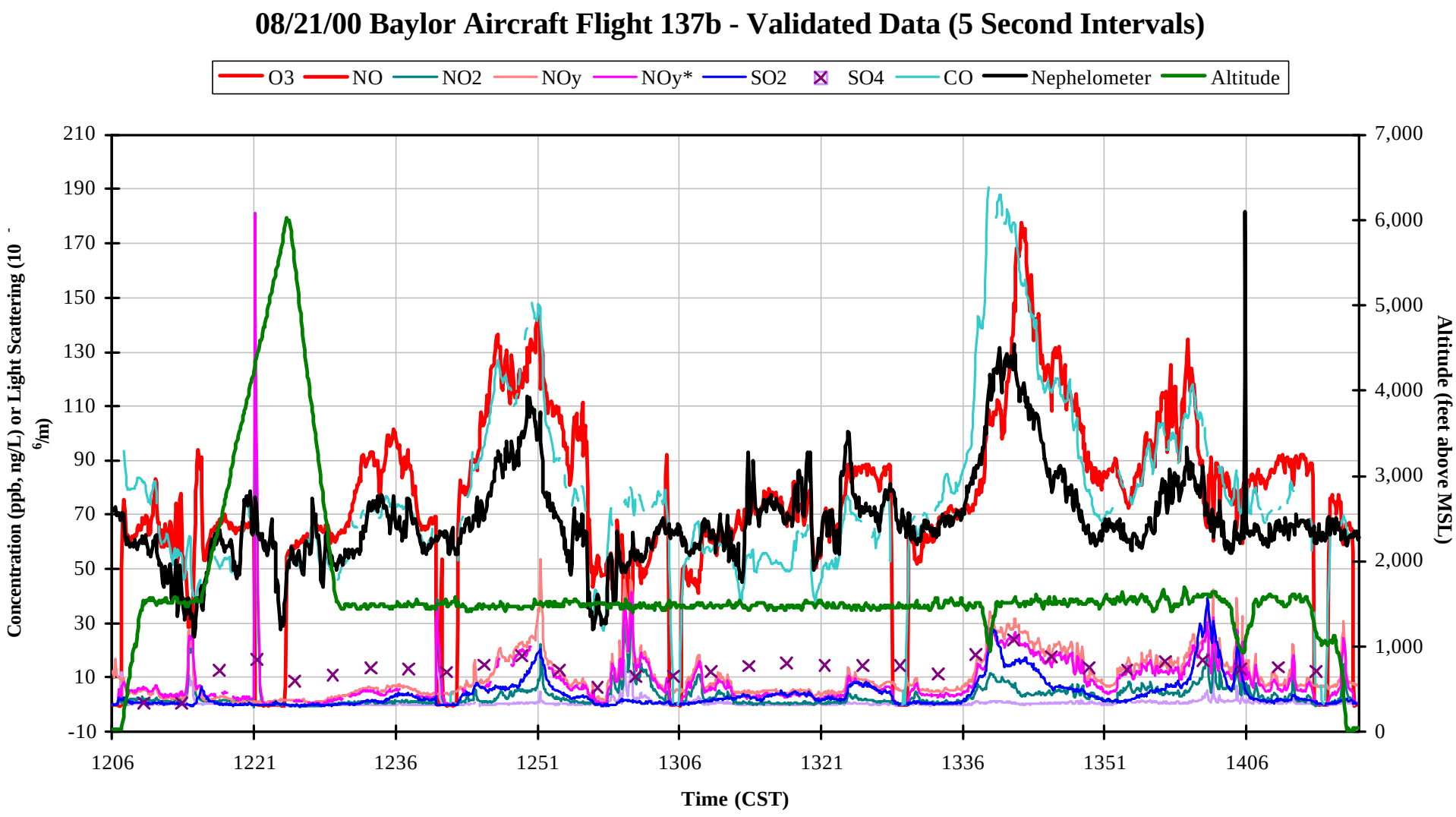
Baylor Aircraft - Ozone Concentrations
Flight 137b, August 21, 2000
1206 CST - 0217 CST




Baylor Aircraft - Sulfur Dioxide Concentrations
Flight 137a, August 21, 2000
0630 CST - 0901 CST
Houston
Baytown Box
0647 CST
La Porte Box
0630 CST
Land
0901 CST
Take off
0623 CST
Trinity Bay Box
0708 CST
Kemah Box
0738 CST
Box up to
10,000 ft
0807 CST
Five minute intervals
Altitude in msl
0 m to 600 m
600 m to 1200 m
1200 m to 8000 m
Sulfure Dioxide
-2 ppb to 2 ppb
2 ppb to 6 ppb
6 ppb to 10 ppb
10 ppb to 20 ppb
20 ppb to 60 ppb
60 ppb to 300 ppb
N
0 15 30 45 60
kilometers
NOx Point Sources
35000 Tons/Year
(scaled by circle area)
Degrees North Latitude
Degrees West Longitude
29.9
29.8
29.7
29.6
29.5
29.4
29.3
-95.5
-95.4
-95.3
-95.2
-95.1
-95.0
-94.9
-94.8
-94.7
-94.6


Baylor Aircraft - Reactive Oxides of Nitrogen Values
Flight 137a, August 21, 2000
(Validated Data)
Houston
Baytown Box
0647 CST
La Porte Box
0630 CST
Land
0901 CST
Take-off
0623 CST
Trinity Bay Box
0708 CST
Kemah Box
0738 CST
Box up to
10,000 ft
0807 CST
Altitude
0 m to 600 m
600 m to 1200 m
1200 m to 8000 m
Reactive Oxides of Nitrogen
0 ppb to 4 ppb
4 ppb to 7 ppb
7 ppb to 10 ppb
10 ppb to 20 ppb
20 ppb to 30 ppb
30 ppb to 100 ppb
Degrees North Latitude
Degrees West Longitude
29.9
29.8
29.7
29.6
29.5
29.4
29.3
-95.5
-95.4
-95.3
-95.2
-95.1
-95.0
-94.9
-94.8
-94.7
-94.6


08/21/00 Baylor Aircraft Flight 137a - Validated Data (5 Second Intervals)
O3
NO
NO2
NOy
NOy*
SO2
SO4
CO
Nephelometer
Altitude
Concentration (ppb, ng/L) or Light Scattering (10 -6/m)
Altitude (feet above MSL)
Time (CST)
190
170
150
130
110
90
70
50
30
10
-10
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
621
636
651
706
721
736
751
806
821
837
852


08/21/00 Baylor Aircraft Flight 137b - Validated Data (5 Second Intervals)
O3
NO
NO2
NOy
NOy*
SO2
SO4
CO
Nephelometer
Altitude
Concentration (ppb, ng/L) or Light Scattering (10 - 6/m)
Altitude (feet above MSL)
Time (CST)
210
190
170
150
130
110
90
70
50
30
10
-10
7,000
6,000
5,000
4,000
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